FISHERY ASSESSMENT REPORT

TASMANIAN ABALONE FISHERY
1997/1998

Compiled by Rickard Officer

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Tasmanian Aquaculture
& Fisheries Institute
University of Tasmania

This assessment of the abalone resource is the first to be produced by the Tasmanian Aquaculture and Fisheries Institute (TAFI) and uses input from the abalone fishery assessment working group (AbFAWG).

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Abalone Fishery Assessment: 1997/98

Summary

This assessment of the status in 1997/98 of the Tasmanian fishery for blacklip abalone (*Haliotis rubra*) and greenlip abalone (*H. laevigata*) was derived primarily using commercial catch-effort statistics and size-composition data. The assessment suggests that blacklip abalone stocks are generally healthy. However, whilst catch rates for blacklip abalone are at their highest levels for 24 years in many statistical blocks, in no more than three blocks can this be clearly interpreted as reflecting an increase in fishable biomass. These are blocks where both catch and catch rate are increasing. The report therefore highlights the limited utility of catch and catch rate trends as indicators of the health of the fishery.

The report highlights the trend of declining blacklip catch from northern areas and the west coast and a trend of increased pressure in the south-east and on the east coast. Current performance indicators are inadequate for determining if these trends are damaging the abalone stocks. Development of more sensitive performance indicators is recommended.

Catch and catch rate trends for the greenlip abalone fishery are less optimistic, especially in the Furneaux Group. In some areas of the Furneaux Group the decline of both catches and catch rates suggests a decline in abundance. Catch and effort statistics are particularly difficult to interpret for greenlip abalone because divers are increasingly targeting larger abalone. Catch rates may therefore decline because the effective minimum size limit is larger than the legal size limit, and the proportion of the legal-sized abalone that is being targeted is declining.

The general decline in greenlip catches from the Furneaux Group and the subsequent closure of the area has resulted in greater fishing pressure on greenlip abalone in other areas. Greenlip catches from King Island now comprise a far greater proportion of the total greenlip catch. The threat of serial depletion of greenlip abalone stocks should therefore not be overlooked. Greenlip abalone catch rates are currently viewed at such a large geographic scale that they may disguise the fact that overfishing is occurring on a local scale. Because of the sporadic nature of recruitment of greenlip abalone the possibility of serial depletion of abalone stocks may be significant.

Regional control of the distribution and level of catches would help alleviate the apparent problems of concentration of the blacklip catch and increased pressure on greenlip abalone. The report therefore endorses moves to implement such controls.

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1. Introduction

1.1 Abalone Biology

1.1.1 Distribution and habitat

Abalone are marine archaeogastropods that inhabit rocky substrata sub-tidally and feed on macro-algae. Two species are fished commercially in Tasmania: the blacklip abalone, *Haliotis rubra* Leach, and the greenlip abalone, *Haliotis laevigata* Donovan. Blacklip abalone occur throughout southern Australia and are fished commercially in Tasmania, Victoria, South Australia, New South Wales and Western Australia (Harrison, 1983; Prince and Shepherd, 1992; Shepherd, 1973). Blacklip abalone live at depths ranging from 0 to at least 50 m, although abundances are highest at 0 to 15 m depth in most areas. Greenlip abalone occupy a more limited distribution and are only fished commercially in Tasmania, Victoria, South Australia and Western Australia. Within its distribution greenlip abalone are constrained to areas of strong tidal flow. The species occurs at depths ranging from 0 to 30 m.

1.1.2 Reproduction

The sexes are separate, and external fertilisation of gametes occurs by synchronous broadcast spawning of eggs and sperm into the water column. Whilst individual abalone can produce million of gametes each reproductive season (Shepherd *et al*., 1992), fertilisation success is influenced by the distance between spawning adults. Highest rates of fertilisation are achieved when male and female adults are within 2 metres of one another. Experimental studies have demonstrated that fertilisation success is less than 5 % at separations greater than 16 metres (S. Shepherd, pers. comm.).

Reproduction of blacklip abalone is reported to occur at different times of the year in different places, although in southern Tasmania spawning intensity is maximal in late winter and early spring, with minor spawning throughout much of the rest of the year (Nash *et al*., 1994). Spawning of greenlip abalone appears to be epidemic, occurring over a period of 2-3 days in late spring/early summer (Rodda *et al*., 1997). There is also evidence that greenlip abalone aggregate before and during spawning, possibly as an adaptive response to maximise fertilisation success (Shepherd, 1986).

The eggs are lecithotrophic, so there is no feeding during the planktonic larval phase, although Manahan and Jaeckle (1997) have demonstrated significant absorption of dissolved organic nutrients through the integument. The larval phase is temperature-dependent but short (a few days) compared with that of species that have planktotrophic larvae (eg., oysters and fish), which have a planktonic larval duration of two weeks or more.

Abalone larvae settle preferentially on crustose coralline algae (McShane, 1996). Chemical cues for settlement include gamma-aminobutyric acid (GABA), a constituent of coralline algae (Morse *et al*., 1979), the mucous grazing trails of conspecific abalone (Seki and Kan-no, 1981) and the bacteria that grow on the surfaces of coralline algae.

1.1.3 Feeding

Small abalone feed on coralline algae until a few mm shell length, then feed for the rest of their lives on macroalgae. Preferred food species of *H. rubra* have been identified using gut analysis (Foale and Day, 1992) and laboratory trials (Fleming, 1995a; Fleming, 1995b). In southern Australia *H. rubra* primarily feeds on fleshy red macroalgae, although a variety of brown algal species are also eaten.

Abalone feed on either attached or drift algae. The relative importance of these two dietary components apparently depends on availability, which in turn depends on the degree of wave action and the species composition of algae growing where the abalone are living (Shepherd, 1973).

1.1.4 Growth and size

Growth rates have been estimated using both mark-recapture and direct ageing methods. Most mark-recapture studies have been of abalone larger than about 60 mm, and the data fitted by various methods to the von Bertalanffy growth function. When abalone smaller than ~60 mm have been tagged it has been shown that growth rate (in absolute terms, such as mm/yr) is maximal at a size greater than zero (Nash, 1995a), indicating that the age-length relationship is a sigmoid one. The use of the von Bertalanffy growth function is therefore not valid for fitting growth data when small sizes are included; these data may be fitted to the Gompertz growth function.

Worthington et al. (1995) have fitted New South Wales *H. rubra* mark-recapture data to several growth functions using the computer program GROTAG. Growth rates of small (10-60 mm) *H. rubra* have been measured by modal progression analysis (Nash, unpublished data).

Following the work of Prince et al. (1988b), who demonstrated the deposition of one shell layer per year, direct ageing of *H. rubra* has been an important part of the assessment of the Tasmanian abalone fishery (Nash, 1992; Nash *et al*., 1994). Nash (1994b) provided additional evidence of one growth ring per year in both adult and juvenile *H. rubra* in southern Tasmania.

Growth rates vary greatly between areas, although there is a trend towards faster growth and larger maximum size from north to south in Tasmanian waters (James, 1981; Nash, 1992; Nash *et al*., 1994).

Maximum age of *H. rubra* is probably at least 20 years. This is difficult to estimate from mark-recapture data because blacklip abalone can live for several years with no growth; thus, age-at-95%-of-L_∞, as is sometimes used to estimate longevity, is therefore of little use. Direct ageing using shell growth rings suggests a maximum age of about 25 years (Nash, 1992; Nash *et al*., 1994)

1.1.5 Age and size at maturity

Size at maturity varies considerably around the State (Nash *et al*., 1994, unpublished data). Size at maturity tends to increase from north to south, although there is considerable variation at small spatial scales. There is some evidence that maturation is related primarily to age, not size (Nash, 1990). Age at 50 percent maturity appears to be in the range 6 to 10 years (Nash, 1992; Nash *et al*., 1994)

1.1.6 Stock structure

Prince et al. (1987; 1988a) have postulated that *H. rubra* larvae may disperse no more than tens or hundreds of metres from the natal source, although the evidence is not conclusive (Sasaki and Shepherd, 1995). Even if the conclusions of Prince et al. are not generally correct, it is very likely that larval dispersal is no more than a few kilometres. Adult movement is at least as extensive as that postulated by Prince et al. for the planktonic larval phase (Nash, 1995a); movements of tagged abalone have been recorded over distances of several hundred metres.

Population genetic studies do not convincingly support the limited dispersal hypothesis, nor do they preclude it. Using enzyme electrophoresis, Brown (1991) found that measures of genetic distance between sites in southern Australia (including Tasmania) suggest an isolation-by-distance model, although significant genetic heterogeneity was found over small spatial scales (<3 km). Some of the four possible population/larval dispersal scenarios listed by Brown to explain this do not include limited larval dispersal. Population genetic studies of this sort are unable to discriminate between these scenarios (Brown, 1991).

Using mitochondrial DNA methods, Barrett (1989) found little genetic variation between sites extending from northern to southern Tasmania, and suggested that gene flow may be sufficient to maintain a homogeneous distribution of mitochondrial DNA genotypes throughout Tasmanian waters.

1.2 Fishery background

1.2.1 Commercial fishery

The Tasmanian abalone fishery has been reviewed by Harrison (1983) and Prince and Shepherd (1992). Abalone have been exploited commercially in Tasmania since the mid-1960s. Management measures introduced for the fishery (size limits, limited entry, total allowable catch, area restrictions, etc.) have been summarised by Nash (1994a; 1996).

A minimum size limit was first introduced in 1962. It has been changed several times to reflect the perceptions of the condition of the fishery and size at onset of sexual maturity. A state-wide increase from 127 to 132 mm occurred in 1987, followed in 1990 by a further increase to 140 mm in the west and south-west (between Wild Wave River and Whale Head). The most recent changes were an increase in size limit for greenlip abalone in 1999 from 132 to 140 mm in the north-west and from 140 to 150 mm in all other greenlip-producing areas.

Entry to the fishery was limited in 1969 to the number of divers in the fishery in 1968 (120). A further five licences were created for the Furneaux group in 1972. The catch increased steadily since the commercial fishery began, peaking in 1984 before a total allowable catch (TAC) and individual transferable quotas (ITQs) were introduced in 1985. Each of the 120 mainland Tasmanian divers were allocated 28 units of quota, and the five Furneaux divers 20 units. Each unit was equivalent to 1.1 tonnes of abalone (live weight). The Furneaux divers were each granted an additional eight quota units in 1990, giving a total of 3,500 units in the entire Tasmanian abalone fishery.

Because of concerns held by both members of the fishing industry and the Fisheries Department, quota was reduced in the four years following the introduction of quotas until, in 1989, a quota unit was equivalent to 600 kg live weight of abalone (a reduction of 45 percent over four years). The TAC (for blacklip and greenlip abalone combined) remained at 2,100 tonnes from 1989 to 1996. In 1997 the TAC was raised 20 percent to 2520 tonnes and it remained at this level in 1998 and 1999.

1998 saw the introduction of the Abalone Fishery Management Plan. Major changes included new requirements for:

- pre-fishing telephone reports from divers,
- post-fishing telephone reports of catch by divers and processors,
- processors to maintain daily balances of stocks on hand, received and dispatched,
- telephone reports from processors prior to dispatch of stock and on receipt of stock,
- greenlip abalone fishing, including regional monthly limits on catch, thus capping landings of greenlip whilst allowing catches throughout the year.

1.2.2 Recreational fishery

Abalone may be harvested by recreational divers who hold a fishing licence (recreational abalone). This licence is obtainable for a fee, and allows a daily catch limit of ten abalone of legal size. There are also possession limits of 20 abalone per person holding a recreational abalone licence and 5 abalone per person for those who do not hold recreational or commercial abalone licences.

Recreational fishing licences endorsed for abalone are issued on an annual basis for the period 1 November to 31 October. There is no limit on the number of recreational abalone divers. Surveys of recreational fishing have been undertaken by the Department of Primary Industry and Fisheries (J. Lyle, pers. comm.).

1.3 Impact of the Fishery on the Marine Environment

Abalone are prised from rock surfaces individually by divers using a knife-like tool. There is a negligible deleterious effect of this fishing method on the habitat.

Because of the ecological interactions that occur between abalone and other organisms in their environment (competition and predation), it is almost certain that reductions in abalone abundance caused by fishing have a corresponding effect on the ecosystem which may alter the habitat in some way. It has not been established, however, that these changes are deleterious to the environment, or whether they fall outside the range of habitat variation that occurs in response to fluctuations in environmental factors not related to or caused by abalone fishing.

2. Management Objectives and Strategies

The Draft Tasmanian Abalone Fishery Policy Document (Anonymous, 1997a) specifies management objectives and strategies under several headings. These objectives are listed below. The strategies employed to achieve these objectives are also listed where they are relevant to the stock assessment.

2.1 Maintain Biomass and Recruitment

Objectives

- To maintain fish stocks at sustainable levels by constraining the catch and size of individual abalone taken by the commercial and non-commercial abalone sectors. In particular, to ensure that:

    a) abalone are harvested at sustainable levels, and,

    b) biomass and egg production do not decrease below the chosen proportion of pre-fishing egg production and that reasonable levels of egg production are maintained in all regions of the fishery.

- To allow abalone to grow to a size were they have had two breeding seasons through the use of appropriate size limits.

Strategies

- Limit the catch of the commercial sector and restrict catching potential of the non-commercial sector.

- To prohibit the taking of abalone at a size below which the fish have not had adequate opportunity to reproduce through the enforcement of minimum legal sizes, whilst ensuring that the minimum size limits reflect differences in both growth rates and harvesting rates around Tasmania.

2.2 Sustaining Yield and Economic Return

Objectives

- To take abalone at or above a size likely to result in the best use of the yield from the fishery.
- To protect abalone below the minimum legal size.
- To maintain economic returns by restricting the level of catch and the number of participants in the commercial fishery.

Strategies

- To prohibit the taking of abalone below the minimum legal size limits.
- Restricting the number of divers in the fishery and limiting their catches within the Total Allowable Catch.

2.3 Commercial Fishing Interactions

Objective

- To separate the activities of abalone divers from those of other commercial divers and the rock lobster fishery, and to limit the harvesting of seaweeds until there is a better understanding of the ecological implications of such a harvest.

2.4 Access to Fish Stocks by Non-Commercial Fishers

Objectives

- To provide reasonable access to abalone stocks for recreational fishers and Aboriginal people.
- To restrict the daily catch of recreational fishers such that it is not a cover for illegal fishing.

2.5 Marine Farming Interactions

Objective

- To enable both the farming of abalone and the harvesting of wild stocks to co-exist without posing a threat to the other.

2.6 Environmental Interactions

Objectives

- To maintain the marine ecosystems upon which Tasmania's abalone stocks depend and minimise the impact of other fisheries on the ecosystems.
- To maintain a robust abalone stock around Tasmania.

Strategies

- Set the TAC for the commercial abalone quota fishery at a conservative level, thereby minimising the impact of population declines on the ecosystems.
- Establish a series of Marine Resources Protected Areas so that representative Tasmanian marine ecosystems are reserved under a no-take policy.
- Set minimum legal size limits to reduce the potential for local depletion and disruption of community structure.

2.7 Enforcement

Objectives

- To prevent the combined take of abalone by licensed commercial and recreational divers, Aboriginal people and unauthorised persons from exceeding the sustainable productivity of the Tasmanian abalone stocks.
- To prevent recreational divers, Aboriginal people and unauthorised persons from selling abalone.
- To prevent unauthorised persons from taking and possessing abalone.
- To prevent any person from possessing commercial quantities of abalone without suitable documentation.

2.8 Cost Recovery and Return to the Community

Objectives

- To recover the Government's operating costs for the abalone fishery (commercial and recreational) from the participants through the fees agreed in the Abalone Deeds of Agreement, and licence fees from holders of abalone quota, commercial abalone divers and recreational licences.

- To recover a proportion of the resource rent generated by the commercial abalone fishery through the fees agreed in the Abalone Deeds of Agreement and licence fees from holders of abalone quota licences.

2.9 Quality Assurance

Objectives

- To maintain the high level of quality assurance for abalone.
- To promote best practice in the handling and processing of marine resources for human consumption.

2.10 Greenlip Abalone

The Tasmanian Abalone Fishery Management Plan also specifies management objectives that are particular to greenlip abalone.

Objectives

- Protecting the greenlip abalone stocks.
- Maintaining the opportunity for value-adding from the Furneaux Group and other areas.

Strategies

- State-wide greenlip abalone fishery to be subdivided into two regions;
- The regions to be the Furneaux Group and the rest (being the blocks around King Island, the north-west and the north-east, where greenlip abalone are usually caught);
- The limit for the Furneaux Group to be subdivided into monthly limits, and the Minister to close the fishery for greenlip abalone in this region for the remainder of the month (or longer if necessary) if the limit has been, or is about to be, reached.
- The annual catch of greenlip abalone for the rest of Tasmania will have a trigger point set, which will be monitored during a year. If the trigger point is reached or appears likely to be reached, then one of the management options is for the Minister to close the fishery;
- The suggested trigger point is the average annual catch for the years 1992 to 1995 inclusive, which is 95 tonnes;
- The minimum size for greenlip abalone has been increased to 140 mm state-wide (except for the north-west coast, blocks 5, 47, 48 and 49) (NB: Subsequent size-limit increases occurred in 1999),

- Large vessels (over 10m) landing abalone at Smithton (that is, after passing through the waters off the north-west coast) must notify the Tasmania Police via a paging service prior to landing to enable their catches to be inspected on landing.

3. Performance Indicators and Trigger Points

There are no biologically based performance indicators currently specified in the management plan for the Tasmanian abalone fishery. In other fisheries (Anonymous, 1997b) performance indicators include an assessment of factors such as:

- Change in the biomass of the stock,
- Level of egg production being maintained, and,
- Relative abundance of under-sized and legal-sized fish.

Trigger points were specified in the Draft Tasmanian Abalone Fishery Policy Document (Anonymous, 1997a). The trigger points are levels of, or rates of change in, the catch and effort that are considered to be too low or outside the normal variation of the stocks and the fishery. When the trigger points are reached, either by themselves or in combination, a review of the management of the abalone fishery is proposed. The regions proposed for use in relation to trigger points are the statistical blocks and regions currently used for the reporting of abalone fishing activity (Fig. 1).

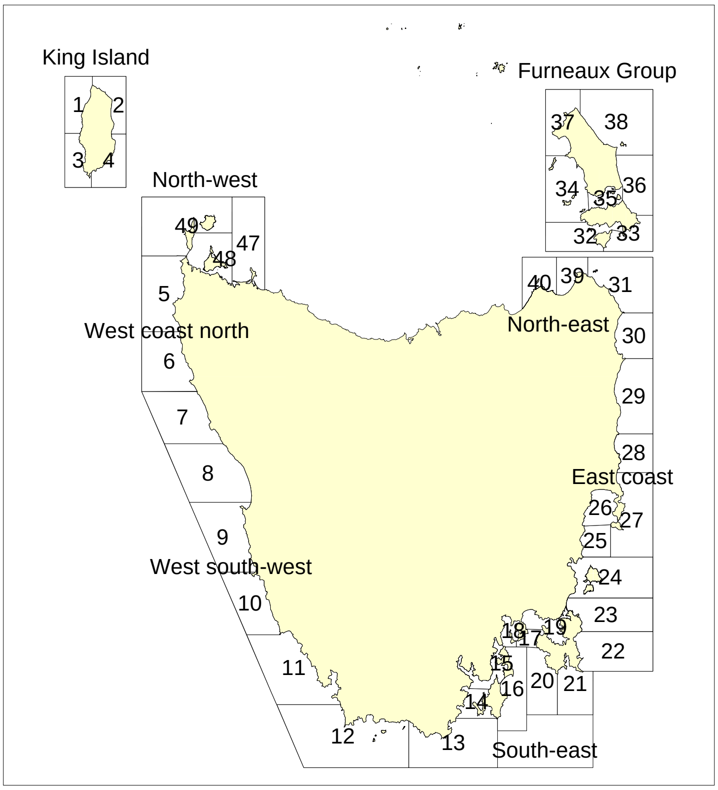


Fig. 1. Statistical blocks used in the Tasmanian abalone fishery. Statistical blocks are commonly grouped for analysis into eight regions. Block 40 has been excluded from the North-east region in previous assessments. It has been included in the North-east region in this assessment due to high recent catches.

3.1 Catch-rate related trigger points

- Annual CPUE at the State level from diver returns falls below 95% of the CPUE for the reference year with the lowest catch rate (ie. 1993, 1994, or 1995).
- Annual CPUE from diver returns for any region or individual block falls below 75% of the CPUE for the reference year with the lowest catch rate for that region, or block.

3.2 Catch related trigger points

- The annual catch for the West and South-west regions is 5% less than the catch in 1995.
- The annual catch for the South-east region is 10% greater than the catch in 1995.
- The annual catch for other regions is 20% greater or less than the catch in 1995.

3.3 Trigger points specific to Greenlip abalone

- The annual catch of greenlip abalone outside the Furneaux Group is 5% above the average catches for the years 1992 to 1995.

- The monthly catch of greenlip abalone from the Furneaux Group reaches 1/12th of the average annual catch for the years 1992 to 1995.

4. Previous Assessments

Using data on the size composition of the catch to assess the impact of fishing Witherspoon (1975) demonstrated a reduction in size composition of the catch between 1968 and 1975 in two selected statistical fishing blocks. In all cases the modal length class was above the legal minimum length.

Harrison (1983) carried out surplus production analyses of Tasmanian abalone populations to provide estimates of sustainable yields and optimum levels of fishing effort. He concluded that catches for 1980-81 exceeded the long-term sustainable yield in most areas. It is noted that the catch for 1983 and 1984 exceeded the 1981 catch. The validity of surplus production analysis relies on the assumption that catch rates may be used as an index of abundance. This assumption has been questioned because of the aggregating behaviour of abalone, the targeting of these aggregations by divers, and the catch rate threshold of individual divers, who will move to another site rather than continue fishing at a site when the catch rate drops below this threshold (Breen, 1992; Prince, 1987; Prince, 1989).

Prince and Shepherd (1992) demonstrated that catch per unit effort (CPUE) becomes an increasingly sensitive index of abundance as fishing mortality increases. In collaboration with Philip Sluczanowski of the South Australian Fisheries Department, Prince prepared a computer model of an abalone population, called AbaSim. The model could be used by fishers, fisheries researchers and managers to explore the effects of different rates of exploitation, TAC levels and size limits on the age composition of the stock, its biomass, and rate of recovery after depletion. As an educational tool it is very useful, but it does not necessarily portray the status and dynamics of the Tasmanian abalone fishery.

The 1995 and 1996 assessments (Nash, 1996; Officer, 1997) used some of the evidence that was used in previous years and provided explicit documentation of the evidence used in the assessment process. These fishery assessments were based on evidence derived from:

- commercial catch/effort/catch rate statistics,
- commercial catch-at-length (market-measuring) data,
- yield- and egg-per-recruit analyses,
- strip transect estimates of abundance (at sites sampled on several occasions), and
- trends (or changes) in age composition (obtained from repeated population surveys at selected sites, using shell growth rings as an index of age).

A steady increase in catch rate was noted in most areas (with some exceptions), accompanied by a change in the distribution of catch and fishing effort. Whilst catch rates were regarded as a poor index of abundance, the catch rate increases generally observed were taken to signify that, in general, there was little evidence of overfishing.

4.1 Yield-per-recruit and egg-per-recruit analyses

Yield-per-recruit (YPR) analyses have been carried out for blacklip abalone (Nash *et al*., 1994, unpublished data) to determine the combinations of minimum size limit and fishing pressure that maximise the yield per recruit from the resource.

A comparison of egg production levels with those of fished abalone stocks elsewhere can indicate the risk of recruitment failure. This comparison is especially useful if the levels of egg production are known for heavily fished stocks shortly before their collapse. Nash (1992) and Nash et al. (1994) used egg-per-recruit (EPR) analysis to estimate current levels of egg production of blacklip abalone, relative to virgin stock egg production, at several sites around Tasmania. These analyses indicated that levels of egg production were relatively high (> 40 percent of virgin stock egg production) and provide little cause for concern that recruitment failure is imminent for blacklip abalone (Koslow, 1992). However, per-recruit (YPR and EPR) analyses rely on assumptions of population equilibrium that are unlikely to be fully satisfied.

Egg-per-recruit analyses have not yet been undertaken for greenlip abalone. However, surveys were conducted in 1998 for this purpose. These analyses will form part of a more detailed assessment of the greenlip resource to be published in 1999.

4.2 Fishery-independent estimates of abundance

Fishery-independent abundance monitoring using strip transects has previously been attempted by the Abalone Assessment Section at a small number of sites. Data gathered over a period of more than two years did not show any significant changes in abundance. However, because abalone generally live in aggregations it is difficult to obtain accurate and precise estimates of abundance or density. Highly variable numbers of abalone in low population density areas require that excessive numbers of replicates be done to achieve a acceptable level of sensitivity. Furthermore, abalone move in response to disturbance (Nash *et al*., 1994) and re-aggregate after stock density has been reduced by fishing (McShane and Smith, 1989; Nash *et al.*, 1994). This movement further complicates abundance estimation. For these reasons Tasmanian transect survey work has lapsed.

During the last few years however, Victorian researchers have adopted a different approach to transect surveys, and are able to detect relatively small changes in abundance while maintaining realistic costs. An evaluation of methods for assessing the abundance of blacklip abalone in Victoria found transect surveys to be the best of five methods assessed (Gorfine *et al*., 1996; Hart and Gorfine, 1997; Hart *et al*., 1997). The study concluded that results would be enhanced by including methods to evaluate the spatial distribution of abalone.

4.3 Commercial catch sampling data

The collection of commercial abalone catch-at-length data through the market measuring program lapsed in 1995. Analyses of size-composition data undertaken to 1996 (Nash, 1996) concluded that:

(i) Sampling has been uneven around the State, and to some extent reflects the contribution of each statistical block to the total catch. The most extensive sampling has been from blocks 9 on the west coast, 13 and 14 in the south-east, and 23, 24 and 27 on the east coast.

(ii) There has been a reduction in the size composition of the catch between 1984 and 1995 in most areas, but in none of the areas does this approach knife-edge fishing (in which case the fishery would be composed primarily of the annual recruits through the size limit). This reduction in size composition may reflect either a true reduction in size composition or an increase in selective targeting of smaller abalone (which the market generally prefers), or a combination of the two factors. This may be resolved using length-frequency data gathered by research personnel; these data should represent true size composition.

(iii) Size composition trends must be viewed in combination with catch rate trends if there is to be any chance of a useful assessment of the stocks using commercial size-composition data. This is because the average size of fish in the catch may increase at high levels of fishing pressure if recruitment rates are declining. The slight decline in size composition of the catch, coupled with the (increasing or stable) catch rate trends in most statistical blocks, provides no evidence of either growth overfishing or recruitment overfishing.

(iv) The market measuring data therefore provide no evidence that the Tasmanian abalone stocks are presently in a state of either growth overfishing or recruitment overfishing.

A commercial catch sampling program was reinstated in 1998. These measurements are likely to prove an invaluable source of information when computer-modelling Tasmanian abalone stocks. Whilst such an analysis is not yet possible, the program will improve both the immediate and ultimate utility of the data.

5. Assessment Methods

5.1 Commercial catch-effort statistics

The 1997/98 assessment is based principally on an analysis of trends in the catch and catch-rate of the commercial fishery. These data are provided by licensed abalone divers on dockets submitted with all abalone landed. Catch and effort are reported by statistical block (Fig. 1) on these dockets. Catch and effort are estimated by block when the catch occurs over multiple blocks or days. Commercial catch and effort data are not standardised and therefore include variations due to factors such as season, weather, and diver experience. Catch rates for the main statistical blocks and regions have been calculated for each diver-day by dividing the catch (in kg) by diving effort (in hours) to yield catch per unit of effort (CPUE) in kg/hour.

5.2 Commercial catch sampling data

The collection of size-composition data from the commercial fishery was recommenced in 1998. These data are collected by licensed abalone divers. The divers photograph a portion of their catch against a calibrated background and note the location at which the abalone were caught. The photographs are subsequently scanned and the abalone are measured from the scanned image using a computer. Data collected by this project up to 2/3/99 are included in the 1997/98 assessment. These data are compared with those obtained by the previous market measuring program from 1984 to 1995, and, where possible, with size-composition data collected in 1997 by research divers. Research data includes measurements of fish below the legal minimum length. These data can therefore better indicate the true modal length of the population sampled and the proportion of the population not yet recruited to the fishery.

Size-composition data was also provided by Tasmania’s largest abalone processor: Tasmanian Seafoods. These data describe the proportion of factory production made up of large abalone. These data were provided from July 1995 to September 1998. Production figures were also provided for several days in 1997 and 1998 where the catch was obtained exclusively from the west coast.

5.3 Recreational fishing surveys

The recreational catch reported in the 1997/98 assessments were derived from the preliminary results of recreational fishing surveys undertaken by the Department of Primary Industry and Fisheries (J. Lyle, pers. comm.). These surveys used a combination of diary and recall methods to obtain estimates of the recreational fishing catch in Tasmania.

6. Fishery Assessment: 1997/98

6.1 Blacklip Fishery Assessment: 1997/98

6.1.1 Evaluation of Trigger Points

In this report the 1998 catches of blacklip abalone were evaluated using the trigger points specified in the Draft Tasmanian Abalone Fishery Policy Document (Anonymous, 1997a). Alternative trigger points were also evaluated because of inadequacies in the blacklip trigger points specified in the Management Plan. The catch-related trigger points for blacklip abalone specified in the Management Plan compare recent catches with those of 1995 only. Hence, they make no allowance for normal inter-annual variation in catches or exceptional catches in 1995 itself. Therefore the 1998 catches in each region and block were also evaluated against average catches from 1992 to 1995 inclusive and 1981 to 1984 inclusive (for statistical blocks only). The comparison with 1992-95 averages compares recent catches with those from a period where the fishery had had time to respond to a period of progressive quota reductions and size limit increases. The comparison with 1981-84 averages compares recent catches with those from the period immediately prior to quota introduction where fishing pressure was at its greatest. This comparison will therefore indicate if catches are reaching new extremes. The following sections evaluate trigger points for blacklip catches exclusively.

Catch-rate related trigger points

1. Annual CPUE at the State level from diver returns falls below 95% of the CPUE for the reference year (1993, 1994 or 1995) with the lowest catch rate.

- Not triggered. The state-wide average catch rate has increased every year since 1990 and now averages 97 kg/hr (Appendix 1).

2. Annual CPUE from diver returns for any region or individual block falls below 75% of the CPUE for the reference year (1993, 1994 or 1995) with the lowest catch rate for that region, or block.

- Not triggered. However, the 1997 catch-rates in block 34 (Furneaux Group) fell close to this trigger point. The 1997 catch rate of 35 kg/hr was 79% of the lowest catch rate recorded in 1993, 1994 or 1995 (45 kg/hr in 1995) (Appendix 2).

Catch related trigger points

1. The annual catch for the West south-west region is 5% less than the catch in 1995.

- REGIONS: Not triggered. Whilst the 1995 lower trigger point was not fired in the West south-west, 1998 catches were only 91% of the average catch from 1992-95 (Fig. 2B).

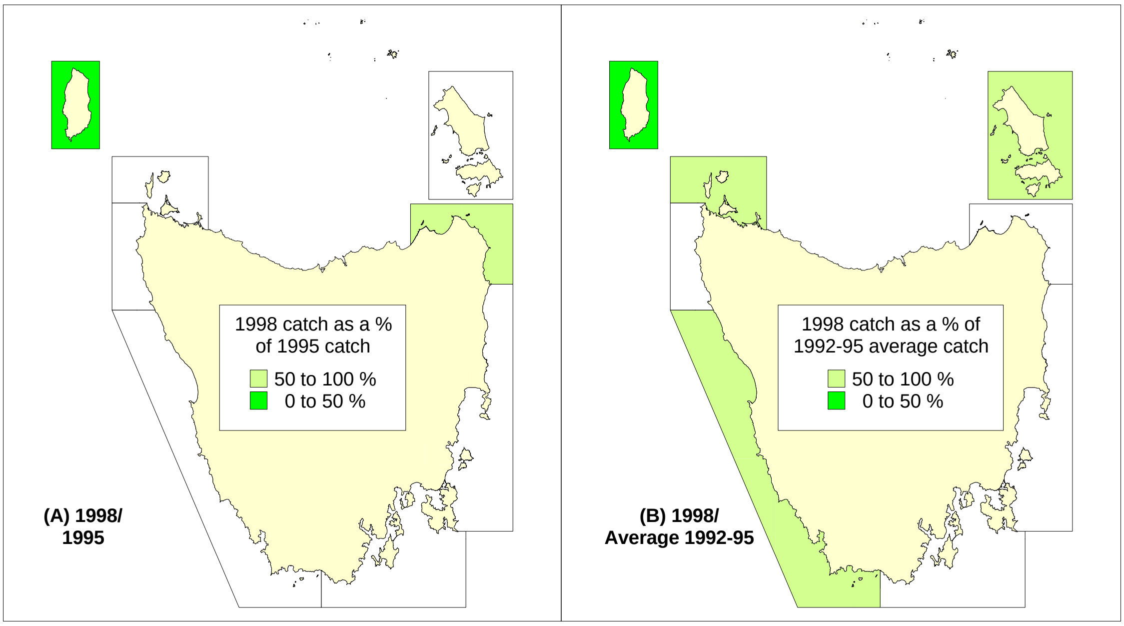


Fig. 2. Regions where blacklip reduced catch trigger points were fired in 1998. Shading indicates the magnitude of the 1998 catch as a percentage of the trigger point. Darker shading indicates a greater decline in the catch.

- BLOCKS: Triggered. 1998 catches in blocks 10 and 11 were only 64% and 89% respectively, of the 1995 catch (Fig. 3A). The 1998 catches from blocks 8, 9, 10 and 11 were less than 95% of the 1992-95 average (82%, 94%, 59% and 78% respectively) (Fig. 3B). 1998 catches from all northern blocks and the entire west coast show marked declines from the 1981-84 average. In 22 of these 26 blocks the 1998 catch is less than 50% of the 1981-84 average (Fig. 3C). Marked declines were also recorded in blocks 14, 15 and 25, but declines in other blocks from the south-east and east coast were generally less than those in other areas of the state.

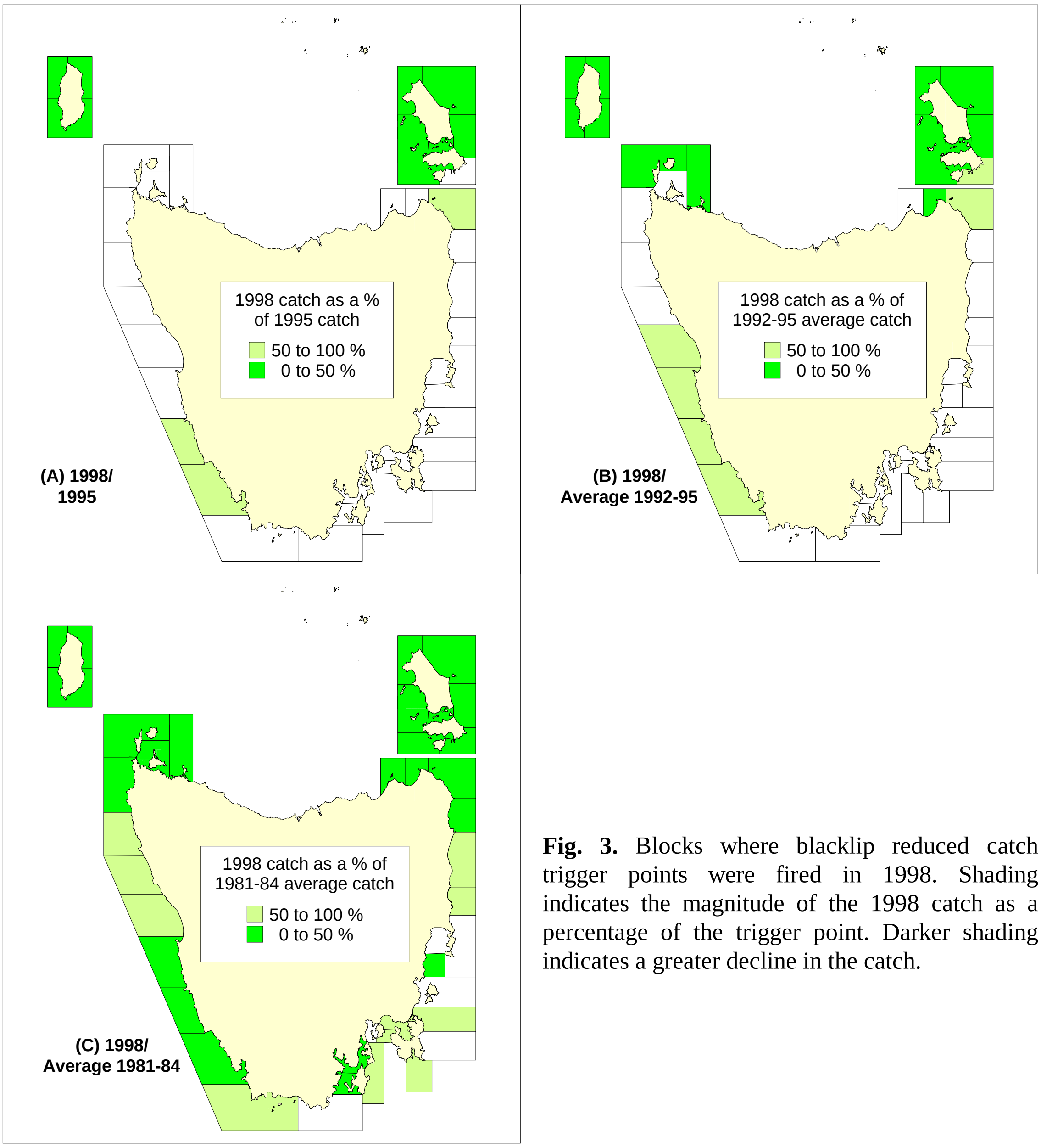


Fig. 3. Blocks where blacklip reduced catch trigger points were fired in 1998. Shading indicates the magnitude of the 1998 catch as a percentage of the trigger point. Darker shading indicates a greater decline in the catch.

2. The annual catch for the South-east region is 10% greater than the catch in 1995.

- REGIONS: Not triggered. Whilst the 1995 upper trigger point was not fired in the South-east, 1998 catches were 121% of the average catch from 1992-95 (Fig. 4B).

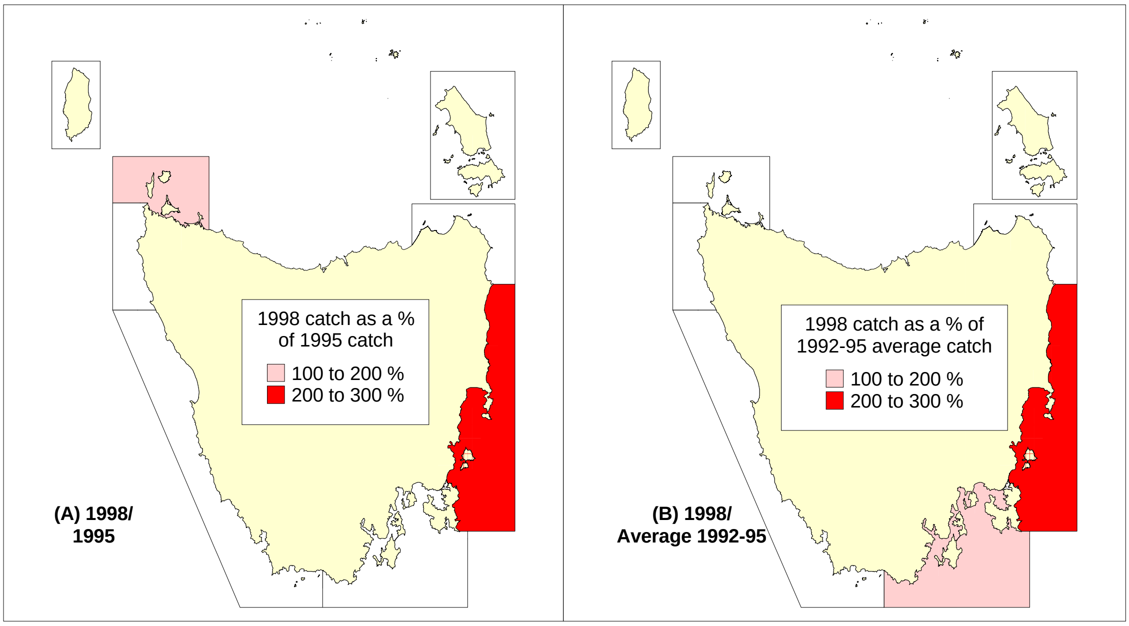
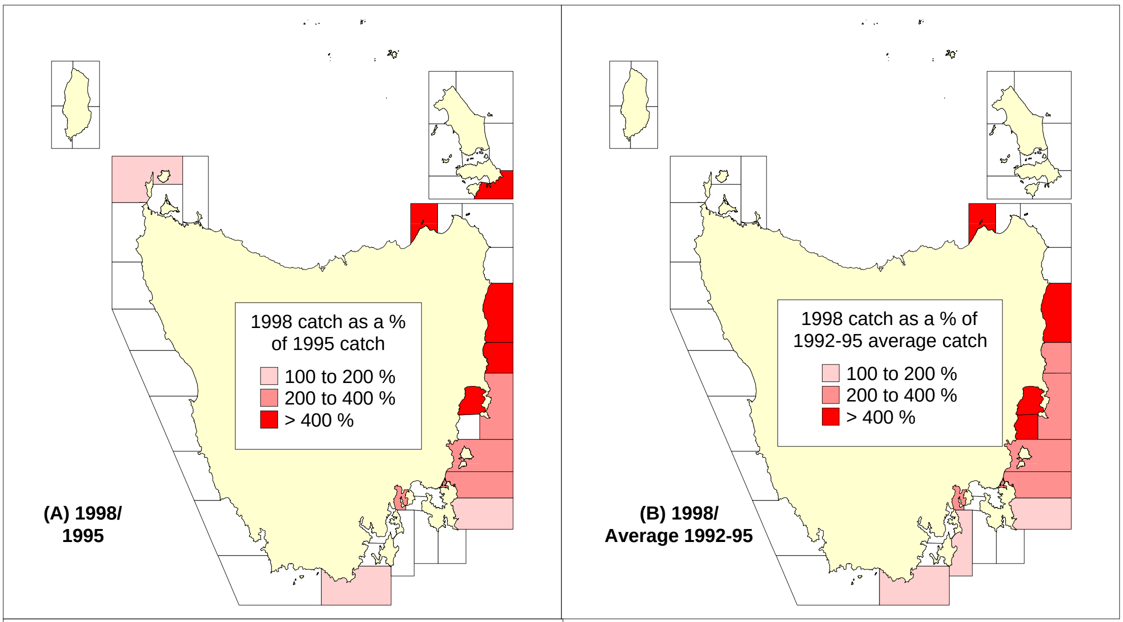


Fig. 4. Regions where blacklip increased catch trigger points were fired in 1998. Shading indicates the magnitude of the 1998 catch as a percentage of the trigger point. Darker shading indicates a greater increase in the catch.

- BLOCKS: Triggered. 1998 catches in blocks 13 and 18 were 154% and 372% respectively, of the 1995 catch (Fig. 5A). The 1998 catches from blocks 13, 16 and 18 were greater than 110% of the 1992-95 average (185%, 122% and 294% respectively) (Fig. 5B). 1998 catches from blocks 13, 18, 20, 22, 24, 26 and 27 were greater than the 1981-84 average (166%, 302%, 199%, 112%, 144%, 206% and 201% respectively) (Fig. 5C).



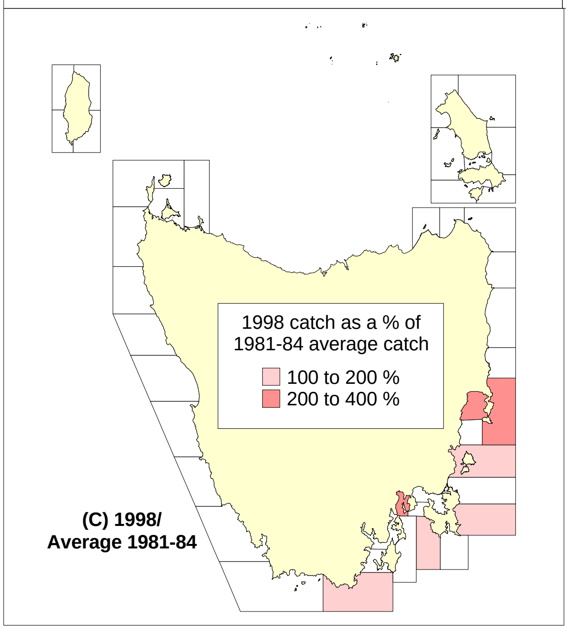


Fig. 5. Blocks where blacklip increased catch trigger points were fired in 1998. Shading indicates the magnitude of the 1998 catch as a percentage of the trigger point. Darker shading indicates a greater increase in the catch.

3. The annual catch for other regions is 20% greater or less than the catch in 1995.

- REGIONS: Triggered. In 1998 the total blacklip catches from King Island and the North-west regions were only 23% and 72% respectively of those in 1995 (Fig. 2A). 1998 blacklip catches were also substantially lower than the average 1992-95 catch from King Island (23% of average), the North-west (63% of average) and Furneaux Group (57% of average) (Fig. 2B).

Conversely, 1998 catches from the North-west and East coast were 129% and 274% greater respectively, than those in 1995 (Fig. 4A). In the South-east and on the East coast the 1998 catches were 121% and 222% greater respectively, than the average catch (1992 to 1995) (Fig. 4B).

- BLOCKS: Triggered. Blocks where reduced blacklip catch trigger points were fired are shown in Fig. 3. Catches of blacklip abalone from King Island (blocks 1, 2, 3 and 4), block 31 and block 32 reduced to 21%, 27%, 25%, 25%, 59% and 14% respectively of the 1995 catch. No blacklip abalone were caught in 1998 from blocks 34 to 38 (Furneaux Group) or block 47. However the 1995 reduced catch trigger point was not fired in block 47 because the 1995 catch was also zero. Blacklip abalone catches in 1998 from King Island were also well below the 1992-95 average (30%, 32%, 6% and 25% respectively for blocks 1, 2, 3 and 4). The 1998 blacklip abalone catches from blocks 31, 32, 33, 39 and 49 were 79%, 33%, 79%, 25% and 42% respectively, of the 1992-95 average.

  Blocks where increased blacklip catch trigger points were fired are shown in Fig. 5. The 1998 catch was greater than 120% of the 1995 catch in all east coast blocks except block 25 (153%, 206%, 373%, 1695%, 223%, 415% and 475% in blocks 22, 23, 24, 26, 27, 28 and 29 respectively). 1998 blacklip catches also exceeded 120% of the 1995 catch in blocks 33, 40 and 49 (491%, 411% and 162% respectively). 1998 catches from all east coast blocks exceeded 120% of the 1992-95 average (122%, 235%, 255%, 591%, 1559%, 212%, 222% and 417% in blocks 22 to 29 respectively). Blacklip catches from block 40 were 1533% of the 1992-95 average.

6.1.2 Commercial catch-effort statistics

The statistical blocks for the abalone fishery are shown in Fig. 1. In order to show changes in the distribution of the catch around the State since 1975, the catch from each of the regions is shown for blacklip abalone in Fig. 6 to Fig. 9. The upper graph in each of these figures shows the catch in absolute terms (tonnes) and the lower graph shows the catch from each of these regions as a proportion of the total annual catch.

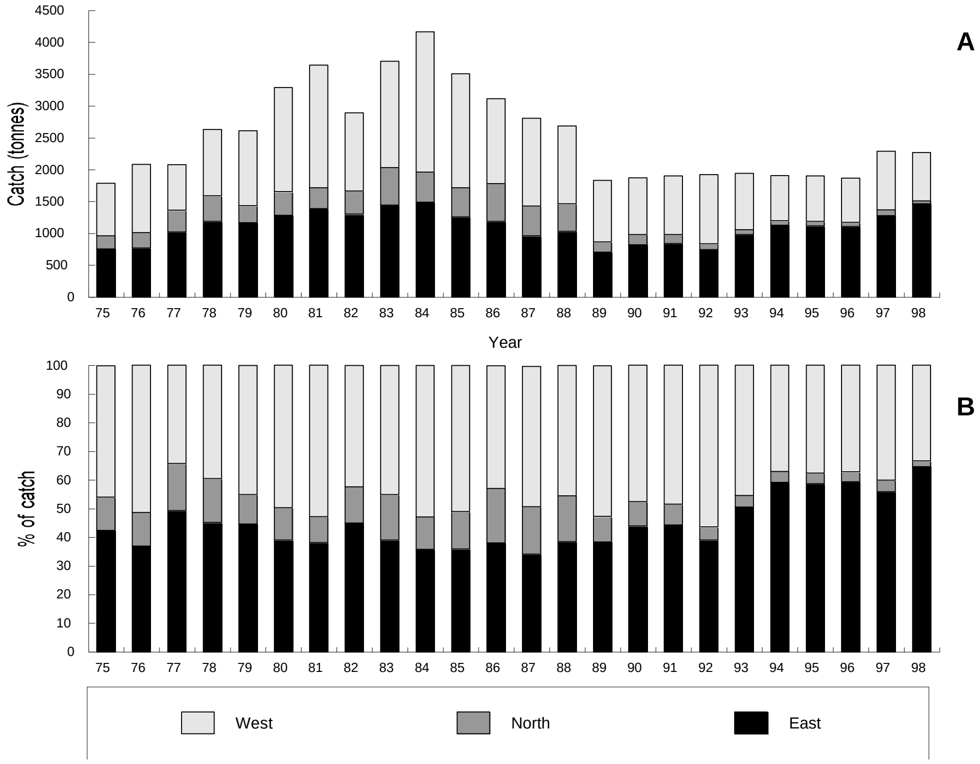


Fig. 6. The catch of blacklip abalone from the three main regions of Tasmania, by year from 1975-98. East: southeast & east coast (blocks 13-29). North: King Island, north-west, north-east & Furneaux Group (blocks 1-4, 30-40, 47-49). West: west coast north, west south-west (blocks 5-12). Catches are expressed in absolute values (tonnes) (A), and as proportions of the total blacklip catch (B).

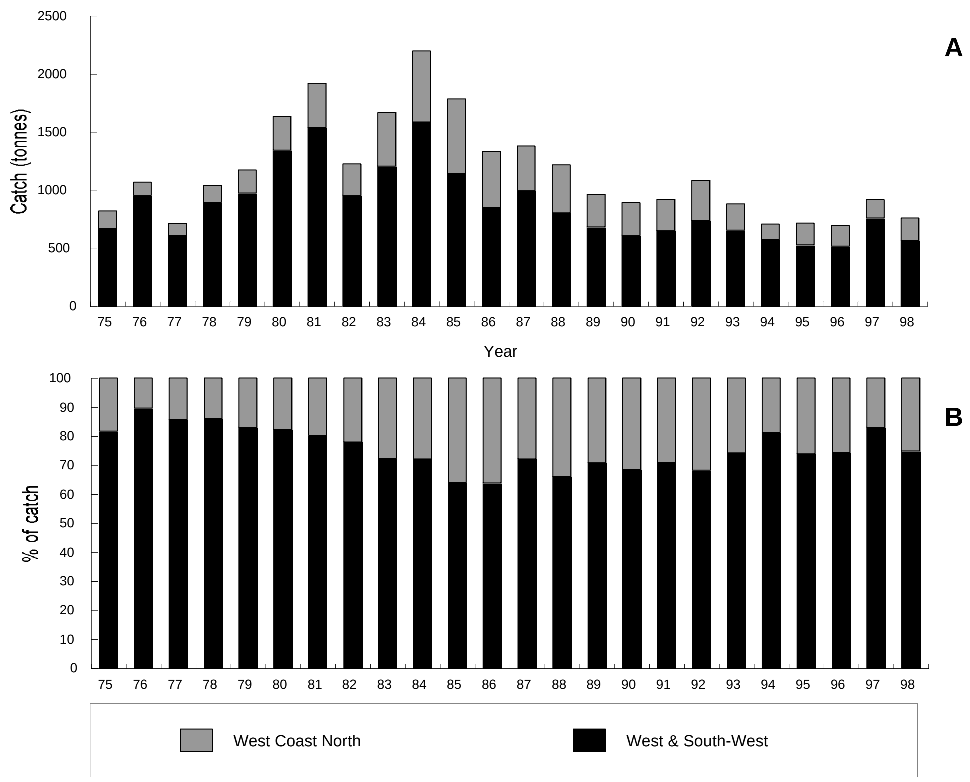


Fig. 7. The catch of blacklip abalone from the west of Tasmania, by year from 1975 to 1998. The catch from each region is expressed in (A) absolute values (tonnes), and (B) as a proportion of the total blacklip catch.

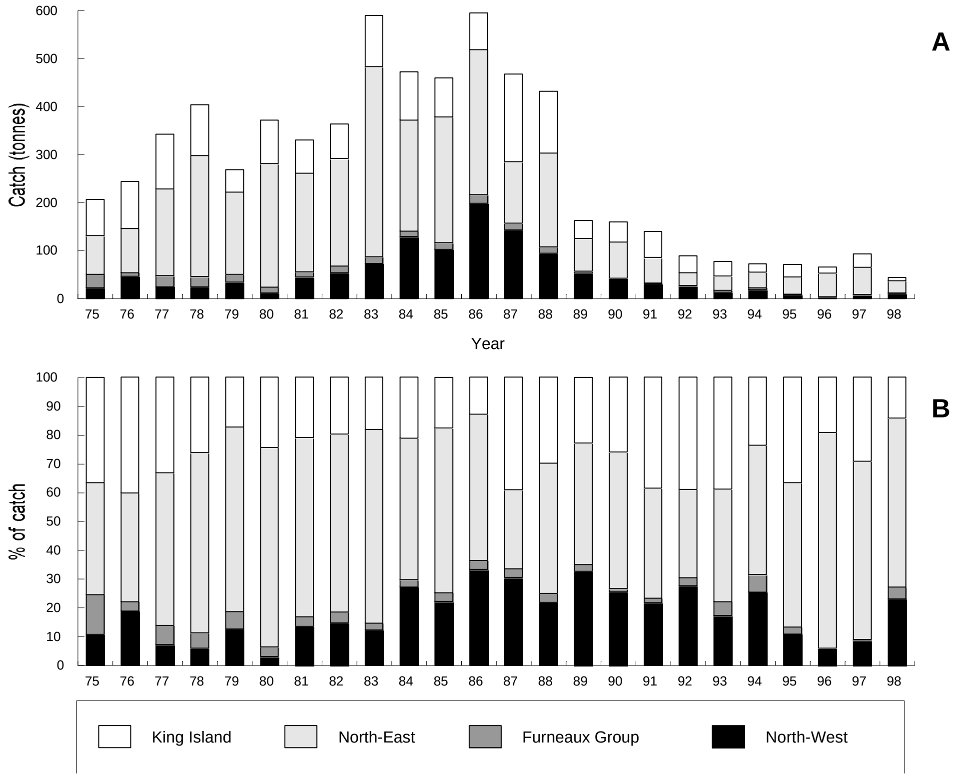


Fig. 8. The catch of blacklip abalone from the north of Tasmania, by year from 1975 to 1998. The catch from each region is expressed in (A) absolute values (tonnes), and (B) as a proportion of the total blacklip catch.

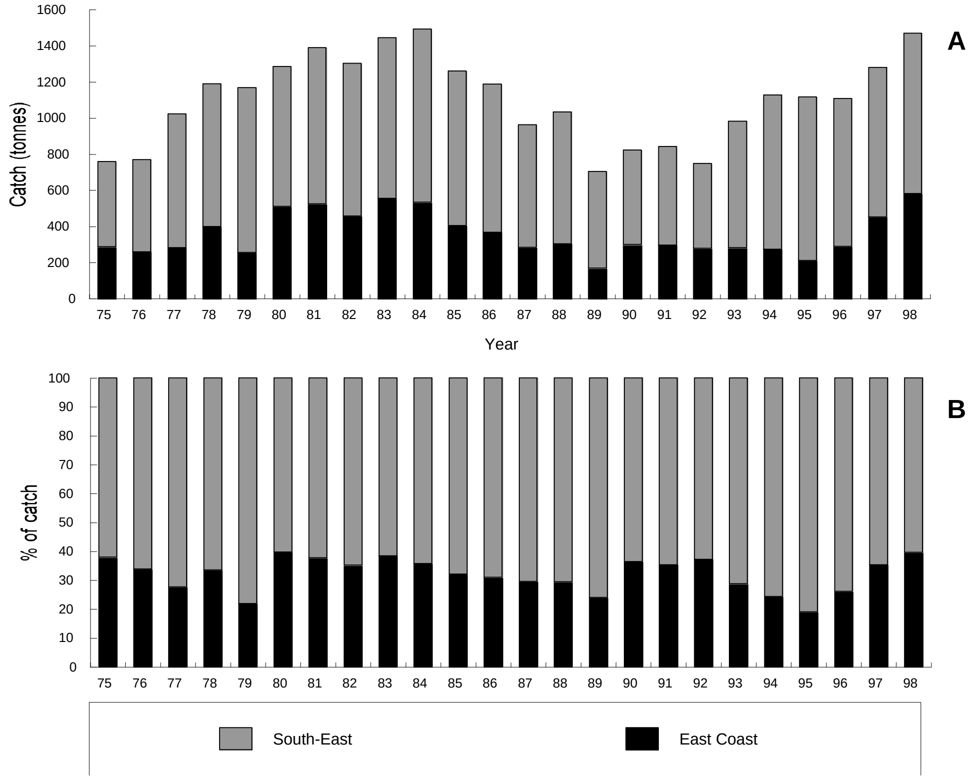


Fig. 9. The catch of blacklip abalone from the east and southeast of Tasmania, by year from 1975 to 1998. The catch from each region is expressed in (A) absolute values (tonnes), and (B) as a proportion of the total blacklip catch.

The following points are noted with reference to these graphs:

(i) The bulk of the blacklip catch has traditionally been taken from the west of the state (blocks 5 to 12) (Fig. 6);

(ii) There has been a steady decline in the catch since 1987 from the west (Fig. 6 and Fig. 7). There has been a corresponding increase in the catch from other areas, principally south-east Tasmania and the east coast (Fig. 6 and Fig. 9).

(iii) Since 1989 there has been a marked decline in the catch coming from the north of the state to very low levels (around 50 T) (Fig. 6 and Fig. 8A);

(iv) Since 1993 the east of the state has produced the greatest proportion of the catch (Fig. 6). In 1998 over 60 percent of the total Tasmanian abalone catch was taken from the east (Fig. 6). In absolute terms (tonnage taken) there has been a marked increase in the catch from the east since 1992. Annual catches in the south-east from 1994 to 1998 are similar to the catches from this region in 1983 and 1984 (Fig. 9) immediately prior to the introduction of quota and progressive quota reductions. Recent catches on the east coast now exceed those prior to the introduction of quota (Fig. 9).

The statistical blocks have been grouped into eight regions (Fig. 1) to show broad regional trends in catch, effort and catch rate (CPUE) (Appendix 1). The state-wide trend is also shown in Appendix 1. Catch, effort and catch rate data for most of the individual statistical blocks for the period 1975 to 1996 are shown in Appendix 2. Statistical block 18 (the Derwent River estuary) and block 41 to 46 (central north coast) have been excluded for brevity; the catch in these blocks is very small or zero.

The following points are noted with reference to these catch-effort graphs:

(i) State-wide, catch rates are at a 24 year high (Appendix 1).

(ii) When statistical blocks are grouped into regions, catch rates are at a 24 year high on the north of the west coast, the west/south west, the south-east, and east coast regions (Appendix 1).

(iii) 1998 catch rates were at their highest levels for 24 years in 16 of the 49 statistical blocks (blocks 6 to 11, 14, 16, 20 to 25, 28 and 29) (Appendix 2).

(iv) Catch rate trends are impossible to interpret in isolation from the associated trends in catch and effort. For example, the unusually high 1998 catch rates in block 25 (Appendix 2), probably reflect the fact that there is little catch coming from this block now, and so the small amount that is taken is by experienced divers who make brief visits to known ‘good-recovery’ areas. The increase in catch rate therefore is not a reliable indicator of the extent to which abundance has changed in this block. The need to use information on both the catch and catch rates when attempting to interpret catch-effort trends is discussed further below.

(v) In blocks where both blacklip and greenlip abalone are harvested, fishing effort is often supplied for both species combined; it is therefore generally impossible to calculate catch rate figures for these species separately. However, in blocks where only one of these species is the sole or predominant component of the catch, the catch rate figures may better represent the trends for that species.

(vi) When examined in combination with the catch levels themselves (see Table 1 and Fig. 10), the catch rate trends suggest an unhealthy condition of the stocks in the following statistical blocks: 3, 4, 34 and 36.

Table 1. Abundance changes suggested by trends in catch and catch rate

These results are summarised in Fig. 10. All interpretations assume that there has been no increasing trend in fishing power and ignore any marked increases in fishing pressure. The shaded bar uses the shading applied to each statistical area in Fig. 10. NW: North-west, SE: South-east, EC: East coast, NE: North east, FG: Furneaux group, WCN: West coast north, WSW: West south west, KI: King Is.

Catch	Catch rate		Probable change in abundance	Region	Statistical areas
Stable	↓	↓	Fishable biomass probably falling at a faster rate than catch rates.		
↓	Stable	↓	If abundances were stable, catch rates should increase because catchability increases when the abalone are given more time to aggregate. Fishable biomass should also increase through greater recruitment to legal size.	FG	3, 4
↓	↓	↓	Worst scenario. Continued decline in catch rates despite displacement of catch may indicate a recruitment decline.		34, 36
↑	↑	↑	Best scenario. Difficult to interpret other than as increasing fishable biomass unless fishing power has increased dramatically and/or fishing is occurring in new areas.	EC	12, 24, 26, 27, 29
Stable	Stable	?	Fishable biomass stable or decreasing, less likely to be increasing.	KI	2, 19, 35, 47
Stable	↑	?	Fishable biomass stable or increasing, less likely to be decreasing.	SE	5, 6, 9, 31, 48
↑	Stable	?	Fishable biomass stable or increasing, less likely to be decreasing.		1, 13, 40
↑	↓	?	Fishable biomass stable or decreasing.		
↓	↑	?	Fishable biomass stable or increasing, could be decreasing.	WCN, WSW	10, 11, 14
Erratic	Erratic	?	No clear trends in catch & catch rate, difficult to interpret the probable change in abundance.	NE, NW	7, 8, 15, 16, 17, 20, 21, 22, 23, 25, 28, 30, 32, 33, 37, 38, 39, 49

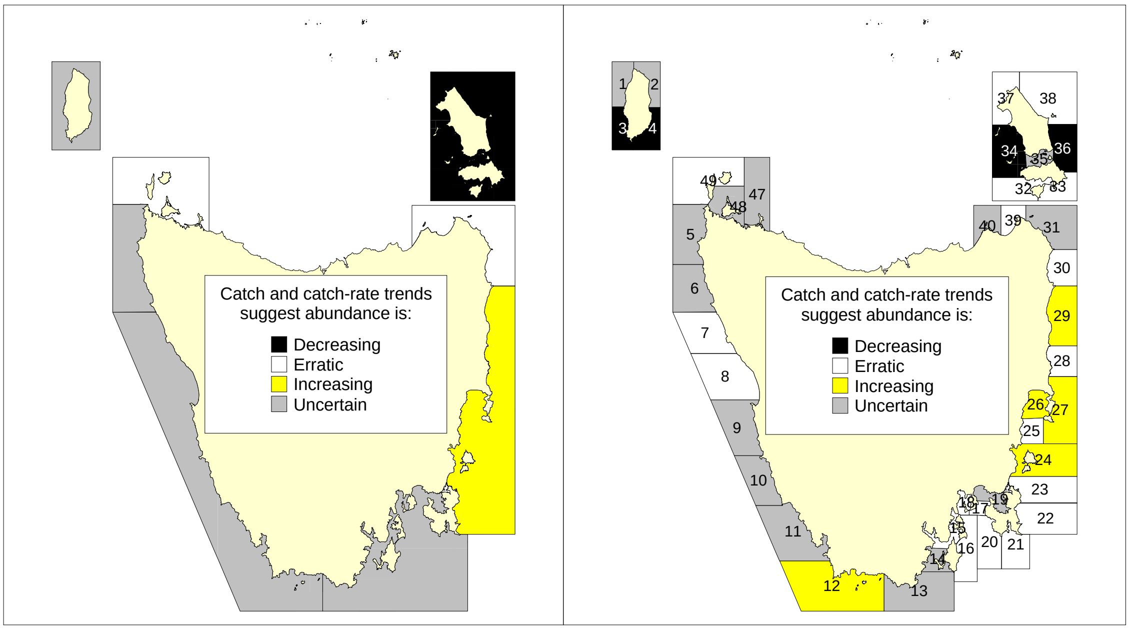


Fig. 10. Abundance trends suggested by trends in catch and catch-rate for each statistical region and block (numbered) of the Tasmanian abalone fishery. The uncertainty of assessment in most areas demonstrates the limited scope of exclusively using catch and catch-rate data to assess the status of the fishery. The inclusion of other data, particularly size-composition data, substantially alters these conclusions in many areas. For example, size-composition data from the west south-west (Table 3) and very high catch rates (Appendix 1) suggest that large, mature abalone are abundant in this area.

6.1.3 Commercial catch sampling data

The measurement of abalone caught commercially recommenced in 1998. This project has yielded length measurements from over 10,800 abalone to date and includes samples from 20 of the 43 main statistical blocks (1, 7, 12, 13B, 14, 16, 17, 19 to 24, 26 to 30, 32, 35 and 39). The level of sampling, and hence the number of fish measured, varied considerably between blocks and ranged from 26 fish in block 26 to 1976 lengths measured in block 24. In this report recent size-composition data are only compared to previous samples where the 1998 samples are of reasonable size (Fig. 11 to Fig. 18).

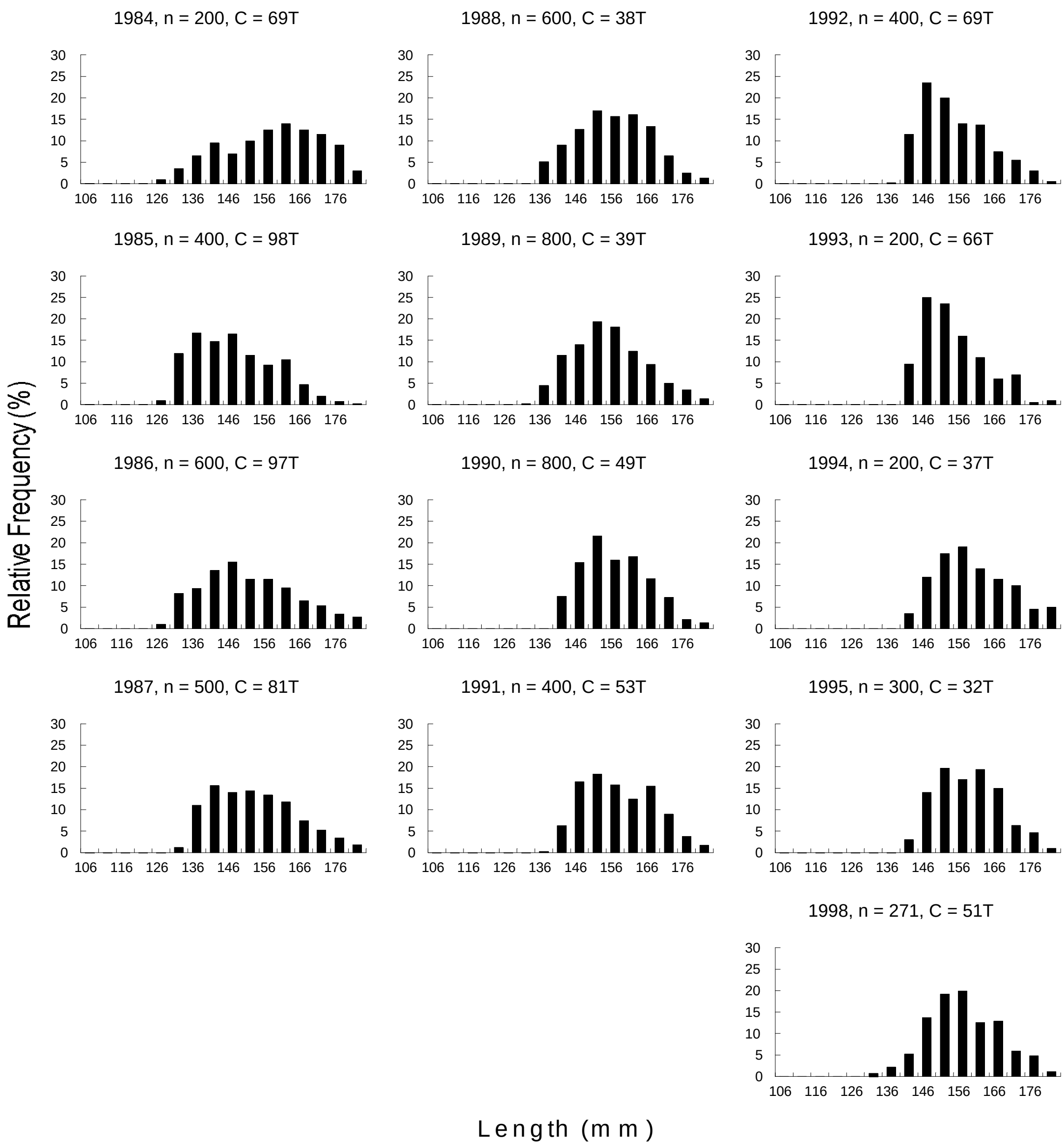


Fig. 11. Size-composition of the commercial catch from statistical block 7. Samples were measured at processing factories from 1984-1995 and supplied by divers in 1998. The number of abalone sampled (n) and the annual catch in tonnes (C) is given for each year.

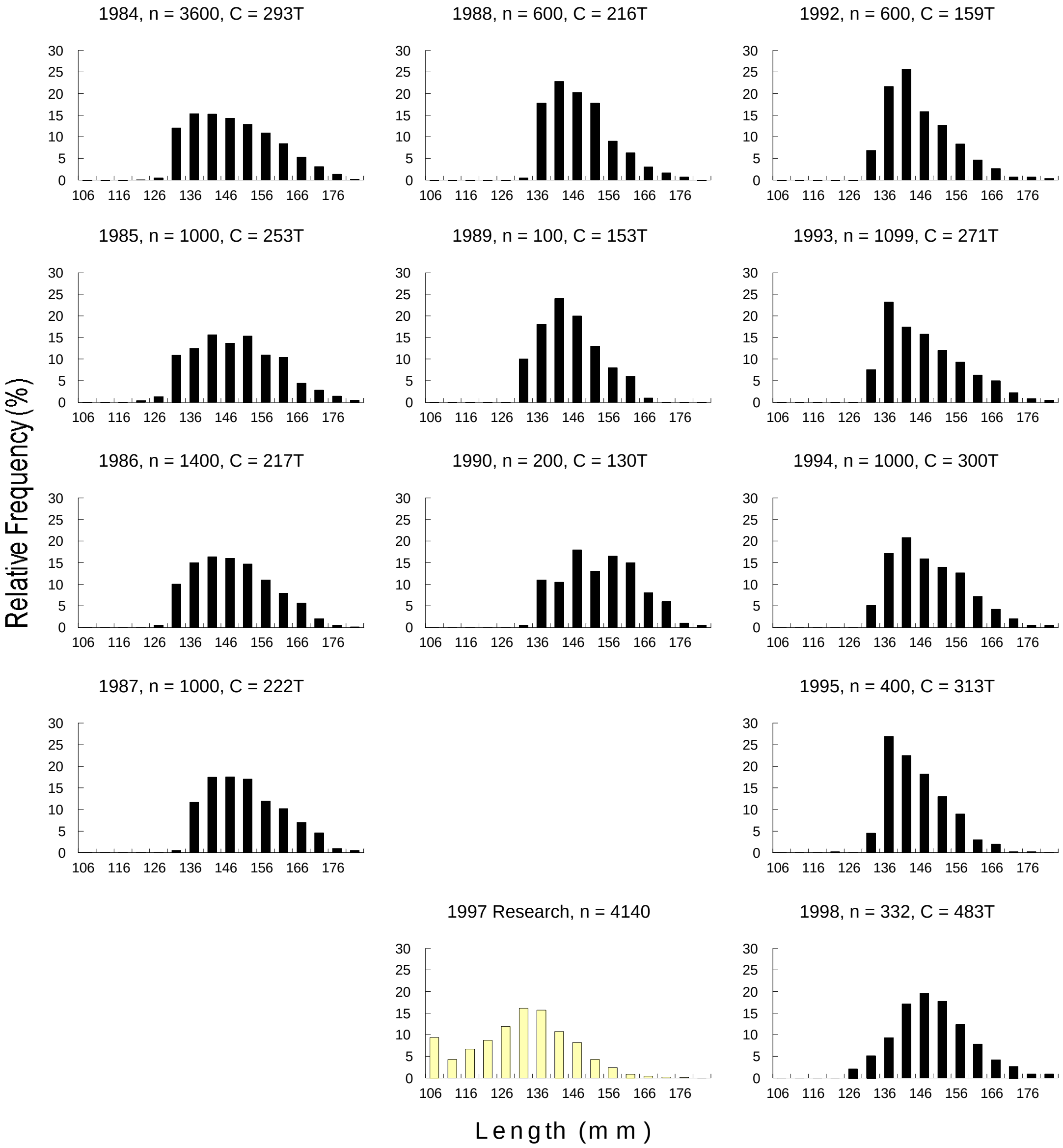


Fig. 12. Size-composition of the commercial catch from statistical block 13. Samples were measured at processing factories from 1984-1995 and supplied by divers in 1998. The size composition of samples taken by research divers in 1997 is also shown for comparison. The number of abalone sampled (n) and the annual catch in tonnes (C) is given for each year.

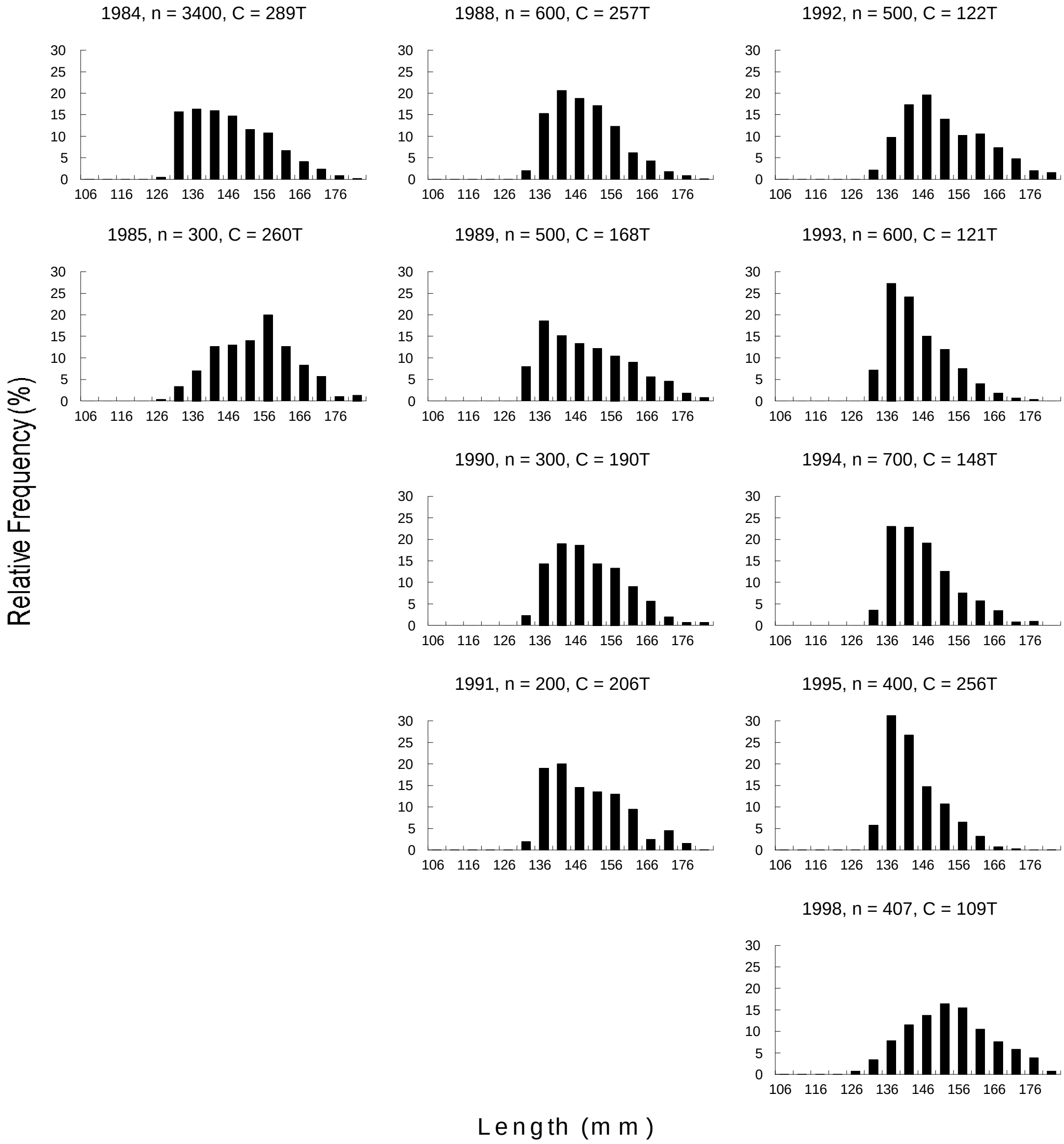


Fig. 13. Size-composition of the commercial catch from statistical block 14. Samples were measured at processing factories from 1984-1995 and supplied by divers in 1998. The number of abalone sampled (n) and the annual catch in tonnes (C) is given for each year.

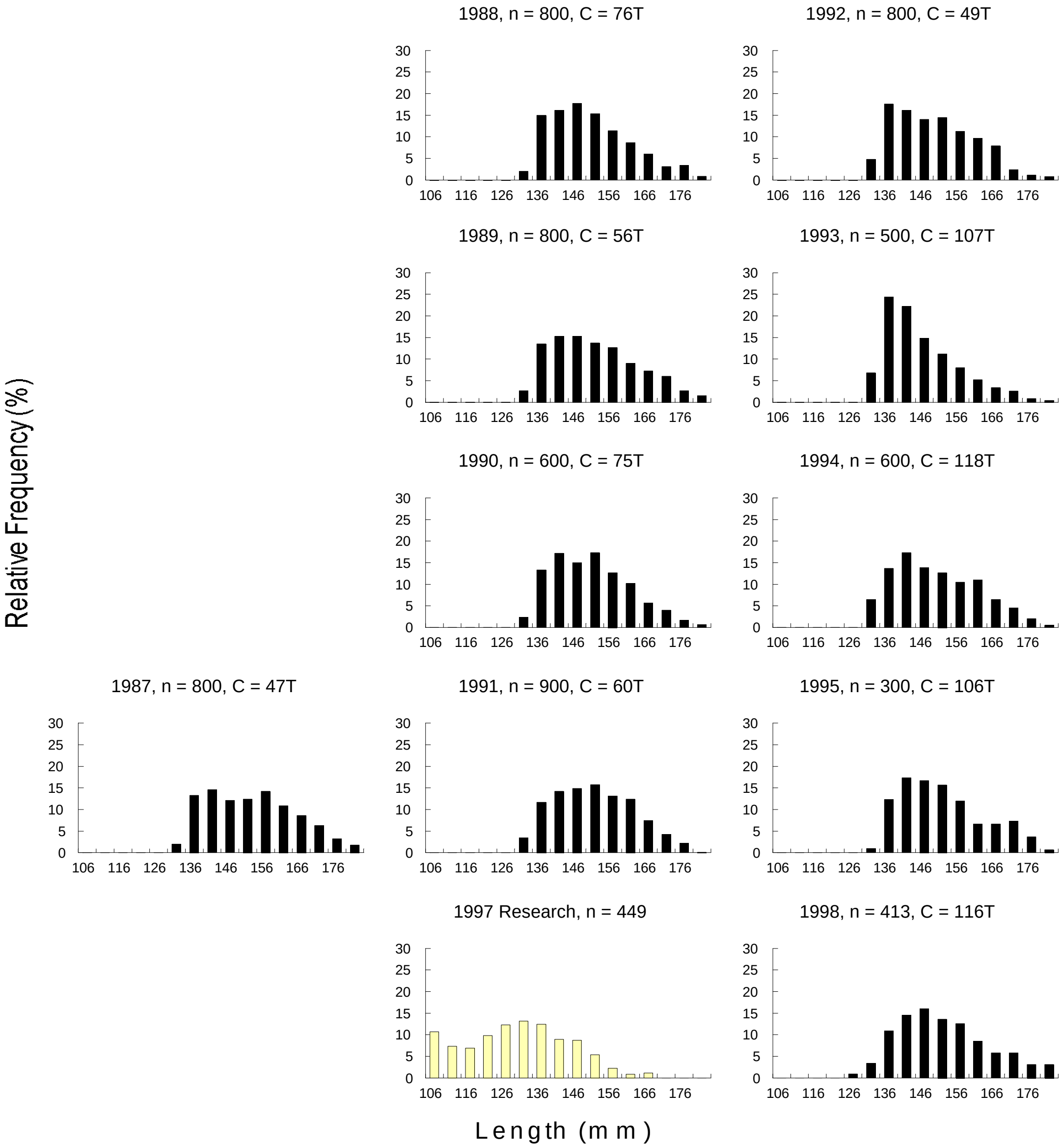


Fig. 14. Size-composition of the commercial catch from statistical block 16. Samples were measured at processing factories from 1984-1995 and supplied by divers in 1998. The size composition of samples taken by research divers in 1997 is also shown for comparison. The number of abalone sampled (n) and the annual catch in tonnes (C) is given for each year.

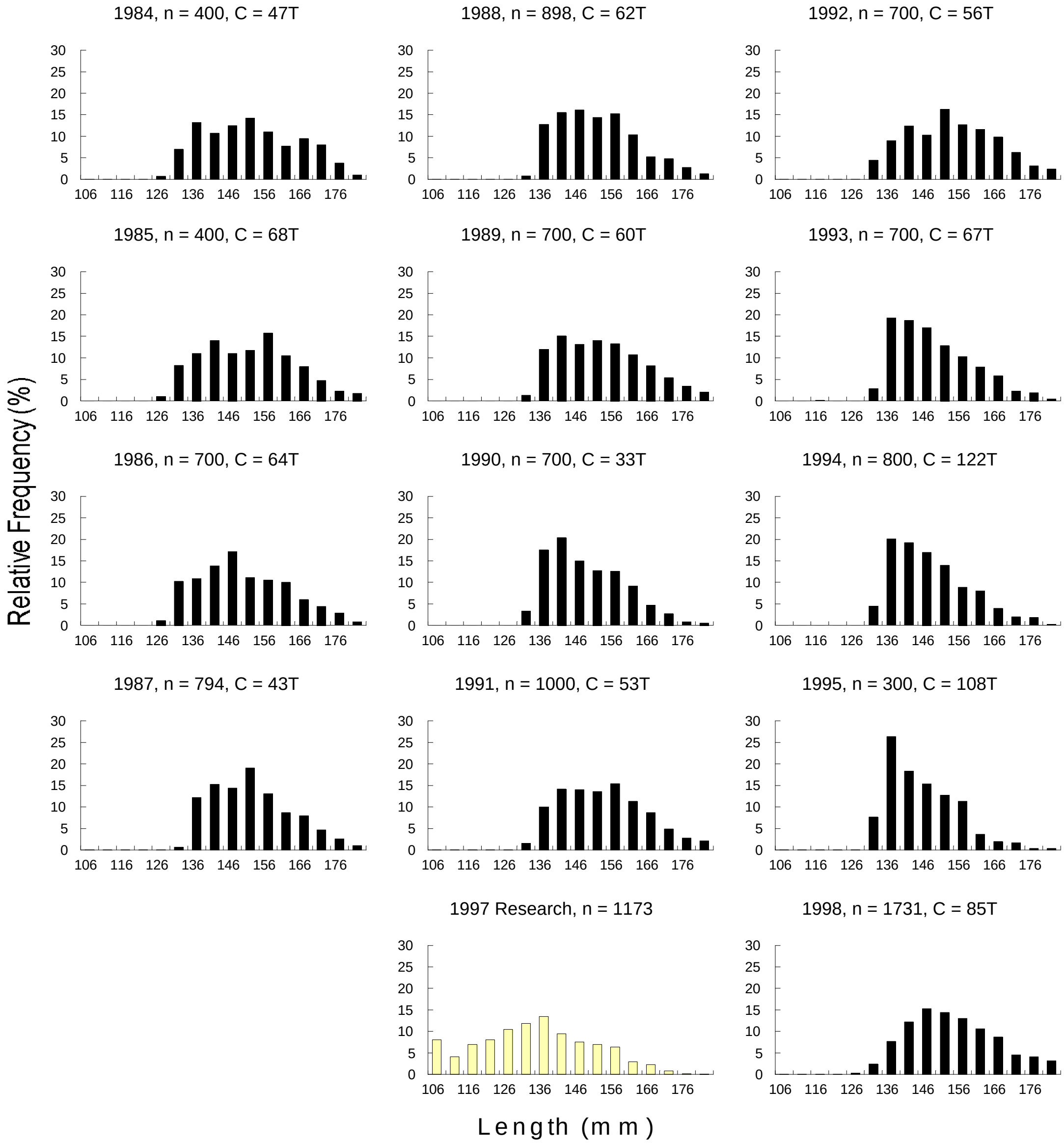


Fig. 15. Size-composition of the commercial catch from statistical block 20. Samples were measured at processing factories from 1984-1995 and supplied by divers in 1998. The size composition of samples taken by research divers in 1997 is also shown for comparison. The number of abalone sampled (n) and the annual catch in tonnes (C) is given for each year.

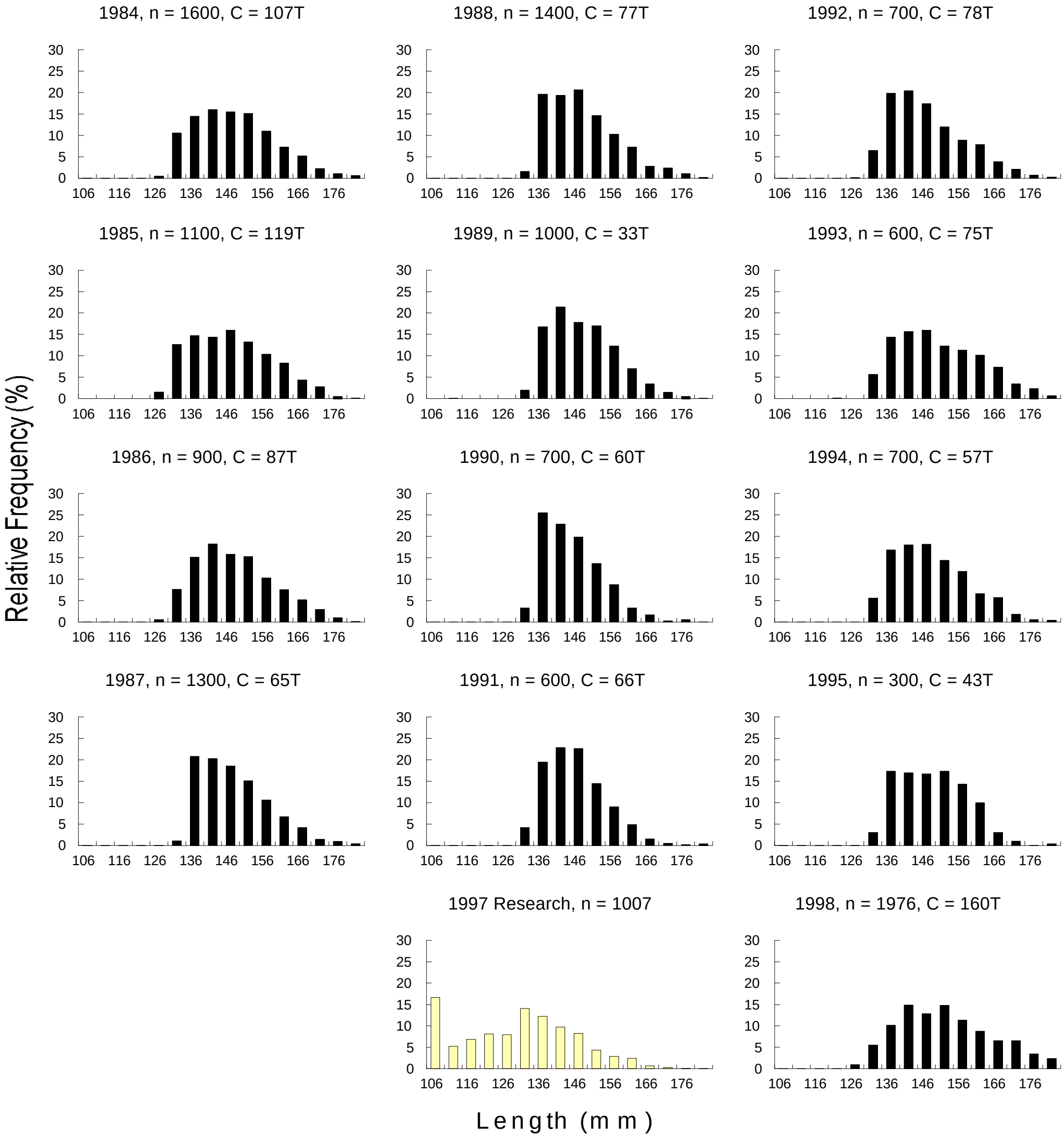


Fig. 16. Size-composition of the commercial catch from statistical block 24. Samples were measured at processing factories from 1984-1995 and supplied by divers in 1998. The size composition of samples taken by research divers in 1997 is also shown for comparison. The number of abalone sampled (n) and the annual catch in tonnes (C) is given for each year.

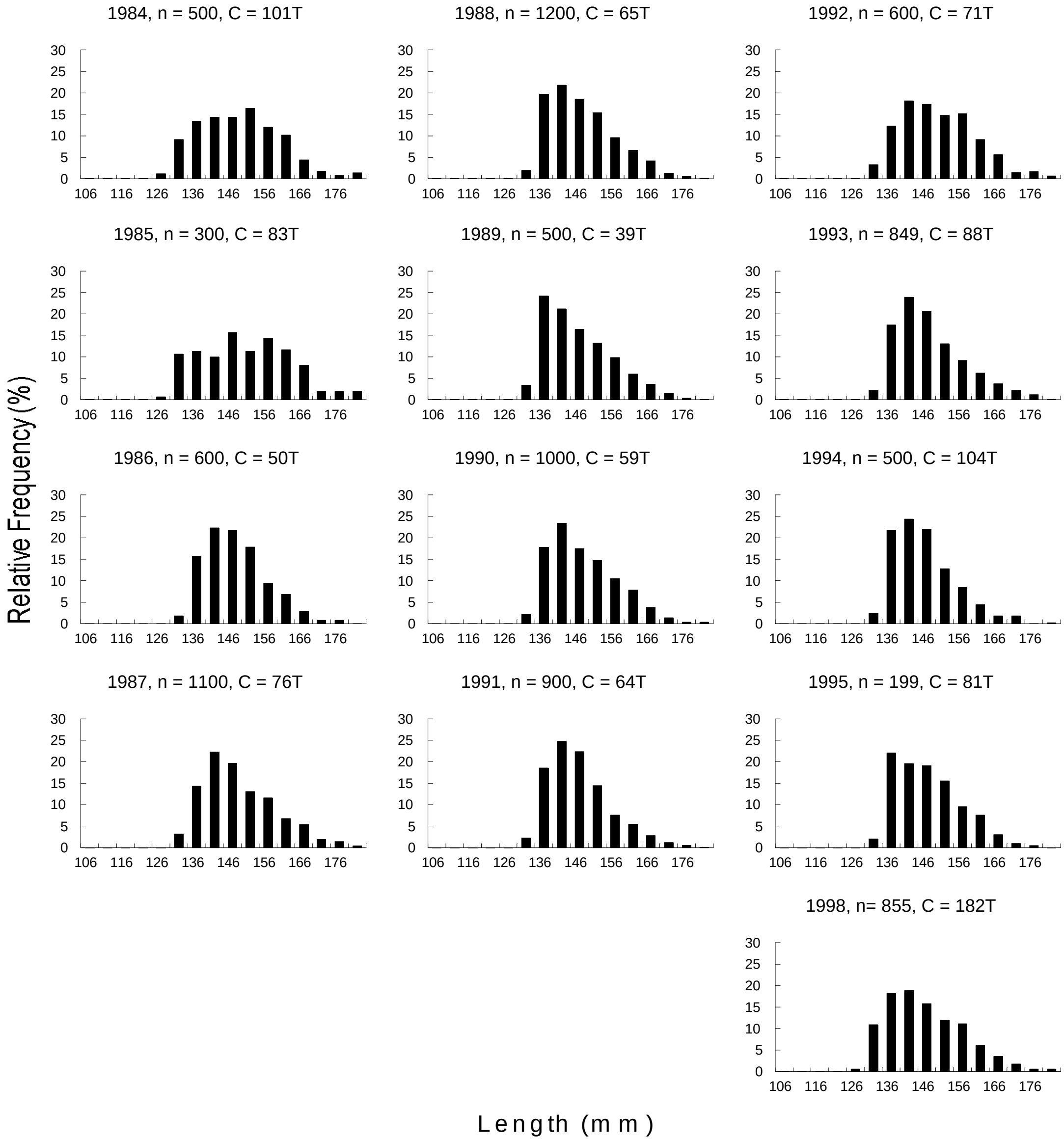


Fig. 17. Size-composition of the commercial catch from statistical block 27. Samples were measured at processing factories from 1984-1995 and supplied by divers in 1998. The number of abalone sampled (n) and the annual catch in tonnes (C) is given for each year.

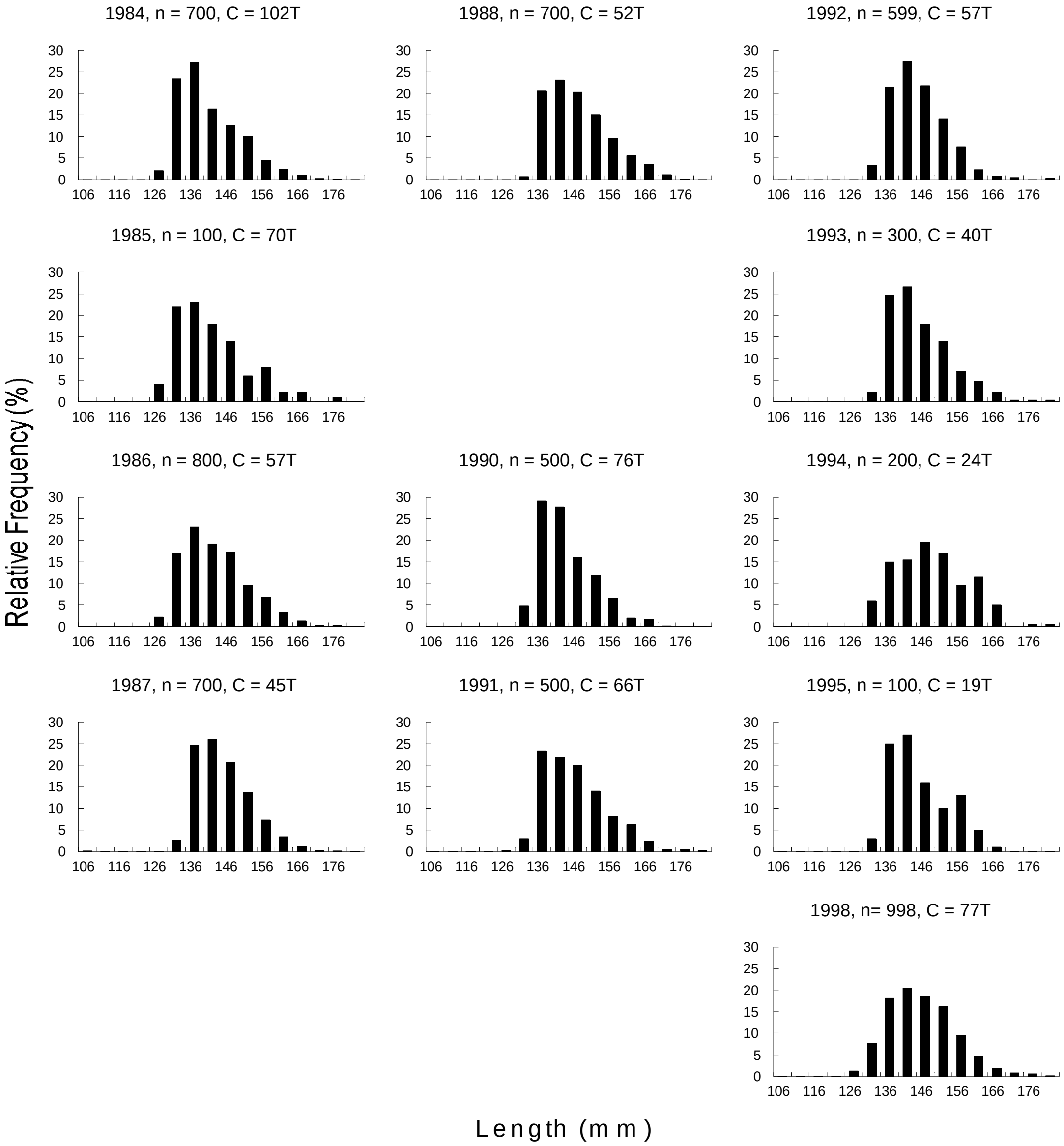


Fig. 18. Size-composition of the commercial catch from statistical block 28. Samples were measured at processing factories from 1984-1995 and supplied by divers in 1998. The number of abalone sampled (n) and the annual catch in tonnes (C) is given for each year.

These data suggest an apparent increase in the mean size of abalone sampled recently compared to 1995 in most areas. In no areas does the size-composition of the commercial catch show knife-edge fishing that would indicate that growth overfishing is occurring. In all blocks where size-composition data from research samples is available the large proportion of the population below the legal minimum length suggests that recruitment to the populations sampled will be maintained in the immediate future.

Sampling from the west coast has been poor but the few samples collected from block 7 suggest that about 60% of abalone measured at least 160 mm. An analysis of production data provided by Tasmanian Seafoods Pty. Ltd. strengthens this conclusion. These data analyse the proportion of production of cans containing one whole abalone or one abalone cut so as to fit it within a can. Such abalone would have a minimum length of 160 mm given the minimum bled meat weight within a can of 213 g, known rates of weight loss during processing (A. Hansen, pers. comm.) and bleeding (Nash, 1995b), and known length-weight relationships (Nash *et al.*, 1994).

Overall production from fish sourced in all areas showed an increase from 1995 to 1997 of product canned one piece whole and larger (Table 2). However, there was some reduction in this percentage from 1997 to 1998 (Table 2).

Table 2. Production of large abalone from one Tasmanian Processor

Details the total production from July 1995 to September 1998 of all grades of abalone product canned by Tasmanian Seafoods (Margate) and the percentage of cans produced containing one abalone, or one cut abalone.

		Abalone production in cartons		
Year	Month	One piece whole and larger	All grades	One piece whole as % of production
1995	July-December	2266	14951	15%
1995	**Total**	**2266**	**14951**	**15%**
1996	January-June	2453	12744	19%
1996	July-December	2051	14777	14%
1996	**Total**	**4505**	**27521**	**16%**
1997	January-June	4229	16043	26%
1997	July-December	3625	20777	17%
1997	**Total**	**7854**	**36820**	**21%**
1998	January-June	2088	12172	17%
1998	July-December	3503	20672	17%
1998	**Total**	**5591**	**32845**	**17%**

When catches from the west coast are analysed exclusively the proportion of very large abalone on the west coast becomes more apparent. These data show that 51% of the west coast abalone production analysed in 1997 was canned one piece whole and larger (Table 3). This proportion decreased to 45% in 1998 but still ranged to over 65% in some catches (Table 3).

Table 3. Tasmanian Seafoods size distribution data

Details the daily production of all grades of abalone product canned by Tasmanian Seafoods (Margate). On the days listed abalone caught on the west coast were processed exclusively. The percentage of cans produced containing one abalone, or one cut abalone is given.

Date	Abalone production in cartons		One piece whole as % of production
	One piece whole and larger	All grades	
30-Jan-97	156	301	52%
2-Feb-97	134	298	45%
3-Feb-97	97	181	54%
4-Feb-97	147	259	57%
25-Mar-97	111	198	56%
9-Jul-97	137	263	52%
10-Jul-97	120	270	44%
1997 total	**903**	**1771**	**51%**
13-Mar-98	50	140	36%
14-Mar-98	113	176	64%
18-Mar-98	52	159	33%
26-Apr-98	95	236	40%
8-May-98	107	282	38%
9-May-98	123	249	49%
18-May-98	94	157	60%
19-May-98	13	36	36%
20-May-98	66	110	60%
27-May-98	33	49	67%
22-Jul-98	57	126	45%
29-Jul-98	50	139	36%
5-Aug-98	62	132	47%
10-Aug-98	167	368	46%
19-Aug-98	103	221	46%
20-Aug-98	158	311	51%
21-Aug-98	157	318	49%
14-Oct-98	155	415	37%
15-Oct-98	178	395	45%
16-Oct-98	59	241	24%
7-Nov-98	120	234	51%
17-Nov-98	67	171	39%
25-Nov-98	188	414	46%
26-Nov-98	134	309	43%
1998 total	**2400**	**5387**	**45%**

6.1.4 Recreational fishery

The number of recreational abalone licences increased from about 4200 in 1995-96 to 4795 in 1996-97. In 1997-98 5461 licenses had been issued for the period 1 November 1997 up until 15 June 1998. Surveys of recreational fishing undertaken by the Department of Primary Industry and Fisheries suggest the recreational abalone harvest in the past year was approximately 37.5 tonnes (about 1.5 percent of the commercial harvest) (J. Lyle, pers. comm.). The distribution and magnitude of the recreational abalone catch in 1997 is shown in Fig. 19. These data suggest that the recreational fishery focuses on blacklip abalone and that 70% of the recreational catch comes from the south-east and east coast. The highest estimated recreational catch was in the North-west (5 % of the commercial catch). This percentage appears high not because the recreational catch itself was large but because of the decline in the commercial catch from this region (Fig. 8A).

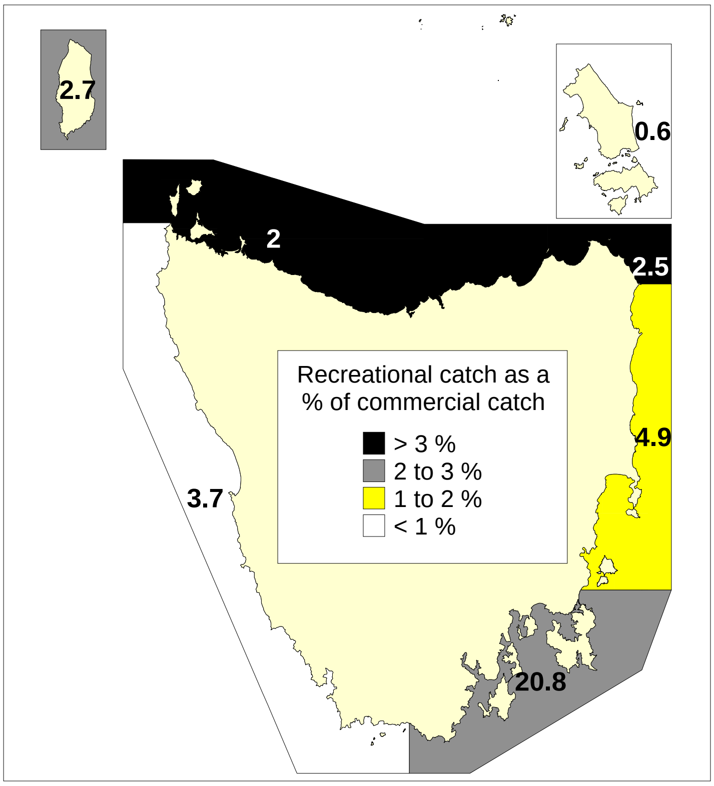


Fig. 19. The 1997 recreational catch in tonnes and as a percentage of the commercial catch for the seven regions used in surveys of recreational fishing in Tasmania (J. Lyle, pers. comm.). Numbers indicate the catch in tonnes, shading indicates the value of these tonnages as a percentage of the commercial catch from each region. Regional boundaries are adjusted from those normally used in abalone assessment to better reflect the boundaries used in recreational fishing surveys.

6.2 Greenlip Fishery Assessment: 1997/98

This assessment includes catch and effort statistics from 1997 and 1998. The assessment is preliminary to a more detailed greenlip fishery assessment which will be published in 1999. The detailed assessment will re-examine size limits for greenlip abalone in the light of recent catch and effort trends, and recent research surveys.

6.2.1 Evaluation of Trigger Points

1998 greenlip catches are evaluated below using the trigger points specified in the Abalone Management Plan (Anonymous, 1997a). These trigger points are designed to identify increased catches of greenlip abalone but do not identify areas where greenlip catches are declining. Therefore greenlip catches were also evaluated against a 5% reduction in the 1998 catches from the average 1992 to 1995 catches. The trigger point specified in the Management Plan particular to the Furneaux Group was designed to identify increased catches from the Group as a whole and not for each block. To identify changes in the catch for each block within the Furneaux Group the 5% trigger points are also applied to the Furneaux Group blocks in this report. 1998 greenlip catches are also compared by block against the average 1981 to 1984 catches. Whilst few greenlip abalone have been caught recently in block 47 this block is included in the analyses because it has recorded reasonable catches in the past. Block 40 is included because it has recently produced very significant catches of greenlip abalone.

Trigger points specific to Greenlip abalone

1. The annual catch of greenlip abalone outside the Furneaux Group is 5% above the average catches for the years 1992 to 1995.

- REGIONS: Triggered. The 1998 catches of greenlip abalone from King Island, the North-west and North-east were 220%, 160% and 219% of the average 1992 to 1995 catch, respectively (Fig. 20A).

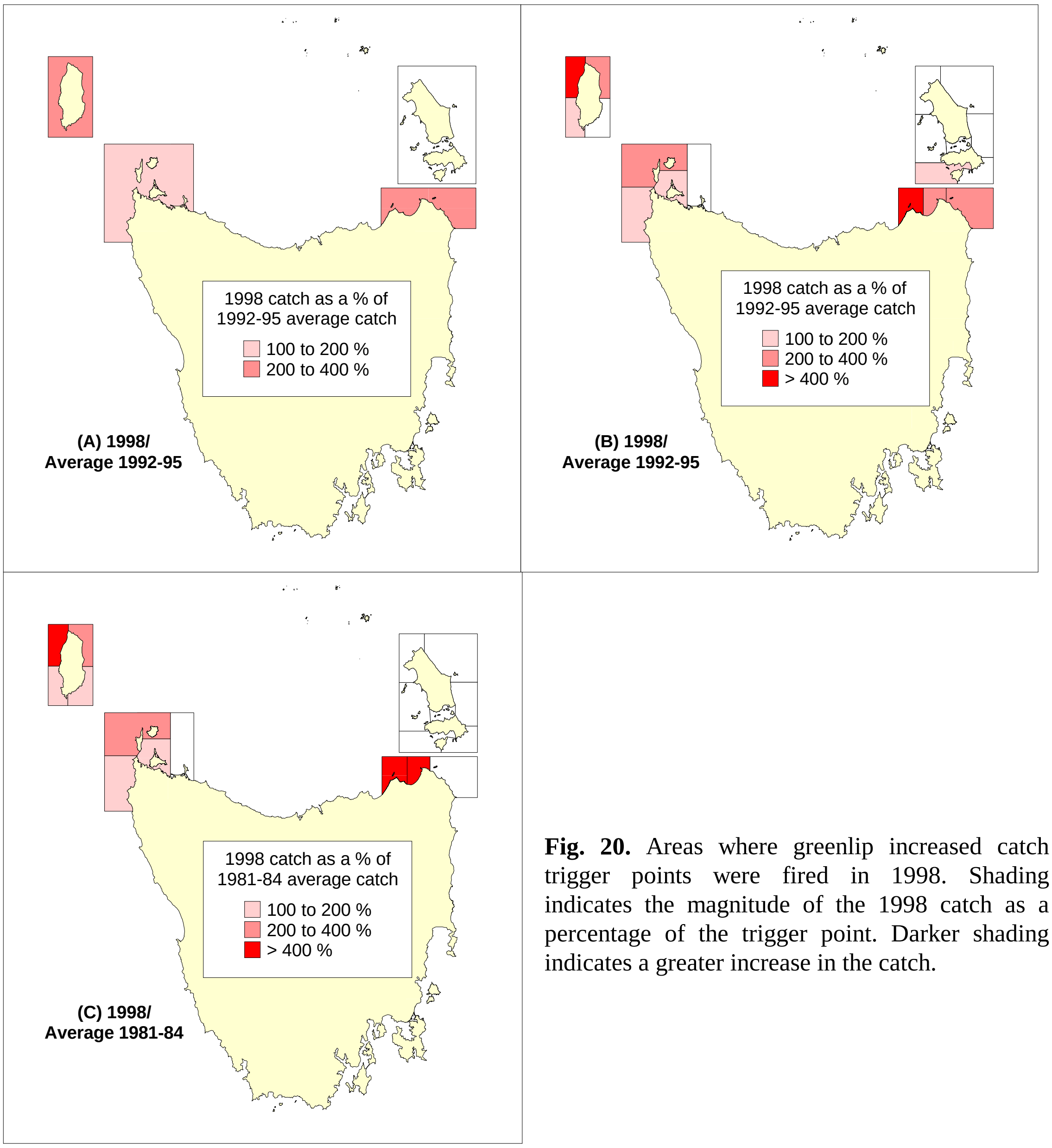


Fig. 20. Areas where greenlip increased catch trigger points were fired in 1998. Shading indicates the magnitude of the 1998 catch as a percentage of the trigger point. Darker shading indicates a greater increase in the catch.

BLOCKS: Triggered. 1998 greenlip catches from blocks 1, 2, 3, 5, 39, 40, 48 and 49 were 585%, 193%, 116%, 239%, 341%, 4718%, 154% and 245% greater than the average catches recorded between 1992 and 1995 (Fig. 20B). 1998 greenlip catches from blocks 1, 2, 3, 4, 5, 39, 40, 48 and 49 were 10826%, 318%, 108%, 122%, 184%, 463%, 1255%, 144% and 231% greater than the average catches recorded between 1981 and 1984 (Fig. 20C).

In 1998 reduced catch trigger points were fired in blocks 4, 31 and 47 (54%, 28% and 49% respectively) (Fig. 21A). Within the Furneaux Group reduced catch trigger points were fired in blocks 34, 36 and 37 (59%, 18% and 59% respectively). 1998 greenlip catches from blocks 31 to 38 and block 47 were less than the average catches recorded between 1981 and 1984 (16%, 70%, 32%, 9%, 60%, 13%, 28%, 51% and 9% respectively) (Fig. 21B).

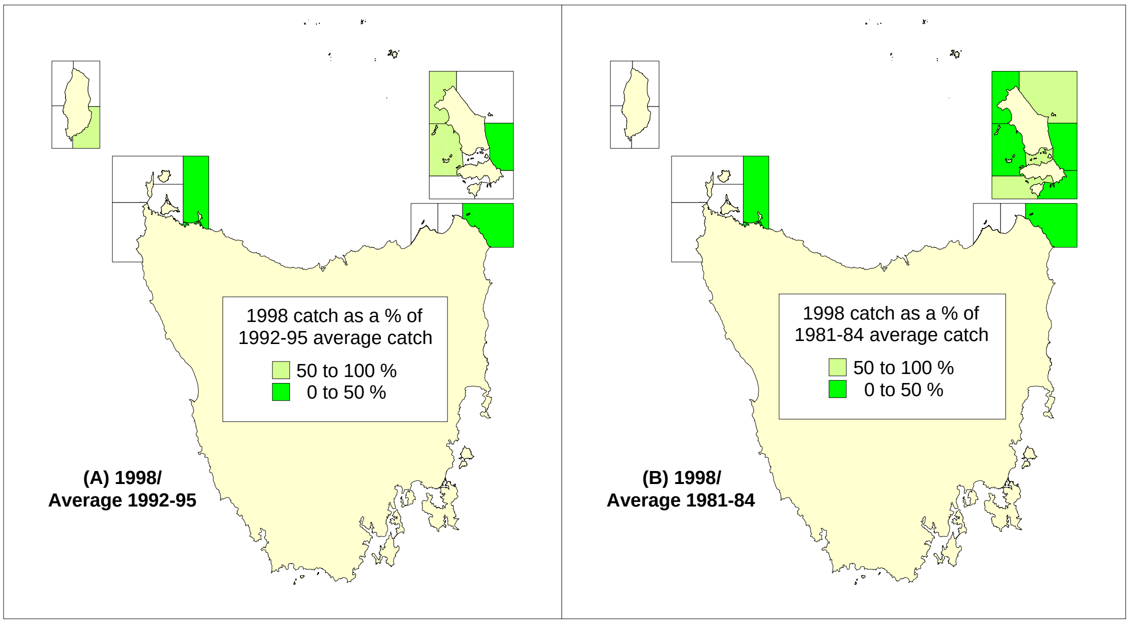


Fig. 21. Blocks where greenlip reduced catch trigger points were fired in 1998. Shading indicates the magnitude of the 1998 catch as a percentage of the trigger point. Darker shading indicates a greater decline in the catch.

2. The monthly catch of greenlip abalone from the Furneaux Group reaches 1/12th of the average annual catch for the years 1992 to 1995.

- Triggered. The greenlip catch from the Furneaux Group exceeded the trigger point every month until the region was closed to commercial fishing (Fig. 22).

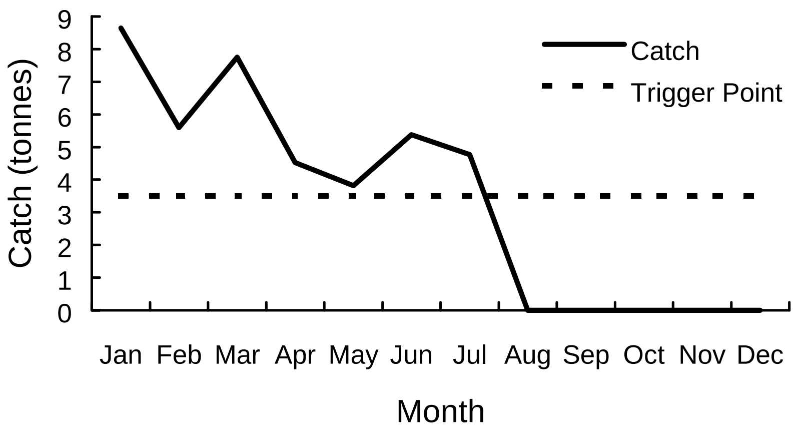


Fig. 22. Monthly catches from the Furneaux group in 1998. The 3.5 tonne monthly trigger point is also shown.

6.2.2 Commercial catch-effort statistics

In order to show changes in the distribution of the catch around the State since 1975, the catch from each of the greenlip abalone producing regions is shown in Fig. 23. The upper graph shows the catch in absolute terms (tonnes) and the lower graph shows the catch from each of these regions as a proportion of the total annual catch.

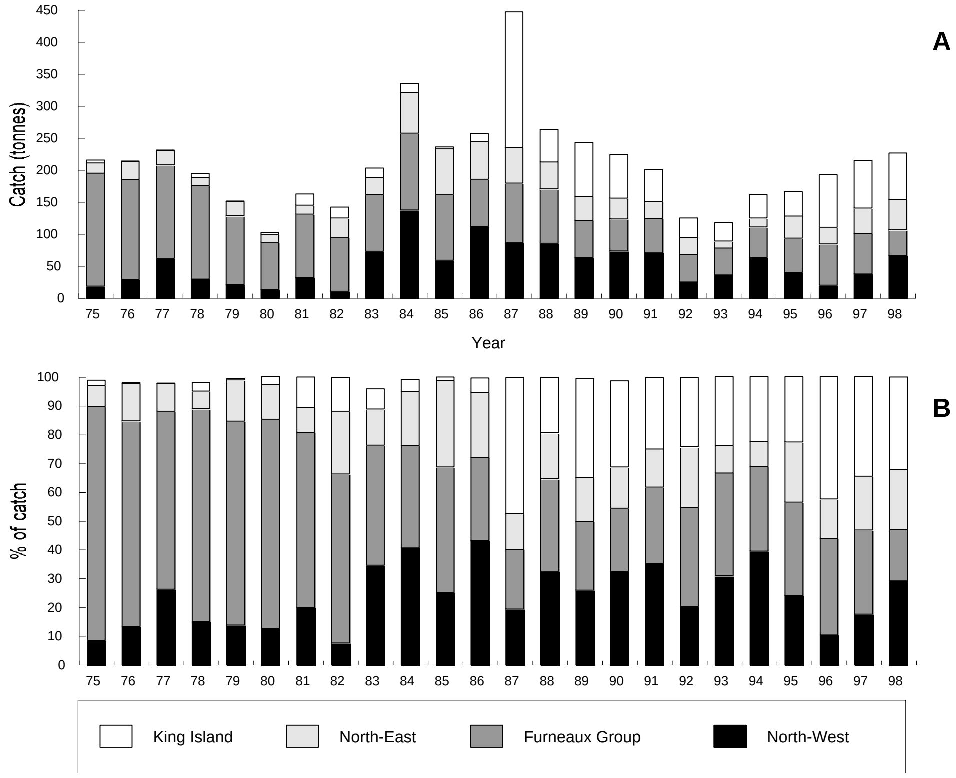


Fig. 23. The catch of greenlip abalone from the four main greenlip-producing regions of Tasmania, by year from 1975 to 1998. King Island includes blocks 1-4. North-east includes blocks 30, 31, 39 and 40. The Furneaux Group includes blocks 32-38. North-west includes blocks 5, 6, 47, 48 and 49 . The catch from each region is expressed in (A) absolute values (tonnes), and (B) as a proportion of the total greenlip catch. Proportions do not sum to 100 % in some years due to minor catches in other blocks or misreported catches in areas that do not produce greenlip abalone.

The following points are noted with reference to these graphs:

(i) The annual greenlip catch peaked in 1987 when large catches were taken from eastern King Island (Fig. 23A). The 1998 greenlip catch is similar to the long-term average (1975-1998), but above the average when the large 1987 catch is excluded.

(ii) The King Island greenlip catch was very small until 1987; catches since 1987 are higher than in these earlier years (Fig. 23A).

(iii) There has been a steady decline in the annual greenlip catch from the Furneaux group, from 175 tonnes in 1975 to about 40 tonnes in 1998 (Fig. 23).

(iv) The greenlip catch from the north-west peaked in 1984 (Fig. 23) and has declined since then. However, it has been increasing since 1996.

(v) The greenlip catch from the north-east (blocks 30, 31, 39 and 40) has varied in both absolute and relative terms, with no readily apparent trend (Fig. 23).

Catch, effort and catch rate data for regions and individual statistical blocks for the period 1975 to 1998 are shown in Appendices 1 and 2. Statistical block 40 has been included in the analysis (and added to the North-east region) because recent catches from this block have been relatively large. When examined in combination with the catch levels themselves (see below), the catch rate trends suggest an unhealthy condition of the stocks in several greenlip abalone producing areas (blocks 3 and 4 (King Island), and 34 and 36 (Furneaux Group)).

6.2.3 Commercial catch sampling data

The size-composition data collected by the commercial catch sampling program in 1998 has mainly come from blacklip abalone. Whilst small samples of greenlip abalone have been measured from statistical blocks 1, 32, 35 and 39 these data are insufficient to allow for a meaningful comparison. Unfortunately few samples have previously been obtained from these areas. This makes an assessment of the recent size composition data difficult. It is anticipated that more samples from greenlip abalone producing areas will be received in the near future. These data will be included in a more detailed assessment of the greenlip fishery due for publication in 1999.

6.2.4 Recreational fishery

Surveys of recreational fishing in Tasmanian suggest that the recreational catch of greenlip abalone is relatively small (Fig. 19) (J. Lyle, pers. comm.). These data suggest that the recreational fishery in the two main greenlip abalone producing areas (King Island and the Furneaux Group) yielded 2.6 and 0.5 tonnes respectively in 1997.

7. Discussion

7.1 Comments on trigger points

The evaluation of trigger points in this assessment highlights some inadequacies in the performance indicators formally specified for the assessment of the fishery. These inadequacies are particularly apparent when the catch in the region being assessed is low and variable. Such data can generate spurious results. For example, in the North-west the trigger point flagging increased catches was fired when the 1998 catch was compared against that in 1995. However, trigger points flagging decreased catches also fired in this region when the 1998 catch was compared against the average catch from 1992 to 1995. These results illustrate the importance of developing trigger points that compare present catches against data that incorporates the inter-annual variability that would normally be expected in the fishery.

Nevertheless, the evaluation of trigger points provides an effective illustration of the shift in catch and effort to the East Coast and South-east, and of the decline in blacklip catch from the King Island, the North-west, West south-west and North-east. Around King Island these data illustrate an almost complete shift in effort from blacklip to greenlip. This decline may be partly explained by the decrease in fishable biomass and catch rates that would have resulted from the increase in size limit in 1987 from 127 to 132 mm. Furthermore, prior to this period no significant targeted fishery for greenlip abalone existed and a substantial proportion of the greenlip catch was probably reported as blacklip abalone.

Inadequacies of the reduced catch trigger points based on comparison with 1995 catches are illustrated in the West south-west. The reduced catch trigger point did not fire in this region when 1998 catches were compared with those of 1995. This was because the 1995 catch was itself exceptionally low. Comparison of the 1998 catch with the average catch from 1992 to 1995 provides a more realistic illustration of the shift in catch away from the West south-west.

Increased catch trigger points based on comparison with 1995 catches can also generate spurious results when the catches compared are reasonably large. This trigger point was not fired at all in the South-east because the 1995 catch from the region was exceptionally high (Appendix 1). Comparison of the 1998 catch with the 1992-95 average better reflects the trend for increasing catch from the South-east that was already established by 1995.

Evaluation of these trigger points by block reveals that the increase in catch on the east coast has apparently occurred in all blocks. However, an analysis of catch returns indicates that this increased catch has been focussed in blocks 24 (Maria Island) and 27 (East of Freycinet Peninsula). The doubling of catch over two years is a cause for concern. This concentration of effort is also evident in the South-east where the majority of the increased catch has come from block 13. In seven blocks the 1998 catches exceed the historical peaks recorded prior to the introduction of quota in 1985. Three of these areas are very important fishing areas (blocks 13, 20 and 27) where recent catches are about double those recorded prior to the introduction of quota.

The fact that these trigger points were fired is even more alarming given that they rely on comparison with the catches recorded from 1992 to 1995. The shift of catch to the East coast and South-east was already under-way during these reference years (Fig. 6) and was established by 1994. Whether or not these catches represent a threat to the resource remains uncertain. Recent catch rates are high and the size composition of commercial catches includes abalone well above the size limit. Where it is available recent research data shows a large proportion of the population below the legal minimum length. Together, these data suggest that there is little immediate danger of either growth overfishing or recruitment overfishing. However it should be noted that high catch rates and a broad size composition would be expected during a rapid increase in catch. The rapid increase in catch is effectively fishing down the fish recruited to the fishery some years earlier. How long such high catch rates and such a broad size composition can be maintained is uncertain and will be a strong test of the productivity of the East coast and South-east.

The inability of the current trigger points to indicate the sustainability or otherwise of recent catches is perhaps the most important conclusion to draw from these analyses. Unfortunately introducing biologically-based trigger points to indicate biomass fluctuations will require the development of an adequate index of abundance and ideally a population model. However, the present lack of such an indicator does not preclude the introduction of other performance indicators. These could include performance indicators that examine changes in levels of egg production, size at maturity, proportion of stock in various size classes, and the productivity of other species that share abalone habitat. The high degree of variability in these parameters between locations would make a general application of these indicators difficult. A more appropriate evaluation could be achieved by the routine re-examination of these parameters at fixed sites. This approach would demand that the sites sampled are numerous and representative of important fishing areas. The present program of population surveys at the Tasmanian Aquaculture and Fisheries Institute is being adapted to achieve these objectives.

7.2 Comments on catch and catch rate trends

Catch rates are widely perceived as being an insensitive index of abalone abundance because of the aggregating behaviour of abalone and the fishing behaviour of abalone divers. The inaccuracy in the relationship between catch rates and abalone abundance is the principal reason for the uncertainty in this assessment. Abalone tend to move (aggregate) to preferred habitat, and divers target these aggregations. Divers maintain high catch rates by moving from aggregation to aggregation, and it is only when there are very small numbers of abalone remaining (too few to reform aggregations) that catch rates show a marked decline.

Similarly, when catch and effort on the stock declines, catch rates may increase because the abalone have, on average, more time between fishing events to aggregate. In such cases catch rates may increase not necessarily due to an increase in abundance, but because the abalone are more easily caught in aggregations.

Despite these difficulties with interpreting catch rate information, it is proposed that, when catch rates are examined in combination with trends in the catch itself, some interpretations are more likely than others. This is illustrated in Table 1 and Fig. 10. 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. These scenarios are discussed in turn.

The first scenario could indicate a recruitment decline: despite a reduction in fishing pressure, catch rates continue to decline because there are increasingly fewer recruits each year to the fishery. Such a situation could be occurring for greenlip abalone in blocks 34 and 36. This trend would be very alarming for greenlip. Greenlip abalone are probably more vulnerable to recruitment failure than blacklip due to their propensity for epidemic spawning. Such a reproductive strategy relies upon environmental conditions being favourable at the time of spawning. If conditions are not optimal reduced fertilisation success may result and be followed with consequent declines in settlement and recruitment. These problems are potentially exacerbated by the tendency of adult greenlip abalone to aggregate prior to spawning. Fertilisation success would be further reduced if fishing pressure has significantly reduced adult densities such that the distance between abalone is so great that aggregation is difficult or many aggregations contain abalone of only one sex.

The second scenario probably indicates an increase in fishable biomass. However, caution is necessary when making this conclusion. For example, whilst blocks 24 and 27 show increasing catch and catch rates the interpretation that this represents an increase in fishable biomass ignores the marked increase in fishing pressure that has occurred in these areas. Catch in both blocks has doubled since the early 1990's. This doubling occurred over two years in block 24 and over one year in block 27. The high catch rates that are being maintained in these blocks are therefore to be expected as recent catches are effectively removing the accumulated biomass recruited to the fishery in previous years of lower catches. There has been insufficient time to see if the recent catches will result in a decline in abundance or recruitment. Fortunately, size composition data suggests that recruitment decline is unlikely.

The interpretation of trends in catch rate is also confounded by changes in the efficiency of divers (fishing power). There has undoubtedly been an increase in fishing power since the commencement of the fishery in the mid-1960s but it is not clear whether, and if so by how much, fishing power has continued to increase in the past 10 to 15 years. If, as some abalone divers have stated, divers' fishing power continues to improve, then the catch rate trends shown in Table 1 and Fig. 10 are optimistic with respect to changes in abundance. Thus, for example, a 20 percent increase in catch rate would overestimate the increase in fishable biomass if there has been an increase in fishing power over the same period of time.

Standardisation of catch rates for increasing diver efficiency (fishing power), or for other factors such as depth or diver experience, has yet to be done. It should be noted, however, that standardisation of fishing effort can only partially improve the relationship between catch rate and abundance.

Fishery independent abundance estimation also holds promise as a better indicator of biomass change. It is proposed that a modified transect method, such as that suggested in Victoria, be tested in Tasmania. The new approach would provide all the information available from previous strip transect methods as well as additional information describing the spatial distribution of abalone. The efficacy of the proposed method would be tested by comparing it with other methods of estimating abundance. Temporal comparison of the spatial distribution of abalone aggregations and their density may provide another measure of the resilience of abalone populations to fishing.

7.3 Comments on size-composition data

The size-composition data from commercial catch sampling included in this assessment appears to strengthen the conclusion that blacklip abalone stocks are generally healthy. However, it must be noted that the commercial catch sampling project has only been re-established for six months and the data presented in this report has not been validated. The samples obtained from divers may not be representative of the fishing blocks from which they were obtained or there may be systematic biases in the measurement system used to generate the size-composition data. Such biases are considered unlikely but will nevertheless be considered in a separate validation study of the commercial catch sampling project. At the conclusion of the project's first year of operation the results of the project will be provided in a separate report that will include tests of the validity of the data.

7.4 Recreational catch

The recreational catch of abalone reported here represents a very minor proportion of the commercial catch. At such levels there is little danger of the recreational catch impacting upon the commercial fishery. However, this does not mean that the recreational catch should be disregarded. Whilst the recreational catch is small overall it is likely to be significant in areas that are close to population centres. Recreational divers are also more likely to continue taking abalone from reefs where the abundance would be insufficient to maintain acceptable commercial catch-rates. For these reasons the level of the recreational catch should continue to be monitored.

7.5 Implications for Management

This assessment highlights the currently uncontrolled concentration of blacklip catch into particular fishing blocks in the south-east and off the east coast. Present performance indicators are inadequate for determining if this trend is damaging to the abalone stocks. Trigger points therefore require re-evaluation in the next management plan to ensure that they provide better indications of the health of the fishery.

Despite these uncertainties it is clear that the catch in some areas now greatly exceeds that ever recorded before. Consequently past performance of the fishery can no longer indicate the sustainability of the currently focussed catches. Caution is therefore warranted and further concentration of catch into these areas should be avoided. Ideally regional control of the distribution of catch should be introduced to prevent the increased concentration of catches. This need has been recognised by industry and government and the introduction of a system of zoning is currently under discussion (see Appendix 3).

The shift in catch away from northern areas and the west coast has been so marked that these areas could now be considered under-exploited when present catches are compared with those sustained in the past. Despite the considerable potential for increased catches from these areas (Appendix 3) the current lack of regional control in the fishery means that an increase in the total allowable catch (TAC) could place further pressure on stocks in the south-east and off the east coast.

It should be noted that, without regional controls, fleet dynamics are unlikely to change in response to changes in the TAC. This is because the cost of fishing in different areas around the State becomes increasingly important at lower profit margins, as is the case for contract divers. In this situation divers may tolerate lower catch rates (for example, on the east coast) than owner-divers because they cannot afford the additional costs associated with fishing in more remote areas (such as the west and south-west) where catch rates are higher. Hence, without regional controls, increases in the TAC are likely to place easily accessible stocks under increased fishing pressure.

The inclusion of both greenlip and blacklip abalone under the one TAC introduces vulnerability to the fishery. Theoretically the entire TAC could be taken on one species. Because greenlip abalone represent the minor portion of the total catch there is potentially a huge amount of latent effort that could be directed towards this species. These arrangements mean that greenlip abalone production is essentially un-managed within the existing state-wide TAC except by closure of the fishing grounds. Operating the fishery in such a fashion induces competition between participants and potentially unsafe fishing practices.

In addition to these human risks operating the fishery under a closure system has the potential to damage the resource. The competitive nature of fishing under a closure system may mean that fishing grounds fished most economically come under increased pressure as participants race to maximise catches prior to the imminent closure of the fishery. The targeting of large greenlip abalone also has implications for the choice of management strategy that may be used to stem the apparent decline in stocks. Raising the legal minimum length for greenlip abalone is unlikely to reduce the catch if the effective minimum size limit is much greater than the existing legal size limit. Furthermore, under extreme fishing pressure reliance on size limits alone is insufficient to ensure the sustainability of abalone stocks. For these reasons formal separation of the greenlip quota allocation from the blacklip allocation would improve the prospects for sustainability for the greenlip fishery.

In the interim the threat of serial depletion of greenlip abalone stocks should not be overlooked. The stability of abalone catch rates when viewed at a large geographic scale may disguise the fact that overfishing is occurring on a local scale and that, because of the limited dispersal capacity of abalone (in either the larval or post-settlement phase), the possibility of serial depletion of abalone stocks may be significant.

At the current high levels of fishing pressure greenlip abalone abundance in many areas appears to have declined considerably. The ability of divers to maintain stocks in healthy condition by moving between areas has also declined because of increased market demand for greenlip abalone. Because of the inability to transfer effort away from depleted areas there is a greater need for regional controls and quota restrictions on the greenlip fishery.

7.6 Recommendations For Future Assessments

- Develop alternative means of fishery independent abundance estimation,
- Incorporate alternative biologically-based performance indicators,
- Construct a computer model of the Tasmanian abalone fishery,
- Employ revised catch and catch-rate trigger points,
- Analyse catch and effort data on a finer spatial scale,
- Utilise data from an expanded commercial catch sampling program.

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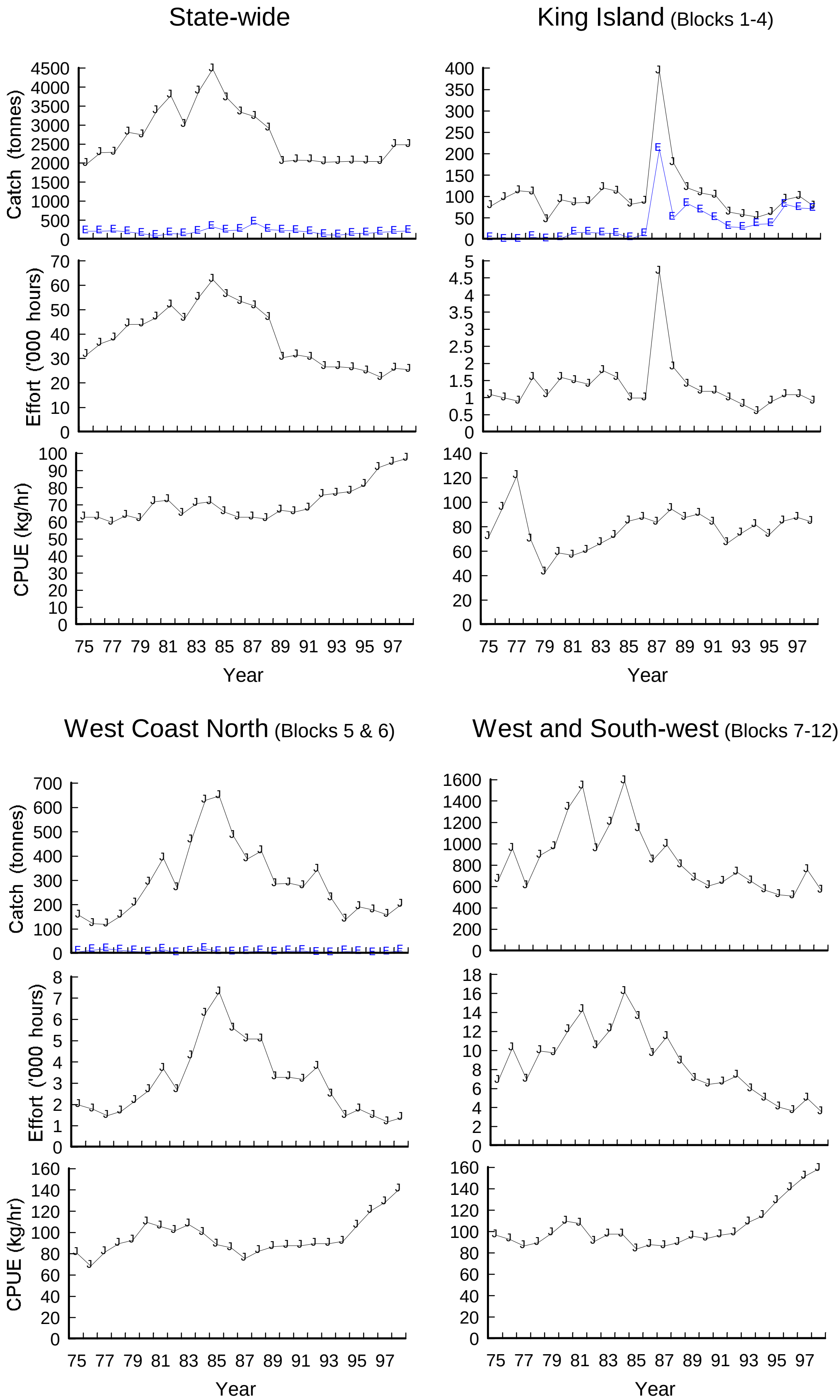
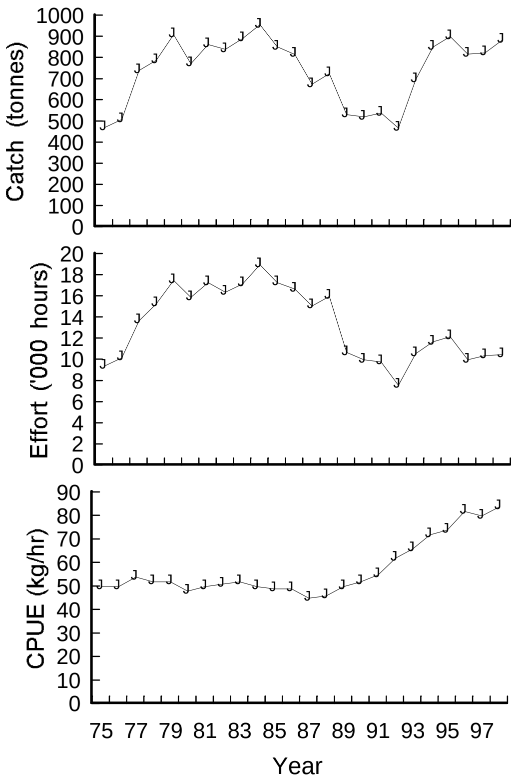
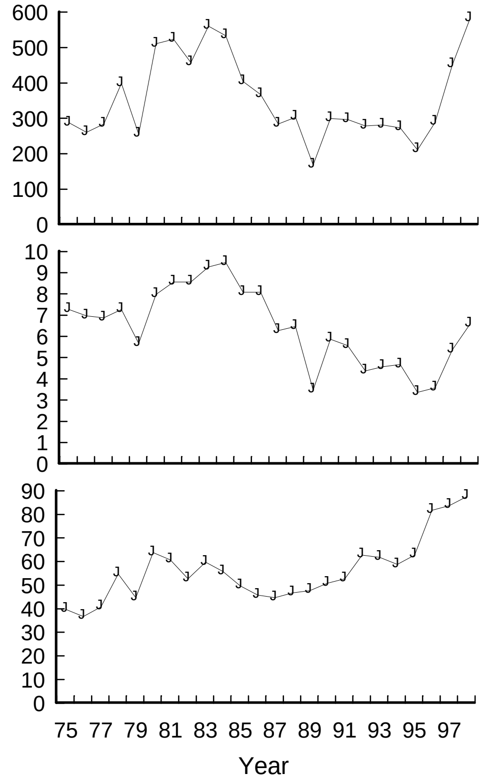


Appendix 1. Total abalone catch, effort and catch-rate (CPUE) by region and year. Greenlip catch is plotted (○) where it is an important part of the total catch.

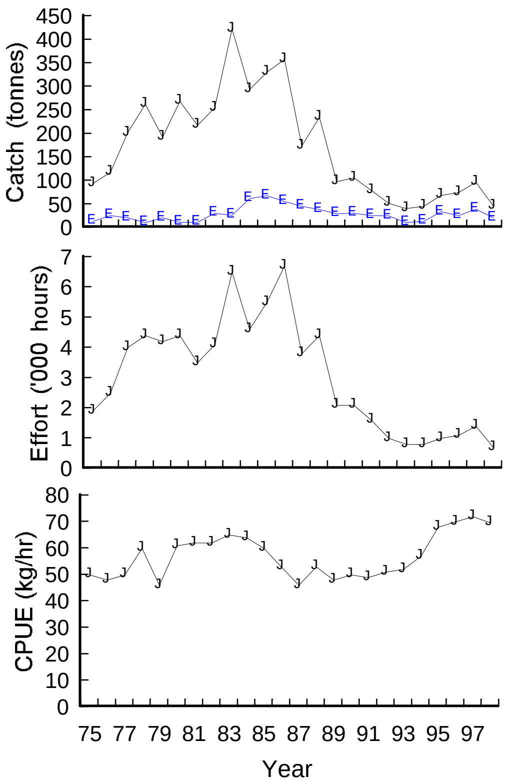
South-east (Blocks 13-21)



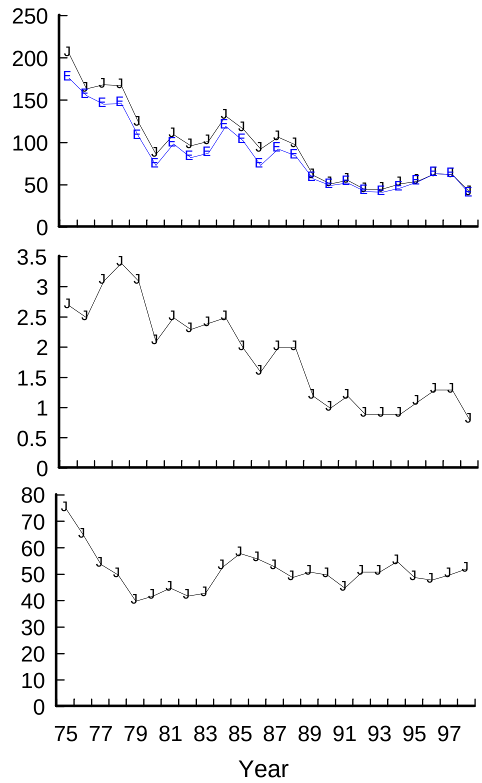
East Coast (Blocks 22-29)

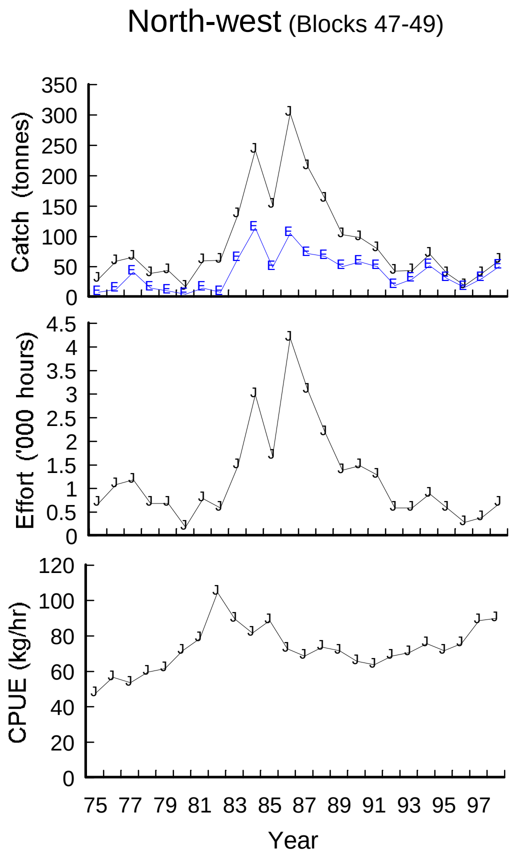


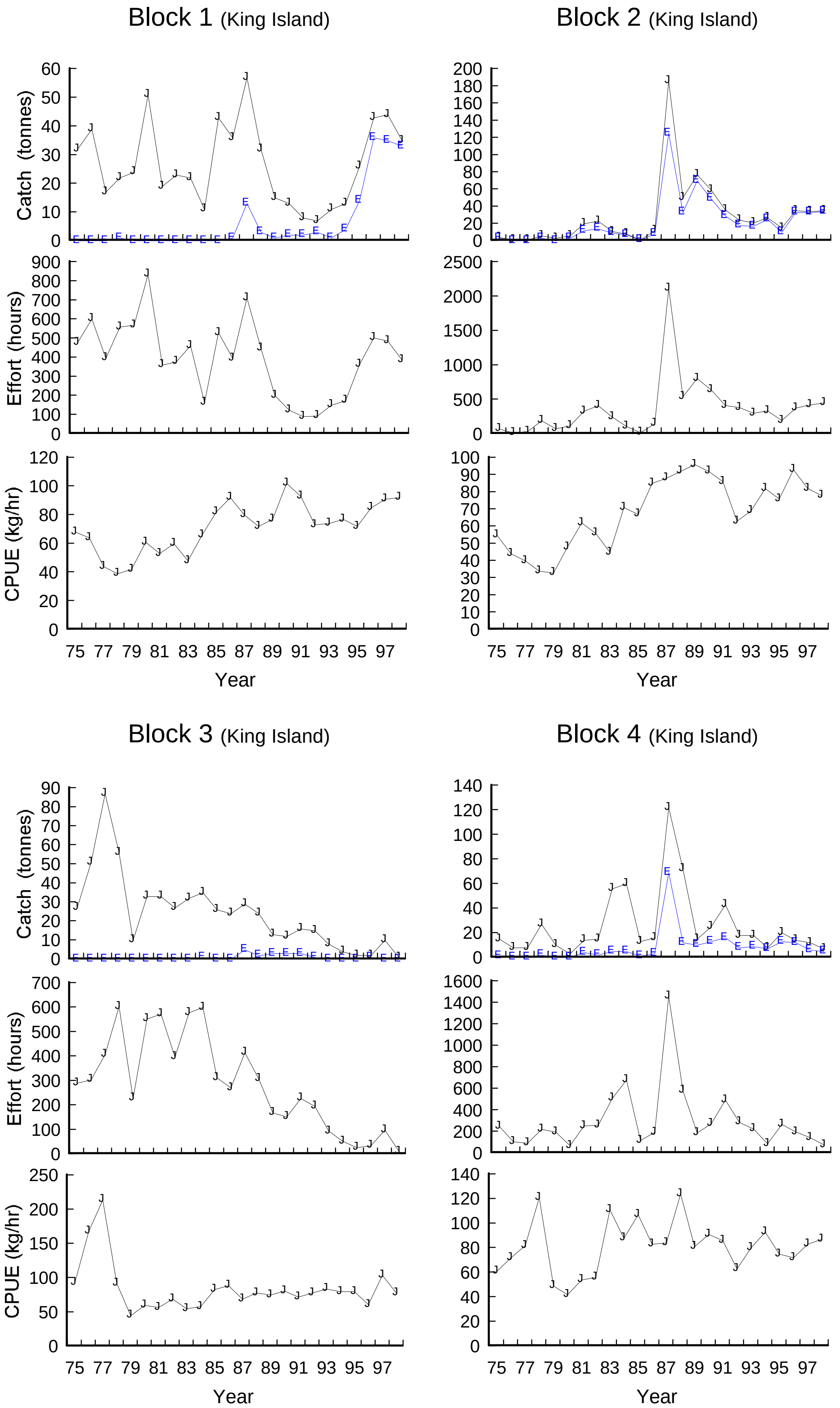
North-east (Blocks 30, 31, 39 & 40)



Furneaux Group (Blocks 32-38)

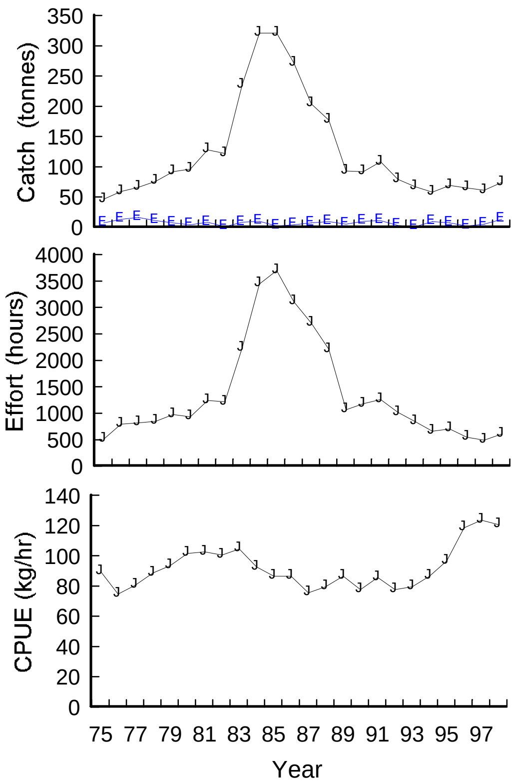



North-west (Blocks 47-49)
Catch (tonnes)
350
300
250
200
150
100
50
0
Effort ('000 hours)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
CPUE (kg/hr)
120
100
80
60
40
20
0
75 77 79 81 83 85 87 89 91 93 95 97
Year

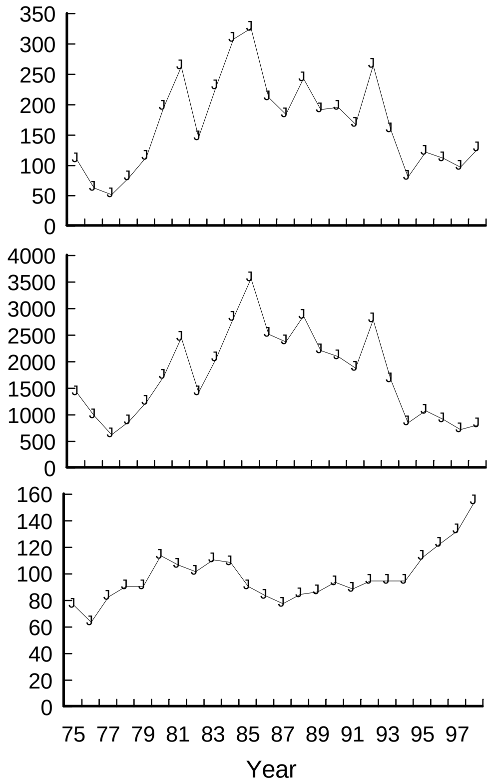


Appendix 2. Total abalone catch, effort and catch-rate (CPUE) by block and year. Greenlip catch is plotted (○) where it is an important part of the total catch.

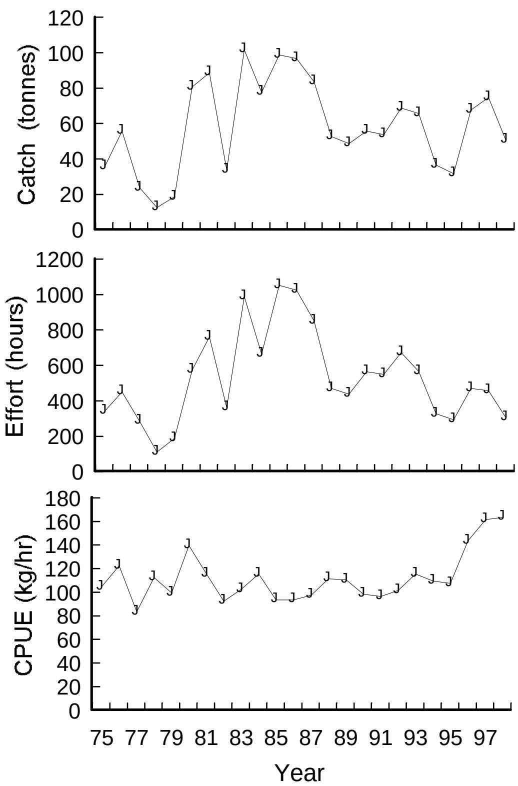
Block 5 (West Coast North)



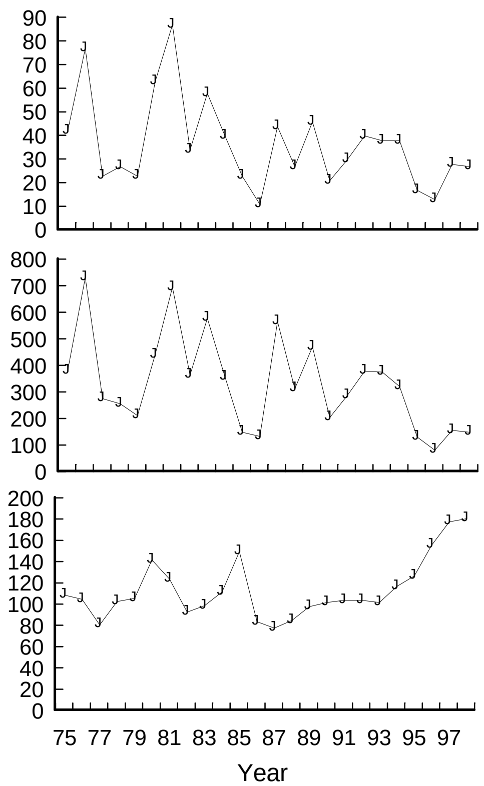
Block 6 (West Coast North)



Block 7 (West & South-west)



Block 8 (West & South-west)



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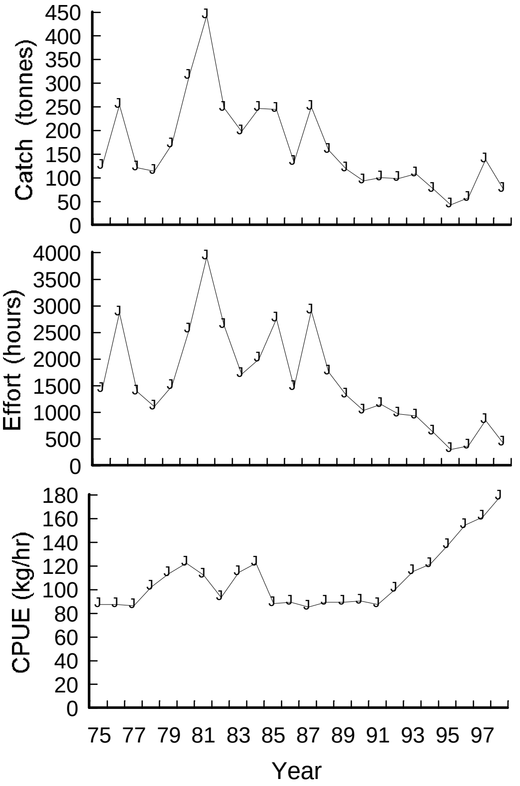

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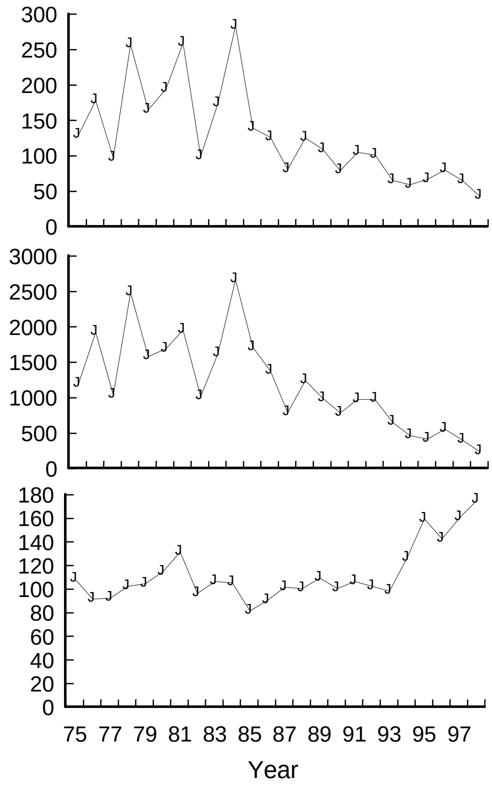

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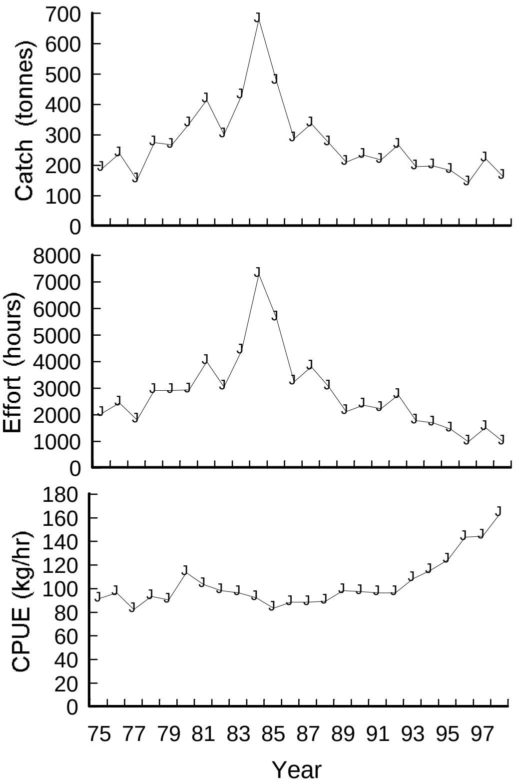

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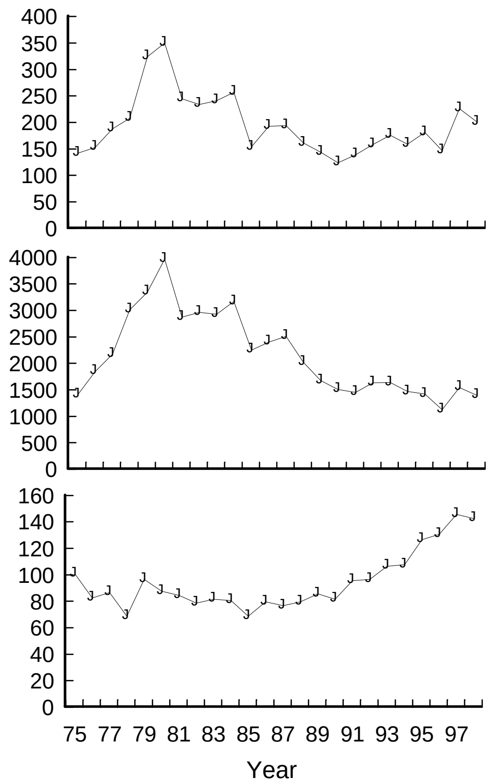

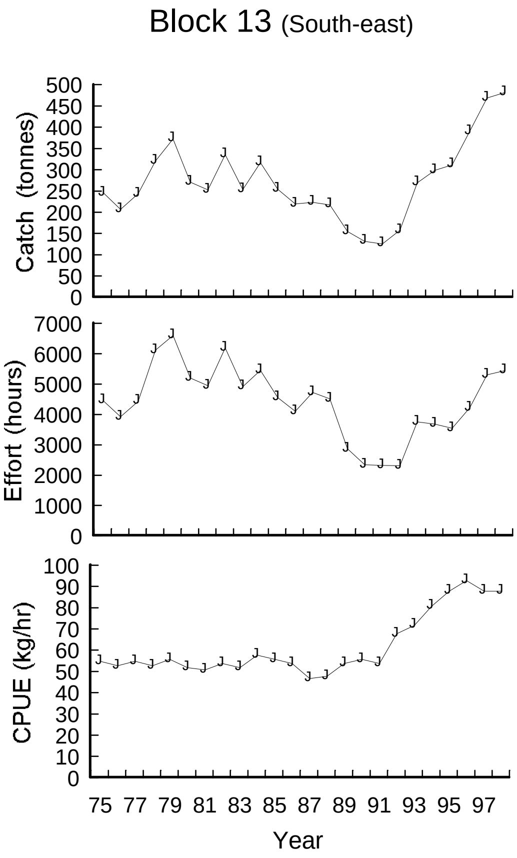
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Catch (tonnes)
Effort (hours)
CPUE (kg/hr)
Year
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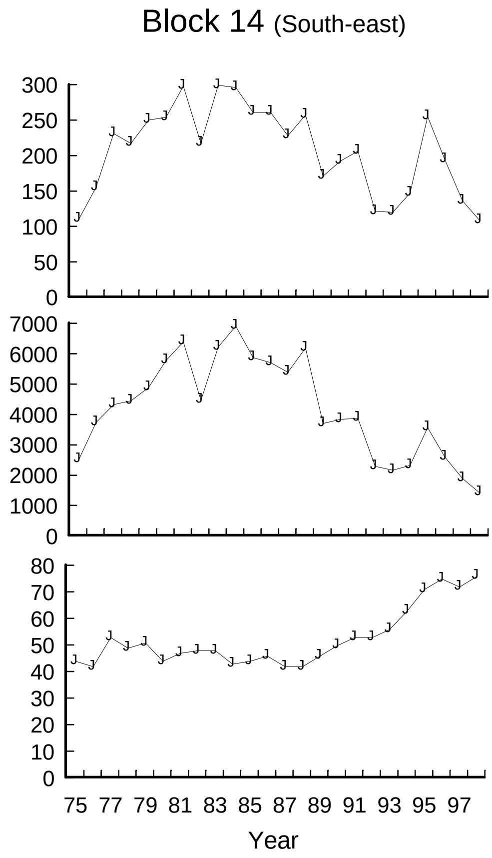
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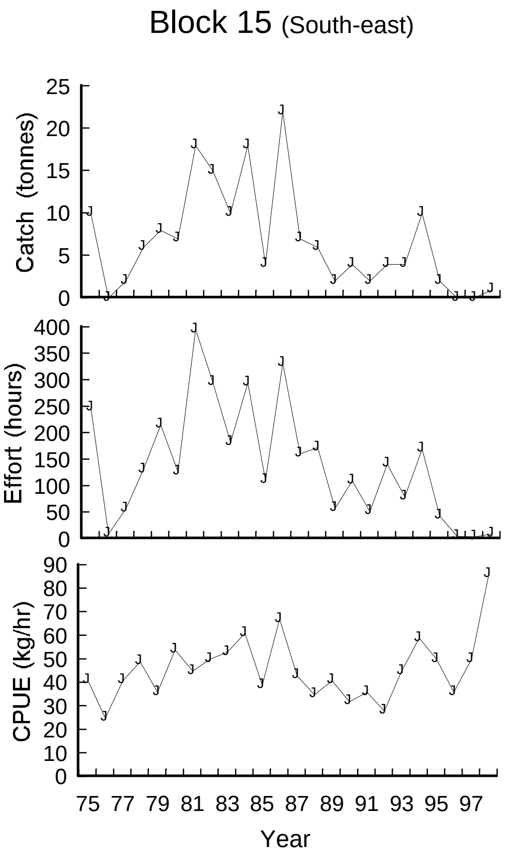
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Catch (tonnes)
Effort (hours)
CPUE (kg/hr)
Year
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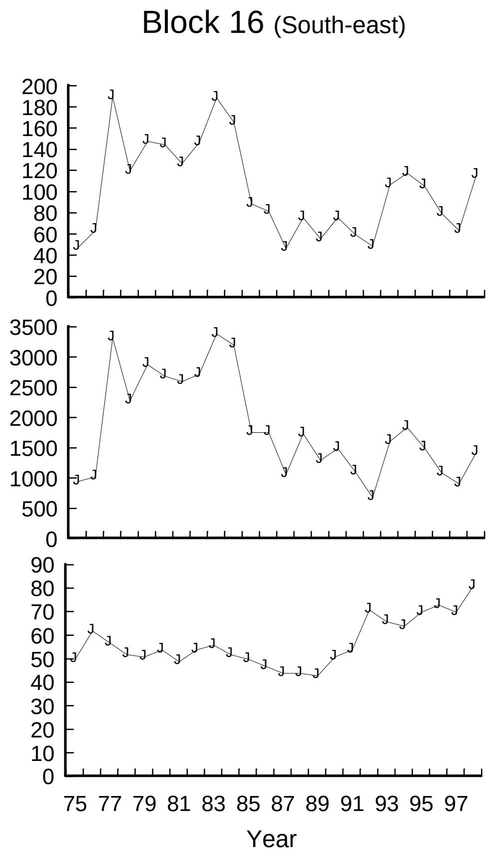
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Year
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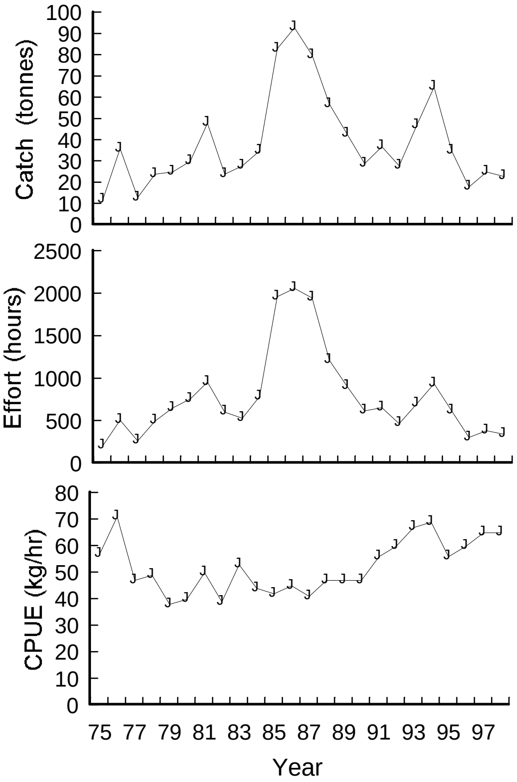

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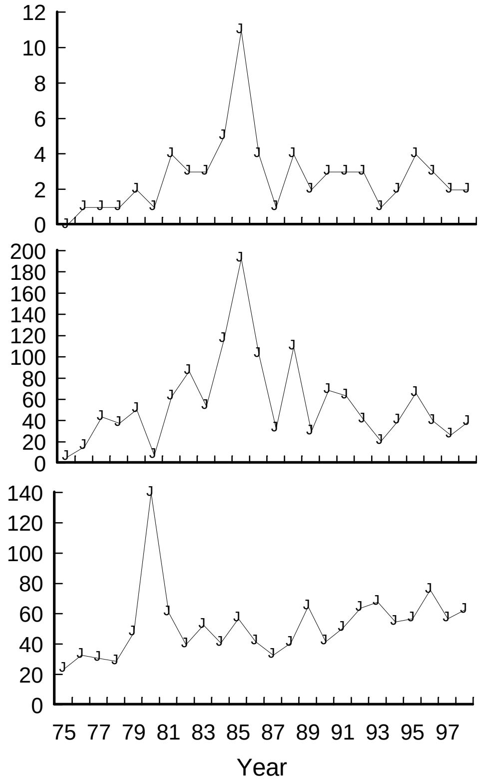

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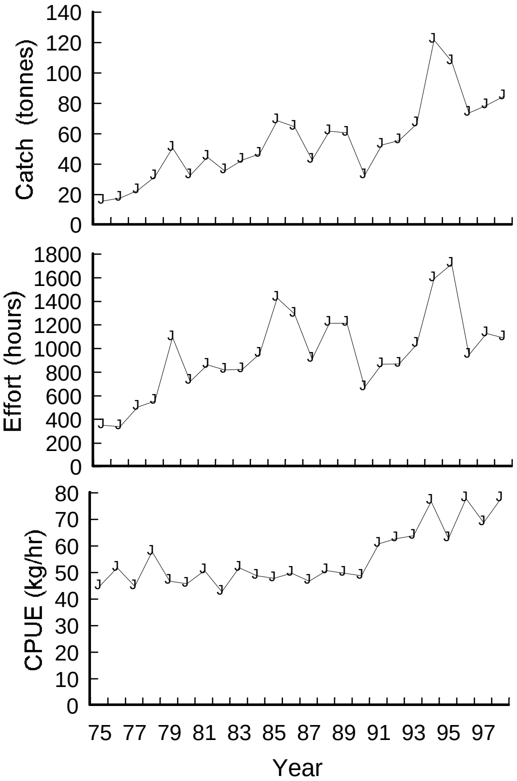

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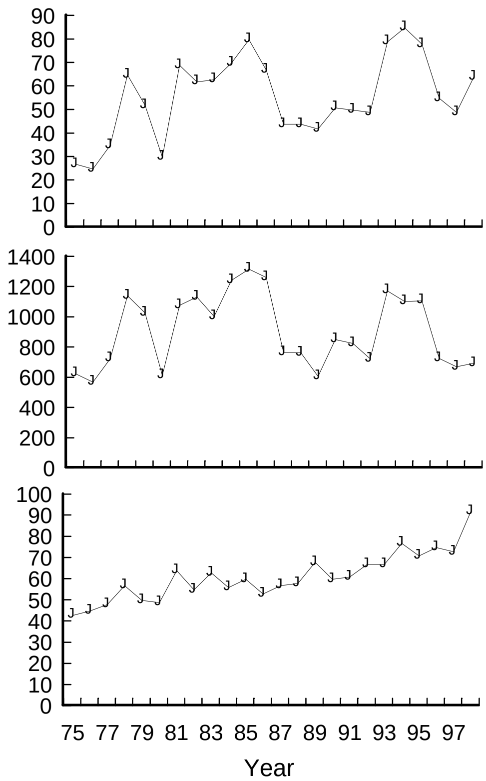

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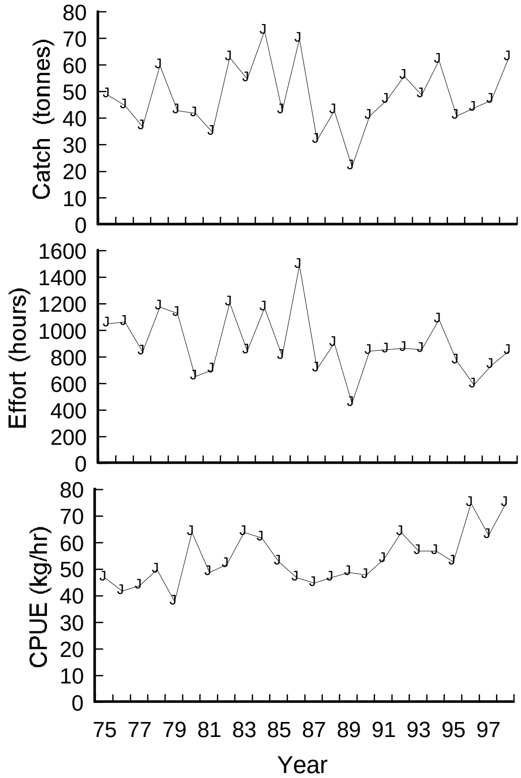

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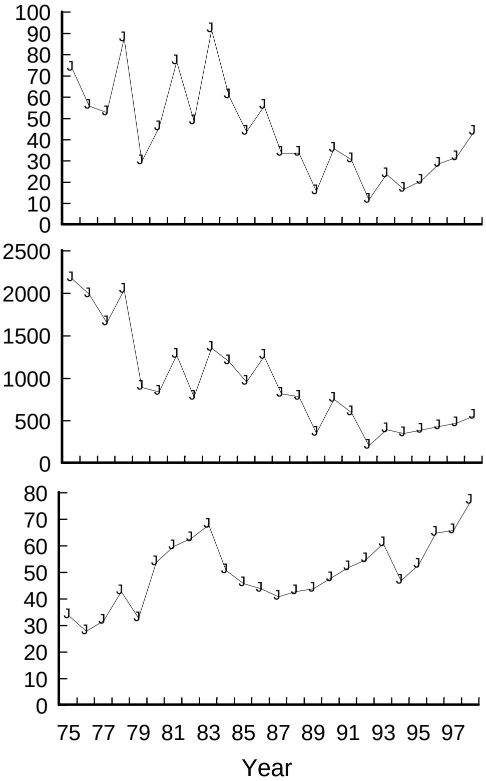

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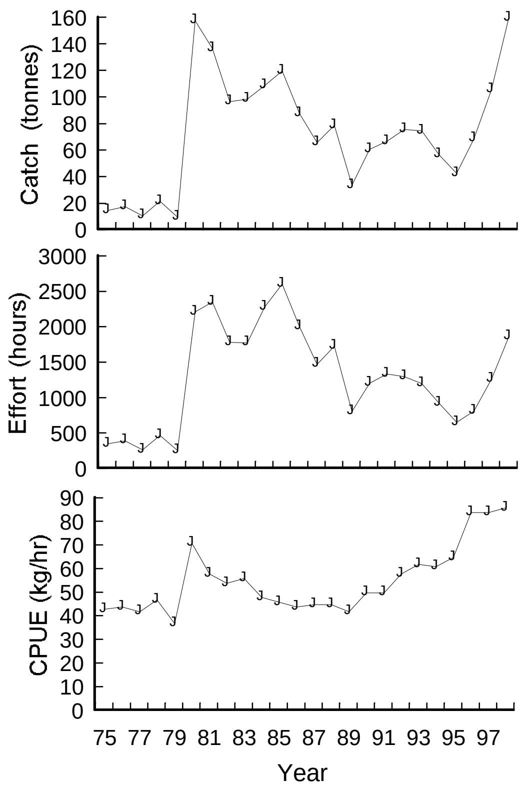

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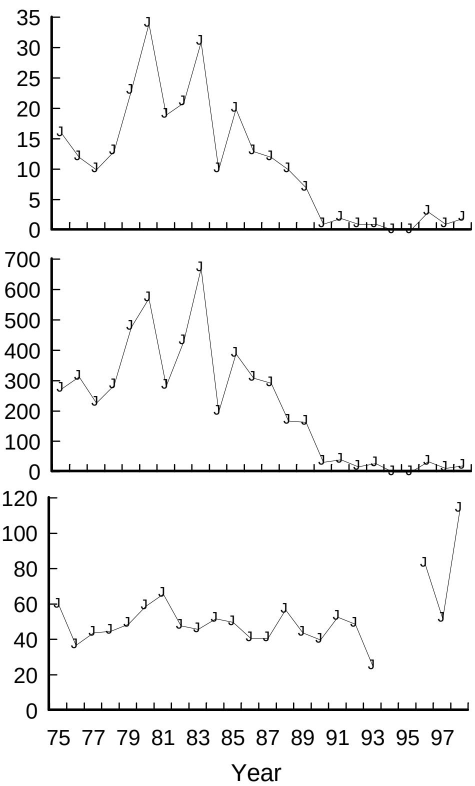

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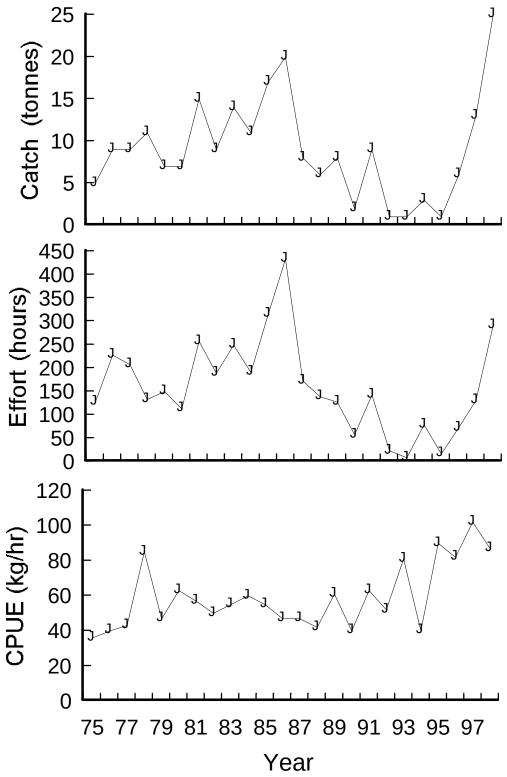

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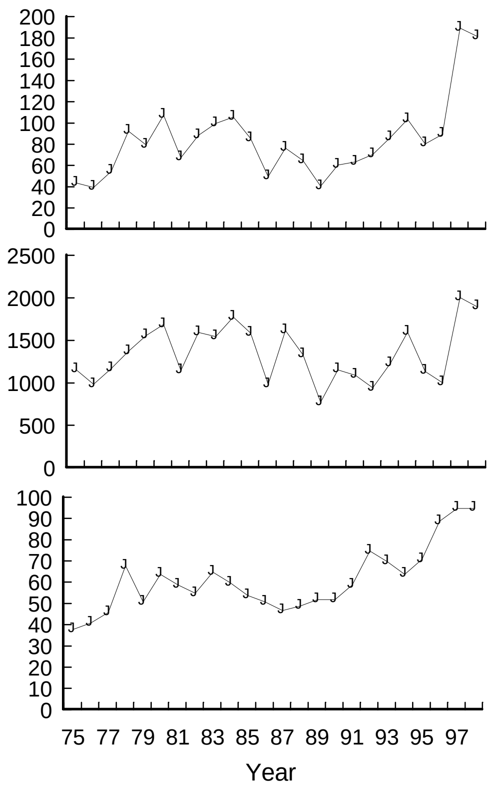

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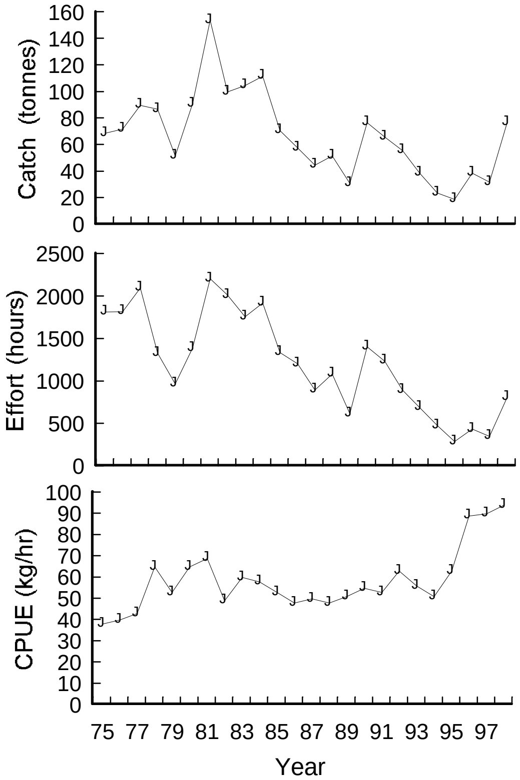

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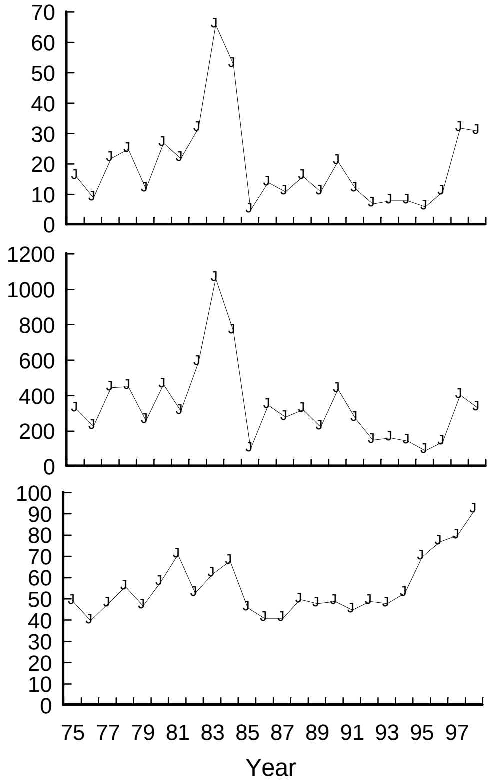

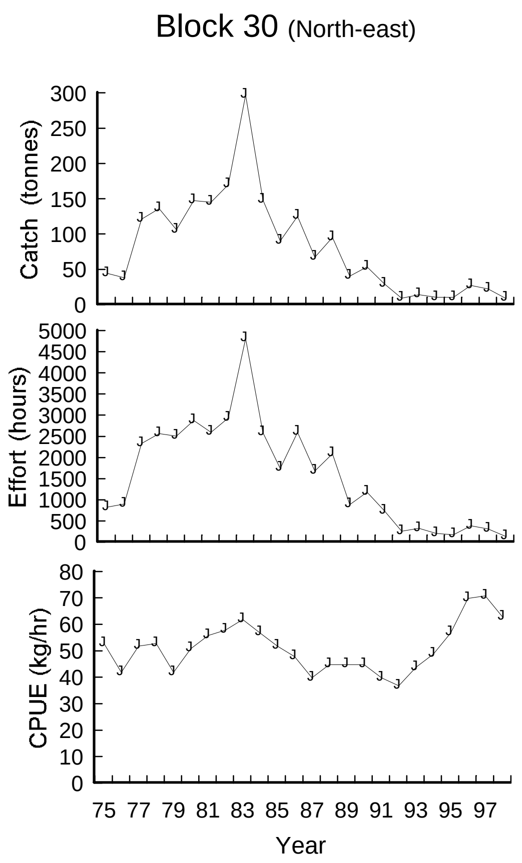
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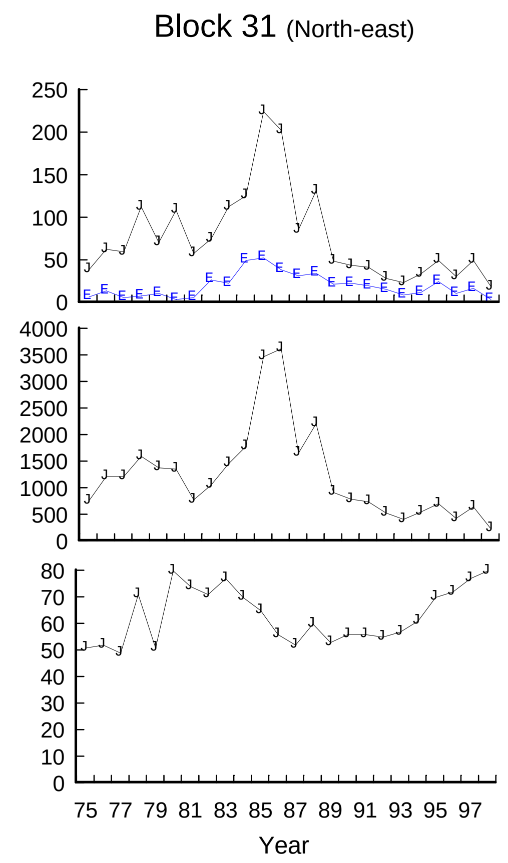
Catch (tonnes)
Effort (hours)
CPUE (kg/hr)
75 77 79 81 83 85 87 89 91 93 95 97
Year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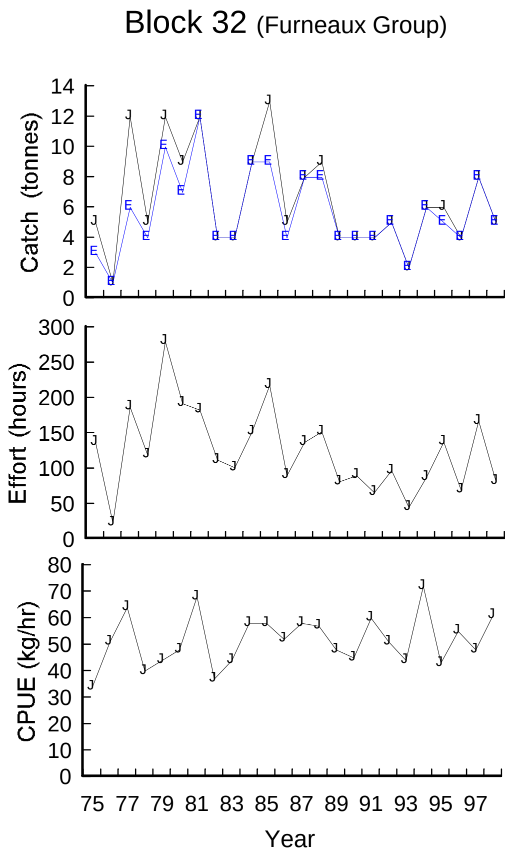
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Catch (tonnes)
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CPUE (kg/hr)
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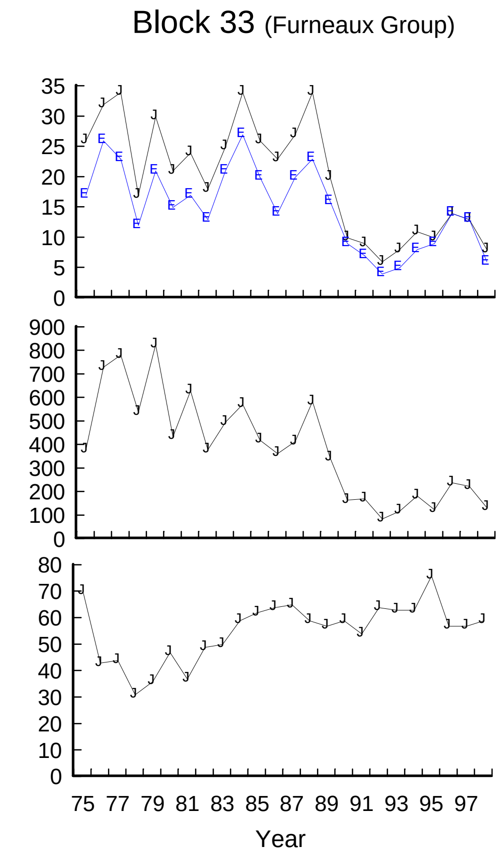
Year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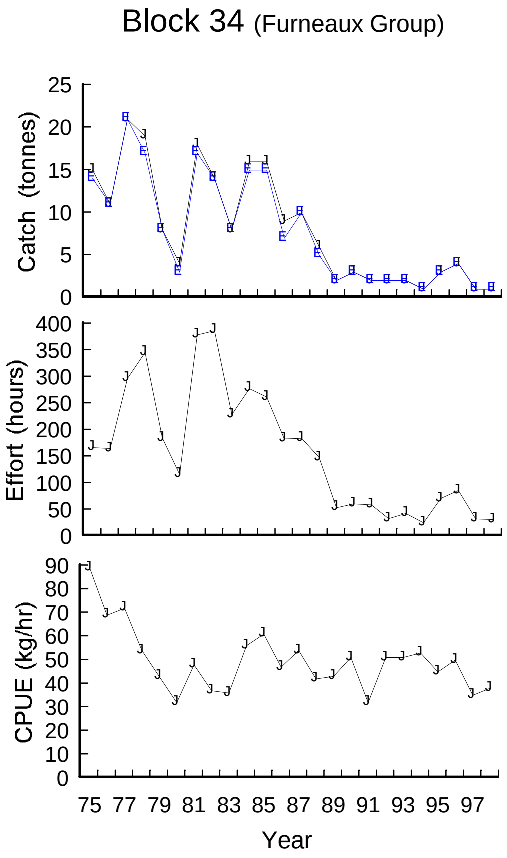
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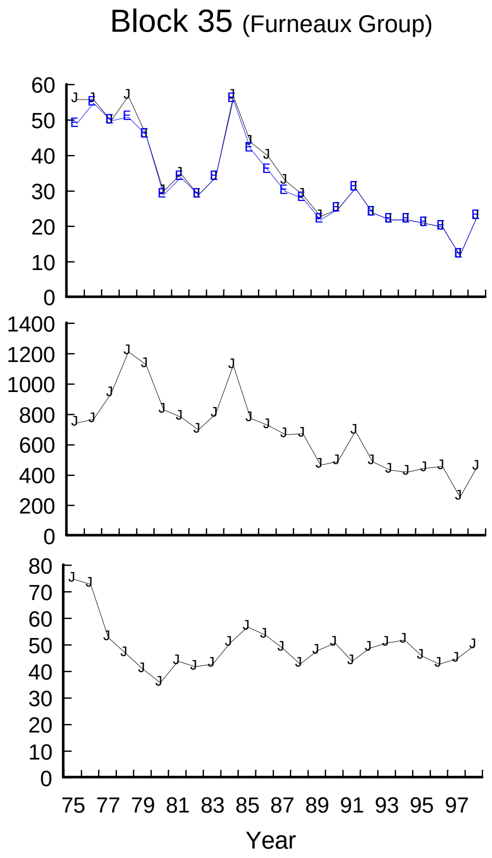
Year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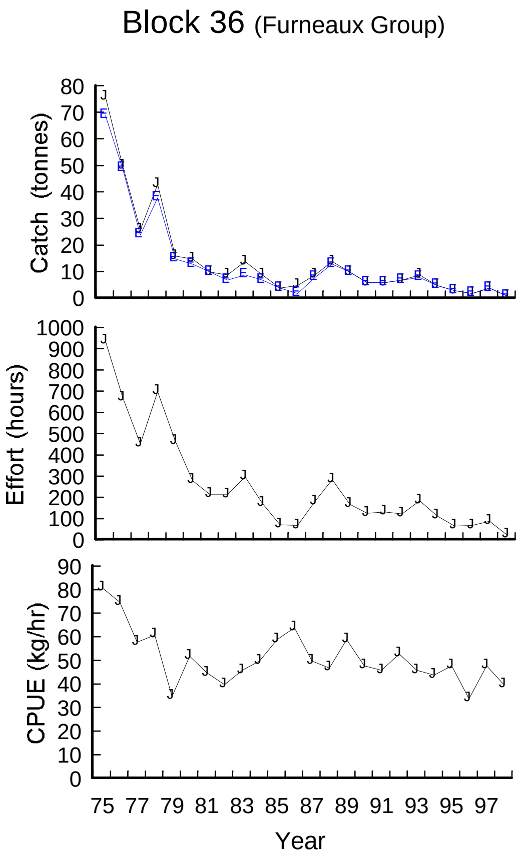
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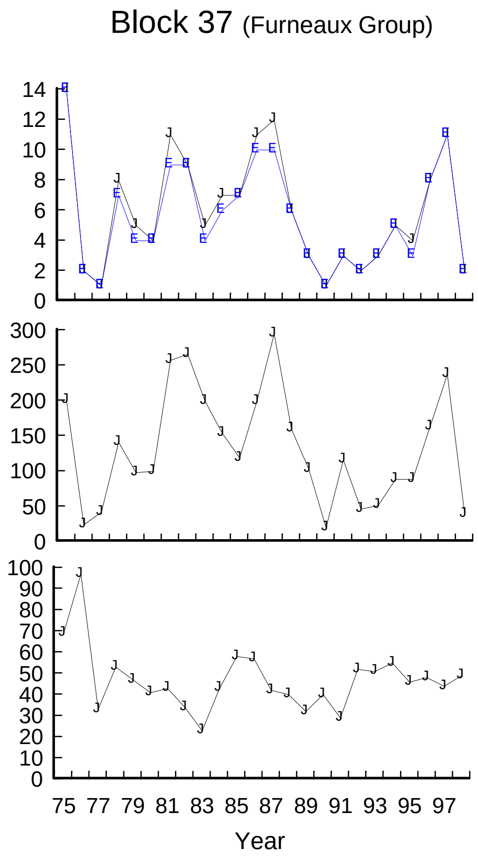
CPUE (kg/hr)
Year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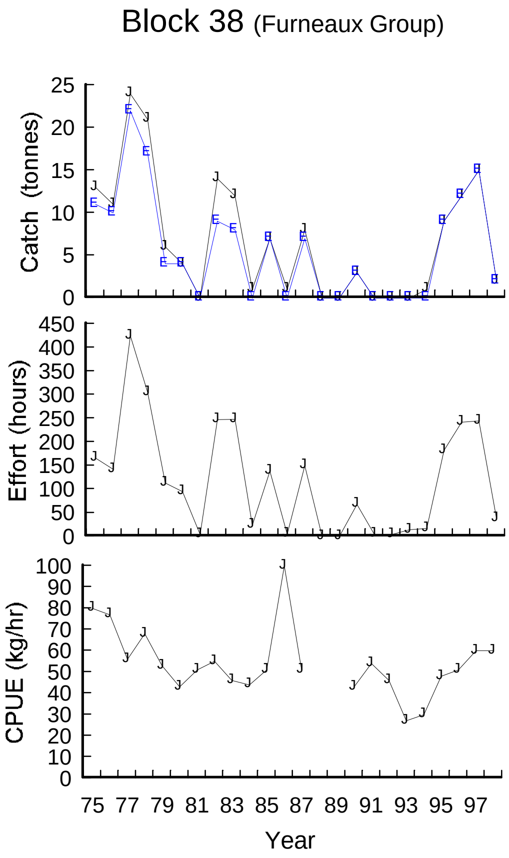
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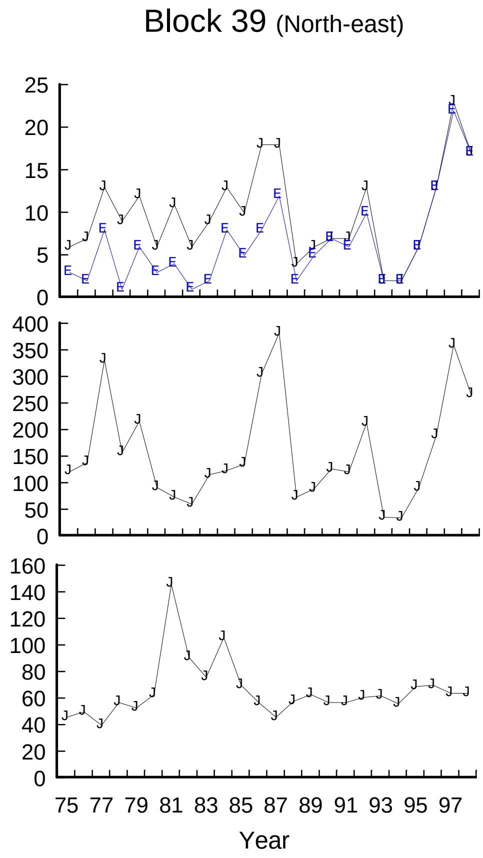
CPUE (kg/hr)
Year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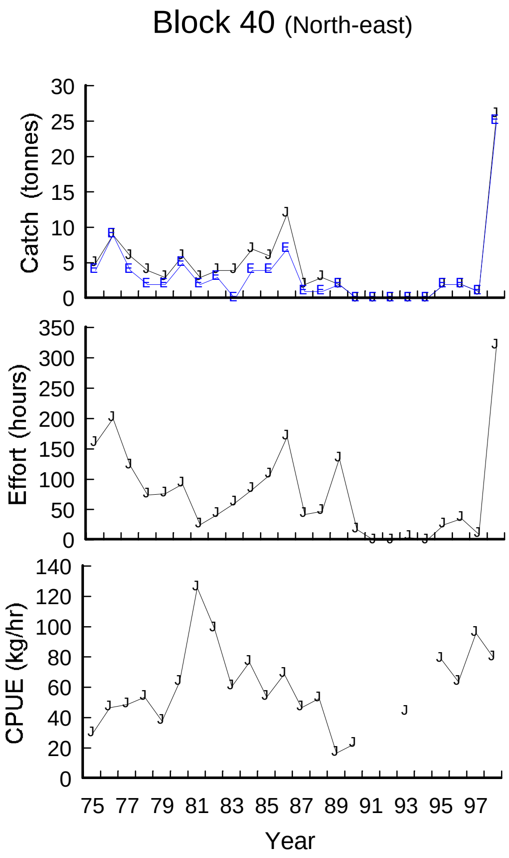
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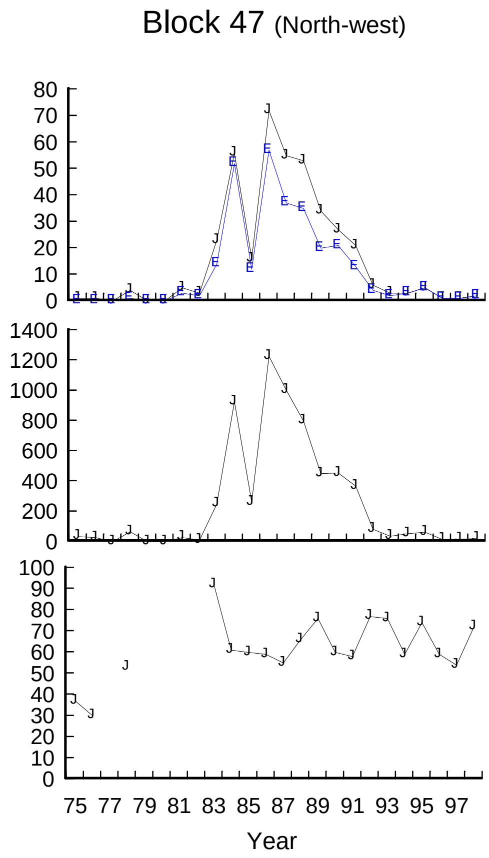
Effort (hours)
CPUE (kg/hr)
Year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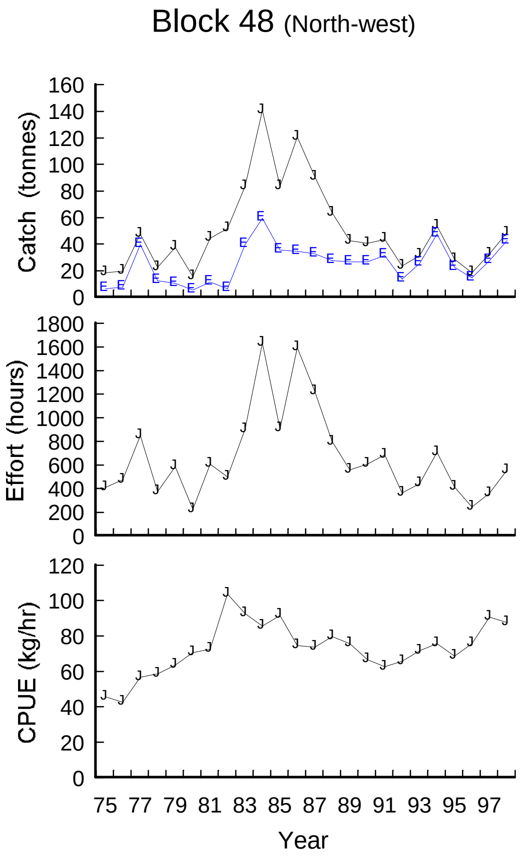
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Effort (hours)
CPUE (kg/hr)
Year
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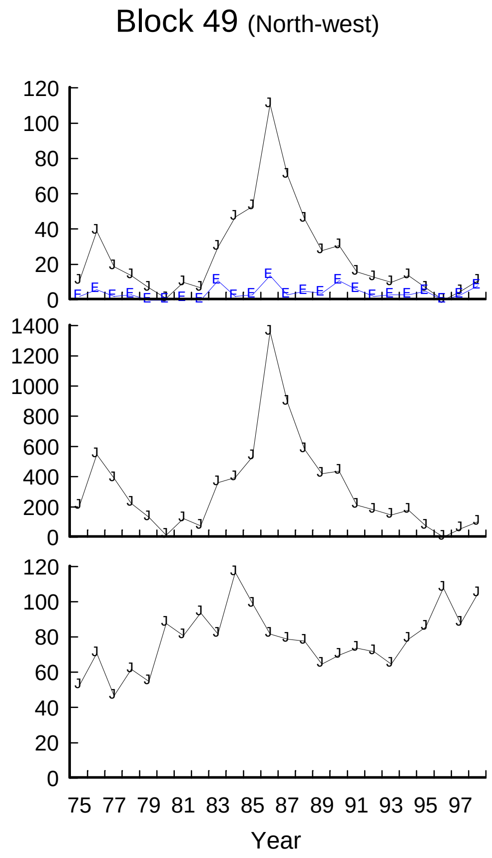
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Year
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Appendix 3. Record of discussions of the abalone stock assessment group on zoning the Tasmanian abalone fishery.

Meeting held at the Marine Research Laboratories, Tasmanian Aquaculture & Fisheries Institute, Taroona on Thursday 11 March, 1998

Attended by:

Dr Rick Officer	(Tasmanian Aquaculture & Fisheries Institute)
Mr Dean Lisson	(Tasmanian Abalone Council)
Mr Scott McKibben	(Tasmanian Abalone Council)
Mr Allen Hansen	(Tasmanian Abalone Council)
Mr Douglas Nicol	(Department of Primary Industries, Water and Environment)
Mr Warwick Nash	(Australian Maritime College)
Mr Greg Woodham	(Tasmanian Abalone Council) (Present as an observer)

The Abalone Stock Assessment Group met on Thursday 11 March, 1998 as part of its normal process of developing the annual Fishery Assessment Report for the Tasmanian Abalone Fishery. The Group was requested by the Senior Management Officer for Abalone (Mr Douglas Nicol) to consider the **Zoning of the Tasmanian Abalone Fishery** as an extraordinary item on the agenda at this meeting.

Particular issues for discussion included the:
- Boundaries of possible zones,
- Division of catch between zones, and,
- The impact of zoning on regional catch limits and overall total allowable catch (TAC).

The group agreed upon some objectives for the introduction of zones. These were to:
- Contain the state-wide catch of greenlip abalone,
- Reduce the catch from the East Coast and South-east, and,
- Redirect catch to the West Coast.

The group was also conscious of the need to facilitate a smooth transition to a zoned fishery. Therefore it sought to recommend:
- a relatively simple system of zones (to reduce the administrative burden on the industry and government), and,
- sensible catch limits within each zone (to minimise negative impacts on the market).

GREENLIP ABALONE:

The group agreed that there should be only one greenlip zone and that the TAC for this zone should be contained below 148 tonnes (the present limit). Division of this TAC by the 3500 quota units in the fishery produces a greenlip portion of each quota unit of about 42 kg/unit. The group agreed that the **Greenlip allocation** should be rounded to **140 tonnes** (40 kg/unit).

BLACKLIP ABALONE:

There was agreement that introducing too many blacklip zones initially would create such an administrative burden that it should be avoided. For this reason the group agreed that the blacklip fishery should be separated into just two zones (east and west) in the first year.

In its discussion of the appropriate boundaries between east and west zones the group recognised that the problems perceived on the East Coast and South-east of increasing catches were potentially exacerbated by the increased concentration of this catch into fewer fishing blocks. Whilst zoning could ameliorate this problem it was also recognised that zoning itself would not prevent catches from becoming increasingly focussed within zones. It was therefore agreed that any system of zoning would need to maintain the capacity for area closures if localised catches became excessive.

The suggested northern boundary between east and west blacklip blocks was that between statistical blocks 43 and 44 (near Port Sorell, see Figure 1). This boundary was chosen because it limits the amount of abalone allocated to the eastern zone and therefore the amount of catch that could be concentrated into smaller areas of the east coast. Furthermore the north coast provides a natural break in the distribution of abalone. The southern boundary agreed to by the group was Whale Head (the present boundary between east and west coast size limits).

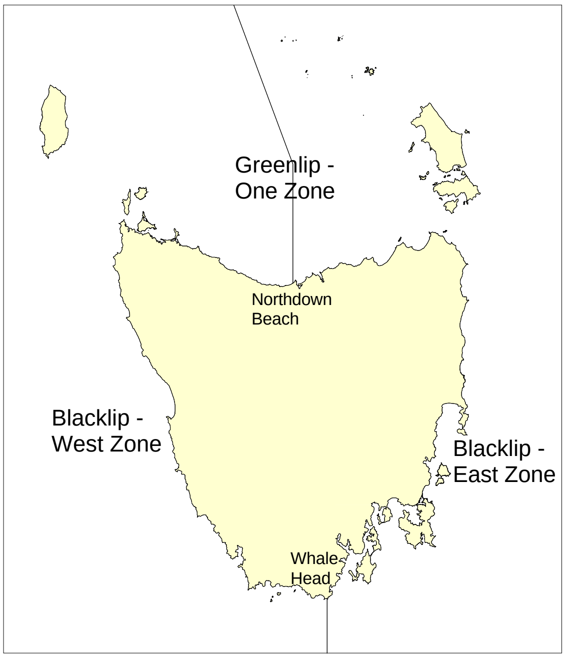

Figure 1. Suggested zones and zone boundaries for the introduction of Zoning to the Tasmanian Abalone Fishery.

The group agreed that northern zones for blacklip abalone in Bass Strait and the North Coast should be considered in the near future and possibly introduced in subsequent years. These areas have shown a marked reduction in catch since the 1987 state-wide increase in size limit from 127 mm to 132 mm. Suggested boundaries for the Northern zone included Arthur River in the north-west and St Helens or Eddystone Point in the north-east. There was agreement that a northern zone for blacklip abalone which included King Island and the Furneaux Group would avoid the extra administrative burden of creating a Bass Strait zone with a very small TAC. However, the group agreed that unless quota was allocated to the Bass Strait islands separately it is unlikely that they would be fished. The group agreed that appropriate size limits should be considered in any northern zone given that blacklip abalone in the north of the state generally have slower growth rates than abalone in other areas of the state. There was a recognition that any reduction in size limit in the north should be preceded by research and assessment work aimed at determining the most appropriate size limit for blacklip abalone in the area. The group agreed that resolution of these issues and the consequent development of northern zones had the potential to improve the value of the Tasmanian abalone catch because abalone present in the north of the State have a higher market value due to their smaller size.

The historical distribution of catches (Table 1) was considered in discussions of the most appropriate allocation of TAC to east and west blacklip zones. The group acknowledged that recent catches from the East coast and South-east are similar to those recorded in the four years prior to the introduction of quota and exceeded these levels in some areas. The principle adopted in proposing the TAC for the eastern zone was to reduce eastern catches to the level they were in the early 1990's following the progressive quota reductions and increase in size limit, but prior to the heavy concentration of effort onto the south-east and east coasts.

The average catch from 1993 to 1996 inclusive from the proposed eastern zone was 1122 tonnes (equivalent to 321 kg/unit). It was suggested that the **Eastern zone allocation** should be **1190 tonnes** in the first year (the equivalent of 340 kg/unit, 106% of the 1993-96 average). This slightly greater allocation was agreed upon because it allowed the transition to a zoned fishery to occur without dramatic effects on markets that rely upon abalone sourced in the eastern zone. Such an allocation would substantially reduce the current eastern catch to:

- 95% of the long-term average (1975-98),
- 84% of the 1997-98 average,
- 80% of the 1998 catch.

Members of the group suggested that the current high catch rates in the eastern zone and the fact that abalone are now fished at a higher size limit provided further support for the biological sustainability of such an allocation.

Table 1. Historical distribution of blacklip abalone catch between the proposed eastern and western zones.

		Average annual catch (T)		Equivalent kg/unit	
	Years	West	East	West	East
	1975-98	1271	1257	363	359
Prior to quota	1975-84	1478	1408	422	402
	1979-82	**1592**	**1514**	**455**	**433**
	1981-84	1913	1685	547	481
	1979	1255	1355	359	387
	1980	1732	1555	495	444
	1981	2032	1606	581	459
	1982	1348	1540	385	440
	1983	1844	1855	527	530
	1984	2428	1737	694	496
After quota	1985-98	1123	1149	321	328
	1993-96	**779**	**1122**	**223**	**321**
	1997-98	861	1416	246	405
	1990	970	900	277	257
	1991	1001	897	286	256
	1992	1139	778	325	222
	1993	923	1015	264	290
	1994	739	1163	211	332
	1995	746	1153	213	329
	1996	708	1157	202	331
	1997	949	1337	271	382
	1998	773	1496	221	427

Quota allocated to the western zone included the balance of quota available once greenlip (40 kg/unit) and eastern allocations (340 kg/unit) had been subtracted. From a 720 kg unit this leaves 340 kg/unit (1190 tonnes). The group agreed that more quota could be allocated to the western zone given that :

- west coast catch-rates are presently at an all-time high,
- the west coast is now fished at a higher size limit,
- size distribution data suggests an abundance of very large abalone on the west coast, and,
- 1190 tonnes is less than the historical (1975-98) average annual production from the area.

It was agreed that:

- West coast catches since the introduction of quota (1985) provide little indication of the potential productivity of the area, and,

- the period prior to the introduction of quota provides a better benchmark of west coast productivity.

During this period west coast catch-rates dropped to their lowest level but were still maintained in excess of 90 kg/hr. Abalone were also fished at the lower size limit of 127 mm. It was therefore agreed that a small increase in quota allocated entirely to the western zone should be biologically sustainable. Proposed western zone allocations were compared against the catches from the four years immediately prior to the introduction of quota (1981-84). Whilst this period represents the years of highest abalone catch, its utility as a measure of the sustainability is debatable. This is because the introduction of quota prevented catches being tested at such a high level over a prolonged period. For this reason proposed western zone allocations were also compared against the catches reported during a period of sustained production prior to quota introduction (1979-82). The suggested increase of about 60 kg/unit (210 tonnes) would create a **Western zone allocation** of 400kg/unit **(1400 tonnes)**. Such an allocation would adjust the west coast to:

- 73% of the catch in the four years immediately prior to quota introduction (1981-84),
- 88% of the catch during a period of sustained production prior to quota introduction (1979-82).

SUMMARY OF RECOMMENDATIONS:

Zone	TAC (tonnes)	Equivalent kg/quota unit
Greenlip - One zone	140	40
Blacklip - Eastern Zone	1190	340
Blacklip - Western Zone	1400	400
Total	**2730**	**780**

- 2730 tonnes represents an 8.3% increase in the state-wide total allowable catch from its current level of 2520 tonnes.

- Additional blacklip zone(s) in the north should be considered during the life of the next management plan.

A draft version of these notes was circulated for comment to all who attended the meeting. Comments were received from all attendees and are incorporated into this final version. Notes made by Rick Officer, March 24, 1999.