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Groper

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GROPER (*Polyprion oxygeneios & P. moeone*)

1.0 INTRODUCTION

The groper fishery comprises two species, hapuku or groper (*P. oxygeneios*) and bass (*P. moeone*) which are usually landed together as groper. They are usually caught by the same vessels and gear, although often at different depths or on different grounds. For long-line and set-net fishermen they have traditionally been regarded as one fishery. In some areas and seasons bass make up most of the "groper" catch. Reported catches often do not distinguish between the two species, despite an obligation to do so. It would be desirable to manage each separately. Throughout this paper "groper" refers to the two species combined. This paper summarises the New Zealand groper fishery, assesses what is known about groper, and reviews the information required for the determination of reasonable yield estimates.

1.1 THE FISHERY

The fishery comprises a relatively large number of domestic commercial fishermen working small to medium sized vessels - trawlers, long-liners and set-netters - working at depths out to 500 m.

The groper fishery is nationwide (Figs. 1 and 2, Table 2); however, largest catches occur in Northland, Cook Strait, Canterbury, East Cape and Hawke Bay. Vessels may fish either close to port or travel considerable distances to offshore grounds and it is difficult therefore to define separate or distinct fisheries (except, perhaps, for the Kaikoura setnet fishery).

In recent years about three quarters of the total New Zealand catch has been by line, and 10% by trawl (Table 1). The trawl catch is largely incidental to other target fisheries. Setnet catches rose to 19% in 1984, mainly because of the Kaikoura fishery and to a lesser extent the Otago fisheries. Longlining however, remains the most dominant method for catching groper and involves trotlining and Dahn/drop lining. The introduction of trotlining during the late 1970's probably contributed significantly to increased fishing efficiency and increased landings.

When first stock assessments of New Zealand's coastal species were required in 1983 there was very little information available on groper. This situation still unfortunately exists today and yield estimates and TAC recommendations still have to be made on rather general principles, supported by historical trends in catches from separate fishing regions, and from general trawl survey data for southern New Zealand waters. The current TAC for groper is set at 1820 tonnes.

1.2 BACKGROUND LITERATURE

Previous work carried out on the biology of both groper species is extremely limited. McDougall (1975) conducted an investigation into the age and growth of hapuku with some success. In 1978-1980, Johnston carried out a study on the Cook Strait groper fishery, examining distribution, migration and general aspects of groper biology (Johnston,1979; 1983a; 1983b; 1983c). There has been a largely unsuccessful search for juvenile groper (Roberts, 1981; 1986). The identity of the New Zealand gropers has recently been reviewed (Roberts in press). The mortality, age, growth rate, feeding and spawning behaviour of Chilean *P.oxygeneios* populations have been investigated recently (Paves & Oyarzun, 1985; Pizarro & Yanez, 1985; Rojas et al, 1985; Flores & Rojas, 1985), and there has been a study on the reproductive biology of *P.oxygeneios* in the south-west Indian Ocean (Lisovenko & Vertunova, 1985). Unfortunately, these works on "foreign" groper populations remain untranslated.

No detailed examination on the size and age composition of the groper catch is presently in progress, either nationally or regionally. However some work of this nature was carried out on the Cook Strait groper fishery from 1978-80 and is discussed in section 3.0.

2.0 REVIEW OF THE FISHERY

2.1 *INSHORE DOMESTIC*

Until 1978 the New Zealand groper catch stayed relatively level at 1000-1500 tonnes (Paul 1985b, Fig. 1). Prior to 1983 there may have been some inclusion of bluenose (Paul, 1985a). From 1979 catches rapidly increased to 2364 tonnes in 1983/84, but dropped to 1522 tonnes in 1985/86 (Table 1). This 36% decline brings landings back to the lower but relatively stable level prevailing between the mid 1930's and 1978. The decline appears large and significant, but in fact it is comparable to the annual increases during the three years 1978 - 80, and may largely reflect the rapidly changing fishing effort over recent years. The 1985/86 decline was extensive but not uniform around the country, with East Northland, Central East and South East coast ports showing the greatest reductions of 39, 52 and 27% of landings respectively. The Challenger region had a 64% increase, mainly from its Cook Strait groper fishing vessels.

Two trends are apparent in landings over recent decades. Firstly, in two of the larger established fisheries (Cook Strait and Canterbury) there has been a gradual decline in landings from 1950 to 1975 (Paul 1985b, Fig. 1). It is not clear if this indicates a stock decline or reduced effort in the fishery by traditional line fishermen. Secondly, in most areas there was a rapid increase in landings from 1979 onwards; this resulted from the development of a new set net fishery at Kaikoura, increased line fishing, and continued exploration of deeper water and new offshore grounds (particularly for bass). There has been increased fishing for bluenose, with two likely results: groper taken as a by-catch and some bluenose misreported as groper.

Total groper landings for New Zealand, plotted monthly from Jan 1983 to Sep 1986 (Fig. 3) indicate a clear winter peak each year, which conforms with the general belief that this is a somewhat seasonal fishery, influenced in many areas by winter spawning runs of fish. Regional landings indicate some differences from this pattern (Figs. 3 and 4). The Northern longline fishery usually exhibits a winter peak but maintains reasonable catches throughout the year. This may be due to bass comprising a higher proportion of catches; any differences in spawning season between species would result in a longer "season" and a steadier catch rate. The East Cape fishery appears erratic, with some late winter peaks. In Cook Strait the line fishery peaks in early to mid winter, and the net fishery (Kaikoura) in mid-winter. The southeast coast line fishery peaks in late summer-autumn. These differences may be due to fish movements between regions, to latitudinal differences in breeding cycles, or to temporal variations in fishing intensity between regions. Catch per unit effort (CPUE) data should be able to show if these regional differences in the seasonality of catch are more related to abundance or effort. The only data so far available, for Kaikoura (Fig. 5), suggest the former; peak CPUE only occurs during the later part of each seasonal increase in effort.

A CPUE analysis of several regional fisheries for 1983/84 - 1985/86 is shown in Fig. 4, based on a summary of Fisheries Statistics Unit (FSU) data. Three annual values cannot reveal clear trends, but do establish the present levels; no serious declines are apparent. However, CPUE data for groper should be interpreted with considerable caution due to the nature of groper fishing patterns. It is common practice among longline fishermen to exploit new areas and fishing grounds in a serial manner, returning to established grounds only when they have "recovered" from fishing pressure. This sequential fishing technique is known as serial depletion, and may maintain an unrealistically high CPUE value. This fishing pattern appears to be less common in the southern fisheries. Differences in the timing and length of fishing season between regions, coupled with the movement of fishermen to alternative seasonal fisheries, may also affect the total CPUE value. Considerable uncertainties exist in the interpretation of CPUE data for the groper fishery. Further study of regional fisheries, including an analysis of monthly values and incorporating local knowledge of each fishery, is planned.

Only one regional study is available, that for the Kaikoura set net fishery from 1979 (Fig. 5). The CPUE trend for 1983 - 86 incorporates data on net length fished. A low value was achieved in 1983, but the 1985 value remained at approximately the 1984 level rather than falling further. There does appear to be a slow decline, CPUE fell by about 20% over the period 1979 - 85, which is less than an earlier analysis had indicated (Paul 1986, Fig. 3). For the top five vessels, CPUE fluctuated more widely and showed, if anything, a slight increase over the same years apart from a decline in 1986. The effects of increasing experience and skill on these figures is not known.

2.2 DEEPWATER AND "FOREIGN"

Groper have been taken by foreign licensed, chartered, and New Zealand-owned trawlers working offshore grounds. They were target-fished by large foreign longliners in the mid 1970's, but generally they are only taken as a small by-catch. It is difficult to assess the reported catches (Table 3). Until

recently only the general category "gropers" was used, and this may have included several other species (presumably serranids, but perhaps also some other "groper-like" fish). Conversely, groper catches may have been underreported, either inadvertently included as "miscellaneous species" or as fishmeal production, or deliberately omitted because of concern over subsequent conflict with the traditional inshore fishery. Catches by these vessels probably totalled several hundred tonnes annually, and in the unrestricted 1970's they may have peaked at about 1000 tonnes.

The location of these catches is shown in Fig. 6 and in Table 3. The line fishery took 100 - 400 tonnes annually from the west coast of New Zealand in the mid 1970's. Data for the trawl fishery indicates that from 1979 most of the groper catch has been from the Chatham Rise and the Stewart - Snares Island region. The foreign by-catch data does support evidence from trawl surveys for a dispersed population on these south-eastern offshore grounds.

The potential impact of these "offshore" catches on the traditional and more coastal New Zealand fishery would appear to be greatest along the southern and eastern coast of the South Island and perhaps in the Cook Strait region. However, there are also some reports of exploratory trawling for groper and other serranids on the ridges and banks immediately north-west of New Zealand; if continued these would probably impact on northern coastal fisheries.

A continuing by-catch in the offshore fishery seems unavoidable, but management decisions must await further information on the size of this by-catch, now being collected by fisheries observers. Due to the uncertainty concerning the size of the groper by-catch, it has not been directly considered in the calculations of the regional yield estimates. Nevertheless, a mean value of the foreign by-catch could be incorporated into the total New Zealand yield estimate.

2.3 MAORI AND RECREATIONAL FISHING

Groper have traditionally been taken by Maori fishermen and are a highly regarded seafood. Best (1929, pp. 46-47) recorded some traditions of South Island hapuku fishing; canoes carrying up to 30 or so men voyaging some distance to fishing grounds during a November - June season. Keene (1963), in an account of fishing activities of the early Northland Maori, wrote "The northern tribes prized the hapuka above all other edible fish. Early pioneer authorities believed that each tribe had definite hapuka fishing grounds allotted to it along the coast." The major fishing expeditions took place in autumn, and strict conventions were observed; fishing on another tribe's grounds, in particular, often had severe consequences. Orbell (1985) noted that hapuku were caught on special and tapu grounds well out to sea and that hapuku were among the kinds of dried fish traded between coastal and inland tribes.

Groper (mainly hapuku) are very desirable target species for recreational small boat fishermen and some charter vessels around most of New Zealand. Although individual catches are low, the fishing activity involved, the folklore, and the total catch are probably substantial. There are no data available on catches.

In some small fishing communities, groper line fishing is an activity which extends accross the categories of traditional Maori fishing, subsistence fishing, recreational fishing, and seasonal commercial fishing. It is difficult to define, and there is little reliable data.

Due to the lack of data for the non-commercial groper fishery, yield estimates must therefore be based on commercial and trawl survey data only and apply only to the commercial fishing sector. However, commercial catch reductions implemented upon introduction of the QMS to effect stock rebuilding, or at least stability, may subsequently benefit the non-commercial fishing sector.

3.0 RESEARCH

Both species are widely distributed around New Zealand, and also occur off southern Australia. Hapuku are known from islands in the southern Indian Ocean and the south-east Pacific, and bass are now believed to be the same species as the wreckfish of the Atlantic and Indian Oceans.

The main habitat of both species appears to be rough ground (ledges, cliffs, pinnacles, and reefs) in 100 - 400 m, with bass extending deeper than hapuku, though their relative abundance at different depths is not well documented. Some fish are found on shallower reefs. Commercial trawling and trawl survey data indicates sparse distribution of groper over smooth sea floor. The proportions of the population (of each species) in these two habitats are not well known because of sampling difficulties, though this is clearly of considerable importance in any estimation of population size.

Previous work carried out on the biology of groper is extremely limited and life histories are poorly known. Spawning occurs during winter, but spawning and nursery grounds have not been located. A slow growth rate is suspected. McDougall, (1975) calculated the ages of 72 groper by breaking and burning otoliths and counting the "annuli". Scales and operculae were found to be unsuitable for use in age-determination of groper. A significant check ring was found in the position of the third otolith annulus that presumably reflects the alteration in the habitat of the fish from a pelagic to a demersal mode of existence. Lengths-at-age were calculated through back-calculation from otolith annulus radii measurements and a growth curve was derived. A large length range per age class was observed, but much of this was attributed to sexual dimorphism as females were found to be larger than males at ages above 3 years. Time taken to attain sexual maturity was estimated from the point of inflection on the growth curve. This was approximately 4-5 years for males and 5-6 years for females, i.e. 40-50 cm and 55-65 cm respectively.

Johnston, (1983a) noted from sampling of commercially caught groper that Cook Strait groper matured over a wide size range, with 50% of all females being mature at 87-89 cm and 50% of males at 85 cm. Using McDougall's growth model, these lengths at maturity suggest an age at maturity of 12-13

years for females and over 16 years for males. This finding directly conflicts with the age at maturity estimated by the growth curve point of inflection technique used by McDougall, (1975). This discrepancy makes it clear that further work on the growth rate and age at maturity of both groper species is required.

The works on Chilean and Southwest Indian Ocean *P.oxygeneios* populations (Flores & Rojas, 1985; Lisovenko & Vertunova, 1985; Pavez & Oyarzun,1985; Pizarro & Yanez, 1985; Rojas et al, 1985) are still to be translated. Use can be made of the information contained therein. Pavez & Oyarzun, (1985) present a growth curve for *P.oxygeneios*, based on scale annuli that indicates a time to maturity of 8 years for females and 10 years for males at lengths of 85 and 87 cm respectively.

Requests for information on juvenile bass and hapuku specimens have yielded limited results (Roberts, 1981; 1986). It is likely that the juveniles are 'surface-living', and occur in small schools associated with floating objects such as logs and other drift material.

Some preliminary studies have been conducted on *P.oxygeneios* during 1987 off East Northland. Fish were tagged near the Poor Knights Islands; the few returns to date mainly show short distance movements. Scanning electron and light microscope examination of the otolith reveals the presence of growth increments analogous to 'daily' increments described in many other species.

3.1 STOCK BOUNDARIES AND MIGRATION

Widespread, moderately deepwater species such as groper would seem unlikely to have formed separate populations, particularly if long-distance migration of individual fish does occur. Unfortunately, the extent of migration between regions is not clear. Johnston, (1983a), tagged a total of 578 mainly juvenile groper in the Cook Strait region from May 1978 to June 1980. A 12.5% return rate was obtained, showing movements of groper to be mainly limited to the Cook Strait area. A few wide-ranging movements were recorded, with 5% of the recaptured fish having moved more than 100 miles either north or south along the east coast. The main movement appears to be one of mature developing fish moving north into the Cook Strait prior to spawning. Length-frequency analysis of northern and southern Cook Strait populations indicated that the northern populations consisted predominantly of mature fish and the southern populations of juveniles. A study of the biochemical genetics of hapuku from Cook Strait, Cape Egmont, and the Wairarapa coasts has shown that, though significant regional differences can be found, which suggest discrete stocks, within-area differences in Cook Strait over a period of time are equally as great (Smith and Johnston, 1985). This is consistent with Johnston's (1983a) suggestion that "groper populations in the Cook Strait region consist of more than one highly mobile stock".

A total of 268 groper were tagged in the Chatham Islands area during two trawl surveys in 1984 and 1985 (Hurst & Bagley, 1985; Hurst & Annala, 1986). No recaptures have yet been reported. Difficulties were encountered in successfully venting and releasing these fish, and it may be that trawl-caught groper are unsuitable for tagging.

A tagging programme in the Otago-Canterbury region is attempting to clarify migration patterns of groper in that area. Some early returns have shown large movements northward.

From existing knowledge, it is not possible to make any scientifically-based division of New Zealand's gropers into regional stocks. However, for management purposes, including the estimation of yields, it is still desirable to consider different regions separately. A single yield value for the whole country might in theory be justified if it could be shown that there was only a single New Zealand stock. However, if it led to the establishment of a single New Zealand TAC, it would allow excessive catches in small areas and local depletion of important fisheries. It could lead, for example, to the larger trawl survey-derived yield estimates for offshore areas, (discussed later), being taken as catches from stressed coastal fisheries. Although this document deals mainly with yield estimates, and only briefly with TACs, it seems prudent to anticipate how the latter might eventually be derived from the data presented here.

Because yield estimates have, to a considerable extent, been based on regional trends in commercial landings, it is appropriate to review the different regions and their particular local fisheries separately. The standard Fisheries Management Area (FMA) boundaries are used here; the only major anomaly occurs in the Cook Strait region, where what is generally regarded as one large fishing ground is subdivided between three FMAs, (Central East, Central West, and Challenger).

3.2 STOCK ASSESSMENT AND YIELD ESTIMATES

Past yield estimates for groper have been based principally upon trends in the recorded regional domestic landings (i.e. how long and how heavily each "stock" has been fished), on the current position of each fishery (i.e. whether catches and catch rates are stable or falling), and on some general cautions derived from the likelihood that these are fairly slow-growing species.

First yield estimates, 1983

First estimates were derived for 10 regions (Anon., 1983) which appeared to be more natural subdivisions of the New Zealand coastline than were the FMA boundaries then being considered. They were based largely on the average level of landings from 1931 to 1982, and took into account any significant trends or fluctuations in these landings. These estimates totalled 1200 tonnes, representing a drop of 37% from the mean 1981 and 1982 landings of 1900 tonnes, but being about equal to the average annual landing over the five years 1971 - 75, and a level that was known to have been sustained over earlier years.

Revised estimates, 1984

These estimates were revised in 1984. There was continuing concern that groper were being overfished. The slow declines in many fisheries from about 1950 (Paul, 1985b), had only been reversed in recent years by greatly increased fishing activity, and there was increasing comment from commercial fishermen that established grounds were being fished out and that new

grounds did not provide good catches for long. In April 1984 a meeting of MAF fisheries scientists reviewed the information available and concluded that the previously estimated yield of 1200 tonnes was too high, and that 1000 tonnes would be preferable (Anon., 1984). It was also recommended that to allow stock rebuilding the yield should be reduced to 800 tonnes or even less.

First TAC calculations, 1984

The provisional groper TAC recommended in late 1984 was derived from the estimated New Zealand yield of 800 tonnes. This was subdivided by FMA's according to regional proportions in the 1983 landings, (the most recent year for which landings by fishing area were readily available).

By using 1983 catches this approach allowed the reduction from existing catch levels to be more evenly spread around the country. However, it allowed no distinction between regions where catches appeared to have been stable and sustainable over a long period of time, and regions with only a brief recent record of high catches.

There was considered to be merit in both approaches, and in subsequent yield determinations (and TAC calculations) an appropriate compromise was generally sought between estimated yields and levels of catch reduction.

Yield and TAC determinations, 1985-86

The yield estimates made in March 1985 (Paul, 1985b) were based on new regional assessments of historical landing trends. They also incorporated some general information provided by fishermen during the meetings in February 1985 between MAF and the fishing industry which discussed the proposed ITQ scheme.

Trawl Survey Biomass Estimates

Some trawl survey biomass calculations (Table 4) were available for inclusion in the Southern FMA estimates. These trawl surveys have given two biomass values, based on either the doorspread or the wingspread measurement of "net opening" - i.e. the width of the strip of seafloor "swept" by the trawl. The doorspread biomass assumes complete herding of fish by doors and sweeps, and is a minimum value. The wingspread biomass assumes no herding, and because of the smaller area "swept" by the trawl, gives a larger biomass value; it is not a maximum however, because it takes no account of fish escaping from the trawl mouth. The current convention is to use the mean of these two biomass values, and to calculate the yield from the biomass using an estimated productivity value; for groper this is 10% (low to moderate). However, the validity of using trawl surveys over clear ground to measure the biomass of fishes such as the two groper species, which are probably clumped over predominantly rough ground, is still uncertain.

With only minor administrative changes these yield estimates became TAC recommendations, and because little further information has subsequently come to hand these estimates remained unchanged in 1986 (Paul, 1986) and again in 1987.

The following account reviews the changes which have been made to yield estimates and recommended TAC's from 1983 to 1987 for each region.

Auckland FMA

Initial yield estimates, based on historical landings to 1982, were 15 tonnes for West Auckland, 200 tonnes for East Northland, 30 tonnes for Hauraki Gulf, and 50 tonnes for Bay of Plenty, totalling 295 tonnes; subsequently reduced to 200 tonnes. The first TAC calculation from 1983 landings was 330 tonnes.

The 1985 review suggested an upward revision. The large area covered by the fleet, with the likelihood of new fishing grounds being discovered, encouraged a higher figure, although reports from commercial fishermen did support the general belief of MAF staff that the traditional grounds were being overfished. Fishing patterns also provided conflicting arguments for altering the yield estimate. Stimulated by higher prices and a rapidly expanding export market, catches increased sharply from the late 1970's, with 1983/84 being the highest year on record. Consequently, there was not a long history of fishing at this level to support any claim that current catches were sustainable. However, groper fishing appeared to have become important to several Northland fishing communities, and it was clear that a severe catch reduction would be economically disruptive and socially undesirable.

The final yield estimate was 350 tonnes. Although a significant reduction from the 1983 landings (which were about 950 tonnes), and even from the mean 1978 - 83 landings (660 tonnes), it reflected the concern that the 1980's surge in landings (see Fig. 1) was already over-exploiting the resource. The gazetted TAC for 1986 and 1987 was 360 tonnes.

No figure is provided for the Kermadec FMA. See Paul (1986) for a brief comment on the significance of potential groper catches made there, and Anon. (1986) for a document providing more background on the problems which could arise from groper fishing in this area, particularly the risk to a valuable population of the spotted black groper *Epinephalus daemelii.*

Central: Central East FMA

Initial yield estimates were 100 tonnes for the east coast and Hawke Bay, and 100 tonnes for the northern part of the Cook Strait, a total of 200 tonnes; subsequently reduced to 130 tonnes. The first TAC calculation from 1983 landings was 180 tonnes.

The 1985 review incorporated 1983 landings and suggested an upward revision. Also, because of some higher trawl survey biomass estimates for the Southern region, which through probable migration could supply migrants to Central areas, the final yield estimate was increased to 200 tonnes. The gazetted TAC for 1986 and 1987 was 210 tonnes.

Central: Central West (Egmont) FMA

The initial yield estimate was 55 tonnes, reduced to 40 tonnes, while the first TAC calculation from 1983 landings was 15 tonnes. In view of the reasonably large offshore area, and the possibility of some immigration from further south, the final yield estimate was 50 tonnes, close to the highest of these figures (despite the lack of any sustained fishing at this level). The gazetted TAC for 1986 and 1987 was 60 tonnes.

Challenger FMA
The initial yield estimate, from Westland, Tasman Bay, and part of Cook Strait was (from landing trends) 190 tonnes, subsequently reduced to 125 tonnes. The first TAC determination was 85 tonnes.

In the 1985 yield review, the higher of the original figures was considered to be more realistic. As the potential fishing ground was large, and there seemed some possibility of immigration from areas to the south-east, the yield estimate was rounded up to 200 tonnes. The gazetted TAC for 1986 and 1987 was 210 tonnes.

Southern FMA
The initial yield estimates (from landing trends) were 200 tonnes from Canterbury Bight, 50 tonnes from Southland, and 200 tonnes from the southern half of Cook Strait, totalling 450 tonnes; subsequently reduced to 300 tonnes. The first TAC calculation (from relatively low 1983 landings) was 190 tonnes. The 1985 review introduced significant changes, described separately for the three sub-areas below.

Chatham Rise: These grounds had not previously been considered, there being no identifiable fishing history by New Zealand vessels (catches from the Rise are included in the landings at several mainland ports). Biomass estimates from a few Japanese trawl surveys (Table 4) suggested a large but dispersed population, with a potential yield of 300 tonnes. This was adopted as the yield estimate, but it was judged unlikely to be taken even by an expanded groper fishery, although it would be important in the question of by-catch limits in trawl fisheries on the Rise. Because of the risk of possible localised over-exploitation of coastal grounds this "offshore" estimate cannot be combined with the separate value estimated for the South Island's east coast, though the probability of some migration could allow greater flexibility in the yield and TAC from this latter area than had previously been considered. The gazetted TAC for 1986 and 1987 was 300 tonnes.

South-east Coast (Kaikoura to South Otago): The yield was estimated at 260 tonnes, partly from long-term landing trends and partly from the assumption that the large but dispersed offshore stock (Chatham Rise and Snares shelf) would maintain catches in adjacent areas at or above their present level. The gazetted TAC for 1986 and 1987 was 270 tonnes.

Southland plus Sub-Antarctic FMA: This area includes the Southland coastline, Stewart and Snares Islands, and perhaps the Aucklands shelf (the southern limit of commercial catches of groper is not clear from present information). Recorded landings have been low, and originally a yield of only 50 tonnes was suggested. Results from trawl surveys (Table 4) have suggested a reasonably large but dispersed population over the Stewart-Snares shelf, with a potential yield of 400 tonnes. As in the Chatham Rise area, much of this is unlikely to be caught in that area, but migration may help maintain mainland fisheries. The gazetted TAC for 1986 and 1987 was 410 tonnes.

3.3 ALTERNATIVE STRATEGIES

The clearest alternative to the present method of managing groper in New Zealand would seem to be to manage bass and hapuku individually. The uncertainties created by interpreting catch data and deriving yield estimates for the two species collectively, could then be avoided. This would require increased cooperation from commercial fishermen in reporting bass and hapuku catches separately on fishing returns. It would also mean separating the two species in the existing hapuku/bass (HPB) category in the Quota Management System, which would involve increased administrative checking of landings data. Although this would almost certainly improve the management of hapuku and bass, the level of compliance likely to be achieved, plus administrative costs, would have to be assessed before implementation.

4.0 MANAGEMENT IMPLICATIONS

YIELD RECOMMENDATIONS

The yield estimates for groper are summarised below. These 1988 estimates differ from previous years, in the way they were derived. Two different yield determinations were attempted:

1. Maximum Constant Yield (MCY)- the maximum constant catch that is estimated to be sustainable at all probable levels of biomass.

2. Current Annual Yield (CAY)- the one-year catch attained by applying a target fishing mortality to an estimate of the fishable (i.e recruited) biomass present during the next fishing year. No estimate of CAY can be calculated for groper as insufficient information is available.

Three MCY values may be calculated, using different combinations of commercial catch and trawl survey biomass data.

(a). From catches alone, using the equation:

$$MCY = cY.$$

The domestic catches from 1936 - 78 were fairly stable; the foreign catches 1974 - 86 less so but relatively much smaller. No consistent change in effort is apparent for the domestic fleet. Both groper are assumed to be long-lived species. Consequently, "c" was taken to be 0.8. The domestic MCY is then 1080 tonnes, and the foreign MCY 230 tonnes, producing a total of 1310 tonnes.

(b). From domestic catch only (MCY = cY), plus offshore trawl survey biomass data (MCY = $^1/_4MB_0$, with M = 0.2) for offshore areas: the Chatham Rise and Stewart-Snares shelf. The domestic MCY is 1080 tonnes, the offshore MCYs are 180 and 190 tonnes respectively, producing a total of 1450 tonnes.

(c). From the domestic catch (1936 - 78) and foreign catch (1974 - 86), the latter assumed to come largely from the mainland and Chatham Rise grounds, plus a trawl survey biomass estimate from the Stewart-Snares shelf. This MCY is 1370 + 190 tonnes, giving a total of 1560 tonnes.

The latter approach (c), is considered the most reasonable, and an MCY of 1560 tonnes rounded upwards to 1600 tonnes is recommended. This yield estimate is less than the estimates made in 1985, 1986 and 1987. The recent landings, yield estimates, and allocated TAC's are summarised in the following table.

Summary of recent landings, yield estimates and allocated TAC's

		Domestic (D) and foreign (F) (licensed and chartered) landings*				Estimated yield & TAC 1985-87	Gazetted TAC 1986	198 MC
		83/84	84/85	85/86	86/87			
Auckland(1)	D	968	637	567	237	350	360	31
	F	6	5	2	-			
Central East(2)	D	493	388	270	183	200	210	18
	F	0	0	0	-			
Central West(8)	D	46	33	25	36	50	60	5
	F	-	-	-	-			
Challenger(7)	D	163	203	192	146	200	210	18
	F	11	4	7	-			
S.E.- Chatham Rise(4)	D	18	16	12	42	300	300	26
	F	37	36	41	-			
S.E. Coast(3)	D	495	406	374	254	260	270	23
	F	10	12	17	-			
Southland and Sub-antarctic (5 & 6)	D	35	62	29	130	400	410	36
	F	270	166	97	-			
Area not known		145	71	64	-			
TOTAL	D	2364	1816	1533	1028	1760	1820	160
	F	334	223	164	-			

* Pre 1986/87 domestic landings totalled by statistical areas of capture (see Fig. 2), which do not exactly equal FMA's. Regional subdivisions of foreign landings (see Fig. 6) also do not equal FMA's. 1986/87 values are from quota monitoring report data.

Total New Zealand landings, yields and TAC's

The 1985 yield estimates totalled 1760 tonnes, considerably above the 1000 tonnes estimate of 1984, and more than twice the value of 800 tonnes which allowed for stock rebuilding. Most of this increase (700 tonnes) was derived from trawl survey biomass estimates of sparsely distributed populations on offshore grounds, effectively not immediately available to targeted commercial fishing, though some are available as a by-catch to deepwater trawlers. Their value lies in the support they may possibly provide, through migration, to the mainland "stocks". Very little is known about such migration and recruitment, and it cannot be assumed that it does actually occur.

The 1986 and 1987 yield estimates have remained the same. (The 1987 TAC is slightly higher because of a small by-catch allowance for deepwater trawlers.)

The 1985/86 landings, 1533 tonnes, were considerably lower than the 1983/84 and 1984/85 values of 2364 and 1816 tonnes respectively. Although this is below the total of the regional yield estimates and the allocated TAC's, the Auckland FMA landings were nearly twice the proposed regional yield, and the South-East Coast and Central East sub-area landings were also significantly above their respective TACs. The apparent balance between landings and yield estimates can only be reached when the uncaught offshore "stock" component is included.

Data from quota monitoring reports show a considerable reduction in landings for 1986/87 to 1028 tonnes. This value is 56.5% of the national TAC and none of the allocated regional TAC's were exceeded.

As discussed earlier, many uncertainties exist when interpreting catch or effort data and in calculating a yield estimate for groper. These uncertainties are caused mainly by the management of the two species as one fishery, the varied fishing patterns within the fishery, the practice of serial depletion by many longliners and the uncertainty concerning the relationship between "offshore" and coastal populations. A conservative approach towards management of this fishery is therefore required.

5.0 REFERENCES

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TABLE 1: Groper landings by domestic vessel method and combined "foreign" (Japanese and Korean licensed and chartered vessel) landings, 1974-1985/86. Catches recorded by calendar year to 1983 then by fishing year (October 1 to September 30) from 1983/84 to 1985/86. Data for October to December 1983 is therefore duplicated.

	Domestic Catch (and percentage)									
	Trawl	%	Line	%	Net	%	Total	"Foreign"	Total	Notes
1974	305	24	935	75	6		1254	141	1393	1, 2, 3,
1975	216	20	886	80	2		1106	316	1422	4
1976	250	23	805	76	7	1	1066	446	1512	5
1977	211	21	760	74	39	4	1025	917	1942	6
1978	256	19	1038	76	62	5	1362	126	1488	7
1979	265	15	1331	76	144	8	1760	318	2078	8
1980	348	16	1659	74	215	10	2235			
1981	343	15	1615	71	310	14	2274	105	2379	
1982	212	10	1580	76	272	13	2071	147	2218	
1983	272	12	1676	74	325	14	2277	234	2511	
1983/84	300	13	1640	69	424	18	2364	334	2695	
1984/85	205	11	1307	72	303	17	1816	223	2039	
1985/86	184	12	1113	73	235	15	1522	162	1695	

* Domestic landings by method for 1936-83 were given by Paul (1985b).

1. "Foreign" catches are those reported by licensed and joint venture or New Zealand chartered vessels, including Japanese trawlers, Japanese line vessels, and Korean trawlers. Reported catches do not always cover a calendar year, and because of underreporting and misidentification or miscoding must be regarded as approximate minimum values only. Recorded Soviet trawl landings do not identify groper separately, but some must have been caught. There are some other gaps; e.g., Korean line vessels.
2. Data sources for foreign catches are Robertson and Paul (1979), King et al. (1985), and various unpublished data summaries held by MAFFish. There are some discrepancies between these, largely due to updates and revisions and different rounding procedures. Domestic catches are from MAFFish Data Series reports.
3. Foreign catch is by Japan, trawl.
4. Foreign catch: 149 Japan trawl, 167 Japan line.
5. Foreign catch: 110 Japan trawl, 336 Japan line.
6. Foreign catch: 275 Japan trawl, 642 Japan line.
7. Foreign catch: 93 Japan trawl, 24 Korea trawl, 9 charter.
8. For 1979-85 foreign catch data by country, see Table 4. Data for 1980 are not available.

TABLE 2: Groper landings (t) by port and FMA (or subdivision of FMA*), 1974-85[†]

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Hokianga		1[§]	-							-	-	2	1
Manukau	2	28	21	-	-	5	24	47	23	28	15	3	20
Raglan, Kawhia					-	-		2	3	-	-	-	-
WEST AUCKLAND	2	28	21	-	-	5	24	49	26	28	15	5	21
Mangonui	87	77	50	65	97	161	297	173	174	283	260	224	183
Whangaroa	74	48	27	42	57	89	155	152	286	256	361	150	134
Russell	7	1	-	5	19	6	25	24	92	20	47	29	5
Whangarei	-	1	1	4	7	10	15	17	38	33	36	28	18
EAST NORTHLAND	168	127	78	116	181	266	492	366	590	592	704	431	340
Leigh										67	55	32	23
Auckland	16	18	16	14	7	84	146	94	64	55	45	52	24
Thames				-			-					-	-
Coromandel			-	-	-	-	8	1	2	-	1	-	1
HAURAKI GULF	16	18	16	14	7	84	154	95	66	122	101	84	48
Mercury Bay	3	1	5	11	23	14	85	47	20	33	29	26	28
Tauranga	73	23	48	47	76	86	52	43	145	125	128	114	38
Whakatane	46	35	7	6	45	131	102	74	124	93	62	54	38
BAY OF PLENTY	123	59	60	64	144	231	239	164	289	231	219	194	104
Gisborne	197	118	80	56	152	233	151	142	145	160	163	81	60
Napier	106	44	50	61	70	46	65	61	90	143	166	43	44
Castlepoint	5	5	3	6	8	10	5	10	8	14	24	21	23
Wellington	214	195	103	189	305	244	173	176	78	94	95	68	56
Makara	-	-	-	-	-	-	-	-	-	-	4	6	3
CENTRAL EAST	522	362	236	312	535	533	394	389	321	411	452	219	186
Paremata	43	30	25	37	31	29	38	31	14	27	51	50	30
Paraparaumu			-	-	-	1	-	-	-	-		-	-
Manawatu	-	-	-	-	-	-	1	-	-	-			-
Wanganui	4	2	2	1	-	1	1	2	1	2	1	1	-
New Plymouth	6	6	1	1	4	22	78	191	37	18	5	6	1
CENTRAL WEST	53	38	28	39	35	53	118	224	52	47	57	57	31
Blenheim	8	6	17	16	10	17	2	3	5	-	2	-	1
Picton	73	77	75	77	106	120	102	92	133	68	79	137	102
Pelorus	3	5	10	10	7	7	6	5	4	6	7	15	9
Nelson	8	17	19	14	15	26	28	39	15	27	9	29	50
Motueka	-	1	1	2	1	3	2	1	15	1	1	3	1
Golden Bay	-	-	-	-	1		6	-	2	1	-	-	-
Westport	-	-	-	-		-	1	1	1	27	14	10	10
Greymouth	22	165	235	149	78	62	125	202	70	175	41	57	41
CHALLENGER	114	271	357	268	218	235	272	343	245	305	153	251	214

Table 2: continued

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Kaikoura	10	9	11	63	72	158	190	248	237	279	354	229	147
Lyttelton	25	17	12	4	23	23	48	36	29	66	31	41	37
Akaroa	29	24	15	15	15	20	35	28	15	26	55	25	25
Timaru	91	46	73	34	62	77	117	119	118	61	76	32	26
Oamaru	39	48	49	21	23	24	20	22	24	24	34	24	43
Moeraki	6	16	8	4	2	1	-	2	1	1	-	1	-
Karitane		-				-	6	14	-	1	-	-	-
Port Chalmers	19	17	32	19	10	17	27	51	-	8	-	-	4
Taieri	5	15	30	12	7	12	13	3	7	11	11	41	21
Nuggets	1	-	2	-	-	-	-	1	3	4	1	4	3
Waikawa	2	3	5	4	2	-	-	-	-	-	-	1	5
SOUTH-EAST COAST	227	195	237	176	216	332	456	525	440	481	551	404	311
Stewart Island-Bluff	20	1	9	12	10	7	9	24	11	9	13	14	9
Riverton	7	1	11	14	9	12	18	25	16	9	7	7	4
Milford				3	-	2	41	58	5	10	18	33	2
SOUTHLAND	27	2	20	29	19	21	68	107	32	28	38	54	15
Chatham Islands	2	2	13	7	8	2	1	10	9	19	18	16	12
New Zealand	1 254	1 102	1 066	1 025	1 363	1 762	2 218	2 272	2 070	2 284	2 308	1 715	1 282

* The port listings are rearranged from Table 3 in Paul 1985a and are now grouped according to current FMAs (or their subdivisions). They are less natural geographic groupings, but provide data which can be more easily compared with other data sets; e.g., the catches by area fished in Fig. 2, or regional yield estimates and TACs.

† There may be minor discrepancies with other recent tables because of changes in the data base and rounding procedures. This table revises and updates Tables 2 and 3 in Paul 1986.

§ Less than 1 t.

TABLE 3: New Zealand regional catches (t) of groper reported by joint venture or chartered and foreign licensed trawlers, 1979-1985/86. Letters in brackets refer to exclusive economic zone (EEZ) area code. Catches recorded by calendar year to 1983 then by fishing year (October 1 to September 30) from 1983/84 to 1985/86. Data for October to December 1983 is therefore duplicated.

	1979	1980-81	1982	1983	1983/84	1984/85	1985/86
Joint venture/chartered trawlers							
East Coast North Island (B)	-†		1				
West Coast North Island (H)	1	2	2	3	4	3	1
Mernoo Bank, Chatham Rise (CM)	5	3	19	16	4	2	5
Central and eastern Chatham Rise (D)	64	22	8	19	17	15	30
Canterbury shelf (C)	28	10	4	8	6	8	8
Eastern Southland Shelf (FE)	4	12	14	14	44	46	38
Western Southland Shelf (FW)	2	24	9	12	133	57	27
West Coast South Island (G)	2	2	3	11	11	4	7
Aucklands Shelf (EA) §	3	17	12	16	2	2	1
	109	92	72	99	221	137	117
Japanese trawlers							
East coast North Island (B)	2						
West coast North Island (H)	2	1	1	1	1	1	-
Mernoo Bank, Chatham Rise (CM)	2			-			
Central and eastern Chatham Rise (D)	23	4	3	8	5	13	5
Canterbury shelf (C)	36						
Eastern Southland Shelf (FE)	17	6	10	3	6	9	9
Western Southland Shelf (FW)	5	2		8	30	11	9
Aucklands Shelf (EA) §	49	28	9	9	0	1	1
Campbell Island Shelf (EC)	1			-			
	138	41	23	29	42	35	24
Korean trawlers							
West coast North Island (H)	4	-	1	6	1	1	1
Central and eastern Chatham Rise (D)	55	6	6	12	15	8	6
Eastern Southland shelf (FE)	4	3	6	7	4	3	6
Western Southland shelf (FW)	5	-	2	3	5	1	2
Bounty Shelf (EB)					1	5	-
Pukaki Rise (EP)					-	2	4
Aucklands Shelf (EA) §	1	1	37	78	45	31	4
	71	10	52	106	71	51	23
All joint venture and foreign licensed trawlers							
East coast North Island (B)	2		1				
West coast North Island (H)	7	3	4	10	6	5	2
Mernoo Bank, Chatham Rise (CM)	7	3	19	16	4	2	5
Central and eastern Chatham Rise (D)	142	32	17	39	37	36	41
Canterbury coast (C)	64	10	4	8	6	8	8
Eastern Southland shelf (FE)	25	21	30	24	54	58	53
Western Southland shelf (FW)	12	26	11	23	168	69	38
West coast South Island (G)	5	2	3	11	11	4	7
Bounty Shelf (EB)				1	5	-	
Pukaki Rise (EP					-	2	4
Aucklands Shelf (EA) §	53	46	58	103	47	34	6
Campbell Island shelf (EC)	1						
	318	143	147	234	334	223	164

* Data are for calendar years, except 1980-81, which is Jan-Mar 1980 plus Apr-Dec 1981. (The remaining data for these years have not yet been analysed.) This table revises and updates that given by Paul (1985a); data are from MAFFish data sets and some published summaries.

† Less than 1 t.

§ Groper catches were made in the northern segment (the southern Snares shelf) of Auckland Islands (EA) region.

TABLE 4: Groper biomass and yield estimates (t) from trawl surveys

Vessel	Date	Region	12-mile zone included	Rough* ground included	Areas excluded	Biomass estimates† Wing	Door	Mean	c.v. (%)	Yield estimate§	Data source¶
Shinkai Maru	Feb 81	Stewart-Snares-Aucklands		Yes	Puysegur Solander	5 600	1 300[1]	3 500[1]	18	350	a
Shinkai Maru	Mar-Apr 82	Stewart-Snares-Aucklands-Campbell Plateau-Bounties		Yes	Puysegur Solander	3 200	800[1]	2 000[1]	17	200	a
Shinkai Maru	Apr 83	Stewart-Snares-Aucklands		Yes	Puysegur Solander	5 300	1 300[1]	3 300[1]	17	330	a
Shinkai Maru	Oct-Nov 83	Stewart-Snares-Aucklands-Campbell Plateau/Bounties		Yes	Puysegur Solander	2 500	900[1]	1 700[1]	27	170	a
Shinkai Maru	Jun 86	Stewart-Snares-Puysegur	Yes			6 200	1 400	3 800[1]	18	380	b
Akebono Maru No. 3	Nov 86	Stewart-Snares-Puysegur	Yes			5 200	1 500	3 400[1]	12	340	b
Tomi Maru	Dec 80-Feb 81	Central west coast		Yes		600	300[1]	500[1]	55	50	a
Shinkai Maru	Oct-Nov 83	Central west coast		Yes		600	100[1]	400[1]	18	40	a
Shinkai Maru	Mar 83	Chatham Rise		Yes		4 300	1 000[1]	2 700[1]	37	270	a
Shinkai Maru	Nov-Dec 83	Chatham Rise		Yes		1 600	500[1]	1 100[1]	40	110	a
Akebono Maru No. 73	Dec 84	Chatham Islands	Yes			3 600	1 200[1]	2 400	12	240	e
			Yes	Yes		5 060	1 640	3 400	12	340	
Akebono Maru No. 73	Dec 85	Chatham Islands	Yes			4 000[1]	1 200[1]	2 600	46	260	c
Shinkai Maru	Jul 86	Chatham Rise	Yes	Yes		5 800	1 300	3 600[1]	46	360	d

* Rough ground not trawled, but biomass calculated for the entire area assuming equal density of fish on clear and rough ground.
† Biomass figures marked 1 are calculated; others are compiled from the original data sources and rounded to the nearest 100 t. Doorspread biomass = wingspread biomass divided by the doorspread-wingspread ratio given in the source documents. Mean is the simple mean of both biomass values.
§ Yield estimate is calculated here as 10% of the mean biomass, an assumed low to moderate productivity rate.
¶ Data sources: a, Hurst and Fenaughty (1985); b, Hurst (notes for 1987 Yield Assessment Meeting); c, Hurst (notes for 1986 TAC Meeting); d, Livingston (unpublished data prepared for 1987 Yield Assessment Meeting); e, Hurst and Bagley (1987).

Figure 1: Groper landings (t) by FMA (or subdivision of FMA) and by major ports, 1974-1986. (Note: Total for FMA or subdivision of FMA indicated by solid line).

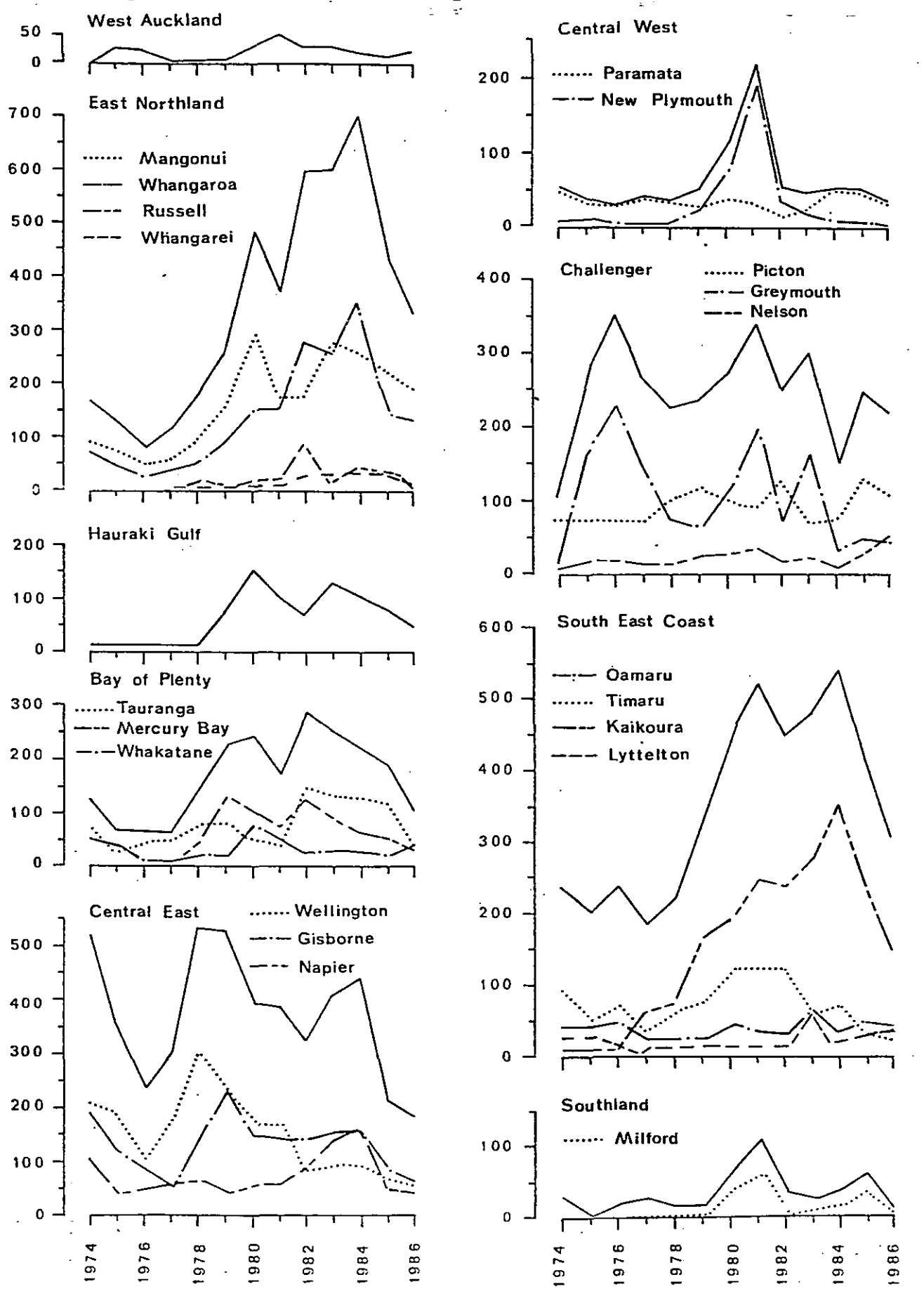


Figure 2: Domestic landings (t) of Groper for fishing years 1983/84; 1984/85; 1985/86 by fishing return area. Area not known: 1983/84 = 145 t, 1984/85 = 71 t, 1985/86 = 153 t. Inset indicates major regions for groper in New Zealand.

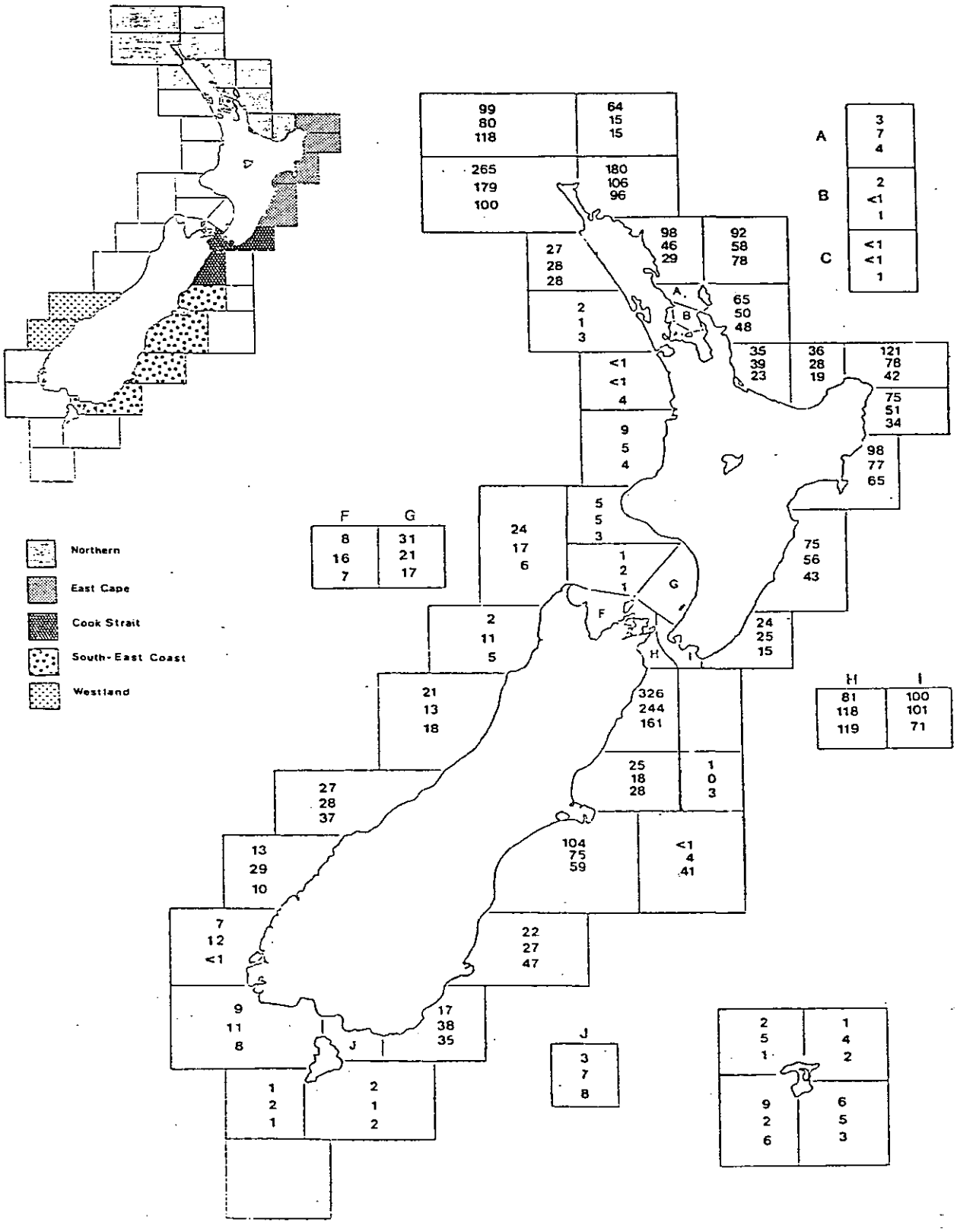


Figure 3: Monthly trends in New Zealand Groper landings, by method (Jan 1984 to Sep 1986) and by region (Jan 1983 to Sep 1986).

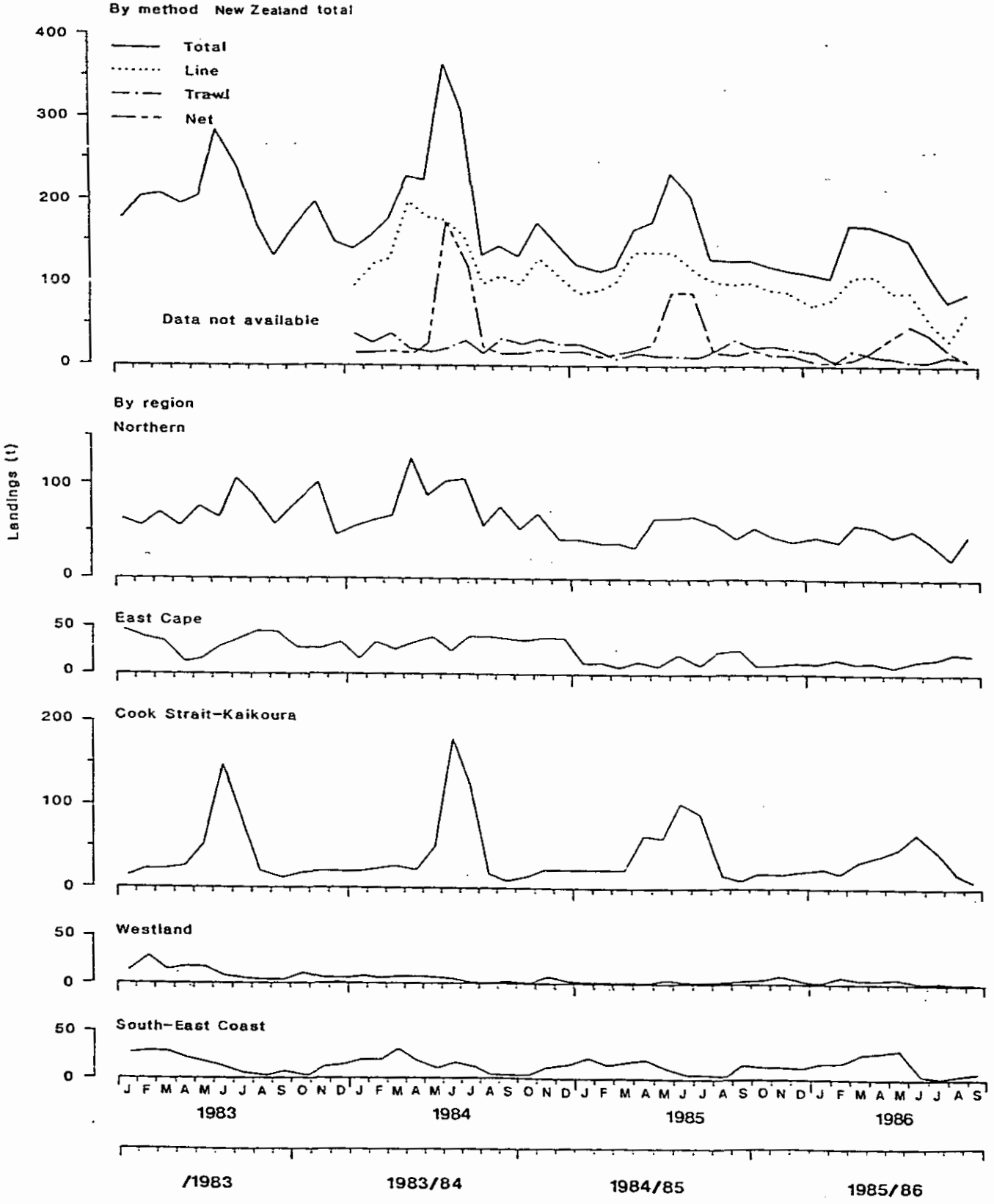


Figure 4: Monthly Groper landings (t) and catch per unit effort data (annual) by region and method, 1983/84-1985/86. Differs from Figure 3 in showing landings by single method, but uses the same regional boundaries. Monthly landings (t) pre 1983/84 are for Jan-Sept 1983.

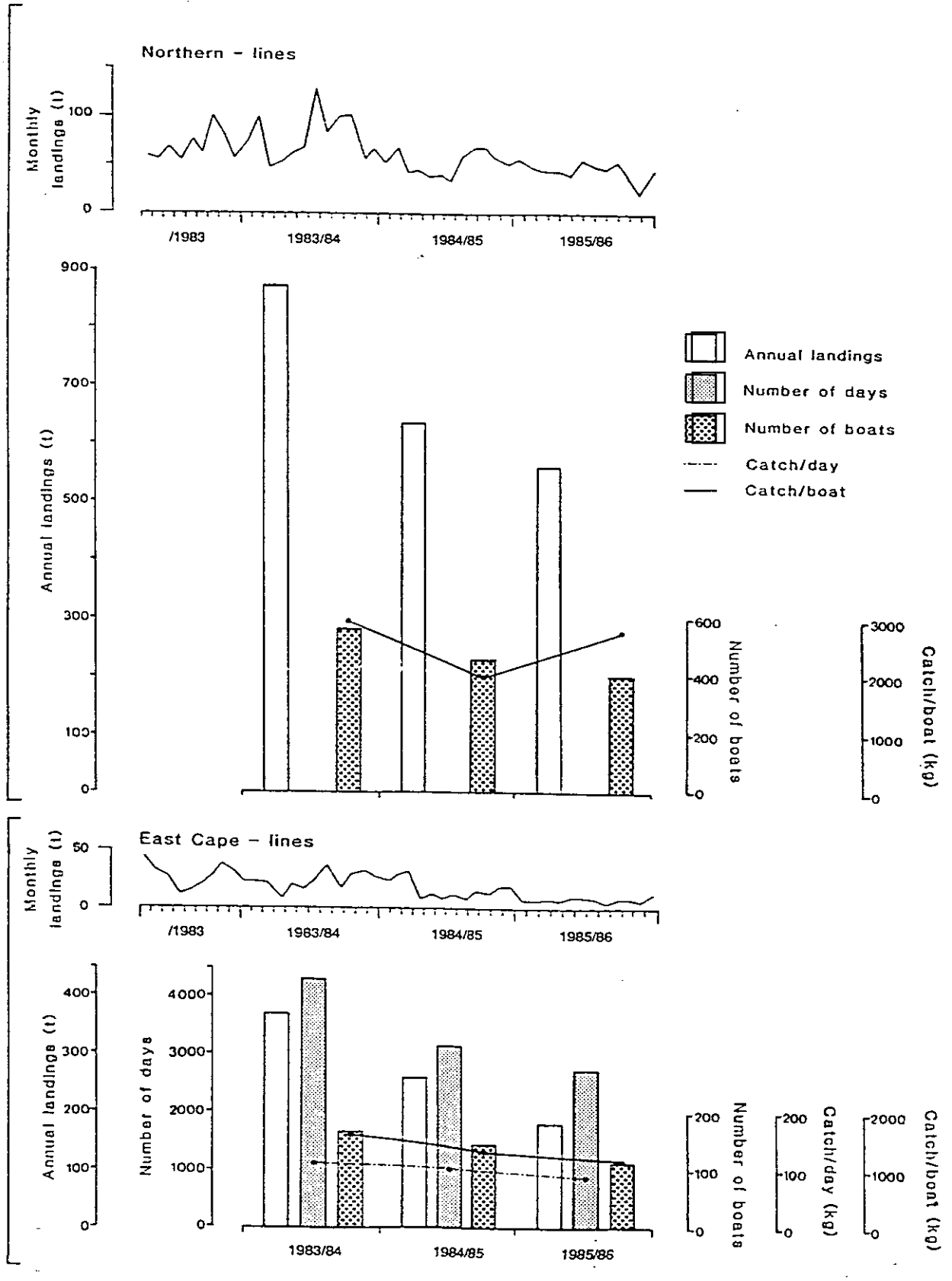


Figure 4: continued

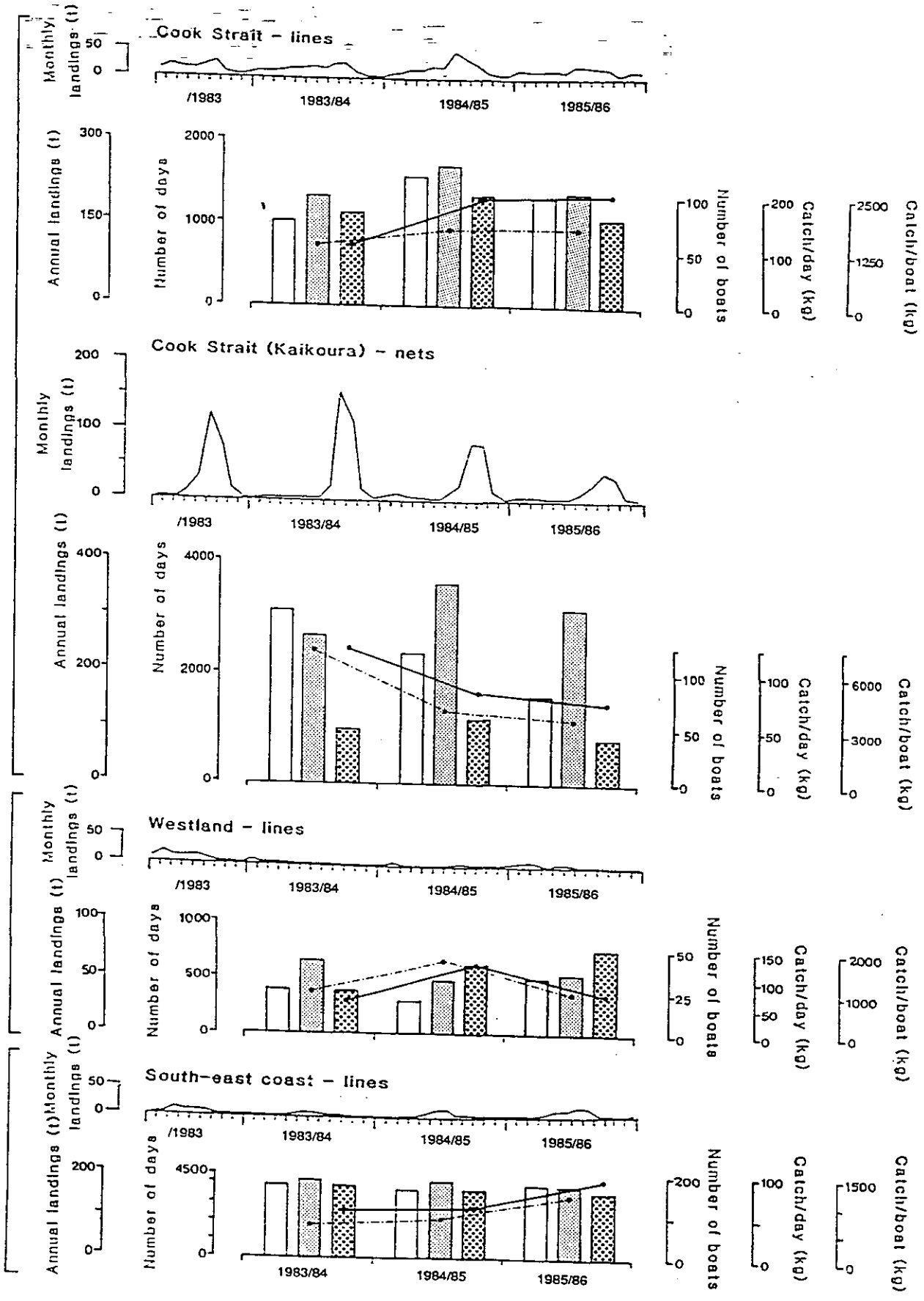
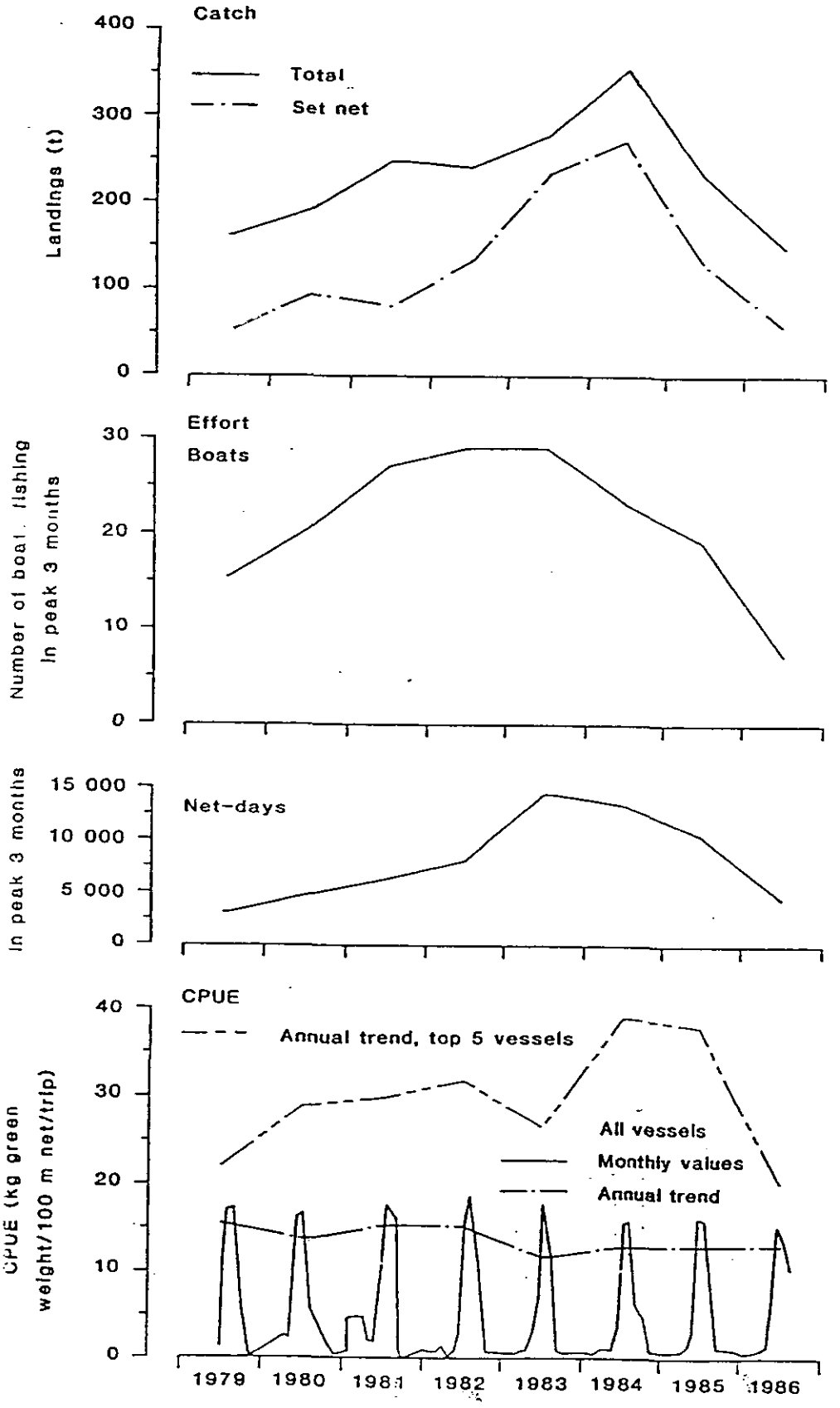
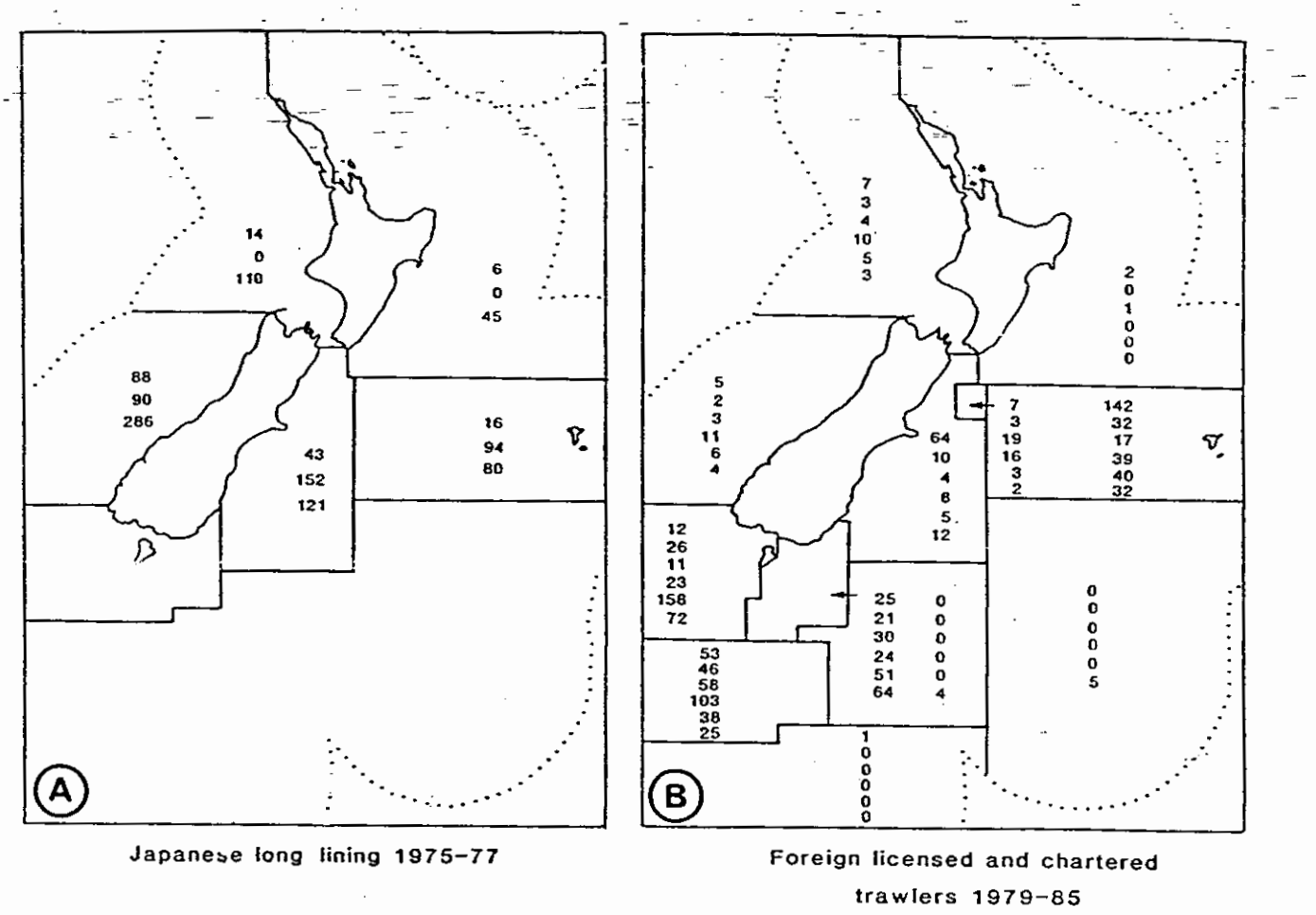


Figure 5: Catch (over the peak three month season, Jun–Aug), Effort, and catch per unit effort data for the Kaikoura set net fishery for groper, 1979–1986. Data from commercial fishing returns, analysis by MAFfish staff, Southern FMA (pers comm. G.A.McGregor, Dunedin).





Japanese long lining 1975-77

Foreign licensed and chartered trawlers 1979-85

Figure 6: Japanese longline catches, 1975-1977 (a) and Foreign licensed and chartered trawler catches, 1979 and 1981-1985 (b) of groper by EEZ area.