National marine diary survey of recreational fishing from charter vessels, 1997–98

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Abstract

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Annual catches of fish and shellfish species by recreational fishers aboard marine charter boats were estimated from a year-long voluntary diary survey (1 November 1997 to 31 October 1998) involving 85 charter-boat operators around New Zealand. Estimated numbers of fish landed are listed by species, quota management system (QMS) status, fishing method, area (recreational survey diary zone, fishstock) and season, and estimated landings (tonnes) are provided by fishstock for 16 QMS species. The survey also provided estimates of fishing effort (hours) by fishing method, area, and month, as well as the proportion of overseas anglers involved, and the percentage of each species released. These estimates have standard errors ranging from ±10% to ±100%, and may also be subject to biases associated with non-response and the non-random nature of the diary survey.

Numerically, snapper was the most important species landed (310 000 fish), followed by blue cod (250 000), and tarakihi (170 000). A total of 105 species (or species groupings) recorded. Although 25% of all fish and shellfish caught were released, the percentages varied greatly between species. Success rates for trips (based on species targeted which were caught) averaged 82%, but were much lower for big game (17%) and marlin trips (5%).

The northeast coast (FMA1) was the most important area with 75% of effort expended, followed by the Marlborough Sounds with 13%. Inshore lining was the most important method (72% of total hours), followed by big game (15%), deepwater line (10%), extractive diving (3%), and other (less than 1%), although set net and potting effort was not measured. Seven percent of all fishers were overseas visitors, with the highest participation rates in northern northeast New Zealand (14% in the North Cape to Bay of Islands area).

Introduction

Quantitative information on marine recreational fishing catch and effort in New Zealand has only recently become available, initially through a series of regional surveys conducted by the Ministry of Fisheries beginning in 1991, and then culminating in a major national telephone and diary survey undertaken in 1996 (Bradford *et al.* 1998a). Results from the latter survey have been extensively reported (Bell & Associates 1996, Bradford 1998a, 1998b, 1998c, Bradford *et al.* 1998a, 1998b)

One limitation of the national survey data was that marine recreational fishing from charter boats formed too small a proportion to permit statistically valid estimates of catch and effort to be made. In addition, the national survey could not sample overseas fishers, so their contribution to the catch was unknown. Finally, it was recognised that charter boat operations are an important part of the recreational fishing sector and more recent data were required. While the big game charter boat fishery for billfish off the northeast coast of the North Island has been long established, many types of charter boat operations, including those for inshore and deepwater bottom species, diving, and an expansion of the big game fishery to include tunas, sharks, and some inshore species, are now of major importance throughout New Zealand.

Thus in 1996 the Ministry of Fisheries initiated a two-year programme to estimate fish catch and effort in New Zealand's marine recreational charter boat industry.

Methods

The 1996–97 questionnaire

The programme developed by NIWA to survey recreational fishing from charter vessels was divided into two phases: a questionnaire survey, and a diary survey. The questionnaire was sent to 366 possible charter boat operators in early 1997, seeking basic information on the charter operation, including the operator's name and address, vessel size and name, number of anglers carried, and fishery type by general area fished and season. Replies were received from 62% of operators, with 54% indicating they were actively fishing during 1996. Results from this questionnaire were published by James *et al*. (1997).

Information from the questionnaire was used to plan the second phase of the programme - a year-long diary survey to provide estimates of national fish catch and effort by recreational fishers using charter vessels, which was conducted from 1 November 1997 to 31 October 1998. The results of this diary survey constitute this report.

The 1997–98 diary survey

Design

After the 1996–97 questionnaire survey, all 365 operators on the original mailing list (including 147 who had not replied to this survey, and reduced from 366 in the questionnaire report (James *et al*.1997) because one operator had duplicate company names) were invited to keep records for the proposed diary survey, on a voluntary basis, during 1997–98. In the interim, a further 11 operators were added to the mailing list, bringing the total to 376. A total of 85 operators eventually completed diaries, including 6 who were recruited by word of mouth after completion of the 1996–97 survey.

For diarists to be prepared to supply full and accurate records voluntarily, we sought and obtained assurances from the Ministry of Fisheries that only grouped information would be reported, thus ensuring that individual catch histories would not be transferred to the Ministry of Fisheries.

The format of the personalised diaries was developed in consultation with Ministry of Fisheries staff involved in recreational fisheries, and several charter boat operators. Appendix 1 contains copies of the diary introductory pages which include instructions, definitions and explanations of the various terms used: trips, fishing methods, hours fished, areas and zones, species targeted, number of each species caught and released, species identification codes, together with a trip record sheet already completed as an example. Every second trip record sheet was carbonised, permitting a duplicate copy to be made which was returned to NIWA; the original book could then be retained by the operator. We emphasised that records should be sent in as soon as possible, and at least every quarter, so that operators were eligible for the prizes being offered, and so that the data being provided could be checked. We also emphasised that returns should be provided for periods when no fishing was undertaken. Additional books were available on request.

A vital part of any voluntary diary scheme is regular communication with participants, and this was achieved primarily through newsletters, sent out at least quarterly. These provided general information on progress with the survey, mentioned any problems that had arisen, and re-emphasised important matters. When necessary, operators were contacted by telephone, fax, and email. All diarists who had not sent in records for a 3-month period were contacted by telephone as a reminder, and to check if any assistance was required. To further publicise the diary survey, we had an article published in a magazine read by many charter boat operators (Ingram 1998). All prospective

participants in the diary survey will be sent a copy of this report to further promote participation in the survey.

As an incentive for operators to participate, we organised a draw for three travel prize packages at the completion of the diary survey, with a total value of over $5000. Each prize included return air travel for two persons; the first prize was to Australia, and the second and third were mystery weekends within New Zealand. Each diarist had one chance to participate in the draw for each 3-month period for which they sent in records. At the suggestion of one diarist, we also offered reduced rates for access to NIWA's sea surface temperature website.

Zones, regions, and fishstocks

To allow data to be aggregated over different geographical regions depending on the fishstock of interest, we developed a hierarchy allowing data to be grouped on four distinct spatial scales. The finest level of detail corresponded to the 40 geographical sub-divisions as defined in the diary (Appendix 1; see also Figure 1, Table 1), which were used for coding the raw data. We refer to these as "Zones" (or occasionally "diary Zones"), where a capital letter indicates usage of the word in its technical sense. Zone boundaries corresponded to those used by Bradford *et al*. (1998a), and were defined to be consistent with the existing New Zealand Fisheries Management Area (FMA) boundaries (Anon. 1998).

Our next level of grouping, which we refer to as "Regions" (Figure 1, Table 1), represented an intermediate level used solely for the purpose of dealing with geographical variation in response rates and participation rates. Region boundaries generally followed those used in the 1996–97 survey (James *et al*. 1997), with some adjustments to ensure they conformed with Zone boundaries. Each Region represented from one to seven Zones. Our assignment of Zones to Regions was partly subjective, representing a compromise between using many small Regions (which would have made the data unnecessarily fragmented), and few large regions (which would have weakened our ability to compensate for regional variation in response rates). Division of the data by Region was therefore important for deriving the expansion factors used later in this report, but was not used for reporting purposes.

The third and fourth levels of grouping corresponded to the standard FMAs and fishstocks as recognised by MFish (Anon. 1998). The relationship between Zones and FMAs is summarised in Table 1: for example, FMA 1 included all of Zones 1–13, and FMA7 corresponds to Zones 26, 27, 28, 39, and 40. Fishstocks, which apply to all QMS species except rock lobster (as well as the more important non-ITQ species), vary between species but always correspond to a combination of one or more FMAs.

Fishstocks for rock lobster do not, in general, coincide with Region and Zone boundaries as used in the 1997–98 survey, so that reporting of catches by fishstock is potentially subject to confusion as to how catches from each Zone should be allocated to fishstock. Although diarists were supplied with a map of rock lobster areas (see Appendix 2) and asked to use these for recording rock lobster fishing trips, this was not always done consistently, particularly when rock lobster were not identified as the target species. We therefore had to assign catches to the appropriate fishstock, based on the more detailed information provided by fishers on fishing locality within each Zone.

In practice, this did not cause any problems, and we were able to unambiguously assign all catches to the appropriate stock. For example, diary Zone 40 (Kahurangi Point to Stephens Island) spans both rock lobster areas E (CRA5) and H (CRA9). However, examination of individual trip records for vessels fishing in Zone 40 confirmed that all trips (and all rock lobster catches) were recorded within area E, either off Abel Tasman National Park or near Stephens Island/French Pass, and were therefore assigned to CRA5. Likewise, rock lobster area G (Long Point to Abut Head) includes diary Zones 35,

36, 37, and 38, along with parts of Zones 34 (Tokomairiro River to Slope Point) and 39 (Awarua Point to Kahurangi Point). However, since rock lobster were recorded only within Zone 38 (Te Waewae Point to Awarua Point, i.e., Fiordland), these catches can all be assigned to area G (CRA8). Consequently, for each diary Zone, rock lobster catches could always be mapped onto the correct fishstock, even when Zone and fishstock boundaries did not coincide.

Data analysis

Data checking and cleaning

The standard of the completed diary pages returned was generally good. Data were stored in a Microsoft™ Access database, providing linkages between records of catch and effort for individual vessels, and between return data for vessels and operators which had also participated in the 1996–97 postal survey. Routine data checks included validation of fields (such as hours per trip or trip date) for which only values within a specified range were legal, and referential integrity checks on cross-linked fields, such as species codes.

About 10% of the completed pages showed evidence of some confusion over precisely what was meant by a "charter trip", defined in the diary instructions as "…one fishing charter, with one group of fishers, using one fishing method, for at most one day …". In many instances these could be resolved quite simply, for example by splitting data for what was clearly a two or three day charter into appropriate daily units. More difficulty arose when the species caught on a given trip were inconsistent with the fishing method used or the area of operation, such as snapper during a big game trip or hapuku by diving. Usually careful inspection of the data suggested that two or more "trips" had been inadvertently listed as one, such as a trip which involved extractive diving or inshore line fishing (often for bait) as a small part of a big game trip. We resolved these cases using whatever data were available, such as other records for the same vessel in the same Zone, our own knowledge of species likely to be taken in each Zone, or follow up calls to the operator involved. Although some errors are likely to have gone undetected, we believe that the number of records affected is small in relation to the full data set (roughly 20 000 catch records in 8000 trips), and that any resulting errors in our estimates of catch and effort are negligible in relation to statistical and non-sampling errors.

Scaling from survey to total estimates

The 85 participants in this survey represented only a part of the total charter fleet. To estimate total catch and total fishing effort from the survey records, the raw data must be scaled up to represent the contribution from charter operators who did not participate in the survey. To estimate the appropriate "expansion factor" we need to know how many charter vessel operations were operating in New Zealand during 1997–98, and the extent to which the operators who participated in the survey represented the whole industry.

Neither is known with complete certainty. The charter vessel industry is constantly changing, with new operators coming in and existing operators closing down, taking on new vessels, or shifting their base of operation. Consequently, the expansion factor (which for a simple random sample is simply the ratio of the total number of operators to the number of operators sampled) is not known exactly. In addition, the 85 operators who participated in this diary survey are unlikely to have been a random subsample of the total.

Because these individuals were volunteers, prepared to take on the additional task of maintaining a diary, their patterns of activity may have differed from those of their non-participating colleagues. Participation rates also varied between regions and during the course of the 1997–98 survey; most

diarists furnished returns for the full 12 month period (even for months during which they had not fished), but a few dropped out during the season. To address these biases we considered four possible sources of error in deriving appropriate expansion factors: variation in participation rates between regions; monthly variation in participation rates during the survey; variation in vessel length between participants and non-participants; and variation in fishing activity between participants and non-participants.

Regional variation. At the broadest level, we assumed that the charter fleet at the time of the 1997–98 survey numbered 376 vessels, one for each operator on the 1997–98 mailing list. Diary returns were obtained for 88 vessels (maintained by 85 operators), representing an average expansion factor of 4.27:1. In reality, the number of vessels per address is likely to have been slightly greater than 1, so this figure is conservative.

To allow for variation in participation rates between different parts of the country, we partitioned the responses into 11 geographical Regions (see Table 1), based on the home port for each vessel. We then partitioned the full list of 376 addresses on the same basis, using home port (if known) or address of operation (if not). We then estimated expansion factors for each Region, based on the number of participating vessels within each Region (Table 2), on the assumption that (a) our address list provided a complete census of all charter operators in that Region, and (b) that the vessels participating in the survey were representative (i.e., were a simple random sample) of the vessels in each Region. In practice neither assumption is likely to be strictly true, and the implications of this are discussed later in the report. Regional expansion factors (E_{region}) ranged from 7.0 for the west coast of the North Island to 1.8 for Fiordland.

To estimate catch and effort, we derived estimates for each of the 40 diary Zones (see Table 1), and then recombined these as appropriate for each FMA or fishstock of interest. For Zones fished only by vessels operating from within the corresponding Region, these estimates involved only a single expansion factor. For example, Zones 10–13 (all waters from Cape Colville to Cape Runaway) were fished only by vessels based in Region 3 (Bay of Plenty), so that for all Zone-specific estimates the raw data were multiplied by a single Regional expansion factor of 3.8 (see Table 2). However, about 13% of trips were recorded by vessels fishing in Zones outside their Region of origin, so that deriving estimates for these Zones involved summing contributions from two or more Regions, each with the appropriate expansion factor. For example, Zone 5 (Great Barrier) was fished by vessels operating out of Region 1 (based at Paihia, Tutukaka, and Bream Bay), Region 2 (based at Tryphena, Leigh, Auckland, Whitianga, and Tairua), and Region 3 (based at Tauranga).

Monthly variation. The instructions on the first page of each diary asked operators to return completed diary records every 3 months, or more often if completed sheets were available. At the end of each 3 month period, an attempt was made to contact all non-respondents and encourage them to forward their returns. Well over two-thirds of the diarists kept records for the full 12 months, but response rates declined steadily as the survey progressed. Ten operators dropped out after the first quarter, a further 9 dropped out after 6 months (partially offset by 7 new operators enlisted during the second quarter), and 9 dropped out after 9 months. Most operators recorded lower levels of activity during winter (June, July, August), with half the diarists (34 out of 69) providing records at this time recording no fishing for at least one of these months. It is possible that some non-respondents simply stopped fishing and did not bother to inform us (despite the incentive of inclusion in the prize draw, even if they had not fished during a particular quarter), but we consider that the main cause of non-response was simply a loss of interest by the less committed diarists. This conclusion is consistent with the steady decline in response rate over the duration of the survey (rather than a more pronounced seasonal decrease), and the difference between the participation rates for November 1997 (79 diarists) compared to October 1998 (61 diarists). Assuming that seasonal variation in charter activity is similar from year to year, there is no *a priori* reason why the number of vessels involved should increase by over 30% between 31 October and 1 November. We therefore assumed that non-respondents had the same average level of fishing activity as respondents during the months when they did not provide records. For deriving catch and effort estimates, this is equivalent to the

assumption that the sample size for each Region and quarter is given by the number of diaries received, rather than the number issued. For example, although a total of 24 individuals provided diary records for Region 3, the numbers of diaries received (and hence the sample sizes) for each quarter were 22, 20, 18, and 15.

To adjust for these individuals, we introduced a second level of expansion factors, specific to each Region and quarter, which compensated for variations in response rate. These expansion factors ($E_{quarter}$) varied from 1 (100% response rate) to 2 (50% response rate), and averaged 1.22 (82% response rate). We then multiplied the Regional and quarterly expansion factors to yield 44 distinct expansion factors ($E_{region \times quarter}$; Table 3) ranging from 2.0 (Region 11, all months) to 10.0 (Region 4, all months except February to April). Conceptually, this procedure is equivalent to dividing the survey into 44 independent strata, where each stratum corresponds to a unique combination of Region and quarter. The expansion factor for each stratum thus has two components: one representing the total addresses in each region divided by the total number of diaries issued during the survey (see Table 2), and one representing the number of diaries issued divided by the number actually received during each quarter.

Vessel length and fishing activity. To estimate biases arising from either of these sources, we compared vessel length and fishing activity for vessels operated by the 1997–98 diarists with those for all vessels on the 1997–98 mailing list, based on length data recorded during or after the 1996–97 survey (207 vessels, Table 4) and effort data from the 1996–97 survey (197 vessels, Table 5). In neither case did the distribution of vessels taking part in the 1997–98 survey differ significantly from that for the full mailing list (χ^2 test, $p > 0.29$ in both cases). This suggests that vessels taking part in the diary survey can be considered as a simple random sample of the vessels known to us at the time, and that bias with respect to vessel length or level of activity was not significant. This conclusion is supported by analysis of effort and catch data in relation to vessel length for vessels involved in the diary survey, which showed no significant correlation between vessel length and effort as total number of trips ($r = 0.08$, $p = 0.48$); effort as total hours ($r = 0.06$, $p = 0.61$); and total catch of snapper ($r = –0.08$, $p = 0.52$). However, we can not rule out the possibility that respondents to the 1996–97 survey, and hence the sub-sample involved in the 1997–98 survey, were biased with respect to all vessels (nominally 376) represented by the full 1997–98 mailing list.

Confidence intervals

Catch and effort estimates derived from the 1997–98 survey data are subject to considerable uncertainty, in terms of both precision (related to errors of a statistical nature, associated with sampling variability), and accuracy (the extent to which the data correctly reflect results for the whole charter fleet, taking into account non-sampling and other possible biases). Neither source of error can be quantified accurately: estimates of precision for most survey strata (i.e., combination of Region and month), using standard statistical techniques, are hampered by small sample sizes and highly skewed catch distributions, and available information about the fishing practices of non-respondents allows no more than a qualitative assessment of non-sampling bias. In this section we discuss these issues in more detail, and give general guidelines as to appropriate confidence intervals for estimates of catch and effort derived from the survey data.

Precision. Given large enough sample sizes, variance estimates (and hence confidence limits) for all catch and effort estimates could readily be derived for each stratum (possibly after applying a suitable transformation to improve normality), and summed over strata as appropriate. In practice, the small number of vessels participating in the survey makes these estimates highly unreliable for all but the largest strata. Standard statistical theory advises caution when applying confidence intervals based on the normal distribution for sample sizes below about 30. In this survey the number of vessels in each stratum ranges from 1 to 24, and exceeds 10 for only 4 out of 11 strata. These figures become even more finely divided when the data are broken down further (e.g., by diary Zone or calendar month): of

the 40 Zones used in this survey, 24 were fished by at most 2 vessels, and only 8 were fished by 10 or more vessels. Consequently, the most reliable estimates are those grouped on the largest scale, such as estimates for one Zone over a full year, or all Zones for a given month, and become progressively more uncertain for smaller subdivisions of the data. In addition, raw catch data are characterised by highly skewed distributions, which (even if data transformations are used) lead to estimates which are strongly dependent on information provided by a few key vessels. For example, snapper were taken by 66 of the vessels providing diary records, with a total catch of 49 576 fish. Of this total, over half (25 968 fish) was taken by just six vessels, representing less than 2% of the charter fleet (based on a total of 376 vessels).

Because of these problems, we have not derived individual confidence intervals for the catch estimates. Instead, we have derived confidence intervals for a representative range of catch estimates (from c. 100 to 100 000 fish), based on monthly catch data for two abundant species (snapper and trevally) in two of the more heavily fished regions (Northland and Bay of Plenty) with reasonable sample sizes (13 and 24 vessels, respectively). When plotted on a log-log scale these data show a well defined linear relationship between each catch estimate and its associated standard error (Figure 2a), which we have used to generate a table summarising the general relationship between estimated catch and standard error (SE) for catches typical of this survey (Table 6). These figures emphasise the tendency for confidence intervals to become very broad as catch estimates decrease, with coefficients of variation (c.v.) exceeding 20% for estimates below about 10 000 fish. Given that 95% confidence intervals are about ±2 SEs, these range from ±20–25% (for catch estimates over 100 000 fish) to over ±100% (for estimates below about 500 fish).

Similar comments apply to estimates of effort in total fisher-hours. Effort raw data are highly skewed, with half of the total effort recorded by diarists (214 000 hours) coming from 16 (18%) of the 88 participating vessels. The relationship between estimated effort and SE (for estimates of total monthly effort in Northland, Bay of Plenty, and the South Island east coast) (Figure 2b) is very similar to that for catch, and leads to similar figures for appropriate confidence intervals (see Table 6).

Accuracy. As discussed above, the number of charter vessels operating during the 1997–98 survey and the extent to which diarists constituted a random sample of the charter fleet remain unclear. In addition to the possibility of bias associated with variation between regions, monthly participation rates, and vessel size, special problems arise because of the absence of a definitive list of charter operators (or even a definition of what constitutes a "charter vessel") and the wide range of operations we encountered in compiling our own list. We decided that anyone advertising themselves as providing fishing charter services should be included in the sampling (*see* definition of charter boat operation in James *et al*. 1997). In some regions we were helped considerably by local representatives of the Marine Transport Association, while in others we were totally reliant on newspapers, fishing magazines, and word of mouth, and it is almost inevitable that some operators were missed. We also encountered some resistance to the survey from operators who were suspicious about the uses to which the data could be put, and not only declined to take part themselves, but also to provide contact details for other operators in their vicinity. Any such omissions constitute an additional source of bias: the effect of a single missed operator on the expansion factor for any given region ranges from an underestimate of just over 1% (for region 3, Bay of Plenty) to 10% or more (region 6, Egmont; region 10, Fiordland). Even for the most popular regions (East Northland, Hauraki, Bay of Plenty, Marlborough Sounds), as few as 5–10 missed operators represents a potential bias of around 10%.

For these reasons, we consider that uncertainty over the size of the charter fleet, and possible non-sampling biases, impose a fundamental limitation on the accuracy of catch and effort estimates in this report. The magnitude of this bias is unlikely to be less than 10% and may well be higher, particularly for less popular regions. For total estimates exceeding 100 000 fish or 100 000 hours, with SEs lower than about 10–15% (see Table 6), non-sampling bias (lack of accuracy) is likely to equal or exceed errors of a purely statistical nature (lack of precision).

Data reporting

All estimates of catch and most estimates of effort given in this report are based on expanded data, as detailed in the previous section. For some tabulations, the raw (i.e. unexpanded) data are also presented; usually this has been achieved by presenting two otherwise identical tables representing the expanded data and the raw data (see Tables 8a and 8b respectively). We did not attempt to estimate total numbers of fishers because the survey emphasised fishing trips rather than individual fishers: simply adding the number of fishers for each trip would overestimate the number of individuals involved in multi-day charters, or charters where fishers used more than one fishing method. Catches are presented as total numbers of fish, and effort as total fisher-hours, i.e., a 4 hour charter trip taken by five fishers was counted as 20 fisher-hours. Effort associated with incidental methods such as potting and set-netting (for which "soak" hours were not usually supplied) was calculated as the number of trips, based on unexpanded data. All figures are rounded to either two significant digits (estimates over 1000), or one significant digit (estimates under 1000), although, as emphasised in the previous section, even this level of rounding probably overstates both the accuracy and precision of the results. Because of rounding, marginal totals in some tables do not necessarily agree with sums for individual rows and columns.

Many varied cross-tabulations of the survey results are possible. To keep this report to a reasonable size we present a limited set of tables, concentrating on cross-tabulations and groupings of data which capture the key results of the survey (such as effort by Zone, catches by Zone or FMA, and catches of QMS species by Fishstock). However, the dataset will be stored on a database (which does not include individual operator names and addresses, or vessel names) at NIWA at Greta Point.

Results

The replies

About 2000 completed diary pages were returned to NIWA, representing 7941 fishing trips 50 421 fishers. Fishing activity (at least one trip by at least one vessel) was recorded in all Zones except Zone 8 (Firth of Thames); Zone 16 (Wairarapa east coast from Cape Turnagain to Turakirae Head); Zones 22 and 24 (Kaipara Harbour to Reef Point); Zone 32 (Canterbury Bight between the Rakaia and Waitaki rivers); and Zone 34 (south Otago from Tokomairiro River to Slope Point). A total of 20 341 catch records were provided, representing 105 species.

Fishing effort

Four methods – inshore line fishing, big game fishing, deepwater line fishing, and extractive diving – accounted for 96.9% of the charter trips (Table 7). Other methods included potting, set netting, scallop dredging, and very occasionally saltwater flyfishing.

For the four main fishing methods, estimated fishing effort by charter vessels from 1 November 1997 to 31 October 1998 totalled 1.12 million hours. The distribution of effort was strongly skewed (75% of total effort) towards Zones 1 to 13 (FMA1), along the east coast of the North Island from North Cape to Cape Runaway (Figure 3, Tables 8a, 8b), with a lesser concentration (13%) around the Marlborough Sounds (Zones 26 – 28). Inshore line fishing (72% of the total effort) was by far the most commonly used method.

Effort varied significantly throughout the season (Tables 9a, 9b). This trend was most marked for big game fishing, over 70% of which was recorded over the 3 months from February to April 1998. Other

fishing methods also showed a tendency for activity levels to drop off during winter, although the seasonal pattern was much less marked for extractive diving and inshore line fishing than for deepwater line fishing.

Characteristics of fishers

The number of fishers per charter trip averaged 6.5 and varied little between fishing methods (Figure 4). Big game charters tended to involve the fewest individuals (4.5 per trip), whereas inshore line trips involved the most (7.2 per trip). Fishing hours per day varied depending on the type of charter. Mean hours per day ranged from 1.5 for extractive diving to 6.5 for big game charters. Deepwater line fishing and inshore line fishing trips averaged 3.7 hours and 4.4 hours, respectively.

Fishers of overseas origin accounted for 7.3% of the total fishers (Table 10, Table 11). Overseas participation rates were similar (6.5–8.5%) for big game fishing (6.5%), deepwater lining (8.4%), and inshore lining (7.8%), but were substantially lower for extractive diving (2.2%). The highest participation rates were mostly associated with the area and season of peak activity, i.e., in the Bay of Islands/Hauraki area during February and March. For Zones 1 to 4 (North Cape to Bay of Islands), overseas fishers made up 14% of the total (for all methods combined), and over 28% of those participating in deepwater line fishing charters.

Trip duration (hours per day) varied substantially between fishing methods (Figure 5). Diving trips were the shortest, seldom exceeding 2 hours in length, whereas big game trips averaged 6.5 hours per day. In practice, many big game trips (and some deepwater line trips) were multi-day charters lasting up to 5 days.

Species targeted and successful trips

Information on target species was available for 7643 trips (96.3%). A total of 54 species was listed at least once, although within each fishing method the most popular target species seldom numbered more than two or three. Key target species were marlins and tuna (for big game charters); hapuku/bass and kingfish (for deepwater line charters); rock lobster (for extractive diving charters); and snapper and blue cod (for inshore line charters) (Table 12).

To characterise the fishing success rate for each target species, we adopted the definition (given by Bradford *et al*. 1998) that a successful trip was any charter during which at least one individual of the specified target species was caught. Success rates averaged 82%, and were usually over 80% for fishing methods other than big game. By contrast, the success rate for big game trips averaged 17%, and was only 5% (31 successes out of 630 trips) for marlins (predominantly striped marlin, although respondents did not always specify a single species).

Total catches

Estimated catches for all 105 species taken during the survey are given in Table 13, expressed both as the total catch (including fish caught and released), and the total harvest (including only fish caught and kept). Catches of individual species ranged from 455 000 snapper (of which 310 000 were kept) to single figure estimates (invariably based on isolated catches of a single individual) for 16 minor species such as stargazer, elephantfish, and turbot. In most of the remaining tables in this report we concentrate on 18 QMS species for which the estimated catch exceeded 1000 individuals (18 species), and 14 non-QMS species of particular significance to the charter fishing industry. These included all

species with an estimated catch of over 2000 individuals, together with spiny dogfish (estimated catch 1253 fish), yellowfin tuna (estimated catch 1130 fish), and butterfish or greenbone (estimated catch 521 fish).

Catches of the main species

Estimated numbers of the 32 main species landed (i.e., caught and killed) are listed in Table 14 by fishing method. The top 11 species were all QMS species, with snapper and blue cod the most important. As expected, snapper, blue cod and tarakihi were predominantly taken by inshore lining, with a few by deepwater lining. Of those species taken in large numbers by "other" methods, scallops were taken by extractive diving and dredging, rock lobster by extractive diving and potting, and butterfish/greenbone and tarakihi by set netting.

The estimated numbers of the main species landed are listed in Table 15 by annual quarter. For the most important three species, landings were spread over the year, with peak catches of snapper and blue cod in February – April, and of tarakihi in November – January. Migratory species such as the tunas were noticeably absent during cooler periods. Table 16 provides estimates of the number of fish landed by diary Zones for eight species of particular importance.

Table 17 gives the numbers of fish landed by Fishstock for all QMS species recorded, and Table 18 provides these same estimates, as tonnages, for 16 species for which data on mean green weights (by Fishstock) are readily available (Bradford 1998c)[1].

Discussion

Estimates of the numbers of fish landed were compared with those derived by Bradford (1998c) from data supplied by the very few diarists using charter boats (3.3% of trips) in the national marine recreational fishing survey in 1996. Although the ranking of species importance is broadly similar in both reports, the estimates obtained from this survey were usually markedly higher, often by a factor of between 2 and 3. For the three most important species snapper, blue cod and tarakihi, the factors were similar at 2.4, 2.8, and 2.3, respectively. For a few species such as kahawai and rock lobster, estimates from the two sources were similar, while for several others, e.g., sea perch and jack mackerel, estimates from this survey were about 10 –15 times greater.

This diary survey provided considerably more information on which to base estimates of fish catch than was available to Bradford in the earlier survey; indeed it was largely the paucity of data in the earlier survey on recreational fishing from charter boats that provided the stimulus to initiate this survey. Thus it is not surprising there are some differences between the two sets of results; perhaps the surprising thing is that there are so many similarities, especially in the ranking of the important species.

Data collected during this survey are robust, but assumptions made regarding the number of charter boats operating are the biggest limitation. Considering the expansion and changes in the industry over the last few years, it could be timely to update the database on charter vessels operating at present. The data obtained from this survey could then be simply updated by modifying the expansion factors where necessary, and an up-to-date estimate produced of fish numbers caught by recreational fishing on charter boats.

[1] Similar estimates could be made for any species for which adequate data on mean green weights are available elsewhere in the literature, or become available in the future.

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This report would not have been possible without the major contribution by the 85 operators who kept records over the year of the survey, usually whilst at sea and also needing to look after clients. Our grateful thanks are due to these participants, and we hope this report is worth their efforts. Particular thanks go to Keith Ingram, former president of the Marine Transport Association, for his advice and assistance when developing the survey. Bell & Associates kindly allowed us to use the area maps developed for the 1996 National Marine Recreational Fishing Survey. Elizabeth Bradford and Alan Kilner reviewed the manuscript. This work was carried out by NIWA under contract to the Ministry of Fisheries (project REC9703).

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Table 1: **Zones and Regions used for the 1997–98 diary survey, and their relationship to the New Zealand Fisheries Management Areas (FMAs)**

Zone	Description	Region	FMA
1	North Cape–Cape Brett	1	1
2	Bay of Islands	1	1
3	Cape Brett–Cape Rodney	2	1
4	Whangarei Harbour	2	1
5	Barrier Islands	2	1
6	Western Gulf	2	1
7	Inner Gulf	2	1
8	Firth of Thames	2	1
9	Eastern Gulf	2	1
10	Eastern Coromandel	3	1
11	Waihi Bluffs–Tarawera River	3	1
12	Tauranga Harbour	3	1
13	Tarawera River–Cape Runaway	3	1
14	Cape Runaway–Whareongaonga	4	2
15	Whareongaonga–Cape Turnagain	4	2
16	Cape Turnagain–Turakirae Head	4	2
17	Turakirae Head–Titahi Bay	4	2
18	Titahi Bay–Waitotara River	6	8
19	Waitotara River–Tirua Point	6	8
20	Tirua Point–Manukau Harbour	5	9
21	Manukau Harbour	5	9
22	Kaipara Harbour	5	9
23	Manukau – Kaipara	5	9
24	Kaipara–Reef Point	5	9
25	Reef Point–North Cape	5	9
26	Pelorus, Kenepuru, Mahau Sounds	7	7
27	Queen Charlotte Sound	7	7
28	Stephens Island–Clarence River	7	7
29	Clarence River–Conway River	8	3
30	Conway River–Sumner Beach	8	3
31	Sumner Beach–Rakaia River	8	3
32	Rakaia River–Waitaki River	8	3
33	Waitaki River–Tokomairiro River	8	3
34	Tokomairiro River–Slope Point	8	3
35	Slope Point–Te Waewae Point	9	5
36	Stewart Island	9	5
37	Paterson Inlet	9	5
38	Te Waewae Point–Awarua Point	10	5
39	Awarua Point–Kahurangi Point	11	7
40	Kahurangi Point–Stephens Island	7	7

Table 2: **Expansion factors by Region for the 1997–98 diary survey**

Region		Number of addresses	Number of vessels	Participation rate %	Expansion factor
1	East Northland	83	13	16	6.4
2	Hauraki	76	14	18	5.4
3	Bay of Plenty	91	24	26	3.8
4	East Coast North	20	3	15	6.7
5	West Coast North	7	1	14	7.0
6	Egmont	10	3	30	3.3
7	Tasman	45	15	33	3.0
8	East Coast South	17	5	29	3.4
9	Southern	14	3	21	4.7
10	Fiordland	11	6	55	1.8
11	West Coast South	2	1	50	2.0
	Total, all regions	376	88	23	4.3

Table 3: **Number of diaries received and expansion factors (EF) by Region and quarter, as used in the 1997–98 diary survey**

			Nov–Jan		Feb–Apr		May–Jul		Aug–Oct	
Region	Total addresses	Diaries issued	Diaries received	EF	Diaries received	EF	Diaries received	EF	Diaries received	EF
1	83	13	13	6.4	12	6.9	9	9.2	9	9.2
2	76	14	14	5.4	11	6.9	10	7.6	9	8.4
3	91	24	22	4.1	20	4.6	18	5.1	15	6.1
4	20	3	2	10.0	3	6.7	2	10.0	2	10.0
5	7	1	1	7.0	1	7.0	1	7.0	1	7.0
6	10	3	3	3.3	3	3.3	3	3.3	3	3.3
7	45	15	13	3.5	13	3.5	13	3.5	11	4.1
8	17	5	4	4.3	5	3.4	3	5.7	4	4.3
9	14	3	2	7.0	3	4.7	3	4.7	3	4.7
10	11	6	4	2.8	4	2.8	4	2.8	3	3.7
11	2	1	1	2.0	1	2.0	1	2.0	1	2.0

Table 4: **Recruitment of diarists in relation to vessel length**

Vessel length (m)	Number of vessels on 1997–98 mailing list	% of total vessels	Number of vessels maintaining diaries in 1997–98	% of total vessels
5–10	60	29	21	28
10–15	128	62	46	61
> 15	19	9	8	11
Total	207		75	

Table 5: **Recruitment of diarists from the 1996–97 survey in relation to annual fishing effort**

Days 1996–97	Number of vessels recorded in 1996–97 survey	% of total vessels	Number of vessels maintaining diaries in 1997–98	% of total vessels
≥ 50	56	28	15	21
51–100	52	26	20	28
101–200	63	32	22	31
> 200	26	13	14	20
Total	197		71	

Table 6: **Approximate standard errors (SE) and coefficients of variation (*c.v.*) for typical estimates of catch (number of fish) and effort (total hours) derived from the 1997–98 diary survey**

Estimate	SE (catch)	*c.v.* (catch) %	SE (hours)	*c.v.* (hours) %
10	10	100	10	78
20	20	85	15	68
50	35	69	30	57
100	60	59	50	50
200	100	51	90	44
500	200	41	200	36
1 000	350	35	300	32
2 000	600	30	560	28
5 000	1 200	24	1 200	23
10 000	2 000	21	2 000	20
20 000	3 500	18	3 500	18
50 000	7 000	15	7 500	15
100 000	12 000	12	13 000	13
200 000	21 000	11	23 000	11

Table 7: **Fishing effort (trips recorded and hours fished) during the 1997–98 diary survey, by fishing method (unexpanded data)**

	Trips recorded		Hours fished	
Fishing method	N	%	N	%
Big game/offshore	1 015	12.7	6 607	19.6
Deepwater line	1 058	13.3	3 943	11.8
Extractive diving	669	8.5	1 034	3.1
Inshore line	4 953	62.4	21 940	65.3
Potting	141	1.8		
Set netting	58	0.7		
Scallop dredging	42	0.5	69	0.2
Other	5	0.1	18	0.1
All methods	7 941		33 610	

Table 8a: **Estimated annual fishing effort (hours) by fishing method, diary Zone, and FMA. Methods not measurable in fisher-hours (potting and set netting) are not included. Refer to Table 6 for approximate standard errors. Estimated catches of less than 10 fish are denoted by ***

Area	Zone	Big Game	Deepwater line	Extractive diving	Inshore line	All methods
FMA1	1	59 000	27 000	200	64 000	150 000
	2	500	5 200		6 400	12 000
	3	14 000	800	500	88 000	100 000
	4			10	200	300
	5	6 100	1 600	5 700	40 000	54 000
	6	300	200	900	63 000	64 000
	7	20			87 000	87 000
	9				4 400	4 400
	10	15 000	2 200	8 400	140 000	170 000
	11	10 000	7 600	7 100	80 000	100 000
	12	1 200	800	60	1 600	3 700
	13	24 000	30 000	2 600	27 000	84 000
Total, FMA1		130 000	76 000	25 000	600 000	840 000
FMA2	14	3 000	4 400	400	11 000	19 000
	15	600	2 900		11 000	15 000
	17				2 700	2 700
Total, FMA2		3 600	7 300	400	25 000	36 000
FMA 3	29	400	90	100	5 800	6 400
	30		2 000	100	9 500	12 000
	31				700	700
	33				13 000	13 000
Total, FMA3		400	2 000	200	29 000	32 000
FMA 5	35				1 400	1 400
	36			600	6 700	7 300
	37				3 900	3 900
	38	*	60	2 300	12 000	15 000
Total, FMA5		*	60	2 900	24 000	27 000
FMA 7	26		5 100	1 500	63 000	70 000
	27		1 100	700	26 000	28 000
	28		16 000	1 200	26 000	43 000
	39	50	*		90	100
	40		70	200	2 400	2 700
Total, FMA7		50	23 000	3 700	120 000	140 000
FMA 8	18				200	200
	19				100	100
Total, FMA8					400	400
FMA 9	20	300			200	500
	21	300			7 500	7 700
	23	3 200			600	3 800
	25	26 000	3 100	400	3 000	33 000
Total, FMA9		30 000	3 100	400	11 000	45 000
Total, all FMAs		170 000	110 000	33 000	810 000	1 120 000

Table 8b: **Annual fishing effort by diarists (hours, unexpanded) by fishing method, diary Zone, and FMA. Methods not measurable in fisher-hours (potting and set netting) are not included**

Area	Zone	Big Game	Deepwater line	Extractive diving	Inshore line	All methods
FMA1	1	8 488	3 603	28	8 956	21 075
	2	62	788		828	1 678
	3	2 224	140	76	12 560	14 999
	4			2	32	34
	5	999	247	817	6 244	8 306
	6	42	30	120	9 640	9 832
	7	4			12 807	12 811
	9				708	708
	10	3 331	480	1 879	30 662	36 351
	11	2 280	1 542	1 574	16 799	22 194
	12	268	202	14	373	857
	13	5 317	6 524	526	5 617	17 983
Total, FMA1		23 014	13 555	5 036	105 224	146 829
FMA2	14	365	485	37	1 194	2 080
	15	96	292		1 330	1 717
	17				331	331
Total, FMA2		461	777	37	2 854	4 128
FMA 3	29	120	20	34	1 537	1 711
	30		575	34	2 430	3 039
	31				198	198
	33				2 908	2 908
Total, FMA3		120	595	68	7 073	7 856
FMA 5	35				300	300
	36			131	1 419	1 550
	37				824	824
	38	3	20	832	4 464	5 318
Total, FMA5		3	20	963	7 007	7 993
FMA 7	26		1 429	429	17 921	19 779
	27		312	194	7 367	7 872
	28		4 626	347	7 309	12 281
	39	23	4		46	73
	40		20	67	688	775
Total, FMA7		23	6 390	1 037	33 331	40 780
FMA 8	18				70	70
	19				38	38
Total, FMA8					108	108
FMA 9	20	40			27	67
	21	40			1 065	1 105
	23	460			80	540
	25	3 764	447	56	434	4 701
Total, FMA9		4 304	447	56	1 606	6 413
Total, all FMAs		27 925	21 783	7 196	157 203	214 107

Table 9a: **Estimated annual fishing effort (hours) by fishing method and calendar month. Methods for which the effort is not measurable in fisher-hours (such as potting) are not included. Refer to Table 6 for approximate standard errors**

Month	Big Game	Deepwater line	Extractive diving	Inshore line	All methods
January	24 000	11 000	3 800	90 000	130 000
February	44 000	12 000	4 000	94 000	150 000
March	39 000	13 000	2 700	90 000	140 000
April	33 000	8 900	2 600	84 000	130 000
May	14 000	10 000	2 200	69 000	96 000
June	1 600	8 600	1 100	46 000	58 000
July	200	4 600	1 800	36 000	42 000
August	0	2 800	2 400	49 000	54 000
September	1 000	6 900	2 000	40 000	50 000
October	1 100	7 900	1 300	51 000	61 000
November	600	15 000	5 700	76 000	97 000
December	6 100	11 000	3 300	86 000	110 000
Annual total	170 000	110 000	33 000	810 000	1 120 000

Table 9b: **Annual fishing effort recorded by diarists (hours, unexpanded) by fishing method and calendar month. Methods for which the effort is not measurable in fisher-hours (such as potting) are not included**

Month	Big game	Deepwater line	Extractive diving	Inshore line	All methods
January	4 777	2 062	909	18 791	26 539
February	7 918	2 511	928	18 365	29 721
March	6 360	2 489	613	18 232	27 693
April	4 892	1 715	578	16 745	23 931
May	1 959	2 063	452	13 409	17 883
June	255	1 726	253	8 469	10 702
July	39	1 019	349	6 526	7 933
August	0	443	388	7 700	8 531
September	169	1 053	285	6 269	7 776
October	178	1 297	239	7 981	9 696
November	155	3 268	1 389	16 898	21 710
December	1 223	2 138	814	17 819	21 993
Annual total	27 925	21 783	7 196	157 203	214 107

Table 10: **Participation in recreational charter fishing by overseas fishers, expressed as a percentage of the total number of fishers, by fishing method and calendar month**

Month	Big Game	Deepwater line	Extractive diving	Inshore line	All methods
January	4.1	9.1	3.9	9.6	8.5
February	11.8	15.1	2.3	9.1	9.9
March	2.2	15.0	2.6	9.4	8.4
April	9.6	9.9	0.7	5.8	6.6
May	6.3	6.2	6.2	6.7	6.5
June	6.1	6.7	0.0	7.9	7.2
July	0.0	4.9	0.4	3.2	3.0
August		2.7	0.0	5.3	4.3
September	1.9	2.8	1.3	3.8	3.4
October	0.0	3.9	2.9	5.6	4.9
November	0.0	3.7	2.2	7.3	6.1
December	3.0	12.9	3.8	12.1	11.1
Annual total	6.5	8.4	2.2	7.8	7.3

Table 11: **Participation in recreational charter fishing by overseas fishers expressed as a percentage of the estimated total number of fishers (N), by fishing method and FMA. Data for FMA1 have been divided into three sub-areas, representing the Bay of Islands (Zones 1–4), the Hauraki Gulf (Zones 5–9), and the Bay of Plenty (Zones 10–13). Refer to Table 6 for approximate standard errors**

		Big Game		Deepwater line		Extractive diving		Inshore line		All methods	
FMA	Zones	N	%	N	%	N	%	N	%	N	%
FMA1	1–4	9 300	7.8	7 100	28.3	600	0.0	34 000	13.1	51 000	14.1
	5–9	800	2.0	400	11.6	1 800	0.0	39 000	8.4	42 000	7.9
	10–13	11 000	4.1	11 000	2.7	9 500	3.2	53 000	6.2	84 000	5.1
FMA1	Total	21 000	5.7	19 000	12.7	12 000	2.5	130 000	8.7	180 000	8.4
FMA2		1 000	5.0	1 500	0.7	300	3.2	4 300	3.8	7 100	3.3
FMA3		30	0.0	500	5.0	300	5.6	7 200	6.7	8 100	6.5
FMA5		8	0.0	60	0.0	2 600	0.3	8 100	8.0	11 000	6.1
FMA7		10	0.0	9 200	1.0	2 200	2.2	30 000	4.3	41 000	3.5
FMA8		0		0		0		100	0.0	100	0.0
FMA9		4 900	10.0	1 100	10.1	200	3.1	2 700	10.7	8 900	10.1
Total, all FMAs		27 000	6.5	31 000	8.4	18 000	2.2	180 000	7.8	250 000	7.3

Table 12: **Success rate of charter trips (unexpanded data) by fishing method and target species. (A successful trip was defined as any charter during which at least one individual of the specified target species was caught)**

Fishing method	Species	Trips	Success	Success rate (%)
Big game	Marlins	630	31	5
	Yellowfin tuna	181	58	32
	Albacore tuna	98	30	31
	Skipjack tuna	43	38	88
	Sharks	21	10	48
	Broadbill swordfish	12	0	0
	Southern bluefin tuna	4	1	25
	Other species	12	5	42
	All species	1 001	173	17
Deepwater line	Hapuku & Bass	433	323	75
	Kingfish	428	371	87
	Bluenose	62	44	71
	Snapper	33	31	94
	Tarakihi	24	23	96
	Other species	62	50	81
	All species	1 042	842	81
Extractive diving	Rock lobster	544	519	95
	Scallop	64	61	95
	Oysters dredge	21	21	100
	Other species	24	20	83
	All species	653	621	95
Inshore line	Snapper	2 439	2 291	94
	Blue cod	981	970	99
	Tarakihi	392	367	94
	Jack mackerel	313	311	99
	Hapuku & Bass	201	169	84
	Kingfish	149	113	76
	Kahawai	40	40	100
	School shark	33	29	88
	Quinnat salmon	31	16	52
	Pink maomao	24	23	96
	Other species	98	70	71
	All species	4 701	4 399	94
Other methods	All species	246	220	89
Total, all methods	All species	7 643	6 255	82

Table 13: **Estimated catch and landings (expressed as total number of fish) by recreational fishers from charter vessels, November 1997 to October 1998, by species. Numbers and % killed are listed by species. Species subject to the QMS are identified by ‡. Estimated catches of less than 10 fish are denoted by *. Refer to Table 6 for approximate standard errors for "expanded" catches**

		Unexpanded		Expanded		
Code	Common name	Total catch	Total killed	Total catch	Total killed	% killed
ALB	Albacore tuna	648	501	3 900	3 000	77
BAR ‡	Barracouta	6 126	4 425	35 000	26 000	75
BAS ‡	Bass groper	217	217	1 100	1 100	100
BCO ‡	Blue cod	89 639	66 967	330 000	250 000	75
BEM	Blue marlin	5	4	30	30	78
BIG	Bigeye tuna	2	2	10	10	100
BKM	Black marlin	3	2	20	10	67
BMA	Blue maomao	3 090	2 342	18 000	14 000	78
BNS ‡	Bluenose	639	611	3 200	3 100	95
BPE	Butterfly perch	133	107	500	400	79
BPF	Banded wrasse	127	27	600	100	18
BRC	Northern bastard cod	40	34	200	200	83
BUT	Butterfish or greenbone	147	147	500	500	100
BWH	Bronze whaler shark	14	0	90	0	0
BWS	Blue shark	357	114	2 200	800	35
BYS ‡	Alfonsino	4	4	20	20	100
CAR	Carpet shark	177	18	700	70	9
CON	Conger eel	139	76	600	300	52
CRA ‡	Rock lobster	12 807	9 650	55 000	41 000	75
CUC	Cucumber fish	1	0	*	0	0
DOF	Dolphinfish	12	12	80	80	100
EGR	Eagle ray	10	0	60	0	0
ELE ‡	Elephantfish	1	1	*	*	100
EMA	Blue mackerel	1 130	1 109	7 900	7 700	98
FLO	Flounder	21	21	70	70	100
FLY	Flying fish	263	263	1 100	1 100	100
FOX	Foxfish	3	3	30	30	100
FRO ‡	Frostfish	94	79	500	400	84
GAR	Garfish	4	4	20	20	100
GTR	Marblefish	15	0	50	0	0
GUR ‡	Gurnard	1 540	1 386	8 300	7 500	90
GWR	Green wrasse	15	0	50	0	0
HAG	Hagfish	24	13	90	50	49
HAP ‡	Hapuku	7 445	7 036	36 000	32 000	90
HEP	Sharpnose sevengill shark	10	0	100	0	0
HHS	Hammerhead shark	14	4	80	20	27
HOK ‡	Hoki	2	2	10	10	100
JDO ‡	John dory	1 637	1 610	11 000	10 000	98
JGU	Spotted gurnard	30	21	100	100	69
JMA ‡	Jack mackerel	9 876	9 677	68 000	67 000	98
KAH	Kahawai	6 603	4 520	37 000	25 000	68
KEL	Kelpfish	1	0	*	0	0
KIN	Kingfish	6 368	2 332	36 000	14 000	40
KOH	Koheru	2 293	1 930	15 000	13 000	83
LEA	Leatherjacket	207	161	1 000	800	78

Code	Common name	Unexpanded Total catch	Unexpanded Total killed	Expanded Total catch	Expanded Total killed	% killed
LIN ‡	Ling	81	57	500	300	73
LIZ	*Synodus* spp.	1	1	*	*	100
MAK	Mako shark	305	115	1 800	700	37
MOK ‡	Moki	255	239	900	800	93
MOR	Moray eel	83	0	500	0	0
OCT	Octopus	42	28	200	100	69
OYS ‡	Oysters (dredge)	10 950	10 950	51 000	51 000	100
PAR	Parore	102	49	500	200	50
PAU ‡	Black & Yellowfoot paua	112	87	500	400	80
PHC ‡	Packhorse rock lobster	32	20	200	100	67
PMA	Pink maomao	6 343	5 345	31 000	26 000	83
POR	Porae	357	342	1 900	1 800	95
POS	Porbeagle shark	1	1	*	*	100
PPI	Pipi	300	300	1 600	1 600	100
RBM	Ray’s bream	6	6	30	30	100
RBP	Red banded perch	42	11	200	60	29
RBY ‡	Rubyfish	48	44	200	200	91
RCO ‡	Red cod	2 019	1 030	8 400	4 200	50
RMO	Red moki	19	19	100	100	100
RMU	Red mullet	5	3	30	20	57
RPI	Red pigfish	532	187	2 800	1 100	38
RRC	Scorpion fish	581	141	3 300	900	28
RSN	Red snapper	4 971	4 219	26 000	22 000	84
SAM	Quinnat salmon	70	58	300	200	80
SBG	Spotted black grouper	1	0	*	0	0
SBR	Southern bastard cod	1	1	*	*	100
SCA ‡	Scallop	32 580	22 582	140 000	100 000	71
SCH ‡	School shark	1 339	770	7 500	3 700	50
SHA	Shark	42	15	200	70	27
SKA	Skate	33	22	100	100	74
SKI ‡	Gemfish	309	301	1 400	1 400	97
SKJ	Skipjack tuna	2 468	2 321	14 000	13 000	95
SNA ‡	Snapper	73 397	49 638	450 000	310 000	68
SOL	Sole	1	0	*	0	0
SPD	Spiny dogfish	1 921	306	8 600	1 300	15
SPE ‡	Sea perch	26 497	14 975	97 000	56 000	58
SPF	Scarlet wrasse	1 406	360	5 300	1 500	28
SPO ‡	Rig	149	88	500	300	60
SPP	Splendid perch	4	0	10	0	0
SQX	Squid	322	298	2 100	1 900	92
SSF	Shortbill spearfish	1	1	*	*	100
STG ‡	Stargazer	1	0	*	0	0
STM	Striped marlin	117	33	800	200	28
STN	Southern bluefin tuna	1	1	*	*	100
STR	Stingray	27	0	200	0	0
STU	Slender tuna	1	1	*	*	100
STY	Spotty	36	14	100	50	39
SUR	Kina	1 258	1 258	12 000	12 000	100
SWE	Sweep	3 514	2 564	18 000	13 000	74
SWO	Broadbill swordfish	1	1	*	*	100

		Unexpanded		Expanded		
Code	Common name	Total catch	Total killed	Total catch	Total killed	% killed
SWR	Sandager's wrasse	1	0	*	0	0
TAR ‡	Tarakihi	41 253	36 997	190 000	170 000	90
THR	Thresher shark	5	3	30	20	52
TRE ‡	Trevally	7 578	6 222	44 000	37 000	83
TRI	Tripod fish	2	2	*	*	100
TRU ‡	Trumpeter	2 489	2 447	11 000	11 000	98
TUR	Turbot	1	1	*	*	100
WAR ‡	Common warehou	20	19	70	70	96
WSE	Wrasses	824	28	3 700	100	4
YFN	Yellowfin tuna	270	247	1 300	1 100	90
Total, all species		377 060	280 200	1 820 000	1 370 000	75

Table 14a: **Estimated landings (number of fish killed, expanded) by recreational fishers from charter vessels, November 1997 to October 1998, for 32 selected species, by fishing method. "Other methods" includes principally potting, set netting, and shellfish dredging; ‡ denotes QMS species. Estimated catches of less than 10 fish are denoted by *. Refer to Table 6 for approximate standard errors**

Species	Big Game	Deepwater line	Extractive diving	Inshore line	Other Methods	All methods
Snapper ‡		3 700		310 000	10	310 000
Blue cod ‡		16 000	200	230 000	90	250 000
Tarakihi ‡		10 000	100	160 000	200	170 000
Scallop ‡			53 000		49 000	100 000
Jack mackerel ‡	90	1 300		65 000		67 000
Sea perch ‡		6 100	50	50 000		56 000
Oysters (dredge) ‡			51 000			51 000
Rock lobster ‡			36 000	70	5 500	41 000
Trevally ‡		1 100	20	36 000	10	37 000
Hapuku & Bass ‡		18 000		15 000		33 000
Barracouta ‡	60	2 100		24 000	20	26 000
Pink maomao		1 900	30	24 000		26 000
Kahawai	800	700	*	23 000	50	25 000
Red snapper		5 200	*	17 000		22 000
Kingfish	400	8 000	1 300	4 700	10	14 000
Blue maomao		40		14 000		14 000
Skipjack tuna	12 000	400		1 000		13 000
Sweep				13 000		13 000
Koheru		600		12 000		13 000
Kina			12 000		*	12 000
Trumpeter ‡		700	*	10 000	*	11 000
John dory ‡		2 600	*	7 800		10 000
Blue mackerel		500		7 300		7 700
Gurnard ‡		70		7 400	*	7 500
Red cod ‡		500	10	3 800		4 200
School shark ‡		600		3 200		3 700
Bluenose ‡		2 400		600		3 100
Albacore tuna	2 900	60				3 000
Gemfish ‡		1 300		80		1 400
Spiny dogfish		90		1 200	*	1 300
Yellowfin tuna	900	200				1 100
Butterfish/greenbone			300		300	500
Total	17 000	84 000	150 000	1 040 000	55 000	1 350 000

Table 14b: **Landings (number of fish killed, unexpanded) by recreational fishers from charter vessels, November 1997 to October 1998, for 32 selected species, by fishing method. "Other methods" includes principally potting, set netting, and shellfish dredging; ‡ denotes QMS species**

Species	Big Game	Deepwater line	Extractive diving	Inshore Line	Other methods	All methods
Snapper ‡		674		48 898	4	49 576
Blue cod ‡		4 517	52	61 920	25	66 514
Tarakihi ‡		2 039	28	34 810	67	36 944
Scallop ‡			10 119		12 463	22 582
Jack mackerel ‡	20	220		9 437		9 677
Sea perch ‡		1 717	15	13 153		14 885
Oysters (dredge) ‡			10 950			10 950
Rock lobster ‡			8 115	11	1 491	9 617
Trevally ‡		149	4	6 040	2	6 195
Hapuku & Bass ‡		4 318		2 879		7 197
Barracouta ‡	8	354		4 055	5	4 422
Pink maomao		281	6	5 058		5 345
Kahawai	155	127	2	4 168	10	4 462
Red snapper		783	1	3 434		4 218
Kingfish	86	1 262	192	778	2	2 320
Blue maomao		9		2 333		2 342
Skipjack tuna	2 053	86		182		2 321
Sweep				2 564		2 564
Koheru		140		1 790		1 930
Kina			1 257		1	1 258
Trumpeter ‡		113	1	2 332	1	2 447
John dory ‡		353	1	1 254		1 608
Blue mackerel		68		1 041		1 109
Gurnard ‡		15		1 369	1	1 385
Red cod ‡		135	3	891		1 029
School shark ‡		140		630		770
Bluenose ‡		472		127		599
Albacore tuna	489	12				501
Gemfish ‡		280		18		298
Spiny dogfish		23		282	1	306
Yellowfin tuna	201	46				247
Butterfish/greenbone			68		78	146
Total	3 012	18 333	30 814	209 454	14 151	275 764

Table 15a: **Estimated landings (number of fish killed) by recreational fishers from charter vessels, November 1997 to October 1998, for 32 selected species, by annual quarter. ‡ denotes QMS species. Refer to Table 6 for approximate standard errors**

Species	Nov–Jan	Feb–Apr	May–Jul	Aug–Oct	Annual total
Snapper ‡	69 000	110 000	72 000	57 000	310 000
Blue cod ‡	50 000	79 000	74 000	47 000	250 000
Tarakihi ‡	68 000	38 000	25 000	41 000	170 000
Scallop ‡	23 000	5 800	12 000	60 000	100 000
Jack mackerel ‡	22 000	24 000	9 800	11 000	67 000
Sea perch ‡	14 000	18 000	9 900	14 000	56 000
Oysters (dredge) ‡			36 000	15 000	51 000
Rock lobster ‡	12 000	16 000	6 200	6 300	41 000
Trevally ‡	8 800	11 000	8 300	8 100	37 000
Hapuku & Bass ‡	8 900	6 600	9 100	8 600	33 000
Barracouta ‡	7 000	3 300	4 200	12 000	26 000
Pink maomao	8 700	12 000	2 000	2 800	26 000
Kahawai	7 400	9 600	5 900	2 000	25 000
Red snapper	9 100	8 400	2 400	2 300	22 000
Kingfish	5 400	5 000	2 300	1 700	14 000
Blue maomao	4 500	4 300	2 300	2 900	14 000
Skipjack tuna	800	8 600	3 900		13 000
Sweep	5 400	3 600	2 300	1 600	13 000
Koheru	2 900	4 700	3 700	1 200	13 000
Kina	12 000	10	300	100	12 000
Trumpeter ‡	600	1 800	4 400	4 000	11 000
John dory ‡	2 400	2 900	2 200	2 900	10 000
Blue mackerel	3 400	500	2 800	1 100	7 700
Gurnard ‡	3 600	1 500	800	1 500	7 500
Red cod ‡	1 500	1 300	800	600	4 200
School shark ‡	400	1 000	1 300	1 000	3 700
Bluenose ‡	500	800	1 100	700	3 100
Albacore tuna	1 600	1 200	100	40	3 000
Gemfish ‡	400	600	200	200	1 400
Spiny dogfish	400	300	300	300	1 300
Yellowfin tuna	400	700			1 100
Butterfish/greenbone	100	200	100	30	500
Total, all species	350 000	380 000	310 000	310 000	1 350 000

Table 15b: **Landings (number of fish killed, unexpanded) by recreational fishers from charter vessels, November 1997 to October 1998, for 32 selected species, by annual quarter. ‡ denotes QMS species**

Species	Nov–Jan	Feb–Apr	May–Jul	Aug–Oct	Annual total
Snapper ‡	13 216	17 710	11 081	7 569	49 576
Blue cod ‡	13 050	23 842	18 559	11 063	66 514
Tarakihi ‡	15 397	8 612	5 922	7 013	36 944
Scallop ‡	5 413	1 413	3 181	12 575	22 582
Jack mackerel ‡	3 772	3 583	1 124	1 198	9 677
Sea perch ‡	3 621	5 375	2 546	3 343	14 885
Oysters (dredge) ‡			7 800	3 150	10 950
Rock lobster ‡	3 065	3 965	1 467	1 120	9 617
Trevally ‡	1 687	2 001	1 360	1 147	6 195
Hapuku & Bass ‡	1 562	1 712	2 235	1 688	7 197
Barracouta ‡	1 385	807	737	1 493	4 422
Pink maomao	2 027	2 575	322	421	5 345
Kahawai	1 362	1 731	1 034	335	4 462
Red snapper	1 983	1 452	441	342	4 218
Kingfish	992	813	294	221	2 320
Blue maomao	963	710	309	360	2 342
Skipjack tuna	190	1 505	626		2 321
Sweep	1 222	770	355	217	2 564
Koheru	518	796	458	158	1 930
Kina	1 170	3	65	20	1 258
Trumpeter ‡	111	517	974	845	2 447
John dory ‡	456	466	309	377	1 608
Blue mackerel	608	73	301	127	1 109
Gurnard ‡	647	321	163	254	1 385
Red cod ‡	372	361	162	134	1 029
School shark ‡	97	224	276	173	770
Bluenose ‡	119	150	220	110	599
Albacore tuna	252	221	21	7	501
Gemfish ‡	87	139	38	34	298
Spiny dogfish	92	81	69	64	306
Yellowfin tuna	94	153			247
Butterfish/greenbone	31	67	40	8	146
Total, all species	75 561	82 148	62 489	55 566	275 764

***Table 16a:*.** **Estimated landings (number of fish killed, expanded) by recreational fishers from charter vessels, November 1997 to October 1998, for 8 selected species, by diary Zone. Estimated catches of less than 10 fish are denoted by *. Refer to Table 6 for approximate standard errors**

Zone	Snapper	Blue cod	Tarakihi	Rock lobster	Trevally	Hapuku/ Bass	Kahawai	Kingfish
1	22 000	400	8 800	300	3 400	600	2 300	5 600
2	600		100		100	30	50	900
3	57 000	400	9 000	600	6 400	200	2 300	900
4	100		20					
5	17 000	200	1 600	5 700	5 100	200	1 100	300
6	34 000	100	300	400	3 000		1 900	300
7	91 000	30	20	50	1 700		3 600	200
9	3 500				*		400	60
10	48 000	700	51 000	12 000	6 400	1 100	2 100	1 000
11	15 000	400	38 000	2 800	7 500	1 100	3 300	700
12	200		1 400	100		30	40	10
13	6 200	70	7 800	3 600	1 200	2 100	1 000	2 400
14	800	200	8 600	200	600	6 900	300	1 200
15	3 900		700		300	1 100	1 500	800
17		80	20		40	10	100	
18		*					70	
19			100					
20	200		100			70		
21	4 100				400		1 900	70
23	100				20		300	
25	600	200	2 500	400	300	200	40	80
26	3 800	59 000	14 000	3 600	100	3 000	1 800	70
27	10	18 000	13 000	1 000		300	200	
28	600	33 000	13 000	2 500	70	10 000	600	*
29		6 100	100	2 000		70	70	
30		37 000	100	1 300		500	*	*
33	20	28 000	400		*	4 500		
35		7 000				200		
36		27 000						
37		5 000						
38		24 000	400	4 600	*	700		
39		200	80			10		
40	20	2 300	70	300		70		
Total	310 000	250 000	170 000	41 000	37 000	33 000	25 000	14 000

Table 16b: **Landings (number of fish killed, unexpanded) by recreational fishers from charter vessels, November 1997 to October 1998, for 8 selected species, by diary Zone**

Zone	Snapper	Blue cod	Tarakihi	Rock lobster	Trevally	Hapuku/ Bass	Kahawai	Kingfish
1	3 116	55	1 321	45	437	85	326	737
2	89		23		17	4	7	129
3	8 087	68	1 405	90	904	36	330	127
4	18		3					
5	2 664	32	258	849	804	37	169	43
6	5 268	18	62	49	443		312	49
7	13 040	5	2	6	254		576	35
9	543				1		75	11
10	9 967	143	10 513	2 498	1 377	234	452	212
11	2 964	66	8 304	617	1 441	210	685	153
12	41		331	26		7	9	3
13	1 233	13	1 673	737	246	421	204	531
14	82	23	965	8	62	726	36	162
15	455		70		35	108	195	86
17		11	3		6	1	13	
18		2					22	
19			32					
20	34		17			10		
21	585				63		266	10
23	16				3		40	
25	82	30	355	57	39	33	6	12
26	1 098	16 621	3 792	1 006	41	847	495	18
27	3	5 246	3 627	297		81	62	
28	181	9 377	3 843	724	19	2 842	164	1
29		1 601	25	544		18	16	
30		9 763	26	354		138	2	1
33	5	5 908	96		1	1 066		
35		1 500				35		
36		5 834						
37		994						
38		8 422	139	1 617	2	232		
39		110	38			5		
40	5	672	21	93		21		
Total	49 576	66 514	36 944	9 617	6 195	7 197	4 462	2 320

Table 17a: **Estimated landings (number of fish killed) by recreational fishers from charter vessels, November 1997 to October 1998, for all QMS species, by fishstock. Each cell shows the estimated catch for the fishstock denoted by the intersection of the corresponding row (species code) and column (stock number). Refer to Table 6 for approximate standard errors, and to Table 17b for species codes**

		Fishstock ‡								
Code	Common name	1	2	3	4	5	7	8	9	Total
BAR	Barracouta	22 000	† -	-	-	0	3 700	-	-	26 000
BCO	Blue cod	2 500	300	72 000	-	63 000	110 000	*	-	250 000
BNS	Bluenose	2 900	200	0	-	-	0	0	-	3 100
BYS	Alfonsino	20	0	0	-	-	0	0	-	20
CRA	Rock lobster	700	25 000	200	0	11 000	0	4 600	0	41 000
ELE	Elephantfish	0	0	0	-	0	*	-	-	*
FRO	Frostfish	400	0	0	-	0	0	0	0	400
GUR	Gurnard	5 000	1 400	70	-	-	1 000	0	-	7 500
HOK	Hoki	10	-	-	-	-	-	-	-	10
HPB	Hapuku and Bass	5 700	8 000	5 100	-	800	13 000	0	-	33 000
JDO	John dory	10 000	50	0	-	-	50	-	-	10 000
JMA	Jack mackerel	66 000	-	0	-	-	900	-	-	67 000
KAH	Kahawai	18 000	1 900	2 700	-	-	-	-	2 200	25 000
LIN	Ling	300	0	10	-	0	*	-	-	300
MOK	Moki	800	-	40	-	0	-	-	-	800
OYU	Oysters (dredge)	-	-	-	-	51 000	0	-	-	51 000
PAU	Black & Yellowfoot paua	200	0	0	-	0	200	-	-	400
PHC	Packhorse rock lobster	100	-	-	-	-	-	-	-	100
RBY	Rubyfish	200	0	0	-	0	0	0	0	200
RCO	Red cod	1 100	20	2 300	-	-	800	-	-	4 200
SCA	Scallop	0	-	-	-	-	100 000	-	-	100 000
SCH	School shark	2 900	40	80	-	0	700	0	-	3 700
SKI	Gemfish	1 400	0	0	-	-	-	-	-	1 400
SNA	Snapper	300 000	4 700	20	-	-	4 500	5 000	-	310 000
SPE	Sea perch	800	40	25 000	-	2 900	27 000	10	0	56 000
SPO	Rig	0	20	200	-	-	80	0	-	300
TAR	Tarakihi	120 000	9 300	600	-	400	40 000	100	-	170 000
TRE	Trevally	35 000	1 000	10	-	-	1 000	-	-	37 000
TRU	Trumpeter	100	700	1 500	-	7 700	800	0	0	11 000
WAR	Common warehou	*	10	*	-	-	50	0	-	70

† Fishstocks which either do not apply to, or were outside the scope of, the diary survey.
‡ Fishstocks 6 and 10 apply to some species, but were outside the scope of the diary survey.
* Estimated catch < 10 fish.

Table 17b: **Landings (number of fish killed, unexpanded) by recreational fishers from charter vessels, November 1997 to October 1998, for all QMS species, by fishstock. Each cell shows reported landings for the fishstock denoted by the intersection of the corresponding row (species code) and column (stock number)**

	Fishstock ‡								
Common name	1	2	3	4	5	7	8	9	Total
Barracouta	3 387	† -	-	-	0	1 035	-	-	4 422
Blue cod	430	34	17 272	-	16 750	32 026	2	-	66 514
Bluenose	574	25	0	-	-	0	0	-	599
Alfonsino	4	0	0	-	-	0	0	-	4
Rock lobster	102	4 864	16	0	3 018	0	1 617	0	9 617
Elephantfish	0	0	0	-	0	1	-	-	1
Frostfish	77	0	0	-	0	0	0	0	77
Gurnard	940	135	17	-	-	293	0	-	1 385
Hoki	2	-	-	-	-	-	-	-	2
Hapuku and Bass	1 077	835	1 222	-	267	3 796	0	-	7 197
John dory	1 588	5	0	-	-	15	-	-	1 608
Jack mackerel	9 436	-	0	-	-	241	-	-	9 677
Kahawai	3 145	244	761	-	-	-	-	312	4 462
Ling	52	0	3	-	0	2	-	-	57
Moki	221	-	10	-	0	-	-	-	231
Oysters (dredge)	-	-	-	-	10 950	0	-	-	10 950
Black/yellowfoot paua	37	0	0	-	0	50	-	-	87
Packhorse rock lobster	20	-	-	-	-	-	-	-	20
Rubyfish	43	0	0	-	0	0	0	0	43
Red cod	218	3	574	-	-	234	-	-	1 029
Scallop	0	-	-	-	-	22 582	-	-	22 582
School shark	538	4	21	-	0	207	0	-	770
Gemfish	298	0	0	-	-	0	-	-	298
Snapper	47 030	537	5	-	-	1 287	717	-	49 576
Sea perch	143	5	6 121	-	1 011	7 602	3	0	14 885
Rig	0	2	63	-	-	23	0	-	88
Tarakihi	24 267	1 038	147	-	139	11 321	32	-	36 944
Trevally	5 924	103	3	-	-	165	-	-	6 195
Trumpeter	21	75	367	-	1 752	232	0	0	2 447
Common warehou	1	1	3	-	-	14	0	-	19

† Fishstocks which either do not apply to, or were outside the scope of, the diary survey.
‡ Fishstocks 6 and 10 apply to some species, but were outside the scope of the diary survey.

Table 18: **Estimated landings (tonnes) by recreational fishers from charter vessels, November 1997 to October 1998, for 16 QMS species, by fishstock. Each non-empty cell in the table contains the catch for the fishstock denoted by the intersection of the corresponding row (species code) and column (stock number). Estimates are rounded to at most two significant figures**

		Fishstock ‡								
Code	Common name	1	2	3	4	5	7	8	9	Total
BAR	Barracouta	170	† -	-	-	0.0	28	-	-	200
BCO	Blue cod	2.4	0.2	58	-	51	76	0.0	-	190
CRA	Rock lobster	0.5	15	0.1	0.0	9.3	0.0	3.2	0.0	28
GUR	Gurnard	4.1	0.6	0.1	-	-	0.5	0.0	-	5.2
HPB	Hapuku and Bass	99	69	44	-	7.3	120	0.0	-	340
JDO	John dory	39	0.2	0.0	-	-	0.1	-	-	40
JMA	Jack mackerel	37	-	0.0	-	-	0.7	-	-	38
KAH	Kahawai	26	2.9	6.5	-	-	-	-	2.2	38
MOK	Moki	5.8	-	0.1	-	0.0	-	-	-	5.9
RCO	Red cod	2.3	0.0	4.7	-	-	0.8	-	-	8.0
SCH	School shark	12	0.1	0.2	-	0.0	1.4	0.0	-	13
SNA	Snapper	270	6.0	0.1	-	-	11	8.7	-	300
SPE	Sea perch	0.5	0.0	15	-	1.6	14	0.0	0.0	32
SPO	Rig	0.0	0.0	0.5	-	-	0.1	0.0	-	0.7
TAR	Tarakihi	150	5.3	0.3	-	0.1	14	0.0	-	170
TRE	Trevally	42	1.4	0.0	-	-	3.2	-	-	47

† Fishstocks which either do not apply to, or were outside the scope of, the diary survey.
‡ Fishstocks 6 and 10 apply to some species, but were outside the scope of the diary survey.

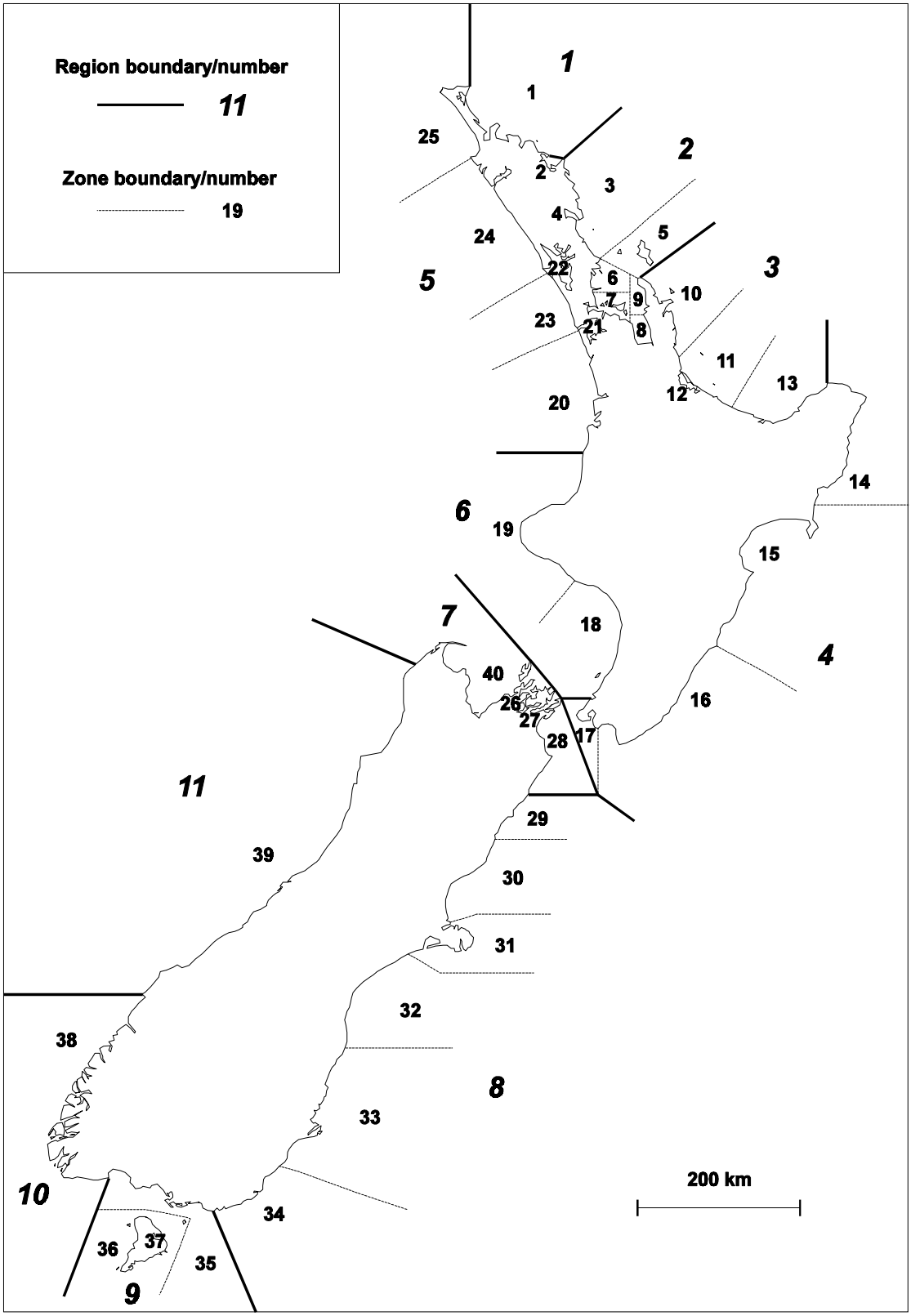

Figure 1: **Zones and Regions used for the 1997–98 diary survey.**

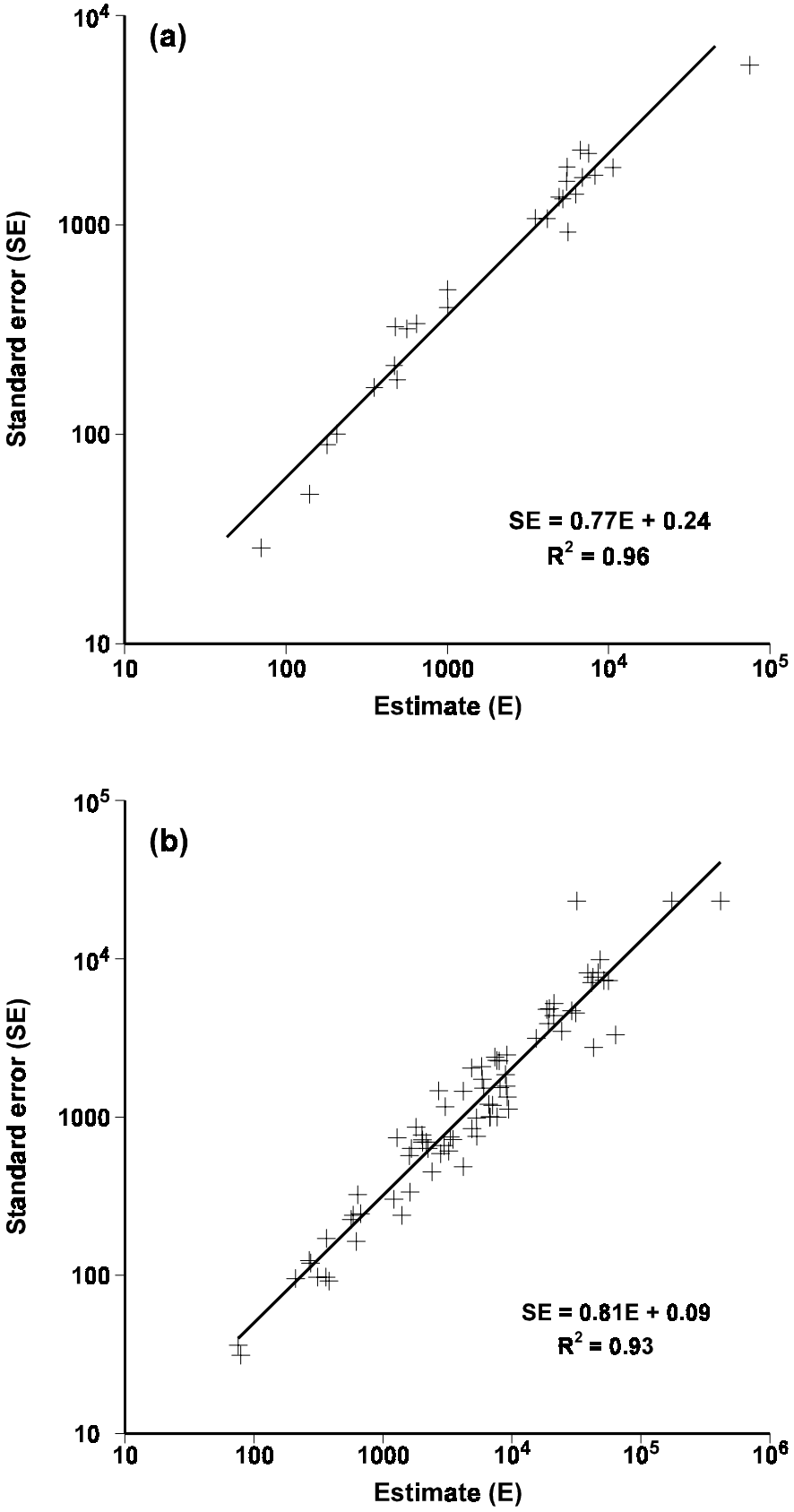

Figure 2: **Relationship between standard error and (a) estimated catch in number of fish, and (b) estimated effort in hours, for typical estimates derived from the 1997–98 diary survey.**

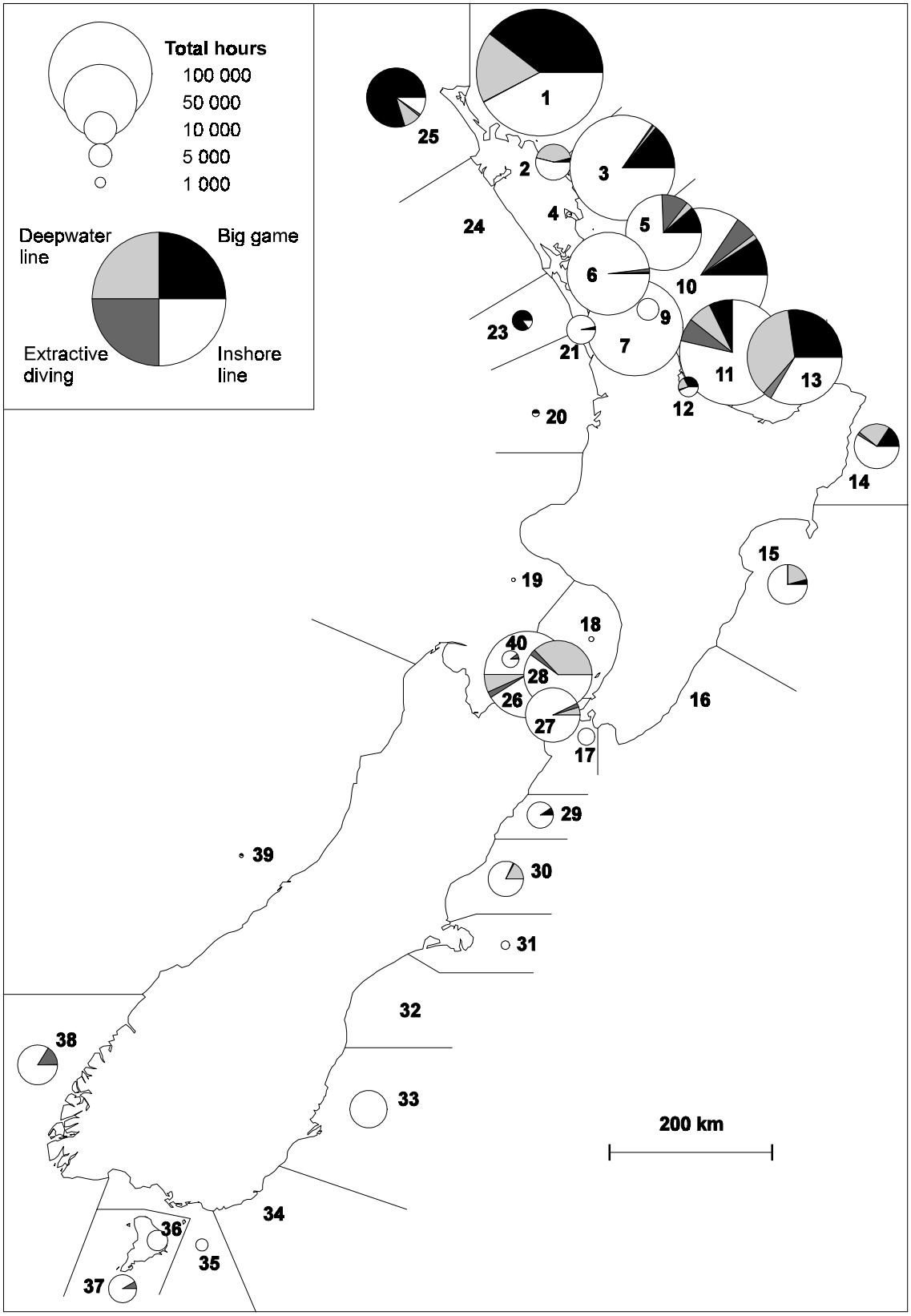

Figure 3: **Estimated annual fishing effort (hours) by recreational fishers from charter vessels, for the 1997–98 Diary Survey, by diary Zone and fishing method.**

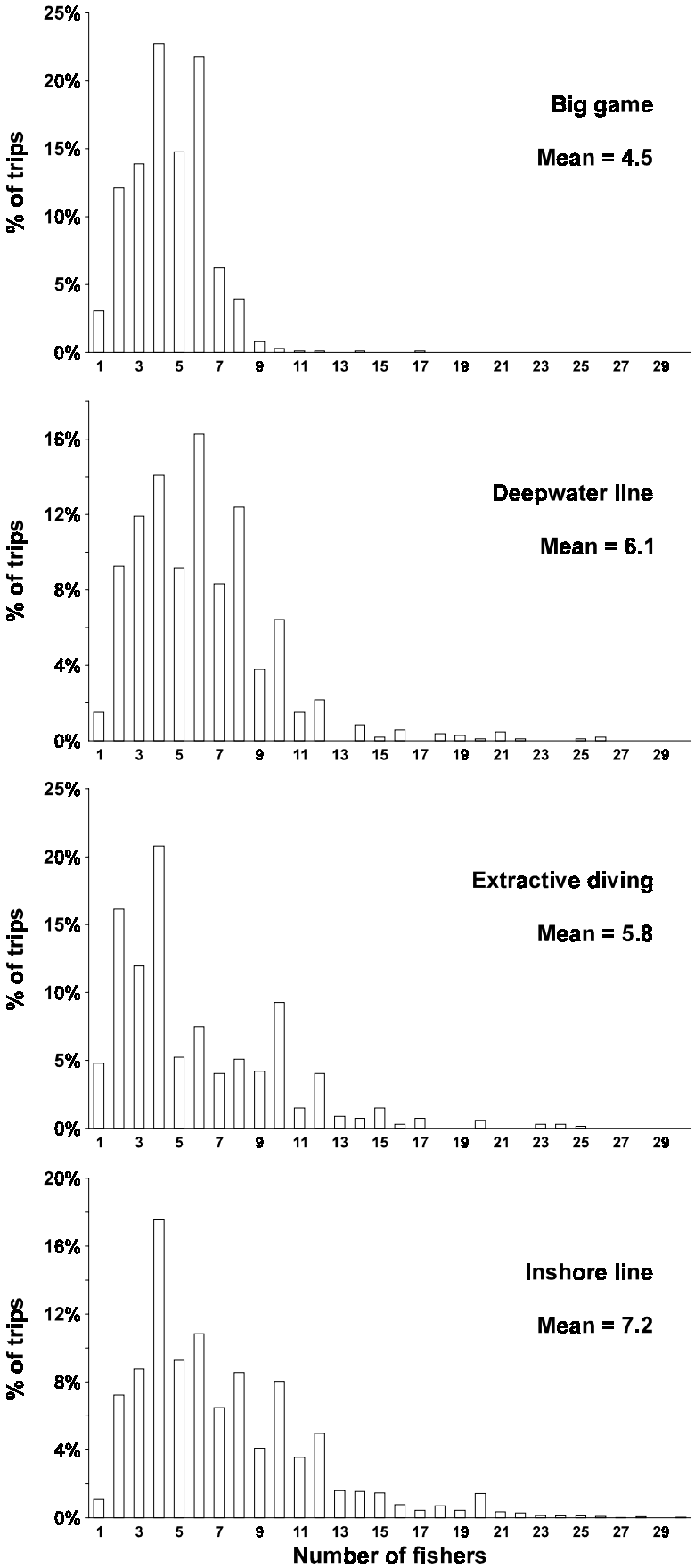

Figure 4: **Number of fishers per charter trip by fishing method. The number of trips for each method is given in Table 7.**

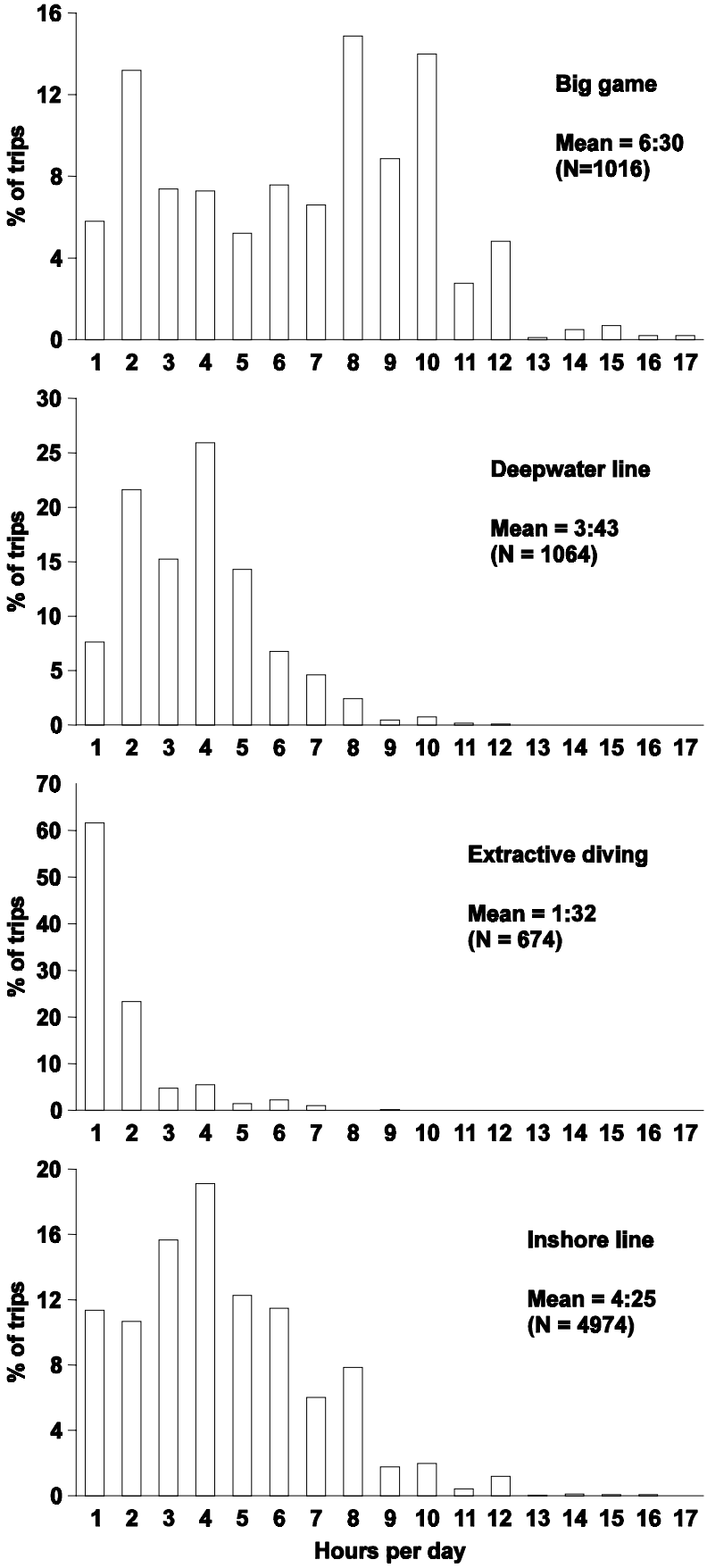

Figure 5: **Trip length (hours per fishing day) by fishing method. Mean trip length is given as hours:minutes.**