New Zealand Fisheries Assessment Research Document 96/10

Scampi stock assessment for 1996

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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. Executive Summary

Scampi assessments made in 1993 and 1995 for QMAs 1 and 2 suggested that annual catches probably represented large proportions of virgin and current biomass, and that continued landings of the same order would probably lead to continued declines in stock size. This tentative conclusion was based on declines in standardised and unstandardised indices of commercial CPUE. Recent increases in CPUE and trawl survey indices of biomass, combined with length frequency distributions which do not show changes consistent with heavy fishing pressure in any stock, now suggest that earlier estimates of biomass and yield were probably conservative. Information from trawl surveys and scientific observers suggests that changes in the catchability of scampi rather than standing biomass have caused the observed pattern in biomass indices. Given the available information on scampi, yield cannot be estimated for any stock.

2. Introduction

2.1 Overview

This document summarises research information presented during the assessment of the New Zealand scampi fishery in 1996. This information consisted of updated (but probably incomplete) landings for all areas, updated but unstandardised commercial CPUE analyses for all areas where a significant catch was taken (QMAs 1, 2, 3, 4, and 6A), fully standardised commercial CPUE for QMA 1 up to the first half of 1994, unscaled length frequency distributions and sex ratios from scientific observers on board commercial vessels in QMAs 1, 2, 3, 4, and 6A, and relative biomass indices and fully scaled length frequency distributions and sex ratios from *Kaharoa* trawl surveys in QMAs 1 and 2.

2.2 Description of the Fishery

The fishery for scampi is conducted almost entirely using light, bottom trawl gear, restricted by permit condition to a minimum mesh size of 55 mm in the codend. Most of the vessels involved are between 20 and 40 m in length, and all use multiple rigs of two or three nets of very low headline height. Most scampi fishing is conducted in QMA 1 (Bay of Plenty, Figure 1), QMA 2 (Hawke Bay and Wairarapa coast), QMAs 3 and 4 (Chatham Rise and Mernoo Bank), and QMA 6A (within 50 nautical miles of the Auckland Islands).

Some small or damaged scampi may be tailed at sea, but the proportion of such processed product is usually small as it commands a lower price than whole scampi graded by size and frozen at sea.

2.3 Literature Review

Cryer *et al.* (unpublished) reviewed the literature, and little information has been published since. Some tagging work was carried out in the Bay of Plenty in late 1995 to determine growth increments and, hence, productivity for scampi (Cryer 1995), but no recapture data are yet available.

3. Review of the Fishery

3.1 TACCs, Catches and Management Controls

Until 1992, access to the scampi fishery was restricted by non-QMS permitting policies and regulations. There were also restrictions on the vessels that could be used in each QMA, but there were no limits on catches. For the 1991–92 and subsequent fishing years, catch limits were applied. Fisheries in QMAs 1, 2, 3, 4, and 6A were considered to be "developed", and catch limits were allocated to individual permit holders on the basis of their catch history. Conversely, fisheries in QMAs 5, 6B, 7, 8, and 9 were not thought to be fully "developed", and catch limits remained competitive. All catch limits and vessel restrictions are specified on the fishing permits of participants. Estimated landings are shown in Table 1.

3.2 Non-commercial Fisheries

There are no non-commercial fisheries for New Zealand scampi.

Table 1: Estimated commercial landings (t) from the 1986–87 to 1994–95 fishing years and current catch limits (t) by QMA (from Ministry of Fisheries catch effort database, Trawl Catch Effort and Processing Returns, TCEPR, as at 16 February 1996; early years may be incomplete; data for 1994–95 provisional and probably incomplete). –, no data probably zero catch; * no separate catch limits for QMAs 6A and 6B before 1992–93, total catch limit 300 t.

	QMA 1		QMA 2		QMA 3		QMA 4		QMA 5	
	Landings	Limit	Landings	Limit	Landings	Limit	Landings	Limit	Landings	Limit
1986–87	5		–		–		–		–	
1987–88	15		5		–		–		–	
1988–89	60		17		–		–		–	
1989–90	103		135		–		–		–	
1990–91	179		295		–		23		–	
1991–92	132	120	221	245	0	60	246	250	0	60
1992–93	125	120	210	245	84	60	211	250	2	60
1993–94	115	120	244	245	64	60	261	250	1	60
1994–95	108	120	226	245	62	60	216	250	0	60

	QMA 6A		QMA 6B		QMA 7		QMA 8		QMA 9	
	Landings	Limit	Landings	Limit	Landings	Limit	Landings	Limit	Landings	Limit
1986–87	–		–		–		–		–	
1987–88	–		–		–		–		–	
1988–89	–		–		–		–		–	
1989–90	–		–		–		–		–	
1990–91	2		–		–		–		–	
1991–92	322	*300	4		0	75	0	60	0	60
1992–93	198	250	81	50	2	75	0	60	2	60
1993–94	224	250	78	50	0	75	0	60	1	60
1994–95	188	250	7	50	2	75	0	60	0	60

4. Research

4.1 Relative biomass indices

4.1.1 Unstandardised CPUE indices for QMAs 1, 2, 3, 4, and 6A

The few vessels that trawl for scampi are mostly of similar size and power. The vessels fishing any particular scampi stock and the seasonal pattern of fishing tend to be similar among years. Thus, although significant seasonal and vessel effects can be detected in linear models of commercial CPUE in QMA 1 (Cryer *et al.* unpublished), the calculation of an unstandardised index as the total catch divided by total fishing effort for a given QMA is also considered to be useful. Unstandardised indices for all QMAs where scampi has been fished consistently are shown in Table 2. These catch rate indices (kg greenweight per hour of trawling) are each indexed to the first year in that QMA when significant fishing was undertaken. Constituent data for unstandardised indices are summarised in Figures 2 to 6.

Table 2: Unstandardised CPUE indices (total catch divided by total effort, kg per hour) for scampi in QMAs where significant fishing has been undertaken. For each QMA, an index relative to the first year of significant fishing has been calculated for each fishing year.

Fishing	QMA 1		QMA 2		QMA 3		QMA 4		QMA 6A	
year	CPUE	Index	CPUE	Index	CPUE	Index	CPUE	Index	CPUE	Index
1988–89	33.03	1.00	33.90	1.00	–	–	–	–	–	–
1989–90	32.08	0.97	29.63	0.87	–	–	–	–	–	–
1990–91	22.82	0.69	25.01	0.74	19.18	1.00	36.01	1.00		–
1991–92	21.82	0.66	25.78	0.76	24.93	1.30	20.62	0.57	66.09	1.00
1992–93	28.25	0.86	30.72	0.91	29.45	1.54	30.20	0.84	47.09	0.72
1993–94	35.64	1.08	29.83	0.88	35.05	1.83	–	–	35.02	0.53
1994–95	47.43	1.44	48.80	1.44	51.64	2.69	–	–	29.55	0.45

4.1.2 Fully standardised CPUE indices for QMA 1

Cryer *et al.* (unpublished) presented fully standardised biomass indices for QMA 1 estimated as year effects from a linear model first developed by Vignaux & Gilbert (1993). This index was not updated for the current assessment because it was considered unlikely that this work would be productive. The standardised index has previously matched the unstandardised index for QMA 1 closely (other than for 1994 when only part of the data was available) and the latter has increased markedly since the previous assessment. Production modelling using either index was considered highly unlikely to generate realistic estimates of current or reference biomass under these circumstances.

Indices for the previous assessments in 1993 and 1995 are given in Table 3.

Table 3: Relative year effects ($A_{j,date}$ being putative relative stock indices from stock assessments in the year given and $s_{Aj,1995}$ and cv_{Aj1995} are the standard error and coefficient of variation of the indices calculated for 1995) from a linear model of log (catch per nautical mile) for scampi in QMA 1 between 1989 and 1994. It should be noted that the index for 1994 includes only about 6 months of data and may be unreliable.

Year	$A_{j,1993}$	$A_{j,1995}$	$s_{Aj,1995}$	cv_{Aj1995} (%)
1989	1.00	1.00	0.00	NA
1990	0.74	0.70	0.03	4
1991	0.67	0.63	0.03	5
1992	0.67	0.66	0.03	5
1993	NA	0.95	0.05	5
1994	NA	0.79	0.05	6

4.1.3 Trawl survey indices for QMAs 1 and 2

Trawl surveys using *Kaharoa* were carried out on the main scampi grounds in QMAs 1 and 2 during January in 1993, 1994, and 1995. Relative biomass estimates were derived using the Trawlsurvey Analysis Program (Vignaux 1994), constrained to strata in areas where commercial fishing for scampi is common (Tables 4 and 5). For all such estimates, a value of 1.0 was assumed for vulnerability, vertical availability, and areal availability. The assumption of vertical availability is likely to be conservative as many animals are probably in burrows and not available to the trawl gear. The assumption of areal availability is likely to be appropriate, given that these indices are derived for currently developed fishery areas only. Estimates for the whole of each QMA would be larger. The selectivity characteristics of the standard research trawl gear and their effect on vulnerability are not known, but are currently under investigation.

Table 4: Relative biomass estimates for QMA 1 estimated from *Kaharoa* trawl surveys. Strata containing depths between 200 and 600 m between Great Barrier Island and White Island were included.

	KAH9301	*KAH9401*	*KAH9501*
Biomass estimate (t)	222.7	275.7	337.8
Standard error (t)	22.6	39.6	45.9
c.v. (%)	10.1	14.4	13.6
Index relative to KAH9301	1.000	1.238	1.517

Table 5: Relative biomass estimates for QMA 2 estimated from *Kaharoa* trawl surveys. Strata containing depths between 200 and 500 m between Mahia Peninsula and Castle Point were included.

	KAH9301	*KAH9401*	*KAH9501*
Biomass estimate (t)	166.5	125.5	154.4
Standard error (t)	22.1	19.9	25.9
c.v. (%)	13.3	15.9	16.8
Index relative to KAH9301	1.000	0.754	0.927

4.1.4 Comparison of relative biomass indices for QMAs 1 and 2

The comparison of relative biomass indices presented here is complicated because the three series are seasonally out of phase. For example, trawl surveys were carried out in January of each year whereas standardised indices of commercial CPUE were calculated for calendar years (and therefore have a midpoint of June). However, the three available indices for QMA 1 and the two available for QMA 2 are plotted together in Figures 7 and 8.

If the (probably unreliable) standardised CPUE index for QMA 1 in 1994 is excluded (on the grounds that it encompasses only half of that year's catch data), then there is excellent concordance among the three indices for QMA 1. A general decline in the relative stock index was observed between 1988 and 1992, followed by a general and somewhat steeper increase. The picture for QMA 2 is less clear, and the unstandardised CPUE index for 1995 appears to be an outlier at this stage, being so much greater than any previous index for QMA 2.

4.2 Production modelling

Production modelling using stock indices was carried out for QMA 1 for the 1993 and 1995 assessments (Annala 1993, 1995). Using decreasing stock indices for QMA 1 scampi, this technique provided estimates of virgin biomass similar to initial estimates made using the Leslie depletion method (Hore and Cryer 1992). However, current stock indices for all areas except QMA 6A show no such overall declines and, in the absence of other information on growth and recruitment, production modelling leads to unrealistically large (infinite) estimates of biomass. The production model for QMA 1 has not, therefore, been updated, and no models have been developed for other areas.

4.3 Length frequency distributions

4.3.1 Trawl survey length frequency distributions for QMAs 1 and 2

Fully scaled length frequency distributions by sex from all *Kaharoa* trawl surveys were produced using the Trawlsurvey Analysis Program (Vignaux 1994). These length frequency distributions (Figures 8 to 11) are directly comparable, being scaled to population estimates and having been taken in the same month (January) of each of the sampled years (1993 to 1995).

For QMAs 1 and 2, there does not appear to be the decrease in the proportion of large individuals and concomitant increase in the proportion of small individuals which would be consistent with heavy exploitation (under relatively constant recruitment). To the contrary, the number and proportion of large individuals appears to have been greatest in the 1995 trawl survey for both males and females.

In QMA 1, the relative abundance of males increased over the three surveys whereas the relative abundance of females stayed about the same. Both sexes behaved similarly in QMA 2.

4.3.2 Observer length frequency distributions for QMAs 1, 2, 3, 4, and 6A

Observers collect length frequency samples on an opportunistic basis, depending on the fishing pattern of the vessel on which they are working. Moreover, samples are taken haphazardly throughout the year and rarely are there sufficient data for a given month or quarter to make a good estimate of overall length frequency distribution. For all these reasons, observer samples cannot be taken as random samples of the whole and cannot be scaled directly to the whole population (fishstock) in any meaningful manner. However, gross changes in scampi population length frequency distributions should be apparent in observer length frequency distributions in the absence of large changes in fishing practice (for example, fishing depths or gear).

Annual amalgamations of all observer length frequency measurements within each QMA are presented in Figures 12 to 16. It is difficult to draw any strong support for any hypotheses of impact on the population by heavy fishing pressure from these data.

In QMA 1, observer length frequency distributions show qualitatively similar trends to fully scaled distributions from trawl surveys in that the proportion of large animals was largest in 1995. This observation should be treated with some caution, however, as there were no significant samples taken in 1993 and 1994, the years of the first two trawl surveys.

In QMA 2, the proportion of large animals was greatest in the first year of sampling in 1991, but there has been no consistent decreasing trend in this proportion since.

The scampi fisheries in QMAs 3 and 4 are both on the Chatham Rise–Mernoo Bank and, as the stock appears to straddle the QMA boundary, these two areas will be considered as one. The proportion of very large (over 60 mm orbital carapace length, OCL) males in length frequency samples from QMAs 3 and 4 was very high in 1992 to 1994, but decreased markedly in 1995, especially in samples from the western side of the area where fishing has been concentrated in recent years. Given the spatially variable nature of this fishery and the (necessarily) haphazard nature of collection of length frequency samples by observers, it is difficult to draw any conclusions from this observation, especially given the relatively small sample taken in 1995. There are few differences among samples of female scampi measured from QMAs 3 and 4.

Anecdotal reports from some skippers of scampi trawlers suggest that the average size of scampi in the fishery in QMA 6A declined markedly between 1992 and 1994. However, although there appears to be a decrease in the proportion of large animals, especially males, over this time, this trend is not very marked.

Strong pulses of recruitment entering any given scampi stock should be reflected in increasing proportions of small animals and, in more extreme cases, by separate and visible cohorts of small individuals. This pattern is not evident in any of the length frequency distributions presented, suggesting that recruitment is not highly variable in this species. The lack of evidence for large changes in recruitment is further evidence that changes in catchability rather than changes in stock size are responsible for much of the observed variation in our indices of stock abundance.

4.4 Sex ratios

In common with length frequency information, sex ratios estimated by trawl survey samples scaled directly to population size (within the survey area) can be considered representative of the population whereas opportunistic samples collected by observers cannot be considered either statistically random or representative. However, sex ratios within commercial catches and trawl surveys have apparently changed quite markedly since sampling began. The nature of these changes is not consistent among QMAs: the proportion of males is low but increasing in QMA 6A, for example, but high and relatively constant in QMA 3 (Table 6).

Table 6. Number of scampi measured and percentage of males measured by scientific observers on board scampi trawlers since 1991 (calendar years, data are unscaled raw counts) and by research staff during *Kaharoa* trawl surveys ("KAH9301" et sec; January of each year, data are scaled population estimates * 10^{-3}) since 1993. Observers use a different notation for Fishery Management Areas, denoted here as AKE, CEE etc.

		1991	1992	KAH9301	1993	KAH9401	1994	KAH9501	1995
AKE	Males	4 890	1 123	2 100	–	2 844	69	3 787	1 728
(QMA 1)	Females	7 068	990	1 986	–	2 311	31	2 465	1 291
	% Male	40.9	53.1	51.4		55.2	69.0	60.6	57.2
CEE	Males	3 861	41	1 679	1 167	1 260	3 693	1 522	3 139
(QMA 2)	Females	4 269	59	1 320	1 718	941	3 843	1 147	4 494
	% Male	47.5	41.0	56.0	40.5	57.2	49.0	57.0	41.1
SEC	Males	23	37	–	3 132	–	1 718	–	833
(QMA 3)	Females	15	18	–	2 297	–	882	–	467
	% Male	60.5	67.3		57.7		66.1		64.1
SOE	Males	114	1 577	–	4 330	–	1 313	–	1 779
(QMA 4)	Females	126	1 382	–	4 088	–	1 087	–	1 321
	% Male	47.5	53.3		51.4		54.7		57.4
SOI	Males	–	4 200	–	4 874	–	2 595	–	1 217
(QMA 6)	Females	–	7 633	–	6 648	–	2 461	–	1 383
	% Male		35.5		42.3		51.3		46.8

For QMA 2, observer estimates of sex ratio from the commercial fishery tend to be biased towards females compared with estimates made from trawl surveys: observers recorded about 55% female compared with 43% female in trawl survey data. (This inference cannot be made for QMA 1 as the level of observer sampling was very low in 1993 and 1994.) The reasons for this difference are not known, but could relate to seasonal differences (commercial fishing being year round compared with trawl surveys in January) or spatial differences in sampling.

4.5 Synthesis of available information by QMA

4.5.1 QMA 1

In QMA 1, catch and effort data from 1988 to 1992 suggested that substantial declines in stock size had occurred. Since that time, fishery dependent (CPUE) and independent (trawl survey) indices of relative abundance have increased, and length frequency and sex ratio estimates have been consistent with a population under light fishing pressure. Relatively large changes in sex ratio, such as those observed in trawl surveys, and the lack of evidence for increasing recruitment of small individuals, are more consistent with a population in which catchability rather than total biomass is changing. This combination of observations suggests that our indices of stock biomass are not good ones in QMA 1 (being sensitive to changes in catchability) but that nonetheless the stock has probably not been reduced to a low level. It appears likely that initial estimates of stock size were conservative, and that current levels of catch will not reduce the stock to a low level in the short term.

4.5.2 QMA 2

In common with QMA 1, catch rates for scampi in QMA 2 declined markedly between 1988 and 1992 and have increased thereafter. In contrast with QMA 1, however, this pattern is not strongly corroborated by trawl survey indices of abundance. Length frequency distributions collected by observers and from trawl surveys are consistent with relatively light fishing pressure and relatively stable recruitment and changes in sex ratio suggest that catchability is a major factor driving the biomass indices. It appears that initial estimates of stock biomass were probably conservative and that current levels of catch are not likely to reduce the stock to low levels in the short term.

4.5.3 QMAs 3 and 4

The changing spatial pattern of the fishery on the Chatham Rise, straddled across QMAs 3 and 4, complicates interpretation of the available data. This is especially the case given that all such data are fishery dependent. However, commercial catch rates appear to have increased markedly since the start of this fishery in 1990 and the information on length frequency distribution and sex ratios from observers is equivocal. Little can therefore be said about the state of this stock.

4.5.4 QMA 6A

Commercial catch rates around the Auckland Islands have fallen consistently since the start of the target fishery in 1991. However, anecdotes from some fishers of large declines in average size are not supported by measurements taken by observers, although there has been some decline in the proportion of very large individuals. Little can be said about the state of this stock, although the large decline in commercial CPUE does suggest that some vigilance should be exercised.

4.6 Yield Estimates

4.6.1 Estimation of Maximum Constant Yield

MCY cannot be estimated for any stock because there are no reliable estimates of current or reference biomass and landings have been constrained by catch limits.

4.6.2 Estimation of Current Annual Yield

CAY cannot be estimated for any stock because there are no estimates of current biomass.

5. Management Implications

This assessment is considerably less certain than previous assessments in 1993 and 1995, although the tentative nature of conclusions in those assessments was stressed at the time. Biomass and yield cannot now be reliably estimated for any stock, and previous estimates of virgin biomass for QMAs 1 and 2 should now be regarded as probably being conservative.

Increases in commercial CPUE in QMAs 1 to 4 since 1992 suggest that some environmental cue may be affecting catch rates through catchability, or that changes in fishing practice across most of the fleet are leading to better catches. Such an increase in fishing power might be expected in a developing new fishery, but the QMA 1 fishery is now relatively established and yet shows one of the strongest increases in recent years. In addition, increases in minimum mesh size since 1991 should have led to somewhat lower catch rates, whereas the opposite has been observed. For QMAs 1 and, to a lesser extent, QMA 2, this assessment suggests that current levels of catch are probably sustainable. Less can be said about QMAs 3 and 4 where the spatial pattern of the fishery has varied over the history of the fishery. It is not known whether current catches are sustainable in these areas.

Catch rates in QMA 6A have gone against the overall trend, declining to the lowest (unstandardised) index relative to initial catch rates so far recorded. The reasons for this are far from clear, although the magnitude of the decline would suggest that the state of this stock merits close observation. Current catch limits may not be sustainable.

Acknowledgments

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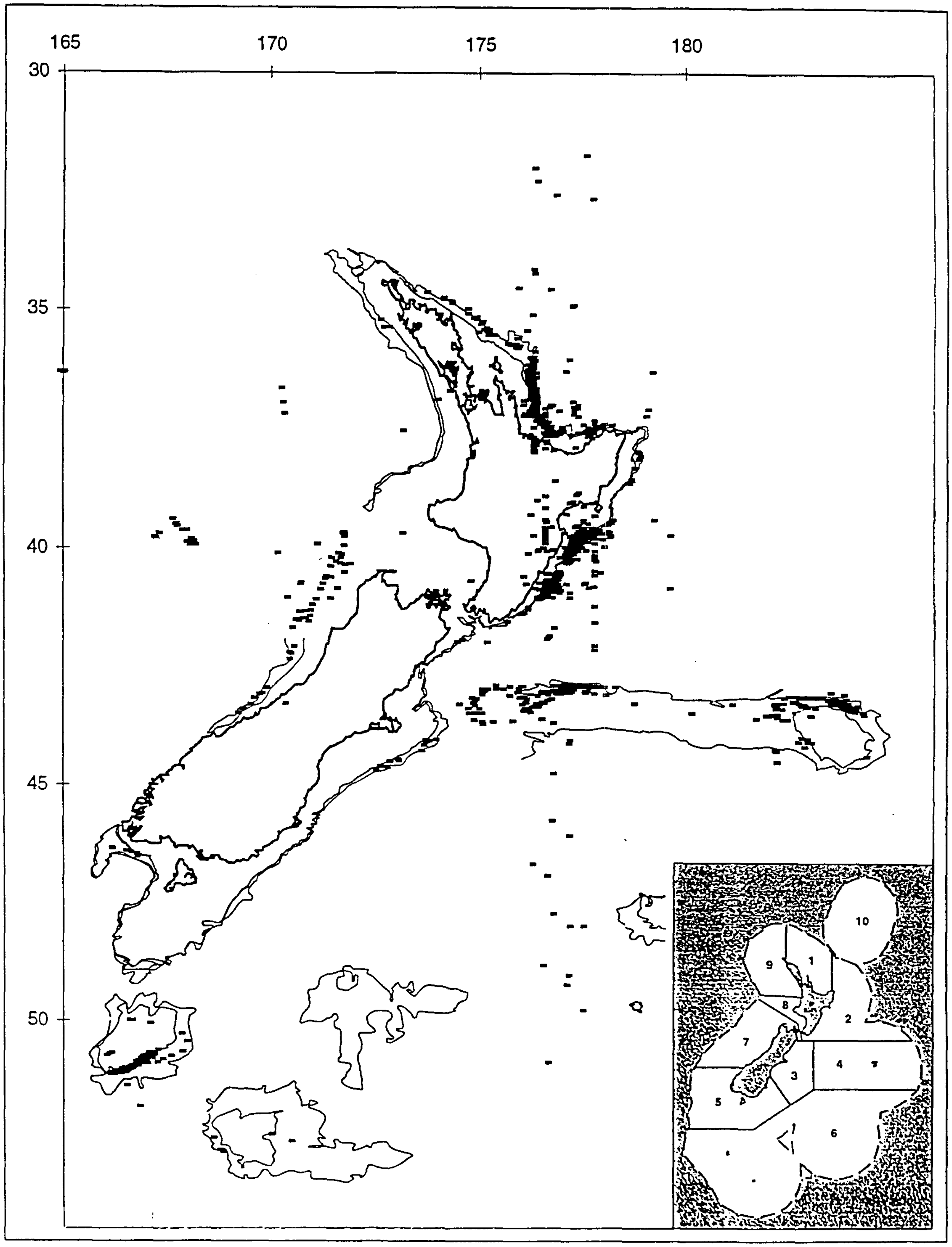
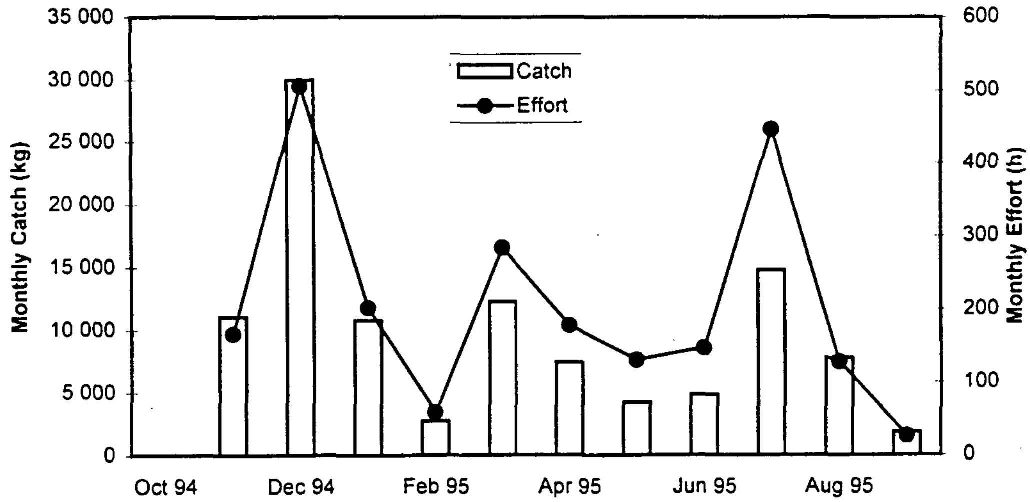
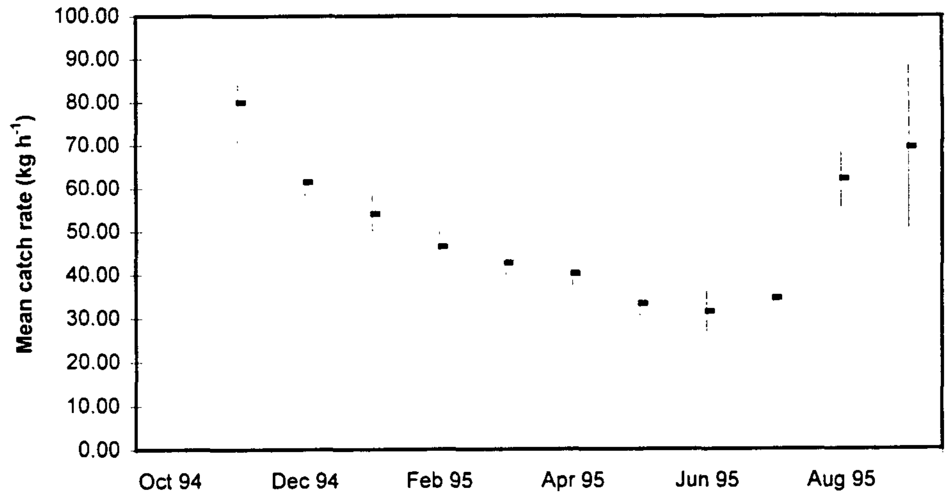


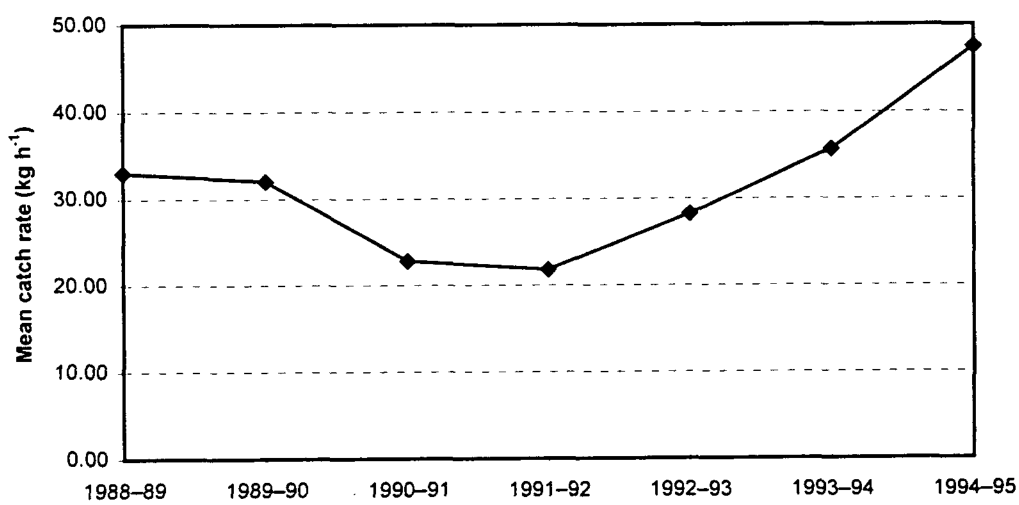
Figure 1: Fishing areas for New Zealand scampi. Depth contours of 200 and 500 m depth are shown where available. Shots outside of this depth range are likely to be errors.



Raw catch (kg) and effort (hours trawling) for QMA1 scampi, 1994–95 fishing year.

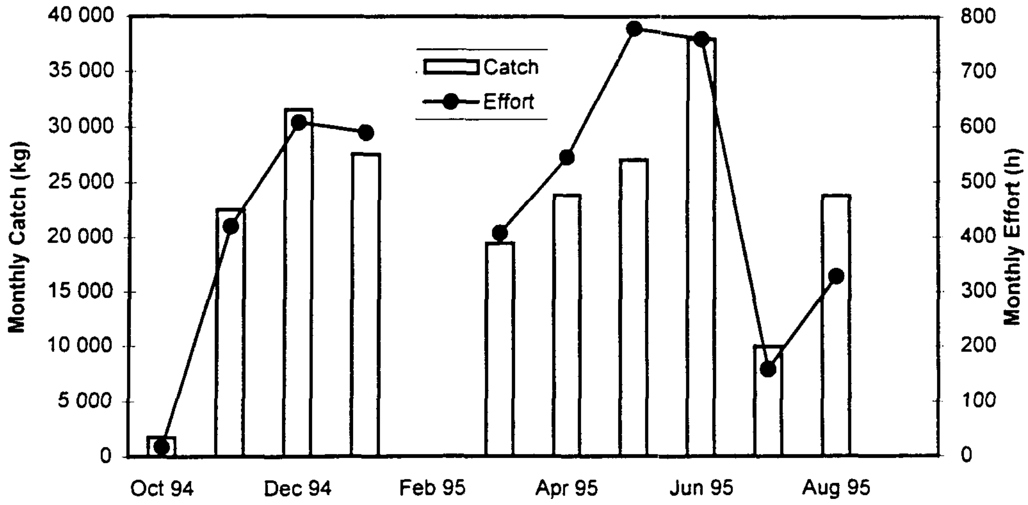


Unstandardised CPUE (kg per hour) for QMA1 scampi, 1994–95 fishing year.

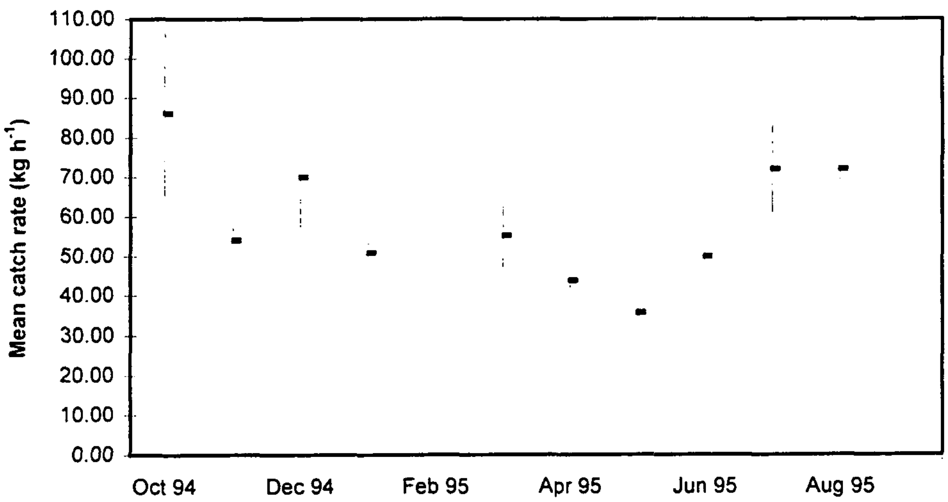


Unstandardised CPUE (kg h^{-1}) for QMA1 scampi, 88–89 to 94–95 fishing years.

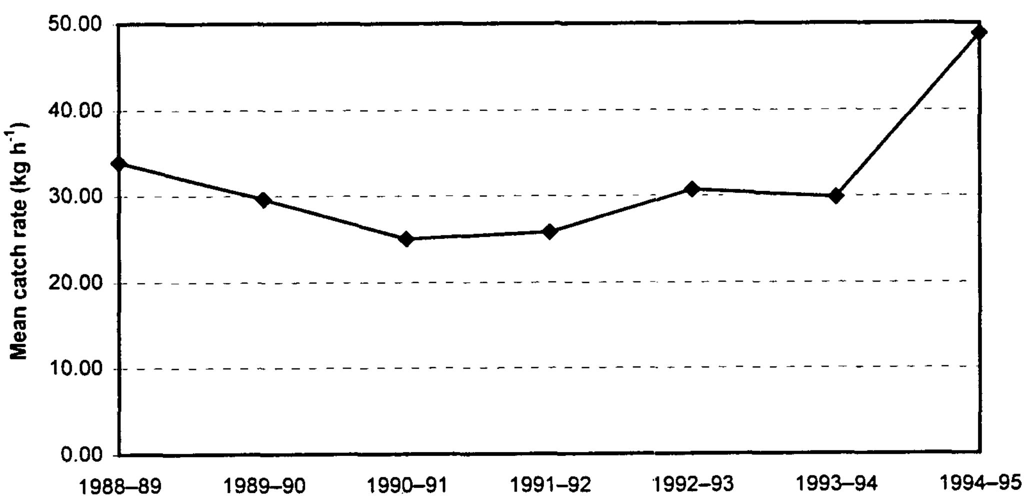
Figure 2: Catch and effort data for QMA 1 scampi in the 1994–95 fishing year (top two panels) and for 1988–89 to 1994–95 fishing years (bottom panel)



Raw catch (kg) and effort (hours trawling) for QMA2 scampi, 1994–95 fishing year.

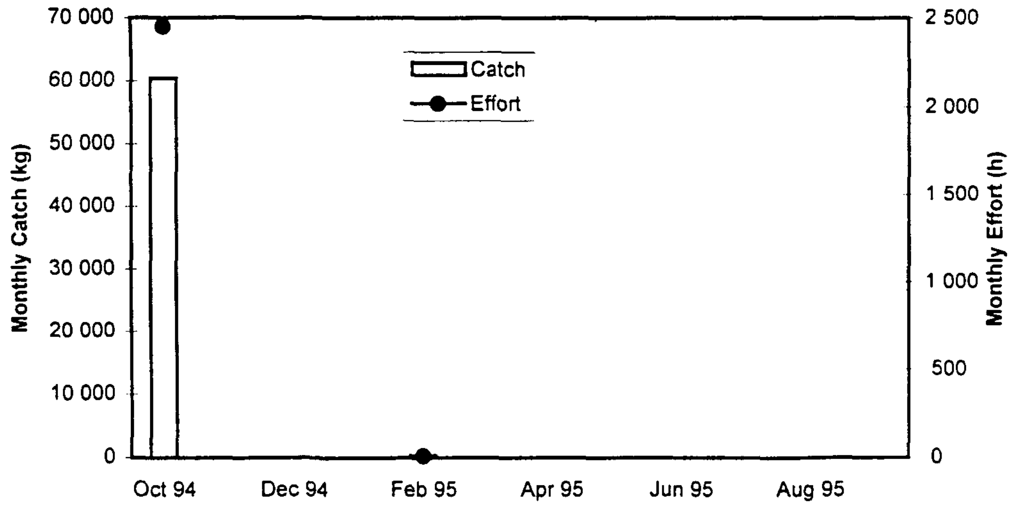


Unstandardised CPUE (kg per hour) for QMA2 scampi, 1994–95 fishing year.

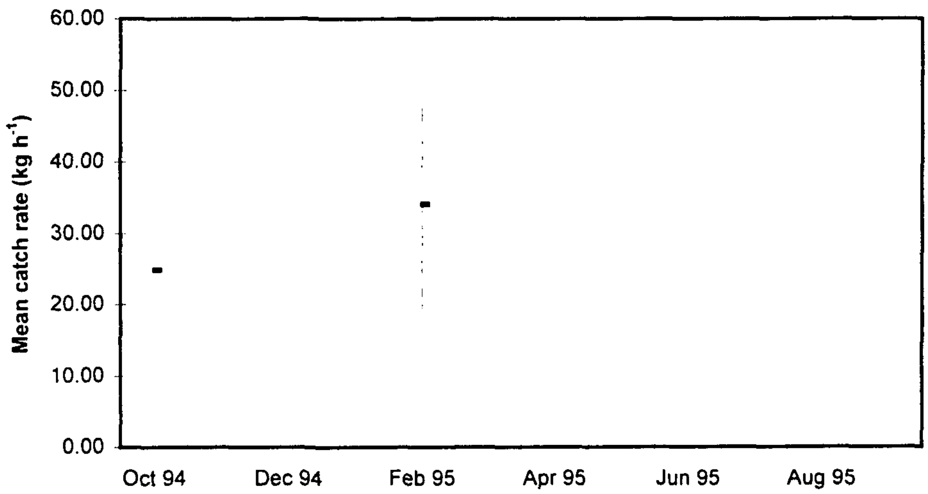


Unstandardised CPUE (kg h^{-1}) for QMA2 scampi, 88–89 to 94–95 fishing years.

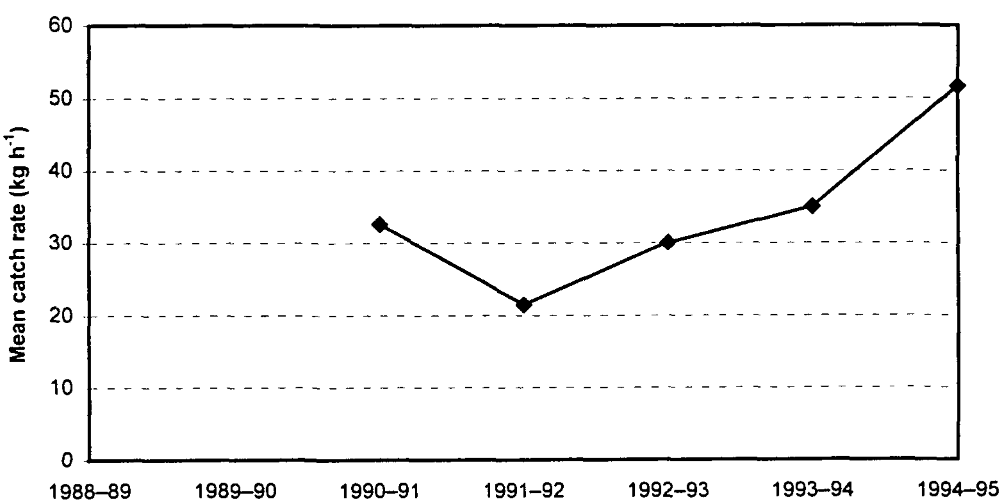
Figure 3: Catch and effort data for QMA 2 scampi in the 1994–95 fishing year (top two panels) and for 1988–89 to 1994–95 fishing years (bottom panel)



Raw catch (kg) and effort (hours trawling) for QMA3 scampi, 1994–95 fishing year.

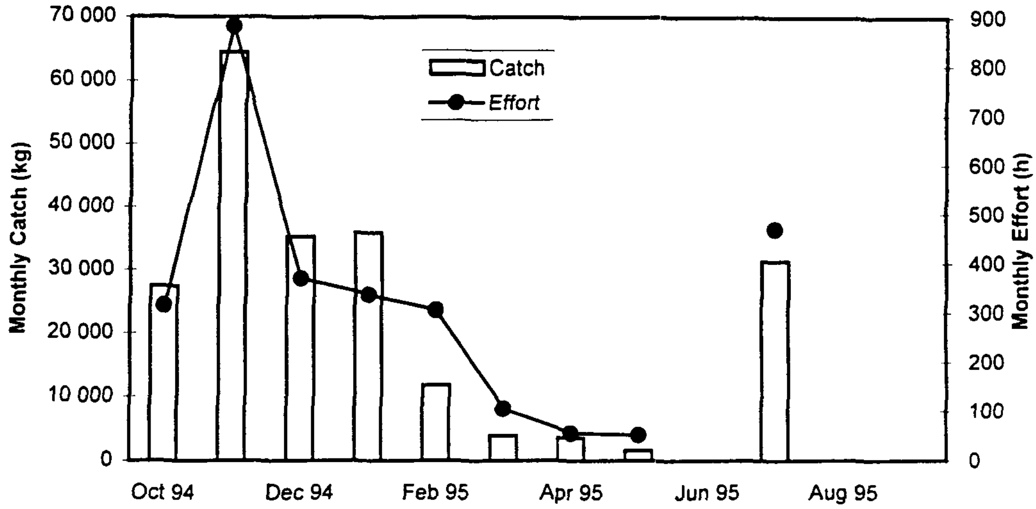


Unstandardised CPUE (kg per hour) for QMA3 scampi, 1994–95 fishing year.

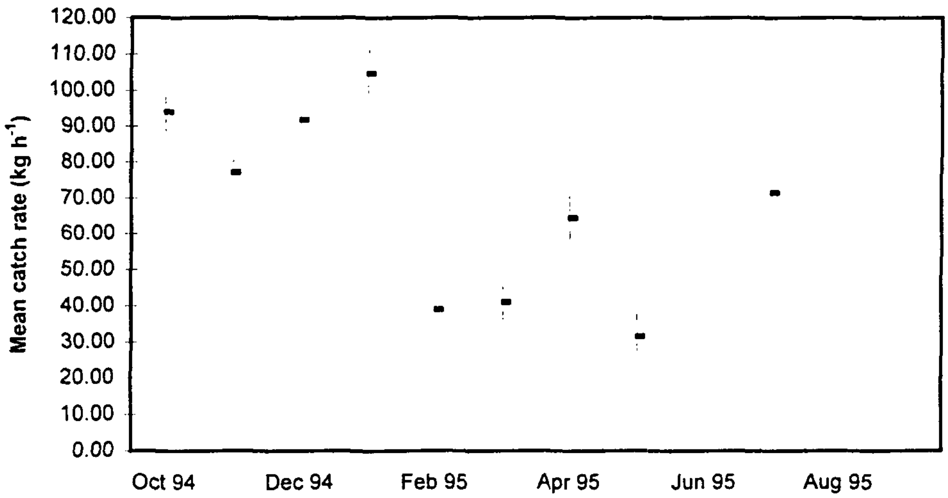


Unstandardised CPUE (kg h^{-1}) for QMA3 scampi, 88–89 to 94–95 fishing years.

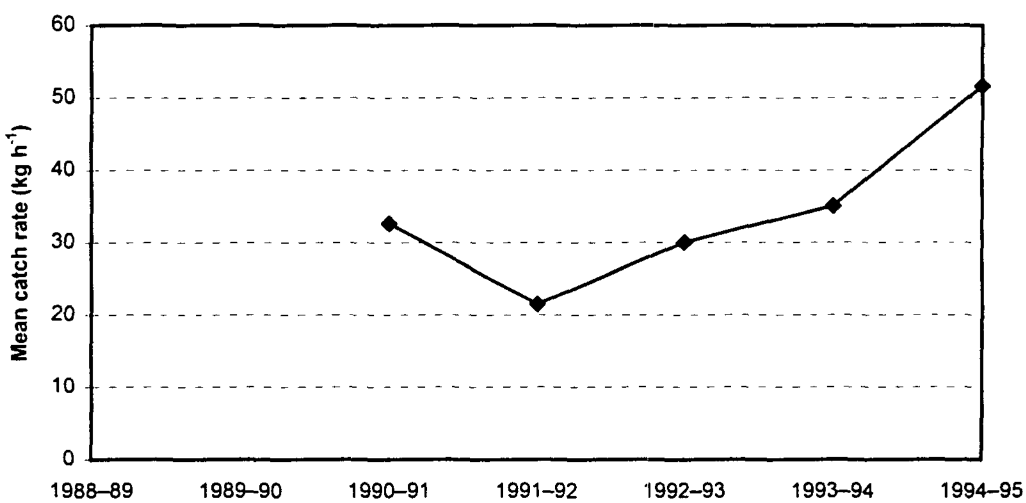
Figure 4: Catch and effort data for QMA 3 scampi in the 1994–95 fishing year (top two panels) and for 1988–89 to 1994–95 fishing years (bottom panel)



Raw catch (kg) and effort (hours trawling) for QMA4 scampi, 1994–95 fishing year.

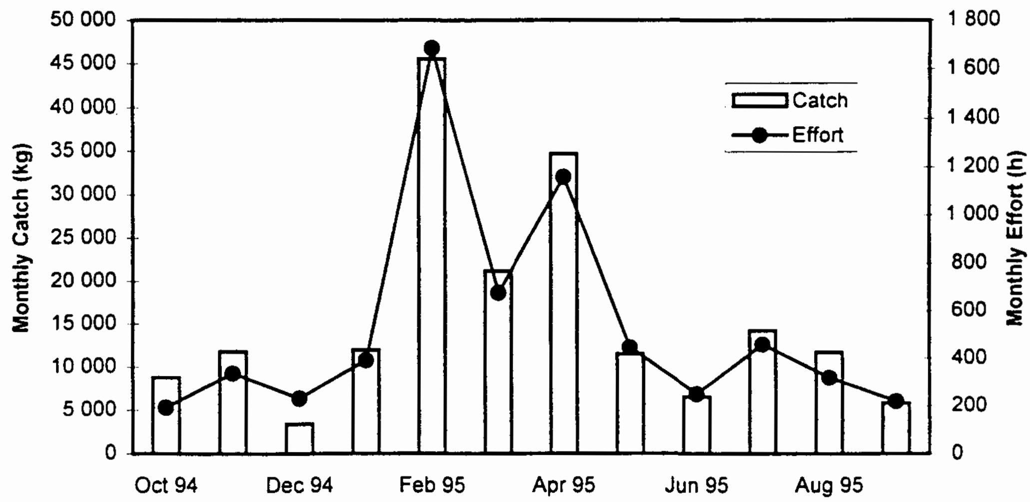


Unstandardised CPUE (kg per hour) for QMA4 scampi, 1994–95 fishing year.

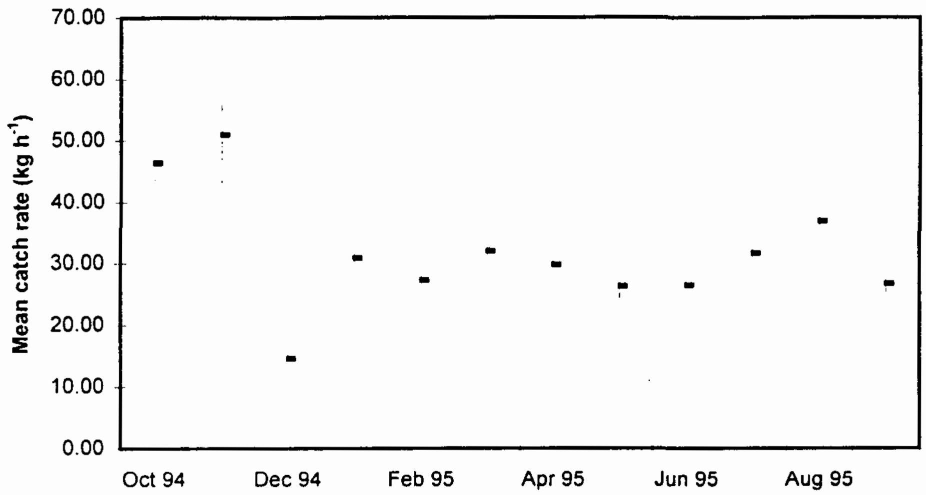


Unstandardised CPUE (kg h^{-1}) for QMA4 scampi, 88–89 to 94–95 fishing years.

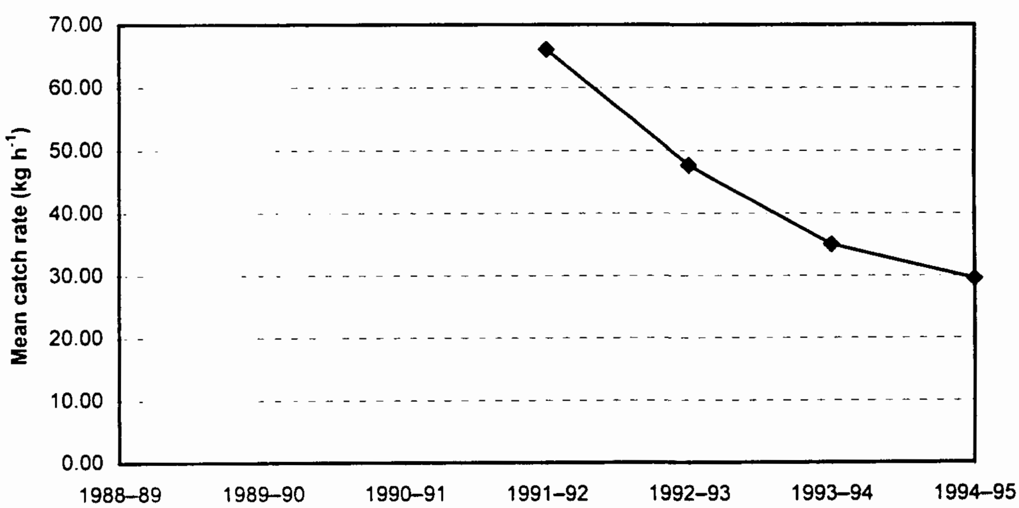
Figure 5: Catch and effort data for QMA 4 scampi in the 1994–95 fishing year (top two panels) and for 1988–89 to 1994–95 fishing years (bottom panel)



Raw catch (kg) and effort (hours trawling) for QMA6A scampi, 1994–95 fishing year.



Unstandardised CPUE (kg per hour) for QMA6A scampi, 1994–95 fishing year.



Unstandardised CPUE (kg h^{-1}) for QMA6A scampi, 88–89 to 94–95 fishing years.

Figure 6: Catch and effort data for QMA 6A scampi in the 1994–95 fishing year (top two panels) and for 1988–89 to 1994–95 fishing years (bottom panel)

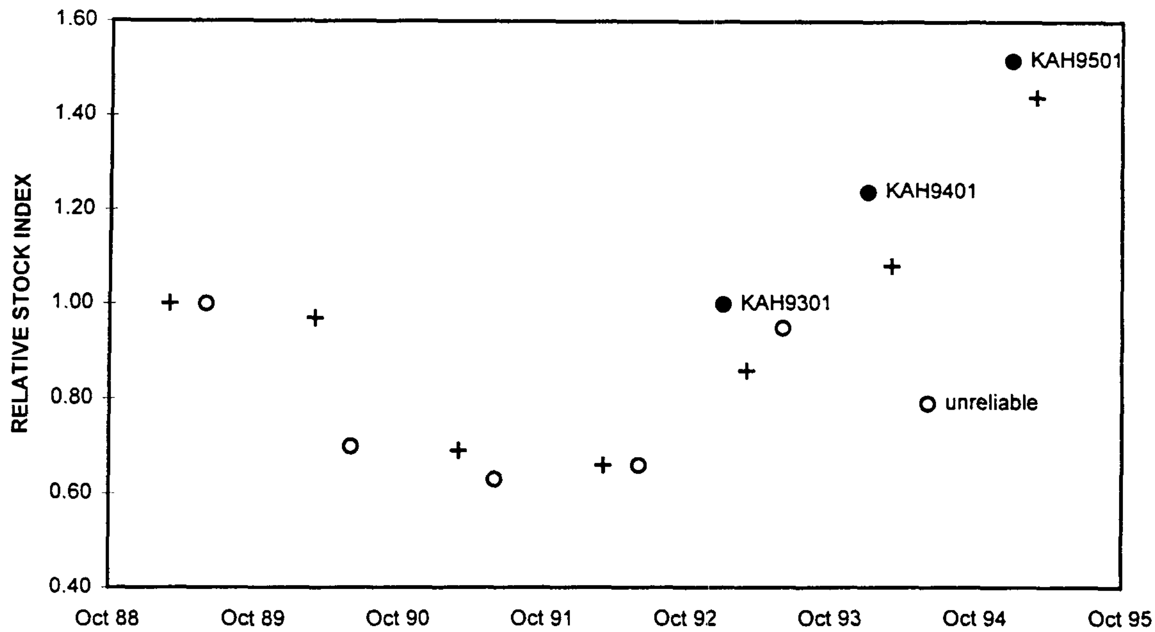


Figure 7: Comparison of three indices of relative biomass for scampi in QMA 1. Crosses indicate unstandardised commercial CPUE, open circles indicate standardised commercial CPUE (the index for 1994 being unreliable because it encompasses only 6 months of data), and closed circles indicte trawl survey indices. All indices are standardised to their respective first estimates.

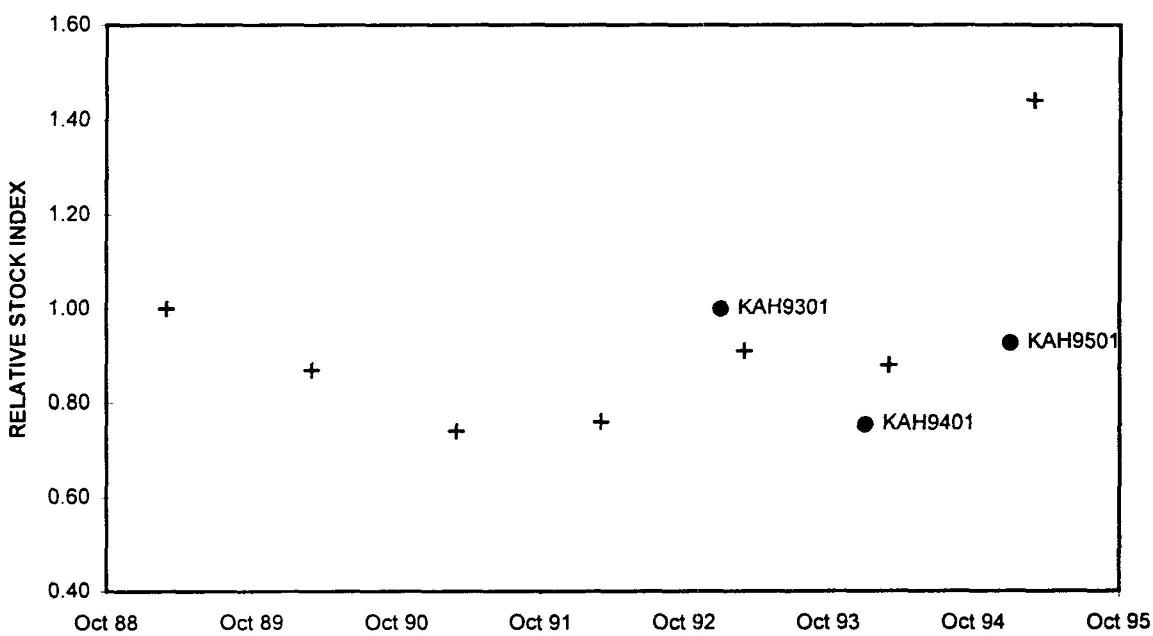


Figure 8: Comparison of two indices of relative biomass for scampi in QMA 2. Crosses indicate unstandardised commercial CPUE and closed circles indicate trawl survey indices. Both indices are standardised to their respective first estimates.

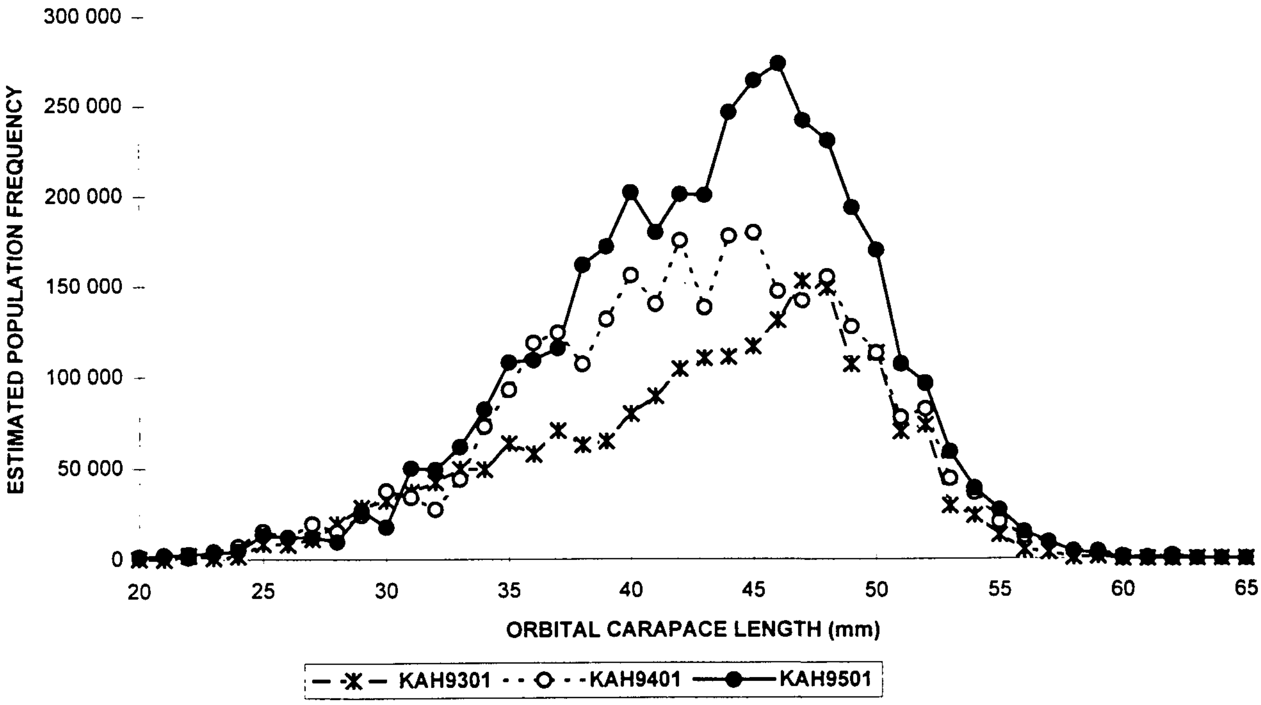


Figure 8: Population length frequency distributions of male scampi in QMA1 (west of White Island) estimated from samples measured during *Kaharoa* trawl surveys in January of 1993, 1994, and 1995.

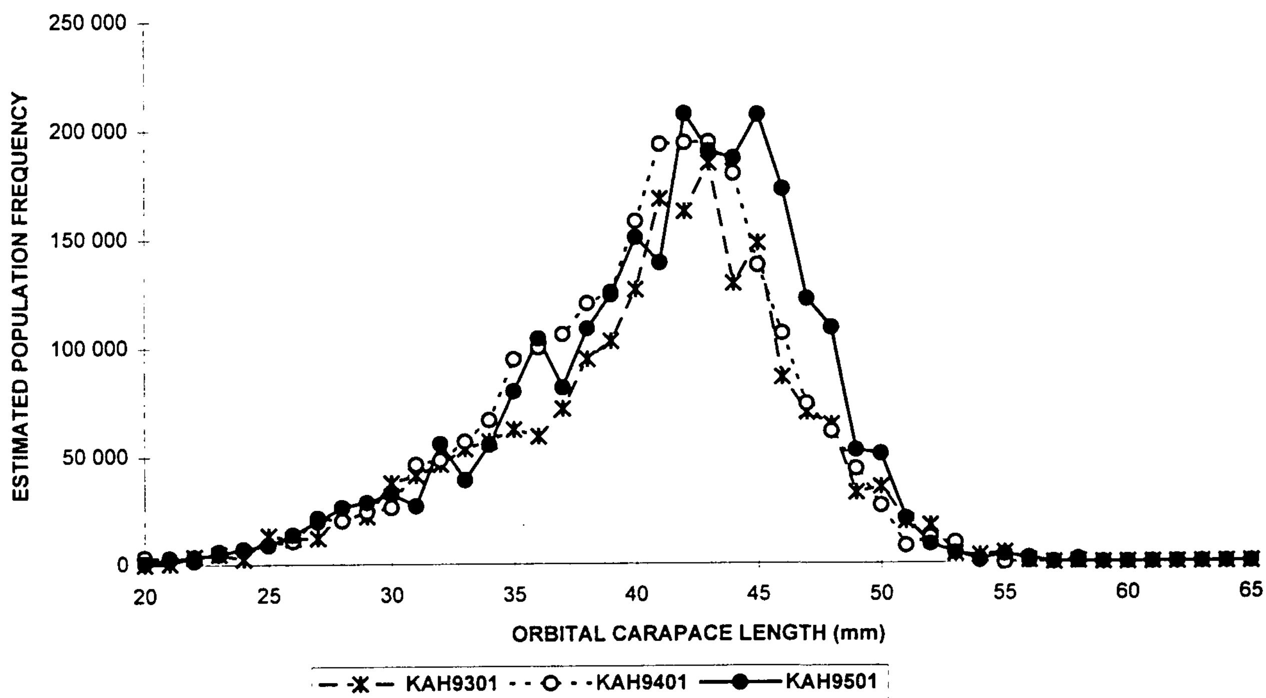


Figure 9: Population length frequency distributions of female scampi in QMA1 (west of White Island) estimated from samples measured during *Kaharoa* trawl surveys in January of 1993, 1994, and 1995.

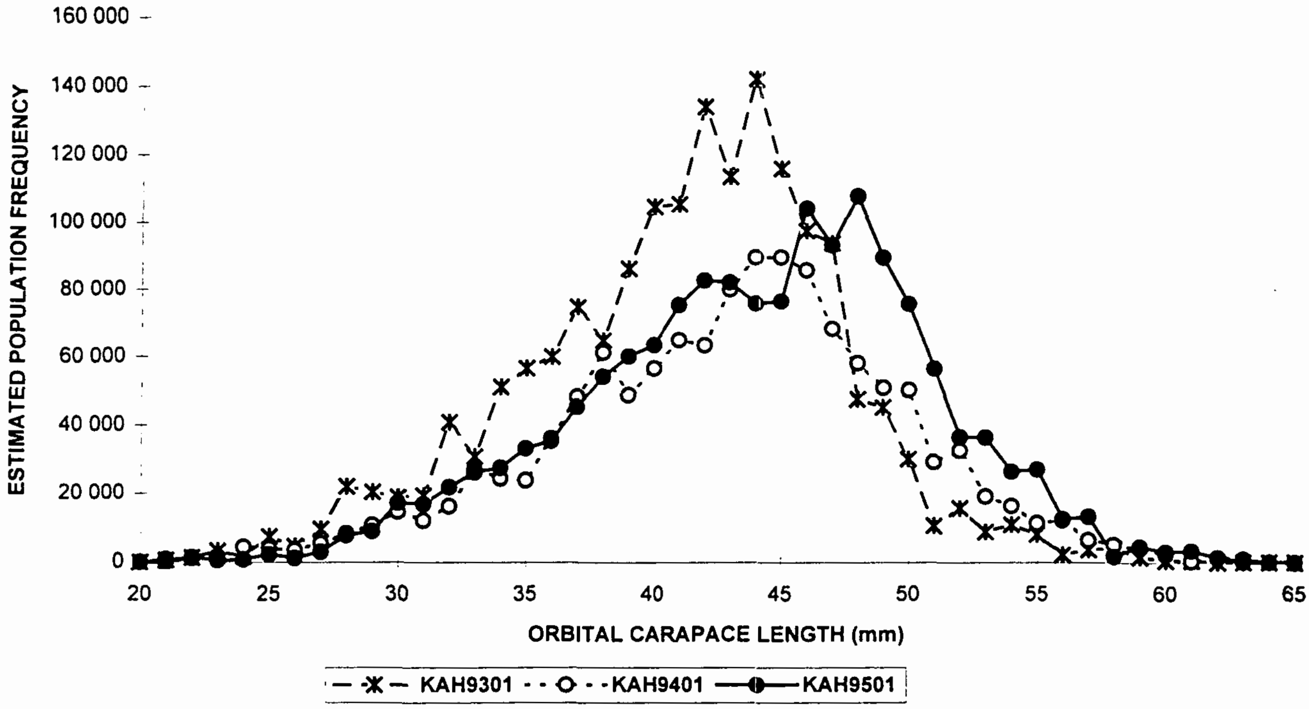


Figure 10: Population length frequency distributions of male scampi in QMA2 (south of Mahia Peninsula) estimated from samples measured during *Kaharoa* trawl surveys in January of 1993, 1994, and 1995.

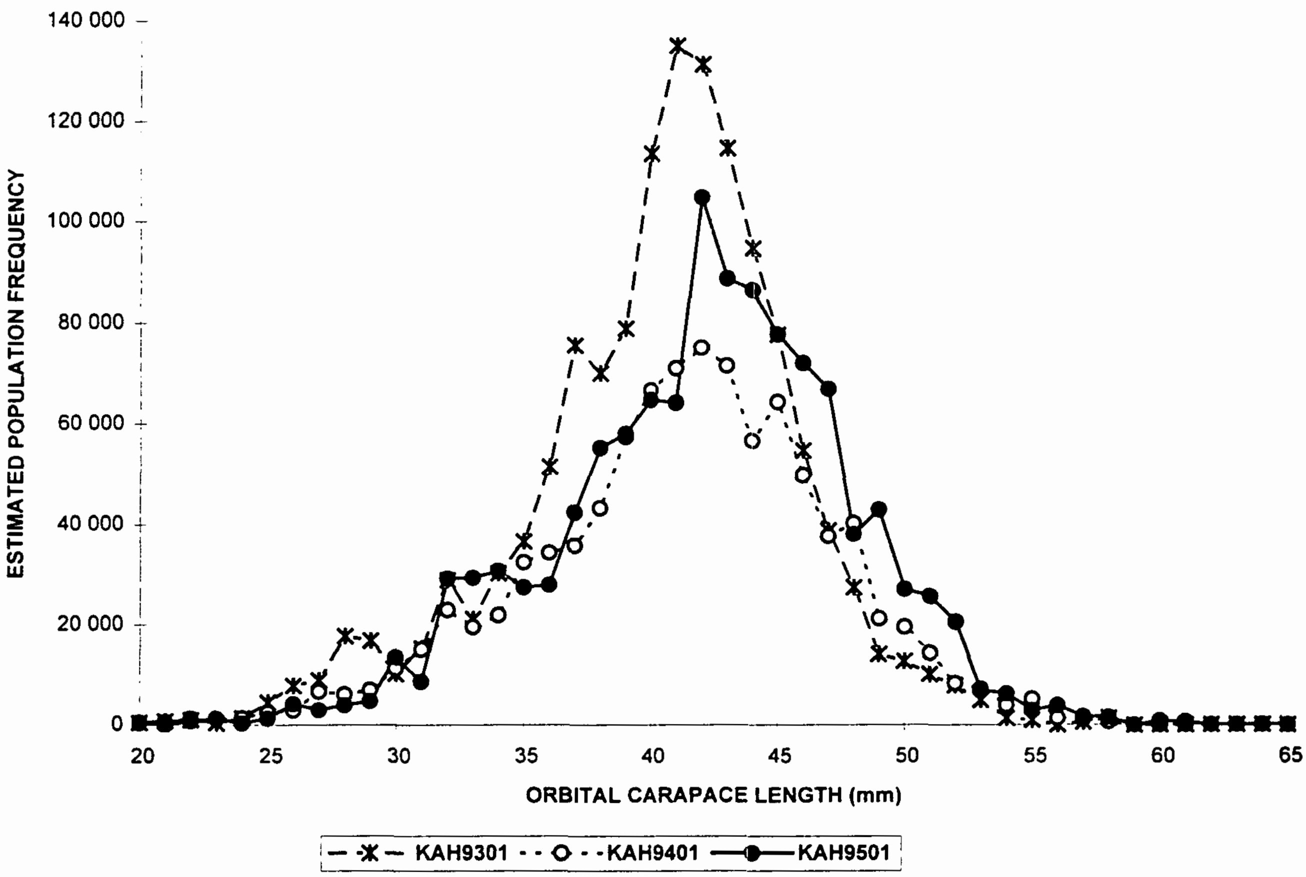


Figure 11: Population length frequency distributions of female scampi in QMA2 (south of Mahia Peninsul estimated from samples measured during *Kaharoa* trawl surveys in January of 1993, 1994, and 1995.

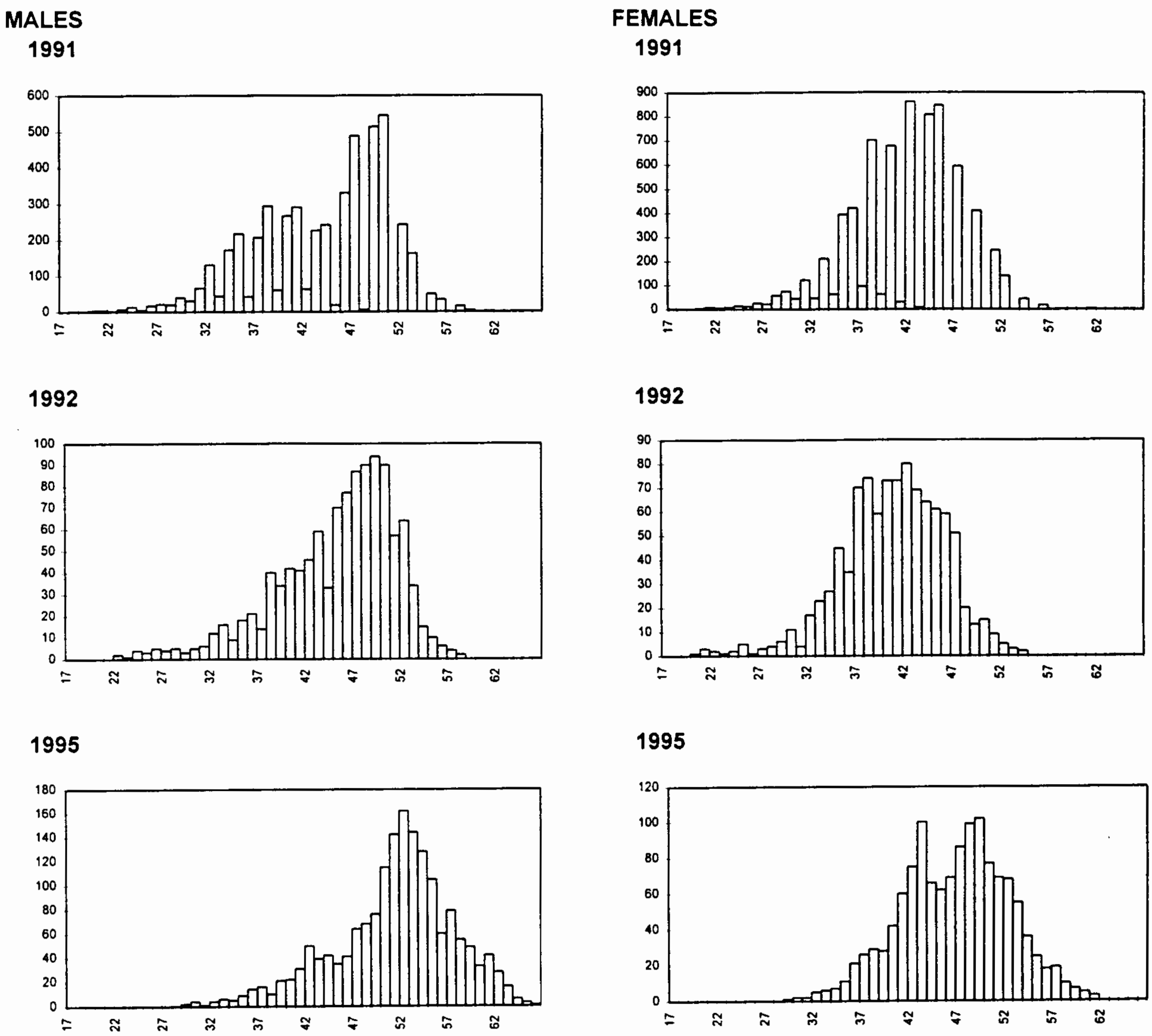


Figure 12: Annual amalgamated length frequency distributions for scampi measured by scientific observers in QMA 1 between 1989 and 1995. Some early samples were collected using different measurement methods and have been converted to the standard orbital carapace length. Years in which few samples were taken have been excluded.

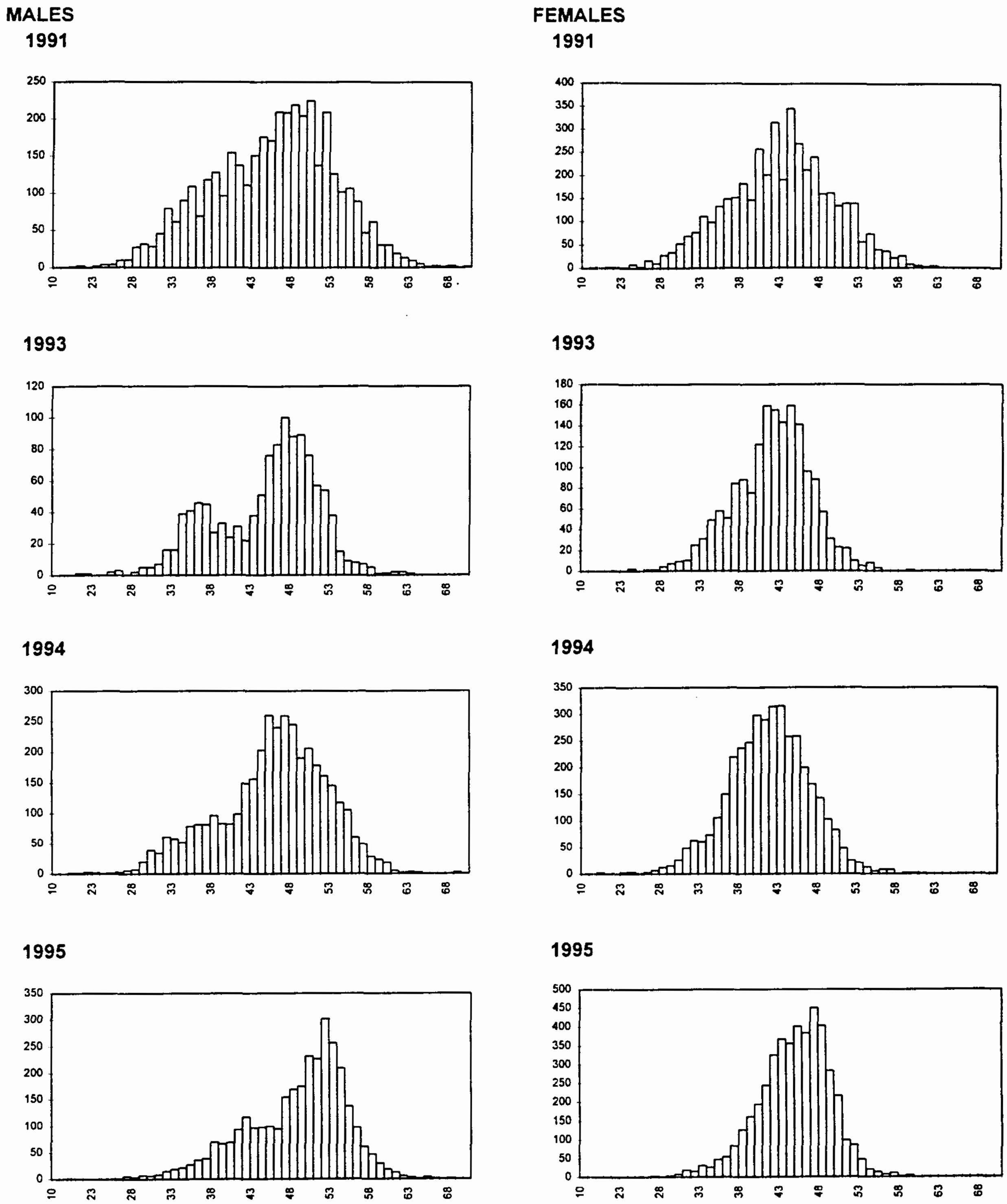


Figure 13: Annual amalgamated length frequency distributions for scampi measured by scientific observers in QMA 2 between 1989 and 1995. Some early samples were collected using different measurement methods and have been converted to the standard orbital carapace length. Years in which few samples were taken have been excluded.

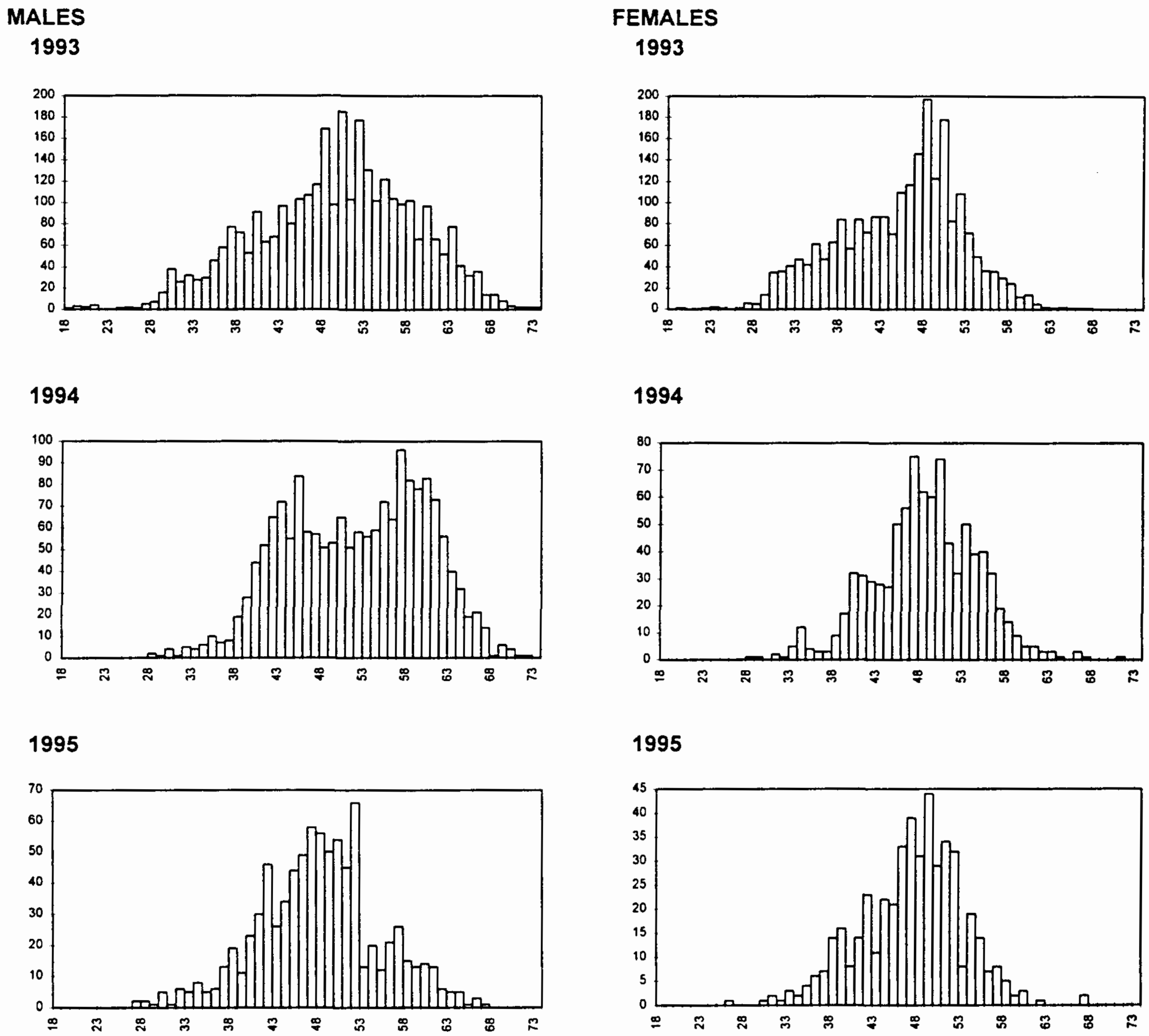


Figure 14: Annual amalgamated length frequency distributions for scampi measured by scientific observers in QMA 3 between 1989 and 1995. Years in which few samples were collected have been excluded.

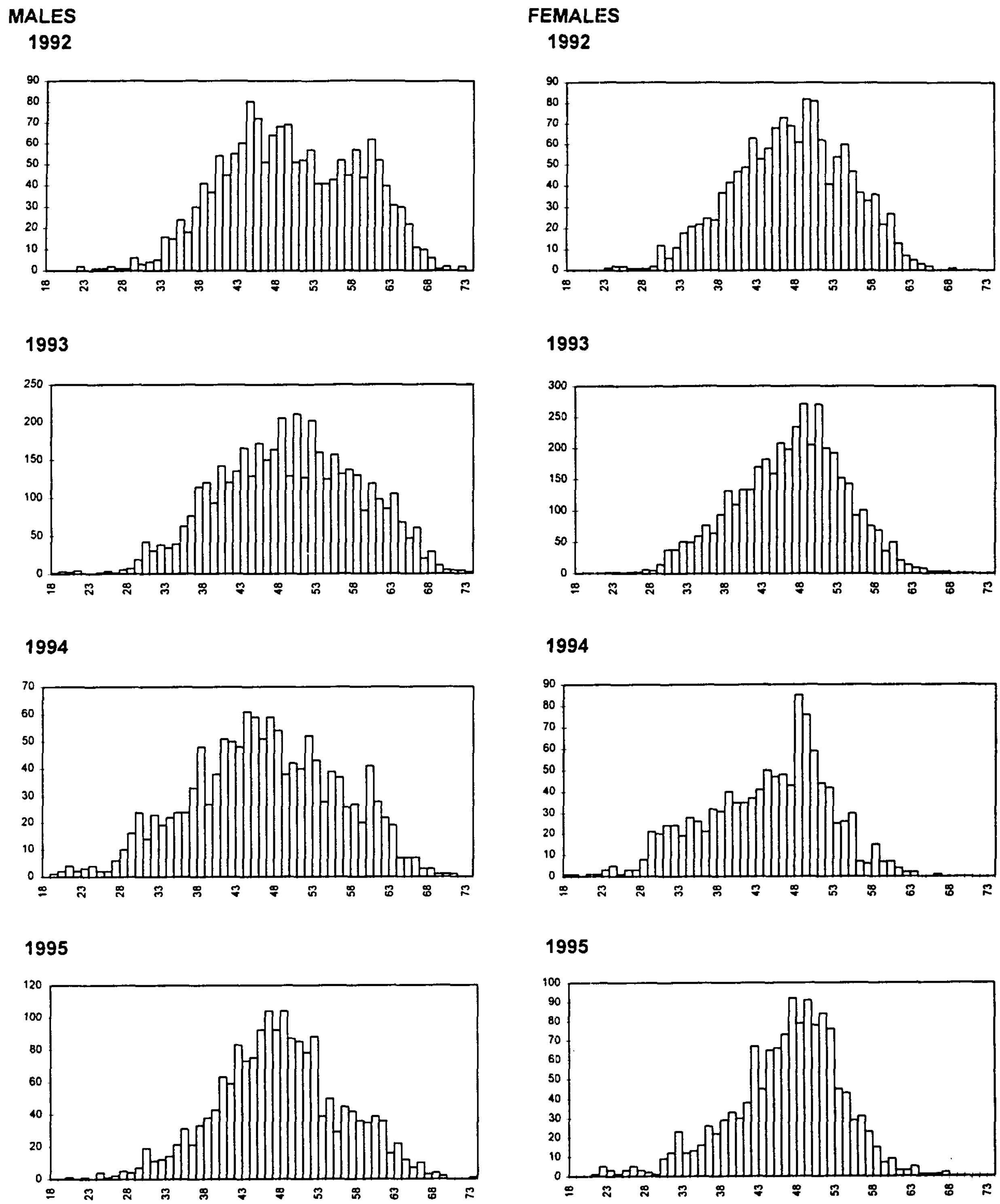


Figure 15: Annual amalgamated length frequency distributions for scampi measured by scientific observers in QMA 4 between 1989 and 1995. Years in which few samples were collected have been excluded.

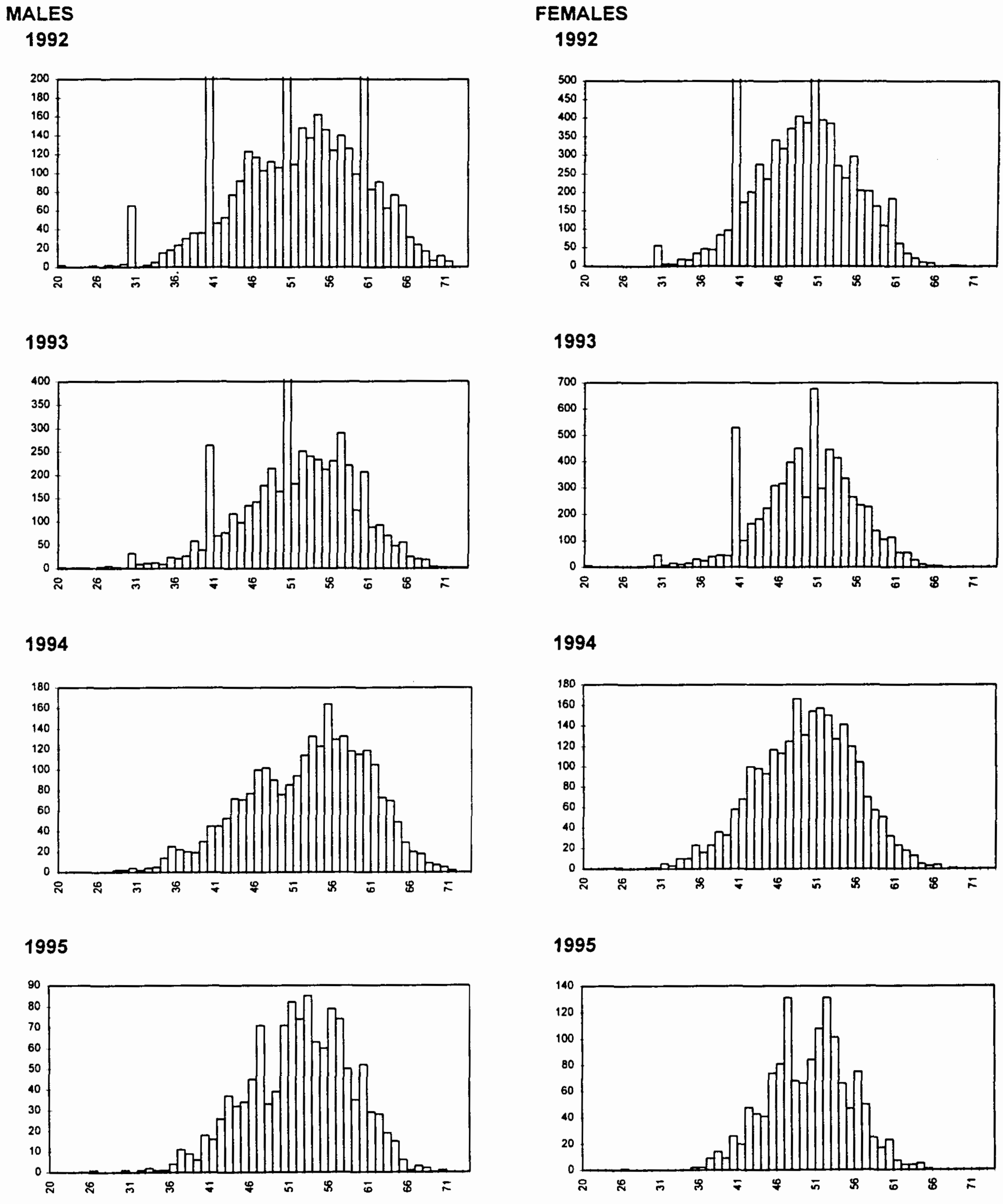


Figure 16: Annual amalgamated length frequency distributions for scampi measured by scientific observers in QMA 6A between 1989 and 1995. Years in which few samples were collected have been excluded. Irregularities in early data is caused by measurement with cm precision instead of mm precision.