TASMANIAN ABALONE FISHERY ASSESSMENT 2013

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Erratum:

Errors were found in catch data in the 2013 Tasmanian Abalone Fishery Assessment published in September 2014, Appendix 6: Annual Catches by Zone – 1975-2013, pages 86-94. The errors arose from allocating catch from some individual blocks to the wrong zone because of shifts that had occurred in boundaries. The errors are identified here, with their corrections. The corrected tables appear in Appendix 6 in this corrected edition. We regret any inconvenience that these errors may have caused.

The following errors concern zone totals and averages following the change of the boundary between the Western and Central Western Zones in 2013. Errors were found among calculated annual totals and the average annual totals derived from them. Errors are shown in bold.

Page 88, Central Western Zone

Year	Original total	Corrected total
1975	110	110
1976	63	63
1977	50	50
1978	79	79
1979	112	112
1980	196	196
1981	257	257
1982	147	147
1983	231	231
1984	298	298
1985	322	322
1986	213	213
1987	185	185
1988	241	241
1989	192	192
1990	197	197
1991	169	169
1992	235	235
1993	154	154
1994	79	79
1995	112	112
1996	103	103
1997	98	98
1998	126	126
1999	149	149
2000	162	162
2001	162	162
2002	144	144
2003	62	62
2004	67	67
2005	75	75
2006	62	62
2007	42	42
2008	70	70
2009	95	95
2010	127	127
2011	136	136
2012	**302**	128
2013	101	101
Average 75-13	**148**	142
Average 85-13	**146**	138
Average 00-13	**115**	102

Page 89, Western Zone

Year	Original total	Corrected total
1975	**590**	668
1976	**824**	957
1977	**562**	608
1978	**855**	894
1979	**933**	974
1980	**1200**	1343
1981	**1366**	1541
1982	**887**	955
1983	**1045**	1204
1984	**1471**	1586
1985	**1019**	1141
1986	**742**	851
1987	**868**	996
1988	**715**	795
1989	**586**	681
1990	**532**	610
1991	**567**	650
1992	**611**	717
1993	**548**	651
1994	**499**	570
1995	**479**	526
1996	**428**	508
1997	**657**	760
1998	**480**	558
1999	**645**	729
2000	**1015**	1119
2001	**983**	1079
2002	**1005**	1104
2003	**1023**	1189
2004	**1031**	1167
2005	**1006**	1167
2006	**1041**	1174
2007	**1097**	1189
2008	**1064**	1159
2009	**913**	1118
2010	**907**	1077
2011	**889**	1048
2012	**902**	1076
2013	981	981
Average 75-13	**845**	952
Average 85-13	**801**	910
Average 00-13	**990**	1118

The following errors relate to the omission of 2013 block totals from averages:

Page 90, Northern Zone:

As published, errors highlighted in bold:

Block	*31*	*39*	*40*	*47*	*48*	*49*	*5*	*1*	*2*	*3*	*4*	*Total*
Average 75-13	24	**4**	2	3	19	**38**	**111**	16	4	**32**	15	**252**
Average 85-13	24	4	2	3	15	**46**	**110**	13	5	**29**	**14**	**250**
Average 00-13	24	6	1	0	**8**	**71**	**105**	**9**	1	**50**	**13**	**286**

Corrected averages

Block	*31*	*39*	*40*	*47*	*48*	*49*	*5*	*1*	*2*	*3*	*4*	*Total*
Average 75-13	24	5	2	3	19	40	110	16	4	33	15	253
Average 85-13	24	4	2	3	15	48	108	13	5	30	13	252
Average 00-13	24	6	1	0	9	74	102	10	1	51	12	288

Pages 91-92, Bass Strait Zone:

As published, errors highlighted in bold:

Block	*32*	*33*	*34*	*35*	*36*	*37*	*38*	*41*	*42*	*43*	*44*	*45*	*46*	*50*	*51*	*52*	*53*	*54*	*55*	*56*	*57*	*Total*
Average 75-13	1	**6**	0	1	1	5	3	1	1	2	0	0	1	0	4	0	10	1	0	2	1	**39**
Average 85-13	1	**6**	0	1	0	6	**3**	**2**	1	3	0	0	1	0	5	0	**13**	1	0	2	1	**48**
Average 00-13	1	**9**	0	0	0	**6**	**6**	1	1	**2**	1	0	1	0	**2**	0	18	2	1	**3**	1	**55**

Corrected averages

Block	*32*	*33*	*34*	*35*	*36*	*37*	*38*	*41*	*42*	*43*	*44*	*45*	*46*	*50*	*51*	*52*	*53*	*54*	*55*	*56*	*57*	*Total*
Average 75-13	1	7	0	1	1	5	3	1	1	2	0	0	1	0	4	0	10	1	0	2	1	41
Average 85-13	1	7	0	1	0	6	4	1	1	3	0	0	1	0	5	0	14	1	0	2	1	49
Average 00-13	1	10	0	0	0	5	8	1	1	3	1	0	1	0	3	0	18	2	1	2	1	57

Abalone Fishery Assessment: 2013

Executive summary

Total landings for the 2013 Tasmanian abalone fishery were 2,008.3 t of blacklip and 139.8 t of greenlip, a total of 2,148.1 t from a total allowable catch (TAC) of 2,149 t. The 2013 landings were 217 t lower than in 2012, attributable to TAC reductions in the Eastern Zone (21 t), Northern Zone (70 t) and Central Western/Western Zones (126 t).

The 2013 catch had a gross landed value of $73.6 million, down by $8.8 million from 2012. The decline in value was mainly due to a reduction in the TAC and also because of lower price for all product types. Beach prices fell steadily from relatively high levels following the Chinese New Year in February, and failed to recover over the course of the year. Towards the end of the year the market became oversupplied as fishing became driven by an increasing need to land allocated quota.

Royalties collected by the Tasmanian Government in 2013 totalled $5.42 million, slightly reduced (by $0.3 million) from the previous year.

The status of the fishery was assessed using two empirical performance measures (catch and catch rates) from diver returns, and supplemented by length-frequency samples from commercial catches. The abalone industry also provided comment on relative stock status, particularly where local knowledge or market preference assists with interpretation of trends.

The major findings of this assessment are summarised for each fishing zone.

Eastern Zone
Reduced demand for Eastern Zone abalone slowed the rate of landings so that only 25% of the TAC was caught by June, which was approximately half the usual rate of landing for the last three years. Subsequently a higher proportion of catch was taken later in the year when catch rates can be lower, affected by seasonal influences such as algal cover. This may produce lower annual mean catch rates than if fishing had been more evenly distributed throughout the year.

The Actaeons (sub-blocks 13C-13E) usually produce at least half of the Eastern Zone catch, but harvest here in 2013 (199 t) was greatly reduced compared to 2012 (268 t) as divers moved to achieve higher catch rates elsewhere. Catch rates remained low (~ 50 kg/h). Abalone abundance was assessed low. In the Lower Channel (14A, 14B) similar conditions prevailed. There were no signs of stock recovery in either region.

At Bruny Island (sub-blocks 14C-14E, Blocks 15 & 16) catch rates were marginally improved over the previous year. This follows three years of large catch reductions of around 60-70% relative to the seven years prior. Abalone abundance was assessed low.

In Storm Bay (Blocks 17-21) the small annual catch, combined with low catch rates indicated that abalone abundance was low. Catch rates here trended upwards indicating some recovery in 2012.

Despite very high levels of catch in recent years, Block 22 appeared to be maintaining these yields, albeit at low catch rates. Abundance was assessed moderate and stable. High catch combined with low catch rates in Block 22 indicated high levels of fishing mortality. It is not known what effect that such intensive fishing will have on future levels of catch, but it carries increased levels of risk.

At the Forestier Peninsula and Maria Island (Blocks 23-24) there has been a resurgence of stock, although these areas were fished heavily through 2013 with reduced catch rates at the end of the year. Abundance was assessed moderate and stable.

Further north in Great Oyster Bay, the Freycinet Peninsula, and the coast north to Seymour (Blocks 25, 26, 27, 28, 29A), part of the fishery was subject to catch restrictions and a 7-mm increase in legal minimum length (LML). Stock levels were not assessed in Blocks 25 and 26 (no fishing). In Block 27, catch restrictions were implemented because stock levels were assessed as low in 2012. In Blocks 28 and 29A stocks were assessed low, but improved catch rates suggested some recovery of stocks may be underway.

The coast north of Seymour to Taylors Beach (sub-blocks 29B, 29C, 29D, 30A) has been fished relatively lightly in recent years, but in 2013 produced an unusually large catch (~four-fold increase). Stocks were assessed moderate and stable.

Very little catch was taken from the Eastern Zone part of Block 31, reportedly because of market preference. Catch rates appeared stable and high although there were reports that some locations with higher quality abalone were depleted.

Central Western Zone
There is concern for the sustainability of fishing in this region (sub-blocks 5D, 6A-6C) because stocks have declined rapidly following five years of large catches at a smaller LML. It is clear that the benefits of the 2008 size-limit reduction were short-lived and that the region is no longer able to sustain successive years of catches exceeding 100 t. Stocks were assessed moderate and falling. The TAC in this zone was reduced to 73.5 t for 2014 in an attempt to prevent further stock decline.

Western Zone
North of Strahan (Blocks 6D, 7 and 8), stocks were greatly reduced following the development of the Central Western Zone in 2009 and its concomitant high annual catches. Since its return to the Western Zone in 2013, the region's catch has fallen substantially from annual catches of around 150 tonnes (2004-2006, 2009-2012) down to 50 tonnes in 2013. Previous catch reductions of this magnitude led to immediate increases in catch rate (2007-2008). Stocks were assessed moderate.

South of Strahan in Block 9, catch rates have fallen rapidly for two successive years and the catch appeared excessive. Stocks were assessed moderate and falling.

Catch rates in the South West (Blocks 10, 11, 12A) have fallen more than 25 kg/h since 2010 to approximately 100 kg/h indicating that the annual catch was excessive. Stocks were assessed moderate and falling.

The South Coast fishery has been stable for the past decade, and consequently a fall in catch rate despite two years of reduced catches was surprising. Stocks have become

depleted throughout the region, particularly on the mainland shore (12B, 12D, 13A, 13B). An exception was in offshore areas of the Maatsuyker Group (12C) where stock levels were higher, and much of the effort was transferred there.

The Western Zone TAC was reduced to 840 t in 2014 from 1001 t in 2013 as a management response to falling stock levels.

Northern Zone
The King Island catch did not reach the catch cap due to low abundance so that divers fished elsewhere. Some depletion was evident but overall catch rates and the large size of abalone relative to the LML indicated that stock levels remained moderate to high.

In Block 5, the size of abalone has become greatly reduced, so that more than a quarter of abalone in sampled catches were within 1 mm of the size limit. In 2008, the size limit in this region was reduced by 5 mm to 127 mm in a test of whether a combination of higher harvest rates and lower size limits would increase productivity in this block. However, the decline in stock with consequent low catch rates and low catch indicates this test has been a failure thus far. Regionally, catch rates have fallen to levels unprecedented in the post-zoning era indicating very depleted stocks. Stock levels were assessed low.

In Blocks 47, 48 and 49 (Hunter Island east to Circular Head), the size limit was reduced across most of this region in 2012 by 5 mm to 120 mm, thereby substantially increasing the size of the exploitable stock. The region has since been heavily fished, yielding 276 t and stocks have been quickly depleted from high levels. Catch rates and the larger size of abalone relative to the LML indicated that stock levels were moderate. Further decline in stocks appears likely should catches remain at the levels seen for the last three years.

The North East blacklip fishery in Blocks 31 and 39 is small, but periodically attracts intensive fishing as the blacklip catch is taken in conjunction with the greenlip stock. In the past this has made it difficult to manage the catch within sustainable limits. Recently, annual catches have been maintained near catch caps, and catch rates have been stable. Stock levels were assessed moderate and stable.

The Northern Zone TAC was reduced to 280 t in 2014 as a management response to falling stock levels.

Bass Strait Zone
Blacklip stocks in the Furneaux Group appeared robust and to be recovering from previous high levels of fishing mortality. The management intervention to reduce the catch in 2012 and 2013 has reversed the catch-rate decline, and stocks have stabilised at moderate to high levels.

In the remote islands of the Bass Strait (Blocks 50-56), the sporadic nature of fishing and extreme variability of catch rates makes assessment difficult. However, levels of catch were low to moderate which implied modest impacts of fishing on stock abundance.

Small quantities of catch were taken from the Central North Coast, mostly from Block 43. Catch rates have increased since 2011, but remained low (~50 kg/h). Stocks were assumed to be at low but stable levels.

Greenlip

In the north-west of King Island, greenlip stocks have failed to recover and this area now produces negligible catch. The island's remaining stocks appear to be producing at maximum capacity, with no margin to rebuild populations or buffer against fluctuations in productivity. It is recommended that the island's catch of greenlip be reduced and the TAC adjusted accordingly.

In the North West (Blocks 5, 48B, 48C, 49), mixed effort from the high frequency of fishing both blacklip and greenlip on single trips in this region reduced confidence in the use of catch rates as means of assessment, but stock levels appear to have fallen from previous levels following intensive fishing. Stock levels were considered moderate.

At Perkins Bay (48A), in accordance with the catch rate trend, stocks at Black Reef were assessed high but falling despite the small 20 t catch cap.

Between Circular Head and Bridport (Blocks 41-47), there was insufficient data to assess stock levels. For several years there has been no interest in fishing greenlip in this region, and its allocated catch is caught elsewhere making management of other regions difficult. Allocating catch to this region thus undermines TAC setting so future TACs should be based on an assumed zero catch for this region.

Stocks in the North East (Blocks 31, 39, 40) appeared reduced from previous levels, although the size of the catch and catch rates indicated that abundance remained moderate.

In the Furneaux Group (Blocks 32-38) the large 2013 catch and falling catch rates indicated that fishing pressure was excessive and that the catch cap should be reduced.

Recreational and other fisheries

The number of recreational abalone diving licenses issued by DPIPWE has fallen from a peak of 13,538 issued in 2008, to 11,256 in 2013.

The most recent survey of recreational abalone fishing catch was undertaken for the 2012/2013 season (Lyle and Tracey, 2014). The survey estimated that 32 t of blacklip and greenlip abalone, or 1.5% of the total Tasmanian abalone catch, was taken by recreational fishers. This catch is less than 50% of the highest annual recreational catch which was reported in 2002-2003.

Approximately 50% of the recreational catch was taken in the east and south-east between Southport and Eddystone Point. In the south-east, the recreational catch was estimated at approximately 4% of the total catch. The recreational catch was proportionally higher than previous years because the commercial catch decreased, and not because the recreational catch increased. In the north-west, the recreational greenlip catch was approximately 10% by weight of the total greenlip catch in that region.

Abalone are caught in Tasmanian waters as part of cultural fishing activities by indigenous people. This catch is not quantified but is believed to be negligible. Catch is also taken under permits for special events and research purposes. In 2013, the catch under permit totalled less than 11 tonnes. This includes 10 tonnes taken at three sites at Hunter Island as part of an IMAS research project to investigate abalone growth rates and quality following the density reduction of blacklip populations.

Illegal fishing is known to occur but no estimates of this catch are available.

Recommendations

1. Following a shift in catch from the Central North Coast and King Island, catch rates in most parts of the greenlip fishery have fallen suggesting unsustainable levels of fishing. It is recommended that catch from areas of the fishery where catch is allocated but not harvested should be removed from the greenlip TAC.

2. Consideration of zonal boundary changes to delineate areas of similar market value will address key spatial management and localised depletion issues in this fishery. For example, under-utilisation of stocks in the Eastern Zone part of Block 31 due to lower market preference remains a problem, particularly when many other parts of the zone have low stock levels. It is becoming progressively less likely that processors will voluntarily source product from areas with lower grade abalone and consequently managers should revisit ways of directing catch, rather restricting catch in preferred areas.

3. Widespread decline in the abundance of abalone in the fishery shows that previous TACs were maintained too high for too long to protect productivity. Part of the decline is attributable to unforseen falls in recruitment but there is clearly a need for more conservative TAC setting to maintain future harvest and economic benefits from the fishery. The history suggests that decision-making processes need to be improved, which is commonly done today through the use of decision rules.

National framework for reporting stock status

The national report on Sustainability of Australian Fish Stocks assesses the performance of fish stocks in terms of recruitment overfishing. That is, whether harvesting is sufficiently controlled to ensure that the supply of juveniles remains unaffected by fishing. The Tasmanian abalone fishery is one of the fisheries included in that report.

Recruitment overfishing in the Tasmanian abalone fishery is controlled by a combination of size limits and catch limits, with the relative importance of these varying from region to region. In some regions the size limit provides a large degree of protection of biomass and thus reproductive output so that the control of fishing mortality with catch limits is less critical.

The prevention of recruitment overfishing ensures the fishery is sustainable but it's a low-level objective for a fishery because it doesn't address other issues like yield and economic overfishing. In the table below we report on the status of regions in the Tasmanian Abalone Fishery using the national approach. These categories are defined in Appendix 2: Assessment of stock status. This assessment includes some regions

where there is concern about the performance of the fishery even though reproductive output may be well protected by size limits. These regions are marked as "sustainable*".

Species: Blacklip

Zone- Region (Blocks, sub-blocks)	Stock Status
EZ - Actaeons (13C, 13E, 13B)	Transitional Recovering
EZ - Lower Channel (14A, 14B)	Transitional Recovering
EZ - Bruny Island (14C, 14D, 14E, 15, 16)	Transitional Recovering
EZ - Storm Bay (17, 18, 19, 20, 21)	Transitional Recovering
EZ - Lower East Coast (22, 23, 24, 25)	Transitional Recovering
EZ - Bicheno-Freycinet (26, 27, 28, 29A)	Transitional Recovering
EZ - Upper North East (29B, 29C, 29D, 30A)	Transitional Recovering
EZ - Sub-block 31A	Sustainable
NZ – North East (31B, 39, 40)	Sustainable
NZ – North West (47, 48, 49)	Transitional Depleting
NZ – North West (5)	Transitional Depleting
NZ – King Island (1, 2, 3, 4)	Transitional Depleting
CW – Couta Rocks (5D, 6A, 6B, 6C)	Transitional Depleting
WZ – Sandy Cape- Granville-Trial (6D, 7, 8)	Transitional Depleting
WZ – Block 9	Transitional Depleting
WZ – South West (10, 11, 12A)	Transitional Depleting
WZ – South Coast (12B, 12C, 12D, 13A, 13B)	Transitional Depleting
BS – Furneaux Group (32, 33, 34, 35, 36, 37, 38)	Sustainable
BS – Central North (41, 42, 43, 44, 45, 46)	Sustainable
BS – Remote Islands (50, 51, 52, 53, 54, 55, 56, 57)	Sustainable

Species: Greenlip

Region (Blocks, sub-blocks)	Stock Status

North West (5, 48B, 48C, 49)	Undefined
Perkins Bay (48A)	Undefined
Furneaux Group (32, 33, 34, 35, 36, 37, 38)	Undefined
North East (31B, 39, 40)	Undefined
Central North (41, 42, 43, 44, 45, 46, 47)	Undefined
King Island (1, 2, 3, 4)	Transitional - depleting

Contents

1. Introduction

This assessment relies on fishery-dependent data, principally, catch and catch rate data, which have been used to infer changes in abalone abundance. In addition, information is presented on changes in the median length of abalone sampled from the commercial catch across fine spatial scales. This provides additional information on changes in abundance, especially in interpreting trends in recruitment and fishing mortality.

The use of catch and catch rates to monitor changes in abalone abundance has often been criticised as unreliable and elsewhere is infrequently used. In theory, the fishing of abalone aggregations, serial depletion and changes in fishing efficiency reduce the strength of the link between catch rates and abundance. These factors are more problematic in areas where effort and catch data are sparse and compounded by the use of arithmetic means that are sensitive to skewed data.

However, when abalone populations are intensively fished, catch and catch-rate trends are more reliable indicators of changes in abundance. When fishing pressure is sufficient, large aggregations are unable to develop, and high visitation rates prevent stock build up and subsequent serial depletion. The confounding effects of effort creep may be reduced by using short-term (10 years or less) catch and catch-rate trends to assess changes in stock levels. Under these circumstances, catch and catch-rate trends appear to reflect changes in abundance.

This document makes use of fisheries data collated over progressively diminishing spatial scales. The top level scale is the zone. The use of zones was first introduced into the Tasmanian fishery in 2000 to manage the spatial distribution of catch. Since 2003, the Tasmanian blacklip fishery has been divided into four zones: Eastern, Western, Northern and Bass Strait. A fifth zone (Central West) was introduced in 2009. The greenlip abalone fishery is managed separately from the blacklip fishery. The greenlip fishery is restricted to the north of the state, and the spatial distribution of its catch is managed by regions.

Whilst zones are now the established method of managing the fishery, they mask details important for fishery assessment. Zones are too large and include too many physical differences (e.g. water temperature regimes, types of habitat, accessibility for divers), and may include divergent recruitment patterns, and different levels of abundance and fishing methods. There is a risk that recruitment in particular parts of a zone may be very different to that of the wider region. In this assessment, understanding of stock abundance is improved by looking at fishing patterns across smaller regions within each zone which have a greater likelihood of sharing common fishing approaches and stock levels.

The regions and region boundaries used in this assessment have been set arbitrarily, but are generally based upon commonly used Tasmanian regions, about which boundaries have been placed aligned with the abalone fishery reporting blocks. Where necessary, reference is made to the component blocks or sub-blocks within a region to help understand the performance of its fishery, provided the annual catch was 10 t or more in any one of the previous nine years.

The zones, regions and statistical blocks from which the 2013 commercial catch was reported or which are referred to in this document are shown below (Figure 1; for sub-blocks see Appendix 11: Maps of catch-reporting blocks and sub-blocks). For information about charts of catch, catch rates and median length, see and Appendix 3: Interpreting graphical information.

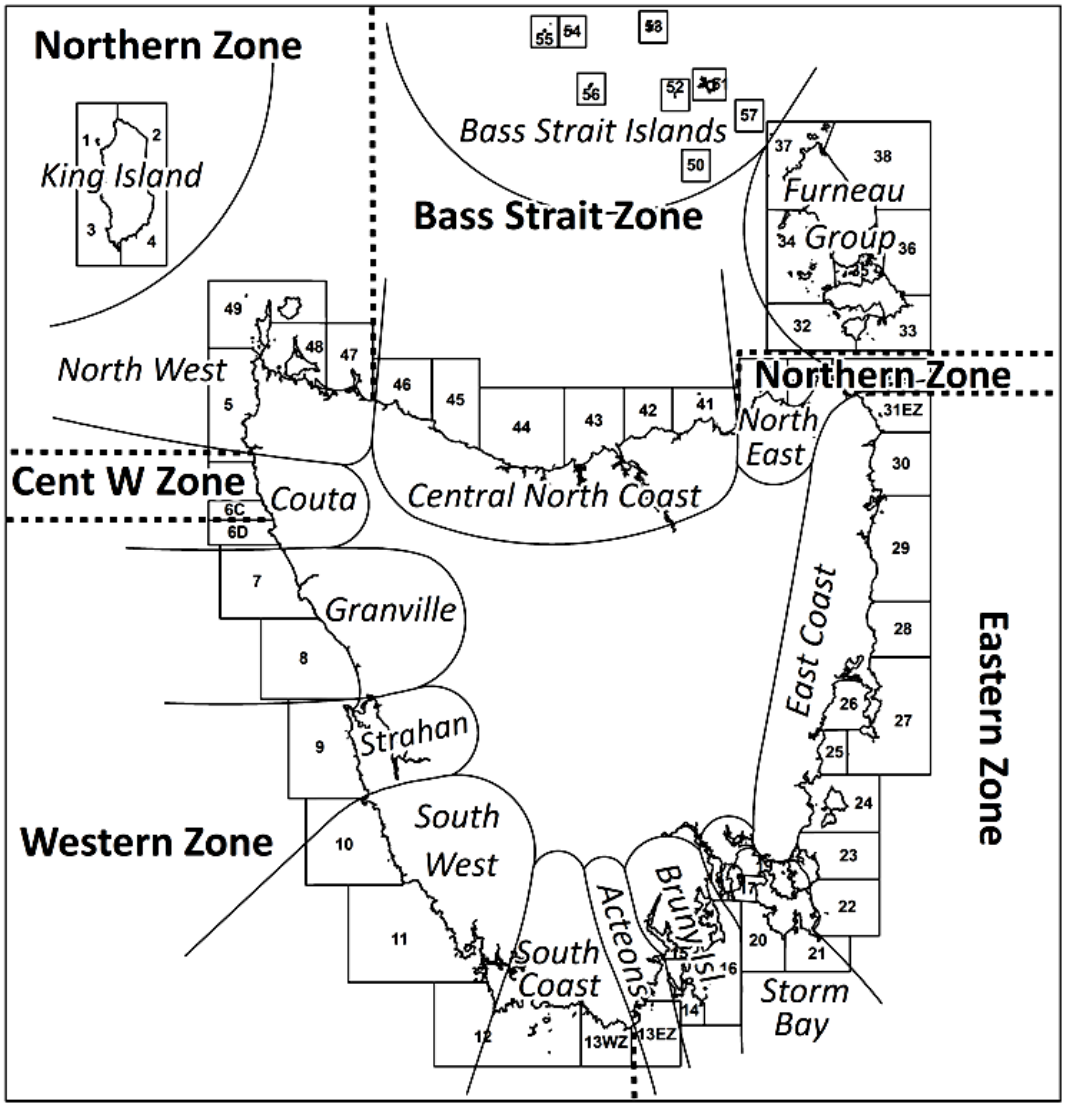


Figure 1. Zones and statistical blocks used in the Tasmanian abalone fishery in 2013. Also shown are the regions used for assessment purposes in this document. Zone boundaries are shown as dotted lines. The greenlip fishery has no geographical boundaries, but mostly takes place on coasts included in the Northern and Bass Strait Zones. More detailed maps of catch reporting areas can be found in Appendix 11: Maps of catch-reporting blocks and sub-blocks.

The zone boundaries and their reporting blocks for the 2013 fishing year were as follows:

Zones (blacklip fishery)
Eastern Zone:
Whale Head to Great Musselroe River. Sub-blocks 13C, 13E, 13E, Blocks 14 to 30, Sub-block 31A.
Northern Zone:
Great Musselroe River to Anderson Bay, then Cowrie Point to Arthur River including King Island. Blocks 1 to 4, Sub-blocks 5A, 5B, 5C, Sub-block 31B, Blocks 39 to 40, Blocks 47 to 49.
Bass Strait Zone:
Central North Coast: Cowrie Point to Anderson Bay. Blocks 41 to 46. Remote Bass Strait Islands: Blocks 50 to 57. Furneaux Group: Blocks 32 to 38.
Central Western Zone:
Arthur River to Wild Wave River. Sub-blocks 5D, 6A, 6B, 6C
Western Zone:
Wild Wave River to Whale Head. Sub-block 6D, Blocks 7 to 12, Sub-blocks 13A, 13B.

The greenlip fishery has no spatial boundaries but is restricted by the natural distribution of greenlip to waters north of the Great Musselroe River in the east and Cape Grim in the west.

Regions
The regions used for blacklip assessment purposes in this document comprise the following reporting blocks:
Actaeons and lower Channel: Sub-blocks 13C, 13D, 13E, 14A, 14B
Bruny Island: Sub-blocks 14C, 14D, 14E, Blocks 15 and 16
Storm Bay: Blocks 17 to 21
East Coast: Blocks 22 to 30, Sub-block 31A
North East: Sub-block 31B, Blocks 39 and 40
Furneaux Group: Blocks 32 to 38
Bass Strait Islands: Blocks 50 to 57
Central North Coast: Blocks 41 to 46
King Island: Blocks 1 to 4
Block 5: Sub-block 5A, 5B, 5C
Remainder North West: Blocks 47 to 49
Couta: Sub-blocks 5D, 6A, 6B, 6C
North of Strahan: Sub-block 6D, Blocks 7 and 8
South of Strahan: Block 9
South West: Blocks 10 to 11, Sub-block 12A
South Coast: Sub-blocks 12B, 12C, 12D, 13A, 13B

The greenlip fishery is reported from the *North West* (Blocks 5, 48B, 48C and 49), *King Island* (Blocks 1 to 4), the *Furneaux Group* (Blocks 32 to 38), the *North East* (Blocks 31, 39 and 40), *Perkins Bay* (sub-block 48A) and the *Central North Coast* (Blocks 41 to 47). Small catches are occasionally reported from the remote *Bass Strait Islands* (Blocks 50 to 57).

This document contains charts of annual total catch and geometric mean catch rates, catch-rate distributions and annual median length. Important details about the use of these charts and the data from which they were produced are summarised below (a

more detailed explanation may be found in Appendix 3: Interpreting graphical information).

The weights from all reported catches between 1975 and 2013 (inclusive) were used to estimate annual total tonnages i.e. no catches were omitted. The catch and effort database is known to contain duplicate, incorrect and incomplete records. These records are difficult to detect, but are corrected when they are encountered, and consequently there may be minor variations in annual catch reported in these documents from year to year.

Sales of abalone commenced during the late 1950's but catch return data is available only from 1975. Between 1975 and 1984 abalone catches were reported by the skipper of the fishing vessel as *estimated* weights, on a monthly basis. Between 1985 and 1992, catches were reported as *landed* weights, by the diver, per landing. Estimated weights by block are unavailable for this period, which means that catches taken from several blocks in one trip may be reported as caught from one of those blocks. Since 1992, *estimated* weights by block have been used, to enable the best spatial resolution of catch. The sum of estimated weights by zone is usually within 2-3% of the sum of landed weights by zone, but between 1992 and 1995 was up to 10% less.

Annual catch rates were derived from the geometric mean of individual catch rates, and all mean catch rates referred to in this document are geometric means. Geometric means are more reliable estimators of the mean catch rate across all divers than arithmetic means (averages), because they are less affected by variable skewness of distributions (e.g. where there are small but variable percentages of high catch rates), and the standard error of the geometric mean is smaller than that of the arithmetic mean. Only catch rates from catches of 40 kg or more were considered when calculating catch-rate means (to reduce the effects of atypical fishing events such as those affected by mechanical breakdown or where greenlip / blacklip abalone were taken as by-catch of fishing for the other species).

Catch-rate distribution charts show the distribution of catch rates across all divers i.e. the proportion of daily records having catch rates in categories grouped from low to high. By comparing the distribution of catch rates between recent years, it is possible to see where changes in catch rate have occurred, and the effect that they have had on the mean catch rate.

The annual median length of abalone, when viewed as a time series of data, is used to show changes in the length of abalone that may reflect changes in fishing pressure or levels of recruitment. Between 1998 and 2000, median length was derived from length measurements obtained from photographs of 25 abalone taken from divers' catches, photographed aboard divers' boats. Since 2000, median lengths were derived from samples of 100 measured abalone randomly selected from individual catches, and in most cases, sampling has been undertaken at factories. Since 2008, the larger processors have conducted this sampling. As a rule of thumb, median lengths are deemed useful when more than 4% of catches in a reporting area have been sampled, although in the less productive blocks where relatively few catches are landed, a much higher proportion of sampled catches is required to produce reliable information.

The performance measures (catch, catch rates and median length) for each region of the fishery were assigned a status (stable, rising, falling and erratic or no data), and an

initial assessment made (Appendix 2: Preliminary assessment of the fishery). The regional assessments were combined and presented as a draft fishery assessment to panels of divers and other industry participants at meetings in Hobart and other regional centres. The initial assessments were subsequently modified where it was apparent that the performance measures reflected changes caused by factors other than changes in stock levels, and a final assessment was developed.

2. Total landings and gross revenue

At the end of 2013 total landings comprised 2,008.3 t of blacklip and 139.8 t of greenlip, a total of 2,148.1 t from a TAC of 2,149 t (Table 1). Total landings were down by 217 t compared with 2012, attributable to reduced TACs in the Eastern Zone (21 t), Northern Zone (70 t) and Central Western/Western Zones (126 t).

Table 1. 2013 landings by zone, in tonnes

Zone	2013 TAC	2013 Landings (tonnes)
Greenlip	140.0	139.8
Eastern Blacklip	528.5	527.1
Northern Blacklip	308.0	307.7
Western Blacklip	1001.0	1001.8
Bass Strait Blacklip	70.0	70.5
Central Western Blacklip	101.5	101.2
	2149.0	2148.1

The 2013 catch had a gross landed value of $73.6 million, down by $8.8 million or 10.7% from the previous year. The reduction in gross landed value was mainly due to the 9.2% decline in the TAC but was also affected by lower price received for all product types. This market weakness was affected by factors including the high Australian dollar, and in China, supply chain problems, and government policy limiting expenditure on luxury food items.

Towards the end of the year the market became oversupplied as fishing became driven by expiry of quota. Beach prices fell steadily from relatively high levels following the Chinese New Year in February, and failed to recover over the course of the year (Figure 2).

Royalties collected by the Tasmanian Government in 2013 totalled $5.42 million, only slightly reduced (by $0.3 million) from the previous year.

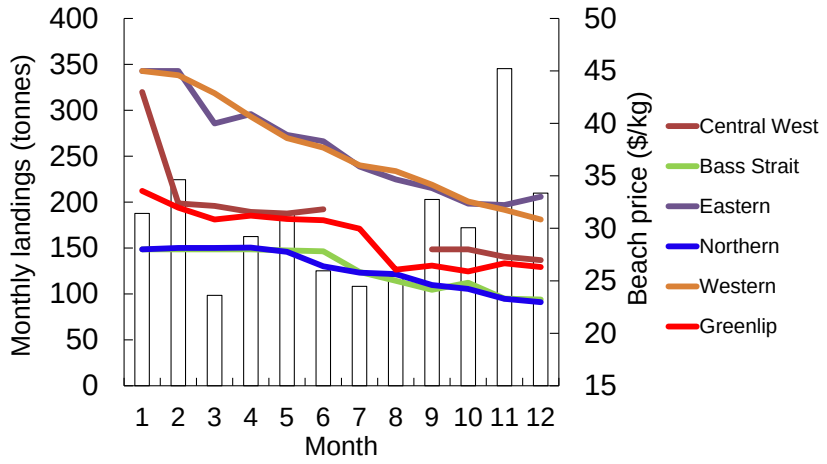


Figure 2. Monthly landings (vertical columns) and monthly trends in average beach price for abalone in 2013, by zone. Bass Strait and Northern Zone abalone were predominantly used for canning; Eastern, Western and Central West Zone abalone were mostly sold to the live market. Greenlip beach-price data were incomplete.

3. Assessment of the Tasmanian abalone fishery

3.1 Eastern Zone.

The Eastern Zone TAC was 528.5 t in 2013. Of the four Eastern Zone regions, most catch was taken from the East Coast (220 t) and the Actaeon regions (211 t), while lesser amounts were taken from Storm Bay (58 t) and Bruny Island (35 t) regions (Figure 3).

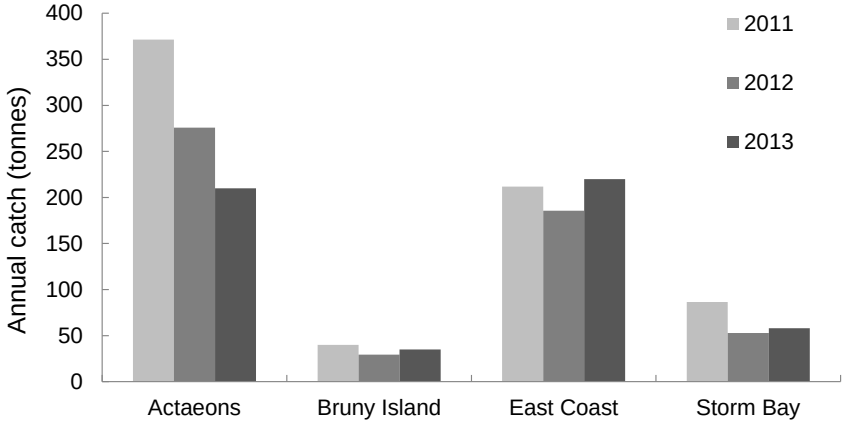


Figure 3. Distribution of catch, Eastern Zone, 2011-2013. During this period, most of the catch reduction has occurred at the Actaeons.

At low levels of effort, changes in catch rates may reflect changes in fleet dynamics more than changes in abundance. Reduced demand for Eastern Zone abalone in 2013 slowed the rate of landings, and by June, the TAC was only 25% caught, which was approximately half the usual rate of landing (Figure 4). This meant that a higher proportion of catch was taken later in the year when catch rates are usually lower, affected by seasonal influences. This is likely to produce lower annual mean catch rates than if fishing was more evenly distributed throughout the year.

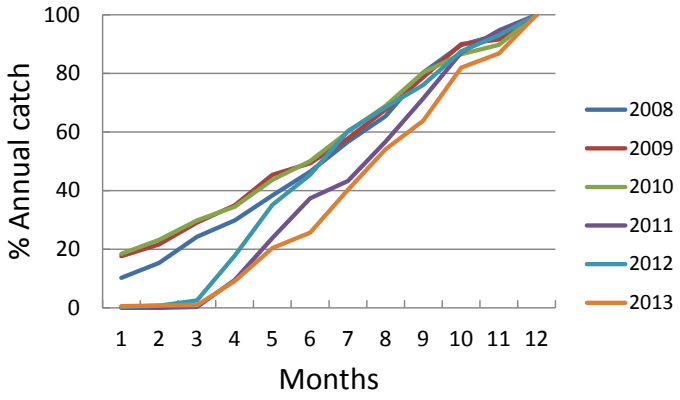


Figure 4. Cumulative catch by month, 2008-2013, Eastern Zone. In 2013, weak market demand reduced the catch during the mid-year peak catch-rate period, leaving a greater proportion of catch to be taken in the last quarter of the year, when catch rates are seasonally lowest.

3.1.1 Actaeons and Lower Channel (Sub-blocks 13C, 13D, 13E, 14A, 14B)

Fishery-dependent data

The Actaeons catch was uncapped in 2013. A total of 211 tonnes was reported from the region, 199 t of which was caught south of the Southport Lagoon entrance (Block 13), the remainder north in sub-blocks 14A and 14B. In comparison, in 2012 269 t was caught from Block 13 and 7 t from Block 14. The reduction in catch occurred mostly in sub-block 13D (down from 73 t to 33 t) and sub-block 13E (down from 181 t to 151 t).

The 2013 CPUE distribution for the region was highly skewed towards lower catch rates with catch rates modal in the 40-49 kg/h range. This distribution is similar to those from the years 2002, 2004 and 2012, all years of low abalone abundance.

In Block 13, catch rates were generally low, with a mean of 51 kg/h, marginally lower than the previous year. Between April and August, catch rates averaged 55 kg/h, but fell below 50 kg/h for the remainder of the year. By December, when 26 t was taken, catch rates had fallen to 42 kg/h (Figure 5). This pattern of seasonal variation in catch rates (highest catch rates coinciding with the cooler months mid-year, lowest catch rates during the warmer months at the start and end the year) has been apparent for many years and has only failed to manifest when stock levels were high (e.g. 2007, 2008) or during closures caused by management intervention (caps, delayed openings).

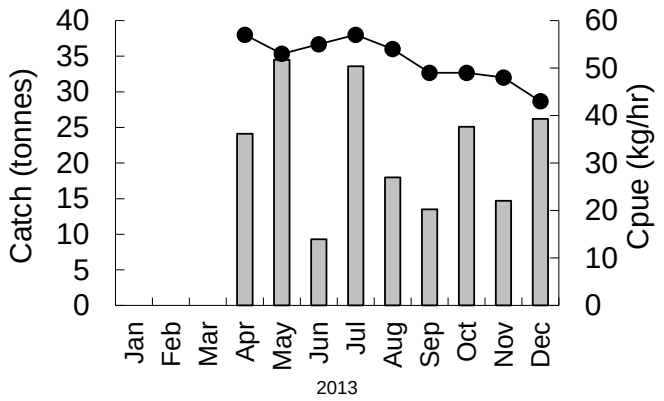


Figure 5. Monthly catch and catch-rates, Actaeons (sub-blocks 13C, 13D, 13E), 2013.

In the Lower Channel (sub-blocks 14A, 14B), 12 t was reported caught at a mean catch rate of 48 kg/h. One third of the catch was taken in December at low catch rates. Average trip weights were below 200 kg/day during the last quarter, and it appeared that divers were fishing residual amounts of quota close to home in low cost fishing operations.

During the past two years, abalone sampled from catches increased in size. In 13E, where 25% of catches were sampled, the median length increased by 2 mm to 147 mm, following a 1-mm increase the previous year. The 25th and 75th percentile length measurements also increased by similar amounts. Abalone from other sub-blocks in the region also increased in size.

Diver observations
Fish stocks appeared to have been maintained in the face of steady fishing. Although most divers experienced low catch rates, they were reasonably satisfied with fishing at the Actaeons and considered it had improved on the previous year. As usual, divers reported seeing many pre-recruits and expressed confidence in this part of the fishery.

Qualitative assessment
Stock levels were assessed low. Performance measures indicated no signs of stock recovery in the region.

This part of the fishery was assessed as sustainable because of the degree of protection provided by the size limit although the legal sized stock was assessed to be at low levels relative to previous years.

3.1.2 Bruny Island (Sub-blocks 14C, 14D, 14E, Blocks 15 and 16)

Fishery-dependent data
Bruny Island produced 35 t of blacklip in 2013, up by 6 t on the previous year, but still, extraordinarily low compared with past years. Many divers visited South Bruny (14D, 14E) in April and May. There were initially good catches, but catch rates fell quickly, and only 11 tonnes was taken from the area. Almost half of the region's fishing trips were reported from North Bruny (16C, 16D), where 14 t was taken. Smaller quantities were taken from Adventure Bay (16B) and further south (16A). No catch was reported from the Channel coast of Bruny (14C, Block 15).

Compared with previous years, two unusual patterns of fishing behaviour were identified at Bruny Island in 2012 and 2013. Firstly, the temporal distribution of the annual catch was highly skewed, one third of it being taken in December (Figure 6) at an average trip weight of 154 kg. This is likely to have biased catch rates downward because of seasonal differences in catch rates in the Eastern Zone. Secondly, in both 2012 and 2013, divers fished North Bruny for shorter periods compared with preceding years (Figure 7) i.e. it appears that many divers fished North Bruny as a place of convenience when they held only small amounts of quota.

Both factors compromise the use of catch rates as a measure of relative abundance. Furthermore, at low or irregular levels of effort the conditions under which we accept that catch rates are acceptable indicators of abundance are not met (see Appendix 3), and that between-year differences of 10–15 kg/h may be meaningless with respect to changes in abundance.

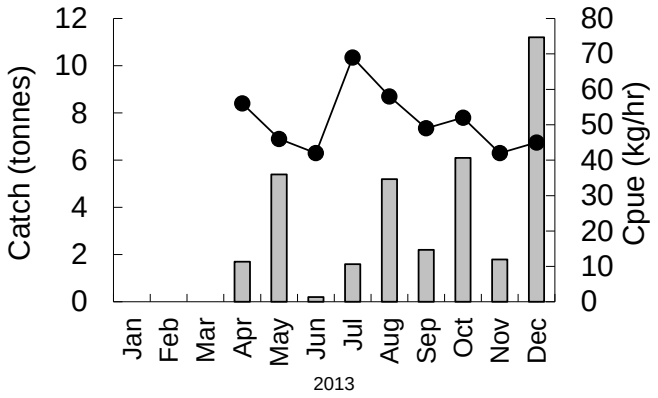


Figure 6. Monthly catch and catch rates, Bruny Island, 2013.

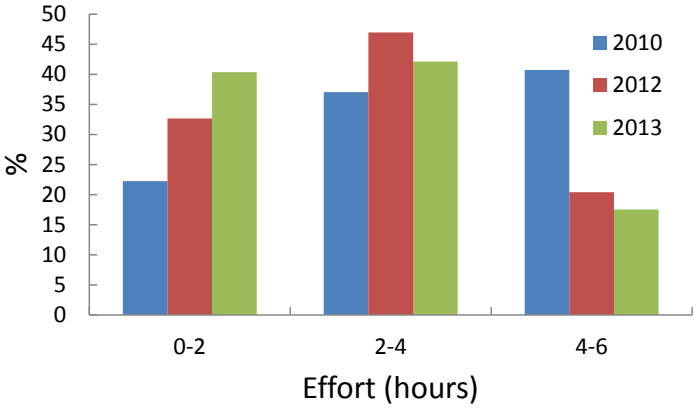


Figure 7. Changes in duration of fishing trips in sub-block 16D, North Bruny between 2010 and 2013. Short trips (< 2 hours) became more frequent over this period and it became apparent that the area was a destination of convenience for many divers with small amounts of quota in 2012 and 2013. In contrast, in 2010 when the Eastern Zone quota unit was 70% larger (256 kg), catch rates were higher and divers spent more time in the water. This change in fishing behaviour is likely to have biased catch rates downwards here.

Regional catch rates were 51 kg/h, approximately 20% higher than the previous year. The CPUE distribution shows that catch rates were bi-modal at 30-39 kg/h and 50-59 kg/h in 2013. The 2013 distribution shows broad similarities with those from 2002, 2004, 2010 and 2012, all years when abundance was assessed to be low

In the Bruny sub-blocks 14D, 14E, and 16D there is evidence that abalone sampled from catches have increased in size by 1-2 mm since 2007 (when the LML was last raised). Median lengths ranged between 149-153 mm in these sub-blocks. Due to unusual sampling conditions, the large size of abalone from 14D in 2012 is probably aberrant and should be disregarded. In 16B, abalone have remained relatively unchanged in size, while in recent years in 16C, the size of abalone has become smaller.

Diver observations

There were conflicting reports from divers about fishing conditions at Bruny Island. Most divers were concerned about stock levels, but some divers said that they found fishing at Bruny was as good as it had ever been. It was said that the decline of Bruny's stocks appeared to be associated with the managed closures of the Actaeons, (usually in

November) between 2007 and 2011 and the corresponding shift in effort to Bruny, at the time of year when catch rates are seasonally low.

Qualitative assessment
While catch rates showed signs of improvement, the size of the catch has been reduced to low levels relative to historical catches, and as a consequence, higher catch rates could be expected. Abalone abundance was assessed low.

This part of the fishery was assessed as sustainable because of the degree of protection provided by the size limit although the legal sized stock was assessed to be at low levels relative to previous years.

3.1.3 Storm Bay (Blocks 17-21)

Fishery-dependent data
The regional catch total was 58 t, an increase of 10% compared with the previous year, but from a half to one third of the level of past annual catches. The catch was evenly distributed throughout the region: Blocks 17 (Betsey Island and the northern Blackjack shore, 19 and 20A (Parsons Bay north to the Blackjack shore) produced 15 t, sub-blocks 20B and 20C (Parsons Bay south to Cape Raoul) produced a further 15 t while the balance (27 t) was taken from between Cape Raoul and Tasman Island in Block 21.

The 2013 CPUE distribution is skewed left, modal at 50-59 kg/h, and shows broad similarity with previous years of low abalone abundance (2002, 2012). However, in contrast to those years, almost 20% of 2013 catches were taken at catch rates of 80 kg/h or more, consistent with increasing stock levels.

Annual mean regional catch rates improved by 5 kg/h to 57 kg/h. Catch rates were consistent throughout the year, between 53 kg/h and 61 kg/h (Figure 8). The distribution of catch by month is similar to previous years, with slightly more catch taken in December. In contrast with other regions which experience a seasonal decline in catch rates in the last quarter, catch rates remained high. Depth/effort profiles by month were consistent throughout the year i.e. catch rates were not maintained at the end of the year by a shift in effort to deep water stocks as has happened here previously. This is considered evidence that stocks were at higher levels than previous years.

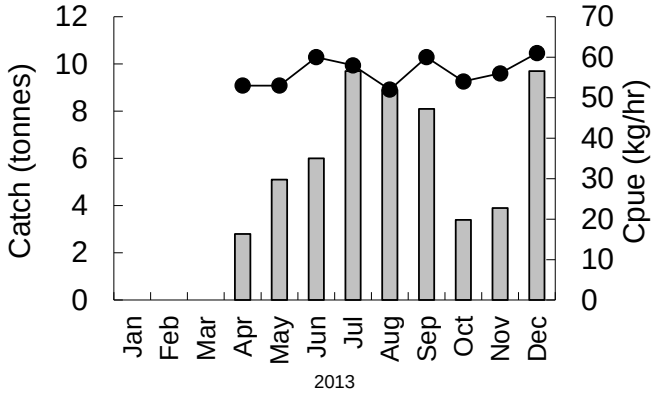


Figure 8. Mean catch and catch rates by month, Storm Bay 2013.

Two areas performed poorly: Block 19 and sub-block 21B. Both are relatively sheltered waters which have produced no more than a few tonnes of abalone at low catch rates in recent years. Periodically abalone populations there recover and provide small but worthwhile fisheries. Tagging studies conducted during the early 1990's at Stinking Bay in sub-block 21B showed that abalone there were slower growing than elsewhere in the region.

Quantitative assessment
While the size of the annual catch is a consequence of management changes and not directly attributable to abundance, its small size combined with low catch rates indicated that abalone abundance was low. However catch rates here showed clear signs of improvement, and it is evident that stocks were more abundant than in 2012.

This part of the fishery was assessed as sustainable because of the degree of protection provided by the size limit although the legal sized stock was assessed to be at low levels relative to previous years.

3.1.4 East Coast (Blocks 22 to 30, Sub-block 31A)

Fishery-dependent data
The annual catch in Block 22 was 56 t, slightly less than in 2012 (60 t), split between 22A (24 t), 22B (25 t) and 22C (7 t). The size of this catch is high. The annual catch from Block 22 has now been above the long-term average (50 t) for eight consecutive years.

During 2013, after some initial early activity in April there was minimal fishing until July. Catches totalling 44 t were reported from the block between July and October. Catch rates were maintained above 55 kg/h until October, when they fell sharply, ending the year at 42 kg/h (Figure 9). The annual mean catch rate was 50 kg/h, slightly higher than in 2012 (46 kg/h).

Median lengths from catch samples obtained after 2006 were variable between 148-153 mm with no clear trends, although in 2012-2013 the median lengths have been as large as or larger than in previous years. Approximately 20% of catches were sampled.

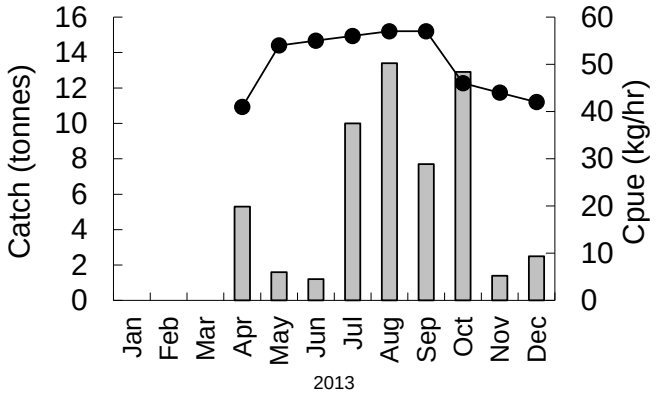


Figure 9. Mean catch and catch rates by month, Block 22, 2013.

In Blocks 23 and 24 (Forestier Peninsula and Maria Island) the annual catch more than doubled over the previous year to 77 t. The catch was mostly taken from 23A (23 t), 23B (15 t) and 24D (21 t).

Until October, monthly catch totals were low, ranging 2-10 t, and with monthly mean catch rates ranging 57-63 kg/h (Figure 10). Between May and August, daily average trip weights were approximately 250 kg/day, with a number of large catches ranging between 400-600 kg landed in this period. Behavioural change of fishers is evident in September, when average trip weights fell sharply to below 200 kg/day, but catch rates remained relatively high (Figure 11), implying that divers were working shorter days. In October, fishing effort intensified, and a further 25 t was landed in that month. From October, catch rates were approximately 10-15% lower. Small amounts of catch (< 5 t) were taken in November and December.

The median length of abalone in catches from 23A has fluctuated in a range between 154 mm (2007) to 151 mm (2013) i.e. they are relatively large. Since 2011, between 25-46% of catches have been sampled annually. On the eastern side of Maria Island (24D, 24E) abalone were smaller, with median lengths between 147-150 mm since 2007. Neither Maria Island nor the Forestier Peninsula catches showed consistent changes in size during the past six years.

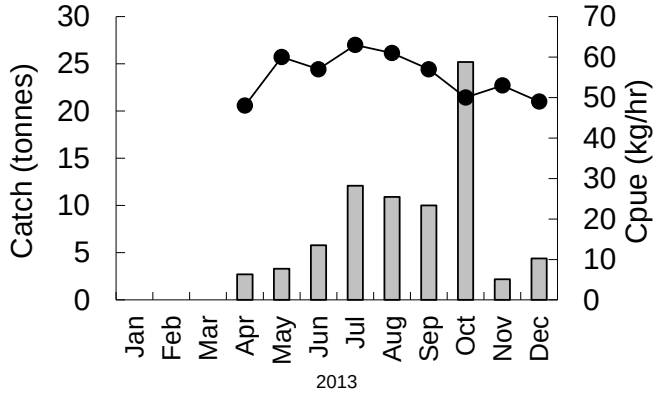


Figure 10. Mean catch and catch rates by month, Blocks 23-24, 2013.

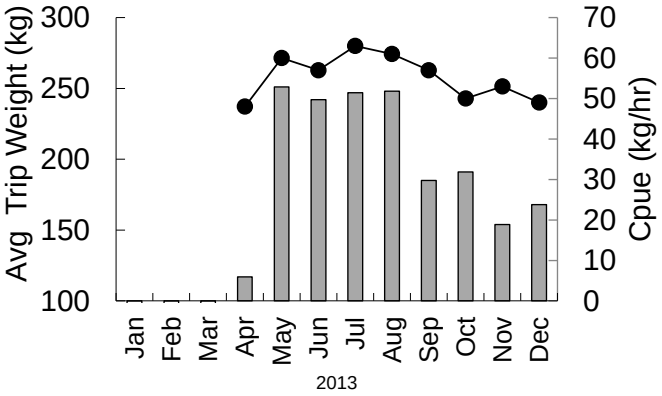


Figure 11. Average trip weight (grey columns) and catch rates by month, Blocks 23-24, 2013.

No catch was reported from either Block 25 or Block 26. Block 25 is seldom fished, and Block 26 has not produced more than a few tonnes of abalone since 2001.

The catch from much of the Freycinet and Bicheno area was capped at 5 t in 2013 to promote the recovery of stocks in the region. The capped area included sub-blocks 26A, Block 27 and sub-blocks 28A and 28B, and was closed in August with 11 t caught. The LML in this area was raised by 7 mm to 145 mm. These sub-blocks mostly produced small amounts of catch (<2 t) except 27D (Wineglass north to the Friendly Beaches), and 28A (Friendly Beaches north to Bicheno) which both produced 4 t. A combined

total of 16 t was taken from the uncapped area north of the Douglas River to the Templestowe Lagoon mouth, north of Seymour (28C, 29A). The regional total catch was 27 t, a 4 t increase on the previous year.

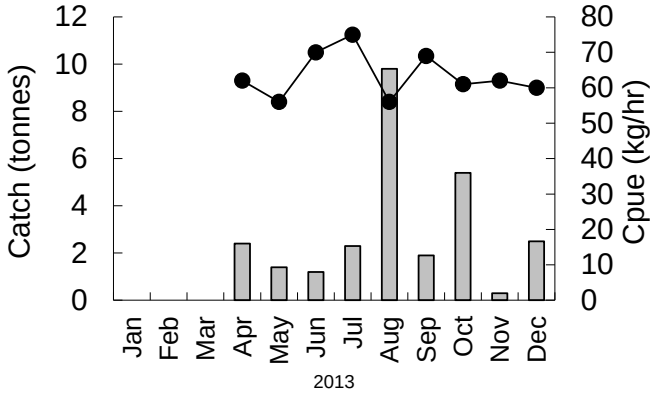


Figure 12. Mean catch and catch rates by month, Freycinet-Bicheno region, 2013.

Small quantities of catch were taken during the four months until August, when almost 10 t was caught. Approximately 80% of the Block 27 catch was taken during this month and catch rates fell to 56 kg/h, perhaps indicating weakness in stock levels. During the rest of the year, catch rates were mostly above 60 kg/h, including the period October-December when warming waters and increased algal growth make fishing more difficult. The mean regional catch rate was 60 kg/h, representing a considerable improvement on the previous year when the mean catch rate was 43 kg/h. The catch rate increase occurred despite a potential reduction in stock size caused by the increased size limit operating across most of the region.

While a relatively high proportion of catches from the region were sampled for length measurements in 2013, previous years have had inconsistent levels of sampling, and between year-comparisons are not useful. The cyclical nature of fishing in the region, where particular sub-blocks are intensively fished for one or two years, but then left relatively unfished for a succession of following years means that sampling rates are insufficiently consistent. The median length of abalone from 29A where 10 catches were sampled in 2013 was 149 mm.

Fishing effort increased in the north-east region between the Templestowe Lagoon mouth to Taylors Beach, north of Binalong Bay (sub-blocks 29B-30A). The annual catch increased by more than three times the average, to 44 t. Of this, 24 t was caught in sub-block 29D, south of St Helens Point.

Monthly catch totals were mostly 5 t or more, reaching 12 t in October (Figure 13). Almost half the annual catch was taken in the last quarter of the year when fishing conditions were seasonally affected, apparent in the decline in catch rates from September. Catch rates were mostly greater than 70 kg/h, reaching 83 kg/h in August. Regional mean catch rates were 68 kg/h, slightly improved on the previous year (64 kg/h).

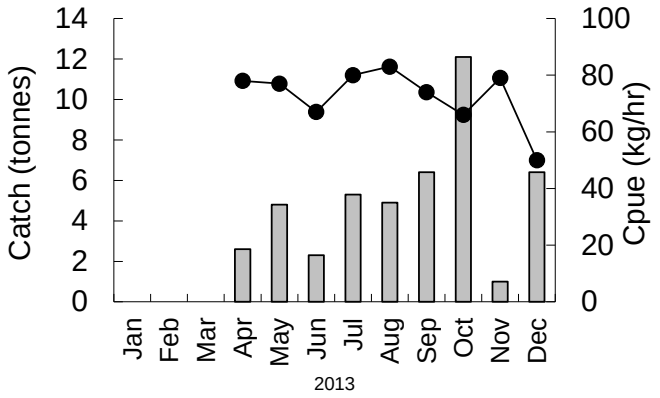


Figure 13. Mean catch and catch rates by month, Templestowe– Binalong Bay, 2013.

At the northern end of the Eastern Zone, the annual catch from Block 31 was considerably reduced compared with previous years, to 15 t, or approximately half the post-zoning period average. This part of the Eastern Zone remains open year-round, to encourage fishing in a part of the fishery where stocks are regarded more plentiful. Under 5 t was caught in the first three months when the rest of the zone was closed, and for several months no catch was taken (Figure 14).

Mean catch rates for the area remained unchanged from the previous year (71 kg/h). Most of the fishing targeted small areas of better quality fish in the south, and catch rates are likely unrepresentative of abalone abundance throughout the broader region.

Abalone from Block 31 are frequently regarded as of lower grade than elsewhere in the Eastern Zone, and when markets were fully supplied in 2013, most processors were not interested in abalone from the area. Consequently this part of the fishery was lightly fished in 2013.

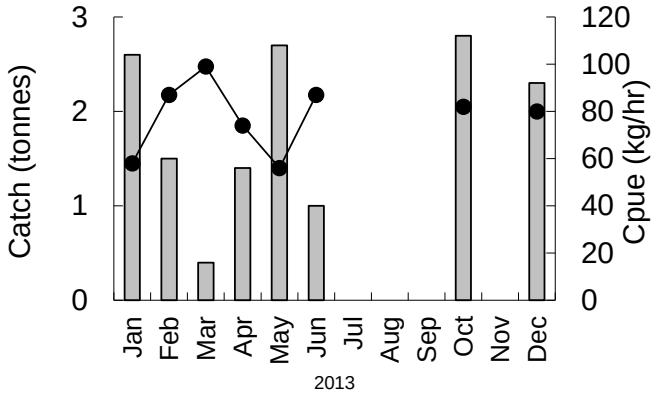


Figure 14. Mean catch and catch rates by month, Eastern Zone Block 31, 2013.

Diver observations

Tasman Peninsula south of Eaglehawk Neck (Block 22) has been heavily fished for the last four years. That it continues to supply such a large quantity of fish at reasonable catch rates is remarkable. Many divers were directed to fish there by processors, and it was a convenient place to fish for divers based in the south-east.

Blocks 23-24 fished better in 2013 than for many years. Reports of small quantities of visible pre-recruits in 2011 and 2012 manifested in improved catches in 2013.

Fishing in Blocks 27-28 and sub-block 29A improved significantly on the previous year. Catch rates were higher than anticipated. Some divers were upset that the low cap prevented them fishing apparently healthy stocks.

Blocks 29B-30A had an exceptionally high level of catch with high catch rates. Divers reported abundant stock levels. Many processors were not interested in travelling the region to collect the fish.

In areas where there were better quality fish (Georges Rocks, Eddystone Point), Block 31A stocks were reduced. Effort in the region was lower, corresponding with reports of dark meats/reduced quality and lack of interest by processors.

Qualitative assessment
Despite very high levels of catch in recent years, Block 22 appears to be maintaining yields, albeit at low catch rates. Abundance was accordingly assessed moderate and stable. The low catch rates indicated high levels of fishing mortality. It is not known what effect that such intensive fishing will have on future levels of catch, but it carries increased levels of risk.

In the region of the Forestier Peninsula and Maria Island (Blocks 23-24) there has been a resurgence of stocks, although these were fished heavily with greatly reduced catch rates at the end of the year. Abundance was assessed moderate and stable.

Stock levels were not assessed in Blocks 25 and 26 (no fishing).

Further north in Great Oyster Bay, the Freycinet Peninsula and the coast north to Seymour (Blocks 27, 28, 29A) part of the fishery was subject to catch restrictions and a 7-mm increase in LML. In Block 27 fishing was restricted to a small catch because stock levels were perceived low in 2012, and the 2013 catch rates supported this. In Blocks 28 and 29A stocks were assessed low, but improved catch rates suggested that stocks were increasing in size.

North of Seymour to Taylors Beach (sub-blocks 29B, 29C, 29D, 30A) produced an unusually large catch. Stocks were assessed moderate and stable.

Very little catch was taken from the Eastern Zone part of Block 31 because its abalone were less preferred by the market. It appears that the small areas of high grade fish in the region have become depleted, but elsewhere stock levels were reported high.

This part of the fishery was assessed as sustainable because of the degree of protection provided by the size limit. The legal-sized stock was assessed to be at low to moderate levels.

3.2 Central West Zone (Sub-blocks 5D, 6A, 6B and 6C)

Fishery-dependent data
The zone was reduced in size in 2013, and sub-blocks 6D and Blocks 7 and 8 were transferred to the Western Zone. The TAC for the zone was reduced to 101 t, and was caught completely. The annual catch has been reduced by one third compared with the period 2010-2012 when the catch for the (reduced) area was between 128-136 t.

Almost all the catch from the region is taken from Block 6, with < 1 t pa from sub-block 5D. The distribution of catch between the three Block 6 sub-blocks varies between years, but generally the area north and south of Couta Rocks (6A), and between the Gannet and Sandy Cape Beach (6C) produces most of the abalone. The abalone from 6C have been more favoured by processors in past years because a higher percentage of them than elsewhere in the zone were suited to live market sales.

This area has been heavily fished since the inception of the Central West Zone in 2009, averaging 122 t pa. This has reduced stock levels, and catch rates have fallen from 135 kg/h to 80 kg/h. One of the hardest hit areas was 6C, which in 2010 produced 55 t at 155 kg /hr, but has since been reduced to producing just 27 t at 80 kg/h.

The size of abalone has fallen in 6A and 6B, both with a median size of 137 mm, where 8% and 7% of catches were sampled. The 25th percentile length in 6A was at the LML (i.e. one quarter of abalone sampled were 132 mm long), and just 1 mm larger in 6B, indicating unusually high fishing pressure. This small size could be expected to reduce catch rates because of the additional handling required. In 6C abalone were larger with a median length of 143 mm.

Diver observations
Divers said that this area had been fished intensively. In many places, divers were "measure fishing", which caused catch rates to be reduced. They were confident that it would recover quickly provided that low levels of catch were maintained for the next couple of years.

Qualitative assessment.
There is concern for this region because stocks have been rapidly reduced to moderate levels following five years of large catches at a reduced LML. It is clear that the benefits of the size-limit reduction were short-lived and that the region is no longer able to sustain successive years of 100-ton catches. The catch in this zone has been reduced to 73.5 t in 2014.

This part of the fishery was assessed sustainable based upon the protection provided by the LML over most of the area, and the relatively high catch rates.

3.3 Western Zone

The Western Zone TAC was 1001 t in 2013. Most catch was taken from the South West region, which has increased its catch since 2011 (Figure 15), while catches in the other regions have fallen. In 2013 the northern boundary of the Western Zone was extended to the Wild Wave River on the beach north of Sandy Cape. Sub-block 6D and Blocks 7 and 8 were transferred from the Central Western Zone to the Western Zone.

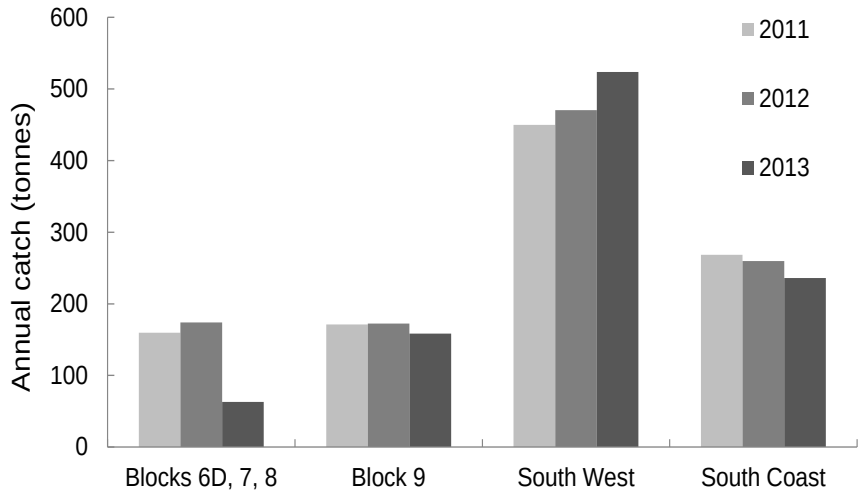


Figure 15. Distribution of regional catch, Western Zone, 2011-2013.

3.3.1 North of Strahan (Sub-block 6D, Blocks 7 to 8)

Fishery-dependent data
The regional catch was 63 t, under half the post-zoning average, and approximately one third of the annual catch when it formed part of the Central Western Zone. In the north in 6D (Sandy Cape), just 11 t was reported. This sub-block has been heavily fished post-zoning, with an average catch of 35 t, so the 2013 catch represents a considerable reduction. Similar reductions were seen further south, and the only sub-blocks with catches in double figures were Rupert Point (7A) with 11 t, and Conical Rocks (7B) with 27 t.

Catch rates were lower, with a regional average of 108 kg/h. There has been a steady decline in catch rates from a high of over 160 kg/h since the inception of the Central West Zone. Catch rates were best in the more remote sub-blocks (e.g. 7A fished at 136 kg/h and 8B near Trial Harbour fished at 216 kg/h). In the north at Sandy Cape, and in the south closer to Granville Harbour, catch rates were much lower at approximately 100 kg/h.

The median size of abalone from sub-block 7B has fluctuated between 152-155 mm since 2008, with 9% of catches sampled in 2013.

Qualitative assessment
Stocks were greatly reduced in the region after the development of the Central Western Zone in 2009 and its concomitant high annual catches. Since its return to the Western Zone in 2013, the catch has been halved and there is an expectation that stocks will recover. Stocks were assessed moderate.

The regional catch has since been reduced through the 2013 Western Zone TAC reduction. This part of the fishery was assessed sustainable based upon the protection provided by the LML over most of the area, and the relatively high catch rates.

3.3.2 South of Strahan (Block 9)

Fishery-dependent data
The Block 9 catch was 158 t in 2013, split between 9B (Cape Sorell south to Gorge Point) with 52 t and 9C (Gorge Point south to Point Hibbs) with 105 t. A further 1.5 t was taken in 9A. The 9C catch increased by approximately one third in 2011, but fell by a similar amount in 9B.

Regional catch rates have fluctuated between 145-170 kg/h during most of the post-zoning period, but in 2012 fell to 137 kg/h, and then to 116 kg/h in 2013. Catch rates were higher in 9C in the south (122 kg/h), while closer to the boat ramps in 9B, they were 109 kg/h.

In the Western Zone, most of the fishing takes place between November and February in the following quota year, with smaller amounts of catch taken as weather permits during the remainder of the year (Figure 16). This often creates an oversupply of abalone, which forces processors to place limits on the amount of abalone that they can accept, and causes weakness in beach prices.

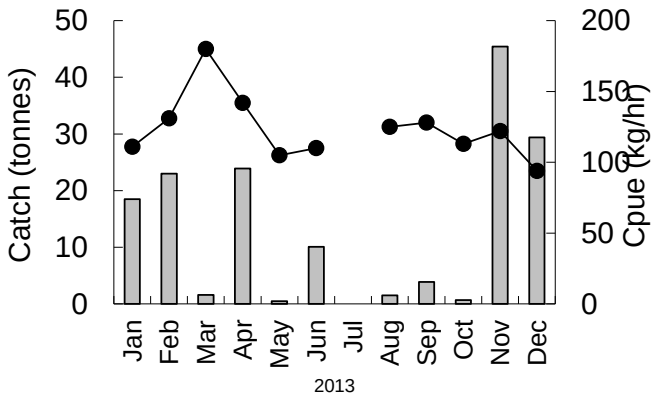


Figure 16. Mean catch and catch rates by month, Block 9, 2013.

Insufficient catch sampling was done on catches reported from 9B in 2013. In 9C, the size of abalone sampled has become smaller. The median length was 155 mm, almost identical to the recent six-year average (154.7 mm). During the six-year period prior to that, the average median size was 158.5 mm. Using length-weight parameters from the region (*weight=a.length^b, a=5.00E-05, b=3.195*), this represents an 8% reduction in weight of abalone *at the median size*.

Diver observations
Oversupply of abalone in November caused processors to restrict many divers operating from Strahan to a catch of 400 kg per day or less. The divers responded by working multiple divers per boat or operating closer to port. Divers said that this caused catch rates to be lower than might be expected. However, they also said that there were less abalone compared with just one or two years earlier, and that the main reason for lower catch rates was falling stock levels caused by overfishing.

Qualitative assessment
Catch rates have fallen for successive years and it is evident that the catch was excessive. Stocks were assessed moderate and falling.

The regional catch has since been reduced through the 2013 Western Zone TAC reduction. This part of the fishery was assessed sustainable based upon the protection provided by the LML over most of the area, and the relatively high catch rates.

3.3.3 South West (Blocks 10, 11, Sub-block 12A)

Fishery-dependent data
The regional catch was 524 t, between 50-90 t more than when the regional catch was first reduced following the creation of the Central Western Zone in 2008. A cap of 400 t was place on the region's catch during 2013, but it was exceeded during a period of intense fishing in November, and the region was closed to fishing on 2 December. However, despite the large size, the annual catch was moderate compared with other catches in the post-zoning period. The catch was distributed between Block 10 (180 t), Block 11 (287 t) and sub-block 12A (56 t).

Regional catch rates have been in decline since the inception of the Western Zone except for a small period 2009-2010. Generally the sub-blocks in the south (i.e. those closer to the ports in the south-east of the State) have lowest catch rates, ranging between 86 kg/h (11E) and 108 kg/h (12A). In Block 10 catch rates have fallen sharply over the past two years ranging between 106 kg/h (10A) and 124 kg/h (10B).

Fishing in the region is influenced by weather and like Block 9 to the north, is also highly seasonal, with peak catches between November and February (Figure 17). Almost all of the 132 t November catch was caught during two short periods when sea conditions subsided enough for divers to work.

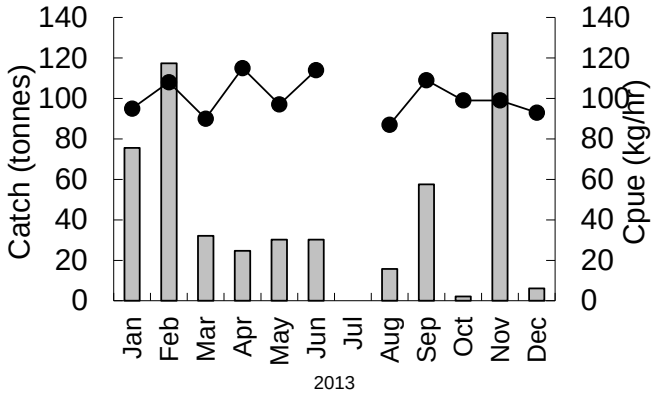


Figure 17. Mean catch and catch rates by month, South West, 2013.

Information from catch sampling in this region is unreliable because catches are usually mixed across several sub-blocks or even regions within the zone when they are stored in the holds of motherships. In recent years, median sizes have tended to increase from 153-154 mm in 2010 to 158-160 mm in Blocks 10 and 11. Given increased fishing pressure, an increase in size seems unlikely i.e. the increase is probably artefactual.

Diver observations
Divers were surprised how quickly the fishing had deteriorated, particularly in the more remote parts of Block 10. It was well accepted that the area around Port Davey and Green Island has been heavily fished for many years, and that better fishing could be found further north, but where just two years ago they would expect to catch 700-800

kg/day or better, they found that they were struggling to catch half that amount. Most divers expressed their concerns about falling stocks, reduced catches and lower catch rates.

Opinions about the state of the fishery were divided. Some divers maintained that the current catch rates were similar to those of the 1990's and that the fishery is sustainable at current levels of catch and catch rate. They thought that it was unrealistic to expect catch rates be maintained at levels approaching 150 kg/h or better.

Qualitative assessment
Catch rates have fallen more than 25 kg/h since 2010 to approximately 100 kg/h, and it is evident that the annual catch was excessive. Stocks were assessed moderate and falling.

The regional catch has since been reduced through the 2013 Western Zone TAC reduction. This part of the fishery was assessed sustainable based upon the protection provided by the LML over most of the area, and the relatively high catch rates.

3.3.4 South Coast (Sub-blocks 12B, 12C, 12D, 13A, 13B)

Fishery-dependent data
The South Coast catch was 236 t, down by 10% on the previous year and approximately 25% less than the period 2008-2010 during which annual catches peaked at unprecedented high levels. Unusually, the 260 t cap was not reached in 2013.

Most catch was reported from 12C (Maatsuyker Group) with 84 t reported caught. Since 2010, there has been a shift in effort to 12C from the other parts of the region. There has been a corresponding reduction in catch in 12D (70 t), which for many years previously had annual catches two or three times the size of the other sub-blocks. Smaller catches were also reported from further west in 12B (42 t), and to the east in 13A (18 t) and 13B (23 t).

Despite the lower catch, regional catch rates fell from the 90-100 kg/h range in which they had been since 2002. The highest catch rates were in the Maatsuyker Group (116 kg/h). Elsewhere catch rates ranged between 65-72 kg/h i.e., catch rates fell by 20 kg/h in all other sub-blocks in the region.

Peak catch levels occurred in January (51 t) and in December (36 t) following the South West closure. Smaller amounts of catch were taken at regular intervals throughout the year.

In 13A and 13B median sizes increased substantially to 160 mm and 155 mm respectively. Divers attributed this to searching infrequently fished reef as a response to low stock levels, thereby encountering larger abalone. In the other sub-blocks, median sizes were 154 mm (12D), 159 mm (12C) and 158 mm (12B).

Diver observations
Divers were concerned about apparently weak stock levels in Block 13.

Qualitative assessment
The South Coast fishery has been stable for many years, and consequently the fall in catch rates after two years of reduced catches is surprising. It has long been apparent

that the eastern part, particularly Block 13 suffers excess fishing pressure, and it now appears that stocks have become depleted throughout the region, particularly on the mainland shore (12B, 12D, 13A, 13B). Given the relatively larger size of abalone and catch rates between 65-72 kg/h, it is evident that stock abundance was no better here than further east at the Actaeons. Offshore at the Maatsuyker Group (12C) stock levels were higher, and much of the effort was transferred there. It remains to be seen whether Maatsuyker can continue to sustain current levels of fishing until the mainland shore recovers, or whether it too will become depleted and the region will require a managed catch reduction.

This part of the fishery was assessed sustainable based upon the protection provided by the LML over most of the area. The potential catch from the region has since been reduced indirectly through the 2013 Western Zone TAC reduction.

3.4 Northern Zone

The Northern Zone TAC was 308 t in 2013, reduced by 70 t from the previous year. Blocks 48 and 49 (Remainder North West) produced the largest amount of catch in 2013, while the catch from Block 5 has been reduced by management intervention (Figure 18).

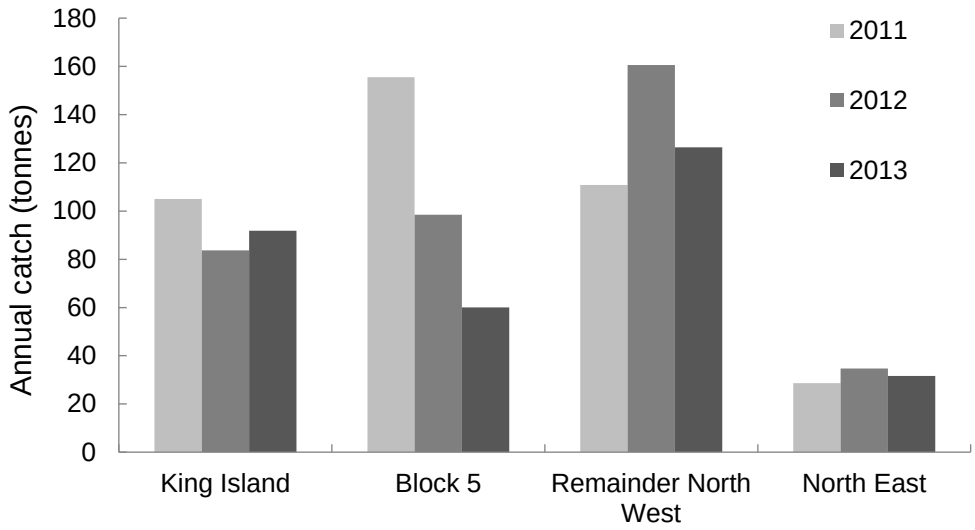


Figure 18. Distribution of regional catch, Northern Zone, 2011-2013.

3.4.1 King Island (Blocks 1 to 4)

Fishery-dependent data
The annual catch from King Island was 92 t, lower than its amended management target of 118 t. The annual catch here is usually determined by the extent to which catch limits in the other regions have been overrun. Most divers found the island too remote and costly to fish, and chose to operate elsewhere. However when the other regions have reached their catch limits, it becomes the only place from where Northern Zone quota can be caught, causing large amounts of catch to be taken late in the year (Figure 19). Periodically, demand for King Island blacklip falls, and effort becomes reduced or nil during some months.

Almost all the catch was taken from the western side of the island, from sub-blocks 1C (22 t), 3A (24 t) and 3C (35 t). Less than 2 t was taken from Block 4 in the south and east. This area has formerly produced much larger amounts of catch (the post-zoning average is 13 t).

Catch rates derived from blacklip-only catches have remained stable over the recent 10-year period, moving in a range between 93-117 kg/h. In 2013, the regional mean catch rate was 101 kg/h. Catch rates between January and July averaged 120 kg/h, but in the last part of the year averaged 89 kg/h. This is partially explained by effort at depth e.g. during February and March when catch rates were higher, almost all effort in sub-block 3C was at depths > 15 m. From August, diving was mostly at depths ≤ 15 m and catch rates were reduced. Stock levels appeared to be higher in deeper water.

Insufficient catch samples have been collected from this area for a representative time series of length data.

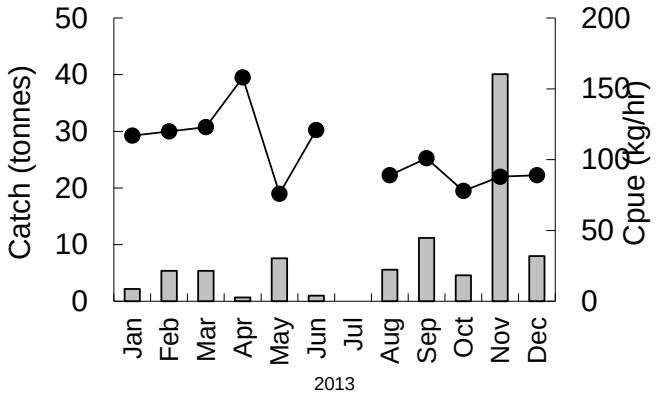


Figure 19. Mean catch and catch rates by month, Northern Zone, King Island, 2013. Some catch rates may have been derived from mixed species catches.

Diver observations

Resident divers have an advantage over visitors to the region because (a) they can choose to dive during more favourable weather conditions and (b) they can avoid areas where the visitors have fished. Consequently, their catch rates were usually relatively high, while visitors generally had lower catch rates. Annual catch rates are therefore dependent on the proportion of the catch taken by the two groups. Opinions about King Island blacklip stocks were divided between the two groups. Residents believed that stock levels were plentiful. Visitors were less confident about stock levels, and said that many areas where they had previously taken good quantities of abalone were depleted.

Large quantities of small blacklip in Block 2 and sub-block 3B have been reported unavailable because the size limit is too high. Potentially, the size limit could be reduced in these areas to increase the stock size.

Qualitative assessment

The King Island catch again failed to reach its management target by approximately 20%. This was mostly due to divers' preferences to fish elsewhere, and not because of low stock levels. Some depletion was evident among the island stocks but overall catch rates and the large size of abalone relative to the LML indicated that stock levels remained moderate to high, particularly at depths > 15 m.

This part of the fishery was assessed sustainable based upon the protection provided by the LML over most of the area, and the relatively high catch rates.

3.4.2 Block 5

In 2013, the Block 5 catch was limited to 83 t but mid-year this was revised downwards to 60 t following low catch rates and reports of poor fishing. The fishery closed on 11 November with 60 t caught and the balance of the management target was transferred to King Island. In the context of recent past catches, this is a relatively small annual catch, less than 2/3 of average catches for the region. In the north in 5A, 23 t was caught, 18 t in 5B and 18 t in 5C. Almost half the catch was taken in February and March.

Mean catch rates were reduced from previous years at 65 kg/h, having fallen continuously for a high of 104 kg/h in 2009. In 5A, catch rates were lowest, at 61 kg/h. In 5B and 5C catch rates reached 70 kg/h.

The size of abalone sampled from catches has become severely reduced. In all three sub-blocks, the 25th percentile length was within 1 mm of the 127-mm LML, the median was between 129-132 mm and the 75th percentile was between 134-137 mm. Between 7%-13% of catches were sampled.

Diver observations
Divers reported that abalone remained relatively abundant, but most were below legal size. They said that the small size meant that they had to measure much of the catch, and that this contributed to low catch rates.

Qualitative assessment
The size of abalone has become extraordinarily reduced, so that more the one quarter of abalone in sampled catches were within 1 mm of the size limit. Regionally, catch rates have fallen to levels unprecedented in the post-zoning era. Stocks have become very depleted in Block 5. Significant populations of sub-legal abalone were reported prevalent however.

The management catch target has been reduced by almost one quarter, to 50 t in 2014. This part of the fishery was assessed sustainable based upon the protection provided by the LML over most of the area, and the relatively high catch rates.

3.4.3 Remainder North West (Blocks 47 to 49)

Fishery-dependent data
This part of the fishery closed on 15 October, with 126 t taken (the catch cap was 100 t). Most of the catch (112 t) was taken from around Hunter, Albatross and Three Hummock Islands in Block 49, with 26 t from 49A, 41 t from 49B and 46 t from 49C. An additional 10 t was taken from east of Woolnorth in 48C, 3 t from the Petrels (48B) and 1 t from Black Reef (48A). No blacklip catch was reported from Block 47.

Catch rates fell across most of the region, to a mean of 71 kg/h. At Three Hummock Island (49A) catch rates fell by 25 kg/h to 70 kg/h following a large (56 t) catch the previous year. At Hunter Island between Cuvier Point and Woolnorth (49C) catch rates fell from 80 kg/h to 68 kg/h. At Albatross Island (49B), the catch has increased from 4 t

in 2012 to over 20 t, with catch rates increasing from 102 kg/h to 120 kg/h, while on the northern half of Hunter Island (also 49B), the catch has been reduced to 16 t, and catch rates have fallen from 102 kg/h to 83 kg/h.

In the southern part of this region (48C, 49C), abalone sampled from catches were the smallest in the region, with 25th percentile lengths 3 mm above the 120-mm LML and median length at 126 mm. There are two size limits operating in sub-block 49B (Albatross Island is fished at 127-mm LML), and there the median length was 137 mm. At Three Hummock Island (49A), the 25th percentile length was 125 mm, and the median length was 130 mm. Sampling rates were low, with between 4%-10% of catches sampled per sub-block.

Diver observations
Like Block 5, divers reported that abalone remained relatively abundant, but most were below legal size. They said that the small size meant that they had to measure much of the catch, and that this contributed to low catch rates.

Qualitative assessment
The size limit was reduced by 5 mm across most of this region in 2012, thereby substantially increasing the size of the stock. The region has since been heavily fished, producing 276 t and stocks have been quickly depleted from high levels. Catch rates and the larger size of abalone relative to the LML indicated that stocks levels were at best moderate. Further reduction of stocks appears inevitable should catches remain excessive.

This part of the fishery was assessed sustainable based upon the protection provided by the LML over most of the area, and the relatively high catch rates.

3.4.4 North East (Sub-block 31B, Blocks 39 and 40)

Fishery-dependent data
The annual catch was 32 t, from a cap set at 30 t. The fishery was closed after it had reached its cap on 7 October. Most fishing was done at Swan Island (31B), where 25 t was caught. A further 7 t was caught at Cape Portland (39A).

Many of the catches from both sub-blocks included greenlip. Previous assessments used mixed catch rates, which were lower than blacklip-only catch rates. In 31B approximately two thirds of trips were reported blacklip-only fishing. In 2013 catch rates were 59 kg/h, similar to those of the past two years, but down from 2010 when they were over 70 kg/h. Regional mean catch rates from blacklip-only catches were 60 kg/h, similar to those of the previous two years.

Catch sampling form the region was inadequate to produce a time-series of length data. Abalone in this region are small and the LML is 127 mm. Approximately 5% of catches from the region were sampled for abalone length measurements in 2013. In 31B and 39B, the respective 25th percentile lengths were 130 mm and 129 mm, and the median lengths were 135 mm and 132 mm.

Qualitative assessment
The North East blacklip fishery is small, but in conjunction with its greenlip periodically attracts high levels of effort, which makes limiting the catch to the cap

difficult. Catch rates from the most productive reefs have been stable in recent years, and the catch has been constrained close to the management catch target. Stock levels were assessed moderate and stable.

This part of the fishery was assessed sustainable based upon the protection provided by the LML over most of the area, and the relatively high catch rates.

3.5 Bass Strait Zone

The Bass Strait Zone blacklip fishery TAC was 70 t in 2013. There was little change in the distribution of catch between regions compared with previous years (Figure 20).

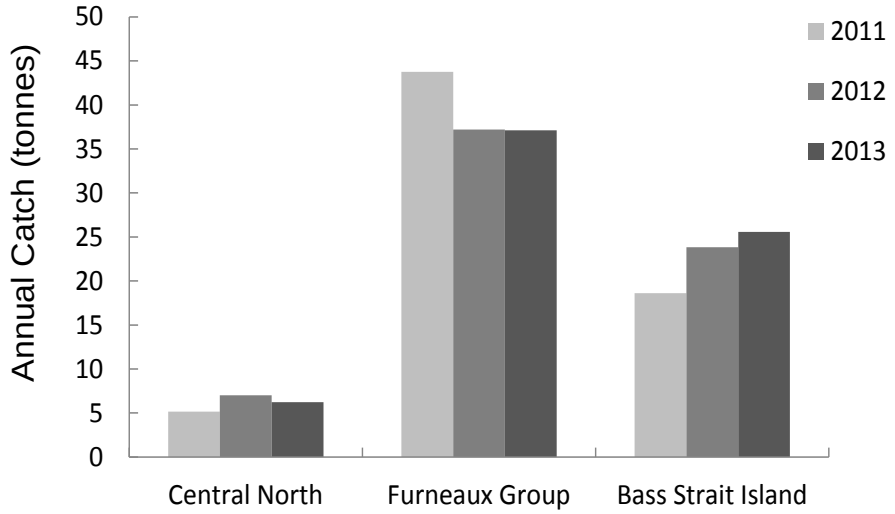


Figure 20. Distribution of regional catch, Bass Strait Zone, 2011-2013.

Fishery-dependent data
The 70 t Bass Strait Zone blacklip TAC was split between the Furneaux Group (37 t), the remote Bass Strait islands including the Kent, Hogan and Curtis Groups (26 t) and the Central North Coast from east of Circular Head (Cowrie Point) to Bridport (6 t).

In the remote islands, most (18 t) of the catch was taken from the Hogan Group (Block 53). Smaller amounts (5 t) were taken from the Kent Group (Block 51) and the Moncoeurs (3 t). There was no catch reported from the Curtis Group (Block 56). The combined regional catch (26 t) was low compared with the period 2003-2005 when the average catch for the regions was 57 t, or the period 2006-2009 when the average catch was 35 t.

Mean catch rates were generally much lower than previous years, at 59 kg/h. At the Hogan Group, catch rates fell by 25% to 58 kg/h, and by a similar amount to 51 kg/h at the Kent Group. They remained high at the Moncoeurs (128 kg/h).

Catch rates from the remote islands often exhibited extreme variability (e.g. between 40 kg/h and 120 kg/h) among divers operating from the same mothership on the same day, with daily catches ranging between 40 kg and 850 kg. Under these circumstances, catch rates probably reflect fleet dynamics more than abundance.

In the Furneaux Group, a catch limit of 30 t was placed on blacklip catch from the eastern half (sub-blocks 33B, 33C, 36A, 36B, 38A, 38B, 38C). The cap closed on 19 August, with 27 t caught. Only three sub-blocks produced significant quantities of abalone: sub-blocks 33B (9 t) and 33C (4 t) at Cape Barren Island, and sub-block 38A (14 t) at Babel Island. Within these three sub-blocks, 84% of catches were for blacklip-only fishing. Another 10 t was caught from outside the capped area, mostly from sub-block 33A (5 t) and 37D (3 t). Small quantities of blacklip were caught while fishing for greenlip in other parts of the region.

Averaged across the region, catch rates from blacklip-only catches have regained former high levels, at 79 kg/h. The mean catch rate from blacklip-only catch in the capped area rose to 83 kg/h, comprising catch rates from 38A (82 kg/h) and from 33B (84 kg/h) and 33C (85 kg/h). Outside the capped area in 33A, catch rates were 146 kg/h, and in 37D, 63 kg/h.

The total catch from the Central North coast (Blocks 41-46) was 6.2 t, similar to that of the previous three years. Almost all the catch (4.9 t) came from Block 43, caught at the mouth of the Tamar. Small quantities of catch (< 1 t) were taken from Blocks 44, 45 and 46. No catch was reported from Blocks 41 or 42.

Catch rates from Block 43 increased by 10% to 51 kg/h. Further west in Blocks 45 and 46, catch rates were below 40 kg/h.

Diver observations
Divers were impressed with the resilience of the fishery at Babel Island and south-east Cape Barren Island. They said that it appears that the size limit and the annual catch were appropriate for the region. They said that they required that high catch rates be maintained here, to make motherboat fishing worthwhile.

Qualitative assessment
Blacklip stocks in the Furneaux Group appear to be robust and recovering from the high levels of fishing mortality in previous years. In the 2012 assessment there was concern that stocks had fallen from high levels following four years of large catches. It appears that management intervention to successfully reduce the catch in 2012 and 2013 has reversed the catch-rate decline, and that stocks have stabilised at moderate to high levels. This area was assessed at low risk of recruitment overfishing and thus sustainable based on the protection provided by the size limit over most of the area.

In the remote islands (Blocks 50-56) the sporadic nature of fishing events and extreme variability of catch rates reduces confidence in their use as a means of assessment. However levels of catch were low to moderate and it is assumed that in the absence of information to the contrary, stock levels were stable and moderate. This area was assessed at low risk of recruitment overfishing and thus sustainable based on the protection provided by the size limit over most of the area.

Small quantities of catch continue to be taken from the Central North Coast, mostly from Block 43. Catch rates have increased since 2011, but remain low. Stocks were assumed to be at low but stable levels. This area was assessed at low risk of recruitment overfishing and thus sustainable based on the protection provided by the size limit over most of the area.

3.6 Greenlip fishery

A fishery of 140 t p.a. for greenlip abalone takes place in northern Tasmania, in the regions of the North West, King Island, North East, Furneaux Group and the Central North Coast between Smithton and Bridport. The amount of catch from these regions is limited by management controls (caps) aimed at distributing catch according to estimates of relative abundance among individual regions. The fishery tends to be limited to a small number of divers, with just 12 divers, almost all of whom were based in the north of the state, catching 50% of the TAC.

Part of the greenlip catch is taken while fishing for blacklip. Divers report effort from both species using three different methods, and comparison of catch rates derived from mixed species fishing trips may be influenced by varying abundance of blacklip and therefore is not useful. This assessment used catch rates derived from trips where only greenlip were caught. In some areas the percentage of greenlip-only trips was too low to make an assessment, but in other areas greenlip-only trips were the norm and catch-rate comparison between years was valid.

Sampling of greenlip catches for length measurements has been too infrequent in earlier years to provide much information about changes in greenlip abalone length. In 2013, there was sufficient sampling only from the North East and the southern part of the Furneaux Group, where approximately 10% of catches were sampled.

King Island
The greenlip catch was 20 t, from a cap of 25 t. Greenlip were caught from Block 1 (2.3 t), Block 2 (12.3 t), Block 3 (1.6 t) and Block 4 (3.9 t). These totals are within the range of post-zoning catches (Appendix 6: Annual Catches by Zone – 1975-2013), excepting Block 1, which is approximately 25% of former levels.

In Blocks 1 and 3 almost all the greenlip catch was taken while fishing for blacklip, and consequently between-year comparisons of catch rates are not useful. In Block 2 and Block 4, 95% and 64% of the greenlip catch was taken while fishing only for greenlip, and these form the basis of the assessment.

Block 2 catch rates were 51 kg/h, the lowest level since 2007. However, in the seven years before that, catch rates were above 51 kg/h only once, so while catch rates are low, they are not unusually low. In addition, they have recovered from these low levels at similar levels of catch. In Block 4 catch rates were higher, averaging 58 kg/h. This is comparable with recent years (since 2007), and better than all post-zoning year prior to that except one (2000). Catch rates appeared moderate and stable in Blocks 2 and 4.

Several divers, including the resident divers, have expressed concern about falling greenlip stock levels on the island. Principal among their concerns are that the greenlip stocks around Christmas and New Year's Island in Block 1 have disappeared and the island is now reliant on a small area around Councillor Island and the Blowhole in Block 2 to provide most of the catch. Should this area be overfished, the island would lose much of its capacity to produce greenlip.

North West Tasmania
The greenlip catch from this region was 22.6 t, from a cap of 18.5 t. Catch was taken from sub-blocks 5A (4.9 t), 48B (5.0 t), 48C (10.2 t) and 49C (2.6 t), all of which

tonnages are unexceptional compared with previous years' catches in the post-zoning era.

Comparisons of catch rates through time are problematic, because most of the greenlip catch from all sub-blocks in the region is taken while blacklip fishing and the number of greenlip-only fishing trips is low. West of Woolnorth in 5A, where 17% of the catch was taken single-species greenlip fishing over just two trips, catch rates were 60 kg/h. East of Woolnorth (48C), with 25% of the catch from greenlip-only fishing over 13 trips, catch rates were 53 kg/h. Immediately north in 49C (16% greenlip-only fishing or two trips), catch rates were 59 kg/h. Further east at the Petrels (48B) catch rates were higher (82 kg/h), but only 11% of catches, (two trips) were greenlip-only. In all cases, catch rates fell or have fallen within the past two years.

Black Reef, Perkins Bay and the Central North Coast
Further east at Black Reef in Perkins Bay (sub-block 48A) the greenlip fishery has been stable at approximately 20 t pa since 2008, when the LML was reduced from 145 mm to 132 mm, and the catch capped at 20 t. For the first time since the start of the current management practises, the catch (17 t) failed to reach the cap (25 t), largely due to market preferences for larger abalone than available in this region. Almost all the catches at Black Reef were greenlip-only. Catch rates have fallen rapidly and for consecutive years, from 140 kg/h in 2011 to 92 kg/h in 2013.

North East Tasmania
In North East Tasmania, 24.5 t of greenlip was caught from a cap of 23 t. Of this, 14.2 t was reported from Block 31, 9.1 t from Block 39 and 1.2 t from Block 40. Most of the catch was taken in April and May, and the region was closed to fishing on 3 June.

Most greenlip fishing was done in conjunction with blacklip fishing, and catch rates trends from greenlip-only fishing trips may fail to adequately represent changes in abundance over the broader fishery. Regionally, catch rates have trended down slightly to 58 kg/h, declining slowly over a three-year period from 65 kg/h. The 2013 regional catch rate was estimated from 34% of trips where greenlip were caught. In Block 31 where most of the catch was taken, catch rates improved to 65 kg/h, but fell elsewhere, to 40 kg/h in Block 39 and 58 kg/h in Block 40.

Between 2012 and 2013 the size of greenlip taken from the North East was reduced, with median lengths falling to between 154-155 mm from 160 mm, and 25th percentiles falling to 149-150 mm from 153-154 mm. The LML is currently 145 mm. This reduction in size is consistent with increased fishing pressure and a reduction in stock levels.

There were varying opinions among divers about this part of the fishery. Most divers indicated that the fishing was satisfactory, although catch rates tended to vary widely, particularly depending upon the amount of experience the divers had fishing greenlip in the North East.

This fishery has been managed with a catch limit of 23 t since 2005. This limit was determined from the geometric mean of annual catches for the region after a succession of years with catches of approximately 30 t caused catch rates to fall. It is difficult to effectively manage a small cap, because (a) divers are able to land several tonnes in a few days, (b) there is a lag of several days in catch reporting, and (c) the Government is

unable to close the fishery immediately, but is required to give notice of its intention to close part of the fishery. Intensive fishing during the period surrounding the closure date usually causes catch overruns, and consequently, the annual catch can quickly exceed 30 t (e.g. 2007, 2009, and 2012).

Furneaux Group
The 2013 greenlip catch was 55 t, mostly reported from southern Cape Barren Island and Clarke Island (Blocks 32 and 33, 31 t), and Franklin Sound (Block 35, 16 t). A further 4 t was taken from north-east Flinders Island, in Block 38. The size of the catch is substantially more than any other catch from the region since the mid-1990's, and the Block 33 catch in particular is one of the largest on record.

In Franklin Sound (Block 35), fishing was predominately for greenlip, and the effect of blacklip effort on catch rates was insignificant. Catch rates have fallen over four years from 64 kg/h to 53 kg/h. In the south the proportion of greenlip-only fishing trips is lower, at between 80- 90%. In Block 33, catch rates have fallen, also over four years, from 85 kg/h to 64 kg/h, and in Block 32, from 79 kg/h in 2012 to 62 kg/h. In Block 38, catch rates have fluctuated within a 50- 60 kg/h range during the since 2008, and were 57 kg/h in 2013.

Between 2012 and 2013, the size of greenlip taken from the southern part of the Furneaux Group (Block 33) was reduced, with median lengths falling to 154 mm from 157 mm, and 25th percentiles from 151 mm to 149 mm. The LML is currently 145 mm. This reduction in size is consistent with increased fishing pressure and a reduction in stock levels.

The relatively large size of the annual catch, the catch-rate decline and reduced size of abalone are evidence that this part of the fishery, at 55 t pa, is being fished beyond its capacity to produce abalone. During the mid-1990's two years of catches of over 60 t caused catch rates to be reduced below 50 kg/h for four years. It was recognised then that the Furneaux Group no longer had the capacity to sustain former levels of greenlip catch, and that 42 t pa was a safe limit. A number of measures were put in place to restore the fishery, including monthly catch caps, 200 kg/day catch limits, a six-month seasonal closure on Franklin Sound and increased LML. Most of these measures were later repealed or let lapse when the fishery recovered. However it became clear that the Furneaux Group could not sustain high levels of catch, and that its maximum capacity was closer to 40 t pa than 60 t pa.

Qualitative assessment
In the north-west of King Island, greenlip stocks have failed to recover and this area now produces negligible catch. The island's remaining stocks appear to be producing at maximum capacity, with no margin to rebuild populations or buffer further declines in productivity. It is recommended that the island's catch cap be reduced.

In the North West (Blocks 5, 48B, 48C, 49), stock levels were considered moderate, but appear to have fallen from previous levels following intensive fishing.

At Perkins Bay (48A), in accordance with the catch rate trend, stocks at Black Reef were assessed high but falling. Fishing was insufficient between Circular Head and Bridport (Blocks 41-47) to make a determination about stock levels.

Stocks in the North East (Blocks 31, 39, 40) were assessed reduced from previous levels, although the size of the catch and catch rates indicated that these levels remained moderate.

In the Furneaux Group (Blocks 32-38) the large catch and falling catch rates indicated that fishing pressure was excessive and that a reduction in catch was warranted.

3.7 Recreational fishery

Recreational fishing licenses are issued annually, expiring on 31 October each year. New licenses are available from 1 November. Most licenses are issued prior to Christmas, coinciding either with the opening of the rock lobster season in November or with the holiday period over Christmas. The number of recreational abalone diving licenses issued by DPIPWE has fallen from a peak of 13,538 issued in 2008, to 11,256 in 2013 (
Figure 21).

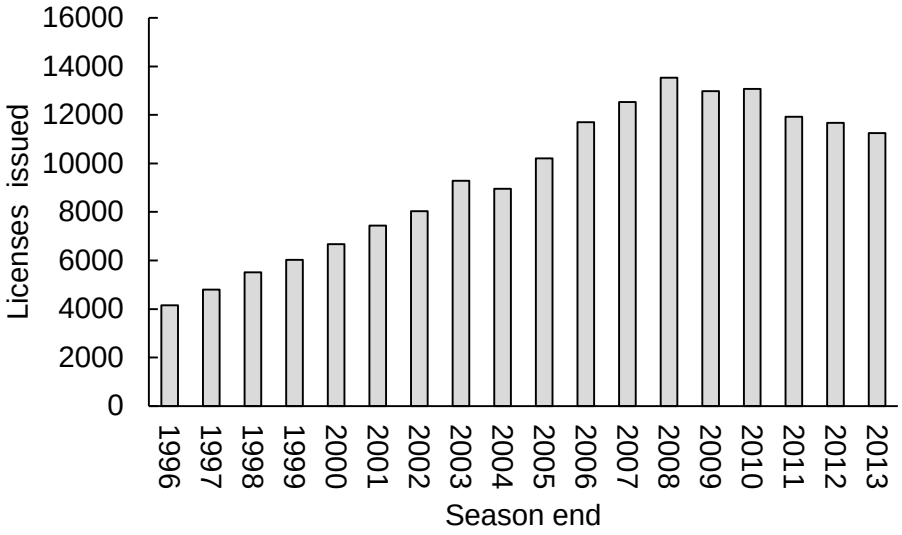


Figure 21. The number of recreational abalone diving licenses issued for the fishing seasons 1996-2013.

The most recent survey of recreational abalone fishing catch was undertaken for the 2012/2013 season (Lyle and Tracey, 2014). The survey estimated that 32 t of blacklip and greenlip abalone, or 1.5% of the total Tasmanian abalone catch, was taken by recreational fishers. This catch is slightly more (3 t) than reported from the previous survey (2010/2011), but is less than 50% of the peak catch reported in 2002-2003.

The recreational catch was proportionally higher than previous years because the commercial catch decreased, and not because the recreational catch increased. Approximately 50% of the recreational catch was taken in the east and south-east between Southport and Eddystone Point, in the area covered by Blocks 14 to 30 of the commercial fishery.

In the south-east, in the area covered by Blocks 14-22, the recreational catch was estimated at 28,233 (95% CI 18,421-38,368) blacklip abalone. Converted to weight, the catch approximated 14.7 t, representing 4% of the total catch. Within this area, 56% of the catch (i.e. approx. 7 t) was reported taken from the lower D'Entrecasteaux Channel. Almost no commercial catch was reported from the lower D'Entrecasteaux Channel in 2013 because of export restrictions due to the presence of bio-toxins in abalone.

In the north-west (which includes the area covered by the managed commercial fishing regions of Blocks 5, 48 and 49) 9,492 (95% CI 2,952-19,467) greenlip were taken by recreational divers. This catch was approximately 10% by weight of the total greenlip catch in that region. The 2012/2013 survey was the first to separate catch by species and there are no earlier statistics for recreational greenlip catch.

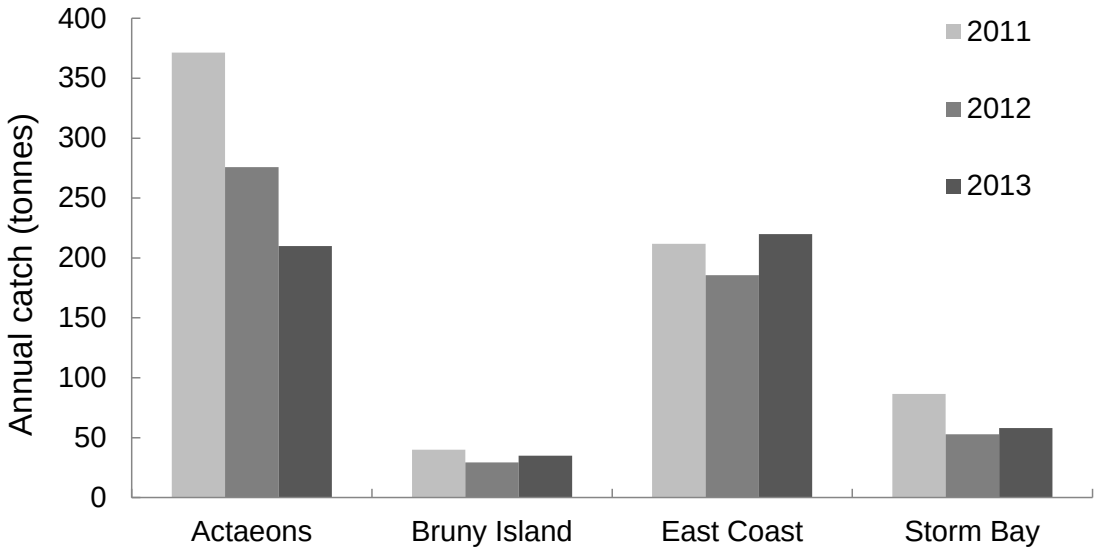
3.8 Indigenous and permit fisheries, and illegal catch

Abalone are caught in Tasmanian waters as part of cultural fishing activities by indigenous people. This catch is not quantified but is believed to be negligible. Catch is also taken under permits for special events and research purposes. In 2013, the catch under permit totalled less than 11 tonnes. This includes 10 tonnes taken at three sites at Hunter Island as part of a research project to improve abalone quality through reducing population densities. Illegal fishing is known to occur but no estimates of its total catch are available.

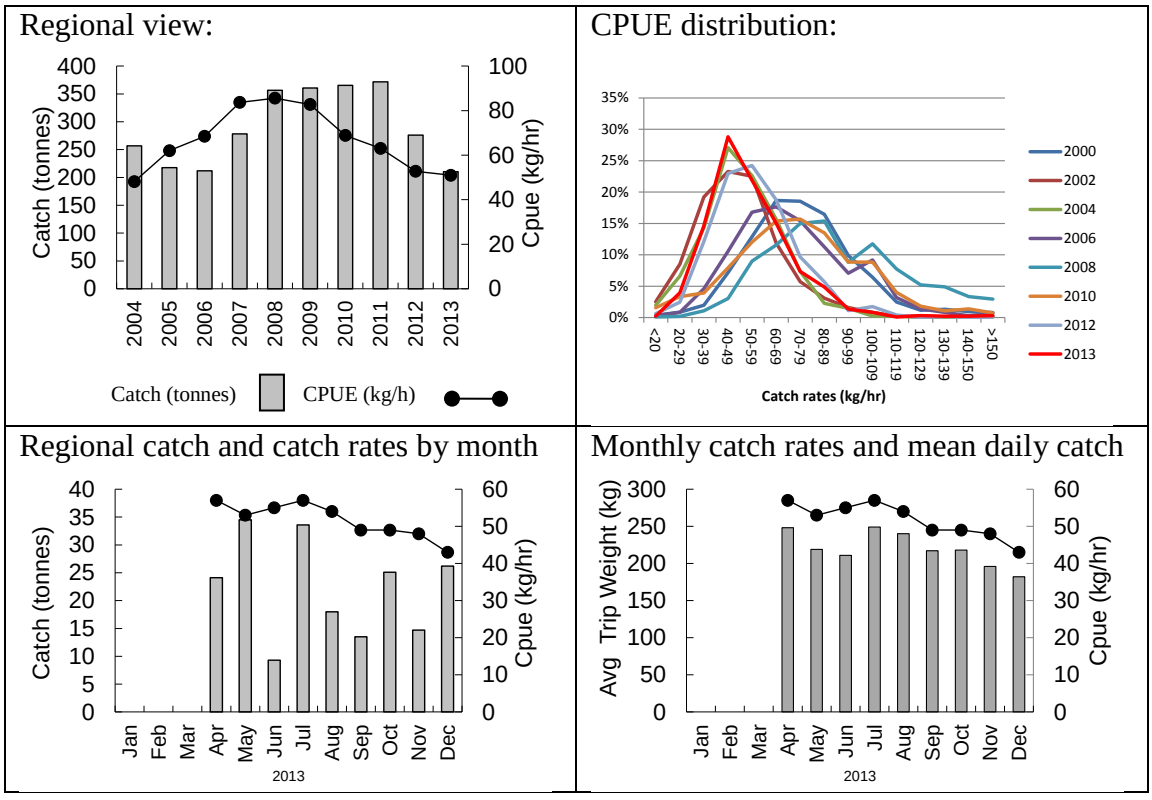
Appendix 1: Catch, catch-rates and size-composition

Eastern Zone blacklip fishery

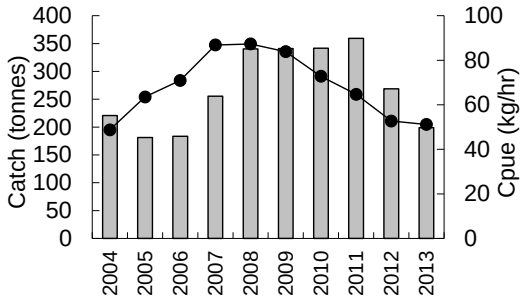
Distribution of catch between the four main regions of the fishery:



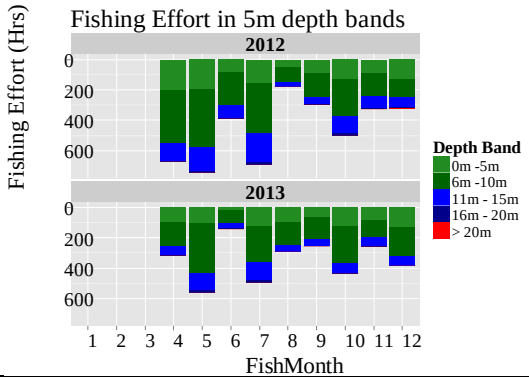
Eastern Zone - Actaeons, Lower Channel (Sub-blocks 13C, 13D, 13E, 14A, 14B)



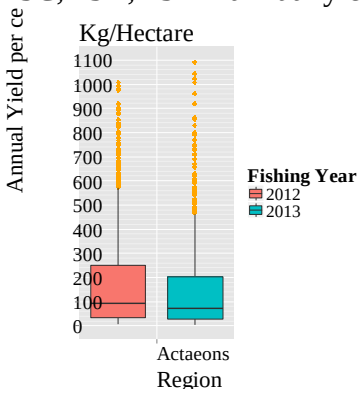
13C, 13D, 13E, catch not capped in 2013, 199 t caught:



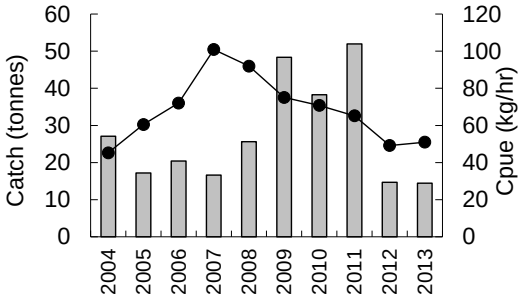
13C, 13D, 13E - monthly effort by depth



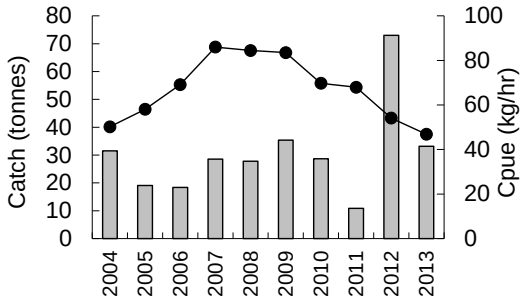
13C, 13D, 13E - annual yield



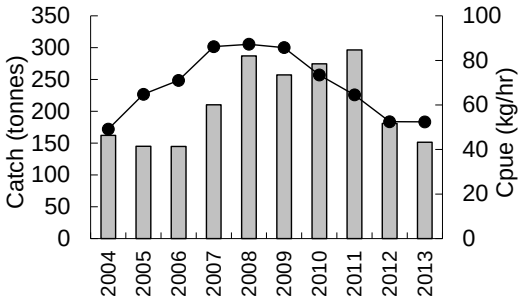
Sub-block 13C
Fishers Point to Whale Head



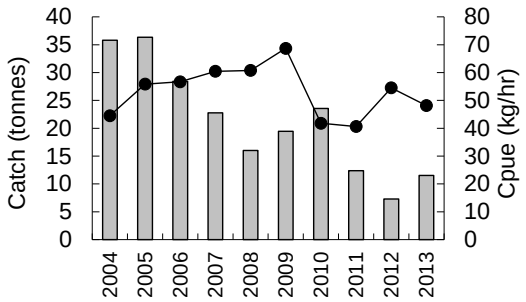
Sub-block 13D
Fishers Point to Southport Lagoon Beach, including Recherche Bay and Black Reef



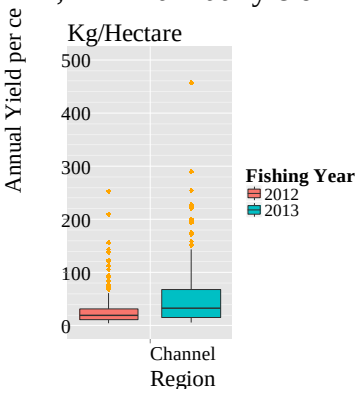
Sub-block 13E
Actaeon and Sterile Islands, and reefs to the south (the Breaks)



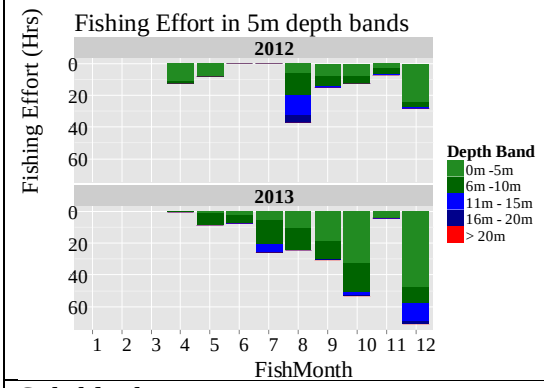
14A, 14B, catch not capped in 2013, 12 t caught.



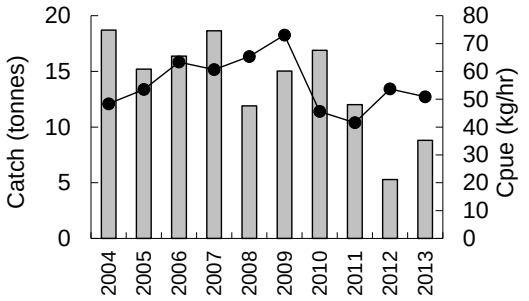
14A, 14B – annual yield



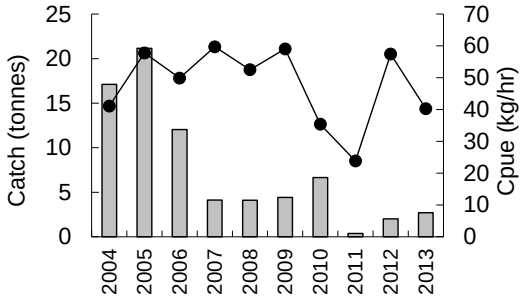
14A,14B - Monthly effort by depth



Sub-block 14A
Southport Lagoon Beach to Burnett Point

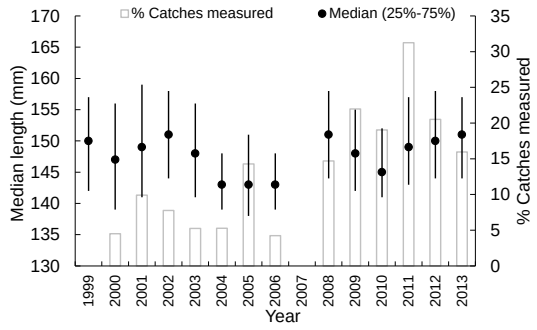


Sub-block 14B
Burnett Point to Blubber Head

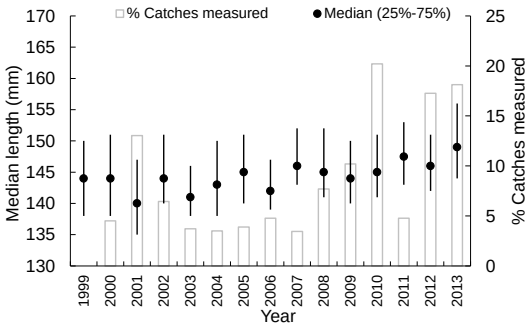


Actaeons, Lower Channel (Sub-blocks 13C, 13D, 13E, 14A, 14B)
Median length of catch

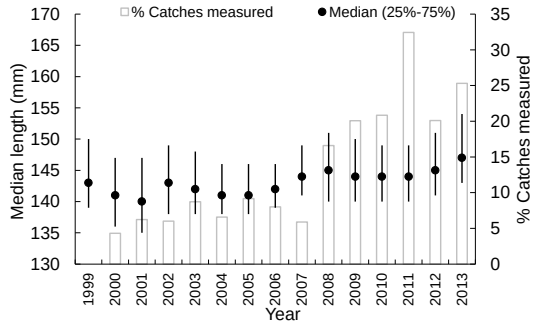
Sub-block 13C
Fishers Point to Whale Head



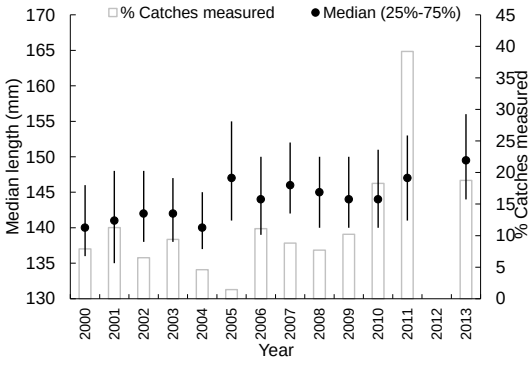
Sub-block 13D, Fishers Point to Southport Lagoon Beach, including Recherche Bay and Black Reef



Sub-block 13E Actaeon Island, Breaks etc.

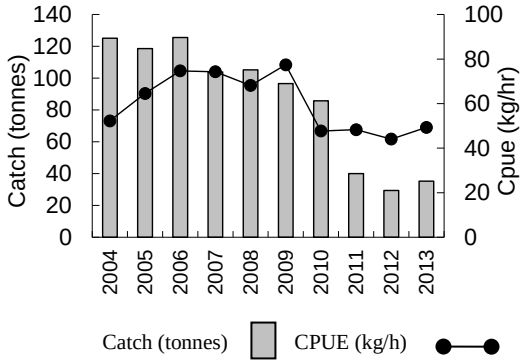


Sub-block 14A Southport Lagoon Beach to Burnett Point

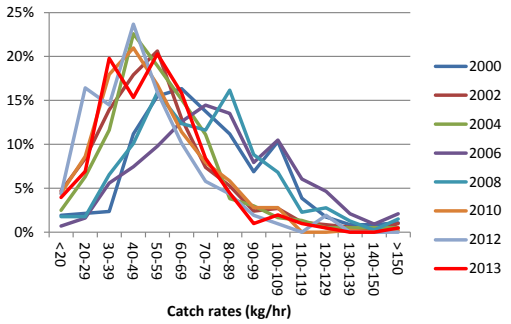


Eastern Zone – Bruny Island (Blocks 14C, 14D, 14E, 15, 16).

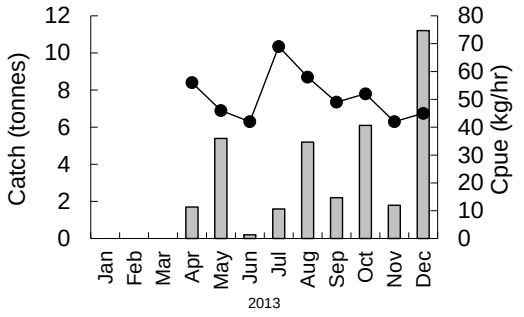
Regional view, catch not capped in 2013, 35 t caught.



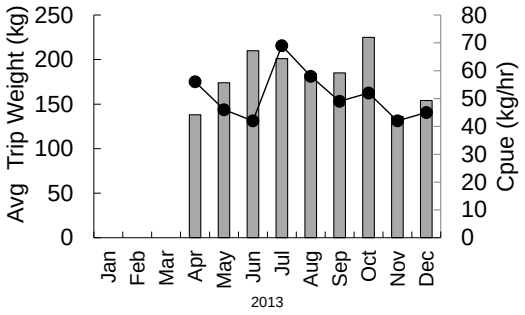
Bruny region - CPUE distribution:



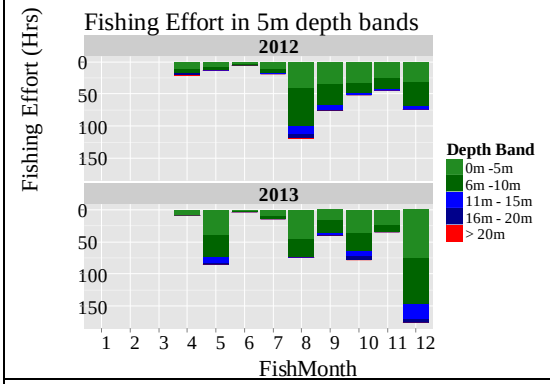
Bruny region - catch and catch rates by month



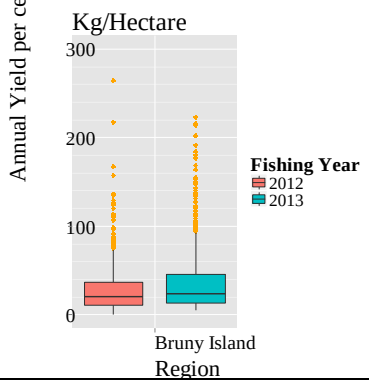
Bruny region - monthly catch rates and mean daily catch



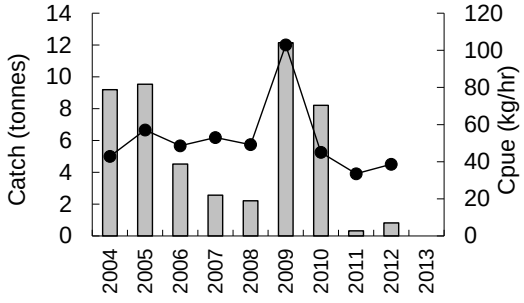
Bruny region - monthly effort by depth



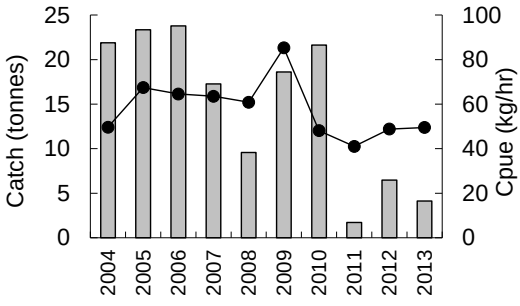
Bruny region – annual yield



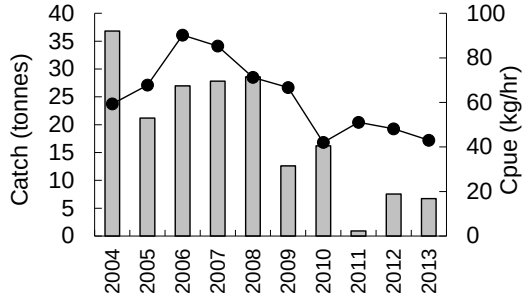
Sub-block 14C Mays Creek to Hopwood Light (Lower Channel) – significant catch reporting errors in 2009. No catch in2013



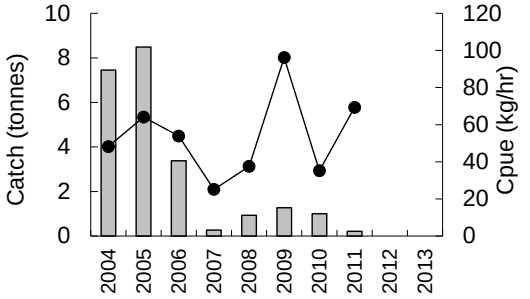
Sub-block 14D Hopwood Point to West Cloudy Head - significant catch reporting errors in 2009.



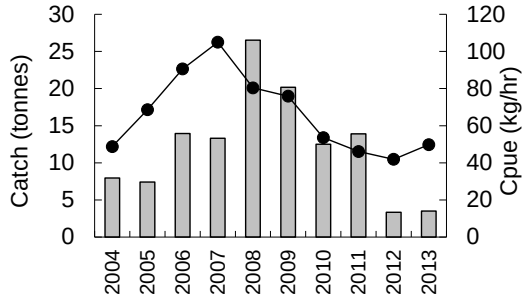
Sub-block 14E
West Cloudy Head to Boreel Head, including the Friars.



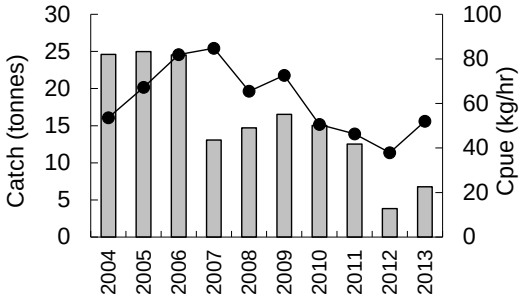
Block 15 D'Entrecasteaux Channel, Huon Estuary- significant catch reporting errors in 2009, no catch reported in 2012 and 2013.



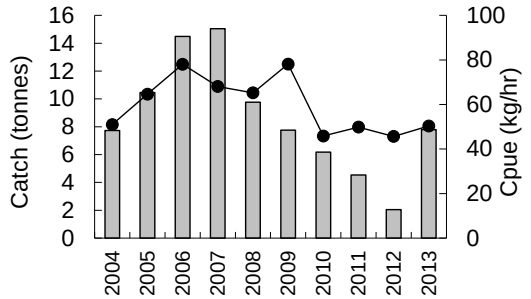
Sub-block 16A
Boreel Head to North Mangana Bluff.



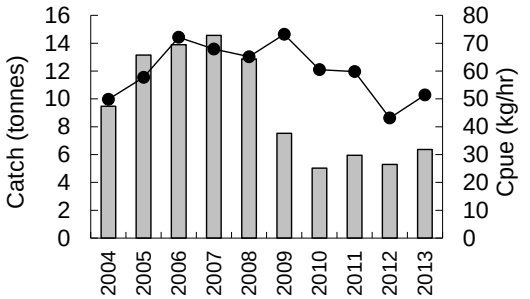
Sub-block 16B
North Mangana Bluff to Neck Beach.



Sub-block 16C
Neck Beach to Trumpeter Bay.

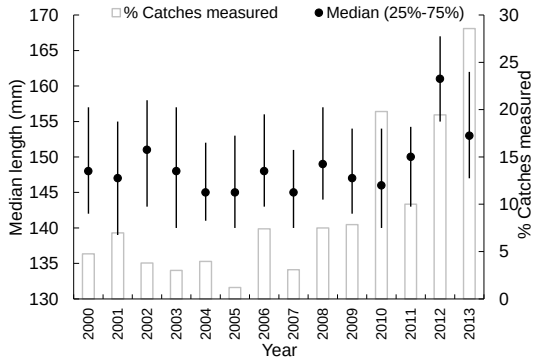


Sub-block 16D
Trumpeter Bay to Dennes Point.

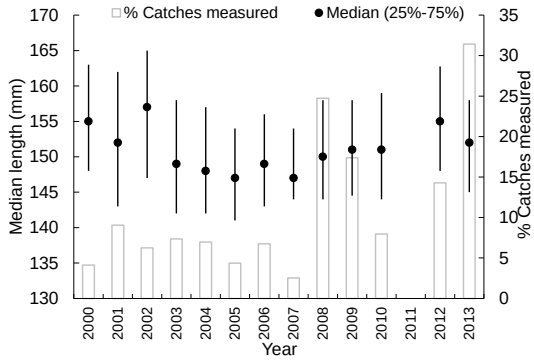


Eastern Zone – Bruny Island (Blocks 14C, 14D, 14E, 15, 16).
Median length of catch

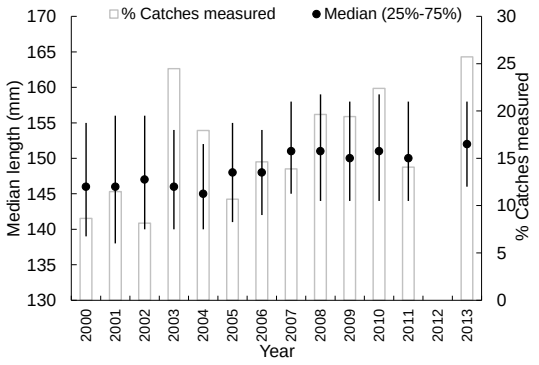
Sub-block 14D Hopwood Point to West Cloudy Head.



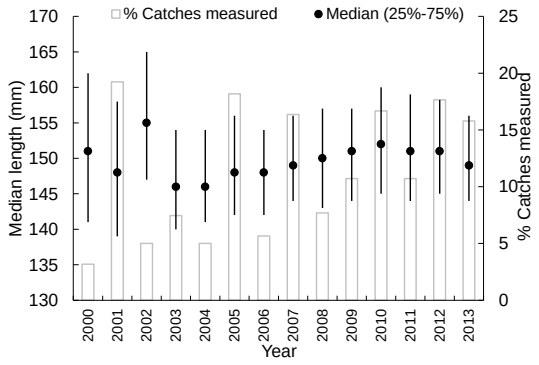
Sub-block 14E West Cloudy Head to Boreel Head, including the Friars.



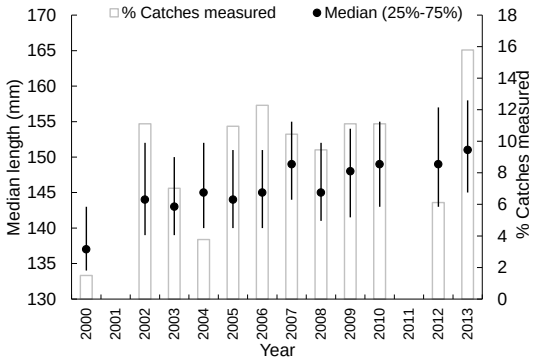
Sub-block 16B
North Mangana Bluff to Neck Beach.



Sub-block 16C
Neck Beach to Trumpeter Bay.

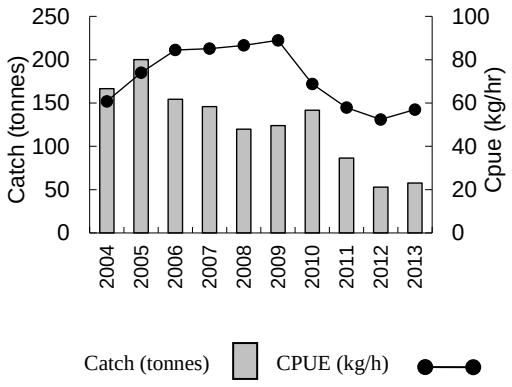


Sub-block 16D
Trumpeter Bay to Dennes Point

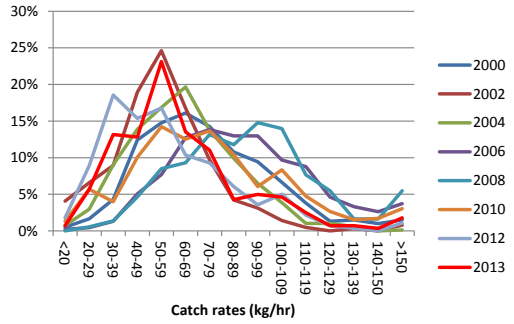


Eastern Zone - Storm Bay (Blocks 17-21)

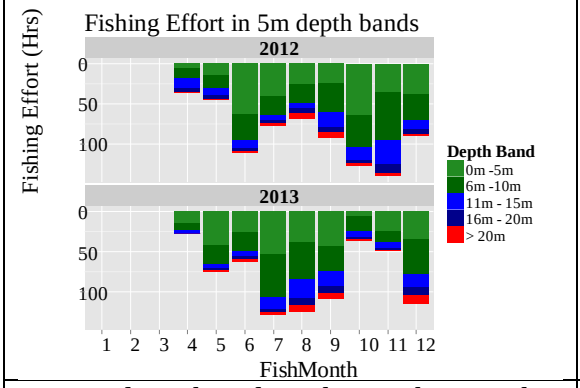
Regional view, catch not capped in 2013, 58 t caught.



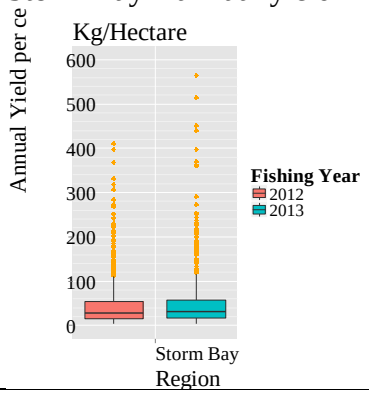
CPUE distribution:



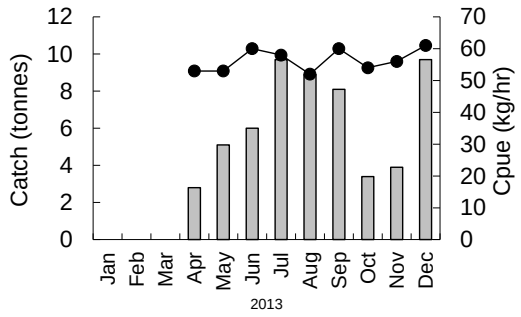
Storm Bay - monthly effort by depth



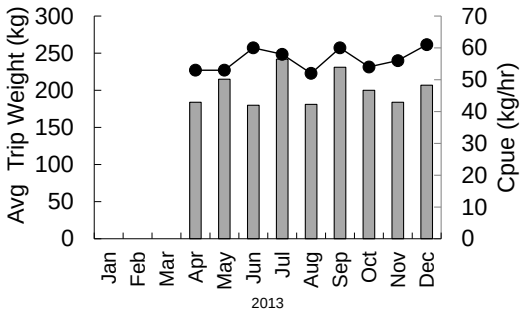
Storm Bay – annual yield



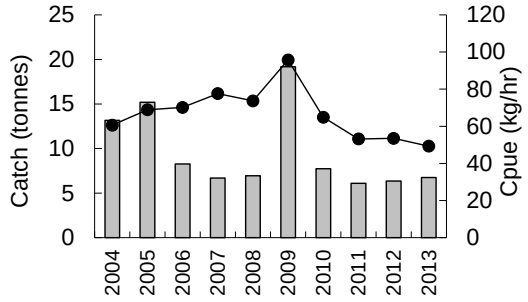
Regional catch and catch rates by month



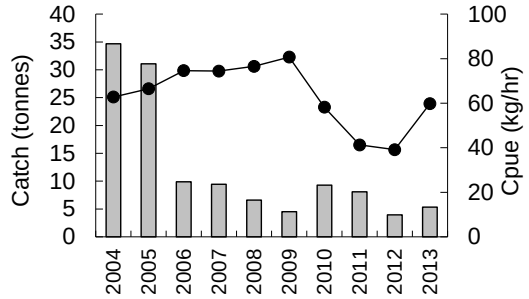
Monthly catch rates and mean daily catch



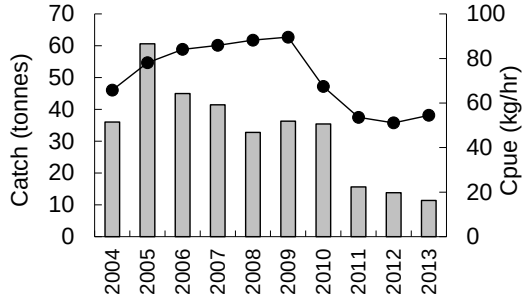
Sub-block 17B
Blackjack shoreline from Lobster Point to Outer North Head



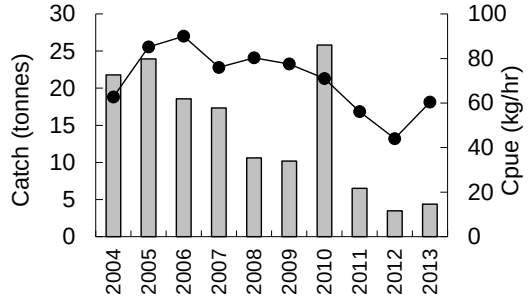
Sub-block 20A
Outer North Head to White Beach



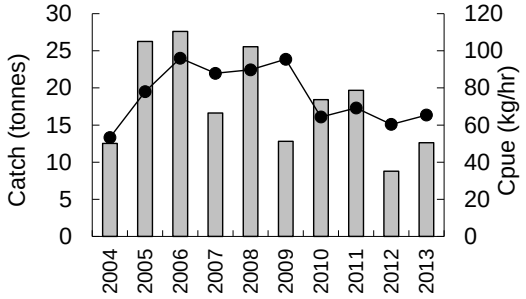
Sub-block 20B
White Beach to Salters Point



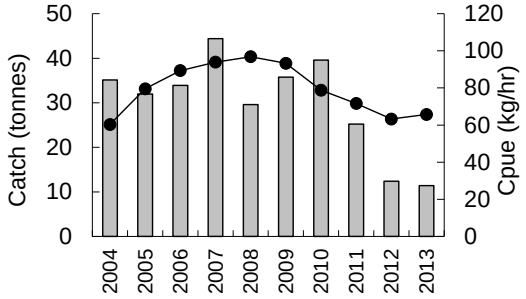
Sub-block 20C
Salters Point to Cape Raoul



Sub-block 21A
Cape Raoul to Port Arthur

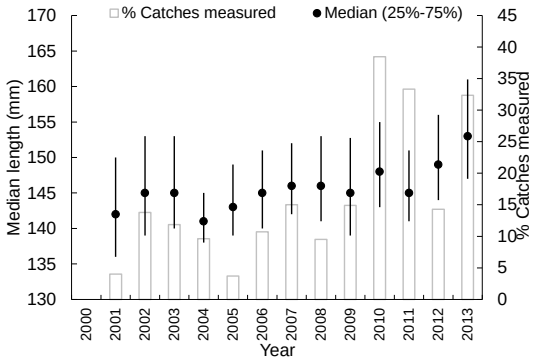


Sub-block 21C
Port Arthur to Cape Pillar

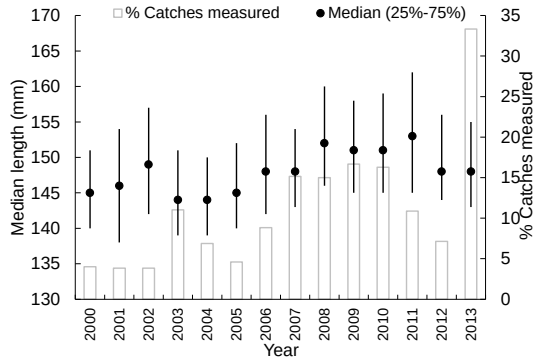


Eastern Zone - Storm Bay (Blocks 17-21)
Median length of catch

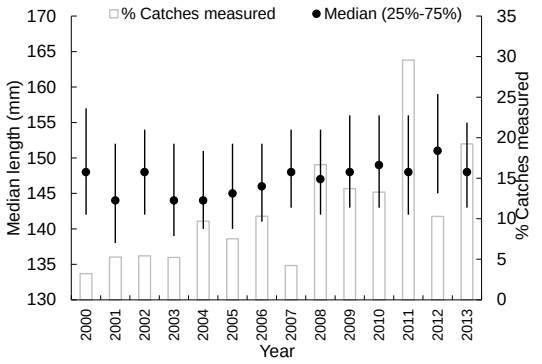
Sub-block 17B Blackjack shoreline from Lobster Point to Outer North Head



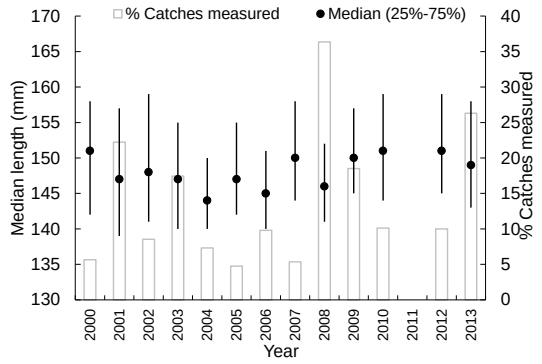
Sub-block 20A
Outer North Head to White Beach



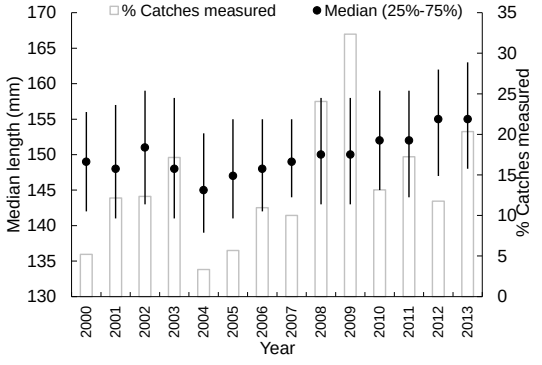
Sub-block 20B White Beach - Salters Point



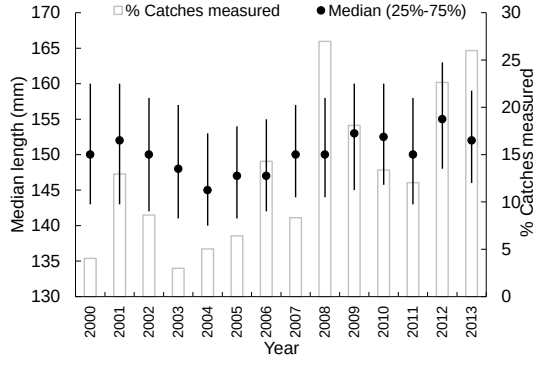
Sub-block 20C Salters Point to Cape Raoul



Sub-block 21A Cape Raoul to Port Arthur

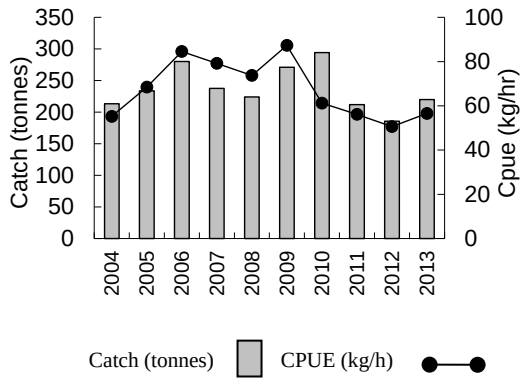


Sub-block 21C Port Arthur to Cape Pillar

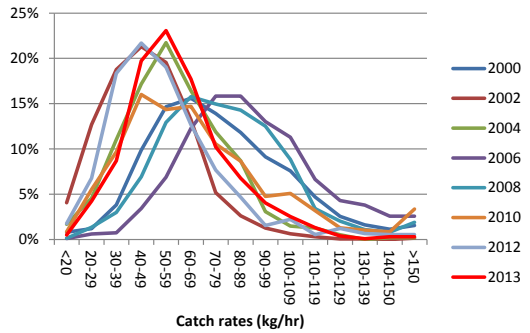


Eastern Zone – East Coast (Blocks 22-31)

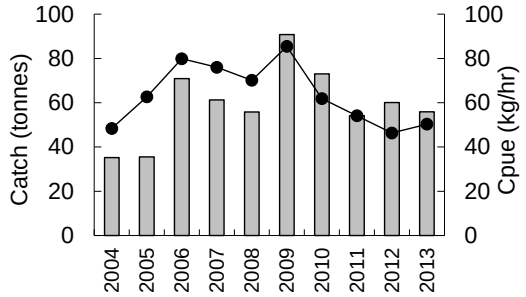
Regional view:



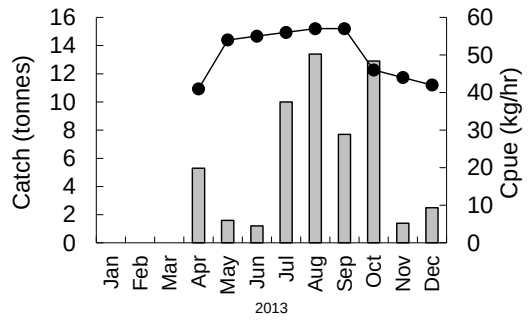
CPUE distribution:



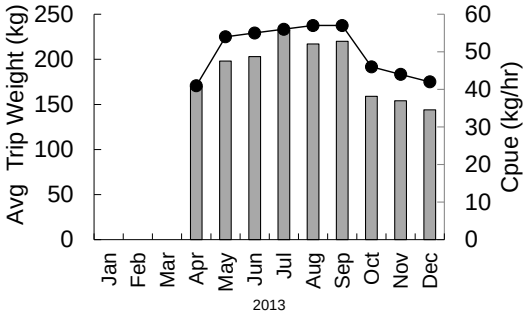
Block 22, catch not capped in 2013, 60 t caught



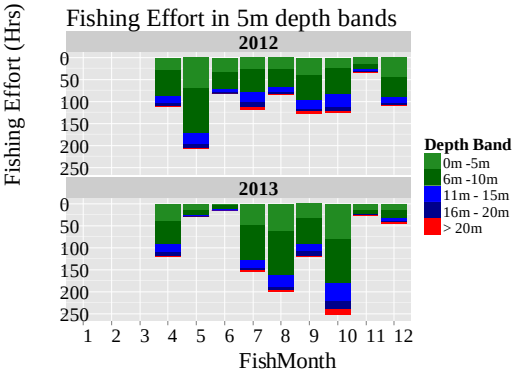
Regional catch and catch rates by month – Block 22



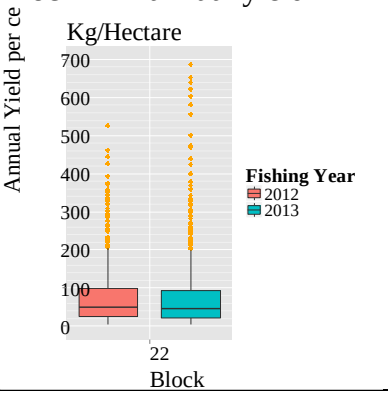
Monthly catch rates and mean daily catch – Block 22



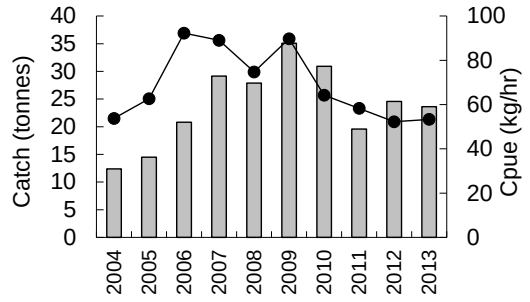
Monthly effort by depth – Block 22



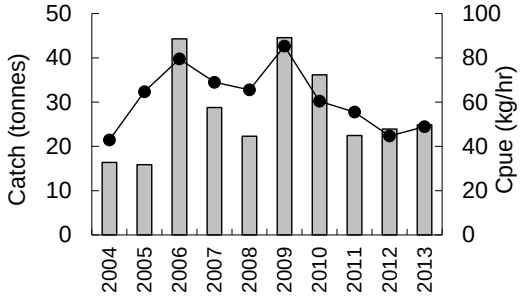
Block 22 – annual yield



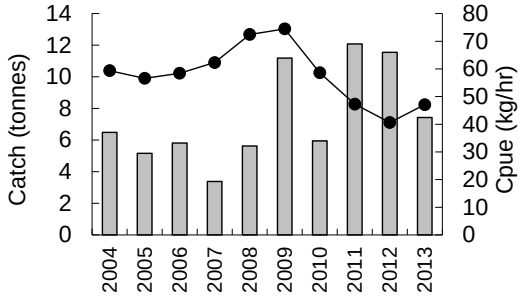
Sub-block 22A
Cape Pillar to the Lanterns



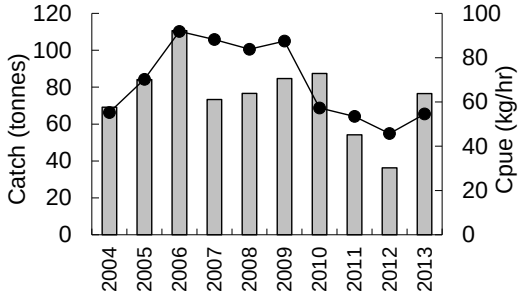
Sub-block 22B
The Lanterns to Eaglehawk Neck



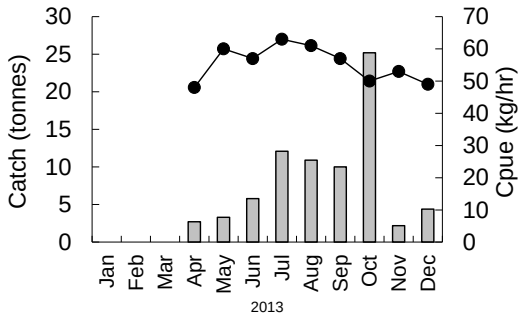
Sub-block 22C
Eaglehawk Neck to Deep Glen Bay



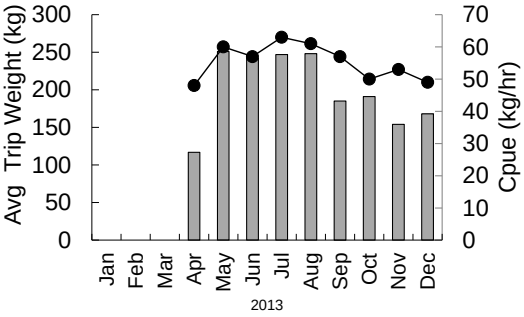
Forestier Peninsula, Maria Island (Blocks 23, 24), catch not capped in 2013, 77 t caught



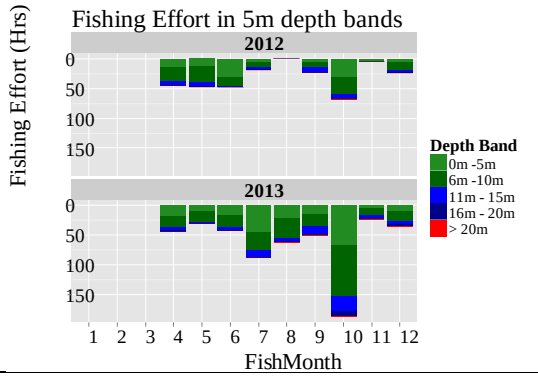
Regional catch and catch rates by month – Blocks 23, 24



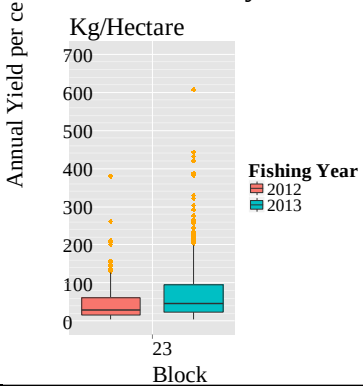
Monthly catch rates and mean daily catch – Blocks 23, 24



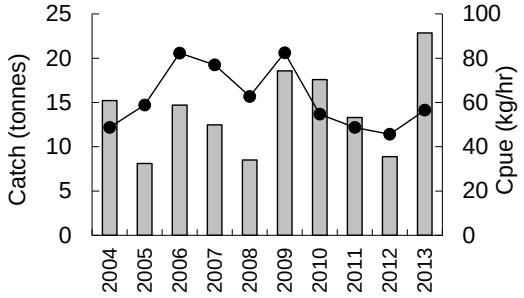
Monthly effort by depth – Block 23



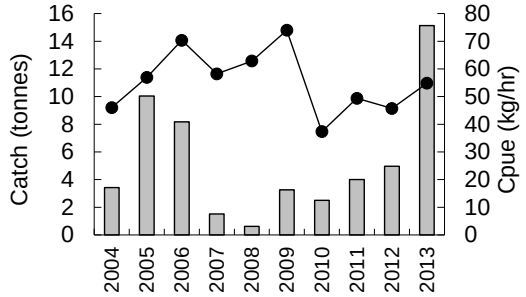
Block 23 – annual yield



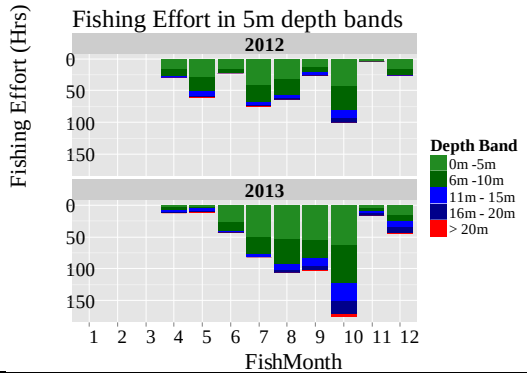
Sub-block 23A
Deep Glen Bay to Lagoon Bay



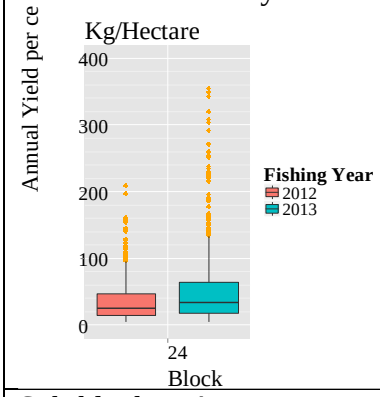
Sub-block 23B
Lagoon Bay to Marion Bay



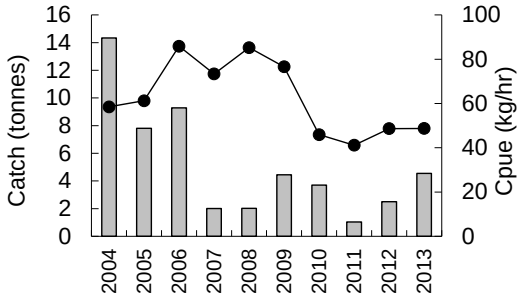
Monthly effort by depth – Block 24



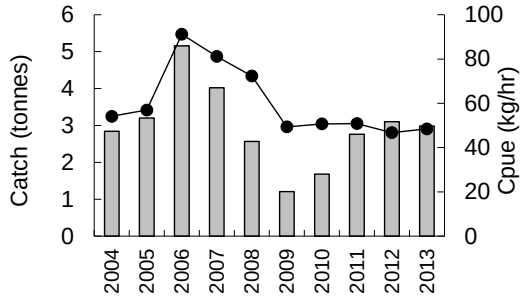
Block 24 – annual yield



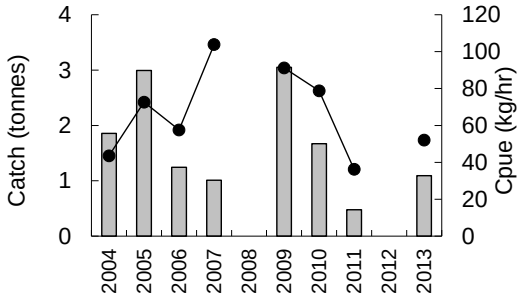
Sub-block 24B
Eastern shore of Mercury Passage



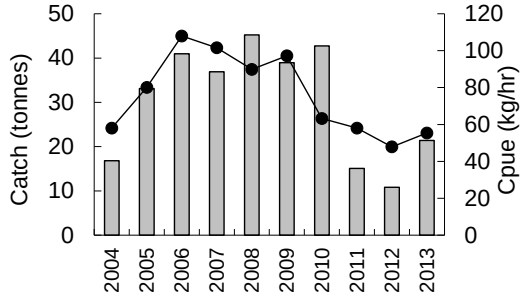
Sub-block 24A
Marion Bay to Rheban



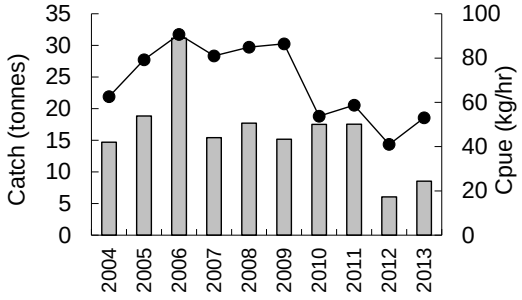
Sub-block 24C
Rheban to Cape Bougainville



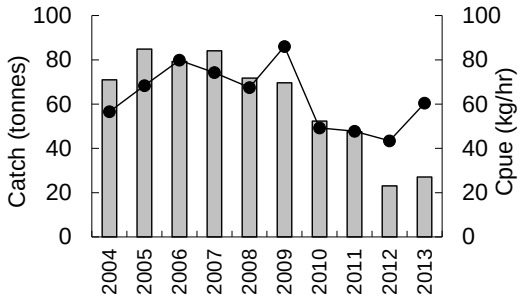
Sub-block 24D
north-east side of Maria Island



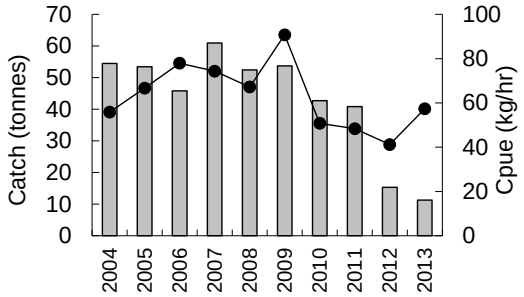
Sub-block 24E
south-east side of Maria Island



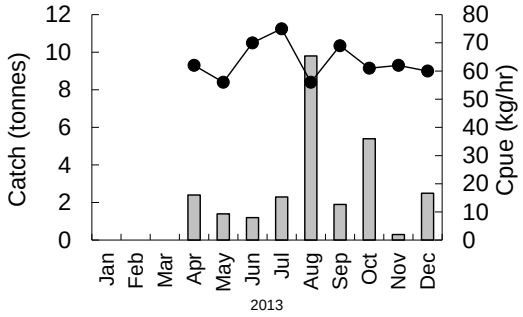
Freycinet-Bicheno (Blocks 25, 26, 27, 28, 29A), 27 t caught



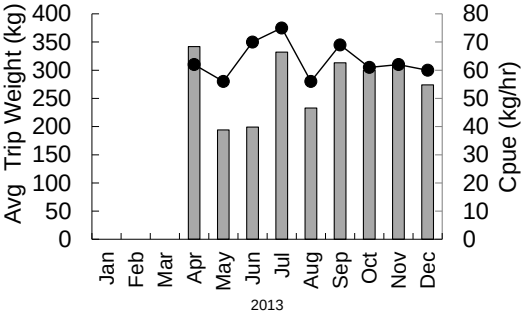
Freycinet-Bicheno capped area (sub-block 26B, Block 27, sub-blocks 28A, 28B), cap 5 t in 2013, 11 t caught)



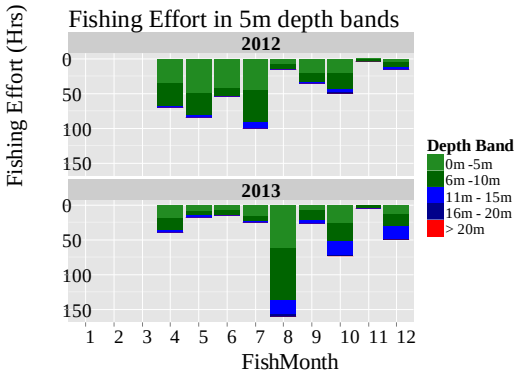
Regional catch and catch rates by month



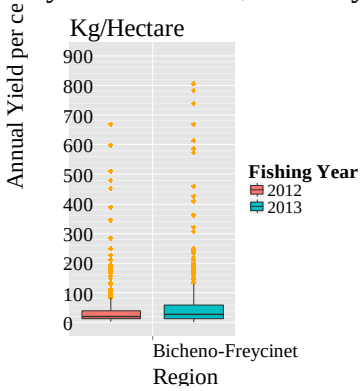
Monthly catch rates and mean daily catch



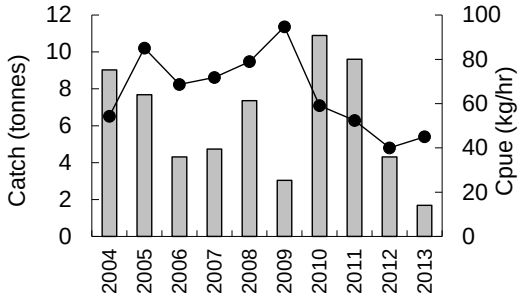
Regional monthly effort by depth



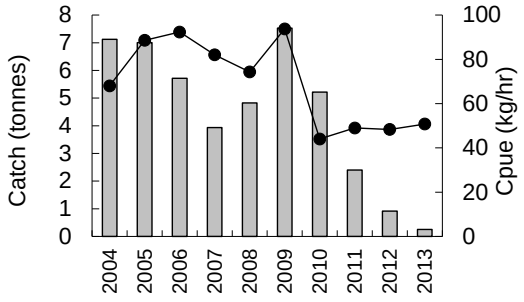
Freycinet-Bicheno, annual yield



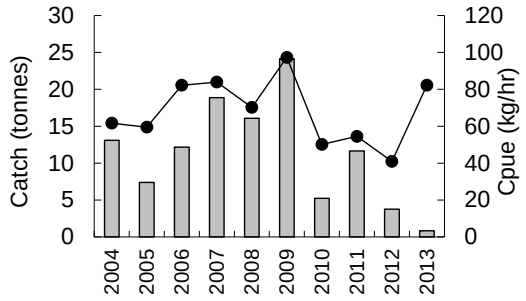
Sub-block 27A
south side of Schouten Island



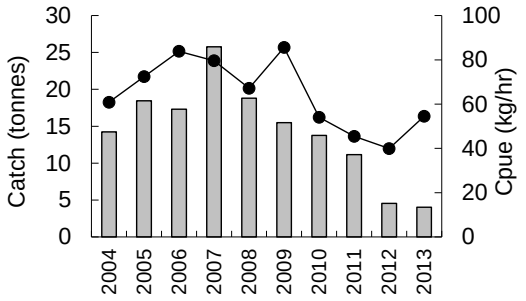
Sub-block 27B
east side of Schouten Island



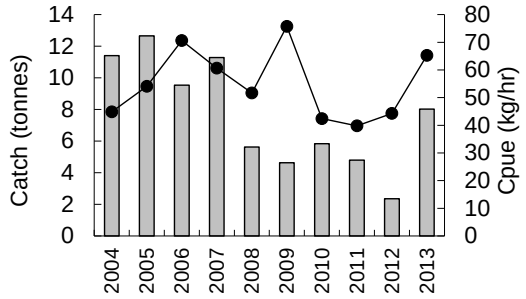
Sub-block 27C
Schouten Passage to Wineglass Bay



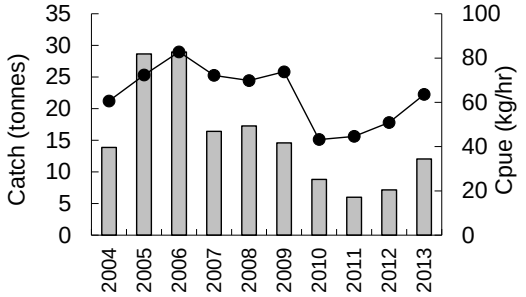
Sub-block 27D
Wineglass Bay to the Friendly Beaches



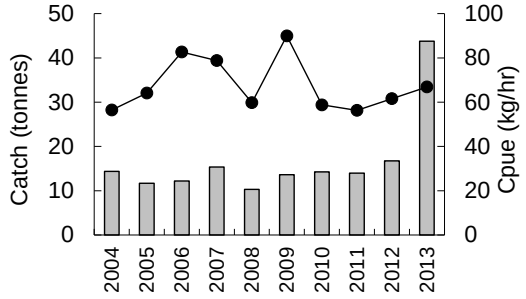
Block 28
Friendly Beaches to Long Point



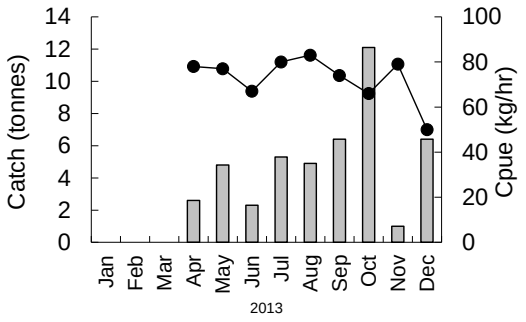
Sub-block 29A – Long Point



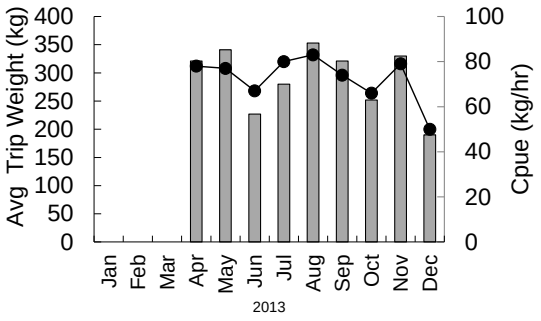
Sub-blocks 29B, 29C, 29D, 30A,
Templestowe Beach to Taylors Beach.



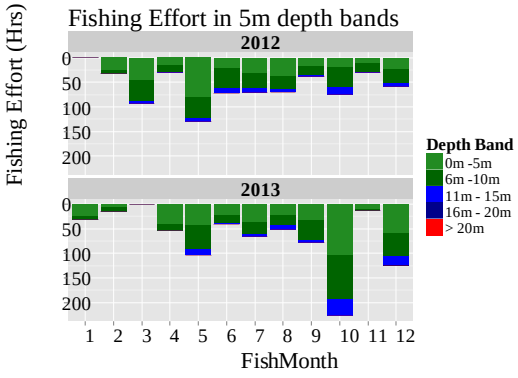
Sub-blocks 29B, 29C, 29D, 30A, –
monthly catch rates



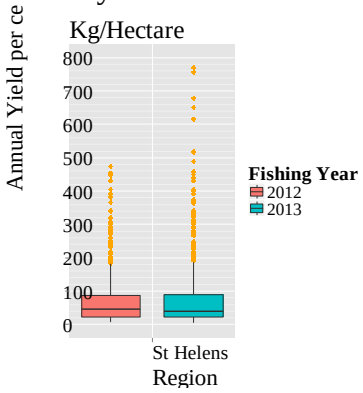
Sub-blocks 29B, 29C, 29D, 30A, –
monthly catch rates and mean daily catch



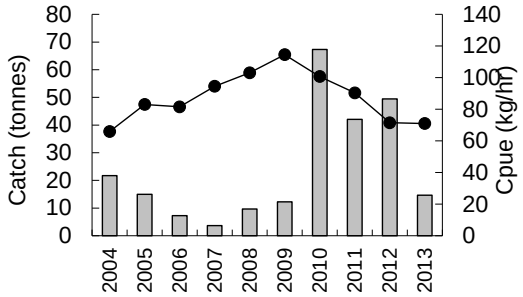
Sub-blocks 29B, 29C, 29D, 30A, –
monthly effort by depth



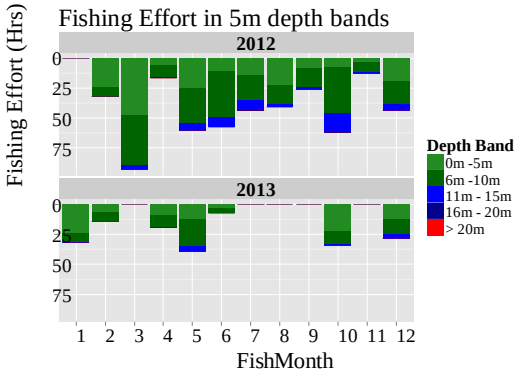
Sub-blocks 29B, 29C, 29D, 30A, – annual yield



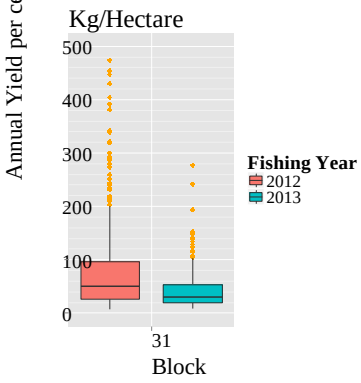
Sub-block 31A (also includes old E zone part of 31B), Eddystone Point to Musselroe



Sub-blocks 31A – monthly effort by depth



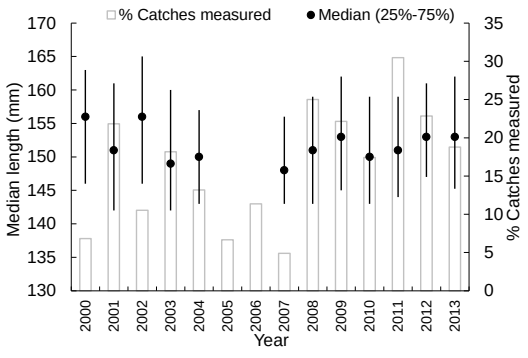
Sub-blocks 31A – annual yield



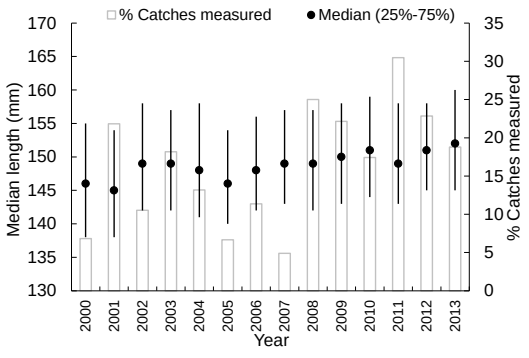
Eastern Zone - East Coast (Blocks 22-31)

Median length of catch

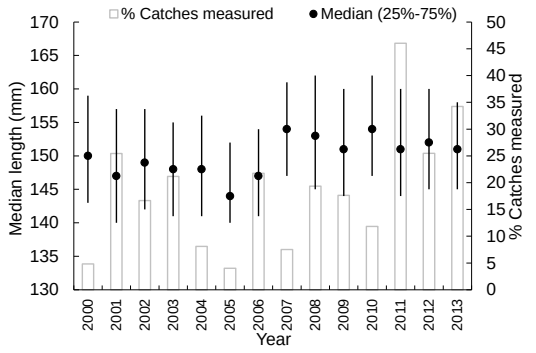
Sub-block 22A Cape Pillar to the Lanterns



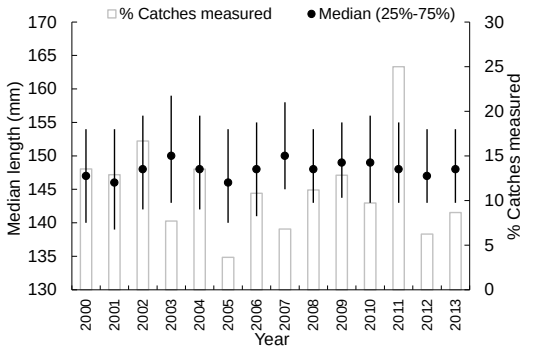
Sub-block 22B The Lanterns to Eaglehawk Neck



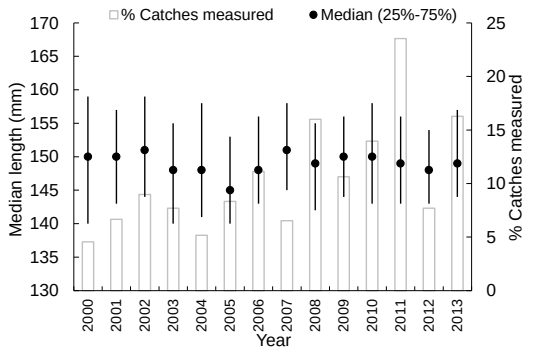
Sub-block 23A Deep Glen Bay to Lagoon Bay



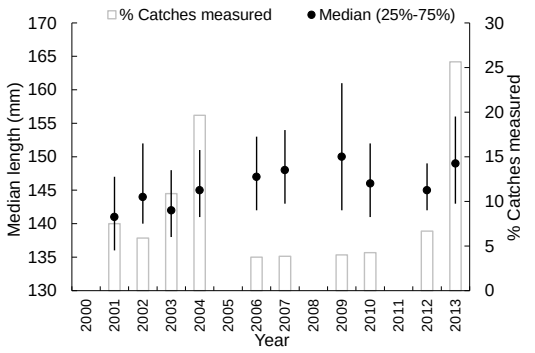
Sub-block 24D north-east side of Maria Island



Sub-block 24E south-east side of Maria Island



Sub-block 29A Long Point to Templestowe Beach

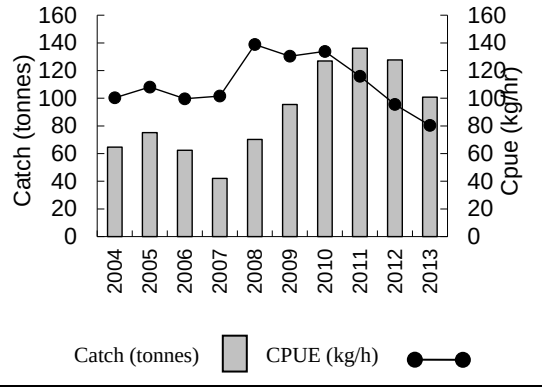


Central Western Zone blacklip fishery

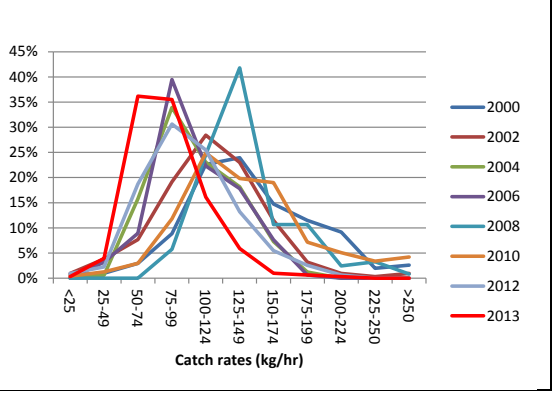
In 2013, the Central western Zone was reduced in size to cover sub-blocks 5D, 6A, 6B and 6C. Sub-block 6D, and Blocks 7 and 8 were transferred to the Western Zone. Negligible catch was taken from sub-block 5D.

Central Western Zone – Couta Rocks (Sub-blocks 5D, 6A, 6B and 6C)

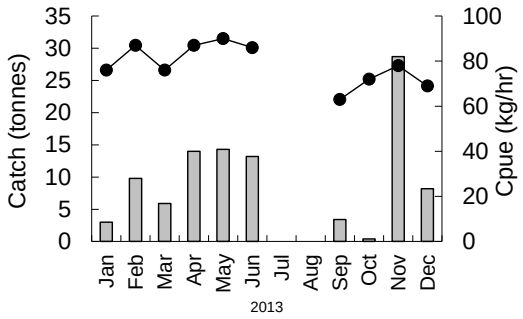
Regional view: 101 t in 2013



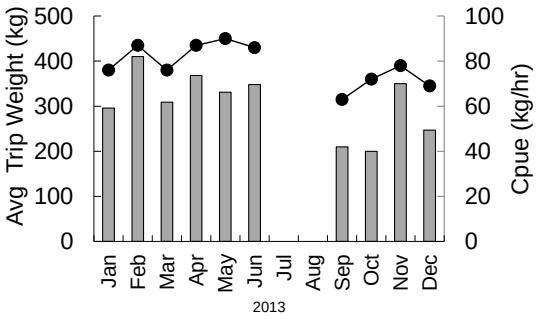
CPUE distribution:



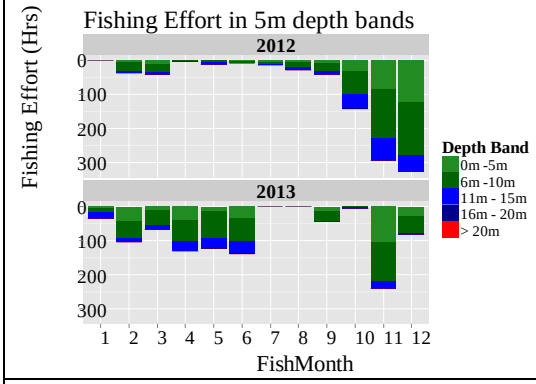
Regional catch and catch rates by month



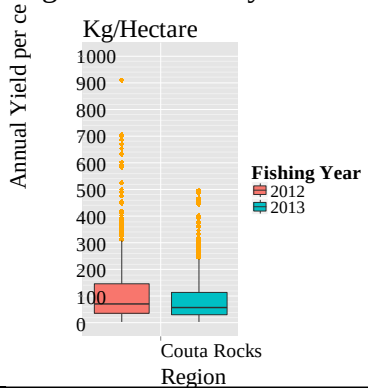
Monthly catch rates and mean daily catch



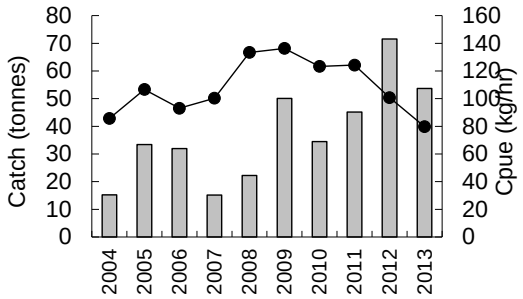
Regional monthly effort by depth



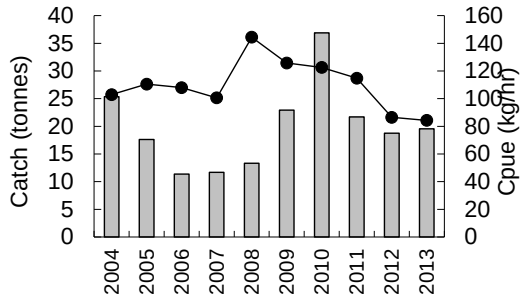
Regional – annual yield



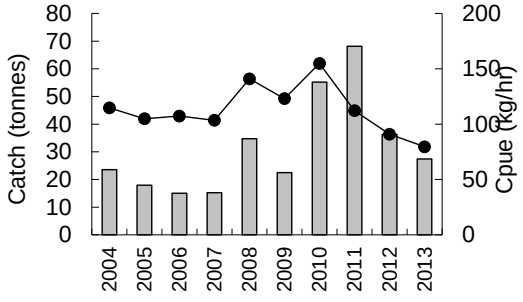
Sub-block 6A
Sundown to Temma



Sub-block 6B
Temma to north of Dawson River

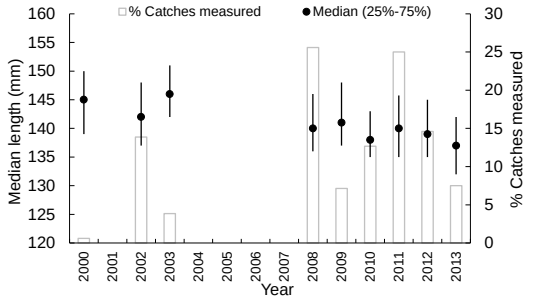


Sub-block 6C
Dawson River to Wild Wave River

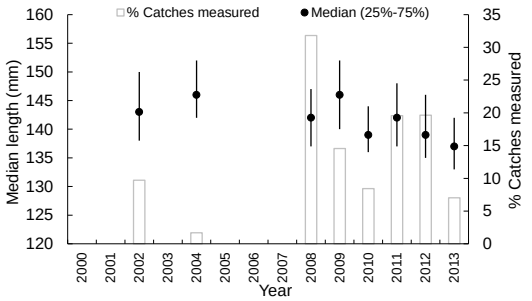


Central Western Zone – Couta Rocks (Block 6)
Median length of catch

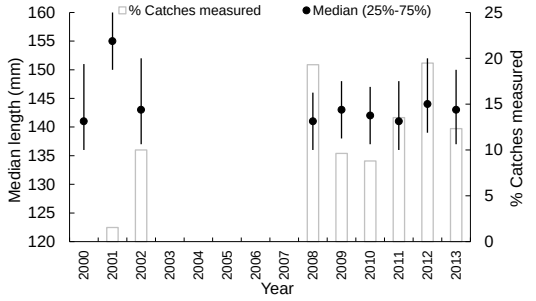
Sub-block 6A
Sundown to Temma



Sub-block 6B
Temma Harbour to north of Dawson River

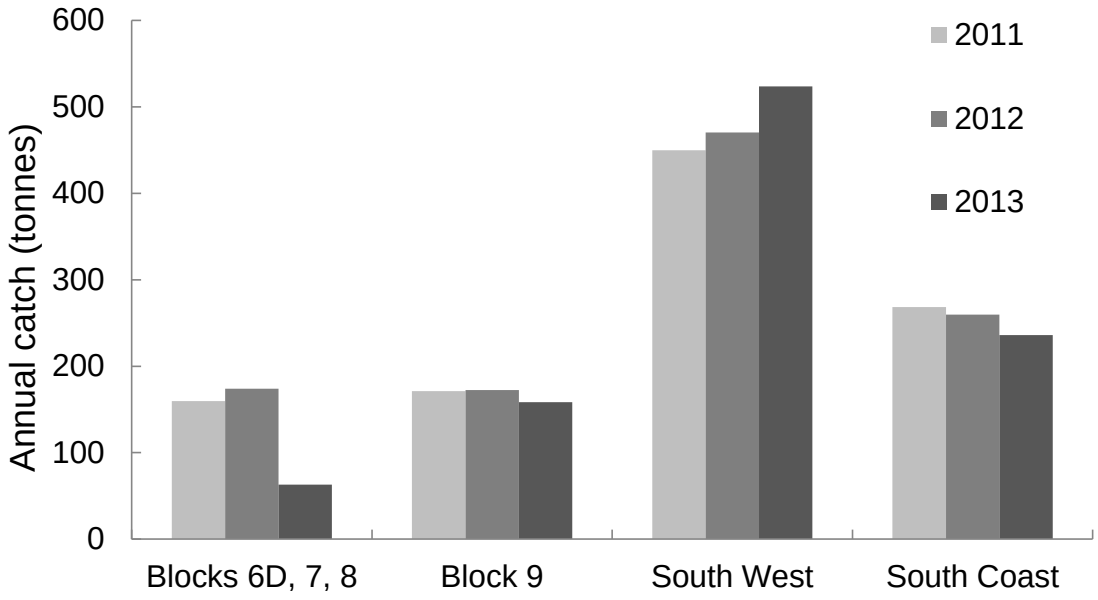


Sub-block 6C
Dawson River to Wild Wave River



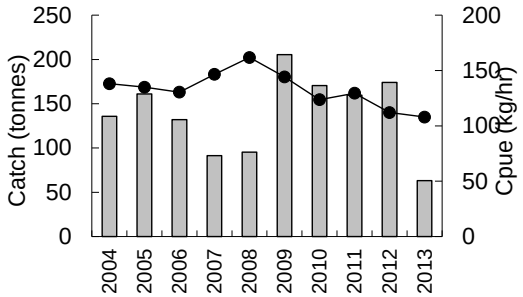
Western Zone blacklip fishery

Distribution of catch in the Western Zone:

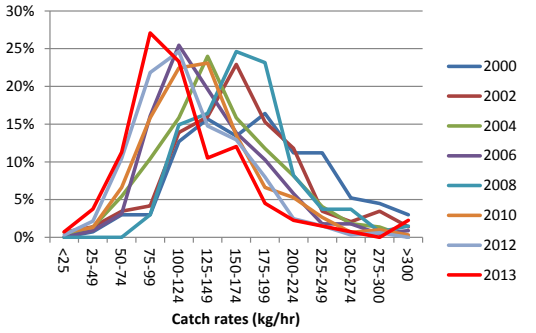


Western Zone – Sandy Cape, Granville and Trial Harbours (Sub-block 6D, Blocks 7 and 8)

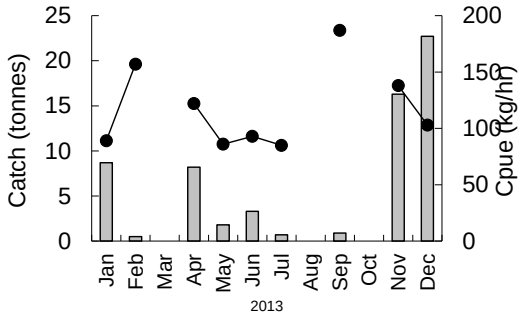
Sub-block 6D, Blocks 7 and 8, cap set at 140 t in 2013, 63 t caught



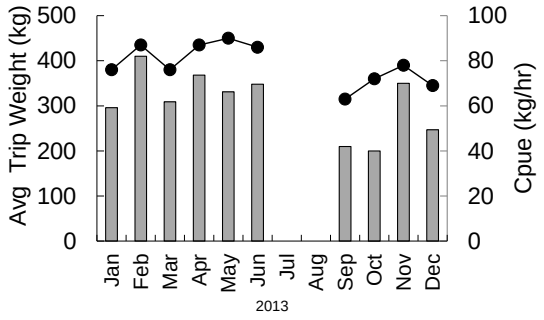
CPUE distribution:



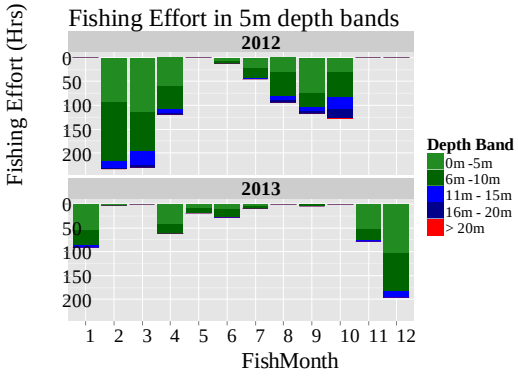
Regional catch and catch rates by month



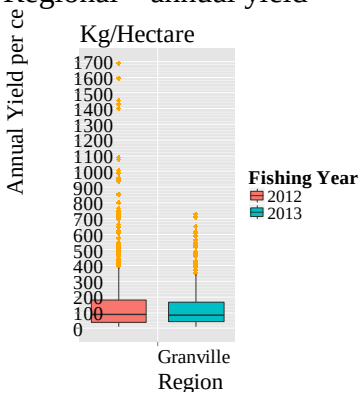
Monthly catch rates and mean daily catch



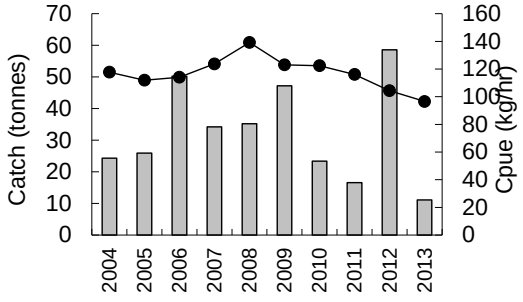
Regional monthly effort by depth



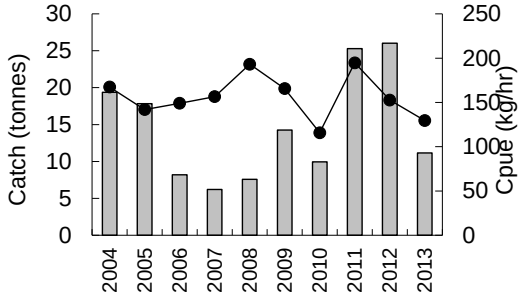
Regional – annual yield



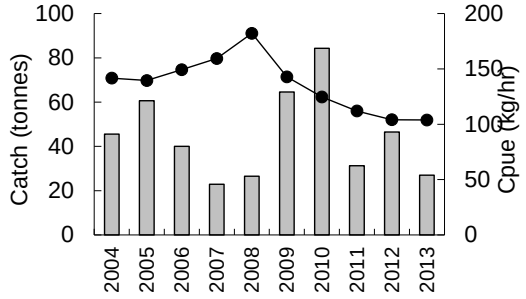
Sub-block 6D - capped area see below
Wild Wave River to Italian River, including Sandy Cape



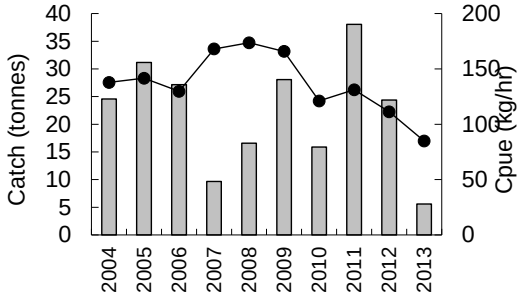
Sub-block 7A
Italian River to Pieman River



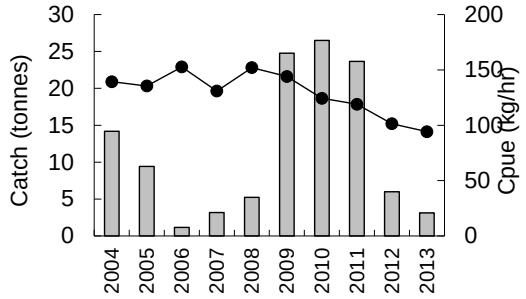
Sub-block 7B
Pieman to Ahrberg Bay



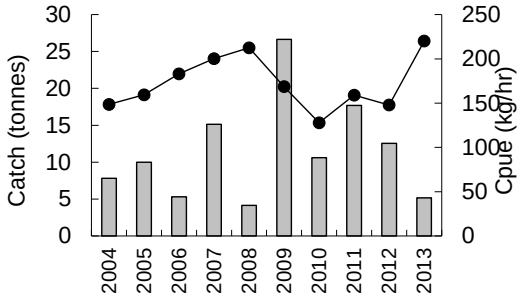
Sub-block 7C
Ahrberg Bay to Granville Harbour



Sub-block 8A
Granville Harbour to Tasman Bay

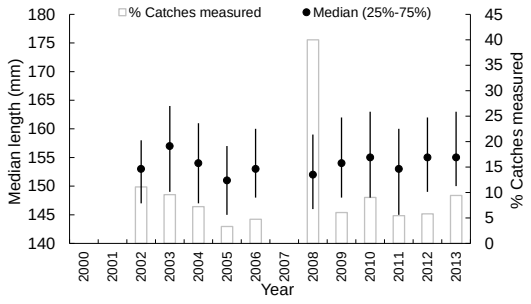


Sub-block 8B
Tasman Bay to Henty River



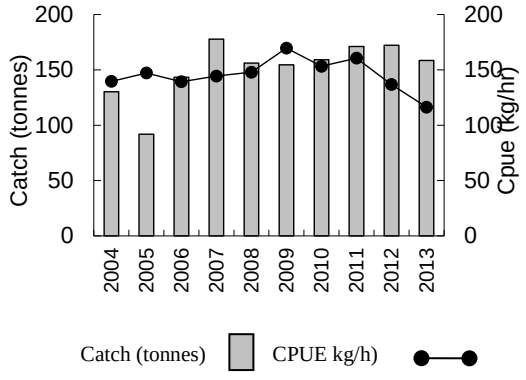
Western Zone – Sandy Cape, Granville and Trial Harbours (Sub-block 6D, Blocks 7 and 8) - Median length of catch

Sub-block 7B
Pieman to Ahrberg Bay

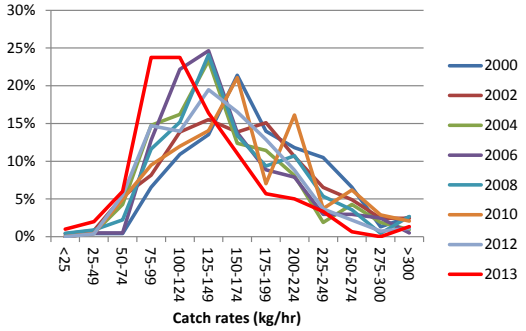


Western Zone – Strahan (Block 9)

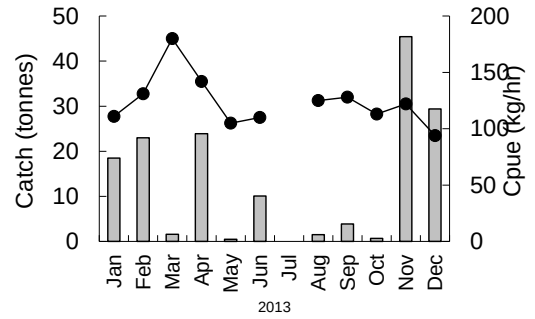
Regional view, cap set at 191 t in 2013, 158 t caught



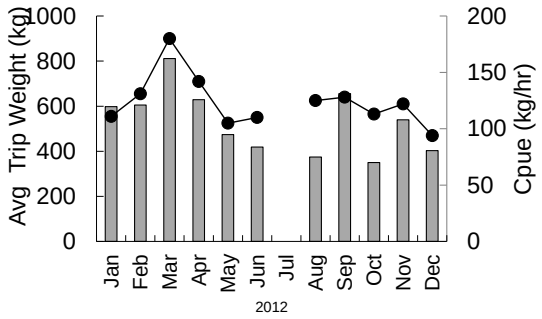
CPUE distribution:



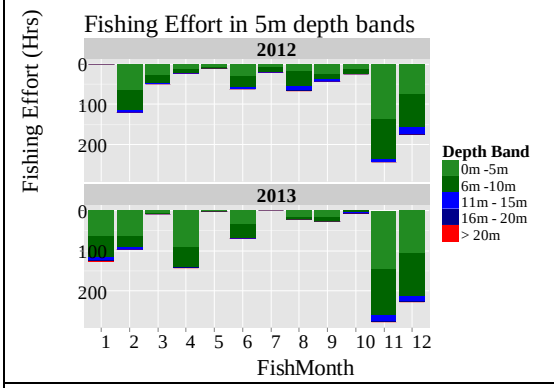
Regional catch and catch rates by month



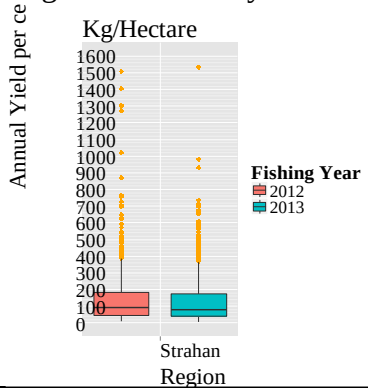
Monthly catch rates and mean daily catch



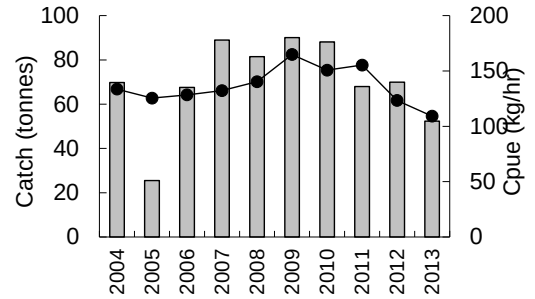
Regional monthly effort by depth



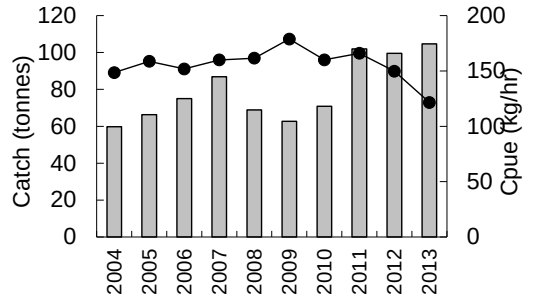
Regional – annual yield



Sub-block 9B
Cape Sorell to Gorge Point

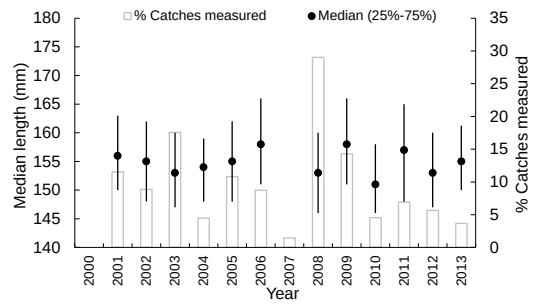


Sub-block 9C
Gorge Point to Point Hibbs

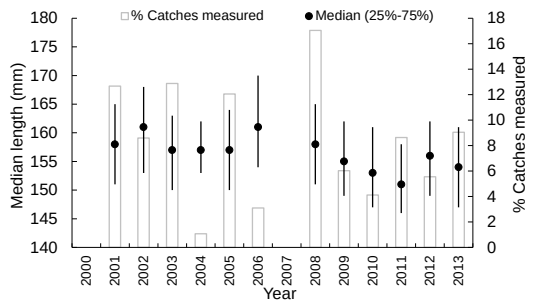


Western Zone – Strahan (Block 9)
Median length of catch

Sub-block 9B
Cape Sorell to Gorge Point

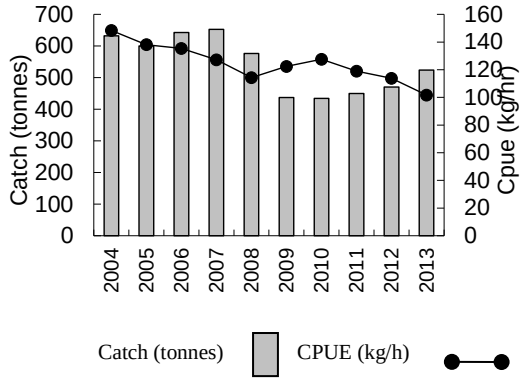


Sub-block 9C
Gorge Point to Point Hibbs

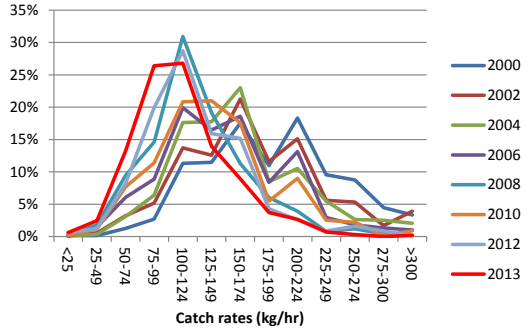


Western Zone - South West (Blocks 10-11, Sub-block 12A)

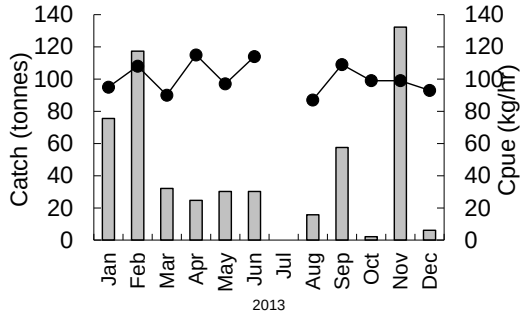
Regional view, no cap set, balance of WZ TAC 458 t, 524 t caught in 2013



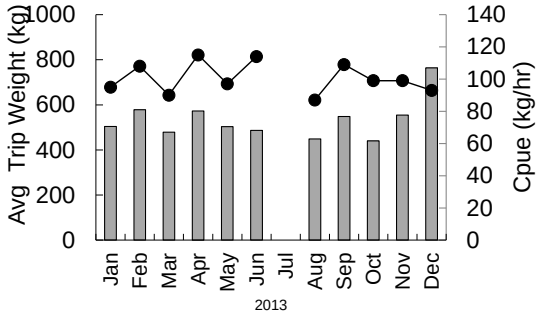
CPUE distribution:



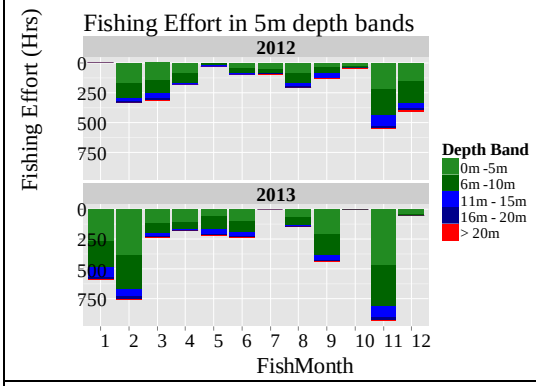
Regional catch and catch rates by month



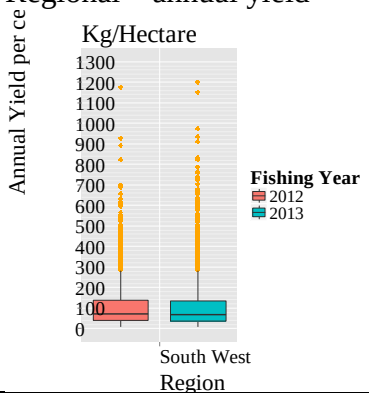
Monthly catch rates and mean daily catch



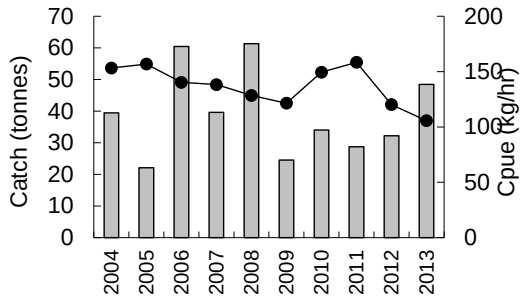
Regional monthly effort by depth



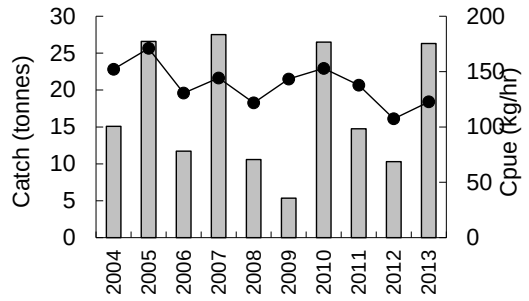
Regional – annual yield



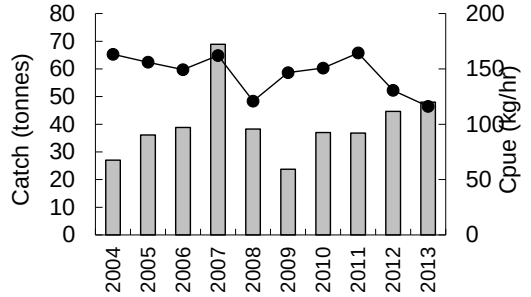
Sub-block 10A
Point Hibbs to Endeavour Bay



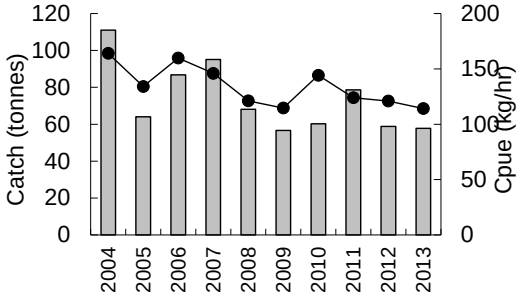
Sub-block 10B
Endeavour Bay to High Rocky Point



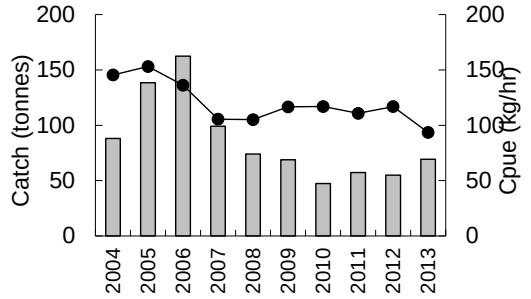
Sub-block 10C
High Rocky Point to Mainwaring River



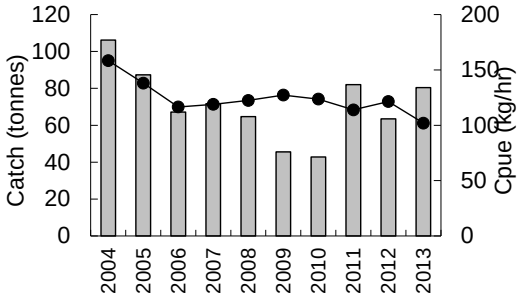
Sub-block 10D
Mainwaring River to Low Rocky Point



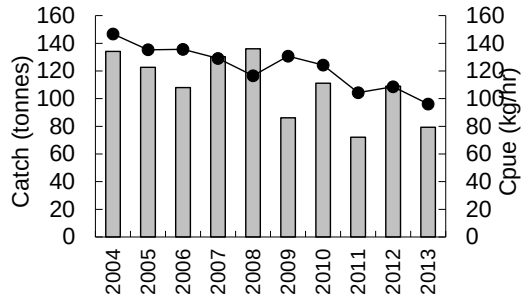
Sub-block 11A
Low Rocky Point to Elliott Point



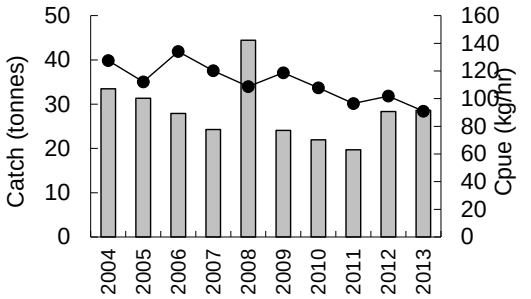
Sub-block 11B
Elliott Point to Svenor Gulches



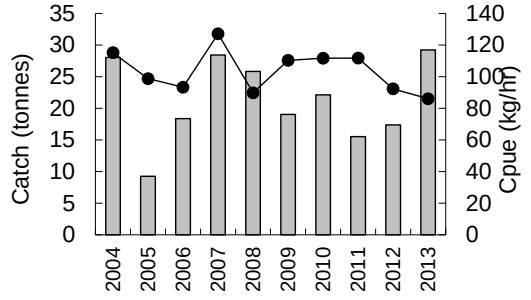
Sub-block 11C
Svenor Gulches to Point St Vincent



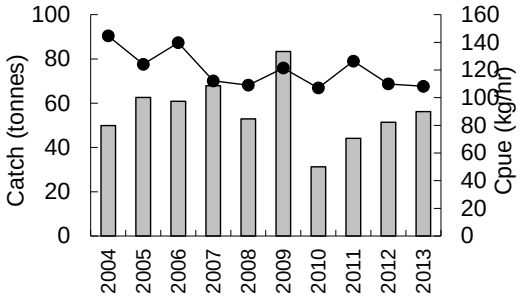
Sub-block 11D
Hilliard Head to Faults Bay



Sub-block 11E
Point St Vincent to Hilliard Head, including Port Davey

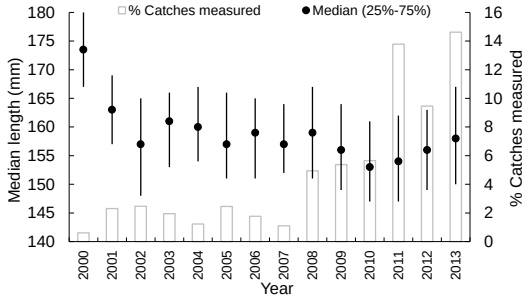


Sub-block 12A
Faults Bay to South West Cape

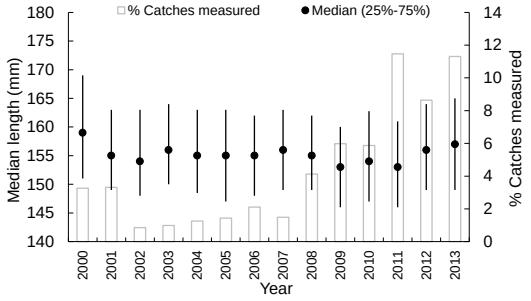


Western Zone - South West (Blocks 10-11, Sub-block 12A)
Median length of catch

Block 10 (aggregated)
Point Hibbs to Low Rocky Point
Note sampling rate below 4% prior to 2008

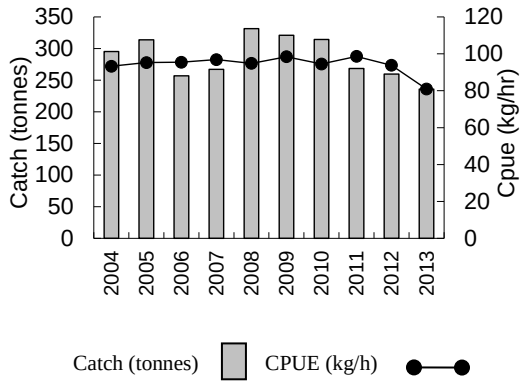


Block 11 (aggregated)
Low Rocky Point to Faults Bay
Note sampling rate below 4% prior to 2008

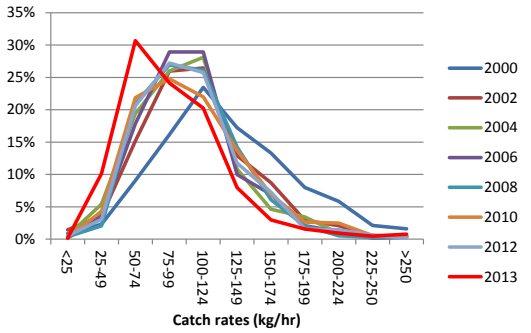


Western Zone - South Coast (Sub-blocks 12B, 12C, 12D, 13A, 13B)

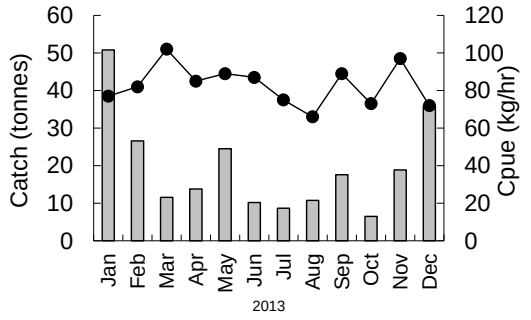
Region view, cap set at 260 t in 2013, 259 t caught



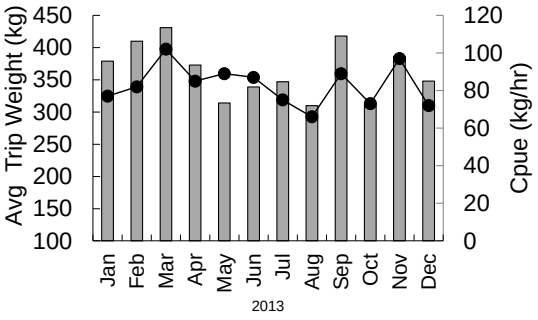
CPUE distribution:



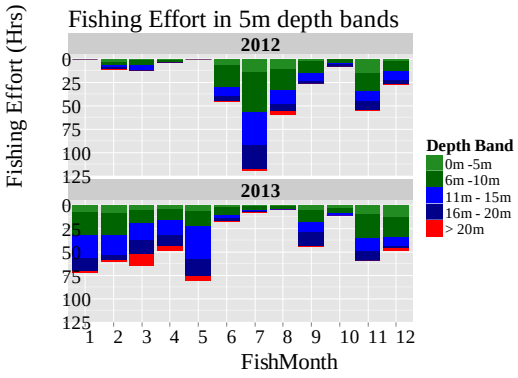
Regional catch and catch rates by month



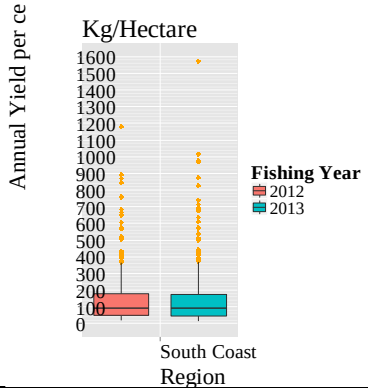
Monthly catch rates and mean daily catch



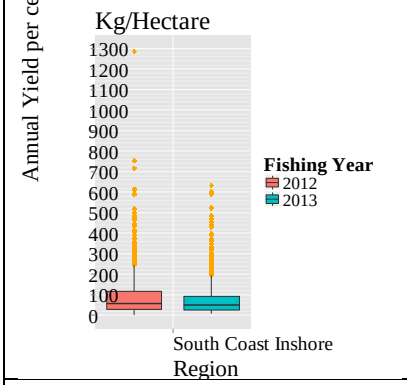
Regional monthly effort by depth



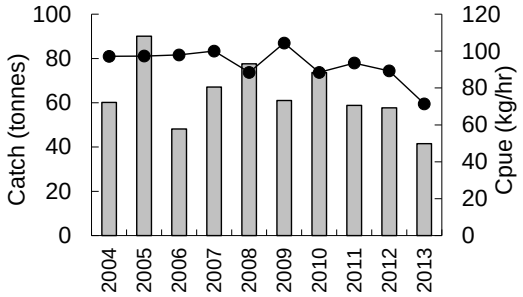
Regional – annual yield including offshore



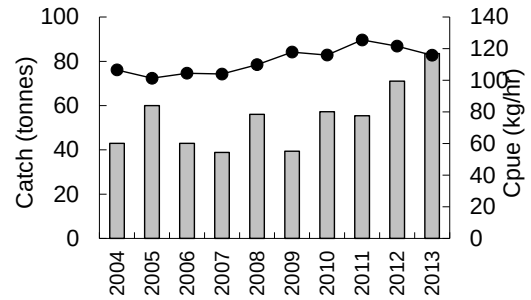
Regional – annual yield inshore



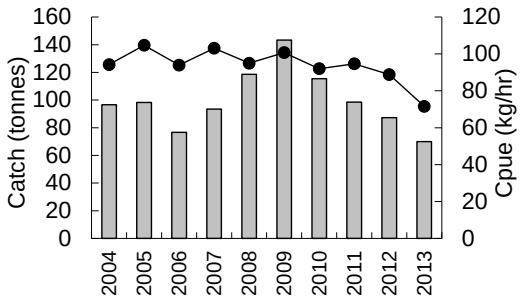
Sub-block 12B
South West Cape to Cox‘s Bluff



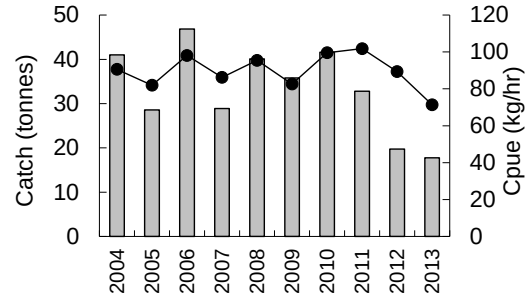
Sub-block 12C
Maatsuyker Group



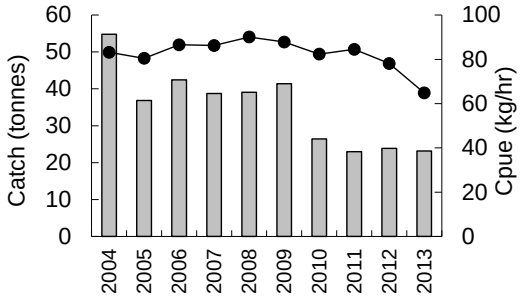
Sub-block 12D
Cox’s Bluff to Prion Beach



Sub-block 13A
Prion Beach to South Cape

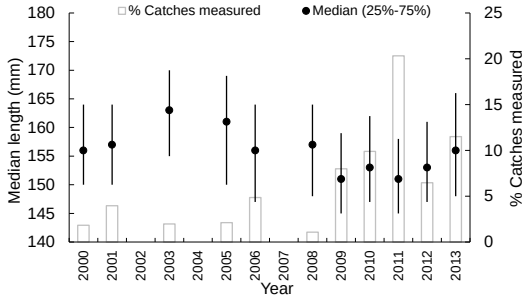


Sub-block 13B
South Cape to Whale Head

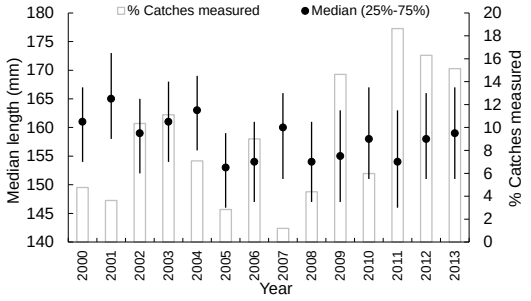


Western Zone - South Coast (Block 12, Sub-blocks 13A, 13B)
Median length of catch

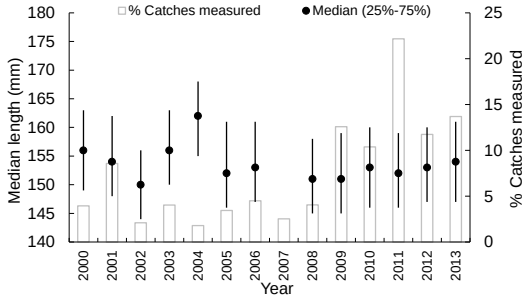
Sub-block 12B
South West Cape to Cox‘s Bluff



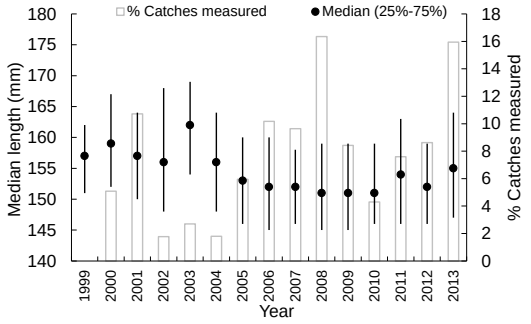
Sub-block 12C
Maatsuyker Group



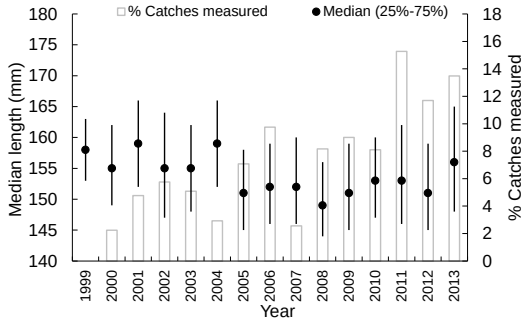
Sub-block 12D
Cox’s Bluff to Prion Beach



Sub-block 13A
Prion Beach to South Cape

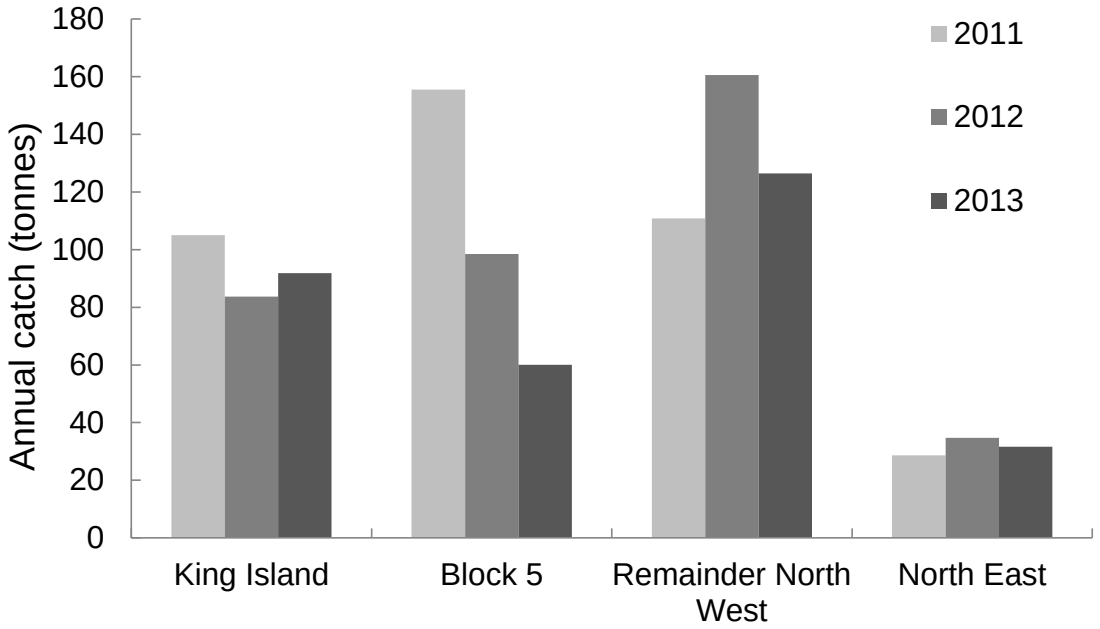


Sub-block 13B
South Cape to Whale Head



Northern Zone blacklip fishery

Distribution of catch between Northern Zone regions:

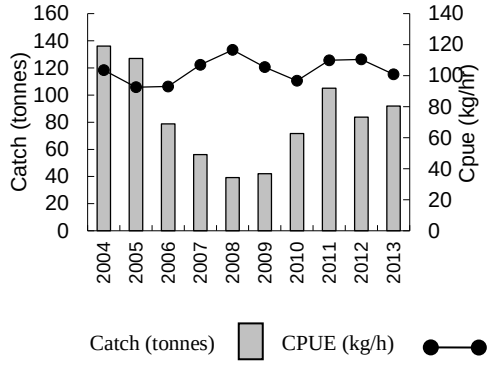


Northern Zone - King Island (Blocks 1-4)

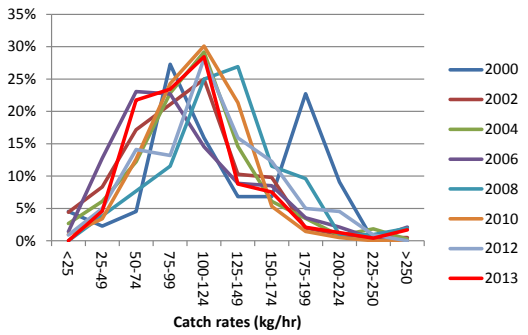
In 2013, blacklip catch from the eastern side of the island (Blocks 2 and 4) totalled < 2 t and most was caught while fishing for both greenlip and blacklip (i.e. produced mixed effort CPUE).

Regional view:

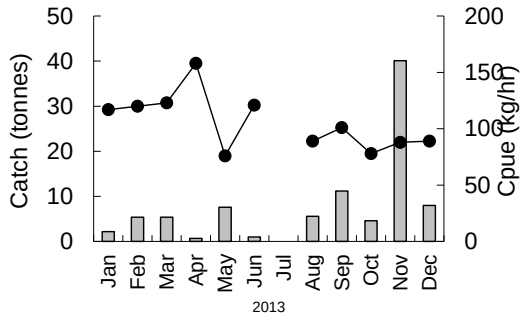
Area cap 95 t in 2013, 92 t caught. Mixed catch CPUE removed, 64% of catch was taken while single species fishing in 2013.



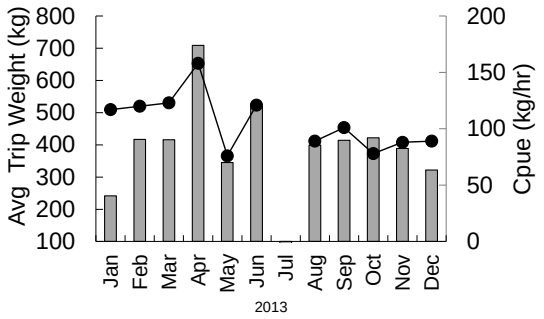
CPUE distribution:



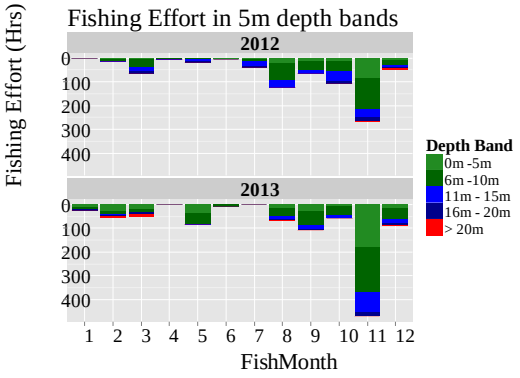
Regional catch and catch rates by month



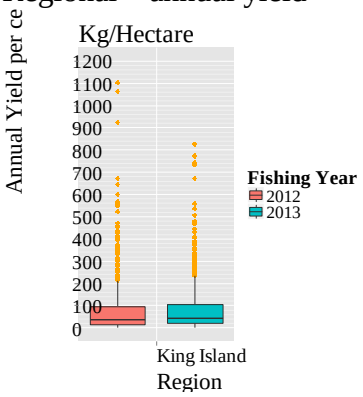
Monthly catch rates and mean daily catch



Regional monthly effort by depth

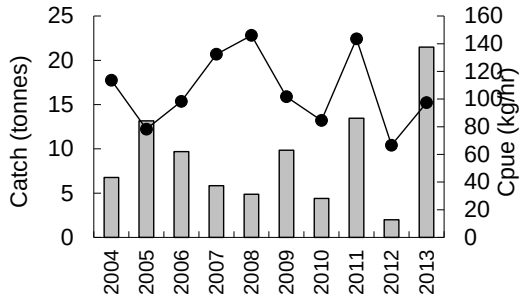


Regional – annual yield

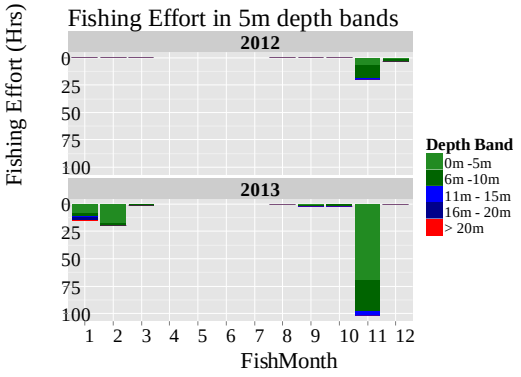


Sub-block 1C

North-west King Island. Mixed catch CPUE removed, 29% of catch was taken while single species fishing in 2013.

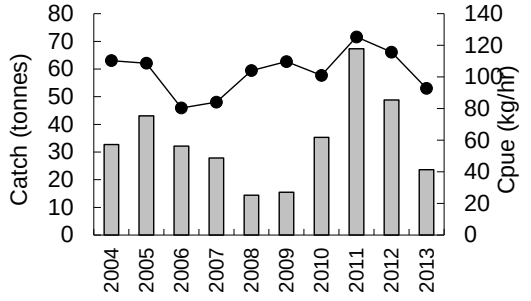


Sub-block 1C monthly effort by depth

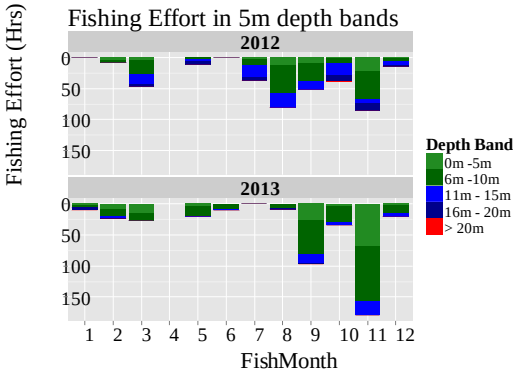


Sub-block 3A

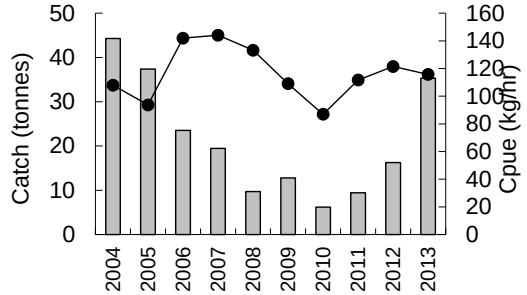
west King Island. Mixed catch CPUE removed, 55% of catch was taken while single species fishing in 2013.



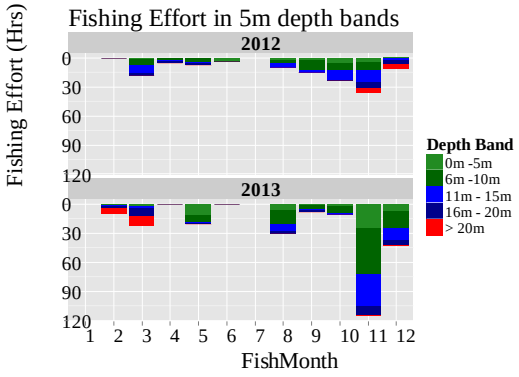
Sub-block 3A monthly effort by depth



Sub-block 3C
South-west King Island. Mixed catch CPUE removed, 90% of catch was taken while single species fishing in 2013.

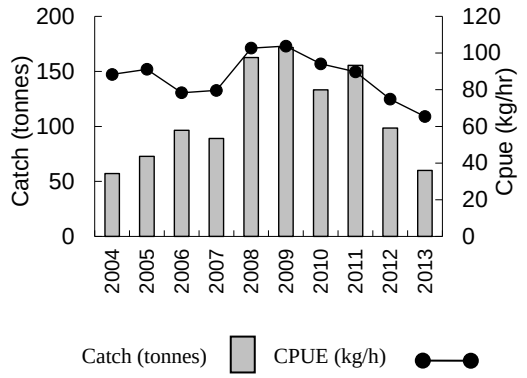


Sub-block 3C monthly effort by depth

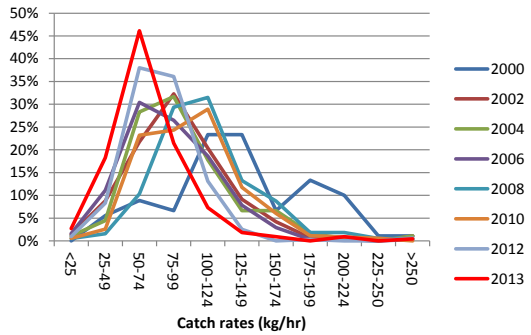


Northern Zone – Block 5

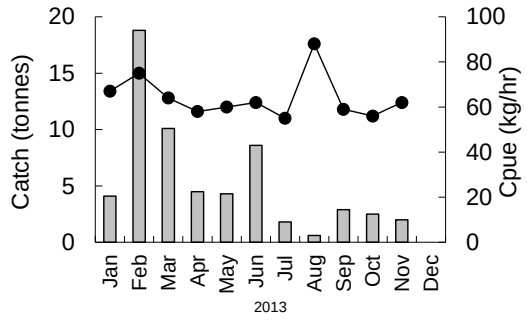
Regional view - Block 5:



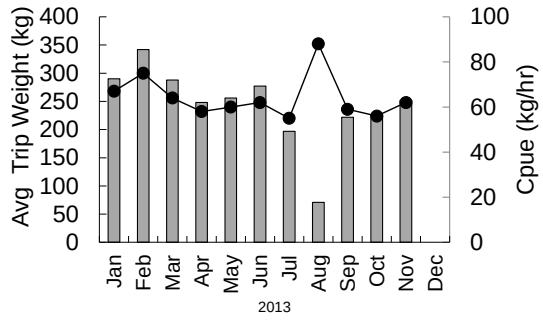
CPUE distribution:



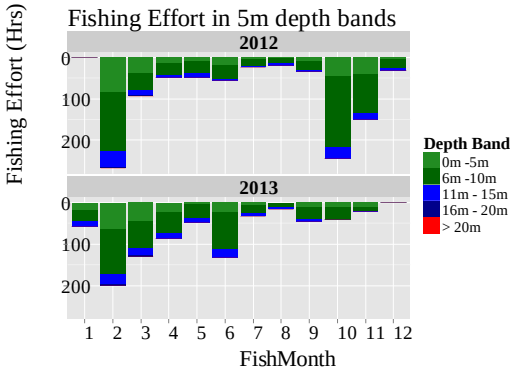
Regional catch and catch rates by month



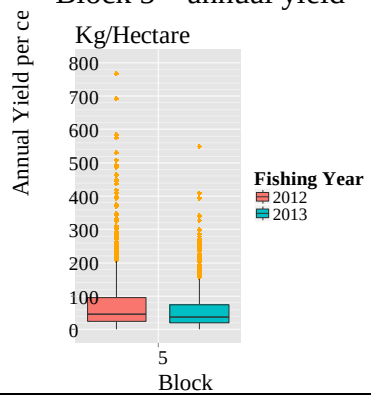
Monthly catch rates and mean daily catch



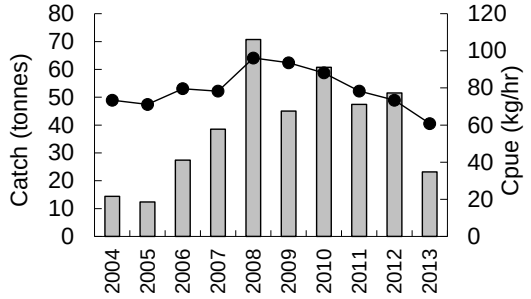
Block 5 monthly effort by depth



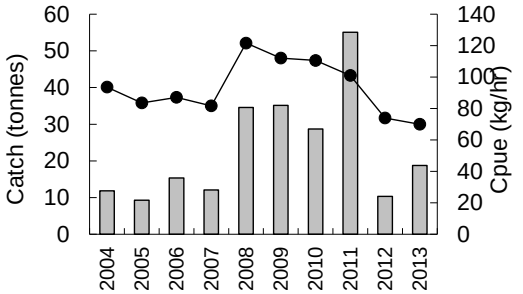
Block 5 – annual yield



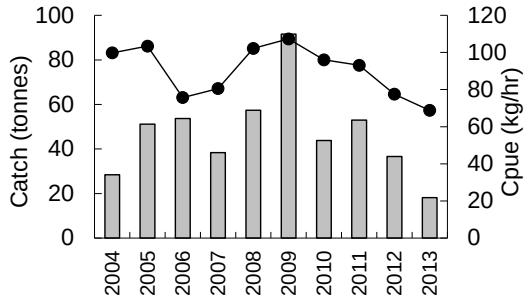
Sub-block 5A
Woolnorth Point to Studland Bay



Sub-block 5B
Studland Bay to Greens Beach, including Mt Cameron West

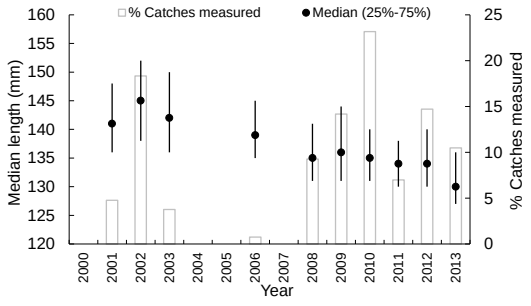


Sub-block 5C
Greens Beach to Arthur River

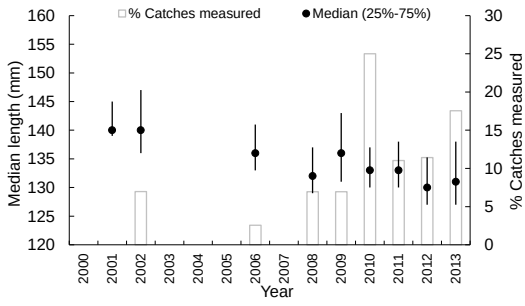


Northern Zone – Block 5
Median length of catch

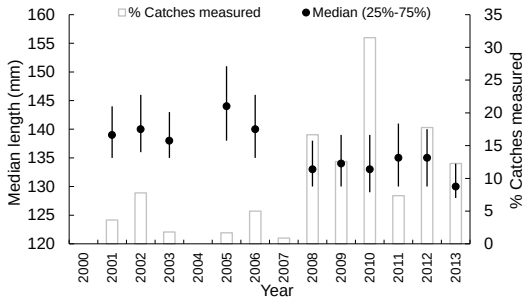
Sub-block 5A
Woolnorth Point to Studland Bay



Sub-block 5B
Studland Bay to Greens Beach, including Mt Cameron West

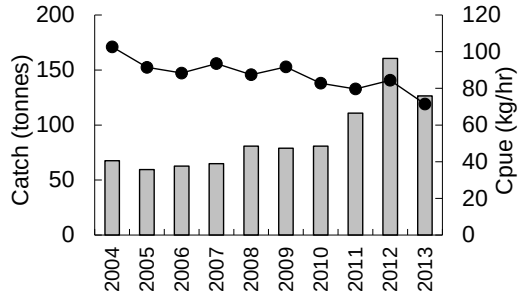


Sub-block 5C
Greens Beach to Arthur River

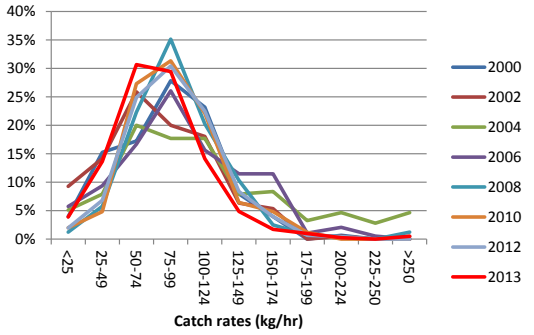


Northern Zone – Remainder North West Coast (Blocks 47, 48 and 49)

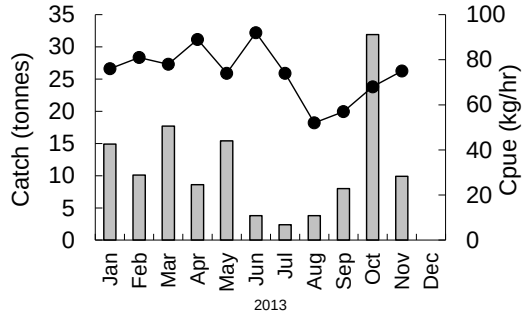
Regional view: Blocks 47-49, area capped 100 t in 2013, 126 t caught.



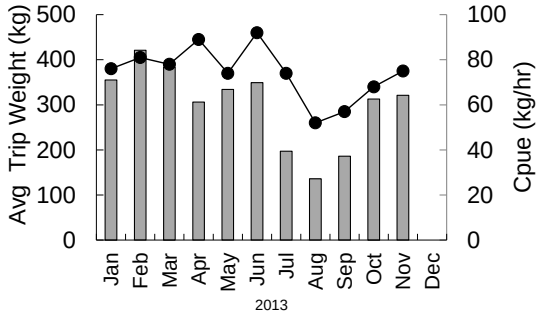
CPUE distribution:



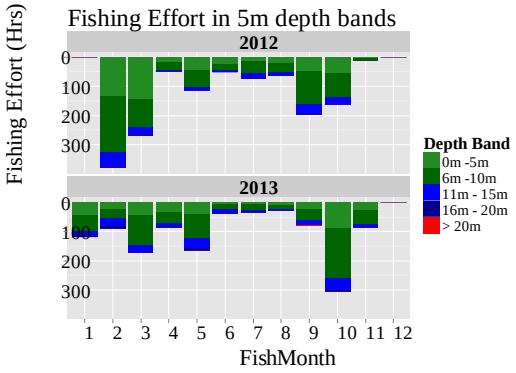
Regional catch and catch rates by month



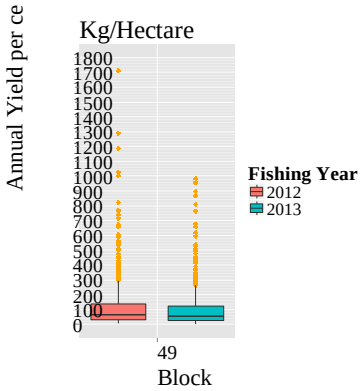
Monthly catch rates and mean daily catch



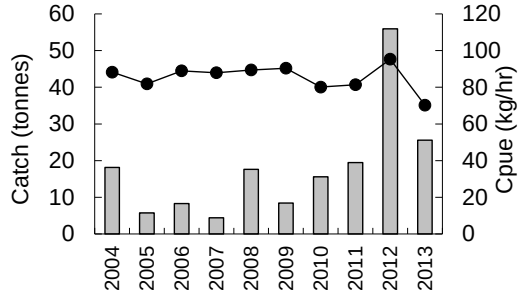
Block 49 monthly effort by depth



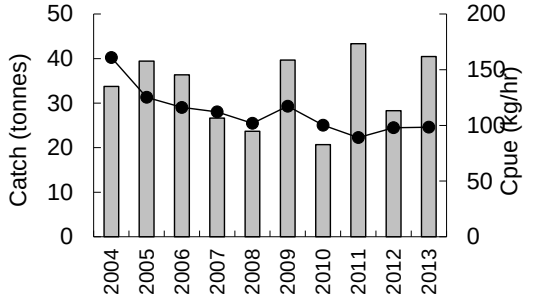
Block 49 – annual yield



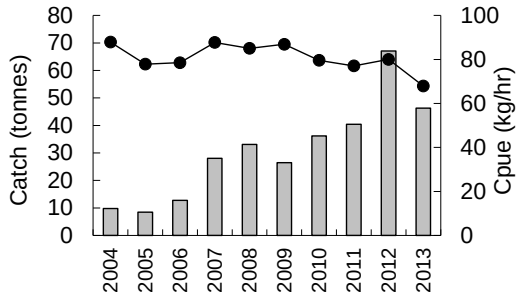
Sub-block 49A
Three Hummock Island



Sub-block 49B
Northern part of Hunter Island and Albatross Island

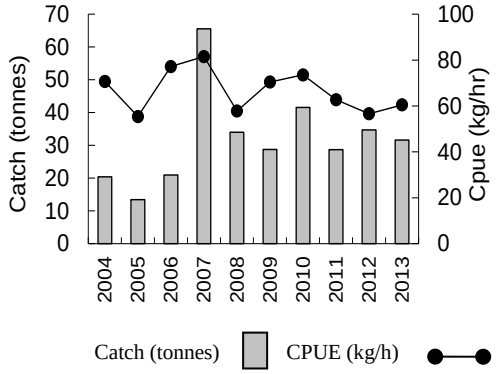


Sub-block 49C
South-western Hunter Island

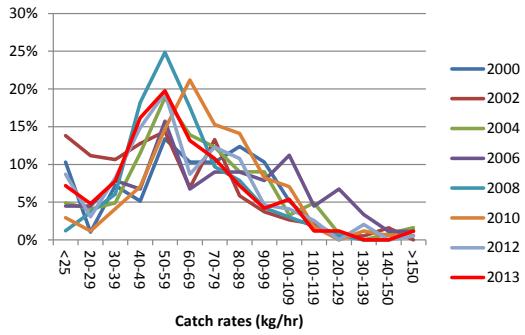


Northern Zone - North East (Sub-block 31B, Blocks 39, 40)

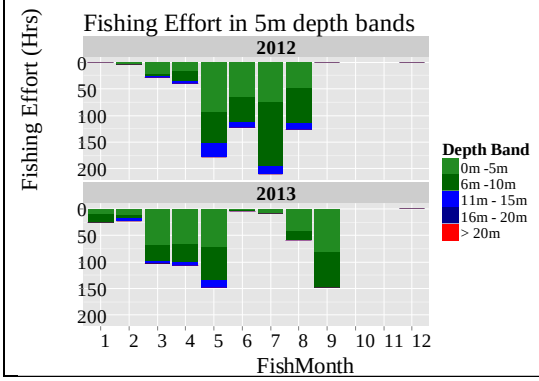
Regional view:
Area cap 30 t in 2013, 32 t caught. Mixed catch CPUE removed, 54% of catch was taken single species fishing in 2013.



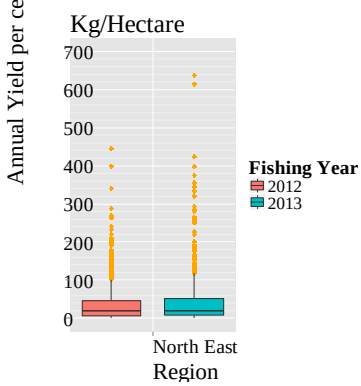
CPUE distribution:



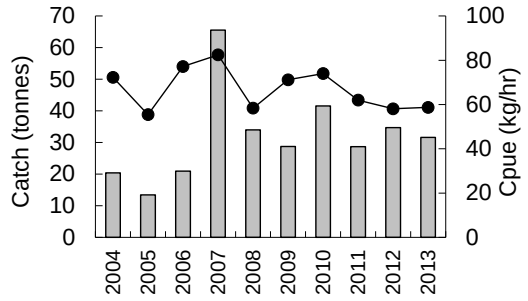
Regional monthly effort by depth



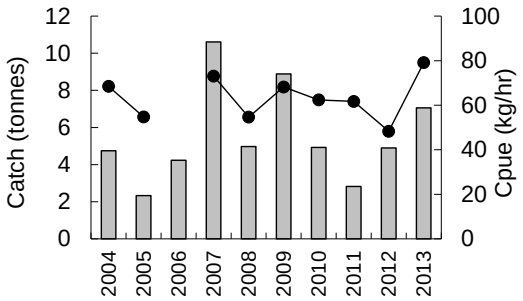
Regional – annual yield



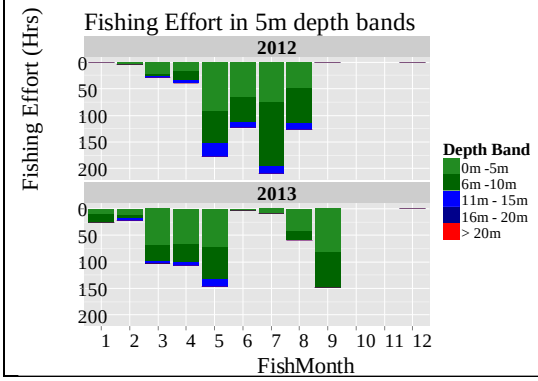
Sub-block 31B
Cape Naturaliste to Little Musselroe Bay
Mixed catch CPUE removed, 69% of catch was taken single species fishing in 2013.



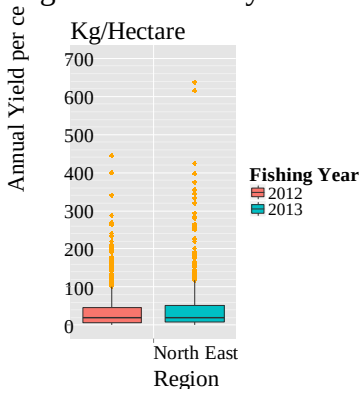
Sub-block 39A
Little Musselroe Bay to Petal Point
Mixed catch CPUE removed, 21% of catch was taken while single species fishing in 2013.



Regional monthly effort by depth

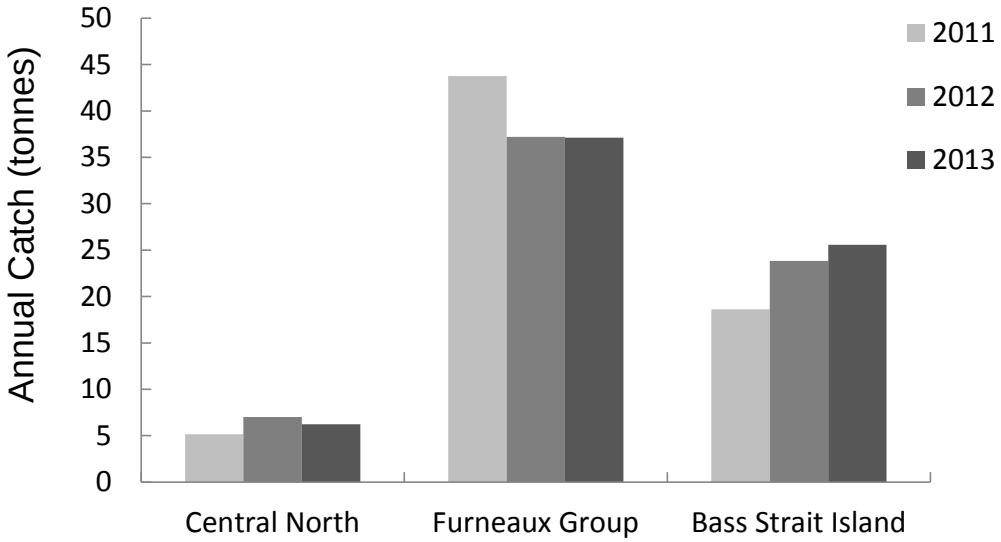


Regional – annual yield



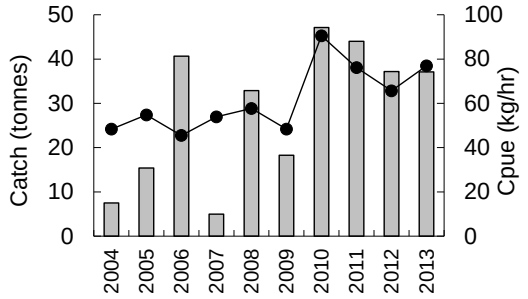
Bass Strait Zone blacklip fishery

Distribution of catch:

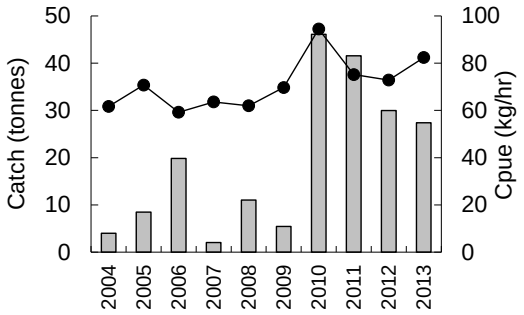


Bass Strait Zone - Furneaux Group (Blocks 32-38)

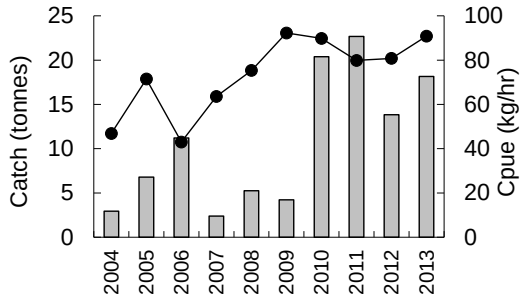
Furneaux Group: (Blocks 32-38)
Region cap 35 t in 2013, 37 t caught. Mixed catch CPUE removed, 81% of catch was taken while single species fishing in 2013.



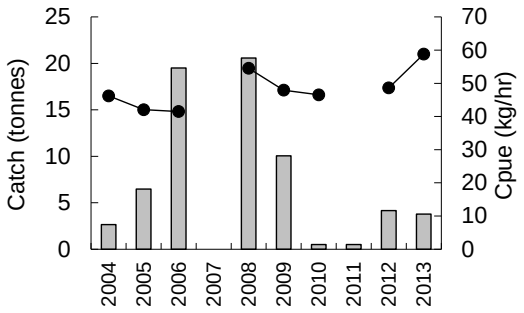
Eastern Furneaux Group: capped area (33B, 33C, 36A, 36B, 38A, 38B, 38C), area cap 30 t, 27 t taken in 2013. Mixed catch CPUE removed, 84% of catch was taken while single species fishing in 2013.



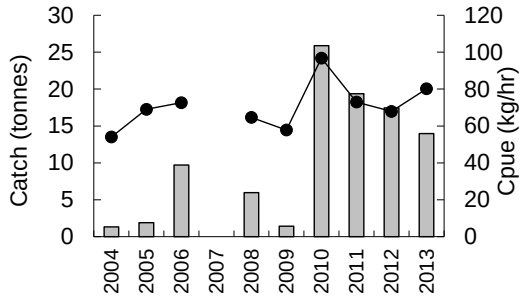
Block 33
South-east Furneaux Group
Mixed catch CPUE removed, 67% of catch was taken while single species fishing in 2013.



Block 37
North Flinders Island, inc. Sisters Islands
Mixed catch CPUE removed, 90% of catch was taken while single species fishing in 2013.

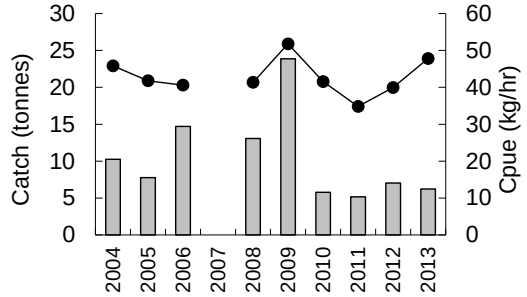


Block 38
East side of Flinders Island, inc. Babel Island. Mixed catch CPUE removed, 99% of catch was taken while single species fishing in 2013.



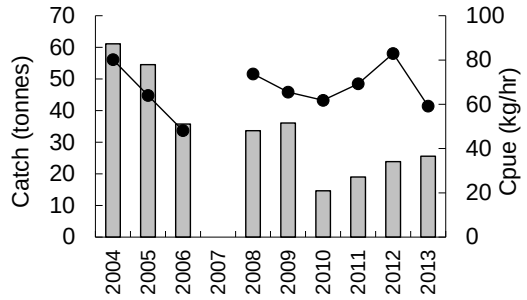
Bass Strait Zone – Central North Coast (Blocks 40-46)

Central North (Blocks 40-46)

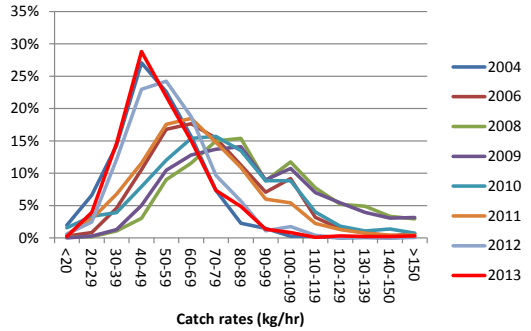


Bass Strait Zone – Remote Islands (Blocks 50-57)

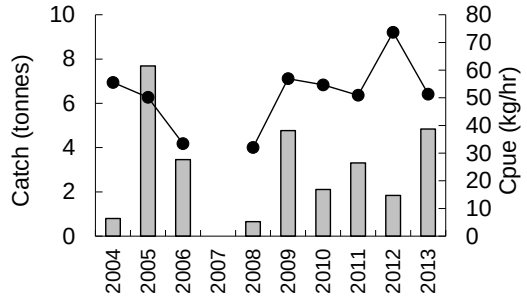
Bass Strait Islands (Blocks 50-56)



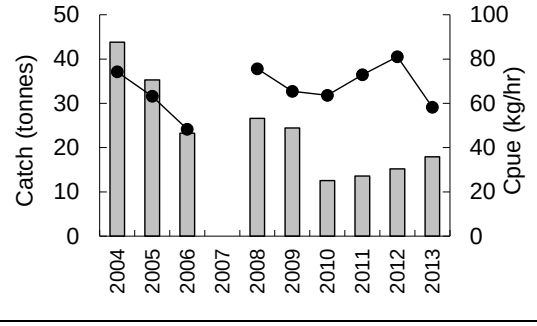
Cpue distribution:



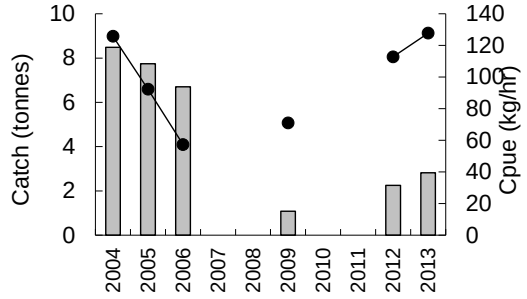
Block 51
Kent Group



Block 53
Hogan Group



Blocks 54, 55
Moncouers, Redondo Island



Greenlip fishery

In 2011 a new fishing region with a cap of 10 t was developed on the Central North coast (Blocks 41 to 47) following the reduction of the size limit there in 2010 to 132mm. No significant quantities of catch have been landed from there.

The 2013 greenlip TAC was 140 t. It was distributed between six regions (note sum of region caps is 148.5 t):

King Island – 25 t
North West – 18.5 t
Perkins Bay- 25 t
Central North-10 t
North East – 23 t
Furneaux Group – 47 t

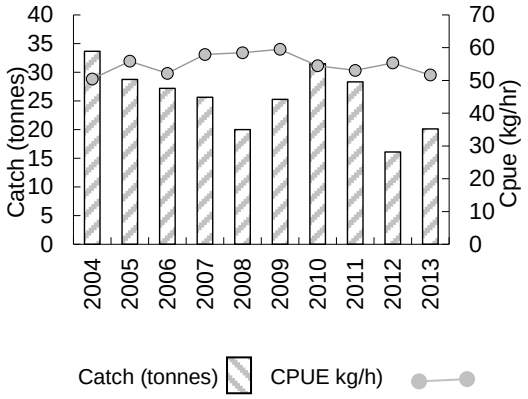
Annual catches:

Year	King Island	North West	North East	Furneaux Group	Perkins Bay	Central North	Total
2000	9.6	41.0	38.9	42.5	8.1	0.1	140.2
2001	18.6	28.9	30.4	44.2	17.8	0	139.9
2002	25.0	29.9	31.3	43.3	10.0		139.5
2003	32.6	30.3	35.3	37.6	4.0	0	139.8
2004	31.0	25.3	31.4	36.8	4.0	0.1	128.6
2005	28.8	25.2	19.4	42.4	7.2	0.1	123.1
2006	27.9	22.9	16.2	39.6	16.1	0.4	123.1
2007	25.6	22.9	33.5	31.1	10.5		123.6
2008	20.0	19.1	24.4	34.9	22.1	0.2	120.7
2009	25.3	13.7	35.0	27.3	20.2	1.1	122.6
2010	33.1	22.4	24.6	33.6	20.1		133.8
2011	28.3	21.1	23.7	44.3	21.0	1.6	140.0
2012	16.1	18.5	32.7	45.4	26.2	0.2	139.1
2013	20.1	22.6	24.5	55.1	17.1	0.3	140.4

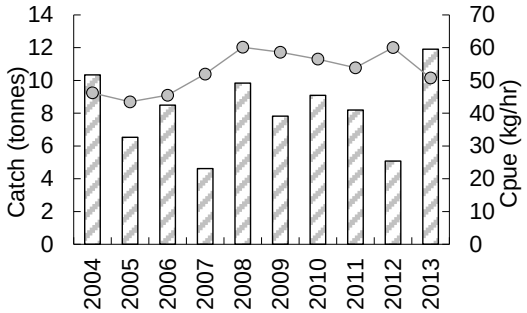
Small quantities (<1.0t pa) have been taken in recent years from Blocks 50 to 57.

Greenlip - King Island (Blocks 1-4)

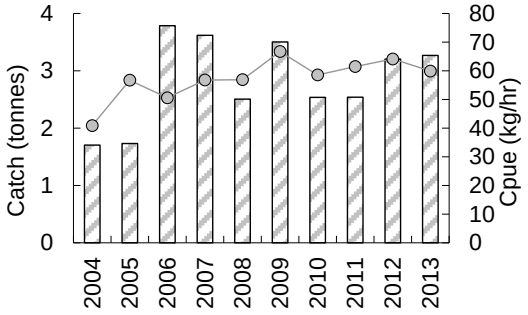
Regional view: Area cap 25 t in 2013, 20 t caught. Mixed catch CPUE removed, 72% of catch was taken while single species fishing in 2013.



Sub-block 2C
east King Island. Mixed catch CPUE removed, 98% of catch was taken while single species fishing in 2013.

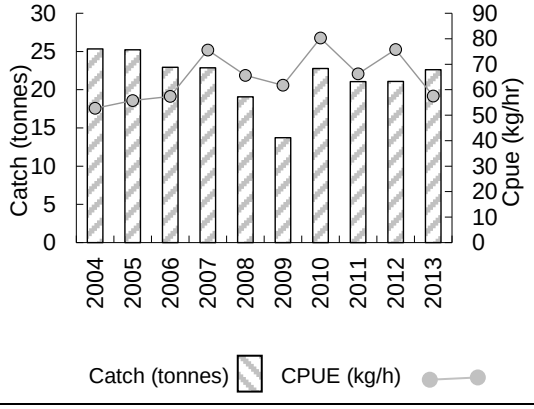


Sub-block 4A
South-east King Island. Mixed catch CPUE removed, 73% of catch was taken while single species fishing in 2013.

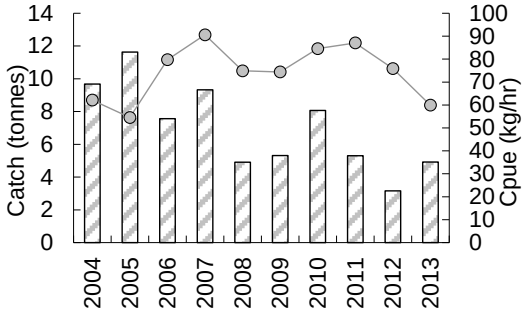


Greenlip - North West (Blocks 5, 48B, 48C, 49)

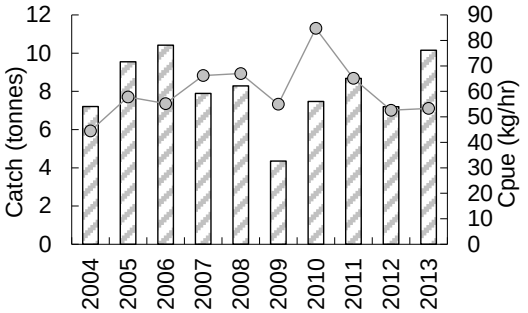
Regional view: Area cap 18.5 t in 2013, 22.5 t caught. Mixed catch CPUE removed, 19% of catch was taken while single species fishing in 2013.



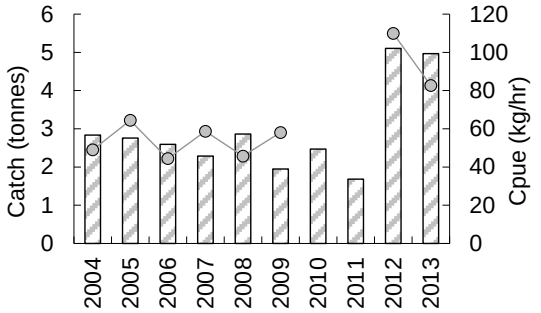
Sub-block 5A
West of Woolnorth Point. Mixed catch CPUE removed, 17% of catch was taken while single species fishing in 2013.



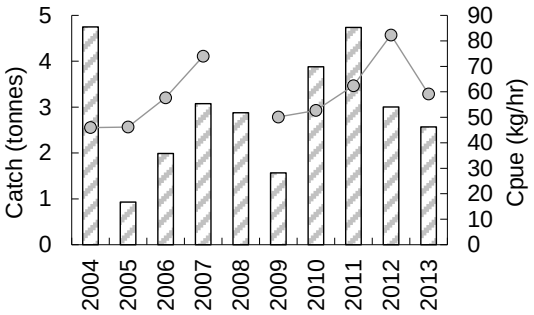
Sub-block 48C
Woolnorth to Robbins Island. Mixed catch CPUE removed, 24% of catch was taken while single species fishing in 2013.



Sub-block 48B
Petrels. Mixed catch CPUE removed, 5 t caught in 2013, all but 2 catches involved fishing mixed species.

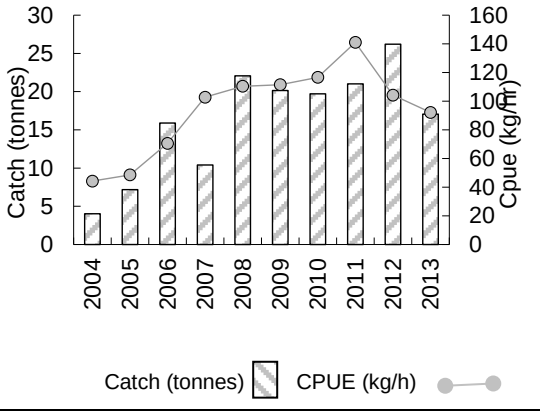


Sub-block 49C
South and west of Hunter Island. Mixed catch CPUE removed, 2.6 t caught in 2013, only 13% (2 out of 15) catches were single-species fishing



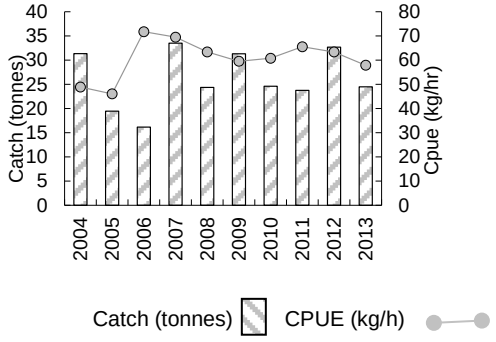
Greenlip – Perkins Bay (Sub-block 48A)

Area cap 25 t in 2013, 17 t caught. Mixed catch CPUE removed, 93% of catch was taken while single species fishing in 2013.

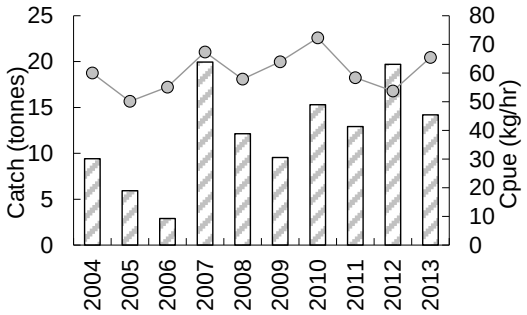


Greenlip - North East (Blocks 31, 39, 40)

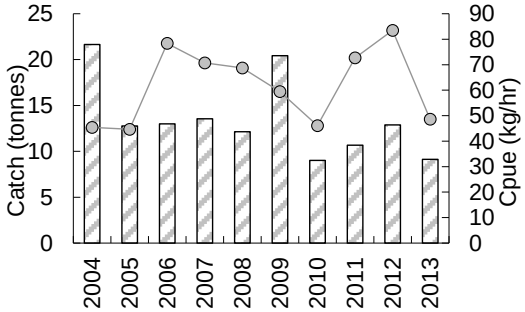
Regional view: Area cap 23 t in 2013, 24.5 t caught. Mixed catch CPUE removed, 34% of catch was taken while single species fishing in 2013.



Block 31
Eddystone to Little Musselroe, Swan Is. Mixed catch CPUE removed, 40% of catch was taken while single species fishing in 2013.

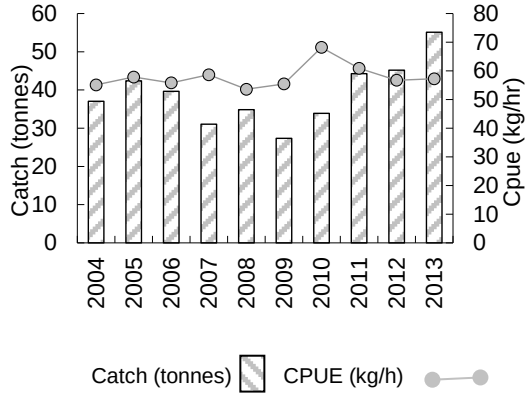


Block 39
Tomahawk to Little Musselroe. Mixed catch CPUE removed, 21% of catch was taken while single species fishing in 2013.

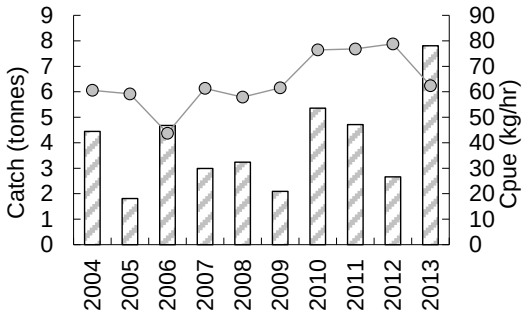


Greenlip – Furneaux Group (Blocks 32-38)

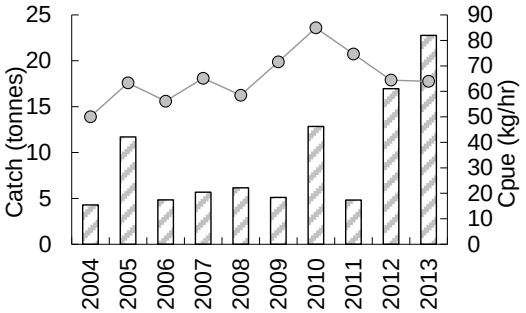
Regional view: Area cap 47 t in 2013, 55 t caught. Mixed catch CPUE removed, 85% of catch was taken while single species fishing in 2013.



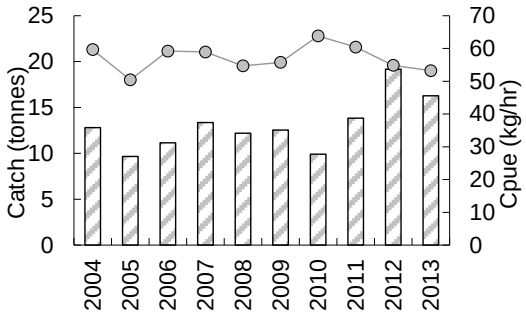
Block 32
Western side of Clarke Is, Armstrong Passage. Mixed catch CPUE removed, 85% of catch was taken while single species fishing in 2013.



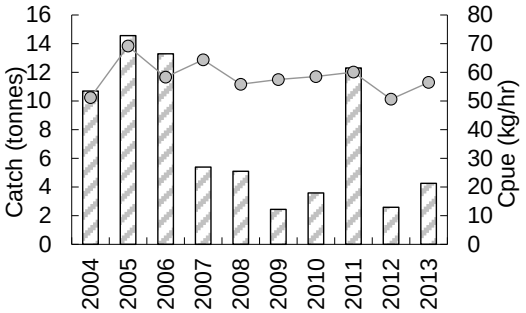
Block 33
south east Clarke, Cape Barren Islands
Mixed catch CPUE removed, 78% of catch was taken while single species fishing in 2013.



Block 35
Franklin Sound
Mixed catch CPUE removed, 91% of catch was taken while single-species fishing in 2013.



Block 38
north-east Flinders Island
Mixed catch CPUE removed, 93% of catch was taken while single-species fishing in 2013.



Appendix 2: Assessment of stock status

In 2012 a common approach to assessing fish stocks was applied for the first time across all Australian jurisdictions to produce a report on the Status of Australian Fish Stocks (Flood et al., 2012). The Tasmanian abalone fishery is included in the national report and the same framework was first applied to the state assessment for the 2012 assessment. The system is based on measures already used in the Tasmanian assessment but formalises the categorisation process. These measures are proxies for biomass and fishing mortality such as trends in catch rate, catch and size structure. These descriptions of stock status relate to the risk of recruitment overfishing which is strongly affected by size limits in many parts of the Tasmanian abalone fishery.

Stock status	Description	Potential implications for management of the stock
SUSTAINABLE	Stock for which biomass (or biomass proxy) is at a level sufficient to ensure that, on average, future levels of recruitment are adequate (i.e. not recruitment overfished) and for which fishing pressure is adequately controlled to avoid the stock becoming recruitment overfished	Appropriate management is in place
TRANSITIONAL-RECOVERING ↑	Recovering stock—biomass is recruitment overfished, but management measures are in place to promote stock recovery, and recovery is occurring	Appropriate management is in place, and the stock biomass is recovering
TRANSITIONAL-DEPLETING ↓	Deteriorating stock—biomass is not yet recruitment overfished, but fishing pressure is too high and moving the stock in the direction of becoming recruitment overfished	Management is needed to reduce fishing pressure and ensure that the biomass does not deplete to an overfished state
OVERFISHED	Stock is recruitment overfished, and current management is not adequate to recover the stock; or adequate management measures have been put in place but have not yet resulted in measurable improvements	Management is needed to recover this stock; if adequate management measures are already in place, more time may be required for them to take effect
UNDEFINED	Not enough information exists to determine stock status	Data required to assess stock status are needed

Table 2. Summary of changes in catch, catch rate (CPUE) and median length, by region, and interpretation for fishery status.

Catch	CPUE	Length	Interpretation	Region
stable	rising	no data or erratic	Stable or increasing abundance	Central North Coast (BSZ)
stable	falling	no data or erratic	Falling abundance	Block 9 (WZ)
stable	stable	no data or erratic	Abundance stable or falling	Bruny Island (EZ), North East (NZ)
stable	erratic	rising	Depends on relative strength of CPUE, but in absence of rising CPUE, abundance probably falling	Block 22 (EZ)
stable	erratic	no data or erratic	Depends on relative strength of CPUE, but in absence of rising CPUE, abundance probably falling	North West (G)
falling	falling	rising	Stock levels almost certainly falling, absence of recruits causes median length to rise, indicates weak recruitment	South Coast (WZ)
falling	falling	falling	Stock levels almost certainly falling, high fishing mortality reduces median size	Block 6 (CWZ), Block 5 (NZ)
falling	falling	no data or erratic	Stock levels almost certainly falling	Block 31 (EZ), Strahan North (WZ), King Island (G)
falling	stable	rising	Stock levels almost certainly falling, absence of recruits causes median length to rise, indicates weak recruitment	Actaeons (EZ) Lower Channel (EZ)
falling	erratic	no data or erratic	Stock levels stable or decreasing, less likely to be increasing.	Furneaux Group (BSZ)
rising	rising	no data or erratic	Increasing abundance	Rem'dr North East (EZ)
rising	falling	rising	Stock levels falling, reduced recruit levels	South West (WZ)
rising	falling	no data or erratic	Stock levels falling	Rem'dr North West (NZ)
rising	stable	no data or erratic	Stock levels stable or increasing, less likely to be decreasing	Furneaux Group (G)
rising	erratic	no data or erratic	No clear signal	Remote Islands (BSZ)
erratic	rising	no data or erratic	No clear signal	Storm Bay (EZ)
erratic	falling	no data or erratic	No clear signal	Perkins Bay (G), North East (G)

Catch	CPUE	Length	Probable change in abundance	Region
erratic	stable	no data or erratic	No clear signal	King Island (NZ)
erratic	erratic	stable	No clear signal	Forestier, Maria (EZ)
erratic	erratic	no data or erratic	No clear signal	Freycinet, Bicheno (EZ)

Appendix 3: Interpreting graphical information

Catch and catch rate by region, block and sub-block.
Catch and catch rate information is shown across a range of geographical scales ranging from large (regional) to small (sub-block) where relevant (i.e. catches consistently larger than 10 t pa, or six or more divers contributed to the catch). Figure 22 shows catch and catch rates for the last eight years for sub-blocks. The vertical columns show catch in tonnes, for the period 2000-2007. The black line with balls shows catch rates (CPUE) over the same period. Greenlip charts show catch as hatched columns, and catch rates as grey balls joined with a grey line.

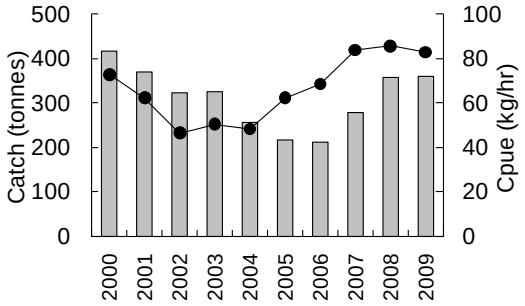


Figure 22. Annual catch (tonnes) and geometric mean catch rates (kg/hour), 2000 - 2009.

Catch and effort were not reported by sub-block and zone prior to 2000, and consequently are shown only from that year onwards. Additionally, catch rates trends over short periods (compared with longer periods) are more likely to reflect changes in abundance of abalone and not changes in fishing methods, and catch rates earlier than 2000 are not used in this assessment.

Regional catch-rate distribution:
The distribution of catch rates provides information about how divers are catching abalone that is not explained by the mean (Figure 23). That the distributions are skewed (not evenly distributed about the category with the highest percentage) implies that fewer divers are achieving high catch rates. Skewness tends to be greatest when abalone abundance is low or has been recently reduced, making high catch rates less common.

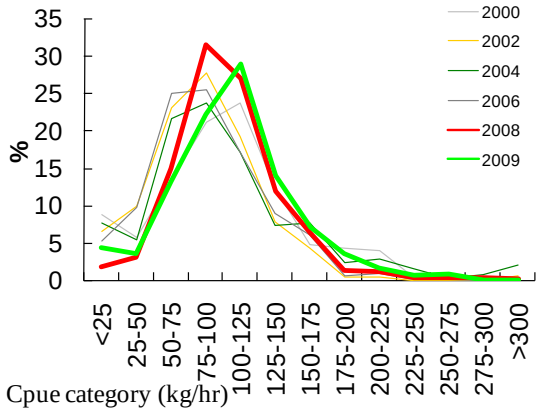


Figure 23. The percentage distribution of catch-rates, 2000 - 2009.

Size-composition charts.

The size-composition of divers' catches is reviewed at sub-block level (Figure 24). At this spatial scale, there is a greater likelihood that the catches come from populations with similar growth characteristics than at larger scales. We are unable to estimate the percentage of catches sampled prior to 2000 because sub-block reporting was not introduced until then. We are able to attribute some sampled catches to sub-blocks in earlier years, because we know the location from where the catches were taken.

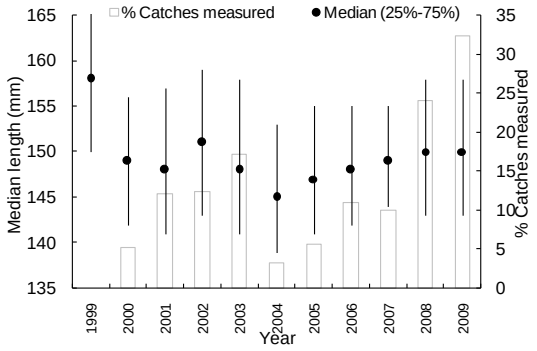


Figure 24. Median length with 25%-75% inter-quartile size range of abalone from commercial catch samples. The vertical columns represent the percentage of catches sampled.

Size-composition charts plot median length (the middle or 50th percentile length if all abalone were sorted from smallest to larges t) for the period 1998-2008 (or the period since catches can be attributed to sub-blocks). They also show the size of abalone at the 25th and 75th percentiles i.e. the size range of the middle 50% of abalone from the sampled catches.

Appendix 4: Interpreting trends in catch and catch rate, and the size composition of the commercial catch

The use of catch and catch rates to infer changes in abundance

This assessment is primarily based upon the interpretation of information produced from fishery catch data; both catch distribution and catch rates. It relies upon the assumption that trends in catch-rates reflect changes in abundance of the fishable stock. Despite CPUE being much discredited as an index of abalone abundance (e.g. Breen, 1992; Prince, 1992; Shepherd *et al.* , 2001) it has been used with some success for many years in the Tasmanian fishery. There are several factors that adversely affect the relationship between CPUE and abalone abundance: gregarious behaviour of abalone, serial depletion of local populations constituting the stock, and changes in fishing efficiency. If the effects of the above factors are understood and can be minimized then the reliability of CPUE as an index of abundance can be improved.

Gregarious behaviour

Abalone tend to aggregate in favourable habitat (e.g. gutters, sand-edges, shallow margins), and a large proportion of abalone may be found in only a small area of each reef (Prince, 1992). When these aggregations are fished, the remaining abalone tend to form new aggregations (Officer et al., 2000), and thus reefs may become depleted while catch rates are maintained (McShane, 1995; Officer et al., 2000). Similar problems among other commercially fished marine species are well documented (e.g. Hilborn and Walters, 1992; Rose and Kulka, 1999).

Where abalone abundance is high and abalone are aggregated, catch rates are primarily a function of handling time (the time taken to detach abalone from the reef and transfer them to the boat). As abalone abundance decreases, and aggregations become smaller and further apart, search time increases, and adds significantly to the overall effort required. This makes the relationship between abalone abundance and CPUE non-linear (hyperstable – CPUE remains high even when stock size reduces), and by the time catch rates start to decline rapidly, abalone abundance will already have been greatly reduced (Prince, 1992).

A related problem occurs when divers search for favourable habitats, and the aggregations within them. Time spent searching for aggregations is only weakly related to the number of individuals landed, and catch rates do not necessarily decline at the same rate as the abundance of aggregations (Breen, 1992). Under these circumstances, catch rates are again unreliable, and extra care is needed when attempting to interpret such information. This problem would also occur if divers were searching for areas containing abalone within a specified size range, or where divers were swimming over larger abalone within an area if selecting a particular size range of abalone.

Where abalone abundance is low, a consequence of aggregating behaviour is that the most favourable habitats can accommodate most of the population and the surrounding areas may be relatively sparsely populated. Provided effort is also low (i.e. diver visitation rates are low), legal-sized abalone move to the favourable habitat (Officer et al., 2000; Shepherd and Partington, 1995) between fishing events. Experienced divers

can maintain catch rates by fishing the most favourable areas (Shepherd and Partington, 1995), and the CPUE/abundance relationship is again non-linear and hyperstable.

Serial depletion

Serial depletion of reefs occurs when divers progressively reduce stock abundance on individual reefs, and maintain stable catch rates by moving between reefs (Prince and Shepherd, 1992). Reefs are abandoned when divers find it harder to maintain levels of daily catch, and effort is focused on reefs with higher stock levels. When there are many reefs with low levels of abundance in a reporting block, divers can move between reefs, depleting stock levels in each, while producing stable but relatively low levels of annual catch at acceptable catch rates.

If management units are large and catch reporting occurs over large spatial scales, falling catch rates caused by depletion of individual reefs are masked when divers transfer effort to reefs with higher levels of abundance. If catch reporting occurred at the scale of individual reefs, the fall in CPUE that precipitated the divers' movements and the fall in catch indicative of depletion would be detected. In Tasmania, the sub-block scale of reporting (Appendix 11) is too large to detect such fine scale declines in CPUE.

Regular patterns observed in the spatial distribution of catch from Tasmania's East Coast appear to indicate that provided effort is low enough, stock levels on the reefs first depleted may recover sufficiently to support further fishing, thus developing a cycle of depletion and recovery. Analysis of catch data from a range of reporting blocks has revealed historically low levels of annual catch. Such low catch levels may appear stable in the short term, but have been seen to fall slowly over a period of years, presumably as reefs become less productive (i.e. the period between fishing and recovery is greater than the period between fishing events). Examples include Blocks 25, 26, 28, 29 and 30. Catch rates under this scenario typically appear stable, or with improvements in diver efficiency, may even rise slowly.

Change in fishing efficiency

The detection and avoidance of difficulties associated with improvement in fishing efficiency, or effort creep is a continuing problem when catch rates are used as an index of stock biomass or abundance when assessing fisheries. Catch rates (CPUE) and the stock biomass are assumed to be related: CPUE = qB, where q is the catchability coefficient and B is the exploitable biomass. If q increases through time in an unknown manner, through diving operations becoming more efficient, then the relationship between CPUE and biomass becomes altered to an unknown degree and the interpretation of CPUE as a measure of biomass becomes biased high.

One of the features of commercial fisheries is that fishermen almost always find ways to make their operations more efficient, and the abalone fishery has been no exception. Thus, because of improved efficiency, if stock levels are unchanged, more abalone can be collected per unit time now than in the past i.e. catchability increases. This leads to a rise in reported catch rates without an associated increase in abalone abundance, or alternatively, it can lead to catch rates appearing to be stable while the stock abundance is, in fact, declining. Two broad categories of causes of change in fishing efficiency have been identified in the Tasmanian abalone fishery – technological and behavioural.

Technological causes of change in fishing efficiency are usually easy to detect. For example, early in the history of the Tasmanian abalone fishery, divers anchored their boats, and often worked without a deckhand. Later, during the 1970's, the boats carried a deckhand who drove the boat and followed the diver, thus eliminating time spent swimming the catch from the reef to the anchored boat. It was estimated that the catching efficiency of divers doubled between the start of the fishery in the 1960's and 1982 (Harrison, 1983).

Possibly the greatest single improvement occurred during the late 1980's when divers widely adopted the practise of attaching their collecting nets to ropes lowered to them by their deckhands (droplines) and they no longer had to surface to the boat every time they filled their nets. This increased efficiency because:
(a) time spent ascending to the boat, unloading the catch and descending back to the reef was eliminated,
(b) the diver maintained his position on the productive part of the reef,
(c) catch bags could be reduced in size, which meant that divers could swim more easily and with less effort.

However, the increase in efficiency caused by droplines is not constant across all abalone densities. At low levels of abundance, divers may finish swimming over a reef before their net is full, so the method offers little improvement. At the other extreme, when nets are being filled every few minutes because abalone are particularly abundant, the method offers great savings in time i.e. the method causes catch rates to change non-linearly with abundance.

More recent technological changes to fishing operations include the increased use of GPS navigation systems, Nitrox breathing gases and diver propulsion vehicles (DPV). The extent of the usage of GPS navigators and associated plotting equipment by abalone divers is unknown, but it apparently has become much more widespread over the last five years. Nitrox gas mixing plants are currently used by only a few divers, but these divers are responsible for landing a large proportion of the catch in the regions where they work. DPVs are also not yet in common usage, but help divers move more quickly between concentrations of abalone, particularly in deeper water.

Changes in fishing efficiency due to behavioural causes, while not as obvious as technological causes, may have a profound effect upon catch rates. Competition between divers for abalone or quota, or inducements offered by processors, or management changes, may all improve, or at least alter, the way divers work (Gorfine, 2001). Divers, either individually or as a group may learn to fish an area more effectively (Breen, 1992). Daily catches may increase when divers realise they are catching at a high rate, leading to a correlation between high catch rates and larger catches (Worthington et al., 1998). These types of changes are more difficult to detect and account for than changes in fishing methods.

In Tasmania, the practise of team diving (where two divers share a boat and catch abalone on the same quota unit) was legitimised in 2005. Team diving potentially has the effect of reducing diver efficiency, but increasing profitability because of cost-sharing between the divers. Prior to 2005 team diving was illegal and unreported but allegedly quite common. There is no information to show that the incidence of team diving post-legalisation is different to the former level, but it is potentially a cause of changes to diver efficiency.

Since 2007, divers have reported that the availability of improved forecasting of sea conditions was responsible for effort creep through improved catch rates, because they could choose to fish the West Coast when conditions were optimal. Previously they had travelled to the west when they hoped conditions were favourable, but often were not, and faced with the prospect of returning home with no catch, were obliged to fish in less favourable conditions with a greater likelihood of reduced catch rates.

The most recent Tasmanian study into the effects of effort creep on abalone catch rates was made using catch-effort data collected between 1975 and 2000, from Blocks 13 and 14. Using documented estimates of effort creep as guidelines (Buckworth, 1987; Haddon and Hodgson, 2000; Harrison, 1983), a series of plausible effort creep scenarios was constructed. Extrapolation of Harrison's (1983) estimate of effort creep (approximately 5% p.a.) caused an overall reduction in relative CPUE over the study period i.e. by removing the confounding effect caused by improvements in diver efficiency, catch rates were higher in 1975 than they were in 2000 (Tarbath et al., 2001). However, the overall relative trends in catch rate were only slightly altered when using the standardization (Figure 25).

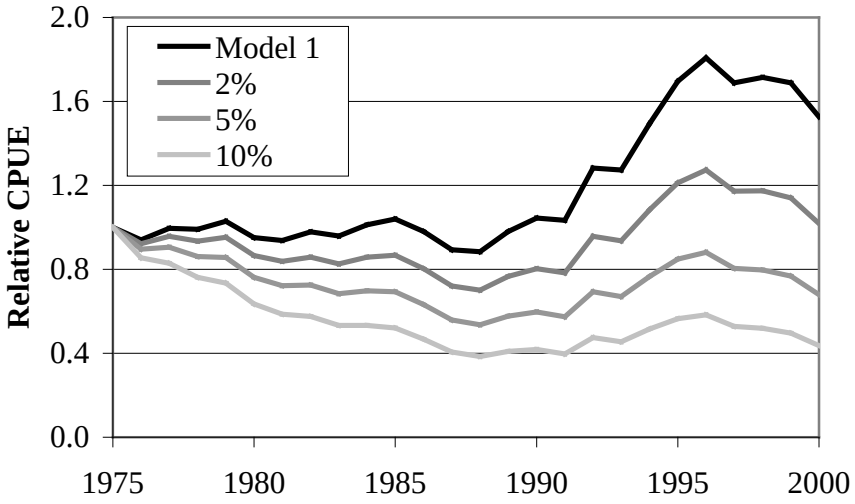


Figure 25. Relative CPUE indices for Block 13, 1975-2000. Model 1 is the raw geometric mean of CPUE. The three effort creep scenarios considered are: (i) 2% per annum; (ii) 5% per annum; and (iii) 10% per annum. All values of CPUE are relative to 1975 (Tarbath et al., 2001).

Improvements in efficiency are extremely difficult to quantify accurately. Without the resources to make an intensive study into historical diving techniques and behaviour (which anyway would have to rely on divers' memories) or alternatively make guesses about how much more efficient current divers have become, we have chosen to limit the comparison of catch rates over ten years during which we assume that divers operated with equal efficiency. By reducing the period over which comparisons are made, it is assumed to be more likely that changes due to improved fishing methods or diver behaviour are avoided, and there is more confidence that catch-rate trends represent changes in abundance, not changes in fishing power.

Circumstances when catch rates are reliable indices of abalone abundance

When problems caused by abalone aggregations, serial depletion and improved efficiency are understood and measures are taken to counter their effects, catch rates can reliably reflect abundance in fished populations. For example, in the NSW blacklip fishery, high visitation and exploitation rates preclude the formation of aggregations of legal-sized abalone, and stocks are uniformly maintained at a low level. A consequence of this is that the recovery-depletion cycle evident in other fisheries is removed. Researchers in NSW have concluded that with the lowered stock abundance catch rates had become a reliable index of abundance (Andrew et al., 1997; Worthington et al., 1998). Similarly, in the more heavily fished parts of Tasmania (e.g. the Actaeons) where it is known that diver visitation rates to reefs are high (i.e. restrict the formation of aggregations), divers are unable to successively deplete reefs (because all reefs support continuous levels of effort). Provided the effects of effort creep are reduced by limiting the review period to years when diving methodology is unchanged, we can assume that catch-rate trends are indicative of changes in abundance.

These conditions of intense fishing pressure are probably common in parts of the Eastern Zone fishery from where most of the catch is taken, particularly the Actaeons and Storm Bay regions, and the more heavily fished parts of the Northern and Western Zone fisheries in North West Tasmania and the South Coast. However, there are many parts of the Tasmanian fishery where these conditions cannot be met, and assessment of these areas based on catch rates must be viewed with caution. The following cases are discussed:

Earlier assessments assumed that abalone abundance was high on Tasmania's west coast because catch rates were relatively high compared with the east coast. It now appears that along much of the coastline, the population remnants contracted to either deep water or the wash zone, where they can still be caught at high catch rates. Earlier assessments also failed to account for the larger size of west coast fish, which causes high catch rates relative to other parts of the fishery. The reported decline of stocks and widespread concern among divers who fish in the South West highlights the dangers of relying upon absolute values of catch rates to gauge abundance levels.

We assume that a change in annual catch (e.g. TAC reduction) will cause effort to be proportionally reduced throughout a zone, but this is not usually the case. Effort is maintained on favoured areas, while less favoured areas may go unfished, and means that effort is not applied consistently to populations. This can increase the time between fishing events and allow aggregations to form where previously there were none, or worse, reduce effort on populations to superficial levels. Both can produce high catch rates and the illusion of high stock levels. Under these circumstances, the relationship between abalone abundance and catch rates is different than under conditions of constant levels of effort, and catch rate trends should be used with caution.

Much of Tasmania's greenlip fishery is fished at low levels of effort, reducing the value of catch rates for assessment purposes. However, there are two further problems to consider with the greenlip fishery. Firstly, it is evident that many divers are learning to fish greenlip abalone more efficiently, compounding the difficulty faced in interpreting the abundance/catch-rate relationship. Secondly, each region's greenlip catch is relatively small, with few participating divers. The entry or exit of a diver who catches at different rates from the others can change the region's catch rates (attempts at

standardising effort by diver have proved unsuccessful). Throughout southern Australia, fishery managers have a long history of monitoring greenlip fisheries using fishery catch and effort data with a notable lack of success. The Victorian fishery collapsed, and fisheries in South Australia (Shepherd et al., 2001), Western Australia (Hart et al., 1999), and Tasmania (Officer, 1999) have all wiped out greenlip populations because CPUE trends provided inadequate warning of stock depletion. Consequently we have placed less reliance on a CPUE/catch-based assessment in these areas.

Despite the difficulties with interpreting catch-rate information, it is proposed that, when catch rates are examined in combination with trends in the catch itself, along with the median size of captured abalone, some interpretations are more likely than others. The strongest indications of abundance change occur in two situations: (i) when catch rates continue to decline despite a decline in the catch; and (ii) when catch rates increase when catches increase.

Declining catches combined with continuing declines in catch rates should indicate a recruitment decline: despite a reduction in fishing pressure, catch rates continue to decline because there are increasingly fewer recruits each year to the fishery. This is expected to be associated with a decline in the median size of abalone because fishing mortality increases and fewer animals are left to grow to larger sizes.

Catch rates increasing with increasing catches are likely to indicate an increase in fishable biomass. It is expected that the median size will eventually increase, though a decrease is possible if the increased catch is due to large numbers of new recruits entering the fishery.

Size composition of the commercial catch

Almost since the start of the fishery, abalone from divers' catches have been sampled for length measurements to provide information about the condition of stocks. However, because the reporting of catches was at the gross spatial scale of blocks, the samples were of limited value in assessing the impact of fishing on populations. While changes in size structure could be seen, it was never certain whether the changes were due to fishing mortality or because divers re-directed effort between populations with vastly different growth characteristics. In 1998, divers started submitting photographic samples of their catches with details of the location from where the catch was taken, which, given adequate levels of sampling, meant that individual populations could be monitored. Although the photographic program stopped in 2000, in that year the start of catch reporting by sub-blocks increased the value of length-based monitoring for the stock assessment.

Between 2000 and 2008, diver's catches from around the State were routinely sampled by IMAS research staff at fish processing factories. Most of the sampling has been from catches taken in the south east and east coasts, but catches from the north and west coasts have also been measured. The fish processing factories have included both canners and live-market traders.

Since 2008, market measuring has been undertaken by four abalone processors (Ralphs Tasmanian Seafoods Pty Ltd, Tasmanian Seafoods (Margate) Pty Ltd, Tasmanian Seafoods (Smithton) Pty Ltd and Abalone Tasmania Pty Ltd) who together process

over 40% of the catch. Processor staff measure samples of 100 abalone from catches using electronic measuring boards.

The aim of catch sampling is to provide information about the size-structure of the catch from fished abalone populations, independent of variation caused by a range of confounding effects. This variation may stem from several causes: e.g. divers' catches from the same sub-block on the same day may comprise abalone of widely varying lengths, caused by fishing populations with different growth characteristics. The size-structure of catch samples may also be influenced by seasonal growth rates, particularly when exploitation rates are low, and consequently samples collected during autumn and winter contain larger abalone than in spring and summer. Market preferences for abalone within a specific size-range will also be reflected in catch samples.

Sampling involves measuring 100 abalone randomly selected from a diver's catch. Sample design was loosely based upon work done by Andrew and Chen (1997) in the New South Wales abalone fishery. Their strategy was to collect small samples from many catches, rather than large samples from a few catches, increasing the likelihood that the samples better represented the whole commercial catch and hence the populations from which they were taken.

For the purpose of this assessment, samples have been grouped by year and sub-block. Sub-blocks where less than 4% of catches have been sampled during more than two years have usually not been reviewed, because the level of sampling is probably inadequate to reflect size-structure of fished populations. Across much of the fishery, the level of sampling has been inadequate. Landings from motherships usually comprise catches from more than one sub-block and more than one day, and because it is not possible to identify the sub-block from where the catch came, size-compositions from areas fished predominately by motherships are generally not available.

The 4% level was chosen arbitrarily, with consideration given to the methods of Andrew and Chen (1997). However, where the number of annual landings is low, much higher percentages of sampling may still be inadequate. For example, during 2003 in the Western Zone sub-block 8A, there were 41 landings. Of these, four were sampled (~10%). The median and inter-quartile length estimates from the samples were larger than both those from earlier years and 2004. One of the four samples was taken from an unusually large catch caught at high catch rates, and it is surmised that, as occasionally happens on the west coast, unusually calm conditions enabled the diver to fish part of a hitherto unexploited population which contained older and larger abalone than normally encountered.

In the Eastern Zone, particularly the south east, the number of landings is much higher and effort is more evenly distributed across populations, thus reducing the effect of unusual catches. The size-composition charts of the south east blocks consistently show similar trends, even those sampled at less than the 4% level. In particular, the median length of 2002 samples in almost all sub-blocks increased, in conjunction with the 4-mm size-limit increase that was applied in that year, regardless of the level of sampling. The relatively high median size of 1998 and 1999 samples and the fall in length since then is also common across sub-blocks where those years were sampled. This trend is consistent with known decreases in the available stock and confirms that the level of sampling is adequate to detect trends. The level of sampling in 1998-1999 can only be guessed at by applying catch numbers from later years, which suggests sampling was

below 4% in many sub-blocks. (The level of sampling of pre-2000 catches could not be determined because although the sampled catch locations were known, all other catches were not reported by sub-block.) We conclude that the 4% level of sampling in the Eastern Zone is adequate, and that trends in median and inter-quartile lengths can reflect changes in the fished population size-structure.

Interpreting annual changes in median and inter-quartile lengths

Catch samples show that since 1998, throughout much of the south east there has been a trend of decreasing median size of abalone in commercial catches. Two opposing scenarios are proposed that might explain falling median length in the south east.

If abundance levels fall yet catch levels remain constant (i.e. exploitation rates rise), the average period of time between attaining legal size (recruiting) and being caught becomes shorter. Because abalone length is a function of time and growth rate, this means that overall growth is reduced, and the median length of the catch will fall. Under these circumstances, the 75th percentile length (the length which, down to the legal limit, includes 75% of the available legal stock) could also be expected to fall with the median. As long as recruitment levels are unaffected, the 25th percentile length would be expected to remain at similar levels to those seen in previous years. If exploitation rates further increase, then the 25th percentile length would eventually fall. As a further indication of falling abundance a corresponding reduction in catch and catch rate trends would be expected.

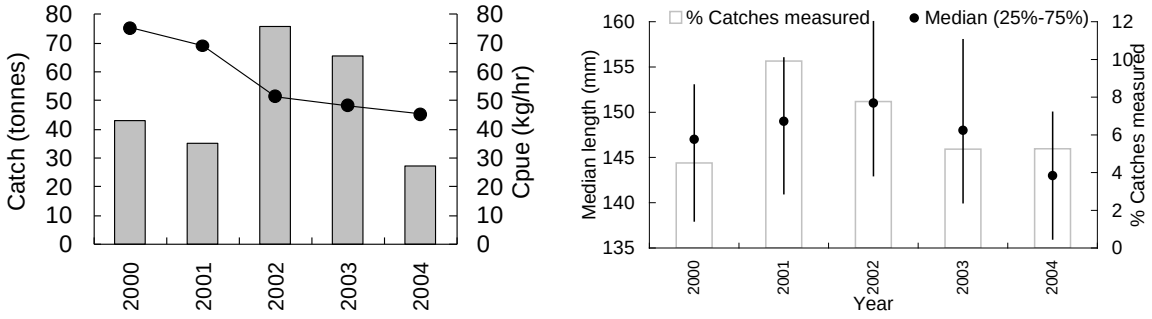


Figure 26. Trends in catch, catch rate and median length (flanked by the 25th and 75th percentile bounds), sub-block 13C, 2000-2004.

For example, in sub-block 13C (Whale Head to Fishers Point, Actaeons region) between 2002 and 2004, firstly catch rates and then catches fell, suggesting high exploitation rates (Figure 26). The median length of landed abalone increased in 2002, when the size limit was raised 4 mm, but has since fallen, again suggesting high exploitation rates. In 2004, the 75th percentile fell sharply, consistent with a fall in the numbers of large abalone landed. In addition, in 2004, the 25th percentile declined suggesting a decline in recruitment. The catch and catch rate trends indicate that abundance here is low. All three indicators suggested unsustainable levels of fishing in 2004 (Figure 26).

The second alternative interpretation of the reduced median length is that abundance of small abalone has increased due to an extraordinarily large influx of recruits. The median and 25th percentile length could be expected to fall, but, unless the fishery was dominated by recruits, the 75th percentile length would be stable or possible increase as

exploitation rates fell. Increased levels of catch and catch rate would confirm that abundance had increased. An example of this has occurred in sub-block 20B (Figure 27).

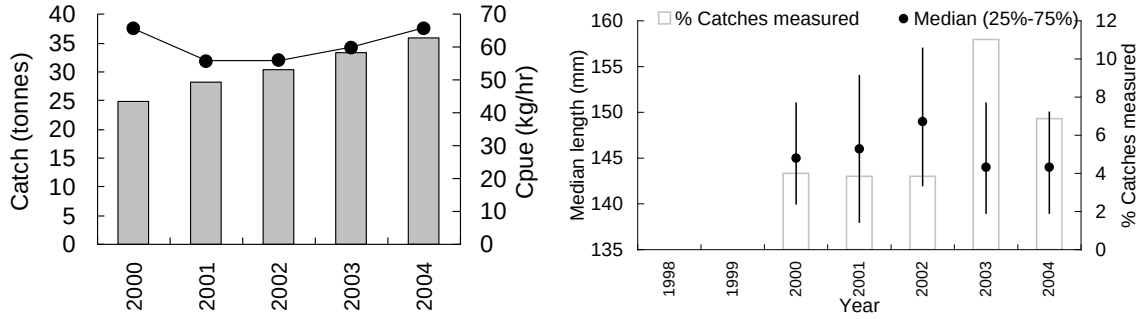


Figure 27. Trends in catch, catch rate and median length (flanked by the 25th and 75th percentile bounds), sub-block 20B, 2000-2004.

Increasing or stable median length, in conjunction with increasing catch and catch rates are strong indicators of rising stock levels. Catch rates and levels of catch in sub-block 24B (Maria Island) have started to recover since 2002 (Figure 28). The median length from catches sampled since then is also consistent with stock recovery. The increase in median length associated with the 4-mm increase in size limit in 2002 is again apparent; however, in contrast to sub-block 13C (Figure 26), the size-structure has been maintained, indicating that the levels of fishing pressure currently appear to be sustainable.

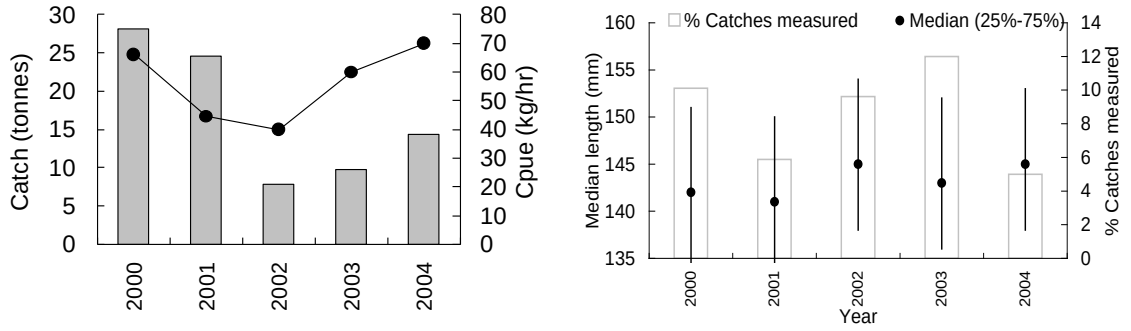


Figure 28. Trends in catch, catch rate and median length (flanked by the 25th and 75th percentile bounds), sub-block 24B, 2000-2004.

Appendix 5: Early abalone production 1960-1981

Annual tonnages of abalone production from Tasmania are shown below. The first two series - divers' catches[a] and Tasmanian processors' receipts[b] have been reproduced from "Summary of Statistics – Tasmania", Abalone Situation Report 10, Demersal Mollusc Research Group, published by CSIRO, 1982. Tasmanian Year Book[c] totals were published each year from 1967 by the Commonwealth Bureau of Census and Statistics (annual totals from 1964 were reported in the 1967 edition).

All three totals were reported by financial year. Abalone catch prior to 1968 was reported by divers in general fish returns as miscellaneous catch, and annual totals are incomplete. Catches are believed to have been substantially under-reported between 1960 and 1981 i.e. catch totals were higher than shown here. Processor receipts were from Tasmanian processors only: much of the early catch was freighted to interstate processors and is not included amongst these processor receipts. Little or no processing was done in Tasmania prior to 1964. The source of the Tasmanian Year Book totals is unknown.

Year	Diver [a] returns	Processor [b] returns	Tasmanian Year Book [c]
1960	*	*	**
1961	*	*	**
1962	*	*	**
1963	*	*	**
1964	*	49	33
1965	*	225	225
1966	412	753	727
1967	1,050	1,722	2,003
1968	1,966	2,354	2,792
1969	1,894	2,139	2,113
1970	2,297	2,613	2,613
1971	2,504	3,488	3,495
1972	2,287	2,971	2,977
1973	1,703	2,174	2,172
1974	1,883	2,106	2,060
1975	1,919	2,108	2,108
1976	2,289	2,429	2,429
1977	2,263	2,368	2,368
1978	2,823	2,524	2,525
1979	2,762	3,100	3,100
1980	3,391	3,204	3,214
1981	3,800	3,621	3,743

* Records unavailable.

** Records not published.

Appendix 6: Annual Catches by Zone – 1975-2013

Eastern Zone

Annual tonnages of blacklip abalone caught within the statistical blocks and sub-blocks comprising the Eastern Zone in 2013 (sub-blocks 13C, 13D, 13E, Blocks 14 to 30 and sub-block 31A). Pre-zoning catches cannot be accurately assigned to zones in blocks where zone boundaries occur (Blocks 13 and 31). Catches in those blocks are reported as Eastern Zone because the majority of later catches occurred there.

	Year	13	14	15	16	17	19	20	21	22
Estimated weights	1975	247	111	10	47	11	0	16	27	49
	1976	208	156	0	64	36	1	18	25	45
	1977	245	232	2	190	11	1	23	35	37
	1978	322	218	6	119	24	1	32	65	60
	1979	374	251	8	148	25	2	51	52	43
	1980	272	255	7	145	30	1	33	30	42
	1981	254	299	18	127	48	4	45	69	35
	1982	337	218	15	147	24	3	36	62	63
	1983	250	300	10	189	28	3	43	63	54
	1984	318	297	18	166	35	5	47	70	73
Landed weights	1985	256	262	4	89	83	11	68	80	43
	1986	220	262	22	82	93	4	65	66	70
	1987	224	229	7	47	80	1	43	44	32
	1988	219	258	6	76	57	4	62	44	43
	1989	156	172	2	56	43	2	61	42	22
	1990	132	193	4	76	29	3	33	51	40
	1991	127	207	2	60	37	3	53	50	47
Estimated weights	1992	140	106	3	28	20	2	51	43	49
	1993	257	116	4	100	40	1	59	78	48
	1994	295	139	10	114	46	1	109	80	55
	1995	310	247	1	100	35	1	95	74	34
	1996	391	195	0	78	18	3	71	55	44
	1997	471	137	0	64	25	2	79	49	47
	1998	470	108	1	116	23	2	85	64	63
	1999	491	66	2	113	35	6	102	72	50
	2000	381	98	2	71	29	4	62	60	69
	2001	324	157	3	108	20	2	56	50	40
	2002	296	101	1	72	16	1	62	58	46
	2003	291	116	2	60	17	1	88	54	35
	2004	221	104	7	50	20	2	92	52	35
	2005	181	90	8	56	20	3	116	62	36
	2006	184	84	3	67	13	2	73	66	71
	2007	255	70	0	56	8	6	68	63	61
	2008	340	56	1	64	8	0	50	61	56
	2009	341	63	1	52	20	1	51	52	91
	2010	342	70	1	39	10	2	71	59	73
	2011	359	15	0	37	8	1	30	47	54
	2012	268	22	0	15	8	1	21	23	60
	2013	199	22	0	24	9	1	21	27	56
Average 75-13		281	156	5	85	29	2	58	54	51
Average 85-13		281	130	3	68	30	3	65	56	51
Average 00-13		285	76	2	55	15	2	62	52	56

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Eastern Zone (continued).

	Year	23	24	25	26	27	28	29	30	31	Total
Estimated weights	1975	74	15	16	5	44	69	16	44	32	835
	1976	56	18	12	9	40	72	9	37	50	857
	1977	53	11	10	8	55	90	22	119	54	1196
	1978	88	22	13	11	93	87	25	137	105	1431
	1979	30	9	23	7	80	52	12	105	60	1332
	1980	46	158	34	7	108	91	27	148	105	1538
	1981	77	137	19	15	68	154	22	146	52	1586
	1982	49	97	20	9	89	100	32	170	48	1519
	1983	92	99	31	14	99	103	65	296	90	1828
	1984	61	109	10	11	106	112	52	148	76	1714
Landed weights	1985	44	120	20	17	86	71	5	84	171	1515
	1986	56	88	12	20	50	58	14	124	164	1472
	1987	34	66	12	8	76	45	11	67	54	1082
	1988	34	79	10	6	65	52	16	93	90	1214
	1989	16	34	7	8	41	31	11	39	27	770
	1990	36	61	1	2	61	77	21	54	22	897
	1991	31	67	2	9	64	66	12	30	21	890
Estimated weights	1992	23	67	1	1	67	45	7	10	13	676
	1993	24	73	1	1	86	39	8	15	15	964
	1994	16	53	0	3	103	24	8	11	21	1088
	1995	19	38	0	1	81	18	6	10	26	1097
	1996	28	67	3	6	89	39	11	28	20	1147
	1997	32	106	1	13	190	32	32	23	33	1336
	1998	44	160	2	25	180	77	31	10	15	1476
	1999	53	143	0	9	95	60	26	11	39	1374
	2000	44	104	1	8	101	16	21	10	90	1171
	2001	24	111	1	14	68	9	27	13	78	1104
	2002	15	46	0	2	53	7	15	12	44	847
	2003	21	51	0	3	50	8	19	3	27	848
	2004	19	51	1	1	44	11	24	6	22	761
	2005	18	66	0	0	43	13	36	7	15	770
	2006	23	88	1	1	40	10	41	0	7	773
	2007	14	59	0	1	55	11	32	0	4	766
	2008	11	68	0	1	48	6	28	0	10	807
	2009	22	63	0	0	50	5	26	2	12	852
	2010	20	67	0	0	38	6	20	3	67	888
	2011	17	37	0	1	35	5	16	4	42	710
	2012	14	22	0	0	14	2	19	5	49	543
	2013	38	39	0	0	7	8	51	7	15	523
Average 75-13		36	71	7	7	71	46	22	52	48	1082
Average 85-13		27	72	3	6	68	29	21	24	42	978
Average 00-13		21	62	0	2	46	8	27	5	34	812

Central Western Zone

Annual tonnages of blacklip abalone caught within the statistical blocks and sub-blocks comprising the Central Western Zone (Sub-block 5D, 6A, 6B, 6C) in 2013. Catches from Block 5 prior to 2001 are reported in the Northern Zone, catches from sub-block 6D from 2000 are reported in the Western Zone.

	Year	5D	6A, 6B, 6C (all block 6 prior to 2000)	Total
Estimated weights	1975		110	110
	1976		63	63
	1977		50	50
	1978		79	79
	1979		112	112
	1980		196	196
	1981		257	257
	1982		147	147
	1983		231	231
	1984		298	298
Landed weights	1985		322	322
	1986		213	213
	1987		185	185
	1988		241	241
	1989		192	192
	1990		197	197
	1991		169	169
Estimated weights	1992		235	235
	1993		154	154
	1994		79	79
	1995		112	112
	1996		103	103
	1997		98	98
	1998		126	126
	1999		149	149
	2000		162	162
	2001	0	162	162
	2002	2	142	144
	2003	0	62	62
	2004	3	64	67
	2005	6	69	75
	2006	4	58	62
	2007	0	42	42
	2008	0	70	70
	2009	0	95	95
	2010	0	127	127
	2011	1	135	136
	2012	1	127	128
	2013	0	101	101
Average 75-13		1	142	142
Average 85-13		1	138	138
Average 00-13		1	101	102

Western Zone

Annual tonnages of blacklip abalone caught within the statistical blocks and sub-blocks comprising the Western Zone in 2013 (Blocks 9 to 12, Sub-blocks 13A, 13B). Pre-zoning (1975-1999) catches from Block 13 are reported in the Eastern Zone.

	Year	6D	7	8	9	10	11	12	13	Total
Estimated weights	1975		36	42	126	130	191	143		668
	1976		56	77	252	179	240	153		957
	1977		24	22	123	98	153	189		608
	1978		13	27	115	258	275	208		894
	1979		19	23	172	166	269	325		974
	1980		81	63	316	195	338	351		1343
	1981		88	87	444	260	417	246		1541
	1982		34	34	249	100	303	235		955
	1983		102	58	199	174	430	242		1204
	1984		78	38	248	284	681	258		1586
Landed weights	1985		99	23	246	140	478	155		1141
	1986		97	11	133	127	289	193		851
	1987		84	44	252	82	339	195		996
	1988		53	27	159	124	270	162		795
	1989		49	46	120	109	212	144		681
	1990		56	21	95	80	232	125		610
	1991		54	30	102	106	219	140		650
Estimated weights	1992		70	36	91	95	266	159		717
	1993		64	38	110	65	197	177		651
	1994		33	38	77	60	202	160		570
	1995		30	17	44	68	186	182		526
	1996		67	13	59	75	145	148		508
	1997		75	28	140	66	224	227		760
	1998		51	27	78	47	163	192		558
	1999		60	24	115	58	220	251		729
	2000	21	61	23	205	148	326	282	54	1119
	2001	49	32	15	186	152	312	290	43	1079
	2002	31	51	17	174	143	360	236	93	1104
	2003	34	104	27	142	239	345	229	67	1189
	2004	24	89	22	130	181	374	250	96	1167
	2005	26	110	26	92	149	389	311	65	1167
	2006	50	76	6	142	198	384	228	89	1174
	2007	34	39	18	178	231	354	267	68	1189
	2008	35	51	9	156	178	345	305	79	1159
	2009	47	107	51	155	110	244	327	77	1118
	2010	23	110	37	159	158	245	277	68	1077
	2011	17	95	48	171	159	247	256	56	1048
	2012	59	97	19	172	146	273	267	44	1076
	2013	11	44	8	158	180	287	251	41	981
Average 75-13		33	65	31	161	141	293	224	67	952
Average 85-13		33	69	26	139	127	280	220	67	910
Average 00-13		33	76	23	159	169	320	270	67	1118

Northern Zone

Annual tonnages of blacklip abalone caught within the statistical blocks and sub-blocks comprising the Northern Zone in 2013 (Blocks 1 to 4, Sub-blocks 5A, 5B, 5C, 31B, Blocks 39 to 40 and Blocks 47 to 49). There are no records for the Northern Zone part of Block 31 prior to the creation of the zone in 2001.

	Year	31	39	40	47	48	49	5	1	2	3	4	Total
Estimated weights	1975		2	1	1	12	9	38	32	1	27	15	139
	1976		5	0	1	12	33	46	39	0	51	8	195
	1977		6	2	0	8	17	51	17	1	87	8	196
	1978		8	2	3	10	11	65	21	3	55	25	204
	1979		6	1	0	27	7	85	24	2	10	9	172
	1980		3	1	0	10	1	92	51	3	33	3	197
	1981		6	2	3	33	10	120	19	8	32	9	242
	1982		5	2	1	45	7	121	22	9	27	13	253
	1983		7	4	9	45	19	228	22	2	31	52	418
	1984		6	3	4	80	44	312	10	1	33	55	548
Landed weights	1985		5	1	4	48	50	319	43	0	26	11	508
	1986		10	5	15	85	97	267	35	4	24	13	556
	1987		6	1	18	58	67	198	44	62	24	54	531
	1988		3	1	18	30	38	165	29	16	21	60	380
	1989		1	28	14	15	24	88	14	7	10	5	206
	1990		0	0	6	14	20	82	11	10	9	11	164
	1991		1	0	8	12	10	97	6	7	14	26	182
Estimated weights	1992		4	0	3	10	11	76	2	3	9	8	126
	1993		0	0	1	7	7	65	8	3	8	9	107
	1994		0	0	0	7	12	49	15	2	4	1	90
	1995		0	0	0	6	2	62	11	3	1	8	94
	1996		0	0	0	4	0	63	7	2	1	2	80
	1997		1	0	0	6	2	56	10	1	10	6	91
	1998		0	1	0	7	3	61	3	1	0	2	78
	1999		5	0	0	14	4	57	5	1	6	6	97
	2000		5	2	0	12	25	45	0	0	9	10	108
	2001	12	11	3	0	17	72	117	2	1	12	12	260
	2002	30	4	3	0	12	48	103	10	2	35	16	262
	2003	7	8	1	0	10	76	73	25	1	61	10	270
	2004	14	6	1	0	6	62	55	10	0	85	34	273
	2005	11	2	0	0	6	54	73	15	2	92	18	273
	2006	16	4	0	0	5	57	96	11	3	57	8	258
	2007	55	11	0	0	6	59	89	6	0	47	3	276
	2008	29	5	0	0	7	74	163	5	0	24	10	317
	2009	20	9	0	0	4	75	172	10	0	27	5	322
	2010	36	5	0	0	8	72	132	5	1	41	24	324
	2011	24	5	0	0	8	103	155	17	1	82	6	400
	2012	30	5	0	0	9	151	99	2	0	74	9	379
	2013	25	7	0	0	14	112	60	22	0	68	2	310
Average 75-13		24	5	2	3	19	40	110	16	4	33	15	253
Average 85-13		24	4	2	3	15	48	108	13	5	30	13	252
Average 00-13		24	6	1	0	9	74	102	10	1	51	12	288

Bass Strait Zone

Annual tonnages of blacklip abalone caught within statistical blocks comprising the Bass Strait Zone in 2013. The fishery was temporarily closed in 2007.

	Year	32	33	34	35	36	37	38	41	42	43	44
Estimated weights	1975	1	10	1	7	7	0	2	0	0	0	0
	1976	0	5	0	1	1	0	0	0	0	1	0
	1977	6	11	0	0	3	1	2	0	0	0	0
	1978	1	5	2	6	5	0	4	0	0	1	0
	1979	2	9	0	0	2	1	2	0	0	0	0
	1980	2	6	1	1	2	1	0	1	0	0	0
	1981	1	6	1	1	0	2	0	0	0	1	0
	1982	0	6	1	0	2	1	4	0	0	0	0
	1983	0	3	0	1	5	1	3	0	0	0	0
	1984	0	7	0	1	2	0	1	0	0	1	0
Landed weights	1985	3	6	1	2	1	0	0	2	0	2	0
	1986	0	9	2	3	2	1	1	1	0	4	0
	1987	0	7	0	2	1	2	1	2	0	8	1
	1988	0	11	1	1	0	0	0	0	0	1	1
	1989	0	3	0	0	0	8	0	19	11	34	1
	1990	0	1	0	0	1	0	0	0	0	0	0
	1991	0	2	0	0	0	17	0	0	0	0	0
Estimated weights	1992	0	2	0	0	0	0	0	0	0	0	0
	1993	0	3	0	0	0	19	0	0	0	0	0
	1994	0	3	0	0	0	0	0	0	0	0	0
	1995	0	0	0	0	0	52	0	0	0	0	0
	1996	0	0	0	0	0	0	0	0	0	0	0
	1997	0	0	0	0	0	0	0	0	0	0	0
	1998	0	2	0	0	0	0	0	0	0	0	0
	1999	0	4	0	0	0	0	1	0	0	0	0
	2000	1	5	0	0	0	0	0	0	0	0	0
	2001	5	10	1	0	0	0	3	0	0	0	0
	2002	1	11	1	0	0	0	2	0	0	0	0
	2003	0	5	0	0	0	6	2	1	2	2	0
	2004	0	3	0	0	0	3	1	4	4	1	0
	2005	0	7	0	0	0	6	2	4	1	2	0
	2006	0	11	0	0	0	20	10	1	4	5	0
	2007	0	2	0	3	0	0	0	0	0	0	0
	2008	1	5	0	0	0	21	6	1	2	5	1
	2009	2	4	0	1	0	10	1	5	2	8	6
	2010	0	20	0	0	0	1	26	1	0	3	0
	2011	0	23	0	1	0	0	19	1	0	2	0
	2012	1	14	0	0	0	4	17	0	0	3	1
	2013	0	18	1	0	0	4	14	0	0	5	1
Average 75-13		1	7	0	1	1	5	3	1	1	2	0
Average 85-13		1	7	0	1	0	6	4	1	1	3	0
Average 00-13		1	10	0	0	0	5	8	1	1	3	1

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Bass Strait Zone (continued).

	Year	45	46	50	51	52	53	54	55	56	57	Total
Estimated weights	1975	0	0	0	0	0	0	0	0	0	0	29
	1976	0	0	0	0	0	0	0	0	0	0	9
	1977	0	0	0	0	0	0	0	0	0	0	23
	1978	0	0	0	0	0	0	0	0	0	0	22
	1979	0	3	0	0	0	0	0	0	0	0	20
	1980	0	0	0	0	0	0	0	0	0	0	13
	1981	0	0	0	0	0	0	0	0	0	0	12
	1982	0	0	0	0	0	0	0	0	0	0	14
	1983	0	0	0	0	0	0	0	0	0	0	14
	1984	0	3	0	0	0	0	0	0	0	0	16
Landed weights	1985	0	0	0	0	0	0	0	0	0	0	18
	1986	0	1	0	0	0	0	0	0	0	0	25
	1987	0	0	0	0	0	0	0	0	0	0	26
	1988	0	1	0	0	0	0	0	0	0	0	16
	1989	5	14	1	24	0	41	4	0	6	0	172
	1990	0	0	0	0	0	0	0	0	0	0	2
	1991	0	0	0	14	5	28	1	0	17	15	98
Estimated weights	1992	0	0	0	0	0	0	0	0	0	0	3
	1993	0	0	0	21	4	37	1	0	6	8	99
	1994	0	0	0	0	0	0	0	0	0	0	4
	1995	0	0	1	46	2	44	0	0	0	5	150
	1996	0	0	0	0	0	0	0	0	0	0	0
	1997	0	0	0	0	0	0	0	0	0	0	0
	1998	0	0	0	0	0	0	0	0	0	0	2
	1999	0	0	0	0	0	0	0	0	0	0	6
	2000	0	0	0	0	0	0	0	0	0	0	7
	2001	0	0	0	0	0	0	0	0	0	2	21
	2002	0	0	0	0	0	0	0	0	0	0	17
	2003	0	2	0	7	2	36	2	0	7	2	78
	2004	0	1	0	1	0	42	5	2	7	0	75
	2005	0	0	0	8	0	35	5	3	3	0	78
	2006	0	5	0	3	0	24	5	2	1	1	91
	2007	0	0	0	0	0	0	0	0	0	0	5
	2008	1	3	0	1	0	27	0	0	6	0	80
	2009	1	1	0	5	0	24	1	0	4	2	78
	2010	1	1	0	2	0	13	0	0	0	0	68
	2011	1	1	0	3	0	13	0	0	2	0	68
	2012	1	1	0	2	0	15	2	0	5	0	68
	2013	1	0	0	5	0	18	3	0	0	0	69
Average 75-13		0	1	0	4	0	10	1	0	2	1	41
Average 85-13		0	1	0	5	0	14	1	0	2	1	49
Average 00-13		0	1	0	3	0	18	2	1	2	1	57

Greenlip Fishery

Annual tonnages of greenlip abalone caught from the Greenlip fishery. Greenlip are taken from northern Tasmanian waters, and the fishery is managed by species. Occasionally, small amounts of catch (< 1 t) are taken from Blocks 50-57.

	Year	32	33	34	35	36	37	38	31	39	40	41	42	43	44
Estimated weights	1975	3	17	14	49	69	14	11	7	3	4	2	0	0	0
	1976	1	26	11	55	49	2	10	14	2	9	2	0	0	0
	1977	6	23	21	50	24	1	22	6	8	4	1	0	1	0
	1978	4	12	17	51	38	7	17	8	1	2	0	0	1	0
	1979	10	21	8	46	15	4	4	11	6	2	1	0	0	0
	1980	7	15	3	29	13	4	4	4	3	5	0	0	0	0
	1981	12	17	17	34	10	9	0	6	4	2	0	0	2	0
	1982	4	13	14	29	7	9	9	27	1	3	0	0	0	0
	1983	4	21	8	34	9	4	8	23	2	0	0	0	0	0
	1984	9	27	15	56	7	6	0	50	8	4	0	0	1	0
Landed weights	1985	9	20	15	42	4	7	7	53	5	4	1	0	1	0
	1986	4	14	7	36	2	10	0	39	8	7	0	0	2	0
	1987	8	20	10	30	8	10	7	32	12	1	1	0	9	5
	1988	8	19	5	28	13	6	0	35	2	1	1	0	2	0
	1989	4	16	2	22	10	3	0	22	5	2	5	1	2	0
	1990	4	9	3	25	6	1	3	23	7	0	2	0	0	0
	1991	4	7	2	31	6	3	0	20	6	0	1	0	0	0
Estimated weights	1992	3	4	1	18	6	2	0	15	9	0	0	1	0	0
	1993	1	4	2	16	8	3	0	9	2	0	0	0	0	0
	1994	3	8	1	17	5	3	0	12	1	0	0	0	0	0
	1995	2	7	3	15	3	3	9	24	6	2	1	0	0	0
	1996	3	13	4	17	2	8	12	11	13	2	0	0	0	0
	1997	8	13	1	12	4	11	15	17	22	1	0	0	0	0
	1998	5	5	1	23	1	2	2	4	17	24	0	0	1	0
	1999	2	17	1	15	1	2	4	6	2	4	0	0	0	0
	2000	8	11	2	14	3	2	2	12	15	12	0	0	0	0
	2001	14	14	2	9	3	1	0	7	20	4	0	0	0	0
	2002	4	16	2	8	2	2	9	17	12	2	0	0	0	0
	2003	5	16	1	10	2	1	3	18	16	1	0	0	0	0
	2004	4	4	1	13	3	1	11	9	22	0	0	0	0	0
	2005	2	12	1	10	3	1	15	6	13	1	0	0	0	0
	2006	5	5	1	11	1	4	13	3	13	0	0	0	0	0
	2007	3	6	1	13	2	0	5	20	14	0	0	0	0	0
	2008	3	6	1	12	4	3	5	13	12	0	0	0	0	0
	2009	2	5	1	13	2	2	2	13	20	1	0	0	0	0
	2010	5	13	2	10	0	0	3	16	9	0	0	0	0	0
	2011	5	5	3	14	4	2	12	13	11	0	1	0	0	0
	2012	3	17	3	19	1	1	3	20	13	0	0	0	0	0
	2013	8	23	2	16	2	1	4	14	9	1	0	0	0	0
Average 75-13		5	13	5	24	9	4	6	17	9	3	1	0	1	0
Average 85-13		5	11	3	18	4	3	5	17	11	3	1	0	1	0
Average 00-13		5	11	2	12	2	1	6	13	14	2	0	0	0	0

continued next page

Greenlip Fishery (continued)

	Year	45	46	47	48	49	5	1	2	3	4	Total
Estimated weights	1975	0	0	0	7	2	8	0	3	0	1	214
	1976	0	0	0	8	6	14	0	0	0	0	212
	1977	0	0	0	40	2	17	0	0	0	0	225
	1978	0	0	1	13	3	12	1	3	0	2	192
	1979	0	0	0	11	0	8	0	0	0	0	147
	1980	0	0	0	6	0	5	0	3	0	0	101
	1981	0	0	3	12	1	9	0	12	0	4	155
	1982	0	0	2	7	0	2	0	14	0	2	141
	1983	0	0	14	40	11	9	0	9	0	5	201
	1984	0	2	52	60	2	11	0	7	1	5	323
Landed weights	1985	0	1	12	36	3	3	0	1	0	1	225
	1986	0	1	57	35	14	5	1	8	0	3	255
	1987	0	1	37	33	3	8	13	125	5	69	446
	1988	0	7	35	21	4	10	3	33	2	12	251
	1989	0	6	20	27	4	6	1	70	3	10	241
	1990	0	4	21	27	11	11	2	49	3	13	224
	1991	0	8	13	32	6	12	2	29	3	16	200
Estimated weights	1992	0	3	4	14	2	4	3	21	0	8	119
	1993	1	3	2	26	4	2	2	18	0	9	113
	1994	0	0	3	48	3	10	4	25	0	7	149
	1995	0	0	5	23	5	8	14	9	0	12	150
	1996	0	1	1	15	0	3	37	33	1	13	191
	1997	0	0	1	28	3	6	35	33	0	6	215
	1998	0	0	2	43	8	14	31	34	0	5	223
	1999	0	0	0	20	1	10	21	25	1	10	142
	2000	0	0	0	24	12	13	2	4	1	3	140
	2001	0	0	0	35	9	3	8	8	1	2	140
	2002	0	0	0	27	7	7	11	6	1	7	140
	2003	0	0	0	14	10	10	14	11	3	4	140
	2004	0	0	0	14	6	10	14	10	4	3	129
	2005	0	0	0	19	1	12	16	7	4	3	123
	2006	0	0	0	29	2	8	11	10	2	5	123
	2007	0	0	0	21	3	9	10	7	3	6	124
	2008	0	0	0	33	3	5	4	10	1	5	121
	2009	0	0	0	26	2	5	8	8	3	6	123
	2010	0	0	0	30	5	8	11	13	4	5	134
	2011	0	0	0	31	5	6	6	9	9	4	140
	2012	0	0	0	35	6	3	2	6	3	4	140
	2013	0	0	0	32	3	5	2	12	2	4	140
Average 75-13		0	1	7	26	4	8	7	18	2	7	177
Average 85-13		0	1	7	28	5	7	10	22	2	9	172
Average 00-13		0	0	0	27	5	7	8	9	3	4	133

Appendix 7: Catch/effort data extract query

Catch/effort data from divers' catch dockets were provided by DPIPWE, with tables updated weekly and stored in an Oracle database at the University of Tasmania. The following SQL query was used to extract catch records from the Oracle database:

```
SELECT DISTINCT
               d.docket_number docket
,    f.fishing_date DAY
,    EXTRACT(month FROM f.fishing_date) MONTH
,    EXTRACT(year FROM f.fishing_date) YEAR
,    UPPER(n3.last_name)||', '
||REPLACE( TRANSLATE(INITCAP(n3.first_names),'abcdefghijklmnopqrstuvwxyz','##########################'),'#','')
diver_name
,    SUBSTR(d.zone_fishery_code, 3, 2) ZONE
,    CASE
          WHEN f.block_code BETWEEN 'AB13C' AND 'AB14B' THEN 'ACT'
          WHEN f.block_code BETWEEN 'AB14C' AND 'AB16D' THEN 'BRUNY'
          WHEN f.block_code BETWEEN 'AB17A' AND 'AB21C' THEN 'STMBY'
          WHEN f.block_code BETWEEN 'AB22A' AND 'AB31A' THEN 'EC'
          WHEN f.block_code BETWEEN 'AB32A' AND 'AB38C' THEN 'FG'
          WHEN f.block_code BETWEEN 'AB39A' AND 'AB40C' THEN 'NE'
          WHEN f.block_code BETWEEN 'AB41' AND 'AB46' THEN 'CN'
          WHEN f.block_code BETWEEN 'AB47A' AND 'AB49C' THEN 'NW'
          WHEN f.block_code BETWEEN 'AB01A' AND 'AB04C' THEN 'KI'
          WHEN f.block_code BETWEEN 'AB05A' AND 'AB05C' THEN 'NW'
          WHEN f.block_code BETWEEN 'AB05D' AND 'AB06D' THEN 'COUTA'
          WHEN f.block_code BETWEEN 'AB07A' AND 'AB08C' THEN 'GRANVILLE'
          WHEN f.block_code BETWEEN 'AB09A' AND 'AB09C' THEN 'STRAHAN'
          WHEN f.block_code BETWEEN 'AB10A' AND 'AB12A' THEN 'SW'
          WHEN f.block_code BETWEEN 'AB12B' AND 'AB13B' THEN 'SC'
          WHEN f.block_code BETWEEN 'AB50' AND 'AB57' THEN 'ISLAND'
          WHEN f.block_code = 'AB31B' THEN 'NE'
     END REGION
,    SUBSTR(f.block_code,1,4) blok
,    f.block_code sub_block
,            CASE WHEN f.blacklip_estimated_weight>0 THEN ROUND(f.blacklip_estimated_weight,0)
          ELSE 0
     END blips
,            CASE WHEN f.greenlip_estimated_weight>0 THEN ROUND(f.greenlip_estimated_weight,0)
          ELSE 0
     END glips
,    NVL(dive_time_1,0) + NVL(dive_time_2,0) + NVL(dive_time_3,0)+ NVL(f.block_dive_time,0) total_time
,    CASE WHEN (NVL(dive_time_1,0) + NVL(dive_time_2,0) + NVL(dive_time_3,0)+ NVL(f.block_dive_time,0)>0) AND
((NVL(f.blacklip_estimated_weight,0)>39 or NVL(f.greenlip_estimated_weight,0)>39))
          THEN LN((NVL(f.blacklip_estimated_weight,0)+ NVL(f.greenlip_estimated_weight,0))/(NVL(dive_time_1,0) +
NVL(dive_time_2,0) + NVL(dive_time_3,0)+ NVL(f.block_dive_time,0)))
     END lncpue
,    CASE WHEN (NVL(dive_time_1,0) + NVL(dive_time_2,0) + NVL(dive_time_3,0)+ NVL(f.block_dive_time,0)>0) AND
NVL(f.blacklip_estimated_weight,0)>39
          THEN LN((NVL(f.blacklip_estimated_weight,0))/(NVL(dive_time_1,0) + NVL(dive_time_2,0) + NVL(dive_time_3,0)+
NVL(f.block_dive_time,0)))
     END blncpue
,    CASE WHEN (NVL(dive_time_1,0) + NVL(dive_time_2,0) + NVL(dive_time_3,0)+ NVL(f.block_dive_time,0)>0) AND
NVL(f.greenlip_estimated_weight,0)>39
          THEN LN((NVL(f.greenlip_estimated_weight,0))/(NVL(dive_time_1,0) + NVL(dive_time_2,0) + NVL(dive_time_3,0)+
NVL(f.block_dive_time,0)))
     END glncpue
,    CASE WHEN (f.blacklip_estimated_weight>0 AND f.greenlip_estimated_weight>0) THEN 'DATA ERROR'
          WHEN f.blacklip_estimated_weight>0 THEN 'B'
          WHEN f.greenlip_estimated_weight>0 THEN 'G'
          ELSE ' '
     END effort_type
,    CASE WHEN (NVL(dive_time_1,0) + NVL(dive_time_2,0) + NVL(dive_time_3,0)+ NVL(f.block_dive_time,0)>0) AND
((NVL(f.blacklip_estimated_weight,0)>0 or NVL(f.greenlip_estimated_weight,0)>0))
          THEN ROUND((NVL(f.blacklip_estimated_weight,0)+ NVL(f.greenlip_estimated_weight,0))/(NVL(dive_time_1,0) +
NVL(dive_time_2,0) + NVL(dive_time_3,0)+ NVL(f.block_dive_time,0)),0)
     END raw_catch_rate
,    CASE WHEN v.overall_length <9 then v.vessel_name
          WHEN v2.overall_length <9 then v2.vessel_name
          ELSE NULL
     END boat_name
,    CASE WHEN v.overall_length <9 then v.overall_length
          WHEN v2.overall_length <9 then v2.overall_length
          ELSE NULL
     END boat_length
FROM qms.abalone_fishing_details f
,    qms.quota_dockets d
--diver name
,    lmm.clients n3
--boats used
,    lmm.vessels v
,    lmm.vessels v2
WHERE EXTRACT (YEAR FROM f.fishing_date)= 2013
     AND d.qudo_id = f.qudo_id
-- diver name
     AND n3.client_id = d.docket_signatory_id
-- get boat id
     AND v.vessel_id (+) = d.primary_vessel_id
-- get seconary boat id (if there is any)
     AND v2.vessel_id (+) = d.secondary_vessel_id
ORDER BY f.fishing_date  ASC
```

Appendix 8: Treatment of errors in catch data in 2013

No amendments were made to catch totals from earlier years presented in this report. Where errors are identified they will be corrected, and any corrections will be reported in subsequent assessment reports. Several errors have been found and corrected in previous years. Although this process is important for rigor of the assessment, the magnitude of any errors identified to date has been small and had no effect on interpretation of stock trends and thus management decisions. This is because errors identified to date typically involve key stroke errors on individual catch records rather than systematic errors affecting a large portion of the catch.

Appendix 9: Ecological effects of abalone fishing

Abalone fishing is typically regarded as having low ecological impact because there is no bycatch (other than sessile organisms on the shells), the conservation status of the target species is secure, and the high energy coastal environments where the fishery operates are typically subject to large environmental variation which creates resilience. For this reason there is little concern regarding the ecological effects of abalone fishing and thus there has been little research initiated on the issue. Nonetheless, consideration of the issue is important for EBFM. Information from recent research at IMAS is presented here.

This summary is an extract from Chapter 2, *Towards integrated multi-species management of Australia's SE reef fisheries: A Tasmanian example.* Report to Fisheries Research and Development Corporation. No. 2004/013. Tasmanian Aquaculture and Fisheries Institute, University of Tasmania. Frusher S, Buxton C, Barrett N, Tarbath D, Redd K, Semmens J, Pederson H, Valentine J & Guest M (2009).

At a global level, overfishing and subsequent depletion leading to the collapse of abalone populations on individual reefs and parts of the coast are common problems (Dugan and Davis, 1993; Karpov et al., 2000; Shepherd and Baker, 1998). While overall the Tasmanian blacklip abalone fishery has been relatively robust, depletion and consequent loss of production are evident in parts of the fishery. For example, following years of fishing at apparently sustainable levels, some reporting areas (‘blocks’) of the abalone fishery in east and north-east Tasmania experienced rapid declines in annual catch to less than 10% of their former levels (Tarbath et al., 2007).

These reporting blocks are large (tens of kilometres), and consequently the history of abalone production at the scale of individual reefs within them is unknown. Divers who once worked extensively along the coastline have reported that many of the reefs had become too depleted to warrant fishing at economic levels, and fishing activity was concentrated on the remaining productive reefs. Similar patterns had also been reported by divers in other previously productive parts of the Tasmanian fishery.

Information was sought about the history of productive abalone reefs from commercial abalone divers. Thirty three divers were interviewed: 16 early divers from pre-1972, 7 mid-era divers from between 1972 and 1992 and 10 current divers. By using a combination of maps, logbooks and diaries, reefs and coastline in use by the fishery were identified in five key areas (Blocks 13, 14, 23, 28, and 30) in the east and south-east, throughout the course of its history.

Perceptions of productivity varied greatly and were affected by economic factors (beach price, costs) as well as abundance. However, by comparing usage of reefs over time, it was possible to identify continuously productive reefs and reefs where production had fallen, and subsequently produce approximate estimates of the extent of reef decline in each of the five key areas. Fished areas were relatively unchanged in Block 13 (10% decline – mostly Recherche Bay), while areas lost to fishing in the east and north-east (Block 28, Block 30) were as high as 90%. Reefs in the northern part of Block 23 were no longer productive, but the remaining 90% of reefs elsewhere in the block were still fished, while in Block 14, mostly in the vicinity of the southern D’Entrecasteaux Channel, productive reef area had declined by 50%.

To assuage doubts about the validity of these estimates, we compared levels of fishing effort through time in each block (current compared with peak years). We found comparable declines in effort in Blocks 13, 28 and 30, but greater declines in Block 14, and Block 23. It was considered likely that losses of productive reef in the last two blocks were underestimated because current divers could fish these areas at low cost and had heightened perceptions of recent productivity.

Associated with depletion, there have been persistent reports from divers concerning changes to reef habitat. These changes appeared to follow extensive depletion of abalone populations by fishing, suggesting a level of interdependency between abalone and habitat. They included the reduction in coverage of crustose coralline algae and its subsequent replacement by sediment, other encrusting organisms and algae. Globally, over-harvesting of herbivores is recognised as one of the main factors contributing to changes in marine systems (Burkepile and Hay, 2006). In abalone fisheries, these changes implied a reduction of habitat type associated with juvenile abalone recruitment (McShane and Smith, 1988; Shepherd and Turner, 1985).

Field surveys were conducted at reefs with a history of abalone production in each region. A quantitative survey of benthic organisms on reefs with contrasting levels of abalone abundance was conducted, and a correlative approach was used to investigate interactions between benthic organisms and abalone to detect effects of fishing on reef communities.

In all regions there were positive correlations between abalone abundance and crustose coralline algae, while understory algae and abundance were negatively correlated. However, these associations were only weakly significant (α=0.05, r^2= 0.02-0.30), implying that abalone abundance explained only a small proportion of the variability in their distribution and abundance. In addition, there were isolated and inconsistent associations between abalone abundance and other understorey groups (sessile invertebrates, canopy-forming algae recruits). Typically, regional differences in community structure were more strongly correlated than abalone density. While not experimentally tested it was apparent that physical characteristics (exposure, reef structure, orientation) played a much greater role in determining community structure than the activities of abalone.

In summary, abalone played a relatively minor role in structuring habitat on reefs fished by abalone divers. As a consequence, it is unlikely that the observed reef-scale changes to habitat on reefs have occurred as a consequence of depletion of abalone stocks. It also means that loss of juvenile abalone habitat (crustose coralline algae habitat) does not necessarily occur following over-fishing.

Appendix 10: History of Management Changes

This history has been compiled from a number of sources, principal among which has been DPIPWE's Abalone Management Plans.

1962	Minimum size limit (MSL) of 5 inches (127 mm) minimum shell diameter introduced.
1964	MSL increased to 6 inches (152 mm).
1965	MSL reduced to 5 inches. Introduction of commercial abalone diving licenses. All abalone to be landed live (no processing at sea). Skippers of boats engaged in abalone fishing required to lodge monthly fish returns as part of their license conditions.
1966	Abalone processing factories required to record the number of persons from whom abalone were bought.
1967	Abalone divers required to carry a measuring device to measure the abalone before taking them. Special penalty introduced for possession of undersized abalone at $1 per fish. Abalone to be sold in live condition to registered processors only.
1968	Abalone catch returns were introduced. These recorded daily catches and effort by reporting block, and were lodged monthly by the skipper (not necessarily a diver) of an abalone fishing vessel. More than one diver's catch could be reported on a return. These returns replaced the general fish return on which earlier catches were reported.
1969	License limitation introduced. Rapid expansion of the fishery led to this first attempt to control effort. Only divers fishing the previous year were licensed to fish in 1969. This figure (120 divers) was maintained in subsequent years.
1971	Only licensed divers allowed to dive from a boat engaged in abalone fishing. Unusually prolonged calm sea conditions and warm water were associated with a widespread die-off of abalone and rock lobster between the Arthur River and Granville Harbour. Substantial quantities of both species were reported killed.
1972	License transfer from a retiring diver to his nominee allowable on grounds of health problems. Annual license fees calculated as 1.5% of the mean of the previous three years value of annual production. An additional five licenses were issued to divers living in the Furneaux Group. These divers were restricted to fishing the Furneaux Group, but the other 120 divers were not prevented from fishing there. Penalties for breaches of regulations in relation to abalone fishing increased.

	Permit to transfer licenses between divers revoked.
1974	License transfer from a retiring diver to his nominee permitted. Computerised catch records started from July 1974.
1979	Penalties for breaches of regulations in relation to abalone fishing increased, with special penalties rising to $2 per fish. Identification cards for divers introduced.
1982	Penalties for breaches of regulations in relation to abalone fishing increased, with special penalties rising to $10 per fish. Catch restricted by marketing crisis: processors limit divers to 24 tonnes pa.
1983	Penalties for breaches of regulations in relation to abalone fishing increased. Easing of market difficulties sees lifting of processor applied catch restrictions.
1985	Individual transferable quota (ITQ) and a total allowable catch (TAC) were introduced. Each of the 120 general license divers were allocated 28 units of quota, the Furneaux Group divers 20 units: therefore there were 3460 units. For 1985, the quota unit was set at 1100 kg i.e. the TAC was 3806 tonnes. – This amount was derived from an estimate of average catches, with a 10% bonus granted by the Minister to compensate for any financial difficulties caused by the new system. License fees were increased to 2.5% of the value of the annual landed catch, for each quota unit held. Quota unit transfers between Furneaux divers and non-Furneaux divers were prohibited. The 120 Tasmanian mainland divers were prohibited from diving in the Furneaux group. Divers were required to own at least 16 units, but could accumulate no more than 80. The catch (kg) per quota unit was determined by the Liaison Committee based upon advice from the Government researchers. Catch dockets recording the catch weight landed by individual divers were introduced.
1986	Annual license fees set at 5% of value of annual landed catch. The catch per ITQ was reduced to 1000 kg (9% reduction) i.e. TAC was 3460 tonnes.
1987	MSL increased to 132 mm from 127 mm. The catch per ITQ was reduced to 950 kg (5% reduction) i.e. TAC was 3287 tonnes.
1988	The catch per ITQ was reduced to 855 kg (5% reduction) i.e. TAC was 2958.3 tonnes. The minimum legal weight for abalone meats was set at 90 g.

1989	The catch per ITQ was reduced to 600 kg (30% reduction) i.e. TAC was 2076 tonnes. A fishery for abalone in Bass Strait was held in April, with a MSL of 110 mm and a maximum size limit of 132 mm. Each diver was limited to 2.4 tonnes, with 198 tonnes caught. The fishery was free of fees, and while only licensed abalone divers could participate, was held to be distinct from the Tasmanian abalone fishery (hence the maximum size limit). The minimum meat weight regulation of 90g was amended to apply only to blacklip abalone.
1990	MSL for blacklip abalone on south and west coasts between the Wild Wave River (north of Sandy Cape) and Whale Head increased to 140 mm. MSL for greenlip in Furneaux Group waters increased to 140 mm. Furneaux Group boundary removed. The Furneaux Group divers were issued with an extra 8 units each, which could only be fished by the divers themselves and were not transferable. This increased the number of units in the fishery to 3500, and the TAC to 2100 tonnes.
1991	A fishery for abalone in Bass Strait was held in May, with a MSL of 118 mm. The TAC was 110 tonnes, with a fee of $1.40 per kg of quota. The license system was restructured: the diving entitlement was uncoupled from the entitlement to hold quota units and the lower and upper limits on the amount of units held was abolished.
1992	Minimum meat weight for greenlip was set at 70 g. Development of DPIF's compliance catch database (SEALSPROD) that enabled auditing of catch from vessel to factory.
1993	A fishery for abalone in Bass Strait was held in May and June, with a MSL of 110 mm. The TAC was 100 tonnes, with a fee of $5.00 per kg of quota. Minimum meat weight regulation amended to 90g for all abalone other than greenlip. Penalties reviewed and significantly increased, with the option of prison terms for serious and repeat offenders. Special penalties increased to $50 per fish.
1994	Quota owners were given the choice of continuing with their annual abalone licenses or entering into a Deed of Agreement that applied for 10 years with the right of renewal for perpetuity. 90% of owners chose the Deed of Agreement. The Deed of Agreement set a fee structure that included both management costs and return to the community, based upon an increasing (but non-linear) proportion of beach price. At $6/kg, no fees were payable, at $35/kg fees were 10% at and at $200/kg, fees were 33% of beach price.
1995	A fishery for abalone in Bass Strait was held in May and June, with a MSL of 110 mm. Only 12 commercial divers (i.e. non-abalone) participated. While the TAC was 100 tonnes, only 21 tonnes was taken. The fee was $10.00 per kg of quota.

	Another Bass Strait fishery was held in November, with both abalone and commercial divers participating. The MSL was 100 mm, and the TAC was set at 140 tonnes, with a fee of $10/kg. Only 106 tonnes was taken before the fishery was closed. It was maintained by divers that a very high proportion of the fishable biomass had been taken, and that continuing the fishery could affect the sustainability of stocks.
1996	The *Living Marine Resources Management Act 1995* was introduced. Trigger points were introduced by DPIF to initiate a management response if catch and catch rates changed by a pre-determined quantity with respect to those from two earlier reference periods.
1997	The TAC was increased to 2520 tonnes (720 kg per quota unit). Difference in beach price between east coast and west coast blacklip first appears – is initially $2.00.
1998	The first abalone Fishery Management Plan was introduced. Among changes that it introduced were catch monitoring, which included: 1. Pre-fishing reporting by divers, 2. Post-fishing reporting of catch by divers and processors, 3. Processors required to maintain a daily balance of stock in, stock out and stock on hand, 4. Processors to report prior to movement of stock out and on receipt of stock, 5. Reports to be made by telephone, where information was immediately available to Compliance Audit Unit and Tasmania Police. For several years, greenlip abalone had attracted premium beach prices, causing a diversion of effort to that species. To enhance protection, a number of management changes were made: • For management purposes, the greenlip fishery was subdivided into two regions: the Furneaux Group and the remainder (North West, North East and King Island) • MSL was raised to 140 mm state-wide (except the North West, which was left at 132 mm), • The annual catch for the Furneaux Group was capped at 42 t based on estimates of sustainable yield. This cap was managed monthly, so that where more than one twelfth of the annual cap (3.5 t) was taken in any month, the Minister could close the fishery until the next month. Within the Furneaux Group, several other rules were introduced to reduce effort: • Divers could only work two days per week. Originally, the days were fixed, but because this forced divers to work in often hazardous conditions, divers were allowed to nominate which two days they could work. • A 200 kg/day bag limit was introduced, as was a 200 kg/day landing limit. This effectively meant that catch was not held on motherships overnight. • These rules were repealed in 1999.

	• The greenlip catch from the remainder of the State was to be limited to 106 tonnes. • Because the Department was unable to monitor catch closely enough, the monthly Furneaux Group catch usually overran its limit, and the fishery there was closed in August when the regional cap was met. The greenlip cap in the rest of the State was also overrun. Vessels over 10 m landing abalone at Smithton or Stanley had to make a prior report to the CAU reporting service so that Tasmania Police could inspect their catch. Fixed trigger points were abandoned as an assessment strategy as rising catch and catch rates indiscriminately fired triggers. Assessments have since used catch and catch rate trends to monitor stock levels. A new compliance catch database (LMM/QMS) introduced by DPIWE
1999	MSL for greenlip raised to 140 mm in North West, and 150 mm for the remainder. This applied to the commercial fishery only, the MSL for recreational fishers remaining at 140 mm. The greenlip fishery was divided into east (Furneaux Group and North East) and west (King Island and North Wes t) with quarterly caps of 17 tonnes and 20 tonnes respectively. Overrun of caps led to a closure of the greenlip fishery in October. Within the Furneaux Group, Block 35 was closed to fishing between 1 October and 31 March to protect spawning abalone.
2000	The blacklip fishery was divided into two East and West management zones with boundaries at Whale Head and Port Sorell. The greenlip fishery was managed separately. Eastern blacklip units were set at 340 kg (TAC 1190 t), Western units at 400 kg (1400 t) and greenlip units at 40 kg (140 t), with a TAC for the whole fishery of 2730 tonnes. Size limits for blacklip abalone remained unchanged. The zone boundaries meant that the Western Zone had a size limit of 140 mm from Whale Head to the Wild Wave River and 132 mm from there to Port Sorell. Following egg-per-recruit studies by researchers, MSL for King Island greenlip was raised to 155 mm, 140 mm for North West and 145 for both the North East and the Furneaux Group. The Block 35 (Franklin Sound - Furneaux Group) greenlip catch was capped at 20 tonnes. Catch were reported on a smaller spatial scale with the introduction of sub-blocks state-wide. Owners of fishing license (abalone dive) were allowed to hold more than one license and allow others to dive those licenses as supervisors.
2001	The Northern Zone (between Arthur River in the west and Musselroe Point in the east) for blacklip abalone was established, with a MSL of 127 mm except between Woolnorth Point and the Arthur River, where 132 mm prevailed. Catch per unit was 80 kg, with a TAC of 280 t. Because the Northern Zone covered coast that was previously included in the two other blacklip zones,

	catch for those zones was proportionally reduced, with a further allowance for declining Eastern Zone stocks. The TAC for the West was set at 1260 t (360kg/unit), and the East at 1120 t (320 kg/unit). The greenlip TAC remained at 140 tonnes, so production from the entire fishery was 2800 t, or 800 kg/unit. In association with establishment of Northern Zone, research monitoring areas were set aside at the Inner Sister, Swan Island, Waterwitch Reef, and the Doughboys. MSL's for recreational divers were changed to 132 mm for blacklip state-wide, and 145 mm for greenlip in all areas except the North West, which remained at 140 mm. The regional catch for the greenlip fishery was limited in three of the main regions. The North West catch was capped at 40 t, the North East at 30 t, while the Furneaux Group catch remained fixed at 42 t. Catch from King Island and the Bass Strait islands (Kent, Curtis, Hogan Groups) was not capped.
2002	MSL for Eastern Zone was increased to 136 mm. MSL for greenlip on King Island was reduced to 150 mm. MSL for greenlip in the North West was increased to 145 mm. Eastern Zone TAC reduced to 857.5 t (245 kg/unit). Western Zone TAC remained 1260 t (360 kg/unit). Northern Zone TAC remained 280 t (80 kg/unit). Greenlip TAC remained 140 t (40 kg/unit). Production for the whole fishery was set at 2537.5 t (725 kg/unit). Catch from the Actaeons (sub-blocks 13C, D and E) was capped at 350 t, managed firstly as a half-yearly cap, then quarterly. The fishery there was closed in September and then mid-October when those caps were reached.
2003	A Bass Strait blacklip zone (TAC 70 tonnes (20kg/unit), MSL of 114 mm) was created within the Northern Zone in central Bass Strait and part of the Furneaux Group. Its purpose was to enable the catching of abalone smaller than allowed by the Northern Zone size limit. The Bass Strait Boundaries were set at Cowrie Point in the west and Anderson Bay in the east. The Flinders Island boundaries were on an unnamed point north of Settlement Point on the western side of the island (40°00'36.32") and Foochow Inlet on the east. Eastern Zone TAC remained 857.5 t (245 kg/unit). Western Zone TAC remained 1260 t (360 kg/unit). Northern Zone TAC remained 280 t (80 kg/unit). Greenlip TAC remained 140 t (40 kg/unit). Bass Strait Zone TAC set at 70 t (20 kg/unit). Fishery production was set at 2607.5 t (745 kg/unit) state-wide.

	Blacklip catch from Block 5 (Northern Zone) was capped at 100 t. MSL for Western Zone between the Wild Wave River and Arthur River was increased to 136 mm from 132 mm. Abalone taken from Western Zone subject to upper size limit of 160 mm by canners and live market buyers. Note that this was not rigidly enforced and market sampling showed most samples contained many abalone over this size.
2004	Eastern Zone TAC reduced to 770 t (220 kg/unit). Western Zone TAC remained 1260 t (360 kg/unit). Northern Zone TAC remained 280 t (80 kg/unit). Greenlip TAC reduced to 129.5 t (37 kg/unit). Bass Strait Zone TAC remained 70 t (20 kg/unit). Fishery production was set at 2509.5 t (717 kg/unit) state-wide. The greenlip TAC reduction affected the North West only, where the annual cap was reduced by 10 t to 30 t. October-March closure for Franklin Sound greenlip fishery abolished. Block 35 cap reduced from 20 t to 15 t.
2005	Eastern Zone TAC remained 770 t (220 kg/unit). Western Zone TAC remained 1260 t (360 kg/unit). Northern Zone TAC remained 280 t (80 kg/unit). Greenlip TAC reduced to 122.5 t (35 kg/unit). Bass Strait Zone TAC remained 70 t (20 kg/unit). Fishery production was set at 2502.5 t (715 kg/unit) state-wide. The greenlip TAC reduction affected the North East only, where the annual cap was reduced by 7 t to 23 t. Team diving (sharing catch from one quota unit by two divers) was introduced to legitimise the practise of divers catching abalone for others when they held no quota to which their catch could be assigned. Team dive dockets were submitted by teams, but not computerised. High grading (discarding large abalone in the catch from the deck) prohibited. Caufing of abalone (holding abalone in cages at sea) was prohibited. Introduction of cancellation reports where a prior reported trip is cancelled. Introduction of single (blacklip) zone fishing provisions. Overcatch provisions introduced to cover unintentional underestimation of catch weight. In Victoria in December, ganglioneuritis detected on two land-based (Portland and Port Fairy) and two offshore (Westernport) aquaculture sites.

2006	Eastern Zone TAC remained 770 t (220 kg/unit) Western Zone TAC remained 1260 t (360 kg/unit) Northern Zone TAC remained 280 t (80 kg/unit) Greenlip TAC remained 122.5 t (35 kg/unit) Bass Strait Zone TAC remained 70 t (20 kg/unit) Fishery production was set at 2502.5 t (715 kg/unit) state-wide. On 1 January 2006, interim reduction in MSL for Perkins Bay greenlip area (Blocks 47, 48A), from 145 mm to 140 mm. On 20 September 2006, MSL for Bass Strait Zone in Blocks 41-46 (North Coast) reduced from 114 mm to 110 mm. On 1 November 2006, MSL for Eastern Zone was increased to 138 mm from 136 mm. MSL for greenlip abalone in Perkins Bay was reduced to 132 mm from 140 mm. As a temporary measure to facilitate research, Block 30 was entirely closed to commercial abalone fishing and partially closed (except sub-block 30A) to recreational abalone fishing. The bag limit for recreational fishers in sub-block 30A reduced to 5 abalone per day. May 2006: Victorian ganglioneuritis (AVG) outbreaks reported from wild stocks adjacent to land-based aquaculture site at Port Fairey. As a precautionary measure, the Tasmanian wild fishery in Bass Strait closest to the Victorian coast was closed to abalone fishing, from 16 August 2006, initially for three months but then extended to 28 February 2007. The closure was for waters within latitudes 39º 12' S and 39 º 33' S, and longitudes 146 º to 147 º 35' (Blocks 51 to 56, and part of Block 57, including Wright Rock and Endeavour Reef). The taking of abalone in Tasmanian waters from vessels used in the Victorian fishery was prohibited, and the transfer by sea of abalone from King Island to the Tasmanian mainland was prohibited.
2007	Eastern Zone TAC remained 770 t (220 kg/unit) Western Zone TAC remained 1260 t (360 kg/unit) Northern Zone TAC remained 280 t (80 kg/unit) Greenlip TAC remained 122.5 t (35 kg/unit) Bass Strait Zone TAC remained 70 t (20 kg/unit) Fishery production was set at 2502.5 t (715 kg/unit) state-wide. However, it was agreed that the Bass Strait component (70 t) would not be caught due to concerns about disease outbreaks (AVG) in abalone stocks in adjacent Victorian waters. In October 2007, it was agreed that the cap for the southern part of the Actaeons (Sub-blocks 13C, 13D and 13E) would be reduced from 350 t to 266 t, and that a cap of 245 t be implemented for the South Coast (Sub-blocks 12B, 12C, 12D, 13A and 13B).

2008	Eastern Zone TAC increased to 808.5 t (231 kg/unit) Western Zone TAC remained 1260 t (360 kg/unit) Northern Zone TAC increased to 332.5 t (95 kg/unit) Greenlip TAC remained 122.5 t (35 kg/unit) Bass Strait Zone TAC remained 70 t (20 kg/unit) The total catch state-wide was set at 2,593.5 t, or 741 kg/unit. As part of a controlled trial in the North West, size limits in Block 5 and part of Block 6 were reduced for divers meeting defined operating requirements on the basis that there were large stocks of abalone too small to catch at the larger size limit, and that removing these smaller abalone would promote growth among the remaining fish. The MSL in the Northern Zone part of Block 5 (5A, 5B and 5C) was reduced from 132 mm to 127 mm, and in sub-blocks 5D, 6A, 6B and 6C, from 136 mm to 132 mm. To promote fishing in the Northern Zone part of Block 5, the cap was increased from 100 t to 152.5 t and the Northern Zone TAC increased to 332.5 t. The remainder of the Northern Zone was capped at 180 t. In Bass Strait, south of 39° 33', the Bass Strait Zone was reopened to fishing on 1 January 2008. North of this line, all islands in the Bass Strait Zone remained closed to fishing as part of measures to reduce the spread of AVG from Victoria. The closed area included the Kent, Hogan and Curtis Groups. It was reopened to fishing on 6 July 2008. Fears of an outbreak of AVG resulted in the closure of the Lower Channel (sub-blocks 14A, 14B, 14C and 14D) to abalone fishing between 16 September 2008 and 12 March 2009. The area was reopened after extensive sampling and testing failed to find diseased abalone. Actaeons (Blocks 13C, 13D, 13E) closed to fishing for the remainder of the year from 21 October because the 266 t catch limit had been reached (340 t). South Coast closed to fishing on 29 October because the 245 t catch limit had been reached (332 t).
2009	Eastern Zone TAC increased to 850.5 t (243 kg/unit) Western Zone TAC reduced to 924 t (264 kg/unit) Central Western Zone TAC established at 304.5 t (87 kg/unit) Northern Zone TAC remained 332.5 t (95 kg/unit) Greenlip TAC remained 122.5 t (35 kg/unit) Bass Strait Zone TAC remained 70 t (20 kg/unit) The total catch state-wide was set at 2,604 t, or 744 kg/unit. A new zone was created on the west coast to transfer catch from the South West further north. The Central Western Zone covers Blocks 6, 7 and 8. The Western Zone was correspondingly reduced to Blocks 9, 10, 11, 12, 13A and 13B. Blocks 7 and 8 were closed to fishing on 13 July because the 108 t cap had

	been reached (155 t). The North West greenlip region (cap 30 t) was closed to fishing on 1 August after the 20 t Perkins Bay cap was reached (20.1 t). The region's catch was 33.9 t. The North East greenlip region was closed to fishing on 19 October because the 23 t cap had been reached (35 t). The Actaeons were closed to fishing on 1 November, because the 340 t cap had been reached (341 t). The South Coast (cap 300 t) was closed to fishing on 1 November with the catch at 321 t. The Block 5 (cap 152 t) was closed to fishing on 5 December with the catch at 172 t.
2010	Eastern Zone TAC increased to 896 t (256 kg/unit). Western Zone TAC remained 924 t (264 kg/unit). Central Western Zone TAC remained 304.5 t (87 kg/unit). Northern Zone TAC remained 332.5 t (95 kg/unit). Greenlip TAC increased to 133 t (38 kg/unit). Bass Strait Zone TAC remained 70 t (20 kg/unit). The total catch state-wide was set at 2,660 t, or 760 kg/unit. In September 2010, the size limit for greenlip caught between Andersons Bay (Block 41) and Cowrie Point (Block 46) was reduced from 145 mm to 132 mm, in line with Blocks 47 and 48A (Perkins Bay/Black Reef) . The size limit for Eastern Zone blacklip caught in Block 31A north of Cod Bay and Georges Rocks (latitude 40º54'53"S) was reduced from 138 mm to 132 mm while fishing under permit. This was a temporary measure between July and October to encourage fishing there. Block 31A was closed to fishing on 4 October after 50 t of abalone had been caught, but was subsequently reopened in December 2010 (at 138 mm) to ease pressure across the remainder of the fishery. Furneaux Group blacklip closed 9 August, capped at 35 t (49 t caught). The Actaeons closed 13 September capped at 340 t cap (342 t). Block 22 closed 13 October when the 60 t cap was almost reached (55 t). It was reopened in December to ease pressure on the reminder of the fishery. Blocks 7, 8 and 6D closed 20 October capped at 150 t (171 t). North East greenlip closed 1 November, capped at 23 t (25 t). North West greenlip closed 13 November, capped at 18 t (23t). Perkins Bay greenlip closed 13 November, capped at 20 t (20t). All the Northern Zone except Block 5 closed 22 November capped at 180 t (191 t caught). South Coast closed 13 December capped at 300 t (311 t).

	King Island greenlip closed on 13 December, cap 30 t (32 t).
2011	Eastern Zone TAC decreased to 721 t (206 kg/unit). Western Zone TAC remained 924 t (264 kg/unit). Central Western Zone TAC remained 304.5 t (87 kg/unit). Northern Zone TAC increased to 402.5 t (115 kg/unit). Greenlip TAC increased to 143.5 t (41 kg/unit). Bass Strait Zone TAC remained 70 t (20 kg/unit). The total catch state-wide was set at 2,565.5 t, or 733 kg/unit. The remainder of the 40 units issued to the five Furneaux Group divers in 1990 were transferred back to the Government. The Eastern Zone was closed to fishing in all parts except Block 31 between 1 January and 31 March. Actaeons (Sub-blocks 13C, 13D and 13E) closed 29 October capped at 341 t (359 t caught). Lower Channel (sub-blocks 14A, 14B) closed 5 December cap 10 t (12.5 t caught). Block 22 closed 12 September, reopened 18 December cap 40 t (54 t caught). Blocks 23, 24 closed 12 November cap 50 t (54 t caught). Freycinet/Bicheno (Blocks 25-28, 29A) closed 5 December cap 40 t (47.5 t caught). Block 5 Northern Zone closed 29 August cap 142.5 t (155 t caught). Remainder NW Northern Zone (Blocks 47, 48, 49) closed 29 October cap 100 t (112 t caught). North East Northern Zone (Block 39, 40, 31B) closed 5 December cap 30 t (29 t caught). Granville Harbour/Sandy Cape (Blocks 7, 8, 6D) closed 23 May cap 160 t (159.5 t caught). Furneaux Group Bass Strait Zone closed 20 June cap 35 t (44 t caught). North West greenlip closed 29 October cap 18 t (21 t caught). Perkins Bay greenlip closed 1 October cap 20 t (21 t caught). North East greenlip closed 5 December cap 23 t (23.5 t caught). Furneaux Group greenlip closed 28 November cap 42 t (44.5 t caught). Telephone reporting requirements were suspended on 16 November when the company operating the call centre unexpectedly ceased trading. Following the discovery of AVG-affected greenlip in NSW in November 2011, all imports of live abalone into that state from Tasmania and Victoria have been subject to restrictions. This measure has since greatly reduced the size of the domestic live greenlip market causing a collapse in high-grade greenlip beach prices.

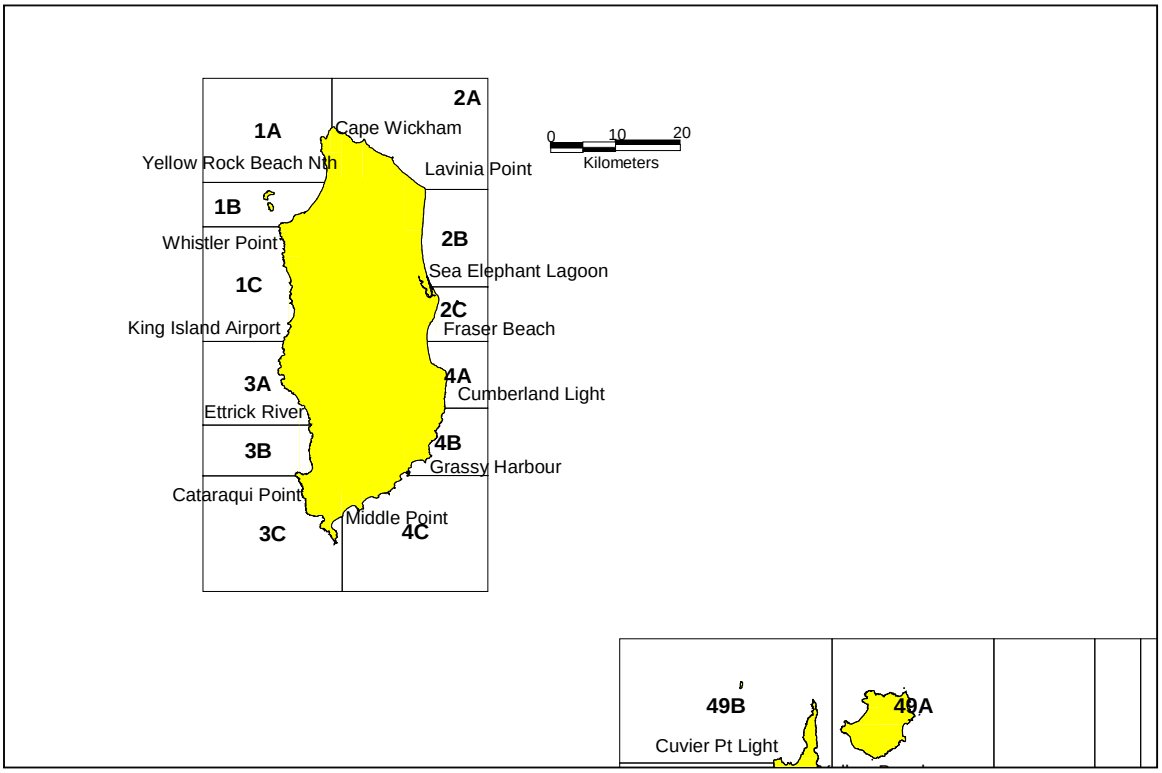
2012	Eastern Zone TAC decreased to 549.5 t (157 kg/unit). Western Zone TAC remained 924 t (264 kg/unit). Central Western Zone TAC remained 304.5 t (87 kg/unit). Northern Zone TAC decreased to 378 t (108 kg/unit). Greenlip TAC decreased to 140 t (40 kg/unit). Bass Strait Zone TAC remained 70 t (20 kg/unit). The total catch state-wide was set at 2,366 t, or 676 kg/unit. No caps were implemented in the Eastern Zone. The Eastern Zone was closed to fishing in all parts except Block 31 between 1 January and 31 March. East Furneaux Bass Strait Zone (sub-blocks 33B, 33C, Blocks 36, 38) closed 13 August, cap 35 t (36.4 t caught). Eastern Zone sub-block 30A closed 13 August, cap 4 t (4.5 t caught). North East greenlip closed 27 August cap 23 t (32.7 t caught). North East Northern Zone closed 27 August cap 30 t (35 t caught). Granville Harbour/Sandy Cape (Blocks 7, 8, 6D) closed 15 October cap 154.5 t (174 t caught). Blocks 47, 48, 49 Northern Zone (Hunter &Three Hummock Islands) closed 15 October, cap 130 t (156 t caught). Sub-block 48A, Block 47 (Black Reef greenlip) closed 12 November cap 20 t (26 t caught). Remainder North West greenlip closed 19 November, cap 18 t (18.5 t caught). Telephone reporting requirements reinstated with a new operator on 27 February. GPS and depth loggers made mandatory from 1 January 2012. LML at Block 49 (Hunter Island & Three Hummock Island but not Albatross Island was reduced from 125 mm to 120 mm. The LML at Albatross Is was increased to 127 mm from 125 mm.
2013	Eastern Zone TAC decreased to 528.5 t (151 kg/unit). Western Zone TAC increased to 1001 t (286 kg/unit). Central Western Zone TAC decreased to 101.5 t (29 kg/unit). Northern Zone TAC decreased to 308 t (88 kg/unit). Greenlip TAC remained 140 t (40 kg/unit). Bass Strait Zone TAC remained 70 t (20 kg/unit). The total catch state-wide was set at 2,149 t, or 614 kg/unit. The Central Western Zone/Western Zone boundary was moved north to the Wild Wave River between 6D and 6C, meaning that Blocks 7 and 8, and sub-block 6D reverted to the Western Zone, and that the Central Western Zone

	comprised 5D, 6A, 6B and 6C. The Eastern Zone was closed to fishing in all parts except Block 31 between 1 January and 31 March. North East greenlip closed 3 June, cap 23 t (24 t caught). Bass Strait Zone east coast Furneaux Group closed 19 August, cap 30 t (27 t caught). Annual catch from waters around the Freycinet Peninsula and northward, (including sub-blocks 26B, 26C, 26D, 27A, 27B, 27C, 27D, 27E, 28A & 28B) was capped at 5 t, and the LML increased to 145 mm, these measures to restore populations in the area. It was closed 26 August, 11 t caught. North West greenlip closed 23 September, cap 18.5 t (23 t caught). Block 30A blacklip closed 23 September, cap 4 t (4.5 t caught). North East blacklip closed 7 October, cap 30 t (32 t caught). Blocks 47, 48, 49 Northern Zone (Hunter &Three Hummock Islands) closed 15 October, cap 100 t (126 t caught). Blocks 5 closed 11 November, cap 60 t (60 t caught). Furneaux Group greenlip closed 25 November, cap 47 t (55 t caught). South West Western Zone closed 2 December, cap 405 t (528 t caught).
2014	Eastern Zone TAC remained 528.5 t (151 kg/unit). Western Zone TAC decreased to 840 t (240 kg/unit). Central Western Zone TAC decreased to 73.5 t (21 kg/unit). Northern Zone TAC decreased to 280 t (80 kg/unit). Greenlip TAC remained 140 t (40 kg/unit). Bass Strait Zone TAC remained 70 t (20 kg/unit). The total catch state-wide was set at 1,932 t, or 552 kg/unit.

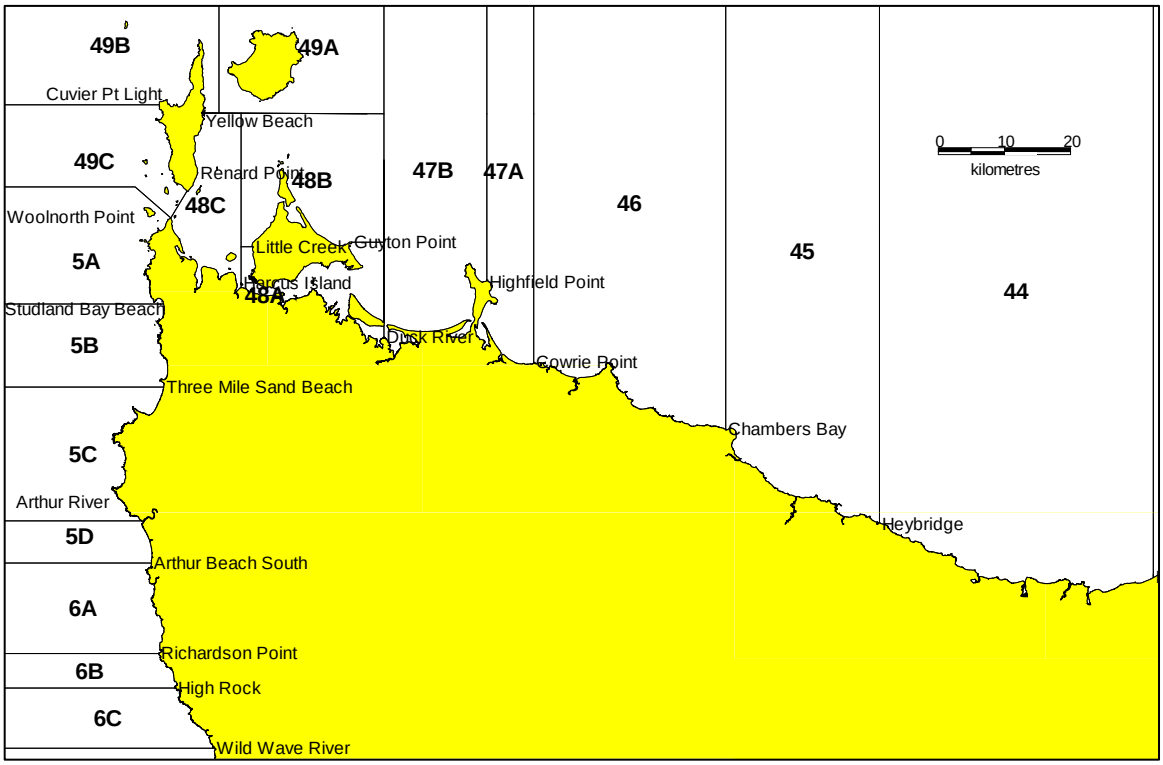
Appendix 11: Maps of catch-reporting blocks and sub-blocks

It is not intended that these maps be used for any purpose other than identifying the position of sub-blocks mentioned in this report.

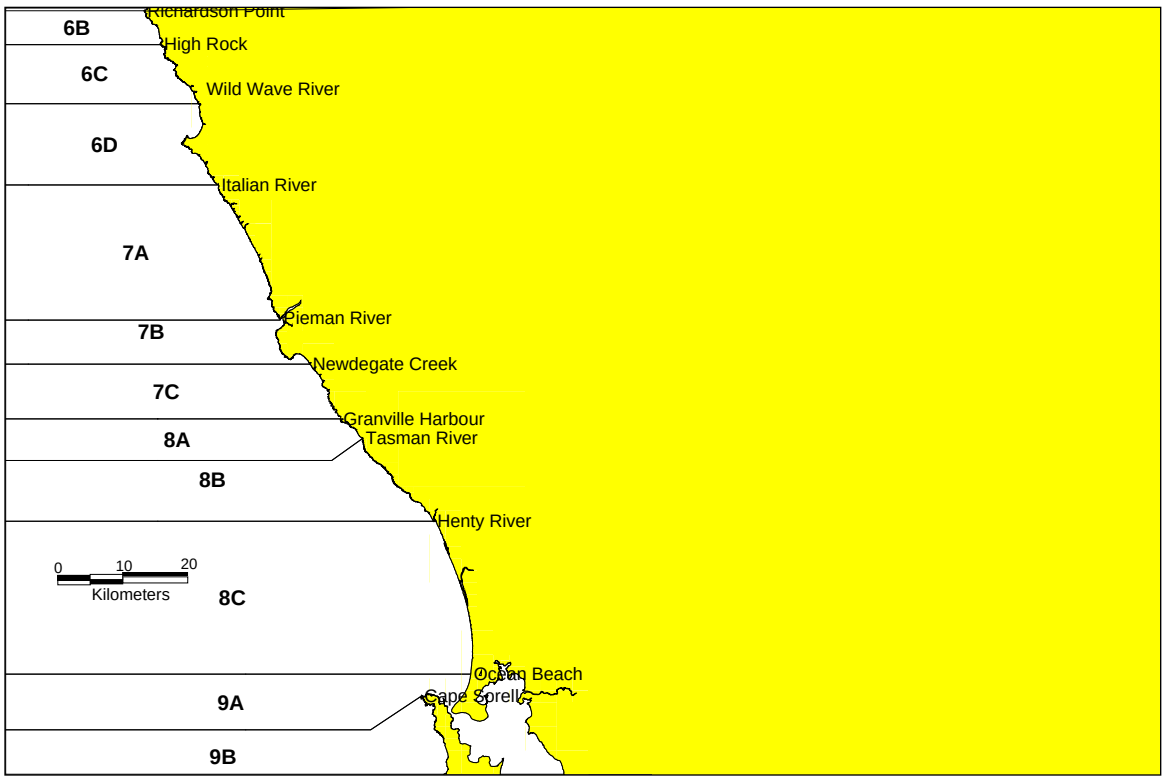
Map1: King Island



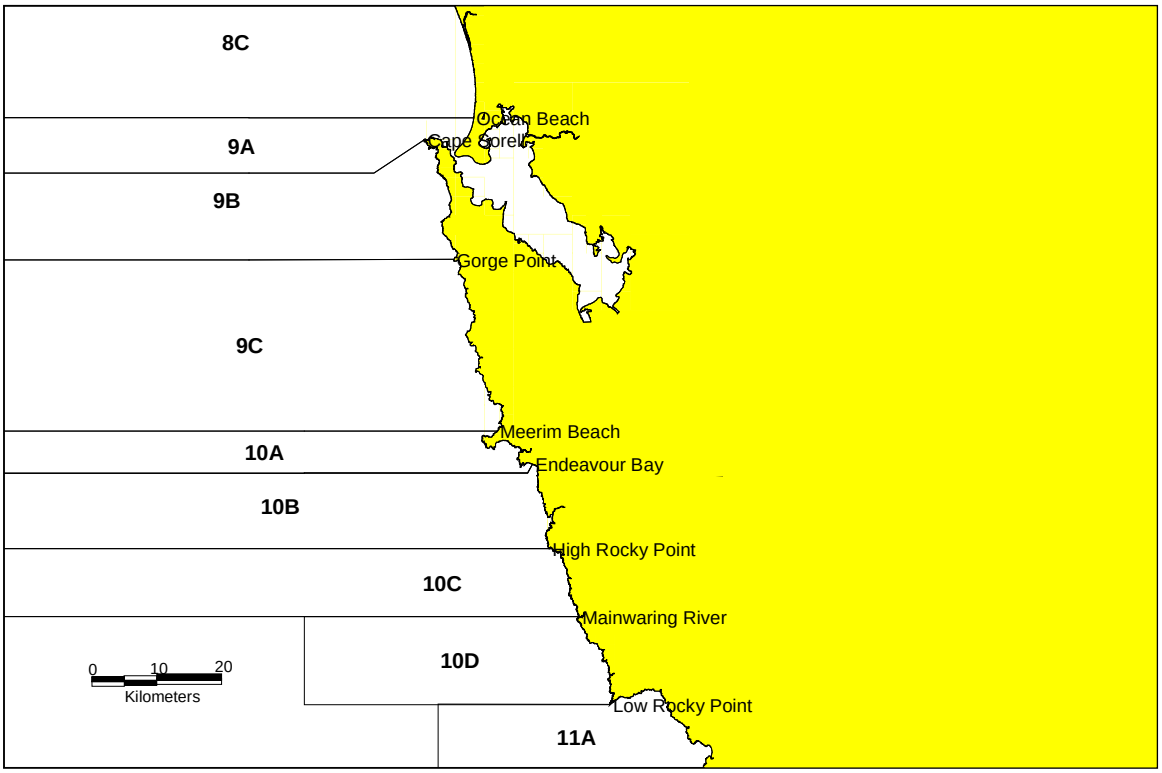
Map 2: North West Tasmania



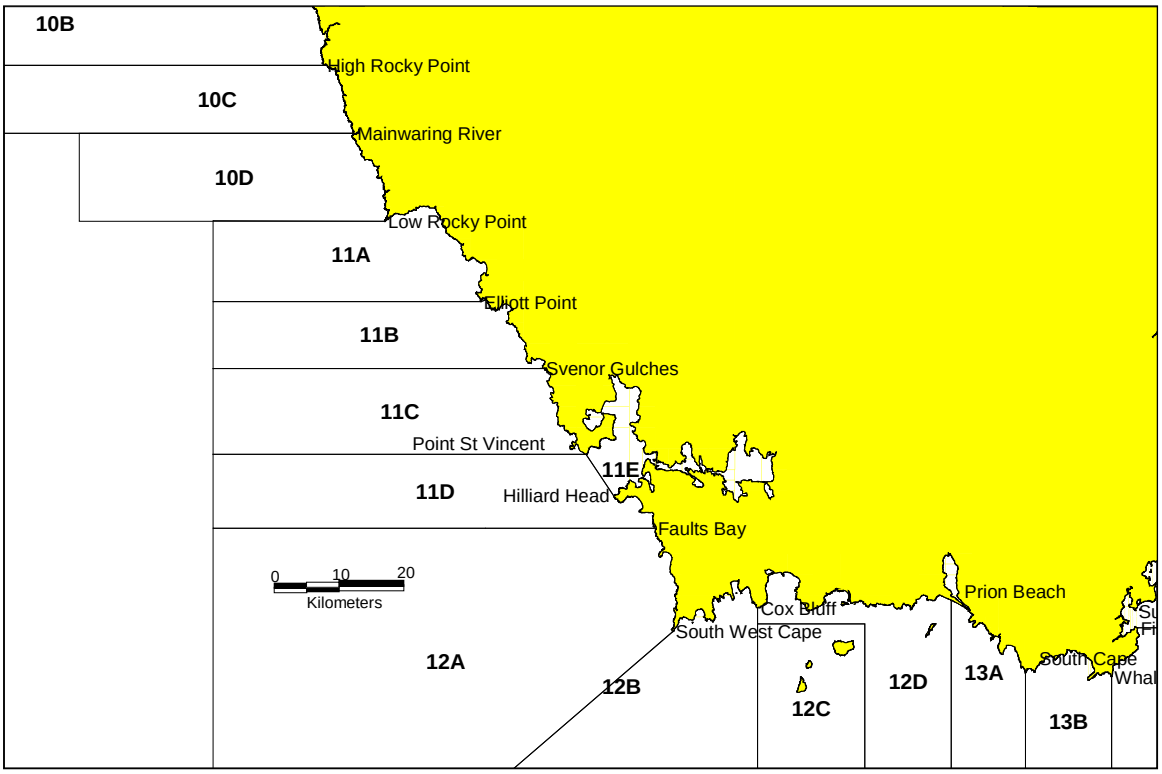
Map 3: Central West Coast (north)



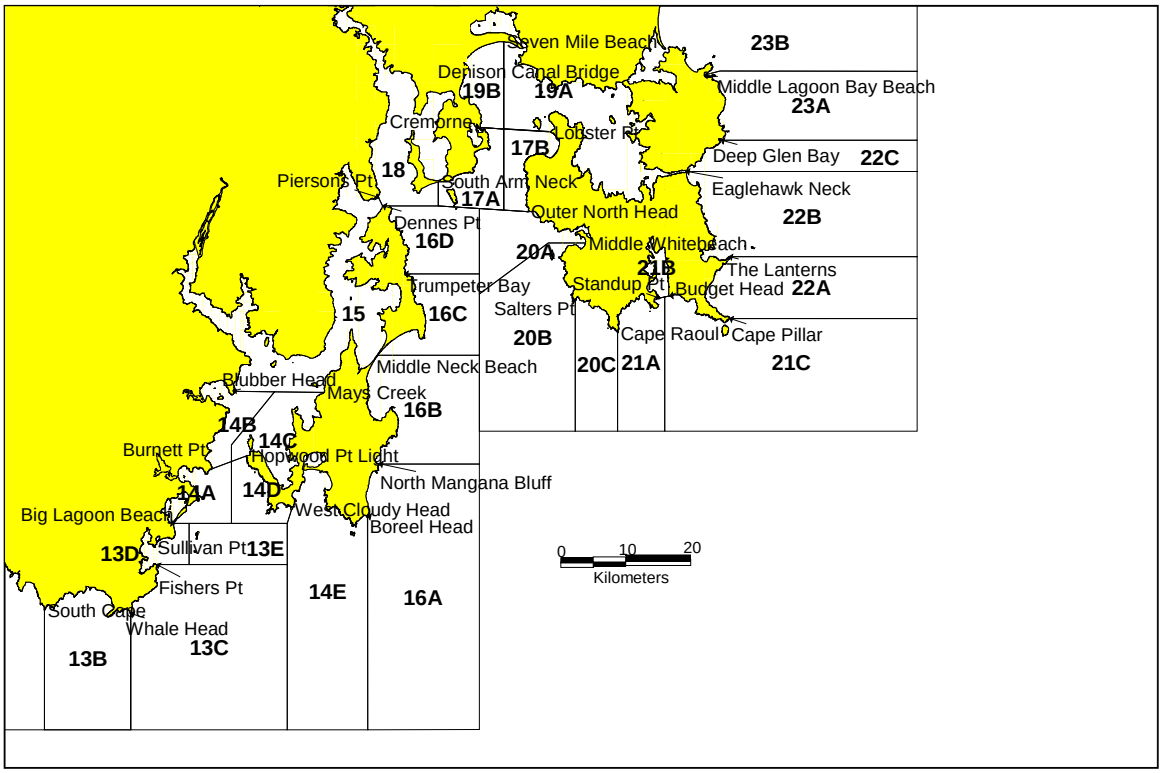
Map 4: Central West Coast (south)



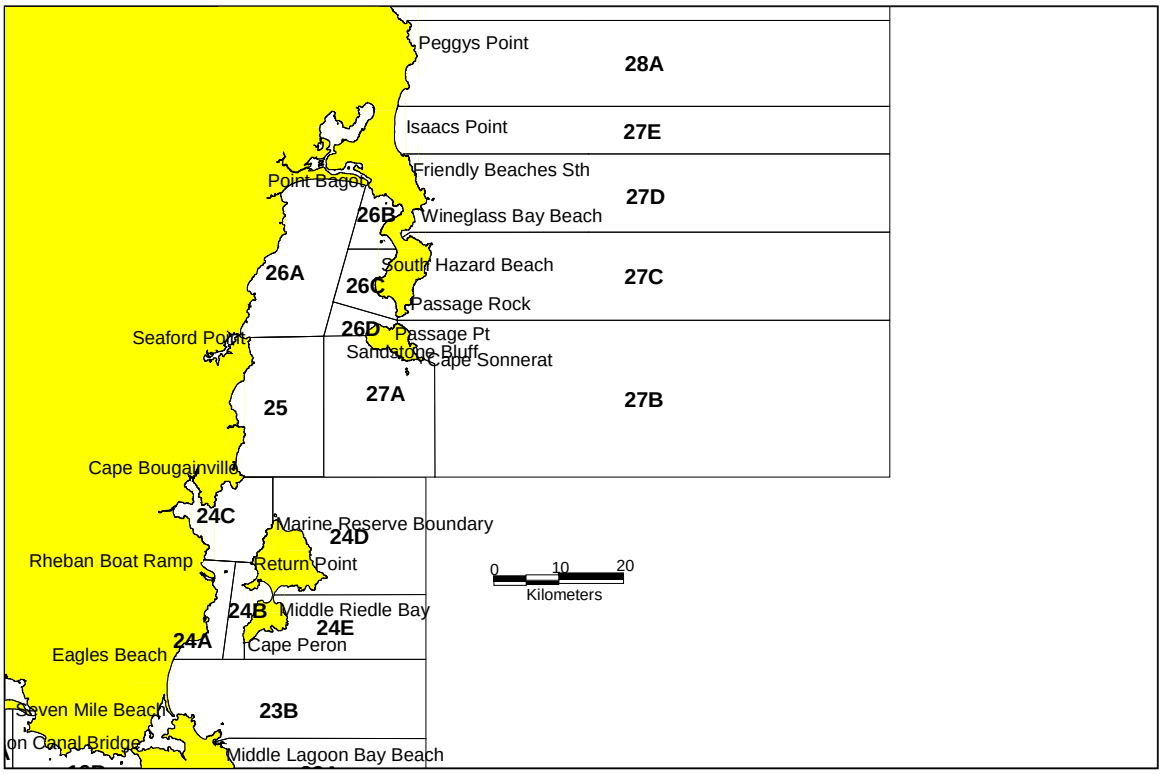
Map 5: South West Tasmania



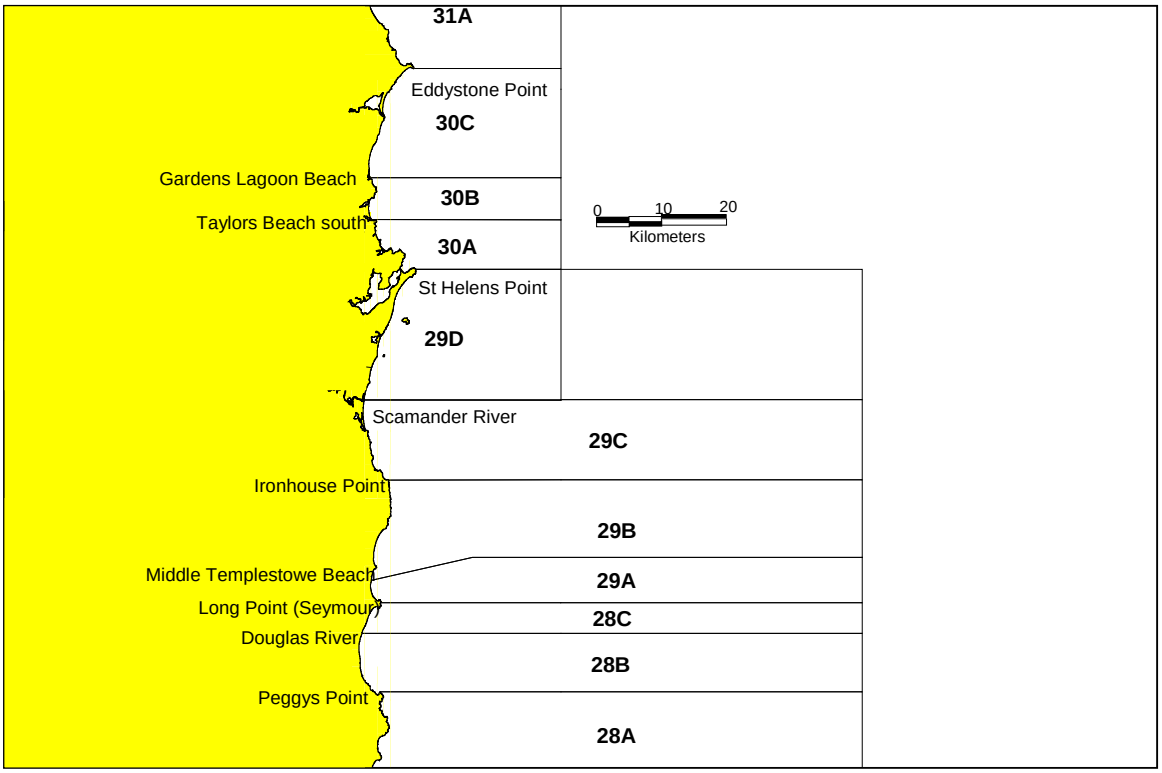
Map 6: South East Tasmania



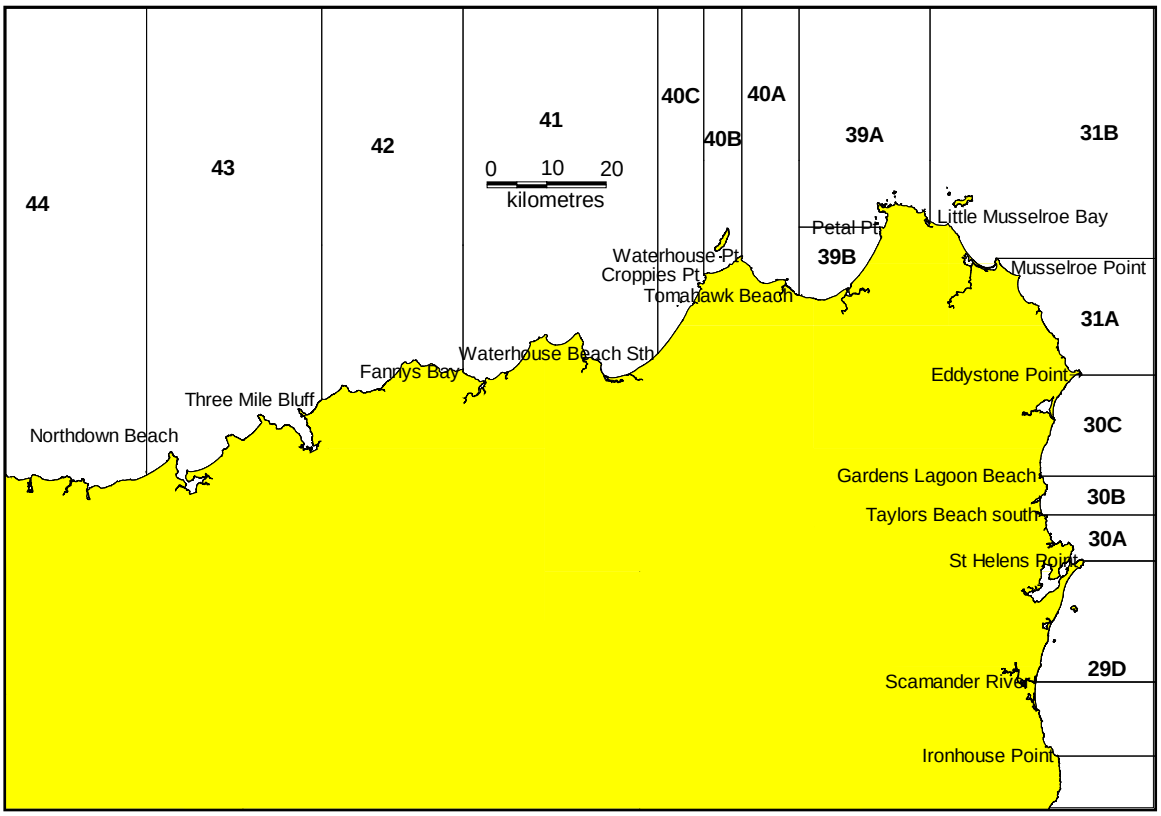
Map 7: Lower East Coast



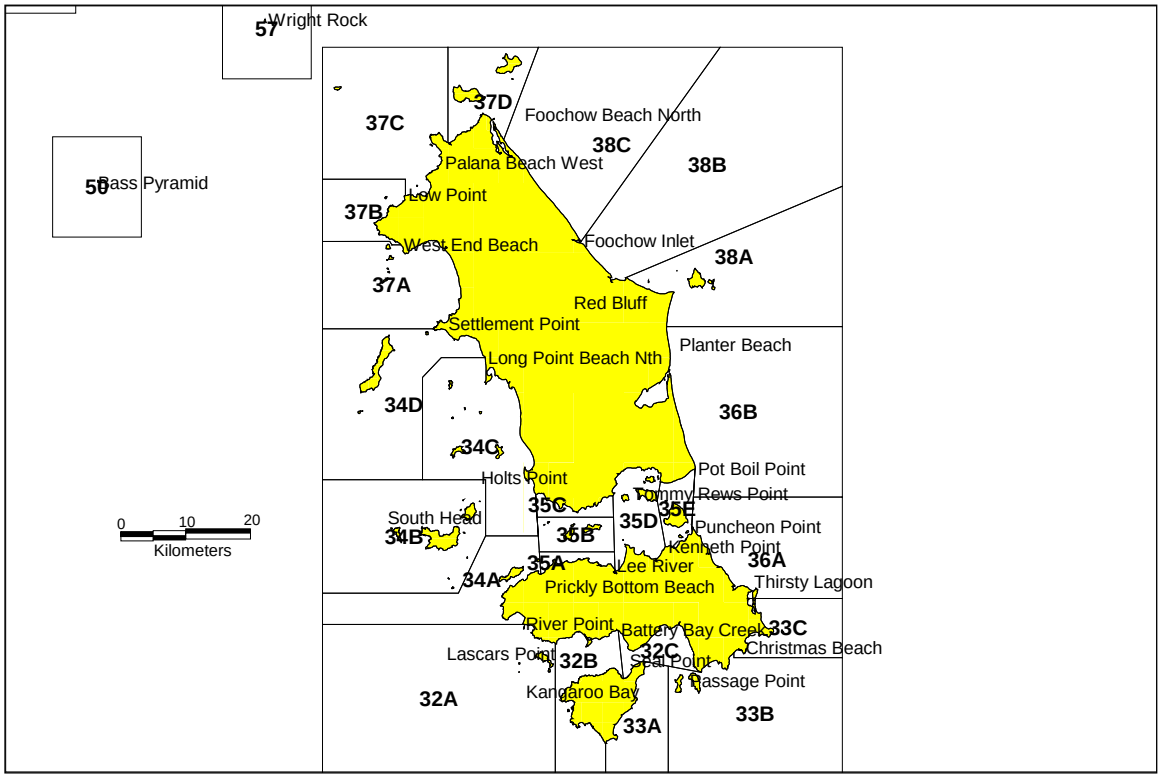
Map 8: Upper East Coast



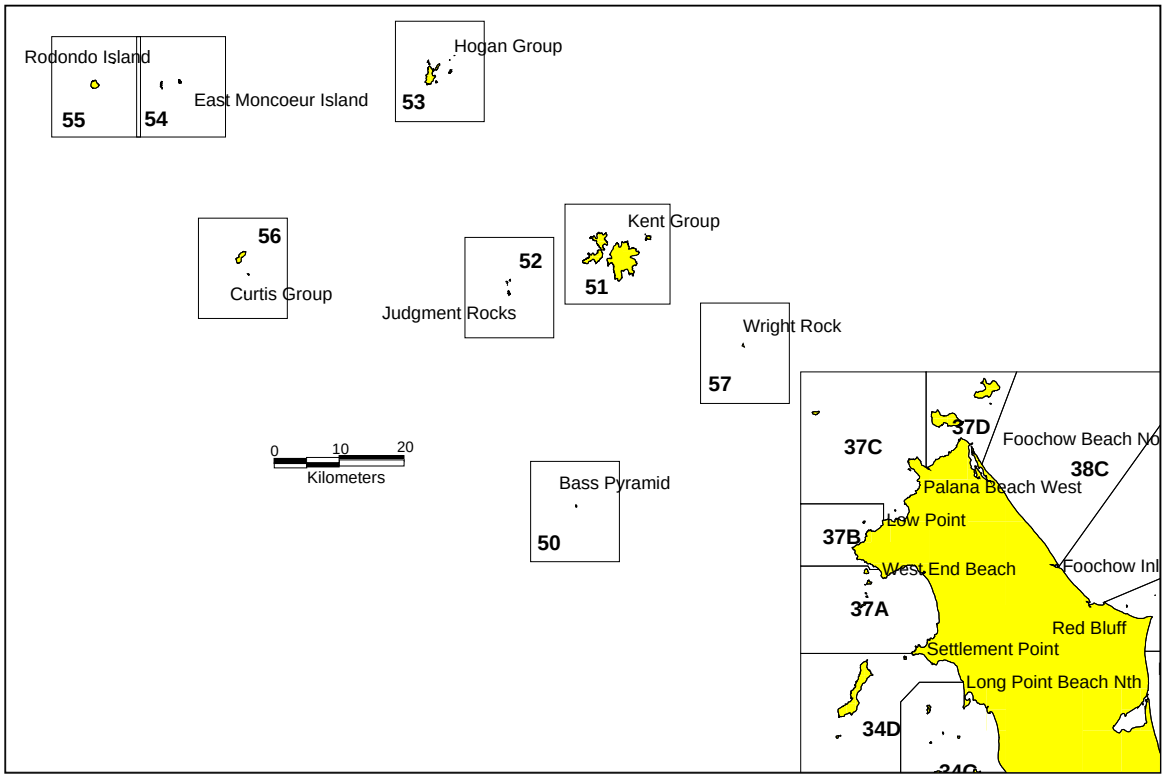
Map 9: North East Tasmania



Map 10: Furneaux Group

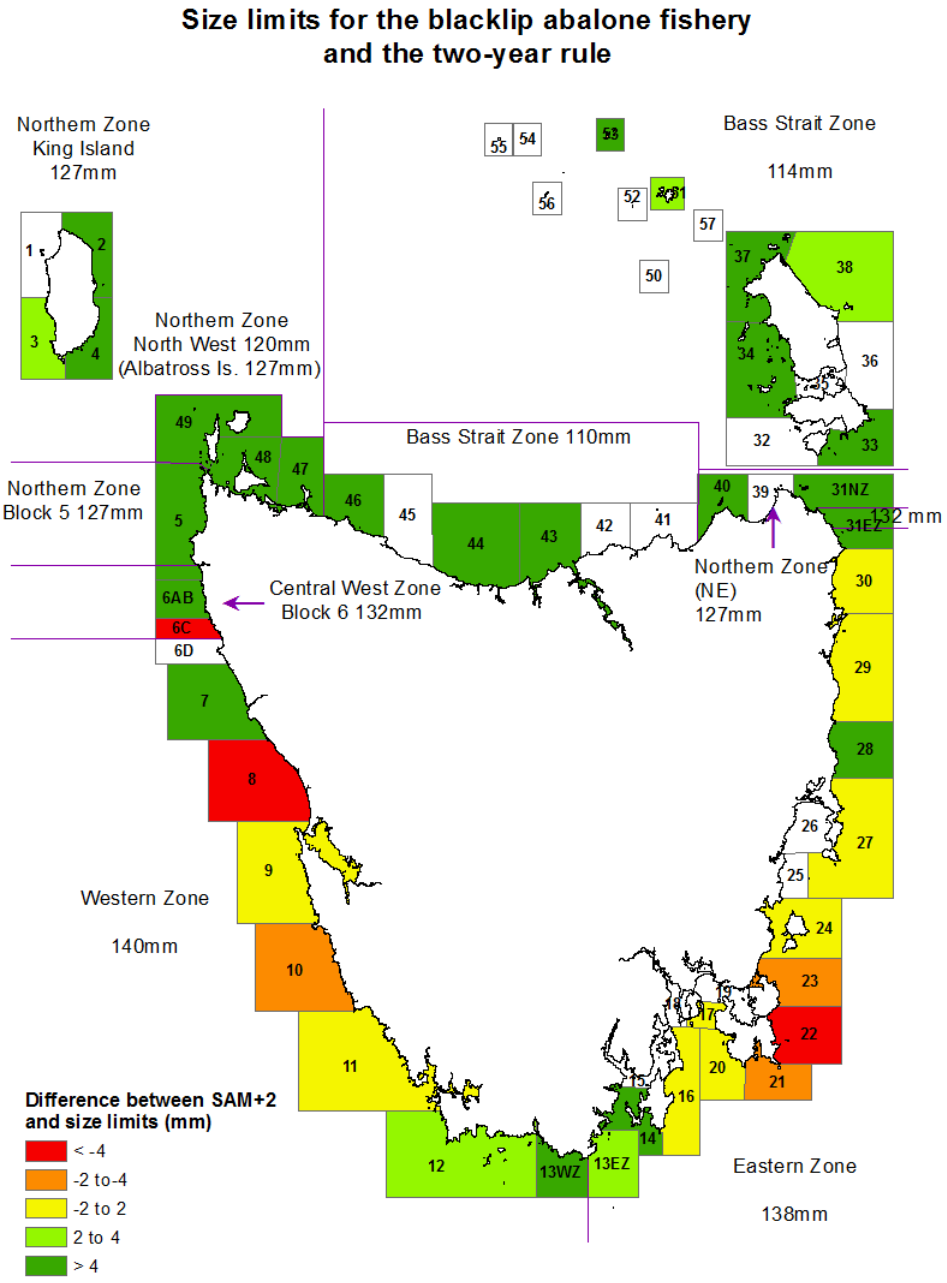


Map 11: Bass Strait Islands



Appendix 12: Application of the "two-year rule" to the blacklip abalone fishery, 2013

In the blacklip fishery, management policy specifies that size-limits allow abalone to have had at least two breeding seasons before they reach legal size. This policy is known as the "two-year rule". Biological information from field studies is used to determine the average size to which abalone grow in the two years following maturation. The map below shows how well size limits match the application of the policy to blacklip populations, grouped by reporting block. The map may change from year to year as new biological information becomes available, or size limits change.



Colours between orange and red show that the estimated size at maturity plus two years growth (SAM+2) is greater than the 2013 size limit operating in a particular block, and by how much (in millimetres). Blocks shaded orange to red means that the size limit is too low to meet the policy. In blocks shaded yellow, SAM+2 is within 2 mm (+/-) of the size limit and the size-limit policy is approximately met. Blocks shaded green show where SAM+2 is less than the size limit, Blocks with no colour indicate no information is available.

Growth rates, maximum size and median size at maturity are highly variable among abalone populations around Tasmania's coast. Generally, abalone in the north grow slower and to a smaller maximum size, and become sexually mature at a smaller size than abalone in the south. There are exceptions, and in the south there are places with significant populations of smaller abalone, while in the north there are places where abalone grow larger and faster than those around them.

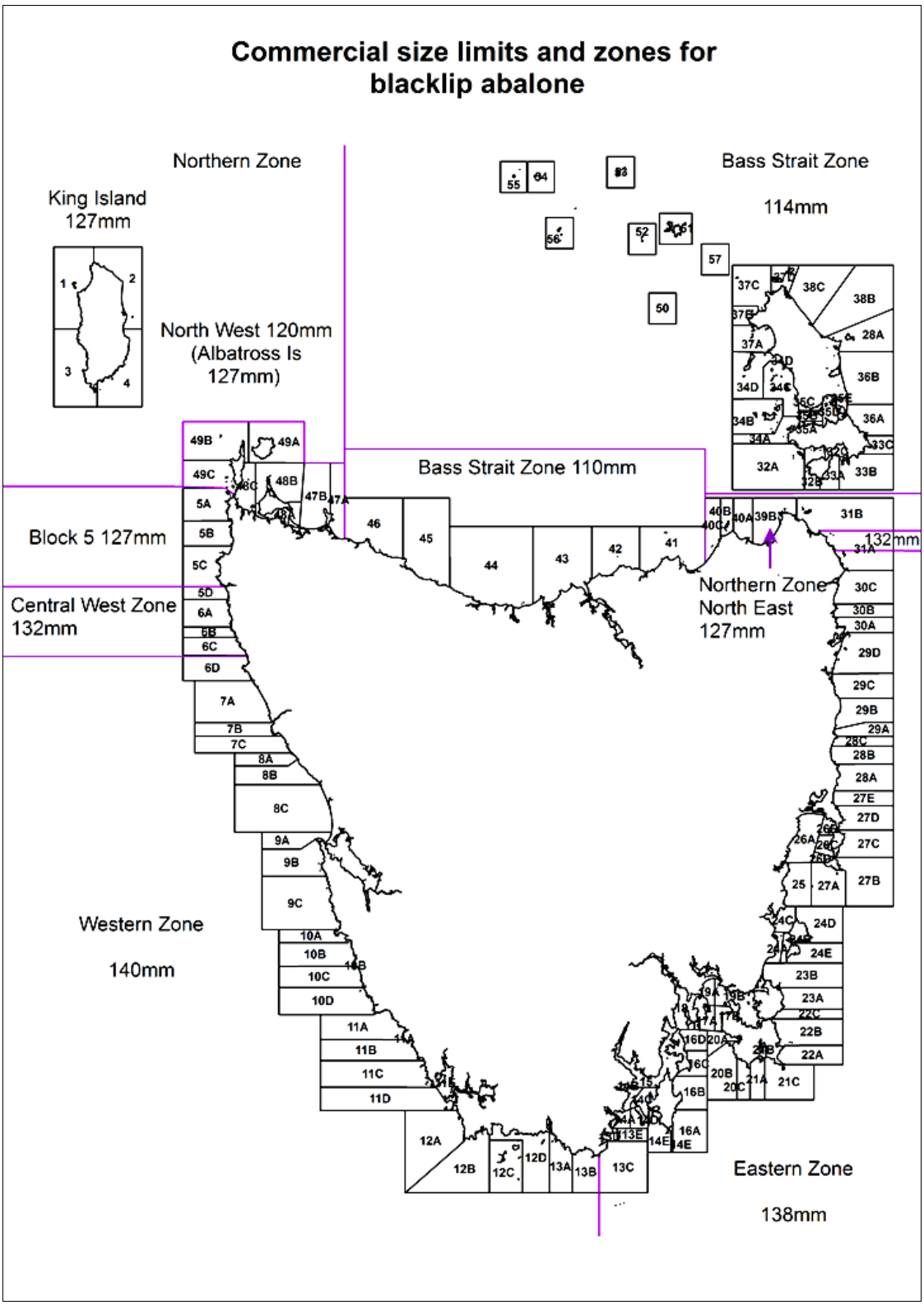
On a smaller scale, within each region, there is also variation in growth and maturity between populations. This occurs particularly in the North East in Block 31 and in the North West, in Block 6, where there are large differences in growth over small distances. In other areas, Block 22 (Tasman Peninsula) and the Western Zone part of Block 13 exhibit greater variation than surrounding blocks. It is impractical to develop size limits that accommodate all the combinations of growth and size at maturity exhibited by populations within a region, so managers aim to achieve the best fit, where the average of SAM+2 meets the management policy.

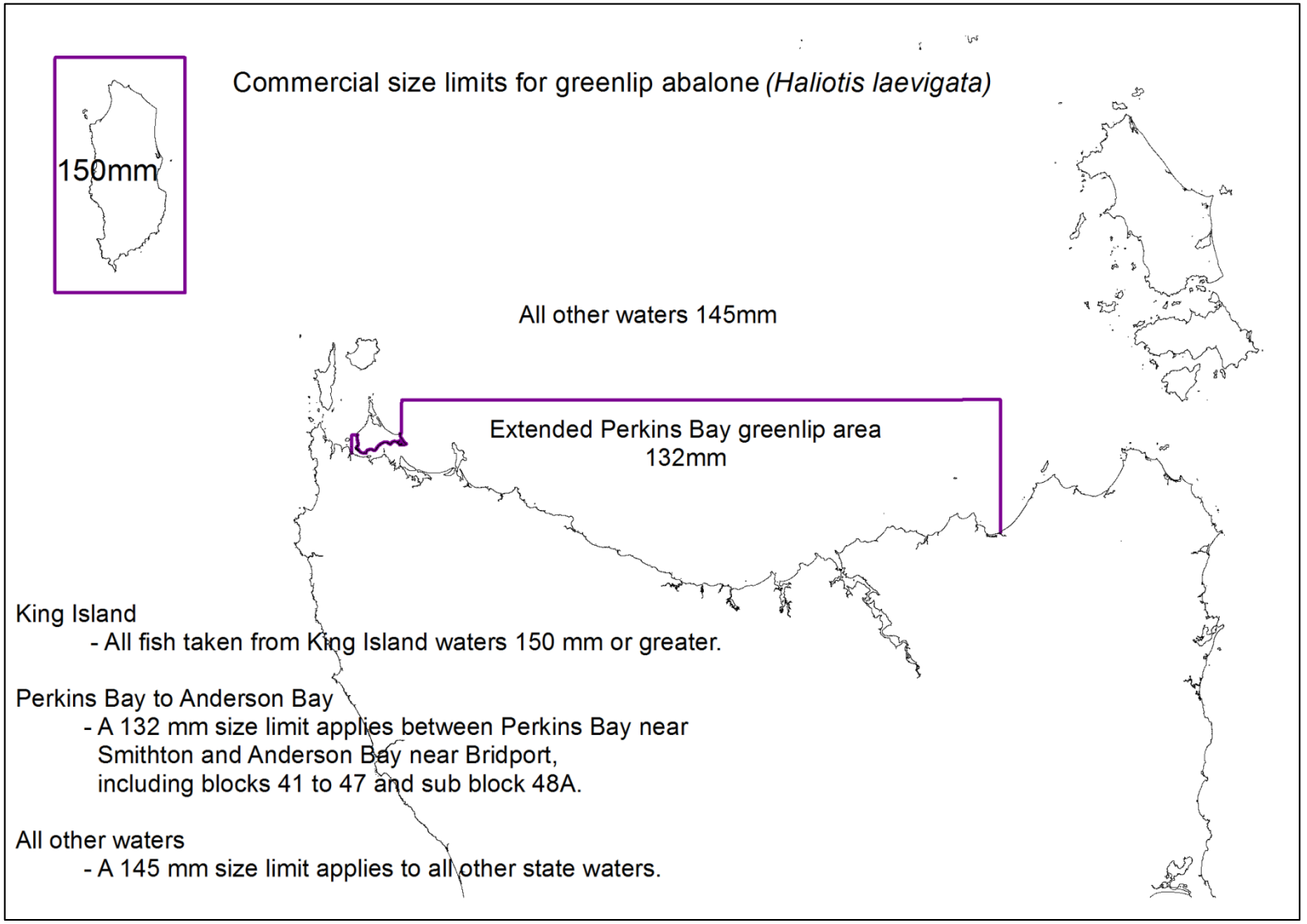
Abalone populations around the coast are regularly sampled by IMAS for the purpose of estimating their median size at maturity. In addition, abalone growth is measured through tagging programs at key parts of the fishery. These maturity and growth studies are ongoing, have been in place since the late 1980's, and useful information from approximately 500 maturity samples and over 40 growth studies is available.

Acquiring biological information is difficult and costly, and while there is substantial knowledge of abalone populations in some regions, others have less than adequate or no information. Where biological information is sparse, there are limitations with the application of SAM+2 across populations within an area, and the map needs to be viewed accordingly. Many of the SAM+2 estimates for the North West, North Coast and Central West blocks were derived from just a few samples, or the samples were collected many years ago, and consequently there is less confidence about these estimates. These include estimates for parts of the coast between the Arthur River and Cape Sorell (Blocks 6-8) and the South Coast (Block 12, WZ Block 13).

Most sites where maturity sampling has occurred lack population-specific growth information, so assumptions about population growth characteristics are made, and growth parameters from regionally similar populations are applied. This means that SAM+2 estimates are only as valid as the assumptions made about regional population growth, and while the best available knowledge is used when developing these assumptions, it is possible that there are some regions where these assumptions are not met.

Appendix 13: Commercial size limits for blacklip and greenlip abalone, 2013




Commercial size limits for greenlip abalone (Haliotis laevigata)
150mm
All other waters 145mm
Extended Perkins Bay greenlip area
132mm
King Island
- All fish taken from King Island waters 150 mm or greater.
Perkins Bay to Anderson Bay
- A 132 mm size limit applies between Perkins Bay near Smithton and Anderson Bay near Bridport, including blocks 41 to 47 and sub block 48A.
All other waters
- A 145 mm size limit applies to all other state waters.

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