Trawl survey of hoki and associated species on the Chatham Rise November-December 1989

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Abstract

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A random trawl survey of the Chatham Rise was carried out in November-December 1989 by *Amaltal Explorer*. The survey area was bounded by latitudes 42° and 45° S and longitudes 172° E and 175° W, and covered depths of 200–800 m. The main aim of the survey was to obtain relative biomass estimates for hoki (*Macruronus novaezelandiae*) and other commercial species. Length frequency and biological information on gonad condition and diet were also collected. Hoki made up 46% of the catch from a total of 107 stations. Other important species included silver warehou (*Seriolella punctata*), black oreo (*Allocyttus niger*), pale ghost shark (*Hydrolagus* sp.), hake (*Merluccius australis*), and ling (*Genypterus blacodes*).

The relative biomasses of hoki, ling, ghost sharks, and several other species were considerably lower in 1989 than in 1983 and 1986. This may be due to the different timing of the surveys (March in 1983, July in 1986) and to seasonal differences in catchability, or to differences in cohort strength in an area that is predominantly a nursery ground for juvenile fish. Interpretation of the declines is difficult because the relative fishing power of the vessels used is unknown. However, this survey does provide information on relative size structure, recruitment strength, and distribution of fish species at depths of 200–800 m on the Chatham Rise.

Introduction

The fishery for hoki (*Macruronus novaezelandiae)* is New Zealand's largest with a Total Allowable Commercial Catch (TACC) of 220 000 t. Hoki are caught in depths of 200–800 m throughout the Exclusive Economic Zone (EEZ). Though most of the catch used to be taken off the west coast of the South Island (WCSI) during the spawning season (Sullivan & Cordue 1992), it is increasingly caught on the Chatham Rise and in the Sub-Antarctic area.

Currently, hoki are managed as two stocks: a larger, western stock that spawns on the WCSI during winter but otherwise resides in the Sub-Antarctic area, and a smaller, eastern stock that spawns in Cook Strait during winter but otherwise resides on the Chatham Rise (Livingston 1990). Although there are no differences in the mitochondrial DNA from the two stocks (P. J. Smith, MAF Fisheries Greta Point, pers. comm.), adult hoki from the two stocks differ morphometrically and have different growth rates (Livingston *et al.* 1992).

Previous trawl surveys of hoki around the South Island have shown that outside the spawning season up to 80% of adult biomass is found south of New Zealand, and up to 90% of juvenile biomass is found on the Chatham Rise (Hurst *et al.* 1988). (Adult fish are over 65 cm total length (TL).) Pre-recruits (less than 35 cm TL) are found around most coastal areas of the South Island (Patchell 1982), but the Chatham Rise is the only area that has significant juvenile biomass (Fenaughty & Uozumi 1989, Livingston *et al.* 1991).

It appears that the bulk of larval and juvenile hoki recruit to the Chatham Rise, and as they approach sexual maturity (about 4–5 years) up to 80% of them recruit to the Sub-Antarctic area and so eventually to the WCSI spawning fishery. The remainder move to deeper waters on the Chatham Rise and then to the east coast spawning fishery (Livingston *et al.* 1992).

Acoustic surveys and commercial catch per hour have been used to monitor relative changes in spawning biomass on the west coast (Cordue 1991, Sullivan 1991, Vignaux 1992). In 1989, off-season trawl surveys were carried out on the Chatham Rise and in the Sub-Antarctic area to assess relative changes in the population since similar surveys were carried out there in 1983 (Hatanaka *et al.* 1989a, 1989b). Preliminary biomass estimates from the surveys were discussed by Hurst & Schofield (1990), and the Sub-Antarctic area survey was described in detail by Livingston & Schofield (1993).

In this report, we further analyse the biomass, length frequency, and biological data collected during the 1989 Chatham Rise survey, and compare the results, particularly for hoki, with those from previous surveys.

Objectives

The main objectives of the survey were as follows.

1. To map the distribution and estimate the abundance of hoki and associated fish species at depths of 200–800 m on the Chatham Rise.
2. To gather length frequency and other biological information on hoki, hake, ling, silver warehou, and other commercial species.
3. To take sufficient water temperature measurements to define any major water mass characteristics within the survey area.
4. To obtain bathymetric data to update existing survey charts.

Methods

Vessel and gear

Amaltal Explorer, a New Zealand factory trawler owned by Amaltal Fishing Company Limited, was used for the survey. It has the following specifications: overall length, 65 m; beam, 12 m; gross tonnage, 1000 t; horsepower, 2700; maximum speed, 14 kn.

A high-opening bottom trawl net with a 60 mm codend, 90 m sweeps, and 55 m bridles with Super Vee trawl doors of 1800 kg (6.5 m^2) was used (*see* Livingston & Schofield (1993) for the net plan). A Scanmar 400 system provided data on doorspread, headline height, water temperature, and depth.

Survey area and design

The survey took place between 25 November and 18 December 1989 in an area bounded by latitudes 42° 50′ S to 45° S, longitudes 172° E to 175° W in depths of 200–800 m. The total survey area of 135 870 km^2 was divided into 24 strata by area and depth (Figure 1). The 107 stations sampled were allocated in proportion to the area of each stratum, with a minimum of 3 stations per stratum (Table 1). Station densities averaged one station to 1270 km^2. Each station within a stratum was selected randomly with a minimum distance of 5 km between stations.

A single-phase stratified random trawl survey design (*after* Francis 1981) was used, as in previous hoki surveys. Tows were about 3 n. miles long and were made during daylight hours only (defined as the period between 30 min after official sunrise to 30 min before official sunset). An average of 4.7 tows per day was achieved. Tow and gear parameters are given in Table 2.

Catch sampling

The catch at each station was sorted into species and weighed on motion-compensating electronic scales to the nearest 0.1 kg. When the catch was over 1.5 t, the weight of the main species was estimated from the number of filled fish cases. Any rare or unusual fish were kept for the Museum of New Zealand collection.

Table 1: Stratum areas, numbers of stations, and station density

Stratum	Area (km^2)	No. of stations: Allocated	No. of stations: Completed	Station density (km^2)
600–800 m				
1	2 394	3	2	1 : 1 197
2	2 765	3	3	1 : 922
3	8 917	7	6	1 : 1 486
4	5 146	4	4	1 : 1 287
5	5 554	4	4	1 : 1 389
6	7 641	6	6	1 : 1 274
400–600 m				
7	4 929	4	4	1 : 1 232
8	3 625	3	3	1 : 1 208
9	5 740	4	4	1 : 1 435
10	9 824	8	6	1 : 1 637
11	6 887	6	6	1 : 1 148
12	6 997	6	7	1 : 1 000
13	7 463	6	6	1 : 1 244
14	5 766	5	5	1 : 1 153
15	5 880	5	5	1 : 1 176
16	4 695	4	4	1 : 1 174
17	6 845	5	5	1 : 1 369
200–400 m				
18	4 637	4	3	1 : 1 546
19	8 189	7	5	1 : 1 638
20	9 299	8	7	1 : 1 328
21	2 515	3	2	1 : 1 258
22	3 893	3	3	1 : 1 298
23	5 532	4	4	1 : 1 383
24	737	3	3	1 : 246
Total (mean)	135 870	115	107	(1 : 1 270)

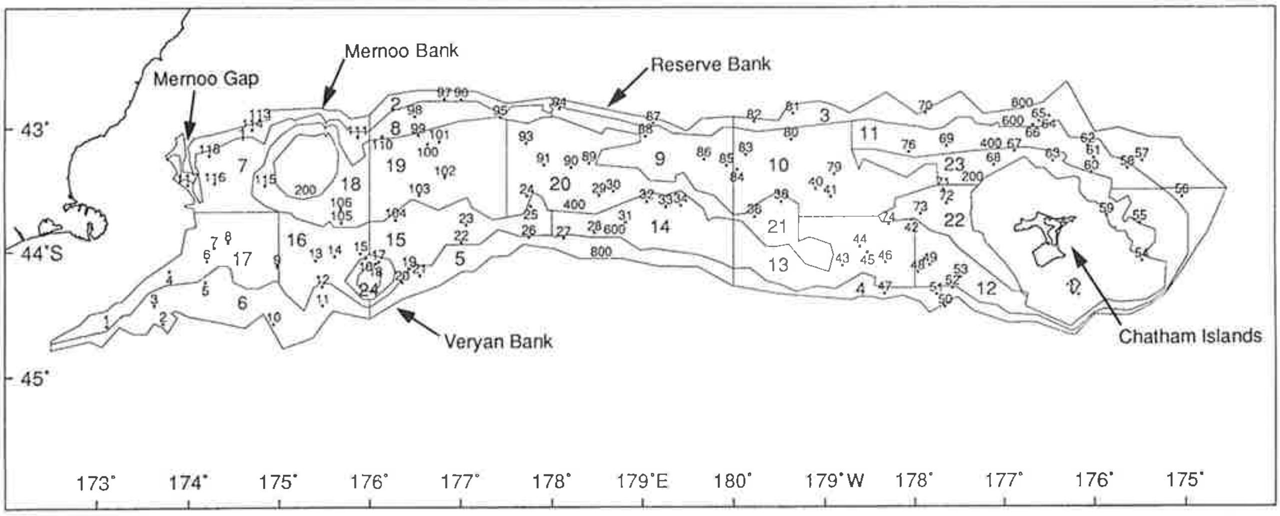

Figure 1: Survey area showing strata and station positions.

Samples of up to 300 hoki were routinely measured (total length) and sexed. Length frequency data were gathered for all other ITQ species and for some commercial non-ITQ species.

At each station, 20 individuals of the four main species (hoki, hake, ling, and silver warehou) were chosen at random to obtain information on length-weight relationships, reproductive condition, and diet by recording the total or fork length, total body weight, sex, gonad stage and weight, and stomach fullness, species composition, and state of digestion.

Bathymetry

Bathymetric data were collected throughout the survey area. Depths were recorded from a Furuno FCV 161 ET echosounder, and position was measured by a Trimble Series 3 global positioning system and atomic clock or taken from satellite navigation fixes.

Table 2: Gear parameters

	n	Mean	*s.d.*	Range
Tow length (n. miles)	107	3.01	0.25	2.3–4.9
Tow speed (kn)	107	3.60	0.19	3–4
200–400 m				
Headline height (m)	26	9.81	1.14	7–12
Doorspread (m)	26	128.11	4.82	116–137
400–600 m				
Headline height (m)	55	9.34	1.00	8–12
Doorspread (m)	55	132.69	4.61	121–145
600–800 m				
Headline height (m)	26	9.48	1.05	8–11
Doorspread (m)	26	133.55	5.20	126–145
Total depth range				
Headline height (m)	107	9.49	1.05	7–12
Doorspread (m)	107	131.79	5.21	116–145

Wingspread assumed to be 30 m.
Ratio of doorspread to wingspread is 4.4 : 1.

Hydrology

Surface water temperatures were recorded from the ship's hull-mounted thermistor which was calibrated with a hand-held mercury thermometer. Bottom temperature at each station was obtained from sensors (part of the Scanmar system, claimed in the manual as accurate to 0.1 °C) mounted on the trawl net.

Biomass estimation

When survey results are to be used to obtain biomass indices, it is important that the area swept by the trawl gear is accurately monitored, and that gear performance is noted. Gear performance was assessed tow by tow as consistency of headline height and doorspread within a tow, distance towed with gear on the bottom, and tow speed. Tows were excluded if headline height or doorspread were consistently 20% above or below average, or if the tow was less than 2 n. miles long.

Biomass indices were estimated by the area-swept method (Francis 1984) assuming that fish were randomly and evenly distributed over the bottom within a stratum; fish distribution did not extend above the headline height of the net; all fish in the path of the doors were caught; and the herding effects of the doors, sweeps, and bridles were constant.

Biomass indices presented here assume that the doors define the effective area of influence of the gear on the fish. They are not absolute biomass indices as the true catchability of the species is unknown.

Biomass indices and coefficients of variation were calculated as follows:

$$B = \Sigma\,(X_i\, a_i) \,/\, cb$$

$$S_B = \sqrt{S_i^2\, a_i^2 \,/\, cb}$$

where B is biomass (t), S_B is the standard error of B, X_i is the mean catch rate (kg.km^{-2}), b is the net mouth opening (m), c is the catchability coefficient, and S_i is the estimated standard error of X_i.

Length frequency distributions

Length frequency data have been standardised by proportion of catch sampled, distance towed, and stratum area, and so represent the population sampled rather than the measured sample.

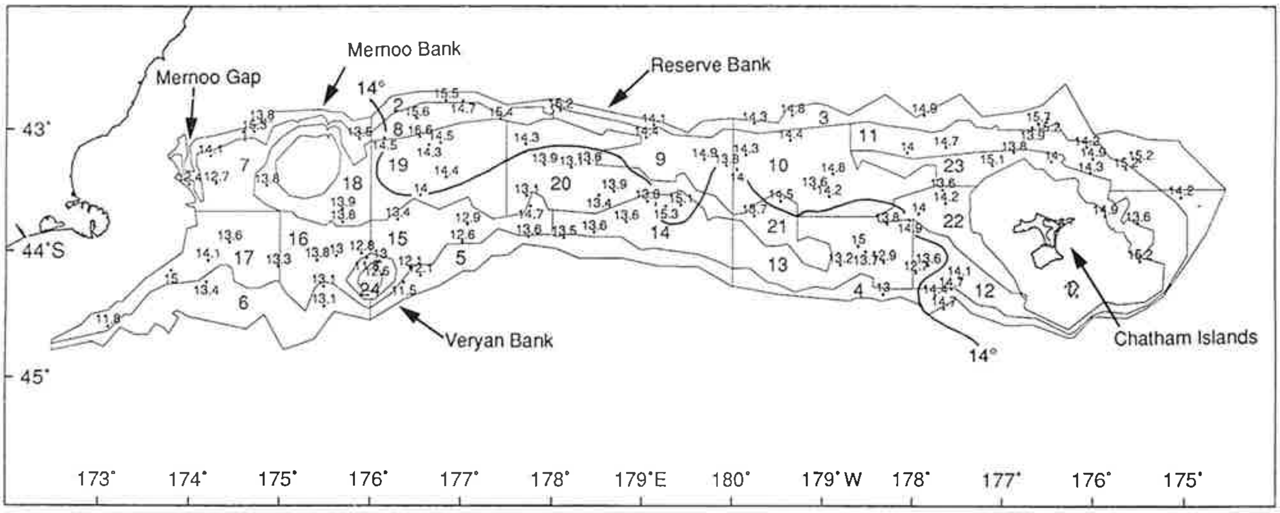

Figure 2: Sea surface temperatures.

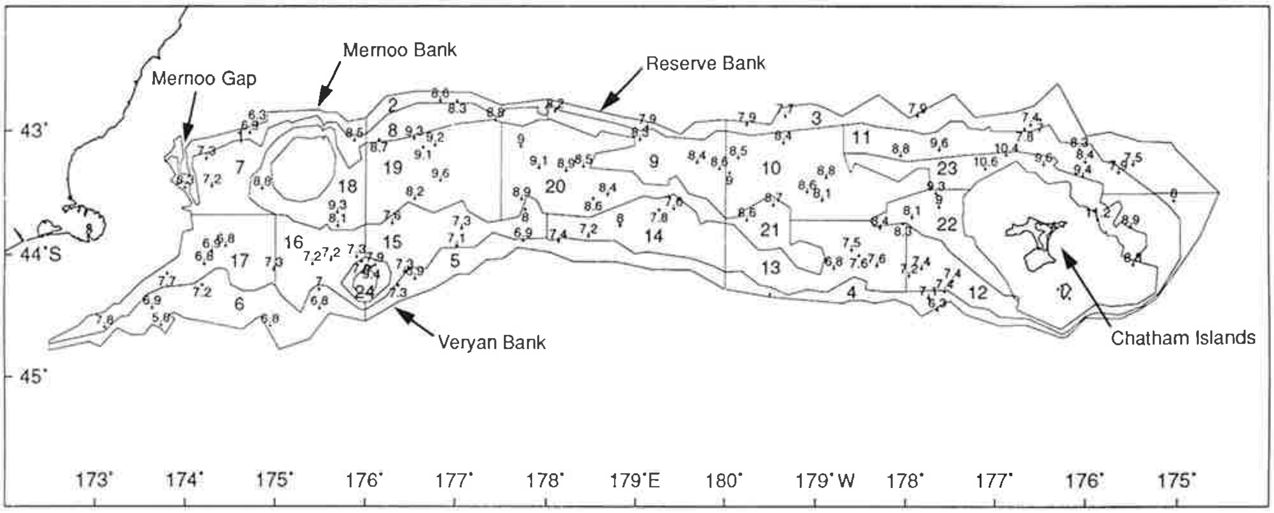

Figure 3: Bottom temperatures.

Results

Gear performance and station coverage

A total of 107 stations was successfully completed (Appendix 1). Five stations fell on rough ground or outside the depth range and alternative positions were trawled. Stations 75 and 77 targeted hake and were excluded from the analyses, as were nine stations where gear performance was unsatisfactory.

Doorspread increased slightly, but not significantly, with depth in both areas (*see* Table 2), and exceeded the theoretical value of 100 m. Headline height ranged from 7.0 to 12.3 m (mean 9.5 m): warp length was adjusted during all tows to try to achieve a standard headline height of 10 m.

Hydrology

The Subtropical Convergence Zone, as defined by the 14 °C isotherm, lay along the crest of the Chatham Rise, from east of Mernoo Bank to the Chatham Islands (Figure 2). Slightly cooler water was evident in the Mernoo Gap. Bottom temperatures were highest in shallow waters on Mernoo Bank, Veryan Bank, and at the Chatham Islands (Figure 3). Temperature differences between surface and bottom were about 4–5 °C, though this varied with location.

Catch summary

The total catch was 138 646 kg, of which 46% was hoki. Silver warehou formed 11% of the catch, black oreo 8%, pale ghost shark 6%, ling 3%, and hake 1.5% (Table 3). In total, 107 species of fish and squid were caught (Appendix 2). Table 4 gives the species sampled, the number of samples, the number of fish measured, and species sex ratios.

Catch rates

The mean catch rates of the main ITQ and bycatch species by stratum are given in Table 5. Hoki, ling, and lookdown dory were distributed throughout the survey area in depths of 200–800 m. Silver warehou and white warehou were found in depths of less than 600 m, and stargazers were

Table 3: Total biomass estimates, coefficients of variation (*c.v.*), and catch for the major species

	Catch (kg)	% of total	Occ.*	Biomass (t)	*c.v.* (%)	% of total
Hoki	63 852	46.1	105	101 048	10	45
Hoki (⩾ 65 cm)	–	–	–	43 855	12	–
Hoki (⩾ 55 cm)	–	–	–	62 491	14	–
Silver warehou	15 000	10.8	63	21 769	72	10
Black oreo	11 384	7.7	22	19 827	28	9
Pale ghost shark	7 661	5.5	96	11 415	8	5
Ling	4 756	3.4	103	8 043	9	4
Other macrourid rattails	4 535	3.3	–	7 802	–	3
Javelinfish	4 676	3.4	98	7 585	14	3
Spiky oreo	3 457	2.5	21	5 746	36	3
Shovelnosed spiny dogfish	2 851	2.1	59	4 785	10	2
Lookdown dory	2 554	1.8	105	4 323	6	2
Hake	2 079	1.5	65	3 576	19	2
Slender mackerel	2 005	1.4	13	3 703	44	2
White warehou	1 949	1.4	61	3 266	30	1
Giant stargazer	1 308	0.9	59	2 083	22	0.9
Longnosed chimaera	1 230	0.9	56	2 109	18	0.9
Sea perch	905	0.7	90	1 586	11	0.7
Alfonsino	953	0.7	41	1 490	55	0.7
Spotted spiny dogfish	746	0.5	45	1 458	19	0.7
Ribaldo	736	0.5	58	1 259	11	0.6
Smooth skate	703	0.5	31	1 224	23	0.5
Baxter's dogfish	634	0.5	26	1 099	28	< 0.5
Dark ghost shark	529	0.4	10	1 190	45	< 0.5
Rudderfish	384	0.3	28	632	23	< 0.5
Silver dory	330	0.2	10	590	56	< 0.5
Smooth oreo	260	0.2	16	453	48	< 0.5
Total		138 646			223 532	10

*Occ. = number of tows in which each species occurred.
– = not calculated.

generally caught in depths of less than 400 m. Javelinfish and ribaldo were found deeper than 400 m. Hake, black oreo, and spiky oreo were concentrated below 400 m. Hake were most prevalent in the north of the survey area, spiky oreos in the northeast, black oreos in the south, and pale ghost shark in the southwest.

Hoki (Figure 4) and ling (Figure 5) were widely distributed. Catch rates of juvenile hoki were highest in 200–400 m depths on the Reserve Bank (stratum 20) and Veryan Bank (stratum 24). The catch rates of hake were highest on the north Chatham Rise (Figure 6), particularly in depths of 400–600 m (strata 8–10).

Catch rates of silver warehou (Figure 7) were very low, except near the Veryan Bank (strata 15 and 24) and northeast of the Chatham Islands (strata 22 and 23).

Appendix 2 gives the occurrence by stratum of all species caught.

Table 4: Numbers of samples (samp.) and fish measured and percentage of females

	Length frequency samples					Biological samples*	
			No. of fish				
	No. of samp.	Total	Male	Female	Percent female	No. of samp.	No. of fish
Alfonsino	3	253	124	65	34	0	0
Barracouta	2	13	0	13	100	0	0
Black oreo	10	1 487	751	736	49	6	120
Hake	63	437	220	212	49	62	325
Hoki	104	17 286	7 336	9 912	57	97	1 372
Jack mackerel	5	388	257	131	34	2	22
Ling	102	1 356	743	613	45	101	1 078
Rudderfish	1	7	4	3	43	0	0
Silver warehou	46	1 353	729	622	46	6	106
Smooth oreo	7	244	118	126	52	0	0
Southern blue whiting	1	25	17	8	32	0	0
Spiky oreo	12	1 023	578	445	43	1	10
Tarakihi	1	7	5	2	29	0	0
White warehou	5	85	45	40	47	0	0

*Biological samples include individual length and weight, gonad stage, stomach contents, and otolith collection.

Table 5: Mean catch rates (kg.km^{-2}) of the main ITQ and bycatch species by stratum

											Species code*	
Stratum	HOK	SWA	BOE	GSP	HAK	LIN	JAV	SOR	LDO	WWA	STA	RIB
200–400 m												
18	543	16	0	0	< 1	31	3	0	23	4	17	0
19	619	34	0	0	6	40	6	0	14	17	45	0
20	1 172	12	0	100	3	36	1	0	27	56	35	0
21	951	31	0	98	11	57	5	0	45	101	117	0
22	769	384	0	80	8	85	18	0	66	188	13	0
23	402	358	0	42	14	15	50	59	6	24	55	0
24	2 993	954	0	671	0	67	0	0	11	34	102	0
400–600 m												
7	1 118	24	0	140	52	106	81	2	19	7	5	14
8	1 409	< 1	0	5	58	100	47	12	17	1	< 1	5
9	629	0	0	45	60	44	52	14	37	5	3	1
10	342	17	0	42	85	54	24	0	34	3	2	1
11	290	11	0	19	33	71	43	297	41	34	15	4
12	1 168	42	8	81	15	78	150	105	60	16	21	13
13	843	39	0	76	15	38	18	0	58	2	6	2
14	1 523	17	< 1	157	17	66	172	0	107	20	1	5
15	990	2 701	8	183	17	45	43	0	36	118	5	4
16	559	11	4	98	5	87	36	0	24	3	11	13
17	1 108	8	6	149	6	105	66	0	21	2	5	22
600–800 m												
1	120	0	0	165	6	70	14	214	4	0	0	22
2	828	0	0	60	144	104	202	109	26	0	13	18
3	158	< 1	4	22	44	35	81	175	19	14	5	14
4	115	0	331	46	4	46	53	26	7	0	3	28
5	1 192	2	508	168	17	109	98	0	29	0	0	20
6	352	< 1	1 976	154	11	37	75	0	10	< 1	0	36

* Species codes are given in Appendix 2.

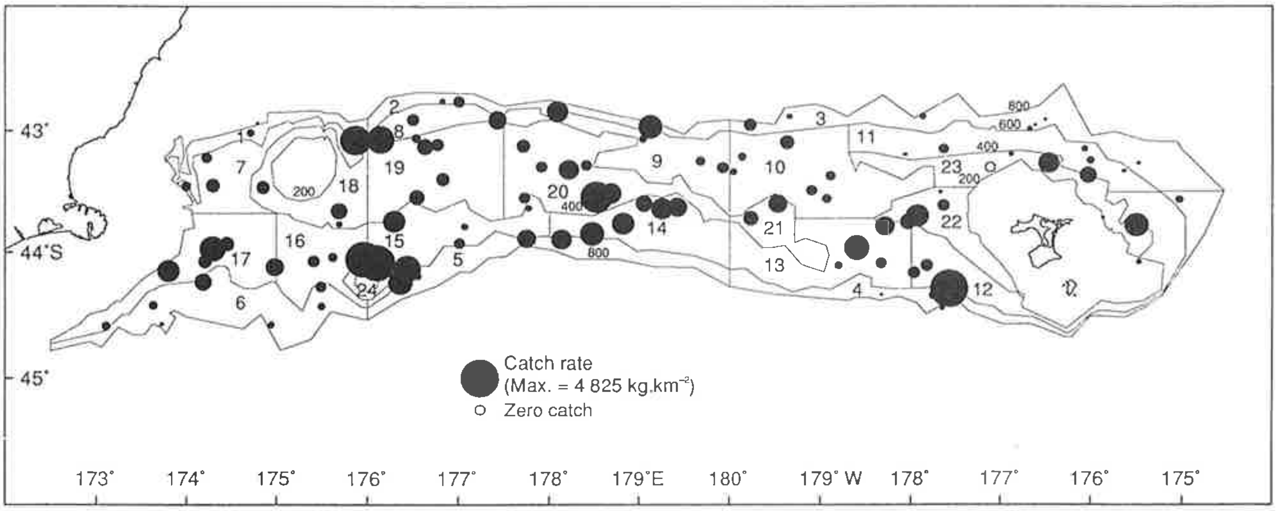

Figure 4: Catch rates of hoki.

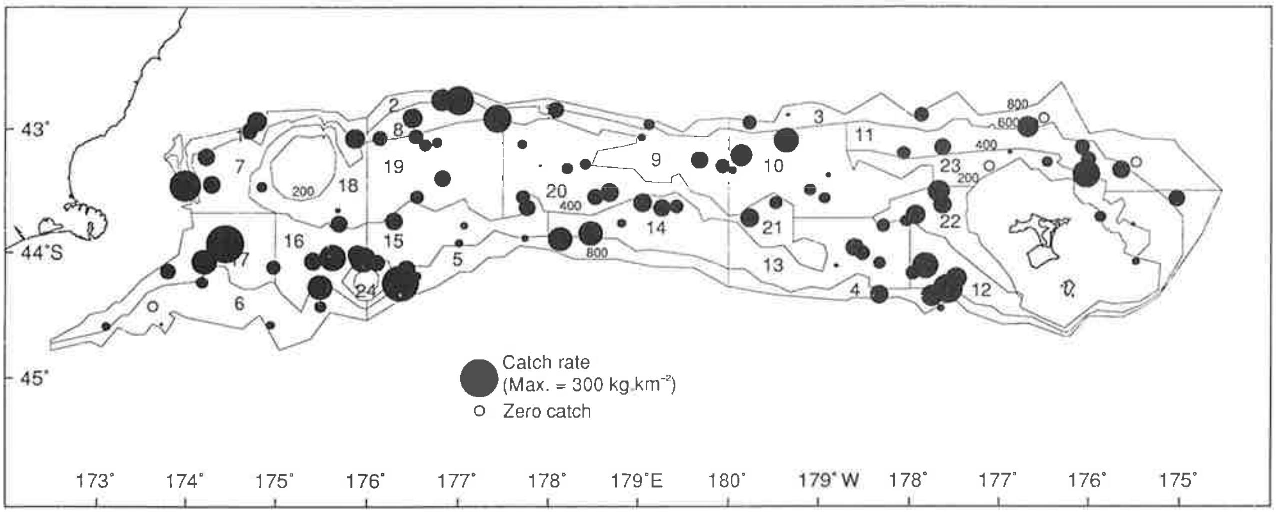

Figure 5: Catch rates of ling.

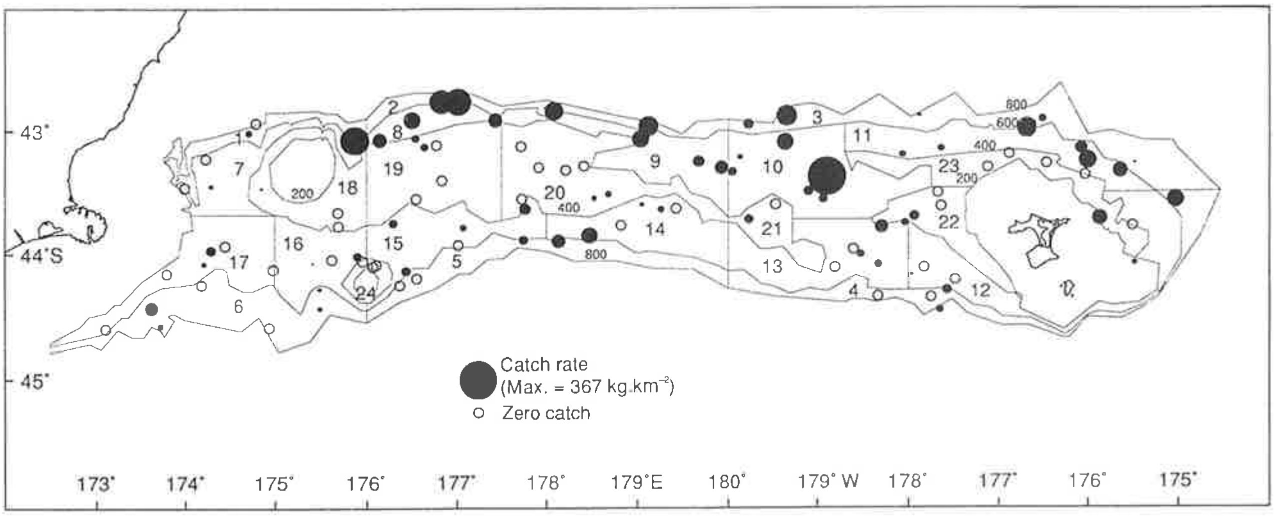

Figure 6: Catch rates of hake.

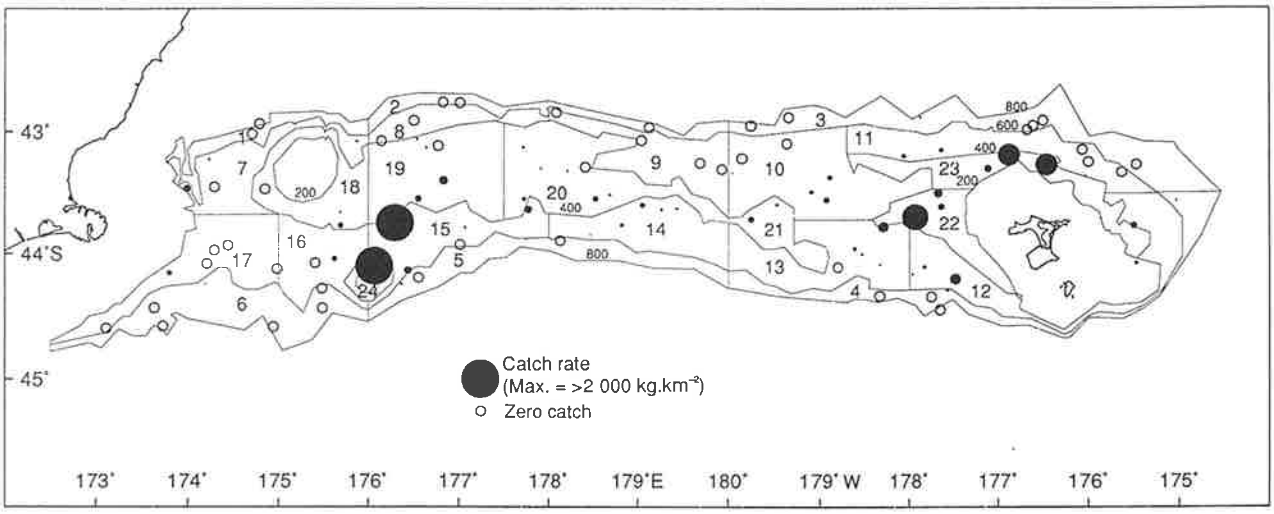

Figure 7: Catch rates of silver warehou.

Biomass estimates

The estimated total biomass of demersal fish in the survey area was about 224 000 t: hoki dominated (46%), and silver warehou and black oreo were the second and third most abundant species (*see* Table 3). The coefficient of variation for all species except silver warehou and spiky oreo was less than 30%. Females formed the greater portion of the biomass of hoki (Table 6) and hake. The sex ratios from the biomass estimates of other species were close to 50 : 50.

Biomass estimates by stratum (Appendix 3) show that many species were most abundant at 400–600 m. A few species (e.g., jack mackerels, spiny dogfish, giant stargazer) were associated with shallow strata and others (e.g., black oreo, spiky oreo, shovelnosed dogfish, Baxter's dogfish) with deep strata. These species were not well targeted by the survey and the biomass estimates merely reflect their abundance on the margins of their depth distribution.

Size composition

The hoki population was dominated by juveniles (< 65 cm TL) with strong modal peaks at 35–39 and 47–52 cm (Figure 8). Hoki making up the younger mode were mostly distributed in shallow strata (200–400 m): those making up the older mode were mostly found in 400–600 m (Appendix 4). Adult hoki (> 65 cm TL) were common in the deepest strata (600–800 m), but they were also present in 400–600 m.

Small catches of hake throughout the survey area contributed to an uneven length frequency distribution (Figure 9): only two modes, at 56–63 and 78–88 cm, are visible. An examination of length frequency distribution by strata showed that younger hake (< 83 cm TL) occurred in most strata, but that older fish (up to 120 cm TL) were present only on the northern side of the Rise, particularly in depths of 600–800 m.

The length frequency distribution of silver warehou is dominated by peaks at 39 (females), 42 (males), and 46 cm (males and females) (Figure 10): the smaller fish were mostly distributed along the western and central Rise in 200–600 m, and the larger fish were found mostly to the east.

The ling length frequency distribution (Figure 11) shows peaks at 62–68 and 84–92 cm which were less evident in data from individual strata. Ling over 80 cm TL tended to occur on the northern side of the Rise, and in the deepest strata. Smaller ling were most common in central and eastern strata at 200–600 m.

The mean lengths of females of hoki, hake, ling, and silver warehou were greater than those of males, though the differences were statistically not significant (Table 7). The length-weight relationships for each sex were similar for each species.

Stomach contents

Over half of the hoki and ling stomachs examined were empty and nearly 40% were part full or full (Table 8). The most frequent dietary components were euphausiids and fish for hoki: fish and *Munida gregaria* for ling (Table 9). Nearly two-thirds of the hake stomachs examined were empty and 31% were full or part full (*see* Table 8). Fish was the most frequent dietary component (*see* Table 9). Over two-thirds of the black oreo

Table 6: Estimated biomass (t) and coefficient of variation (*c.v.*) by sex of the main species

	Total		Males		Females	
	(t)	*c.v.* (%)	(t)	*c.v.* (%)	(t)	*c.v.* (%)
Hoki	101 048	9.8	39 598	9.8	61 321	10.5
Silver warehou	21 769	72.2	12 526	78.4	9 204	64.3
Black oreo	19 827	27.8	10 138	31.5	9 487	25.1
Ling	8 043	9.1	3 511	10.1	4 532	10.0
Hake	3 576	18.8	1 245	36.0	2 221	12.7

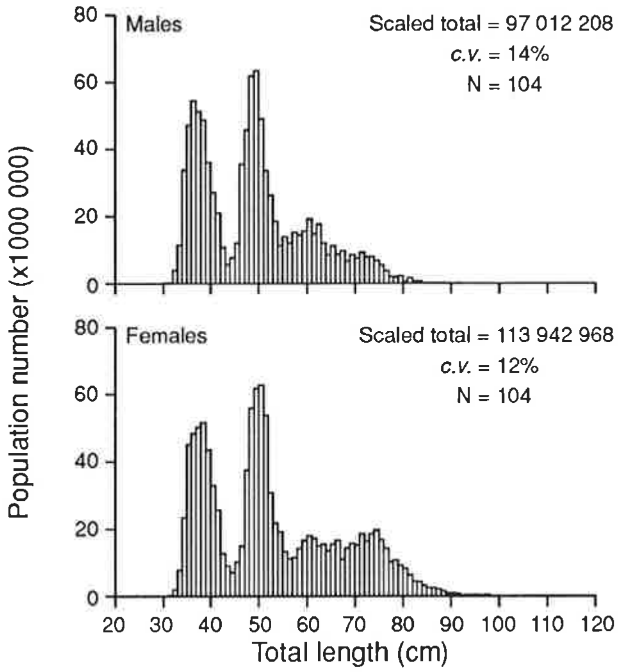

Figure 8: Scaled length frequencies of male and female hoki (*c.v.* is coefficient of variation; N is number of tows sampled).

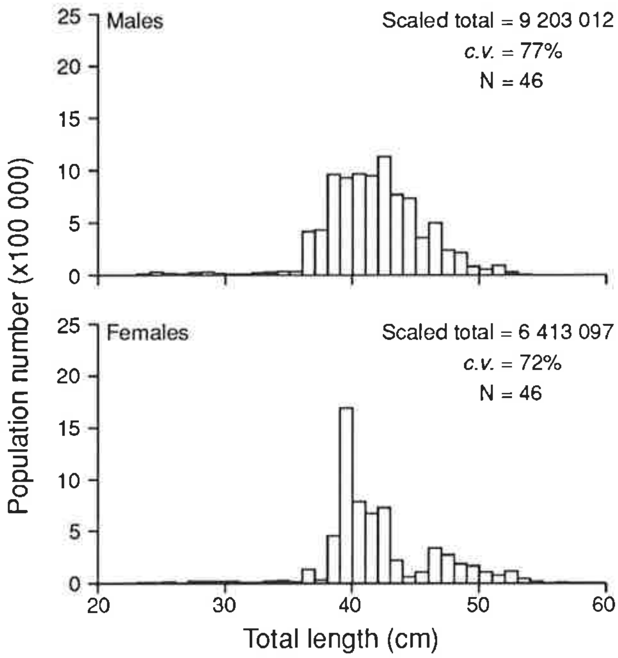

Figure 10: Scaled length frequencies of male and female silver warehou (*c.v.* is coefficient of variation; N is number of tows sampled).

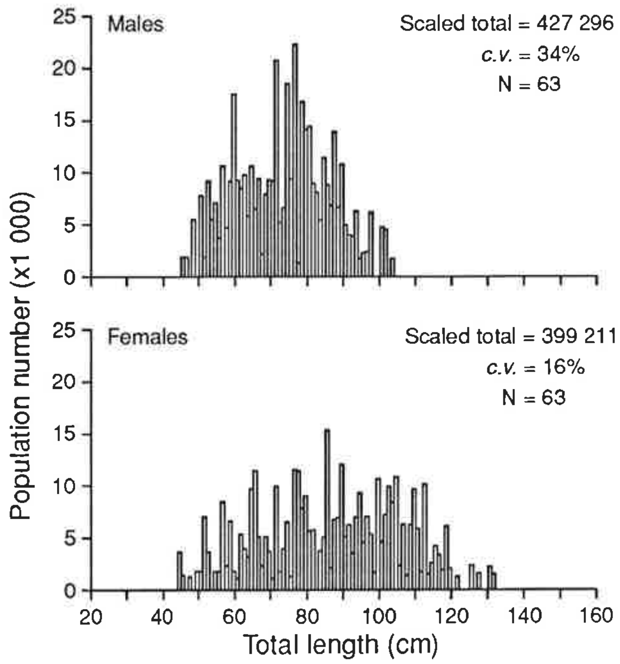

Figure 9: Scaled length frequencies of male and female hake (*c.v.* is coefficient of variation; N is number of tows sampled).

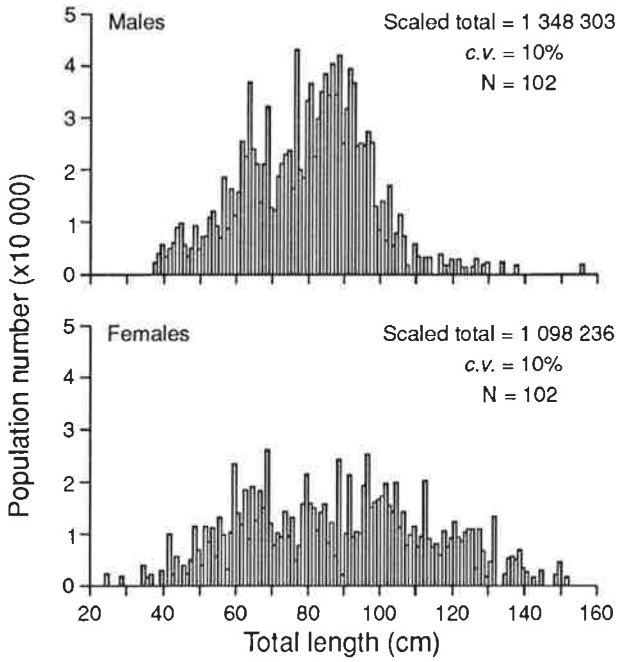

Figure 11: Scaled length frequencies of male and female ling (*c.v.* is coefficient of variation; N is number of tows sampled).

Table 7: Length-weight relationships (log-log regression) for hoki, hake, ling, and silver warehou by sex

		Length (cm)			Weight (g)				
	No.	Mean	*s.d.*	Range	Mean	*s.d.*	Range	Equation	r^2
Hoki									
Males	374	68.61	12.47	34–101	1 085	520	120–3 420	$W = 0.0036L^{2.96}$	0.94
Females	1 038	75.34	10.56	32–109	1 360	519	95–4 190	$W = 0.0032L^{2.99}$	0.94
Total	1 412	73.56	11.49	32–109	1 287	533	95–4 190	$W = 0.0034L^{2.97}$	0.94
Hake									
Males	172	77.24	12.52	45–117	3 512	1 644	540–8 240	$W = 0.0051L^{3.07}$	0.95
Females	196	90.46	18.63	45–131	6 386	3 884	620–18 300	$W = 0.0045L^{3.11}$	0.88
Total	368	84.29	17.35	45–131	5 043	3 369	540–18 300	$W = 0.0041L^{3.13}$	0.91
Ling									
Males	612	80.68	17.00	37–137	2 796	1 886	190–16 500	$W = 0.0016L^{3.24}$	0.98
Females	512	90.11	25.57	28–151	4 460	3 737	80–19 200	$W = 0.0014L^{3.25}$	0.98
Total	1 124	84.97	21.84	28–151	3 554	2 996	80–19 200	$W = 0.0015L^{3.25}$	0.98
Silver warehou									
Males	68	43.38	3.31	34–51	1 604	344	770–2 390	$W = 0.0242L^{2.94}$	0.94
Females	36	46.86	3.53	39–55	2 044	486	1 080–3 410	$W = 0.0137L^{3.09}$	0.94
Total	104	44.59	3.76	34–55	1 757	449	770–3 410	$W = 0.0185L^{3.01}$	0.95

Table 8: Stomach state of the main species (*n* = sample size)

	Empty		Trace		Full or part full		Everted		Total
	n	%	*n*	%	*n*	%	*n*	%	*n*
Hoki	736	52	117	8	548	39	11	1	1 412
Ling	573	51	135	12	421	37	5	< 1	1 134
Hake	233	63	15	4	113	31	7	2	368
Black oreo	42	35	1	0.8	35	29	42	35	120
Silver warehou	0	0	0	0	106	100	0	0	106

Table 9: Stomach contents of the main species sampled

	Hoki		Ling		Hake		Black oreo		Silver warehou	
Prey	*n**	%†	*n*	%	*n*	%	*n*	%	*n*	%
Euphausids	370	68	43	8	7	6	5	14	0	0
Fish	331	60	227	54	100	78	7	20	0	0
Squid	23	4	15	4	2	2	0	0	0	0
Prawns	13	2	51	12	2	2	3	9	0	0
Munida	0	0	230	55	0	0	0	0	0	0
Unidentified crustaceans	21	4	91	22	0	0	10	29	0	0
Salps	1	< 1	0	0	0	0	18	51	106	100
Other	9	2	13	3	3	3	2	6	0	0
Total	768		670		114		45		106	

* *n* = Number of occurrences of prey in the stomachs examined.
† % = Percentage occurrence of prey species in part full and full stomachs.

stomachs were empty or everted and 30% were full or part full (*see* Table 8). Salps and unidentified crustacea were the most frequent dietary components (*see* Table 9). All of the 106 silver warehou whose stomachs were examined were full or part full of salps.

Gonad condition

Most hoki and ling were either juveniles (stage 1) or in the resting phase (stage 2) (Table 10): these two stages have been combined as they are difficult to distinguish visually. Some silver warehou and hake were running ripe (stage 5) suggesting that there was some spawning during the survey. No spawning schools were found.

Table 10: Reproductive state of six commercial species examined

	Gonad stage*						
	1 or 2	3	4	5	6	7	Total
Hoki	1 513	2	0	0	4	147	1 797
Ling	446	180	146	3	3	1	880
Hake	21	36	13	9	7	9	100
Black oreo	120	0	0	0	0	0	0
Silver warehou	9	9	13	16	3	6	57
Jack mackerel	0	0	3	0	0	0	3

* Stage 1: immature, juvenile
Stage 2: resting adults
Stage 3: maturing gonads (eggs visible in ovaries; swollen gonads)
Stage 4: ripe (hyaline eggs present in ovaries; milt present in testes)
Stage 5: running ripe (eggs or milt released with a little pressure)
Stage 6: partially spent (partial release of eggs or milt has already occurred)
Stage 7: fully spent (gonads bloodshot, flaccid with few eggs or milt left)

Discussion

All strata in the survey area were sampled and 107 stations were successfully completed. Biomass estimates of hoki, hake, and ling have coefficients of variation sufficiently low for use in stock assessment.

As in previous surveys of the area, hoki dominated the catch and formed about 45% of the total estimated biomass. This compares with 51% in July 1986 (Livingston *et al.* 1991) and 57% in March 1983 (Fenaughty & Uozumi 1989).

In 1989 the length frequency distribution of hoki showed a population dominated by juvenile fish, as in all previous surveys of the Chatham Rise (Kerstan & Sahrage 1980, Kuo & Tanaka 1984, Fenaughty & Uozumi 1989, Hatanaka *et al.* 1989b, Livingston *et al.* 1991). The number of modal peaks varies: in the present survey there were two strong peaks centred at 36 and 49 cm; in July 1986 there was a single peak at about 50 cm; and in March 1983 there were peaks at 42, 50, and 60 cm. Individual peaks correspond to individual year classes (Sullivan & Cordue 1994). Clearly, recruitment to the Chatham Rise can differ significantly from year to year. This is now being taken into account in hoki stock assessments (Sullivan & Cordue 1992, 1994).

A comparison of the relative proportions of adult (> 65 cm TL) and juvenile (< 65 cm TL) hoki on the Chatham Rise and in the Sub-Antarctic area shows that, as in 1983, 97–98% of the juvenile biomass in the two areas combined was on the Chatham Rise (Table 11). Juvenile hoki have been found only in small quantities on the west coast of the South Island and on the Challenger Plateau. The Chatham Rise is therefore assumed to be the main nursery ground for hoki, regardless of their spawning origin. The reasons for this distribution are not clear. The Chatham Rise has only 100 000 km^2 within the optimal depth range for juvenile hoki (200–600 m) compared with 185 000 km^2 in the Sub-Antarctic area. The Challenger Plateau (total area, 95 200 km^2) is smaller than the Chatham Rise (133 000 km^2) and there are very few hoki there. Contributing factors may be the length of time that hoki spend in the plankton before recruiting to the bottom, the dominant direction of currents from the main spawning grounds, and the availability of food. The 200–600 m depth ranges on the Challenger Plateau are largely north of the Subtropical Convergence Zone, and those in the Sub-Antarctic area are south of it. The Chatham Rise, however, is almost always traversed by the Subtropical Convergence which may provide increased productivity of, and optimal food availability for, for young hoki.

Between-survey comparisons of biomass estimates and catch rates to assess changes in population size ideally require that each survey covered the same area and used the same vessel and trawl gear at the same time of year. In most deepwater areas that have been surveyed for research purposes in New Zealand, the depth range or size of area sampled, the vessel, and the gear have differed on each occasion. Although the area sampled can usually be standardised between surveys by extrapolation or reduction, there has been little success in standardising for vessel or gear differences. The biomass estimates (*see* Table 11) and the catch rates (Tables 12–15) may therefore reflect differences both in vessels and gear (i.e., fishing power and gear efficiency) as well as any real differences in biomass.

Despite these difficulties, we considered it important to identify gross differences between surveys in biomass estimates and length distribution of the main species. Length distribution and relative catch rates within a survey provide some indication of changed distribution between surveys. We compared the biomass and relative proportions of hoki, hake, ling, and pale ghost shark between the Chatham Rise and the Sub-Antarctic area in 1983 and in 1989.

The biomass estimates of these species were much lower in the 1989 survey than in a similar survey in March 1983 (*see* Table 11). Hurst & Schofield (1990) argued that it was unlikely that these and other species had all suffered a decline in population size as many form a minor part of the catch on commercial vessels.

The relative proportions of hoki (total) in the Sub-Antarctic area and on the Chatham Rise were almost the same in 1989 as in 1983 (*see* Table 11)

Table 11: Biomass estimates (t) and percentages (in parentheses) of hoki, hake, ling, and pale ghost shark in the Sub-Antarctic area and on the Chatham Rise, 1989 and 1983

	1989			1983		
	Oct-Nov Sub-Antarctic	Nov-Dec Chatham Rise	Total	Oct-Nov Sub-Antarctic	Mar Chatham Rise	Total
Hoki (total)	62 081 (38)	101 048 (62)	163 129	213 738 (39)	335 045 (61)	548 783
Hoki (> 65 cm)	60 553 (58)	43 855 (42)	104 408	208 437 (66)	106 377 (34)	314 814
Hoki (< 65 cm)	1 528 (3)	57 193 (97)	58 721	5 301 (2)	324 408 (98)	329 709
Hake	2 660 (43)	3 576 (57)	6 238	10 333 (52)	9 606 (48)	19 939
Ling	20 016 (71)	8 043 (29)	28 059	30 048 (70)	12 741 (30)	42 789
Pale ghost shark	17 629 (61)	11 415 (39)	29 044	21 238 (52)	19 552 (48)	40 790

(Data sources: present survey; Livingston & Schofield (1993); MAF Fisheries unpublished voyage reports from 1983.)

and the proportions of juvenile hoki (< 65 cm TL) were similar. Only the adult hoki (> 65 cm TL) biomass was different: it dropped from 66% in 1983 to 58% in 1989 in the Sub-Antarctic area, and increased from 34 to 42% on the Chatham Rise. This may reflect the high exploitation of Sub-Antarctic adult sized hoki during the spawning season on the west coast of the South Island (Sullivan & Cordue 1992).

The relative proportions of hake increased from 48% in 1983 to 57% in 1989 on the Chatham Rise and declined from 52 to 43% in the Sub-Antarctic area (*see* Table 11). Apart from the high coefficients of variation, there is no obvious reason for this, particularly as the relative proportions of hake in 1990 and 1991 were closer to those of 1983 than of 1989 (Colman & Vignaux 1992).

The relative proportions of ling showed no change in either area between 1983 and 1989 and those of pale ghost shark decreased on the Chatham Rise.

Catch rates of economically important species (hoki, hake, ling, and silver warehou) from 1983, 1986, and 1989 were compared to determine differences in fish density between surveys across the Chatham Rise. Catch rates of hoki were highest in the central part of the Chatham Rise in November-December 1989, November-December 1983, and March 1993, whereas in July 1986 catch rates, though high over the whole survey area, were highest on the western rise at depths of 400–600 m (Table 12). The relative density distribution of hoki between surveys supports the seasonal distribution found by Kerstan & Sahrhage (1980), who suggested that hoki are more widely dispersed in summer than in autumn when they accumulate at the western end, possibly before migrating to spawn.

Catch rates of hake were generally higher on the central and eastern parts of the Chatham Rise, particularly in depths of 600–800 m (Table 13).

Table 12: Hoki catch rates (kg.km^{-2}) to nearest kilogram on random trawl surveys of the Chatham Rise (data source: research database, MAF Fisheries Greta Point)

Depth (m)	1983 (Mar)	1983 (Nov-Dec)	1986 (Jul)	1989 (Nov-Dec)
Western Rise				
200–400	1 817	ns*	2 094	543
400–600	6 463	ns	8 215	928
600–800	5 041	ns	1 750	236
Central Rise				
200–400	2 293	1 250	1 274	896
400–600	4 342	2 200	3 260	1 138
600–800	7 935	1 892	2 122	1 010
Eastern Rise				
200–400	1 171	887	1 367	707
400–600	1 569	831	873	661
600–800	1 341	441	316	137

* ns = not surveyed.

Table 13: Hake catch rates (kg.km^{-2}) to nearest kilogram on random trawl surveys of the Chatham Rise (data source: research database, MAF Fisheries Greta Point)

Depth (m)	1983 (Mar)	1983 (Nov-Dec)	1986 (Jul)	1989 (Nov-Dec)
Western Rise				
200–400	6	ns*	2	1
400–600	107	ns	56	21
600–800	93	ns	107	8
Central Rise				
200–400	9	88	197	5
400–600	137	95	81	38
600–800	220	148	177	81
Eastern Rise				
200–400	20	27	199	11
400–600	92	98	37	37
600–800	56	61	104	24

* ns = not surveyed.

Table 14: Ling catch rates (kg.km^{-2}) to nearest kilogram on random trawl surveys of the Chatham Rise (data source: research database, MAF Fisheries Greta Point)

Depth (m)	1983 (Mar)	1983 (Nov-Dec)	1986 (Jul)	1989 (Nov-Dec)
Western Rise				
200–400	9	ns*	186	31
400–600	82	ns	198	99
600–800	80	ns	108	53
Central Rise				
200–400	97	164	168	38
400–600	118	109	187	64
600–800	106	88	116	107
Eastern Rise				
200–400	250	118	100	52
400–600	88	129	128	60
600–800	53	196	45	41

* ns = not surveyed.

Table 15: Silver warehou catch rates (kg.km^{-2}) to nearest kilogram on random trawl surveys of the Chatham Rise (data source: research database, MAF Fisheries Greta Point)

Depth (m)	1983 (Mar)	1983 (Nov-Dec)	1986 (Jul)	1989 (Nov-Dec)
Western Rise				
200–400	627	ns*	79	16
400–600	36	ns	415	23
600–800	< 1	ns	5	< 1
Central Rise				
200–400	58	503	197	23
400–600	23	50	275	680
600–800	< 1	16	8	< 1
East Rise, Chathams				
200–400	41	130	66	258
400–600	53	72	79	27
600–800	< 1	19	1	< 1

* ns = not surveyed.

Seasonal trends in distribution have not been evident in the past (Kerstan & Sahrhage 1980), though hake aggregate near the Chatham Islands to spawn in December (Hurst & Bagley 1987) and possibly in winter as well (Livingston *et al.* 1991).

Catch rates of ling varied less than those of other species throughout the Chatham Rise area in most surveys (Table 14). Again, this confirms seasonal observations by Kerstan & Sahrhage (1980).

Silver warehou catches have always been patchy, but the larger catches were usually taken from the central or western part of the Chatham Rise (Table 15). Seasonal trends are difficult to discern. Kerstan & Sahrhage (1980) found that silver warehou were scarce during winter months.

In conclusion, the 1989 survey provided information on relative size structure, recruitment strength, and distribution of fish species (in particular, hoki, hake, and ling) at depths of 200–800 m on the Chatham Rise. Though biomass estimate comparisons with earlier surveys are limited as we are unable to estimate vessel fishing power, a standard series may enable estimation of the relative fishing power of these vessels at a later date.

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References

Colman, J. A. & Vignaux, M. 1992: Assessment of hake (*Merluccius australis*) for the 1992–93 fishing year. N.Z. Fisheries Assessment Research Document 92/17. 23 p. (Draft report held in MAF Fisheries Greta Point library, Wellington.)

Cordue, P. L. 1991: Hoki acoustic biomass indices for the west coast South Island 1988, 1989, and 1990. N.Z. Fisheries Assessment Research Document 91/11. 31 p. (Draft report held in MAF Fisheries Greta Point library, Wellington.)

Fenaughty, J. M. & Uozumi, Y. 1989: A survey of demersal fish stocks on the Chatham Rise, New Zealand, March 1983. *N.Z. Fisheries Technical Report No. 12.* 42 p.

Francis, R. I. C. C. 1981: Stratified random trawl surveys of deep-water demersal fish stocks around New Zealand. *Fisheries Research Division Occasional Publication No. 32.* 28 p.

Francis, R. I. C. C. 1984: An adaptive strategy for stratified random trawl surveys. *N.Z. Journal of Marine and Freshwater Research 18*: 59–71.

Hatanaka, H., Uozumi, Y., Fukui, J., Aizawa, M., & Hurst, R. J. 1989a: Japan-New Zealand trawl survey off southern New Zealand, October-November 1983. *N.Z. Fisheries Technical Report No. 9.* 52 p.

Hatanaka, H., Uozumi, Y., Fukui, J., Aizawa, M., & Livingston, M. E. 1989b: Trawl survey of hoki and other slope fish on the Chatham Rise, New Zealand, November-December 1983. *N.Z. Fisheries Technical Report No. 17.* 31 p.

Hurst, R. J. & Bagley, N. W. 1987: Results of a trawl survey of barracouta and associated finfish near the Chatham Islands, New Zealand, December 1984. *N.Z. Fisheries Technical Report No. 3.* 44 p.

Hurst, R. J., Livingston, M. E., Coombs, R., & Patchell, G. J. 1988: Hoki. *In* Baird, G. G. & McKoy, J. L. (Comps & Eds.). Papers from the workshop to review fish stock assessments for the 1987–88 New Zealand fishing year, pp. 129–141. (Unpublished report held in MAF Fisheries Greta Point library, Wellington.)

Hurst, R. J. & Schofield, K. A. 1990: Preliminary biomass estimates of hoki and selected species from trawl surveys of Southland/Sub-Antarctic and the Chatham Rise, Oct-Dec 1989, and comparison with previous *Shinkai Maru* surveys. N.Z. Fisheries Assessment Research Document 90/6. 23 p. (Draft report held in MAF Fisheries Greta Point library, Wellington.)

Hurst, R. J. & Schofield, K. A. 1991: Preliminary biomass estimates of hoki and other main species from trawl surveys of Southland/Sub-Antarctic, Jul-Aug and Nov-Dec 1990. N.Z. Fisheries Assessment Research Document 91/15. 25 p. (Draft report held in MAF Fisheries Greta Point library, Wellington.)

Kerstan, M. & Sahrhage, D. 1980: Biological investigations on fish stocks in waters off New Zealand. *Mitteilungen aus dem Institut für Seefischerei der Bundesforschungsanstalt für Fischerei, Hamburg, No. 29.* 187 p.

Kuo, C. & Tanaka, S. 1984: Otolith features and reliability for age determination of hoki *Macruronus novaezelandiae* (Hector) in waters around New Zealand. *Bulletin of the Japanese Society of Scientific Fisheries 50*: 1349–1355.

Livingston, M. E. 1990: Spawning hoki (*Macruronus novaezelandiae* Hector) concentrations in Cook Strait and off the east coast of the South Island, New Zealand, August-September 1987. *N.Z. Journal of Marine and Freshwater Research 24*: 503–517.

Livingston, M. E. & Schofield, K. A. 1993: Trawl survey of hoki and associated species south of New Zealand, October-November 1989. *N.Z. Fisheries Technical Report No. 36.* 39 p.

Livingston, M. E., Schofield, K. A., & Sullivan, K. J. 1992: The discrimination of hoki (*Macruronus novaezelandiae*) groups in New Zealand waters using morphometrics and age-growth parameters. N.Z. Fisheries Assessment Research Document 92/18. 29 p. (Draft report held in MAF Fisheries Greta Point library, Wellington.)

Livingston, M. E., Uozumi, Y., & Berben, P. H. 1991: Abundance, distribution, and spawning condition of hoki and other mid-slope fish on the Chatham Rise, July 1986. *N.Z. Fisheries Technical Report No. 25.* 47 p.

Patchell, G. J. 1982: The New Zealand hoki fisheries 1972–82. *Fisheries Research Division Occasional Publication No. 38.* 23 p.

Sullivan, K. J. 1991: A review of the 1989–90 hoki fishery and a preliminary assessment of hoki stocks for 1991. N.Z. Fisheries Assessment Research Document 91/13. 34 p. (Draft report held in MAF Fisheries Greta Point library, Wellington.)

Sullivan, K. J. & Cordue, P. L. 1992: Stock assessment of hoki for the 1992–93 fishing year. N.Z. Fisheries Assessment Research Document 92/12. 43 p. (Draft report held in MAF Fisheries Greta Point library, Wellington.)

Sullivan, K. J. & Cordue, P. L. 1994: A review of the 1991–92 hoki fishery and assessment of hoki stocks for 1993. N.Z. Fisheries Assessment Research Document 94/2. 42 p. (Draft report held in MAF Fisheries Greta Point library, Wellington.)

Vignaux, M. 1992: Catch per unit of effort (CPUE) analysis of the hoki fishery. N.Z. Fisheries Assessment Research Document 92/14. 31 p. (Draft report held in MAF Fisheries Greta Point library, Wellington.)

Appendix 1: Station data

Station	Stratum	Date	Start of tow Latitude	Start of tow Longitude	Depth (m) Min.	Depth (m) Max.	Headline height (m)	Doorspread (m)
1	17	26 Nov 89	44°35.5´S	173°06.7´E	485	505	11.0	130.0
2	06	26 Nov 89	44°34.5´S	173°43.9´E	750	781	10.3	126.0
3	06	26 Nov 89	44°25.8´S	173°38.0´E	695	710	8.4	136.0
4	17	26 Nov 89	44°09.2´S	173°48.0´E	490	500	10.0	130.0
5	06	26 Nov 89	44°14.5´S	174°11.2´E	612	624	10.0	126.0
6	17	27 Nov 89	44°04.5´S	174°12.6´E	543	560	10.0	129.0
7	17	27 Nov 89	43°58.3´S	174°17.3´E	543	544	9.0	130.0
8	17	27 Nov 89	43°55.9´S	174°26.7´E	541	566	8.5	129.0
9	16	27 Nov 89	44°07.2´S	174°59.1´E	504	510	8.3	131.6
10	06	27 Nov 89	44°34.8´S	174°56.7´E	756	794	8.0	130.0
11	06	28 Nov 89	44°26.0´S	175°29.7´E	699	701	11.3	126.9
12	06	28 Nov 89	44°16.7´S	175°29.4´E	608	616	9.0	132.0
13	16	28 Nov 89	44°04.2´S	175°24.8´E	508	512	9.9	128.0
14	16	28 Nov 89	44°02.4´S	175°37.5´E	530	536	10.0	132.0
15	16	28 Nov 89	44°10.0´S	175°54.3´E	499	518	11.0	135.0
16	24	29 Nov 89	44°03.2´S	175°57.5´E	314	335	9.5	122.0
17	24	29 Nov 89	44°04.9´S	176°06.4´E	390	397	10.0	118.9
18	24	29 Nov 89	44°05.8´S	176°04.1´E	210	254	12.0	125.4
19	15	29 Nov 89	44°08.1´S	176°26.5´E	569	572	10.3	144.8
20	05	29 Nov 89	44°14.8´S	176°22.0´E	607	654	11.4	130.3
21	05	29 Nov 89	44°11.5´S	176°33.3´E	640	646	11.1	134.0
22	15	30 Nov 89	43°55.6´S	177°01.1´E	531	555	9.4	135.4
23	15	30 Nov 89	43°47.4´S	177°04.4´E	490	496	7.8	144.0
24	20	30 Nov 89	43°33.3´S	177°43.6´E	374	400	10.0	133.0
25	15	30 Nov 89	43°38.4´S	177°46.3´E	446	468	9.6	133.0
26	05	30 Nov 89	43°53.1´S	177°44.9´E	628	654	10.0	140.0
27	05	01 Dec 89	43°53.7´S	178°08.0´E	598	610	7.9	136.0
28	14	01 Dec 89	43°51.1´S	178°28.2´E	497	506	8.7	139.0
29	20	01 Dec 89	43°32.9´S	178°31.4´E	348	351	8.9	128.8
30	20	01 Dec 89	43°31.1´S	178°41.2´E	333	352	9.8	131.2
31	14	01 Dec 89	43°46.0´S	178°49.2´E	448	448	8.9	130.0
32	14	01 Dec 89	43°36.0´S	179°03.1´E	405	408	9.0	135.0
33	14	02 Dec 89	43°38.5´S	179°15.7´E	445	453	8.3	132.5
34	14	02 Dec 89	43°37.8´S	179°25.8´E	423	452	9.8	131.9
35*	21	02 Dec 89	43°41.0´S	179°51.3´W	366	381	9.0	134.0
36	21	02 Dec 89	43°43.2´S	179°45.8´W	357	360	8.0	132.0
37*	21	02 Dec 89	43°38.5´S	179°25.5´W	385	390	9.0	133.3
38	21	02 Dec 89	43°36.0´S	179°28.2´W	386	388	9.0	130.5
39*	10	03 Dec 89	43°36.5´S	179°15.6´W	404	410	10.5	130.0
40	10	03 Dec 89	43°29.8´S	179°05.9´W	455	463	9.1	133.4
41	10	03 Dec 89	43°33.7´S	178°56.1´W	456	457	8.6	135.3
42	13	03 Dec 89	43°45.1´S	178°02.2´W	405	406	12.2	130.1
43	13	03 Dec 89	44°06.6´S	178°48.0´W	450	457	11.0	135.0
44	13	04 Dec 89	43°57.7´S	178°36.4´W	455	459	9.3	134.3
45	13	04 Dec 89	44°00.4´S	178°31.5´W	446	449	8.6	135.6
46	13	04 Dec 89	44°05.2´S	178°19.5´W	460	480	9.3	121.0
47	04	04 Dec 89	44°20.3´S	178°19.9´W	721	742	9.5	132.0
48	12	04 Dec 89	44°10.1´S	177°57.7´W	500	502	10.1	130.0
49	12	04 Dec 89	44°06.6´S	177°49.5´W	476	488	8.0	131.6
50	04	05 Dec 89	44°26.8´S	177°39.3´W	735	749	9.5	131.3
51	04	05 Dec 89	44°20.9´S	177°44.9´W	610	618	10.0	132.6
52	12	05 Dec 89	44°17.6´S	177°34.5´W	517	527	8.6	130.0
53	12	05 Dec 89	44°12.3´S	177°28.8´W	464	477	8.9	127.8
54	12	06 Dec 89	44°04.6´S	175°28.7´W	426	448	9.8	125.9
55	12	06 Dec 89	43°46.5´S	175°30.3´W	413	420	12.3	124.0
56	12	06 Dec 89	43°33.8´S	175°02.0´W	616	622	9.4	130.0
57	04	06 Dec 89	43°16.2´S	175°28.9´W	674	676	10.4	137.8
58	11	06 Dec 89	43°20.1´S	175°38.6´W	561	582	10.0	138.5
59	23	07 Dec 89	43°42.9´S	175°52.2´W	228	230	10.0	116.3
60	11	07 Dec 89	43°22.0´S	176°01.9´W	413	448	8.5	131.8
61	11	07 Dec 89	43°14.9´S	176°00.3´W	518	540	8.5	130.0
62	11	07 Dec 89	43°09.0´S	176°04.2´W	567	584	8.0	134.0
63	23	07 Dec 89	43°16.3´S	176°27.8´W	362	380	10.0	130.1
64	03	07 Dec 89	42°54.8´S	176°30.4´W	764	773	8.0	135.0
65	03	08 Dec 89	42°57.1´S	176°37.2´W	673	694	9.4	131.8
66	03	08 Dec 89	42°59.2´S	176°41.1´W	610	617	8.5	132.4
67	23	08 Dec 89	43°11.6´S	176°53.1´W	320	356	7.0	137.0
68	23	08 Dec 89	43°18.2´S	177°07.1´W	282	288	10.0	133.7
69	11	08 Dec 89	43°09.3´S	177°38.3´W	411	435	9.0	131.0
70	03	08 Dec 89	42°53.1´S	177°52.6´W	618	653	8.5	136.9
71	22	09 Dec 89	43°30.3´S	177°40.5´W	362	365	10.0	122.4
72	22	09 Dec 89	43°36.9´S	177°38.2´W	371	388	8.0	130.8

Appendix 1 – *continued*

Station	Stratum	Date	Start of tow Latitude	Start of tow Longitude	Depth (m) Min.	Depth (m) Max.	Headline height (m)	Doorspread (m)
73	22	09 Dec 89	43°42.1´S	177°55.8´W	360	384	9.6	134.9
74	13	09 Dec 89	43°47.1´S	178°17.5´W	400	419	10.0	127.4
76	11	09 Dec 89	43°12.2´S	178°03.8´W	449	480	9.5	133.0
78*	10	10 Dec 89	43°21.1´S	178°40.6´W	418	423	9.0	134.5
79	10	10 Dec 89	43°22.7´S	178°53.6´W	425	438	8.5	134.0
80	10	10 Dec 89	43°05.9´S	179°21.8´W	532	538	10.0	139.0
81	03	10 Dec 89	42°53.3´S	179°20.6´W	632	675	10.7	145.0
82	03	11 Dec 89	42°57.2´S	179°46.0´W	607	624	8.0	144.8
83	10	11 Dec 89	43°13.2´S	179°51.4´W	509	510	9.0	139.8
84	10	11 Dec 89	43°20.4´S	179°57.3´W	438	446	8.0	141.1
85	09	11 Dec 89	43°18.6´S	179°55.7´E	452	466	9.0	133.7
86	09	11 Dec 89	43°15.4´S	179°40.9´E	470	481	9.0	138.1
87	02	11 Dec 89	42°58.2´S	179°07.5´E	624	628	10.0	139.0
88	09	12 Dec 89	43°04.3´S	179°02.4´E	423	439	9.0	134.0
89	20	12 Dec 89	43°17.5´S	178°24.6´E	370	380	10.7	131.5
90	20	12 Dec 89	43°19.3´S	178°13.0´E	320	325	10.0	125.0
91	20	12 Dec 89	43°18.1´S	177°55.1´E	296	300	11.9	124.4
92*	20	12 Dec 89	43°13.5´S	177°45.1´E	305	310	10.1	122.2
93	20	12 Dec 89	43°07.7´S	177°43.1´E	315	318	10.0	123.3
94	09	13 Dec 89	42°50.9´S	178°05.2´E	532	540	9.5	133.4´
95	08	13 Dec 89	42°55.0´S	177°26.0´E	400	408	9.3	125.9
96	02	13 Dec 89	42°46.0´S	177°01.0´E	642	660	9.8	130.6
97	02	13 Dec 89	42°45.8´S	176°49.9´E	636	658	9.5	139.1
98	08	13 Dec 89	42°54.8´S	176°30.2´E	475	480	10.5	132.5
99	19	13 Dec 89	43°03.8´S	176°32.5´E	370	390	10.0	130.1
100	19	14 Dec 89	43°08.1´S	176°38.6´E	322	330	10.0	127.3
101	19	14 Dec 89	43°06.9´S	176°46.3´E	320	337	9.2	127.1
102	19	14 Dec 89	43°24.3´S	176°50.1´E	250	260	9.1	129.0
103	19	14 Dec 89	43°33.0´S	176°33.0´E	347	397	9.9	130.0
104	15	14 Dec 89	43°44.8´S	176°17.9´E	418	425	8.5	135.0
105	18	14 Dec 89	43°46.1´S	175°41.9´E	374	398	11.4	130.0
106	18	15 Dec 89	43°39.6´S	175°41.4´E	288	304	10.0	131.2
107*	18	15 Dec 89	43°34.6´S	175°49.3´E	282	289	10.0	132.9
108*	19	15 Dec 89	43°26.1´S	176°10.3´E	384	384	10.0	128.8
109*	19	15 Dec 89	43°24.8´S	176°04.4´E	371	376	11.0	132.3
110	08	16 Dec 89	43°04.5´S	176°08.8´E	440	466	10.0	128.4
111	07	16 Dec 89	43°04.7´S	175°52.3´E	460	480	9.5	129.4
112*	01	16 Dec 89	42°57.5´S	174°56.1´E	648	680	9.5	130.0
113	01	16 Dec 89	42°56.4´S	174°47.6´E	733	742	9.5	127.2
114	01	16 Dec 89	43°01.2´S	174°42.7´E	616	637	10.0	129.6
115	18	17 Dec 89	43°28.3´S	174°51.1´E	325	340	9.5	127.9
116	07	17 Dec 89	43°27.1´S	174°17.3´E	566	575	8.3	139.4
117	07	17 Dec 89	43°27.6´S	173°59.7´E	428	459	10.5	130.0
118	07	17 Dec 89	43°13.5´S	174°13.7´E	596	598	8.0	131.4

*Stations with unsatisfactory gear performance and not included in analyses in this report.

Appendix 2: Species taken during the survey

Scientific name	Common name	Species code	Strata in which present
Elasmobranchii			
Chlamydoselachidae			
Chlamydoselachus anguineus	frill shark	FRS	2
Scyliorhinidae			
Apristurus macrorhyncus	deepwater catshark	APR	6
Cephaloscyllium isabella	carpet shark	CAR	7, 2, 3
Carcharhinidae			
Galeorhinus galeus	school shark	SCH	5, 6, 12, 13, 15, 18–20, 23, 24
Squalidae			
Centrophorus squamosus	deepwater spiny dogfish	CSQ	3, 10, 16
Centroscymnus crepidater	deepwater dogfish	CYP	1–4, 6, 7, 11, 13
C. plunketi	Plunket's shark	PLS	1–8
C. owstonii	Owston's spiny dogfish	CYO	1–3, 6, 17
Dalatias licha	black shark	BSH	1–4, 6–12, 17, 23
Deania calcea	shovelnosed spiny dogfish	SND	1–12, 14–17, 19, 22, 23
Etmopterus baxteri	Baxter's dogfish	ETB	3–6, 12, 14–17, 20
E. lucifer	Lucifer dogfish	ETL	1–17, 20, 21, 23
Oxynotus bruniensis	prickly dogfish	PDG	2–4, 6–11, 13–15, 17, 19, 22–24
Squalus acanthias	spotted spiny dogfish	SPD	5, 7–24
Torpedinidae			
Torpedo fairchildi	electric ray	ERA	2
Narkidae			
Typhlonarke aysoni	blind electric ray	BER	2, 8, 22
Rajidae			
Bathyraja sp.	bluntnosed skate	BTH	3–5, 10–14, 16, 17, 20, 23
Pavoraja asperula	deepsea skate	BTA	1, 2, 5–7, 9, 12, 14, 15, 17–19
P. spinifera	prickly deepsea skate	BTS	2, 19
Raja innominata	smooth skate	SSK	2–5, 7, 8, 10–14, 17–20, 22, 23
Chimaeridae			
Hydrolagus novaezelandiae	dark ghost shark	GSH	8, 18–20
Hydrolagus sp.	pale ghost shark	GSP	1–17, 20–24
Hydrolagus sp.	purplefinned ghost shark	HYP	5, 13
Rhinochimaeridae			
Harriotta raleighana	longnosed chimaera	LCH	1–17, 20, 23, 24
Teleostei			
Notacanthidae			
Notacanthus sexspinis	spineback	SBK	1–17, 22, 23
Synaphobranchidae			
Diastobranchus capensis	basketwork eel	BEE	6
Congridae			
Bassanago bulbiceps	swollenheaded conger	SCO	2, 3, 5–8, 10, 12, 14, 15, 20, 21
B. hirsutus	hairy conger	HCO	1–6, 8–18, 20–22
Gonorynchidae			
Gonorynchus gonorynchus	sandfish	GON	1, 12
Argentinidae			
Argentina elongata	silverside	SSI	4, 6–24
Alepocephalidae			
Xenodermichthys sp.	black slickhead	BSL	3
Photichthyidae			
Species not identified	lighthousefish	PHO	3, 12
Malacosteidae			
Species not identified	loosejaw	MAL	7
Paralepididae			
Magnisudis prionosa	barracudina	BCA	13
Myctophidae			
Species not identified	lanternfish	LAN	4, 10, 19
Moridae			
Halargyreus johnsonii	Johnson's cod	HJO	1–3
Lepidion microcephalus	smallheaded cod	SMC	1, 4, 6, 12, 23
Mora moro	ribaldo	RIB	1–17
Pseudophycis bachus	red cod	RCO	3, 5, 11, 12, 18–24
Tripterophycis gilchristi	grenadier cod	GRC	8, 9
Euclichthyidae			
Euclichthys polynemus	eucla cod	EUC	6, 12, 17
Gadidae			
Micromesistius australis	southern blue whiting	SBW	24
Merlucciidae			
Macruronus novaezelandiae	hoki	HOK	1–24
Merluccius australis	hake	HAK	1–23

Appendix 2 – *continued*

Scientific name	Common name	Species code	Strata in which present
Macrouridae			
Caelorinchus aspercephalus	obliquebanded rattail	CAS	6, 7, 9–24
C. bollonsi	bigeyed rattail	CBO	1–24
C. fasciatus	banded rattail	CFA	1–7, 9–12, 14–17, 19, 20, 23
C. innotabilis	notable rattail	CIN	1, 4, 6, 11
C. kaiyomaru	Kaiyomaru rattail	CKA	1
C. matamua	Mahia rattail	CMA	1–4, 9, 12
C. oliverianus	Oliver's rattail	COL	2–7, 11–18
Coryphaenoides murrayi	abyssal rattail	CMU	4, 6, 7
C. serrulatus	serrulate rattail	CSE	1–3, 11, 19
C. subserrulatus	fourrayed rattail	CSU	3
Lepidorhynchus denticulatus	javelinfish	JAV	1–23
Macrourus carinatus	ridgescaled rattail	MCA	4, 6
Trachyrincus sp.	unicorn rattail	WHX	1, 3–6
Ventrifossa nigromaculata	blackspotted rattail	VNI	3–6, 9, 11, 13, 14
Ophidiidae			
Genypterus blacodes	ling	LIN	1–24
Carapidae			
Echiodon cryomargarites	messmate fish	ECR	3
Ceratiidae			
Cryptopsarus couesi	seadevil	SDE	21
Trachipteridae			
Trachipterus trachypterus	dealfish	DEA	2
Trachichthyidae			
Hoplostethus mediterraneus	silver roughy	SRH	1–3, 7, 8, 11, 12, 20, 23
Paratrachichthys trailli	common roughy	RHY	18, 22
Zeidae			
Capromimus abbreviatus	capro dory	CDO	20
Cyttus novaezelandiae	silver dory	SDO	3, 11, 18, 22, 23
C. traversi	lookdown dory	LDO	1–24
Oreosomatidae			
Allocyttus niger	black oreo	BOE	3–6, 12, 14–17
A. verrucosus	warty oreo	WOE	6
Neocyttus rhomboidalis	spiky oreo	SOR	1–4, 7–9, 11, 12, 23
Pseudocyttus maculatus	smooth oreo	SSO	1–4, 6, 16
Macrorhamphosidae			
Centriscops obliquus	redbanded bellowsfish	BBE	1–15, 17–24
Scorpaenidae			
Helicolenus percoides	sea perch	SPE	1–24
Congiopodidae			
Congiopodus leucopaecilus	southern pigfish	PIG	5, 18, 20
Triglidae			
Chelidonichthys kumu	red gurnard	GUR	11, 18, 19
Hoplichthyidae			
Hoplichthys haswelli	deepsea flathead	FHD	2–7, 9–21, 23
Psychrolutidae			
Psychrolutes sp.	blobfish	PSY	6
Unidentified toadfish	toadfish	TOA	1, 3, 10, 12–20, 22, 24
Percichthyidae			
Polyprion americanus	bass groper	BAS	11, 18, 23
P. oxygeneios	hapuku	HAP	14, 22
Serranidae			
Lepidoperca sp. A	orange perch	OPE	18–20
Apogonidae			
Epigonus lenimen	bigeyed cardinalfish	EPL	3, 4, 20
E. robustus	cardinalfish	EPR	1–3, 10–12, 23
E. telescopus	deepsea cardinalfish	EPT	1, 3, 7–9, 12
Carangidae			
Trachurus murphyi	slender mackerel	JMM	3, 5, 7, 10, 11, 13, 20, 22, 23
Bramidae			
Brama brama	Ray's bream	RBM	1, 4, 7–9, 12, 14, 15, 17–22
Emmelichthyidae			
Emmelichthys nitidus	redbait	RBT	8, 18–24
Plagiogeneion rubiginosus	rubyfish	RBY	3, 23
Cheilodactylidae			
Nemadactylus macropterus	tarakihi	TAR	19, 23
Uranoscopidae			
Kathetostoma giganteum	giant stargazer	STA	2–4, 7–24
Pinguipedidae			
Parapercis gilliesi	yellow cod	YCO	19

Appendix 2 – *continued*

Scientific name	Common name	Species code	Strata in which present
Gempylidae			
Rexea solandri	gemfish	SKI	19, 23
Thyrsites atun	barracouta	BAR	7, 11, 18, 19, 22, 23
Trichiuridae			
Lepidopus caudatus	frostfish	FRO	12, 23
Centrolophidae			
Centrolophus niger	rudderfish	RUD	1, 3, 5–7, 9–13, 15, 17, 20, 22
Hyperoglyphe antarctica	bluenose	BNS	10–12, 22
Icichthys australis	ragfish	RAG	4, 6
Seriolella caerulea	white warehou	WWA	1, 3, 6–24
S. punctata	silver warehou	SWA	3, 5–8, 10–24
Tetragonuridae			
Tetragonurus cuvieri	squaretail	TET	15
Bothidae			
Arnoglossus scapha	witch	WIT	16, 18–23
Neoachiropsetta milfordi	finless flounder	MAN	4
Pleuronectidae			
Pelotretis flavilatus	lemon sole	LSO	3, 21–23
Cephalopoda			
Amphitretidae			
Unidentified	deepwater octopus	DWO	1, 2, 5, 6, 15–17
Ommastrephidae			
Unidentified	arrow squid	SQU	5, 14, 15, 17, 20, 21, 24
Ommastrephes bartrami	red squid	RSQ	2, 3, 6, 8, 9, 11, 12, 17, 20, 23
Onychoteuthidae			
Unidentified	warty squid	WSQ	1–6, 9, 11, 12, 14–20, 22–24

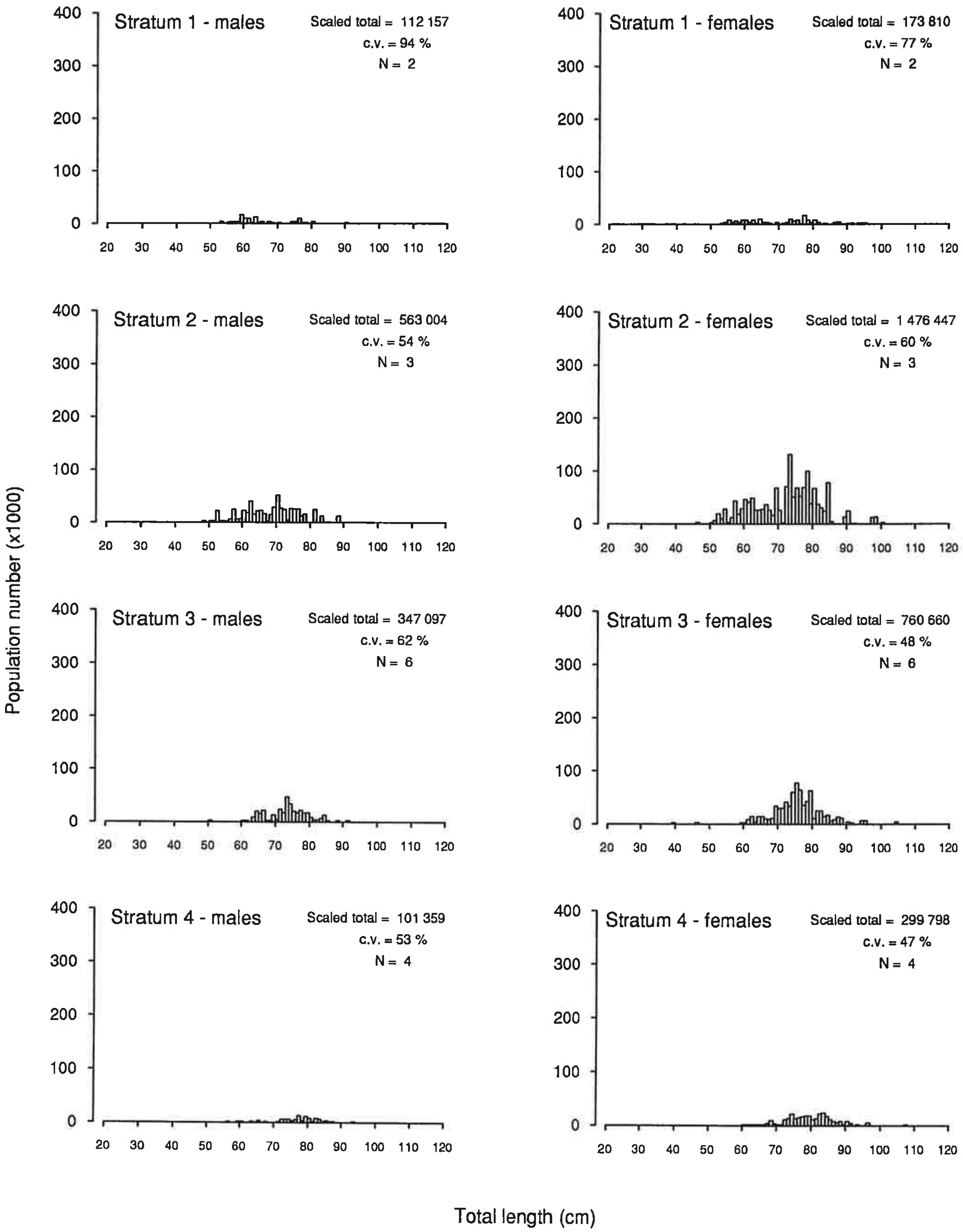
Appendix 3: Biomass estimates (t) and coefficients of variation (%, in parentheses) for the main ITQ and bycatch species by stratum, grouped by depth. Species codes are given in Appendix 2.

										Species code	
Stratum	HOK	SWA	BOE	GSP	LIN	JAV	SOR	LDO	HAK	WWA	STA
200–400 m											
18	2 518	73	0	0	143	14	0	106	4	19	80
	(41)	(89)			(51)	(69)		(49)	(100)	(74)	(81)
19	5 070	276	0	0	327	46	0	116	52	138	371
	(17)	(58)			(14)	(65)		(31)	(61)	(58)	(70)
20	10 903	116	0	928	332	10	0	248	24	521	329
	(36)	(42)		(41)	(26)	(78)		(28)	(66)	(42)	(63)
21	2 392	52	0	247	143	13	0	112	14	253	294
	(21)	(57)		(9)	(38)	(92)		(46)	(100)	(96)	(85)
22	2 995	1 495	0	310	329	70	0	259	32	732	49
	(68)	(80)		(42)	(11)	(89)		(12)	(100)	(77)	(53)
23	2 223	1 981	0	230	80	275	327	36	79	133	306
	(89)	(52)		(53)	(49)	(90)	(83)	(41)	(100)	(68)	(45)
24	2 206	703	0	494	50	0	0	8	0	25	75
	(50)	(77)		(95)	(58)			(57)		(51)	(32)
Subtotal	28 307	4 696	0	2 209	1 404	428	327	885	205	1 821	1 504
400–600 m											
7	5 512	117	0	688	523	399	8	94	256	34	23
	(61)	(73)		(32)	(34)	(41)	(100)	(25)	(96)	(49)	(62)
8	5 107	2	0	17	364	172	43	61	209	5	1
	(45)	(100)		(27)	(37)	(41)	(71)	(16)	(11)	(100)	(100)
9	3 610	0	0	258	250	296	82	215	346	28	19
	(47)			(19)	(24)	(40)	(58)	(22)	(20)	(13)	(100)
10	3 361	168	0	409	529	235	0	331	835	34	19
	(19)	(48)		(44)	(41)	(19)		(13)	(67)	(63)	(100)
11	1 995	76	0	132	486	296	2 047	280	230	237	106
	(46)	(58)		(42)	(26)	(32)	(82)	(39)	(39)	(86)	(90)
12	8 170	293	58	570	545	1 051	733	417	107	112	149
	(56)	(52)	(92)	(33)	(33)	(76)	(100)	(13)	(67)	(61)	(15)
13	6 292	289	0	571	283	147	0	434	111	19	46
	(36)	(62)		(34)	(22)	(27)		(22)	(45)	(54)	(45)
14	8 781	98	2	905	382	994	0	619	97	118	9
	(12)	(37)	(100)	(35)	(28)	(51)		(23)	(75)	(65)	(81)
15	5 824	15 884	50	1 076	262	252	0	210	103	697	30
	(48)	(98)	(100)	(15)	(29)	(29)		(21)	(32)	(96)	(47)
16	2 623	50	20	460	407	168	0	113	23	14	51
	(32)	(97)	(90)	(21)	(27)	(22)		(16)	(95)	(62)	(64)
17	7 582	52	39	1 019	717	449	0	145	42	14	35
	(34)	(100)	(100)	(12)	(51)	(33)		(31)	(75)	(77)	(76)
Subtotal	58 857	17 029	169	6 105	4 748	4 459	2 913	2 919	2 359	1 312	488
600–800 m											
1	286	0	0	395	168	33	512	8	14	45	0
	(69)			(11)	(21)	(76)	(29)	(100)	(100)	(100)	
2	2 289	0	0	167	289	559	300	72	398	0	36
	(67)			(24)	(43)	(7)	(25)	(50)	(18)		(15)
3	1 411	7	34	193	310	723	1 558	166	389	128	43
	(49)	(100)	(100)	(25)	(43)	(19)	(54)	(18)	(44)	(72)	(77)
4	590	0	1 706	238	238	270	135	36	21	0	13
	(46)		(57)	(33)	(52)	(37)	(100)	(42)	(87)		(100)
5	6 622	8	2 819	934	606	543	0	162	94	0	0
	(31)	(84)	(53)	(14)	(58)	(10)		(39)	(66)		
6	2 689	2	15 101	1 174	279	570	0	77	83	6	0
	(39)	(100)	(34)	(37)	(57)	(27)		(47)	(63)	(63)	
Subtotal	13 887	17	19 660	3 101	1 890	2 698	2 505	521	999	179	92
Total	101 048	21 769	19 827	11 415	8 043	7 585	5 746	4 323	3 576	3 266	2 083
	(10)	(72)	(28)	(8)	(9)	(14)	(36)	(6)	(19)	(30)	(22)

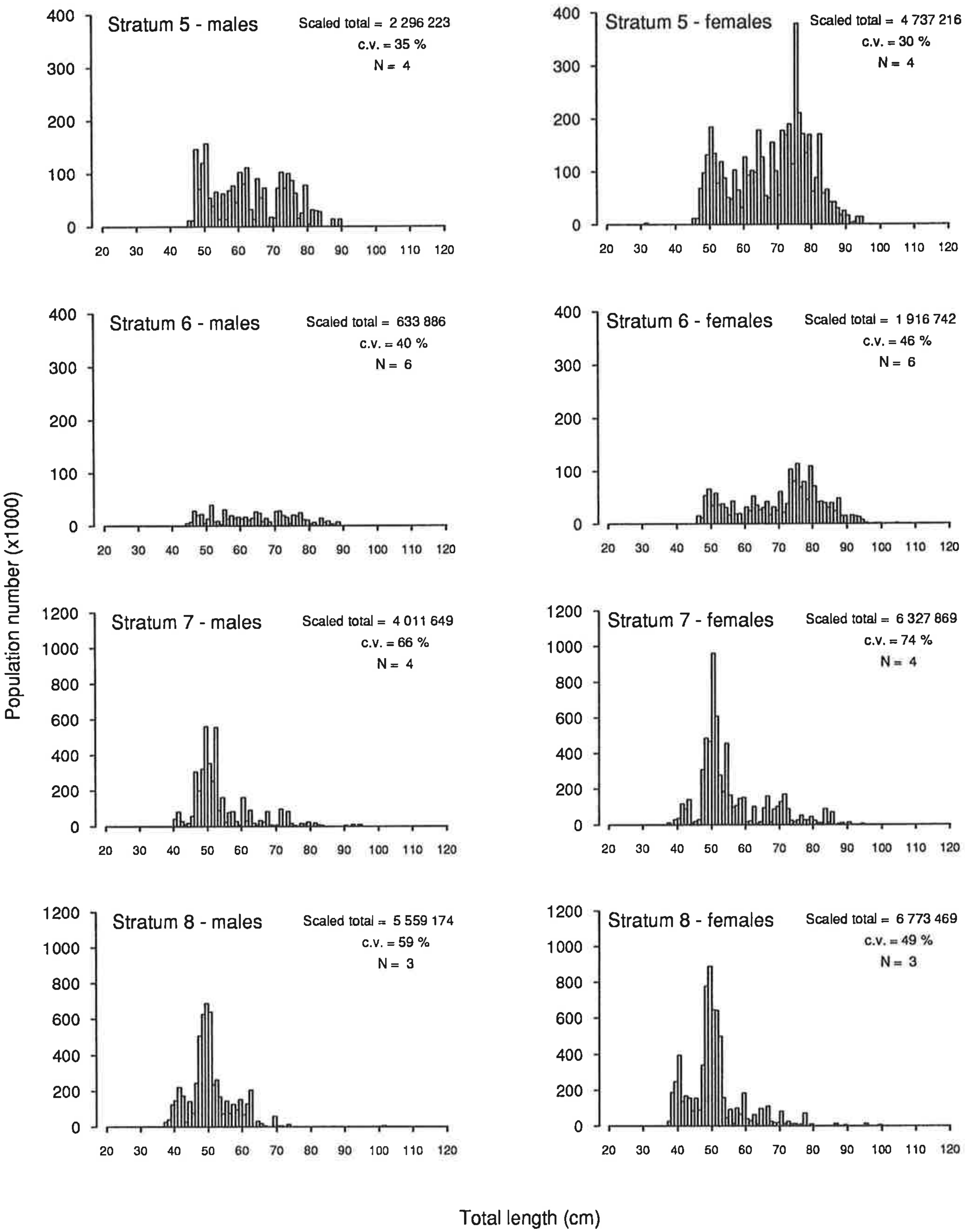
Appendix 3 – *continued*

Stratum	RAT	SND	JMM	SPE	BYX	SPD	RIB	ETB	SSO	All Species
								Species code		
200–400 m										
18	49	0	0	21	47	448	0	0	0	3 909
19	276	0	0	127	2	448	0	0	0	8 326
20	559	0	0	208	8	147	0	0	0	14 778
21	99	0	0	11	5	115	0	0	0	3 827
22	6	8	1	15	18	101	0	0	0	7 070
23	71	91	3 504	31	10	57	0	0	0	10 029
24	21	0	0	1	0	1	0	0	0	3 611
Subtotal	1 081	99	3 505	414	90	1 123	0	0	0	51 550
400–600 m										
7	442	494	6	84	15	18	70	0	0	9 023
8	172	34	0	72	8	41	17	0	0	6 487
9	161	11	0	81	90	6	6	0	0	5 646
10	271	42	11	54	11	45	12	0	0	6 715
11	167	109	170	24	577	19	29	0	0	7 785
12	452	65	0	34	683	9	89	1	0	13 916
13	476	0	5	74	1	32	18	0	0	9 248
14	441	12	0	182	3	59	28	15	0	13 295
15	335	46	0	160	0	77	22	58	0	25 507
16	864	35	0	80	0	9	62	52	0	5 227
17	822	484	0	127	0	19	152	91	0	12 194
Subtotal	4 603	1 332	192	982	1 388	334	505	217	0	115 043
600–800 m										
1	97	518	0	4	0	0	53	0	48	2 547
2	76	886	0	13	0	0	50	0	2	5 372
3	248	1 311	3	27	9	0	121	110	15	7 742
4	103	483	0	19	4	0	143	16	204	4 537
5	707	40	0	103	0	0	111	257	0	13 992
6	946	114	4	28	0	0	277	499	183	22 750
Subtotal	2 177	3 352	7	194	13	0	755	882	453	56 940
Total	7 861	4 785	3 703	1 586	1 490	1 458	1 259	1 099	453	223 535
		(9)	(44)	(11)	(55)	(19)	(11)	(28)	(48)	(10)

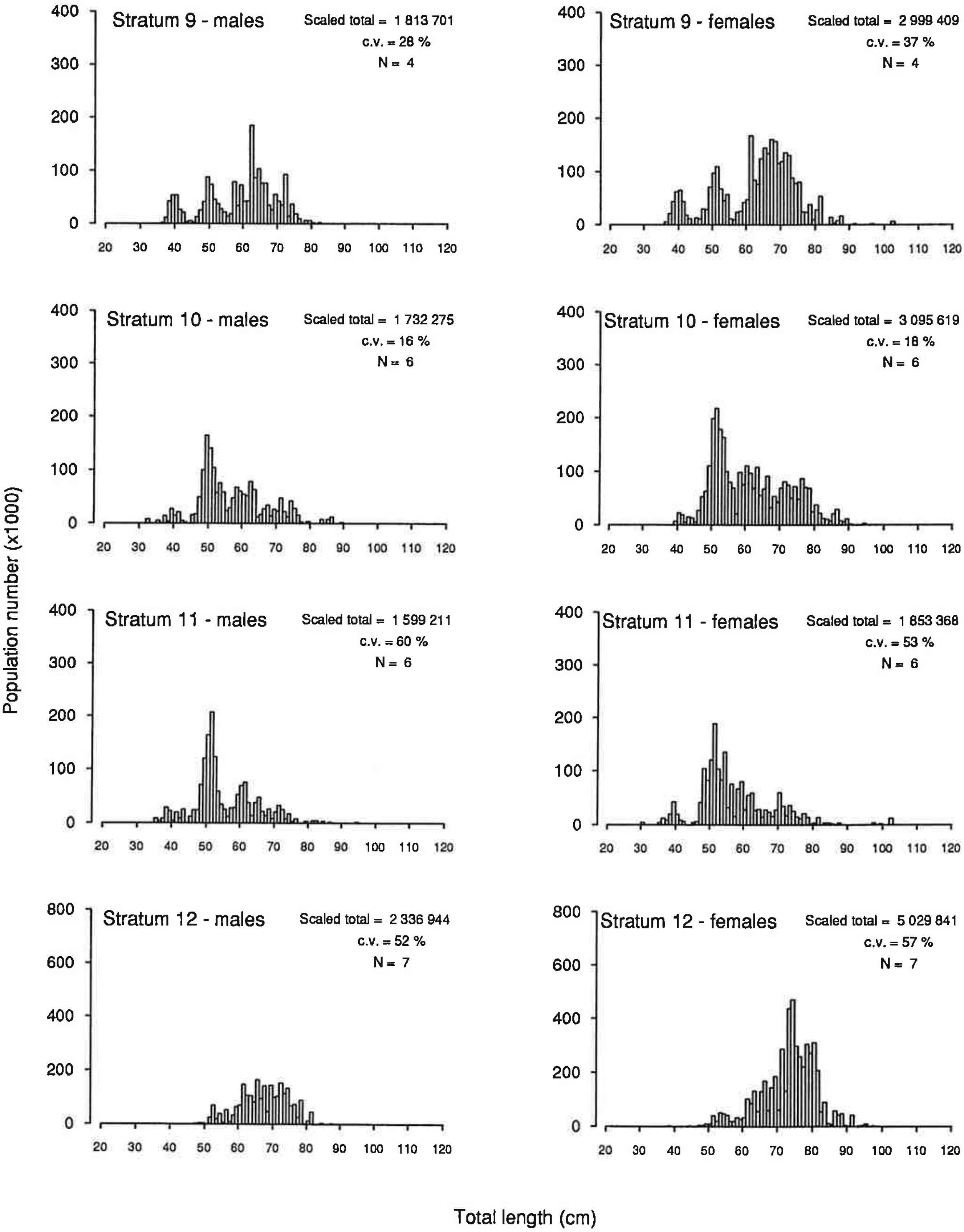
Appendix 4: Scaled length frequencies of male and female hoki by stratum (N = number of tows sampled)



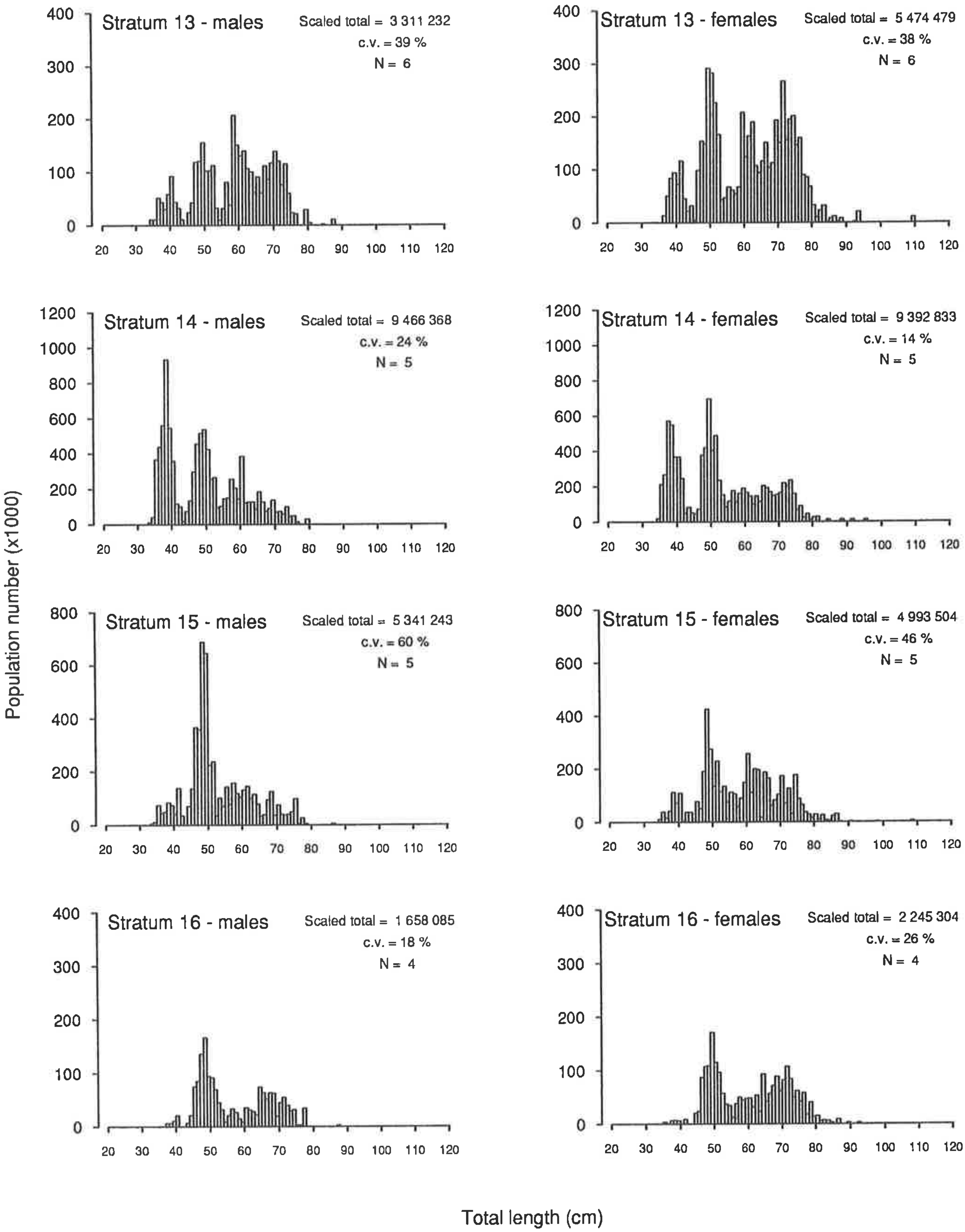
Appendix 4 — *continued*



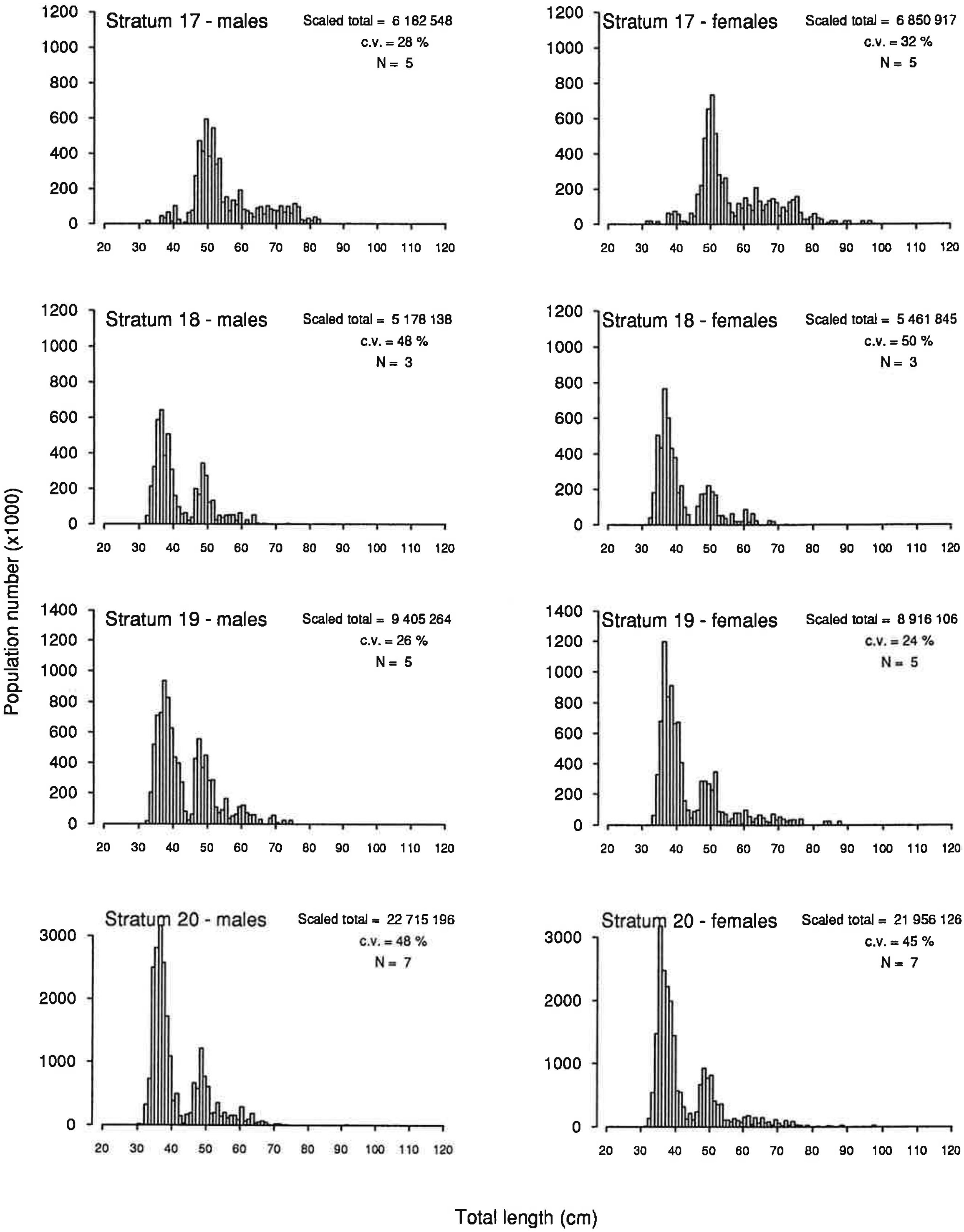
Appendix 4 — *continued*



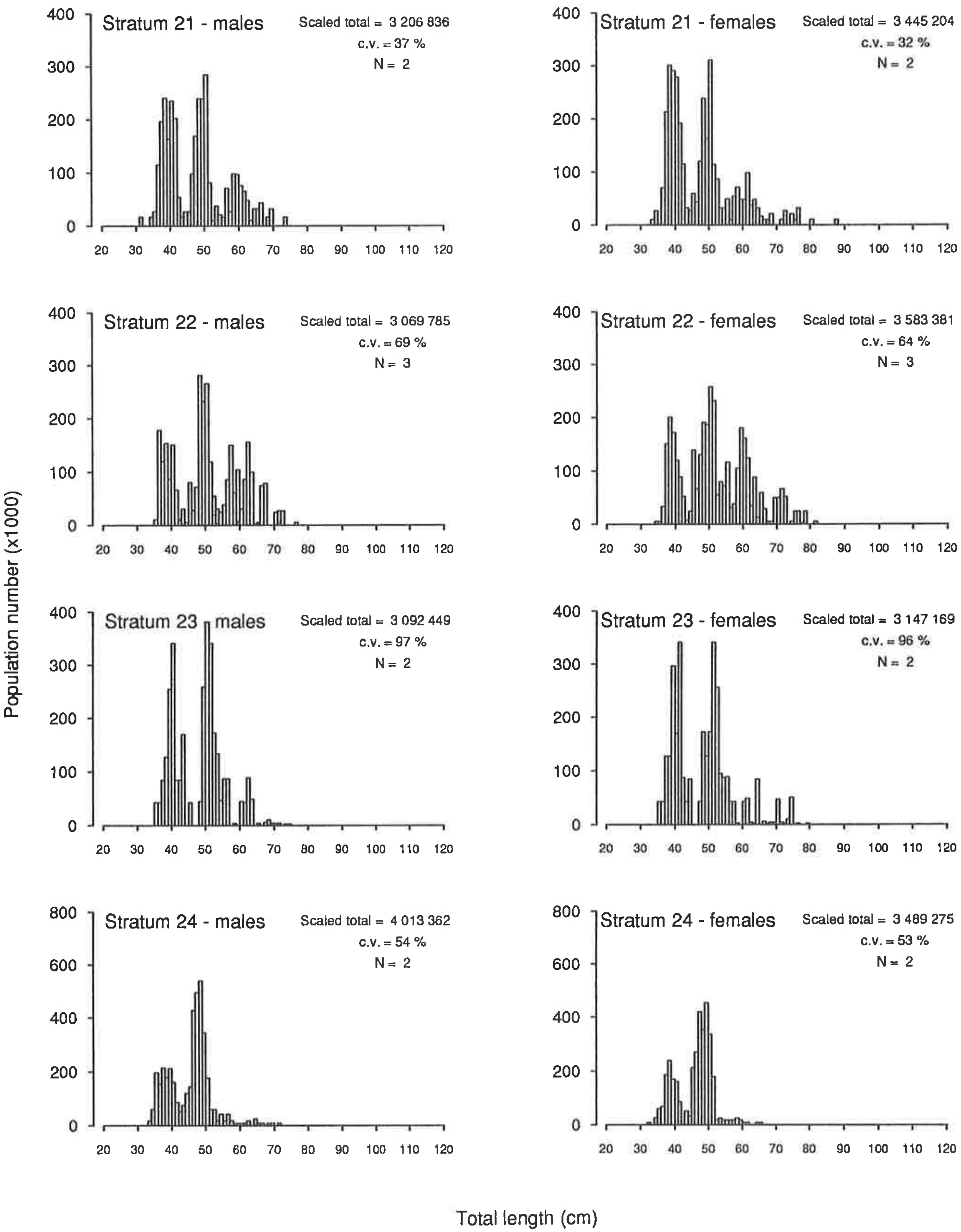
Appendix 4 — *continued*



Appendix 4 — *continued*



Appendix 4 — *continued*



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