The barracouta, *Thyrsites atun*, fishery around New Zealand: historical trends to 1984

R. J. Hurst

New Zealand Fisheries Technical Report No. 5
ISSN 0113-2180 1988
MAF Fish

The barracouta, *Thyrsites atun*, fishery around New Zealand: historical trends to 1984

R. J. Hurst

New Zealand Fisheries
Technical Report No. 5
1988

Published by MAFFish
Wellington
1988

ISBN 0-477-08070-7

MAF Fish

MAFFish is the fisheries business group of the New Zealand Ministry of Agriculture and Fisheries. It was established on 1 April 1987 and combines the functions of the old Fisheries Research Division and Fisheries Management Division and the fisheries functions of the old Economics Division.

The *New Zealand Fisheries Technical Report* series in part continues the *Fisheries Research Division Occasional Publication* series. Conference proceedings and bibliographies will now be published in the *New Zealand Fisheries Occasional Publication* series.

Inquiries to:
The Editor,
Fisheries Research Centre,
P.O. Box 297,
Wellington,
New Zealand.

Edited by S. J. Baird and G. G. Baird

Set in 10 on 11 English Times

Typesetting by Industrial Art and Communication Ltd.

Printed by Thames Publishing Co. Ltd.

Contents

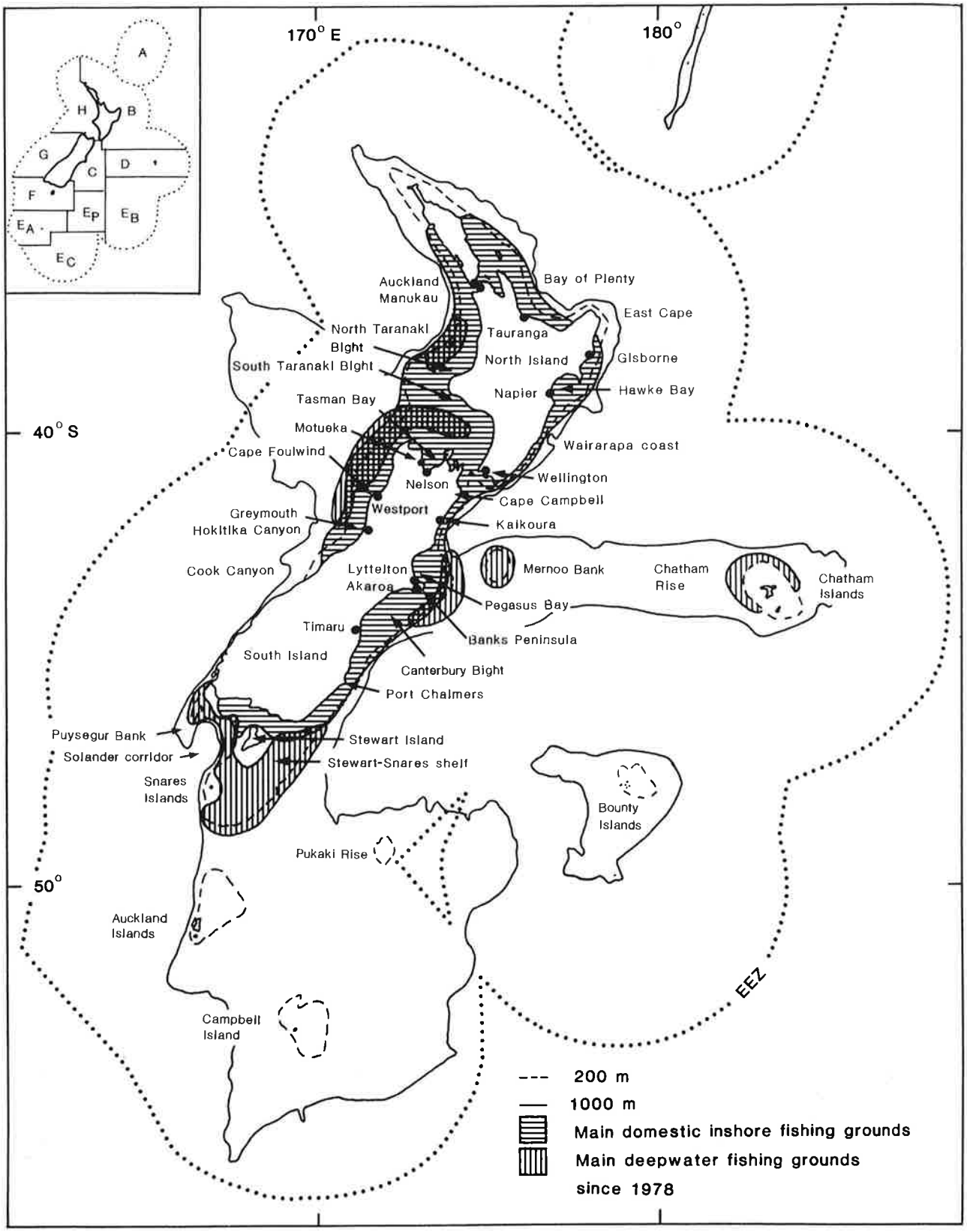


Fig. 1: New Zealand Exclusive Economic Zone fisheries management areas (B-H), main barracouta fishing grounds, and places mentioned in the text.

Abstract

Hurst, R. J. 1988: The barracouta, *Thyrsites atun*, fishery around New Zealand: historical trends to 1984. *New Zealand Fisheries Technical Report No. 5*. 43 p.

Significant exploitation of barracouta around New Zealand began in 1968 by Japanese vessels, and the fishery peaked at 47 000 t in 1977. Since the introduction of the 200 n. mile New Zealand Exclusive Economic Zone (EEZ) in 1978, additional fishing areas have been developed, and annual catches have averaged about 22 000 t. In 1984 barracouta made up about 10% of all finfish caught within the EEZ and ranked third by weight and fifth by value. They are caught almost exclusively by inshore domestic and deepwater bottom trawlers. Catching effort is seasonal and often targets the spawning concentrations. However, substantial catches are made outside the spawning season, sometimes as a by-catch of other target fisheries. The largest catches are around the South Island (EEZ areas C, G, and F). Analysis of trends in catch per unit of effort of the deepwater fisheries suggests that catch rates in areas G, D, and F have declined. This may be because populations were virgin (or near virgin) at the start of the time series. Overfishing and natural fluctuations in population size may also be contributing factors. Management of the fishery began in 1983 with the setting of a total allowable catch level of 31 000 t, based on the analysis of commercial data and research survey results.

Introduction

Distribution

Barracouta (or snoek), *Thyrsites atun* (Euphrasen, 1791) (Gempylidae), are semipelagic fish found in temperate, continental shelf waters of the Southern Hemisphere: South Australia, New Zealand, South and West Africa, southern South America, Tristan da Cunha, and the islands of Amsterdam and St. Paul.

The largest barracouta fishery is off South and West Africa, where 71 100 t were caught in 1983 (FAO 1984). Most of these fish are caught by bottom trawlers, though there is also a well established line fishery. The second largest fishery occurs in New Zealand waters, where the reported catch in the fishing year 1983–84 was 28 737 t (Table 1). Barracouta in this fishery are almost exclusively caught by bottom trawlers.

The Australian fishery supported landings of 6000 t per year in the peak fiscal years 1945–46 and 1946–47 (Winstanley 1979), but it has declined substantially over recent years, to 176 t in 1983 (FAO 1984). The main fishing method is trolling from small boats. There is also a small fishery (31 t in 1983) off Chile.

The New Zealand fishery

In New Zealand, barracouta are found in shelf waters of the North and South Islands, on the Stewart-Snares shelf, and around the Chatham Islands (Fig. 1). The largest recorded annual catches are from around the South Island, where barracouta are one of the dominant shelf species and occur mainly in 60–300 m. They are caught around the Auckland Islands, but

TABLE 1: Annual catches* (t) of barracouta from the New Zealand EEZ† from 1967

Fishing year‡	New Zealand	Japan	Korea	U.S.S.R.	Joint venture	Total
1967	232	2 276		–§		2 508
1968	569	10 744		–		11 313
1969	643	13 613		–		14 256
1970	755	16 191		–		16 946
1971	1 100	14 421		–		15 521
1972	1 428	17 118		–		18 546
1973	2 850	9 981		–		12 831
1974	3 375	18 219		–		21 594
1975	2 503	10 560		–		13 063
1976	3 673	10 151		–		13 824
1977	4 697	34 357	8 109	–		47 163
1978–79	5 335	4 781	2 481	–	58	12 655
1979–80	7 748	4 339	3 879	47	6 979	22 992
1980–81	10 058	4 227	15	60	4 995	19 355
1981–82	12 055	2 813	373	–	11 077	26 318
1982–83	10 814	1 746	1 888	31	7 110	21 589
1983	7 763	803	1 115	–	2 961	12 642
1983–84	12 372	1 786	4 353	–	10 226	28 737

* Domestic statistics and all figures since 1978–79 are from New Zealand sources. Foreign data before 1978–79 were provided by each nation.
† 200 n. mile Exclusive Economic Zone.
‡ Since the introduction of the EEZ in 1978, annual statistics are from 1 Apr-31 Mar. The fishing year changed to 1 Oct-30 Sep from Oct 1983, which resulted in a 6 month changeover period 1 Apr-30 Sep in 1983.
§ Not recorded.

have not been recorded in significant quantities from the Bounty Islands, Campbell Island, or the Pukaki Rise.

Barracouta were first caught in significant quantities in 1968, the year after Japanese trawlers had started to fish in New Zealand waters. Barracouta and jack mackerels (*Trachurus* spp.) were the main species taken by these trawlers until 1976, when exploitation of arrow squid (*Nototodarus* spp.) and some of the deeper water fisheries (e.g., hoki (*Macruronus novaezelandiae*)) increased. In the first 11 years of Japanese fishing (1967–77) an average catch of 14 300 t of barracouta was reported annually, and a peak of 34 357 t was caught in 1977 (*see* Table 1). The Koreans entered the fishery in 1977 and caught 8109 t that year.

The introduction of the 200 n. mile Exclusive Economic Zone (EEZ) in April 1978 (and interim controls in October 1977) resulted in an initial decline in annual catch by foreign trawlers and the development of new barracouta fisheries around the Chatham Islands and the Stewart-Snares shelf. The New Zealand domestic industry expanded in regions previously fished by foreign trawlers, and since 1980–81 about 50% of all barracouta caught in New Zealand waters has been landed by domestic inshore vessels. In 1984 barracouta ranked third in all finfish caught by weight (29 121 t) and fifth by export value ($10,500,000 (D. Cosh pers. comm.)).

Interim management controls were introduced on the barracouta fishery on 1 October 1983, under the deepwater trawl policy, and an annual total allowable catch (TAC) was set at 31 000 t. This publication describes general historical trends in the New Zealand barracouta fishery and provides a more detailed background to some of the data used to derive and review the original TAC (Hurst 1983, 1985, 1986). It also outlines recent developments since these controls were introduced. Historical trends in the exploitation of the barracouta resource by domestic "inshore" and foreign and joint venture "deepwater" vessels are described separately because these vessels usually operate in separate regions and record their catches in different ways. This separation is not meant to imply that the two sectors of the industry are exploiting separate populations or stocks of barracouta.

The domestic fishery

Introduction

Landings of barracouta by domestic vessels were insignificant until early 1971, when the annual tonnage first exceeded 1000 t (Fig. 2). Since then landings have increased steadily, and from 1976 barracouta have consistently ranked in the three major wetfish species landed by weight (Appendix 1). Barracouta first exceeded more than 10% of the annual wetfish landings in 1980 and topped the domestic landings at 12 220 t in 1981, though they ranked only eleventh by value ($1,578,000).

The large increase in recent years was partly due to the importation of larger domestic trawlers (at least 21 m long) under the duty-free importation scheme (1976–80) and a government subsidy paid to fishermen (May 1979 to August 1980, May 1981 to March 1982) to catch "less preferred" species (i.e., barracouta and jack mackerels).

Data sources

Domestic statistics were compiled from fishing returns submitted by fishermen to the New Zealand Ministry of Agriculture and Fisheries. Before 1983 landings were recorded by region. Data from 1974–82 have been summarised by King (1985). In 1983 the Fisheries Statistics Unit implemented a new system which now also provides data by area fished. Domestic landing regions and fishery areas are shown in Appendix 2.

The reliability of the domestic statistics for barracouta may have been influenced by several factors:

1. changes to the fishing return forms in 1974 and 1975;
2. introduction of a fisheries statistics "pilot scheme" in Nelson in 1980;
3. lack of data on the amount of barracouta not landed (i.e., dumped in favour of higher value species or used as bait).

Fishing methods

The change in fishing methods used to catch barracouta is given in Table 2. In 1940–41 and 1950 about 60% of barracouta landed was taken by line. In 1960 the catch by this method had dropped to 14% and during 1980–84 accounted for less than 0.01% of the total.

The proportion of the total catch of barracouta landed by bottom trawlers increased to 99% in 1970. In 1984 most (96%) were caught by single trawlers, the rest (4%) by pair trawlers. Purse-seine vessels have landed small catches in recent years, but there is little or no midwater trawling for this species.

Regional landings

Catches at the main barracouta landing regions for 1975–84 are shown in Fig. 3. The four major regions are all in the South Island and each has landings of more than 1000 t per year. Nelson was the most important region until Timaru recorded a tenfold increase from 1978 to 1981. This was directly related to the importation of larger trawlers in 1979 under the duty-free importation scheme. The recent decline in barracouta landings at Nelson is due to more effort being put into other fisheries, particularly the fishery for orange roughy (*Hoplostethus atlanticus*) on the Wairarapa coast.

Greymouth and Lyttelton are the third and fourth most important barracouta regions and have also

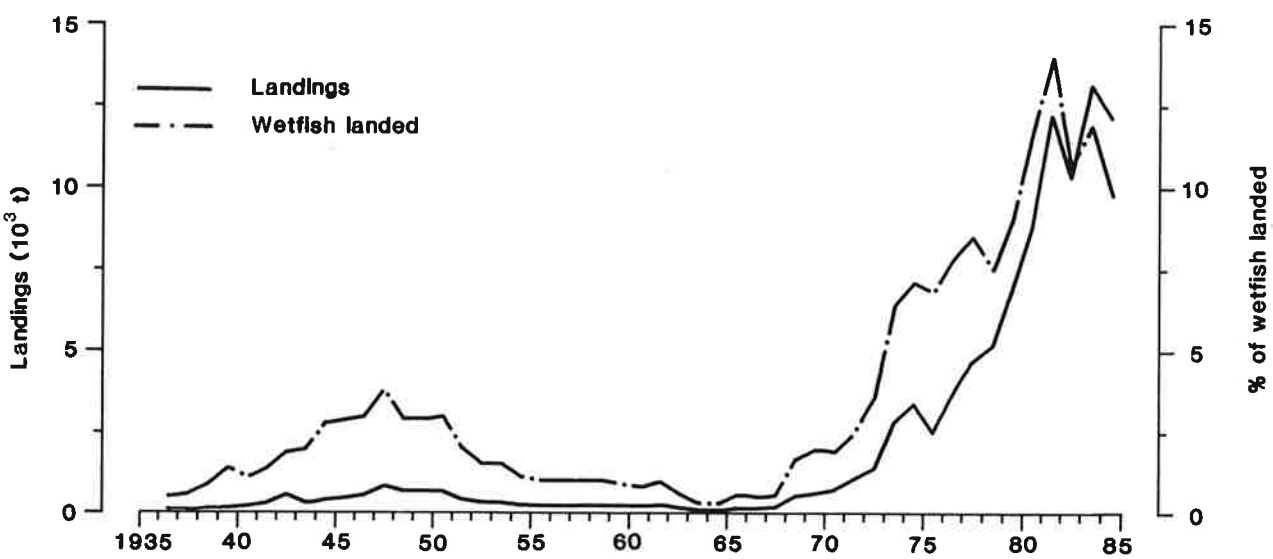


Fig. 2: Domestic barracouta landings and relative importance in the total wetfish landings from 1937–38 (April-March) to 1984.

shown dramatic increases recently. Fluctuations in annual landings in the other main South Island regions are related to the addition of larger trawlers to local fleets and their later transferral to other ports (Motueka and Port Chalmers) and to the abundance of red cod (*Pseudophycis bachus*) (Akaroa in 1979 and 1983).

The above seven South Island regions rely substantially on barracouta. For five of them, this species constituted at least 10% of all wetfish landed in most years during 1975–84 (Table 3).

Barracouta are a much less important component of wetfish landings in the main North Island regions. Annual landings have never exceeded 1000 t and have rarely constituted 10% or more of the total wetfish landed during 1975–84. This is because of the lower abundance of barracouta in North Island waters and the greater abundance of more valuable species, particularly snapper (*Chrysophrys auratus*).

Areas fished

Although many vessels catch and land barracouta locally, vessels working out of ports such as Nelson and Motueka have fished in several different regions. The landings in these two regions have made up a significant proportion of the barracouta catch (66% in 1975, decreasing to 18% in 1984), but an accurate breakdown of catch by areas fished was not possible until 1983.

The collection of domestic fishery statistics by 52 domestic fishery areas in 1983 and 1984 provided data on the locality of domestic catches (Fig. 4) and enabled comparisons with the deepwater (foreign chartered and foreign licensed) fishery in the seven EEZ areas in which barracouta are taken (Table 4).

The east coast of the South Island (area C) was the most important domestic barracouta fishery in 1983 and 1984; 5858 and 5502 t were landed (both 45% of the total domestic catch). About 60 and 40% of the Nelson and Motueka landings came from area C in 1983 and 1984, and the percentage for the previous 5 years was probably similar (*see* Fenaughty and Bagley 1981). Therefore, area C has been the most important domestic fishery since at least 1979.

Areas G, B, and H made up 16, 17, and 11% of the total in 1983 and 24, 17, and 8% in 1984. The exploitation of area F by domestic fishermen has been minimal; the 1984 landings were only 18 t, less than 1% of the total.

Seasonal landings

Regional exploitation of barracouta fisheries depends on seasonal fluctuations, which are partly due to the seasonal availability of higher value species, but are also related to the seasonal abundance of barracouta in each region. In Fig. 5, monthly landings for 1978–84 in the main ports are used to represent the regions as a whole. Monthly catches for 1983 and 1984 are shown by the more precise domestic fishery areas grouped into regions in Fig. 6.

In the Tauranga region the main season during 1978–84 was July-October, and it peaked in August-September. This pattern was also found over all the fishery areas in the Bay of Plenty, Hawke Bay, and the Wairarapa coast (domestic areas 003–016) in 1983 and 1984.

Seasonal fishing patterns at Manukau, Greymouth, and fishery areas 041–047 and 033–035 on the west coasts of the North and South Islands were similar to patterns described above, with the main peak in July-September. However, the small Tasman Bay fishery (area 038) peaked in November-February.

The seasonal fishing pattern on the east coast of the South Island was different to that of the other main areas. In the northern area, Cape Campbell to Pegasus Bay (areas 018–020), the major peak occurred in September-November, and there was a secondary peak in February. However, south of Banks Peninsula there was generally a longer fishing season (December-June). The most notable feature in monthly catches is not the peak, as in previous areas, but the sudden drop in July-August, especially since 1981. This is partly related to the comparative seasonal unavailability of barracouta and also to the movement of larger trawlers to the west coast of the South Island to catch hoki. Some of these vessels remain on the west coast after the hoki season and catch barracouta in August-September which they land into west coast ports. The atypical 1979 and 1980 landings at Timaru can be explained by the arrival of trawlers imported under the duty-free importation scheme.

The small southern South Island barracouta fishery had two seasonal peaks in 1983: October-November on the western side of Stewart Island (area 030) and February-March on the eastern side (area 026). This pattern reflects the seasonality in the much larger deepwater fishery in area F and is discussed more fully in that section.

TABLE 2: Barracouta catches (t) for different fishing methods used by domestic fishermen

	1940–41	1950	1960	1970	1980	1981	1982	1983	1984
Trawl									
Pair bottom					1 528	1 829	1 385	1 601	461
Single bottom					7 289	10 373	8 863	11 376	11 632
Midwater					3	2		1	
Total*	105	284	190	748	8 820	12 204	10 249	12 978	12 092
Danish seine		-†		2	1	-	1	-	1
Purse seine				1	9	9	27	169	31
Line	133	375	31	-	1	1	-	-	1
Net				-	3	7	2	4	6
Total*	238	659	221	755	8 833	12 220	10 278	13 151	12 131

* Some totals are ±1 t because of rounding errors.
† Less than 0.5 t.

TABLE 3: Barracouta as a percentage of total finfish landed in the major regions*

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
South Island										
Timaru	6.3	12.0	14.5	9.6	24.0	39.2	52.3	38.2	42.0	31.2
Nelson	43.4	36.5	40.6	21.6	20.0	22.6	25.7	14.6	10.4	7.4
Greymouth	8.6	21.4	10.9	8.0	12.4	18.5	20.4	24.8	22.5	18.7
Lyttelton	4.8	5.0	7.1	6.5	8.6	12.8	6.6	13.1	30.0	25.3
Westport	10.3	0.0	0.8	0.5	1.5	0.6	2.8	4.8	6.6	10.3
Port Chalmers	5.4	7.4	5.9	11.1	9.7	35.3	25.9	9.3	4.0	0.1
Motueka	14.0	18.1	31.3	29.8	33.6	24.2	27.3	35.5	19.9	23.3
Akaroa	1.5	10.0	15.2	13.1	5.8	11.1	48.3	50.0	10.9	9.6
North Island										
Manukau	4.2	3.9	3.8	4.8	6.3	13.3	9.4	9.5	13.4	6.7
Wellington	0.3	0.5	2.1	0.9	1.2	0.9	0.4	3.7	6.5	14.0
Auckland	2.3	2.2	1.8	3.0	4.6	4.0	5.0	4.2	9.1	6.3
Napier	1.2	0.0	0.2	0.7	0.1	0.1	0.1	2.3	4.6	11.6
Tauranga	1.9	4.4	4.3	8.1	4.9	4.8	6.4	4.8	11.8	8.2
Gisborne	0.0	0.0	0.6	0.7	1.0	1.5	0.4	2.1	4.9	4.6

* Landing regions are shown in Appendix 2.

TABLE 4: Domestic and deepwater barracouta catches (t) and percentage of total finfish catch by EEZ area for 1983 and 1984

Year	EEZ area†	Registration* DOM	FCD	LIC	Total	%	% of total finfish
1983	B	2 166			2 166	8.1	5.3
	C	5 858	569	3	6 430	24.1	16.5
	D	380	2 529	1 256	4 165	15.6	10.4
	E‡		274	2 014	2 288	8.6	5.7
	F‡	402	1 896	755	3 053	11.5	13.6
	G	2 044	2 048		4 092	15.4	12.7
	H	1 424	1 106	1 055	3 585	13.5	8.0
	Unknown	877	5		882		
	Total	13 151	8 427	5 083	26 661		10.2
1984	B	2 120			2 120	7.3	4.3
	C	5 502	169		5 671	19.5	13.0
	D	1	1 676	257	1 933	6.6	5.2
	E		914	5 265	6 179	21.2	17.1
	F	18	4 672	1 090	5 780	19.9	16.8
	G	2 924	1 791		4 715	16.2	12.0
	H	991	642	514	2 147	7.4	4.9
	Unknown	576	1		577		
	Total	12 131	9 865	7 125	29 121		10.4

* DOM, domestic; FCD, foreign chartered; LIC, foreign licensed.
† Catch in area A is zero.
‡ The boundary between areas E and F was changed on 1 Oct 1983.

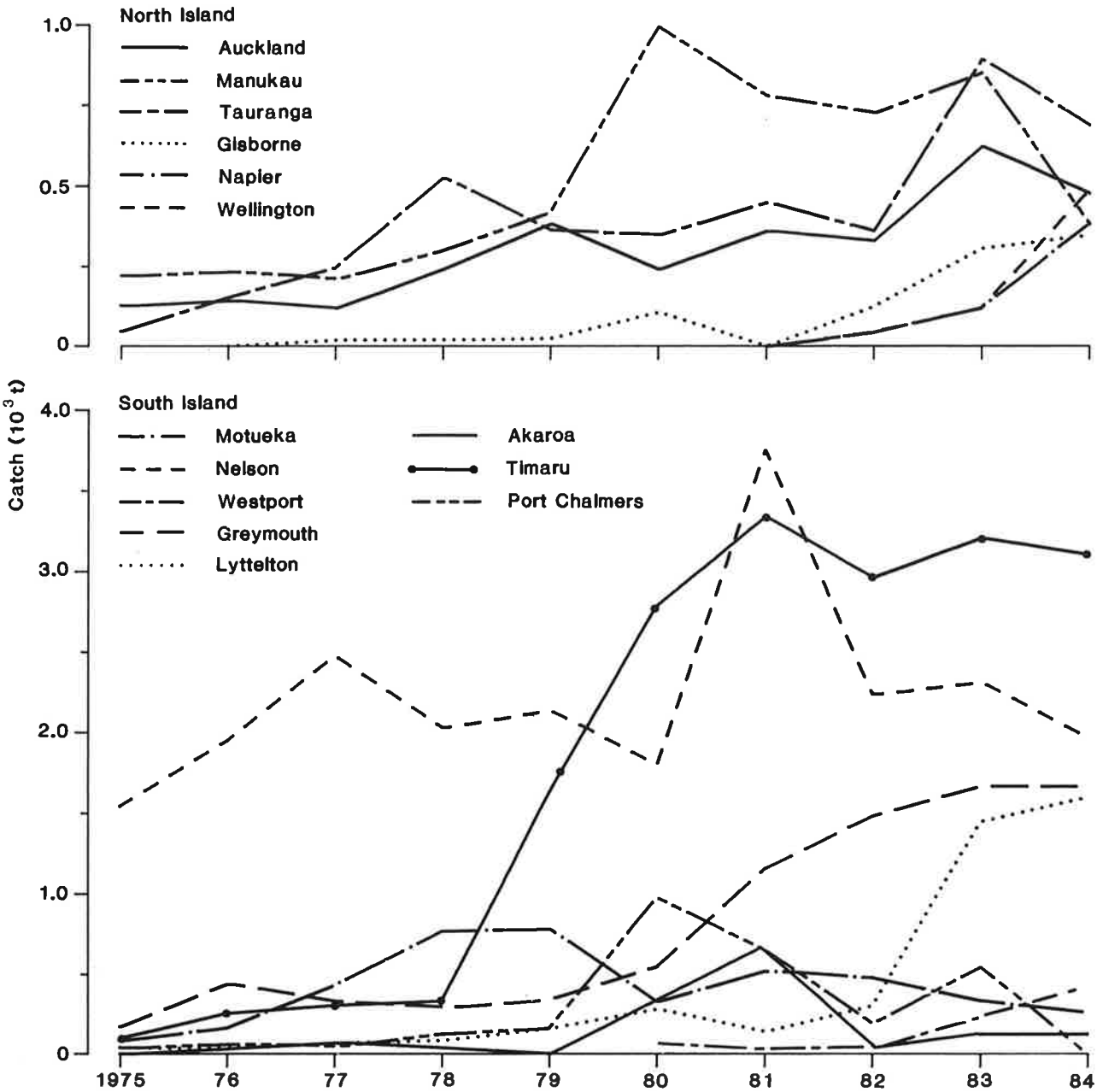


Fig. 3: Barracouta catch in major landing regions (where the average of the 10 year catch or the 1984 catch exceeded 100 t), 1975-84. (The 1980 figure for Nelson may be low because of the fisheries statistics pilot scheme which operated in that year.)

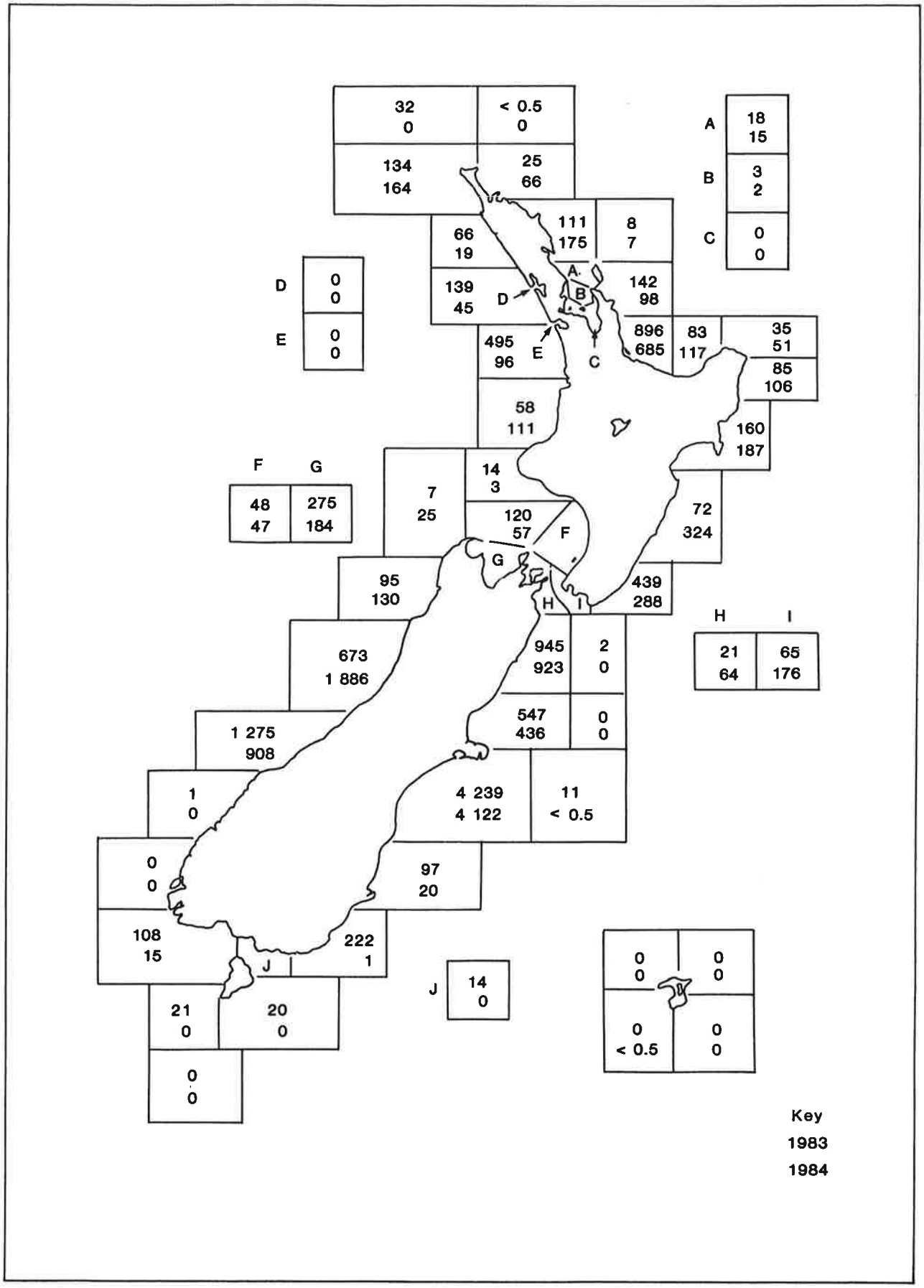


Fig. 4: Barracouta catch (t) by domestic fishery area for 1983 and 1984. (Area not known: 1983, 1340 t; 1984, 578 t.)

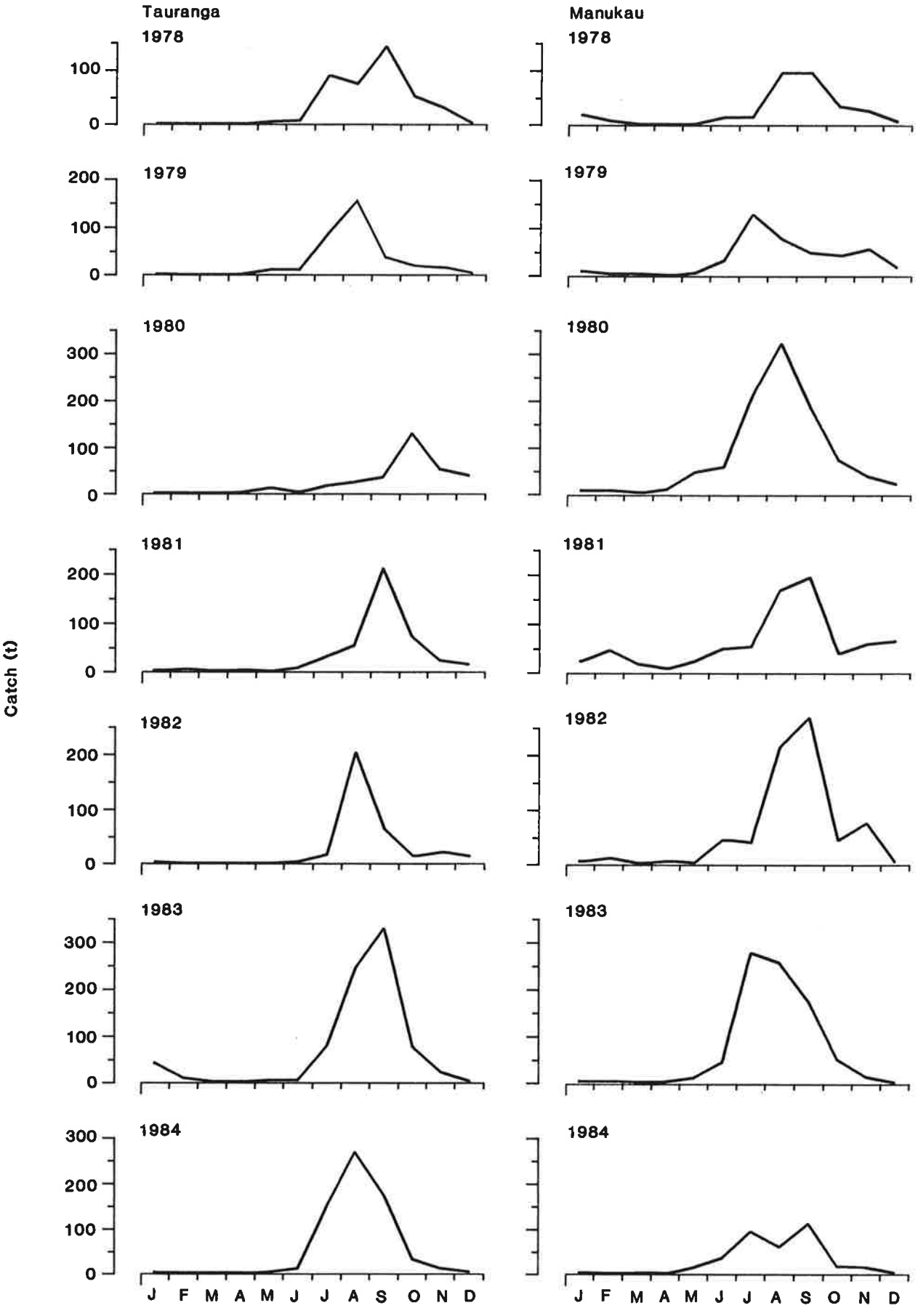


Fig. 5: Monthly barracouta catch in the four main domestic landing regions.

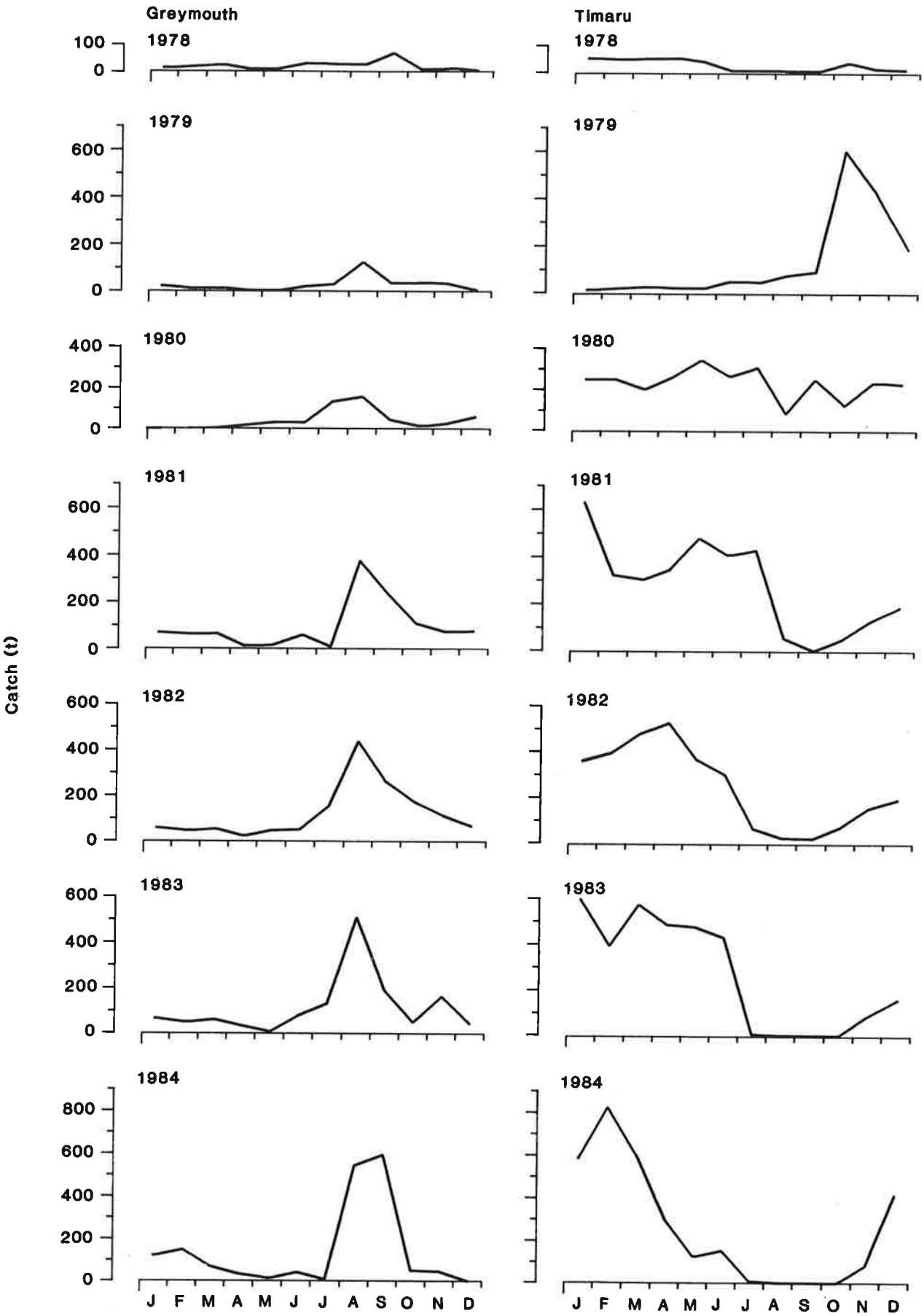


Fig. 5—*continued.*

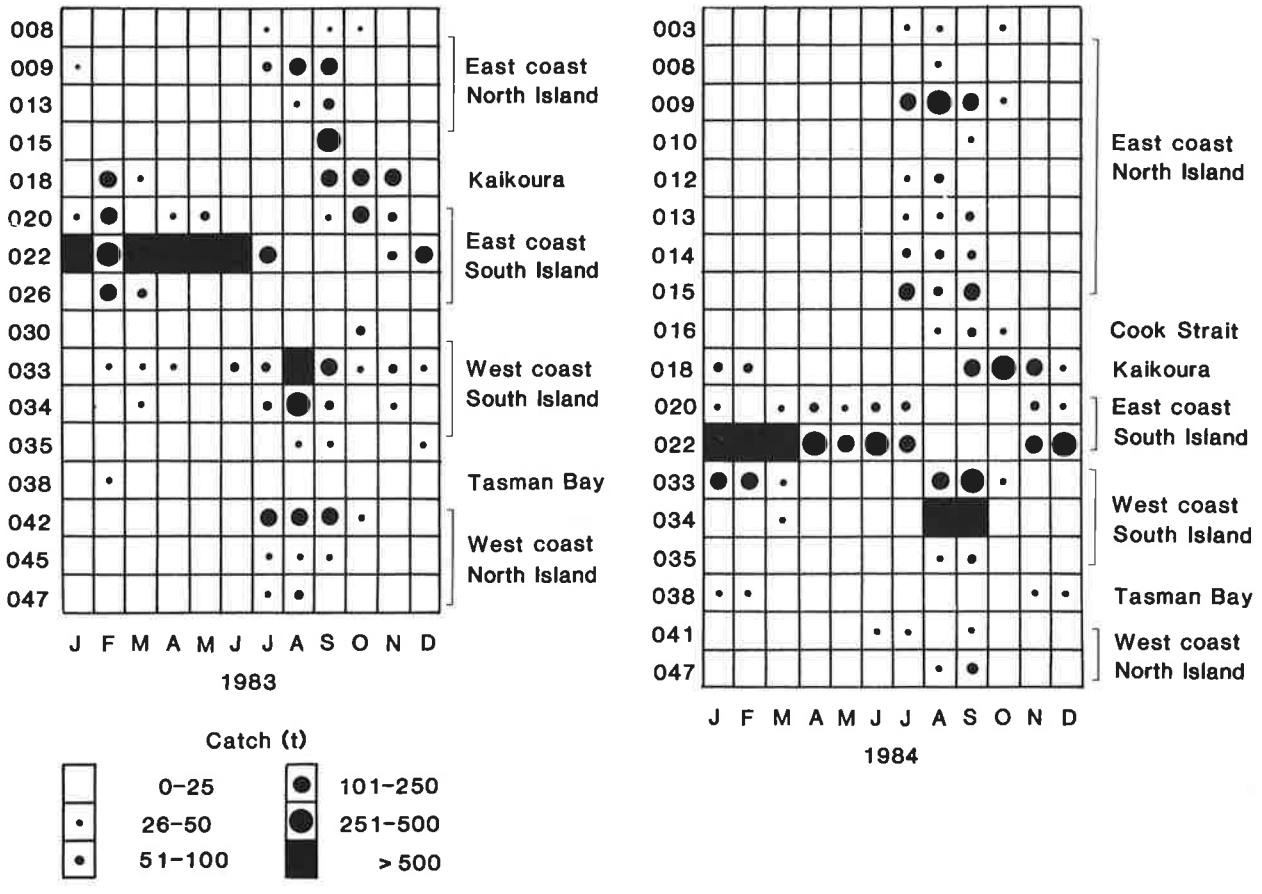


Fig. 6: Monthly barracouta catch by domestic fishery area (for areas where the annual total was at least 100 t).

Foreign and joint venture fisheries

Introduction

Before the implementation of the 200 n. mile EEZ in April 1978, foreign trawlers were excluded only from the 12 n. mile territorial sea and, therefore, had access to much of the shallow, continental shelf waters around mainland New Zealand.

However, with the introduction of the EEZ, and the associated interim control measures brought in on 1 October 1977, foreign vessels were excluded from extended closed areas along the coasts of the North and South Islands and later from several EEZ areas (Fig. 7). In addition, total area quotas and some species quotas were imposed, and minimum cod-end mesh sizes were introduced. Full details of trawling restrictions which have influenced deepwater barracouta fisheries are given in Appendix 3.

Joint venture (called foreign charter after April 1983) companies rapidly developed, and their vessels were allowed into some of the areas from which foreign licensed vessels were excluded. However, joint venture vessels were still excluded from the extended coastal closed areas, and this had a major influence on the barracouta fishery and its development. New areas south of the South Island (area F) and the Chatham Rise (area D) were more extensively fished, and catches of barracouta in these areas increased significantly.

On 1 April 1983 the deepwater trawl policy was introduced, and New Zealand companies with foreign chartered or large domestic vessels were given a 10 year allocation of the major deepwater species (Anon. 1982). Barracouta quotas were also brought in under this policy on 1 October 1983.

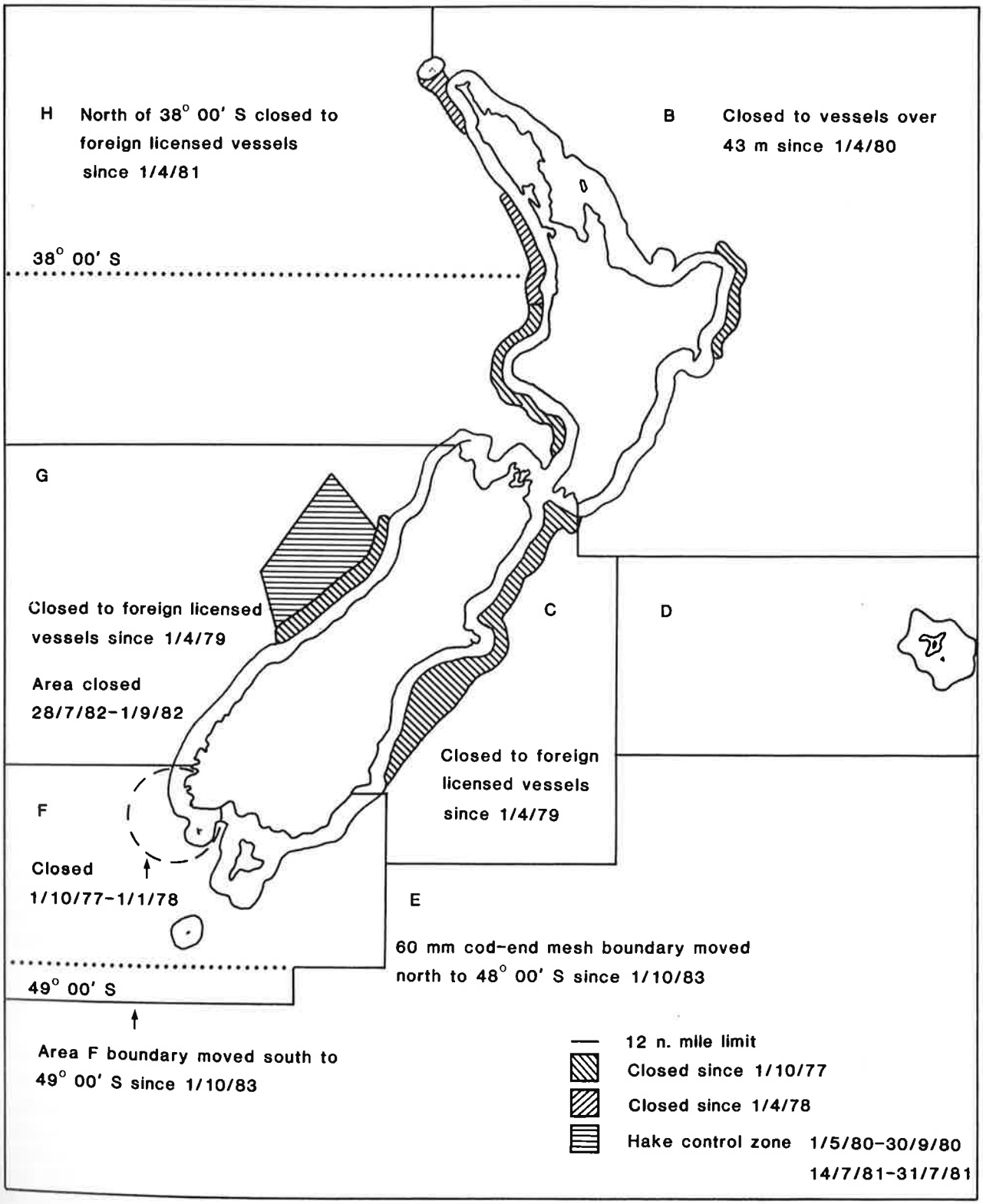


Fig. 7: Trawling restrictions on foreign licensed and foreign chartered vessels since 1 October 1977 which may have affected deepwater barracouta fishing patterns.

Data sources and presentation

Most of the data available on foreign fishing for barracouta before the introduction of the EEZ comes from the Japanese (1972–77 logbooks held at Fisheries Research Centre (FRC), Saito and Sato 1977), and they have continued to supply unpublished, annual catch statistics summaries for both their licensed and chartered fleets since 1978 (unpublished documents held on FRC Japan file, FRC). However, these recent reports do not include data for barracouta in areas C, G, and D and, therefore, are of little value in comparing pre- and post-EEZ catch rates.

Barracouta catches by Soviet vessels before 1978 are unknown, but probably formed part of the "mix" or "meal" categories in their catch records. Korean vessels did not trawl in New Zealand waters until 1977.

Since the introduction of the EEZ, all foreign licensed and foreign chartered vessels have been required to record individual trawl shot catches. This has enabled detailed analysis of catches and catch per unit of effort (CPUE). However, analysis of these CPUE data for barracouta has several complications:

1. Individual station data recorded in deepwater logbooks include estimated catches of the major species only. These data were used for CPUE analysis. Actual processed weights were only recorded once per day. The accuracy of the estimated catches is unverifiable.
2. Barracouta are often a by-catch of other fishing operations, for example, target fishing on squid in areas F-E and jack mackerels in area H. Therefore, only CPUE data for the barracouta target fishery have been used. This has meant that CPUE can only be analysed in detail from 1978–79, though some CPUE data are available from the Japanese effort in 1977. These earlier data are not strictly comparable because the amount of target effort was not given, and there were no mesh size regulations in force.
3. Barracouta may have been recorded occasionally as the target species only because they formed the largest proportion of the catch. If this happened to a significant extent, the CPUE figures would be overestimations.
4. Barracouta are often very localised, and analysis of CPUE data by EEZ area may be on too large a scale. Fishing effort is usually concentrated into two or three half-degree, latitude by longitude squares. Therefore, CPUE data have been presented in three ways: as monthly summaries by EEZ area; as monthly summaries of catches, CPUE, and areas target fished by half-degree squares; and as annual comparisons of CPUE in which only the three half-degree squares with the largest catches were included.
5. Barracouta fisheries are very seasonal, and only the peak target seasons can be compared between years. The annual comparisons of CPUE were done on a weekly basis during these peaks (defined as over 10 t per week per half-degree square).
6. Vessels which have fished for barracouta in the EEZ since 1978–79 have ranged in size from 300 to 4000 t. The catching capacity of these vessels varies substantially, but this is difficult to allow for because the annual fishing patterns vary greatly also. Annual comparisons of CPUE have been made only where a breakdown of these data by tonnage class was practical (where the tonnes per tonnage class per month exceeded 50 t in at least 3 years).
7. Data for the 1980–81 fishing year are unedited, and the extract program used to analyse data by half-degree squares and tonnage classes cannot be used on these data at present.
8. A cod-end mesh size of 60 mm was allowed in area E until October 1983 and thereafter in area F also, south of 48° 00′ S (100 mm for the rest of the EEZ). This may influence CPUE data.
9. Probable misreporting of barracouta since the introduction of the deepwater policy, particularly in area E, means that 1983–84 CPUE data for areas E, F, and possibly D may be inaccurate.

Annual catches

Foreign and joint venture vessel catch statistics from 1967 to 1982–83 were given in Table 1. The importance of barracouta to Japanese and Korean foreign and joint venture operations is shown in Fig. 8 (Soviet barracouta catches do not appear because this species was not recorded before 1978 and has remained insignificant or unrecorded). Although the proportion of barracouta in deepwater catches has declined from 30–50% in the early 1970s to 5–10% since 1978, barracouta are still an important part of the catch and rank fourth or fifth by weight.

The main influence of the EEZ has been to limit the total catch of all finfish and to place quotas on some species. However, the barracouta catch remained uncontrolled until 1 October 1983, and the greatest effect of EEZ regulations on the deepwater barracouta fishery has not been on the annual catches, but on the areas fished.

Fishery areas

Japanese fisheries, 1967–77

When the Japanese trawlers began to fish in New Zealand waters in 1967 they were only restricted from fishing inside the 12 n. mile territorial sea (introduced in 1965). Intensive fishing began in 1968 and concentrated on barracouta on the east coast of the South Island (areas D2 and D4) and jack mackerels on the west coasts of the North and South Islands (areas D7 and D8, Fig. 9).

The barracouta catch from the east coast fishery averaged 9900 t per year (range 5700 to 14 300) during 1968–75 and constituted 79% of all barracouta caught by the Japanese in these years. Saito and Sato (1977) recorded a decline from 2.2 to 0.4 $t.h^{-1}$ for the target fishery over the same period.

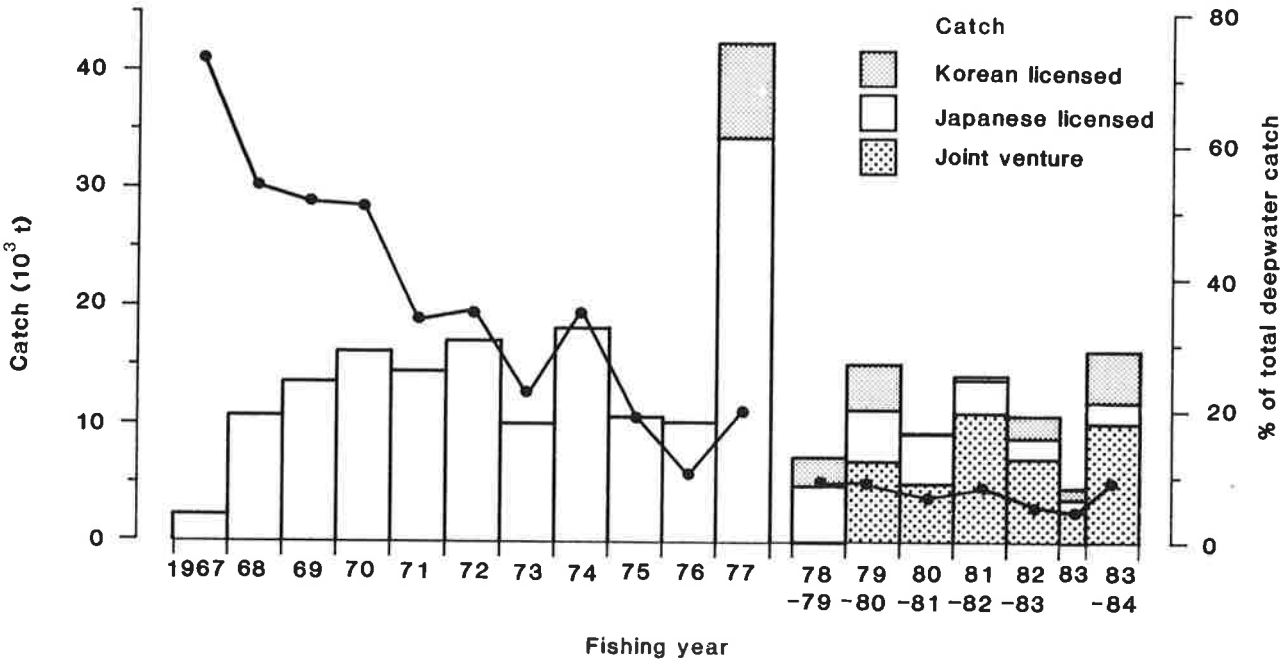


Fig. 8: Deepwater barracouta catch and relative importance in total deepwater catch. (1967–77, Japanese data only; 1978–79 to 1983–84, all foreign licensed and foreign chartered vessels. Total includes arrow squid.)

Barracouta were caught on the west coast of the North Island mainly as a by-catch of the northern jack mackerel fishery. It was not until 1974 that the more productive barracouta grounds off the west coast of the South Island (area D7) began to be exploited. Hence, target CPUE figures are low (under 1 $t.h^{-1}$) compared with those of the east coast fishery.

The effect of increased Japanese effort and new Korean effort in 1977–78 was substantial; 57% of the total estimated deepwater catch of 43 950 t of barracouta came from the west coast South Island fishery (Table 5, Fig. 10). Target fishing in the peak month of September caught 10 949 t at 4.2 $t.h.^{-1}$. A new and significant fishery for barracouta was also found around the Chatham Islands in the summer of 1977–78. The main areas of Japanese fishing for 1977 are shown in Fig. 11.

Deepwater fisheries from 1978–79

Foreign licensed vessels were excluded from areas C and G from April 1979 and area B from April 1980. Joint venture vessels were also excluded from area B, closed areas in area C, and some areas in area G which were permanently or seasonally closed. Areas C and G were the main fishing grounds for barracouta up to 1978. However, new grounds rapidly developed, particularly in the southern areas F and EA. Foreign licensed and joint venture vessels continued to be restricted from fishing in the 12 n. mile territorial sea. Annual catches by EEZ area by nation from 1975–76 to 1983–84 are given in Table 5.

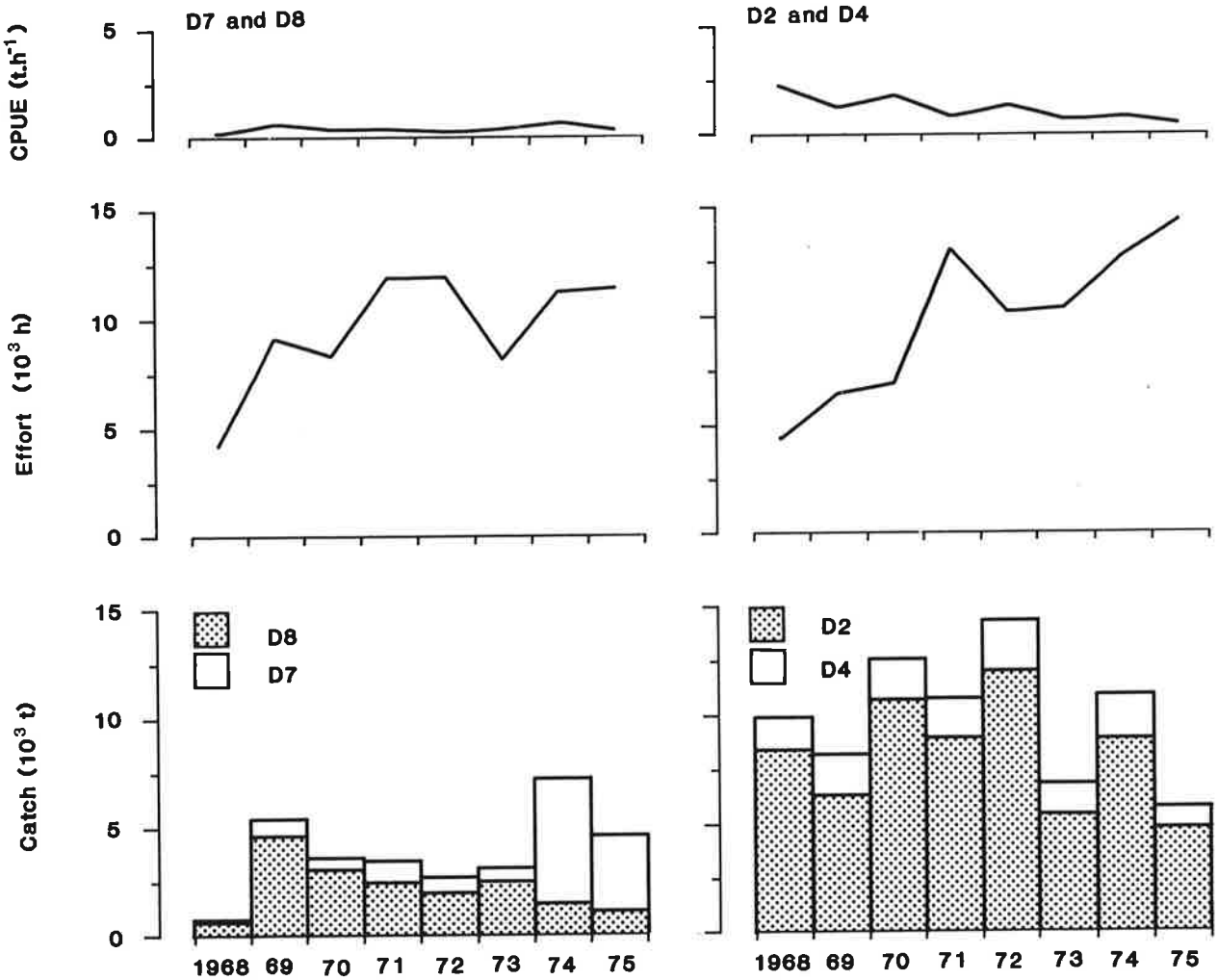
Chatham Islands (area D). Fishing effort for barracouta around the Chatham Islands has been very erratic since it began in 1977 and has been partly related to the onset of the squid fishery in area EA (Kawahara 1983). However, there appeared to be a seasonal peak in catches during December-February (Fig. 12), and more than 50% of the barracouta caught during these summer months was targeted for. There was a secondary peak in catches in the winters of 1979, 1983, and 1984, when some vessels remained in the area.

The main area and season of the fishery in area D (and other EEZ areas described later) is defined here as those half-degree squares for which at least 100 tonnes per month were target fished at a CPUE of at least 1 $t.h^{-1}$.

The main summer and the 1983 and 1984 winter target fisheries took place almost exclusively in one half-degree square west of the islands: 43° 30′ to 44° 00′ S, 177° 30′ to 177° 00′ W (Fig. 13). The winter fishery in 1979 occurred on the eastern side of the islands (mainly in one half-degree square: 43° 30′ to 44° 00′ S, 176° 00′ to 175° 30′ W) and may have been associated with a winter fishery for squid in the area.

Catch rates during the peak summer months (December-February) were generally over 1 $t.h^{-1}$. However, the CPUE has dropped since 1979–80 from 3.4 to under 1 $t.h^{-1}$ in 1983–84. The larger catch rates (over 1 $t.h^{-1}$) have been recorded in 170–300 m and have not shown a clear peak during daylight (0400–2000 h New Zealand Standard Time in summer, 0500–1800 h in winter).

Analysis of CPUE by tonnage class (Table 6, Fig. 14) shows that little effort was put into the fishery by the smaller vessels (classes 1 and 2). The suggested decline in the overall peak CPUE from 1979–80 to 1983–84 was also apparent for the CPUE of the larger vessels (classes 3 and 4).



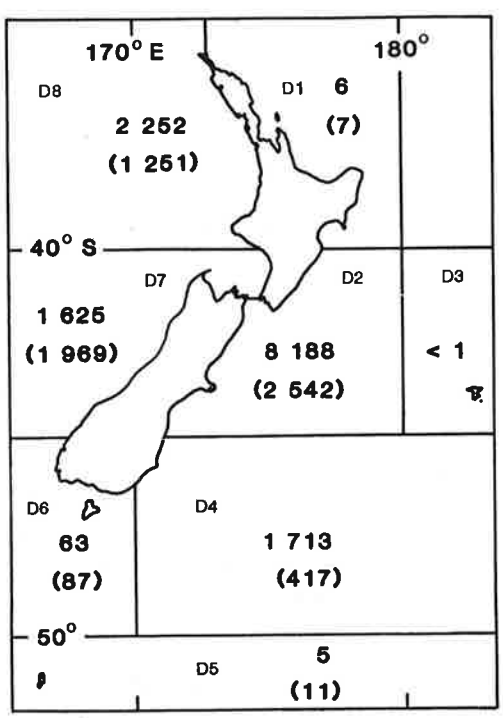


Fig. 9: A, Japanese statistical areas and mean annual barracouta catch (t) (and standard deviation), 1968–75; B, catch, effort, and CPUE for barracouta target fisheries, 1968–75 (after Saito and Sato 1977).

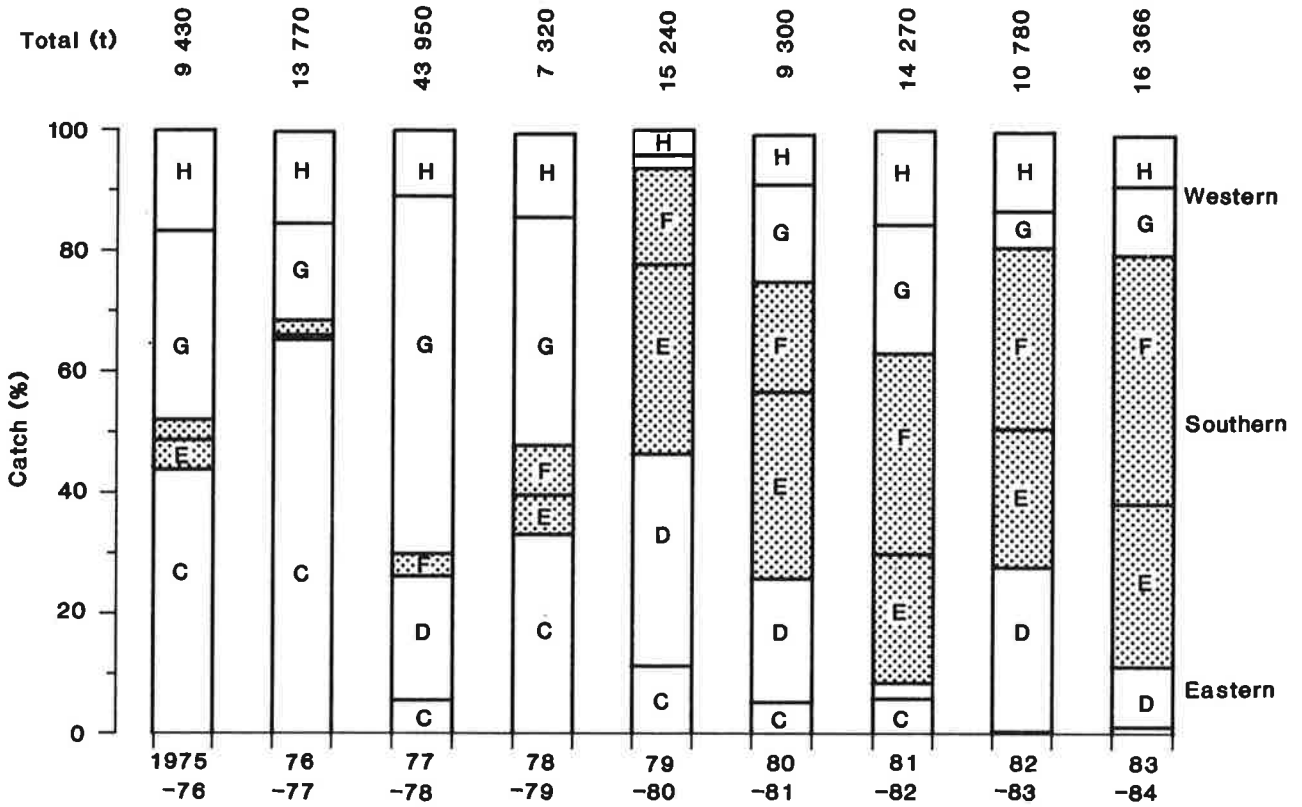


Fig. 10: Barracouta catch by EEZ area by foreign chartered (previously joint venture) and foreign licensed trawlers, 1975–76 to 1983–84. (1983–84, 1 October-30 September; other years, 1 April-31 March. The 6 month changeover in 1983 is omitted.)

Stewart-Snares shelf (areas F-EA). Since the introduction of the EEZ this region has supported the largest deepwater barracouta fishery. Most of the barracouta caught was reportedly targeted for; up to 95% in area F in 1981–82 (Fig. 15) and up to 80% in area EA in 1980–81 (Fig. 16), though they are also taken as a by-catch of other fisheries (e.g., arrow squid and common warehou (*Seriolella brama*)).

The fishery was effectively split in two by the pre-October 1983 F-EA boundary at 48° 30′ S. The description given here is based on this division.

The fishing season for barracouta normally begins in October on the western side of Stewart Island, in the Solander corridor. The largest monthly catches were taken from this region and to the east of Stewart Island during October-December (Fig. 17). Catches and catch rates were low in January in both area F and area EA. Fishing effort then moved south to the southern side of the Snares Islands (part of area EA until 1983) for the beginning of the squid season. Monthly catches in this area peaked in February-March. There was a secondary peak in May-July in 1981–82 and 1982–83. The larger catches and catch rates (over 1 $t.h^{-1}$) have been recorded in 70–200 m in the Solander corridor and 120–260 m around the Snares Islands, and there was no clear peak during daylight (0500–2000 h).

The CPUE data for the Stewart-Snares shelf has been divided into the two subregions because of the difference in monthly peaks and in cod-end mesh size regulations. In area F the minimum size allowed until October 1983 was 100 mm, whereas in area EA 60 mm cod-end mesh was allowed, mainly so that squid could be caught. This could result in higher catch rates of barracouta in area EA.

In area F the overall CPUE in the peak months of November-December was low (about 1 $t.h^{-1}$) until 1981–82. When the data are broken down by tonnage class the only vessels fishing at this time were the smaller class 1 and class 2 vessels (*see* Table 6). The substantial target fishery was not developed until 1981–82, and the larger vessels (class 4) now appear to dominate the fishery. The CPUE of class 2, class 3, and class 4 vessels has declined slightly since 1981–82 (*see* Fig. 14).

In area EA the February-March overall CPUE fluctuated between 1 and 2 $t.h^{-1}$ from 1979–80 to 1981–82. The amount of target fishing in 1982–83 was insignificant. Analysis of CPUE by tonnage class is complicated by erratic fishing patterns and is inconclusive.

Since barracouta quotas were introduced in October 1983 large catches have been reported from around the Auckland Islands by some Korean vessels (for area E: 1983–84, 4232 t; 1984–85, 4780 t). The location of most of these catches was probably misreported because there was no barracouta limit set in area E in these years. Results of trawl surveys by *Shinkai Maru* (Kawahara and Tokusa 1981, van den Broek *et al.* 1984, Uozumi *et al.* 1987) showed negligible catches of barracouta in this area. In addition, other vessels, particularly Japanese, fishing at the same time in the

TABLE 5: Foreign and joint venture (JV) barracouta catches (t), 1975–76 to 1983–84

Year*	Nation	EEZ area B	C	D	E†	F†	G	H	Total
1975–76	Japan	8	4 130	–‡	462	309	2 943	1 574	9 427
1976–77	Japan	36	8 979	5	106	331	2 208	2 106	13 770
1977–78	Japan	4	2 380	8 732	3	1 590	18 442	4 693	35 843
	Korea						6 657§		8 109
	Total						25 099		43 952
1978–79	Japan	25	2 403	–	439	603	646	666	4 781
	Korea	–	–	16	–	–	2 113	352	2 481
	JV	–	22	–	35	1	–	–	58
	Total	25	2 425	16	474	604	2 759	1 018	7 320
1979–80	Japan	8	–	722	3 085	240	–	284	4 339
	Korea	–	–	2 490	309	836	–	244	3 879
	U.S.S.R.	–	–	–	2	28	17	–	47
	JV	3	1 716	2 136	1 378	1 313	318	113	6 979
	Total	11	1 716	5 348	4 774	2 417	335	641	15 244
1980–81‖	Japan	–	–	1 441	2 127	280	18	360	4 227
	Korea	–	–	–	15	–	–	–	15
	U.S.S.R.				60				60
	JV	55	435	467	665	1 414	1 484	410	4 995
	Total	55	435	1 908	2 867	1 694	1 502	770	9 296
1981–82	Japan	–	–	96	1 404	234	8	1 071	2 813
	Korea	–	–	27	162	153	–	31	373
	JV	–	842	253	1 493	4 329	3 033	1 129	11 077
	Total	–	842	376	3 059	4 716	3 041	2 231	14 266
1982–83	Japan	–	4	194	589	326	–	630	1 746
	Korea	–	–	482	1 268	132	–	6	1 888
	U.S.S.R.	–	–	–	31	–	–	–	31
	JV		37	2 267	570	2 769	650	780	7 110
	Total	–	41	2 943	2 458	3 227	650	1 415	10 776
1983	Japan	–	–	430	4	98	–	271	803
	Korea	–	–	256	710	31	–	117	1 115
	U.S.S.R.	–	–	–	–	–	–	–	–
	FCD¶	–	467	285	12	26	1 970	201	2 961
	Total	–	467	971	726	155	1 970	589	4 879
1983–84	Japan	–	–	151	5	1 214	–	417	1 786
	Korea	–	–	225	3 800	298	–	31	4 354
	U.S.S.R.	–	–	–	–	–	–	–	–
	FCD	–	190	1 367	619	5 203	1 869	978	10 226
	Total	–	190	1 643	4 424	6 175	1 869	1 426	16 366

* Years before 1983 are 1 Apr-31 Mar; 1983, 1 Apr-30 Sep; from 1983–84, 1 Oct-30 Sep.
† The areas F-E boundary changed on 1 Oct 1983.
‡ Not recorded.
§ Only area G catch is known. The rest came from other areas, but was unspecified.
‖ 1980–81 data are unedited.
¶ Foreign chartered (previously joint venture) vessels.

same depths did not report significant quantities of barracouta. Therefore, catch and CPUE data for area EA for 1983–84 in Table 6 and Figs. 14 and 16 refer to the old area EA Snares Islands fishery only and do not include data from the area EA Auckland Islands fishery (these data are presented only in Fig. 17).

West coast South Island (area G). The pattern of deepwater fishing in area G has been greatly affected by regulations introduced since 1 October 1977. Access to the major barracouta grounds was restricted by the 25 n. mile closed area, and there were additional area closures during and after the hake (*Merluccius australis*) and hoki seasons, which immediately preceded the barracouta season (*see* Fig. 7, Appendix 3). Foreign licensed vessels were given catch limits on barracouta in 1978–79 (11 250 t) and were excluded after April 1979.

The seasonality of barracouta fishing in area G recently has become similar to that for the inshore domestic fleet. Catches peaked in August-September, when a high percentage (over 75% since 1981–82) of barracouta was reportedly targeted for (Fig. 18). In 1978–79 some target fishing also occurred in other months, but significant catches and catch rates by half-degree square (at least 100 tonnes per month at at least 1 $t.h^{-1}$) were only recorded in May 1978–79. Target catch and CPUE for area G are shown in Fig. 19.

The main area now fished is limited, from the Hokitika Canyon north to Cape Foulwind. This contrasts with Japanese fishing in 1977, when large catches were made south of the Hokitika Canyon as far as the Cook Canyon (*see* Fig. 11). Catch rates of over 1 $t.h^{-1}$ have been recorded in 170–350 m from 0500 to 1800 h.

TABLE 6: Trends in CPUE from 1977 to 1983–84* by vessel tonnage class

			Tonnage class													
			Class 1 (0–550)			Class 2 (550–1500)			Class 3 (1500–2500)			Class 4 (2500–4000)			Total	
EEZ area	Year†	Weeks‡	Catch (t)	No. of hours	CPUE ($t.h^{-1}$)	Catch (t)	No. of hours	CPUE ($t.h^{-1}$)	Catch (t)	No. of hours	CPUE ($t.h^{-1}$)	Catch (t)	No. of hours	CPUE ($t.h^{-1}$)	Catch (t)	No. of hours	CPUE ($t.h^{-1}$)
D	1977§	48–53	-‖	-	-	-	-	-	-	-	-	2 202	1 089	2.0	2 202	1 089	2.0
	1978–79	48–53	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1979–80	49–52	112	75	1.5	-	-	-	820	226	3.6	536	119	4.5	1 468	420	3.5
	1981–82	50–52	4	18	0.2	-	-	-	-	-	-	97	60	1.6	101	78	1.3
	1982–83	1–6	-	-	-	62	56	1.1	1 318	777	1.7	556	362	1.5	1 936	1 195	1.6
	1983–84	52–4	64	60	0.9	3	8	0.4	156	185	0.8	19	18	1.1	242	271	0.9
F	1977	48–53	-	-	-	1 063	837	1.3	-	-	-	-	-	-	1 063	837	1.3
(Solander)	1979–80	50–52	103	102	1.0	357	181	2.0	-	-	-	-	-	-	460	283	1.6
	1981–82	43–53	654	587	1.1	506	399	1.3	536	316	1.7	1 998	504	4.0	3 694	1 806	2.1
	1982–83	44–51	-	-	-	123	113	1.1	101	70	1.4	912	325	2.8	1 136	508	2.2
	1983–84	45–52	234	237	1.0	289	396	0.7	32	49	0.7	682	306	2.2	1 237	988	1.3
F-EA	1979–80	52–11	48	67	0.7	570	341	1.7	684	345	2.0	431	234	1.8	1 733	987	1.8
(Snares)	1981–82	7–23	-	-	-	322	424	0.8	238	109	2.2	451	269	1.7	1 011	802	1.3
	1982–83	6–10	-	-	-	-	-	-	114	31	3.7	-	-	-	114	31	3.7
	1983–84	5–16	-	-	-	-	-	-	36	8	4.5	687	342	2.0	723	350	2.1
G	1977	31–39	-	-	-	5 765	2 123	2.7	5 041	1 091	4.6	4 574	868	5.3	15 380	4 082	3.8
	1978–79	38–40	1	11	0.1	23	53	0.4	-	-	-	216	188	1.2	240	252	1.0
	1979–80	36–37	90	96	0.9	53	79	0.7	23	14	1.6	-	-	-	166	189	0.9
	1981–82	34–38	271	325	0.8	191	152	1.3	886	282	3.1	508	133	3.8	1 856	892	2.1
	1982–83	35–37	151	170	0.9	-	-	-	130	176	0.7	273	322	0.8	554	668	0.8
	1983	34–39	56	78	0.7	80	88	0.9	1 181	443	2.7	351	382	0.9	1 668	991	1.7
	1983–84	35–39	150	64	2.3	149	265	0.6	199	95	2.1	755	476	1.6	1 253	900	1.4

* 1980–81 data unedited; there was no fishing in area F in 1978–79.
† For fishing years *see* Table 5.
‡ Calendar weeks (i.e., week 1 as from 1 Jan).
§ 1977 data for areas D, F, and G represent non-target fishing for the whole area (Japanese data only).
‖ No data (i.e., no vessels of that size class target fished for barracouta during the specified weeks).

The catch and overall CPUE for the peak months of August-September declined substantially after the intensive effort in 1977, from Japanese target CPUE of 4.2 $t.h^{-1}$ in September 1977 (Japanese unpublished summaries recorded a target CPUE for 2000–4000 t trawlers of about 7 $t.h^{-1}$) to an overall target CPUE of 0.9 and 0.7 $t.h^{-1}$ in 1978–79 and 1979–80. This big decline in CPUE could be partly explained by the new 25 n. mile closed area, the change in cod-end mesh size, the absence of the Japanese fleet in August-September 1978, and the exclusion of all foreign licensed vessels from April 1979. However, the improvement in CPUE in 1981 was short-lived and levels again fell to under 1.5 $t.h^{-1}$ in September 1982, 1983, and 1984.

Analysis of CPUE data by tonnage classes 2–4 for the main area and weeks fished generally supports the observed overall trend (*see* Table 6, Fig. 14). The 1981–82 season appears to have been an improved one after several years of generally low catch rates (under 1.5 $t.h^{-1}$). The trend after 1981–82 is confused by the variable amounts of effort by different tonnage classes (often under 100 h for the season) and the variability in CPUE between tonnage classes (this is one of the few examples where catch rate does not increase with tonnage class). Overall, catch rates appeared to decline below the 1981–82 level in 1982–83, but the pattern since then has not been consistent between tonnage classes.

West coast North Island (area H). Barracouta catch rates in area H have been consistently low, with minimal target fishing. There was no clear seasonal peak consistently between years (Fig. 20), though most barracouta were caught between August and February. This is because barracouta were primarily taken as a by-catch of the seasonal jack mackerel fishery.

The overall monthly target fishing effort for barracouta has occasionally exceeded 100 h (1978–79, 1980–81), but the corresponding CPUE is always under 1 $t.h^{-1}$. Therefore, a breakdown of CPUE by tonnage class was inappropriate.

The south Taranaki Bight has been target fished in all months in different years from 1978–79 to 1983–84 (*see* Fig. 19). Target fishing in the north Taranaki Bight has been erratic and minimal and has not extended as far north as the Japanese effort did in 1977 (foreign licensed vessels were excluded from north of 38° 00′ S since 1 April 1982). Although monthly catch rates have occasionally exceeded 1 $t.h^{-1}$, the monthly catch per half-degree square has always been under 100 t.

East coast South Island (area C). Barracouta catches by deepwater vessels in area C were affected greatly by the introduction of the EEZ. Foreign licensed vessels were excluded from April 1979, and joint venture vessels were restricted to deeper waters outside the Canterbury Bight and Mernoo Bank (*see* Fig. 7, Appendix 3).

These restrictions affected the fishery areas and seasons. The Canterbury Bight region was previously an important summer fishery for deepwater vessels

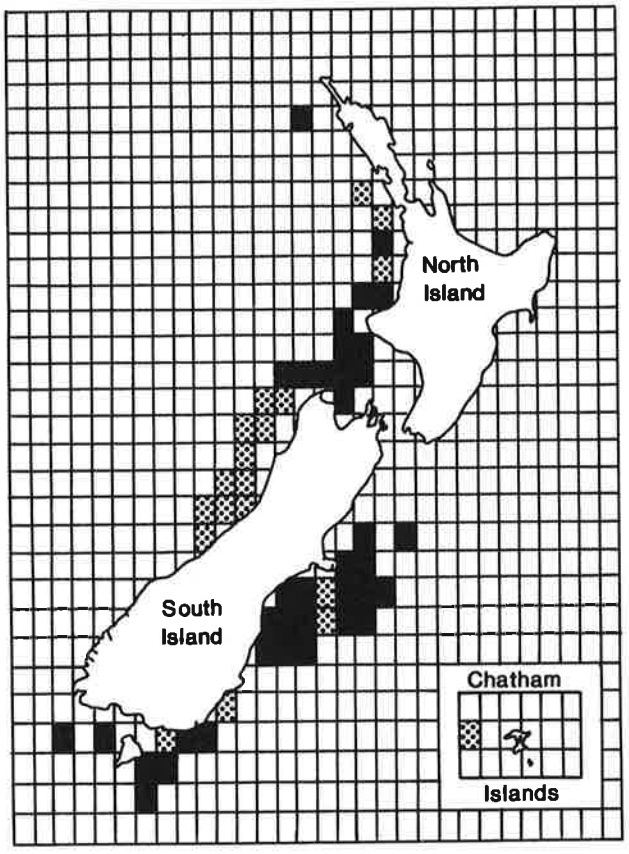


Fig. 11: Japanese barracouta fishery areas, 1977.

(e.g., February 1977), but there is now little target fishing in summer, and the largest catches are in September-December and April-May (Fig. 21).

The overall monthly CPUE when at least 100 t were caught has rarely exceeded 1 $t.h^{-1}$ since 1977, except in November-December 1978–79 and April-May 1981–82. Monthly CPUE by half-degree square showed a similar pattern, with significant catches and catch rates only in April, November, and December (Fig. 22). Because the seasons and areas fished have changed so much since 1977, and because the target tonnage was minimal, analysis of CPUE data by tonnage class was inappropriate.

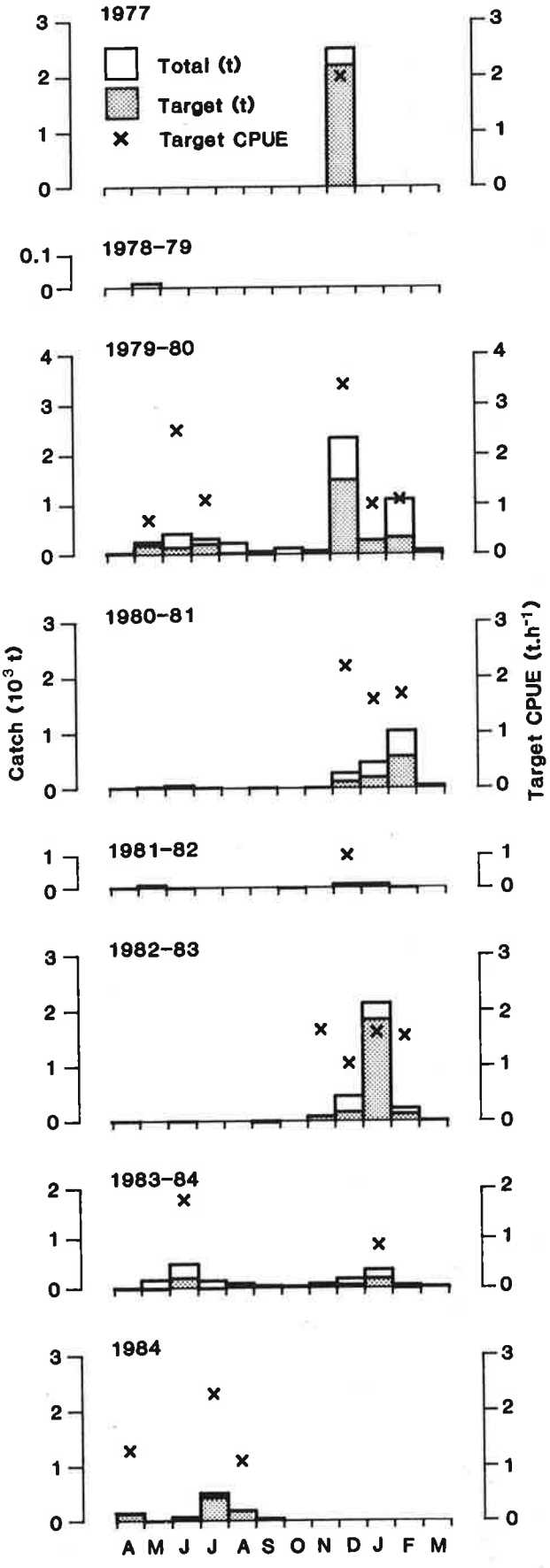


Fig. 12: Monthly barracouta catch, target catch, and target CPUE, where the monthly target catch was at least 100 t, for area D. (1977 data are for Japan only, 1980–81 data are unedited.)

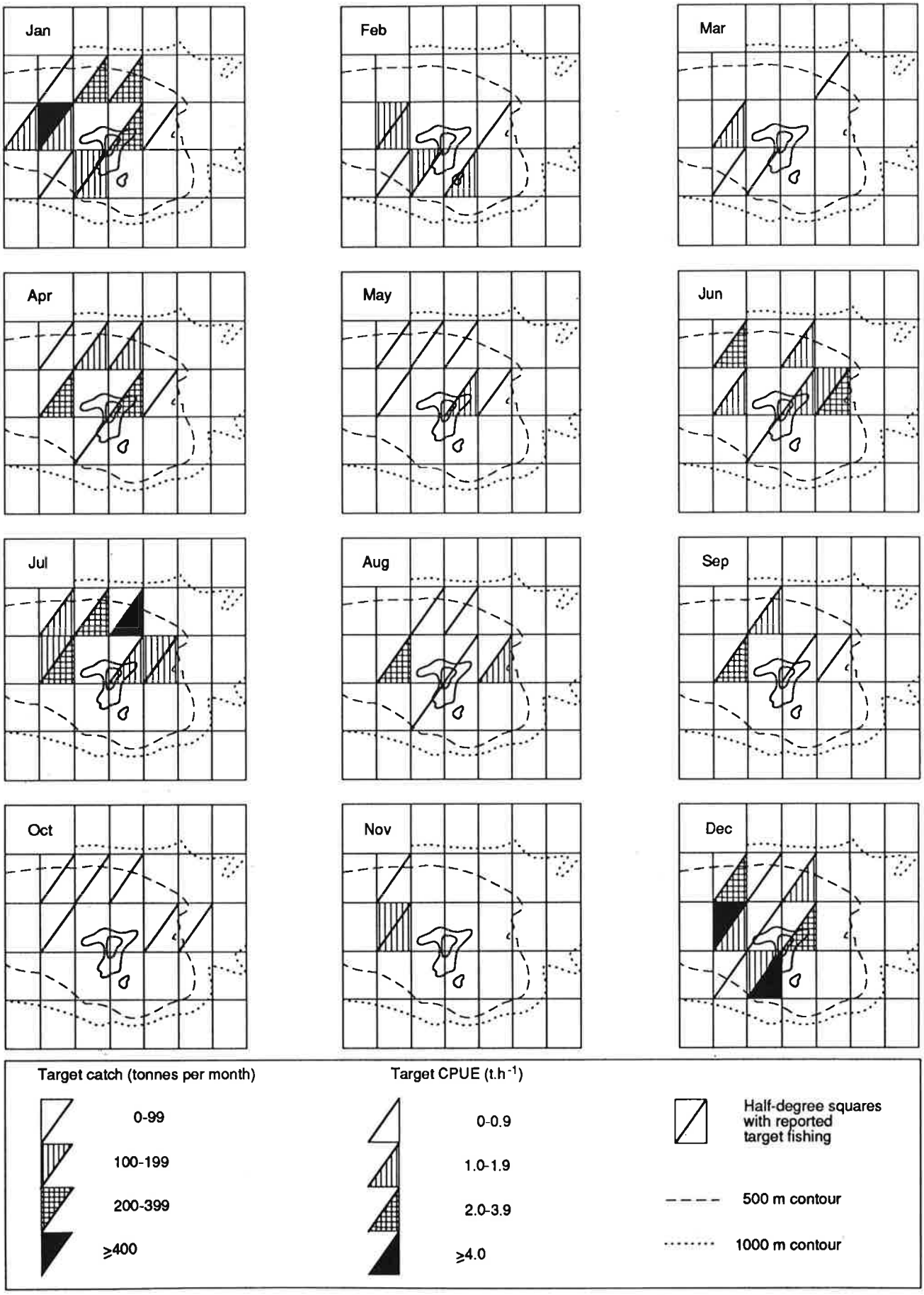


Fig. 13: Deepwater maximum monthly barracouta target catch and target CPUE from 1978–79 to 1983–84 (1980–81 data were unedited), for area D.

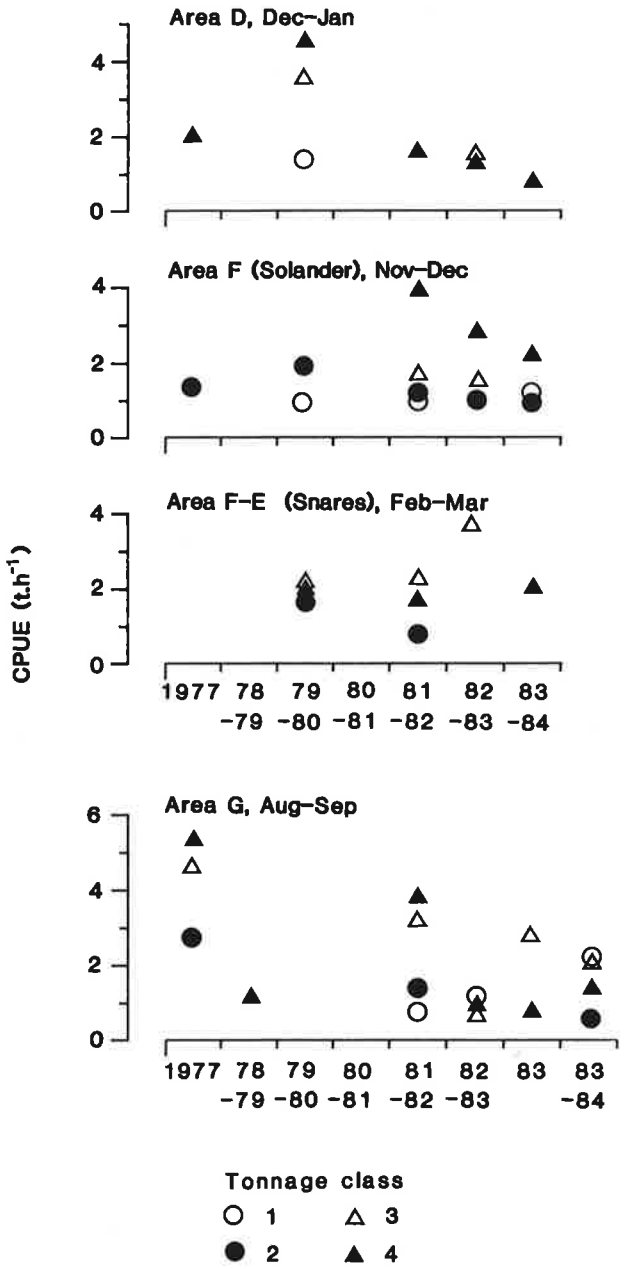


Fig. 14: Catch per unit of effort of barracouta target fisheries from 1978–79 to 1983–84 and non-target fisheries 1977, where effort recorded was at least 100 h for the peak season (*see* Table 6).

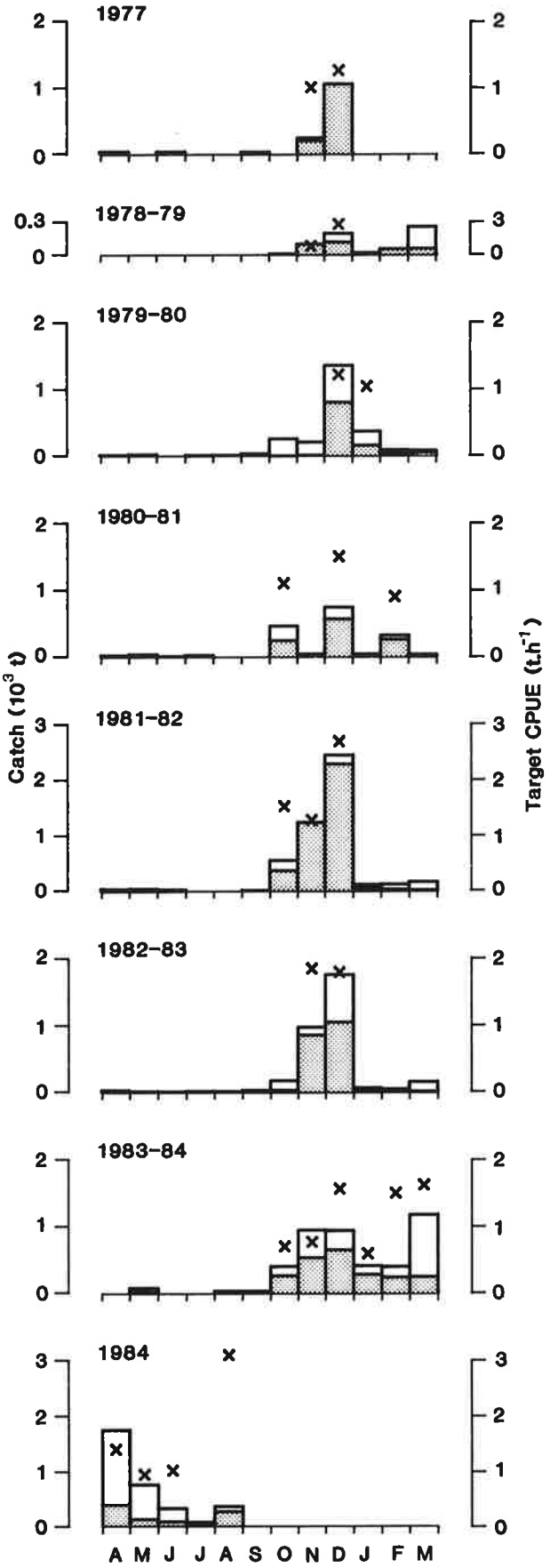


Fig. 15: Monthly barracouta catch, target catch, and target CPUE, where the monthly target catch was at least 100 t, for area F (Snares Islands (48° 30′ to 49° 00′ S) were included from 1 October 1983; 1977 data are for Japan only, 1980–81 data are unedited) (*see* key in Fig. 12).

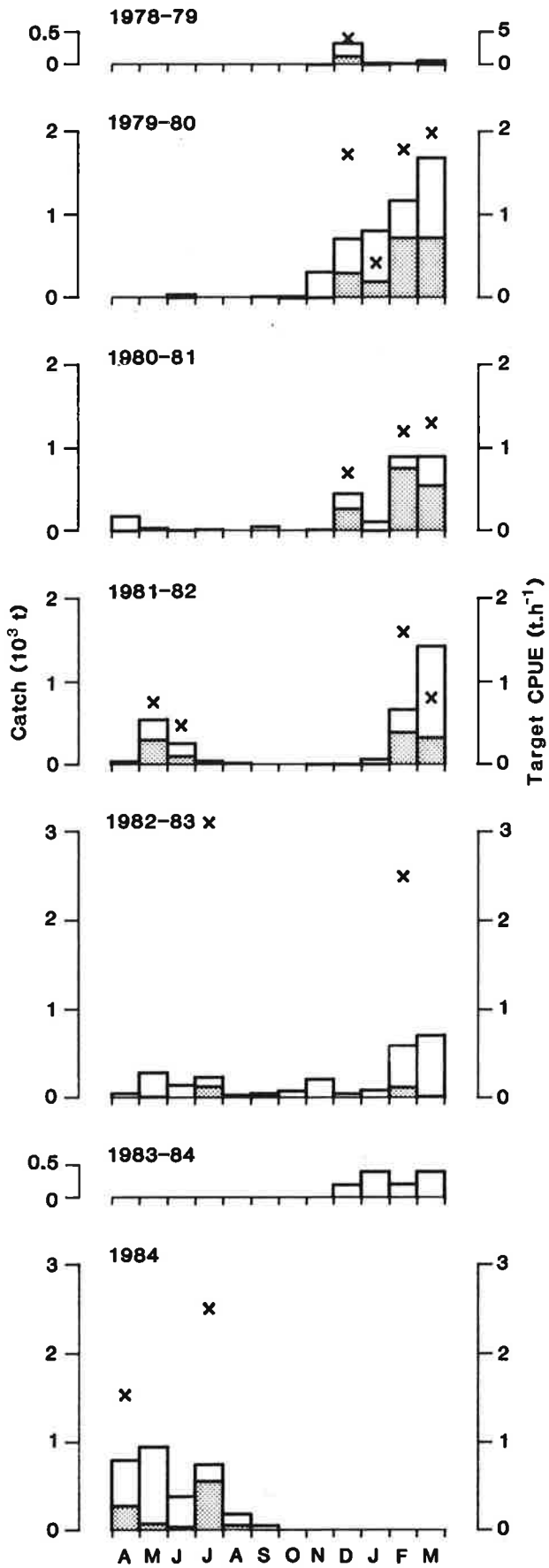


Fig. 16: Monthly barracouta catch, target catch, and target CPUE, where the monthly target catch was at least 100 t, for area EA (Snares Islands (48° 30′ to 49° 00′ S) were excluded from 1 October 1983; 1980–81 data are unedited) (*see* key in Fig. 12).

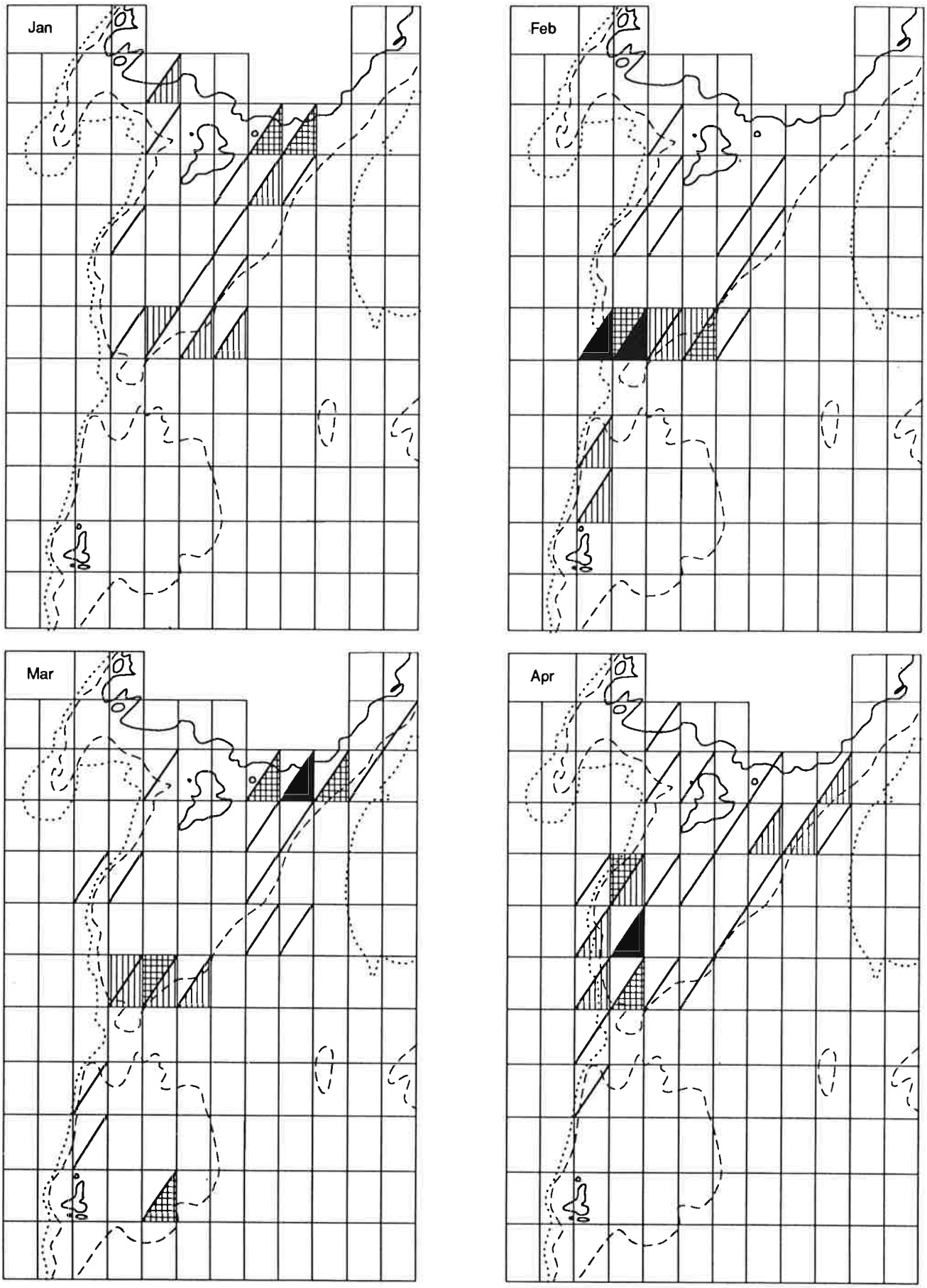


Fig. 17: Deepwater maximum monthly barracouta target catch and target CPUE from 1978–79 to 1982–83 (1980–81 data are unedited, 1983–84 data are not included because of area misreporting), for areas F-EA (*see* key in Fig. 13).

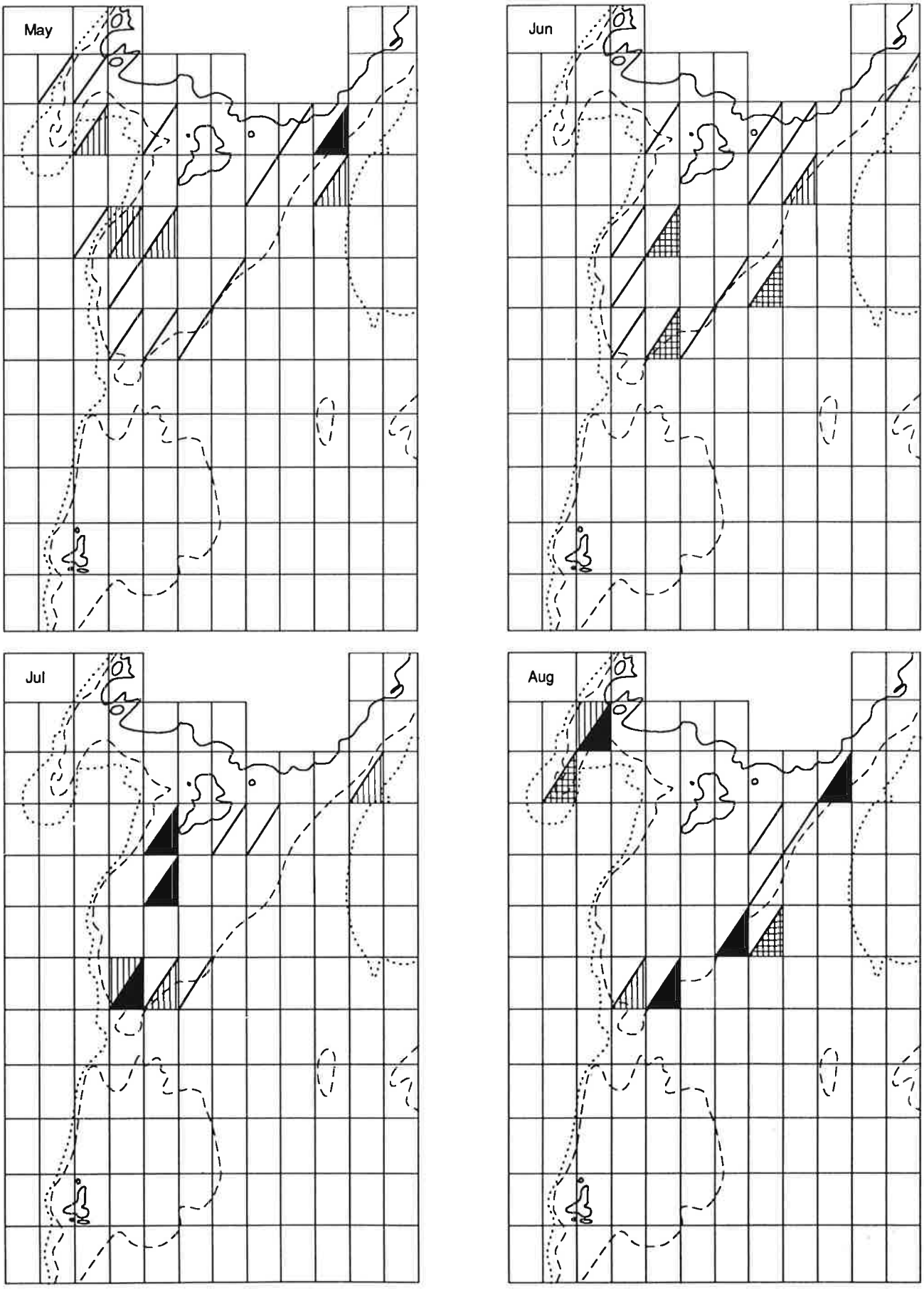


Fig. 17—*continued.*

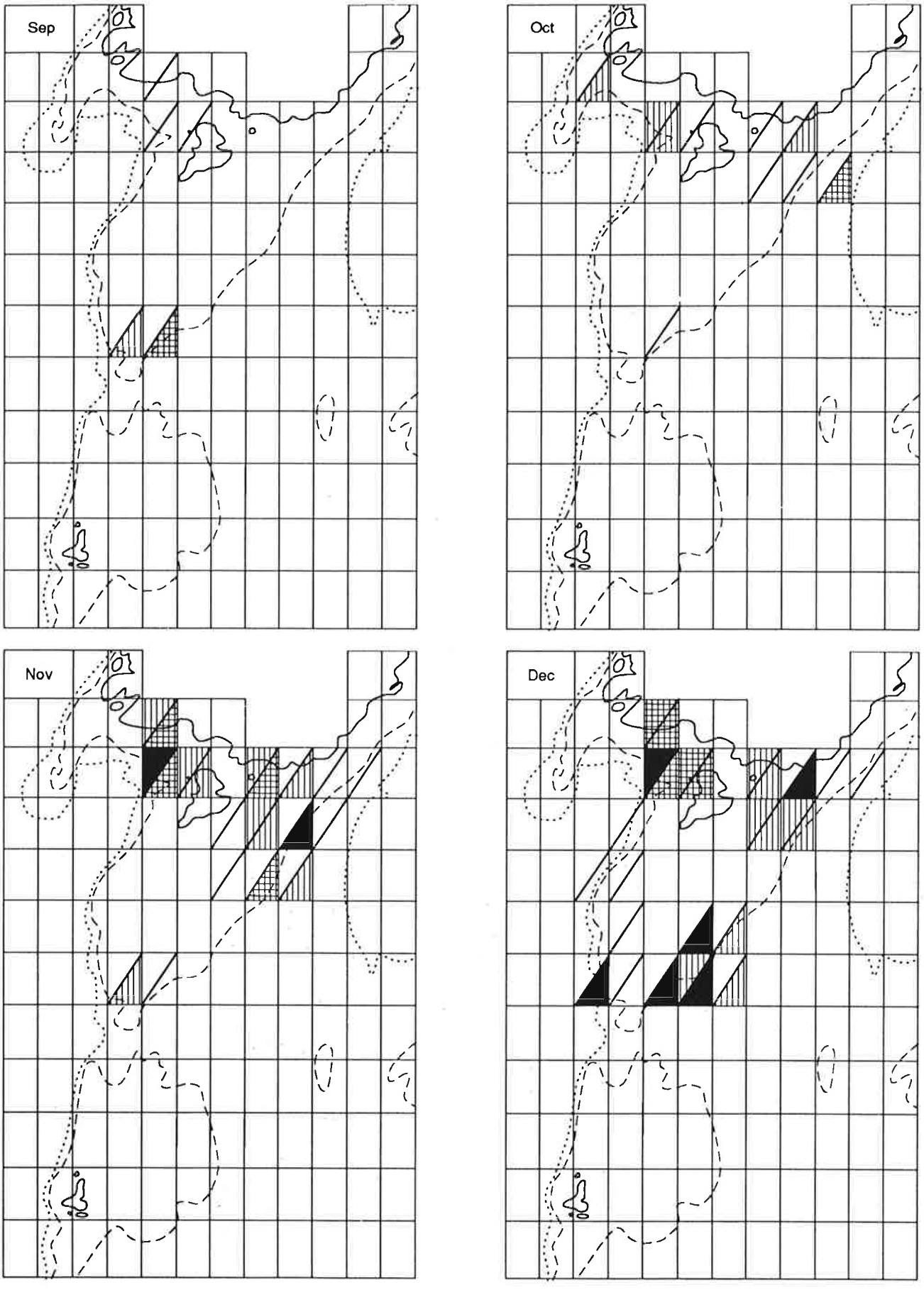


Fig. 17—*continued.*

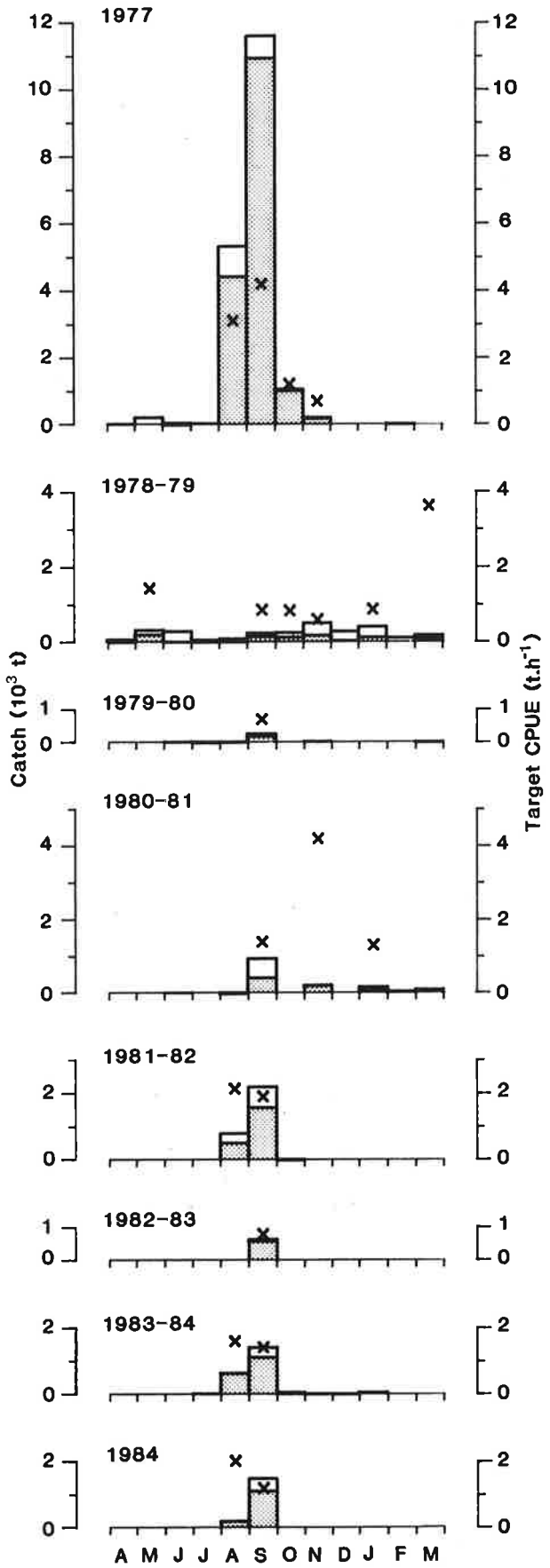


Fig. 18: Monthly barracouta catch, target catch, and target CPUE, where the monthly target catch was at least 100 t, for area G (*see* key in Fig. 12). (1977 data are for Japan only, 1980–81 data are unedited; area was closed from 28 July to 1 September 1982.)

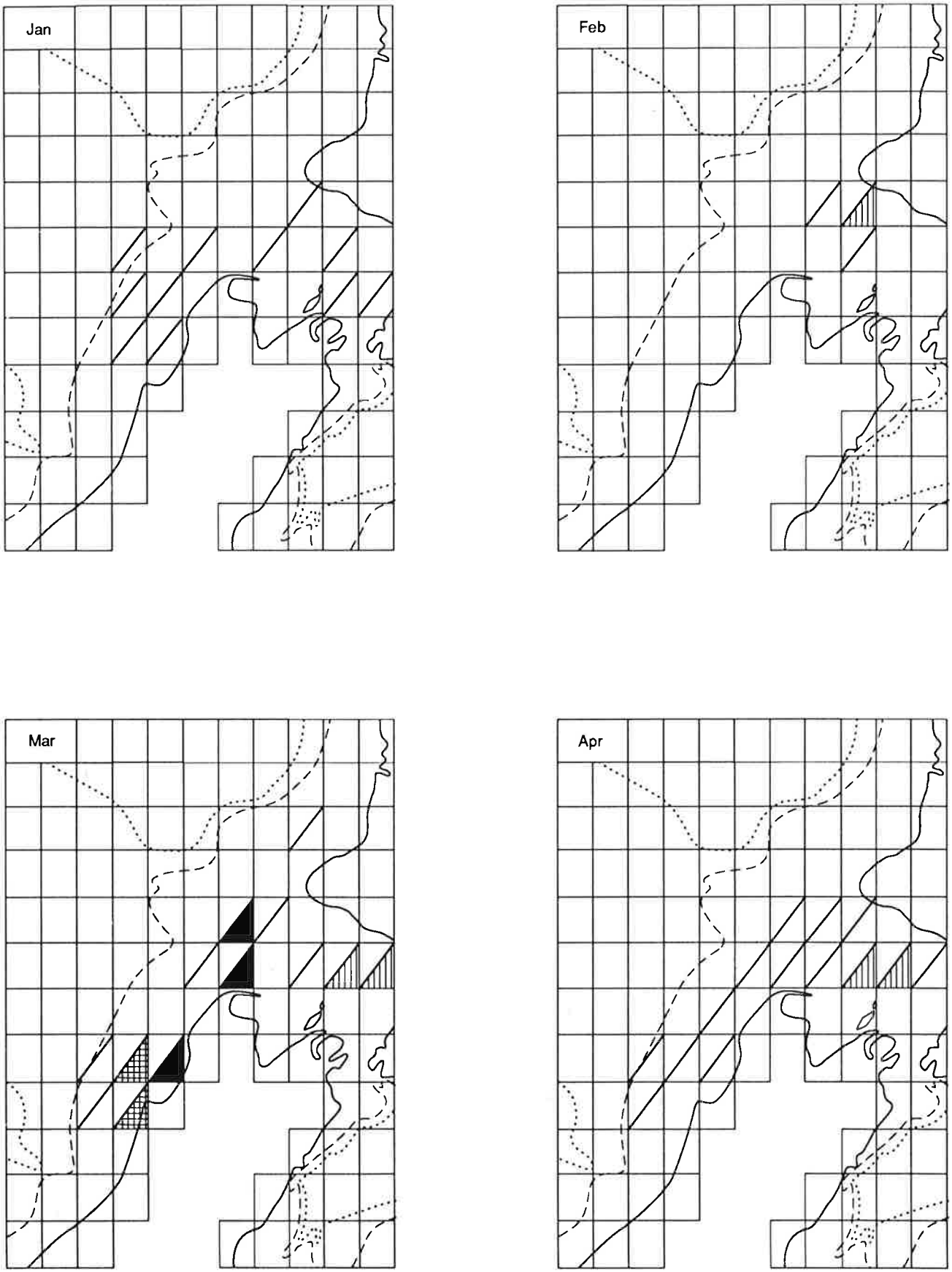
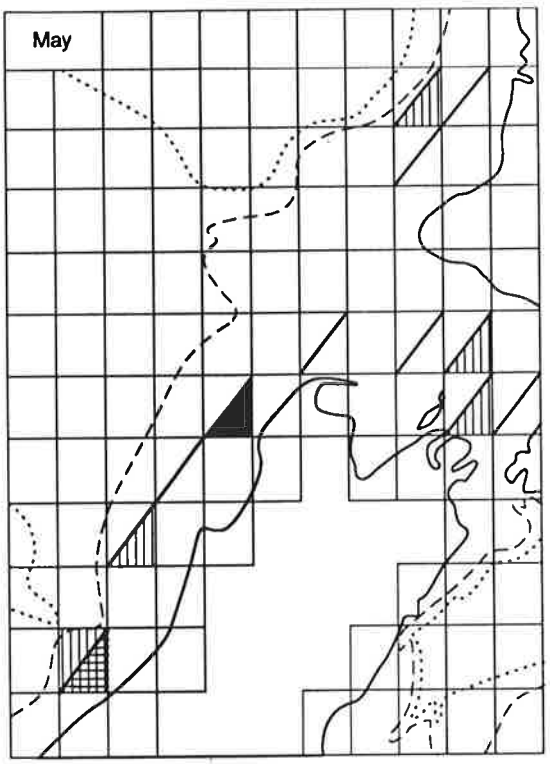
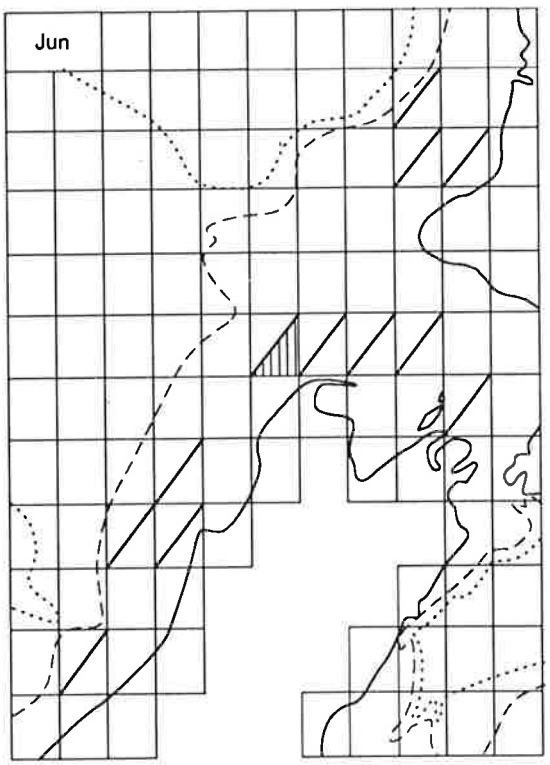
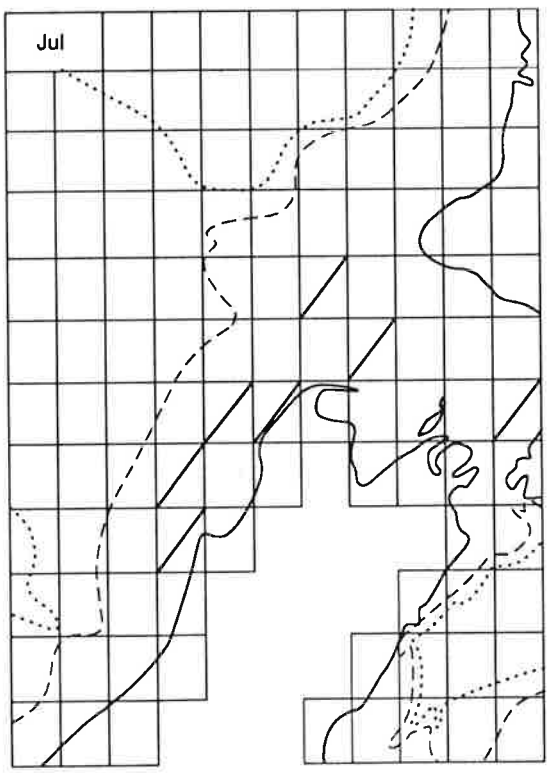


Fig. 19: Deepwater maximum monthly barracouta target catch and target CPUE from 1978–79 to 1983–84 (1980–81 data are unedited), for areas G-H (*see* key in Fig. 13).







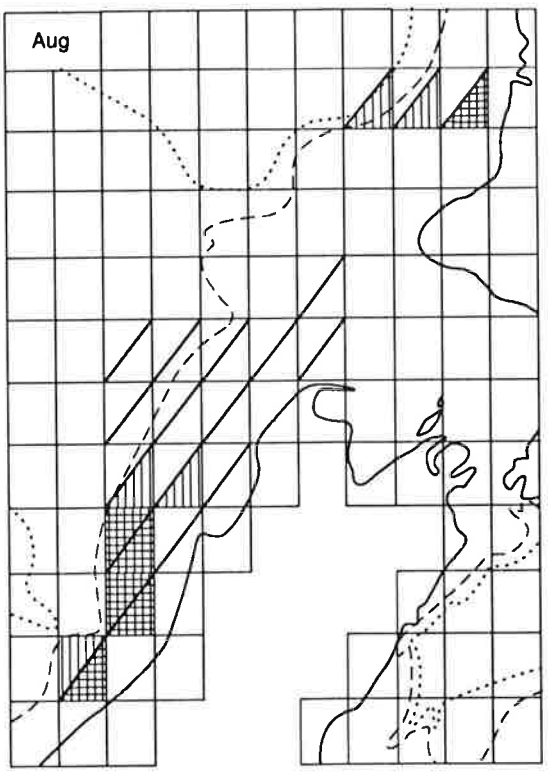
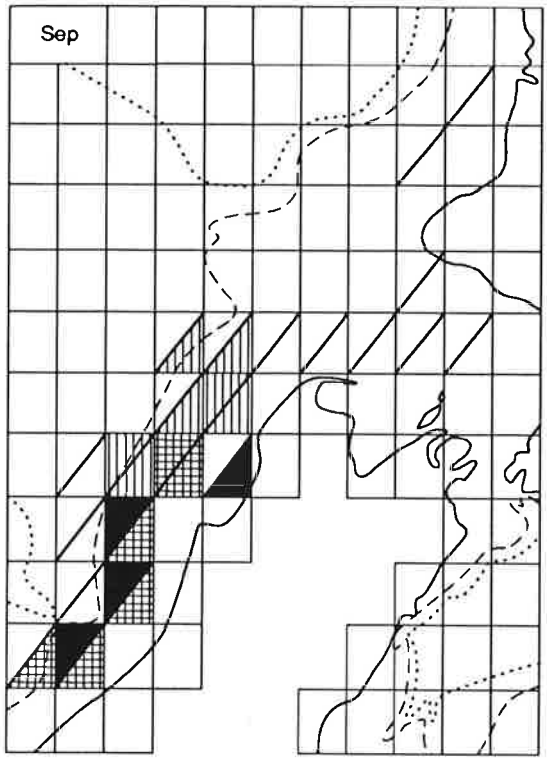
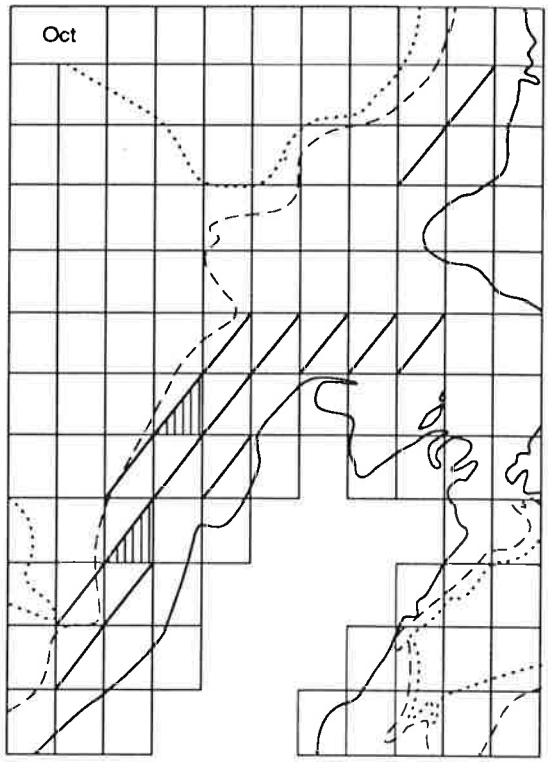
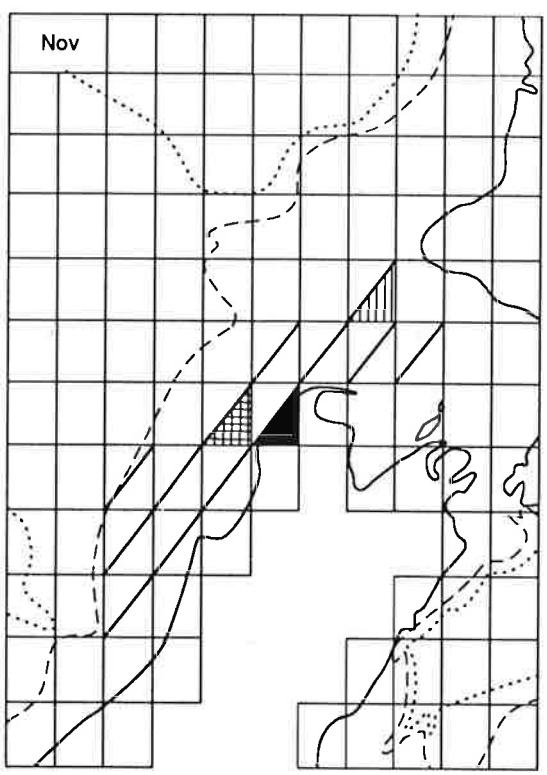


Fig. 19—*continued.*







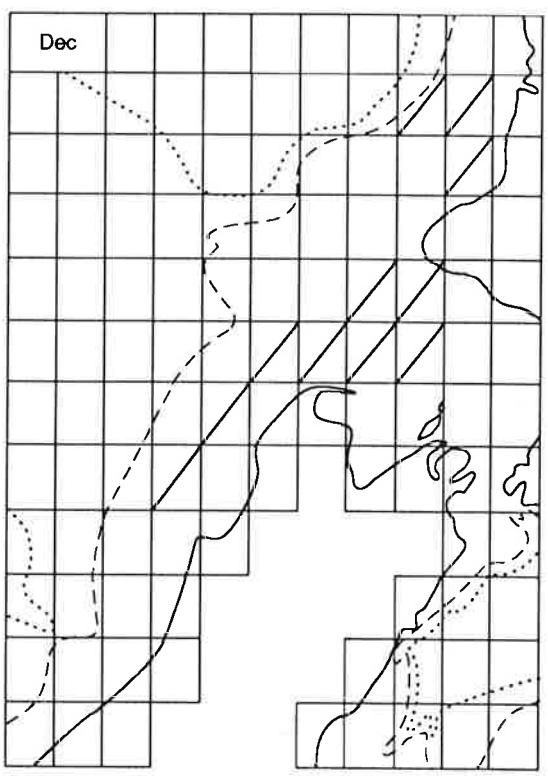


Fig. 19—*continued.*

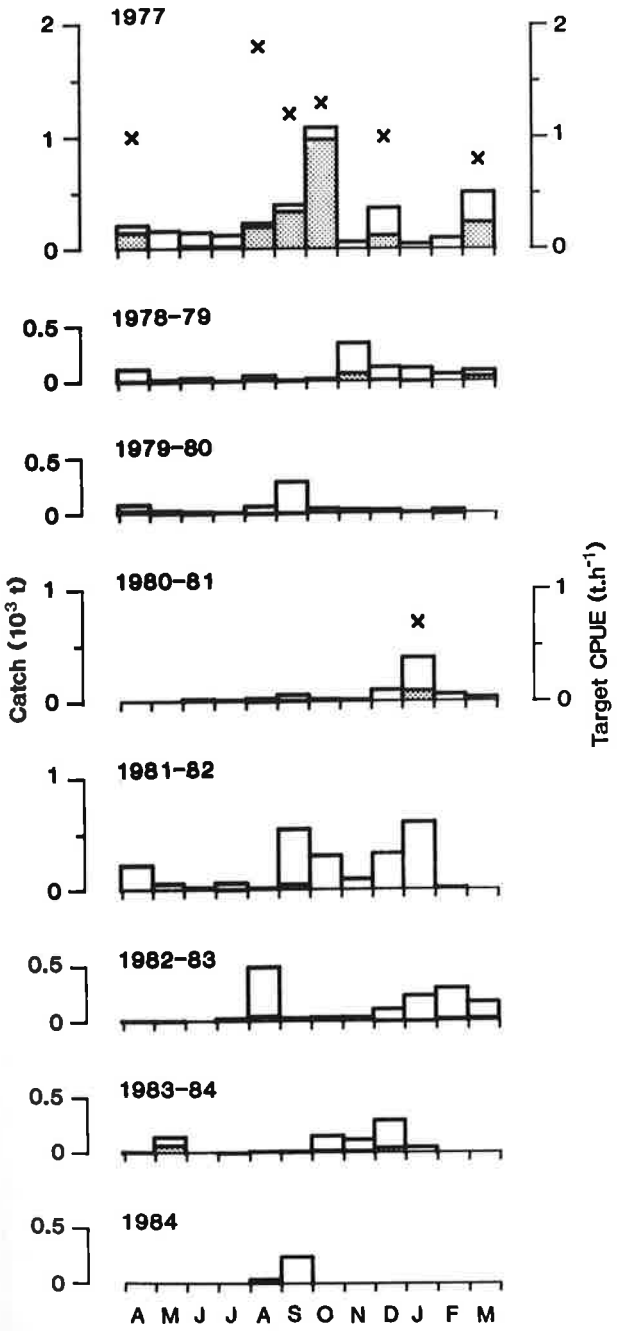


Fig. 20: Monthly barracouta catch, target catch, and target CPUE, where the monthly target catch was at least 100 t, for area H (*see* key in Fig. 12). (1977 data are for Japan only, 1980–81 data are unedited.)

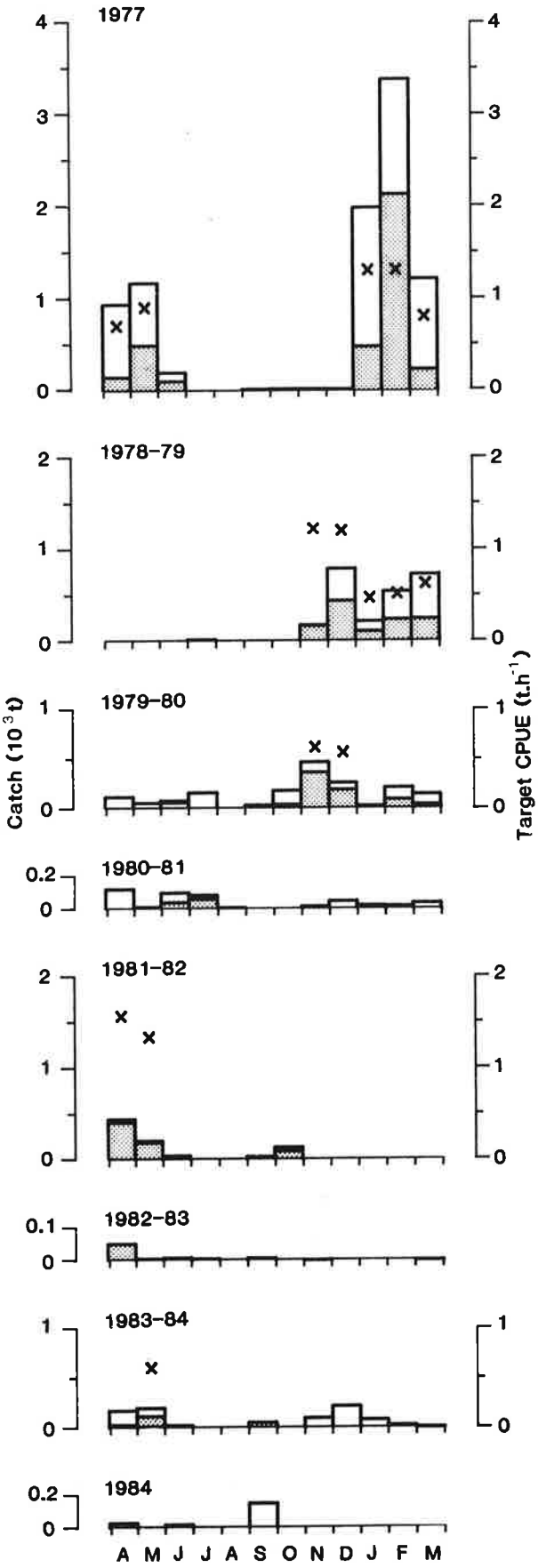


Fig. 21: Monthly barracouta catch, target catch, and target CPUE, where the monthly target catch was at least 100 t, for area C (*see* key in Fig. 12). (1977 data are for Japan only, 1980–81 data are unedited.)

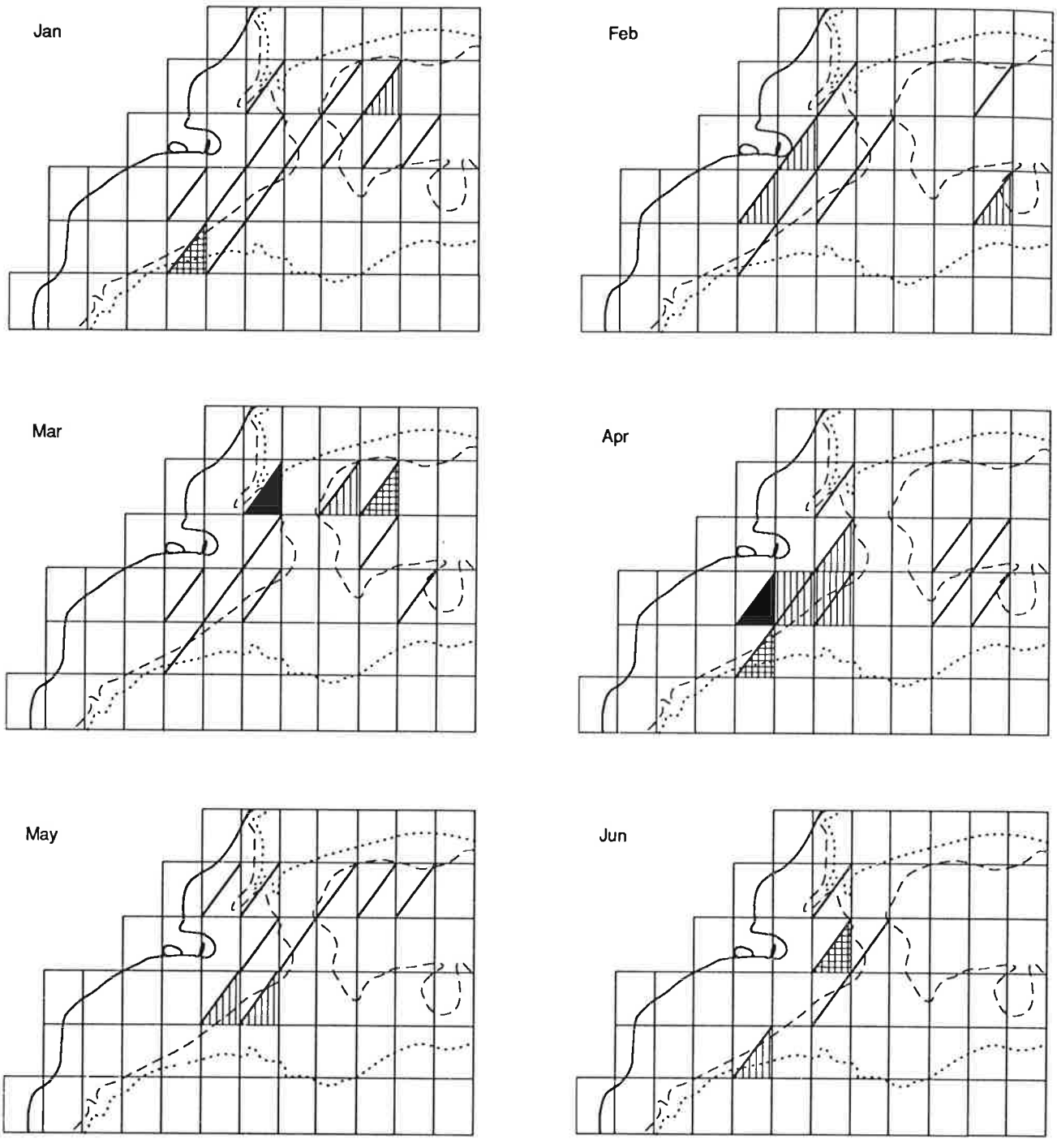


Fig. 22: Deepwater maximum monthly barracouta target catch and target CPUE from 1978–79 to 1983–84 (1977 data are for Japan only, 1980–81 data are unedited), for area C (*see* key in Fig. 13).

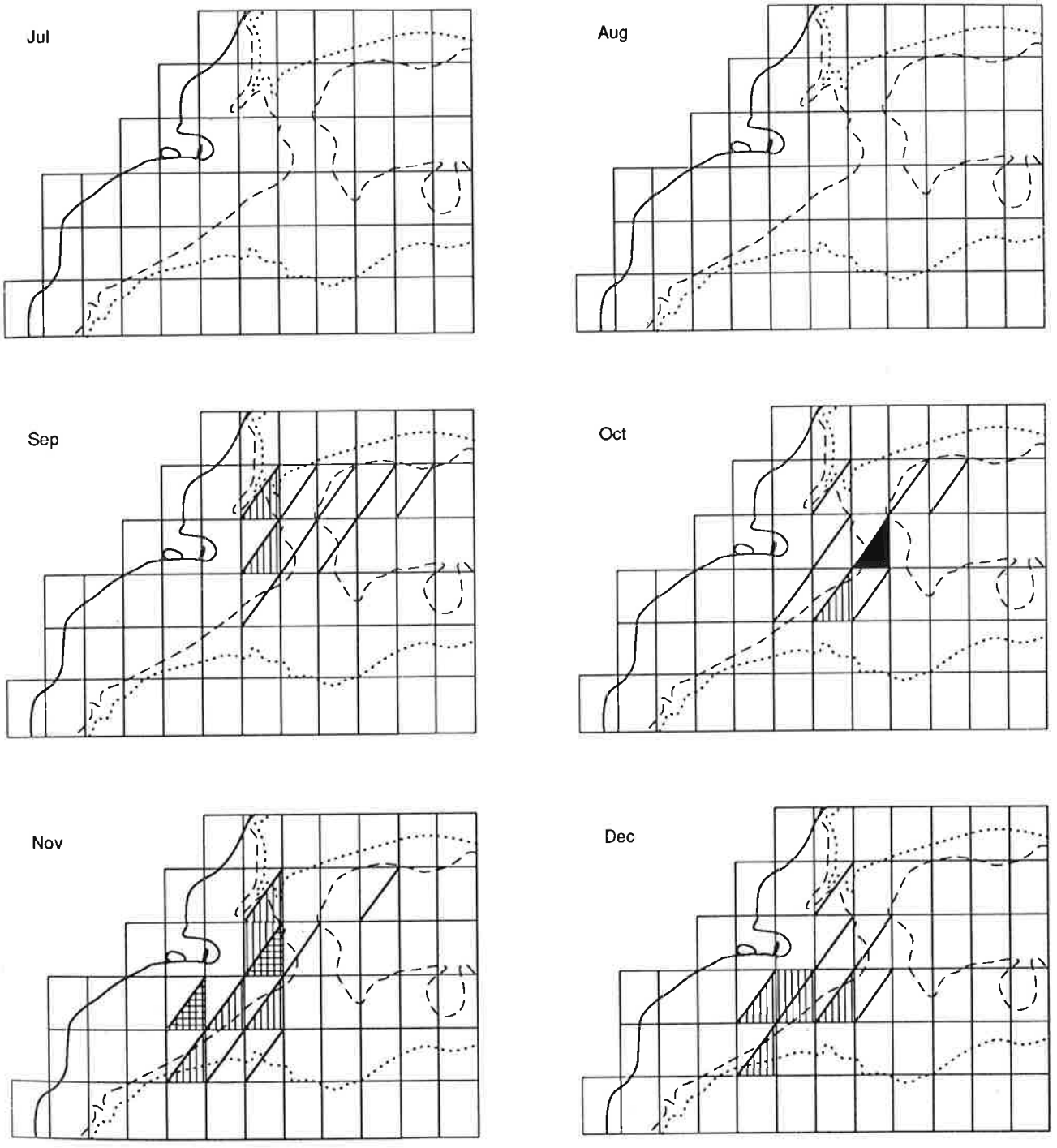


Fig. 22—*continued.*

Discussion

Significant exploitation of the New Zealand barracouta fishery began in 1968, when the total catch first exceeded 10 000 t. Annual catches peaked at 47 000 t in 1977 and recently have fluctuated between 20 000 and 29 000 t. The development of the domestic and deepwater sectors of the industry were described here separately, mainly because of the difference in the size of vessels used (domestic, under 43 m; deepwater, over 50 m) and their resulting range and mobility, the difference in management restrictions which have led to different EEZ areas being fished (domestic, mainly in areas C, G, and B; deepwater, mainly in areas F-EA, D, and G), and the difference in the type of fisheries statistics collected from each fleet. Data for both sectors of the industry have been combined by EEZ area for 1983 and 1984 to give an overall picture of the New Zealand fishery (*see* Table 4, Fig. 23).

Barracouta constituted about 10% of the total finfish catch in 1983 and 1984. They made up a significant proportion (over 10%) of the finfish catch in EEZ areas C, F, and G in both years and in area D in 1983 (most of the area E catch in 1984 was probably taken in area F). These areas, with area H in 1983, each contributed more than 10% of the barracouta catch. These data suggest that barracouta are more abundant in southern waters.

The combination of monthly domestic and deepwater data for 1983 and 1984 shows the more prolonged and/or productive fishing seasons in the southern areas C, G, D, F, and EA. The prolonged seasons in areas C (southern half) and F-EA (Stewart-Snares shelf) were summer-autumn fisheries and were known to be based on non-spawning aggregations, as shown by research surveys of the Canterbury Bight in 1980–82 (author's unpublished data) and *Shinkai Maru* surveys in areas F-EA in 1981–83 (Kawahara and Tokusa 1981, van den Broek *et al.* 1984, Uozumi *et al.* 1987). Research surveys have found that barracouta were scarce in these areas in winter-spring (area C, Fenaughty and Bagley 1981, Hurst and Fenaughty 1985; areas F-E, Hatanaka *et al.* in press). The more pronounced seasonal peaks, which occurred in late winter-spring were based on known spawning concentrations in areas G (Hurst and Bagley 1984), B (Robertson 1973, author's unpublished data), and D (Hurst and Bagley 1987). Other known spawning areas are Kaikoura (Mehl 1971, author's unpublished data) and the Mernoo Bank (Robertson and Mito 1979, N. W. Bagley pers. comm.) in late spring; hence, the secondary spring peak in area C. Commercial fishing data (roe production figures) suggested a spawning area in the Solander corridor, also in late spring, and this was confirmed in November 1986 (Bagley and Hurst 1987). The recent deepwater CPUE data (Table 6) did not suggest any differences in catch rates between fisheries based on spawning and non-spawning aggregations. However, the highest mean target CPUE recorded during the history of the fishery (about 7 $t.h^{-1}$ by 2000–4000 t Japanese vessels in September 1977) was on spawning concentrations in area G.

Most of the known spawning activity takes place from August to December around the North Island and north-east and west coasts of the South Island. The fishing patterns shown in Fig. 24 further suggest a southward movement of significant quantities of barracouta in early summer to feeding areas in the Canterbury Bight and around the Snares Islands. There have been few trawl surveys in northern areas which have provided estimates of relative seasonal abundance. However, there are some data which suggest barracouta are scarce in northern areas outside the spring spawning season (area B, barracouta surveys May 1983, September 1984, 1985 (author's unpublished data); area H (Paul *et al.* 1983)). Seasonal biomass estimates of barracouta from two jack mackerel surveys in areas H and the northern part of area G (December 1980 to February 1981, October-November 1981, Robertson *et al.* 1983) are difficult to compare because different sized vessels, tow speeds, and tow durations were used.

Tagging results from east coast South Island fish have shown extensive northward movements during autumn-winter to the east and west coasts of the North Island (Hurst and Annala 1986). The maximum direct distance travelled was 500 n. miles in 6 months. De Jager (1955) recorded similar extensive movements (up to 630 n. miles in 5 months) for South African barracouta (snoek). However, the proportion of fish that move between areas in New Zealand has not been measured, and the direction and extent of any movements of fish in areas G, F, EA, and D are unknown.

Estimation of the size and state of the various barracouta fisheries from historical fisheries data is complicated by several factors:

1. the unknown or unquantified extent and direction of seasonal migration;
2. the long history of significant exploitation (from 1968) before quantitative research surveys began in 1981;
3. the variability in the amount and location of fishing effort which was caused by the change in management strategies of deepwater fisheries since 1 October 1977, government subsidies for barracouta in 1979–80 and 1981–82, the proposed inshore fisheries management since 1983, and the development of new fisheries, particularly the fishery for orange roughy;
4. the large non-target component of the fishing effort in some areas and seasons (e.g., Stewart-Snares shelf);

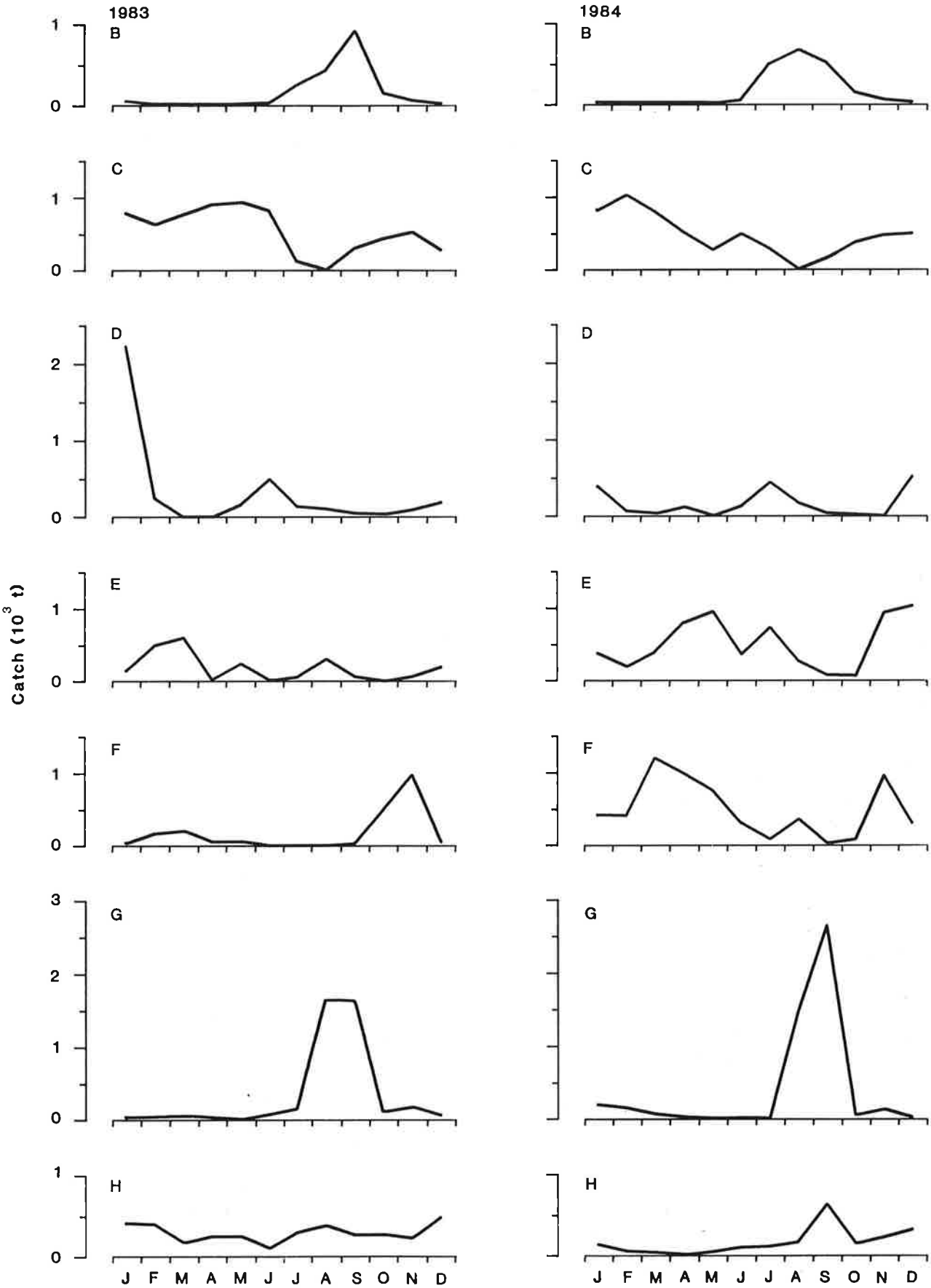


Fig. 23: Monthly reported barracouta catches of domestic and deepwater vessels by EEZ area for 1983 and 1984. (The catch from area E in 1984 was probably misreported.)

5. the unknown and probably variable reliability of fisheries statistics (particularly those on barracouta in areas F-EA since 1 October 1983), and the major differences in the way deepwater and inshore catches (particularly CPUE data) were recorded.

Therefore, the historical fisheries data presented here are of limited use on their own in the determination of the state or possible size of the fisheries. However, some general conclusions are possible:

1. The largest annual catch from a barracouta fishery was an estimated 25 099 t from area G in 1977–78 (Table 5). At least 18 000 t were taken during the spawning season (August-October) by Japanese vessels. The highest mean CPUE for these vessels, which were fishing (non-target) on barracouta, was 4.2 $t.h^{-1}$ for 10 950 t caught during September 1977. The 2000–4000 t Japanese trawlers recorded a target mean CPUE of about 7 $t.h^{-1}$ in this month. These were the largest monthly barracouta mean CPUE figures calculated by FRC or the Japanese. The only other fishery which recorded a CPUE over 3 $t.h^{-1}$ for more than 100 tonnes per month caught (FRC data) was at the Chatham Islands (area D) in December 1979. It is possible that these mean catch rates may have been typical of what was achievable on spawning concentrations of virgin or near-virgin stocks.
2. It should have been possible to determine the effect of removing large tonnages of fish from some areas in 1977 (particularly areas G and D) by following trends in deepwater CPUE data. However, any trends have been obscured by the introduction of permanent and temporary area closures (particularly in area G) and erratic fishing patterns (particularly in area D). In general, catch rates in areas G, D, and F (Solander corridor) appear to have declined recently. Whether these declines are real, or whether they are annual fluctuations about an average which is lower than the CPUE on virgin or near-virgin stocks, cannot be determined because the data set is insufficient.

   However, the CPUE data suggest that the 25 099 t taken out of area G in 1977–78, and the 8732 and 5348 t taken out of area D in 1977–78 and 1979–80 (Table 5), were unsustainable levels of exploitation. The decline from 2.2 to 0.4 $t.h^{-1}$ recorded by the Japanese (Saito and Sato 1977) in the east coast South Island fishery from 1968 to 1975 also suggested that catch levels (annual average about 10 000 t) were not sustainable in this area.

   The annual catches in areas F-EA have been increasing since 1977 as the fishery developed. Catch per unit of effort data alone have not yet indicated what the sustainable yield of this fishery might be. Recent declines (1981–82 to 1983–84) in area F were confirmed in the Japanese time series for 2000–4000 t vessels (Hatanaka and Katsuyama 1984). Trends in this fishery can no longer be followed because of the closure from 1 October 1985 of the Solander corridor to deepwater vessels. Any long-term analysis of trends in the Snares Islands fishery should take into account the change in cod-end mesh size regulations from 1 October 1983 and is complicated by misreporting in 1983–84 and 1984–85.
3. Research surveys designed to estimate fish abundance have generally supported the suggestion from CPUE analyses that the high catches in areas G and D in 1977 were not sustainable (Hurst 1985). However, the derivation of yield estimates from these surveys is based on several assumptions about barracouta catchability and productivity.
4. Research surveys can also be used to estimate annual variations in abundance indices of fish stocks and the state of the fisheries. The only barracouta fishery which has been surveyed quantitatively over several years is the fishery in areas F-EA. General random trawl surveys were carried out by *Shinkai Maru* in February 1981 (Kawahara and Tokusa 1981), March-April 1982 (van den Broek *et al.* 1984), and April 1983 (Uozumi *et al.* 1987). It would have been valuable to have been able to compare trends in annual

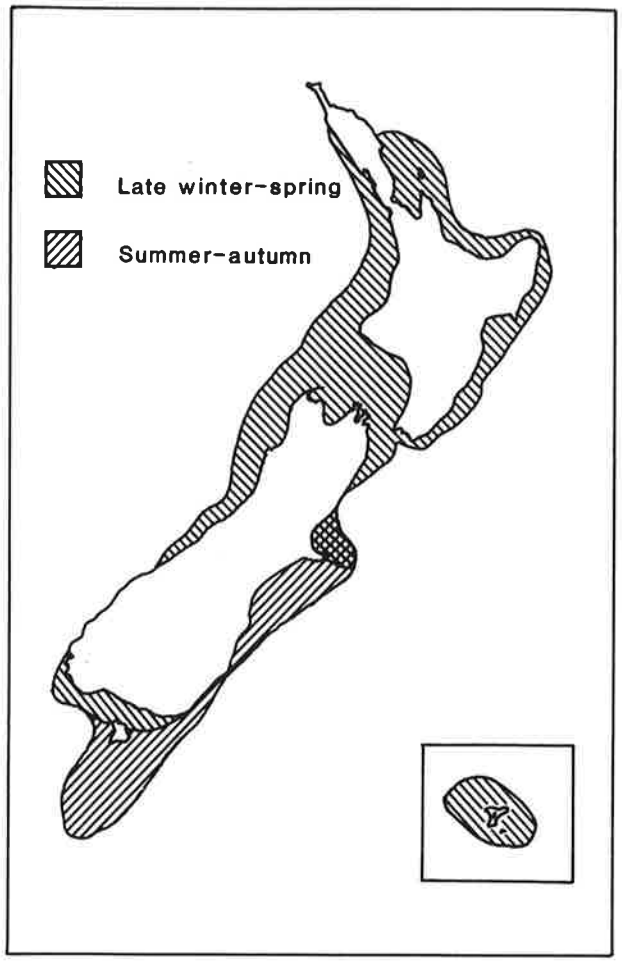


Fig. 24: Generalised seasonal pattern of the main barracouta target fisheries by domestic and deepwater vessels.

estimated abundance with trends in CPUE data. However, the value of this comparison is lost because the coefficients of variation (*c.v.*) of the abundance estimates were high, and even though there was an increase in abundance in 1983 it was not significantly different from the previous 2 years (1981, 100 200 t, *c.v.* 24%; 1982, 103 000 t, *c.v.* 50%; 1983, 201 500 t, *c.v.* 25%). In addition, comparable CPUE data came from the Stewart-Snares shelf fishery, but the summer 1981 data were unavailable and the amount of target effort recorded in 1983 was insignificant.

Analyses of historical data presented in this paper and research data on stock sizes and movements have been used to derive stock estimates since 1983 (Hurst 1985). The original TACs set on 1 October 1983 by EEZ area were: area B, 2000 t; area C, 7000 t; area D, 3000 t; area F, 9000 t; areas G and H, 10 000 t; New Zealand total, 31 000 t. The only recent major changes to these TACs have been to amalgamate area E (originally not put under limits) with area F (areas E and F, 9000 t), to overcome misreporting problems (Hurst 1985) and to allocate TACs by the new fisheries management areas (Hurst 1986).

References

Anon. 1980: Regulations allow greater control. *Catch '80 7 (7)*: 3.

_____1982: Deepwater trawl plan agreed. *Catch '82 9 (11)*: 28.

_____1983: Finfish allocations offered. *Catch '83 10 (1)*: 32.

Bagley, N. W., and Hurst, R. J. 1987: Southern shelf species surveyed. *Catch '87 14 (7)*: 23–26.

De Jager, B. v. D. 1955: The South African pilchard (*Sardinops ocellata*). The development of the snoek (*Thyrsites atun*) a fish predator of the pilchard. *Division of Fisheries Investigational Report No. 19* (Department of Commerce and Industries). 16 p.

FAO 1984: 1983 catches and landings. *Yearbook of fishery statistics Vol. 56*. Food and Agriculture Organization of the United Nations, Rome. 394 p.

Fenaughty, J. M., and Bagley, N. W. 1981: *W. J. Scott* New Zealand trawl survey, South Island east coast. *Fisheries Technical Report, N.Z. Ministry of Agriculture and Fisheries, No. 157*. 224 p.

Hatanaka, H., and Katsuyama, K. 1984: The outline of Japanese trawl fisheries for finfishes in 1983 and early 1984 in New Zealand waters. 15 p. (Unpublished document, presented at the May 1984 bilateral Japan-New Zealand talks on 1984–85 allocations. JPN Doc 84/1 held on FRC Japan file, Fisheries Research Centre, Wellington.)

Hatanaka, H., Uozumi, Y., Fukui, J., Aizawa, M., and Hurst, R. J. (in press): Japan-New Zealand trawl survey off southern New Zealand, October-November 1983. *New Zealand Fisheries Technical Report*.

Hurst, R. J. 1983: Barracouta. *In* Taylor, J. L., and Baird, G. G. (Comps. and Eds.), New Zealand finfish fisheries: the resources and their management, pp. 27–29. Trade Publications Limited, Auckland.

_____1985: Barracouta. *In* Colman, J. A., McKoy, J. L., and Baird, G. G. (Comps. and Eds.), Background papers for the 1985 Total Allowable Catch recommendations, pp. 17–21. Fisheries Research Division, N.Z. Ministry of Agriculture and Fisheries. (Unpublished report, held in Fisheries Research Centre library, Wellington.)

_____1986: Barracouta. *In* Baird, G. G., and McKoy, J. L. (Comps. and Eds.), Background papers for the Total Allowable Catch recommendations for the 1986–87 New Zealand fishing year, pp. 20–25. Fisheries Research Division, N.Z. Ministry of Agriculture and Fisheries. (Preliminary discussion paper, held in Fisheries Research Centre library, Wellington.)

Hurst, R. J., and Annala, J. A. 1986: Recent fish tagging programmes. *Catch '86 13 (2)*: 10.

Hurst, R. J., and Bagley, N. W. 1984: West Coast barracouta surveyed. *Catch '84 11 (10)*: 10–11.

_____1987: Barracouta and associated finfish near the Chatham Islands: results of a trawl survey, December 1984. *New Zealand Fisheries Technical Report No. 3*. 44 p.

Hurst, R. J., and Fenaughty, J. M. 1985: Report on biomass surveys 1980–84: summaries and additional information. Fisheries Research Division Internal Report, N.Z. Ministry of Agriculture and Fisheries, No. 21. 53 p. (Draft report, held in Fisheries Research Centre library, Wellington.)

Kawahara, S. 1983: The outline of Japanese trawl fishery for finfishes in New Zealand waters. 15 p. (Unpublished document, presented at the April 1983 bilateral Japan-New Zealand talks on 1983–84 allocations. JPN Doc 83/1 held on FRC Japan file, Fisheries Research Centre, Wellington.)

Kawahara, S., and Tokusa, K. 1981: Report on 1981 Japan/New Zealand joint squid survey in areas E and F by *Shinkai Maru*. 62 p. (Unpublished manuscript, from Japan Marine Fishery Resource Research Center and Far Seas Fisheries Research Laboratory, held in Fisheries Research Centre library, Wellington.)

King, M. R. 1985: Fish and shellfish landings by domestic fishermen, 1974–82. *Fisheries Research Division Occasional Publication: Data Series, N.Z. Ministry of Agriculture and Fisheries, No. 20*. 122 p.

Mehl, J. A. P. 1971: Spawning and length-weight of barracouta (Teleostei: Gempylidae) from eastern Cook Strait. *N.Z. Journal of Marine and Freshwater Research 5 (2)*: 300–317.

Patchell, G. J. 1982: The hoki season off the west coast, South Island. *Catch '82 9 (11)*: 22–23.

Paul, L. J., Roberts, P. E., and James, G. D. 1983: Distributions of temperature, salinity, and demersal fish off the west coast, North Island, New Zealand, 1971–72. *Fisheries Research Division Occasional Publication, N.Z. Ministry of Agriculture and Fisheries, No. 22*. 60 p.

Robertson, D. A. 1973: Planktonic eggs and larvae of some New Zealand marine teleosts. 480 p. (PhD thesis, lodged in University of Otago library.)

Robertson, D. A., Grimes, P. J., and Francis, R. I. C. C. [1983]: Central west coast fish biomass survey, October-November 1981. 32 p. (Unpublished internal report, Fisheries Research Division, available from authors, Fisheries Research Centre, Wellington.)

Robertson, D. A., and Mito, S. 1979: Sea surface ichthyoplankton off southeastern New Zealand, summer 1977–78. *N.Z. Journal of Marine and Freshwater Research 13 (3)*: 415–424.

Saito, T., and Sato, T. [1977]: Present and future sources in various waters for Japanese fish supplies. (Unpublished proceedings of the Symposium on Fisheries in New Zealand and Japan, 4–5 May 1977. Incomplete manuscript held by R. J. Hurst, Fisheries Research Centre, Wellington.)

Uozumi, Y., Yatsu, A., and Robertson, D. A. 1987: Japan-New Zealand trawl survey off southern New Zealand, April 1983. *New Zealand Fisheries Technical Report No. 4*. 52 p.

Van den Broek, W. L. F., Tokusa, K., and Kono, H. 1984: A survey of demersal fish stocks in waters south of New Zealand, March-May 1982. *Fisheries Research Division Occasional Publication, N.Z. Ministry of Agriculture and Fisheries, No. 44*. 51 p.

Winstanley, R. H. 1979: Snoek. Fishery Situation Report 4. Commonwealth Scientific and Industrial Research Organization. 16 p.

Acknowledgments

I thank N. W. Bagley, K. A. Fisher, D. M. Jones, and G. J. Patchell for assistance with data extraction.

Appendix 1

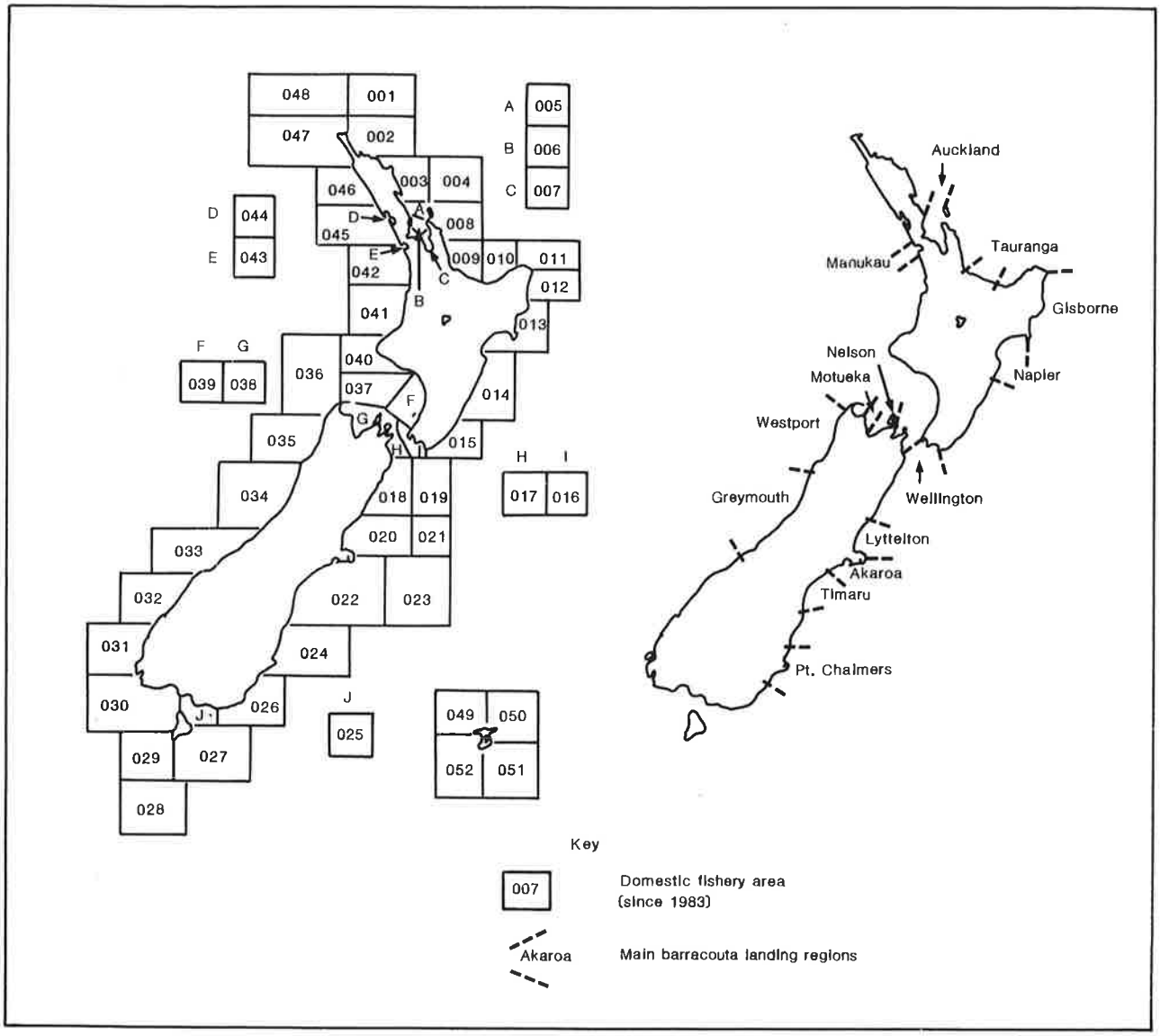
Domestic barracouta landings (t), 1936–37 to 1984

Year*	Landings	% total wetfish†	Rank	Year	Landings	% total wetfish	Rank
1936–37	95	0.5		1961	277	1.0	15
1937–38	111	0.6	16	1962	163	0.6	17
1938–39	170	0.9	16	1963	87	0.3	21
1939–40	184	1.4	13	1964	91	0.3	23
1940–41	238	1.1	14	1965	188	0.6	17
1941–42	322	1.4	13	1966	179	0.5	18
1942–43	583	1.9	10	1967	232	0.6	21
1943–44	301	2.0	11	1968	569	1.7	14
1944	430	2.8	9	1969	643	2.0	12
1945	494	2.9	8	1970	755	1.9	14
1946	581	3.0	9	1971	1 100	2.5	9
1947	847	3.8	8	1972	1 428	3.6	6
1948	665	2.9	8	1973	2 850	6.4	5
1949	666	2.9	8	1974	3 396	7.1	4
1950	659	3.0	8	1975	2 503	6.8	4‡
1951	407	2.0	10	1976	3 673	7.8	3‡
1952	315	1.5	12	1977	4 697	8.5	3
1953	303	1.5	13	1978	5 197	7.5	3
1954	238	1.1	15	1979	6 970	9.1	2
1955	212	1.0	15	1980	8 833	11.7	2
1956	225	1.0	14	1981	12 220	14.0	1
1957	264	1.0	13	1982	10 290	10.6	3
1958	239	1.0	15	1983	13 151	11.9	2
1959	227	0.9	16	1984	12 131	9.8	2
1960	221	0.8	16				

* Calendar year, except 1936–37 to 1943–44 (1 Apr-31 Mar).
† Wetfish are all finfish, excluding squid.
‡ 1976–80 inclusive, skipjack tuna not included (caught by foreign vessels).

Appendix 2

Domestic fishery areas and main barracouta landing regions



Appendix 3

Trawling restrictions implemented during 1977–83 which affected the deepwater barracouta fishery

Many of the management measures introduced in conjunction with the EEZ had an effect on the barracouta fishery. The most relevant measures were:

1. From 1 October 1977
   Extended closed areas to foreign licensed and foreign chartered vessels along the coast (in addition to the 12 n. mile territorial sea), which included 13 n. mile wide strips on the east and west coasts of the South Island, 8 n. mile wide strips on the Taranaki Bight and East Cape coasts, and area closures of the Canterbury Bight and Tasman Bay (*see* Fig. 7).
2. 1 October 1977–1 January 1978
   Closure of the Solander corridor (an interim control to protect the ling fishery on Puysegur Bank). Minimum cod-end mesh size regulations were also introduced: 100 mm in all areas except area E and 60 mm in area E.
3. 1 April 1978–31 March 1979
   Species limits were placed on barracouta in area G (11 250 t) and area C (3000 t) for foreign licensed vessels. (The Japanese fleet did not actually start to fish for their allocation until October 1978.)
4. From 1 April 1979
   Foreign licensed vessels were excluded from EEZ areas C and G and limited to a total species quota of 1000 t in area B.
5. From 1 April 1980
   Foreign vessels (and all vessels over 43 m) were excluded from area B.
6. 1980–81
   Limitations were placed on joint venture trawlers in a specified control zone in area G from 1 May to 30 September to protect hake spawning grounds. These controls excluded joint venture vessels for the first weeks of the hake run and then from the fishery east of the 650 m contour (Anon. 1980).
7. 1981–82
   Joint venture vessels were again excluded from the hake control zone in area G from 14 to 31 July.
8. From 1981–82
   Foreign licensed vessels were excluded from trawling north of 38° 00′ S in area H.
9. 1982–83
   The hake control zone was dropped, and joint venture vessels were excluded from the whole of area G from 28 July to 1 September (Patchell 1982).
10. From April 1983
    The deepwater trawl policy was introduced in conjunction with a change in the fishing year from April-March to October-September. Foreign licensed vessels were allocated about half of their 1982–83 catch (Anon. 1983), whereas joint venture vessels were given a full year's quota for the 6 month period.
11. From October 1983
    Quotas were brought in on the barracouta fishery. The total EEZ quota was 31 000 t; 3350 t was allocated to foreign licensed vessels, 10 000 t to foreign chartered (joint venture) companies, and 17 650 t to the "others" category (inshore domestic vessels). The EEZ areas F-E boundary was moved south to 49° 00′ S. However, the area in which a 60 mm cod-end mesh could be used was moved north to 48° 00′ S.

Printed by Thames Publishing Co. Ltd. under the authority of
V. R. WARD, GOVERNMENT PRINTER, WELLINGTON, NEW ZEALAND—1988