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Harvest estimates from the 1996 national marine recreational fishing surveys

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1. Executive Summary

The recreational harvest estimates of all QMS species and some important non QMS species are given. The estimates in numbers come from the results of the 1996 national marine recreational fishing diary survey. A coefficient of variation (*c.v.*) on the numbers estimate is given when 19 or more diarists caught the species in a Fishstock. A Fishstock is a management area for a species and most Fishstocks span one or more Quota Management Areas and are defined for each species. A condition of this sort is required to ensure that we have a representative sample of diarists catching the species in the Fishstock. Tonnage estimates are made for QMS species (and some other Fishstocks) where an estimate of the mean greenweight of recreationally harvested fish is available and a *c.v.* on the numbers estimate was calculated. The tonnage (greenweight) estimates are given as a point estimate and a range calculated as one standard deviation (rounded) either side of the point estimate. The actual recreational harvest is reasonably likely to lie within this range.

The mean weights were estimated, where possible, from length measurements made during the 1996 national boat ramp survey. When the number of length measurements was too small or no data were available from the area, the lengths were augmented with lengths from previous boat ramp surveys.

Estimates of recreational harvests in numbers are included for some non QMS species with a large recreational harvest.

Changes in harvest estimates from those given previously for the regional diary surveys are not considered explicitly, but if this is done, some factors need to be considered. For snapper in SNA 1 and some other Fishstocks, regulatory changes introduced since the regional surveys will have led to (generally) lower harvests. Also, the weather can influence the amount of recreational effort and effort is a major factor determining the overall harvest. Some differences in the harvest estimates presented here from those given in the earlier regional diary surveys will have arisen from differences in the mean weight used to estimate tonnage and from problems with species identification. The diarists often give a generic name, such as cod, for the fish they have caught and a table of unassigned harvests of generic species is included. The common names of many recreationally caught species are not unique and different assignments to a species could have been made in the different surveys.

2. Introduction

The Ministry of Fisheries and NIWA ran a national diary survey of marine recreational fishers during 1996. The diarists were selected from households identified as containing marine recreational fishers during a telephone survey of households randomly selected from the 18 Telecom telephone directories (Bell & Associates 1996). The diarists kept a log of their fishing activities, including the fish they caught, and how and where they caught them. The diarists form a random sample of marine recreational fishers and their catches can be scaled to give estimates of the total marine recreational harvest (in numbers).

Bradford *et al.* (1998a) gave an overview of the results from the diary survey and included in that report are definitions of the diary zones which can be combined into QMAs (Figure 1) from which most Fishstocks (management areas for a species) are formed. Individual Fishstocks were defined by Annala & Sullivan (1997a, 1997b). Diarists were asked to locate their catch into one of 40 areas (zones). They were also asked to give their fishing location and this information has been used to check on the allocation of the trip, and hence catch, to zone.

Bradford (1998a) explained how the factors (called scaling factors) which were used to scale the diarist catches to the total harvest were estimated. The scaling factors take into account the fraction of households surveyed, the mean number of fishers in a household, non-response, and the possibility of new fishers entering the fishery. There is also a possible correction to be made to account for confusion between "catch" and "take". This confusion resulted from the way the instructions to diarists were written. A complication in the survey design is that the sampling fraction for South region residents was larger than that for the rest of the country. The definitions of the residence regions are shown in Figure 1 and given by Bradford (1998a). Hence, where the fisher was resident had to be taken into account in the scaling factors. The Snapper Working Group also required that separate scaling factors be estimated for North and Central region residents (for compatibility with the regional surveys run previously) when estimating the SNA 1 recreational catch.

An estimate of the mean weight of recreationally caught fish is required to get from the harvest in numbers to a tonnage estimate of harvest. Greenweights are used throughout this report. Boat ramp surveys were run in many parts of the country during 1996 to measure the lengths of fish landed at boat ramps. Hartill *et al.* (in press) described the results of these surveys. Diarists who had caught more than 10 snapper, blue cod, or kahawai were asked if they would measure the lengths of these fish. Bradford *et al.* (1998b) compared these results with the data from the 1996 boat ramp survey and showed that the diarists provided adequate mean lengths of recreationally caught fish for use in Fishstocks where the recreational catch does not form a substantial part of the total harvest. These data are likely to have a positive bias of unknown magnitude (mainly due to the way fish were measured), discussed in more detail in Bradford *et al.* (1998b)) and are used here only to give alternate estimates for the South Island blue cod Fishstocks.

Teirney *et al.* (1997) gave harvest estimates from the three regional diary surveys (South 1991–92, Central 1993–94, and North 1993–94). Bradford (1996, 1997) gave

more detail on the harvest estimates from the 1993–94 North region diary survey and how the mean weights were estimated. These reports should be consulted if comparisons with previous harvest results are required.

The common and scientific names of finfish and shellfish species are given in the first table in which the species is mentioned. There are a few species which are often specified generically by recreational fishers. The important examples are cod (blue, red, or rock cod), mackerel (the three species of jack mackerel or blue mackerel), mullet (grey or yellow-eyed mullet), yellowtail (jack mackerel, kingfish, or koheru), and sharks (probably mainly school shark and rig). Some fish given non-specific names usually associated with school shark could have been misclassified as school shark. There could be confusion between yellow-eyed mullet and sprats. Some species, particularly wrasses, scorpionfish, and sea perch, have confused common names. Fish identification is necessarily done by diarists and, wherever possible, the name given by the diarist is assumed to be accurate. If a reasonable guess as to the actual species could be made, the harvest was coded by species (but the coding could be erroneous), otherwise the harvest was coded generically. Another identification problem arises with butterfish which has the common name of greenbone in southern parts of the country, which causes no problem, but a green wrasse is called butterfish in the south, which does introduce confusion.

The full harvest of some species such as sea perch and spotties may not have been recorded. The sea perch numbers are lower in 1996 than in the 1991–92 South and 1992–93 Central region surveys despite efforts to identify records where other common names for sea perch were used. Some species with multiple common names may have been coded differently in this survey to the regional surveys.

3. Estimation of mean greenweights

Where possible, length data from the 1996 national boat ramp survey and an appropriate length-weight relation were used to estimate the mean greenweight (referred to as weight). Where the 1996 national survey provided insufficient data, lengths from the 1994 North region boat ramp survey and/or the 1992–93 Central region boat ramp survey were used to augment the data. The 1991 North region boat ramp data were not used as they were collected too far back in time.

Table 1 contains the weight-length relations used and the source from which they were obtained. Where practicable, a separate mean weight is estimated for each Fishstock. However, there are some species for which the available data are insufficient to do this, and a nation-wide estimate is used. Where only the 1996 national boatramp survey data were used, the mean weights have been taken from Hartill *et al.* (in press), otherwise mean weights have been re-estimated. BCO 3 has been divided into north (Clarence River to Rakaia River) and south (Rakaia River to Slope Point) to prevent the large number of blue cod measured from Motunau biasing the overall estimate for BCO 3. Blue cod are somewhat smaller in the Motunau area than in the southern parts of BCO 3 (Bradford *et al.* 1998b). The mean weight from BCO 3S is used for BCO 5. Butterfish are assumed to have the same weight-length

relation as blue moki (the only known relation used gutted weight). An estimate of 1514 g was used. Table 2 contains the mean weights used in this report and includes information on the number of fish involved in the estimation and the surveys from which the data came. No mean weight for trumpeter has been estimated. A mean weight of of 100 g for recreationally caught yellow-eyed mullet has been assumed (Paul Taylor, NIWA, pers. comm.).

During the 1992–93 Central region boat ramp survey, weights of all fish of each species caught by a fisher were measured and mean weight estimates made (Ryan & Kilner, unpubl. draft FARD). For fish caught in QMA 2, the mean weight estimates (from weight measurements) were higher for blue cod, red gurnard, and snapper but lower for kahawai than the mean weights estimated from length measurements from the same survey using a weight length conversion relation. Mean weights estimated from measured lengths were used here. The differences are of the order of 10–20%. Such differences can arise from small sample sizes and/or inadequate weight-length relations.

4. Estimates of recreational harvests

4.1. Finfish

The recreationally caught finfish have been divided into groups.

1. Those QMS species (and species likely to enter the QMS in the near future) for which the recreational harvest in at least one of the Fishstocks is substantial.
2. Those QMS species for which the recreational harvest is not substantial in any Fishstock (this category includes some species where there is no recorded recreational harvest).
3. Those non-QMS species for which there is a substantial recreational harvest.

For these purposes, a substantial recreational harvest has been defined such that at least 20 fishers (sometimes reduced to 19) in the Fishstock area caught the species. This number is chosen as representing the sample size for which we can be reasonably certain that the assumptions involved in the estimation of a *c.v.* on the harvest in numbers hold. Tonnage estimates are given for those QMS (and some other) species where there is a substantial catch. Alternative estimates are given for SNA 1 (*see* section 4.1.1), KAH 1 (*see* section 4.1.2), and South Island blue cod stocks (*see* section 4.1.3).

The estimates in numbers are rounded to the nearest 1000, but a category "< 500" is used to distinguish a small number of the species recorded as caught from no fish recorded.

The scaling factors used to scale the fish numbers recorded by the diarists to estimates of the harvest by the whole population were derived by Bradford (1998a). The scaling factor when the fisher was resident in the North or Central region was 139.99 and when the fisher was resident in the South region was 80.25. For snapper in SNA 1, the

separate scaling factors for the North and Central region residents were 149.69 and 127.39 respectively. Much of this difference between North and Central residents comes from an inadvertent difference in the fraction of households surveyed (the design assumed the same fraction throughout the Central and North regions) which will have arisen, in part, from the general drift northwards of the New Zealand population. The survey design was necessarily done using 1991 Census data, whereas the scaling factor estimation used the 1996 Census data. The possible bias (estimated at 5–10%) introduced by the confusion between catch and harvest (Bradford (1998a) has been ignored, but there are some Fishstocks where this factor may be important. These are the Fishstocks where the maximum bag size is small enough for fishers to discard some of their catch, or where the practice of "catch and release" is common. The fish were assigned to the Fishstock where they were caught irrespective of where the fisher was resident.

The estimation of the *c.v.* on the recreational harvest numbers used a similar method to that used in previous surveys, but has to treat the harvests by the South region residents and the Central and North region residents separately (*see* Appendix 1).

The total number of fish, N, harvested in a Fishstock is estimated as:

$$N = S_s H_s + S_{cn} H_{cn}$$

where S_s and S_{cn} are the scaling factors for South region and Central and North region residents and H_s and H_{cn} are the harvests of the species in the Fishstock by South region and Central and North region residents (with an obvious extension if separate scaling factors are used for Central and North region residents). A point estimate of the harvest in tonnes, H_t, is estimated as:

$$H_t = Nw10^{-6}$$

where w is the mean weight of a recreationally caught fish in the Fishstock measured in grams. Because of the various uncertainties in the estimation of the recreational harvest, a tonnage range of approximately one standard deviation each side of the estimated tonnage is also given based on the *c.v.*s on N and w and some rounding. The actual recreational harvest is likely to lie within this range.

4.1.1. Recreational harvest of snapper in SNA 1

Table 3 contains the various estimates for SNA 1 including the different estimates given by the two sets of scaling factors referred to above. Because SNA 1 is divided into sub-regions for stock assessment, harvest estimates in these regions are included. The regulations governing the recreational fishing of snapper in SNA 1 were changed between the 1993–94 North region diary survey and the 1996 national diary survey. The minimum legal size was increased from 25 to 27 cm and the daily bag limit was reduced from 20 to 9.

The reduction in snapper harvest in SNA 1 was greater than that expected from the regulatory changes. The North region diary survey estimates were given by Bradford (1997) and Teirney *et al.* (1997). There was a reduction in fishing effort in the north from 1994 to 1996 (possibly as a result of the weather in 1996 being less favourable for fishing than that in 1994). The factors influencing the snapper harvest in SNA 1 were discussed in more detail in Bradford (1998b).

4.1.2 Recreational harvest of kahawai in KAH 1

Table 4 contains the recreational harvest in KAH 1 for each of the three sub-regions East Northland, Hauraki Gulf, and Bay of Plenty. The numbers of fish caught in east Northland and the Hauraki Gulf are less than in the 1993–94 North region survey and slightly greater in the Bay of Plenty. The mean weight increased in east Northland and the Bay of Plenty, but dropped in the Hauraki Gulf. The result is that the overall tonnage in KAH 1 remained nearly the same.

4.1.3. Alternative recreational harvests of blue cod in BCO 3, BCO 5, and BCO 7

Concern has been expressed that the blue cod mean weight measured in the southern part of BCO 3 may be negatively biased because of the common practice of filleting at sea in that area. Also, the many access points in the Marlborough Sounds make getting representative samples of adequate size difficult in a boat ramp survey.

Hence, alternative recreational harvest estimates in BCO 3, BCO 5, and BCO 7 are given using weights obtained via the lengths measured by diarists in the national diary survey (Table 5). These mean weights were given by Bradford *et al.* (1998b). These weight estimates are likely to be positively biased. Diarists were asked to measure their fish to the nearest centimetre and not to the nearest centimetre below. The diarists who were measuring lengths were the more experienced fishers who had caught at least 10 snapper, kahawai, or blue cod during the previous year and who had agreed to measure their fish. Diarists tend to say that they caught "cod", which is a problem particularly in BCO 3. Where lengths were entered in the blue cod column of the length recording form but "cod" was given as the catch, the lengths are generally assumed to be blue cod, but some could have been red cod. The harvest estimates in Table 5 should be used with caution.

4.1.4. QMS and other finfish species with substantial recreational harvests

Table 6 contains the harvest estimates for QMS and other finfish with a substantial recreational catch which are included in Annala & Sullivan (1997a, 1997b) or may soon become QMS species and were assessed for the first time in 1998. Table 6 includes the values of the estimated number of fish caught and its *c.v.*, the point and range estimates of the harvest (t), and the commercial catch and TACC for the 1995–96 fishing year. Estimates are given by Fishstock. The numbers of fish recorded by the diarists are not given. The catches by South region residents are scaled differently from those of the rest of the country.

The estimates in Table 6 are those which are potentially required for stock assessment purposes and for determining recreational catch allowances before a TACC is set.

4.1.5. QMS species with little or no recreational harvest

No recreational harvest is recorded from QMAs 4, 6, and 10 which do not adjoin the New Zealand coast. Any Fishstocks which are formed solely from these QMAs are ignored. No recreational harvest of cardinalfish, ghost sharks, orange roughy, oreos, silver warehou, southern blue whiting, or white warehou was recorded in the 1996 national diary survey. The small number of "warehou" recorded was assumed to be blue warehou.

Table 7 contains the numerical estimates of the recreational harvest of those QMS species for which the recreational harvest was too small to estimate a *c.v.* in any of its Fishstocks. These estimates are small and uncertain and no attempt has been made to estimate a tonnage. There was no harvest recorded by diarists for any other Fishstocks of the species in Table 7.

4.1.6. Generic species

The harvest estimates in numbers of the generic species cod, mackerel, mullet, sharks, and yellowtail are given in Table 8. The sharks which are rarely caught have been included in the general shark category: these are blue whaler, bronze whaler, carpet, hammerhead, mako, and thresher sharks.

The harvest of blue and red cod, jack and blue mackerel, kingfish, grey mullet, yellow-eyed mullet, school shark and rig could be somewhat greater than given in Table 6 because a generic species name was given. The possible magnitude of the effect is indicated in Table 8 and is generally small. Only in QMA 1 were there enough instances of generic identification to allow the calculation of a meaningful *c.v.*

The harvests of some species could be in error because of problems in defining which the species was caught. Most problems arise with wrasses, scorpionfishes and sea perch. Yellow-eyed mullet (which were always assumed to include herrings) and sprats may have been confused by the diarists.

4.1.7. Non QMS species with a substantial recreational harvest

The harvests in numbers by QMA of several species which are not yet QMS species but which have a substantial recreational harvest are given in Table 9 for completeness. Most of this harvest comes from QMA 1, but salmon are caught in the South Island. Tuna (all types) includes the catches of albacore and skipjack given earlier in Table 9 as well as yellowfin tuna, slender tuna, and fish specified as "tuna" by the diarists.

4.2. Shellfish

The estimates of recreational harvests of these species were made in the same way as for finfish.

4.2.1. Rock lobster

The diarists were asked to record the location of the rock lobster harvests (and trips targeting rock lobster) according to the rock lobster Fishstocks. Where this was not done, the fishing locality and diary zone information were used to assign the catch or trip to the appropriate rock lobster Fishstock.

Rock lobster (or crayfish) were assumed to be *Jasus edwardsii* unless the diarist stated he had caught packhorse lobster.

The tail widths of rock lobsters landed were measured during the 1996 boat ramp survey, however the rock lobsters were sexed consistently only at one site and occasionally at other sites. Male and female rock lobsters tend to be of different sizes and to have different tail width to weight relations (Table 10). A mean weight has been assigned as the average of the weights obtained by assuming the lobsters were all males and all females (Table 11). Given that there is little information on the sex ratio (except from Motunau), a better value cannot be calculated. Rock lobsters will be sexed in subsequent surveys. The rock lobster harvest estimates are given in Table 12.

4.2.2. Paua

Little is known about the size of recreationally harvested paua but they are assumed to be *Haliotis iris* and to be mainly harvested close to the minimum legal size. The weight at the minimum legal size for *Haliotis iris* of 125 mm shell length is 253 g from the relation

$$W = 0.00215L^{2.418}$$

where the weight, W, is in grams, and the shell length, L, is in millimetres (McShane *et al.* 1994). McShane *et al.* (1994) derived this relation from data from several sites around New Zealand.

The paua harvest estimates are given in Table 12. The tonnage estimates assume a mean whole greenweight of 253 g.

4.2.3. Scallops

The diary zone boundaries do not align with the scallop management area boundaries in the North region, but the fishing locality information supplied by the diarists enables the assignment of the scallop harvests to these areas. The main scallop management areas in the north are Northland (Reef Point to Cape Rodney) and

Coromandel (Cape Rodney to Town Point). Substantial quantities are taken in the west coast harbours (Manukau and Kaipara) which have been treated as a separate area. The largest recreational harvest of scallops comes from QMA 7.

The mean weights from surveys of the commercial beds in 1994 were used for the Northland and Coromandel areas (Cryer & Parkinson, NIWA, Auckland, unpubl. data). The overall mean from that survey was used for the west coast harbours. A nominal mean whole greenweight of 100 g was used for QMA 7. Most of scallops taken by diarists in QMA 7 were from Tasman and Golden Bays.

The scallop harvest estimates are given in Table 13.

4.2.4. Other shellfish

The harvest estimates of other shellfish of recreational and/or commercial importance are included in Table 13. "Molluscs" are any shellfish which were so identified on the diarist forms and are probably pipi, tuatua, or similar (particularly others with Maori names).

Large numbers of some of the shellfish in Table 13 are taken. The numbers are indicative as accurate counts were not always given, particularly where the allowable take is large.

5. Discussion

The diary surveys are thought to give good estimates of the numbers of fish caught by marine recreational fishers. A little confusion is introduced by the use of generic species names by recreational fishers and variants in local names for species. Some problems were encountered in estimating the mean weight of recreationally caught fish because we do not always have good weight data. For the major North Island species, we have good length data which can be used to estimate the mean weight if a suitable weight-length relation is available. The length samples obtained for South Island blue cod Fishstocks could be biased.

The national diary survey allowed the estimation of Fishstock harvests throughout the whole country at one time, and removed the complication of harvests having contributions from different years, as with the three regional surveys.

The recreational harvest in SNA 1 appears to be lower than the 1994 harvest. This reduction was more than would be expected just from the regulatory changes introduced between the end of the North region diary survey and the start of the national diary survey. The difference may be accounted for by 1994 having particularly good fishing weather in the north and 1996 having fewer days of good weather.

Diarists often give a generic name for the fish caught. Where possible, the catch is coded to a particular species. Of most concern is the use of "cod" in those areas where

both blue cod and red cod are likely to be caught. The species (mainly wrasses, scorpionfishes, and sea perch) for which identification is difficult and common names are inconsistent could have had the wrong scientific name assigned from the common name given. Most of these species are of little commercial importance at present but some form a substantial part of the recreational harvest. Decisions on the way the common names used by diarists were assigned to scientific names can vary from person to person and could lead to apparent differences in harvests from the regional and national diary surveys.

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Table 1: Coefficients in the weight-length relation $W = a\ L^b$ for the finfish species for which a tonnage estimate is made. W is the greenweight and L the length (usually fork length, but total length where appropriate). Common and species names are included. Unpublished sources are given as Annala & Sullivan (1997a). Butterfish were assumed to have same weight-length relation as blue moki

Fishstock	Common name	Scientific name	*a*	*b*	Source
BAR (all)	Barracouta	*Thyrsites atun*	0.0075	2.900	Hurst & Bagley (1994)
BCO (all)	Blue cod	*Parapercis colias*	0.0102	3.123	Blackwell (1997)
	Butterfish	*Odax pullus*	0.0550	2.713	see caption
EMA (all)	Blue mackerel	*Scomber australasicus*	0.0088	3.110	Annala & Sullivan (1997a)
GMU (all)	Grey mullet	*Mugil cephalus*	0.0360	2.754	Annala & Sullivan (1997a)
FLA (all)	Flatfish[1]		0.0380	2.660	Annala & Sullivan (1997a)
GUR 1	Red gurnard	*Chelidonichthys kumu*	0.0100	2.990	Elder (1976)
GUR 7			0.0053	3.190	Stevenson (1998)
HPB (all)	Groper[2]	*Polyprion spp*	0.0242	2.867	Johnston (1993)
JDO (all)	John dory	*Zeus faber*	0.0364	2.900	Hore (1982)
JMA 1&7	Jack mackerel[3]	*Trachurus spp.*	0.0255	2.840	Horn (1991)
KAH 1&9	Kahawai	*Arripis trutta*	0.1024	2.502	Bradford (1998c)
KAH 3			0.0400	2.760	Drummond & Wilson (1993)
KIN (all)	Kingfish	*Seriola lalandi lalandi*	0.0246	2.845	Annala & Sullivan (1997a)
MOK (all)	Blue moki	*Latridopsis ciliaris*	0.0550	2.713	Francis (1979)
RCO (all)	Red cod	*Pseudophycis bachus*	0.0055	3.140	Stevenson (1998)
SNA (all)	Snapper	*Pagrus auratus*	0.0447	2.793	Paul (1976)
SCH (all)	School shark	*Galeorhinus galeus*	0.0068	2.940	Hurst et al. (1990)
SPD (all)	Spiny dogfish	*Squalus acanthias*	0.0021	3.150	Hanchet (1986)
SPE (all)	Sea perch[4]		0.0262	2.920	Stevenson (1998)
SPO (all)	Rig	*Mustelus lenticulatus*	0.0010	3.320	M. Francis (pers. comm.)
TAR (all)	Tarakihi	*Nemadactylus macropterus*	0.0141	3.087	Tong & Vooren (1972)
TRE (all)	Trevally	*Pseudocaranx dentex*	0.0160	3.064	James (1984)
YEM	Yellow-eyed mullet	*Aldrichetta forsteri*			Weight assumed

[1] Several species of flounder, sole, and turbot are included in this grouping
[2] *Polyprion oxygeneios* (hapuku), *P. americanus* (bass)
[3] *Trachurus declivis, T. novaezelandiae, T. murphyi*
[4] This grouping includes several scorpionfishes, primarily *Helicolenus percoides*

Table 2: Mean greenweights, mean length,, and the survey from which the lengths were obtained. NAT96 1996 national boat ramp survey; CEN93 1992–93 Central region boat ramp survey; NOR94 1994 North region boat ramp survey. NAT96 results are from Hartill *et al.* (in press), other results are recalculated. BOC 3N is Clarence River to Rakaia River and BCO 3S is Rakaia River to Slope Point

Fishstock	N	Mean weight (g)	*c.v.(%)*	Mean length (cm)	Survey
BCO 1	350	495	3	30.6	NAT96
BCO 2	605	560	2	32.2	CEN93
BCO 3N	8 813	696	< 1	35.0	NAT96
BCO 3S (&5)	827	815	1	36.6	NAT96
BCO 7	1 824	671	1	34.2	NAT96
GUR 1	1 665	413	1	34.4	NAT96
GUR 2	3 001	431	1	34.9	CEN93
GUR 3	6	535	13	41.5	NOR94, NAT96
GUR 7	718	448	2	33.0	CEN93, NAT96
KAH 1	3 656	1 441	1	43.8	NAT96
KAH 2	1 504	1 525	1	44.3	CEN93
KAH 3	674	605	3	30.0	CEN93, NAT96
KAH 9	1 797	1 022	1	38.0	NAT96
SNA 1	16 356	915	1	33.6	NAT96
SNA 2	458	1 282	5	36.5	CEN93
SNA 7	467	2 398	3	47.3	NAT96
SNA 8	2 040	871	2	32.8	NAT96
SPE(QMA 3)	1 793	611	1	30.6	NAT96
SPE(QMA 7)	178	523	3	29.3	NAT96
TAR 1	1 186	612	1	31.3	NAT96
TAR 2	240	573	3	30.4	CEN93
TAR 3	22	512	6	29.7	NAT96
TAR 7	337	343	2	24.0	CEN93, NAT96
TRE 1	1 202	1 210	2	37.7	NAT96
TRE 2	68	1 513	7	40.4	CEN93
TRE 7	248	1 056	4	36.0	NAT96
BAR	191	2 536	4	77.6	CEN93, NOR94, NAT96
BUT	195	1 514	2	43.0	CEN93, NOR94, NAT96
EMA	65	300	7	27.8	CEN93, NOR94, NAT96
FLA	814	358	1	30.9	CEN93, NOR94, NAT96
GMU	294	962	2	40.0	CEN93, NOR94, NAT96
JDO	538	1 904	2	41.7	CEN93, NOR94, NAT96
JMA	1 049	284	1	26.0	CEN93, NOR94, NAT96
HPB	153	4 316	8	63.3	CEN93, NOR94, NAT96
KIN	569	5 984	4	73.3	CEN93, NOR94, NAT96
MOK	205	1 483	5	41.0	CEN93, NOR94, NAT96
RCO	227	1 041	4	45.8	CEN93, NOR94, NAT96
SCH	102	1 982	15	63.1	CEN93, NOR94, NAT96
SPO	82	1 250	13	61.2	CEN93, NOR94, NAT96
SPD	61	1 549	6	71.4	CEN93, NOR94, NAT96
YEM	153	100[1]	–	25.4	CEN93, NOR94, NAT96

[1]Assumed

Table 3: Harvest estimates of snapper in SNA 1 estimated from the 1996 national recreational surveys. Estimates are made for SNA 1, ENLD (East Northland), and HGBP (Hauraki Gulf and Bay of Plenty). Numbers of fish are rounded to the nearest 1000. The point and range tonnage estimates are described in the text. Estimates are given for two different sets of scaling factors (*see* text). Mean weights are given by Hartill *et al.* (in press)

Species	Fishstock	Number	*c.v.*(%)	Tonnage Point est.	Tonnage range	Mean weight (g)
Same scaling factors for North and Central residents						
Snapper	ENLD	646 000	7	671	620–720	1 039
	HGBP	1 746 000	5	1 519	1 420–1 610	870
	SNA 1	2 392 000	5	2 274	2 165–2 385	915
Different scaling factors for North and Central residents						
Snapper	ENLD	686 000	7	713	660–760	1 039
	HGBP	1 854 000	5	1 613	1 520–1 700	870
	SNA 1	2 540 000	5	2 324	2 200–2 440	915

Table 4: Harvest estimates of kahawai in KAH 1 estimated from the 1996 national recreational surveys. Estimates are made for ENLD (East Northland), and HAGU (Hauraki Gulf), and BPLE (Bay of Plenty) and the KAH 1 total. Numbers of fish are rounded to the nearest 1000. The point and range tonnage estimates are described in the text. Mean weights are given by Hartill *et al.* (in press)

Species	Fishstock	Number	*c.v.*(%)	Tonnage Point est.	Tonnage range	Mean weight (g)
Kahawai	ENLD	155 000	8	243	225–265	1 562
	HAGU	146 000	9	152	140–170	1 042
	BPLE	365 000	7	557	520–600	1 527
	KAH 1			952	–	

Table 5: Harvest estimates of South Island blue cod Fishstocks estimated from the 1996 national recreational diary survey. Numbers of fish are rounded to the nearest 1000. The point and range tonnage estimates are described in the text. Mean weights estimated from diary measured lengths are given in table 7 of Bradford *et al.* (1998b)

Species	Fishstock	Number	*c.v.*	Tonnage Point est.	Tonnage range	Mean weight (g)
Blue cod	BCO 3	217 000	11	223	200–250	1 026
	BCO 5	171 000	12	164	145–185	959
	BCO 7	356 000	8	252	230–275	709

Table 6: Harvest estimates of QMS and other finfish species estimated from the 1996 national recreational surveys. – indicates that not enough diarists caught fish in this Fishstock to make a reliable estimate of the *c.v.* or tonnage. Numbers of fish are rounded to the nearest 1000. < 500 indicates less than four fish were recorded by diarists. The point and range tonnage estimates are described in the text. Commercial harvests (t) and TACCs (t) are for the 1995–96 fishing year

Species	Fishstock	Number	*c.v.*(%)	Tonnage Point est.	Tonnage range	Commercial harvest	TACC
Barracouta	BAR 1	68 000	8	173	160–190	11 268	9 969
	BAR 5	1 000	–	–	–	4 324	9 282
	BAR 7	74 000	15	187	160–220	8 613	10 925
Blue cod [1]	BCO 1	34 000	11	17	10–20	11	45
	BCO 2	145 000	12	81	70–90	2	10
	BCO 3	217 000	11	174	155–195	158	162
	BCO 5	171 000	12	139	120–155	1 503	1 536
	BCO 7	356 000	8	239	220–260	65	70
	BCO 8	159 000	12	79	70–90	31	74
Blue moki	MOK 1	63 000	14	93	80–110	435	400
	MOK 3	16 000	18	24	20–30	91	126
	MOK 5	9 000	–	–	–	3	43
Flatfish	FLA 1	308 000	11	110	95–125	628	1 187
	FLA 2	67 000	18	24	15–35	481	726
	FLA 3	113 000	13	40	30–50	2 298	2 681
	FLA 7	44 000	16	16	10–20	1 163	2 066
Grey mullet[1]	GMU 1	110 000	25	106	80–130	866	1 006
	GMU 2	1 000	–	–	–	0	20
	GMU 3	0	–	–	–	0	30
	GMU 7	0	–	–	–	1	20
Hapuka	HPB 1	11 000	17	49	40–60	335	481
	HPB 2	23 000	22	100	75–125	214	264
	HPB 3	4 000	–	–	–	321	335
	HPB 5	2 000	–	–	–	144	451
	HPB 7	9 000	–	–	–	215	236
	HPB 8	< 500	–	–	–	78	80
Jack mackerel[1]	JMA 1	79 000	16	22	15–30	6 779	10 000
	JMA 3	< 500	–	–	–	19 749	18 000
	JMA 7	21 000	–	–	–	12 268	32 536
John dory	JDO 1	46 000	9	87	80–100	696	704
	JDO 2	1 000	–	–	–	139	270
	JDO 7	< 500	–	–	–	42	91
Kahawai	KAH 1	666 000	6	960	900–1 020	1 750	
	KAH 2	142 000	9	217	190–240	760	
	KAH 3	226 000	7	137	125–145	1 580	
	KAH 9	199 000	9	204	195–225	230	

[1] The numbers given here do not include any contribution from the related generic species (cod, mullet, or mackerel). Numbers for the generic species are in Table 8

Table 6 — continued

Species	Fishstock	Number	*c.v.*(%)	Tonnage Point est.	Tonnage range	Commercial harvest	TACC
Kingfish[1]	KIN 1	64 000	8	382	350–410	205	
	KIN 2	5 000	–	–	–	112	
	KIN 3	3 000	–	–	–	5	
	KIN 8	2 000	–	–	–	22	
Red cod[1]	RCO 1	11 000	18	11	5–15	28	42
	RCO 2	88 000	11	92	80–105	584	500
	RCO 3	99 000	9	103	90–115	11 038	12 389
	RCO 7	38 000	15	40	30–50	3 728	3 125
Red gurnard	GUR 1	262 000	7	108	100–120	1 162	2 287
	GUR 2	38 000	15	16	10–20	567	725
	GUR 3	1 000	–	–	–	633	601
	GUR 7	26 000	14	12	10–15	382	815
	GUR 8	68 000	14	28	25–35	182	543
Rig[1]	SPO 1	28 000	31	35	25–45	603	829
	SPO 2	4 000	–	–	–	107	86
	SPO 3	12 000	20	15	10–20	408	454
	SPO 7	19 000	20	24	20–30	400	350
	SPO 8	7 000	–	–	–	330	370
School shark[1]	SCH 1	23 000	17	46	35–55	804	668
	SCH 2	5 000	–	–	–	212	199
	SCH 3	3 000	–	–	–	296	322
	SCH 5	1 000	–	–	–	690	694
	SCH 7	8 000	24	16	5–25	635	534
	SCH 8	11 000	22	21	15–25	521	441
Snapper	SNA 1	2 392 000	5	2 274	2 165–2 385	4 941	4 938
	SNA 2	31 000	11	40	25–55	279	252
	SNA 3	1 000	–	–	–	0	32
	SNA 7	74 000	9	177	150–200	146	160
	SNA 8	275 000	7	240	215–255	1 558	1 500
Tarakihi	TAR 1	498 000	7	305	280–330	1 422	1 398
	TAR 2	114 000	13	64	55–75	1 551	1 633
	TAR 3	3 000	–	–	–	1 125	1 169
	TAR 5	3 000	–	–		73	153
	TAR 7	69 000	12	22	20–25	890	1 087
	TAR 8	46 000	16	28	25–35	105	225
Trevally	TRE 1	194 000	7	234	215–255	1 174	1 506
	TRE 2	9 000	19	13	10–15	211	241
	TRE 3	2 000	–	–	–	0	22
	TRE 7	67 000	11	70	60–80	2 019	2 153

[1] The numbers given here do not include any contribution from the related generic species (yellowtail, cod, or shark). Numbers for the generic species are in Table 8

Table 6 — continued

Species	Fishstock	Number	*c.v.*(%)	Tonnage Point est.	Tonnage range	Commercial harvest	TACC
Butterfish	QMA 1	11 000	–	–	–		
	QMA 2	39 000	22	59	45–75		
	QMA 3	17 000	19	25	20–30		
	QMA 5	18 000	–	–	–		
	QMA 7	6 000	–	–	–		
	QMA 8	9 000	–	–	–		
Blue mackerel[1]	QMA 1	47 000	14	14	10–20		
	QMA 2	1 000	–	–	–		
	QMA 7	2 000	–	–	–		
	QMA 8	2 000	–	–	–		
	QMA 9	3 000	–	–	–		
Sea perch	QMA 1	2 000	--	--			
	QMA 2	25 000	–	–	–		
	QMA 3	28 000	17	17	10–25		
	QMA 5	3 000	–	–	–		
	QMA 7	40 000	17	21	15–25		
	QMA 8	11 000	–	–	–		
Spiny dogfish	QMA 1	1 000	–	–	–		
	QMA 2	5 000	–	–	–		
	QMA 3	21 000	17	33	25–40		
	QMA 5	9 000	–	–	–		
	QMA 7	24 000	21	37	30–45		
	QMA 8	15 000	–	–	–		
	QMA 9	1 000	–	–	–		
Trumpeter	QMA 1	< 500	–	–	–		
	QMA 2	1 000	–	–	–		
	QMA 3	13 000	19	–	–		
	QMA 5	21 000	19	–	–		
	QMA 7	3 000	–	–	–		
Yellow-eyed mullet[1]	QMA 1	91 000	14	9	5–15		
	QMA 2	80 000	–	–	–		
	QMA 3	38 000	–	–	–		
	QMA 5	2 000	–	–	–		
	QMA 7	66 000	19	7	5–10		
	QMA 8	74 000	21	7	5–10		
	QMA 9	31 000	–	–	–		

[1] The numbers given here do not include any contribution from the related generic species (mackerel or mullet). Numbers for the generic species are in Table 8. Yellow-eyed mullet could also have been misidentified as sprats (Table 9)

Table 7: Harvest estimates of QMS species where insufficient diarists in the 1996 national diary survey caught the species in any of its Fishstocks to enable a reliable estimate of *c.v.* or tonnage to be made. Numbers of fish are rounded to 1000. < 500 indicates leas than four fish recorded by diarists for this Fishstock. There was no recreational harvest recorded in the unlisted Fishstocks of these species

Common name	Scientific name	Fishstock	Number
Alfonsino	*Beryx splendens, B. decadactylus*	BYX 1	< 500
Arrow squid	*Nototodarus gouldi, N. sloanii*	SQU1J	< 500
Bluenose	*Hyperoglyphe antarctica*	BNS 1	5 000
		BNS 2	< 500
Blue warehou	*Seriolella brama*	WAR 2	7 000
		WAR 3	3 000
		WAR 7	1 000
Elephantfish	*Callorhinchus milii*	ELE 2	< 500
		ELE 3	1 000
		ELE 7	< 500
Gemfish	*Rexea solandri*	SKI 1	4 000
		SKI 2	1 000
		SKI 7	< 500
Hake	*Merluccius australis*	HAK 1	1 000
Hoki	*Macruronus novaezelandiae*	HOK 1	< 500
Ling	*Genypterus blacodes*	LIN 1	3 000
		LIN 5	< 500
		LIN 7	< 500
Rubyfish	*Plagiogeneion rubiginosum*	RBY 1	1 000
		RBY 2	< 500
Skates	*Raja nasuta, R. innominata*	SKA 2	< 500
		SKA 3	1 000
		SKA 5	< 500
		SKA 7	1 000
		SKA 8	< 500
Stargazer[1]		STA 1	1 000
		STA 3	< 500

[1] Likely to be *Kathetostoma giganteum*, *Geniagnus monopterygius*, or *Leptoscopus macropygus*

Table 8: Harvest estimates of generic species which could include QMS species and where there is a substantial recreational harvest from the 1996 national diary survey. No tonnage estimates are given. – indicates that not enough diarists recorded this group in this QMA to make a reliable estimate of *c.v.*. Numbers are rounded to the nearest 1000. < 500 means that less than four fish in this group were recorded by diarists

Species group	Fishstock	Number	*c.v.*(%)
Cod	QMA 1	6 000	–
	QMA 2	6 000	–
	QMA 3	6 000	–
	QMA 5	< 500	–
	QMA 7	21 000	–
	QMA 8	1 000	–
Mackerel	QMA 1	24 000	19
	QMA 2	4 000	–
	QMA 7	< 500	–
	QMA 8	6 000	–
	QMA 9	1 000	–
Mullet	QMA 1	43 000	23
	QMA 2	1 000	–
	QMA 3	6 000	–
	QMA 7	16 000	–
	QMA 8	5 000	–
	QMA 9	27 000	–
Sharks	QMA 1	21 000	14
	QMA 2	8000	–
	QMA 3	1000	–
	QMA 5	< 500	–
	QMA 7	5 000	–
	QMA 8	13 000	–
	QMA 9	5 000	–
Yellowtail	QMA 1	15 000	4
	QMA 9	2 000	–

Table 9: Harvest estimates of non QMS species for which there is a substantial recreational harvest in some QMAs from the 1996 national diary survey. No tonnage estimates are given. – indicates that not enough diarists caught the species in the QMA to make a reliable estimate of *c.v.*. Numbers are rounded to the nearest 1000. <500 means that less than four fish were caught in this QMA

Common name	Scientific name	Fishstock	Harvest	*c.v.*(%)
Albacore	*Thunnus alalunga*	QMA 1	16 000	18
		QMA 2	20 000	–
		QMA 3	< 500	–
		QMA 5	2 000	–
		QMA 8	5 000	–
		QMA 9	8 000	–
Skipjack	*Katsuwonus pelamis*	QMA 1	88 000	2
		QMA 2	3 000	–
		QMA 8	< 500	–
		QMA 9	1 000	–
Tuna (all types)	*T. albacares, T. alalunga*	QMA 1	112 000	11
	K. pelamis	QMA 2	24 000	–
	Allothunnus fallai	QMA 3	< 500	–
		QMA 5	2 000	–
		QMA 8	6 000	–
		QMA 9	10 000	–
Blue maomao	*Scorpis violaceus*	QMA 1	85 000	11
		QMA 2	2 000	–
		QMA 8	4 000	–
		QMA 9	2 000	–
Pink maomao	*Caproden longimanus*	QMA 1	29 000	3
		QMA 2	< 500	–
Maomao[1]		QMA 1	37 000	3
		QMA 2	2 000	–
		QMA 8	3 000	–
		QMA 9	2 000	–
Koheru	*Decapterus koheru*	QMA 1	81 000	13
		QMA 2	< 500	–
		QMA 3	< 500	–
		QMA 8	< 500	–
		QMA 9	1 000	–
Parore	*Girella tricuspidata*	QMA 1	24 000	4
		QMA 2	< 500	–
		QMA 8	< 500	–
		QMA 9	4 000	–
Parrotfish[2]		QMA 1	13 000	16
		QMA 2	4 000	–
		QMA 3	10 000	–
		QMA 5	6 000	–
		QMA 7	7 000	–
		QMA 8	5 000	–
		QMA 9	< 500	–

[1] Either pink or blue maomao
[2] Unspecified wrasses

Table 9 — continued

Common name	Scientific name	Fishstock	Number	*c.v.*(%)
Rock cod	*Lotella rhaeinus*	QMA 1	15 000	18
		QMA 2	2 000	–
		QMA 3	3 000	–
		QMA 5	< 500	–
		QMA 7	4 000	–
		QMA 8	4 000	–
		QMA 9	4 000	–
Red snapper	*Centroberyx affinus*	QMA 1	34 000	2
Salmon[1]	*Oncorhynchus tshawytscha*	QMA 2	1 000	–
		QMA 3	19 000	14
		QMA 5	< 500	–
		QMA 7	< 500	–
Sprats	*Sprattus antipodum*	QMA 1	35 000	–
	S. muelleri	QMA 2	5 000	–
		QMA 3	3 000	–
		QMA 8	1 000	–
		QMA 9	5 000	–
Spotty	*Notolabrus celidotus*	QMA 1	17 000	–
		QMA 2	14 000	–
		QMA 3	4 000	–
		QMA 5	< 500	–
		QMA 7	37 000	16
		QMA 8	1 000	–
		QMA 9	1 000	–

[1] Probably *Oncorhynchus tshawytscha*

Table 10: Coefficients in the rock lobster tail width to weight relation $W = \exp(a + b \log(TW))$ where W is the greenweight (g) and TW is the tail width (mm) (T. Kendrick, NIWA, unpubl. data)

Common name	Scientific name	Fishstock	sex	*a*	*b*
Rock lobster or crayfish	*Jasus edwardsii*	CRA 1, 2, & 9	male	-3.3970	2.4230
			female	-1.7550	1.9030
		CRA 7	male	-5.9267	3.0415
			female	-3.6005	2.3686
		CRA 5	male	-5.8321	3.0048
			female	-2.7355	2.1765

Table 11: Rock lobster mean whole greenweights in grams. N number of animals measured, "all male" all rock lobsters assumed to be male, and similarly for "all female". The tail width data were measured during the 1996 national boat ramp survey (Hartill *et al.* in press)

Fishstock	N	All male	All female	Average
CRA 1	567	870	503	686
CRA 2	1 179	776	461	618
CRA 5	2 196	1 085	627	858
CRA 5 (sexed males)	440	861		
CRA 5 (sexed females)	1 127		694	
CRA 8 (assumed)				700

Table 12: Harvest estimates of rock lobster (*Jasus edwardsii*) and paua (assumed to be *Haliotis iris*) estimated from the 1996 national recreational surveys. – indicates that not enough diarists caught animals in this Fishstock to make a reliable estimate of *c.v.* or tonnage. Numbers are rounded to the nearest 1000. The point and range tonnage estimates are described in the text. Commercial harvests (t) and TACCs (t) are for 1995–96

				Tonnage		Commercial	
Species	Fishstock	Number	*c.v.*	Point est.	Range	harvest	TACC
Rock lobster	CRA 1	74 000	18	51	35–65	126.7	130.5
	CRA 2	223 000	10	138	115–155	212.6	214.6
	CRA 3	27 000	–	–	–	155.5	163.9
	CRA 4	118 000	14	73	55–90	488.0	495.7
	CRA 5	41 000	16	35	25–45	297.6	303.7
	CRA 7	3 000	–	–	–	81.3	138.9
	CRA 8	22 000	20	16	10–20	820.6	888.1
	CRA 9	26 000	–	–	–	45.4	47.0
Paua	PAU 1	55 000	19	14	10–20	0.99	1.93
	PAU 2	209 000	13	53	45–65	119.75	121.19
	PAU 3	38 000	–	–	–	92.89	91.60
	PAU 5	105 000	14	27	20–35	424.07	442.98
	PAU 7	23 000	–	–	–	263.71	267.48

Table 13: Harvest estimates of shellfish species estimated from the 1996 national recreational surveys. – indicates that not enough diarists caught animals in this Fishstock/QMA to make a reliable estimate of the *c.v.*. Numbers are rounded to the nearest 1000. <500 means that less than four animals were recorded by diarists

Common name	Scientific name	Fishstock	Number	*c.v.*(%)	Tonnage
Scallops	*Pecten novaezelandiae*	E Bay of Plenty	8 000	–	–
		Coromandel	614 000	12	62
		Northland	272 000	18	32
		QMA 5	24 000	–	–
		QMA 7	1 680 000	15	168
		WC harbours	352 000	18	38
Cockles	*Austrovenus stutchburgi*	QMA 1	569 000	18	
		QMA 2	30 000	–	–
		QMA 3	144 000	–	–
		QMA 5	73 000	–	–
		QMA 7	325 000	–	–
		QMA 8	35 000	–	–
		QMA 9	49 000	–	–
Sea urchins	*Evechinus chloroticus*	QMA 1	316 000	24	
		QMA 2	61 000	–	–
		QMA 3	12 000	–	–
		QMA 5	20 000	–	–
		QMA 7	2 000	–	–
		QMA 8	43 000	–	–
		QMA 9	30 000	–	–
Mussels	*Perna canaliculus*	QMA 1	818 000	12	
	Mytilus galloprovincialis	QMA 2	80 000	–	–
		QMA 3	76 000	21	
		QMA 5	71 000	–	–
		QMA 7	322 000	20	
		QMA 8	43 000	–	–
		QMA 9	271 000	23	
Dredge oysters	*Tiostrea chilensis*	QMA 3	56 000	–	–
		QMA 5	106 000	–	–
		QMA 7	168 000	–	–
Rock oysters	*Saccosterea glomerata*	QMA 1	5 000	–	–
		QMA 2	4 000	–	–
		QMA 3	62 000	–	–
		QMA 5	< 500	–	–
		QMA 7	11 000	–	–
		QMA 9	28 000	–	–
Pacific oysters	*Crassostrea gigas*	QMA 1	32 000	–	–
		QMA 3	8 000	–	–
		QMA 8	58 000	–	–
		QMA 9	27 000	–	–
Oysters	*Saccosterea glomerata*	QMA 1	168 000	–	–
	or *Crassostrea gigas*	QMA 7	3 000	–	–
		QMA 9	182 000	–	–

Table 13 — continued

Common name	Scientific name	Fishstock	Number	*c.v.*	Tonnage
Pipi	*Paphies australis*	QMA 1	2 191 000	11	
		QMA 2	61 000	–	
		QMA 3	55 000	–	
		QMA 5	5 000	–	
		QMA 7	87 000	–	
		QMA 8	58 000	–	
		QMA 9	289 000	–	
Tuatua	*Paphies subtriangulata*	QMA 1	1 141 000	14	
		QMA 2	3 000	–	
		QMA 3	87 000	–	
		QMA 9	390 000	–	
Molluscs[1]		QMA 2	40 000	–	
		QMA 3	15 000	–	
		QMA 7	7 000	–	
		QMA 9	38 000	–	

[1] Likely to be pipi or tuatua, but could be other species

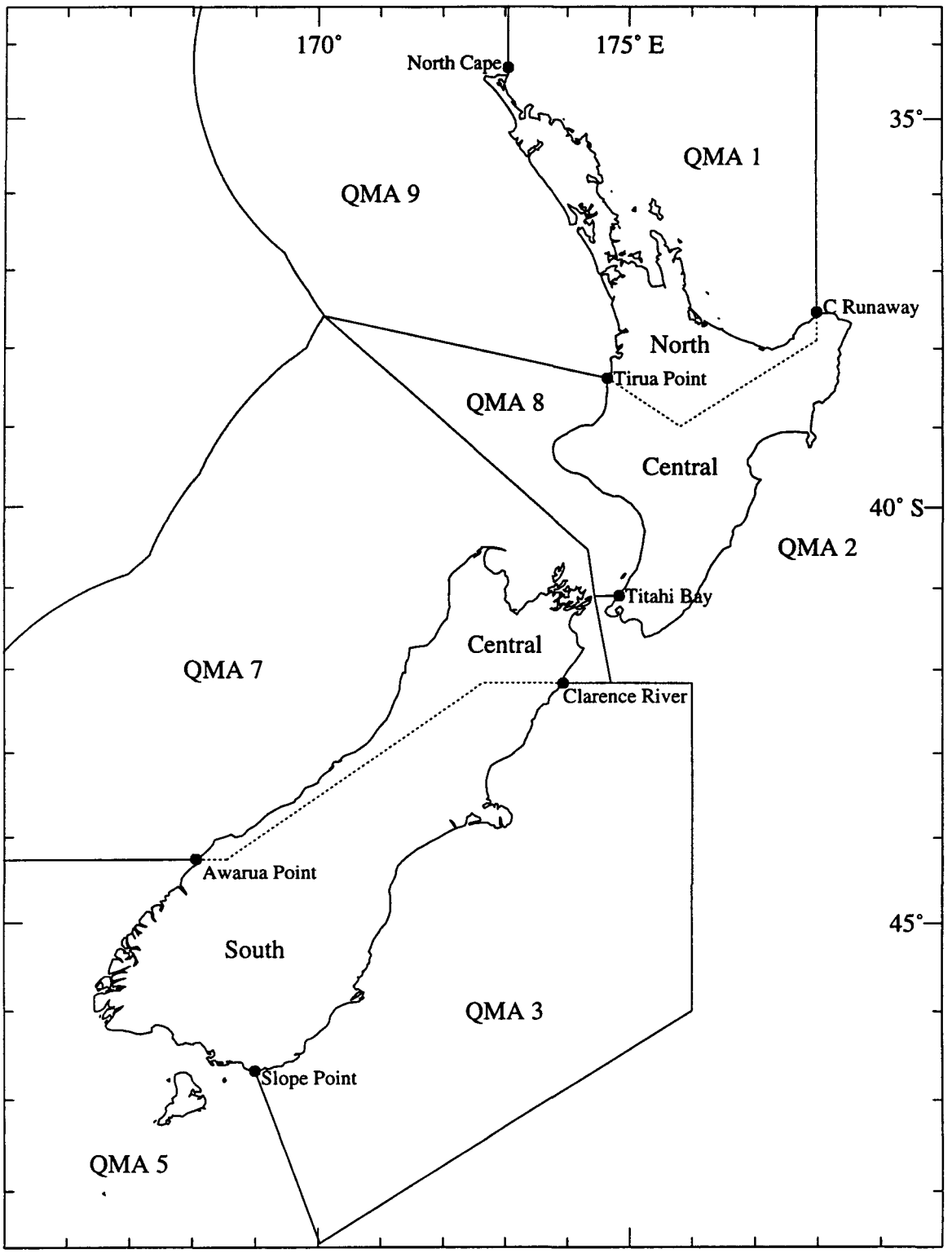

Figure 1: Map of New Zealand showing the land areas taken to be associated with North, Central, and South regions and the QMAs which adjoin the coastline.

Appendix 1: Estimation of *c.v.*s on the total catch

The total recreational catch (in numbers) of a particular species may be written as

$$N = S_s \times A_s \times B_s + S_{cn} \times A_{cn} \times B_{cn}$$

where N is the total number of fish caught. The subscripts s and cn refer to South region and North plus Central region diarists respectively. The variables S, A, and B are the scaling factors (Bradford 1998a), the number of diarists catching that species, and the mean catch per diarist of the species respectively. If A is assumed to have a Poisson distribution, the standard error of A equals $\sqrt{A}$ and the *c.v.* equals $1/\sqrt{A}$. The *c.v.* of B is calculated using the usual formula of standard error divided by the mean. The *c.v.* of each of the terms in the expression for N is then of the form

$$\sqrt{c.v.(S)^2 + c.v.(A)^2 + c.v.(B)^2}$$

from which we can find the variances of both terms in the expression for N and hence the variance of N (which is the sum of the two calculated variances) and finally its *c.v.*

The restriction placed on the sample size for appropriate estimation of the *c.v.* is made mainly to make certain that the numbers of diarists catching the species can reasonably be assumed to come from a Poisson distribution.