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Scampi stock assessment for 1997

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1. Executive Summary

Detailed spatial, temporal, and operational characterisations of scampi fisheries in QMAs 1, 2, 3, 4 (eastern and western portions), and 6A are summarised in this document, together with other information on New Zealand scampi. Standardised and unstandardised indices of commercial CPUE are developed and, other than that for QMA 6A, these all show an increase in recent years to levels above, sometime considerably above, index years. The index for QMA 6A declined steadily between 1991–92 and 1994–95, but the 1995–96 index showed no further decline.

Trends in commercial CPUE are consistent internally and with information from trawl surveys in suggesting systematic changes in catch rates on daily and seasonal cycles, and between years. Catch rates are best early in the morning, and in the spring and summer. Changes in catch rates are probably caused by changes in catchability (specifically, vertical availability) as this is a burrowing animal which appears to spend a variable proportion of time available to trawl gear.

It is suggested that commercial CPUE and trawl survey indices of relative biomass are not good indices of abundance for this species, at least in the short to medium term, as changes in the index due to changing stock size are likely to be small compared with those due to catchability effects. Visual assessment methods using remote cameras may provide additional information on availability and trawl efficiency in the future, and this will be investigated in a research project during the 1997–98 year.

Because of the difficulties in interpreting changes in CPUE as changes in stock size, and because catches have, for the past 5 years been limited, no estimates of biomass or yield are available for any scampi stock.

The bycatch of QMS finfish species by the scampi trawl fishery is examined. The length frequency distributions of hoki, ling, giant stargazer, and gemfish show heterogeneity by area and by year, although it is difficult to draw any conclusions because of the unstructured and opportunistic manner in which these data were collected. The extent to which changes in length frequency among years are reflective of similar changes in target fisheries for these species, or can be explained by the biology of the species, is not examined in detail, but there does not seem to be strong support for the claim that scampi fisheries take a large bycatch of juvenile QMA species.

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2. Introduction

2.1 Overview

This document summarises catch, effort, observer, and research information for scampi fisheries in QMAs 1, 2, 3, 4 (east and western portions), and 6A. All major scampi fisheries are characterised in detail for the first time. Unstandardised indices of CPUE for all areas and the standardised index for QMA 1 are updated, and new standardised indices of CPUE for QMAs 2, 3, 4 (east and western portions), and 6A are developed. Scampi length frequency distributions from scientific observers presented in 1996 are not updated because almost no new information is available from scientific observers or trawl surveys. New estimates of growth rate from a tagging study in QMA 1, and length frequency distributions of the four major finfish bycatch species, hoki, ling, giant stargazer, and gemfish, are presented.

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 in QMA 1 (Bay of Plenty), QMA 2 (Hawke Bay, Wairarapa), QMA 3 (western Mernoo Bank), QMA 4 (eastern Mernoo Bank and the Chatham Rise), and QMA 6A (Auckland Islands) (Figure 1).

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 and frozen at sea.

2.3 Literature review

Cryer *et al.* (1995) and Cryer (1996) reviewed the literature and little information has been published since, other than that describing the release and recapture phases of a tagging study to estimate growth rates, carried out in 1995–96 in the Bay of Plenty (Cryer & Stotter 1997 and unpublished results).

3. Review of the Fishery

3.1 TACCs, catch, landings, and effort data

3.1.1 Estimated landings

Until 1992, access to the scampi fishery was restricted by non-QMS permitting policies and regulations. There were restrictions on the vessels that could be used in each QMA, but no limits on catches. For the 1991–92 and subsequent fishing years, catch limits were applied to all QMAs. Fisheries in QMAs 1, 2, 4, and 6A were considered to be "developed" and catch limits were allocated individually to permits in proportion to their "catch history".

Conversely, fisheries in QMAs 3, 5, 6B, 7, 8, and 9 were not considered to be "developed" and catch limits in these areas remained competitive. The QMA 3 fishery was erroneously ascribed to the former category by Cryer (1996). Estimated landings are shown in Table 1.

Table 1: Estimated commercial landings (t) from the 1986–87 to 1995–96 fishing years and current catch limits (t) by QMA (from Ministry of Fisheries catch effort database, Trawl Catch Effort and Processing Returns, TCEPR; early years data may be incomplete). – no catch limits before 1991–92; * 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	West : East	Limit	Landings	Limit
1986–87	5	–	0	–	0	–	0 : 0	–	0	–
1987–88	15	–	5	–	0	–	0 : 0	–	0	–
1988–89	60	–	17	–	0	–	0 : 0	–	0	–
1989–90	103	–	135	–	0	–	0 : 0	–	0	–
1990–91	179	–	295	–	0	–	1 : 31	–	0	–
1991–92	132	120	221	245	0	60	156 : 74	250	0	60
1992–93	125	120	210	245	84	60	213 : 11	250	2	60
1993–94	115	120	244	245	64	60	251 : 0	250	1	60
1994–95	108	120	226	245	62	60	216 : 0	250	0	60
1995–96	114	120	228	245	76	60	226 : 0	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	0	–	0	–	0	–	0	–	0	–
1987–88	0	–	0	–	0	–	0	–	0	–
1988–89	0	–	0	–	0	–	0	–	0	–
1989–90	0	–	0	–	0	–	0	–	0	–
1990–91	2	–	0	–	0	–	0	–	0	–
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	241	250	61	50	0	75	0	60	1	60
1994–95	209	250	14	50	2	75	0	60	0	60
1995–96	220	250	50	50	1	75	0	60	0	60

3.1.2 Spatial and operational trends in scampi fisheries

3.1.2.1 Trends in QMA 1

The spatial extent of the longest established scampi fishery, that in QMA 1, has remained largely unchanged since 1988–89 (Figure 2), although there has been some variability in the number of shots in peripheral areas such as around the Poor Knights Islands (fished mostly in 1990–91 and 1994–95) and west of Cape Runaway (1988–89, 1990–91, and 1994–95). In recent years, the fleet has remained fairly stable (Appendix 1). Fishing is carried out year round (Figure 3, Appendix 1) and there is a tendency for shots to be started early in the morning (before 0600 h) and about midday (Figure 4). The average duration of trawl shots increased gradually from less than 3 hours in 1988–89 to about 5.5 hours in 1991–92 and has remained relatively constant since (Figure 5). The average depth of fishing in the early years of the QMA 1 scampi fishery was about 400 m (Figure 6). This decreased gradually to about 360–370 m in 1992–93, after which it has tended gradually to increase, to about 390 m in 1995–96.

3.1.2.2 Trends in QMA 2

The spatial extent of the scampi fishery in QMA 2 has also remained largely unchanged since 1988–89 (Figure 7), although there has been some variability in the number of shots in peripheral areas, such as off Gisborne (fished mostly in 1990–91, 1991–92 and 1994–95). In recent years, the fleet has remained fairly stable (Appendix 2). Fishing is carried out year round (Figure 8, Appendix 2) and there is some tendency for shots to be started early in the morning (before 0600 h) and about midday (Figure 9). Fishing during the night is more common than it is in QMA 1. The average duration of trawl shots increased gradually from less than 3 hours in 1988–89 to almost 6 hours in 1995–96 (Figure 10). The average depth of fishing has not changed much from about 340 m throughout the history of the QMA 2 scampi fishery (Figure 11).

3.1.2.3 Trends in QMA 3

The spatial extent of the scampi fishery in QMA 3 has changed markedly (Figure 12). During 1988–89 to 1991–92, a small number of exploratory shots were made each year, mostly off Banks Peninsula. However, from 1992–93 to date, there has been an increasing concentration of fishing effort on the northeastern face of the Mernoo Bank, close to the boundary with QMA 4. In recent years, the fleet has remained large and stable (Appendix 3), and fishing is carried out in an intensive period at the start of each fishing year, reflecting the highly competitive nature of this fishery (Figure 13, Appendix 3). There is no diel pattern to fishing (Figure 14). The average duration of trawl shots increased gradually from less than 2 hours in the exploratory years 1988–89 to 1991–92 to slightly over 5 hours in 1995–96 (Figure 15). The average depth of fishing was less than 400 m during the exploratory years, but was close to 440 m in 1994–95 and 1995–96 (Figure 16).

3.1.2.4 Trends in QMA 4

The fishery in QMA 4 is carried out in two distinct areas: on the northern face of the western Chatham Rise (close to the Mernoo Bank) and north of the Chatham Islands. As these two areas are separated by over 100 n. miles and the latter was fished only for 3 years, the two will be considered separately. The dividing line between the two management areas will, for the purpose of this document, be set at 180° E. The management areas for the fishery on the western Chatham Rise will be defined as QMA 4W, and that close to the Chatham Islands as QMA 4E.

The spatial extent of the fishery in QMA 4W has remained largely unchanged since its inception in 1991–92 (Figure 17) and the fleet has remained fairly stable (Appendix 4). Fishing is carried out for most of the year, with some tendency for lower effort in winter (Figure 18, Appendix 4), although 1995–96 was unusual in that there was no fishing during January to March. There is a weak diel pattern, with a tendency for shots to be started early in the morning (before 0600 h) and about midday (Figure 19), although shots can be started at almost any time. The average duration of trawl shots has remained relatively constant at about 5 hours since 1992–93 (Figure 20). The average depth of fishing has not changed much from about 370 m since 1992–93 (Figure 21).

The spatial extent of the fishery in QMA 4E changed throughout its brief history from 1990–91 to 1992–93 (Figure 22) and the fleet was highly variable, consisting of 10 vessels in 1991–92 and only 1 or 2 in the other 2 years (Appendix 5). Fishing was carried out in the winter of 1991, the spring, summer, and autumn of 1991–92, and the autumn of 1993 (Figure 23, Appendix 5). There was no particular diel pattern of fishing (Figure 24), and shots were started throughout the day. The average duration of trawl shots was about 4 hours in 1990–91 and about 5 hours in 1991–92 and 1992–93 (Figure 25). The average depth of fishing started at about 420 m in 1990–91 but decreased to about 350 m in 1992–93 (Figure 26).

3.1.2.5 Trends in QMA 6A

The spatial extent of the scampi fishery in QMA 6A (within 50 n. miles of any of the Auckland Islands) has remained relatively constant since heavy fishing began in 1991–92 (Figure 27), although there has been an increasing tendency to develop fishing on a second "ribbon". The fleet has always been very stable (Appendix 6). Until and including 1992–93, the fishery was seasonal with less fishing in the winter, but fishing is now carried out year round (Figure 28, Appendix 6). There is a fairly strong diel pattern, with a tendency for shots to be started early in the morning (before 0600 h) at about midday, and late in the evening (after 1800 h) (Figure 29). Fishing at night is common. The average duration of trawl shots increased gradually from about 5 hours in 1991–92 to about 6.5 hours in 1995–96 (Figure 30). The average depth of shots has increased gradually from about 420 m in 1991–92 to about 460 m in 1995–96 (Figure 31).

3.1.3 CPUE analyses

3.1.3.1 General methodology

Data were taken from MFish databases (Trawl Catch Effort and Processing Returns, TCEPR). All records where scampi was the target species were extracted. All were by the method of bottom trawl. The following fields were extracted and screened for their utility as explanatory variables: vessel id, date, start and end times, start and end location, wing spread, net depth during fishing, bottom depth during fishing, headline height, speed of tow, duration of tow, and catch of scampi. Data editing was undertaken only to remove gross errors. Tows with zero catches were accorded a nominal 1 kg catch to allow the use of a logarithmic transformation. Vignaux & Gilbert (1993) showed that, for the scampi fishery in QMA 1, the choice of nominal catch for zero tows did not affect the performance of the model. Data for some vessels were excluded from the model if there were very few shots or the vessel was present only for 1 year.

Standardised indices of CPUE were calculated using a multiple regression approach described by Vignaux & Gilbert (1993, 1994). The model was used to estimate multiplicative effects on scampi CPUE (kg green per nautical mile trawled) of environmental, vessel, and year variables:

$$C_t = M + Y_{i,t} + P_{j,t} + Q_{k,t} + R_{l,t} + \ldots$$

Where C_t is the logarithm of catch per nautical mile trawled on tow t, M is an overall mean for C_t, $Y_{i,t}$ is the effect on C_t of tow t being in year i, $P_{j,t}$ is the effect of variable P having value j_t, $Q_{k,t}$ is the effect of variable Q having value k_t, and so on.

Likely variables (from previous analyses) include seasonality, time of day, depth, areal location within each QMA, and vessel. Vessel and fishing year are categorical by nature, and the other variables were converted to categories by splitting into 8 equal-sized bins. Eight bins were used because this was small enough to allow simultaneous analysis of all data for a QMA, yet adequate to model any relationships. Some variables that were truly continuous but recorded in a discrete manner (e.g. depth is often recorded to the nearest 5 m)were "jittered" to overcome problems with the model failing due to becoming singular. An initial screening for likely influential variables (in a given QMA) was conducted by including all variables in a stepwise regression procedure. Only those shots without missing data can be used in this process, and this was sometimes only about two-thirds of all the data (missing data are common, especially for gear descriptors such as headline height and wingspread in the early years of these fisheries).

Following initial screening, all shots without missing data for the likely influential variables were included in a final stepwise procedure, using, for ease of interpretation, 12 categorical bins for seasonality and time of day (giving bins equivalent to months and 2 hour time slots respectively). Most records were included in the final model because the variables used tended to be those for which missing data are rare. Variables were included until no significant improvement in explanatory power was achieved (improvement in R^2 less than 2 percentage points).

The year effects in the multiple regression model are taken as putative indices of stock abundance as:

$$A_i = exp(Y_i - Y_0)$$

Where Y_i is the regression coefficient for year i, Y_0 is the regression coefficient for the base year (usually the year when fishing started), and A_i is the year effect in year i relative to the year effect in the base year. If the year effect explains variance (viz. changes in CPUE) in a way that is not explained by any of the other variables, then it may be measuring changes in stock size. The variance of this estimate, A_i, can be estimated from:

$$s^2_{A_i} = A_i^2\, exp(\sigma^2)\, (exp(\sigma^2) - 1)$$

where $$\sigma^2 = Var(Y_i) + Var(Y_0) - 2\, Cov\, (Y_i, Y_0)$$

3.1.3.2 QMA 1 (Bay of Plenty)

Cryer *et al.* (1995) described a standardised index of CPUE for scampi in QMA 1. This model has been updated using data up to the end of the 1995–96 fishing year (Table 2). Similar variables were found to be significant in the model in the two assessments, although the order has changed slightly, with the year effect now being the most important (Table 3).

Table 2: Data available for CPUE model for QMA 1. "N tows" is the number of tows included in the model, "N vessels" is the number of vessels fishing in a given year, and "Raw cpue" is the total catch divided by total fishing effort, standardised to the index year (1988–89)

Year	88–89	89–90	90–91	91–92	92–93	93–94	94–95	95–96
N tows	418	831	1467	1065	669	568	397	360
N vessels	2	6	9	8	6	5	6	6
Catch (t)	39	101	163	130	114	111	103	114
Mean kg h^{-1}	32.9	32.1	22.6	21.7	28.3	36.3	47.1	60.5
Raw cpue	1.00	0.98	0.69	0.66	0.86	1.10	1.43	1.84

Table 3: Choice of significant variables for 1995 and 1997 QMA 1 scampi assessments (in the order chosen) and the percentage of variation in log(cpue) (R^2) explained following the inclusion of each in 1997

1995 assessment	1997 assessment	R^2(%) (1997)
area	year	8.2
month	time	15.5
time	area	21.7
year	month	25.7
depth	depth	28.1
vessel		

Table 4: Standardised (from a multiple regression model) and unstandardised indices of relative abundance for scampi (with standard errors, S.E., for the standardised indices) in QMA 1 1988–89 to 1995–96. The standardised model explains 28.1% of the variation in log(cpue)

Year	Unstandardised index	Standardised index	S.E. (standardised)
88–89	1.00	1.00	0.00
89–90	0.98	0.78	0.04
90–91	0.69	0.68	0.03
91–92	0.66	0.70	0.04
92–93	0.86	0.98	0.05
93–94	1.10	1.03	0.06
94–95	1.43	1.45	0.09
95–96	1.84	1.65	0.10

The standardised index for QMA 1 shows a steady increase since the 1990–91 fishing year (Table 4) and now stands at a level 65% higher than at the start of the fishery in 1988–89. The pattern in the standardised index is very similar to that in the un-standardised index, and to previous standardised analyses by Vignaux & Gilbert (1993) and Cryer *et al.* (1995).

3.1.3.3 QMA 2 (Hawke Bay, Wairarapa coast)

Data from one vessel with only 1 tow, and from another vessel with 19 tows in only a single year were dropped from the database. The data are summarised in Table 5.

Table 5: Data for CPUE model for QMA 2. "N tows" is the number of tows included in the model, "N vessels" is the number of vessels fishing in a given year, and "Raw cpue" is the total catch divided by total fishing effort, standardised to the index year (1988–89)

Year	88–89	89–90	90–91	91–92	92–93	93–94	94–95	95–96
N tows	186	1287	2272	1597	1340	1416	847	918
N vessels	3	6	9	10	10	8	6	8
Catch (t)	16.4	142.7	260.5	212.1	207.9	230.6	218.1	228.0
Mean kg h^{-1}	33.7	29.4	25.1	25.8	30.5	29.8	47.8	41.8
Raw cpue	1.00	0.87	0.74	0.77	0.91	0.88	1.42	1.24

Table 6: Choice of significant variables for the 1997 QMA 2 scampi assessments (in the order chosen) and the percentage of variation in log(cpue) (R^2) explained following the inclusion of each

Variable	R^2 (%)
Year	4.65
Time of day	7.91
Month	10.87

The month effect in the model (Table 6) suggests that the best catch rates are experienced in summer and are about double the worst catch rates in the winter. Effort tends to occur evenly throughout the year, however. The time of day effect suggests that the best catch rates are experienced early in the morning and are about 1.5 times that of the worst catch rates in the evening.

The standardised index for QMA 2 shows a steady increase since the 1990–91 fishing year (Table 7) and now stands about 22% higher than at the start of the fishery in 1988–89. The pattern in the standardised index is very similar to that in the unstandardised index.

Table 7: Standardised (from a multiple regression model) and unstandardised indices of relative abundance for scampi (with standard errors, S.E., for the standardised indices) in QMA 2 1988–89 to 1995–96. The model explains 10.9% of the variation in log(cpue)

Year	Unstandardised index	Standardised index	S.E. (standardised)
88–89	1.00	1.00	0.00
89–90	0.87	0.86	0.06
90–91	0.74	0.71	0.05
91–92	0.77	0.77	0.06
92–93	0.91	0.89	0.06
93–94	0.88	0.98	0.07
94–95	1.42	1.58	0.12
95–96	1.24	1.22	0.09

3.1.3.4 QMA 3 (Mernoo Bank)

Because the fishery before 1992–93 was very small and occurred in a different area from that which started on the Mernoo Bank (which essentially started in 1992–93, Figure 12) the standardised analysis has been restricted to the years 1992–93 to 1995–96. This leaves 2386 records (Table 8).

Table 8: Data for CPUE model for QMA 3. "N tows" is the number of tows included in the model, "N vessels" is the number of vessels fishing in a given year, and "Raw cpue" is the total catch divided by total fishing effort, standardised to the index year (1992–93). The 1992–93 year was chosen as the index year because the pattern of fishing changed dramatically at this time

Year	88–89	89–90	90–91	91–92	92–93	93–94	94–95	95–96
N tows	5	7	13	34	764	675	540	407
N vessels	1	1	4	8	9	9	9	9
Catch (t)	0.0	<0.1	0.2	0.6	83.2	60.2	67.1	76.1
Mean kg h^{-1}	0.0	2.1	6.1	5.9	29.0	20.7	25.1	36.4
Raw cpue	–	–	–	–	1.00	0.71	0.87	1.26

Vessel, year, month, time of day, and longitude were identified as potentially useful in explaining variability in log(cpue). Of these, vessel, month, and a year effect were included in the final model (Table 9). Because fishing in this area is highly seasonal (driven by the competitive catch limit of 60 t), there is almost no fishing other than in October to December. Records for months other than this period were therefore included in a "catch-all" category giving a total of 4 month bins compared with 12 for most other areas. The year effect for this fishery was very strong, showing an almost three-fold increase over 4 years (Table 10).

Table 9: Choice of significant variables for the 1997 QMA 3 scampi assessments (in the order chosen) and the percentage of variation in log(cpue) (R^2) explained following the inclusion of each

Variable	R^2(%)
Vessel	10.07
Year	14.97
Month	16.85

Table 10: Standardised (from a multiple regression model) and unstandardised indices of relative abundance for scampi (with standard errors, S.E., for the standardised indices) in QMA 3 1992–93 to 1995–96. The model explains 16.9% of the variation in log(cpue)

Year	Unstandardised index	Standardised index	S.E. (standardised)
92–93	1.00	1.00	0.00
93–94	0.71	1.35	0.09
94–95	0.87	1.71	0.13
95–96	1.26	2.49	0.20

Six vessels were in the fishery throughout the period analysed (1993–96) and they account for most of the effort. Most of the remaining vessels were present for more than 1 year. The strongest feature of the data is the "gold rush" effect with catch being taken competitively in the weeks after the start of each fishing year on 1 October. Since 1992–93, the fishery has been progressively compressed in time. In the last 2 years the fishery has lasted less than 2 months. Fishing within QMAs 3 and 4 spans the boundary at 176° E and suggests that this analysis (nominally for QMA 3) does not relate to a discrete stock. It is treated separately here because the competitive catch limit enforces a pattern of fishing effort which is very different from that observed in the neighbouring QMA 4.

The selection of Vessel as an important variable, explaining 10% of the variability in log(cpue), contrasts with the models for most other QMAs where Vessel was not important. As a sensitivity test, records from only the top six vessels were used in the model, whereupon Vessel was no longer an important variable and the year effect became the most important. The standardised index from this latter model had a similar trend to that of the base model, but increased to a maximum of about three times the index year in 1995–96 compared with 2.5 times the index year for the base model.

Because there is so little data outside the October to January period it is not clear if there is a seasonal effect similar to that found in other QMAs. However, the trend of increasing cpue within the October to January period is consistent with the pattern in other QMAs where the highest catch rates are experienced in summer. The "time of day" effect is not selected as an important explanatory variable in QMA 3, and is suggested in only 1 of the 4 years of data. The reasons for this difference from other areas are not clear, but could be a result of the competitive fishing process.

3.1.3.5 QMA 4W (western Chatham Rise)

Because the fishery before 1991–92 was very small this analysis was restricted to the years 1991–92 to 1995–96. The only five tows for one vessel (in 1991–92) were dropped. A year effect, time of day, vessel, seasonality, and longitude were identified as possibly useful in explaining log(cpue) in this data set. Using these five variables, there were 4747 complete records (Table 11).

Table 11: Data for CPUE model for QMA 4W. "N tows" is the number of tows included in the model, "N vessels" is the number of vessels fishing in a given year, and "Raw cpue" is the total catch divided by total fishing effort, standardised to the index year (1991–92). The 1991–92 year was chosen as the index year because there was very little fishing previously

Year	90–91	91–92	92–93	93–94	94–95	95–96
N tows	11	1368	1358	1111	446	469
N vessels	2	13	10	11	8	8
Catch (t)	1.23	155.7	213.7	251.0	180.0	226.0
Mean kg h^{-1}	25.60	25.1	30.3	42.4	74.8	101.0
Raw cpue	–	1.00	1.21	1.69	2.98	4.02

Table 12: Choice of significant variables for the 1997 QMA 4W scampi assessments (in the order chosen) and the percentage of variation in log(cpue) (R^2) explained following the inclusion of each

Variable	R^2(%)
Year	27.43
Time of day	34.76
Vessel	37.28
Month	39.61

The data design is fairly good (for this type of analysis) as there is a reasonable distribution of fishing effort by year and vessel. Seven vessels fished throughout 1991–92 to 1995–96, and they account for most of the effort. Most of the remaining vessels were present for more than 1 year.

The model is unusual in accounting for almost 40% of the variation in log(cpue) (Table 12). Most of this (27%) was accounted for by the strong year effect. Standardised catch rates have increased markedly over the period and the 1995–96 index is about 3.6 times the reference index (1991–92) (Table 13).

Table 13: Standardised (from a multiple regression model) and unstandardised indices of relative abundance for scampi (with standard errors, S.E., for the standardised indices) in QMA 4W 1991–92 to 1995–96. The model explains 39.6% of the variation in log(cpue)

Year	Unstandardised index	Standardised index	S.E. (standardised)
91–92	1.00	1.00	0.00
92–93	1.21	1.16	0.04
93–94	1.69	1.80	0.07
94–95	2.98	2.45	0.12
95–96	4.02	3.63	0.19

There is a daily cycle of catch rates with the best (late morning) being about double the worst (late evening). Effort is spread throughout the day with slightly more fishing during daylight hours. There appears to be a seasonal cycle of catch rates with the best catch rates (spring) being about double the worst (autumn). This is a slightly different seasonal pattern to that in most other QMAs. This might be an artefact of the somewhat patchy distribution of effort through the year, and a trend toward fishing close to the beginning of the fishing year in recent years.

The vessel effect accounts for 2–3% of variation in log(cpue). Most of the variation between vessels occurred among those vessels that did the least fishing. As a sensitivity test, records from only the 7 vessels doing the most fishing were used. This resulted in the vessel effect becoming insignificant, the year effect becoming the most important variable followed by time of day and seasonality (total R^2 of 40%). The abundance index from this "main 7" model was very similar to the base model using all vessels.

3.1.3.6 QMA 4E (eastern Chatham Rise)

Fishing on the eastern Chatham Rise and close to the Chatham Islands was conducted in three years, 1990–91 to 1992–93. Since then, fishing has been concentrated close to the Mernoo Bank where catch rates have continued to increase. The data are summarised in Table 14.

Table 14: Data for CPUE model for QMA 4E. "N tows" is the number of tows included in the model, "N vessels" is the number of vessels fishing in a given year, and "Raw cpue" is the total catch divided by total fishing effort, standardised to the index year (1990–91). The 1990–91 year was chosen as the index year because it was the first year of fishing in this area

Year	90–91	91–92	92–93
N tows	212	698	77
N vessels	2	11	1
Catch (t)	31.1	73.7	11.1
Mean kg h^{-1}	36.0	20.3	30.1
Raw cpue	1.00	0.56	0.84

The three tows for one vessel were excluded from the analysis, leaving 984 records. Because there was no loss of data due to missing data at the initial selection stage, selection of potentially useful variables becomes redundant. The year effect was not selected in the stepwise procedure, but was included as it is the variable of interest in this analysis (Table 15).

Table 15: Choice of significant variables for the 1997 QMA 4E scampi assessments (in the order chosen) and the percentage of variation in log(cpue) (R^2) explained following the inclusion of each. Note that the year effect was not automatically selected (its inclusion led to an improvement in R^2 of <2%) but was included as it is the putative index of stock size and is therefore the variable of interest in this analysis

Variable	R^2(%)
Vessel	24.56
Time of day	35.10
Month	40.84
Longitude	44.32
Latitude	45.96
Year (not significant)	46.61

Table 16: Standardised (from a multiple regression model) and unstandardised indices of relative abundance for scampi (with standard errors, S.E., for the standardised indices) in QMA 4E 1990–91 to 1992–93. The model explains 46.6% of the variation in log(cpue). Note that this year effect was not influential in the model and will be poorly determined

Year	Unstandardised index	Standardised index	S.E. (standardised)
90–91	1.00	1.00	0.00
91–92	0.56	0.95	0.22
92–93	0.84	2.17	0.68

The model was severely unbalanced as most effort occurred in a single year (1991–92) and only a single vessel fished in two of the years. This means any year effect will be poorly determined. The model is unusual in accounting for almost 47% of the variation in log(cpue). Most of this (~40%) is accounted for by vessel, time of day, and month variables. Position has modest explanatory power (longitude and latitude variables adding a further 5% in R^2).

There is a daily cycle of catch rates with the best (late morning) being better than double the worst (late evening). Effort is spread throughout the day (somewhat more heavily during daylight). There is a seasonal cycle of catch rates with the best (spring) being about double the worst (autumn), although this may not be well defined because of the lack of any fishing in October and November in any year. The pattern of catch rates is, however, similar to that on the western side of the Chatham Rise.

The year effect is poorly determined by this analysis, and there is no significant change in the index over the 3 years for which data are available (Table 16).

3.1.3.7 QMA 6A (Auckland Islands)

The few records for 1990–91 (14 tows) were not included in the analysis, and the only three records for one vessel were excluded (they may be errors). Available data are summarised in Table 17. A year effect, seasonality, time of day and, perhaps, location and vessel were identified as potentially useful in explaining log(cpue). Year, month, and time of day were included in the final model (Table 18).

Table 17: Data for CPUE model for QMA 6A. "N tows" is the number of tows included in the model, "N vessels" is the number of vessels fishing in a given year, and "Raw cpue" is the total catch divided by total fishing effort, standardised to the index year (1991–92). The 1991–92 year was chosen as the index year because there was very little fishing in this area before previously

Year	90–91	91–92	92–93	93–94	94–95	95–96
N tows	14	963	661	1263	1315	1284
N vessels	5	13	12	12	12	12
Catch (t)	1.9	322.7	194.0	241.1	209.1	220.4
Mean kg h^{-1}	63.7	67.1	51.7	34.4	25.4	26.4
Raw cpue	–	1.00	0.77	0.51	0.38	0.39

Table 18: Choice of significant variables for the 1997 QMA 6A scampi assessment (in the order chosen) and the percentage of variation in log(cpue) (R^2) explained following the inclusion of each.

Variable	R^2(%)
Year	12.05
Month	18.09
Time of day	21.20

The model is well balanced as there has been a fairly stable fleet with similar effort over time. There is a seasonal cycle of catch rates with the best (summer) being about four times better than the worst (winter). Most effort occurred from January to April, probably to coincide with fishable weather in this location. There was a daily cycle of catch rates with the best (late morning) being about double the worst (late evening). Effort is spread evenly over the day.

There are two preferred depth ranges in QMA 6A (around 400 m and 500 m) with a trend towards the 500 m band with time. However, depth is not an important variable in the cpue model. As a sensitivity test, the shallower of the two depth bands (350 to 450 m) was modelled separately, but the results were very similar to the base model and the year effects differed by no more than 0.04 from those in the base model. The 1995–96 catch rates were only about one third of 1991–92 catch rates (Table 19). There have been more frequent reports of nil catches (of scampi when scampi was the target species) in recent years (less than

3% of tows 1991–93 compared with about 9% of tows 1994–96), although the extent to which this is an artefact caused by problems with gear and poor reporting is not known.

Table 19: Standardised (from a multiple regression model) and unstandardised indices of relative abundance for scampi (with standard errors, S.E., for the standardised indices) in QMA 6A 1991–92 to 1995–96. The model explains 21.2% of the variation in log(cpue).

Year	Unstandardised index	Standardised index	S.E. (standardised)
91–92	1.00	1.00	0.00
92–93	0.77	0.65	0.04
93–94	0.51	0.40	0.02
94–95	0.38	0.28	0.02
95–96	0.39	0.32	0.02

3.1.3.8 Summary of standardised CPUE analyses

The variables represented in scampi CPUE models most consistently were the temporal ones (Table 20): month (six out of six models), time of day (five out of six), and year (five out of six, also the putative index of stock size). Vessel effects were included in three models, area effects in two, and a depth effect in just one. The most important variable was usually the year effect (four out of six), and where it was not, the vessel effect was most important.

The month variable usually showed a maximum in spring (fisheries on the Chatham Rise) or summer (fisheries off the east North Island coast and Auckland Islands). The worst catch rates were in autumn or early winter. The magnitude of the effect was roughly constant at a factor of 2 between best and worst, other than at the Auckland Islands fishery (which is the most hostile environment for fishing) where there was a factor of about 5 between best and worst.

Table 20: Summary of influential variables for scampi CPUE models by QMA. For QMA 4E, the "area" effect is a composite of longitude and latitude effects, whereas that for QMA 1 is a single categorical variable. Note that there was no significant year effect in QMA 4E and one had to be "forced" in the analysis. Current "status" is the standardised index of CPUE for 1995–96 relative to the index year (usually the start of substantive fishing in each QMA)

Variable	QMA 1	QMA 2	QMA 3	QMA 4W	QMA 4E	QMA 6A
1	Year	Year	Vessel	Year	Vessel	Year
2	Time of day	Time of day	Year	Time of day	Time of day	Month
3	Area	Month	Month	Vessel	Month	Time of day
4	Month	–	–	Month	Area	–
5	Depth	–	–	–	–	–
Total R^2(%)	28.1	10.9	16.9	39.6	46.6	21.2
Current "status"	1.65	1.22	2.49	3.63	2.17	0.32

The time of day effect always showed a maximum in the early morning, tows being started between 0400 h and 0800 h being the best. Similarly, the worst catch rates were experienced in all areas for shots started in late evening (17:00 to 22:00) which tended to run overnight. The magnitude of the effect was roughly constant at a factor of 2 between best and worst. This is consistent with the results of short research trawls in the Bay of Plenty (Cryer & Stotter 1997) which showed a dramatic increase in scampi catch rates at dawn followed by a steady decline throughout the day.

The consistency of temporal effects among QMAs (Figure 32) strongly suggests that the pattern observed in CPUE analyses is real, that there is indeed temporal variation in catch rates by trawl. This variation probably stems from the activity cycle of the animals as they emerge and re-enter burrows from which they cannot be taken by trawl.

Vessel variables were less useful in explaining scampi CPUE than they are for many other trawl fisheries (e.g. Ballara *et al.* (1997) for hoki, Hanchet (1997) for southern blue whiting, Ingerson & Colman (1997) for gemfish, where vessel effects are influential). This may be because most of the vessels fishing in given QMAs are of a similar size and power, and use very similar gear. In addition, most of the variability between scampi vessels in these analyses appears to come from the vessels which are new to the fishery or do least fishing, suggesting that fishing behaviour and experience are confounded with vessel fishing power in the Vessel variable. Similarly, depth effects were rarely significant, although it is clear from research trawl surveys and commercial catch and effort data that scampi catch rates are greater between 350 and 500 m than outside this range. It seems likely that depth is not a significant explanatory variable because commercial fishing is highly concentrated in those depths where catch rates are reliably high, and that this depth range is easily located by fishers.

Table 21: Summary of month and time of day variables for scampi CPUE models by QMA. "Best" times are given as the middle of 2 hour bins for start of shots. * Models for QMAs 3 and 4E do not allow for good definition of seasonal effects as these fisheries are seasonal (Oct–Dec and Dec–Sep, respectively), and the diel effect has little explanatory power in QMA 3. The "magnitude of effect" for diel and seasonal cycles is estimated as the "best" divided by the "worst" index

Variable	QMA 1	QMA 2	QMA 3	QMA 4W	QMA 4E	QMA 6A
"Best" month	January	January	December*	August	September*	January
"Worst" month	May	May	*	March	May*	June
Magnitude of effect	1.85	1.91	–	2.03	–	4.64
"Best" time	07:00	05:00	–	07:00	05:00	07:00
"Worst" time	21:00	19:00	–	21:00	19:00	21:00
Magnitude of effect	2.68	1.58	–	2.02	2.98	2.10

3.2 Other information

3.2.1 Length frequency distributions of scampi

Length frequency distributions and sex ratios of scampi from measurements taken by Scientific Observers on board scampi trawlers were presented by Cryer (1996). Insufficient observer trips have been undertaken since this information was last collated to warrant updating this analysis. These length frequency distributions do not show any gross changes which would be consistent with large decreases in stock size (for example, large reductions in the proportion of large, presumably old, individuals). To the contrary, cumulative unscaled length frequency distributions derived for QMAs 1 and 6A (Figures 33 and 34) both show increasing proportions of larger individuals between 1991–92 and 1995–96.

The extent to which these differences among years are due to changes in fishing gear and its selectivity (mesh sizes are known to have increased since the early years of the fishery for instance) or to the opportunistic and unstandardised nature of observer sampling are not known. Examination of the spatial location and depth of shots in QMA 1 from which observers measured scampi suggest that data collected in 1991 and 1992 were taken mostly from the main fishery area close to the Aldermen Islands, whereas samples in 1995 and 1996 were spread throughout areas that might be considered peripheral, such as north of Great Barrier Island and east of Mayor Island. Even within the Aldermen Islands area, shots sampled in 1992 were significantly deeper than those sampled in 1991. Similarly, while the depth distribution of the fishery in QMA 6A changed consistently between 1992 and 1996, the depth of observed shots did not change very much, although there were some spatial changes which broadly mimicked the changes in the wider fishery.

Both location and depth of trawl shots for scampi can be expected to have significant implications for the size range of scampi available to observers and, without a very large number of samples, it is very difficult to generate the standardised length frequency distributions which are routinely generated by trawl survey methods. In addition, it is not clear whether differences in the location and depth of observed and unobserved shots can lead to length frequency distributions generated by observers being biased, although there is clear potential for this to occur.

If observer length frequency distributions are accepted as unbiased samples of commercial catches within a given QMA, and if commercial catches are accepted as providing consistent samples of the available population, then the observer length frequency distributions for QMAs 1 and 6A are not easy to explain. An increase in the proportion of large individuals is not usually consistent with a stock responding to heavy exploitation, but could be consistent with a stock in which recruitment has recently been relatively poor.

3.2.2 Length frequency distributions of major bycatch species

Hoki, ling, giant stargazer, and gemfish are the major QMS bycatch species in all QMAs. There is considerable other bycatch, but the information for these other species is scant because observers have been instructed to concentrate on measuring scampi QMS bycatch.

Figures 35–48 show raw (unscaled) length frequency distributions for these four species since observer coverage began in 1990–91. Those length frequency distributions for scampi fisheries in QMAs 3, 4W, and 4E have been amalgamated as they are essentially subsets of a Chatham Rise continuum. A full analysis and a test of the proposition that scampi fisheries take a large bycatch of juvenile QMS fish would require comparison with observer measurements in respective target fisheries.

For hoki, the modal class in all QMAs was 60–65 cm in 1990–91, rising steadily to 85–90 cm in 1994–95 and 1995–96 (Figure 35–38). This is consistent with the progression of the 1987 yearclass identified by Ballara *et al.* (1997) from the west coast South Island target fishery for spawning hoki. Smaller (30–50 cm) hoki are caught by the scampi fleet mainly in QMA 2 (Figure 36), and especially between 1991–92 and 1993–94 (in which year small hoki were also relatively common in scampi bycatch on the Chatham Rise). These fish may represent the 1991 and 1992 yearclasses of hoki. It does not appear that the length frequency distributions of hoki taken as a bycatch by scampi trawlers are markedly different from those of fish taken by target fisheries and documented by Ballara *et al.* (1997).

There is much less consistency in the length frequency distributions of ling measured by observers on board scampi trawlers (Figures 39–42). The small sample of ling measured by observers in QMA 1 shows a range from about 50 to 120 cm in several years (Figure 38). In QMA 2, a wide range of sizes was measured in 1990–91 (including many very large ling over 140 cm), whereas in subsequent years the ling taken by scampi trawlers have been much smaller, typically 30–80 cm (Figure 40). The length frequency of ling taken as a bycatch of scampi trawlers is most consistent on the Chatham Rise, with the bulk of fish being between 80 and 140 cm total length in all years when samples were taken (Figure 41). In common with QMA 2, the average sizes of ling taken in QMA 6A in 1991–92 to 1993–94 were very low compared with other years (Figure 42). This may represent the recruitment of one or more good yearclasses of ling into these areas.

Few giant stargazers are taken in QMA 1, but for the other areas the length frequency distributions are broadly similar among years (Figures 43–46). In QMA 2, the fish are large, averaging 60–80 cm (Figure 44), whereas on the Chatham Rise and off the Auckland Islands, a smaller size class of 40–60 cm is usually also apparent and, in the latter area, dominant (Figures 45 and 46).

The numbers of gemfish measured by observers on scampi trawlers is small and confined to QMAs 1 and 2. There is little or no consistency between years, but some consistency between the two areas (Figures 47 and 48).

3.3 Recreational and Maori customary fisheries

There is no quantitative information on the level of recreational or Maori customary take, but both are probably non-existent.

3.4 Other sources of fishing mortality

Other sources of fishing mortality could include illegal catch, mortality of discarded scampi (this is currently a non-QMS fishery and discarding is legal, although unusual), and incidental mortality associated with trawling. There is no quantitative information on the level of such other sources of mortality.

4. Research

4.1 Stock structure

The stock structure of scampi in New Zealand waters is not well known. Preliminary electrophoretic analyses showed substantial genetic heterogeneity in samples collected in QMAs 1, 2, and 4 and 6A (P. Smith, NIWA Wellington, pers. comm.). The largest difference was between scampi from QMA 6A and those from other areas. The abbreviated larval phase (Wear 1976) and lack of large scale migration (Cryer & Stotter unpublished results) of this species may lead to low rates of gene mixing. Size at maturity varies between areas, and other differences among QMAs, such as depth distribution, diel changes in catchability, and catch to bycatch ratios, also suggest that treatment as separate management units is appropriate.

4.2 Resource surveys

Fully scaled length frequency distributions and sex ratios from trawl surveys in QMAs 1 and 2 were presented by Cryer (1996). The only new information comes from scampi trawling conducted for other purposes in QMA 1. This work includes gear selectivity in April 1996 (MFish project SHSP05 ("Scampi trawl selectivity"), voyage KAH9604), and tagging and its associated trawling activities to estimate growth in September and October 1995 and 1996 (Cryer & Stotter 1997 and unpublished results; MFish project SHSP08 ("Age and growth of scampi in QMA 1"), voyages KAH9511, DRY9601, and DRY9602).

4.3 Other studies

4.3.1 Estimates of growth rate and natural mortality

The growth rate of scampi was estimated by tagging in the Bay of Plenty 1995–96. Tagged animals were released in late September 1995 (voyage KAH9511, Cryer & Stotter 1997), and target fishing to recapture these animals was conducted in September and October 1996 (voyages DRY9601 and DRY9602 Cryer & Stotter, unpublished results). Despite considerable target fishing in the area of release, a large proportion of returns was provided by industry from recaptures made during normal fishing activities. It is fortunate that most returns came in the last few weeks of the fishing year when the tagged animals had been at liberty for close to the 12 months ideal. Unfortunately, only females were recaptured in sufficient numbers to estimate the parameters of a von Bertalanffy growth model with any certainty, leading to parameter estimates of $K = 0.11–0.14\ yr^{-1}$ and $L_{\infty} = 48–49$ mm OCL.

Using published relationships (e.g. Pauly 1980, Charnov *et al.* 1993), M can be predicted from K, albeit with poor precision. The estimate of M for female scampi in the Bay of Plenty at 400 m depth was $M = 0.20–0.25$ with a *c.v.* of over 30%.

4.3.2 Work planned for the 1997–98 year

Work contracted for the 1997–98 fishing year includes an update of all CPUE analyses, further analysis of observer and research length frequency distributions and tag returns to estimate scampi distribution, growth rate and mortality, and an examination of changes in bycatch with fishery development. A trawl survey will not be conducted, but a comparison of trawl and visual (camera) methods of estimating relative biomass will be undertaken in QMA 1.

4.3.3 The development of fishery-independent biomass indices

From the trawl surveys in QMAs 1 and 2, and from detailed analyses of commercial CPUE, it appears likely that the catchability of New Zealand scampi varies on several temporal scales. Catch rates clearly undergo daily and seasonal cycles and there may also be changes on longer time scales which would affect the year effects in CPUE models (through vertical availability: scampi in burrows cannot be caught by trawl gear). For example, the 50% increase in the trawl survey index for scampi in QMA 1 between 1993 and 1995 stemmed almost entirely from a near doubling of the index for males. This is most unlikely to be a reflection of a real change in the sex ratio for this relatively long-lived species (Cryer and Stotter, unpublished results), suggesting that increased catchability of males was the cause. From this, it seems likely that there are inter-annual changes in catchability which, in the short term, would confound the use of CPUE as an index of abundance. Moreover, the magnitude of these catchability effects between years may be much larger than any signal likely to come from changes in stock size and, without auxiliary information on catchability and vertical availability, it may not be possible to disentangle changes in catchability from any year effect. These problems militate against the suitability of trawl survey or CPUE indices of abundance for scampi in New Zealand waters over short to medium timeframes.

However, the comparison of visual and trawl sampling methods for scampi in 1997–98 may provide a means by which directed trawl surveys, at least, can be "corrected" for vertical availability and hence provide a better relative biomass estimate. The correction of commercial CPUE data for vertical availability would be much more problematic, given the wide temporal and spatial spread of the sampling effort. Following correction for vertical availability, the inclusion of trawl selectivity data collected in 1995–96 may allow the estimation of absolute biomass by trawl survey.

As an alternative to their use in correcting trawl survey catch rates, camera surveys could be used "stand alone" to estimate absolute abundance of scampi from the density of their burrows (e.g. Tuck *et al.* 1997). These estimates could be converted to biomass using suitable estimates of average weight derived from, for example, parallel trawling using standardised gear, measurements from scientific observers, or commercial packing counts.

4.4 Biomass estimates

No new biomass estimates are available. Relative estimates from trawl surveys in QMAs 1 and 2 between 1993 and 1995 are presented in Table 22, and described in detail in Cryer *et al.* (1995).

Table 22. Relative biomass estimates (t) for QMA 1 (top: strata from Great Barrier Island to White Island included) and QMA 2 (bottom: strata from Mahia Peninsula to Castle Point included) estimated from *Kaharoa* trawl surveys

			Kaharoa voyage
	KAH9301	KAH9401	KAH9501
QMA 1			
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	1.00	1.24	1.52
QMA 2			
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	1.00	0.75	0.93

4.5 Yield estimates

4.5.1 Estimation of MCY

MCY cannot be estimated for any scampi stock because there are no reliable estimates of biomass, and catches have been constrained by catch limits since 1991–92.

4.5.2 Estimation of CAY

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

4.5.3 Other yield estimates

There are no other estimates of yield.

5. Management Implications

There are no estimates of biomass and yield, but CPUE analyses developed here and length frequency distributions collected to date (e.g. Cryer 1996) do not suggest serious problems in any scampi stock, with the possible exception of that in QMA 6A. For most scampi stocks, CPUE has risen over the past few years, markedly in some instances, whereas the index for QMA 6A has declined to a level of about one-third the index year. If CPUE indexes stock size well, then the analysis would suggest that some caution should be exercised in the management of scampi close to the Auckland Islands. The very low fecundity of this species (in the order of hundreds of eggs, only 10–20% of the fecundity of *Nephrops norvegicus* and several orders of magnitude below the fecundity of most finfish stocks) would suggest a *shallow stock recruit relationship, and maximum stock productivity at relatively high stock* biomass (40–50% of B_0).

It is, however, not known whether CPUE is a good index of stock size, and there are reasons to suspect that CPUE indices (whether commercial or trawl survey) may be sensitive to changes in catchability. It may be that changes in the catchability of one or both sexes are responsible for the observed changes in CPUE indices.

6. Acknowledgments

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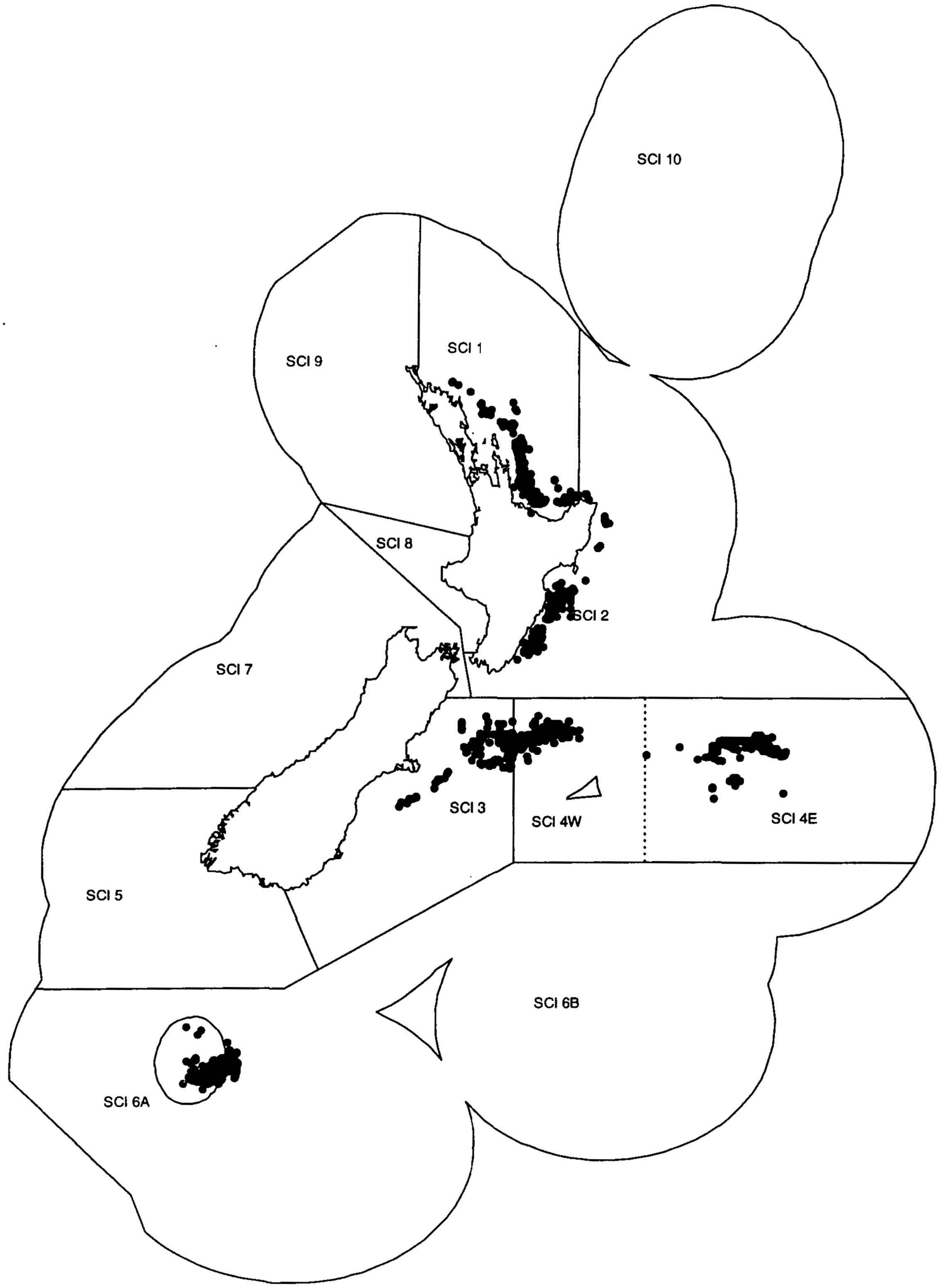


Figure 1: Fishery management areas and the location of the main fishing areas for scampi, *Metanephrops challengeri*, in New Zealand waters. SCI 6A is a separate regulated management area containing all waters within 50 miles of the Auckland Islands, whereas SCI 4 is informally separated into eastern and western portions at latitude 180 ° E.

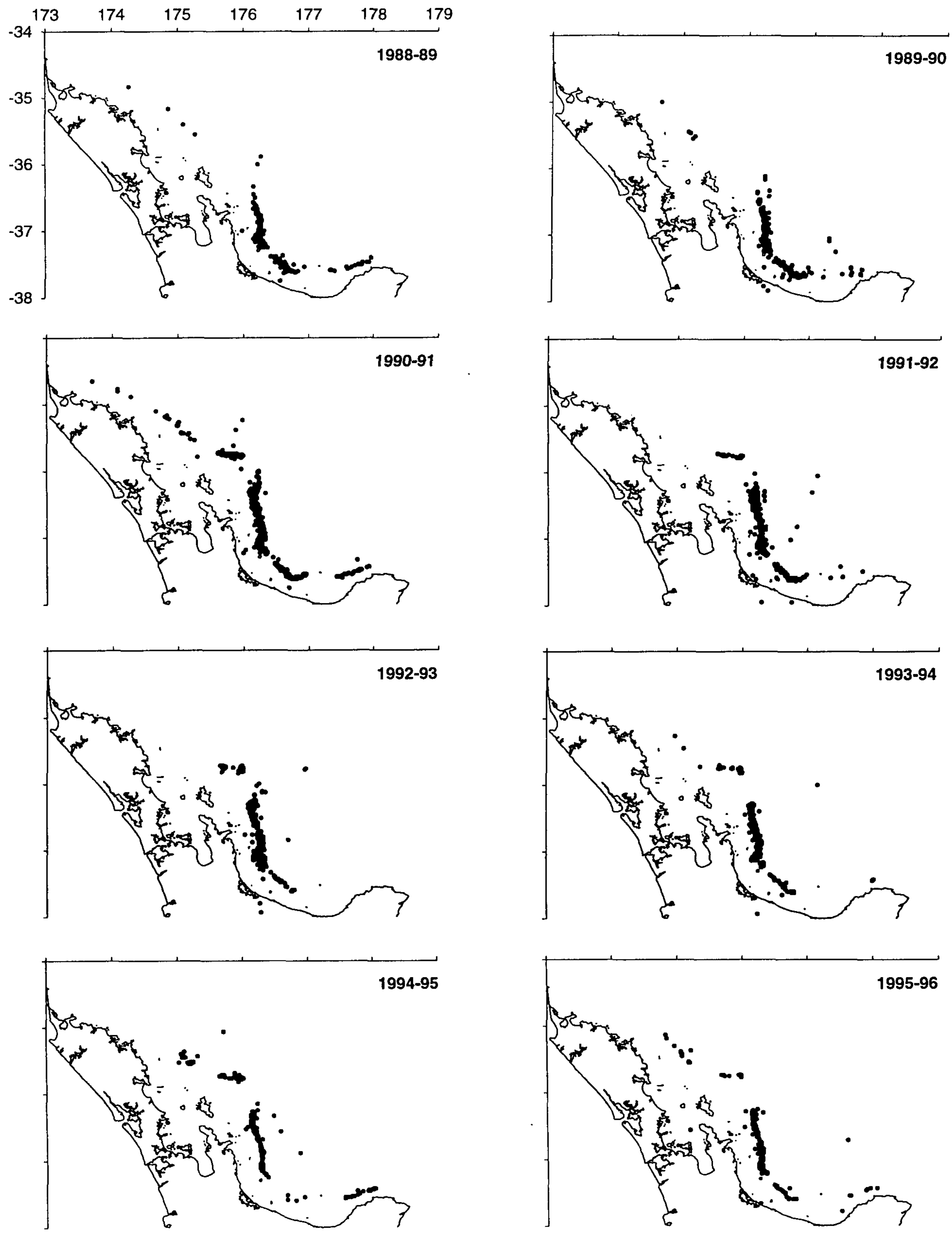


Figure 2: Spatial distribution of shots for scampi in QMA 1 by fishing year.

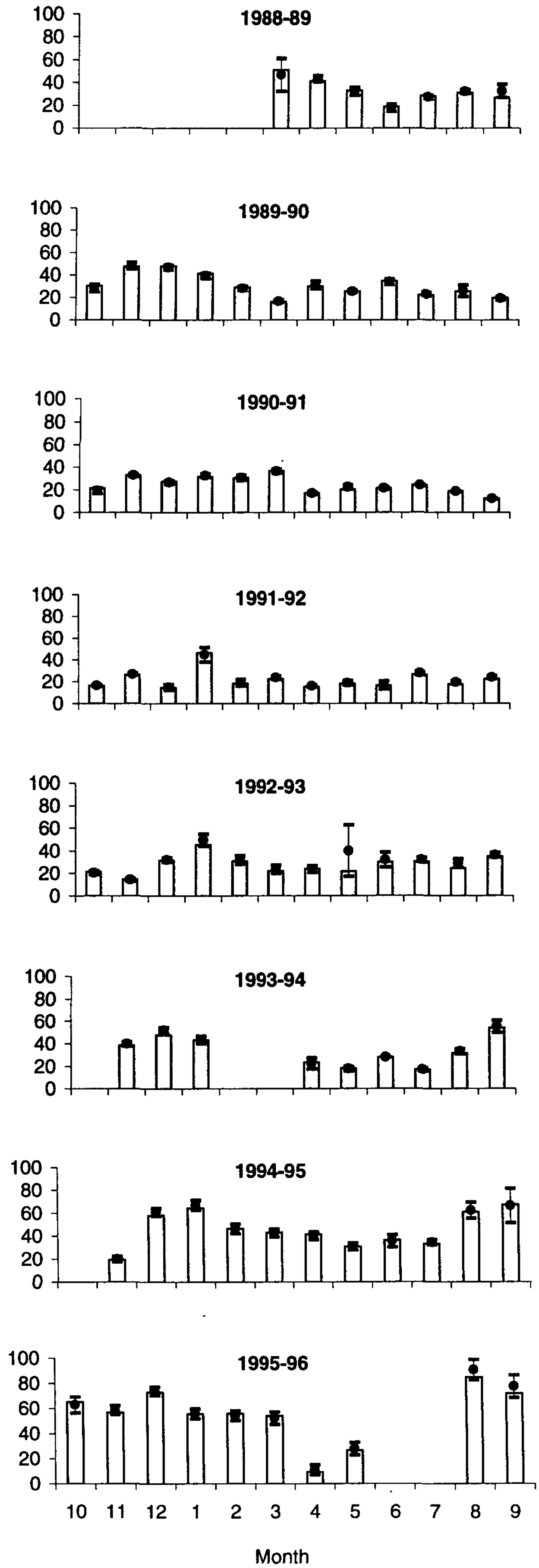


Figure 3: Catch rates (kg/h trawled) of scampi in QMA 1 by fishing year by month. Histograms denote unstandardised monthly means and dots with error bars denote the mean of individual shot catch rates ± the standard error of the mean.

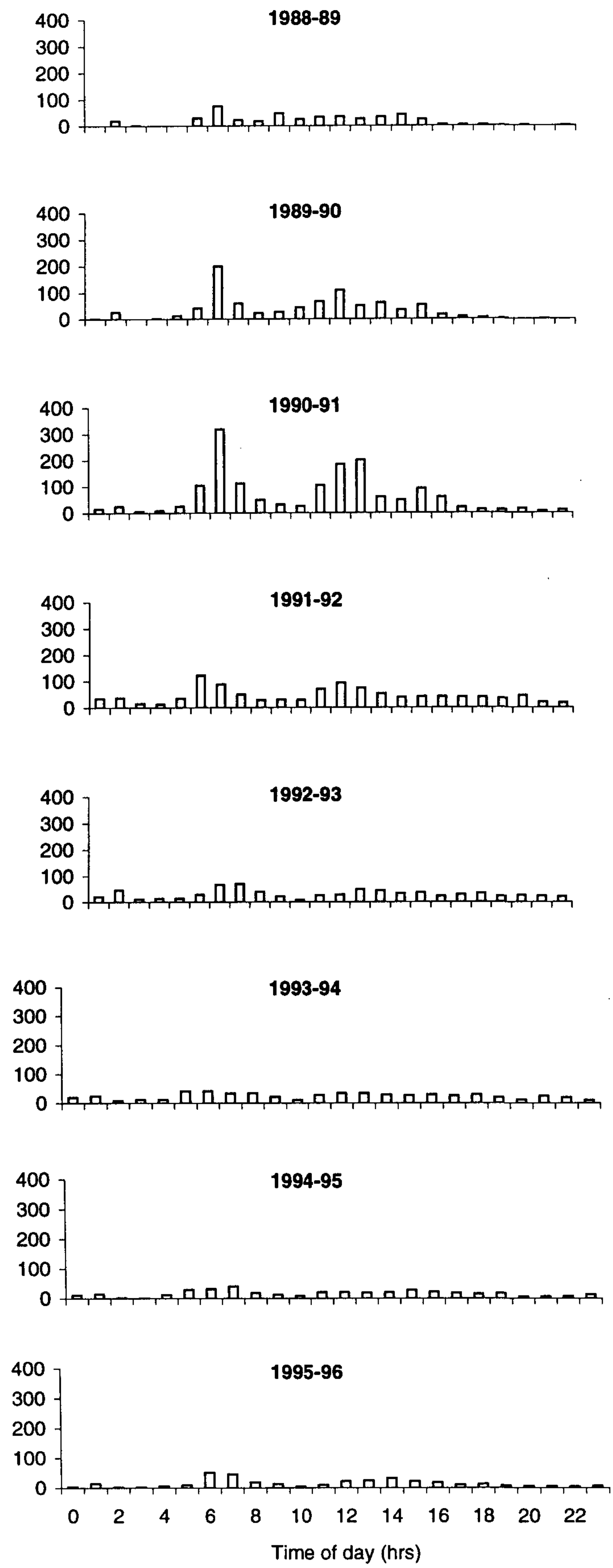


Figure 4: Diel distribution of shot start times for scampi by fishing year in QMA 1.

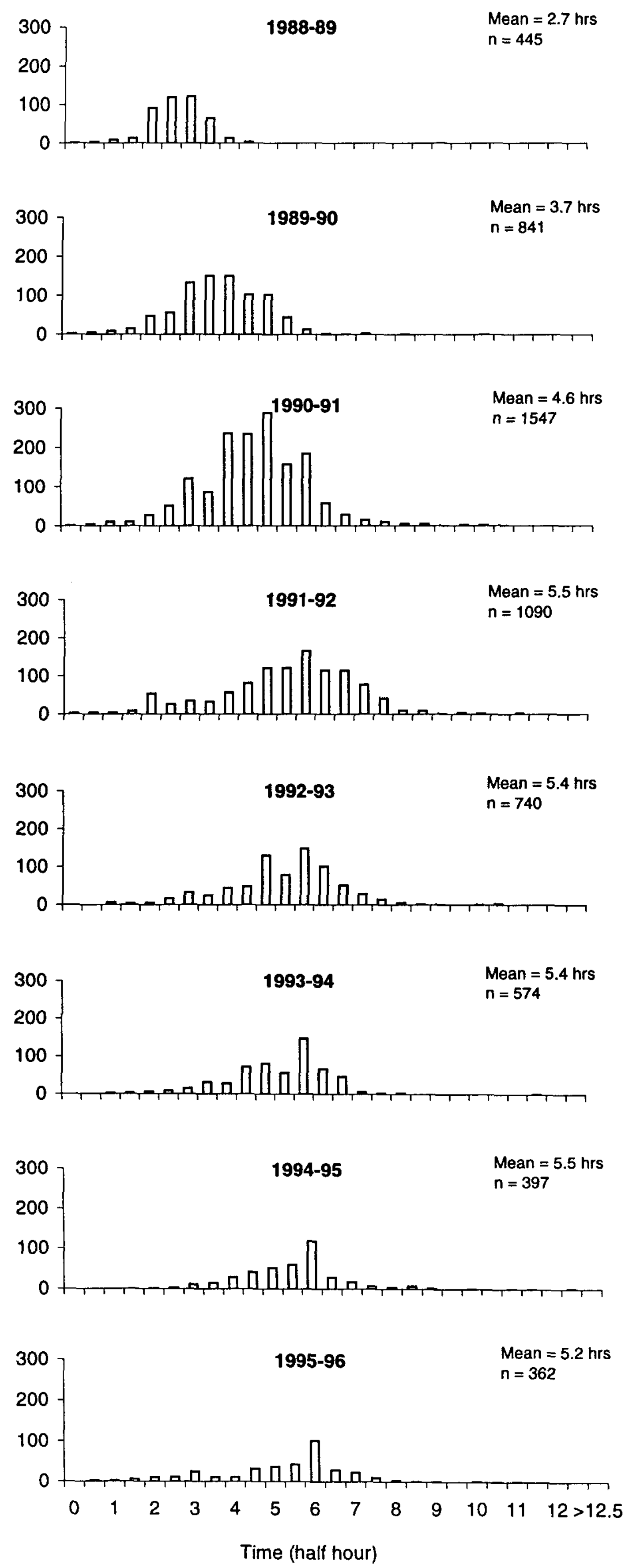


Figure 5: Scampi shot duration (rounded to nearest half hour) by fishing year in QMA 1.

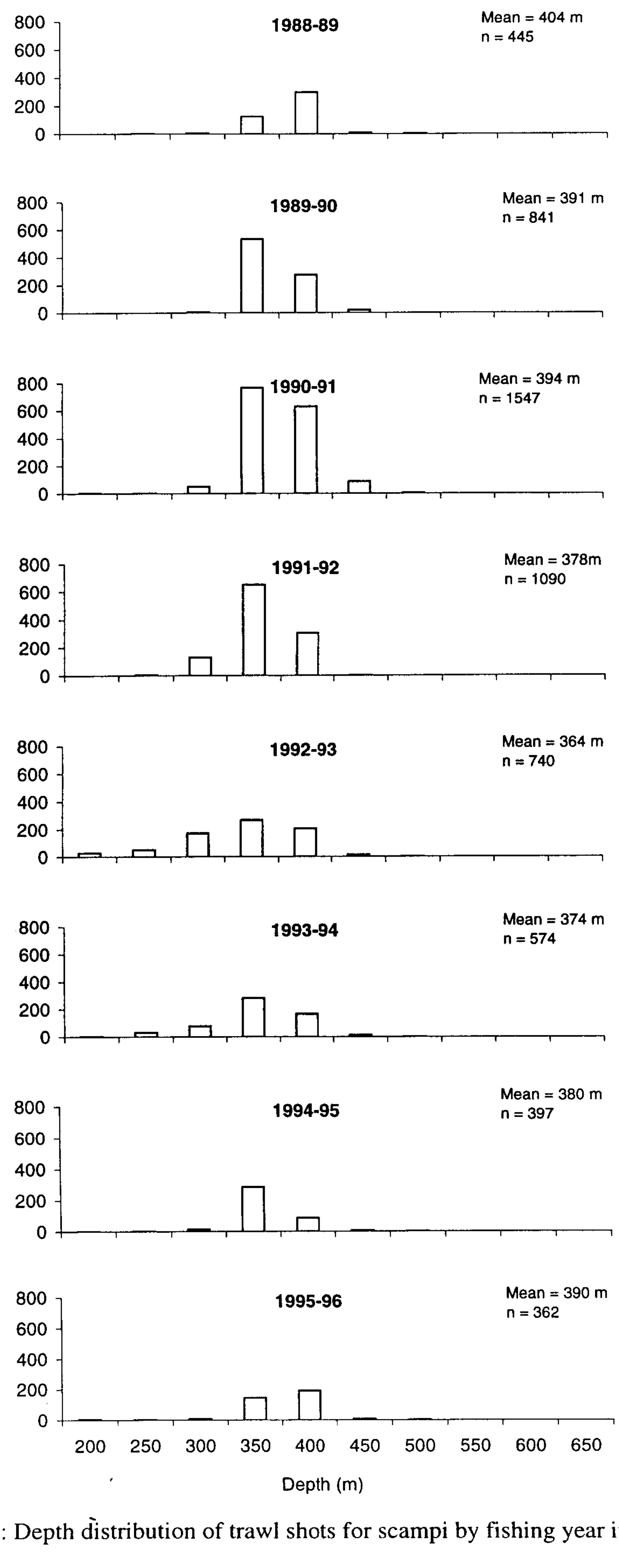


Figure 6: Depth distribution of trawl shots for scampi by fishing year in QMA 1.

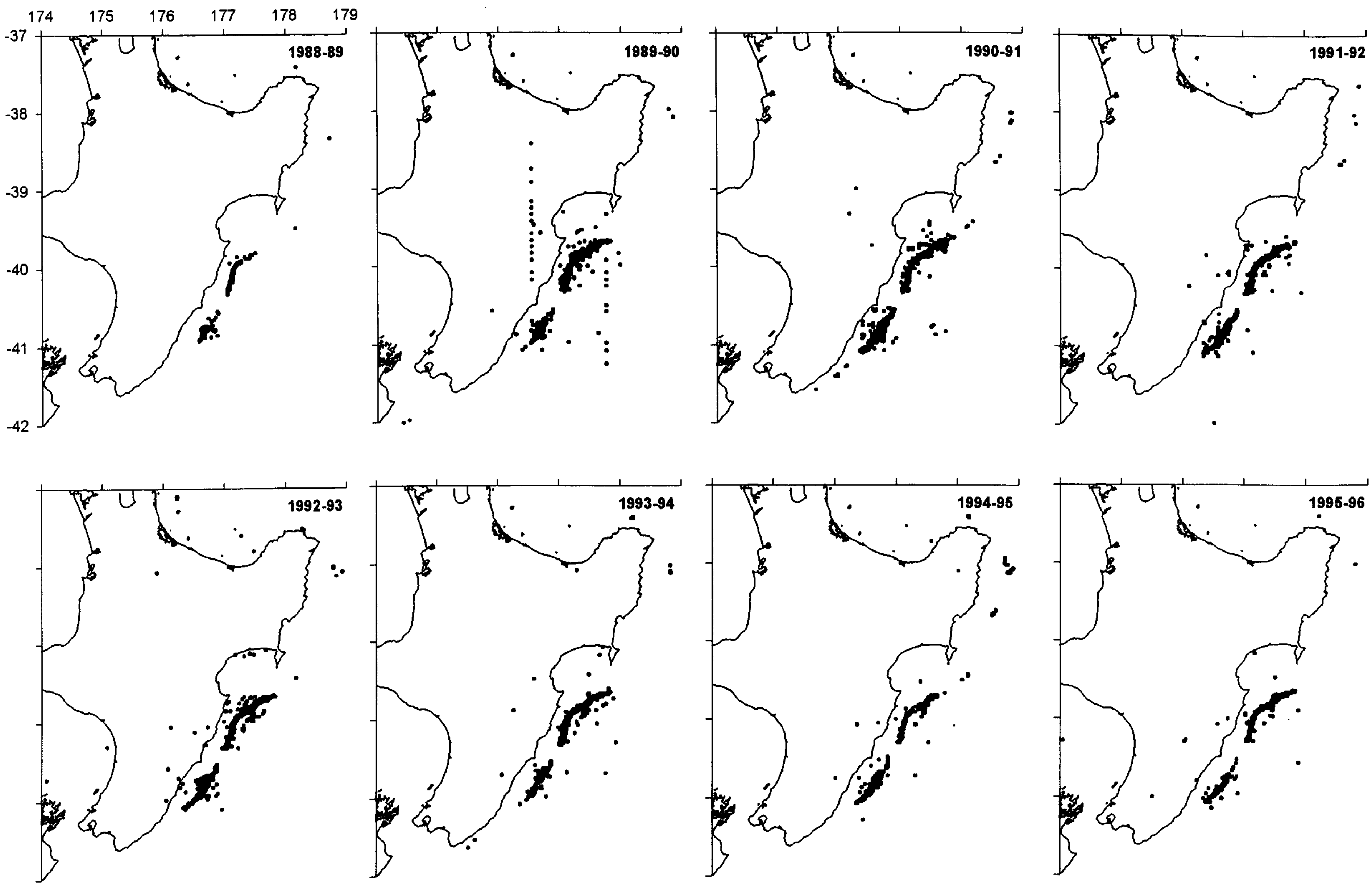


Figure 7: Spatial distribution of shots for scampi in QMA 2 by fishing year.

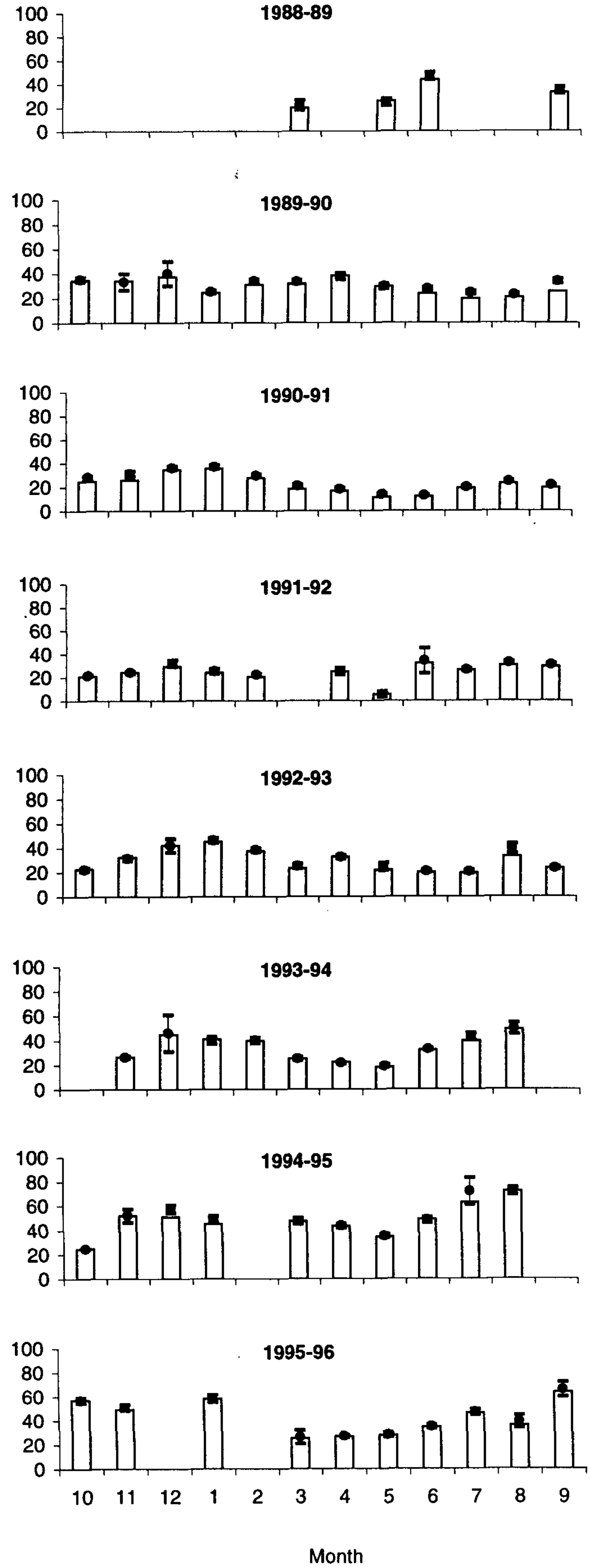


Figure 8: Catch rates (kg/h trawled) of scampi in QMA 2 by fishing year by month. Histograms denote unstandardised monthly means and dots with error bars denote the mean of individual shot catch rates ± the standard error of the mean.

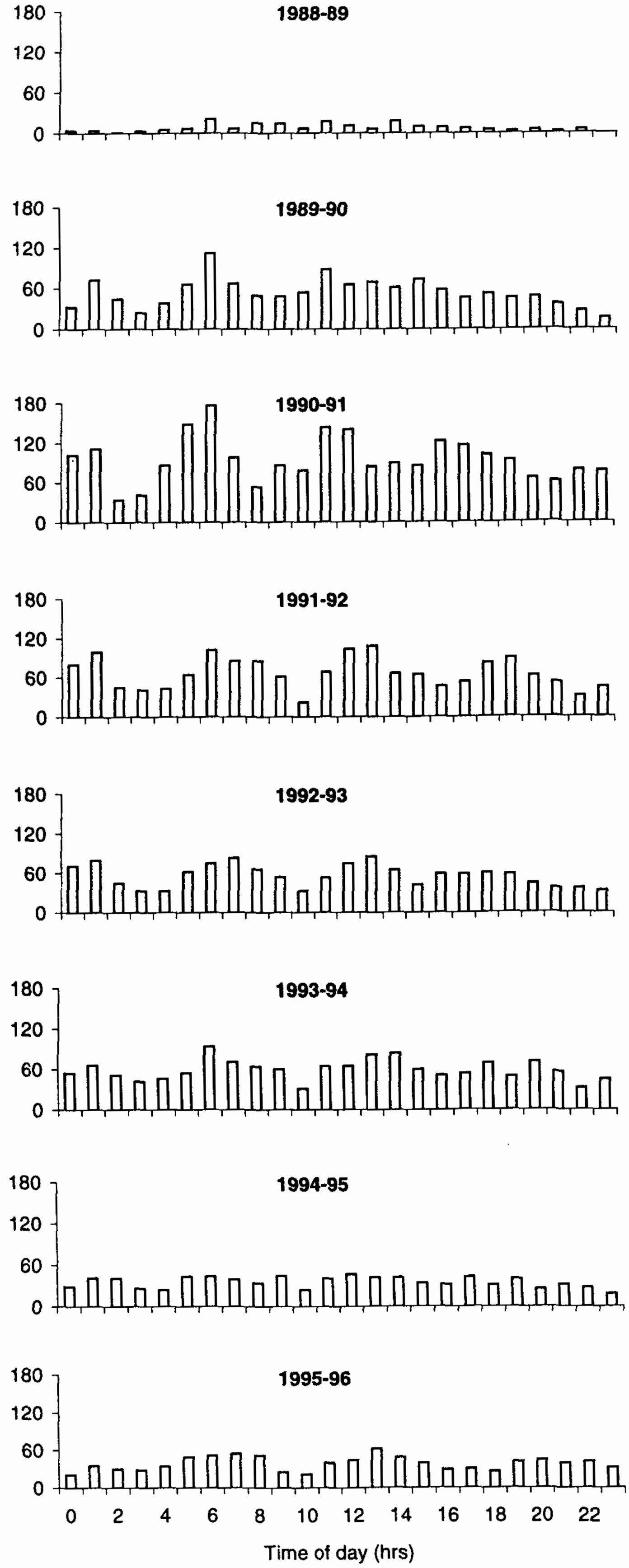


Figure 9: Diel distribution of shot start times for scampi by fishing year in QMA 2.

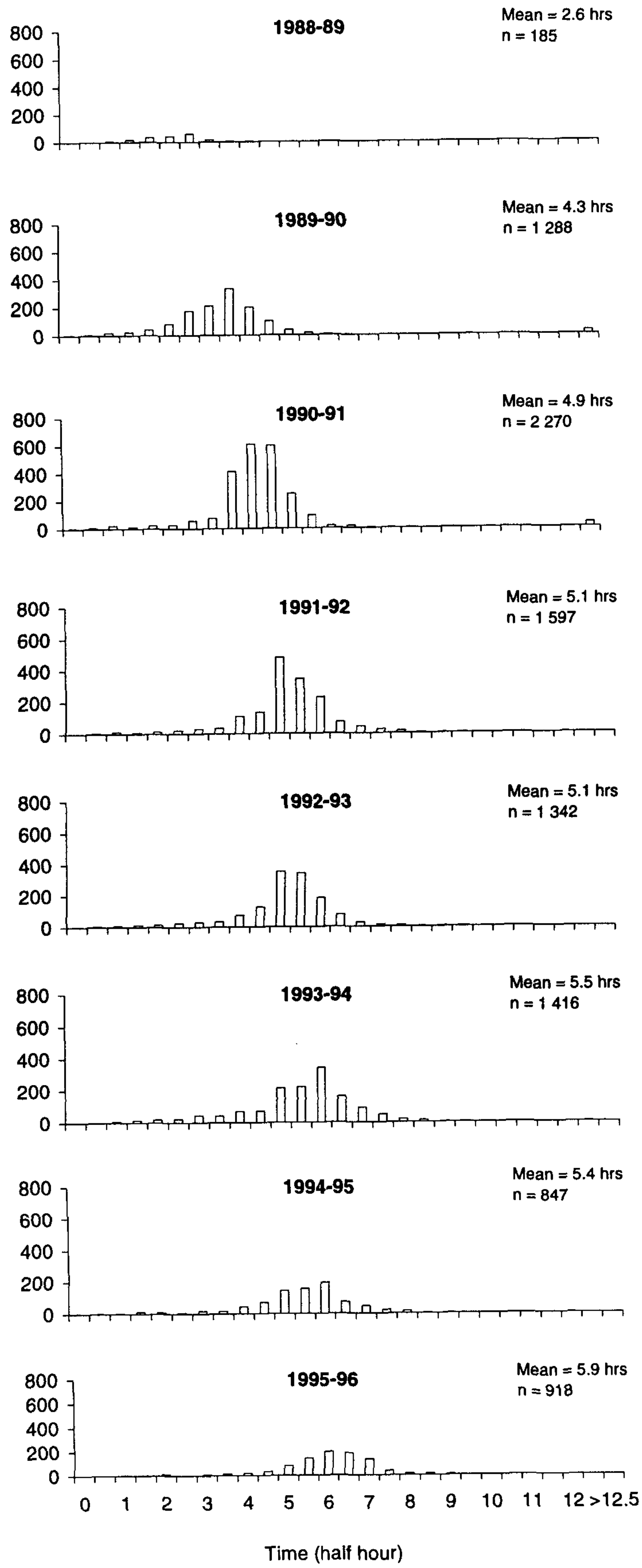


Figure 10: Scampi shot duration (rounded to nearest half hour) by fishing year in QMA 2.

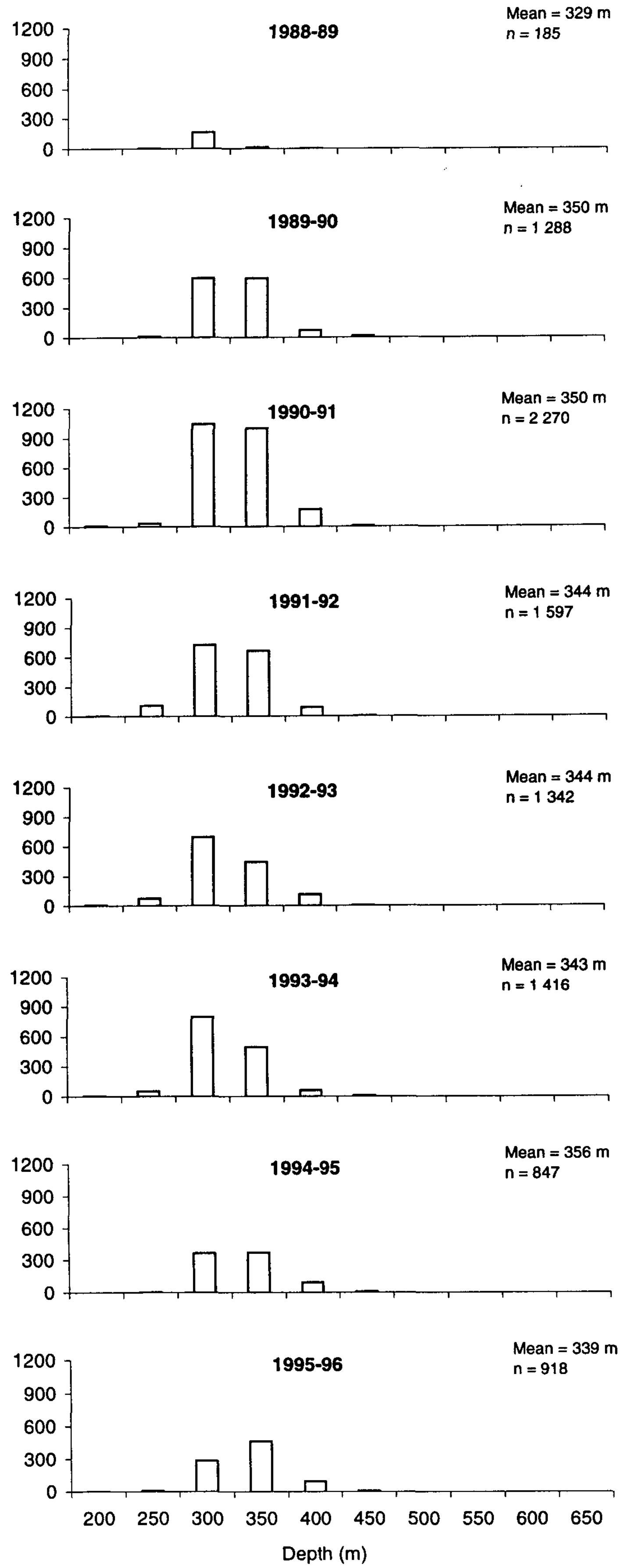


Figure 11: Depth distribution of trawls shots for scampi by fishing year in QMA 2.

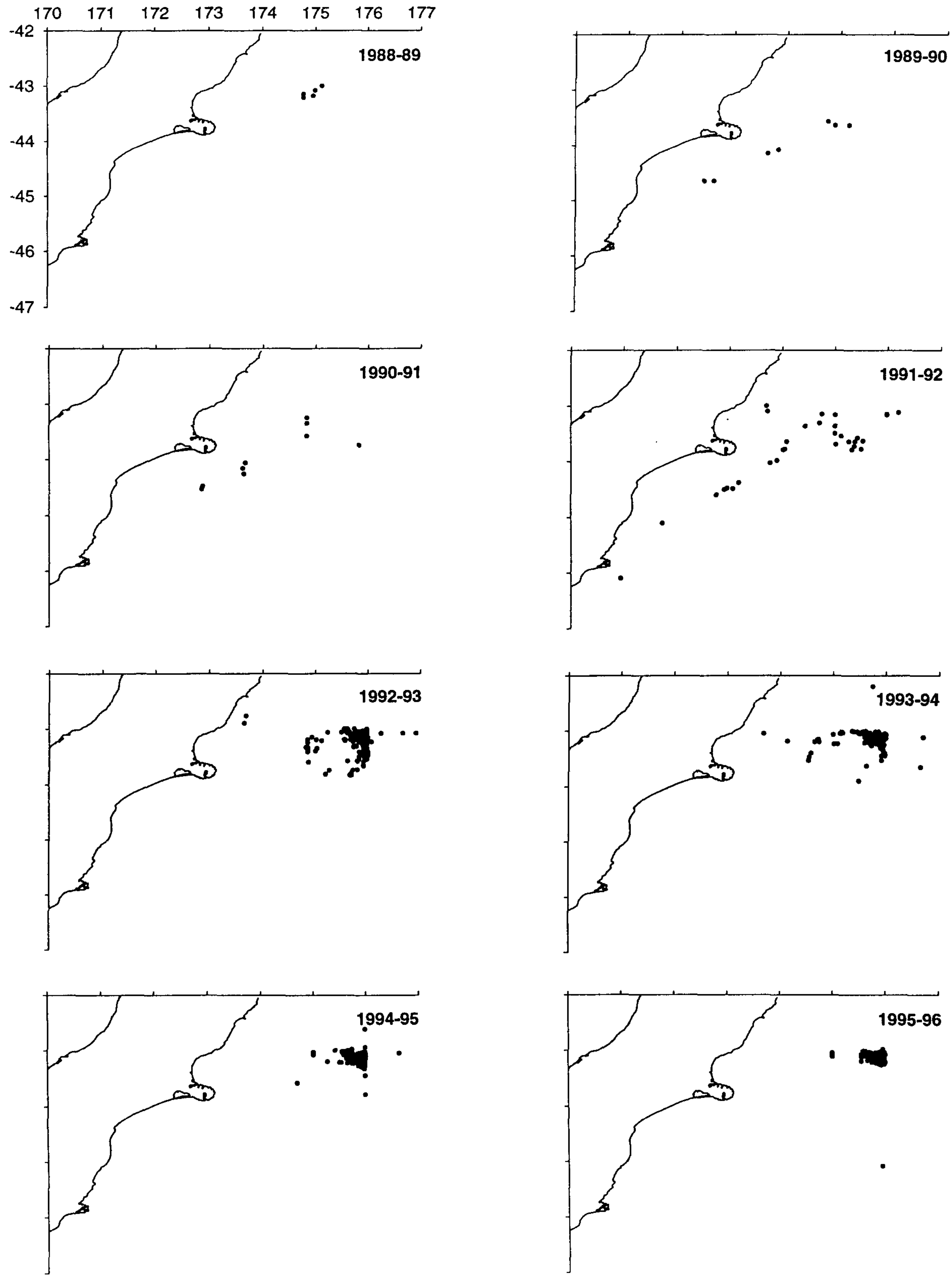


Figure 12: Spatial distribution of shots for scampi in QMA 3 by fishing year.

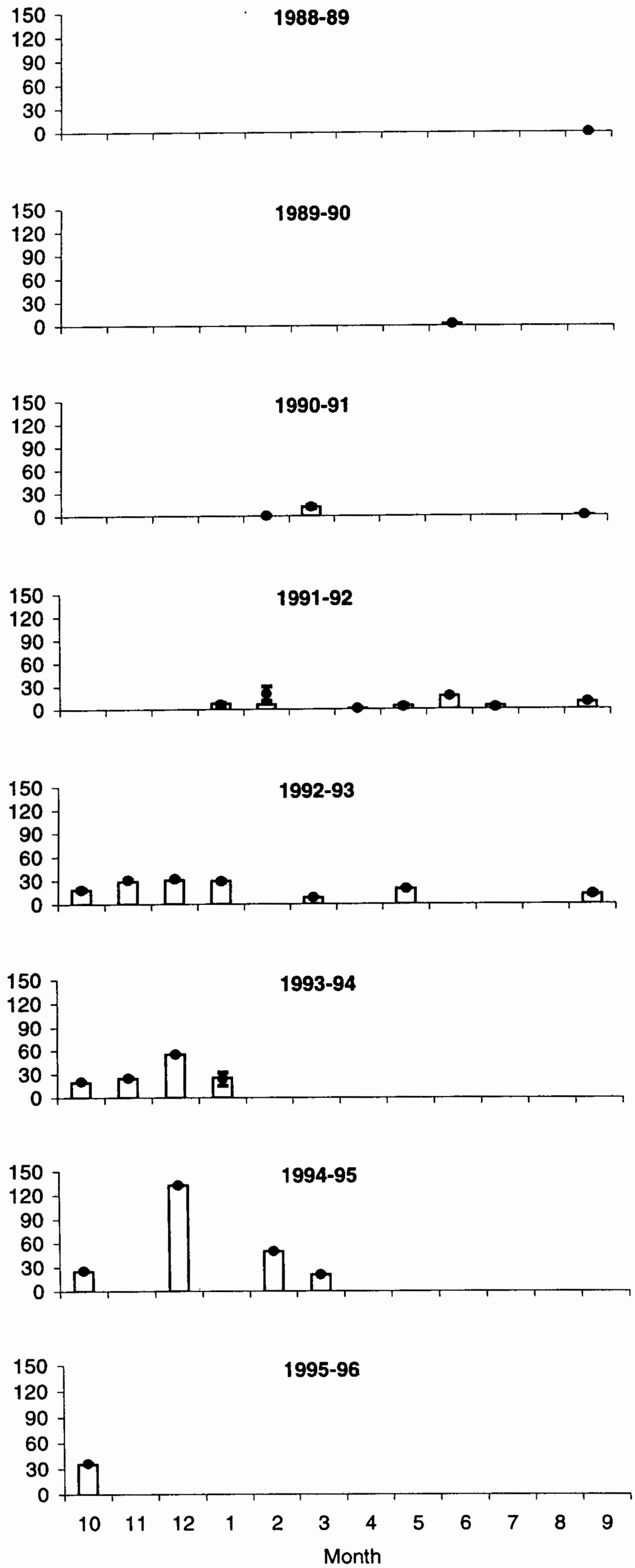


Figure 13: Catch rates (kg/h trawled) of scampi in QMA 3 by fishing year by month. Histograms denote unstandardised monthly means and dots with error bars denote the mean of individual shot catch rates ± the standard error of the mean.

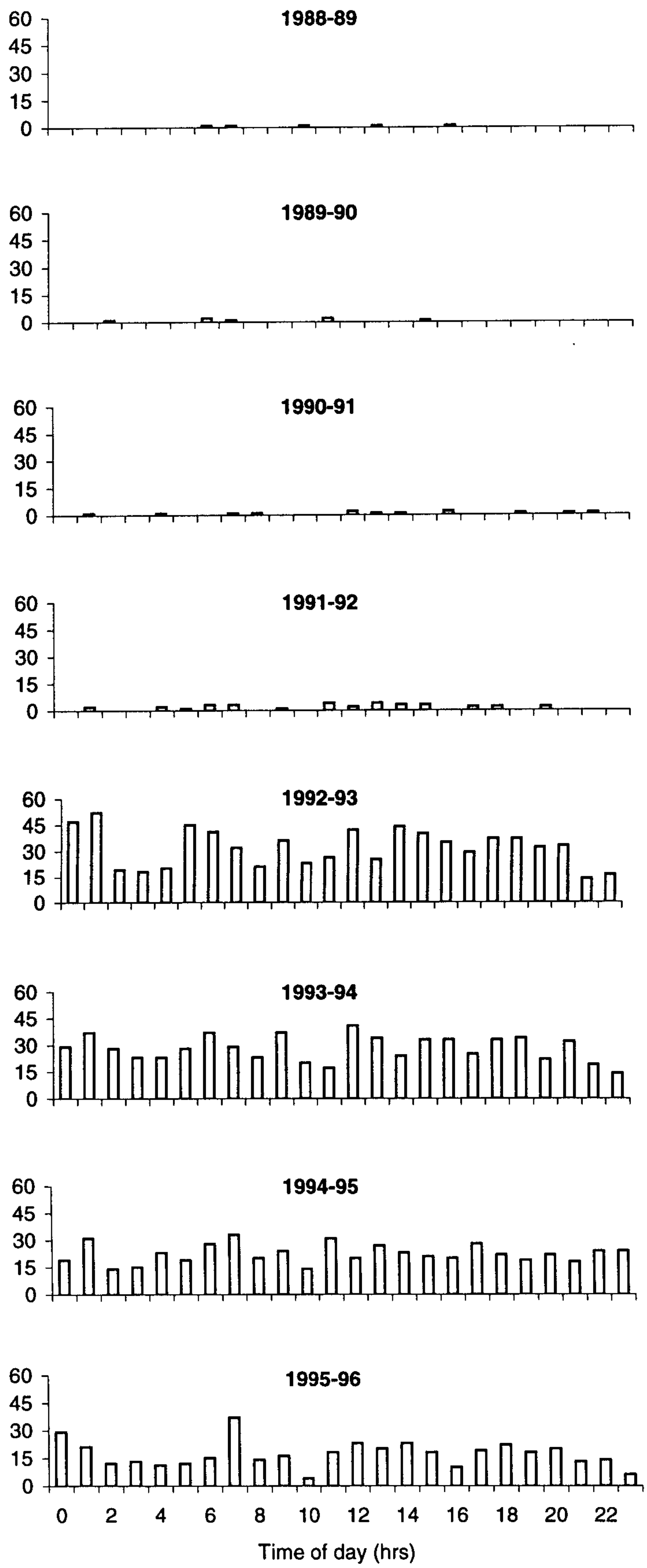


Figure 14: Diel distribution of shot start times for scampi by fishing year in QMA 3.

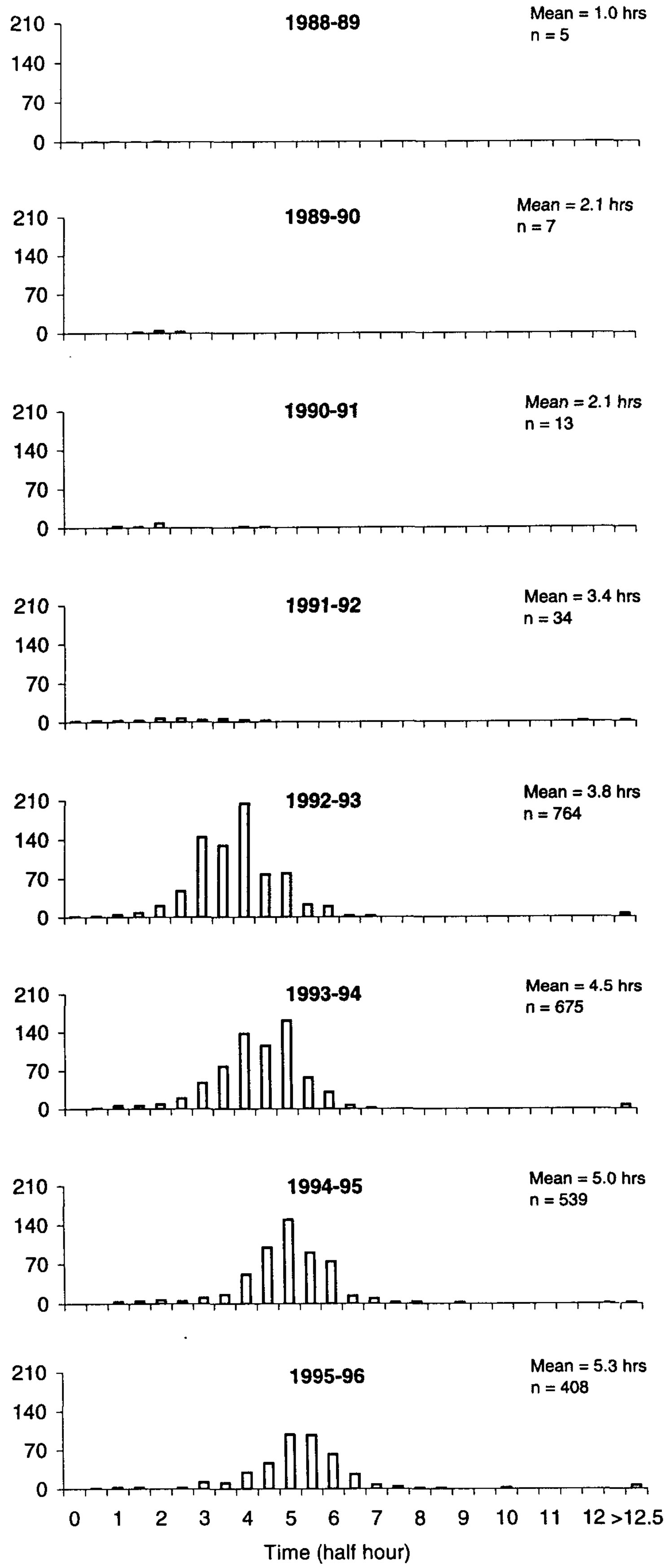


Figure 15: Scampi shot duration (rounded to nearest half hour) by fishing year in QMA 3.

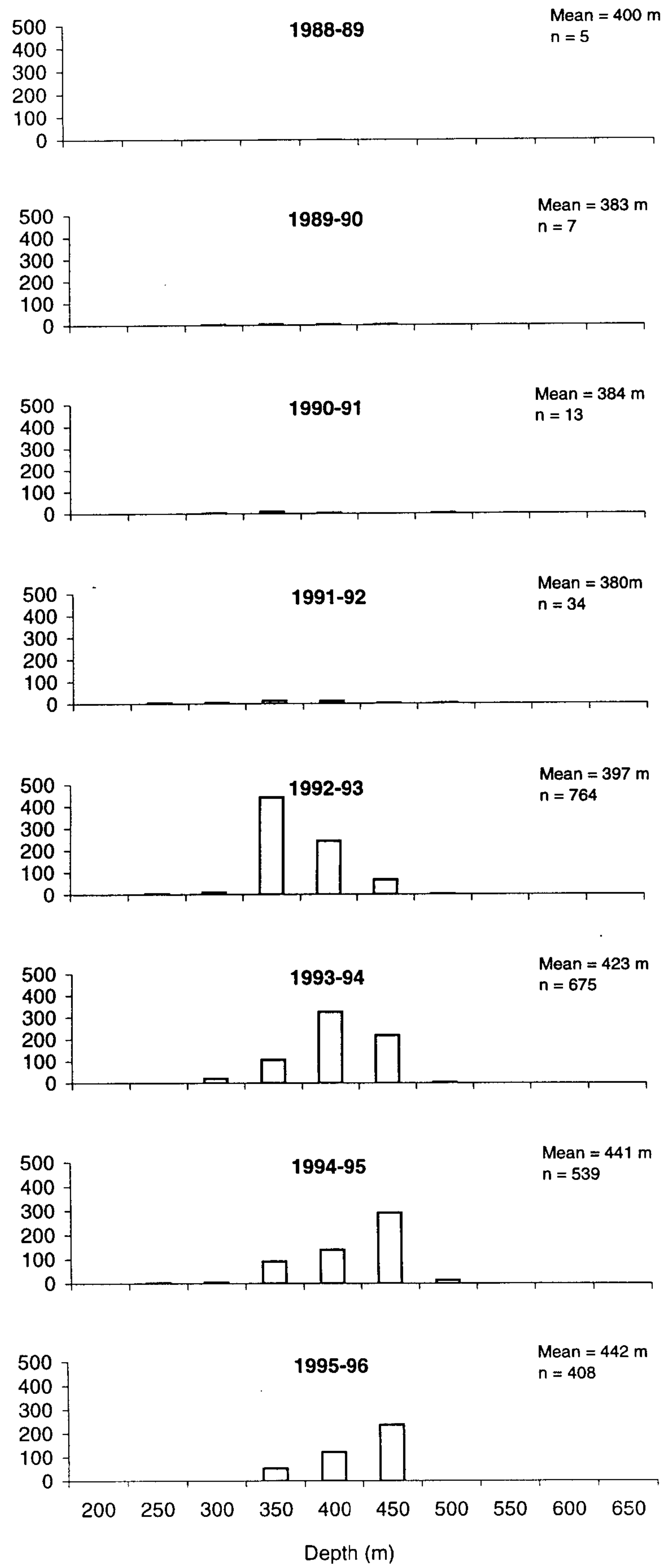


Figure 16: Depth distribution of trawl shots for scampi by fishing year in QMA 3.

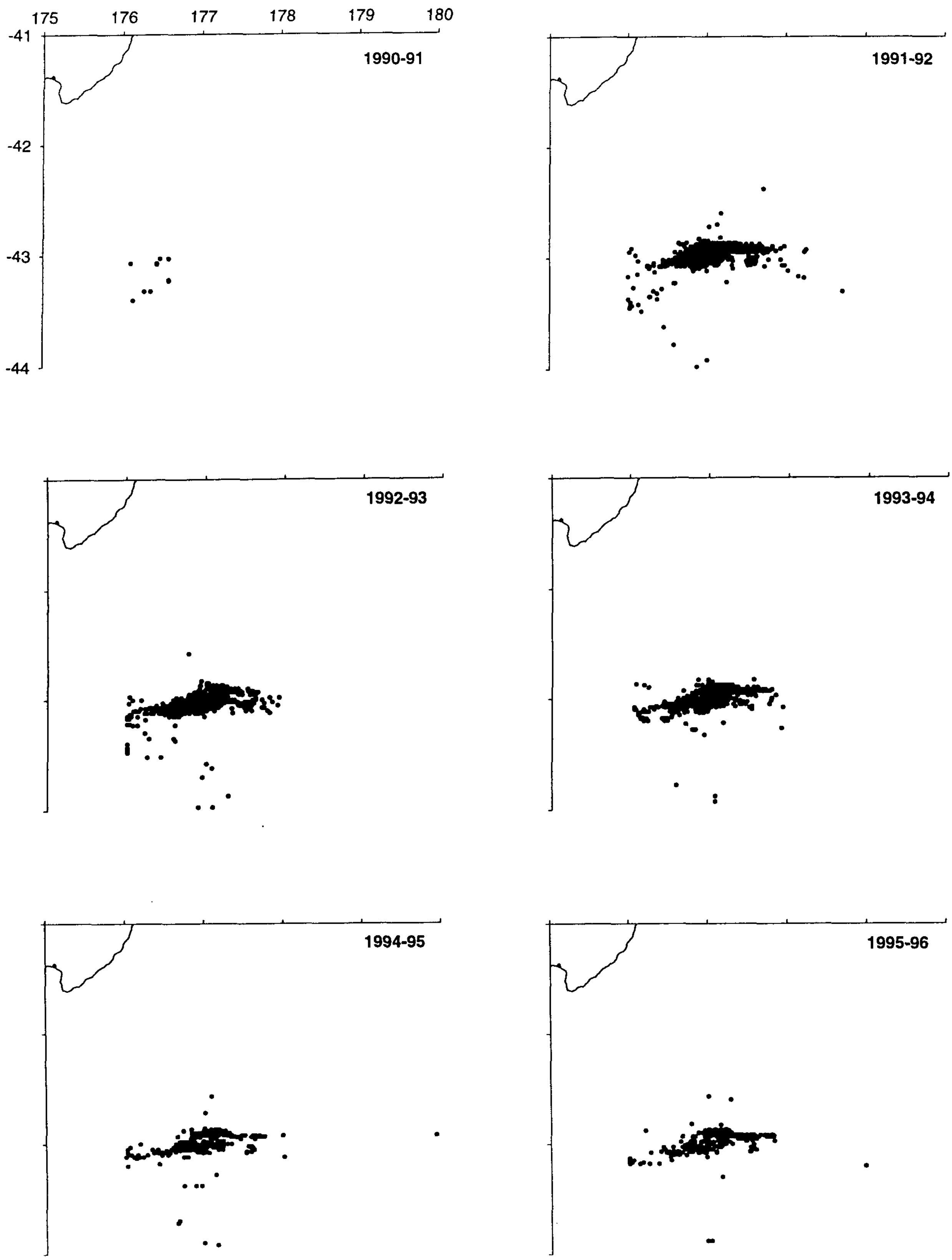


Figure 17: Spatial distribution of shots for scampi in QMA 4W by fishing year.

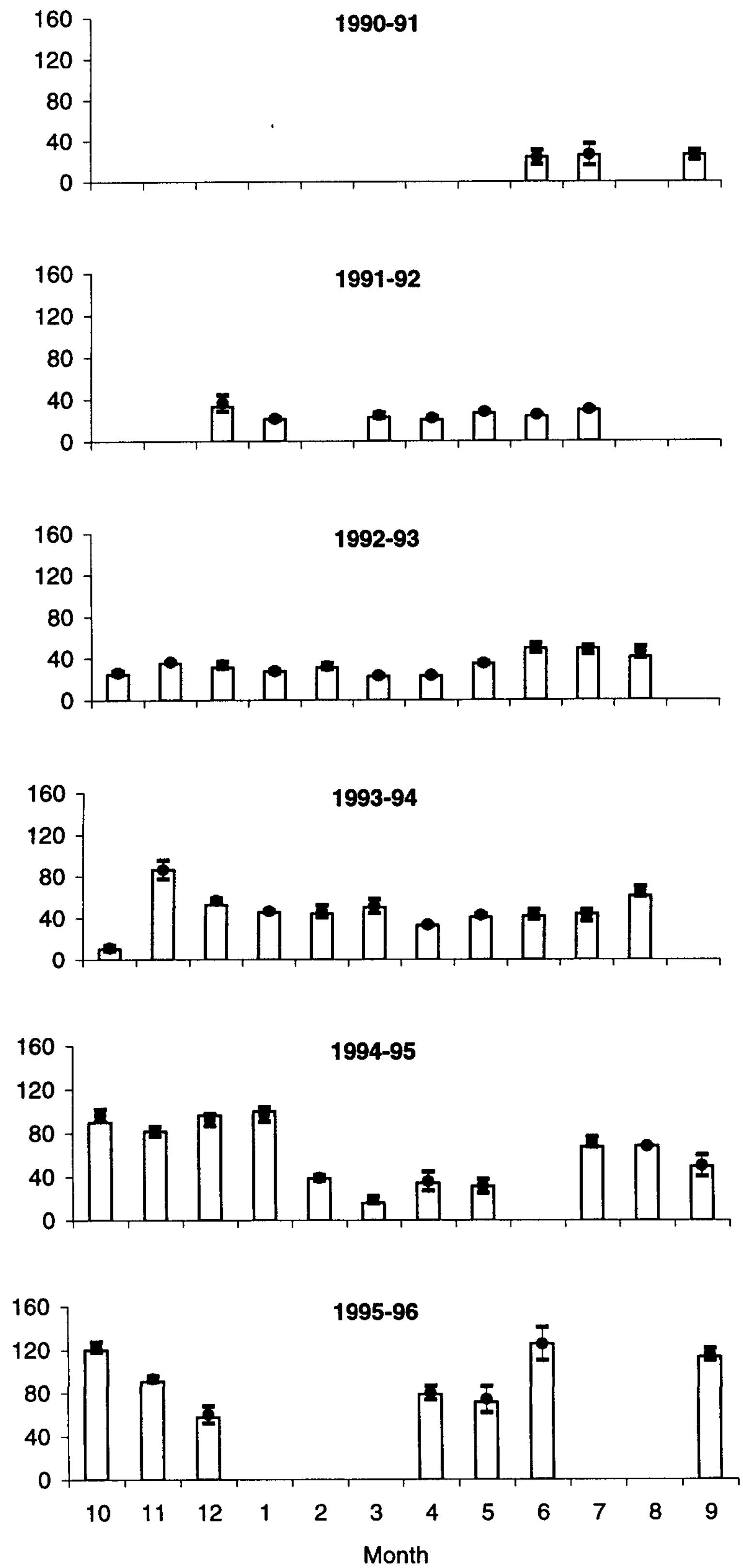


Figure 18: Catch rates (kg/h trawled) of scampi in QMA 4W by fishing year by month. Histograms denote unstandardised monthly means and dots with error bars denote the mean of individual shot catch rates ± the standard error of the mean.

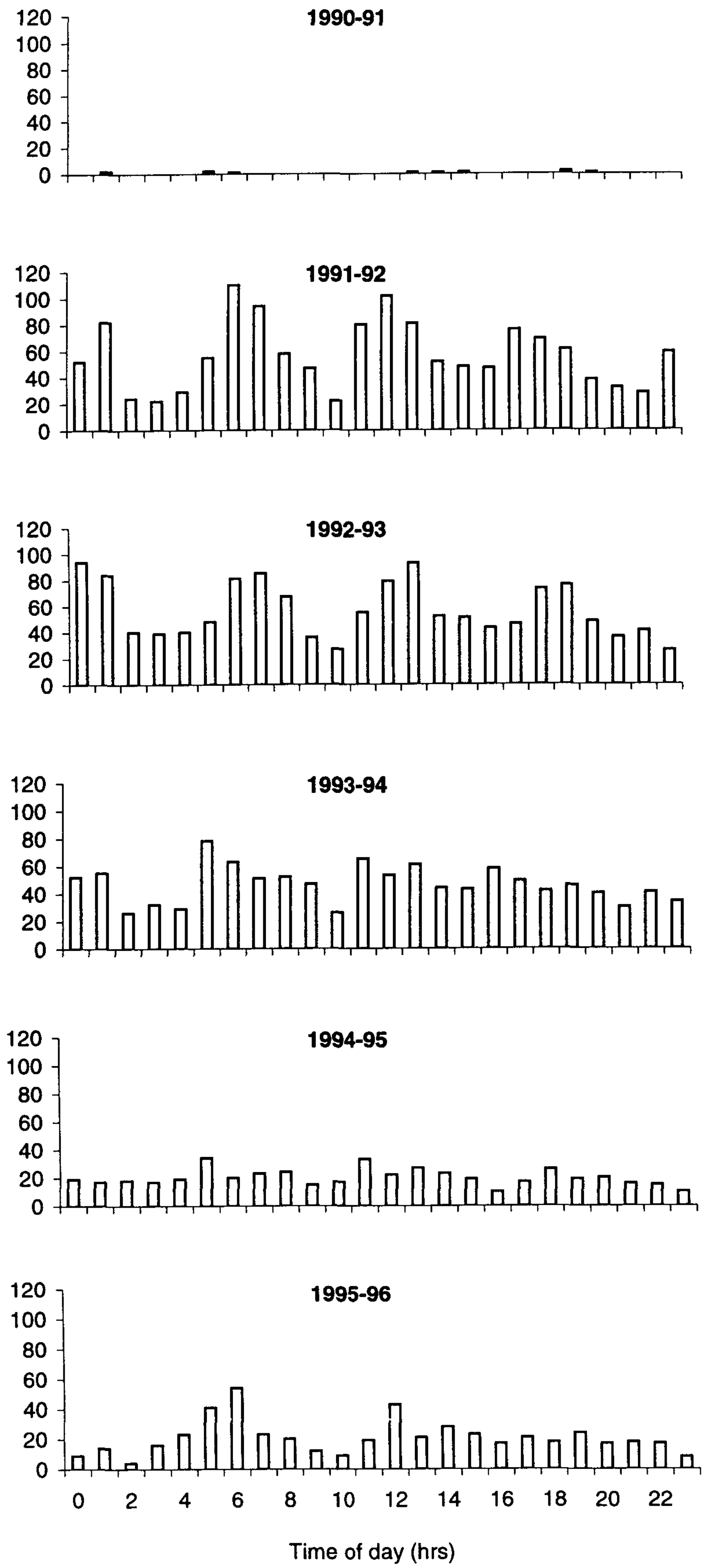


Figure 19: Diel distribution of shot start times for scampi by fishing year in QMA 4W.

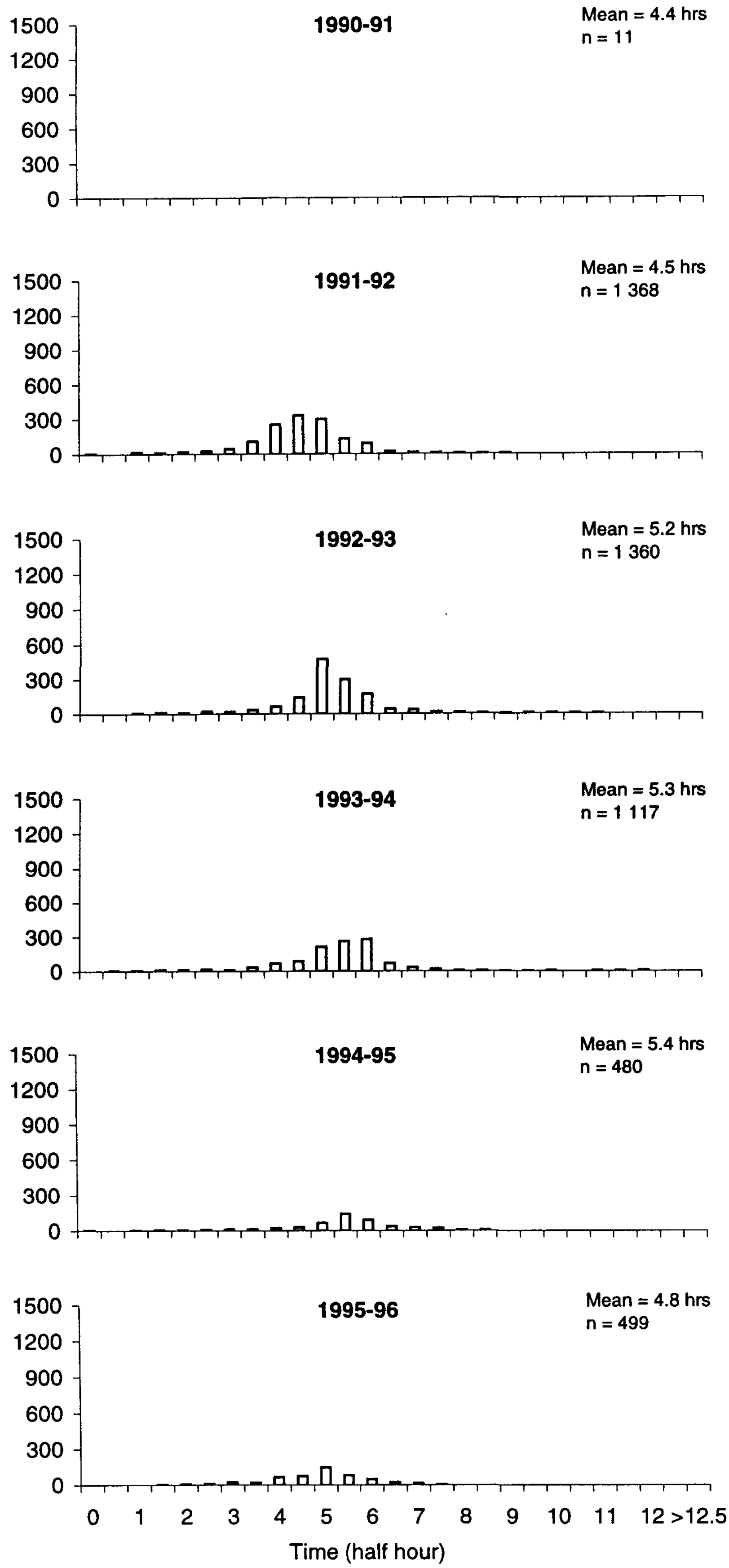


Figure 20: Scampi shot duration (rounded to nearest half hour) by fishing year in QMA 4W.

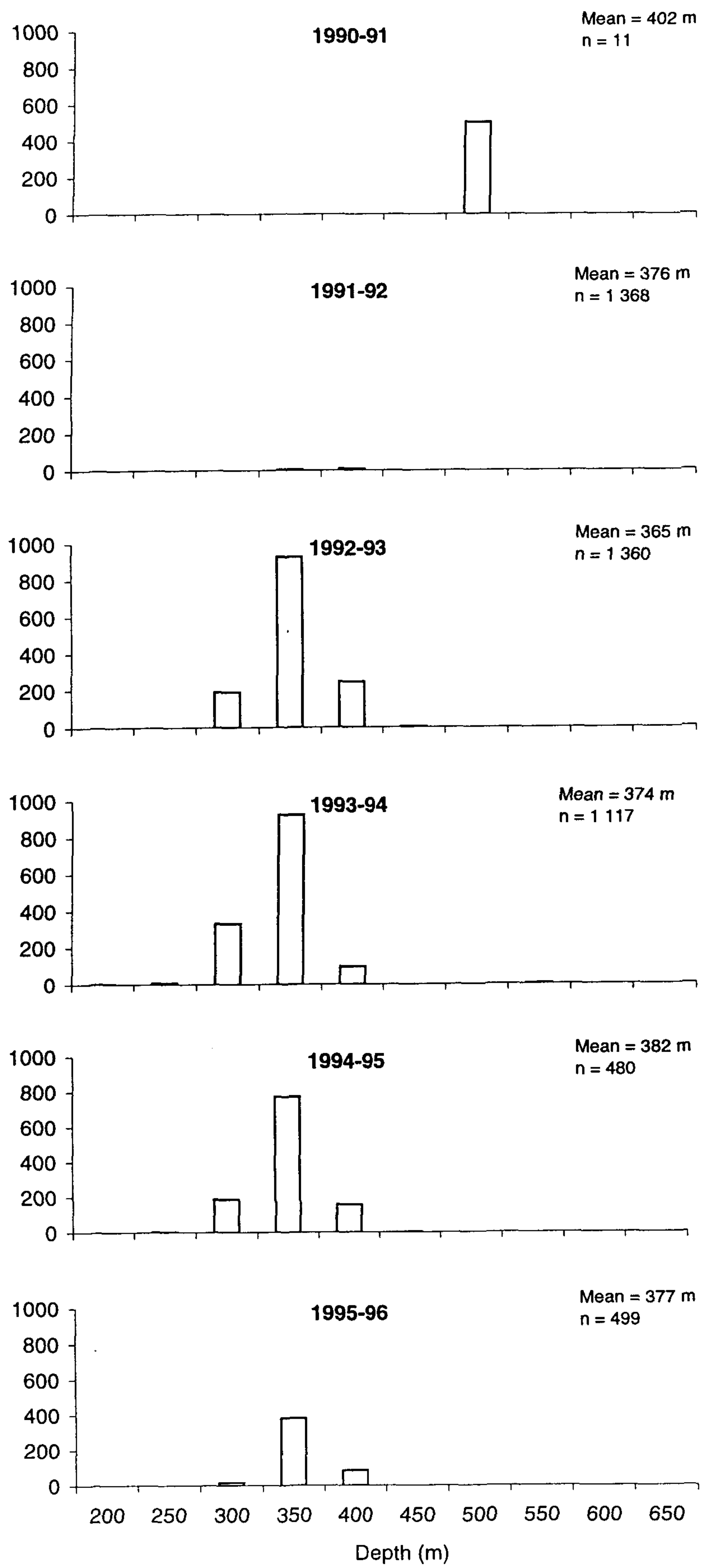


Figure 21: Depth distribution of trawl shots for scampi by fishing year in QMA 4W.

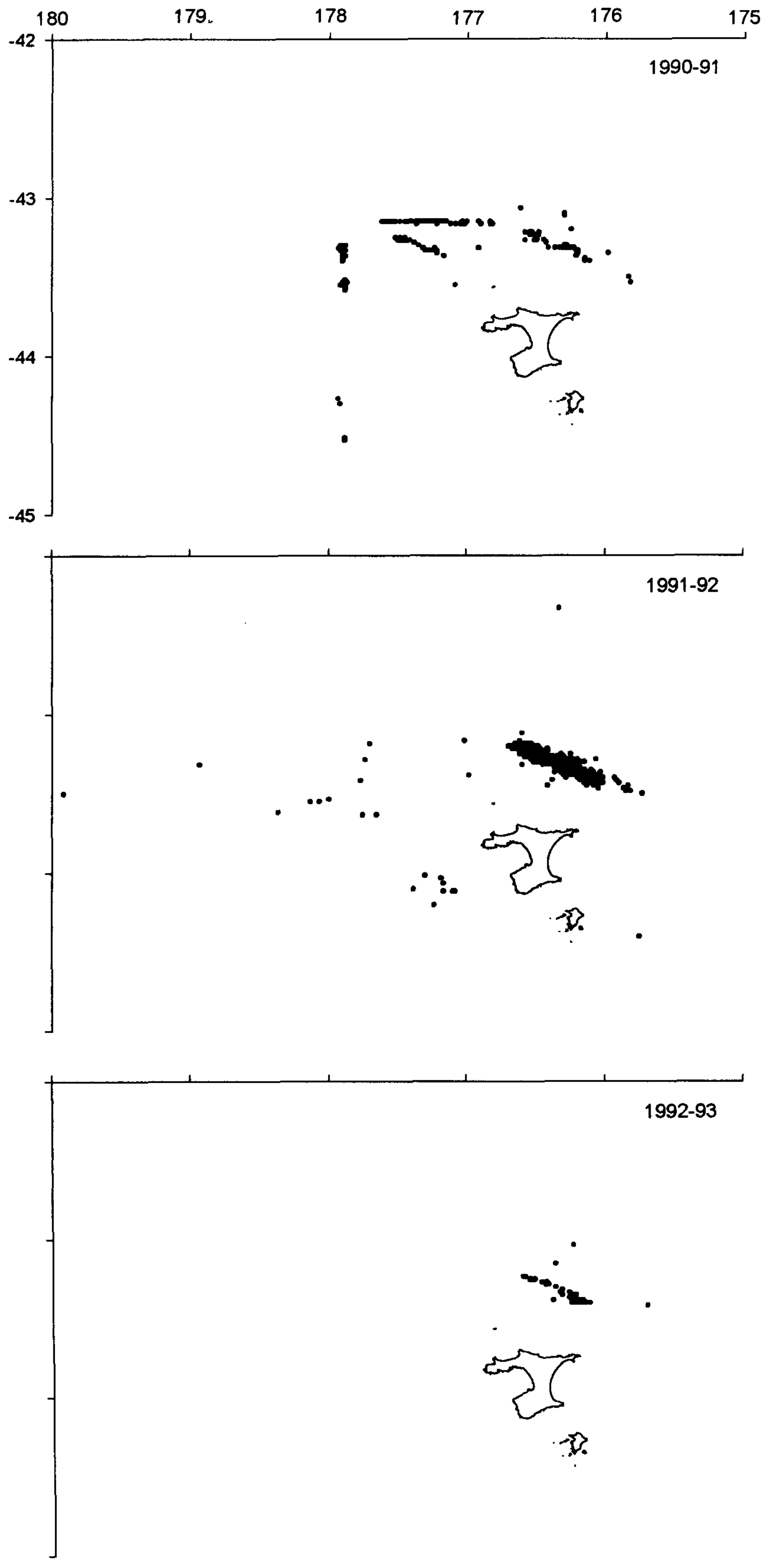


Figure 22: Spatial distribution of shots for scampi in QMA 4E by fishing year.

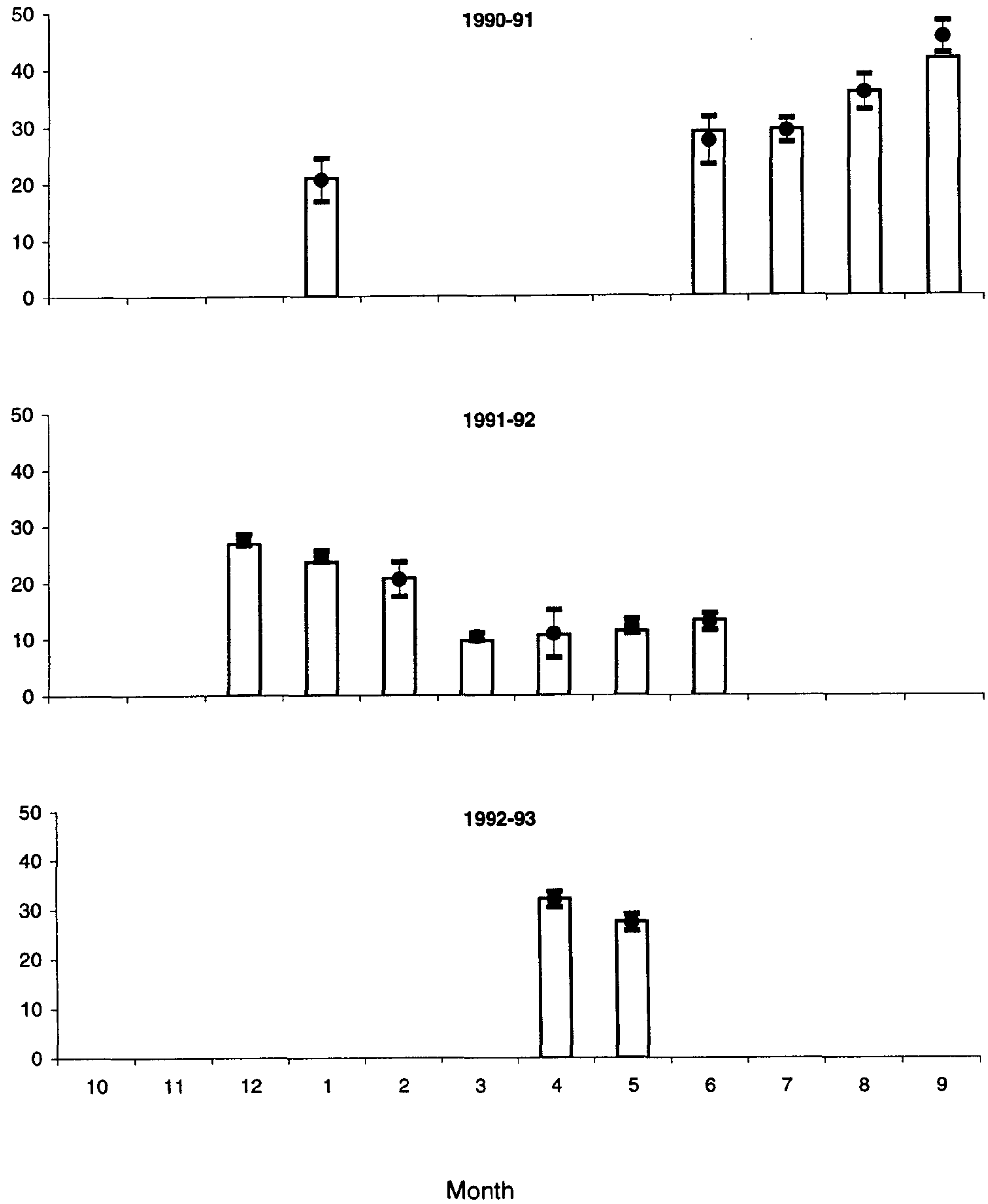


Figure 23: Catch rates (kg/h trawled) of scampi in QMA 4E by fishing year by month. Histograms denote unstandardised monthly means and dots with error bars denote the mean of individual shot catch rates ± the standard error of the mean.

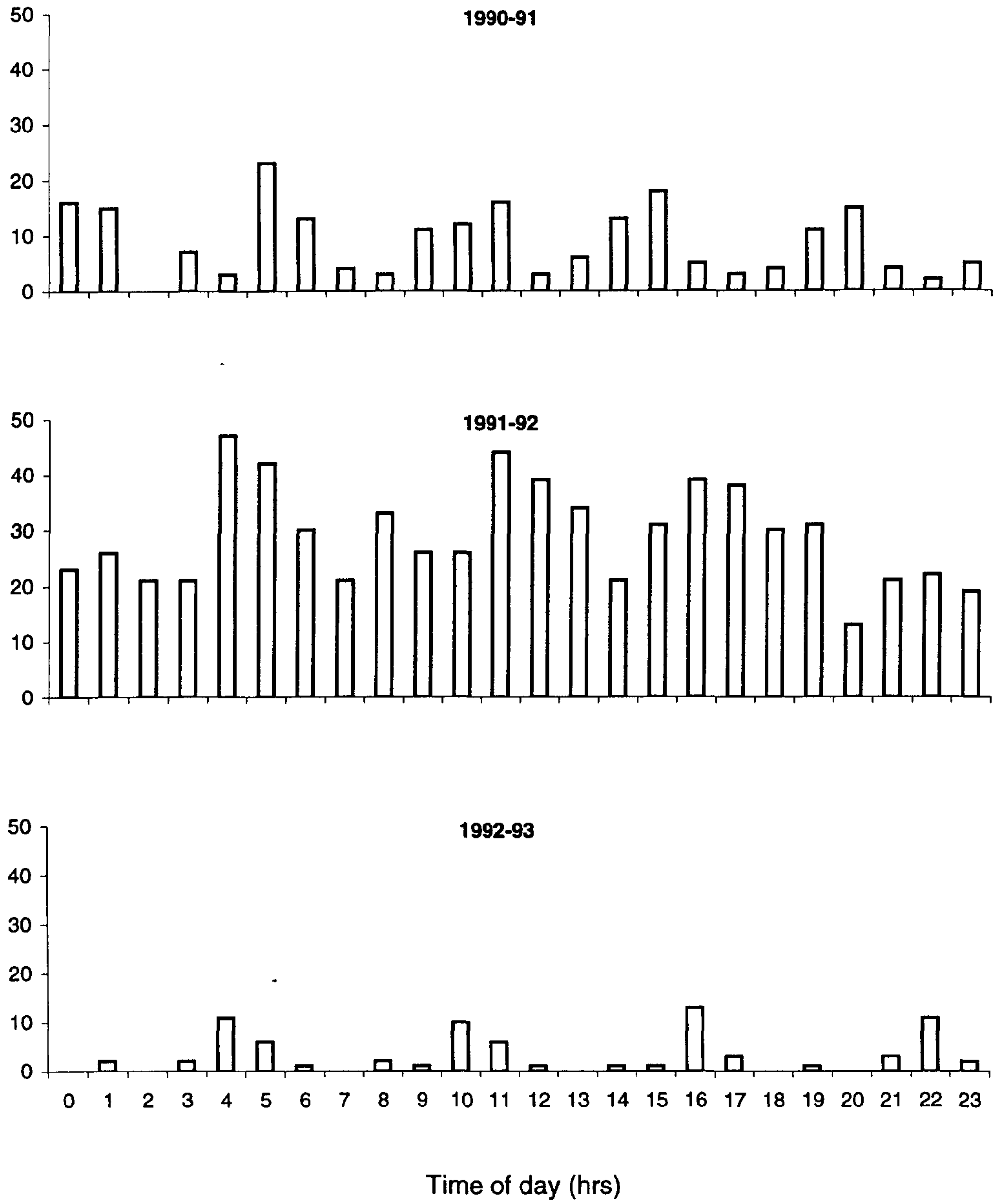


Figure 24: Diel distribution of shot start times for scampi by fishing year in QMA 4E.

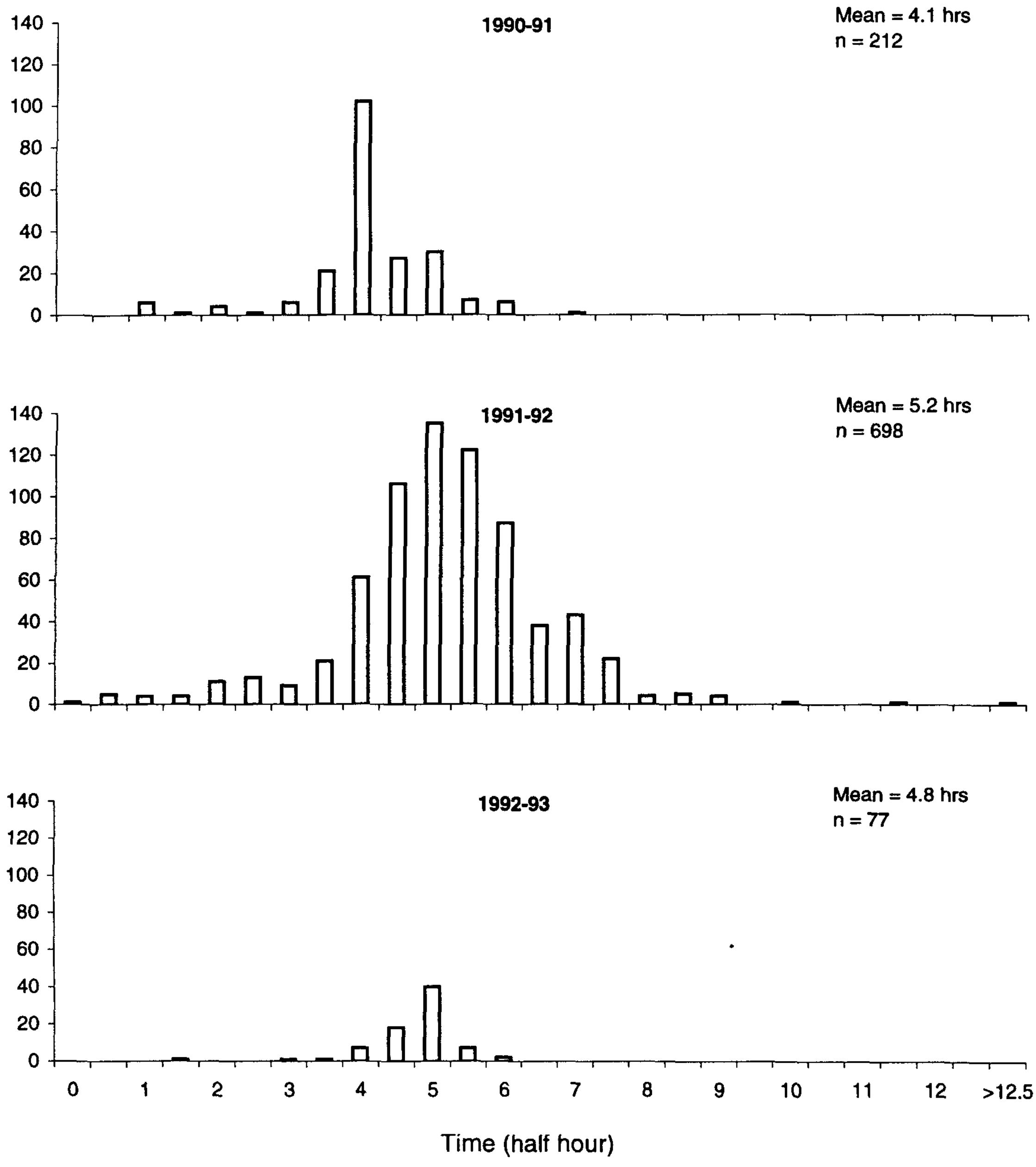


Figure 25: Scampi shot duration (rounded to nearest half hour) by fishing year in QMA 4E.

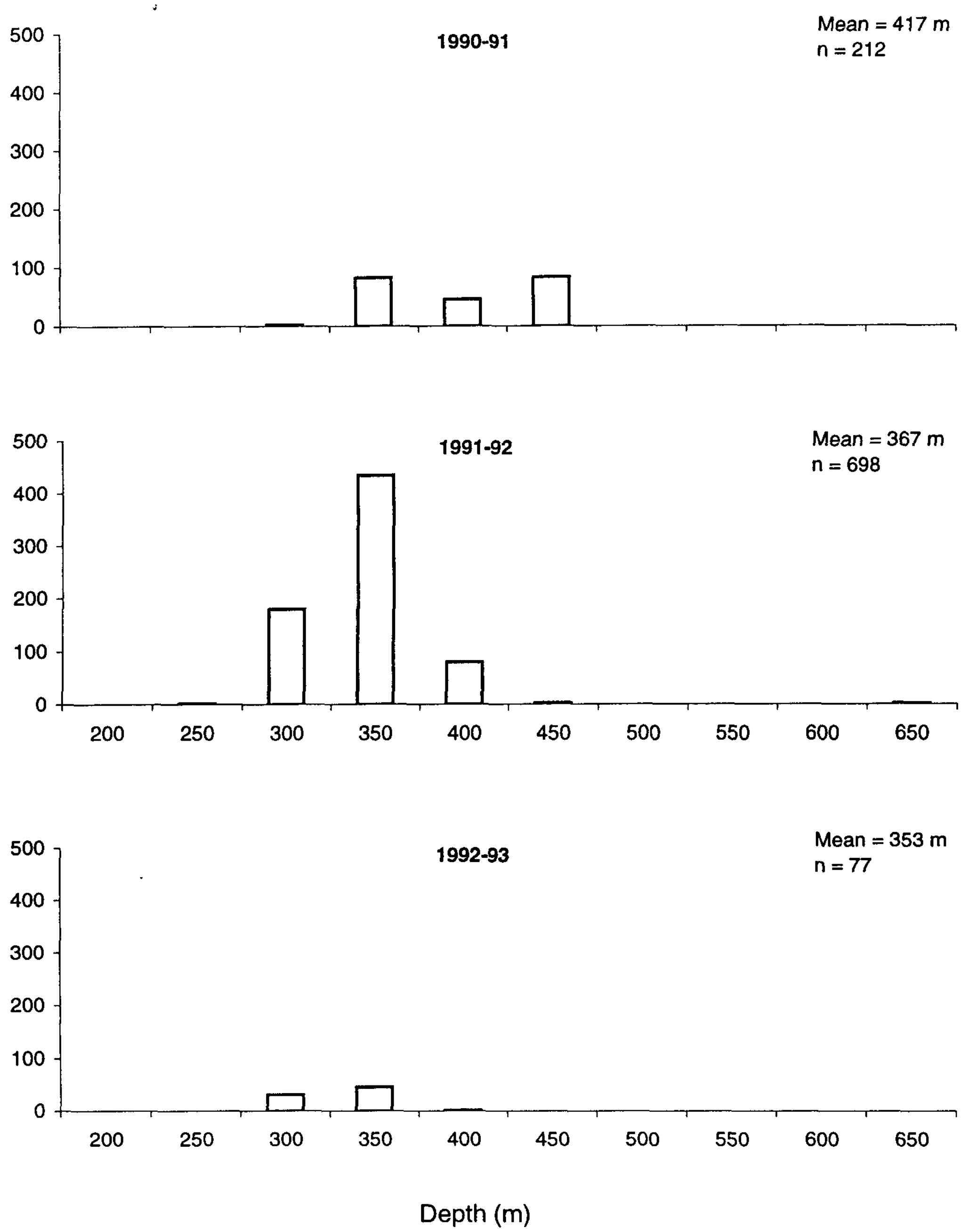


Figure 26: Depth distribution of trawl shots for scampi by fishing year in QMA 4E.

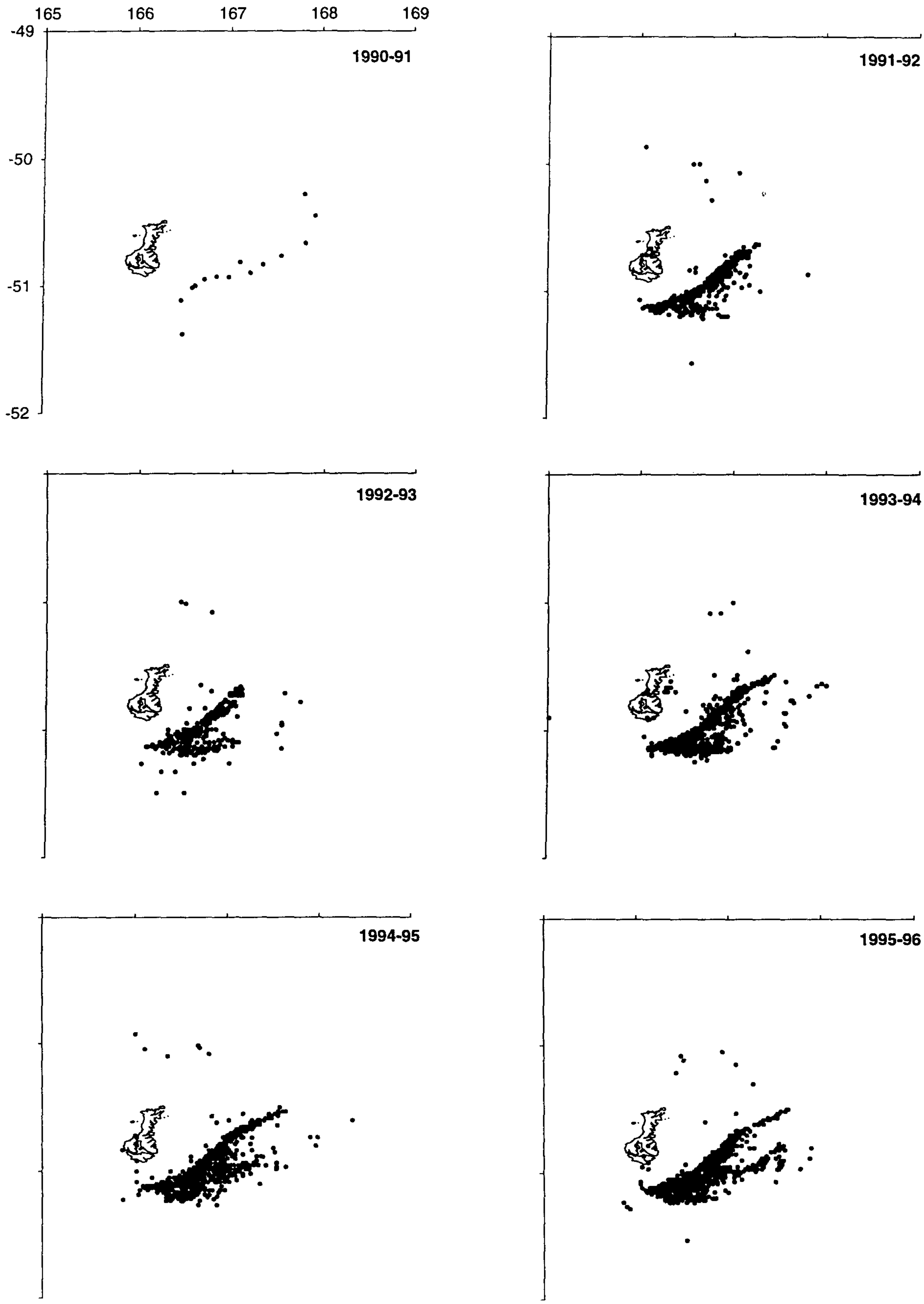


Figure 27: Spatial distribution of shots for scampi in QMA 6A by fishing year.

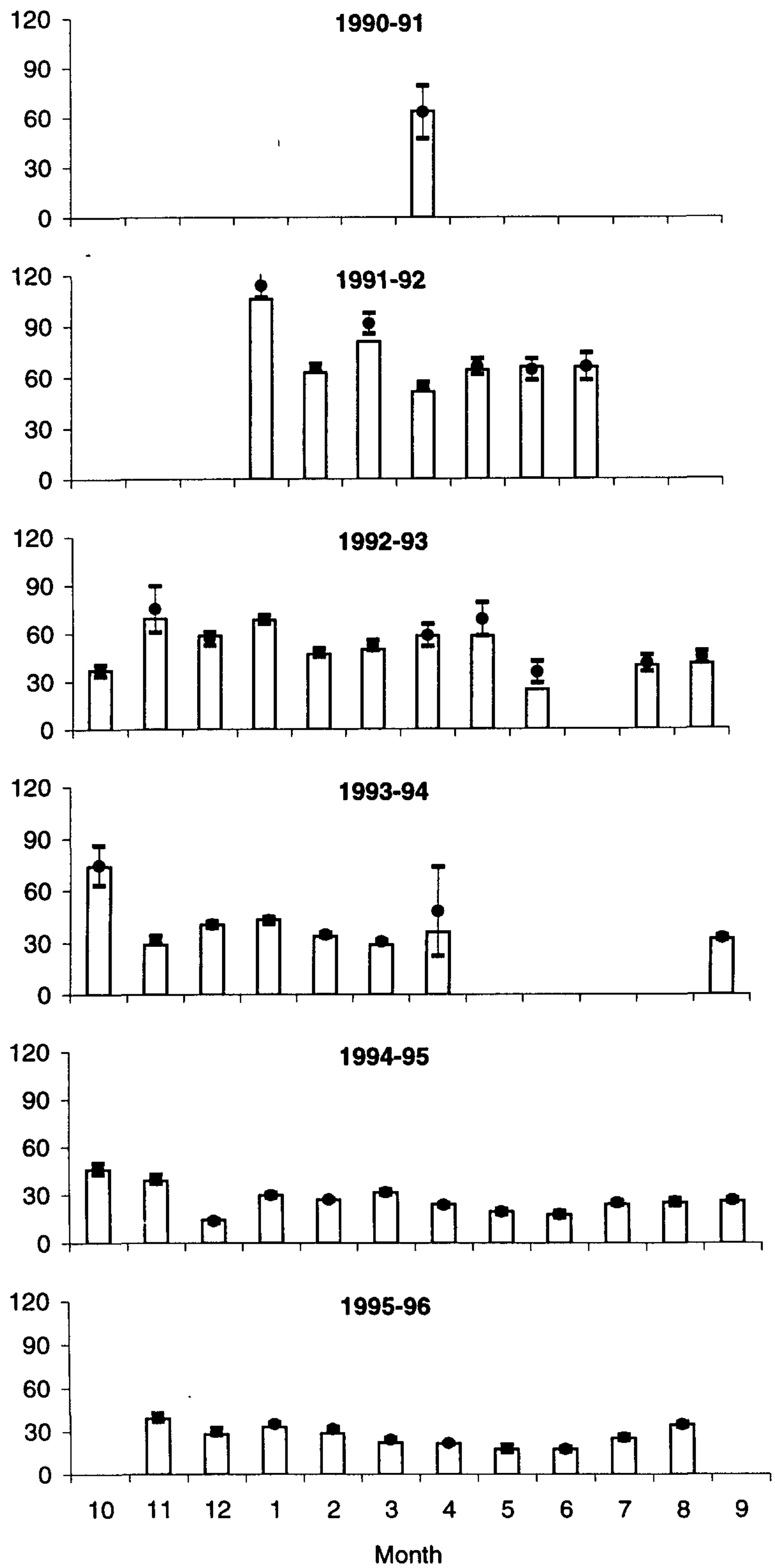


Figure 28: Catch rates (kg/h trawled) of scampi in QMA 6A by fishing year by month. Histograms denote unstandardised monthly means and dots with error bars denote the mean of individual shot catch rates ± the standard error of the mean.

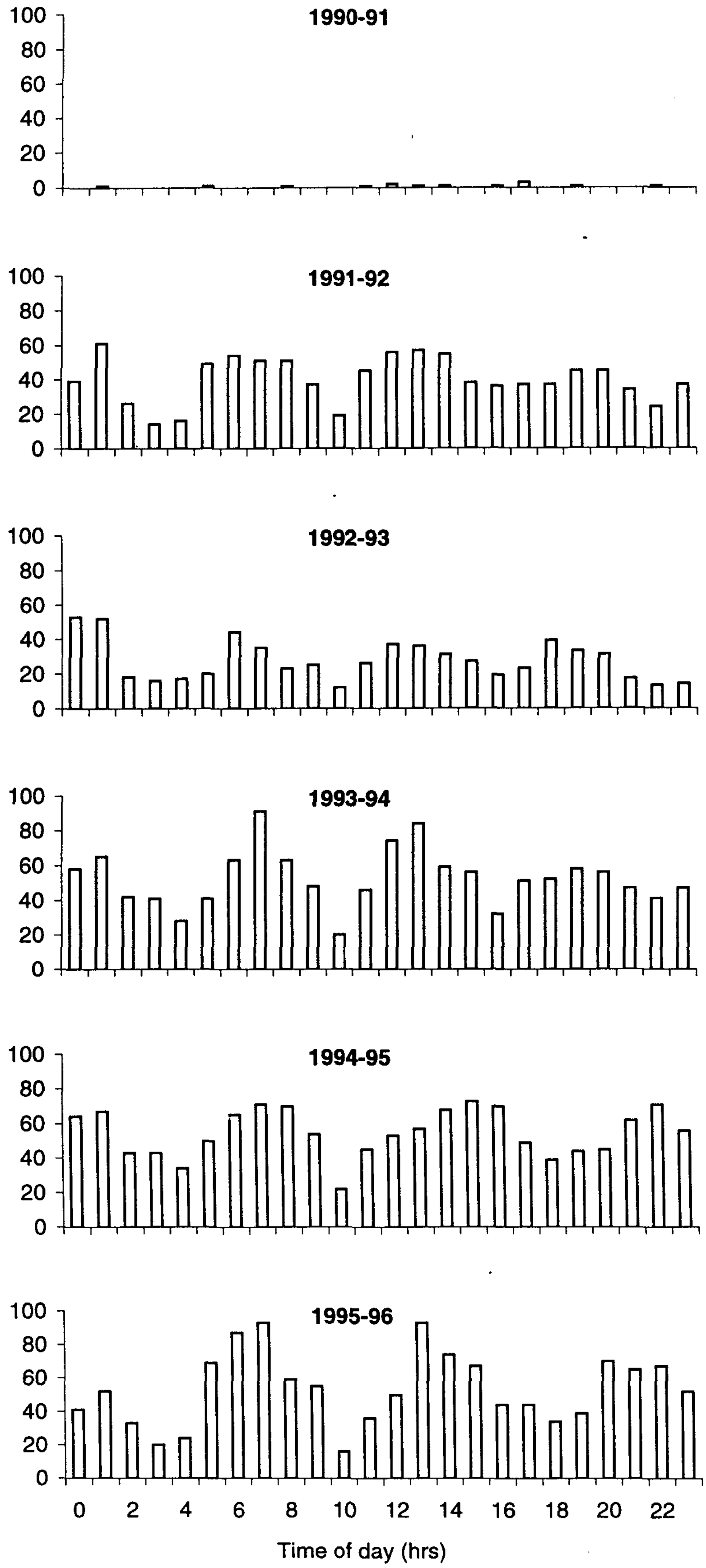


Figure 29: Diel distribution of shot start times for scampi by fishing year in QMA 6A.

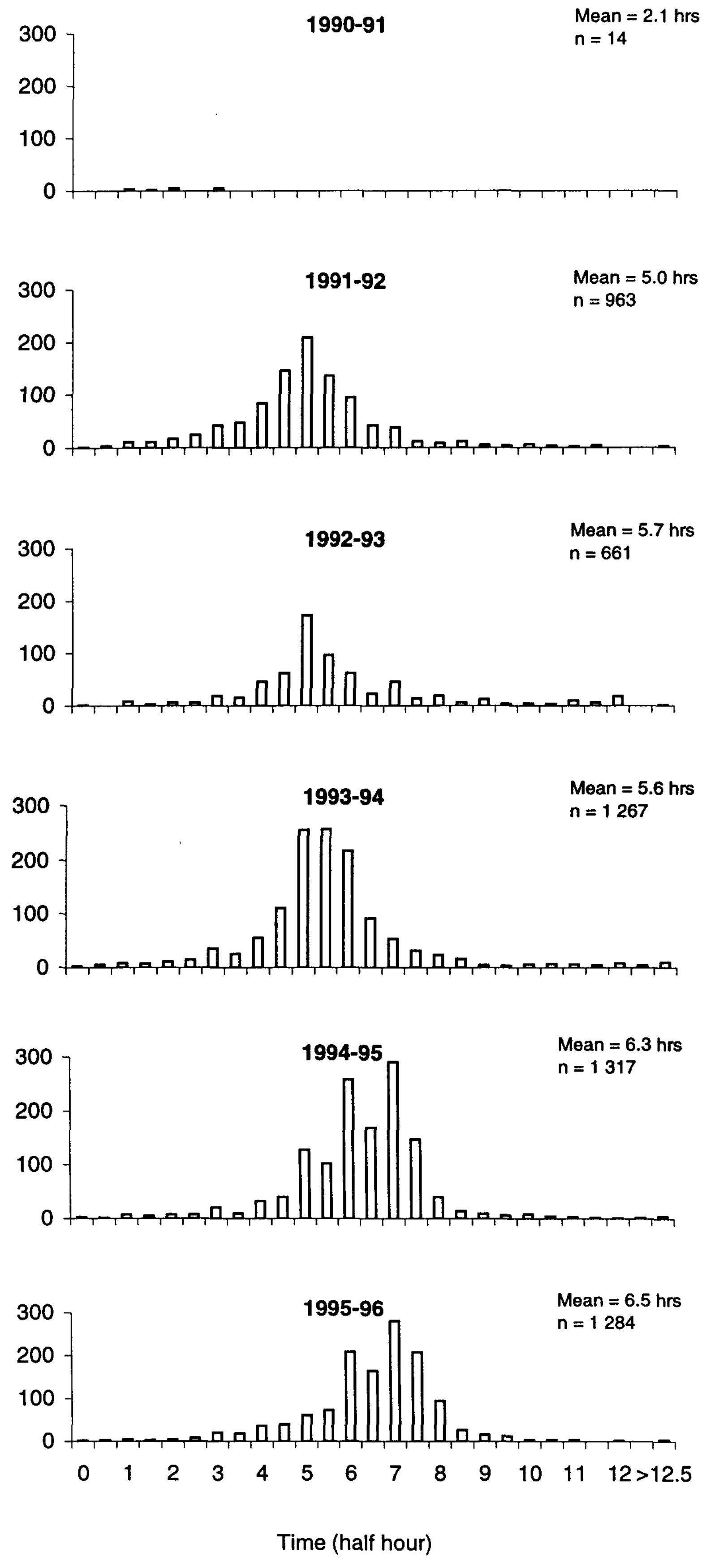


Figure 30: Scampi shot duration (rounded to nearest half hour) by fishing year in QMA 6A.

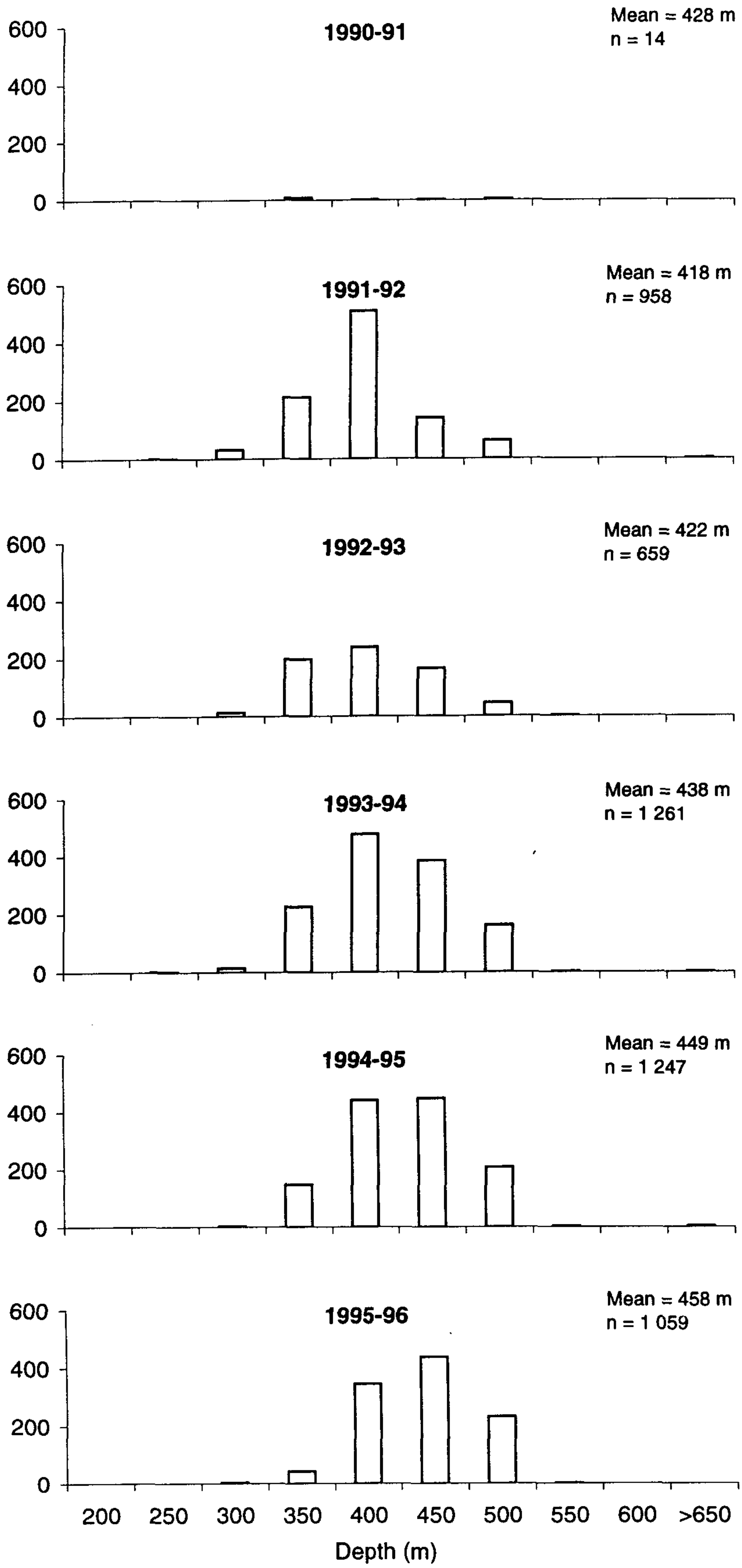


Figure 31: Depth distribution of trawl shots for scampi by fishing year in QMA 6A.

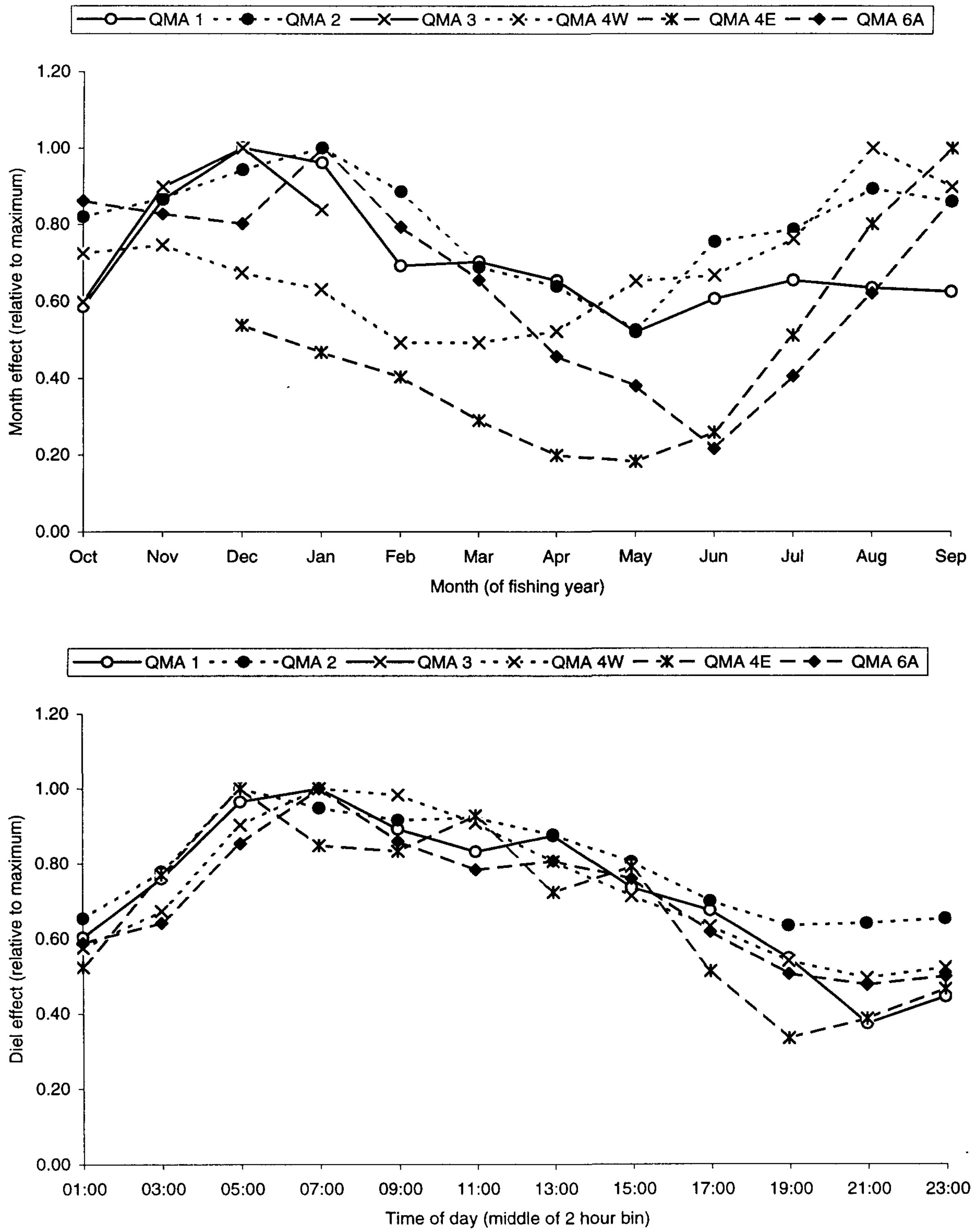


Figure 32: Relative effects on catch rates of seasonal (top) and diel (bottom) catchability cycles in models of commercial CPUE for scampi fisheries.

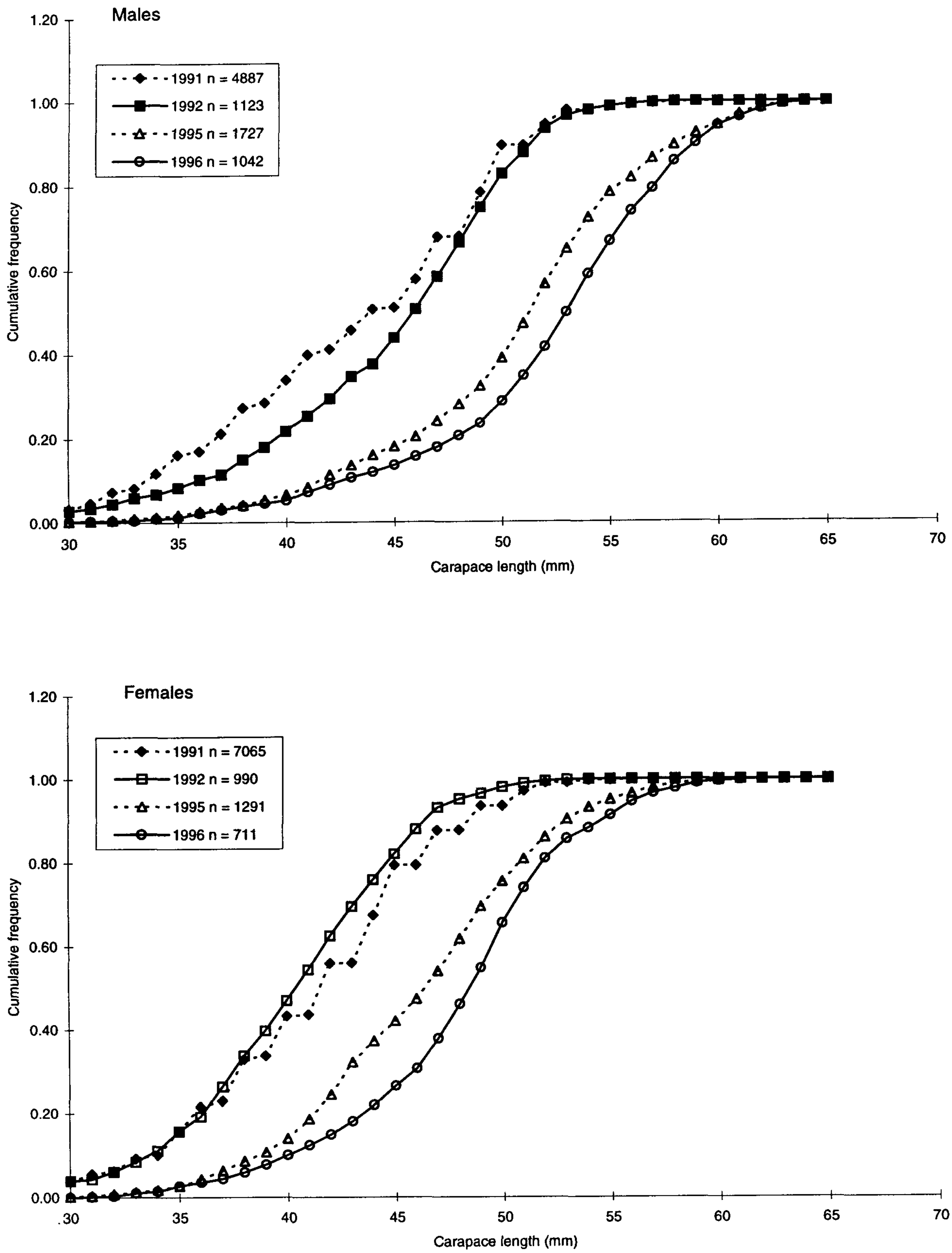
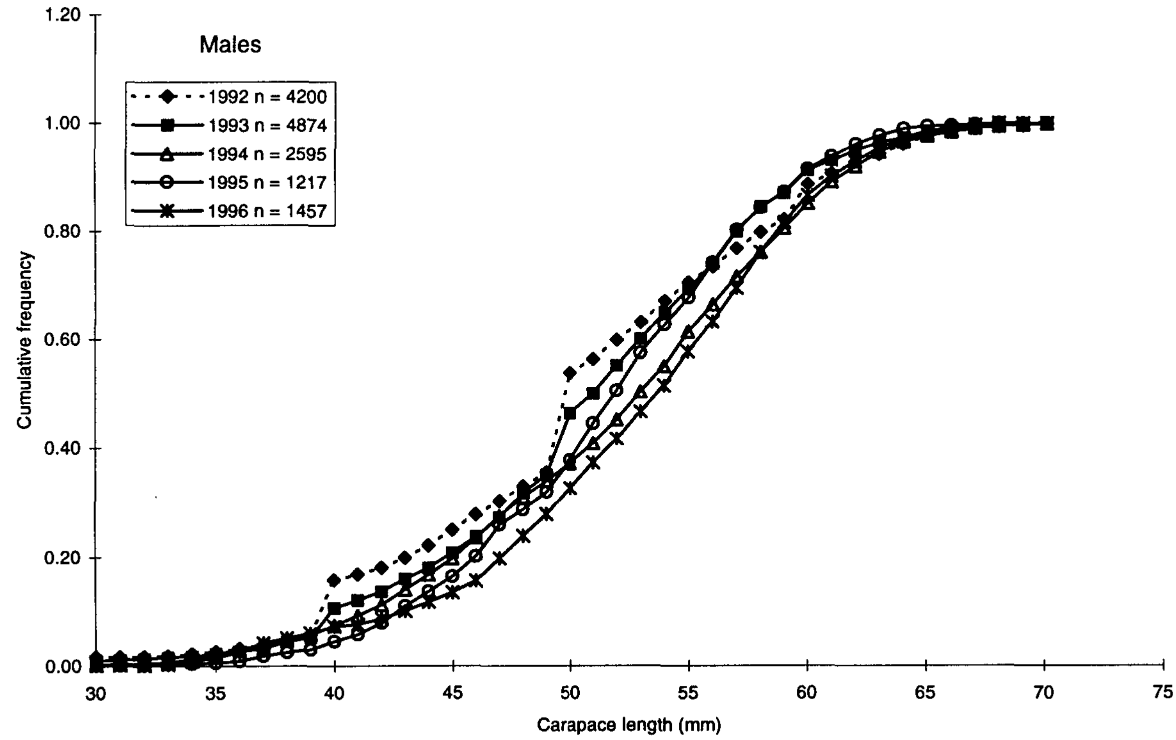


Figure 33: Cumulative length frequency distributions for male (top) and female (bottom) scampi in QMA 1 measured by scientific observers (1991, 1992, 1995, 1996). Irregularities in early data caused by conversion from non–standard (i.e., other than orbital carapace length) measurement methods.



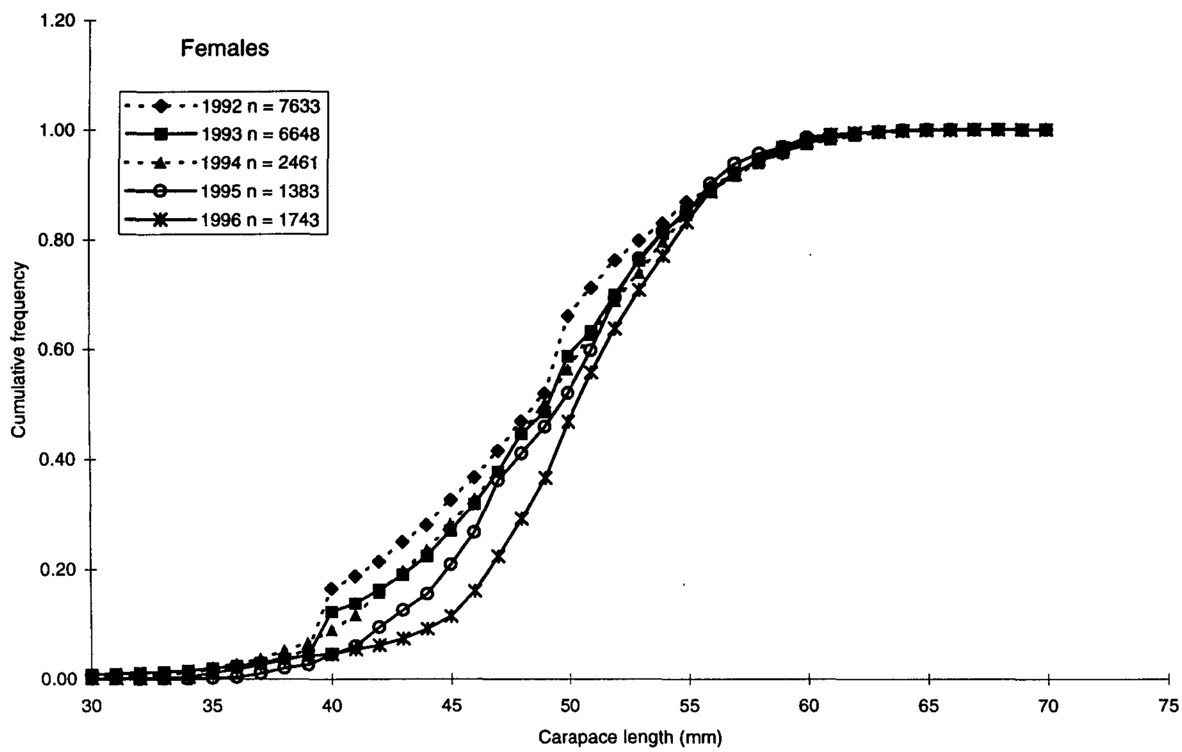


Figure 34: Cumulative length frequency distributions for male (top) and female (bottom) scampi in QMA 6A measured by scientific observers (1992 –1996). Irregularities in early data caused by measurement with 10 mm precision instead of the standard 1 mm precision.

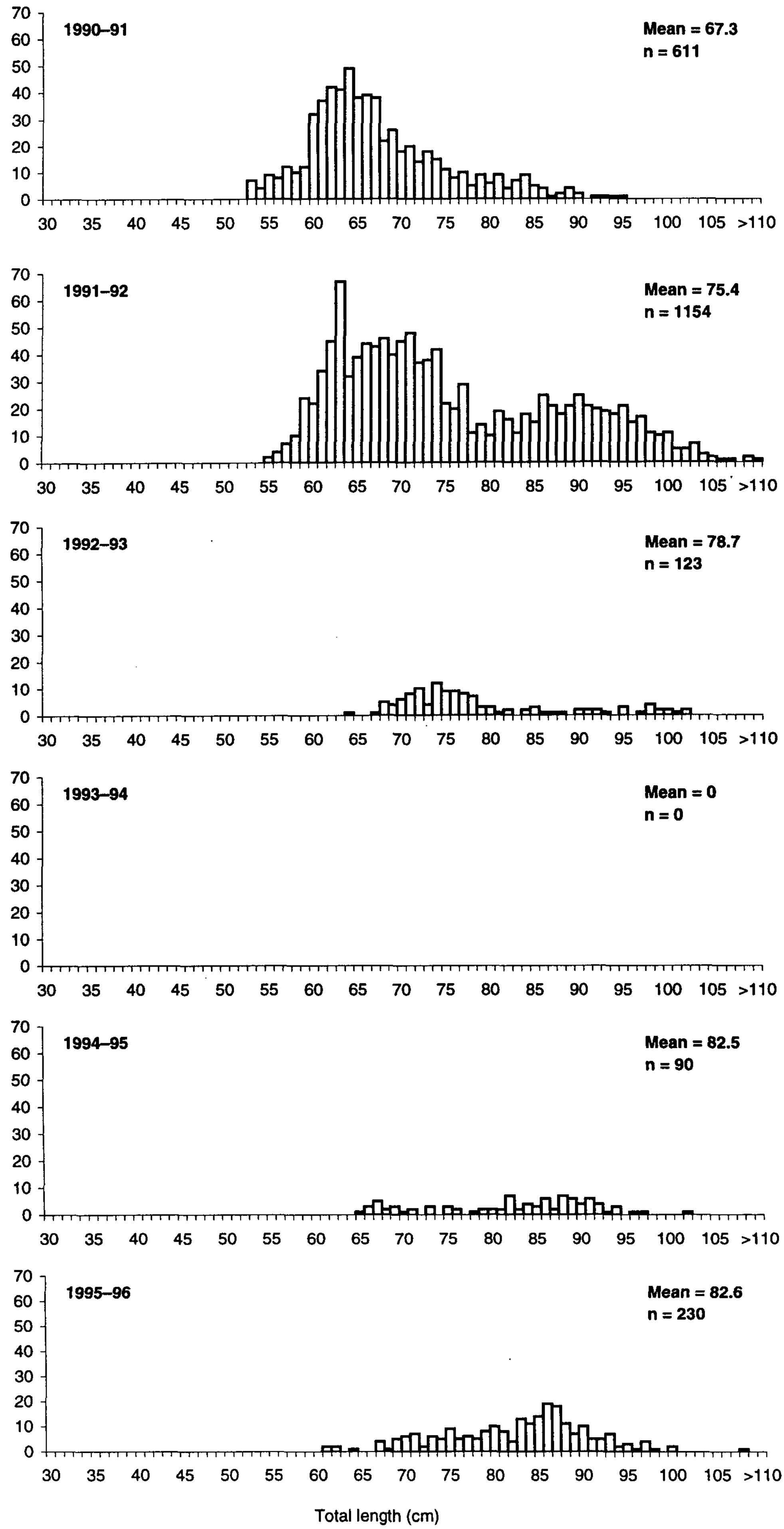


Figure 35: Length frequency distributions for hoki measured by scientific observers on board scampi trawlers in QMA 1 (area AKE). No hoki were measured in 1993–94.

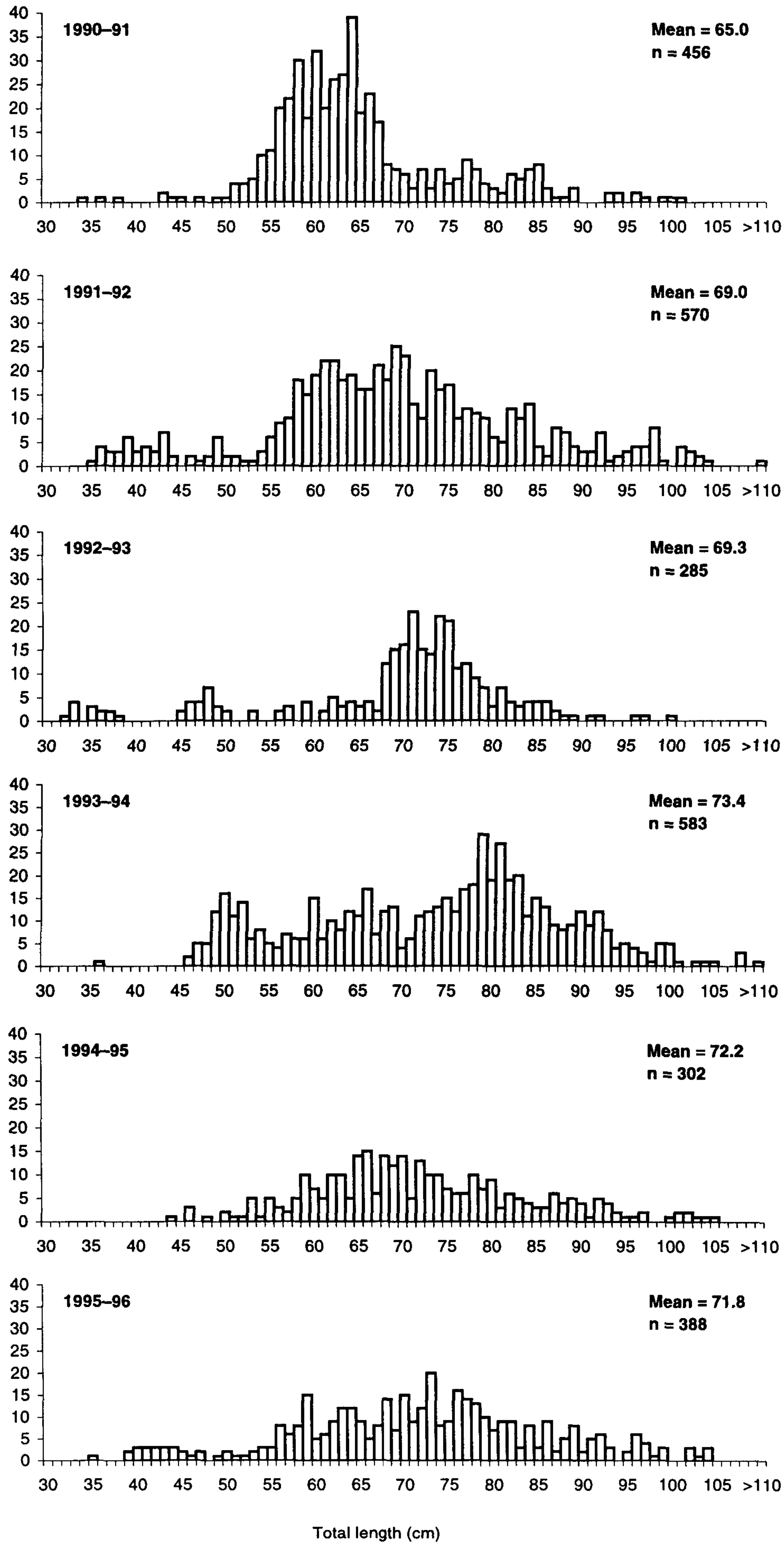


Figure 36: Length frequency distributions for hoki measured by scientific observers on board scampi trawlers in QMA 2 (area CEE).

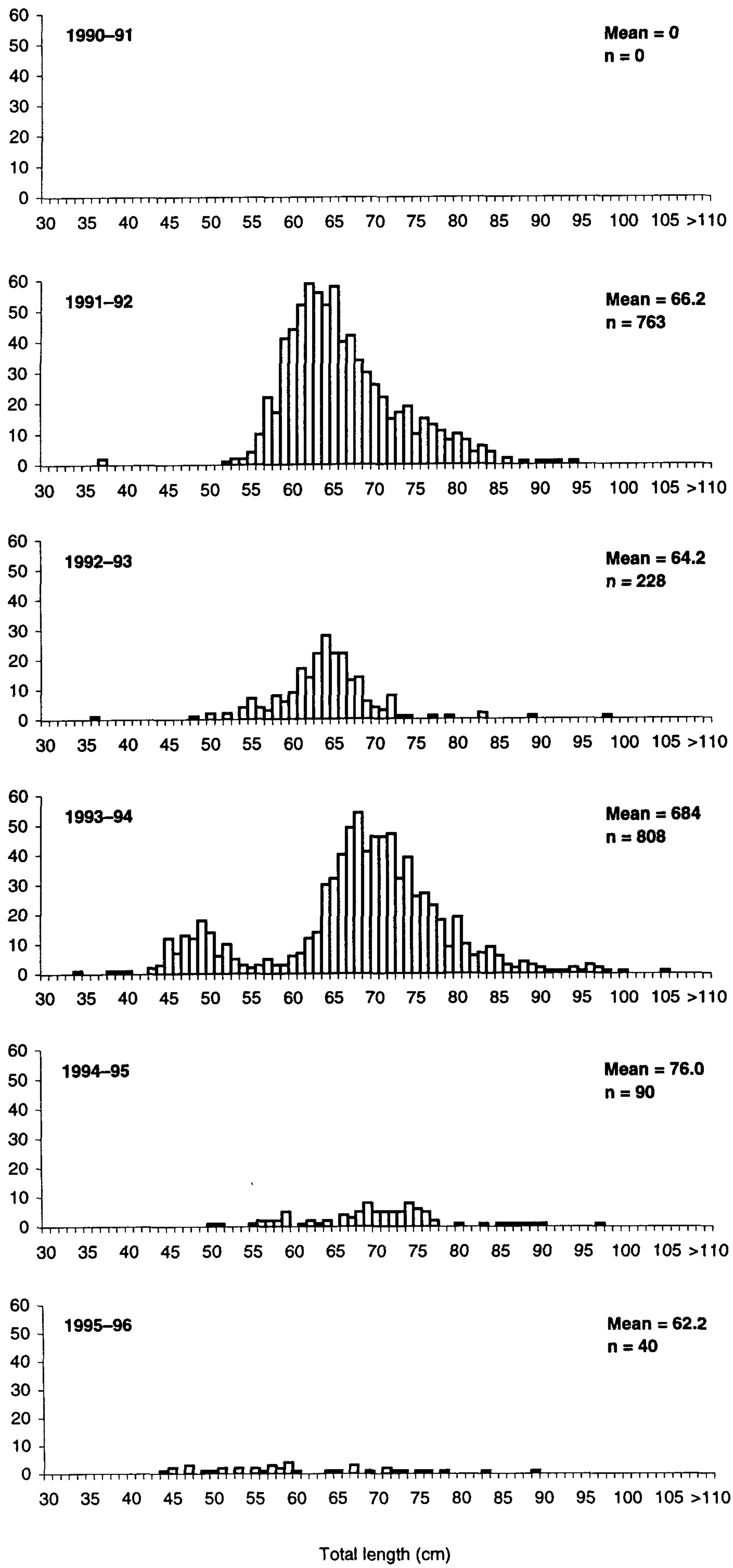


Figure 37: Length frequency distributions for hoki measured by scientific observers on board scampi trawlers in QMAs 3 & 4 (areas SOE & SEC). No hoki were measured in 1990–91.

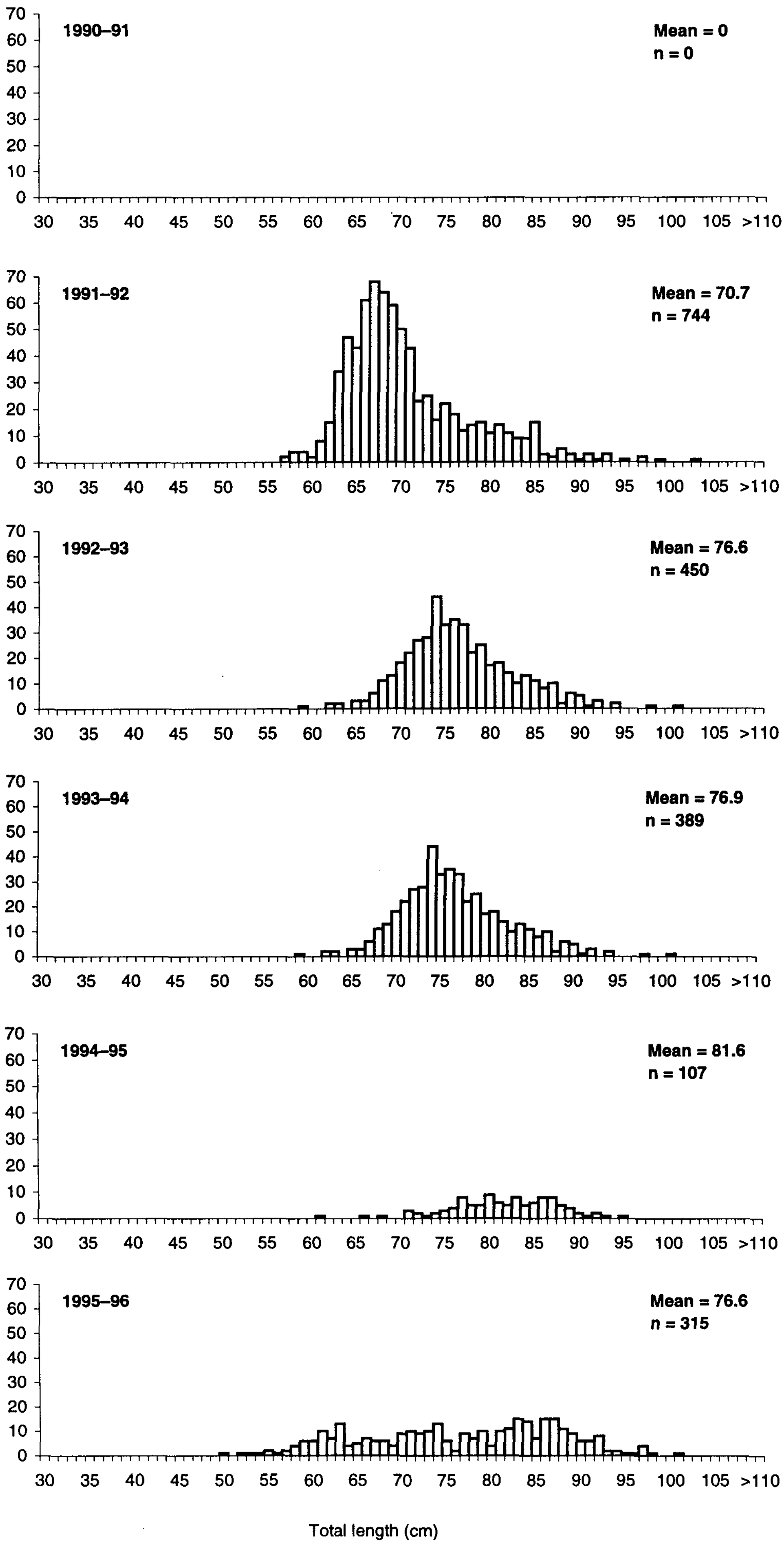


Figure 38: Length frequency distributions for hoki measured by scientific observers on board scampi trawlers in QMA 6 (area SOI). No hoki were measured in 1990–91.

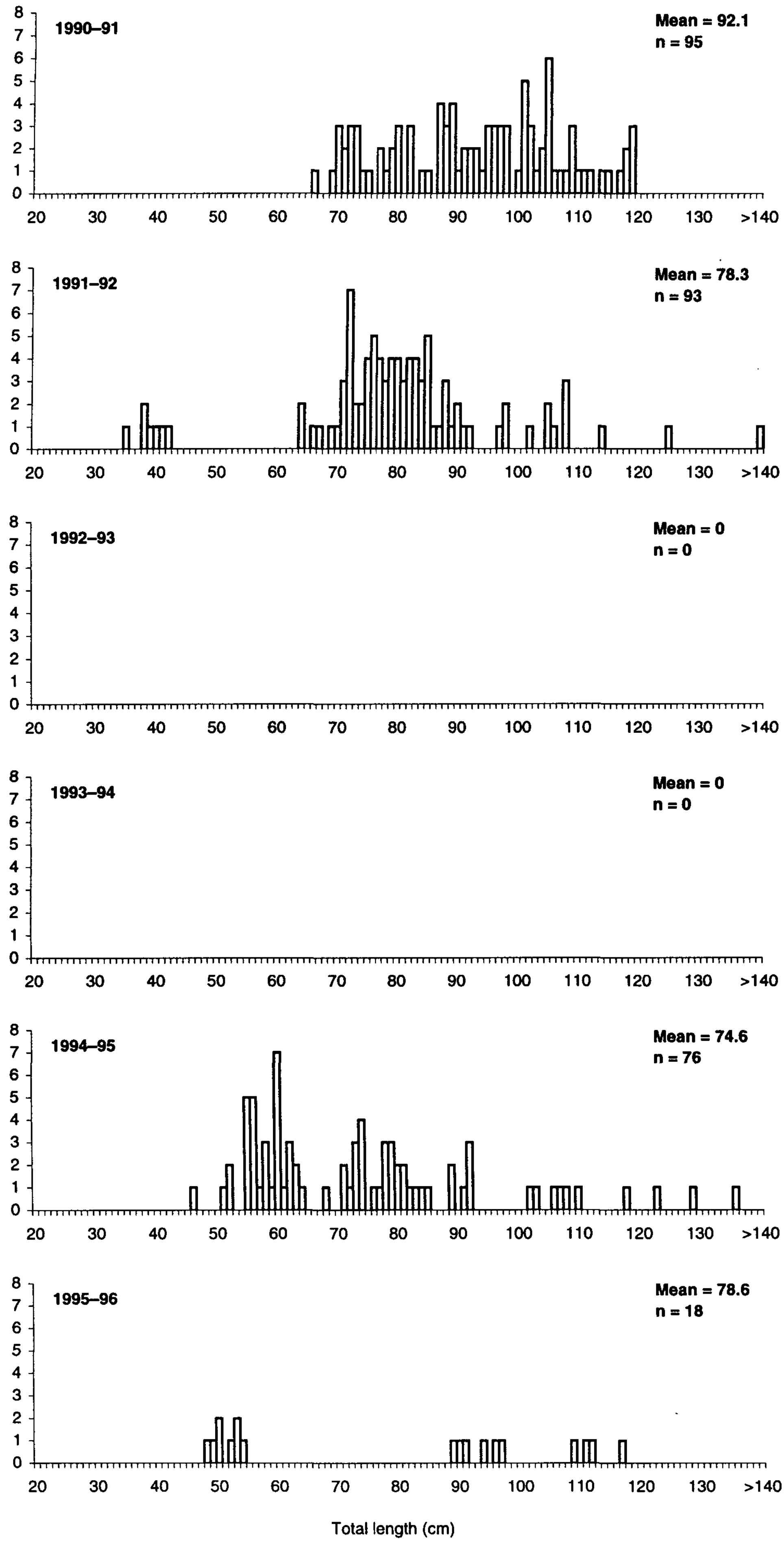


Figure 39: Length frequency distributions for ling measured by scientific observers on board scampi trawlers in QMA 1 (area AKE). No ling were measured in 1992–93 and 1993–94.

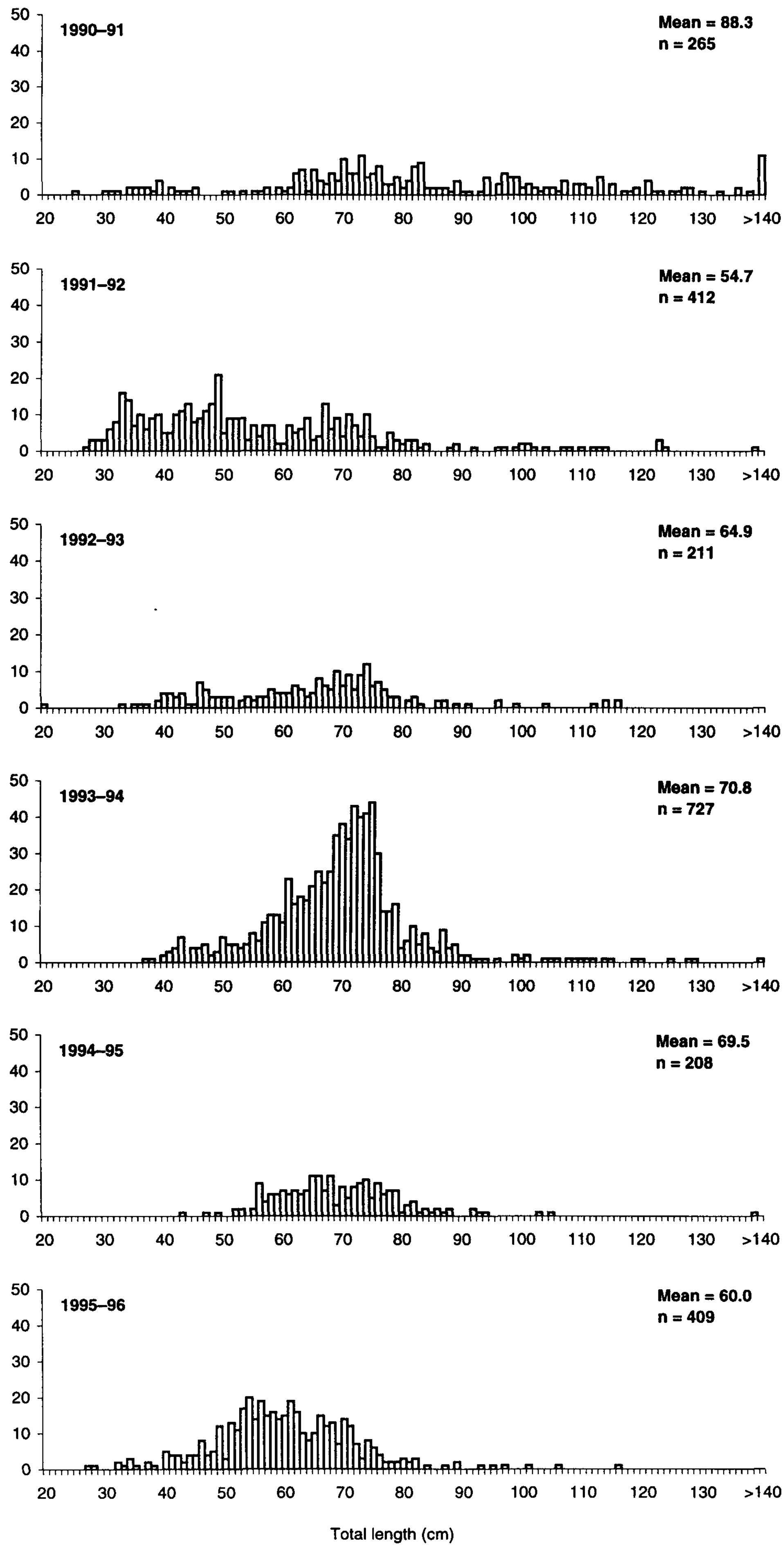


Figure 40: Length frequency distributions for ling measured by scientific observers on board scampi trawlers in QMA 2 (area CEE).

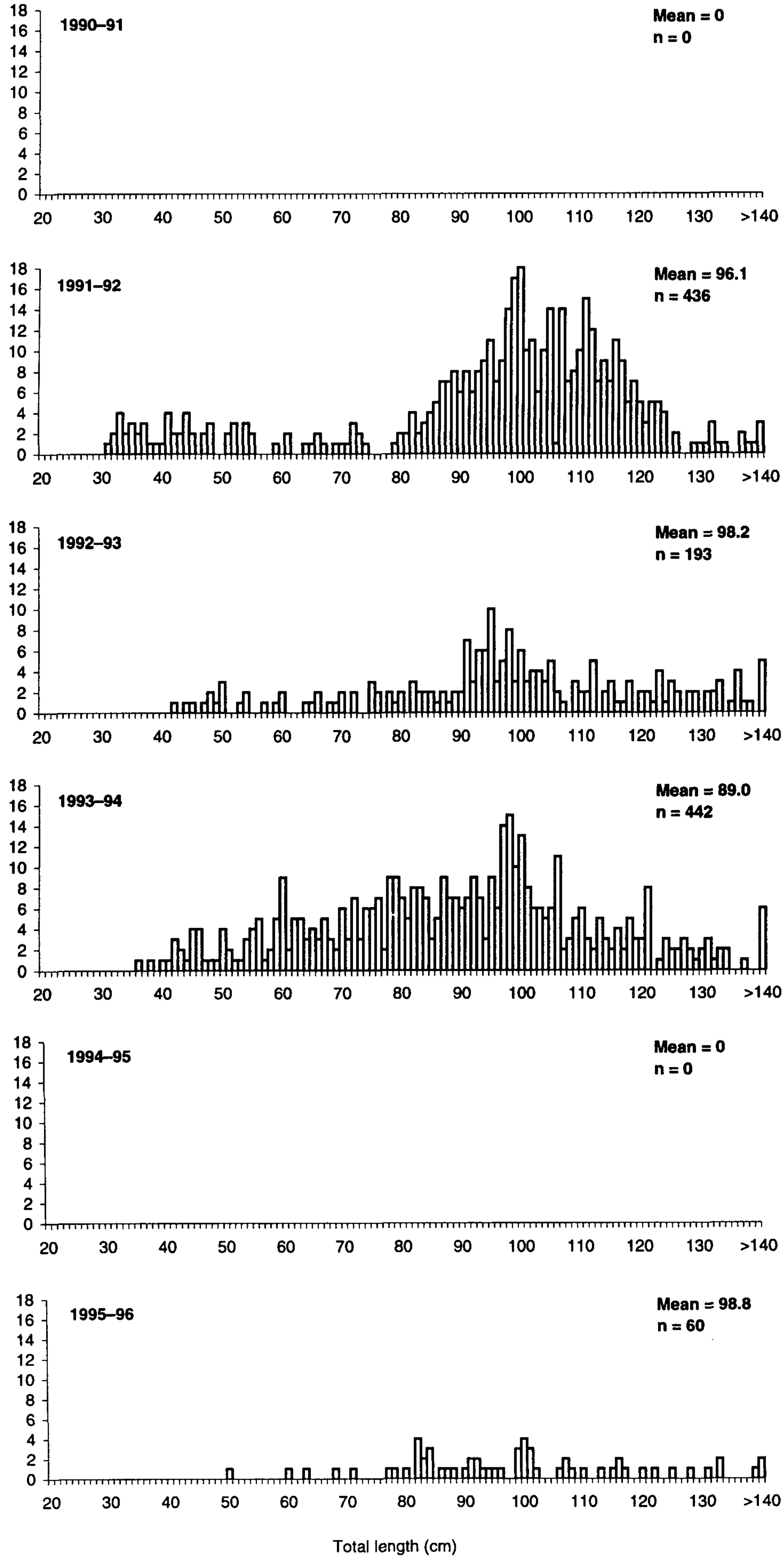


Figure 41: Length frequency distributions for ling measured by scientific observers on board scampi trawlers in QMAs 3 & 4 (areas SOE & SEC). No ling were measured in 1990–91 and 1994–95.

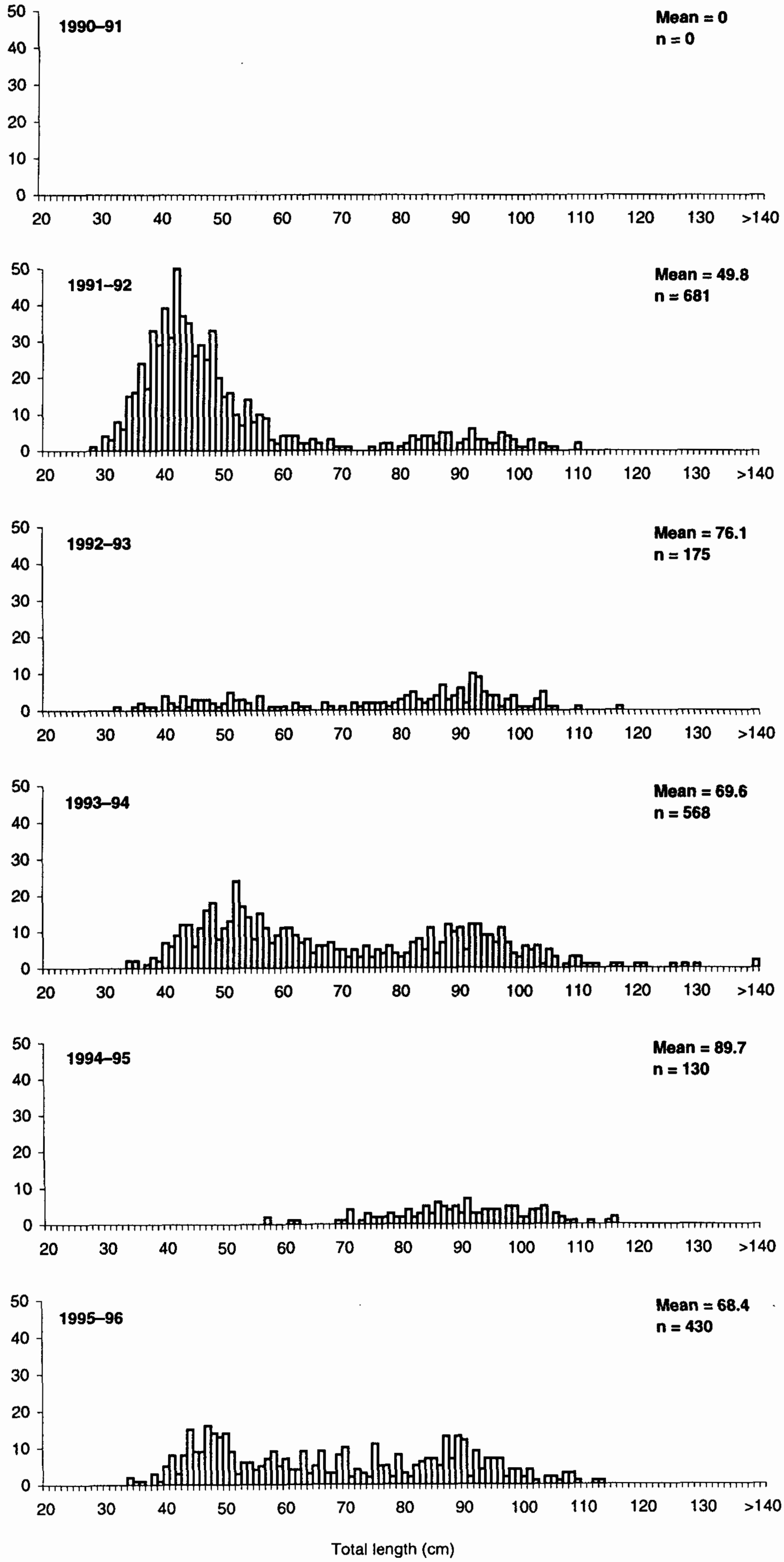


Figure 42: Length frequency distributions for ling measured by scientific observers on board scampi trawlers in QMA 6 (area SOI).

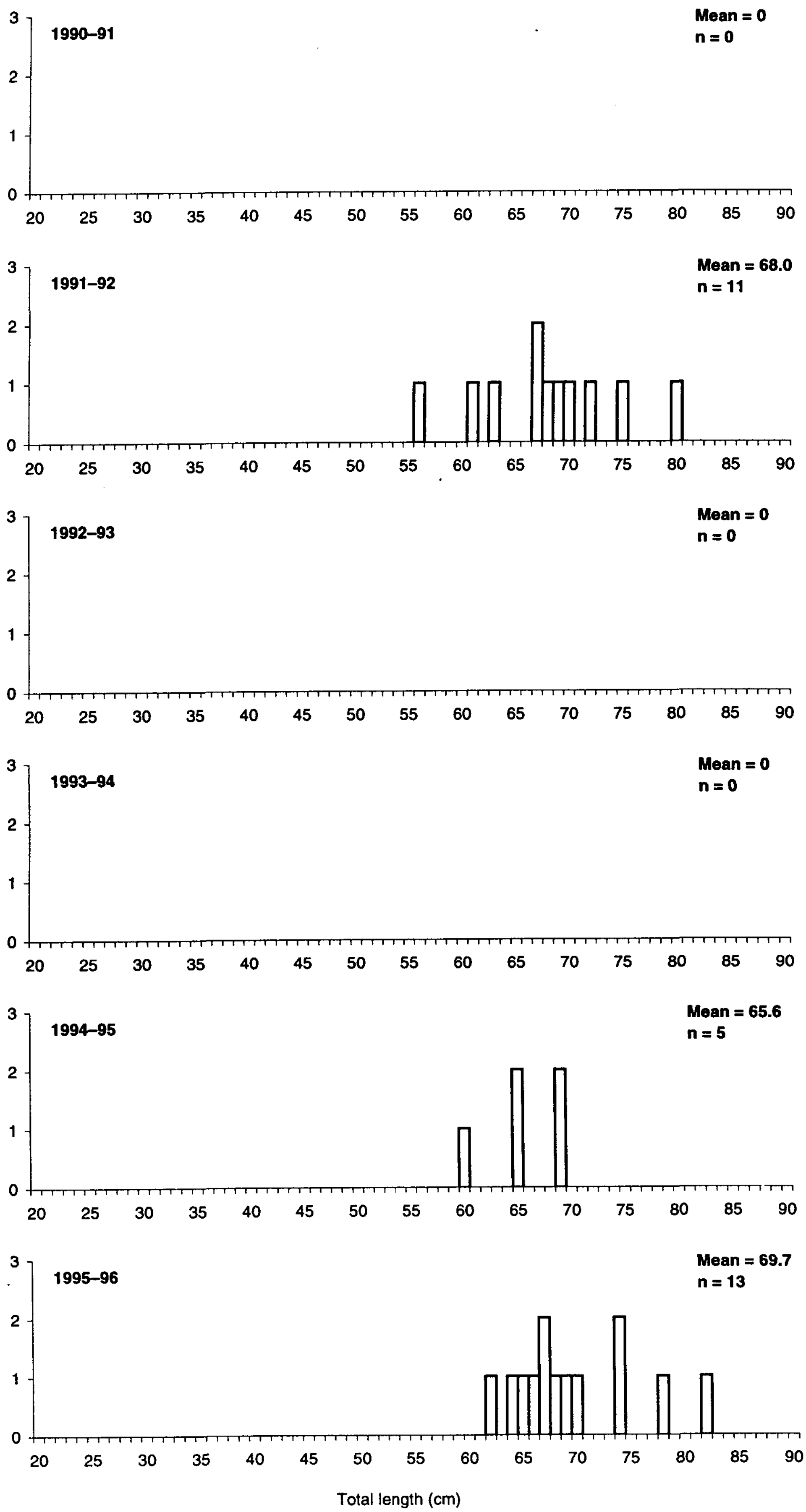


Figure 43: Length frequency distributions for giant stargazer measured by scientific observers on board scampi trawlers in QMA 1 (area AKE). No stargazers were measured in 1990–91, 1992–93 and 1993–94.

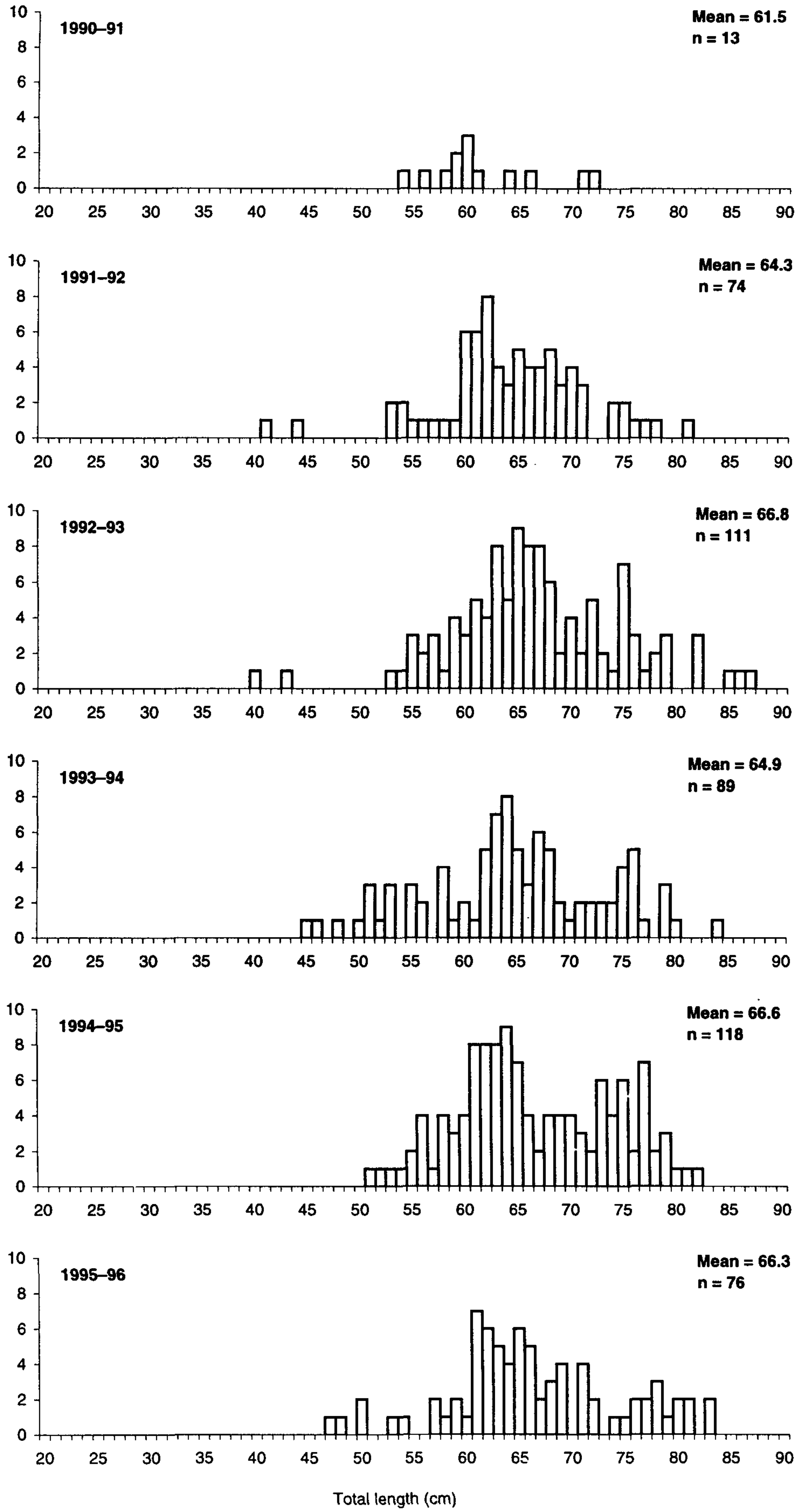


Figure 44: Length frequency distributions for giant stargazer measured by scientific observers on board scampi trawlers in QMA 2 (area CEE).

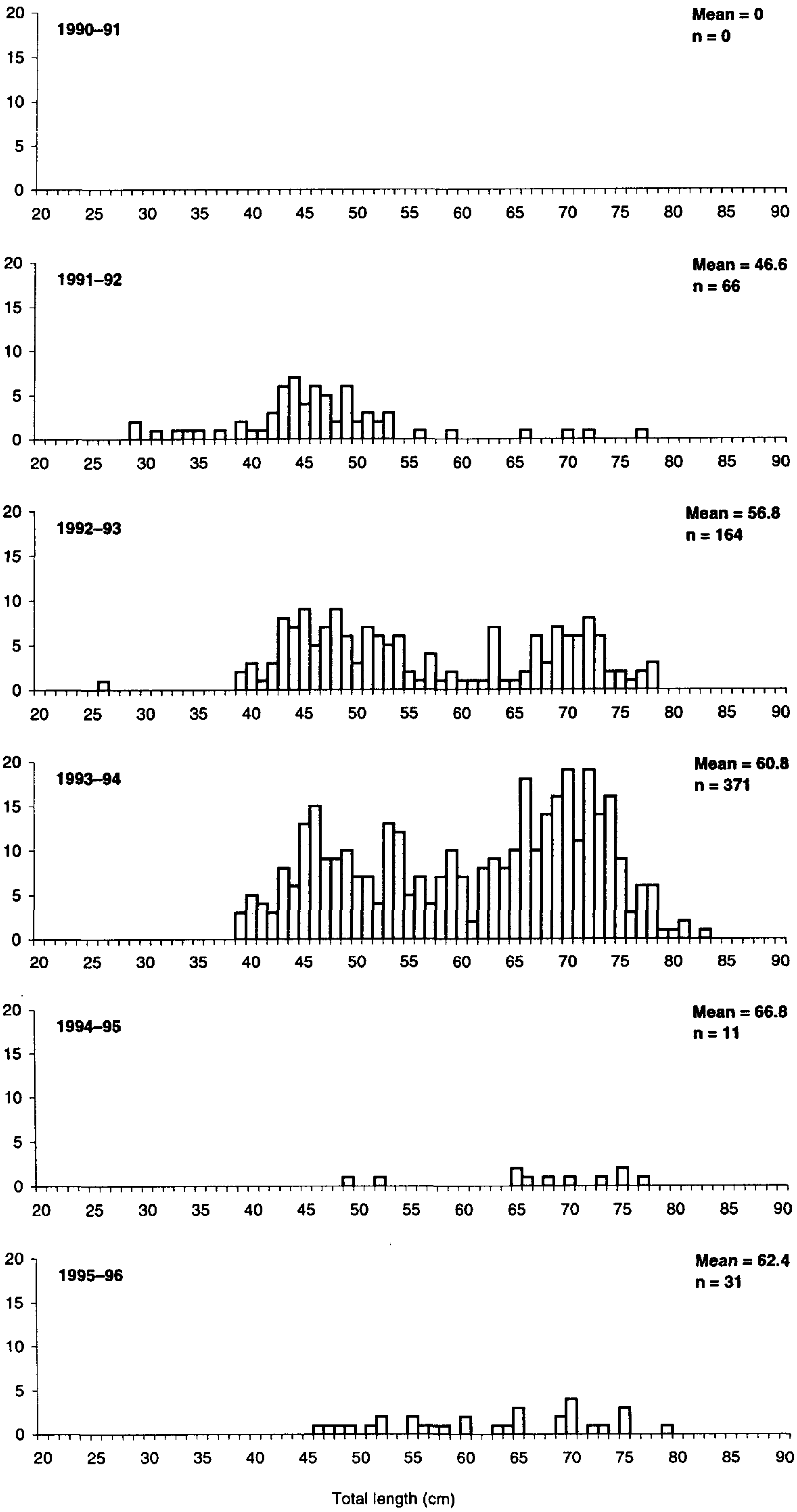


Figure 45: Length frequency distributions for giant stargazer measured by scientific observers on board scampi trawlers in QMAs 3 & 4 (areas SOE & SEC). No stargazers were measured in 1990–91.

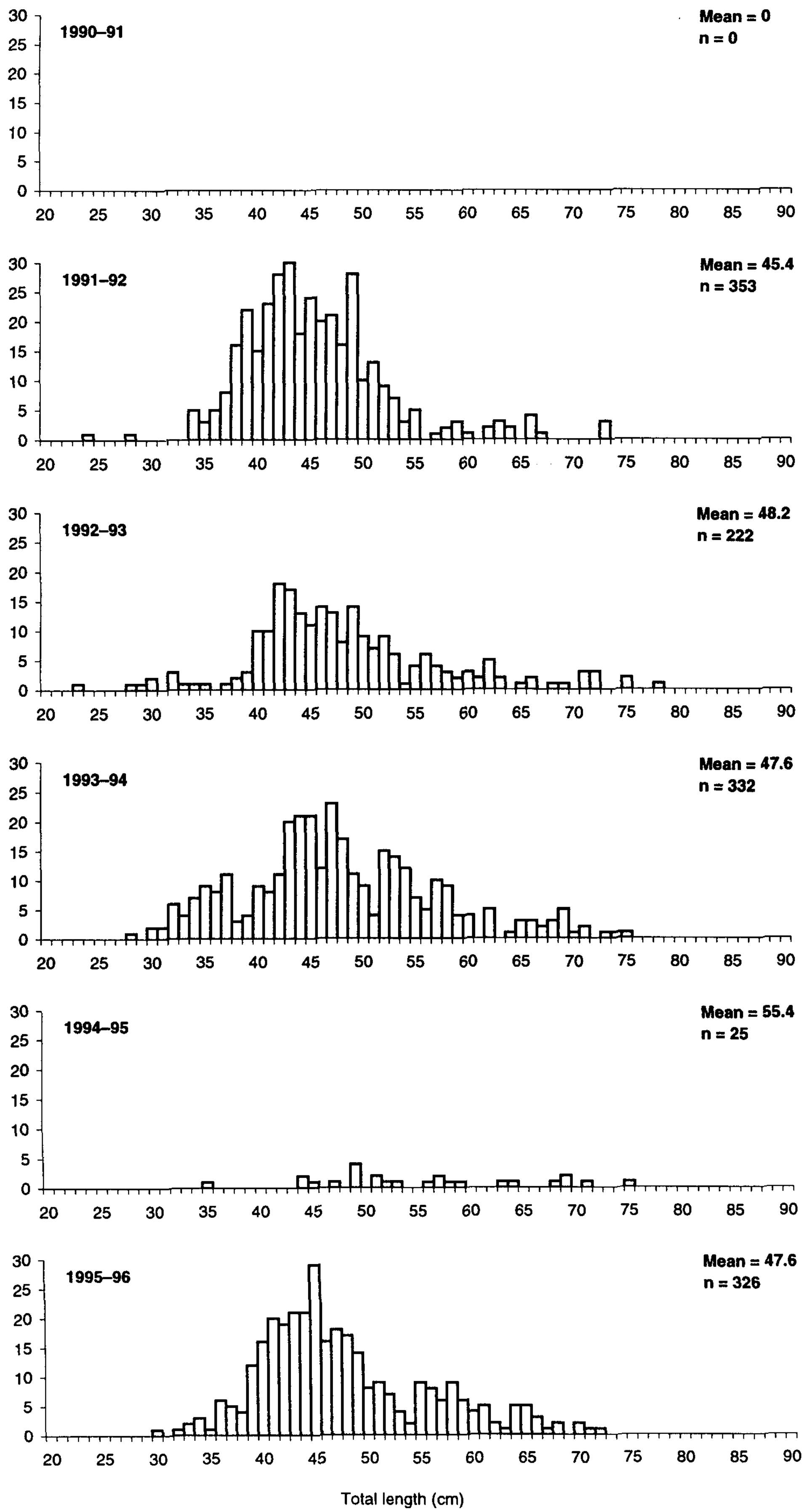


Figure 46: Length frequency distributions for giant stargazer measured by scientific observers on board scampi trawlers in QMA 6 (area SOI). No stargazers were measured in 1990–91.

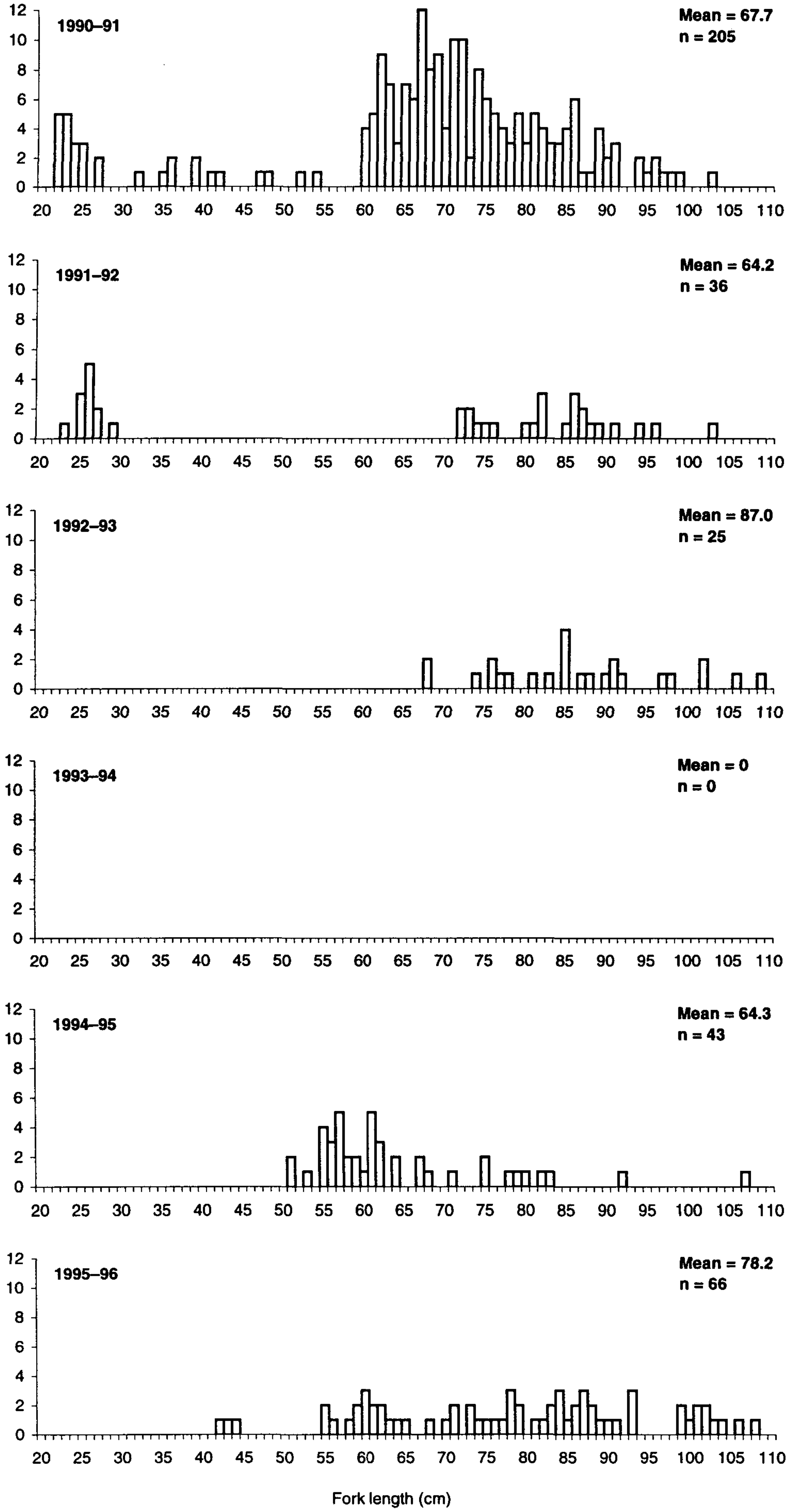


Figure 47: Length frequency distributions for gemfish measured by scientific observers on board scampi trawlers in QMA 1 (area AKE). No gemfish were measured in 1993–94.

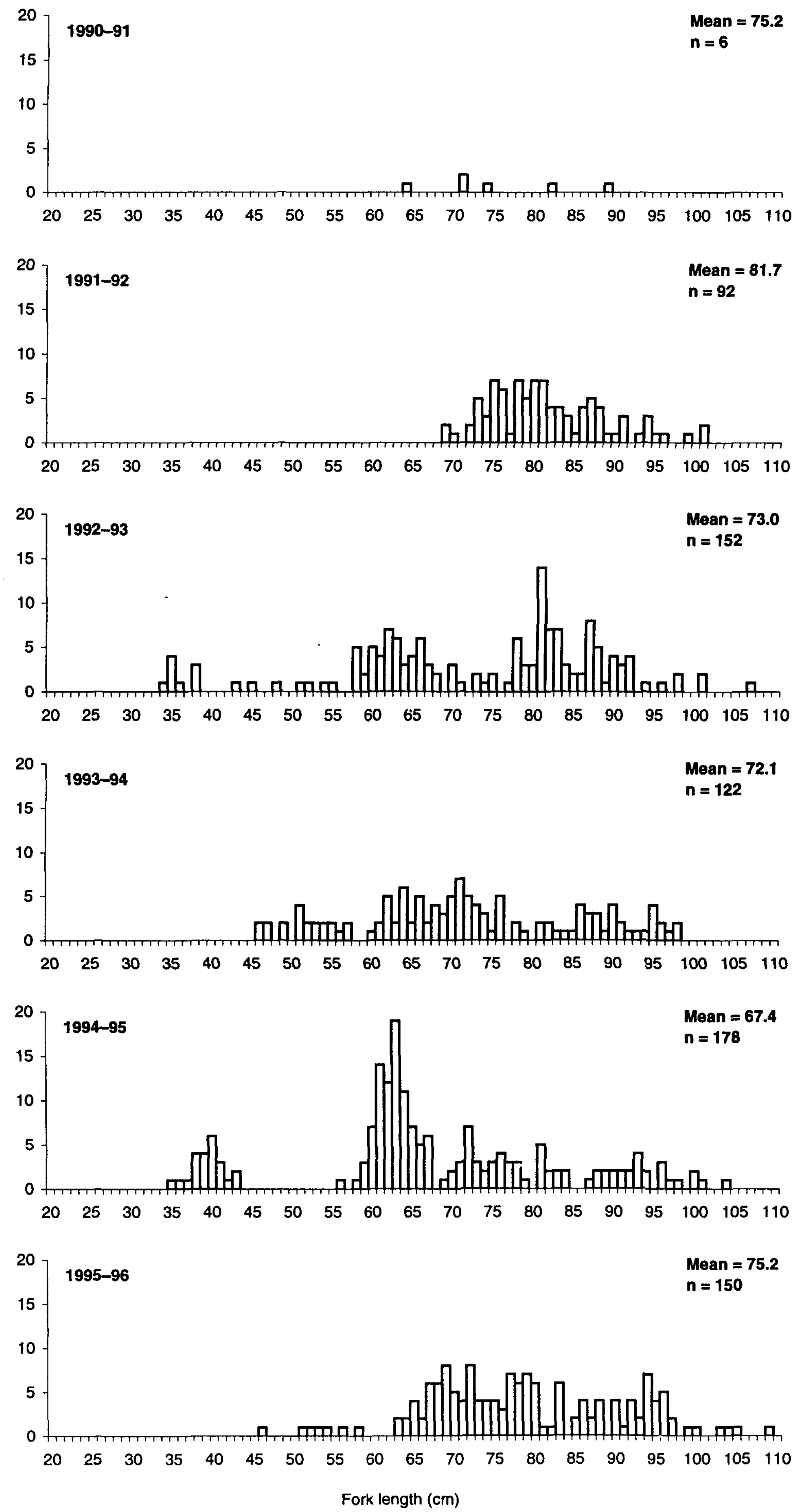


Figure 48: Length frequency distributions for gemfish measured by scientific observers on board scampi trawlers in QMA 2 (area CEE).

Appendix 1: Number of shots, total fishing effort, total catch and the vessels involved in the scampi trawl fishery in QMA 1 since 1988–89

Number of shots per fishing year per month in QMA 1 for the fishing years 1988–89 to 1995–96

Month	1988–89	1989–90	1990–91	1991–92	1992–93	1993–94	1994–95	1995–96
10	–	34	42	131	52	–	–	22
11	–	60	64	323	61	112	3	54
12	–	110	112	14	99	132	96	70
1	–	126	112	7	52	61	53	30
2	–	102	50	46	64	–	10	33
3	7	21	109	30	46	–	49	35
4	143	49	108	73	52	10	32	2
5	29	131	129	14	24	22	25	33
6	13	67	148	3	52	1	23	–
7	97	47	225	90	114	78	72	–
8	96	12	305	175	57	119	29	49
9	60	82	143	184	67	39	5	34
Total	445	841	1 547	1 090	740	574	397	362

Hours fished per fishing year per month in QMA 1 for fishing years 1988–89 to 1995–96

Month	1988–89	1989–90	1990–91	1991–92	1992–93	1993–94	1994–95	1995–96
10	–	100	173	797	299	–	–	106
11	–	205	252	1 903	381	615	15	307
12	–	354	439	92	545	673	513	395
1	–	402	459	44	288	299	268	188
2	–	373	198	86	337	–	59	186
3	15	74	460	161	230	–	285	211
4	336	175	449	455	262	47	178	6
5	61	493	507	91	110	126	145	187
6	34	315	680	16	275	6	130	–
7	301	227	1 134	370	620	452	446	–
8	258	53	1 603	961	318	656	122	186
9	181	376	853	1 007	362	201	33	113
Total	1 186	3 148	7 206	5 983	4 026	3 075	2 194	1 885

Landed catch (kg) of scampi from QMA 1 for the fishing years 1988–89 to 1995–96

Month	1988–89	1989–90	1990–91	1991–92	1992–93	1993–94	1994–95	1995–96
10	–	3 061	3 715	13 015	6 395	–	–	6 861
11	–	9 701	8 330	50 225	5 565	23 724	290	17 356
12	–	16 952	11 977	1 320	17 241	32 000	29 766	28 713
1	–	16 680	14 494	2 068	13 059	12 947	17 249	10 464
2	–	10 911	6 040	1 554	10 427	–	2 748	10 351
3	796	1 188	16 900	3 635	5 075	–	12 309	11 382
4	13 970	5 227	7 780	7 030	6 321	1 102	7 398	60
5	2 035	12 569	10 362	1 660	2 379	2 310	4 469	4 919
6	632	11 001	14 563	250	8 227	168	4 751	–
7	8 540	5 020	27 857	9 886	18 916	7 765	14 834	–
8	8 107	1 345	30 451	16 884	7 814	20 680	7 419	15 765
9	4 915	7 450	10 706	22 773	12 699	10 787	2 195	8 150
Total	38 995	101 105	163 175	130 300	114 118	111 483	103 428	114 021

Vessels participating (5 or more shots per year) in the QMA 1 scampi fishery by fishing year

Vessel	1988–89	1989–90	1990–91	1991–92	1992–93	1993–94	1994–95	1995–96
A	–	–	Y	Y	Y	Y	Y	–
B	–	–	Y	Y	Y	–	–	–
C	–	–	–	–	–	–	Y	Y
D	Y	Y	Y	Y	–	–	–	–
E	–	–	Y	–	–	Y	Y	Y
F	–	–	Y	Y	–	–	–	–
G	–	Y	Y	Y	Y	–	–	Y
H	Y	Y	Y	Y	Y	Y	Y	Y
I	–	Y	Y	Y	Y	Y	Y	Y
J	–	Y	Y	–	–	Y	Y	–

NB. Vessels randomly reassigned alphanumeric codes for each quota management area. Y = Yes

Appendix 2: Number of shots, total fishing effort, total catch and the vessels involved in the scampi trawl fishery in QMA 2 since 1988–89

Number of shots per fishing year per month in QMA 2 for the fishing years 1988–89 to 1995–96

Month	1988–89	1989–90	1990–91	1991–92	1992–93	1993–94	1994–95	1995–96
10	–	69	250	327	58	–	1	78
11	–	6	207	213	70	113	23	129
12	–	2	171	74	17	6	134	79
1	–	89	270	73	244	64	123	50
2	–	121	193	154	223	78	–	–
3	14	164	169	–	63	101	73	9
4	–	87	131	21	76	201	96	166
5	45	70	116	4	98	222	141	88
6	71	111	137	2	150	445	174	133
7	–	97	135	98	150	171	32	105
8	–	237	177	318	95	15	50	49
9	55	235	314	313	98	–	–	32
Total	185	1 288	2 270	1 597	1 342	1 416	847	918

Hours fished per fishing year per month in QMA 2 for the fishing years 1988–89 to 1995–96

Month	1988–89	1989–90	1990–91	1991–92	1992–93	1993–94	1994–95	1995–96
10	–	242	1 170	1 677	324	–	2	448
11	–	23	973	1 101	322	592	128	751
12	–	5	848	372	79	26	602	485
1	–	314	1 249	350	1 181	281	602	343
2	–	384	977	835	1 183	398	–	–
3	56	569	794	–	332	511	412	49
4	–	307	574	96	393	1 050	546	951
5	111	267	593	20	496	1 133	784	500
6	173	486	619	5	764	2 592	993	799
7	–	562	669	491	769	1 061	160	667
8	–	1 163	931	1 584	483	80	328	302
9	143	1 161	1 684	1 691	492	–	–	157
Total	483	5 482	11 082	8 223	6 818	7 725	4 558	5 453

Landed catch (kg) of scampi from QMA2 for the fishing years 1988–89 to 1995–96

Month	1988–89	1989–90	1990–91	1991–92	1992–93	1993–94	1994–95	1995–96
10	–	8 320	29 136	35 422	7 346	–	50	25 630
11	–	790	25 214	26 754	10 452	15 705	6 673	37 004
12	–	200	29 396	10 930	3 349	1 185	30 707	25 424
1	–	7 705	44 620	8 455	53 300	11 523	27 409	19 974
2	–	11 898	26 880	17 262	44 369	15 805	–	–
3	1 120	17 942	14 650	–	7 710	12 868	19 640	1 236
4	–	11 803	9 633	2 371	12 938	23 498	23 814	25 600
5	2 905	7 890	6 685	110	10 760	20 501	27 115	13 887
6	7 625	11 480	7 375	160	15 426	83 573	48 891	27 576
7	–	11 088	12 743	12 971	14 850	41 999	10 038	30 864
8	–	24 065	21 325	48 302	15 966	3 930	23 740	10 837
9	4 679	29 602	32 733	49 267	11 570	–	–	9 975
Total	16 329	142 783	260 390	212 004	208 036	230 587	218 077	228 007

Vessels participating (5 or more shots per year) in the QMA 2 scampi fishery by fishing year

Vessel	1988–89	1989–90	1990–91	1991–92	1992–93	1993–94	1994–95	1995–96
A	–	Y	Y	Y	Y	Y	Y	Y
B	–	–	Y	Y	–	Y	–	Y
C	–	–	–	–	Y	–	–	–
D	–	–	Y	Y	Y	Y	Y	Y
E	Y	Y	Y	Y	–	–	–	–
F	–	–	Y	Y	Y	–	–	–
G	–	–	–	Y	Y	Y	Y	Y
H	Y	Y	–	Y	Y	Y	–	Y
I	–	Y	Y	Y	Y	Y	Y	Y
J	Y	Y	Y	Y	Y	Y	Y	Y
K	–	Y	Y	Y	Y	Y	Y	Y

NB. Vessels randomly reassigned alphanumeric codes for each quota management area. Y = Yes

Appendix 3: Number of shots, total fishing effort, total catch and the vessels involved in the scampi trawl fishery in QMA 3 since 1988–89

Number of shots per fishing year per month in QMA 3 for the fishing years 1988–89 to 1995–96

Month	1988–89	1989–90	1990–91	1991–92	1992–93	1993–94	1994–95	1995–96
10	–	–	–	–	77	589	536	408
11	–	–	–	–	167	81	–	–
12	–	–	–	–	301	1	1	–
1	–	–	–	10	213	4	–	–
2	–	–	1	4	–	–	1	–
3	–	–	7	–	1	–	1	–
4	–	–	3	4	–	–	–	–
5	–	–	–	7	1	–	–	–
6	–	7	–	1	–	–	–	–
7	–	–	–	6	–	–	–	–
8	–	–	–	–	–	–	–	–
9	5	–	2	2	4	–	–	–
Total	5	7	13	34	764	675	539	408

Hours fished per fishing year per month in QMA 3 for the fishing years 1988–89 to 1995–96

Month	1988–89	1989–90	1990–91	1991–92	1992–93	1993–94	1994–95	1995–96
10	–	–	–	–	299	2 596	2 668	2 175
11	–	–	–	–	609	383	–	–
12	–	–	–	–	1 152	6	6	–
1	–	–	–	26	853	19	–	–
2	–	–	2	16	–	–	6	–
3	–	–	14	–	4	–	13	–
4	–	–	4	13	–	–	–	–
5	–	–	–	17	5	–	–	–
6	–	15	–	4	–	–	–	–
7	–	–	–	36	–	–	–	–
8	–	–	–	–	–	–	–	–
9	5	–	9	3	19	–	–	–
Total	5	15	28	114	2 941	3 004	2 692	2 175

Landed catch (kg) of scampi from QMA 3 for the fishing years 1988–89 to 1995–96

Month	1988–89	1989–90	1990–91	1991–92	1992–93	1993–94	1994–95	1995–96
10	–	–	–	–	5 399	50 087	65 578	76 310
11	–	–	–	–	17 460	9 264	–	–
12	–	–	–	–	34 965	330	840	–
1	–	–	–	192	25 025	486	–	–
2	–	–	–	96	–	–	275	–
3	–	–	165	–	35	–	255	–
4	–	–	–	10	–	–	–	–
5	–	–	–	70	96	–	–	–
6	–	30	–	60	–	–	–	–
7	–	–	–	150	–	–	–	–
8	–	–	–	–	–	–	–	–
9	–	–	4	25	220	–	–	–
Total	–	30	169	603	83 200	60 167	66 948	76 310

Vessels participating (5 or more shots per year) in the QMA 3 scampi fishery by fishing year

Vessel	1988–89	1989–90	1990–91	1991–92	1992–93	1993–94	1994–95	1995–96
A	–	–	–	–	Y	Y	Y	Y
B	–	–	–	–	Y	Y	–	–
C	–	–	–	–	–	Y	Y	Y
D	–	–	–	–	–	Y	Y	Y
E	–	–	–	–	Y	Y	Y	Y
F	–	–	Y	–	Y	Y	Y	Y
G	–	–	–	Y	Y	Y	Y	Y
H	–	–	–	–	–	–	Y	Y
I	–	–	–	Y	Y	–	–	–
J	Y	Y	–	–	–	–	–	–
K	–	–	–	–	Y	Y	Y	Y
L	–	–	–	–	–	–	–	Y
M	–	–	–	–	Y	–	–	–

NB. Vessels randomly reassigned alphanumeric codes for each quota management area. Y = Yes

Appendix 4: Number of shots, total fishing effort, total catch and the vessels involved in the scampi trawl fishery in QMA 4E since 1988–89

Number of shots per fishing year per month in QMA 4E for the fishing years 1990–91 to 1992–93

Month	1990–91	1991–92	1992–93
10	–	–	–
11	–	–	–
12	–	292	–
1	5	165	–
2	–	5	–
3	–	115	–
4	–	3	45
5	–	81	32
6	18	37	–
7	55	–	–
8	41	–	–
9	93	–	–
Total	212	698	77

Hours fished per fishing year per month in QMA 4E for the fishing years 1990–91 to 1992–93

Month	1990–91	1991–92	1992–93
10	–	–	–
11	–	–	–
12	–	1 415	–
1	31	905	–
2	–	28	–
3	–	637	–
4	–	17	206
5	–	413	161
6	57	209	–
7	212	–	–
8	179	–	–
9	386	–	–
Total	865	3 624	367

Landed catch (kg) of scampi from QMA 4E for the fishing years 1990–91 to 1992–93

Month	1990–91	1991–92	1992–93
10	–	–	–
11	–	–	–
12	–	37 965	–
1	640	21 365	–
2	–	570	–
3	–	6 130	–
4	–	180	6 630
5	–	4 677	4 435
6	1 650	2 770	–
7	6 250	–	–
8	6 451	–	–
9	16 135	–	–
Total	31 126	73 657	11 065

Vessels participating (5 or more shots per year) in the QMA 4E scampi fishery by fishing year

Vessel	1990–91	1991–92	1992–93
A	–	Y	–
B	–	Y	–
C	–	Y	–
D	–	Y	–
E	–	Y	–
F	–	Y	Y
G	Y	Y	–
H	–	Y	–
I	Y	Y	–
J	–	Y	–

NB. Vessels randomly reassigned alphanumeric codes for each quota management area. Y = Yes

Appendix 5: Number of shots, total fishing effort, total catch and the vessels involved in the scampi trawl fishery in QMA 4W since 1988–89

Number of shots per fishing year per month in QMA 4W for the fishing years 1990–91 to 1995–96

Month	1990–91	1991–92	1992–93	1993–94	1994–95	1995–96
10	–	–	104	4	70	139
11	–	–	282	11	54	215
12	–	8	114	180	63	50
1	–	34	121	210	62	–
2	–	–	55	47	57	–
3	–	32	167	35	51	–
4	–	154	225	308	18	36
5	–	395	173	244	10	28
6	3	546	21	22	–	2
7	4	199	25	25	89	–
8	–	–	73	31	1	–
9	4	–	–	–	5	29
Total	11	1 368	1 360	1 117	480	499

Hours fished per fishing year per month in QMA 4W for the fishing years 1990–91 to 1995–96

Month	1990–91	1991–92	1992–93	1993–94	1994–95	1995–96
10	–	–	505	13	315	638
11	–	–	1 413	43	256	1 069
12	–	30	569	854	381	269
1	–	170	614	1 129	390	–
2	–	–	286	264	309	–
3	–	120	861	185	296	–
4	–	665	1 216	1 703	106	178
5	–	1 725	879	1 347	52	134
6	12	2 529	108	130	–	7
7	16	965	171	128	470	–
8	–	–	449	167	5	–
9	20	–	–	–	38	114
Total	48	6 204	7 070	5 964	2 618	2 410

Landed catch (kg) of scampi from QMA 4W for the fishing years 1990–91 to 1995–96

Month	1990–91	1991–92	1992–93	1993–94	1994–95	1995–96
10	–	–	12 290	137	28 239	76 220
11	–	–	49 489	3 730	20 775	96 938
12	–	980	17 609	44 704	36 590	15 456
1	–	3 551	16 592	51 158	38 878	–
2	–	–	8 780	11 545	11 884	–
3	–	2 715	19 180	9 199	4 704	–
4	–	13 595	27 566	55 317	3 605	13 998
5	–	45 977	30 259	54 185	1 614	9 540
6	290	60 298	5 292	5 360	–	931
7	410	28 612	8 390	5 580	31 550	–
8	–	–	18 255	10 100	310	–
9	530	–	–	–	1 878	12 950
Total	1 230	155 728	213 702	251 015	180 027	226 033

Vessels participating (5 or more shots per year) in the QMA 4W scampi fishery by fishing year

Vessel	1990–91	1991–92	1992–93	1993–94	1994–95	1995–96
A	–	Y	Y	Y	Y	Y
B	–	Y	–	–	–	–
C	–	Y	Y	Y	Y	Y
D	–	Y	Y	Y	–	–
E	–	–	Y	Y	–	–
F	–	Y	–	–	–	–
G	–	Y	–	–	–	–
H	Y	Y	Y	Y	Y	Y
I	–	Y	–	Y	Y	Y
J	–	Y	Y	Y	Y	Y
K	–	Y	Y	–	–	–
L	–	Y	Y	Y	Y	Y
M	–	Y	Y	Y	Y	Y
N	–	Y	Y	Y	Y	Y

NB. Vessels randomly reassigned alphanumeric codes for each quota management area. Y = Yes

Appendix 6: Number of shots, total fishing effort, total catch and the vessels involved in the scampi trawl fishery in QMA 6A since 1988–89

Number of shots per fishing year per month in QMA 6A for the fishing years 1990–91 to 1995–96

Month	1990–91	1991–92	1992–93	1993–94	1994–95	1995–96
10	–	–	33	4	31	–
11	–	–	59	102	25	16
12	–	–	57	204	52	33
1	–	109	79	195	85	264
2	–	228	146	340	280	307
3	–	209	150	322	108	247
4	14	320	22	3	253	150
5	–	55	22	–	128	30
6	–	39	23	–	63	85
7	–	3	–	–	121	89
8	–	–	17	–	82	63
9	–	–	53	93	87	–
Total	14	963	661	1 263	1 315	1 284

Hours fished per fishing year per month in QMA 6A for the fishing years 1990–91 to 1995–96

Month	1990–91	1991–92	1992–93	1993–94	1994–95	1995–96
10	–	–	163	26	192	–
11	–	–	351	610	162	116
12	–	–	358	1 187	315	235
1	–	506	440	1 013	435	1 525
2	–	1 136	755	1 784	1 732	1 947
3	–	911	778	1 818	677	1 596
4	30	1 650	115	23	1 498	1 015
5	–	282	120	–	752	213
6	–	309	154	–	429	591
7	–	19	–	–	831	653
8	–	–	74	–	570	465
9	–	–	447	551	632	–
Total	30	4 813	3 756	7 012	8 225	8 356

Landed catch (kg) of scampi from QMA6A for the fishing years 1990–91 to 1995–96

Month	1990–91	1991–92	1992–93	1993–94	1994–95	1995–96
10	–	–	6 020	1 935	8 785	–
11	–	–	24 285	17 585	6 305	4 479
12	–	–	20 940	47 619	4 476	6 570
1	–	53 521	29 967	43 591	12 873	50 275
2	–	71 222	35 425	59 982	46 371	55 673
3	–	73 540	38 835	52 038	21 242	35 303
4	1 900	84 747	6 730	835	35 872	21 736
5	–	18 075	6 980	–	14 615	3 696
6	–	20 330	3 809	–	7 559	10 273
7	–	1 260	–	–	20 215	16 467
8	–	–	2 902	–	14 329	15 900
9	–	–	18 115	17 614	16 469	–
Total	1 900	322 695	194 008	241 199	209 111	220 371

Vessels participating (5 or more shots per year) in the QMA ^A scampi fishery by fishing year

Vessel	1990–91	1991–92	1992–93	1993–94	1994–95	1995–96
A	–	Y	Y	Y	Y	Y
B	–	Y	Y	Y	Y	Y
C	Y	Y	Y	Y	Y	Y
D	–	Y	Y	Y	Y	Y
E	–	Y	–	Y	Y	–
F	–	Y	Y	Y	Y	Y
G	–	Y	Y	Y	Y	Y
H	–	Y	Y	Y	Y	Y
I	–	Y	Y	Y	Y	Y
J	–	Y	Y	Y	Y	Y
K	–	Y	Y	Y	Y	Y
L	–	Y	Y	Y	Y	Y

NB. Vessels randomly reassigned alphanumeric codes for each quota management area. Y = Yes