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A summary of biology and commercial landings and a stock assessment of rough and smooth skates (*Raja nasuta* and *R. innominata*)

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1. EXECUTIVE SUMMARY

Two endemic species of skate, rough skate (*Raja nasuta*) and smooth skate (*R. innominata*), are fished commercially in New Zealand. Both species occur throughout New Zealand, but are most abundant around the South Island in depths down to 500 m. Most of the commercial catch is taken by bottom trawlers. About 60% of the recent annual landings have been taken from QMA 3, mainly as a bycatch of the flatfish, red cod, and barracouta trawl fisheries. Most of the remainder is taken from QMAs 5 and 7.

New Zealand skate landings were negligible up to 1978. Landings then increased linearly to reach nearly 3000 t in 1992–93 and 1993–94, and then declined slightly to about 2800 t in 1994–95 and 1995–96. The increase in total landings during the 1990s was mainly due to increased landings from QMAs 4, 5, and 6. A total (competitive) quota of 900 t was introduced for QMA 3 in October 1991, but it has been exceeded (by 72–103%) every year since it was introduced.

Rough and smooth skates reproduce by laying yolky eggs, enclosed in leathery cases, on the seabed, but the number of eggs laid annually by each female is unknown. The young hatch at about 10–15 cm pelvic length. Nothing is known about growth rates. Male rough skates mature at 54–56 cm and females at 58–60 cm. Rough skates grow to at least 79 cm, and a weight of 11 kg. At pelvic lengths greater than about 55 cm, female rough skates are heavier than males of the same length. Length at maturity of smooth skates is 88–100 cm for males and about 100–110 cm for females. Smooth skates grow larger than rough skates, reaching at least 158 cm and 60 kg. In both species, females grow larger than males.

Skate relative biomass was estimated from recent trawl survey series. No trends were apparent in QMAs 2, 4, 5, 6, or 7. In QMA 3, the biomass of both species combined declined from 1928 t in 1991 to 562 t in 1996. However the decline was not uniform, being steepest between 1991 and 1992, with no change between 1992 and 1996. MCY and CAY could not be estimated because of insufficient data. The lack of trends in relative biomass in all QMAs except QMA 3 suggest that landings at current levels are probably sustainable. In QMA 3, it is not known whether recent catches are sustainable.

2. INTRODUCTION

2.1 Overview

This report reviews the history, and spatial and seasonal variability, of commercial landings of skates in New Zealand, and skate management measures. Relative biomass estimates from research trawl surveys are provided for rough and smooth skates for much of the New Zealand continental shelf and slope. Size-frequency data from trawl surveys are also presented, and used to estimate length at hatching, length at maturity, maximum length, and length-weight relationships. Yield estimates (MCY and CAY) could not be determined.

2.2 Description of the fishery

Two endemic species of skate, rough skate (*Raja nasuta*, species code RSK) and smooth skate (*R. innominata*, SSK), are fished commercially in New Zealand. Smooth skates, which are also known in the fishing industry as barndoor skates, grow considerably larger than rough skates, but both species are landed and processed. Two other species of deepwater skate (*Bathyraja shuntovi* and *Raja hyperborea*) are large enough to be of commercial interest, but are relatively uncommon and probably make up a negligible proportion of the landings.

Rough and smooth skates occur throughout New Zealand, but are most abundant around the South Island in depths down to 500 m. Most of the commercial catch of skates is taken by bottom trawlers. About 60% of the recent annual landings have been taken from QMA 3, mainly as a bycatch of the flatfish, red cod, and barracouta trawl fisheries. Most of the remainder is taken from QMAs 5 and 7, also as bycatch. Skates are also taken as bycatch by longliners; significant bycatch has been reported from the Bounty Plateau in QMA 6.

Skate flesh ammoniates rapidly after death, so the wings are removed at sea and chilled or frozen. On arrival at the shore factories, the wings are machine-skinned, graded, and packed for sale. Most of the product is exported to Europe, especially France and Italy. Skates of all sizes and both species are processed, though some factories impose a minimum weight limit of about 1 kg (200 g per wing), and occasionally wings from very large smooth skates are difficult to market.

2.3 Literature review

There have been no detailed studies on New Zealand skates. The smooth skate was scientifically described only in 1974 (Garrick & Paul 1974), and most early reports apply to both species.

Skates were caught along much of the east coast of New Zealand, between Foveaux Strait and Bay of Plenty, and at the Chathams, during the 1907 Government Trawling Expedition (Waite 1909). Most of Waite's observations appear to have been made on rough skates, because he described and illustrated a rare "colour variety" that is clearly a smooth skate. Waite also reported taking egg cases, which are deposited by skates on the seabed, at trawl stations between Hawke Bay and Foveaux Strait, and at the Chathams. He illustrated an egg case and two embryos at different development stages, but the species involved is uncertain. Waite gave the dimensions of a number of egg cases, showing that they varied considerably in size; however some of the variation may be attributable to interspecific differences. Waite also reported a 2.53 m total length skate (presumably a smooth skate) being caught at Milford Sound. It contained two developing uterine eggs and had crayfish in its stomach.

Graham (1939a) investigated the stomach contents of skates from Otago waters. Their diet included fishes (8 species), molluscs (3), crabs (4), and worms (2), indicating that they are carnivores with a diverse diet. The invertebrates and some of the fish species would have been taken from the seabed, but the presence of sprats in the diet suggests skates may also forage in mid water, possibly nocturnally (Graham 1956). Graham (1939a) found a skate in the stomach of a ling. Juvenile skates may be prey for a variety of large, demersal-feeding fishes.

(Graham 1938) suggested that female skates grow larger than males. Skates containing eggs that were almost ready for laying have been found in October, January, and March (Graham 1939b). During a recent trawl survey of the east coast of South Island (KAH9618) in December–January, egg cases ready for extrusion were found in female rough skates. These observations indicate that rough skates lay eggs at least in spring–summer.

Garrick & Paul (1974) estimated the length at maturity of male rough skates to be about 65 cm total length (ca. 47 cm pelvic length), and that male smooth skates mature at a larger, undetermined size. They stated that smooth skates tend to be taken in deeper water than rough skates, but that both species are frequently caught together.

3. REVIEW OF THE FISHERY

3.1 Commercial landings and quotas

The commercial skate catch includes two main species: rough skate and smooth skate. However many fishers and processors do not distinguish the two species in their landing returns, and code them instead as "skates" (SKA). Because it is impossible to determine the species composition of the catch from landings data, all data reported here consist of the sum of the three species codes RSK, SSK, and SKA, unless otherwise stated.

All landings have been converted from processed weight to whole weight by application of conversion factors. There have been historical changes to the conversion factors applied to skates by MAF Fisheries and Ministry of Fisheries. Unfortunately, no record seems to have been kept of the conversion factors in use before 1987, so it is not possible to reconstruct the time series of landings data using the currently accepted factors. A computer printout of the MAF "conversion file" generation 22, dated 7 April 1982, gives the conversion factor for skates landed in all states as 2.13. "The Fisheries (Conversion Factors) Notice 1986 (1986/283)" provided no conversion factor for skates, but when it was amended on 1 July 1987 (1987/165) a default category for sharks, skates, and rays was introduced. That category did not specify a conversion factor for skate wings, but they were probably treated as "fillets" with a conversion factor of 2.7. A specific conversion factor for skate wings (2.65) was first introduced on 1 October 1991 in "The Fisheries (Conversion Factors) Notice 1991 (1991/211)", and has applied ever since. Therefore consistent and appropriate conversion factors have been applied to skate landings since the end of the 1986–87 fishing year. Before that, it appears that a lower conversion factor was applied, resulting in an underestimation of landed whole weight by about 20%. No correction has been made for that in this report.

New Zealand annual skate landings, estimated from a variety of sources, are shown in Table 1. No FSU deepwater data were available before 1983, and it is not known whether deepwater catches, including those of foreign fishing vessels, were significant during that period. CELR and CLR data are provided by inshore and deepwater trawlers respectively. "CELR estimated" landings were always less than "CELR landed" landings, because the former include only the top five fish species (by weight) caught by trawlers, whereas the latter include all species landed. As a relatively minor bycatch, skates frequently do not fall into the top five species. The sum of the "CELR landed" and CLR data provides an estimate of the total skate landings (column 8 in Table 1). This estimate usually agreed well with LFRR data supplied by fish processors (column 9), especially in 1993–94 and 1994–95, but in 1992–93 the difference was 467 t. The right hand column provides the "best estimate" of the annual landings, being FSU data up to 1985–86 and LFRR data thereafter.

Total skate landings (based on the "best estimate" in Table 1) were negligible up to 1978 (Figure 1), presumably because of a lack of suitable markets and the availability of other more abundant and desirable species. Landings then increased linearly to reach nearly 3000 t in 1992–93 and 1993–94. Since then, landings have declined slightly to about 2800 t in 1994–95 and 1995–96 (Figure 1, Table 1).

Because skates are taken mainly as bycatch of bottom trawl fisheries, historical catches have probably been proportional to the amount of effort in the target trawl fisheries. Past catches were probably higher than historical landings data suggest because of unrecorded discards, and unrecorded foreign catch before 1983.

The proportion of skate landings taken from each QMA was estimated from the CELR and CLR data combined from 1989–90 onwards. In 1989–90, QMA 3 accounted for 80% of the New Zealand landings, but this declined to an average of 58% over the last 4 years for which data were available (Figure 2). Most of the remainder of the landings came from QMAs 5, 6, and 7.

The quantity of skates landed from each QMA was estimated by multiplying the total LFRR landings by the proportion of the combined CELR and CLR landings reported for each QMA (Table 2, Figure 1). QMA 3 landings increased slowly to peak in 1993–94 and then declined slightly in 1994–95. Landings from QMAs 4, 5, 6, and 7 were low in 1989–90 and 1990–91, but increased markedly in 1991–92. Thus the increase in total landings from 1991–92 onwards was due to increased landings in all important QMAs, especially QMAs 5, 6 and 7 (*see* Figure 1).

Monthly variations in skate landings (LFRR data) are shown in Figure 3. There is no clear seasonal pattern in landings, but during the last 3 years catches peaked in September–January. CELR data indicate that skates are caught year round in QMA 3 (Figure 4), which is consistent with the observations of Canterbury Bight fishers who report that skates are always present. Monthly variations in skate landings probably result from variations in effort directed at the three main target species in QMA 3, flatfish, red cod, and barracouta. The low landings in September 1994 and September 1995, and high landings in October 1994, probably reflect the availability of quota for target species at the end (September) and beginning (October) of the fishing year.

A total (competitive) quota of 900 t was introduced for QMA 3 in October 1991 (for the 1991–92 fishing year) and has applied ever since. The quota technically applies to all species of skates and rays, but only rough and smooth skates are caught in QMA 3 in significant quantities. Skate landings have exceeded the quota every year since it was introduced, by 72–103% (*see* Table 2).

In QMAs 1, 4, and 9, skates have been prohibited as target species since October 1991, but they are allowed to be taken and landed as bycatch. In QMAs 2, 5, 6, 7, and 8, skates have been permitted target species, subject to quota and method restrictions, since October 1991. However no quotas or method restrictions have so far been implemented so skates are effectively prohibited target species in those QMAs also.

No other management measures apply to skates, apart from trawl exclusion zones in a number of harbours and shallow coastal areas, and in marine reserves and around the Auckland Islands. These areas are insignificant in relation to the habitat range of both species of skates.

3.2 Recreational, traditional, and Maori fisheries

Recreational fishing surveys indicate that skates are very rarely caught by recreational fishers. No traditional or Maori fisheries are known.

4. RESEARCH

4.1 Stock structure

Nothing is known about stock structure in skates. In the absence of information on stock structure, skates should probably be managed in relatively small management areas. Management areas larger than the current QMAs could encompass multiple skate stocks, and may lead to suboptimal management of those stocks.

4.2 Resource surveys

4.2.1 Distribution

Research trawl survey data indicate that both rough and smooth skates are distributed from the Three Kings Islands to Campbell Island and the Chatham Islands, including the Challenger Plateau, Chatham Rise, and Bounty Plateau (Figures 5 and 6). It is likely that some records in the trawl database involve misidentification of skate species, but the general distributions illustrated are probably substantially correct. The absence of records from the central Challenger Plateau and Fiordland is due to a lack of trawl stations in those areas. Skates have not been recorded from QMA 10, including the Kermadec Islands.

Catch rates of rough and smooth skates were determined for all *Kaharoa* and *Tangaroa* stations at which the species were caught. Many of the earlier *Kaharoa* stations had no information on doorspread, so results are presented as kg per km towed, rather than kg per km^2. *Kaharoa* and *Tangaroa* catch rates are not directly comparable. Catch rates were typically low (mostly less than 20 $kg.km^{-1}$) (Figure 7). Since rough skates weigh as much as 11 kg, and smooth skates as much as 60 kg, the number of skates caught per tow was usually small. There was no clear latitudinal trend in catch rates, but catch rates were always low south of 49° S, on the Southern Plateau (*see* Figure 7).

Both rough and smooth skates are commonest in depths of 0–500 m, with some individuals occurring down to 800 m (Figure 8). Records of both species deeper than this may represent misidentifications of the deepwater skates, *Bathyraja shuntovi* or *Raja hyperborea*.

4.2.2 Biological sampling

Since mid 1995, scientific staff on trawl surveys have used an identification kit to ensure accurate identification of rough and smooth skates. In addition, data on skate length, weight, sex, and maturity are now routinely collected, though sample sizes have been small for most surveys. Because total length is difficult to measure in large individuals, pelvic length (PL, the distance between the tip of the snout and the posterior margin of the pelvic fins) was measured instead. Male maturity was determined from the degree of development of the claspers, and female maturity was determined from the size and colour of the ovarian eggs (*see* Francis & Mace 1980). For both sexes, a simple three-point maturity scale (immature, maturing, and mature) was used.

Rough skates

Length-frequency data collected from the east coast of South Island suggest that rough skates less than 40 cm were confined to waters shallower than 75 m (Figure 9). Larger fish (40–67 cm) of both sexes occurred in depths of 0–150 m. On the Stewart – Snares shelf, few small fish were caught, and they were confined to depths less than 150 m (Figure 10). Length-frequency distributions were dominated by large fish (50–70 cm) in all depth strata, and males outnumbered females by 1.46 : 1.

Several surveys of Tasman Bay and Golden Bay produced small numbers of rough skates. The samples included small skates less than 40 cm, but no fish over 60 cm (Figure 11). A large sample of rough skates from the east coast of North Island consisted mainly of large fish, with a prominent mode between 46 and 57 cm (Figure 12).

The largest female rough skates measured were 87 cm and 98 cm (*see* Figure 10), but these lengths were exceptional and could conceivably have been mis-identified smooth skates. The next largest female was 79 cm. The largest male was 76 cm (*see* Figure 12), but this too was exceptional; the next largest male was 69 cm (*see* Figure 10). Until these exceptional lengths are confirmed, the maximum lengths for rough skates are taken as 69 cm for males and 79 cm for females. This suggests that females grow larger than males, as in many other elasmobranch species.

The smallest rough skate measured on trawl surveys were 15 cm (*see* Figure 12). However, rough skates as small as 10–13 cm (estimated from disc width measurements) were recorded from Otago throughout the year in 1982–83 by S. Hanchet (NIWA, pers. comm.).

Male rough skates reach 50% maturity at about 54–56 cm, and females reach maturity at about 58–60 cm (Figure 13). Therefore females probably mature at slightly larger sizes than males.

At pelvic lengths greater than about 55 cm, female rough skates are heavier than males of the same length (Figure 14). The divergence between the sexes coincides approximately with the onset of maturity in females. It is not known whether the increase in female weight is associated with gonad or somatic development, or both. Because of the difference between the sexes, separate length-weight relationships have been developed:

Males: Weight = $0.0393(PL)^{2.838}$ $r^2 = 0.987$, $n = 425$, range = 17–69 cm
Females: Weight = $0.0218(PL)^{3.001}$ $r^2 = 0.990$, $n = 335$, range = 19–87 cm

where weight is measured in grams and pelvic length in centimetres.

Smooth skates

Length-frequency distributions for smooth skates are shown in Figure 15. The sample from the east coast of North Island was dominated by small fish less than 60 cm. Samples from the east coast South Island and the Stewart–Snares shelf also included fish less than 60 cm, but had modes of larger fish at 80–110 cm. Sample sizes were too small to assess sex ratios, or whether depth affected the length distributions.

The largest smooth skate measured was a 158 cm female, and the largest male measured 121 cm (*see* Figure 15). This suggests that females grow larger than males, although the numbers of large fish examined was small. The smallest smooth skate measured 17 cm.

The length at maturity of smooth skates cannot be accurately determined because of the small sample sizes, but it is about 88–100 cm for males, and 100–110 cm for females (*see* Figure 13).

A length-weight relationship was obtained for both sexes combined from the data in Figure 14:

Weight = $0.0268(PL)^{2.933}$ $r^2 = 0.992$, $n = 150$, range = 17–158 cm

where weight is measured in grams and pelvic length in centimetres.

4.3 Other studies

Nothing is known about age, growth, or longevity of rough and smooth skates.

Skates have internal fertilisation. As in other species of *Raja,* female rough and smooth skates produce yolky eggs that are enclosed in leathery cases and deposited on the seabed. A single embryo develops inside each egg case using the energy contained in the yolk. Based on the length of the smallest free-living skates (10 cm for rough skates, 17 cm for smooth skates, and 13 and 14 cm for unidentified skates), it is presumed that both species hatch at about 10–15 cm. Female skates probably produce two egg cases at a time (one in each uterus) as in other oviparous elasmobranchs. The timing of mating, egg laying and hatching are unknown, as is the number of eggs laid per female per year.

4.4 Biomass estimates

There are no absolute biomass estimates for rough or smooth skates.

Relative biomass estimates are available for rough and smooth skates from a number of trawl survey series (Tables 3–8). Biomass estimates are not provided for surveys of: (a) west coast North Island because of major changes in survey areas and strata during the series; or (b) east Northland, Hauraki Gulf, and Bay of Plenty because of the low relative biomass of skates present (usually less than 100 t). In the first survey of each of two series (east coast South Island and Chatham Rise; Tables 5 and 6), the two skate species were not (fully) distinguished. Furthermore, there are doubts about the accuracy of species identification in some other earlier surveys. Consequently, trends in biomass of individual species must be interpreted cautiously. To enable comparison among all surveys within each series, total skate biomass is also reported.

Biomass estimates for the east coast North Island (QMA 2) were low and variable, and for smooth skate the coefficients of variation (c.v.s) were high (Table 3). These biomass estimates may be unreliable.

For Tasman Bay–Golden Bay and the west coast of South Island (QMA 7), biomass estimates for both rough and smooth skates were stable, and had low to moderate c.v.s (Table 4). The biomass of smooth skate was larger than that of rough skate.

Off the east coast South Island (QMA 3), the biomass of both species combined declined from 1928 t in 1991 to 562 t in 1996 (Table 5). C.v.s were mostly low. However the decline was not uniform, being steepest between 1991 and 1992, with no significant change between 1992 and 1996. The biomass trends of the two species were inconsistent, possibly because of identification errors before 1996.

Most of the biomass on the Chatham Rise (QMAs 3 and 4) consisted of smooth skates (Table 6). Biomass estimates were variable with no clear trends. C.v.s were very high for rough skate, but low to moderate for smooth skate.

On the Stewart–Snares shelf (QMA 5), the biomass of rough skate was greater than that of smooth skate, and neither species showed any trend through time (Table 7). C.v.s were mostly low.

A further series of surveys of the deep part of the Stewart–Snares shelf (> 300 m) and the Subantarctic (QMAs 5 and 6) showed that the biomass of both species was low, and c.v.s were high (Table 8).

4.5 Yield estimates

MCY and CAY cannot be estimated.

The MCY estimator that has the lowest data requirements (MCY = cY_{av}; Method 4) relies on selecting a time period during which there were "no systematic changes in fishing mortality (or fishing effort, if this can be assumed to be proportional to fishing mortality)" (Annala & Sullivan 1996). This method was not applied because no information is currently available on skate fishing mortality, or on trawl fishing effort in the main skate fishing areas.

5. MANAGEMENT IMPLICATIONS

In the absence of information on stock structure, skates should probably be managed in relatively small management areas. Management areas larger than the current QMAs could encompass multiple skate stocks, and may lead to suboptimal management of those stocks.

Relative biomass estimates from trawl surveys indicate that skate stocks in QMAs 4, 5, 6, and 7 showed no trend in recent years. Therefore landings at the current levels in those QMAs are probably sustainable, and will allow the stocks to move towards a size that will support the MSY.

Landings from QMA 3 have significantly exceeded the total quota of 900 t (by 70–103%) in every year since it was implemented. Biomass indices for both skate species combined in QMA 3 declined significantly between 1991 and 1996. However, the decline was not uniform, being steepest between 1991 and 1992, with no change between 1992 and 1996. It is not known if recent catch levels or the total quota are sustainable or at levels that will allow the stock to move towards a size that will support the MSY.

Species that constitute a minor bycatch of trawl fisheries are often difficult to manage using TACCs and ITQs. Skates are widely and thinly distributed, and would be difficult for trawlers to avoid after the quota had been caught. A certain level of incidental bycatch is therefore inevitable. However, skates are hardy, and frequently survive being caught in trawls (though mortality would depend on the length of the tow and the weight of fish in the codend). Skates returned to the sea probably have a greater chance of survival than do most other fishes.

6. REFERENCES

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Table 1: New Zealand skate landings (whole weight) for calendar years 1974–1983, and fishing years (1 October–30 September) 1983-84–1995-96. Values in parentheses are based on part of the fishing year only. Landings do not include foreign catch before 1983, or unreported discards. FSU = Fisheries Statistics Unit; CELR = Catch, Effort and Landing Return; CLR = Catch Landing Return; LFRR = Licensed Fish Receivers Return; Best Estim. = best available estimate of the annual skate catch; – = no data.

Year	FSU In-shore	FSU Deep-water	FSU Total	CELR Estim.	CELR Landed	CLR	CELR Landed + CLR	LFRR	Best Estim.
1974	23	–	–	–	–	–	–	–	23
1975	30	–	–	–	–	–	–	–	30
1976	28	–	–	–	–	–	–	–	28
1977	27	–	–	–	–	–	–	–	27
1978	36	–	–	–	–	–	–	–	36
1979	165	–	–	–	–	–	–	–	165
1980	441	–	–	–	–	–	–	–	441
1981	426	–	–	–	–	–	–	–	426
1982	648	–	–	–	–	–	–	–	648
1983	634	178	812	–	–	–	–	–	812
1983–84	686	298	983	–	–	–	–	–	983
1984–85	636	250	886	–	–	–	–	–	886
1985–86	613	331	944	–	–	–	–	–	944
1986–87	723	285	1 007	–	–	–	–	1 019	1 019
1987–88	1 005	421	1 426	–	–	–	–	1 725	1 725
1988–89	(530)	(136)	(665)	(252)	(265)	(28)	(293)	1 513	1 513
1989–90	–	–	–	780	1 171	410	1 581	1 769	1 769
1990–91	–	–	–	796	1 334	359	1 693	1 820	1 820
1991–92	–	–	–	1 112	1 994	703	2 698	2 620	2 620
1992–93	–	–	–	1 175	2 595	824	3 418	2 951	2 951
1993–94	–	–	–	1 247	2 236	788	3 024	2 997	2 997
1994–95	–	–	–	956	1 973	829	2 803	2 789	2 790
1995–96	–	–	–	–	–	–	–	2 789	2 789

Table 2: Skate landings by QMA (estimated by multiplying the LFRR total landings by the proportion of the combined CELR and CLR landings reported for each QMA)

Year	QMA 3	QMA 4	QMA 5	QMA 6	QMA 7	Other QMAs	Best estimate (LFRR total)
1989–90	1 415	7	35	0	248	64	1 769
1990–91	1 292	46	91	36	291	64	1 820
1991–92	1 546	73	210	236	524	31	2 620
1992–93	1 564	77	561	236	443	71	2 951
1993–94	1 828	183	300	210	420	57	2 997
1994–95	1 646	100	363	112	502	67	2 790
Mean	1 548	81	260	138	405	59	2 491

Table 3: Doorspread biomass estimates of rough and smooth skates for the **east coast of North Island (QMA 2)** determined from *Kaharoa* trawl surveys conducted in February–March over a depth range of 20–400 m

Voyage	Year	Number of stns	Rough skate Biomass (t)	Rough skate *c.v.* %	Smooth skate Biomass (t)	Smooth skate *c.v.* %	Total skates Biomass (t)
KAH9402	1994	99	189	12	144	38	333
KAH9502	1995	117	52	20	20	59	72
KAH9602	1996	97	309	24	85	36	394

Table 4: Doorspread biomass estimates of rough and smooth skates for **Tasman Bay – Golden Bay and the west coast of South Island (QMA 7)** determined from *Kaharoa* trawl surveys conducted in March–April over a depth range of 20–400 m

Voyage	Year	Number of stns	Rough skate Biomass (t)	Rough skate *c.v.* %	Smooth skate Biomass (t)	Smooth skate *c.v.* %	Total skates Biomass (t)
KAH9204	1992	113	173	27	339	19	512
KAH9404	1994	116	196	23	341	18	537
KAH9504	1995	102	251	22	315	20	566

Table 5: Doorspread biomass estimates of rough and smooth skates for the **east coast of South Island (QMA 3)** determined from *Kaharoa* trawl surveys conducted in May–June over a depth range of 30–400 m

Voyage	Year	Number of stns	Rough skate Biomass (t)	Rough skate *c.v.* %	Smooth skate Biomass (t)	Smooth skate *c.v.* %	Total skates Biomass (t)	Total skates *c.v.* %
KAH9105	1991	55	1 928*	25	–	–	1 928#	25
KAH9205	1992	80	224	24	605	18	829	16
KAH9306	1993	74	335	21	658	25	993	21
KAH9406	1994	100	517	20	306	25	823	15
KAH9606	1996	118	177	19	385	24	562	18

* Includes SSK (all skates were recorded as RSK).
# Strata 7 (100–200 m) and 9 (200–400 m) were not surveyed, resulting in a total survey area that was 89% of that covered in subsequent surveys. However, strata 7 and 9 produced very low skate biomass estimates in subsequent surveys, so the value reported for KAH9105 is probably comparable with the remainder of the time series.

Table 6: Doorspread biomass estimates of rough and smooth skates for the **Chatham Rise (QMAs 3 & 4)** determined from *Tangaroa* trawl surveys conducted in December–February over a depth range of 200–800 m

Voyage	Year	Number of stns	Rough skate Biomass (t)	Rough skate *c.v.* %	Smooth skate Biomass (t)	Smooth skate *c.v.* %	Total skates Biomass (t)
TAN9106	1991–2	184	94	63	1 027	29	2 129*
TAN9212	1992–3	194	55	83	1 071	18	1 126
TAN9401	1994	165	220	44	958	23	1 178
TAN9501	1995	123	76	43	769	31	845
TAN9601	1996	89	11	100	1 511	30	1 522

* Includes 1008 t of "SKA", which is presumed to have been mostly smooth skate.

Table 7: Doorspread biomass estimates of rough and smooth skates for the **Stewart–Snares shelf (QMA 5)** determined from *Tangaroa* trawl surveys conducted in February–March over a depth range of 30–600 m

Voyage	Year	Number of stns	Rough skate Biomass (t)	Rough skate *c.v.* %	Smooth skate Biomass (t)	Smooth skate *c.v.* %	Total skates Biomass (t)
TAN9301	1993	112	592	20	528	20	1 120
TAN9402	1994	129	1 064	15	342	21	1 406
TAN9502	1995	150	801	7	335	19	1 136
TAN9604	1996	124	1 055	11	504	29	1 559

Table 8: Doorspread biomass estimates of rough and smooth skates for the **Stewart–Snares Shelf and the Subantarctic (QMAs 5 & 6)** determined from *Tangaroa* trawl surveys conducted in November–December over a depth range of 300–1000 m

Voyage	Year	Number of stns	Rough skate Biomass (t)	Rough skate *c.v.* %	Smooth skate Biomass (t)	Smooth skate *c.v.* %	Total skates Biomass (t)
TAN9105*	1991	154	37	72	382	23	419
TAN9211#	1992	160	52	69	113	47	165
TAN9310#	1993	138	132	57	117	43	249

* Excludes Bounty Plateau
# Includes Bounty Plateau

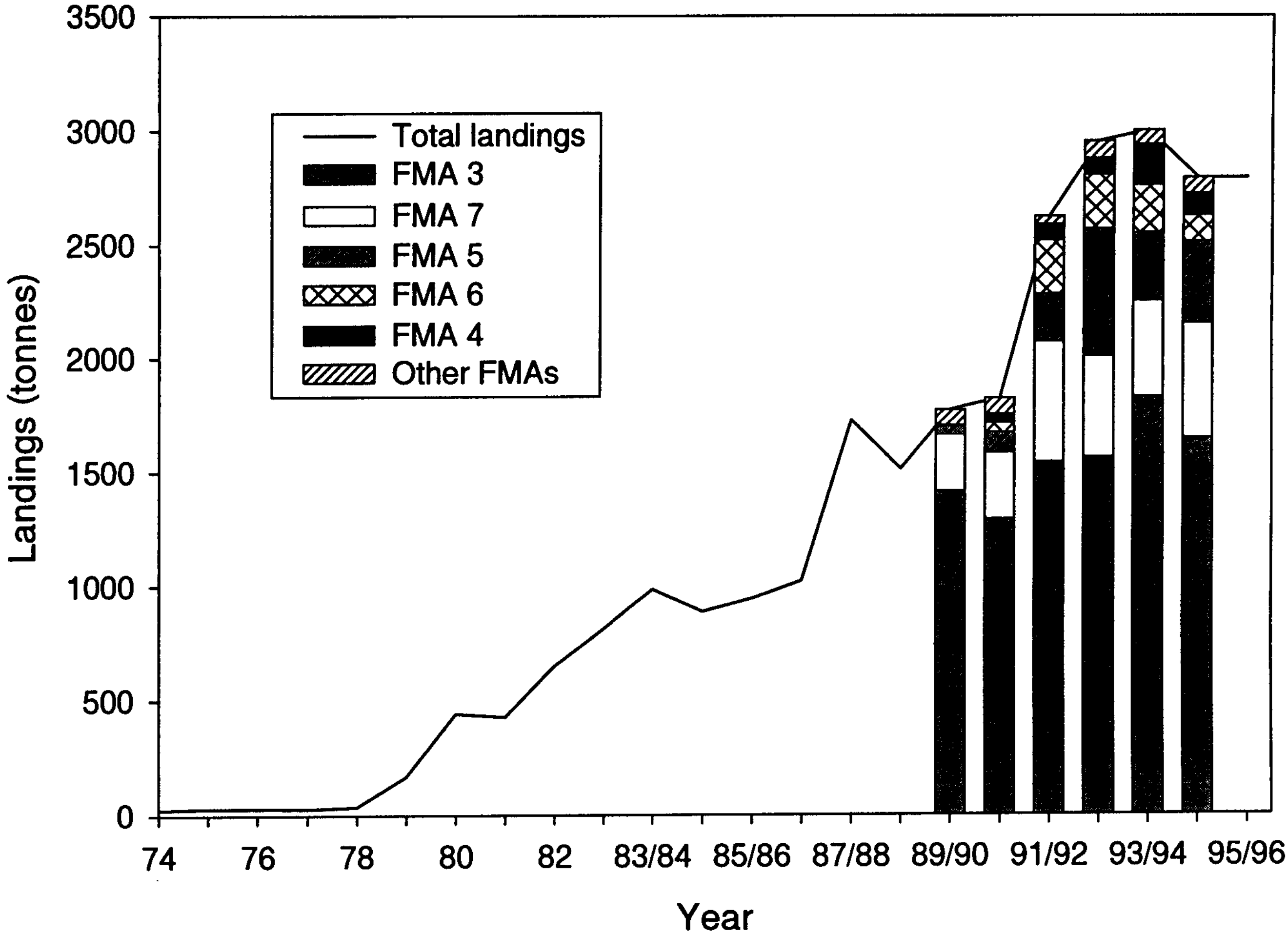


Figure 1: Total New Zealand landings of skate ("best estimate" from Table 1), and estimated landings by FMA since 1989/90. Calendar years to 1983, fishing years thereafter.

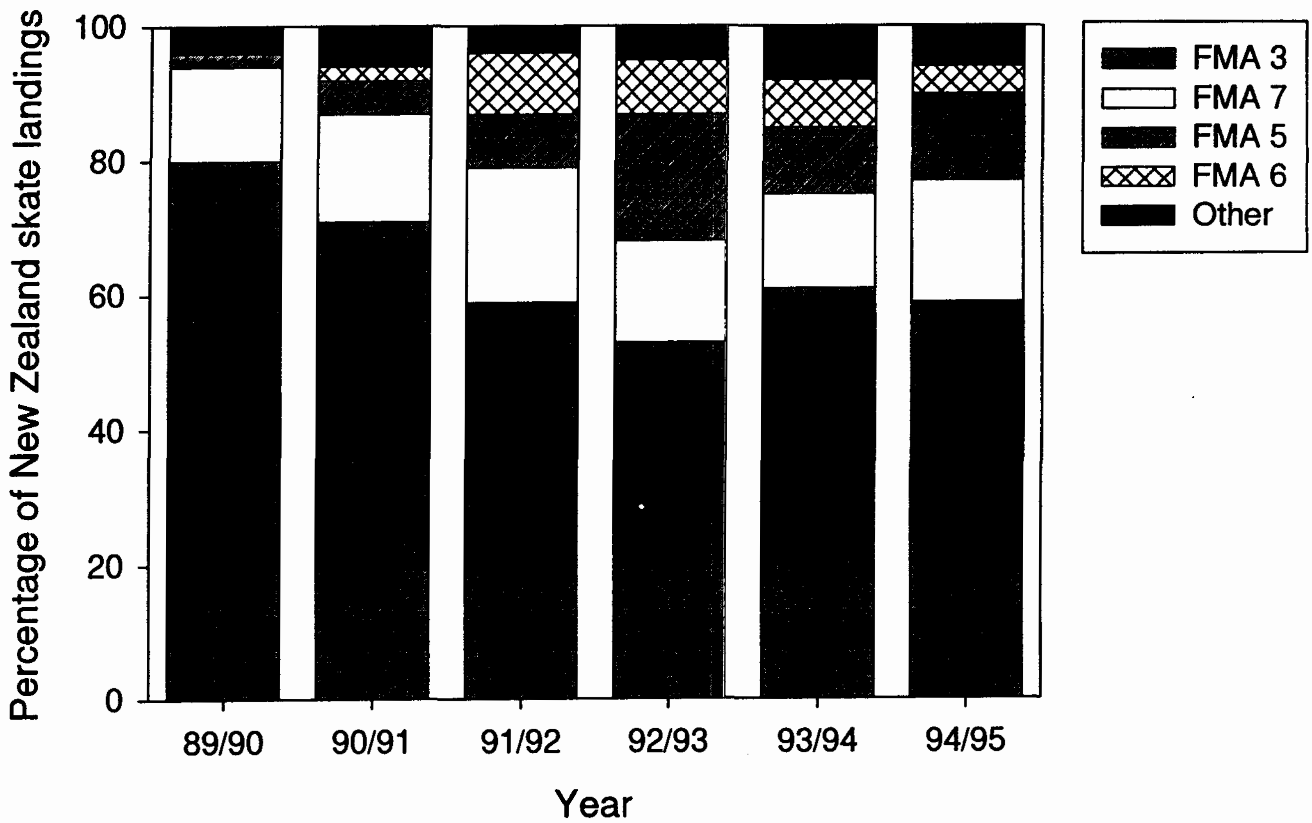


Figure 2: Proportion of New Zealand skate landings taken by FMA (CELR landed + CLR)

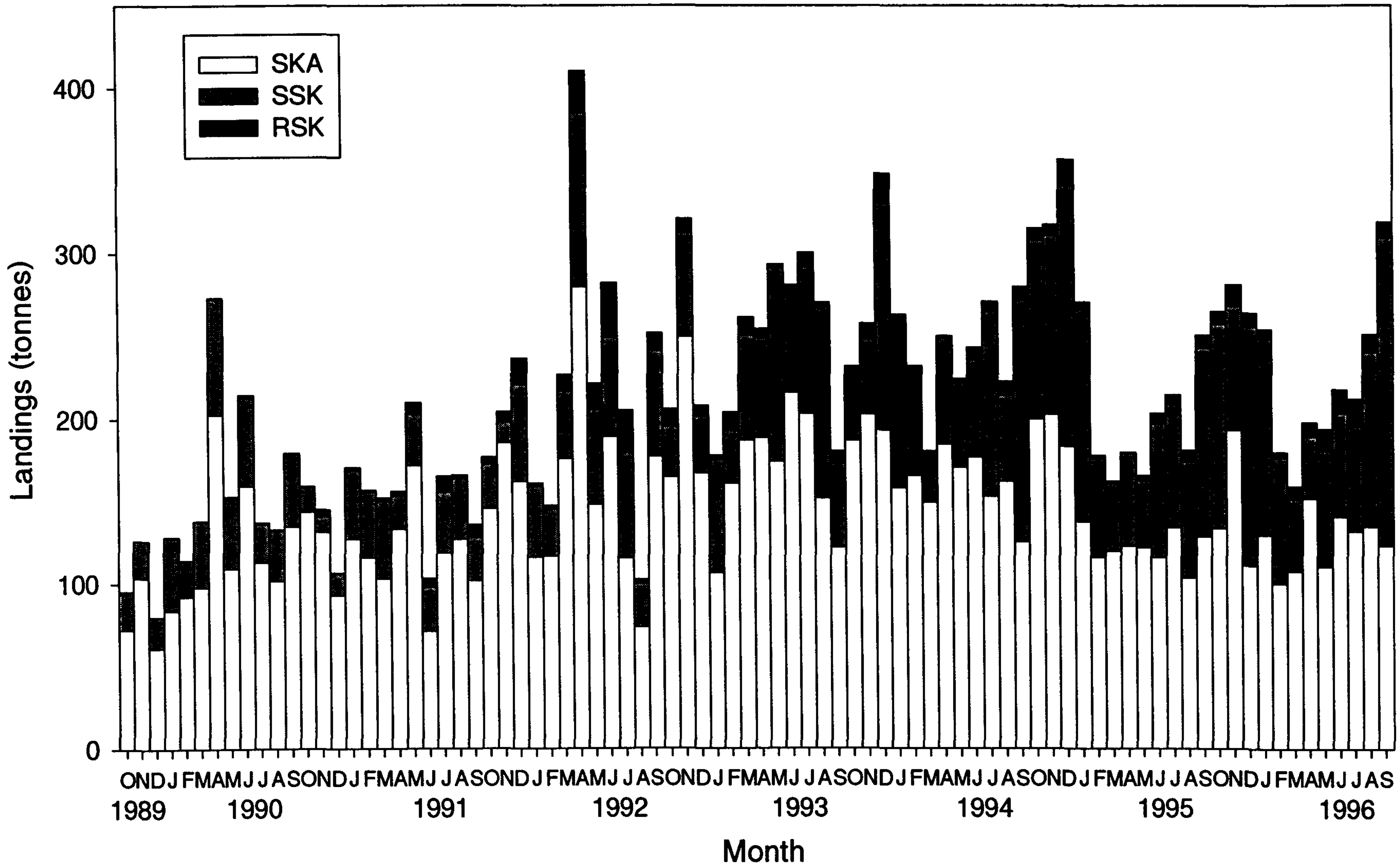


Figure 3: Monthly New Zealand landings of skates (LFRR) by species code. SKA = unidentified skate; SSK = smooth skate; RSK = rough skate.

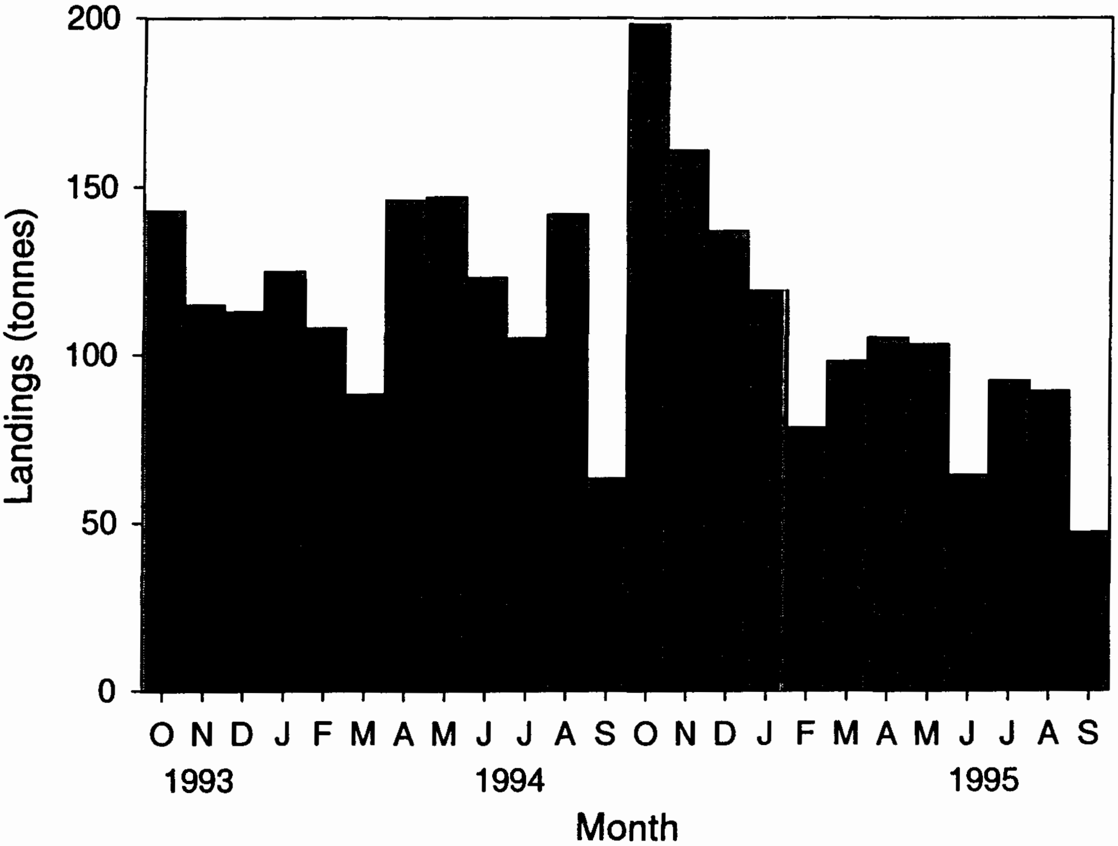


Figure 4: Monthly skate landings from FMA 3 (CELR landed; SKA, SSK and RSK combined)

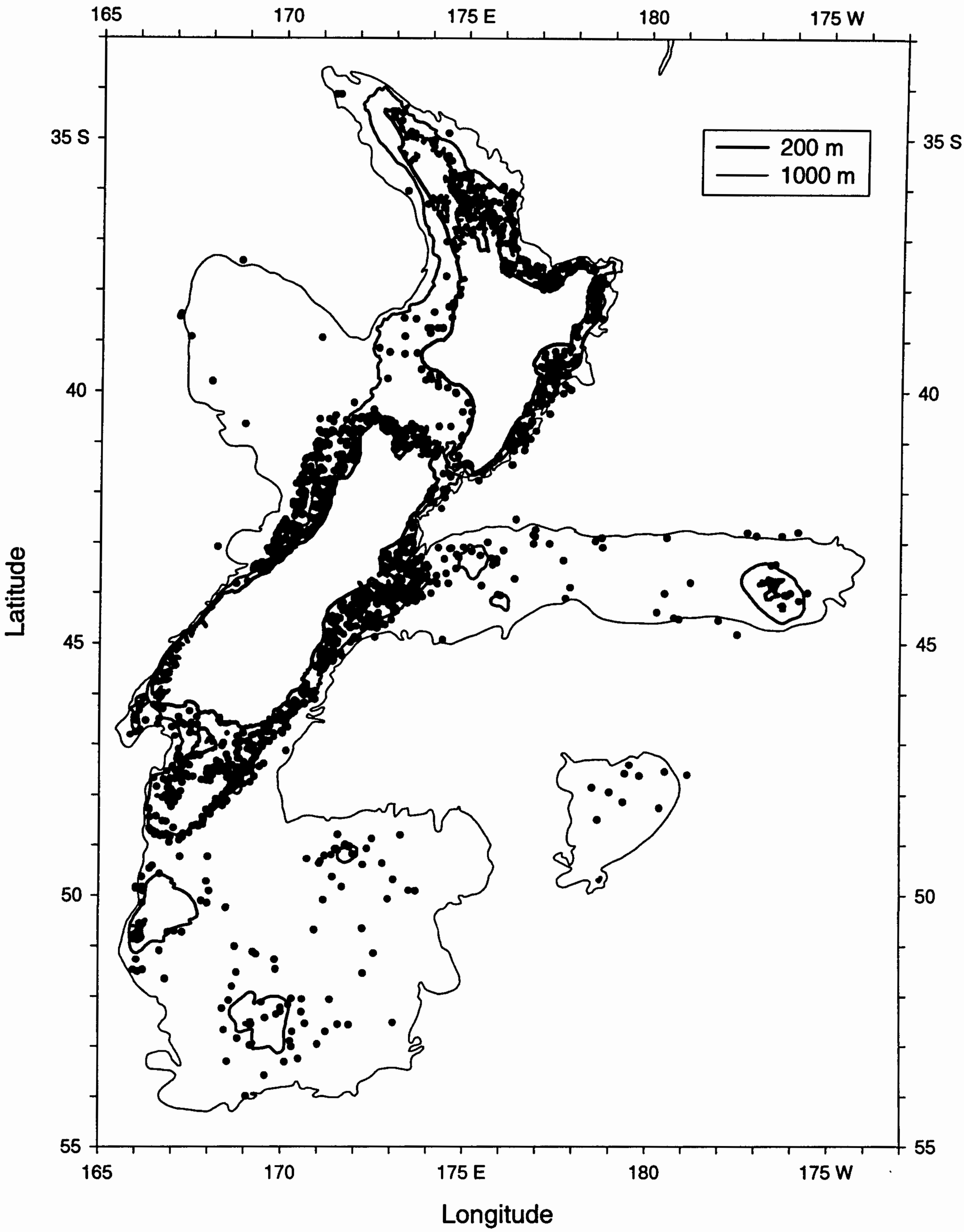


Figure 5: Location of research tows that caught rough skates

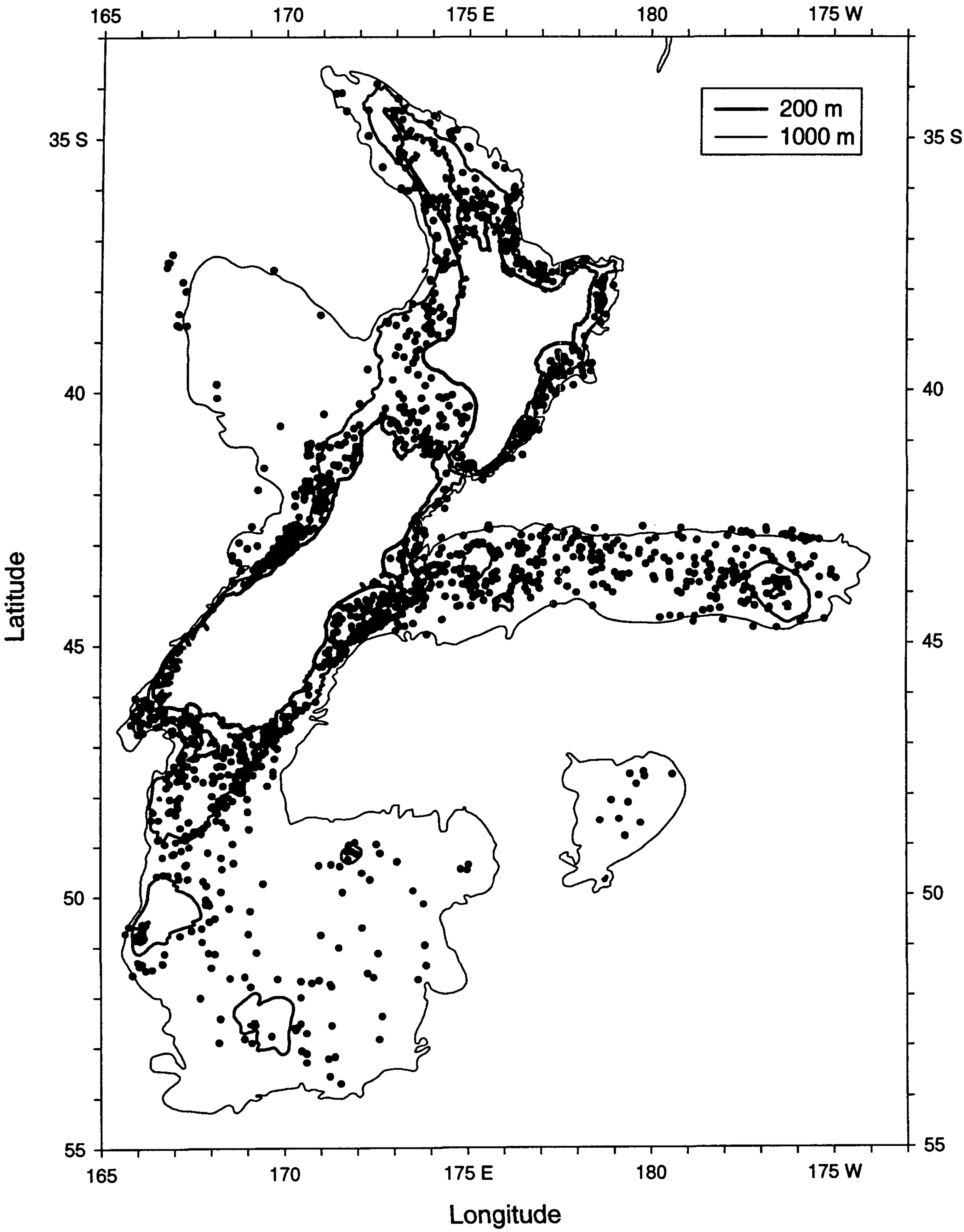


Figure 6: Location of research tows that caught smooth skates

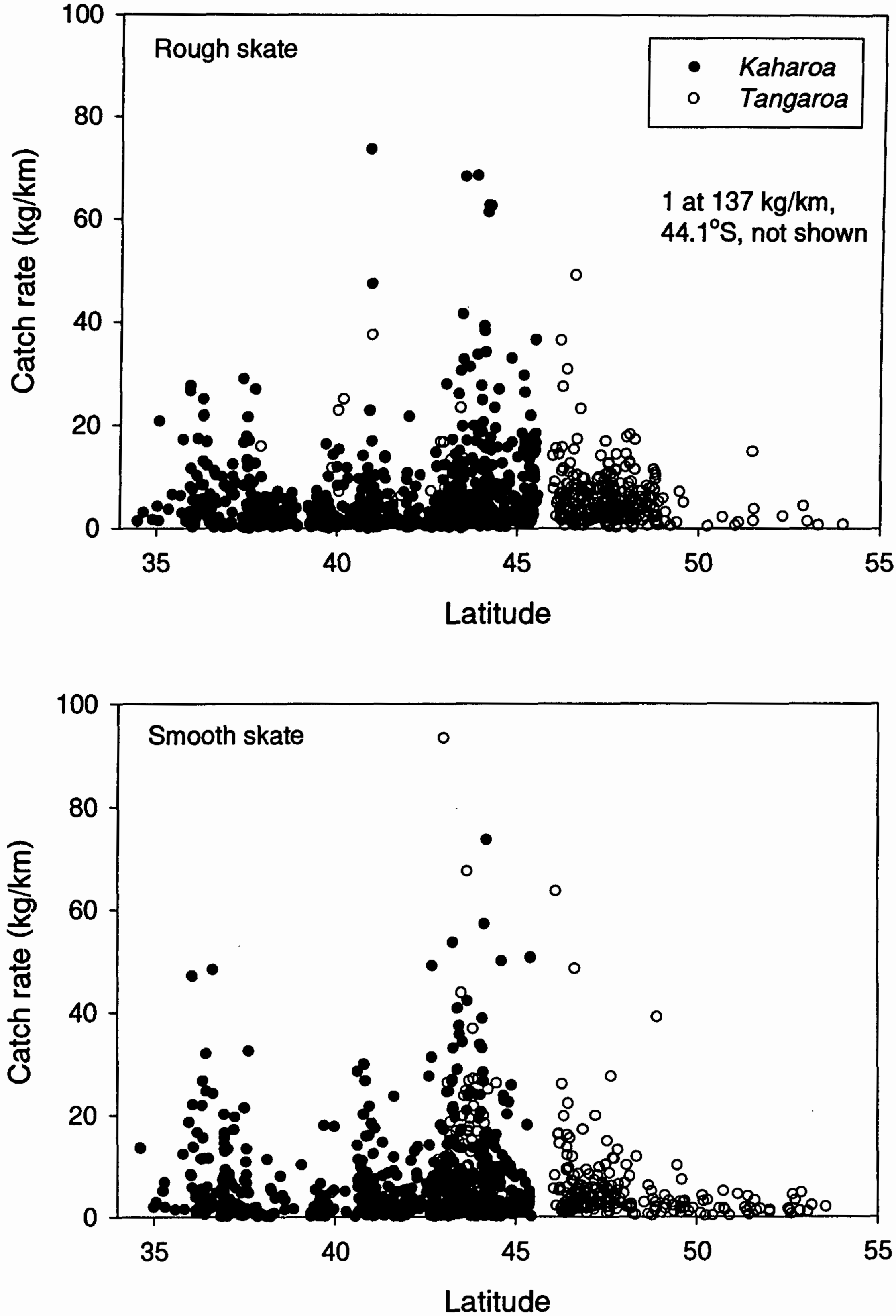
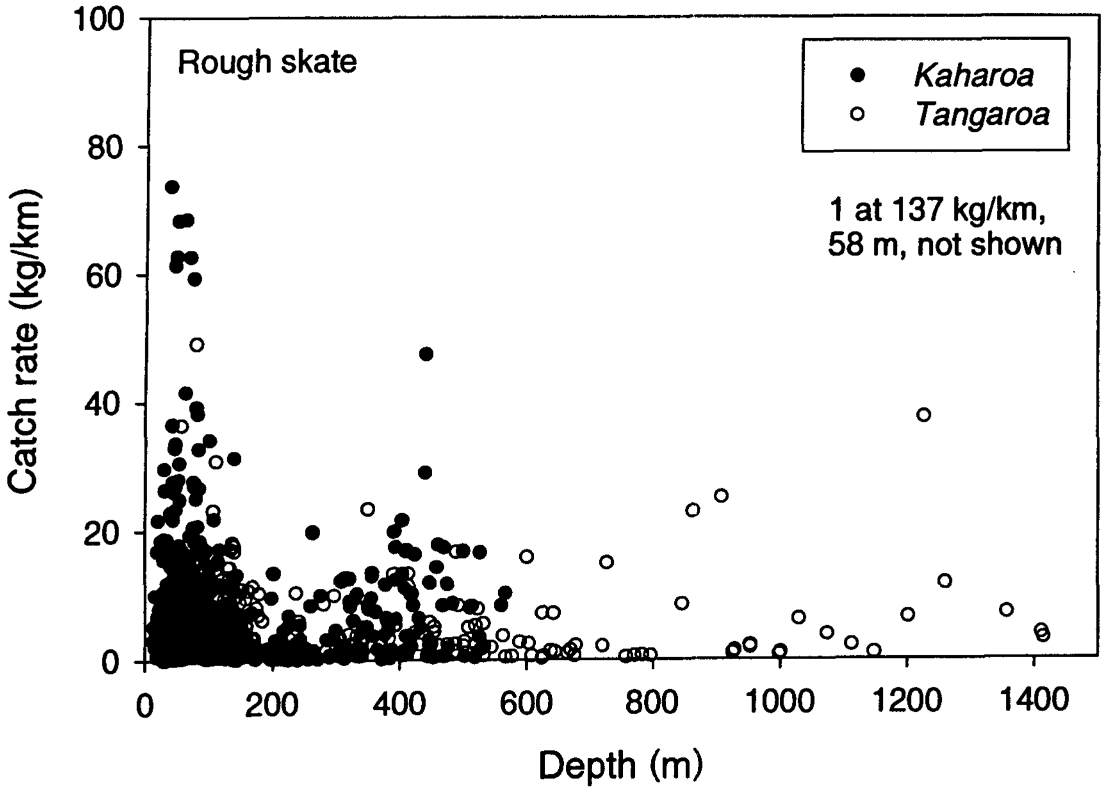


Figure 7: Variation in *Kaharoa* and *Tangaroa* catch rates of rough and smooth skates with latitude



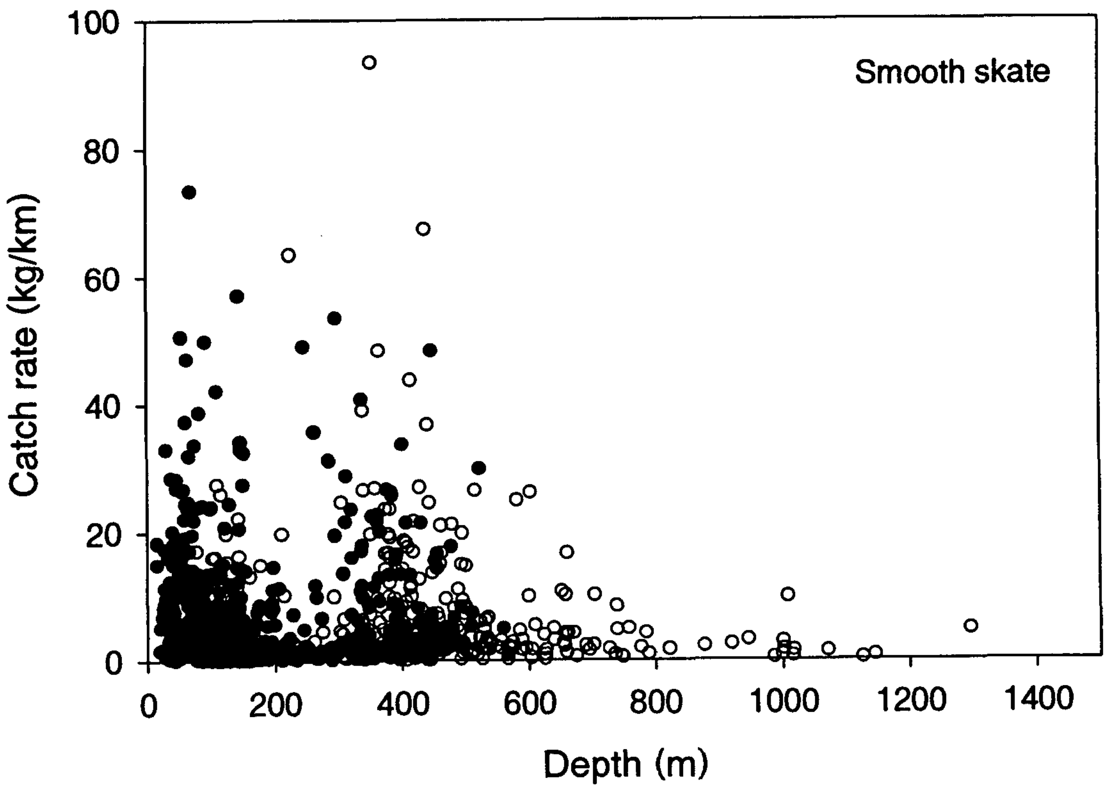


Figure 8: Variation in *Kaharoa* and *Tangaroa* catch rates of rough and smooth skates with depth

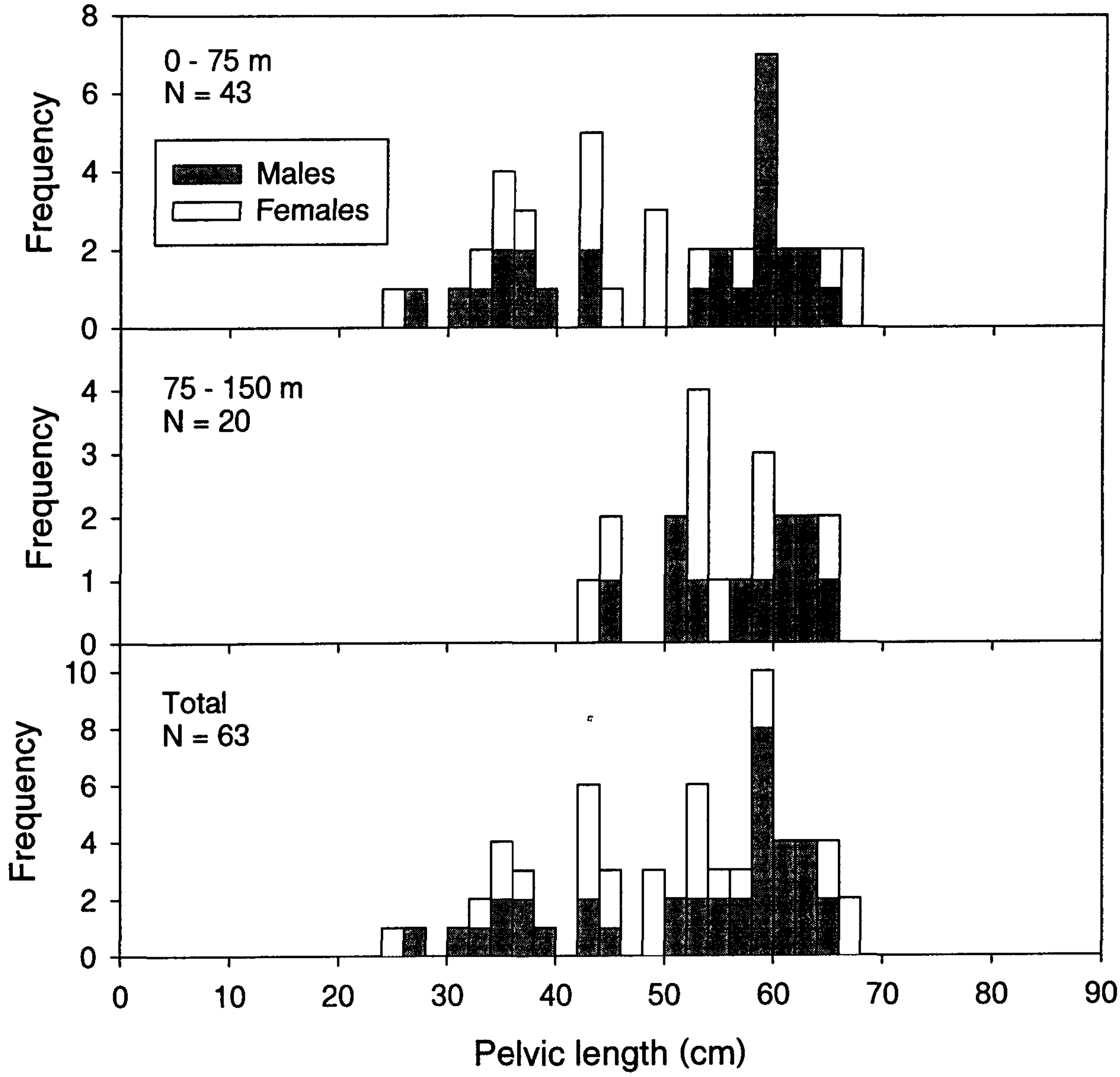


Figure 9: Length-frequency distributions of rough skate by depth zone off east coast South Island, May-June 1996 (KAH9606)

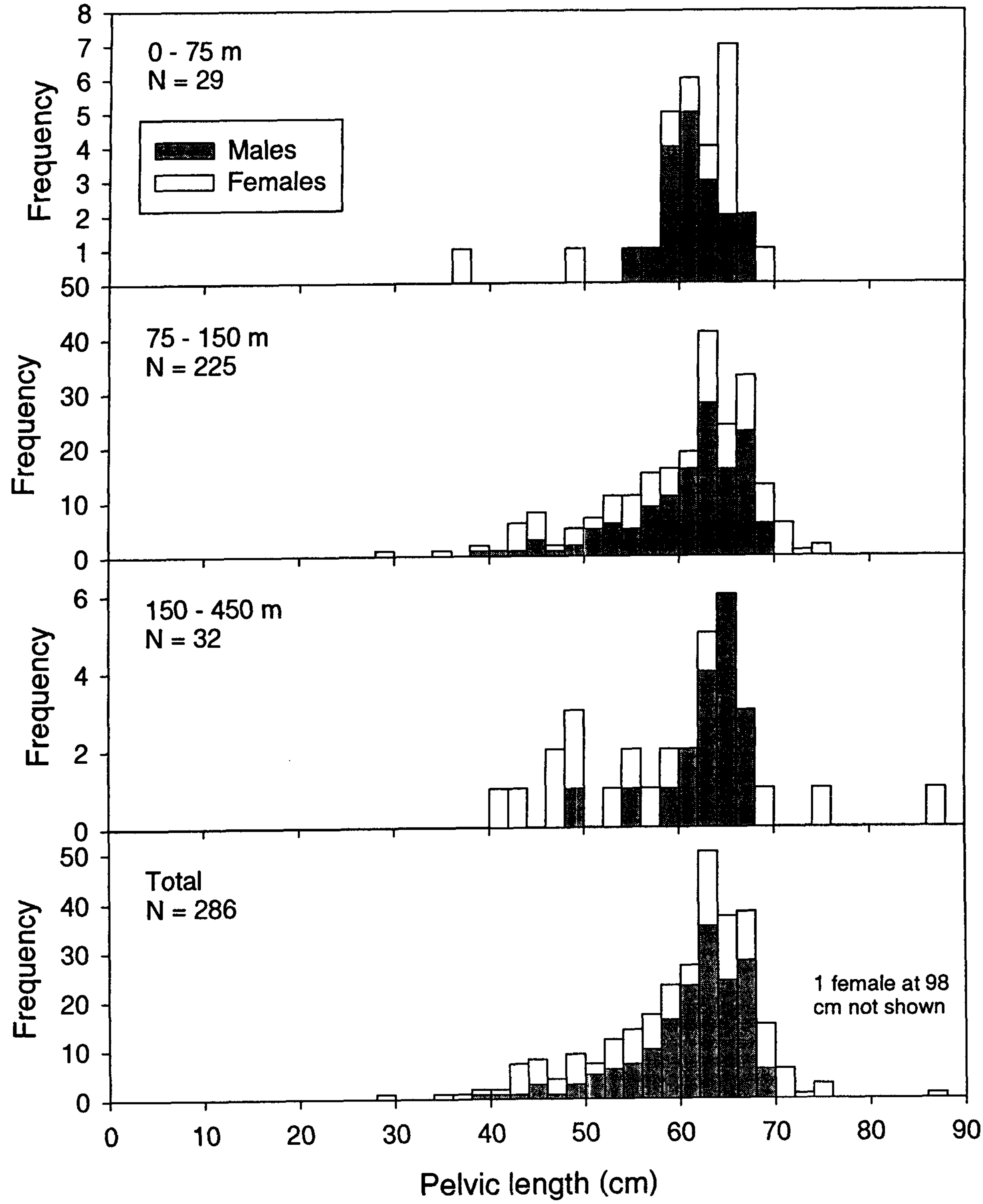


Figure 10: Length-frequency distributions of rough skate by depth zone on Stewart-Snares shelf, February-March 1996 (TAN9604)

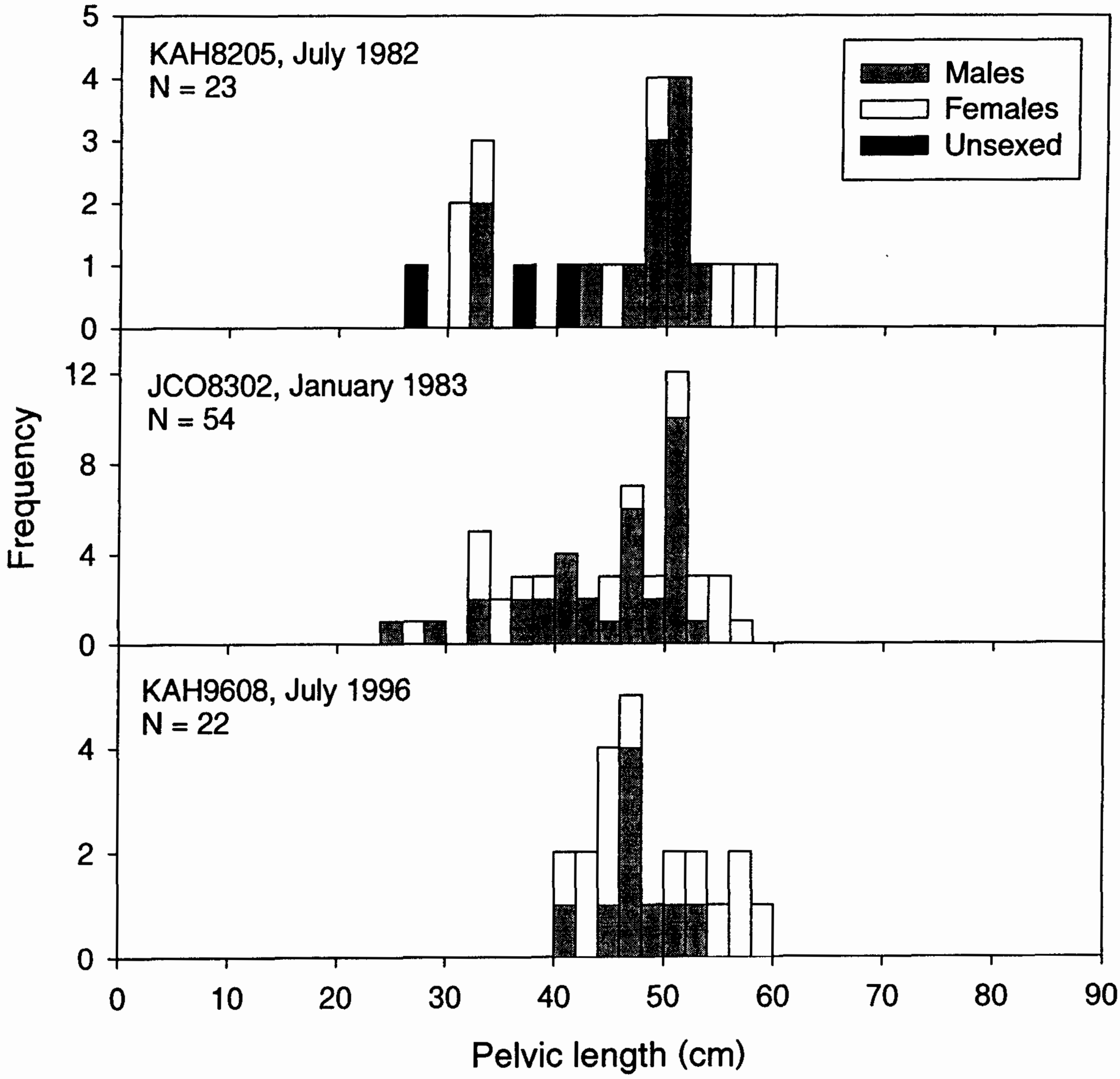


Figure 11: Length-frequency distributions of rough skate in Tasman Bay - Golden Bay

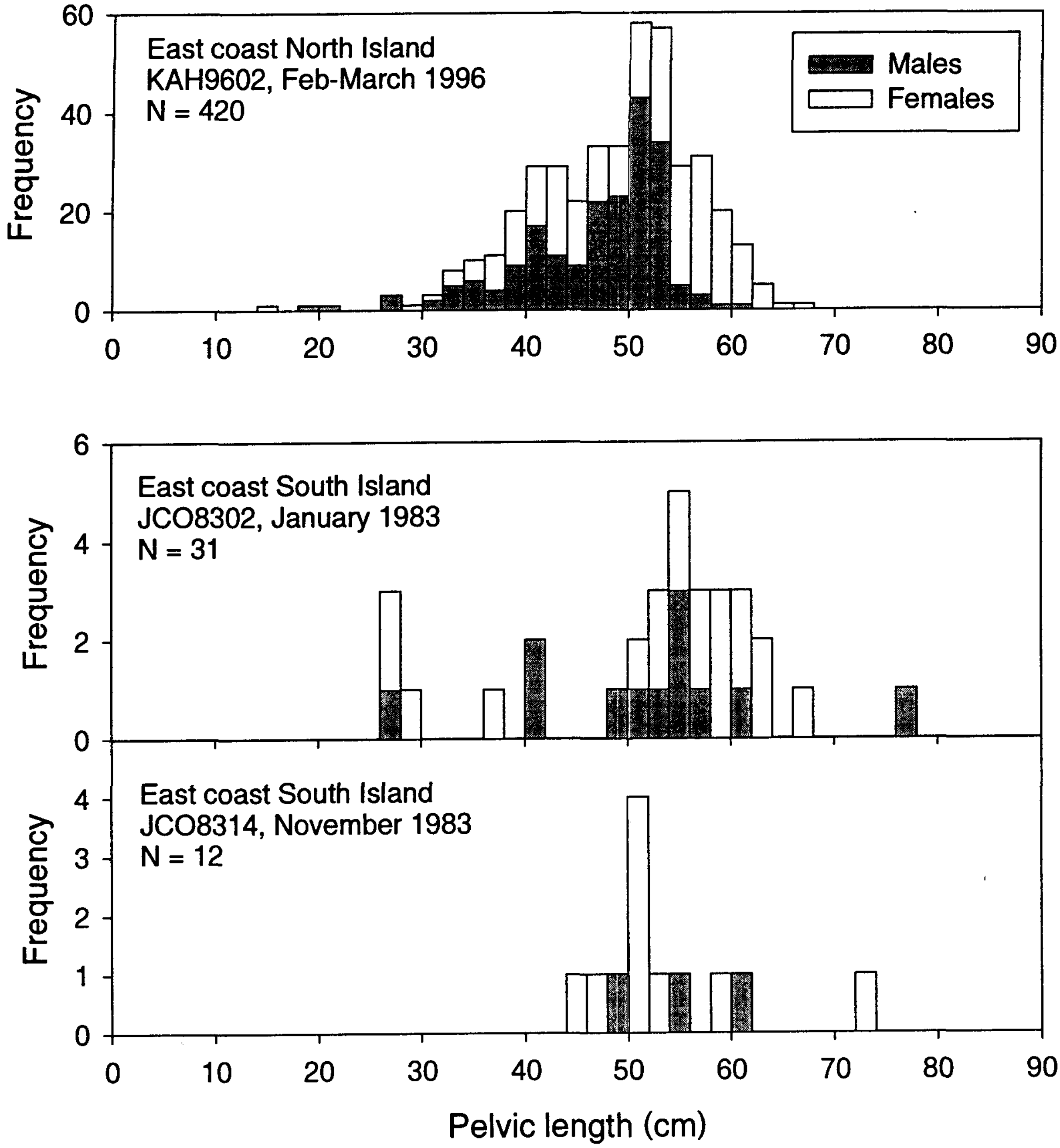


Figure 12: Length-frequency distributions of rough skate from east coast North Island and east coast South Island

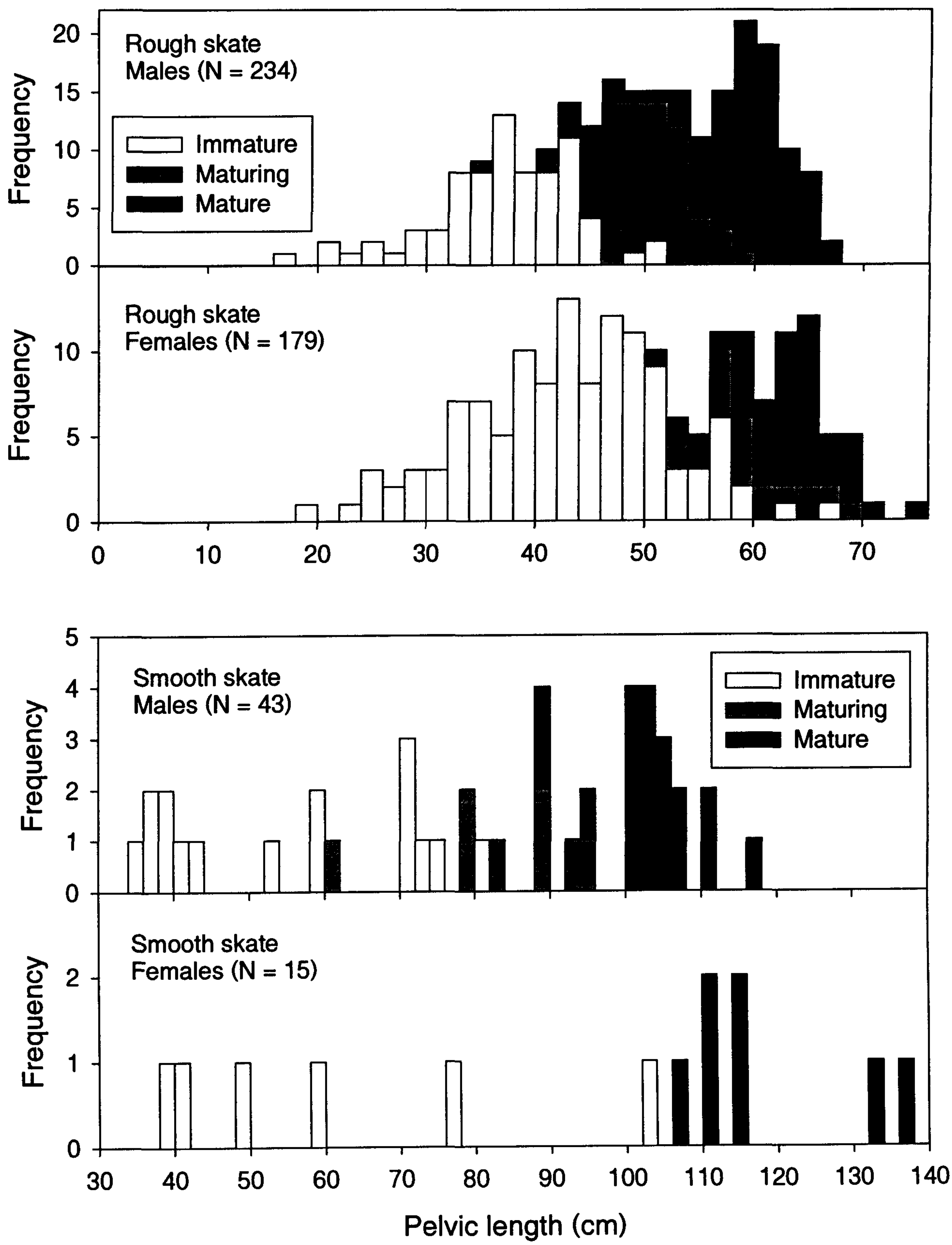
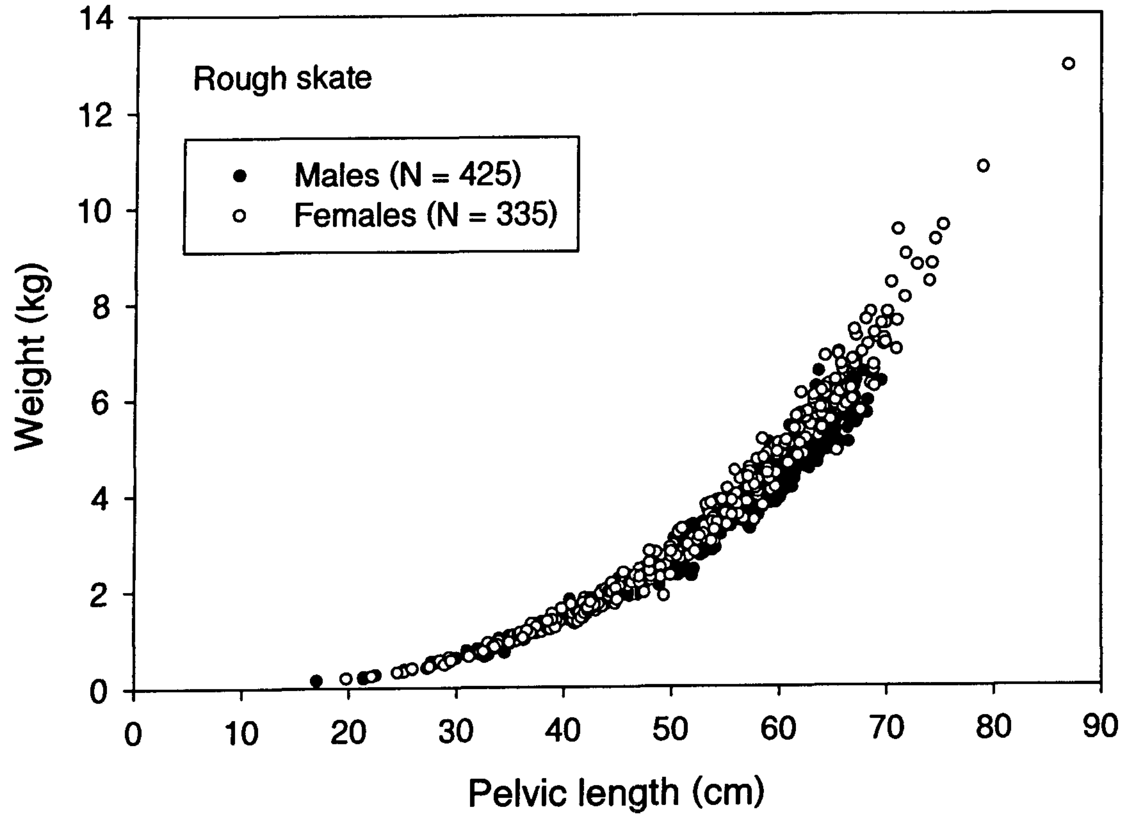


Figure 13: Length at maturity of rough and smooth skates



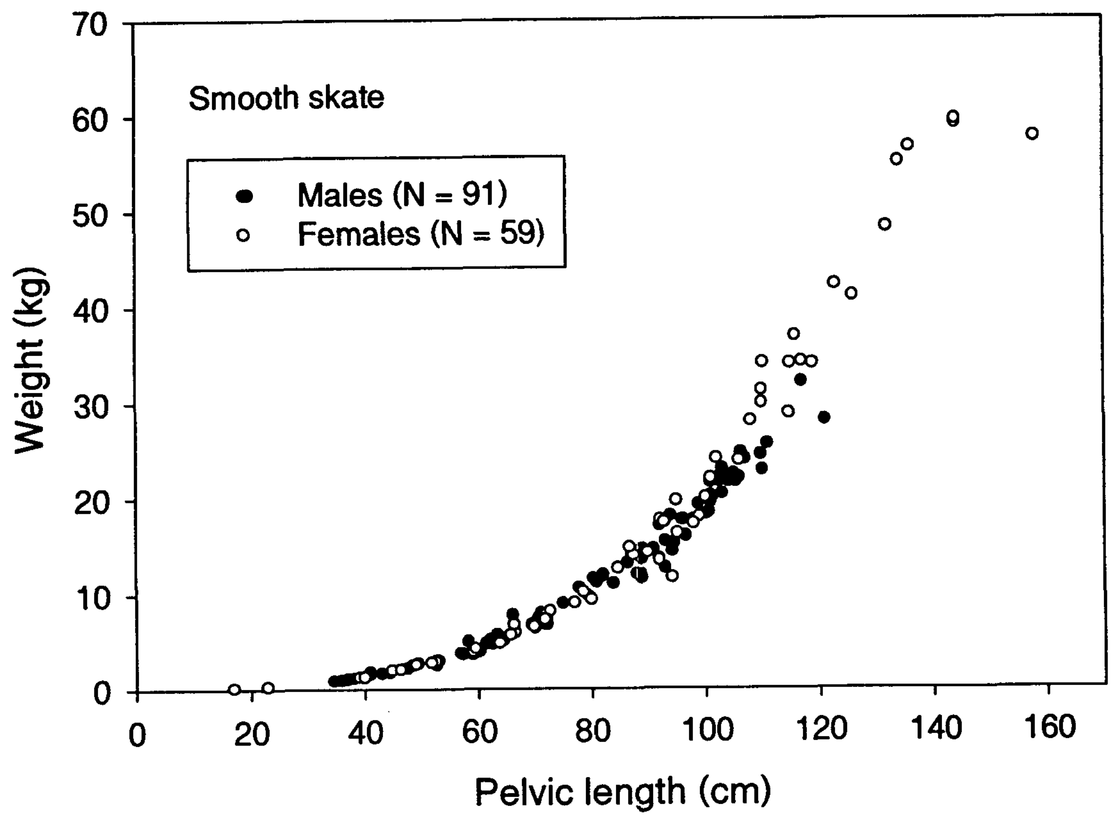


Figure 14: Length-weight relationships for rough and smooth skates

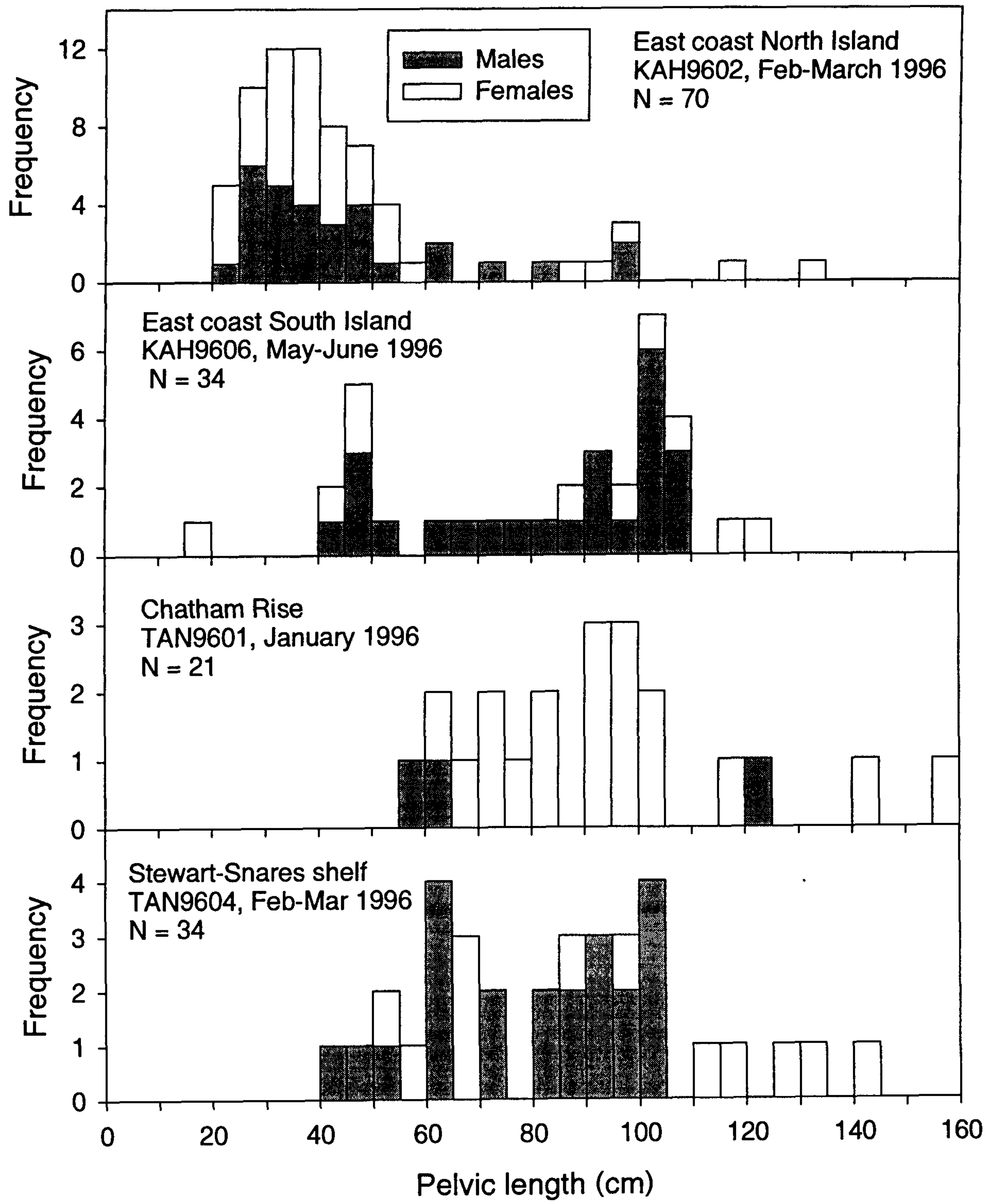


Figure 15: Length-frequency distributions of smooth skate from four regions