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EXECUTIVE SUMMARY

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This report forms part of Ministry of Fisheries project HPB2002/01, which has the overall objective: To monitor the relative abundance of major groper and school shark Fishstocks. Objective 2 is addressed here: To evaluate indices of relative abundance for groper derived from existing commercial bycatch data.

The study investigated whether CPUE indices for groper, derived from fisheries where they were taken as bycatch instead of nominated target species, had any advantage over targeted CPUE indices.

The period studied covered fishing years 1989–90 to 2002–03. Estimated catch values were used, rather than landings, despite the known limitations of these data, in particular the recording of processed weight rather than full weight. The proportion of data errors, and their effect on results, was assumed constant across years. Integrating effort data with full landing records is complex and also has limitations. Full extracts of New Zealand groper catches were obtained, from which the data from four regional fisheries were selected: Northern lines (dropline and bottom longline), Cook Strait lines, Southern lines, and Kaikoura setnet. The records included vessel, catch date, fishing method, statistical area, target species, groper catch, and total catch. Each record represented one day's catch, and the measure of effort used was a day fishing. Raw (unstandardised) CPUE was calculated as kg/day.

Each region's data were selected using fishing statistical areas. QMAs are unsuitable for groper stock assessment. Line fishing was categorised as droplining (drop, Dahn, and trotlining), and bottom longlining. Handlining was excluded, although it would overlap with at least droplining. Data were groomed to exclude outliers and missing essential values or records. The relatively few groper catches of less than 10 kg/day or more than 5 t/day were excluded; the latter value is considered more likely to have excluded errors rather than valid catches.

The fishery in each region is tabulated in terms of groper catch (by fishing year) by method, statistical area, and method and target species (groper themselves, species combined), bluenose, ling, school shark, and (for setnet only) tarakihi). The data are presented (by month) by method, and as targeted groper catch and groper taken as bycatch.

CPUE indices are given for the target line (or setnet) groper fisheries in each region, and the associated fisheries which took moderate quantities of groper as bycatch. Most CPUE series, both targeted and bycatch, fluctuate to some extent but show no longer term trend. Many are influenced for much or all of the period by catch levels, and vary in parallel with them. Targeted and bycatch CPUE indices for the same region sometimes trend together, sometimes in opposite directions. There are more stable or rising CPUE indices than there are declining trends. These indicate that the regional stocks may be stable, but do not guarantee this because of the localised nature of groper fishing, and the ability of fishers to progressively exploit new grounds, or return to alternate grounds, all of which could mask a decline.

Groper bycatches are taken mainly in line fisheries closely associated with target groper fishing (bluenose, ling, and school shark lining). Deficiencies in the way single target species are nominated limit the ability to discriminate target catches from bycatches. Where groper do constitute a true bycatch, the target fisheries (for bluenose, ling, etc.) are considered sufficiently different to preclude aggregated analyses. The groper fishery also seems to have several features which make a simple measure of effort (fishing day) of limited value, as well as complexities which govern true effort but not well recorded. There is no simple way to monitor groper by either targeted or bycatch CPUE trends. Recording two species as one compounds the difficulty in undertaking stock assessments.

1. INTRODUCTION

The New Zealand groper fishery is not large, with annual landings during its recorded history, 1936 to 2004, generally in the range of 1000–2000 t. Landings exceeded 2000 t only from 1980 to 1983–84, reaching 2700 t in the latter year. In 2003–04 groper landings of 1607 t ranked about 40[th] by weight in finfish species values. Only a few fishers make moderate landings of targeted groper, but many take small quantities in a variety of mixed fisheries or as an accidental bycatch. Groper (hapuku and bass) are popular, high-value species, the 2003–04 landings had a port price value of about $6,000,000, and an estimated retail value of $20,000,000.

Some estimates of the relative abundance of groper have been obtained from analyses of catch and effort from "target fisheries", mostly line fisheries (Paul 2002a), although these proved rather difficult to define because of their overlap with other line fisheries. In addition, groper fisheries have characteristics that are difficult to incorporate in CPUE studies; they are small, spatially dispersed, much of the catch is taken by relatively few fishers, and there is limited continuity (seasonally and annually) by these and the large number of fishers reporting small catches. In some regions the same fishing grounds continue to be worked (with some rotation or "resting" of particular localities), and in other regions there is some progressive movement over time from established to newly discovered fishing grounds. Another – and in this case unnecessary – complication is that the reported catch of "groper" combines two species, hapuku (*Polyprion oxygeneios*) and bass (*P. americanus* = *P. moeone*), which are likely to have different biological characteristics.

The recent study by Paul (2002b) tracked CPUE indices for the line fisheries which sought both species of groper, in association with bluenose (*Hyperoglyphe antarctica*), ling (*Genypterus blacodes*), and school shark (*Galeorhinus galeus*) in various combinations. The CPUE trends for 1989–90 to 1998–99 proved to be essentially level, but this was considered a possible artefact of the combined data. The present study extends the time series to 2002–03, and subdivides the fishery into the component which nominally targeted groper, and the "bycatch" of groper when the other species were nominally targeted.

CPUE and aggregated species

In almost all fisheries, the relationship between CPUE and fish abundance is not straightforward, particularly where the species schools or has some other form of aggregation, such as localised dependence on a particular, irregularly distributed habitat, such as rough seafloor. In some cases, stable CPUE indices can be highly misleading, as in the following hypothetical scenarios. (1) If species '*x*' has a dispersed component plus localised areas of high abundance, targeted fishing activity is likely to move from the former to the latter as they are progressively located by fishers. CPUE indices will rise, as fish abundance falls. (2) Subsequently, when most of the good grounds have been located, or searching for new grounds ceases, CPUE will also not track actual fish abundance. Where species '*x*' is most aggregated, catches (and CPUE) taken from the centre of the aggregation can remain high and stable even as the localised population declines. (3) The converse may also be true. If species '*y*' also has clumped and dispersed components, but the former are small and quickly fished down when targeted, vessels will move to the area of dispersed fish in search of new clumps, and CPUE will decline (until a new clump is located) more rapidly than does actual abundance. The review by Dunn et al. (2000) concluded, in the context of "simple recipes for calculating CPUE indices", that "there are no easy answers, and every analysis requires a good understanding of both the fishery and the factors that can affect the CPUE/abundance relationship."

The fishery for groper (*Polyprion* spp.) has such complications. As currently understood, each species has highly aggregated distributions centred on reefs, with a relatively small part of its population (mainly juveniles) over open seafloor. These reef aggregations could each be fished down, but the CPUE maintained or increased by fishers moving on to new reefs within the same broad fishing area, such as a single statistical fishing area. That is, "serial depletion" may occur but cannot be detected. It is also difficult to interpret what is meant by "targeted groper" in catch records. The two groper species have different but overlapping depth ranges, and a fisher may continue working at one location but at increasingly greater depths. In this case, declining catches of the shallower-dwelling hapuku may be compensated by increasing catches of the deeper-living bass. Groper line fishers also target bluenose and ling, generally at bass depths or greater. They also target and/or catch school shark, though usually on nearby open seafloor and with different lines (longlines cf. droplines, extending horizontally rather than vertically). Groper are thus taken in a mixed-species line fishery, where it is difficult to discern from catch records which species is being targeted, and whether small but important changes in gear configuration, fishing location, and/or depth are occurring.

CPUE indices are almost always calculated for target fisheries. This is presumably on the assumption that if fishers are striving to catch a certain species, a decline in their catch rate must reflect a decline in the abundance of that species. This may sometimes be true, but reviews of how CPUE may actually be related to abundance (e.g. Hilborn & Walters 1992, Dunn et al. 2000) are strongly cautionary.

The value (or otherwise) of determining CPUE indices for bycatches is seldom proposed, but this option should at least be considered when CPUE indices for target fisheries prove inappropriate. Although CPUE bycatch studies are rare, there does not seem to be a strong argument against this method, which has the theoretical advantage of using random, non-directed fishing effort.

2. METHODS

2.1 Choice of fisheries

The account by Paul (2002b) of trends in groper CPUE was based on target fisheries for both species combined, and incorporated data for the other important species (bluenose, ling, school shark) often caught in association with them. In most fisheries there were insufficient data, and the time series was considered too short, to distinguish between catches when groper were nominally targeted and bycatches when the other species were nominally targeted. The addition of four years to the time series encourages further investigation, although the subdivided (target, bycatch) datasets are still small.

Using summarised data, Paul (2002a,b) described several regional line fisheries and one setnet fishery, based on fishing statistical areas but not Fishstocks or Quota Management Areas (QMAs). These data were reinterpreted for this study to define the most important regions where moderate bycatches of groper were made, and which were likely to define reasonably discrete unit fisheries – in the sense that few vessels worked beyond their boundaries. These boundaries were defined by statistical areas with low dropline catches, and again they did not correspond with QMAs (Figure 1), and most vessels did not work across all the grounds within them. There are three geographically large line fisheries. The Northern fishery includes QMA 1 (North Cape to Cape Runaway, statistical areas 1 to 5 and 8 to 10 – which excludes the inner Hauraki Gulf) plus the region north and west of Ninety Mile Beach (areas 47 and 48) worked by the same vessels. The Cook Strait fishery includes statistical areas from four Fishstocks and QMAs (2, 3, 7, and 8), Castlepoint to Wanganui, Cape Farewell to Kaikoura (areas 15–19, 37–39). The Southern fishery includes parts of Fishstocks and QMAs 3 and 5, the coastal region south of Banks Peninsula and Jacksons Head (areas 22, 24–26, 30–32). The single setnet fishery is centred on Kaikoura, statistical area 18, lying mostly within QMA and Fishstock 3.

2.2 Data sources

The most comprehensive and accessible data on estimated commercial catches, fishing effort, and recorded landings are held in the Ministry of Fisheries catch-effort database for the fishing years (October to September) 1989–90 onwards. This study used data extracts to the fishing year 2002–03 inclusive. NIWA has developed extract procedures using the 'niwa...fishing_event' table to obtain estimated catches from the catch-effort landing return (CELR) and trawl catch-effort processing return (TCEPR) subsets of the catch-effort database which summarise individual vessel catch data by: vessel identifier (coded); date (year, month, day); fishing method; statistical fishing area; target fish species; catch by species code; and total catch. The extracts included all fishing methods but the subset of line and setnet data analysed used in this study came only from CELR forms. The data to 1998–99 were originally obtained for the study by Paul (2002a, 2002b); the new extracts (1999–2000 to 2002–03) included the same complete data (all methods, all areas) but only comparable subsets were used.

Extracts used the codes BAS (bass), and HAP (hapuku), which are correct for the catch-effort database. They also had to use the code HPB (bass and/or hapuku), which should only be a Quota Management System (QMS) code but is frequently used in the catch-effort database. A previous study (Paul 2002a) found that only one third of the catch and landing records separated the species, and all fishers recorded the combined code HPB at some time; consequently, this study also had to group all data for the three codes as "groper".

"Estimated catches" are simply that. The estimates are usually made at sea, but sometimes recorded back on shore (after short trips) when the catch is actually weighed. The former are rounded values, approximating the actual value; the latter precisely match the landed weights recorded on the lower part of the CELR forms. Consequently, the values vary in reliability. Fishers can estimate weights very well, but often record the processed weight instead of the (required) full greenweight. Processed weight is about 70% of greenweight. There is a separate problem in that the CELR form has space for only five species, so minor species are omitted. In this study, all the line catch data are from fishers who targeted groper or an associated species, and both hapuku and bass are likely to have been recorded for most fishing events. This is less likely to be true in the Kaikoura setnet fishery, where the greater number of bycatch species may drop a small groper catch below the top five.

There are some complex analytical procedures which can convert estimated catches to either full catches or to greenweight landings, although the issue of target species becomes problematic when different species are targeted on different days. It was unclear whether this conversion would derive better CPUE trends. In this study the reported estimated catch values are used, and it is assumed that the proportion of data errors was reasonably consistent between years.

Effort values were total number of days in a fishing year when any of the selected line (or setnet) vessels reported a catch of more than 10 kg of groper. Finer-scale values, such as number of lines, hooks, or sets are known to have errors, transpositions, or omissions, which are difficult to resolve and require the removal of otherwise useful data. In small fisheries, it is desirable to retain as many data records as possible.

2.3 Data grooming

Data extracted from the Ministry of Fisheries catch-effort database were groomed for obvious errors. Data with null vessel identifiers were removed, as were those with a null statistical area. Rock lobster area codes were converted to the equivalent finfish area code. There is a known problem where Fishstock code numbers are recorded instead of the statistical area number; this is difficult to detect without detailed examination of target species, catch, and landing point information, and an unknown number of incorrect entries remain in the data. Unusually high and low catch values are also a problem, and in this study values greater than 5 t and less than 10 kg per day, were removed; the few values greater than 5 t appeared to be errors, and many of the low values appeared implausible. All vessels which met these criteria were retained, even if they reported relatively small catches and/or fished in only a few years. Identifying the "core vessels" which made moderate catches in several years (consecutive or otherwise) was considered likely to reduce the already-small datasets by too much, and as the emphasis in this study was on bycatch rather than targeted catch this distinction was not made.

Gear configurations are coded in fishing returns as TL (trotline) or DL (dropline/Dahn line), but in this study they were all considered to be vertical lines and combined as DL (droplines), in contrast to the horizontal longlines fished on the seafloor, coded as BLL (bottom longlines). There may be some real overlap in gear configuration between these categories, and it is also possible that over time some fishers have changed their reported gear code when still using essentially the same fishing gear.

The extracts acquired catch data where the species code was BAS, HAP, HPB (bass, hapuku, groper), and the target species was included in the extract. The target species used in this study were BNS (bluenose), LIN (ling), or SCH (school shark). Other target species were combined as "other" in the catch summaries, but were excluded from the CPUE analyses. There were some apparently anomalous extract records, such as a groper catch when LIM (limpet) was the target. These were assumed to be punch-code errors (LIM for LIN) and corrected, as were KIN (kingfish) to LIN, BWS (blue whaler shark) to BNS, SCA (scallop), and SCG (scaly gurnard) to SCH. These were only encountered because the target code was not limited. The catch code for the extracts was defined as the three groper codes listed above; any punch-code errors in this field, i.e, mis-punching BAS, HAP, HPB as some other code, would have removed valid data from the extract.

Some fish listed as the target species were unlikely to be the real target, and these records are assumed to result from the fisher's misinterpretation of the target, total catch, and single-species fields on the CELR form, or from punching. These could not be corrected and were excluded completely; although there were relatively few of them they suggest there may be a larger problem in the recording of target and total catch values. The field "total catch" was extracted but not groomed or used in analyses; the number of "null" records (2–3% of annual totals) may also indicate a problem in the value written in this field, i.e., it may be the weight of the target species instead of the weight of the total catch. Because these null records otherwise appeared plausible they were retained, but this was a subjective decision.

Groper catch records where the method was listed as cod-potting (CPO) or lobster-potting (RLP) were omitted, although there is a high probability that the record was partly correct. The groper were probably caught by line on days when both lines and pots were fished, and the CELR form misinterpreted somewhere in the data recording and interpretation sequence between the fishing operation and punch-coding.

Catches by handline were omitted from this study, although this is a valid catching method; the lines resemble small droplines, or sometimes bottom longlines, and it is not possible to allocate them between these methods.

Data are plotted by month, and thus calendar year, in the presentation of catch data. Annual values of catch and CPUE are tabulated and plotted by fishing year, October to September; where a single year is listed, it is named for the January to September segment of the fishing year.

2.4 Data presentation

In all fisheries, it was possible to present analyses for target and bycatch components, the latter usually subdivided by target species. For the general descriptive accounts of each fishery, the data are summarised by month and fishing year. Raw (unstandardised) CPUE analyses are based on catch per day, plotted as annual means ± two standard errors. Standardised CPUE indices were not calculated. The estimated catch and effort (days fishing) data for the selected fisheries are tabulated in Appendix 1.

3. RESULTS

3.1 The Northern line fishery

3.1.1 General account

Catch by line method

Apart from 1989–90, when records may be incomplete, catches by line method have been about equal (Table 1), but with a shift from dropline to longline as the dominant method. It is not known whether this shift is real, or represents a re-definition of the fishing gear.

Catch by fishing area

Catches are not spread evenly across fishing areas (Table 1). Highest catches are usually reported in areas 1–3, but area 1 values are probably incorrect (too high) because of confusion with the "Fishstock 1" code number. Statistical area 1 contains few if any fishing grounds. After 2000, catches increased in the northwestern area 47 (off Ninety Mile Beach).

Table 1: Estimated catch of groper (t) by method (lines only) and by fishing statistical area (line methods combined) in the Northern line fishery. BLL, bottom longline; DL, droplines.

Fishing	Method		Fishing statistical areas									
year	BLL	DL	47	48	1	2	3	4	5	8	9	10
1989–90	29	162	10	5	47	85	10	2	1	7	11	13
1990–91	98	135	9	2	78	58	12	7	< 1	14	20	35
1991–92	101	109	6	1	18	69	12	34	1	7	37	26
1992–93	130	128	18	4	27	93	25	27	2	25	5	32
1993–94	103	114	21	1	28	83	20	11	6	13	7	26
1994–95	126	102	27	10	46	63	30	8	2	12	9	22
1995–96	150	95	21	10	74	55	24	14	2	16	8	20
1996–97	139	108	23	1	53	39	49	24	4	10	6	38
1997–98	155	99	32	3	56	53	56	18	4	9	4	20
1998–99	146	118	24	4	69	63	63	13	2	7	2	18
1999–00	240	91	44	12	67	62	88	19	0	13	4	20
2000–01	272	78	88	10	47	48	67	36	8	12	9	23
2001–02	260	90	83	5	60	83	48	37	1	12	6	14
2002–03	271	101	90	7	74	42	55	51	1	18	3	28

Targeted catch and bycatch

The relationship between the targeted groper catch and the bycatch of groper is shown in Figure 2. The targeted dropline catch is very much greater than the bycatch taken by this method, demonstrating that droplines are used mainly for groper, or when groper are the nominated target species. There is a strong seasonal signal in the targeted catch through the 1990s, centred on September, which disappears after 2000. There is a downward trend in the annual catches, and the magnitude of peak catches. There is no apparent seasonal signal in the small quantity of groper landed as bycatch, but the annual trend is also downwards.

The targeted groper catch taken by longline has some seasonal peaks similar to those in the dropline data, but much less regular. The bycatch by this method (taken when bluenose, ling, and school shark are targeted) has a few corresponding seasonal peaks but is generally irregular. In contrast to the dropline catches, longline catches have increased, particularly after 2000.

The difference between dropline and longline catch trends with time may result either from fishers changing their gear from droplines, or from their re-definition and re-coding of the gear they were using.

The annual groper catch (targeted and as bycatch with other targets) is summarised in Table 2. The amount taken as bycatch is relatively small, most being taken when longlining for bluenose.

Table 2: Estimated catch of groper (t) by method, when targeted and taken as bycatch of other species in the Northern line fishery. HPB, hapuku plus bass; BNS, bluenose; LIN, ling; SCH, school shark.

Fishing	Dropline				Longline			
year	Targeted	Bycatch of			Targeted	Bycatch of		
	HPB	BNS	LIN	SCH	HPB	BNS	LIN	SCH
1989–90	150	11	1	< 1	2	26	< 1	< 1
1990–91	125	7	2	< 1	52	45	< 1	1
1991–92	102	8	0	< 1	54	42	4	1
1992–93	125	3	< 1	< 1	106	19	4	1
1993–94	106	7	0	0	69	30	3	1
1994–95	96	5	0	< 1	74	47	4	1
1995–96	87	6	2	0	111	30	5	4
1996–97	106	2	0	0	94	38	5	1
1997–98	93	6	< 1	< 1	106	40	8	2
1998–99	114	3	0	0	90	46	7	2
1999–00	89	2	0	< 1	178	48	8	5
2000–01	76	1	0	0	213	43	9	5
2001–02	87	3	< 1	1	207	42	6	3
2002–03	97	3	< 1	0	197	67	4	1

3.1.2 CPUE trends

Despite the possible ambiguity in distinction between fishing methods, they are treated separately in a comparison between targeted and bycatch groper CPUE (Figure 3). The targeted dropline catch and CPUE declined in the early 1990s, remained about level through the rest of the 1990s, and then rose after 2001. The dropline bycatch of groper taken with bluenose trended irregularly down with time, but CPUE showed no trend. The targeted longline groper catch and CPUE have both trended strongly upwards. The longline bycatch of bluenose has fluctuated slightly upwards, and the CPUE has fluctuated with no trend.

3.2 *The Cook Strait line fishery*

3.2.1 General account

Catch by line method

In general, dropline catches have been higher than longline catches, but in some years the latter have been equal or higher (Table 3). Dropline catches showed no general trend through the 1990s, while longline catches increased.

Catch by fishing area

Catches have been highest in central Cook Strait (areas 16 and 17) (Table 3). They have been moderate and consistent in the Manawatu area 39, perhaps mainly taken in the southernmost (Mana and Kapiti Islands) sector where there is more rough seafloor. Increased catches were reported from area 19 from 1995 onwards; they came from several vessels, probably fishing the northernmost Cook Strait sector.

Table 3: Estimated catch of groper (t) by method (lines only) and by fishing statistical area (line methods combined) in the Cook Strait line fishery. BLL, bottom longline; DL, droplines.

Fishing	Method		Fishing statistical areas							
year	BLL	DL	15	16	17	18	19	37	38	39
1989–90	32	85	4	23	59	4	1	1	2	24
1990–91	44	114	5	35	64	19	2	< 1	1	31
1991–92	43	116	9	39	74	8	1	1	2	25
1992–93	63	104	10	52	51	14	0	0	11	29
1993–94	50	122	22	47	57	9	1	< 1	4	32
1994–95	104	92	23	39	51	16	40	1	2	25
1995–96	97	83	9	28	51	20	31	7	5	29
1996–97	59	89	6	30	44	17	15	5	2	29
1997–98	43	86	6	32	43	11	10	1	3	23
1998–99	85	117	10	49	52	29	24	2	3	33
1999–00	42	89	5	49	33	12	6	1	1	23
2000–01	53	66	8	35	37	14	1	1	2	21
2001–02	43	80	7	27	52	7	0	< 1	2	28
2002–03	44	115	11	52	60	4	2	2	1	29

Targeted catch and bycatch

The relationship between the targeted groper catch and the bycatch of groper, by month, is shown in Figure 4. The targeted dropline catch is very much greater than the bycatch taken by this method, demonstrating that droplines are used mainly for groper, or when groper are the nominated target species. The small groper bycatch taken by dropline does not follow the monthly pattern of target catch.

In contrast, the targeted longline groper catch is similar in magnitude to the bycatch of other species, and the monthly patterns, although erratic, are somewhat similar.

The annual groper catch (targeted and as bycatch with other targets) is summarised in Table 4. The amount taken as bycatch is relatively small, most being taken when longlining for school shark, and to a lesser extent ling.

Table 4: Estimated catch of groper (t) by method, when targeted and taken as bycatch of other species in the Cook Strait line fishery. HPB, hapuku plus bass; BNS, bluenose; LIN, ling; SCH, school shark.

Fishing	Dropline				Longline			
year	Targeted	Bycatch of			Targeted	Bycatch of		
	HPB	BNS	LIN	SCH	HPB	BNS	LIN	SCH
1989–90	82	1	2	1	17	1	1	13
1990–91	106	1	7	1	23	< 1	2	18
1991–92	113	1	3	< 1	15	2	7	19
1992–93	96	1	6	1	38	< 1	9	16
1993–94	111	1	8	1	23	1	12	14
1994–95	82	5	4	< 1	51	8	17	29
1995–96	79	2	2	1	36	19	12	29
1996–97	80	6	1	1	25	15	7	12
1997–98	73	9	2	3	29	1	5	8
1998–99	109	2	4	1	49	12	13	11
1999–00	87	1	1	< 1	23	< 1	8	10
2000–01	63	< 1	2	1	32	1	9	12
2001–02	78	< 1	1	< 1	24	< 1	10	9
2002–03	109	1	4	< 1	27	< 1	6	11

3.2.2 CPUE trends

Despite the possible ambiguity in distinction between fishing methods, they are treated separately in a comparison between targeted and bycatch groper CPUE (Figure 5). The targeted dropline catch fluctuated a little through the 1990s, with a slight rising trend in CPUE. Dropline bycatches were too small to be analysed. The targeted longline catch fluctuated, generally upwards, through the 1990s, while CPUE rose quite steadily; both declined after 1999. The longline bycatch of groper taken with school shark rose and fell during the years examined, and CPUE simply trended with this until 2000–01 when it rose while catches were stable. The longline catch of groper taken with ling also rose and then fell during the 1990s; CPUE rose until 1998, and then declined.

3.3 The Cook Strait (Kaikoura) setnet fishery

3.3.1 General account

Catch by method

This section considers only setnet catches, which in statistical area 18 were very much higher than line catches (Table 5).

Table 5: Estimated catch of groper (t) by method (lines and setnet) in fishing statistical area 18 (Kaikoura).

Fishing	Method, area 18	
year	Setnet	Lines
1989–90	93	4
1990–91	115	19
1991–92	101	8
1992–93	109	14
1993–94	103	9
1994–95	101	16
1995–96	94	20
1996–97	114	17
1997–98	117	11
1998–99	108	29
1999–00	123	12
2000–01	143	14
2001–02	137	7
2002–03	145	4

Note: Area 18 line catches are considered within the Cook Strait line fishery, see Section 3.2.

Targeted catch and bycatch

The relationship between the targeted groper catch and the bycatch of groper is shown in Figure 6. The targeted catch is very strongly seasonal, extending from May to August and centred on July. When taken as a bycatch in the setnet fishery targeting tarakihi, ling, or some combination of about 15 other species, the groper catch is also strongly seasonal; it peaks in May in the tarakihi fishery, May to July in the ling fishery.

The annual groper catch (targeted and as bycatch with other targets) is summarised in Table 6. The amount taken as bycatch is relatively large, mainly when ling and tarakihi are targeted.

Table 6: Estimated catch of groper (t) by method, when targeted and taken as bycatch of other species in the Kaikoura setnet fishery. HPB, hapuku plus bass; LIN, ling; TAR, tarakihi.

Fishing	Targeted	Bycatch of		
year	HPB	LIN	TAR	Others
1989–90	58	25	10	< 1
1990–91	64	24	15	12
1991–92	59	25	13	4
1992–93	56	30	13	9
1993–94	63	23	9	8
1994–95	59	19	10	13
1995–96	47	28	10	9
1996–97	60	23	22	9
1997–98	58	31	23	4
1998–99	74	21	11	3
1999–00	57	22	35	9
2000–01	90	31	10	12
2001–02	79	33	14	12
2002–03	74	28	28	14

3.3.2 CPUE trends

CPUE in the setnet fishery targeted at groper declined slightly during the 1990s, then rose again after 2000; there is no overall trend (Figure 7). When taken as bycatch when ling were targeted, groper CPUE rose very slightly. When taken as bycatch when tarakihi were targeted, groper CPUE was stable through the early 1990s, then rose – with fluctuations – from 1996 to 2003.

3.4 The Southern line fishery

3.4.1 General account

Catch by line method

Droplining has been the main method, but catches fluctuated during the 1990s (Table 7). Small to moderate longlining catches also fluctuated. Dropline catches increased markedly from 1999–2000 onwards.

Catch by fishing area

Catches are not spread evenly across fishing areas (Table 7). Highest and most consistent catches were usually reported in areas 25 and 30, off the southern Southland coast. Catches in other areas were sometimes moderate, but variable. In most areas, catches increased from 1999–2000 onwards.

Table 7: Estimated catch of groper (t) by method (lines only) and by fishing statistical area (line methods combined) in the Southern line fishery. BLL, bottom longline; DL, droplines.

Fishing	Method		Fishing statistical areas						
year	BLL	DL	22	24	25	26	30	31	32
1989–90	9	43	6	17	11	3	5	5	6
1990–91	12	50	4	9	19	1	18	8	4
1991–92	17	36	5	9	12	1	9	6	11
1992–93	25	30	4	6	17	2	14	9	3
1993–94	15	81	4	12	25	3	34	11	7
1994–95	19	84	6	9	36	3	24	14	11
1995–96	21	85	5	2	55	3	18	10	12
1996–97	33	68	7	< 1	37	2	14	13	27
1997–98	8	45	5	6	17	7	9	3	6
1998–99	13	58	4	13	29	3	10	2	11
1999–00	14	101	13	18	22	4	45	6	8
2000–01	37	119	11	24	21	9	58	15	18
2001–02	26	107	10	18	31	5	48	6	15
2002–03	21	108	12	17	14	8	46	13	18

Targeted catch and bycatch

The relationship between the targeted groper catch and the bycatch of groper is shown in Figure 8. There is a strong and regular seasonal pattern in the targeted dropline catches; from 2000 onwards the seasonal signal remains strong but the catches during the low season – winter – increase, accounting for much of the increase in the targeted annual catch by this method. The dropline bycatch is insignificant, demonstrating that droplines are used mainly for groper, or when groper are the nominated target species. The targeted longline groper catch is relatively small, reaching 5 t in some months and 7.5 t in 2001; the bycatch by longline is small but not insignificant, with monthly fluctuations usually matching the targeted catch.

The annual groper catch (targeted and as bycatch with other targets) is summarised in Table 8. The amount taken as bycatch is relatively small, most of this in association with longlining for ling.

Table 8: Estimated catch of groper (t) by method, when targeted and taken as bycatch of other species in the Southern line fishery. HPB, hapuku plus bass; BNS, bluenose; LIN, ling; SCH, school shark.

Fishing	Dropline				Longline			
year	Targeted	Bycatch of			Targeted	Bycatch of		
	HPB	BNS	LIN	SCH	HPB	BNS	LIN	SCH
1989–90	42	< 1	0	< 1	6	1	2	1
1990–91	49	< 1	< 1	1	9	< 1	1	2
1991–92	32	0	4	1	11	< 1	4	1
1992–93	30	< 1	0	< 1	18	< 1	6	1
1993–94	79	1	< 1	< 1	9	< 1	5	1
1994–95	83	1	0	0	14	1	4	0
1995–96	84	1	0	< 1	15	1	5	< 1
1996–97	67	< 1	< 1	0	25	1	8	0
1997–98	43	2	0	0	3	< 1	5	0
1998–99	58	< 1	0	0	6	1	6	< 1
1999–00	100	1	0	0	7	1	5	< 1
2000–01	118	1	0	< 1	27	2	5	2
2001–02	105	2	0	0	17	1	5	2
2002–03	106	1	0	< 1	13	3	4	2

3.4.2 CPUE trends

Despite the possible ambiguity in distinction between fishing methods, they are treated separately in a comparison between targeted and bycatch groper CPUE (Figure 9). The targeted dropline catch fluctuated through the 1990s, while CPUE rose steadily. From 1999–2000, these catches reached their highest level, while CPUE peaked in 2000–01 and then fell. The very small bycatch of groper taken when other species were targeted fluctuated without a trend, as did CPUE. The targeted longline catch and CPUE trended upwards to 1997, then catches dropped for three years before recovering. Targeted longline CPUE fluctuated but trended slightly upwards. The small bycatch of groper taken with ling changed little through the 1990s, and its CPUE had no trend.

The most important component of the Southern fishery, the targeted dropline catch, was investigated further to determine whether the fluctuating rise in catches, and the steadier rise in CPUE, coincided with any geographical shift of fishing effort within the region. Fishing effort (number of days) and estimated catch did vary between fishing areas during the period (Figure 10), but there was no apparent relationship to the rising trend in CPUE for the whole region.

4. DISCUSSION

Fisheries are discussed below in the sequence: target line fisheries, dropline then bottom longline, each north to south, and bycatch; target setnet fishery; bycatch line fisheries in the same method/north-south sequence; bycatch setnet fisheries.

CPUE indices for the three targeted dropline fisheries, generally considered to be the main fishing method for groper, showed either no trend (Northern and Cook Strait), or a rising trend and the start of a decline (Southern). Catch and CPUE for the Northern and Cook Strait fisheries usually trended together, which is not unexpected in fisheries where most vessels are small. Their catch per day is not an ideal index, as it is influenced (i.e., limited) by the size of a vessel (its fish-holding capacity) or by the requirement and processing limitation of the market the fisher is landing into. Catch and CPUE for the Southern dropline fishery, however, generally trended upwards but they were not otherwise closely correlated.

CPUE for the three targeted (or nominally targeted) bottom longline fisheries differed, both in their trends and in their relationship to annual catches. The Northern fishery CPUE trended upwards, with little apparent relationship between catch and CPUE, apart from higher values from 1999–2000 onwards. The Cook Strait longline fishery showed a close relationship between catch and CPUE, both fluctuating without a long-term trend. The Southern longline fishery catch and CPUE trended together until 1997, and then CPUE remained moderately stable which the catch fluctuated.

The Kaikoura targeted setnet fishery also showed fluctuations but no overall trend.

The main purpose of this study was to see whether groper bycatch CPUE indices provided different and/or more satisfactory information than target fishery indices. Unfortunately, bycatches (or at least, catches reported as bycatches) were relatively small. It would be useful if the bycatches taken with different target species could be grouped, but each such fishery (e.g., for bluenose, school shark) is believed to have sufficiently different gear and depth characteristics to preclude this. It was done, by necessity, for the Southern line fisheries where there were only very small data sets for each.

In the Northern dropline fishery, the CPUE of groper taken as bycatch when bluenose were nominally targeted fluctuated relatively more than the targeted CPUE, was at about half the level (100 cf. 200 kg per day), but was similarly level from 1989–90 to 2002–03. It was moderately influenced by catch size in the latter half of this period. There was no Cook Strait dropline bycatch fishery large enough for analysis. In the Southern dropline fishery, CPUE indices are shown for the bycatch taken with targeted bluenose, ling, and school shark; fluctuations in the early 1990s are followed by stable values in later years, but catches are really too small and variable for these to have any value.

In the Northern longline fishery, only the bycatch taken with bluenose is large enough to analyse. Unlike the targeted longline groper CPUE, the bycatch index fluctuates without trend, and is clearly influenced by catch level. In the Cook Strait longline fishery, two bycatch groper CPUE indices can be calculated, with targeted school shark, and targeted ling. CPUE with school shark is strongly influenced by catch level, and fluctuates without trend. With ling, CPUE appears to be influenced by catch level at the start and end of the period, less so when catch declines in the late 1990s. In the Southern longline fishery, the bycatch groper taken with ling is small, but CPUE is stable with no trend.

In the Kaikoura setnet fishery, the bycatch of groper taken when ling were nominally targeted rises very slightly, and CPUE follows this with similar fluctuations. The bycatch taken when tarakihi were targeted rises a little more clearly, but is also clearly strongly influenced by catch level.

It is difficult to reach any general conclusions, other than that the CPUE indices, both for targeted catches and bycatches of groper, are either stable or rising slightly. This does not necessarily track the stock size of groper, given the aggregated nature of both species, the close association of the line fisheries (at least) for groper, bluenose, ling, and – probably to a lesser extent – school shark, and perhaps the progressive or sequential shift of fishing activity to different grounds within the rather large regions grouped in this study. That is, it does not show that any regional stock sizes are declining.

Does it reveal any advantage in studying bycatch, instead of target, CPUE? Probably not, at least for this fishery. The problem, or at least "blurring", arising from combination of the two species (hapuku and bass) in the data is not overcome. And bycatch CPUE, like targeted CPUE, often follows the general trend in catches. The reason for this relationship is unknown, but it may simply be that in some years groper are relatively more "available" to fishers within a region, and catch rates and catches rise together.

At a finer level, bycatch CPUE sometimes followed targeted CPUE, sometimes showed a different trend. And when two or more bycatch CPUE series were available for a region, they sometimes agreed, sometimes differed.

A dilemma in searching for valid CPUE indices in small fisheries, such as that for groper, lies in the association between vessel size and fisher behaviour. The vessels are usually small, have a relatively small holding capacity for fresh fish, and the fisher operates to catch a certain quantity of fish for his shed as efficiently as possible, balancing such factors as seasonal weather, anticipated availability of fish on the grounds, quota holdings, fish price, and the timing and relative value of alternative fisheries for which uncaught quota is held or can be obtained. The fishers use personalised gear configurations that must be allocated a dropline or longline code, and they fish multiple lines in a variety of setting and hauling procedures that are not well recorded on a standard form. A rather small number of fishers are responsible for much of the catch, and relatively few fish consistently for more than a few years. The present study used the very simplest unit of fishing effort, a day's fishing when groper were caught. It sought to "even out" these ambiguities. But it missed "true effort" parameters. The alternative approach, of using fine-scale measures such as number of lines, number of hooks, soak time, water depth, tidal size and timing, and greater localisation of the fishing ground, and some measure of fisher experience or "boat effect" would be preferable, but is not at present practicable because these parameters are either recorded inconsistently and with a high error rate, or are not recorded at all.

The groper fishery is particularly difficult to monitor because of its close association with other line fisheries. Only a single target species can be recorded, and it is not clear whether this reflects the fisher's real intent, the species which proves to be commonest in the catch, or one of the group of species (in particular, hapuku, bass, or bluenose) which are being sought (or caught) more or less equally on the day. These, and several other issues, are believed to influence a fisher's choice of the target species nominated for a line set, or a day's fishing. They consequently have a considerable influence on the subdivision of recorded catch into "targeted" and "bycatch".

5. ACKNOWLEDGMENTS

I thank Brian Sanders for his knowledgeable and efficient approach to obtaining the appropriate catch and effort data extracts. This work was funded by the Ministry of Fisheries project HPB2002/01.

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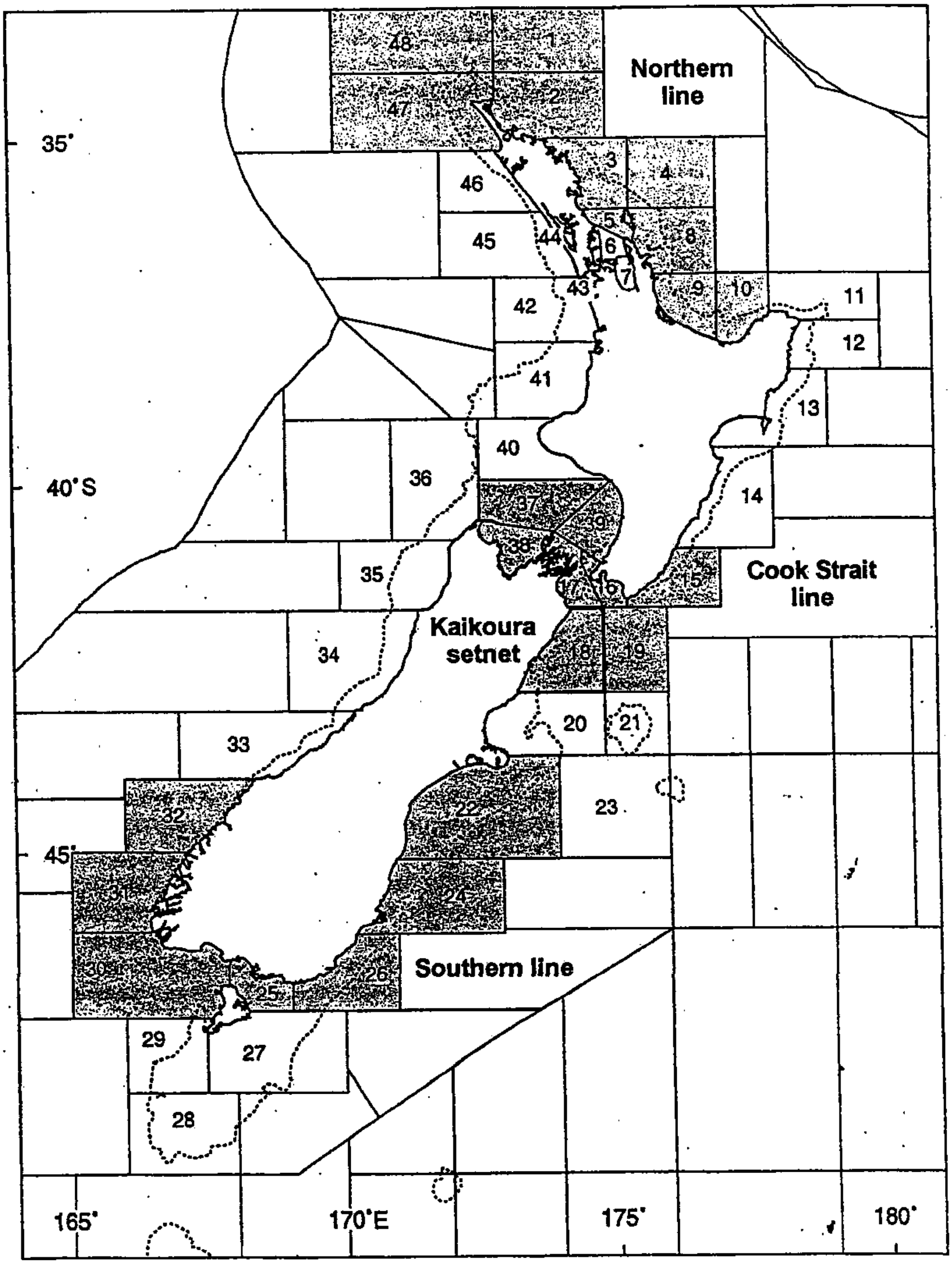


Figure 1: The location of the three line fisheries (shaded areas) and one setnet fishery described in this study. The Kaikoura setnet fishery is restricted to statistical area 18, within the larger Cook Strait region.

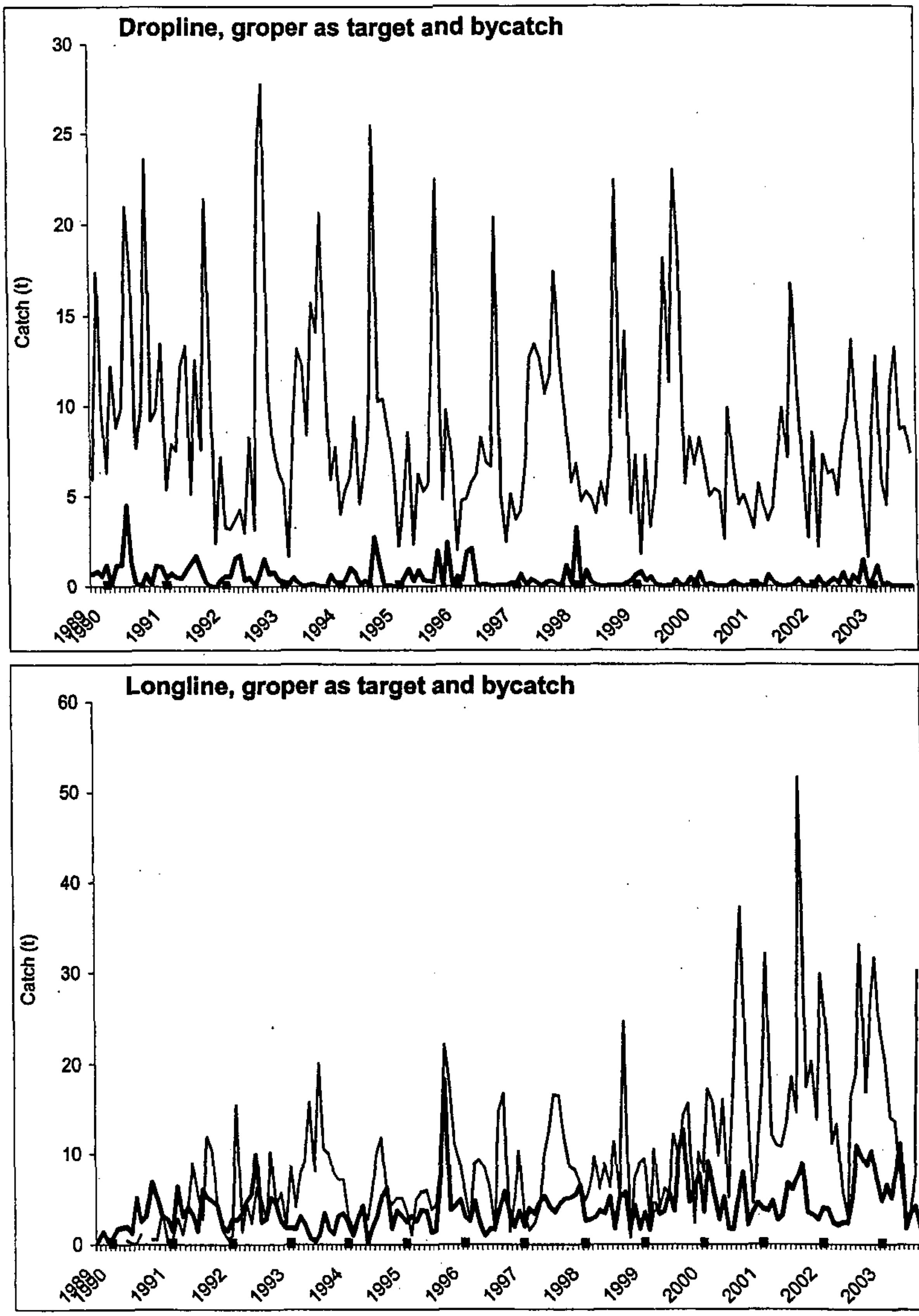


Figure 2: Monthly trends in the catch of targeted groper (light line), and the bycatch of groper caught with bluenose, ling, and school shark (heavy line), in the Northern line fishery, by dropline and bottom longline. Values cover October 1989 to September 2003; January is shown as an annual reference point.

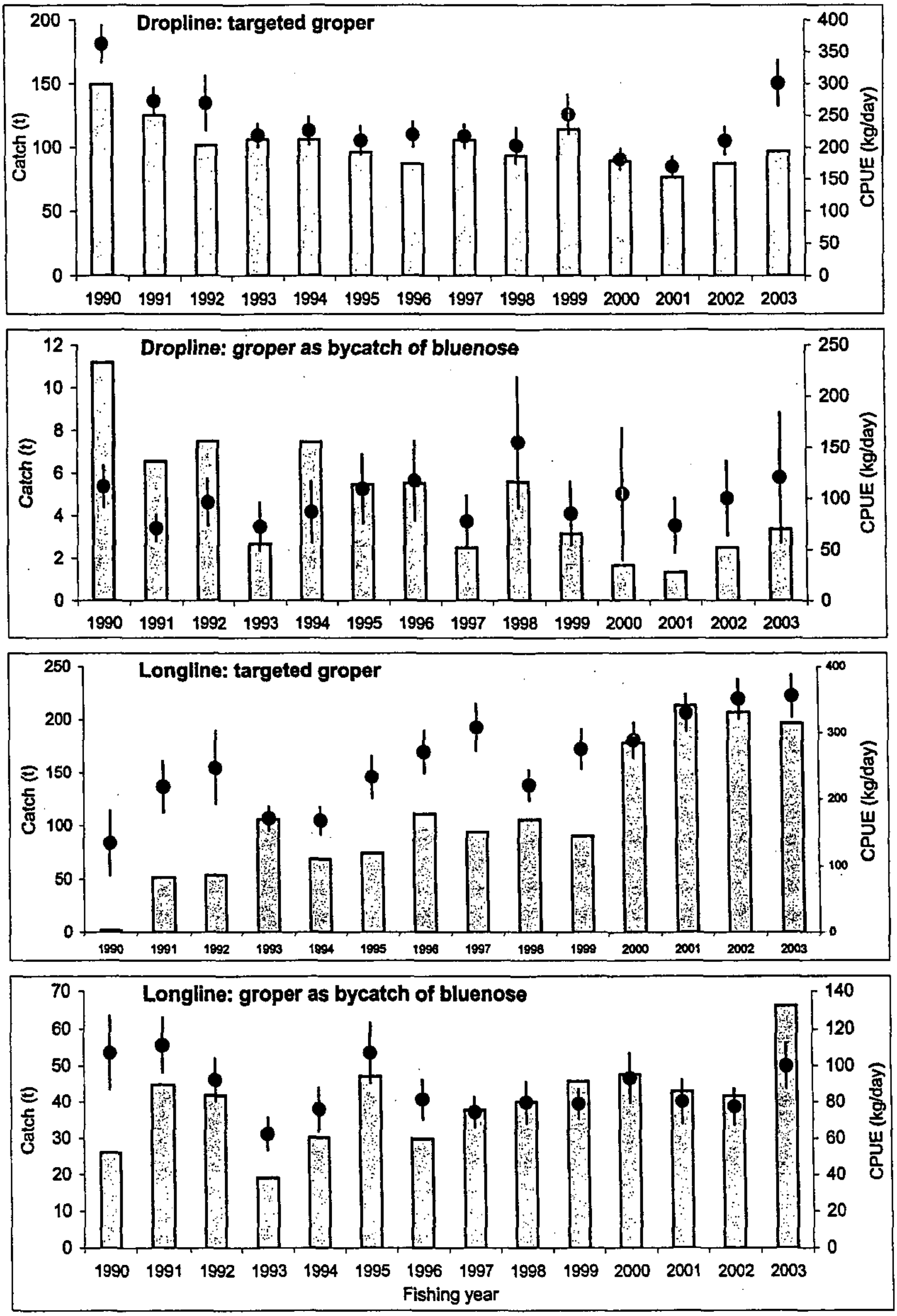
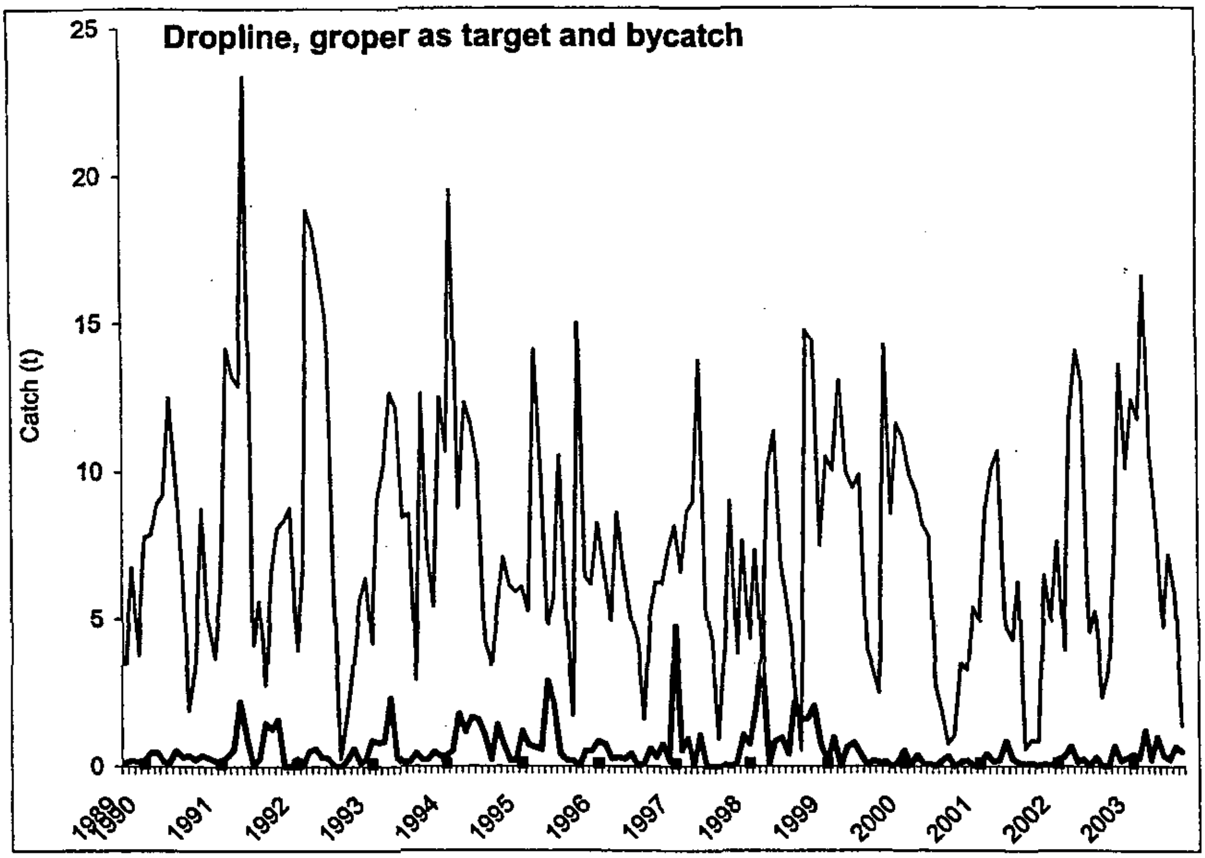


Figure 3: Estimated catches (t), and CPUE indices (kg/day, mean ± 2SE) of groper, in the Northern line fishery, targeted and taken as bycatch of bluenose by dropline and by longline.



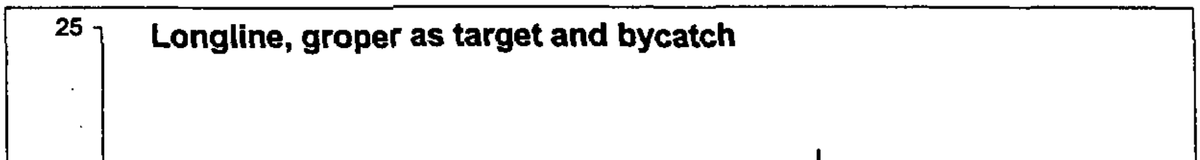


Figure 4: Monthly trends in the catch of targeted groper (light line), and the bycatch of groper caught with bluenose, ling, and school shark (heavy line), in the Cook Strait line fishery, by dropline and bottom longline. Values cover October 1989 to September 2003; January is shown as an annual reference point.

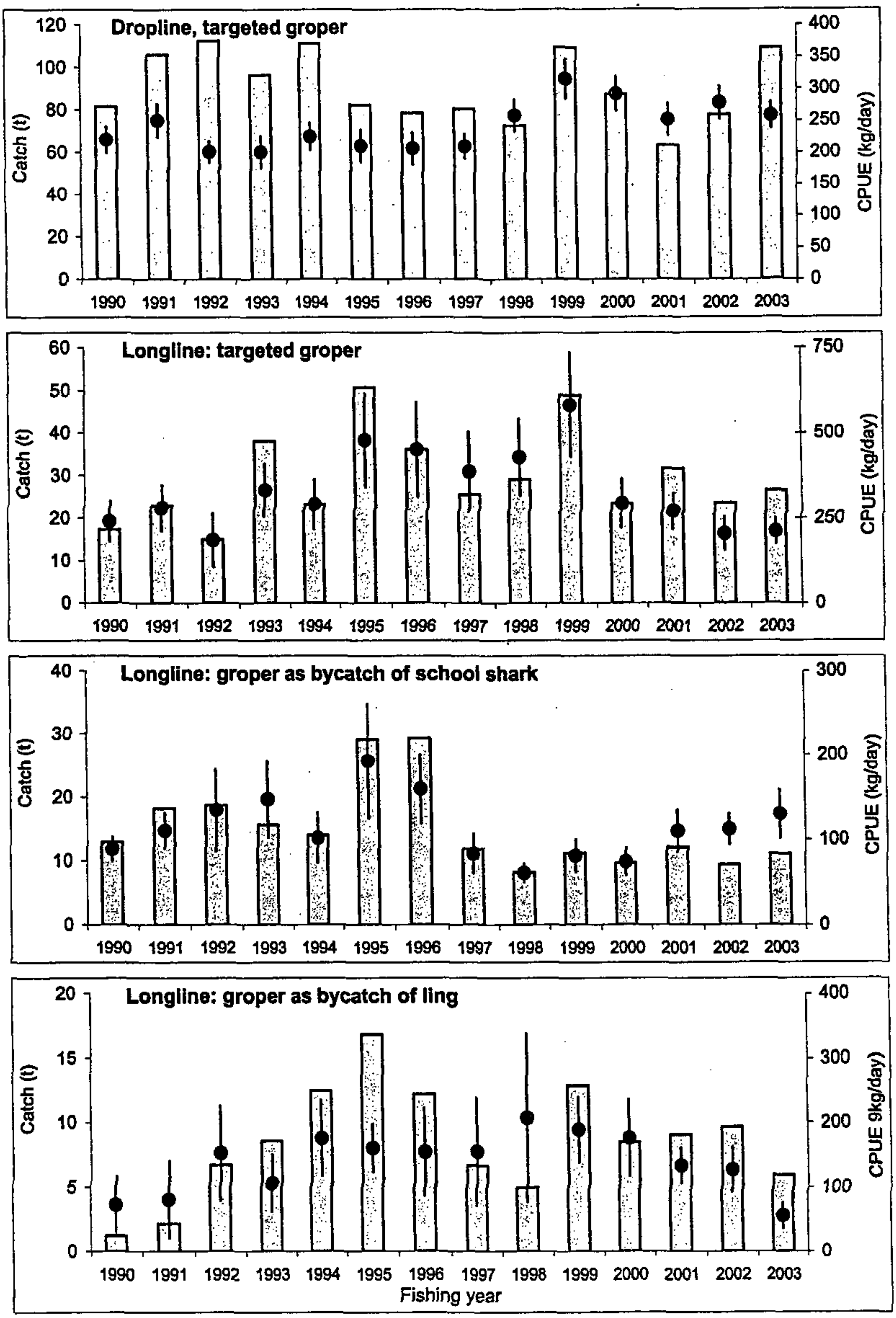


Figure 5: Estimated catches (t), and CPUE indices (kg/day, mean ± 2SE) of groper, in the Cook Strait line fishery, targeted by dropline, and targeted and taken as bycatch of school shark and ling by longline.

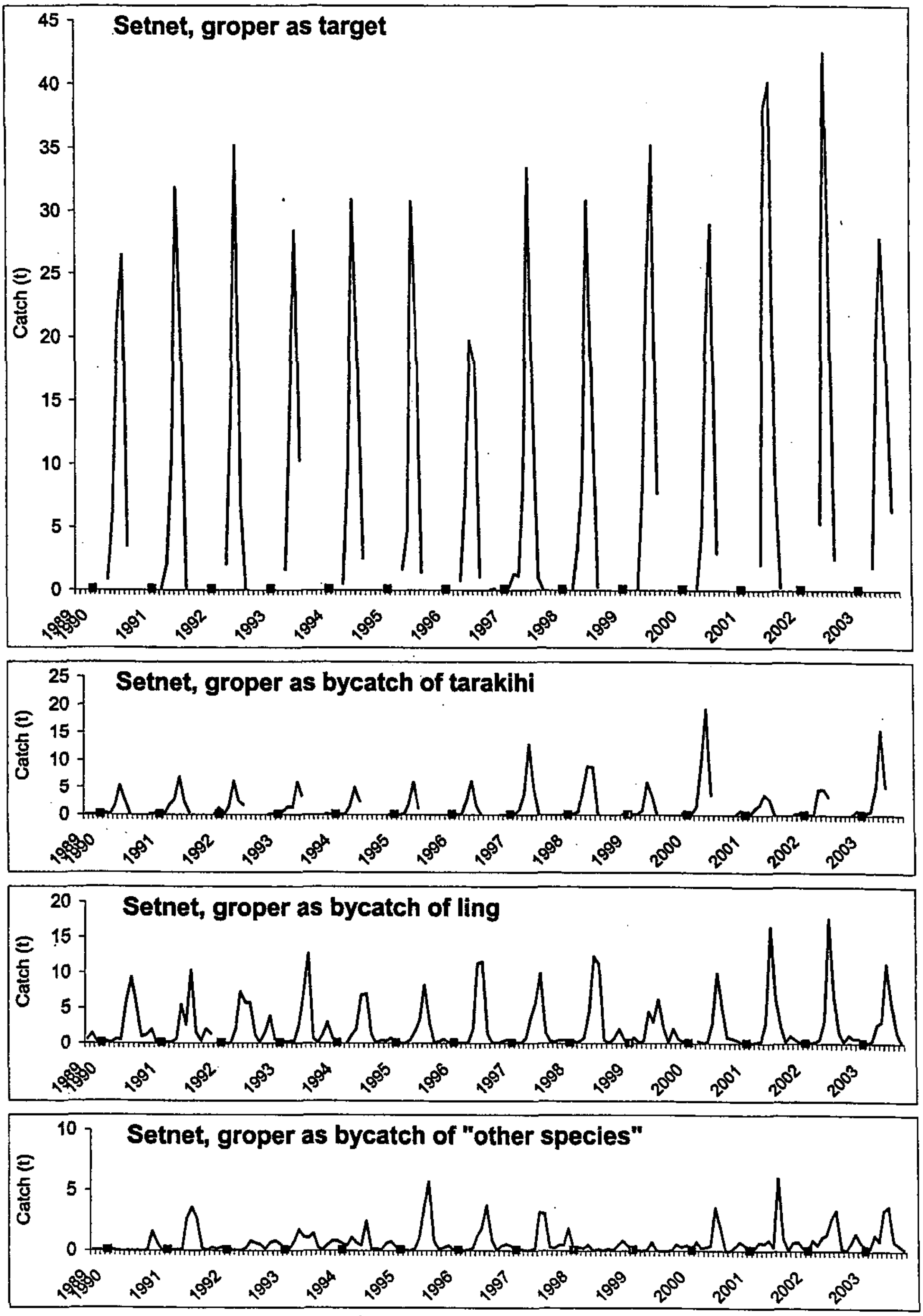


Figure 6: Monthly trends in the catch of targeted groper (top), and the bycatch of groper caught with tarakihi, ling, and "other species" (lower panels), in the Kaikoura setnet fishery. Values cover October 1989 to September 2003; January is shown as an annual reference point.

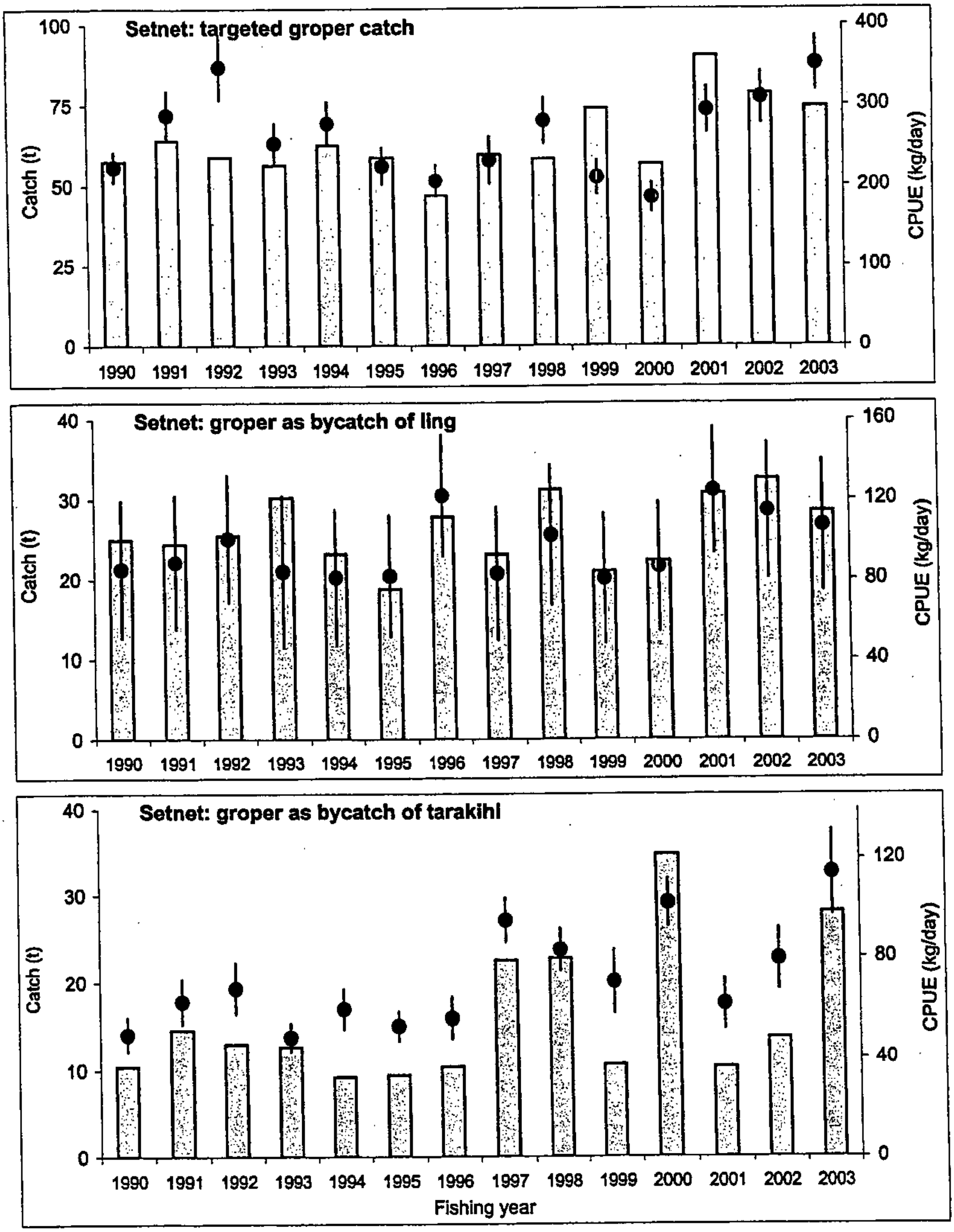


Figure 7: Estimated catches (t), and CPUE indices (kg/day, mean ± 2SE) of groper, in the Kaikoura setnet fishery, targeted and taken as bycatch of ling and tarakihi.

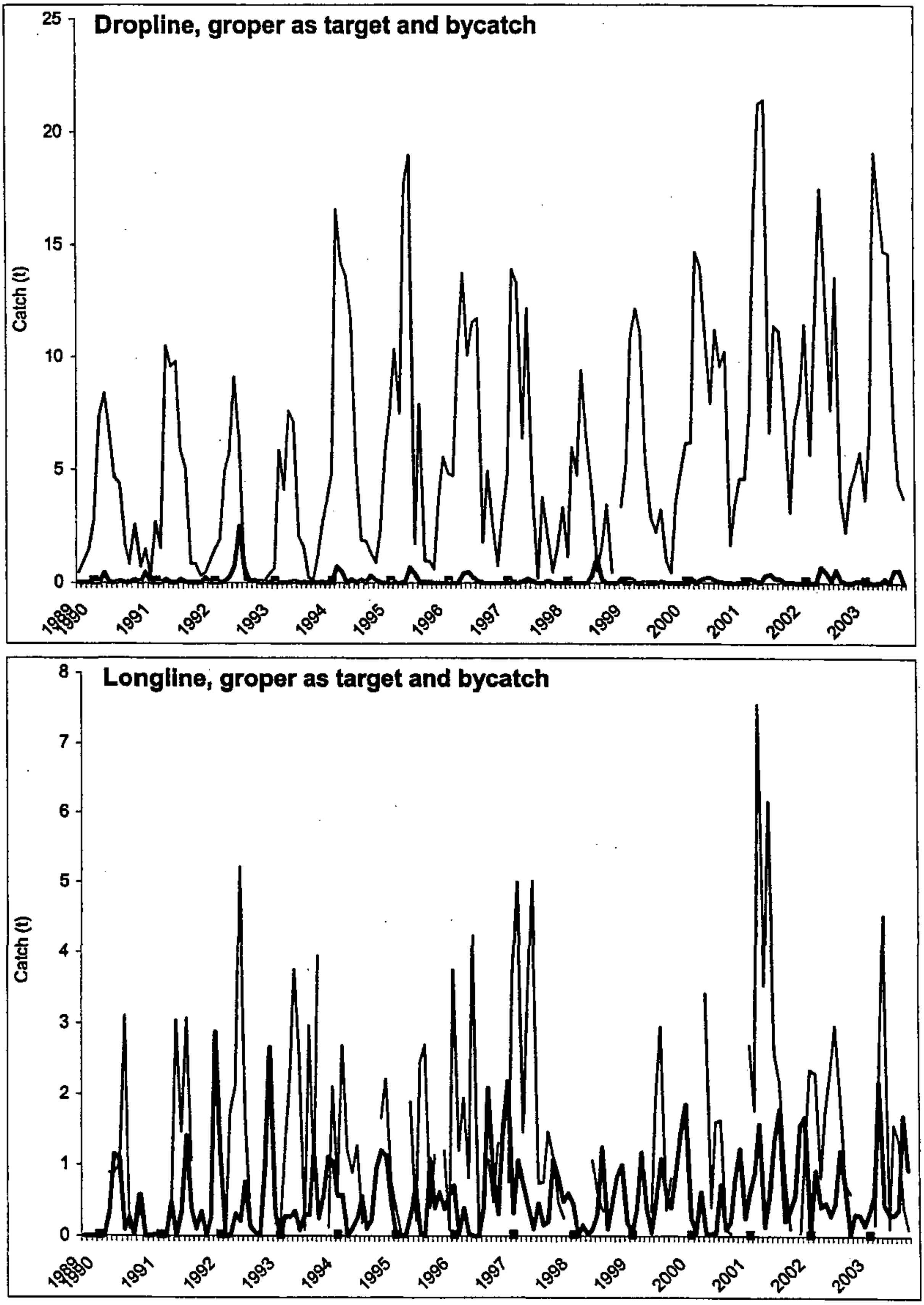


Figure 8: Monthly trends in the catch of targeted groper (light line), and the bycatch of groper caught with bluenose, ling, and school shark (heavy line), in the Southern line fishery, by dropline and bottom longline. Values cover October 1989 to September 2003; January is shown as an annual reference point.

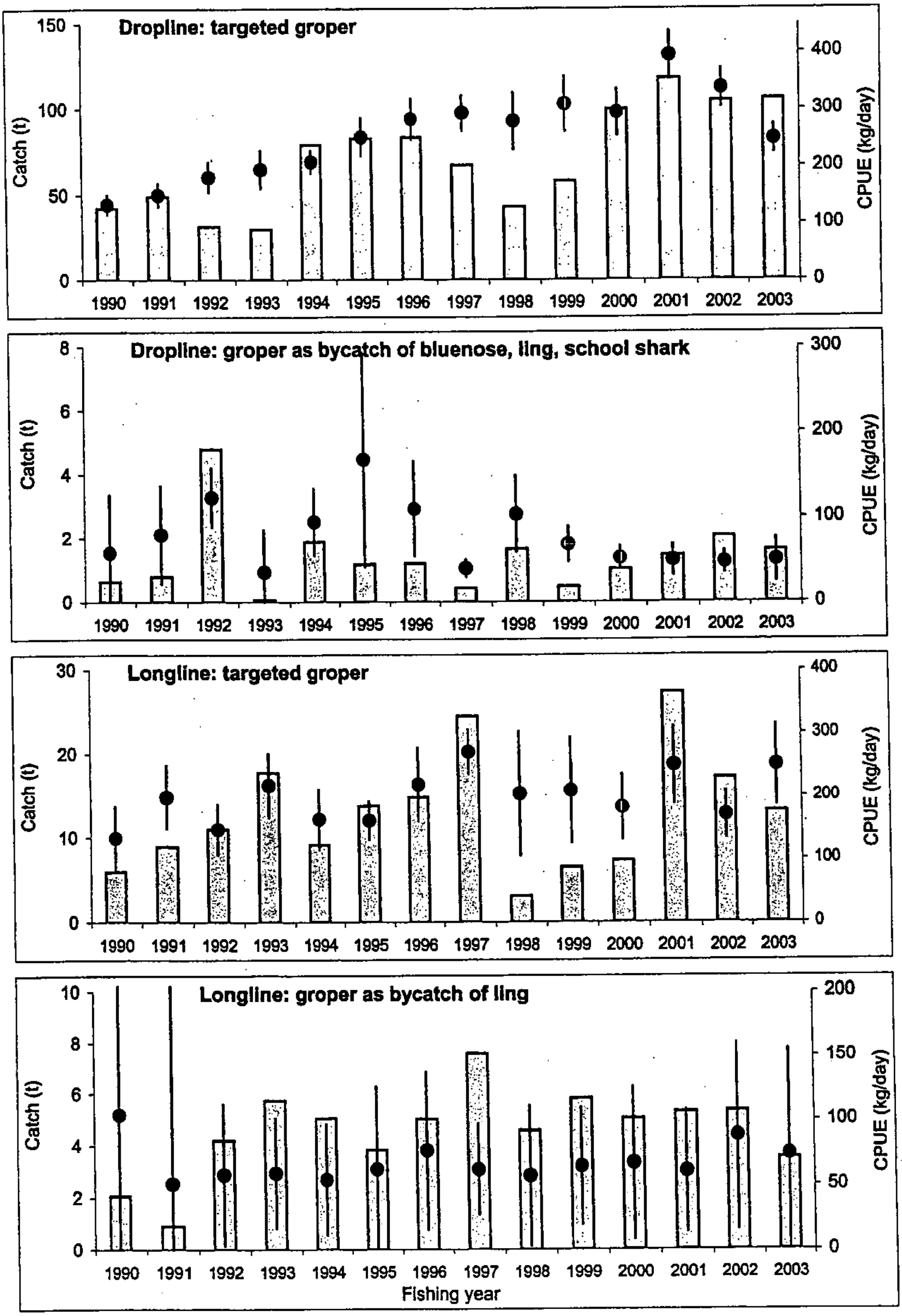


Figure 9: Estimated catches (t), and CPUE indices (kg/day, mean ± 2SE) of groper, in the Southern line fishery, targeted and as bycatch of bluenose, line, and school shark by dropline, and targeted and taken as bycatch of ling by longline.

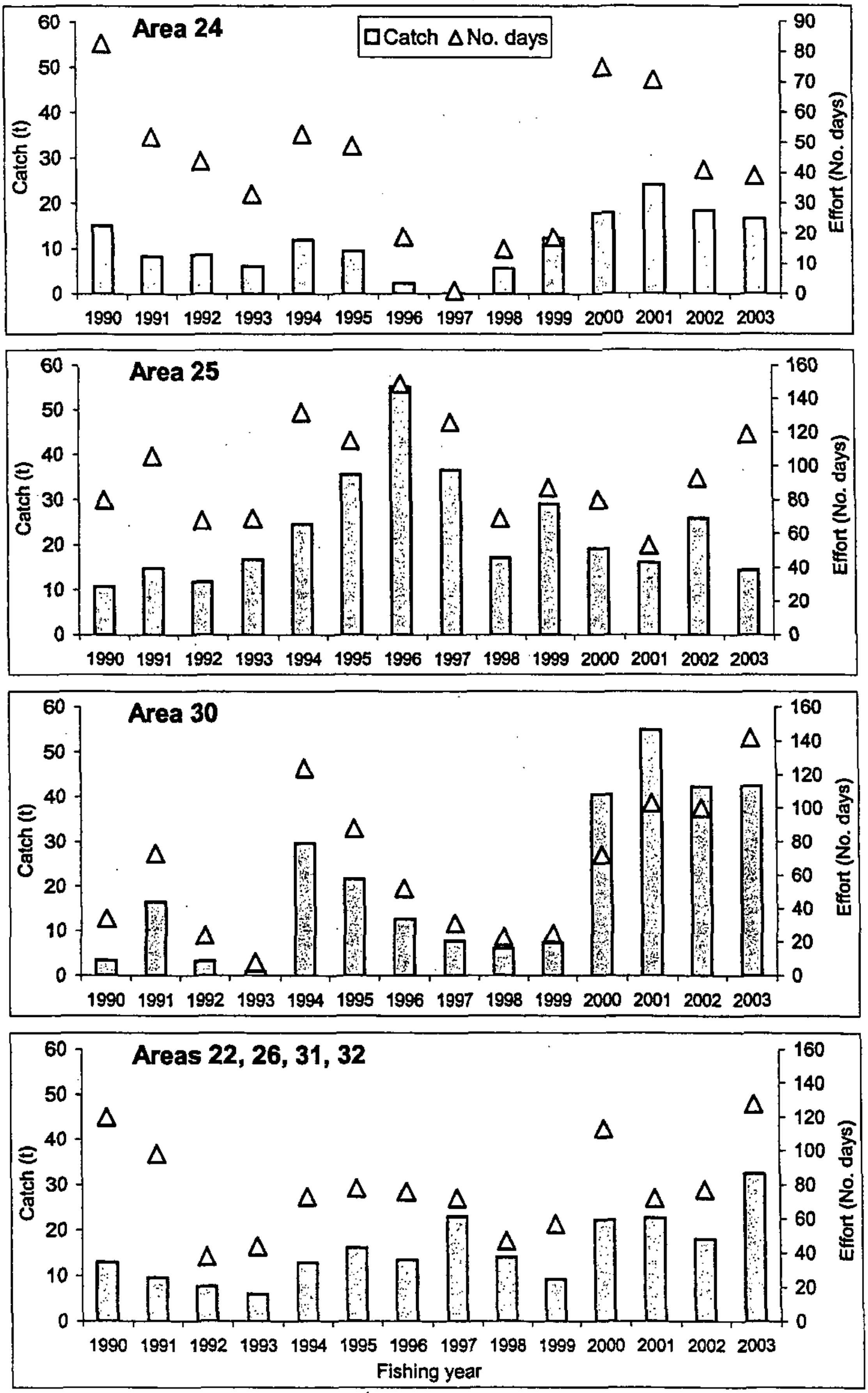


Figure 10: Estimated catches (t) of groper and effort (days) by fishing area in the Southern dropline fishery targeting groper. Note, data for each area are plotted at the same scale, with minor areas (22, 26, 31, 32) combined.

Appendix 1: Catch and effort data for the fisheries covered by this report

Northern line fishery, dropline

Target species, groper catch (t), and effort (days)

Fishing year	Groper (t)	Groper days	Bluenose (t)	Bluenose days	Ling (t)	Ling days	School shark (t)	School shark days	Total (t)	Total days
1989–90	150	413	11	100	1	9	< 1	3	162	525
1990–91	125	459	7	92	3	30	< 1	6	135	587
1991–92	102	377	8	78	0	0	< 1	1	109	456
1992–93	125	606	3	37	< 1	1	< 1	4	128	648
1993–94	106	469	7	86	0	0	0	0	114	555
1994–95	96	457	5	50	0	0	< 1	1	102	508
1995–96	87	397	6	47	2	7	0	0	95	451
1996–97	106	486	2	32	0	0	0	0	108	518
1997–98	93	462	6	36	< 1	1	< 1	1	99	500
1998–99	114	454	3	37	0	0	0	0	118	491
1999–00	89	499	2	18	0	0	< 1	1	91	518
2000–01	76	461	1	24	0	0	0	0	78	485
2001–02	87	420	3	27	< 1	2	< 1	1	90	450
2002–03	97	338	3	36	< 1	1	0	0	101	375

Northern line fishery, bottom longline

Target species, groper catch (t), and effort (days)

Fishing year	Groper (t)	Groper days	Bluenose (t)	Bluenose days	Ling (t)	Ling days	School shark (t)	School shark days	Total (t)	Total days
1989–90	2	17	26	244	< 1	6	< 1	2	29	269
1990–91	52	237	45	403	< 1	10	1	6	98	656
1991–92	54	218	42	454	4	75	1	11	101	758
1992–93	106	620	19	306	4	54	1	7	130	987
1993–94	69	414	30	399	3	56	1	6	103	875
1994–95	74	319	47	440	4	54	1	9	126	822
1995–96	111	409	30	367	5	64	4	26	150	866
1996–97	94	305	38	508	6	67	1	11	139	891
1997–98	106	479	40	502	8	64	2	14	155	1 059
1998–99	90	328	46	580	7	58	2	14	146	980
1999–00	178	628	48	559	8	53	5	26	239	1 266
2000–01	213	652	43	599	9	65	5	37	270	1 353
2001–02	207	591	42	602	6	57	3	28	258	1 278
2002–03	197	560	67	709	4	71	1	7	269	1 347

Cook Strait line fishery, dropline

Target species, groper catch (t), and effort (days)

Fishing year	Groper (t)	Groper days	Bluenose (t)	Bluenose days	Ling (t)	Ling days	School shark (t)	School shark days	Total (t)	Total days
1989–90	82	371	1	10	2	41	1	14	85	436
1990–91	106	424	1	10	7	65	1	16	114	515
1991–92	113	561	1	9	3	41	< 1	7	116	618
1992–93	96	481	1	19	6	85	1	12	104	597
1993–94	111	495	1	26	8	86	1	7	122	614
1994–95	82	392	5	48	4	51	< 1	3	92	494
1995–96	79	382	2	25	2	28	1	9	83	444
1996–97	80	384	6	35	1	13	1	11	89	443
1997–98	73	282	9	37	2	14	3	20	86	353
1998–99	109	347	2	16	4	26	1	12	117	401
1999–00	87	299	1	6	1	17	< 1	5	89	324
2000–01	63	252	< 1	1	2	22	1	8	66	283
2001–02	78	280	< 1	4	1	16	< 1	1	80	301
2002–03	109	423	1	20	4	61	< 1	2	115	506

Cook Strait line fishery, bottom longline

Target species, groper catch (t), and effort (days)

Fishing year	Groper (t)	Groper days	Bluenose (t)	Bluenose days	Ling (t)	Ling days	School shark (t)	School shark days	Total (t)	Total days
1989–90	17	72	1	2	1	17	13	146	32	237
1990–91	23	82	< 1	1	2	27	18	165	44	275
1991–92	15	81	2	11	7	44	19	139	43	275
1992–93	38	115	< 1	3	9	81	16	106	63	305
1993–94	23	80	1	10	12	71	14	138	50	299
1994–95	51	106	8	30	17	105	29	151	104	392
1995–96	36	80	19	29	12	79	29	184	97	372
1996–97	25	66	15	23	7	43	12	143	59	275
1997–98	29	68	1	6	5	24	8	136	43	234
1998–99	49	84	12	14	13	68	11	139	85	305
1999–00	23	80	< 1	2	8	48	10	131	42	261
2000–01	32	117	1	14	9	68	12	110	53	309
2001–02	24	115	< 1	5	10	76	9	84	43	280
2002–03	27	126	< 1	7	6	106	11	85	44	324

Southern line fishery, dropline

Target species, groper catch (t), and effort (days)

Fishing Year	Groper (t)	Groper days	Bluenose (t)	Bluenose days	Ling (t)	Ling days	School shark (t)	School shark days	Total (t)	Total days
1989–90	42	317	< 1	9	0	0	< 1	2	43	328
1990–91	49	329	< 1	2	< 1	1	1	7	50	339
1991–92	32	174	0		4	31	1	8	36	213
1992–93	30	154	< 1	1	0	0	< 1	1	30	156
1993–94	79	382	1	9	< 1	9	< 1	2	81	402
1994–95	83	330	1	7	0	0	0	0	84	337
1995–96	84	296	1	9	0	0	< 1	2	85	307
1996–97	67	230	< 1	6	< 1	5	0	0	68	241
1997–98	43	154	2	16	0	0	0	0	45	170
1998–99	58	188	< 1	5	< 1	2	0	0	58	195
1999–00	100	340	1	20	0	0	0	0	101	362
2000–01	118	299	1	29	0	0	< 1	1	119	330
2001–02	105	311	2	44	0	0	0	0	107	356
2002–03	106	428	1	31	0	0	< 1	2	108	462

Southern line fishery, bottom longline

Target species, groper catch (t), and effort (days)

Fishing Year	Groper (t)	Groper days	Bluenose (t)	Bluenose days	Ling (t)	Ling days	School shark (t)	School shark days	Total (t)	Total days
1989–90	6	45	1	11	2	20	1	9	9	85
1990–91	9	45	< 1	4	1	18	2	14	12	81
1991–92	11	75	< 1	3	4	73	1	17	17	168
1992–93	18	82	< 1	7	6	98	1	15	25	202
1993–94	9	56	< 1	4	5	9	1	10	15	164
1994–95	14	86	1	15	4	62	0	0	19	163
1995–96	15	68	1	10	5	66	< 1	5	21	149
1996–97	25	91	1	6	8	123	0	0	33	220
1997–98	3	15	< 1	1	5	81	0	0	8	97
1998–99	6	31	1	8	6	91	< 1	4	13	134
1999–00	7	40	1	11	5	76	< 1	3	14	131
2000–01	27	110	2	12	5	88	2	14	37	226
2001–02	17	101	1	17	5	61	2	20	26	199
2002–03	13	53	3	23	4	48	2	15	21	139

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	Target species, groper catch (t), and effort (days)									
Fishing	Groper		Bluenose		Ling		Tarakihi		Total	
year	(t)	days	(t)	days	(t)	days	(t)	days	(t)	days
1989–90	58	258	< 1	4	25	294	10	212	93	779
1990–91	64	223	< 1	3	24	276	15	234	115	870
1991–92	59	170	0	0	25	254	13	193	101	732
1992–93	56	223	1	11	30	360	13	264	109	1 081
1993–94	63	226	< 1	7	23	287	9	158	103	861
1994–95	59	262	10	103	19	230	10	181	101	891
1995–96	47	228	8	93	28	228	10	187	94	761
1996–97	60	258	8	98	23	279	22	237	114	918
1997–98	58	208	2	82	31	306	23	274	117	917
1998–99	74	352	2	62	21	261	11	152	108	863
1999–00	57	306	5	43	22	259	35	341	123	1 056
2000–01	90	307	8	64	31	247	10	169	143	901
2001–02	79	254	3	41	33	285	14	173	137	902
2002–03	74	212	4	33	28	267	28	246	145	988

Note: Total values may sum to more than the listed target species because of a small category "other targets".