ISSN 1175-1584

MINISTRY OF FISHERIES
Te Tautiaki i nga tini a Tangaroa

A description of the commercial fishery for school shark, *Galeorhinus galeus*, in New Zealand, 1945 to 1999

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New Zealand Fisheries Assessment Report 2001/32
June 2001

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Published by Ministry of Fisheries
Wellington
2001

ISSN 1175-1584

Citation:
Paul, L.J.; Sanders, B.M. (2001).
A description of the commercial fishery for school shark, *Galeorhinus galeus*,
in New Zealand, 1945 to 1999.
New Zealand Fisheries Assessment Report 2001/32. 63 p.

This series continues the informal
New Zealand Fisheries Assessment Research Document series
which ceased at the end of 1999.

EXECUTIVE SUMMARY

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This report addresses the Overall Objective: *To carry out a stock assessment of school shark* in Ministry of Fisheries project SCH1999/01, by supplying background and supporting information on the school shark fishery for the Specific Objective: *To develop a standardised CPUE index for school shark.*

The study characterises the fishery for school shark in New Zealand, with emphasis on the years 1990 to 1999, the decade for which the most detailed commercial catch and landing statistics are available. Although it is essentially descriptive, its purpose is to determine whether this is a fishery which can be monitored by developing and tracking CPUE indices.

In the 1940s a fishery developed for liver oil, mostly extracted from school shark. The sharks were not landed, and it can only be estimated that catches briefly peaked in 1946–48 at about 2500 t. Subsequently, annual catches (as reported landings) remained at only a few hundred tonnes until 1980, then rose rapidly to almost 5000 t in 1984. The 1986 quota (2590 t) reduced the catch to 1946 t in fishing year 1986–87, and subsequent catches have closely followed the quota's administrative rise to 3107 t in fishing years 1995–96 to 1998–99.

The recent (1990s) catch level of about 3000 t has been maintained for only a few years. It appears high when compared with a similar shark fishery in southern Australia which eventually collapsed, and it is important that the sustainable level of catches be determined.

The total catches in the New Zealand fishery are first described by region, method, and target species. Each region's fishery is then described separately. The regions are based on QMAs, except for central New Zealand where a Cook Strait region is created by combining appropriate parts of four QMAs. The regions have very different catch histories, and generally differ in the proportion of targeted catch to bycatch, main methods, and the fisheries in which a school shark bycatch is taken. Most regions comprise reasonably distinct unit fisheries, with little movement of vessels to adjacent regions.

School shark are caught, generally in small quantities, by a large number of vessels. To simplify analysis, vessels landing less than 1 t in a year (over half the vessels, but landing only 4% of the catch), are separated as the "minor fleet" and their data analysed in general terms. The fishing activity and catch of the "main fleet", by region, is described by method, season, and target species.

Only the estimated catch is available by these parameters. It represents only about two-thirds of the weight of landings (or "total catch") for two reasons. (1) Estimated catch records are limited to the top five species, and school shark falls below this threshold in many mixed-species fisheries, particularly those worked by trawlers. (2) School shark catches are often recorded as processed weight, which is about half the whole weight.

To fully characterise the fishery, daily vessel catches (linked to effort: method, area, target) were integrated with monthly vessel landings, and the effort information transferred to the latter. A considerable number and variety of errors were found, only some of which could be corrected. This procedure, with associated error-checking, was time-consuming, and only the three fishing years 1989–90, 1994–95, and 1998–99 could be completed. Trends through the intervening years are described from the (incomplete) estimated catch data alone.

Although half the school shark catch is recorded as targeted, much of this comprises very small catches made by a large number of fishers during less than 10 days fishing, often at the end of the fishing year. It is unlikely to be suitable for CPUE analysis.

Only a few fishers make moderate to large, and regular, targeted longline or setnet catches of school shark. Often the latter are associated with catches of rig, either jointly or separately targeted. Identifying true target fishing for school shark is difficult There are probably too few target fishers working consistently from year to year, within most regions, to provide data for reliable CPUE indices.

Cook Strait and Southland have the two biggest fisheries with identifiable target fishing. For catch monitoring and stock assessment, consideration should be given to defining Cook Strait as a separate fishing region.

Because of the nature and extent of errors in the catch effort database, and the highly fragmented nature of the fishery, with a significant targeted catch taken by only a few fishers, development of reliable CPUE indices seems unlikely. Another method for assessing the sustainability of school shark catches should be sought.

1. INTRODUCTION

It is usually considered prudent to make a preliminary assessment of a fishery by reviewing the biology of the species or group of species being harvested, and the recorded changes in the catch level – or preferably the catch rate (CPUE) – over as long a time period as possible. This can suggest the most appropriate aspects of the fishery to be investigated in more detail. It often leads to studies of "productivity": patterns of distribution and abundance of the species, its (or their) growth characteristics, natural mortality rate, and reproduction and recruitment.

However, an even more elementary step is sometimes omitted: a straightforward description of the fishery. How long has it existed? What is its geographic extent? How much of the catch is targeted, and by what methods? In what other fisheries is the bycatch taken? If there is a seasonal pattern in catches, how much of this is driven by targeting a seasonal abundance of the species, and (in both the target catch and bycatch) is this simply a result of fishing patterns driven by the seasonality of other species, particularly those of higher value?

Although routine, rather elementary annual assessments of the New Zealand school shark fishery have been prepared since the introduction of the Quota Management System (QMS) in 1986, and some aspects of the species biology (age, growth, and migration) have been studied, the accounts of the fishery itself have been somewhat cursory. This report addresses the question of describing the fishery in sufficient detail to clarify the issues that need further investigation. In particular, it describes the diversity of the New Zealand school shark fishery, and those features which have made it difficult to develop reliable measures of CPUE. It is an extension of the scoping study by Paul & Sanders (1998), and it complements the study on catch rate indices by Bradford (2001). Data extracts were obtained by B.M. Sanders, analysis and write-up was undertaken by L.J. Paul.

As noted by Hilborn & Walters (1992), stock assessment studies tend to focus on the resource itself, and not on the "fishers" – the fleet as a whole, and its sometimes quite diverse components, the types and operation of fishing gear, and the behaviour of fishers in choosing, seeking, and working different grounds, and different target species. If a fishery is likened to a predator-prey system, this neglects, or at least downplays, the predator side of the equation. Pelletier & Ferraris (2000) consider this issue in some detail in an analysis of two quite different fisheries. They list three features within a fishing operation: the fishing location, or ground; the fishing gear to be used; and the species (one or several) to be targeted. To these they add a seasonal (month) factor. They note that combinations of these have been variously termed "directed fisheries", "fishery management units", "fishing strategies", and "fisheries tactics", and they adopt the last of these to define the decisions made by fishers before each fishing operation. Their statistical study of two fisheries used multivariate analyses to identify complexities that must be understood before conventional stock assessment models are applied to catch and effort data. The present study of the New Zealand school shark fishery does not use such a sophisticated methodology, but it does incorporate the same reasoning: to properly describe and understand a fishery, the "fishing tactics" used by its fishers, comprising fishing methods, fishing location, target species, and time of year, must be clearly defined.

The present study uses the same fishing regions (Figures 1 and 2) established by Paul & Sanders (1998), which are modifications of the standard Quota Management Areas (QMAs), but differ from the present school shark Fishstocks which have little relevance to stock assessment requirements.

2. LITERATURE REVIEW

There is little published information on school shark in New Zealand directly relevant to stock assessment, but some that is indirectly useful. This account, of necessity, incorporates material summarised from the annual stock assessment reviews, from Colman et al. (1985) to Annala et al. (2000), and anecdotal fisheries information obtained by NIWA before and during this study.

When the QMS was introduced in October 1986, the total unregulated catch of school shark was reduced from its level of 4000–5000 t to a quota of about half this, 2590 t. It was a precautionary move, based only on a suspicion that the existing catches were too high. Regional quotas (by QMA) were set, also somewhat arbitrarily, at subdivisions of this that reflected (a) the length of time each QMA had been sustaining a high level of catches (QMAs with only a brief period of sharply rising catches were cut back by a relatively greater amount), and (b) the area of the QMA over which school shark were expected to occur. For the two QMAs with poor catch history information (Chatham Rise and Campbell Plateau) quotas were based on biomass estimates from trawl surveys; this procedure is now considered obsolete, but there are no alternative replacement values. The QMA boundaries were set administratively for all fish species in the QMS; in some cases these coincided with possible stock boundaries for one or more quota species, but in others they did not. For species having little or no available information on natural biological stocks, the administrative boundaries were accepted as a method of spreading the fishing effort and minimising the risk of localised depletion. Paul (1988) summarised the fishery as it was understood in the mid 1980s, from rather limited commercial catch data and some anecdotal information.

Opportunistic tagging of school shark began at several localities around New Zealand in the mid 1980s, and sufficient recaptures made to establish that extensive movement occurred (Hurst et al. 1999). Although short-term recoveries were mainly from the same QMA, fish that had been at liberty for a year or more had moved much further; several had travelled the length of the country, usually to the north, though the non-random nature of tag releases and (at that time) the poorly understood distribution of commercial fishing effort did not allow any conclusions on migration patterns. After five years (1986–91), four sharks were recaptured off southern Australia (Coutin et al. 1992, Paul 1992), and in subsequent years more trans-Tasman crossings were recorded (McGregor 1994, Hurst et al. 1999), at a high enough level (ca. 10% of recoveries) to generate some uncertainty in Australian stock assessments because the extent of immigration from New Zealand was unknown (Punt & Walker 1998, Punt et al. 2000a).

School sharks are regularly caught in research trawl surveys. Most are juveniles, and it is probable that the large adults are not easily taken by trawl. These data are invaluable for identifying nursery areas (Hurst et al. 2000). Size modes that represent age groups (Francis & Mulligan 1998) are readily identifiable, allowing some inferences on regional juvenile growth rate to be drawn, but as regional surveys are usually undertaken at the same time of year it is not possible to track the seasonal growth of these age groups.

The size range and sex ratio of school sharks taken by the commercial fishery are not well known, but some data can be collated from the shark fishery logbook project run by the fishing industry (N.Z. Seafood Fishing Industry Council, unpublished data). The participants in this are mainly rig fishers, but many also take school shark. The size range, by sex, is shown for four of the regions used in this present study for different years from 1995–96 to 1998–99 in Figure 3. Direct comparisons of *population size structure* between regions and years is not possible because of differences in mesh size, but some comments on the *size of fish caught* can be made. Fish from the east coast of the South Island were mostly less than 110 cm in length, with an even distribution of sexes; a second less common size group taken was 130–180 cm, and predominantly female. Fish caught off Southland (where a larger mesh size is used) were generally larger, but at 120–150 cm slightly smaller than the second group off the east coast, and a high proportion were males. In both these South Island regions the size distribution was similar in the years sampled. In Cook Strait, the size range was similar (and broad, at 70–170 cm) in three of four years, and predominantly female. In the fourth year (1997–98) two distinct size modes occurred, males at 100–110 cm, and females at 130–160 cm. In the Cape Egmont region only one year's data are available, showing modes at 80–110 cm and 130–150 cm, with a different sex ratio in each.

No general conclusions can yet be drawn from these data, although they do illustrate the known propensity of this species (and indeed most sharks) to school by size and sex. Fishers targeting what they believe to be a single school report uniformity of size, and a preponderance of one sex. There is

anecdotal information that when larger than usual catches are made, both sexes tend to be present. However, it is not clear whether this is a characteristic of large schools, or whether two or more single-sex schools had been encountered during one fishing operation.

There is limited information on the reproductive cycle of school shark in New Zealand waters, given the difficulty of routinely and randomly sampling mature females. Maturity is considered to be reached at 125–135 cm in males (Francis & Mulligan 1998, Hurst et al. 1999), 135–140 cm in females (NIWA, unpublished data). Fecundity may be lower in New Zealand than elsewhere (NIWA, unpublished data). Productivity is also low because females give birth only every second or third year elsewhere; the cycle length in New Zealand is not known. The youngest pups occur in very shallow water, along the open coastline as well as in bays and inlets, where they are vulnerable to setnets targeting several inshore fish species.

From the limited data so far available, it appears that in most regions a high proportion of the catch of school shark is of immature fish. An exception is Kaipara Harbour, where the catch is predominantly of large (and usually pregnant) females (NIWA, unpublished data).

A study on the growth rate of New Zealand school shark (Francis & Mulligan 1998) used X-rays of thin vertebral sections, juvenile length frequency modes, and tag-and-recapture data to age fish up to 25 years; few large fish were sampled, and the longevity of school shark in New Zealand remains uncertain. Australian school shark are believed to reach 60 years (Walker 1999).

Fishers targeting school shark can, with a fair degree of success, take school shark of an optimum size for industry requirements. This varies regionally, but generally the largest sharks (particularly the pregnant females) and the smallest are avoided. Grounds where these sizes predominate, permanently or seasonally, are not fished, appropriate mesh sizes are used for setnets, and longline fishers who catch large females during short sets report releasing them alive and in apparently good condition.

Some general reviews of the New Zealand school shark fishery have been compiled in recent years, with emphasis on trends in landings and on management strategies. These have been written in the context of fisheries for *Galeorhinus galeus* in various parts of the world (Walker 1999), or of New Zealand fisheries for a number of shark species (Francis 1998, Francis & Shallard 1999).

A precursor to the present study was carried out by Paul & Sanders (1998). They described the school shark fishery in some detail (catch and landings by method, region, and target species) for one year (1989–90), and in less detail for the subsequent years to 1996–97, using the modified regional boundaries adopted for this present study. They described the highly fragmented nature of the fishery, and noted that few (11) vessels consistently landed even moderate quantities (less than 10 t) of school shark each year during this period. They did not attempt to develop CPUE indices, but suggested a number of options for doing so; all required extensive grooming and manipulation of data beyond the scope of that investigation. They reported, also, that there were discrepancies between estimated catch and reported landing values that appeared to involve the inappropriate use (or non-use) of conversion factors, and recommended that this apparent problem be investigated more carefully before further analytical work on the fisheries data was undertaken.

3. DATA SOURCES AND METHODS

3.1 General

This study is largely based on catch, effort, and landings data held in Ministry of Fisheries databases, summarised in extracts obtained by NIWA staff. It is augmented by unpublished information on school shark and its fishery held by NIWA, and by information obtained from a Ministry-approved questionnaire sent to some of the main fishers in this fishery.

3.1.1 Definitions

Main fleet, or main vessels. Vessels which landed 1 t or more of school shark during the year considered.
Minor fleet, or minor vessels. Vessels which landed less than 1 t of school shark during the year considered.
Statistical area. The standard fishing areas used to record the location of fish catches. Nos. 1–52 are coastal, 101–625 (broken series) are offshore (see Figure 1).
Region. A combination of statistical areas. One region (Southland) equates to a Fishstock, others to Quota Management Areas (QMAs), and others – particularly around Cook Strait – to subdivisions of QMAs (see Figure 2).
Target species. The species nominated as the target species for the day on which a school shark catch was recorded.

3.2 Data extracts, fishing years 1989–90 to 1998–99

3.2.1 Databases and form types

Data for this part of the study were extracted from the Ministry of Fisheries catch effort (CATCHEFF) database. This database holds data from a variety of forms completed by commercial fishers, or by fishing companies, that cover their fishing activities and landings. This study used three form types.

- Catch Effort Landing Return (CELR) forms that record the estimated catch, actual effort and (in a separate panel) the actual landings for a trip; they cover several fishing methods and are used mainly by inshore fishing vessels, including small trawlers.

- Trawl Catch Effort Processing Return (TCEPR) forms that record the estimated catch, actual effort, and information on the processed catch; they are used by the larger trawl fishing vessels, and in more recent years by smaller trawlers as well.

- Catch Landing Return (CLR) forms that record the actual landings of vessels completing TCEPR forms and are comparable to the landings panel on the CELR forms.

Data relating to the effort and estimated catch were selected from the tables 'niwa..fishing_event' and 'niwa..estimated_subcatch', The "CEL" (CELR) and "TCP" (TCEPR) form types were selected separately. The "TCP" data were grouped by date, vessel, fishing year, method, target species, and Statistical Area to give a summary comparable with the data extracted for the "CEL" vessels.

The school shark landings were summed by month for each vessel from the 'niwa..specprod_act' table. This aggregates landings data from the CELR and CLR forms; the latter records landings from the vessels recording catches on TCEPR forms.

In summary, this gave three extracts. The first two of these gave method, target species, and Statistical Area fished, by day; the third, the monthly landed catch.

- Estimated catch, by vessel and day, from CELR forms.
- Estimated catch, by vessel and day, from TCEPR forms.
- Landed catch, by vessel and month, from a combination of CELR and CLR forms.

3.2.2 Data grooming

Extracts from the catch effort database had some high and low catch (and landing) values that clearly needed investigation. Estimated catches on CELR and TCEPR forms ranged from 30 000 kg (30 t) down to 1 kg per day. These high and low potential outliers were examined separately.

3.2.2.1 High catches

The estimated "catch per day" values have a distribution tail which plausibly reaches 10 000 kg (10 t). There are relatively few (18) reported catches greater than 10 t per day for the fishing years 1989–90 to 1997–98, in a total of almost 84 000 catches. However, if they were erroneous, their inclusion would distort analyses of small unit fisheries. Consequently, annual data extracts were examined for high catches, and all catches of 6 t and greater were checked for "reasonableness" (values to this lower limit were included in order to develop an understanding of reasonable and unreasonable catch and landing patterns). Two checks were made, which in combination allowed most of these high values to be judged either correct (or at least reasonable) or spurious.

- The catch history of the vessel was examined, to determine whether the value was unusually higher than its other catches, or higher than its recorded total catch for that day.

- The estimated catches for the vessel for the particular month were checked against the recorded landings for that vessel in the same and adjacent months.

Sometimes it was clear that spurious additional digits, often zeros, were included, and these were removed. Usually the figure was judged incorrect but the source of the error was not clear, and a reasonable new value substituted, based on the total daily catch, catches for other days, and the landed catch for the month in question for that vessel.

A moderate number of reported catches in the 6–10 t range could not be resolved as either correct or incorrect. They were mostly much higher than other daily estimated catches by the vessel, but supported by the reported monthly landing value. It is possible that the latter was also incorrect, but all these values were retained. The overall pattern of catch data and some anecdotal information suggest that vessels can make one (or more) large daily catch of school shark in a season. The effect of correcting these high outliers is shown in Table 1.

Table 1: The effect of correcting high outlier values in estimated catch records.

Fishing year	Vessel	Reported catch (t)		Corrected catch (t)		Percent decrease (%)	
		Day	Year	Day	Year	Day	Year
1989–90	284	6.544	9.556	0.065	3.077	99	68
	All		1619.965		1613.486		< 1
1991–92	4583	15.932	42.895	1.593	28.556	90	33
	All		1793.666		1779.377		< 1
1994–95	6212	30.000	104.655	3.000	77.655	90	26
	3789	18.309	24.484	1.839	8.014	90	67
	All		1919.188		1875.718		2
1995–96	891	8.000	23.260	0.800	16.060	90	31
	All		2266.425		2259.225		< 1
1996–97	1918	10.010	10.440	0.100	0.530	99	95
	All		1967.041		1957.131		< 1
1998–99	3835	11.500	26.920	1.150	16.570	90	38
	6053	401.200	465.601	1.200	65.601	99	86
	All		2510.981		2100.631		16

Notes:

1. No change in 1990–91, 1992–93, 1993–94, 1997–98.
2. Values are given to three decimal places (=kg), which sometimes clarifies the nature of the correction.

Correcting the most obvious errors in estimated daily catches of 6 t and greater resulted in a reduction of 90–99% in that daily catch for the vessel in question, and a reduction of 26–86% of the annual catch of that vessel. These corrections made little difference (generally less than 1%) to the total estimated catch for the year, except for fishing year 1998–99 when correction of two errors (two vessels, one day each) reduced the total catch by 16%.

Other catches over 6 t were probably, but not obviously, incorrect, and could not be corrected. There would undoubtedly also be some incorrectly recorded lower catches, i.e., catches within the expected range, which would be extremely difficult to identify.

3.2.2.2 Low catches and landings

There are two categories of "low catches and/or landings".

(1) Very low quantities of school shark landed in a complete year. For these vessels, school shark was clearly a minor bycatch.

(2) Reported catches and landings of very low quantities of school shark, as low as 1 kg per day and/or per landing, which may perhaps be incorrect. A 1 kg school shark is about 60 cm long, relatively slender, and if caught singly or in small numbers is presumably of little commercial value. However, the fishing industry's shark fishery logbook project (unpublished data) records fish from this size upward as taken by commercial fishers, and without further investigation these low records cannot be rejected as erroneous, although some may represent small catches incorrectly recorded as numbers instead of weights.

To investigate the pattern of low catch and landing values, landings were chosen instead of estimated catches. They comprised a smaller and more tractable data set from the ten years 1989–90 to 1998–99, and they included a greater proportion of the actual catch, i.e., they constituted the catch that was actually landed. The pattern of landings, as number of vessels in different categories of landing size (t), is shown in Figure 4. Summary values and percentages are given in Table 2.

Table 2: Distribution of the size of annual landings of school shark, by vessel, fishing years 1989–90 to 1998–99. Values are the number of vessels making an annual landing within the tonnage ranges listed.

Annual	Fishing year										
landing (t)	89–90	90–91	91–92	92–93	93–94	94–95	95–96	96–97	97–98	98–99	Mean
< 1	540	558	547	596	560	565	489	482	432	375	514
1–10	205	229	200	241	223	237	250	269	236	222	231
11–20	22	14	27	30	26	24	35	27	31	38	27
> 20	20	22	24	24	22	23	37	38	31	51	29
Total	787	823	798	891	831	849	811	816	730	686	802
< 1t as %	69	68	69	67	67	67	60	59	59	55	64
1–10t as %	26	28	25	27	27	28	31	33	32	32	29
11–20t as %	3	2	3	3	3	3	4	3	4	6	3
> 20t as %	3	3	3	3	3	3	5	5	4	7	4

Half to two-thirds of the vessels which recorded a landing of school shark during the year made annual landings of less than 1 t. A further quarter to one-third of vessels landed between 1 and 10 t (inclusive). Very few vessels, 5–13% of the fleet, made annual landings less than 10 t. Within the two lowest categories, most vessels made landings in the lower end of the respective ranges (Figure 4). The highest number of vessels (one-quarter to one-third of the fleet) made annual landings of less than 0.1 t (1–100 kg). Although there was little variation in the annual pattern of landings (Table 2), from 1995–96 onwards there was a trend towards relatively more vessels making landings greater than 20 t.

The contribution that each landing category made to the total annual tonnage landed must also be examined. What proportion of the annual landing comes from the large number of vessels each making very small landings? The pattern is shown in Figure 5, and the summary values with percentages are given in Table 3.

Table 3: Distribution of the size of annual landings of school shark, fishing years 1989–90 to 1998–99. Values are the summed annual landings (t) by vessels making landings within the tonnage ranges listed.

Annual	Fishing year										
landing (t)	89–90	90–91	91–92	92–93	93–94	94–95	95–96	96–97	97–98	98–99	Mean
< 1	117	108	118	121	115	116	103	104	88	97	109
1–10	689	786	694	805	736	848	963	1,007	883	877	829
11–20	334	213	387	421	390	350	506	413	467	599	408
> 20	896	1,043	1,223	1,430	1,311	1,280	1,920	1,658	1,561	1,898	1,422
Total	2 036	2 150	2 422	2 777	2 552	2 594	3 492	3 182	2 999	3 471	2 768
< 1 as %	6	5	5	4	5	4	3	3	3	3	4
1–10 as %	34	37	29	29	29	33	28	32	29	25	30
11-20 as %	16	10	16	15	15	13	14	13	16	17	15
> 20 as %	44	49	50	51	51	49	55	52	52	55	51

Although many vessels made small individual annual landings of less than 1 t (see Table 2), their cumulative landings made up a minor part (3–6%) of the total annual landings (t) by the fleet. About one-third of the total annual tonnage was landed by vessels which each contributed 1–10 t, and two-thirds by vessels each landing more than 10 t. In the latter group, 10–17% of the annual tonnage was landed by vessels each landing 11–20 t, and about half (44–55%) of the total tonnage was landed by vessels each landing more than 20 t.

Within the two lowest categories, vessels landing less than 1 t, and 1–10 t, there were no clear patterns within years or trends between years. Summed vessel catches of less than 1 t were generally distributed fairly evenly in 100 kg units across the range (see Figure 4). Summed vessel catches of 1–10 t, in 1 t units, showed a slight trend for more of the catch to come from the lower two-thirds of this range.

To simplify the main analyses of the school shark fishery, we divided the fleet into two categories: vessels landing less than 1 t in a year, and those which landed 1 t or more. Years were considered separately, so individual vessels sometimes fell into one category, sometimes the other. However, because the overall pattern of landings was reasonably consistent between years, all years were combined for an inspection of the smaller (1 kg to 10.9 t) annual landings by vessel (Figure 6). There is no obvious value which separates the two categories, but the 1 t value used in the tabulation of data above seems appropriate. The number of vessels making landings lower than this rises very steeply, while there is a slower change (i.e., less variation) in the number of landings greater than 1 t.

Although 1 t is an arbitrary threshold value, it almost certainly categorises those vessels which took shark only as a very minor bycatch. Also, the "under 1 t fleet" is likely to include those vessels with the very low estimated catch weight values (of 1 kg to perhaps 5 kg) which may be erroneous.

However, the "under 1 t fleet" represents at least half the vessels which reported a catch or landing of school shark. They were removed from the main characterisation study, which examines annual trends in school shark landings by method, region, month, and target species.

This 1 t threshold removes 53–68% (mean 63%) of vessels from the main analysis, for the loss of 3–6% (mean 4%) of the landed tonnage.

These two groups of vessels are termed the "main fleet" and "minor fleet" (see Definitions, 3.1.1), and some of their characteristics are described in Section 4.1.3).

3.3 Estimated catches and recorded landings

3.3.1 Integrating catches and landings

There is no standard, automated procedure for linking full catches (i.e., landings) with fishing effort. It is not possible to link the effort data from the top panel of the CELR and TCEPR forms with the landed data recorded on the lower panel of the CELR forms and (for TCEPR data) on CLR forms. Only the approximated and often incomplete estimated catch data on the top panel can be directly linked with effort.

If estimated catches are used, it is not possible to properly describe or characterise the fishery, in terms of method, area, and target species (when school shark were taken as bycatch). In particular, there is a bias in the estimated data towards targeted fisheries, and towards those fisheries in which few other species are caught. In both cases school shark are more likely to be listed in the top (estimated) panels of the forms, which provide space for recording only five species.

In the scoping study of the school shark fishery (Paul & Sanders 1998), an experimental, manual procedure was developed to convert estimated catches into "full catches" for the fishing year 1989–90. Catch effort database extracts were obtained of school shark "estimated catches" and "landings". Estimated catches were summarised by vessel (coded), month, and day, and landings by vessel and month. These were combined in an Excel spreadsheet, which then comprised one or more rows of daily estimated catches for a vessel, followed by a row giving that vessel's landed catch for the month. Information on method, area, and target species was copied from the "estimated catch" row(s) to the monthly "catch landed" rows. Where more than one method, area, or target species was recorded in a month, the landing was subdivided in the proportion of the estimated catch values in each category. This procedure was time-consuming, but it resulted in the entire landed catch being linked to vessel, method, area, and target species, by month, and gave a new value, termed in that study the "calculated landed" catch.

It was hoped that this would lead to an automated procedure to link effort to full catch (i.e., landing) data, but it proved impossible during that study, and no progress has been made during the present study. There are too many missing values and errors in the data, which would lead either to incorrect monthly results, or (if automatic checks were used) to many null values. The manual procedure involved both the interpolation of missing data and the correction of spurious codes and values, and this required not only some knowledge of the school shark fishery, but the fisheries with which it is associated.

This procedure developed by Paul & Sanders (1998) increased the "catch" of school shark which could be associated with effort variables (method, area, target species). For 1989–90, the estimated catch was 68% of the QMR (Quota Management Report) landings, whereas the calculated landed catch was 87% of the QMR landings. The latter difference is similar in magnitude to discrepancies in "landings" between different data sources for several other fisheries at this time (Ministry of Fisheries, unpublished data extracts, and see figure 1 in Francis (1998)). It was suspected that one cause of this problem was variation in the fisher's, or Ministry's, interpretation of the processed state of estimated catches and recorded landings, and inconsistency in the use of conversion factors from processed weight to whole (green) weight. Estimated catches are required to be recorded as whole weight, and there is no provision on the form for alternative values such as processed weight, but we are aware that the latter are sometimes used.

For the present study, the procedure described above of pro-rating the estimated catch data up to landings data, by method, area (region), and target species, was applied to data from two additional years, 1994–95 and 1998–99, in order to span the decade. Details of this procedure, and on how the erroneous or doubtful data were handled, are given in Appendices 1 and 2. The term "calculated landing" is used for the new values.

3.3.2 The relationship between catches and landings

When catches were pro-rated to landings as described in the preceding Section, in a few cases both values were the same. This implied that (a) the fisher had completed both parts of his catch form at the same time, and (b) that our extracts which used data from different sources were valid. However, it became increasingly clear that there was a variety of discrepancies between estimated catch and landing values. They fell into four categories.

- Discrepancies due to rounding. Estimated values were usually rounded, landed values precise. Estimated values were usually within a few percent of the landings. These were not a problem.

- Catches in one month landed in the next. This gave large monthly discrepancies, but they were resolved when the values for two or more months were combined.

- Estimated catches significantly less than landings, when a minor bycatch. This usually occurred with trawlers, or for other methods working a multi-species fishery, when school shark were likely to have only sometimes fallen within the top five species of the catch (and thus included in the estimated catch panel of the form). This was not a problem in itself, but when monthly landings had to be subdivided between two regions, or two or more target species, the subdivision was of necessity arbitrary.

- Estimated catches approximately half the value of landings, even when school shark were targeted and/or taken in moderate quantity as bycatch. This occurred sufficiently often to be suspicious, and given that the conversion factor from processed school shark to greenweight is about 2 (2.2 to 1.95 from 1980, Francis (1998)), led to further investigation. It seemed possible that estimated weights were being recorded as processed weight, with the matching landed weight converted up to greenweight.

Because monthly comparisons had the additional problem of catches carried forward (see above), annual values of estimated catches and recorded landings were compared for all vessels landing more than 1 t of school shark in a year, estimated catches being plotted as a percentage of landings (Figure 7). (Annual values for a single vessel are thus included for as many years as it fished.)

The zero values represent vessels making no estimated catch but recording a landing. For all methods the distribution of percentages is bimodal, with peaks at about 50% and 100%, supporting the likelihood that many vessels were recording their estimated catch as processed weight. This becomes clearer when the line and net vessels are separated from "other methods", mainly trawling. The "other methods" have a small mode at 100% (estimated and landed values probably recorded correctly, although both could be unconverted processed weights), a possible mode about 50% (estimated weights probably processed weights), and many values less than 50%, representing those cases where school shark were not recorded among the top five species in a catch.

3.4 Catches and landings by individual vessels

Following the procedure outlined in Section 3.3, for most analyses each annual dataset of catches and landings was subdivided into those vessels which landed more than 1 t during that fishing year, the "main fleet", and those vessels which landed less than 1 t, the "minor fleet" (see also Section 4.1.3).

4. REVIEW OF THE NEW ZEALAND FISHERY

4.1 Fishing effort in the New Zealand fishery

4.1.1 The fishing fleet

During examination of the catch and effort data it soon became apparent that may fishing vessels, using a wide variety of fishing methods, reported catching or landing school shark. This is quantified in Table 4, which gives the number of vessels in New Zealand likely to catch fish (not shellfish), and the numbers which reported school shark.

Table 4: The number of vessels in the total New Zealand fishing fleet, 1989–90 to 1998–99, with the potential to catch school shark, and the number and percentage of vessels from that fleet which did report a catch or landing of school shark.

	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
All vessels[1]	1 644	1 763	1 787	1 871	1 803	1 707	1 592	1 495	1 371	1 270
Vessels catching[2]	720	751	725	799	721	749	717	723	641	588
Vessels landing[3]	787	823	798	891	831	849	811	816	730	686
Catching vessels %[4]	44	43	41	43	40	44	45	48	47	46
Landing vessels %[5]	48	47	45	48	46	50	51	55	53	54

Notes:
1. 'All vessels', the number of vessels which recorded a fishing activity for finfish in one or more of the categories listed. This value includes each vessel only once, and is not the total of vessel x method; many vessels fished using more than one method.
2. 'Vessels catching', the number of vessels which reported an estimated catch of school shark.
3. 'Vessels landing', the number of vessels which recorded a landing of school shark.
4. The number of vessels reporting an estimated catch of school shark, as a percentage of the fleet fishing for finfish.
5. The number of vessels reporting a landing of school shark, as a percentage of the fleet fishing for finfish.

School shark are caught by almost all fishing methods used to take marine finfish, and by a large proportion of the New Zealand fishing fleet. Over the decade 1989–90 to 1998–99, 40–48% of the fleet recorded an estimated catch of school shark, and (more reliably) 45–55% of the fleet recorded a landing of school shark. From the mid 1990s the numbers of fishing vessels (in total, and those catching or landing school shark) declined. This decline varies with method (Table 5), and the reason for it is unknown.

The proportion of the fleet, by method, which took school shark during the decade can only be determined from the estimated catch data (Table 5).

Table 5: The number of vessels in the total New Zealand fishing fleet, by the main fishing methods, 1989–90 to 1998–99, with the potential to catch school shark, and the number and percentage of vessels from that fleet which did report a catch landing of school shark.

	Fishing year										
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	Mean
Setnet											
All vessels (n)	640	704	720	765	672	606	567	533	475	444	
SCH vessels (n)	205	231	242	280	236	233	230	222	195	168	
SCH vessels %	32	33	34	37	35	38	41	42	41	38	37
Longline											
All vessels (n)	429	466	478	468	454	386	334	289	253	228	
SCH vessels (n)	215	229	214	252	220	217	217	201	174	158	
SCH vessels %	50	49	45	54	48	56	65	70	69	69	58
Dahn line											
All vessels (n)	105	120	124	141	151	161	131	120	102	101	
SCH vessels (n)	60	66	61	71	84	81	74	61	43	52	
SCH vessels %	57	55	49	50	56	50	56	51	42	51	52
Trotline											
All vessels (n)	26	28	23	23	26	27	15	12	11	7	
SCH vessels (n)	23	16	14	13	15	13	9	5	3	3	
SCH vessels %	88	57	61	57	58	48	60	42	27	43	54
Single trawl											
All vessels (n)	451	440	437	446	437	446	443	468	429	384	
SCH vessels (n)	260	265	239	253	230	256	254	276	262	253	
SCH vessels %	58	60	55	57	53	57	57	59	61	66	58

Note:

1. Methods not shown here include pair-trawl, midwater trawl, Danish seine, surface longline, troll, beach seine/dragnet, and handline, which all have quite low proportions of vessels reporting a school shark catch.

The percentages based on catches are about 5% less than those based on landings (see Table 4), although this will vary (to an unknown degree) by method. The proportion of setnet vessels which catch school shark (32–41%) seems low, given that this is an important method for taking the species; however, many vessels in the total setnet fleet would be targeting flatfish either in waters too shallow, or in the wrong habitat, for school shark. The proportion of longline vessels reporting a catch is higher (45–69%), probably because this gear is set in appropriate depths, and the number of bycatch species low enough for school shark to often occur among the top five species caught. Just over half the Dahnlining and trotlining vessels catch school shark, perhaps because their vertical lines are usually set near rough ground for groper. The proportion of single trawlers reporting a catch of school shark is surprisingly high at 53–66% (mean 58%, as for longliners), given that the species must often rank outside the top five species caught.

School shark have also been reported as taken by pole-and-line, lobster pot, cod pot, and fyke net, but these method records are considered spurious and have been converted to null during analyses. It seems likely that most of these records arise from the use of more than one method in a day, but where only the main method is recorded. Fish *are* caught in lobster and cod pots, but the moderate weights of school shark reported in most of these catches seem more likely to be recording errors.

4.1.2 Target fishing effort

The numbers of vessels, by fishing method, which targeted school shark in the decade 1989–90 to 1998–99 are shown in Table 6.

Table 6: Number of vessels in the New Zealand fleet which target-fished for school shark, by method and year, in 10-day units.

No. of days

	89-90	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99
Longline										
1-10	12	21	19	20	20	27	31	25	26	23
11-20	6	4	2	7	6	4	10	7	3	5
21-30	1	2	6	5	3	2	3	5	2	4
>30	6	5	3	3	5	5	6	4	4	7
Dahnline										
1-10	7	8	7	4	6	6	9	8	6	2
11-20	0	0	0	1	0	1	0	0	1	0
Trotline										
1-10	3	2	1	1	1	3	1	1	0	0
Setnet										
1-10	36	39	47	39	36	37	35	32	29	26
11-20	11	15	13	9	11	10	11	12	11	10
21-30	5	0	6	6	4	6	9	6	6	5
>30	10	11	8	9	9	11	8	5	7	10
All methods										
1-10	58	70	74	64	63	73	76	66	61	51
11-20	17	19	15	17	17	15	21	19	15	15
21-30	6	2	12	11	7	8	12	11	8	9
>30	16	16	11	12	14	16	14	9	11	17
Total	97	107	112	104	101	112	123	105	95	92

During the decade, between 92 and 123 setnet and line vessels (mean 105) targeted school shark at some time during any one year. (A few trawlers recorded targeting school shark, but these are considered erroneous and are not included.) The largest group of vessels (51 to 76, or 57–66%) fished between 1 and 10 days in a year. In fact, 39 to 60 vessels (40–49%) fished for only 1 to 5 days per year.

4.1.3 Catches, landings, and vessels in the main and minor fleets

4.1.3.1 Catches and landings

The analyses of the total New Zealand fishery (Section 4) and regional fisheries (Section 5) are subdivided by fleet, the main fleet comprising vessels which took 1 t or more of school shark in a year, and the minor fleet those vessels which took less than 1 t in a year. The total annual estimated catches and landings of these two fleets are given in Table 7.

Table 7: Catches and landings (t) of school shark, fishing years 1989–90 to 1998–99, recorded by the main fleet (vessels landing 1 t or more) and the minor fleet (vessels landing less than 1t). Source: catch effort database.

	Main fleet			Minor fleet			Minor
Fishing year	Estimated catch	Recorded landing	Catch as % landing	Estimated catch	Recorded landing	Catch as % landing	landing as % total
1989–90	1 528	1 959	78	82	125	66	6
1990–91	1 523	2 031	75	79	118	67	5
1991–92	1 707	2 299	74	73	123	59	5
1992–93	1 974	2 646	75	81	129	63	5
1993–94	1 802	2 417	75	74	123	60	5
1994–95	1 779	2 463	72	91	129	70	5
1995–96	2 173	3 388	64	86	107	80	3
1996–97	1 901	3 070	62	56	114	49	4
1997–98	1 804	2 905	62	48	94	51	3
1998–99	2 027	3 336	61	73	105	70	3
Mean			69			64	4

In the main fleet, estimated catches declined as a percentage of recorded landings, from 74–78% in the early 1990s to 61–64% in later years.

4.1.3.2 Vessels

Over the period 1989–90 to 1998–99, 1899 separate vessels recorded a catch of school shark. More vessels (1696) fished as part of the minor fleet than as part of the main fleet (762), and the mean number of years these vessels worked in the minor fleet was lower (3.0 cf. 3.8 years). Most vessels worked for relatively few years in the fishery; in the main fleet, 517 vessels (68% of that fleet) worked for less than 5 years. In any one fishing year, between 686 and 891 (mean 802) vessels recorded a school shark landing. There were always more (mean 514) vessels in the minor fleet than in the main fleet (mean 218) (Table 8).

Table 8: Numbers of vessels recorded as landing school shark, fishing years 1989–90 to 1998–99, categorised as the main fleet (vessels landing 1 t or more) and the minor fleet (vessels landing less than 1t), and the total fleet (all vessels working). Vessels working for different numbers of years, and vessels working in each fishing year. Source: catch effort database.

No. of years worked	No. of vessels working			Fishing year	No. of vessels working		
	Main fleet	Minor fleet	Total fleet		Main fleet	Minor fleet	Total fleet
1	232	588	511	1989–90	247	540	787
2	121	323	276	1990–91	265	558	823
3	97	242	209	1991–92	251	547	798
4	67	167	167	1992–93	295	596	891
5	49	111	141	1993–94	271	560	831
6	44	85	104	1994–95	284	565	849
7	34	69	100	1995–96	322	489	811
8	32	50	96	1996–97	334	482	816
9	33	38	94	1997–98	298	432	730
10	53	23	201	1998–99	311	375	686
Total	762	1 696	1 899	Mean[2]	288	514	802
Mean[1]	3.8	3.0	4.2				

Notes:
1. The mean number of years worked by vessels in each fleet.
2. The mean number of vessels in each fleet for the fishing years 1989–90 to 1998–99.

These two fleets are an artificial concept, and not discrete entities, and defined only by the size of the catch made by a vessel in each year. Over the 10 year period, 599 vessels appeared (in different years) in each fleet; that is, in some years they landed more than 1 t of school shark, in some years less. The subdivision into two fleets has been made primarily in order to remove the large number of minor vessels from the analysis of each year's fishery. The fishing pattern of these minor vessels is analysed, much more simply, separately.

4.2 Total catch

4.2.1 General

The general catch history of school shark in New Zealand has been described in several accounts, including Garrick & Paul (1975), Paul (1988), Francis (1998) and successive reports on the species in Stock Assessment Plenary documents (e.g., Annala et al. 2000). A small fishery operated for a few years around 1900 in the Auckland area; liver oil and (from the carcasses) farm fertiliser were produced, but there are no records. Only small bycatches were then taken, and generally discarded, until the early 1940s, when a fishery developed for liver oil to replace war-disrupted supplies. Although records of school shark landings are available from 1945 (Table 9, Figure 8), only the livers of the sharks caught for this particular fishery were retained. From the quantity of liver processed, it is estimated that a peak of about 2500 t of school shark would have been taken in 1946–48. The liver-oil fishery collapsed when synthetic vitamin A became readily available in the early 1950s, and only a modest fishery for the fillets continued, with much of this product exported to Australia. This fishery was depressed twice, in 1972 and 1978, by high mercury-level warnings, but in 1980 landings increased rapidly with the development of more efficient setnets, development of better local markets, and an export market to Australia that continued growing. Landings peaked at almost 5000 t in 1983–84, then declined a little before being reduced by the imposition of TACs when the QMS was introduced in 1986 (see Section 2).

Table 9: Reported New Zealand landings (t) of school shark.

Year	Landing	Year	Landing	Year	Landing	Year	Landing	Year	Landing
1945	68	1956	164	1967	376	1978	161	1989	2 309
1946	104	1957	301	1968	360	1979	481	1990	2 377
1947	57	1958	323	1969	390	1980	1 788	1991	2 215
1948	75	1959	304	1970	450	1981	2 716	1992	2 508
1949	124	1960	308	1971	597	1982	2 965	1993	2 839
1950	147	1961	362	1972	335	1983	3 918	1994	2 603
1951	157	1962	354	1973	400	1984	4 776	1995	2 583
1952	179	1963	380	1974	459	1985	4 501	1996	3 387
1953	142	1964	342	1975	518	1986	3 717	1997	3 153
1954	185	1965	359	1976	914	1987	1 946	1998	2 917
1955	180	1966	316	1977	1 231	1988	2 367	1999	3 421

Notes:

1. Sources: Annual Reports on Fisheries, to 1972; unpublished data, 1973; King (1985), 1974–82; King (1986), 1983; Annala et al. (2000), 1984–99. To 1986, calendar years or Apr-Mar years; from 1986–87 (1987 in table), QMS data for Oct-Sep fishing years.
2. Before 1986, recorded landings are almost certainly considerably less than actual catches.

4.2.2 Comparison of data from different sources for the period 1989–90 to 1998–99

The analyses of regional fisheries in Section 5 are based on data from the Ministry of Fisheries catch effort database. It is appropriate to compare these with recorded landings data from other official sources, particularly from the QMR and LFRR databases (Table 10).

Table 10: Catches and landings (t) of school shark, fishing years 1989–90 to 1998–99, recorded in different databases.

	Catch effort		LFRR	QMS
Fishing year	Est. catch	Recorded landing	Recorded landing	Recorded landing
1989–90	1 620	2 084	2 542	2 337
1990–91	1 602	2 150	2 276	2 215
1991–92	1 779	2 422	2 536	2 508
1992–93	2 055	2 776	2 880	2 839
1993–94	1 876	2 540	2 633	2 603
1994–95	1 870	2 593	2 717	2 583
1995–96	2 259	3 495	3 561	3 387
1996–97	1 956	3 184	3 229	3 153
1997–98	1 854	2 998	2 967	2 915
1998–99	2 101	3 442	3 444	3 418

Note:

1. Francis (1998) reported landings from the catch effort database reaching almost 4000 t in 1995–96, apparently resulting from 'double-counting' of landings where both carcasses and fins were landed, but these errors appear to have been corrected.

Apart from the first year, 1989–90, for which the catch effort data may be incomplete, there is good agreement between the three series of landing values. The estimated catch values are much lower, on average 69% (annual values 61–78%) of the catch effort landings data.

4.3 Catch by region

4.3.1 Catches by the main fleet

The calculated landings by region, for the three fishing years 1989–90, 1994–95, and 1989–90, are shown in Table 11.

Table 11: Calculated landings (t) of school shark by region, for three fishing years in the decade 1989–90 to 1998–99, recorded by the main fleet (vessels landing 1 t or more). Sources: catch effort database and landings database.

Region	1989–90	1994–95	1998–99	Mean of 3 years
NE North I.	141	200	193	178
E North I.	69	81	132	94
Cook Strait	459	493	729	560
E South I.	176	232	222	210
Chatham Rise	3	28	60	30
Chatham Is	5	21	73	33
Southland	377	634	669	560
W South I.	266	106	262	211
Egmont	200	345	390	312
Kaipara Hbr	67	35	38	47
NW North I.	178	272	439	296

The two main regions were Cook Strait and Southland, followed by Egmont and the northwest coast of the North Island (QMA 9). Of moderate importance are the eastern South Island and western South Island. Catches in most areas have increased over the decade; the eastern and western South Island have remained about the same, and the Kaipara catch has fallen.

It is possible to determine the extent to which vessels which fish predominantly within one region also fish in adjacent regions. In this study it has been done only for three fishing years (1989–90, 1994–95, and 1998–99) where catches by statistical area have been pro-rated up to landings by region. This more properly represents the fishing activity of trawlers which have a relatively greater range. The values in Table 12 sum the catches (as landings) of the vessels which fished predominantly in a region, and the catches of these same vessels in adjacent (or other) regions. All vessels in the main fleet could be categorised as having one main fishing region.

Table 12: Fishing activity for school shark between regions, expressed as the summed catch (t) of vessels which predominantly fished in a region, and the catch of the same group of vessels in other regions. The data for three fishing years are tabulated separately. Sources: catch effort and landings databases.

Fishing year 1989–90

Regional catch	Main region fished											
	NE NI	E NI	Ck St	E SI	Ch R	Ch I.	Slnd	W SI	Egmt	NW NI	Kaip	Total[1]
NE NI	134	1	0	0	0	0	0	0	0	3	0	138
E NI	0	54	0	1	0	0	0	0	0	0	0	55
Cook St	1	14	417	4	1	1	6	12	19	0	0	474
E SI	0	0	0	158	0	0	10	0	0	0	0	169
Chat R	0	0	0	0	2	0	0	0	0	0	0	2
Chat I	0	0	0	0	0	1	0	0	0	0	0	3
Sthlnd	0	0	3	4	0	3	313	6	13	2	0	343
W SI	1	0	18	7	0	0	45	237	1	1	0	311
Egmont	0	0	21	2	0	0	3	10	167	4	0	214
NW NI	5	0	0	0	0	0	0	0	0	169	0	175
Kaipara	0	0	0	0	0	0	0	0	0	0	67	67
Total[2]	141	69	459	176	3	5	377	266	200	178	67	1 952

Fishing year 1994–95

Regional catch	Main region fished											
	NE NI	E NI	Ck St	E SI	Ch R	Ch I.	Slnd	W SI	Egmt	NW NI	Kaip	Total[1]
NE NI	175	2	0	0	0	0	0	0	0	4	0	181
E NI	3	67	10	4	0	0	0	0	5	0	0	89
Cook St	0	7	439	25	0	0	0	18	20	4	0	515
E SI	0	0	1	200	4	1	3	2	3	0	0	215
Chat R	0	0	0	0	20	1	1	0	0	0	0	23
Chat I	0	0	0	0	0	17	0	0	0	0	0	18
Sthlnd	0	0	0	0	4	2	629	0	0	0	0	635
W SI	0	0	7	1	0	0	1	85	0	0	0	89
Egmont	0	0	41	0	0	0	0	1	278	0	0	320
NW NI	23	9	0	0	0		0	0	41	264	0	331
Kaipara	0	0	0	0	0	0	0	0	0	0	35	35
Total[2]	200	81	493	232	28	21	634	105	345	272	35	2 431

Fishing year 1998–99

Regional catch	Main region fished											
	NE NI	E NI	Ck St	E SI	Ch R	Ch I.	Slnd	W SI	Egmt	NW NI	Kaip	Total[1]
NE NI	138	10	0	0	0	0	0	0	0	9	0	158
E NI	1	111	2	1	0	1	0	0	1	0	0	121
Cook St	0	2	652	1	0	0	0	16	74	0	0	753
E SI	0	0	3	209	5	0	0	0	0	1	0	223
Chat R	0	0	0	9	50	3	3	0	0	0	0	65
Chat I	0	1	4	1	4	69	0	0	0	0	0	80
Sthlnd	0	0	0	0	0	0	657	8	0	0	0	666
W SI	6	0	35	0	0	0	8	235	6	0	0	294
Egmont	0	0	31	1	0	0	0	0	271	1	0	305
NW NI	48	8	1	0	0	0	0	0	37	427	0	525
Kaipara	0	0	0	0	0	0	0	0	0	0	38	38
Total	193	132	727	222	60	73	669	260	390	439	38	3 229

Notes:

1. Total catch in each region, made by all vessels which fished there.
2. Total catch made by vessels which primarily fished the main region listed.
3. Some anomalies in regional fishing patterns may result from confusion on the catch effort forms between statistical area numbers, QMA numbers, and Fishstock numbers; only the most obvious could be corrected.
4. Regional totals may not sum to the main totals, because some null regional data are omitted.

In most regions, the vessels which were based in a region, or predominantly fished there, took most of their catch from that region. For vessels predominantly working the northeastern North Island, almost all their catch was taken there in 1989–90, with progressively more taken from the northwestern North Island in the two later years. For the eastern North Island, there was a moderate overlap with the Cook Strait region in 1989–90, but progressively less in later years. For Cook Strait, catches were predominantly taken from within the region in the three years, with some vessels also fishing the Cape Egmont and the (northern) west coast South Island regions. For the east coast of the South Island, a very high proportion of catches were made there, with small and irregular catches from all adjacent regions (Cook Strait, Chatham Rise, Southland, even the west coast of the South Island). For the Chatham Rise, with only small catches until the late 1990s, catches were also made off the east coast of the South Island and Southland. The area around the Chatham Islands appeared to be fished in association with Southland waters in 1989–90, but became more of an identifiable region in the two later years. For Southland, there was some overlap with fishing activity off the east coast of the South Island in 1989–90, but as the fishery increased in importance during the 1990s the activity became more localised there, with some fishing extending to the (southern) west coast of the South Island. For the west coast of the South Island, catches were predominantly made there, with small and diminishing catches in adjacent regions. The Cape Egmont region is probably the least useful as a self-contained fishing ground. Vessels based or predominantly fishing there also worked in the Cook Strait region to the south, and the northwestern North Island to the north. The northwestern North Island region, however, is a more clearly defined ground. Few of the vessels which mainly worked there, worked elsewhere; only small catches were taken in the two adjacent regions. The Kaipara Harbour, in earlier years the site of a moderate school shark fishery, is nominally part of the northwestern North Island region. In this study it is treated separately, and this analysis of fishing activity suggests no interaction between the harbour fishery and the adjacent coastal fishery; if there is, the data do not reveal it.

The Cook Strait (non-QMA) values are comparable to those from the standard QMAs, with fishing in adjacent areas at a level to be expected from a central region with boundaries to five others. Catches from this region have generally been the highest in the country, and its separation, or recognition, as a fishing region in its own right seems logical.

4.3.2 Fishing patterns of the minor fleet

The pattern of fishing by the minor vessels is shown in Table 13, expressed as the number of vessels which worked in each region over the decade 1989–90 to 1998–99.

Table 13: Fishing activity of the minor fleet, by region, fishing years 1989–90 to 1998-99 combined. Values are "vessel-years".

Region	No. of vessels working	
	In region	In additional region
NE North I.	570	19
E North I.	94	10
Cook Strait	212	11
E South I.	128	17
Chatham Rise	4	0
Chatham Is	48	0
Southland	117	10
W South I.	75	12
Egmont	75	4
Kaipara H.	36	4
NW North I.	63	13
Unknown	235	–

The largest number of vessels taking small catches of school shark work off the northeast coast of the North Island. Most vessels worked within one defined region during the decade in question, only 7% also worked in another, usually adjacent, region.

4.4 Catch by method

4.4.1 Catches by the main fleet

Setnetting has remained the main method, although the longline catch increased most rapidly over the decade (Table 14). The catch by trawl (a bycatch) has been relatively important at 20–28% of the total.

Table 14: Calculated landings (t) of school shark by method, for three fishing years in the decade 1989–90 to 1998–99, recorded by the main fleet (vessels landing 1 t or more). Sources: catch effort database and landings database.

Method	1989–90	1994–95	1998–99	Mean of 3 years
Setnet	1 027	1 281	1 313	1 207
Longline	367	630	930	642
Dahnline[1]	25	34	50	36
Trotline[1]	41	24	19	28
Trawl	489	488	924	634
Other	3	2	5	3
Null	7	5	103	38
Total	1 959	2 464	3 344	2 589

Note
1. Dahnlines and trotlines are considered to be reasonably similar methods, and because they provide only small catches they are combined as "droplines" in the remainder of this report.

4.4.2 Fishing patterns of the minor fleet

The data are briefly summarised. As estimated catches, they under-state the catch by trawlers, and the catch in fisheries where school shark will often not be among the top five species. All main methods are represented (Table 15).

Table 15: Estimated catch (t) by method of school shark by the minor fleet, the vessels landing less than 1 t in a fishing year (1990 is fishing year 1989–90).

Method	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Setnet	27	24	26	29	23	23	19	16	15	16
Longline	16	21	16	23	16	39	31	14	10	13
Dropline[1]	8	5	1	8	10	9	7	6	3	5
Trawl[2]	26	24	22	17	20	17	12	16	16	20
Other[3]	3	4	7	2	4	1	16	3	4	20
Total	82	79	73	81	74	91	86	56	48	73

1. Dropline combines dahnline and trotline.
2. Single bottom trawl
3. Other methods include pair trawl, midwater trawl, Danish seine, handline, beach seine, and ringnet. Records of school shark catches by lobster pot, cod pot, and dredge are considered erroneous.

4.5 Catch by season

4.5.1 Catches by the main fleet

Complete and moderately reliable values for catch by month during the decade 1989–90 to 1998–99 can be given only for three October to September fishing years (Table 16). They are presented as the total monthly school shark catch, and as the targeted monthly school shark catch.

Table 16: Calculated landings (t) of school shark from New Zealand by month, for the three fishing years 1989–90, 1994–95, and 1998–99, recorded by the main fleet (vessels landing 1 t or more). Sources: catch effort database and landings database.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Total												
1989–90	71	209	161	221	249	189	153	96	186	119	69	215
1994–95	196	225	309	361	308	162	215	109	101	58	113	235
1998–99	129	337	251	573	404	321	218	220	173	150	148	153
Targeted												
1989–90	17	108	83	116	159	121	81	39	124	63	24	146
1994–95	90	103	184	221	213	95	131	37	34	24	52	98
1998–99	19	141	110	393	244	168	95	71	27	57	27	28

The seasonal pattern of school shark for New Zealand (in total) is similar for both the total catch and the targeted catch (Figure 9). The peak catch is in January–February. Catches then decline steadily to a minimum around July–August. The catch in September (the final month of the fishing year) is about double that of August, with the targeted catch increasing relatively more than the total catch. Both the targeted and total catch drops in October, and the November and December catches approximately double again to a similar level in each month, before to the January peak.

The summer peak in this seasonal pattern is strongly influenced, naturally, by the two largest fisheries – Southland and Cook Strait. A peak in December, January, or February is present in some of the smaller fisheries, but not all. The September (end of fishing year) peak, however, is usually strongest in the smaller fisheries.

The seasonal patterns for each region (Figures 9 and 10) are covered in separate accounts below. It is difficult to determine what drives the seasonality. In some regions it must be related to the seasonal availability of school shark; Kaipara Harbour is probably the best example of this, with adult school shark entering the harbour from late spring through summer. In other regions it is also inextricably linked with fishing activity for other species; school shark are targeted in the low season for other species (e.g., rock lobster, groper), and as bycatch are taken more often in the high months for other seasonal target fisheries (e.g., hoki trawling, snapper trawling and longlining, flatfish trawling and setnetting).

4.6 Catch by target species

4.6.1 Catches by the main fleet

It is clear from any of the data summaries that although there is some target fishing for school shark, much of the catch is taken as bycatch in many other fisheries. The full extent of this can be demonstrated only with the data for fishing years 1989–90, 1994–95, and 1998–99, where the full catch (the landing) of school shark can be allocated not only to fishing method and region, but to target species (Table 17).

Table 17: Calculated landings (t) of school shark taken as a target species, and as bycatch in other target fisheries, for the fishing years 1989–90, 1994–95, and 1998–99. The values are derived from landings, pro-rated to different target species by using the proportions recorded in estimated catches. The total tonnage of school shark taken by trawl fisheries should be reliable, being based on landings. Its allocation to target species (other than school shark) will be less reliable, being based on the incomplete estimated catch records; it will be allocated relatively more often to fisheries where it is recorded more frequently among the top five species caught. Ordered in mean frequency of occurrence in target fisheries in the three years.

Target	1989–90	1994–95	1998–99	Mean	Main fishing methods with shark as bycatch
School shark	1 087	1 318	1 399	1 268	
Rig	105	283	254	214	Setnet
Groper	87	146	243	159	Dropline, longline, trawl, setnet
Tarakihi	74	89	197	120	Trawl, setnet
Ling	58	78	202	113	Trawl, longline
Snapper	100	106	80	95	Trawl, longline, setnet
Barracouta	66	46	145	86	Trawl
Hoki	25	40	109	58	Trawl
Stargazer	29	23	115	56	Trawl
Gurnard	12	23	103	46	Trawl, longline
Trevally	20	45	73	46	Trawl, setnet
Red cod	32	48	31	37	Trawl
Jack mackerels	80	14	9	34	Trawl
Bluenose	13	30	54	33	Dropline, trawl
Spiny dogfish	29	44	13	29	Setnet, trawl
Flatfish	17	20	38	25	Trawl, setnet
Blue warehou	16	18	31	22	Trawl, setnet
Gemfish	9	16	38	21	Trawl
Elephantfish	10	18	6	11	Trawl, setnet
Others[3]	28	13	34	26	(Various)
Null[4]	60	45	170	92	(Various)
Total	1 959	2 464	3 344	2 589	

Notes:

1. Other species, in order of frequency, include: squid, scampi, blue moki, silver warehou (though SWA is often an error for SNA), kingfish, ghost sharks, blue cod, John dory, northern spiny dogfish, porae, alfonsino, trumpeter, rubyfish, butterfish, kahawai, sea perch, red moki, skate, tunas (mainly albacore), and red snapper.
2. Null. This category represents estimated catches where no target species was given, or where the target species code was erroneous in most if not all cases (e.g., rock lobsters).

The largest bycatch of school shark was taken with rig listed as a target species. Rig is itself a trawl bycatch, but here the data are largely, if not entirely, derived from rig targeted with setnets. Some setnet fishers target both rig and school shark in the same operation, or at least on the same day, but can only list one target species. There can be some differences in targeting these two species (locality, depth, mesh size, and the way the nets are set), but there is considerable overlap in catches.

Although groper is mostly targeted with droplines near rough ground, and school shark are more likely to be caught on bottom longlines on open ground, there is an overlap of bycatch in these two target fisheries.

Ling are targeted with bottom longlines over a depth range where school shark occur, and this fishery takes a moderate school shark bycatch.

The school shark bycatches with hoki and barracouta are taken in the large trawl fisheries for these species. The bycatch with snapper is taken in the trawl, line, and setnet fisheries around northern New Zealand where school shark are sometimes locally common in relatively shallow water. The bycatch

with tarakihi is mainly taken in the trawl fishery operating close to the shelf edge (150–200 m), with some taken in localised setnet fisheries.

There are considerable regional differences in the presence of school shark in target fisheries for other species, generally simply related to the occurrence and relative importance of these fisheries in different areas. Details of this are given in each regional account, below.

4.6.2 Fishing patterns of the minor fleet

School shark catches by the minor fleet are taken with a large number of nominated target species (Table 18).

Table 18: Estimated catch (t) by target species of school shark by the minor fleet, the vessels landing less than 1 t in a fishing year (1990 is fishing year 1989–90).

Target	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
School shark	11	9	8	11	10	31	23	2	3	10
Snapper	15	13	12	12	10	9	8	8	8	6
Groper	7	7	7	12	11	10	7	9	4	8
Flatfish	9	7	7	7	6	6	6	7	7	10
Rig	6	7	9	9	7	9	5	6	5	8
Other[1]	32	33	26	27	27	24	32	21	18	30
Other[2]	< 1	< 1	< 1	2	< 1	< 1	< 1	< 1	< 1	< 1
Total	82	79	73	81	76	91	86	56	48	73

Notes:

1. Other finfish target species, in order of frequency, include: tarakihi, hoki, bluenose, gurnard, ling, trevally, stargazer, squid, blue cod, warehou, red cod, spiny dogfish, scampi, barracouta, blue moki, elephantfish, gemfish, jack mackerels, butterfish, John dory, kingfish, grey mullet, kahawai, ghost shark, tunas (mainly albacore), silver warehou (SWA, at least partly in error for SNA), trumpeter, "sharks and dogfish" (probably including school shark), sea perch, rubyfish, alfonsino, orange roughy, porae, leatherjacket, cardinalfish, red moki, skates, parore, wrasses, blue mackerel, ribaldo, and red snapper.
2. Other species listed as a target include rock lobster, oyster, paddle crab, sea urchin, scallop and queen scallop. These are errors, resulting from one catch effort form being used for two fishing operations on the same day, and from coding errors such as SCA (scallop) for SCH.

5. REGIONAL FISHERIES

Fisheries for school shark differ considerably by region, although the increase in catches about 1950 is common to most (Figure 11). The following regional accounts follow a standard sequence: definition of region (QMAs, statistical areas), catch history, catch by statistical area, catch by method, catch by target species, and catch by season. They refer only to catches by the main fleet (see Sections 3.1.1 and 3.2.2.2.)

The minor fleet is important only in that it exerts a nominally large amount of fishing effort which results in little catch. There are many vessels which fish in such a way that they occasionally catch (i.e., report) one or more school sharks. This study used a threshold value of 1 t landing in a year to define (and remove) these minor vessels, though future studies may find other values more useful. The nature of this fleet varied by region, generally comprising the main fishing activity (by method, season, and target species) in each.

5.1 Northeastern North Island (QMA 1)

The northeastern North Island region represents the eastern half of SCH 1, and the standard QMA 1. Reported annual catches (see Figure 11) were 50–200 t until 1975, although actual catches in the 1940s at least would have been considerably higher when the fishery for livers only operated. They rose to exceed 800 t in 1984, then following the introduction of the QMS were reduced significantly and have fluctuated between 150 t and 250 t in the 1990s. The catch by statistical area is listed in Table 19. The main areas have generally been 2 and 3, off the east Northland coast, and in some years area 4, outside Great Barrier Island. Area 8 has had lower but consistent catches. In other areas catches were variable.

Table 19: Catch of school shark by statistical area off the northeastern North Island (QMA 1). Values are estimated catches, by all methods, pro-rated up to the full recorded landing from the region, based on the relationship between estimated and landed catches in the three fishing years 1989–90, 1994–95, and 1998–99.

	Fishing year									
Area	89–90	90–91	91–92	92–93	93–94	94–95	95–96	96–97	97–98	98–99
1	10	39	25	12	10	7	46	9	15	21
2	74	65	86	140	80	72	78	114	44	52
3	33	6	18	9	16	83	33	22	32	41
4	25	86	69	91	2	4	35	24	4	3
5	17	4	4	2	2	13	4	13	6	1
6	1	4	2	1	3	4	1	1	1	1
7	3	0	2	10	4	2	1	43	54	11
8	10	13	18	16	14	22	32	23	23	14
9	6	6	1	2	2	5	6	7	5	5
10	4	10	5	13	14	13	8	10	14	21

Note: The offshore areas (105, 106, 107) in this region have zero catches or catches less than 1 t.

Setnetting and longlining were initially about equally important, but by 1998–99 longlining had become dominant, the trawl bycatch had increased, and setnetting was relatively unimportant (Table 20).

Table 20: Calculated landings (t) of school shark from northeastern North Island by method, for three fishing years in the decade 1989–90 to 1998–99, recorded by the main fleet (vessels landing 1 t or more). Sources: catch effort database and landings database.

Method	1989–90	1994–95	1998–99
Setnet	54	73	16
Longline	46	66	82
Dropline	22	25	35
Trawl	19	37	56
Null	0	0	1
Total	141	201	190

Catches by target species are shown in Table 21.

Table 21: Calculated landings (t) of school shark from northeastern North Island by target species, for three fishing years in the decade 1989–90 to 1998–99, recorded by the main fleet (vessels landing 1 t or more). Sources: catch effort database and landings database.

Target species	1989–90		1994–95		1998–99	
	t	%	t	%	t	%
School shark	47	33	45	22	26	14
Groper	21		48		63	
Snapper	41		13		16	
Tarakihi	6		27		25	
Trevally	6		24		14	
Rig	4		25		0	
Bluenose	8		9		8	
Other	8		10		38	
Total	141		201		190	

Estimated catch values, by target species, can be given for each year of the decade (Table 22).

Table 22: Estimated catches of school shark from northeastern North Island by the main target species, for the decade 1989–90 to 1998–99, recorded by the main fleet (vessels landing 1 t or more). Incomplete and biased towards line and setnet catches. Sources: catch effort database (1990 is fishing year 1989–90).

Target	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
School shark	51	79	78	89	30	38	78	39	43	19
Groper	14	29	21	36	27	32	31	48	31	40
Snapper	17	12	22	14	7	9	6	10	7	5
Tarakihi	5	10	8	13	12	14	10	11	13	9
Trevally	3	8	7	19	4	19	8	20	7	4
Rig	8	0	3	7	7	17	2	10	1	0
Bluenose	6	5	1	1	1	5	3	3	3	5

In changing proportions over the years, school shark was taken by setnet and then by longline. Its targeted catch dropped from 33% to 14% of the region's school shark landings. It was taken as bycatch in the longline and dropline fisheries for groper, in the setnet fishery for rig and trevally, the longline fishery for snapper, and the trawl fishery for snapper, trevally, and tarakihi.

The monthly total and targeted catches of school shark are shown in Table 23.

Table 23: Calculated landings (t) of school shark from northeastern North Island by month, for the three fishing years 1989–90, 1994–95, and 1998–99, recorded by the main fleet (vessels landing 1 t or more). Sources: catch effort database and landings database.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Total												
1989–90	6	12	12	21	18	9	5	11	9	24	8	7
1994–95	28	35	10	4	15	5	9	5	6	9	13	60
1998–99	15	19	11	11	10	11	14	19	15	14	15	38
Targeted												
1989–90	1	2	6	16	10	2	1	3	1	2	3	1
1994–95	4	2	0	0	1	0	0	1	1	3	3	22
1998–99	0	0	0	1	0	1	6	5	5	0	0	8

There are insufficient data from which to infer any clear trends. In the total catch data there is a slight tendency for catches to be higher from September to November. In the target fisheries there is a small peak in January and February, with a September peak in one year.

5.2 Eastern North Island (QMA 2)

The eastern North Island region represents SCH 2, and the standard QMA 2, less eastern Cook Strait (Statistical Areas 15, 16). Reported annual catches (see Figure 11) rose slowly to 60 t in 1971, and then after a decline rose rapidly to peak at 200 t in 1984. They dropped to less than 50 t when the QMS was introduced in 1986, but have since returned in the mid and late 1990s to fluctuate between 100 t and 170 t. The catch by statistical area is listed in Table 24. The main areas have generally been 12, 13, and 14, from East Cape to Castlepoint, with lower catches in area 11 north of East Cape.

Table 24: Catch of school shark by statistical area off the eastern North Island coast (most of QMA 2). Values are estimated catches, by all methods, pro-rated up to total the full recorded landing from the region, based on the relationship between estimated and landed catches in the three fishing years 1989–90, 1994–95, and 1998–99.

	Fishing year									
Area	89–90	90–91	91–92	92–93	93–94	94–95	95–96	96–97	97–98	98–99
11	7	4	4	11	36	19	16	16	11	12
12	6	18	8	19	15	20	69	31	21	18
13	35	19	42	63	45	26	33	37	35	36
14	27	32	43	45	38	29	49	65	44	66

Note: Catches less than 1 t were only occasionally reported in the offshore areas (201, 204) of this region.

Setnetting and longlining reversed in importance in the second half of the decade, and by 1998–99 the trawl bycatch had become dominant (Table 25). There was little droplining.

Table 25: Calculated landings (t) of school shark from northeastern North Island by method, for three fishing years in the decade 1989–90 to 1998–99, recorded by the main fleet (vessels landing 1 t or more). Sources: catch effort database and landings database.

Method	1989–90	1994–95	1998–99
Setnet	25	11	17
Longline	12	31	29
Dropline	2	0	2
Trawl	30	39	84
Total	69	81	132

Catches by target species are shown in Table 26.

Table 26: Calculated landings (t) of school shark from the eastern North Island by target species, for three fishing years in the decade 1989–90 to 1998–99, recorded by the main fleet (vessels landing 1 t or more). Sources: catch effort database and landings database.

Target species	1989–90		1994–95		1998–99	
	t	%	t	%	t	%
School shark	16	23	13	17	8	6
Tarakihi	22		23		40	
Gemfish	3		10		18	
Ling	8		11		11	
Groper	3		5		7	
Warehou	1		2		16	
Bluenose	2		4		4	
Barracouta	0		0		5	
Other	14		10		21	
Total	69		78		130	

Estimated catch values, by target species, can be given for each year of the decade (Table 27).

Table 27: Estimated catches of school shark from the eastern North Island by the main target species, for the decade 1989–90 to 1998–99, recorded by the main fleet (vessels landing 1 t or more). Incomplete and biased towards line and setnet catches. Sources: catch effort database (1990 is fishing year 1989–90).

Target	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
School shark	11	8	11	19	23	14	11	6	4	5
Tarakihi	9	6	7	13	9	7	10	16	9	15
Gemfish		2	4	8	8	5	15	11	9	11
Ling	6	4	3	5	4	10	14	11	4	5
Groper	2	4	7	6	6	4	14	5	5	5
Warehou	1	1	3	3	4	2	12	13	8	14
Bluenose	1	7	9	10	10	4	2	4	5	4
Barracouta				1			1	1		1

In changing proportions over the decade, school shark was taken by both setnet and longline, but the bycatch by trawl was larger, particularly in 1998–99. Its targeted catch dropped from 23% to 6% of the region's school shark landings. It was taken as bycatch in the longline fishery for ling, in the setnet fishery for blue warehou, and the trawl fishery for tarakihi and gemfish.

The monthly total and targeted catches of school shark are shown in Table 28.

Table 28: Calculated landings (t) of school shark from the eastern North Island by month, for the three fishing years 1989–90, 1994–95, and 1998–99, recorded by the main fleet (vessels landing 1 t or more). Sources: catch effort database and landings database.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Total												
1989–90	2	6	5	7	7	9	7	9	5	6	1	6
1994–95	5	7	6	7	3	5	5	6	6	4	5	21
1998–99	7	10	8	8	10	15	14	15	11	8	10	16
Targeted												
1989–90	0	0	1	3	0	6	1	5	0	1	0	0
1994–95	4	2	0	0	1	0	0	1	1	1	1	6
1998–99	0	1	0	1	1	0	0	0	0	0	4	0

In the total catch data there is a slight tendency for catches to be higher from March to May, with another peak in September. There are insufficient data In the target fisheries to show any trends.

5.3 Cook Strait (part QMAs 2,7, and 8)

The Cook Strait region represents the southernmost portions of SCH 2 (Statistical Areas 15, 16), and SCH 8 (Statistical Areas 37, 39), plus the northernmost portions of SCH 3 (Statistical Areas 18, 19) and SCH 7 (Statistical Areas 17, 37, 38). Reported annual catches (see Figure 11) were low (less than 100 t) until 1970, although actual catches in the 1940s at least would have been considerably higher, Cook Strait being one of the main centres for the liver oil fishery. There was a slow rise to over 400 t in 1977, a drop to a tenth of that in 1978 when concern over mercury levels discouraged landings, and then a rapid rise to peak at almost 1500 t in 1984. Landings were reduced suddenly when the QMS was introduced in 1986, and from the late 1980s through the 1990s have fluctuated between 400 t and 800 t. The catch by statistical area is listed in Table 29. The main areas have generally been 17 and 39 (western Cook Strait and the Horowhenua coast), with areas 16 (the eastern strait), 18 (Kaikoura), and 38 (Tasman Bay) being variable between years. Anecdotal information from fishers supports this, with one recognised fishing ground comprising the central and southern parts of areas 16 and 17 plus the northern part of area 18, and another ground comprising much of area 39 plus the eastern part of area 37. The standard QMA and Fishstock boundaries pass through the centres of these grounds. Fishers working "Cook Strait" for school shark, or taking school shark as bycatch, must hold quota for up to

four Fishstocks. It was considered probable (and information supplied confidentially supported this) that catches from this region by small vessels using CELR forms are reported against the Fishstock a fisher still holds quota for, regardless of the actual capture locality (statistical area). While this must introduce anomalies in the QMS data, it does not affect this present analysis.

Table 29: Catch of school shark by statistical area in the Cook Strait region (components of QMAs 2, 3, 7, 8). Values are estimated catches, by all methods, pro-rated up to total the full recorded landing from the region, based on the relationship between estimated and landed catches in the three fishing years 1989–90, 1994–95, and 1998–99.

	Fishing year									
Area	89–90	90–91	91–92	92–93	93–94	94–95	95–96	96–97	97–98	98–99
15	3	8	4	13	9	9	12	7	7	6
16	31	35	43	60	18	30	57	59	69	100
17	13	181	119	131	199	148	193	193	170	172
18	31	56	30	51	95	50	98	78	77	123
19	1	10	0	0	9	29	21	11	3	1
37	64	47	20	55	94	70	104	73	84	80
38	45	61	41	63	65	52	96	31	39	33
39	234	230	120	131	135	167	147	132	116	190

Setnetting and longlining were initially about equally important, but by 1998–99 longlining had become dominant and the trawl bycatch had increased (Table 30). Droplining was relatively unimportant.

Table 30: Calculated landings (t) of school shark from Cook Strait by method, for three fishing years in the decade 1989–90 to 1998–99, recorded by the main fleet (vessels landing 1 t or more). Sources: catch effort database and landings database.

Method	1989–90	1994–95	1998–99
Setnet	170	181	204
Longline	192	213	316
Dropline	21	7	27
Trawl	76	91	182
Total	459	492	729

Catches by target species are shown in Table 31.

Table 31: Calculated landings (t) of school shark from Cook Strait by target species, for three fishing years in the decade 1989–90 to 1998–99, recorded by the main fleet (vessels landing 1 t or more). Sources: catch effort database and landings database.

Target species	1989–90		1994–95		1998–99	
	t	%	t	%	t	%
School shark	319	69	240	49	338	46
Rig	10		94		99	
Hoki	7		35		91	
Groper	20		25		50	
Ling	9		9		33	
Tarakihi	12		11		24	
Barracouta	12		28		24	
Bluenose	1		2		18	
Jack mackerels	23		4		7	
Other	46		44		45	
Total	459		492		729	

Estimated catch values, by target species, can be given for each year of the decade (Table 32).

Table 32: Estimated catches of school shark from Cook Strait by the main target species, for the decade 1989–90 to 1998–99, recorded by the main fleet (vessels landing 1 t or more). Incomplete and biased towards line and setnet catches. Sources: catch effort database (1990 is fishing year 1989–90).

Target species	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
School shark	275	315	175	164	260	224	304	215	199	241
Rig	7	25	38	77	71	71	38	35	50	60
Hoki	2	2	1	1	4	14	44	46	53	54
Groper	14	17	10	29	15	14	22	28	15	33
Ling	9	4	2	13	2	6	4	8	5	22
Tarakihi	7	12	4	5	5	4	7	8	7	9
Barracouta	5	11	5	8	3	7	8	7	2	11
Bluenose		1	1		1	1	7	7	3	6
Jack mackerels	21	9	5	1	7	1	18	12	4	6

In changing proportions over the decade, school shark was targeted by both longline and setnet, the latter to a lesser degree in 1998–99. Its targeted catch dropped from 69% to 46% of the region's school shark landings, but this remains a high regional rate. It is taken as bycatch in the longline and dropline fisheries for groper, in the setnet fishery for rig and (sometimes) spiny dogfish, and the trawl fishery for hoki, barracouta, tarakihi, and sometimes jack mackerels.

The monthly total and targeted catches of school shark are shown in Table 33.

Table 33: Calculated landings (t) of school shark from Cook Strait by month, for the three fishing years 1989–90, 1994–95, and 1998–99, recorded by the main fleet (vessels landing 1 t or more). Sources: catch effort database and landings database.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Total												
1989–90	18	38	36	63	76	46	73	34	33	9	1	32
1994–95	57	46	57	58	80	40	45	35	26	9	28	12
1998–99	20	81	65	86	132	79	73	67	60	20	18	29
Targeted												
1989–90	14	28	22	43	54	32	51	17	22	6	0	26
1994–95	46	33	34	26	40	11	8	8	12	2	15	4
1998–99	4	53	39	40	83	40	37	25	5	5	3	5

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Targ BLL[1]	10	37	29	28	43	17	19	11	6	3	5	6
Targ SN[1]	11	1	2	9	14	10	13	5	7	2	1	5

Note: [1] = Mean of the three years.

The target fishery takes 50–70% of the total school shark catch in this region, so the seasonal trends in the total and targeted catch are essentially the same. Catches rise from a minimum in July–August to their highest level between November and April, with the main peak in February and lesser peaks in November and April. There is a difference between the two main target fisheries; the longline fishery peaks between November and February, while the setnet fishery has a minor peak in October and a larger peak from February to April.

5.4 Eastern South Island (QMA 3)

The eastern South Island region represents SCH 3, and the standard QMA 3, less southern Cook Strait and Kaikoura (Statistical Areas 17–19). Reported annual catches (see Figure 11) were low (less than 100 t) until the late 1970s, then rose rapidly to peak at about 500 t in 1984. There was an equally rapid fall following the introduction of the QMS in 1986, then a quick recovery to a level of 200 t to 250 t through the 1990s. The catch by statistical area is listed in Table 34. The main areas have generally

been 22 and 14, the South Canterbury Bight, with lower catches in area 20 north of Banks Peninsula until a slight increase in 1997–98.

Table 34: Catch of school shark by statistical area off the eastern South Island coast (most of QMA 3). Values are estimated catches, by all methods, pro-rated up to total the full recorded landing from the region, based on the relationship between estimated and landed catches in the three fishing years 1989–90, 1994–95, and 1998–99.

	Fishing year									
Area	89–90	90–91	91–92	92–93	93–94	94–95	95–96	96–97	97–98	98–99
20	9	23	20	19	30	30	41	28	50	47
21	0	4	5	24	1	33	15	24	6	11
22	105	47	127	95	54	100	86	52	62	69
24	57	117	84	47	63	75	70	82	75	108
26	19	16	13	6	4	6	10	1	11	10

Note: In the offshore area 23 catches were 0–6 t (mean 1.6 t).

Setnetting and trawling were the two main methods during the decade (Table 35).

Table 35: Calculated landings (t) of school shark from the eastern South Island by method, for three fishing years in the decade 1989–90 to 1998–99, recorded by the main fleet (vessels landing 1 t or more). Sources: catch effort database and landings database.

Method	1989–90	1994–95	1998–99
Setnet	100	122	117
Longline	0	20	20
Dropline	2	1	0
Trawl	74	89	85
Total	176	232	222

Catches by target species are shown in Table 36.

Table 36: Calculated landings (t) of school shark from the eastern South Island by target species, for three fishing years in the decade 1989–90 to 1998–99, recorded by the main fleet (vessels landing 1 t or more). Sources: catch effort database and landings database.

Target species	1989–90		1994–95		1998–99	
	t	%	t	%	t	%
School shark	42	24	69	30	60	27
Rig	35		51		31	
Red cod	29		41		24	
Flatfish	7		6		21	
Ling	5		19		18	
Spiny dogfish	15		10		13	
Barracouta	18		4		10	
Bluenose	1		1		0	
Other	24		31		45	
Total	176		232		222	

Estimated catch values, by target species, can be given for each year of the decade (Table 37).

Table 37: Estimated catches of school shark from the eastern South Island by the main target species, for the decade 1989–90 to 1998–99, recorded by the main fleet (vessels landing 1 t or more). Sources: catch effort database.

Target species	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
School shark	33	36	65	46	23	45	68	38	34	51
Rig	22	21	30	13	21	41	62	27	37	25
Red cod	12	7	9	12	11	16	27	6	17	10
Flatfish	3	3	5	5	4	2	6	6	13	12
Ling	2	8	1	1	1	9	10	4	3	11
Spiny dogfish	12	14	10	13	15	8	23	8	5	11
Barracouta	6	10	5	6	1	1	3	2	2	5
Bluenose	1	0	0	0	0	1	1	1	0	0

The proportions of school shark taken by different methods remained fairly stable over the decade, with longlining increasing in the latter half. Its targeted catch was 24–30% of the region's school shark landings in the three years determined. It was taken as bycatch in the setnet fishery for rig, spiny dogfish, to a lesser extent elephantfish and (in 1989–90) groper, and in the trawl fishery for red cod, flatfish, and elephantfish. From 1994–95 it was also taken as bycatch in the expanding longline fishery for ling.

The monthly total and targeted catches of school shark are shown in Table 38.

Table 38: Calculated landings (t) of school shark from the eastern South Island by month, for the three fishing years 1989–90, 1994–95, and 1998–99, recorded by the main fleet (vessels landing 1 t or more). Sources: catch effort database and landings database.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Total												
1989–90	5	34	32	34	29	14	12	6	5	1	1	4
1994–95	14	29	75	50	14	13	10	9	8	1	2	7
1998–99	17	26	31	32	24	33	10	15	10	11	8	5
Targeted												
1989–90	0	11	15	6	2	2	0	0	0	0	0	0
1994–95	0	6	19	13	3	5	4	2	0	0	0	0
1998–99	0	5	4	15	13	14	1	0	1	5	0	0

Although the targeted catch is only about one quarter of the total, the seasonal pattern for both is similar. In the total catch there is a rapid rise from October to December, and a steady decline to minimum values in July and August. The target fishery (mostly setnets) extends from November to March, with few catches in other months.

5.5 Chatham Rise (part QMA 4)

Moderate catches from the Chatham Rise must have been made from the 1970s onwards, as bycatch in various trawl fisheries and in the early longline fisheries for ling, but the few records that exist are unreliable. The catches shown in Figure 11 (from Annala et al. 1999) come from the entire Chatham Rise, including the shelf around the Chatham Islands. They start in 1985, are minimal (less than 50 t) until 1995, and then increase sharply to over 200 t in 1996 and over 100 t in the late 1990s. From 1990, catches from the Rise have generally lower than those from the shelf. The catch by statistical area is listed in Table 39. The catches have generally been small and widespread, with the largest (but not large) catches in a few years being in area 401 at the Mernoo Bank, and areas 404 and 410 just west of the Chatham Islands shelf.

Table 39: Catch of school shark by statistical area on the deeper part of the Chatham Rise (most of QMA 4). Values are estimated catches, by all methods, pro-rated up to total the full recorded landing from the region, based on the relationship between estimated and landed catches in the three fishing years 1989–90, 1994–95, and 1998–99.

	Fishing year									
Area	89–90	90–91	91–92	92–93	93–94	94–95	95–96	96–97	97–98	98–99
401	1	2	12	2	6	5	9	23	9	11
402	0	1	2	1	1	1	4	6	3	5
404	0	1	2	1	1	13	21	7	5	23
407	3	0	1	0	0	1	5	1	6	2
408	0	0	1	0	0	0	3	2	9	1
410	0	1	2	2	3	6	11	3	2	10

Note: In areas 205, 206, 403, 406, 409, and 412 there were occasional catches up to 5 t.

Longlining became progressively more important during the decade (Table 40).

Table 40: Calculated landings (t) of school shark from the Chatham Rise by method, for three fishing years in the decade 1989–90 to 1998–99, recorded by the main fleet (vessels landing 1 t or more). Sources: catch effort database and landings database.

Method	1989–90	1994–95	1998–99
Longline	1	28	60
Dropline	2	0	0
Trawl	0	0	1
Total	3	28	61

Catches by target species are shown in Table 41.

Table 41: Calculated landings (t) of school shark from the Chatham Rise by target species, for three fishing years in the decade 1989–90 to 1998–99, recorded by the main fleet (vessels landing 1 t or more). Sources: catch effort database and landings database.

Target species	1989–90		1994–95		1998–99	
	t	%	t	%	t	%
School shark	0	0	5	17	0	0
Ling	0		24		60	
Groper	2		0		0	
Blue cod	1		0		0	
Scampi	0		0		1	
Total	3		29		61	

Estimated catch values, by target species, can be given for each year of the decade (Table 42).

Table 42: Estimated catches of school shark from the Chatham Rise by the main target species, for the decade 1989–90 to 1998–99, recorded by the main fleet (vessels landing 1 t or more). Incomplete and biased towards line and setnet catches. Sources: catch effort database (1990 is fishing year 1989–90).

Target species	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
School shark	0	0	0	0	1	3	1	4	0	0
Ling	0	3	11	5	4	13	27	24	21	38
Groper	2	0	1	0	1	0	5	0	0	0
Blue cod	0	0	0	0	1	0	1	0	0	0
Scampi	0	0	1	0	0	0	0	0	0	1

School shark was only occasionally targeted by longline, in the mid 1990s. It was mainly (though in small quantities) taken as bycatch in the longline fishery for ling, particularly in the late 1990s, less

frequently in the dropline fishery for groper, and occasionally in the line fishery for blue cod and the trawl fishery for scampi.

Catches are too small to show any seasonal pattern.

5.6 Chatham Islands (part QMA 4)

Catches of school shark have almost certainly been made in the Chatham Islands area for many decades, but with no market have gone unreported. The catches shown in Figure 11 (from Annala et al. 1999) come from the entire Chatham Rise, including the shelf around the Chatham Islands. They start in 1985, are minimal (less than 50 t) until 1995, and then increase sharply to over 200 t in 1996 and over 100 t in the late 1990s. From 1990, and particularly in 1995–96 and 1996–97, catches from the shelf around the islands have been equal to or higher than those from the deeper waters of the Rise. The catch by statistical area is listed in Table 43. Catches have generally been higher from the two areas (49, 50) north of the islands.

Table 43: Catch of school shark by statistical area on the Chatham Islands shelf (part of QMA 4). Values are estimated catches, by all methods, pro-rated up to total the full recorded landing from the region, based on the relationship between estimated and landed catches in the three fishing years 1989–90, 1994–95, and 1998–99.

	Fishing year									
Area	89–90	90–91	91–92	92–93	93–94	94–95	95–96	96–97	97–98	98–99
49	4	2	4	2	3	8	65	46	31	12
50	1	2	0	1	5	6	44	35	22	21
51	1	0	0	2	7	2	3	24	30	18
52	0	0	6	3	1	4	29	21	6	15

A small but increasing amount was taken by longlining, and there was a minor trawl bycatch (Table 44).

Table 44: Calculated landings (t) of school shark from around the Chatham Islands by method, for three fishing years in the decade 1989–90 to 1998–99, recorded by the main fleet (vessels landing 1 t or more). Sources: catch effort database and landings database.

Method	1989–90	1994–95	1998–99
Longline	0	5	64
Dropline	0	10	0
Trawl	5	4	8
Null	0	2	0
Total	5	21	72

Catches by target species are shown in Table 45.

Table 45: Calculated landings (t) of school shark from around the Chatham Islands by target species, for three fishing years in the decade 1989–90 to 1998–99, recorded by the main fleet (vessels landing 1 t or more). Sources: catch effort database and landings database.

Target species	1989–90		1994–95		1998–99	
	t	%	t	%	t	%
School shark	0	0	7	33	12	16
Groper	0		7		24	
Ling	0		4		23	
Other	5		3		14	
Total	5		21		73	

Estimated catch values, by target species, can be given for each year of the decade (Table 46).

Table 46: Estimated catches of school shark from around the Chatham Islands by the main target species, for the decade 1989–90 to 1998–99, recorded by the main fleet (vessels landing 1 t or more). Incomplete and biased towards line and setnet catches. Sources: catch effort database (1990 is fishing year 1989–90).

Target species	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
School shark	0	0	0	0	4	4	18	15	10	12
Groper	0	0	0	2	4	4	9	14	16	10
Ling	0	0	4	3	3	3	22	34	27	15
Barracouta	1	1	1	0	0	2	18	9	1	0
Tarakihi	0	0	1	0	0	1	4	2	6	3
Stargazer	0	0	0	0	1	0	10	1	3	1

School shark was targeted by dropline and then by longline in the late 1990s. Its targeted catch increased slightly, but its bycatch in the line fisheries for groper and ling increased more rapidly, and it was irregularly taken as bycatch in the trawl fisheries for barracouta, stargazer, and tarakihi.

Catches are too small to show any seasonal pattern.

5.7 Southland (QMA 5)

The Southland region represents Fishstock SCH 5 and the standard QMA 5. Reported annual catches (see Figure 11) in this region became significant only about 1980, rising rapidly – in parallel with the development of school shark fisheries in other regions – to peak at over 900 t in 1984 and 1985. After introduction of the QMS in 1986 it has fluctuated between 400 t and 700 t. In this region (as Fishstock SCH 5) since the mid 1990s the catches have approximated the TACC. The catch by statistical area is listed in Table 47. Catches have been greatest from the two Southland coastal areas (25, 30), and area 27 south-east of Stewart Island.

Table 47: Catch of school shark by statistical area around the southern South Island (QMA 5). Values are estimated catches, by all methods, pro-rated up to total the full recorded landing from the region, based on the relationship between estimated and landed catches in the three fishing years 1989–90, 1994–95, and 1998–99.

	Fishing year									
Area	89–90	90–91	91–92	92–93	93–94	94–95	95–96	96–97	97–98	98–99
25	66	143	170	270	325	249	118	92	193	105
27	127	148	206	159	156	138	121	223	143	101
28	9	5	13	1	0	0	1	1	1	0
29	47	16	42	23	29	18	29	73	37	42
30	113	243	179	173	85	187	164	95	168	309
31	40	26	40	42	33	17	53	18	17	8
32	97	24	56	6	18	55	24	26	21	42

Note: In the offshore areas of QMA 5 (502, 504) and QMA 6 (602–625) there were occasional catches up to 1 t.

Setnetting has been dominant in the 1990s, with a much smaller catch by trawl and longlining (Table 48).

Table 48: Calculated landings (t) of school shark from Southland by method, for three fishing years in the decade 1989–90 to 1998–99, recorded by the main fleet (vessels landing 1 t or more). Sources: catch effort database and landings database.

Method	1989–90	1994–95	1998–99
Setnet	290	578	496
Longline	16	23	61
Dropline	2	6	1
Trawl	65	28	112
Total	373	635	670

Catches by target species are shown in Table 49.

Table 49: Calculated landings (t) of school shark from Southland by target species, for three fishing years in the decade 1989–90 to 1998–99, recorded by the main fleet (vessels landing 1 t or more). Sources: catch effort database and landings database.

Target species	1989–90		1994–95		1998–99	
	t	%	t	%	t	%
School shark	294	79	570	90	490	73
Stargazer	20		20		105	
Groper	12		21		29	
Ling	2		6		21	
Other	45		18		25	
Total	373		635		670	

Estimated catch values, by target species, can be given for each year of the decade (Table 50).

Table 50: Estimated catches of school shark from Southland by the main target species, for the decade 1989–90 to 1998–99, recorded by the main fleet (vessels landing 1 t or more). Incomplete and biased towards line and setnet catches. Sources: catch effort database.

Target species	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
School shark	318	421	496	469	449	447	321	355	405	390
Stargazer	15	9	7	11	13	13	8	8	9	21
Groper	13	6	8	3	12	17	19	14	1	17
Ling	3	1	4	4	3	4	12	7	5	14

The school shark catch in this region is dominated by the targeted setnet catch. Small amounts are taken as bycatch in the longline and dropline fisheries for groper and ling, and in the trawl fishery for stargazer.

The monthly total and targeted catches of school shark are shown in Table 51.

Table 51: Calculated landings (t) of school shark from Southland by month, for the three fishing years 1989–90, 1994–95, and 1998–99, recorded by the main fleet (vessels landing 1 t or more). Sources: catch effort database and landings database.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Total												
1989–90	2	32	18	13	59	61	28	14	64	36	18	33
1994–95	18	31	77	149	161	67	74	14	3	10	2	27
1998–99	25	41	69	302	129	28	6	17	15	26	7	5
Targeted												
1989–90	0	18	12	3	55	54	20	5	55	33	13	21
1994–95	5	28	70	136	153	66	72	11	0	5	0	25
1998–99	8	16	52	258	99	17	0	14	10	14	0	1

The targeted catch, mostly by setnet, is a high proportion (over 70%) of the total school shark catch for this region, and the seasonal trends are similar for the two. The total catch rises steadily from a minimum between May and October to peak in January, and then declines steadily again. This pattern is accentuated in the targeted catch, which falls to low and erratic levels (or zero) between May and October.

5.8 Western South Island (QMA 7)

The western South Island region represents SCH 7, and the standard QMA 7, less Tasman Bay and south-western Cook Strait (Statistical Areas 38, 17). Reported annual catches (see Figure 11) in this region became significant only about 1980, rising rapidly to about 460 t in the years 1983–85. They declined quickly to less than 100 t when the QMS was introduced in 1986, then recovered but have fluctuated between 100 t and 300 t through the 1990s. The catch by statistical area is listed in Table 52. Apart from a few high and low years in some areas, the geographical distribution of catches has relatively uniform in this region.

Table 52: Catch of school shark by statistical area along the western coast of the South Island (part of QMA 7). Values are estimated catches, by all methods, pro-rated up to total the full recorded landing from the region, based on the relationship between estimated and landed catches in the three fishing years 1989–90, 1994–95, and 1998–99.

	Fishing year									
Area	89–90	90–91	91–92	92–93	93–94	94–95	95–96	96–97	97–98	98–99
33	96	46	39	21	13	12	22	28	6	33
34	138	73	99	81	41	23	69	62	40	106
35	58	27	22	30	28	21	31	20	18	47
36	36	53	131	133	106	53	153	79	117	78

Note: In the offshore areas of QMA 7 (703–706) there were occasional catches up to 1 t.

Setnetting was the main method, followed by trawling. Lining has been relatively unimportant (Table 53).

Table 53: Calculated landings (t) of school shark from the western South Island by method, for three fishing years in the decade 1989–90 to 1998–99, recorded by the main fleet (vessels landing 1 t or more). Sources: catch effort database and landings database.

Method	1989–90	1994–95	1998–99
Setnet	176	57	111
Longline	18	14	29
Dropline	5	0	0
Trawl	67	34	122
Total	266	105	262

Catches by target species are shown in Table 54.

Table 54: Calculated landings (t) of school shark from the western South Island by target species, for three fishing years in the decade 1989–90 to 1998–99, recorded by the main fleet (vessels landing 1 t or more). Sources: catch effort database and landings database.

Target species	1989–90		1994–95		1998–99	
	t	%	t	%	t	%
School shark	133	50	43	41	92	35
Barracouta	15		8		92	
Ling	35		3		20	
Groper	14		4		13	
Rig	13		6		12	
Tarakihi	14		6		8	
Spiny dogfish	0		13		0	
Jack mackerels	17		0		0	
Other	25		35		25	
Total	266		105		262	

Estimated catch values, by target species, can be given for each year of the decade (Table 55).

Table 55: Estimated catches of school shark from the western South Island by the main target species, for the decade 1989–90 to 1998–99, recorded by the main fleet (vessels landing 1 t or more). Incomplete and biased towards line and setnet catches. Sources: catch effort database (1990 is fishing year 1989–90).

Target species	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
School shark	113	82	137	104	69	29	107	60	72	83
Barracouta	9	8	6	9	5	3	18	18	10	31
Ling	23	12	12	9	4	1	8	11	5	11
Groper	15	2	4	11	7	5	7	8	9	13
Rig	9	6	6	4	14	4	5	10	11	6
Tarakihi	11	6	6	2	4	2	6	2	1	3
Spiny dogfish	8	0	0	4	3	16	5	1	0	0
Jack mackerels	9	7	8	7	8	1	10	3	2	0

Setnetting has been the main method, in which much of the school shark was targeted, although during the decade the targeted catch dropped from 50% to 35% of the region's school shark landings. It was taken as bycatch in the setnet fishery for rig and spiny dogfish, and in the trawl fishery for barracouta, flatfish, tarakihi, and hoki.

The monthly total and targeted catches of school shark are shown in Table 56.

Table 56: Calculated landings (t) of school shark from the western South Island by month, for the three fishing years 1989–90, 1994–95, and 1998–99, recorded by the main fleet (vessels landing 1 t or more). Sources: catch effort database and landings database.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Total												
1989–90	4	38	35	29	20	24	16	5	23	13	15	44
1994–95	8	11	21	12	4	1	8	18	12	2	1	8
1998–99	4	36	18	49	26	32	28	19	19	16	5	11
Targeted												
1989–90	0	28	10	15	12	16	6	3	9	0	0	35
1994–95	0	4	13	5	0	0	4	9	2	0	0	1
1998–99	0	12	3	26	5	17	12	10	1	3	0	0

The total catch peaks from November to January, then there is an irregular decline to July and August, followed by a September peak. There is no clear pattern in the target fishery, apart from low catches from June to August.

5.9 Egmont (QMA 8)

The (Cape) Egmont region represents SCH 8, and QMA 8, less northern Cook Strait (part of Statistical Areas 37 and 39). The reported annual catches from "Cape Egmont" shown in Figure 11 are not a good indication of actual catches from these grounds, the values from this region up to 1986 being based only on landings at New Plymouth, whereas catches were also made by vessels working out of ports in the Cook Strait region to the south, and from the port of Manukau to the north (and also working the northwestern coast). Catches between 1975 and 1985 were almost certainly higher than the peak of 240 t in 1981 suggests. The decline following introduction of the QMS in 1986 is probably real, as is the recovery to between 300 t and 400 t in the 1990s. The catch by statistical area is listed in Table 57. Catches were fairly evenly distributed between the two coastal areas 40 and 41, with little catch from the offshore area 801.

Table 57: Catch of school shark by statistical area in the Cape Egmont region (QMA 8). Values are estimated catches, by all methods, pro-rated up to total the full recorded landing from the region, based on the relationship between estimated and landed catches in the three fishing years 1989–90, 1994–95, and 1998–99.

	Fishing year									
Area	89–90	90–91	91–92	92–93	93–94	94–95	95–96	96–97	97–98	98–99
40	128	96	149	186	158	150	233	133	134	195
41	78	70	159	302	233	262	186	209	185	202
801	1	6	8	6	4	1	0	1	0	1

Setnetting has been the main method, longlining sometimes moderately important, plus a trawl bycatch (Table 58).

Table 58: Calculated landings (t) of school shark from the Cape Egmont region by method, for three fishing years in the decade 1989–90 to 1998–99, recorded by the main fleet (vessels landing 1 t or more). Sources: catch effort database and landings database.

Method	1989–90	1994–95	1998–99
Setnet	133	215	261
Longline	15	112	89
Dropline	1	1	0
Trawl	51	17	40
Total	200	345	390

Catches by target species are shown in Table 59.

Table 59: Calculated landings (t) of school shark from the Cape Egmont region by target species, for three fishing years in the decade 1989–90 to 1998–99, recorded by the main fleet (vessels landing 1 t or more). Sources: catch effort database and landings database.

Target species	1989–90		1994–95		1998–99	
	t	%	t	%	t	%
School shark	103	52	206	60	223	57
Rig	31		90		90	
Groper	2		10		16	
Gurnard	2		3		16	
Jack mackerels	34		8		0	
Tarakihi	1		0		12	
Warehou	4		8		3	
Other	23		20		30	
Total	200		345		390	

Estimated catch values, by target species, can be given for each year of the decade (Table 60).

Table 60: Estimated catches of school shark from the Cape Egmont region by the main target species, for the decade 1989–90 to 1998–99, recorded by the main fleet (vessels landing 1 t or more). Incomplete and biased towards line and setnet catches. Sources: catch effort database (1990 is fishing year 1989–90).

Target species	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
School shark	103	76	129	230	188	187	168	161	119	181
Rig	17	8	45	65	58	84	81	62	62	60
Groper	1	0	4	18	3	7	13	8	15	12
Gurnard	2	1	4	1	1	1	0	2	8	9
Jack mackerels	15	23	25	21	10	6	16	4	7	0
Tarakihi	1	0	0	0	2	0	0	1	3	6
Warehou	3	2	6	5	4	5	7	3	5	2

Setnetting for both school shark and rig have taken the greatest quantity of school shark over the decade. Longlining for school shark has been moderately important. The targeted school shark catch by these two methods has been relatively high, 52–60% in the three recorded years. It has been only a modest bycatch in the longline fishery for groper, and – to a minor degree – bluenose. The trawl fisheries for trevally, gurnard, and tarakihi have also taken modest quantities, and that for jack mackerels in the first half of the decade also took school shark.

The monthly total and targeted catches of school shark are shown in Table 61.

Table 61: Calculated landings (t) of school shark from the Cape Egmont region by month, for the three fishing years 1989–90, 1994–95, and 1998–99, recorded by the main fleet (vessels landing 1 t or more). Sources: catch effort database and landings database.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Total												
1989–90	15	30	2	22	9	10	6	4	31	8	9	55
1994–95	49	38	44	45	12	24	42	10	25	2	13	39
1998–99	17	67	24	42	39	81	30	26	22	9	19	15
Targeted												
1989–90	0	6	1	5	5	2	2	2	26	3	3	49
1994–95	31	20	38	22	5	12	37	4	15	1	8	14
1998–99	7	46	8	32	30	60	26	1	5	6	0	3

There is no clear seasonal trend in either the total catches, or the targeted catches (longline and setnet combined, or separately). In general terms the setnet catches are highest between January and April, and peak again in September.

5.10 Northwestern North Island (QMA 9)

The west Auckland/Northland region represents the western half of SCH 1, but the standard QMA 9, less Kaipara Harbour (Statistical Area 44). Reported annual (see Figure 11) in this region were minimal (less than 50 t) until 1980, then rose to between 300 t and 400 t in the 1990s. The peak of 400–500 t in the late 1980s, corresponding to a drop in landings from the Cape Egmont grounds to the south, may just represent a period of unreliable reporting, or may represent a shift in fishing activity. The catch by statistical area is listed in Table 62. The main area has been from Ninety Mile Beach to North Cape (47), followed by the coastal area south of Manukau Harbour (42), and then the coastline with a narrower shelf between these (45, 46).

Table 62: Catch of school shark by statistical area along the northwestern coast of the North Island (QMA 9). Values are estimated catches, by all methods, pro-rated up to total the full recorded landing from the region, based on the relationship between estimated and landed catches in the three fishing years 1989–90, 1994–95, and 1998–99.

	Fishing year									
Area	89–90	90–91	91–92	92–93	93–94	94–95	95–96	96–97	97–98	98–99
42	81	68	119	102	59	36	60	81	122	66
45	15	40	46	54	43	46	35	45	29	54
46	30	12	7	38	112	30	57	54	69	46
47	108	56	95	186	176	188	236	208	244	208

Note: In the offshore area 48 of QMA 9 there were catches of 1–12 t, and areas 101 and 104 there were occasional small catches up to 1 t.

Trawling has been the main method, taking about half the catch as it more than doubled during the decade (Table 63). Setnetting remained moderately important, but was overtaken by longlining in the latter half of the decade.

Table 63: Calculated landings (t) of school shark from the northwestern North Island by method, for three fishing years in the decade 1989–90 to 1998–99, recorded by the main fleet (vessels landing 1 t or more). Sources: catch effort database and landings database.

Method	1989–90	1994–95	1998–99
Setnet	79	40	88
Longline	0	86	141
Dropline	7	8	5
Trawl	92	138	201
Total	178	272	435

Catches by target species are shown in Table 64.

Table 64: Calculated landings (t) of school shark from the northwestern North Island by target species, for three fishing years in the decade 1989–90 to 1998–99, recorded by the main fleet (vessels landing 1 t or more). Sources: catch effort database and landings database.

Target species	1989–90		1994–95		1998–99	
	t	%	t	%	t	%
School shark	66	37	86	32	112	26
Snapper	48		87		57	
Gurnard	5		18		69	
Tarakihi	15		21		77	
Trevally	9		12		47	
Groper	7		21		36	
Rig	11		7		7	
Other	28		27		37	
Total	178		272		435	

Estimated catch values, by target species, can be given for each year of the decade (Table 65).

Table 65: Estimated catches of school shark from the northwestern North Island by the main target species, for the decade 1989–90 to 1998–99, recorded by the main fleet (vessels landing 1 t or more). Incomplete and biased towards line and setnet catches. Sources: catch effort database.

Target species	1989–90	1990–91	1991–92	1992–93	1993–94	1994–95	1995–96	1996–97	1997–98	1998–99
School shark	67	25	63	42	87	59	71	49	62	56
Snapper	20	13	25	48	35	36	39	29	45	21
Gurnard	4	3	7	9	11	14	16	27	24	35
Tarakihi	10	15	11	32	30	13	26	38	27	27
Trevally	6	14	12	28	8	11	8	21	32	23
Groper	5	1	2	15	7	11	20	16	16	15
Rig	7	19	18	18	21	7	17	15	23	6

In 1989–90 school shark were exclusively targeted by setnet, in 1994–95 and 1998–99 mainly by longline. During the decade the targeted catch dropped from 37% to 26% of the region's school shark landings. Considerable quantities were taken as bycatch in the trawl fisheries for snapper, gurnard, trevally, and tarakihi. There was a smaller bycatch in the setnet fisheries for snapper, gurnard, and rig, and in the longline fishery for groper.

The monthly total and targeted catches of school shark are shown in Table 66.

Table 66: Calculated landings (t) of school shark from the northwestern North Island by month, for the three fishing years 1989–90, 1994–95, and 1998–99, recorded by the main fleet (vessels landing 1 t or more). Sources: catch effort database and landings database.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Total												
1989–90	19	11	8	10	18	14	6	13	16	20	16	27
1994–95	17	28	9	21	9	7	22	12	15	21	49	61
1998–99	24	54	24	31	21	35	41	42	21	46	66	34
Targeted												
1989–90	2	1	3	3	8	5	0	4	11	16	5	7
1994–95	0	8	0	5	0	1	6	1	3	12	25	26
1998–99	0	5	4	8	0	12	11	16	0	24	20	11

In the total catches there is a trend for higher catches from July to September, and again in November. This is more clearly shown by the targeted catches, particularly those taken by longline.

5.11 Kaipara Harbour (part QMA 9)

The Kaipara Harbour region comprises Statistical Area 44 in the western half of SCH 1 and QMA 9. Reported annual catches (see Figure 11) from the Kaipara Harbour show a steady rise in landings from 1945 to almost 100 t in 1968. The actual catches in the 1940s would have been higher because of unreported shark taken in the liver oil fishery, but from the 1950s a steady fishery for the fish developed. Catches dropped sharply from 1970 to 1975, and have since fluctuated widely, from almost zero in some years to a high of 180 t in 1984 and 1985, just prior to the QMS introduction. Subsequent catches have fluctuated between 6 t and 60 t.

Almost the whole catch is taken by longlining (Table 67).

Table 67: Calculated landings (t) of school shark from the Kaipara Harbour by method, for three fishing years in the decade 1989–90 to 1998–99, recorded by the main fleet (vessels landing 1 t or more). Sources: catch effort database and landings database.

Method	1989–90	1994–95	1998–99
Setnet	0	5	2
Longline	67	30	36
Total	67	35	38

In the three fishing years examined in detail (1989–90, 1994–95, 1998–99) the entire catch recorded by the main fleet (vessels landing 1 t or more) was targeted.

Estimated catch values, by target species, for each year of the decade show only very small quantities taken as bycatch (Table 68).

Table 68: Estimated catches of school shark from the Kaipara Harbour by the main target species, for the decade 1989–90 to 1998–99, recorded by the main fleet (vessels landing 1 t or more). Incomplete and biased towards line and setnet catches. Sources: catch effort database (1990 is fishing year 1989–90).

Target species	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
School shark	52	6	16	31	24	31	39	50	12	35
Other	<1	<1	<1	2	3	<1	<1	<1	<1	<1

Virtually all the school shark catch in Kaipara Harbour over the decade was targeted by longline. Very small quantities were taken as bycatch in setnet fisheries for rig, snapper, trevally, and flatfish.

The monthly total and targeted catches of school shark are shown in Table 69.

Table 69: Calculated landings (t) of school shark from Kaipara Harbour by month, for the three fishing years 1989–90, 1994–95, and 1998–99, recorded by the main fleet (vessels landing 1 t or more). Sources: catch effort database and landings database.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Total												
1989–90	0	8	13	22	13	2	0	0	0	2	0	7
1994–95	0	0	10	15	10	0	0	0	0	0	0	0
1998–99	0	3	1	12	13	7	2	0	0	0	0	0
Targeted												
1989–90	0	8	13	22	13	2	0	0	0	2	0	7
1994–95	0	0	10	14	10	0	0	0	0	0	0	0
1998–99	0	3	0	12	13	7	2	0	0	0	0	0

The Kaipara fishery, a longline target fishery, is strongly seasonal. It begins in November, and extends to March or April.

6. DISCUSSION

This report's description of regional fisheries must be interpreted cautiously, as some text has had to be based on incomplete catch values. The trends described in these fisheries will be more reliable than the tonnages listed. In northern and southern New Zealand, QMAs (not necessarily Fishstocks), adequately define these regional fisheries, but a Cook Strait region which incorporates part of four QMAs provides a more appropriate definition of the large fishery centred on Cook Strait.

This study examined the available catch and landings data for the New Zealand school shark fishery more closely than has hitherto been possible. It extended the exploratory work of Paul & Sanders (1998), by again using the procedure they described for integrating the incomplete set of "estimated catches" by various parameters (method, region, target species), and the full set of "fish landings", into datasets which allow the latter to be assigned to these parameters. The procedure is time-consuming, as the catch, effort, and landings data are replete with ambiguities and errors which must be individually corrected, where possible, during the process. In the 1998 study, data for only one year (1989–90) were integrated. In this study, data for two more years (1994–95 and 1998–99) were put through the same integration and grooming procedure. These three years mark the beginning, mid-point, and end of the ten years of detailed data currently available from Ministry of Fisheries databases.

Catch, effort, and landings data from the other years of the decade were also used, and have moderate value in describing some of the patterns in the main regional fisheries. They are less suitable for describing the fishery as a whole, the catch and effort values being incomplete when school shark is not regularly among the top five species in a catch.

This study was based on fine-scale catch data. These comprised the daily (estimated) catch of school shark by each vessel, by method and target species, and the monthly landing of each vessel. As a result, a considerable number and variety of errors – most of which would have been concealed in summaries – become immediately obvious. It is highly probable that others exist but could not be detected. It was not possible to fully groom the large datasets used, but some obvious errors were corrected. In particular, high outlier catch and landing values were cross-checked (i.e., catches and landings for the same event compared) and modified. Surplus digits, probably data-entry mistakes, appeared to be the main problem. Incorrect species and method codes were not uncommon. Area codes, which should be statistical areas, were often QMA codes, or Fishstock codes. Where combinations of area, fishing method, and target species formed highly unlikely combinations, these could be identified and (usually) corrected. Others which were unusual but not impossible were retained.

The most unfortunate shortcoming in the estimated catch data is the frequent use of processed weight instead of greenweight. During the data integration procedure which linked catch with landing it became clear that catch values were often approximately half the landed values; this can be explained by the processed (trunked) weight of school shark being about half the total weight. From enquiries made, it appears that fishers are either unaware of the requirement to use greenweight, or they write a marginal note on their CELR form that the values are processed weights (but there is no way to evaluate such comments during data entry). Paul & Sanders (1998) pointed out that an anomalous relationship existed between catch weights, landed weights, fish state (whole or processed) and the conversion factor used, but were unable to resolve the problem, though recommended the issue be investigated. It now seems likely that the incorrect listing of processed weights explains much of this anomaly. The proportion of probable errors was not determined, but could be as high as 50% in some regional fisheries. (It is likely that this problem – processed weight used instead of whole weight – occurs in the catch records of any species that is processed shortly after capture, and before weight values are recorded. Possible examples include rig, spiny dogfish, elephant fish, and groper.)

The use of processed weights adds to the unreliability of estimated catch records, but the latter have been used in this study on the assumption that errors are probably constant from year to year. More emphasis is placed on the converted values for the three years 1989–90, 1994–95, and 1998–99, as these are based on landings, pro-rated by the ratio, rather than the actual value, of estimated catches.

The New Zealand school shark catch is taken by a large number of vessels. At least half the total number of New Zealand's commercial vessels actively fishing, and using fishing methods likely to have caught school shark, did report an estimated catch. A slightly higher number (c. 5% more) reported a landing. These are minimum numbers, but it is difficult to be more precise. There will be some vessels fishing outside the school shark's main habitat (e.g., shallow setters), and there will be some (perhaps the largest trawlers) which omit incidental school shark bycatches from their records. It is possible that two-thirds, perhaps three-quarters, of the vessels likely to encounter school shark do make occasional catches of the species. The most important point, however, is that of the vessels which did report school shark, about half caught less than 1 t in a year, and collectively they took only a few percent of the total tonnage. It was considered appropriate to categorise them as the "minor fleet", and remove them from the main analyses.

In the remaining "main fleet", a high proportion of the school shark catch was taken as bycatch in association with most target species in each region. In the three years for which the school shark catch by target species could be reasonably assessed, about half the catch was targeted. The main targeting methods were bottom longlines, and setnets. This level of targeted catch would seem appropriate for

CPUE analyses, even when subdivided by region, but a number of factors reduce the options. The main ones are these:

- Most of the vessels which target school shark, even the successful ones (in terms of high daily catches) do so for less than 10 days in a year, and a high proportion target-fish less than 5 days.

- In most regions, though not the two largest (Cook Strait and Southland), a peak in landings occurred in September, the final month of the fishing year. This may well represent fishers who hold relatively small quantities of school shark quota to cover bycatch, briefly targeting school shark to catch the remainder of their entitlement.

- Setnet vessels often recorded targeting school shark and rig on adjacent days in a month. Although the school shark catch was usually higher when it was the nominated target species, it was often a substantial bycatch of rig. Anecdotal information from fishers indicates that these two "fisheries" are not separate, and that in some regions both species are targeted together.

The number of longline or setnet fishers who consistently (within a year, and in successive years) target school shark, is small, particularly when subdivided by region, a point previously made by Paul & Sanders (1998). It is not clear from the analyses described in this study whether there are sufficient fishers, taking a sufficiently large catch, sufficiently often, to generate catch and effort data from which reliable CPUE indices can be calculated. But when the unfortunate mixture of greenweight and processed weight values in the estimated catch data is considered, it seems unlikely.

Paul & Sanders (1998) suggested that alternative CPUE indices could be developed for school shark bycatches taken in well defined regional fisheries which targeted one or a standard suite of other species. If the school shark bycatch was large enough, even trawl fisheries should be considered. However, the more detailed analyses of school shark catches now available suggest that this is unlikely to be successful. The bycatch is spread quite sparsely across a wide variety of target species in all regions.

If CPUE indices prove to be impractical for tracking changes in the stock size of New Zealand school shark, an alternative measure of abundance and sustainability should be sought. Monitoring the mean fish size, by region, is one possibility, but is likely to be difficult because of the very diverse and fragmented fishery, the extremely non-random distribution ("schooling") of fish by size and sex, and the consequent ability to target fish for size groups to meet market requirements.

This study demonstrates that the New Zealand school shark fishery has some similarities to the Australian "southern shark" fishery, which takes a mixture of both school shark and gummy shark (a close relative of rig), and is roughly similar in size to that for both species here. However, it differs in two important respects. First, the Australian fishery has been well studied for decades, and the recent catch and effort data are carefully groomed and moderately reliable. Second, the Australian fishery appears to have a higher proportion of targeted catch, and a larger number of fishers who have remained in the fishery for many years, fishing for a moderate number of days in a year, allowing CPUE analyses and the development of stock assessment models (Walker 1999, Punt et al. 2000a, 2000b).

However, the Australian school shark stock eventually became overfished; it supported catches of at least 2000 t from 1950 to 1990, reaching 4000 t in the late 1960s and the mid 1980s (Walker 1999), but by the late 1990s it had been reduced by regulation to about 1100 t, with further reductions recommended (Anon. 2000). (Australian values are usually listed as carcass weights; they are converted here to whole weight by doubling them.) A 40-year period of good catches did not guarantee sustainability. New Zealand has a shorter record of school shark catches at about 3000 t, and sustainability at this level remains unknown.

7. CONCLUSIONS

The data on commercial catches and landings of school shark contain an unacceptably high number and variety of errors. Confusion between total weight (greenweight) and processed weight values, in particular, severely compromises analyses of the estimated catch data. These errors become apparent only when the data are examined in detail. (Such errors may have been present, but not been noticed, in studies of other New Zealand coastal fisheries based on aggregated data.)

About half the commercial vessels in New Zealand which target finfish report school shark landings. Most landings are small, and represent bycatches in a wide variety of fisheries. Although about half the school shark catches are listed as targeted, most of these are also small, and taken during only a few days fishing, often at the end of the fishing year. They are unlikely to be suitable for CPUE analyses.

Within these constraints, the main features are described, and a case is made for establishing a separate Cook Strait region, where a large school shark fishery is centred.

8. ACKNOWLEDGMENTS

We thank Elizabeth Bradford for her cooperation and advice throughout this project, as she worked on the even more difficult task of developing CPUE indices for selected school shark setnet and longline fisheries. We also acknowledge the input of several commercial fishers who completed our questionnaire, and whose comments allowed us to develop a clearer understanding of this fishery. The work was funded by the Ministry of Fisheries project SCH 1999/01.

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Walker, T.I. (1999). *Galeorhinus galeus* fisheries of the world. pp. 728–772, *In* Shotton, R. (ed.), Case studies of the management of elasmobranch fisheries. *FAO Fisheries Technical Paper 378*.

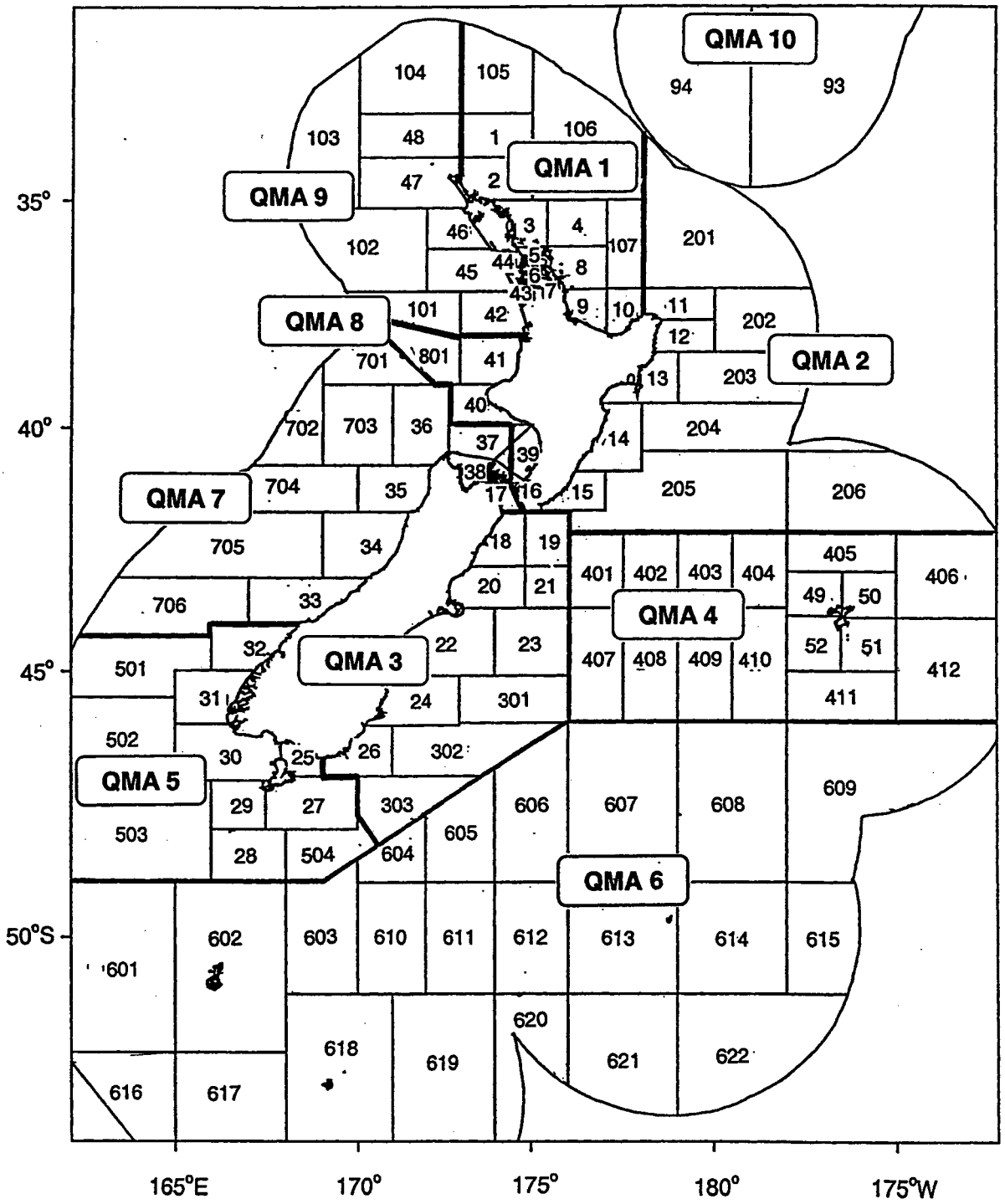

Figure 1: Fishing statistical areas around New Zealand. Areas not clearly shown are 5 (outer Hauraki Gulf), 6 (central Hauraki Gulf), 7 (inner Hauraki Gulf), 16 (eastern Cook Strait), 17 (western Cook Strait), 25 (Foveaux Strait), 43 (Manukau Harbour), 44 (Kaipara Harbour). Also, the standard Quota Management Areas, QMAs 1 to 10.

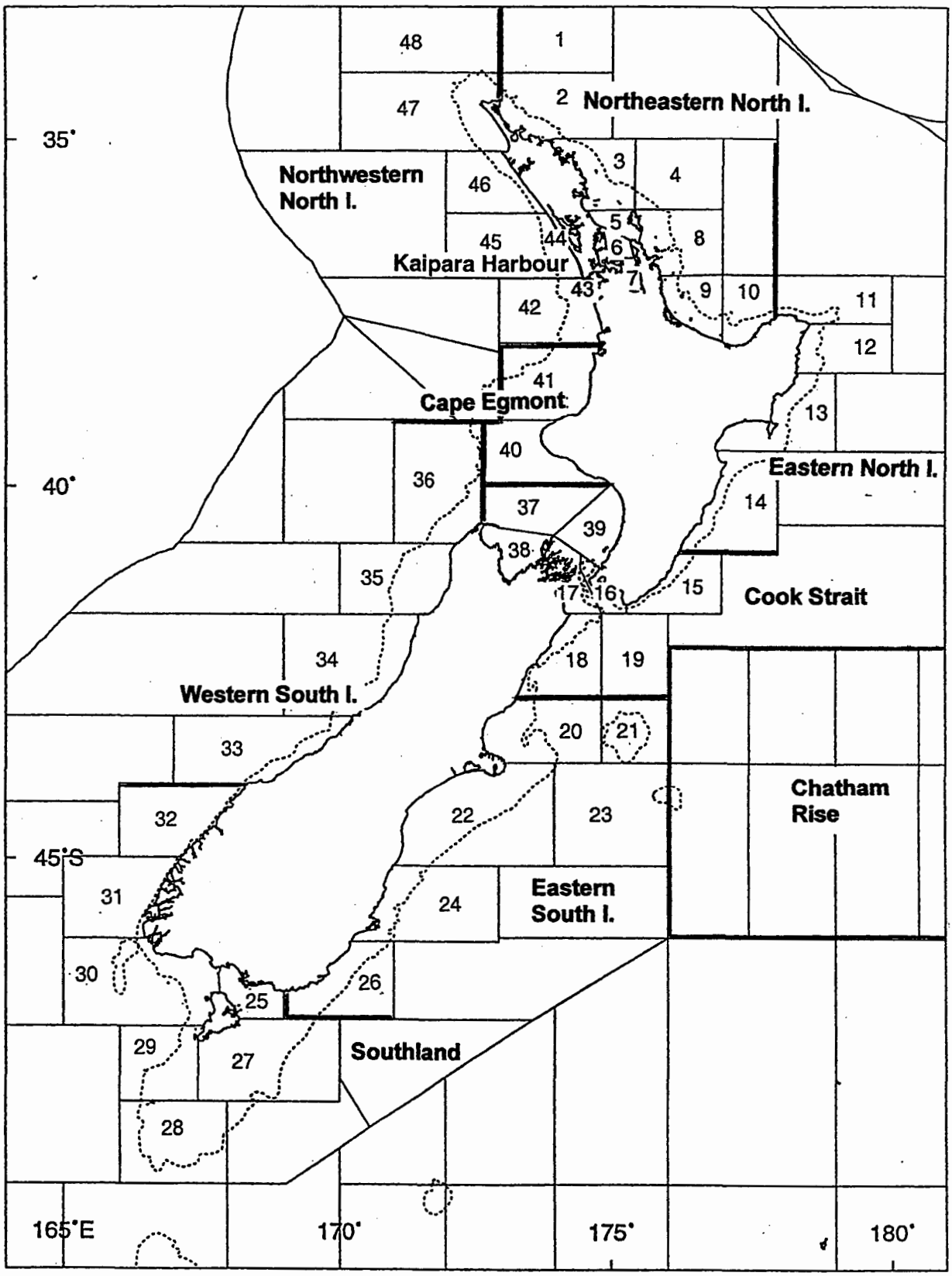

Figure 2: The fishing regions used in this study, defined by combinations of fishing statistical areas. Based on Quota Management Area (QMA) or Fishery Management Area (FMA) boundaries where possible, but a separate Cook Strait region was created in order to describe the large fishery centred there.

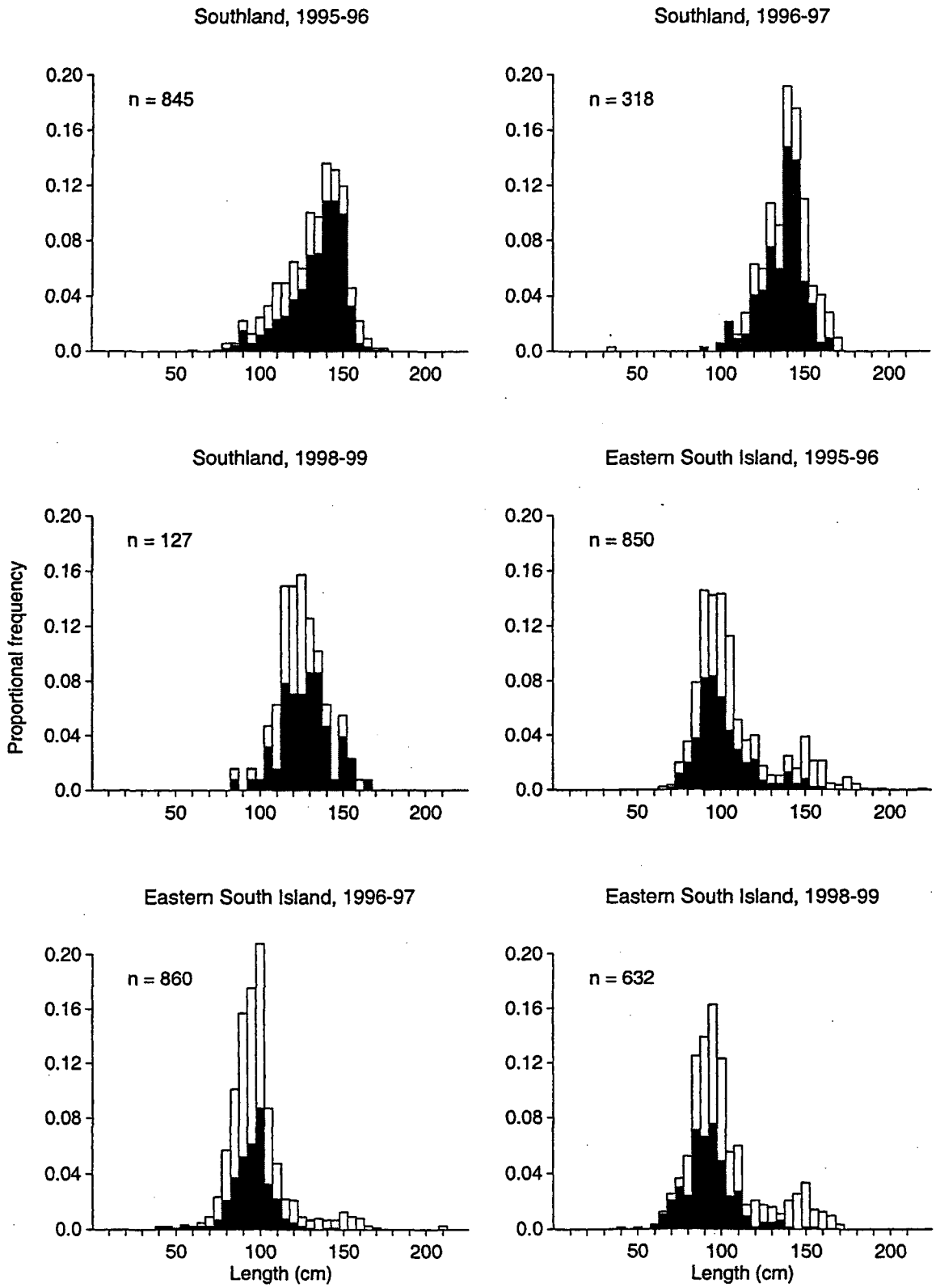

Figure 3: Size frequency of school shark measured in the fishing industry's logbook project, grouped into the fishing regions used in this study. The logbook project was established mainly to monitor an adaptive management programme for setnet-caught rig. The school shark measured were caught by setnet, in association with some of New Zealand's main rig fisheries, and are not necessarily representative of the main school shark catch. Black – males, white – females plotted cumulatively.

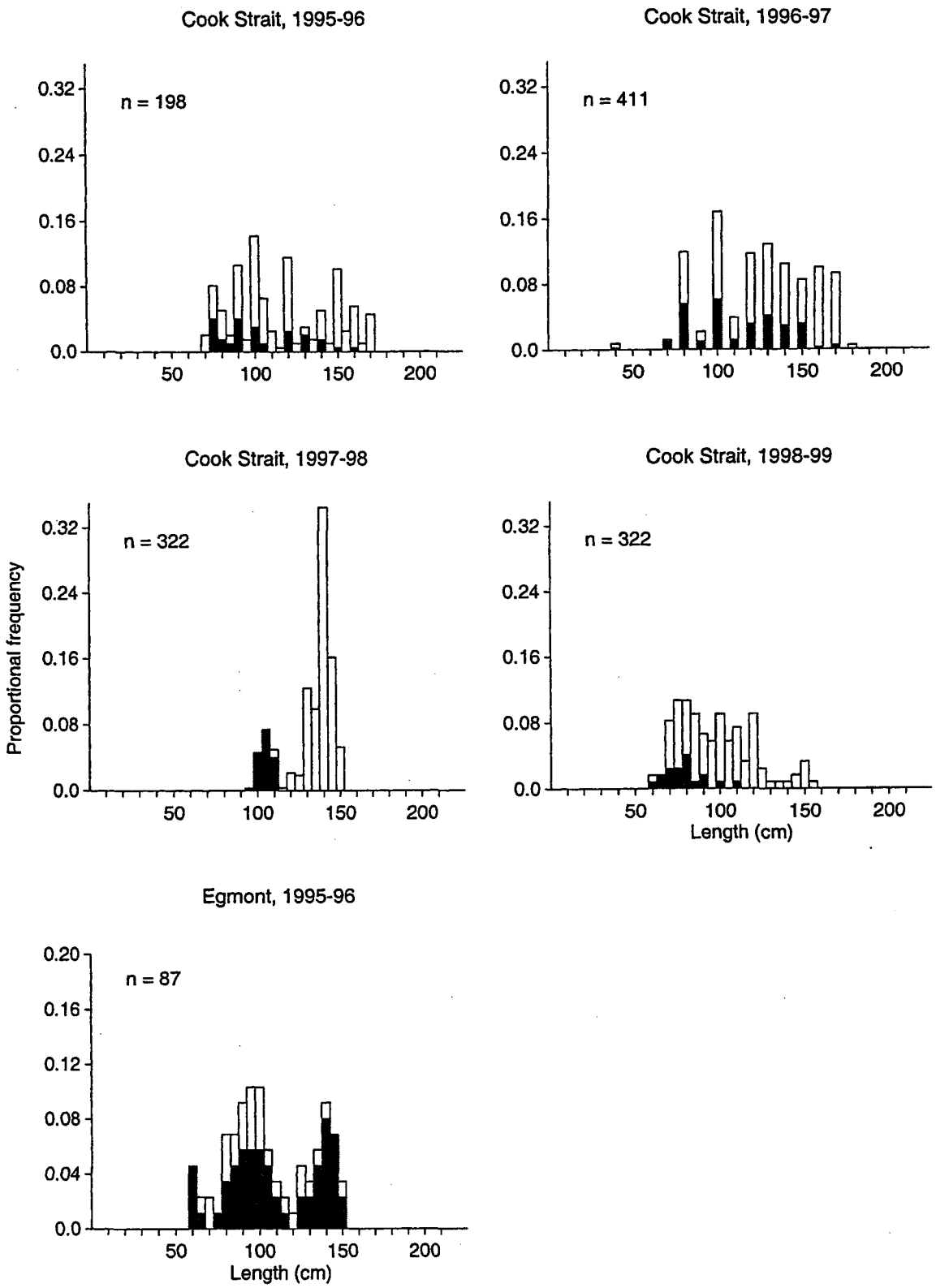

Figure 3: (continued)

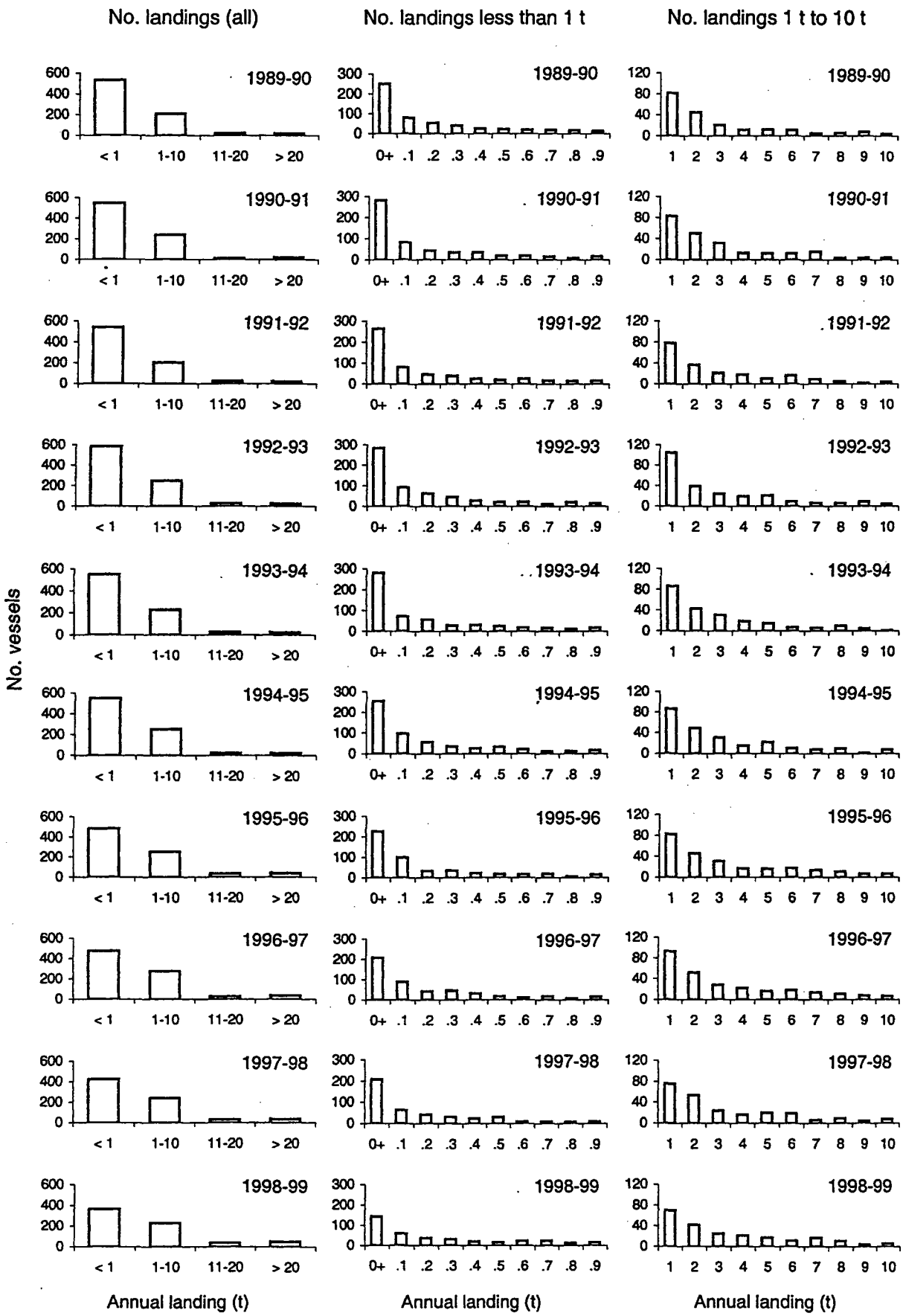

Figure 4: The pattern of school shark landings, shown as the number of vessels recording different levels of landings. First column, all landings, in the categories: less than 1 t, 1–10 t, 11–20 t, and greater than 20 t. Second column, landings less than 1 t, subdivided in 0.1 t units. Third column, landings from 1 t to 10 t, subdivided in 1 t units.

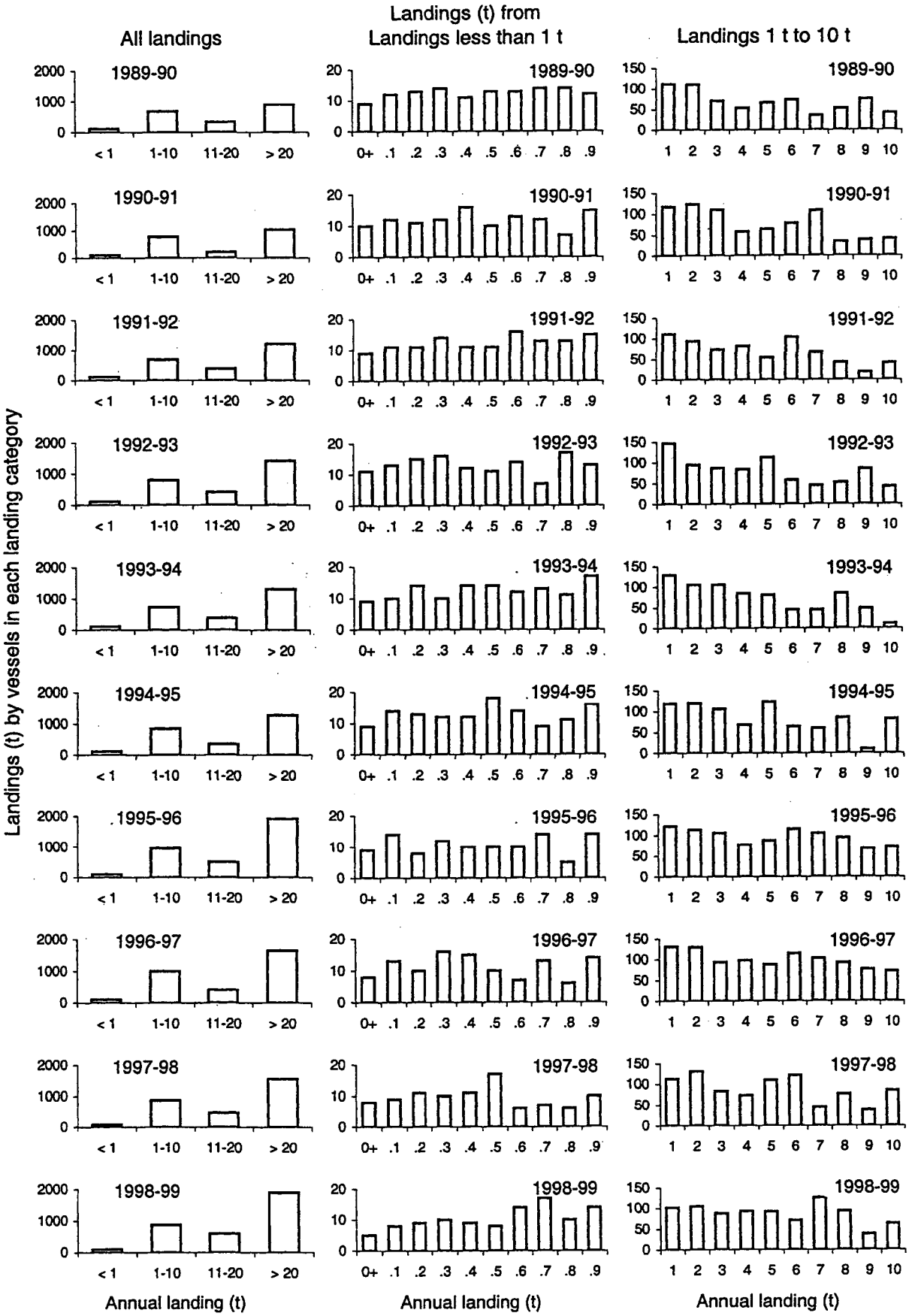

Figure 5: The contribution to school shark landings, in tonnes, from vessels recording different levels of landings. First column, all landings, in the categories: less than 1 t, 1–10 t, 11–20 t, and greater than 20 t. Second column, landings less than 1 t, subdivided in 0.1 t units. Third column, landings from 1 t to 10 t, subdivided in 1 t units.

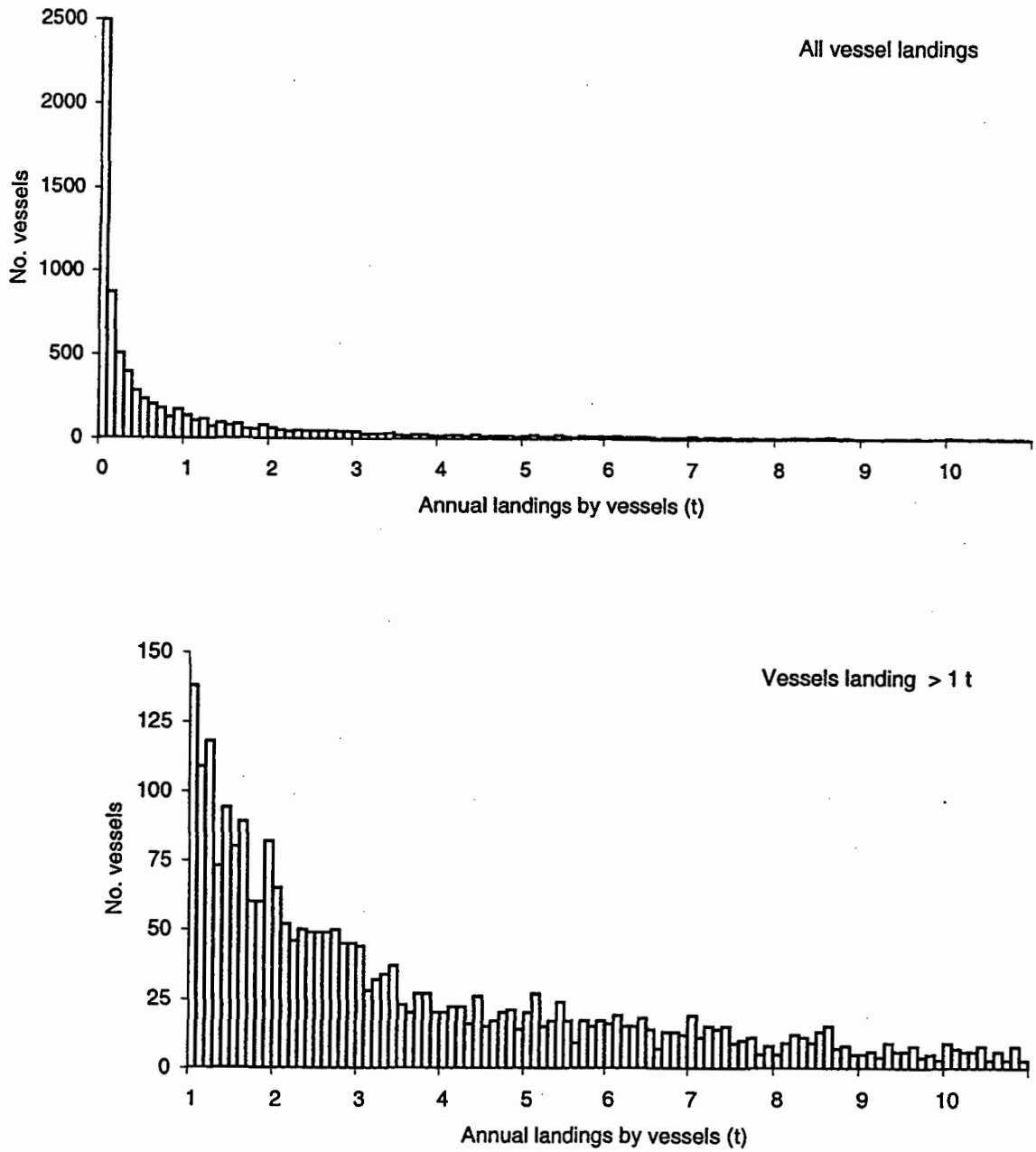

Figure 6: Distribution of the size of annual landings of school shark (t) made by individual vessels. All landings for the decade 1989–90 to 1998–99 combined. Most vessel landings were less than 1 t.

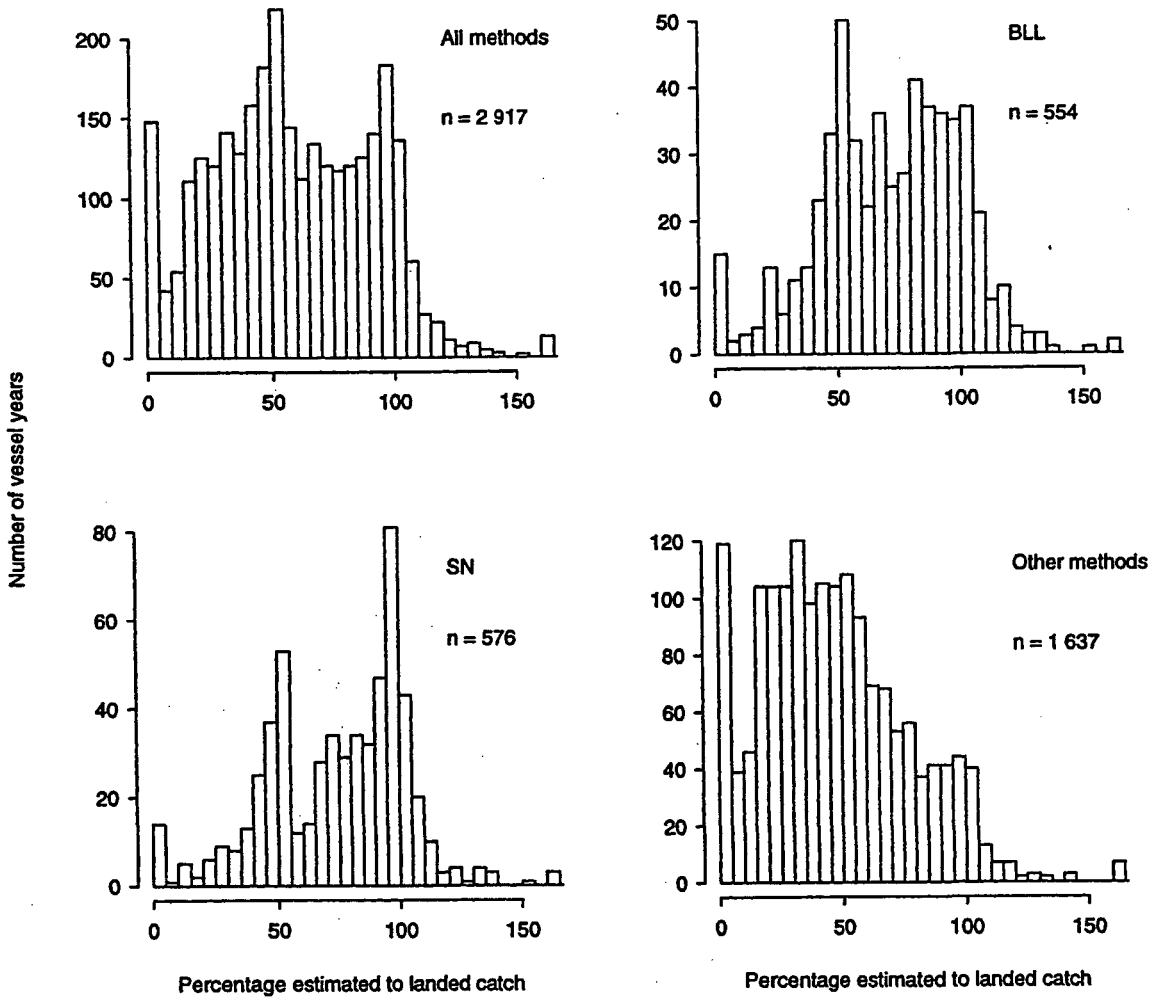

Figure 7: Percentage of estimated to landed catch for a vessel year by method for vessels making landings greater than 1 t in a year. Identified methods are SN (set net); BLL (bottom long line); Other methods (not BLL or SN). Counts greater than 160 are plotted at 160.

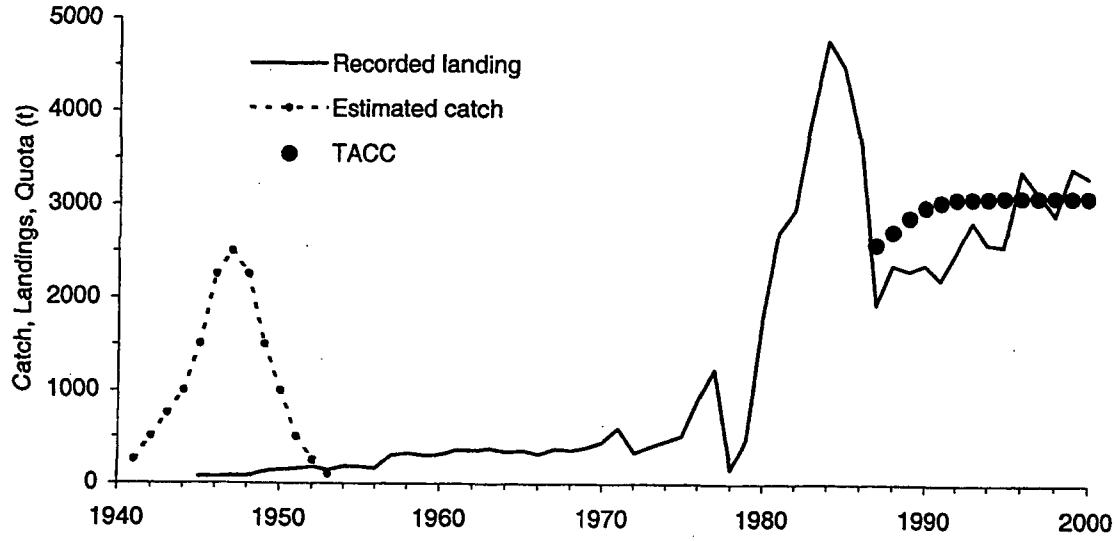

Figure 8: Total recorded landings (t) of school shark in New Zealand, as total weight (greenweight) from 1945 to fishing year 1990–00. Also, estimated catch during the fishery for shark liver oil in the 1940s and early 1950s, and the quotas (TACs, then TACCs) imposed from fishing year 1986–87 onwards. Data sources: landings, *Annual Reports on Fisheries* to 1974, Fisheries Statistics Unit data 1975 to 1985–86; Quota Management System data 1986–87 to 1998–99. Landings data from 1948, and quota values, are tabulated in Annala et al. (2000). Estimated liver oil fishery data, 1941–1953, are approximate only, based on recorded liver-weight landings which (a) are incomplete, and (b) incorporate a small but unknown proportion of livers from other fish species.

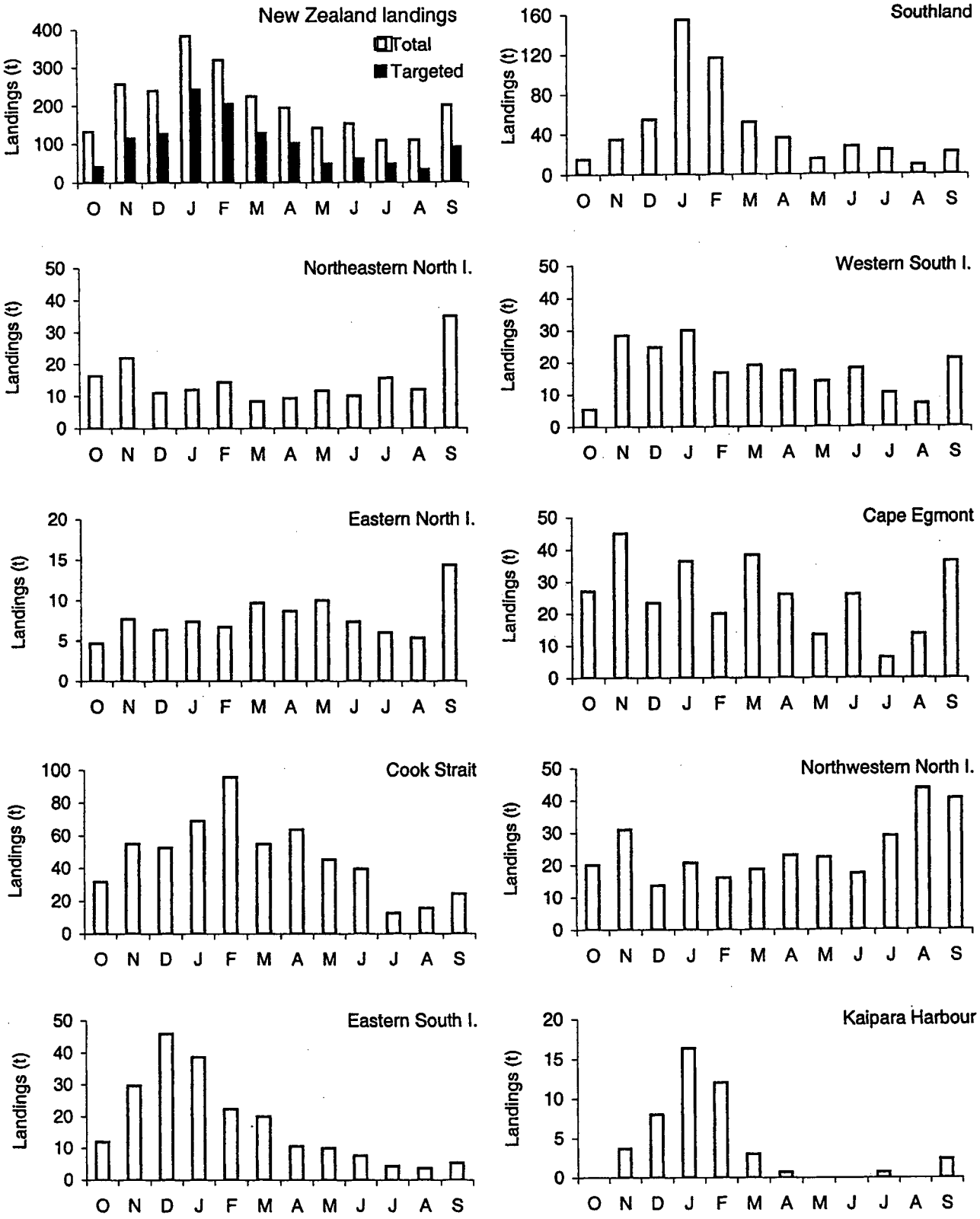

Figure 9: Monthly landings of school shark, New Zealand total and by region. Top left panel, New Zealand total school shark catch, and targeted catch. Other panels, total catch by region. Values (t) are means for the three fishing years 1989–90, 1994–95, and 1998–99, the only years for which complete data are currently available.

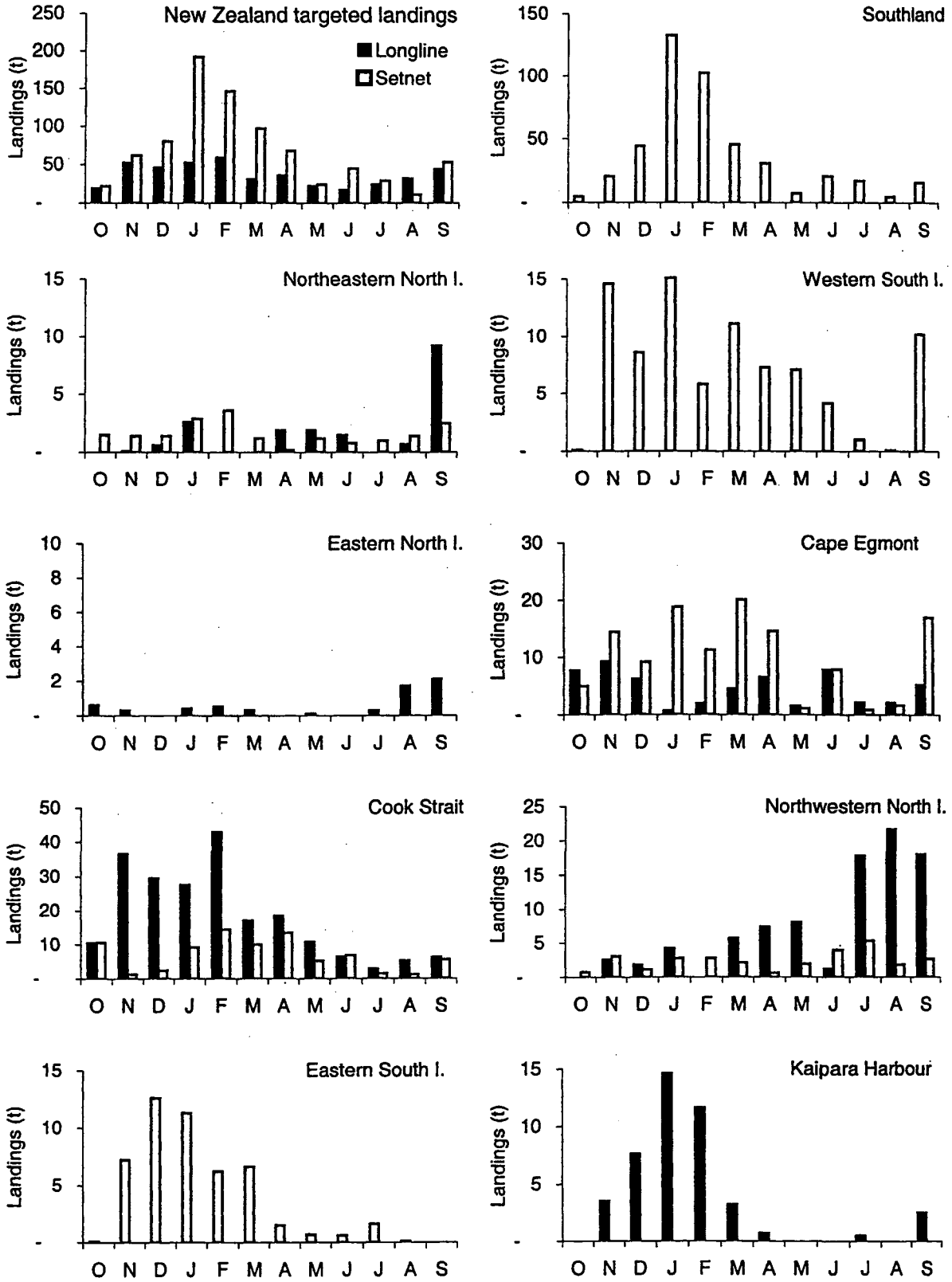

Figure 10: Monthly targeted landings of school shark, by region. Top left panel, New Zealand targeted catch by all methods, and targeted catch by longline and set. Other panels, regional values of targeted by all methods, and by longline and/or setnet. Values (t) are means for the three fishing years 1989–90, 1994–95, and 1998–99, the only years for which complete data are currently available.

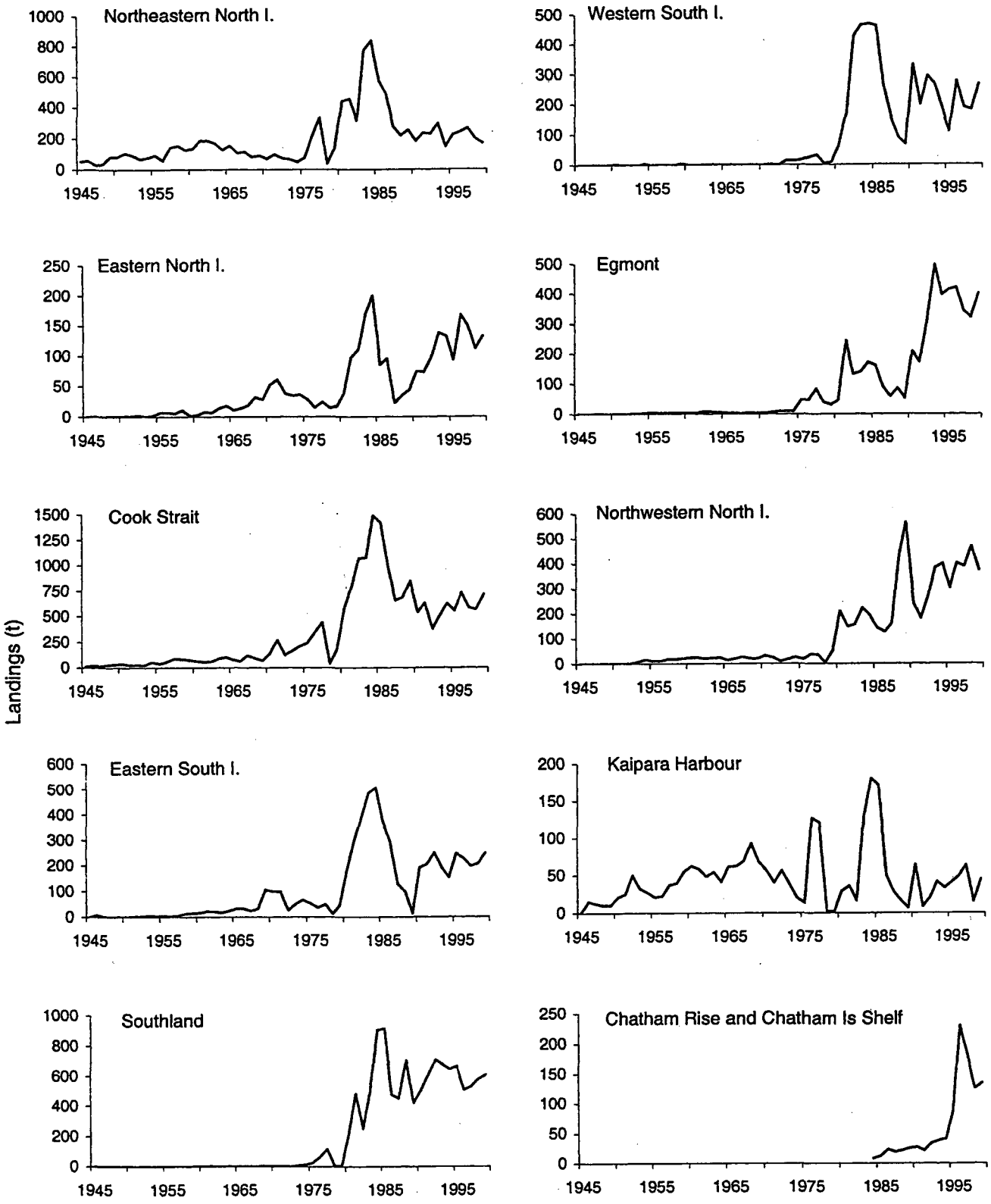

Figure 11: Reported catch history (t) of school shark in the fishing regions defined in this study. Data are from a variety of sources. Most values to 1986 are from ports within the region. Data from 1987 to 1989 are from incomplete data by fishing statistical area, scaled uniformly up to the New Zealand total. Data from the fishing year 1989–90 onwards are from estimated catches by fishing statistical area, scaled up independently by region to the QMS New Zealand total. There are discrepancies between data sources; these are indicative trends only.

Appendix 1: Integration of estimated catches with landings, by vessel, by month

Vessel	Form type	Year	Month	Day	Est. SCH kg	Landed SCH kg	Fish.-Year	Method	Target	Region	Stat. Area	Total catch
284	CEL	1995	9	6	2000		1995	SN	SPO		3	4400
284	CEL	1995	9	7	1800		1995	SN	SPO		5	4300
284	CEL	1995	9	11	2000		1995	SN	SPO		8	2480
284	CEL	1995	9	15	100		1995	SN	SPO		8	NULL
284	CEL	1995	9	17	600		1995	SN	SPO		5	NULL
284	CEL	1995	9	18	700		1995	SN	SPO		5	NULL
284	CEL	1995	9	20	1000		1995	SN	SPO		8	3000
284	GRE	1995	9			9303	1995	**SN**	**SPO**	**1**		
307	GRE	1994	10			16	1995	***BT***	***SNA***	***9***		
307	TCP	1994	11	11	450		1995	BPT	SNA		47	2866
307	TCP	1994	11	12	450		1995	BPT	SNA		47	4326
307	GRE	1994	11			1316	1995	**BT**	**SNA**	**9**		
307	GRE	1994	12			92	1995	***BT***	***SNA***	***9***		
307	TCP	1995	1	5	90		1995	BPT	SNA		47	1220
307	TCP	1995	1	6	675		1995	BPT	TRE		47	1950
307	*TCP*	*1995*	*1*			***200***	*1995*	***BPT***	***SNA***	**9**		
307	GRE	1995	1			***1505***	1995	**BT**	**TRE**	**9**		
307	GRE	1995	2			8	1995	**BT**	**NULL**	**9**		
307	GRE	1995	3			145	1995	**BT**	**NULL**	**9**		
307	TCP	1995	4	2	235		1995	BPT	SNA		47	1500
307	TCP	1995	4	30	45		1995	BPT	SNA		47	190
307	GRE	1995	4			965	1995	**BPT**	**SNA**	**9**		
307	GRE	1995	5			216	1995	***BPT***	***SNA***	***9***		
307	GRE	1995	6			217	1995	***BPT***	***SNA***	***9***		
307	GRE	1995	7			51	1995	***BPT***	***SNA***	***9***		
307	TCP	1995	8	23	450		1995	BPT	SNA		47	765
307	GRE	1995	8			1085	1995	**BPT**	**SNA**	**9**		
307	TCP	1995	9	5	180		1995	BPT	SNA		42	1925
307	TCP	1995	9	6	90		1995	BPT	SNA		42	1195
307	TCP	1995	9	10	135		1995	BPT	SNA		42	1826
307	TCP	1995	9	17	350		1995	BPT	SNA		45	1915
307	TCP	1995	9	18	45		1995	BPT	SNA		45	315
307	TCP	1995	9	20	45		1995	BPT	SNA		42	440
307	TCP	1995	9	29	135		1995	BPT	SNA		47	920
307	GRE	1995	9			1767	1995	**BPT**	**SNA**	**9**		
312	CEL	1994	10	28	100		1995	BT	TAR		4	1250
312	GRE	1994	10			507	1995	**BT**	**TAR**	**1**		
312	GRE	1994	11			70	1995	***BT***	***TAR***	***1***		

Notes:

1. Daily catch values are from Form types CEL [CELR, catch effort & landing return] and TCP [TCEPR, trawl catch effort & processing return]. Monthly landed values are from Form type GRE [landed greenweight].
2. Monthly entries for method, target, and region, determined from the daily catch rows and entered in the landed rows, are shown in bold.
3. Interpolated entries or data, added where information was missing, or where the monthly entries had to be subdivided by method, target, or region, are shown in italic.
4. Where the method, target, or statistical area entries were incomplete or erroneous, NULL was put in the landed row. One exception was allowed: when a few entries were missing but the remainder were consistent (i.e., a single method, target, or region), the monthly totals were completed in the standard way.

Appendix 2: Procedures for integrating *estimated catch* values with *recorded landed* values to produce *"calculated landed"* values of school shark, using Excel

Procedure	Comments
Extract landed catch by vessel, year, month (GRE file)	One file for each fishing year seems appropriate.
Extract estimated catch by vessel, year, month, day, method, area, target species (CEL, TCP files)	One file for each fishing year seems appropriate. CELR and TCP (TCEPR) files are extracted separately, but use the same structure of catch by day.
Integrate the three extract files (per year), and sort by vessel and month[1].	A set of lines for each vessel, by month, of estimated daily catches, followed by monthly landings.
Copy method, target species from information in estimated catch rows to landed catch row, and assign a fishing region[2].	Where the estimated data are incomplete, or show more than one method, region, or target species in a month, the following decisions are made.
Problems	**Decisions and adjustments**
Landed catch, no estimated catch value(s)	If only a single method is shown for other months, this is used; otherwise NULL If only a single region is fished (or predominantly fished) in other months, this is used; otherwise NULL If only a single target species is fished (or predominantly fished) in other months, this is used; otherwise NULL If no information is shown for other months, NULL
Estimated catch value(s), no landed catch	Landed catch entry created using estimated values
Estimated catch much greater than landed catch (and without a landing in the following month)	Unless there is good reason to believe the landed catch value, the estimated value is substituted
Error in Statistical Area reported	If obvious (e.g. a Fishstock code), a correction is made; this is often apparent from a combination of the method, area, and target species entries
Unlikely method listed	Lobster pot or cod pot are sometimes listed. If other entries for the vessel show it to fish only with lines, or only nets, these are substituted; otherwise NULL
More than one method used in a month[3]	Landed value subdivided, using ratio of estimated values
More than one region fished in a month[3]	Landed value subdivided, using ratio of estimated values
More than one target species in a month[3,4]	Landed value subdivided, using ratio of estimated values
Obvious data entry errors	Where an entry is clearly a data entry error, e.g. 4 in a sequence of 44s, or B in a sequence of BTs, it is corrected
Ambiguities in any field	Unless a correction can be determined from the pattern of fishing for the rest of the year, NULL is entered
Vessel identifier is given as NULL	Rare. Data are deleted, as a match between estimated and landed catches cannot be made. This is the only instance where data are deleted. There are, however, some landed catch entries which have to be given NULL for all other parameters (method, region, and target species)
Subsequent identification of changes	New data rows (e.g. a landed catch row is split by method), or data values changed from the original, are colour-coded

Notes:

1. Before integration in Excel, it is convenient to colour-code the landed catch file. Landed catch rows are then easily distinguished from estimated catch rows, particularly when the latter have missing values.
2. For school shark, fishing regions used standard QMA boundaries where possible, but a new Cook Strait region was created, incorporating the southernmost areas of QMAs 2 and 8, and northernmost areas of QMAs 3 and 7. Kaipara Harbour data were recorded separately from QMA 9.
3. Where, in a month, 90–99% of the estimated catch was taken by one method, in one region, or with one target species, the entire landed catch was allocated to this.
4. Where a trawler fished in the same Statistical Area(s) for several target species in what appeared to be a mixed trawl fishery, NULL was entered as the target.
5. Apart from NULL vessel records, all incomplete records were retained with NULL entered in the appropriate column. The NULL method catch was 0.8% of the total, the NULL region catch was 1.3%, and the NULL catch by target species was 3.8% (but included trawl landings where several similar target species were nominated during the month).