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A summary of biology and commercial landings, and a stock assessment of rubyfish, *Plagiogeneion rubiginosum* (Hutton, 1875) (Percoidei: Emmelichthyidae)

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1. EXECUTIVE SUMMARY

Published information on the rubyfish, *Plagiogeneion rubiginosum* (recently emended from *P. rubiginosus*), is limited to descriptions, locality listings, or very generalised accounts.

Rubyfish were first listed in catch statistics in 1983. By 1990 250 t was reported. In the three years 1992–93 to 1994–95 the catch reached 600–700 t, about one-third being targeted.

The main grounds for rubyfish as a target species, or as an alfonsino bycatch, are the banks or hill complexes off the east coast of the North Island (Quota Management Area (QMA) 2). As a bycatch of gemfish, barracouta, hoki, and jack mackerel fisheries rubyfish are caught in the outer Bay of Plenty, off the east and west Northland coasts, the outer North Taranaki Bight, and off Westland. Concentrations of rubyfish probably also exist in other areas around New Zealand.

Reported landings by QMA for the period 1991–92 to 1994–95 show 76% coming from QMA 2, 17% from QMA 1, 6% from QMA 7, and negligible amounts from QMAs 3, 4, 8, and 9.

A preliminary unstandardised catch per unit effort (CPUE) analysis of the larger vessel component of the targeted east coast North Island fishery shows a decline from 1991–92 to 1994–95. Interpretation is difficult because of the low number of target tows, and because fishing shifted over time between areas within the region, but the decline is also apparent in data from the main fishing ground.

There are no Maori, traditional, or recreational fisheries.

The rubyfish has been recorded from Australasia to South Africa, and from banks in the southern Indian and southeast Atlantic oceans. It occurs in subtropical water around New Zealand, being absent from the southern Chatham Rise and the Campbell Plateau.

It has a wide depth range from 50 to at least 800 m, but trawl survey and commercial catch data show it to be most abundant between 200 and 400 m.

The recorded size range is 12 to 58 cm; limited data from research tows show catches usually contain only one modal group, suggesting rubyfish school by size. A published growth rate from Indian Ocean fish is of limited value, being based only on scales, and may refer to a related species; there are no New Zealand studies. There is no information on reproduction. Some observations on stomach contents show that they feed on midwater crustaceans, salps, and myctophid fishes.

No resource surveys have been made. A provisional yield estimate was calculated from the brief period of commercial catches, but was not considered robust enough to be included in the formal assessment. It is not known whether the current level of landings is sustainable.

The standard QMAs, with some amalgamation, would form an appropriate basis for Fishstocks.

2. INTRODUCTION

2.1 Overview

This document summarises information on the biology of the rubyfish, *Plagiogeneion rubiginosum*, species code RBY, in New Zealand waters, and the development of a fishery for this species during the last decade.

2.2 Description of the Fishery

Small trawl bycatches have been made since at least the mid 1980s. The catch increased — still as a bycatch — in the late 1980s with the increase in fishing for alfonsino (*Beryx* spp., BYX) on the east coast of the North Island. From about 1992, about one-third of the reported annual catch of 600–700 t has been taken as a target species.

2.3 Literature Review

There are no existing general accounts of the rubyfish or its fishery. The species was first described from a New Zealand specimen as *Therapon rubiginosus* by Hutton (1875, 1876), but with doubts on its generic affinity. Forbes (1890) placed it in the new genus *Plagiogeneion*, and a more detailed description was given by Waite (1913). Parin (1991) emended *rubiginosus* to *rubiginosum* following a gender ruling on *Plagiogeneion* by Eschmeyer & Bailey (1990).

Thomson & Anderton (1921) observed that "The fish is one of the deep-sea forms, which is picked up only during the winter months, stranded on beaches — e.g. at Moeraki — and appears to come ashore on still nights, like the frost-fish." Webb (1974) recorded rubyfish in skipjack and albacore stomach contents, and Paul *et al.* (1983) suggested that it was an "apparently schooling species from the shelf edge at several localities around New Zealand". Shuntov (1979) recorded the species from a depth range of 100–400 m. Rubyfish are mentioned in accounts of exploratory fishing by Japanese vessels around New Zealand in the 1970s (e.g. JFA 1978, JAMARC 1979), but without detail. Ayling & Cox's (1982) brief general account noted "Rubyfish are reasonably common in 200 to 500 m ... on the upper continental slope but almost nothing is known of their habits and behaviour."

Heemstra & Randall (1977) reviewed the family Emmelichthyidae and in their account of this species listed its distribution as "New Zealand, Australia, St Paul and Amsterdam Islands [South Indian Ocean] and South Africa" and its known depth range as 30–300 fathoms (55–550 m). Yatsu, in Amaoka *et al.* (1990) briefly described and illustrated rubyfish, gave a depth range of 50–734 m, and followed Heemstra & Randall (1977) in listing only one other (southern Australian) species in the genus. Parin (1991) described three additional species of *Plagiogeneion*, and suggested that at least some of the fish previously listed as *P. rubiginosus* may have been misidentified.

The parasites of rubyfish are listed by Hewitt & Hine (1972), Korotaeva (1972), and Slankis & Korotaeva (1974).

In New Zealand waters rubyfish have occasionally been measured when taken as a small bycatch in research trawl surveys, and given only brief listings in survey reports. Some larger catches were made during exploratory fishing around the North Island in the mid 1980s, and Clark & King (1989) presented some length frequency data by sex, but essentially little biological information exists. Mel'nikov & Ivanin (1995) present growth data on *P. rubiginosum* in the west Indian Ocean, but concede that their fish may have been one of Parin's new species.

Mel'nikov & Ivanin (1995) described *P. rubiginosum* as widely distributed in tropical to temperate oceans of the world, and commercially important in some areas, particularly over submarine ridges and seamounts. However, this generalisation undoubtedly incorporates information on the other recently described species of *Plagiogeneion*.

3. REVIEW OF THE FISHERY

3.1 Catches, Landings, Effort, CPUE, and Management

3.1.1 Catches and landings

Rubyfish were first listed in New Zealand's commercial fisheries statistics in 1982–83 (Tables 1 and 2, Figure 1), but small catches were undoubtedly made in previous years by domestic vessels and incorporated in the category "mixed species", and by foreign fishing vessels whose catch records were invariably incomplete. However, there is no anecdotal evidence that the latter targeted rubyfish, and it is likely that until 1985 total annual landings were less than 50 t. The data summarised in Table 2 indicate that in the early 1980s rubyfish were mainly a bycatch in the barracouta, hoki, jack mackerel, and gemfish fisheries, and occasionally taken with orange roughy, silver warehou, and alfonsino. As far as is known, the total catch is taken by bottom or midwater trawl gear fished close to the bottom.

Catches doubled in 1988–89 to more than 200 t (*see* Table 1), apparently still as a bycatch in the barracouta, hoki, gemfish, and alfonsino fisheries (*see* Table 2). However, the estimated catch data on which this conclusion is based are incomplete as a result of dumping, being recorded among "mixed species", and failing to make the top five species in the "estimated" sections of the Catch Effort Landing Return (CELR) and Trawl Catch Effort Processing Return (TCEPR) catch-per-tow datasets.

From 1990–91 the catch approximately doubled to about 550 t in 1991–92, about 200 t of this being directly targeted (Figure 1, Table 2). In the three subsequent years the catch has been about 700 t, with at least 200 t targeted. With greater market acceptance of the species fishers were able to land most of their catch, and to increase their target fishing. The expectation of rubyfish being added to the Quota Management System (QMS) also probably encouraged more complete recording for establishing catch histories.

The location of fishing grounds where rubyfish have been targeted or caught as a bycatch are shown in Figure 2. The data from which this has been determined are incomplete, being based only on catch and effort data from TCEPR catch records (*see* Table 2). The following patterns are evident in the data.

Rubyfish as Target Species: Principally the east coast of the North Island between East Cape and Castlepoint, from about 1988. The grounds are located over or near the submarine banks or hill complexes along this coast which are fished for several species, notably orange roughy and alfonsino. Those where rubyfish have been targeted include (from north to south), Koutunui, Tuaheni, Ritchie and Paoanui, Motukura, Madden, and Kaiwhata. Some targeted fishing has also been reported in the Bay of Plenty, on or close to the grounds more usually fished for gemfish and scampi.

Bycatch in Alfonsino Fishery: The east coast of the North Island, from about 1987, along all the banks from Palliser Bank in the south to Koutunui in the north.

Bycatch in Barracouta Fishery: Off the Westland coast, intermittently and only in small quantities from 1983 (perhaps earlier).

Bycatch in Gemfish Fishery: Off the Westland coast, along the east coast of the North Island from Castlepoint to Gisborne, in the outer Bay of Plenty, off East Northland, and off Ninety Mile Beach. From 1983 (perhaps earlier) in intermittent small quantities, but in increasing quantities around the North Island since 1989.

Bycatch in Hoki Fishery: Off the Westland coast, on or near some east coast North Island banks (Madden to Ritchie), and in the outer Bay of Plenty. In intermittent small quantities since at least 1983.

Bycatch in Jack Mackerel Fishery: Off the Westland coast, and in the outer North Taranaki Bight, intermittently and in small quantities since 1986.

Bycatch in Other Fisheries: Rubyfish have also been reported as a small and intermittent bycatch when the target species was listed as bluenose, black cardinalfish, orange roughy, silver warehou, scampi, and even shallower water species such as tarakihi and trevally.

It is difficult to quantify the proportions of the rubyfish catch taken in each of these fisheries. The available data are not only incomplete but biased, in that for some fisheries (e.g. hoki, gemfish, perhaps jack mackerel) rubyfish would not always be listed among the top five species of a catch in the commercial catch records from which this analysis is made. However, the CELR and TCEPR catch data which identify both fishing locality and target species (covering about 50% of the reported rubyfish catch from 1983 to 1995) suggest that about 50% of the rubyfish were taken as a target species, about 20% in each of the alfonsino and gemfish fisheries, 5% in both the hoki and barracouta fisheries, and 1% or less with jack mackerel, silver warehou, and the "others".

The estimate of 50% of the rubyfish catch being targeted may be too high. Figure 1 shows targeted rubyfish at 35–40% between 1991–92 and 1994–95, but it is also based on incomplete data. It seems likely that the true value is between these limits.

Catches of rubyfish by QMA can be examined in a combination of CLR and $CELR_{landed}$ data for the years 1991–92 to 1994–95, when total reported landings exceeded 500 t (Table 3). QMA 2 is the main region, with 76% of landings (as recorded in these datasets); this is the region where rubyfish are targeted, and also form a substantial bycatch in the alfonsino fishery, and are also taken with gemfish and hoki (*see* Fig. 2). QMA 1 is the second most important region, but with only 17% of the total rubyfish catch, taken as a target and also a gemfish bycatch. Landings (as bycatch) from QMA 7 has averaged 6% of the total. There were negligible recent landings from QMAs 3, 4, 8, and 9.

Commercial concentrations of rubyfish probably exist in other areas, especially around northern New Zealand, that have not yet been fished in appropriate depths.

3.1.2 Effort

Establishing a reliable measure of effort for the "rubyfish fishery" is complex. Less than half the catch is reported as caught as a target species. It is not clear that all tows listed as targeting rubyfish had this intention. It may sometimes be in a fisher's interest to record a non-quota species as a target, e.g. when the quota for a species has nearly been reached but further catches of it are likely. Alternatively, some tows targeting alfonsino caught a substantial quantity of rubyfish; if the target had not been listed it may have been retrospectively recorded as rubyfish. Figure 3 illustrates some of this complexity. Tows with rubyfish nominated as the target species did include a much higher percentage of tows where significant catches of rubyfish were made; this could result either from very successful targeting, or post-tow recording of the target species. In the other fisheries, reported catches of rubyfish were generally less than 1 t. In the alfonsino fishery, as might be expected from the similar habitat of the species, there was a higher proportion of rubyfish

"bycatches" in the 1–4 t range. There is also the issue of the high number of unsuccessful rubyfish-targeted tows, shown in Figure 3 (top left) as zero catches. The extracts from the fisheries statistics database on which these analyses are made showed that many of these targeted tows which caught no rubyfish caught little else as well, but some did catch modest quantities of quota species.

In summary, rubyfish are both targeted and taken as a bycatch. The issue of determining effort involves deciding whether to use only nominated rubyfish-targeted tows (including those catching no rubyfish), or tows with a catch of rubyfish within the top few species.

3.1.3 CPUE analysis

Despite the uncertainties outlined in 3.1.2, a preliminary unstandardised analysis of CPUE was made for the years 1991–92 to 1994–95, when rubyfish became a targeted species. Initially, a comparison was made between trends in all those tows for which (a) rubyfish was the nominated target species but not always caught, and (b) rubyfish was nominated as the target and also caught. These trends in these two datasets were very similar. For simplicity, only category (b) tows were subsequently used. The analysis is also restricted to the main east coast fishing grounds in QMA 2 (Figure 4). Mean annual values suggest a CPUE decline from 6 t per tow to 3 t per tow over these four years. However, the issue is complicated, as the level of fishing activity, and CPUE trends, differed between the four main hill-complex fishing grounds. Catch and CPUE appear linked on the main ground (Tuaheni) where there was a decrease in both catch and CPUE. On the other grounds there is no relationship. In this partial record of fishing activity (TCEPR data only) there was a decline in fishing on the three southern grounds after 1992–93 but no consistent effect on catch or CPUE. The time series is too short and complex to allow any firm conclusions, but the overall decline in CPUE, and the decline on the main Tuaheni ground, indicates a need for further investigation, perhaps by a standardised CPUE analysis, and monitoring.

A preliminary investigation was made of the distribution of catch sizes (t per tow) for TCEPR targeted tows over this period (Figure 5). That is, did catches become smaller? No trend was apparent in the combined data, but in view of the shift in effort between grounds a finer-scale analysis, at least ground by ground, is required. In theory, a time-series change in the proportion of targeted tows with no rubyfish catch would also be informative, but to interpret this it will be necessary to have a better understanding of how fishers nominate "target species" when working on orange roughy/alfonsino/rubyfish fishing grounds.

3.1.4 Management controls

As far as can be determined, no management controls are in existence.

3.2 Non-Commercial Fisheries

3.2.1 Recreational fisheries

There is no reported recreational catch. In theory, however, they are just accessible to lines and occasional catches might be made in depths over 100 m, particularly near offshore banks.

3.2.2 Maori customary fisheries

There is no information on any Maori fishery for this species.

4. RESEARCH

4.1 Distribution

The rubyfish is currently considered to be southern Indo-Pacific, distributed from the eastern South Atlantic to Australasia (Mel'nikov & Ivanin 1995). Around New Zealand, records from the MFish research trawl database show it to be widely distributed in subtropical water (Figure 6); it is not present around the southern South Island or on the Campbell Plateau, but occurs along the northern edge of the Chatham Rise and around the Chatham Islands.

The depth range of rubyfish as defined by the research trawl survey database is 50–900 m, with greatest abundance at 250–450 m peaking at 300 m (NIWA, unpublished data). This range is similarly demonstrated by commercial fisheries data (Figure 7). There are some differences between fisheries that probably reflect fishing depths for the targeted species. As a target species it is mainly fished between 150 and 500 m, and appears to be most abundant (in t per tow) in 150–250 m, but has been reported from 800 m. In the alfonsino fishery it is mainly taken in 200–400 m. In the barracouta fishery it is mainly taken between 200 and 300 m, with highest catches at 250–300 m. In the gemfish fishery the main range is 200–400 m, and in the jack mackerel fishery the main range is 260–420 m, with some catches as shallow as 100 m. As in the barracouta fishery, these shallower catches may be of rubyfish above the seafloor on the outer shelf. In the hoki fishery the main rubyfish depth range is 300–400 m.

4.2 Stock Structure

There is no information on whether different regional stocks occur around New Zealand.

The location of fishing grounds for rubyfish suggests that, with some amalgamation, the standard set of QMAs would be appropriate for establishing Fishstocks. Recommended Fishstocks are as follows:

(1) QMAs 1 plus 9 would contain the rubyfish catch taken in the northern fishery for gemfish.

(2) QMA 2 would contain the main target fishery for rubyfish, and the bycatch in the main east coast alfonsino fishery.

(3) QMAs 7 plus 8 would contain the central west and southwest bycatch in the hoki, barracouta, and jack mackerel fisheries.

(4) QMAs 3 plus 4 plus 5 would contain the relatively small rubyfish catch reported from the Chatham Rise and southeast coast.

4.3 Length Frequency Distributions

Research trawl surveys have caught rubyfish between 12 and 58 cm in length (Figure 8). Several distinct size modes are present. However, there are insufficient fish in the 10 cruises in which rubyfish were measured to obtain an indication of growth, or to properly examine size differences between regions or depth ranges. Most samples came from central west New Zealand, Cape Foulwind to Cape Egmont. The only presumed juveniles, the 14–20 cm mode in February–March 1990, were caught in 134 m (but near the shelf edge) west of Kawhia Harbour.

Although the size modes of fish in the range 30–50 cm probably each represent more than one age class schooling by fish size, they may also indicate a relatively fast growth rate.

4.4 Age and Growth

The age and growth study on Indian Ocean fish identified as *Plagiogeneion rubiginosum* by Mel'nikov & Ivanin (1995) is conceded by them to perhaps "... have to be referred to *P. fiolenti*." Their work was based on scale-reading, which they found difficult beyond 7–8 years because of crowded rings at the scales' edge; nevertheless they obtained ages up to 9 (males), or 10 (females). Scale-reading generally underestimates ages, particularly if ring-crowding is observed, and these maximum ages can be regarded only as approximations for "*Plagiogeneion*".

4.5 Reproduction

There is no information available, but rubyfish are presumably free-spawners in offshore waters, probably in their preferred habitat above seamounts and submarine ridges.

4.6 Sex Ratios

The only information is from one catch from the Rumble III seamount north of the Bay of Plenty, where fish had a male:female ratio of 1:0.6 (Clark & King 1989, fig. 45; October–November in Figure 8 here). The sample was bimodal, at 36 and 44 cm, and both modes had a similar ratio. Benthopelagic fish often school by size and sex, and this single sample is unlikely to be representative of the population.

4.7 Feeding

Clark & King (1989) recorded midwater crustaceans (amphipods, euphausiids, decapods), salps, and myctophid fishes from rubyfish.

4.8 Resource Surveys

There have been no resource surveys of rubyfish, and the species is taken only irregularly during trawl surveys for other species (hoki, orange roughy, etc.). Such surveys are either in the right depth range but wrong area (hoki) or in the right area but wrong depth range (orange roughy). Consequently, there are no biomass estimates.

4.9 Yield Estimates

This is the first stock assessment for rubyfish.

With no biomass estimates for rubyfish, little appropriate biological information, and only a short period of commercial exploitation as both a target and bycatch species, it is debatable whether a Maximum Constant Yield (MCY) value can be estimated. The simplest procedure for calculating MCY, $MCY = cY_{av}$ (Annala & Sullivan 1997, method 4) requires a reasonably stable catch history (Y_{av}) over a period equal to at least half the exploited life span, no systematic changes in fishing effort, and some knowledge of the mean natural mortality, from which an estimate of the variability factor, c, can be made.

Reported catches were reasonably stable at 558–699 t for the four fishing years 1991–92 to 1994–95 (*see* Table 1). Fishing effort in these years — in terms of number of TCEPR tows with rubyfish in the top five species (*see* Table 2) — has varied between about 300 and 450; the number of CELR-recorded tows is unfortunately not known. The estimation of c is also difficult. If some the length frequency modes in Figure 8 represent single age groups, a moderately fast growth could be assumed, probably with a moderately high natural mortality and consequent biomass variability, for which a c value of 0.6 would be appropriate.

From these assumptions, MCY = 0.6 x 637 t, = 382 t. However, this is an extremely provisional estimate, and in view of the short catch history and the uncertainty in c it can only be indicative. An MCY is not formally presented in the final assessment (Annala & Sullivan 1997).

It is not possible to determine the Current Annual Yield (CAY)

5. STATUS OF THE STOCKS

The total landings of rubyfish have remained at 600–700 t over the last 3 years. An unstandardised CPUE analysis from the TCEPR segment of the targeted catch in QMA 2 (the main fishery) shows a decline. Although there are different trends at the four hill-complexes fished in this QMA, the main ground (Tuaheni) also shows a decline. Some decline is to be expected in a newly exploited species, but a standardised CPUE analysis, using more complete data (TCEPR plus CELR) from a longer time-series, should be undertaken if this fishery is to be monitored. Several hundred tows annually either target rubyfish or include rubyfish among the top few species.

It is likely that the level of recent commercial catches is sustainable in the short term, although there may be instances of localised depletion. Given the short history of fishing in QMA 2, it is not known whether the recent commercial catches from this area are sustainable in the long term, or are at a level that will allow the stock to move towards a size that will support the maximum sustainable yield. For all other areas it is not known if recent catches are sustainable or will allow the stocks to move towards the size that will support the maximum sustainable yield. Commercial concentrations of rubyfish probably also exist in areas that have not been fished at appropriate depths, especially off the northern half of New Zealand.

6. MANAGEMENT IMPLICATIONS

With new fisheries such as this it has been the practice in New Zealand to recommend a yield at some historical level of catch. With so little known about rubyfish, it would be prudent to regard the recent few years catches of 600–700 t as a maximum yield until some information on age and growth (and hence productivity) at least is obtained and an appropriate study of CPUE is undertaken.

Fishstocks could be defined using existing QMA boundaries. QMA 2 would contain the major Fishstock, and three others could be formed from QMAs 1 plus 9, QMA 7 plus 8, and QMA 3 plus 4 plus 5.

The substantial catches of rubyfish taken in association with alfonsino demonstrate the potential for a bycatch problem in the midwater trawl fishery off the North Island east coast, if inappropriate quota mixes were held. Irregular, though smaller, catches in other trawl fisheries also have the potential to become a bycatch issue.

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Table 1: Reported landings (t) of rubyfish by fishing year, from various sources. FSU, Fisheries Statistics Unit; CELR, catch, effort and landing return; TCEPR, trawl, catch, effort and processing return; CLR, catch landing return; LFRR, licensed fish receivers return. Fishing years are from 1 October to 30 September. From 1988–89 the best estimate was taken as the greater value of either the LFRR total or the sum of the CLR and $CELR_{landed}$ data. It can be argued the LFRR totals from 1988–89 onwards are the more reliable values, but most differences are small

Year	FSU Inshore	FSU Deepwater	FSU Total	CELR Estimated	CELR Landed	TCEPR Estimated	TCEPR Processed	CLR	LFRR	Best estimate
82–83	11	21	33	–	–	–	–	–	–	33
83–84	11	18	29	–	–	–	–	–	–	29
84–85	23	5	28	–	–	–	–	–	–	28
85–86	70	<1	70	–	–	–	–	–	–	70
86–87	31	12	43	–	–	–	–	–	73	73
87–88	33	10	43	–	–	–	–	–	95	95
88–89	27	89	116	4	8	6	0	4	203	203
89–90	–	–	–	170	150	44	15	49	241	241
90–91	–	–	–	249	167	40	11	78	241	245
91–92	–	–	–	347	250	309	13	308	547	558
92–93	–	–	–	205	142	424	10	472	699	699
93–94	–	–	–	160	116	343	9	460	515	575
94–95	–	–	–	49	51	341	8	530	716	716

Table 2: Estimated catches (t) of rubyfish taken in different target fisheries, by large vessels only. Data for 1983 to mid 1989 from FSU deepwater forms, data from mid 1989 to mid 1995 from QMS TCEPR forms. The annual totals are less than the total reported catch ("Best estimate", Table 1) because (a) these forms list (for individual tows) only the top five species in the catch, and (b) the smaller vessels complete CELR forms not included in this analysis. Number of tows in brackets

Target Species [1]	Year												
	82-3	83-4	84-5	85-6	86-7	87-8	88-9	89-90	90-1	91-2	92-3	93-4	94-5
BAR	19.0 (34)	3.2 (2)	–	–	3.9 (1)	1.5 (13)	0.6 (1)	3.8 (2)	7.2 (4)	0.2 (1)	8.8 (9)	–	1.4 (6)
BNS	–	–	–	–	–	–	–	–	–	–	0.3 (3)	<0.1 (1)	–
BYX	–	–	<0.1 (3)	–	1.2 (22)	1.4 (5)	77.3 (30)	11.7 (39)	2.0 (3)	18.0 (7)	47.1 (47)	33.2 (71)	129.4 (154)
CDL	–	–	–	–	–	<0.1 (1)	–	–	–	–	–	–	5.5 (15)
HOK	1.8 (8)	0.7 (7)	–	–	1.1 (14)	3.9 (20)	–	15.9 (6)	1.9 (3)	3.1 (12)	23.7 (27)	10.9 (40)	8.3 (15)
JMA	–	–	–	–	4.1 (4)	0.5 (18)	4.7 (3)	5.0 (8)	–	8.4 (7)	<0.1 (1)	–	0.7 (2)
ORH	–	–	<0.1 (3)	–	–	0.6 (6)	–	–	–	–	–	–	<0.1 (2)
RBY [2]	–	–	–	–	–	11.4 (3)	–	5.0 (2)	16.2 (7)	216.4 (40)	288.5 (123)	218.6 (67)	214.5 (92)
SCI	–	–	–	–	–	–	–	<0.1 (2)	0.2 (10)	<0.1 (3)	0.6 (4)	<0.1 (2)	–
SKI	<0.1 (1)	–	–	–	0.7 (3)	1.2 (15)	0.6 (50)	7.7 (20)	11.7 (18)	62.9 (72)	72.4 (100)	79.3 (221)	116.3 (173)
SWA	–	<0.1 (2)	–	–	<0.1 (2)	–	–	7.1 (3)	–	–	1.5 (1)	2.0 (3)	–
Unknown or Minor	<0.1 (1)	13.9 (1)	4.7 (50)	0.4 (4)	1.3 (4)	0.6 (6)	<0.1 (7)	2.1 (3)	–	1.2 (3)	1.2 (4)	<0.1 (1)	0.8 (8)
Total:	20.8 (44)	17.8 (12)	4.7 (56)	0.4 (4)	12.3 (50)	21.1 (87)	83.2 (91)	58.3 (85)	39.2 (45)	310.2 (145)	444.1 (319)	344.0 (406)	476.9 (467)

[1] Species codes: BAR, barracouta, *Thyrsites atun*; BNS, bluenose, *Hyperoglyphe antarctica*; BYX, alfonsinos, *Beryx splendens* and *B. decadactylus*; CDL, black cardinalfish, *Epigonus telescopus*; HOK, hoki, *Macruronus novaezelandiae*; JMA, jack mackerels, *Trachurus declivis, T. novaezelandiae, T. murphyi*; ORH, orange roughy, *Hoplostethus atlanticus*; RBY, rubyfish, *Plagiogeneion rubiginosum*; SCI, scampi, *Metanephrops challengeri*; SKI, gemfish, *Rexea solandri*; SWA, silver warehou, *Seriolella punctata*.

[2] Rubyfish nominated as target species. Tows with rubyfish nominated as the targeted species, but with no rubyfish catch, are not included in these data; they made up 17% of the rubyfish-targeted tows.

Table 3: Reported landings (t) of rubyfish by fishing year and region (QMA), for the years 1991–92 to 1994–95 (the years when total landings rose above 500 t). Derived from the sum of CLR and $CELR_{landed}$ data

Region (QMA)	1991–92	1992–93	1993–94	1994–95	Total (t)	% of total
1	146	90	116	42	395	17
2	389	491	379	500	1 759	76
3	–	–	3	3	6	<1
4	–	–	–	12	12	<1
5	–	–	–	–	0	0
7	21	32	72	13	138	6
8	1	–	–	–	1	<1
9	–	–	5	10	15	<1
Total	558	613	575	580	2 326	100

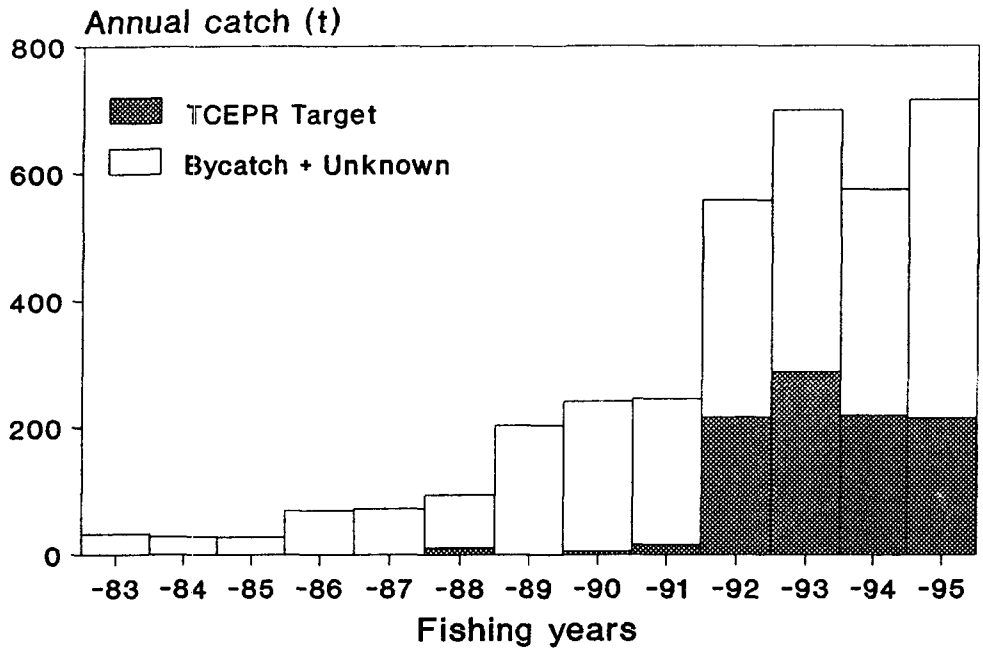

Figure 1: Best estimate of total reported landings (t) of rubyfish for New Zealand, 1982–83 to 1994–95 (*see* Table 1). The proportion of total landings taken by target fishing is almost certainly a minimum. The targeted rubyfish value could only be derived from TCEPR data, which contained about half the total landings from 1989–90 to 1994–95; they are not scaled up to the total catch, as the proportion of targeted rubyfish reported in TCEPR data is almost certainly higher than in other data. Within the TCEPR data (*see* Table 2) about 60% of the rubyfish catch between 1991 and 1995 was targeted.

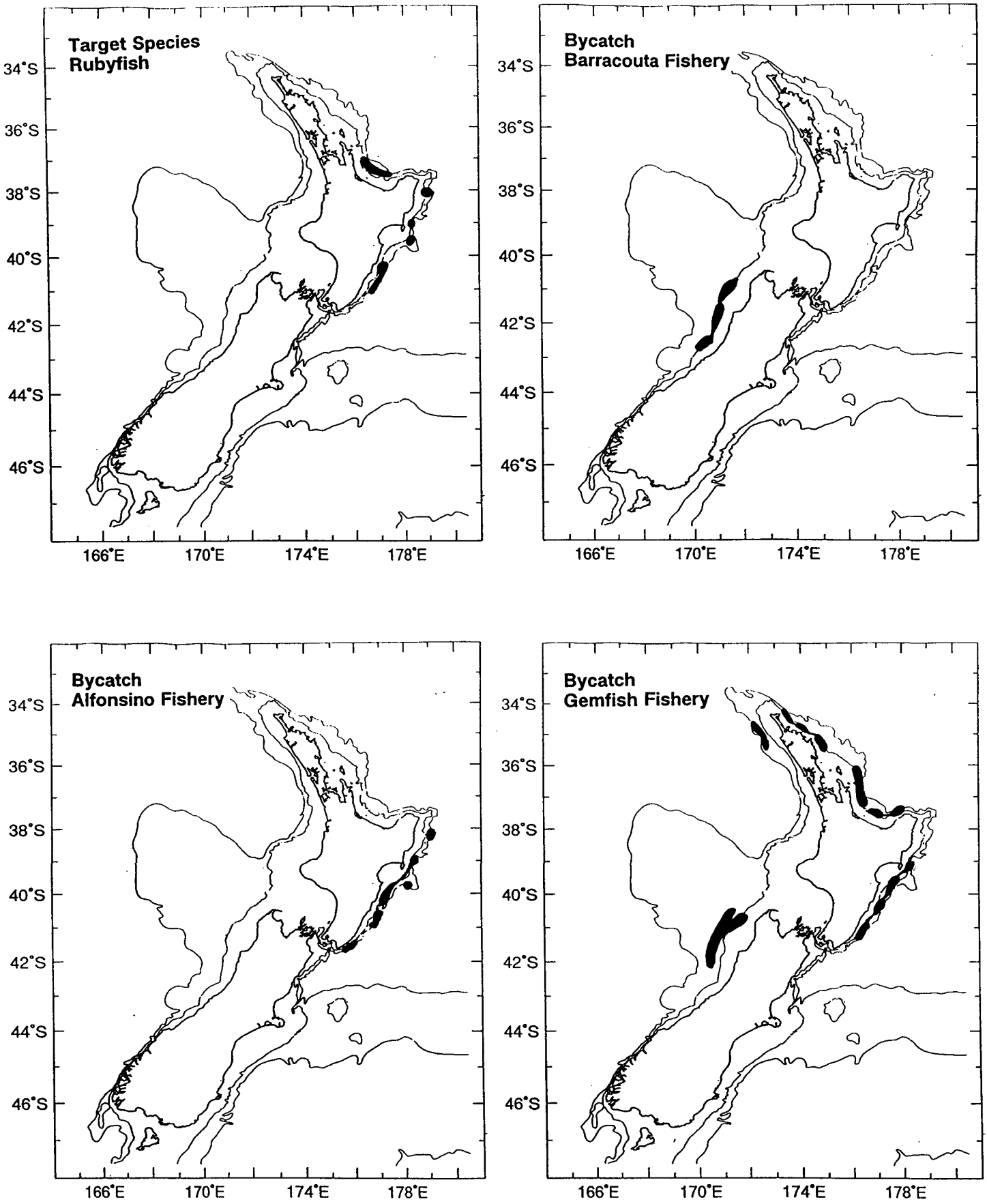

Figure 2: Distribution of rubyfish fishing grounds, as a target species and as a bycatch in the main fisheries where it is taken as a bycatch. Data from 1983 to 1995, CELR and TCEPR databases (*see* Table 2).

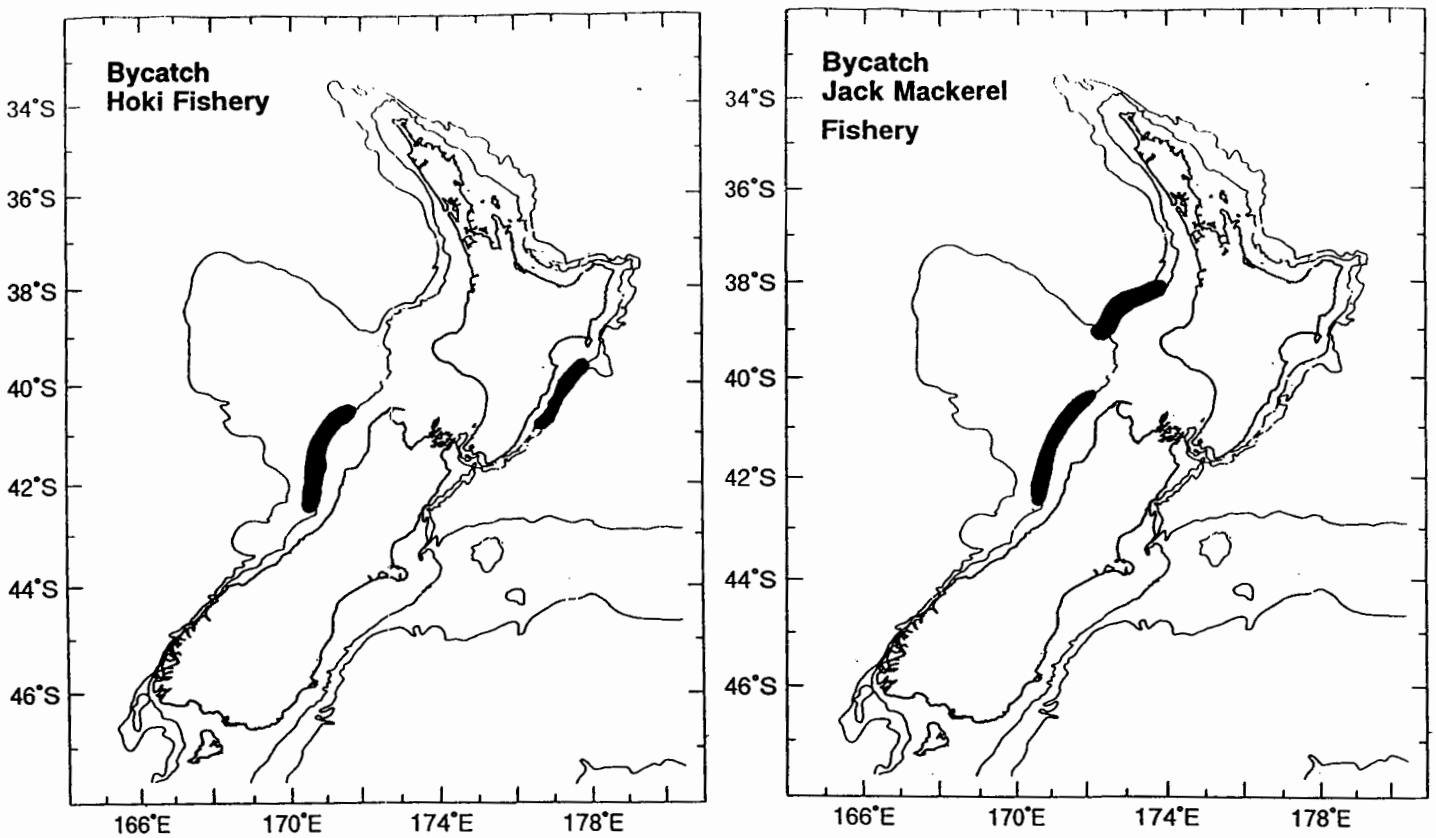

Figure 2: (continued) Distribution of rubyfish fishing grounds, as a target species and as a bycatch in the main fisheries where it is taken as a bycatch. Data from 1983 to 1995, CELR and TCEPR databases (*see* Table 2).

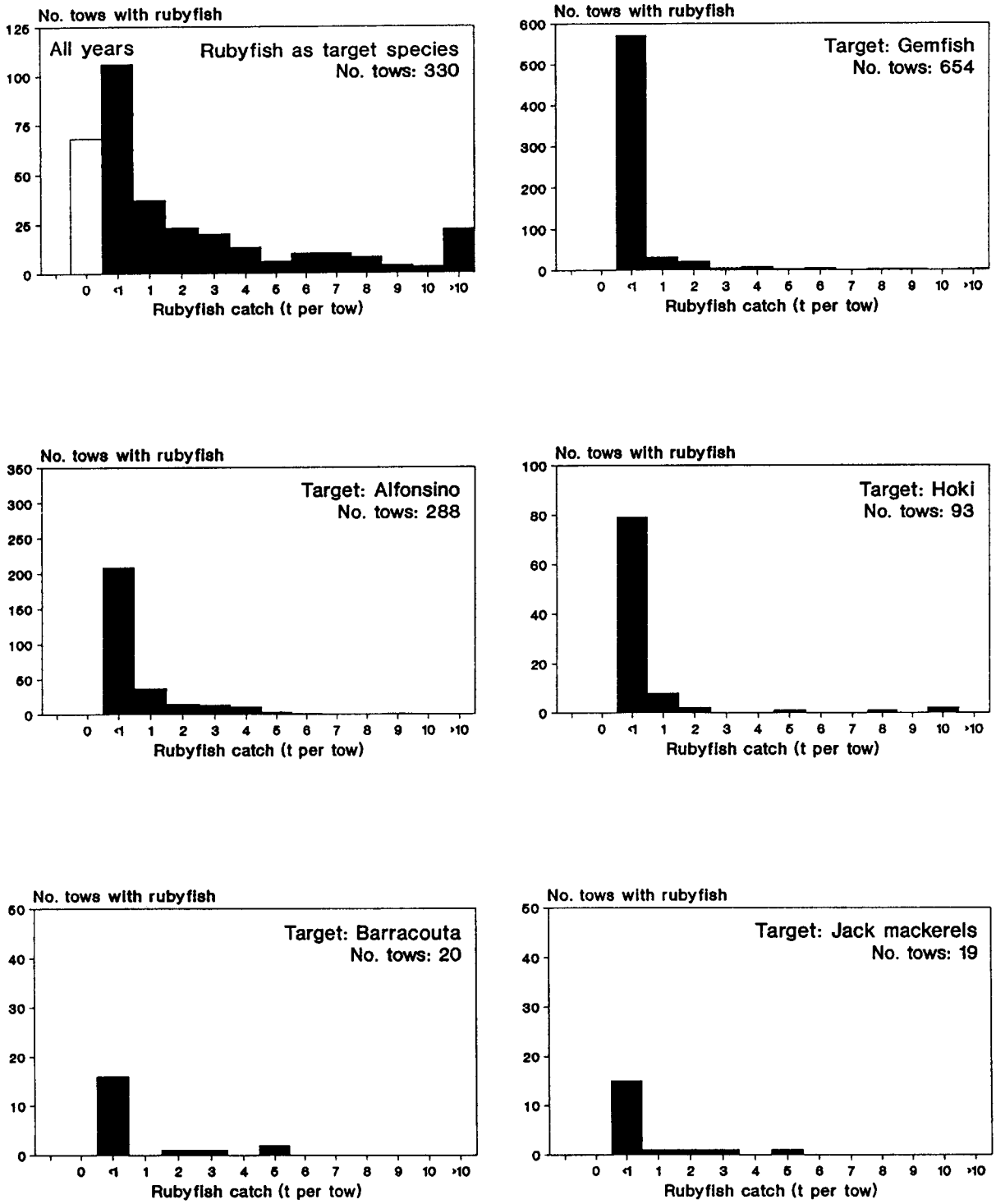

Figure 3: Distribution of rubyfish catch sizes (t per tow) in the target fishery and in the main fisheries where it is taken as a bycatch. Data from 1990 to 1995, TCEPR database.

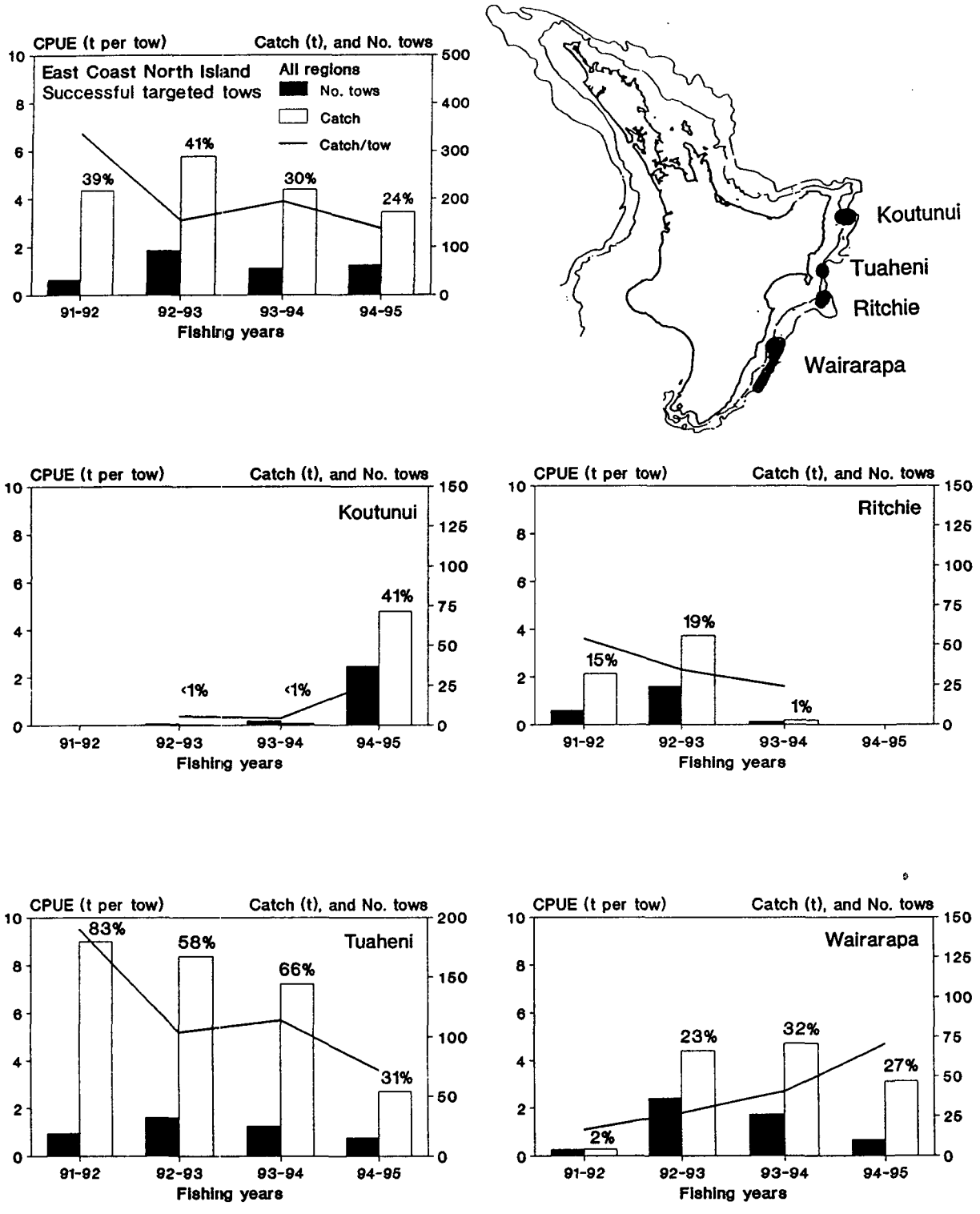

Figure 4: A preliminary unstandardised analysis of rubyfish CPUE (t per tow) for the years 1991–92 to 1994–95 when rubyfish were targeted. Derived from TCEPR (trawl catch effort and processing return) data, i.e. catches from the larger trawlers, and restricted to tows off the east coast of the North Island (East Cape to Wairarapa) in QMA 2 which successfully targeted rubyfish. Top left: catch, effort, and CPUE trends from the east coast region; the percentages are for the east coast TCEPR catch as a percentage of the New Zealand catch is listed. Top right: the four main fishing grounds in the east coast region. Lower four panels: catch, effort, and CPUE trends from the four main fishing grounds; the catch from each ground as a percentage of the east coast TCEPR catch is listed.

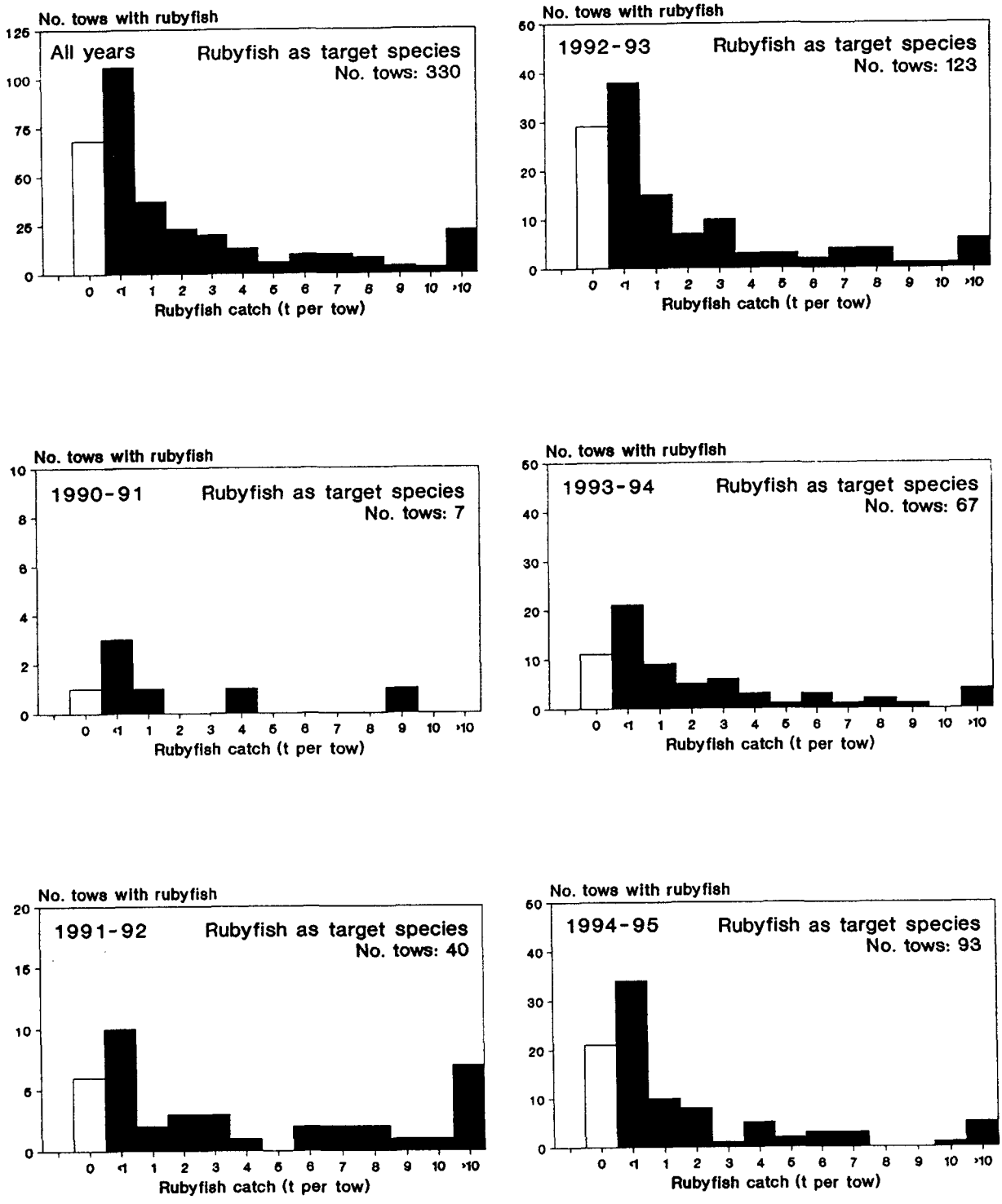

Figure 5: The distribution of rubyfish catch size (t per tow) in all targeted tows over the period 1990–91 to 1994–95. Data from TCEPR database.

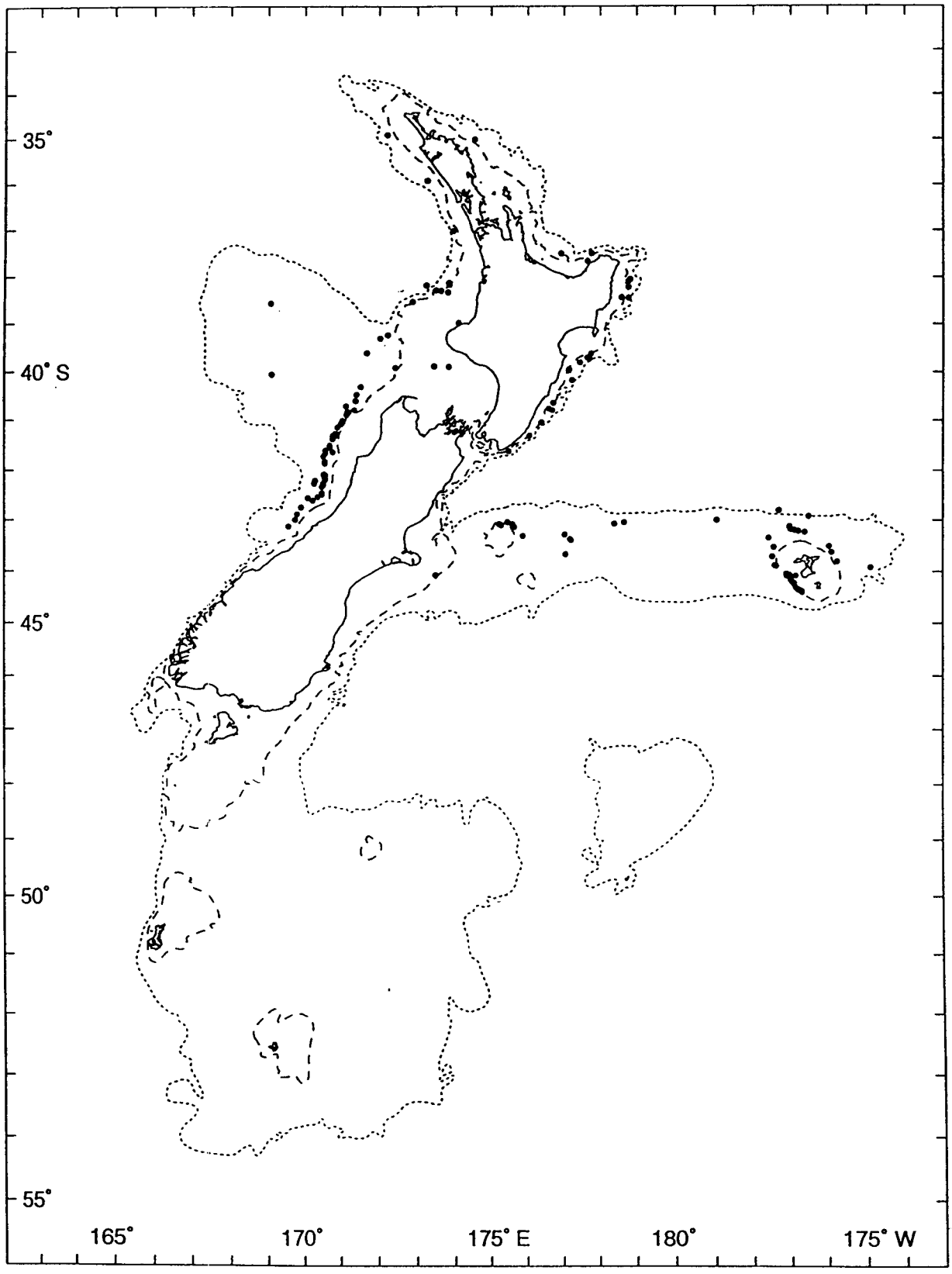

Figure 6: Distribution of rubyfish in New Zealand waters, from recorded catches in the Ministry of Fisheries research trawl database. Depth contours at 200 m and 1000 m.

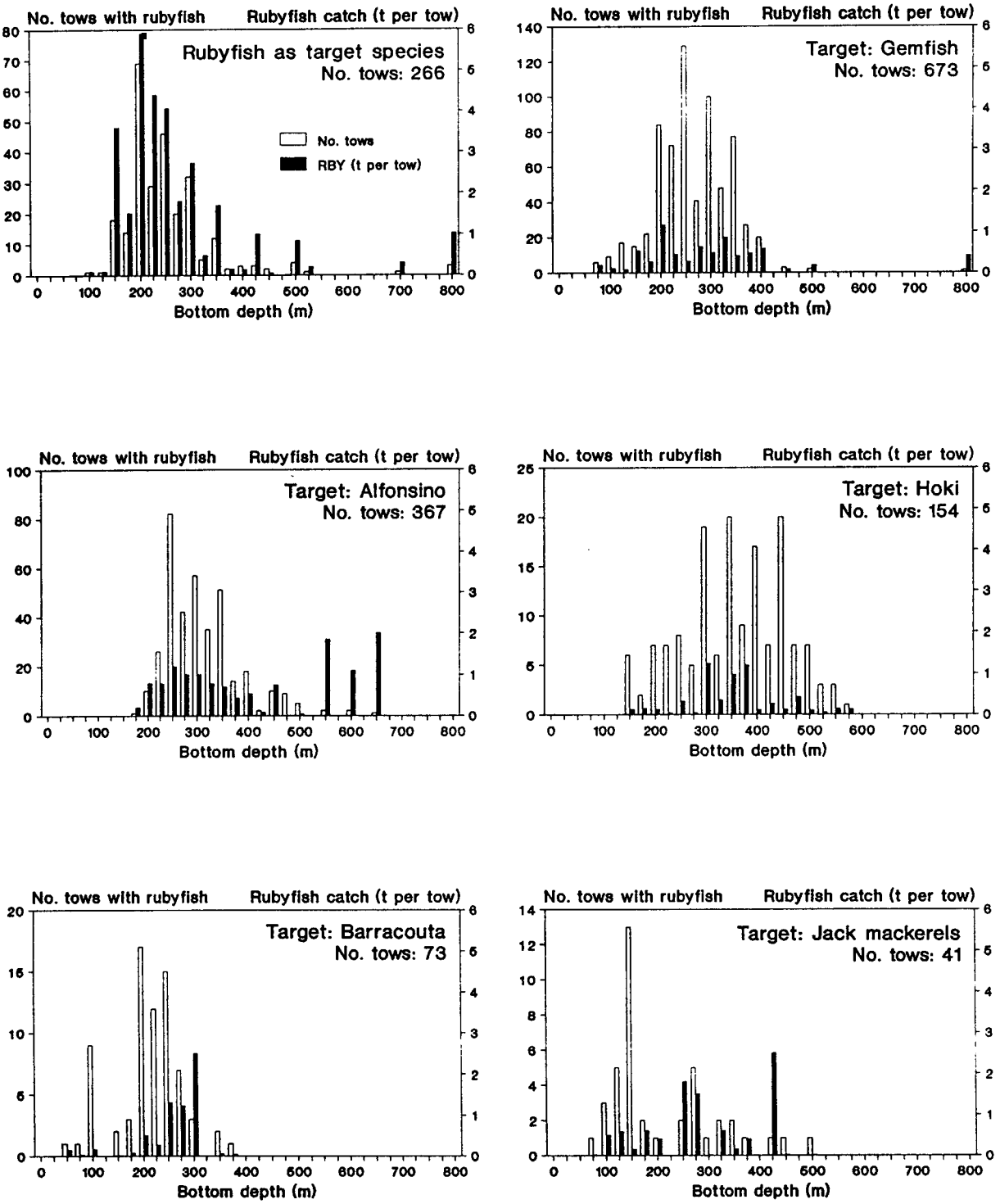

Figure 7: Depth distribution of rubyfish when caught commercially as a target species and in the main fisheries where it is taken as a bycatch. Data from 1983 to 1995, CELR and TCEPR databases *see* Table 2).

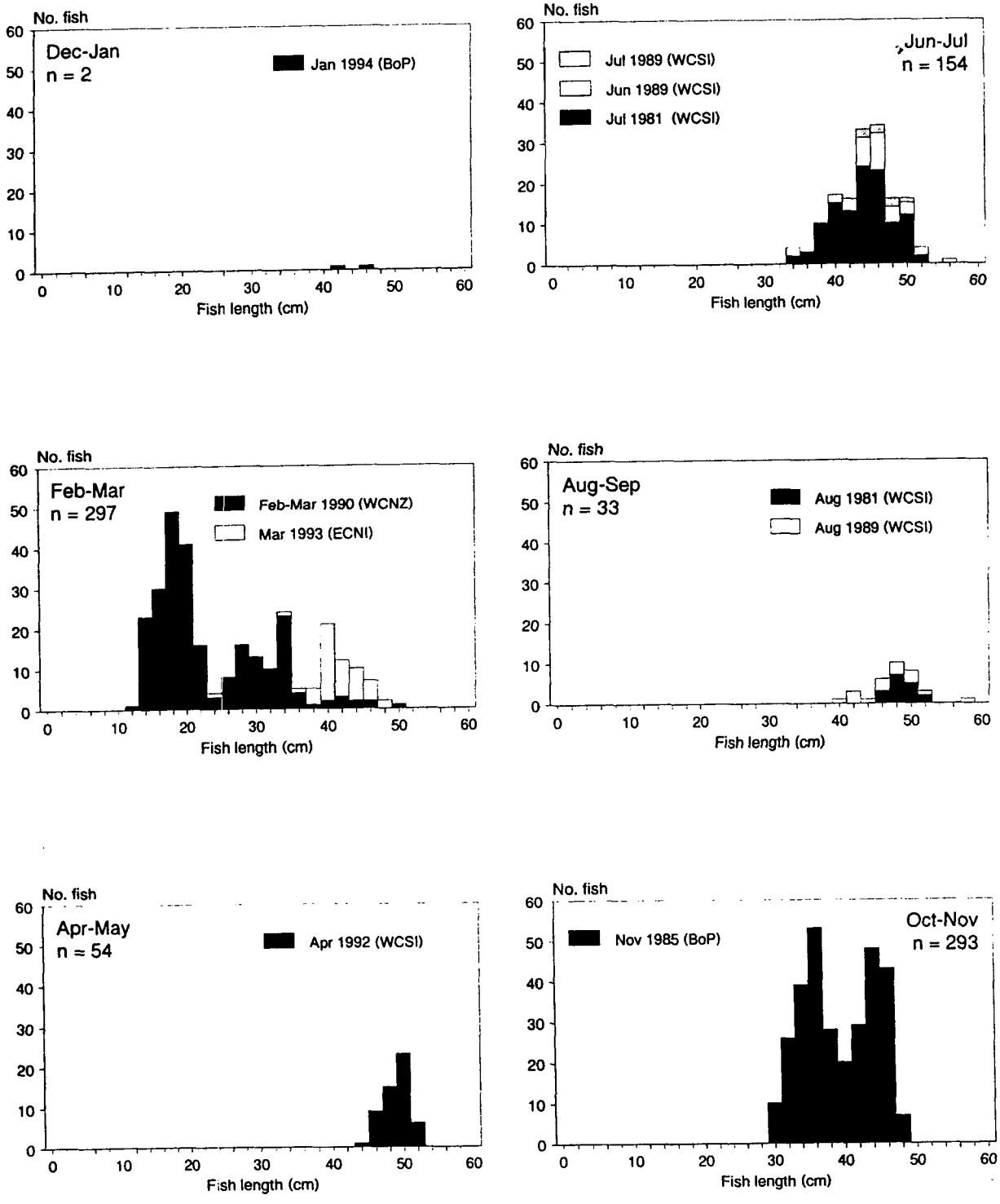

Figure 8: Length frequencies of rubyfish measured opportunistically during research trawl surveys for other species, from several vessels. Data from 10 cruises are shown separately. **Dec-Jan**, *Kaharoa* KAH9401; **Feb-Mar**, *Cordella* COR9001 and *Kaharoa* KAH9304; **Apr-May** *Kaharoa* KAH9204; **Jun-Jul**, *WJ Scott* WJS8124, *James Cook* JCO8905, JCO8906; **Aug-Sep**, *WJ Scott* WJS8126, *James Cook* JCO8907; **Oct-Nov**, *Wanaka* WAN8503.