TASMANIAN ABALONE FISHERY ASSESSMENT 2012

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Abalone Fishery Assessment: 2012

Executive summary

In 2012, landings of abalone totalled 2,363 t, comprising 2,223 t of blacklip and 140 t of greenlip, from a Total Allowable Catch (TAC) of 2,366 t. The total catch was lower compared with the previous year, due to a reduction (171.5 t) in the Eastern Zone TAC. Despite this reduction, the gross landed value fell by only $2.4 million to $82.4 million, as prices for live market product (mostly sourced from the Eastern, Western and Central West Zones) were stronger in 2012, while prices for canned product (mostly from the Northern and Bass Strait Zones) remained stable. Royalties collected by the Tasmanian Government in 2012 fell by $0.63 million to $5.72 million as a result of lower value.

The status of the fishery was assessed using catch and catch rates from diver returns, and samples of catches were measured to provide information about the length of abalone. Information on stocks also comes through consultation with the abalone industry to obtain their observations on the state of stocks and market drivers affecting the fishery.

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

Eastern Zone
As a management response to falling stock levels, the Eastern Zone TAC was reduced by 346.5 t to 549.5 t between 2010-2012.

During the four years prior to 2012, the annual catch at the Actaeons was historically high, and averaged 363 t. This part of the fishery tends to be based on new recruits, typically with over 50% of the catch in this category and is thus more exposed to recruitment changes than most other parts of the fishery. In 2011, stocks were assessed as moderate but falling, and it was concluded that recruitment was inadequate for the size of the catch. As a consequence, the 2012 catch was reduced by almost 25%, but catch rates continued to fall as stocks were assessed to be at low levels in 2012 relative to previous years.

The Bruny Island catch was also considerably lower at under 30 t or 75% of the 2011 level. Assessing stock levels is less certain with such low levels of catch. Nonetheless, sustained low catch rates over recent years indicate that stock levels are low and size data suggest lower than usual recruitment at South Bruny.

In Storm Bay (Blocks 17-21), both catch and catch rates were abnormally low. This suggests reduction in stocks, particularly in Block 20, but also in the formerly productive Block 21. Recruitment again appears to be below average in these blocks based on the observed falling catch rates, low catch and the increasing size of abalone (which was already high). Stocks levels were assessed as low.

On the lower and middle parts of the East Coast between Tasman Island and Long Point (Seymour), catch rates have continued to fall and stock levels were assessed as low. Northwards of Long Point in Blocks 29 and 30, catch rates were generally higher, and although the amount of catch taken here was relatively small, stock levels appeared

to be higher. In Block 31, catch rates have fallen considerably yet remain higher than blocks to the south. Stock levels were assessed as moderate.

Central Western Zone
In 2008, the region encompassed by Blocks 6, 7 and 8 and sub-block 5D was identified as under-fished, and catch was transferred to this region from the depleted Western Zone further south. This led to four years of high catch in Block 6, following which catch rates have declined. Recently this decline has intensified, which provides evidence that too much has been taken from the region. Stock levels were assessed as moderate and falling.

Further south in Blocks 7 and 8, catch rates have fallen steadily, and are now at their lowest level in more than 15 years. Stocks were assessed as moderate, with the more heavily fished areas approaching low levels. This region and sub-block 6D have now been transferred back to the Western Zone, which is expected to lead to a substantial reduction in catch because this area is less favoured for harvesting.

Western Zone
South of Strahan in Block 9, catch rates have been stable at moderately high levels for many years, but fell in 2012. This decline was partially attributed to fishing in adverse conditions when the Eastern Zone was closed between January and March. However, catch rates remained low after this period and it was evident that stocks were in fact reduced. The annual catch now appears excessive and has resulted in a decline in catch rate. Stocks were assessed as moderately high but falling.

In the South West (Blocks 10, 11 and sub-block 12A) the regional catch was reduced to 450 t in 2009 to arrest falling catch rates. There was a temporary improvement in 2010, but since then catch rates have continued downwards towards 100 kg/hr. Part of the catch rate decline may be attributed to the closure of the Eastern Zone and to behavioural changes by divers but high catch appears to be the predominate factor. Trends in logbook and size structure data suggest that stocks are not rebuilding, and that a further catch reduction is required. Stocks were assessed to be at low levels.

South Coast (sub-blocks 12B-12D, 13A-13B) catch rates, which were relatively low compared with other parts of the Western Zone, have fluctuated within a narrow range since 2002. More recently, abalone from this area have been smaller than other parts of the zone indicating a greater dependency on new recruits. The lower catch rates and smaller abalone were consistent with high levels of fishing mortality and suggested greater reliance on recruits and thus risk of exposure to recruitment decline. The stability of catch rates suggests that stock levels here were stable at moderate levels, and that the size of the catch was appropriate for the region.

Northern Zone
The King Island blacklip catch fell by approximately 20% due to good fishing conditions in other more accessible parts of the Zone. Catch rates were at the same levels or better than previous years and the size structure of abalone was large relative to the LML. Stock levels were assessed to be moderate to high.

In Block 5, catch rates have fallen steadily since 2008, and the annual catch has dropped below 100 t with many divers choosing to fish elsewhere in nearby Block 49. In part of Block 5 (5B), harvested abalone were smaller, with 25% at the LML,

indicating extraordinarily heavy fishing pressure. This suggests that catch levels were too high and that a reduction in catch is required. While in some areas small but dense pockets of low-grade abalone remain, the marketable portion of the stock was assessed to be at a low level.

In Block 49, the LML was reduced by 5 mm, thus increasing the size of the harvestable stock. Fishing was intensive and the initially high catch rates fell rapidly throughout the year until its closure in October, by which time more than 150 t had been taken. Due to the unusual nature of fishing conditions caused by the change in LML, catch rates were less reliable as indicators of abundance. Stocks were assessed to be at moderate levels.

Blacklip stocks in the North East (sub-blocks 31B, 39A) have been subject to high fishing pressure, and annual catches over 30 t have resulted in lower catch rates in recent years. The catch from this region has been difficult to manage because the small size of the cap (catch limit) and the popularity of the region among divers has meant that the cap was overrun quickly. Stock levels were considered reduced from moderate to low.

Bass Strait Zone

The eastern part of the Furneaux Group was again the most heavily fished part of the Bass Strait blacklip fishery following its transfer into the zone at a reduced size limit in 2010. At Babel Island in Block 38, catch rates were initially high, but have since fallen. In the south in Blocks 32 and 33, blacklip and greenlip are usually fished on the same trip and this mixed effort makes interpretation of catch rates difficult. Nonetheless, catch-rate data indicates a decline in stock to moderate levels.

Effort has been greatly reduced in the more remote islands of Bass Strait including the Hogan, Curtis and Kent Groups, where catch rates have improved, indicating that stocks there have continued to rebuild. Stocks were assessed as moderate.

Small amounts of catch were taken from other parts of the zone, including the Central North Coast and other parts of the Furneaux Group including the Sisters in Block 37. Stocks were assessed to be at relatively low levels in these areas.

Greenlip

Assessments of the greenlip fishery have proven to be difficult because of variations in reporting of combined blacklip and greenlip effort on single trips, divers fishing to different sized stocks because of market requirements, the involvement of relatively few divers in the fishery and a paucity of information about the size structure of the catch. The problems caused by these issues have either been addressed or their influence has reduced in recent years and consequently our assessment of greenlip stocks is more certain.

At King Island the annual catch was low, almost half the catch of previous years. There appears to have been a reduction in the area of reef supporting greenlip fishing, with only small catches at low catch rates from the north-west of the island in Block 1. The east coast continued to provide the main part of the catch, although here too catch rates were reduced. Stock levels on the island were assessed as low.

In the North West (not including Black Reef) catch rates have improved or remained stable at moderate levels. The regional catch has been reduced to below 25 t since 2004, and stocks appear to have rebuilt. Stock levels were assessed as moderate.

At Black Reef catch rates were high, but have fallen from even higher levels. The regional cap was overrun by 30% and while stock levels appeared high, overruns such as this have the potential to greatly reduce future productivity due to the harvest coming from such a small area of reef. Further east at Circular Head and the remainder of the North Coast only 200 kg were landed from the 10 t cap, and the region has not been assessed.

The North East catch cap was substantially overrun (40%) and closed to fishing in August. Abalone from the region were relatively large and appeared to be fast growing. Observations by divers also suggest that increasing the LML would improve yields with little impact on short-term catch rates. Catch rates were stable and stock levels were assessed as moderate.

At the Furneaux Group, divers who travelled to the area mostly fished in the southern part of the region. Catch rates were at moderate levels. The catch from Block 33 (mostly Clarke Island) was unusually large and has the capacity to reduce stock levels to levels of concern if repeated. Further north in Block 35 (Franklin Sound) the annual catch increased and catch rates were generally lower, having fallen in recent years. Stock levels at the Furneaux Group were assessed as moderate.

Recreational and other fisheries
The most recent survey of recreational divers (2010/2011 fishing season) estimated the recreational catch at 39 t, or 1.7% of the total catch of abalone from Tasmanian waters. More than half of the recreational catch was taken in the east and south-east.

Other sources of fishing mortality include abalone taken as part of cultural fishing activities by indigenous people; abalone taken under permits for special events and research purposes, and through illegal fishing. The quantity of abalone taken under permits was less than two tonnes. There were no estimates for the catch from cultural fishing activities, but it is believed to be negligible. The size of the illegal catch is also unknown but is believed to be small in terms of influence on stock trends.

Recommendations

1. Stock sizes were assessed to have been sufficiently reduced to warrant substantial reductions of catch in the following areas: Block 5 (Northern Zone), and Blocks 10, 11 and 12A (Western Zone).
2. Some areas have had declines in catch rates although from higher stock levels where consideration should also be given to reducing catch. These areas are Blocks 6, 7 and 8 (Central Western Zone/Western Zone), Block 9 (Western Zone), Block 31 (Eastern and Northern Zones), and Block 49 (Northern Zone).
3. Parts of the greenlip fishery are of concern. King Island appears to be less productive than it was historically and may no longer be capable of supplying former levels of catch. The 10 t greenlip catch allocated to Circular Head and the Central North Coast has never been caught there and has the potential to be shifted to other areas which risks harming those areas. There may be

opportunity to increase yield and quality in the north-east through an increased LML.

4. The Eastern Zone TAC reduction was a pre-emptive strategy to reduce the risk of fishery impacts on the stock, and the catch is now at record lows. As yet, the low catch has not led to a widespread recovery of catch rates. Fishers appear to have modified the way that they fish in response to lower catch rates, possibly biasing catch rate data used for assessment. This means it is difficult to determine stock trends and it is recommended that there is no increase in TAC until changes in stock levels are clearly apparent.
5. No change is recommended in TAC or size limits for the remaining blocks.

National framework for reporting stock status

The national Status of Key Australian Fish Stocks Reports 2012 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 is a low-level objective for a fishery because it does not address other issues such as 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 (p. 65). 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: Greenlip

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

Species: Blacklip

Zone- Region (Blocks, sub-blocks)	Stock Status
EZ - Actaeons (13C, 13E, 13B)	Sustainable*
EZ - Lower Channel (14A, 14B)	Sustainable*
EZ - Bruny Island (14C, 14D, 14E, 15, 16)	Undefined
EZ - Storm Bay (17, 18, 19, 20, 21)	Sustainable*
EZ - Lower East Coast (22, 23, 24, 25)	Transitional - depleting
EZ - Bicheno-Freycinet (26, 27, 28, 29A)	Sustainable*
EZ - Upper North East (29B, 29C, 29D, 30A)	Sustainable
EZ - Sub-block 31A	Sustainable*
NZ – North East (31B, 39, 40)	Sustainable*
NZ – North West (47, 48, 49)	Sustainable*
NZ – North West (5)	Sustainable*
NZ – King Island (1, 2, 3, 4)	Sustainable
CW – Couta Rocks (5D, 6A, 6B, 6C, 6D)	Sustainable*
CW- Granville (7, 8)	Sustainable*
WZ – Block 9	Sustainable*
WZ – South West (10, 11, 12A)	Sustainable*
WZ – South Coast (12B, 12C, 12D, 13A, 13B)	Sustainable
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

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 which 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 years since 2000.

The zones, regions and statistical blocks from which the 2012 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 Appendix 1: Catch, catch-rates and size-composition (page 29) and Appendix 3: Interpreting graphical information (page 68).

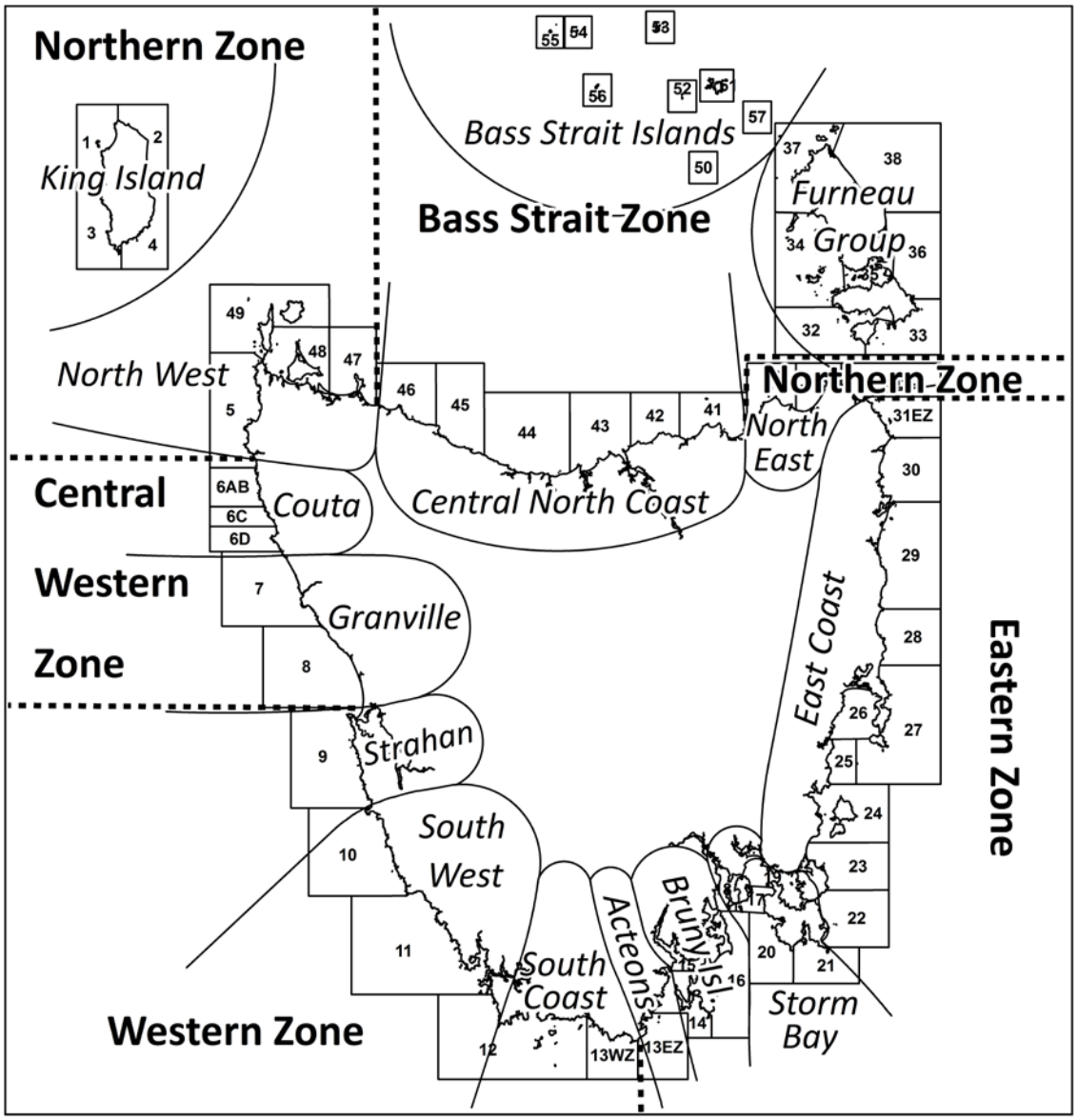


Figure 1. Zones and statistical blocks used in the Tasmanian abalone fishery in 2012. Also shown are the regions used for assessment purposes in this document. Zone boundaries are shown as dotted lines. The greenlip fishery has no geographical boundaries, but mostly takes place on coasts included in the Northern and Bass Strait Zones. More detailed maps of catch reporting areas are shown in Appendix 11: Maps of catch-reporting blocks and sub-blocks.

The zone boundaries and their reporting blocks for the 2012 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, Cowrie Point to Arthur River including King Island, Sub-block 31B, Blocks 39 to 40, Blocks 47 to 49, Sub-blocks 5A, 5B, 5C.
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 n.b. changed in 2013:
Arthur River to Ocean Beach, Sub-blocks 5D, 6A, 6B, 6C
Western Zone n.b. changed in 2013:
Ocean Beach to Whale Head, Blocks 9 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
North West: Blocks 47 to 49, Sub-blocks 5A, 5B, 5C
Couta: Sub-block 5D, Block 6
Granville: Blocks 7 to 8
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 2012 (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 2012 annual totals of reported landings comprised 2,222.7 t of blacklip and 139.8 t of greenlip, a total of 2,362.7 t from a TAC of 2,366 t (Table 1). Like the previous year, total landings fell in 2012, attributable to a large reduction (171.5 t) in the Eastern Zone TAC.

Table 1. 2012 landings by zone, in tonnes

Zone	2012 TAC	2012 Landings (tonnes)
Greenlip	140.0	139.8
Eastern Blacklip	549.5	547.5
Northern Blacklip	378.0	376.4
Western Blacklip	924.0	924.6
Bass Strait Blacklip	70.0	69.9
Central Western Blacklip	304.5	304.5
	2366.0	2362.7

The 2012 catch had a gross landed value of $82.4 million, down by only $2.4 million from the previous year, despite the large Eastern Zone catch reduction. Prices for live market product (mostly sourced from the Eastern, Western and Central West Zones, and the greenlip fishery) were stronger in 2012 while prices for canned product (mostly from the Northern and Bass Strait Zones) remained stable.

Like previous years, prices for live product fell after the Chinese New Year, but then trended higher from April to the year's end. Demand appears to have remained strong in December despite the unusually large November catch (Figure 2).

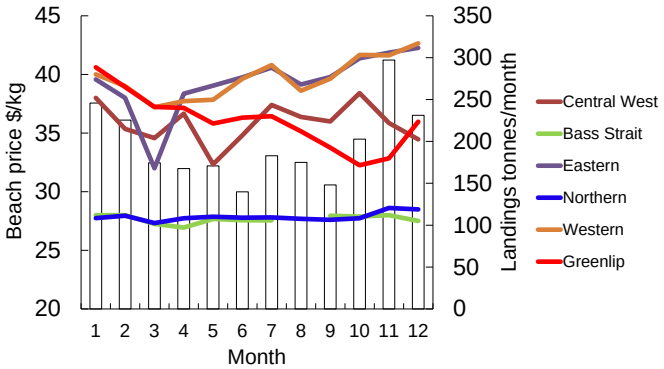


Figure 2. Monthly trends in average beach price for abalone in 2012, by zone. Bass Strait and Northern Zone abalone were predominantly used for canning; Eastern, Western and Central West Zone abalone were mostly sold to the live market. Greenlip beach- price data were incomplete.

Domestic market prices for live greenlip fell after AVG was detected in a consignment of abalone in NSW in November 2011, following which that state (the largest domestic

market) imposed import restrictions. Most greenlip were then sold in processed form, and received a lower price.

Royalties collected by the Tasmanian Government in 2012 fell by $0.63 million to $5.72 million as a result of the smaller catch.

3. Assessment of the Tasmanian abalone fishery

3.1 Eastern Zone

As part of a management response to falling stock levels, the Eastern Zone TAC was reduced to 721 t (from 896 t) in 2011. In 2012, it was further reduced to 549.4 t. Catches in most parts of the Eastern Zone regions have fallen accordingly.

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

Fishery-dependent data
Landings from this region fell by a quarter in 2012, from 371 t to 276 t. The lower production was primarily due to a reduction in the TAC. Unlike previous years, catch from the region was uncapped, and it remained open to fishing for the entire Eastern Zone season. In past years, the offshore reefs and islands of 13E have comprised the most productive area. While much of the catch (181 t) was taken there again in 2012, it was substantially reduced because both the TAC was lower, and divers chose to work more in adjacent 13D (inshore reefs and Recherche Bay). Previously, high levels of paralytic shellfish toxin were detected in abalone from the inshore parts of this region including 13D, rendering them unacceptable for live export, and effectively closing the area to fishing. When the Eastern Zone opened in April, 13D had not been fished since the previous May, and divers took advantage of a build-up in stock levels; consequently an unusually large amount (73 t) was taken. Smaller amounts were taken closer to Southport (14A – 5 t) and the lower part of the D'entrecasteaux Channel (14B – 2 t), which were also affected by PST restrictions on live export of abalone in both 2011 and 2012.

The regional mean annual catch rate continued to fall, from a period of high catch rates (83-85 kg/hr) during 2007-2009 to 53 kg/hr in 2012. There was little variation between sub-blocks (13C – 49 kg/hr to 14B – 57 kg/hr). Monthly mean catch rates drifted down from 63 kg/hr at the start of the season in April to 51 kg/hr in October before falling sharply in November, when the remaining catch (30 t) was taken at 40-43 kg/hr.

In sub-blocks 13C, 13D and13E approximately 20% of catches were sampled in 2012, and length measurements obtained. Abalone were clearly larger in 13C relative to the previous season, with reduced numbers of smaller fish (recruits). An increase in size was apparent in 13E, although less pronounced than in 13C, but again indicated reduced recruitment. Some early season catches from 13D comprised abalone noticeably larger than median size, and it was assumed that these reflected low fishing mortality due to PST affected fishing in 2011. This region has relatively fast growth rate, which means that the small median size of abalone caught in the region is indicative of a fishery based on recruits.

Diver observations
Poor fishing due to low stock levels in many other parts of the Eastern Zone, plus the need to reduce costs and fish as cheaply as possible caused many divers to concentrate their fishing activities at the Actaeons. Fishing pressure was intense and much of the time they believed that they were swimming over reef which had just been fished by another diver. They said that the high rate of fishing meant that the abalone were typically small relative to the legal minimum size but most supported its retention saying that there were large numbers of under-sized fish and that these fish grew to legal size quickly. There was some support for a larger legal size. Catch rates were especially slow on reefs holding smaller and slower growing abalone, such as the Middle Ground and parts of Black Reef. Dense weed growth made fishing in shallow water difficult from October onward.

Qualitative assessment
This part of the fishery is unusually dependent on recruits, which typically comprise more than half the catch. During the four years 2008-2011 the annual catch was historically high, and averaged 363 t. At the end of this period, stocks were assessed moderate but falling, and it was concluded that recruitment was inadequate for the size of the catch. Subsequently, the 2012 catch fell by almost one quarter, but catch rates continued to fall.

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 and falling.

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

Fishery-dependent data
The annual catch from Bruny Island was 29 t, which is the lowest annual catch since at least 1975. As recently as 2001, the annual catch was 223 t, and was above 100 t p.a. until 2009. The low catch is attributable partially to lower caps and TACs, and partially to divers' preferring to fish elsewhere prompted by low catch rates.

The catch from South Bruny (14C, 14D and 14E) was 14 t, half of which was caught in August following the lifting of PST restrictions. Small amounts of catch (2-5 t) were taken from each of the sub-blocks on the eastern side of Bruny (16A, 16B, 16C and 16D). Fishing in Block 15 was affected by PST restrictions, and no catch was reported from there.

Annual catch rates were low at 42 kg/hr, varying between 38 kg/hr (16B) and 46 kg/hr (16C). Catch rates were highly variable, with several large (> 350 kg) catches taken at over 100 kg/hr but many small (<100 kg) catches taken at 20-30 kg/hr.

The size of abalone from South Bruny increased substantially. In 14D, eight samples (from a total of 36 catches) with a median length of 161 mm were measured, more than 13 mm larger than the average of the previous 12 years. There was a similar increase in 14E. In both sub-blocks, the 25^{th} percentile length was larger than 150 mm, reflecting an unusually low proportion of recruits in the catch. In contrast, the size distribution of

abalone from eastern Bruny was typical of previous years, with median lengths of approximately 150 mm, and no indications of abnormal levels of recruits.

Diver observations

Divers reported that Bruny Island stock levels were very low, and many were concerned about the future of this part of the fishery. Occasionally, they found good patches of abalone, but these were limited in size. More often they were reduced to fishing sparsely distributed populations at low catch rates. Fishing was affected by seasonal increase in weed growth from September. Much of the fishing, particularly towards the end of the year, was for small orders of abalone, so that divers were not particularly concerned about low catch rates provided that their fishing costs remained low.

Qualitative assessment

It is useful to examine the low annual catch and catch rates in the region within the context of past catches. Accurate estimates of Bruny's catch prior to 2000 are unavailable because its southern reporting region (Block 14) included the western shore of the lower D'entrecasteaux Channel, so the combined Blocks 14, 15 and 16 catches are shown, together with catch rates from Blocks 14 and 16 (Figure 3). Comparisons of catch rates over periods of many years are problematic, because fishing methods and efficiencies changed and invalidate the comparison. The two changes which have had most effect are the practise of fishing from a moving boat vs. anchored, thus covering a larger area (became more common mid-1970's), and improvements in handling techniques (e.g. use of droplines) that enabled divers to transfer quantities of abalone from the reef to the boat more quickly (late-1980's). Handling improvements have greatest effect at high catch rates when abalone are abundant, and least effect at low stock levels.

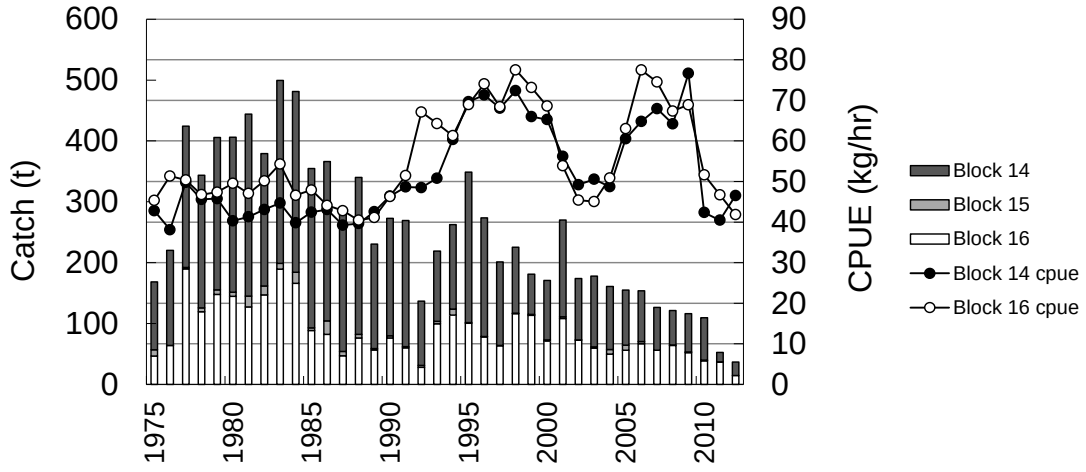


Figure 3. Annual totals of catch from Blocks 14-16 which includes Bruny Island, 1975-2012.

Catches trended downwards after a period of large (>400 t) catches during 1977-1984, mostly due to limits on output (TACs) by fishery managers (Figure 3). There have been four major downturns in stock levels in south-east Tasmania: 1973-1975 (Frusher et al., 2009), 1987-1992, 2001-2004, and the most recent, starting in 2011. These downturns are evident as periods when catch rates fell towards 40 kg/hr. There have been two peaks in catch rates, when catch rates rose almost to 80 kg/hr. Following the catch

reductions of the 1980's intended to curb over-fishing, catch rates rose with minor fluctuations, until a peak in 1998.

Between 1995 and 2000, catch rates fluctuated in a tight range at approximately 70 kg/hr, but a decline appeared from 1998 despite falling levels of catch, indicating that the decline was a response to falling recruitment, not overfishing. Apart from 2001, when there were unusually large catches from 14E, catches have continued to decline, apparently independently of catch rates.

Assessing this part of the fishery at such low levels of catch carries substantial risk that effort may be affected more by fleet dynamics and diver behaviour than stock abundance, and consequently the risk that catch rate trends fail to reflect trends in abundance is higher than usual. Catch reductions notwithstanding, the low catch and sustained low catch rates over recent years indicate that stock levels are very low. There was evidence of lower than usual recruitment at South Bruny.

The size limit protects a smaller portion of the stock in these blocks than further south. The stock status could not be defined because although the exploitable biomass appears to be very low there has been a substantial reduction in fishing mortality and CPUE appears stable. The low catch means there is little data available to determine the status.

3.1.3 Storm Bay (Blocks 17-21)

Fishery-dependent data
The regional catch was 53 t, which is approximately one third of the size of annual catches since zoning was introduced in 2000, and the lowest from the region since accurate records have been kept (1975). The catch was at this low level primarily because the TAC was reduced. Just 13 t was taken from between the Iron Pot and Nubeena (Blocks 17, 19, 20A), and a further 17 t from the coast between Nubeena and Cape Raoul (20B, 20C). Only 23 t was taken in Block 21 between Cape Raoul and Cape Pillar (Maingon Bay).

Catch rates were low, at levels comparable with those of the stock downturn of 2001-2004. The regional catch rate was 51 kg/hr. Catch rates were lowest (39 kg/hr) in 20A, which includes the shore north and west of Nubeena. Further north along the Blackjack shore (17B) catch rates improved (53 kg/hr) and were highest at Betsey Island (64 kg/hr) although only 1.3 t was taken there in 2012. Between Nubeena and Cape Raoul, catch rates were 52 kg/hr (20B) and 43 kg/hr (20C). In Maingon Bay, catch rates were higher at 56 kg/hr (21A) and 62 kg/hr (21C). Approximately one third of the catch was taken in the last quarter of the year, by which time monthly catch rates had fallen below 50 kg/hr.

The size distributions of abalone from Storm Bay, including the eastern side of Bruny Island (16C, 16D, 17B, 20A, 20B, 20C, 21A and 21B) exhibit a similar form. Between 2000 and 2004, the size became reduced. After 2004 the size rose steadily until a peak, in most sub-blocks, in 2010. Since 2010, the size has remained relatively stable, with no changes common to all sub-blocks, either larger or smaller.

Diver observations
Divers reported low stock levels and slow fishing. There was a preference to fish from Port Arthur where stock levels were considered to be higher. Some divers obtained high

catch rates from deep water. Apart from low stock levels, divers said that thick weed growth in shallow water reduced catch rates after September.

Quantitative assessment
Both catch and catch rates were unusually low. Abalone stock levels continued to be reduced, particularly in Block 20, but also in the formerly productive Block 21.In conjunction with falling catch rates, the high and increasing size of abalone was consistent with reduced levels of recruitment.

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 and falling.

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

Fishery-dependent data
The annual catch for the region was 186 t, which is the lowest recorded total since accurate records have been kept. The catch was at this low level primarily because the TAC was reduced. Approximately one third (60 t) of the catch was taken from Block 22, which includes the coast south of Eaglehawk Neck. Almost 50 t was taken in sub-block 31A, between Eddystone Point and the Eastern Zone northern boundary at Musselroe Bay. Smaller amounts of between 13-25 t were taken from Maria Island (Block 24), the coast from Long Point to St Helens (Block 29), the Freycinet Peninsula and Schouten Island (Block 27) and the eastern shore of the Forestier Peninsula (Block 23).

Catch rates were generally low, between 40 and 50 kg/hr across much of the coast. There was also a broad pattern across the coast of further decline in catch rates, most consistently in the south. The regional mean catch rate was 50 kg/hr. Catch rates were slightly higher in the south, in sub-block 22A (52 kg/hr), and in the north in Block 29 (53 kg/hr), sub-block 30A (56 kg/hr) and in sub-block 31A (71 kg/hr). Catch rates were generally higher mid-year at between 50-60 kg/hr in most areas, but fell closer to 40 kg/hr after October.

In Blocks 23 and 24, the size of abalone appears to have been falling since 2010. There were no clear trends in the size distribution of abalone measured in catches from Blocks 22, 27, 29 and 31. In most blocks north of Block 23, the level of sampling for size structure has varied from year to year, and has frequently been inadequate to provide useful information. In sub-block 31A, short-term reductions in LML north of Cod Bay were responsible for the variation in size.

Diver observations
Divers continued to be concerned about stock levels in this region, particularly at the Freycinet Peninsula and Schouten Island where they said that stock levels were low and under pressure from encroaching urchin barrens created by *Centrostephanus.* They reported that *Centrostephanus* were common and widespread throughout most of the East Coast except north of Eddystone Point. They were concerned about future levels of recruitment given the apparently high levels of fishing mortality on the reduced stock. In Block 31, the high grade abalone at Eddystone Point and George Rocks have been considerably reduced from former levels, but the non-preferred lower grade abalone were plentiful.

Qualitative assessment
Throughout much of the region between Tasman Island (Block 22) and Long Point (Block 28) catch rates have continued to fall and stock levels were assessed low. Catch was low in many of these blocks relative to previous years yet this has not resulted in rebuilding because recruitment is low. This part of the fishery was classified as transitional-depleting based on the low and falling stock which receives limited protection from the size limit.

Northwards of Seymour Point in Blocks 29 and 30, the size limit is effective at protecting reproduction although this is a particularly variable region and this observation does not hold for all reefs. Catch rates were generally higher in this region than further south on the east coast, and although the amount of catch taken was relatively small, stock levels were believed to be higher. This area was assessed as sustainable based on moderate stock levels and moderate catch, indicative of moderate fishing mortality.

Stocks in sub-block 31A were assessed as sustainable because of the degree of protection provided by the size limit although the legal sized stock was assessed to be at lower levels relative to previous years and falling.

3.2 Central West Zone

3.2.1 Couta Rocks Region (Sub-block 5D and Block 6)

Fishery-dependent data
The annual catch reported from this region was 187 t, approximately 20% more than catches in the previous three years. The distribution of catch between sub-blocks changed compared with the earlier years: much more (72 t) was taken from sub-blocks 6A (72 t) and 6D (58 t) at the northern and southern ends of the block, whereas comparatively little was taken from 6C (36 t) and 6B (19 t). No catch was reported from 5D, the coastline of which is mostly beach with negligible reef area.

Sub-block 6D was included in the Block 7 and 8 management area because its abalone are preferred by the live market to those from further north, so its catch was capped with the southern blocks and it closed on 15 October. Its inclusion in the capped area meant that most of the fishing in 6D was done before winter. In contrast, most catch from the remainder of Block 6 was taken much later in the year: in sub-blocks 6A-6C, only 33t was taken until October, thereafter 95 t was taken. This pattern of seasonal fishing has occurred since the opening of the Central Western Zone in 2009.

Catch rates have fallen in all areas since 2009 by between 20-60 kg/hr, from approx. 122 kg/hr to 102 kg/hr in 6D, from 134 kg/hr to 100 kg/hr in 6A, from 118 kg/hr to 81 kg/hr in 6B, and from 155 kg/hr to 91 kg/hr in 6C.

The median size of abalone from 6D has trended smaller in recent years from approximately 155 mm between 2000-2003 to 147 mm, or 7 mm larger than the 140-mm LML. Elsewhere, where the LML is 132 mm, the median size has been stable at approximately 140 mm.

Diver observations
Like previous years, the catch from 6C was taken predominately by motherships, much of it in December. The arrival of several motherships in a small area such as 6C causes intense localised fishing pressure, and catch rates fall rapidly compared with taking the same amount of catch over a more extended period. This sub-block was targeted by motherships because the fish were of higher quality than those from further north, and it was closer to the anchorage at Sandy Cape. Divers said that stock levels have been reduced compared with previous years.

Divers were concerned about the size of the annual catch from Block 6 and said that stock levels were being steadily eroded. There was particular concern for Sandy Cape (6D). In the 1980's, Block 6 produced annual catches of more than 200 t, but divers said that much of the catch was taken from places that no longer supported fishing.

Qualitative assessment.
Following four years of high levels of catch, catch rates have declined and recently fell sharply. This is clear evidence that stocks were being depleted, and that too much catch has been taken from the region.

This area was assessed as sustainable based on the protection provided by the size limit over most of the area and the high catch rate. However there is concern for this area in terms of fishery performance with moderate and falling stock levels.

3.2.2 Granville Harbour Region (Blocks 7 to 8)

Fishery-dependent data
The combined catch from the region was 116 t. The catch from Block 7 was 97 t, which is high in the context of the long-term average annual catch (65 t). Since 2003, seven annual catches of approximately 100 t have been taken, significantly more in recent years than at any other time in its past. In contrast the adjacent Block 8 catch was only 19 t, or approximately half its long-term average. Most (85%) of the catch was taken from north of Granville Harbour, with 26 t from Rupert Point (7A) and 46 t from Conical Rocks (7B).

Catch rates have fallen in all sub-blocks. Catch rates were highest in the sub-blocks at either end of the region; in 7A (153 kg/hr), and 8B (148 kg/hr). In the more accessible sub-blocks (7B, 7C, 8A) they were much lower, at approximately 100 kg/hr.

Insufficient commercial catch samples were obtained to provide information about the length of abalone from the catch in all sub-blocks except 7B. In this sub-block where 6% of catches were sampled there was no evidence to show changes in the size of abalone.

Diver observations
As per previous years, divers reported high density of abalone from north of the Pieman in 7A. They said that obtaining large catches was much more difficult closer to Granville Harbour. The reduced catch from Block 8 was attributed to preferences by mothership operators to work closer to the anchorage at Sandy Cape, and consequently the catch from 6D was much higher than usual.

Qualitative assessment
In 2008, this region was identified as under-fished, and catch was transferred here from the depleted Western Zone. Since then, in most parts catch rates have fallen steadily, and are now at their lowest level in more than 15 years, having been reduced by high levels of fishing mortality. The region has now been transferred back to the Western Zone and consequently it is anticipated that there will be a substantial reduction in catch.

This area was assessed as being at low risk of recruitment overfishing and thus sustainable based on the protection provided by the size limit over most of the area and the high catch rate. However there is concern for this area in terms of fishery performance with moderate and falling stock levels.

3.3 Western Zone

3.3.1 Strahan Region (Block 9)

Fishery-dependent data
The amount of catch was similar to the previous year (172 t) and thus higher than almost all other years in the recent 10-year period. The cap for the region was 186 t, but like earlier years, was not reached. The catch was split between sub-blocks 9A (2 t), 9B (70 t) and 9C (100 t). Levels of catch were low for most of the year, generally below 20 t each month except in November and December when 52 t and 28 t were taken.

Catch rates have fallen steeply in 9B, from approximately 150 kg/hr between 2009-2011 to 123 kg/hr in 2012. In 9C, catch rates fell to 150 kg/hr from 160-180 kg/hr. In the first few months of the year, catch rates were generally lower but picked up to 160 kg/hr in November when the largest amount of catch was taken. Regional catch rates appear very responsive to the size of catch, which in recent years has been pivotal at approximately 150 t p.a. which is less than the current cap (Figure 4).

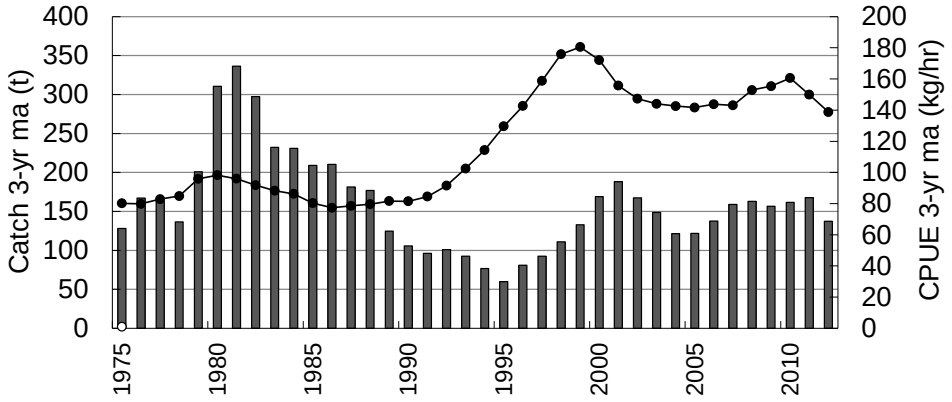


Figure 4. Response of catch rates to changes in annual catch, Strahan region (Block 9), 1975-2012, showing three-year moving averages of catch (vertical columns) and catch rates (line with balls). When annual catches change excessively, catch rates respond. In 1980, catch-rates changed direction when levels of catch exceeded 200 t, but since then catch rates appeared to respond at approximately 150 t pa. i.e. 20 t less than recent levels of catch. Differences in peak catch rates before and after 1990 were attributed to improvements in fishing efficiency, and not necessarily higher stock levels.

Rates of catch sampling from this region have fallen since 2008, from approximately 20% of catches to 4-9%, and this may reduce the reliability of information about abalone length. In this period, in both sub-blocks 9B and 9C, median lengths have ranged between 151-158 mm, with 25th percentile lengths 146-151 mm, or between 6-11 mm greater than the LML.

Diver observations
In contrast to previous years, divers were concerned about stock levels in Block 9. They said that low catch rates in the first three months of the year were attributable to fishing in adverse sea conditions to fill orders for fish that would formerly have been taken in the Eastern Zone. The runabout divers reported that motherships were becoming increasingly common, while the mothership divers said that they had been forced to move north because fishing was too poor in Blocks 11 and 10 to the south.

Qualitative assessment
Catch rates have been stable at moderately high levels for many years, but fell in 2012. Part of this decline can be attributed to fishing in adverse conditions when the Eastern Zone was closed between January and March, but after this period catch rates seldom reached the levels of earlier years and it was evident that stocks have been reduced. The annual catch which has recently increased now appears excessive and is the primary driver of the catch rate decline.

This area was assessed as being at low risk of recruitment overfishing and thus sustainable based on the high catch rate. However there is concern for this area in terms of fishery performance because although stocks are moderately high, catch rates are falling and fishing mortality was high due to high catches.

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

Fishery-dependent data
The catch from this region was 470 t, of which 146 t came from Block 10 (Low Rocky Point to Point Hibbs), 273 t from Block 11 (Faults Bay just south of Port Davey to Low Rocky Pt.), and 51 t from sub-block 12A (South West Cape to Faults Bay). These catches are approximately two-thirds of 2000-2008 catches, but in line with long-term average catches.

Catch rates have continued to fall across the region and at 112 kg/hr, were at the lowest levels since the implementation of zoning in 2000. Catch rates were approximately 100 kg/hr in three sub-blocks in Block 11 (11C, 11D, 11E), and one sub-block in Block 10 (10B). The highest catch rates were in the north, in 10C (131 kg/hr).

Catch rates were lower in the first three months at 100-110 kg/hr with 195 t landed, 102 t of which was landed in January following strong demand for live-market abalone. Fishing slowed until November when a further 100 t was taken at 130 kg/hr. Catch rates fell again in December.

The percentage of catches sampled from Blocks 10 and 11 was low: between 5-14% in Block 10 and 4-11% in Block 11. Catches were frequently mixed between the two blocks (and occasionally between Block 9 and the South Coast) and consequently the

reliability of length information from this region is reduced. Nevertheless, there has been a consistent multi-year trend towards smaller abalone. During the last five years (since 2007), catches attributed to Block 10 had median lengths 153-159 mm, while 25th percentile lengths ranged between 147-151 mm i.e. 7-11 mm larger than the LML. Abalone from Block 11 over the same period were slightly smaller, with median lengths 153-156 mm, and 25th percentiles between 146-149 mm.

Diver observations
The confidence expressed by divers about stock levels in the region in earlier years has gone. Most divers were disappointed about fishing conditions and said that they had to work longer and travel further. By the end of the year, most agreed that stock levels had declined.

Falling catch rates in the South West were discussed at the July 2012 FRAG meeting. Divers said that there were several reasons why catch rates had declined from the previous year apart from reduced stocks. These included:

- Low catch rates when more than 50% of the catch was taken in the first three months of the year and December. Strong demand for abalone early in the year when the Eastern Zone was closed caused divers to fish in the Western Zone in sea conditions that made catching abalone more difficult. In December divers again worked in unfavourable conditions to catch fish before the quota expired.
- Weak demand for abalone after the opening of the Eastern Zone meant that divers travelled west on motherships with only small amounts of quota, reducing the incentive to work hard. There was strong disagreement between divers about the extent to which this affected catch rates.
- Behavioural changes aimed at reducing costs, including increased rates of doubled-up diving have reduced catching efficiency (the high level of unspecified dive tenders in returns prevented confirmation of this effect).

Qualitative assessment
The regional catch was reduced to 450 t in 2009 to halt falling catch rates caused by a widespread stock decline. There was a temporary improvement in 2010, but since then catch rates have continued downwards towards 100 kg/hr. The catch rate decline may be attributed partly to the closure of the Eastern Zone and to behavioural changes by divers but predominately the cause is excessive catch. It is clear that stocks were not rebuilding, and that a further catch reduction is required.

This area was assessed as being at low risk of recruitment overfishing and thus sustainable based on the high catch rate. However there is concern for this area in terms of fishery performance because stocks were assessed to be at low levels and appear likely to decline further without reduction in catch.

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

Fishery-dependent data
The South Coast catch of 259 t was reached at the end of the year and the 260 t cap was not triggered. The coast between Prion Bay and Cox's Bluff (12D) again produced the greatest amount of catch (87 t), with smaller amounts (57 t) from South West Cape to Cox's Bluff (12B), 20 t from Prion Bay to South Cape (13A) and 24 t from South Cape

to Whale Head (13B). More catch (71 t) was taken from the Maatsuyker Group (12C) than in previous years.

Regional catch rates were 92 kg/hr, compared with previous years during which catch rates have fluctuated over a narrow range of approximately 90-100 kg/h since 2002. The highest catch rates were again from the offshore islands in 12C (122 kg/hr), whilst along the coast westward from South East Cape they ranged from 79 kg/hr (13B) to 85 kg/hr (12B).

Almost one quarter of the catch (57 t) was taken in January, with smaller amounts taken in July (34 t) and November (33 t). Catch rates were generally flat throughout the year, ranging between 91-102 kg/hr in the higher yielding months. Peak catch rates (116 kg/hr) occurred in June when 18 t was caught.

The median length of abalone from most sub-blocks has been reduced during the past 10 years, to 150-153 mm, which is smaller than abalone from other parts of the Western Zone. This reduction in size is believed to be a direct result of high fishing mortality, and it appears that the fishery is more reliant on recruits than other parts of the Western Zone. Abalone from the Maatsuyker Group (12C) were larger, but they too have been reduced in size in recent years.

Diver observations
January's large catch was taken in response to strong demand for live product to fill orders for the Chinese New Year. The closure of the Eastern Zone in the first three months of the year has caused most live product to be sourced from the West. Catch rates were less affected by adverse weather conditions than in the South West and Block 9.

While most divers would have preferred higher catch rates and would like to see the region managed so that this was achieved, they were more concerned about reduced catch rates in the South West than the South Coast. They said that South West abalone were substantially larger, and that the rapidly closing gap between South Coast and South West catch rates meant that there were fewer abalone in the South West.

Qualitative assessment
South Coast catch rates, which are relatively low compared with other parts of the Western Zone, have fluctuated within a narrow range since 2002. More recently, its abalone have been smaller than other parts of the Zone indicating a greater dependency on recruits. The lower catch rates and smaller abalone are consistent with high levels of fishing mortality, indicating higher levels of risk should recruitment fall, and this part of the fishery should be managed accordingly.

This area was assessed as being at low risk of recruitment overfishing and thus sustainable based on the high catch rate. The consistency of catch rates and the size structure are evidence that stock levels here were stable at moderate levels, and that the size of the catch was appropriate for the region.

3.4 Northern Zone

3.4.1 King Island (Blocks 1 to 4)

Fishery-dependent data
The annual catch fell by approximately 20%; from 105 t to 86 t. Almost the entire catch was reported from the southern part of the island, between the airport in the west and Grassy Harbour in the east. More than half of the catch (49 t) was taken in sub-block 3A, on the coast either side of Currie, while another 18 t was taken further south in 3C, on the coast between Cataraqui Point and Stokes Point. Smaller amounts of catch were taken from 4C (6 t) and 3B (7 t). The amount of coastline from where catch has been reported has become reduced: in earlier years when motherships fished the island more regularly, greater amounts of catch were once taken from the west coast between the airport and Whistler Point (1C), and the east coast north of Grassy.

Catch rates averaged 106 kg/hr for the region, with the most productive parts of the west coast fishing at 116 kg/hr (3A) and 126 kg/hr (3C). Fishing was considerably slower on the east coast, between 80-90 kg/hr, although this also included small amounts of greenlip effort which tended to suppress blacklip catch rates. Resident divers generally fished at higher catch rates than divers visiting on motherships, because they had local knowledge and more opportunity to fish the western side of the island than the visitors.

The monthly distribution of catch was heavily skewed towards the later part of the year, when other parts of the Northern Zone were closed. Catch rates also fell in this period, to approximately 100 kg/hr attributable to visiting divers who were prevented from working in the most productive areas by unsuitable weather conditions.

Catch sampling for abalone length has been infrequent, and insufficient data have been collected for a representative time series. Eight samples were collected from catches taken in 3A in 2012: they show a median length of 135 mm, with 25th and 75th percentiles at 130 and 140 mm respectively.

Diver observations
Divers were generally confident that blacklip abalone stocks at King Island were at healthy levels. The 20-t decline in annual catch compared with the previous year was attributable to the popularity and lower cost of fishing at Hunter Island, not to any perception of low stock levels at King Island. Mothership divers were frequently restricted by weather to fishing on the less productive east coast. Motherships mostly visited later in the year.

Qualitative assessment
The King Island blacklip catch fell by approximately 20% due to good fishing conditions in other, more accessible parts of the Zone. Catch rates were at the same levels or better than previous years and the size structure of abalone was large relative to the LML.

This area was assessed as being at low risk of recruitment overfishing and thus sustainable based on the high catch rate and the high degree of protection of reproduction afforded by the LML over most of the area. Stock levels were assessed to be moderate to high.

3.4.2 North West (Blocks 47 to 49, Sub-blocks 5A, 5B, 5C)

Fishery-dependent data
The catch from this region was 259 t, almost the same as the previous year's catch (266 t), and one of highest since the 1980's. In Block 5, 99 t was caught, distributed between 5A in the north (52 t), 5B (10 t) and 5C in the south (37 t). In Block 49 a total of 151 t was taken. Of this, 56 t was caught at Three Hummock Island (49A), 28 t from the northern half of Hunter Island and Albatross Island (49B) and the remainder from the south of Hunter Island and offshore islands north of Woolnorth (49C). East of the Woolnorth-Hunter Island line 7 t was taken from 48C, and 2 t taken from the Petrels (48B).

In Block 5, catch rates have declined continuously from a high of 103 kg/hr in 2008 when the LML was reduced by 5 mm to 127 mm, to 73 kg/hr in 2012. The highest catch rates (78 kg/hr) were achieved in the south in 5C, while further north in 5B they wear 66 kg/hr. West of Woolnorth in 5A they were 73 kg/hr. In January and February, 33t was taken at approximately 80 kg/hr, and a further 23 t was caught in October at 82 kg/hr, but by then depletion was evident, with remaining catches taken at 65 kg/hr

In Block 49 where the LML had been reduced by 5 mm to 120 mm at the start of the year thus increasing the stock, catch rates were much higher: 95 kg/hr at Three Hummock Island, 98 kg/hr at Albatross and north Hunter Islands and 80 kg/hr closer to Woolnorth, including the south of Hunter Island. By the end of February 54 t had been caught at approximately 100 kg/hr. From then until 15 October when Block 49 was closed to fishing, catch rates ranged between 75-95 kg/hr

In the remaining parts of the region (48A, 48B, 48C, and 47A) catch rates were below 70 kg/hr.

In sub-block 5B there was a relatively severe reduction in the length of abalone, by 3 mm in all three categories. Precisely 25% of abalone measured 127 mm or less (the LML is 127 mm). The median and 75th percentile lengths were reduced to 130 mm and 135 mm respectively. In both 5A and 5C, median lengths were larger at 134 and 135 mm respectively, with 25th percentiles at 130 mm in both sub-blocks. Since the size limit reduction in 2008, abalone appeared to be slightly smaller in 5A, very much smaller in 5B, and slightly larger in 5C. During this period, sampling levels have been between 7%-31%, with 2012 sampling levels at 11% (5B) to 18% (5C) of catches.

As a consequence of the 2012 size-limit change in Block 49, comparisons with previous years' length data are invalid. In 2012, 25th percentile lengths were 3-4 mm larger than the LML, medians ranged between 127-129 mm and the 75th percentile lengths were between 133-135 mm in all three sub-blocks.

Diver observations
Divers were concerned that the size of the annual catch from Block 5 was excessive. They said that areas where they had formerly landed good catches had become depleted to the extent that they no longer produced sufficient abalone to warrant fishing. They said that there remained some high density patches of small low-grade fish, but that these were very limited in extent, and that their poor quality made them unacceptable to processors.

In areas that formerly held good quantities of abalone but were now extensively depleted, such as the Trefoil patch, Mt Cameron or the coast south of Bluff Hill Point, the quality of the abalone had not improved, despite extensive thinning and consequent improved food availability. Divers said that abalone would continue to have thick crusty shells regardless of management initiatives because of the high incidence of mudworm in the region.

Divers were divided about the suitability of the 127-mm LML. There was a belief that the reduced size limit had opened up more coast to fishing, and that increasing the LML would increase effort in the areas supporting larger abalone, leaving much of the coast relatively unfished. There was an opposing view that Block 5 had safely supported a reasonable level of catch (100 t) for many years at 132-mm LML, and that when stocks had recovered, the fishery should revert to the higher size limit.

There was general agreement that the annual catch should be capped at reduced levels until catch rates improved.

Most divers seemed ambivalent about the reduced size limit and increased catch in Block 49. In the short term, they benefitted from the changes, but they could see that without careful management, it would develop into the same situation faced in Block 5. They expected catch rates to drop quickly once the newly exposed stock had been reduced.

Divers requested that size limits east of the Woolnorth-Hunter Island boundary (Block 48) be reduced to the same size as those in Block 49. The boundary intersected reef that held reasonable quantities of both greenlip and blacklip. It was said that it was difficult to fish near the boundary because the headlands at either end were low and frequently obscured by rocks and small islands and consequently hard to see, and divers and deckhands were often unsure about which side of the line that they were fishing. Strong tidal flows in the area compounded the problem, moving boats that were clearly fishing in Block 49 into the uncertain area around the boundary. Block 48 (125 mm LML) holds relatively small quantities of abalone and they grow no larger than those in Block 49, so the divers considered that a 120-mm LML should be appropriate.

Qualitative assessment

In Block 5, catch rates have fallen steadily since 2008, and the annual catch has dropped below 100 t with many divers choosing to fish in Block 49. In part of this block (5B), abalone in the catch were smaller, with 25% of abalone at the LML, indicating extraordinarily heavy fishing pressure. While in some areas small pockets of low-grade abalone were reported, the marketable portion of the stock was assessed to be at low levels.

In Block 49 where the LML was reduced by 5 mm thus increasing the size of the stock, fishing was intensive, and initially high catch rates fell rapidly throughout the year until its closure in October, by which time more than 150 t had been taken. Due to the unusual nature of fishing conditions caused by the change in LML, catch rates were less reliable as indicators of abundance.

This area was assessed as being at low risk of recruitment overfishing and thus sustainable based on the protection of reproduction afforded by the LML over most of the area. Stocks were assessed at moderate levels.

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

Fishery-dependent data
The total catch from the region was 35 t. The catch was capped at 30 t, and the region was closed to fishing on 27 August 2012. 30 t was taken from sub-block 31B, mostly from Swan Island, the remaining 5 t from sub-block 39A.

In 2012, there were 197 individual fishing days reported from the region, 156 of which involved divers fishing for both blacklip and greenlip abalone on one trip. Divers recorded catch for both species but used different methods for allocating effort between species. Some divers reported a precise estimate of the time taken to catch each species, others split their total time by proportion of each species weight, while others reported their total time twice (once for each species). Compounding the problem, use of these methods has been inconsistent over recent years, reducing the effectiveness of catch rates as indicators of abundance.

Annual averages of mixed-catch catch rates were generally lower than catch rates for either blacklip or greenlip, and to remove their effects, single-species catch rates were estimated for the region and for sub-blocks 31B and 39A. Approximately one quarter of trips (8.5 t) landed blacklip only and most catches were from Swan Island in sub-block 31B, where catch rates have fallen since 2007, from 83 kg/hr to 51 kg/hr.

Insufficient catches were sampled from this region to provide information about the size of its abalone.

Diver observations
Divers were concerned that blacklip stocks had become depleted. In 2007, Swan Island fished particularly well, and over 50 t was taken at good catch rates. Since then, this part of the fishery has declined, and they described the fishing as poor in 2012. Fishing in the region was popular for many divers and processors, because they could combine greenlip and blacklip fishing for a lower cost than in other parts of the state.

Qualitative assessment
The region appears unusually sensitive to excessive fishing pressure, and annual catches over 30 t apparently cause lower catch rates for several years afterwards. It is difficult to manage the amount of catch taken from the region, because the small size of the cap (catch limit) and the popularity of the region among divers means that the cap can be overrun quickly.

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 and falling.

3.5 Bass Strait Zone

Fishery-dependent data
The 70 t Bass Strait Zone blacklip TAC was split between the Furneaux Group (38 t), the remote offshore islands including the Kent, Hogan and Curtis Groups (25 t) and the Central North coast from east of Circular Head (Cowrie Point) to Bridport (7 t).

In the Furneaux Group, almost half the catch (17 t) was taken from Babel and surrounding islands in sub-block 38A. This sub-block has been intensively fished, producing over 60 t since its size limit was reduced and the region transferred to the Bass Strait Zone in 2010. Catch rates were initially over 90 kg/hr, but they have fallen to more moderate levels and were 68 kg/hr in 2012.

Further north, the Sisters and the nearby northern coast of Block 37 has occasionally produced 20 t p.a., but only 4 t was harvested in 2012. Catch rate averaged 48 kg/hr.

In the south and east of Cape Barren Island (Blocks 32-33) 15 t was caught. Almost 90% of trips landed both greenlip and blacklip, and effort was inconsistently reported for both species. Consequently changes in catch rates should be viewed with caution when used as an index of abundance. Between 2010 and 2012, using catches where blacklip only were landed, catch rates were stable between 84 kg/hr in 2010 and 81 kg/hr in 2012 (note the small sample size).

Catch sampling from the region was inadequate to produce information about the size of abalone.

In the remote Bass Strait Islands, two-thirds (15 t) of the catch was taken from the Hogan Group (Block 53). Smaller amounts taken from the other island groups: 5 t from Curtis (Block 56), 3 t from the Moncoeurs (Block 54) and the remaining 2 t from the Kent Group (Block 51). The 25 t regional catch 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.

Catch rates varied from 113 kg/hr in the Moncoeurs, 90 kg/hr at Curtis, 79 kg/hr at Hogan and 74 kg/hr in the Kent Group. Regional catch rates (81 kg/hr) were the highest in the zone, and almost as high as those seen when the zone was first opened in 2003.

Catch sampling for abalone length from this region has been insufficient to show trends in size over time. In 2012, six out of the 44 catches reported from the Hogan Group were sampled. The abalone were relatively large considering the 114 mm LML, with 25^{th} percentile, median and 75^{th} percentile at 123 mm, 128 mm and 135 mm respectively.

On the Central North Coast, fishing was again at subdued levels. This part of the coast is relatively unproductive, and just 7 t were landed in 2012, compared with the recent three-year average of 6 t. In contrast, 13 t and 24 t were taken in 2008-2009. Half the 2012 catch was taken at the mouth of the Tamar River (Block 43), with approximately one tonne each from Blocks 44, 45 and 46, and less than one half tonne from Block 41.

Catch rates were low, with the best (48 kg/hr) from the Tamar and Block 44, while the coast further west in Blocks 45 and 46 fished at 31 kg/hr.

The region has a LML of 110 mm. Four of the 44 catches from the Tamar were sampled for length, with 25^{th} percentile, median and 75^{th} percentile lengths of 115 mm, 118 mm and 128 mm respectively. Further west in Block 46 the abalone were much smaller. Two of the eight catches were sampled, with lengths of 112 mm, 115 mm and 118mm for the 25^{th} percentile, median and the 75^{th} percentile.

Diver observations
In contrast to the greenlip fishery, most of the blacklip fishing in the Furneaux Group was done by visiting divers on motherships, although several divers fished from runabouts launched from the north-east mainland. These runabouts mostly restricted their fishing to the south and east of Cape Barren Island or Clarke Island.

Fishing conditions in the south of the Furneaux Group were described as variable, with divers occasionally finding good patches of blacklip, but generally catch rates were lower than previous years. At Babel Island, divers reported that fishing was not as good as previous years.

At the Hogan and Curtis Groups fishing was better, but involved more travelling and required more settled weather conditions than Babel Island, so while the Furneaux Group remained open to fishing divers would fish there in preference to travelling further north.

Qualitative assessment
The eastern part of the Furneaux Group was again the most heavily fished part of the Bass Strait blacklip fishery following its transfer into the zone at a reduced size limit in 2010. At Babel Island, catch rates have fallen steadily over the three year period to more moderate levels. In the south in Blocks 32 and 33 where blacklip and greenlip are usually fished on the same trip, mixed effort makes catch rates unreliable, but here too catch rates have been reduced. This area was assessed as at low risk of recruitment overfishing and thus sustainable based on the protection provided by the size limit over most of the area. However there is concern for this area in terms of fishery performance with moderate and falling stock levels.

Effort has been greatly reduced in the more remote islands of Bass Strait, including the Hogan, Curtis and Kent Groups, and catch rates have improved, indicating that stocks there have continued to rebuild. This area was assessed as at low risk of recruitment overfishing and thus sustainable based on the protection provided by the size limit over most of the area. Stocks were assessed moderate.

Small amounts of catch were taken from other parts of the zone, including the Central North Coast and other parts of the Furneaux Group including the Sisters in Block 37. This area was assessed as at low risk of recruitment overfishing and thus sustainable based on the protection provided by the size limit over most of the area. Stocks were assessed to be at relatively low levels in these areas although catch was also very low.

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 perceptions of abundance among individual regions. The fishery tends to be specialised, with 12 divers, almost all of whom were based in the north of the state, catching 50% of the TAC.

The following issues have affected fishery-derived performance measures (catch, catch rate) when used to assess greenlip stocks:

- The greenlip TAC is relatively small, and each region's catch is capped, effectively masking changes in distribution of catch that might indicate changed stock levels in one or more regions. In practise, it is very difficult to manage the spatial distribution of small amounts of catch, and regional caps can be overrun by up to 50%, so changes in regional catch may be informative.
- Current knowledge of a region's stocks can greatly increase an individual's catch rates. Increases in catch rate can occur when individual divers fish exclusively in a region gaining local knowledge and expertise, and then catch increasingly larger proportions of the available regional cap. Conversely catch rate declines may be caused regardless of changes in stock size by increased numbers of visitors to a region. In 2012 a much larger proportion of the greenlip TAC was caught by visiting divers, and more divers participated in the fishery, reducing the effect of local knowledge.
- Where divers caught both greenlip and blacklip in a single fishing trip, effort was estimated in at least three different ways. Some divers estimated the proportion of time taken to catch each species based on final catch weight, while others reported the total amount of fishing time twice, once for each species. Yet others estimated precisely the amount of effort spent catching both species. Inconsistent use of the three methods causes variation in catch rates. However, in sub-blocks where greenlip fishing predominates, the use of effort from trips where only greenlip catch was landed will be informative.
- The differences in price between different sized abalone were often sufficient for some divers to selectively fish for large greenlip, which meant that their catch rates were lower than if they were fishing the stock from the smaller LML. Following the effective closure of the NSW-based live market for Tasmanian greenlip in November 2011, most greenlip have been sold in a processed form, large abalone no longer attract premium prices and most divers fish to the LML i.e. to the same size stock.

King Island

The King Island greenlip catch was 16 t, which is approximately half the level at which the cap was set (30 t), and half the average catch of the previous three years. Of the 16 t, 5 t was taken from the area near Councillor Island and the Blowhole (2C) and 3 t from the coast immediately south at Naracoopa (4A). Most of the remaining catch was collected in small amounts while fishing for blacklip, particularly from 3A (2.5 t). The catch from the islands in sub-block 1B was 2 t. These totals were considerably reduced compared with previous years.

Catch rates from sub-blocks with predominately greenlip effort were 54 kg/hr (2C) and 56 kg/hr (1B), and have fluctuated in a narrow range between 50-60 kg/hr since 2007. In 2012, catch rates were noticeably lower at the end of the year suggesting significant stock depletion.

Divers were concerned about low stock levels on King Island. They said that recruitment appeared to be less than previous years, particularly at Christmas and New Year Islands in 1B, and at the Blowhole in 2C. Towards the end of the year, stocks became so reduced in these areas that they were no longer worth fishing. There were quantities of greenlip in other parts of the island, but they were too small or of poor

quality and were unsuitable for market requirements. They said that there were insufficient abalone of acceptable quality available to fill the 30 t cap in 2012.

North West Tasmania
In the North West (sub-block 5A, Block 49, sub-blocks 48B, 48C), 18.5 t was landed from a 18 t cap. This catch was distributed: 5t from the Petrels (48B) where the annual catch doubled, 7 t from east of Woolnorth and Hunter Island (48C), and 3 t each from north-west of Woolnorth (49C) and west of Woolnorth/south of Trefoil Island (5A).

Like previous years, catch rates were maintained at relatively high levels. Almost all trips combined blacklip and greenlip fishing but in contrast to other parts of the state, greenlip catch rates from mixed catches were 15-30 kg/hr higher than in other regions. In 48B where only minor amounts of blacklip were caught and effort could almost entirely be attributed to greenlip, catch rates were 80 kg/hr, having increased steadily from 47 kg/hr in 2008.

Sampling of catches for abalone length has been inconsistent, but in 2012 many more catches from the region were sampled. In 48B, 14% of catches were sampled, with 25th percentile, median and 75th percentile lengths at 149 mm, 154 mm and 161 mm respectively. These length parameters were identical in 48C (7% of catches sampled), but up to 4 mm smaller in 5A (11%) and 49C (25%).

Divers generally reported good fishing conditions in the North West. Stocks have been reduced close to Woolnorth in 5A, 49C and 48C, but this area was heavily fished and divers found better fishing in more remote areas. The 18 t cap was considered appropriate for the region.

Black Reef, Perkins Bay and the Central North Coast
Further east, at Black Reef in Perkins Bay north of Smithton (48A) the 20 t cap was overrun, and 26.1 t was landed. Over half this catch was caught over a short period between October and November, and the fishery was closed on 12 November. The overrun was due partly to the limitations imposed by the requirement that divers be given 2 weeks notice of closure, and partly to inadvertent misreporting of catch. Less than 200 kg was landed from the coast east of Black Reef, including Circular Head and the coast eastwards to Bridport. This part of the coast has a 10 t catch cap.

Catch rates at Black Reef remained high (104 kg/hr), but in the five-year period since size limit were reduced, 2012 had one of the lower catch rates.

Since November 2008, the region has been fished at a LML of 132 mm. From 2009, between 30-40% of catches have been sampled for length each year. The median length of abalone was 139 mm, with 25th and 75th percentile lengths at 135 mm and 145 mm respectively. This size structure has remained essentially unchanged between 2009-2012.

Divers reported good fishing conditions at Black Reef, and said that stock levels remained high. They said that abalone from the region generally grew smaller than elsewhere. They thought that the intensive nature of the fishery had reduced the population density, thereby reducing intra-specific competition for food, and consequently the condition of the abalone had greatly improved. They considered that

the 20 t cap was appropriate for Black Reef. These abalone were too small for the live domestic market, and were sold in processed form.

As occurred in previous years, negligible amounts of greenlip were caught from Circular Head or on the coast eastward to Bridport. The cap for this region is 10 t. The abalone here were considered low grade, attracted a low beach prices and divers preferred to fish elsewhere.

North East Tasmania
Fishing for both blacklip and greenlip in North East Tasmania stopped on 27 August after the caps for both species were reached. The greenlip cap was 23 t, and 33 t was caught i.e. the cap was overrun. Approximately 5.5 t of greenlip was caught during the two-week period between the announcement of the closure and the day it was implemented. Almost 20 t was caught from 31B and 13 t taken from 39A. Small amounts of catch (<1 t) were taken from adjacent blocks outside the managed region.

Abalone fishing in this region is predominately for mixed species. In 2012, there were 211 reports of greenlip fishing, 77 of which were from trips solely fishing greenlip. Estimates of mean CPUE were made after excluding effort from trips with mixed catches. The remaining effort was derived solely from greenlip fishing, and it was assumed that catch rates from this reduced number of trips adequately represented greenlip fishing in the region.

Regionally, catch rates have been stable between 60-67 kg/hr since 2007. However, within individual reporting areas catch rates have been dynamic, fluctuating between 45 and 74 kg/hr, presumably as reefs have become alternatively depleted then allowed to recover. Between 2010-2012, catch rates in sub-block 39A rose from 45 kg/hr to 73 kg/hr whilst in sub-block 31B during the same period, they fell from 72 kg/hr to 54 kg/hr.

Catch sampling for abalone length has been inconsistent, with only 4% of catches sampled from 31B and 7% from 39A. In both sub-blocks, median lengths were 160 mm, with 25th percentile lengths at 153 and154 mm and 75th percentile lengths at 167 and 165 mm respectively.

Divers reported good fishing but because of the popularity of the region and its relatively low area of reef, they often found that it was difficult to avoid fishing where another diver had recently fished. Consequently, they might hope to land 300-400 kg, but end up with 200 kg. They said that the low reef area meant that the risk of overfishing was high. The area was popular because good catches of both species could be made, and the greenlip were of good quality and received a high beach price. Several divers said that greenlip in the North East grew more rapidly than elsewhere, and that the 145 mm LML should be increased so that yields from the region would be larger and of higher value.

Furneaux Group
The 42 t regional cap was overrun slightly and 45 t was reported caught from the region. Of this almost 20 t was reported from the south of Cape Barren Island and Clarke Island, with sub-block 33A producing 15.6 t. Further north, Franklin Sound (Block 35) produced 19 t and Blocks 34 and 38 each produced approximately 2.5 t, while small quantities (< 1 t) were reported from Blocks 36 and 37.

Unlike the North East, most greenlip (39 t) were caught on greenlip specific trips and in the most productive areas, catch rates were not complicated with the inclusion of blacklip effort. Catch rates were generally highest in the south in Blocks 32 and 33 and lowest in Block 35. In 33A, catch rates have fallen to 65 kg/hr from a high of 88 kg/hr in 2010 when 10 t was caught. In Block 35, catch rates have fallen from 63 kg/hr in 2010 to 54 kg/hr.

Ten percent of catches from sub-block 33A were sampled, with 25th percentile, median and 75th percentile lengths at 151 mm, 157 mm and 166 mm respectively. Low percentages of catches were sampled form other sub-blocks in the region, but sampling has been too sparse and inconsistent to provide information.

Divers reported good fishing condition for greenlip at Clarke Island and in the Armstrong Channel. The number of visiting divers increased, operating from either motherships or large runabouts launched from ramps in north-east Tasmania.

Qualitative assessment

Assessments of the greenlip fishery in recent years have proven difficult because of the reporting of both blacklip and greenlip effort on single trips, divers fishing to different sized stocks because of market requirements, the involvement of relatively few divers in the fishery and a paucity of information about the size structure of the catch. The problems caused by these issues have been addressed and consequently our assessment of greenlip stocks is more certain.

At King Island the annual catch was low, almost half the catch of previous years. There appears to have been a reduction in the area of reef supporting greenlip fishing, with only small catches at low catch rates from the north-west of the island in Block 1. The east coast continued to provide the main part of the catch, although here too catch rates were reduced. This region was assessed as transitional-depleting because stock levels were assessed low and are declining.

In the North West (not including Black Reef) catch rates have improved or remained stable at moderate levels. The regional catch has been reduced to below 25 t since 2004, and stocks appear to have rebuilt. This region was assessed as sustainable because stock levels were moderate and stable.

At Black Reef catch rates remained high, but have fallen from even higher levels. The regional cap was overrun by 30% and while stock levels were high, similar-sized overruns have the potential to greatly reduce productivity from such a small area of reef. Further east at Circular Head and the remainder of the North Coast only 200 kg were landed from the 10 t cap, and the region could not be assessed.

The North East cap was overrun by 40% and closed to fishing in August. Abalone from the region were relatively large and appeared to be fast growing, and several divers have suggested that increasing the LML would improve yields with minimal impact on catch rates. This region was assessed as sustainable because stock levels were moderate and stable.

At the Furneaux Group there has been a significant influx of visiting divers who mostly fished in the southern part of the region. Catch rates were at moderate levels. The catch from Block 33 (mostly Clarke Island) was unusually large and has the capacity to

impact on stock levels if repeated. Stock levels were assessed moderate. Further north in Block 35 (Franklin Sound) the annual catch increased and catch rates were generally lower, have fallen in recent years. The broader region was assessed as sustainable because stock levels were moderate and stable.

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 most recent catch survey of recreational abalone fishing was undertaken for the 2010/2011 season (Lyle and Tracey, 2012). It found that notwithstanding a 30% increase in issued licenses between the recreational fishing seasons 2002-2003 to 2010-2011 (Figure 5), active participation in recreational abalone fishing has fallen by approximately 25%, from a peak of 5,853 to 4,349 divers.

The survey estimated 60,943 abalone (approximately 29 t) were taken by the recreational fishery, i.e. approximately 1% of the of the total Tasmanian abalone catch. This is a 25% catch reduction since the previous (2008/2009) survey, and is less than 50% of the peak catch reported in 2002-2003.

Approximately 50% of the recreational catch was taken in the east and south-east between Southport and Eddystone Point, i.e. the area covered by Blocks 14 to 30. As a proportion of total catch (recreational plus commercial), recreational catch was highest in the area covered by Blocks 28 to 30 (Friendly Beaches to Eddystone Point). Here the recreational catch was 11.5% of the total regional catch, but this was not because the recreational catch was large, but because the commercial catch was unusually low. In the south-east covered by Blocks 14-22, the recreational catch was 4.9% of the total catch.

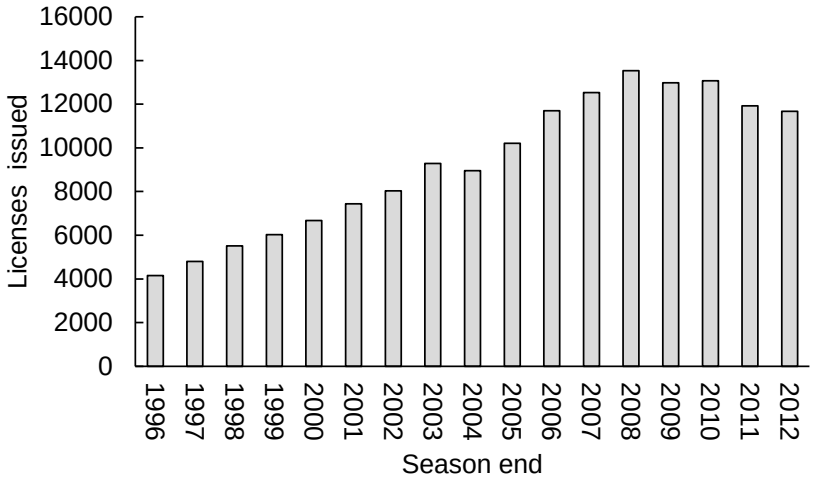


Figure 5. The number of recreational abalone diving licenses issued for the fishing seasons 1996-2012.

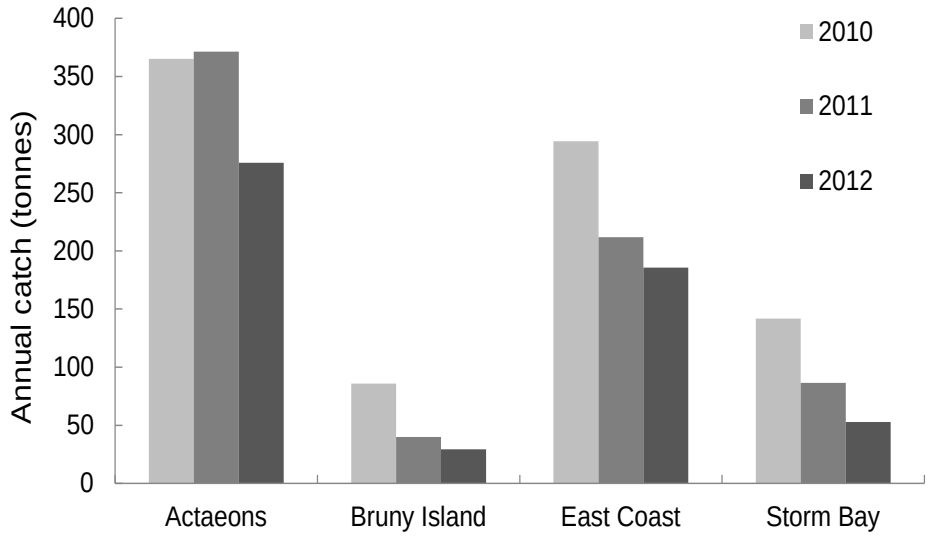
3.8 Indigenous and permit fisheries, and illegal catch

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 with a total of less than 2 tonnes through these processes in 2012. Illegal fishing is known to occur but no estimates are available.

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

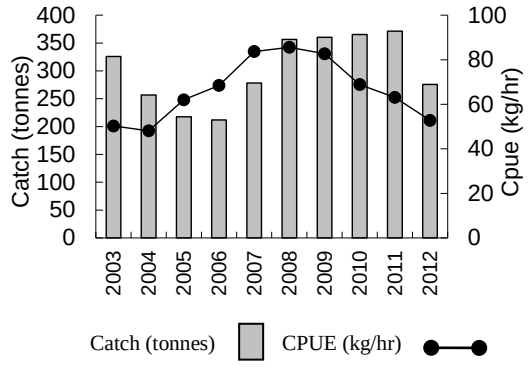
4.1 Eastern Zone blacklip fishery

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

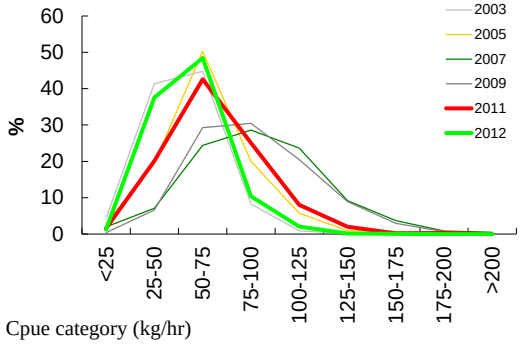


Eastern Zone - Actaeons, Lower Channel (Sub-blocks 13C, 13D, 13E, 14A, 14B)

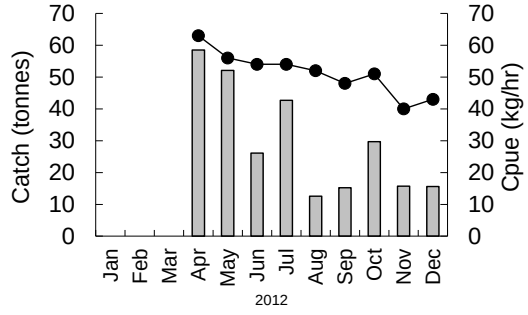
Regional view:



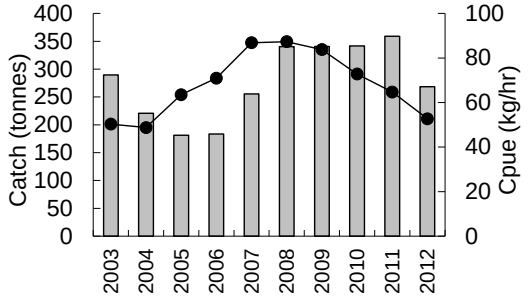
CPUE distribution:



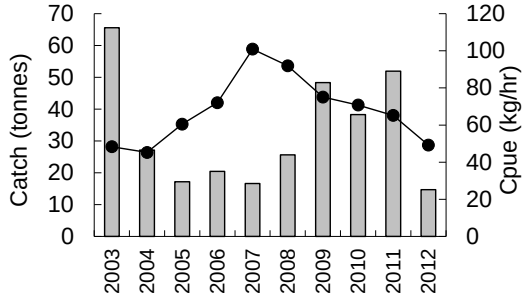
Regional catch and catch rates by month



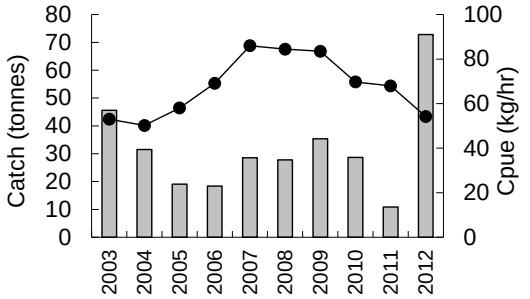
13C, 13D, 13E, catch not capped in 2012, 268 t caught:



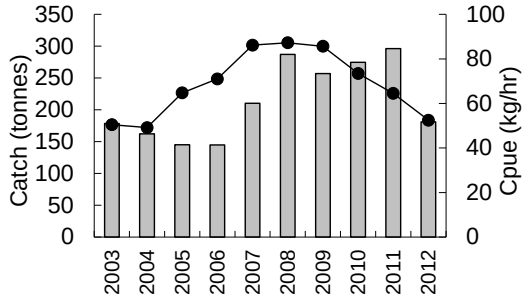
Sub-block 13C
Fishers Point to Whale Head



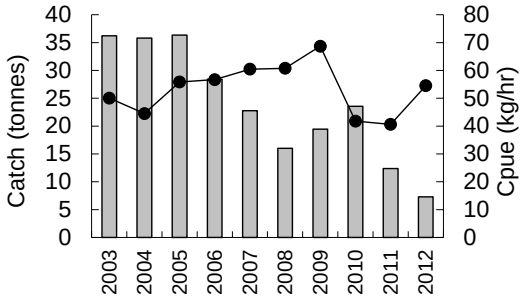
Sub-block 13D
Fishers Point to Southport Lagoon Beach, including Recherche Bay



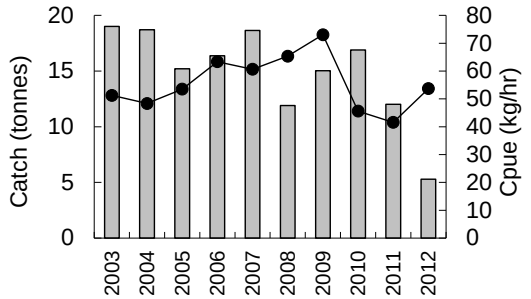
Sub-block 13E
Actaeon and Sterile Islands, and reefs to the south (the Breaks)



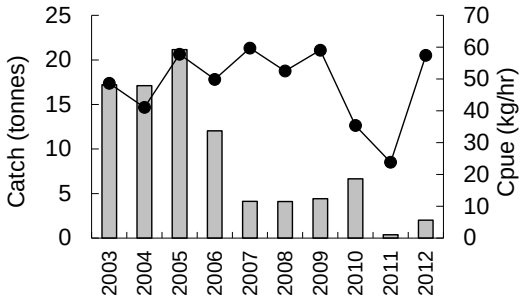
14A, 14B, no cap in 2012, 7 t caught.



Sub-block 14A
Southport Lagoon Beach to Burnett Point

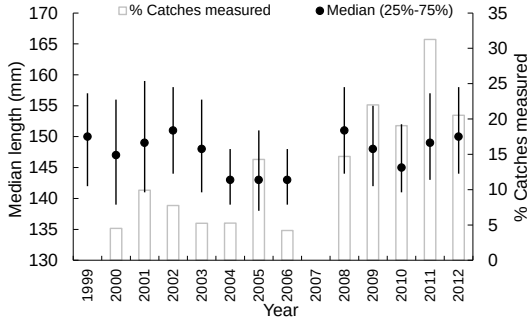


Sub-block 14B
Burnett Point to Blubber Head

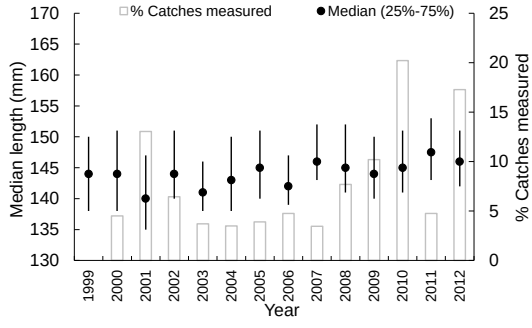


Actaeons, Lower Channel (Sub-blocks 13C, 13D, 13E, 14A, 14B)
Median length of catch

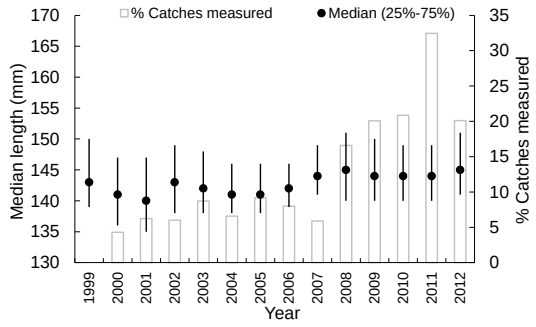
Sub-block 13C
Fishers Point to Whale Head



Sub-block 13D (Black Reef, Recherche)

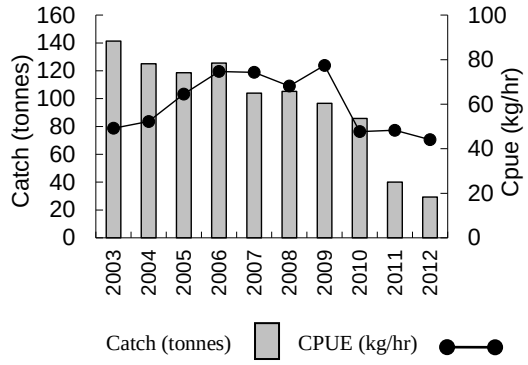


Sub-block 13E (Actaeon Island, Breaks etc.)

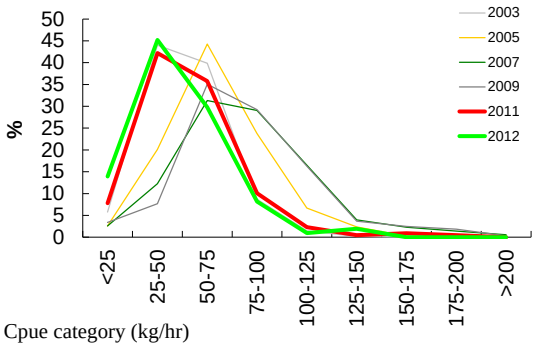


Eastern Zone – Bruny Island (Blocks 14C, 14D, 14E, 15, 16).

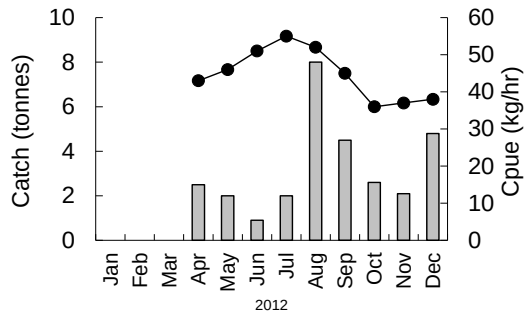
Regional view, catch not capped in 2012, 29 t caught.



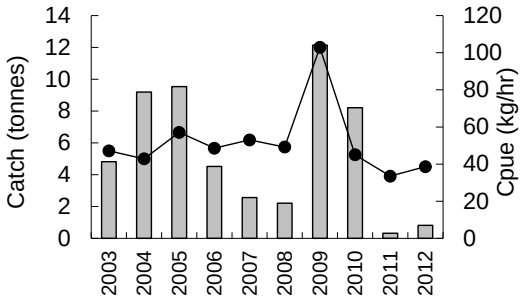
CPUE distribution:



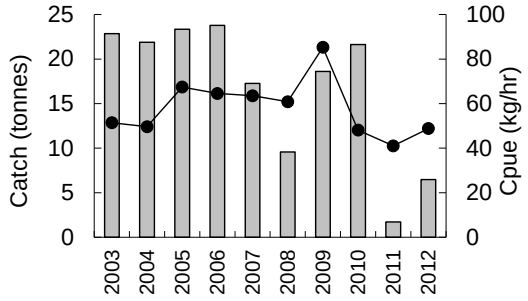
Regional catch and catch rates by month



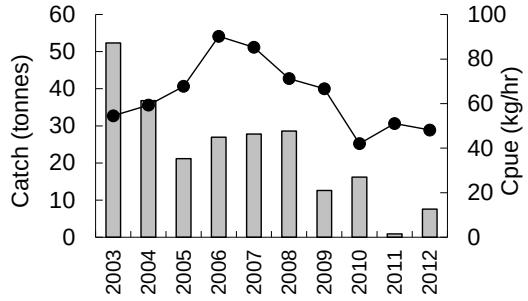
Sub-block 14C Mays Creek to Hopwood Light (Lower Channel) – significant catch reporting errors in 2009.



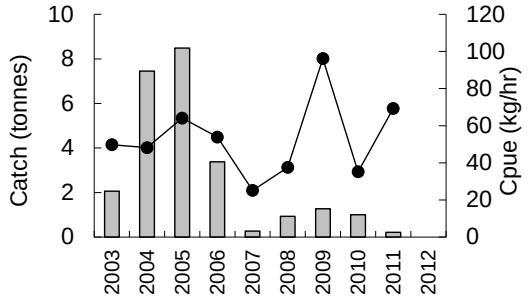
Sub-block 14D Hopwood Point to West Cloudy Head - significant catch reporting errors in 2009.



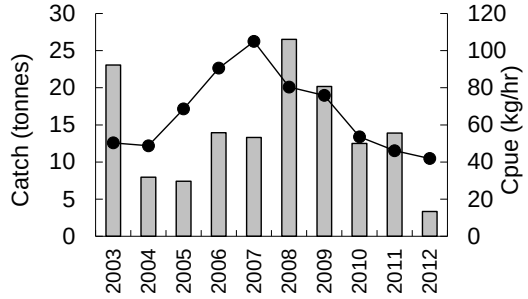
Sub-block 14E
West Cloudy Head to Boreel Head, including the Friars



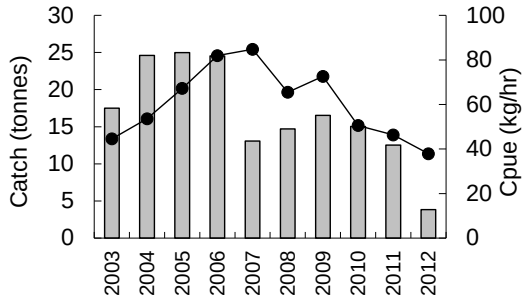
Block 15 D'Entrecasteaux Channel, Huon Estuary- significant catch reporting errors in 2009, no catch reported in 2012



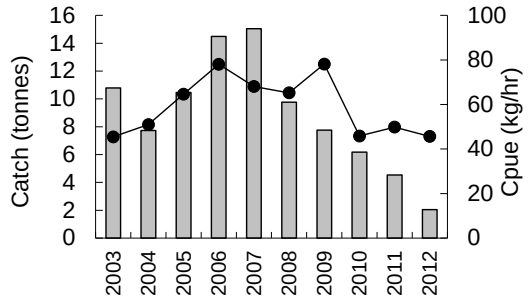
Sub-block 16A
Boreel Head to North Mangana Bluff



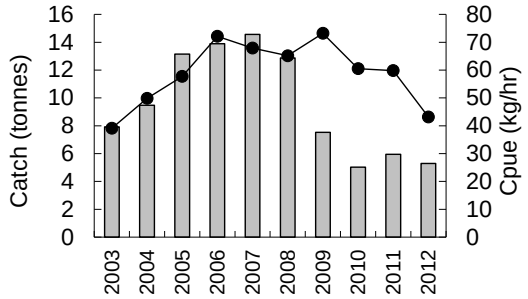
Sub-block 16B
North Mangana Bluff to Neck Beach



Sub-block 16C
Neck Beach to Trumpeter Bay

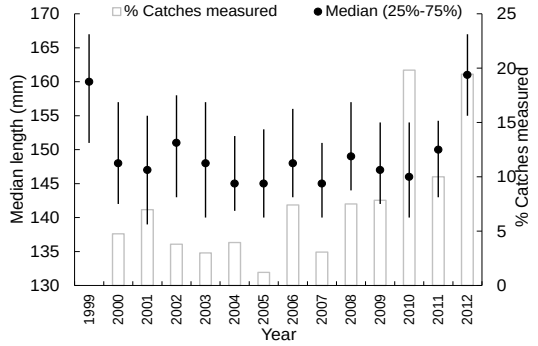


Sub-block 16D
Trumpeter Bay to Dennes Point

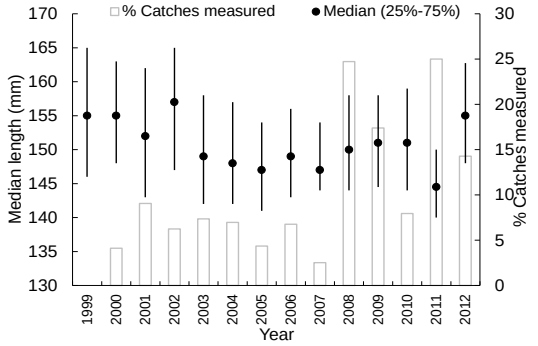


Eastern Zone – Bruny Island (Blocks 14C, 14D, 14E, 15, 16).
Median length of catch

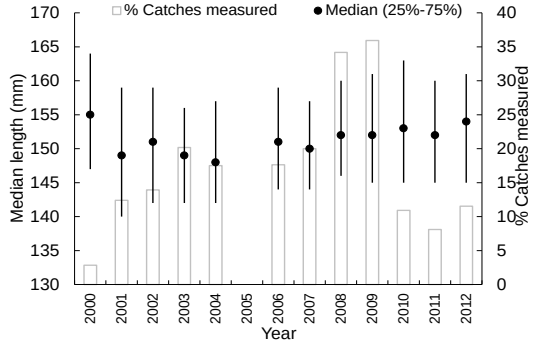
Sub-block 14D Hopwood Point to West Cloudy Head



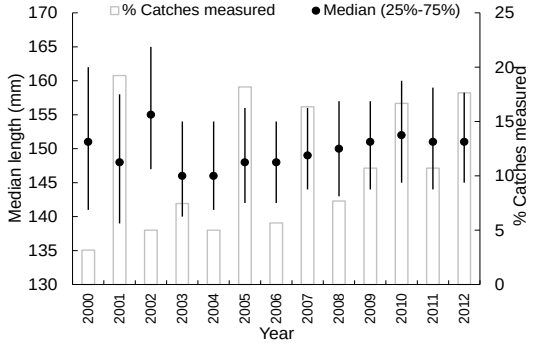
Sub-block 14E West Cloudy Head to Boreel Head, including the Friars



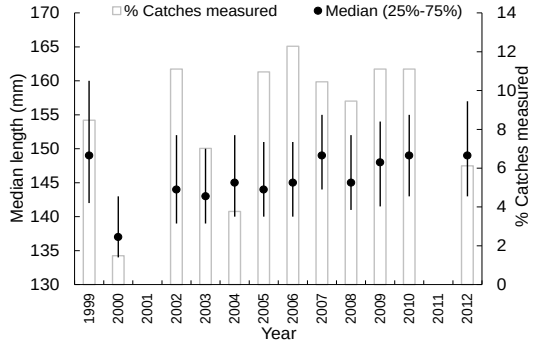
Sub-block 16A
Boreel Head to North Mangana Bluff



Sub-block 16C
Neck Beach to Trumpeter Bay

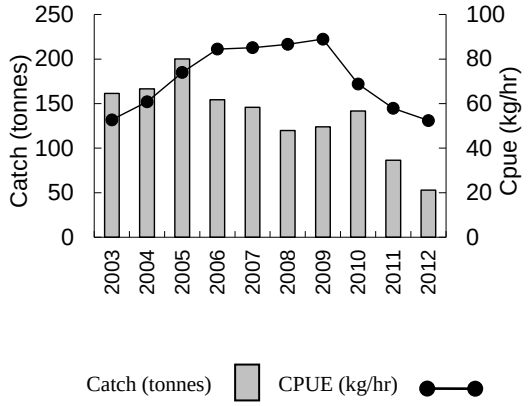


Sub-block 16D
Trumpeter Bay to Dennes Point

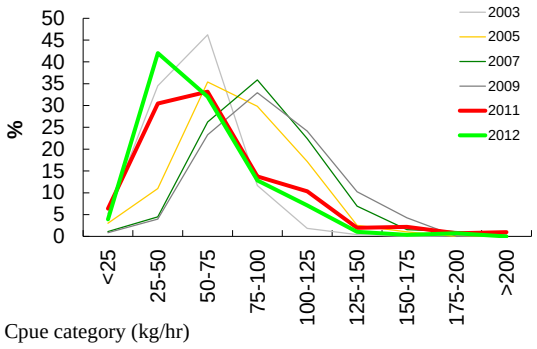


Eastern Zone - Storm Bay (Blocks 17-21)

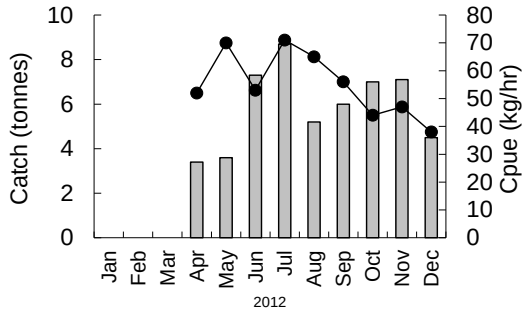
Regional view, catch not capped in 2012, 53 t caught



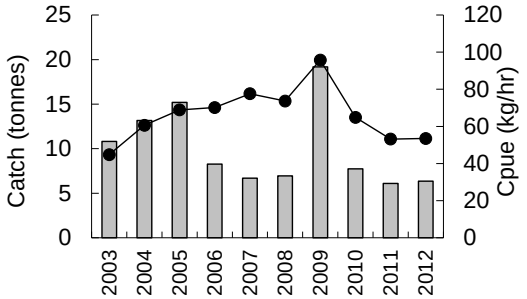
CPUE distribution:



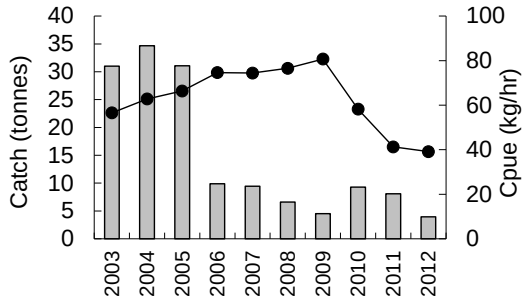
Regional catch and catch rates by month



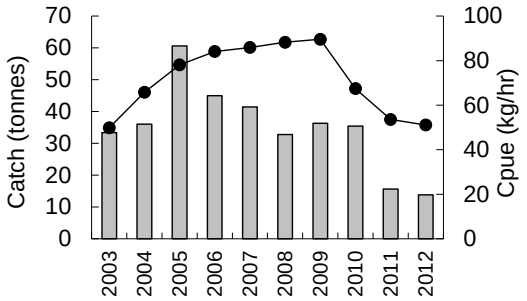
Sub-block 17B
Blackjack shoreline from Lobster Point to Outer North Head



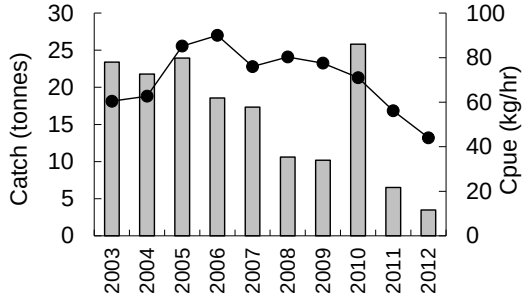
Sub-block 20A
Outer North Head to White Beach



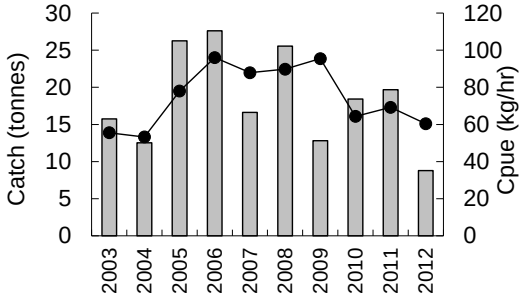
Sub-block 20B
White Beach to Salters Point



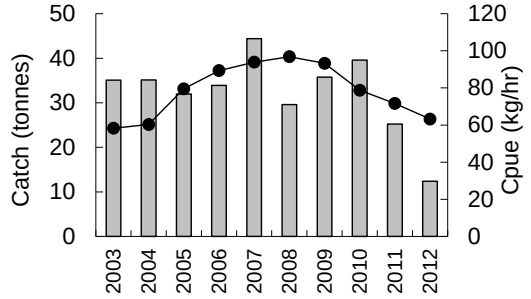
Sub-block 20C
Salters Point to Cape Raoul



Sub-block 21A
Cape Raoul to Port Arthur

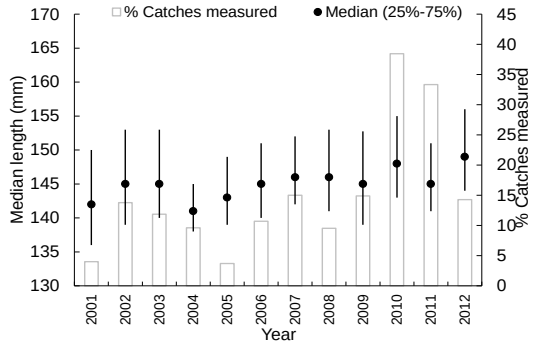


Sub-block 21C
Port Arthur to Cape Pillar

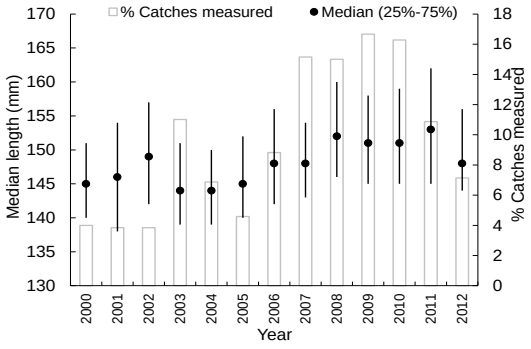


Eastern Zone - Storm Bay (Blocks 17-21)
Median length of catch

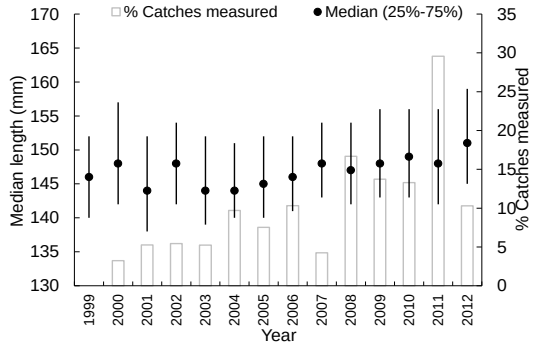
Sub-block 17B Blackjack shoreline from Lobster Point to Outer North Head



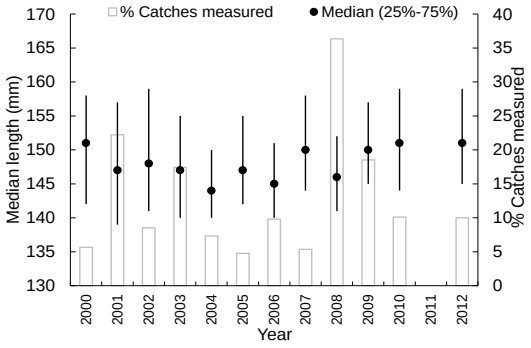
Sub-block 20A
Outer North Head to White Beach



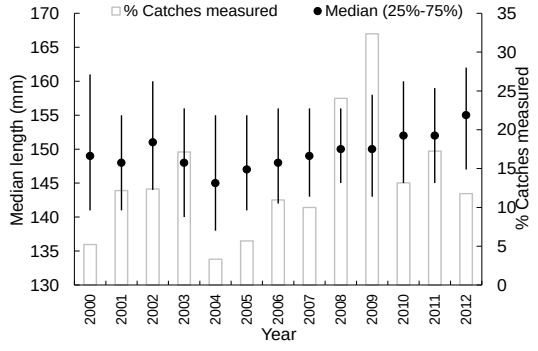
Sub-block 20B White Beach - Salters Point



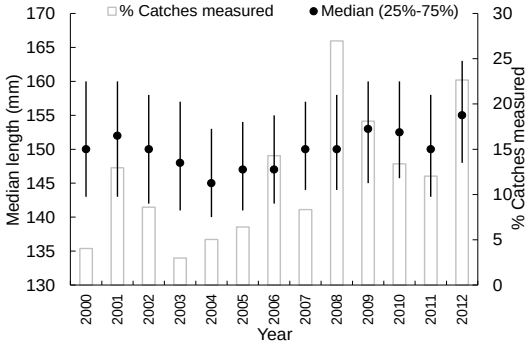
Sub-block 20C Salters Point to Cape Raoul



Sub-block 21A Cape Raoul to Port Arthur

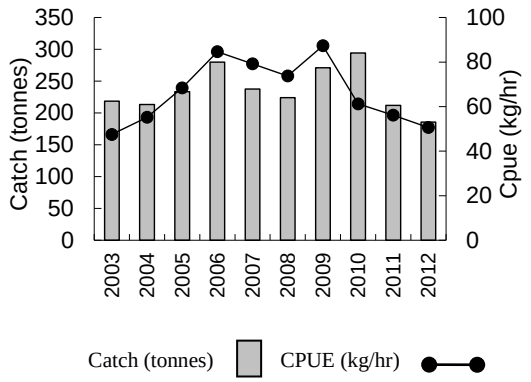


Sub-block 21C Port Arthur to Cape Pillar

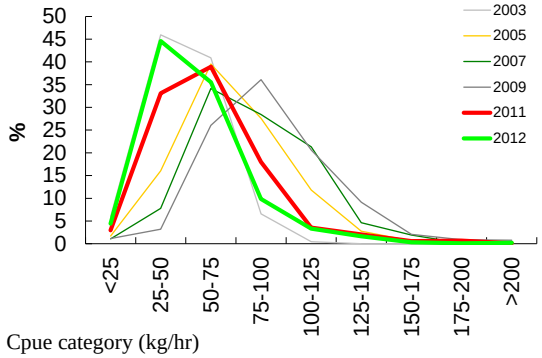


Eastern Zone – East Coast (Blocks 22-31)

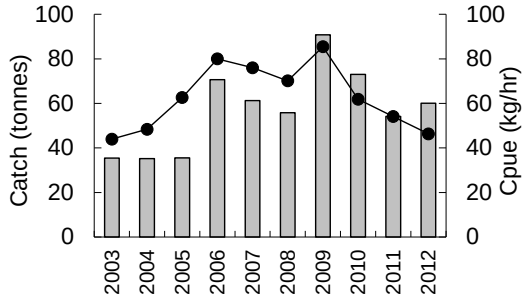
Regional view:



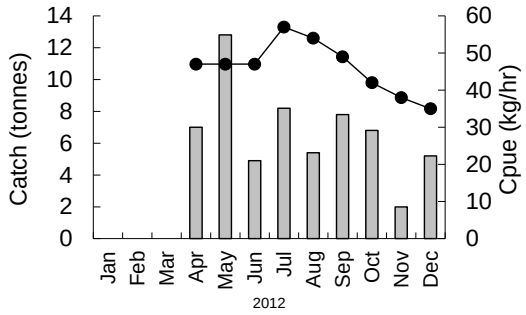
CPUE distribution



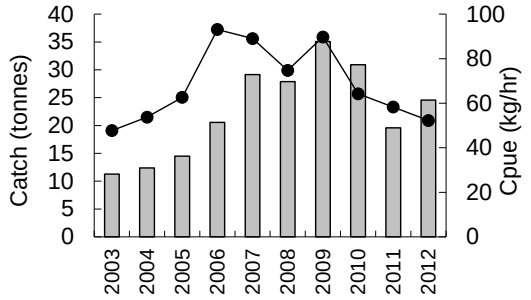
Block 22, catch not capped in 2012, 60 t caught



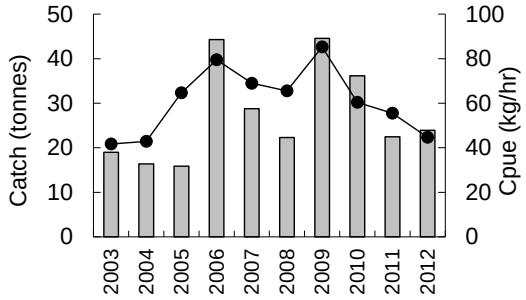
Regional catch and catch rates by month – Block 22



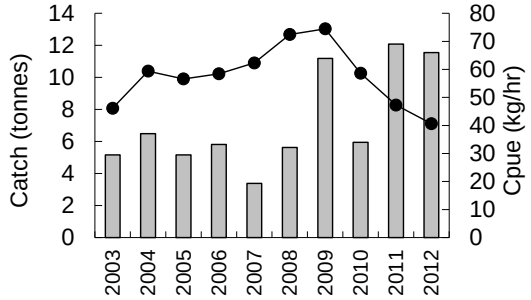
Sub-block 22A
Cape Pillar to the Lanterns



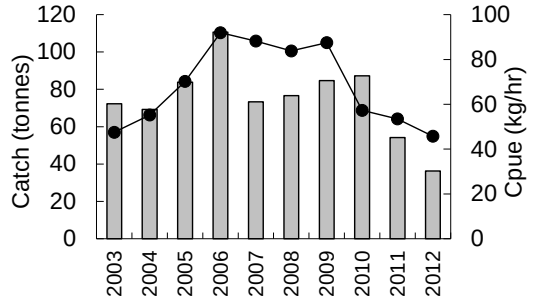
Sub-block 22B
The Lanterns to Eaglehawk Neck



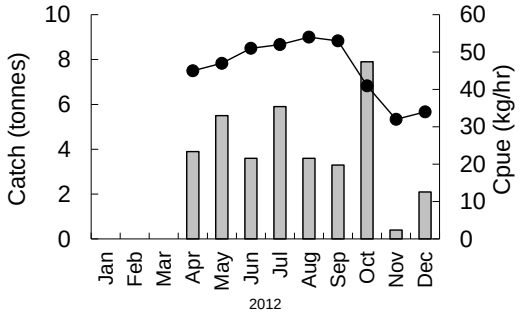
Sub-block 22C
Eaglehawk Neck to Deep Glen Bay



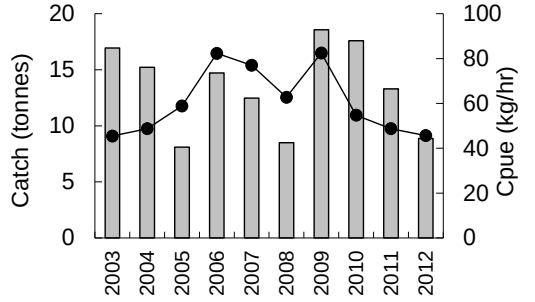
Forestier Peninsula, Maria Island (Blocks 23, 24), catch not capped in 2012, 36 t caught



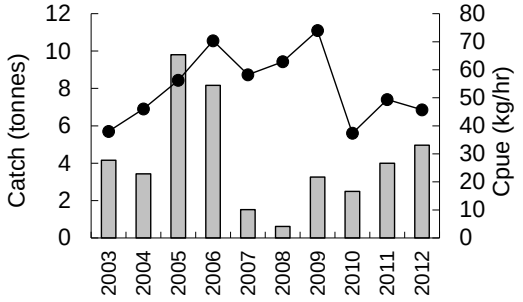
Regional catch and catch rates by month



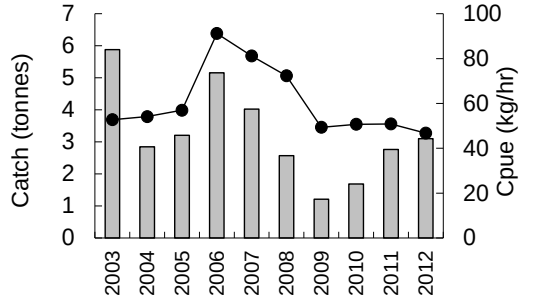
Sub-block 23A
Deep Glen Bay to Lagoon Bay



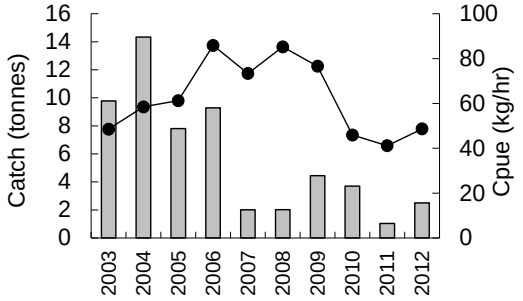
Sub-block 23B
Lagoon Bay to Marion Bay



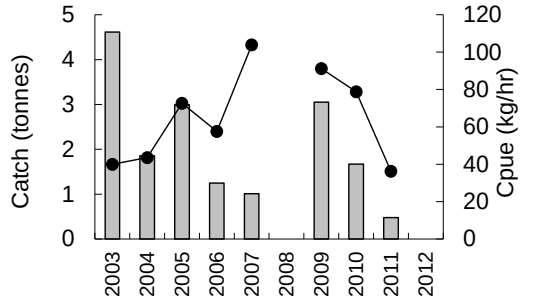
Sub-block 24A
Marion Bay to Rheban



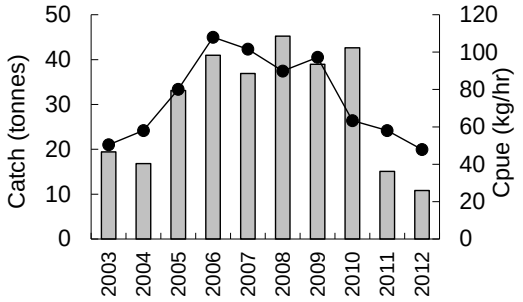
Sub-block 24B
Eastern shore of Mercury Passage



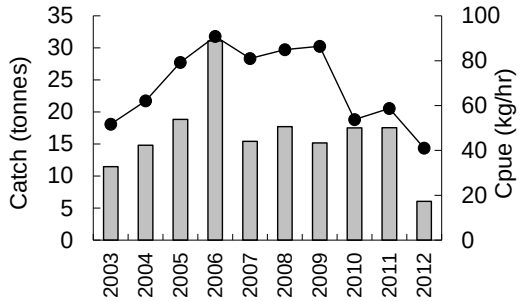
Sub-block 24C
Rheban to Cape Bougainville



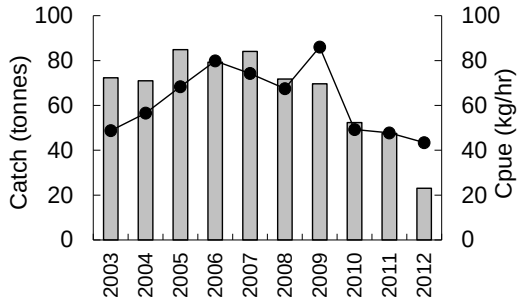
Sub-block 24D
north-east side of Maria Island



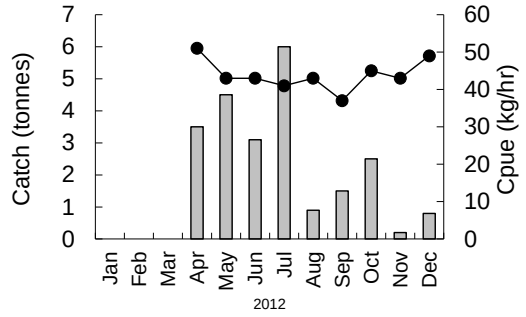
Sub-block 24E
south-east side of Maria Island



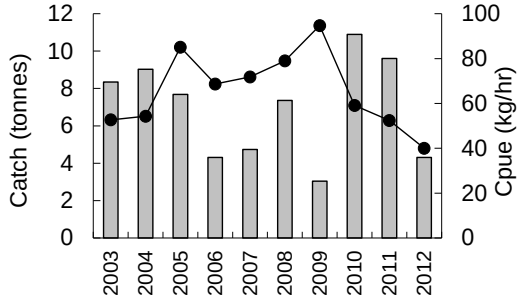
Freycinet-Bicheno (Blocks 25, 26, 27, 28, 29A), catch not capped in 2012, 23 t caught



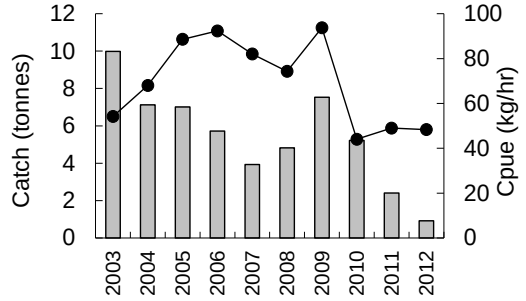
Regional catch and catch rates by month



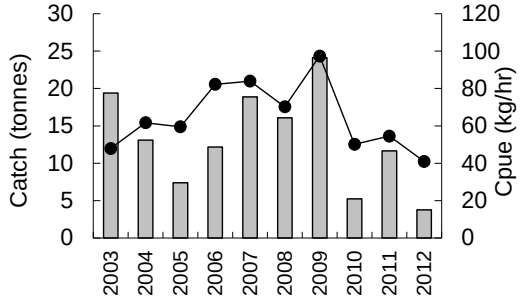
Sub-block 27A
south side of Schouten Island



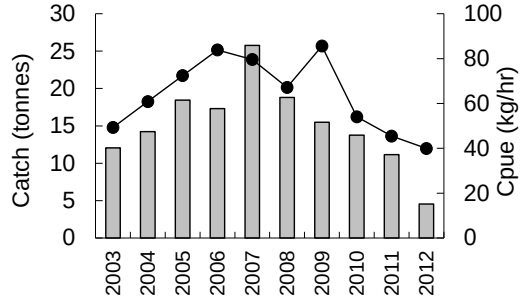
Sub-block 27B
east side of Schouten Island



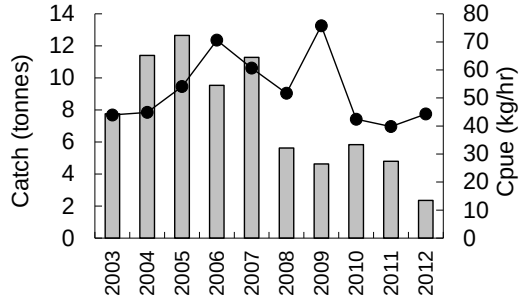
Sub-block 27C
Schouten Passage to Wineglass Bay



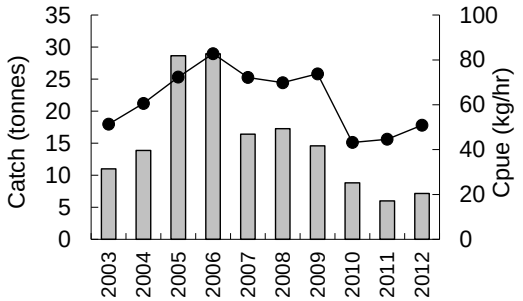
Sub-block 27D
Wineglass Bay to the Friendly Beaches



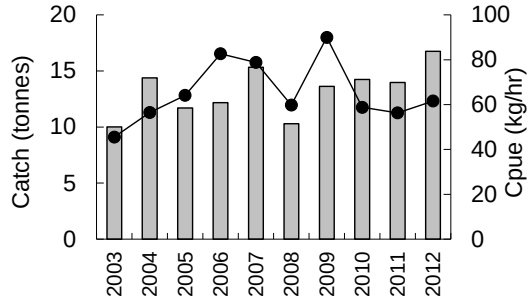
Block 28
Friendly Beaches to Long Point



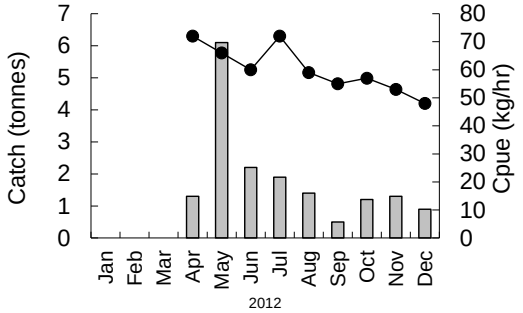
Sub-block 29A – Long Point



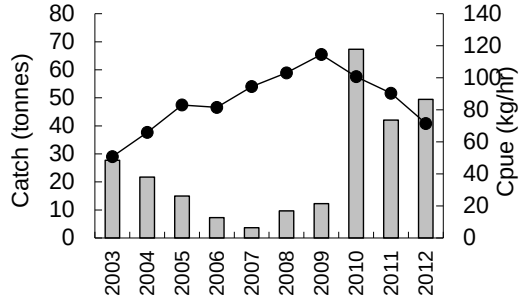
Sub-blocks 29B, 29C, 29D, 30A, Templestowe Beach to Taylors Beach,



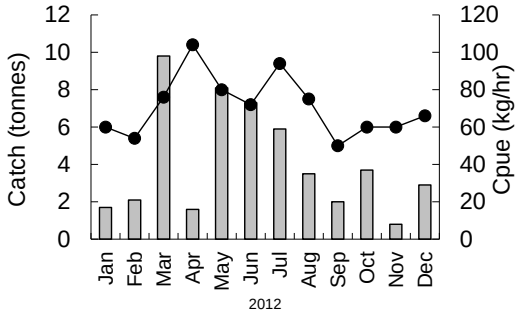
Sub-blocks 29B, 29C, 29D, 30A, – monthly catch rates



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

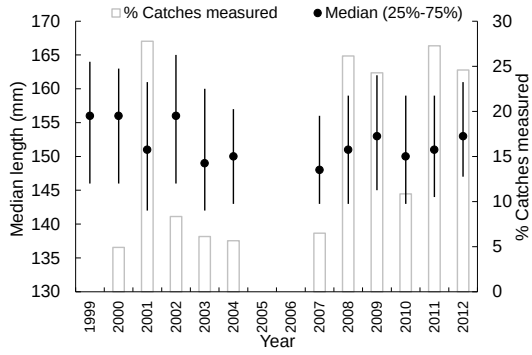


Sub- block 31A – monthly catch rates

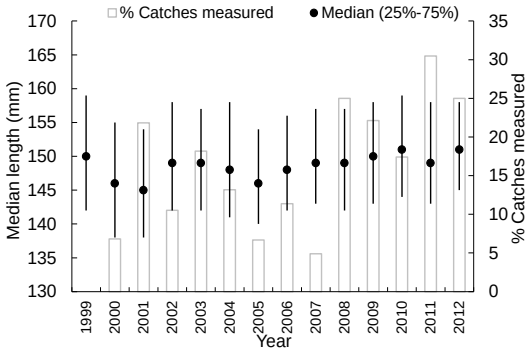


Eastern Zone - East Coast (Blocks 22-31)
Median length of catch

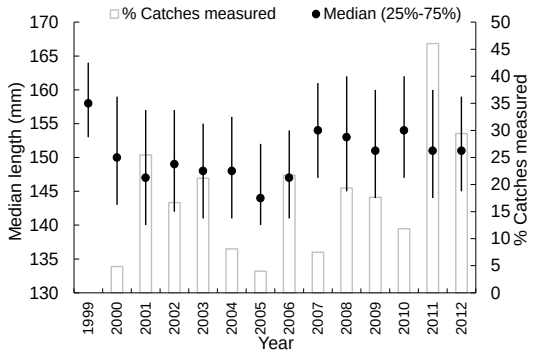
Sub-block 22A Cape Pillar to the Lanterns



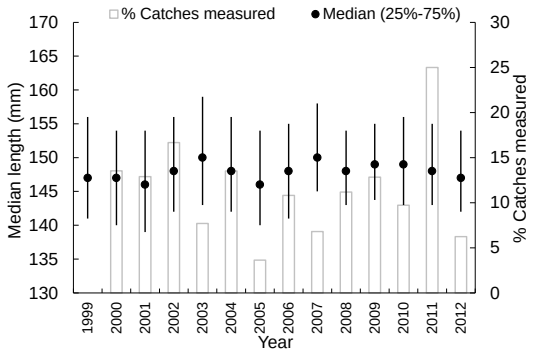
Sub-block 22B The Lanterns to Eaglehawk Neck



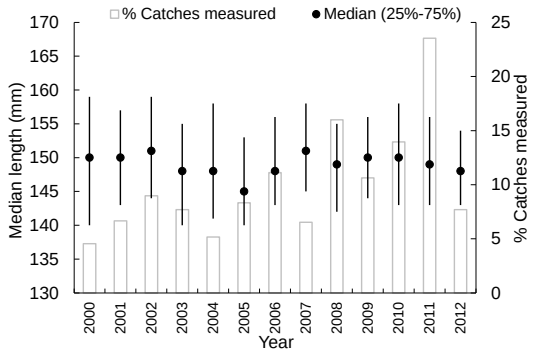
Sub-block 23A Deep Glen Bay to Lagoon Bay



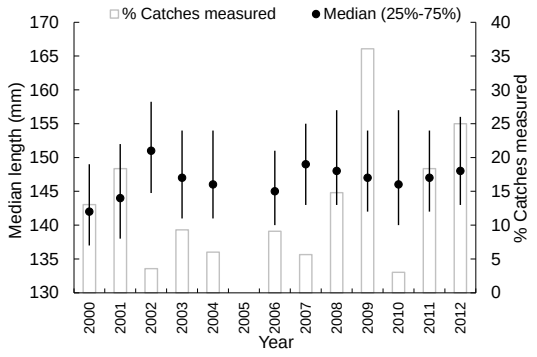
Sub-block 24D north-east side of Maria Island



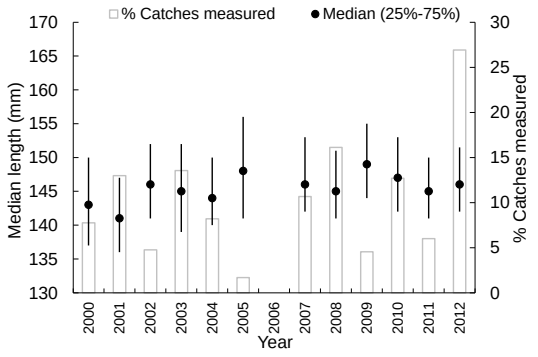
Sub-block 24E south-east side of Maria Island



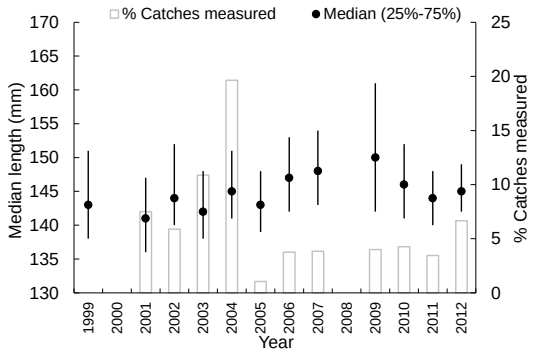
Sub-block 27C Schouten Passage to Wineglass Bay



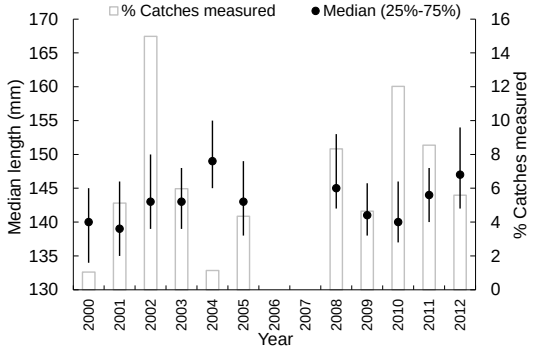
Sub-block 27D Wineglass Bay to the Friendly Beaches



Sub-block 29A Long Point to Templestowe Beach

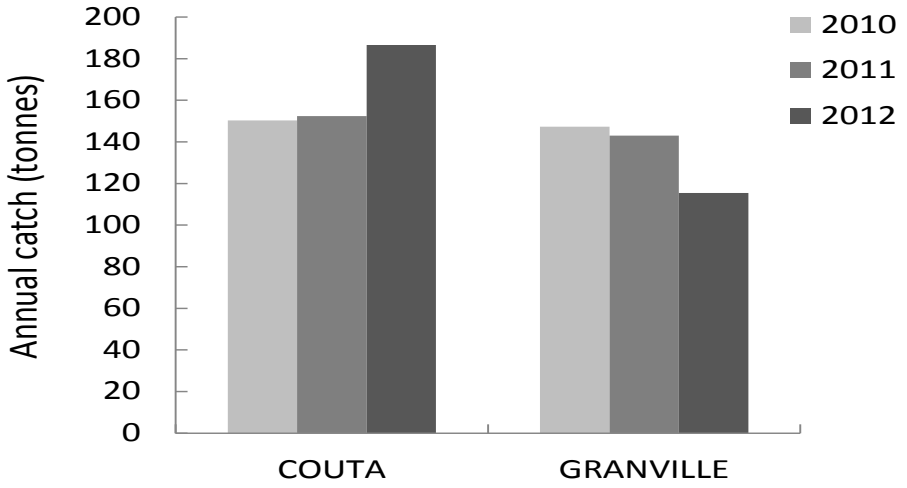


Sub-block 31A Eddystone Point to Musselroe



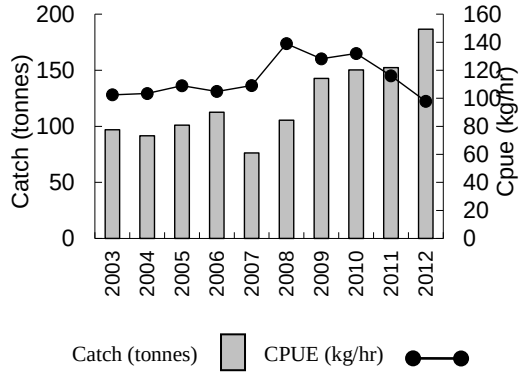
4.2 Central Western Zone blacklip fishery

Distribution of catch between the Couta Rocks region (Block 6) and the Granville Harbour region (Blocks 7 and 8):

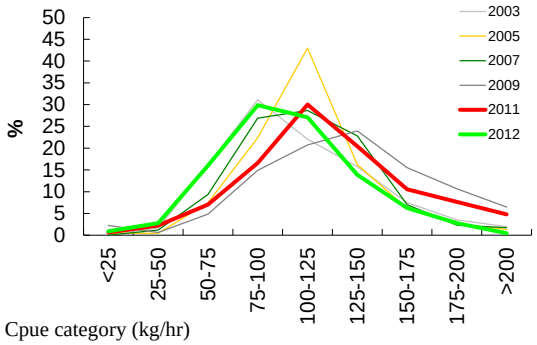


Central Western Zone – Couta Rocks (Block 6)

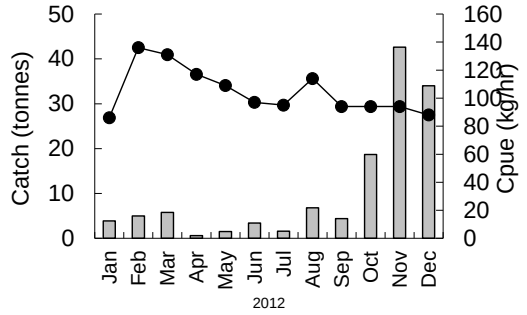
Regional view: 187 t in 2012



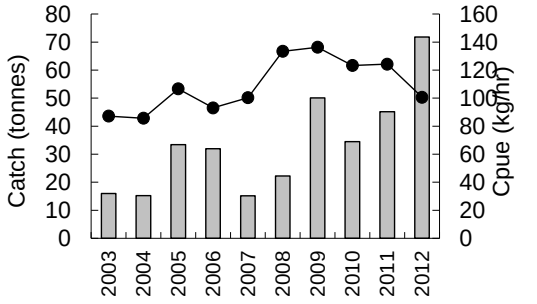
CPUE distribution:



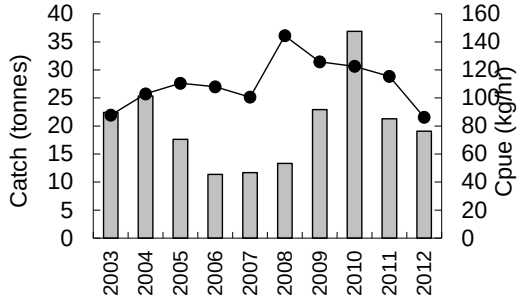
Regional catch and catch rates by month



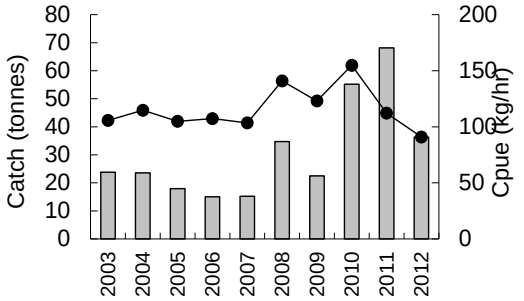
Sub-block 6A
Sundown to Temma



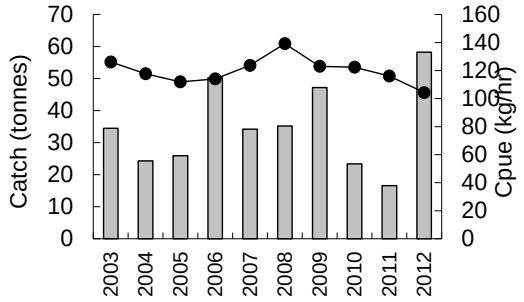
Sub-block 6B
Temma to north of Dawson River



Sub-block 6C
Dawson River to Wild Wave River

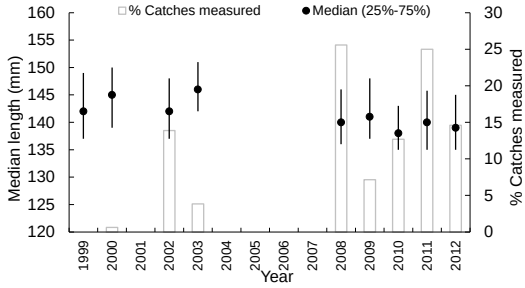


Sub-block 6D - capped area see below
Wild Wave River to Italian River, including Sandy Cape

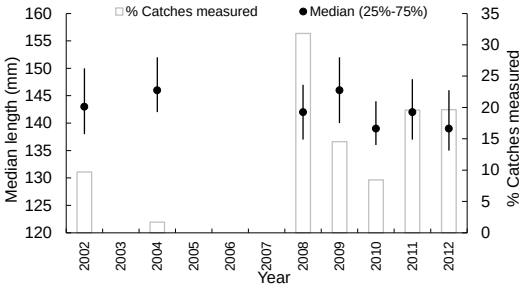


Central Western Zone – Couta Rocks (Block 6)
Median length of catch

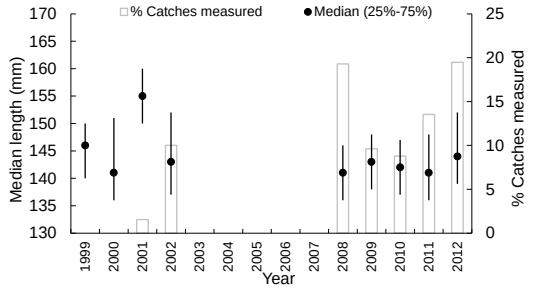
Sub-block 6A
Sundown to Temma



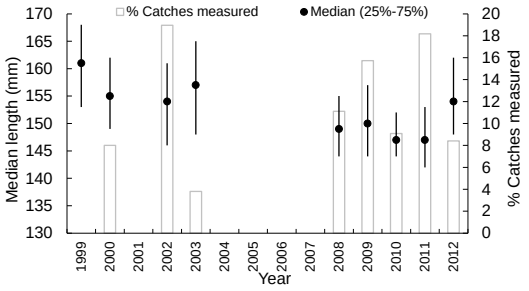
Sub-block 6B
Temma Harbour to north of Dawson River



Sub-block 6C
Dawson River to Wild Wave River

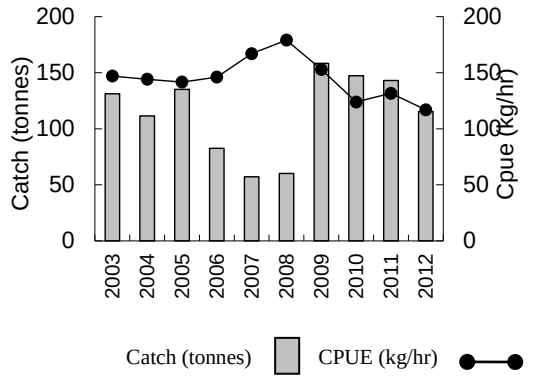


Sub-block 6D - capped area see below
Wild Wave River to Italian River, including Sandy Cape

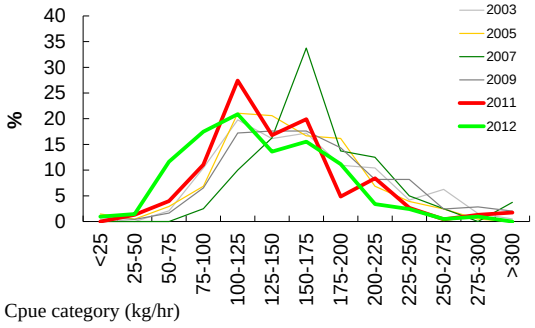


Central Western Zone – Granville Harbour (Blocks 7 and 8)

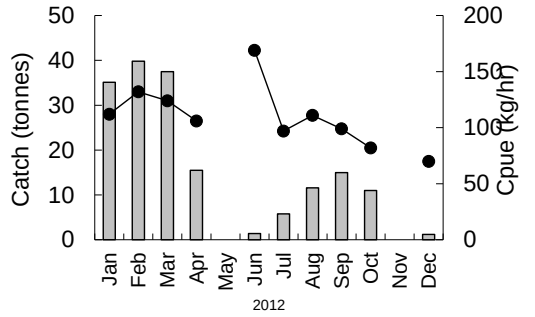
Blocks 7 and 8



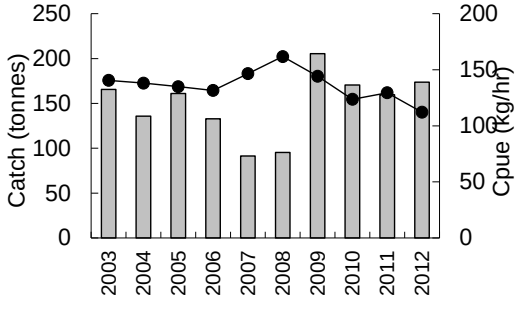
CPUE distribution:



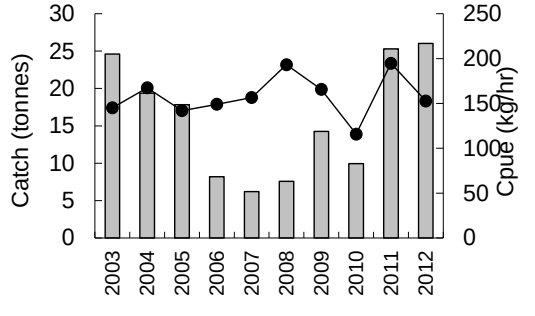
Regional catch and catch rates by month



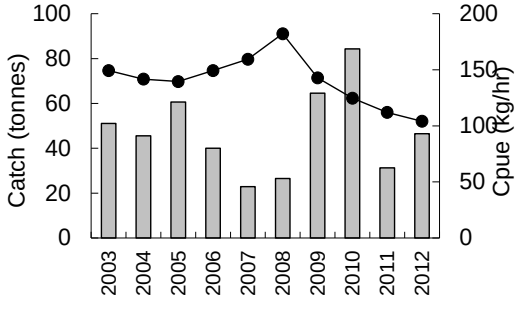
Sub-block 6D, Blocks 7 and 8, cap set at 154.5 t in 2012, 174 t caught



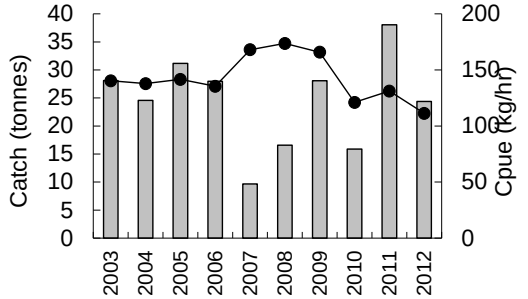
Sub-block 7A
Italian River to Pieman River



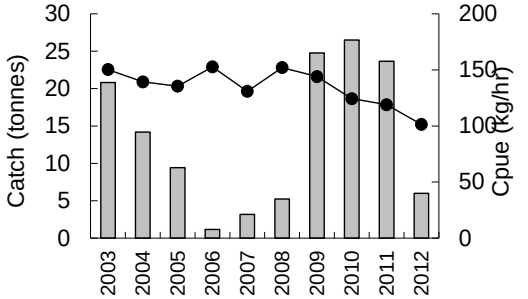
Sub-block 7B
Pieman to Ahrberg Bay



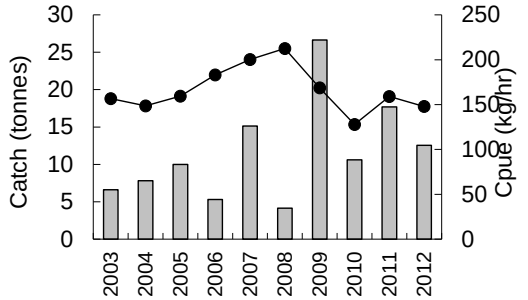
Sub-block 7C
Ahrberg Bay to Granville Harbour



Sub-block 8A
Granville Harbour to Tasman Bay

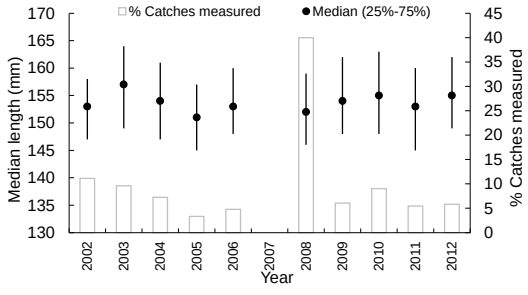


Sub-block 8B
Tasman Bay to Henty River



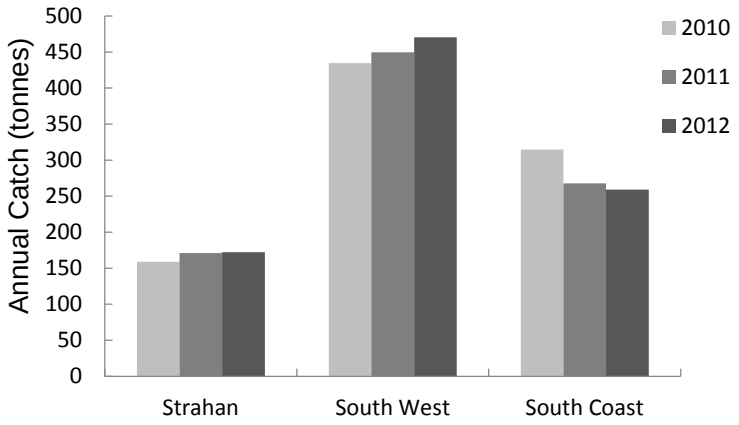
Central Western Zone – Granville Harbour (Blocks 7 and 8)
Median length of catch

Sub-block 7B
Pieman to Ahrberg Bay



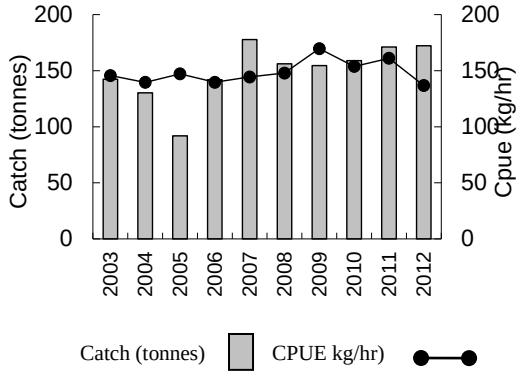
4.3 Western Zone blacklip fishery

Distribution of catch in the Western Zone:

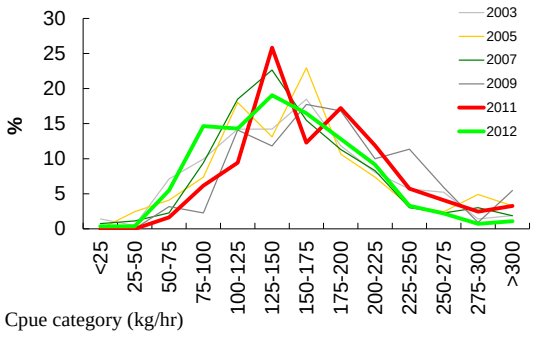


Western Zone – Strahan (Block 9)

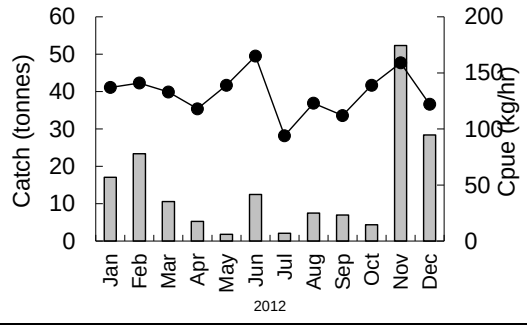
Regional view, cap set at 186t in 2012, 171 t caught



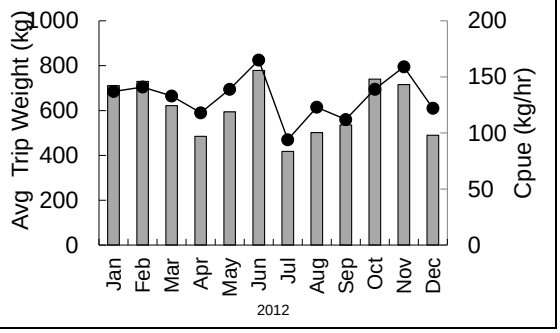
CPUE distribution:



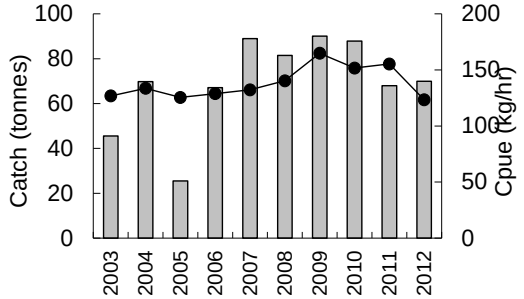
Regional catch and catch rates by month



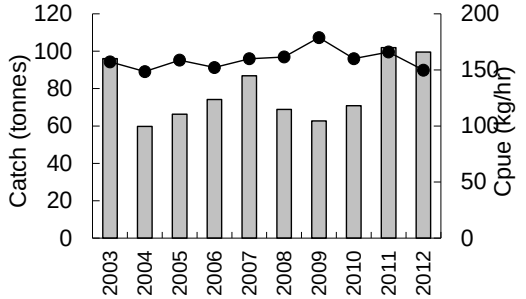
Average daily catch vs catch rate – month



Sub-block 9B
Cape Sorell to Gorge Point

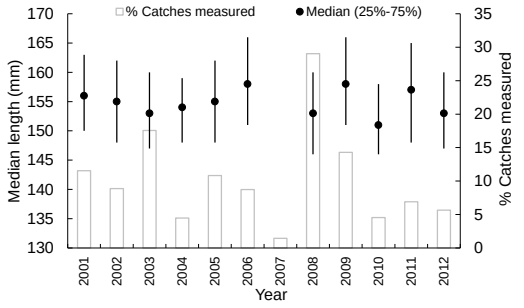


Sub-block 9C
Gorge Point to Point Hibbs

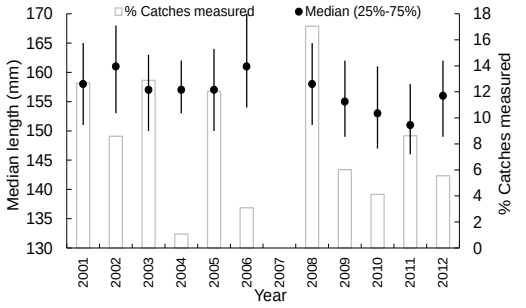


Western Zone – Strahan (Block 9)
Median length of catch

Sub-block 9B
Cape Sorell to Gorge Point

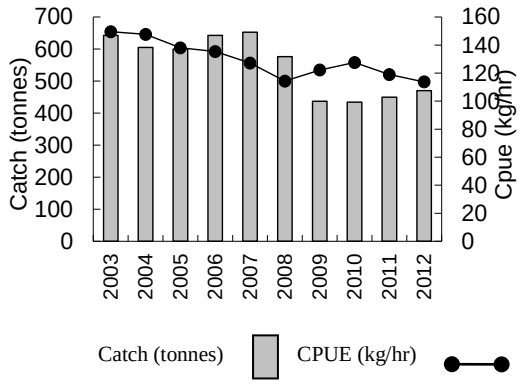


Sub-block 9C
Gorge Point to Point Hibbs

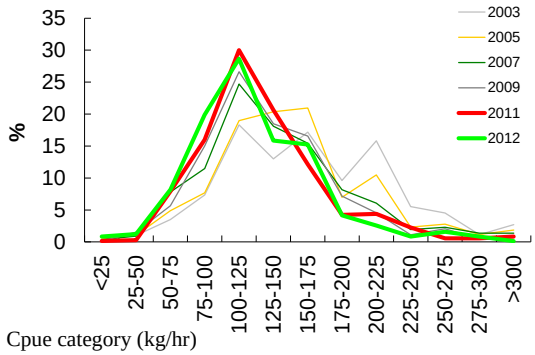


Western Zone - South West (Blocks 10-11, Sub-block 12A)

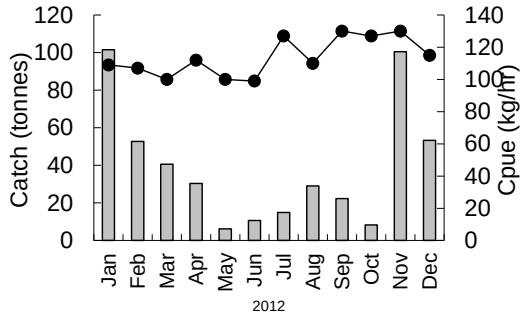
Regional view, no cap set, balance of WZ TAC 458 t, 470 t caught in 2012



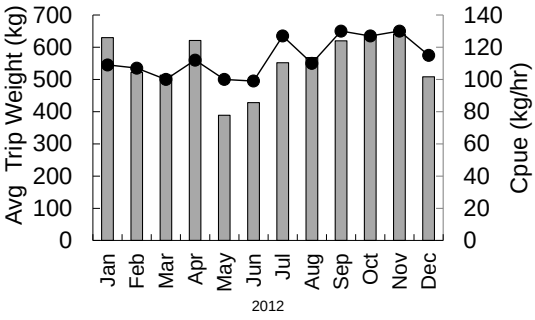
CPUE distribution:



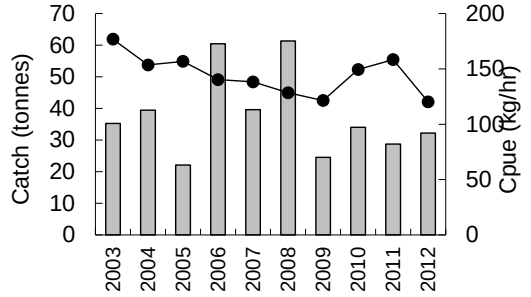
Regional catch and catch rates by month



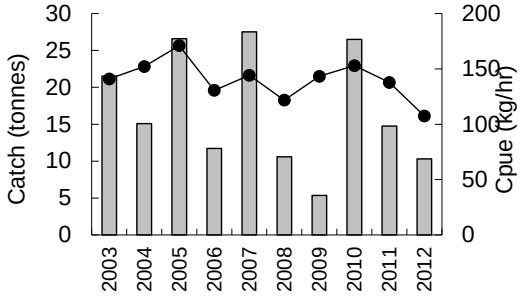
Average daily catch vs catch rate – month



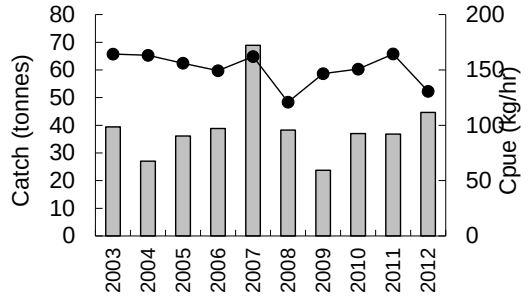
Sub-block 10A
Point Hibbs to Endeavour Bay



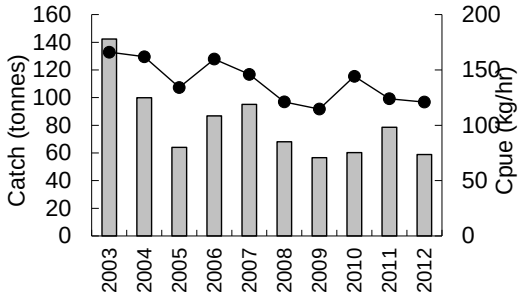
Sub-block 10B
Endeavour Bay to High Rocky Point



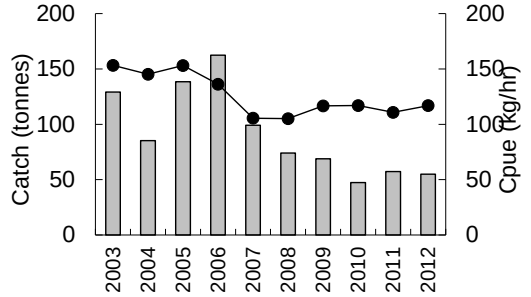
Sub-block 10C
High Rocky Point to Mainwaring River



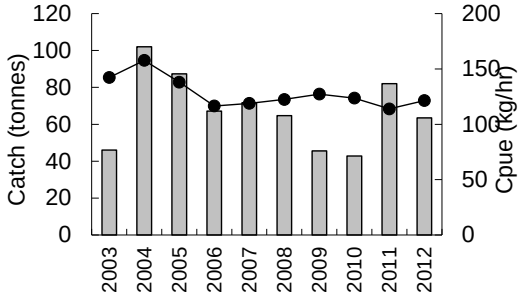
Sub-block 10D
Mainwaring River to Low Rocky Point



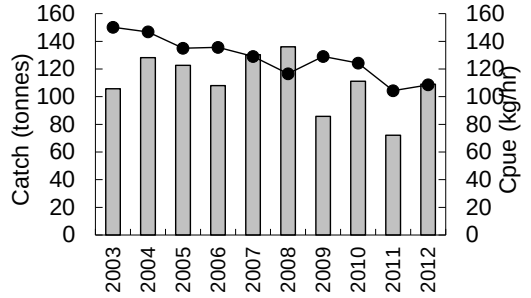
Sub-block 11A
Low Rocky Point to Elliott Point



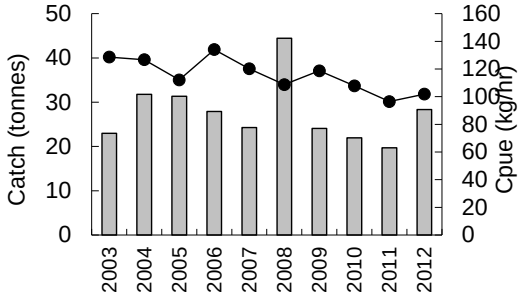
Sub-block 11B
Elliott Point to Svenor Gulches



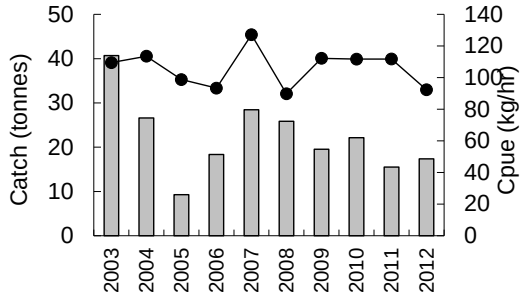
Sub-block 11C
Svenor Gulches to Point St Vincent



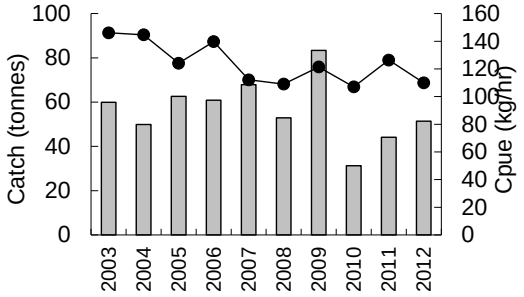
Sub-block 11D
Hilliard Head to Faults Bay



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

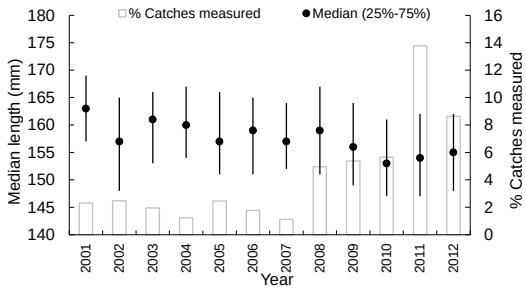


Sub-block 12A
Faults Bay to South West Cape

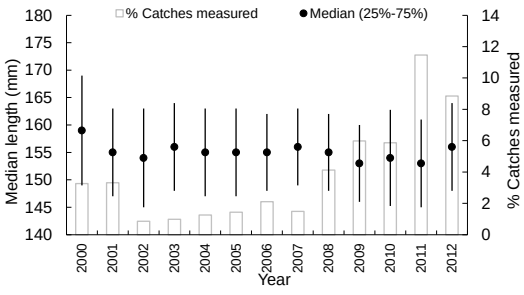


Western Zone - South West (Blocks 10-11, Sub-block 12A)
Median length of catch

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

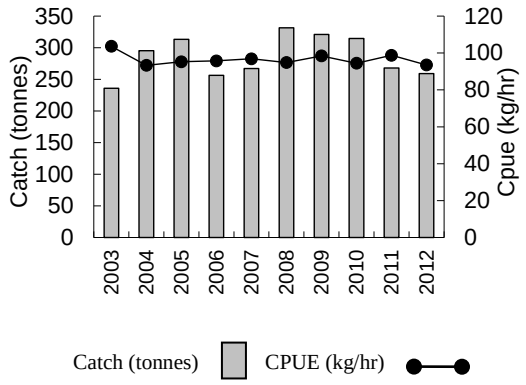


Block 11 (aggregated)
Low Rocky Point to Faults Bay
Note sampling rate below 4% prior to 2008

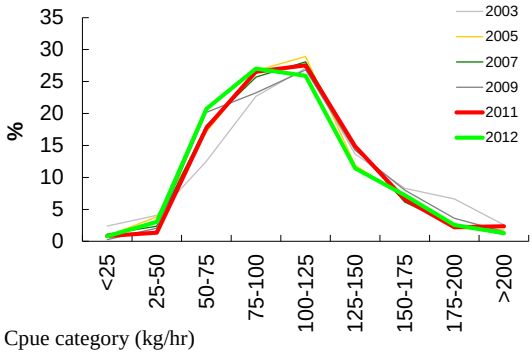


Western Zone - South Coast (Sub-blocks 12B, 12C, 12D, 13A, 13B)

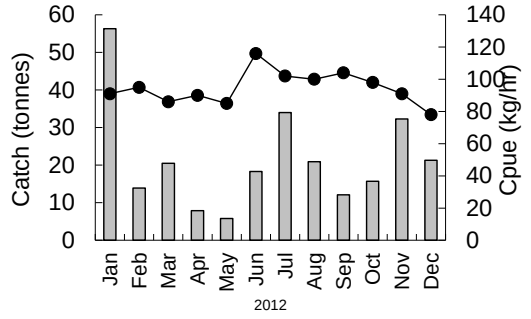
Region view, cap set at 260 t in 2012, 259 t caught



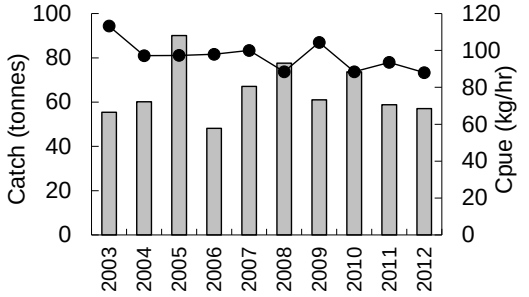
CPUE distribution:



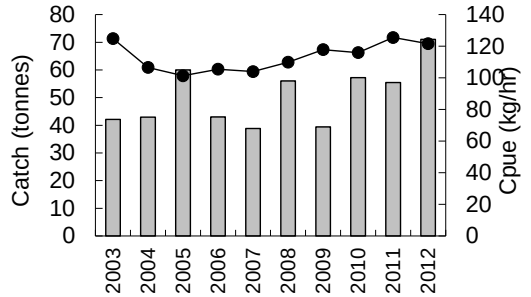
Regional catch and catch rates by month



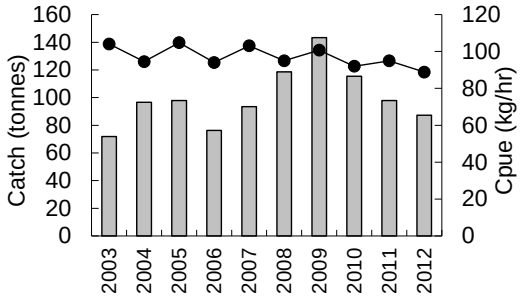
Sub-block 12B
South West Cape to Cox‘s Bluff



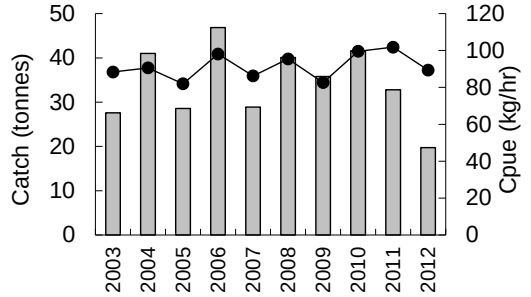
Sub-block 12C
Maatsuyker Group



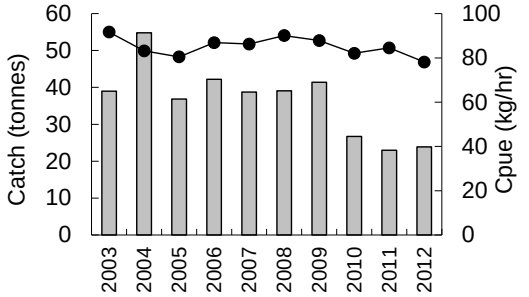
Sub-block 12D
Cox’s Bluff to Prion Beach



Sub-block 13A
Prion Beach to South Cape

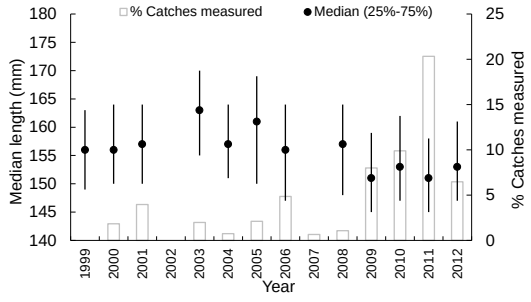


Sub-block 13B
South Cape to Whale Head

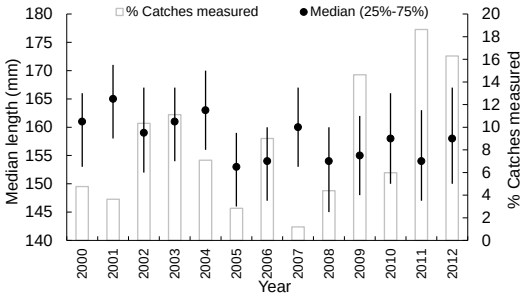


Western Zone - South Coast (Block 12, Sub-blocks 13A, 13B)
Median length of catch

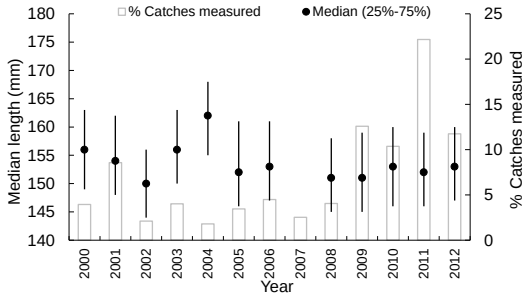
Sub-block 12B
South West Cape to Cox‘s Bluff



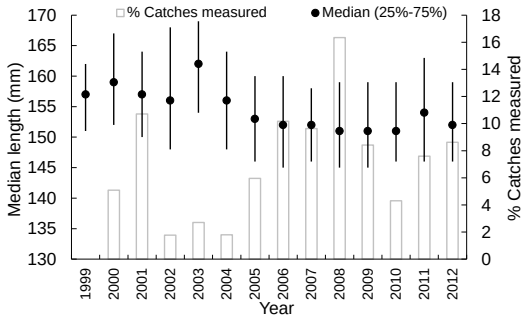
Sub-block 12C
Maatsuyker Group



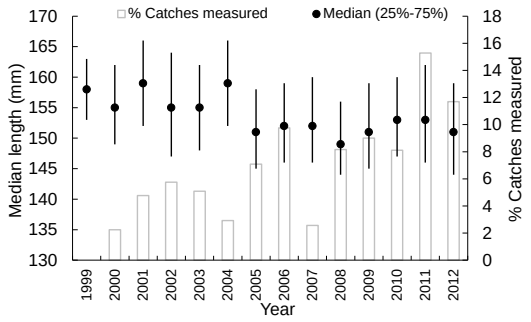
Sub-block 12D
Cox's Bluff to Prion Beach



Sub-block 13A
Prion Beach to South Cape



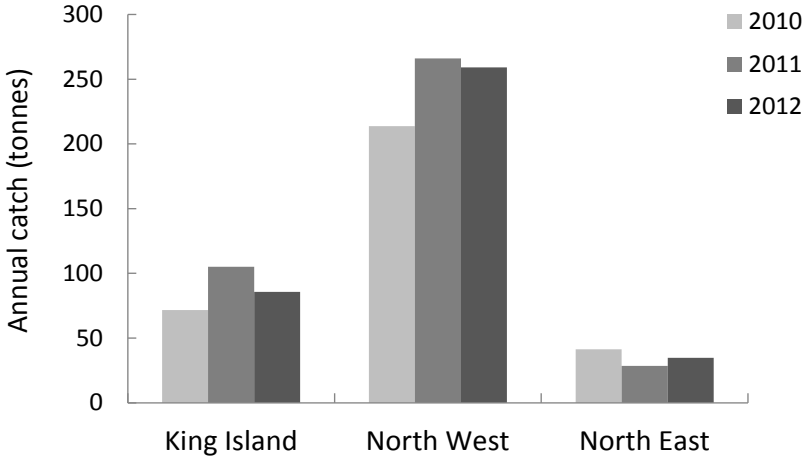
Sub-block 13B
South Cape to Whale Head



4.4 Northern Zone blacklip fishery

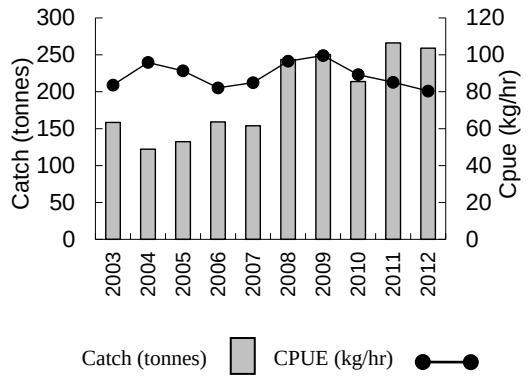
Until 2010, the southern part of the Furneaux Group blacklip fishery was in the Northern Zone. In 2010, the size limit operating there was reduced from 127mm to 114mm, and this part of the fishery as moved to the Bass Strait Zone.

Distribution of catch between Northern Zone regions:

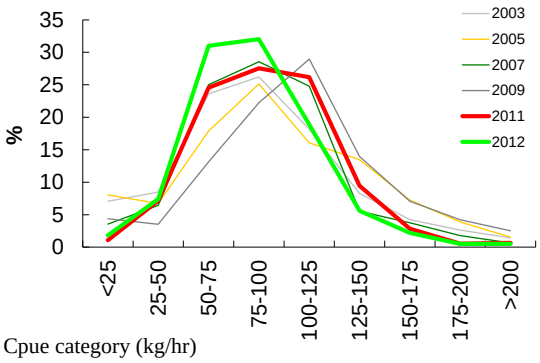


Northern Zone - North West (Blocks 5, 47- 49)

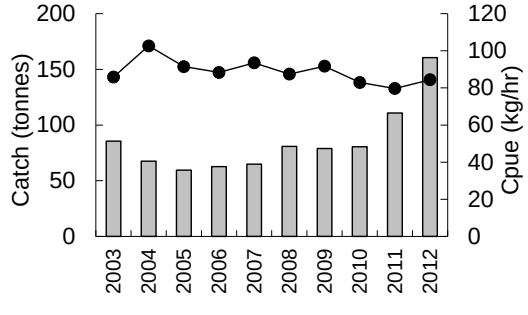
Regional view (Blocks 5, 47-49):



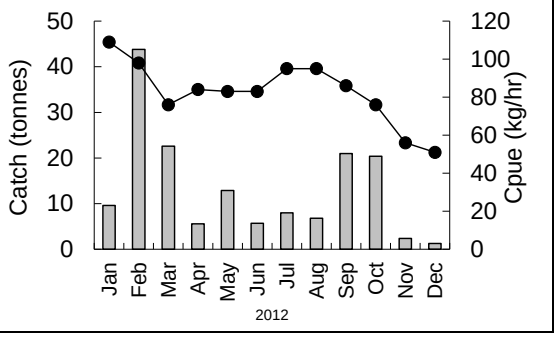
CPUE distribution:



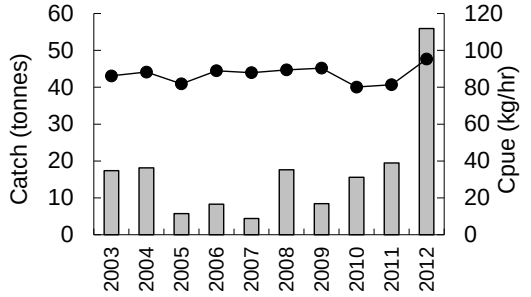
Blocks 47-49, area capped 130 t in 2012, 161 t caught.



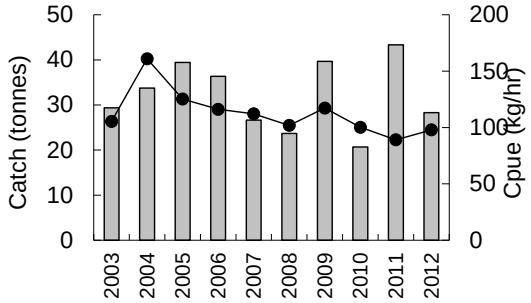
Blocks 47-49 catch and catch rates by month



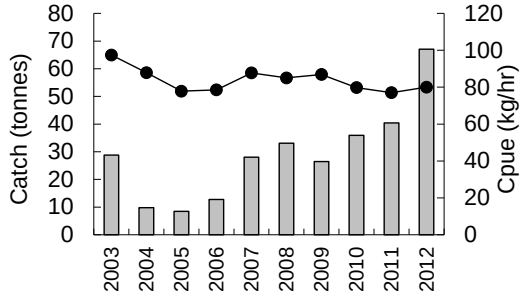
Sub-block 49A
Three Hummock Island



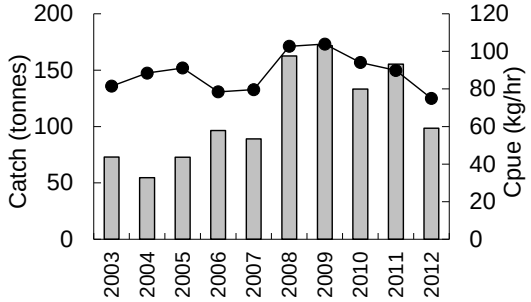
Sub-block 49B
Northern part of Hunter Island and Albatross Island



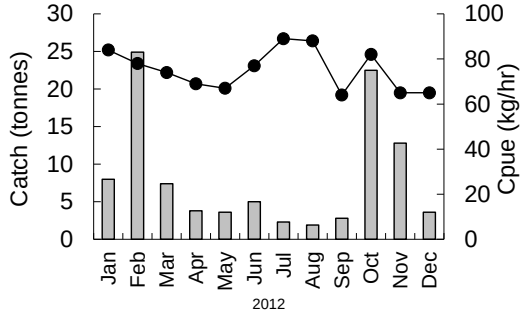
Sub-block 49C
South-western Hunter Island



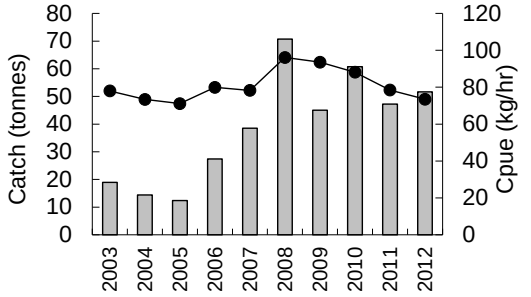
Block 5, area capped 122.5 t in 2012, 99 t caught.



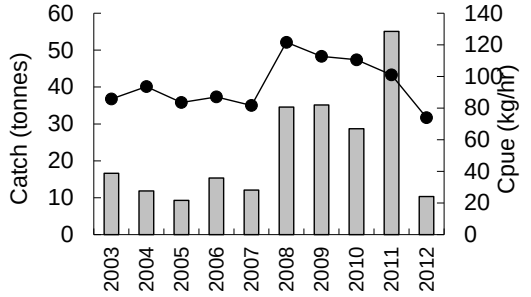
Block 5 catch and catch rates by month



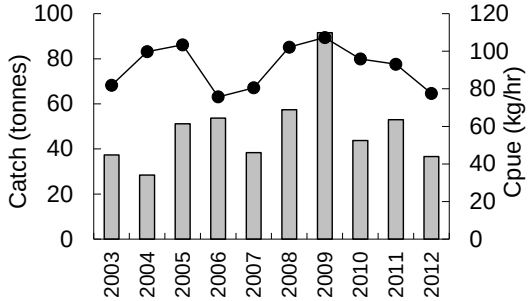
Sub-block 5A
Woolnorth Point to Studland Bay



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



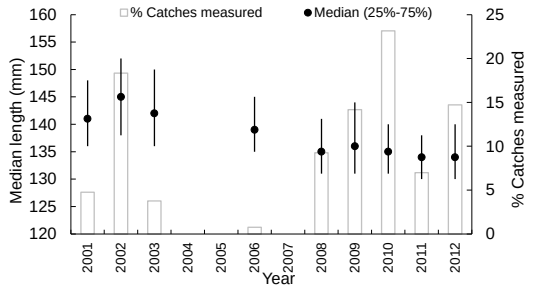
Sub-block 5C
Greens Beach to Arthur River



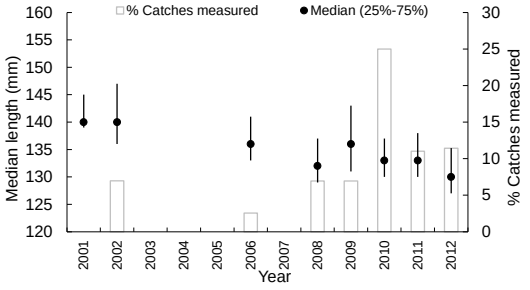
Northern Zone – North West (Blocks 5, 47- 49)

Median length of catch

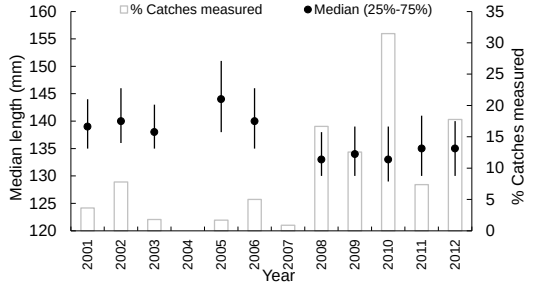
Sub-block 5A
Woolnorth Point to Studland Bay



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

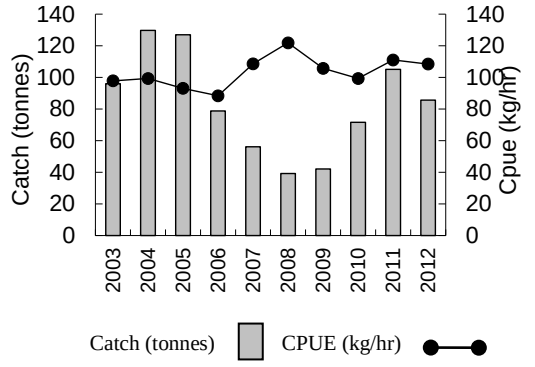


Sub-block 5C
Greens Beach to Arthur River

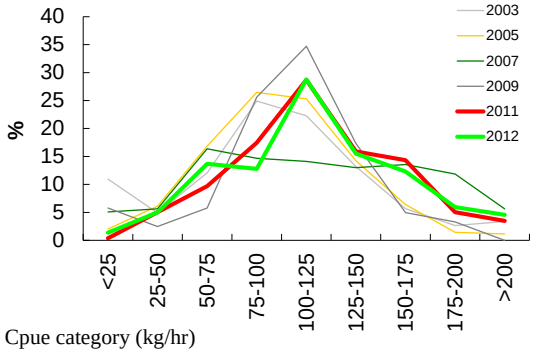


Northern Zone - King Island (Blocks 1-4)

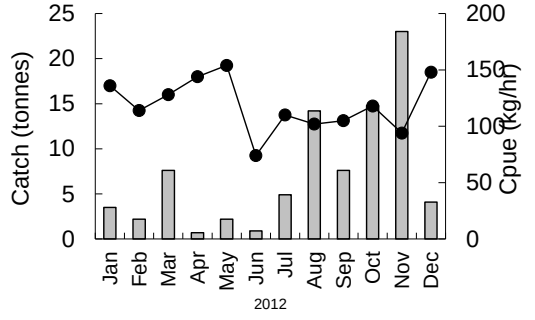
Regional view:
Area cap 95 t in 2012, 86 t caught.



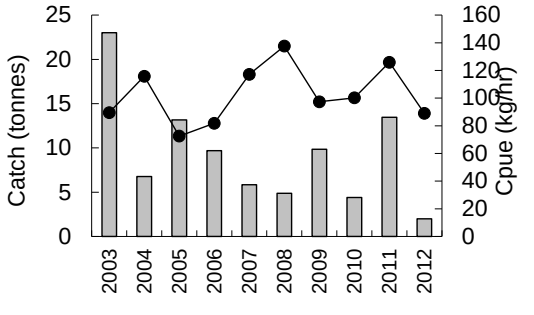
CPUE distribution:



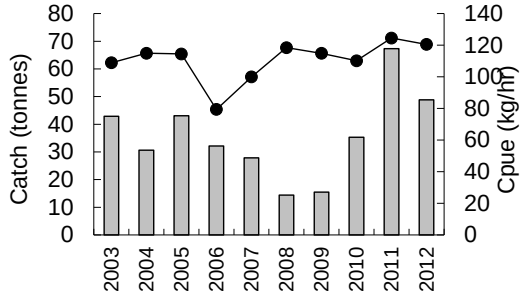
Regional catch and catch rates by month



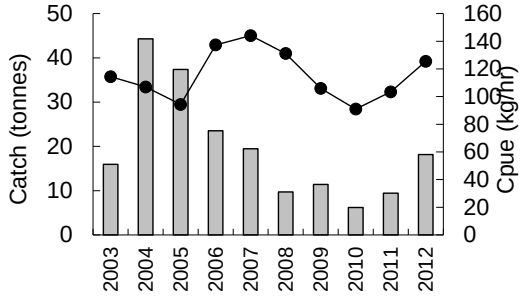
Sub-block 1C
North-west King Island



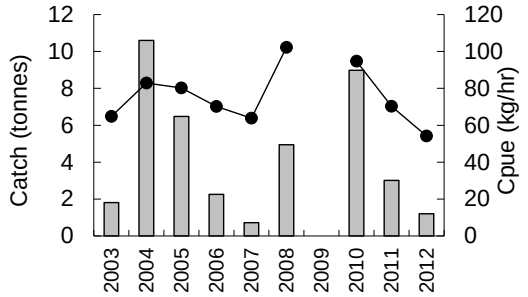
Sub-block 3A
west King Island



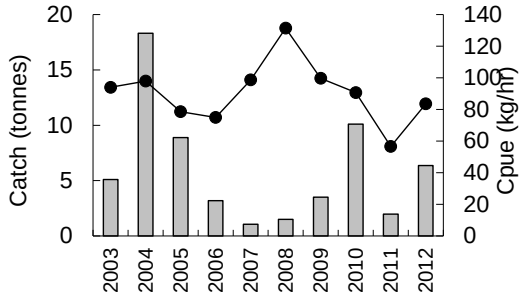
Sub-block 3C
South-west King Island



Sub-block 4B
South-east King Island

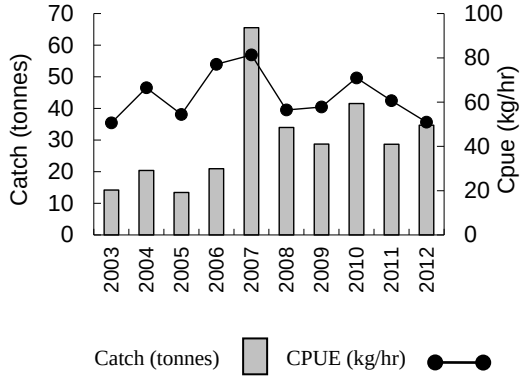


Sub-block 4C
South-east King Island

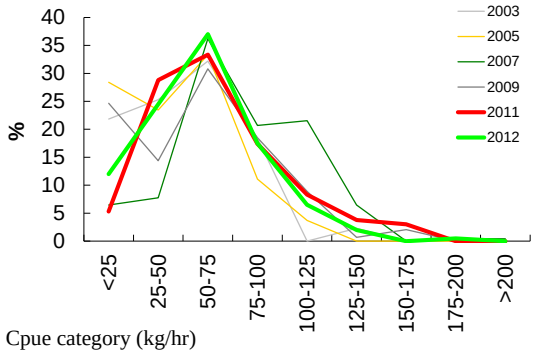


Northern Zone - North East (Sub-block 31B, Blocks 39, 40)

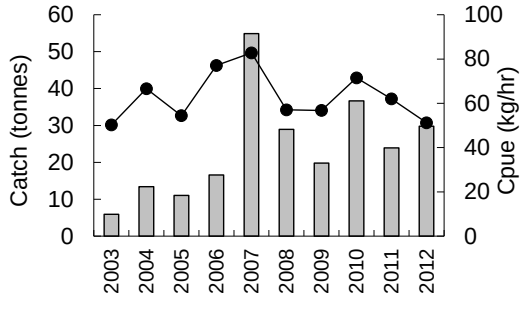
Regional view:
Area cap 30 t in 2012, 35 t caught.
Mixed catch CPUE removed



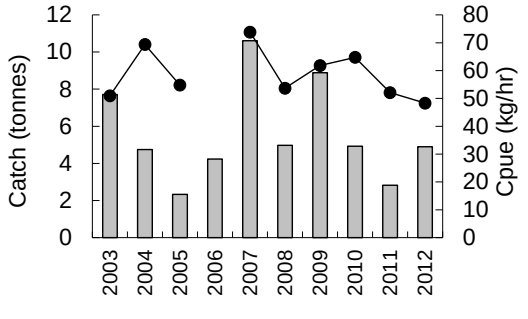
CPUE distribution:



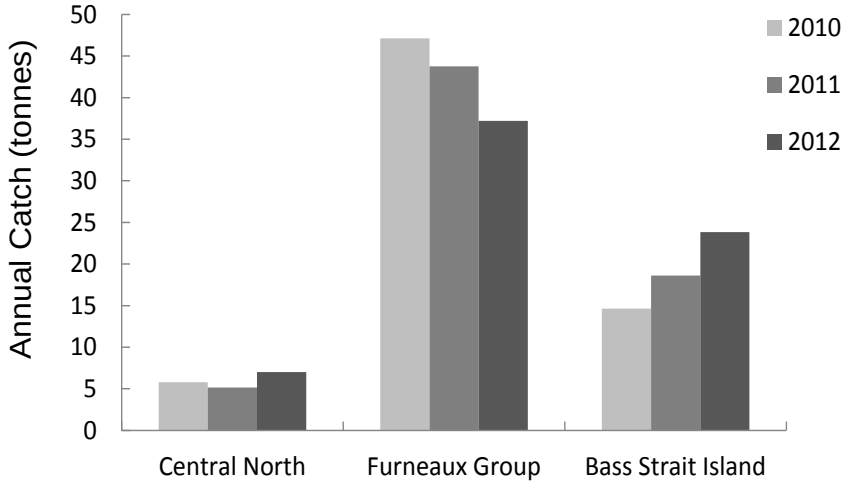
Sub-block 31B
Cape Naturaliste to Little Musselroe Bay
Mixed catch CPUE removed



Sub-block 39A
Little Musselroe Bay to Petal Point
Mixed catch CPUE removed

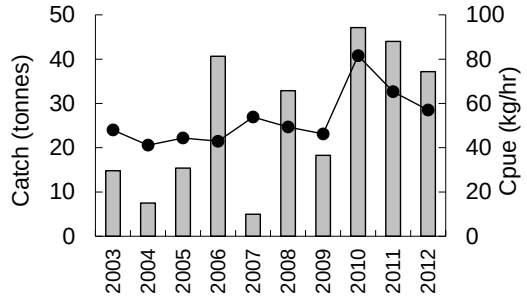


4.5 Bass Strait Zone blacklip fishery

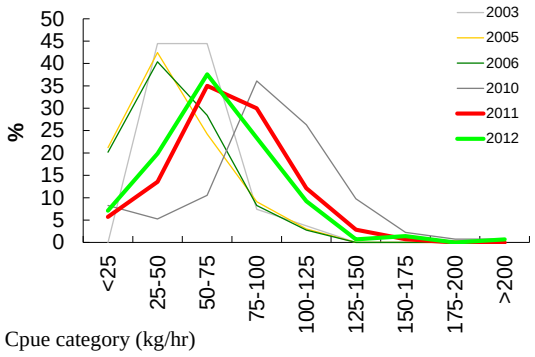


Bass Strait Zone - Furneaux Group (Blocks 32-38)

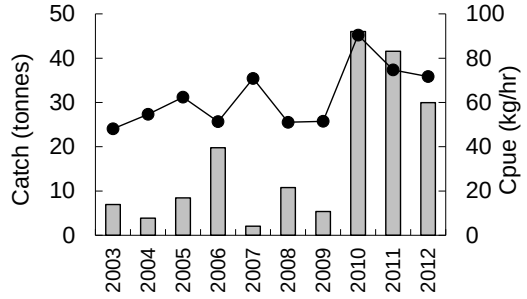
Furneaux Group: (Blocks 32-38)
Region cap 35 t in 2012, 37 t caught.
CPUE derived from mixed catches.



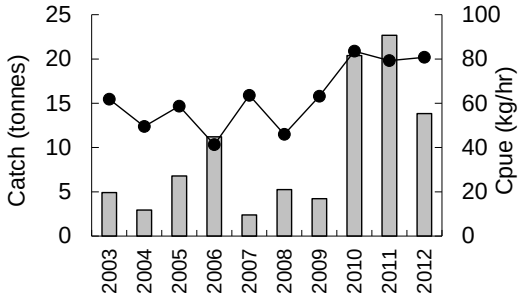
CPUE distribution:



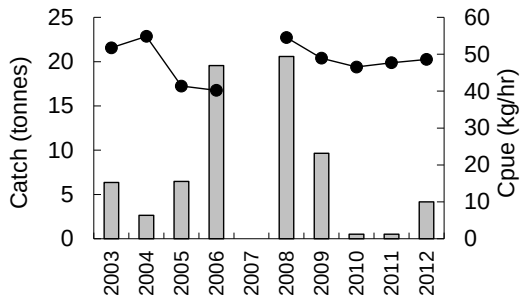
Furneaux Group: capped area (33B, 33C, 36A, 36B, 38A, 38B, 38C)



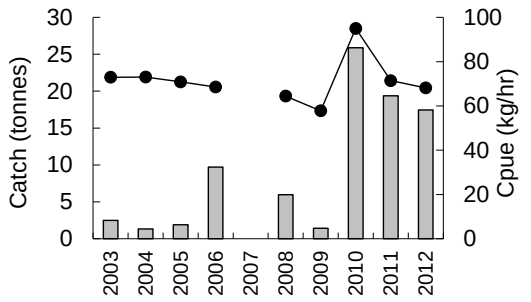
Block 33
South-east Furneaux Group
Mixed catch CPUE removed



Block 37
North Flinders Island, inc. Sisters Islands

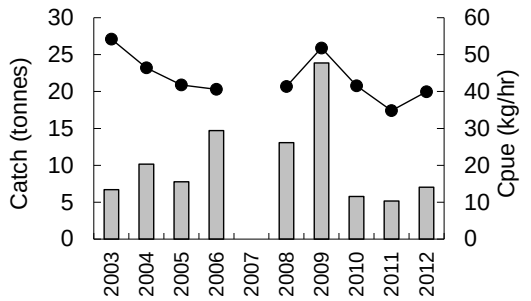


Block 38
East side of Flinders Island, inc. Babel Island



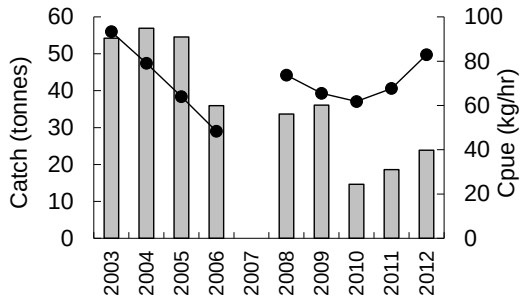
Bass Strait Zone – Central North Coast (Blocks 40-46)

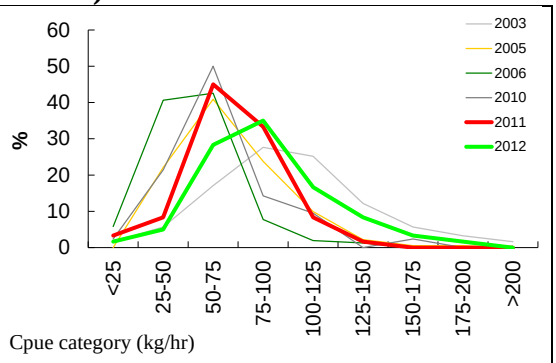
Central North (Blocks 40-46)



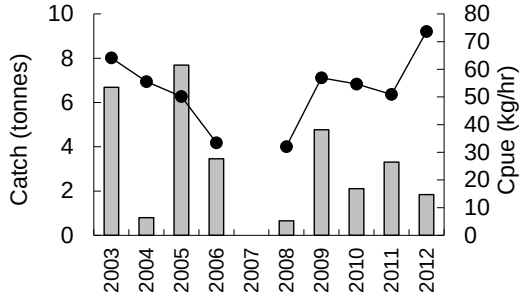
Bass Strait Zone – Remote Islands (Blocks 50-57)

Bass Strait Islands (Blocks 50-56)

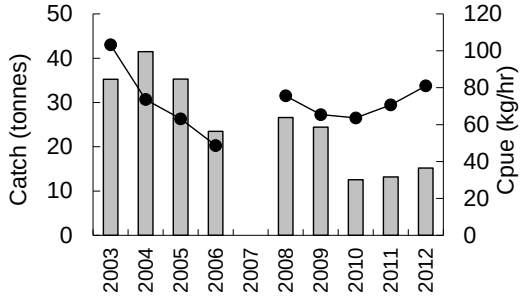


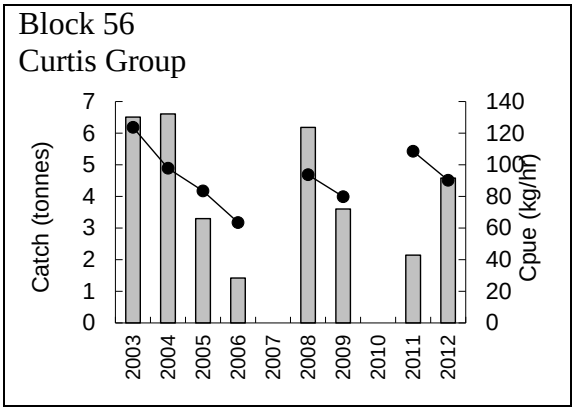


Block 51
Kent Group



Block 53
Hogan Group




Block 56
Curtis Group
Catch (tonnes)
Cpue (kg/hr)
0
1
2
3
4
5
6
7
0
20
40
60
80
100
120
140
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012

4.6 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. The 2012 greenlip TAC of 140 t was distributed between six regions:

King Island – 30 t
North West – 18 t
Perkins Bay- 20 t
Central North-10 t
North East – 23 t
Furneaux Group – 42 t

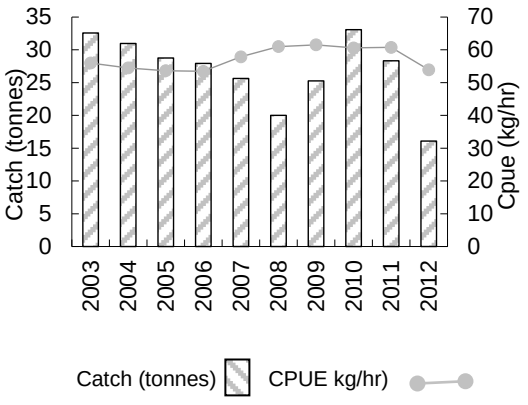
Annual catches:

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

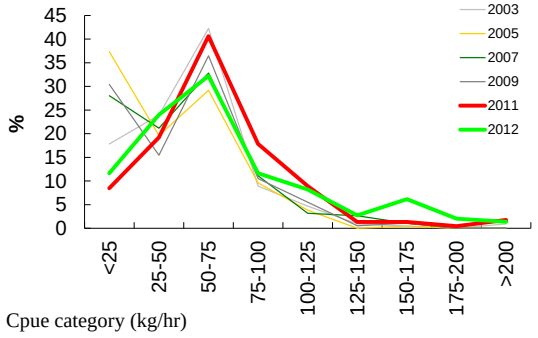
Small quantities (<1.0t pa) have been taken in recent years from Blocks 50 to 57.

Greenlip - King Island (Blocks 1-4)

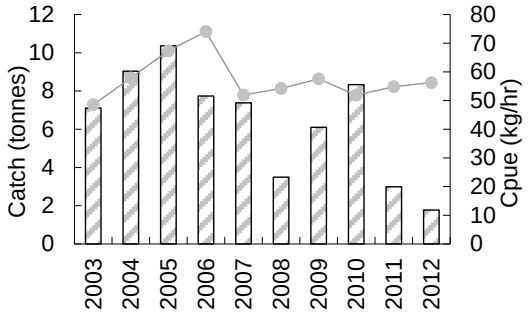
Blocks 1-4:



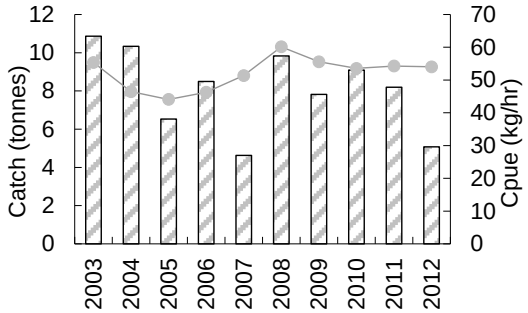
CPUE distribution:



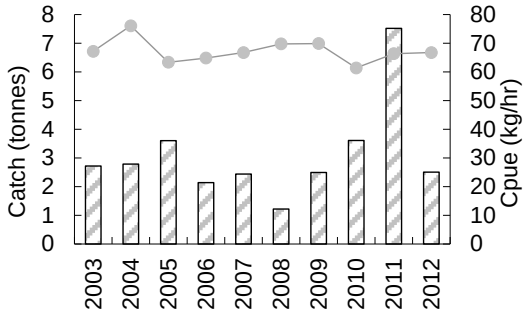
Sub-block 1B
north-west King Island



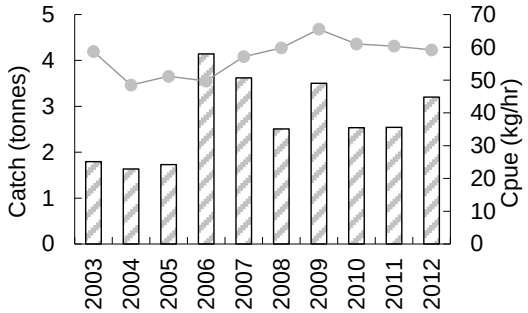
Sub-block 2C
east King Island



Sub-block 3A
west King Island

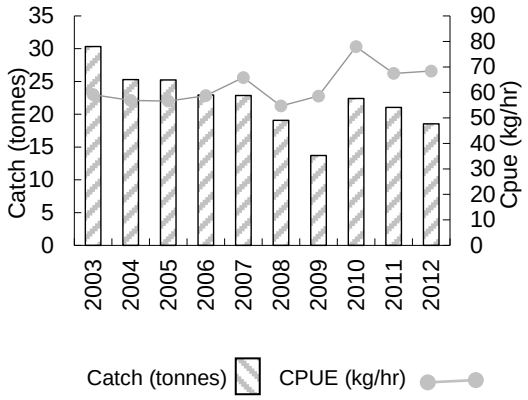


Sub-block 4A
South-east King Island



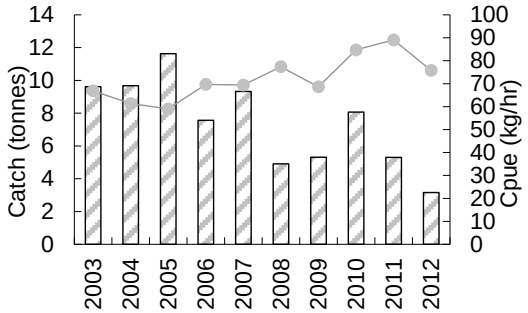
Greenlip - North West (Blocks 5, 48B, 48C, 49)

Regional view:

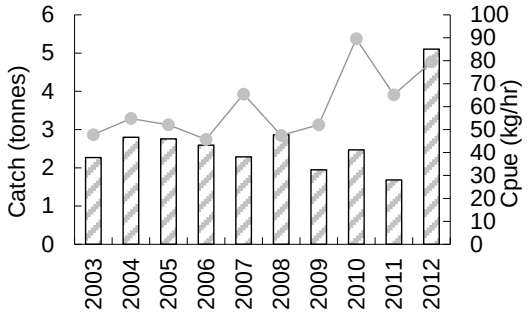


CPUE distribution:

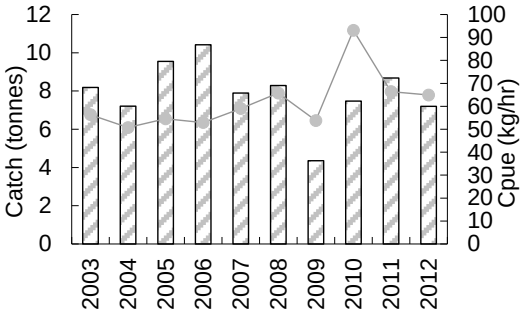
Sub-block 5A
west of Woolnorth Point



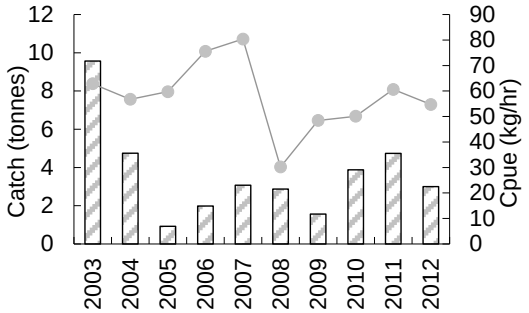
Sub-block 48B
Petrels



Sub-block 48C
Woolnorth to Robbins Island

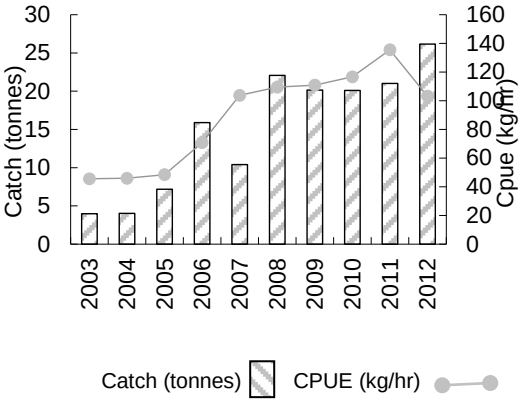


Sub-block 49C
west of Hunter island

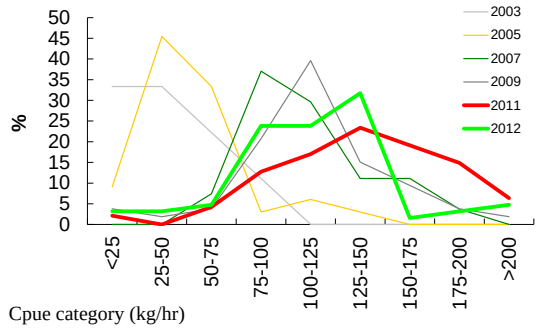


Greenlip – Perkins Bay (Sub-block 48A)

Sub-block 48A, Black Reef. 26t caught in 2012

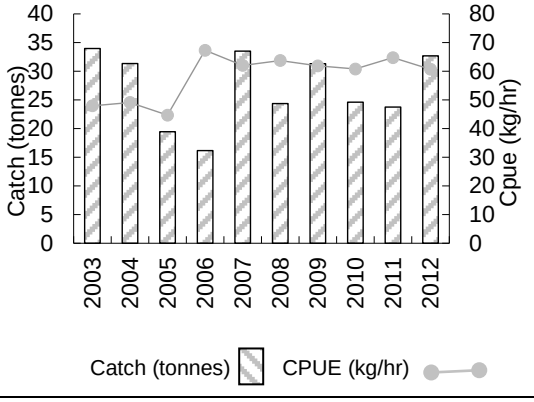


CPUE distribution:

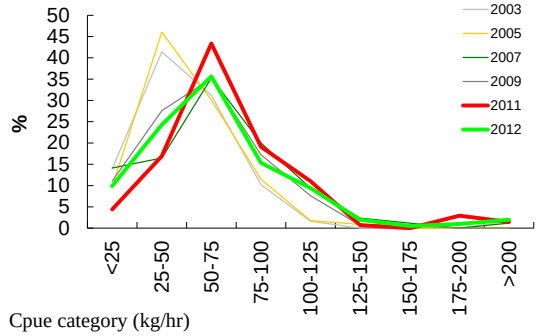


Greenlip - North East (Blocks 31, 39, 40)

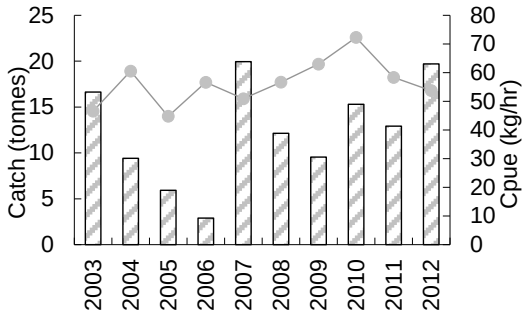
Regional view:
Mixed catch CPUE removed



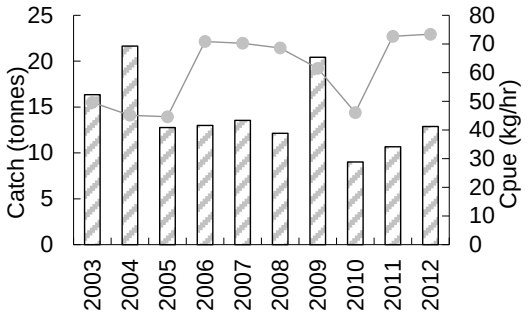
CPUE distribution:



Block 31
Eddystone to Little Musselroe, Swan Is.
Mixed catch CPUE removed

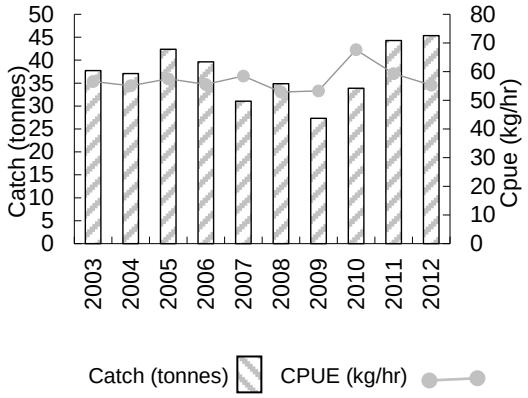


Block 39
Tomahawk to Little Musselroe
Mixed catch CPUE removed

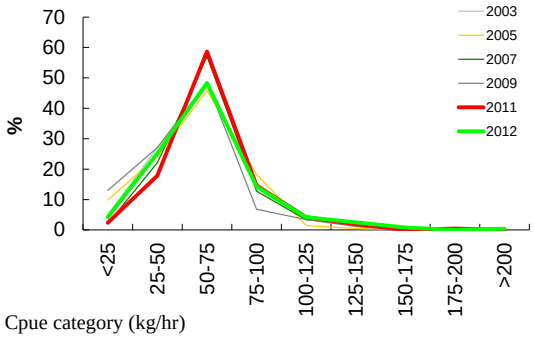


Greenlip – Furneaux Group (Blocks 32-38)

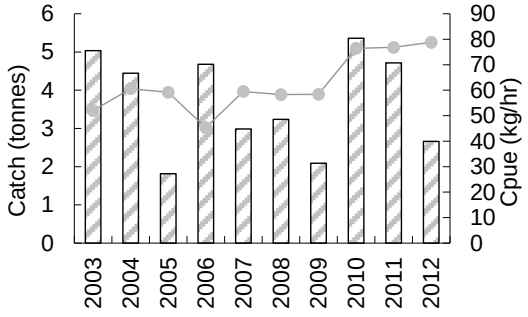
Regional view: 45 t caught
Mixed catch CPUE removed



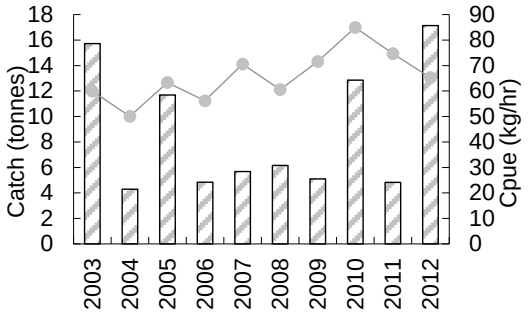
CPUE distribution:



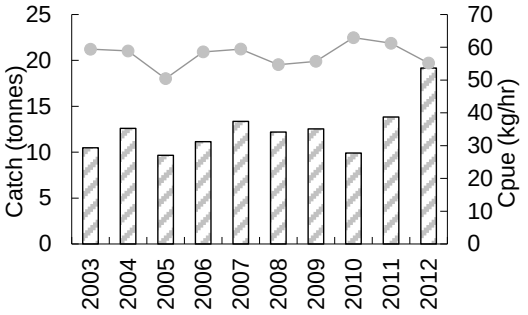
Block 32
western side of Clarke Is, Armstrong Passage, Mixed catch CPUE removed



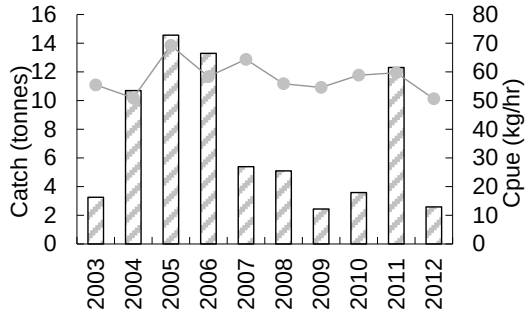
Block 33
south east Clarke, Cape Barren Islands
Mixed catch CPUE removed



Block 35
Franklin Sound



Block 38
north-east Flinders Island



5. 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 preliminary assigned fishery status prior to review by divers.

Region	Catch	CPUE	Length	Probable change in abundance
	stable	rising	rising	Stable or increasing abundance, low levels of fishing mortality enable growth of fish
	stable	rising	falling	Stable or increasing abundance, falling median length indicates substantial increase in recruits
	stable	rising	stable	Stable or increasing abundance, no effect on length of abalone detected
	stable	rising	no data or erratic	Stable or increasing abundance
	stable	falling	rising	Falling abundance, falling recruitment
	stable	falling	falling	Falling abundance, high fishing mortality reduces abalone length, serial depletion possible
Block 6 (CWZ)	stable	falling	stable	Falling abundance
	stable	falling	no data or erratic	Falling abundance
	stable	stable	rising	Increasing abundance, survival rates > fish mortality, sufficient to enable growth of median length
	stable	stable	falling	If catch and CPUE low, implies falling abundance through serial depletion, which maintains CPUE and catch, but fishing pressure reduces size. If catch and CPUE moderate to high, implies stable stock levels, increasing recruitment
South Coast (WZ)	stable	stable	stable	Abundance stable or falling
King Island (NZ) North West (G)	stable	stable	no data or erratic	Abundance stable or falling
	stable	erratic	rising	Depends on relative strength of CPUE, but in absence of rising CPUE, abundance probably falling
	stable	erratic	falling	
	stable	erratic	stable	
	stable	erratic	no data or erratic	

Region	Catch	CPUE	Length	Probable change in abundance
	falling	rising	rising	Insufficient exploitation for clear signal, indicates current levels of exploitation insufficient to impact on stocks, which could be at low or high levels
	falling	rising	falling	
	falling	rising	stable	
	falling	rising	no data or erratic	
Storm Bay (EZ), Bruny Is (EZ)	falling	falling	rising	Stock levels almost certainly falling, absence of recruits causes median length to rise, indicates weak recruitment
Block 5 (NZ)	falling	falling	falling	Stock levels almost certainly falling, high fishing mortality reduces median size
Actaeons (EZ)	falling	falling	stable	Stock levels almost certainly falling
King Island (G), Granville Hbr (CWZ), East Coast 22-28 (EZ)	falling	falling	no data or erratic	Stock levels almost certainly falling
	falling	stable	rising	Stock levels almost certainly falling, absence of recruits causes median length to rise, indicates weak recruitment
	falling	stable	falling	Stock levels almost certainly falling, high fishing mortality reduces median size
	falling	stable	stable	Stock levels almost certainly falling
Furneaux Group (BSZ)	falling	stable	no data or erratic	Stock levels almost certainly falling
	falling	erratic	rising	Stock levels stable or decreasing, less likely to be increasing.
	falling	erratic	falling	Stock levels stable or decreasing, less likely to be increasing.
	falling	erratic	stable	Stock levels stable or decreasing, less likely to be increasing.
Lower Channel (EZ)	falling	erratic	no data or erratic	Stock levels stable or decreasing, less likely to be increasing.

Region	Catch	CPUE	Length	Probable change in abundance
	rising	rising	rising	Increasing abundance, low levels of fishing mortality enable growth of fish
	rising	rising	falling	Increasing abundance, falling median length indicates substantial increase in recruits or size limit decrease
	rising	rising	stable	Increasing abundance
Bass Strait Islands (BSZ)	rising	rising	no data or erratic	Increasing abundance
	rising	falling	rising	Stock levels falling, reduced recruit levels
South West (WZ)	rising	falling	falling	Stock levels falling, increasing fishing mortality
Couta Block 6(CWZ)	rising	falling	stable	Stock levels falling
Perkins Bay (G), Furneaux Group (G), North East (G), Block 9 (WZ), Block 49 (NZ), Block 31 (EZ)	rising	falling	no data or erratic	Stock levels falling
	rising	stable	rising	Stock levels stable or increasing, less likely to be decreasing
	rising	stable	falling	Stock levels stable or increasing, less likely to be decreasing
	rising	stable	stable	Stock levels stable or increasing, less likely to be decreasing
Blocks 29-30 (EZ)	rising	stable	no data or erratic	Stock levels stable or increasing, less likely to be decreasing
	rising	erratic	rising	No clear signal
	rising	erratic	falling	No clear signal
	rising	erratic	stable	No clear signal
	rising	erratic	no data or erratic	No clear signal
	erratic	rising	rising	No clear signal
	erratic	rising	falling	No clear signal
	erratic	rising	stable	No clear signal
	erratic	rising	no data or erratic	No clear signal

Region	Catch	CPUE	Length	Probable change in abundance
North East (NZ)	erratic	falling	rising	No clear signal
	erratic	falling	falling	No clear signal
	erratic	falling	stable	No clear signal
	erratic	falling	no data or erratic	No clear signal
	erratic	stable	rising	No clear signal
	erratic	stable	falling	No clear signal
	erratic	stable	stable	No clear signal
	erratic	stable	no data or erratic	No clear signal
Central North Coast (BSZ)	erratic	erratic	rising	No clear signal
	erratic	erratic	falling	No clear signal
	erratic	erratic	stable	No clear signal
	erratic	erratic	no data or erratic	No clear signal

6. 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 6 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.

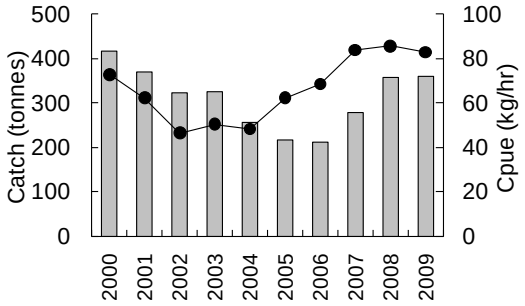


Figure 6. Annual catch (tonnes) and geometric mean catch rates (kg/hour), 2000 - 2009.

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 7). 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.

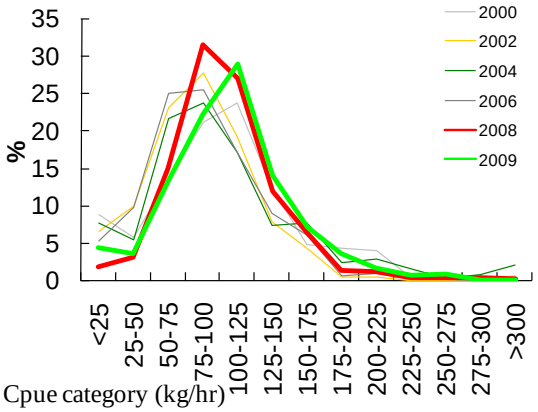


Figure 7. The percentage distribution of catch-rates, 2000 - 2009.

Size-composition charts.

The size-composition of divers' catches is reviewed at sub-block level (Figure 8). 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.

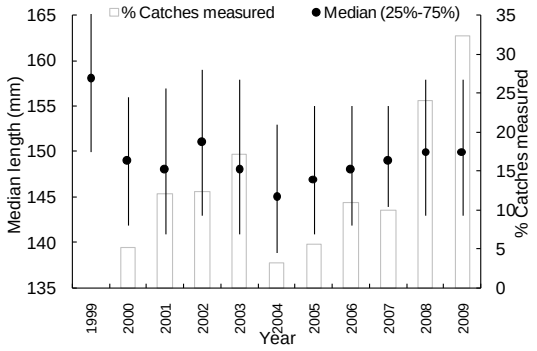


Figure 8. Median length with 25%-75% inter-quartile size range of abalone from commercial catch samples. The vertical columns represent the percentage of catches sampled.

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.

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

7.1 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 9).

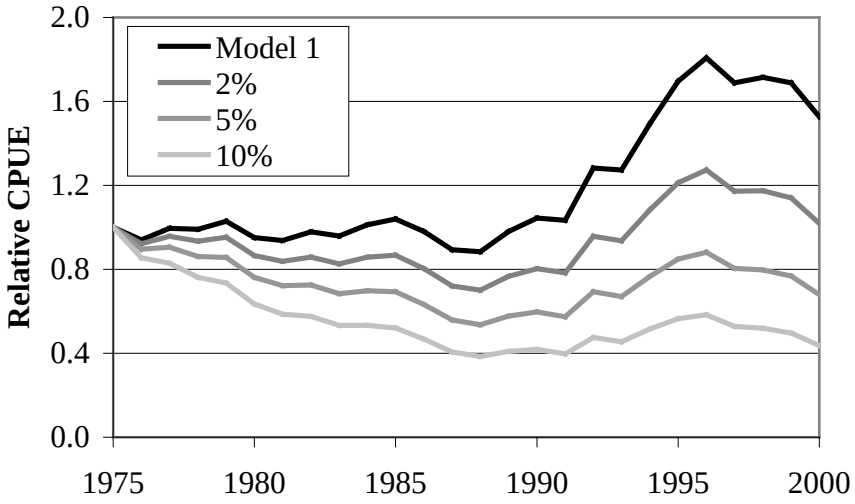


Figure 9. Relative CPUE indices for Block 13, 1975-2000. Model 1 is the raw geometric mean of CPUE. The three effort creep scenarios considered are: (i) 2% per annum; (ii) 5% per annum; and (iii) 10% per annum. All values of CPUE are relative to 1975 (Tarbath et al., 2001).

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.

7.2 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.

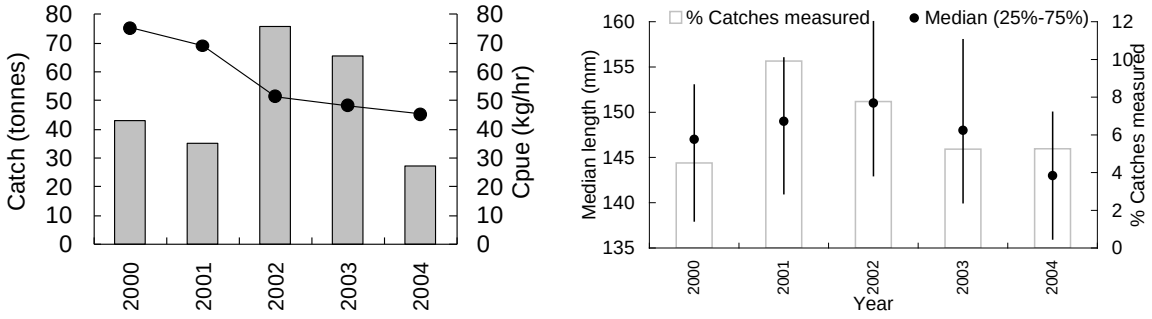


Figure 10. Trends in catch, catch rate and median length (flanked by the 25th and 75th percentile bounds), sub-block 13C, 2000-2004.

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 10). 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 10).

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 11).

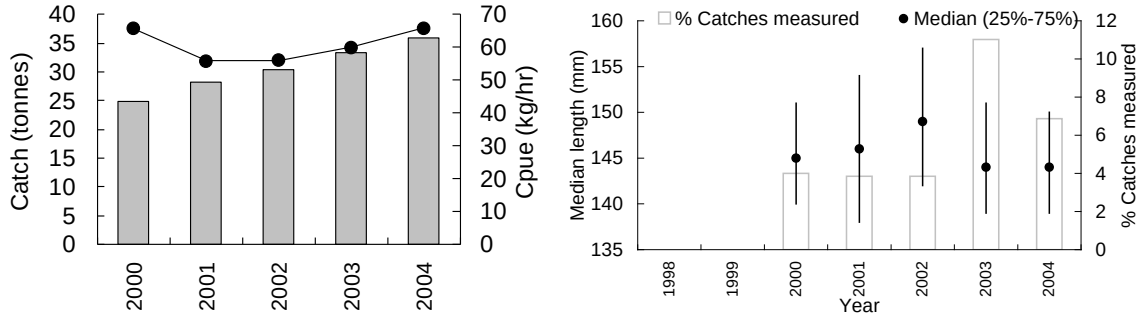


Figure 11. Trends in catch, catch rate and median length (flanked by the 25th and 75th percentile bounds), sub-block 20B, 2000-2004.

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 12). 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 10), the size-structure has been maintained, indicating that the levels of fishing pressure currently appear to be sustainable.

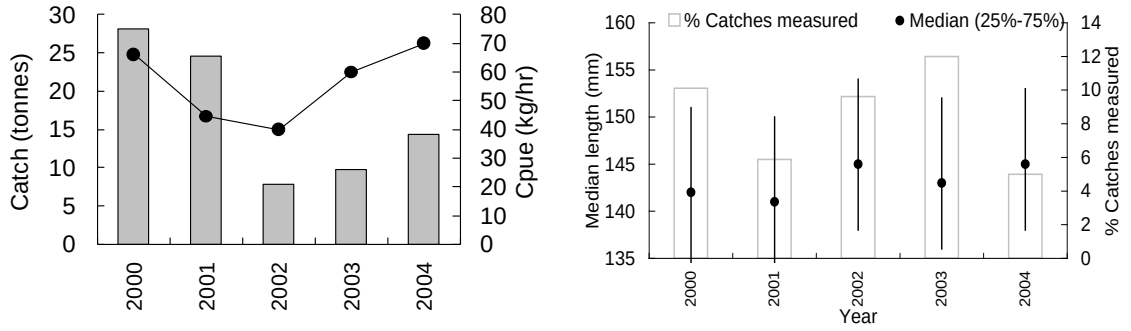


Figure 12. Trends in catch, catch rate and median length (flanked by the 25th and 75th percentile bounds), sub-block 24B, 2000-2004.

8. 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.

9. Appendix 6: Annual Catches by Zone – 1975-2012

Eastern Zone

The Eastern Zone comprises Sub-blocks 13C, 13D, 13E, Blocks 14 to 30 and Sub-block 31A). The Western and Eastern Zones were not established until 2000, and the Northern Zone until 2001; prior to those years catches cannot be accurately assigned to zones in blocks where zone boundaries occur (Blocks 13 and 31). Catches in these blocks are reported as Eastern Zone because the majority of later catches occurred there, and consequently the average catch for these two blocks may be overestimated.

	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
Average 75-12		283	160	5	87	30	2	59	55	50
Average 85-12		284	134	4	70	31	3	67	57	51
Average 00-12		291	81	2	57	15	2	65	54	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
Average 75-12		36	72	7	7	73	47	22	53	49	1097
Average 85-12		27	73	3	6	71	30	19	24	43	994
Average 00-12		20	64	0	2	49	8	25	5	36	834

Central Western Zone

Annual tonnages of blacklip abalone caught within the statistical blocks and sub-blocks comprising the Central Western Zone (Sub-block 5D, Blocks 6, 7 and 8). Catches from Block 5 prior to 2001 are reported in the Northern Zone.

	Year	5	6	7	8	Total
Estimated weights	1975		110	36	42	188
	1976		63	56	77	196
	1977		50	24	22	96
	1978		79	13	27	118
	1979		112	19	23	154
	1980		196	81	63	340
	1981		257	88	87	432
	1982		147	34	34	215
	1983		231	102	58	390
	1984		298	78	38	413
Landed weights	1985		322	99	23	444
	1986		213	97	11	321
	1987		185	84	44	313
	1988		241	53	27	320
	1989		192	49	46	287
	1990		197	56	21	275
	1991		169	54	30	253
Estimated weights	1992		235	70	36	341
	1993		154	64	38	256
	1994		79	33	38	150
	1995		112	30	17	159
	1996		103	67	13	183
	1997		98	75	28	201
	1998		126	51	27	204
	1999		149	60	24	233
	2000		183	61	23	266
	2001	0	210	32	15	257
	2002	2	173	51	17	243
	2003	0	97	104	27	229
	2004	3	88	89	22	203
	2005	6	95	110	26	236
	2006	4	109	76	6	196
	2007	0	76	39	18	133
	2008	0	105	51	9	166
	2009	0	143	107	51	301
	2010	0	150	110	37	297
	2011	1	151	95	48	295
	2012	1	185	97	19	302
	Average 75-12	1	155	66	32	253
	Average 85-12	1	155	70	27	252
	Average 00-12	1	136	79	25	240

Western Zone

Annual tonnages of blacklip abalone caught within the statistical blocks and sub-blocks comprising the Western Zone in 2009 (Blocks 9 to 12, Sub-blocks 13A, 13B). Pre-zoning (1975-1999) catches from Block 13 are reported in the Eastern Zone.

	Year	9	10	11	12	13	Total
Estimated weights	1975	126	130	191	143		590
	1976	252	179	240	153		824
	1977	123	98	153	189		562
	1978	115	258	275	208		855
	1979	172	166	269	325		933
	1980	316	195	338	351		1200
	1981	444	260	417	246		1366
	1982	249	100	303	235		887
	1983	199	174	430	242		1045
	1984	248	284	681	258		1471
Landed weights	1985	246	140	478	155		1019
	1986	133	127	289	193		742
	1987	252	82	339	195		868
	1988	159	124	270	162		715
	1989	120	109	212	144		586
	1990	95	80	232	125		532
	1991	102	106	219	140		567
Estimated weights	1992	91	95	266	159		611
	1993	110	65	197	177		548
	1994	77	60	202	160		499
	1995	44	68	186	182		479
	1996	59	75	145	148		428
	1997	140	66	224	227		657
	1998	78	47	163	192		480
	1999	115	58	220	251		645
	2000	205	148	326	282	54	1015
	2001	186	152	312	290	43	983
	2002	174	143	360	236	93	1005
	2003	142	239	345	229	67	1023
	2004	130	181	374	250	96	1031
	2005	92	149	389	311	65	1006
	2006	142	198	384	228	89	1041
	2007	178	231	354	267	68	1097
	2008	156	178	345	305	79	1064
	2009	155	110	244	327	77	913
	2010	159	158	245	277	68	907
	2011	171	159	247	256	56	889
	2012	172	146	273	267	44	903
	Average 75-12	161	140	293	223	69	842
	Average 85-12	139	125	280	219	69	795
	Average 00-12	159	169	323	271	69	990

Northern Zone

The Northern Zone comprises 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
Average 75-12		24	4	2	3	19	38	111	16	4	32	15	252
Average 85-12		24	4	2	3	15	46	110	13	5	29	14	250
Average 00-12		24	6	1	0	8	71	105	9	1	50	13	286

Bass Strait Zone

Annual tonnages of blacklip abalone caught within statistical blocks comprising the Bass Strait Zone. 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
Average 75-12		1	6	0	1	1	5	3	1	1	2	0
Average 85-12		1	6	0	1	0	6	3	2	1	3	0
Average 00-12		1	9	0	0	0	5	7	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
Average 75-12		0	1	0	4	0	10	1	0	2	1	39
Average 85-12		0	1	0	5	0	13	1	0	2	1	48
Average 00-12		0	1	0	2	0	18	2	1	3	1	55

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
Average 75-12		5	13	5	25	9	4	6	17	9	3	1	0	1	0
Average 85-12		5	11	3	18	4	3	5	18	11	3	1	0	1	0
Average 00-12		5	10	2	12	2	2	6	13	15	2	0	0	0	0

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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
Average 75-12		0	1	7	26	4	8	8	18	2	7	178
Average 85-12		0	1	8	27	5	7	10	22	2	9	174
Average 00-12		0	0	0	26	5	8	9	8	3	4	132

10. 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
,         ROUND(f.blacklip_estimated_weight,0) blips,
ROUND(f.greenlip_estimated_weight,0) glips,    NVL(dive_time_1,0) + NVL(dive_time_2,0) +
NVL(dive_time_3,0) total_time
FROM qms.abalone_fishing_details f
   , qms.quota_dockets d
   , lmm.clients n3
WHERE EXTRACT(year FROM f.fishing_date)= 2012
   AND d.qudo_id = f.qudo_id
   AND n3.client_id = d.docket_signatory_id
ORDER BY
f.fishing_date  asc
```

11. Appendix 8: Treatment of errors in catch data in 2012

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.

12. 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.

13. Appendix 10: History of Management Changes

This history has been compiled from a number of sources, principal among which has been DPIW'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 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 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 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 145mm to 132mm, 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).

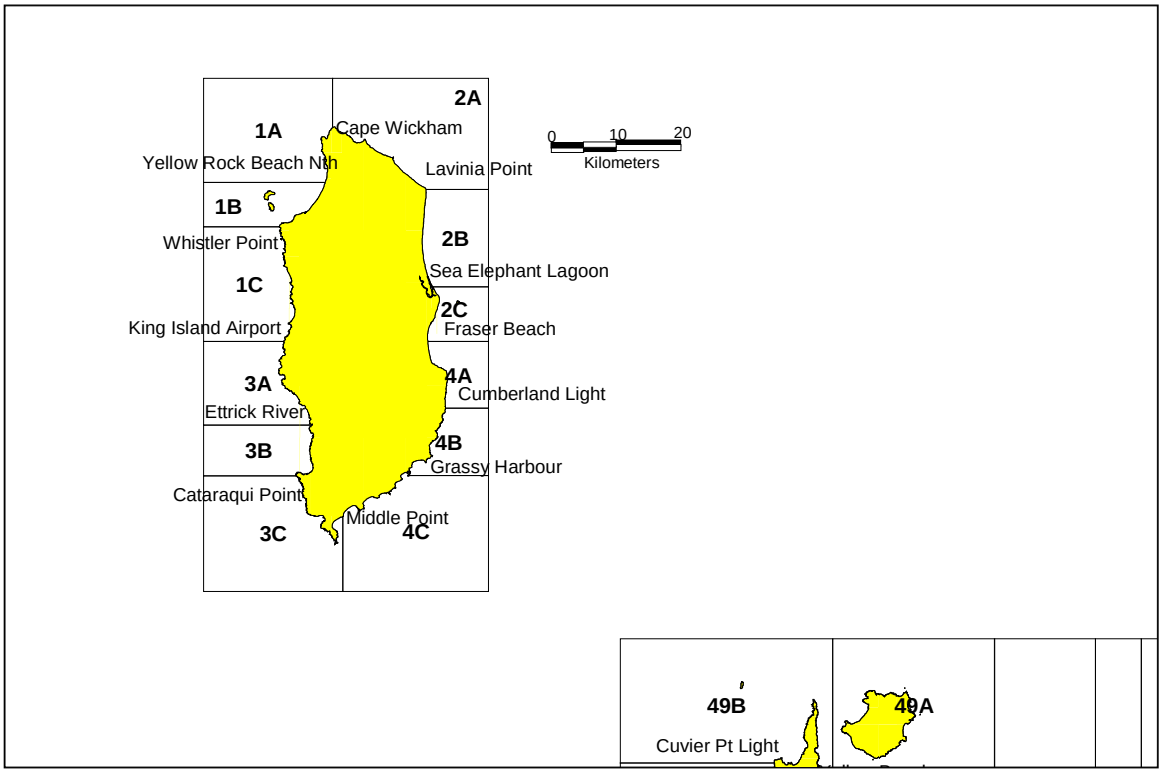
	King Island greenlip closed on 13 December, cap 30 t (32 t).
2011	Eastern Zone TAC decreased to 721 t (206 kg/unit) Western Zone TAC remained 924 t (264 kg/unit) Central Western Zone remained 304.5 t (87 kg/unit) Northern Zone TAC increased to 402.5 t (115 kg/unit) Greenlip TAC increased to 143.5 t (41 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. 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 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. 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.

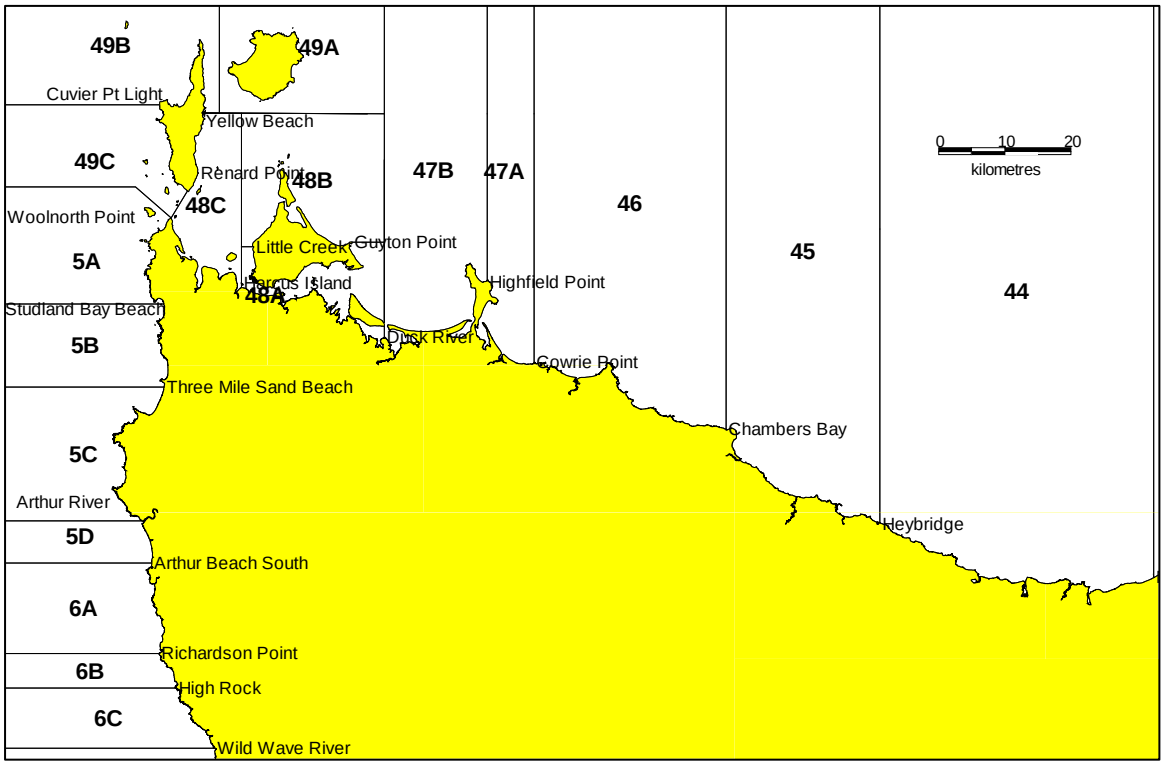
14. Appendix 11: Maps of catch-reporting blocks and sub-blocks

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

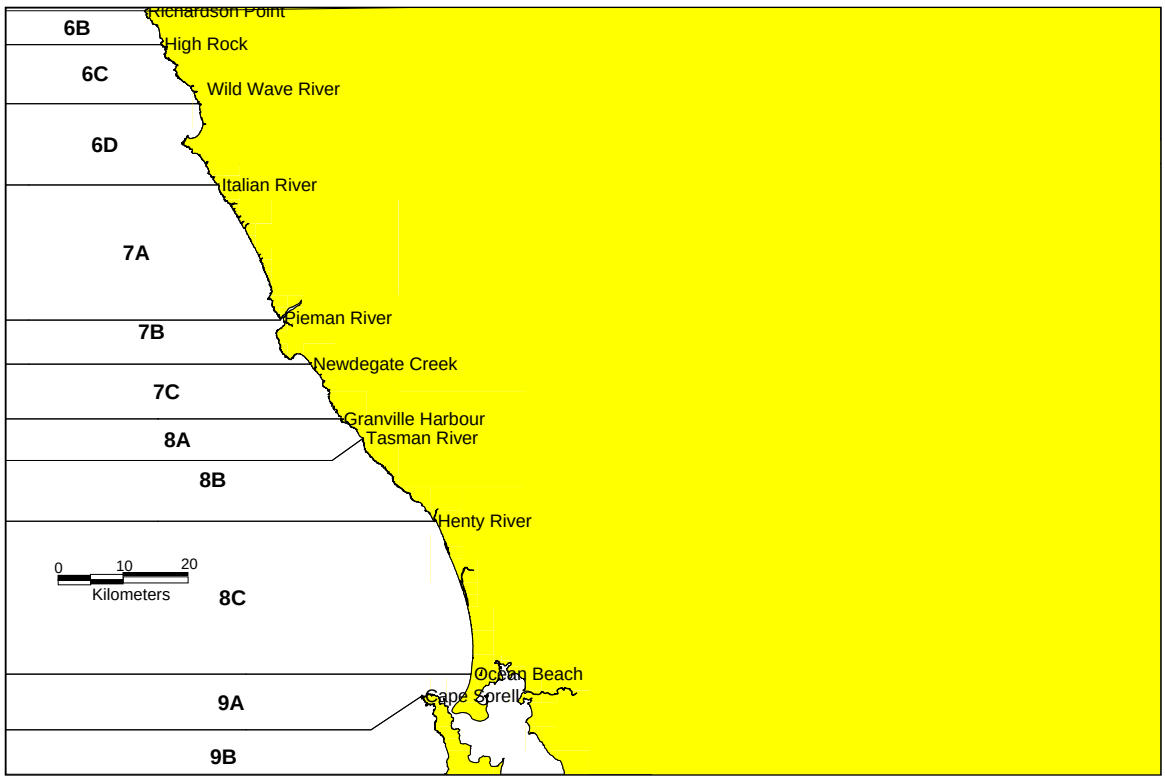
Map1: King Island



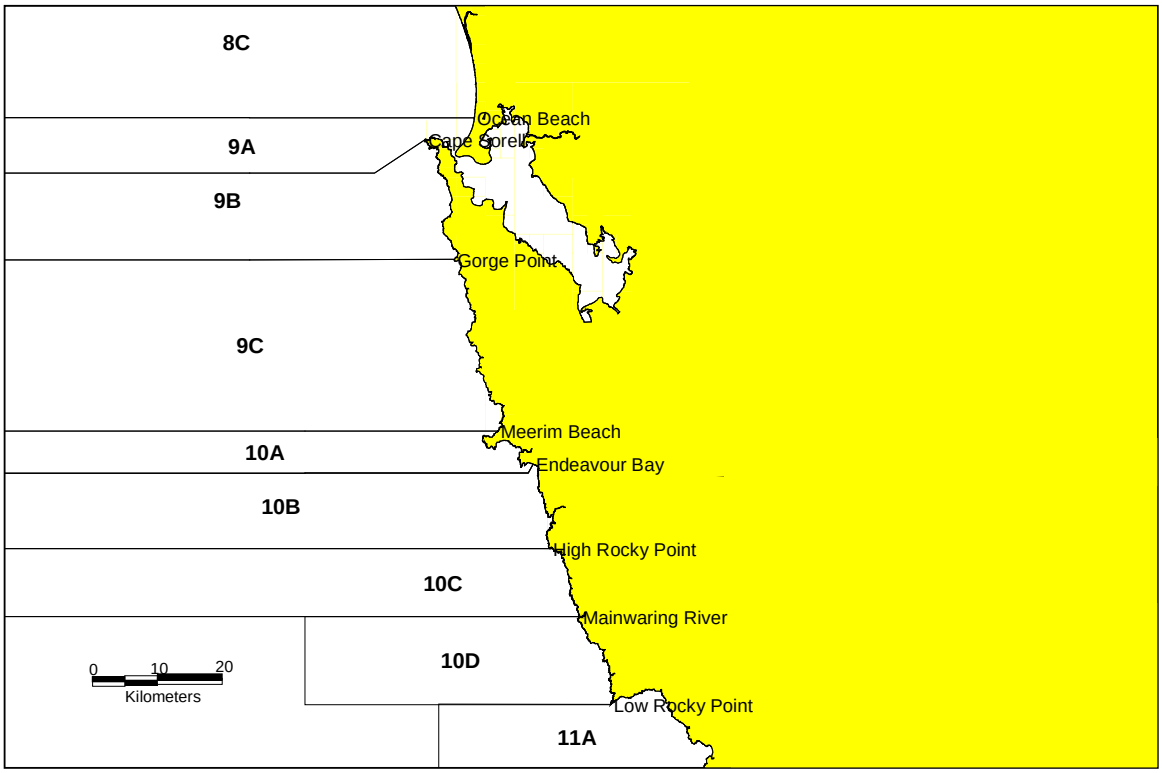
Map 2: North West Tasmania



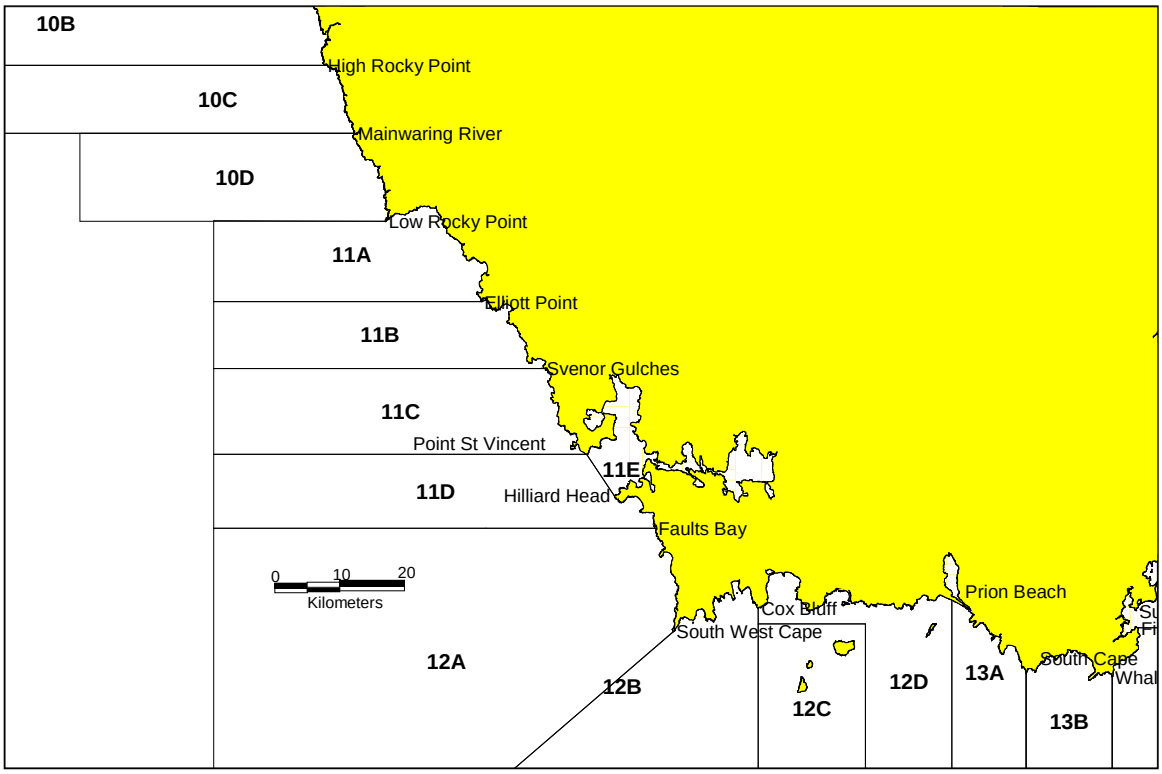
Map 3: Central West Coast (north)



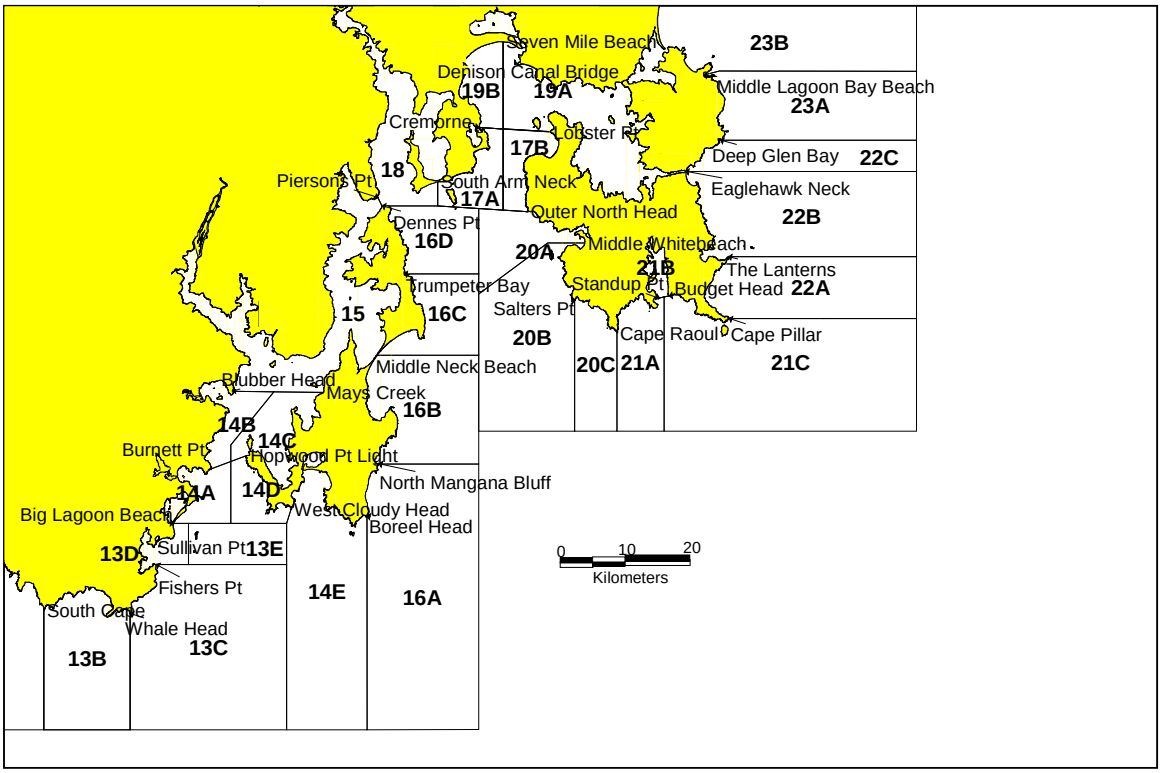
Map 4: Central West Coast (south)



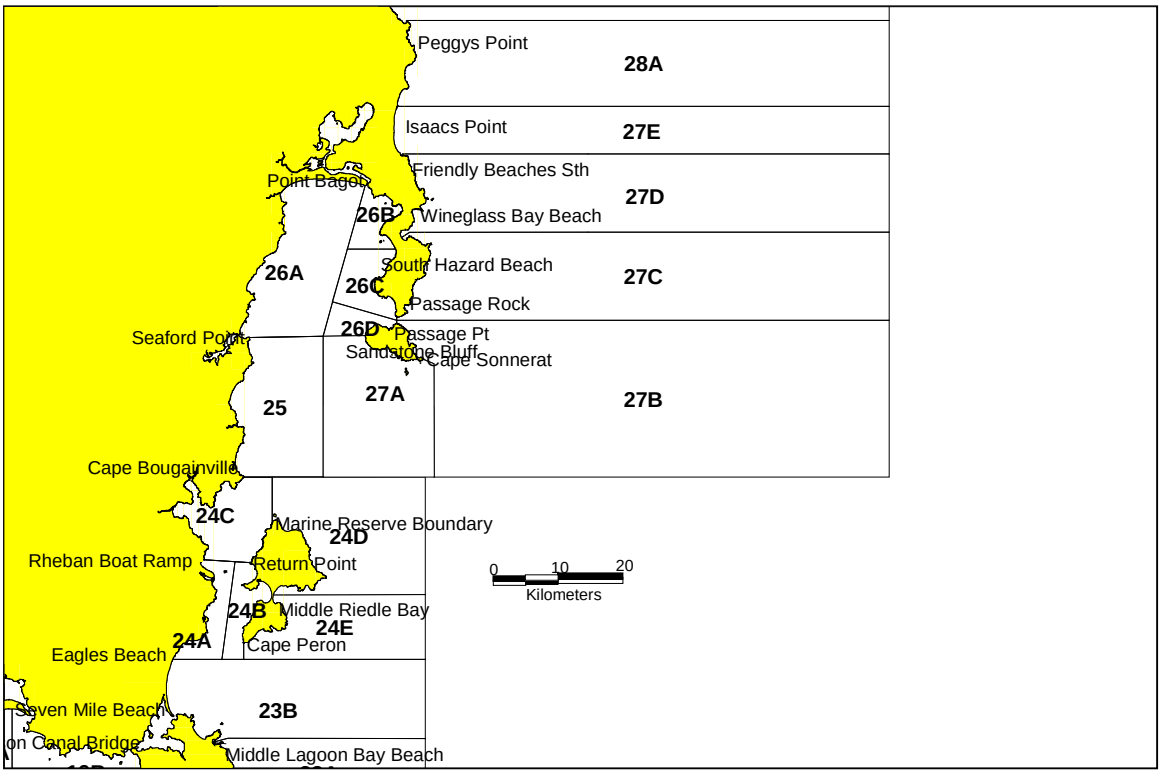
Map 5: South West Tasmania



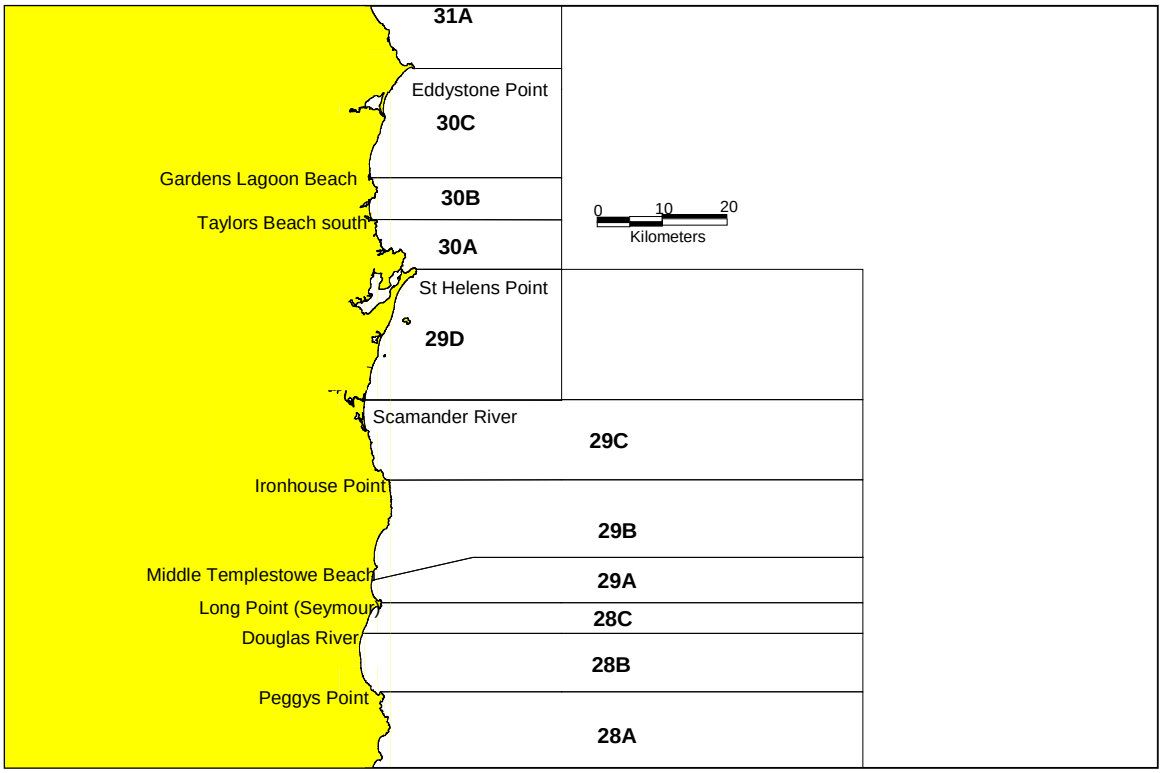
Map 6: South East Tasmania



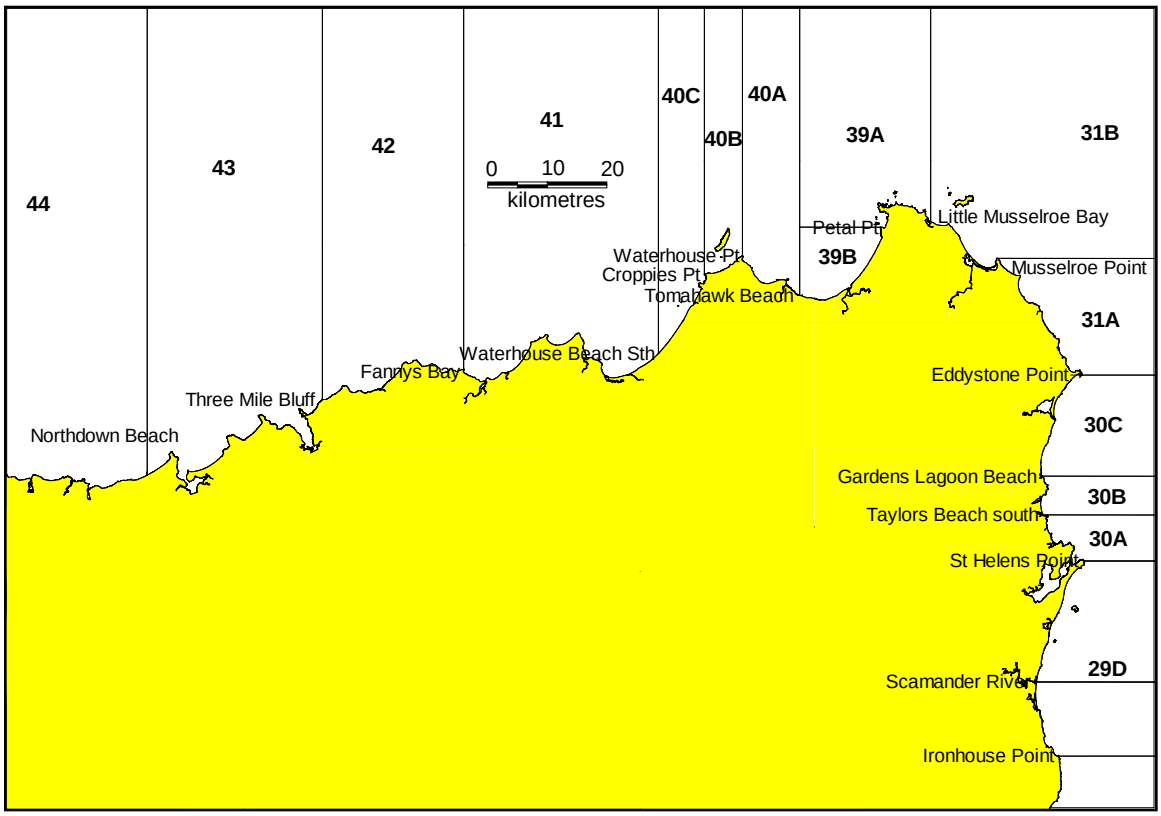
Map 7: Lower East Coast



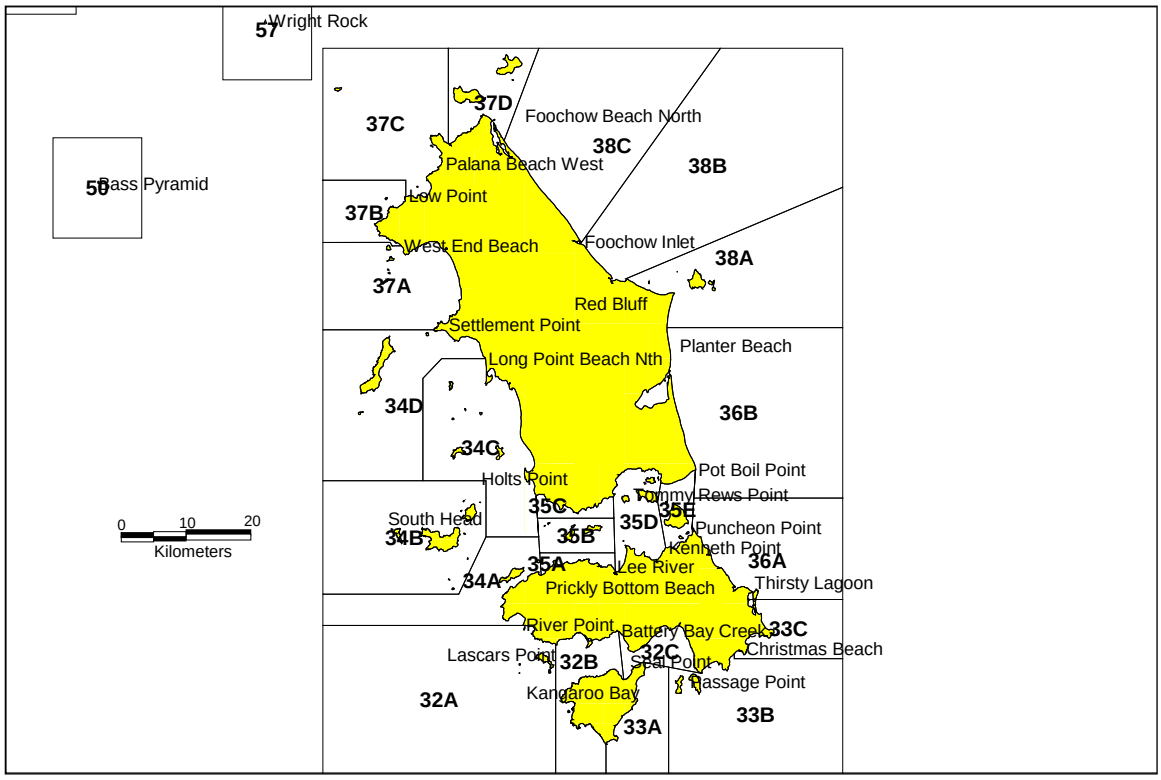
Map 8: Upper East Coast



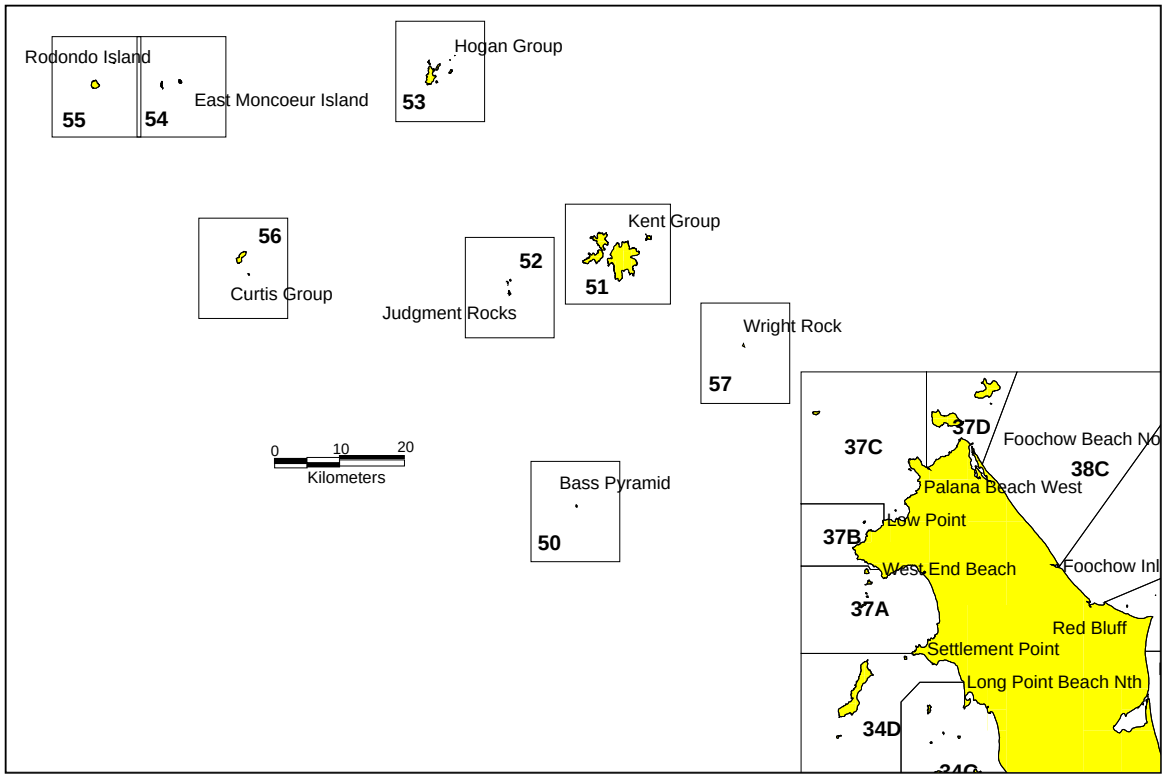
Map 9: North East Tasmania



Map 10: Furneaux Group

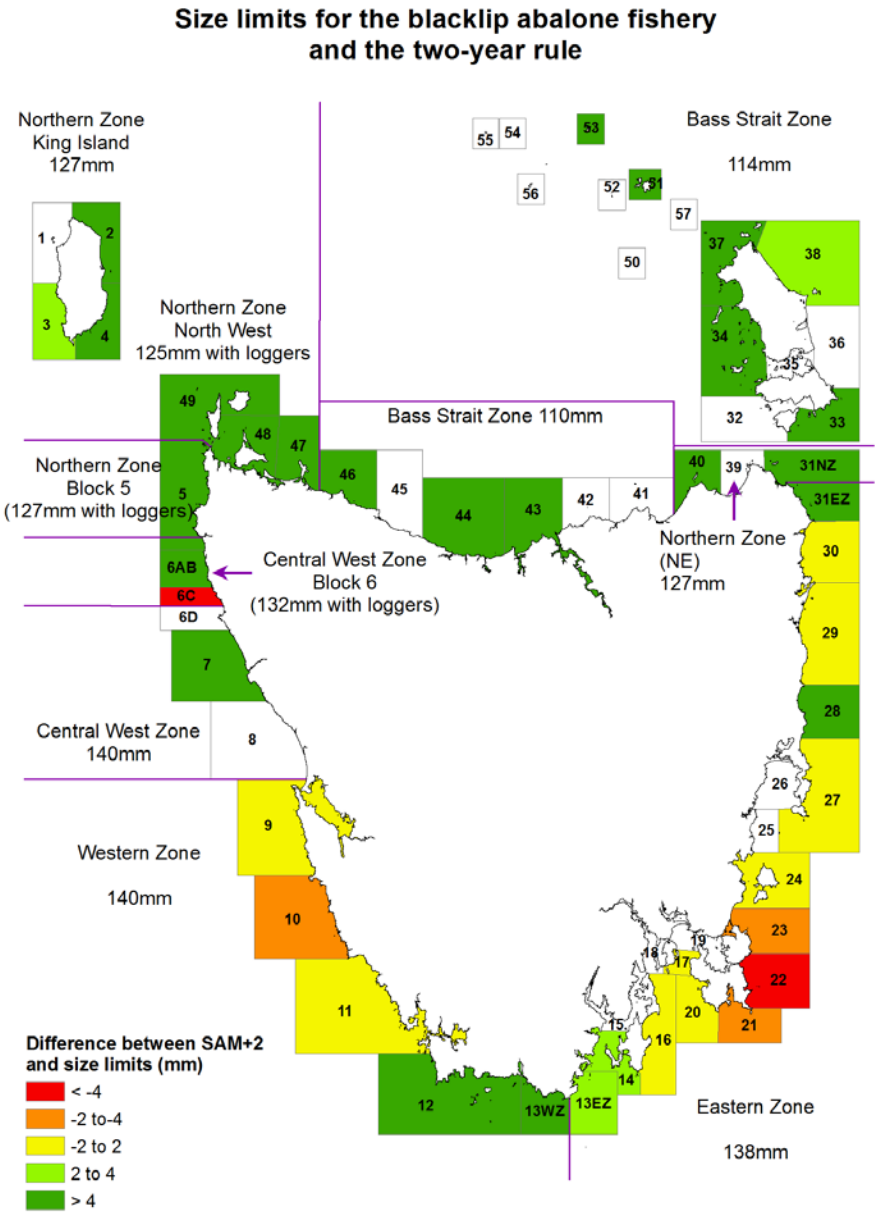


Map 11: Bass Strait Islands



15. Appendix 12: Application of the "two-year rule" to the blacklip abalone fishery, 2012

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 2011 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.

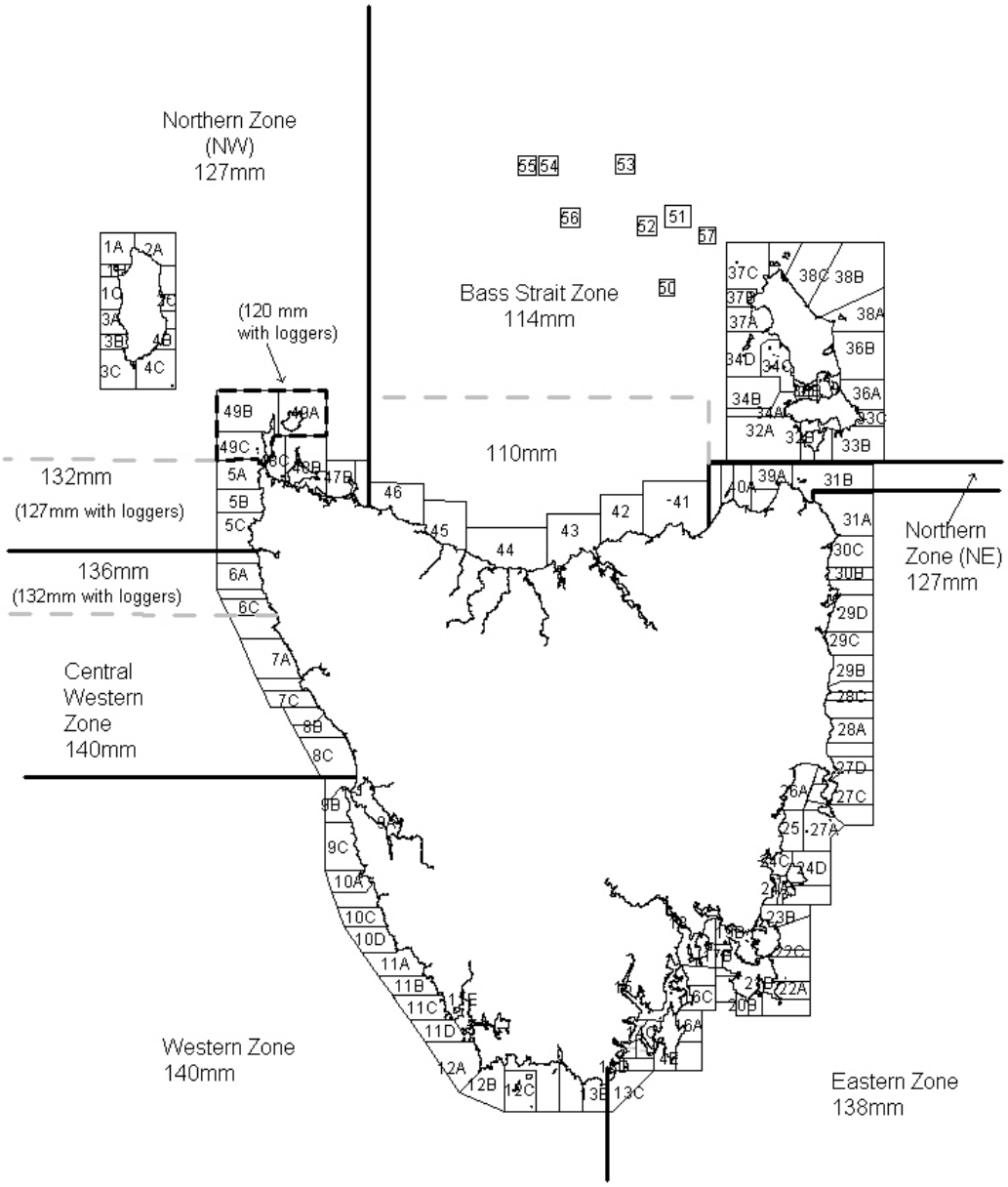
On a smaller scale, within each region, there is also variation in growth and maturity between populations. This occurs particularly in the North East in Block 31 and in the North West, in Block 6, where there are large differences in growth over small distances. In other areas, Block 22 (Tasman Peninsula) 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.

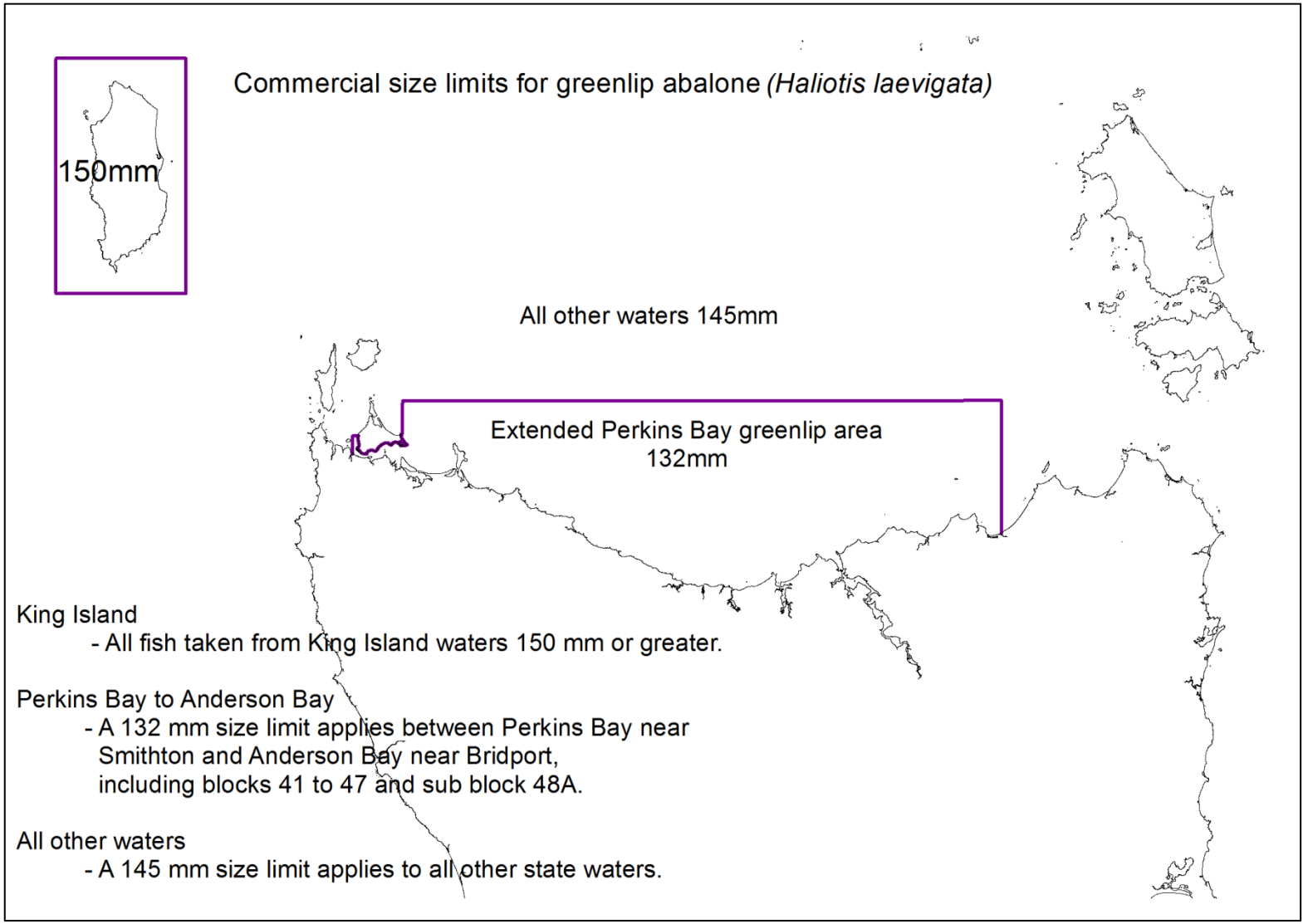
Acquiring biological information is difficult and costly, and while there is substantial knowledge of abalone populations in some regions, others have less than adequate or no information. Where biological information is sparse, there are limitations with the application of SAM+2 across populations within 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.

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.

16. Appendix 13: Commercial size limits for blacklip and greenlip abalone, 2012



In 2012 the LML for blacklip in Block 49 (including Hunter Island, Three Hummock Island but not Albatross Island) was reduced to 120 mm from 125 mm. The LML at Albatross Island was increased from 125 mm to 127 mm.


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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