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**FISHERY ASSESSMENT REPORT**

TASMANIAN ABALONE FISHERY

2006

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# Abalone Fishery Assessment: 2006

## Executive summary

In 2006, the combined TAC for the Tasmanian abalone fishery was 2502.5t, comprising 770t in the Eastern Zone, 1260t in the Western Zone, 280t in the Northern Zone, 70t in the Bass Strait Zone, and 122.5t in the greenlip fishery.

The 2006 Abalone Fishery Assessment was based primarily on commercial catch and effort data 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 and Water (DPIW), and screened by the Tasmanian Aquaculture and Fisheries Institute (TAFI). 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 obtained primarily by TAFI research staff, with additional samples provided by abalone divers. Changes in median length of commercial catch samples assisted with interpretation of trends in stock status.

In summary, the major findings of this assessment were: (a) that the Eastern Zone stocks had the appearance of acceptable recovery, however, improvement in catch rates was at a catch level 400t less than in earlier years. In addition, expected recruitment in 2008 and 2009 may be less than average in the short term and therefore a cautious approach is required when considering the potential for increased catch over this period; (b) that Western Zone stocks in the South West have continued to fall and a reduction in catch in this area is required.

## Eastern Zone

There has been a consistent increase in catch rates during the last 2-4 years, with increased median length in many areas implying reduced fishing pressure. Divers report fewer drops per catch and greatly improved fishing. All four regions (Actaeons, Bruny, Storm Bay and the East Coast) appeared to have recovered from the depleted levels caused by overfishing both prior to and during the earliest years of zoning. However, due to the extent of the stock decline in the early part of the century, there remains a risk that recruitment may fall to lower levels in the next few years. For this reason, it is recommended that a cautious approach be taken to rebuilding stocks in this Zone.

## Western Zone

Catches and catch rates appear to be stable in the North West and Central West, suggestive of stable stock levels. Increasing median lengths of abalone from catch samples in the Central West suggest that fishing pressure has been reduced and/or that selective fishing was not as prevalent. Diver reports indicated that stock levels were low but starting to recover in the North West, and were at moderate levels in the Central West.

Catch rates have continued to fall in the South West. Other indicators (number of drops, diver fishing patterns, diver sentiment) also suggested that stock levels were falling.

The intermittent nature of the fishery here meant that abundance was probably falling at a faster rate than catch rate trends otherwise indicated. The higher priced live market will continue to direct excess effort both here and to the South Coast unless catch is restricted. The data suggest that catch levels in the South West are too high and are leading to significant depletion which will need to be curtailed to maintain catch rates and profitability.

Levels of catch from the South Coast remain high while catch rates have stabilized at a relatively low level for this region. Falling median lengths also indicated that fishing pressure remained high. Smaller median length and reduced catch rates suggested that at current levels of annual catch there will be limited stock rebuilding and limited resilience to selective fishing, reductions in recruitment, or other perturbations.

Management options for the Western Zone include:

- *Status quo*. The “do nothing” option has prevailed until now, but has led to falling stock levels.
- Imposing catch limits on both the South Coast (no greater than 2006), and South West (at a level lower than the 2006 catch). This will redirect effort to the Central West and North West which, although now apparently stable, have experienced falling catch rates at higher levels of catch. The effects of increased catch in these regions may be mitigated if the exploitable biomass in the North West is increased by reducing size limits. Note this is unproven and the potential biomass increase is unknown.
- A combination of TAC reduction and catch limits on the South Coast and South West. This option is most likely to promote sustainable fishing in these regions.

### **Northern Zone**

The annual blacklip catch on King Island fell to about two thirds of recent levels. Shallow-water King Island stocks have been depleted in recent years, but deeper-water stocks were reported to be abundant. Quarantine restrictions on the movement of abalone between King Island and mainland Tasmania and the inherent difficulties faced by non-resident divers working on the island are likely to maintain catches below the peak levels of 2003-2005, which caused the shallow water depletion.

An increase in catch was taken from the other regions, particularly the North West, which supplied over half the Northern Zone TAC in 2006. Catch rates remained stable in most parts of the Northern Zone. A major exception was in Block 5 in the North West, where catch rates in the southern part fell sharply. On some parts of this coast, large numbers of undersized abalone were reported, and it has been suggested that reducing the size limit would make more stocks available while meeting the requirement of the two-year minimum legal length guideline. Similar views have been expressed about other parts of the Northern Zone, particularly the Furneaux Group and North East, where stock levels were reported by divers as ‘adequate’. Additional growth and size-at-maturity data will be required in these areas to support any change.

In the Northern Zone it is recommended that management adopt a precautionary approach, particularly if increased levels of catch are to be taken from the North West in the future. Management options would include lowering size limits to increase

exploitable biomass (within the limits of the two-year minimum legal length guideline), and/or maintaining strict limits on regional or block catches to prevent overfishing.

### **Bass Strait Zone**

In the Bass Strait islands catch rates continued to fall, although stock levels were reported by divers to be at satisfactory levels. The economic viability of this fishery may depend on catch rates continuing at current levels. In the Furneaux Group and on the Central North Coast, catch rates were low, and stock levels were reported to be low. Continued fishing at 2006 levels will further deplete stocks.

The Bass Strait Zone was closed for 2007, and there are no pressing requirements for the management of catch and effort in 2008. If a worthwhile increase in catch could be demonstrated, size limits in the Furneaux Group and the Central North Coast could be reduced further under the two-year minimum legal length guideline.

### **Greenlip**

Stock levels appear stable in the North West and North East. At Perkins Bay, a 20t catch cap is needed to maintain egg production levels at a size limit of 132mm. On King Island, stocks of legal-sized greenlip abalone have declined and divers there have suggested reducing the cap to 25t. In the Furneaux Group, stocks of large abalone are inadequate to meet market demands.

Management options for Greenlip include:

- Imposing a cap of 20t on the Perkins Bay fishery.
- Maintaining the *status quo* or reducing the King Island cap to 25t to prevent stock decline.
- Investigating ways of enhancing stock levels of large greenlip abalone.

### **Other catch**

The recreational fishery for abalone in Tasmania is small but increasing by about 10% pa. In July 2007, the number of recreational abalone licenses issued for 2006-2007 was 12,521. The estimated annual catch was approximately 70t, most of which was caught in the south-east or east. This small increase in the level of catch was considered unlikely to detract from the sustainability of commercial abalone fishing in the Eastern Zone.

Abalone are caught in Tasmanian waters as part of cultural fishing activities by indigenous people, but there is currently no estimate for the total catch from cultural fishing.

Abalone are also taken under permits for research and other purposes. The quantity of abalone taken under permits was less than one tonne in 2006.

Finally, abalone are also taken during illegal fishing operations but there are no estimates available of the catch.

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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. This has been supplemented with information from a secondary source: changes in the median length of abalone sampled from the commercial catch and grouped across relatively fine spatial scales. Combined with changes in median length, trends in catch rates are useful indicators of changes in abalone populations.

The use of catch and catch rates to monitor changes in abalone abundance has often been criticised as unreliable and elsewhere is infrequently used. In theory, the fishing of abalone aggregations, serial depletion and improvements in fishing efficiency (effort creep) are likely to contribute to the failure of catch and catch rates to correlate with abundance. These factors are considered more serious in areas where effort and catch are low. When abalone populations are intensively fished, aggregations are unable to develop, and the high visitation rates prevent stock build up and subsequent serial depletion. The confounding effects of effort creep may be reduced by using short-term catch and catch-rate trends to assess changes in stock levels. Under circumstances of high fishing pressure and short-term time series (e.g. 10 years), catch and catch-rate trends appear to reflect changes in abundance.

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 10t or more in any one of the years since 2000, with the proviso that six or more divers contributed to the annual catch.

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

Catch rate changes are reviewed by using geometric means of catch rates. 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 therefore a more reliable estimator 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 events that were adversely 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 and interpreting 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 show the location of each of the areas under review.

## 2. Landed Catches, 2006

At the end of 2006, annual landings comprised 2380.396t of blacklip and 122.281t of greenlip, a total of 2502.677 t from a TAC of 2502.5 t (Table 1).

**Table 1. 2006 landings by zone, in tonnes**

Zone	2006 TAC	2006 Landings
Greenlip	122.5	122.281
Eastern Blacklip	770.0	770.616
Northern Blacklip	280.0	279.334
Western Blacklip	1260.0	1260.842
Bass Strait Blacklip	70.0	69.604

The zones, regions and statistical blocks from which the 2006 commercial catch was reported or which are referred to in this document are shown below (Figure 1; for sub-blocks see Appendix 9). The zone boundaries and reporting blocks are as follows:

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

**Western Zone:** Arthur River to Whale Head, Sub-block 5D, Blocks 6 to 12, Sub-blocks 13A, 13B.

**Northern Zone:** Arthur River to Cowrie Point including King Island, Anderson Bay to Great Musselroe River, Sub-blocks 5A, 5B, 5C, part of 31B, Blocks 39 to 40, Blocks 47 to 49. In the Furneaux Group, Blocks 32 to 36, Sub-block 38A.

**Bass Strait Zone:** Cowrie Point to Anderson Bay, Blocks 41 to 46, 50 to 57. In the Furneaux Group, Block 37, Sub-blocks 38B, 38C.

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

### Regions

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 (Northern Zone): Blocks 32 to 36, 38A

Furneaux Group (Bass Strait Zone): Block 37, 38B, 38C

Bass Strait Islands: Blocks 50 to 56

Central North Coast: Blocks 41 to 46

King Island: Blocks 1 to 4

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

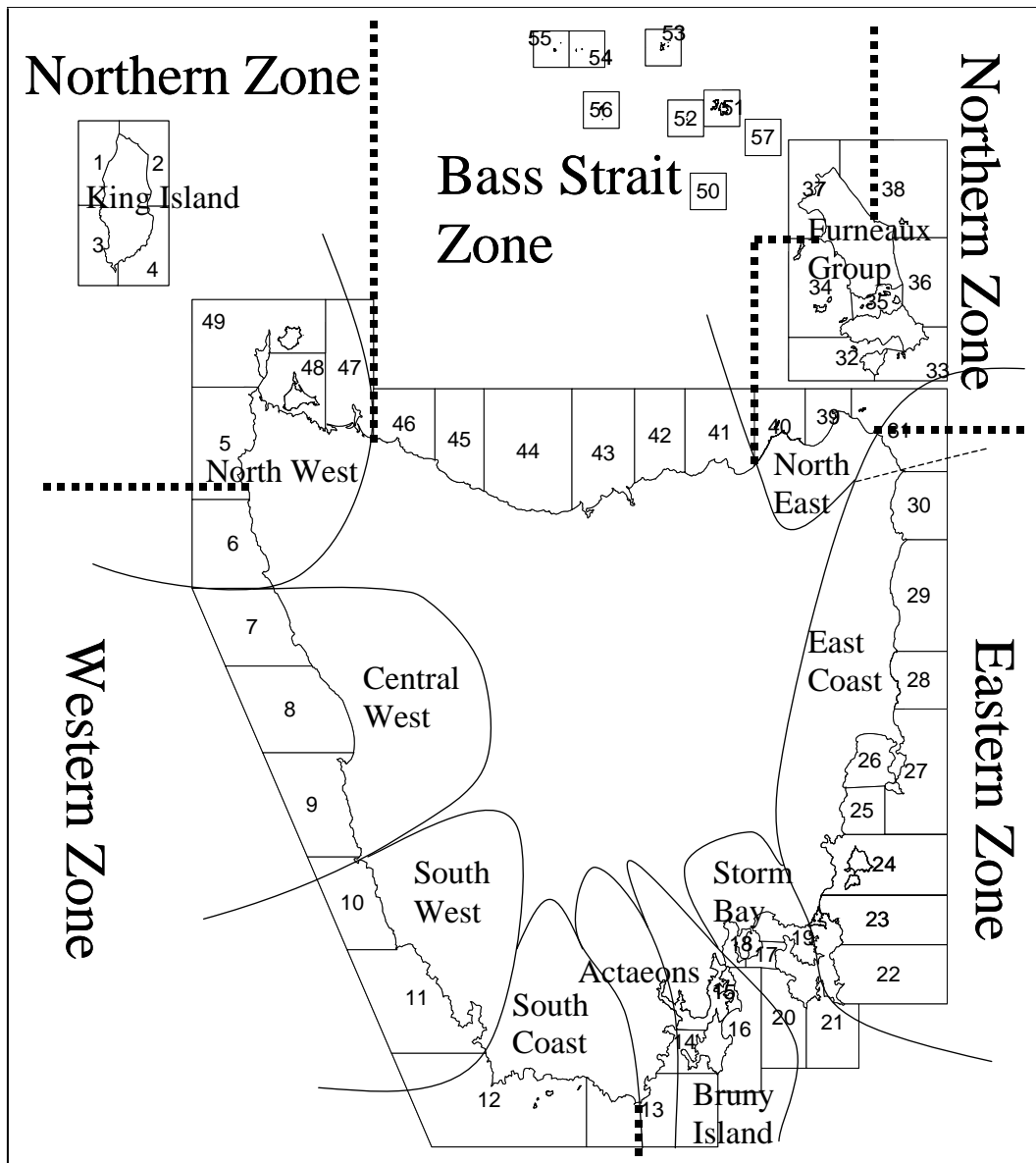
North West (Western Zone): Sub-block 5D, Block 6

Central West: Blocks 7 to 9

South West: Blocks 10 to 11

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 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 2006. 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 (*e.g.* gutters, sand-edges, shallow margins), and a large proportion of abalone may be found in only a small area of each reef (Prince, 1992). When these aggregations are fished, the remaining abalone tend to form new aggregations (Officer *et al.*, 2000), and thus reefs may become depleted while catch rates are maintained (McShane, 1995; Officer *et al.*, 2000). Similar problems among other commercially fished marine species are well documented (*e.g.* Hilborn and Walters (1992), Rose and Kulka (1999)).

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

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

Where abalone abundance is low, a consequence of aggregating behaviour is that the most favourable habitats can accommodate most of the population and the surrounding areas may be relatively sparsely populated. Provided effort is also low (*i.e.* diver

visitation rates are low), legal-sized abalone move to the favourable habitat (Officer *et al.*, 2000; Shepherd and Partington, 1995) between fishing events. Experienced divers can maintain catch rates by fishing the most favourable areas (Shepherd and Partington, 1995), and the CPUE/abundance relationship is again non-linear and hyperstable.

### *Serial depletion*

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

If management units are large and catch reporting occurs over large spatial scales, falling catch rates caused by depletion of individual reefs are masked when divers transfer effort to reefs with higher levels of abundance. If catch reporting occurred at the scale of individual reefs, the fall in CPUE that precipitated the divers' movements and the fall in catch indicative of depletion would be detected. In Tasmania, the recently introduced sub-block scale of reporting (Appendix 9) is an improvement, but is still too large to detect such fine scale declines in CPUE.

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

### *Change in fishing efficiency*

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

One of the features of commercial fisheries is that fishermen almost always find ways to make their operations more efficient, and the abalone fishery has been no exception. Thus, because of improved efficiency, if stock levels are unchanged, more abalone can be collected per unit time now than in the past *i.e.* catchability increases. This leads to a rise in reported catch rates without an associated increase in abalone abundance, or

alternatively, it can lead to catch rates appearing to be stable while the stock abundance is, in fact, declining. Two broad categories of causes of change in fishing efficiency have been identified in the Tasmanian abalone fishery – technological and behavioural.

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

Possibly the greatest single improvement occurred during the late 1980's when divers widely adopted the practise of attaching their collecting nets to ropes lowered to them by their deckhands (droplines) and they no longer had to surface to the boat every time they filled their nets. This increased efficiency because:

- (a) time spent ascending to the boat, unloading the catch and descending back to the reef was eliminated,
- (b) the diver maintained his position on the productive part of the reef,
- (c) catch bags could be reduced in size, which meant that divers could swim more easily and with less effort.

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

More recent technological changes to fishing operations include the increased use of GPS navigation systems 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.

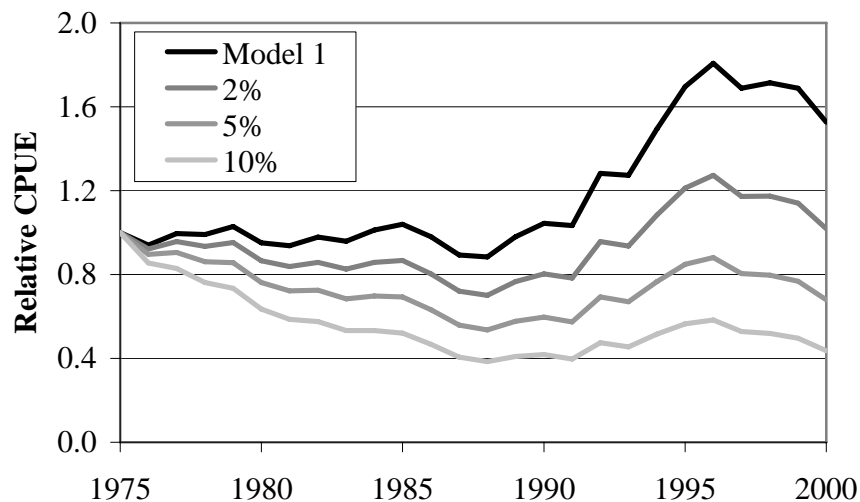
Changes in fishing efficiency due to behavioural causes, while not as obvious as technological causes, may have a profound effect upon catch rates. Competition between divers for fish or quota, or inducements offered by processors, or management changes, may all improve, or at least alter, the way divers 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 (Buckworth, 1987; Haddon and Hodgson, 2000; Harrison, 1983), a series of plausible effort creep scenarios was constructed. Extrapolation of Harrison's (1983) estimate of effort creep (approximately 5% p.a.) caused an overall reduction in relative CPUE over the study period *i.e.* by removing the confounding effect caused by improvements in diver efficiency, catch rates were higher in 1975 than they were in 2000 (Tarbath *et al.*, 2001). However, the overall relative trends in catch rate were only slightly altered when using the standardization (Figure 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 seven years. (The introduction of sub-blocks and consequent finer scale reporting in 2000 means that most comparisons at a finer geographical scale are currently limited to a seven-year period.) By reducing the period over which comparisons are made, it is

assumed to be more likely that changes due to improved fishing methods or diver behaviour are avoided, and there is more confidence that catch-rate trends represent changes in abundance, not changes in fishing power.

*Circumstances when catch rates are reliable indices of abalone abundance*

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

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

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

Because of past quota reductions, much of the Eastern Zone, particularly the northern part of the East Coast, has been fished at low levels of effort. This means that effort has been not been consistently applied to populations, allowing the formation of aggregations between fishing events, which may span fishing years. In addition, in recent years, catch levels have been dependent upon divers rotating effort and successively depleting reefs on much of the East Coast between Triabunna and Eddystone Point (Blocks 25 – 30). Under these circumstances, the relationship between abalone abundance and catch rates is almost certainly different than under conditions of constant levels of effort, and catch rate trends should be used with caution.

Much of Tasmania's greenlip fishery is fished under similar circumstances to the East Coast blacklip, reducing the value of catch rates for assessment purposes. However, there are two further problems to consider with the greenlip fishery. Firstly, it is evident that many divers are learning to fish greenlip abalone more efficiently, compounding the difficulty faced in interpreting the abundance/catch-rate relationship. Secondly, each region's greenlip catch is relatively small, with few participating divers. The entry or exit of a diver who catches at different rates from the others can change the region's catch rates (attempts at standardising effort by diver have proved unsuccessful). Throughout southern Australia, fishery managers have a long history of monitoring greenlip fisheries using fishery catch and effort data with a notable lack of success. The Victorian fishery collapsed, and fisheries in South Australia (Shepherd *et al.*, 2001), Western Australia (Hart *et al.*, 1999), and Tasmania (Officer, 1999) have all wiped out greenlip populations because CPUE trends provided inadequate warning of stock depletion. Consequently we have placed less reliance on a CPUE/catch-based assessment in these areas.

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

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

Catch rates increasing with increasing catches are likely to indicate an increase in fishable biomass. Examples include most of the east, south east and west coast blocks in the early and mid 1990's, and more recently, the Actaeons. It is expected that the median size will eventually increase, though a decrease is possible if the increased catch is due to large numbers of new recruits entering the fishery.

### **Size composition of the commercial catch**

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

Since 2000, diver's catches from around the State have been routinely sampled by TAFI research staff, mostly at fish processing factories, but occasionally at boat ramps and aboard boats. Most of the sampling has been from catches taken in the south east and east coasts, but catches from the north and west coasts have also been measured. The fish processing factories have included both canners and live-market traders. Catches are selected haphazardly, depending upon the availability of both catches and catch-samplers.

The aim of catch sampling is to provide information about the size-structure of the catch from fished abalone populations, independent of variation caused by a range of confounding effects. For example, divers' catches from the same sub-block on the same day may comprise abalone of widely varying lengths, caused by fishing populations with different growth characteristics. In the south east, the size-structure of catch samples may be influenced by seasonal growth rates, particularly when exploitation rates are low, and consequently samples collected during autumn and winter contain larger abalone than in spring and summer. Market preferences for abalone within a specific size-range will also be reflected in catch samples. There are also other more minor sources of bias relating to measuring errors, stemming from both the diver and the catch sampler.

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

For the purpose of this assessment, samples have been grouped by year and sub-block. Sub-blocks where less than 4% of catches have been sampled during more than two years have usually not been reviewed, because the level of sampling may be inadequate to reflect size-structure of fished populations. We have been unable to obtain adequate numbers of samples from the Northern Zone, the greenlip fishery, the Bass Strait Zone and much of the Western Zone. Landings from motherships are usually not sampled, because they mostly comprise catches from more than one sub-block and more than one day, and it is not possible to identify the sub-block from where the catch came.

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

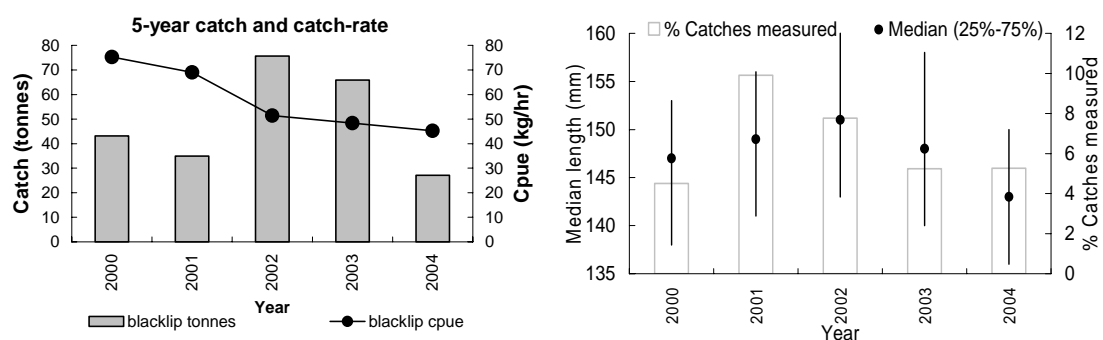
In the Eastern Zone, particularly the south east, the number of landings is much higher and effort is more evenly distributed across populations, thus reducing the effect of unusual catches. The size-composition charts of the south east blocks consistently show

similar trends, even those sampled at less than the 4% level. In particular, the median length of 2002 samples in almost all sub-blocks increased, in conjunction with the 4-mm size-limit increase that was applied in that year, regardless of the level of sampling. The relatively high median size of 1998 and 1999 samples and the fall in length since then is also common across sub-blocks where those years were sampled. This trend is consistent with known decreases in the available stock and confirms that the level of sampling is adequate to detect trends. The level of sampling in 1998-1999 can only be guessed at by applying catch numbers from later years, which suggests sampling was below 4% in many sub-blocks. (The level of sampling of pre-2000 catches could not be determined because although the sampled catch locations were known, all other catches were not reported by sub-block.) We conclude that the 4% level of sampling in the Eastern Zone is adequate, and that trends in median and inter-quartile lengths can reflect changes in the fished population size-structure.

### *Interpreting annual changes in median and inter-quartile lengths*

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

If abundance levels fall yet catch levels remain constant (*i.e.* exploitation rates rise), the average period of time between attaining legal size (recruiting) and being caught becomes shorter. Because abalone length is a function of time and growth rate, this means that overall growth is reduced, and the median length of the catch will fall. Under these circumstances, the 75<sup>th</sup> 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 25<sup>th</sup> percentile length would be expected to remain at similar levels to those seen in previous years. If exploitation rates further increase, then the 25<sup>th</sup> percentile length would eventually fall. As a further indication of falling abundance a corresponding reduction in catch and catch rate trends would be expected.

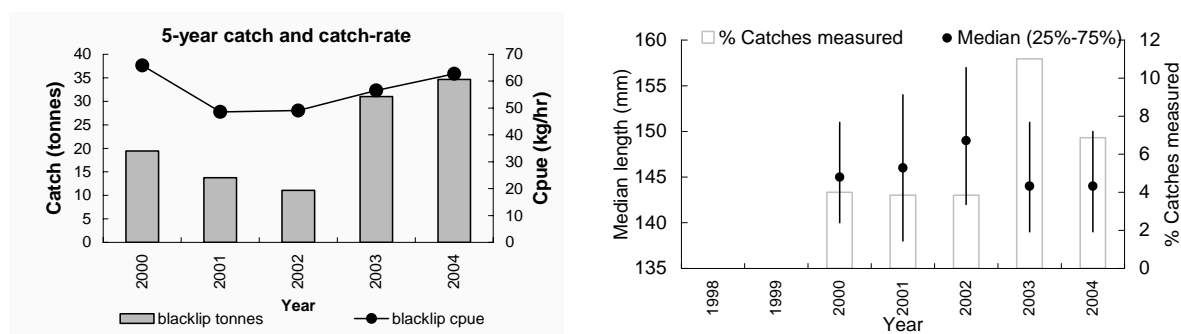


**Figure 3.** Trends in catch, catch rate and median length (flanked by the 25<sup>th</sup> and 75<sup>th</sup> percentile bounds), sub-block 13C, 2000-2004.

For example, in sub-block 13C (Whale Head to Fishers Point, Actaeons region) between 2002 and 2004, firstly catch rates and then catches fell, suggesting high exploitation rates (Figure 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 75<sup>th</sup> percentile fell sharply, consistent with a fall in the

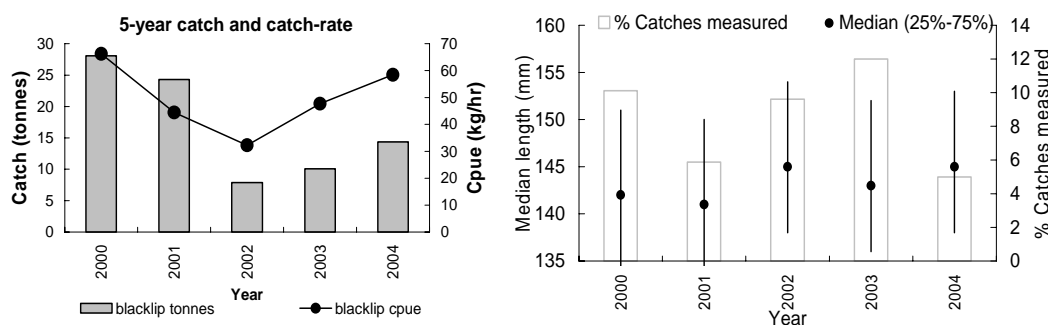
numbers of large abalone landed. In addition, in 2004, the 25<sup>th</sup> percentile declined suggesting a decline in recruitment. The catch and catch rate trends indicate that abundance here is low. All three indicators suggested unsustainable levels of fishing in 2004 (Figure 3).

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 25<sup>th</sup> percentile length could be expected to fall, but, unless the fishery was dominated by recruits, the 75<sup>th</sup> 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 25<sup>th</sup> and 75<sup>th</sup> percentile bounds), sub-block 20B, 2000-2004.

Increasing or stable median length, in conjunction with increasing catch and catch rates are strong indicators of rising stock levels. Catch rates and levels of catch in sub-block 24B (Maria Island) have started to recover since 2002 (Figure 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 (Figure 3), the size-structure has been maintained, indicating that the levels of fishing pressure currently appear to be sustainable.

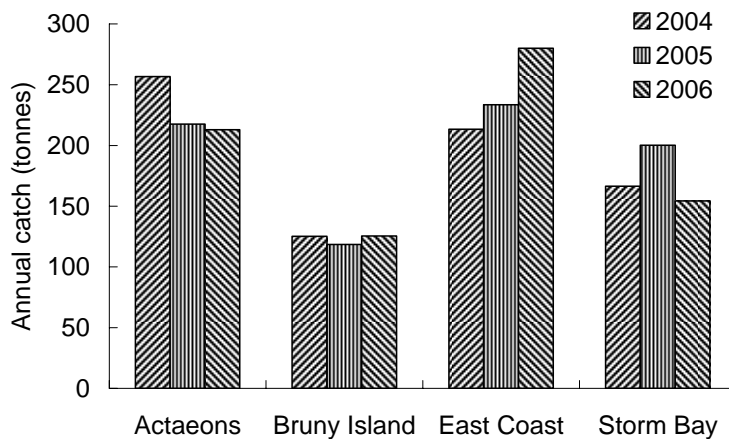


**Figure 5.** Trends in catch, catch rate and median length (flanked by the 25<sup>th</sup> and 75<sup>th</sup> percentile bounds), sub-block 24B, 2000-2004.

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

### Eastern Zone Blacklip fishery

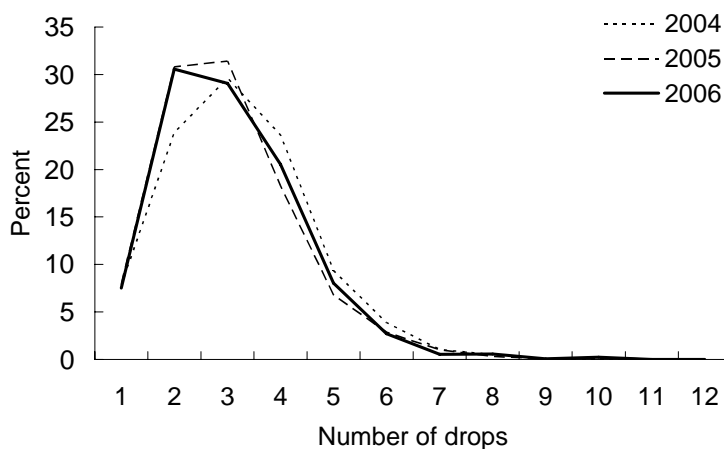
Since 2004, the Eastern Zone TAC has been held at 770t to promote the rebuilding of stock levels. During this period, there has been movement by divers away from the Actaeons, which had previously supplied a much greater proportion of the Eastern Zone catch.



**Figure 6.** Regional distribution of catch, by region, Eastern Zone 2004-2006.

The 2006 catch from the Actaeons and Bruny Island was at similar levels to the previous year (213t, 126t respectively). The East Coast catch has risen by approximately 70t over the past three years and is now 280t, while Storm Bay catch was lower by 46t at 154t (Figure 6).

The number of drops reported by divers fell slightly compared with the two previous years (Figure 7). In particular, there has been a clear modal shift from 3 drops to 2 drops per catch since 2004, which is interpreted as divers need to move less frequently to find abalone to maintain satisfactory catch levels (*i.e.* abalone are more abundant).

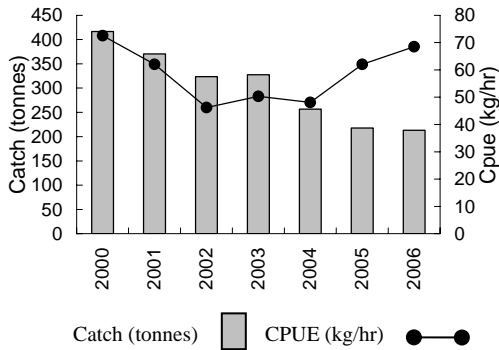


**Figure 7.** The number of drops reported by divers, Eastern Zone, 2004-2006.

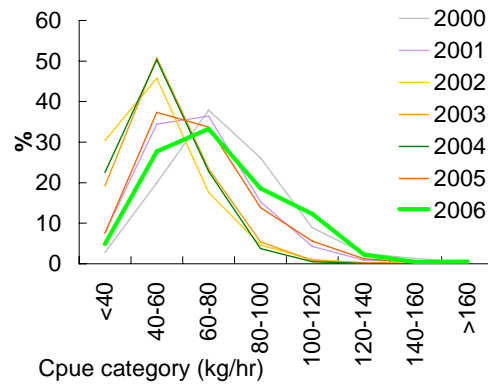
**Actaeons, Lower Channel (Sub-blocks 13C, 13D, 13E, 14A, 14B)**

**Catch and catch rates**

**Regional view:**

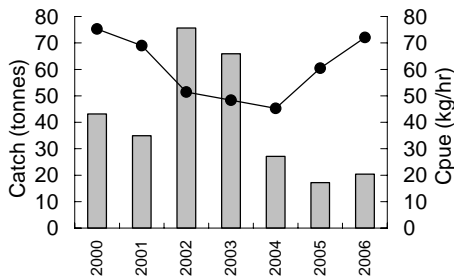


**CPUE distribution**



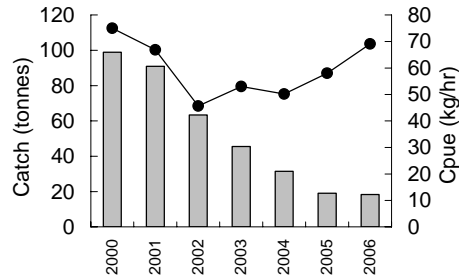
**Sub-block 13C**

**Fishers Point to Whale Head**



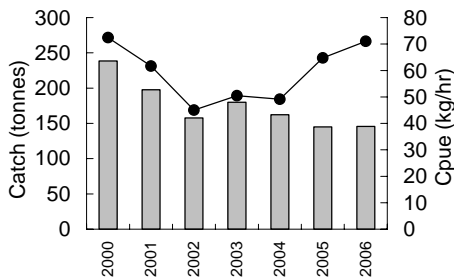
**Sub-block 13D**

**Fishers Point to Southport Lagoon Beach, including Recherche Bay**



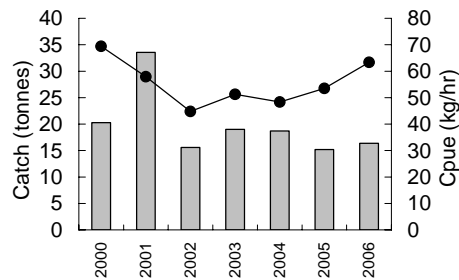
**Sub-block 13E**

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



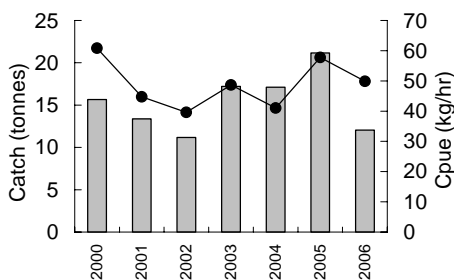
**Sub-block 14A**

**Southport Lagoon Beach to Burnett Point**

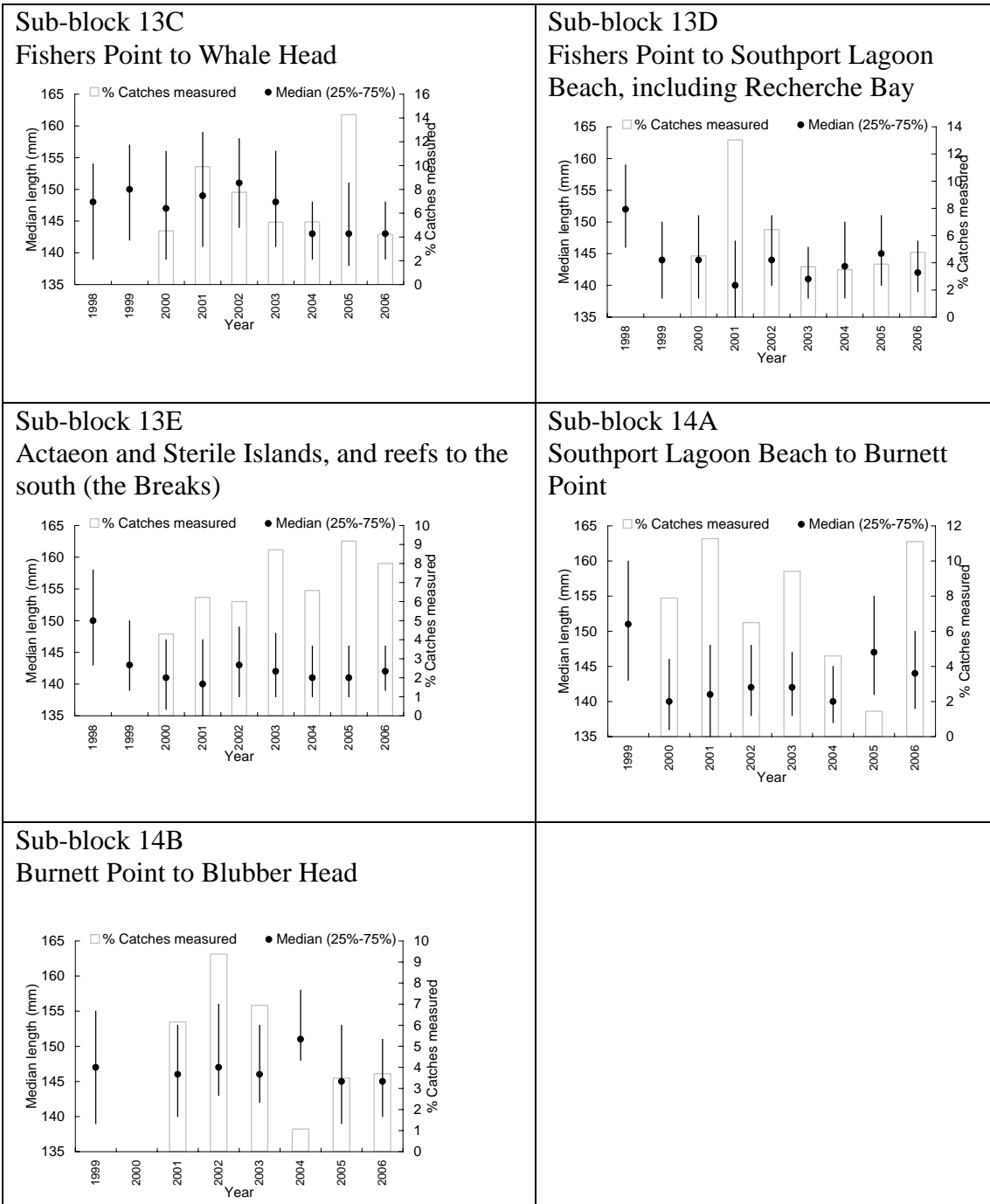


**Sub-block 14B**

**Burnett Point to Blubber Head**

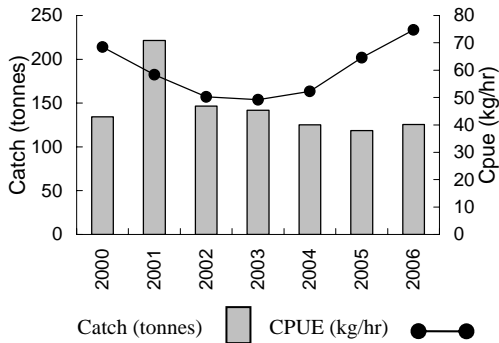


**Actaeons, Lower Channel (Sub-blocks 13C, 13D, 13E, 14A, 14B)**  
**Median length of catch**

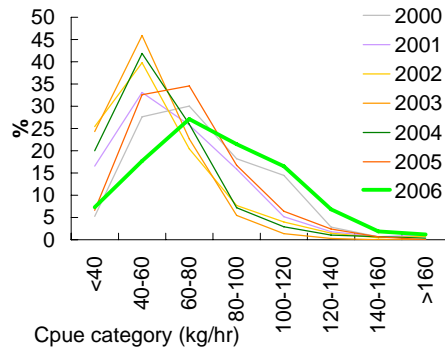


**Eastern Zone – Bruny Island (Blocks 14C, 14D, 14E, 15, 16).**  
**Catch and catch rates**

Regional view:

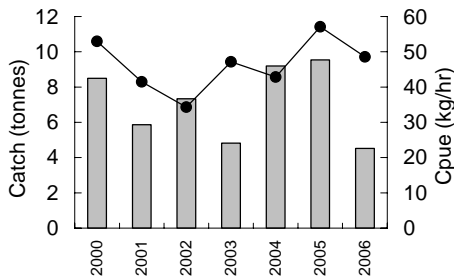


CPUE distribution



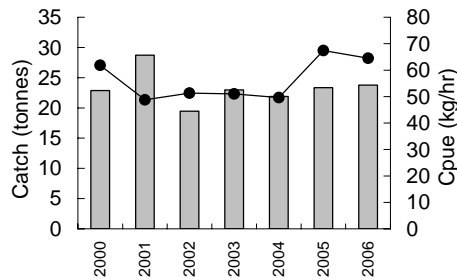
Sub-block 14C

Mays Creek to Hopwood Light (Lower Channel)



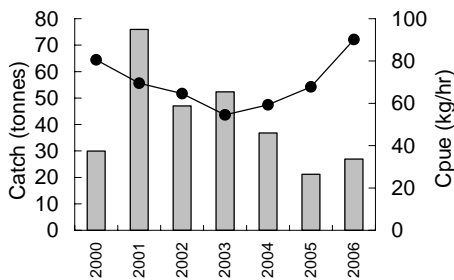
Sub-block 14D

Hopwood Point to West Cloudy Head



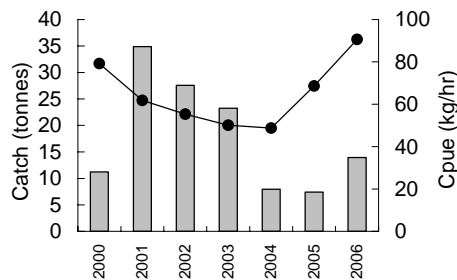
Sub-block 14E

West Cloudy Head to Boreel Head, including the Friars



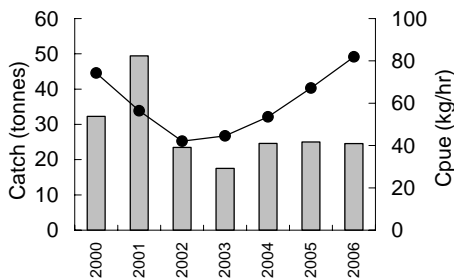
Sub-block 16A

Boreel Head to North Mangana Bluff



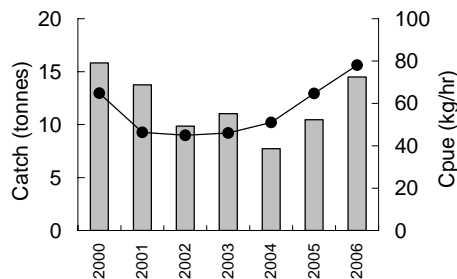
Sub-block 16B

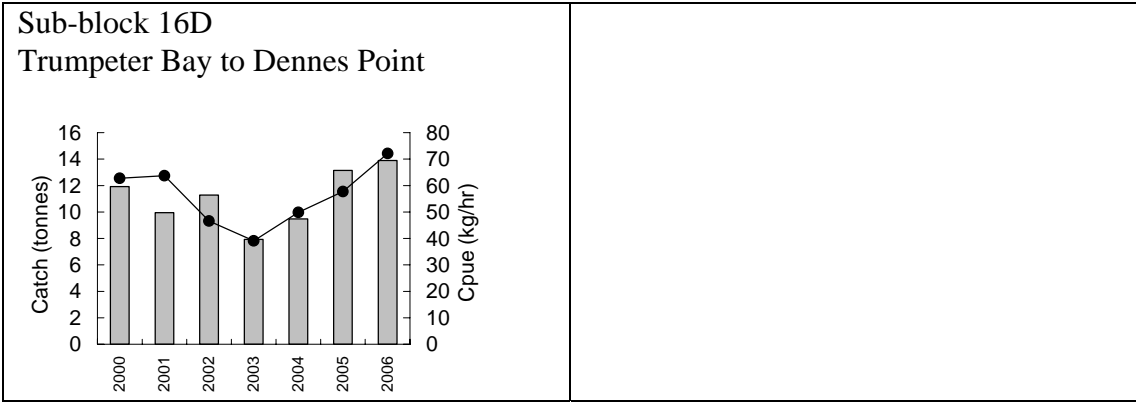
North Mangana Bluff to Neck Beach



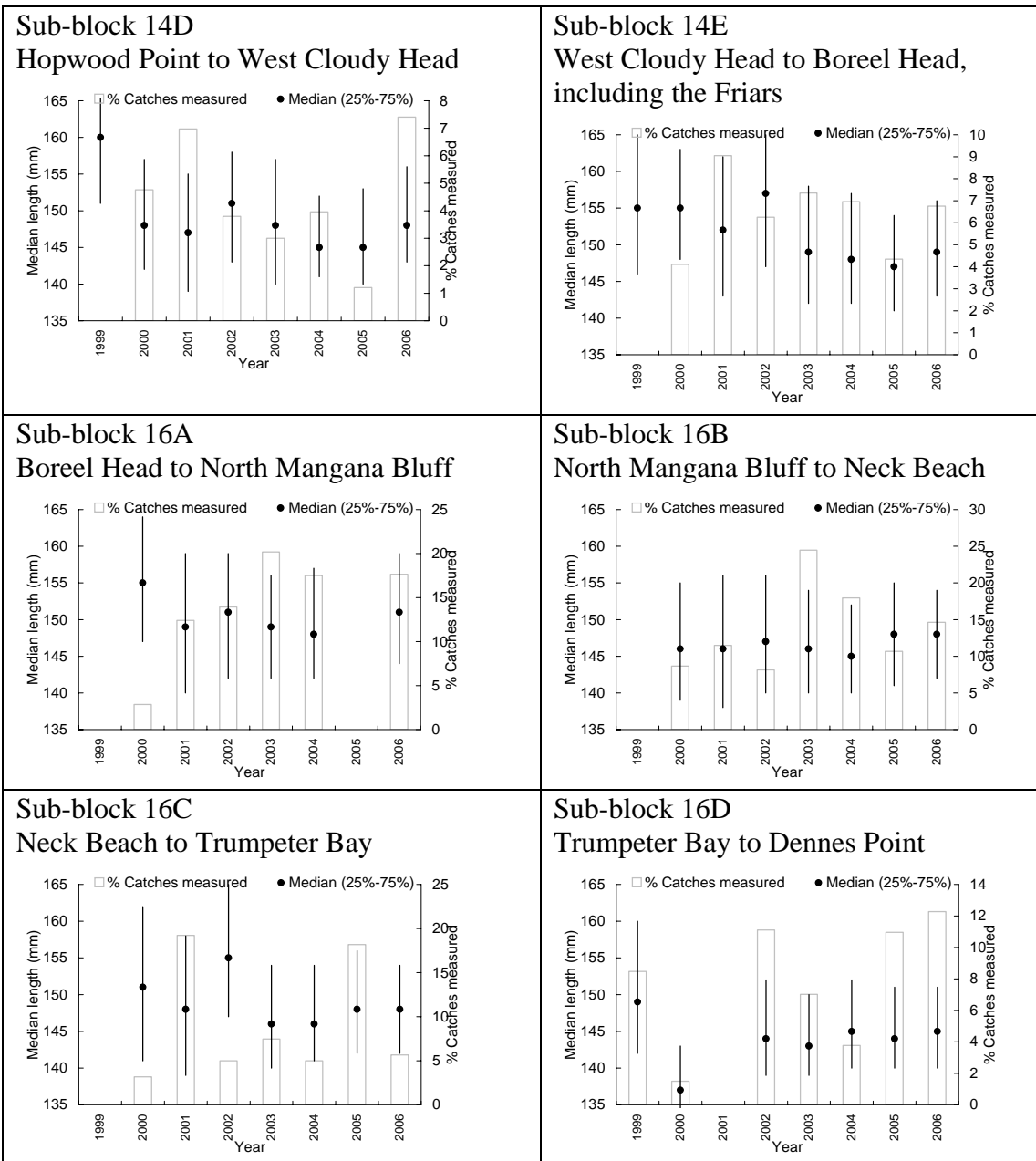
Sub-block 16C

Neck Beach to Trumpeter Bay

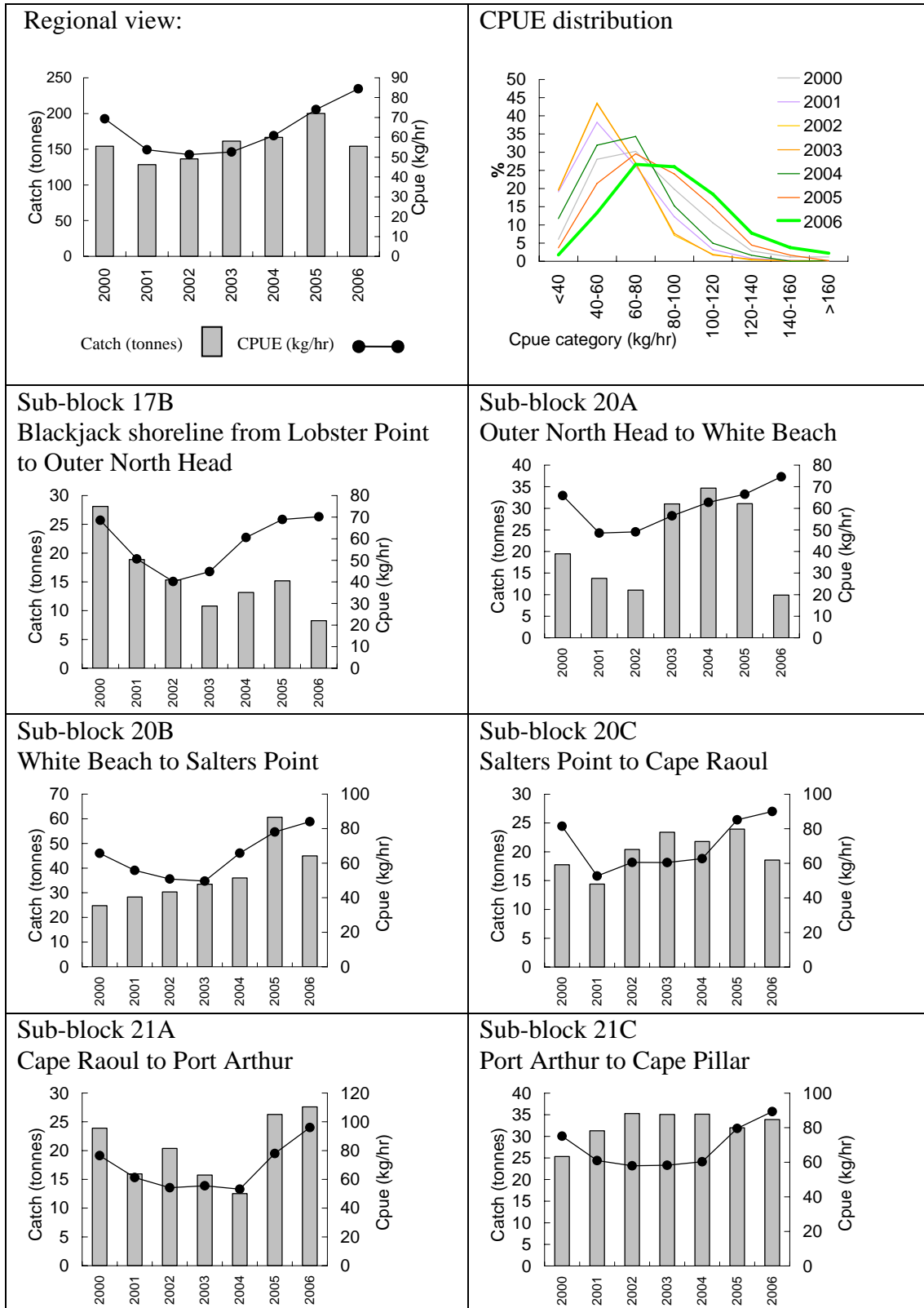




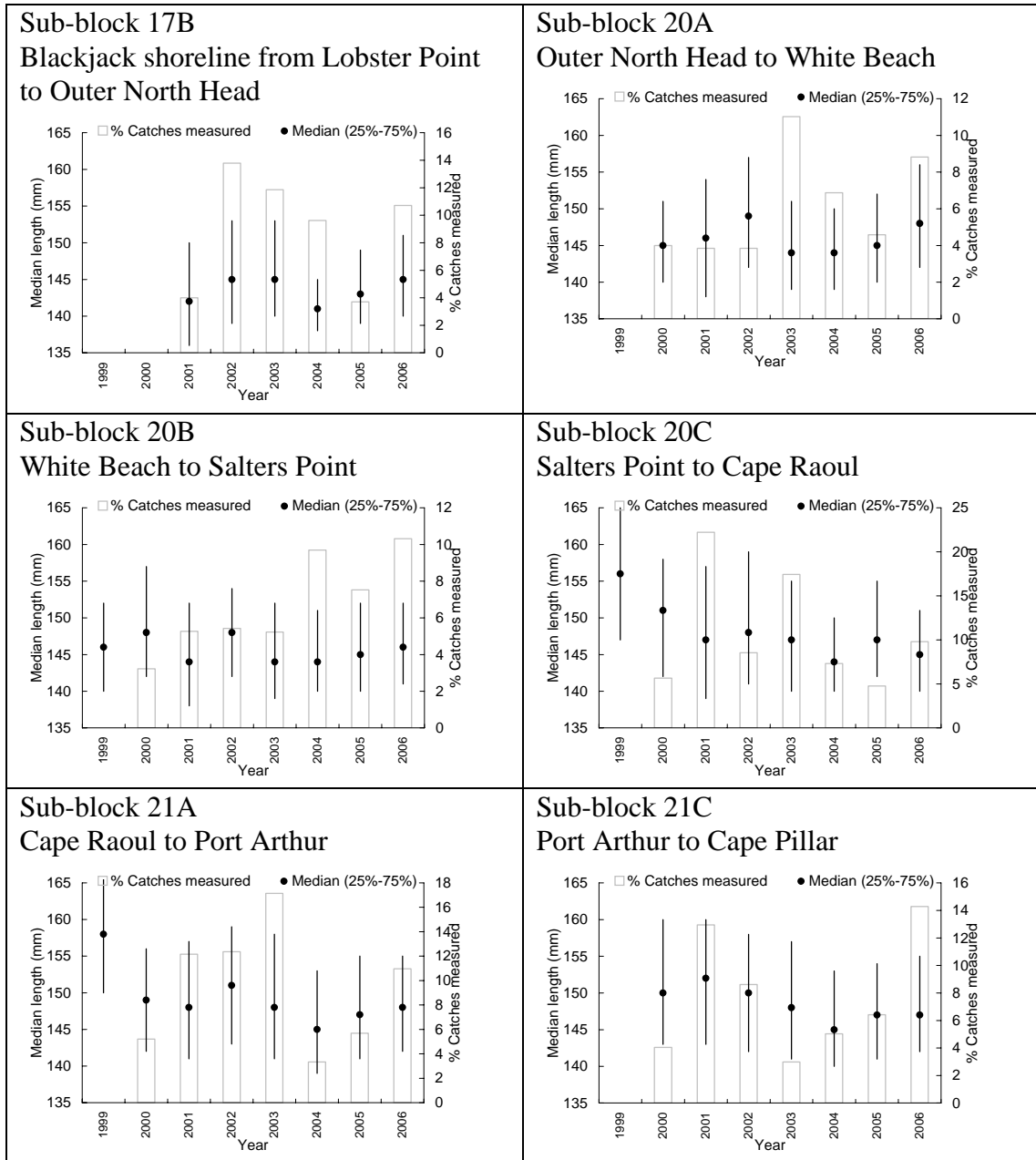
**Eastern Zone – Bruny Island (Blocks 14C, 14D, 14E, 15, 16).**  
**Median length of catch**



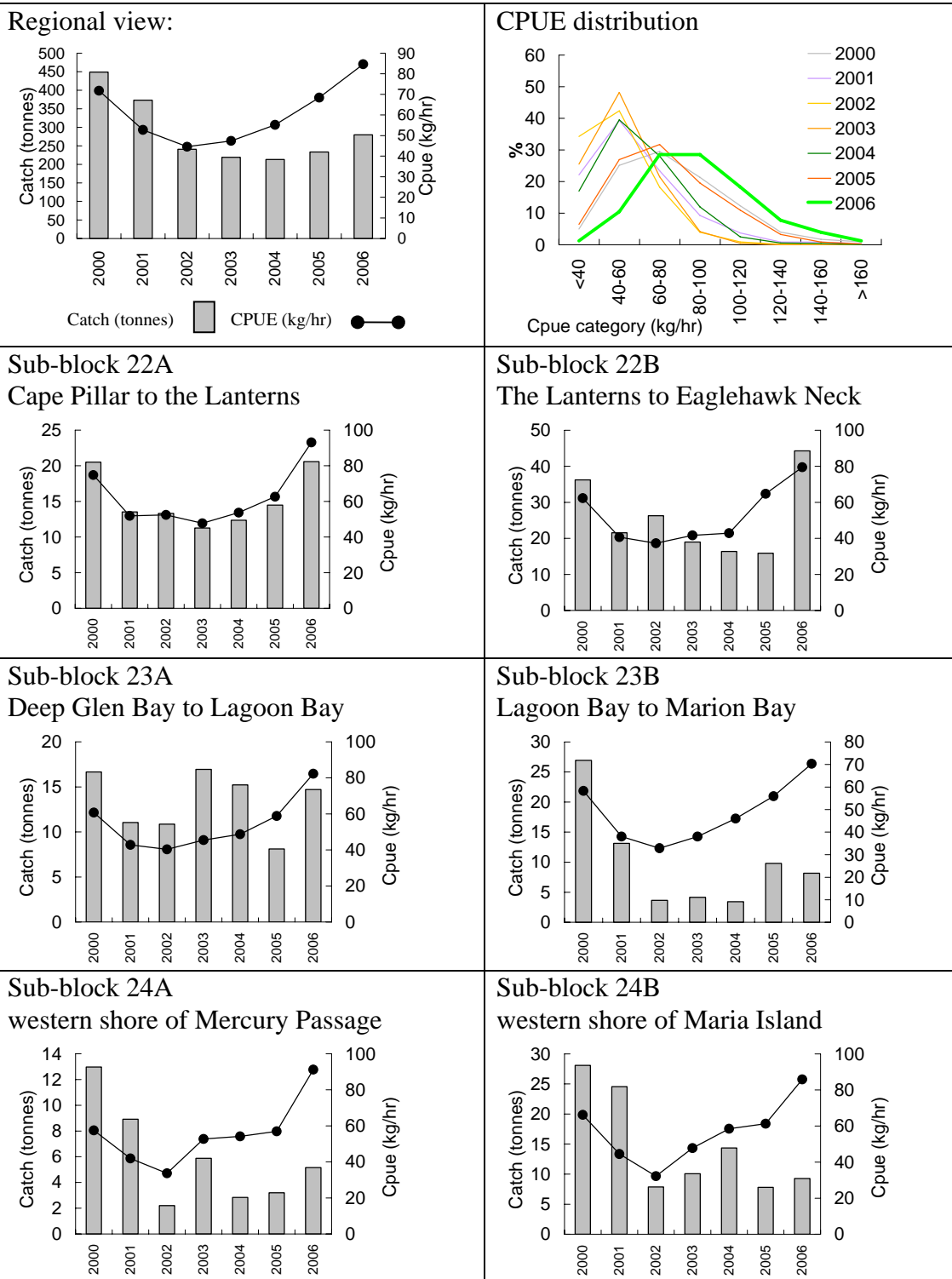
**Eastern Zone - Storm Bay (Blocks 17-21)**  
**Catch and catch rates**

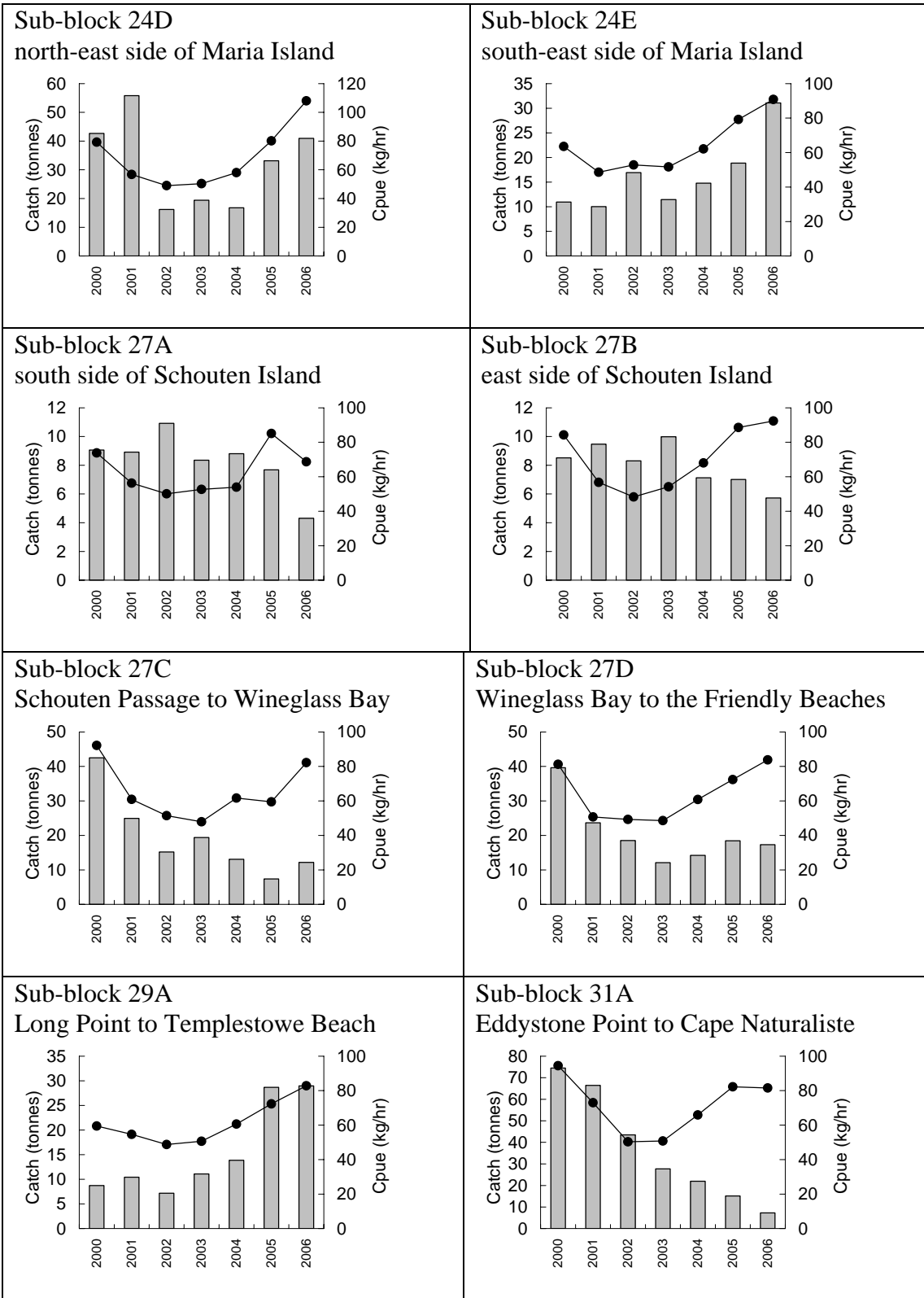


**Eastern Zone - Storm Bay (Blocks 17-21)**  
**Median length of catch**

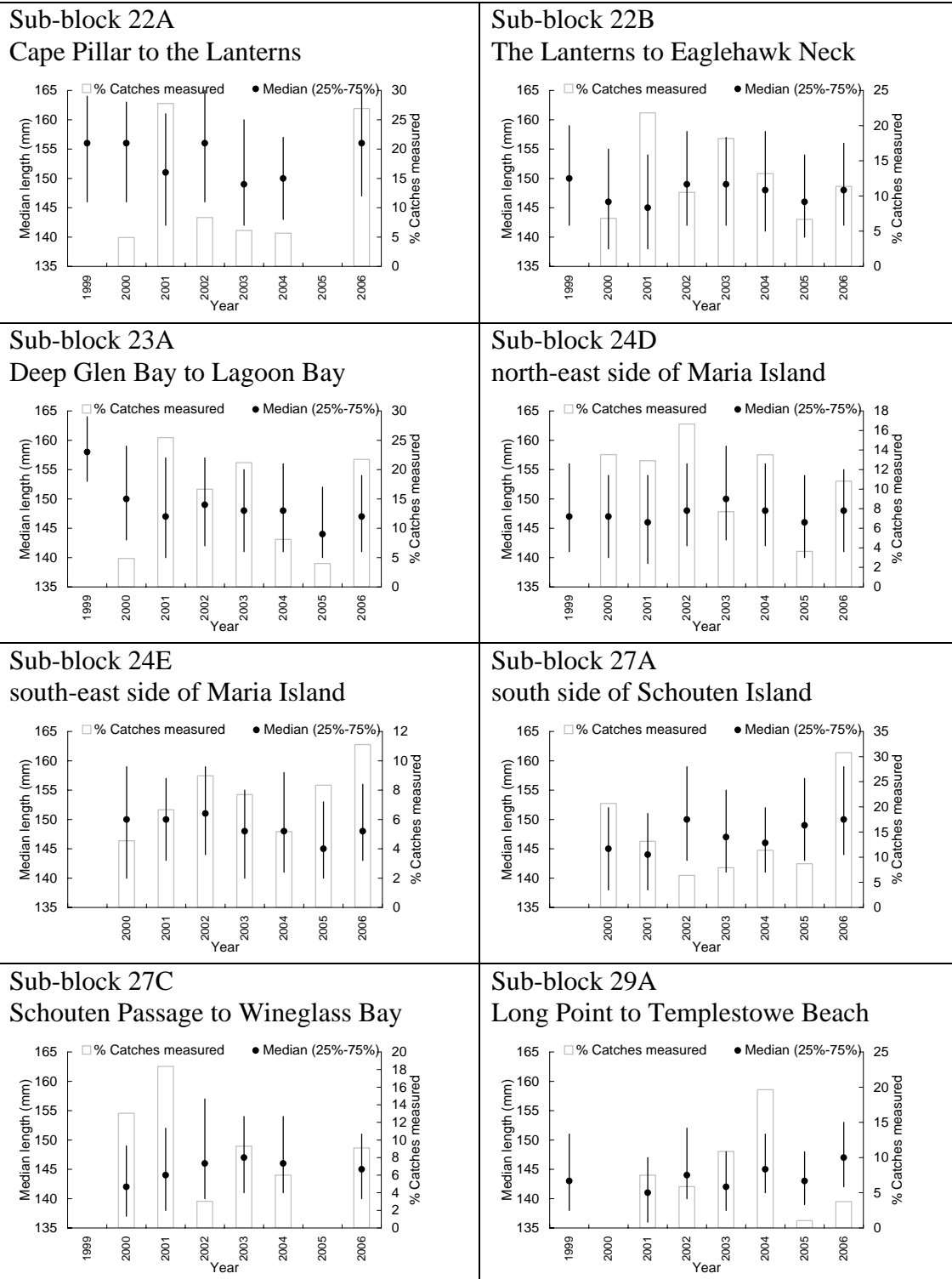


**Eastern Zone – East Coast (Blocks 22-31)**  
**Catch and catch rates**



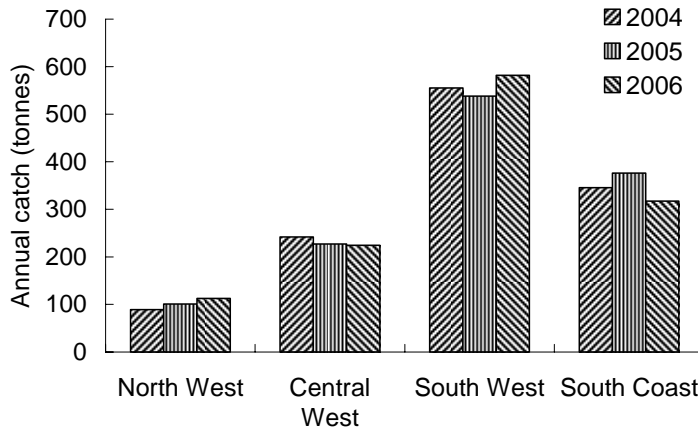


**Eastern Zone – East Coast (Blocks 22-31)**  
**Median length of catch**



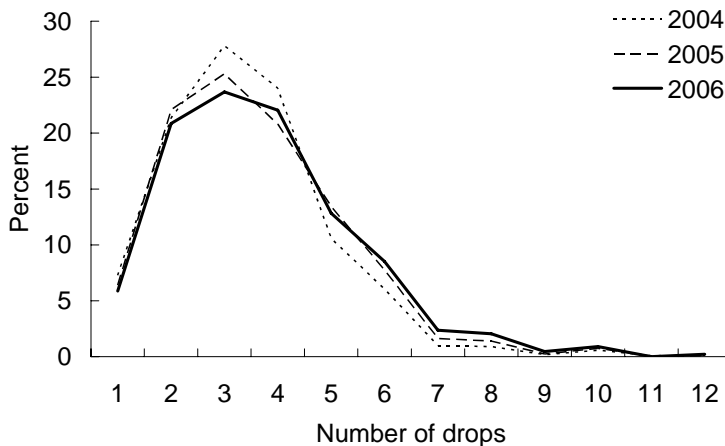
**Western Zone blacklip fishery**

There were small shifts in the regional distribution of the 1260t Western Zone TAC between regions, principally between the mothership catch from the South West, which increased 8% over the previous year to approximately 580t, and the South Coast, which fell to approximately 320t (Figure 8). Note that the South Coast region includes catch from sub-block 12A, which is west of South West Cape .



**Figure 8.** Distribution of Western Zone catch (tonnes) by region, 2004-2006.

Some of the divers who completed the 2006 diver questionnaire said that they had to make more drops to maintain their levels of catch. In 2006, fewer divers were able to take their catch in two or three drops compared to 2004, with a corresponding increase in occasions when five or more drops were required (Figure 9).

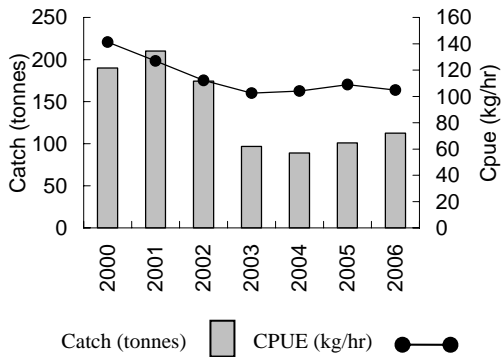


**Figure 9.** Number of drops per catch, Western Zone, 2004-2006.

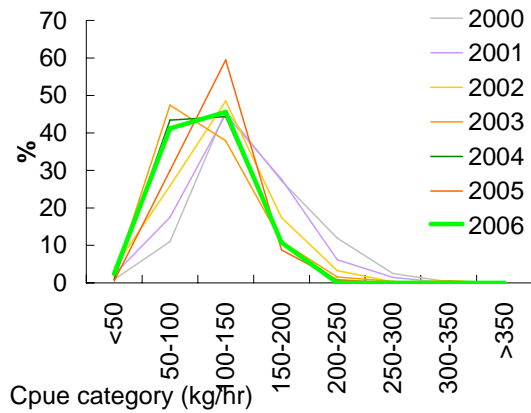
**Western Zone - North West (Block 6, Sub-block 5D)**

**Catch and catch rates**

Regional view:

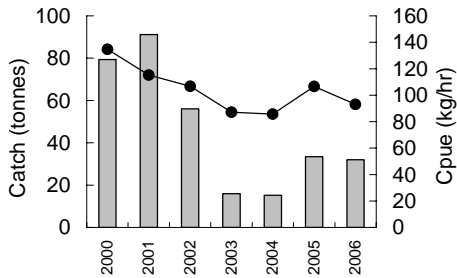


CPUE distribution:



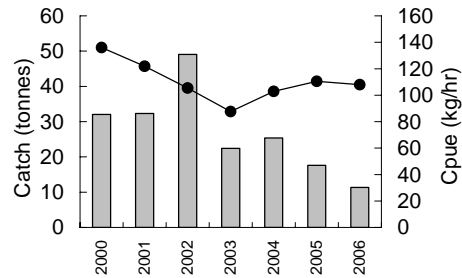
Sub-block 6A

Sundown to Temma



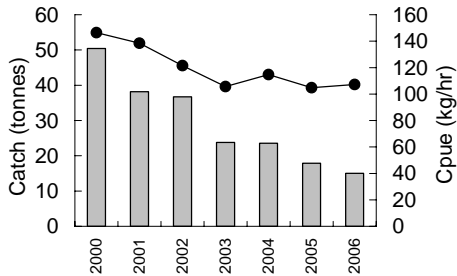
Sub-block 6B

Temma Harbour to north of Dawson River



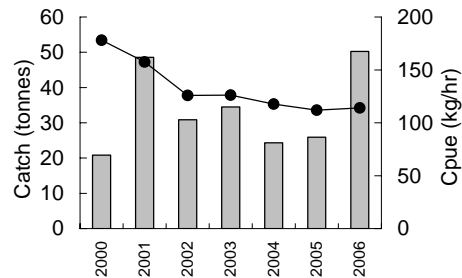
Sub-block 6C

Dawson River to Wild Wave River



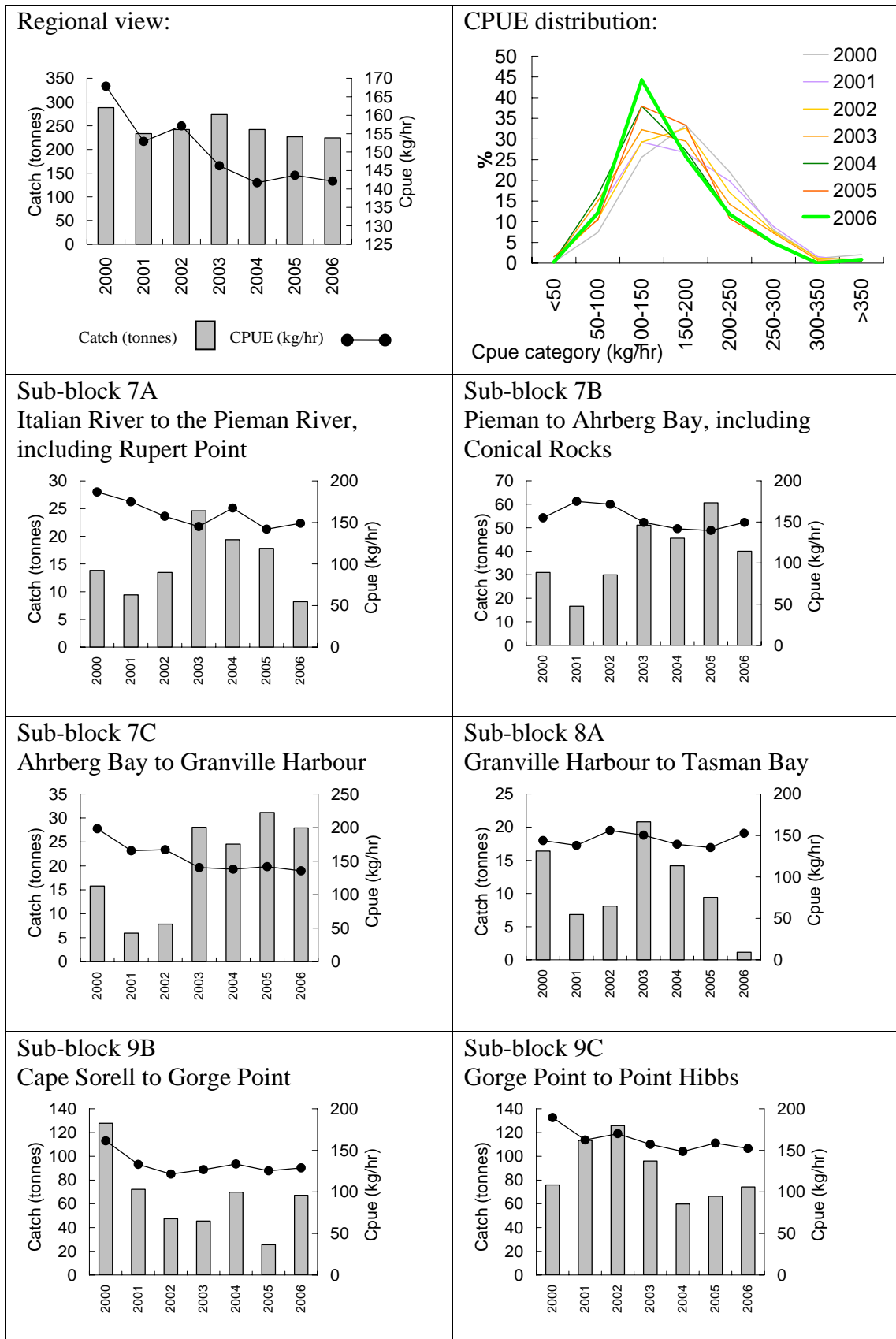
Sub-block 6D

Wild Wave River to Italian River, including Sandy Cape



**Western Zone - Central West (Blocks 7-9)**

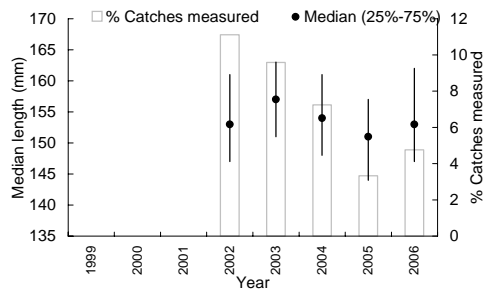
**Catch and catch rates**



**Western Zone - Central West (Blocks 7-9)  
Median length of catch**

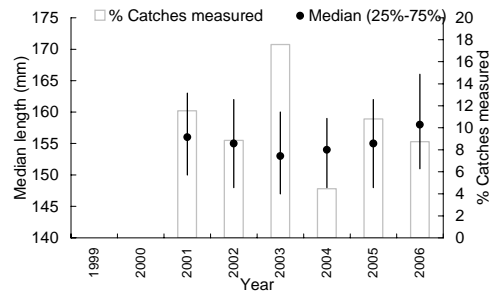
**Sub-block 7B**

Pieman to Ahrberg Bay, including  
Conical Rocks



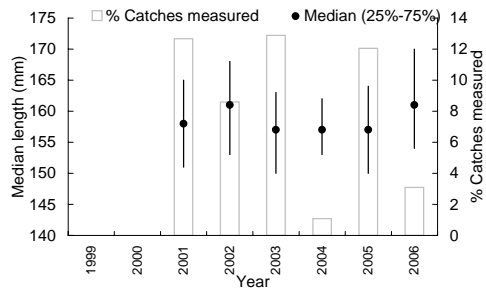
**Sub-block 9B**

Cape Sorell to Gorge Point



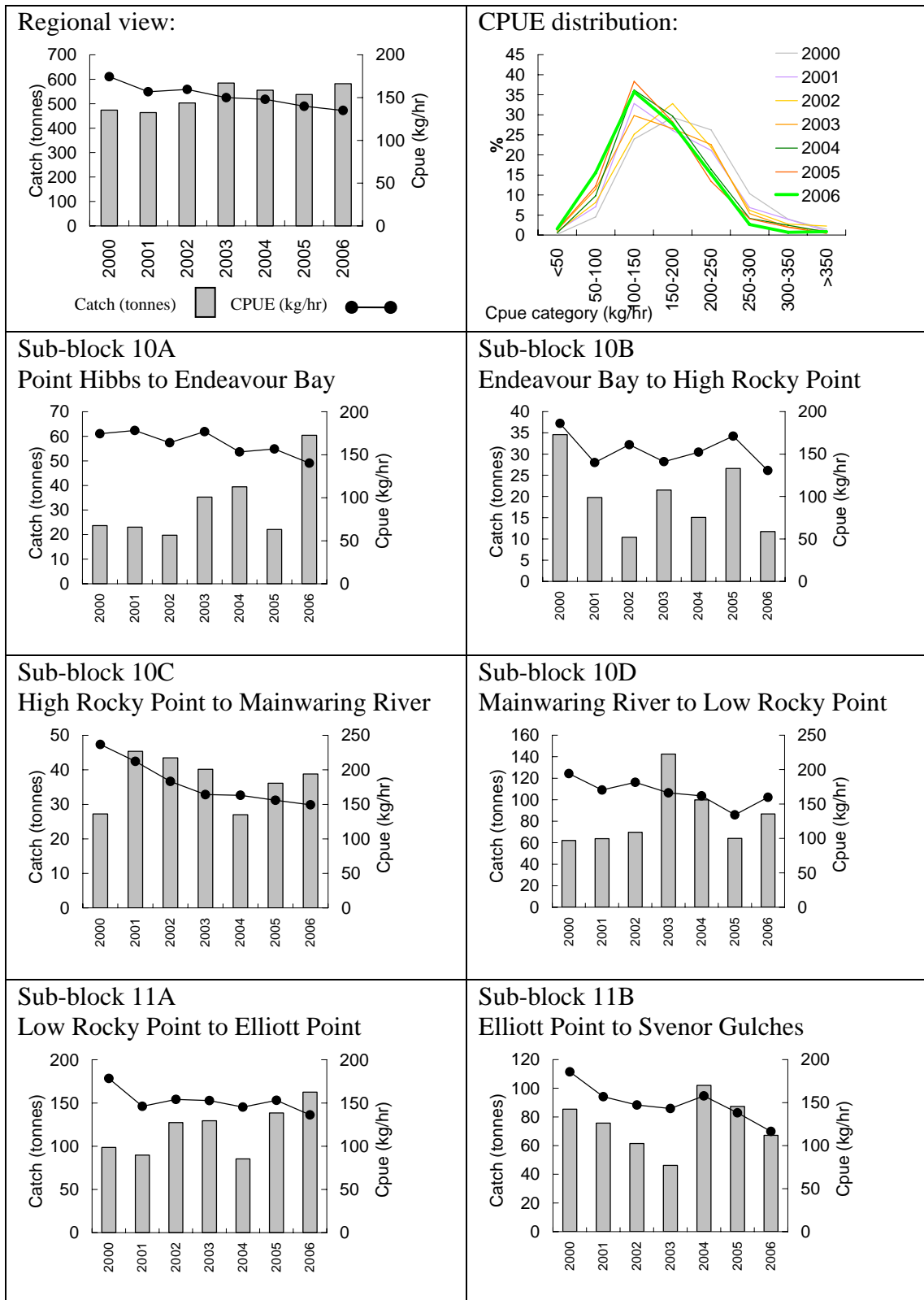
**Sub-block 9C**

Gorge Point to Point Hibbs

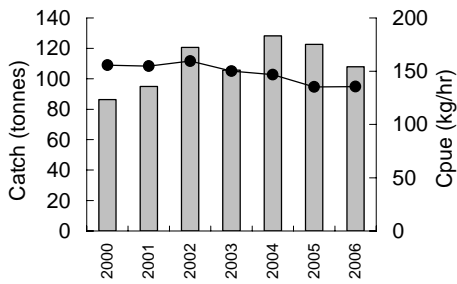


**Western Zone - South West (Blocks 10-11)**

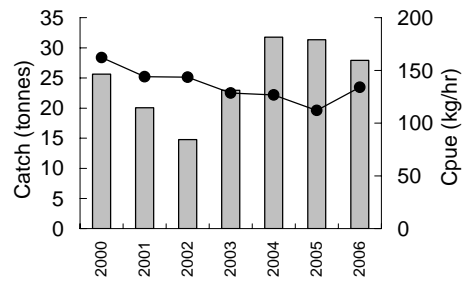
**Catch and catch rates**



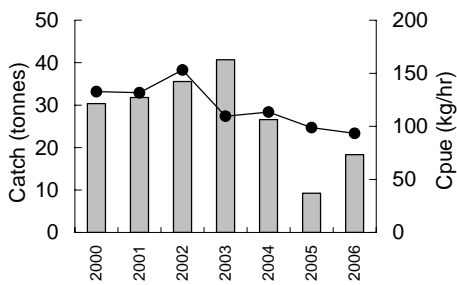
**Sub-block 11C**  
Svenor Gulches to Point St Vincent



**Sub-block 11D**  
Hilliard Head to Faults Bay

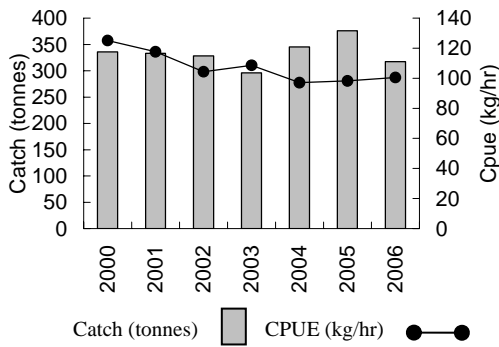


**Sub-block 11E**  
Point St Vincent to Hilliard Head, including Port Davey

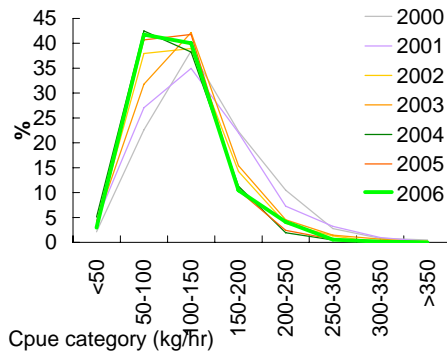


**Western Zone - South Coast (Block 12, Sub-blocks 13A, 13B)**  
**Catch and catch rates**

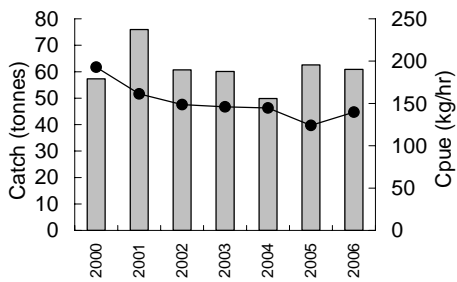
**Region view:**



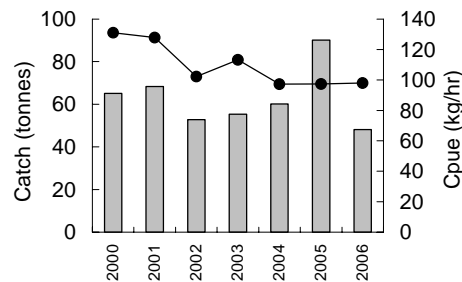
**CPUE distribution:**

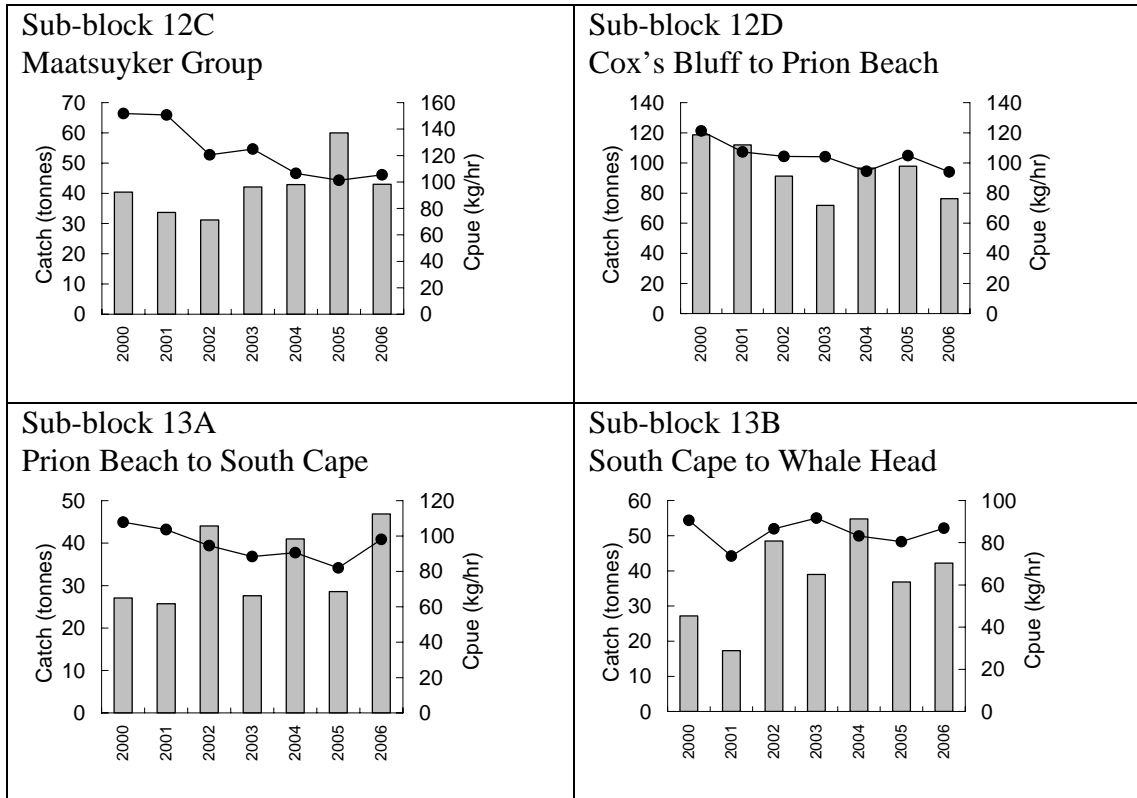


**Sub-block 12A**  
Faults Bay to South West Cape

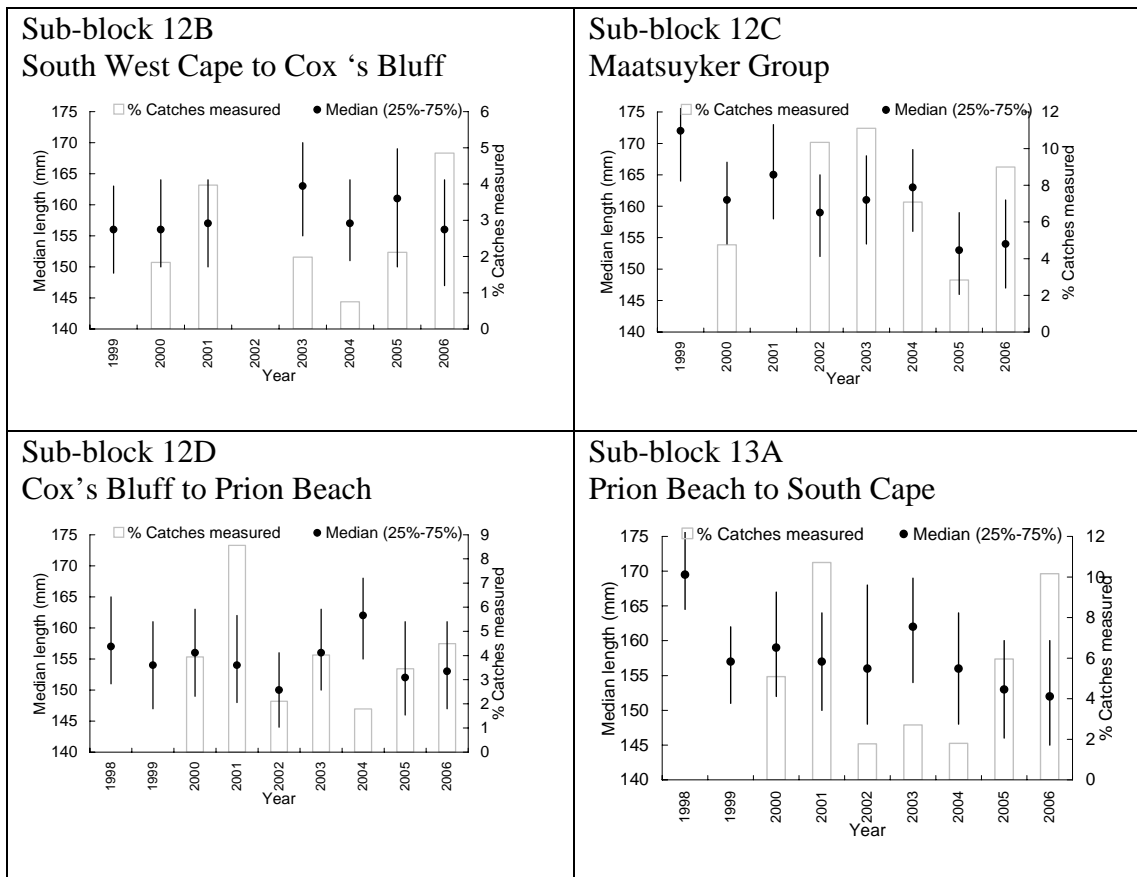


**Sub-block 12B**  
South West Cape to Cox 's Bluff



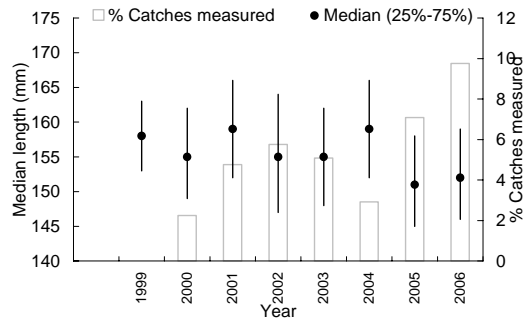


**Western Zone - South Coast (Block 12, Sub-blocks 13A, 13B)  
Median length of catch**



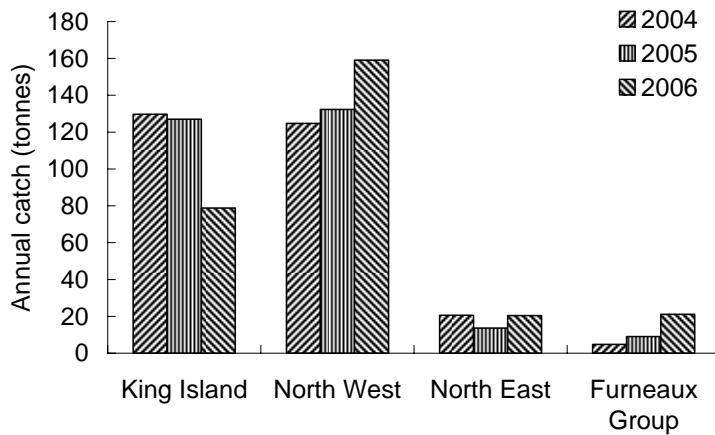
Sub-block 13B

South Cape to Whale Head



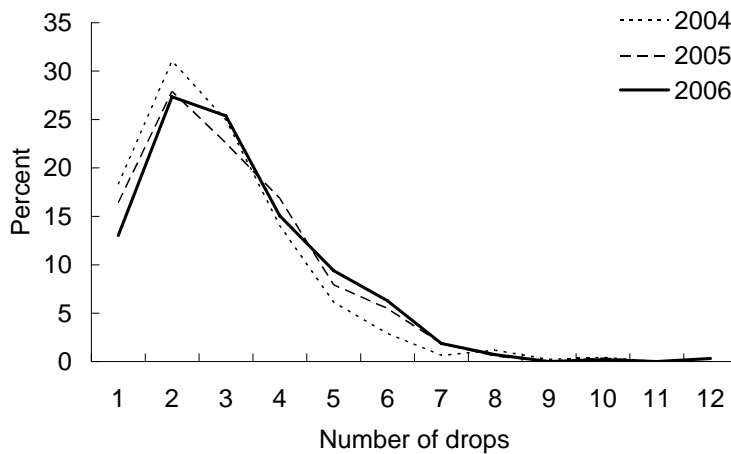
### Northern Zone blacklip fishery

Effort was redistributed away from King Island in 2006, and catches in the three other Northern Zone regions increased. In the North West, catches increased by more than 25% to approximately 160t, in the Furneaux Group by more than 50% to 21t, and in the North East by 30% to 20t (Figure 10).



**Figure 10.** Regional distribution of catch, Northern Zone, 2004-2006.

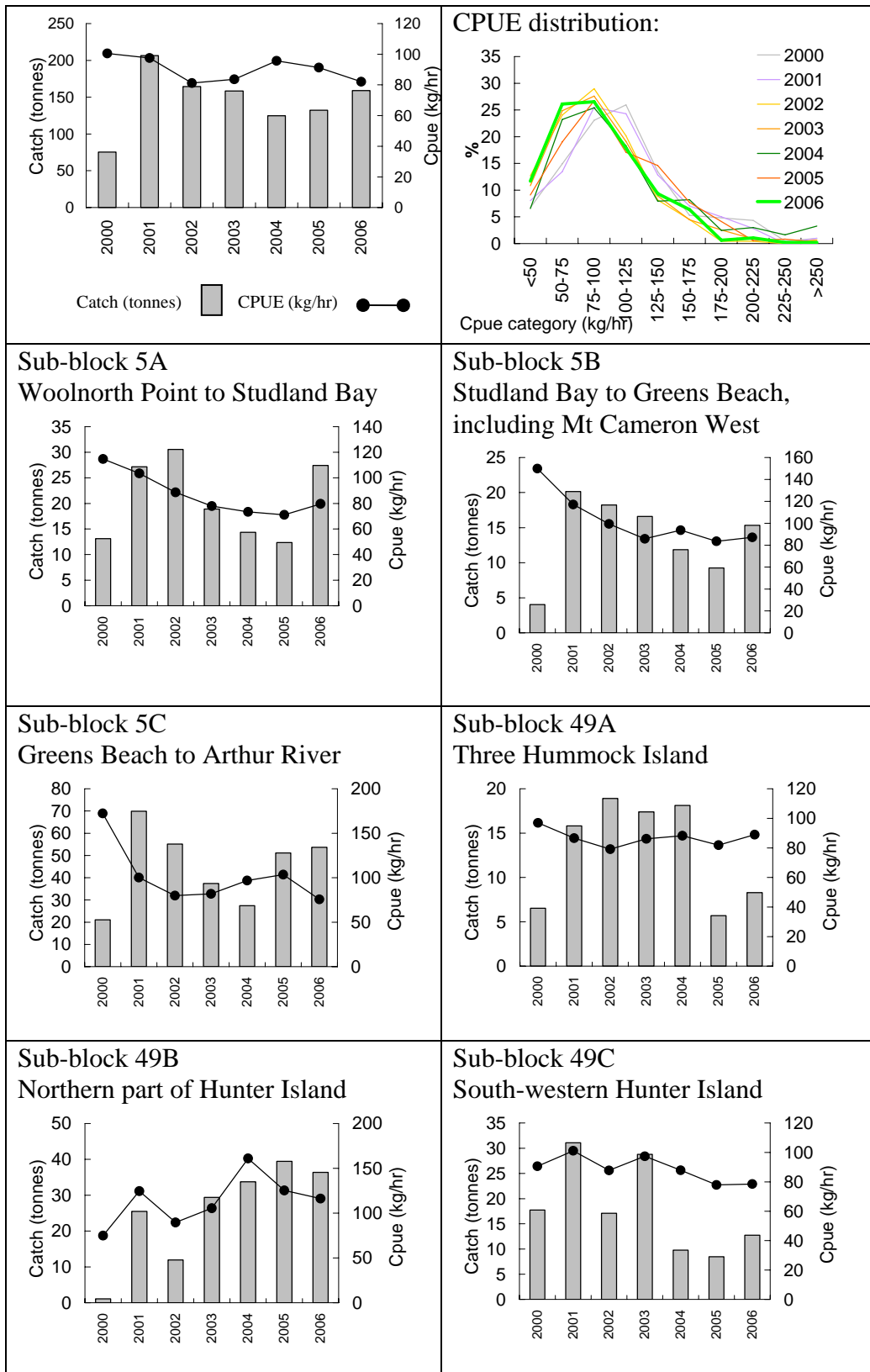
Since 2004, there has been an increase in the number of drops made by divers, which suggests that they are covering more coastline to maintain catch levels (Figure 11).

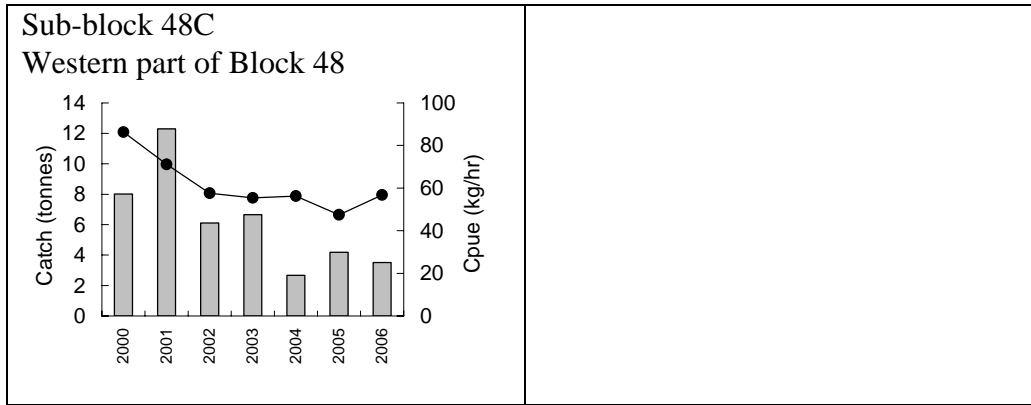


**Figure 11.** Number of drops per catch, Northern Zone 2004-2006.

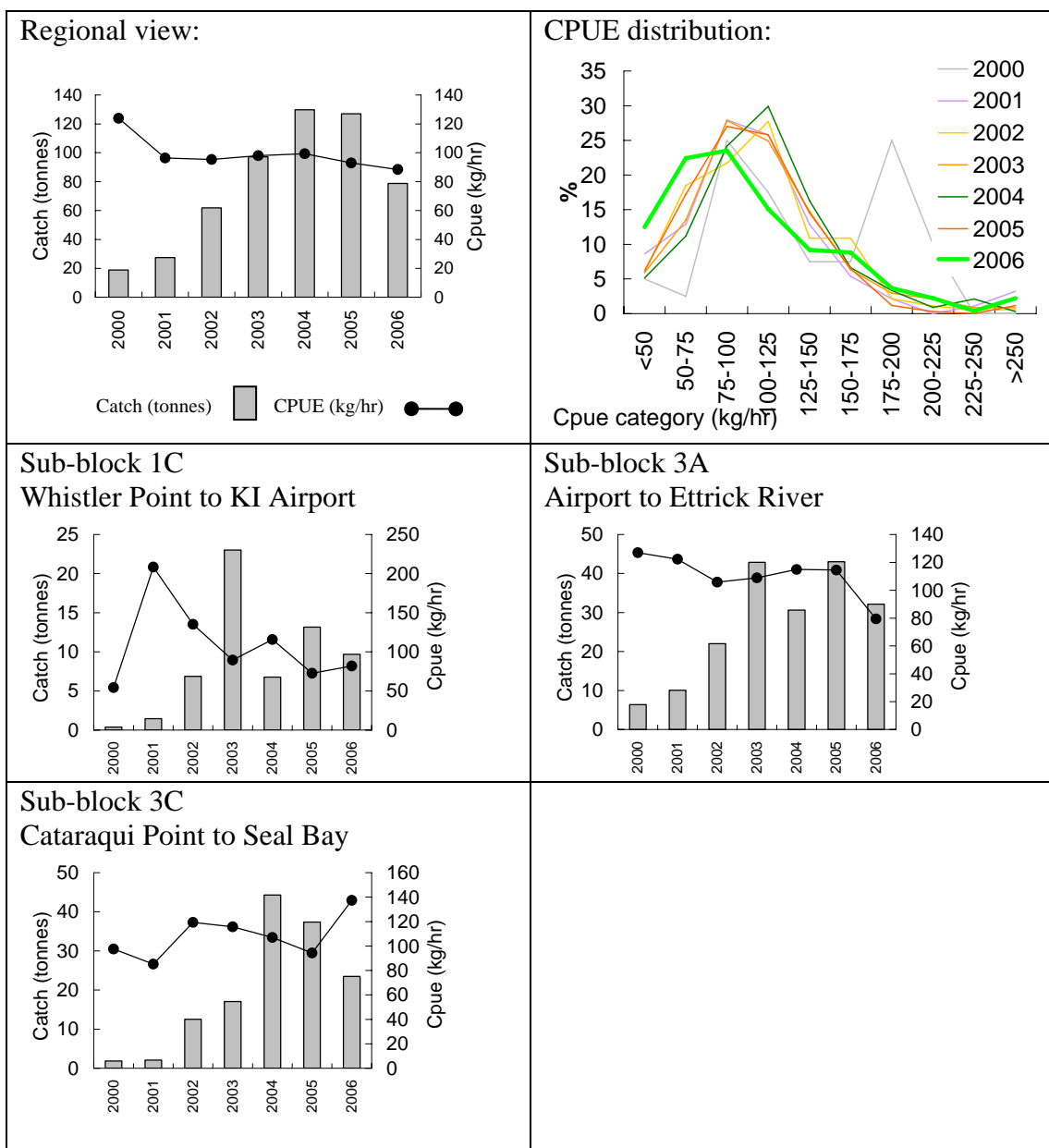
**Northern Zone - North West (Blocks 5, 47- 49)**

**Catch and catch rates**



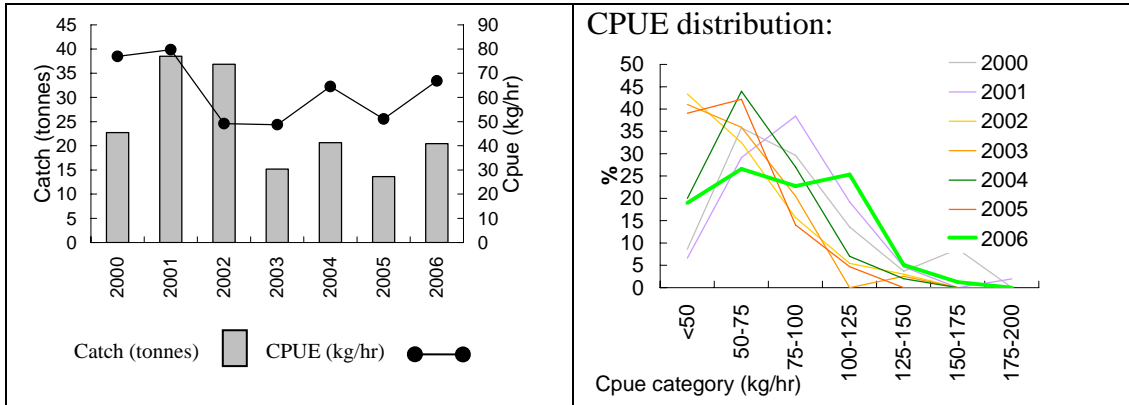


**Northern Zone - King Island (Blocks 1-4)**  
Catch and catch rates

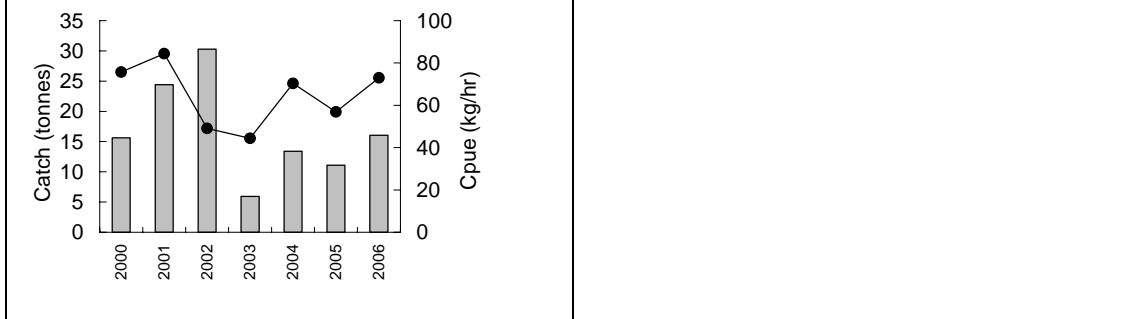


**Northern Zone - North East (Sub-block 31B, Blocks 39, 40)**

**Catch and catch rates**

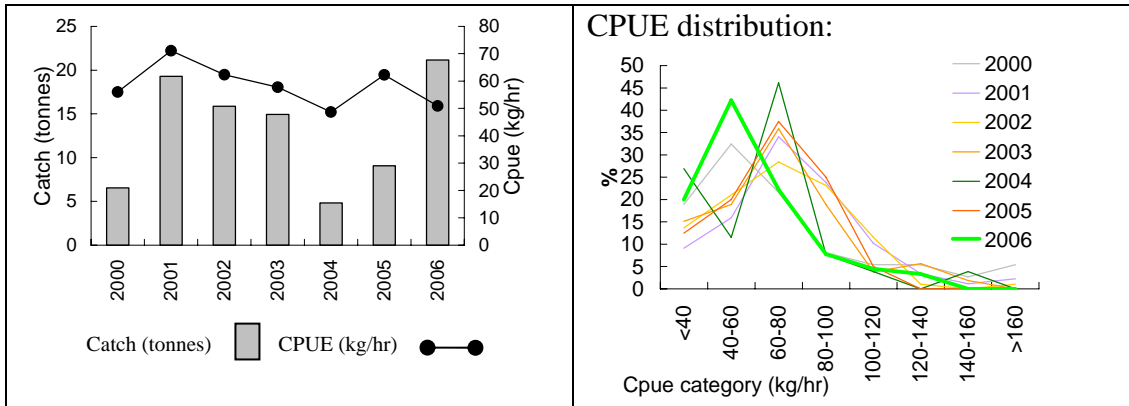


**Sub-block 31B Little Musselroe to Musselroe Bay, including Swan Island**

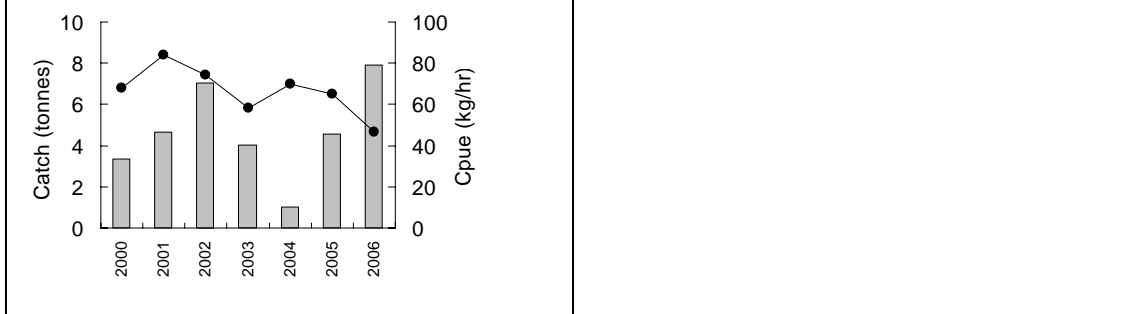


**Northern Zone - Furneaux Group (Blocks 32-36, Sub-blocks 38A, 38B)**

**Catch and catch rates**

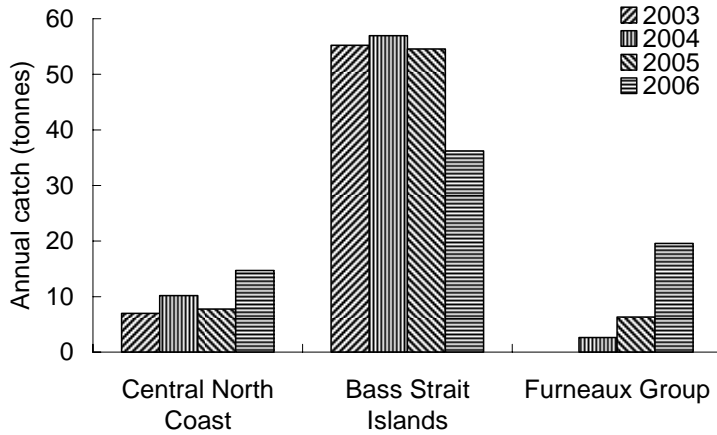


**Sub-block 33B South Cape Barren Island**



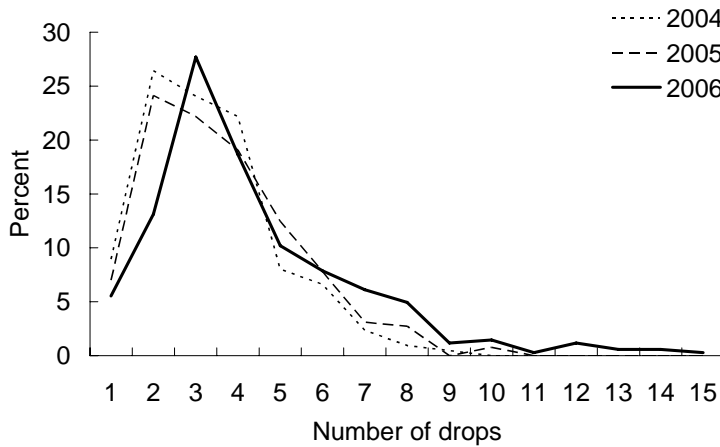
**Bass Strait Zone blacklip fishery**

Closure of the Bass Strait islands to abalone fishing in mid-August 2006 caused effort to be transferred to the remaining parts of the fishery (Figure 12). Catches from the Furneaux Group (20t) and the Central North Coast (15t) increased substantially. The Bass Strait islands catch was 36t, of which 24t was taken from the Hogan Group.

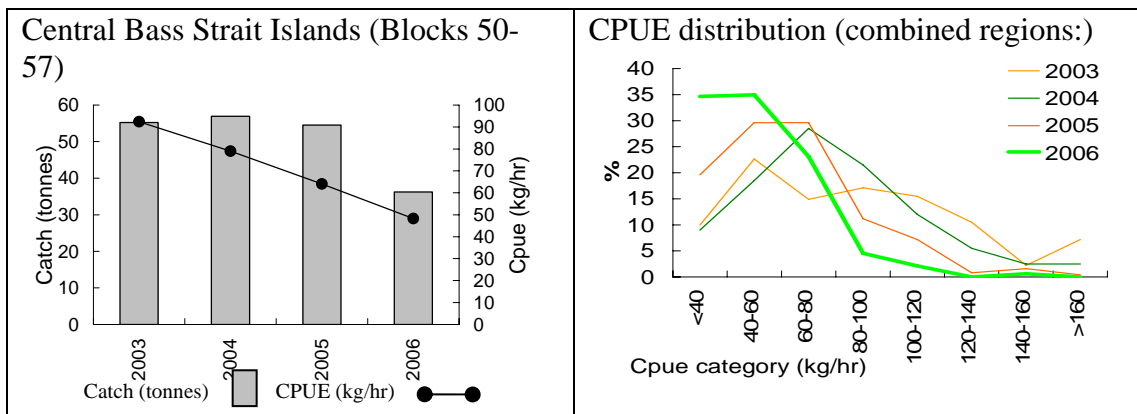


**Figure 12.** Regional distribution of catch, Bass Strait Zone, 2004-2006.

The number of drops per catch increased in 2006 (Figure 13). Some of this increase was due to the closure of the Bass Strait islands, and was caused by divers being forced to move to new fishing grounds from places where they had caught fish in previous years.



**Figure 13.** Number of drops per catch, Bass Strait Zone 2004-2006.



## Greenlip fishery

Distribution of the 2006 catch between the four regions was fixed at the following levels:

King Island	30t
North West	30t
North East	23t
Furneaux Group	42t

An additional 20t was made available from sub-block 48A and Block 47 from 1<sup>st</sup> November 2006, at a reduced size limit (132mm). Note that the sum of the caps (125t) prior to that date was 2.5t greater than the TAC (122.5t).

Its comparatively small size and remoteness mean that most of the catch from the fishery has been taken by either resident northern divers or a few mothership divers. Over half the TAC was taken by six divers, all of whom have substantial experience with catching greenlip. The number of drops was modal at 2 drops/catch, varying little from the two previous years (Figure 14). It implies that the fishery is in a steady state, because divers did not need to make more frequent movements to maintain satisfactory levels of catch.

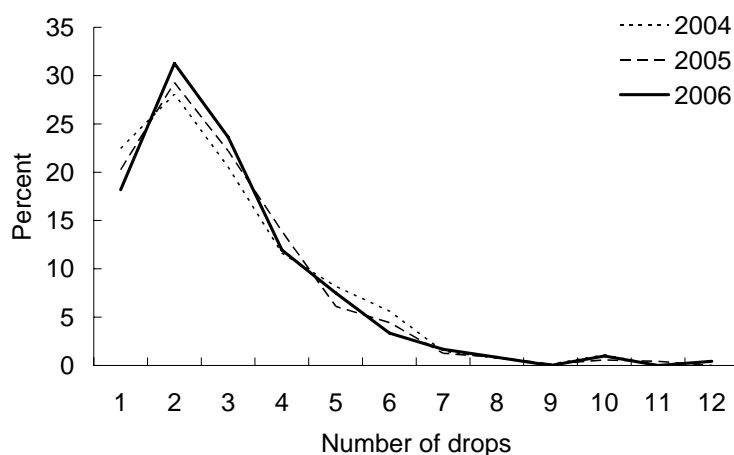
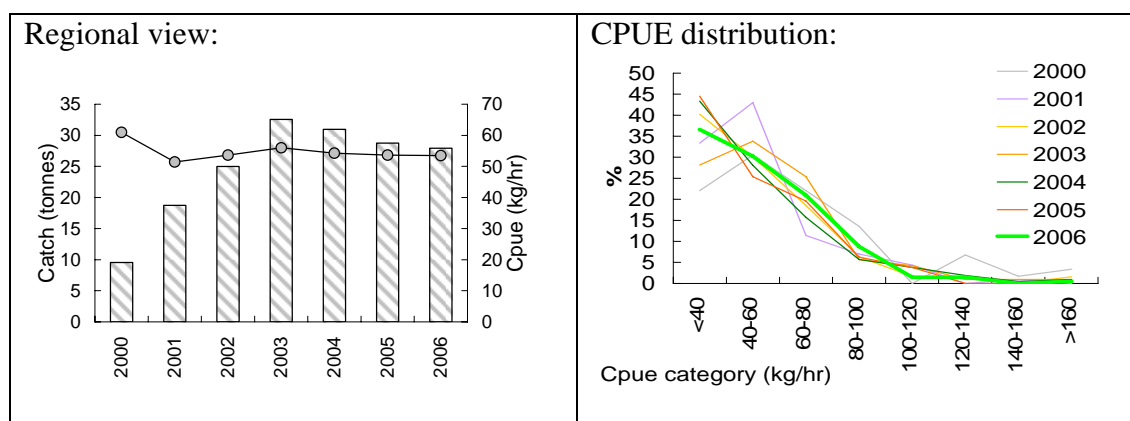
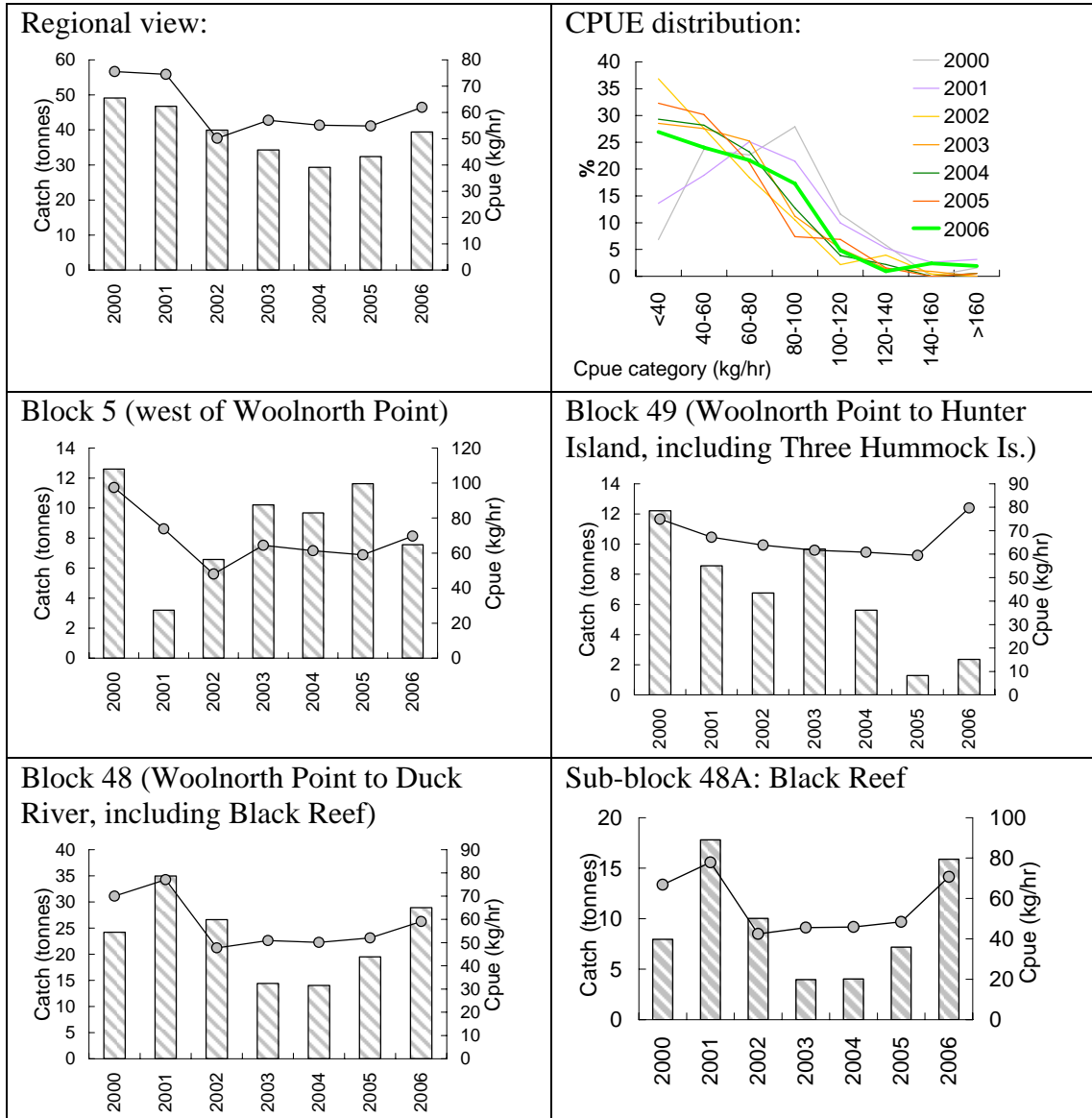


Figure 14. Number of drops per catch, greenlip fishery, 2004-2006.

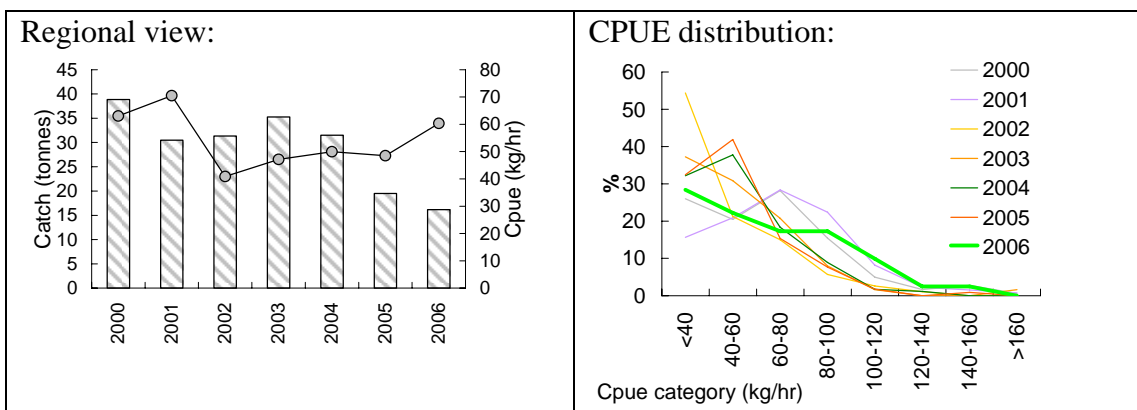
## Greenlip - King Island (Blocks 1-4) Catch and catch rates



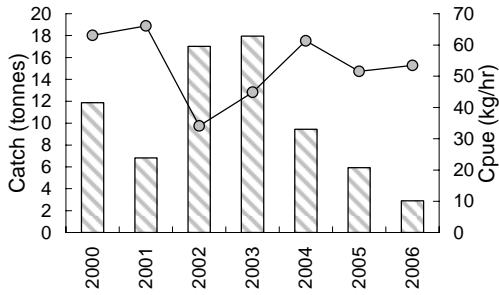
**Greenlip North West (Blocks 5, 47-48)**  
**Catch and catch rates**



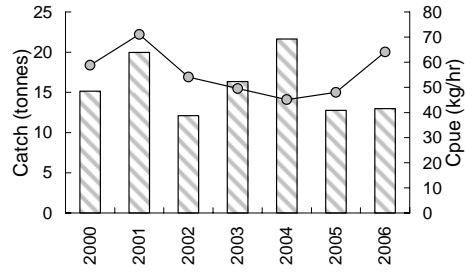
**Greenlip - North East (Blocks 31, 39, 40)**  
**Catch and catch rates**



**Block 31 (Little Musselroe to Cape Naturaliste)**

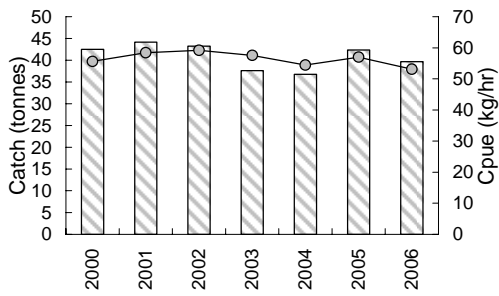


**Block 39 (Little Musselroe to Tomahawk)**

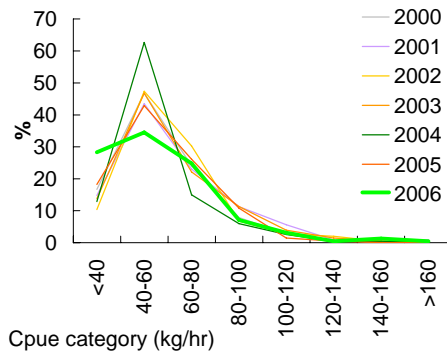


**Greenlip - Furneaux Group (Blocks 32-38)  
Catch and catch rates**

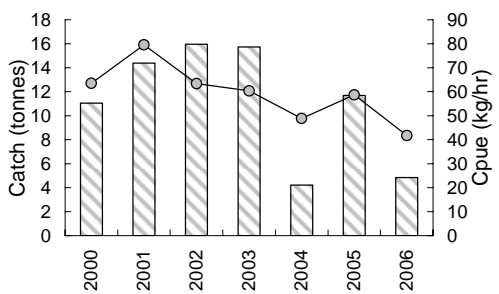
**Regional view:**



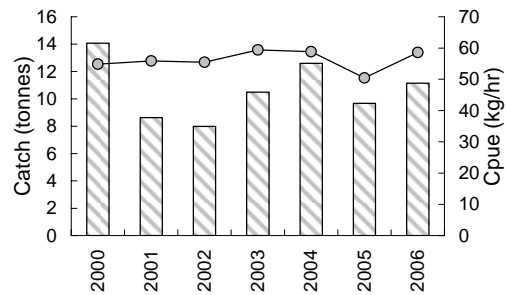
**CPUE distribution:**



**Block 33 (south east Clarke, Cape Barren Islands)**



**Block 35 (Franklin Sound)**



## 5. Assessment of the Tasmanian abalone fishery

### Eastern Zone

#### Actaeons:

The 213t total catch from this region has remained at similar levels to 2005 (218t), which is almost half the amount caught in 2000 (417t). While much of this catch decline has been due to progressive reductions in Eastern Zone TAC since 2000, it was also partly due to better fishing opportunities in the other regions and fewer divers living at Dover and Southport. The 2006 CPUE distribution shows an increase over recent years in the number of catches landed at greater than 100 kg/hr, while mean annual catch rates have improved for the second successive year to 68 kg/hr, and have continued to rise in the first half of 2007. The similarity between the size of the 2005 and 2006 annual catches means that this catch rate increase is more likely to have been driven by stock recovery *i.e.* was not merely a consequence of a reduced catch as was considered likely in the previous assessment. We interpret the small median length (142-145 mm) of market samples combined with rising catch rates as an indication of an increase in levels of recruits (see Section 3 for further explanation). However, we also note that this region is more dependent upon the annual crop of recruits than anywhere else in the fishery where market samples are collected, and that the risk of a downturn in stock levels is correspondingly greater here.

The distribution of catch between sub-blocks remains essentially unchanged from 2005, with Sub-block 13E again producing most of the catch (146t). Recherche Bay (13D) and the coast further south (13C) remained comparatively under fished compared with past years and divers report that the spread of *Macrocystis* (string kelp) and other canopy algae has made fishing here difficult.

The only sub-block underperforming 2005 levels was 14B, where both catch and catch rates were down. Divers who fished here have said that this part of the coast (Blubber Head to Burnett Point, including Port Esperance) and further north on both sides of the D'Entrecasteaux Channel once consistently produced much greater levels of catch. The area was heavily fished and depleted during the 1990's and again in 2003 when the Actaeons were closed, and productivity has not yet recovered to former levels.

#### Bruny Island:

The catch from Bruny Island (126t) remains at historically low levels, probably due more to the low Eastern Zone TAC rather than divers choosing to fish elsewhere. Catch rates have increased rapidly, from a low of ~50 kg/hr in 2002-2003 to 75 kg/hr in 2006. West of Cloudy Bay (14D) on the southern Bruny coast, catches have been at stable levels for many years (20 to 25t). On the coast east of Cloudy Bay and at the Friars (14E), and on the eastern side of Bruny north to Mangana Bluff (16A) reported catches have fallen in recent years and are now at low levels, but mean catch rates are now particularly high (>90kg/hr). Market samples from these sub-blocks show that median length fell from 2003, but generally increased in 2006. This is interpreted to mean that in recent years the reduced catch levels have enabled abalone to grow to a larger size prior to capture, and is evidence for stock recovery. In 16B (including Coal Point and

Fluted Cape), catch rates have not quite reached the same levels as further south, but they have risen consistently for the last four years. The low catches, rising catch rates and increasing median length all indicate stocks are recovering in this area. North of Adventure Bay (16C, 16D) catches and catch rates have also been increasing rapidly, and divers reported that fishing here has been as good as it ever had been.

Market samples from the Bruny region showed no signs of falling median length, which in conjunction with rising catch rates as at the Actaeons, might be interpreted as an abnormal influx of recruits. It is likely that the stock recovery here is associated more with the rebuilding of stocks associated with the reduction in TAC than unusually high levels of recruitment. If this is true, then this region may be more sensitive to increases in levels of catch and therefore more likely to show reduced catch rates should there be a substantial increase in catch.

#### Storm Bay:

In recent years, levels of catch in much of the Storm Bay region (Iron Pot to Tasman Island) have increased greatly, particularly from Block 20, where for several years catches have been considerably higher than the long-term average of reported catches. These high levels of catch appeared to have no effect on stock levels, evidenced by catch rates, which from a low in 2002, climbed steadily for the next four years. In 2003, divers reported that they saw many more smaller abalone, and market samples in 2004 indicated abnormally high levels of recruitment. It is likely that this recruitment pulse promoted recovery in this region earlier than in the remainder of the Eastern Zone, and support for the unusually high levels of catch and catch rates.

In 2006, the regional catch fell by 25% to slightly more than 150t. Divers said that they preferred to fish the clearer water of the East Coast in preference to Storm Bay, and given the improved fishing on the East Coast in 2006, many divers spent more time there. The reduction in catch was greatest north of Nubeena, where both Block 17 and Block 20 were down by more than 30%. Catch rates continued to rise in most parts of the two blocks.

The greatest improvement in this region has occurred further south along the southern coast of the Tasman Peninsula (Block 21), where after successive years of catch rates hovering at about 60 kg/hr, they have increased substantially and in 2006 were approaching 100kg/hr. There was a slight (4t) increase in catch to 66t which is 10t more than the long-term average.

Market samples mostly show a trend to larger median lengths, and in combination with high and rising catch rates, are interpreted to mean that the impact of fishing on stocks at current levels is becoming reduced *i.e.* the period between recruitment and being caught is longer because of lower rates of fishing mortality.

#### East Coast:

The 2006 East Coast catch increased in 2006 to 280t, more than 25% greater than its historical low in 2004, but still less than two thirds its long-term average. As noted in previous assessments, when catches are at such low levels, it is difficult to assess the more isolated parts of the fishery, such as Blocks 29 and 31. This is 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, and in some cases, are at high levels.

Improvement in catch rates has been greatest on the eastern sides of the Tasman Peninsula (22A, 22B) and Maria Island (24D, 24E), where both catch and catch rates have increased substantially. Length profiles from market samples from Block 22 show that abalone were taken at larger sizes, particularly from 22A, which is consistent with reduced levels of fishing mortality and growing stock levels. Block 24, primarily Maria Island, has a history of cyclical annual catches fluctuating between lows of less than 50t to peaks over 150t. In recent years there has been a trend of increasing catches and catch rates suggestive of another rising cycle. Catch rates from parts of Maria Island (24D) are now consistently greater than 100kg/hr, indicative of high levels of abundance. Most of the effort has been reported from the eastern side of the island (24D, 24E), and here the catch has increased sharply. Although market samples show slightly larger median sizes in 2006, there are no clear trends in length within each sampling area.

Stock levels are reported to be high in the remaining (northern) part of the Eastern Zone, including Freycinet Peninsula (Block 27), Long (Seymour) Point (Block 29) and Eddystone Point and further north (Block 31). With the exception of Long Point, catch and effort was at very low levels and catch rate trends are thus meaningless. At Long Point, the catch was the same size as the previous year (29t), with rising catch rates.

### **Western Zone**

The Western Zone fishery is more exposed to prolonged periods of weather and sea conditions unsuited to inshore diving than most of the other parts of Tasmania's abalone fishery. This means that it is fished at irregular intervals, and particularly during winter and spring, months may pass before abalone fishing can take place on much of the coast. Consequently, abalone are able to re-aggregate between fishing events, which then enables divers finding aggregations to catch them at high rates. Abalone abundance is likely to change at greater rates than in a fishery such as in the east and south east, where they are more dispersed and more regularly fished. Under these circumstances, catch rates cannot be considered reliable indices of abundance as it is possible to maintain high catch rates while depleting the stock. Under these conditions, falling catch-rate trends should be viewed with great concern, as it is likely that declining catch rates potentially under-represent impacts of fishing on the stock.

In contrast to the Eastern Zone, catch rates in parts of the west have been trending downward for many years. This was considered acceptable, because low levels of effort in the 1990's prior to zoning allowed stocks to build to high levels. The transfer of effort associated with the implementation of zoning in 2000 saw an immediate increase in catch and the abundant stocks produced correspondingly high catch rates. However, after seven years of annual catches at levels consistently higher than the long term average, stocks have been considerably reduced. In many parts of the Western Zone, catch rates have now fallen to levels that many divers find economically marginal, and they report that stocks are extensively depleted. A survey of divers in late 2006 found

that the majority were undertaking more drops to maintain catch levels, and the catch data support this (Figure 9).

#### North West

The regional catch has continued to slowly increase from low levels, and in 2006 was 113t. This is substantially lower than catches both earlier this century and in the early 1990's, when catches were much higher (approximately 200t pa). In 2006, almost half the catch was taken from the southern part of block 6 (sub-block 6D – Sandy Cape), and fishing from this area has been reported greatly improved. The annual catch from 6C and 6B was unusually small (15t, 11t) and in these sub-blocks the annual catch has fallen for several successive years. Divers have recently taken better catches from 6C, and are confident of stock recovery, particularly at Jack Smiths and Ordnance Point. In the north of the region, 32t was caught from 6A and 4t from 5D, (in the context of previous years, low to moderate levels of catch). Some divers have observed unusually large inter-annual variations in numbers of pre-recruits in this region, which appear to influence catches in following years. They have reported that in the southern part of Block 6, there are many undersized abalone which they believe augers well for the future.

For the past four years, catch rates across most of the region have been stable, fluctuating between 100 and 120 kg/hr. In the north (6A) catch rates are generally 10 kg/hr lower. The size-limit in the northern three sub-blocks was increased by 4mm in 2003 (from 132 to 136mm), and one of the region's processors believes that this has had a deleterious effect on the fishery, particularly in 6A. It has meant that much of the catch now has to be measured which reduces diver catch rates and effectively prevents fishing of some particularly slow growing old-aged populations. The problem is compounded because the remaining populations increase in density, possibly further suppressing growth rates. The size-limit increase has had less effect further south, where the abalone are noticeably larger

#### Central West

Generally, divers reported that fishing in this region was satisfactory. The annual catch (225t) was virtually unchanged from that of the previous year, but is lower than earlier years. The distribution of catch between blocks within this region appears to have been determined more by fleet dynamics (*e.g.* where processors are prepared to collect fish from) than abalone abundance. This has meant that some divers who formerly worked from Granville Harbour moved south to Strahan in 2006, which caused a reduction in catch in Block 7 (down 30% to 76t) and Block 8 (down 75% to 6t), and an increase in Block 9 catch (up 50% to 142t).

Catch rates, while recently stable, have trended downward since the inception of the Western Zone in 2000 and the consequent redistribution of effort into this part of the fishery. The CPUE distribution shows a strong increase about the 100-150kg/hr mode caused by a reduction in the number of divers reporting higher catch rates. The median length of samples from the catch is generally larger than last year suggestive of a reduction of fishing mortality, but we do not know whether the increased size truly reflects this, or that divers are now taking larger abalone (as reported), or simply that our sampling is insufficient to accurately reflect size changes.

## South West

This region is usually fished from motherships, which return to ports in the south east with catch for the live market. The higher live market prices and falling catch rates combined with rising operating costs on the South Coast have made the South West fishery more attractive to divers, and consequently the annual catch (582t) from this region has been well above the long term average for many years.

Most divers who have fished this region have expressed concern for declining stock levels. Some have said that they must spend more time fishing at extremes of depth *i.e.* either much deeper than normal or in the wash zone, and they are aware that these areas are in turn becoming steadily depleted. Others have reported that they now cycle between favoured fishing sites more quickly, which they say indicates that the reefs are not supporting the level of catch that they once sustained. Mothership operators have said that reefs around common anchorages are able support fewer motherships on any one day, and they are now likely to continue on to another anchorage if they find a vessel anchored where they had intended to fish.

Catch rates (apart from a slight increase in 2002) have fallen steadily since 2000, and unlike the other Western Zone regions, have shown no sign of stabilising. Catch rates from sub-blocks within the South West generally followed the regional trend downwards, although in both 10D and 11D catch rates increased. While the 11D catch was comparatively small increasing the likelihood that catch rates were influenced by fleet dynamics, the 10D catch was much larger (84t) and so catch rates may reflect increased stock levels. Notwithstanding this increase, the overall seven-year trend in all sub-blocks is downward.

The 2006 CPUE distribution is almost unchanged from the previous year except for a downward shift from the modal 100-150kg/hr size class caused by an increase in the number of 50-100kg/hr catch rates. Unlike the Eastern Zone, where in some cases stocks are fished almost on a daily basis, effort on South West stocks is applied at much greater intervals. This invalidates the assumption of constant and regular effort which is critical to the successful application of catch rates as an index of abundance. It is likely that falling catch rates in this region mean that abundance is falling at faster rates than indicated by the catch rate trend.

The number of market samples measured from this region has been insufficient to meet the four percent threshold level, and we have no reliable indicators of trends in median size. Many divers have said that they take all abalone that they encounter *i.e.* to meet their required levels of catch they cannot afford to selectively leave large abalone. However, it has been suggested that size-selective fishing is still practised by some divers, but the extent is not known.

Almost all indicators suggest that catch levels in this region are higher than can be sustained by current stock levels. A preliminary review of catch and catch rates up to mid-July 2007 showed that catch rates were continuing to fall throughout the region. While the part-year catch rates may be influenced by confounding seasonal affects, the most likely explanation is that stocks are still declining and that this region is being fished at levels of increasing risk.

## South Coast

The South Coast regional catch has fallen from 376t to 317t, and this fall appears to have reduced pressure on stocks. In contrast to the South West, catch rates have remained at the same level (~100kg/hr) since 2004 and can be considered stable, although they are low compared with other parts of the Western Zone. The CPUE distribution is contradictory, showing an increased mode at 50-100kg/hr caused by a reduction in the next higher catch-rate categories, and a small increase in the 200-250kg/hr category. This increase in the latter category is associated with an increase in catch rates in sub-block 12A, north and west of South West Cape, where mean catch rates are more similar to those of the South West than the South Coast.

The eastern sub-blocks (13A, 13B) also experienced a catch-rate increase, but it appears to be due more to fleet dynamics than rebounding stock levels. Closer examination of the catch records of individual divers reveals that the improved catch rates were restricted to a very small minority of divers who landed a substantial part of the catch from these sub-blocks, while most of the other divers maintained catch rates at similar levels between 2004 and 2006.

Market samples from 12C, 12D, 13A and 13B show a fall in median length since 2004. 75<sup>th</sup> percentiles have been 161mm or less, which must be considered small for Western Zone abalone while the 25<sup>th</sup> percentiles have been 145mm or larger, and show no sign (*i.e.* by falling lower) of increased levels of recruitment. These length profiles, combined with the low catch rates are consistent with high levels of fishing mortality and low stock levels.

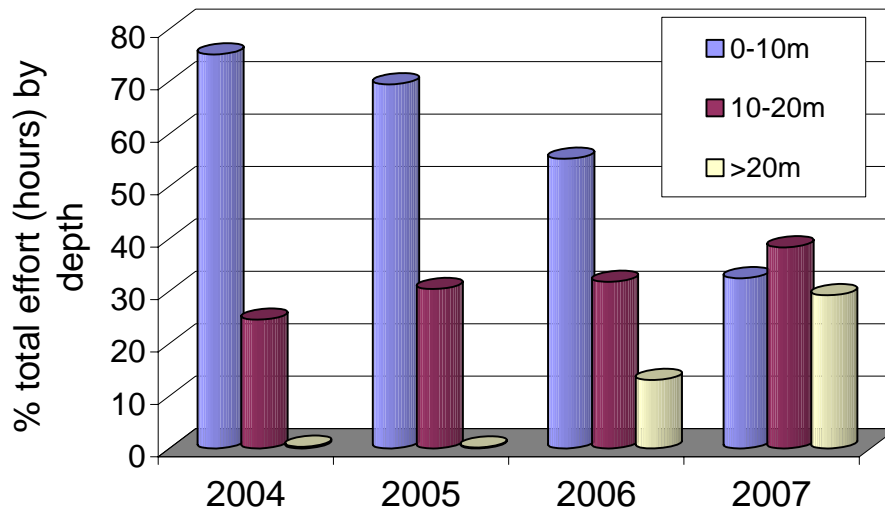
## Northern Zone

### King Island

The King Island blacklip fishery was revived when the Northern Zone was created following years of comparative inactivity between the late 1980's and 2001. Annual catches were low during the first three years (2001-2003), but increasing popularity with the island due to high catch rates and readily accessible stocks caused an influx of divers operating from motherships, and a corresponding increase in catch. Most of their effort was directed at shallow water (<10m) stocks in the southern part of Block 1, Block 3 and Block 4. The high level of fishing mortality on the shallow reefs could not be sustained, and catch rates, initially over 100kg/hr, quickly fell to less than 50 kg/hr in some areas. Fishing at lower catch rates while paying mothership fees became less rewarding. In mid-2006, the remote Bass Strait islands (Blocks 50 – 56) were closed to abalone fishing as part of measures to control the spread of the abalone ganglioneuritis outbreak, which further reduced the opportunity for motherships to travel to northern waters. It became easier for non-resident divers to operate in the other Northern Zone regions, particularly the North West, and consequently there was a substantial redistribution of effort away from King Island (Figure 10), and the catch fell from ~130t (2004-2005) to 79t.

For many years, until the late 1980's, the King Island blacklip fishery sustained an annual catch of approximately 100t, although most of this was probably not from shallow water. It was common practise for divers to start the day at 20m and work

shallower. Several years ago, resident divers obtained Nitrox breathing equipment to enable them to safely work in deeper water, where the earlier divers fished. The subsequent change in distribution of effort by depth is striking, although it is heightened by the overall reduction in effort (Figure 15). The divers have said that deep water stocks are abundant, and report high catch rates.



**Figure 15.** Percentage of total effort by depth, King Island blacklip fishery, 2004-2007. Since 2004, effort has been reported by depth (0-10m, 10-20m, >20m). The shift in effort from shallow to deeper water since then is apparent.

#### North West

The Northern Zone catch from the North West increased by more than 25% to approximately 160t. Throughout the region, catch rates were mostly stable, particularly in the heavily fished sub-blocks near Woolnorth Point (5A and 49B). The overall regional catch rates fell, attributable to low catch rates in two areas which contribute half the catch. In the southernmost part of the region (sub-block 5C), catch rates fell by more than 25% in the face of successive years of large (>50t) annual catches.

Size and shell profiles from catches (6 shells/catch) sampled by Tasmanian Seafoods Ltd show that catches in much of the North West comprise old abalone taken from ageing populations, and indicate that Block 5 in particular (where the size limit is 132mm) could benefit from a reduction in size limit. It is reported that there are populations of small abalone in Block 5, requiring extensive use of the size measure making fishing slow (and catch rates low). However, there is ongoing debate about the extent of the small populations, the effect that a reduction in size limit would have on the larger and faster growing populations and the net benefit of reducing the size limit.

In the northern sub-block 49B catch rates have fallen from very high levels. Because of their remoteness, abalone populations on offshore islands had built up to high levels, and while these have been progressively reduced in size, divers say that abalone are still abundant.

## Furneaux Group, North East

The combined annual catch from both regions increased substantially, but at just 41t, remained less than 20% of the Northern Zone catch. This increase in catch can be attributed to an increase in the number of motherships operating in the Furneaux Group, moving there after the closure of the remote island part of the Bass Strait Zone. Catch rates in both regions have fluctuated erratically in recent years but probably reflect fleet dynamics and not changes in abundance. The sporadic nature of fishing operations here conflicts with the assumptions under which catch rates are considered reliable indicators of abundance, and we must rely on the opinions of divers to assess the status of stocks.

Most of the catch from the two regions was taken from around Babel Island (38A), the south-east of Cape Barren Island (33B), and Swan Island (31B). Divers' reports were variable – some saying that fishing was difficult because of low stock levels, while others were impressed with the way in which stock levels have been maintained. Several divers expressed the view that size limits were too high, and that they were taking only old, poor quality fish. The small area of reef, high size limit, slow growth rates and slow recovery mean that both regions will only contribute minor amounts to the Northern Zone catch.

## Bass Strait Zone

Since 2003, most of the 70t TAC (~55t) has been taken from the remote Bass Strait islands (Blocks 50 to 56), principally from the Hogan Group (Block 53). Closure of the islands to fishing in mid-August 2006 caused effort to be transferred to the Central North Coast (Blocks 42-46) and the northern part of the Furneaux Group. Because of the closure, only 36t was taken from the islands, and increased amounts were taken from the Central North Coast (15t) and Furneaux Group (20t).

Catch rates at the remote islands have declined sharply since they were first fished in 2003. Despite this, divers maintain that stock levels are still high, and that the small size and low weight of individual abalone (over four per kilo, compared with approximately two per kilo in the Eastern Zone) makes comparisons of absolute rates of catch between the Bass Strait Zone and other zones invalid. However, the rate of catch rate decline is quite steep (approximately 10kg/hr pa), and notwithstanding the small size of the abalone, indicates that fishing mortality is high, and not sustainable in the long term.

Catch rates on the Central North Coast and Furneaux Group were also low, and divers who fished both regions said that the size limit was too high, despite a reduction on the Central North Coast in September from 114mm to 110mm. Stock levels in both regions are low, and the fish small and slow growing. Neither region has produced the levels of catch seen during the pulse fisheries that took place between 1989 and 1995.

## Greenlip

Almost all the 122.5t greenlip TAC is taken in the state's north from four distinct regions: King Island, North West, North East and the Furneaux Group (insignificant

quantities are occasionally taken from the central north coast and the remote Bass Strait islands). The catch from each region is capped: King Island and the North West at 30t each, the North East at 23t and the Furneaux Group at 42t. In November 2006, the size limit operating at Perkins Bay in the North West (Blocks 47 and 48A) was reduced from 145mm to 132mm and the expected extra catch from the region as a result of the size-limit reduction capped at 20t. The remaining North West cap was reduced to 25t in consideration of the 5t that was formerly taken in the area now covered by the Perkins Bay management area. The sum of the caps (140t) was 17.5t greater than the TAC.

In 2006, the catch from the North West was 39t (16t from Perkins Bay and 23t from the remainder). As might be expected, catch rates in Perkins Bay after the size limit reduction were high, typically 100 kg/hr. However, almost all effort has been directed at Black Reef, and no catch has been reported from other parts of Perkins Bay, notably Block 47.

Greenlip fisheries are notoriously difficult to manage. The fishery in Victoria which at one stage supplied 200t pa has almost entirely collapsed, and much of the fishery in the other states is greatly reduced from historical levels through chronic overfishing and failure of managers to address the issue. During the 1990's, Tasmanian stock levels began spiralling downward, prompting a review of management strategies (Officer, 1999) which resulted in (among other measures) an increase in size limits state-wide. The size limit increase was based upon a strategy to maintain egg production above critical levels at which populations had been found to decline.

The size-limit increase was a major factor in the recovery of the Tasmanian greenlip fishery, but meant that many small-growing populations, such as those in Perkins Bay, became unproductive because the size limit was now too large. Consequently, the size limit at Perkins Bay was reviewed and re-appraised using the egg-per-recruit model (Tarbath, 2006). Its recommendations have yet to be fully implemented, and while the size limit has been reduced, no catch limit is operational in 2007. The successful implementation of this model relies upon several key assumptions, two of which are: (a) that effort will be dispersed and fishing mortality applied evenly among populations, and (b) that egg production is a function of size limit and spawning biomass.

The first assumption means that populations should not be serially depleted lest the numbers of spawners decline to levels which are inadequate to supply eggs to maintain the population. The egg-production model assumed that the communities of Perkins Bay greenlip formed a meta-population and that there was mixing and transfer of eggs between communities caused by currents and tidal flow. Should this mixing be inadequate, it means that heavily fished populations may be left so depleted that they are no longer able to supply sufficient eggs to ensure sustainability. In Perkins Bay, it means that Black Reef should not be fished to the exclusion of other reefs in Block 47.

The second assumption means that to preserve sufficient egg-production, the further the size limit is reduced, then the sustainable yield must become smaller. Larger abalone produce more eggs than smaller abalone. To maintain egg volumes at sustainable threshold levels then the fishery may operate with a large size limit combined with a high yield or a small size limit combined with a small yield (or even a large size limit with a small yield, although this produces the least catch). It cannot operate with a

small size limit combined with a large yield. If the recommended 20t Perkins Bay cap is increased without a corresponding increase in size limit, then estimated levels of egg production will fall below critical levels and may jeopardise sustainability.

Catch rates in other parts of the North West were better than or similar to previous years, implying that stock levels were stable. They provide some evidence of recovery from the low stock levels common throughout the region prior to the reduction of the cap from 40t to 30t in 2004. Most divers believed that stocks were at satisfactory levels, although one diver reported that some areas where he used to fish have not recovered and remain depleted.

For the second successive year the catch in the North East (16t), was lower than the cap. Like the North West, the North East stock appear to have been over-fished for many years, and catch rates fell sharply in 2002. In 2004, divers and managers were concerned that populations were being heavily depleted, and the 30t cap was reduced to its current level. Catch rates in Block 39 have increased, and divers are confident that fishing in the region has improved.

In recent years, the domestic market for large (160mm plus) live greenlip has strengthened and pays a premium of up to \$12 difference between these and smaller greenlip, which are mostly exported as frozen meats. Factors such as the strengthening Australian currency relative to the US currency, which puts downward pressure on the price of frozen product, and rising demand in the domestic market for large live abalone have driven this difference. The Australian dollar is expected to continue appreciating against the US dollar, and there are no signs that the Australian economy is slowing thus limiting domestic demand. It is likely that the domestic/export market price difference will continue and possibly increase in the short term.

While all regions have large greenlip, they are more common and hence most are caught at the more remote King Island and Furneaux Group. King Island has a 150mm size limit, and most of the greenlip landed in the Furneaux Group have until recently been caught at 160mm. Beach prices paid for abalone from these regions are as much as 20% higher than beach prices from other regions, particularly Perkins Bay. This price difference has the potential to influence the distribution of effort among the regions without regard for available biomass, because quota owners will usually attempt to get the best returns by using divers who work on King Island or the Furneaux Group.

The 2006 King Island catch was 28t, a small decrease from previous years, and in contrast to previous years, was mostly caught by resident divers. This was partly due to the remoteness of the island and the consequent difficulty and cost of fishing there for Tasmanian mainland divers. Motherships mostly stayed away from the island, partly because of the low catch rates experienced by most divers fishing King Island blacklip in shallow water in 2005, and perhaps partly because of the closure of the remote island part of the Bass Strait Zone in August 2006.

Local divers have reported that greenlip fishing was slow, and that catch rates are low at approximately 50kg/hr. They have expressed concern that stocks of large abalone on the eastern side of the island and in the north are being over fished, and that it would be reasonable that the cap be reduced to 25t.

Some of the mothership effort shifted to the Furneaux Group, where divers could fish greenlip and Bass Strait Zone or Northern Zone. The Furneaux Group catch reached 40t, 2t short of its cap. In recent years, most of the Furneaux Group catch has been taken at 160mm (15mm above the legal limit) to meet the domestic market requirements. However, the biomass of 160mm plus abalone has been steadily reduced because demand and fishing mortality have exceeded stock levels, and catch and catch rates of the larger greenlip have fallen. While there is no concern for sustainability of populations (levels of egg production at 160mm are considerably greater than threshold sustainability levels and divers fishing to the legal size measure for the export market continue to operate at high catch rates), it is likely that there will be some economic impact to the fishery.

At both King Island and the Furneaux Group there are considerable stocks of greenlip that, like those at Perkins Bay, grow slower and to a smaller size than the legal size limit. Potentially these abalone could be fished at a reduced size limit provided that they were in a well defined area where a special size limit fishery could be managed. However, throughout much of the regions, the stunted populations are dispersed and found in isolated pockets between populations of larger growing abalone and a reduced size limit would risk the sustainability of the larger growing populations. More importantly, small greenlip are not as valuable, and no-one would suggest that the larger growing populations be jeopardised by increasing the catch of smaller abalone.

Divers in both regions believe that growth rates of greenlip are largely determined by habitat, and there is long-established documented evidence to support this (Day and Fleming, 1992; Emmett and Jamieson, 1988; Wells and Mulvay, 1995). Individually, the divers have proposed that they move quantities of stunted abalone to the faster growth areas. The stunted abalone would grow to the larger sizes preferred by the domestic market, and attract the premium beach price. The stunted stocks of abalone would be incorporated into the fishery and thus bolster the dwindling supplies of large abalone. Whether it is economically viable to catch abalone twice (and release them once) has not been determined, but if the beach price of domestic market abalone continues to rise, at some point it will become viable. The complex issue of maintaining egg production at the source of the stunted stock also needs to be considered.

## **Assessment Summary and Management Options**

### **Eastern Zone**

- There has been a consistent increase in catch rates during the last 2-4 years, with increased median length in many areas inferring reduced fishing pressure.
- Divers report less drops per catch and greatly improved fishing.
- Catch rates in 2006 are comparable with those seen in 2000, but at a much lower TAC (770 and 1190 tonnes respectively).
- TAFI is concerned that recruitment to the fishery may decline between 2007 and 2009 due to low stock levels between 2001 and 2002. It is recommended that a cautious approach be taken to rebuilding stocks.

## Western Zone

- Catches and catch rates appear to be stable in the North West and Central West suggestive of stable stock levels. Increasing median lengths suggest that fishing pressure has been reduced and/or that selective fishing is not as prevalent.
- Catch rates have continued to fall in the South West. Other indicators (number of drops, diver fishing patterns, diver sentiment) also suggest that stock levels are falling. The intermittent nature of the fishery here means that abundance is probably falling at a faster rate than catch rate trends would otherwise indicate. The higher priced live market will continue to direct excess effort both here and to the South Coast unless catch is restricted. Catch levels in the South West are too high and are leading to significant depletion that needs to be curtailed.
- Levels of catch from the South Coast remain high while catch rates have stabilized at a relatively low level for this region. Falling median lengths also indicate that fishing pressure remains high. Smaller median length and reduced catch rates suggest that at current levels of annual catch there will be limited stock rebuilding and limited resilience to selective fishing, reductions in recruitment, or other perturbations.
- Management options include:
  - *Status quo*. The “do nothing” option has prevailed until now, but has led to falling stock levels.
  - Impose catch limits on both the South Coast (no greater than 2006), and South West (at a level lower than the 2006 catch). This will redirect effort to the Central West and North West which, although now apparently stable, have experienced falling catch rates at higher levels of catch. The effects of increased catch in these regions may be mitigated if the exploitable biomass in the North West is increased by reducing size limits. Note this is unproven and the potential biomass increase is unknown.
  - A combination of TAC reduction and catch limits on the South Coast and South West. This option is most likely to promote sustainable fishing in these regions.

## Northern Zone

- There was a large shift in catch from King Island to the North West. Shallow water King Island stocks have been depleted, but deeper water stocks accessible to divers using specialised breathing equipment appear to be abundant. Quarantine restrictions on the movement of abalone between King Island and mainland Tasmania should maintain catches below peak levels.
- Catch rates remained stable in most parts of the Northern Zone. A major exception was in Block 5, where catch rates fell sharply. On some parts of this coast, large numbers of undersized abalone are reported to be found, and it has been suggested that reducing the size limit would make more stocks available while meeting the requirement of the two-year minimum legal length guideline. Similar views have been expressed

about other parts of the Northern Zone, particularly the Furneaux Group and North East. Additional growth and size at maturity data will be required in some areas to support any change.

- It is recommended that Management adopt a precautionary approach, particularly if increased levels of catch are to be taken from the North West in the future. Management options include lowering size limits (within the limits of the two-year minimum legal length guideline) to increase exploitable biomass, and/or maintaining strict limits on regional or block catches to prevent overfishing.

#### Bass Strait Zone

- In the Bass Strait islands catch rates continued to fall, although stock levels were reported by divers to be at satisfactory levels. The economic viability of this part of the fishery may depend upon catch rates continuing at current levels.
- In the Furneaux Group and on the Central North Coast, catch rates were low, and stock levels have been reported low. Continued fishing at 2006 levels will further deplete stocks.
- Management options: the Bass Strait Zone is closed for 2007, and there are no pressing requirements for the management of catch and effort. If a worthwhile increase in catch could be demonstrated, size limits in the Furneaux Group and the Central North Coast could be reduced further under the two-year minimum legal length guideline.

#### Greenlip

- Stock levels appear stable in the North West and North East. At Perkins Bay, a 20t catch cap is needed to maintain egg production levels at a size limit of 132mm.
- On King Island, stocks of legal-sized greenlip abalone have declined and divers there have suggested reducing the cap to 25t. In the Furneaux Group, stocks of large abalone are inadequate to meet market demands.
- Management options:
  - Impose a cap of 20t on the Perkins Bay fishery.
  - Maintain the status quo or reduce the King Island cap to 25t to prevent stock decline.
  - Investigate ways of enhancing stock levels of large abalone.

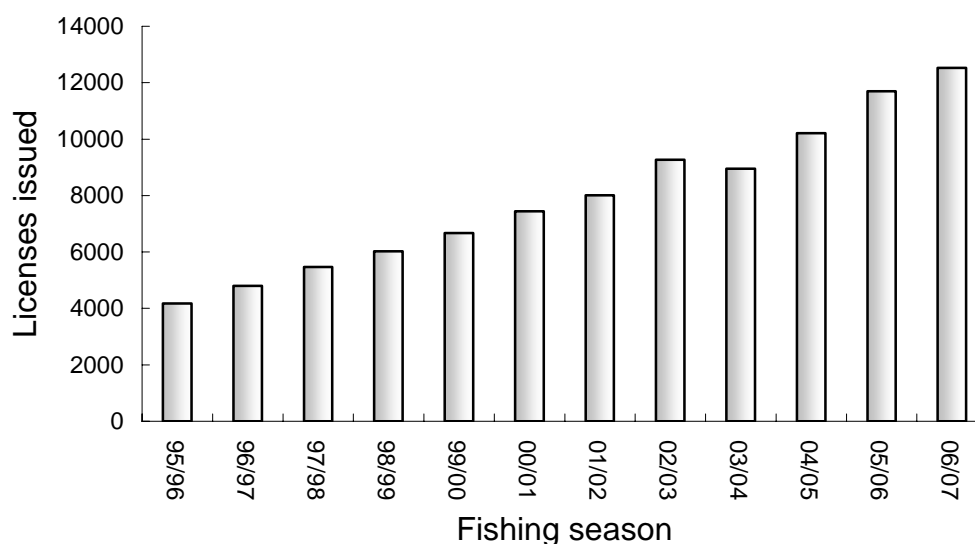
## 6. Other fisheries

### Recreational fishery

Recreational abalone fishing licenses are issued annually, expiring on 31<sup>st</sup> October each year. New licenses are available from 1<sup>st</sup> 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 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.

The number of recreational abalone licenses has increased by an average of ~10% annually since the 1995-96 season (Figure 16), and at 27 July 2007, 12,521 recreational abalone diving licenses had been issued. The current annual catch, if caught at the same rates as the 2004-05 catch, is estimated to be approximately 70t.



**Figure 16.** The number of recreational abalone diving licenses issued for the fishing seasons 1995-2007.

### Indigenous, illegal and permit fisheries

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

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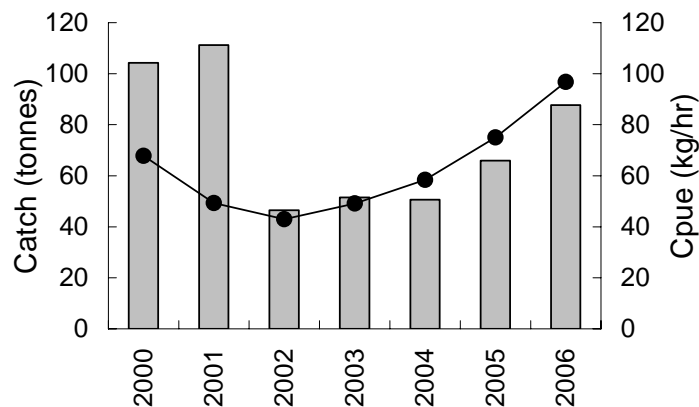
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## Appendix 1: Interpreting graphical information

### *Catch and catch rate by region, block and sub-block.*

Catch and catch rate information is shown across a range of geographical scales ranging from large (regional) to small (sub-block) where relevant (*i.e.* catches consistently larger than 10t pa, or six or more divers contributed to the catch). Figure 17 shows catch and catch rates for the last seven years for sub-blocks. The vertical columns show catch in tonnes, for the period 2000-2006. The black line with balls shows catch rates (CPUE) over the same period. Greenlip charts show catch as hatched columns, and catch rates as grey balls joined with a grey line.



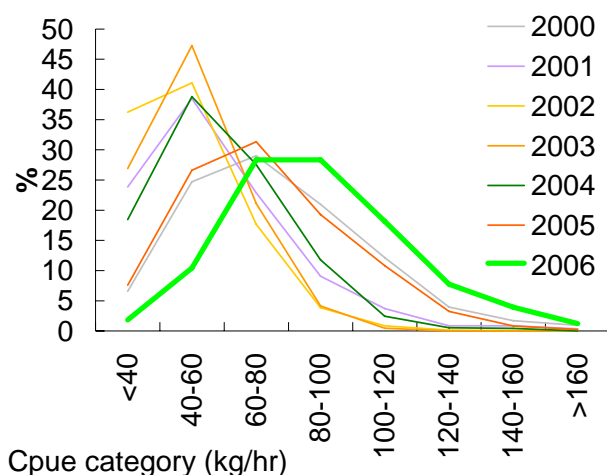
**Figure 17.** Annual catch (tonnes) and geometric mean catch rates (kg/hour), 2000 - 2006.

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

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

### *Regional catch-rate distribution:*

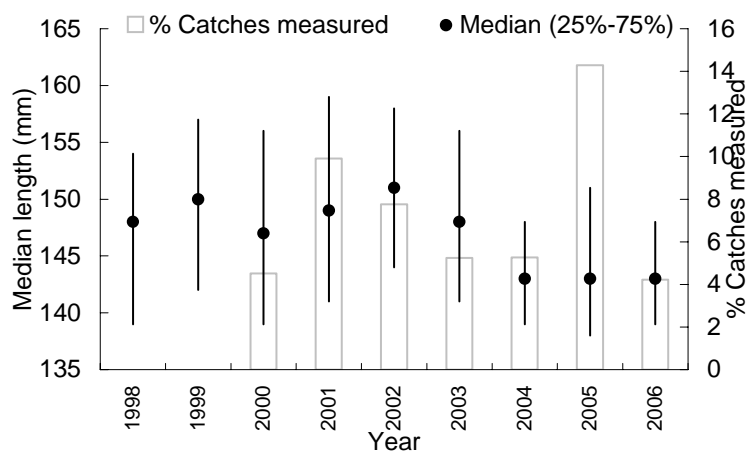
The distribution of catch rates provides information about how divers are catching abalone that is not explained by the mean (Figure 18). That the distributions are skewed (not evenly distributed about the category with the highest percentage) implies that fewer divers are achieving high catch rates. Skewness tends to be greatest when abalone abundance is low or has been recently reduced, making high catch rates less common.



**Figure 18.** The percentage distribution of catch-rates, 2000 - 2006.

*Size-composition charts.*

The size-composition of divers’ catches is reviewed at sub-block level (Figure 19). 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 19.** 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 50<sup>th</sup> percentile length if all abalone were sorted from smallest to largest) for the period 1998-2006 (or the period since catches can be attributed to sub-blocks). They also show the size of abalone at the 25<sup>th</sup> and 75<sup>th</sup> percentiles *i.e.* the size range of the middle 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 - 2006.

Reported annual tonnages of blacklip abalone caught within the statistical blocks and sub-blocks comprising the Western Zone in 2006. 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. In accordance with DPIW's requirements that divers' catches remain confidential, where five or less divers have contributed to the annual catch, the catch is not shown but is represented by an asterisk (\*).

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	*	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	*	44	68	185	182		651
1996		113	68	*	59	81	145	148		627
1997		98	75	*	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		212	32	15	185	152	311	290	43	1241
2002	2	173	51	17	174	143	359	236	93	1248
2003	*	97	104	27	142	239	345	229	67	1251
2004	*	88	89	21	130	181	374	250	96	1230
2005	6	95	110	26	92	149	389	311	65	1242
2006	4	109	76	6	142	198	384	228	89	1236
Average	2	161	62	32	161	136	294	212	72	1075

**Appendix 3: Annual Catches From The Eastern Zone 1975 - 2006.**

Reported annual tonnages of blacklip abalone caught within statistical blocks and sub-blocks comprising the Eastern Zone in 2006. 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. In accordance with DPIW's requirements that divers' catches remain confidential, where five or less divers have contributed to the annual catch, the catch is not shown but is represented by an asterisk (\*).

Year	13	14	15	16	17	19	20	21	22	23	24	25	26	27	28	29	30	31	Total
1975	247	111	*	48	12		16	27	49	74	15	16	5	44	69	16	45	32	836
1976	208	156		64	36	*	18	25	45	56	18	12	9	40	72	9	39	50	858
1977	245	232	2	190	13	*	23	35	37	53	11	10	9	55	90	22	122	54	1204
1978	322	218	6	120	24	*	32	65	60	88	22	13	11	93	87	25	137	105	1429
1979	374	251	8	148	25	*	51	52	43	30	10	23	7	80	52	12	107	60	1335
1980	272	255	7	145	30	*	33	30	42	46	158	34	*	108	91	27	148	105	1539
1981	254	299	18	127	48	*	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	*	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	*	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	*	9	64	66	12	30	21	888
1992	159	122	4	49	28	*	56	49	56	12	76	*	*	71	56	7	10	13	773
1993	271	121	4	107	47	*	67	79	49	24	75	1	*	87	39	8	15	15	1011
1994	300	148	10	118	65	2	122	85	62	17	57		3	104	24	8	11	21	1157
1995	313	256	*	106	35	*	108	78	41	21	43		*	81	19	6	11	26	1151
1996	392	195		80	18	*	74	55	44	29	69	*	*	90	39	11	28	20	1156
1997	470	137		64	25	*	79	49	47	32	106	*	13	190	32	32	23	33	1335
1998	483	109	*	116	23	2	85	64	63	44	160	*	25	182	77	31	10	15	1492
1999	474	66	1	106	34	6	97	61	47	53	139	*	9	94	60	24	10	39	1319
2000	381	98	*	71	29	4	62	60	69	44	104	*	8	101	16	21	10	90	1170
2001	324	157	3	108	20	2	56	50	40	24	111	*	14	68	9	27	13	79	1105
2002	296	101	*	72	16	*	62	58	46	15	46	*	2	53	7	15	12	44	847
2003	291	116	*	60	17	*	88	54	35	21	51		3	50	8	19	3	27	848
2004	221	104	7	50	20	*	92	52	35	19	51	*	*	44	11	24	6	22	761
2005	181	90	8	56	20	*	116	62	36	18	66		*	43	13	36	7	15	770
2006	184	84	3	67	13	*	73	66	71	23	88	*	*	40	10	41		7	773
Average	278	182	6	96	35	3	61	56	48	40	76	8	8	79	55	21	64	53	1169

#### Appendix 4: Annual Catches From The Northern Zone 1975 - 2006.

Reported annual tonnages of blacklip abalone caught within statistical blocks comprising the Northern Zone in 2006. 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. In accordance with DPIW's requirements that divers' catches remain confidential, where five or less divers contribute to the annual catch, it is represented by an asterisk (\*).

Year	31	39	40	32	33	34	35	36	38	47	48	49	5	1	2	3	4	Total
1975		*	*	2	9	1	7	7	2	*	12	*	39	*	*	*	14	167
1976		*			6		1	1	*	*	12	*	46	39	*	*	8	205
1977		5	*	6	11		0	2	2		8	17	50	*	*	*	*	216
1978		*	*	1	5	2	6	5	4	*	10	*	65	21	3	56	25	227
1979		*	*	2	9	*	0	1	2		27	*	85	*	*	*	*	187
1980		*	*	2	6	*	1	*			10	*	92	51	3	*	*	209
1981		*	*		7	*	1			*	33	*	120	19	*	33	*	250
1982		*	*		5	*	*	*	*	*	45	*	121	23	9	27	13	265
1983		*	*		4	0	1	5	*	*	44	19	227	22	*	32	*	431
1984		5	*		7	0	1	2	*	4	81	45	311	*	*	34	55	562
1985		5	2	4	6	1	2			4	48	50	319	*		26	12	522
1986		10	5	*	9	*	*	*	*	15	86	97	267	35	4	24	13	575
1987		6	*		7	*	2	*	*	18	58	68	197	44	61	24	53	542
1988		2	*	1	11	*	*	*		18	36	41	168	29	17	22	60	410
1989		1	28		4	*	0			14	16	24	88	14	7	10	5	211
1990					1		*			6	14	20	82	11	10	9	12	165
1991		*			2	1	1			8	12	10	97	*	7	13	27	185
1992		3			*	*	*			2	10	11	76	4	6	14	10	139
1993					3	*	*	*		*	6	7	66	*	4	*	9	116
1994					*	*	*			*	6	11	49	9	2	*	1	86
1995				1	1	*	0				6	2	62	12	3	*	8	97
1996							0				4		63	7	2	*	2	79
1997		1					0				5	2	56	10	1	10	6	91
1998			1		2						6	3	61	3	1	*	2	80
1999		4	1	0	4		0	*	1		13	4	57	5	1		6	95
2000		5	*	*	5	*	*	*	*		12	26	38	*		*	*	105
2001	12	11	*	5	10	*	*	*	*		17	72	117	2	*	*	12	276
2002	30	4	*	1	11	*	*	*	2		12	48	103	10	*	35	16	278
2003	7	8	*	*	5	*	*	*	*	*	10	76	73	25	*	62	10	279
2004	14	5	*	*	3	*	*	*	*	*	6	61	57	10	*	85	34	278
2005	11	2	*		7	*	*	*	*	*	6	54	73	15	*	92	18	282
2006	16	4	*	*	11	*	*	*	10	*	5	57	96	11	2	57	8	279
Average	15	4	2	1	5	0	1	1	1	3	21	28	107	18	5	28	17	247

### Appendix 5: Annual Catches From The Greenlip Fishery 1975 - 2006.

Reported annual tonnages of greenlip abalone caught within the statistical blocks comprising the Greenlip fishery in 2006. These tonnages are derived from estimated weights, which do not correspond exactly with landed weights. In accordance with DPIW's requirements that divers' catches remain confidential, where five or less divers contribute to the annual catch, it is represented by an asterisk (\*).

Year	31	39	40	32	33	34	35	36	37	38	47	48	49	5	1	2	3	4	Total
1975	7	*	*	3	17	14	49	69	14	11		7	*	8		*		1	212
1976	14	*	*	*	26	11	55	49	*	*		8	*	14					207
1977	6	8	*	6	23	*	50	24	*	22		40	2	17					224
1978	8	*	*	4	12	17	51	38	*	17	*	13	*	12	1	3		2	192
1979	11	*	*	10	21	*	46	15	*	4		11		8					146
1980	4	*	*	7	15	*	29	*	*	4		6		5		3			101
1981	6	*	*	12	17	*	34	10	*		*	12	*	9		*		*	152
1982	27	*	*	*	13	*	*	*	*	*	*	7		2		14		2	143
1983	23	*		*	21	8	34	9	*	*	*	40	11	9		*		*	201
1984	50	8	*	9	27	15	56	7	6		52	60	2	11		*	1	5	320
1985	53	5	4	9	20	15	42	*	*	*	12	36	3	3		*		1	222
1986	39	8	7	*	14	*	*	*	*		57	35	14	5	1	8		3	250
1987	32	12	*	8	20	*	30	*	10	*	37	33	3	8	13	125	5	69	431
1988	35	2	*	8	23	*	*	*	*		35	28	5	10	3	33	2	12	249
1989	22	5	2	*	16	*	22	*	*		20	27	4	6	1	70	3	10	227
1990	23	7		4	9	*	*	6	*	*	21	27	11	11	2	49	3	13	218
1991	20	*		*	7	2	31	*	3		13	32	6	12	*	29	3	16	192
1992	16	10		*	*	*	*	*	*		4	14	2	4	3	18	1	8	124
1993	9	*		*	5	*	*	*	3		*	26	3	2	*	17		9	113
1994	12	*		*	*	*	*	*	*		3	48	3	10	4	25		7	161
1995	25	*	*	5	9	*	21	*	3	*	*	23	5	8	14	10		13	164
1996	11	13	*	4	14	*	20	2	8	*	*	15		3	36	33	*	12	191
1997	17	22	*	8	13	*	12	*	11	*	*	28	3	6	35	33		6	216
1998	4	17	25	5	6	*	23	*	*	*	*	43	8	14	33	34		5	225
1999	6	2	4	2	17	*	15	*	2	4		18	1	10	21	25	1	10	141
2000	12	15	12	8	11	*	14	*	*	*	*	24	12	*	*	*	*	*	140
2001	7	20	4	14	14	*	*	*	1	*	*	35	9	3	8	8	*	*	140
2002	17	12	*	4	16	*	8	*	*	*		27	5	7	11	6	*	9	139
2003	18	16	*	5	16	*	*	*	*	*	*	14	10	10	14	11	3	*	140
2004	9	22	*	4	4	*	13	*	*	*		14	6	10	14	*	4	3	128
2005	6	13	*	*	12	*	10	*	*	*		19	1	12	16	*	4	*	123
2006	3	13	*	5	5	*	11	*	4	*	*	29	2	8	11	*	2	5	123
Average	17	8	3	6	14	6	28	11	5	6	9	25	4	8	8	19	1	8	186

### Appendix 6: Annual Catches From The Bass Strait Zone 1975 - 2006.

Reported annual tonnages of blacklip abalone caught within statistical blocks comprising the Bass Strait Zone in 2006. These tonnages are derived from estimated weights, which do not correspond exactly with landed weights. In accordance with DPIW's requirements that divers' catches remain confidential, where five or less divers contribute to the annual catch, it is represented by an asterisk (\*).

Year	37	41	42	43	44	45	46	50	51	52	53	54	55	56	57	Total
1975		*														0
1976				*												1
1977	*	*														1
1978	*			*												1
1979	*	*					*									4
1980	*	*		*												1
1981	*			*												3
1982	*						*									1
1983	*						*									1
1984	0	*	*	*			*									5
1985		*	*	*	*											4
1986	*	*	*	*		*	1									8
1987	2	*		8	*		*									14
1988	*		*	*	*		*									4
1989	*	19	11	34	*	5	14	24	0	41	4	0	6			167
1990	*	*	*													1
1991	17	*					*	14	5	28	1	0	17	15		96
1992	*				*			*								1
1993	19						*	*	21	4	37	1	0	6	8	95
1994	*															0
1995	52	*						*	46	2	44	0	0	0	5	149
1996		*														0
1997																0
1998																0
1999	0															0
2000	*	*			*											0
2001	*														*	2
2002	*				*		*					*			*	2
2003	6	*	*	2	*	*	*	7	*	36	*		7	2		70
2004	3	4	*	1		*	*	*	*	42	5	2	7			70
2005	6	4	*	2			*	8	*	35	5	3	3	*		69
2006	20	*	*	5			5	3		24	5	2	*	*		70
Average	5	2	2	5	0	1	2	1	15	2	36	3	2	7	4	28

**Appendix 7: Catch/effort data extract query.**

Catch/effort data from divers' catch docket are provided by DPIW, with tables updated weekly and stored in an Oracle database at the University of Tasmania. The following SQL query was used to extract 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-06' and '31-DEC-06'
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 DPIW's Abalone Management Plans.

1962	Minimum size limit (MSL) of 5 inches (127 mm) minimum shell diameter introduced.
1964	MSL increased to 6 inches (152 mm).
1965	MSL reduced to 5 inches. Introduction of commercial abalone diving licenses. All abalone to be landed live (no processing at sea). Skippers of boats engaged in abalone fishing required to lodge monthly fish returns as part of their license conditions.
1966	Abalone processing factories required to record the number of persons from whom abalone were bought.
1967	Abalone divers required to carry a measuring device to measure the abalone before taking them. Special penalty introduced for possession of undersized abalone at \$1 per fish. Abalone to be sold in live condition to registered processors only.
1968	Abalone catch returns were introduced. These recorded daily catches and effort by reporting block, and were lodged monthly by the skipper (not necessarily a diver) of an abalone fishing vessel. More than one diver's catch could be reported on a return. These returns replaced the general fish return on which earlier catches were reported.
1969	License limitation introduced. Rapid expansion of the fishery led to this first attempt to control effort. Only divers fishing the previous year were licensed to fish in 1969. This figure (120 divers) was maintained in subsequent years.
1971	Only licensed divers allowed to dive from a boat engaged in abalone fishing.
1972	License transfer from a retiring diver to his nominee allowable on grounds of health problems. Annual license fees calculated as 1.5% of the mean of the previous three years value of annual production. An additional five licenses were issued to divers living in the Furneaux Group. These divers were restricted to fishing the Furneaux Group, but the other 120 divers were not prevented from fishing there. Penalties for breaches of regulations in relation to abalone fishing increased. Permit to transfer licenses between divers revoked.
1974	License transfer from a retiring diver to his nominee permitted. Computerised catch records started from July 1974.

1979	<p>Penalties for breaches of regulations in relation to abalone fishing increased, with special penalties rising to \$2 per fish.</p> <p>Identification cards for divers introduced.</p>
1982	<p>Penalties for breaches of regulations in relation to abalone fishing increased, with special penalties rising to \$10 per fish.</p> <p>Catch restricted by marketing crisis: processors limit divers to 24 tonnes pa.</p>
1983	<p>Penalties for breaches of regulations in relation to abalone fishing increased.</p> <p>Easing of market difficulties sees lifting of processor applied catch restrictions.</p>
1985	<p>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>i.e.</i> the TAC was 3806 tonnes. –</p> <p>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.</p> <p>License fees were increased to 2.5% of the value of the annual landed catch, for each quota unit held.</p> <p>Quota unit transfers between Furneaux divers and non-Furneaux divers were prohibited.</p> <p>The 120 Tasmanian mainland divers were prohibited from diving in the Furneaux group.</p> <p>Divers were required to own at least 16 units, but could accumulate no more than 80.</p> <p>The catch (kg) per quota unit was determined by the Liaison Committee based upon advice from the government researchers.</p> <p>Catch dockets recording the catch weight landed by individual divers were introduced.</p>
1986	<p>Annual license fees set at 5% of value of annual landed catch.</p> <p>The catch per ITQ was reduced to 1000 kg (9% reduction) <i>i.e.</i> TAC was 3460 tonnes.</p>
1987	<p>MSL increased to 132 mm from 127 mm.</p> <p>The catch per ITQ was reduced to 950 kg (5% reduction) <i>i.e.</i> TAC was 3287 tonnes.</p>
1988	<p>The catch per ITQ was reduced to 855 kg (5% reduction) <i>i.e.</i> TAC was 2958.3 tonnes.</p> <p>The minimum legal weight for abalone meats was set at 90 g.</p>
1989	<p>The catch per ITQ was reduced to 600 kg (30% reduction) <i>i.e.</i> TAC was 2076 tonnes.</p> <p>A fishery for abalone in Bass Strait was held in April, with a MSL of 110</p>

	<p>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).</p> <p>The minimum meat weight regulation of 90g was amended to apply only to blacklip abalone.</p>
1990	<p>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.</p> <p>MSL for greenlip in Furneaux Group waters increased to 140 mm.</p> <p>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.</p>
1991	<p>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.</p> <p>The license system was restructured: the diving entitlement was uncoupled from the entitlement to hold quota units and the lower and upper limits on the amount of units held was abolished.</p>
1992	<p>Minimum meat weight for greenlip was set at 70 g.</p> <p>Compliance catch database (SEALSPROD) that enabled auditing of catch from vessel to factory introduced by DPIF.</p>
1993	<p>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.</p> <p>Minimum meat weight regulation amended to 90g for all abalone other than greenlip.</p> <p>Penalties reviewed and significantly increased, with the option of prison terms for serious and repeat offenders. Special penalties increased to \$50 per fish.</p>
1994	<p>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.</p> <p>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.</p>
1995	<p>A fishery for abalone in Bass Strait was held in May and June, with a MSL of 110 mm. Only 12 commercial divers (<i>i.e.</i> non-abalone) participated. While the TAC was 100 tonnes, only 21 tonnes was taken. The fee was \$10.00 per kg of quota.</p> <p>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</p>

	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 <i>Living Marine Resources Management Act 1995</i> 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	<p>The first abalone Fishery Management Plan was introduced. Among changes that it introduced were catch monitoring, which included:</p> <ol style="list-style-type: none"> <li>1. Pre-fishing reporting by divers,</li> <li>2. Post-fishing reporting of catch by divers and processors,</li> <li>3. Processors required to maintain a daily balance of stock in, stock out and stock on hand,</li> <li>4. Processors to report prior to movement of stock out and on receipt of stock,</li> <li>5. Reports to be made by telephone, where information was immediately available to Compliance Audit Unit and Tasmania Police.</li> </ol> <p>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:</p> <ul style="list-style-type: none"> <li>• For management purposes, the greenlip fishery was subdivided into two regions: the Furneaux Group and the remainder (North West, North East and King Island)</li> <li>• MSL was raised to 140 mm state-wide (except the North West, which was left at 132 mm),</li> <li>• 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.</li> </ul> <p>Within the Furneaux Group, several other rules were introduced to reduce effort:</p> <ul style="list-style-type: none"> <li>• 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.</li> <li>• 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</li> </ul>

	<p>overnight.</p> <ul style="list-style-type: none"> <li>• These rules were repealed in 1999.</li> <li>• The greenlip catch from the remainder of the State was to be limited to 106 tonnes.</li> <li>• 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.</li> </ul> <p>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.</p> <p>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.</p> <p>A new compliance catch database (LMM/QMS) introduced by DPIWE</p>
1999	<p>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.</p> <p>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.</p> <p>Within the Furneaux Group, Block 35 was closed to fishing between 1 October and 31 March to protect spawning abalone.</p>
2000	<p>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.</p> <p>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.</p> <p>Following egg-per-recruit studies by researchers, MSL for King Island greenlip was raised to 155 mm, 140 mm for North West and 145 for both the North East and the Furneaux Group.</p> <p>The Block 35 (Franklin Sound - Furneaux Group) greenlip catch was capped at 20 tonnes.</p> <p>Catch were reported on a smaller spatial scale with the introduction of sub-blocks state-wide.</p> <p>Owners of fishing license (abalone dive) were allowed to hold more than one license and allow others to dive those licenses as supervisors.</p>
2001	<p>The Northern Zone (between Arthur River in the west and Musselroe Point</p>

	<p>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.</p> <p>In association with establishment of Northern Zone, research monitoring areas were set aside at the Inner Sister, Swan Island, Waterwitch Reef, and the Doughboys.</p> <p>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.</p> <p>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.</p>
2002	<p>MSL for Eastern Zone was increased to 136 mm.</p> <p>MSL for greenlip on King Island was reduced to 150 mm.</p> <p>MSL for greenlip in the North West was increased to 145 mm.</p> <p>Eastern Zone TAC reduced to 857.5 t (245 kg/unit).</p> <p>Western Zone TAC remained 1260 t (360 kg/unit)</p> <p>Northern Zone TAC remained 280 t (80 kg/unit)</p> <p>Greenlip TAC remained 140 t (40 kg/unit)</p> <p>Production for the whole fishery was set at 2537.5 t (725 kg/unit).</p> <p>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.</p>
2003	<p>A Bass Strait blacklip zone (TAC 70 tonnes (20 kg/unit), MSL of 114 mm) was created within the Northern Zone in central Bass Strait and part of the Furneaux Group. Its purpose was to enable the catching of abalone smaller than allowed by the Northern Zone size limit. The Bass Strait Boundaries were set at Cowrie Point in the west and Anderson Bay in the east. The Flinders Island boundaries were on an unnamed point north of Settlement Point on the western side of the island (40°00'36.32") and Foochow Inlet on the east.</p> <p>Eastern Zone TAC remained 857.5 t (245 kg/unit).</p> <p>Western Zone TAC remained 1260 t (360 kg/unit)</p> <p>Northern Zone TAC remained 280 t (80 kg/unit)</p>

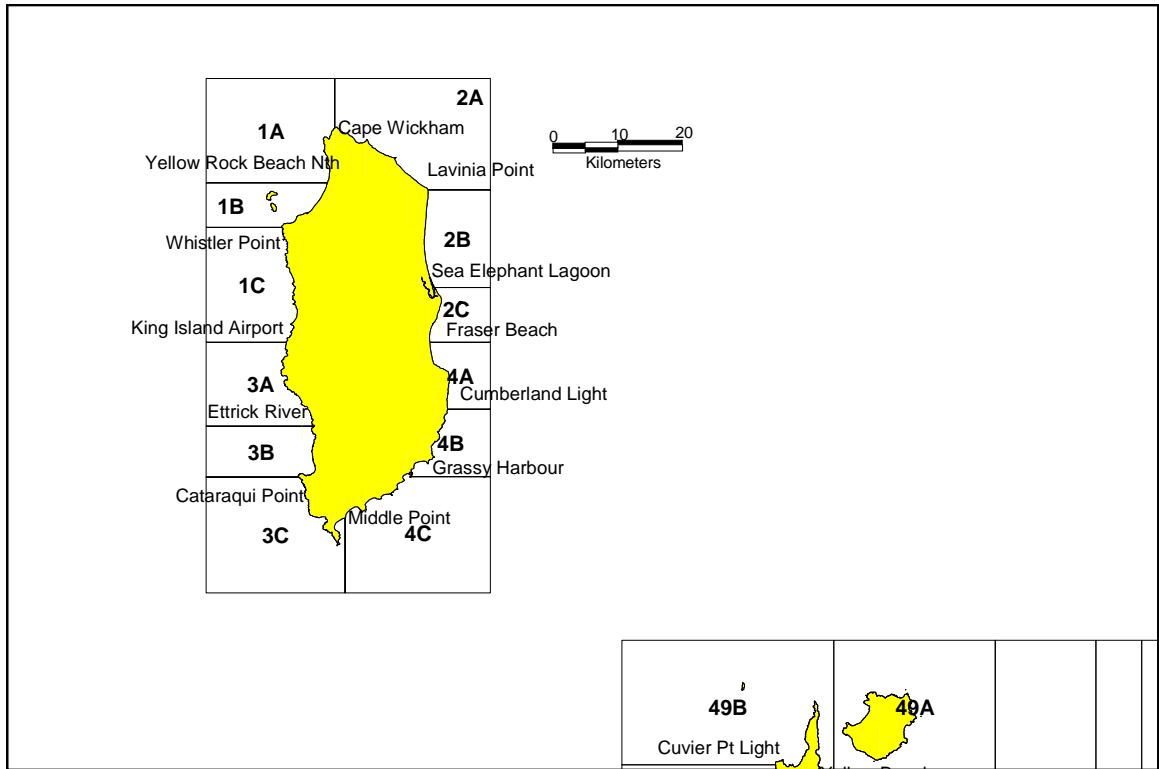
	<p>Greenlip TAC remained 140 t (40 kg/unit)</p> <p>Bass Strait Zone TAC set at 70 t (20 kg/unit)</p> <p>Fishery production was set at 2607.5 t (745 kg/unit) state-wide.</p> <p>Blacklip catch from Block 5 (Northern Zone) was capped at 100 t.</p> <p>MSL for Western Zone between the Wild Wave River and Arthur River was increased to 136mm from 132mm.</p> <p>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.</p>
2004	<p>Eastern Zone TAC reduced to 770 t (220 kg/unit)</p> <p>Western Zone TAC remained 1260 t (360 kg/unit)</p> <p>Northern Zone TAC remained 280 t (80 kg/unit)</p> <p>Greenlip TAC reduced to 129.5 t (37 kg/unit)</p> <p>Bass Strait Zone TAC remained 70 t (20 kg/unit)</p> <p>Fishery production was set at 2509.5 t (717 kg/unit) state-wide.</p> <p>The greenlip TAC reduction affected the North West only, where the annual cap was reduced by 10 t to 30 t.</p> <p>October-March closure for Franklin Sound greenlip fishery abolished. Block 35 cap reduced from 20 t to 15 t.</p>
2005	<p>Eastern Zone TAC remained 770 t (220 kg/unit)</p> <p>Western Zone TAC remained 1260 t (360 kg/unit)</p> <p>Northern Zone TAC remained 280 t (80 kg/unit)</p> <p>Greenlip TAC reduced to 122.5 t (35 kg/unit)</p> <p>Bass Strait Zone TAC remained 70 t (20 kg/unit)</p> <p>Fishery production was set at 2502.5 t (715 kg/unit) state-wide.</p> <p>The greenlip TAC reduction affected the North East only, where the annual cap was reduced by 7 t to 23 t.</p> <p>Team diving (sharing catch from one quota unit by two divers) was introduced to legitimise the practise of divers catching abalone for others when they held no quota to which their catch could be assigned. Team dive docketts were submitted by teams, but not computerised.</p> <p>High grading (discarding large abalone in the catch from the deck) prohibited.</p> <p>Caufing prohibited.</p> <p>Introduction of cancellation reports where a prior reported trip is cancelled.</p> <p>Introduction of single (blacklip) zone fishing provisions.</p> <p>Overcatch provisions introduced to cover unintentional underestimation of</p>

	<p>catch weight.</p> <p>In Victoria in December, ganglioneuritis detected on two land-based (Portland and Port Fairy) and two offshore (Westernport) aquaculture sites.</p>
2006	<p>Eastern Zone TAC remained 770 t (220 kg/unit)</p> <p>Western Zone TAC remained 1260 t (360 kg/unit)</p> <p>Northern Zone TAC remained 280 t (80 kg/unit)</p> <p>Greenlip TAC remained 122.5 t (35 kg/unit)</p> <p>Bass Strait Zone TAC remained 70 t (20 kg/unit)</p> <p>Fishery production was set at 2502.5 t (715 kg/unit) state-wide.</p> <p>On 1 January 2006, interim reduction in MSL for Perkins Bay greenlip area (Blocks 47, 48A), from 145 mm to 140 mm.</p> <p>On 20 September 2006, MSL for Bass Strait Zone in Blocks 41-46 (North Coast) reduced from 114mm to 110mm.</p> <p>On 1 November 2006, MSL for Eastern Zone was increased to 138mm from 136mm. MSL for greenlip abalone in Perkins Bay was reduced to 132mm from 140mm, with annual catch capped at 20t.</p> <p>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.</p> <p>May 2006: Victorian ganglioneuritis outbreaks reported from wild stocks adjacent to land-based aquaculture site at Port Fairey. As a precautionary measure, from 16 August 2006, the Tasmanian wild fishery in Bass Strait closest to the Victorian coast was closed to abalone fishing, initially for three months but then extended to 28 February 2007. The closure was for waters within latitudes 39° 12' S and 39 ° 33' S, and longitudes 146 ° to 147 ° 35' (Blocks 51 to 56, and part of Block 57, including Wright Rock and Endeavour Reef). The taking of abalone in Tasmanian waters from vessels used in the Victorian fishery was prohibited.</p>
2007	<p>Eastern Zone TAC remained 770 t (220 kg/unit)</p> <p>Western Zone TAC remained 1260 t (360 kg/unit)</p> <p>Northern Zone TAC remained 280 t (80 kg/unit)</p> <p>Greenlip TAC remained 122.5 t (35 kg/unit)</p> <p>Bass Strait Zone TAC remained 70 t (20 kg/unit)</p> <p>Fishery production was set at 2502.5 t (715 kg/unit) state-wide. However, it was agreed that the Bass Strait component (70t) would not be caught due to concerns about disease outbreaks in abalone stocks in adjacent Victorian waters.</p>

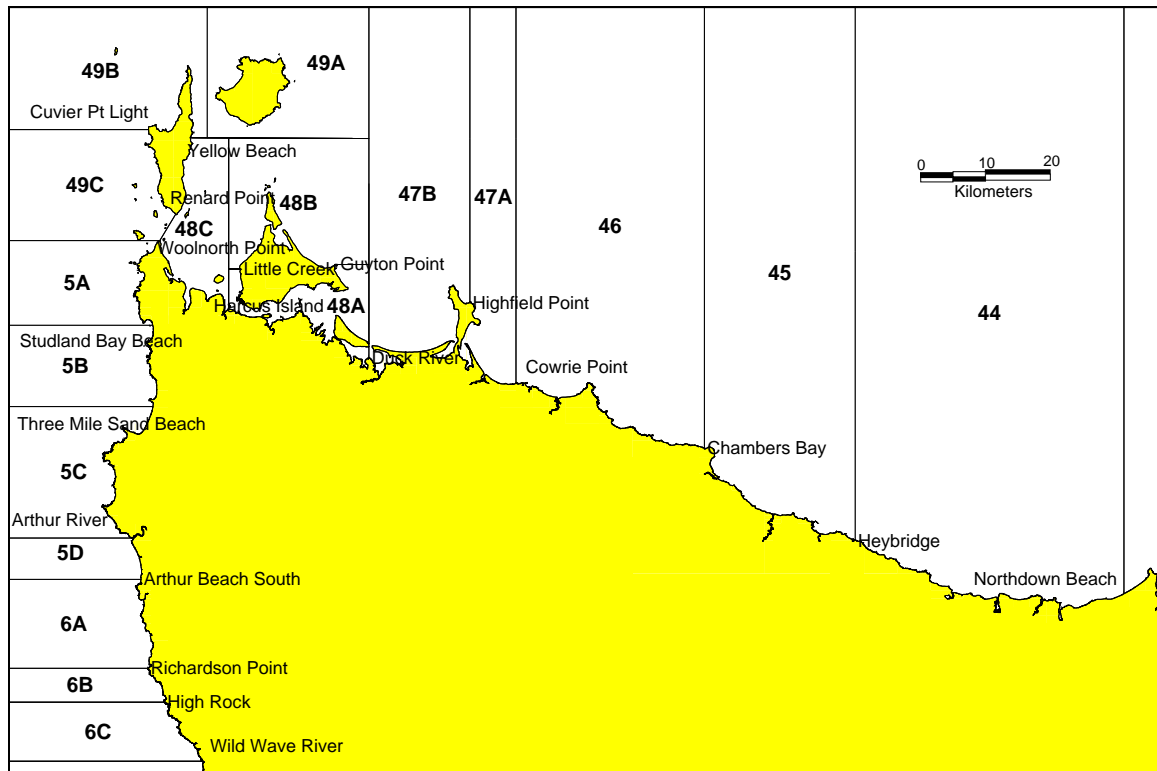
**Appendix 9. Maps of catch-reporting blocks and sub-blocks.**

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

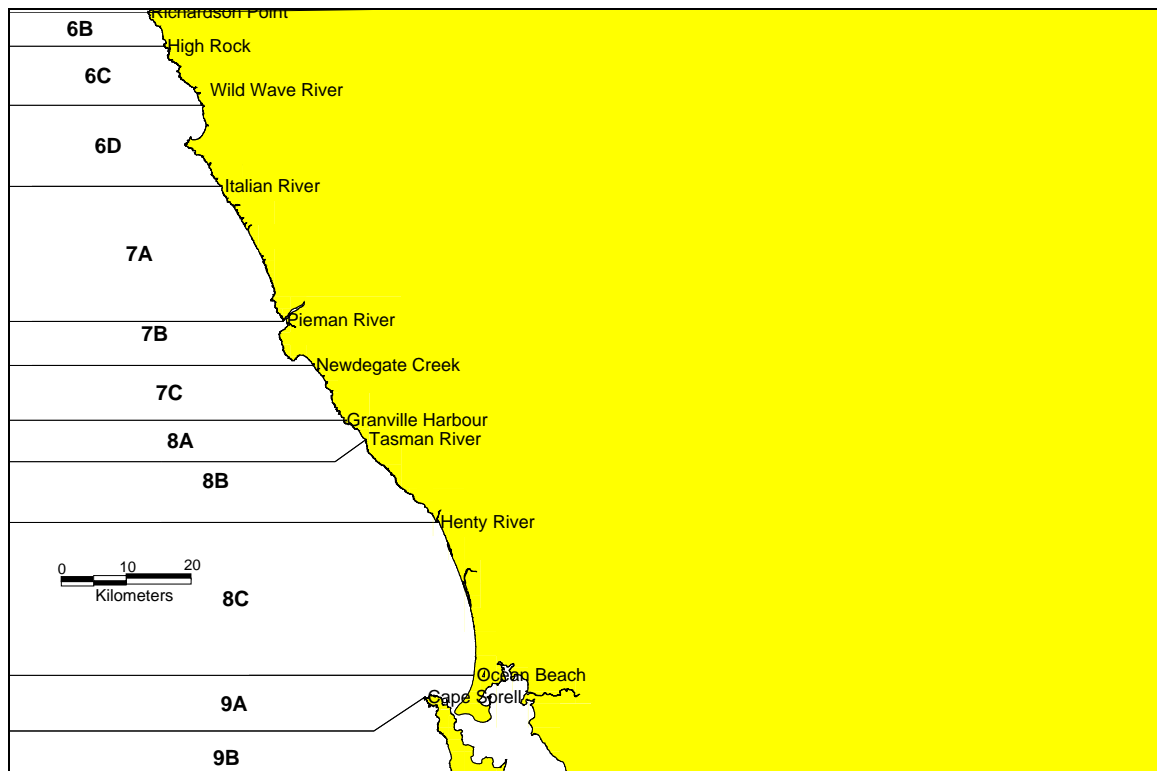
Map1: King Island



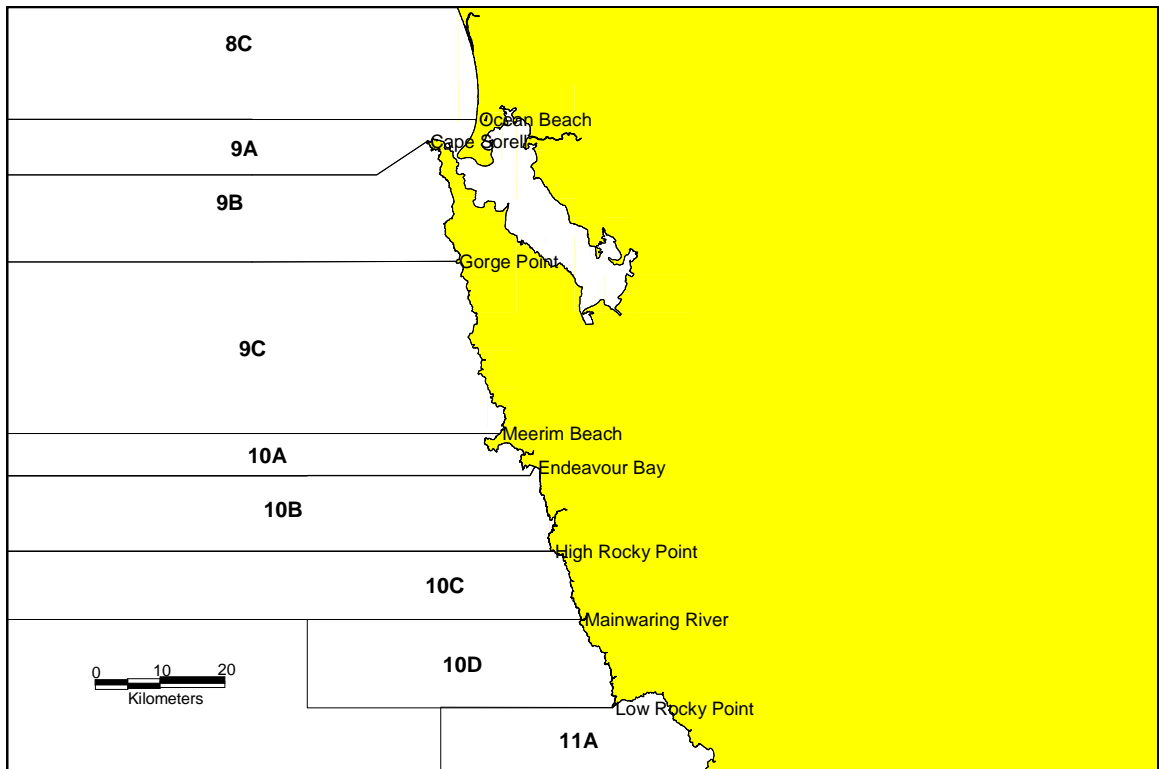
Map 2: North West Tasmania



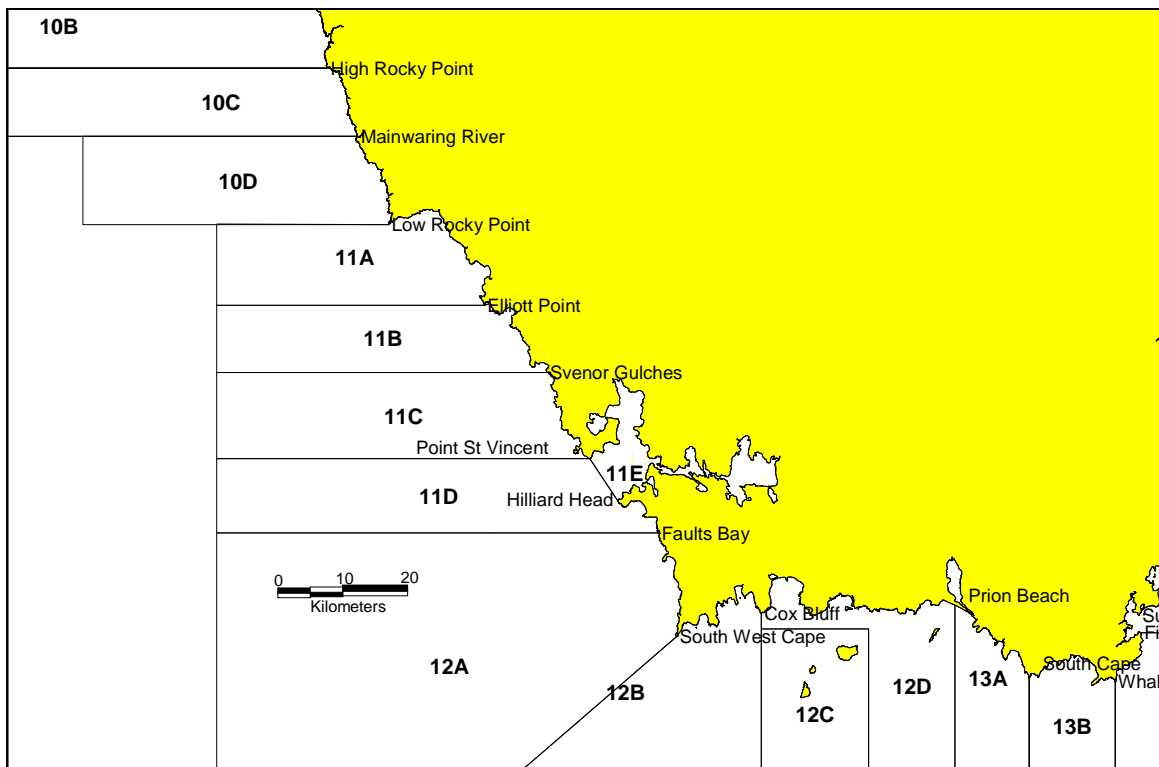
Map 3: Central West Coast (north)



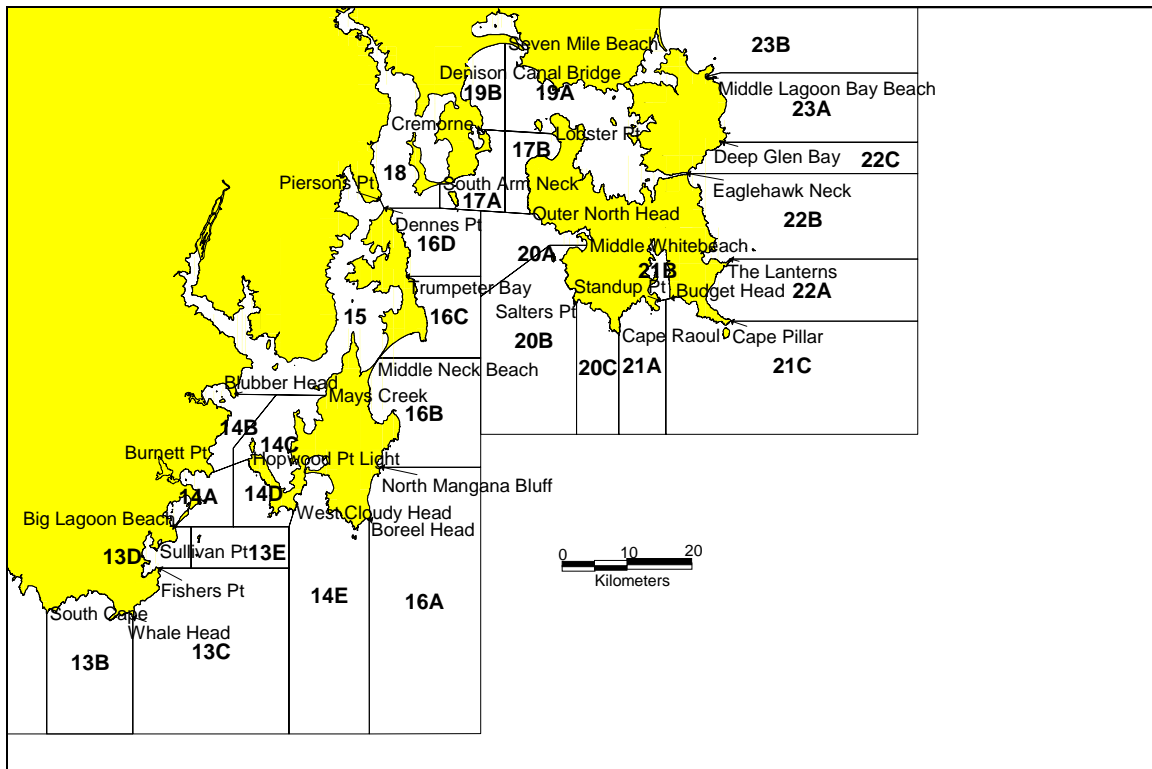
Map 4: Central West Coast (south)



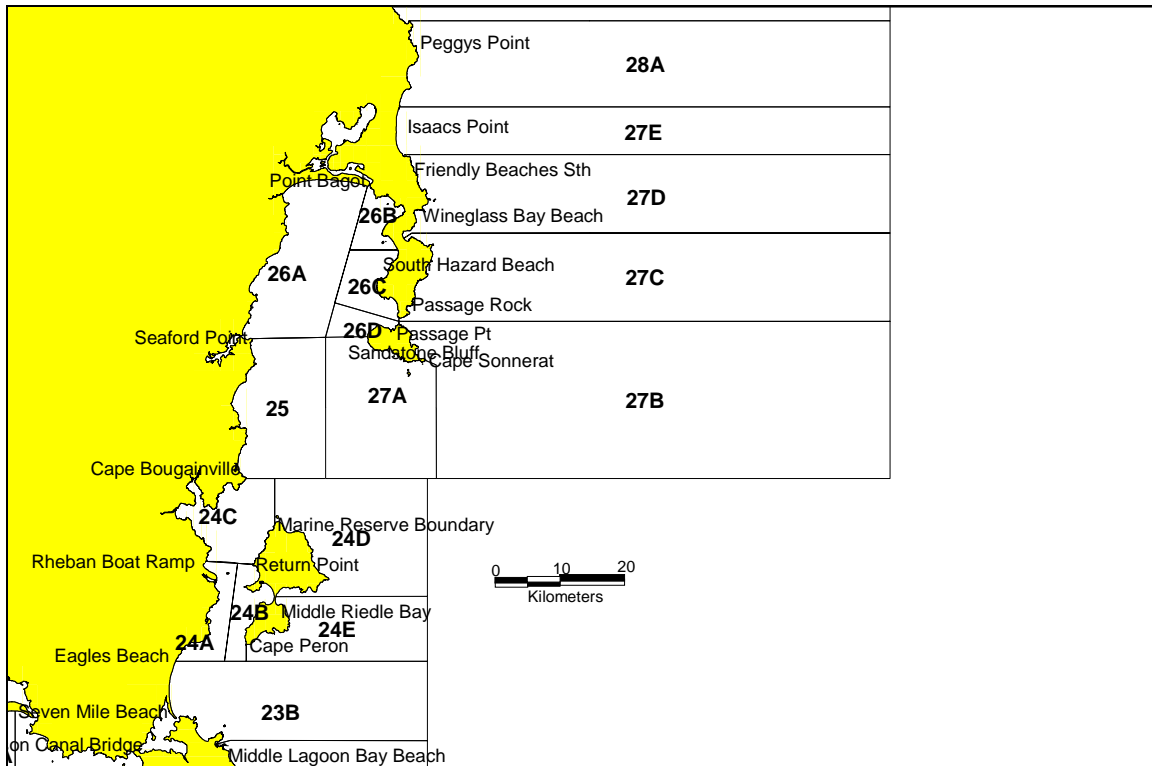
Map 5: South West Tasmania



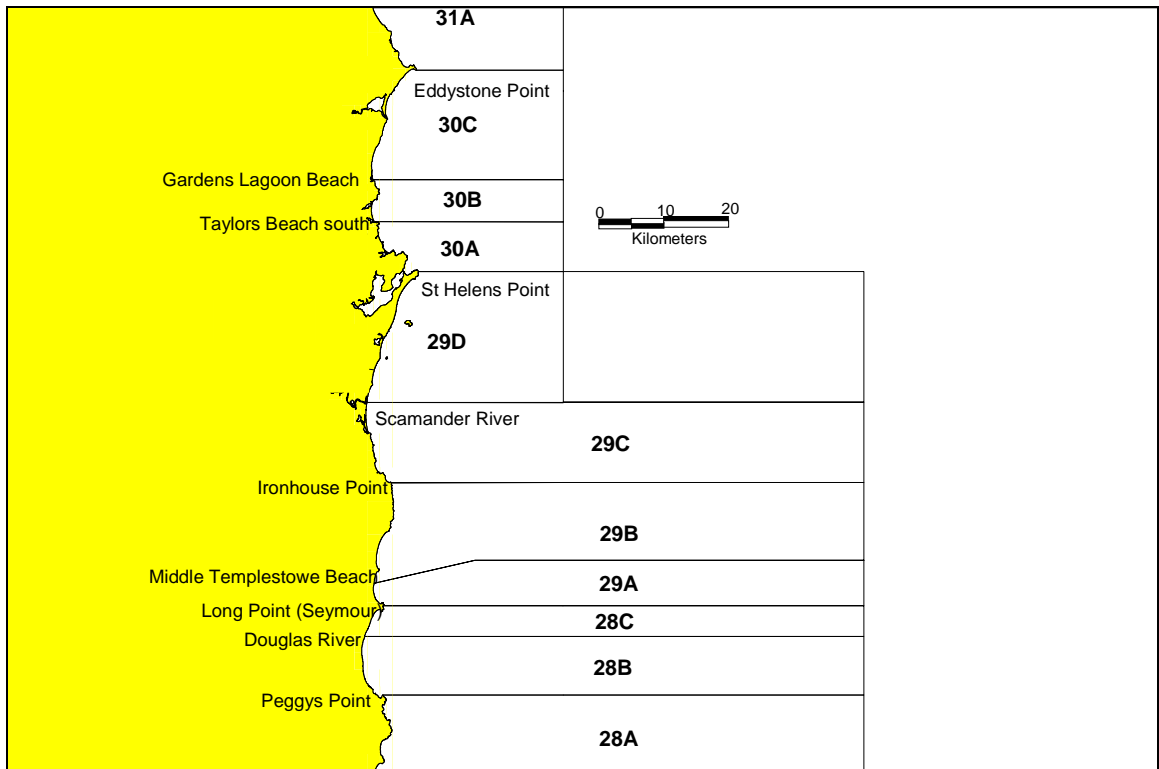
Map 6: South East Tasmania



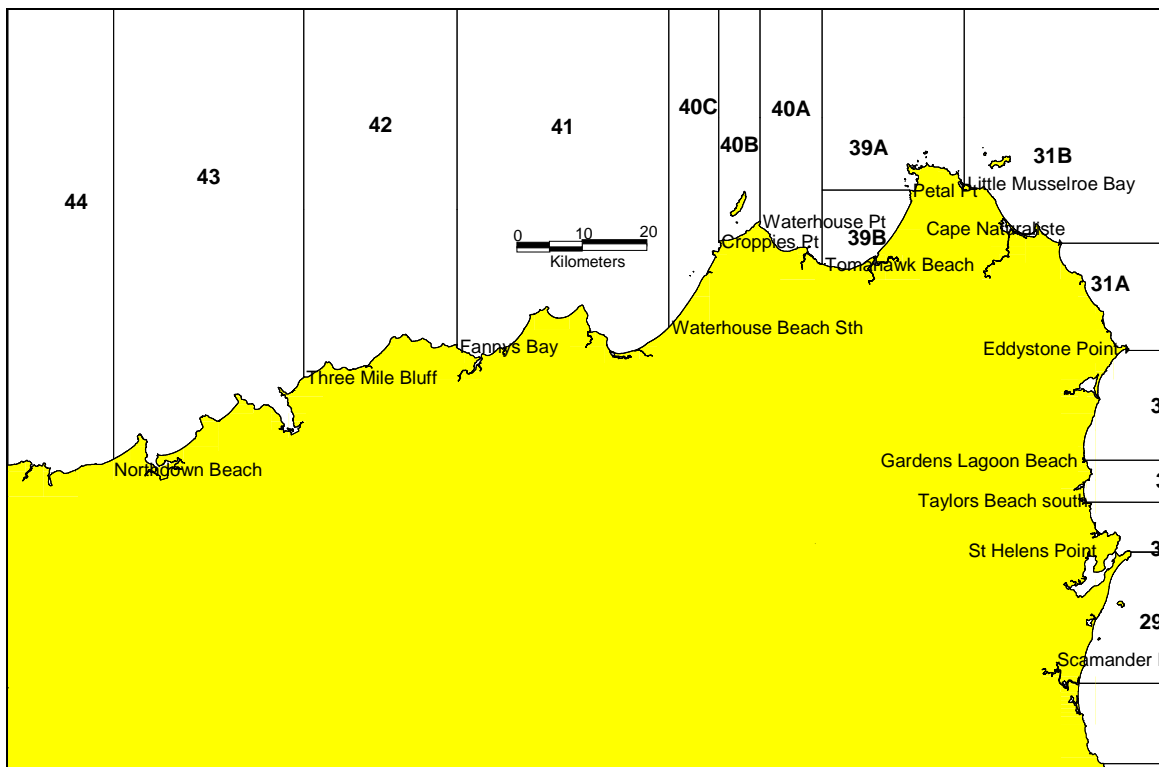
Map 7: Lower East Coast



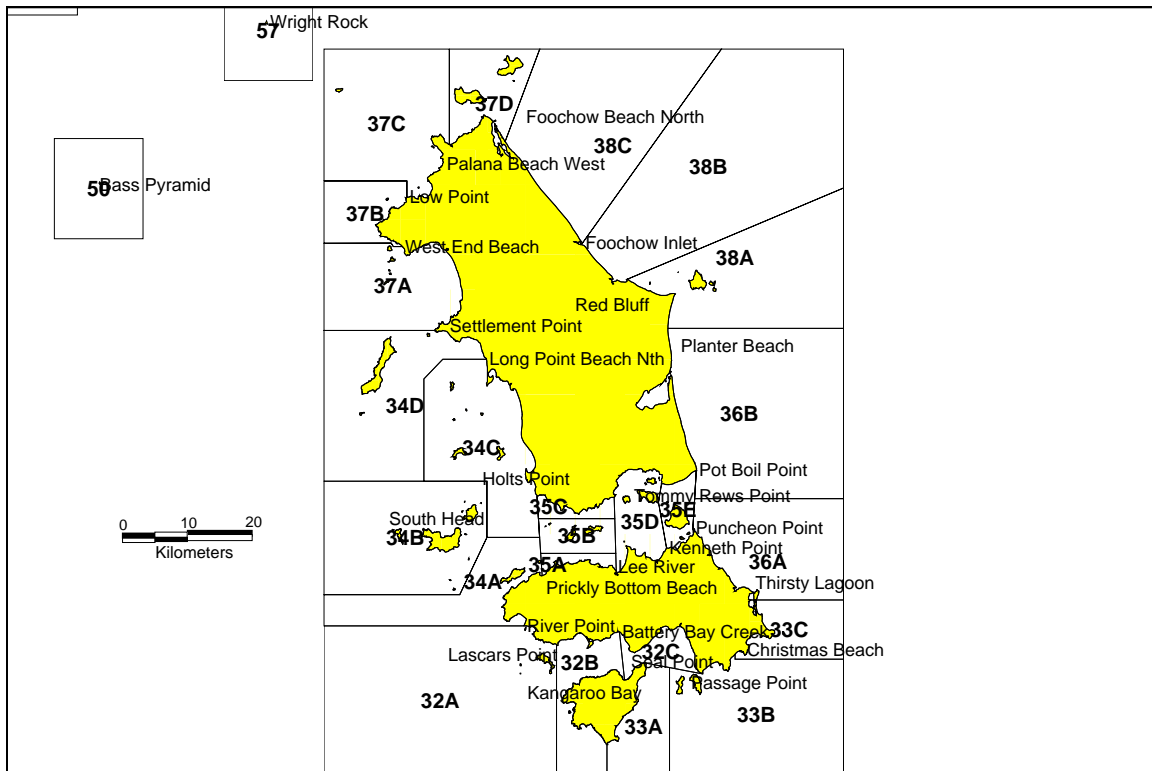
Map 8: Upper East Coast



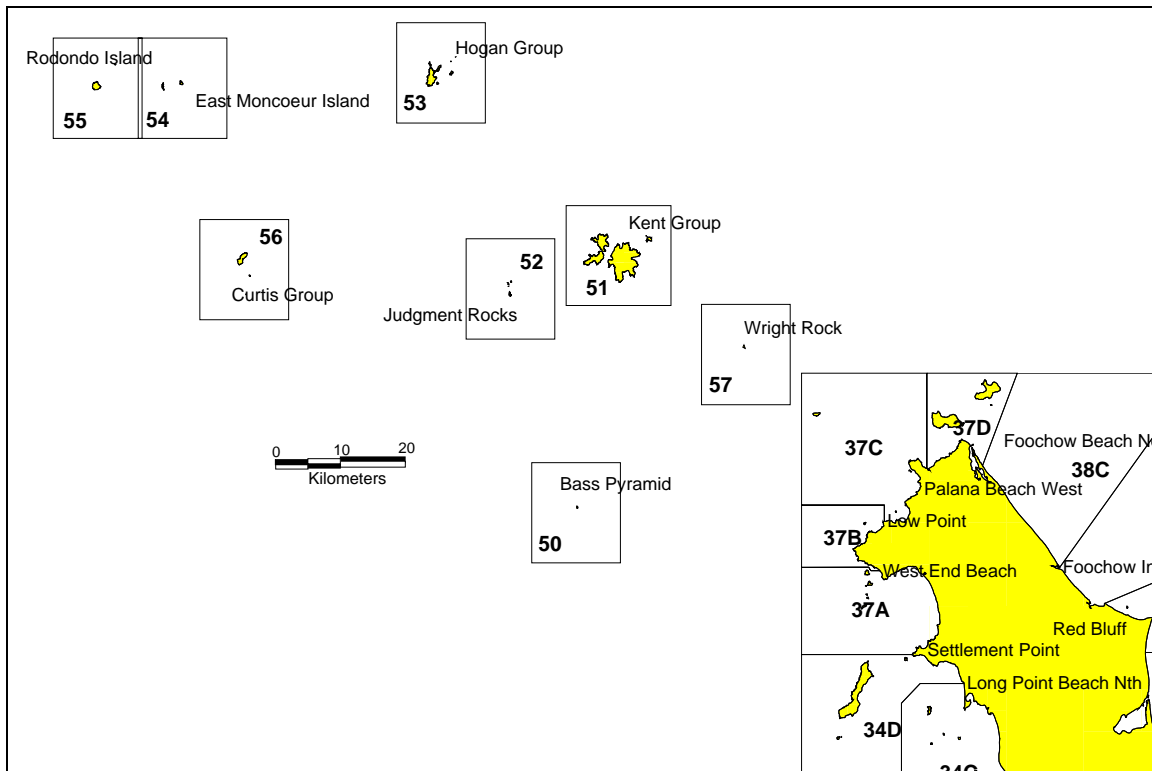
Map 9: North East Tasmania



Map 10: Furneaux Group



Map 11: Bass Strait Islands



## 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 2007 the Abalone Stock Assessment Group included the following people:

Dr. Jeremy Lyle	TAFI (Chairman)
Assoc. Prof. Malcolm Haddon	TAFI
Mr Allen Hansen	Tasmanian Abalone Council
Mr Berkely Dilworth	Tasmanian Abalone Council
Mr Roger King	Tasmanian Abalone Council
Mr Dean Lisson	Tasmanian Abalone Council
Mr Greg Hurd	Tasmanian Abalone Council
Dr Craig Mundy	TAFI
Mr Andrew Sharman	DPIW
Mr David Tarbath	TAFI
Mr Nigel Wallace	Tasmanian Abalone Council
Mr Greg Woodham	Tasmanian Abalone Council
Mr John Hoult	Tasmanian Abalone Council
Mr Tony Burton	TARFish