*New Zealand Fisheries Assessment Research Document 90/7*

# Rock lobster stock assessment, 1990

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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.

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## 1. INTRODUCTION

### 1.1 Overview

This document updates the information given in previous stock assessment reviews (Breen 1988; Breen 1989), reviews recent trends in the reported landings for the two commercial rock lobsters *Jasus edwardsii* and *J. verreauxi,* estimates maximum constant yield (MCY) for two stocks, and considers the management implications for all stocks of the new Total Allowable Commercial Catches (TACCs).

It is assumed here that red rock lobsters (*J. edwardsii*) in the North & South Islands combined, including Stewart Island, form one stock (NSI) while those on the Chatham Islands form a separate stock (CHI); and that *J. verreauxi* form a single stock (PHC).

For the NSI stock, the present state of the fishery is reviewed. Recruitment now appears unpredictable, and lower than that seen in previous years; catch constraints are recommended.

For the CHI and PHC stocks, MCY is estimated directly from reported catches. For both of these stocks, changes to the historical landings data have resulted in changes to the MCY estimate.

### 1.2 Description of the fishery

The fishery was comprehensively described by Annala (1983); specific fishery statistics are provided in Breen (1988; 1989) and updated here. The remainder of this document deals with *Jasus edwardsii*, the most important of the two commercial species, unless otherwise indicated.

The rock lobster fishery continued as a limited–entry fishery during 1989, with ten 'Controlled Fishery Areas' (CFAs). There was one regulatory change in 1989. This involved the minimum legal size (MLS) for females in the Southern CFA. For the commercial fishery throughout New Zealand except for the Otago CFA, the MLS was changed in June 1988 to 58 mm tail width for female lobsters and 54 mm tail width for males. These are the New Zealand–wide equivalents of the previous MLS of 152 mm tail length. Because of geographic differences in morphometry, the female tail width equivalent to this tail length for the southern part of the country is less than 58mm (Breen et al. 1988). For the Southern CFA, the MLS for females was changed back to 152 mm tail length on 1 January 1989 (males stayed at 54 mm tail width). The female size was changed to 56 mm tail width on 1 May 1989, then to 57 mm tail width on 1 May 1990; it is scheduled to change to 58 mm tail width on 1 May 1991.

During 1989 in Otago, tail length of 127 mm continued to be used for MLS in the 'concession season', but 54 and 58 mm tail widths applied at other times. Tail length of 216 mm continued to be used for packhorse lobster throughout the country. Amateurs continued to use tail lengths of 152 mm for red rock lobster and 216 mm for packhorse lobster for MLS. Other management measures continued as before.

Two important management changes took place early in 1990. First, the MLS for amateurs changed on 1 April 1990 from 152 mm tail length to 54 mm tail width for males and 58 mm tail width for females. This brought the amateur fishery under the same regulation of MLS as the commercial fishery (Anon. 1990).

Second, empowered by the Maori Fisheries Act 1989 and the Fisheries Amendment Act 1990, the limited–entry fishery for rock lobsters was replaced on 1 April 1990 by individual quota fisheries. Each Quota Management Area (QMA) has a separate TACC. Unlike the individual transferable quota (ITQ) in other quota fisheries in New Zealand, the quota for rock lobster is valid for only 25 years, and is called transferable term quota (TTQ).

The red rock lobster fishery NSI stock has been subdivided into 8 QMAs, with the sum of the TACCs being 3200 t: QMAs 1–5,7 & 8 conform with previously existing CFAs; QMA 9 comprises the combined Westland and Taranaki CFAs. The TACCs set within the Act for each QMA are shown in Table 1. QMA 6 is the CHI stock, with a TACC of 503 t, the MCY estimate of the Working Group (see below). QMA 10 comprises the Kermadec Islands, which has been allocated a TACC of 0.1 t. The TACC for the PHC stock is 27 tonnes.

### 1.3 Literature review

Only those publications relevant to the rock lobster fishery appearing after those documented in the previous assessment document (Breen 1989) are cited here. An annotated list of references dealing with *Jasus edwardsii*, additional to those listed by Breen & McKoy (1988), is available from the Publications Clerk, MAF Fisheries Greta Point.

Booth (1989a) describes the history of biological research on rock lobsters in New Zealand and provides an indexed (by subject and area) bibliography.

The occurrence of pueruli at the New Plymouth Power Station is described by Booth (1989b). Breen & Booth (1989) describe the correlation between puerulus abundance and later juvenile abundance at Stewart Island, and explore whether early survival and growth are density–dependent.

MacDiarmid (1989) describes the size at onset of maturity of *Jasus edwardsii* in the Cape Rodney–Okakiri Point Marine Reserve near Leigh, and also describes the importance of body size in males during the mating season.

Horn (1989) describes results of experimental potting with traps having the regulation escape gaps, traps with no escape gaps, and traps made entirely from 54 mm steel mesh.

Booth (1989c) and Provenzano (1989) describe the potential for rock lobster culture in New Zealand and discuss possible problems.

Webber & Booth (1988) describe a deepwater rock lobster, *Projasus parkeri*, newly discovered in New Zealand. The species is unlikely to be of any economic importance.

## 2. REVIEW OF THE FISHERY

### 2.1 Catch, landings, and effort data

Table 2 gives the reported landings by month and CFA for the calendar years 1988 and 1989, taken from the Quota Management Reports (QMRs). For unknown reasons, these data and the data reported in Table 3 of Breen (1989) include packhorse rock lobsters. It should be noted that the reported landings for the NSI stock for the calendar years 1988 and 1989 were therefore something less than 3128 and 3247 t respectively. (Discussions with industry indicate that the 1988 and 1989 landings for packhorse rock lobster were close to but no more than 15 and 10 t, respectively.)

Table 3 gives the reported landings by month for the calendar years 1988 and 1989, taken from the Licensed Fish Receiver Reports (LFRRs). Apparently these do not include packhorse rock lobsters.

Table 4 gives reported landings from the QMR and LFRR systems and the export statistics as supplied by the New Zealand Fishing Industry Board, for calendar years 1987 through 1989 and, where possible, for the fishing years 1986–87 through 1988–89.

NSI *Jasus edwardsii* catches in 1989 did not increase significantly from the low value of 1988. It is thought that the effects of the introduction of tail width MLS measure for red rock lobsters had been largely overcome, and that the continued low landings were probably the result of decreased recruitment resulting from other causes. The combined catch of both species of rock lobster from all New Zealand (except the Chatham Islands) in 1988 and 1989 (3128 and 3247 t, respectively) were much lower than NSI red rock lobster landings of the previous 9 years (4050 – 4911 t), and the lowest seen since the mid–1970s.

Effort data since 1988 are incomplete or unavailable: their absence restricts analyses for all stocks.

An audit of the rock lobster data 1979 – mid–1988 was completed in 1990. Fishers were given the opportunity to correct the catch and effort data they had supplied to MAF. Although final results from the audit are unavailable, provisional audit data have been used below in the MCY estimates for CHI and PHC; no new effort data are available for any stock.

Final audit figures are not expected to allow further useful analyses of the NSI stock because the changes to catches were not great, and area information and effort data were not collected properly.

For the *Jasus edwardsii* CHI stock, two new sources of information were considered in stock assessment. First, preliminary results from the rock lobster audit resulted in changes to the estimated total catch from 1979–87. The proportional increases in reported landings discovered by the audit were assumed to be applicable to the whole

Fisheries Statistics Unit (FSU) database for each year, and the landings were re-estimated accordingly (Table 5). This increased the FSU annual landings between 6 and 15%. Second, the processors on the Chatham Islands submitted their estimates of processed catches, 1981–1987. Data from 2 of the major processors were accepted on the advice of the audit team, who will be obtaining verification. There were major differences (both positive and negative) between the revised FSU data and the processor data for 1985, 1986 and 1987. Table 5 shows a vector of annual catches based on the highest of the FSU and processor data for each year. Landings of red rock lobster from CHI in 1988 and 1989 (434 and 368 t, Table 2) have been within the range seen in the uncorrected FSU data for the previous 9 years (343 – 574 t).

For the *Jasus verreauxi* stock (PHC), Table 6 shows the best available reported landings, obtained from the FSU and audited FSU databases. The low landings in 1988 and 1989 (estimated to be close to but less than 15 and 10 t, repectively, compared with 8–73 t in the previous 9 years; Table 6) result from little fishing effort being directed at this species.

The Compliance Group estimates that 274 t of *Jasus edwardsii* were taken illegally in the 1988–89 fishing year, and estimates that this figure is accurate within a factor of 2.

### 2.2 Other information

In 1989 a programme of rock lobster catch sampling was begun, under the responsibility of the new Stock Monitoring Programme. Total abundance, length frequencies, recruit and pre-recruit abundance and breeding female abundance are being monitored for future stock assessments. At present, since there is less than a year of data, the results of catch sampling are not presented here.

### 2.3 Recreational, traditional, and Maori fisheries

Estimates of non-commercial and unreported catches were discussed by Breen (1989). No estimates of Maori catches are available for 1989; the amateur catch is thought to have been about the same as that estimated for 1987 (153 t).

## 3. RESEARCH

### 3.1 Stock structure

As described above, three stocks are assumed. Based on biochemical genetic studies, there is one *J. edwardsii* stock on the North & South Islands combined (NSI) (Smith et al. 1980). The Chatham Islands (CHI) stock of *J. edwardsii* is probably genetically the same, but is considered separately for stock assessment purposes. There is one *Jasus verreauxi* stock (PHC) throughout the country (Booth 1986). A project to examine further stock structure of the red rock lobster is in progress. The CHI stock is thought to depend heavily on the NSI stock as a source of larval recruitment.

The NSI stock probably receives some larval recruitment from southeastern Australia, where the rock lobster species is the same as ours. However, the extent of dependence of the New Zealand stock on the Australian source is unknown. The *J. verreauxi* stock may receive some larval recruitment from eastern Australia (Booth 1986).

## 3.2 Resource surveys

### 3.2.1 Puerulus monitoring

Puerulus settlement continues to be monitored on collectors at key sites around the country. The key sites are at Gisborne, Napier, Castlepoint, Kaikoura, Moeraki, Halfmoon Bay, Chalky Inlet and Caswell Sound. The pattern noted earlier (see Breen 1988) persists, with high catches along the east coast of the North Island south of Matakaoa Point, lower catches along the east coast of the South Island, and moderate catches in the southwest of the South Island.

An explanation for the difference in strength of puerulus settlement between the east coast of the North Island and the east coast of the South Island is the greater abundance of phyllosoma larvae off the North Island revealed in plankton surveys during 1987–88.

Yearly indices of settlement strength for some key sites along the east coast of the country are given in Fig. 1. Sites inshore of the Southland Current along the east coast of the North and South Islands, and Stewart Island, have in common that settlement showed peaks in 1981, 1983 and 1987 (Table 7). There appears to have been a different pattern of year to year settlement at Gisborne, Napier, and in the southwest of the South Island.

Although no correlation has been established for *J. edwardsii* between strength of puerulus settlement and recruitment to the fishery, it is useful to consider how the peaks in settlement might impact on recruitment assuming that such a relationship does exist. Table 7 gives by area the mid–point of possible impact of high settlement years.

### 3.2.2 Juvenile surveys

A program at Halfmoon Bay, Stewart Island to monitor juvenile abundance for comparison with puerulus settlement was described by Breen & Booth (1989) and continues. There is a good relation between puerulus abundance and subsequent juvenile abundance. Similar data are being collected at Moeraki; attempts are underway to institute pre–recruit abundance surveys at other key puerulus monitoring sites.

## 3.3 Other studies

Surplus production modelling of the NSI stock reported in Breen (1989) led to an estimate of equilibrium catch at that time on the order of 4100 t, and a maximum equilibrium catch on the order of 4400 t.

In 1989 a bioeconomic model, based on the biological simulation model described by Breen (1989), was used to examine the economic consequences of various Total Allowable Catch (TAC) options for the NSI stock. This work anticipated the introduction of total catch controls for rock lobsters. From Department of Statistics surveys, there appeared to be no present economic surplus from the catching sector of the fishery. The results suggested that the potential annual surplus for the NSI stock would be on the order of $ 40 million.

The study, which is being completed for publication, also compared the net present value (NPV) of economic surpluses from the catching sector under different stock rebuilding strategies and examined the cost of postponing stock rebuilding. The NPV of the fishery under one rebuilding strategy was estimated to be on the order of $ 300 million. The cost of postponing rebuilding for one year was estimated to be on the order of $ 40 million, estimated from the decrease in NPV.

### 3.4 Biomass estimates

No direct estimates of biomass are available for any of the three stocks. Breen (1989) reported a biomass estimate from the biological simulation model, but the stock has decreased from the 1987 level. Without effort data, biomass is impossible to estimate from surplus–production modelling.

### 3.5 Yield estimates

### 3.5.1 Estimation of Maximum Constant Yield

#### 3.5.1.1 *Jasus edwardsii*, NSI stock

As reference to Tables 2, 4 and 5 shows, landings from the NSI stock have declined substantially since 1987. As a result of the observed decline, a special Stock Assessment Plenary was held in November 1989 to discuss possible reasons why landings decreased. Results of this meeting are attached to this document as a paper to the Senior Fishery Management Committee (Appendix I).

The decline in landings since 1987 was thought to reflect a real decline in the recruited biomass, in turn caused by decreased recruitment resulting from factors other than just the new MLS measure. The recent recruitment is outside the range predicted by the simulation model (Breen 1989).

We consider that MCY cannot now be estimated for this stock because recruitment and recruitment variability cannot be predicted from the data available and because present stock biomass is unknown. The estimate of MCY made in 1989 (3600 t) is now considered inappropriate.

#### 3.5.1.2 *Jasus edwardsii*, CHI stock

MCY was estimated using the equation $MCY = cY_{av}$ (Method 5). The fishery is a developed one in which catches have varied without trend. Mean annual landings for 1979–88 (529 t) (Table 5) were used. Although the time series 1979–88 has an apparent decline in CPUE, choice of the shorter period 1984–87, when CPUE was more stable, leads to a mean catch of 594 t. Landings during 1983–87 were the highest since 1973, and a catch of 594 t has not been attained since 1986. It was therefore decided to use the longer 1979–88 time series even though CPUE was decreasing, rather than adopt the higher mean catch. Variation in reported effort accounted for 95% of the variability in catch, 1979–87; therefore the value of c was set at 0.95. However, it is not possible to assess any level of risk to the stock of harvesting the population at the estimated MCY value.

$$MCY = cY_{av} = 0.95 * 529 \text{ t} = 503 \text{ t}.$$

#### 3.5.1.3 *Jasus verreauxi*

MCY was estimated using the equation MCY = $cY_{av}$ (Method 5). Mean annual landings for 1979–87 were 26.9 t (Table 6). Absence of QMS landings data for 1988 and 1989 means that an MCY estimate incorporating 1988 and 1989 catches is not possible. Because this is a fishery in which effort has varied widely for a variety of reasons and for which the fishing mortality is thought to have been low, the value of c was set at 1.0. However, it is not possible to assess any level of risk to the stock of harvesting the population at the estimated MCY value.

$$MCY = cY_{av} = 1.0 * 26.9 \text{ t} = 27 \text{ t}$$

### 3.5.2 Estimation of Current Annual Yield

CAY cannot be estimated for any stock because no biomass estimates are available.

## 4. MANAGEMENT IMPLICATIONS

### 4.1 *Jasus edwardsii*, NSI stock

For at least 10 years effort has been 2–3 times higher than optimal for this fishery. As a consequence the stock is smaller than the optimal level. Further consequences are that the catch is less than the potential MSY, economic yields are small compared with their potential, and the fishery may decline further and be in some danger of collapse.

The present fishery is in some danger of collapse even if the stock can be maintained at its present level. The present fishery returns no overall economic surplus. The present catch of 3200 t is far below the estimated sustainable yield near 4300 t that could be taken if the stock were rebuilt. If the fishery were rebuilt it would be far safer and would return an annual surplus on the order of $40 million.

Rebuilding the fishery requires a reduced catch for several years, so that not all the available catch is taken. Current levels of available catch are around 3200 t, so the catch must be reduced below this in order for rebuilding to occur. The lower the catch, the greater the chance that stocks will stop declining and that rebuilding will occur.

There is no certainty that a combined TACC of 3200 t will reduce fishing mortality rate. Recruitment has become unpredictable, and may possibly decrease further for the 1991–92 fishing year. The probability of decreasing fishing mortality rate would increase if a lower catch level were set.

No catch level can be considered safe. This is always true for any fishery, but is especially true for this fishery now. If we are seeing stock–recruit effects, then a catch level of zero might not stop what is about to happen.

The present uncertainty underscores the need for rebuilding. The level of uncertainty would be expected to decrease with a rebuilt stock. The present situation, where the fishery removes much of the recruitment each year with a very high fishing intensity, is not at all safe and should not be allowed to persist.

### 4.2 *Jasus edwardsii*, CHI stock

It is considered that this stock is under less stress than the NSI stock. The current TACC of 503 t is considered to be sustainable, and no changes are recommended to catch levels. However, it is not known whether declines in the NSI stock will have any effect on recruitment to this stock. If the reduced reproductive output from the NSI stock reduces recruitment to the CHI stock, then the CHI catch may have to be reduced at some stage.

### 4.3 *Jasus verreauxi*

It is believed that this fishery is not under stress and that a TACC of 27 t is sustainable and will adequately protect the resource. No changes are recommended to current catch levels.

## 5. REFERENCES


ANON. 1990: Measuring rock lobsters. *New Zealand Fisheries Information Series 19*: 4 p.

ANNALA, J.H. 1983: New Zealand rock lobsters: biology and fishery. *Fisheries Research Division Occasional Publication No. 42*. 36 p.

ANNALA, J.H., and BREEN, P.A. 1988: Yield– and egg–per–recruit data inputs and model results for the rock lobster *Jasus edwardsii* from 10 areas around New Zealand. *Fisheries Research Centre Internal Report No. 87*. 46 p. (Draft report, held in Fisheries Research Centre library, Wellington.)

ANNALA, J.H., and BREEN, P.A. 1989: Yield– and egg–per–recruit analyses for the New Zealand rock lobster, *Jasus edwardsii. N.Z. Journal of Marine and Freshwater Research 23*: 93–105.

BOOTH, J.D. 1986: Recruitment of packhorse rock lobster *Jasus verreauxi* in New Zealand. *Canadian Journal of Fisheries and Aquatic Sciences 43*: 2212–2220.

BOOTH, J.D. 1989a: History of biological research into the rock lobsters of New Zealand. *In* B.F. Phillips (Ed.) Workshop on Rock Lobster Ecology and Management, pp. 35–52. *CSIRO Marine Laboratories Report 207.*

BOOTH, J.D. 1989b: Occurrence of the puerulus stage of the rock lobster, *Jasus edwardsii* at the New Plymouth power station, New Zealand. *N.Z. Journal of Marine and Freshwater Research 23*: 43–50..

BOOTH, J.D. 1989c: Rock lobster farming in New Zealand: problems and possibilities. *In* Beardsell, M.F. (Comp. and Ed.) Proceedings of AQUANZ '88: A National Conference on Aquaculture, pp. 100–104. *N.Z. Fisheries Occasional Publication 4.*

BREEN, P.A. 1988: Rock lobster stock assessment. *N.Z. Fisheries Assessment Research Document 88/1*. 37 p.

BREEN, P.A. 1989: Rock lobster stock assessment 1989. *N.Z. Fisheries Assessment Research Document 89/6*. 36 p.

BREEN, P.A., & BOOTH, J.D. 1989: Juvenile and puerulus abundance in the rock lobster *Jasus edwardsii* at Stewart Island, New Zealand. *N.Z. Journal of Marine and Freshwater Research 23(4)*: 519–523.

BREEN, P.A., BOOTH, J.D., and TYSON, P.J. 1988: Feasibility of a minimum size limit based on tail width for the New Zealand rock lobster *Jasus edwardsii. N.Z. Fisheries Technical Report No. 6*. 16 p.

BREEN, P.A., & McKOY, J.L. 1988: An annotated bibliography of the red rock lobster, *Jasus edwardsii*, in New Zealand. *N.Z. Fisheries Occasional Publication 3*: 43 pp.

HORN, P.L. 1988: The escapement efficiency of rock lobster pots: escape gaps v. minimum mesh size. *Central Fisheries Region Internal Report 9*. 20 p.

MacDIARMID, A.B. 1989: Size at onset of maturity and size-dependent reproductive output of female and male spiny lobsters *Jasus edwardsii* (Hutton) (Decapoda, Palinuridae) in northern New Zealand. *Journal of Experimental Marine Biology and Ecology 127:* 229–243.

PROVENZANO, A.J. 1989: Current and future trends in crustacean aquaculture. *In* Beardsell, M.F. (Comp. and Ed.) Proceedings of AQUANZ '88: A National Conference on Aquaculture, pp. 105–109. *N.Z. Fisheries Occasional Publication 4.*

SMITH, P.J.; MCKOY, J.L.; MACHIN, P.J. 1980: Genetic variation in the rock lobsters *Jasus edwardsii* and *Jasus novaehollandiae. New Zealand Journal of Marine and Freshwater Research 14*: 55–63.

WEBBER, W.R.; BOOTH, J.D. 1988: *Projasus parkeri* (Stebbing, 1902) (Crustacea, Decapoda, Palinuridae) in New Zealand and description of a *Projasus* sp. puerulus from Australia. *National Museum of New Zealand Records 3*: 81–92.

WILLIAMS, B.G., and DEAN, I.C. 1989: Timing of locomotor activity in the New Zealand rock lobster, *Jasus edwardsii. N.Z. Journal of Marine and Freshwater Research 23*: 215–224.

Table 1. Total Allowable Commercial Catches (TACCs) (t) of rock lobster specified in the Maori Fisheries Act 1989, Second Schedule, and Fisheries Amendment Act 1990. All refer to *Jasus edwardsii*, except for PHC which is *Jasus verreauxi*.

| Stock | Quota Management Area | QMA # | TACC |
|---|---|---|---|
| NSI | Northland | 1 | 153 |
| NSI | Bay of Plenty | 2 | 230 |
| NSI | Gisborne | 3 | 427 |
| NSI | Wellington/Hawkes Bay | 4 | 573 |
| NSI | Canterbury/Marlborough | 5 | 460 |
| CHI | Chatham Islands | 6 | 503 |
| NSI | Otago | 7 | 175 |
| NSI | Southern | 8 | 1128 |
| NSI | Westland/Taranaki | 9 | 54 |
| NSI | Kermadec | 10 | 0.1 |
| PHC | All New Zealand waters | | 27 |
| | TACC totals by stock: | | |
| | NSI total | | 3200.1 |
| | CHI total | | 503 |
| | PHC total | | 27 |

Table 2. Landings reported to the QMR system by month and controlled fishery area for 1988 and 1989. These include both species. 1989 figures are preliminary only. Monthly landings are in kg; area totals are rounded to the nearest t.

| AREA<br>Month | NTH<br>CRA1 | BoP<br>CRA2 | GSB<br>CRA3 | WHB<br>CRA4 | CBM<br>CRA5 | CHT<br>CRA6 | OTG<br>CRA7 | STH<br>CRA8 | WLD<br>CRA9 | TKI<br>CRA10 | NSI<br>TOTAL | <br>TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8801 | 35,462 | 25,047 | 33,315 | 78,798 | 81,331 | 84,432 | 4,719 | 116,374 | 3,383 | 8,021 | 470,882 | 386,450 |
| 8802 | 24,990 | 13,069 | 14,601 | 32,258 | 26,843 | 76,063 | 3,299 | 122,703 | 4,736 | 5,322 | 323,884 | 247,821 |
| 8803 | 12,321 | 5,898 | 9,497 | 14,418 | 7,506 | 23,568 | 1,364 | 32,729 | 2,232 | 4,584 | 114,117 | 90,549 |
| 8804 | 5,356 | 1,480 | 3,387 | 3,382 | 5,127 | | 46 | 18,499 | 1,309 | 1,749 | 40,335 | 40,335 |
| 8805 | 2,279 | 242 | 1,177 | 38,329 | 17,308 | 9,525 | 47 | 4,611 | 170 | 39 | 73,727 | 64,202 |
| 8806 | 1,479 | 1,935 | 11,904 | 63,063 | 11,094 | 26,942 | 10,659 | 21,070 | 1,155 | 276 | 149,577 | 122,635 |
| 8807 | 8,188 | 17,163 | 9,731 | 32,494 | 6,689 | 21,092 | 36,172 | 33,605 | 859 | 1,800 | 167,793 | 146,701 |
| 8808 | 17,770 | 24,179 | 6,134 | 23,893 | 7,956 | 11,300 | 51,036 | 43,173 | 1,375 | 870 | 187,686 | 176,386 |
| 8809 | 19,568 | 34,411 | 21,693 | 73,729 | 19,507 | 6,210 | 31,687 | 119,674 | 3,577 | 3,058 | 333,114 | 326,904 |
| 8810 | 18,231 | 32,897 | 64,236 | 128,131 | 28,176 | 37,444 | 45,454 | 173,292 | 753 | 2,333 | 530,947 | 493,503 |
| 8811 | 25,210 | 26,894 | 49,467 | 161,474 | 74,034 | 60,391 | 27,601 | 193,853 | 3,115 | 7,314 | 629,353 | 568,962 |
| 8812 | 31,071 | 31,238 | 45,486 | 110,292 | 75,599 | 77,181 | 5,740 | 153,817 | 2,617 | 8,171 | 541,212 | 464,031 |
| TOTAL | 202 | 214 | 271 | 760 | 361 | 434 | 218 | 1,033 | 25 | 44 | 3,563 | 3,128 |

| <br>Month | NTH<br>CRA1 | BoP<br>CRA2 | GSB<br>CRA3 | WHB<br>CRA4 | CBM<br>CRA5 | CHT<br>CRA6 | OTG<br>CRA7 | STH<br>CRA8 | WLD<br>CRA9 | TKI<br>CRA10 | <br>TOTAL | NSI<br>TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8901 | 19,712 | 24,515 | 27,084 | 74,108 | 77,916 | 100,059 | 3,288 | 162,390 | 6,184 | 9,161 | 504,417 | 404,358 |
| 8902 | 17,199 | 16,984 | 14,911 | 30,967 | 18,779 | 98,787 | 831 | 78,304 | 4,078 | 5,530 | 286,370 | 187,583 |
| 8903 | 12,159 | 9,725 | 26,554 | 25,452 | 8,582 | 98 | 1,314 | 31,821 | 441 | 3,526 | 119,672 | 119,574 |
| 8904 | 4,050 | 1,311 | 8,817 | 14,098 | 7,419 | 0 | 15 | 10,891 | 558 | 968 | 48,127 | 48,127 |
| 8905 | 1,290 | 565 | 6,739 | 22,700 | 14,388 | 11,549 | 0 | 4,058 | 20 | 33 | 61,342 | 49,793 |
| 8906 | 893 | 1,898 | 17,113 | 57,918 | 6,724 | 23,094 | 4,574 | 18,840 | 21 | 22 | 131,097 | 108,003 |
| 8907 | 7,496 | 18,394 | 20,486 | 50,630 | 7,958 | 20,481 | 12,133 | 31,992 | 63 | 2,674 | 172,307 | 151,826 |
| 8908 | 12,058 | 19,753 | 5,828 | 13,942 | 8,020 | 8,533 | 13,296 | 115,437 | 712 | 3,927 | 201,506 | 192,973 |
| 8909 | 18,823 | 29,148 | 21,173 | 59,429 | 19,158 | 4,228 | 22,502 | 226,185 | 2,800 | 4,103 | 407,549 | 403,321 |
| 8910 | 18,756 | 37,770 | 53,675 | 142,915 | 30,270 | 33,855 | 22,540 | 296,857 | 3,524 | 1,476 | 641,638 | 607,783 |
| 8911 | 28,477 | 43,500 | 76,107 | 135,616 | 48,299 | 26,578 | 6,543 | 211,325 | 3,669 | 4,332 | 584,446 | 557,868 |
| 8912 | 30,223 | 30,040 | 76,800 | 103,766 | 50,791 | 40,244 | 6,039 | 110,100 | 3,081 | 5,380 | 456,464 | 416,220 |
| TOTAL | 171 | 234 | 355 | 732 | 298 | 368 | 93 | 1,298 | 25 | 41 | 3,615 | 3,247 |

Table 3. Landings of *Jasus edwardsii* from all of New Zealand on Licensed Fish Receiver Reports for 1988 and 1989. Figures from October 1989 onward are preliminary only.

| | Month | Landings (kg) | Month | Landings (kg) |
|---|---|---|---|---|
| | 8801 | 464,454 | 8901 | 526,177 |
| | 8802 | 353,342 | 8902 | 293,608 |
| | 8803 | 120,806 | 8903 | 130,104 |
| | 8804 | 38,210 | 8904 | 51,563 |
| | 8805 | 82,453 | 8905 | 65,831 |
| | 8806 | 147,084 | 8906 | 134,840 |
| | 8807 | 163,149 | 8907 | 174,474 |
| | 8808 | 191,530 | 8908 | 220,875 |
| | 8809 | 333,305 | 8909 | 434,219 |
| | 8810 | 521,251 | 8910 | 595,951 |
| | 8811 | 646,707 | 8911 | 565,842 |
| | 8812 | 532,208 | 8912 | 497,572 |
| Total (t) | | 3,594 | | 3,691 |

Table 4. A summary of reported landings (t) from all of New Zealand for both species by calendar year and fishing year (1 October–30 September) from each of the systems indicated. Export statistics (t) are also given. 1989 figures are preliminary only.

| | Calendar Year | | | Fishing Year | | |
|---|---|---|---|---|---|---|
| System | '87 | '88 | '89 | 86–87 | 87–88 | 88–89 |
| QMS Reports | 4989 | 3563 | 3615 | 5403 | 4248 | 3634 |
| LFRR | 4938 | 3594 | 3691 | 5364 | 4247 | 3732 |
| Export Statistics | 5230 | 4093 | 4220 | | | |

Table 5. Reported landings (t), and CPUE, for *Jasus edwardsii*, CHI stock, 1979–88. All columns, except for the last, give landings, rounded to the nearest t after calculation. The column "Original FSU total" is from the sources cited by Breen (1989). The "Audit base" comprises the sum of catch histories reviewed by the rock lobster audit in 1989. "Net change" shows the net increase discovered by the audit with respect to the audited base. The "Revised FSU total" was calculated as follows:

Revised FSU total = Original FSU total * ((Audit base + Net change)/Audit base)

Data obtained from the two major processors are shown in the "Industry total " column. The following column shows the higher of the FSU and industry estimates (for 1988, the QMS value is given). The final column gives kg/pot–lift, calculated from the revised FSU total and the estimated no. of pot–lifts cited by Breen (1989, Tables 1 & 8).

| Year | Original FSU total | Audit base | Net change | Revised FSU total | Industry total | Higher estimate | CPUE |
|---|---|---|---|---|---|---|---|
| 79 | 384 | 248 | 30 | 431 | | 431 | 2.6 |
| 80 | 343 | 231 | 30 | 386 | | 386 | 2.2 |
| 81 | 453 | 312 | 38 | 508 | 530 | 530 | 2.5 |
| 82 | 415 | 268 | 47 | 488 | 487 | 488 | 2.1 |
| 83 | 553 | 365 | 61 | 645 | 646 | 646 | 2.1 |
| 84 | 491 | 372 | 41 | 545 | 539 | 545 | 1.7 |
| 85 | 574 | 500 | 40 | 619 | 653 | 653 | 1.5 |
| 86 | 562 | 498 | 55 | 624 | 571 | 624 | 1.7 |
| 87 | 468 | 390 | 23 | 496 | 552 | 552 | 1.7 |
| 88 | | | | | | 434 | |
| | | | | | 1979–88 mean | 529 | |

Table 6. The best available reported landings data (t) for *Jasus verreauxi* 1979–87. Data for 1979–82 and 1986–87 are landings reported to the Fisheries Statistics Unit (Breen 1989; Table 9). Data for 1983–85 are provisional results from the rock lobster audit. No landings data are available for 1988 or 1989 because packhorse lobsters were grouped with red rock lobsters under the QMS during most of that period.

| Year | Landings |
|---|---|
| 1979 | 29.1 |
| 1980 | 11.2 |
| 1981 | 25.2 |
| 1982 | 28.9 |
| 1983 | 73.1 |
| 1984 | 36.8 |
| 1985 | 20.3 |
| 1986 | 7.7 |
| 1987 | 10.2 |
| Mean | 26.9 |

Table 7. Mid–point of possible impact on recruitment of high puerulus settlement years observed along the east coast of New Zealand. These estimates are based on the MLS of 54 mm tail width for males and 58 mm for females, except for Moeraki where size at recruitment is 127 mm tail length

| Site | Estimated years to recruitment | Settlement peaks | Estimated mid–point of the period of peak recruitment |
|---|---|---|---|
| | (male, female) | | (male, female) |
| Gisborne | 6, 9 | 1979 | 1985, 1988 |
| | | 1982 | 1988, 1991 |
| | | 1985 | 1991, 1994 |
| | | 1988 | 1994, 1997 |
| Napier | 6, 9 | 1981 | 1987, 1990 |
| | | 1983 | 1989, 1992 |
| Castlepoint | 6, 9 | 1983 | 1989, 1992 |
| | | 1987 | 1993, 1996 |
| Kaikoura | 7, 9 | 1981 | 1988, 1990 |
| | | 1983 | 1990, 1992 |
| | | 1987 | 1994, 1996 |
| Moeraki | 4, 4 | 1981 | 1985, 1985 |
| | | 1983 | 1987, 1987 |
| | | 1987 | 1991, 1991 |
| Halfmoon Bay | 7, 7 | 1981 | 1988, 1988 |
| | | 1983 | 1990, 1990 |
| | | 1987 | 1994, 1994 |

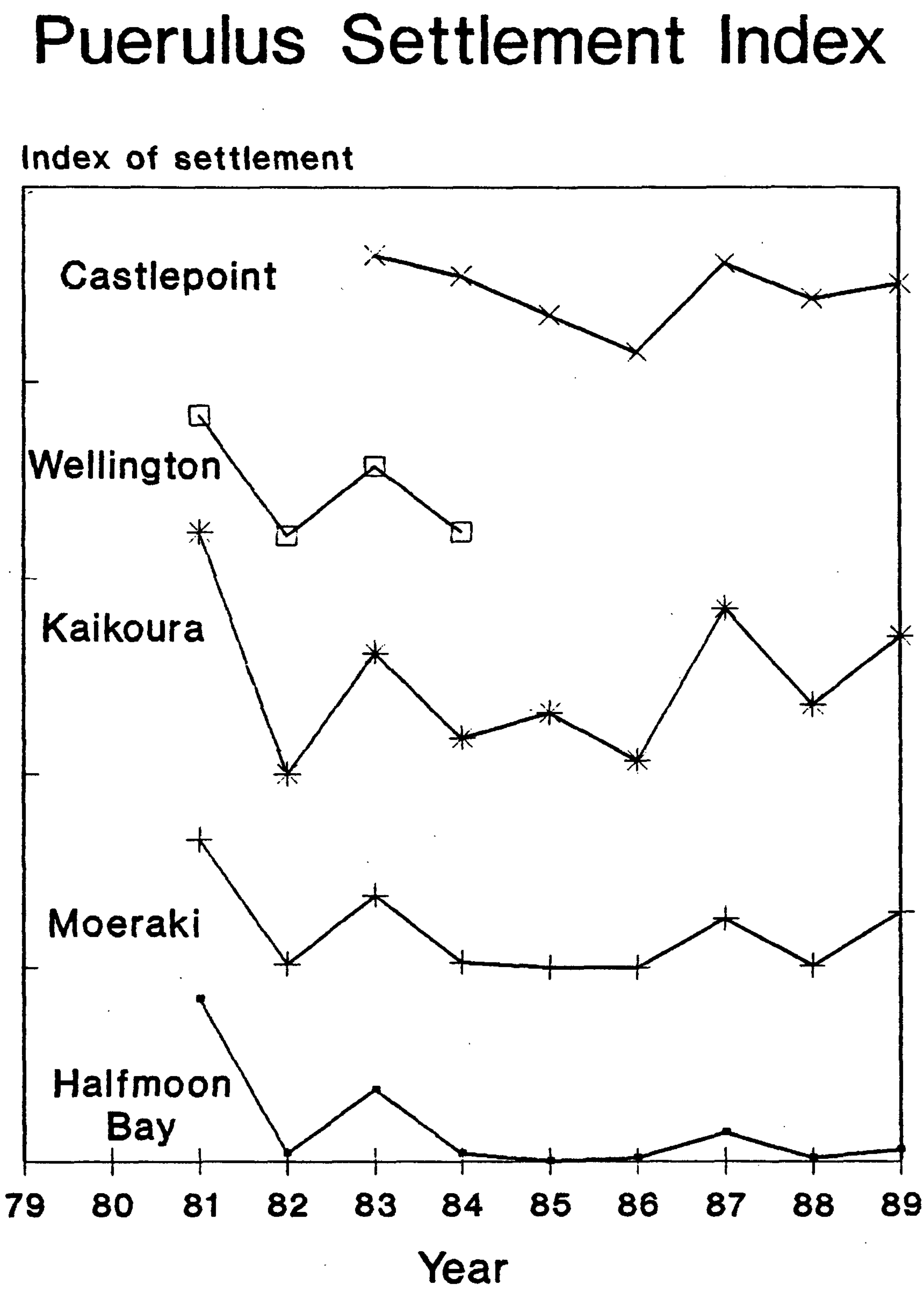



Figure 1. Indices of puerulus settlement on artificial collectors at sites along the east coast of New Zealand, 1981–89.

Appendix 1

This paper resulting from a special Fishery Assessment Plenary session was prepared for the Senior Fisheries Management Committee meeting of 28 November 1989. Specific recommendations (on pages 1 and 5, and all of page 6) have been removed.

Chairman
Senior Fisheries Management Committee

Maori Fisheries Bill - Rock Lobster Fishery TAC

Purpose

This paper makes a TAC recommendation for the red rock lobster fishery, North & South Islands stock. The recommendation is based on available information at 23 November 1989 and arises from a special Fishery Assessment Plenary Session.

Background

The spiny (red) and packhorse rock lobster fisheries are to be managed under a system of Transferable Term Quotas (TTQs) from 1 April 1990. This management, including specification of Total Allowable Catches (TACs), is provided for in the Maori Fisheries Bill.

The rock lobster fishery comprises three stocks: J. verreauxi (less than 1% of total landings); J. edwardsii in the Chathams (about 12% of total landings) and J. edwardsii in the North & South Islands combined (NSI stock). This paper is entirely concerned with the TAC for the NSI stock.

The NSI stock was assessed at the May 1989 Stock Assessment Plenary, and MCY was estimated from simulations that examined the effect of recruitment variability. The model simulated the situation at the end of 1987 - at that time no more recent data were available. The MCY was estimated at 3600 tonnes.

The 1989 stock assessment paper clearly flagged the possibility that current stock might not be the same as the end-1987 stock.

Catch (but not effort) data are now available for 1988 and much of 1989. In light of a large decrease in catch in 1988, which has not been reversed in 1989, the NSI stock assessment was reviewed at a special Plenary session on 23 November 1989. Based on that review, described in more detail below, new TAC recommendations are provided.

Landings for 1988 and 1989

Table 1 shows the 1988 landings: for the NSI stock they decreased more than 30% in 1988, from 4529 t to 3118 t.

Landings for 1989 are tracking toward the same total as in 1988 (Table 2).

When combined with the uncertainties discussed in the 1989 Stock assessment document[1] the large decrease in 1988 and 1989 landings is cause for some concern.

<u>Why are the landings so low?</u>

There are 4 potential explanations for the low 1988 and 1989 landings. These will all be listed and discussed, but only one explanation is plausible.

1) Landings may have been under-reported.

This is not a credible explanation. Operations report they are confident that the QMS system captures all the <u>reported</u> landings. There is little incentive not to report landings in the commercial fishery at this stage: the introduction of quotas will be based on past history for each fisher.

There has been good recent agreement between landings and exports (Breen 1989: table 5). The FIB Annual Report for 1 April 1988-31 March 1989 shows the exports of rock lobsters as 4042 t, compared with 1988 landings of 3590 t. Exports in 1987 were 5230 t, so the 23% drop in exports supports the drop in landings.

2) Effort may have diminished in 1988 and 1989.

Also not credible as a complete explanation, although effortmight have decreased. Unfortunately the demise of the FSU and the failure of the QMS to collect effort data combine to create a gap in the effort time series: there are few effort data for 1988 and no effort data so far for 1989. There may have been effort decreases in some parts of the country after the introduction of the tail width measure, as suggested for Stewart Island; but those resulted from reduced catch availability and should be considered as tail width effects rather than as decreased effort effects.

3) The tail width measure, introduced in mid-1988, may be responsible for the decrease.

The tail width measure is probably responsible for some decline in 1988, but not the whole decline. Tail width affected the Southern fishery and parts of the Canterbury-Marlborough fishery, especially for females, through morphometric

[1] Paul A. Breen, 1989: Rock lobster stock assessment 1989. New Zealand Fisheries Research Assessment Document 89/6.

deviation. For much of the rest of the fishery, the tail width decreased the effective size limit, especially for females on the east coast North Island, and landings were expected to increase as a result of tail width. Instead, some of the biggest declines were seen in areas where the tail width should have had a positive effect, such as Gisborne and the Bay of Plenty (Table 1)

In Otago, where the size limit was left alone, the catch fell from about 260 t in 1987 to 217 t in 1988, a decrease of 16%. Otago landings for 1989 are not expected to reach 100 t.

Declines caused by tail width were expected to be partially reversed in 1989 as a result of growth by those animals excluded from the recruited stock by the change to tail width. The persistence of low landings in 1989 suggests that some other factor is operative in addition to whatever effect tail width may have had.

4) The declines may have been caused by real decreases in abundance.

This is the most likely explanation. The fishery remains intense; there have been no structural changes apart from the new minimum legal size (June 1988); we are aware of no changes in fishing pattern or reporting pattern; so the most obvious cause for decreased landings is a real underlying decrease in the stock.

The 1988 effort data from the FSU system, associated with about 1000 t of landings, suggest an average catch rate of 0.54 Kg/pot-lift. This compares with 0.72 Kg/pot-lift in 1987, but the 1988 data may have a seasonal bias. These data are suggestive of a real decline in abundance between 1987 and 1988.

Much of the fishery is heavily dependent on the newly-recruited individuals: Figures 1a and 2a show the size distribution of males and females at Napier in January 1989. The relative scarcity of individuals more than a few mm greater than the minimum legal sizes suggests a very intense fishery, and one which is highly dependent on annual recruitment.

So declines in abundance probably reflect declines in recruitment. There are two possible explanations for the 1988-89 declines in recruitment.

a) Stock-recruit effects. The breeding stock may have been reduced to such a low level 6-10 years ago that recruit strength has now decreased as a result. There is no information on the stock-recruit relation for this species with which to test this explanation.

b) Random recruitment variability. Variability was estimated for the simulation model by examining variability in CPUE for each of the 5 model areas. This was then related to recruitment variability on the basis of simple simulations exploring the relationship at different values of F.

In the model's stochastic runs with high fishing intensity, the catch never fell as low as 3100 t (it was nearly always above 3500 t). Either the model under-estimates recruitment variability or the scale of variability has changed to cause the recent pattern.

There is no way to distinguish between the two alternative explanations for decreased recruitment in 1988 and 1989. The two explanations need not be not mutually exclusive.

Implications of reduced lobster abundance

The NSI stock is smaller than it has ever been: never before has so much fishing effort been expended; the CPUE has never been as low as observed in 1988.

The present sustainable yield (the yield which could be obtained with the present level of effort in an average year) is considerably less than the potential sustainable yield. The present catch is only 3100 t; the potential MCY is on the order of 4200 t. The fishery cannot produce at its potential unless the stock is rebuilt.

Unpredictable fluctuations in recruitment must have a greater immediate impact when the stock is low. The present fishery removes many individuals soon after recruitment (eg. Figure 1), so the recruitment fluctuations are transmitted directly to the fishery landings. If the stock were larger, these variations would be damped.

Most importantly, the low stock is at greater risk of unpredictable collapse than a larger stock would be. The history of the fishery suggests that the 1960's and 1970's fisheries operated at effort and stock levels that did not precipitate stock-recruitment problems. At least under the conditions that obtained then, the fishery was evidently "safe": it behaved predictably, recruitment was maintained at a high level, and stock declines were reversible. The last is demonstrated by the 4-fold increase in biomass after the Marine Reserve at Leigh was closed to fishing.

Whereas there are grounds to think that a fishery operating at lower effort levels was safe, there is no reason to suppose that the present situation is safe. The stock may well be so low as to cause reduced breeding success and reduced future recruitment, if that has not already occurred.

## Puerulus settlement

Figure 2 shows settlement rates on collectors at a number of key sites from 1981 to the present. There appears to be similarity among patterns at sites from Stewart Island to the east coast North Island. Good settlements were observed in 1981 and 1983; then settlement was reduced until 1987. There are excellent correlations between puerulus settlement and 3-yr old juvenile abundance at Halfmoon Bay.

If fluctuations in recruitment are driven by variations in puerulus settlement, then the poor settlements from 1984-86 would be expected to result in poor recruitment, possibly at even lower levels than at present, continuing for some time. The most recent relatively good settlement was in 1987.

## Modelling

To model the future state of a population requires assumptions about its behaviour, particularly with respect to recruitment. The 1989 stock assessment assumed a constant recruitment, modified by a level of fluctuation that was estimated from catch data. That assumption appeared robust when the past history of the fishery was examined, but the recent recruitments are outside the predicted range of values.

The population is thus behaving unpredictably with respect to recruitment. If this is a stock-recruit effect, then recruitment will continue to be low and may in fact collapse; but no information is available on the stock-recruit function. If the present low recruitment is a random fluctuation, it appears to be outside the range of previous values.

Without making assumptions about what recruitment is about to do, it isn't possible to model the situation.

Table 1. Landings (tonnes) from the QMS system by Controlled Fishery Area for 1988. It is not possible to make area comparisons with 1987, so instead comparisons are made with the mean of 1983-87 landings from the FSU system.

| AREA | 1988 | mean 83-87 | percentage difference |
|---|---|---|---|
| Northland | 202 | 210 | -3.81 |
| Bay of Plenty | 214 | 280 | -23.57 |
| Gisborne | 271 | 607 | -55.35 |
| Taranaki | 44 | 40 | 10.00 |
| Wellington/Hawkes Bay | 760 | 891 | -14.70 |
| Canterbury/Marlborough | 360 | 624 | -42.31 |
| Otago | 217 | 238 | -8.82 |
| Southern | 1024 | 1598 | -35.92 |
| Westland | 25 | 41 | -39.02 |
| Chatham Is | 433 | 525 | -17.52 |
| New Zealand Total | 3550 | 5054 | -29.7 |
| NSI Stock Total | 3118 | 4529 | -31.2 |

1

Table 2. Landings by month (kg), 1988 and 1989, NSI stock, from the QMS system. The 1989 data are preliminary.

| MONTH | 1988 | 1989 | percentage difference |
|---|---|---|---|
| January | 386,450 | 405,238 | + 4.9 |
| February | 247,821 | 187,269 | -24.4 |
| March | 90,549 | 119,497 | +32.0 |
| April | 40,335 | 48,039 | +19.1 |
| May | 64,202 | 49,632 | -22.7 |
| June | 122,635 | 118,085 | - 3.7 |
| July | 146,701 | 150,585 | + 2.6 |
| August | 176,572 | 181,698 | + 2.9 |
| September | 327,003 | 363,546 | +11.2 |
| October | 487,045 | 460,628 | - 5.4 |
| Total | 2,089,313 | 2,084,217 | - 0.2 |

FIGURE CAPTIONS

Figure 1a. Size frequency (tail width) of male red rock lobsters observed in catch sampling at Napier in January 1989. The vertical line indicates the minimum legal size.

Figure 1b. Size frequency (tail width) of female red rock lobsters observed in catch sampling at Napier in January 1989. The vertical line indicates the minimum legal size.

Figure 2. Indices of puerulus settlement on artificial collectors at several sites, 1981-89. Each site has been scaled so that all maxima are identical. At each site, the settlement was expressed on a per-collector basis.

Figure 3. Catch vs effort for the NSI stock of red rock lobsters, 1945-88. The line is a fitted surplus-production curve. Arrows indicate the approximate optimum equilibrium position and the 1988 position. The great surplus of effort over optimum levels, and the reduced catch level from optimum levels, should both be noted.

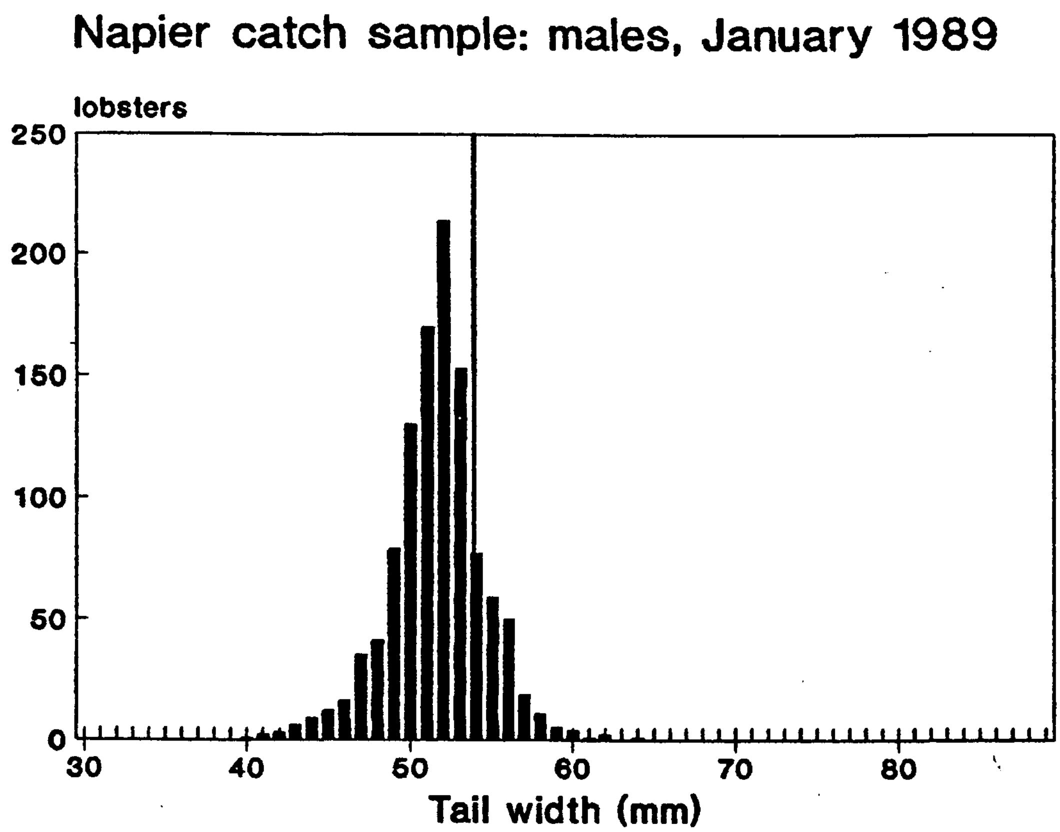



Figure 1a.

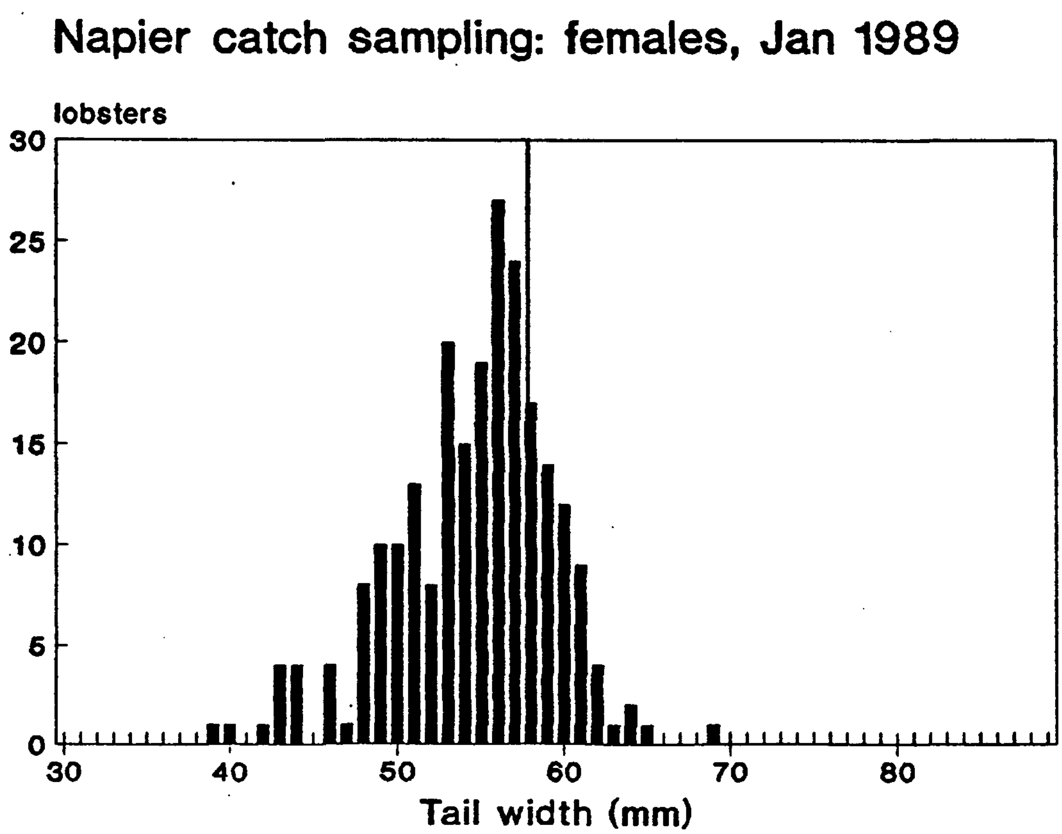
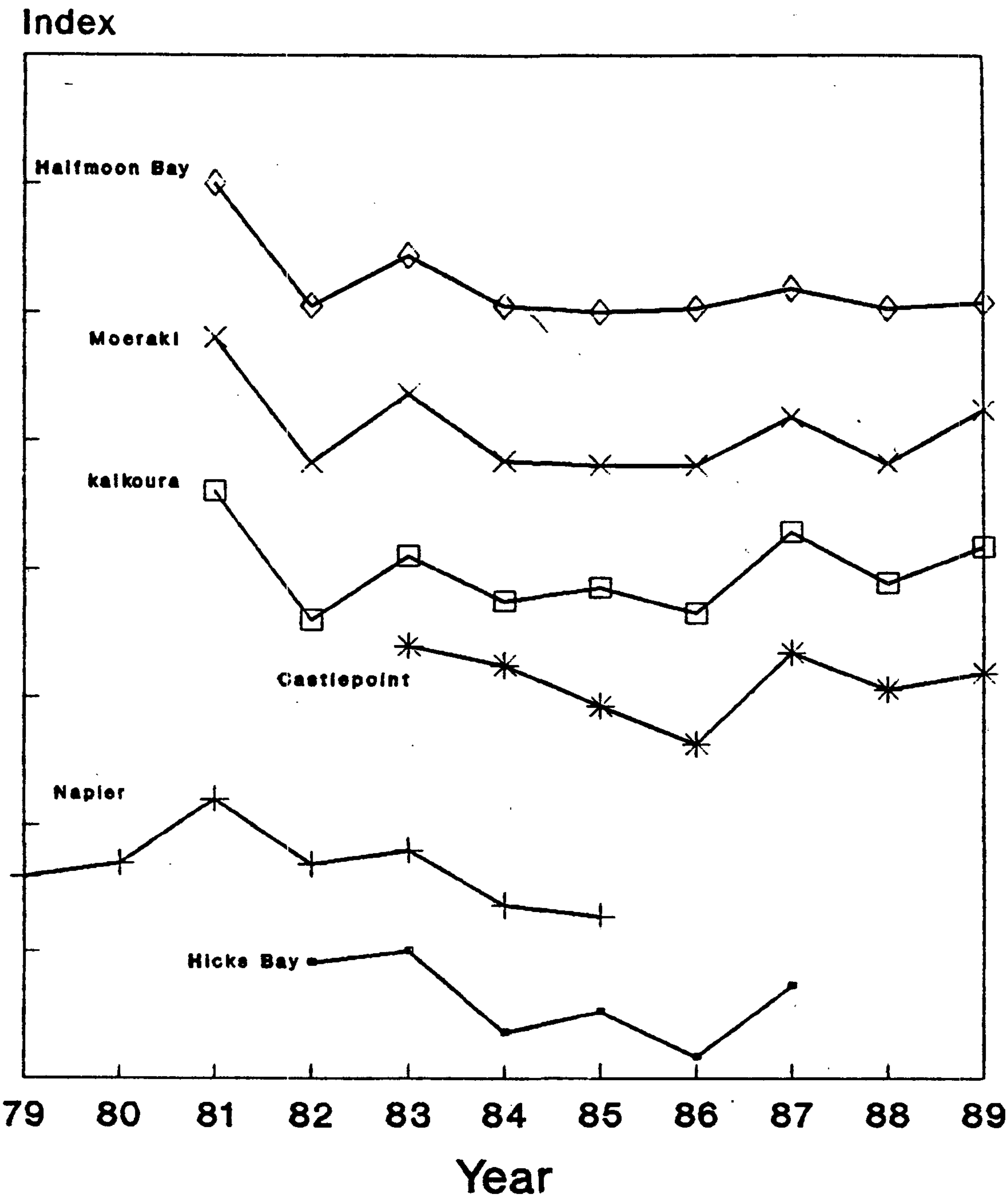



Figure 1b.


Index
Halfmoon Bay
Moeraki
kaikoura
Castlepoint
Napier
Hicks Bay
79
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89
Year

Figure 2

# Commercial catch vs effort, 1945-88

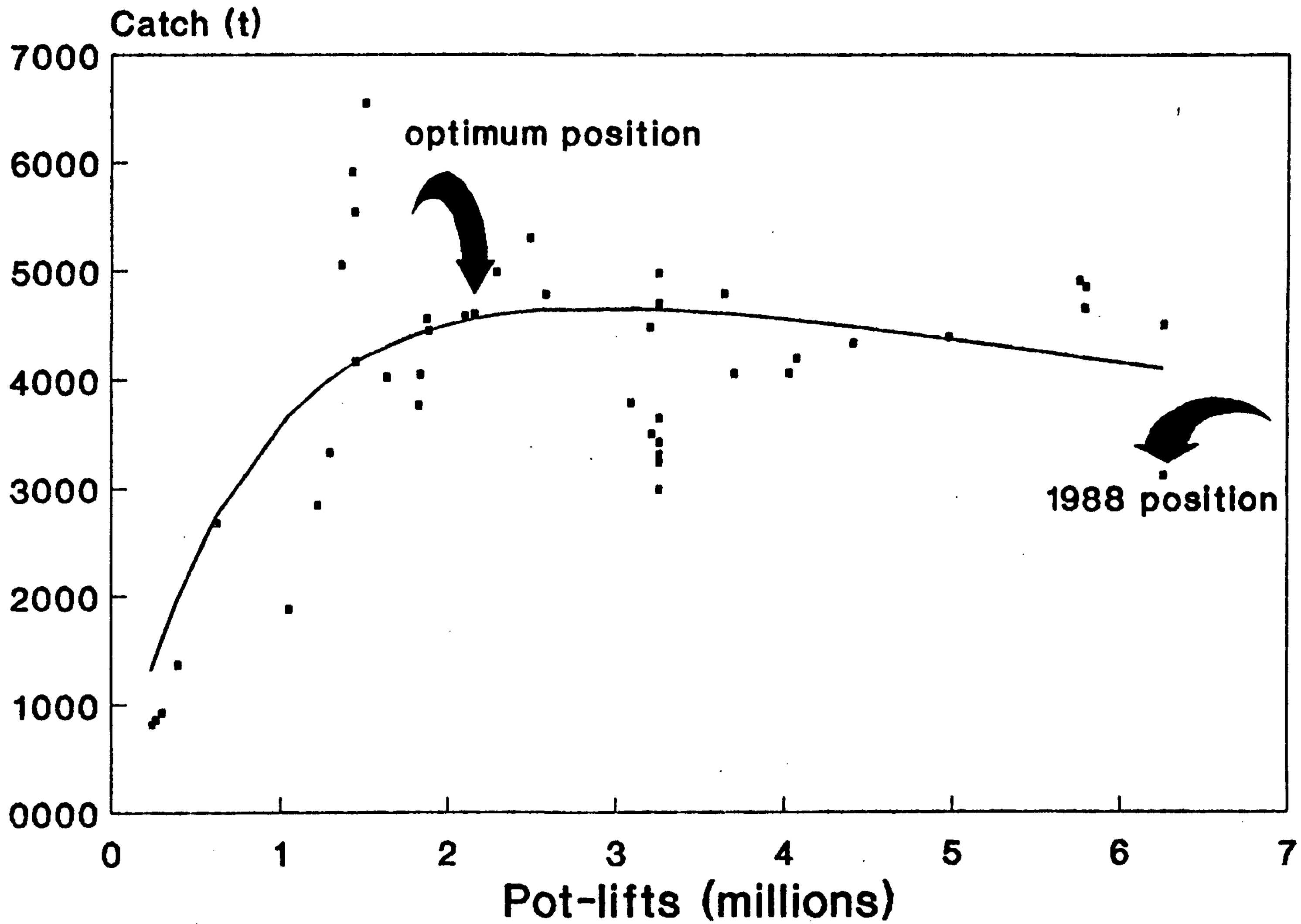


Figure 3