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FISHERY ASSESSMENT REPORT

TASMANIAN ABALONE FISHERY

2007

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Abalone Fishery Assessment: 2007

Executive summary

The TAC for the 2007 Tasmanian abalone fishery was 2502.5t, comprising for blacklip abalone (*Haliotis rubra*): 770t in the Eastern Zone, 1260t in the Western Zone, 280t in the Northern Zone and 70t in the Bass Strait Zone; and for greenlip abalone (*H. laevigata*): 122.5t in all waters. The TAC was fully caught in all parts of the fishery except the Bass Strait Zone, which was closed and where no catch was taken, as a precautionary measure to prevent the spread of abalone viral ganglioneuritis (AVG) from Victoria.

The 2007 Abalone Fishery Assessment was based primarily on commercial catch and effort data and commercial size-composition data from the Tasmanian fishery. Commercial catch and effort data were supplied by the Tasmanian Department of Primary Industry and Water (DPIW). Catch rates were derived from the catch-effort data and annual variation in catch rate was interpreted as an approximate relative index of abalone abundance. The catch sampling size-composition data were obtained primarily by TAFI research staff, with recent samples provided by fish processors. Changes in median length of commercial catch samples assisted with interpretation of trends in stock status. In addition, extensive consultation has been undertaken with the abalone industry with respect to their perceptions of the state of the fishery and key factors influencing the operation of the fishery through 2007.

In summary, the major findings of this assessment were: (a) that in all four regions of the Eastern Zone, catch rates have reached high levels. Catch rates at the Actaeons continued to increase from 2006 levels, and in Storm Bay and Bruny Island, were stable. However, on the East Coast, it is of concern that catch rates, although still high, fell slightly in most parts of the region; (b) that low catch rates in the South West and South Coast regions of the Western Zone are now of significant concern and a reduction in catch in this area is required. Performance of the fishery in the Central West and North West regions of the Western Zone are not sufficient to absorb the reduction required in the southern regions.

Eastern Zone:
The Eastern Zone TAC was reduced to historically low levels to counter rapid stock declines following the large catches of the late 1990's. This reduction has been beneficial to stocks, and in 2007 catch rates again reached relatively high levels across most parts of the zone. Catch rates at the Actaeons continued to increase, and in Storm Bay and Bruny Island were stable. On the East Coast, it is of concern that catch rates, although still high, fell slightly in most of the reporting blocks of the region, for reasons of which we are uncertain. Median lengths of abalone have also tended to increase in all four regions, which, coupled with the high catch rates and the low TAC, suggests that catches have been sustainable. Divers reported a continuation of the good fishing conditions evident in 2006.

It remains possible that diminished egg production from the low stock levels that occurred during 2001 and 2002 may adversely affect recruitment to the fishery during 2008 and 2009. TAFI is concerned that the downturn in catch rates on the East Coast may have been caused by reduced recruitment and that catch rates may continue to

decline. In conjunction with this assessment, the available 2008 data for the Eastern Zone needs to be reviewed before adopting the scheduled annual 5% TAC increase. TAFI is not opposed to the annual 5% TAC increase but would withdraw support for the schedule of increases should there be a continuation of the downturn in the catch rates on the East Coast.

Western Zone:
Catches and catch rates were either stable or increased slightly in the Central West. In the North West, the annual catch has fallen, but here too, catch rates were stable or increased slightly. This suggests that stocks were stable in both regions, with sustainable levels of fishing.

In the South West, catch rates have continued to fall. Even under flat sea conditions catch rates were lower than at any other time in the previous 10 years, indicating that stocks have become extensively depleted. TAFI confirms previous assessments of stocks in the South West: the level of catch is too high and is not sustainable. We remain concerned that the longer that fishing is maintained at current levels the longer any recovery is likely to take.

The risk of exceeding the cap on catches from the South Coast was identified in October 2007; however the complications and practicality of closing the fishery at a late stage in the fishing year resulted in the fishery remaining open. The South Coast region was over-caught by an estimated 22t at the end of the year and this must be avoided in future. Catch rates, while appearing stable, were at a relatively low level, and combined with falling median lengths, indicate that fishing pressure remained high. Our assessment of South Coast stocks is that the levels of catch in 2007 and previous years were too high. While there have been no indications of long-term effects of over-fishing here, we believe it would be prudent to ensure that the catch is reduced.

It is recommended the catch, particularly from the South West, but also the South Coast be reduced, and that the Western Zone TAC be reduced to accommodate the reductions in those regions. Displacing sufficient catch from the South West and South Coast to the Central West and the North West is no longer a sustainable option.

Northern Zone:
Effort on King Island has been reduced following the implementation of quarantine provisions to manage the potential risks relating to AVG. Consequently, the annual catch has fallen and catch rates have risen. On the basis of fishery-dependent data and diver perception, it is likely that 2007 levels of catch were sustainable.

In the North West, the overall catch and catch rates were similar to those in 2006, and it is likely that 2007 levels of catch were sustainable. However, in the North East, catch rose sharply to almost twice the previous highest level since 2000. While catch rates were also high, implying high stock levels, similar fishing patterns have proven unsustainable in other parts of the fishery. Given the small area of reef in the region, it would be of concern should similarly high levels of catch be taken in 2008.

Furneaux Group blacklip catches were unusually low in 2007, probably also associated with AVG quarantine provisions and the widespread reduction in mothership activity in northern waters.

It is recommended that should the catch from King Island continue to be at reduced levels in 2008, then the effects of the displacement of its catch to the other regions, particularly the North East must be adequately monitored.

Bass Strait Zone:
The Bass Strait blacklip fishery was closed in 2007, and no catches were reported.

Greenlip:
Stock levels appeared stable in the North West, and catches were within the management catch limits. However, in the North East, the catch cap was over-caught by almost 50%. This level of catch has caused reductions in stock levels and catch rates in the past, and is clearly unsustainable. Because of low levels of catch in the previous two years, there may be no adverse consequences, but better methods of catch monitoring are required to detect catches that approach caps and prevent catch over-runs.

On King Island, stocks of legal-sized greenlip were reported low despite the reduced level of catch, and the 30t cap was not caught. In both the Furneaux Group and King Island, stocks of large abalone were inadequate to meet the domestic market's demand for premium product, and were replaced by lower grade (smaller) product, causing beach prices to fall.

It is recommended that the distribution of catch in the North West be reviewed, with particular reference to the contribution of the Perkins Bay area. While the current level of demand for greenlip from Perkins Bay is low, the egg-production model used to ensure that the 132-mm size limit was sustainable was contingent upon catch being limited at or below 20t. Caps for Perkins Bay and the remaining part of the North West need to be established.

Recreational and other fisheries:
The number of recreational abalone licenses has increased by an average of approximately 10% annually since the 1995-96 season and in the 2006/07 season, 12,514 recreational abalone diving licenses were issued. Surveys of recreational divers indicate that 105,500 abalone were taken in 2006/07, weighing an estimated 49t. Approximately 40% of the catch was taken in the south-east.

Abalone were caught in Tasmanian waters as part of cultural fishing activities by indigenous people, under permits for special events and research purposes, and as part of illegal fishing operations. There were no estimates available for either the illegal catch or for the total catch from cultural fishing activities. The quantity of abalone taken under permits was less than one tonne.

Summary of Recommendations:

Eastern Zone:

- FRAG to review data from 2007 in conjunction with available 2008 data for the Eastern Zone before adopting the scheduled annual 5% TAC increase. TAFI is not opposed to the annual 5% TAC increase but would withdraw support for the schedule of increases should there be a continuation of the downturn in the catch rates in the East Coast region.

Western Zone:

- Reduce the Western Zone TAC so as to reduce the catch from the South West and the South Coast regions of the Western Zone. Displacing sufficient catch from these regions to the Central West and the North West is no longer a sustainable option.

Northern Zone:

- On-going review of the effects of the displacement of catch from King Island to other regions of the Northern Zone.

Greenlip Fishery:

- Review the distribution of catch in the North West, with particular reference to the contribution of the Perkins Bay area.

Contents

1. Introduction

This assessment relies wholly on fishery dependent data. Principally, changes in catch and catch rate have been used to make inferences about changes in abalone abundance. This has been supplemented with information from a secondary source: changes in the median length of abalone sampled from the commercial catch and grouped across relatively fine spatial scales. Combined with changes in median length, trends in catch rates are useful indicators of changes in abalone populations in Tasmania.

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 improvements in fishing efficiency (effort creep) are likely to contribute to the failure of catch and catch rates to correlate with abundance. These factors are considered more serious in areas where effort and catch are low.

However, when abalone populations are intensively fished, as occurs throughout much of the Tasmanian fishery, catch and catch rate trends appear to be reliable indicators of changes in abundance. When fishing pressure is sufficient, 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 control falling stock levels by managing the spatial distribution of catch. In 2007, the Tasmanian blacklip fishery was divided into four zones: Eastern, Western, Northern and Bass Strait. The greenlip abalone fishery was 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 are not convenient areas for fishery assessment. Zones are too large and include too many physical differences (*e.g.* water temperature regimes, geology, accessibility), and may include divergent recruitment patterns, and different levels of abundance and fishing methods. There is a risk that downturns in part of a zone may be masked by improved catches elsewhere in the zone, because there is insufficient spatial information. In this assessment, the risk is reduced by looking at fishing patterns across smaller regions which have a greater likelihood of sharing common fishing practises 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, with a proviso that the annual catch was 10t or more in any one of the years since 2000.

The zones, regions and statistical blocks from which the 2007 commercial catch was reported or which are referred to in this document are shown below (Figure 1; for sub-blocks see Appendix 11).

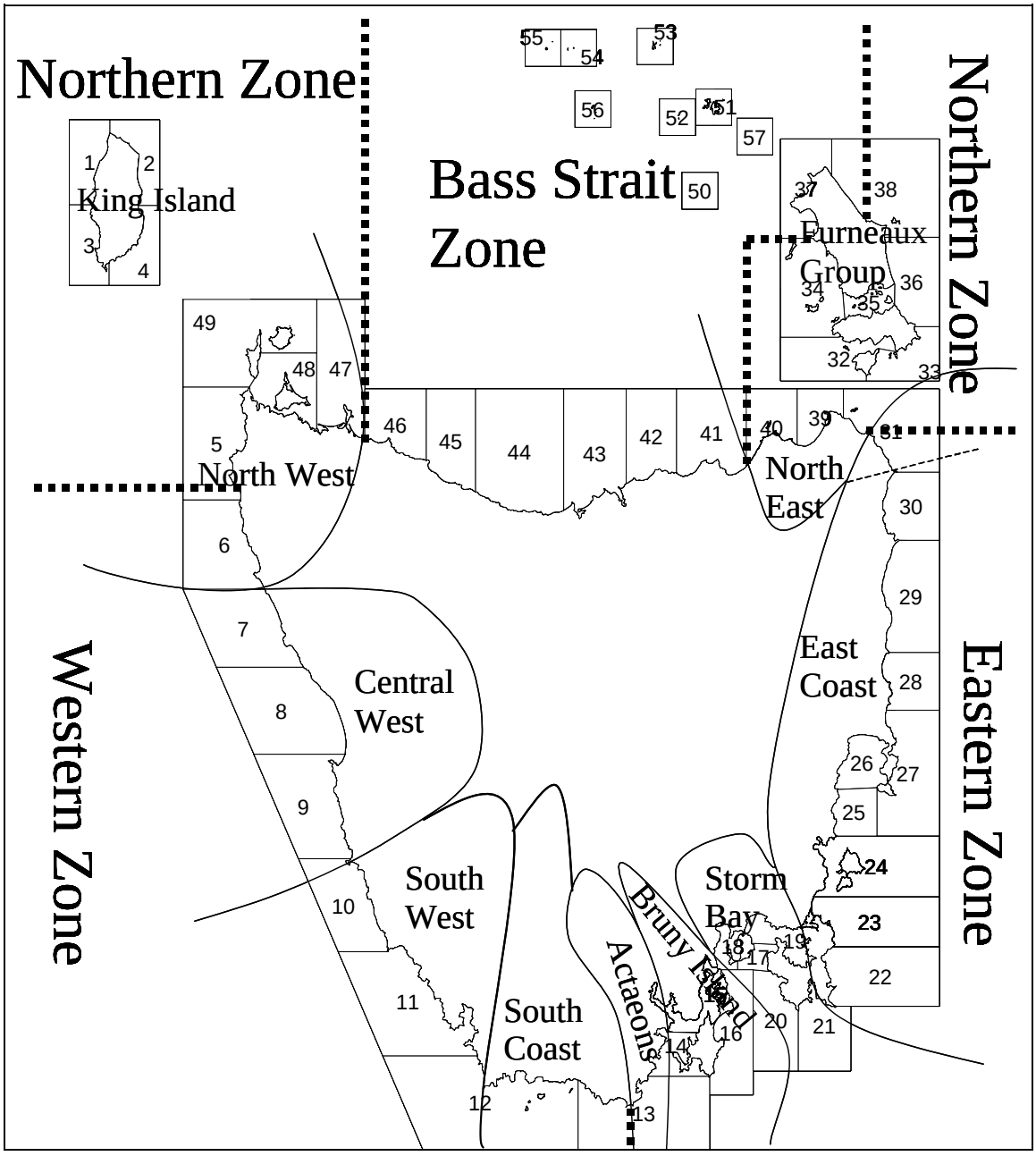


Figure 1. The zones and statistical blocks used in the Tasmanian abalone fishery in 2007. Also shown are the regions used for assessment purposes in this document. Zone boundaries are shown as dotted lines. The Greenlip fishery has no geographical boundaries, but mostly takes place on coasts included in the Northern and Bass Strait Zones. More detailed maps of catch reporting areas are shown in Appendix 11.

The zone boundaries and their reporting blocks are as follows:

Zones

Eastern Zone: Whale Head to Great Musselroe River, Sub-blocks 13C, 13E, 13E, Blocks 14 to 30, Sub-blocks 31A, part of 31B.

Western Zone: Arthur River to Whale Head, Sub-block 5D, Blocks 6 to 12, Sub-blocks 13A, 13B.
Northern Zone: Arthur River to Cowrie Point including King Island, Anderson Bay to Great Musselroe River, Sub-blocks 5A, 5B, 5C, part of 31B, Blocks 39 to 40, Blocks 47 to 49. In the Furneaux Group, Blocks 32 to 36, Sub-block 38A.
Bass Strait Zone: Cowrie Point to Anderson Bay, Blocks 41 to 46, 50 to 57. In the Furneaux Group, Block 37, Sub-blocks 38B, 38C.

Catches from the greenlip fishery are reported by species *i.e.* the greenlip fishery has no spatial boundaries.

Regions
The regions used for the blacklip fishery in this document comprise the following reporting blocks:
Actaeons: 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-blocks 31A, part of 31B (south of Great Musselroe River)
North East: Part of 31B (north of Great Musselroe River), Blocks 39 and 40
Furneaux Group (Northern Zone): Blocks 32 to 36, 38A
Furneaux Group (Bass Strait Zone): Block 37, 38B, 38C
Bass Strait Islands: Blocks 50 to 56
Central North Coast: Blocks 41 to 46
King Island: Blocks 1 to 4
North West (Northern Zone): Blocks 47 to 49, Sub-blocks 5A, 5B, 5C
North West (Western Zone): Sub-block 5D, Block 6
Central West: Blocks 7 to 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, 47 to 49), King Island (Blocks 1 to 4), the Furneaux Group (Blocks 32 to 38) and the North East (Blocks 31, 39 and 40). Small catches are occasionally reported from the Central North Coast (Blocks 41 to 46) and 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 here, (a more detailed explanation may be found in Appendix 1):

- The catches from all reported catches between 1975 and 2007 (inclusive) were used to estimate annual total catches *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. Consequently, there may be minor variations in annual catch reported in these documents from year to year. (See Appendix 9 for details of recent corrections.)

- Annual catch rates were derived from the geometric mean of individual catch rates, and not arithmetic means (averages), and all mean catch rates referred to

in this document are geometric means. Geometric means are a more reliable estimator of the mean catch rate across all divers, because they are more consistent and less affected by variable skewness of distributions (*e.g.* where there are small but variable percentages of high catch rates). Only catch rates from catches of 40kg or more were considered when calculating catch-rate means (to reduce the effects of fishing events that were adversely affected by mechanical breakdown or calculating catch rates on the by-catch of fishing for different 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 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 which 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. Median lengths are deemed useful when more than 4% of catches in a reporting area have been sampled.

2. Assessment of the Tasmanian abalone fishery

For information about zone, region, block and sub-block boundaries used in this section, see Section 1 (Introduction) or Appendix 11. For information about catch, catch rates and median length, see Section 3 (Catch, catch-rates and size-composition).

Eastern Zone

Actaeons (Sub-blocks 13C, 13D, 13E, 14A, 14B):

Fishery-dependent data

The 2007 Actaeons catch was 278t. This was high relative to catches from recent years, but slightly less than the long term (1975-2007) average (this average was calculated using 80% of pre-2000 Block 13 catches and 30% of pre-2000 Block 14 catches, then sub-block catches thereafter). At 255.5t, the combined catch from sub-blocks 13C, 13D and 13E was within the 266t catch cap established in October 2007. The major portion of the Actaeons catch was taken from sub-block 13E (210t) . The catch from 13C (17t) and 13D (29t) was approximately 25% of former peak levels. In Block 14, catches from 14A (19t) and 14B (4t) were also below peak levels. Past catch records (*e.g.* 1977 – 1988) supported by information supplied by early divers indicate that the lower Channel (including 14A and 14B) once consistently produced much higher levels of catch.

In the southern part of the region (Block 13), geometric mean catch rates were over 85kg/hr, which must be considered high for Eastern Zone catches. In the northern part of the Actaeons (sub-blocks 14A and 14B), geometric mean catch rates were at lower levels (~60kg/hr), and while they have improved, it is of concern to us that they have not improved in line with those from the south given the low level of catch in recent years.

The median size of abalone measured from samples of divers' catches has generally increased. The 2-mm increase in size limit that occurred in November 2006 will explain some of that increase. Other factors that may have contributed to the increase in mean size are growth of a large cohort moving through the fishery, or a reduction in the availability, or harvest, of smaller abalone close to the size limit.

Qualitative assessment and fisher perception

Divers reported that despite initial concerns caused by raising the size limit, fishing was as good as it had ever been. They have said that they see many fish under the size limit (pre-recruits) and are confident that stock levels will remain at high levels in the short term. Their reports confirm our view that stock levels in the most productive part of the Actaeons were at high levels.

It has also been reported by divers that increased nutrient levels from fish farms in the lower Channel have promoted the growth of green algaes not normally found on abalone reefs of the region, and have reduced the capacity of the region to produce abalone. However, TAFI diver surveys undertaken as part of a FRDC funded project

found that the green algae was not widespread, and could detect no significant levels of habitat change that might prevent recovery of abalone populations.

Other divers have said that the lower Channel was heavily fished at low catch rates (implying high rates of fishing mortality) in 2002, as an alternative to the southern part of the Actaeons when that area was closed to fishing by management action. Since then, recovery of populations to fishable levels across much of the reef area has been very slow. It could be expected that given recent management initiatives (reduced TAC, increased size limit), greater levels of egg production in the area might lead to recovery of populations and eventual restoration of production.

The lower Channel is usually fished as a place of last resort when the divers who operate from Dover or Southport have to fill market orders but bad weather prevents them fishing further south. It is important that stock levels in this region are not affected by marine farm effluent or over-fishing, and that populations recover. The level of catch in this and other parts of the D'Entrecasteaux Channel means that it has become insignificant compared with more productive areas, and it is likely that it will become a forgotten part or the fishery. This area requires on-going monitoring.

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

Fishery-dependent data

The 2007 catch (104t) from Bruny Island was low, both historically and relative to recent past catches. The catch was under half the 1975-2007 average of 227t. (This 1975-2007 average uses Blocks 15 and 16, plus 70% of Block 14 catches up to 2000, then 14C, 14D and 14E thereafter).

Regional geometric mean catch rates remain essentially unchanged from the previous year at 74kg/hr. Within sub-blocks, there were no pronounced trends in catch rates, and it is possible that inter-annual fluctuations in catch rates were due to changes in fishing patterns rather than changes in abundance. For example, the sub-blocks closer to the ramps at Margate and Dover (16C, 16D and 14D) had lower catch rates than the more remote blocks, which was probably a reflection of heightened levels of effort (16C and 16D both had relatively high annual catches) as divers found it less costly to operate there.

The median size of fish sampled from catches increased in sub-blocks 16B, 16C and 16D, probably due more to the increased size limit than lower rates of fishing mortality. Insufficient samples were obtained from sub-blocks 14D and 14E to provide satisfactory estimates of median size (see also explanations given for change in size in the Actaeons region).

Qualitative assessment and fisher perception

While part of the reason for the reduced Bruny catch is that Blocks 15 and 14C appear to have lost the capacity to consistently produce significant levels of catch, perhaps the most important reason is the 2007 Eastern Zone TAC was low and that divers were able to catch their limited allocations of quota in more preferred regions such as Storm Bay or the Actaeons. Divers generally reported good fishing conditions around the eastern and southern coasts of Bruny Island, with some reservations with stock levels at 14D. They confirm our view that stocks on these coasts were at acceptable levels. We reiterate our concerns about stock levels in the D'Entrecasteaux Channel.

Storm Bay (Blocks 17-21):

Fishery-dependent data

The Storm Bay catch has fallen marginally to 146t, which is slightly below the 1975-2007 average (151t). All sub-blocks apart from 21C (Port Arthur to Cape Pillar) experienced reductions in catch. In 21C, where catch rates were very high (~100kg/hr), the catch increased by more than 30% to 44t.

Regionally, geometric mean catch rates were stable between 80 and 90kg/hr (mean 85kg/hr). At the sub-block level, catch rates were also stable or increased slightly, except in the south-west corner of the Tasman Peninsula (20C and 21A), where catch rates fell from 90 to 76kg/hr, and from 96 to 88kg/hr respectively.

The median size of fish continued to increase.

Qualitative assessment and fisher perception

The decline in catch since 2005 is not a reflection of reduced abundance in the region, but is associated with limited allocation of quota and a shift in effort to the Actaeons. Divers reports ranged from good to excellent fishing conditions. In some places they said that abalone were as plentiful as they had ever seen, and some recorded catch rates of over 200kg/hr. They said that their catches were limited not by abalone abundance, but by the availability of quota and the capacity of processors to accept fish.

East Coast (Blocks 22 to 30, Sub-blocks 31A, part of 31B)**:**

Fishery-dependent data

The 2007 East Coast catch (232t) was among the lowest recorded and was well below the 441t average for the region.

In contrast to the other three Eastern Zone regions, catch rates on the East Coast, although still at high levels, were lower than in 2006. The regional mean catch rate was 79kg/hr, a reduction of 5kg/hr from 2006, ending a four-year run of successive catch-rate increases. Catch rates fell in nearly all reporting blocks producing significant volumes of catch.

The median length of abalone increased in most sub-blocks.

Qualitative assessment and fisher perception

Like Storm Bay and Bruny, the low catch seems to have been due more to the limitations imposed by the low Eastern Zone TAC and improved fishing at the Actaeons rather than constraints imposed by low stock levels. The lower catch rates in 2007 compared to 2006 prompts the question: why, if catch levels were so low, should catch rates fall? It is difficult to believe that a fall across such a large area could be attributed to fleet dynamics, market preferences or the 2-mm size-limit increase, and it suggests a softening in the strong recovery of stocks seen in previous years.

The increase in median length is suggestive of reduced levels of fishing mortality. However, in the context of the low catch and the downturn in catch rates from high levels, this increase could also be attributed to the size-limit increase, and possibly a reduction in numbers of recruits following the decline in abundance during the early part of the century.

Reports from divers varied greatly. Many said that fishing was as good as it gets, but others said that that they had noticed that fishing was not quite as good as the preceding year. The fall in catch rates was attributed by some divers to unusually heavy weed growth in the early part of 2007, others to raised water temperatures.

In the north-east, Block 31 has produced very little catch in recent years because of live market processor preferences for fish from areas closer to their factories. Appropriate use of Block 31 stocks could reduce pressure on some of the more heavily fished areas further south and enable more rapid stock rebuilding.

Western Zone

North West (Sub-block 5D and Block 6):

Fishery-dependent data

The 2007 catch from the North West part of the Western Zone was 76t, or 70% of the previous years catch. The average catch for the years 1975-2007 was 160t. Catch from this region has been falling steadily since 2001.

In previous assessments we have expressed concern for stock levels in the region, particularly following steep declines in catch and catch rates between 2000 and 2002. Since 2003, geometric mean catch rates in the northern sub-blocks have generally been stable at approximately 100kg/hr, while in 6D, they have averaged slightly higher (124kg/hr).

Qualitative assessment and fisher perception

The size limit in all sub-blocks except 6D was raised by 4mm to 136mm in 2003. In 6D, it remained at 140mm. It is uncertain whether the arresting of the decline in catch rates has been due to stock recovery brought about by the size-limit increase, or because of the low level of catch due to market preferences. The fall in catch from Block 6 has been attributed to (a) its remoteness from most of the live market processors, and (b) fish from the northern part of Block 6 were less favoured by canners. Catches were at low levels in 6A (15t), 6B (12t) and 6C (15t), and moderate levels in 6D (34t). No catch was reported from 5D.

Divers reported improving stock levels, particularly in 6D and 6C, with quantities of pre-recruits evident. The stable catch rates, low level of catch and diver reports indicate that fishing was at sustainable levels.

Central West (Blocks 7 to 9):

Fishery-dependent data

The annual catch from the Central West in 2007 was marginally higher at 235t than in 2006 (225t), but lower than the 1975-2007 average of 254t. Continuing the trend from 2006, most of the catch now comes from Block 9 (178t, up from 142t in 2006).

Catch rates in the region were generally stable or increased slightly. In Block 7 and 8, catch rates were higher (between 160 and 180kg/hr), perhaps because of the low level of catch. In the more accessible sub-block 9B, catch rates were lower (132kg/hr), but further south in 9C were 160kg/hr.

Qualitative assessment and fisher perception

As in 2006, the distribution of catch between blocks within this region was probably determined more by fleet dynamics than abalone abundance. Processors preferred to collect fish from Strahan, and most divers found it easier to work there than at Granville Harbour. This region includes the coast north of Macquarie Harbour almost to Sandy Cape (Blocks 7 and 8), and the coast south almost to Point Hibbs (Block 9). The region is mostly fished by divers operating from runabouts launched from West Coast ports (Strahan and Macquarie Heads, Granville Harbour and occasionally from Couta Rocks). Divers on motherships operating from ports in south-east Tasmania usually found it uneconomic to travel as far north as Block 9, but in 2007 six motherships moved from the South West (Blocks 10 and 11) further north to find better stock levels.

Beach prices reported to DPIW by processors were generally lower throughout the year for catches landed at the West Coast ports compared with the beach price for catches landed in the south-east. The annual average beach price per kilogram paid for Western Zone fish (but not accounting for intra-annual variation) from Couta Rocks, Granville Harbour and Macquarie Harbour (Strahan and Macquarie Heads) was $37.72, $37.63 and $37.86 respectively, whereas the average beach price paid across the Western Zone for 2007 was $39.84. This price difference is a reflection on the end-use of the fish, rather than their quality: fish landed in the south-east were more likely to go to the higher priced live markets, whereas fish landed at West Coast ports usually go to canners. Live market buyers prefer not to collect fish from West Coast ports because they believe that the travel involved with transferring fish from the West Coast to the south-east by road stresses the fish, leading to higher rates of mortality.

Divers said that it was difficult to get good catches in 9B unless sea conditions were particularly flat. They reported that although they would like to see less pressure on 9B, stocks levels throughout the region were generally satisfactory.

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

Fishery-dependent data

The annual catch for the region was 653t. This is the largest catch reported from this region (Block 10, 11 and sub-block 12A) since sub-block reporting began (2000). It is also larger than all estimates of annual catches prior to sub-block reporting except for four years immediately prior to the implementation of a TAC, the size of which prompted the development of a quota managed fishery. The average catch 1975-2007 (using an estimated value for catches from sub-block 12A based upon catches 2000-2007) was 486t.

The Block 11 catch has fallen below levels of recent years, but at 354t is still above the 296t long-term average. In 2007, there was a small shift in effort from Block 11 to Block 10. The 2007 Block 10 catch of 231t is much greater than the long-term average (139t). The increased catch has been taken predominately from sub-blocks 10B and 10C.

Catch rates in this region have generally fallen since the inception of zonal management in 2000, as divers fished down high stock levels that had built up as a result of relative inactivity in this part of the fishery. This fall continued in 2007, and

the geometric mean catch rate was 130kg/hr. The CPUE distribution, once dominated by catches taken at between 150 and 200kg/hr, now has a highly pronounced mode at 100-150kg/hr, with increased percentage of catches at 50-100kg/hr and much reduced percentages of catches in categories above 150kg/hr.

This region is usually fished from motherships, which return to ports in the south-east with catch destined mostly for the live market. In recent years, the higher prices paid by the live market have meant that quota owners generally received a better return for fish from the South West and the South Coast than from the two regions further north. The average prices for Western Zone fish landed at the south-east ports were higher than the average across all ports. As a consequence, the capacity to fish this region has increased with increased investment in infrastructure such as motherships (Figure 2) and live processing facilities.

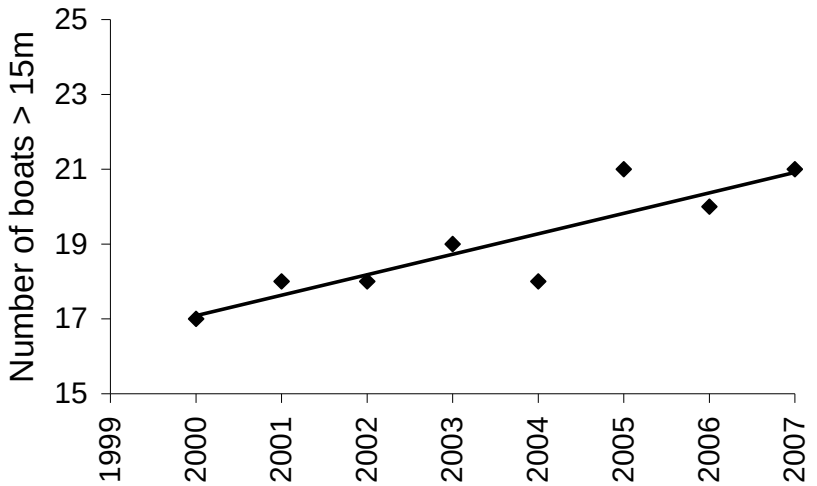


Figure 2. The number of boats > 15m length fishing in the South West, 2000-2007. The increase is indicative of the increase in infrastructure for fishing in the region.

Occasionally it has been said that catch rates were affected by weather conditions during the year *i.e.* that there have been fewer periods of flat sea conditions which consequently prevented divers fishing the higher concentrations of abalone in the shallows, and as a result annual mean catch rates were reduced because of the weather. Since 2004, divers have been required to categorise and report sea conditions on a scale of 1-3 (1= worst conditions, 2 = average conditions, 3 = best conditions). Assuming consistent reporting of sea conditions, comparison of catch rates within each category of sea conditions should eliminate any bias caused by sea conditions. The downward trend in all three categories shows that catch rates have fallen during the four-year period independently of sea conditions (Figure 3), and confirms that sea conditions played little or no part in the overall fall in catch rates within the region.

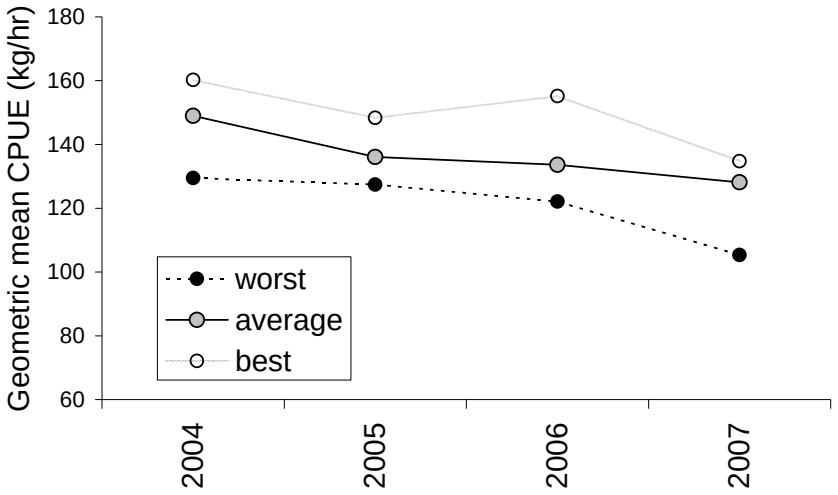


Figure 3. Comparison of catch rates in South West Tasmania within each category of sea condition. Preliminary catch records from 2008 show the trend continuing.

Qualitative assessment and fisher perception

When questioned about stock levels in the region, all divers reported that abalone had become increasingly scarce, particularly in Block 11. Some have said that much of the deeper reef area that could be fished when seas were higher now carried no stocks. To the north, in the more remote Block 10, the few divers who once had this block to themselves reported that there was competition to work areas that they formerly worked alone, and that they had noticed that stocks were being steadily reduced. The incoming divers said that they had moved north because they found that many of the areas that they normally worked in Block 11 were too depleted to warrant fishing unless sea conditions were sufficiently low and allowed them to work in the shallows.

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

Fishery-dependent data

The South Coast regional catch increased fractionally to 267t. The long term average for the region is 225t, so the 2007 catch was significantly above that level. In October 2007, a catch limit of 245t was placed on the region to ensure sustainable levels of fishing. The cap was reached in early December, but due to the short amount of time left in the year, and the time required to notify divers of a closure, the cap was not implemented and consequently was over-caught by 22t.

The region has been heavily fished since 1997, with over 250t taken every year. The effect of this high level of catch was reflected in catch rates, which fell steadily from ~140kg/hr in 1997 to 104kg/hr in 2002, and since then have been stable (with minor variations) at approximately 100kg/hr. The average daily catch from the South Coast has fallen from more than 700kg in 1998 to approximately 400kg in recent years. In the more accessible sub-blocks 13A and 13B, catch rates were lower still, falling below 90kg/hr. However, there is no longer a downward trend in catch rates, and since 2004, catch rates in all sub-blocks have been relatively stable.

The median length of abalone from catches taken in sub-block 13A has continued to fall. In previous years we have noticed a similar fall in length in the other South Coast sub-blocks (insufficient samples were obtained from those sub-blocks in 2007). We believe that the smaller size of abalone in the context of the low catch rates is indicative of continuously high levels of fishing mortality. The alternative explanation for the smaller median length is that 13A stocks have had an unusually large influx of recruits, but if this was the case, we would expect catch rates to have increased and divers to have reported improved fishing, neither of which have occurred.

Qualitative assessment and fisher perception

Most of the region's catch was taken by divers operating from runabouts and was sold to the live market, and consequently there was a strong demand for fish from the region. Most divers said that they were unhappy with stock levels on the South Coast, and the consequent low levels of catch. Some mothership operators said that they no longer considered fishing there unless forced to by adverse weather elsewhere. Other (runabout) operators said that fishing the South Coast was economically unviable given the combination of low catch rates and high fuel costs, and was only worthwhile if they had a second diver on board to help defray costs. However others were more optimistic about stock levels, and said that given the broken boulder structure of typical South Coast reefs, it was very difficult to deplete stocks to levels that would affect recruitment, and stocks would recover quickly once fishing pressure was reduced.

Northern Zone

King Island (Blocks 1 to 4):

Fishery-dependent data

The King Island blacklip catch, at 56t, was much lower than previous years, when catch levels peaked at approximately 130t (2004-2005). Most of the blacklip catch (80%) was taken from Block 3. The size of the 2007 catch was directly affected by quarantine provisions to reduce the likelihood of the spread of AVG from Victoria. Limited availability of fish processing facilities on the island combined with provisions that prevented the transfer of abalone by sea from King Island to mainland Tasmania reduced the number of visiting divers in the region and consequently the island was fished mostly by the resident divers. In addition, the closure of the Bass Strait Zone to fishing deterred motherships from visiting the region.

Catch rates trended downwards during the period 2001-2005 following the rapid increase in effort associated with the high catch, and reached a low of 88kg/hr in 2006. Since then, the mean catch rate increased sharply to 109kg/hr, which was associated with the shifting of effort to deeper water stocks.

Qualitative assessment and fisher perception

Like 2006, some divers have targeted extensive deep water stocks using Nitrox breathing apparatus, and most of the catch has been taken by them. Divers reported that both shallow and deep water stocks were at satisfactory levels. It is considered that fishing at these low levels of catch is sustainable.

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

Fishery-dependent data

The size of the Northern Zone catch from the North West was similar to the previous year's at 154t. The Block 5 catch (89t) was within its 100t catch cap. Catches increased greatly in sub-blocks 5A and 49C, which are both close to the launch site at Woolnorth Point. Catches have decreased in the remaining sub-blocks (5B, 5C, 49A, 49B).

Since 2002, regional catch rates have essentially been stable, but with minor fluctuations between 80 and 95kg/hr. Catch rates in the remote north-west part of Hunter Island and islands further offshore (49B) have fallen sharply, but from high levels as divers have reduced built up stocks following years of inactivity there. The high levels of catch from 5A and 49C were not associated with changes in catch rates.

Qualitative assessment and fisher perception

Most of the North West catch was sold to the canning market which, unlike the live market, had a steady demand for product. The decrease in catch from Three Hummock Island (49A), where less than 5t was taken, was attributed to its remoteness, reduced mothership activity in the area, and better quality abalone in other parts of the region. Sub-block 5C was fished more by visiting divers than residents, and in previous years, much of the catch has been bought by live-market buyers. The downturn in catches in 5C in 2007 was attributed to fluctuations in demand from the live market when buying opportunities failed to coincide with favourable weather conditions.

Local divers reported no significant issues with stock levels. This confirms our view that current levels of catch in this region were sustainable.

Furneaux Group (Blocks 32 to 36, 38A), **North East** (Northern part of 31B , Blocks 39 and 40):

Fishery-dependent data

The North East catch increased threefold to 66t, most of which (55t) came from sub-block 31B. No catch data exist for sub-block 31B prior to 2000, but comparisons with historical catches from neighbouring Block 39 indicate that the 2007 catch was unusually high, and this increase is of concern.

The catch from the Furneaux Group was much smaller, at just 5t. Because of the lack of activity in Bass Strait by mothership operators, there was little opportunity for visiting divers to fish in the Furneaux Group, and most of the catch was caught in the south of the region by divers launching from the North East. Unlike the previous year when 10t was taken, no catch was reported from Babel Island (38A) in 2007.

Catch rates in the North East were high (geometric mean 75kg/hr) considering the large catch and small size of fish in the region. The mean catch rate was exceeded only in 2001, when the opening of the Northern Zone caused effort to be directed to areas that had been unfished for many years and consequently had high stock levels.

Qualitative assessment and fisher perception

There is ample evidence to show that when unusually large catches are taken from a region, fishing in subsequent years has generally been poor, although in the case of the North East, the evidence is ambiguous.

In the 1980's large quantities of catch were taken from the area now included in sub-block 31B, from areas such as Swan Island and Black Reef , which subsequently took many years to recover. Later, between 2001 and 2002, 55t was reported caught from sub-block 31B. In the following years, catch rates fell and divers left the area. Although the lower catch rates were attributed to stock declines, there was a coincidental shift in effort to King Island and the North West and consequent loss of interest in the North East. While it is unlikely that the 2007 North East catch is sustainable, little catch had come from the region in the previous four years. Nevertheless, given the small area of reef in the region, it would be of concern if similar levels of catch were taken in 2008.

Much of the 2007 catch increase in the North East was due to loss of fishing opportunity at King Island and the consequent displacement of effort from there. However, there was also a substantial increase in effort from southern divers who fished there for both Northern blacklip and greenlip, partially due to increased acceptance of fish from the region by southern processors.

Bass Strait Zone

No catch was taken from the Bass Strait blacklip zone in 2007 as a precautionary measure to reduce the risk of the spread of abalone viral ganglio-neuritis (AVG).

Greenlip

Fishery-dependent data

Almost all the 122.5t greenlip TAC is taken in the state's north from four distinct regions: King Island, North West, North East and the Furneaux Group (insignificant quantities are occasionally taken from the central north coast and the remote Bass Strait islands). The catch from each region is capped: King Island and the North West at 30t each, the North East at 23t and the Furneaux Group at 42t. The sum of the caps (125t) is 2.5t greater than the TAC. In 2006, it was recommended that the size limit operating at Perkins Bay in the North West (Blocks 47 and 48A) be reduced from 145mm to 132mm and the expected extra catch from the region as a result of the size-limit reduction be limited to 20t (Tarbath, 2006).

In 2007, the catch from the North West was 33t (10t from Perkins Bay and 23t from the remainder). In both 2006 and 2007, the Perkins Bay catch never reached 20t (2006 – 16.1t, 2007 – 10.5t), so the level of catch has not threatened the assumptions of the egg-production model. Under current market conditions, which favour large greenlip, the catch is likely to remain within the recommended limit. However, reliance on market forces is risky and if the fishery is to be properly regulated and managed sustainably, the 20t limit should be implemented or the size limit increased to former levels.

As might be expected, catch rates in 2007 in Perkins Bay after the size limit reduction were high (geometric mean 104kg/hr). However, almost all effort has been directed at Black Reef, and only 291kg has been reported from other parts of Perkins Bay since the size limit was reduced. There are extensive populations of small greenlip between Stanley and Robbins Island which are available to be caught.

The catch from the North East was 34t *i.e.* the cap was over-caught by 11t. This level of catch has been proven unsustainable, and while it may have eased fishing pressure in other regions, it may cause problems in the North East. The cap was implemented and

progressively reduced to 23t because of low stock levels and poor recovery when catches were above 30t. While it is evident that stocks have recovered, this region has a much lower area of reef compared with the other regions, and has proven to be incapable of sustaining equivalent volumes of catch. Note that 16t was taken in 2006, and 19t the preceding year, so the 2007 over-catch may prove to be inconsequential.

The 2007 King Island catch was 26t. The 30t cap has not been caught since 2004, and annual catches have been progressively lower since then. The Furneaux Group catch (31t) was also lower than its cap (42t). In both regions, catch rates have mostly fluctuated between 50 and 60kg/hr since 2000, and in 2007 were 58kg/hr (King Island) and 60kg/hr (Furneaux Group).

Qualitative assessment and fisher perception

The primary reason for reducing the size limit in Perkins Bay to such a small size (132mm) was to encourage divers to spread their effort throughout the bay, and not concentrate on Black Reef. The recommended 20t cap was based upon levels of egg production at 132mm using average levels of yield that were estimated to have occurred in the bay throughout its history. The remaining North West cap was recommended to be reduced to 25t in consideration of the 5t that was formerly taken in the area now covered by the Perkins Bay management area. While the size limit reduction took place in November 2006, the catch was not capped at 20t, and nor was the catch in the remainder of the region reduced to 25t.

Elsewhere in the North West, the catch was relatively low, and catch rates (although relatively meaningless as an indicator of abundance in this part of the fishery) were either stable or tended to increase. Perhaps more significantly, divers said that greenlip stocks were at satisfactory levels and that in many places, pre-recruits were evident in good numbers. The greenlip fishery in the North West appears to be operating at sustainable levels.

In recent years, the domestic market for large (160mm plus) live greenlip has grown and pays a $10-$15 premium between these and smaller greenlip, which are mostly exported as frozen meats. Factors such as the strengthening Australian currency relative to the US currency, which puts downward pressure on the price of frozen product, and rising demand in the domestic market for large live abalone have driven this difference. While all regions have large greenlip, they are more common and hence most are caught at the more remote King Island and Furneaux Group.

As a consequence of the domestic market demand, most of the Furneaux Group catch has been taken at 160mm (15mm above the legal limit) to meet the market's requirements. However, the biomass of 160mm plus abalone has been steadily reduced because demand and fishing mortality have exceeded stock levels, and catch and catch rates of the larger greenlip have fallen. While there is no concern for sustainability of populations in the Furneaux Group (levels of egg production at 160mm are considerably greater than threshold sustainability levels and divers fishing to the legal size measure for the export market have no problems getting good catches), it is likely that there will be some economic impact to the fishery.

Annual catch rates from King Island and the Furneaux Group have fluctuated over a narrow range since greenlip effort has been recorded separately from blacklip effort (2000), suggestive of stable stock levels; however, because greenlip fishing seldom

meets criteria under which catch rates reflect abundance, we are wary of using them as an index of stock levels in this fishery, and this stability may be spurious. Divers who worked at King Island reported that greenlip stocks were at much reduced levels, and that catch rates, particularly in the once prime fishing areas around the islands in Block 1 and the Blowhole in Block 2 were low at 50-60kg/hr. Occasionally they found better patches of fish, and in the shallows pre-recruits were evident. Much of the deeper water reef that was productive 10 years ago has not recovered. They said that the economic viability of catching greenlip at low catch rates was reduced because of rising costs and falling beach prices.

Recreational fishery

Recreational abalone fishing licenses are issued annually, expiring on 31st October each year. New licenses are available from 1st November. Most licenses are issued prior to Christmas, coinciding either with the opening of the rock lobster season in November or with the holiday period over Christmas.

The number of recreational abalone licenses has increased by an average of ~10% annually since the 1995-96 season (Figure 4), and in the 2006/07 season, 12,514 recreational abalone diving licenses were issued. Surveys of recreational divers indicate that 105,500 abalone were taken in 2006/07, weighing an estimated 49t. Approximately 40% of the catch was taken in the south-east (Lyle, 2008).

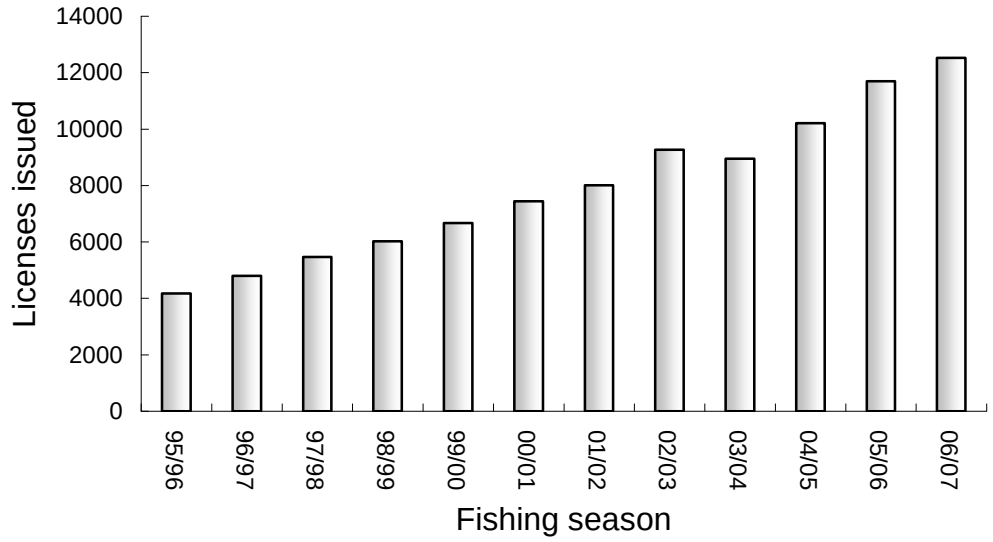


Figure 4. The number of recreational abalone diving licenses issued for the fishing seasons 1995-2007.

Indigenous, illegal and permit fisheries

Abalone were caught in Tasmanian waters as part of cultural fishing activities by indigenous people, under permits for special events and research purposes, and as part of illegal fishing operations. There were no estimates available for either the illegal catch or for the total catch from cultural fishing activities. The quantity of abalone taken under permits was less than one tonne.

Assessment Conclusions

Eastern Zone:

- There has been a consistent increase in catch rates in recent years and they are now at relatively high levels across the Eastern Zone. Catch rates at the Actaeons continued to increase, catch rates in Storm Bay and Bruny Island have stabilized, but catch rates on the East Coast in 2007, although still high, fell slightly.
- Median lengths have also increased in all four regions, which, coupled with the high catch rates and the low TAC, suggests that catches have been sustainable.
- Divers reported a continuation of the good fishing conditions evident in 2006 despite the slight fall in catch rates on the East Coast.
- It remains possible that recruitment to the fishery may decline during 2008 and 2009 due to diminished egg production from the low stock levels that occurred in 2001 and 2002.

Western Zone:

- Catches and catch rates were either stable or increased slightly in the Central West. In the North West, the annual catch has fallen, but here too, catch rates were stable or increased slightly. This suggests that stocks were stable in both regions, with sustainable levels of fishing.
- In the South West, catch rates have continued to fall. Even under flat sea conditions catch rates were lower than at any other time in the previous 10 years, indicating that stocks have become extensively depleted. TAFI confirms previous assessments of stocks in the South West: the level of catch is too high and is not sustainable. We remain concerned that the longer that fishing is maintained at current levels the longer any recovery is likely to take.
- Despite ongoing decreases in catch rates in this region the level of infrastructure and degree of capitalisation in this part of the fishery continued to increase. The higher beach price received for live market product suggests that there are strong financial incentives for levels of catch to be maintained or even increase.
- The risk of exceeding the cap on catches from the South Coast was identified in October 2007. However the complications of closing the fishery at a late stage in the fishing year resulted in the fishery remaining open. The South Coast region was over-caught by 22t at the end of the year, and this must be avoided in future. Catch rates, while appearing stable, were at a relatively low level, and combined with falling median lengths, indicate that fishing pressure remained high. Our assessment of South Coast stocks is that the levels of catch in 2007 and previous years were too high. While there have been no indications of long-term effects of over-fishing here, we believe it would be prudent to ensure that the catch is reduced.

Northern Zone:

- Effort on King Island has been reduced following the implementation of quarantine provisions to manage the potential risks relating to AVG. Consequently, the annual catch has fallen and catch rates have risen. On the

basis of fishery-dependent data and diver perception it seems likely that 2007 levels of catch were sustainable.

- In the North West, the overall catch and catch rates were similar to those in 2006, and it is likely that 2007 levels of catch were sustainable.
- The North East catch rose sharply to almost twice the previous highest level in recent history. While catch rates were also high, implying high stock levels, similar fishing patterns have proven unsustainable in other parts of the fishery. Given the small area of reef in the region, it would be of concern should similar levels of catch be taken in 2008.
- Furneaux Group blacklip catches were unusually low in 2007, probably associated with AVG quarantine provisions and the widespread reduction in mothership activity in northern waters.

Bass Strait Zone:

- The Bass Strait blacklip fishery was closed in 2007, and no catches were reported.

Greenlip:

- Stock levels appeared stable in the North West. At Perkins Bay, catches need to be limited at or below 20t to meet the requirements of the model used to evaluate the effects of the 132mm size-limit upon egg-production in the area.
- In the North East, the catch cap was over-caught by almost 50%. This level of catch has caused reduction in stock levels and catch rates in the past, and is clearly unsustainable. Because of low levels of catch in the previous two years, there may be no adverse consequences, but better methods of catch monitoring are required to detect catches that approach caps and prevent catch over-runs.
- On King Island, stocks of legal-sized greenlip abalone were reported by divers as being low despite the reduced level of catch. In both the Furneaux Group and King Island, stocks of large abalone were inadequate to meet domestic market demands for premium product, and were replaced by lower grade (smaller) product, causing beach prices to fall.

Management recommendations

Eastern Zone:

- FRAG to review data from 2007 in conjunction with available 2008 data for the Eastern Zone before adopting the scheduled annual 5% TAC increase. TAFI is not opposed to the annual 5% TAC increase but would withdraw support for the schedule of increases should there be a continuation of the downturn in the catch rates on the East Coast.

Western Zone:

- Reduce the Western Zone TAC so as to reduce the catch from the South West and the South Coast regions of the Western Zone. Displacing sufficient catch from these regions to the Central West and the North West is no longer a sustainable option.

Northern Zone:

- On-going review of the effects of the displacement of catch from King Island to other regions of the Northern Zone.

Greenlip Fishery:

- Review the distribution of catch in the North West, with particular reference to the contribution of the Perkins Bay area.

General Recommendations:

- Continue the development of spatial decision rules and performance measures for catch levels to manage total catch in the fishery.
- Support the development of the Fishery Resource Assessment Group (FRAG).

3. Catch, catch-rates and size-composition

Landed Catches - 2007

At the end of 2007, annual totals of reported landings comprised 2310.774 t of blacklip and 122.604 t of greenlip, a total of 2433.378 t from a TAC of 2502.5 t (Table 1). The Bass Strait Blacklip Zone was closed in 2007 as a precautionary measure to stop the spread of abalone viral ganglioneuritis (AVG) from Victoria to Tasmania, and consequently no fish were landed.

Table 1. 2007 landings by zone, in tonnes

Zone	2007 TAC	2007 Landings
Greenlip	122.5	122.604
Eastern Blacklip	770.0	770.059
Northern Blacklip	280.0	279.899
Western Blacklip	1260.0	1260.816
Bass Strait Blacklip	70.0	0

Eastern Zone blacklip fishery

Distribution of catch

Since 2004, the Eastern Zone TAC has been held at 770t to promote the rebuilding of stock levels. Figure 5 compares levels of catch in the Eastern Zone during the period when the TAC has been maintained at 770t.

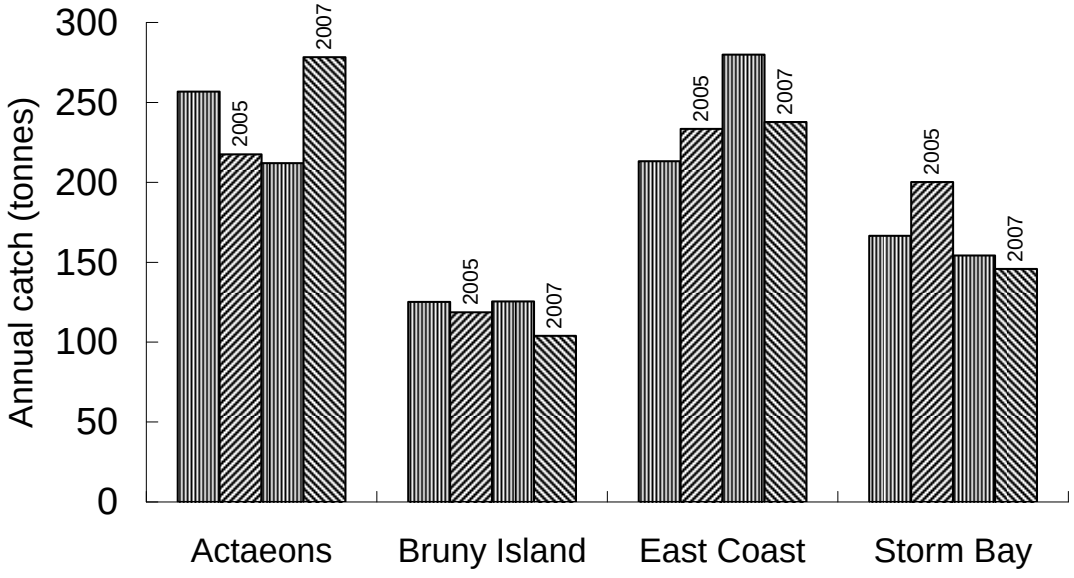


Figure 5. Distribution of catch, by region, Eastern Zone 2004-2007. During this period, the TAC for the Eastern Zone was set at 770t.

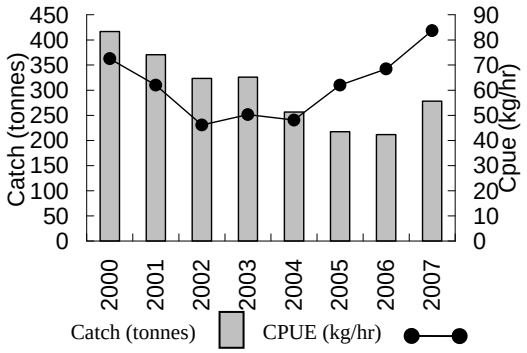
The 2007 Actaeons catch was high relative to catches of previous years, but not high in a historical context. It was 278t, slightly under the average of 289t. (This 1975-2007 average was calculated using 80% of Block 13 catches and 30% of Block 14 catches up to 2000, then 13C to 14B catches from thereafter).

The Bruny Island catch was low, both historically, and relative to recent past catches. The 2007 catch was 105t, under half the 1975-2007 average of 227t. (The 1975-2007 average includes catch from Blocks 15, Block 16, plus 70% of Block 14 up to 2000, then 14C, 14D, 14E, plus Blocks 15 and 16 thereafter).

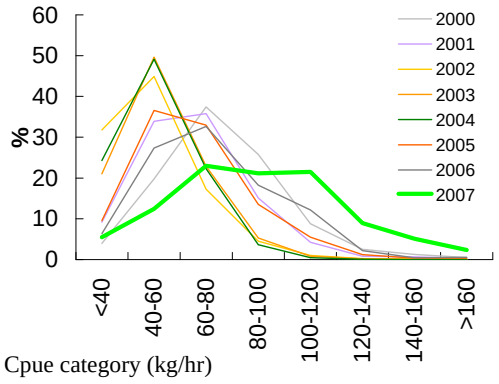
The East Coast and Storm Bay catches fell. The East Coast catch at 232t was among the lowest since 1975, and is well below the 441t average, while the Storm Bay catch was slightly below average (151t).

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

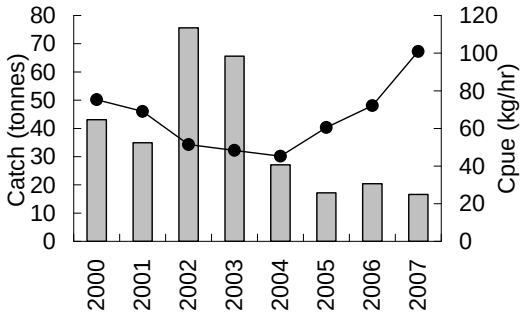
Regional view:



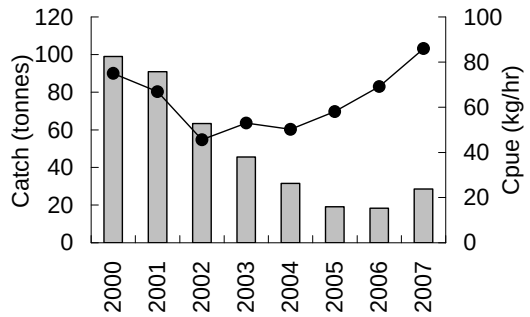
CPUE distribution



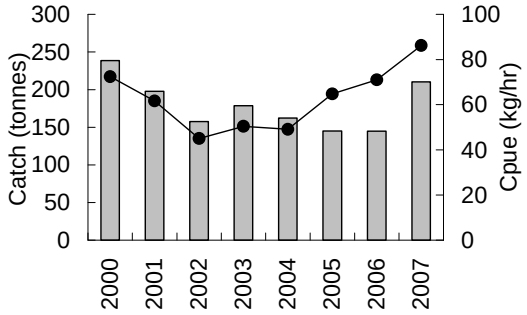
Sub-block 13C
Fishers Point to Whale Head



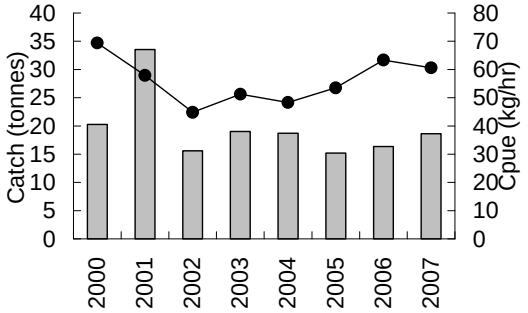
Sub-block 13D
Fishers Point to Southport Lagoon Beach, including Recherche Bay



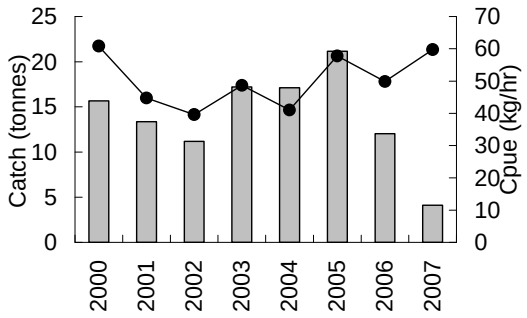
Sub-block 13E
Actaeon and Sterile Islands, and reefs to the south (the Breaks)



Sub-block 14A
Southport Lagoon Beach to Burnett Point

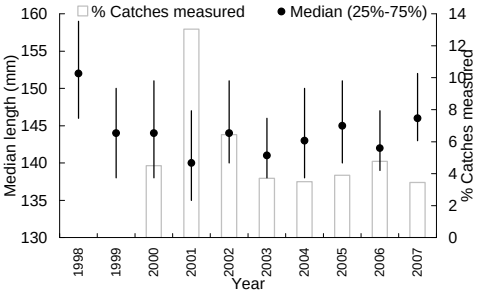


Sub-block 14B
Burnett Point to Blubber Head

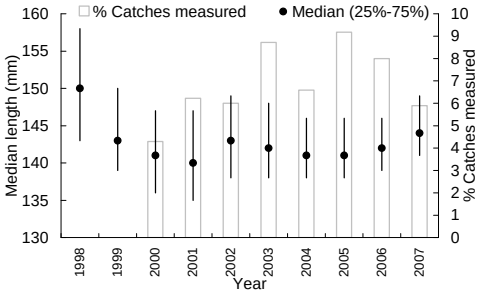


Actaeons, Lower Channel (Sub-blocks 13C, 13D, 13E, 14A, 14B)
Median length of catch

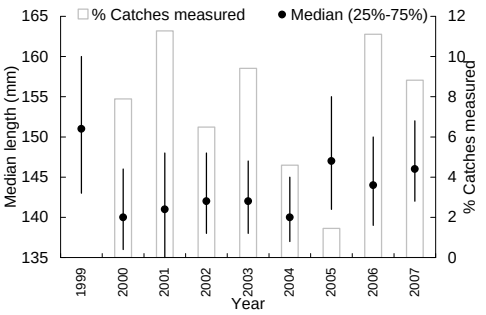
Sub-block 13D
Fishers Point to Southport Lagoon Beach, including Recherche Bay



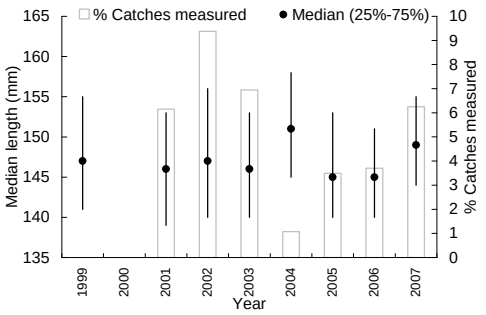
Sub-block 13E
Actaeon and Sterile Islands, and reefs to the south (the Breaks)



Sub-block 14A
Southport Lagoon Beach to Burnett Point

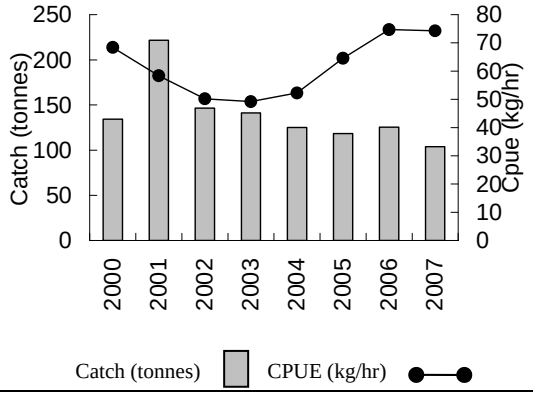


Sub-block 14B
Burnett Point to Blubber Head

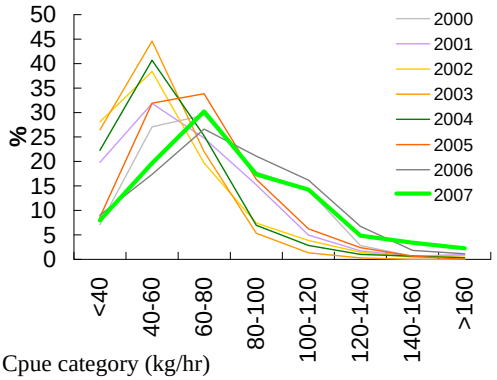


Eastern Zone – Bruny Island (Blocks 14C, 14D, 14E, 15, 16).
Catch and catch rates

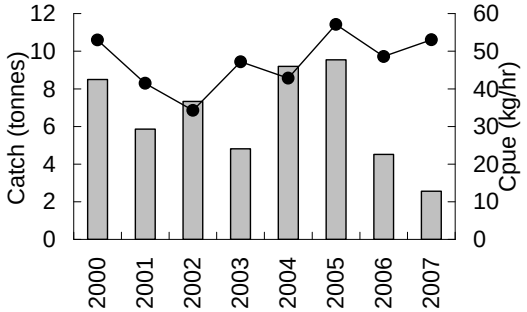
Regional view:



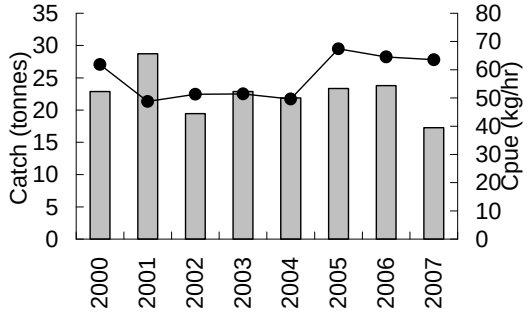
CPUE distribution



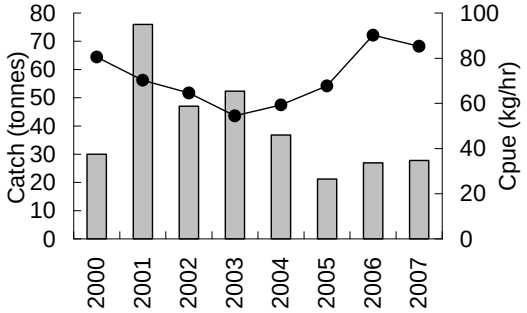
Sub-block 14C
Mays Creek to Hopwood Light (Lower Channel)



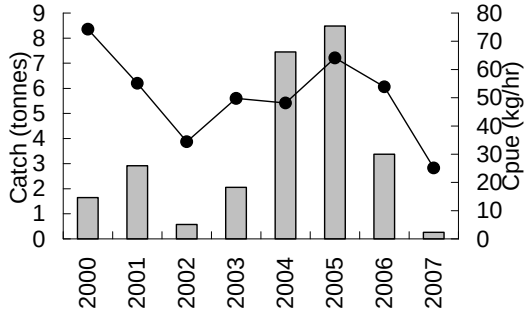
Sub-block 14D
Hopwood Point to West Cloudy Head



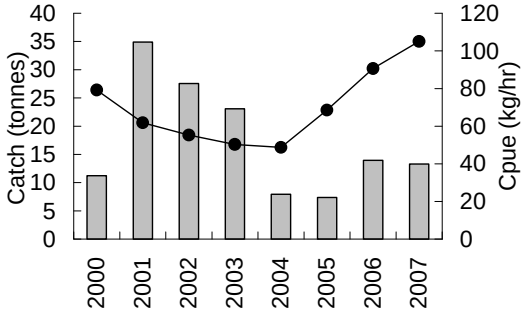
Sub-block 14E
West Cloudy Head to Boreel Head, including the Friars



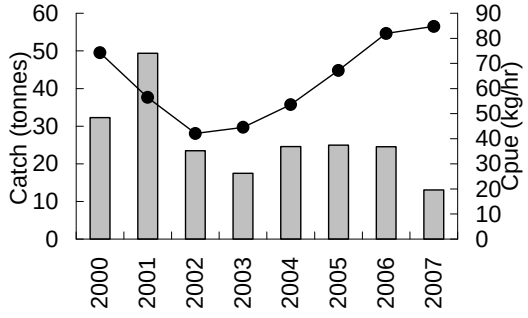
Block 15
D'Entrecasteaux Channel



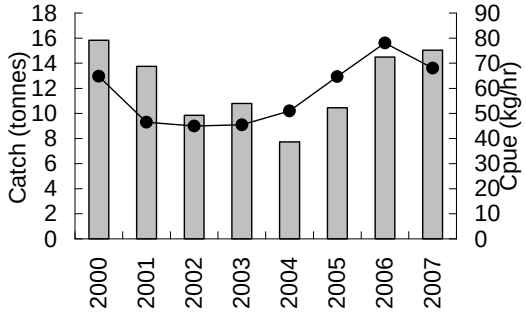
Sub-block 16A
Boreel Head to North Mangana Bluff



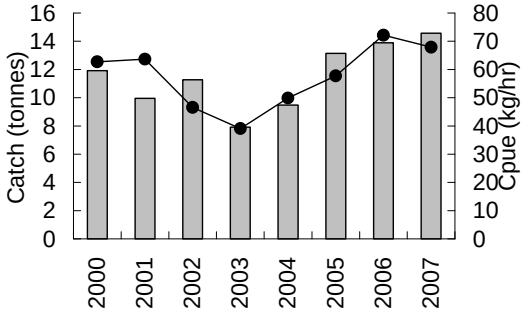
Sub-block 16B
North Mangana Bluff to Neck Beach



Sub-block 16C
Neck Beach to Trumpeter Bay

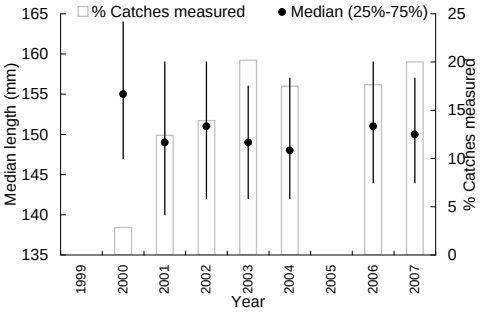


Sub-block 16D
Trumpeter Bay to Dennes Point

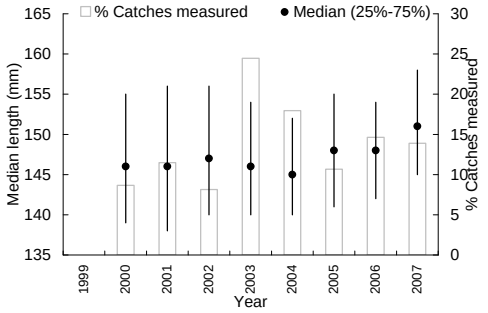


Eastern Zone – Bruny Island (Blocks 14C, 14D, 14E, 15, 16).
Median length of catch

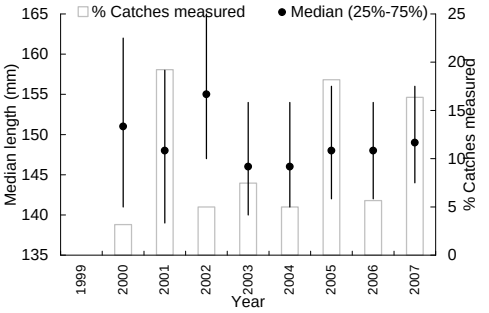
Sub-block 16A
Boreel Head to North Mangana Bluff



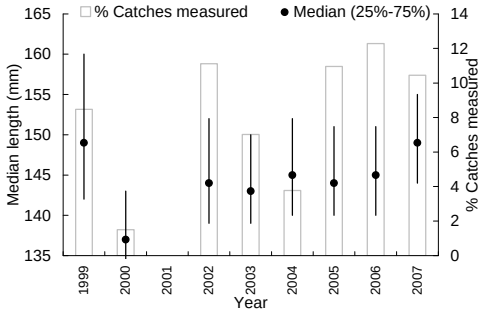
Sub-block 16B
North Mangana Bluff to Neck Beach



Sub-block 16C
Neck Beach to Trumpeter Bay

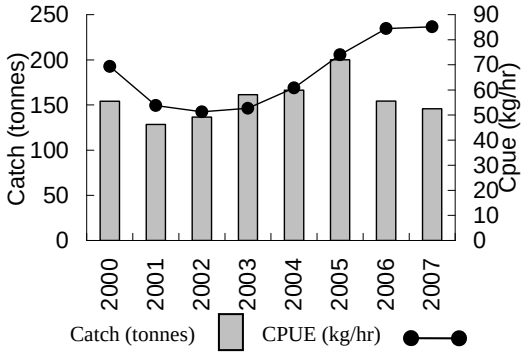


Sub-block 16D
Trumpeter Bay to Dennes Point

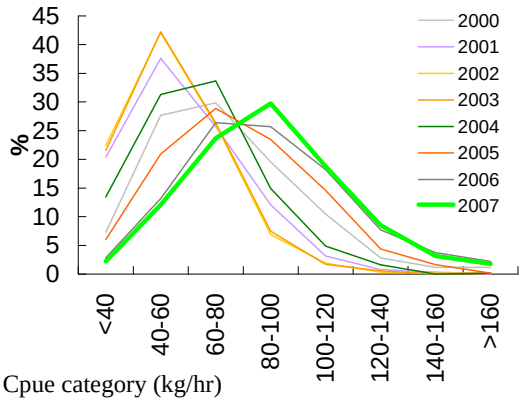


Eastern Zone - Storm Bay (Blocks 17-21)
Catch and catch rates

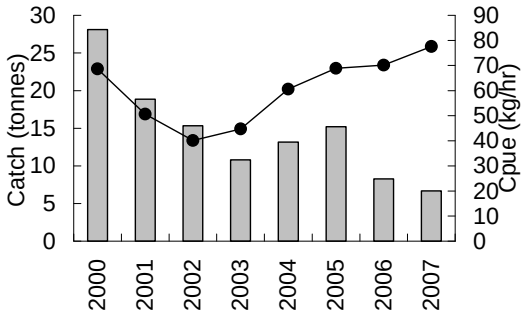
Regional view:



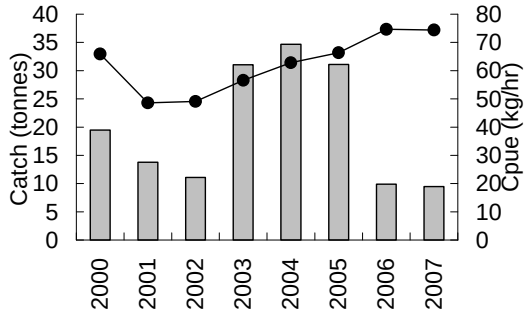
CPUE distribution:



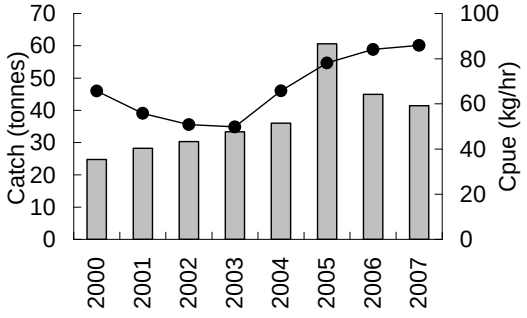
Sub-block 17B
Blackjack shoreline from Lobster Point to Outer North Head



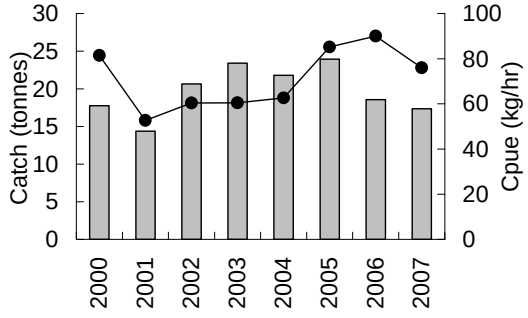
Sub-block 20A
Outer North Head to White Beach



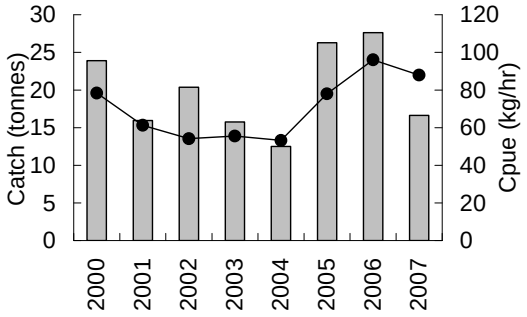
Sub-block 20B
White Beach to Salters Point



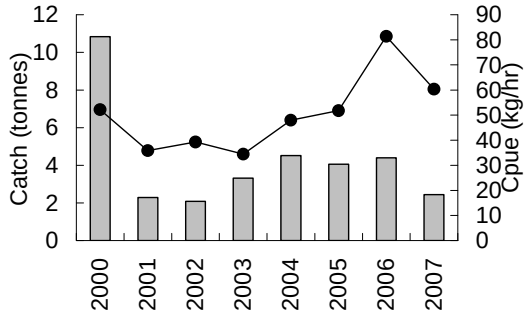
Sub-block 20C
Salters Point to Cape Raoul



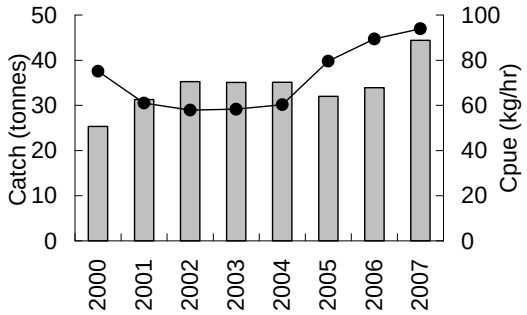
Sub-block 21A
Cape Raoul to Port Arthur



Sub-block 21B
Port Arthur

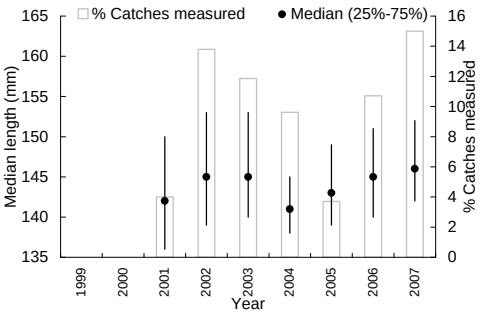


Sub-block 21C
Port Arthur to Cape Pillar

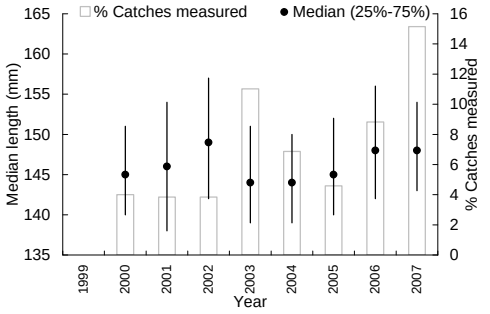


Eastern Zone - Storm Bay (Blocks 17-21)
Median length of catch

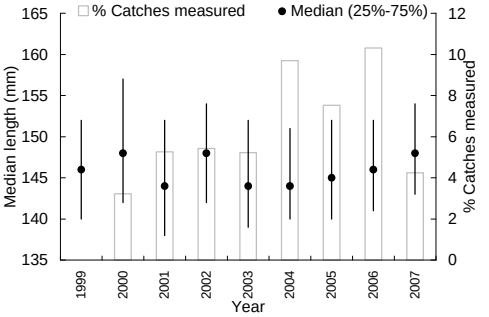
Sub-block 17B
Blackjack shoreline from Lobster Point to Outer North Head



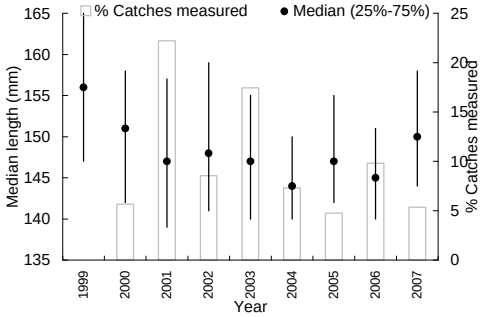
Sub-block 20A
Outer North Head to White Beach



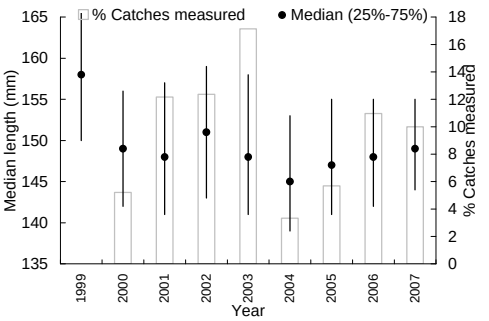
Sub-block 20B
White Beach to Salters Point



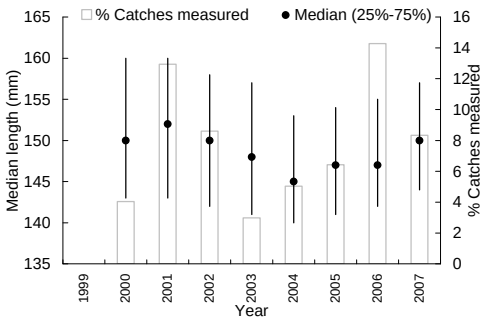
Sub-block 20C
Salters Point to Cape Raoul



Sub-block 21A
Cape Raoul to Port Arthur

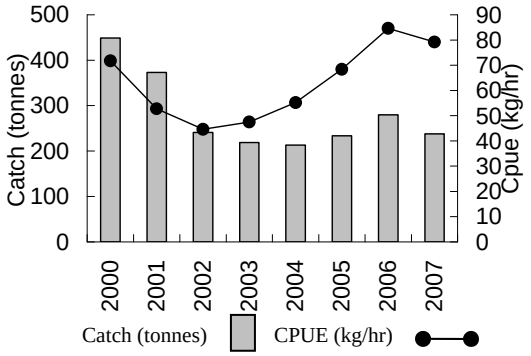


Sub-block 21C
Port Arthur to Cape Pillar

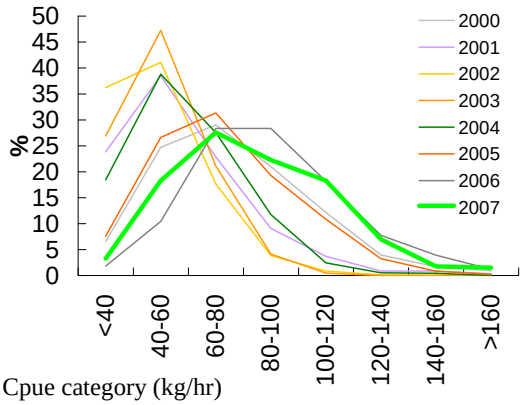


Eastern Zone – East Coast (Blocks 22-31)
Catch and catch rates

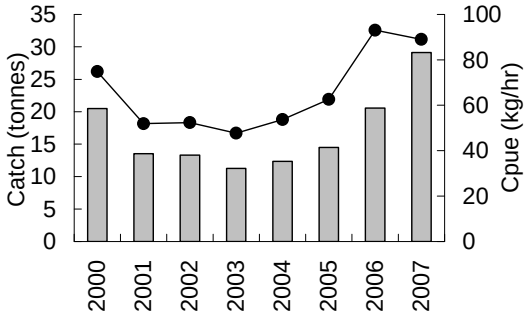
Regional view:



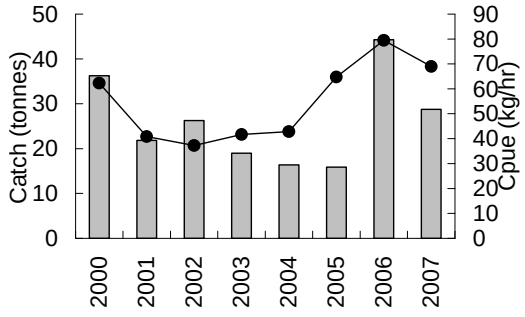
CPUE distribution:



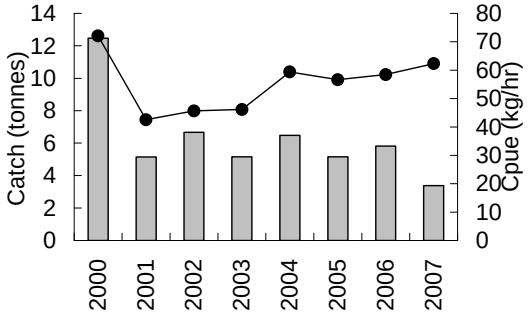
Sub-block 22A
Cape Pillar to the Lanterns



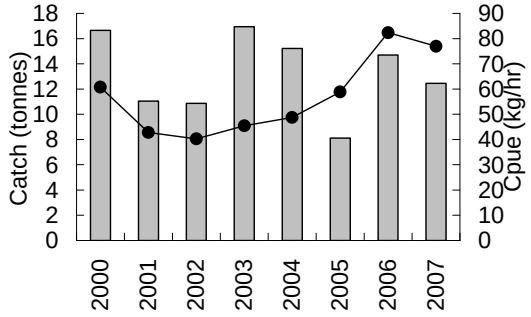
Sub-block 22B
The Lanterns to Eaglehawk Neck



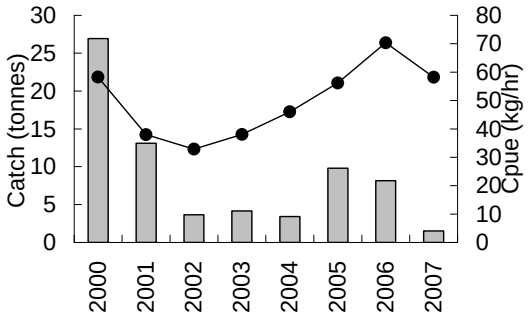
Sub-block 22C
Eaglehawk Neck to Deep Glen Bay



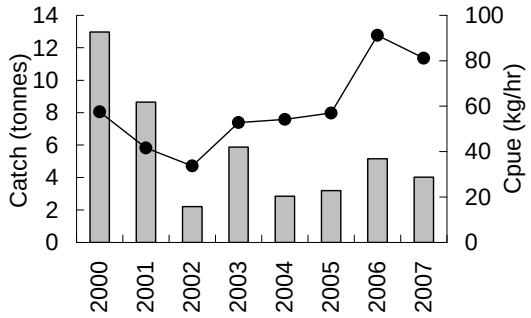
Sub-block 23A
Deep Glen Bay to Lagoon Bay



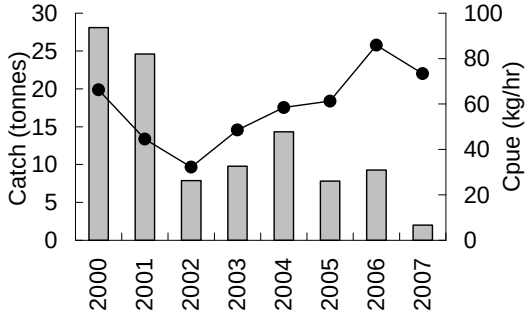
Sub-block 23B
Lagoon Bay to Eagles Beach



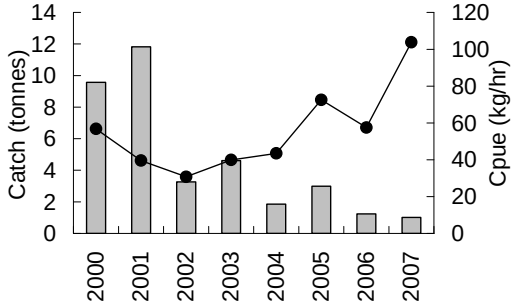
Sub-block 24A
western shore of Mercury Passage



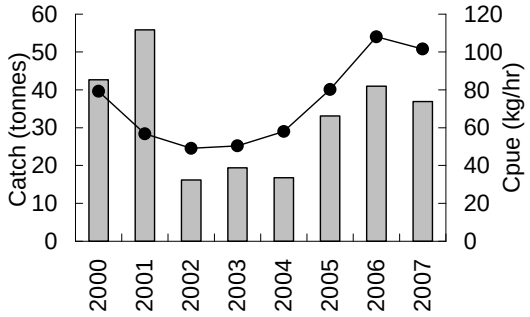
Sub-block 24B
eastern shore of Mercury Passage



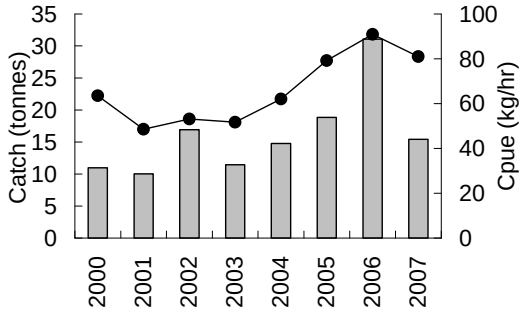
Sub-block 24C
Rheban to Cape Bougainville



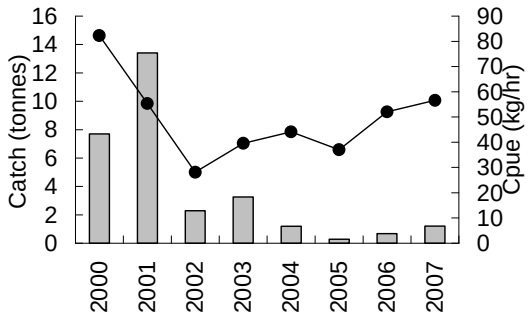
Sub-block 24D
north-east side of Maria Island



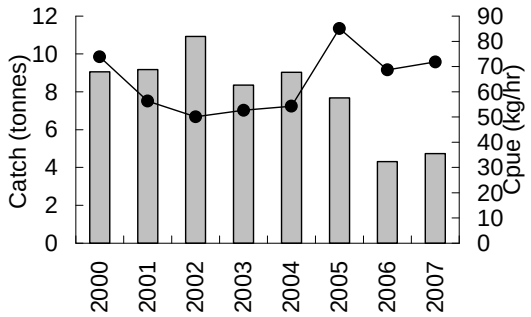
Sub-block 24E
south-east side of Maria Island



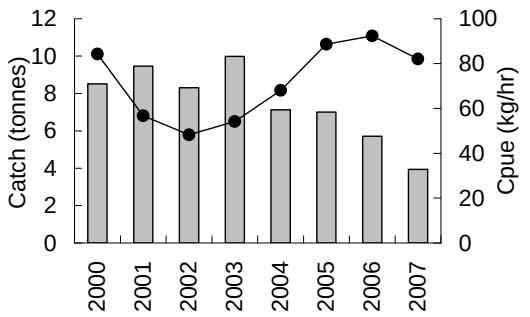
Block 26
Great Oyster Bay



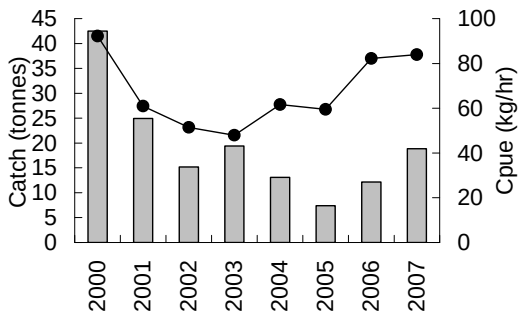
Sub-block 27A
south side of Schouten Island



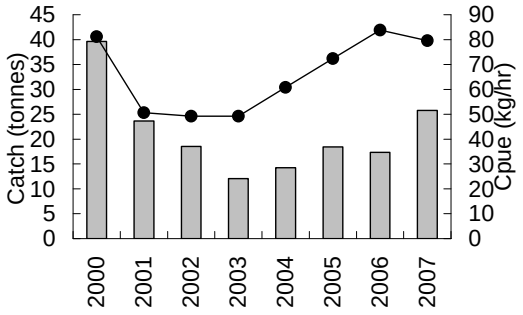
Sub-block 27B
east side of Schouten Island



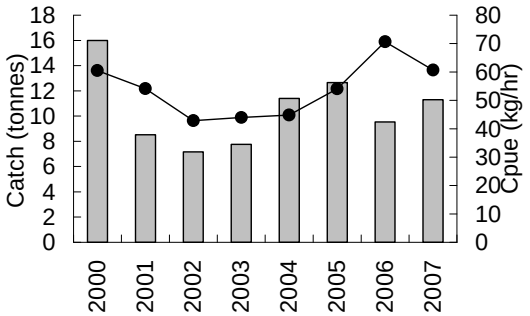
Sub-block 27C
Schouten Passage to Wineglass Bay



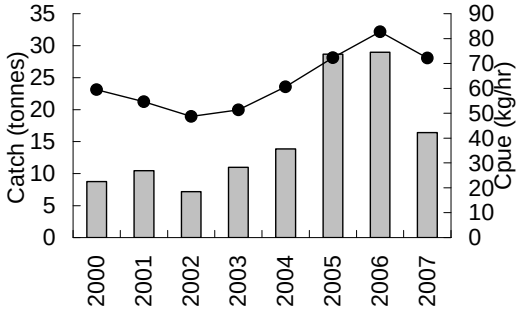
Sub-block 27D
Wineglass Bay to the Friendly Beaches



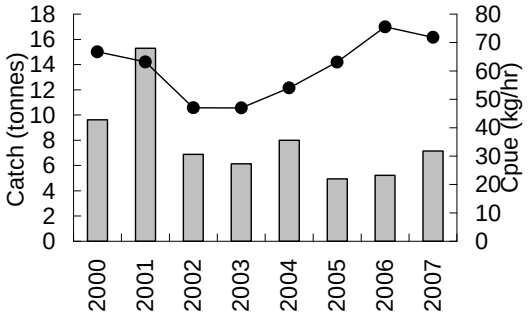
Block 28
Isaacs Point to Long Point



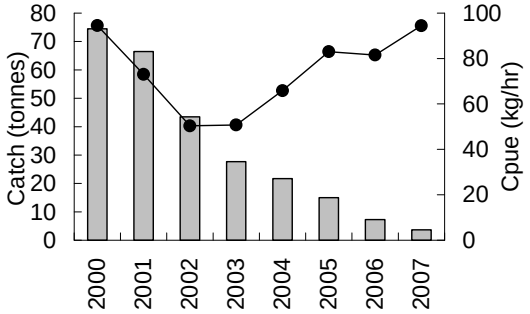
Sub-block 29A
Long Point to Templestowe Beach



Sub-block 29D
Scamander to St Helens Point

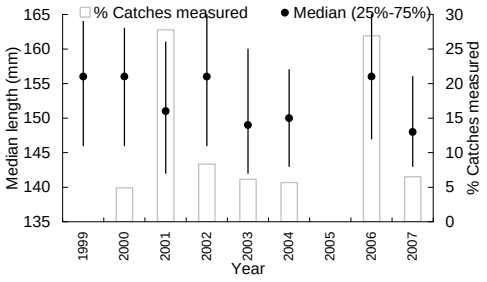


Sub-block 31A
Eddystone Pt to Cape Naturaliste

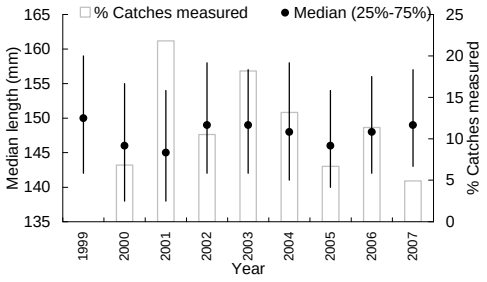


Eastern Zone – East Coast (Blocks 22-31)
Median length of catch

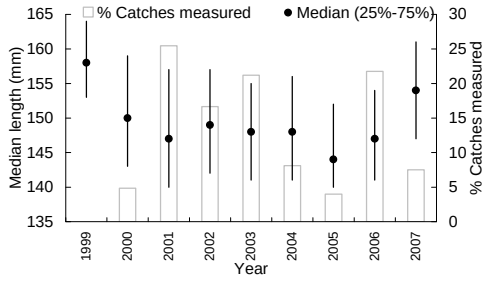
Sub-block 22A
Cape Pillar to the Lanterns



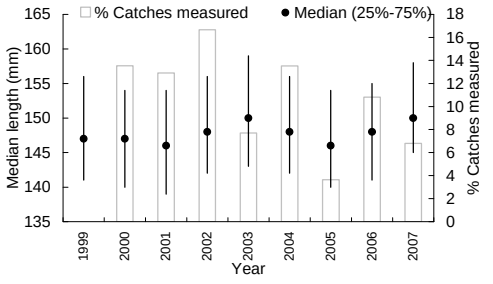
Sub-block 22B
The Lanterns to Eaglehawk Neck



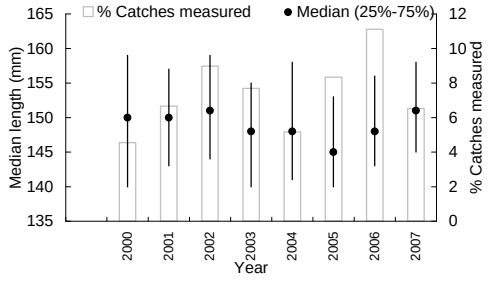
Sub-block 23A
Deep Glen Bay to Lagoon Bay



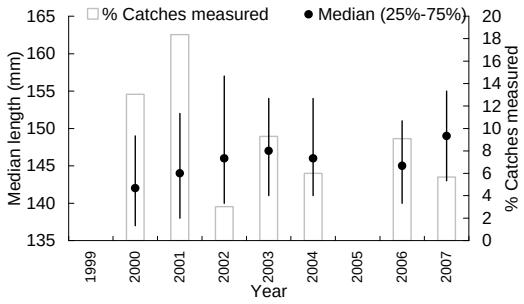
Sub-block 24D
north-east side of Maria Island



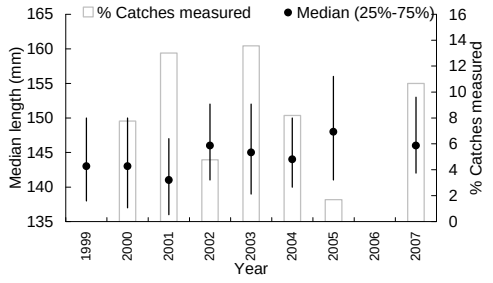
Sub-block 24E
south-east side of Maria Island



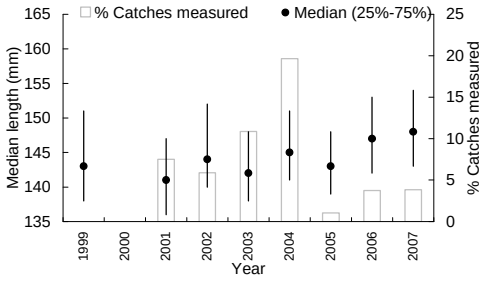
Sub-block 27C
Schouten Passage to Wineglass Bay



Sub-block 27D
Wineglass Bay to Friendly Beaches



Sub-block 29A
Long Point to Templestowe Beach



Western Zone blacklip fishery

Distribution of catch

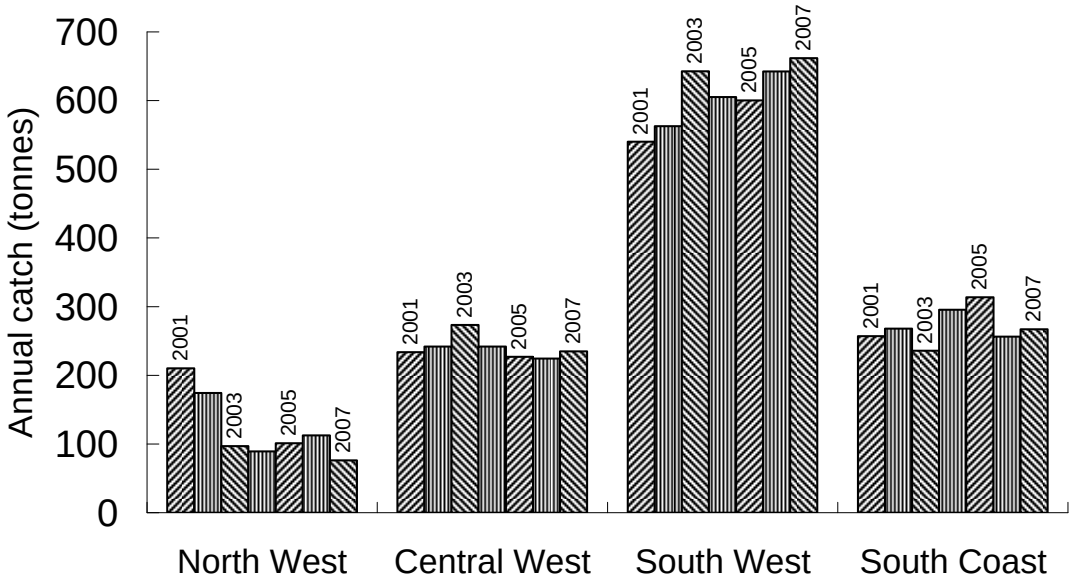
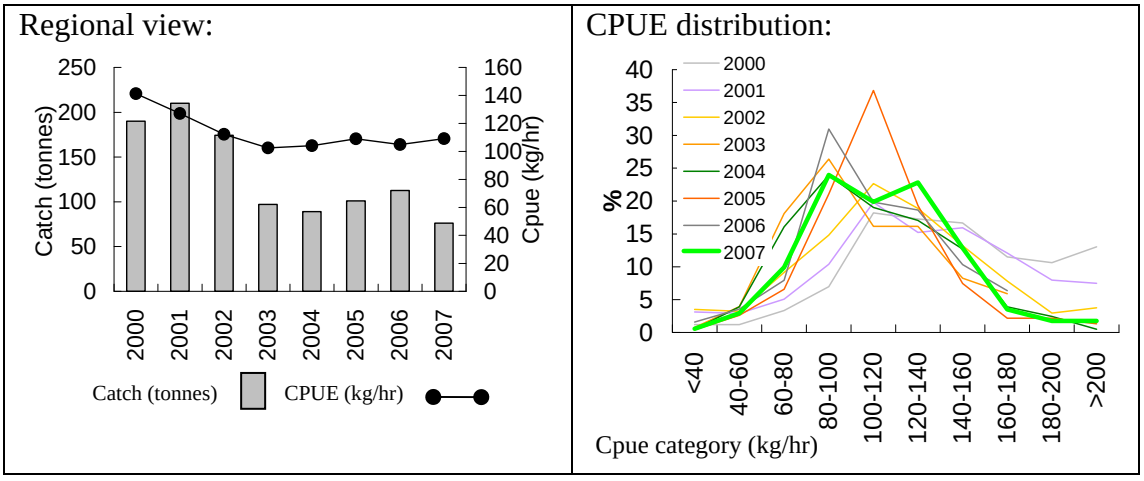


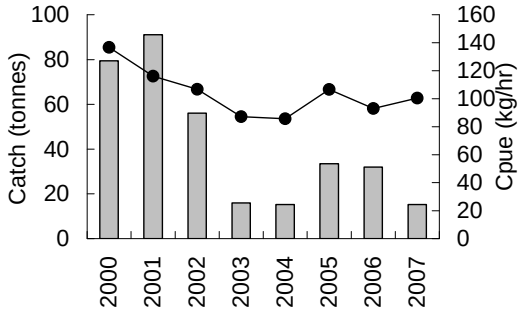
Figure 6. Distribution of catch by region, Western Zone 2001-2007. The annual TAC was 1260t during this period.

Note that the South West catch has been steadily increasing between 2001 and 2007, while the North West catch has fallen. Catches from the Central West and South West have been relatively stable.

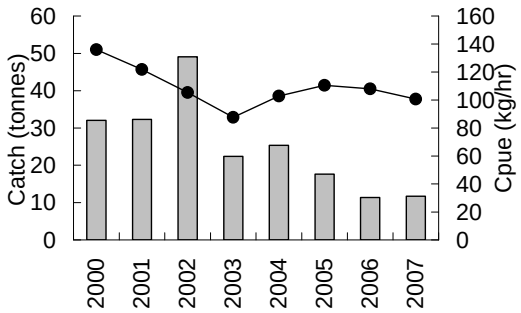
Western Zone - North West (Block 6, Sub-block 5D)
Catch and catch rates



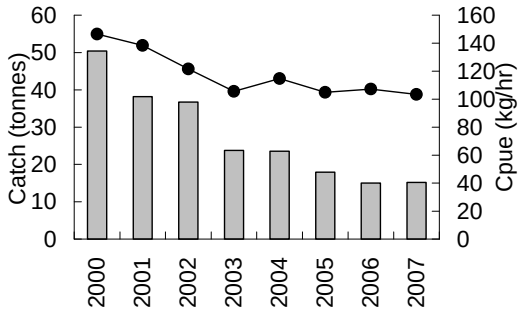
Sub-block 6A
Sundown to Temma



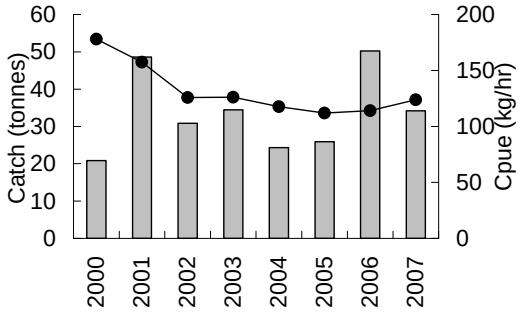
Sub-block 6B
Temma Harbour to north of Dawson River



Sub-block 6C
Dawson River to Wild Wave River

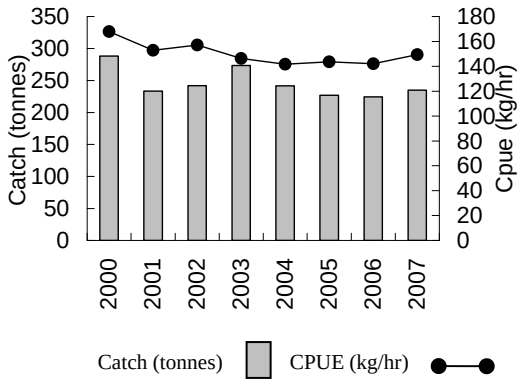


Sub-block 6D
Wild Wave River to Italian River, including Sandy Cape

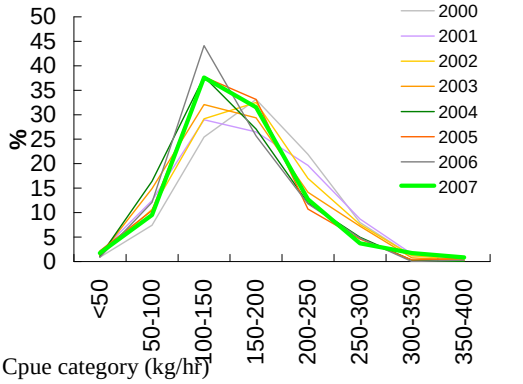


Western Zone - Central West (Blocks 7-9)
Catch and catch rates

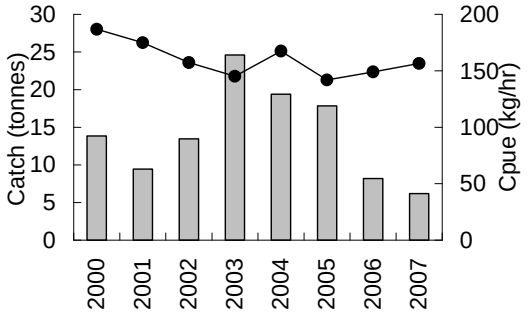
Regional view:



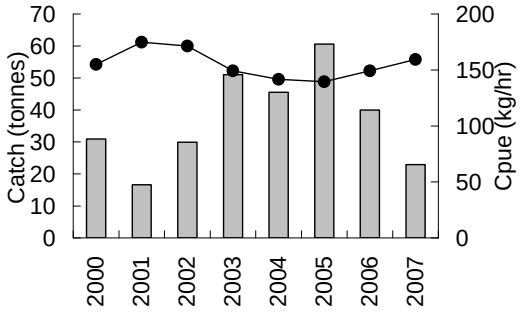
CPUE distribution:



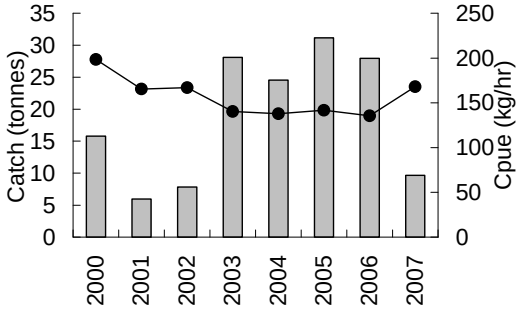
Sub-block 7A
Italian River to Pieman River



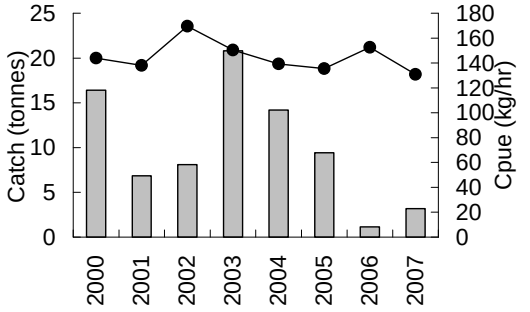
Sub-block 7B
Pieman to Ahrberg Bay, including Conical Rocks



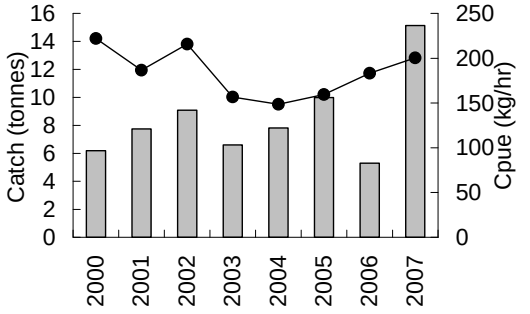
Sub-block 7C
Ahrberg Bay to Granville Harbour



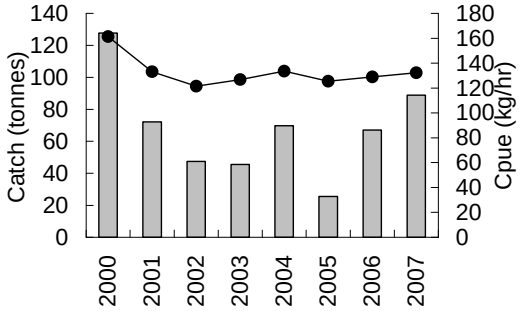
Sub-block 8A
Granville Harbour to Tasman Bay



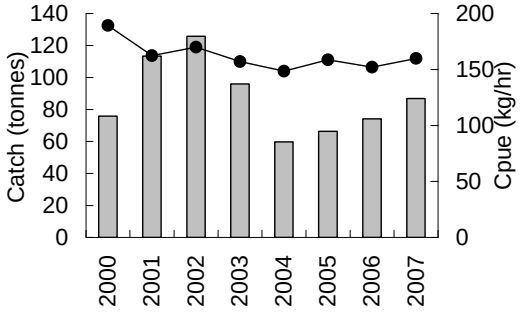
Sub-block 8B
Tasman Bay to Henty River



Sub-block 9B
Cape Sorell to Gorge Point

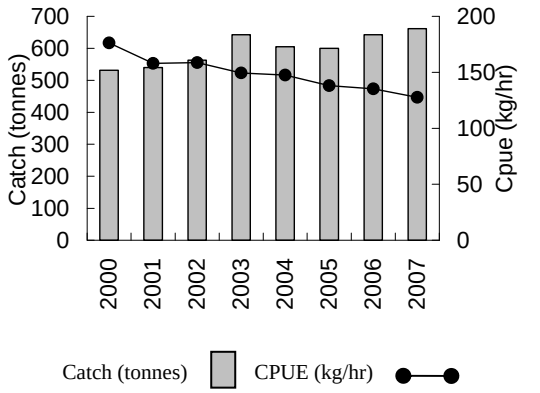


Sub-block 9C
Gorge Point to Point Hibbs

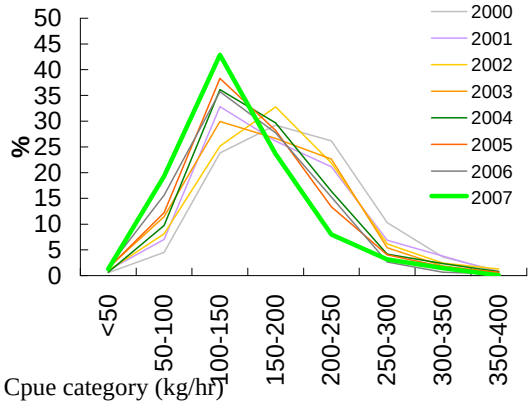


Western Zone - South West (Blocks 10-11)
Catch and catch rates

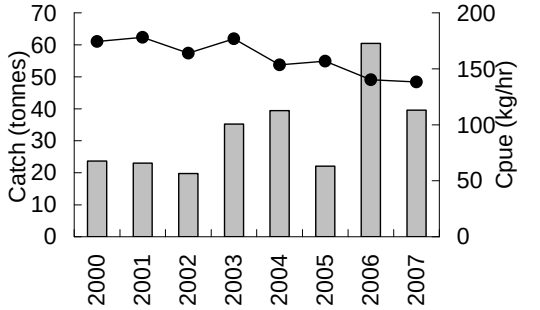
Regional view:



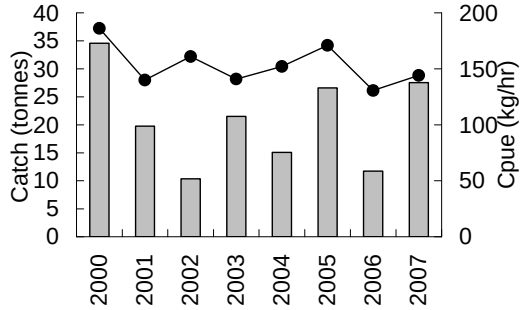
CPUE distribution:



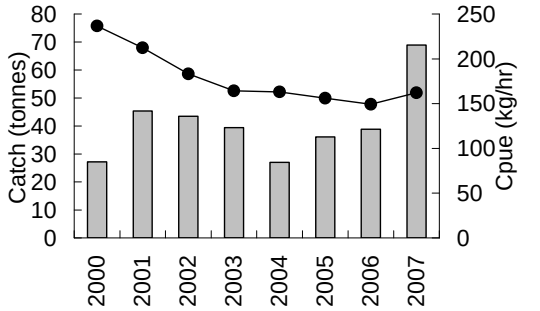
Sub-block 10A
Point Hibbs to Endeavour Bay



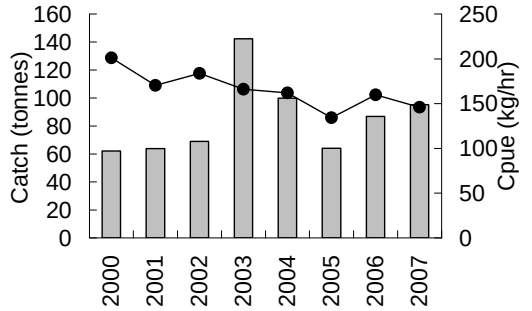
Sub-block 10B
Endeavour Bay to High Rocky Point



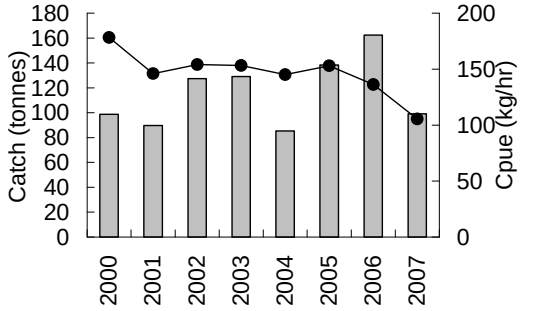
Sub-block 10C
High Rocky Point to Mainwaring River



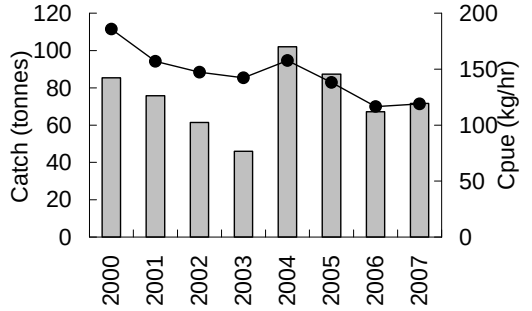
Sub-block 10D
Mainwaring River to Low Rocky Point



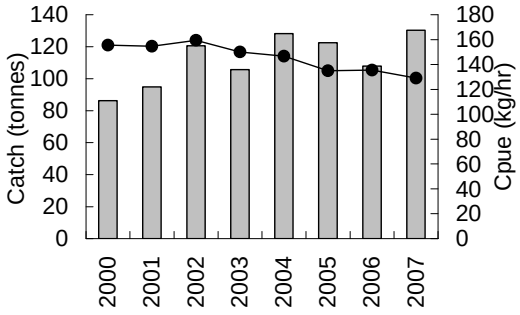
Sub-block 11A
Low Rocky Point to Elliott Point



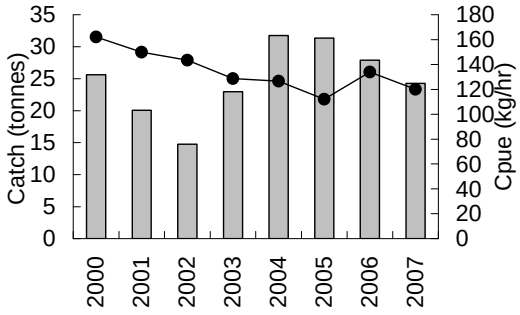
Sub-block 11B
Elliott Point to Svenor Gulches



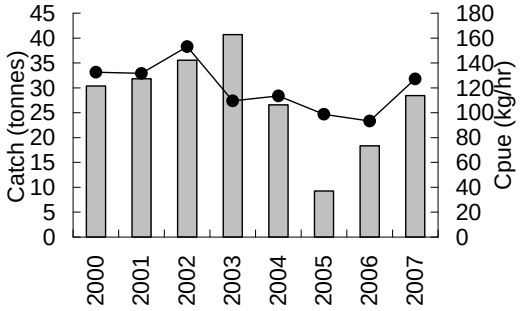
Sub-block 11C
Svenor Gulches to Point St Vincent



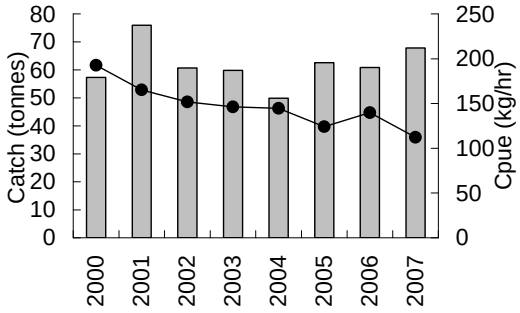
Sub-block 11D
Hilliard Head to Faults Bay



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

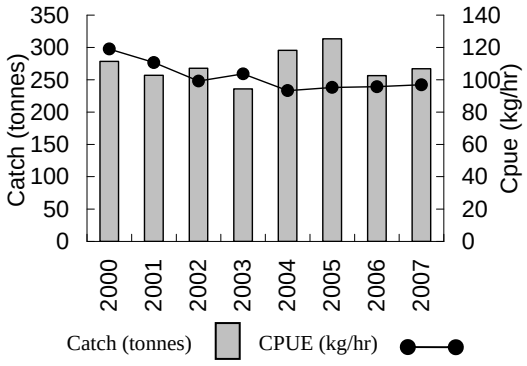


Sub-block 12A
Faults Bay to South West Cape

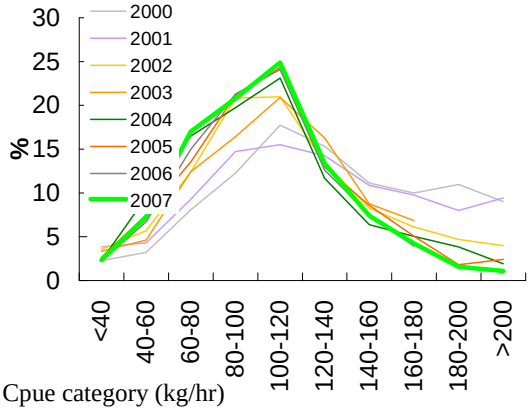


Western Zone - South Coast (Block 12, Sub-blocks 13A, 13B)
Catch and catch rates

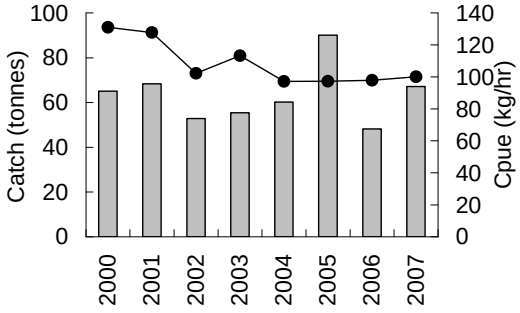
Regional view:



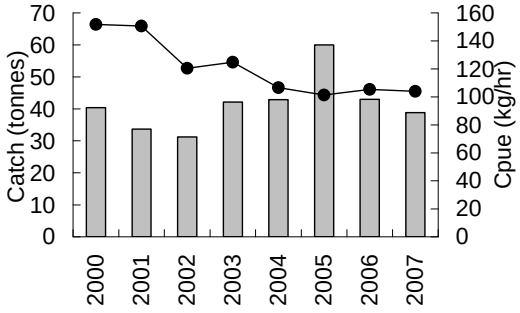
CPUE distribution:



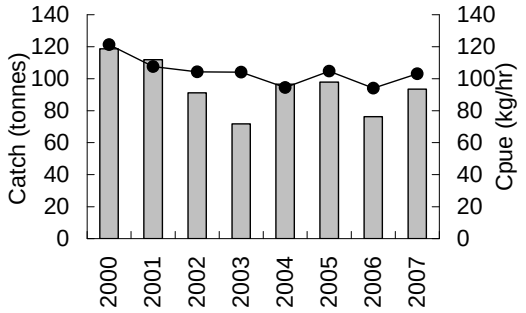
Sub-block 12B
South West Cape to Cox Bluff



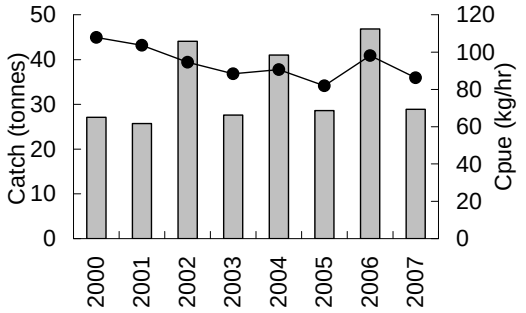
Sub-block 12C
Maatsuyker Group



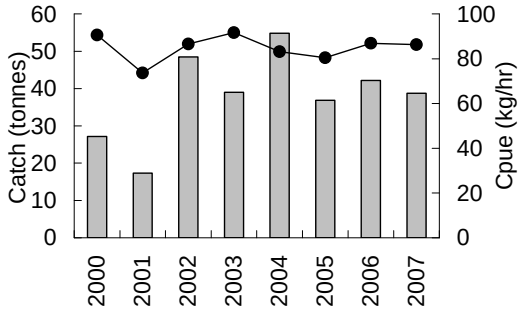
Sub-block 12D
Cox's Bluff to Prion Beach



Sub-block 13A
Prion Beach to South Cape

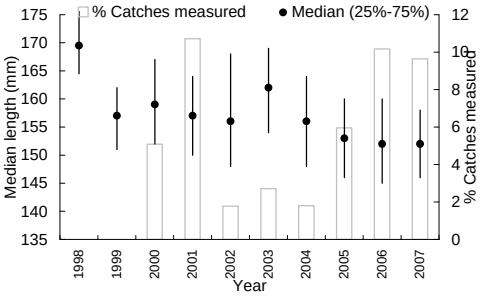


Sub-block 13B
South Cape to Whale Head



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

Sub-block 13A
Prion Beach to South Cape



Northern Zone blacklip fishery

Distribution of catch

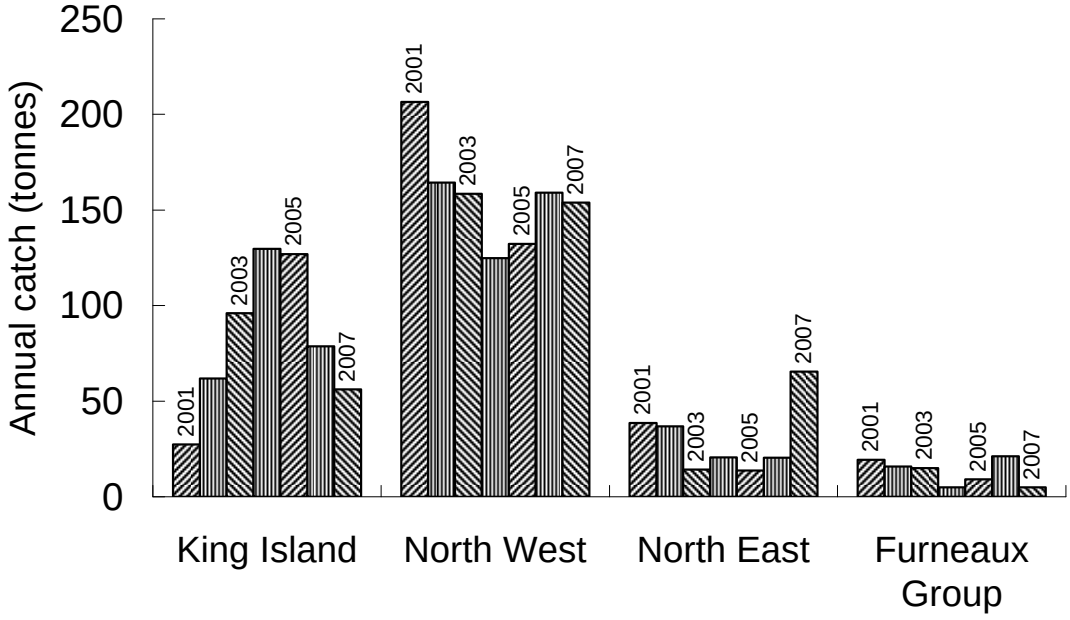
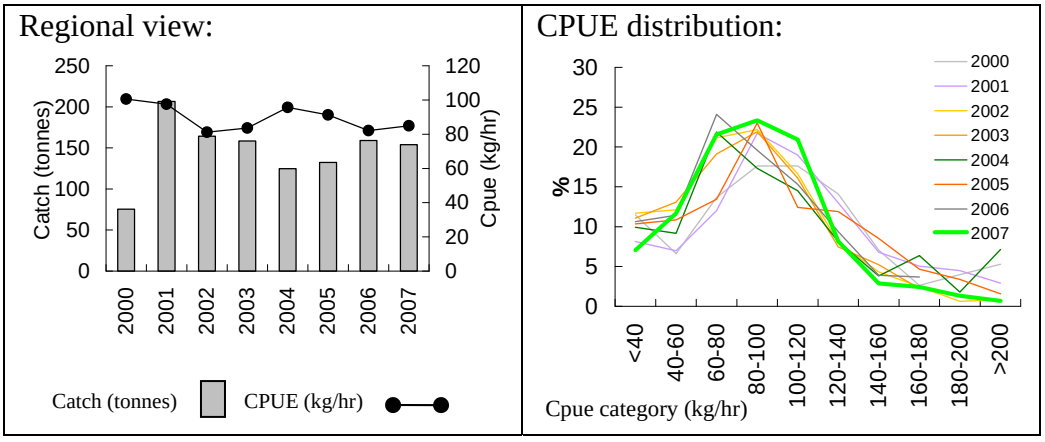


Figure 7. Distribution of catch by region, Northern Zone 2001-2007. The blacklip catch was maintained at 280t pa during this period.

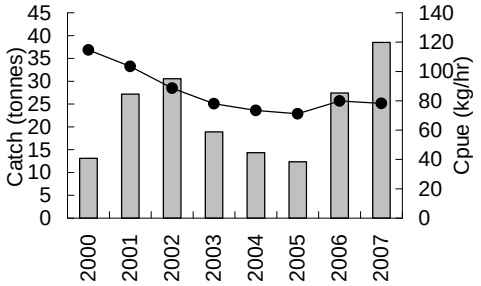
Since the introduction of the Northern Zone in 2001, most of the catch has come from the North West and King Island. The King Island catch was affected by the AVG quarantine requirements and probably the closure of the Bass Strait Zone in 2007, which reduced the number of divers in the area. Note also the sharp increase in catch from the North East in 2007.

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

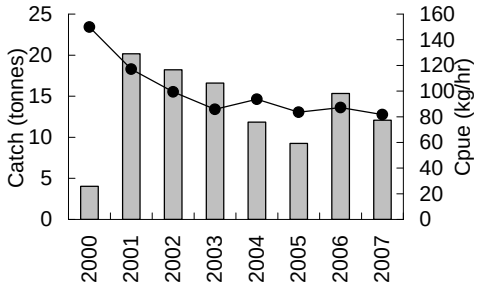
Catch and catch rates



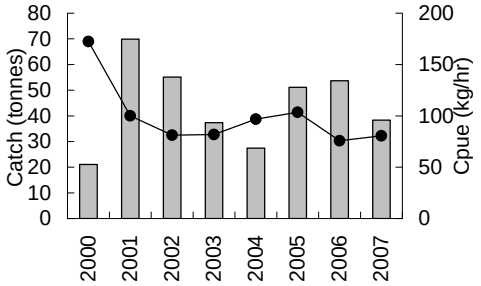
Sub-block 5A
Woolnorth Point to Studland Bay



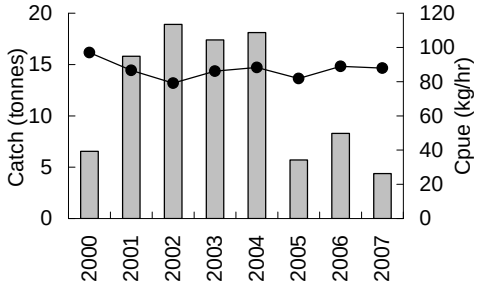
Sub-block 5B
Studland Bay to Greens Beach, including Mt Cameron West



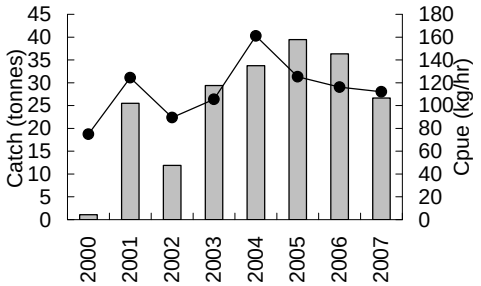
Sub-block 5C
Greens Beach to Arthur River



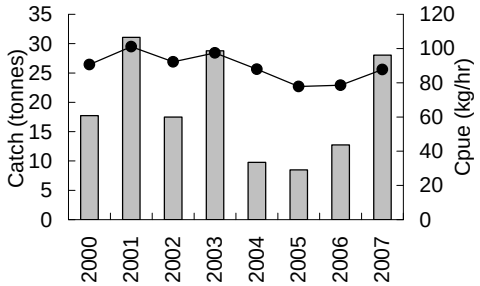
Sub-block 49A
Three Hummock Island



Sub-block 49B
Northern part of Hunter Island

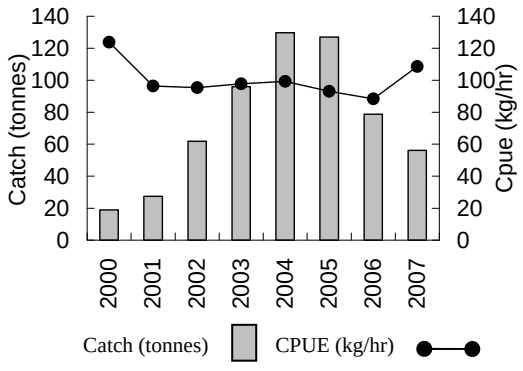


Sub-block 49C
South-western Hunter Island

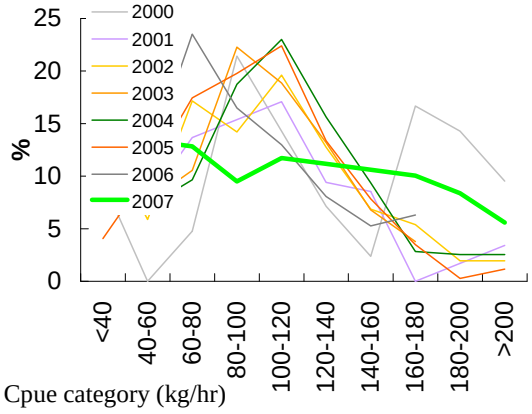


Northern Zone - King Island (Blocks 1-4)
Catch and catch rates

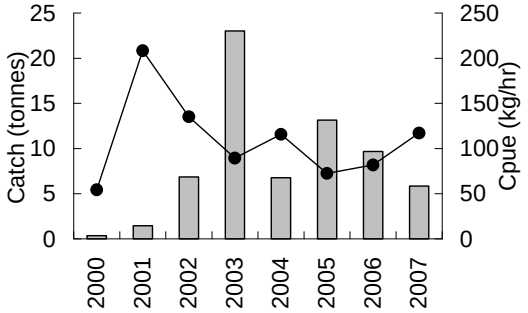
Regional view:



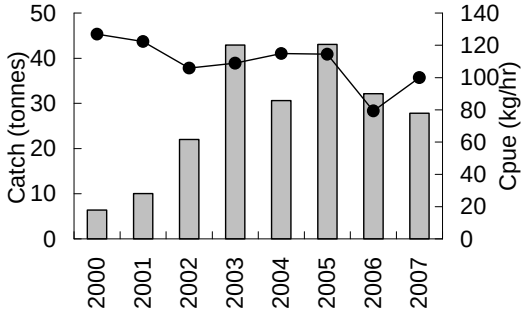
CPUE distribution:



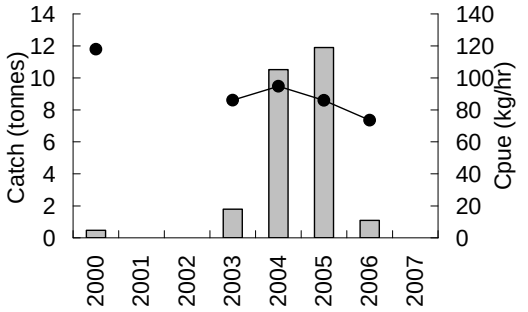
Sub-block 1C
west coast King Island



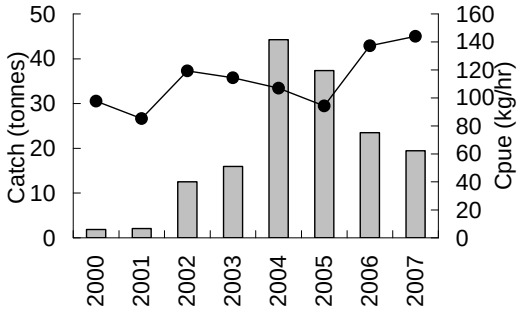
Sub-block 3A
west coast King Island



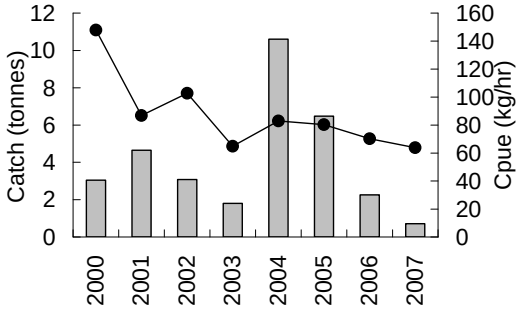
Sub-block 3B
west coast King Island



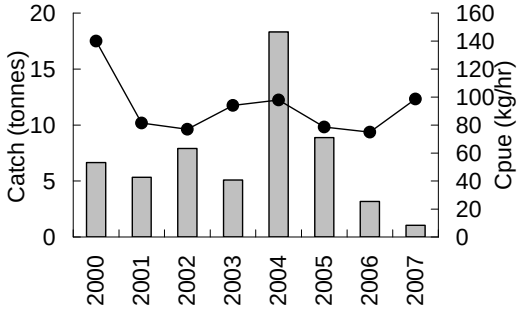
Sub-block 3C
south-west King Island



Sub-block 4B
south-east King Island

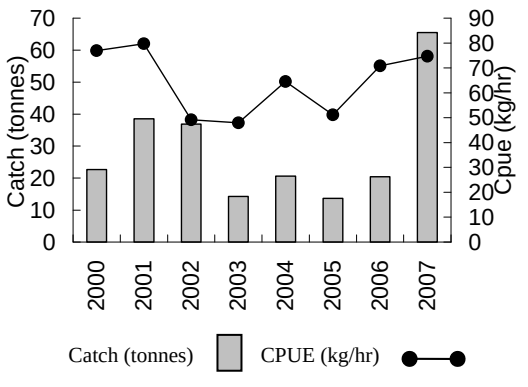


Sub-block 4C
south-east King Island

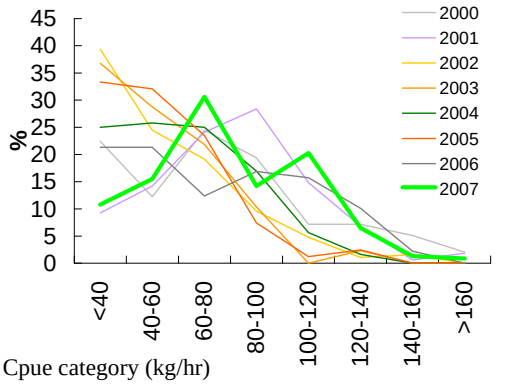


Northern Zone - North East (Sub-block 31B, Blocks 39, 40)
Catch and catch rates

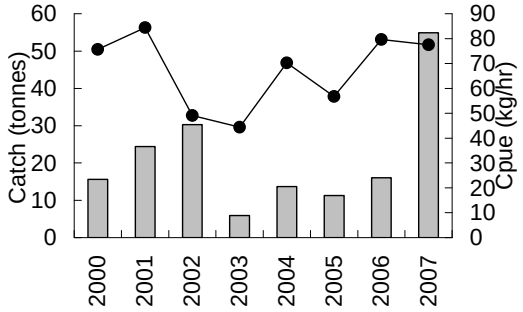
Regional view:



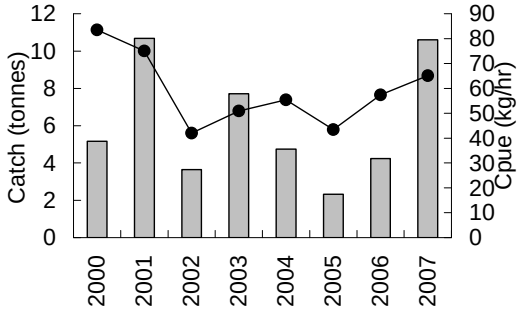
CPUE distribution:



Sub-block 31B Little Musselroe to Musselroe Bay, including Swan Island

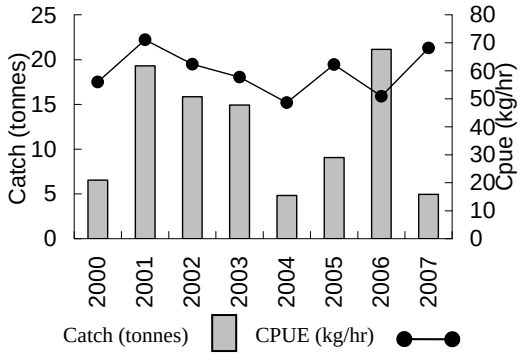


Sub-block 31B
Little Musselroe to Petal point

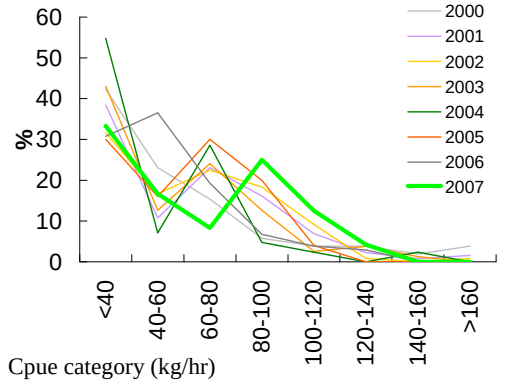


Northern Zone - Furneaux Group (Blocks 32-36, Sub-blocks 38A, 38B)
Catch and catch rates

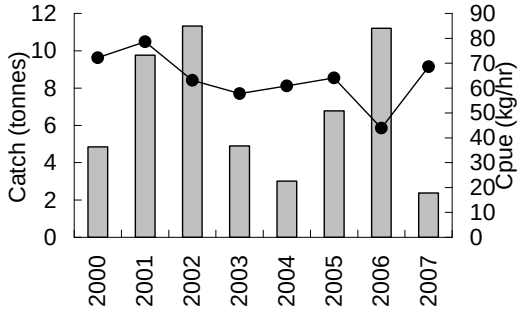
Regional view:



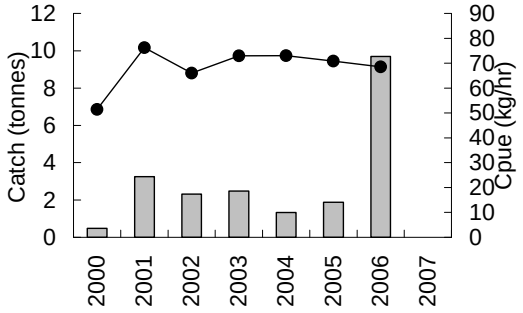
CPUE distribution:



Block 33
south-east Furneaux Group



Sub-block 38A
east side of Flinders Is, inc Babel Island



Bass Strait Zone blacklip fishery

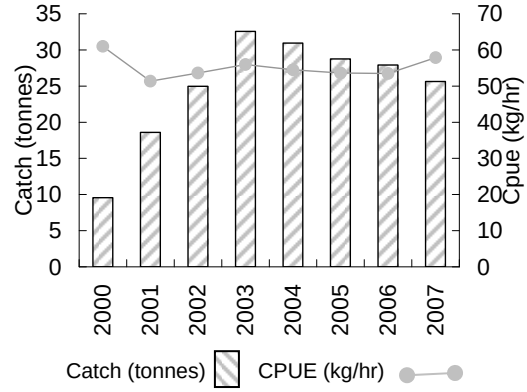
The Bass Strait blacklip zone was closed in 2007 as part of measures to control the spread of abalone viral ganglioneuritis from Victoria.

Greenlip fishery

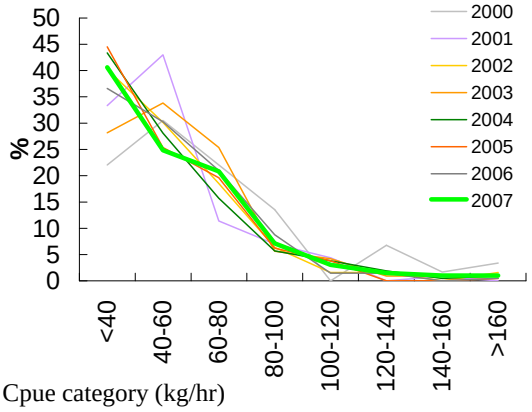
Distribution of the 2007 122.5t TAC was fixed between the four regions at the following levels:
King Island – 30t
North West – 30t
North East – 23t
Furneaux Group – 42t

Greenlip - King Island (Blocks 1-4)
Catch and catch rates

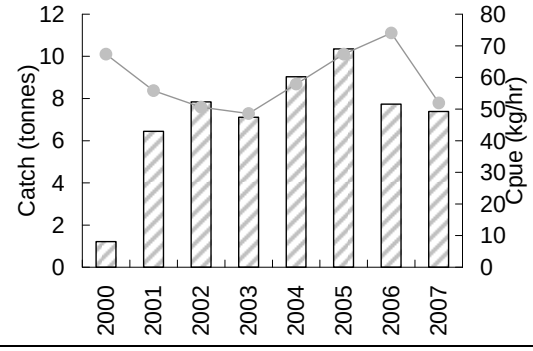
Regional view:



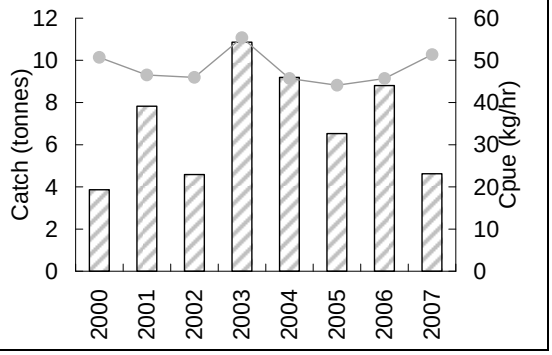
CPUE distribution:



Sub-block 1B
north west King Island

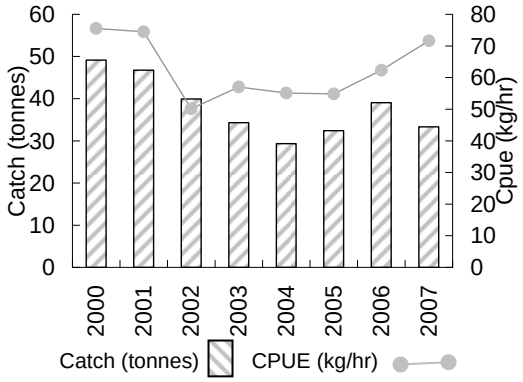


Sub-block 2C
north east King Island

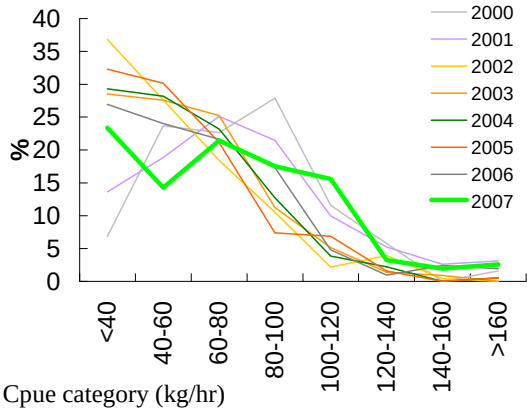


Greenlip North West (Blocks 5, 47-48)
Catch and catch rates

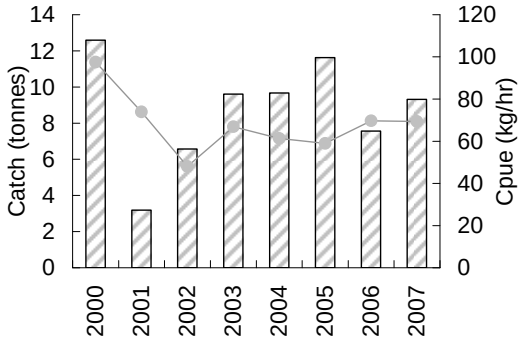
Regional view:



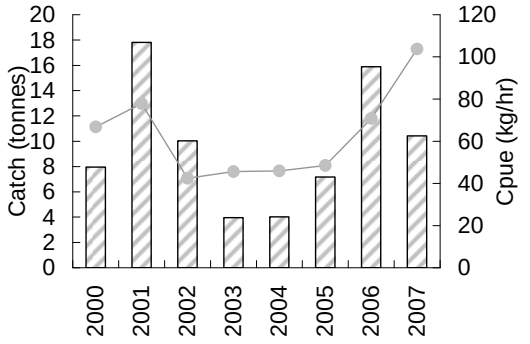
CPUE distribution:



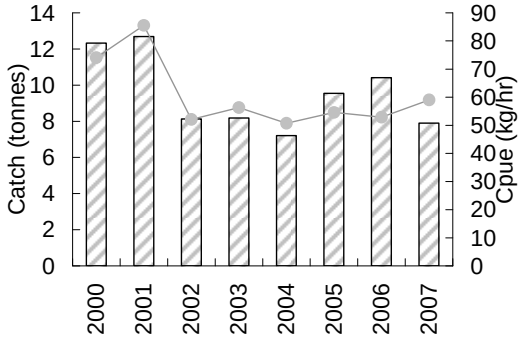
Sub-block 5A
west of Woolnorth Point



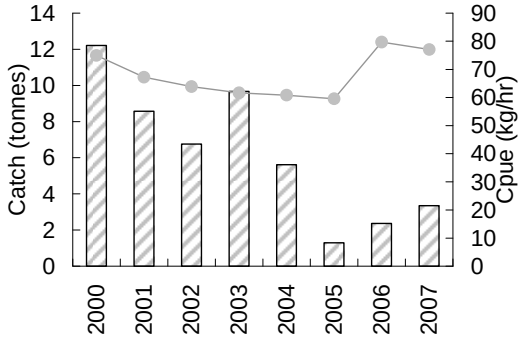
Sub-block 48A
Black Reef



Sub-block 48C
Woolnorth Point to Robbins Island

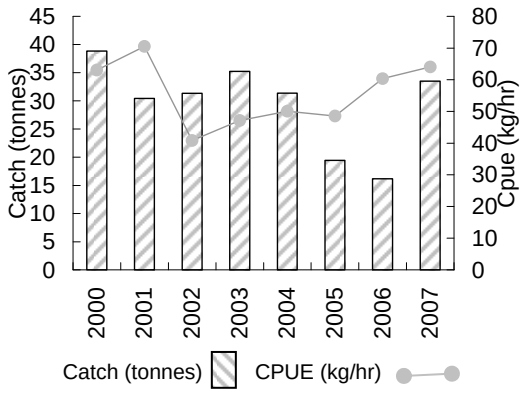


Block 49
Woolnorth Point to Hunter Island,
including Three Hummock Is.

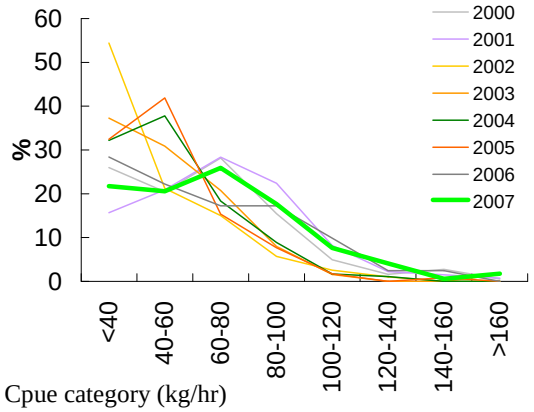


Greenlip - North East (Blocks 31, 39, 40)
Catch and catch rates

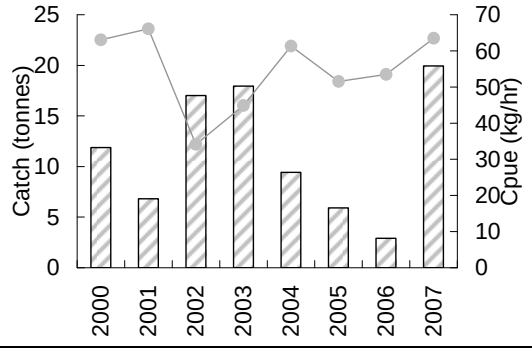
Regional view:



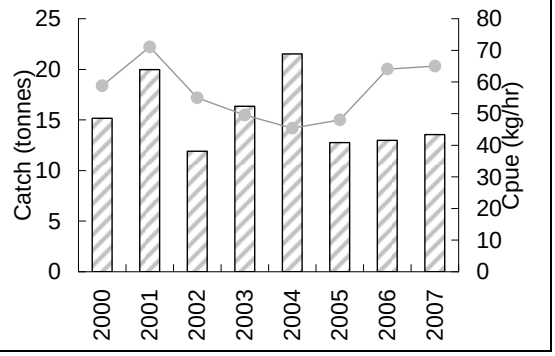
CPUE distribution:



Sub-block 31B
Little Musselroe to Cape Naturaliste

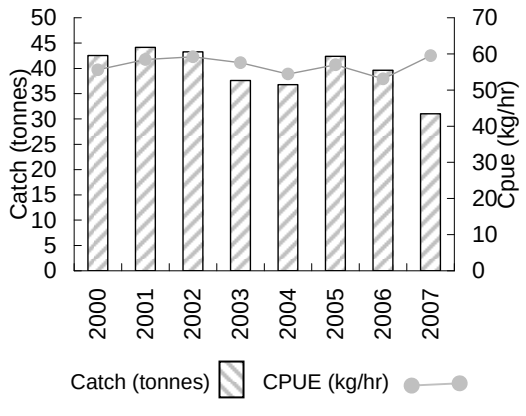


Sub-block 39A
Little Musselroe to Petal Point

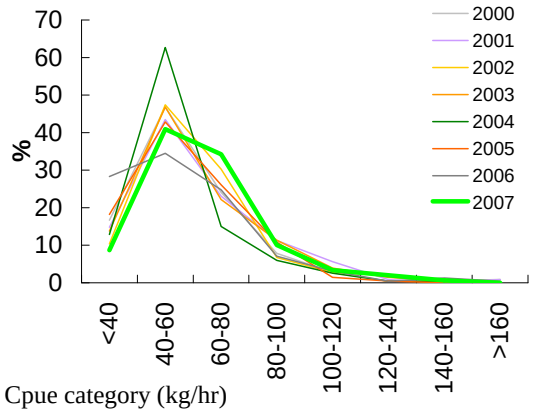


Greenlip - Furneaux Group (Blocks 32-38)
Catch and catch rates

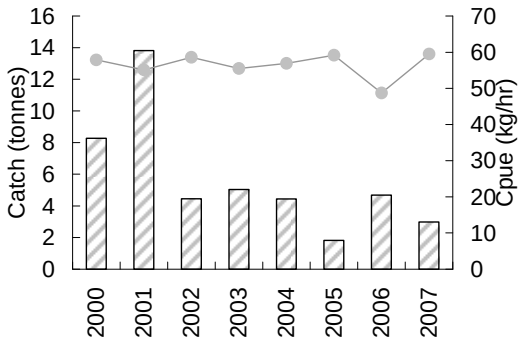
Regional view:



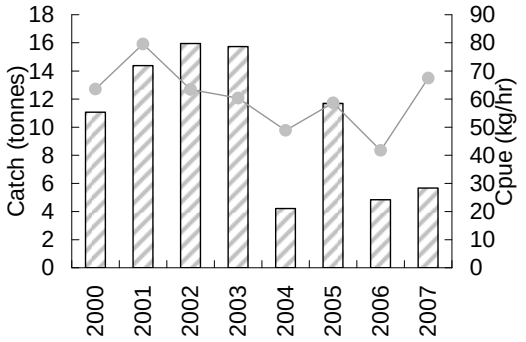
CPUE distribution:



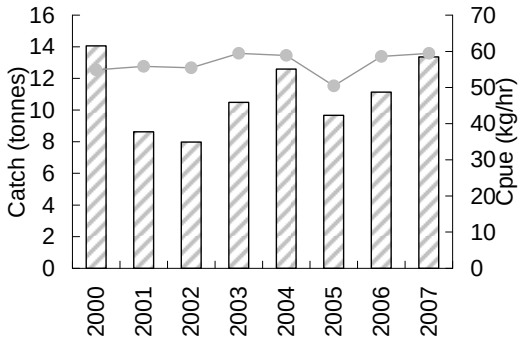
Block 32
west side of Clarke Is, Armstrong Passage



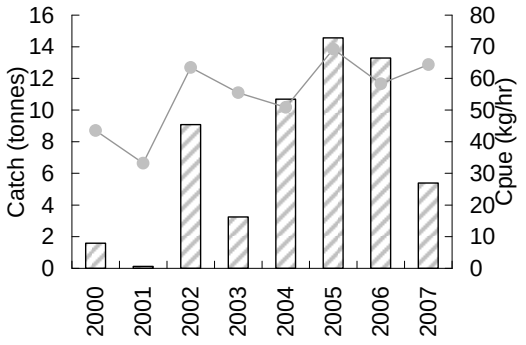
Block 33
south east Clarke, Cape Barren Islands



Block 35
Franklin Sound



Block 38
north-east Flinders Island



4. Appendices

Appendix 1: 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 10t pa, or six or more divers contributed to the catch). Figure 8 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.

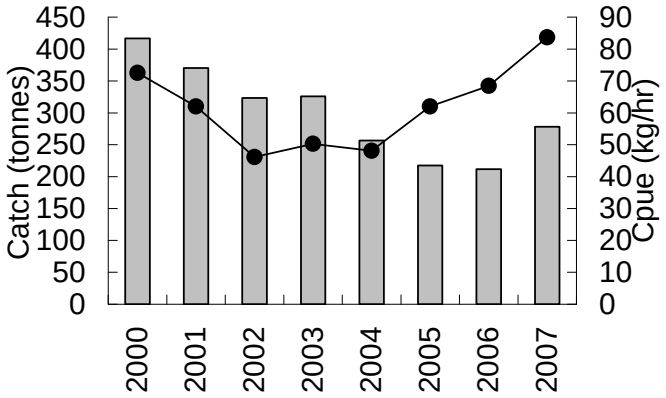


Figure 8. Annual catch (tonnes) and geometric mean catch rates (kg/hour), 2000 - 2007.

Catch rates are expressed as geometric mean catch rates rather than arithmetic means because abalone catch rates do not tend to follow statistically normal distributions and using the geometric mean helps avoid biasing the estimated catch rates for all divers combined. Highly skewed catch-rate distributions, such as those from the Western Zone typically have arithmetic means approximately 10% higher than geometric means. Arithmetic means are also more sensitive to extreme values than geometric means, which, in the context used here, are usually attributable to fleet dynamics, not regular fishing practises.

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 9). 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.

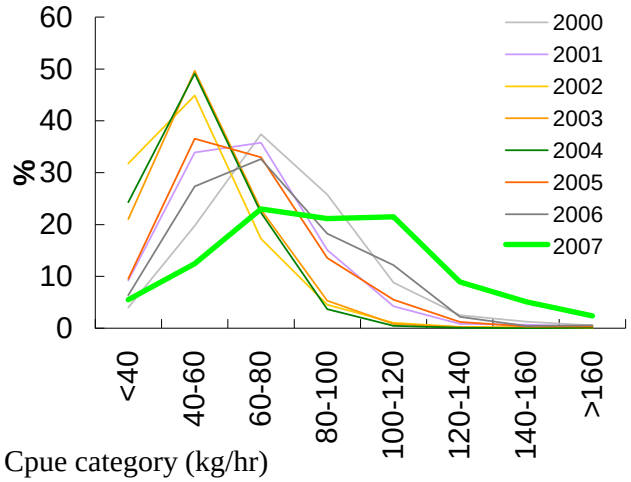


Figure 9. The percentage distribution of catch-rates, 2000 - 2007.

Size-composition charts.

The size-composition of divers' catches is reviewed at sub-block level (Figure 10). 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.

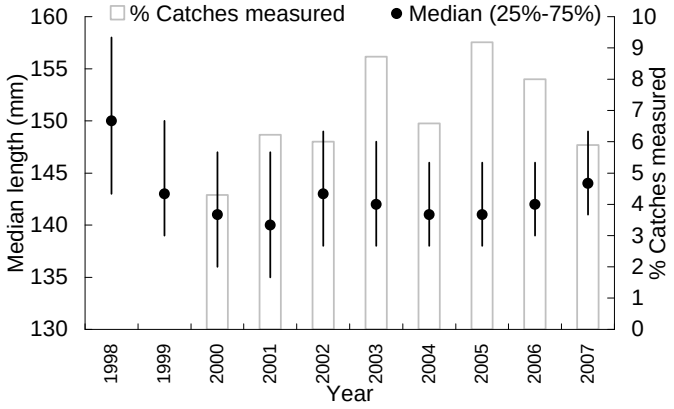


Figure 10. Median length with 25%-75% inter-quartile size range of abalone from commercial catch samples. The vertical columns represent the percentage of catches sampled.

Size-composition charts plot median length (the middle or 50th percentile length if all abalone were sorted from smallest to largest) for the period 1998-2007 (or the period since catches can be attributed to sub-blocks). They also show the size of abalone at the

25^{th} and 75^{th} percentiles *i.e.* the size range of the middle 50% of abalone from the sampled catches.

Appendix 2: Interpreting trends in catch and catch rate, and the size composition of the commercial catch.

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

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

Gregarious behaviour

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

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

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

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

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

Serial depletion

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

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

In 2007, divers reported that the recent availability of improved forecasting of sea conditions was responsible for effort creep, 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 11).

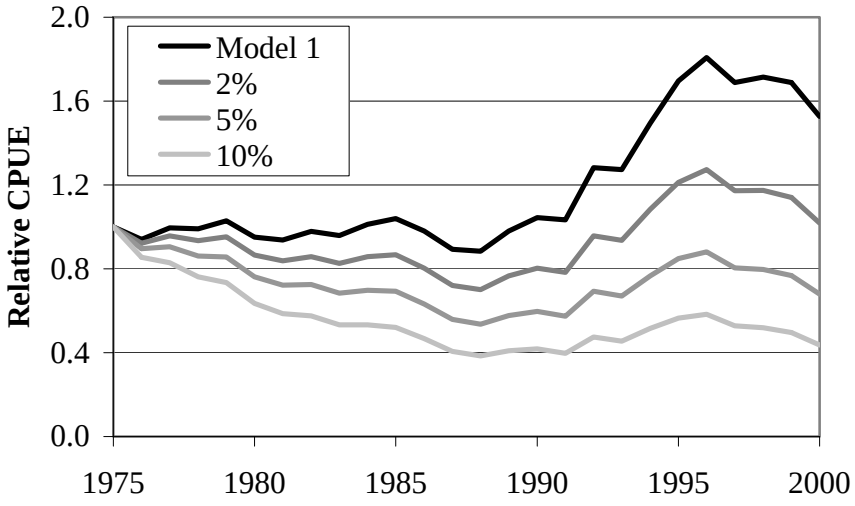


Figure 11. Relative CPUE indices for Block 13, 1975-2000. Model 1 is the raw geometric mean of CPUE. The three effort creep scenarios considered are: (i) 2% per annum; (ii) 5% per annum; and (iii) 10% per annum. All values of CPUE are relative to 1975 (Tarbath et al., 2001).

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 a short period during which we assume that divers operated with equal efficiency. This assessment reviews catch-rate trends over the last seven years. (The introduction of sub-blocks and consequent finer scale reporting in 2000 means that most comparisons at a finer geographical scale are currently limited to

a seven-year period.) 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. 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:

Previous assessments assumed that abalone abundance was high in parts of the Western Zone (South West and Central West) given the relatively high catch rates reported there. Because diver visitation rates to these areas were relatively low enabling abalone to form aggregations between fishing events, less credence was placed on catch rates as an indication of stock abundance. However, it was previously concluded that stocks levels remained adequate, because catch rates were relatively high compared with other parts of the fishery that were known to be sound. It now appears that along much of the coast line, the population remnants contracted to either deep water or the wash zone, where they could still be caught at high catch rates. 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.

Because of past quota reductions, much of the Eastern Zone, particularly the northern part of the East Coast, has been fished at low levels of effort. This means that effort has been not been consistently applied to populations, allowing the formation of aggregations between fishing events, which may span fishing years. In addition, in recent years, catch levels have been dependent upon divers rotating effort and successively depleting reefs on much of the East Coast between Triabunna and Eddystone Point (Blocks 25 – 30). Under these circumstances, the relationship between

abalone abundance and catch rates is almost certainly 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 under similar circumstances to the East Coast blacklip, 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 could 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. Examples include most of the east, south east and west coast blocks in the early and mid 1990's, and more recently, the Actaeons. It is expected that the median size will eventually increase, though a decrease is possible if the increased catch is due to large numbers of new recruits entering the fishery.

Size composition of the commercial catch

Almost since the inception 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.

Since 2000, diver's catches from around the State have been routinely sampled by TAFI research staff, mostly at fish processing factories, but occasionally at boat ramps and aboard boats. 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. Catches are selected haphazardly, depending upon the availability of both catches and catch-samplers.

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. For example, 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. In the south east, the size-structure of catch samples may 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. There are also other more minor sources of bias relating to measuring errors, stemming from both the diver and the catch sampler.

Sampling involves measuring 100 abalone randomly selected from a diver's catch. Sample design was 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 may be inadequate to reflect size-structure of fished populations. We have been unable to obtain adequate numbers of samples from the Northern Zone, the greenlip fishery, the Bass Strait Zone and much of the Western Zone. Landings from motherships are usually not sampled, because they mostly comprise catches from more than one sub-block and more than one day, and it is not possible to identify the sub-block from where the catch came.

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.

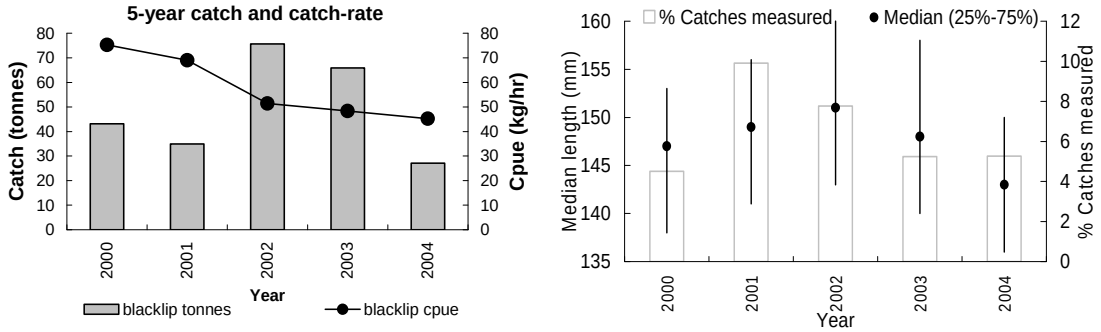


Figure 12. Trends in catch, catch rate and median length (flanked by the 25th and 75th percentile bounds), sub-block 13C, 2000-2004.

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 12). 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 12).

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 13).

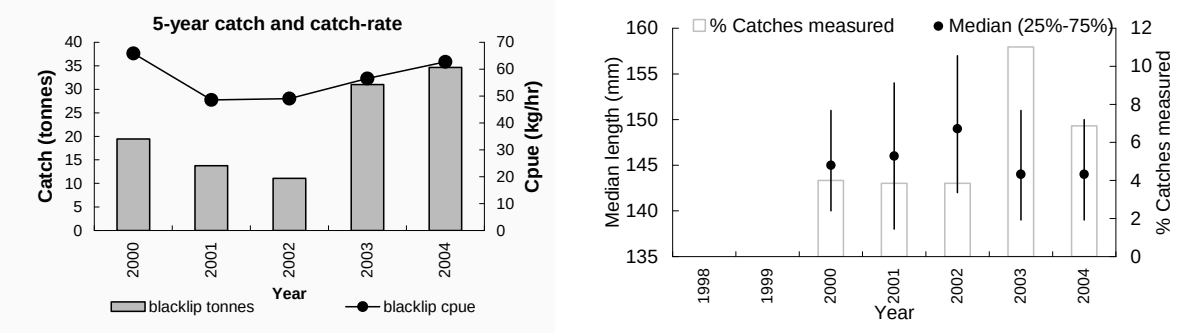


Figure 13. Trends in catch, catch rate and median length (flanked by the 25th and 75th percentile bounds), sub-block 20B, 2000-2004.

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

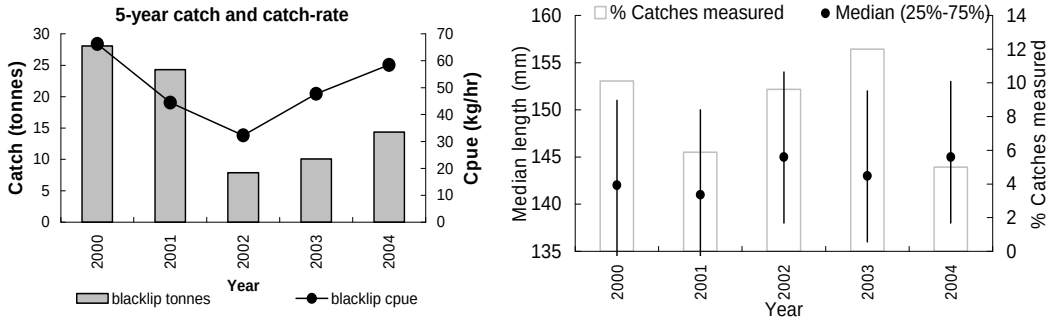


Figure 14. Trends in catch, catch rate and median length (flanked by the 25th and 75th percentile bounds), sub-block 24B, 2000-2004.

Appendix 3: Annual Catches From The Western Zone 1975 - 2007.

Reported annual tonnages of blacklip abalone caught within the statistical blocks and sub-blocks comprising the Western Zone in 2007. These tonnages are derived from estimated weights, which do not correspond exactly with landed weights. Because the Western and Eastern Zones were established in 2000, and the Northern Zone in 2001, prior to those years it has not been possible to accurately assign catches to zones in blocks where zone boundaries occur. Consequently, catches in those blocks have been placed in the zone where the majority of catches occurred, so that earlier catches from Blocks 5 and 13 have been placed in the Northern and Eastern Zones respectively.

Year	5	6	7	8	9	10	11	12	13	Total
1975		110	36	42	126	130	191	143		778
1976		63	56	77	252	179	240	153		1020
1977		50	24	22	123	98	153	189		658
1978		79	13	27	115	258	275	208		973
1979		112	19	23	172	166	269	325		1086
1980		196	81	63	316	195	338	351		1539
1981		257	88	87	444	260	417	246		1798
1982		147	34	34	249	100	303	235		1102
1983		231	102	58	199	174	430	242		1435
1984		298	78	38	248	284	681	258		1884
1985		322	99	23	246	140	478	155		1463
1986		213	97	11	133	127	289	193		1064
1987		185	84	44	252	82	339	195		1181
1988		241	53	27	159	124	270	162		1036
1989		192	49	46	120	109	212	144		873
1990		197	56	21	95	80	232	125		807
1991		169	54	30	102	106	219	140		819
1992		235	70	36	91	95	266	159		952
1993		154	64	38	110	65	197	177		805
1994		79	33	38	77	60	202	160		649
1995		112	30	17	44	68	186	182		638
1996		103	67	13	59	75	145	148		611
1997		98	75	28	140	66	224	227		858
1998		126	51	27	78	47	163	192		684
1999		149	60	24	115	58	220	251		878
2000		183	61	23	205	148	326	282	54	1281
2001	0	210	32	15	186	152	312	290	43	1241
2002	2	173	51	17	174	143	360	236	93	1248
2003	0	97	104	27	142	239	345	229	67	1251
2004	3	88	89	22	130	181	374	250	96	1234
2005	6	95	110	26	92	149	389	311	65	1242
2006	4	109	76	6	142	198	384	228	89	1236
2007	0	76	39	18	178	231	354	267	68	1231
average	2	156	62	32	161	139	296	214	72	1077

Appendix 4: Annual Catches From The Eastern Zone 1975 - 2007.

Reported annual tonnages of blacklip abalone caught within statistical blocks and sub-blocks comprising the Eastern Zone in 2007. These tonnages are derived from estimated weights, which do not correspond exactly with landed weights. Because the Western and Eastern Zones were not established until 2000, and the Northern Zone until 2001, prior to those years it has not been possible to accurately assign catches to zones in blocks where zone boundaries occur (Blocks 13 and 31). Consequently, catches in those blocks have been placed in the Eastern Zone, because the majority of later catches occurred there. This means that the average catch for these two blocks is probably overestimated.

Year	13	14	15	16	17	19	20	21	22	23	24	25	26	27	28	29	30	31	Total
1975	247	111	10	47	11	0	16	27	49	74	15	16	5	44	69	16	44	32	835
1976	208	156	0	64	36	1	18	25	45	56	18	12	9	40	72	9	37	50	857
1977	245	232	2	190	11	1	23	35	37	53	11	10	8	55	90	22	119	54	1196
1978	322	218	6	119	24	1	32	65	60	88	22	13	11	93	87	25	137	105	1431
1979	374	251	8	148	25	2	51	52	43	30	9	23	7	80	52	12	105	60	1332
1980	272	255	7	145	30	1	33	30	42	46	158	34	7	108	91	27	148	105	1538
1981	254	299	18	127	48	4	45	69	35	77	137	19	15	68	154	22	146	52	1586
1982	337	218	15	147	24	3	36	62	63	49	97	20	9	89	100	32	170	48	1519
1983	250	300	10	189	28	3	43	63	54	92	99	31	14	99	103	65	296	90	1828
1984	318	297	18	166	35	5	47	70	73	61	109	10	11	106	112	52	148	76	1714
1985	256	262	4	89	83	11	68	80	43	44	120	20	17	86	71	5	84	171	1515
1986	220	262	22	82	93	4	65	66	70	56	88	12	20	50	58	14	124	164	1472
1987	224	229	7	47	80	1	43	44	32	34	66	12	8	76	45	11	67	54	1082
1988	219	258	6	76	57	4	62	44	43	34	79	10	6	65	52	16	93	90	1214
1989	156	172	2	56	43	2	61	42	22	16	34	7	8	41	31	11	39	27	770
1990	132	193	4	76	29	3	33	51	40	36	61	1	2	61	77	21	54	22	897
1991	127	207	2	60	37	3	53	50	47	31	67	2	9	64	66	12	30	21	890
1992	140	106	3	28	20	2	51	43	49	23	67	1	1	67	45	7	10	13	676
1993	257	116	4	100	40	1	59	78	48	24	73	1	1	86	39	8	15	15	964
1994	295	139	10	114	46	1	109	80	55	16	53	0	3	103	24	8	11	21	1088
1995	310	247	1	100	35	1	95	74	34	19	38	0	1	81	18	6	10	26	1097
1996	391	195	0	78	18	3	71	55	44	28	67	3	6	89	39	11	28	20	1147
1997	471	137	0	64	25	2	79	49	47	32	106	1	13	190	32	32	23	33	1336
1998	470	108	1	116	23	2	85	64	63	44	160	2	25	180	77	31	10	15	1476
1999	491	66	2	113	35	6	102	72	50	53	143	0	9	95	60	26	11	39	1374
2000	381	98	2	71	29	4	62	60	69	44	104	1	8	101	16	21	10	90	1171
2001	324	157	3	108	20	2	56	50	40	24	111	1	14	68	9	27	13	66	1092
2002	296	101	1	72	16	1	62	58	46	15	46	0	2	53	7	15	12	44	847
2003	291	116	2	60	17	1	88	54	35	21	51	0	3	50	8	19	3	27	848
2004	221	104	7	50	20	2	92	52	35	19	51	1	1	44	11	24	6	22	761
2005	181	90	8	56	20	3	116	62	36	18	66	0	0	43	13	36	7	15	770
2006	184	84	3	67	13	2	73	66	71	23	88	1	1	40	10	41	0	7	773
2007	255	70	0	56	8	6	68	63	61	14	59	0	1	55	11	32	0	4	766
average	276	177	6	93	33	3	61	56	48	39	75	8	8	78	53	22	61	51	1147

Appendix 5: Annual Catches From The Northern Zone 1975 - 2007.

Reported annual tonnages of blacklip abalone caught within statistical blocks comprising the Northern Zone in 2007. These tonnages are derived from estimated weights, which do not correspond exactly with landed weights. There are no records for the Northern Zone part of Block 31 before that zone was created in 2001.

Year	31	39	40	32	33	34	35	36	38	47	48	49	5	1	2	3	4	Total
1975		2	1	1	10	1	7	7	2	1	12	9	38	32	1	27	15	167
1976		5	0	0	5	0	1	1	0	1	12	33	46	39	0	51	8	203
1977		6	2	6	11	0	0	3	2	0	8	17	51	17	1	87	8	218
1978		8	2	1	5	2	6	5	4	3	10	11	65	21	3	55	25	225
1979		6	1	2	9	0	0	2	2	0	27	7	85	24	2	10	9	187
1980		3	1	2	6	1	1	2	0	0	10	1	92	51	3	33	3	209
1981		6	2	1	6	1	1	0	0	3	33	10	120	19	8	32	9	251
1982		5	2	0	6	1	0	2	4	1	45	7	121	22	9	27	13	266
1983		7	4	0	3	0	1	5	3	9	45	19	228	22	2	31	52	431
1984		6	3	0	7	0	1	2	1	4	80	44	312	10	1	33	55	560
1985		5	1	3	6	1	2	1	0	4	48	50	319	43	0	26	11	522
1986		10	5	0	9	2	3	2	1	15	85	97	267	35	4	24	13	573
1987		6	1	0	7	0	2	1	1	18	58	67	198	44	62	24	54	543
1988		3	1	0	11	1	1	0	0	18	30	38	165	29	16	21	60	393
1989		1	28	0	3	0	0	0	0	14	15	24	88	14	7	10	5	210
1990		0	0	0	1	0	0	1	0	6	14	20	82	11	10	9	11	166
1991		1	0	0	2	0	0	0	0	8	12	10	97	6	7	14	26	185
1992		4	0	0	2	0	0	0	0	3	10	11	76	2	3	9	8	129
1993		0	0	0	3	0	0	0	0	1	7	7	65	8	3	8	9	111
1994		0	0	0	3	0	0	0	0	0	7	12	49	15	2	4	1	94
1995		0	0	0	0	0	0	0	0	0	6	2	62	11	3	1	8	95
1996		0	0	0	0	0	0	0	0	0	4	0	63	7	2	1	2	80
1997		1	0	0	0	0	0	0	0	0	6	2	56	10	1	10	6	92
1998		0	1	0	2	0	0	0	0	0	7	3	61	3	1	0	2	79
1999		5	0	0	4	0	0	0	1	0	14	4	57	5	1	6	6	103
2000		5	2	1	5	0	0	0	0	0	12	25	45	0	0	9	10	114
2001	12	11	3	5	10	1	0	0	3	0	17	72	117	2	1	12	12	279
2002	30	4	3	1	11	1	0	0	2	0	12	48	103	10	2	35	16	277
2003	7	8	1	0	5	0	0	0	2	0	10	76	73	25	1	61	10	279
2004	14	6	1	0	3	0	0	0	1	0	6	62	55	10	0	85	34	277
2005	11	2	0	0	7	0	0	0	2	0	6	54	73	15	2	92	18	282
2006	16	4	0	0	11	0	0	0	10	0	5	57	96	11	3	57	8	279
2007	55	11	0	0	2	0	3	0	0	0	6	59	89	6	0	47	3	280
average	21	4	2	1	5	0	1	1	1	3	20	29	106	18	5	29	16	247

Appendix 6: Annual Catches From The Greenlip Fishery 1975 - 2007.

Reported annual tonnages of greenlip abalone caught within the statistical blocks comprising the Greenlip fishery in 2007. These tonnages are derived from estimated weights, which do not correspond exactly with landed weights.

Year	31	39	40	32	33	34	35	36	37	38	47	48	49	5	1	2	3	4	Total
1975	7	3	4	3	17	14	49	69	14	11	0	7	2	8	0	3	0	1	213
1976	14	2	9	1	26	11	55	49	2	10	0	8	6	14	0	0	0	0	210
1977	6	8	4	6	23	21	50	24	1	22	0	40	2	17	0	0	0	0	223
1978	8	1	2	4	12	17	51	38	7	17	1	13	3	12	1	3	0	2	191
1979	11	6	2	10	21	8	46	15	4	4	0	11	0	8	0	0	0	0	146
1980	4	3	5	7	15	3	29	13	4	4	0	6	0	5	0	3	0	0	100
1981	6	4	2	12	17	17	34	10	9	0	3	12	1	9	0	12	0	4	153
1982	27	1	3	4	13	14	29	7	9	9	2	7	0	2	0	14	0	2	141
1983	23	2	0	4	21	8	34	9	4	8	14	40	11	9	0	9	0	5	201
1984	50	8	4	9	27	15	56	7	6	0	52	60	2	11	0	7	1	5	320
1985	53	5	4	9	20	15	42	4	7	7	12	36	3	3	0	1	0	1	222
1986	39	8	7	4	14	7	36	2	10	0	57	35	14	5	1	8	0	3	251
1987	32	12	1	8	20	10	30	8	10	7	37	33	3	8	13	125	5	69	431
1988	35	2	1	8	19	5	28	13	6	0	35	21	4	10	3	33	2	12	240
1989	22	5	2	4	16	2	22	10	3	0	20	27	4	6	1	70	3	10	227
1990	23	7	0	4	9	3	25	6	1	3	21	27	11	11	2	49	3	13	218
1991	20	6	0	4	7	2	31	6	3	0	13	32	6	12	2	29	3	16	191
1992	15	9	0	3	4	1	18	6	2	0	4	14	2	4	3	21	0	8	115
1993	9	2	0	1	4	2	16	8	3	0	2	26	4	2	2	18	0	9	110
1994	12	1	0	3	8	1	17	5	3	0	3	48	3	10	4	25	0	7	149
1995	24	6	2	2	7	3	15	3	3	9	5	23	5	8	14	9	0	12	149
1996	11	13	2	3	13	4	17	2	8	12	1	15	0	3	37	33	1	13	190
1997	17	22	1	8	13	1	12	4	11	15	1	28	3	6	35	33	0	6	215
1998	4	17	24	5	5	1	23	1	2	2	2	43	8	14	31	34	0	5	222
1999	6	2	4	2	17	1	15	1	2	4	0	20	1	10	21	25	1	10	142
2000	12	15	12	8	11	2	14	3	2	2	0	24	12	13	2	4	1	3	140
2001	7	20	4	14	14	2	9	3	1	0	0	35	9	3	8	8	1	2	140
2002	17	12	2	4	16	2	8	2	2	9	0	27	7	7	11	6	1	7	140
2003	18	16	1	5	16	1	10	2	1	3	0	14	10	10	14	11	3	4	140
2004	9	22	0	4	4	1	13	3	1	11	0	14	6	10	14	10	4	3	128
2005	6	13	1	2	12	1	10	3	1	15	0	19	1	12	16	7	4	3	123
2006	3	13	0	5	5	1	11	1	4	13	0	29	2	8	11	10	2	5	123
2007	20	14	0	3	6	1	13	2	0	5	0	21	3	9	10	7	3	6	124
average	17	8	3	5	14	6	26	10	4	6	9	25	4	8	8	19	1	7	183

Appendix 7: Annual Catches From The Bass Strait Zone 1975 - 2007.

Reported annual tonnages of blacklip abalone caught within statistical blocks comprising the Bass Strait Zone in 2007. These tonnages are derived from estimated weights, which do not correspond exactly with landed weights. The Bass Strait blacklip fishery was closed in 2007, and no catches were reported.

Year	37	38	41	42	43	44	45	46	50	51	52	53	54	55	56	57	Total
1975	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1976	0		0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
1977	1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1978	0		0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
1979	1		0	0	0	0	0	3	0	0	0	0	0	0	0	0	4
1980	1		1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1981	2		0	0	1	0	0	0	0	0	0	0	0	0	0	0	3
1982	1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1983	1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1984	0		0	0	1	0	0	3	0	0	0	0	0	0	0	0	5
1985	0		2	0	2	0	0	0	0	0	0	0	0	0	0	0	4
1986	1		1	0	4	0	0	1	0	0	0	0	0	0	0	0	8
1987	2		2	0	8	1	0	0	0	0	0	0	0	0	0	0	14
1988	0		0	0	1	1	0	1	0	0	0	0	0	0	0	0	4
1989	8		19	11	34	1	5	14	1	24	0	41	4	0	6	0	168
1990	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1991	17		0	0	0	0	0	0	0	14	5	28	1	0	17	15	96
1992	0		0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
1993	19		0	0	0	0	0	0	0	21	4	37	1	0	6	8	95
1994	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1995	52		0	0	0	0	0	0	1	46	2	44	0	0	0	5	149
1996	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1997	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1998	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1999	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2001	0		0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
2002	0		0	0	0	0	0	1	0	0	0	0	0	0	0	0	2
2003	6	0	1	2	2	0	0	2	0	7	2	36	2	0	7	2	70
2004	3	0	4	4	1	0	0	1	0	1	0	42	5	2	7	0	70
2005	6	0	4	1	2	0	0	0	0	8	0	35	5	3	3	0	69
2006	20	0	1	4	5	0	0	5	0	3	0	24	5	2	1	1	70
2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
average	4	0	1	1	2	0	0	1	0	4	0	9	1	0	1	1	26

Appendix 8: Catch/effort data extract query.

Catch/effort data from divers' catch dockets were provided by DPIW, 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, 1) 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 'AB06D' THEN 'NW'
          WHEN f.block_code BETWEEN 'AB07A' AND 'AB09C' THEN 'CW'
          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 'BS'
          WHEN (f.block_code = 'AB31B' AND d.zone_fishery_code =
'AQE') THEN 'EC' ELSE '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 f.fishing_date BETWEEN '01-JAN-07' AND '31-DEC-07'
     AND d.qudo_id = f.qudo_id
     AND n3.client_id = d.docket_signatory_id
ORDER BY f.fishing_date  asc
```

Appendix 9: Recent treatment of errors in catch data.

A recent review of catch records in the TAFI historical catch and effort database found a number of errors. As a result, the following catch totals were amended:

1998, Block 12, catch total reduced from 199t to 192t
1998, Block 13, catch total reduced from 502t to 470t
1998, Block 14, catch total reduced from 130t to 108t.
In all three cases, a number of catch records from 1998 were listed twice, and consequently the duplicates were removed.
2000, Block 5, Northern Zone total increased to 45t from 38t, because catch from 5D was incorrectly excluded.
2004, Block 5, 2t transferred from Northern to Western zone, because catch was recorded Northern Zone whereas diver reported that he fished in 5D (Western Zone).
2007, Block 10, catch total reduced from 240t to 231t - data entry error.

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.
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 form 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. Compliance catch database (SEALSPROD) that enabled auditing of catch from vessel to factory introduced by DPIF.
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 West) 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 (140t), 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 (360 kg/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 (20 kg/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 136mm from 132mm. 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)

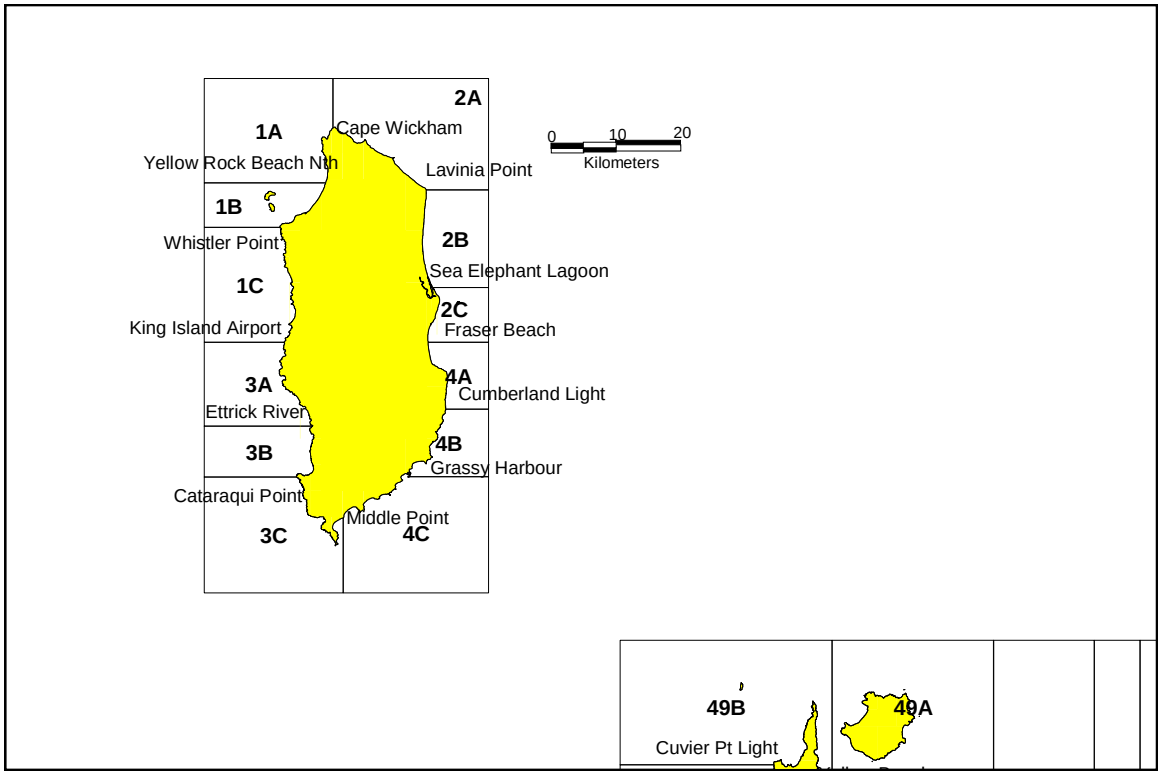
	Northern Zone TAC remained 280 t (80 kg/unit) Greenlip TAC remained 122.5 t (35 kg/unit) Bass Strait Zone TAC remained 70 t (20 kg/unit) Fishery production was set at 2502.5 t (715 kg/unit) state-wide. On 1 January 2007, interim reduction in MSL for Perkins Bay greenlip area (Blocks 47, 48A), from 145 mm to 140 mm. On 20 September 2007, MSL for Bass Strait Zone in Blocks 41-46 (North Coast) reduced from 114mm to 110mm. On 1 November 2007, MSL for Eastern Zone was increased to 138mm from 136mm. MSL for greenlip abalone in Perkins Bay was reduced to 132mm from 140mm. Block 30 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 2007: Victorian ganglioneuritis (AVG) outbreaks reported from wild stocks adjacent to land-based aquaculture site at Port Fairey. As a precautionary measure, from 16 August 2007, the Tasmanian wild fishery in Bass Strait closest to the Victorian coast was closed to abalone fishing, 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.
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 (70t) 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 350t to 266t, and that a cap of 245t be implemented for the South Coast (Sub-blocks 12B, 12C, 12D, 13A and 13B).
2008	Eastern Zone TAC increased to 808.5t 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 2,593.5t, 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 fish too small to catch at the larger size limit, and that removing these smaller fish would promote growth among the remaining fish. The MSL in the Northern Zone part of Block 5 (5A, 5B and 5C) was reduced from 132mm to 127mm, and in sub-blocks 5D, 6A, 6B and 6C, from 136mm to 132mm. To promote fishing in the Northern Zone part of Block 5, the cap was increased from 100t to 152.5t and the Northern Zone TAC increased to 332.5t. The remainder of the Northern Zone was capped at 180t. 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 .

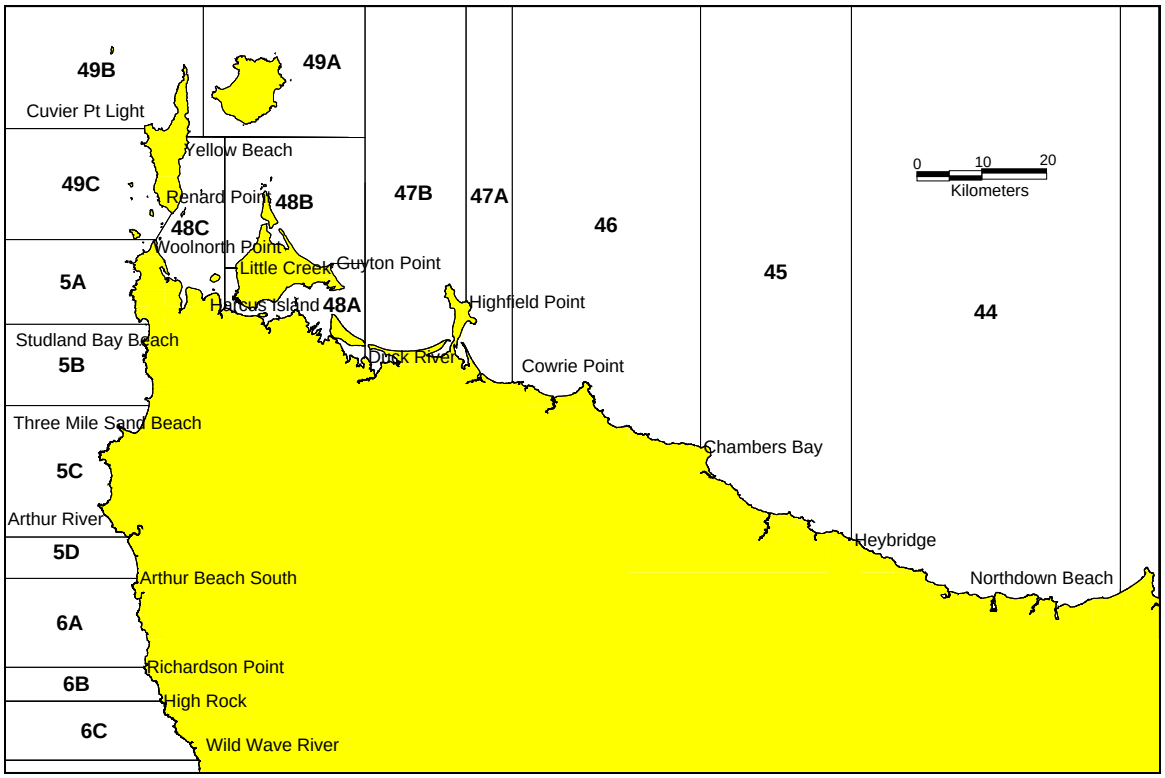
Appendix 11. Maps of catch-reporting blocks and sub-blocks.

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

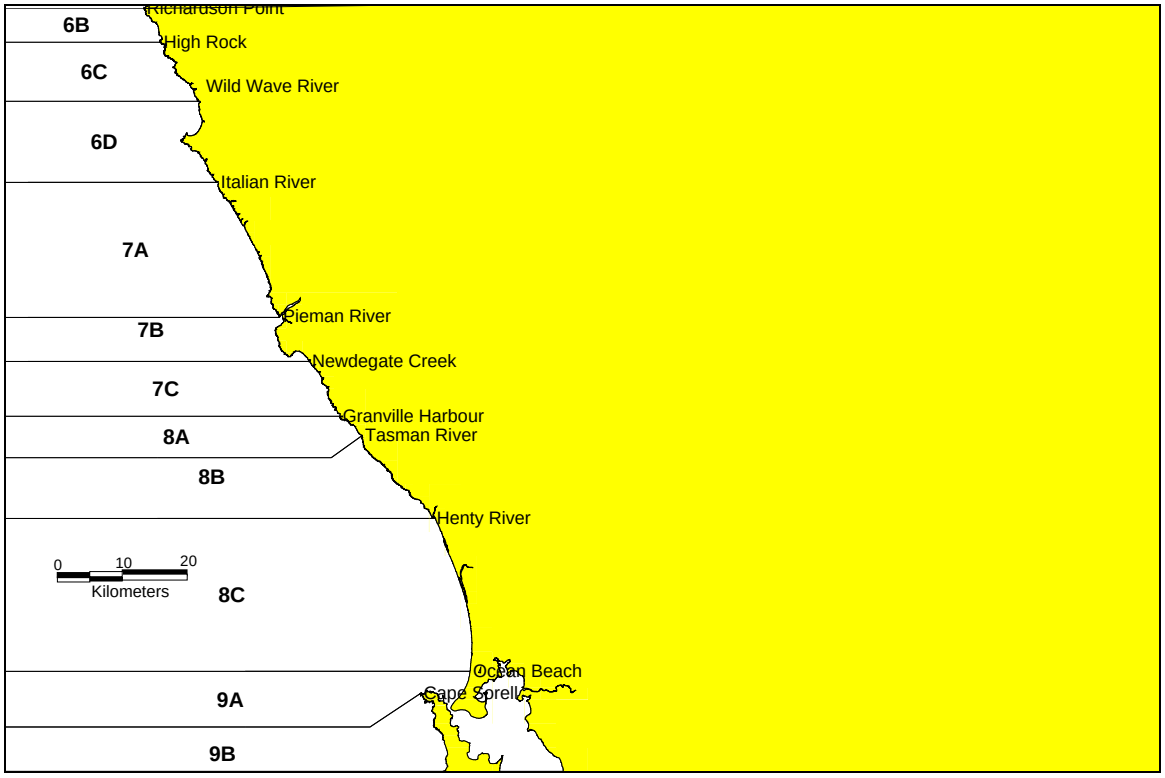
Map1: King Island



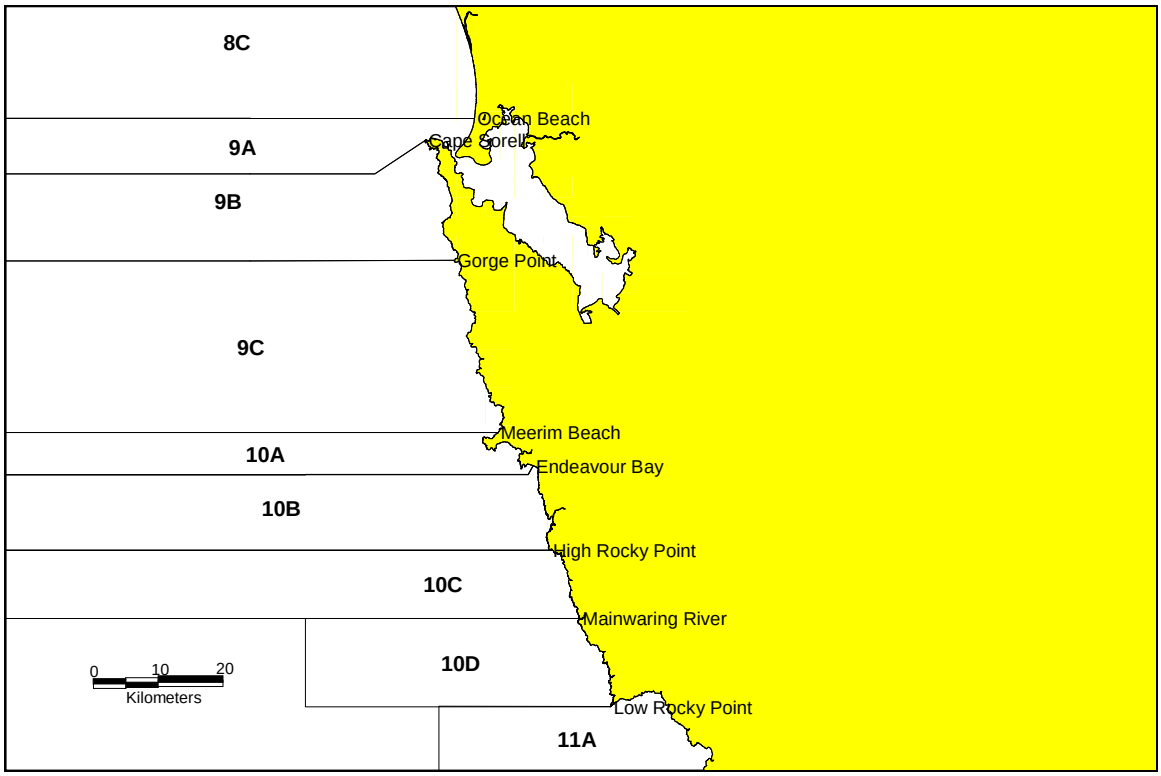
Map 2: North West Tasmania



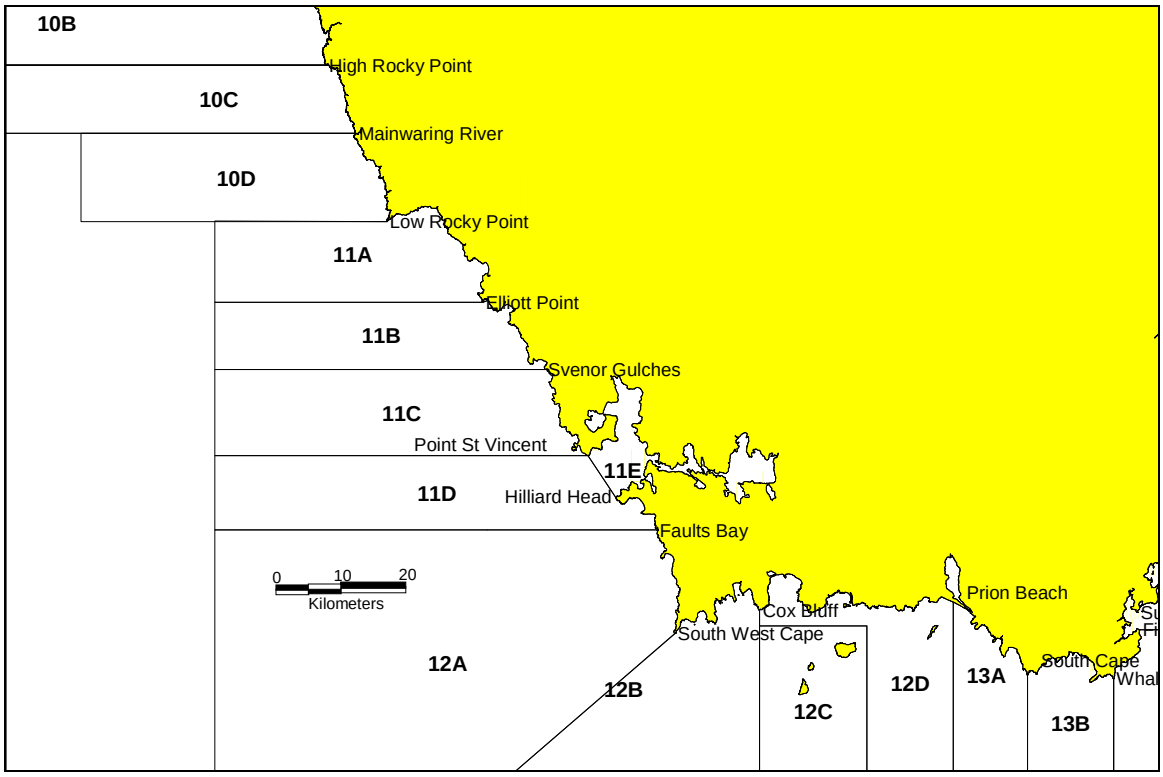
Map 3: Central West Coast (north)



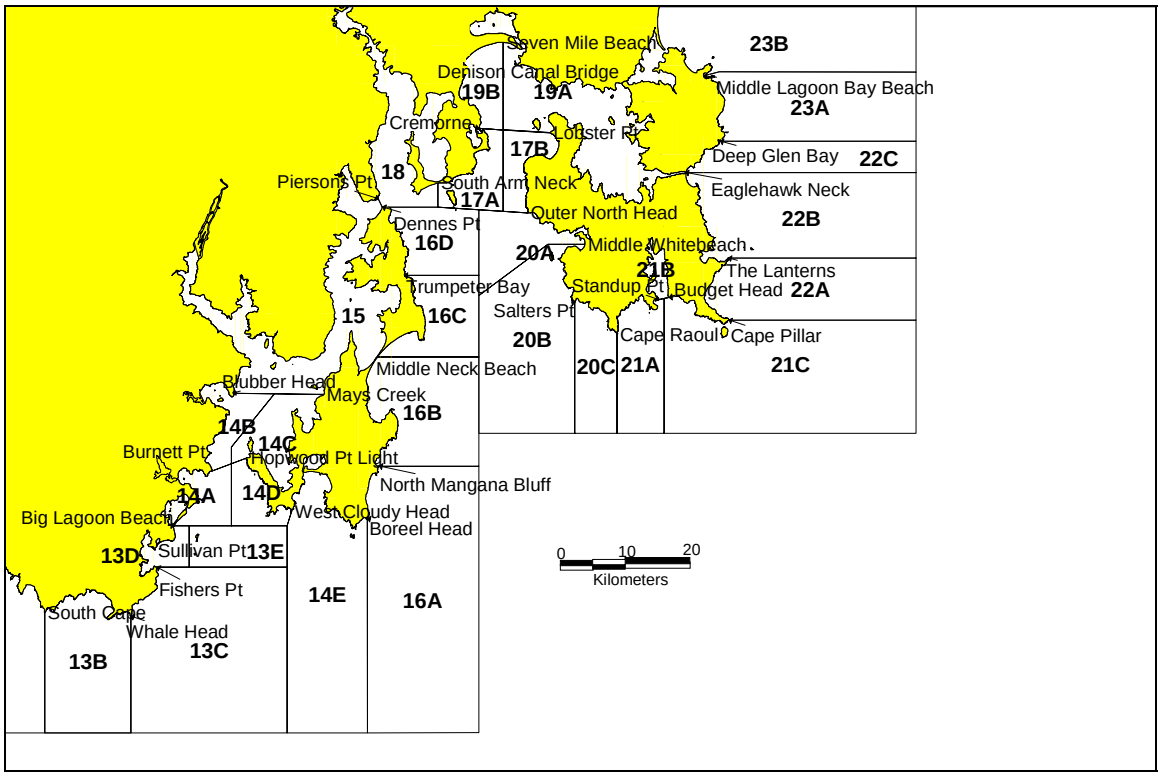
Map 4: Central West Coast (south)



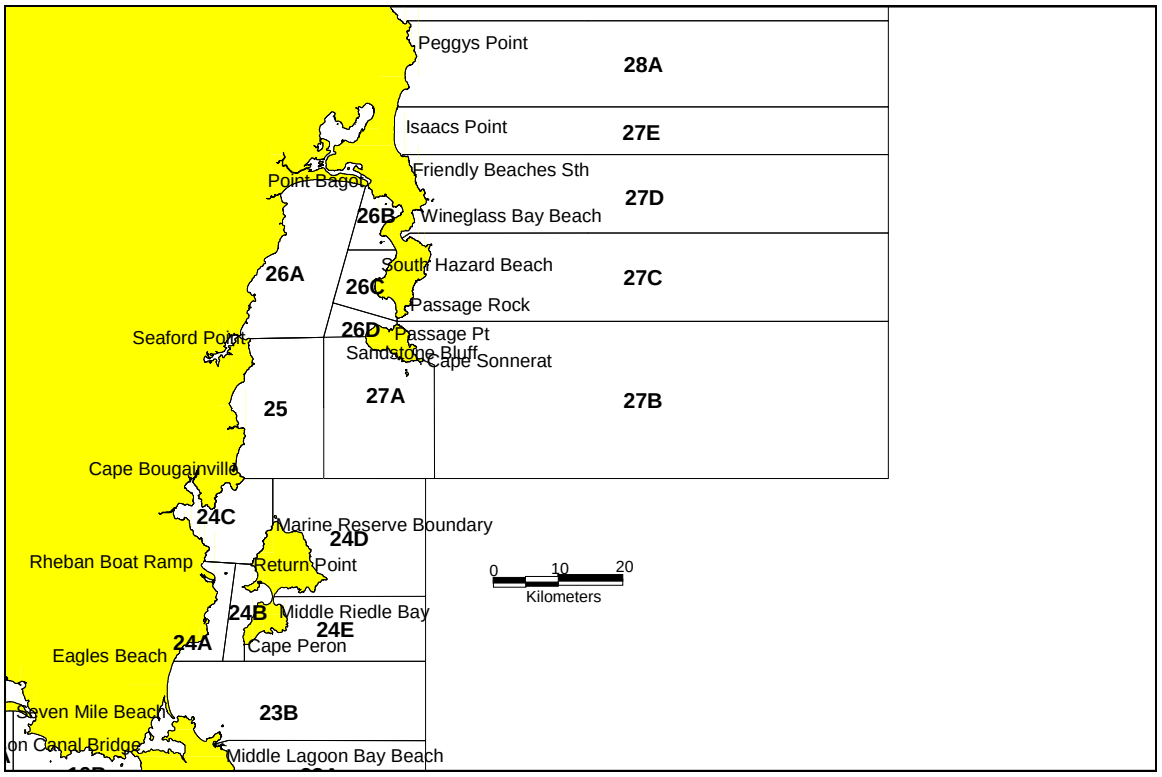
Map 5: South West Tasmania



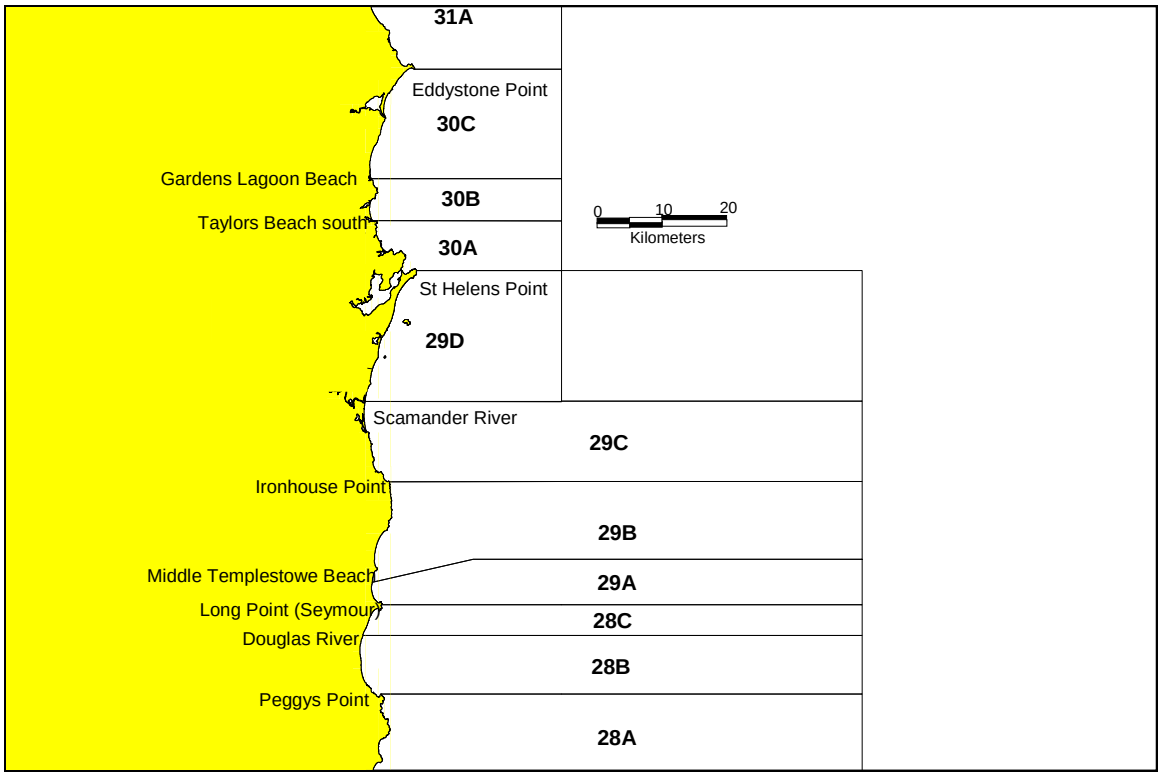
Map 6: South East Tasmania



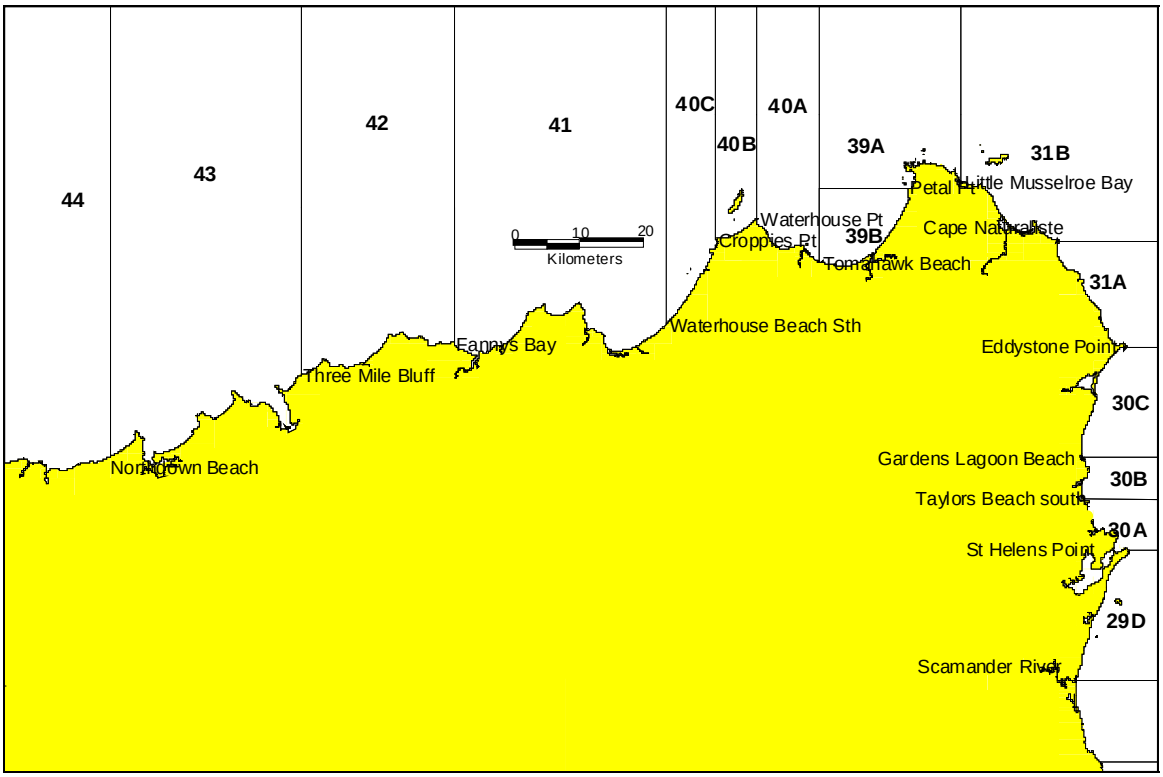
Map 7: Lower East Coast



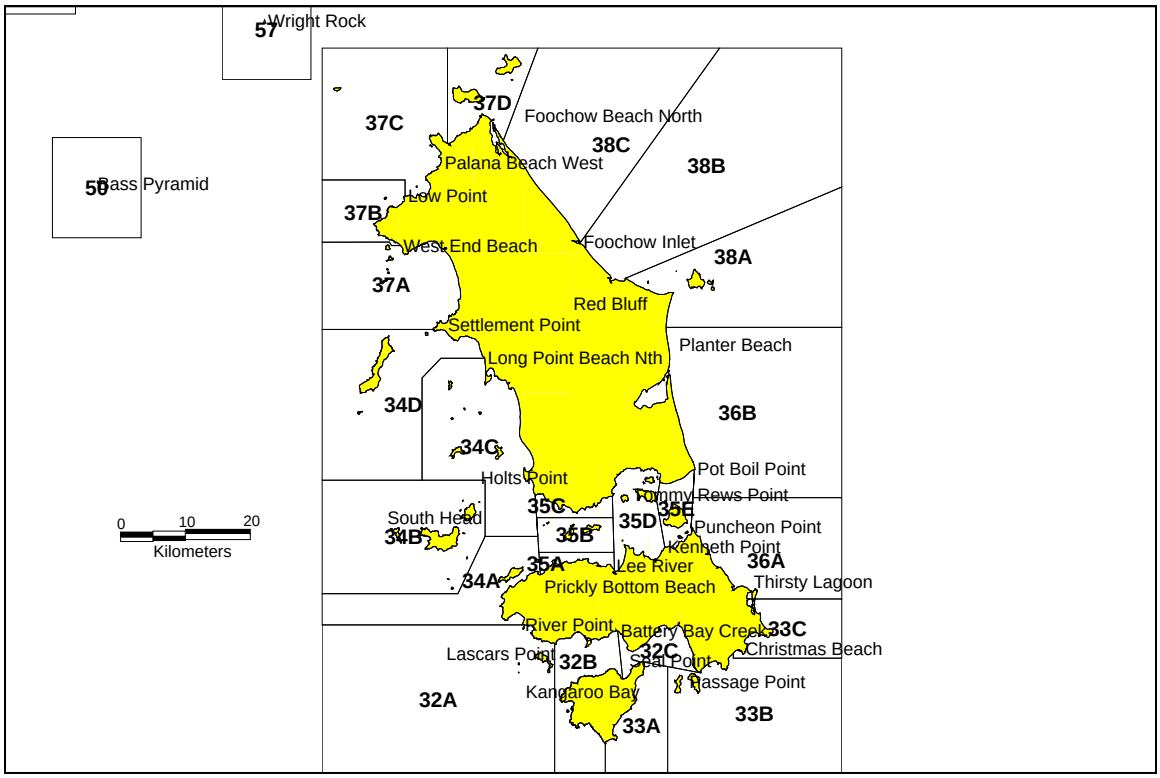
Map 8: Upper East Coast



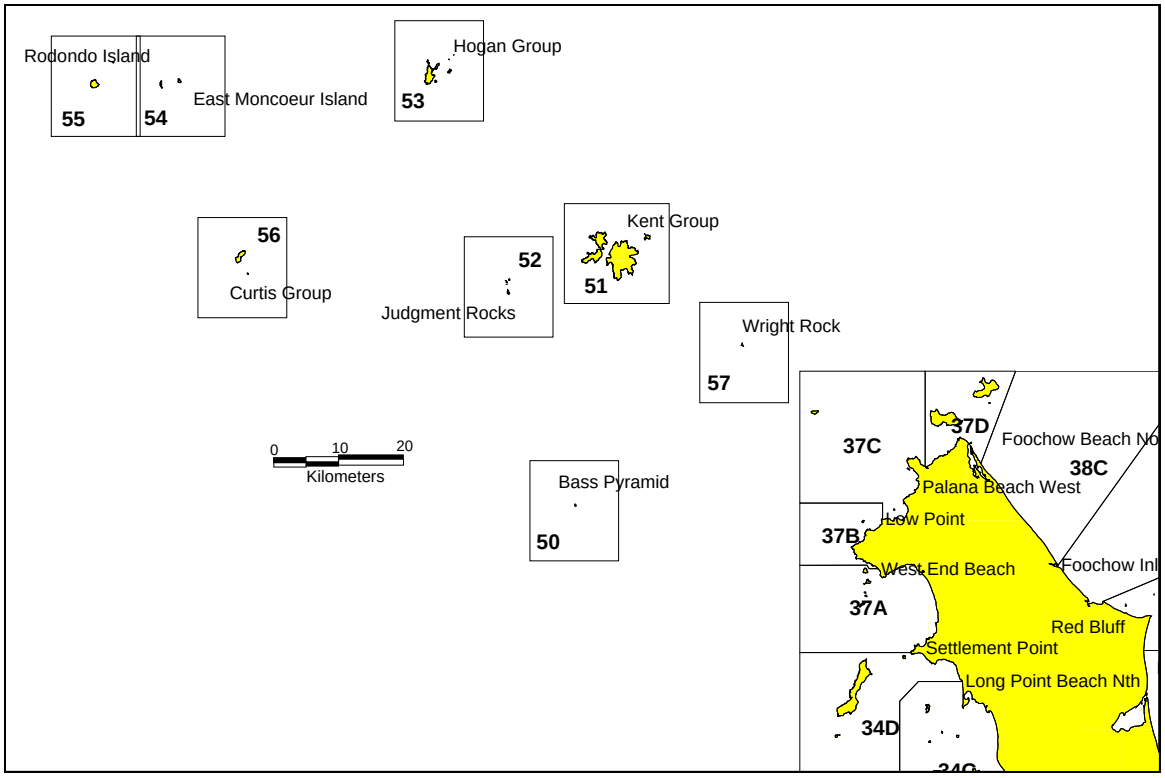
Map 9: North East Tasmania



Map 10: Furneaux Group

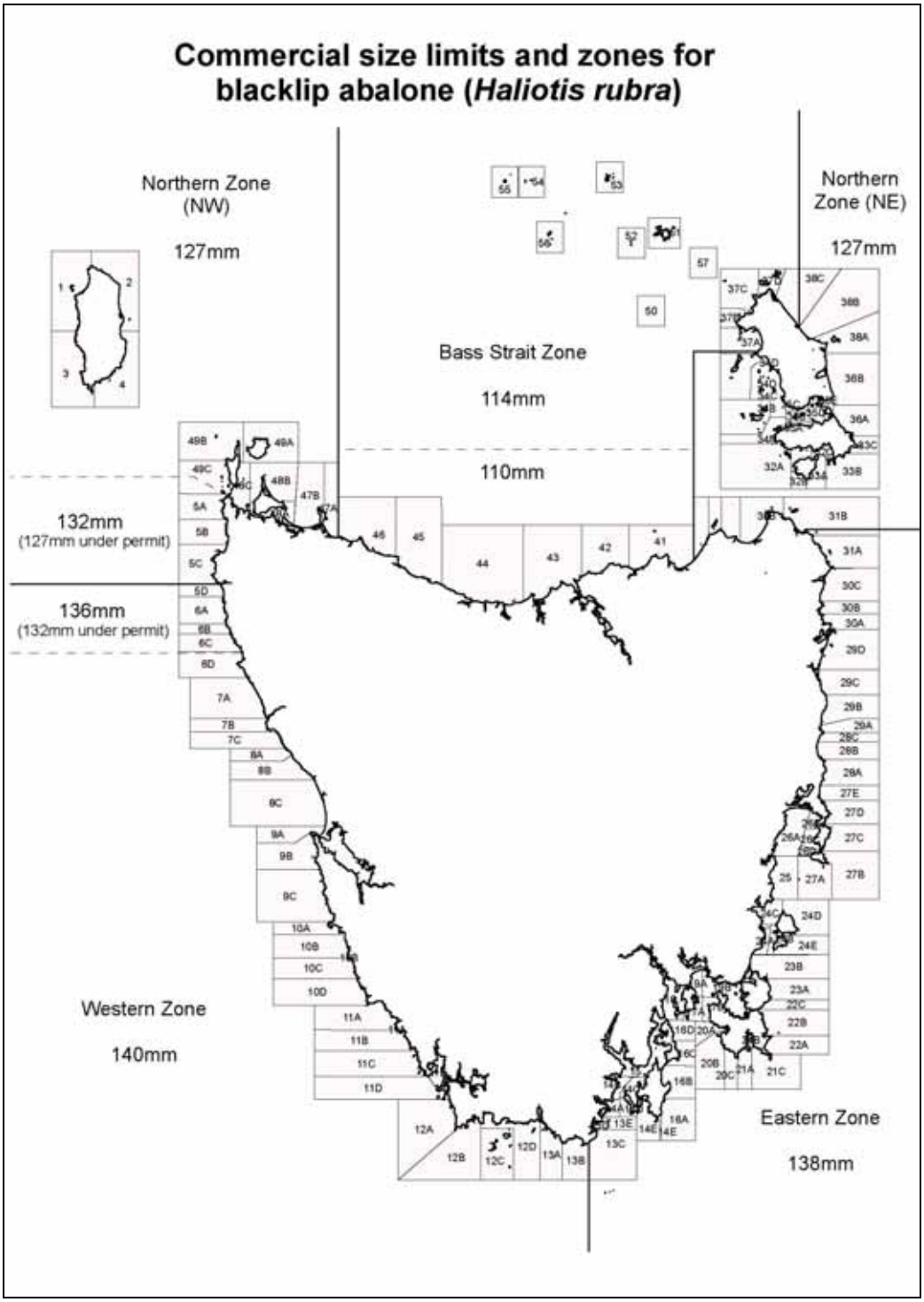


Map 11: Bass Strait Islands

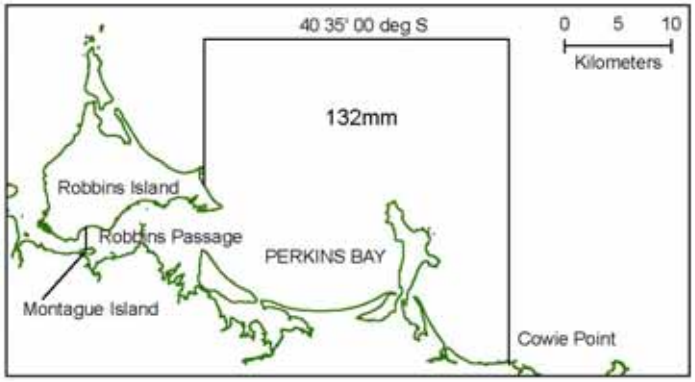


Appendix 12. Commercial Size Limits for blacklip and greenlip abalone, 2008

A management rule introduced in 2007 enabled abalone to be taken at reduced size limits under special permit in north-west Tasmania in 2008. All other size limits remained unchanged from previous years.



Commerical size limits for greenlip abalone (*Haliotis laevigata*)



King Island

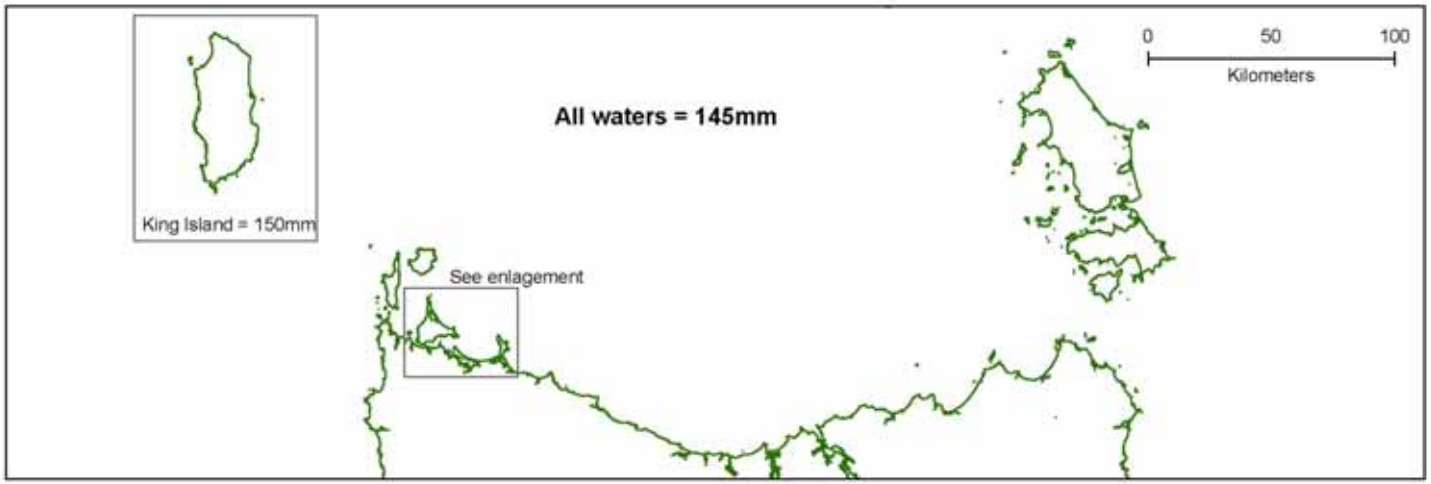
- All fish taken from King Island waters 150mm or greater.

Perkins Bay

- A 132mm size limit applies in Perkins Bay which is defined by waters which are enclosed with the following boundaries:
  - N/S of Montagu Island in Robbins passage to Cowrie Pt. and to a northward extent of 40 35' 00 deg S. to a western extent of 145 02' 52 E.

All other waters

- A 145 mm size limit exists for all other state waters for the take of greenlip abalone.



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We sought and received specific advice, particularly about stock levels, from a number of divers whom we would like to thank for the time and help that they provided to us.

No meeting of the Abalone Stock Assessment Working Group was held in 2007. Instead, a document containing the charts and tables used in this assessment was provided to the Fisheries Research Advisory Group (FRAG) for use in its discussion of appropriate catch levels in the fishery. Both groups have members in common, and the FRAG were able to help with the interpretation of the fisheries data used in this report.