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FISHERY ASSESSMENT REPORT

TASMANIAN ABALONE FISHERY

2005

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Abalone Fishery Assessment: 2005

Executive summary

Like previous assessments, the 2005 Abalone Fishery Assessment was based primarily on commercial catch and effort statistics and size-composition data from the Tasmanian fisheries for blacklip abalone (*Haliotis rubra*) and greenlip abalone (*H. laevigata*). Commercial catch and effort data were supplied by the Tasmanian Department of Primary Industry, Water and Environment (DPIWE). These data were obtained from catch dockets provided by licensed divers. 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 commercial catch sampling size-composition data were mostly collected by TAFI research staff, but some data were obtained directly from divers. Changes in median size of commercial catch samples were used in addition to any trends in catch and catch rates to assist in understanding the status of different stocks.

Since 2000, the Tasmanian blacklip abalone fishery has been sub-divided into geographical management zones, which in 2005 included the Eastern, Western, Northern and Bass Strait Zones. The purpose of zoning is to provide a mechanism for managing the distribution of effort and to protect the more accessible areas from high fishing pressure and consequent over-exploitation. Each of these zones and the greenlip abalone fishery are individually managed, with separate total allowable catch (TAC), legal minimum size(s) and in some cases, include annual catch limits (catch caps) in smaller regions of the zones. In 2005, the combined TAC for Tasmania was 2502.5 tonnes.

The use of catch and effort data to monitor trends in abundance of abalone is widely regarded as unreliable by fisheries researchers, and has been associated with the collapse of many abalone fisheries. There are several factors that adversely affect the relationship between catch rates and abalone abundance: the gregarious behaviour of abalone; the serial depletion of local populations making up each stock; and changes in fishing efficiency by divers. However, provided that the effect of these factors on abundance is understood and compensated for where possible, catch rates in Tasmania appear to provide a reliable index of abundance. There is a high degree of confidence in the use of catch rates to monitor the Tasmanian fishery, particularly throughout the south east part of the Eastern Zone, and other parts of the fishery where effort is consistently applied. Less confidence in the use of catch rates to describe abundance occurs where there is evidence of a recent increase in effective effort potentially affecting catch rates, or the relative effort is low in proportion to the size of abalone populations and is applied at irregular intervals (*e.g.* most of the Western Zone). Catch rates are not considered reliable in the greenlip fishery, the King Island blacklip fishery and the Bass Strait Zone, hence the assessment is correspondingly less certain in these areas.

It is apparent that recovery of **Eastern Zone** stocks has continued in 2005 following earlier signs of recovery during the previous year. The Eastern Zone has operated in both 2004 and 2005 with the TAC set at 770t, which is a relatively low level of catch compared to earlier years. This has resulted in several of the most depleted areas

receiving less fishing pressure, and other areas of higher abundance have been fished at only moderate levels. This reduction appears to have promoted recovery in all four fishing regions. At the Actaeons, there were good indications that recovery had started. At Bruny Island, most areas continued to exhibit the indications of recovery observed in 2004. In Storm Bay, where signs of recovery were first observed in 2003 and which has received proportionally the greatest levels of fishing pressure, the performance of the fishery has continued to improve. On the East Coast there were continuing signs of recovery. All fishery performance measures indicated that Eastern Zone stocks were being fished sustainably.

There continues to be concern for **Western Zone** stock levels, which are believed to be declining after being fished at historically high levels of catch since 2000 when zonal TACs were introduced. In the 2004 assessment, there was concern that divers were selectively fishing for smaller abalone, and thus only taking the TAC from a fraction of the fishable biomass with the potential to deplete this size class. This practise is clearly unsustainable. More recent information, obtained from divers' responses to a detailed questionnaire, revealed that the extent of this practise has become very limited, and most divers now take all abalone of legal size. Nevertheless, nearly all questionnaire respondents (20 of 28) who fished in the Western Zone expressed concern at the level of stock depletion.

The most problematic regions in the Western Zone were the South Coast and the North West. Catch rates in most parts of the South Coast have declined continuously since 2000, and have now been below the suggested mean threshold levels of 100 kg/hr for two years. There were consistent indications that the median size of abalone in this region's 2005 catch was getting smaller, implying increasing fishing mortality. The 2005 catch in Block 12 on the South Coast was among the highest recorded. These all indicated that continued fishing on the South Coast at the prevailing high levels was likely to be unsustainable. In the North West, catch rates have shown little response to greatly reduced levels of catch in recent years, suggesting that stock levels should be considered low. During the 1980's, the North West supplied much greater annual catches, and we are unable to explain the region's apparent decline in productivity since this time.

Stock levels in the remainder of the Western Zone were indeterminate but were believed to be falling. In the Central West region, for the past three years the Block 7 catch has greatly exceeded its long term average, and in 2005 was the highest recorded for this block. While catch rates in Block 7 were stable at moderate levels suggestive of sustainable fishing, some divers have moved elsewhere and reported that populations were being depleted. In the South West, the Block 11 catch has also been high, but here catch rates have fallen in most areas since the inception of the Western Zone in 2000, indicative of on-going depletion.

Previous experience in other blocks suggests that the risk is increasing that current levels of fishing in the Western Zone are becoming unsustainable. The irregular spatial and temporal nature of fishing in the Western Zone causes catch rates to be a poor predictor of abundance and stock levels are likely to be declining at faster rates than catch-rate trends indicate.

The **Northern Zone** has been primarily dependent on the North West and King Island for most of its catch, and there were significant problems with stock levels in both regions. King Island blacklip populations on shallower reefs have been extensively depleted, while deeper water populations that were reported abundant are difficult to access with standard air supplies. Current levels of catch are not high in a historical context, and while serial depletion has occurred, a transfer of effort to the deeper reef/water populations may enable recovery in shallower water while maintaining catch levels. However, the majority of the blacklip catch has been taken by visiting mothership-based divers who have used standard air supplies and any future redistribution of effort and catch to deeper waters will be dependent upon the willingness and ability of the these divers to work in deeper water.

The 280t Northern Zone TAC was partly based on the understanding that North West blacklip catches during the 1980's were mostly sustainable, and that a TAC derived from a smaller fraction of those catches would be sustainable. It is of concern that the region's stocks now appear to be either fully exploited, or at risk of overfishing at much lower levels of catch than those used to estimate the TAC. Stock levels may be recovering in the south of Block 5, but have yet to recover from intensive fishing in the north. The Block 5 100t catch cap is no longer effective as a means of preserving sustainability. Other parts of the region, particularly Block 48, which in the 1980's were productive, also no longer appear capable of supporting former levels of catch. There is little opportunity for increased levels of catch in this region and any transfer of catch from King Island would be unsustainable.

Catches from the North East and the Furneaux Group have never reached the size of those from either King Island or the North West, because the amount of productive reef is small, abalone sizes and growth rates are less than in the west, and the remoteness of both regions has deterred many buyers. Whilst stock levels have appeared more secure here, it has been reported that neither region could provide more than a minor increase in catch to compensate for any loss of productivity in the western regions.

Most of the **Bass Strait Zone** catch has continued to be taken from the Hogan Group and other Bass Strait islands, where stocks were reported to be depleted. It seems likely that this level of fishing has been unsustainable. Blacklip stocks were also reported depleted on the central North Coast and the Furneaux Group, but in these regions there remained substantial quantities of abalone smaller than the size limit. The proposed reduction of the size limit to 110mm on the central North Coast should increase the productivity of this part of the fishery, but the extent of the smaller populations and their likely yield are unknown. There is an increasing risk that the current TAC is unsustainable, particularly if Hogan Group populations diminish rapidly.

The potential levels of catch from the Bass Strait Zone and its TAC were estimated using the landed tonnages from the special fisheries for stunted abalone between 1989 and 1995. These fisheries were unusual, because they operated for only a few weeks every two years. Many parts of the zone, particularly in the Furneaux and Kent Groups, were heavily depleted during those fisheries, and have failed to produce former levels of catch since then. It is likely that the early fisheries were inappropriate indicators of potential yield for a fishery operating year-around, and the rapid fall in stock levels since 2003 supports this concern.

The TAC for the **Greenlip** fishery was reduced to 122.5t in 2005 following a reduction in the catch cap in the North East to 23t to promote recovery of depleted stock levels. The cap was not reached and low stock levels have been reported, with few signs of recovery. On King Island, where there was widespread depletion following heavy fishing at smaller size limits during the 1990's, there has been a limited recovery of stocks in the north west, but on the eastern side of the island, indications of recovery were weak. At the Furneaux Group fishing pressure on stocks was relatively light, and most of the catch was caught at a larger size than in other parts of the state, and consequently stock levels were stable or increasing slightly. Throughout most of the North West it was reported that stock levels have become depleted and that the 30t catch cap was probably excessive and should be reduced. However, in one part of the region (Perkins Bay, or Blocks 47 and 48A) stock levels were found to be high because they either had not been fished for many years, or were fished very lightly. A recent TAFI report has recommended that the size limit in Perkins Bay be lowered from 145mm to 132mm, because most individuals did not grow to 145mm. Given their small size, it was found that stocks should be adequately protected with the reduced size limit provided that the catch in that area was capped at 20t.

The number of recreational abalone fishing licenses has continued to increase by approximately 10% annually since the 1995-96 season. Half the catch was estimated to be caught from the southeast (between Marion Bay and Whale Head), with another 25% from further north on the East Coast. Although the recreational catch was only a small proportion of the overall commercial catch, the regional distribution of recreational catch and effort may contribute significantly to localised depletions. This is of particular concern for the more accessible parts of the Eastern Zone that are also heavily fished by the commercial sector.

Abalone were also caught in Tasmanian waters in the following ways: as part of cultural fishing activities by indigenous people; under exploratory permits for special events; for research purposes (*e.g.* TAFI sponsored abalone research); 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 exploratory permits was less than five tonnes in 2005.

Recommendations

- The inadequacy of CPUE-based assessments for many parts of the Tasmanian fishery, using the current reporting system, is stressed, and it is strongly recommended that alternative methods for tracking changes in relative abundance be developed, such as some form of fishery-independent abundance survey program and/or the quality of commercial catch and effort data be improved.

- When developing TACs for management zones, it is recommended that estimates of potential TACs be made with great caution if derived from past annual catches. In recent years, the failure of parts of the Western, Northern and the Bass Strait Zones to supply abalone at expected levels of production suggests that former levels of fishing were probably unsustainable and provided the wrong expectations.

- The 350t catch cap for Actaeons sub-blocks 13C, 13D and 13E is no longer an effective management tool given current levels of TAC, and if not reduced to levels that may control excess effort, should be reconsidered.

- On the South Coast (Blocks 12, 13A and 13B) there is a high level of risk that fishing at current catch levels is unsustainable. Because it can be economically more beneficial to fish the region at low catch rates than travel on a mothership to the South West, it is likely that the 2006 catch will be as large as or larger than the 2005 catch. It is recommended that the 2006 catch from this region be capped. The level of the cap should be addressed by the FAC at the earliest convenience to prevent greater rates of depletion than currently occur.

- In the Western Zone there is currently no strategy to halt the decline in stocks and catch rates. It is therefore recommended that a committee be set the task of developing performance measures and a harvest strategy that will initiate management action.

- In the Northern Zone, there are signs of recovery in Block 5, where the catch has been reduced to low levels. Should catch be transferred from King Island to the North West, as expected following the decline of King Island's shallow water stocks, then the Block 5 recovery may be adversely affected. It is recommended that the current cap on Block 5, which was set at 100t, be reduced to close to the current level of catch (73t) so that the recovery can proceed.

- If TAFI's recommendation for a reduced size limit for greenlip in Perkins Bay is followed, it is essential that managers ensure that there is no transfer of catch from the remainder of the North West to Perkins Bay above the recommended cap. It is recommended that the two areas (Perkins Bay and the remainder of the North West) should be managed with separate size limits and caps. It is recommended that the remainder of the North West cap be reduced from 30t to a more sustainable level.

- There is a high level of risk that Bass Strait Zone stocks are being fished at unsustainable levels. The proposed central North Coast size-limit reduction should enable some transfer of catch from at-risk stocks. It is therefore recommended that managers carefully monitor catch and catch rates in the zone and investigate diver's reports of depletion to ensure that the central North Coast stocks are not overfished.

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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. While this method has been often criticised as unreliable and elsewhere is infrequently used, it has been found that when problems caused by abalone aggregations, serial depletion and improved fishing efficiency are understood, and measures are taken to counter their effects, catch and catch rate trends appear to reflect changes in abundance. Interpreting catch rate trends has been supplemented with information from a secondary source: changes in the median size of abalone samples taken from the commercial catch grouped across fine spatial scales. Combined with trends in catch rates, changes in median size of the catch are powerful indicators of changes in abalone populations.

This document groups the fishery by major regions within zones. Where necessary, reference is made to the blocks or sub-blocks within a region to help understand the performance of each region. One of the criteria for reviewing performance at sub-block level is that the annual catch was 10 tonnes or more in any one of the six review years. However the fishery in each sub-block is rarely independent of the fishery in adjacent sub-blocks so it is neither valid nor practical to review the performance of every sub-block in the fishery.

Together with each region's catch and catch-rate chart, comparisons of catch-rate distributions for each of the last six years have been included. These 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 distributions between the most recent six years, it is possible to see where changes in catch rate have occurred, and what effect they have had on the mean catch rate.

As in previous years, geometric mean catch rates have been used instead of arithmetic means. Geometric means are less affected by variable skewness of distributions (for example, where there are a small but variable percentage of high catch rates) and are more reliable estimators of the mean catch rate across all divers. Only catch rates from catches of 40 kg or more were considered when calculating mean catch rates. This was done to reduce the effects of fishing affected by mechanical breakdown or calculating catch rates on the by-catch of fishing for different species.

At the end of this document are a number of appendices. Appendix 1 contains detailed explanations about reading the catch, catch-rate and size-composition charts. Appendices 2-6 contain tables of annual catches for the blocks in each zone for all years since reliable catch data was first kept. A history of management changes in the fishery and a series of maps of sub-block boundaries have been included to simplify the location of each of the areas under review.

2. Landed Catches, 2005

At the end of 2005, annual landings comprised 2379.682t of blacklip and 122.514t of greenlip, from a TAC of 2502.5 t (Table 1).

Table 1. 2005 landings by zone, in tonnes

Zone	2005 TAC	2005 Landings
Greenlip	122.5	122.514
Eastern Blacklip	770.0	769.420
Northern Blacklip	280.0	279.954
Western Blacklip	1260.0	1260.441
Bass Strait Blacklip	70.0	69.867

The zones, regions and statistical blocks from which the 2005 commercial catch was reported or which are referred to in this document are shown below (Figure 1). The zone boundaries and reporting blocks are as follows:

Eastern Zone: Whale Head to Cape Naturaliste, Sub-blocks 13C, 13E, 13E, Blocks 14 to 30, Sub-blocks 31A, part of 31B.
Western Zone: Whale Head to Arthur River, Sub-block 5D, Blocks 6 to 12, Sub-blocks 13A, 13B.
Northern Zone: Arthur River to Cowrie Point including King Island, Great Musselroe River to Cape Naturaliste, 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 Great Musselroe River, Blocks 41 to 46, 50 to 57. In the Furneaux Group, Block 37, Sub-blocks 38B, 38C.

Catches from the greenlip fishery have no zone boundaries, but are reported by species.

The regions used for the blacklip assessment 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 (north to Cape Naturaliste)
North East: Part of 31B (north of Cape Naturaliste), Blocks 39 and 40
Furneaux Group: Blocks 32 to 38
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
South Coast: Block 12, Sub-blocks 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 part of the North Coast (Blocks 41 to 46) and the remote Bass Strait islands (Blocks 50 to 57).

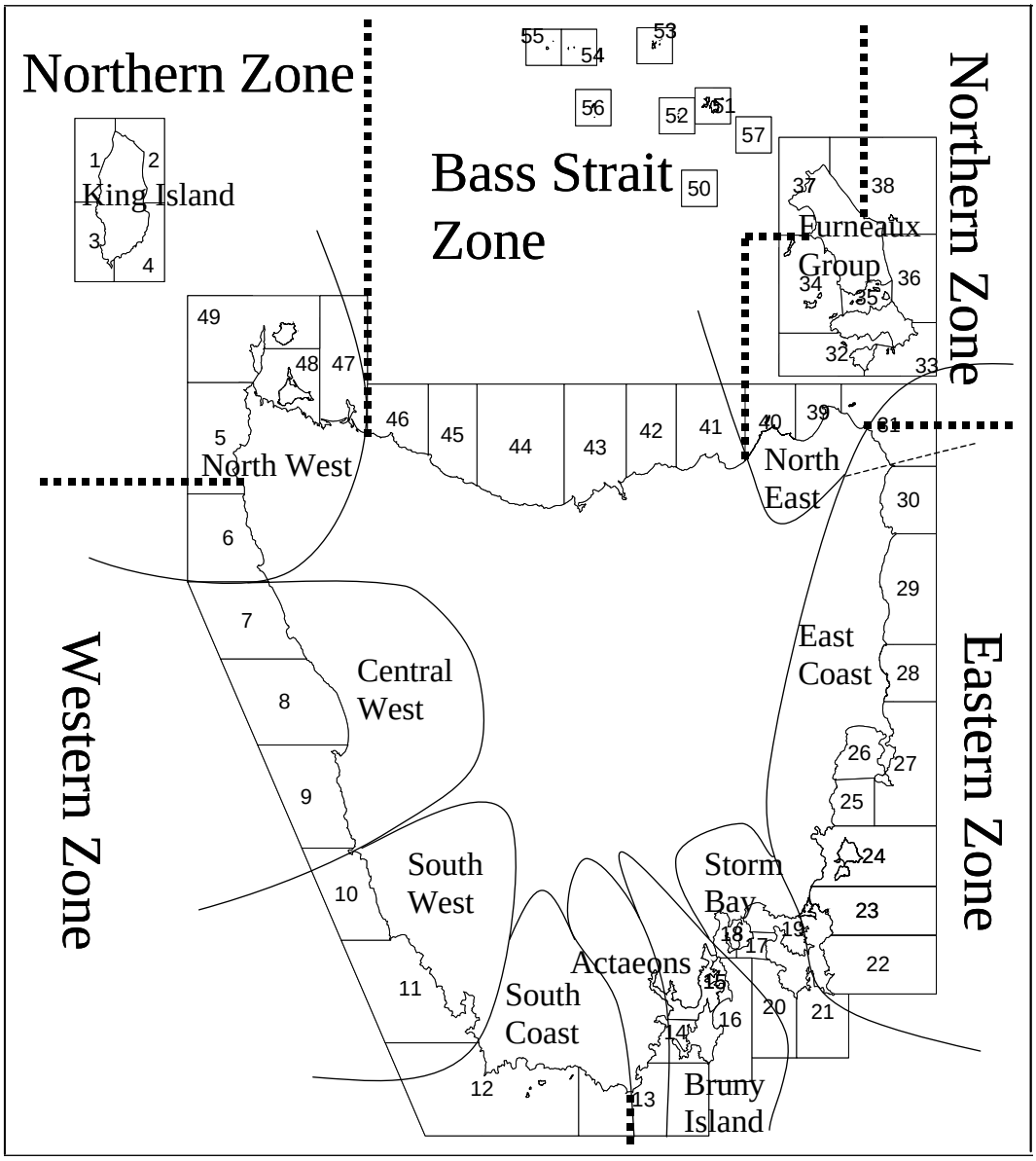


Figure 1. Statistical blocks and zones used in the Tasmanian abalone fishery in 2005. Also shown are the regions used for assessment purposes in this document. Zone boundaries are shown as dotted lines. The Greenlip fishery has no geographical boundaries, but mostly takes place on coasts included in the Northern and Bass Strait Zones.

3. 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 (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 in 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 while selecting abalone by size.

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 (Shepherd and Partington, 1995; Officer *et al.*, 2000) 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 stocks 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 9) is an improvement, but is still much 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 to assess 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 noticed 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 and the use of Nitrox gas mixing plants. 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.

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 2006, 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 (Harrison, 1983; Buckworth, 1987; Haddon and Hodgson, 2000), 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 2).

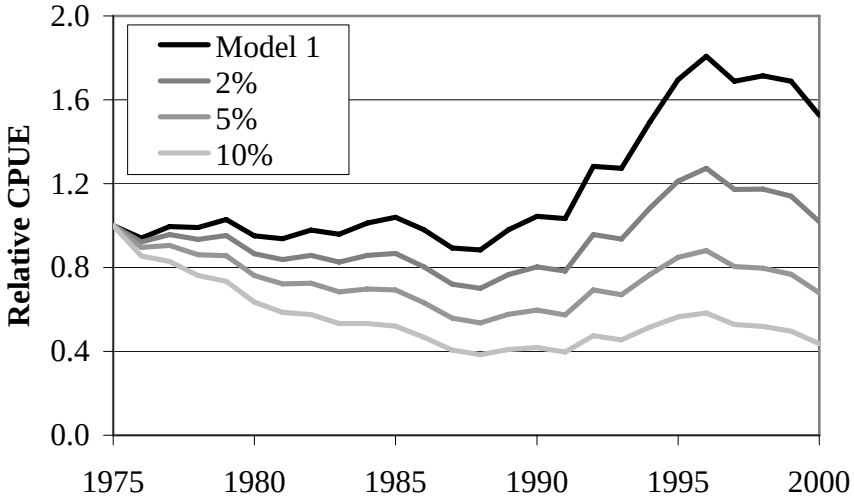


Figure 2. Relative CPUE indices for Block 13, 1975-2000. Model 1 is the raw geometric mean of CPUE. The three effort creep scenarios considered are: (i) 2% per annum; (ii) 5% per annum; and (iii) 10% per annum. All values of CPUE are relative to 1975 (Tarbath *et al*., 2001).

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 ten 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 six-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. Having said that, recent changes in diving practices (increased use of GPS, Nitrox) and improved weather forecasting services on the West Coast, suggest that the standardization of catch rates be re-examined.

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 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 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:

It is assumed that abalone abundance remains 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 are relatively low, and abalone are allowed to form aggregations, less credence may be placed on catch rates as an indication of stock abundance. We conclude that stocks levels remain adequate, because catch rates are relatively high compared with other parts of the fishery that we know to be sound. In addition, more reliance has been placed on divers with catch history in those areas to advise us about trends in abundance.

Because of recent quota reductions, much of the Eastern Zone, particularly parts of the East Coast, is now fished at low levels of effort. This means that effort is inconsistently 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 rates trends are 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.

The first scenario 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. An example of this appears to be occurring in the southern parts of Block 6, where catches and catch rates have been in almost continuous decline since 2000. 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.

The second scenario probably indicates 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, Block 20. It is expected that the median size will 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.

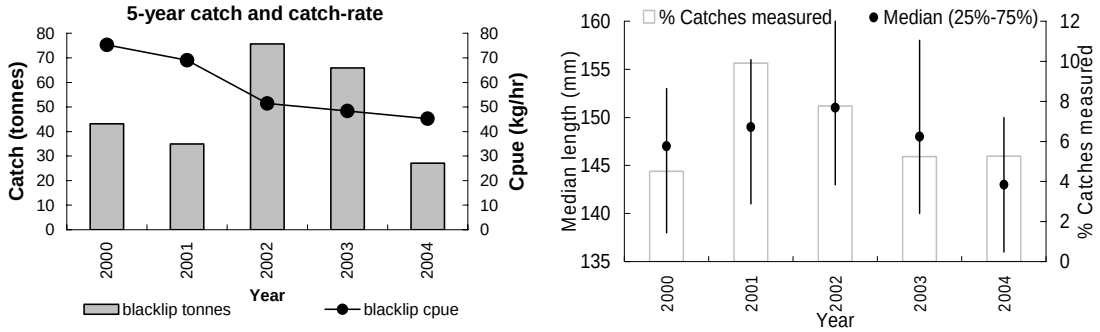


Figure 3. Trends in catch, catch rate and median length (flanked by the 25th and 75th percentile bounds), sub-block 13C.

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 3). 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 suggest unsustainable levels of fishing (Figure 3).

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 4).

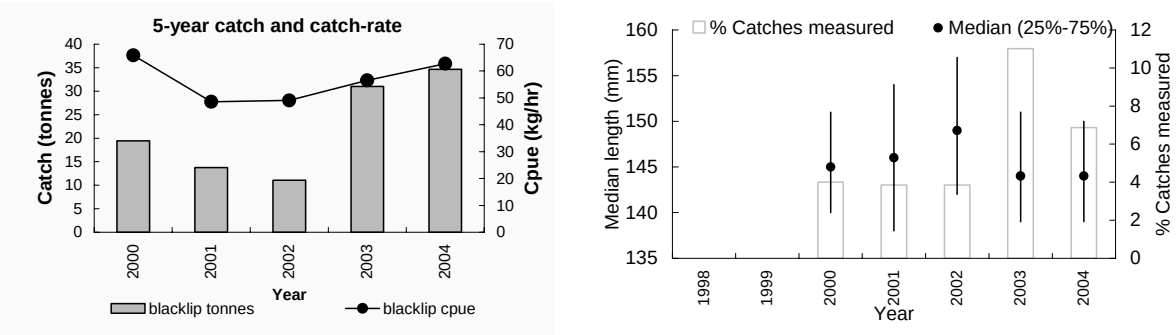


Figure 4. Trends in catch, catch rate and median length (flanked by the 25th and 75th percentile bounds), sub-block 20B.

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

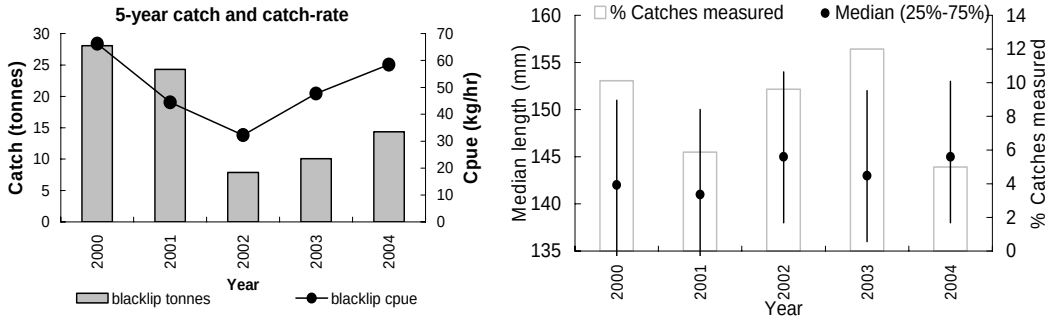
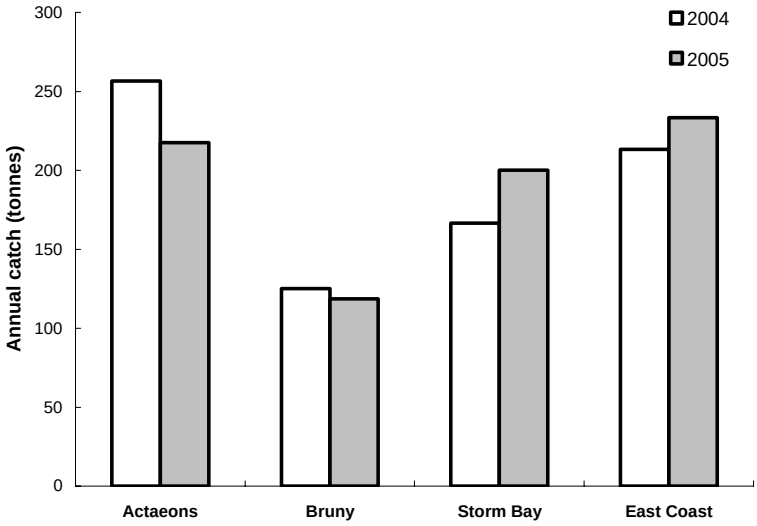


Figure 5. Trends in catch, catch rate and median length (flanked by the 25th and 75th percentile bounds), sub-block 24B.

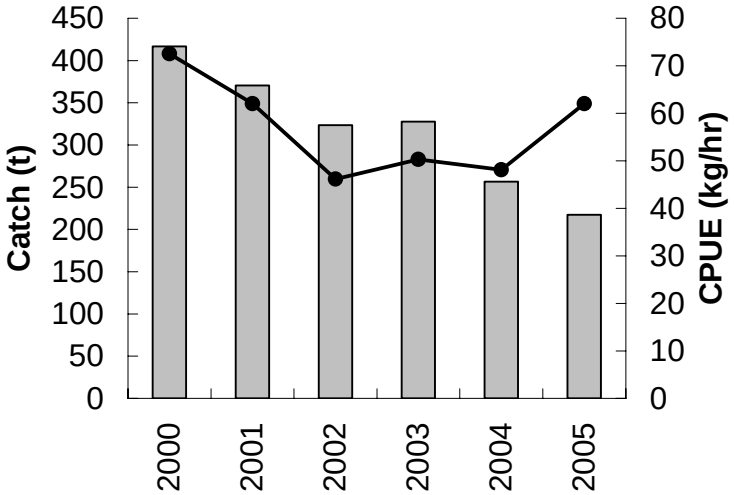
4. Catch, catch-rate and size-composition figures

Eastern Zone Blacklip fishery – distribution of catch

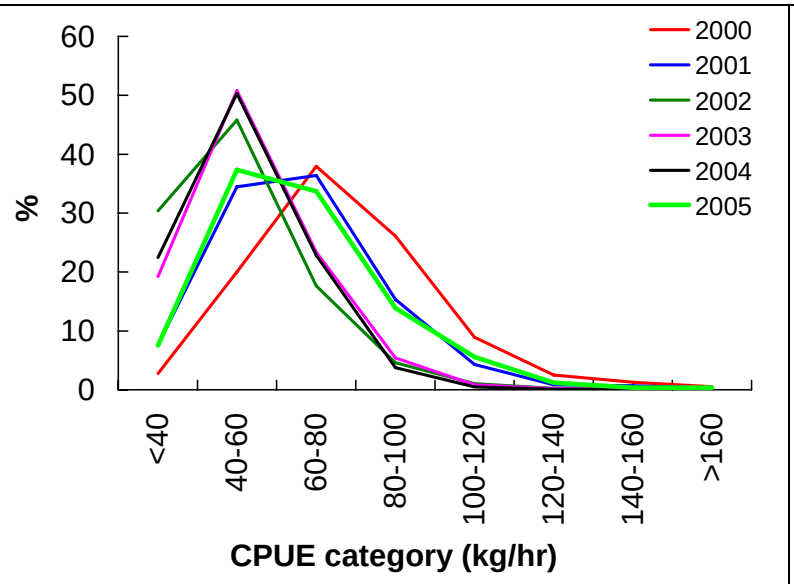


There has been a redistribution of catch from the Actaeons to Storm Bay and the East Coast in 2005.

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

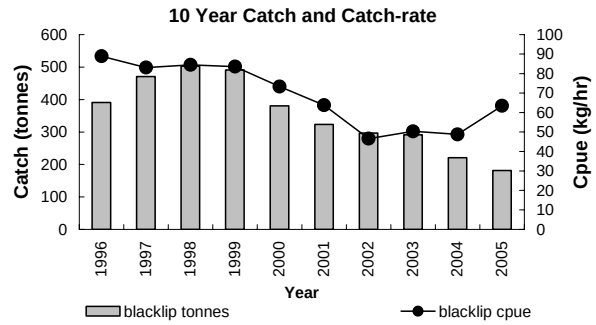


In all parts of the Actaeons, catch rates have risen. Across the region there has been a 12 kg/hr increase in mean catch rates to 62 kg/hr in 2005. However, given the size of the reduction in annual catch (~218t in 2005), an increase in catch rates could be expected and does not necessarily indicate increased levels of recruitment.



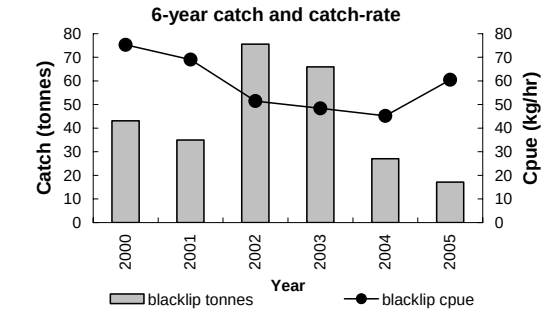
The increased catch rates are reflected by a shift in CPUE category from 40-60 kg/hr to 60-80 kg/hr. Catch rates are now very similar to those exhibited in 2001.

Block 13 (Actaeons, plus South Coast from Whale Head to Prion Bay)

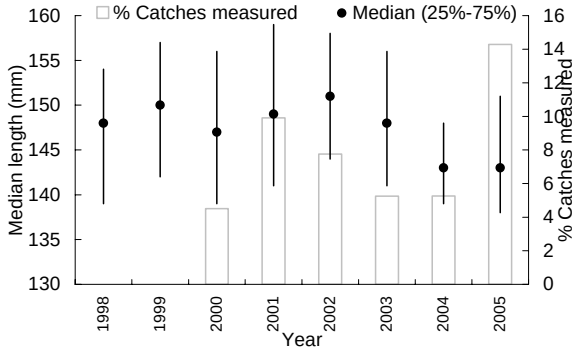


The ten-year view of catch rates in Block 13 puts the 2005 increase in catch rates in perspective and reinforces the belief that the increase has been driven by catch reductions and not due to unusual levels of recruitment.

Sub-block 13C
Fishers Point to Whale Head

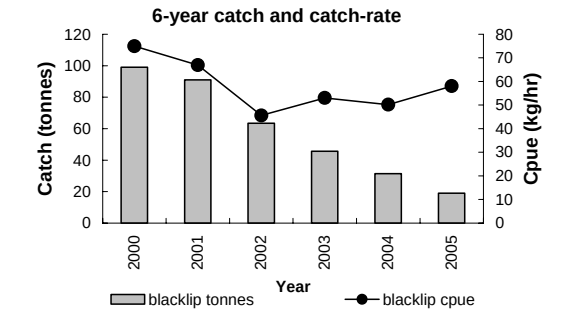
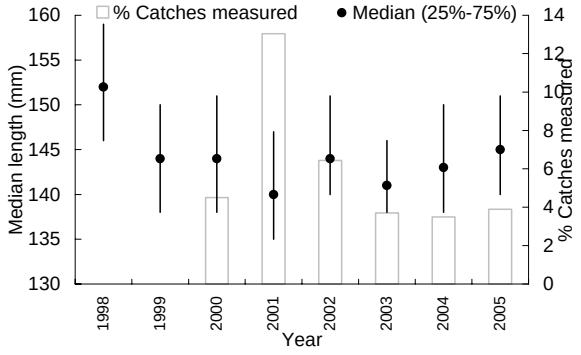


Greatly reduced levels of annual catch 2004-2005.

	Increased 75th percentile compared with 2004 indicates some larger abalone in divers' catches. The decreasing 25% suggests recruitment.

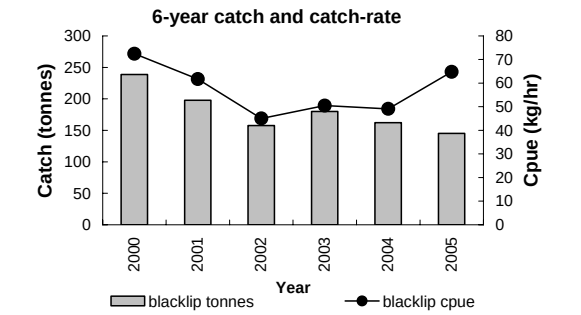
Sub-block 13D

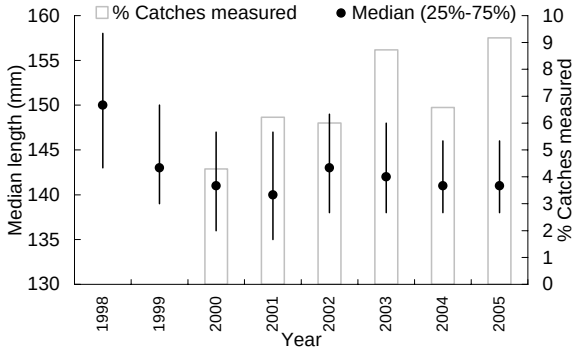
Fishers Point to Southport Lagoon Beach, including Recherche Bay

	Sustained fall in annual catch since 2000, moderate improvement in catch rates.
	Marginal levels of sampling and low annual catch in recent years means that changes in median size may not be indicative of changes in population size structure.

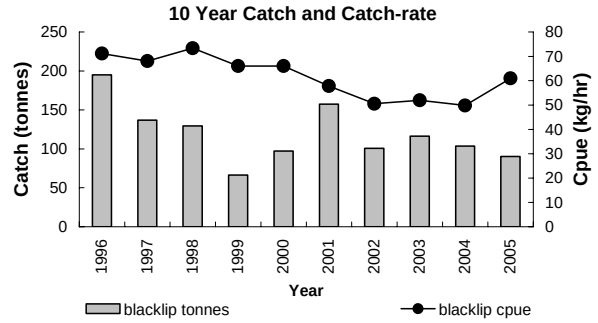
Sub-block 13E

Actaeon and Sterile Islands, and reefs to the south (the Breaks)

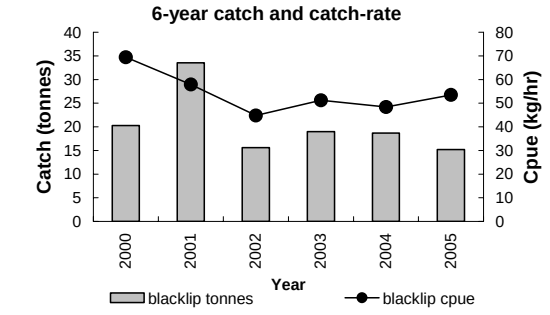
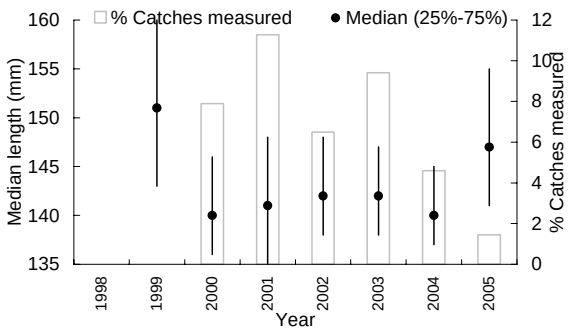
	Catch rates climbed from ~50 kg/hr to 65 kg/hr, catch levels continue to fall to 145t in 2005.

	Median size and range of percentiles unchanged from 2004, consistent with recruitment based fishery.

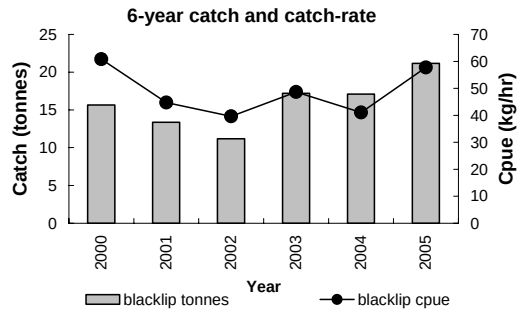
Block 14 (Lower Channel, south Bruny Island and the Friars)

	Reduced levels of catch with sharp increase in catch rates.

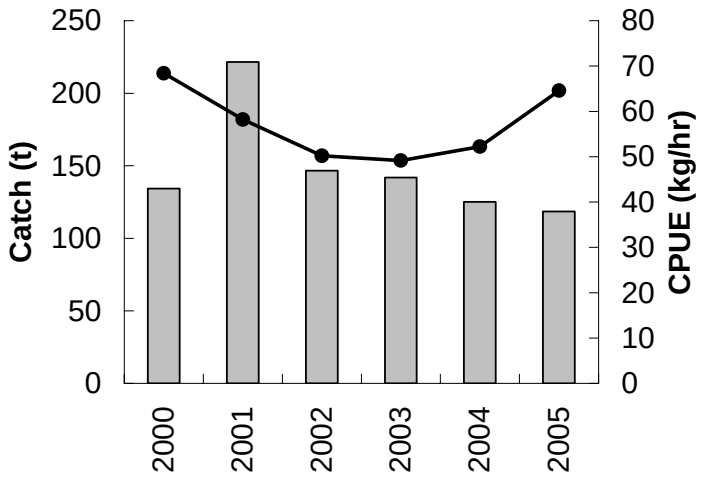
Sub-block 14A
Southport Lagoon Beach to Burnett Point

	
	Level of sampling inadequate in 2005, apparent changes in median size may not be real or significant.

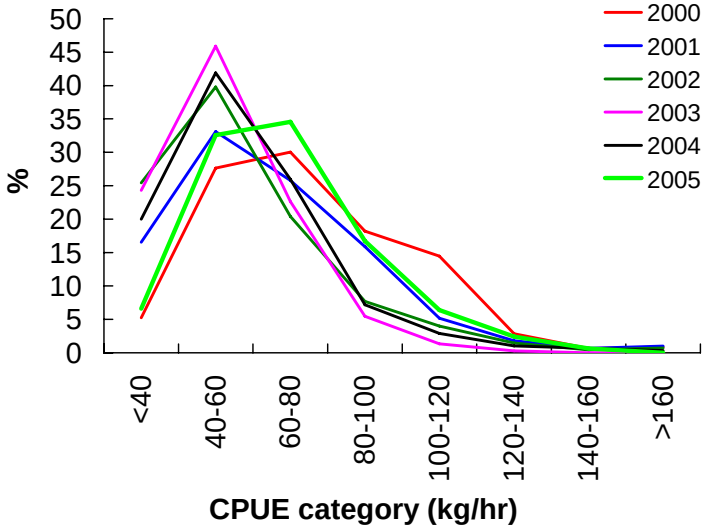
Sub-block 14B
Burnett Point to Blubber Head



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

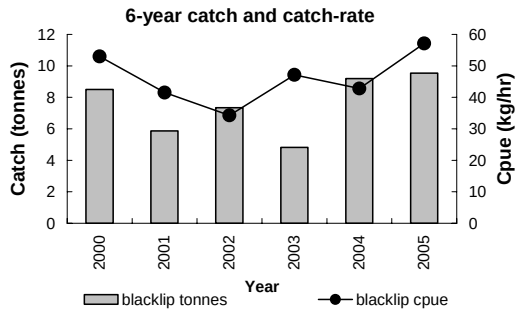


The regional catch has fallen to 119t, while catch rates have increased since 2003, and have now reached 65 kg/hr. The most likely explanation for the increase in catch rates is the sustained reduction in annual catch in recent years, and not increased levels of recruitment.

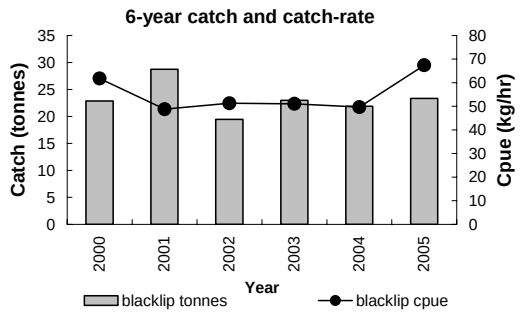
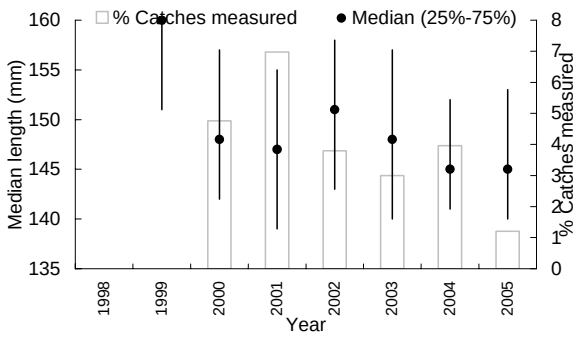


CPUE distributions show a modal transition from 40-60 kg/hr to 60-80 kg/hr. There are also correspondingly increased levels of catches taken at higher catch rate categories.

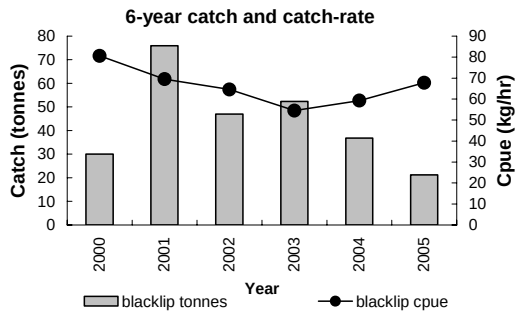
Sub-block 14C
Mays Creek to Hopwood Light (Lower Channel)

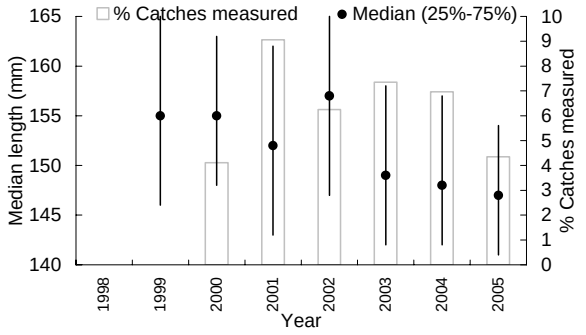
	

Sub-block 14D
Hopwood Point to West Cloudy Head

	Sharp rise in catch rates, consistent levels of catch during last six years.
	Inadequate level of sampling in 2005.

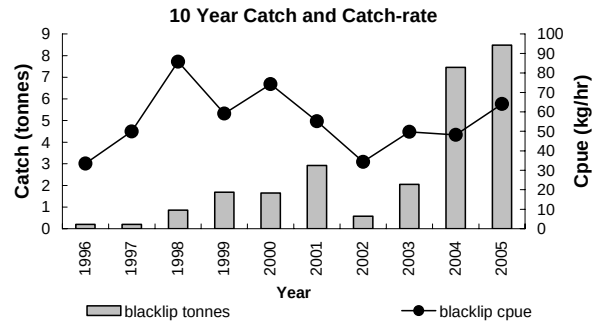
Sub-block 14E
West Cloudy Head to Boreel Head, including the Friars

	Continued improvement in catch rates to 68 kg/hr while catch has fallen to 21t.



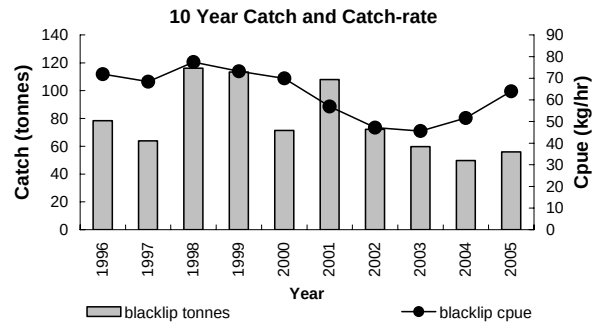
This sub-block has traditionally been a big fish area. The fall in median size since 2002 suggests increasing levels of effort and increased reliance on recruits.

Block 15 (D'Entrecasteaux Channel)



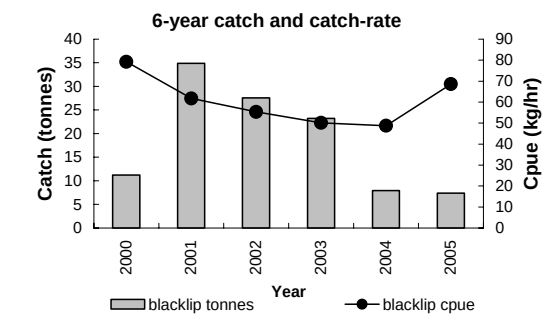
This block contains only a small area of abalone habitat and does not regularly contribute to the fishery.

Block 16 (eastern side of Bruny Island)



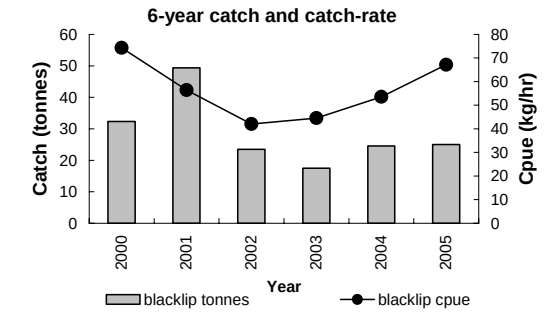
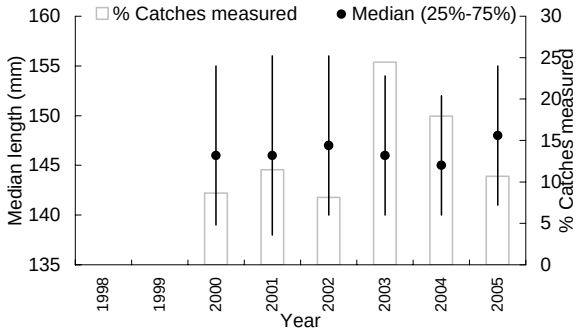
Catch rates have steadily improved over the last two years, although catches remain at historically low levels.

Sub-block 16A
Boreel Head to North Mangana Bluff

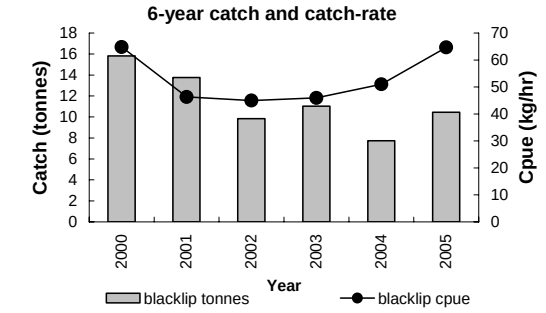


Very low levels of catch (7.4t) compared with 2001.

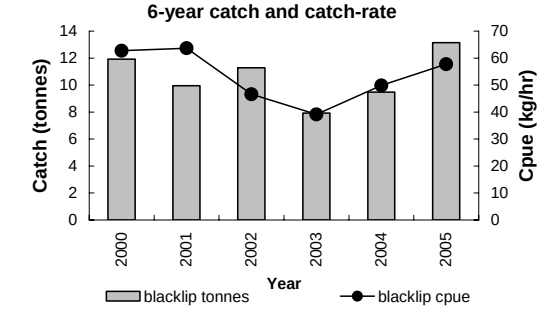
Sub-block 16B
North Mangana Bluff to Neck Beach

	Catch rates have increased for three successive years. Suggests current level of catch (25t) is sufficiently low to permit continued rebuilding and is obviously sustainable.
	Does the increase in median size reflect reduced levels of effort and a shift from a fishery that was dependent on recruits to one where greater proportions of older fish are landed?

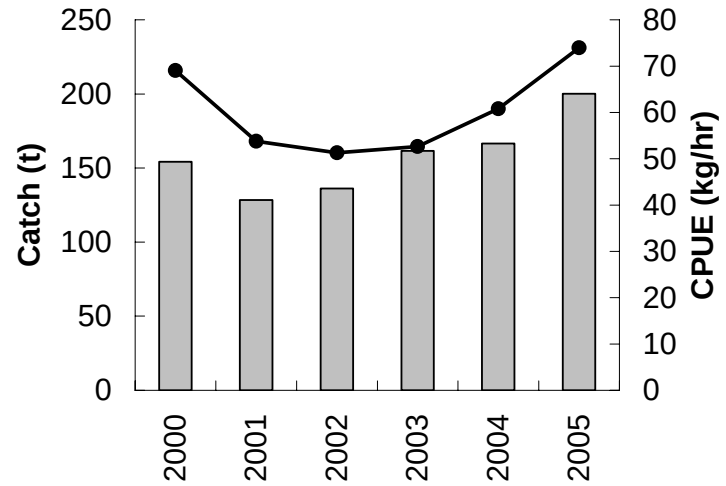
Sub-block 16C
Neck Beach to Trumpeter Bay

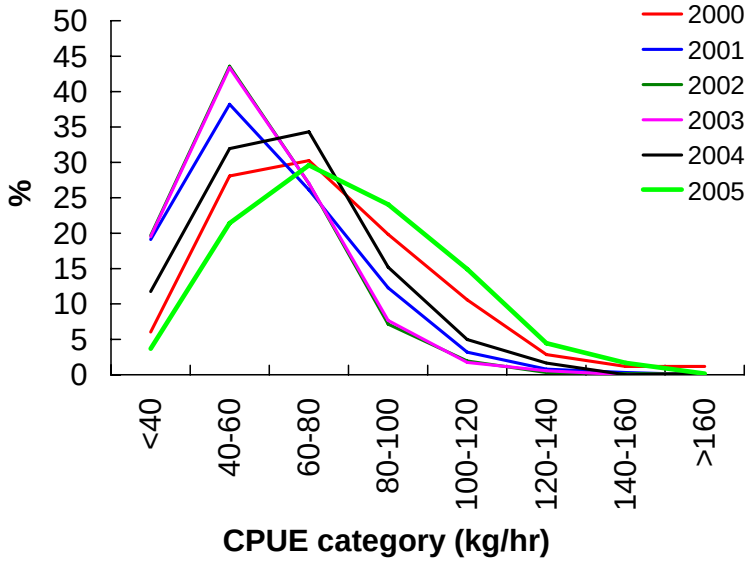
Sub-block 16D
Trumpeter Bay to Dennes Point

Eastern Zone - Storm Bay (Blocks 17-21).

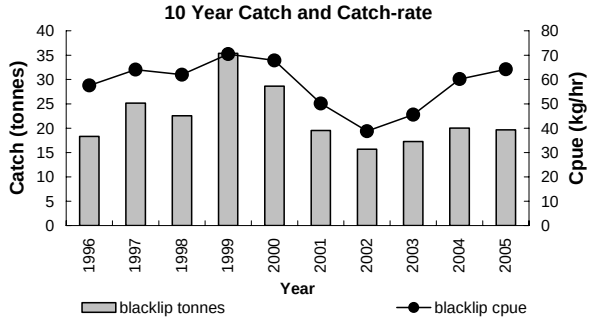


The annual catch has continued to increase following a shift in effort from the Actaeons. This catch increase appears to have had no adverse effect upon catch rates, which in 2005 were among the highest in the Eastern Zone.



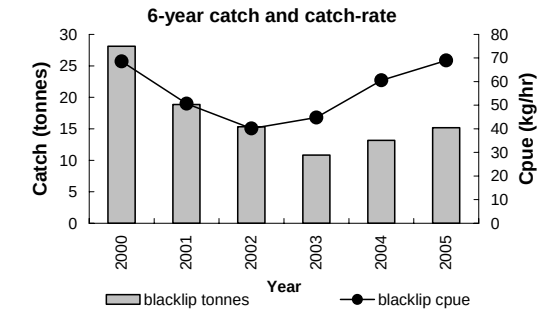
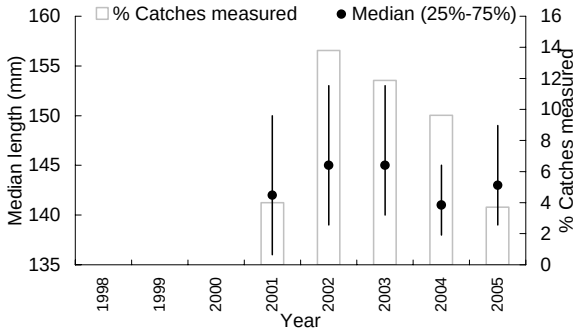
The 2005 CPUE distribution was less skewed than in earlier years. The increase in catch rates is apparent in the higher CPUE categories, with a reduction in lower CPUE categories.

Block 17 (South Arm to Cremorne, Blackjack shoreline to Outer North Head)

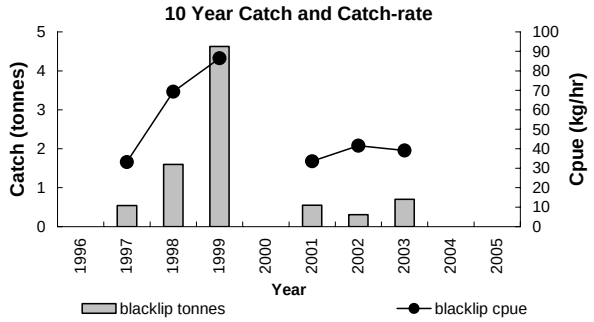


Low levels of catch in recent years (~20t). Catch rates continued to rise in 2005, but last years' increase was moderate.

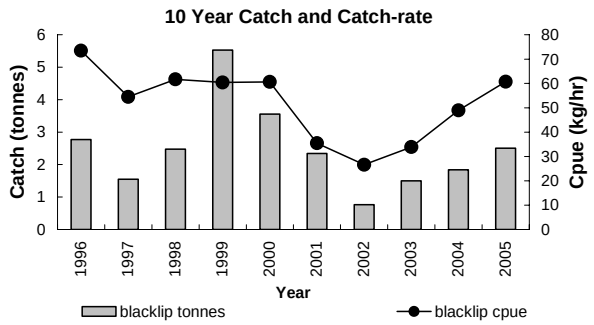
Sub-block 17B
Blackjack shoreline from Lobster Point to Outer North Head

	
	Small increase in median size.

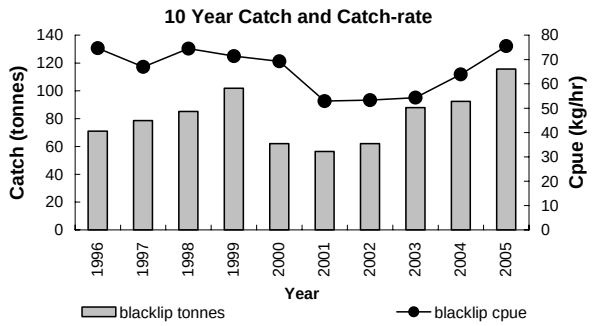
Block 18 (Derwent River, Iron Pot)

	This block contains marginal abalone habitat, and is not an important part of the fishery.

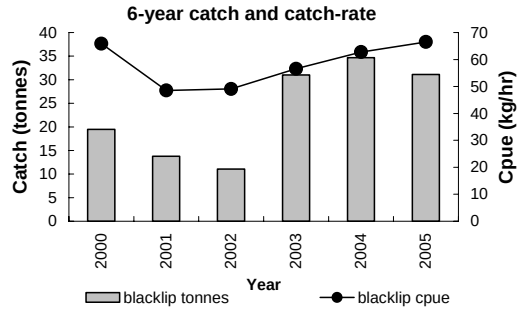
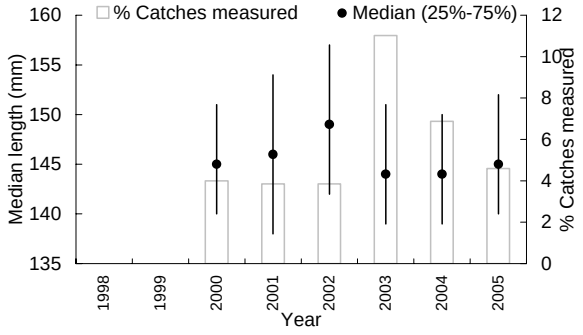
Block 19 (Northern Frederick Henry Bay)

	This block contains marginal abalone habitat, and is not an important part of the fishery. Catches and catch rates are at low levels, catch rates are increasing.

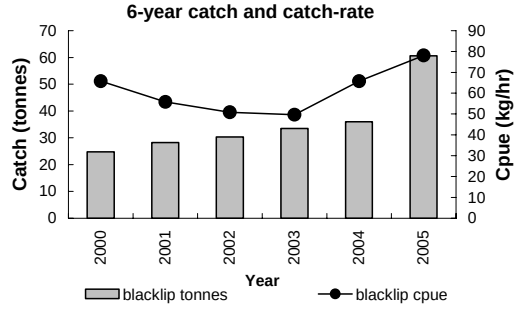
Block 20 (western side of Tasman Peninsula)

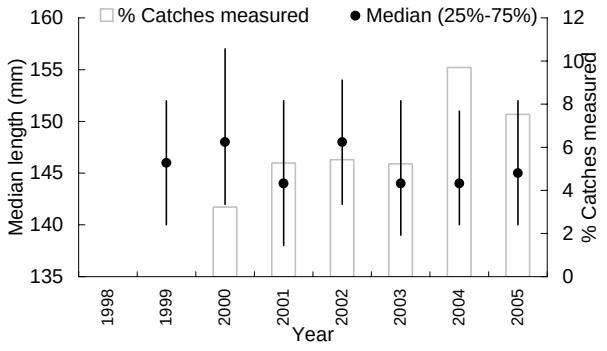
	Steadily improving catch and catch rates.

Sub-block 20A
Outer North Head to White Beach

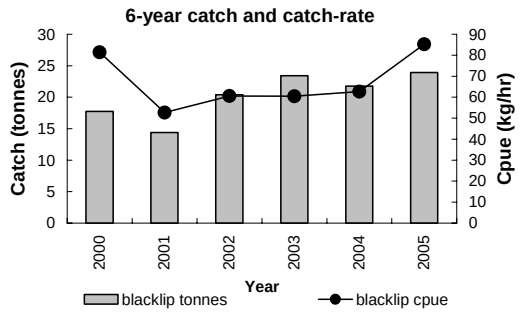
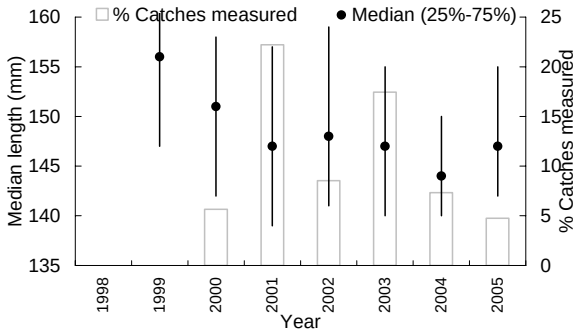
	Greatly increased level of catch since 2003, improved catch rates.
	Small increase in median size.

Sub-block 20B
White Beach to Salters Point

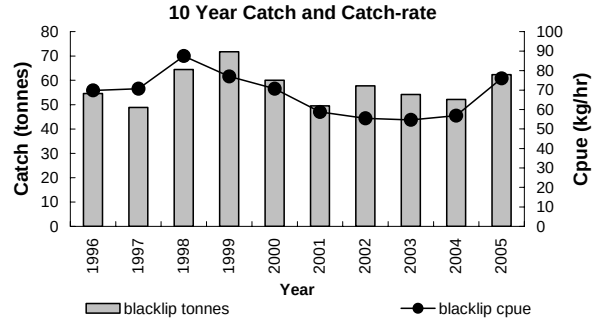
	Large increase in catch to 61t in 2005. Catch rates continued to increase in 2005, with many daily landings exceeding 500 kg.

	Small increase in median size.

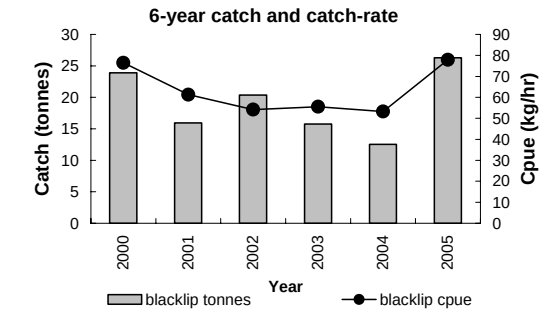
Sub-block 20C
Salters Point to Cape Raoul

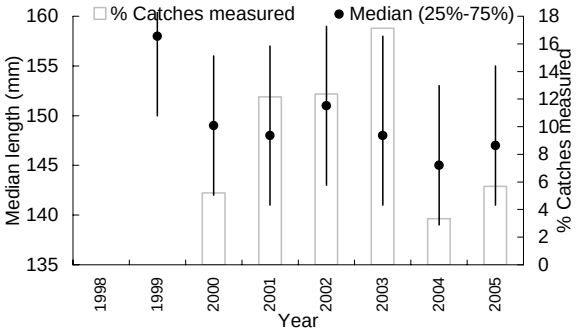
	Sustained level of catch between 20t - 24t in recent years, with sharp rise in catch rates.
	Small increase in median size.

Block 21 (southern shore of Tasman Peninsula)

	Pronounced (20 kg/hr) increase in catch rates to 76 kg/hr with small (10t) increase in catch to 62t.

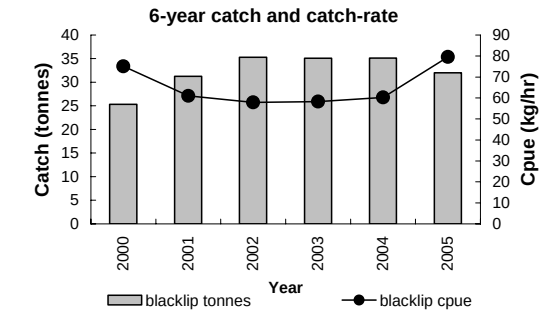
Sub-block 21A
Cape Raoul to Port Arthur

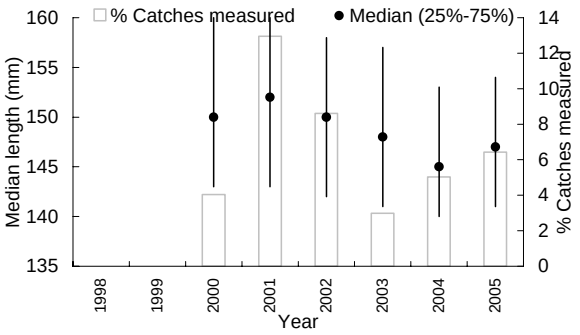




Small increase in median size.

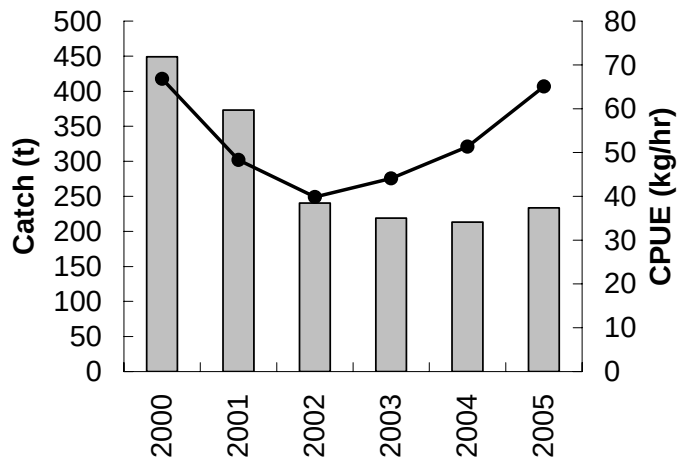
Sub-block 21C
Port Arthur to Cape Pillar



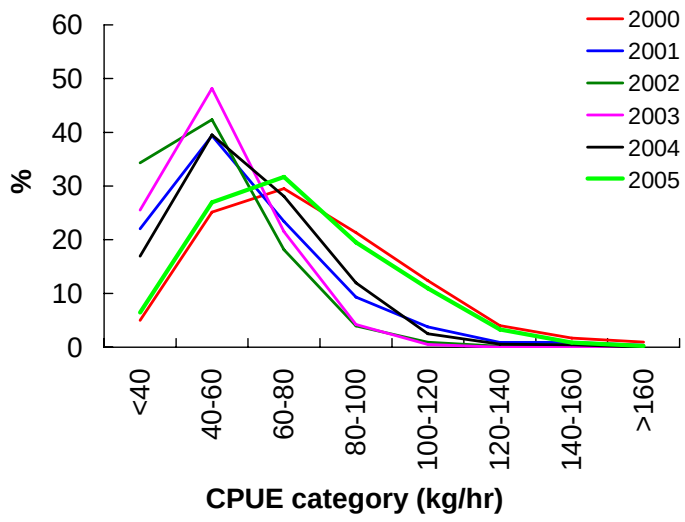


Small increase in median size.

Eastern Zone – East Coast (Blocks 22–31B)

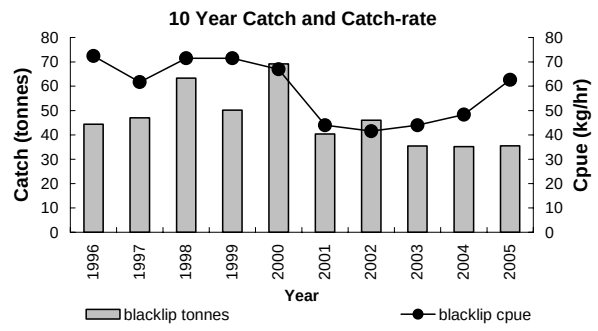


The regional catch remained low in 2005 (233t), while catch rates continued to increase rapidly to 68kg/hr.



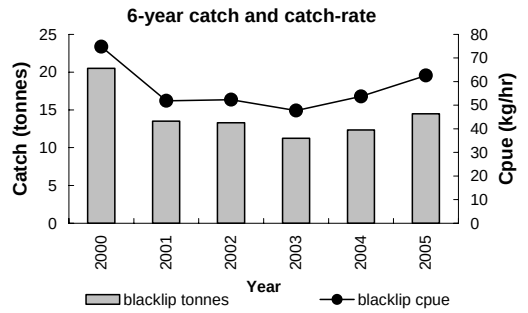
CPUE distributions show a modal shift to the 60-80kg/hr category, a fall in lower CPUE categories and an increase in higher (> 80kg/hr) categories. Catch rates in 2005 are almost the same as they were in 2000.

Block 22 (east Tasman Peninsula)

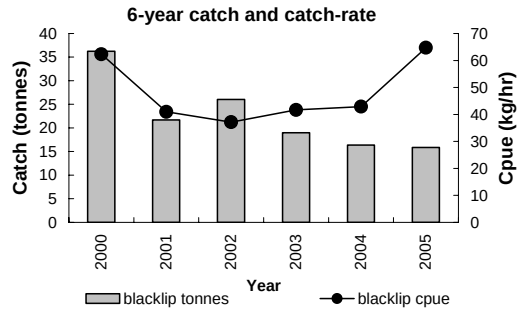
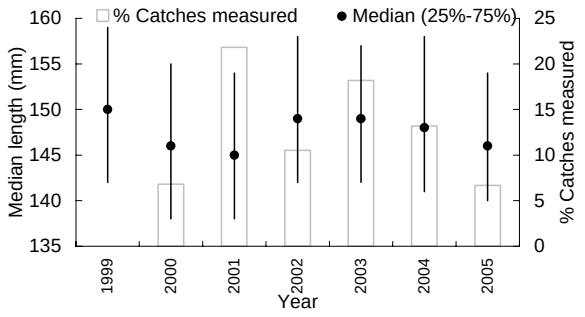


Since 2001 catch rates have been at low levels (~50 kg/hr). However, in 2005 there was a large increase to 63 kg/hr.

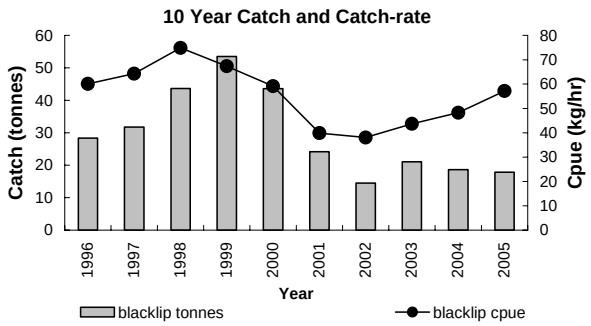
Sub-block 22A
Cape Pillar to the Lanterns

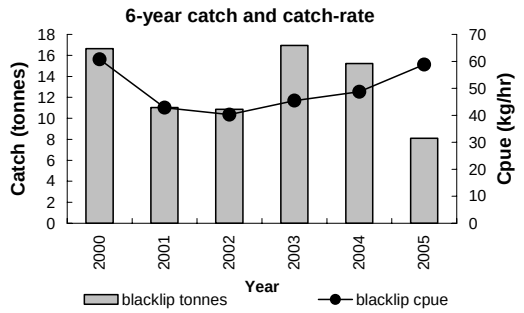
Sub-block 22B
The Lanterns to Eaglehawk Neck

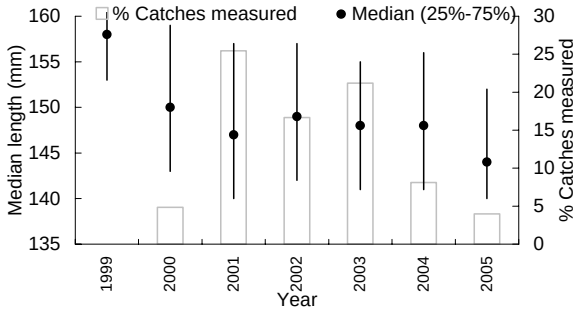
	Low levels of catch (16t), sharp increase in catch rates to 64 kg/hr.
	The size of sampled abalone fell in 2005

Block 23 (Forestier Peninsula)

	Low levels of catch, steady increase in catch rates.

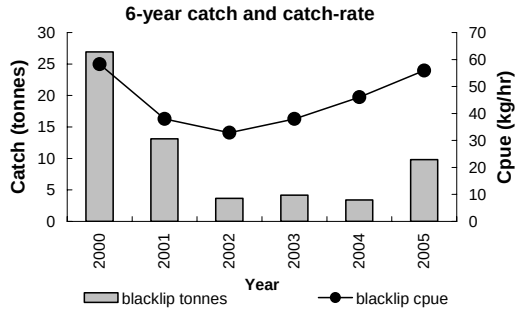
Sub-block 23A
Deep Glen Bay to Lagoon Bay



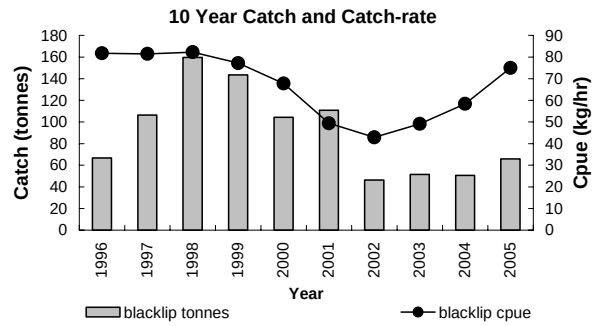


While median size appears to have fallen, level of catch combined with level of sampling may be too low to accurately reflect changes in size.

Sub-block 23B
Lagoon Bay to Marion Bay

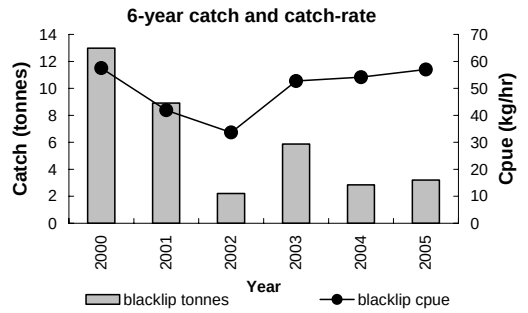


Block 24 (Maria Island, western shore of Mercury Passage)

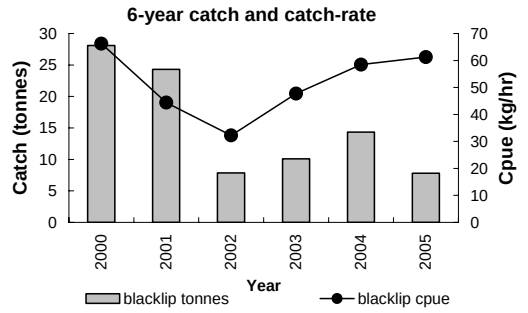
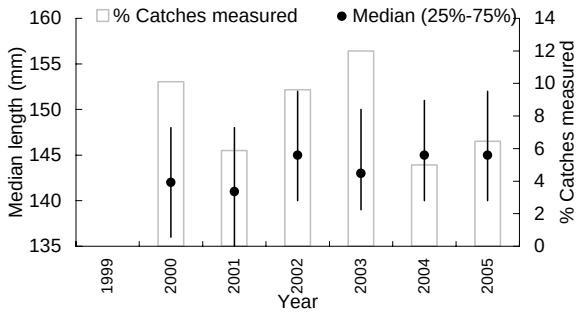


Rapidly escalating catch rates, low levels of catch.

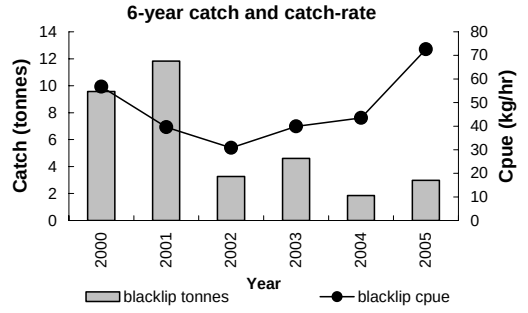
Sub-block 24A
western shore of Mercury Passage

	Low levels of catch, catch rates provide little indication of stock recovery.

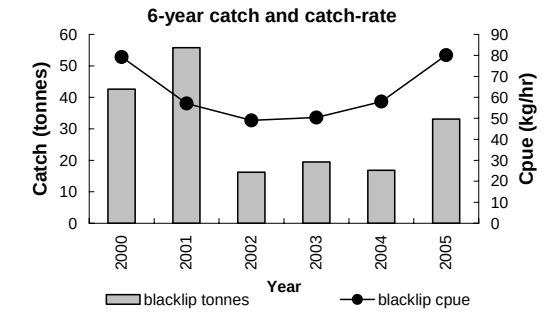
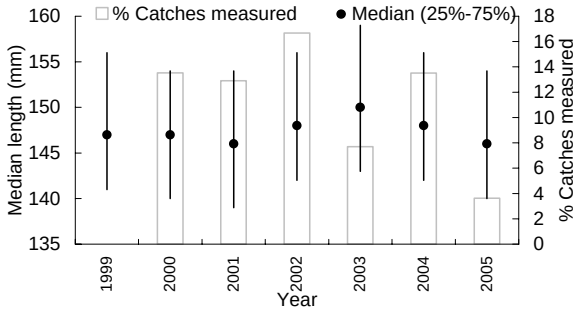
Sub-block 24B
western shore of Maria Island

	Low levels of catch.
	Median size has been relatively unchanged since 2002, when the size limit was increased.

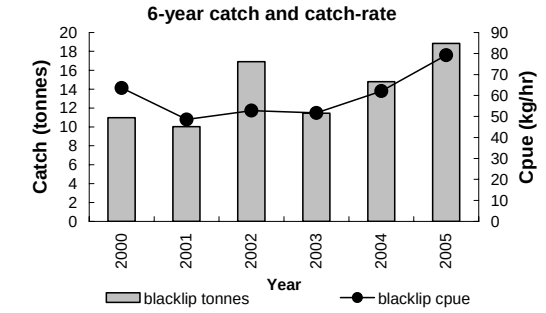
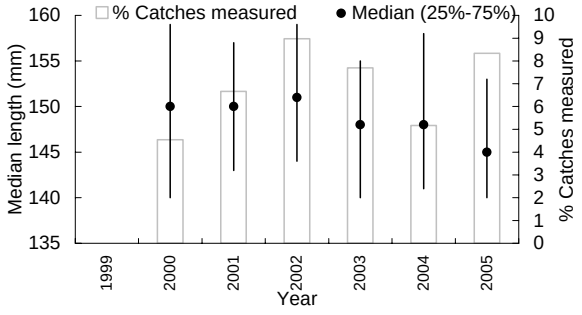
Sub-block 24C
Spring Bay

	Low levels of catch.

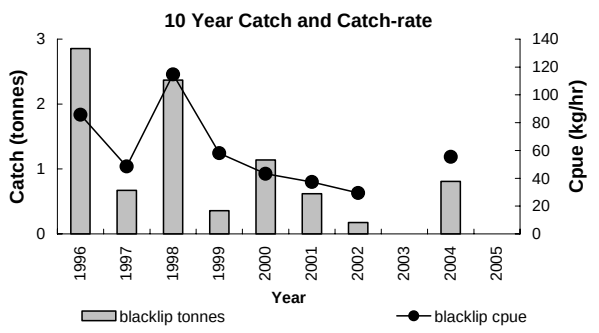
Sub-block 24D
north-east side of Maria Island

	Increased catch rates and moderate levels of catch suggest stock recovery.
	Sub-optimal level of sampling (3.6%) indicates decreasing size of sampled abalone.

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

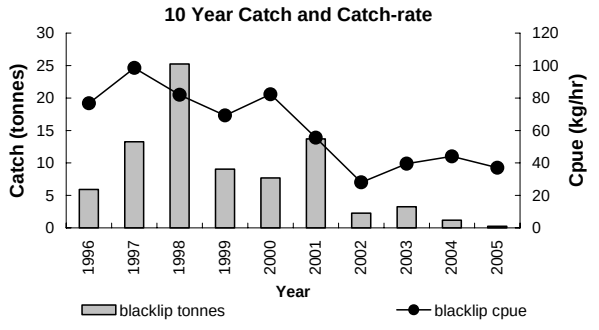
	The increase in catch and catch rates here is more pronounced than in 24D. Combined with smaller sized abalone from catch samples in both blocks, it suggests that there has been a larger than normal influx of recruits in the two sub-blocks.
	

Block 25 (Cape Bougainville to Seaford Point)



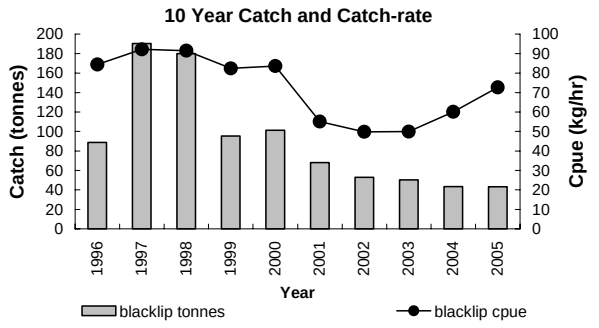
Intermittent fishery which collapses when fished after years of recovery.

Block 26 (Great Oyster Bay, Seaford Point to Sandstone Bluff)



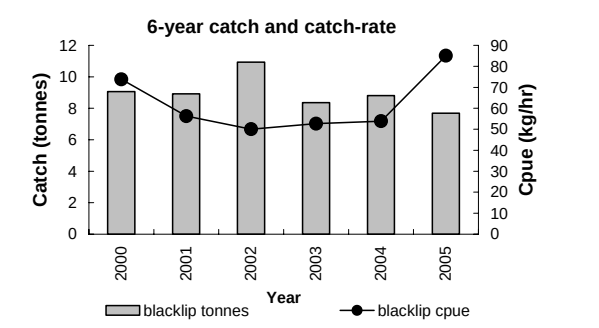
As above.

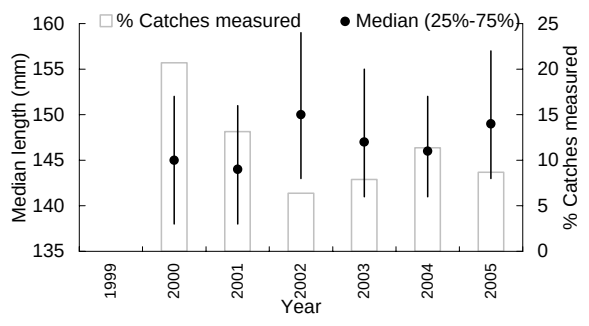
Block 27 (Eastern side of Freycinet Peninsula, Schouten Island)



Levels of catch are still very low, and there are no indications that this is not driving the increase in catch rates. The extent of recovery here will not be realised until catch levels increase.

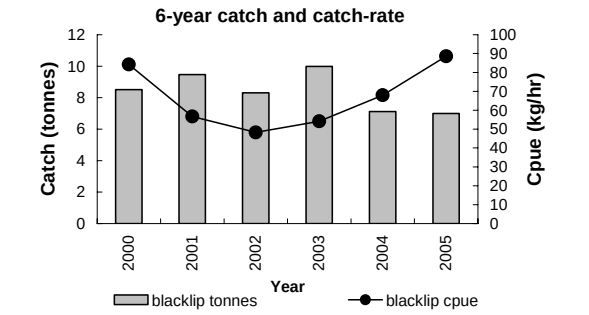
Sub-block 27A
south side of Schouten Island



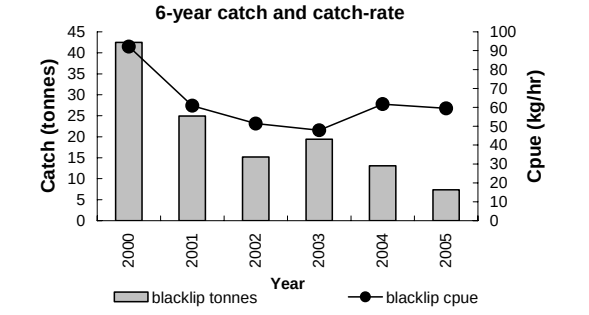


Median size has increased after falling for two years following the raised size limit in 2002. Note that while the level of sampling appears adequate (>4%), the low number of catches means that the sample statistics may not reflect those of populations in this sub-block.

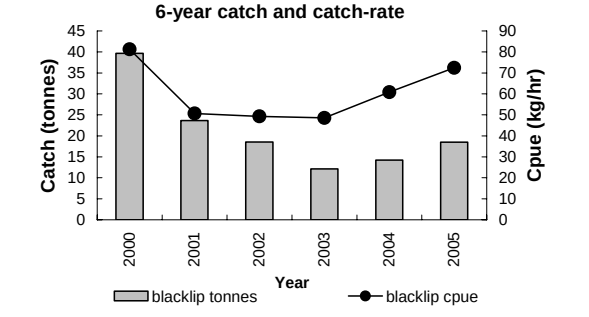
Sub-block 27B
east side of Schouten Island



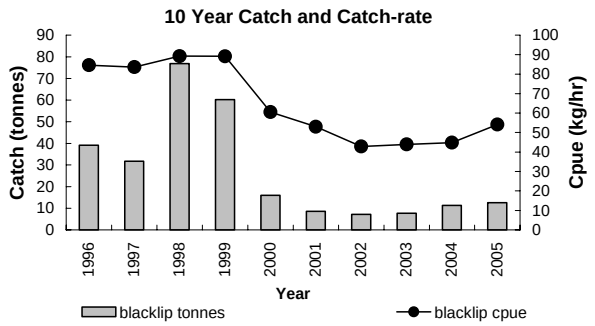
Sub-block 27C
Schouten Passage to Wineglass Bay



Sub-block 27D
Wineglass Bay to the Friendly Beaches

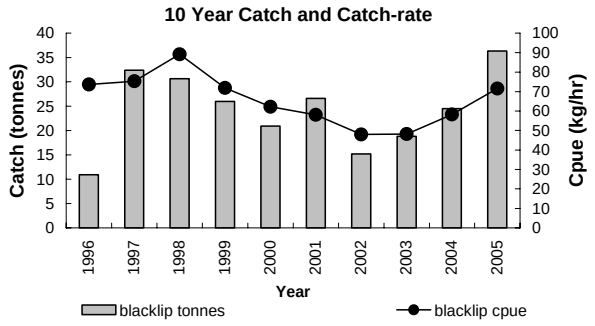


Block 28 (Friendly Beaches to Seymour, including Bicheno)



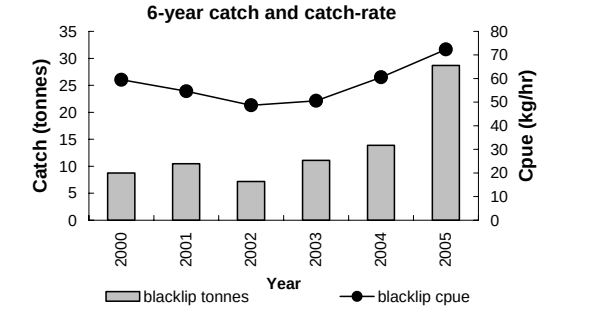
Catch levels remain low and combined with low catch rates suggest that recovery to a fishery that can support its average level of catch (56t) is still years away.

Block 29 (Seymour to St Helens Point)

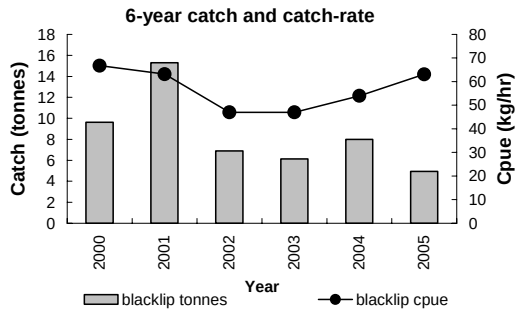


The annual catch, most which was caught at Long Point, increased substantially in 2005 and at 36t, is approaching double the long-term average. Catch rates continued to increase in 2005, but this level of catch may be unsustainable.

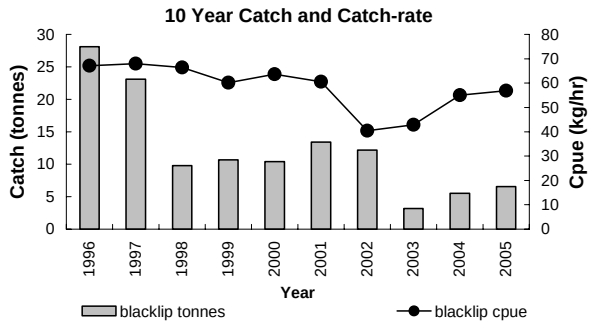
Sub-block 29A
Long Point to Templestowe Beach



Sub-block 29D
Scamander to St Helens Point, including St Helens Island

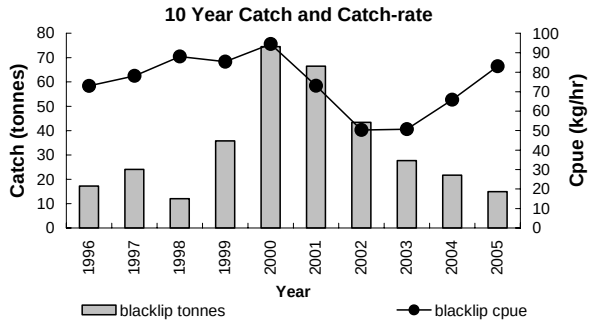


Block 30 (St Helens Point to Eddystone Point)



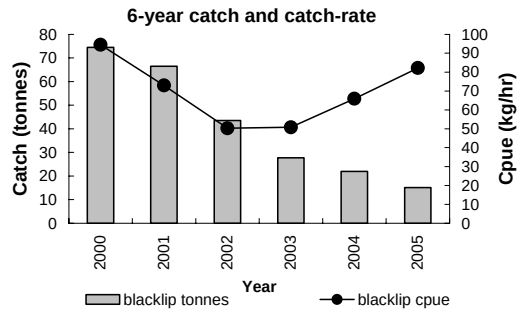
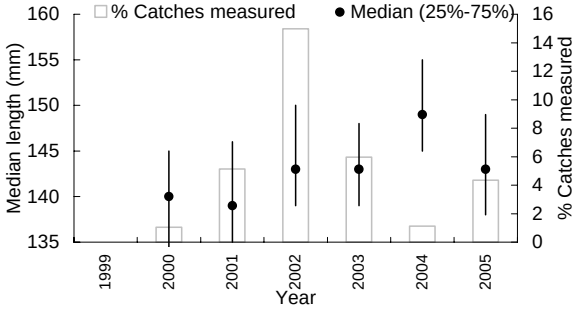
Although some limited recovery has been reported by divers, catch and rates remained low.

Block 31 (Eddystone to Musselroe Bay)

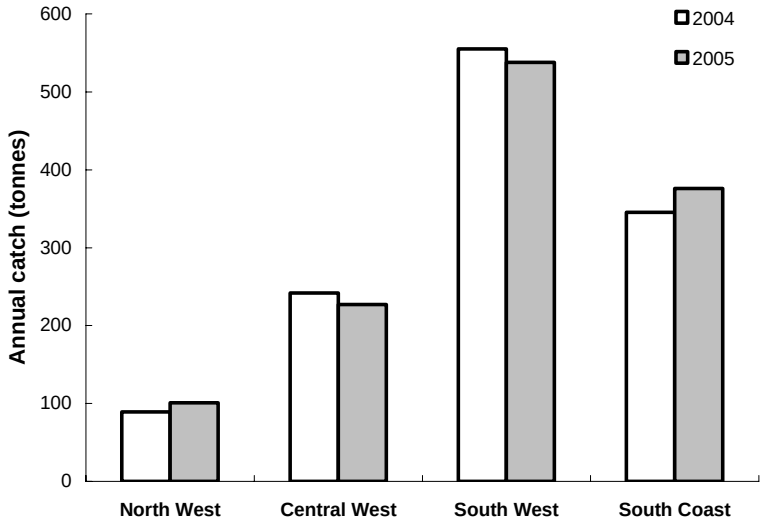


Rising catch rates and greatly reduced levels of catch suggest that this block should continue to recover.

Sub-block 31A
Eddystone Point to Cape Naturaliste

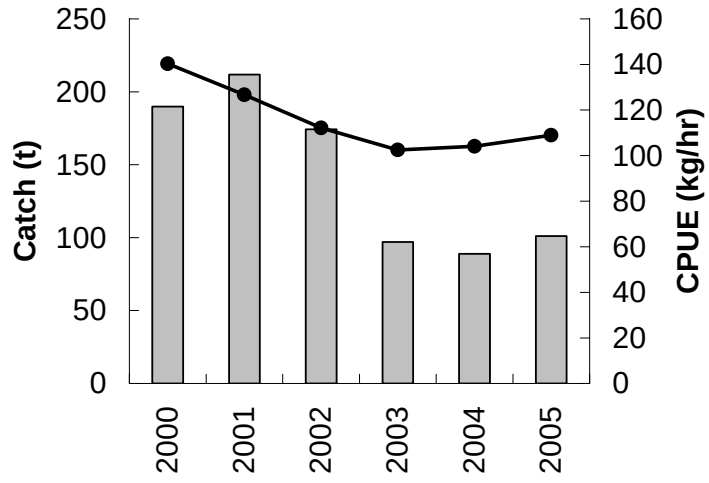
	Catch rates have responded to the reduction in catch.
	Assuming the high 2004 median size was affected by inadequate levels of sampling, median size appears to be stable since the 2002 size limit increase

Western Zone blacklip fishery – distribution of catch

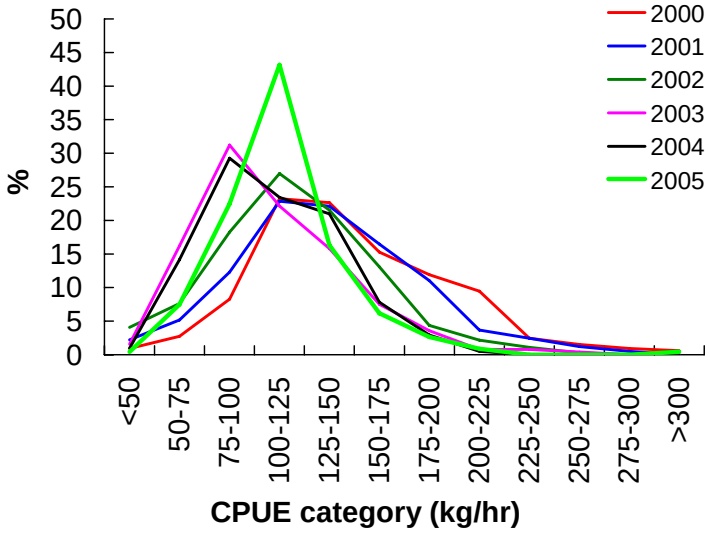


The South West region continued to be the largest contributor of catch, although landings were down on the previous year. Catch from the South Coast increased substantially. Minor changes in catch occurred in the other two regions.

Western Zone - North West (Block 6, Sub-block 5D)

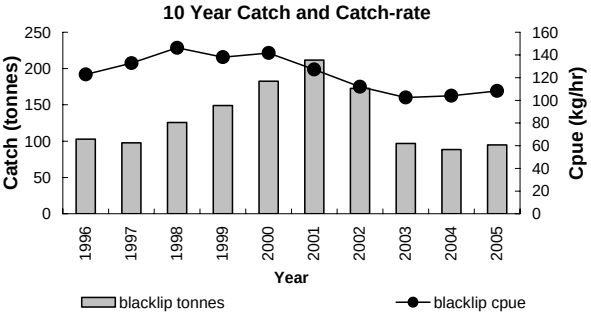


Catch rates have stabilised and appear to be increasing following a reduction in catch since 2001. However, the catch has been very low for three years, and the weak catch-rate response suggests fishable biomass is low.



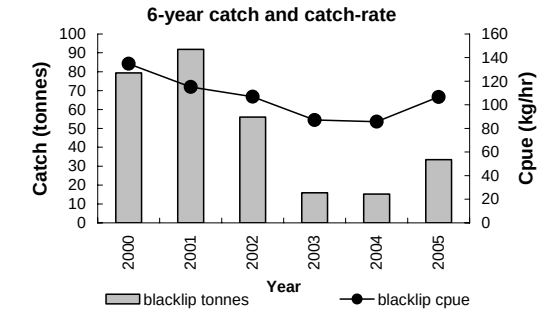
Big change in CPUE distribution, with strong shift to a 100-125 kg/hr mode. Note the absence of higher category catch rates (>150 kg/hr).

Block 6 (Arthur Beach to Italian River, including Sundown, Couta Rocks, Temma and Sandy Cape)



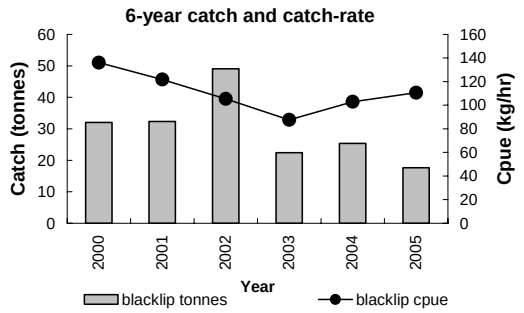
After a steady decline in catch rates from a peak in the late 1990's, catch rates are now low but stable, or increasing slightly. The annual catch is also at low levels.

Sub-block 6A
Sundown to Temma

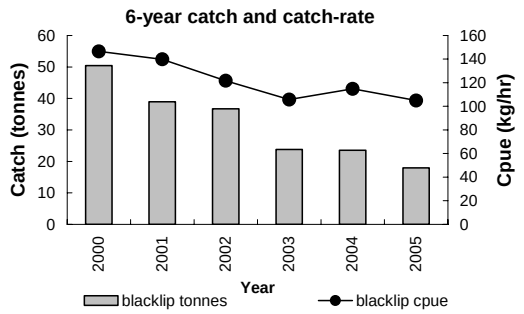


Positive change in catch rates following reduced catches since 2003.

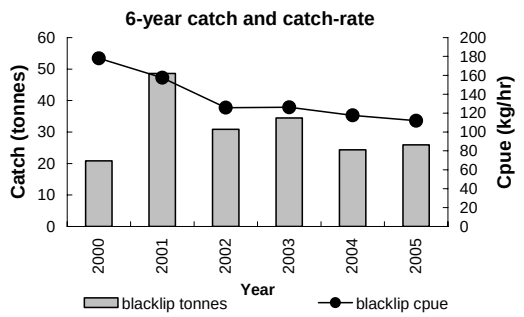
Sub-block 6B
Temma Harbour to rocks north of Dawson River

	Positive change in catch rates following reduced catches since 2003.

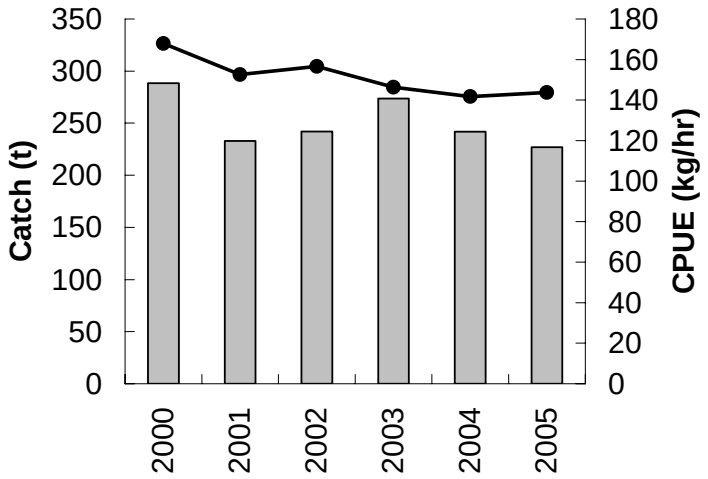
Sub-block 6C
Rocks north of the Dawson River to Sandy Cape Beach – Wild Wave River

	Catch rates have not responded to catch reductions and remain at levels considered low for this part of the West Coast. Falling catch and CPUE are classic recruitment failure indicators.

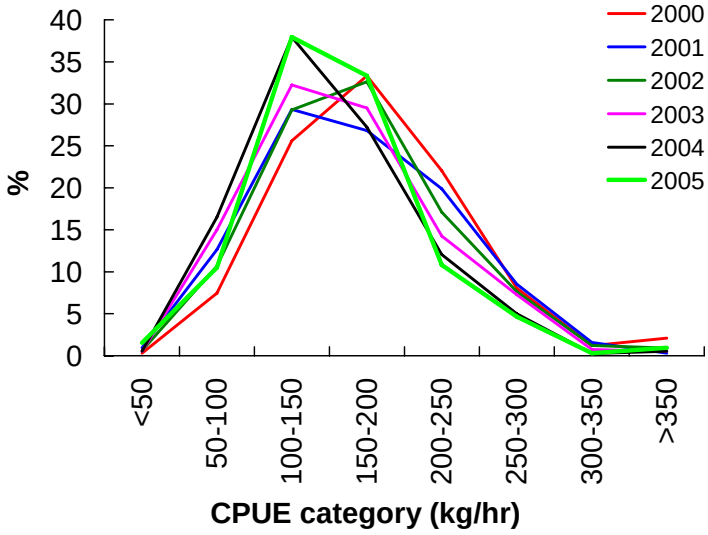
Sub-block 6D
Wild Wave River to Italian River, including Sandy Cape

	Catch rates have not responded to catch reductions and remain at levels considered low for this part of the West Coast.

Western Zone - Central West (Blocks 7-9)

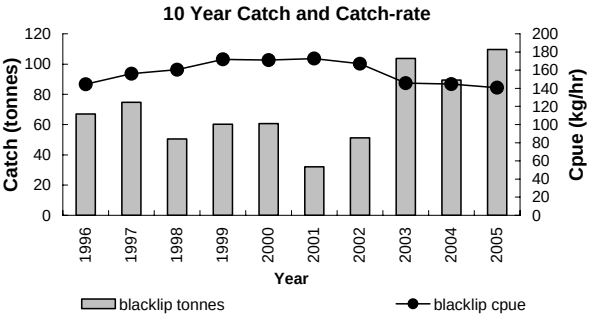


Catches and catch rates have fallen since 2000, with catch rates stable at ~145 kg/hr since 2003.



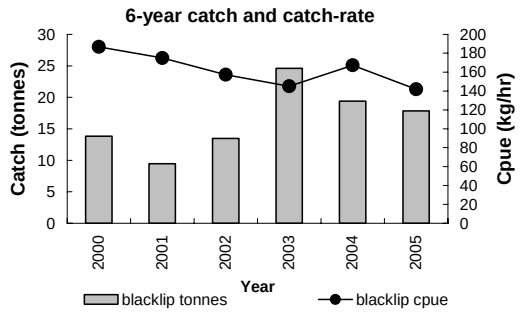
The CPUE distribution remains essentially unchanged from the previous two years.

Block 7 (Italian River to Granville Harbour)

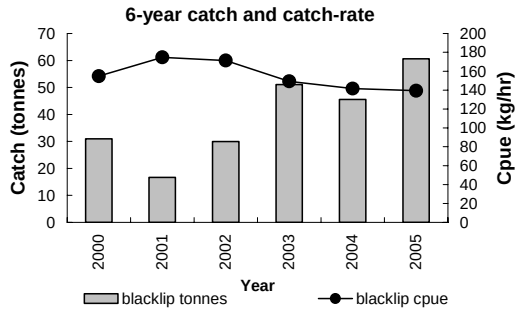


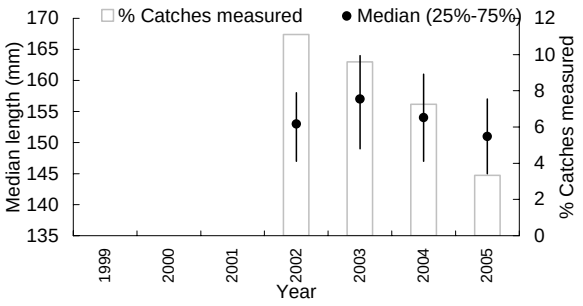
For the third successive year, landings from Block 7 have been much higher than average. The 2005 catch was 110t. Catch rates have slowly trended downward since the turn of the century but have been stable at approximately 140 kg/hr since 2003.

Sub-block 7A
Italian River to the Pieman River, including Rupert Point



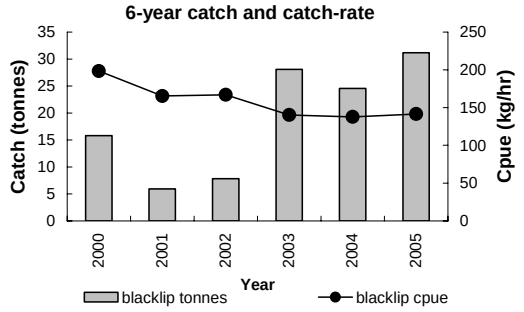
Sub-block 7B
Pieman to Ahrberg Bay, including Conical Rocks

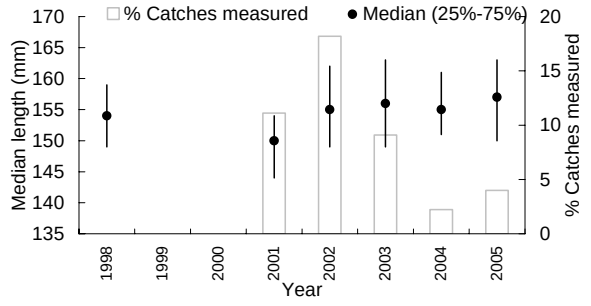




Median size appears to be falling, although the number of catches may have been inadequate to have confidence in this result.

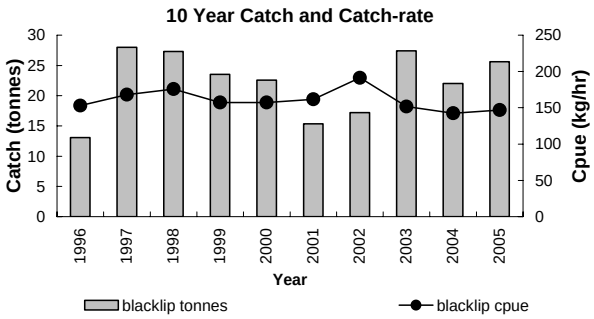
Sub-block 7C
Ahrberg to Granville Harbour





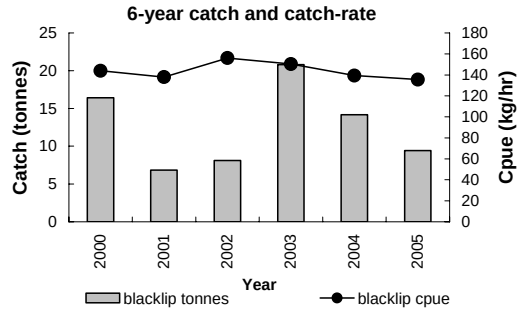
Median size appears to be approximately stable, although once more, the level of sampling was not adequate to reliably detect changes.

Block 8 (Granville Harbour to Ocean Beach)

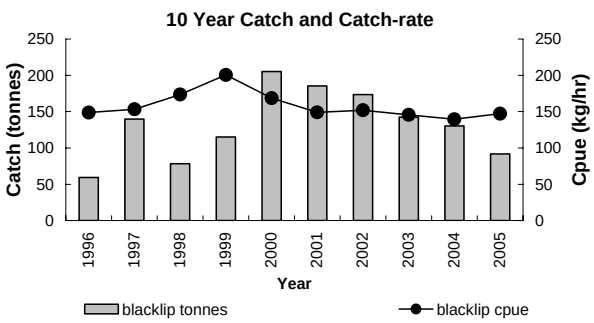


Since 1995, annual catches have been below the 33t long-term average. Catch rates appear to be stable at ~ 145 kg/hr.

Sub-block 8A
Granville to Tasman Bay

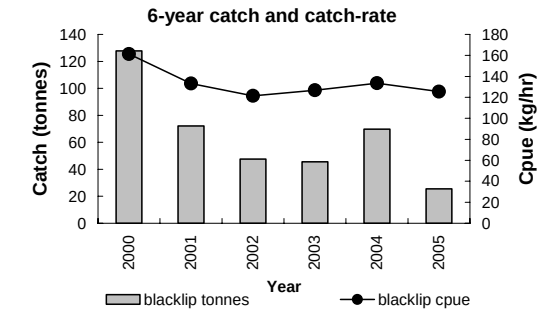
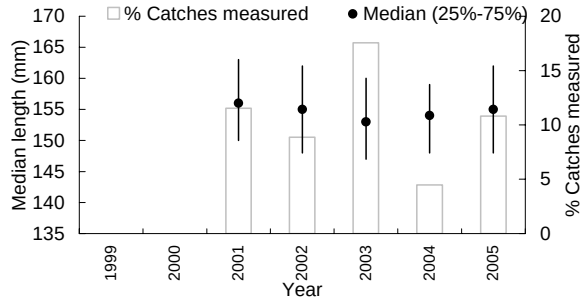


Block 9 (Ocean Beach to Point Hibbs)

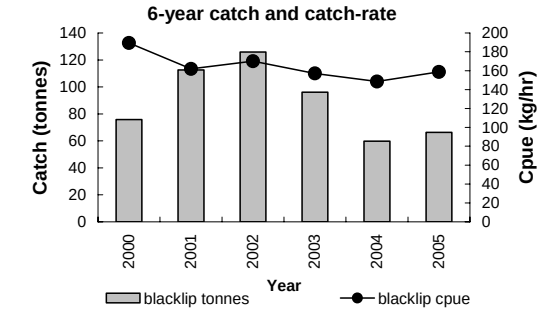
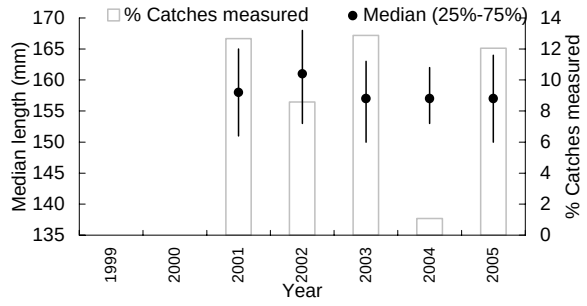


Catches in recent years (post 2003) have been lower than average while the 92t 2005 catch was exceptionally low. Catch rates appear to have stabilised at ~145 kg/hr.

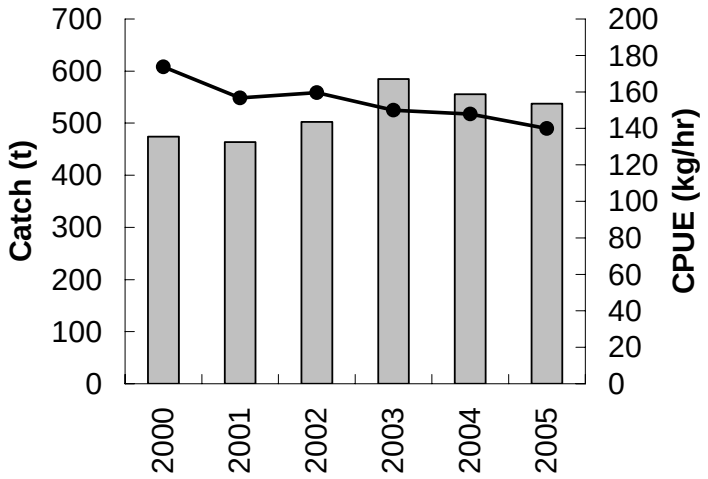
Sub-block 9B
Cape Sorell to Gorge Point

	Are low catches, falling catch rates indicative of widespread depletion? Divers report good catches only when sea conditions are flat.
	Size of samples from divers' catches appears to be stable. There are no trends to confirm reports that divers are targeting smaller abalone and leaving large quantities of large abalone, nor are there indications of depletion.

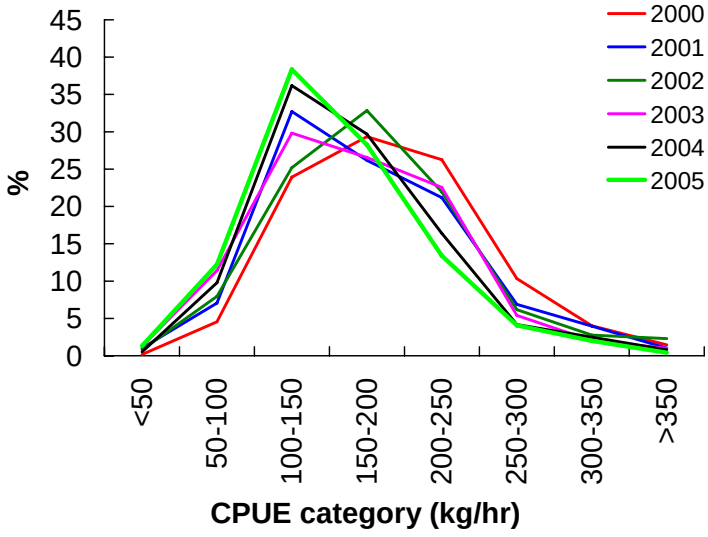
Sub-block 9C
Gorge Point to Point Hibbs

	Do stable catch rates and lower levels of catch since 2004 suggest sustainable levels of fishing?
	Catches prior to 2003 were comprised of larger abalone than more recently, but the change is slight, and could be attributed to either depletion or selective fishing.

Western Zone - South West (Blocks 10-11)

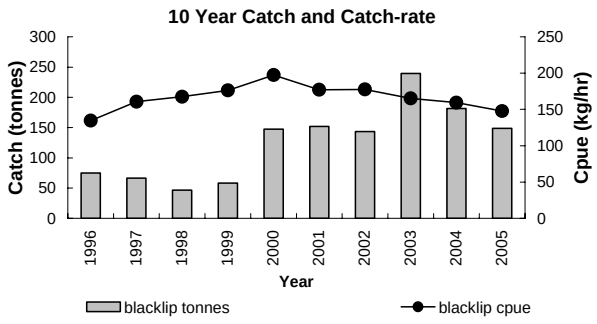


Catch rates continued to steadily decline (to 140 kg/hr) in 2005, while the catch fell to 538t.



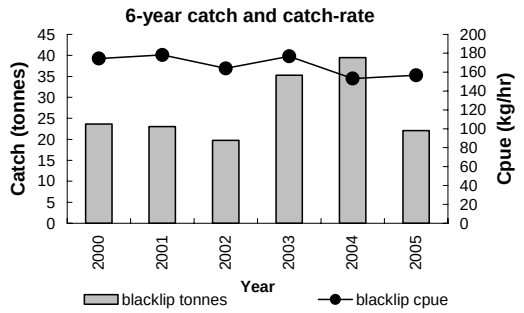
CPUE distribution shows the continued loss of catches in higher CPUE categories (>150 kg/hr) since 200

Block 10 (Point Hibbs to Low Rocky Point)

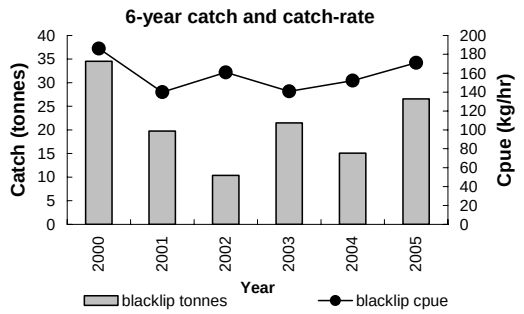


Catch and catch rates continue to fall slowly; the size of the 2003 and 2004 catches concerned us previously, but the 2005 catch (~149t) has fallen back to levels more likely to be sustainable.

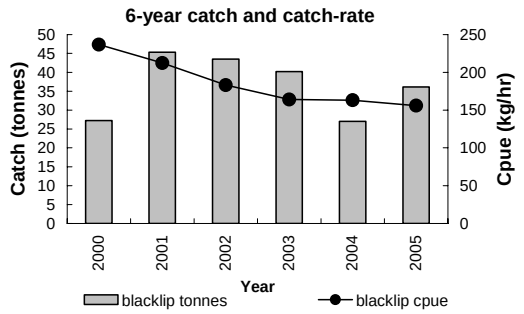
Sub-block 10A
Point Hibbs to Endeavour Bay



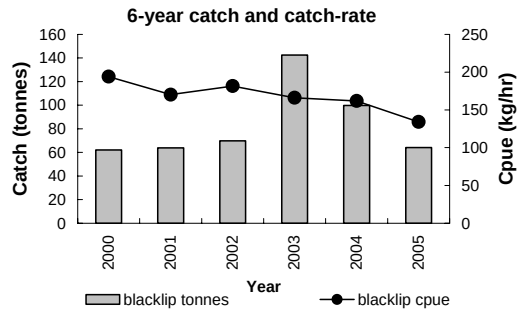
Sub-block 10B
Endeavour Bay to High Rocky Point



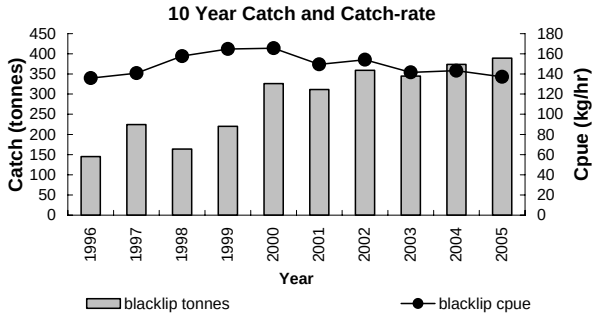
Sub-block 10C
High Rocky Point to Mainwaring River



Sub-block 10D
Mainwaring River to Low Rocky Point

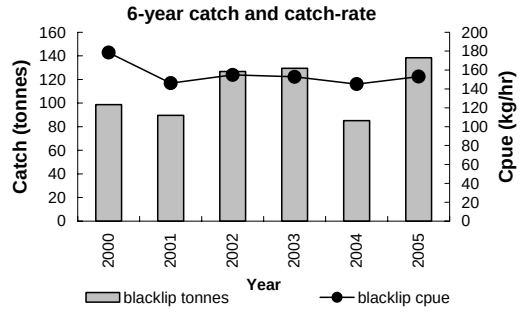


Block 11 (Low Rocky Point to Faults Bay, including Port Davey)

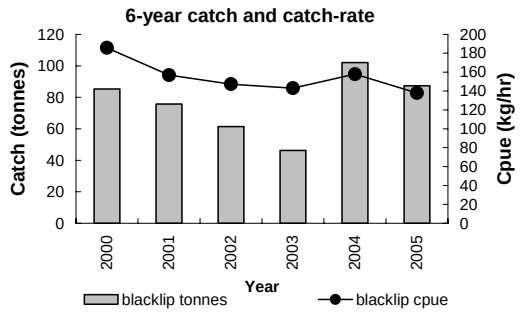


The 2005 catch (~389 t) was the highest over 10-year period, catch rates have fallen since 2000 when they were165 kg/hr, are now ~137 kg/hr.

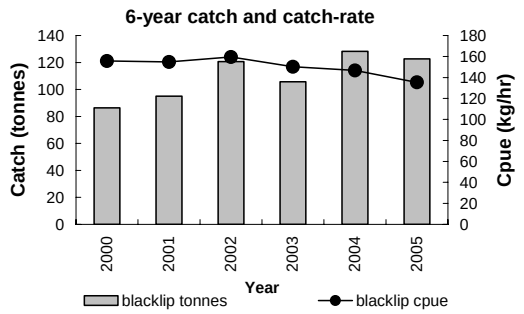
Sub-block 11A
Low Rocky Point to Elliott Point



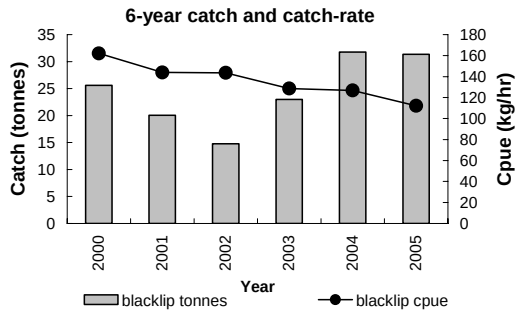
Sub-block 11B
Elliott Point to Svenor Gulches



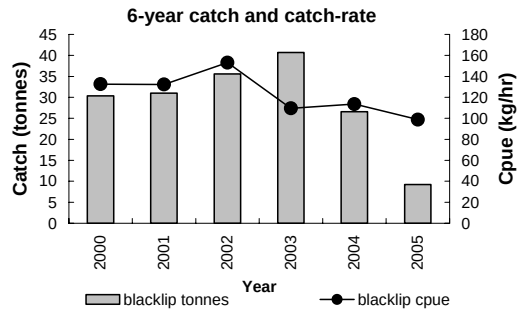
Sub-block 11C
Svenor Gulches to Point St Vincent



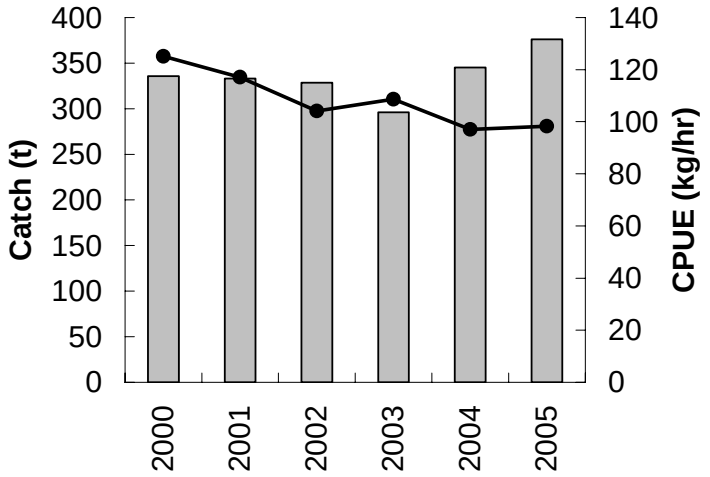
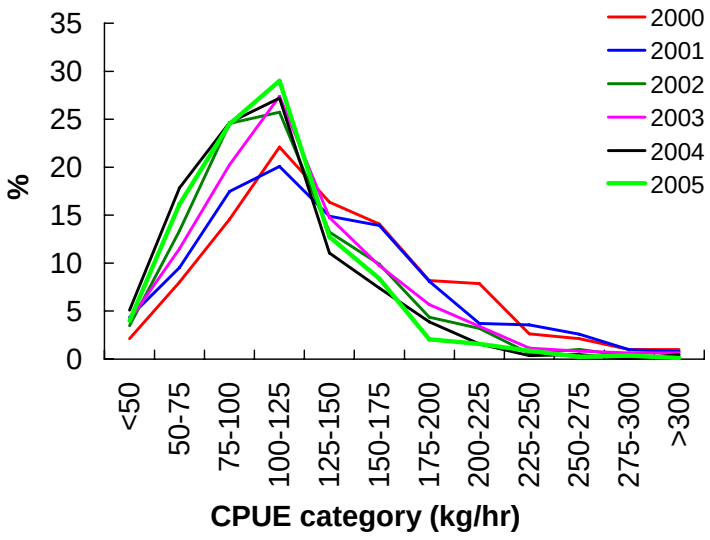
Sub-block 11D
Hilliard Head to Faults Bay



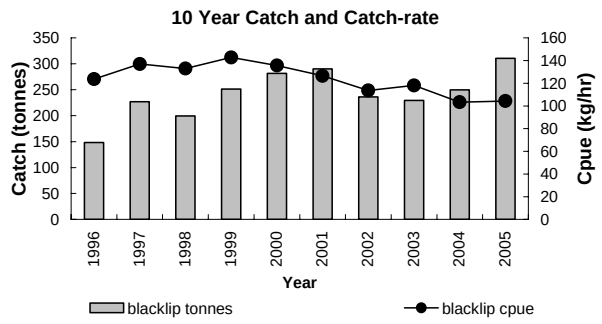
Sub-block 11E
Point St Vincent to Hilliard Head, including Port Davey

	The reduction is possibly because divers are choosing to go elsewhere to avoid the MPA closure or possibly because a significant resource has been closed.

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

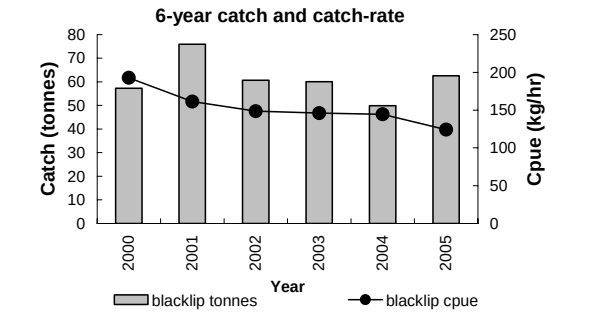
	The 2005 annual catch increased. Catch rates have fallen almost continuously since the imposition of zoning, and for the last two years have been below the 100 kg/hr point where past ABSAG's have suggested that management action be required.
	Continued loss of higher CPUE categories in 2005.

Block 12 (Faults Bay to Prion Beach, including South West Cape, Cox Bight and Maatsuyker Island)

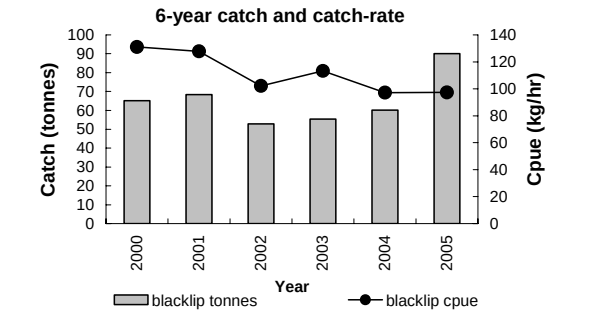


Catch rates have fallen since 1999. The 2005 catch rate was 104 kg/hr (same as 2004). The 2005 annual catch of 311t was the third highest recorded (the others were in 1979: 325t and 1980: 351t).

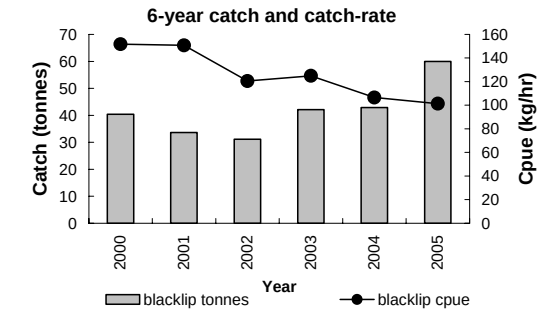
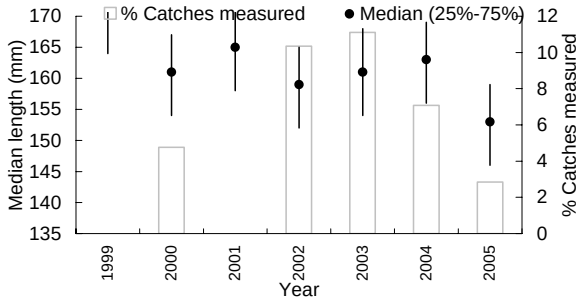
Sub-block 12A
Faults Bay to South West Cape



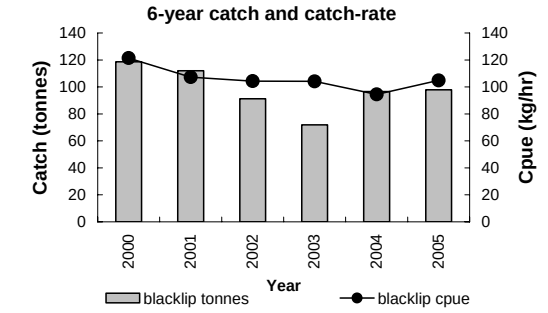
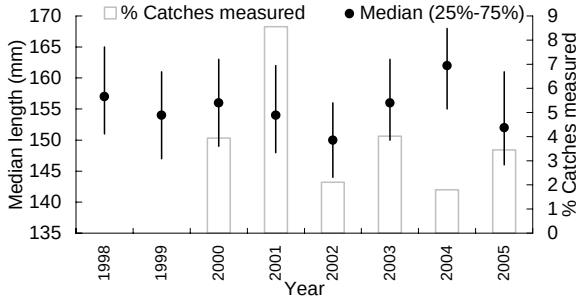
Sub-block 12B
South West Cape to Cox ‘s Bluff



Sub-block 12C
Maatsuyker Group

	
	Fall in median size, although sampling level was inadequate.

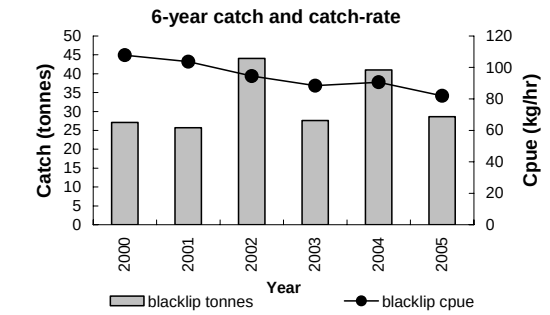
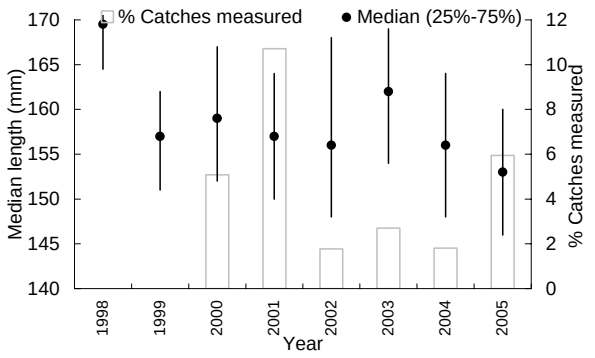
Sub-block 12D
Cox's Bluff to Prion Beach

	
	Fall in median size, although sampling level has been below required levels since 2002.

Block 13 (Prion Beach to Whale Head)

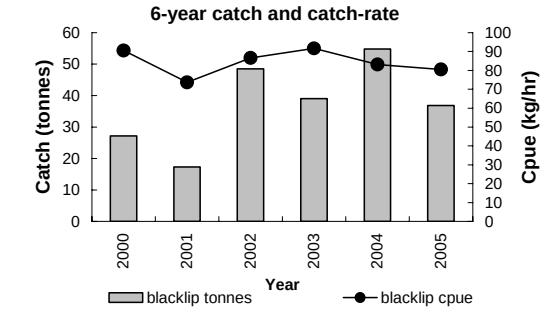
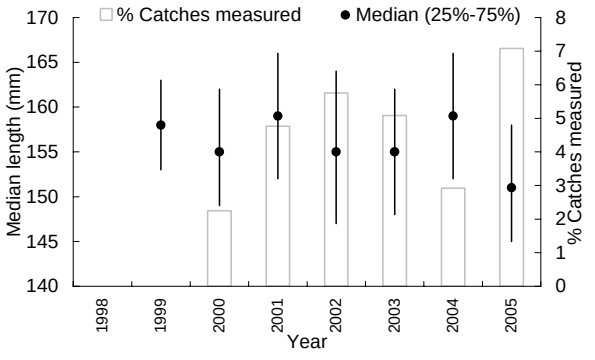
Sub-block 13A

Prion Beach to South Cape

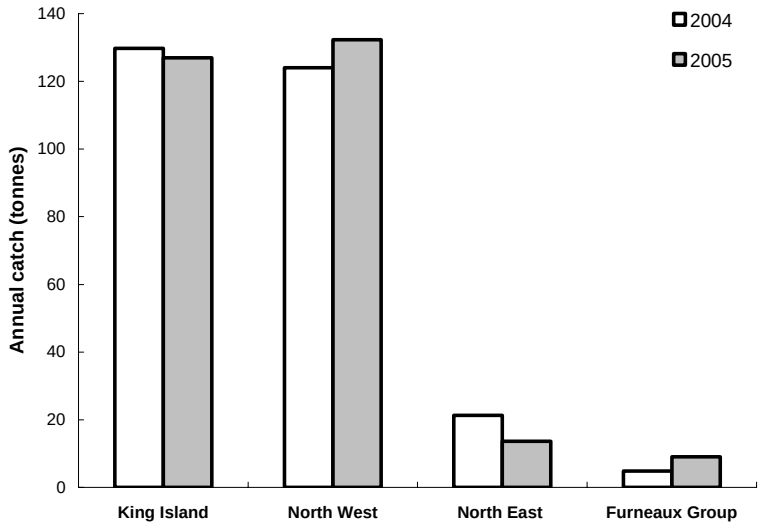
	Catch has fluctuated; catch rates have declined almost constantly since 2000 with the catch at 29t and catch rates at 82 kg/hr in 2005.
	Fall in median size, although sampling in earlier years was at low levels.

Sub-block 13B

South Cape to Whale Head

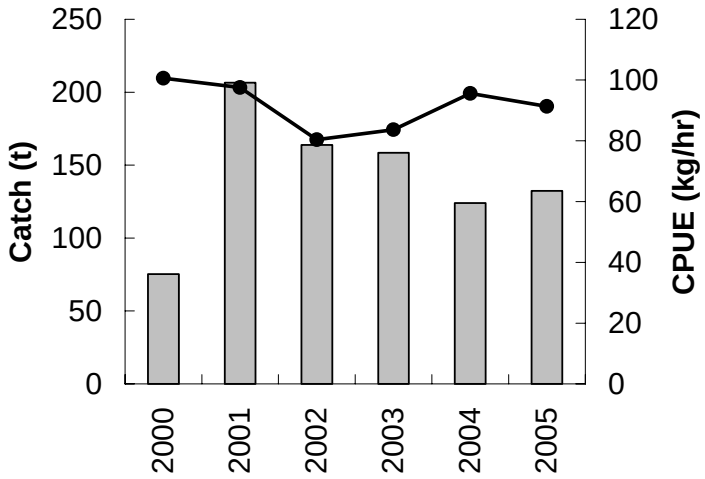
	Catch and catch rates have fluctuated, with the catch at 37t and catch rates at 81 kg/hr in 2005.
	Reasonable levels of sampling show a fall in median size.

Northern Zone blacklip fishery – changes in the regional distribution of catch.

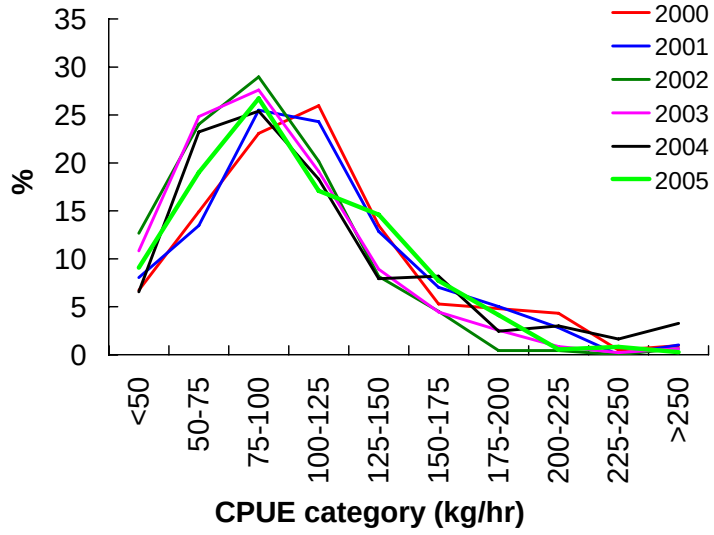


The distribution of catch between regions remains relatively unchanged.

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

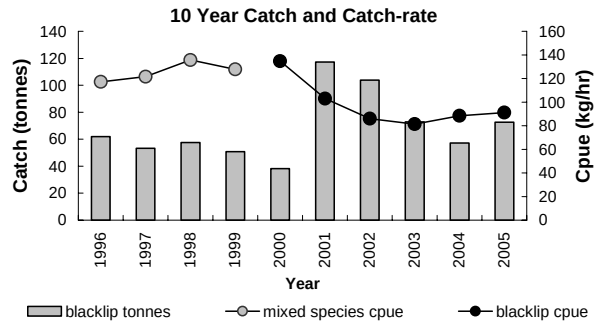


The annual catch has been between 124t-132t since 2004, which as indicated by stable catch rates, appears sustainable.



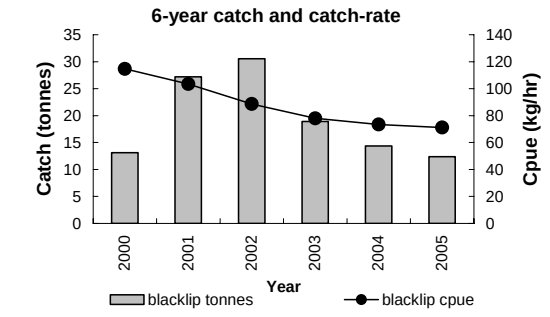
While the CPUE distribution shows a decline in some of the higher category (100-125 kg/hr) catch rates, the lower categories (<75 kg/hr) have also diminished. This is indicative of stability and suggests that this part of the fishery has become less reliant on unfished populations, and is more likely sustainable.

Block 5 (South Arthur Beach to Woolnorth Point)



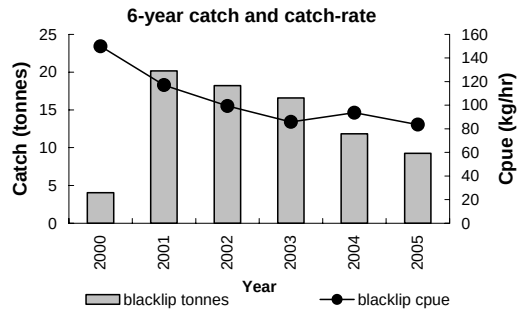
Catch rates, which fell sharply following the rapid depletion of large stock levels prior to zoning appear to have stabilised as catches fallen to more sustainable levels.

Sub-block 5A
Woolnorth Point to Studland Bay

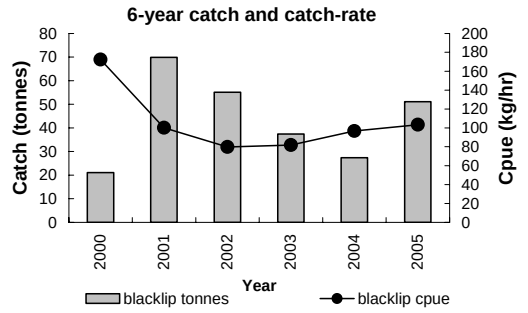


Localised depletion close to Woolnorth has been reported by divers. They say that the fishery is easily accessible and can be worked in more severe westerly weather conditions than further south.

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

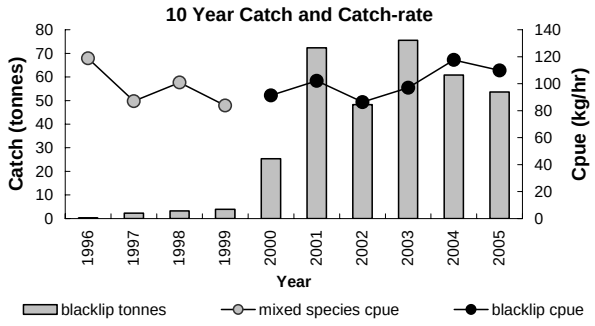


Sub-block 5C
Greens Beach to Arthur River



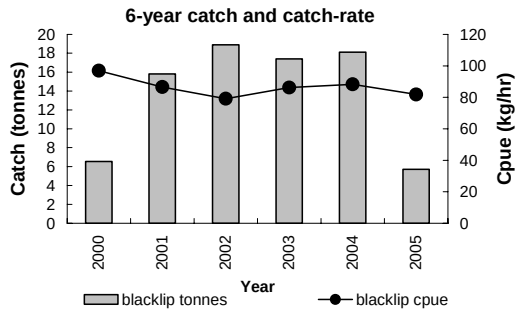
This part of the Block 5 fishery was heavily exploited when the Northern Zone was first implemented, and catch rates fell more than expected considering its history of large annual catches. Catch rates appear more stable since the level of catch has fallen.

Block 49 (Woolnorth Point to Hunter Island, including western and northern Hunter Island, and Three Hummock Island)

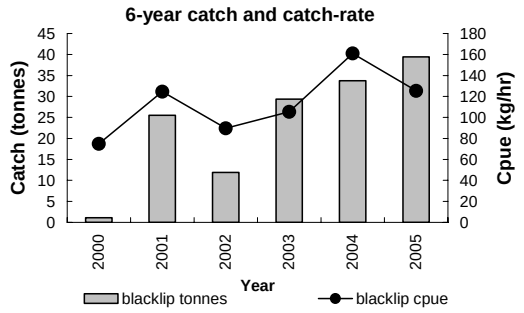


In 2004 divers found relatively unfished populations around offshore islands in the north of the block, which were fished at high catch rates. Opportunities for this sort of fishing were reduced in 2005, and catch and catch rates fell.

Sub-block 49A
Three Hummock Island

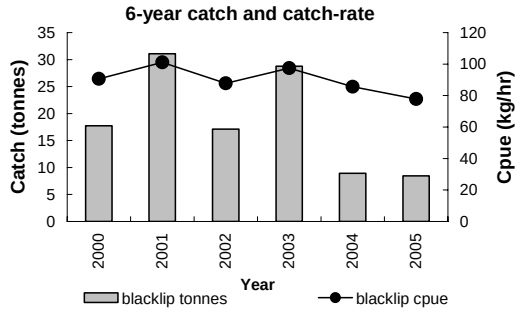


Sub-block 49B
Northern part of Hunter Island

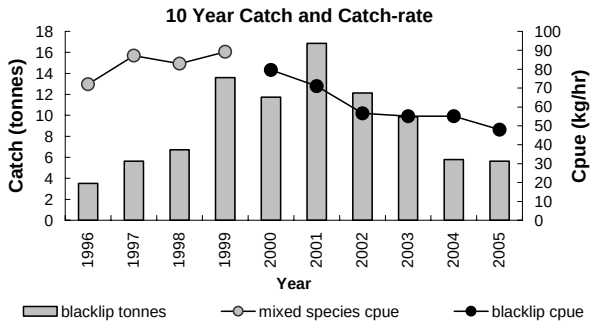


Higher catch rates in 2004 were from remote and seldom fished populations, some evidence of depletion in 2005.

Sub-block 49C
South-western Hunter Island

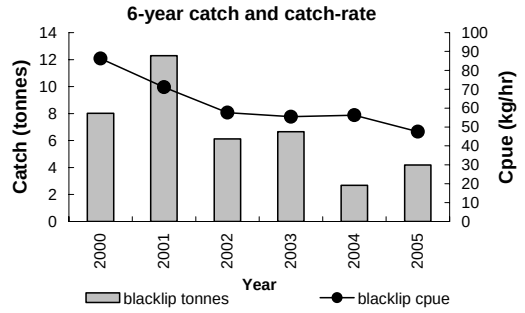


Block 48 (Woolnorth Point to the Duck River, including the eastern side of Hunter Island, the Petrels and Black Reef)

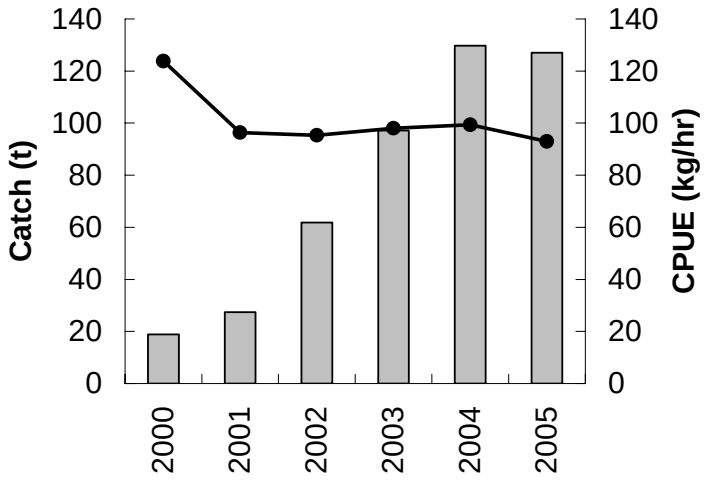


Negligible amounts of catch have been taken from this block in recent years, and most of it has been taken in conjunction with greenlip.

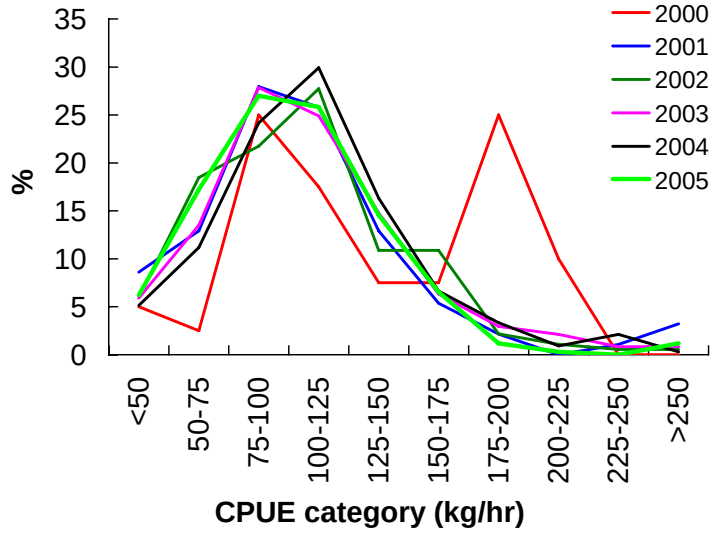
Sub-block 48C
Western part of Block 48



Northern Zone - King Island (Blocks 1-4)

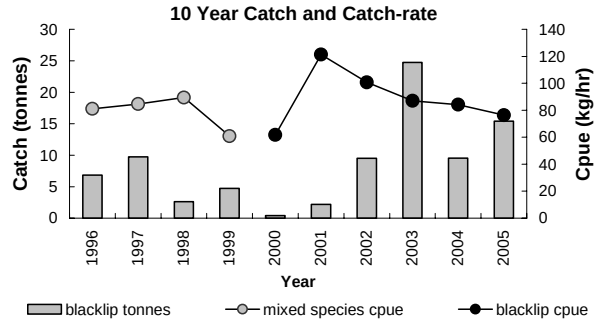


The 2005 catch was 127t, the fall from 2004 probably not significant, being within the expected range of error produced from estimates of landed weights. Although catch rates fell slightly (93 kg/hr), they have fluctuated between 93 and 99 kg/hr since 2001.

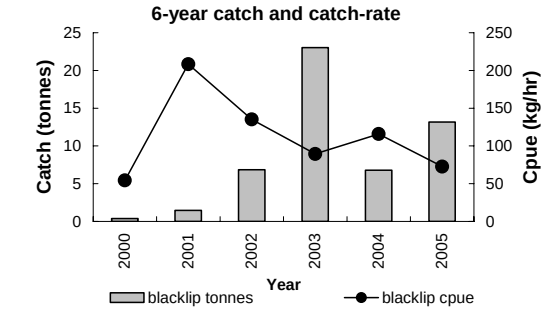


The 2005 mode moved one category smaller to 75-100 kg/hr, and there were small reductions in the larger CPUE categories.

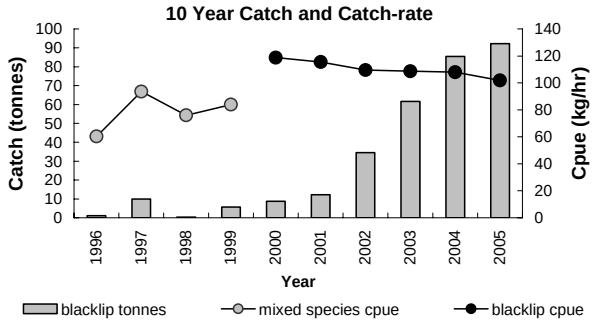
Block 1 (north-west King Island)



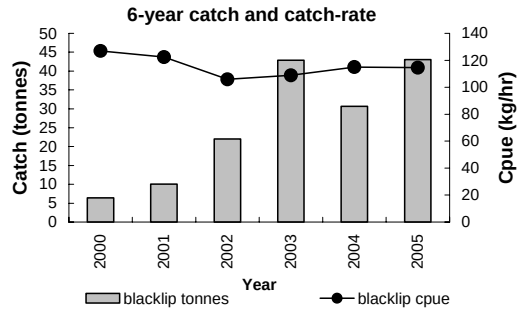
Sub-block 1C
Whistler Point to KI Airport



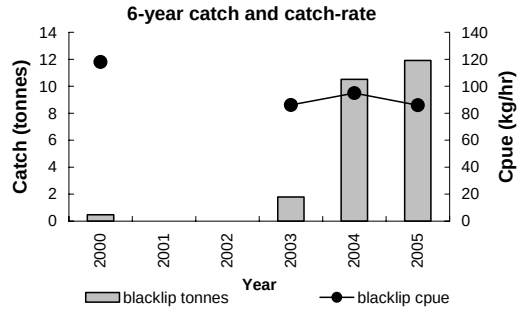
Block 3 (south-west King Island)



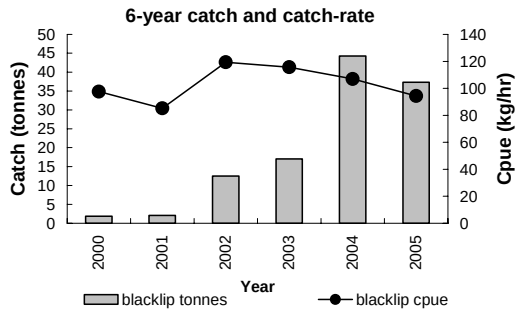
Sub-block 3A
Airport to Ettrick River



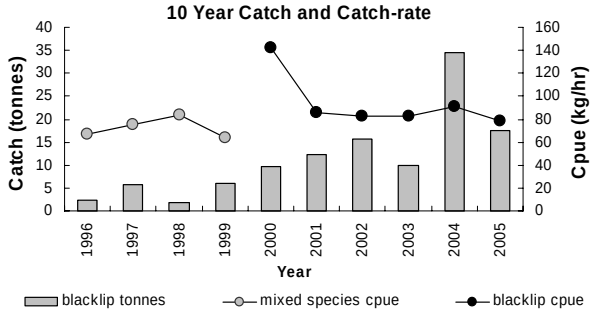
Sub-block 3B
Ettrick River to Cataraqui Point



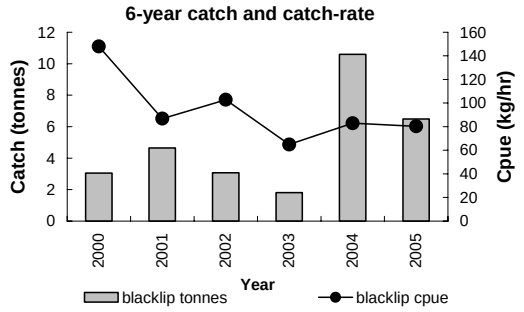
Sub-block 3C
Cataraqui Point to Seal Bay



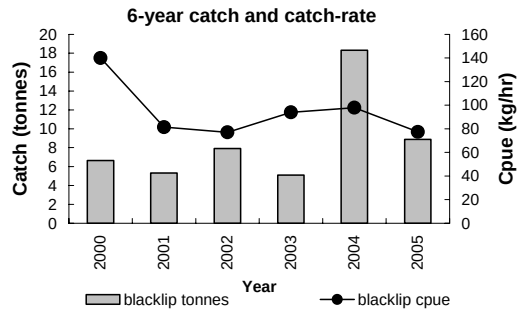
Block 4 (south-east King Island)



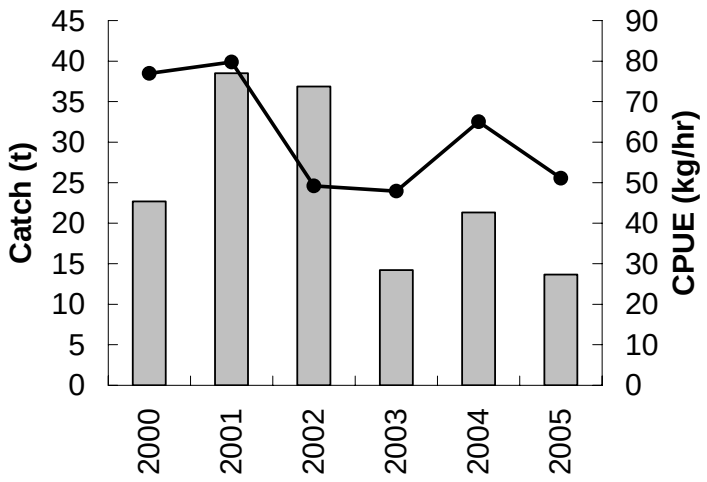
Sub-block 4B
Cumberland Light to Grassy Harbour



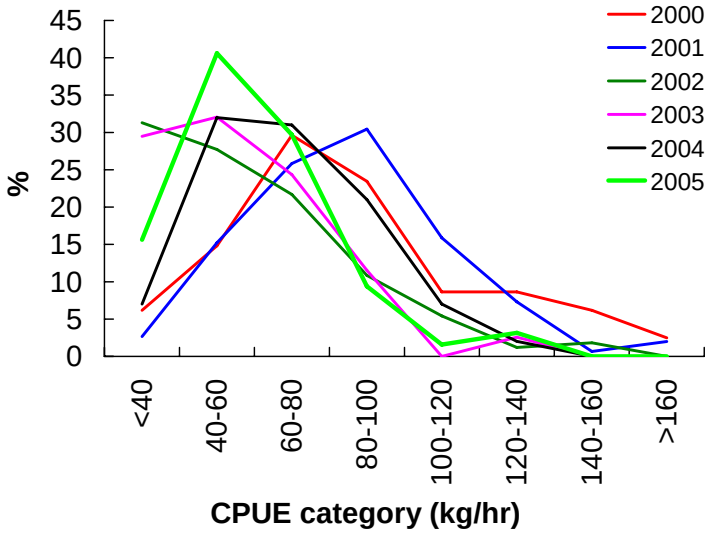
Sub-block 4C
Grassy Harbour to Seal Bay



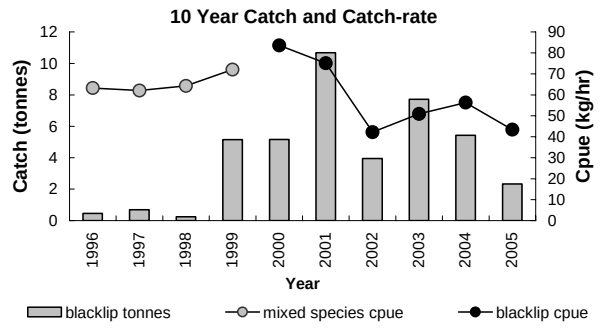
Northern Zone - North East (Sub-block 31B, Blocks 39, 40)



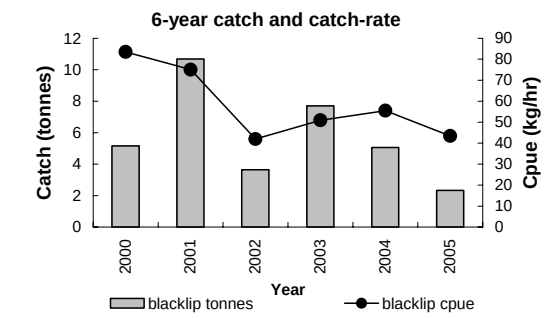
It has been reported that many processors are unwilling to take abalone from parts of this region – partly because of its isolation, and partly because the meat is reported to be too dark. Much of the catch is taken in conjunction with greenlip, hence the fluctuating catch rates. Stocks are reported to be stable at the current low level of catch.



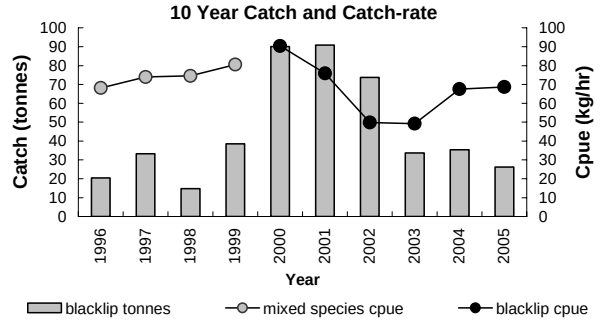
Block 39 (Tomahawk to Little Musselroe)



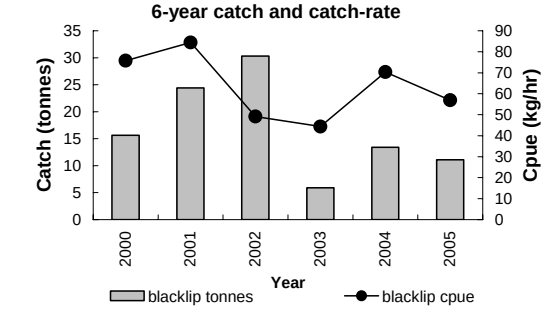
Sub-block 39A
Petal Point to Little Musselroe Bay



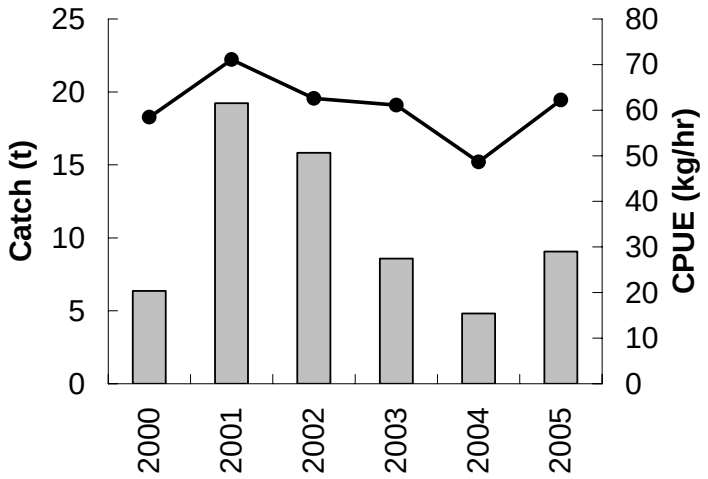
Block 31 (Little Musselroe to Musselroe Bay, including Swan Island)



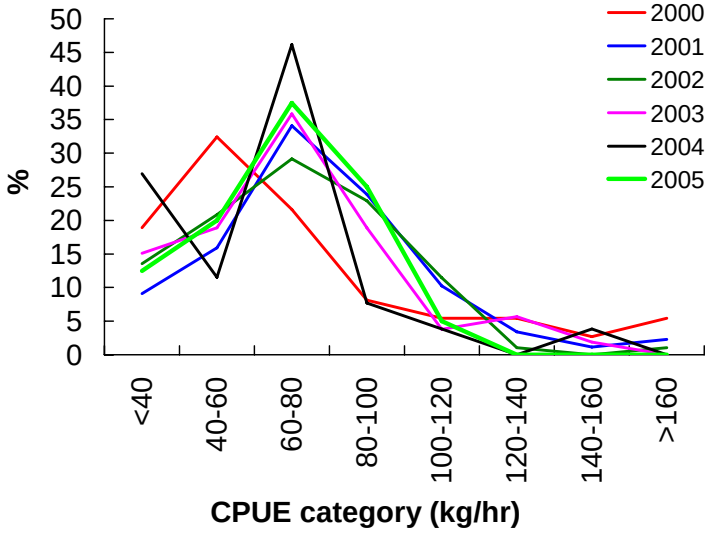
Sub-block 31B Little Musselroe to Musselroe Bay, including Swan Island



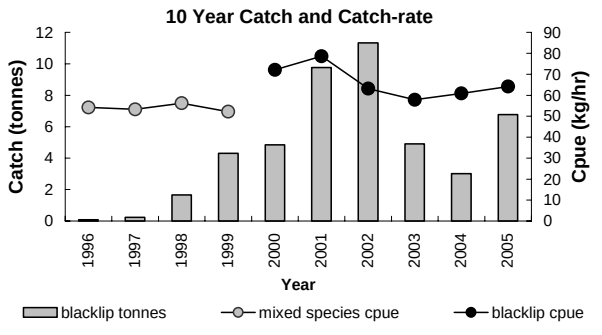
Northern Zone - Furneaux Group (Blocks 32-36, Sub-blocks 38A, 38B)



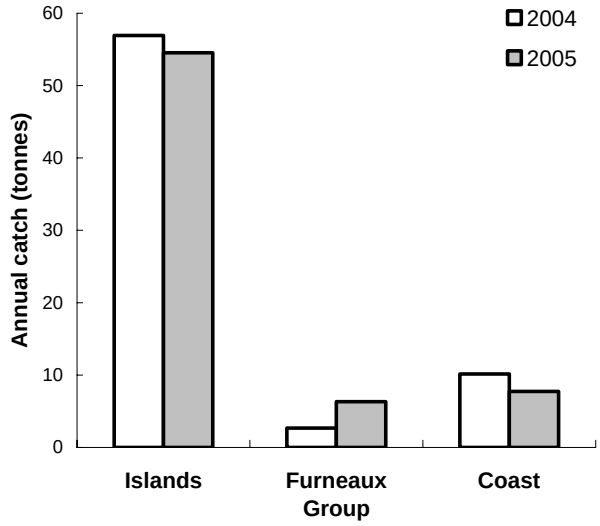
The small increase in catch and catch rates was due to increased levels of effort by local divers.



Block 33 (south-east Cape Barren Island)

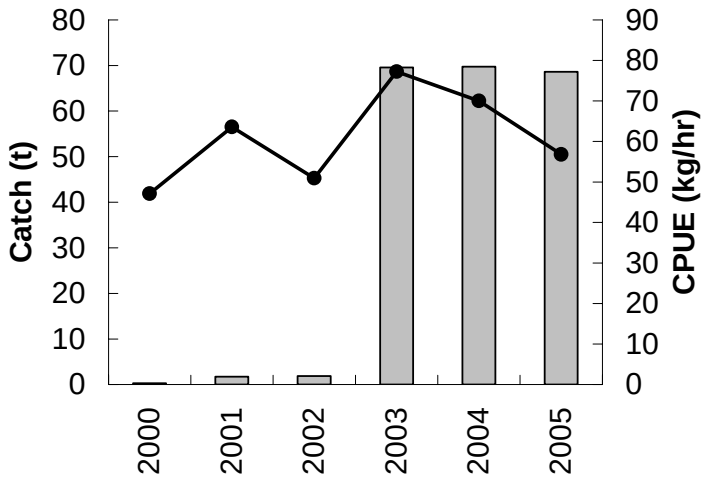


Bass Strait Zone blacklip fishery –distribution of catch

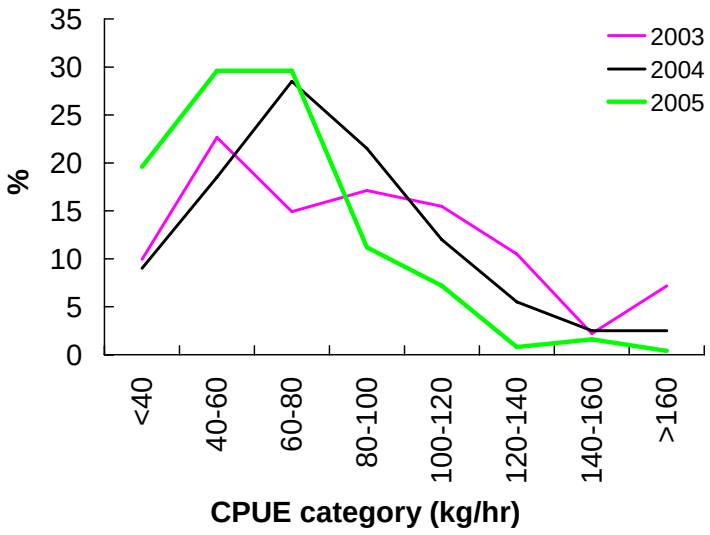


Compared with 2004, the 2005 catch taken from the Bass Strait islands fell slightly, and catch from the central North Coast between Stanley and Tomahawk (and offshore islands) fell relatively more, while the Furneaux Group catch more than doubled. Neither the coastal catch nor the Furneaux Group catch were large (<10t).

Bass Strait Zone (Sub-block 38C, Blocks 37, 41-46, 50-57)

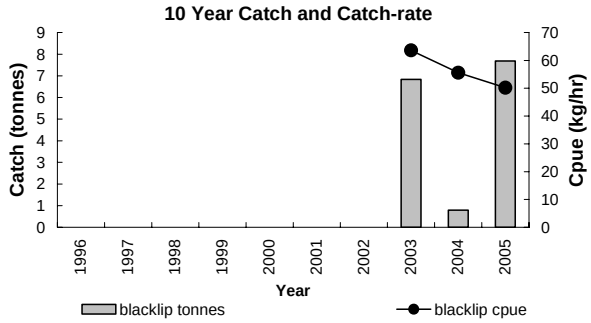


Catch rates have fallen as stock levels become more depleted.



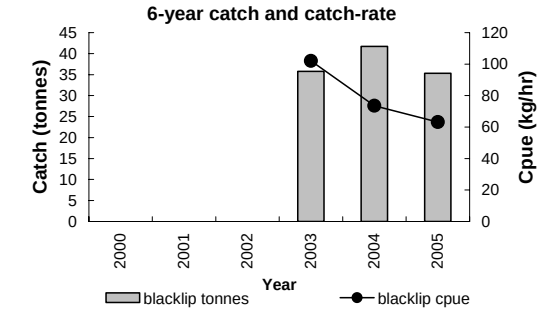
CPUE distribution shows a sharp increase in low CPUE and a large reduction in higher (> 80 kg/hr) categories.

Block 51 (Kent Group)



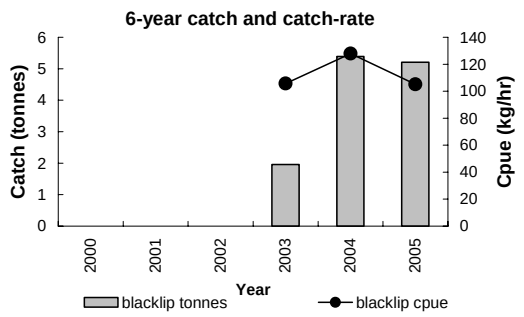
Catch rates have fallen to very low levels. Stock levels here have not recovered following the pulse fisheries of the 1990's.

Block 53 (Hogan Group)

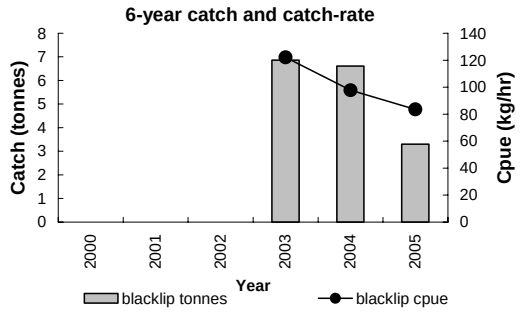


Catch and catch rates fell in 2005. Divers report that stocks are now extensively depleted.

Block 54 (Moncouer Island)



Block 56 (Curtis Group)

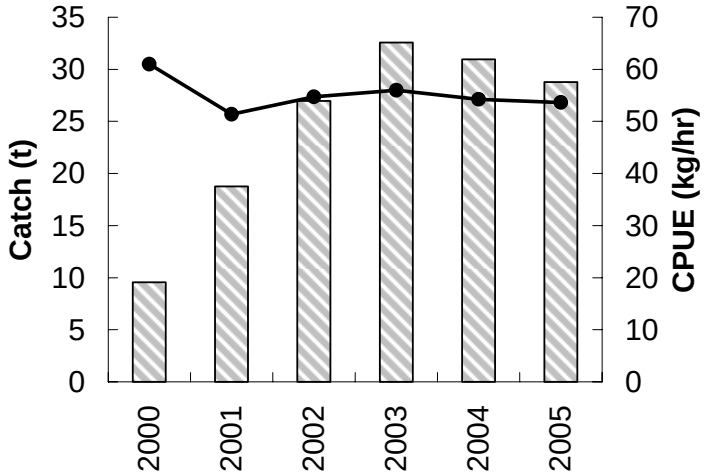


Greenlip fishery

Distribution of the 2005 catch between the four regions was fixed at the following levels:
King Island – 30t
North West – 30t
North East – 23t
Furneaux Group – 42t

Note that the sum of the caps (125t) is 2.5t greater than the TAC (122.5t).

Greenlip - King Island (Blocks 1-4)

<table>
<tr>
<td> 
</td>
<td rowspan="2">The catch rate stability probably reflects divers learning to fish more efficiently rather than stable stock levels. It is reported that levels of pre-recruits are low, and there is concern for the future of the stocks here.</td>
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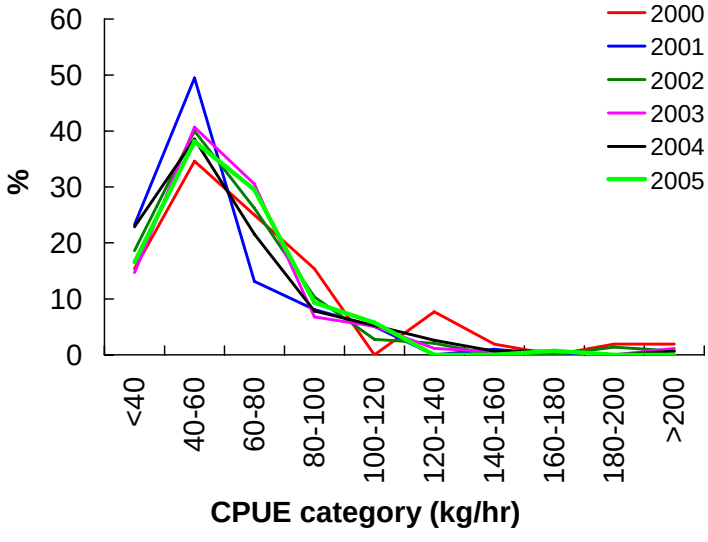
<td> 
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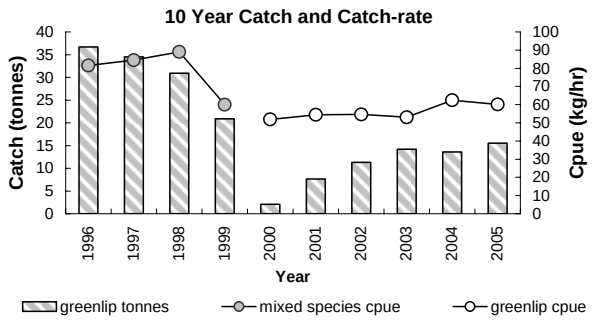
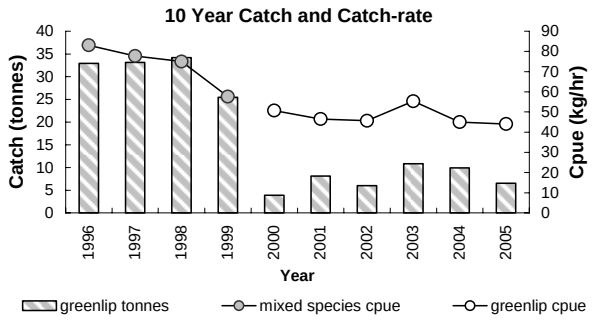
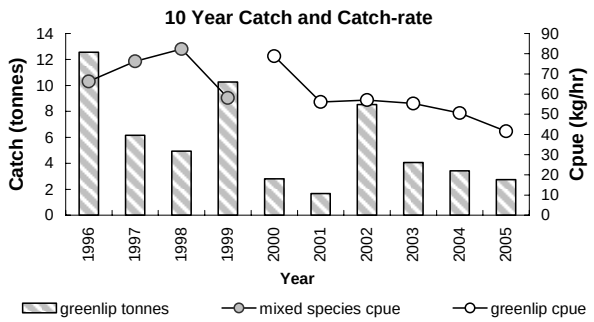
Block 1 (north west King Island)



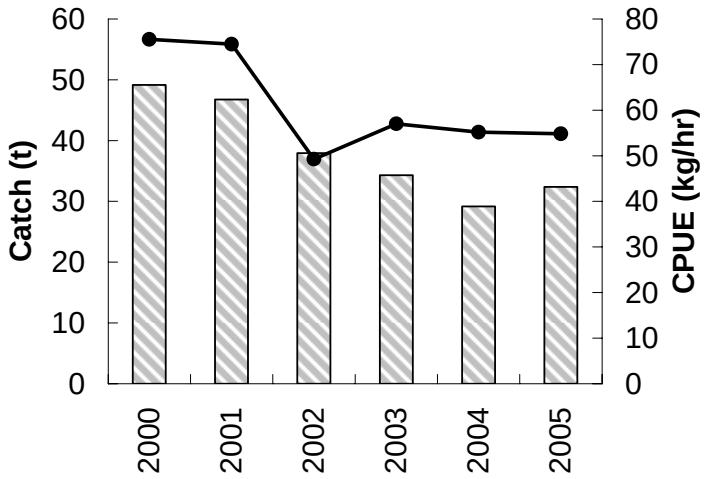
Block 2 (north east King Island)



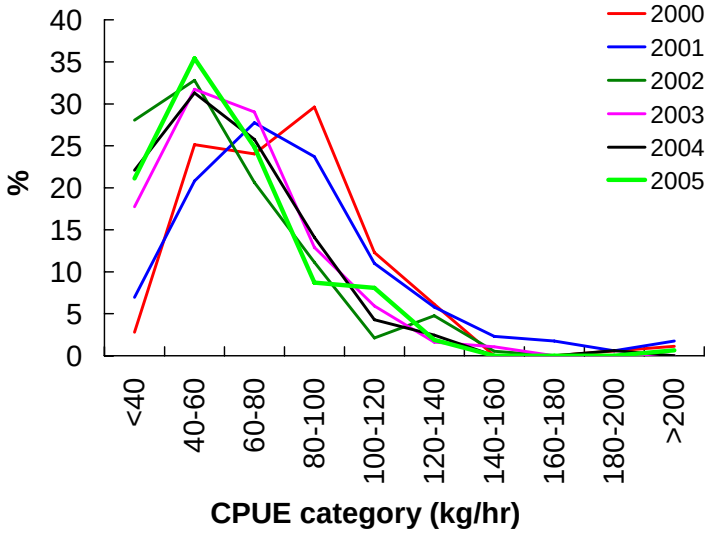
Block 4 (south east King Island)



Greenlip - North West (Blocks 5, 47-48)

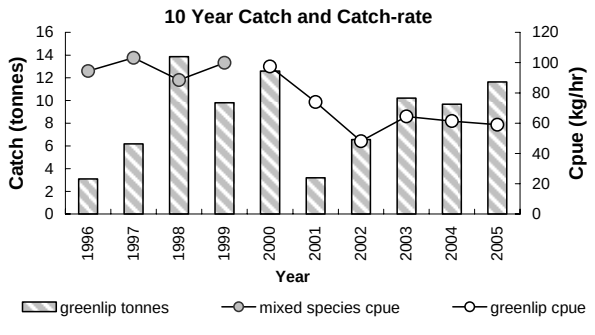


Most of the 2005 catch was caught by the same divers as the preceding two years, so catch rates probably have some relevancy here. They suggest stability in stock levels, although divers report otherwise. The 30t cap was overrun slightly (2.4t estimated weights).

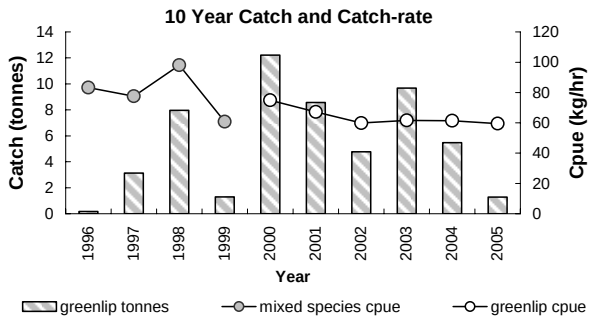


CPUE distribution is similar to previous two years.

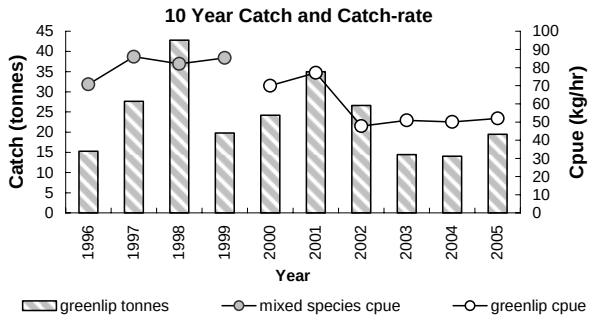
Block 5 (west of Woolnorth Point)



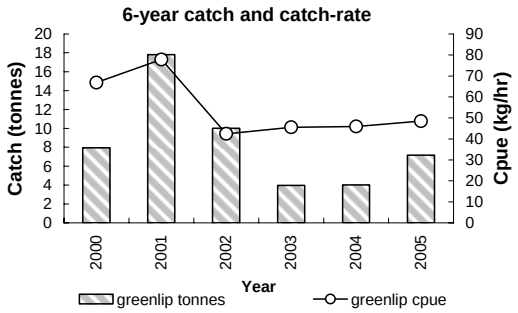
Block 49 (Woolnorth Point to Hunter Island, including Three Hummock Is.)



Block 48 (Woolnorth Point to Duck River, including Black Reef)

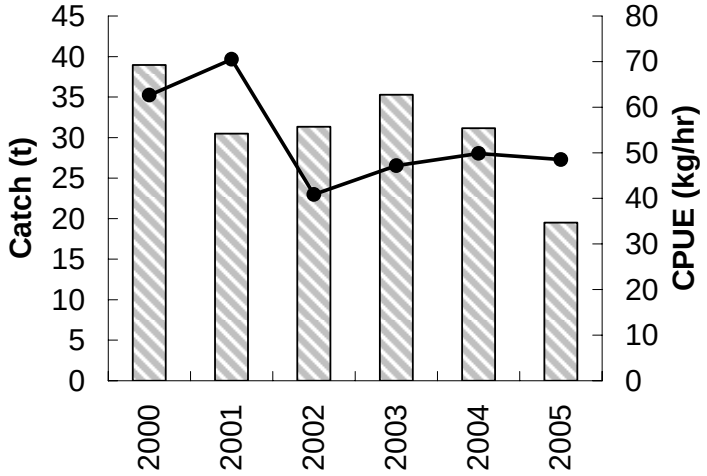


Sub-block 48A
Black Reef

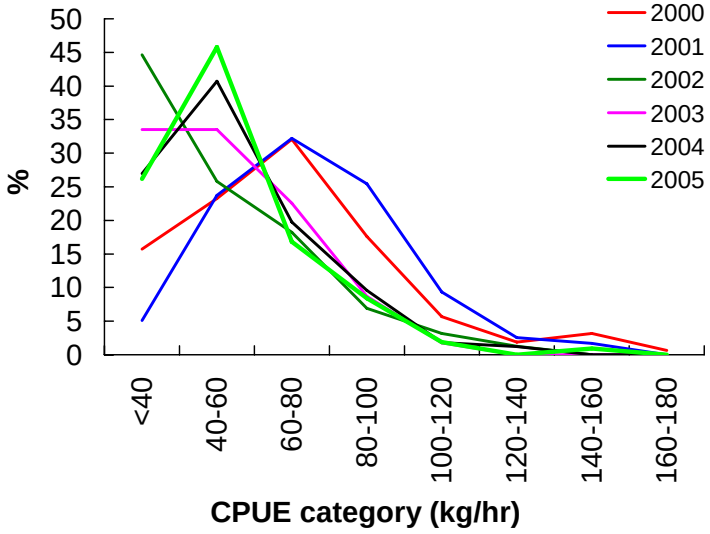


Abalone are abundant here, but finding quantities larger than the size limit has proven difficult.

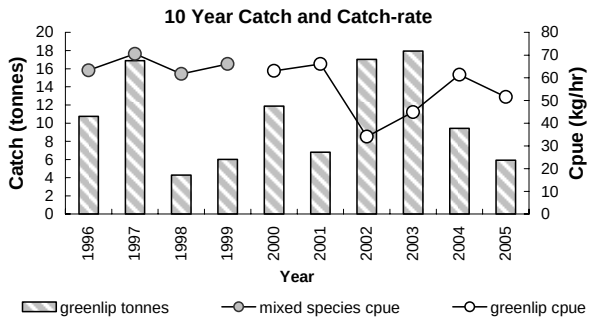
Greenlip - North East (Blocks 31, 39, 40)



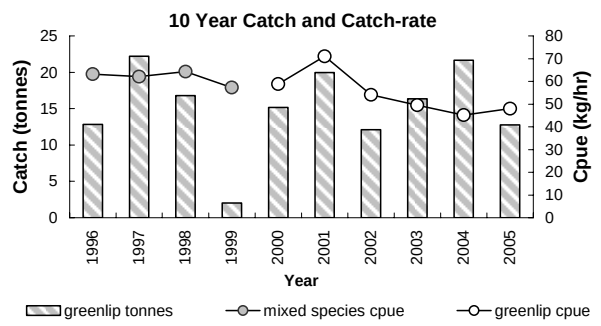
The annual cap was reduced from 30t to 23t for 2005. The cap was not reached, the sum of estimated weights of landings being 19.5t. Stocks in the region were reported depleted in 2003 and 2004, so the unexpected reduction in catch should be of some benefit.



Block 31 (Little Musselroe to Cape Naturaliste)

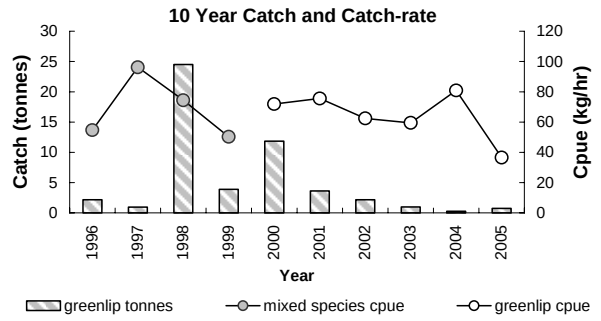


Block 39 (Little Musselroe to Tomahawk)



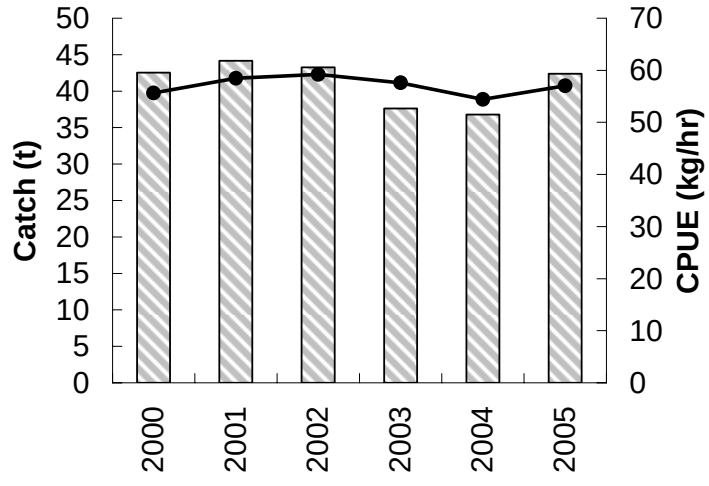
Low abundance, reported decline in numbers of pre-recruits.

Block 40 (Tomahawk to Waterhouse Beach)

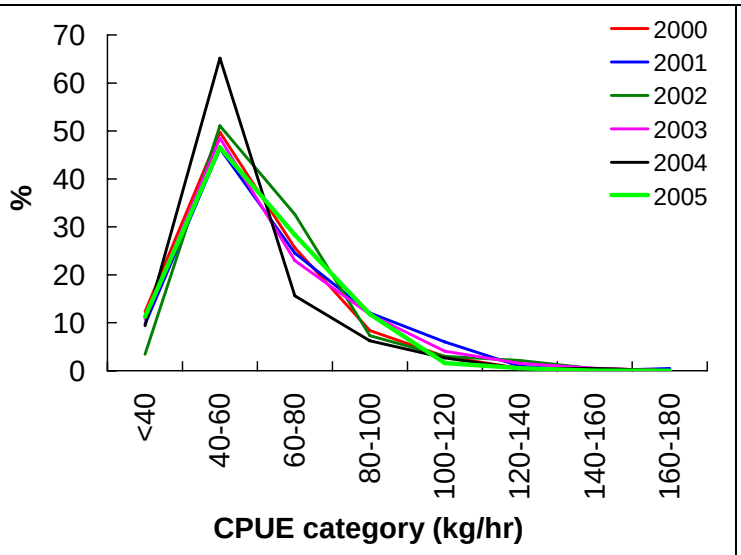


Heavily depleted, now non-productive.

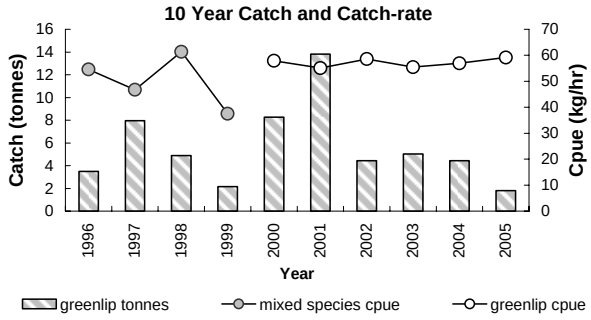
Greenlip - Furneaux Group (Blocks 32-38)



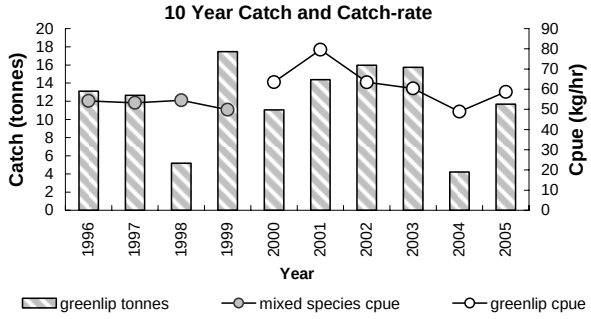
Stocks in this region continue to be robust. Less catch came from Franklin Sound and greater amounts came from Blocks 33 and 38. Using estimated weights, the 42t cap was marginally overrun (381 kg).



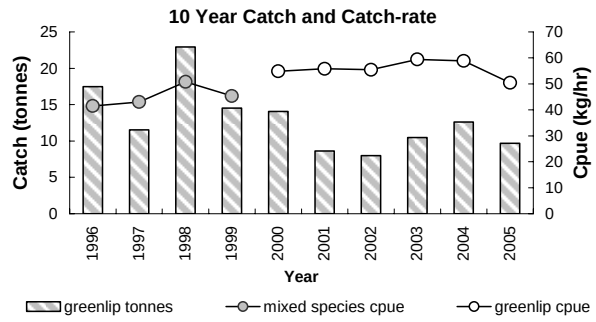
Block 32 (south Cape Barren Island, Armstrong Channel)



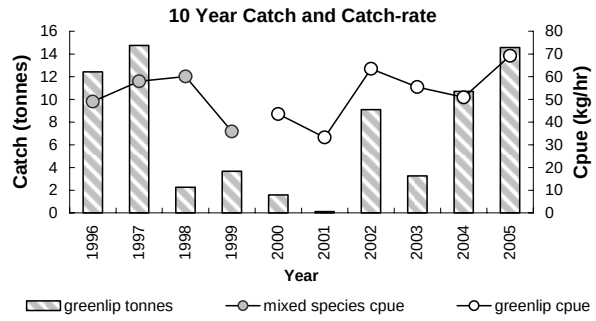
Block 33 (south east Clarke, Cape Barren Islands)



Block 35 (Franklin Sound)



Block 38 (north east Flinders Island)



5. Assessment of the Tasmanian abalone fishery

Eastern Zone

Actaeons:

The regional catch has fallen by ~200t since 2000 (from 417t to 218t, a 48% reduction compared to a 32% reduction in TAC). While much of this has been due to progressive reductions in Eastern Zone TAC since 2000, it was also partly due to divers choosing to fish in other regions where they could land better catches. Catch rates in the Actaeon region improved quite markedly this year to a mean of 62 kg/hr in 2005 after being static at slightly less than 50 kg/hr for the preceding three years. It is not known whether the catch rate increase is a consequence of reduced fishing effort, or stock recovery. The majority of abalone caught were in a size range which growth studies show could be obtained in one year or less *i.e.* the fishery here remains heavily dependent on the annual crop of recruits. It was considered that the small median size and increasing catch rates could point to increasing levels of recruitment such as appears to have occurred in other parts of the Eastern Zone. Assuming a positive relationship between stock levels and subsequent recruitment, increased levels of recruitment might now be expected in the Eastern Zone given the high stock level in the mid to late 1990's. However, if increased catch rates were due to increased recruitment levels, then a coincident increase in catch, not a decrease, would be expected, and therefore the most likely scenario is that the increased catch rates are probably due more to an increase in biomass caused by successive falls in annual catch rather than an abnormal increase in numbers of recruits.

Bruny Island:

In recent years (2000 – 2005) the Bruny regional catch has mostly ranged between 120t - 150t. Compared with previous annual catches since 1975, this level of catch is historically low. In 2005, catches from the south-east of Bruny Island, particularly in sub-blocks 16A and 14E, which includes the Strip and the Friars, were greatly reduced compared with previous years, and recent levels of the Block 16 portion of the Bruny catch (50t - 70t) are now approximately at two thirds of the long-term average catch. There was a minor increase in catch from the D'Entrecasteaux Channel (Block 15) which at 9t, was relatively high. Block 15 produces catches at this level at approximately 10-year intervals.

Catch rates have increased from a low of ~50 kg/hr in 2002-2003 to 65 kg/hr in 2005. In 14E, catch samples showed that the median size of abalone fell, and combined with declining levels of catch suggest that this area of the fishery is depleted of large abalone and increasingly dependent on recruits. Rising catch rates suggest that effort has been reduced sufficiently and that a recovery in stock levels should occur here. In 16B an increase in median size combined with rising catch rates indicates that this part of the fishery continues to recover. There is no evidence for an abnormal influx of recruits in the Bruny region, and it is likely that recovery here is associated with the rebuilding of stocks following a large reduction in TAC.

Storm Bay:

Levels of catch in much of the Storm Bay region have increased greatly. In Block 20, the 2005 annual catch (116t) was almost twice the long term average, and despite this large increase, catch rates have continued to rise and are now among the highest in the Eastern Zone. In Block 21, catches increased by 10t from the previous year to 62t, slightly larger than the long-term mean (56t). Catch rates rose sharply by almost 20 kg/hr after remaining unchanged at ~55kg/hr since 2002. Only in Block 17 was there no increase in catch, which at 20t is substantially less than its long term average (35t). The trend in falling median size seen in previous years was reversed in 2005, with all sub-blocks showing small increases in median size. In 2004, the fall in median size combined with large catches and rising catch rates was interpreted to mean that there had been an abnormally large influx of recruits to some parts of the region. The recent increase in median size is believed to mean that while recruitment of the fishery is now at more normal levels, the current high levels of effort have not yet depleted stocks and that catch levels, although high, are likely to be sustainable in the short term.

East Coast:

The 2005 East Coast catch was 233t, which is approximately half the long-term average for this region. It is difficult to assess the more isolated parts of the fishery in this region such as Blocks 27 (Freycinet Peninsula) and 31 (North of Eddystone Point), because levels of effort have fallen so low that (a) the assumptions under which catch rates are interpreted as reliable indices of abundance (constant and high levels of effort) are violated, and (b) the amount of fishing data is inadequate to make any generalisations about the state of stocks in those areas. However, divers who fish there have reported that stocks are recovering.

Among the more accessible areas, Long Point (Block 29) is producing almost double its long-term average catch, which previous experience suggests is not sustainable, although catch rates continued to increase in 2005. Catch statistics from this part of the fishery may be unreliable though, because the boundary between Blocks 28 and 29 falls in the middle of Long Point. While catches in the last decade have been reported as Block 29, some earlier catches may have been reported as Block 28, thus lowering the long-term average here.

Further south at Maria Island (Block 24), catches and catch rates have continued to improve, and this, combined with the reduced median size of sampled abalone from catches from the eastern side of the island (24D, 24E) suggests abnormally high levels of recruitment. Elsewhere in the Eastern Zone, although catches and catch rates have improved, there is no evidence for unusually large numbers of recruits being landed, and stock recovery seems to be driven more by the reduction in catch rather than increased levels of recruitment.

Western Zone

North West:

Over the last 10 years, annual catches have generally been below the 165t long-term average catch (except in 2001 when catch was 212t), and in recent years have only

been slightly greater than half the long-term average. Despite these low annual catches, catch rates have mostly remained at levels which are considered relatively low for this part of the West Coast. There has been a modest improvement in catch rates in the two northernmost sub-blocks, but catch rates continued to fall in 6C and 6D. Given its catch history, the weak response of catch rates to the catch reduction suggests that levels of fishable biomass are low in the region.

Until 2003, the minimum legal size (MLS) in 6A, 6B and 6C was 132mm. In these three sub-blocks the MLS was increased to 136mm. The MLS in 6D was unchanged and remains at 140 mm. The size-limit increase in the northern sub-blocks of Block 6 may have been responsible for part of the catch rate decline. However, catch rates had been falling for several years prior to the MLS increase, and their fall may simply be a response to higher levels of catch in 2000 – 2001 that was due to an influx of new divers to the area following the introduction of zoning. Many of these divers stopped fishing in Block 6 in 2003 and the catch reduction may have benefited the northern sub-blocks. Further south in 6C, where fish grow larger, reefs are reported to be extensively depleted, and during the years of the higher catches (2000 – 2001), the MLS may have been too small to protect populations. The almost continual decline in catch and catch rates in 6C and 6D in recent years is consistent with recruitment decline.

This region (Block 6) used to support catches of much larger magnitude (200t - 300t) for many years when managed with a smaller size limit which offered much less protection. The reason for the decline in productivity of this block is unknown and of concern, and its future performance will be watched with interest.

Central West:

There has been a fall in annual catch from this region by almost 50t to 227t. Much of this fall has occurred in Block 9, particularly between Cape Sorell and Sloop Point Divers have reported in recent years that they can land good catches only when sea conditions are flat and shallow exposed reefs can be accessed *i.e.* stocks on this part of the coast are depleted. Because the catch is now so low in 9B, there is insufficient catch data from which to draw firm conclusions about the status of this part of the fishery. The median size of abalone landed from 9B appears to be stable. There are no trends to confirm reports that divers are targeting smaller abalone and leaving large quantities of large abalone, nor are there indications of depletion. Further south in 9C, catch rates have been stable between approximately 149-159 kg/hr in recent years, with recent years' catches at reduced levels. The median size of abalone has fallen since 2003, which could be a reflection of the reported selected fishing for smaller abalone. To the north of Strahan in Block 8, catches and catch rates appear to be stable.

For the third successive year, landings from Block 7 have been much higher than average, which has been of increasing concern to both divers who fish there and to managers. The 2005 catch was 110t. Catch rates have slowly trended downward since 2000 but have been stable at approximately 140 kg/hr since 2003. That catches so much greater than the long-term average can be sustained at these catch rates suggests that the long-term average may be an under-estimate and that in earlier years much greater landings were taken from this block than were reported. Market measuring data was not obtained at a level sufficient to draw useful conclusions.

South West:

Catch rates in this region continued to decline (to 140 kg/hr) in 2005, while the catch fell to 538t. In Block 10, catch and catch rates continued to fall. The high 2003 and 2004 catches were previously of concern, but the 2005 catch (~149t) has fallen back to levels approaching the long-term average and is likely to be more sustainable. In Block 11, the 2005 catch (~389t) was the highest since 1985, and almost 100t greater than the long-term average. Catch rates have fallen markedly since 2000 (when they were 165 kg/hr), and are now ~137 kg/hr. The risk that catch levels on this section of coast are unsustainable must now be considered high, and catch rates may be expected to decline further.

South Coast:

The South Coast catch increased by approximately 30t to 376t in 2005, following a 50t increase the previous year. Regional catch rates have fallen almost continuously since 2000, which coincides with both the introduction of the Eastern and Western Zones and the rapid expansion of the live abalone market. For the last two years catch rates have been below the 100 kg/hr point where industry participants at past stock assessment working groups have suggested that management action be required. With the exception of one diver, all respondents to the TAFI questionnaire who had fished there expressed concern about the size of the annual catch and level of effort on the South Coast fishery.

In Block 12, catch rates have mostly fallen since 1999. The 2005 catch rate was 104 kg/hr (same as 2004). The 2005 annual catch of 311t was the third highest recorded (the others were in 1979: 325t and 1980: 351t). There are no long-term records of catches from the Western Zone part of Block 13 because there were no catch reporting boundaries there prior to 2000, but the annual catch was reduced by 31t to 65t in 2005, while catch rates had fallen to 82 kg/hr.

All parts of the South Coast show reductions in median size of landed abalone in 2005 compared with previous years. While the level of sampling was at satisfactory levels only in 13B, that the reduction in median size was consistent across the rest of the region suggests that the size reduction was real and not an artefact caused by inadequate sampling. This size reduction, falling catch rates, increased levels of catch and the opinions of divers all indicate that the risk of the region being fished at unsustainable levels is high.

Northern Zone

King Island:

Following a rapid escalation in effort since the start of the Northern Zone in 2001, the annual catch at King Island appears to have stabilised at approximately 130t. Catch rates have fluctuated in a narrow range between 93 and 99 kg/hr since then, probably due more to changes in fleet dynamics than a reflection of abundance. It is believed that effort is intermittently and unequally applied across populations which are being serially depleted. For example, in parts of Blocks 1 and 3, it is reported that while abalone populations in shallow water have become extensively depleted (some divers

have reported sub-50 kg/hr catch rates), they remain abundant in depths down to 30 m, where they are now being fished by local divers using Nitrox breathing apparatus. The majority of the blacklip catch is taken by visiting mothership-based divers, and whether current levels of catch can continue to be taken here appears to be dependent upon the willingness and ability of the visiting divers to work at depths greater than 20 metres.

North West:

The region's catch has ranged from 165t down to 124t during the past four years, with catch rates fluctuating over a small range that suggests stable levels of abundance. However, at a smaller spatial scale, there are verbal reports from divers that stability is being maintained through serial depletion and that the risk of unsustainable levels of fishing here is increasing.

Abalone stocks close to Woolnorth Point (5A, 49C, 48C) are reported by divers to have been extensively depleted since the inception of the Northern Zone in 2001, although small but dense populations remain on the western side of Hunter Island (49C) which are either not marketable or grow insufficiently large enough to be regularly fished. Catch from this sub-block has fallen to below 10t for successive years, and catch rates have continued to fall (78 kg/hr in 2005), confirming divers' reports that the area is being depleted. In recent years, divers have taken large quantities of abalone from relatively unexploited populations in the most remote parts of the region (49B). The 2005 catch from here increased to 40t, but previously high catch rates could not be sustained and fell sharply (125 kg/hr), suggesting that it is unlikely to continue providing the same level of catch. Three Hummock Island (49A) produced 15t – 19t between 2001 and 2004, but in 2005 only 6t was taken. The amount of fishable reef here is relatively small, and while catch rates have fluctuated within a limited range (79 – 88 kg/hr) during this period suggesting sustainable fishing, it is reported that populations here have been depleted with little likelihood of greater levels of catch in the short term. Block 48 no longer supplies significant levels of catch.

In Block 5, stocks in the southern part (5C) were reported to be recovering from high levels of catch in 2001-2002, and in 2005 the catch doubled that of the previous year to 50t with increasing catch rates over 100 kg/hr. Closer to Woolnorth, catch rates remained unstable and falling (84 kg/hr) in 5B although the annual catch is now less than 10t, and in 5A, while catch rates (71 kg/hr) are still falling, it appears likely the decline will stop and remain stable at the current low levels of catch (12t). The total catch from this block was 73t, and it is evident that the 100t catch cap is now no longer effective as a means of preserving sustainability.

The North West supplied much greater levels of catch in the 1980's. The 280t Northern Zone TAC was based on the premise that this region's earlier catches were mostly sustainable and consequently that the smaller fraction of those catches used to estimate the current TAC was sustainable. It is of concern therefore that the region's stocks appear to be either fully exploited, or at risk of overfishing at much lower levels of catch. There is little opportunity for increased levels of catch in this region should the need arise to transfer catch from King Island.

North East, Furneaux Group:

Both the North East and the Furneaux Group supplied similarly low levels of blacklip catch (< 20t p.a.), with catch rates fluctuating between 50 and 70 kg/hr. Because of their remoteness and the logistical difficulties of keeping abalone in good condition, mainstream processors prefer catches from more accessible areas. Consequently effort in recent years has been sporadic and unevenly applied to populations, and catch rates dependent more upon fleet dynamics than changes in abundance. It is noted that in both regions, the amount of productive reef is small, particularly under the 127-mm size limit in the Furneaux Group. Abalone in both regions tend to be smaller and grow slower than in the North West or King Island.

In the North East it is reported that the levels of catch and effort are appropriate for current stock levels *i.e.* stocks are fully exploited. In the Furneaux Group, in the absence of evidence to the contrary, we accept divers' reports that stock levels are healthy and present levels of catch are sustainable. However, whilst stock levels appear more secure here, it is apparent that neither region could provide more than a minor increase in catch to compensate for any loss of productivity in the western regions.

Bass Strait Zone

At least half of the zone's catch continues to be taken from the Hogan Group (35t), with minor amounts (<20t) coming from the other Bass Strait islands. Catch rates have continued to fall, and stocks are reported to have become depleted in these areas. Growth studies conducted in the mid-1990's showed relatively fast growth rates in the Hogan Group, which partially explains its greater productivity. However, this also means that its abalone are less protected by the size limit and potentially more vulnerable to overfishing.

Catch from the central North Coast and offshore islands (between Stanley and Tomahawk) was low (7t), with mean catch rates falling to 42 kg/hr. The Furneaux Group catch (8t) and catch rates (41 kg/hr) were at similar levels. While there was a transfer of effort from the islands and the North Coast to the Furneaux Group in 2005, the low catch rates there indicate that the Furneaux Group has little capacity to provide greater levels of catch. In both the central North Coast and the Furneaux Group, it is reported that there are populations of abalone that are too small to be fished at the 114-mm size limit.

Greenlip Fishery

In 2005, there was a minor redistribution of catch away from the North East and King Island to the Furneaux Group, and for the first time since 2003, the 42t cap was reached. In recent years, up to 90% of the Furneaux Group catch has been caught by one diver, but in 2005 many other divers visited and the regional catch increased. The visiting divers mostly fished either in the southern Blocks 33 and 32 after launching runabouts from the North East, or Franklin Sound (Block 35). In the northern parts of the Furneaux Group, better catch rates were achieved using Nitrox to access stocks in deeper water. It is reported that there are extensive populations of greenlip too small to fish under the 145-mm size limit on the western side of Flinders Island.

At King Island, it is reported that greenlip populations in Block 1 that were extensively depleted in the late 1990's have started to recover, and some moderate-sized catches were landed in 2005. The high size limit on King Island should offer adequate protection to these populations and promote further recovery, but it effectively prevents economic fishing of smaller growing populations in Block 2. The status of stocks on the east coast of the island is unknown, but catches and catch rates fell in 2005, suggesting that if there is a stock recovery, it is weak.

In the North West, divers reported that the 30t catch was excessive for the region. In most areas stocks are reported depleted, and it was suggested that the cap was too large for the area of fishable reef required to support it. In 49C, the annual catch has fallen from over 10t in 2000, to less than 1t in 2005, and the catch from 48B has been at low levels for many years. In two areas however, abalone are more abundant. It was reported that stock levels are healthy between Woolnorth Point and Trefoil Island (5A), and east of Woolnorth (48C) with extensive numbers of pre-recruits. In Perkins Bay, abalone on Black Reef (48A) and reefs offshore from North Point (47) were particularly abundant, but mostly smaller than the 145-mm size limit operating in 2005. Despite this, the catch from 48A increased from 4t to 7t in 2005.

Assessment summary

Eastern Zone

Actaeons

1. The Actaeons catch, at 218t, is much reduced from the levels of previous years.
2. The median size of abalone although small is stable or even increasing slightly in some areas.
3. There is evidence that a recovery of stock levels has started.
4. Under the current Eastern Zone TAC, the annual cap of 350t is no longer an effective management control.

Bruny Island

1. Since 2002, the Bruny regional catch (119t in 2005) has been at historically low levels.
2. Catch rates have increased in all areas. In the east and north, catch rates have increased for two or three years. In much of the south, catch rates increased for the first time since 2000.
3. Increasing median size is consistent with reduced levels of effort on abalone populations.
4. There is evidence that stocks are continuing to build in the east and that a recovery of stock levels has started in the south.

Storm Bay

1. The level of catch in much of this region is among the highest recorded.
2. There is no evidence to suggest that this level of catch is currently too high.
3. Catch rates have continued to increase, and are among the highest in the Eastern Zone.
4. There has been a consistent increase in median size in most areas, suggesting that the level of fishing mortality applied to populations remains low.
5. The recovery of stocks in this region is continuing.

East Coast

1. The level of catch has been at low levels (< 250t) since 2002.

2. Catch rates have increased substantially in most areas.
3. Fishing pressure in this region has been reduced to the extent that there is insufficient catch/effort data to reliably assess this region.
4. The recovery of stock levels in this region appears to be continuing.

Western Zone

North West

1. The level of catch in this region has been low (<100t) since 2003.
2. Catch rates in this region have fallen since 2000. In 2005, catch rates increased in the northern sub-blocks, but in the south their continued decline suggests on-going depletion and recruitment decline. Combined with such low levels of catch, they suggest greatly reduced stock levels.
3. Stock levels appear to be low but stable in the north, and declining in the south.
4. There is evidence of a recent failure in recruitment in the two southern sub-blocks.

Central West

1. In the north (Block 7), levels of catch are very high, whilst south of Strahan (Block 9), catch levels are low and not conducive for providing reliable estimates of abundance.
2. Catch-rate trends do not suggest that the Block 7 catch is unsustainable.
3. Size-selective fishing (fishing to an upper size limit) is uncommon in this region.

South West

1. Levels of catch in recent years have been high, particularly in Block 11.
2. Catch rates have declined almost continuously since 2000.
3. Stock levels are being depleted.
4. Size-selective fishing (fishing to an upper size limit) is no longer common in this region.
5. There is increasing risk that current catch levels are unsustainable.

South Coast

1. Levels of catch in recent years have been very high, particularly in Block 12.
2. Catch rates have declined almost continuously in recent years.
3. Stock levels are being depleted, and continuing catches at current levels are likely to be unsustainable.
4. There was a consistent decline in median size of market samples in 2005.
5. Size-selective fishing (fishing to an upper size limit) is uncommon in this region.

Northern Zone

North West

1. High stock levels have been fished down since the start of the Northern Zone fishery.
2. In the north near Woolnorth, stocks have been further depleted.
3. Increasing catch and catch rates in the southern part of Block 5 suggest stock recovery.
4. Parts of the region (particularly Block 48) no longer supply catch at levels recorded in the 1980's.
5. Remote stocks in 49B have been depleted.

6. There is little opportunity for increased levels of catch in this region should the need arise to transfer catch from King Island.

King Island

1. In recent years catch rates have been stable between 90 and 100kg/hr.
2. Levels of catch are high at approximately 130t for the second successive year.
3. Increasing levels of catch have been taken from deep water (>20m) at high catch rates, while the shallow reefs in Blocks 1 and 3 are reported extensively depleted.
4. The high level of catch has been maintained by serial depletion, which makes catch and catch rates meaningless as indices of abundance but the necessity to serially deplete stocks indicates that current catch levels are not sustainable.

North East

The level of catch from this region is low, and there are no indications that it is unsustainable. However, the area of fishable reef in this region is small, and blacklip populations are reported to be fully exploited.

Furneaux Group

The level of catch from this region is low, and there are no indications that it is unsustainable. Like the North East, the area of productive reef under the 127-mm size limit is small and is unlikely to yield significant increases in catch.

Bass Strait Zone

1. Most of the catch continues to be taken from the Hogan Group and other Bass Strait Islands, where stocks have become depleted.
2. While catch levels were low, central North Coast and Furneaux Group stocks have also been depleted.
3. The planned reduction of the size limit on the central North Coast to 110mm will increase the fishable biomass, but populations are not extensive, and there is little capacity for a major transfer of effort here from the Bass Strait islands.

Greenlip Fishery

King Island

Although greenlip populations in Block 1 are reported recovering, in Block 2 there is evidence that populations continue to decline, or the high size limit is a hindrance to economically viable fishing.

North West

1. The 30t cap for the region is excessive.
2. Greenlip populations are at acceptable levels only in the vicinity of Woolnorth and Perkins Bay (Smithton).
3. Remaining areas have been steadily depleted.
4. The proposed reduction in size limit at Perkins Bay may reduce pressure on stocks in the 145-mm size limit region.

North East

Although the 2005 catch was less than 20t, populations were heavily depleted in previous years and there are no signs of recovery.

Furneaux Group

All available information indicates that stock levels here are stable or increasing, and that catch levels are sustainable.

6. Other fisheries

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 6). While the number of licenses fell slightly in 2003-04, it increased again for the most recent season, and by 31 October 2005, 10,213 licenses had been issued.

The annual recreational catch for the season 2004-05 when 10,133 licenses were issued was estimated at 112,571 abalone (95% CI: 92,262 – 134,795) or approximately 56 tonnes (Lyle and Morton, 2006). About half the catch was taken from the southeast (between Marion Bay and Whale Head), with another 27% taken from further north on the East Coast. Compared with the commercial catch, the recreational catch may seem insignificant, yet because it is taken mostly from the more accessible parts of the coast, and often from areas of the Eastern Zone which have been heavily fished by the commercial fishery, it may cause localised depletion in those areas.

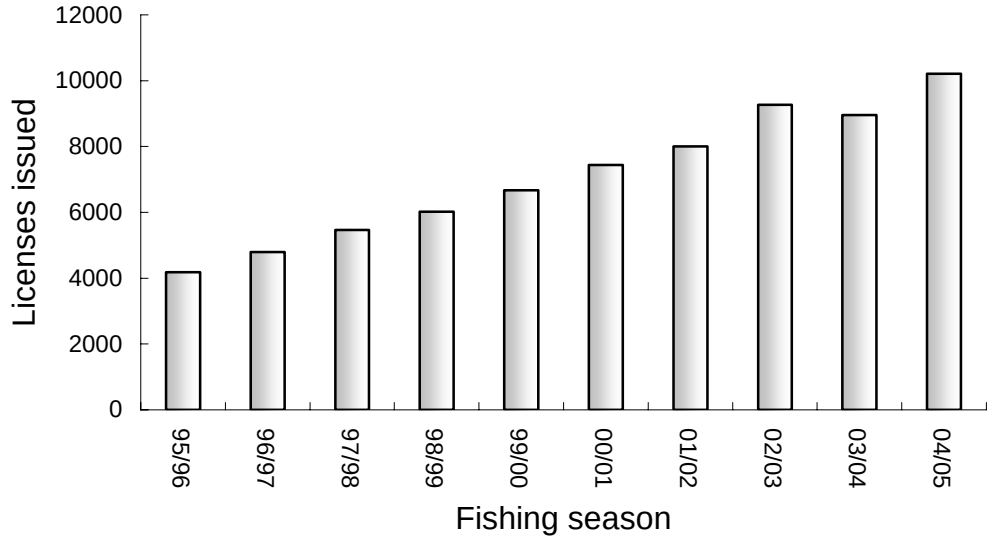


Figure 6. The number of recreational abalone diving licenses issued for the fishing seasons 1995-2005.

Indigenous, illegal and permit fisheries

Abalone are caught in Tasmanian waters as part of cultural fishing activities by indigenous people, under exploratory permits for special events, for research purposes (*e.g.* TAFI sponsored abalone research), and as part of illegal fishing operations. There are no estimates available for either the illegal catch or for the total catch from cultural fishing activities. The quantity of abalone taken under exploratory permits was less than five tonnes.

7. Recommendations for Managers

This assessment is based primarily on commercial catch-effort and size-composition data from the Tasmanian abalone fishery. While size-composition data can assist interpretation of catch-rate trends, the exclusive reliance upon catch and effort data reported at the level of block and sub-block to monitor trends in stock performance is inappropriate. The inadequacy of this method in many parts of the Tasmanian fishery requires stress, and it is strongly recommended that additional assessment methods be implemented, such as fishery-independent abundance survey programs and improvements to reporting scale and quality of catch and effort data.

While **Eastern Zone** stocks are continuing their recovery to higher levels of abundance and there is every indication that Eastern Zone stocks are being fished sustainably, it would be prudent for managers to reduce the current 350t cap on the Actaeons catch to levels where it would be effective, or dispense with it altogether if it is no longer needed.

Concern remains for **Western Zone** stock levels, which are believed to be declining after being fished at historically high levels of catch since 2000. One of the regions most adversely affected was the South Coast (Blocks 12, 13A, 13B). Because it can be economically more beneficial to fish the region at low catch rates than travel on a mothership to the South West, it is likely that the 2006 catch will be as large or larger than the 2005 catch. It is therefore recommended that the 2006 catch from this region be capped, as a minimum at 2005 levels (376t), to prevent greater rates of depletion than currently occur.

In the 2004 assessment, we were greatly concerned that divers were selectively fishing for smaller abalone, and thus taking the TAC from a fraction of the fishable biomass, a clearly unsustainable practise. More recent information that was obtained from divers' responses to a questionnaire sent to them by TAFI revealed that the extent of this practise has become very limited, and most divers now take all abalone of legal size. While this has lessened our level of concern for the consequences of selective fishing, a common reason given for not selectively fishing was that there were now no abalone left that were too large to catch. In fact, nearly all questionnaire respondents who fished in the Western Zone (20 out of 28) expressed varying degrees of concern at the level of stock depletion there.

The risk that current levels of fishing in the Western Zone are becoming unsustainable is increasing. The irregular nature of fishing in the Western Zone invalidates the assumptions upon which the validity of catch rates as an indicator of abundance is predicated, and stock levels are likely to be declining at faster rates than trends indicate. It is therefore recommended that a committee be set the task of developing performance measures and a harvest strategy that will initiate management action.

The **Northern Zone** is primarily dependent on the North West and King Island for most of its catch, and there are significant problems with stock levels in both regions. King Island blacklip stocks on the shallower reefs have been extensively depleted, which may cause divers to transfer effort elsewhere, particularly to the North West. It is therefore recommended that managers take steps to protect stocks in the more

accessible parts of the North West. Appropriate measures might include reducing the Block 5 cap to current catch levels (73t).

Most of the **Bass Strait Zone** catch continues to be taken from the Hogan Group and other Bass Strait Islands, where stocks are now reported depleted, and it seems likely that this level of fishing is unsustainable. Stocks are also reported depleted on the central North Coast and the Furneaux Group. While the proposed reduction of the size limit to 110 mm on the central North Coast should increase the productivity of this part of the fishery, the extent of the smaller populations and their likely yield are unknown.

The potential levels of catch from the Bass Strait Zone and its TAC were estimated using the size of the catches from the stunted fisheries between 1989 and 1995. These fisheries were unusual, because they operated for only a few weeks every two years. Many parts of the zone, particularly in the Furneaux and Kent Groups were heavily depleted during those fisheries, and have failed to produce former levels of catch since then. Perhaps because of this, the stunted fisheries were not good indicators of potential yield for a fishery operating year-around, and stock levels have fallen very quickly since 2003. It is recommended that managers closely monitor the status of stocks throughout the zone in 2006 and be prepared to take measures that will curb unsustainable levels of fishing should it arise.

The TAC for the **Greenlip** fishery was reduced in 2005 following a reduction in the catch cap in the North East to promote recovery of depleted stock levels there. More recently, in the North West it has been reported that stock levels have become depleted in many parts of the region, and that the 30t catch cap was probably excessive and should also be reduced. A recent TAFI report has recommended that the size limit in part of the region (Perkins Bay, or Blocks 47 and 48A) be lowered from 145mm to 132mm, because stock levels there were high and stocks either had not been fished for many years, or were fished very lightly. Given the small size of greenlip in Perkins Bay, it was found that stocks should be adequately protected with the reduced size limit with the proviso that the catch in that area be capped at 20t. If the TAFI recommendation is followed, it is essential that managers ensure that there be no transfer of catch from the remainder of the North West to Perkins Bay above the recommended cap. It is recommended that the two areas (Perkins Bay and the remainder of the North West) should be managed separately, each with its own size limit and cap, and that the remainder of the North West cap be reduced from 30t to a more sustainable level.

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Appendix 1: Interpreting graphical information

Regional catch and catch rates:

The vertical columns show catch in tonnes, for the period 2000-2005. The black line with balls shows catch rates over the same period (Figure 7).

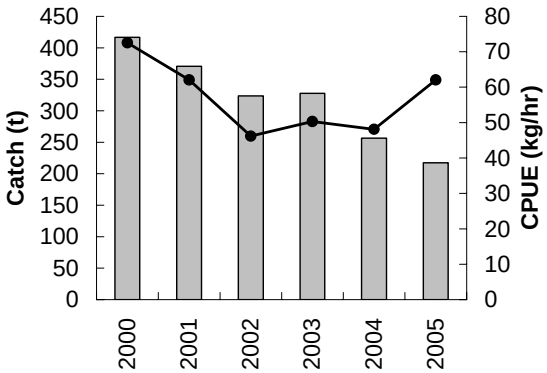


Figure 7. Six year regional total catch (tonnes) and mean catch rates (kilograms per hour), 2000 - 2005.

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 8). That the distributions are skewed (not evenly distributed about the category with the highest percentage) implies that fewer divers are achieving high catch rates.

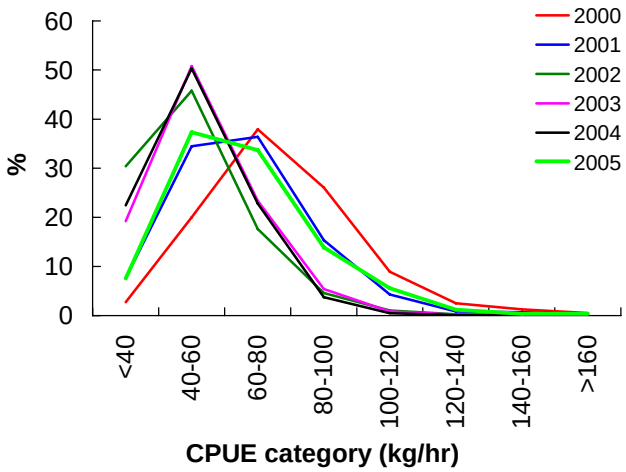


Figure 8. The percentage distribution of catch-rates, 2000 - 2005.

Catch, catch rate by block

The following figures provide catch and catch rate information on a smaller geographical scale.

Figure 9 shows catch (left y-axis) and catch rate (right y-axis) for the last 10 years for a statistical block.

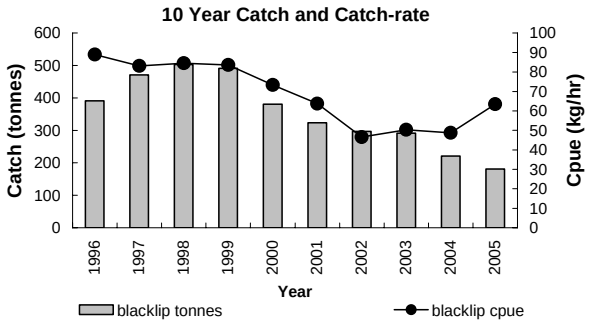


Figure 9. Example ten-year catch and catch rate, by block. Catch rates (geometric means – see below) are shown as a line with balls marking every year. Catch (tonnes) is shown as vertical columns.

Catch rates are expressed as geometric mean catch rates rather than arithmetic means because abalone catch rates do not tend to follow statistical normal distributions and using the geometric mean avoids biasing the estimated catch rates for all divers combined. Catch data are presented only for a ten year period because we believe divers have been fishing in much the same way for the last ten years, and therefore changes in catch rate are due to changes in abundance of abalone, not because the divers have altered the way they fish (by changes in the use of droplines, GPS, boats, equipment etc.).

Figure 10 shows catch and catch rates for the last six years for sub-blocks. Because sub-blocks have only existed since 2000, we cannot show catches (or catch rates) to sub-block level before then. While these charts generally have been limited to sub-blocks supplying 10 or more tonnes during any of the last three years, some sub-blocks with annual catches less than 10 tonnes are included if they are of particular interest.

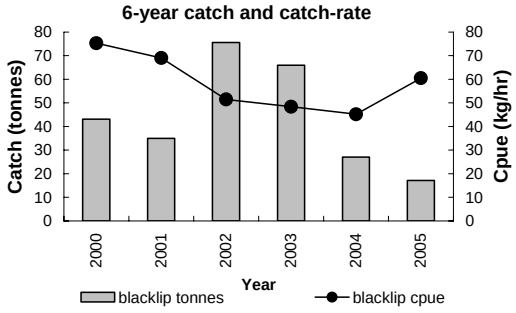


Figure 10. Example catch and catch rate at sub-block level.

Size-composition charts.

The size-composition of divers' catches is reviewed at sub-block level (Figure 11). 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.

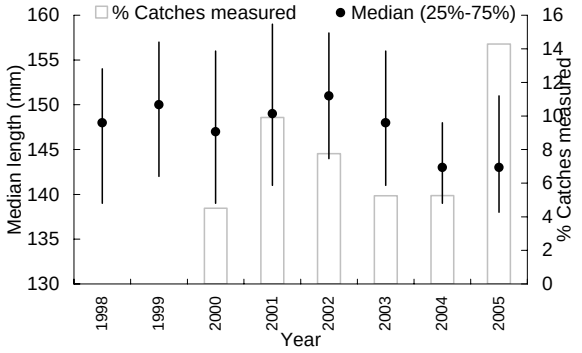


Figure 11. Median length with 25%-75% inter-quartile size range of abalone from commercial catch samples. The vertical columns represent the percentage of catches sampled.

Size-composition charts plot median length (the middle or 50th percentile length if all abalone were sorted from smallest to largest) for the period 1998-2005 (or the period since catches can be attributed to sub-blocks). They also show the size of abalone at the 25th and 75th percentiles *i.e.* the size range of 50% of abalone from the sampled catches. A reduction in median size may be due to divers landing more smaller abalone, either because the larger abalone have become depleted or because recruitment has increased and made more small abalone available to catch. If catch rates fell across the review period then the former is likely whereas as if they increased, then reduction in median size may be explained by increased levels of recruitment.

Appendix 2: Annual Catches From The Western Zone 1975 - 2005.

Annual tonnages of blacklip abalone caught within the statistical blocks and sub-blocks comprising the Western Zone in 2005. 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		111	36	42	126	130	191	143		779
1976		64	56	77	255	179	240	154		1025
1977		53	24	23	123	98	153	189		663
1978		81	13	27	115	258	277	209		980
1979		115	19	23	172	166	269	325		1089
1980		197	81	63	316	195	338	351		1541
1981		264	89	87	444	260	417	246		1807
1982		147	34	34	249	100	303	235		1102
1983		231	102	58	199	175	431	242		1438
1984		309	78	40	248	284	682	258		1899
1985		327	99	23	246	140	479	155		1469
1986		213	97	11	134	127	289	194		1065
1987		185	84	44	251	82	339	195		1180
1988		244	53	27	160	126	276	162		1048
1989		193	49	46	120	110	212	145		875
1990		197	56	21	95	80	235	125		809
1991		169	54	30	102	106	219	140		820
1992		266	69	40	100	102	269	159		1005
1993		160	66	38	110	66	197	177		814
1994		82	37	38	78	60	200	160		655
1995		123	32	17	44	68	185	182		651
1996		113	68	13	59	81	145	148		627
1997		98	75	28	140	66	224	227		858
1998		129	51	27	78	44	165	202		696
1999		131	51	18	107	42	192	229		770
2000		183	61	23	205	148	333	286	54	1291
2001	0	212	32	15	185	152	311	290	43	1241
2002	2	173	51	17	174	143	359	236	93	1248
2003	0	97	104	27	142	239	345	229	67	1251
2004	1	88	89	21	130	181	374	250	96	1230
2005	6	95	110	26	92	149	389	311	65	1242
mean	2	163	62	33	161	134	292	211	70	1070

Appendix 3: Annual Catches From The Eastern Zone 1975 - 2005.

Annual tonnages of blacklip abalone caught within statistical blocks and sub-blocks comprising the Eastern Zone in 2005. 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	48	12	0	16	27	49	74	15	16	5	44	69	16	45	32	836
1976	208	156	0	64	36	1	18	25	45	56	18	12	9	40	72	9	39	50	858
1977	245	232	2	190	13	1	23	35	37	53	11	10	9	55	90	22	122	54	1204
1978	322	218	6	120	24	1	32	65	60	88	22	13	11	93	87	25	137	105	1429
1979	374	251	8	148	25	2	51	52	43	30	10	23	7	80	52	12	107	60	1335
1980	272	255	7	145	30	1	33	30	42	46	158	34	7	108	91	27	148	105	1539
1981	254	299	18	127	48	4	45	69	35	77	137	19	15	68	154	22	146	52	1589
1982	337	218	15	147	24	3	36	62	63	49	97	21	9	89	100	32	171	48	1521
1983	255	300	10	189	28	3	43	63	55	92	99	31	14	100	105	66	298	90	1841
1984	318	297	18	166	35	5	47	70	73	61	109	10	11	106	112	53	149	76	1716
1985	256	262	4	89	83	11	69	80	43	44	120	20	17	86	71	5	91	171	1522
1986	221	262	22	82	93	4	65	67	70	56	88	13	20	50	58	14	126	164	1475
1987	225	229	7	47	80	1	43	44	32	34	66	12	8	77	45	11	68	54	1083
1988	219	258	6	76	57	4	62	44	43	34	79	10	6	65	52	16	96	90	1217
1989	156	172	2	56	43	2	61	42	22	16	34	7	8	41	31	11	41	27	772
1990	133	193	4	76	29	3	33	51	41	36	61	1	2	61	77	21	54	22	898
1991	127	207	2	60	37	3	53	50	47	31	67	2	9	64	66	12	30	21	888
1992	159	122	4	49	28	3	56	49	56	12	76	1	1	71	56	7	10	13	773
1993	271	121	4	107	47	1	67	79	49	24	75	1	1	87	39	8	15	15	1011
1994	300	148	10	118	65	2	122	85	62	17	57	0	3	104	24	8	11	21	1157
1995	313	256	2	106	35	4	108	78	41	21	43	0	1	81	19	6	11	26	1151
1996	392	195	0	80	18	3	74	55	44	29	69	3	6	90	39	11	28	20	1156
1997	470	137	0	64	25	2	79	49	47	32	106	1	13	190	32	32	23	33	1335
1998	483	109	1	116	23	2	85	64	63	44	160	2	25	182	77	31	10	15	1492
1999	474	66	1	106	34	6	97	61	47	53	139	0	9	94	60	24	10	39	1319
2000	381	98	2	71	29	4	62	60	69	44	104	1	8	101	16	21	10	90	1170
2001	324	157	3	108	20	2	56	50	40	24	111	1	14	68	9	27	13	79	1105
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
mean	281	185	6	97	35	3	61	56	47	40	76	9	8	80	56	21	66	54	1181

Appendix 4: Annual Catches From The Northern Zone 1975 - 2005.

Annual tonnages of blacklip abalone caught within statistical blocks comprising the Northern Zone in 2005. 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 prior to the establishment of that zone in 2001.

Year	31	39	40	32	33	34	35	36	38	47	48	49	5	1	2	3	4	Total
1975		3	1	2	9	1	7	7	2	1	12	9	39	32	1	27	14	167
1976		5	0	0	6	0	1	1	1	1	12	33	46	39	1	51	8	205
1977		5	2	6	11	0	0	2	2	0	8	17	50	17	1	87	8	216
1978		8	2	1	5	2	6	5	4	3	10	11	65	21	3	56	25	227
1979		6	1	2	9	0	0	1	2	0	27	7	85	24	3	10	10	187
1980		3	1	2	6	1	1	2	0	0	10	1	92	51	3	33	3	209
1981		7	1	0	7	1	1	0	0	2	33	9	120	19	8	33	10	250
1982		5	1	0	5	1	0	2	5	1	45	7	121	23	9	27	13	265
1983		7	4	0	4	0	1	5	4	9	44	19	227	22	2	32	51	431
1984		5	3	0	7	0	1	2	1	4	81	45	311	11	1	34	55	562
1985		5	2	4	6	1	2	0	0	4	48	50	319	43	0	26	12	522
1986		10	5	1	9	2	3	3	1	15	86	97	267	35	4	24	13	575
1987		6	1	0	7	0	2	1	1	18	58	68	197	44	61	24	53	542
1988		2	2	1	11	1	1	1	0	18	36	41	168	29	17	22	60	410
1989		1	28	0	4	0	0	0	0	14	16	24	88	14	7	10	5	211
1990		0	0	0	1	0	0	0	0	6	14	20	82	11	10	9	12	165
1991		1	0	0	2	1	1	0	0	8	12	10	97	6	7	13	27	185
1992		3	0	0	2	0	0	0	0	2	10	11	76	4	6	14	10	139
1993		0	0	0	3	1	0	1	0	1	6	7	66	10	4	8	9	116
1994		0	0	0	3	0	0	0	1	0	6	11	49	9	2	4	1	86
1995		0	0	1	1	0	0	0	0	0	6	2	62	12	3	1	8	97
1996		0	0	0	0	0	0	0	0	0	4	0	63	7	2	1	2	79
1997		1	0	0	0	0	0	0	0	0	5	2	56	10	1	10	6	91
1998		0	1	0	2	0	0	0	0	0	6	3	61	3	1	1	2	80
1999		4	1	0	4	0	0	0	1	0	13	4	57	5	1	0	6	95
2000		5	2	1	5	0	0	0	0	0	12	26	38	0	0	6	10	105
2001	12	11	3	5	10	1	0	0	3	0	17	72	117	2	1	9	12	276
2002	30	4	3	1	11	1	0	0	2	0	12	48	103	10	2	35	16	278
2003	7	8	1	0	5	0	0	0	2	0	10	76	73	25	1	62	10	279
2004	14	5	1	0	3	0	0	0	0	1	6	61	57	10	0	85	34	278
2005	11	2	0	0	7	0	0	0	2	0	6	54	73	15	2	92	18	282
mean	15	4	2	1	5	0	1	1	1	4	22	27	107	18	5	27	17	245

Appendix 5: Annual Catches From The Greenlip Fishery 1975 - 2005.

Annual tonnages of greenlip abalone caught within the statistical blocks comprising the Greenlip fishery in 2005. 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	212
1976	14	2	9	1	26	11	55	49	2	10	0	8	6	14	0	0	0	0	207
1977	6	8	4	6	23	21	50	24	1	22	0	40	2	17	0	0	0	0	224
1978	8	1	2	4	12	17	51	38	7	17	1	13	3	12	1	3	0	2	192
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	101
1981	6	4	2	12	17	17	34	10	9	0	3	12	1	9	0	12	0	4	152
1982	27	1	3	4	13	14	29	7	9	9	2	7	0	2	0	14	0	2	143
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	250
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	23	5	28	13	6	0	35	28	5	10	3	33	2	12	249
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	192
1992	16	10	0	5	4	2	24	7	2	0	4	14	2	4	3	18	1	8	124
1993	9	2	0	2	5	2	22	8	3	0	2	26	3	2	1	17	0	9	113
1994	12	2	0	6	8	1	22	5	5	0	3	48	3	10	4	25	0	7	161
1995	24	6	2	2	7	3	15	3	3	9	5	23	5	8	14	9	0	12	150
1996	11	13	2	3	13	4	17	2	8	12	1	15	0	3	36	33	1	13	187
1997	17	22	1	8	13	1	12	4	11	15	1	28	3	6	35	33	0	6	216
1998	4	17	24	5	5	1	23	1	2	2	2	43	8	14	31	34	0	5	221
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	5	7	11	6	1	9	139
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
mean	18	8	3	6	14	6	28	11	5	6	9	25	5	8	7	20	1	8	187

Appendix 6: Annual Catches From The Bass Strait Zone 1975 - 2005.

Annual tonnages of blacklip abalone caught within statistical blocks comprising the Bass Strait Zone in 2005. These tonnages are derived from estimated weights, which do not correspond exactly with landed weights.

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	0	24	0	41	4	0	6	0	167
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
mean	4	0	1	1	2	0	0	1	0	4	0	8	1	0	1	1	25

Appendix 7: Catch/effort data extract query.

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

```
select distinct
     d.docket_number docket
,    f.fishing_date day
,    extract(month from f.fishing_date) month
,    extract(year from f.fishing_date) year
,    f.block_code blok
,    d.zone_fishery_code zone
,    nvl(dive_time_1,0) + nvl(dive_time_2,0) + nvl(dive_time_3,0)
total_time
,    f.blacklip_estimated_weight blips
,    d.blacklip_landed_weight bland
,    f.greenlip_estimated_weight glips
,    d.greenlip_landed_weight gland
,    upper(Concat(Concat(n3.last_name,', '), n3.first_names))diver
,    upper(p.port_name) port
,    case when (d.processor_licence_id is null) then 'no landing'
          else case when n.organisation_name is not null then
          n.organisation_name
                    when n.trading_name is not null then
          n.trading_name
                    else n.last_name
               end
          end processor
,    v.vessel_mark boat1
,    v2.vessel_mark boat2
from qms.abalone_fishing_details f
   , qms.quota_dockets d
--diver name
   , lmm.clients n3
--where landed
   , lmm.ports p
--boats used
   , lmm.vessels v
   , lmm.vessels v2
--processor
   , lmm.licences l
   , lmm.certificates c
   , lmm.clients n
where f.fishing_date between '01-JAN-05' and '31-DEC-05'
and d.qudo_id = f.qudo_id
-- diver name
and n3.client_id = d.docket_signatory_id
-- boat id
and v.vessel_id (+) = d.primary_vessel_id
-- secondary boat id (if there is any)
and v2.vessel_id (+) = d.secondary_vessel_id
-- where landed
and p.port_code (+)= d.port_code
-- processor
and (l.licence_id(+)=d.processor_licence_id and
c.certificate_number(+)=l.certificate_number and
n.client_id(+)=c.client_id)
order by d.docket_number  asc
```

Appendix 8: History of Management Changes

This history has been compiled from a number of sources, principal among which has been DPIWE'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). Divers required to provide monthly catch statistics 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.
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.
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.
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.
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). Differential 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.
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, the 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.

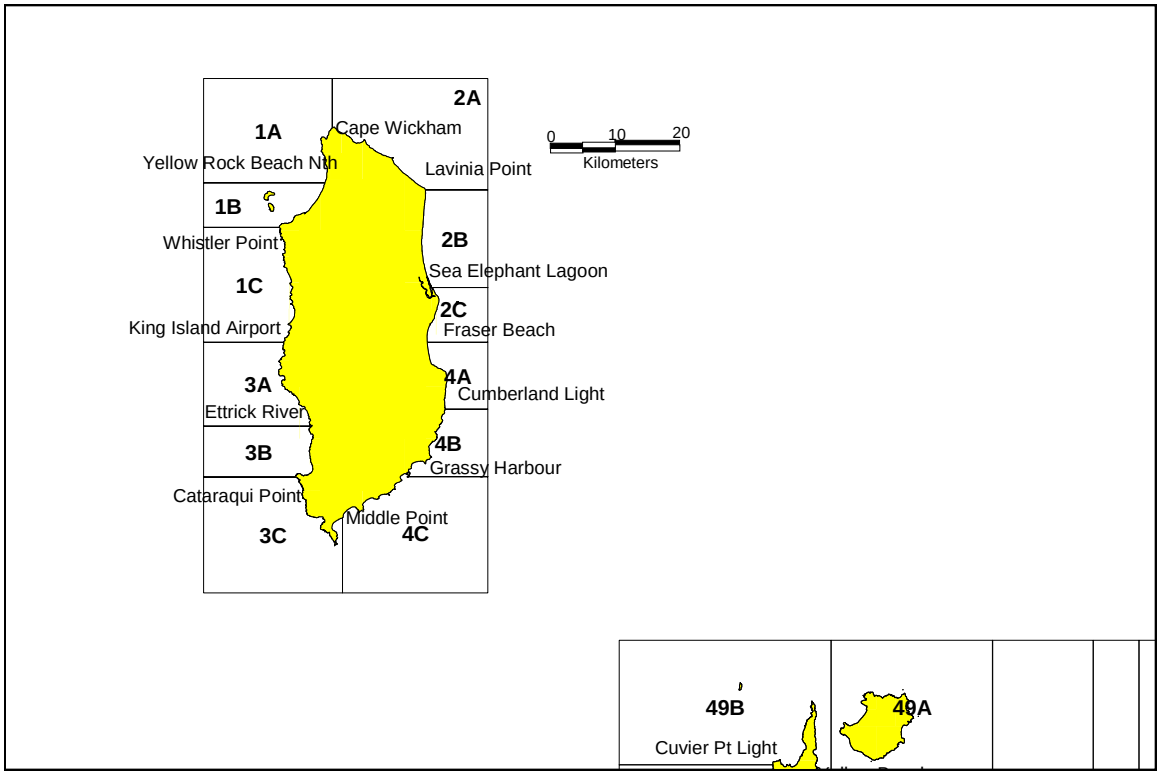
2003	A Bass Strait blacklip zone (TAC 70 tonnes (20 kg/unit), MSL of 114 mm) was superimposed over the Northern Zone in central Bass Strait and part of the Furneaux Group. Its purpose was to enable the catching of abalone smaller than allowed by the Northern Zone size limit. The Bass Strait Boundaries were set at Cowrie Point in the west and Anderson Bay in the east. The Flinders Island boundaries were on an unnamed point north of Settlement Point on the western side of the island (40°00'36.32") and Foochow Inlet on the east. Eastern Zone TAC remained 857.5 t (245 kg/unit). Western Zone TAC remained 1260 t (360 kg/unit) Northern Zone TAC remained 280 t (80 kg/unit) Greenlip TAC remained 140 t (40 kg/unit) Bass Strait Zone TAC set at 70 t (20 kg/unit) Fishery production was set at 2607.5 t (745 kg/unit) state-wide. Blacklip catch from Block 5 (Northern Zone) was capped at 100 t. MSL for Western Zone between the Wild Wave River and Arthur River was increased to 136 mm from 132 mm. Abalone taken from Western Zone subject to upper size limit of 160 mm by canners and live market buyers. Note that this was not rigidly enforced and market sampling showed most samples contained many abalone over this size.
2004	Eastern Zone TAC reduced to 770 t (220 kg/unit) Western Zone TAC remained 1260 t (360 kg/unit) Northern Zone TAC remained 280 t (80 kg/unit) Greenlip TAC reduced to 129.5 t (37 kg/unit) Bass Strait Zone TAC remained 70 t (20 kg/unit) Fishery production was set at 2509.5 t (717 kg/unit) state-wide. The greenlip TAC reduction affected the North West only, where the annual cap was reduced by 10 t to 30 t. October-March closure for Franklin Sound greenlip fishery abolished. Block 35 cap reduced from 20 t to 15 t.
2005	Eastern Zone TAC remained 770 t (220 kg/unit) Western Zone TAC remained 1260 t (360 kg/unit) Northern Zone TAC remained 280 t (80 kg/unit) Greenlip TAC reduced to 122.5 t (35 kg/unit) Bass Strait Zone TAC remained 70 t (20 kg/unit) Fishery production was set at 2502.5 t (715 kg/unit) state-wide. The greenlip TAC reduction affected the North East only, where the annual cap was reduced by 7 t to 23 t. Team diving (sharing catch from one quota unit by two divers) was introduced to legitimise the practise of divers catching abalone for others

	when they held no quota to which their catch could be assigned. High grading (discarding large abalone in the catch from the deck) prohibited. Caufing prohibited. Introduction of cancellation reports where a previously reported trip does not occur. Introduction of single (blacklip) zone fishing provisions. Overcatch provisions introduced to cover unintentional underestimation of catch weight.
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 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. An interim reduction in size limit was set for the Perkins Bay greenlip area, from 145 mm to 140 mm. MSL for Eastern Zone was increased to 136 mm (to take effect from 1 November 2006). 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.

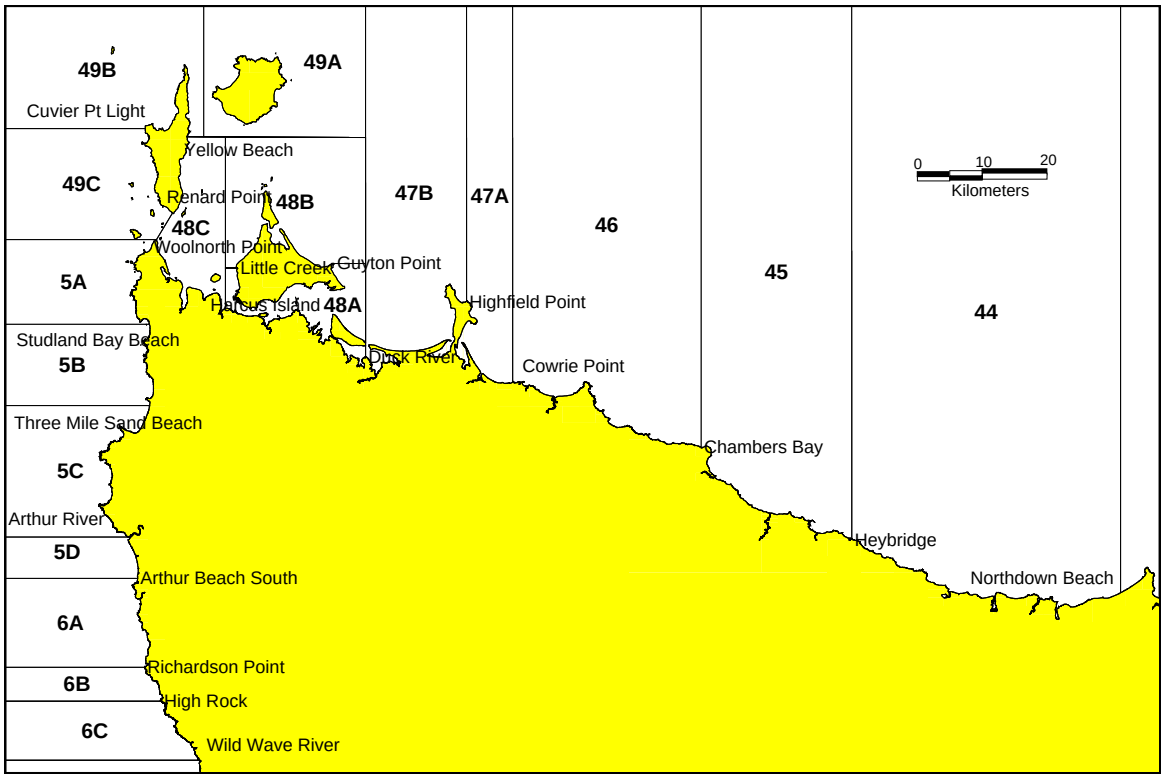
Appendix 9. Maps of catch-reporting blocks and sub-blocks.

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

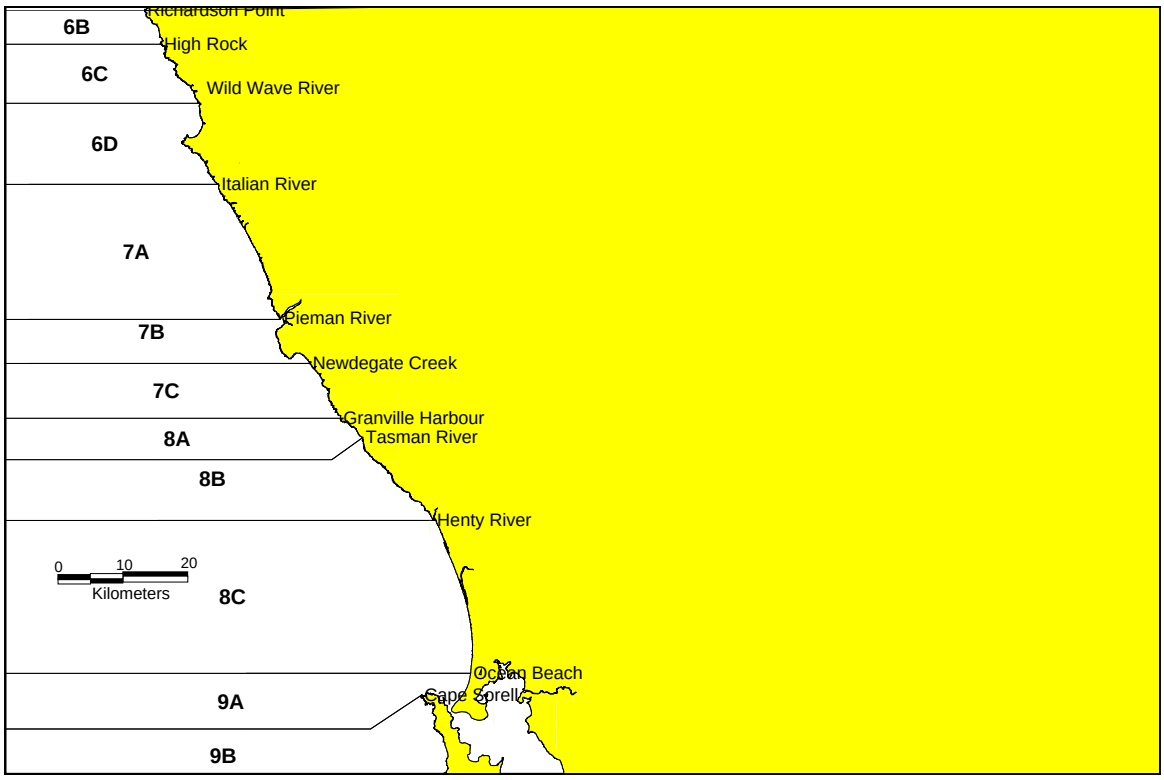
Map1: King Island



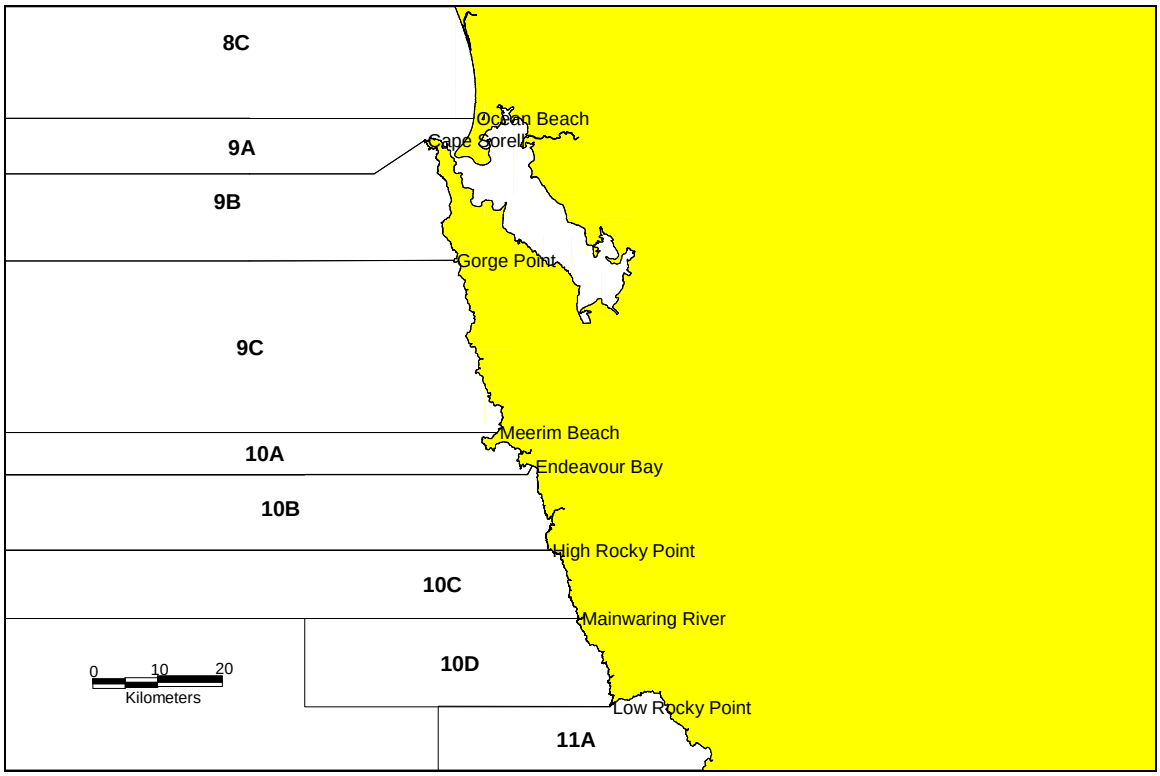
Map 2: North West Tasmania



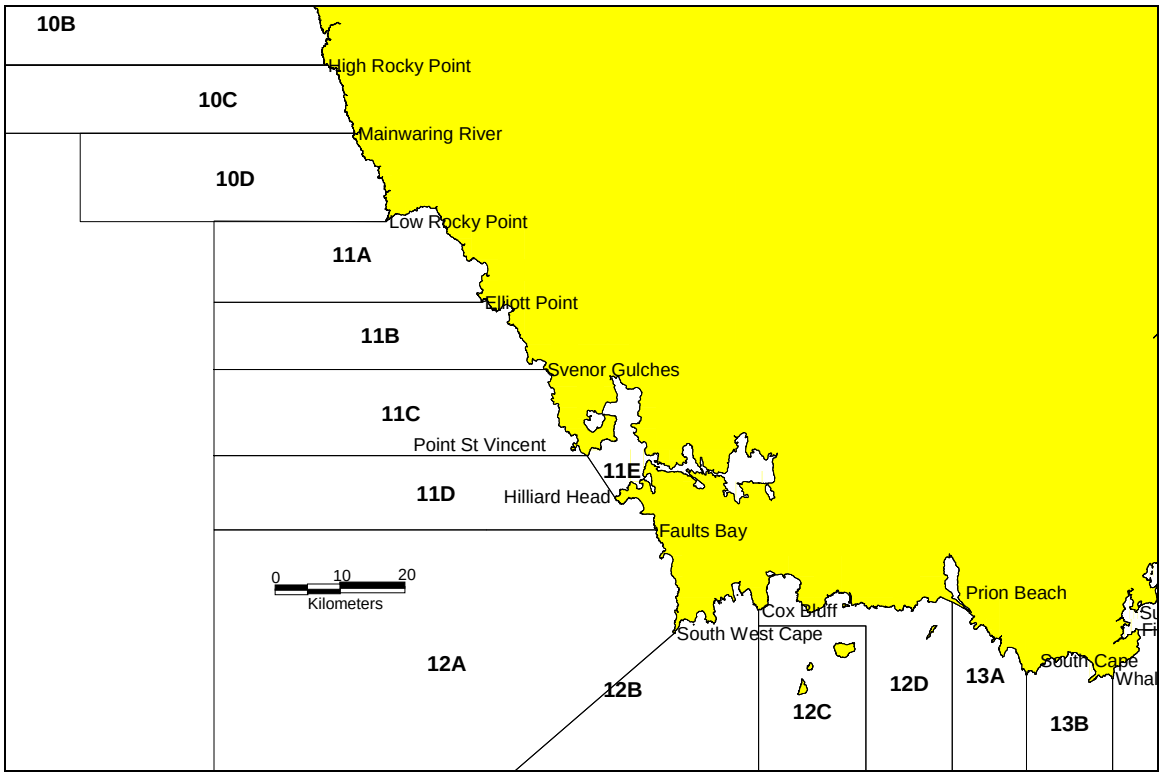
Map 3: Central West Coast (north)



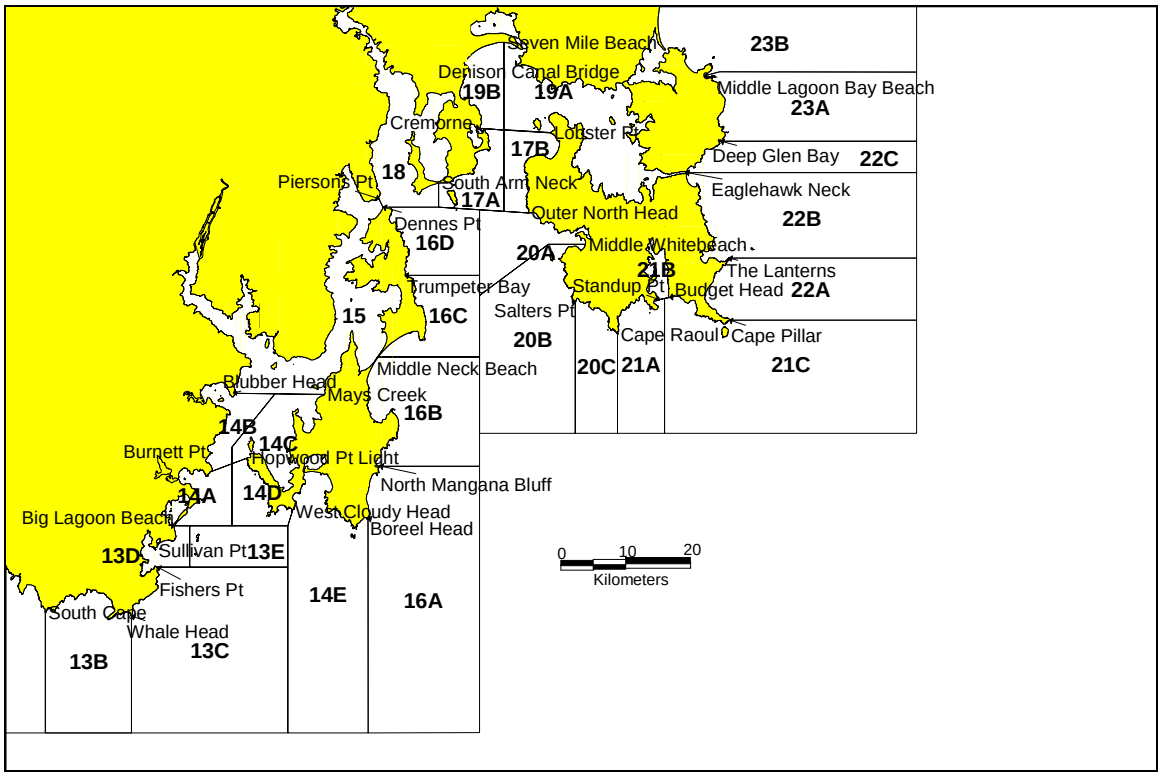
Map 4: Central West Coast (south)



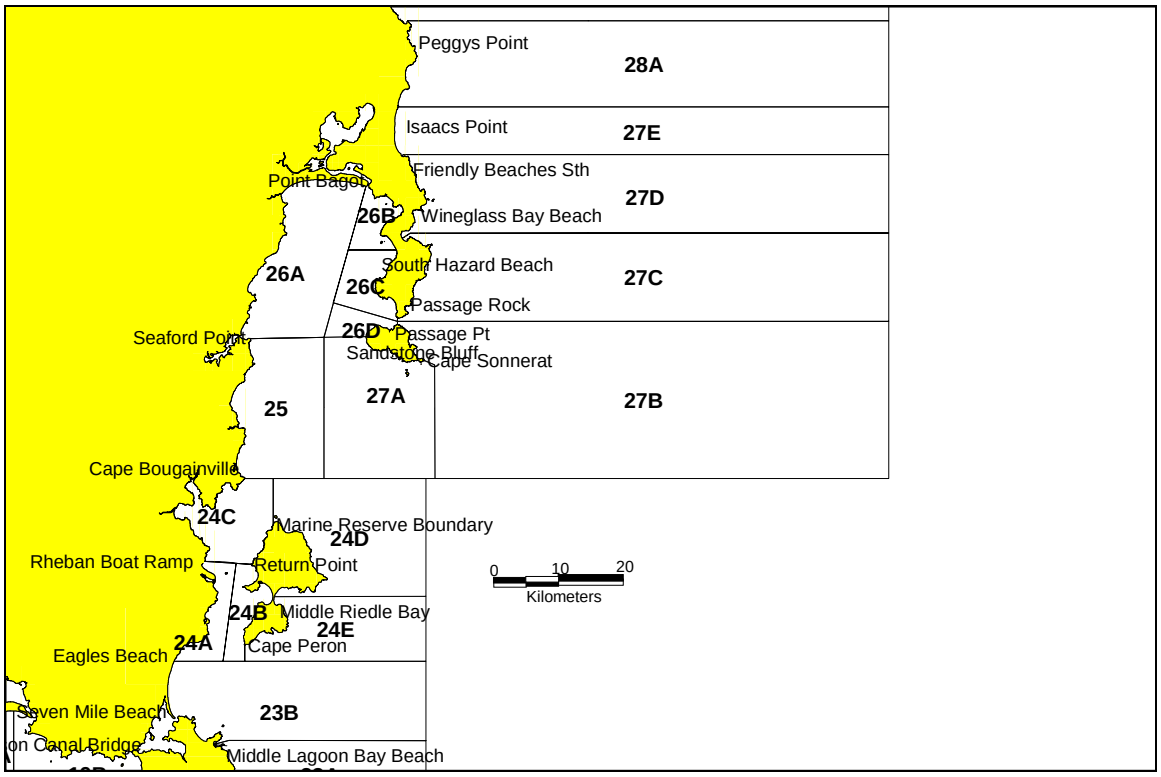
Map 5: South West Tasmania



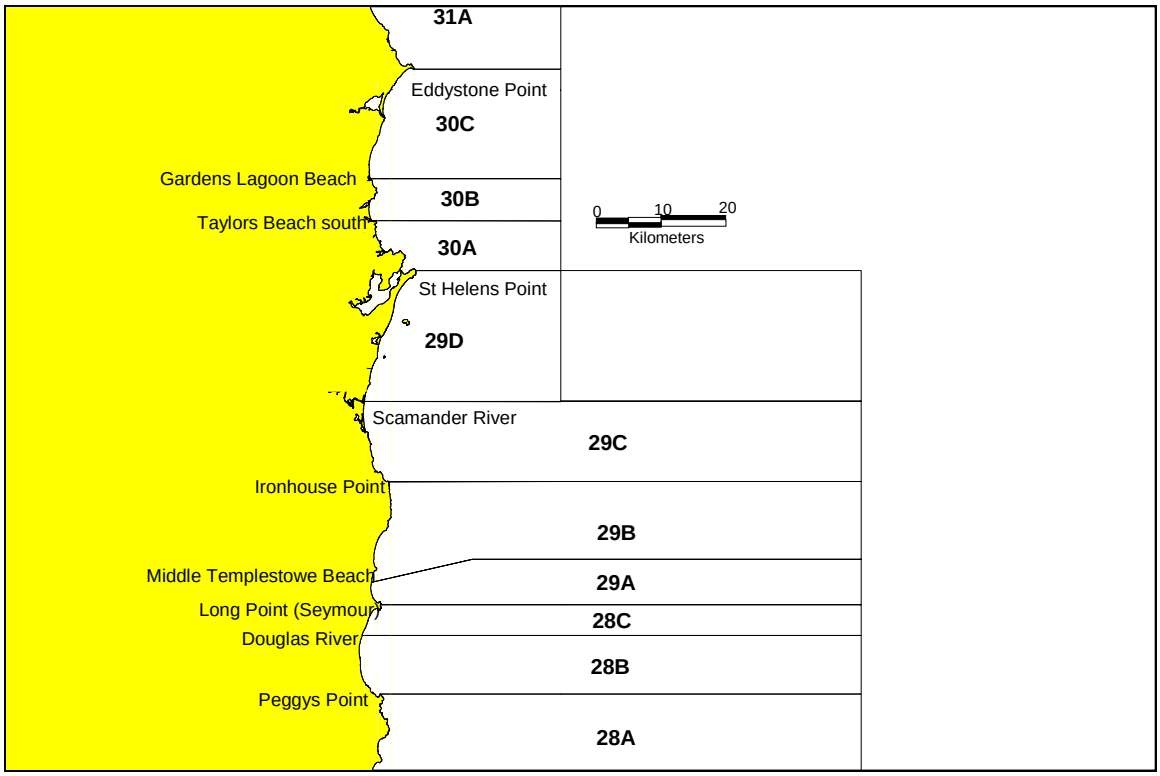
Map 6: South East Tasmania



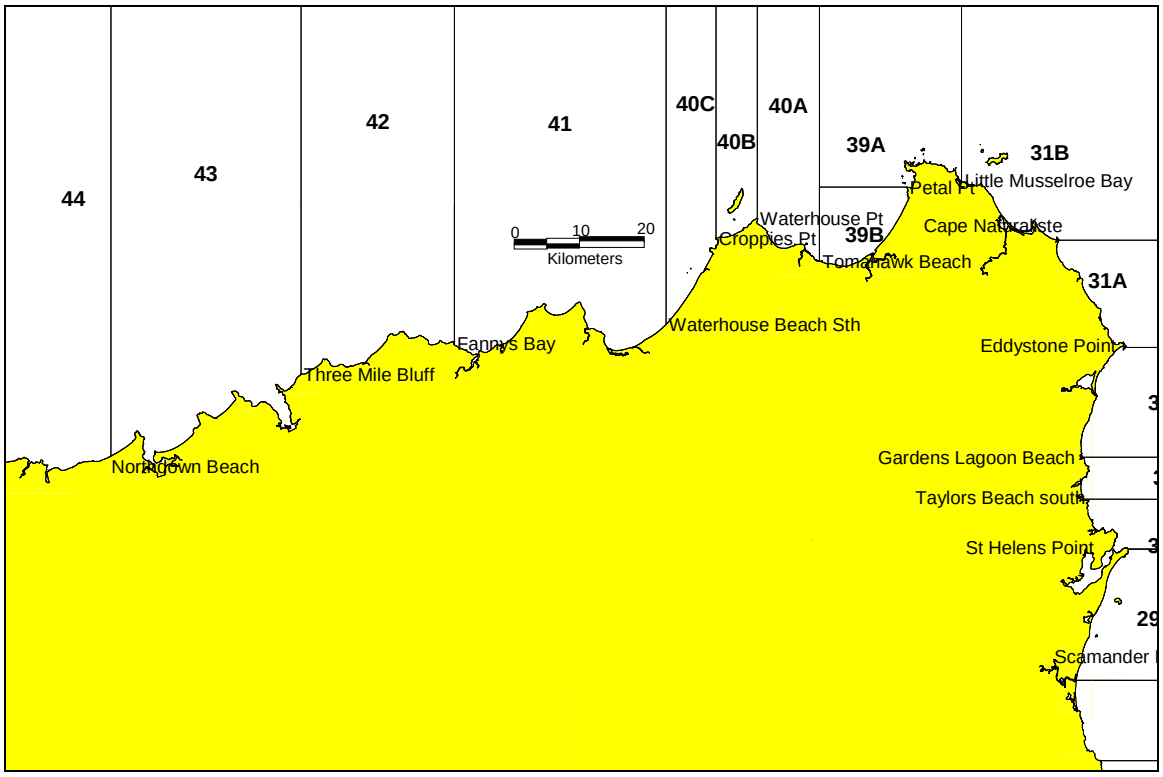
Map 7: Lower East Coast



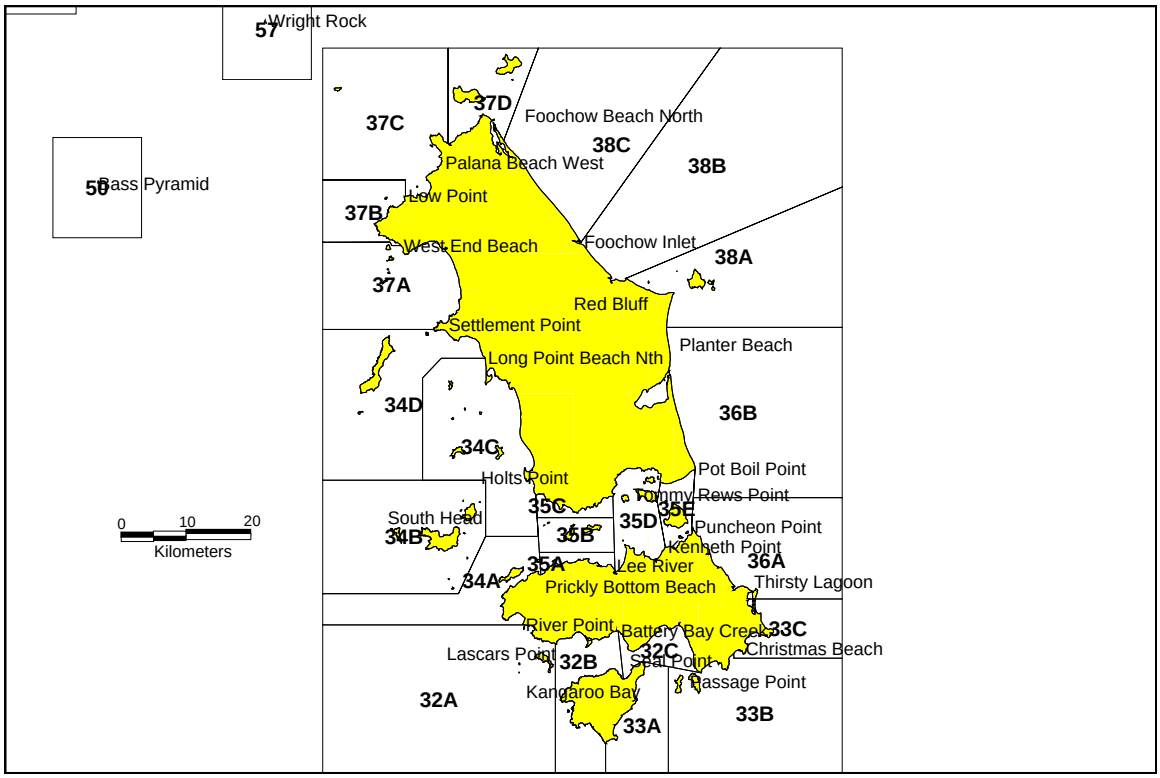
Map 8: Upper East Coast



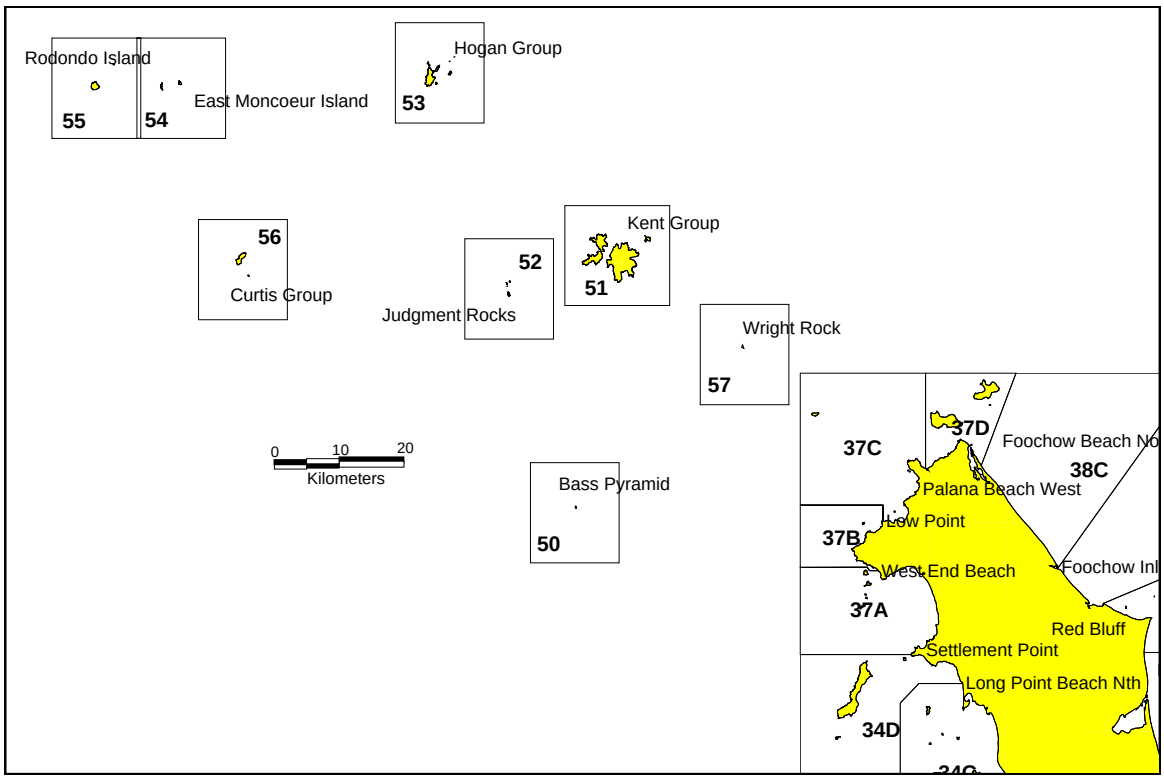
Map 9: North East Tasmania



Map 10: Furneaux Group



Map 11: Bass Strait Islands



Appendix 10: Questionnaire sent to licensed divers in 2005

A questionnaire was sent to all divers who held a commercial abalone license in 2005. It was intended partly to enable TAFI to develop a broader perspective of some of the issues affecting fishing and stock levels, but also to check that no part of the fishery that was experiencing stock problems was overlooked.

The following questions were asked:

1. What is your name? (Although we would like to know your name, you do not have to supply your name if you do not want to.)
2. Approximately how many tonnes of abalone did you catch in each zone in 2005?
    a) Eastern…….
    b) Western……
    c) Northern……...
    d) Greenlip……....
    e) Bass Strait……
3. Within each zone, where did you catch most of your fish? You can answer this question in several ways: by using block numbers (*e.g.* blocks 13 to 16), or regions (eg Actaeons and South Bruny) or the names of locations (*e.g.* Whale Head to the Friars).
4. In the areas where you caught most of your fish, would you say that 2005 stock levels were better than previous years, were much the same, or were worse. Answer this question by writing better, same or worse next to the areas you supplied in question 3 above.
5. If you fished in the **Western** Zone, were there any places where you had to leave large numbers of abalone because they were too big? Where were these places?
6. If you fished in the **Eastern** Zone, were there any places where you had to leave large numbers of abalone because they were too big? Where were these places?
7. Are there any places which concern you because numbers of undersized fish are low?
8. Is there any other information about stock levels that you think we should know about?

Replies were received from 28 divers. Because of the open-ended nature of the questions, the responses were not readily summarised. However, the following information can be reported.

Question 2: the respondents landed a combined total of approximately 756t in 2005, or about 30% of the State's catch.

Question 5: 20 respondents said that they landed all legal-sized abalone from the Western Zone, four did not answer the question or replied not applicable because they did not fish there, three supplied one location where they had left large abalone and one supplied multiple locations where abalone were too large to be taken.

Question 6: 23 respondents said that they landed all legal-sized abalone from the Eastern Zone, four did not answer the question or replied not applicable because they did not fish in the Eastern Zone, and one replied with multiple locations where abalone were too large to be taken.

We would like to thank all respondents for completing the questionnaire.

Acknowledgements

In recent years, abalone divers' catches have been frequently sampled at Tasmanian Seafoods Pty Ltd, Coastal Waters Seafoods Pty Ltd, Seafood Traders Pty Ltd, and Ralph's Tasmanian Seafood Pty Ltd. These operators, and processors where sampling has taken place less frequently, are thanked for their cooperation.

We sought and received specific advice, particularly about stock levels, in the more isolated parts of the fishery from a number of other people whom we would like to thank for the time and help that they provided to us.

A draft copy of this assessment was provided to the Abalone Stock Assessment Group for comment (ABSAG). Specifically, ABSAG members were asked to comment on catch rates and trends (in particular any anomalies) in certain areas of the fishery with which they were most familiar. Information provided by ABSAG members was incorporated into this report. In 2006 the Abalone Stock Assessment Group included the following people:

Assoc. Prof. Stewart Frusher	TAFI (Chairman)
Dr Philippe Ziegler	TAFI (Secretary)
Assoc. Prof. Malcolm Haddon	TAFI
Mr Allen Hansen	Tasmanian Abalone Council
Mr Andrew Bartle	Tasmanian Abalone Council
Mr Roger King	Tasmanian Abalone Council
Mr Dean Lisson	Tasmanian Abalone Council
Mr Paddy Maguire	Tasmanian Abalone Council
Dr Craig Mundy	TAFI
Mr Andrew Sharman	DPIWE
Mr David Tarbath	TAFI
Mr Nigel Wallace	Tasmanian Abalone Council
Mr Greg Woodham	Tasmanian Abalone Council

Ms Fay Helidoniotis, TAFI, attended as an observer.