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EXECUTIVE SUMMARY

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We used scientific observer programme data to determine which fish species were caught on tuna longlines, and to estimate the catch per unit effort (CPUE) and the number of fish caught by observed vessels during the 2002–03, 2003–04, and 2004–05 fishing years. Data were summarised by fishing fleet (chartered foreign vessels and New Zealand domestic vessels), and geographical area (north and south). For the main non-target species, we used observer data to estimate the proportion of fish that were alive and dead on recovery, and the proportion that were retained and discarded. The size distribution, sex composition, maturity composition, and catch weight of blue, porbeagle, and mako sharks and Ray's bream were determined. We also analysed stomach content data recorded by observers for blue, porbeagle, and mako sharks.

The total number of hooks set by longline vessels fishing in the New Zealand Exclusive Economic Zone (EEZ) and adjacent waters declined from a maximum of 27 million hooks in 1980–81 to less than 4 million in the mid 1990s when foreign licensed vessels ceased fishing in New Zealand. The domestic fishing fleet has been the dominant fleet in the fishery since 1993–94 and the number of hooks set by this fleet increased rapidly in the late 1990s to a peak of almost 10 million set in 2001–02. Effort of the domestic fleet has dropped substantially over the three fishing years 2002–03 to 2004–05. In 2004–05, 3.7 million hooks were set by the fishery, the lowest in nine years. The effort of chartered foreign vessels also dropped in 2004–05. In 2002–03 Philippine vessels fished in New Zealand waters for the first and only time.

A number of pelagic species were brought into the Quota Management System (QMS) for the first time in the 2004–05 fishing year and this changed fishing practices and reduced the number of domestic boats in the fishery. However, the downward trend in effort was evident from the 2002–03 fishing year onwards. Observer coverage on charter vessels continues to be high, but domestic coverage remains below 5%.

Between 2002–03 and 2004–05, 124 516 fish and invertebrates from at least 75 species were observed. Most species were rarely observed, with only 36 species (or species groups) exceeding 100 observations between 1988–89 and 2004–05. The most commonly observed species over all years were blue shark, albacore tuna, and Ray's bream, these three making up 75% of the catch by numbers. Other important non-target species were bigscale pomfret, dealfish, yellowfin tuna, deepwater dogfish, escolar, porbeagle shark, moonfish, lancetfish, rudderfish, swordfish, and mako shark. The catch composition varied with fleet and area fished.

Fishing effort and observed catches were stratified by fleet (Charter and Domestic) and area (North and South) for estimating CPUE and numbers caught. For most species there were large differences in CPUE between fleets and between areas. CPUE could be reliably determined only for the Charter fleet. CPUE declined for many species in 2004–05 but increased for mako and school sharks, southern bluefin tuna, Ray's bream, and bigscale pomfret. Increases tended to be for those species that were newly introduced into the QMS. Porbeagle shark CPUE has been low for five years. Catch in numbers also fell for many species due to the decline in effort, but increases were seen for Ray's bream and bigscale pomfret.

Catch weights estimated for 2003–04 and 2004–05 respectively were 1731 t and 1223 t for blue shark, 168 t and 162 t for porbeagle shark, 48 t and 27 t for mako shark, and 45 t and 20 t for Ray's bream. Catch weights could not be estimated for 2002–03 due to lack of observer coverage of the Domestic fleet.

Length frequency data combined with length-at-maturity information indicated that most blue, porbeagle, and mako sharks were immature. A higher proportion of females were immature, and greater proportions of mature male blue and mako sharks were observed in the North. Most female Ray's bream were immature in the North, whereas in the South most were mature.

Most blue shark, mako shark, deepwater dogfish, school shark, Rays bream, bigscale pomfret, moonfish, escolar, oilfish, and rudderfish were alive when recovered. Most dealfish, lancetfish, swordfish, and butterfly tuna were recovered dead, along with about one-third of porbeagle shark. Most blue, porbeagle, mako, and school sharks were processed in some way, either just finned or retained for their flesh. Since blue, mako, and porbeagle sharks became quota species, fewer blue shark were discarded, but the Charter fleet discarded more mako shark. Most moonfish, albacore, yellowfin and butterfly tuna, and swordfish were processed, and more moonfish and Ray's bream were retained by the Charter fleet since becoming quota species. Most deepwater dogfish, bigscale pomfret, dealfish, escolar, rudderfish, oilfish, and lancetfish were discarded. Discarding of rudderfish, oilfish, bigscale pomfret, and escolar varied with fleet. In the period 2002–03 to 2004–05, 47 striped marlin were observed, and most of these were returned to the sea, except for 19 fish caught by the Domestic fleet outside the New Zealand EEZ which were retained.

Fish and squid were the predominant prey consumed by blue, mako, and porbeagle sharks, with roughly equal occurrence of both prey types in stomachs of blue sharks, a greater proportion of fish in porbeagle shark stomachs, and a predominance of fish in mako stomachs. There was a change in the relative importance of fish and squid with increasing size of blue and porbeagle sharks, with both species changing from consuming mostly squid to consuming mostly fish. Makos consumed mainly fish at all sizes.

Few conclusions could be made about trends in CPUE and catches made by the Domestic fishery due to low observer coverage, especially in southern New Zealand waters. We recommend that observer coverage of the Domestic fleet be increased and that efforts are made to ensure that the coverage is representative of the spatial and temporal distribution of the fishing effort and therefore the catch.

1. INTRODUCTION

The Ministry of Fisheries is responsible for determining the impacts of fishing on associated or dependent species, including non-target fish species. To fulfil this responsibility, it is necessary to obtain regular estimates of the catch and catch rates of non-target fish species taken as bycatch during normal fishing operations. Estimates of target and non-target discard quantities are also required. These quantities provide an estimate of the level of removals from the population.

New Zealand has an obligation to provide estimates of the numbers of non-target fish species taken in the tuna longline fishery as part of its contribution to the Ecological Species Working Group under the Convention for the Conservation of Southern Bluefin Tuna (CCSBT), and to the Western and Central Pacific Fisheries Commission (WCPFC). New Zealand is also currently developing a National Plan of Action (NPOA) on sharks, as a result of an FAO initiative to improve the assessment and management of shark fisheries worldwide. Information on the shark bycatch from New Zealand tuna longline fisheries is crucial to the development of an NPOA.

Tuna longline fishing is often considered a highly specific, environmentally sound fishing technique compared with other methods (e.g., trawling and pelagic driftnet fishing). However, for some target species, areas, and seasons, bycatch levels can be high (Francis et al. 1999, 2000, 2001, 2004, Ayers et al. 2004). In the New Zealand Exclusive Economic Zone (EEZ) and adjacent waters more than 70 non-target fish species have been recorded by scientific observers in the bigeye and southern bluefin tuna fisheries, although only 12 species (or species groups) are commonly taken (Francis et al. 1999, 2000, 2004). During the period 1988–2002, blue shark (*Prionace glauca*), albacore tuna (*Thunnus alalunga*), and Ray's bream (*Brama brama*) were the most abundant species. Non-target fish species made up 13 of the 17 most abundant species. In addition to blue shark, the main bycatch species were (in descending order of abundance), porbeagle shark (*Lamna nasus*), dealfish (*Trachipterus trachypterus*), lancetfish (*Alepisaurus* spp.), moonfish (*Lampris guttatus*), oilfish (*Ruvettus pretiosus*), deepwater dogfish (Squaliformes), swordfish (*Xiphias gladius*), butterfly tuna (*Gasterochisma melampus*), mako shark (*Isurus oxyrinchus*), rudderfish (*Centrolophus niger*), and school shark (*Galeorhinus galeus*).

Concerns have been raised about the numbers of non-target fish species, especially sharks, swordfish, and marlins, taken as bycatch in the tuna longline fishery. Oceanic sharks are an important bycatch throughout the Pacific Ocean, and the demand for shark fins in Asia has led to an increase in their catch over the last few decades (Bonfil 1994, Hayes 1996, Stevens 2000). Oceanic sharks generally have low reproductive rates, long life spans, and possibly slow growth, and they segregate by size and sex. These features make them vulnerable to overfishing (Fogarty et al. 1989, Compagno 1990, Hoenig & Gruber 1990). To date, the only assessments of shark bycatch on tuna longlines in temperate South Pacific waters have been in the Australian Fisheries Zone (Stevens 1992, Stevens & Wayte 1999), and NIWA's previous studies in New Zealand waters (Francis et al. 1999, 2000, 2001, 2004, Ayers et al. 2004). Bailey et al. (1996) reviewed bycatch and discards in Western Pacific tuna fisheries.

Billfish species are commonly caught in longline fisheries targeting tunas. The species caught in tuna longline fisheries vary with area and fishery. Bailey et al. (1996) reported that blue marlin were the most common bycatch species in the western tropical Pacific longline fishery while in Australia short-billed spearfish predominate. In New Zealand, swordfish are commonly caught, and striped marlin (*Tetrapturus audax*) are occasionally taken; other marlins are rarely caught (Francis et al. 2004). Only swordfish can be retained by domestic fishers; the other billfish species must be returned to the water alive or dead. Commercial fishers view the practice of dumping dead marlin as a waste of a valuable resource of no benefit to any fishing sector or to the resource, and they have sought a change in regulations to allow them to retain dead marlin, especially striped marlin which have high commercial value. Recreational fishers, on the other hand are concerned about any potential impact on the recreational striped marlin

fishery from increased domestic tuna longline activity, especially fishing effort which might target striped marlin. Both commercial and recreational sector groups have requested information on the number of marlin caught and on the discard rate before changes to the current regulations are considered.

Only a small proportion of the tuna longline fishing effort in the New Zealand fishery has been observed, but this is the only independent source of information on the scale of bycatch and discarding in the fishery.

NIWA has reported the results of previous Ministry of Fisheries projects that investigated the bycatch of the New Zealand tuna longline fleet (Francis et al. 1999, 2000, 2004, Ayers et al. 2004). The present study, funded by Ministry of Fisheries project TUN2004/01, updates and extends those previous analyses. It addresses the following objectives:

1. To estimate the catch rates of non-target fish in the longline fisheries for tuna using data from the Observer Programme and commercial fishing returns for the 2002/03, 2003/04 and 2004/05 fishing years.
2. To estimate the quantities of non-target fish caught in the longline fisheries for tuna using data from the Observer Programme and commercial fishing returns for the 2002/03, 2003/04 and 2004/05 fishing years.
3. To estimate the discards of non-target fish caught in the longline fisheries for tuna using data from the Observer Programme and commercial fishing returns for the 2002/03, 2003/04 and 2004/05 fishing years.
4. To describe trends in the non-target fish catches in the tuna longline fisheries using data from this project and the results of previous similar projects.

In 2003 a new Tuna Longlining Catch Effort Return (TLCER) form was introduced, and fishers were required to record discarded fish. In October 2004, several tuna and longline-caught bycatch species were introduced into the Quota Management System (QMS), namely southern bluefin tuna, Pacific bluefin tuna, bigeye tuna, swordfish, blue shark, porbeagle shark, mako shark, moonfish, and Ray's bream. This study spans the period from immediately before to immediately after these management and reporting changes.

2. METHODS

2.1 Data sources and data treatment

Tuna longline vessels submit information on their fish bycatch to the Ministry of Fisheries on TLCERs, and a small amount is reported on Catch Effort Landing Returns (CELRs). These returns underestimate bycatch because much of it is discarded at sea and not recorded (Francis et al. 2000). More reliable data on the amount of fish bycatch are available from the Ministry of Fisheries Observer Programme, in which observers on board commercial vessels identify and count all of the bycatch during the time they are observing. Observers also record whether fish are alive or dead on recovery, their subsequent fate, and lengths, weights, and sex of individual fish. Observer data can therefore provide a good independent source of information on the scale of bycatch and discarding in the fishery. We used observer data to determine which non-target fish species are caught, and to estimate catch per unit effort (CPUE), the total number of fish caught, the proportion of the catch alive and dead on recovery, and the proportion of fish processed and discarded.

New Zealand tuna longline fishery data for the 2002–03, 2003–04, and 2004–05 fishing years were obtained from two sources: commercial fishing data and observer data.

Data recorded by observers on tuna longline vessels were extracted from database *l_line*. Some records that could not be used in our analyses were rejected (two sets were not observed as the observer was ill, and deck log data were lost for six sets). The earlier observer data (1989–90 to 2001–02) was that used by Ayers et al. (2004).

Groomed commercial longline data from TLCER and CELR forms were extracted from the database *tuna*. Further grooming was carried out before analysis as follows.

- Records with no hook number were checked against sets on adjacent days for that vessel and an appropriate hook number inserted.
- Records with low hook numbers (less than 150 hooks) were checked and corrected in a similar way as appropriate.
- Records with no set position (latitude and longitude) were compared with sets on adjacent days for that vessel and assigned to area North or South (see below) as appropriate.
- Records that could not be corrected as above were deleted from the dataset.

A new data extract was obtained for the historical period (1989–90 to 2001–02), rather than using the dataset available from previous projects in this series (e.g., Ayers et al. 2004), because additional records are now available due to improved data processing (Wei 2006). Forty-four sets were rejected from the historical data (9 sets with no hook number, 27 sets lacking positional information, and 8 sets with inappropriate vessel nation) and 457 records were amended as described above. No sets were deleted from the 2002–03 to 2004–05 dataset, but 52 were updated. Data were added for 26 sets that were observed but were not in the commercial database. Hook numbers were available from the observer data for determining total effort, but there were no commercial catch data for these sets.

Data were stratified by fishing year, fleet, and area for analysis. Three fleets have routinely fished in New Zealand waters: foreign licensed vessels (mainly Japanese but also some Korean), foreign vessels chartered by New Zealand companies, and New Zealand domestic owner-operated vessels. Foreign licensed vessels have not fished in New Zealand waters since 1995. Foreign licensed and chartered vessels have been grouped together for analysis because they fished similar areas with similar gear (Ayers et al. 2004, Francis et al. 2004), and this grouping is used to present a time series of trends in fishing effort. One large domestic vessel that routinely fished with the Japanese charter fleet was grouped with the "Foreign and Charter" fleet for analysis. A Philippine charter fleet fished in New Zealand waters for the first and only time in 2002–03 and these vessels were treated as a separate fleet because the area and way they fished were different from those of the other fleets. In 2002–03 to 2004–05, there were no foreign licensed vessels and "Charter" refers to the Japanese charter fleet plus the large domestic vessel, and Philippine vessels are shown separately as "Philippine". New Zealand domestic vessels, other than the one large vessel fishing with the Japanese vessels, are referred to as "Domestic".

Two geographical areas are used, "North" and "South". The North area is defined as sets that began north of latitude 39.5° S on the west coast and north of 43.75° S on east coast, these being the same boundaries as used previously by Ayers et al. (2004). The South area has previously been subdivided into south-west and south-east area (Ayers et al. 2004) but few sets were made in the south-east area during the timeframe of this study, so this separation was not made. One Philippine set made south of 39.5°S on the west coast was included in area "North" with all of the other sets made by this fleet. Sets outside the New Zealand EEZ in the North region were included.

As with previous years (Ayers et al. 2004, Francis et al. 2004), some species were grouped together. "Deepwater dogfish" included those recorded as DWD (species unknown), Owston's dogfish (*Centroscymnus owstoni*), Portuguese dogfish (*Centroscymnus coelolepis*), Plunket's shark (*Centroscymnus plunketi*), seal shark (*Dalatias licha*), velvet dogfish (*Zameus squamulosus*), cookie-

cutter shark (*Isistius brasiliensis*), spiny dogfish (*Squalus acanthias*), and shovelnose dogfish (*Deania calcea*). Owston's dogfish was the most abundant of these (89% of the observed deepwater dogfish). Shortnose and longnose lancetfish, *Alepisaurus ferox* and *A. brevirostris*, were combined. Deepwater dogfish and lancetfish were usually cut off the lines and observers often did not have the opportunity to identify them to the species level. Hapuku and bass (*Polyprion oxygeneios* and *P. americanus*) were combined as they were often not separated to the species level.

2.2 Estimation of catch per unit effort and total numbers

CPUE was expressed as the number of fish observed caught per 1000 hooks set. The basic unit of sampling was an individual set; a set i has information on the number of fish caught (c_i) and the amount of effort expended (u_i the number of hooks). All hooks on a set may not be observed. In the calculation of CPUE we used the estimated number of observed hooks; this estimate was derived from the proportion of the haul observed (based on the haul duration and the time recorded as unobserved in the observer events logs) multiplied by the number of hooks set.

For the main catch species, CPUE values ($\hat{y}$) were calculated for each stratum (fleet, area, and fishing year) from a dataset that spanned fishing years 1988–89 to 2004–05 by use of a ratio of means estimator (see Bradford 2002, Ayers et al. 2004):

$$\hat{y} = \frac{\sum_{i=1}^{n} c_i / n}{\sum_{i=1}^{n} u_i / n} = \frac{\sum_{i=1}^{n} c_i}{\sum_{i=1}^{n} u_i}$$

where n is the number of observed sets.

Ayers et al. (2004) compared the use of two analytical and one bootstrap variance estimators and found the difference was negligible. These authors reported estimates of variance based on the sample means, which have better statistical properties (Thompson 1992):

$$\hat{\text{var}}(\hat{y}) = \frac{1}{\mu_u^2}\left(\frac{N-n}{N}\right)\frac{s_{\hat{y}}^2}{n}$$

where $s_{\hat{y}}^2 = \frac{1}{n-1}\sum_{i=1}^{n}(c_i - \hat{y}u_i)^2$

and μ_u is the population mean of the effort variable. There has been some indication that the estimator $\hat{\text{var}}(\hat{y})$ is correlated with the mean of the effort variable ($\bar{u}$). An adjusted estimator,

$$\tilde{\text{var}}(\hat{y}) = \left(\frac{\mu_u}{\bar{u}}\right)^2 \hat{\text{var}}(\hat{y})$$

has been suggested to alleviate this problem (Thompson 1992). This was used to provide analytical estimates of confidence intervals.

The total number of each species caught in each stratum was estimated by scaling up the CPUE to the total number of hooks set (N): thus, $\hat{T} = N\hat{y}$. These numbers were then summed across strata to give total annual catch estimates. The estimated variance of these totals was given by $\hat{\text{var}}(\hat{T}) = N^2\,\tilde{\text{var}}(\hat{y})$.

CPUE values and catch estimates are provided below for all strata where more than 10 sets and 2% of the hooks set were observed. These criteria were used to avoid presenting estimates that are based on grossly

inadequate observer coverage. For the estimated annual total catches, if one fleet did not meet this criterion, the catch estimate for the other fleet is provided if that fleet accounted for more than 85% of the hooks set in that year. Catch numbers estimated from observer data were compared with catch numbers reported by commercial fishers on their TLCERs.

CPUE and catches were summed across target species (defined as bigeye tuna, southern bluefin tuna, and albacore), and across non-target species. In the 2002–03 to 2004–05 fishing years, bigeye tuna was recorded as the target species for 54% of all commercial sets, southern bluefin for 32% of sets, and albacore tuna for 10% of the sets. Other species including Pacific bluefin tuna, yellowfin tuna, and swordfish were targeted in only 4% of sets.

2.3 Status of fish on recovery and subsequent treatment

The status of the fish at time of recovery (i.e., retrieval to the side of the vessel) and the subsequent treatment (i.e., whether processed or discarded), were analysed from observer data for 2002–03 to 2004–05 for each of the main non-target species, plus albacore. Fish status was recorded as alive, dead, killed by crew, or unobserved. Fish recorded as killed by crew were treated as alive on recovery. Fish treatment was recorded as retained, finned, discarded, lost, or unobserved. Retained and finned fish were grouped as fish that were processed in some way, whereas the discarded and lost fish were categorised as not processed.

2.4 Length frequency analysis and catch weights

Observer length data were extracted for blue, mako, and porbeagle sharks, Ray's bream, and striped marlin, and length frequency distributions were summarised by sex and area.

The total estimated catch weights of blue, mako, and porbeagle sharks, Ray's bream, and striped marlin were calculated from the estimated numbers caught. Observers measured the length (generally fork length, FL) and weight of many of the fish caught, giving priority to tunas and billfish. We assume that the size composition and sex ratio of the observed samples is representative of the catch in each stratum (i.e., area and fleet). The length-frequencies were converted to proportions of the measured sample, and the number caught in each length class was calculated as the proportion multiplied by the estimated total number caught. These numbers were converted to weights by multiplying by the mean weight for the length class, as determined from length–weight regressions calculated using all data in the observer database up to 2001–02, as reported by Ayers et al. (2004). Estimated weights were then summed over all length classes, sexes, and areas to provide an estimate for the total weight caught during the fishing year. The length-weight regressions were as follows.

Blue sharks, males:	$\log_{10}\text{Weight} = -5.802 + 3.282\log_{10}\text{FL}$	$N = 1666$,	$R^2 = 0.942$
Blue sharks, females:	$\log_{10}\text{Weight} = -6.196 + 3.485\log_{10}\text{FL}$	$N = 3053$,	$R^2 = 0.948$
Porbeagle sharks, all:	$\log_{10}\text{Weight} = -4.669 + 2.924\log_{10}\text{FL}$	$N = 2457$,	$R^2 = 0.934$
Mako sharks, all:	$\log_{10}\text{Weight} = -4.622 + 2.847\log_{10}\text{FL}$	$N = 1016$,	$R^2 = 0.955$

Observer length-weight data on Ray's bream cannot be used because of the lack of precision in weight measurements which especially affects the small fish (Francis et al. 2004), so a length–weight regression for this species was derived from fish caught in trawl surveys.

Ray's bream, all:	$\log_{10}\text{Weight} = -5.224 + 3.288\log_{10}\text{FL}$	$N = 932$,	$R^2 = 0.952$

The length-weight relationship determined for striped marlin by Ayers et al. (2004) was used, as no striped marlin have been weighed by observers since 2002.

Striped marlin, all: $\log_{10}\text{Weight} = -2.817 + 2.024\log_{10}\text{FL}$ $N = 15$, $R^2 = 0.902$

2.5 Diet of pelagic sharks

Stomach content information recorded by observers from 1994 (when recording of stomach content information began) to 2005 for blue, mako, and porbeagle sharks was summarised by size class.

3. RESULTS

3.1 Fishing effort and observer coverage

The New Zealand tuna longline fishery was dominated by the foreign licensed fleet during the 1980s (Francis et al. 2004). Most effort came from Japanese vessels, but Korean vessels were also involved. The total number of hooks set declined from a maximum of 27 million in 1980–81 to less than 4 million in the mid 1990s when the foreign licensed vessels ceased fishing in New Zealand (Figure 1).

Chartered Japanese vessels fished in New Zealand waters mainly from 1986 onwards and their effort (including effort by one large New Zealand vessel) peaked at 2.2 million hooks during 1990–91. During the past 12 years Charter effort has been lower, averaging 1.3 million hooks annually. The large New Zealand domestic vessel ceased fishing after the 2003–4 fishing season. The Philippine fleet fished under charter arrangements in 2002–03 only, setting almost 1 million hooks.

The Domestic fleet has increased its effort since 1991–92 and has been the dominant fleet in the fishery since 1993–94 (Table 1, Figure 1). Domestic effort peaked at almost 10 million hooks set in 2001–02, producing a second fishery peak of almost 11 million total hooks. Domestic and total effort have dropped substantially over the past three fishing years. In 2003–04, a total of 7.4 million hooks were set, 5.9 million of them (80%) by the Domestic fleet. In 2004–05, this dropped further to 3.7 million hooks, of which 3.1 million (84%) were set by the Domestic fleet (Figure 1, Table 1).

Eight pelagic species were brought into the QMS in October 2004 and this resulted in changed fishing practices and a reduction in the number of Domestic boats in the fishery. However the downward trend in Domestic effort was evident from 2002–03 onwards.

The number of observed trips and sets, observed hooks and reported hooks by fleet and the percentage of reported hooks on CELR forms are shown in Table 1. Use of CELR forms for reporting longline fishing has decreased and now accounts for fewer than 1% of hooks set. A new TLCER form was introduced in 2003 and phased in during that year.

Observed hooks as a percentage of those set by the fishery are shown in Table 2, and by fleet and area in Figure 2, for all years. Observer coverage on Charter vessels continues to be high, but Domestic coverage remains sparse. There was no Domestic coverage in 2002–03, but cover improved in 2004–05 to almost 5%. Domestic observer coverage was especially low in South area, but few hooks were set there by Domestic vessels (Figure 2).

The percentage of hooks observed per set during 2002–03 to 2004–05 is shown in Table 3. Most Domestic sets were fully observed, but this was not possible on Charter vessels where hauls often exceeded 12 hours and observers needed to take breaks. Most sets on Charter vessels were 90–99 % observed, but a considerable number were only 70–89% observed.

Fishing positions of reported and observed sets in 2002–03, 2003–04, and 2004–05 are shown in Figures 3, 4, and 5 respectively. In previous years, the Domestic fleet fished mainly in the North and the Foreign and Charter vessels fished predominantly in the South (Ayers et al. 2004, Francis et al. 2004). This trend continued during 2002–03 to 2004–05 for the Domestic vessels and Japanese Charter vessels, but the Philippine vessels operated differently, fishing only in the North area, with most sets in the Kermadec Fisheries Management Area.

Japanese Charter vessels fished for southern bluefin tuna mainly in the second quarter in the South area, and then moved north in late June-early July. In 2002–03 and 2003–04, Charter vessels targeted bigeye tuna in the North area, around the Three Kings Islands (north of 35° S), but in 2004–05 they fished for southern bluefin tuna near East Cape. Philippine vessels fished only in 2002–03 in the North, targeting albacore from April to September. Domestic vessels fished all year round for a variety of target species, including southern bluefin, bigeye, albacore, Pacific bluefin, and yellowfin tunas. In 2004–05, after introduction into the QMS, swordfish was also targeted.

Observer coverage of the Charter fleet represented the spatial distribution and temporal distribution of the fishery well (Figures 3–5). For the Domestic fleet, however, few sets were observed in the South, and observed sets in the North were concentrated south of East Cape in 2003–04 and in the Bay of Plenty in 2004–05. Furthermore Domestic coverage did not adequately represent effort between October and February (Figure 6).

The numbers of reported and observed sets and hooks available for the estimation of CPUE and numbers of fish caught are shown by fishing year, area and fleet in Table 4.

3.2 Species composition

Between 2002–03 and 2004–05, 124 516 fish and invertebrates from at least 75 species were observed (Table 5). Observed totals since 1988–89 are also shown. Nonfish bycatch (seabirds, marine mammals, and turtles) were excluded. The most commonly observed species over all years were blue shark, albacore tuna, and Ray's bream, which constituted 75% of the catch by numbers. Most species were rarely observed, with only 36 species (or species groups) exceeding 100 recorded fish since 1988–89.

From 2002–03 to 2004–05, albacore was the most abundant species caught due to high catches in 2002–03 by the Philippine vessels. The second most abundant species was blue shark, followed by Ray's bream, southern bluefin tuna, bigscale pomfret, dealfish, yellowfin tuna, deepwater dogfish, escolar, porbeagle shark, moonfish, lancetfish, rudderfish, swordfish, and mako shark. Catches of butterfly tuna, oilfish, and school shark, all previously in the top 15 most abundant species (Ayers et al. 2004, Francis et al. 2004), were comparatively less abundant during this three-year period: school shark ranked 20th, oilfish 23rd, and butterfly tuna 25th. Numbers of bigscale pomfret, yellowfin tuna, and escolar were higher than previously seen. There were 656 unidentified fish observed from 2002–03 to 2004–05. Most of these were cut off or lost and not seen by the observer.

Observed catches by year, fleet, and area from 2002–03 to 2004–05 are shown in Table 6. These data provide a useful within-stratum comparison of relative species abundance, but should not be compared among strata because of the different numbers of observed hooks in each stratum. The Charter South

fishery caught mainly blue shark and Ray's bream, with smaller amounts of southern bluefin tuna, dealfish, bigscale pomfret, and deepwater dogfish. In the North, the Charter fleet caught mainly blue shark, albacore, and escolar. The Domestic North fleet also caught mainly blue shark and albacore, and significant amounts of mako and porbeagle sharks, swordfish, and lancetfish. The catches of Philippine vessels fishing in the far north were strongly dominated by albacore (the target species) with a significant amount of yellowfin tuna.

Percentage of the catch and percentage retained for species observed in 2002–03 to 2004–05 is summarised for each year in Appendix 1.

3.3 Catch per unit effort

CPUE estimates were calculated for each fleet and area for strata in which more than 10 sets and 2% of the hooks were observed (Figure 7). The number of sets and hooks used in the CPUE calculations are shown in Table 4. The CPUE results from the Domestic fleet should be interpreted with caution due to the lower observer coverage of this fleet. CPUE estimates for the Charter fleet can be considered reliable from 1992–93 onwards.

Notable features of the CPUE for the Charter fleet in 2002–03 to 2004–05 include:

- Increase in CPUE for blue, mako, porbeagle (North), and school sharks by the Charter fleet in 2004–05 (although this is small for blue sharks)
- Increasing CPUE for deepwater dogfish since 2000–01, with a slight drop in 2004–05
- Highest ever CPUE for bigeye tuna by the Charter fleet in the North in 2003–04, followed by a big decline in 2004–05
- Lower CPUE for southern bluefin tuna in the South than in the previous 2 years
- Low CPUE for southern bluefin tuna in the North, then a big increase in 2004–05
- Increase in CPUE of butterfly tuna in the North in 2004–05, while low in the South
- A dramatic increase in Ray's bream and bigscale pomfret CPUE in the South to the highest level ever recorded in 2004–05. Ray's bream increased in the North in 2004–05
- Dealfish CPUE declined, and in 2004–05 dropped to the lowest level since 1993–94
- Swordfish CPUE in the North dropped in 2004–05
- Moonfish and oilfish CPUE declined in 2003–04 and increased in 2004–05
- Rudderfish CPUE in the South dropped in 2004–05
- CPUE of escolar in the North reached the highest ever in 2003–04 then dropped in 2004–05

Many of the differences between years in CPUE in the Charter fleet in the North area can be explained by differences in the area they were fishing and the species targeted. In 2002–03 and 2003–04, the Charter fleet targeted bigeye tuna in the area around Three Kings Islands, while in 2004–05, they were targeting southern bluefin tuna off East Cape. This directly affected the CPUE trends for the target species. Higher CPUEs in 2004–05 for mako sharks, porbeagle sharks, moonfish, oilfish, and Ray's bream may reflect greater abundance of these species off East Cape than in the Three Kings region, and lower CPUEs for albacore, swordfish, and escolar may indicate greater abundance around Three Kings Islands then East Cape. These differences may be related to factors such as water temperature or fishing depth.

Apparent trends in the Domestic fleet in the North during 2002–03 to 2004–05 include an increase in CPUE for mako sharks, southern bluefin tuna, yellowfin tuna, and butterfly tuna in 2004–05, and a decrease in albacore and porbeagle sharks in 2004–05. Low domestic coverage precludes any firm conclusions.

Over the full time-series the following trends were apparent:

- After a peak in 1994–95, blue shark CPUE in the North dropped and has been closer to that of the South in recent years.
- CPUE of mako sharks was higher in the North than the South, while for porbeagle sharks it was higher in the South than the North until recent years when they have been more similar. Porbeagle CPUE has been low for the past five years.
- CPUE of school sharks was higher in the South than the North and much higher in the South for deepwater dogfish
- CPUE of southern bluefin tuna was higher in the South than the North in most years since the late 1990s, but there was a big increase in 2004–05 in the North.
- Catch rates of albacore, bigeye tuna, yellowfin tuna, swordfish, moonfish, oilfish, escolar, and lancetfish were greatest in the North
- Greatest catch rates of albacore, yellowfin tuna, swordfish, striped marlin, escolar, and lancetfish were usually made by the Domestic fleet in the North area
- CPUE of Ray's bream, bigscale pomfret, and dealfish were highest in the South and for the Charter fleet
- CPUE of Ray's bream and bigscale pomfret increased dramatically to the highest levels seen in 2004–05 while that of dealfish followed the opposite trend.
- Escolar CPUE was highly variable.

CPUE trends for all species combined were strongly influenced by blue shark and albacore CPUE (Figure 7). Both total and non-target levels peaked in 1994–95 mainly due to high catch rates of blue sharks by the Charter North fleet, while CPUE of target species was highest for this fleet in 1997–98. Highest target species CPUE was seen in the Domestic fleet in the North in 1996–98, and in 2004–05 dropped to the lowest level recorded. CPUE of target species caught by the Foreign and Charter fleet in the South was lower than in the North, but steady.

3.4 Total numbers of fish caught

The reported numbers and estimated numbers of fish caught by species are shown in Figure 8. Estimates were not made for the following years because the Domestic fleet had low observer coverage and accounted for a high proportion of the fishing effort: 1993–94 (Domestic hooks 50.5 % of total hooks), 1998–99 (78.2%), 1999–00 (86.1%), 2001–02 (91.0%), and 2002–03 (79.7%).

Catch numbers were underestimated when an area stratum (North or South) had zero observer coverage. In these cases the catch estimate was calculated for just the remaining area stratum. Usually the number of hooks set in the stratum that was not represented by observer effort was less than 5%, so the degree of underestimation was low; however the following strata had higher numbers of unrepresented hooks: 1995–96 Foreign+Charter South (7.8% of total hooks), 1994–95 Domestic South (17.1%), 1995–96 Domestic South (8.3%) and 2003–04 Domestic South (6.1%).

Some problems are apparent in the commercial catch data, due to inaccurate recording of fish numbers and weights in some years by some fleets. In many cases only one of these is recorded and it is difficult to determine whether it was the number of fish or the weight, especially in the case of very high numbers. This problem is especially bad in 1988–89 and 1989–90 for the Foreign and Charter vessels and there were similar problems with some Domestic vessels in the mid 1990s. Fish "number" by fishing year is shown for blue sharks, mako sharks, and moonfish in Figure 9 to illustrate this. Some large values that are probably errors would account for much of the large peak of reported mako sharks in 1994–95 and high

levels of reported moonfish in 1994–95 and 1995–96 (see Figure 8). We have not attempted to groom these data and they are presented here as they were recorded.

CELR data were not included because either fish number or fish weight is reported, so the data for fish numbers are incomplete. This will cause a negative bias especially in years when a high proportion of the catch is reported on CELR forms (see Table 1).

Reported and estimated catches declined for blue, mako, and porbeagle sharks, and deepwater dogfish during the three year period (2002–03 to 2004–05) but especially in 2004–05 (see Figure 8). Albacore reported catches were highest in 2002–03 when the Philippine fleet was fishing in New Zealand waters, but reported and estimated catches have fallen since then. Reported catches of bigeye tuna peaked in 2000–01 and have fallen since then, while estimated catch levels are below the reported levels. Swordfish reported and estimated catches declined throughout the past three years, and estimated catches were higher than reported catches. Ray's bream reported and estimated catches were at the highest level even seen in 2003–04, then dropped in 2004–05. Reported and estimated catches of moonfish, oilfish, and rudderfish have all fallen from 2002–03 to 2004–05. Reported catches of escolar peaked in 2001–02 and have fallen since then. Reported catches of bigscale pomfret increased in 2004–05, although the estimated catches did not.

There was a decline in reported and estimated catches of all species combined and target species from 2002–03 to 2004–05. The pattern is unclear for non-target species. The decline in catch numbers of most species is due to the decline in effort in this three year period, especially in 2004–05.

Most bycatch species were poorly reported in earlier years but this has improved. Species such as dealfish, rudderfish, and lancetfish were not reported at all in the 1980s and much of the 1990s. Ray's bream and oilfish were reported sparsely. Bigscale pomfret and escolar have appeared in TLCERs only in recent years, and reported catches have increased for both of these species; however, estimated catches showed no long-term trend (Figure 8).

3.5 Length-frequency distributions and catch weights

Observed length frequency distributions of blue, mako, and porbeagle sharks, Ray's bream, and striped marlin, by year, area, and sex are shown in Figures 10–14 for fish measured in 2002–03 to 2004–05.

Length frequency distributions of blue sharks showed differences in size composition between North and South areas, with more large sharks caught in the North (Figure 10). The largest blue sharks (250+ cm fork length) were large males caught in the North in 2002–03, mainly by the Philippine fleet. There were more female blue sharks caught than males (64.7% overall), with a higher proportion of females in the South (74.7%).

Based on the length-frequency distributions and approximate mean lengths at maturity of 192.5 cm FL for males and 180 cm for females (Francis & Duffy 2005), most blue sharks were immature (85.1% of males and 90.1% of females, overall). Greater proportions of mature blue sharks were found in the North, with 26.3% of males and 19.7% of females mature.

Porbeagle length distributions show two modes, with the largest mode between 60 and 100 cm for both sexes in both areas and a smaller mode from 120 to 200 cm (Figure 11). More large porbeagle sharks were caught in the South area. Based on length-frequencies and mean lengths at maturity of 145 cm FL for males and 175 cm FL for females (Francis & Duffy 2005), most porbeagle sharks were immature

(69.9% of males and 96.1% of females, overall). Sex ratios were similar (56.3% males and 43.7% females), but more males were caught in 2002–03.

Length distributions of mako sharks showed differences in size composition between North and South areas (Figure 12). The distribution was broad in the North area for both sexes, while more large sharks occur in the South, and few small ones were seen in the South. With mean length of maturity of 182.5 cm FL for males and 280 cm FL for females (Francis & Duffy 2005), most female mako sharks were immature (96.9% of females, overall), while most males in the North were immature (78.2%), and most males in the South were mature (71.1%). More males were caught than females (60.8%) and the proportion of females was higher in the South (78.1%) than the North (54.5%).

Total catch weights could not be estimated for 2002–03 due to the lack of observer coverage of the Domestic fleet. Estimated weights of blue sharks caught by all vessels in 2003–04 and 2004–05 were 1731 t and 1233 t respectively. For porbeagle sharks, the estimated catch weights were 168 t and 162 t, and for makos, 48 t and 27 t for 2003–04 and 2004–05 respectively.

The length distributions of Ray's bream for all three years combined show that there is a North/South difference but the distributions for males and females are similar (Figure 13). Due to lack of data by sex in the North area plus the large number of Ray's bream measured but unsexed, distributions are shown for each fishing year by North and South only, with males, females, and unsexed fish combined (Figure 13). The distributions vary from year to year, especially in the North area. In the North area in 2002–03, there was one predominant mode at 48 cm, while in 2003–04 there were two modes, one at 33 cm (mainly unsexed fish) and the other around 48 cm, and in 2004–05 there was one predominant mode centred at 39 cm. South distributions show a mode at 47 cm each year with an additional mode at 40 cm in 2004–05. This latter mode of small fish was not evident in earlier years (Ayers et al. 2004, Francis et al. 2004).

Female Ray's bream mature at about 43 cm (Francis et al. 2004), and most females in the North were probably immature (69.8%), while most females in the South were probably mature (72.6%). The estimated catch weights of Ray's bream were 45 t in 2003–04, and 20 t in 2004–05.

Only 23 striped marlin were measured in 2002–03, 2003–04 and 2004–05 (Figure 14), ranging from 163 to 251 cm fork length. The estimated catch weights of striped marlin were 18 t in 2003–04, and 41 t in 2004–05, but as these estimates were based on low catches they should be regarded with caution.

3.6 Status of fish on recovery and discards

The percentages of the main non-target species recorded alive or dead, by fleet, area, and year, are shown in Table 7. The top 15 most abundant species in the three-year period are included in this table, along with butterfly tuna, oilfish, school shark, and striped marlin, which have been included in previous bycatch reports (Ayers et al. 2004, Francis et al. 2004). Bigscale pomfret, escolar, and yellowfin tuna are included as they were more abundant than in previous years.

Most sharks were landed alive, with highest percentage alive for blue sharks and deepwater dogfish and lowest for porbeagle sharks. Most Ray's bream, bigscale pomfret, moonfish, escolar, oilfish, and rudderfish were alive when recovered, while most dealfish and lancetfish were recovered dead. Most yellowfin tuna and striped marlin were recovered alive while most of the butterfly tuna and swordfish were dead on recovery. Most of the albacore landed by the Charter fleets (including the Philippine vessels fishing in the North) were alive, but most of those caught by the Domestic fleet were dead. Dealfish, which are almost all caught by the Charter fleet in the South, showed a big difference in percentage dead

or alive among years: most were dead in 2002–03 and 2003–04, while most were alive in 2004–05 (though the sample size in the last year was small).

The proportions of each species retained and discarded are shown in Table 8. Most blue, mako, porbeagle, and school sharks were processed in some way, while almost all deepwater dogfish were discarded. Most blue sharks were finned only, with few retained for further processing. Most of the mako sharks were retained for further processing by the Charter fleet, while most were finned only or discarded by the Domestic fleet. Fewer porbeagle shark were retained for further processing, most finned only by the Charter vessels and discarded by the Domestic fleet. Most school sharks were retained for their flesh, but some school sharks were discarded by the Charter fleet. Since the blue, mako, and porbeagle sharks became quota species, fewer blue sharks were discarded, but the Charter fleet discarded more makos and there did not seem to be any change with the porbeagles. Philippine vessels finned most blue and porbeagle sharks and processed nearly half of the mako sharks.

More moonfish and Ray's bream were retained by the Charter fleet since they became quota species, this representing a change from previous practice when many moonfish, and most Ray's bream were discarded (Francis et al. 2004). These two species were usually retained by Domestic vessels (Francis et al. 2004), and this trend has continued. Almost all dealfish and lancetfish were discarded by both the Charter and Domestic fleets. Rudderfish and oilfish were mostly retained by the Domestic fleet and discarded by the Charter fleet, following a similar trend to that previously reported (Francis et al. 2004). The proportion of bigscale pomfret retained by the Charter fleet appears to have increased from 2002–03 to 2004–05, while escolar was mostly discarded by the Charter fleet and retained by the Domestic vessels. Philippine vessels retained escolar and a few rudderfish and lancetfish, and discarded moonfish, Ray's bream, bigscale pomfret, and oilfish.

Almost all albacore and swordfish were retained, along with most yellowfin and a large proportion of butterfly tuna. The proportion of swordfish retained may have increased since they became quota species. Charter vessels discarded nearly half of the yellowfin tuna that they caught in 2002–03. Domestic vessels kept yellowfin tuna, and Philippine vessels retained albacore, yellowfin tuna, and swordfish.

In the period 2002–03 to 2004–05, 48 striped marlin were observed, and most of these were returned to the sea, except for 19 fish caught by the Domestic fleet outside the New Zealand EEZ.

3.7 Diet of pelagic sharks

The proportions of fish, squid, crustaceans, salps, and other bait types found in stomachs of blue, mako, and porbeagle sharks are shown in Figure 15. Fish and squid are the predominant prey consumed by all three species, with roughly equal occurrence of both in stomachs of blue sharks, a greater proportion of fish in porbeagle shark stomachs, and a predominance of fish in mako stomachs. Observers recorded the species of fish consumed where it was recognisable. Dealfish and Ray's bream were the two species most commonly identified in the stomach of blue and porbeagle sharks, while Ray's bream and albacore were the most common species identified in the stomach of mako sharks. Other species found in the stomach of these sharks include squaretail, rudderfish, escolar, hoki, lancetfish, and oilfish. While the occurrences of crustaceans in shark stomachs were infrequent, observers recorded prawns, krill, and shrimps. Other prey types included octopus, nautilus, and, in the case of blue sharks, parts of seabirds.

There was a change in the relative importance of fish and squid with size of blue and porbeagle sharks, with both changing from consuming mostly squid to consuming mostly fish (Figure 16). Makos consumed mainly fish at all sizes.

4. DISCUSSION

Major changes occurred in the New Zealand tuna longline fishery in 2002–03 to 2004–05. Introduction of a new TLCER form with better reporting of discarded species, and introduction of several important target and non-target species into the QMS, coincided with a decline in fishing effort, particularly for the Domestic fleet. Domestic effort peaked in 2001–02 and has declined since then. Charter effort also declined during this time. From 1999–2000, the Japanese Charter fleet has consisted of four vessels, and this dropped to two vessels in 2004–05. A fleet of Philippine vessels fished in New Zealand waters for the first and only time in 2002–03.

The species most commonly observed on tuna longlines in 2002–03 to 2004–05 were blue shark, albacore tuna, and Ray's bream, as in previous years (Francis et al. 1999, 2000, 2004, Ayers et al. 2004). Catch composition varied with area fished and fleet. The Philippine fleet targeted albacore and fished subtropical waters in the far north and this is reflected in their high catches of albacore and yellowfin tuna. The Japanese Charter fleet fished a similar area on the west coast of the South Island in all three years, but the area fished in the North varied. They fished for bigeye tuna around Three Kings Islands in 2002–03 and 2003–04 and for southern bluefin tuna off East Cape in 2004–05. Differences in CPUE trends in 2004–05 in the Charter fleet in the North may reflect different fishing methods or varying abundance of species in these two areas.

We have not been able to adequately quantify changes in catch made by the Domestic fleet due to low observer coverage of this fleet, which contributed most of the effort.

While CPUE has increased for many species during this three-year period, with the decline in fishing effort, catch numbers of most species have decreased throughout this period.

Overall, estimated numbers caught are higher than numbers reported for all years with a bigger shortfall for the non-target species than for the target species. With reported catch numbers of some bycatch species closer to that of estimated catch numbers in recent years, it appears that reporting of some bycatch species has improved particularly for Ray's bream, bigscale pomfret, oilfish and escolar. Many are under-reported, especially sharks. This has been investigated further under Objective 5 of this project (Griggs et al. 2006).

Since blue, mako and porbeagle sharks became quota species, fewer blue sharks were discarded, but the Charter fleet discarded a higher proportion of mako sharks. More moonfish and Ray's bream were retained by the Charter fleet since they became quota species, while previously many moonfish and most Ray's bream were discarded.

Francis et al. (2004) suggested that it is unlikely that New Zealand's tuna longline fishery is having a serious impact on the stock of blue, mako and porbeagle sharks, and catch levels in recent years are unlikely to have made any changes to this, although adequate assessment of the wider stock has not been carried out. However, under-reporting of sharks (and other non-target species), and low Domestic observer coverage, create considerable uncertainty about the true level of fishery removals from these stocks.

We recommend that observer coverage of the Domestic fleet be increased and that efforts are made to ensure that the coverage is representative of the spatial and temporal distribution of the fishing effort and therefore the catch.

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Table 1: Number of tuna longline trips, sets, and hooks observed, and number of hooks reported on TLCER and CELR forms by tuna longline vessels fishing in New Zealand. "Foreign and charter" vessels are predominantly Japanese, with some Korean effort in the 1980s, Philippine effort in 2002–03, and the effort of one large domestic vessel that fished with the Japanese charter fleet.

	Observed		Observed hooks			Set hooks			
Fishing year	Trips	Sets	Domestic	Foreign+ charter	Total	Domestic	Foreign+ charter	Total	% on CELR
1988-89	5	86	0	234 826	234 826	11 800	9 953 745	9 965 545	0.1
1989-90	6	154	0	447 239	447 239	117 562	8 553 288	8 670 850	1.3
1990-91	3	150	0	421 808	421 808	350 897	15 316 845	15 667 742	2.0
1991-92	8	192	19 525	508 629	528 154	544 658	10 362 346	10 907 004	1.9
1992-93	17	373	0	1 057 985	1 057 985	996 293	5 970 648	6 966 941	1.8
1993-94	9	246	2 418	693 262	695 680	1 798 970	1 763 343	3 562 313	11.2
1994-95	12	339	65 694	815 807	881 501	3 003 260	1 641 585	4 644 845	15.7
1995-96	5	147	162 922	0	162 922	3 048 663	258 203	3 306 866	21.2
1996-97	15	424	79 991	882 763	962 754	2 336 462	1 455 906	3 792 368	6.9
1997-98	15	438	70 835	989 566	1 060 401	2 943 762	1 277 666	4 221 428	4.6
1998-99	9	402	35 264	1 052 721	1 087 985	5 394 338	1 504 271	6 898 609	3.6
1999-00	13	274	38 458	659 923	698 381	7 143 042	1 150 085	8 293 127	2.9
2000-01	23	474	240 979	818 744	1059 723	8 907 172	943 018	9 850 190	1.3
2001-02	17	398	144 716	773 443	918 159	9 973 801	984 695	10 958 496	0.3
2002-03	9	610	0	1 887 816	1 887 816	8 650 712	2 216 292	10 867 004	0.2
2003-04	16	549	128 399	1 336 066	1 464 465	5 924 227	1 471 454	7 395 681	0.1
2004-05	14	343	150 574	562 825	713 399	3 091 477	642 074	3 733 551	0.6
Total	196	5599	1 139 775	13 143 423	14 455 467	64 237 096	64 465 464	129 702 560	2.9

Table 2: Percentage of hooks observed

Fishing year	Domestic	Foreign+ charter	Total
1988-89	0.0	2.4	2.4
1989-90	0.0	5.2	5.2
1990-91	0.0	2.8	2.7
1991-92	3.6	4.9	4.8
1992-93	0.0	17.7	15.2
1993-94	0.1	39.3	19.5
1994-95	2.2	49.7	19.0
1995-96	5.3	0.0	4.9
1996-97	3.4	60.6	25.4
1997-98	2.4	77.5	25.1
1998-99	0.7	70.0	15.8
1999-00	0.5	57.4	8.4
2000-01	2.7	86.8	10.8
2001-02	1.5	78.5	8.4
2002-03	0.0	85.2	17.4
2003-04	2.2	90.8	19.8
2004-05	4.9	87.7	19.0
Total	1.8	20.3	11.1

Table 3: Percentage of hooks observed on observed sets. Values are the numbers of sets in each category.

		Number of sets		
Fishing year	% hooks observed	Domestic	Foreign+ charter	Total
2002-03	30-39		1	1
	40-49		3	3
	50-59		3	3
	60-69		32	32
	70-79		129	129
	80-89		129	129
	90-99		316	316
	100		1	1
	Total		**616**	**616**
2003-04	40-49		2	2
	50-59		3	3
	60-69	1	7	8
	70-79		24	24
	80-89		154	154
	90-99		254	254
	100	101	3	104
	Total	**102**	**447**	**549**
2004-05	40-49	1		1
	50-59		4	4
	60-69	1	13	14
	70-79		58	58
	80-89		24	24
	90-99		100	100
	100	142		142
	Total	**144**	**199**	**343**

Table 4: Numbers of sets and hooks available for estimating CPUE and numbers of fish caught, by fishing year, fleet and area. Reported hooks are in thousands.

		Foreign and Charter fleet				Domestic fleet			
Fishing year	Area	Reported sets	% sets observed	Reported hooks	% hooks observed	Reported sets	% sets observed	Reported hooks	% hooks observed
1988–89	N	1 284	3.7	3 701	3.3	12	0.0	12	0.0
1989–90	N	1 294	6.0	3 752	6.0	265	0.0	117	0.0
1990–91	N	2 052	5.9	6 032	5.6	447	0.0	319	0.0
1991–92	N	1 550	5.4	4 500	5.4	691	0.0	540	0.0
1992–93	N	445	28.8	1 207	27.5	1117	0.0	944	0.0
1993–94	N	49	65.3	137	63.4	1978	0.0	1 649	0.0
1994–95	N	23	56.5	61	44.9	2705	1.8	2 210	3.0
1995–96	N	0	–	0	–	3154	2.1	2 775	2.3
1996–97	N	48	91.7	136	87.0	2792	3.6	2 328	3.4
1997–98	N	123	76.4	328	73.9	3267	2.4	2 930	2.4
1998–99	N	53	54.7	167	50.0	5383	0.7	5 376	0.7
1999–00	N	46	54.3	134	50.5	6547	0.0	7 087	0.0
2000–01	N	31	100.0	83	93.5	7731	2.6	8 842	2.7
2001–02	N	4	100.0	12	97.9	8196	1.5	9 683	1.5
2002–03	N	27	100.0	80	86.0	7120	0.0	8 539	0.0
2003–04	N	16	100.0	52	79.6	4722	2.1	5 487	2.2
2004–05	N	42	100.0	138	84.8	2754	4.9	3 017	4.7
1988–89	S	2137	1.8	6253	1.8	0	–	0	–
1989–90	S	1628	4.7	4801	4.6	2	0.0	0.45	0.0
1990–91	S	3127	0.9	9285	0.9	23	0.0	31.4	0.0
1991–92	S	1995	4.6	5862	4.6	7	0.0	4.98	0.0
1992–93	S	1563	15.7	4763	15.2	29	0.0	52.62	0.0
1993–94	S	560	37.7	1626	37.3	129	0.0	150.415	0.0
1994–95	S	540	51.1	1580	49.9	798	0.0	793.42	0.0
1995–96	S	96	0.0	258	0.0	323	25.1	273.818	35.9
1996–97	S	457	61.1	1320	57.9	14	0.0	8.81	0.0
1997–98	S	318	82.7	950	78.7	16	0.0	13.5	0.0
1998–99	S	436	77.1	1338	72.5	34	0.0	18.715	0.0
1999–00	S	334	63.8	1016	58.3	60	0.0	56.4	0.0
2000–01	S	277	87.0	860	86.2	79	0.0	65.04	0.0
2001–02	S	320	84.7	973	78.3	283	0.0	291.225	0.0
2002–03	S	348	100.0	1134	92.7	150	0.0	137.485	0.0
2003–04	S	431	100.0	1420	91.2	410	1.2	448.25	1.4
2004–05	S	157	100.0	504	88.4	107	7.5	96.882	7.9

		Philippine fleet			
Fishing year	Area	Reported sets	% sets observed	Reported hooks	% hooks observed
2002–03	N	241	96.7	1002	76.6

Table 5: Numbers of fish reported by observers during 2002–03, 2003–04, and 2004–05, and the total observed catch since 1988–89. Numbers for porbeagle and mako sharks are from 1992–93 when observers could reliably distinguish these two species. Species are ranked in descending order of abundance since 1988–89.

Species	Scientific name	2002-03	2003-04	2004-05	Total
Blue shark	*Prionace glauca*	7 078	10 713	9 387	137 093
Albacore tuna	*Thunnus alalunga*	32 160	4 164	3 705	89 285
Ray's bream	*Brama brama*	6 424	11 845	8 423	64 029
Southern bluefin tuna	*Thunnus maccoyii*	1 700	2 064	1 159	31 601
Porbeagle shark	*Lamna nasus*	423	714	359	16 483
Dealfish	*Trachipterus trachypterus*	1 901	908	148	14 701
Lancetfish	*Alepisaurus ferox & A. brevirostris*	703	314	335	8 362
Moonfish	*Lampris guttatus*	736	279	453	7 289
Oilfish	*Ruvettus pretiosus*	83	90	209	6 706
Deepwater dogfish	Squaliformes	518	1 050	347	6 669
Swordfish	*Xiphias gladius*	188	396	466	5 622
Rudderfish	*Centrolophus niger*	420	739	156	4 455
Mako shark	*Isurus oxyrinchus*	334	289	421	4 242
Bigscale pomfret	*Taractichthys longipinnis*	1 010	1 077	979	4 201
Butterfly tuna	*Gasterochisma melampus*	125	81	89	3 786
Escolar	*Lepidocybium flavobrunneum*	1 111	638	64	3 641
Yellowfin tuna	*Thunnus albacares*	1 822	9	88	3 236
School shark	*Galeorhinus galeus*	113	257	274	3 148
Bigeye tuna	*Thunnus obesus*	652	236	62	2 929
Hoki	*Macruronus novaezelandiae*	216	239	97	1 736
Ray, unidentified	Torpediniformes	632	59	43	1 670
Sunfish	*Mola mola*	91	196	103	1 629
Thresher shark	*Alopias vulpinus*	165	120	71	1 188
Skipjack tuna	*Katsuwonus pelamis*	783	13	5	1 106
Dolphinfish	*Coryphaena hippurus*	204	3	2	463
Striped marlin	*Tetrapturus audax*	17	6	25	405
Barracouta	*Thyrsites atun*	2	3	3	344
Flathead pomfret	*Taractes asper*	125	54	4	341
Black barracouta	*Nesiarchus nasutus*	22	19	4	330
Shark, unidentified	Selachii	12	2	1	188
Pacific bluefin tuna	*Thunnus orientalis*	9	8	12	183
Slender tuna	*Allothunnus fallai*	3	4	4	155
Hapuku and bass	*Polyprion oxygeneios & P. americanus*	8	23	32	152
Shortbill spearfish	*Tetrapturus angustirostris*	65	1	1	122
Bronze whaler shark	*Carcharhinus brachyurus*	1	8	60	119
Cubehead	*Cubiceps* sp.	0	72	45	118
Ray, unidentified	Myliobatiformes	0	4	5	89
Kingfish	*Seriola lalandi*	7	3	1	78
Frostfish	*Lepidopus caudatus*	70	1	0	77
Wahoo	*Acanthocybium solandri*	69	0	0	70
Opah	*Lampris immaculatus*	1	6	0	65
Fanfish	*Pterycombus petersii*	9	2	1	60
Snipe eel	Nemichthyidae	3	3	1	52
False frostfish	*Paradiplospinus gracilis*	36	0	0	40
Bigeye thresher	*Alopias superciliosus*	1	0	13	35
Wingfish	*Pteraclis velifera*	2	5	1	33
Hake	*Merluccius australis*	4	6	5	32

Table 5 (*continued*). Species marked with an asterisk were not recorded in observed longline catches before 2002-03.

Species	Scientific name	2002-03	2003-04	2004-05	Total
Unicornfish	*Lophotus capellei*	9	2	1	18
Gemfish	*Rexea solandri*	1	0	0	18
Oceanic whitetip shark	*Carcharhinus longimanus*	5	1	1	16
Blue marlin	*Makaira mazara*	4	1	1	14
Hammerhead shark	*Sphyrna zygaena*	0	0	4	13
Skate	Rajidae	0	0	0	11
Pilotfish	*Naucrates ductor*	0	0	1	10
Marlin, unspecified	Isiophoridae	5	0	1	8
Barracudina	*Magnisudis prionosa*	0	0	0	8
Black marlin	*Makaira indica*	2	0	1	7
Barracuda	*Sphyraena novaehollandiae*	0	0	0	7
Ragfish	*Icichthys australis*	0	0	0	7
Pelagic stargazer	*Pleuroscopus pseudodorsalis*	0	0	1	6
Ribaldo	*Mora moro*	1	0	0	6
Remora	Echeneidae	0	0	0	6
Sawtooth eel	*Serrivomer* sp.	0	0	0	6
Squid	Cephalopoda	1	0	0	5
Squaretail*	*Tetragonurus cuvieri*	0	0	4	4
Seahorse	*Hippocampus* sp.	0	1	2	4
Broadnose seven gill shark	*Notorynchus cepedianus*	1	0	1	4
Bluenose	*Hyperoglyphe antarctica*	0	0	0	4
Pomfret, unidentified*	Bramidae	0	3	0	3
Smallscaled brown slickhead*	*Alepocephalus australis*	3	0	0	3
Basking shark	*Cetorhinus maximus*	0	2	0	3
Black mackerel	*Scombrolabrax heterolepis*	0	0	0	3
Manta ray	*Mobula japanica*	0	0	0	3
Great white shark	*Carcharodon carcharias*	0	0	0	3
Scalloped dealfish	*Zu elongatus*	0	0	0	3
Pufferfish	*Sphoeroides pachygaster*	2	0	1	3
Bigeye scabbard fish	*Benthodesmus elongatus*	0	1	0	2
Blue cod	*Parapercis colias*	0	0	0	2
Carpet shark	*Cephaloscyllium isabellum*	0	0	0	2
Crab*	Malacostraca	2	0	0	0
Octopus	Cephalopoda	0	0	0	2
Pelagic butterfish	*Schedophilus maculatus*	0	0	0	2
Amberjack*	*Seriola rivoliana*	0	0	1	1
Silky shark*	*Carcharhinus falciformis*	0	1	0	1
Prickly anglerfish*	*Himantolophus appelii*	0	1	0	1
Jack mackerel*	*Trachurus* sp.	0	0	1	1
Kahawai*	*Arripis trutta*	0	0	1	1
Scissortail*	*Psenes pellucidus*	0	1	0	1
Trevally*	*Pseudocaranx dentex*	0	1	0	1
Large headed slickhead	*Rouleina* sp.	0	0	0	1
Brown stargazer	*Xenocephalus armatus*	0	0	0	1
Manefish	*Caristius* sp.	0	0	0	1
Blue mackerel	*Scomber australasicus*	0	0	0	1
Frigate tuna	*Auxis thazard*	0	0	0	1
Sharpnose seven gill shark	*Heptranchias perlo*	0	0	0	1
Red cod	*Pseudophycis bachus*	0	0	0	1

Table 5 (*continued*).

Species	Scientific name	2002-03	2003-04	2004-05	Total
Salp	Thaliacea	0	0	0	1
Snapper	*Pagrus auratus*	0	0	0	1
Sprat	*Sprattus* sp.	0	0	0	1
Tiger shark	*Galeocerdo cuvier*	0	0	0	1
Tasmanian ruffe	*Tubbia tasmanica*	0	0	0	1
White warehou	*Seriolella caerulea*	0	0	0	1
Unidentified fish		619	35	2	3972
All species		60 711	36 773	27 686	432 566

Table 6: Numbers of the commonest species observed in 2002–03 to 2004–05 by fishing year, fleet and area. (Phili.=Philippine). Species are shown in descending order of abundance for the three years combined.

	2002–03			2003–04				2004–05			
		Charter	Phili.		Charter	Domestic			Charter	Domestic	
Species	North	South	North	North	South	North	South	North	South	North	South
Albacore tuna	698	754	30 708	733	376	3 053	2	846	525	2 312	22
Blue shark	319	5 876	883	134	8 579	1 972	28	761	5 752	2 668	206
Ray's bream	17	6 262	145	4	11 566	212	63	333	7 909	101	80
Southern bluefin t.	0	1 674	26	0	1 990	62	12	366	598	194	1
Bigscale pomfret	1	987	22	1	1 071	5	0	4	973	2	0
Dealfish	0	1 898	3	1	901	1	5	0	148	0	0
Yellowfin tuna	7	0	1 815	0	0	9	0	0	0	88	0
Deepwater dogfish	0	515	3	0	1 049	1	0	0	347	0	0
Escolar	592	0	519	559	1	78	0	5	0	59	0
Porbeagle shark	14	391	18	7	397	303	7	112	139	99	9
Moonfish	153	95	488	59	69	151	0	268	49	134	2
Lancetfish	42	2	659	16	15	282	1	37	10	288	0
Rudderfish	0	406	14	0	609	127	3	3	66	83	4
Swordfish	72	68	48	49	34	312	1	82	15	367	2
Mako shark	38	71	225	14	86	188	1	114	33	273	1
Bigeye tuna	229	0	423	205	0	31	0	8	0	54	0
School shark	1	112	0	0	256	0	1	39	230	4	1
Oilfish	38	3	42	8	0	82	0	159	0	49	1
Butterfly tuna	2	109	14	0	76	5	0	27	16	45	1
Striped marlin	5	0	12	0	1	5	0	0	0	24	1

Table 7: Percentage of main non-target species that were alive or dead when observed during the 2002–03, 2003–04, and 2004–05 fishing years, by fleet, region, and fishing year. Small sample sizes (number observed < 20) omitted. 1. Sharks.

Species	Fleet	Area	Year	% alive	% dead	Number
Blue shark	Charter	North	2002–03	95.8	4.2	285
			2003–04	92.2	7.8	115
			2004–05	94.6	5.4	572
		South	2002–03	93.2	6.8	4 730
			2003–04	94.1	5.9	5 486
			2004–05	95.2	4.8	3 239
	Philippine	North	2002–03	97.0	3.0	722
	Domestic	North	2003–04	78.7	21.3	1 271
			2004–05	89.7	10.3	2 270
		South	2003–04	87.5	12.5	24
			2004–05	99.5	0.5	201
	Total			**92.7**	**7.3**	**18 915**
Deepwater dogfish	Charter	South	2002–03	95.3	4.7	507
			2003–04	95.8	4.2	997
			2004–05	83.7	16.3	166
	Total			**94.4**	**5.6**	**1 674**
Porbeagle shark	Charter	North	2004–05	83.5	16.5	109
		South	2002–03	66.9	33.1	363
			2003–04	67.2	32.8	366
			2004–05	88.9	11.1	135
	Domestic	North	2003–04	64.8	35.3	295
			2004–05	58.6	41.4	99
	Total			**69.0**	**31.0**	**1 419**
Mako shark	Charter	North	2004–05	97.1	2.9	105
		South	2002–03	88.7	11.3	71
			2003–04	92.1	7.9	76
			2004–05	93.1	6.9	29
	Philippine	North	2002–03	87.1	12.9	217
	Domestic	North	2003–04	76.6	23.4	188
			2004–05	76.6	23.4	273
	Total			**84.0**	**16.0**	**1 004**
School shark	Charter	North	2004–05	97.4	2.3	39
		South	2002–03	65.7	34.3	108
			2003–04	64.8	35.3	244
			2004–05	92.9	7.1	225
	Total			**77.5**	**22.5**	**622**

Table 7: (continued). 2. Teleosts.

Species	Fleet	Area	Year	% alive	% dead	Number
Ray's bream	Charter	North	2002–03	96.8	3.2	94
			2004–05	98.5	1.5	195
		South	2002–03	83.1	16.9	4 202
			2003–04	90.5	9.5	6 896
			2004–05	97.7	2.3	3 036
	Philippine	North	2002–03	96.4	3.6	28
	Domestic	North	2003–04	72.5	27.5	142
			2004–05	86.9	13.1	99
		South	2003–04	91.3	8.7	23
			2004–05	100.0	0.0	53
	Total			**89.9**	**10.1**	**14 771**
Bigscale pomfret	Charter	South	2002–03	77.2	22.8	863
			2003–04	87.8	12.2	943
			2004–05	96.6	3.4	675
	Total			**86.4**	**13.6**	**2 514**
Dealfish	Charter	South	2002–03	2.7	97.3	1 125
			2003–04	29.6	70.4	497
			2004–05	74.1	25.9	81
	Total			**14.1**	**85.9**	**1 713**
Moonfish	Charter	North	2002–03	94.1	8.6	464
			2003–04	90.2	9.8	41
			2004–05	90.7	9.3	246
		South	2002–03	82.8	17.2	87
			2003–04	86.2	13.9	65
			2004–05	91.5	8.5	47
	Philippine	North	2002–03	87.0	13.0	138
	Domestic	North	2003–04	61.3	38.7	150
			2004–05	78.4	21.6	134
	Total			**85.4**	**14.6**	**1 374**
Escolar	Charter	North	2002–03	90.6	9.4	587
			2003–04	99.7	0.3	334
	Philippine	North	2002–03	93.2	6.8	222
	Domestic	North	2003–04	70.1	29.9	77
			2004–05	78.0	22.0	59
	Total			**91.44**	**8.56**	**1 285**
Lancetfish	Charter	North	2002–03	25.8	74.2	508
			2004–05	51.4	48.6	37
	Philippine	North	2002–03	41.2	58.8	34
	Domestic	North	2003–04	37.2	62.8	282
			2004–05	57.0	43.0	277
	Total			**38.7**	**61.3**	**1 182**

Table 7: (continued).

Species	Fleet	Area	Year	% alive	% dead	Number
Rudderfish	Charter	South	2002–03	91.1	8.9	348
			2003–04	94.7	5.3	525
			2004–05	85.5	14.5	55
	Domestic	North	2003–04	88.0	12.0	125
			2004–05	94.0	6.0	83
	Total			**92.1**	**7.9**	**1 159**
Oilfish	Charter	North	2002–03	81.2	18.8	69
			2004–05	84.1	15.9	157
	Domestic	North	2003–04	80.5	19.5	82
			2004–05	79.6	20.4	49
	Total			**82.5**	**17.5**	**377**

Table 7: (continued). 3. Tuna and billfish.

Species	Fleet	Area	Year	% alive	% dead	Number
Albacore	Charter	North	2002–03	71.0	29.0	7 374
			2003–04	89.7	10.3	593
			2004–05	83.7	16.3	724
		South	2002–03	80.5	19.5	722
			2003–04	74.4	25.6	348
			2004–05	85.7	14.3	497
	Philippine	North	2002–03	76.6	23.4	19 981
	Domestic	North	2003–04	30.0	70.0	3 004
			2004–05	41.3	58.7	2 310
		South	2004–05	90.9	9.1	22
	Total			**69.8**	**30.2**	**35 577**
Yellowfin tuna	Charter	North	2002–03	71.7	28.3	640
	Philippine	North	2002–03	76.4	23.6	1 146
	Domestic	North	2004–05	80.7	19.3	88
	Total			**75.0**	**25.0**	**1 883**
Swordfish	Charter	North	2002–03	44.9	55.1	69
			2003–04	44.1	55.9	34
			2004–05	84.6	15.4	78
		South	2002–03	54.1	45.9	61
			2003–04	63.6	36.4	33
	Philippine	North	2002–03	40.0	60.0	40
	Domestic	North	2003–04	31.4	68.6	312
			2004–05	30.2	69.8	367
	Total			**40.02**	**59.98**	**1 012**
Butterfly tuna	Charter	North	2004–05	63.0	37.0	27
		South	2002–03	28.9	71.1	97
			2003–04	21.1	78.9	71
	Domestic	North	2004–05	17.8	82.2	45
	Total			**31.4**	**68.6**	**277**
Striped marlin	Domestic	North	2004–05	70.8	29.2	24
	Total			**78.3**	**21.7**	**46**

Table 8: Percentage of main non-target species that were discarded or lost during the 2002–03, 2003–04, and 2004–05 fishing years, by fleet, region, and fishing year. Small sample sizes (number observed < 20) omitted. 1. Sharks.

Species	Fleet	Area	Year	% retained or finned	% discarded or lost	Number
Blue shark	Charter	North	2002–03	82.7	17.3	289
			2003–04	87.3	12.7	118
			2004–05	78.5	21.5	600
		South	2002–03	53.4	46.6	4 838
			2003–04	67.8	32.2	5 602
			2004–05	75.9	24.1	3 462
	Philippine	North	2002–03	92.9	7.1	734
	Domestic	North	2003–04	41.7	58.3	1 278
			2004–05	49.9	50.1	2 275
		South	2003–04	33.3	66.7	24
			2004–05	97.5	2.5	201
	Total			**63.7**	**36.3**	**19 421**
Deepwater dogfish	Charter	South	2002–03	0.4	99.6	513
			2003–04	0.2	99.8	998
			2004–05	0.0	100.0	205
	Total			**0.2**	**99.8**	**1 720**
Mako shark	Charter	North	2002–03	74.7	5.3	38
			2004–05	75.4	24.6	114
		South	2002–03	84.5	1.5	71
			2003–04	95.2	4.8	83
			2004–05	90.9	9.1	33
	Philippine	North	2002–03	76.3	23.7	224
	Domestic	North	2003–04	32.4	67.6	188
			2004–05	36.8	63.2	272
	Total			**61.0**	**39.0**	**1 039**
Porbeagle shark	Charter	North	2004–05	71.4	28.6	112
		South	2002–03	70.7	29.3	379
			2003–04	74.8	25.2	381
			2004–05	79.0	21.0	138
	Domestic	North	2003–04	13.2	86.8	295
			2004–05	26.3	73.7	99
	Total			**58.5**	**41.5**	**1 459**
School shark	Charter	North	2004–05	100.0	0.0	39
		South	2002–03	91.9	8.1	111
			2003–04	98.8	1.2	251
			2004–05	99.1	0.9	230
	Total			**97.0**	**3.0**	**638**

Table 8: (continued). 2. Teleosts.

Species	Fleet	Area	Year	% retained	% discarded or lost	Number
Ray's bream	Charter	North	2002–03	17.7	82.3	96
			2004–05	97.2	2.8	211
		South	2002–03	28.4	71.6	4 318
			2003–04	51.1	48.9	6 968
			2004–05	98.2	1.8	3 194
	Philippine	North	2002–03	0.0	100.0	28
	Domestic	North	2003–04	89.4	10.6	142
			2004–05	68.0	32.0	100
		South	2003–04	95.7	4.3	23
			2004–05	100.0	0.0	54
	Total			**55.6**	**44.4**	**15 138**
Bigscale pomfret	Charter	South	2002–03	26.5	73.5	886
			2003–04	50.3	49.7	956
			2004–05	47.1	52.9	720
	Total			**40.9**	**59.1**	**2 597**
Dealfish	Charter	South	2002–03	0.1	99.9	1540
			2003–04	2.1	97.9	583
			2004–05	0.0	100.0	103
	Total			**0.6**	**99.4**	**2 236**
Escolar	Charter	North	2002–03	29.4	70.6	821
			2003–04	0.0	100.0	334
	Philippine	North	2002–03	96.4	3.6	225
	Domestic	North	2003–04	80.5	19.5	77
			2004–05	71.2	28.8	59
	Total			**38.2**	**61.8**	**1 297**
Moonfish	Charter	North	2002–03	32.8	67.2	475
			2003–04	100.0	0.0	59
			2004–05	99.2	0.8	260
		South	2002–03	87.1	12.9	93
			2003–04	80.6	19.4	67
			2004–05	85.1	14.9	47
	Philippine	North	2002–03	0.7	99.3	138
	Domestic	North	2003–04	95.3	4.7	150
			2004–05	97.8	2.2	134
	Total			**64.9**	**35.1**	**1 425**
Lancetfish	Charter	North	2002–03	1.2	98.8	642
			2004–05	0.0	100.0	37
	Philippine	North	2002–03	8.8	91.2	34
	Domestic	North	2003–04	0.0	100.0	282
			2004–05	0.0	100.0	277
	Total			**0.8**	**99.2**	**1 316**

Table 8: (continued).

Species	Fleet	Area	Year	% retained	% discarded or lost	Number
Rudderfish	Charter	South	2002–03	0.0	100.0	368
			2003–04	4.2	95.8	529
			2004–05	0.0	100.0	64
	Domestic	North	2003–04	80.0	20.0	125
			2004–05	63.9	36.1	83
	Total			**15.9**	**84.1**	**192**
Oilfish	Charter	North	2002–03	1.4	98.6	69
			2004–05	0.00	100.00	159
	Domestic	North	2003–04	81.7	18.3	82
			2004–05	79.6	20.4	49
	Total			**28.4**	**71.6**	**380**

Table 8: (continued). 3. Tuna and billfish.

Species	Fleet	Area	Year	% retained	% discarded or lost	Number
Albacore	Charter	North	2002–03	97.4	2.6	8 206
			2003–04	99.9	0.1	667
			2004–05	98.8	1.2	771
		South	2002–03	98.7	1.3	750
			2003–04	96.5	3.5	369
			2004–05	99.4	0.6	519
	Philippine	North	2002–03	99.9	0.1	20 252
	Domestic	North	2003–04	96.6	3.4	3 004
			2004–05	97.4	2.6	2 311
			2004–05	95.5	4.6	22
	Total			**98.8**	**1.2**	**36 873**
Yellowfin tuna	Charter	North	2002–03	56.4	43.6	660
	Philippine	North	2002–03	96.3	3.7	1 162
			2004–05	97.7	2.3	88
	Total			**82.5**	**17.5**	**1 919**
Swordfish	Charter	North	2002–03	87.5	12.5	80
			2003–04	98.0	2.0	49
			2004–05	90.1	9.9	81
		South	2002–03	95.5	4.5	67
			2003–04	94.1	5.9	34
	Philippine	North	2002–03	95.0	5.0	40
	Domestic	North	2003–04	86.5	13.5	312
			2004–05	97.3	2.7	367
	Total			**92.5**	**7.5**	**1 048**
Butterfly tuna	Charter	North	2004–05	100.0	0.0	27
		South	2002–03	67.9	32.1	106
			2003–04	90.5	9.5	74
	Domestic	North	2004–05	37.8	62.2	45
	Total			**71.4**	**28.62**	**290**
Striped marlin	Domestic		2004–05	79.2	20.8	24
	Total			**41.7**	**58.3**	**48**

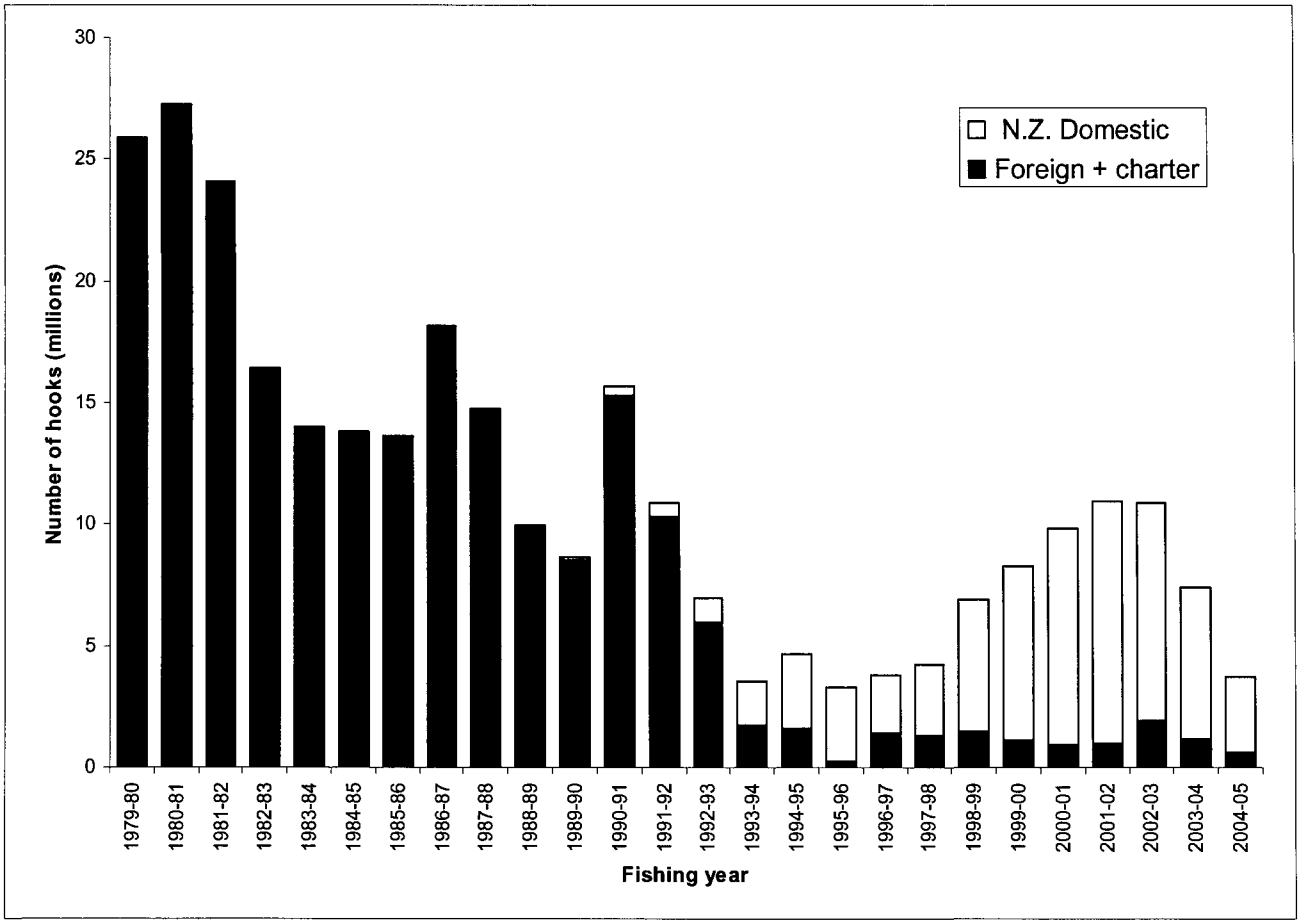


Figure 1: Number of hooks set by fishing year and fleet from 1979–80 to 2004–05. "Foreign + charter" includes Japanese foreign licensed and charter vessels, Korean foreign licensed vessels, Philippine charter vessels, and one large New Zealand domestic vessel which fished with the charter fleet.

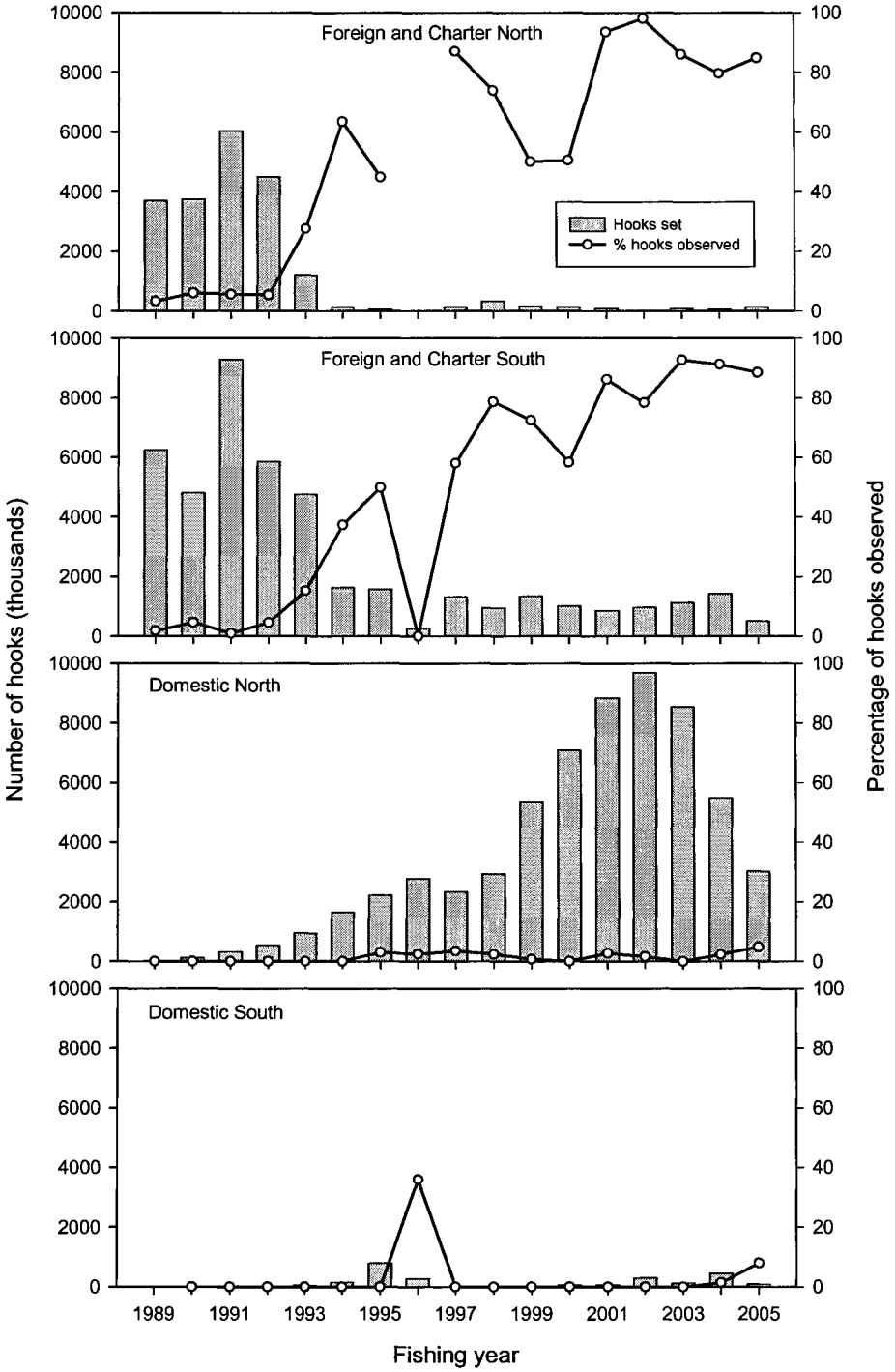


Figure 2: Numbers of hooks set, and percentage of hooks observed, by fleet, area, and fishing year. "Foreign + charter" includes Japanese foreign licensed and charter vessels, Korean foreign licensed vessels, Philippine charter vessels and one large New Zealand domestic vessel which fished with the charter fleet.

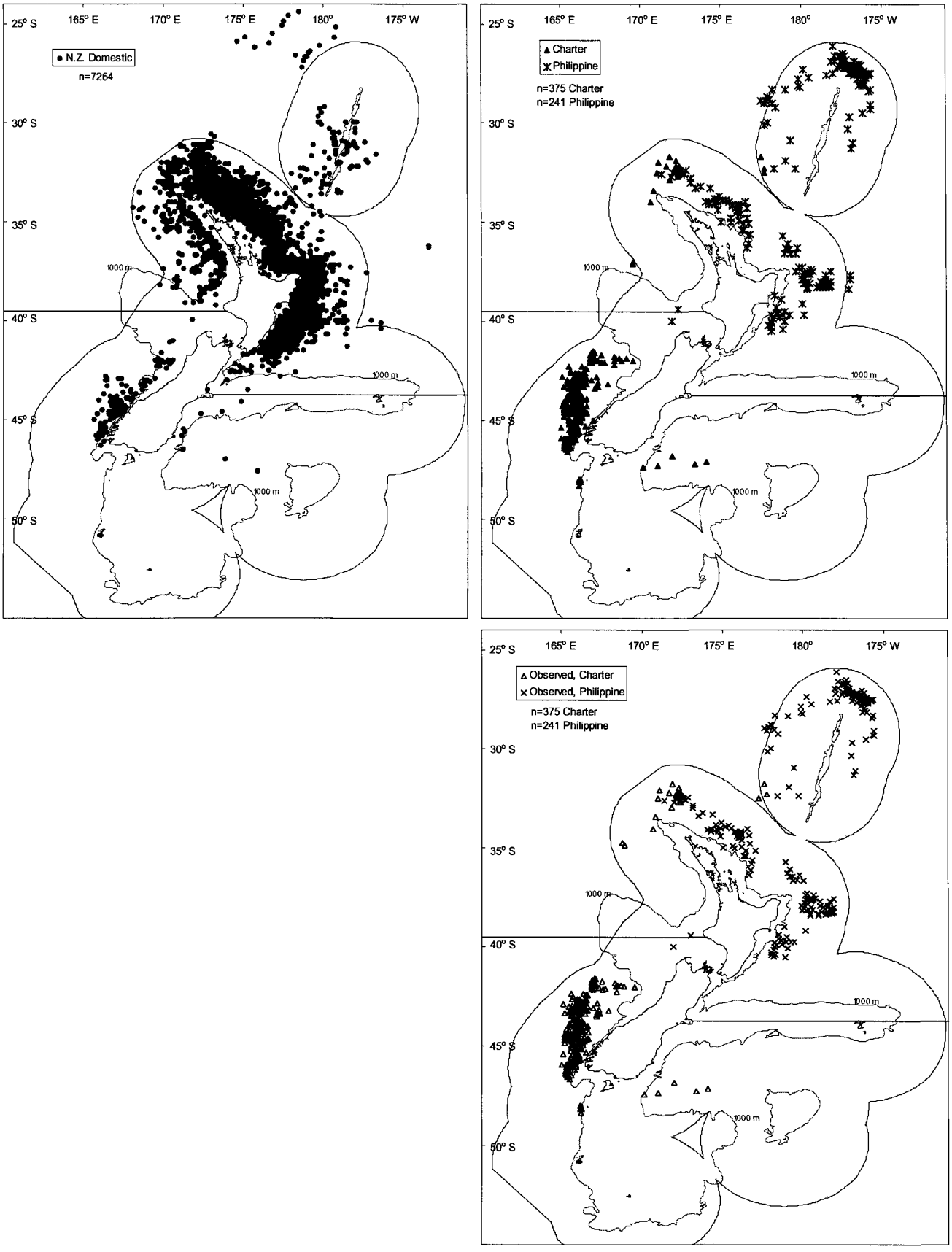


Figure 3: Start positions for tuna longline sets reported (above) and observed (below) in 2002–03. "Charter" refers to the Japanese charter fleet plus one large domestic vessel; the Philippine charter fleet is shown separately.

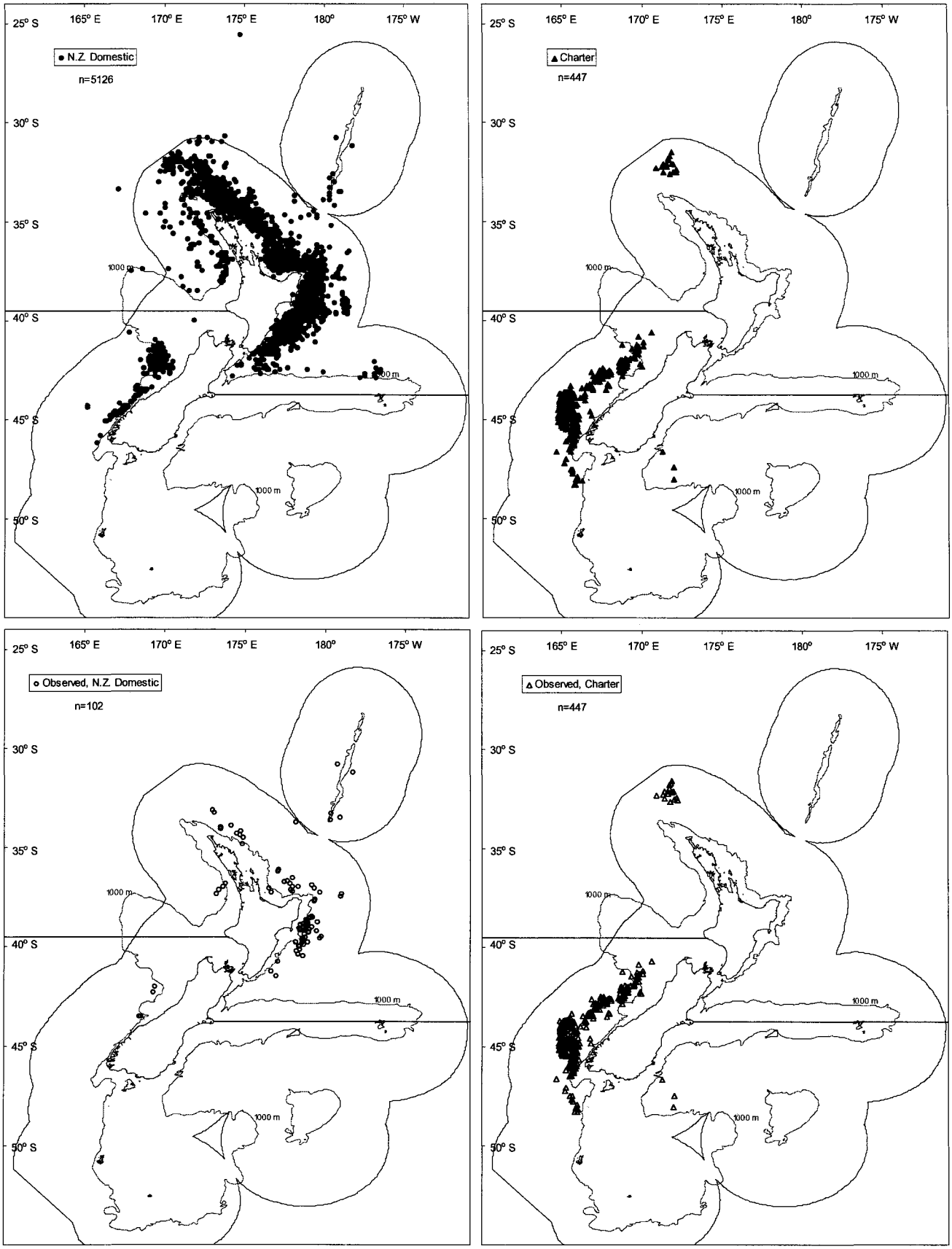


Figure 4: Start positions for tuna longline sets reported (above) and observed (below) in 2003–04.

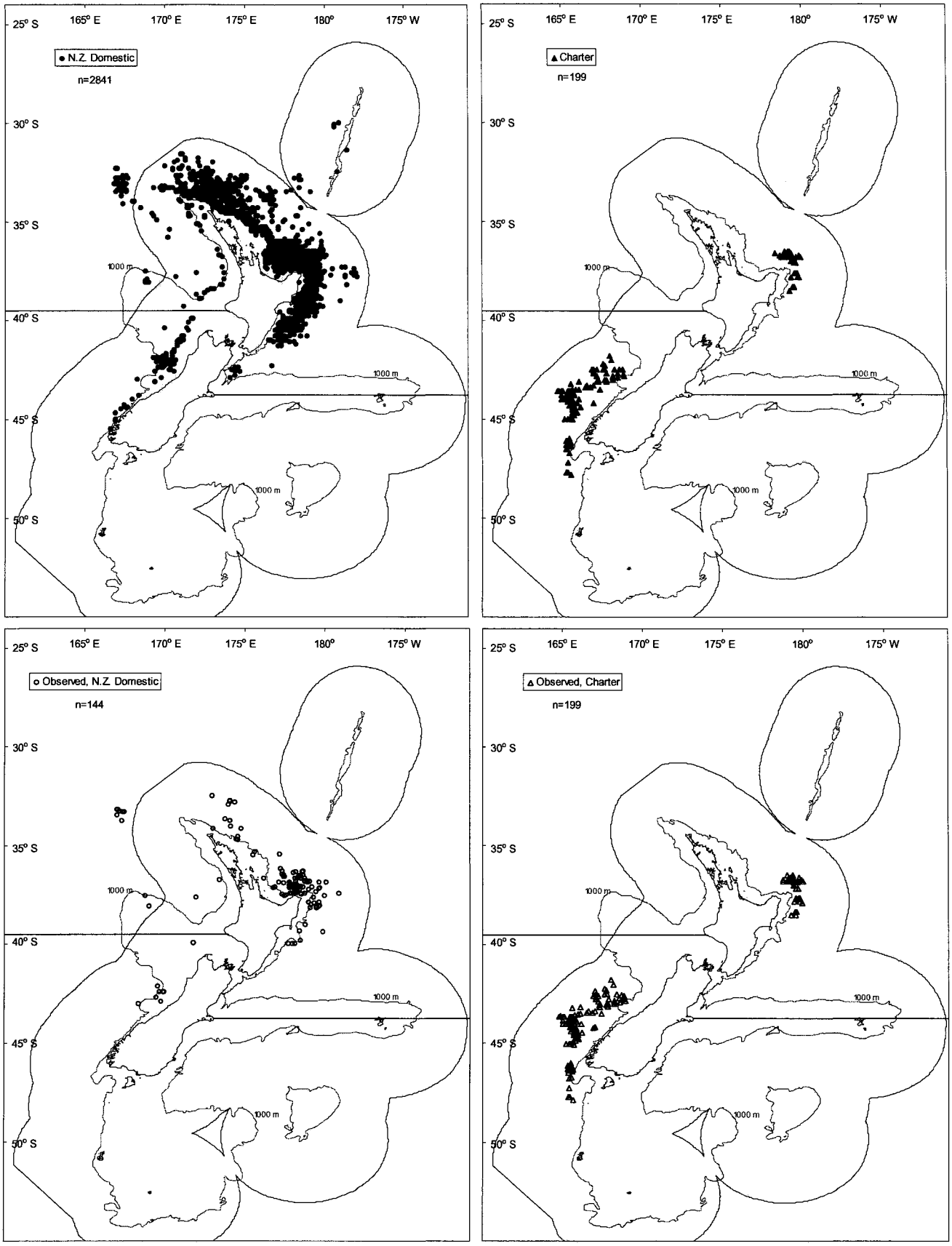
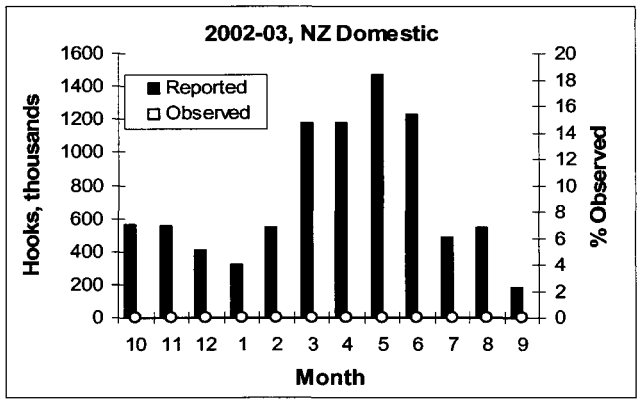
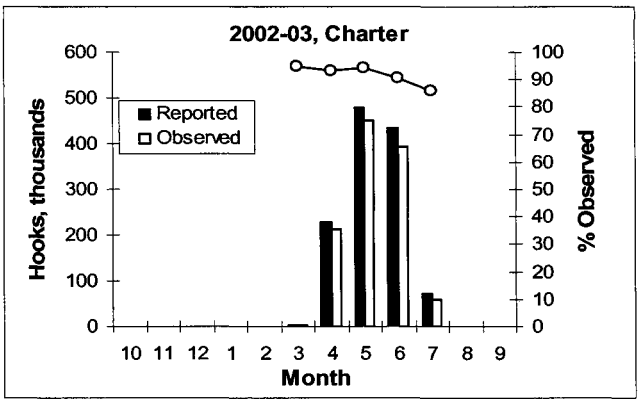
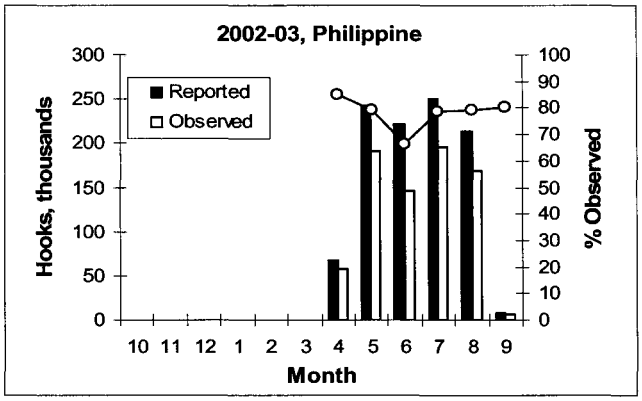
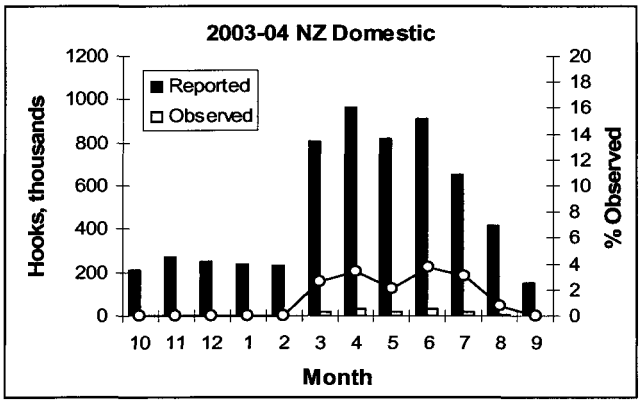


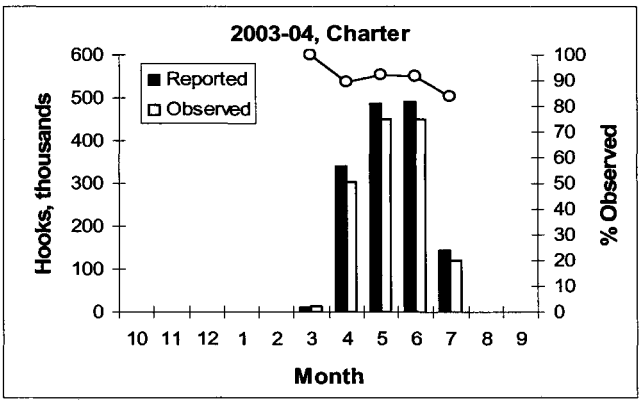
Figure 5: Start positions for tuna longline sets reported (above) and observed (below) in 2004–05.

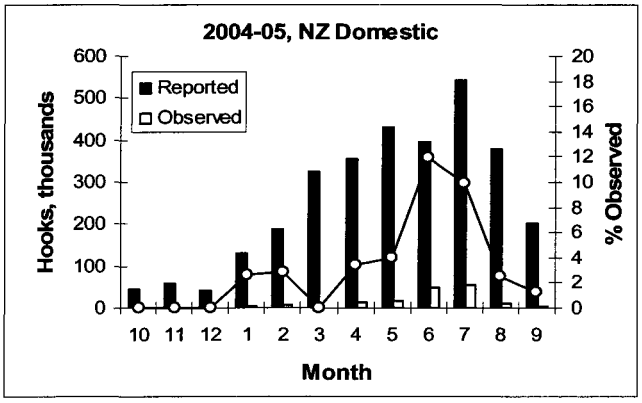












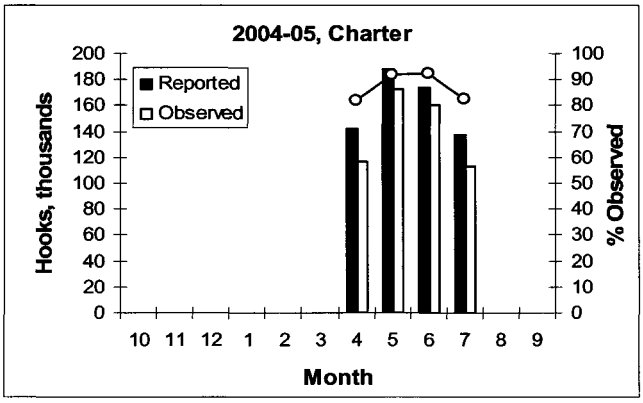


Figure 6: Monthly distribution of reported and observed sets by fishing year and fleet. The percentage of hooks observed is shown on the right hand axes (white circles).

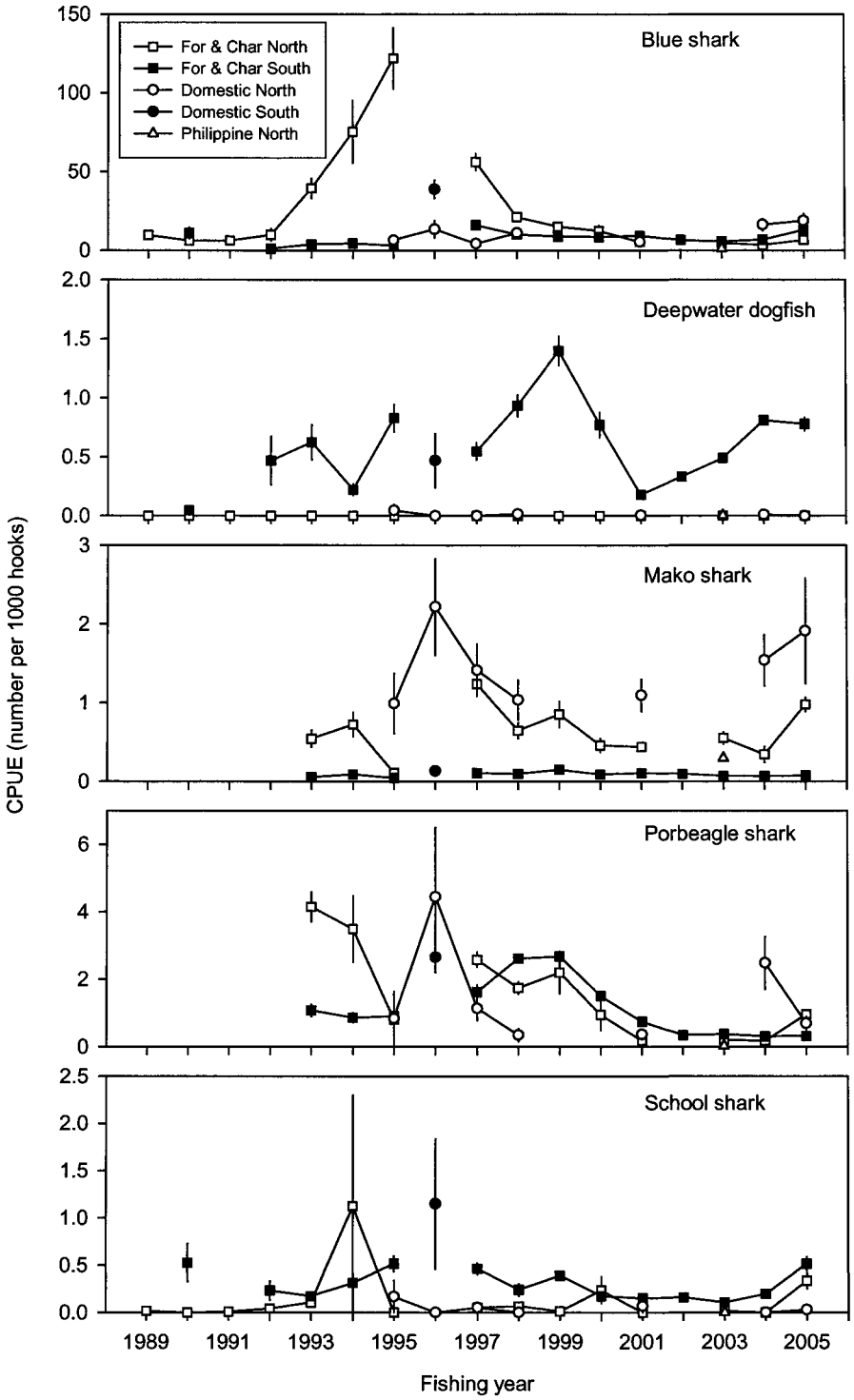


Figure 7: Annual variation in CPUE by fleet and area. Plotted values are the mean estimates with 95% confidence limits. Fishing year 1989 = October 1988 to September 1989. 1. Sharks.

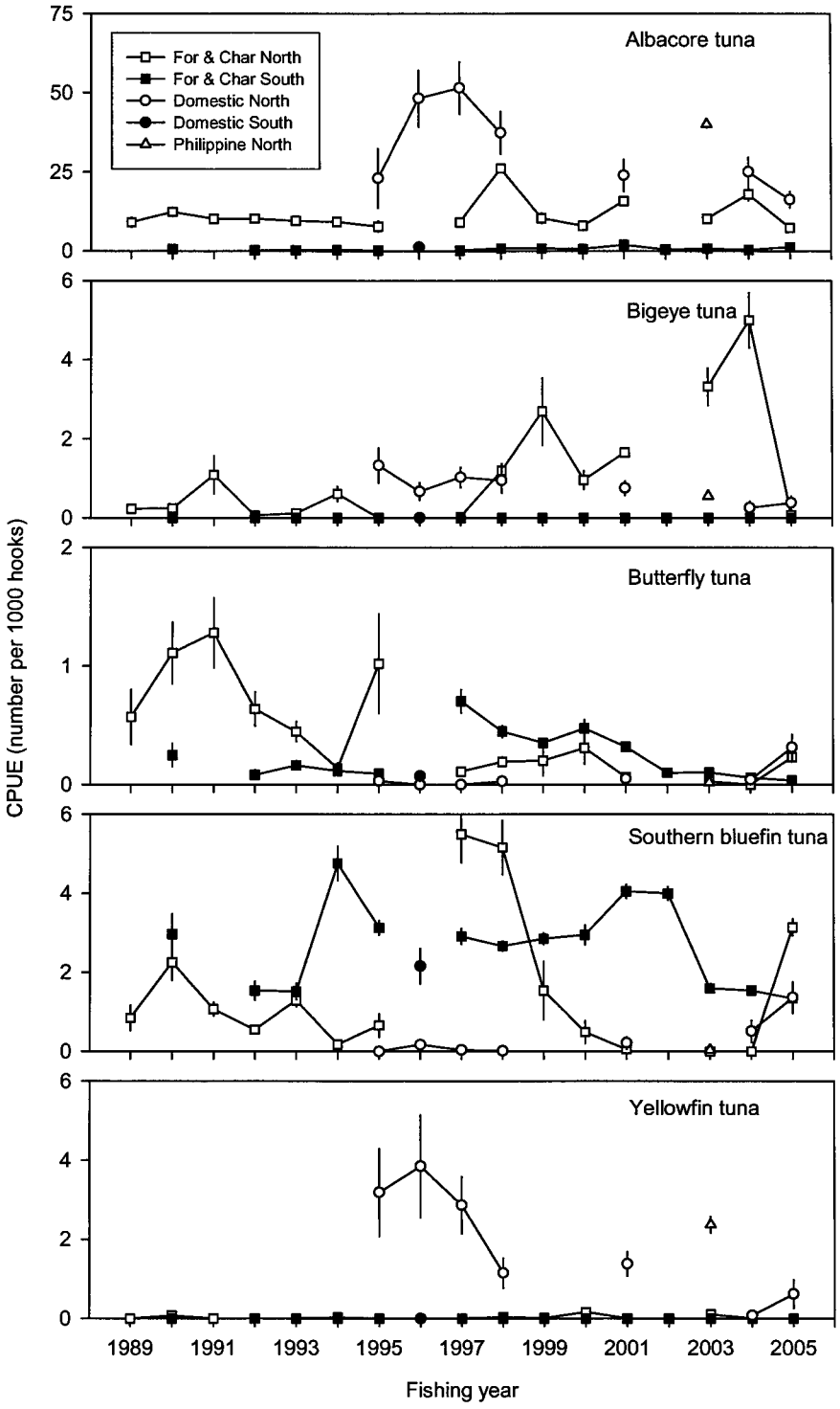


Figure 7 (continued): 2. Tunas.

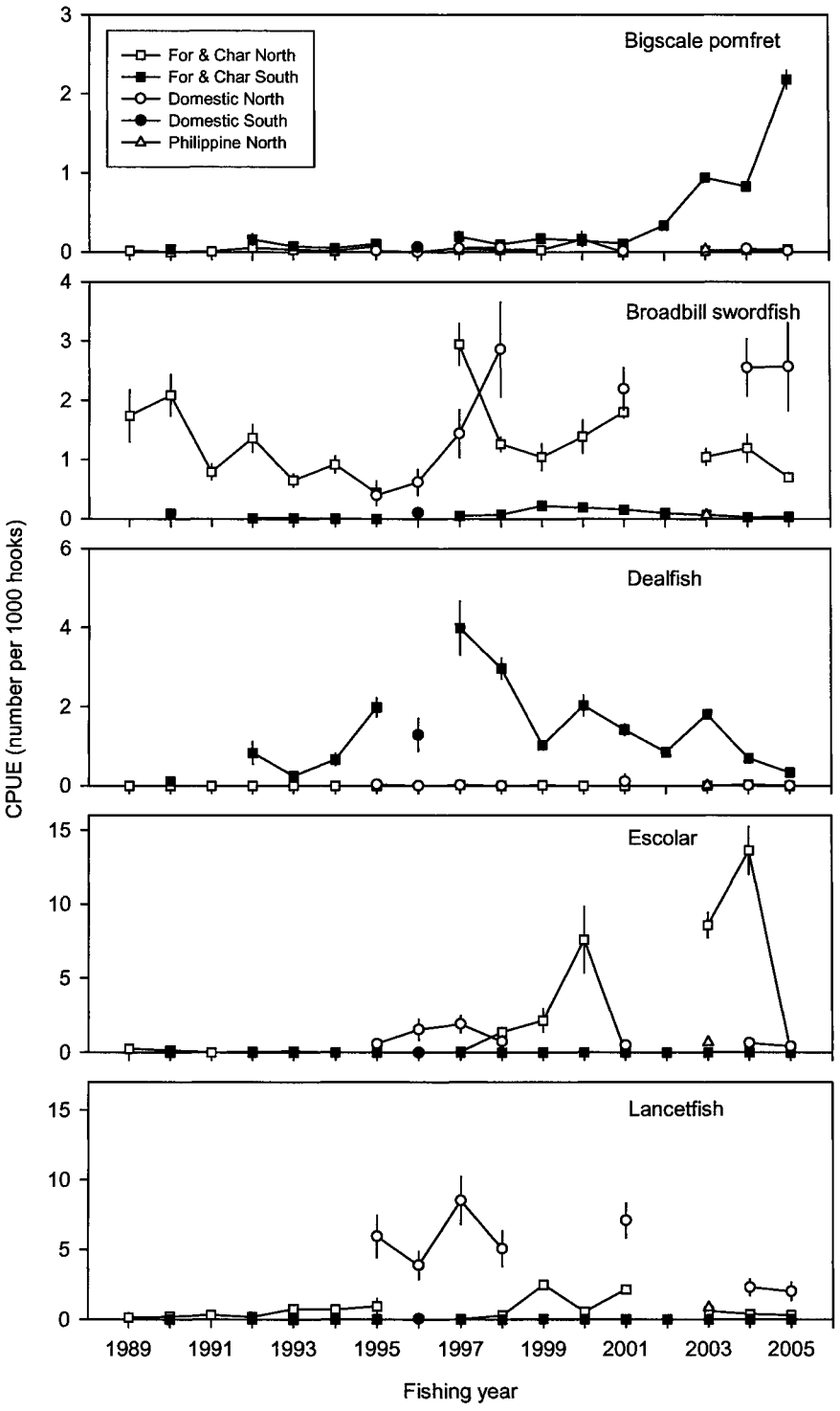


Figure 7 (continued): 3. Other species.

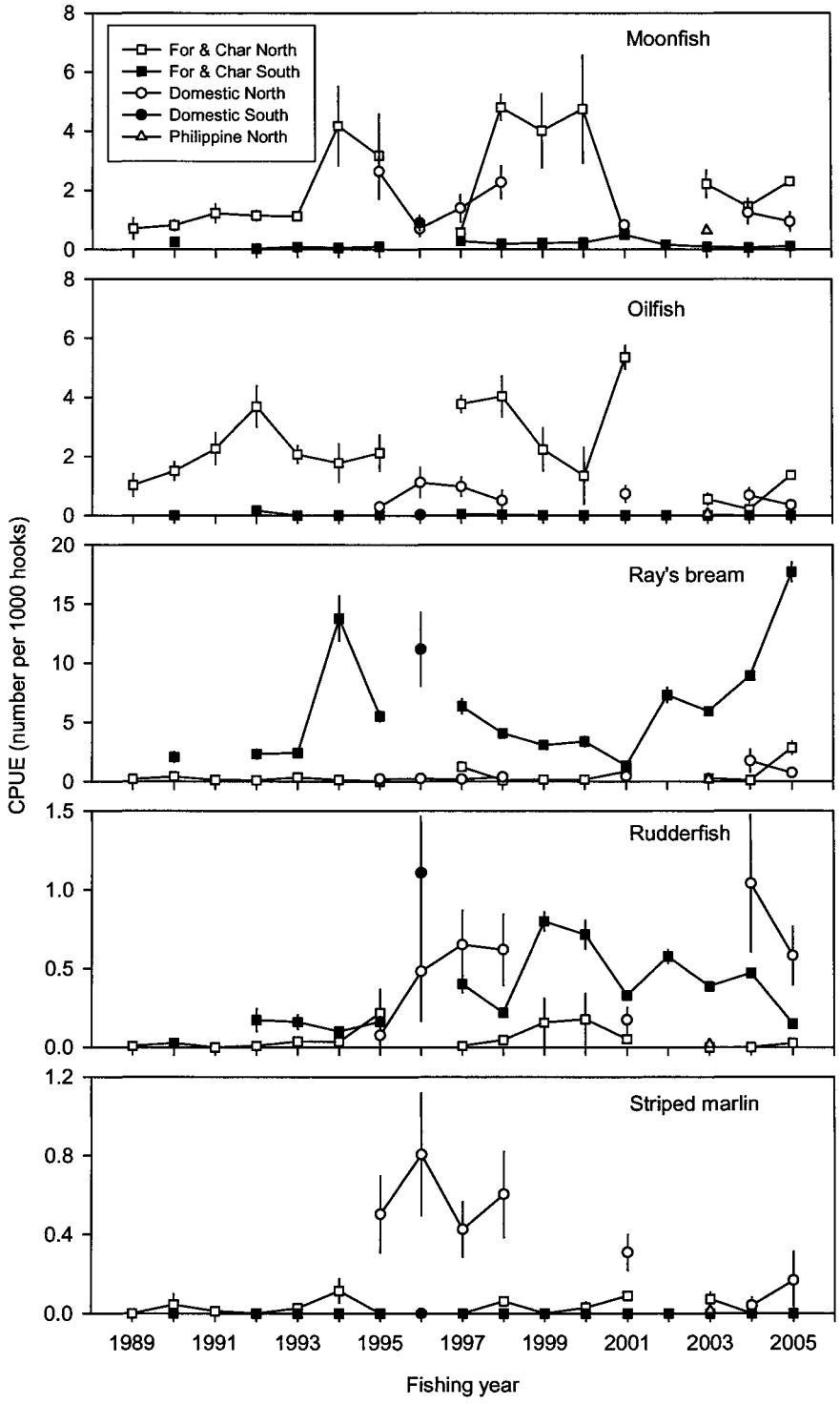


Figure 7 (continued): 3. Other species.

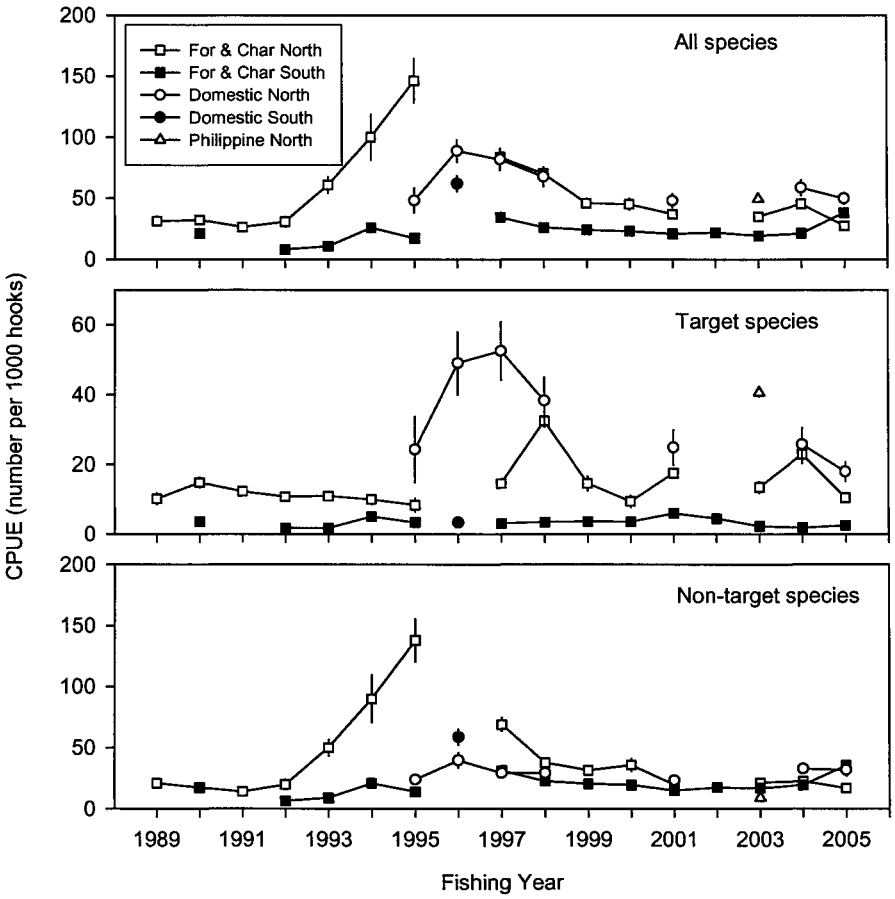


Figure 7 (continued): 4. Target and non-target species. Target species are bigeye, southern bluefin, and albacore tuna.

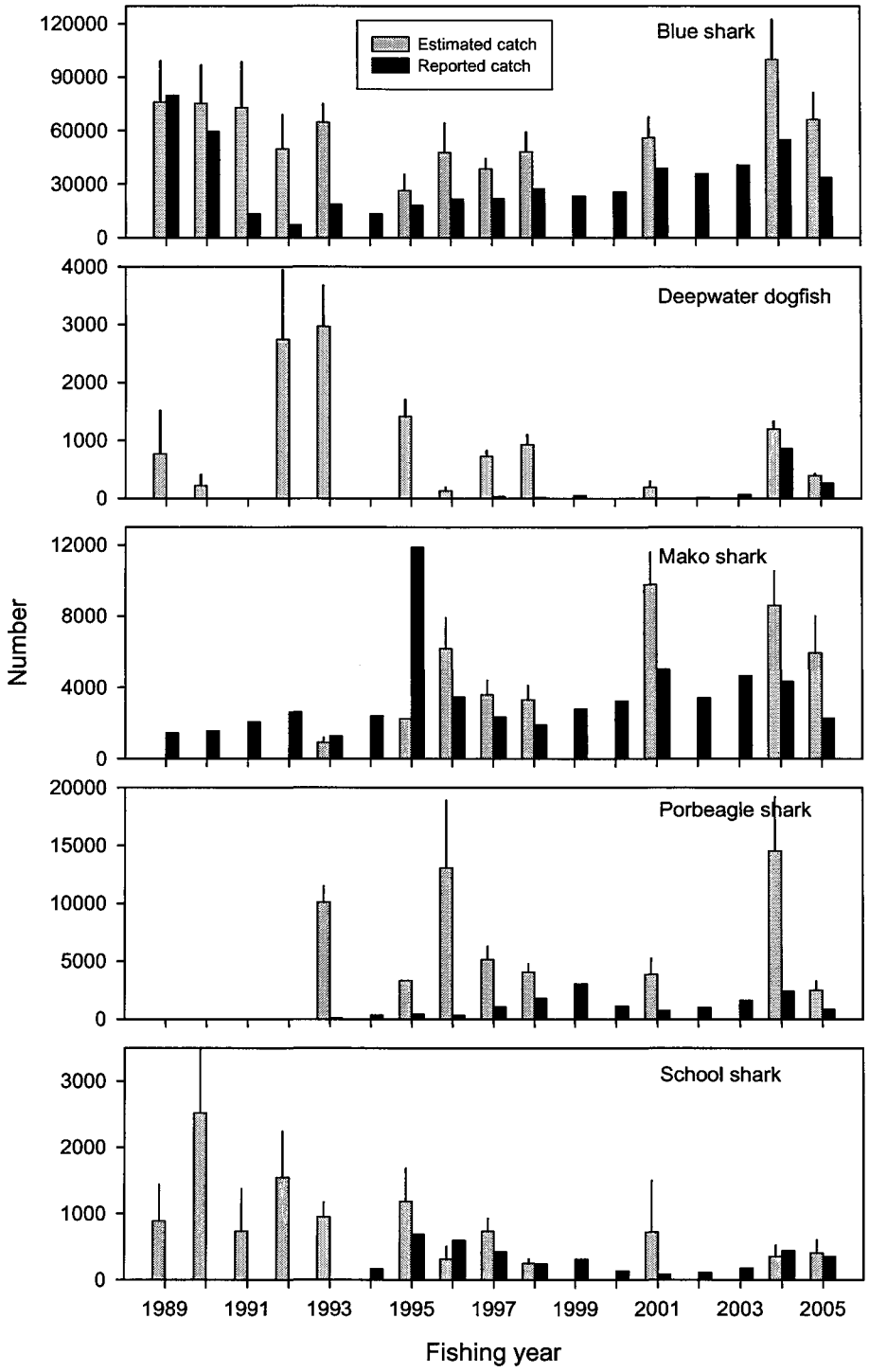


Figure 8: Observer-based estimates of scaled total numbers of fish caught, with 95 % confidence limits, and numbers reported caught on TLCER forms. Fishing year 1989 = October 1988 to September 1989. 1. Sharks. Refer to section 2.2 for explanation of data used.

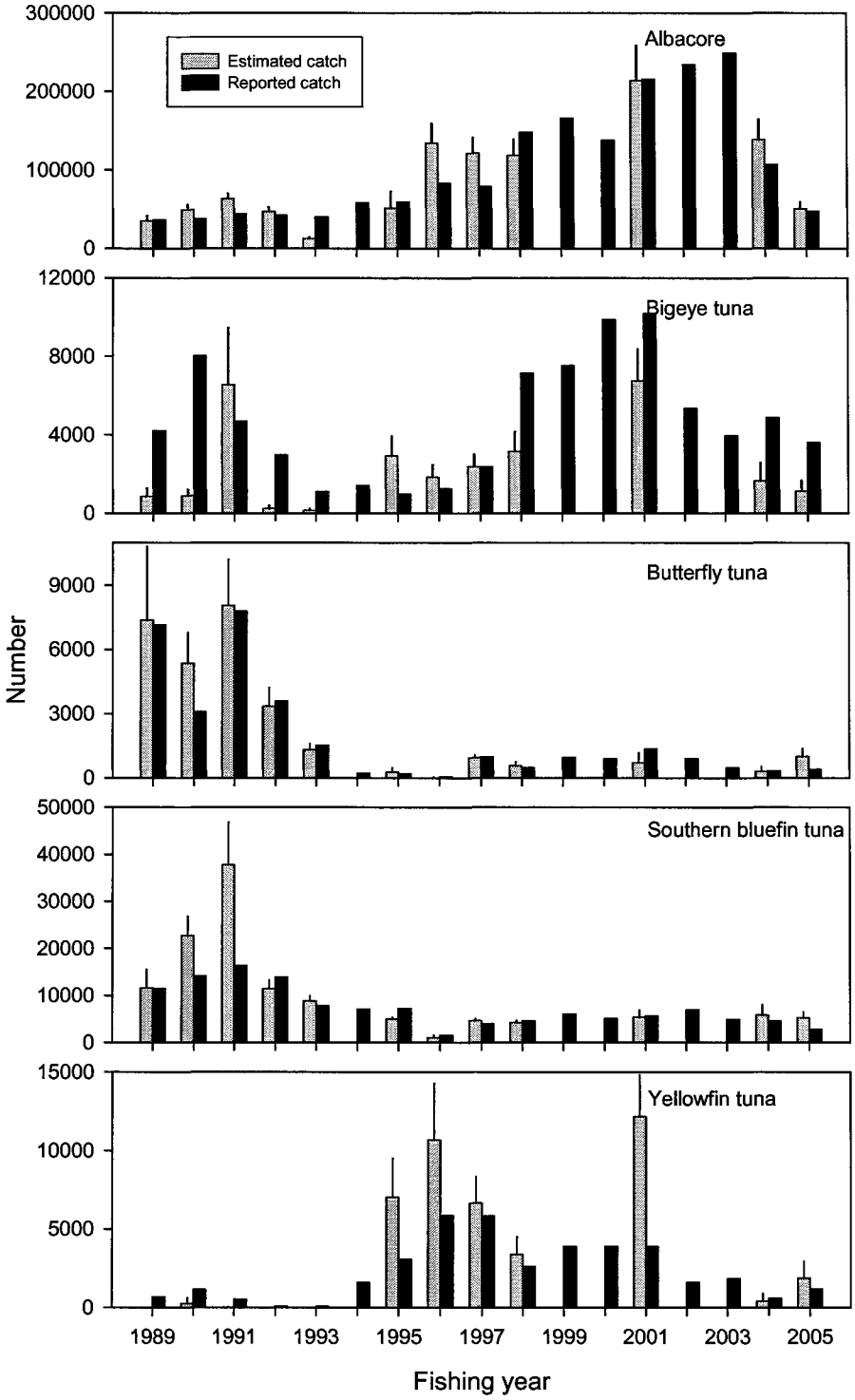


Figure 8 (continued): 2. Tunas.

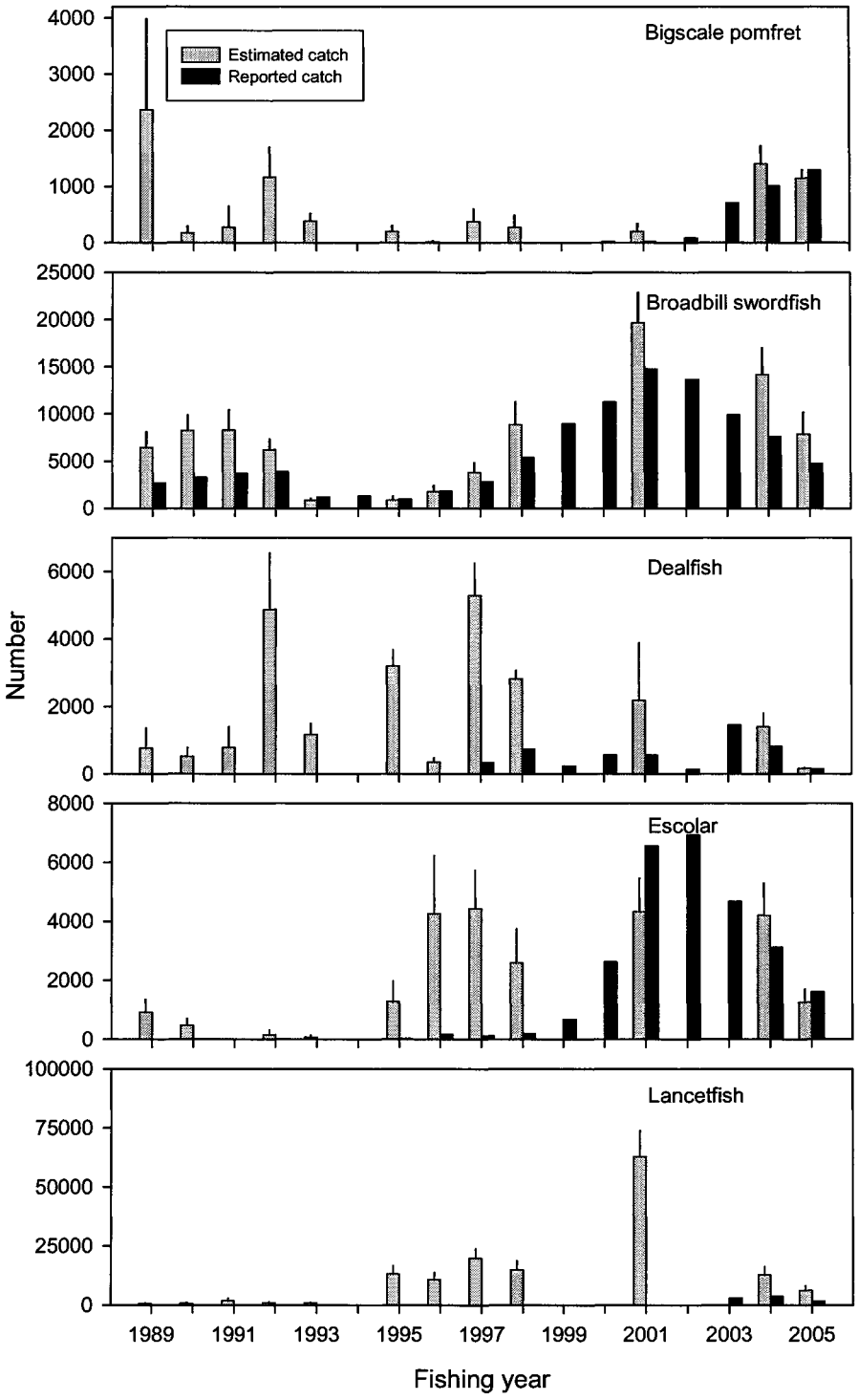


Figure 8 (continued): 3. Other species.

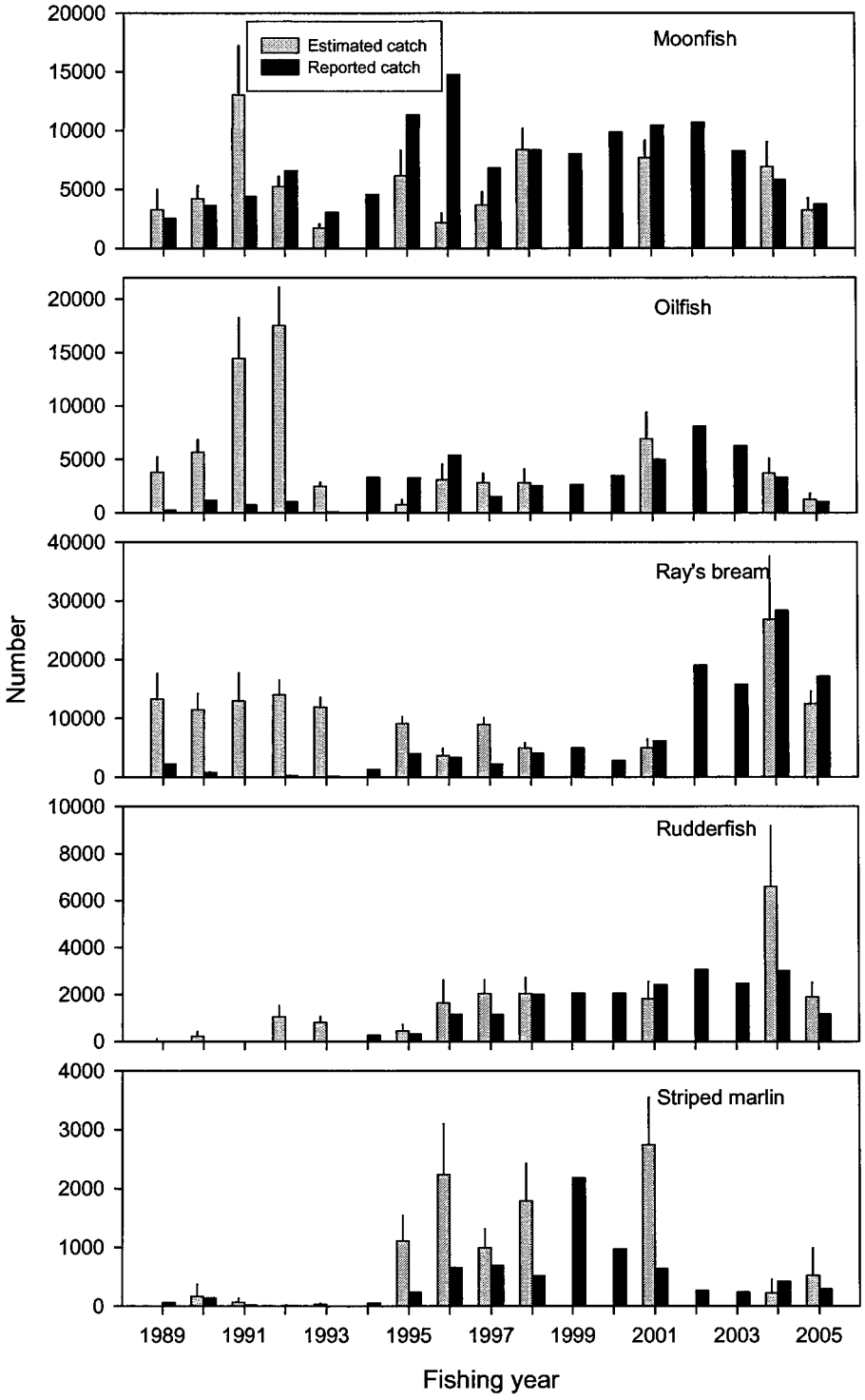


Figure 8 (continued): 3. Other species.

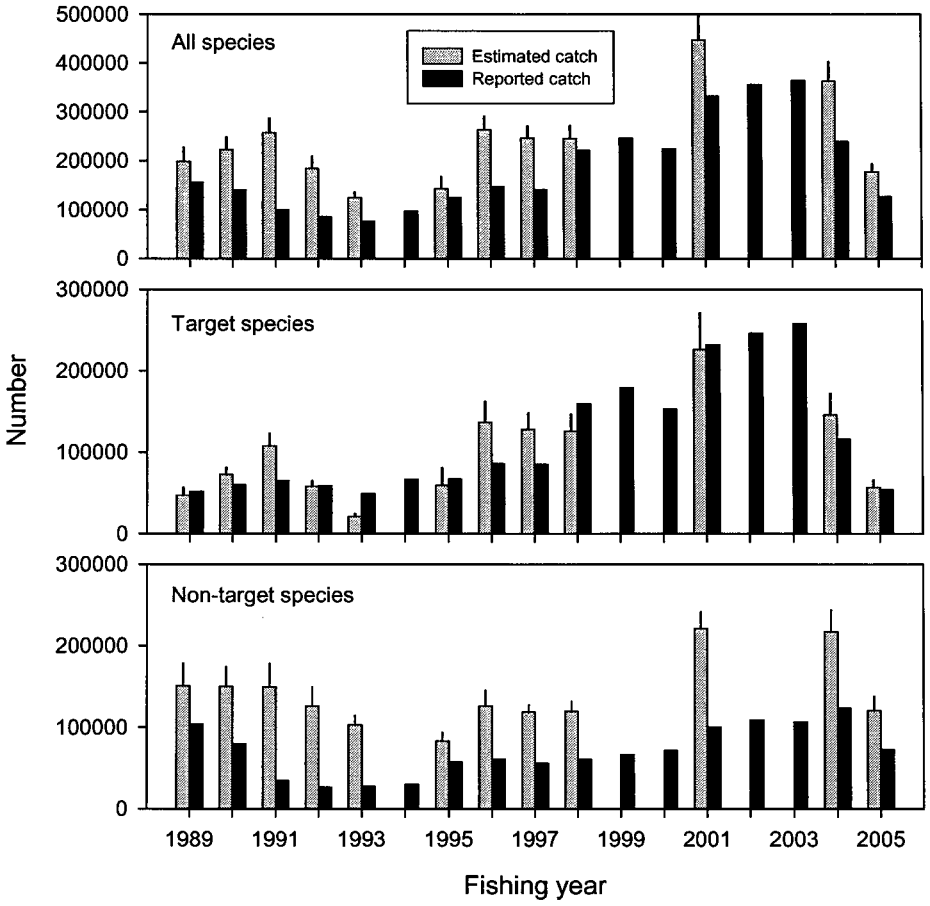


Figure 8 (continued): 4. Target and non-target species. Target species are bigeye, southern bluefin, and albacore tuna.

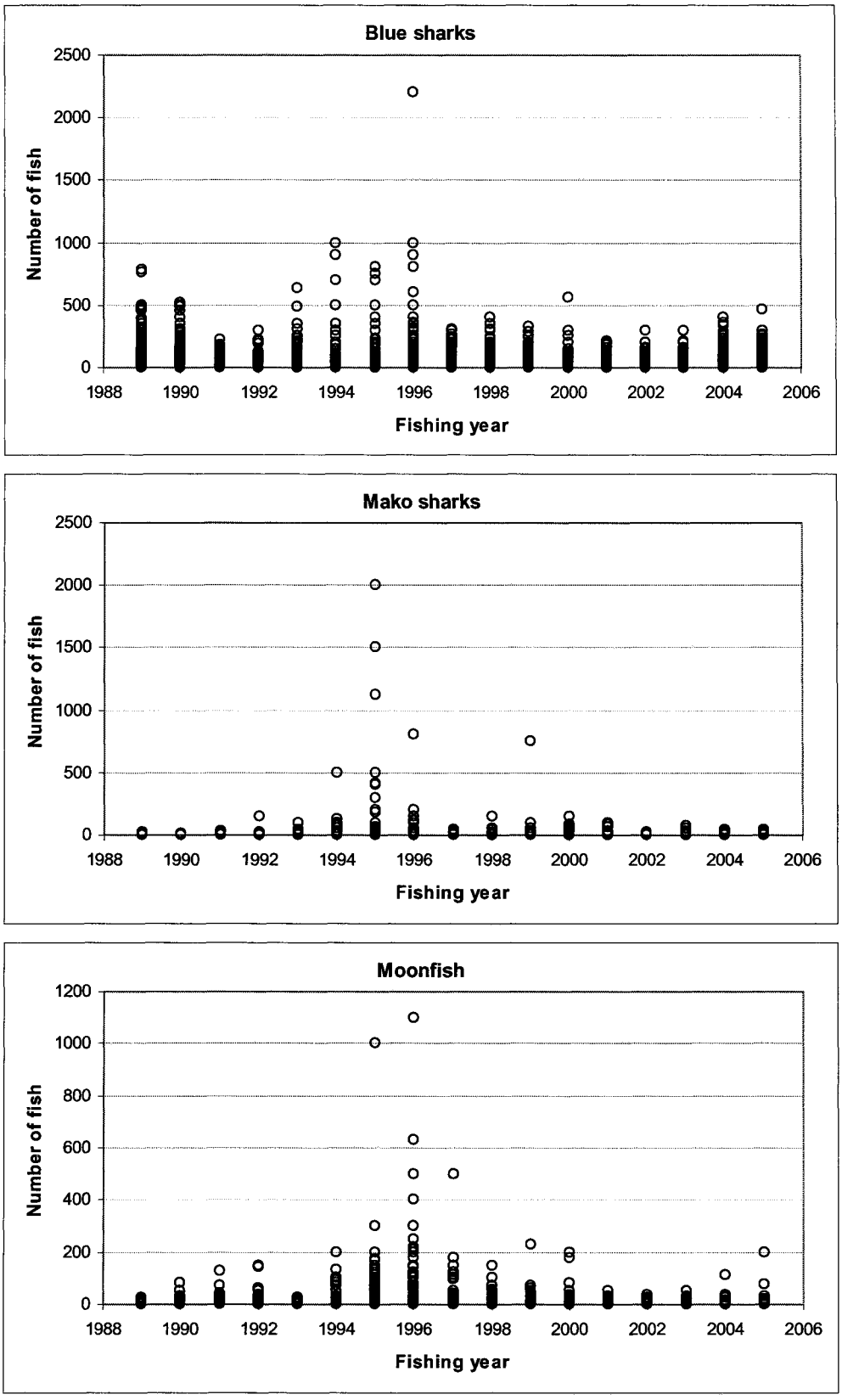


Figure 9: Reported numbers of blue sharks, mako sharks and moonfish on TLCER forms by fishing year (1989 = October 1988 to September 1989).

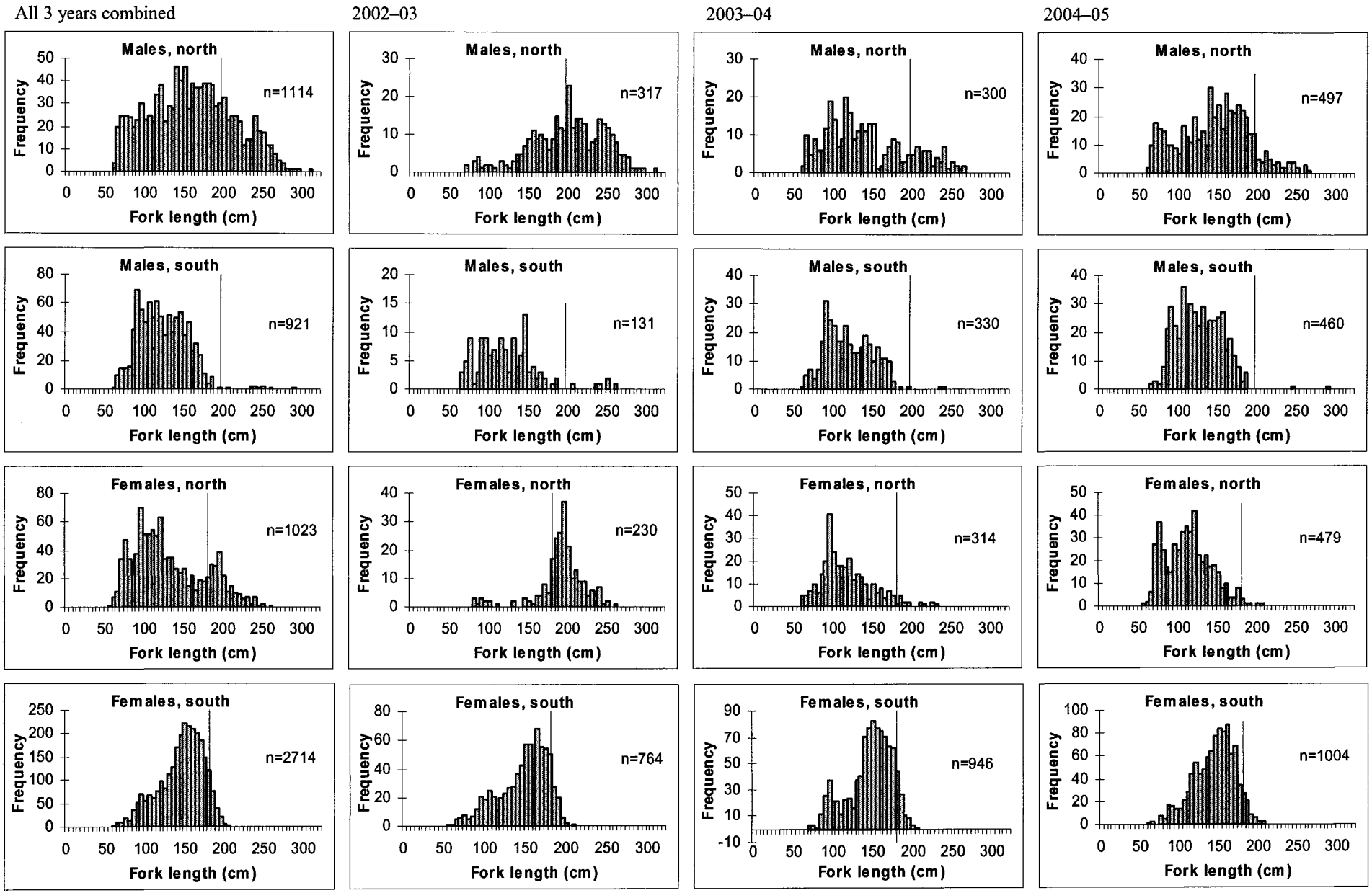


Figure 10: Length-frequency distributions of blue shark by fishing year, sex, and region. Vertical lines indicate length at maturity.

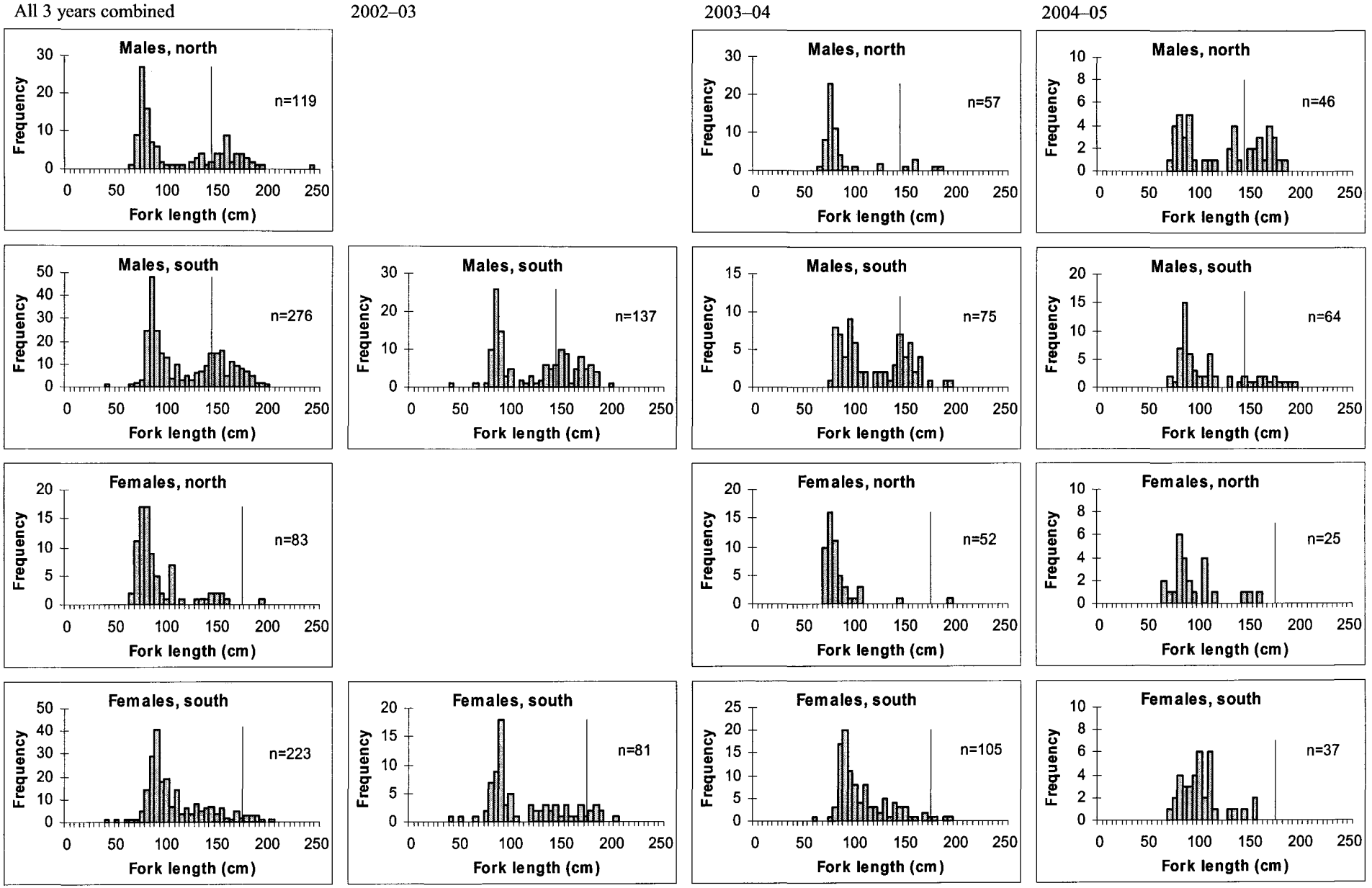


Figure 11: Length-frequency distributions of porbeagle shark by fishing year, sex, and region.. Sample sizes of less than 20 fish not shown. Vertical lines indicate length at maturity.

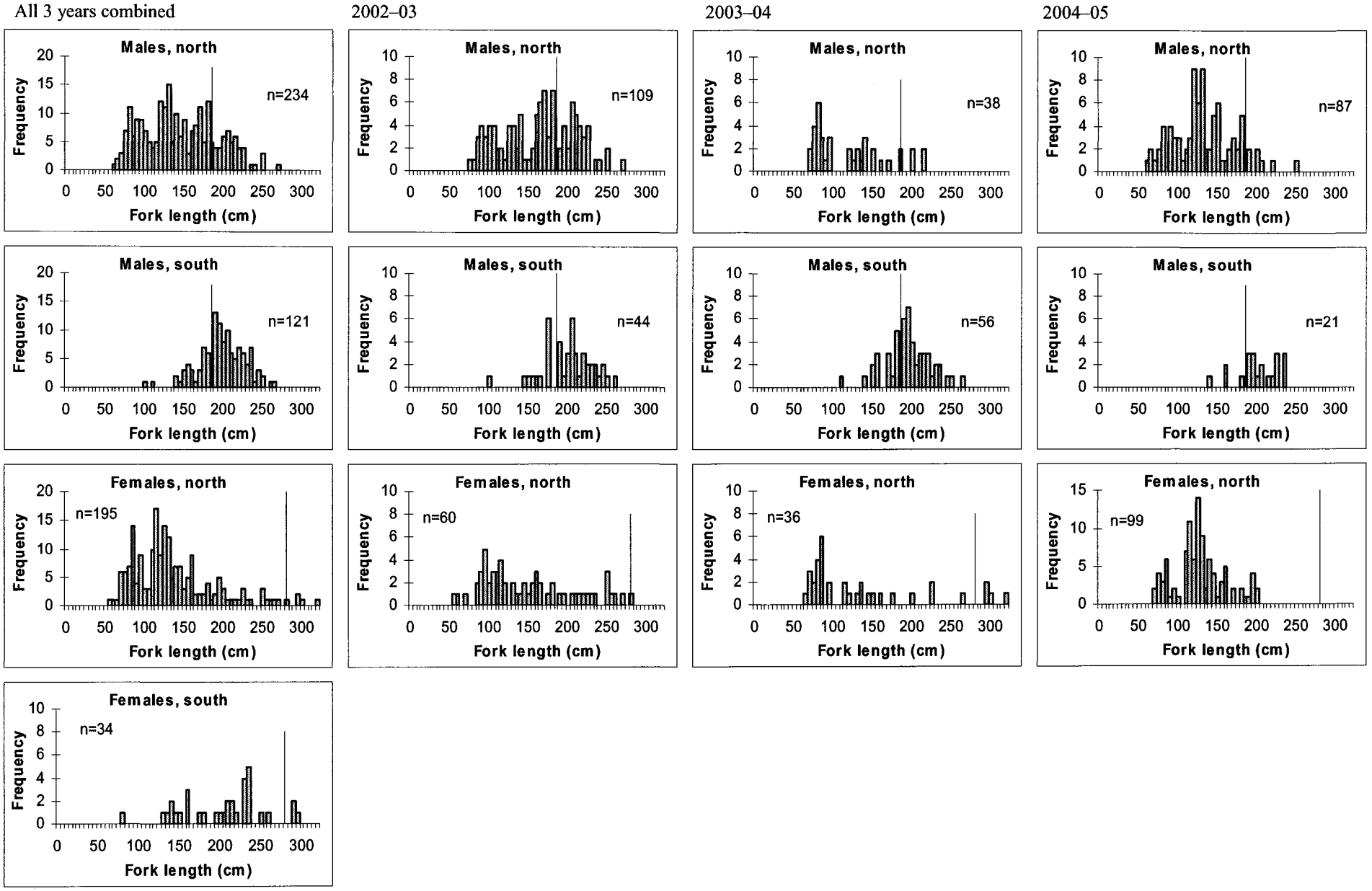


Figure 12: Length-frequency distributions of mako shark by fishing year, sex, and region. Sample sizes of less than 20 fish not shown. Vertical lines indicate length at maturity.

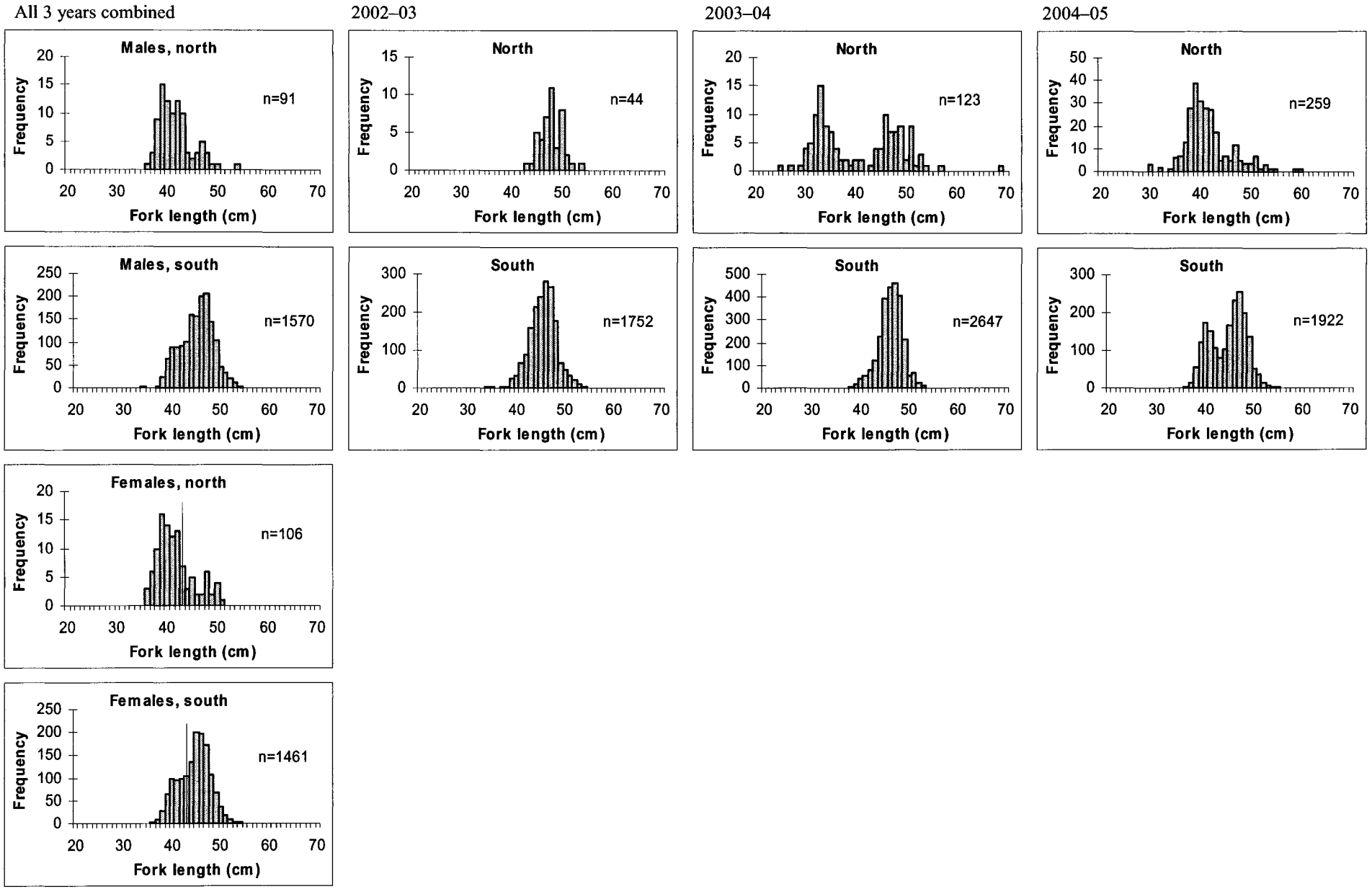


Figure 13: Length-frequency distributions of Ray's bream by sex and region. Plots for individual fishing years are for both sexes combined. Vertical lines indicate length at maturity.

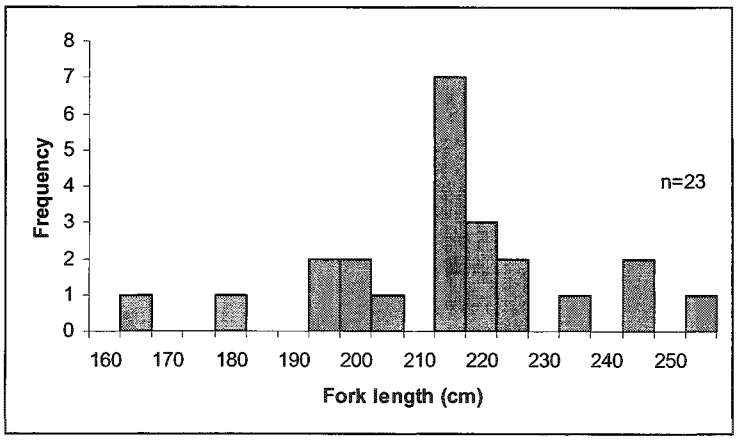


Figure 14: Length-frequency distribution of striped marlin, 2002–03 to 2004–05.

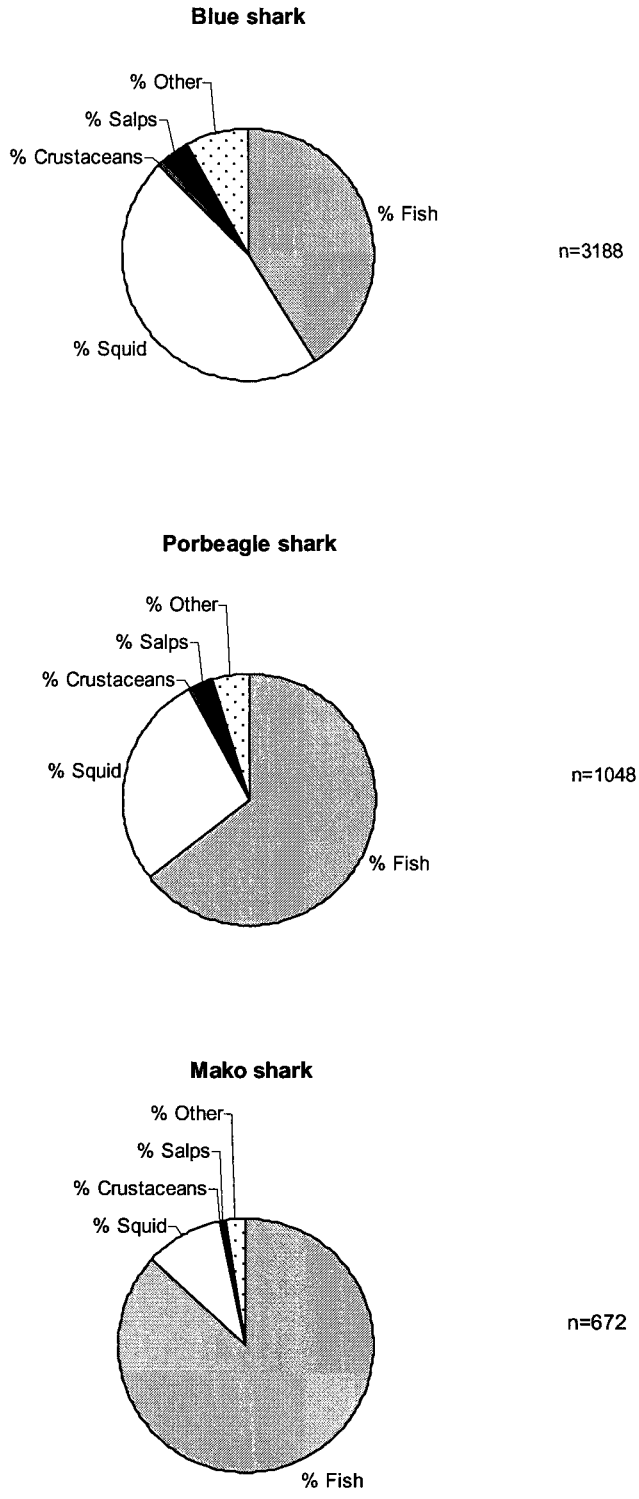


Figure 15: Percentage composition of stomach contents of pelagic sharks.

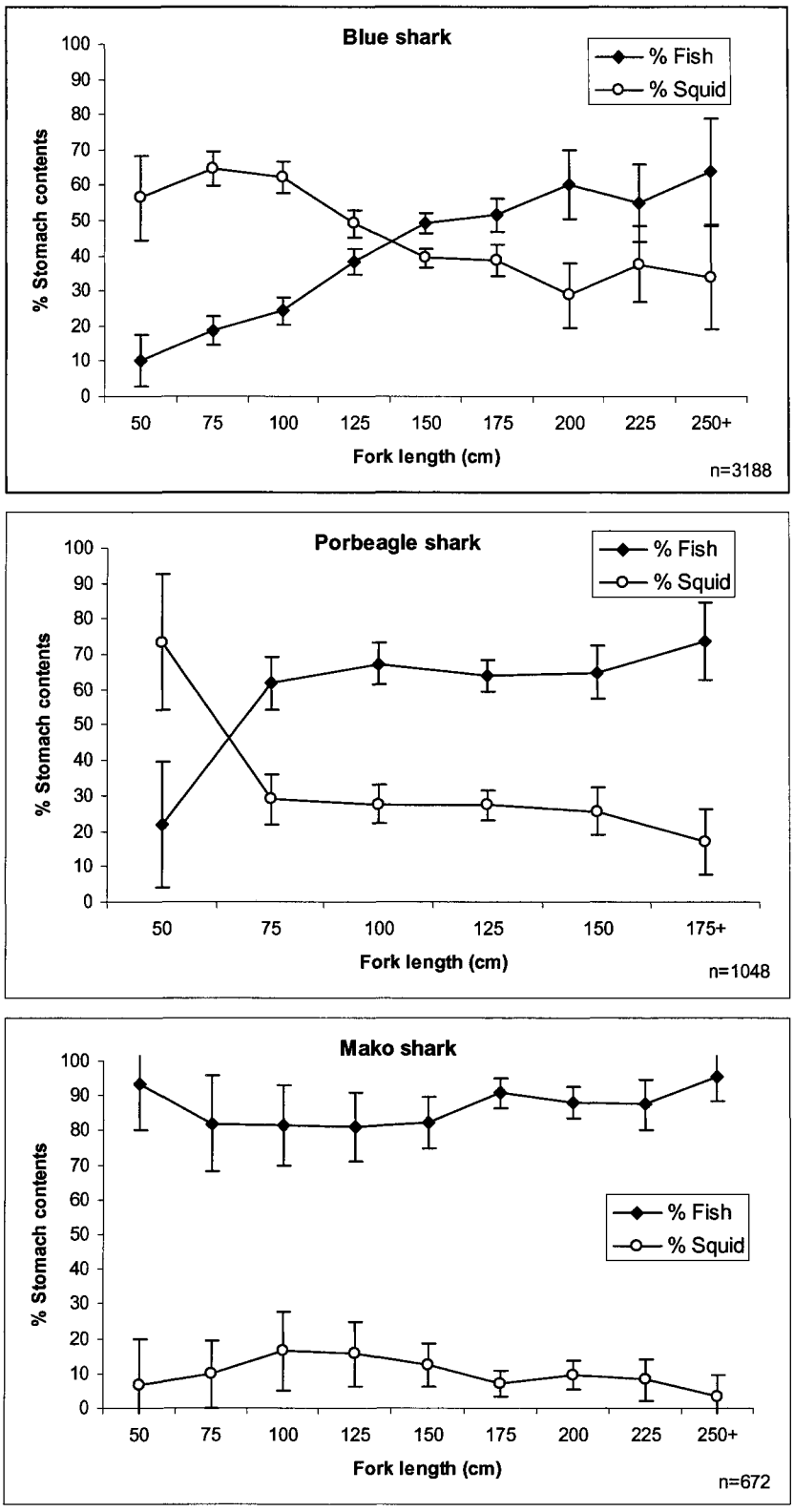


Figure 16: Changes in percentage of fish and squid stomach content of pelagic sharks with fork length. The right-most length class includes a few fish larger than the maximum length in that class.

Appendix 1: Percentage of the catch and percentage retained for species observed in 2002–03 to 2004–05. Species are shown in descending order of abundance for the three years combined.

		% of catch			% retained		
Species	Scientific name	2002-03	2003-04	2004-05	2002-03	2003-04	2004-05
Albacore tuna	*Thunnus alalunga*	53.0	11.3	13.4	99.1	97.1	98.0
Blue shark	*Prionace glauca*	11.7	29.1	33.9	60.5	63.0	67.3
Ray's bream	*Brama brama*	10.6	32.2	30.4	28.0	51.7	98.6
Southern bluefin tuna	*Thunnus maccoyii*	2.8	5.6	4.2	98.8	97.3	97.0
Big scale pomfret	*Taractichthys longipinnis*	1.7	2.9	3.5	26.1	50.2	60.7
Dealfish	*Trachipterus trachypterus*	3.1	2.5	0.5	0.1	2.0	0.0
Yellowfin tuna	*Thunnus albacares*	3.0	0.0	0.3	81.8	66.7	97.7
Deepwater dogfish	Squaliformes	0.8	2.9	1.3	0.4	0.2	0.0
Escolar	*Lepidocybium flavobrunneum*	1.8	1.7	0.2	47.6	15.0	65.6
Porbeagle shark	*Lamna nasus*	0.7	1.9	1.3	72.0	48.3	62.5
Moonfish	*Lampris guttatus*	1.2	0.8	1.6	33.6	92.8	97.3
Lancetfish	*Alepisaurus ferox & A. brevirostris*	1.2	0.9	1.2	1.6	0.0	0.0
Rudderfish	*Centrolophus niger*	0.7	2.0	0.6	2.1	19.0	36.1
Swordfish	*Xiphias gladius*	0.3	1.1	1.7	92.0	88.6	95.9
Mako shark	*Isurus oxyrinchus*	0.6	0.8	1.5	80.1	52.4	51.3
Bigeye tuna	*Thunnus obesus*	1.1	0.6	0.2	87.1	99.6	96.7
Skipjack tuna	*Katsuwonus pelamis*	1.3	<0.1	<0.1	99.0	69.2	80.0
Ray, unidentified	Torpediniformes	1.0	0.2	0.2	1.0	0.0	0.0
Unidentified fish		1.0	0.1	<0.1	1.8	8.6	0.0
School shark	*Galeorhinus galeus*	0.2	0.7	1.0	90.2	96.0	97.8
Hoki	*Macruronus novaezelandiae*	0.4	0.6	0.4	25.6	82.8	99.0
Sunfish	*Mola mola*	0.1	0.5	0.4	15.7	1.5	1.0
Oilfish	*Ruvettus pretiosus*	0.1	0.2	0.8	2.4	74.4	18.7
Thresher shark	*Alopias vulpinus*	0.3	0.3	0.3	25.0	41.9	50.7
Butterfly tuna	*Gasterochisma melampus*	0.2	0.2	0.3	60.7	91.1	68.5
Dolphinfish	*Coryphaena hippurus*	0.3	<0.1	<0.1	75.0	100.0	100.0
Flathead pomfret	*Taractes asper*	0.2	0.1	<0.1	40.8	33.3	100.0
Cubehead	*Cubiceps spp.*	0.0	0.2	0.2	–	0.0	6.8
Frostfish	*Lepidopus caudatus*	0.1	<0.1	0.0	97.1	0.0	–
Bronze whaler shark	*Carcharhinus brachyurus*	<0.1	<0.1	0.2	100.0	50.0	31.7
Wahoo	*Acanthocybium solandri*	0.1	0.0	0.0	97.1	–	–
Shortbill spearfish	*Tetrapturus angustirostris*	0.1	<0.1	<0.1	0.0	0.0	0.0
Hapuku and bass	*Polyprion oxygeneios & P. americanus*	<0.1	0.1	0.1	87.5	95.7	93.8
Striped marlin	*Tetrapturus audax*	<0.1	<0.1	0.1	0.0	16.7	76.0
Black barracouta	*Nesiarchus nasutus*	<0.1	0.1	<0.1	4.5	0.0	0.0
False frostfish	*Paradiplospinus gracilis*	0.1	0.0	0.0	77.8	–	–
Pacific bluefin tuna	*Thunnus orientalis*	<0.1	<0.1	<0.1	88.9	100.0	91.7
Shark, unidentified	*Selachii*	<0.1	<0.1	<0.1	0.0	100.0	0.0
Hake	*Merluccius australis*	<0.1	<0.1	<0.1	75.0	100.0	100.0
Bigeye thresher	*Alopias superciliosus*	<0.1	0.0	<0.1	100.0	–	7.7
Fanfish	*Pterycombus petersii*	<0.1	<0.1	<0.1	0.0	0.0	100.0
Unicornfish	*Lophotus capellei*	<0.1	<0.1	<0.1	11.1	0.0	0.0
Slender tuna	*Allothunnus fallai*	<0.1	<0.1	<0.1	33.3	0.0	0.0
Kingfish	*Seriola lalandi*	<0.1	<0.1	<0.1	71.4	0.0	100.0
Ray, unidentified	Myliobatiformes	0.0	<0.1	<0.1	–	0.0	0.0
Barracouta	*Thyrsites atun*	<0.1	<0.1	<0.1	0.0	100.0	100.0

Appendix 1 (*continued*).

		% of catch			% retained		
Species	Scientific name	2002-03	2003-04	2004-05	2002-03	2003-04	2004-05
Wingfish	*Pteraclis velifera*	<0.1	<0.1	<0.1	0.0	0.0	0.0
Opah	*Lampris immaculatus*	<0.1	<0.1	0.0	0.0	60.0	–
Snipe eel	*Nemichthyidae*	<0.1	<0.1	<0.1	0.0	33.3	100.0
Oceanic whitetip shark	*Carcharhinus longimanus*	<0.1	<0.1	<0.1	100.0	0.0	0.0
Blue marlin	*Makaira mazara*	<0.1	<0.1	<0.1	0.0	0.0	100.0
Marlin, unspecified	Isiophoridae	<0.1	0.0	<0.1	0.0	–	0.0
Hammerhead shark	*Sphyrna zygaena*	0.0	0.0	<0.1	–	–	0.0
Squaretail	*Tetragonus cuvieri*	0.0	0.0	<0.1	–	–	0.0
Black marlin	*Makaira indica*	<0.1	0.0	<0.1	0.0	–	0.0
Seahorse	*Hippocampus* spp.	0.0	<0.1	<0.1	–	0.0	0.0
Pomfret, unidentified	*Bramidae* spp.	0.0	<0.1	0.0	–	100.0	–
Smallscaled brown slickhead	*Alepocephalus australis*	<0.1	0.0	0.0	0.0	–	–
Broadnose seven gill shark	*Notorynchus cepedianus*	<0.1	0.0	<0.1	100.0	–	0.0
Basking shark	*Cetorhinus maximus*	0.0	<0.1	0.0	–	0.0	–
Pufferfish	*Sphoeroides pachygaster*	<0.1	0.0	0.0	100.0	–	–
Crab	Crustacea	<0.1	0.0	0.0	0.0	–	–
Gemfish	*Rexea solandri*	<0.1	0.0	0.0	0.0	–	–
Pilotfish	*Naucrates ductor*	0.0	0.0	<0.1	–	–	100.0
Pelagic stargazer	*Pleuroscopus pseudodorsalis*	0.0	0.0	<0.1	–	–	0.0
Ribaldo	*Mora moro*	<0.1	0.0	0.0	100.0	–	–
Squid	Cephalopoda	<0.1	0.0	0.0	100.0	–	–
Bigeye scabbard fish	*Benthodesmus elongatus*	0.0	<0.1	0.0	–	0.0	–
Amberjack	*Seriola rivoliana*	0.0	0.0	<0.1	–	–	100.0
Silky shark	*Carcharhinus falciformis*	0.0	<0.1	0.0	–	0.0	–
Prickly anglerfish	*Himantolophus appelii*	0.0	<0.1	0.0	–	100.0	–
Jack mackerel	*Trachurus spp.*	0.0	0.0	<0.1	–	–	0.0
Kahawai	*Arripis trutta*	0.0	0.0	<0.1	–	–	0.0
Scissortail	*Psenes pellucidus*	0.0	<0.1	0.0	–	0.0	–
Trevally	*Pseudocaranx dentex*	0.0	<0.1	0.0	–	0.0	–