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**New Zealand scallop**

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This series documents the scientific basis for stock assessments and fisheries management advice in New Zealand. It addresses the issues of the day in the current legislative context and in the time frames required. The documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

## New Zealand scallop

### 1. INTRODUCTION

- 1.1 This document briefly reviews the current status of the NZ scallop fishery (Pecten novaezelandiae), research work that has been carried out and some alternative forms of management that should be considered. It was written for the purposes of the MAFFish Fish Stock Assessment meetings held in April 1988. A more detailed paper looking at proposals for future management of NZ scallop fisheries including integration of enhancement operations into management has been prepared separately (Clement & Bull 1988).

The developing fishery for the deep water Southern Queen scallop Chlamys delicatula has not been considered in either of these two papers.

- 1.2 Scallops have been fished commercially in NZ for 28 years. Currently fishing is concentrated in three major areas: Tasman Bay/Golden Bay/Marlborough Sounds = Southern Scallop Fishery; Bay of Plenty/Hauraki Gulf = Coromandel Fishery and Bream Bay/Whangaroa/Rangaunu Bay/Doubtless Bay/Spirits Bay = Northland Scallop Fishery. Limited fishing has also begun at the Chatham Islands.

Fishing is by dredge, either ring bag or box type and annual landings have recently totalled about 3,000-4,000 tonnes green weight with the three major areas contributing about 58%, 27% and 15% respectively. The fishery is currently worth about 6-8 million dollars per year to the fishermen.

The Southern and Coromandel fisheries have been managed as controlled fisheries since 1978 and since that time the boat numbers involved have stabilized at 48 and 22 respectively. A moratorium was placed on the issuing of new permits in the Northland fishery in 1981 and boat numbers there have now been reduced to 39. However, in this fishery permit transfers (on a one in one out basis) are allowed and there has recently been a marked trend of increasing fishing effort by individuals fishing longer hours over more of the season.

Other management measures are a size limit of 100 mm, limited season length (September-November for Southern mid-July - mid-December for Coromandel, mid-July - mid-February for Northland), daily quotas (currently 30 cases/boat for Southern, 840 kg/boat for Coromandel, 25 sacks/boat for Northland), daylight only and five day fishing week, some amateur only areas and in the last two seasons the Southern fishery has been managed with individual seasonal meat weight quotas.

These management measures are aimed at:

- (i) Protecting part of the spawning stock to ensure a reasonable chance of recruitment success (size limit, daily quotas in conjunction with limited season length and/or individual seasonal quotas).
- (ii) Giving some stability to the fishery by spreading harvest of particularly strong year classes over more than one year (again size limit and quotas).
- (iii) Maximizing yield per recruit (size limit and setting season to coincide with peak meat yields).
- (iv) Limiting indirect fishing mortality (closing the season in the Southern and Coromandel fisheries before the main spatfall period).

In recent years an attempt has been made to obtain annual estimates of relative stock abundance in the Southern and Coromandel fisheries and restrict take accordingly by seasonally adjusted individual quotas or daily quotas and limited season length. This approach is however, currently being reviewed because of concerns over cost effectiveness of annual surveys. A number of alternatives including moving to a rotational fishing system or a system where the annual closing date for the fishery is determined by the fleet reaching a predetermined trigger point of minimum catch rates are considered in detail in the paper by Bull and Clement (1988).

## 2. REVIEW OF THE FISHERY

### 2.1 Catch, landings and effort data

Annual yield figures for the three major fishing areas since their inception are shown in Table 1 along with some indication of the number of vessels participating. As can be seen, vessel numbers in these areas have been held at either a constant level or decreased over the last five years. In all three areas effort has been further limited by imposition of daily landing limits and in the Southern fishery in 1986 and 1987 by individual seasonal quotas.

In the Southern and Coromandel fisheries these limits have been reviewed (and if necessary changed) annually on the basis of predictions of stock availability from pre-season surveys. In these areas, effort that can be exerted on the fishery has therefore been strictly limited by management practice and analysis of catch/effort data cannot be expected to provide much indication of the state of the fish stocks. For example, in the Southern fishery the catch in 1984 was approximately  $1\frac{1}{2}$  times that achieved in 1983 but in both years most boats achieved their daily catch limits of respectively 29 and 30 cases per day, the major difference being that the 1984 season was three months rather than the two months allowed in 1983.

A decrease in production is predicted for 1988 in the Southern fishery based on recent survey information but an increase is expected in the Coromandel fishery. No information is available on the likely production from the Northern fishery.

Based on the relative stability of production from the three fisheries over the last five years (1,800-3,000 t for Southern, 700-1,400 t Coromandel 500-700 Northern) it must be assumed that current levels of exploitation are sustainable.

### 2.2 Potential for increased production

The major hope for increased production is from development of enhancement operations and/or changes in management that will allow for better utilization of resources currently available.

Estimated production from the Southern Scallop Fishery this year is in the order of 1,200-1,600 tonnes but an additional 600-700 tonnes of scallops should be available from patches seeded with spat as part of the

enhancement study in 1986. Such localised enhancement provides an opportunity to increase production without risk to parent stock levels.

### 2.3 Maori and recreational fishing patterns

We have very little data on use of the resource by these groups but clearly the exploitation demands by these groups is going to increase substantially with an increasing population with more leisure time. In the Southern scallop fishery most commercial scallop beds are in relatively deep murky water more than one nautical mile offshore whereas recreational fishing is concentrated in the near shore area around the Abel Tasman National Park coastline and the Marlborough Sounds. Exclusion of these prime amateur areas from commercial fishing would be unlikely to reduce commercial catches by more than 10% and may in fact aid stability of the fishery by providing a parent stock which is subject to different pressures to those in the commercial fishery.

Scallop beds in the Coromandel and Northland fisheries on the other hand, are generally close to shore in clear water at suitable diving depths and many of them are near tourist centres. Very significant portions of these fisheries could in future be claimed by recreational fishing interests.

### 3. RESEARCH

#### 3.1 Stock structure

Size frequency histograms show great variation in relative size of modal peaks between different beds and between different years on the same beds indicating the variability of success of recruitment from year to year.

Usually 0+ and 1+ age classes can be distinguished as separate modes in size frequency histograms but later age classes merge. It has not been possible to successfully apply the aging techniques used for other species overseas (i.e., counting annual or sub-annual rings on shells) and the only information on scallop age has been gained from the results of tagging studies or following through strong age classes. (Bull 1976, McKoy Pers. Comm).

Based on these latter considerations it is concluded that scallops in the Southern fishery generally reach the 100 mm legal size in 2½-3 years and few live longer than five or six years. A similar growth rate is indicated for Whitianga beds but scallops in the Hauraki Gulf appear to grow exceptionally fast reaching commercial size in 1½ years (Allen 1985).

#### 3.2 Resource surveys

A number of surveys aimed at establishing distribution and abundance of scallop stocks have been carried out over the years using both dredging and diving techniques. In the Southern fishery surveys were carried out by Choat (1960), Tunbridge 1961-66, Stead 1969-77 and Bull 1978-82. (See Doonan et. al. 1985).

For these surveys catch was recorded in terms of number (and usually size) of scallops and other invertebrates caught for a given length of tow. Limited exploratory dredging has been carried out in Fiordland (Stead 1973) and on the Wellington-Wanganui coastline (Bull unpublished). Dive surveys on an amateur bed at Whangaroa Harbour were carried out by Mason and Ritchie in the early 1980s. From 1977-87 dive and dredge surveys aimed at assessing population size and structure on the main Whitianga beds were carried out annually by Tauranga and Auckland based Fisheries Management Division staff (Walshe, Allen and Bartrom). These were used to give total population estimates in the survey area by either:

- (a) Giving an assessment of average scallop density from stratified random sampling using circular searches by divers, or;
- (b) Sampling using standard dredge tows arrayed over the scallop bed in a grid pattern. Dredge efficiency was estimated from trial dredging tows over an area where densities had been previously estimated from dive transect searches.

Since 1983 annual dredge surveys have been conducted in the Southern fishery to assess stock size and distribution in order to be able to make appropriate annual changes to season length and/or quota allocations. These surveys basically rely on repeating the same stations each year using as near as possible the same gear and thus obtaining an estimate of the relative abundance of different size classes from year to year. By comparing the catches taken by the commercial fleet in each sub-area of the fishery with the previous years survey results it is possible to use survey data as an index of relative abundance from year to year and make gross predictions as to likely yield in the following year. As can be seen from Figure 2 numbers of scallops of potentially takeable size per 100 minutes of towing on survey stations gives a reasonable estimate of the likely size of the catch from the area in comparison with previous years.

### 3.3 Other studies

#### 3.3.1 Tagging

Tagging studies to assess growth rate, fishing intensity and survival have been carried out in the Southern and Coromandel fisheries. Most tagging has been done using dredge or dive caught scallops of unknown age but recently tagging of seeded scallops of known origin has provided useful information on growth and survival. Most of the data remains unpublished but in summary indications are:

- (i) Hauraki Gulf - Rapid growth rates of 100 mm in 1½ years. (Allen 1985).
- (ii) Whitianga - Slower growth rates of around 3 years to legal size. (Walshe & Allen unpublished).
- (iii) Southern scallop fishery - Growth rates of 2½ years to legal size.

- Exploitation rate of 60% in a season recorded in one area.
- 49% recapture of a batch of seeded scallops tagged at 10 mths of age and heavily fished 2 years later indicating high survival rate.
- Trials currently being conducted on tagging small scallops down to 10 mm using Hallmark tags with superglue look encouraging.
- Previous trials of marking seeded scallops with tetracycline proved unsuccessful.

### 3.3.2 Mortality estimates

Estimates of annual mortality rates of adult scallops based on the relative abundance of recently dead shells with resilium in tact to live shells (i.e., clucker ratios) and a knowledge of the disintegration rate of the resilium have provided estimates of 23% and 39% for two areas in the Marlborough Sounds. (Bull 1976). Clucker ratios have been recorded for most survey tows in the Southern Scallop Fishery over the last six years and further trials on resilium disintegration rates have been carried out but the data obtained still requires analysis and writing up.

Survival estimates for seeded scallops based on regular surveying of a seeded area by diving suggests very heavy mortality in the first three months after seeding (>70%) and less than 30% mortality over the following two year period (Bull 1986).

### 3.3.3 Survival of undersized scallops discarded by commercial fishermen

Trials on the post release survival of dredge caught scallops have produced variable results. In the late 1970s experimental releases of scallops from dredge catches into seabed cages indicated very high levels of mortality were likely (> 80%). However, more recent trials using hanging cages indicate that in some cases mortality can be quite low (< 10%). Low post release mortality is also suggested by the high recapture rate of live tagged scallops from the enhancement project transplanting trials. Of three batches of scallops taken for transplanting by dredging and heavily fished

two years later tag returns of 32%, 41% and 17% were recorded (Bull 1986, Bull 1987).

#### 3.3.4 Reproductive biology/condition index

Information on the seasonality of gonadal development and spawning is available in theses of Bull (1976) and Nicholson (1978). Unpublished data obtained by McKoy 1983-86 and Bull 1978-87 is held on MAFFish files.

#### 3.3.5 Larval studies

Studies of the distribution and abundance of scallop larvae in the Southern fishery were carried out by Cranfield and Michael of Fisheries Research Division of MAF during the period 1983-1986 but results are as yet unpublished. Limited information on larval abundance in Golden Bay was also obtained as part of the scallop enhancement programme (Bull 1985, 1986 (2)).

#### 3.3.6 Spat settlement timing and location

Information on timing and location of spat settlement in the Southern area is available as a result of miscellaneous spat catching efforts by MAF and private operators during the period 1972-1983 and a regular sampling programme carried out by MAF during the period 1983-1988. (Bull 1985, 1986 (2)). These data confirm a very wide settlement period but with peak settlement occurring between mid-November and late January.

Test collectors set in the Hauraki Gulf in the 1986/87 and 1987/88 summers indicate a late December peak of settlement for that area (A Bartrom pers. comm.) and collectors set at Stewart Island from 1984 to 1987 also indicated a December peak although settlement was generally at a low level (S Marwick pers. comm.).

#### 3.3.7 Dredge efficiency

A number of trials have been carried out aimed at determining the efficiency of local scallop dredges. Results depend on dredge design and bottom type and a wide range of estimates have been made e.g., 15-47% (Tunbridge 1968) and 27%-50% (Bull unpublished data).

### 3.4 Biomass estimates

Scallops which are short lived and highly fecund exhibit great natural fluctuation in stock recruitment and subsequently in biomass. Because of this and the reliance of the fishery on only those beds which reach

fishable density biomass estimates are of little relevance to management of the fishery.

### 3.5 Yield estimates

- (i) Estimation of MCY. With the large natural fluctuation in recruitment apparent in the Southern scallop fishery MCY must be set near zero.
- (ii) Estimation of CAY. Again because of fluctuation in recruitment CAY can only be assessed by pre-season surveys which apart from part of the Southern Scallop Fishery have not been done this year.

## 4. MANAGEMENT CONSIDERATIONS

### 4.1 Current Management

Current management is based on the assumption that successful recruitment relies on:

- (i) A certain minimum level of parent stocks.
- (ii) Adequate environmental conditions (food, temperature, currents).
- (iii) Adequate settlement material for larvae.
- (iv) Adequate survival of juveniles.

These requirements respectively are catered for by:

- (i) The size limit and limits on catch and fishing effort (quotas, season length and boat numbers).
- (ii) Uncontrollable.
- (iii) Enhancement operations and prohibition on dredging horse mussels.
- (iv) No dredging after December.

There are however a number of problems with this management approach including the following:

- (a) High harvesting costs due to the need for sorting undersized but marketable scallops from the catch.

- (b) Harvesting inefficiencies caused by daily quota requirements and limitations on gear design.
- (c) Higher than necessary indirect fishing mortality caused by repeated handling of undersized scallops and repeated dredging of the same areas of seabed.
- (d) Reliance on costly annual surveys of limited precision to set seasonal quotas when we have little information as to what is a safe minimum parent stock size.
- (e) The lack of protection afforded by catch quotas to the survival of any high density beds which are probably important for spawning success.
- (f) The exclusion from exploitation of certain populations which produce marketable scallops but where because of low growth rates few reach legal size.

#### 4.2 Rotational fishing - an alternative approach to management

Rotational fishing of grounds on a three or four year cycle without a size limit would avoid many of the above problems with current management. Temporary closure of at least two thirds of the fishery in any one year would ensure adequate parent stock is available within the fishery without the need for other artificial controls and allow for maximization of harvesting efficiency. Enforcement of area restrictions may however be a problem.

The major concern about switching to such a system however, would be the ability of larvae to disperse from parent stock in currently closed areas to adjacent depleted areas. Enhancement operations as currently being established in the Southern fishery could be used to augment this natural dispersal but may not be feasible in some areas.

#### 4.3 Implications for future yield

- 4.3.1 Under the current management system total annual yield for all sectors can be expected to continue at about the present level although some further restriction on the Northland fishery may be necessary.
- 4.3.2 Increasing demands from recreational and Maori fishing interests are likely to result

in a decrease in yield from the commercial sector (especially in the North Island).

- 4.3.3 Significant increases in yield may be possible with a switch to rotational fishing in conjunction with local enhancement by reseedling. However, this management option entails certain risks and it is suggested that trials to this end be commenced in the Southern fishery with the other fisheries only being included as experience dictates.

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TABLE 1 : ANNUAL YIELD FROM NZ SCALLOP FISHERIES 1959-1987  
 Southern Scallop fishery July - June years  
 Coromandel and Northland fisheries calendar years

Year	Southern = Nelson/Marlborough		Coromandel		Northland	
	Catch t green wt	Boat Nos. (with landing)	Catch t green wt	Boat Nos.	Catch t green wt	Boat Nos.
1959	15	1				
1960	114	6				
1961	104	4				
1962	288	6				
1963	952	17				
1964	764	22				
1965	334	18				
1966	246	21				
1967	106	26				
1968	65	14				
1969	627	25				
1970	640	34				
1971	1,724	49				
1972	1,892	67				
1973	2,566	83				
1974	4,848	96	4	2	40	
1975	9,969	190	122		75	
1976	4,378	245	80		133	
1977	4,597	189	747		133	
1978	1,338	121	1,364	130?	113	
1979	836	98	858	33	150	
1980	331	61	1,016		220	
1981	0	0	1,081	0	540	
1982	0	0	1,070		721	70
1983	1,801	48	1,380	23	693	
1984	2,938	48	1,190	23	494	41
1985	1,958	48	710	23	691	-
1986	2,844	48	700	23	472	
1987	1,752	48	1,098	22	503	39

Source Southern Fishery (1959-1980 King and McKoy 1984  
 (1983-1985 FSU data  
 (1986+1987 QMR reports x 8

Coromandel (1974-82 King 1985  
 and Northland (1983-86 MAF Regional records  
 (1987 FSU Provisional data

Figure 1: Combined size frequency histograms for the same groups of stations taken in consecutive annual surveys. Note variation in year class strength from year to year.

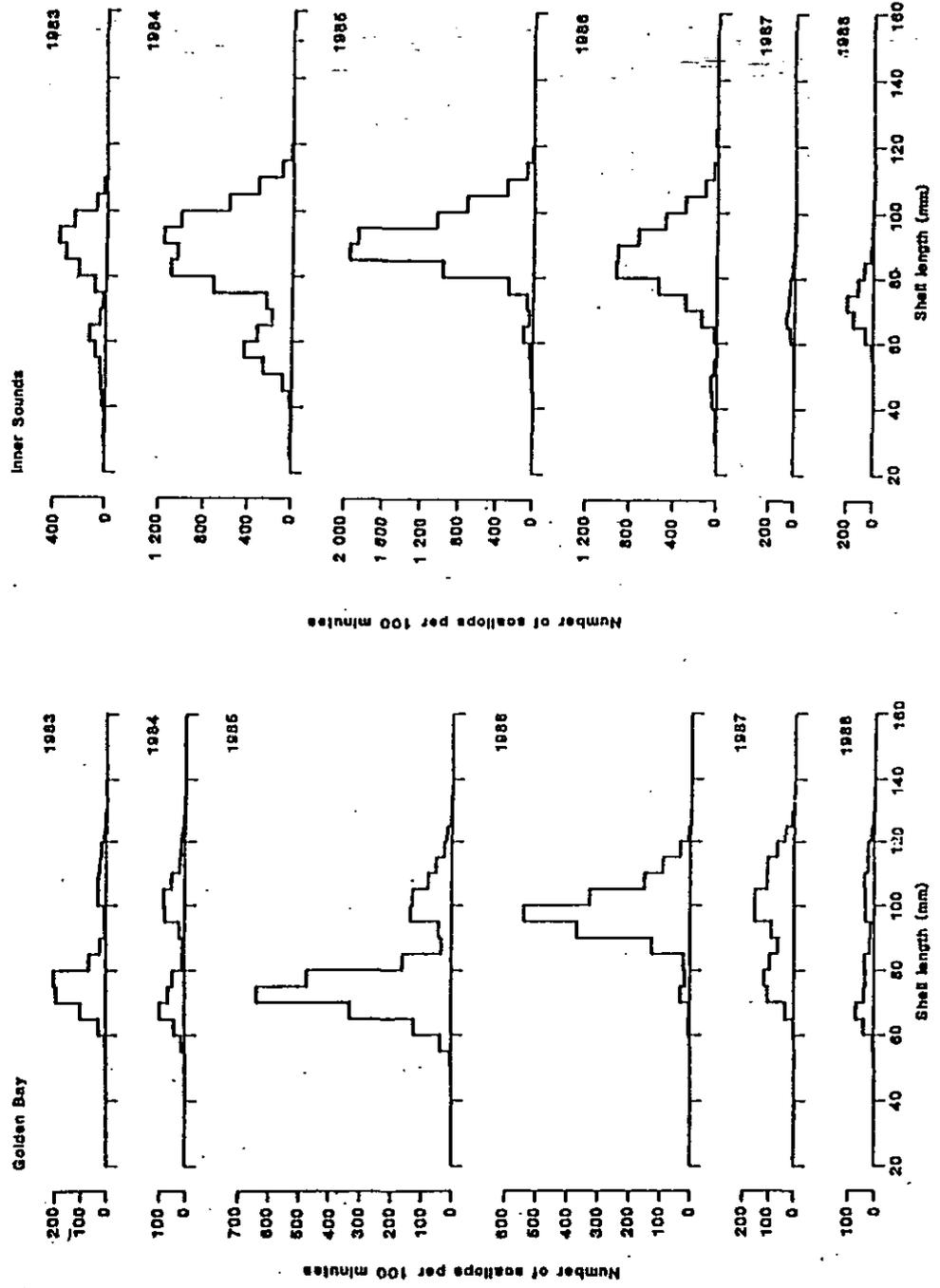
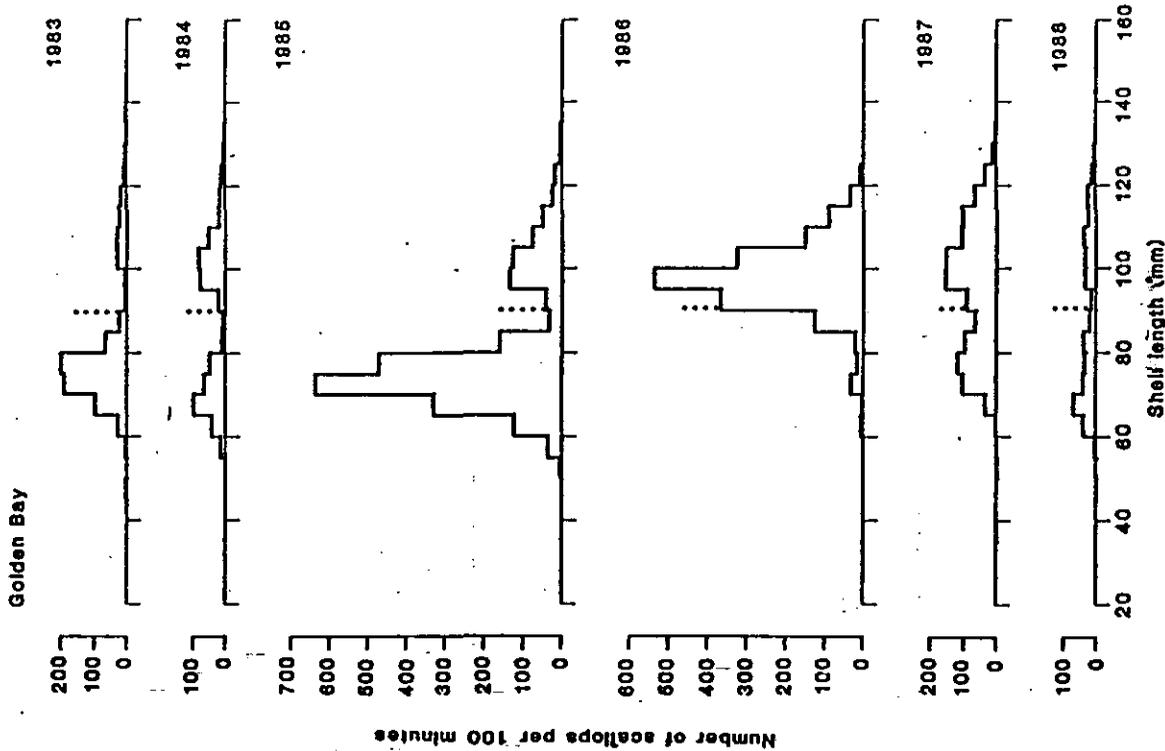


Figure 2: Comparison of the relative abundance of potentially takeable stock indicated by pre-season survey data and the actual yields obtained during subsequent seasons.



Year	Abundance of >90mm scallops relative to 1986 level	Actual yield in tonnes
1983	5%	2
1984	15%	398
1985	30%	395
1986	100%	2,290
1987	40%	690
1988	10%	?