

Western Australian Marine Stewardship Council Report Series

Western Australian Abalone Managed Fishery

Addendum 1

November 2018

Strain, L., Hart, A. and Walters, S.

Table of Contents

1. Background.....	3
1.1 Stock Status	3
2. Unit of Certification – Roe’s abalone	4
2.1 Area 2 Fishery	4
2.2 Area 5 Fishery	6
2.3 Area 6 Fishery	8
2.4 Area 7 Fishery	10
3. Unit of Certification – Greenlip abalone	14
3.1 Area 2 Fishery	14
3.2 Area 3 Fishery	17
3.3 Condition 1 – Stock Status 1.1.1	22
4. Unit of Certification – Brownlip abalone	23
4.1 Area 2 Fishery	23
4.2 Area 3 Fishery	25
4.3 Condition 2 – Stock Status 1.1.1	26
4.4 Condition 3 – Harvest Strategy 1.2.1	26
5. References.....	27

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 first addendum to Hart et al. (2017) and provides catch and effort information for the 2016 and 2017 fishing seasons 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 1st MSC Surveillance Audit carried out in October 2018.

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 2107). 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-independent and fishery-dependent 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 2016 and 2017 seasons (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 2 to 4 seasons as a result of cooler seawater temperatures. The effect of the marine heatwave ranged from the catastrophic mortality event in Area 8 and the closure of this fishery, 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 (annual summer SST) to predict the density of harvest size animals (71+ mm) and subsequently set the Total Allowable Catch (TAC). 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 have been below the TACC in Area 2, 5 and 6 for both the 2016 and 2017 season (Table 2.1). The commercial Industry has attributed the reduced catch 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 (above the point at which fishing may cause recruitment impairment).

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 2016 and 2017 season in each Management Area.

	2016			2017		
	TACC (kg)	Catch (kg)	% Catch	TACC (kg)	Catch (kg)	% Catch
Area 2	18,000	16225.0	90	18,000	13142.8	73
Area 5	20,000	7451.4	37	20,000	6933.3	35
Area 6	12,000	1484.5	12	12,000	4458.5	37
Area 7	32,000	23521.4	74	24,000	23680.6	99
Area 8	0	0		0	0	

Note, a voluntary Industry in season quota of 24,000 kg was applied to Area 7 in 2016.

2.1 Area 2 Fishery

In Area 2 the catch of Roe’s abalone was 13.1 t (whole weight) in 2017, which was 73% of the TACC (Table 2.2). Over the last 4 seasons between 61% and 90% of the annual TACC has been caught, while 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 at a lower level than the previous 8 seasons but higher than those in the early 2000's (Table 2.2). Catch rates for dedicated Roe's abalone divers in 2017 were similar to the historical average (1989-2017) (Figure 2.1). The annual SCPUE exhibited a sharp decline after 2012 and reached a historical low in 2015 (Figure 2.2). In the last 2 seasons it has increased to pre-2012 levels following lower catches over the last 4 seasons. 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 TAC (kg), catch (kg, whole weight), fishing effort (diver days) and catch rate (kg/day) for all operators.

Quota period	Roe's TAC kg	Roe's Total catch kg whole wt	Roe's Total Diver days	Roe's catch rate kg/diver 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	19,477	123	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	16,225	113	144
2017	18,000	13,143	108	122

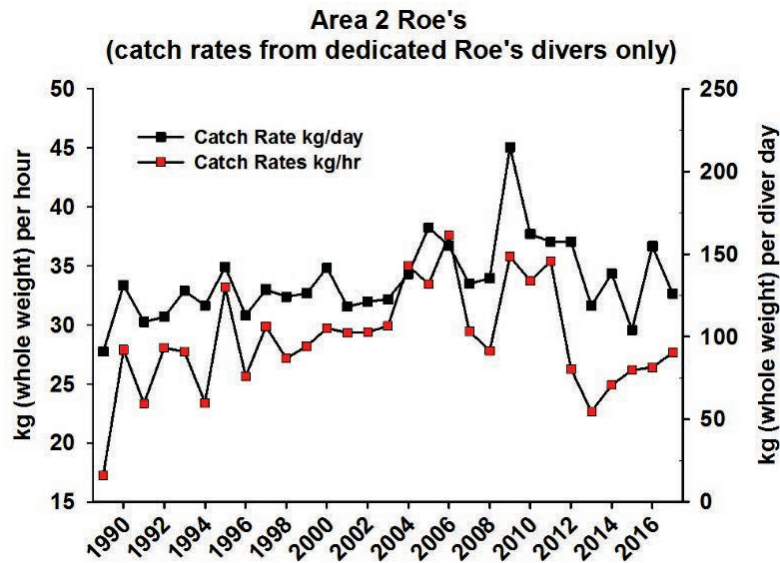


Figure 2.1: Area 2 Roe's abalone catch rates (kg/hr and kg/day) for dedicated Roe's abalone divers only.

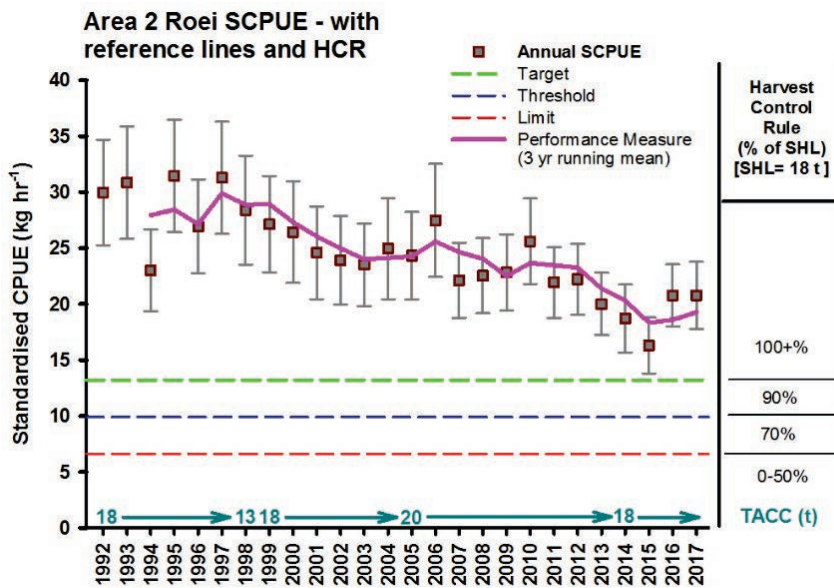


Figure 2.2: The annual standardised CPUE (kg.hr⁻¹) for Roe's abalone with the performance indicator (3 year running mean), reference levels (target, threshold and limit) and harvest control rule in Management Area 2.

2.2 Area 5 Fishery

In Area 5 the catch was 6.9 t (whole weight) in 2017, which was 35% of the TACC (Table 2.3). Over the last 4 seasons less than 40% of the annual TACC has been caught, and the full allocation has not been caught since the early 2000's. The catch rate for all divers has fluctuated under 100 kg/day over the last 5 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 2009 the catch rate declined until 2015 and

in 2017 it was slightly lower than the historical average (1989-2017) (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 4 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 TAC (kg), catch (kg, whole weight), fishing effort (diver days) and catch rate (kg/day) for all operators.

Quota period	Roe’s TAC kg	Roe’s Total catch kg whole wt	Total Diver days Roe’s	Roe’s catch rate kg/diver day
2000	20,000	19,939	176	113
2001	20,000	18,718	191	98
2002	20,000	19,775	191	104
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	7,451	79	94
2017	20,000	6,933	77	90

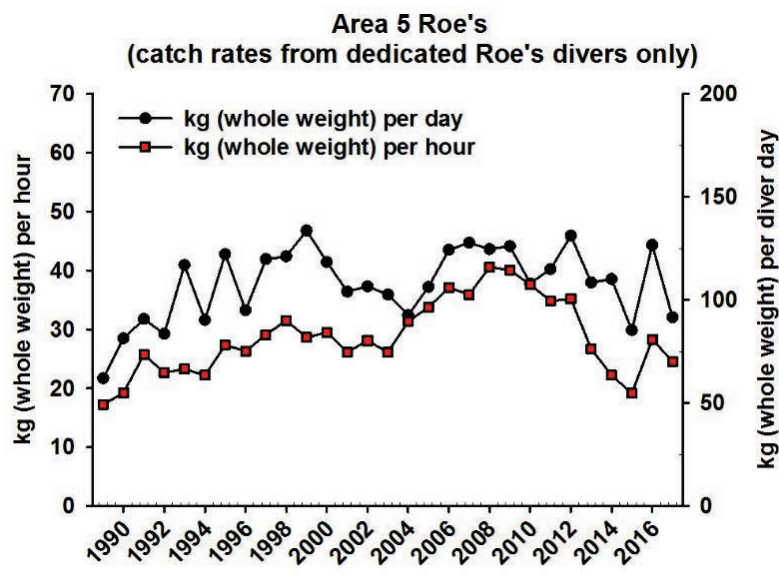


Figure 2.3: Area 5 Roe’s abalone catch rates (kg/hr and kg/day) for dedicated Roe’s abalone divers only.

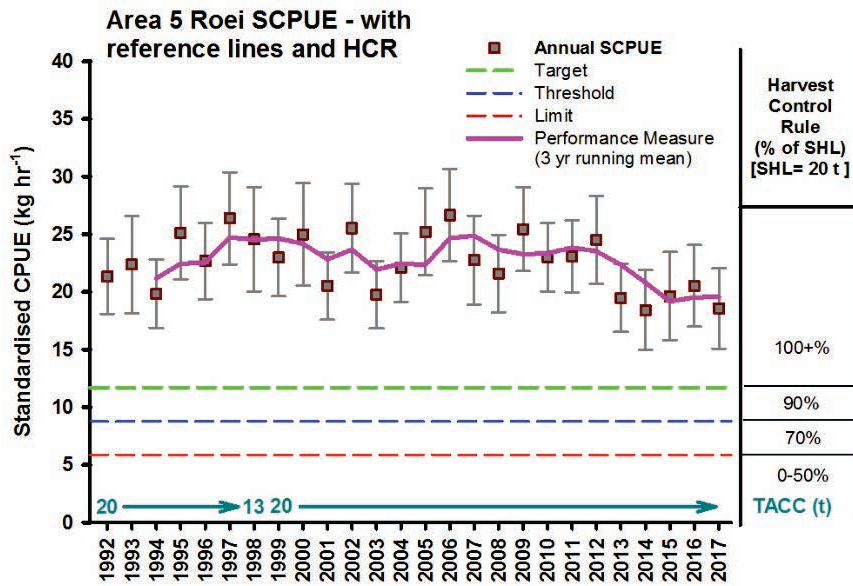


Figure 2.4: The annual standardised CPUE ($\text{kg}\cdot\text{hr}^{-1}$) for Roe’s abalone with the performance indicator (3 year running mean), reference levels (target, threshold and limit) and harvest control rule in Management Area 5.

2.3 Area 6 Fishery

In Area 6 the Roe’s abalone catch was 4.5 t (whole weight) in 2017, which was 37% of the TACC (Table 2.4). The TACC has been constant since 1999 (12 t whole weight) and prior to 2011, 90% or greater of the TACC was caught annually. Since 2011 the catch has declined to less than 5 t annually and remained at this level for the last 4 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 2002 and 2011, before declining sharply over the next 2 seasons. After this period, the catch rate increased rapidly and has now been at historically high levels for the last 3 seasons (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 has resulted from the decline in catch since 2011 and the very low levels of catch between 2014 to 2017. 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 TAC (kg), catch (kg, whole weight), fishing effort (diver days) and catch rate (kg/day) for all operators.

Quota period	Roe's TAC kg	Roe's Total catch kg whole wt	Total Diver days Roe's	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	2,604	13	200
2016	12,000	1,485	7	212
2017	12,000	4,459	41	109

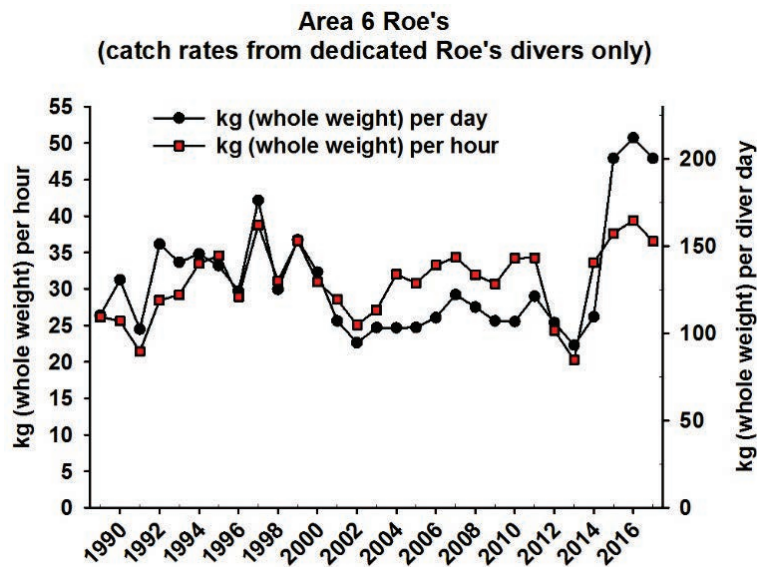


Figure 2.5: Area 6 Roe's abalone catch rates (kg/hr and kg/day) for dedicated Roe's abalone divers only.

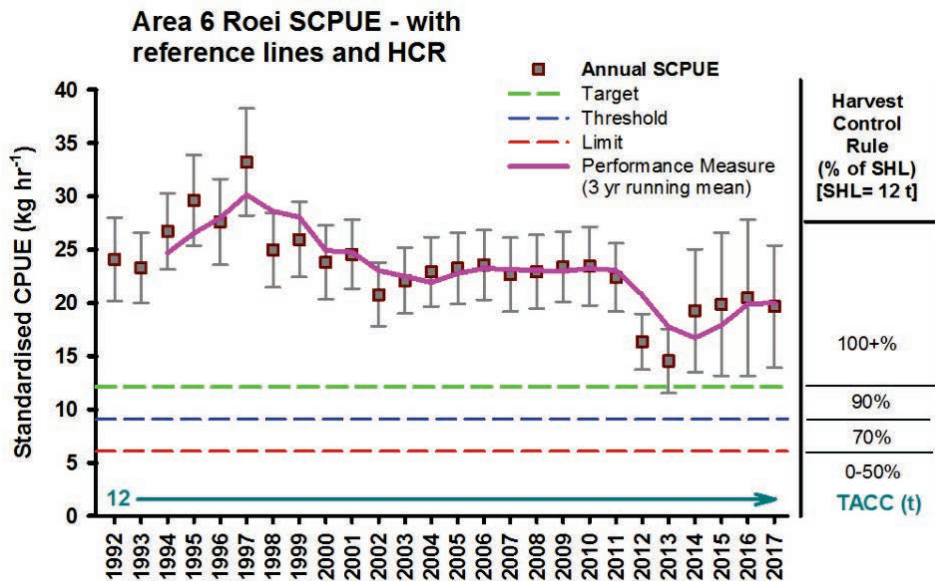


Figure 2.6: The annual standardised CPUE ($\text{kg}\cdot\text{hr}^{-1}$) for Roe's abalone with the performance indicator (3 year running mean), reference levels (target, threshold and limit) and harvest control rule in Management Area 6.

2.4 Area 7 Fishery

The commercial catch in Area 7 was 23.7 t (whole weight) in 2017, which was 99% of the TACC (Table 2.5). Apart from 2012 and 2016 (Industry decision), greater than 98% 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 increased over the last 2 seasons and was just below the historical average (Table 2.5 and Figure 2.7). However, this was well below some of the peak catch rates recorded between 2000 and 2013. The catch rate per hour has increased over the last 4 seasons and in the 2017 was at the historical average (Figure 2.7). The annual SCPUE steadily declined between 2005 and 2014, but has since increased in each of the last three 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, main stock indicator) 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 three years from the record-low levels during 2012-2015, while the density on the subtidal habitat is at the highest level since 2011 (Figure 2.9a). Importantly, this increase in density is present in both unfished and fished stocks, suggesting that favourable environmental

conditions for growth have returned (Figure 2.9b). Age 1+ (17 – 32 mm) animals have also shown an increase in density over the last three 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). Note, that while all stock indicators have increased again in 2018, they are still below pre-heatwave levels. These results indicate the range of effects the 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).

The stock prediction model indicates a decline in harvest sized animals (71+ mm) in 2019 due to the record low Age 1+ density in 2015 (Figure 2.10b). Recovery is expected to occur after 2019 as Age 1+ recruitment is increasing (Figure 2.10a) but this will also be affected by the summer SST over the coming years. It is worth noting that the density of harvest-sized animals has increased significantly between 2016 and 2018, even though the density of Age 1+ animals decreased in the corresponding lagged years (2012-2014) (Figure 2.10b). Therefore, this increase was contrary to expectations and indicates a greater level of resilience in response to very good environmental conditions (low summer SST) during this time.

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

Quota period	Roe’s TAC kg (whole weight)	Roe’s Total catch kg whole wt	Total Diver days Roe’s	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	23,521	189	124
2017	24,000	23,681	174	136

* Voluntary reduction from 32,000kg

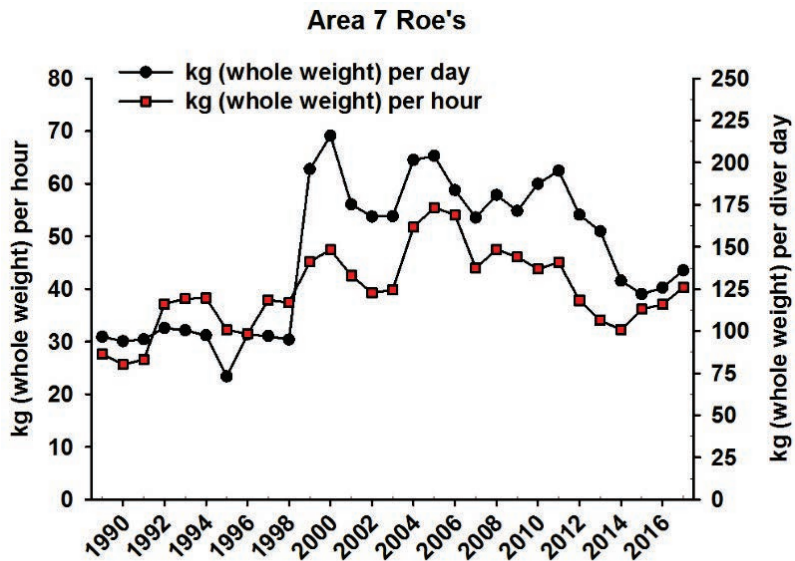


Figure 2.7: Area 7 Roe's abalone catch rates (kg/hr and kg/day) for all operators.

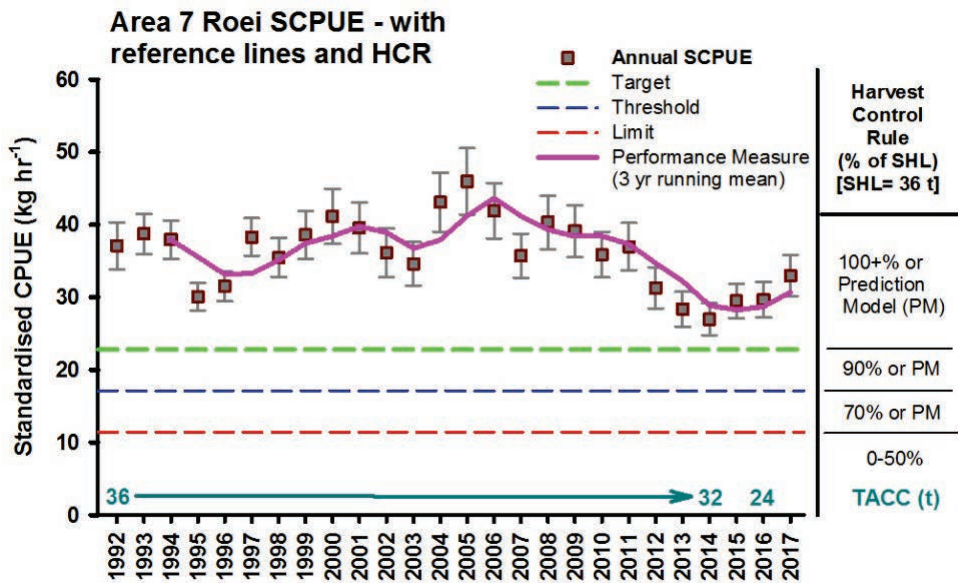


Figure 2.8: The annual standardised CPUE (kg.hr⁻¹) for Roe's abalone with the performance indicator (3 year running mean), reference levels (target, threshold and limit) and harvest control rule in Management Area 7.

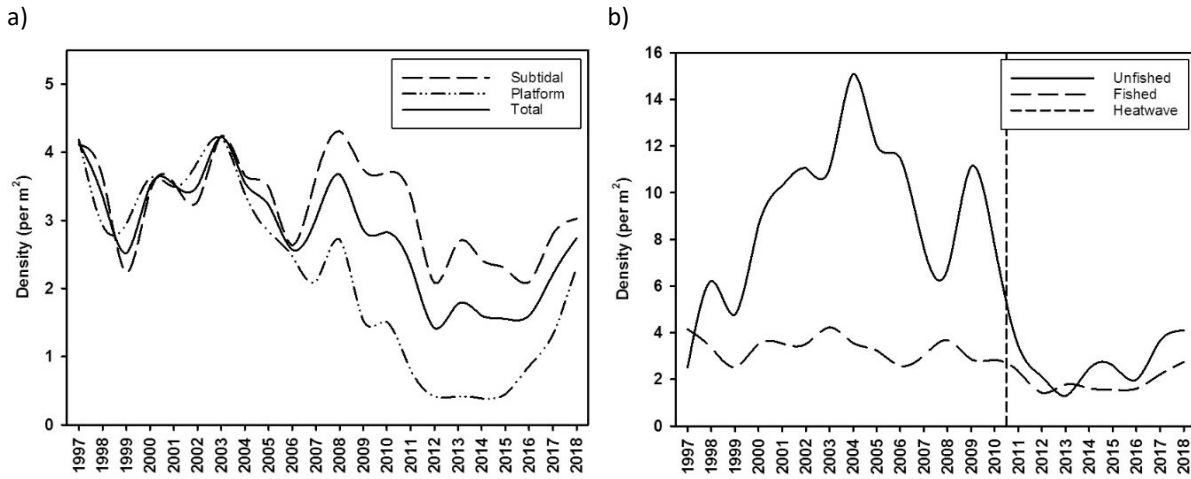


Figure 2.9: (a) Density of harvest size (71+ mm) Roe's abalone in fished areas on the platform and subtidal habitats, (b) Density of harvest size (71+ mm) Roe's abalone in fished and unfished areas. The occurrence of the marine heatwave (dashed vertical line) is also shown.

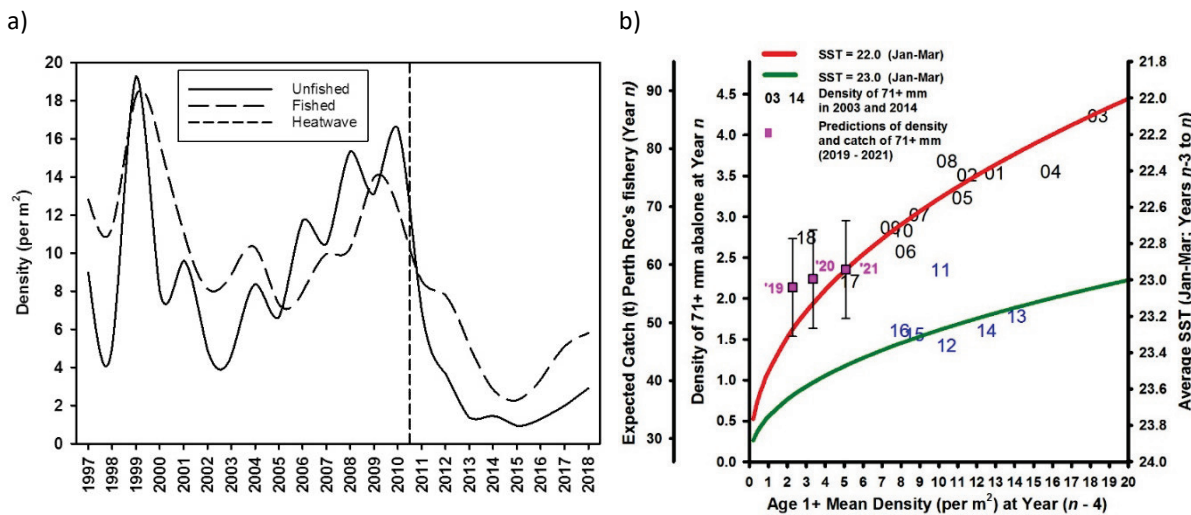


Figure 2.10: (a) Density of Age 1+ (17 – 32 mm) Roe's abalone in the Perth stock in fished and unfished areas, (b) Density and stock prediction model (y axis = density and expected catch of 71+mm abalone in year n, x axis = density of Age 1+ (17 – 32 mm) at year n – 4, e.g. 15 = density of Age 1+ in 2011) with mean summer SST during the 4 year period (years n - 3 to n).

3. Unit of Certification – Greenlip abalone

The annual SCPUE has declined to record low levels in both Area 2 and Area 3 in 2017 (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 5 to 7 seasons. Reductions in TACC's in response to the declining PI occurred in 2015 and 2016 in Area 2 and between 2014 and 2017 in Area 3. Both management areas are aligned with the harvest control rule in 2017 (Area 2 at 60% and Area 3 at 70% of long-term sustainable harvest level, Table 3.1). In 2017 Industry imposed a voluntary in-season quota reduction to 12 t in Area 2 and 16 t in Area 3. Overall, the Greenlip abalone stock status in WA is considered sustainable (above the point at which fishing may cause recruitment impairment).

As part of the quota setting process for the 2018 season, Industry requested the voluntary quota of 12 t from 2017 be reduced to 9 t and set as the TACC for 2018 in Area 2, which was supported by the Department. In Area 3, given the annual SCPUE has gone below the limit and the PI is close to the limit reference level, a precautionary approach was taken by the Department and Industry when setting the 2018 TACC. Consequently, the TACC in Area 3 was reduced to 23% of the long-term sustainable harvest level for 2018 (8 t meat weight).

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 2016 and 2017 season in each Management Area.

	2016			2017		
	TACC (kg)	Catch (kg)	% Catch	TACC (kg)	Catch (kg)	% Catch
Area 2	18,000	17601.9	98	18,000	11999.1	67
Area 3	25,600	19153.0	75	24,500	16407.7	67

Note, a voluntary Industry in season quota of 12,000 kg was applied to Area 2 in 2017.

3.1 Area 2 Fishery

In Area 2 the catch of Greenlip abalone was 12 t (meat weight) in 2017, which was 67% of the TACC (Table 3.2). Between 2014 and 2016 the annual catches have declined by 10.9 t due to reductions in TACC, while in 2017 a voluntary Industry catch limit of 12 t was imposed. Before the 2014 season this fishery had a relatively constant TACC and catches of between 28 and 31 t. Catch rates for Area 2 remained relatively stable until 2013 where they declined to record low levels in 2017 (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 7 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) (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 2017. The PI has now been below the threshold for the last 3 seasons but is still above the limit reference level. There has been no response from the SCPUE given the reductions in catch over last 4 seasons to 40% of the long-term sustainable harvest level.

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

Quota period	Greenlip TAC kg	Total Greenlip catch kg meat wt	MAIN STOCK				STUNTED STOCK		
			Greenlip catch kg meat wt	Greenlip average meat weight (g)	Greenlip only catch rate kg/hr	Greenlip only catch rate kg/diver day	Greenlip catch kg meat wt	Greenlip average meat weight (g)	Greenlip only catch rate kg/hr
2000	30,000	30,889	30,889	178	16	54	0	0	0
2001	30,000	30,095	25,232	180	15	59	4863	121	24
2002	30,000	24,321	19,753	199	14	47	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	58	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	53	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	52	2116	104	12
2009	28,000	27,999	25,529	181	14	52	2470	119	12
2010	28,000	27,409	26,416	178	16	55	993	126	19
2011	28,800	28,732	26,957	172	14	57	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	48	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	17,602	16,118	173	10	36	1,484	107	12
2017	18,000	11,999	11,999	166	9	34	0	0	0

Area 2 Greenlip Statistics (sub-areas)

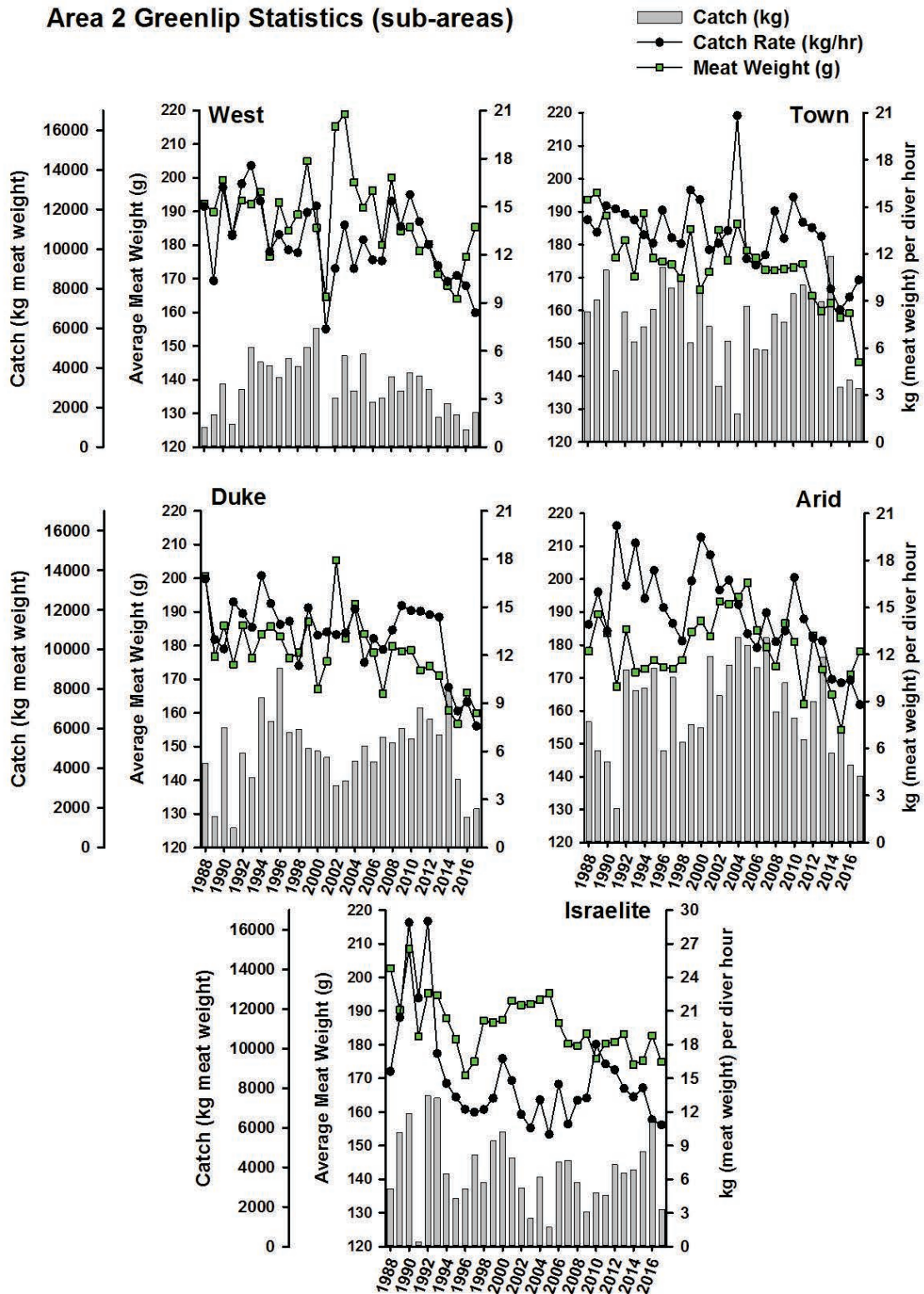


Figure 3.1: Greenlip abalone catch (kg, meat weight), catch rate (kg/hr) and individual meat weight (g) for the five sub-areas, West, Town, Duke, Arid and Israelite in Area 2.

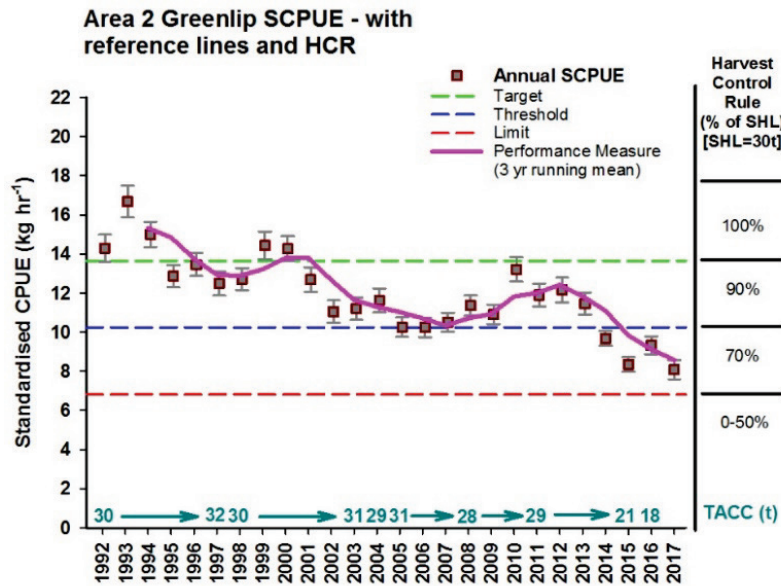


Figure 3.2: The annual standardised CPUE (kg.hr⁻¹) for Greenlip abalone with the performance indicator (3 year running mean), reference levels (target, threshold and limit) and harvest control rule in Management Area 2.

3.2 Area 3 Fishery

The Area 3 Greenlip abalone 2017 stock assessment is presented in the weight of evidence table below. Key points are that in 2017 the annual SCPUE was below the limit, while the PI was close to the limit reference level. 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 2018 quota reduction to 23% of the long-term sustainable harvest (8 t) was predicated on the Harvest Control Rule, 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 recruit density are all at historical lows and the preliminary stock prediction of legal size animals at historical lows for the next 4 years. For the Augusta sub-area, the catch will be voluntarily capped at half (4 t) of the Area 3 TACC in 2018.

Category	Lines of evidence
Catch	The catch was 16.4 t (meat weight) in 2017, which was 67% of the TACC (Table 3.3). Over the last 4 seasons catches have declined due to TACC reductions (10.5 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 the last decade (234 g in 2007 to 186 g in 2017, 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).
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 2000/01 (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 4 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 7 seasons it has steadily declined to a point where in 2017 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 4 seasons.
Performance Indicator (PI)	The PI has continually declined since 2010 and in 2017 it was close to the limit reference level (Figure 3.4). Accounting for uncertainty around the PI estimate there is a greater than 80% probability that the PI is above the limit reference level.
Augusta sub-area SCPUE	The Augusta sub-area annual SCPUE is currently (6 – 7 kg/hr) about a third 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 is not currently managed separately from Area 3 and this is the first season it has been presented to Industry separately as a standardised catch rate. However, the Augusta sub-area accounts for 54% of the catch from Area 3 since 2000, therefore the declining catch rate in the Augusta sub-area substantially contributes to the Area 3 catch rate trends.
Fishery-Independent Surveys (FIS)	FIS in the Augusta sub-area indicate total density of Greenlip abalone at the lowest level since the surveys inception in 2004, with a declining trend since 2014 (Figure 3.6a). The densities of juvenile animals (40 – 80 mm shell length) over the last 4 years are also at record low levels (Figure 3.6b). Note that the cooler water temperatures of the past two 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 3.6c) from the densities of juvenile animals with a 4 year lag. This index indicates that for the next 4 years the densities of legal sized animals may be at the lowest levels recorded (Figure 3.6d).

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

Quota period	Greenlip TAC kg	Total Greenlip catch kg meat wt	MAIN STOCK			STUNTED STOCK		
			Greenlip catch kg meat wt	Greenlip average meat weight (g)	Greenlip only catch rate kg/hr	Greenlip catch kg meat wt	Greenlip average meat weight (g)	Greenlip only 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	36,486	31,725	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	33,831	33,831	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	19,153	19,153	181	10.1	0	0	0
2017	24,500	16,408	16,408	186	8.8	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)

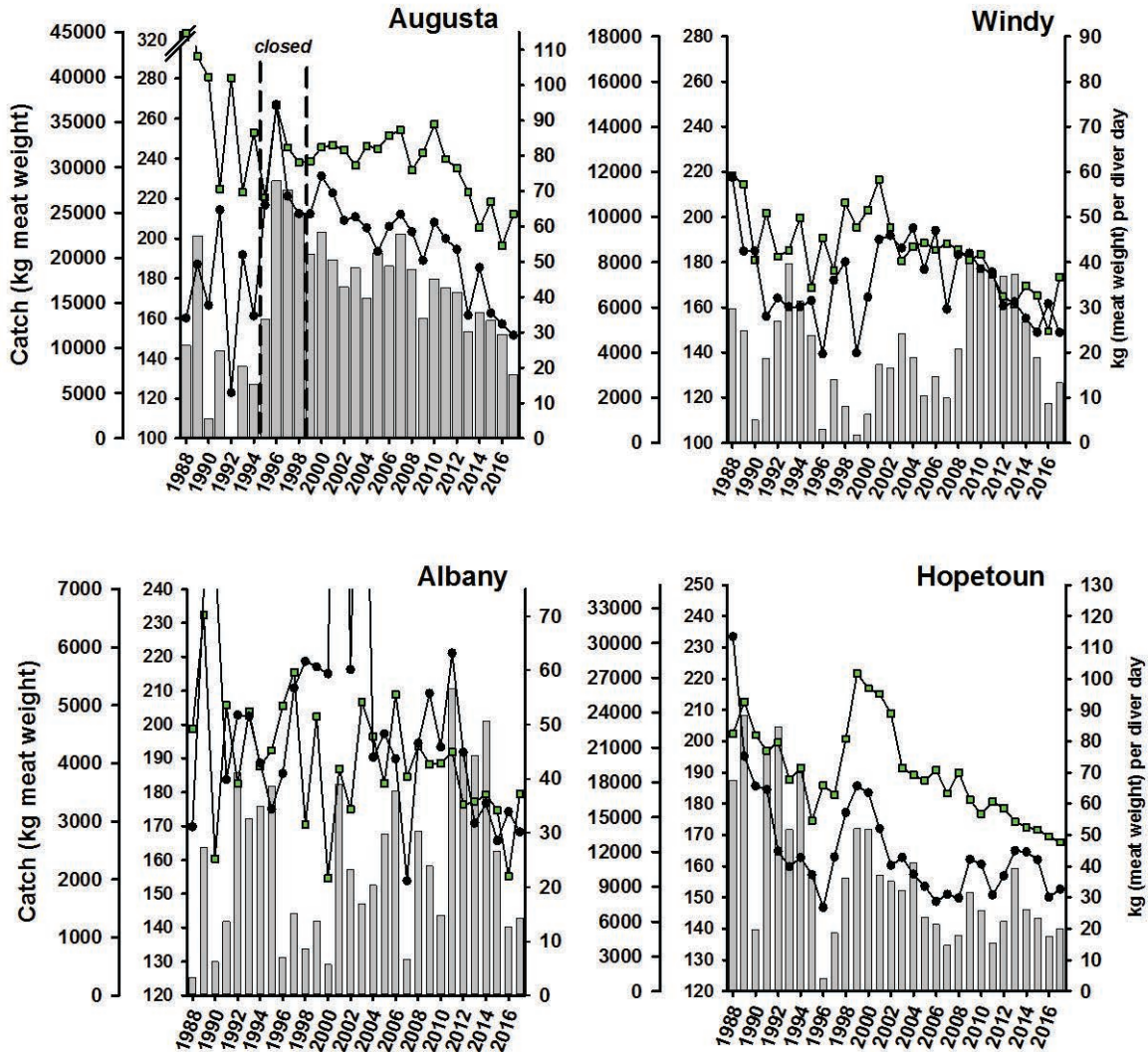


Figure 3.3: Greenlip abalone catch (kg, meat weight), catch rate (kg/hr) and individual meat weight (g) for the four sub-areas, Augusta, Windy Harbour, Albany and Hopetoun in Area 3.

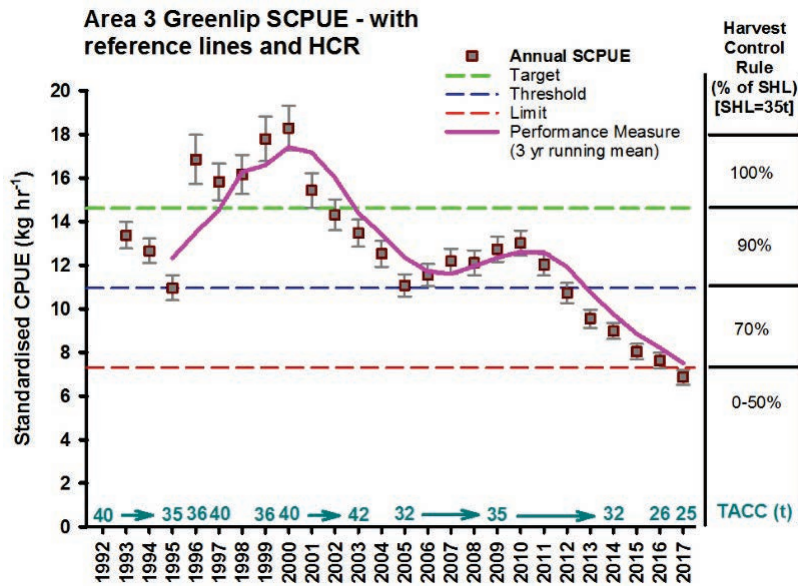


Figure 3.4: The annual standardised CPUE ($\text{kg}\cdot\text{hr}^{-1}$) for Greenlip abalone with the performance indicator (3 year running mean), reference levels (target, threshold and limit) and harvest control rule in Management Area 3.

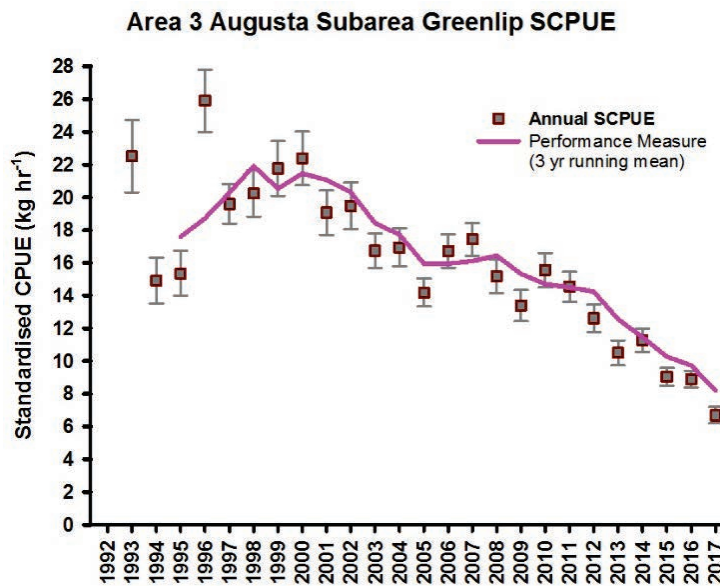


Figure 3.5: The annual standardised CPUE ($\text{kg}\cdot\text{hr}^{-1}$) for Greenlip abalone in the Augusta sub-area only of Area 3 with the proposed performance indicator (3 year running mean).

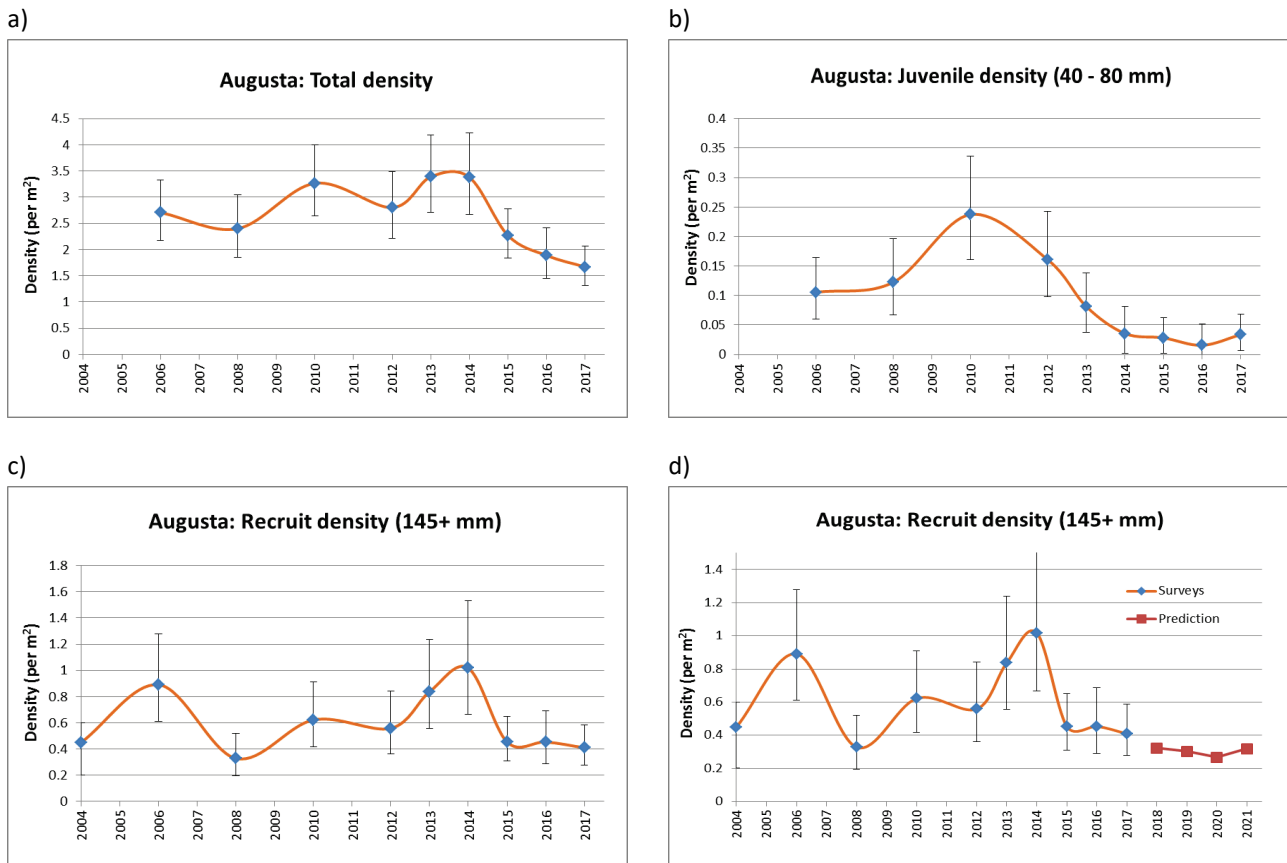


Figure 3.6: Trends in density (abalone per m²) of different size classes (a-c) of Greenlip abalone in the Augusta sub-area of Area 3, based on data collected in fishery-independent surveys. Preliminary stock prediction (d) of legal size animals (145+ mm) based on the juvenile cohort (40-80 mm) in the Augusta sub-area.

3.3 Condition 1 – Stock Status 1.1.1

1st 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 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. Management action has been implemented in Area 2 and Area 3 to bring the TACC's in line with the harvest control rule. The reductions in catch quota under the revised Harvest Strategy have reduced fishing mortality. The effect of these will be monitored annually to determine if the reductions are sufficient to prevent the stock from reaching a point at which fishing may cause recruitment impairment.

In the Harvest Strategy there is no specified level of uncertainty surrounding the PI. Accounting for uncertainty around the PI estimate through bootstrapping, there is a greater than 80% probability that the PI is above the limit reference level in Area 3.

4. Unit of Certification – Brownlip abalone

Catches of Brownlip abalone have been close to the TACC in Area 2 (>95%) and below the TACC in Area 3 (78-85%) for both the 2016 and 2017 season (Table 4.1). The commercial Industry has indicated the reduced catch in Area 3 over the last 2 seasons was due to licencing issues. The annual SCPUE has exhibited a decline post 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 2016 and 2017 seasons and are in line with the harvest control rule (Table 4.1). The main stock indicator (annual SCPUE) has shown a response to the TACC reductions in 2012 and 2015 with the PI below the threshold but above the limit for Area 2 and at the target reference level for Area 3 in 2017. 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 (above the point at which fishing may cause recruitment impairment).

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 2016 and 2017 season in each Management Area.

	2016			2017		
	TACC (kg)	Catch (kg)	% Catch	TACC (kg)	Catch (kg)	% Catch
Area 2	5,000	4914.0	98	5,000	4762.0	95
Area 3	5,000	3917.4	78	5,000	4230.6	85

4.1 Area 2 Fishery

In Area 2 the catch of Brownlip abalone was 4.8 t (meat weight) in 2017, which was 95% of the TACC (Table 4.2). Since 2000 there has only been 3 seasons where less than 95% of the annual TACC has been caught. Brownlip abalone mean meat weight (individual animal) has maintained a relatively constant at 230 to 250 g since 2011, 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 Area 2 sub-areas 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 2012. However, over the next three years (2012-2014) it declined markedly before levelling off below the threshold but above the limit reference level in the last two seasons (Figure 4.1). The reduction in TACC to 71% of the long-term sustainable harvest level as triggered by the PI breaching the threshold reference level in 2015, appears to have arrested the decline observed in the annual SCPUE.

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

Quota period	Brownlip TAC 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	2,346	488
2010	8,700	8,560	250	2,177	484
2011	7,920	7,900	244	2,345	474
2012	7,200	7,199	246	2,551	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	4,914	249	2,020	467
2017	5,000	4,762	240	1,800	386

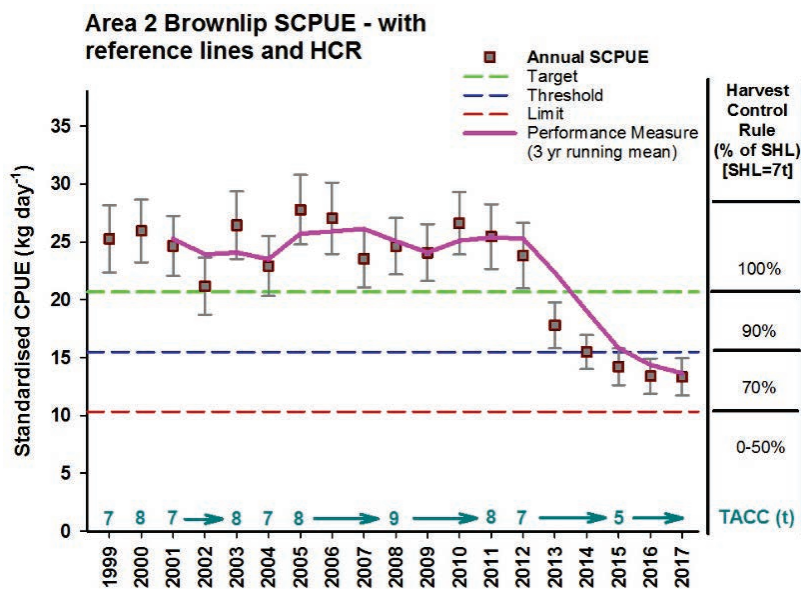


Figure 4.1: The annual standardised CPUE (kg.day⁻¹) for Brownlip abalone with the performance indicator (3 year running mean), reference levels (target, threshold and limit) and harvest control rule in Management Area 2.

4.2 Area 3 Fishery

In Area 3 the catch of Brownlip abalone was 4.2 t (meat weight) in 2017, which was 85% of the TACC (Table 4.3). Catches in Area 3 are generally greater than 85-90% of the TACC, however in 2016 it was lower (79%) due to an Industry licence issue. Brownlip abalone mean meat weight (individual animal) has increased from 230 g in 2013 to 243 g in 2017. This is still lower than 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 over 1999 to 2011. A relatively stable, increasing trend has been observed from 2013 to 2017 and the annual SCPUE is currently at the target reference level (Figure 4.2). During this time the TACC was reduced by 37.5% (between 2012 and 2015) and brought into line with the harvest control rule (TACC at 83% of long-term commercial sustainable harvest level). The SCPUE has exhibited a positive response to the reductions in TACC and increased to the target reference level.

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

Quota period	Brownlip TAC 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	1,802	598
2001	6,000	5,989	274	2,140	582
2002	6,000	5,844	279	2,080	619
2003	6,800	6,538	277	2,438	632
2004	6,800	6,456	271	2,396	687
2005	7,500	7,541	274	2,581	710
2006	8,000	7,044	281	2,454	678
2007	8,000	7,583	270	2,166	599
2008	8,000	7,141	266	2,463	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	3,046	829
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	3,917	235	2,268	617
2017	5,000	4,231	243	2,294	587

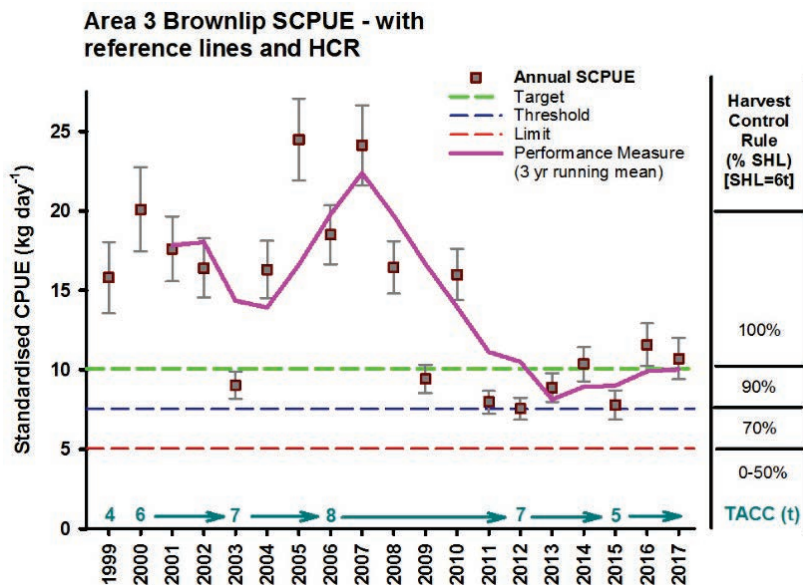


Figure 4.2: The annual standardised CPUE (kg.day⁻¹) for Brownlip abalone with the performance indicator (3 year running mean), reference levels (target, threshold and limit) and harvest control rule in Management Area 3.

4.3 Condition 2 – Stock Status 1.1.1

1st 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 primary stock indicator of the 3-year moving average of annual SCPUE in both management areas appears to be responsive to the reductions in TACC as per the harvest control rule. While the PI in Area 3 has returned to the target reference level, in Area 2 the PI's declining trend towards the limit reference level has arrested.

4.4 Condition 3 – Harvest Strategy 1.2.1

1st 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 has started.

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 both 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 been initiated for Brownlip abalone in both Area 2 and Area 3.

5. 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.