ISSN 1175-1584

MINISTRY OF FISHERIES
Te Tautiaki i nga tini a Tangaroa

A description of the New Zealand fisheries for the two groper species, hapuku (*Polyprion oxygeneios*) and bass (*P. americanus*)

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New Zealand Fisheries Assessment Report 2002/13
March 2002

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Published by Ministry of Fisheries
Wellington
2002

ISSN 1175-1584

Citation:
Paul, L.J. (2002).
A description of the New Zealand fisheries for the two groper species, hapuku (*Polyprion oxygeneios*) and bass (*P. americanus*).
New Zealand Fisheries Assessment Report 2002/13. 47 p.

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

EXECUTIVE SUMMARY

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The groper fishery, based on two species (bass, hapuku), is relatively small. Landings reached 2500 t in the early 1980s, but were reduced to 1000 1500 t by the Quota Management System (QMS). Both species are valuable, and catches are made by many (500 700) fishers. Landings around the New Zealand mainland are close to and constrained by regional TACCs. This report describes the main features of the groper fishery.

The pre-QMS fishery is briefly described, in terms of catch (= landing) by region and method. The post-QMS fishery is described in more detail. The 1986 89 data are unreliable, so analyses of catches and landings are restricted to the fishing years 1989 90 to 1998 99.

To define regions, Quota Management Area (QMA) boundaries were used where appropriate, but creation of a Cook Strait region (enclosing the main fishery) required modification of the adjoining QMAs.

Estimated catches are only 70 80% of landings, but the latter are difficult to analyse by region, method, target species, etc. Two procedures were used to combine landings values with effort parameters. For all 10 years, vessels recording groper landings were categorised by region and method by interpreting their estimated catch records. For fishing year 1997 98 only, a more complex procedure categorised landings by region, method, and also target species.

Using landings rather than catches overcame two problems with the estimated catches. (1) Small catches, particularly by trawlers, do not appear in the data. (2) Catches are often recorded as processed weight instead of true greenweight, giving mixed and lower totals.

Although one quarter of the catch is recorded by species code instead of the combined-groper code, only 4 11% of catches can be considered reliably separated. Landings are not separated. It is not possible to analyse fishery data for each species separately. Based on the catch by species data, about one quarter of the catch is bass and three-quarters hapuku.

About half the catch (landing) is targeted. However, much of this is taken sporadically and in small quantities.

Nine regional fisheries are described, in terms of catch history (from 1931 where relevant), and from 1990 onwards by main fishing areas, and by method. The main fisheries in each region are described by target species, and the groper catch in these main target fisheries is then analysed by season (month).

There are six main target fisheries. Dropline: northeast North Island, Cook Strait, and Southland. Bottom longline: northeast North Island and Cook Strait. Setnet: one area (Kaikoura) within the Cook Strait region. Although groper are often listed as the target species, they are regularly taken in association with ling, bluenose, and school shark, and it may be appropriate to consider at least line-caught groper, ling, and bluenose as a unit fishery.

Differences in the seasonal timing of peak catches in northern and southern target fisheries may indicate north/south movement of a single "stock" of groper (perhaps hapuku), or it may simply result from seasonal movement of fishers between the groper fishery and other, more seasonally constrained fisheries.

1. INTRODUCTION

This report addresses Objective 1 of Project HPB1999/01: "To characterise the fisheries for hapuku and bass by analysis of existing commercial catch and effort data."

There is a requirement to understand and monitor the New Zealand groper fishery. Initial yield estimates made in the mid 1980s were only approximate, and subsequent work has not yielded reliable enough information to revise them. In addition, it is now considered unrealistic to obtain even relative biomass values for both species from trawl surveys, as was done for two of the initial yield estimates. The development of appropriate CPUE indices may be the best option for monitoring the status of at least the main target fisheries.

The New Zealand fishery for groper (hapuku and bass combined) is small. Landings during the 1990s have ranged between 1100 t and 1550 t, less than 1% of total finfish landings. However, groper have a relatively high unit value, and groper quota is in short supply and also has a high intrinsic value. In the absence of published port prices it is difficult to establish a monetary value for the fishery, but for the fishing year 1999–2000 the value of traded (sold) quota, weighted by Quota Management Area (QMA) and summed to equal the total landings (t), was $18 million (Ministry of Fisheries Quota Monitoring Reports). That is, the fishing industry has invested this sum into tradable rights to catch groper.

The "groper fishery" has never been clearly described, beyond the generalisation that it includes all lining and netting (including trawling, Danish seining) fishing methods, that some line and setnet vessels target-fish the two species, and that a considerable proportion of groper landings comprise bycatch from a number of other fisheries (Watkinson & Smith 1972, Roberts 1986, Paul & Davies 1988, Annala & Sullivan 1998). Both species are taken throughout New Zealand, over a wide range of depths from the shallow shelf to at least 500 m. The two species are taken in different proportions regionally, and by depth; this has changed over time, but is not documented.

For this project, "fishery characterisation" covers a general description of the fishery: its development, the extent and nature of fishing grounds, fishing gear and some information on changes over time. It covers its relationship with other fisheries, particularly those in which smaller fishing vessels alternately target groper and other species, but does not examine this in depth. Historical catch trends are described, by region and method. More detailed information from fishing years 1989–90 onwards are described in terms of target catch and bycatch, and catch by region, method, target species, and season. This account covers the two species in combination, but biological information and fishery data are examined to determine whether some fisheries for hapuku and bass can be described separately.

This report is directed at defining any groper fisheries which might yield useful CPUE indices, either by single species, or by the combined-groper category. Associated reports deal separately with the CPUE indices themselves, and with the issue of whether there might be separate stocks of each of the two groper species.

2. LITERATURE REVIEW

2.1 General

Hapuku, *Polyprion oxygeneios*, and bass, *P. americanus*, occur throughout New Zealand, but their relative distribution and abundance are not clear. Anderson et al. (1998) charted their distribution patterns based on trawl surveys, but as both species favour rough bottom this information is incomplete. These surveys show that hapuku are much more common than bass on the open seafloor worked by trawlers. Bass occur at the Kermadec Islands. Both species extend from Northland to Stewart Island, and across the Stewart/Snares shelf and Chatham Rise. Trawl surveys have not taken them on the Campbell Plateau, but hapuku do straggle south to the Auckland Islands (Clive Roberts, MoNZ, pers. comm). Neither species is recorded from trawl catches on the Challenger Plateau, but could be present there, close to pinnacles.

Hapuku are most abundant in 100–300 m, peaking at about 200 m; bass are most abundant in 250–500 m, peaking at about 400 m. These depth ranges agree with the observations of a fisherman (Hull 1978), presumably based on catches from rougher seafloor, that the main depth range of hapuku was 50–350 m, commonly 150–200 m, while that of bass was 100–550 m, commonly 200–400 m. Roberts (1986) gave similar depth ranges.

The wider geographic distribution of the two species known in New Zealand as hapuku and bass is uncertain. Hapuku (*Polyprion oxygeneios*) occurs off southern Australia, and has been recorded at islands in the southern Indian Ocean, and off the Pacific coast of South America. Bass, as *Polyprion moeone*, also occurs off southern Australia. If it is the wreckfish, *P. americanus*, as proposed by Roberts (1986) on morphometric and meristic grounds, it occurs in several broad regions of the Northern and Southern Hemisphere, but is absent from the North Pacific Ocean. Sedberry et al. (1996) inferred long distance movements in the North Atlantic. In the most recent study, Ball et al. (2000) found that microsatellite genetic markers separated the Australasian "wreckfish" population from the Brazilian and Northern Hemisphere populations as distinctly as *Polyprion oxygeneios* was separated from *P. americanus*, and may be the separate species *P. moeone* as originally described. The issue is unresolved.

2.2 Hapuku

There have been few biological studies directly relevant to stock assessment of hapuku in New Zealand waters. General work in Cook Strait, particularly on the recovery patterns of tagged fish, has allowed some inferences on seasonal movements (Johnston 1983). This led to an inconclusive investigation of hapuku stock differentiation by Smith & Johnston (1985), when genetic variation *within* a sample of Cook Strait hapuku was found to be as great as *between* samples from Cook Strait and elsewhere. A review of tagged fish movements by Beentjes & Francis (1999) shows a moderate mixing of eastern South Island and Cook Strait fish, but possibly a separate stock in eastern Northland, although there were relatively few Northland-tagged fish. Information on the size range of hapuku taken during trawl surveys is held on a Ministry of Fisheries database; examination of these data shows that small juveniles occur on the Stewart/Snares shelf, and slightly larger juveniles on the Chatham Rise, suggesting that these may be important nursery grounds at least for southern and central New Zealand. The size range of juvenile hapuku taken in surveys elsewhere in New Zealand has not been determined, but information on this may also help define nursery areas. An age and growth study by Francis et al. (1999) showed that hapuku live to at least 50 years, possibly to 60 years. Most fish they examined were younger than 25 years, but their sample included relatively few large to very large fish. Roberts (1989) investigated the reproduction of both hapuku and bass, disproving the suspicion that they were hermaphroditic and underwent a sex change.

Previous studies on the New Zealand groper fishery, predominantly on hapuku in Cook Strait, have investigated catch and landings trends but have yielded inconclusive results on the status of the fishery (Tunbridge 1962, York 1979, Johnston 1983). Landings trends have been difficult to interpret because of changing fishing patterns, and an apparently complex movement of fish into or through Cook Strait. These studies have incorporated a variety of anecdotal information from fishermen, but have been hampered by inadequate access to detailed catch and effort data on the fisheries for groper (target and bycatch), and on the associated fisheries (e.g., for ling, school shark, rock lobster) which appear to be linked to groper fisheries.

Information on *Polyprion oxygeneios* and its fisheries elsewhere is given by Lisovenko & Vertunova (1985), Flores & Rojas (1985), Rojas et al. (1985), Pavez & Oyarzun (1985), and Pizarro & Yanez (1985).

2.3 Bass

There is little information on the bass in New Zealand waters, but there is some information on its biology and fisheries elsewhere (Menni & Lopez 1979, Glukhov & Zaferman 1982, Ryall & Hargrave 1984,

Gauvin et al. 1993, 1994, Haimovici et al. 1994, Sedberry et al. 1994, 1996, 1999, Vinnichenko 1997, Peres & Haimovici 1998).

2.4 Development of yield estimates and TACs

In 1984, when the sustainable yields from New Zealand's main fisheries were first seriously considered, the potential long-term yield from the total New Zealand groper fishery was estimated to be in the order of 1400 t. A series of lower short-term yields, from 500 t to 1200 t, were proposed to promote the rebuilding of what was assumed to be an over-fished "stock" over different time-frames (Paul 1985a). These yield estimates were based only on regional catch histories, the recorded commercial catches by domestic vessels fishing coastal waters. In 1985 a new assessment included data on groper biomass from trawl surveys of the Campbell Plateau and Chatham Rise, which increased the total yield estimate to 1760 t. This formed the basis of the first (1986–87) TAC of 1830 t, 10 t being administratively added to most regions. In subsequent years successful quota appeals by individual fishers increased the TAC (later the TACC) to 2179 t.

These yield estimates and TACs were based on data from regional fisheries, or from regional trawl surveys. They were combined into a national total on the assumption that there was likely to be only one biological stock each of hapuku and bass in the New Zealand region. However, it was recommended that regional quotas be established in order to prevent localised depletion.

The QMA boundaries were chosen for administrative convenience, rather than stock assessment relevance. They differed substantially from those which had been used for the determination of regional yields (Paul 1985a). In combination with a decision to reduce catches by reasonably equivalent percentages in all areas (although this had no catch history justification), this resulted in groper catches being strongly constrained by quota in some QMAs from 1986–87 onwards, and being considerably less than the quota in others. For example, the large Cook Strait fishery had a long and relatively stable catch history, yet was reduced in line with small fisheries with only a few years of high catches. Cook Strait grounds, which supported a recognisably discrete fishery, were divided among four QMAs which collectively covered about two-thirds of the country's coastline. Data on groper landings by QMA have been of little or no value in stock assessment work.

In summary, there has been no recent work on the New Zealand groper fishery able to confirm or revise the initial estimates of sustainable yield for the two species, either separately or in combination. Limitations of data extracts from the catch-effort database have also prevented an adequate descriptive study of this fishery, which should contain analyses of the catch by method, area, and target species.

However, recent progress in developing data extract and analytical procedures (see Paul & Sanders 1998) now allow a more comprehensive description or "characterisation" of a fishery than has previously been possible. Such descriptions should always precede more detailed stock assessment work.

3. DATA SOURCES AND METHODS

3.1 General

Assorted unpublished information has been collated and integrated with the brief published accounts. Unpublished information includes notes from interviews with fishermen; observations on gear, methods, etc. made during field trips; and data on fish size, sex, and maturity, from commercial groper-fishing vessels and from trawl surveys.

Total New Zealand commercial landings from 1948, and landings by QMA from 1983–84, were given by Annala et al. (2000). Landings by method by port and vessel nationality (i.e., an estimate of catches by

foreign vessels) are given for various earlier sequences of years in Paul (1985b), Paul & Davies (1988), and in a number of unpublished documents held by NIWA.

3.2 Regional fisheries

To retain consistency with QMS data, fishery "regions" were QMAs or subdivisions of QMAs wherever this was considered appropriate. However, previous analyses have shown the largest reasonably discrete groper fishery to be centred on Cook Strait, and a separate new Cook Strait region was defined, taking segments (statistical fishing areas) from QMAs 2, 3, 7, and 8. Catch histories were developed from port landings within these regions, and from groupings of appropriate statistical fishing areas. The fishing regions used in this study are defined in Figure 1.

3.3 Catch and effort data, 1990s

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 1998–99 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); day; fishing method; statistical fishing area; target fish species; catch by species code; and total catch. A separate extract was obtained from the table 'niwa...specprod_act' table, which aggregates landings data from the CELR and CLR forms (the latter being a record of landings by vessels using TCEPR forms). This gave recorded landings by vessel identifier; month; and species code. That is, CELR and TCEPR catch data were obtained as daily summaries, and all landings data as monthly summaries, by vessel.

Only the landings values represent "total catches". The estimated catch values are incomplete where groper do not come within the five species that can be listed on catch forms, and (as is explained in Section 3.6.2.5) these estimated catch values are often listed as processed weight, about 70% of total weight or greenweight. However, they are not categorised by fishing method, fishing region, or target species. It is possible to fully cross-link these (see Section 3.4 below), but this was considered too time-consuming for all 10 years in the series. A simpler method was devised to categorise landings by method and region, but not target species (though these could be subsequently incorporated in selected subsets of target fishery data). For each year, the estimated catch extracts were used to determine the main fishing method, and main region, for each vessel. These parameters were then linked to the monthly landed values by vessel. Missing parameters (some vessels had made landings but recorded no catch) were extrapolated from adjacent years, or where data were sparse and the values small the vessels' records were deleted. This procedure did not allow landings by a vessel to be allocated to more than one method or region in a year, but this proved to be a minor issue; only a few vessels fished outside their main region, and then usually only briefly, although this was a complex matter and not quantified.

3.4 Catch and effort data, 1997–98

A more detailed characterisation was undertaken for a single fishing year, 1997–98, the most recent for which catch and landings values were likely to be complete. For this year, the three extracts from the Ministry of Fisheries databases (CELR estimated, TCEPR estimated, CLR landed) were integrated in a procedure (see Paul & Sanders 1998) that allocated monthly landing, recorded only by vessel, to geographic region (as described above), fishing method, and target species. The landing values from the bottom panel of the CELR, and from the CLR, were apportioned by region, method, and target, using the estimated catches from the top of the CELR and TCEPR.

The main purpose was to fully describe the fishery for this one year, in terms of total catch (= landing) by region, method, and target species. It brings the small bycatches of groper which do not fall within the top five species listed for a fishing operation (particularly trawl catches) into the dataset. The procedure has a secondary value. Examination of the data at this fine scale, particularly the effort parameters in the estimated catch extracts, provides a subjective assessment of their quality – a variety of errors can be seen that are not apparent in subtotals or totals.

3.5 Data grooming

Data extracted from the Ministry of Fisheries catch-effort database were groomed for obvious errors. Data with Null vessel identifiers were removed. Data with a Null statistical area were retained, and grouped as Area Unknown. Rock lobster area codes were converted to the equivalent finfish statistical area code. It is known that there is a problem where Fishstock numbers are recorded instead of the statistical area; this was corrected (to region) in the 1997–98 data when an anomaly could be recognised, but an unknown number of incorrect entries clearly remain in the data which were used. High catch or landing values which were clearly outliers were corrected by cross-checking and estimation, or the entries were removed. Low catch weights (less than 5 kg) were problematic; some are undoubtedly correct, representing single small fish, while others could be fish numbers. They were retained, as they had little effect on the analyses. Estimated and landed fish weights were treated as greenweight values, although it became clear that many of the former were in fact processed weight. There was no simple procedure to recognise and correct these.

3.6 Estimated catches and recorded landings

Estimated catches are recorded at sea, or (for some small vessels) immediately after landing. They list only approximate values for the top five species caught. For CELR data (the majority of data used in this report's analyses) they are daily totals by vessel, area, and fishing method, but if the vessel changed fishing area or method they are subtotals. For TCEPR (trawl) data they list the top five species caught in each trawl shot; the extracts used in this report are daily totals from tows in which groper (fish codes HAP, BAS, HPB) were listed in the top five species.

Landings record the true weight of the landed catch. The monthly landing extracts used in this report should approximate the sum of estimated weights for vessels which usually listed groper among the top five species in the estimated catches. They will differ for one (or more) of several reasons: (a) groper was not always among the top five species; (b) fishing trips extended across two months, with groper recorded as caught in one month being landed in the next; (c) conversion factors were incorrectly applied either to catch or landing values.

In general, "catch" and "landing" have these meanings in this report. A catch is taken at sea, and the "estimated catch" is an approximation and usually an underestimate of this. A landing is the quantity of fish brought ashore and more accurately weighed. There is one exception to this: the term "catch history" is used in its usual sense, the historical record of landed values. In other instances "catch" may be used with a qualifier, or its meaning otherwise explained, e.g., "total catch" (= landing) is sometimes retained as a useful phrase to refer to the estimated catch value pro-rated up to equal the landed value.

3.6.1 Integrating catches and landings

There is no standard, automated procedure for linking "total catches" (i.e., landings) with fishing effort, or even the basic fishing descriptors such as method, area, and target species. That is, it is not possible to link the (estimated) catch and the (recorded) fishing effort descriptors and values, provided on the top panel of the CELR and TCEPR forms, with the full landed data recorded on the lower panel

of the CELR form and (for TCEPR data) on CLR forms. Only the (incomplete) estimated catch data are linked with effort.

If these estimated values are used, it is not possible to fully describe or characterise the fishery, in terms of method, area, and target species (when groper were taken as bycatch). In particular, there is a bias in the estimated catch data towards targeted fisheries, and towards those fisheries in which few other species are caught. In both these cases groper are more likely to be listed in the top (estimated) panels of the forms.

The commercial fishery for groper is similar to that for school shark, with the catch being taken by a large number of vessels, much of it as bycatch. In a preliminary study of the school shark fishery (Paul & Sanders 1998), a procedure was developed which converted estimated catches into "total catches" by linking vessel-codes with landings. From the Ministry of Fisheries' catch-effort database, extracts were obtained of "estimated catches" and "landings" for one fishing year. Estimated catches were summarised by vessel (coded), month, and day, and landings by vessel and month. These were combined in an Excel spreadsheet, which then comprised one or more rows of daily estimated catches for a vessel, followed by a row of that vessel's landed catch for the month. Information on method, area, and target species was copied from the "estimated catch" row(s) to the monthly "catch landed" rows. This procedure was time-consuming, but resulted in the entire landed catch being linked to vessel, method, area, and target species, by month, and it yielded a new, more informative value, termed in that study the "calculated landed" catch. Appendix 1 gives details of this procedure, and the decision rules adopted for spurious or doubtful data.

Consideration was given to automating this procedure during a subsequent study on the school shark fishery (Paul & Sanders 2001), and during the present study on groper, but it proved impractical. The data contain too many errors, of several kinds. While some are simple errors that could be automatically corrected, most are more complex and require some judgement to resolve. For example, missing entries for area and method can often be added from information on the same vessel for adjacent days and months, and erroneous method or target species codes corrected in the same way. Some entries have valid species, method, or area codes, but their combination is unlikely or impossible. Hand-written three-letter codes are mis-read or mis-punched as another valid code, and Fishstock numbers are sometimes recorded instead of statistical area numbers. Knowledge of likely patterns in the fishery can enable some of these to be corrected, but an unknown number cannot be resolved without recourse to a large amount of supplementary information.

One fishing year's catch and landings data were integrated using this procedure. This time-consuming work (there were 12 000 rows of data) had three purposes: (a) it quickly identified outliers, mainly high estimated catch values; (b) it provided a subjective overview of data quality (missing, spurious, or ambiguous entries could often be recognised, even though many could not be corrected); and (c) it enabled (full) landings by method, region, and target species to be compared with (partial) estimated catches by these parameters.

3.6.2 The relationship between catches and landings

3.6.2.1 Trends over the decade 1989–90 to 1998–99

In this report, "catches" are not equivalent to "landings". Estimated catches, landed weights, and the recorded QMR landed values, are compared in Table 1.

Table 1: Comparison of catch and landing values (t) of groper, fishing years 1989–90 to 1998–99. Catch is estimated catch from CELR and TCEPR forms, summed from records when groper fall within the top five species of a fishing operation (trawl, line, or set net); some annual totals may include processed weight values rather than total weights (greenweight). Landings are landed weights from CELR and CLR forms, usually recorded as processed weight and converted to total weight (greenweight). QMR landed values are from a separate series of quota monitoring report forms, reported in summary form by Annala et al. (2000).

	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Catch	744	970	1 010	1 206	1 207	1 259	1 253	1 151	1 090	1 178
Landing	947	1 214	1 291	1 463	1 585	1 573	1 643	1 561	1 577	1 647
QMR value	1 098	1 282	1 319	1 405	1 455	1 437	1 479	1 418	1 406	1 562
Catch as % of landing	79	80	78	82	76	80	76	74	69	72
Landing as % QMR value	86	95	98	104	109	109	111	110	112	105

Estimated catches are between 69% and 82% of recorded landings, generally being in the lower end of this range in the late 1990s. The difference between the two values results at least in part from the omission of groper from recorded catches where they are not among the top five species.

Recorded landings increase from 86% of QMR values in 1989–90 to about 110% of the latter from 1993–94 onwards. The reason for this trend in differences is unknown.

In this report, "catch" means estimated catch (unless otherwise defined), and landing(s) means recorded landing(s), not the QMR value.

3.6.2.2 Catches and landings by region

A comparison of estimated catches and recorded landings by region was made only from the integrated extracts for the fishing year 1997–98 (Table 2).

Table 2: Estimated catches and recorded landings (t) of groper for the fishing year 1997–98, by region.

Region	Estimated catch	Landing	Catch as % landing
Northeast North I.	272	367	74
Eastern North I.	134	189	71
Cook Strait	273	405	67
Eastern South I.	128	192	67
Chatham Rise	64	81	79
Southern South I.	55	84	65
Western South I.	35	42	83
Cape Egmont	26	29	90
Northwest North I.	54	70	77
Kermadec	22	30	73
Unknown	26	85	31
Total	1 089	1 576	69

In the larger regions, those with landings of 100 t or greater, estimated catches were about 70% of landings. In the regions with smaller catches and landings the relationship was variable but usually closer; the reason for this is unknown. In the Cape Egmont region, estimated catch was 90% of the landing, probably because of a higher level of targeted lining and netting. Off the southern South Island (Southland), estimated catch was only 65% of landings.

3.6.2.3 Catches and landings by method

A comparison of estimated catches and recorded landings by method was made only from the integrated extracts for the fishing year 1997–98 (Table 3).

Table 3: Estimated catches and recorded landings (t) of groper for the fishing year 1997–98, by method.

Method	Estimated catch	Landing	Catch as % landing
Bottom longline	410	487	84
Dahnline	258	420	61
Trotline	52	67	78
Handline	4	4	100
Trawl	195	363	54
Setnet	164	231	71
Danish seine	< 1	< 1	79
Null	5	3	-
Total	1 089	1 576	69

Note:
1. Null means method not recorded, plus methods considered to be erroneous (cod-pot; lobster-pot; surface longline (SLL = BLL?); pole and line (PL = DL?).
2. Dahnline and trotline data are subsequently combined in this account as 'Dropline'. Trotlines are essentially groups of dahnlines, with the hooks in a vertical series. In bottom longlines the hooks are deployed on a horizontal line. The combined dropline values for this table are 310 t, 487 t, and 64%.

For the main fishing method (in 1997–98), bottom longlining, the estimated catch was a high proportion (84%) of landings. For the two other main lining methods (dahnlining and trotlining) the proportion was lower, a surprisingly low 61% for dahnlines, but 78% for trotlines. These two methods are similar and can be combined as droplines (64%); they are the conventional method for targeting groper. The moderate setnet catch, some of which would also have targeted groper, was 71% of landings. The differences between catch and landings in these essentially targeted fisheries are believed to result from incorrect (processed weight) catch values, but this is difficult to establish. The estimated catch by trawl, all of which would be bycatch, was only 54% of reported landings. Groper are often not among the top five species in a trawl catch, and thus are not recorded; they may also be recorded incorrectly as processed weight.

3.6.2.4 Catches and landings by target species

A comparison of estimated catches and recorded landings by target species was made only from the integrated extracts for the fishing year 1997–98 (Table 4).

Table 4: Estimated catches and recorded landings (t) of groper for the fishing year 1997–98, by target species.

Target species	Estimated catch	Landing	Catch as % landing
Groper	520	645	81
Ling	139	185	75
Bluenose	135	149	91
Tarakihi	74	116	64
Red cod	51	92	55
School shark	33	41	80
Snapper	31	37	84
Hoki	10	24	42
Barracouta	11	23	48
Red gurnard	12	21	57
Silver warehou	7	18	39
Squid	11	16	68
Gemfish	11	16	68
Flatfishes	7	11	64
Minor species[1]	30	41	73
Null[2]	8	144	18[3]
Total	1089	1576	69

Notes:

1. Minor species include, in order, (blue) warehou, stargazer, scampi, rig, moki, jack mackerels, spiny dogfish, John dory, trevally, trumpeter, alfonsino, sea perch, elephant fish, blue cod, ghost shark, rubyfish, butterfish.
2. Null means target species not recorded (144 t landed), plus target species codes considered to be erroneous (less than 1 t estimated), e.g., SCA (SCH?), CRA.
3. The large discrepancy between the two NULL values is mainly caused by vessels which have recorded a monthly landing of groper, but which have no estimated catch of groper for any day in that month. From the information for other months it is usually possible to identify the fishing method used by these vessels, and the region they fished (giving more complete data used in previous sections), but it is seldom possible to assign a target species to the groper landing (the exception being when a vessel clearly targeted just a single species).

In the fishing year 1997–98, the estimated catch was closest to the landings value for those target species most closely associated with groper in longline fisheries: bluenose, groper itself (i.e., targeted), school shark, and ling. The proportion of catch to landing was surprisingly high for snapper, possibly because when groper is taken as bycatch in the snapper line or trawl fishery it is either regarded as sufficiently important to be listed among the main five species, or in these fisheries there are relatively few bycatch species. The proportion of groper catch to landing is lower for the other target species, most of which represent multi-species trawl fisheries.

3.6.2.5 Catches and landings by individual vessels

When the catch and landings data for the fishing year 1997–98 (see Section 3.4) were manually integrated, vessel by vessel, month by month, three patterns became apparent. (1) There was a poor relationship between catches and landings. This was most common for trawlers, and presumably resulted from groper being a bycatch and usually not among the top five species recorded. (2) Catches and landings for a vessel-month were very similar, and sometimes identical. The similar values were reassuring, suggesting that the two data-sets were correct, or at least the extract procedures were comparable and gave the same correct or incorrect values; the identical values presumably resulted from the fisher completing both parts (panels) of the CELR form at the same time. (3) Monthly landings were 1.2 to 1.5 times the monthly catches. This was reminiscent of the pattern of catches and landings in the school shark fishery, where landings were often twice the value of catches, as a result of the conversion factor (x2) not being applied to processed weight values (Paul & Sanders 2001). The conversion factor (to greenweight) for processed groper is about 1.4 (there have been small changes in recent years). It appeared likely that some estimated catches were recorded as processed weight and

not converted (as required) to greenweight, while the corresponding landings values were correctly converted up to greenweight by the correct factor of 1.4.

To investigate this point further, the annual paired values (estimated catch weights, recorded landings) were compared for each vessel over the decade 1989–90 to 1998–99. Estimated catches were calculated as a percentage of landings, annually, for each vessel; thus some vessels provide 10 values, some only one. Vessels were categorised by method (bottom longline, dropline, setnet, trawl) according to their main fishing method in each year (Figure 2). The results are also shown for vessels with different levels of landings: 1 t and greater, 5 t and greater, and 10 t and greater; only vessels landing less than 1 t are excluded. (The three groups are not exclusive – the first includes the second and third, etc.) The results do suggest a conversion factor problem. One set of values peaks at about 100%, i.e., estimated weights do approximate the landed weight. But if some estimated weights were not converted up by 1.4, there would be a second peak of values at 70%. This does occur in the data for longline, dropline, and setnet values. The primary peak is a little less than 100%, particularly for the main targeting methods of dropline and setnet. There is no pattern in the trawl data, as would be expected for a bycatch species unlikely to be among the top five in a catch.

4. REVIEW OF THE NEW ZEALAND FISHERY

4.1 Fishing effort in the New Zealand fishery

4.1.1 The fishing fleet

Groper landings are reported by a large number of vessels. Over the period 1989–90 to 1998–99, a total of 1521 individual vessels recorded a landing in one or more years. In a single year, 527 to 713 (mean 641) vessels recorded a landing. Many of these landings are small, resulting from bycatches in a variety of fisheries, but because groper are valuable these small catches are still important to fishers. This importance will vary among fisheries, a catch of 50 kg will be relatively more valuable to a small longliner than to a large trawler. However, a standard threshold must be chosen in order to distinguish between the "main fleet", and what may be regarded as the "minor fleet" – vessels which catch groper so irregularly that they can be omitted from most analyses. Defining the main fleet, i.e., an appropriate group of vessels for which CPUE indices can be derived, is not straightforward. Several options were examined in the groper fishery data.

First, the level of annual landings can be considered.

- A threshold of 1 t in the decade. Those vessels which reported a cumulative landing of less than 1 t of groper during the decade were removed from the total. This removed 117 to 210 (mean 166) vessels annually, or 21% to 31% of the fleet. Apart from a few vessels with a landing of almost 1 t in a single year, these vessels had very small landings across the series of years they fished. Groper was clearly only an incidental bycatch.

- A threshold of 1 t per year. Those vessels which reported a landing of less than 1 t of groper in a year were removed (from that year only). This removed 299 to 462 (mean 413) vessels annually, or 57% to 71% of the fleet. However, this threshold of 1 t was still considered too low to correctly identify the vessels which were significantly committed to groper fishing.

- Those vessels which reported a landing of less than 10 t of groper in a year were removed (from that year only). This removed 500 to 684 vessels (mean 608) annually, or 92% to 97% of the fleet. Only 19 to 47 (mean 35) vessels were retained in a year. In total, there were 126 vessels in the latter category, 18 of which were trawlers (or had taken their groper when trawling). If only line and net vessels are considered, 17 to 43 (mean 33) vessels landed 10 t or more of groper in a year.

Second, the number of years that a vessel had recorded an appropriate level of landings can be considered. The following options deal only with the vessels in the last category above, those vessels (excluding trawlers) that landed 10 t or more of groper in any single year in the decade 1989–90 to 1998–99 (Table 5).

Table 5: From the subset of vessels (excluding trawlers) which landed at least 10 t of groper in at least one year, the numbers of vessels recorded as landing groper, fishing years 1989–90 to 1998–99, tabulated as vessels in different categories of landing, working different numbers of years.

No. of years worked	No. vessels reporting a landing	No. vessels reporting a landing of 10 t or greater	No. vessels reporting a reasonable[1] landing
1	6	42	0
2	8	18	0
3	7	14	1
4	5	12	1
5	14	4	1
6	7	4	1
7	14	8	2
8	7	2	3
9	13	0	6
10	27	4	11
	108	108	26

Notes:
1. "Reasonable": consistent annual landings, usually but not always above the 10 t threshold (see text).

Even among the vessels which reported a landing of 10 t or more in one year during the decade 1989–90 to 1998–99, relatively few fished consistently through the decade. Of the 108 individual vessels, 47 fished for 8 or more years. Only 6 of these, however, landed 10 t or more in each of these years. If the criterion is relaxed a little, however, to include vessels which land more than the 10 t threshold in most years and only a little less in others, 20 of these 26 vessels made "reasonable" landings in 8 or more years.

This account covers the total New Zealand fleet. It covers the main targeting methods: setnetting, droplining (Dahn and trotlines), and bottom longlining. When the totals are subdivided by region and method, it is clear that there are very few consistent (or committed) groper fishers in each category.

For detailed CPUE work, it would seem appropriate to choose a threshold value of 10 t landed weight, either vessels which have landed this in a single year, or which have consistently landed 10 t over a number of years. If, by region and method, this gives a very small sample size, it may be necessary to relax these conditions.

4.1.2 Targeted and non-targeted fishing

Groper are both targeted and taken as bycatch, but in recent years the relative proportions have been difficult to determine from reported commercial catch and landings data. The following account is based on groper (BAS, HAP, HPB) identified as the targeted species in estimated catches, as a percentage of the total estimated catch, and of the (higher) landings values (Table 6). Although total catch values are incomplete (i.e., do not equal landings values) the reported targeted catches are probably close to the true targeted catch values. The difference between estimated catches and landings comprises some (but not all) of the groper taken as bycatch. It also results from some of the former being listed as processed weight rather than greenweight.

Table 6: Targeted groper catch by fishing year (t), and as a percentage of the estimated groper catch and the recorded groper landing.

	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Targeted	434	507	504	629	644	693	649	637	520	628
Catch	743	970	1010	1206	1207	1259	1254	1151	1090	1178
Landing	947	1214	1291	1463	1585	1573	1643	1561	1577	1647
Targeted:										
as % catch	58	52	50	52	53	55	52	55	48	53
as % landing	46	42	39	43	41	44	40	41	33	38

The targeted groper catch is about 50% of the estimated groper catch, but 33–46% (mean 40%) of groper landings.

It is possible to determine the percentage of the estimated catch, by method, which is targeted (Table 7).

Table 7: Targeted groper catch by fishing year and method (t), and the percentage of targeted groper catch in the estimated catch by method.

	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Targeted (t)										
Dropline	302	328	300	296	327	371	317	290	246	307
Longline	36	98	125	246	218	236	251	231	198	221
Setnet	67	74	73	66	79	75	64	79	68	83
Targeted (%)										
Dropline	94	89	92	82	86	82	89	92	79	94
Longline	27	37	35	51	45	49	45	49	48	45
Setnet	48	43	51	44	53	51	47	47	41	59

A high proportion (79–94%) of the dropline catch is targeted. About half (41–59%) of the setnet catch is targeted. A more variable and smaller proportion (27–51%, mean 43%) of the bottom longline catch is targeted, though the variability decreased to 45–49% in the late 1990s as the targeted catch by this method increased.

CPUE analyses are more reliably based on targeted catch. The most useful groper fisheries to monitor are likely to be regional dropline fisheries, which take the greatest quantity of targeted catch, and in which the targeted catch is a high proportion of the total catch (estimated catch, not landing).

4.2 Groper species identification

Hapuku (HAP) and bass (BAS) are required to be recorded separately on catch-effort forms. The combined groper code (HPB) is meant to be used only in the Quota Monitoring System records. Unfortunately, it is also frequently used in the catch-effort records, which precludes reliable analyses of catch (or landing) by species. The proportions of "bass", "hapuku", and "groper" in the estimated catch data are given in Table 8.

Table 8: Estimated catches (tonnes, and percentage of all groper) of bass (BAS), hapuku (HAP), and "groper" (HPB), by fishing year.

Fishing year	Bass (BAS) (t)	Bass (BAS) (%)	Hapuku (HAP) (t)	Hapuku (HAP) (%)	"Groper" (HPB) (t)	"Groper" (HPB) (%)	Total groper (t)
1989–90	<1	0	<1	0	744	100	744
1990–91	60	6	172	18	737	76	970
1991–92	57	6	204	20	749	74	1 010
1992–93	112	9	294	24	800	66	1 206
1993–94	67	6	321	27	819	68	1 207
1994–95	103	8	287	23	869	69	1 259
1995–96	60	5	283	23	910	73	1 253
1996–97	53	5	164	14	934	81	1 151
1997–98	65	6	170	16	854	78	1 090
1998–99	41	3	195	17	943	80	1 178

From fishing year 1990–91 onwards, 19–34% (mean 26%) of the groper catch was recorded correctly as either bass or hapuku. This is a rather small subtotal to conduct analyses on, and is likely to be biased towards certain vessels. The position is considerably worse than this when the numbers of vessels which recorded only bass or hapuku, or bass and hapuku (but not HPB) are identified (Table 9)

Table 9: Numbers of vessels which did not use the general groper code (HPB), and their estimated catches, by fishing year, 1990–91 to 1998–99.

Year	No. vessels recording catch as				Catch (t)		Total fleet	
	BAS	HAP	BAS & HAP[1]	All but HPB	BAS	HAP	No. vessels	Catch (t)
1990–91[2]	8	74	4	78	2	60	572	970
1991–92	6	74	2	78	11	33	589	1 010
1992–93	10	72	2	80	18	56	622	1 206
1993–94	5	88	2	91	37	81	643	1 207
1994–95	14	85	7	92	40	54	627	1 259
1995–96	11	112	7	116	46	95	533	1 253
1996–97	17	91	10	98	25	75	522	1 151
1997–98	13	88	8	93	37	72	501	1 090
1998–99	12	84	8	88	37	97	461	1 178

Notes:
1. These values are incorporated in the previous two columns.
2. In the previous fishing year, 1998–90, insignificant quantities of BAS and HAP were recorded.

During the 1990s (fishing years 1990–91 to 1998–99), between 78 and 116 vessels recorded BAS and HAP catches separately, without also recording HPB catches. Some of these recorded only BAS, and a larger number recorded only HAP. By year, between 2 and 10 vessels recorded both these species codes. The annual catch by these vessels (44–141 t) is between 4% and 11% of the total estimated catch; the proportion increases over this time period.

Thus, although about a quarter of the annual catches were nominally coded to species (BAS, HAP) rather than to "groper" (HPB), 11% or less of the catch is actually subdivided by species. The difference comprises catches by vessels which used species codes plus the combined code, either within the same month, or within the same year.

Although neither of these subdivisions of the data into catch by species can be considered reliable, they do permit a first attempt to estimate the relative proportions of bass and hapuku in the groper catch. If all the data categorised as BAS or HAP are used (from Table 8), 17–28% (mean 23%) of the estimated groper catch comprises bass. If only the data from vessels which did not list the combined

HPB code are used, 3–43% (mean 29%) of the estimated groper catch comprises bass. Both subsets of data are too small to allow a realistic subdivision of the catch by species by region.

4.3 Total landings

4.3.1 General

The first recorded landing in 1936 was about 1600 t (Figure 3). At this time groper was already a popular commercial fish; earlier unrecorded landings may have been higher. Landings declined a little in the late 1930s, and then dropped during the war years (1942–45) when fishing effort was restricted by the closure of grounds and general wartime controls. Post-war landings increased rapidly to almost 2000 t in 1949, but then declined slowly to about 1000 t in 1968. From 1978 they began rising steeply, more than doubling to 2700 t in 1983–84. They then fell sharply to 1700 t in 1985–86; this was the year before TACs were imposed under the Quota Management System (QMS), but introduction of the QMS had been delayed one year, and some fishers left the fishery in anticipation of restrictive limits. For the first few years under the QMS regime total landings remained at about 1000 t, before rising slowly to 1400–1500 t from 1993–94 to 1998–99. These landings were always well below the TACs, which rose from 1830 t in 1986–87 to about 2100 t from 1989–90 onwards as a consequence of appeals by fishers against inadequate allocated quotas.

Some difficulties with these landings data must be kept in mind. (1) Being high quality fish, some groper catches have always gone directly from fishing vessels to retail outlets. And with minimal handling required, some groper are also likely to have passed quickly through wholesale premises to retailers. In comparison with factory-processed fish, this has allowed more opportunity for undetected under-reporting – at least prior to introduction of the QMS in 1986. (2) Foreign catches were very poorly reported in the 1970s. Groper were only a small bycatch of the large trawlers fishing the outer shelf and deeper waters, but the total catch by foreign vessels is likely to have been several hundred tonnes, perhaps 1000 t in the mid 1970s when bottom longliners were targeting ling on offshore grounds. After declaration of the EEZ in 1978 these large offshore vessels were progressively chartered by New Zealand companies or replaced by New Zealand-owned vessels, and a greater proportion of their groper catch was properly recorded. (3) Conversion factors have changed over time, and as most groper are landed in a processed state the back-calculation to original catch weights have varied.

Total landings of groper have varied within the range 1300–1500 t between 1990–91 and 1996–97 (Annala et al. 1998). No regional (QMA or Fishstock) landings have declined. However, there are several, interrelated, reasons why this information cannot be considered a satisfactory measure of a stable fishery.

- On the basis of historical landing trends, there are two categories of groper fishery: relatively stable fisheries with a long catch history; and fisheries with very short periods of high, and/or erratic catches and landings.

- Some of the Fishstock boundaries do not realistically coincide with what appear to be natural fisheries; that is, grounds which are consistently worked by vessels from the same set of ports. Some Fishstocks consequently combine data from the above two categories of fisheries.

- All Fishstocks are relatively large. Although some groper fishermen have consistently worked the same grounds for many years, others have progressively located and worked new grounds within a region. In some areas there has been serial depletion of at least the most accessible grounds, in others there has been rotational fishing as grounds recover. These variations occur within individual Fishstocks.

For these reasons, there must be very careful selection of the data, by area, from which CPUE indices might be developed. The areas chosen must represent reasonably discrete fisheries, and also be small enough to detect any substantial geographic shift of fishing effort, over time, within the larger Fishstocks.

4.3.2 Landings by region

Historical trends in landings varied between the eight main regions used in this study (Figure 5), but a few features are common to some. Cook Strait, east coast South Island, and Southland showed a decline from the late 1940s to the mid 1970s. All regions show an increase in landings from either the late 1970s or early 1980s; in most, landings dropped when the TACs were introduced in 1986–87, but in some (Southland, northwest North Island) landings continued to rise. In some regions (the three western regions) there was negligible catch before 1975.

The regions used in this study differ from the groper Fishstocks (QMAs or QMA combinations) for which catches are reported against quota. However, they allow some conclusions to be drawn about the regions where catches are constrained by the TAC, or are significantly less than it (and contribute to the shortfall evident in Figure 4). In Table 10, reported landings are listed as percentages of the Fishstock TACs.

Table 10: Reported landings of groper by Fishstock from 1986–87 to 1998–99, expressed as a percentage of the TAC for each Fishstock. Derived from data in Annala et al. (2000), Groper, table 2.

Fishstock QMA	HPB 1 1 & 9	HPB 2 2	HPB 3 3	HPB 4 4	HPB 5 5 & 6	HPB 7 7	HPB 8 8	Total
1986–87	66	85	96	14	32	71	58	57
1987–88	64	92	94	14	22	73	87	56
1988–89	57	75	88	16	16	56	50	48
1989–90	67	68	89	12	30	52	54	52
1990–91	73	86	95	24	28	54	60	60
1991–92	58	96	91	18	25	74	63	61
1992–93	78	103	91	21	29	79	78	65
1993–94	76	109	93	28	33	82	86	67
1994–95	69	98	82	46	36	81	85	66
1995–96	70	81	96	54	32	91	98	68
1996–97	69	89	90	41	33	79	89	65
1997–98	78	98	98	27	20	62	75	64
1998–99	90	96	104	37	22	92	98	72

From 1986–87 to 1989–90 total landings were 48–57% (mean 53%) of the TAC. In subsequent years they were 60–72% (mean 65%). However, Fishstock HPB 3 landings have been close to the TAC in all years, HPB 2 close since 1991, HPB 7 and 8 since 1996, and HPB 1 landings have moved closer to the TAC during the 1990s (Figure 4). Conversely, in Fishstocks HPB 4 (Chatham Rise) and HPB 5 (southern and Subantarctic, but in reality only the Stewart/Snares shelf) catches have always been considerably less than the TAC. Around New Zealand's mainland shelf groper landings (i.e., catches) are almost certainly now constrained by TACs, and in some areas have been constrained for several years.

The difference between total landings and total TAC (Figure 3, Table 10) is mainly due to the "shortfall" of catches in the two offshore Fishstocks, HPB 4 and HPB 5 (Figure 4). The yields (subsequently TACs) for these two Fishstocks were estimated in the mid 1980s from trawl survey biomass values; this procedure was declared obsolete in 1993 (Annala 1993), but no further data have become available to revise these values. Although they may still be reasonably correct, it has always been recognised that they were based on dispersed populations which may never be economic to exploit fully. TACs for the mainland Fishstocks were based more directly on regional catch histories.

4.3.3 Landings by method

Before 1950 over 90% of the recorded groper landings were taken by longline. From 1950 until the late 1960s this declined to about 70% (Figure 6), in parallel with a slow and fluctuating decline in total landings (see Figure 3); these declines appear to have resulted from a contraction of the large Wellington-based fishery centred on Cook Strait (see Figure 5). They rose rapidly in the late 1970s to about 1700 t in the early 1980s, dropped even more rapidly in the mid 1980s when the QMS was established, but recovered steadily through the early 1990s. Landings by trawlers rose quickly in the late 1940s to 200–350 t (20–30% of the total) in the 1950s and 1960s, fluctuated erratically downwards in the 1970s and 1980s (although there was almost certainly under-reporting by the deepwater trawlers in the 1970s), and then increased again in the 1990s. Landings by setnet were negligible until the late 1970s, rose quickly to peak at over 400 t in 1984, dropped sharply when the QMS was established, and recovered to around 200 t during the 1990s.

The peak in setnet landings in the early 1980s came from a sudden increase in the use of this method for several inshore species, particularly at Kaikoura. The rise in longline landings at the same time came mainly from increased fishing activity on new fishing grounds around northern New Zealand. The increase in reported landings by all methods at this time may also have resulted from the incentive for fishers to establish a good catch history for groper before the introduction of ITQs within the QMS.

4.3.4 Catch by target species

This section deals with catch, not landing. In the main fisheries which target groper (most dropline fisheries, some longline fisheries, one setnet fishery) some catch is also taken when bluenose, ling, and school shark are targeted. There is a moderate bycatch of groper in the northern longline fishery for snapper. In the Kaikoura setnet fishery, groper is targeted and also a bycatch in the ling and tarakihi target fisheries.

Groper is a bycatch in almost all trawl fisheries.

Details are more appropriately given in the separate accounts of regional fisheries.

4.3.5 Landings by season

The analysis of landings by season is appropriate only for those fisheries where a significant proportion of the catch is targeted. In these, the seasonal pattern varies by region and method (Figure 7).

In two northern (northeast and eastern North Island) bottom longline fisheries, landings trend slowly up from January to a peak in September, then decline. In the Cook Strait fishery the seasonal pattern is almost the reverse, landings drop to a low between June and October.

A northern (eastern North Island) dropline fishery has a similar pattern to the two northern longline fisheries, peaking in September. In the Cook Strait dropline fishery landings rise from November to May, drop to a minimum in August, and rise again in September and October. The smaller Southland dropline fishery has a similar pattern to Cook Strait, but landings rise slightly a little later.

The groper catch in the only significant setnet fishery, off Kaikoura, peaks in June. The targeted groper proportion (60% of the catch) peaks in this month, with the bycatch in the ling fishery peaking in July, and the bycatch in the tarakihi fishery, probably located in slightly shallower water, peaking in May.

The September peak in some fisheries may result from fishers who have held on to quota to cover bycatch using it (and targeting groper) at the end of the fishing year. However, this pattern is not consistent between regions.

5. REGIONAL FISHERIES

The following accounts of regional fisheries are based on the catches and landings by vessels which recorded a landing of 1 t or more in a year. (The vessels which landed less than 1 t in a year took less than 3% of total landings).

The regional accounts follow the sequence: catch history (historical landings); catch (estimated) by statistical area; landings by fishing method; catch (estimated) by target species; catch (estimated) by season for certain target fisheries. The estimated catch values will sum to less than the landings values.

5.1 Northeastern North Island (QMA 1)

The northeastern North Island region represents the eastern half of HPB 1, and the standard QMA 1.

Catch history

Landings were 200 t or less through until 1970 (Figure 5), increased briefly in the early 1970s, and then steeply in the late 70s and early 80s to peak at over 1000 t in 1984. They dropped very sharply just before the introduction of the QMS in 1986. In the 1990s they averaged about 350 t.

Catch by statistical area

The size and distribution of estimated catches in this region (Table 11) is likely to be unreliable because of incorrect recording of QMAs 1–10 as statistical areas 1–10. For example, the high catches in statistical area 1 are unrealistic, and probably include catches for all areas in QMA 1.

Table 11: Estimated catches (t) in the northeastern North Island region by statistical area, fishing years 1989–90 to 1998–99.

Statistical area	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	48	80	19	29	30	50	74	53	57	70
2	90	64	74	100	95		73	63	48	63
3	25	23	24	39	34	39	31	57	74	75
4	2	9	36	29	12	10	16	24	19	13
5	3	3	6	7	15	11	6	9	7	6
8	10	26	23	38	24	23	26	17	15	20
9	13	24	42	8	11	11	10	10	6	5
10	14	40	31	34	30	28	22	40	23	26

Note: Areas 6, 7, with a mean annual catch of 1 t or less, are omitted.

The main areas were 1–3 (more probably 2 and 3), off the east Northland coast. Moderate catches were made in 8 and 10, off the western and eastern Bay of Plenty.

Landings by method

Although landings by method are not directly reported, an approximation can be obtained by identifying the main method used by each vessel, and then allocating the landings by vessel to method (Table 12). Errors will inevitably be introduced where vessels have used more than one method in a year.

Table 12: Landings (t) by method in the northeastern North Island region, fishing years 1989–90 to 1998–99; approximate values (see text).

Method	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Dropline	163	148	150	145	137	154	160	180	163	186
Longline	53	168	173	192	159	175	165	185	168	192
Setnet	1	5	6	7	6	5	6	5	3	3
Trawl	10	18	11	3	7	6	3	11	11	21
Total	228	339	340	347	309	339	334	382	344	402

Groper in this region were taken almost entirely, and about equally, by dropline and bottom longline. The dropline fishery was centred on areas 1 and 2, which include deep banks off the northeastern coast. The bottom longline fishery was spread between areas 2 and 3 (east Northland) and 8 and 10 (Bay of Plenty).

Catch by target species

Catch by target species can be summarised for the two main fisheries, bottom longline (Table 13) and dropline (Table 14).

Table 13: Estimated catches (t) of groper, by target species in the bottom longline fishery, northeastern North Island region, fishing years 1989–90 to 1998–99.

Target species	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Groper	2	52	53	100	65	62	94	81	84	73
Bluenose	25	48	42	19	30	43	25	36	37	44
Snapper	22	31	37	36	43	37	24	21	24	29
Ling	0	0	4	4	3	4	4	6	8	7
School shark	0	1	1	1	0	1	2	1	0	2

Groper were the main target species, comprising 39–63% (mean 50%) of the annual catch. If the snapper fishery is excluded (it is an inshore fishery where groper are only an incidental – though valuable – bycatch), the groper target fishery took 51–81% (mean 63%) of the annual catch. The mean annual targeted catch was 67 t, and the mean annual catch 137 t.

Table 14: Estimated catches (t) of groper, by target species in the dropline fishery, northeastern North Island region, fishing years 1989–90 to 1998–99.

Target species	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Groper	134	116	97	109	89	78	81	96	94	106
Bluenose	11	7	0	0	4	5	6	2	6	3

Groper were the main target species in this fishery, with minor catches taken when bluenose was targeted. The mean annual targeted catch was 100 t, and the mean annual catch 104 t.

Catch by season

In the bottom longline fishery, targeting groper, bluenose, ling and school shark, the annual catch (estimated) during the 1990s has averaged 107 t. There is a late winter peak. From mean values, monthly catches rise from 6 t in Dec-Jan to 10 t in July, to 13 and 19 t in August and September, and then drop to 8 t in Oct-Nov. In the dropline fishery, targeting groper and bluenose, the annual catch (estimated) during the 1990s averaged 106 t. As in the longline fishery, there is a late winter peak. From mean values, monthly catches rise from 5 t in Jan-Feb to 9 t in July, to 13 and 19 t in August and

September, and then drop to 8 t in October. However, these catches are too small to provide a clear picture.

5.2 Eastern North Island (most QMA 2)

The eastern North Island region represents HPB 2, and the standard QMA 2 less eastern Cook Strait (statistical areas 15, 16).

Catch history

Landings briefly reached 200–300 t in the late 1930s, but remained at 100 t or less until 1960 (see Figure 5). There was a steady rise during the 1960s to 460 t in 1970, followed by fluctuations between 100 t and 300 t in the 1980s and 1990s. The 1986 QMS introduction appears to have reduced landings, but the values in the late 1980s are uncertain.

Catch by statistical area

Estimated catches by statistical area are listed in Table 15.

Table 15: Estimated catches (t) in the eastern North Island region by statistical area, fishing years 1989–90 to 1998–99.

Statistical area	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
11	4	10	9	12	14	8	8	5	9	10
12	3	15	14	19	21	19	25	21	17	17
13	20	47	63	65	66	67	58	52	69	61
14	40	45	44	47	47	29	23	30	39	25

Note: Areas 201, 204, with a mean annual catch of 1 t or less, are omitted.

The main area was 13 (Gisborne/Hawke Bay)

Landings by method

Although landings by method are not directly reported, an approximation can be obtained by identifying the main method used by each vessel, and then allocating the landings by vessel to method (Table 16). Errors will inevitably be introduced where vessels have used more than one method in a year.

Table 16: Landings (t) by method in the eastern North Island region, fishing years 1989–90 to 1998–99; approximate values (see text).

Method	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Dropline	1	1	25	45	37	23	24	30	35	12
Longline	23	32	65	89	131	53	106	37	83	46
Setnet	21	23	12	9	4	3	12	21	18	8
Trawl	41	66	74	78	84	85	67	75	92	89
Total	86	123	177	220	256	163	209	163	227	155

The largest and most consistent component of groper landings was taken by trawl, inevitably a bycatch. Bottom longlining was the next most important method, but with considerable annual variation. Droplining and setnetting are relatively unimportant. The longline fishery was centred on area 13, but with moderate catches in the adjacent areas north and south. The small dropline fishery was essentially restricted to area 13.

Catch by target species

Catch by target species can be summarised for the two main fisheries, bottom longline (Table 17) and dropline (Table 18).

Table 17: Estimated catches (t) of groper, by target species in the bottom longline fishery, eastern North Island region, fishing years 1989–90 to 1998–99.

Target species	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Groper	8	12	10	20	32	24	21	16	16	15
Bluenose	3	27	37	24	29	16	12	9	14	13
Ling	11	7	14	26	22	20	16	14	25	16

Note: In a few years small quantities were taken with snapper and school shark listed as target species.

In this fishery, on average, one-third of the groper catch was targeted, and two-thirds taken when bluenose or ling were targeted. The mean annual targeted catch was 17 t, and the mean annual catch 53 t.

Table 18: Estimated catches (t) of groper, by target species in the dropline fishery, eastern North Island region, fishing years 1989–90 to 1998–99.

Target species	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Groper	1	3	14	7	3	18	24	17	16	14
Ling	1	3	0	0	3	0	0	0	0	0

Groper were the main target species in this small fishery, with minor catches taken when ling was targeted. The mean annual targeted (and total) catch was 12 t.

Catch by season

In the bottom longline fishery, targeting groper, bluenose, and ling, the annual catch (estimated) during the 1990s has averaged 54 t. There is a late winter peak. From mean values, monthly catches are 2–4 t from December to July, rise to 6 and 11 t in August and September, then decline again.

The dropline fishery is too small (mean annual estimated catch 13 t) to show any pattern.

5.3 Cook Strait (part QMAs 2, 3, 7, 8)

The Cook Strait region represents the southernmost portions of HPB 2 (statistical areas 15, 16), and SCH 8 (statistical areas 37, 39), plus the northernmost portions of HPB 3 (statistical areas 18, 19) and HPB 7 (statistical areas 17, 37, 38).

Catch history

Landings rose during the 1930s and 1940s (with a dip in the war years) to peak at almost 1000 t in 1949 (see Figure 5). They declined to about 500 t in 1960, remaining at 500–600 t through until the mid 1980s, apart from a drop to 250–350 t in the mid 1970s. The QMS appears to have reduced landings back to less than 300 t (the late 1980s data are uncertain), but during the 1990s landings rose again to over 400 t.

Catch by statistical area

Estimated catches by statistical area are listed in Table 19.

Table 19: Estimated catches (t) in the Cook Strait region by statistical area, fishing years 1989–90 to 1998–99.

Statistical area	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
15	6	13	12	14	26	34	16	10	14	14
16	25	38	43	55	51	46	38	37	37	58
17	63	69	81	53	62	61	58	48	49	58
18	100	137	112	127	116	119	120	133	133	151
19	1	2	1	0	1	41	33	15	11	24
37	1	1	1	0	0	2	7	5	1	3
38	2	2	3	12	5	3	6	3	3	3
39	28	31	26	29	33	26	32	33	25	38

Note: A mean annual catch of more than 1 t was made in all areas.

Largest catches were made in area 18, which represents the Kaikoura fishery. Moderate and equally consistent catches were made in the two central Cook Strait areas, 16 and 17, with smaller catches in northern Cook Strait, area 39.

Landings by method

Although landings by method are not directly reported, an approximation can be obtained by identifying the main method used by each vessel, and then allocating the landings by vessel to method (Table 20). Errors will inevitably be introduced where vessels have used more than one method in a year.

Table 20: Landings (t) by method in Cook Strait, fishing years 1989–90 to 1998–99; approximate values (see text).

Method	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Dropline	113	141	149	108	142	124	141	115	126	155
Longline	34	49	32	97	36	139	130	73	61	116
Setnet	117	131	114	117	124	117	121	125	187	122
Trawl	11	16	23	18	21	39	46	83	44	54
Total	274	336	317	340	322	419	438	396	418	446

The largest and most consistent component of groper landings was taken by dropline. The catch by setnet was also moderately large and consistent. Bottom longlining has been moderately important over the decade, but more variable. The trawl bycatch increased from 1995 onwards.

The dropline catch was taken from the three central Cook Strait areas, 16, 17, and 39. The bottom longline catch was taken from areas 17, 18, and 19. The setnet catch was taken almost exclusively from area 18, Kaikoura.

Catch by target species

Catch by target species can be summarised for the three main fisheries: bottom longline (Table 21), dropline (Table 22), and setnet (Table 23).

Table 21: Estimated catches (t) of groper, by target species in the bottom longline fishery, Cook Strait region, fishing years 1989–90 to 1998–99.

Target species	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Groper	17	23	15	35	23	51	36	25	29	49
School shark	13	18	19	16	14	29	29	12	8	11
Ling	1	2	7	9	12	17	12	7	5	13
Bluenose	1	0	2	0	1	8	19	15	1	12

Groper were the main target species, targeted groper making up 35–67% (mean 50%) of the annual catch. The mean annual targeted catch was 30 t, and the mean annual catch was 62 t.

Table 22: Estimated catches (t) of groper, by target species in the dropline fishery, Cook Strait region, fishing years 1989–90 to 1998–99.

Target species	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Groper	82	107	112	96	111	77	79	80	73	109
Ling	0	6	3	5	8	3	2	0	2	4
Bluenose	0	0	1	1	2	3	2	6	9	2

Groper were the main target species in this fishery, with minor catches taken when ling and bluenose were targeted. The mean annual targeted catch was 93 t, and the mean annual catch was 99 t.

Table 23: Estimated catches (t) of groper, by target species in the setnet fishery, Cook Strait region, fishing years 1989–90 to 1998–99.

Target species	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Groper	58	64	59	56	62	59	49	60	58	74
Ling	25	25	26	30	24	19	28	23	31	21
Tarakihi	11	15	13	13	9	10	11	23	23	11
Bluenose	0	0	0	0	0	10	8	8	2	2
School shark	0	0	0	0	2	1	0	1	0	0

Groper were the main target species, targeted groper comprising 50–69% (mean 59%) of the annual catch. The remainder was mainly taken when ling or tarakihi were targeted. The mean annual targeted catch was 60 t, and the mean annual catch was 102 t.

Catch by season

In the bottom longline fishery, targeting groper, school shark, ling and bluenose, the annual catch (estimated) during the 1990s has averaged 62 t. There was not a strong seasonal pattern, but from mean values the monthly catches from December to May were higher (6–9 t) than from June to November (2–4 t).

In the dropline fishery, targeting groper, ling, and bluenose, the annual catch (estimated) during the 1990s averaged 101 t. The seasonal pattern was reasonably similar to that in the longline fishery, with a winter minimum. Catches rose slowly from November-December to peak (13 t mean) in May, declined to a minimum (3 t mean) in August, and recovered in September and October.

In the setnet fishery (area 18, Kaikoura), targeting groper, ling, tarakihi, and bluenose, the annual catch (estimated) during the 1990s averaged 92 t. There was a strong seasonal pattern. Catches peaked in May-July, with minimal catches in all other months.

5.4 Eastern South Island (most QMA 3)

The eastern South Island region represents HPB 3, and the standard QMA 3, less southern Cook Strait and Kaikoura (statistical areas 17–19).

Catch history

Landings rose from 100–200 t in the early 1930s to almost 600 t in 1950, but with a large drop during the war years (see Figure 5). There was then a steady decline to about 200 t in 1970. During the 1970s, 1980s, and 1990s landings have fluctuated between 100 t and 300 t, with the QMS introduction in 1986 apparently having little effect.

Catch by statistical area

Estimated catches by statistical area are listed in Table 24.

Table 24: Estimated catches (t) in the eastern South Island region by statistical area, fishing years 1989–90 to 1998–99.

Statistical area	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
20	12	16	19	34	48	47	59	30	32	38
21	2	16	17	7	16	17	17	6	8	5
22	44	40	57	54	30	28	43	45	53	42
23	0	3	2	4	14	8	0	0	0	0
24	26	21	21	17	32	28	8	10	19	29
26	7	3	6	6	8	5	8	6	15	5

Note: A mean annual catch of more than 1 t was made in all areas.

Largest catches were made in areas 20 and 22, the north and south Canterbury Bights, with moderate catches in area 24, north of Dunedin.

Landings by method

Although landings by method are not directly reported, an approximation can be obtained by identifying the main method used by each vessel, and then allocating the landings by vessel to method (Table 25). Errors will inevitably be introduced where vessels have used more than one method in a year.

Table 25: Landings (t) by method off the eastern South Island, fishing years 1989–90 to 1998–99; approximate values (see text).

Method	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Dropline	30	27	18	16	32	36	23	24	33	33
Longline	2	22	1	3	34	1	27	0	7	4
Setnet	12	12	18	13	26	34	17	15	21	16
Trawl	99	122	129	127	120	87	106	134	142	169
Total	143	183	165	159	212	157	172	174	203	223

The largest and most consistent component of groper landings were taken by trawl, inevitably a bycatch. There was a small and moderately consistent dropline fishery, mainly in areas 22 and 24.

Catch by target species

Catch by target species can be summarised for the main fishery in which groper were targeted, the dropline fishery (Table 26).

Table 26: Estimated catches (t) of groper, by target species in the dropline fishery, eastern South Island region, fishing years 1989–90 to 1998–99.

Target species	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Groper	26	19	20	15	29	31	12	10	18	20
Ling	0	4	0	0	0	0	0	0	0	0
Bluenose	1	0	1	0	0	0	0	0	0	0

Groper were the main target species in this small fishery, with minor catches taken when ling or bluenose were targeted. The mean annual targeted catch was 20 t, and the mean annual catch 21 t.

Catch by season

In the small dropline fishery, targeting mainly groper, the annual catch (estimated) during the 1990s averaged only 26 t. There was little seasonal pattern, but mean catches were a little higher from February to June (3–5 t) than the rest of the year (1 t).

5.5 Chatham Rise (QMA 4)

The Chatham Rise represents HPB 4, (statistical areas 49–52, 401–412).

Catch history

It is difficult to reconstruct the catch history for this region. Some landings were recorded from the Chatham Islands (or area) but are likely to be incomplete (unreported local sales). There has been at least periodic targeted fishing at Mernoo Bank, but the catches are landed at Napier, Wellington, Lyttelton, and Port Chalmers (and have been unavoidably recorded in the totals for these regions). There are some equally unreliable values for the 1970s and 1980s; groper were inevitably caught by the large foreign or chartered trawlers fishing on the Chatham Rise, but only minimal values are reported.

Catches during the 1990s (data from the present analyses) rose from 20–30 t to 100–150 t.

Catch by statistical area

Estimated catches by statistical area are listed in Table 27.

Table 27: Estimated catches (t) on the Chatham Rise by statistical area, fishing years 1989–90 to 1998–99.

Statistical area	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
49	4	1	10	3	22	39	64	27	6	21
50	3	4	7	20	20	4	10	18	19	22
51	4	16	2	6	10	7	7	20	21	26
52	7	2	4	1	3	4	8	17	11	11
401	2	10	14	6	21	7	25	9	4	9

Note: Areas 402–410, with a mean annual catch of 1 t or less, are omitted.

The three main areas, 49–51, are north and east of the Chatham Islands. Moderate catches are also taken in area 401, the northeastern Mernoo Bank.

Landings by method

Although landings by method are not directly reported, an approximation can be obtained by identifying the main method used by each vessel, and then allocating the landings by vessel to method (Table 28). Errors will inevitably be introduced where vessels have used more than one method in a year.

Table 28: Landings (t) by method on the Chatham Rise, fishing years 1989–90 to 1998–99; approximate values (see text).

Method	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Dropline	16	17	1	25	7	77	26	1	1	0
Longline	1	0	35	55	73	19	117	96	58	87
Setnet	0	0	0	0	0	0	0	0	0	0
Trawl	2	13	15	12	5	11	6	11	19	25
Total	19	31	51	92	84	107	149	108	78	112

Reported groper landings from this region have been relatively small. The main component has been from bottom longline after 1992, from the three areas northeast of the Chatham Islands.

Catch by target species

Catch by target species can be summarised for the main fishery, bottom longlining (Table 29).

Table 29: Estimated catches (t) of groper, by target species in the bottom longline fishery, Chatham Rise, fishing years 1989–90 to 1998–99.

Target species	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Groper	0	3	1	12	26	14	5	28	13	30
Ling	1	5	11	6	18	2	50	42	31	36
School shark	0	0	0	0	0	0	11	5	3	1
Bluenose	0	5	0	0	0	0	0	0	3	1

Groper were more often taken as a bycatch in the targeted ling fishery, particularly from 1995–96 onwards. The mean annual targeted catch of groper was 13 t, and the mean annual catch was 36 t.

Catch by season

In the bottom longline fishery, targeting groper and ling, the annual catch (estimated) during the 1990s has averaged only 36 t but has been higher since 1995–96. There was no seasonal pattern to catches.

5.6 Southland (QMA 5)

The Southland region represents Fishstock HPB 5, and the standard QMA 5.

Catch history

Landings have been relatively small, less than 150 t (see Figure 5). From 1950 to 1975 there was a steady decline which is very similar to that for the east coast of the South, followed by a much more irregular increase to 1995 and then a slight fall. The QMS introduction in 1986 had little apparent effect.

Catch by statistical area

Estimated catches by statistical area are listed in Table 30.

Table 30: Estimated catches (t) in the Southland region by statistical area, fishing years 1989–90 to 1998–99.

Statistical area	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
25	26	22	14	21	29	42	6	52	20	34
27	8	5	2	2	2	8	3	2	1	1
28	12	9	6	14	8	19	2	7	6	4
29	9	3	6	8	1	2	1	4	3	4
30	12	29	25	37	51	35	25	21	14	20
31	5	8	7	11	12	14	11	13	4	2
32	6	5	11	4	8	11	13	28	7	12

Note: Areas 504, 602, with a mean annual catch of 1 t or less, are omitted.

The two main and most consistent areas were 25 and 30, off the southern Southland coast. Less consistent catches were taken in areas 28 (Snares Islands), and 31 and 32 (Fiordland).

Landings by method

Although landings by method are not directly reported, an approximation can be obtained by identifying the main method used by each vessel, and then allocating the landings by vessel to method (Table 31). Errors will inevitably be introduced where vessels have used more than one method in a year.

Table 31: Landings (t) by method from the southern Island, fishing years 1989–90 to 1998–99; approximate values (see text).

Method	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Dropline	36	46	44	22	60	64	66	49	24	29
Longline	7	10	23	23	14	16	12	24	2	16
Setnet	1	2	1	6	3	6	2	15	5	6
Trawl	74	34	60	70	46	50	20	22	26	58
Total	118	91	129	121	123	135	99	111	56	109

The largest but quite variable component of groper landings is taken by trawl, inevitably a bycatch. Droplining was the next most important method, but catches are not large and are also variable; most of these catches have come from area 25, sometimes also from area 30.

Catch by target species

Catch by target species can be summarised for the main fishery, droplining (Table 32).

Table 32: Estimated catches (t) of groper, by target species in the dropline fishery, Southland region, fishing years 1989–90 to 1998–99.

Target species	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Groper	19	37	17	18	61	67	73	57	25	38
Bluenose	0	0	0	0	1	2	1	0	0	1
School shark	0	1	1	0	0	0	0	0	0	0

Groper were the main target species in this small fishery, with minor catches taken when bluenose and school shark were targeted. The mean annual targeted catch was 41 t, and the mean annual catch was 42 t.

Catch by season

In the dropline fishery, targeting groper and bluenose, the annual catch (estimated) during the 1990s has averaged 37 t. There was some seasonal pattern; in common with the eastern South Island mean catches were a little higher from February to June (3–6 t) than the rest of the year (1–2 t).

5.7 Western South Island (most QMA 7)

The western South Island region represents HPB 7, and the standard QMA 7, less Tasman Bay and southwestern Cook Strait (statistical areas 38, 17).

Catch history

There were small landings of 50 t or less before 1950, and then from 1953 to 1973 almost zero landings (see Figure 5). In the late 1970s and early 1980s landings fluctuated between 50 t and over 200 t, appeared to drop to 50 t or less when the QMS was introduced in 1986, and have subsequently varied between 50 t and 150 t.

Catch by statistical area

Estimated catches by statistical area are listed in Table 33.

Table 33: Estimated catches (t) in the western South Island region by statistical area, fishing years 1989–90 to 1998–99.

Statistical area	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
33	10	12	14	18	17	12	15	12	7	10
34	6	12	19	20	11	14	14	14	10	13
35	4	3	3	10	16	20	13	8	1	3
36	5	8	12	16	24	18	33	32	16	30

Note: A mean annual catch of more than 1 t was made in all areas.

Moderate catches were taken in all areas in different years; the largest in area 36 (Cape Farewell), the most consistent in area 33 (southern Westland).

Landings by method

Although landings by method are not directly reported, an approximation can be obtained by identifying the main method used by each vessel, and then allocating the landings by vessel to method (Table 34). Errors will inevitably be introduced where vessels have used more than one method in a year.

Table 34: Landings (t) by method off the western South Island, fishing years 1989–90 to 1998–99; approximate values (see text).

Method	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Dropline	2	6	18	3	3	68	40	2	1	4
Longline	17	22	42	51	51	73	80	78	42	40
Setnet	7	6	2	0	3	1	12	14	0	1
Trawl	4	18	12	29	8	30	20	14	10	20
Total	27	52	74	83	66	172	151	107	52	65

The largest component of groper landings was taken by bottom longline, with moderately consistent catches from 1992 onwards. This fishery extended along central and southern Westland (areas 33 and 34), with catches also taken near Cape Farewell (area 36). Landings by other methods are small and/or variable.

Catch by target species

Catch by target species can be summarised for the main fishery, bottom longlining (Table 35).

Table 35: Estimated catches (t) of groper, by target species in the bottom longline fishery, western South Island region, fishing years 1989–90 to 1998–99.

Target species	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Groper	2	1	9	14	19	19	16	15	11	13
Ling	6	9	16	24	20	16	23	19	10	11
Bluenose	0	2	3	6	1	6	11	9	5	18
School shark	0	0	3	3	6	1	5	4	3	2

In this fishery, on average, less than one-third of the groper catch was targeted; most was taken as a bycatch when ling and bluenose were targeted. Targeted groper made up 8–45% (mean 31%) of the annual catch. The mean annual targeted catch of groper was 12 t, and the mean annual catch was 36 t.

Catch by season

In the bottom longline fishery, targeting groper, bluenose, ling and school shark, the annual catch (estimated) during the 1990s averaged 36 t. Although there was a slight trend for catches to be higher in September-October, there was really no seasonal pattern.

5.8 Egmont (most QMA 8)

The (Cape) Egmont region represents HPB 8, and QMA 8, less northern Cook Strait (parts of statistical areas 37 and 39).

Catch history

Landings have been less than 50 t since the 1930s, apart from two years in the early 1980s when the landing, possibly from one or two vessels based in New Plymouth, reached 90 t and then 180 t (Figure 5).

Catch by statistical area

Estimated catches by statistical area are listed in Table 36.

Table 36: Estimated catches (t) in the Cape Egmont region by statistical area, fishing years 1989–90 to 1998–99.

Statistical area	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
40	5	1	3	14	12	6	13	14	11	11
41	0	0	4	15	12	26	19	15	15	13

Note: Area 801, with a mean annual catch of 1 t or less, is omitted.

Catches have been fairly evenly split between the two areas.

Landings by method

Although landings by method are not directly reported, an approximation can be obtained by identifying the main method used by each vessel, and then allocating the landings by vessel to method (Table 37). Errors will inevitably be introduced where vessels have used more than one method in a year.

Table 37: Landings (t) by method in the Cape Egmont Region, fishing years 1989–90 to 1998–99; approximate values (see text).

Method	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Dropline	3	0	0	0	0	0	0	0	4	0
Longline	0	0	2	14	33	2	29	22	23	35
Setnet	0	0	0	2	3	0	1	1	1	0
Trawl	0	0	0	4	0	0	0	0	0	0
Total	3	0	2	19	35	2	29	23	27	35

Most groper landings in this region came from bottom longline catches, but values were small and variable.

Catch by target species

There was only occasional targeted fishing for groper in this region, with very small catches.

Catch by season

The bottom longline fishery caught only small quantities of groper in the late 1990s, and only some of these were targeted. There are too few data from which to derive a seasonal pattern.

5.9 North-western North Island (QMA 9)

The west Auckland/Northland region represents the western half of HPB 1, but the standard QMA 9, less Manukau and Kaipara harbours (statistical areas 43 and 44).

Catch history

Reported landings from this region were minimal until the mid 1970s, and have since risen, with large annual variations, to about 50 t (see Figure 5). It is unclear whether introduction of the QMS had any impact.

Catch by statistical area

Estimated catches by statistical area are listed in Table 38.

Table 38: Estimated catches (t) in the northwestern North Island region by statistical area, fishing years 1989–90 to 1998–99.

Statistical area	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
46	2	6	1	3	8	4	3	5	9	7
47	14	9	6	29	35	31	23	28	38	27
48	5	2	1	4	1	10	10	1	4	5

Note: Areas 42, 45, with a mean annual catch of 1 t or less, are omitted.

The main catch was taken from area 47, probably from the deep banks well offshore from Ninety Mile Beach, which are worked by vessels from ports on both the northwest and northeast coast.

Landings by method

Although landings by method are not directly reported, an approximation can be obtained by identifying the main method used by each vessel, and then allocating the landings by vessel to method (Table 39). Errors will inevitably be introduced where vessels have used more than one method in a year.

Table 39: Landings (t) by method off the northwestern North Island, fishing years 1989–90 to 1998–99; approximate values (see text).

Method	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Dropline	27	28	2	19	13	15	3	11	13	6
Longline	0	0	11	4	26	30	17	31	27	32
Setnet	0	0	0	0	0	0	0	0	0	3
Trawl	1	1	2	8	14	8	2	7	17	1
Total	28	29	14	31	53	53	22	49	56	41

Landings by the main methods in this region (bottom longline and dropline) were small and rather variable. They were almost entirely taken from area 47.

Catch by target species

Catch by target species can be summarised for the two main fisheries, bottom longline (Table 40) and dropline (Table 41).

Table 40: Estimated catches (t) of groper, by target species in the bottom longline fishery, northwestern North Island region, fishing years 1989–90 to 1998–99.

Target species	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Groper	0	0	1	6	5	13	17	15	25	20
Bluenose	0	0	0	0	0	5	5	3	5	4
School shark	0	0	0	0	0	1	2	0	2	1

Groper were the main target species in this very small fishery. The mean annual targeted catch was 10 t, and the mean annual catch was 13 t.

Table 41: Estimated catches (t) of groper, by target species in the dropline fishery, northwestern North Island region, fishing years 1989–90 to 1998–99.

Target species	Fishing year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Groper	16	14	4	6	20	14	8	10	9	7

Groper were the only target species in this very small fishery, with a mean annual catch of 11 t.

Catch by season

In the bottom longline fishery, targeting groper and bluenose, catches have only exceeded 15 t in a few recent years, and there is no seasonal pattern. In the dropline fishery, targeting groper only, catches have been small and variable with no seasonal pattern.

6. SUMMARY OF THE MAIN GROPER FISHERIES

The identifiable target fisheries for groper are summarised by region and method in Table 42. The size of each fishery is given by its targeted catch, and its catch with the other most closely associated target species (bluenose, ling, and school shark). Values are mean annual estimated catches for the decade 1989–90 to 1998–99, in tonnes; for a couple of fisheries which did not exist through the whole decade they are necessarily for a slightly shorter time period.

Table 42: The main target fisheries for groper (species combined) during the 1990s, by region and method. Values are mean annual estimated catches (t) for targeted groper, and for all groper caught with closely associated target species in each fishery.

Region	Bottom longline		Dropline		Setnet	
	Targeted	Total	Targeted	Total	Targeted	Total
Northeast North I.	67	137	100	104	0	0
Eastern North I.	17	52	12	12	0	0
Cook Strait	30	62	93	99	60	102
Eastern South I.	0	0	20	21	0	0
Chatham Rise	13	36	0	0	0	0
Southland	0	0	41	42	0	0
Western South I.	12	36	0	0	0	0
Northwest North I.	10	13	11	11	0	0

One of the purposes of this descriptive account of the groper fishery was to identify and define suitable unit fisheries for which CPUE indices could be derived from their more detailed catch and effort data. Some fisheries are almost certainly too small for development of reliable CPUE series. Regardless of size, however, the most critical issue is consistency within each fishery. There needs to be reasonable consistency of participating vessels, localities fished within an area, season fished, and consistency in the variety of decisions made by fishers when choosing to target groper or one of the associated species in each regional fishery. In small fisheries where quotas are a limiting factor, this will almost certainly include the level of quota(s) held or available as the fishing year progresses. There must also be consistency in the way estimated catches are recorded each year, i.e., as greenweight (total weight) or as processed weight (a partial weight).

On size alone (mean annual catch of at least 40 t) there are only six fisheries for which CPUE indices could be derived. Off the northeast North Island coast there is a bottom longline and a dropline fishery. (Vessels fishing in at least the latter move around to fish off the northwest North Island, but the geographic distance and the extent of northwest coast grounds make the combination of these two regions unreasonable.) In Cook Strait there are bottom longline, dropline, and (around Kaikoura) setnet fisheries. Off Southland there is a dropline fishery.

7. DISCUSSION

This account of the groper fishery is based partly on reported landings for the decade 1989–90, and partly on estimated catch values. There are difficulties and approximations with both data sets.

Landings have been allocated to region (usually a modified QMA) and fishing method according to an interpretation of the main region, and the main method, linked to each vessel for an entire year. It is difficult to do otherwise, but this procedure will introduce errors where vessels fished several regions, or used several methods.

Estimated catches are often recorded as processed weight, not greenweight. This can be recognised in aggregated data, but it is difficult to determine in individual records, where estimated catches and recorded landings can vary for a number of valid reasons. If fishers have "corrected" their recording procedure over time, there will be a bias towards higher catch values.

Estimated catches were 70–80% of landings during the 1990s. This proportion varies by method and by region (1997–98 data only). It is highest for bottom longlining (84%) and setnetting (71%), and lowest for trawling (54%) where as a bycatch it is often not among the top five species in a catch. In the most important target fishery, droplining, however, the estimated catch is also a rather low (64%) percentage of landings; this is suspected to result from relatively more of these fishers, who normally process (head and gut) their catch at sea, recording their catch as the processed weight. The proportion is generally higher in regions where there are target fisheries, although lower where the main target fishery is droplining and more of the catch is recorded as (lower) processed weight.

Landings values differ, however, from QMR values. They were usually lower (86–109%) than QMR values in the early 1990s, higher (105–112%) in the late 1990s, for unknown reasons. Consequently, the true "catch" or "landing" of groper is uncertain.

The full characterisation of the fishery for the 1997–98 fishing year allowed a full description of the fishery for this one year in terms of total catch (= landing) by region, method, and target species. Small bycatches, as well as large targeted catches, could be analysed. It had two other outcomes. (1) It provided a subjective assessment of data quality; a considerable variety and number of errors could be seen that were not apparent in subtotals or totals. (2) There may be some practical value in identifying those fisheries, and hence those groups of vessels, where groper are caught in small and irregular quantities. These fisheries are likely to be among those where quota matching problems may occur, although this study did not address this particular issue.

About half the groper catch (from estimated catch values) is targeted. Nevertheless, most vessels in the "groper fishery" make small catches and landings. Few land more than 10 t in a year. This is likely to make it difficult to select a suitable set of vessels (i.e., which have fished in a consistent manner), even in the larger target fisheries, from which to develop CPUE indices. At least two options need to be considered: any vessel landing over a threshold value (perhaps about 10 t) in a year, or only those vessels which have landed above this threshold during a reasonable proportion (perhaps 75%) of the years being considered.

This study essentially described the "groper" fishery. In the QMS database bass and hapuku are combined in the code HPB. In the catch-effort database they are required to be separated under the codes BAS (bass) and HAP (hapuku). In reality, most catches and landings are recorded as HPB. During the 1990s, about one-quarter of the catch was recorded as either BAS or HAP. On closer inspection, however, many of the vessels which (correctly) used a species code also (incorrectly) used the combined code. When these vessels are removed, only 11% or less of the catch is coded to species, and some doubt must remain over whether the code HAP was sometimes used to cover a small catch of bass. The data suggest that one-quarter of the groper catch may be bass. It is not possible to analyse fisheries for the two groper species separately.

The regions used to define groper fisheries are based on groper Fishstock boundaries, but differ significantly in central New Zealand, where the Fishstock boundaries subdividing the important Cook Strait fishery make no sense for stock assessment purposes. The regions thus become: northeast North Island, eastern North Island, Cook Strait, eastern South Island, Chatham Rise (QMA 4), Southland (QMA 5), western South Island, Cape Egmont (QMA 8), and northwest North Island. The Cape Egmont region was retained because it represented a potentially useful QMA, but subsequent analysis of geographic fishing patterns casts some doubt on this. The southern half (area 40) was worked by vessels usually working Cook Strait, and the northern half (area 41) by vessels usually working the northwest North Island. The other regions did prove to be reasonably discrete; the detailed analysis of 1997–98 data showed that few vessels worked outside their "main region". It would have been possible to quantify this, but difficult to make a sensible interpretation. Relatively more trawlers worked in more than one region, but their catch was bycatch. For other vessels, including those targeting groper (or the associated group of species: bluenose, ling, school shark), it would have been

difficult to determine whether their movements were random, seasonal, or permanent (e.g., sale of vessel, or relocation to another port).

Six main target fisheries were identified. The seasonal pattern of catches in these target fisheries differed considerably. Northern line fisheries peaked in late winter to early spring, Cook Strait and southern line fisheries in summer and autumn. The Cook Strait setnet fishery peaks in winter. Although this could be interpreted as a seasonal movement between southern and northern New Zealand, it may simply result from the seasonal fishing activity of the vessels in these fisheries which target groper. Few if any fishers work only in the groper fishery, and their seasonal fishing strategy is usually determined by the seasonal presence, or seasonally regulated access to, equally or more valuable resources such as rock lobster, oyster, scallop, tunas, etc. In order to decide whether this seasonal pattern of landings in the groper fishery really does reflect a seasonal north-south movement (and increased availability) it would be necessary to investigate the seasonal activity of these vessels in this whole range of fisheries.

From this descriptive account of the groper fishery it is not possible to determine the status of regional stocks. The landings from most regional mainland fisheries appear to be constrained by quotas. To determine whether one or more stocks are declining, it is necessary to investigate time series of CPUE indices. These should be useful in the long-established fisheries, such as Cook Strait, where essentially the same grounds have been worked over a long period of time. They may be less useful in other regions with newer fisheries (such as the large area off the eastern, western and northern Northland coast), where anecdotal information suggests that during the 1980s at least, and perhaps the 1990s, small new offshore grounds (banks, pinnacles, canyons) were progressively located, fished, and left to recover.

This study highlights some deficiencies in the catch recording system. There should be enforcement of the existing requirement to record the two species separately. There should also be enforcement of the existing requirement to record catches as greenweight. Consideration should be given to modifying Fishstock boundaries, so that QMR data, as well as catch-effort data, become useful in assessing regional stocks. In this context, the possibility that one or both species of groper undergo seasonal north-south migrations needs investigation. It may be possible to simplify Fishstocks into northern, central, and southern, using some of the existing boundaries. The option of having only a single Fishstock should also be considered. Subdivision into several Fishstocks (despite the inappropriate boundaries) was intended to prevent localised depletion. Quota holdings appear to be dispersed around New Zealand, and localised depletion may no longer be an important issue, particularly if the two groper species undergo even moderate migrations.

8. ACKNOWLEDGMENTS

Thanks are due to Brian Sanders, who obtained the catch-effort extracts on groper on which part of this account is based. Clive Roberts provided much relevant unpublished information on the biology of both species. This work was funded by the Ministry of Fisheries (project number HPB 1999/01.

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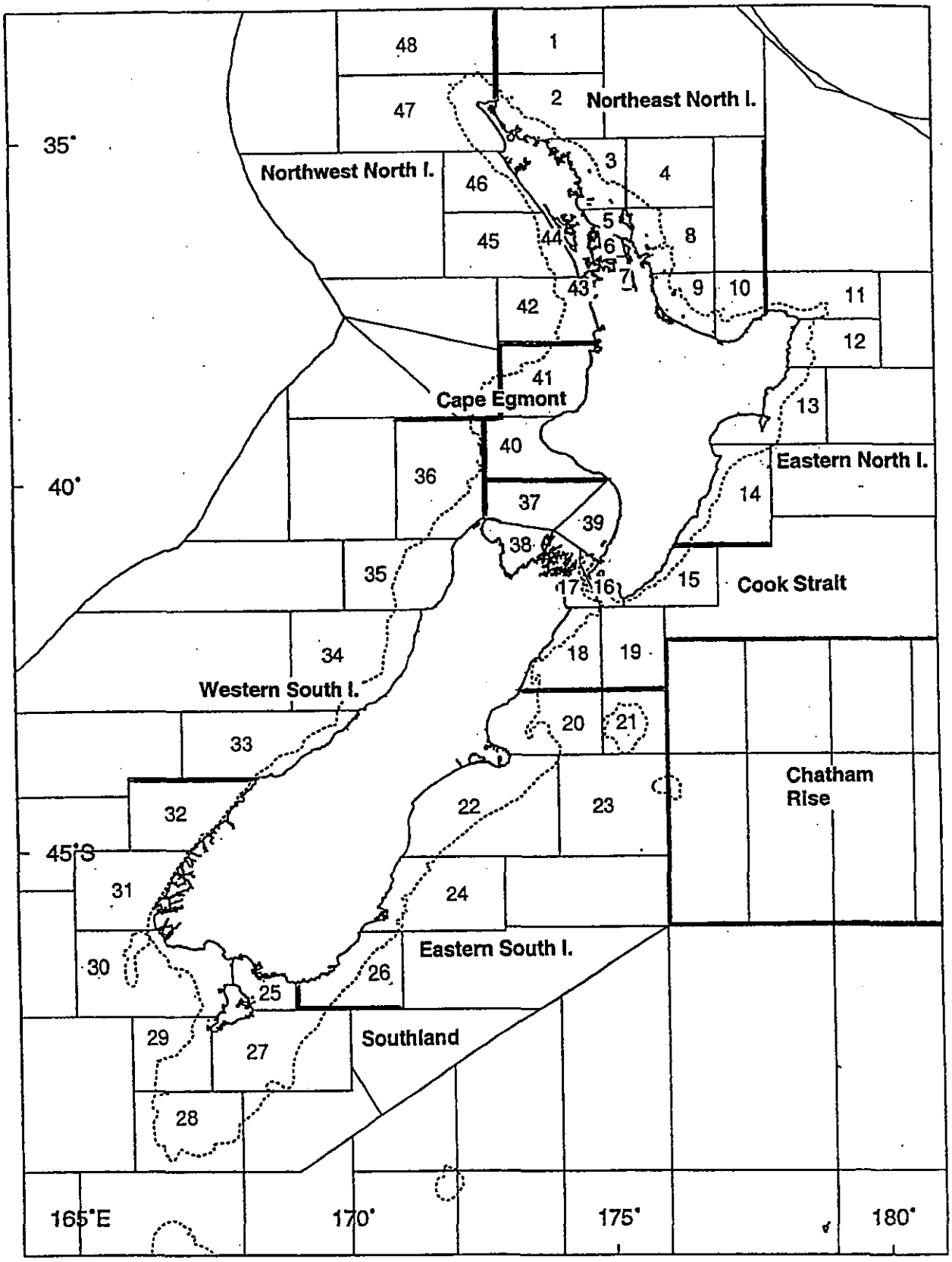

Figure 1: The fishing regions used in this study, defined by combinations of fishing statistical areas. The regions were based on QMA or FMA boundaries where possible, but a separate Cook Strait region was created in order to appropriately describe the major fishery centred there.

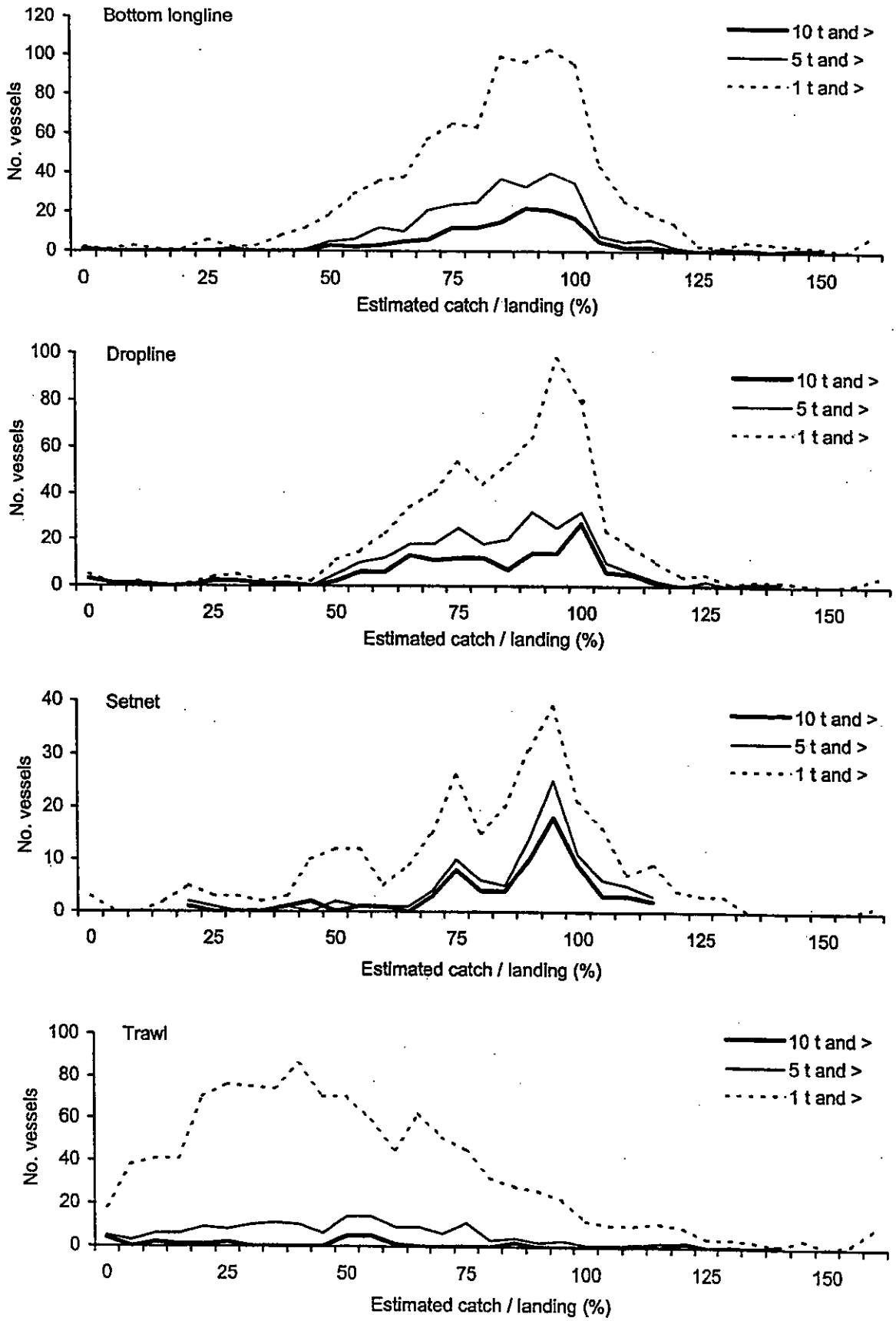

Figure 2: Relationship between estimated catches and reported landings, by fishing method. Estimated catches are calculated as a percentage of landings for each vessel, annual values, fishing years 1989–90 to 1998–99.

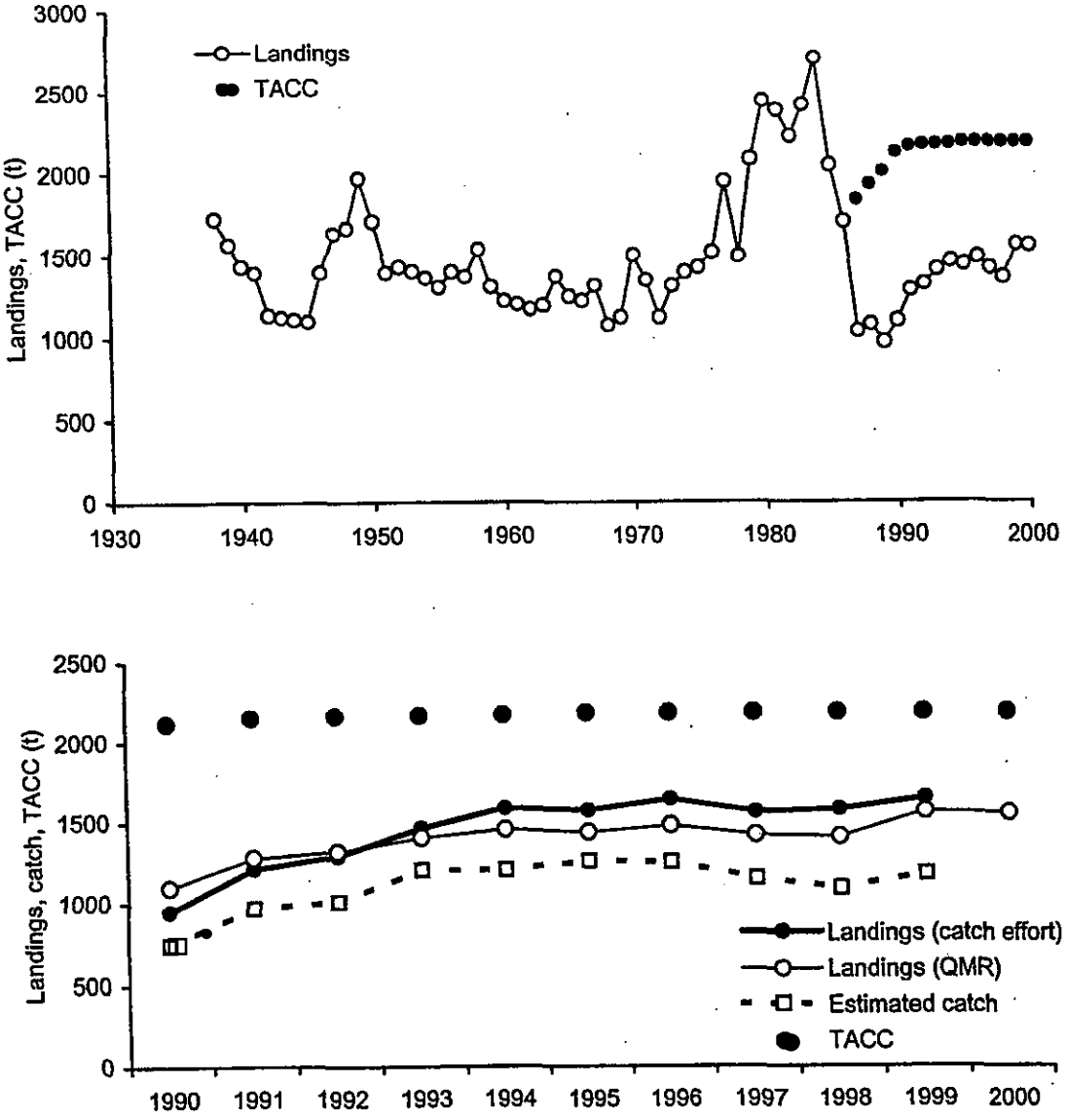

Figure 3: Upper: Recorded landings (t) of the total New Zealand catch of groper (bass and hapuku combined), 1936 to fishing year 1999–00. Also, the TACC values from 1986–87 to 1999–2000. Only some regional values are available from 1931 to 1934 (*see* Figure 5); consequently the New Zealand total for these first few years is incomplete and is not shown here. Lower: Relationship between catch, landing, and TACC values for fishing years 1989–90 to 1998–99. Catches are estimated catches, known to be incomplete (see text). Landings are from the catch-effort database (summed from CELR-landed and CLR forms), and from Quota Monitoring Returns.

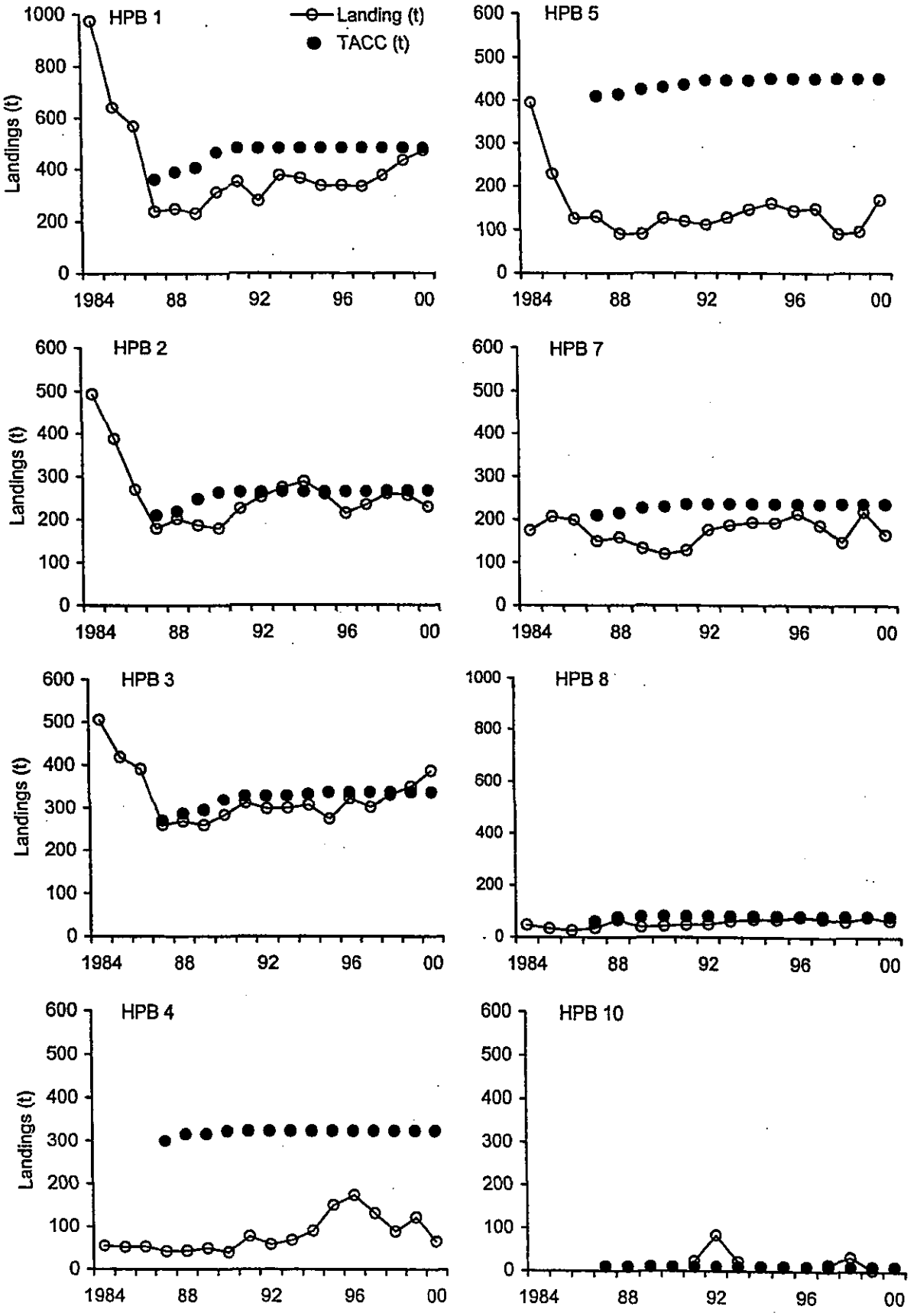

Figure 4: Landings (t) and TACCs (t) of groper by Fishstock, fishing years 1983–84 (plotted as 1984) to 1999–00. Fishstocks equal or combine QMAs as follows: HPB 1 = QMAs 1 & 9, HPB 2 = QMA 2, HPB 3 = QMA3, HPB 4 = QMA 4, HPB 5 = QMAs 5 & 6, HPB 7 = QMA 7, HPB 8 = QMA 8, HPB 10 = QMA 10.

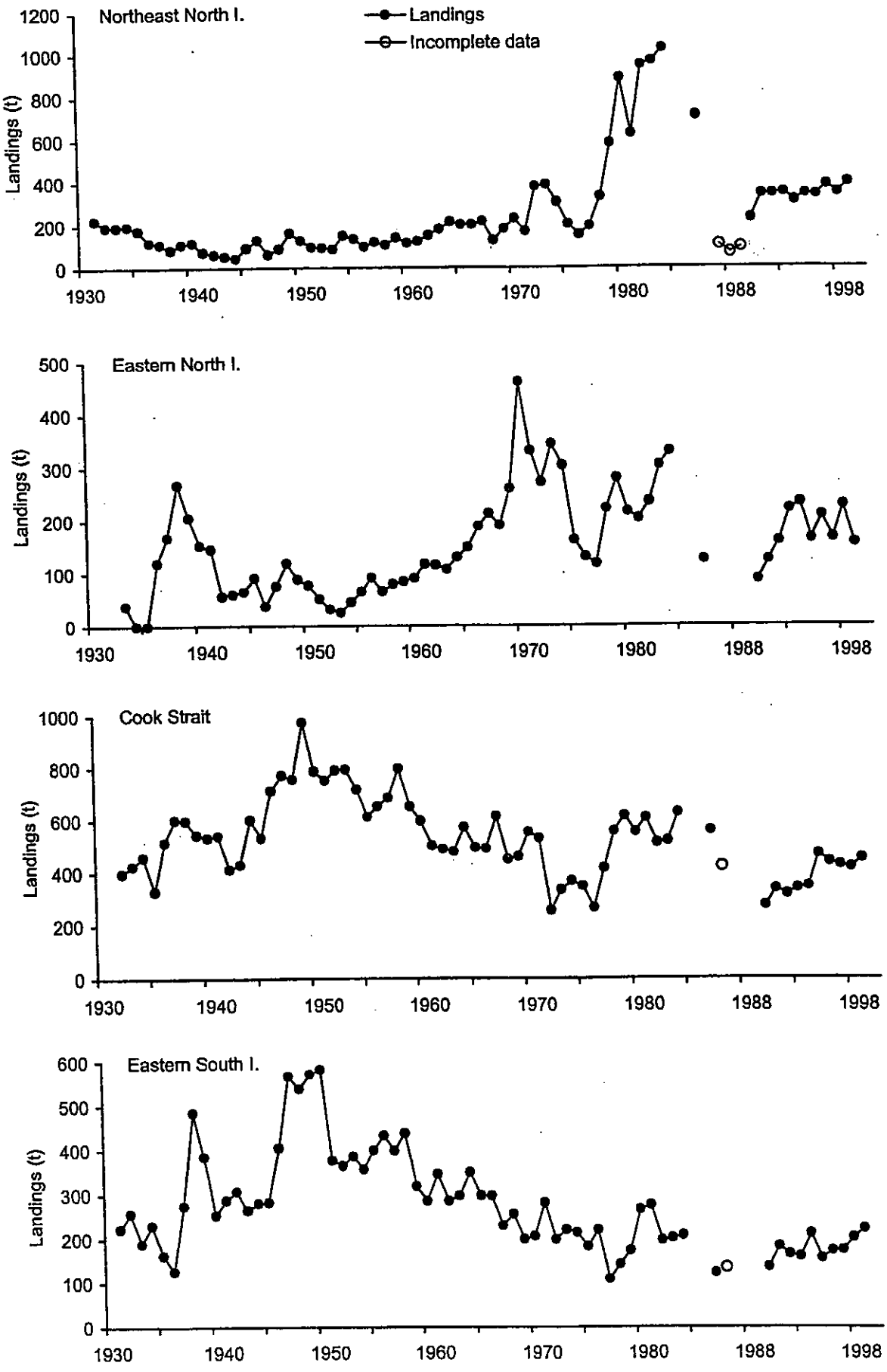

Figure 5: Landings (t) of groper (bass and hapuku combined) by region, 1931 to 1998–99. Values to 1984 based on groupings of port landings. Values from 1989–90 based on landings from vessels fishing in fishing statistical areas grouped into similar regions. Reliable data from the late 1980s are not available.

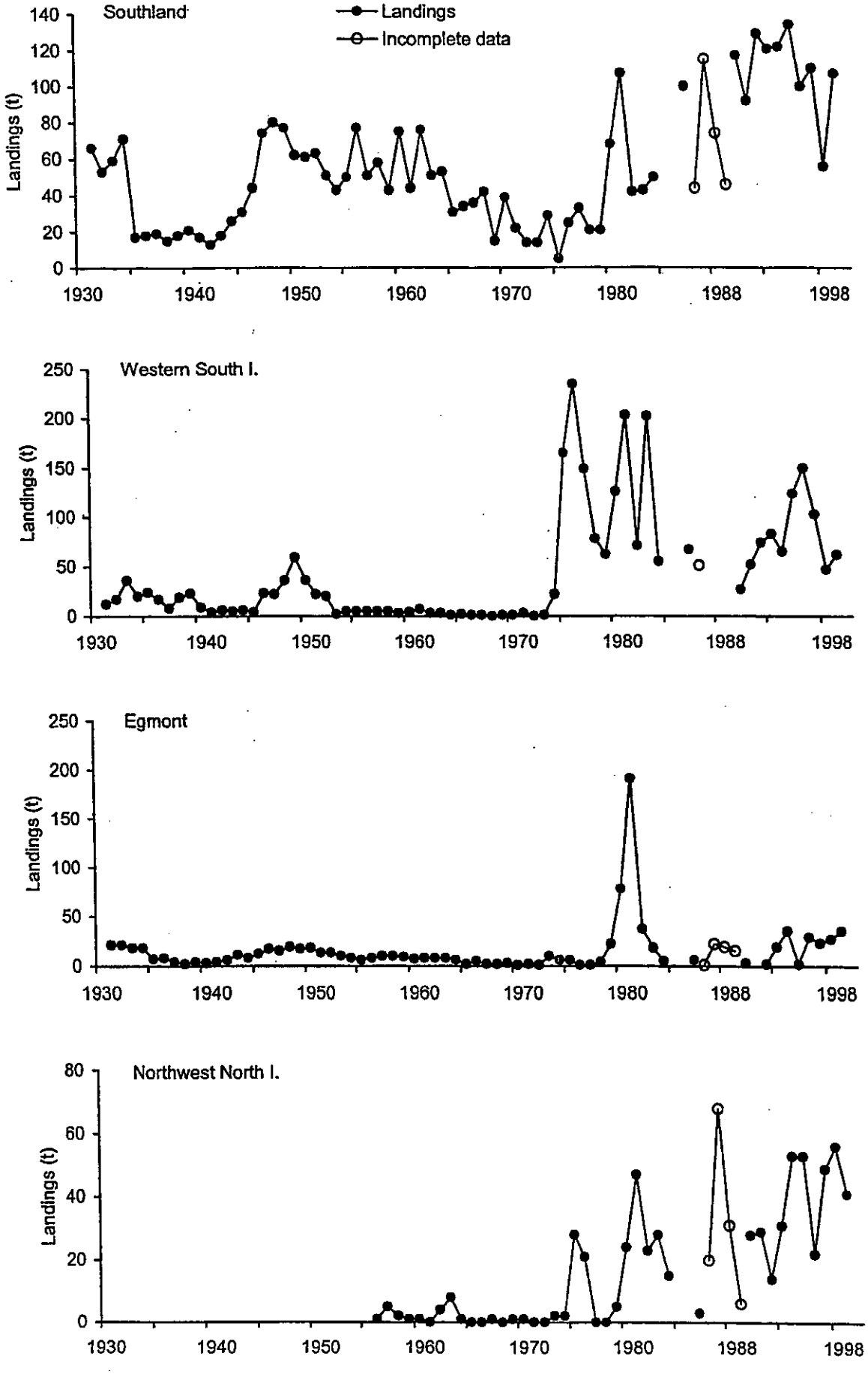

Figure 5: Landings (t) of groper by region (continued)

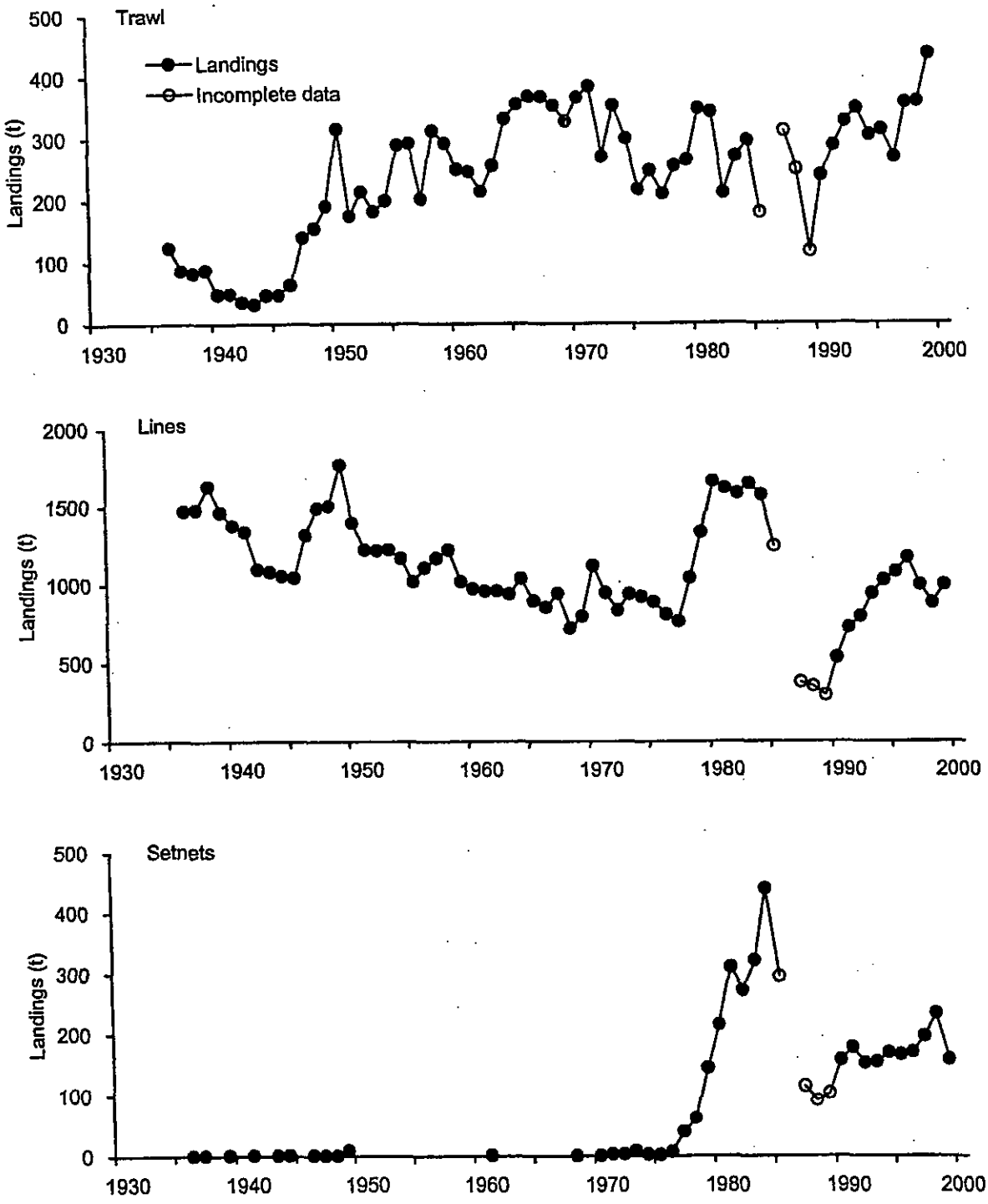

Figure 6: Landings (t) of groper (bass and hapuku combined) by fishing method. All trawling methods (single, pair, midwater) are combined, and the two main "vertical" lining methods (dahnline, trotline) are combined into dropline. Values to 1984 based on published annual reports. Values from 1989– based on landings by vessels identified as fishing with a predominant methods listed with their estimated catches. Reliable data from the late 1980s are not available.

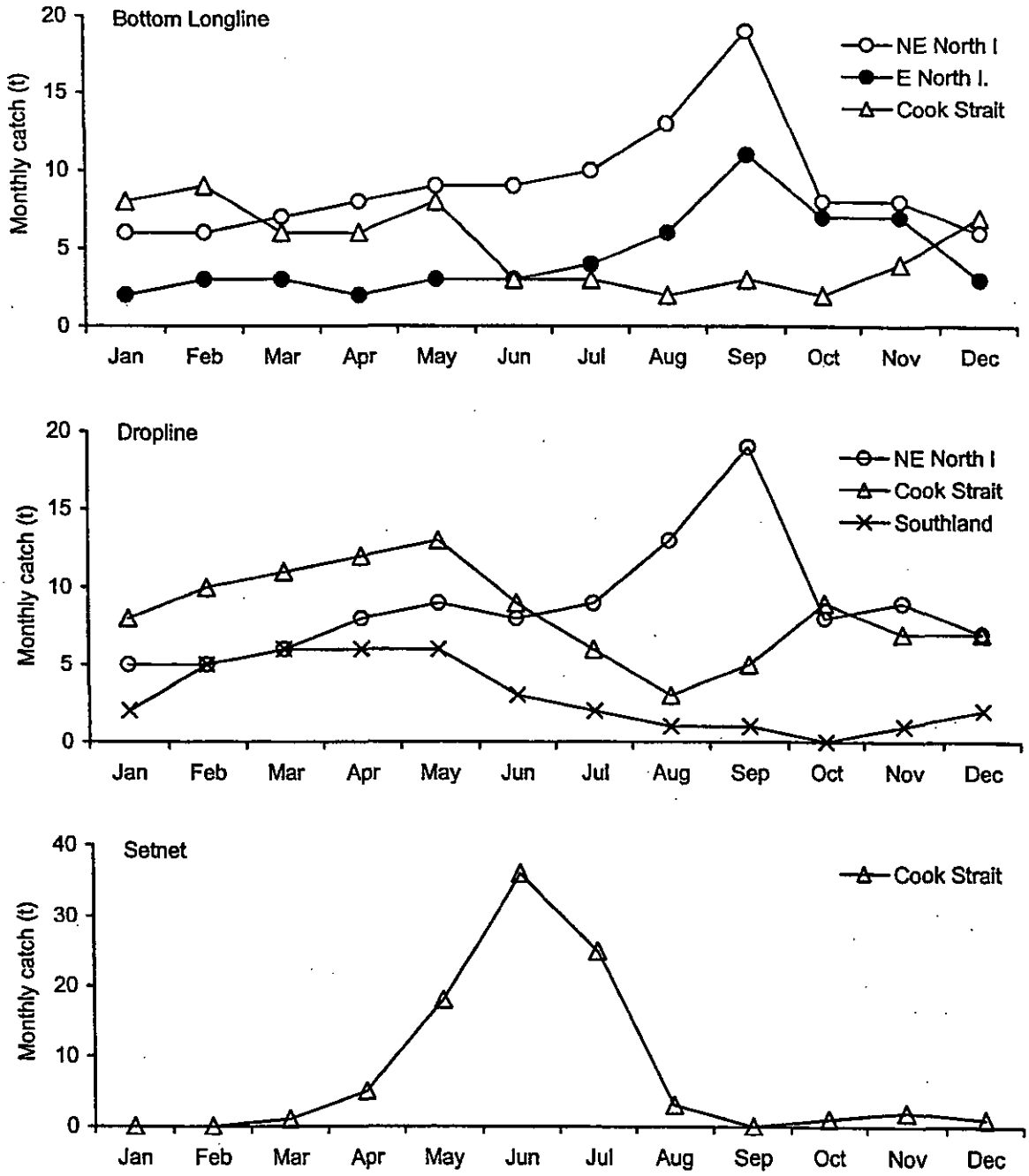

Figure 7: Monthly trends in the seven main target fisheries, by method and region. The monthly values (t) are estimated catch means summed for the years 1989–90 to 1998–99.

Appendix 1: Procedures for integrating *estimated catch* values with *recorded landed* values to categorise landings of groper by effort parameters. Integration was carried out by combining Excel spreadsheets.

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

Notes:

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