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Taihoro Nukurangi

Estimation of hoki and middle depth fish abundance on the Chatham Rise using trawl surveys

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Final Research Report for
Ministry of Fisheries Research Project HOK1999/02
Objectives 1 and 2

National Institute of Water and Atmospheric Research

March 2001

Final Research Report
Ministry of Fisheries Project HOK1999/02, Objectives 1-2

Date : 30 September 2000

Contractor: NIWA

Project Title: Estimation of hoki and middle depth fish abundance on the Chatham Rise using trawl surveys

Project Code: HOK1999/02

Project Leader: Mary Livingston

Duration of Project Start date: 1 October 1999
Completion date: 30 September 2000

Executive Summary:

The ninth survey of the Chatham Rise was successfully completed in January 2000. The results show that the total biomass of hoki, and of recruited hoki (3+ and older) were the lowest since 1992, and continue a downward trend that has been evident since 1997. The strong year 1997 class identified as 1+ fish in 1999 did not appear to be strong as 2+ fish this year. Possible explanations for this include: 1+ hoki are poorly sampled by the bottom trawl and are unreliable indicators of year class strength; this cohort moved off the Rise between January 1999 and January 2000; this cohort suffered higher mortality than usual; the distribution of 2+ hoki in January 2000 was unusual.

The higher station number to improve sampling of hake yielded more samples of fish, but biomass estimates did not increase. Further, sampling of the new deep stratum 800-1000 m did not significantly increase the overall biomass of hake.

Objectives for 1998/99 covered by this Report:

1. To continue the time series of relative abundance indices of recruited hoki (eastern stock), hake (HAK 4) and other middle depth species on the Chatham Rise using trawl surveys. The survey design will be optimised for hake (target c.v. of 20 %) with target c.v. for recruited hoki of 15 %.

2. To determine the relative year class strengths of juvenile hoki (1, 2 and 3 year olds) on the Chatham Rise, with target c.v. of 20 % for the number of 2 year olds.

Methods, Results, Conclusions:

Methods

The survey followed the random station, two-phase design used in previous years, as documented in the attached Technical Report. Strata in which hake are taken more frequently were subdivided to increase the number of sample. A new stratum (21) in a depth of 800-

1000 m was explored for hake. Standardised gear, also used in previous years, was used for the survey. Biomass estimation followed an area-swept method, also detailed in the attached report.

Results

The survey in January 2000 was completed successfully, and the results of the survey are detailed in the attached Technical Report. Target *c.v.'s* for 2+ and adult hoki of 20% and 15% respectively were met. The total biomass of hoki in January 2000 is the lowest ever observed. Based on the size of the 1+ cohort in 1999, we were expecting a relatively strong 2+ cohort this year. While the 2+ mode dominates the length frequency, its biomass was much lower than expected. This result could be a consequence of several different factors including mass mortality of 2+ hoki, early movement of 2+ fish off the Chatham Rise to the Southern Plateau and abnormal distribution of 2+ fish.

The attached report covers only the survey of 2000.

Conclusions:

The Chatham Rise trawl survey continues to provide a valuable record of the relative abundance of hoki, hake, and ling, hoki recruitment and the population age structure of these three species, that is used in stock assessment. It is the only data set within the EEZ that monitors the recruitment of hoki, and because it is annual, provides a unique fishery-independent time series for hoki and other middle-depth species. The effect of the decline in eastern stock biomass on the assessment will be determined during stock assessment 2001.

Publications:

See attached manuscript to be published in the NIWA Technical Report series.

Data Storage:

The data are held in the MFish Trawlsurvey Database at Greta Pt. Wellington.

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Trawl survey of hoki and middle depth species on the Chatham Rise, January 2000 (TAN0001)

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NIWA Technical Report XX
ISSN xxxx
XXXX

Published by NIWA
Wellington
xxxx

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Introduction

In January 2000, the ninth Chatham Rise hoki trawl survey, in a time series of annual surveys initiated in January 1992, was completed. The surveys were designed to sample hoki, hake, and ling and provide relative abundance indices of these and other middle depth species occurring in 200–800 m depths on the Chatham Rise. The area stratification was similar to 1999 (Bagley & Livingston 2000), however, to improve the sampling of hake, some strata were sub-divided in this survey. The survey also incorporated a new depth stratum, Stratum 21, to investigate the distribution of hake in 800-1000 m northwest of the Chatham Islands.

Earlier surveys in this time series are documented by Horn (1994a, 1994b), Schofield & Horn (1994), Schofield & Livingston (1995, 1996, 1997), Bagley & Hurst (1998), and Bagley & Livingston (2000). Comparisons with the first four surveys in the time series (1992 to 1995) were made by Livingston & Schofield (1996). Surveys of the Chatham Rise before the current time series were documented by Schofield & Livingston (1995).

The survey was part of an ongoing research programme to estimate the abundance of hoki and other middle depth species for stock assessment. This year, the estimation of the abundance of hake was a high priority. The survey also provided information on the size structure of a range of Individual Transferable Quota (ITQ) species, and on their distribution across the Chatham Rise.

This report summarises the catch, distribution, length, and biomass estimates of the ITQ species, and more abundant non-ITQ species, caught on the survey.

Objectives

To continue the time series of relative abundance indices of recruited hoki (eastern stock), hake (HAK 4) and other middle depth species, particularly hake and ling, on the Chatham Rise using trawl surveys. The survey design will be optimised for hake (target *c.v.* of 20%) with a target *c.v.* for recruited hoki of 15%.

To determine the relative year class strengths of juvenile hoki (1, 2, and 3 year olds) on the Chatham Rise, with a target coefficient of variation (*c.v.*) of 20% for the number of 2 year olds.

Additional survey information to be collected included biological data and otoliths from hoki and other middle depth species for studies on ageing, growth, and stock separation and the definition of major water mass characteristics by measuring surface and bottom temperature within the survey area.

Timetable and personnel

The survey was carried out from 27 December 1999 to 22 January 2000 using RV *Tangaroa*. M. Livingston and P. McMillan (NIWA, Wellington) led the voyage (1st and 2nd legs respectively) and were responsible for data collection. N. Bagley (NIWA, Wellington) carried out the final edits to the database. M. Livingston (NIWA, Wellington) led the project.

Methods

Survey area and design

As in previous years, the survey was of a two-phase random design (*after* Francis 1984). The survey area (Figure 1) was divided into the same 20 strata used in 1999 (Bagley & Livingston 2000), with the addition of stratum 21 in 800-1000 m depth northwest of the Chatham Islands. Strata 2, 8, 10, and 11 were further subdivided because they often have high catches of hake, a target species for the survey. Phase 1 station allocation was optimised to achieve the target *c.v.*s of 15% for recruited hoki and 20% for 2+ hoki. Stratum areas and catch rates from the eight previous *Tangaroa* trawl surveys were used to simulate the optimal allocation. Optimisation of station distribution to meet the required c.v. of hake was also carried out, but fell within the station distribution required to sample hoki. However, additional stations in the sub-stratified strata 2, 8, 10 and 11 ensured that more samples of hake were collected to develop a satisfactory age-length key. Optimisation used bootstrap simulation to allocate stations to strata with high catch rates, based on the same principle as the phase 2 station allocation of Francis (1984). A minimum of 108 random stations were planned for phase 1. Additional stations for phase 2 were allocated after the completion of phase 1 to improve the *c.v.* for target species or hoki age classes as required.

All station positions were selected randomly using the NIWA Random Stations Generation Program (version 1.6). Mid-tow positions were always separated by a minimum of 3 n. miles.

Vessel specifications

RV *Tangaroa* is a purpose-built research stern trawler with the following specifications: length overall, 70 m; beam, 14 m; gross tonnage, 2282 t; power, 3000 kW (4000 hp).

Gear specifications

The trawl gear was the same as that used on previous *Tangaroa* surveys in this series, i.e., an eight-seam hoki bottom trawl with a 58.8 m groundrope, 45 m headrope (*see* Hurst & Bagley 1994 for the net plan and rigging details) and a codend mesh size of 60 mm. It was rigged with 100 m long sweeps, 50 m bridles, and 12 m backstrops. The trawl doors were Super Vee type with an area of 6.1 m^2. The doorspread and headline height were recorded every 5 minutes during each tow (from the Scanmar system and either the Kaijo Denki or Furuno net monitor, respectively) and an average was calculated. Doorspread readings were recorded from 127 tows. The five missing values were calculated from an average for the appropriate depth range from doorspread data collected during the survey.

Trawling procedure

Trawling was carried out during daylight, i.e., between sunrise and sunset (minimum start time = 0515, maximum finish time = 1905). If time was running short at the end of the day, the vessel steamed towards the last station and the trawl was shot on that transect line in time to ensure completion of the tow by sunset, as long as 50% or more of the distance between stations had been completed. At each station it was planned to tow for 3 n.miles at a speed of 3.5 knots over the ground. If a station occurred in an area of foul ground, then the area within 3 n. miles of that position was searched for trawlable bottom. If suitable ground was not found, the station was abandoned and another random position

chosen. If foul ground was encountered during trawling, the tow was considered invalid if less than 2 n.miles of the tow had been covered in total. Tows less than 2 n. miles long were replaced with another random station in the same stratum. The average speed over the ground was calculated at the end of each tow.

Gear configuration was maintained as constant as possible during the survey and within the ranges described as desirable by Hurst *et al.* (1992).

Hydrology

Surface temperatures are normally obtained at the start of each tow from a temperature sensor mounted on the hull at a depth of about 5 m. Unfortunately, surface temperature readings were unable to be obtained due to a faulty temperature sensor. In lieu of surface temperature recordings, we present the monthly average sea surface temperature recordings obtained by satellite, in January 2000. Bottom temperature readings were obtained for 56 of the first 60 stations at the beginning of the survey from the average of recordings taken every 5 minutes from the Furuno net monitor, mounted on the trawl headline about 6.5 m above the seabed during trawling. Unfortunately, problems were also experienced with the net monitor, and no bottom temperature readings were obtained after the first 60 stations.

Catch sampling

The catch at each station was sorted into species and weighed on motion-compensating electronic scales accurate to within ± 0.3 kg. For large catches of mixed rattails, the weights of individual species were estimated by sub-sampling, i.e., a sub-sample was sorted and weighed by species and the total catch was scaled according to the percentage weight of each species in the sub-sample.

Samples of up to 200 hoki and 50–200 of other commercial species were randomly selected from the catch to measure length (total, fork, mantle (squid), and chimaera (tip of snout to posterior end of dorsal fin)) and determine sex. At almost every station they occurred, up to 20 specimens of hoki, hake and ling were selected from the length frequency sample for detailed biological analysis and otolith removal. Data collected were length, weight, sex, gonad stage and weight, and stomach fullness, stomach contents, and prey digestion state.

Length, weight, and sex data were also collected from samples of alfonsino, arrow squid, banded giant and giant stargazer, dark and pale ghost shark, lemon sole, lookdown dory, orange perch, red cod, ribaldo, scampi, school shark, sea perch, shovelnose dogfish, silver warehou, spiny dogfish, tarakihi, and white warehou (*see* Appendix 2 for scientific names). These data were for calculation of length-weight relationships to enable more accurate scaling of the length frequencies for these species.

Data analysis

Doorspread biomass was estimated by the area-swept method of Francis (1984, 1989). The *c.v.* is a measure of the precision of the biomass estimate, and is calculated by:

$$c.v.\ (\%) = S_B / B \times 100$$

where S_B is the standard error of the biomass (B).

The catchability coefficient (an estimate of the proportion of fish in the survey area available to be caught in the net) is the product of vulnerability (v), vertical availability (u_v), and areal availability (u_a) as defined by Francis (1989). These factors were all set to 1 in these analyses, the assumptions being that fish were randomly 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 effect of the doors, sweeps, and bridles was constant.

Data from all stations with satisfactory gear performance (code 1 or 2).

Scaled length frequencies were calculated for the main species with the Trawlsurvey Analysis Program, version 3.2 (Vignaux 1994). The data from each station were scaled by the percentage of the catch sampled (to represent each catch) and by the ratio of the area swept to stratum area (to represent the total population). A further correction (usually minor) was made to ensure that the biomass calculated from the scaled length frequencies equated to the biomass calculated from catch data. Total biomass and biomass by stratum for 1+, 2+, and 3++ (a plus group of hoki aged 3 years or more) age groups were also calculated using the Trawlsurvey Analysis Programme.

Results

Survey coverage

One hundred and eighteen phase 1 stations were successfully completed (Table 1). Fourteen additional phase 2 stations were put into strata 8b, 9, 18, and 19 in an attempt to improve the *c.v.* for hoki and ling. The station density in individual strata ranged from 1:288 in stratum 17 to 1:3772 km^2 in stratum 4 (*see* Table 1). Mean station density over the whole survey area was 1:1395 km^2. The positions of all trawl survey stations successfully completed are given in Figure 1, and individual station data, foul shots, and acoustic trawls are given in Appendix 1.

Gear performance

Gear configuration remained relatively constant over the 200–1000 m depth range: mean doorspread measurements by 200 m depth interval ranged from 111.6 to 115.8 m and headline height from 6.9 to 7.4 m, all falling within the accepted range (Hurst *et al.* 1992) (Table 2). The mean doorspread of individual tows ranged from 99.8 to 129.9 m and the desirable range (100–130 m) was exceeded only slightly on one occasion. Stations 61 and 124 were given a poor gear performance code (i.e., came fast) and were excluded from all analyses.

Hydrology

The average sea surface temperatures on the Chatham Rise from satellite retrievals for the month of January 2000 ranged from 14.0 to 17.5°C (Figure 2a). Bottom temperatures were recorded for 56 of the first 60 stations and ranged from 7.2 to 10.4°C (Figure 2b).

Sea surface temperatures were highest from the northwestern part of the survey area and lowest in the southwestern part. Lower surface temperatures, 15°C or less, were recorded along the southern edge of the Chatham Rise and around the Chatham Islands. Higher surface temperatures, 16.5°C or more were recorded along the northern edge of the Chatham Rise. Although restricted to the eastern portion of the

survey area, bottom temperatures were highest in the shallower areas to the west and east of the Chatham Islands as in previous surveys.

Catch composition

One hundred and fifty-four species or species groups were recorded: 93 teleosts, 28 elasmobranchs, 12 crustaceans, 7 cephalopods, and 1 agnathan, the remainder consisting of assorted benthic and pelagic organisms. A full list of species caught, and the number of stations at which they occurred, is given in Appendix 2.

The total catch was 128.9 t, of which 45.4 t (35.2%) was hoki, 9.3 t (7.2%) was dark ghost shark, 6.7 t (5.1%) was Bollons' rattail, and 6.3 t (4.9%) was spiny dogfish (Table 3).

Biomass estimation

Estimates of the biomass of the major commercial and non-commercial species are given in Table 3 and biomass by stratum for hoki in the 1+, 2+, and 3++ age groups in Table 4. Estimates of biomass by stratum of the 18 next most abundant species are presented in Table 5. Parameters of length-weight relationships used in the Trawlsurvey Analysis Program to scale length frequencies and to calculate hoki biomass by cohort are given in Table 6.

Hoki was the most abundant species, with 59% of the biomass being smaller sized fish in the 1+ and 2+ age groups. Black oreo, dark ghost shark, ling, silver warehou, pale ghost shark, sea perch, spiky oreo, red cod, white warehou, giant stargazer, and hake were other commercial ITQ species with a biomass over 1500 t. Most of the alfonsino and oreos caught were pre-recruits. The most abundant commercial non-ITQ species were spiny dogfish, lookdown dory, and shovelnose dogfish. A substantial biomass of non-commercial species, primarily rattails, was also estimated from the survey (*see* Table 3).

Species distribution

Catch rates for hoki from the 1+, 2+, and 3++ age groups are given in Figure 3. Catch rates for the 19 next most abundant species are given by stratum in Table 7 and distribution by station is shown in Figure 4.

Hoki were caught at 130 of the 132 successful biomass stations. The largest single catch rate of hoki (8 736 kg.km^{-2}) was caught in stratum 9 and mostly consisted of 2+ fish. Strata 18, 19 and 20 (to the east of Mernoo Bank) and stratum 9 (north of the Chatham Islands) yielded the highest catch rates of 1+ hoki and contributed to 97% of the biomass of this age group. Two year old hoki were also abundant in these strata (50% of 2+ biomass) and in the deeper (400–600 m) strata 7, 8b and 16 (29% of 2+ biomass). Larger 3++ hoki were distributed in 200–1000 m depths throughout the survey area. The largest catch was taken in stratum 9 to the north of the Chatham Islands.

Catches of hake were small, with the largest haul of 102 kg.km^{-2} taken north of the Mernoo Bank in stratum 7. Some hake were taken in and around the hake spawning area in strata 8b, 10a, 10b, 11a, 11b, and 11c. Few hake were taken at depths of 200–400 m. Ling catches were evenly distributed over the Chatham Rise between 200 and 600 metres. The largest catch of ling (872 kg.km^{-2}) was taken on the Veryan Bank (southeast of the Mernoo Bank).

Lookdown dory, seaperch, big eyed rattail, spiny dogfish, javelinfish and giant stargazer were widely distributed across the survey area and taken in larger quantities at depths between 200 and 600 m. Black oreo were taken from 600–800 m strata on the south Chatham Rise and spiky oreo and shovelnose dogfish were taken at the same depth range on the north Chatham Rise. Dark ghost shark occurred mainly in the 200–400 m strata with one large catch (7725 kg.km-^{2}) taken in stratum 17, and pale ghost shark were mostly taken at depths greater than 400 m. Silver warehou and white warehou were patchily distributed and predominantly taken at depths of 200–400 m with the largest catches in stratum 5 and 20 respectively. Occasional catches of alfonsino and red cod were made in shallower strata east of Mernoo Bank and around the Chatham Islands.

Biological data

The numbers of fish of each species from which length or more detailed biological data were collected are given in Table 8. Length frequencies for all hoki by sex and depth are given in Figure 5a and by sex, depth, and area in Figure 5b. Length frequencies of hoki by stratum are given in Appendix 3. Length frequencies by sex and depth range (200–400 m, 400–600 m and 600–800 m) are given for hake (includes stratum 21, 800-1000m) (Figure 6) and ling (Figure 7). Scaled length frequency histograms by sex of the other major commercial species are presented in Figure 8. These length frequencies represent the population structure for the survey area as sampled by bottom trawl.

Scaled length frequencies and calculated numbers at age for hoki are dominated by two relatively strong cohorts: a 1+ cohort with a mode at 40 cm total length (TL) and a 2+ cohort with a mode at 54 cm total length. The 1+ cohort was mostly caught in the 200–400 m depth range on the western side of the survey area. No 1+ and few 2+ hoki were caught deeper than 600 m. Overall sex ratios were 0.9:1 (males to females) with more females 0.4:1 in 600–800 m and 0.7:1 at 400–600 m. More males 1.1:1 were caught at 200–400 m depths.

Sex ratios were about even for most other species, except for spiny dogfish for which there were fewer males than females (sex ratios exceeded 1:1.5 M:F), and barracouta, red cod, scampi, and spiky oreo which were predominantly male (sex ratio exceeded 1.5:1).

Gonad stages of hake, hoki and ling are summarised in Table 9. Hoki were either resting or immature; adult hake were in active reproduction stages (81% of males and 54% of females) ripening to partially spent (stages 3–6); adult ling showed 22% of males and 1% of females with active spawning reproduction stages.

Discussion

The allocation of phase 1 stations and phase 2 effort achieved the target precision levels 15% (final *c.v.* 12.3%) for adult hoki and slightly exceeded the target levels of 20% (final *c.v.* 20.7 %) for 2+ hoki. Phase 2 stations were directed at 2+ hoki, primarily in stratum 8b and 9, and lowered the *c.v.* for 2+ hoki from 44% after phase 1 to 21%.

The estimated total biomass of hoki is the lowest since the time series was initiated in 1992 and it continues a downward trend evident since 1997. The hake biomass in stratum 21 was low (62 t) and only constituted 2.9% of the overall hake biomass estimate.

Acknowledgments

Thanks to all the participating scientific staff and the Master, officers, and crew of *Tangaroa* who contributed to the success of this voyage. Thanks also to Owen Anderson for providing constructive comments on this manuscript. This work was carried out by NIWA under contract to the Ministry of Fisheries (Contract No. HOK9902).

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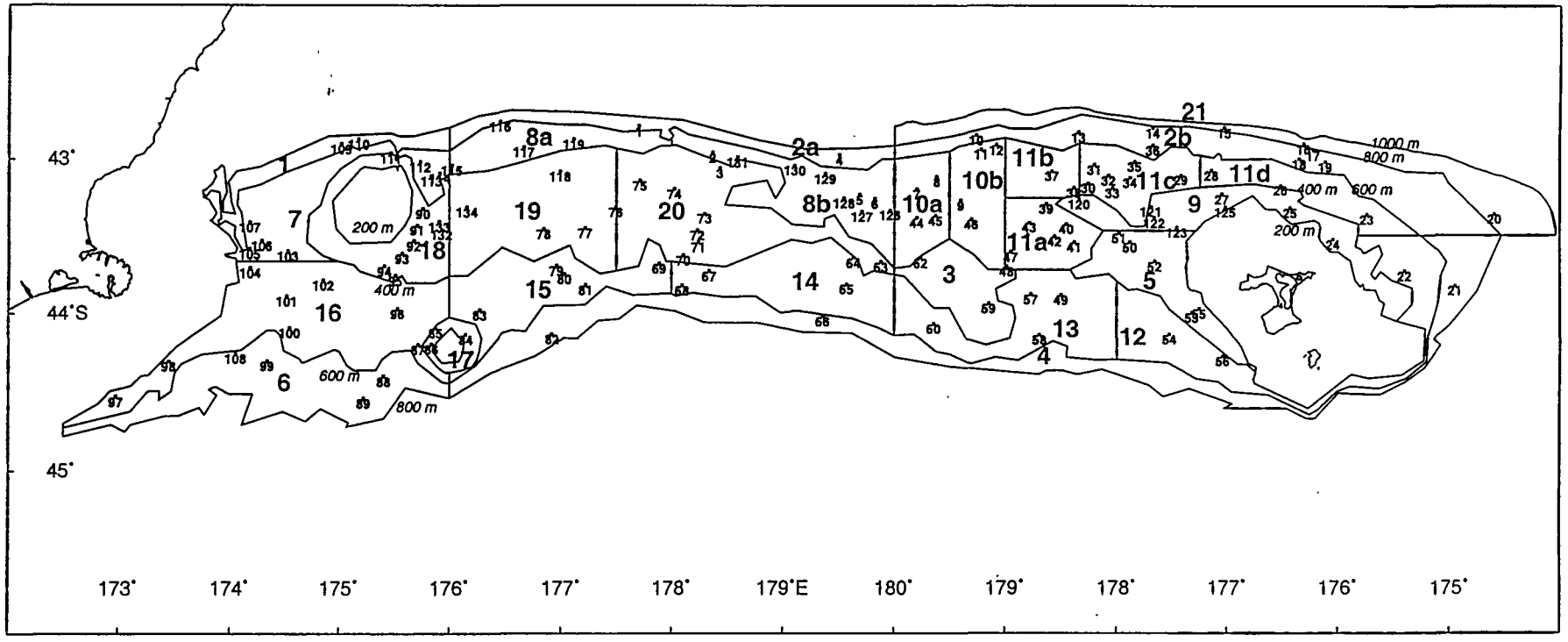


Figure 1: Chatham Rise showing survey area, strata and trawl survey positions.

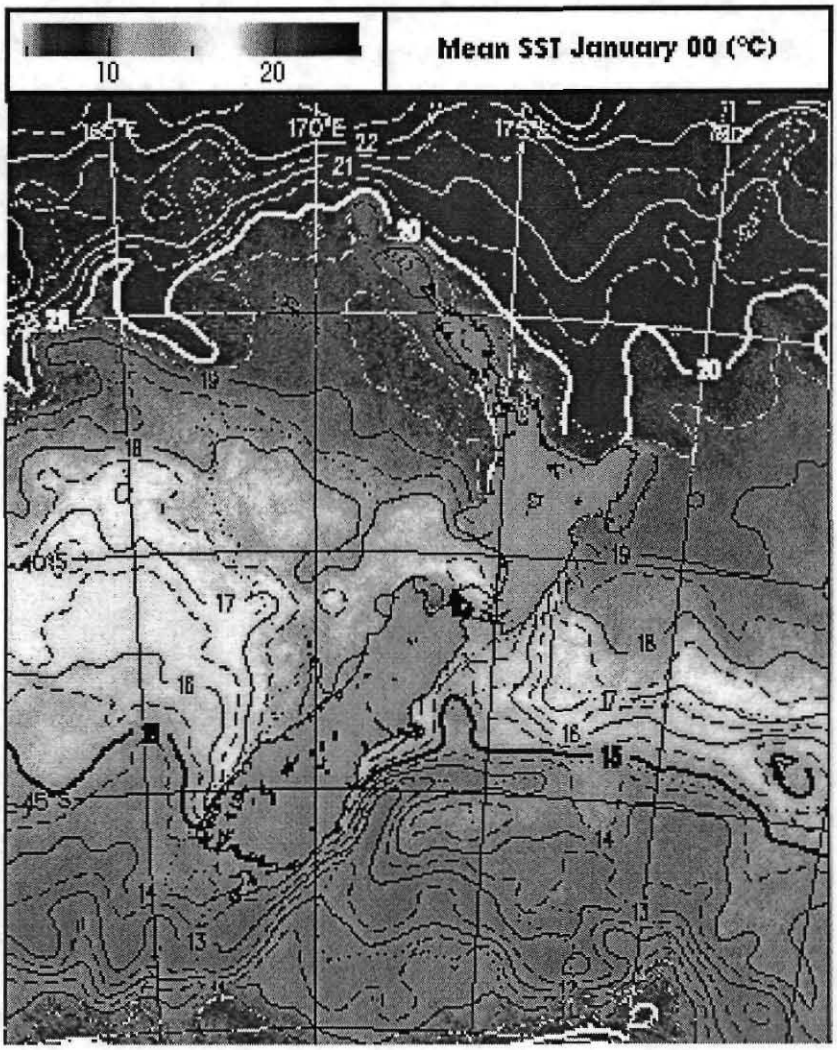


Figure 2a: Positions of average sea surface temperature isotherms from satellite retrievals for January 2000.

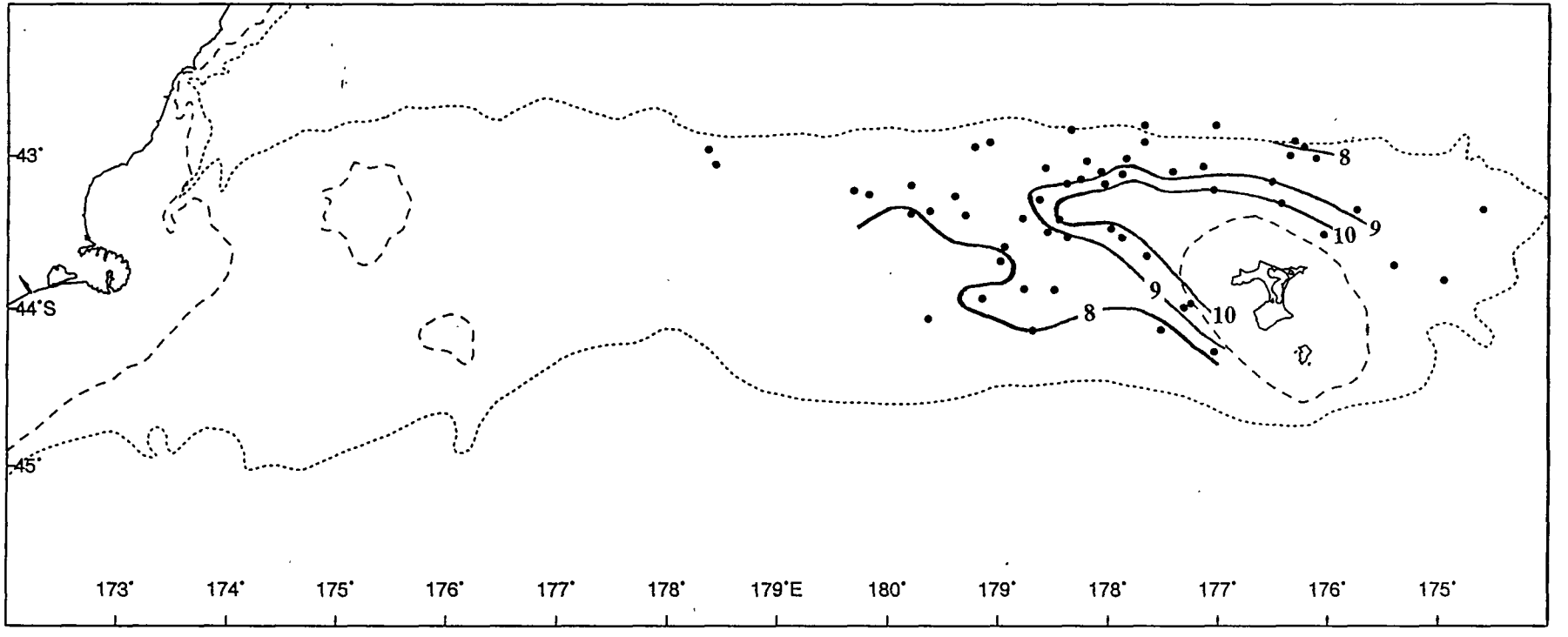


Figure 2b: Positions of bottom temperature recordings and isotherms estimated from these data.

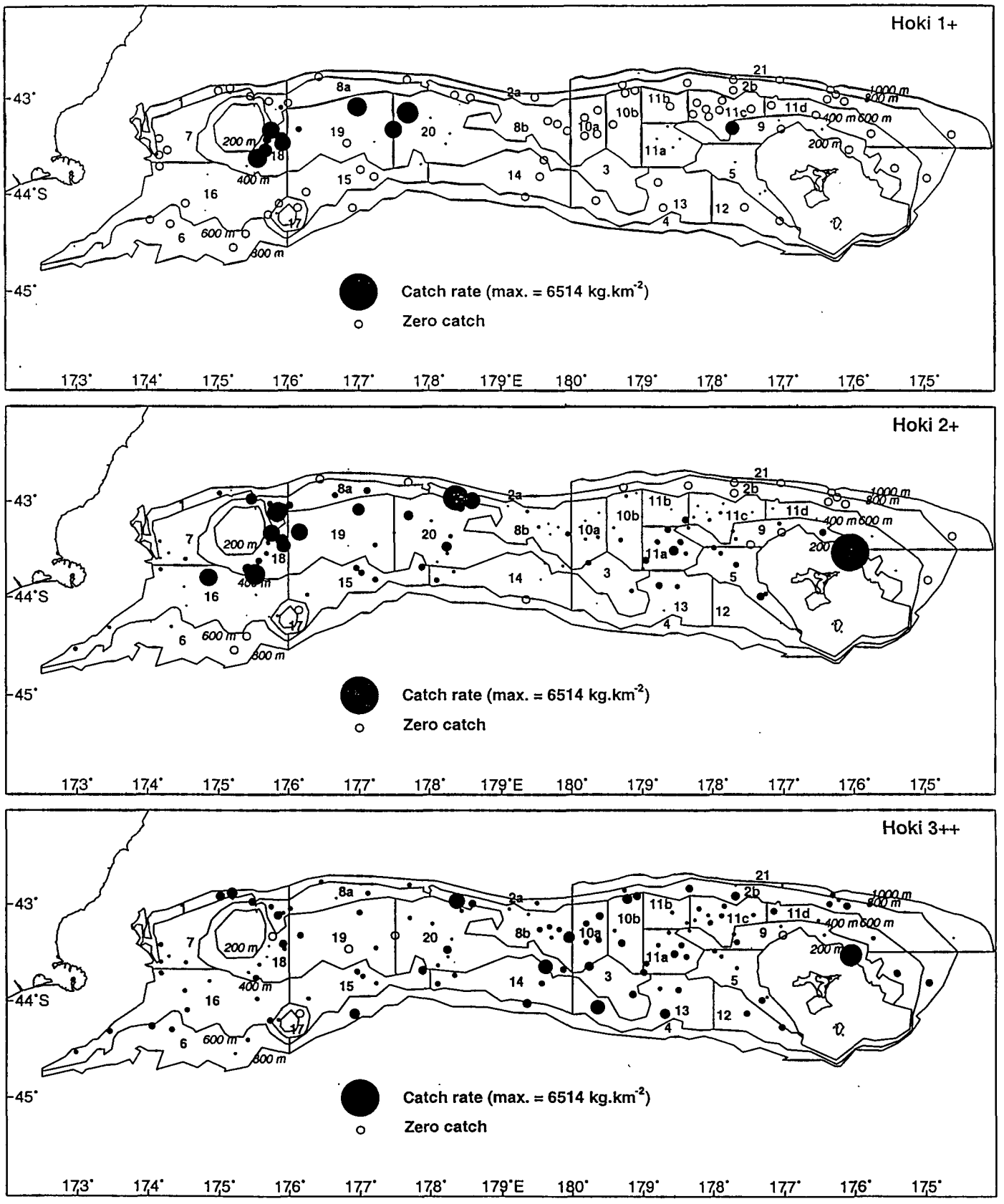


Figure 3: Catch rates (kg.km^{-2}) of hoki by age group. 1+, designates a fish between 1 and 2 years old; 2+, designates a fish between 2 and 3 years old; 3++, designates all fish 3 years and older. Circle area is proportional to catch rate. (max., maximum catch rate)

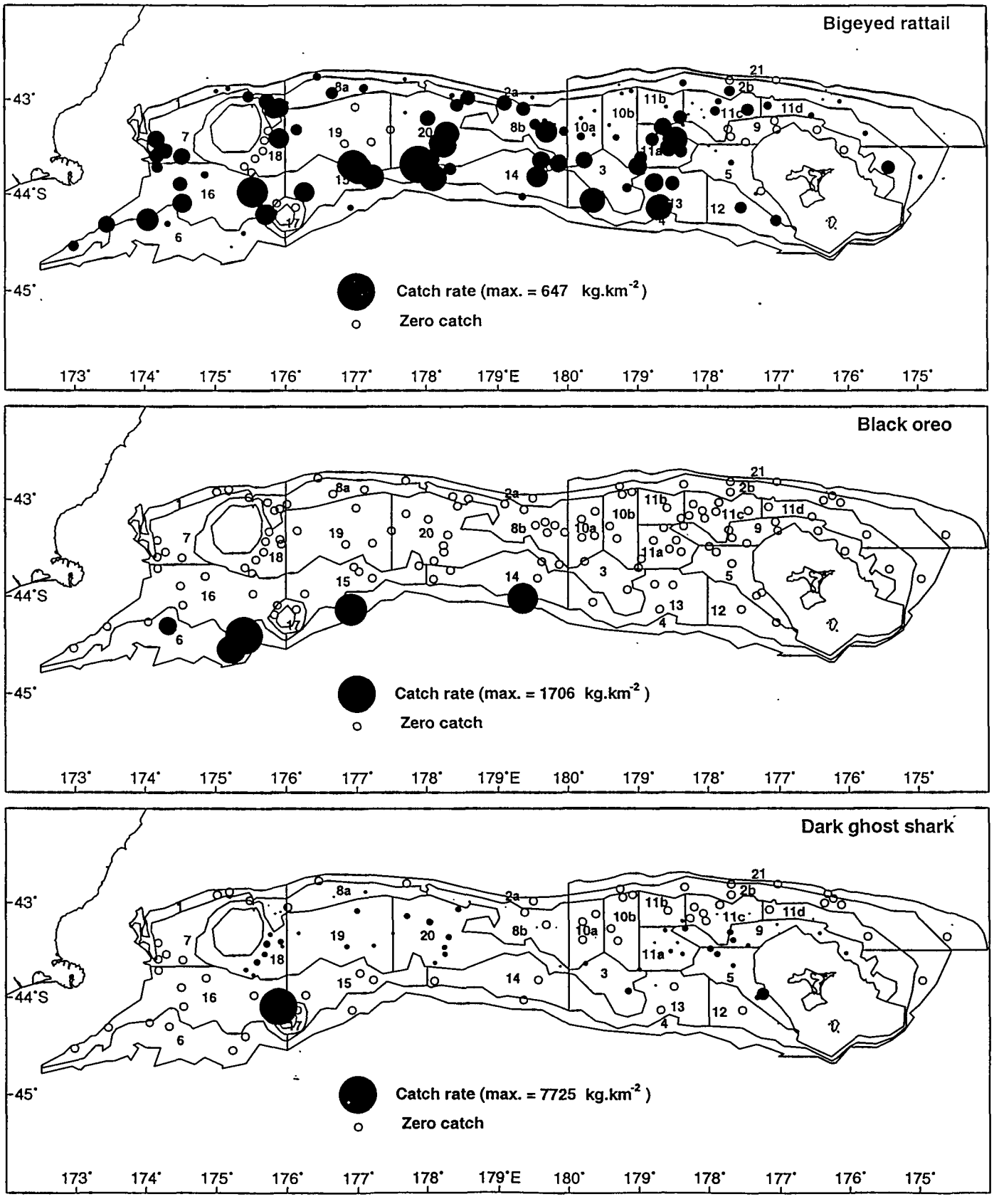


Figure 4: Catch rates (kg.km^{-2}) of the most abundant species (after hoki). Circle area is proportional to catch rate. (max., maximum catch rate)

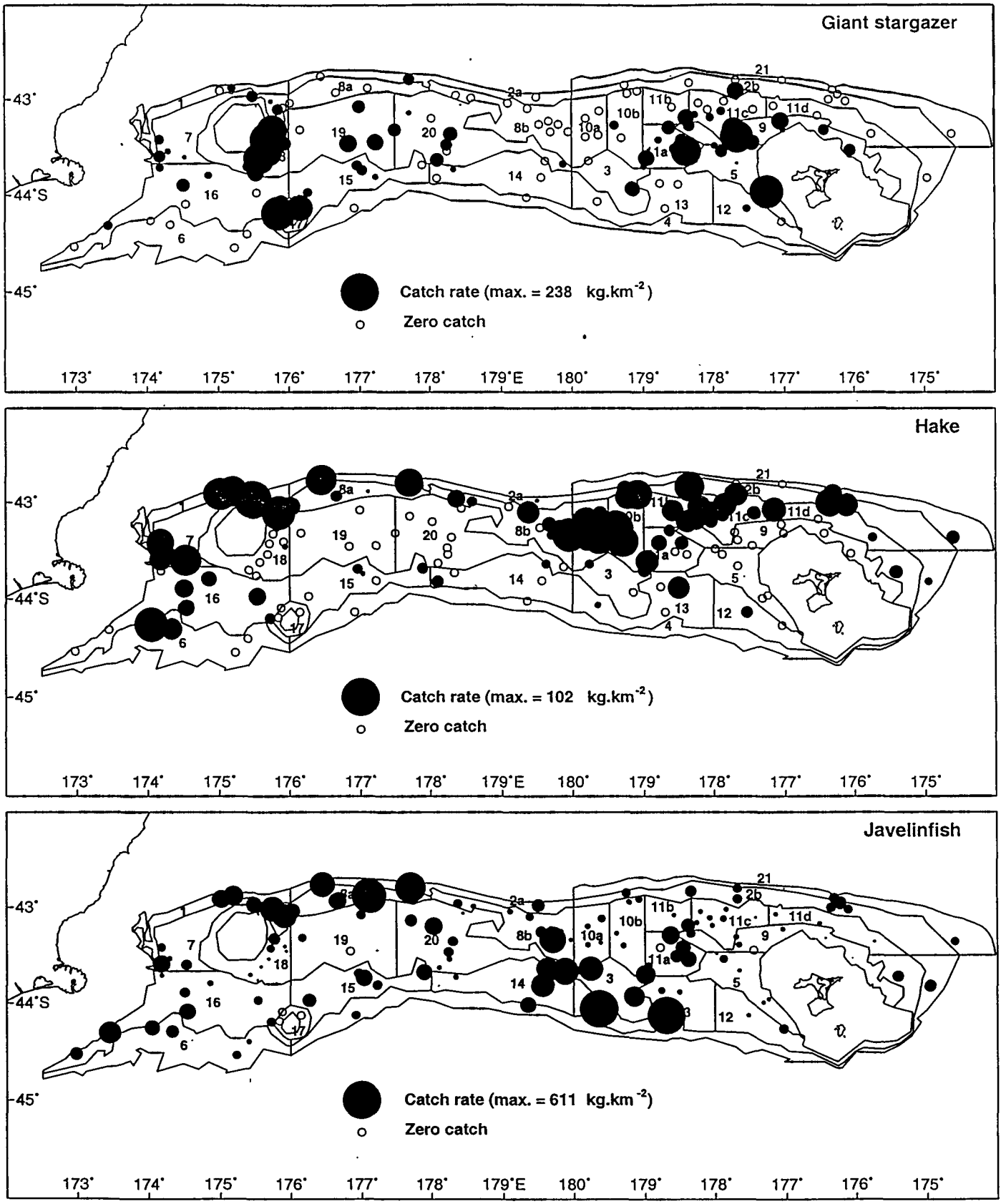


Figure 4 – *continued*

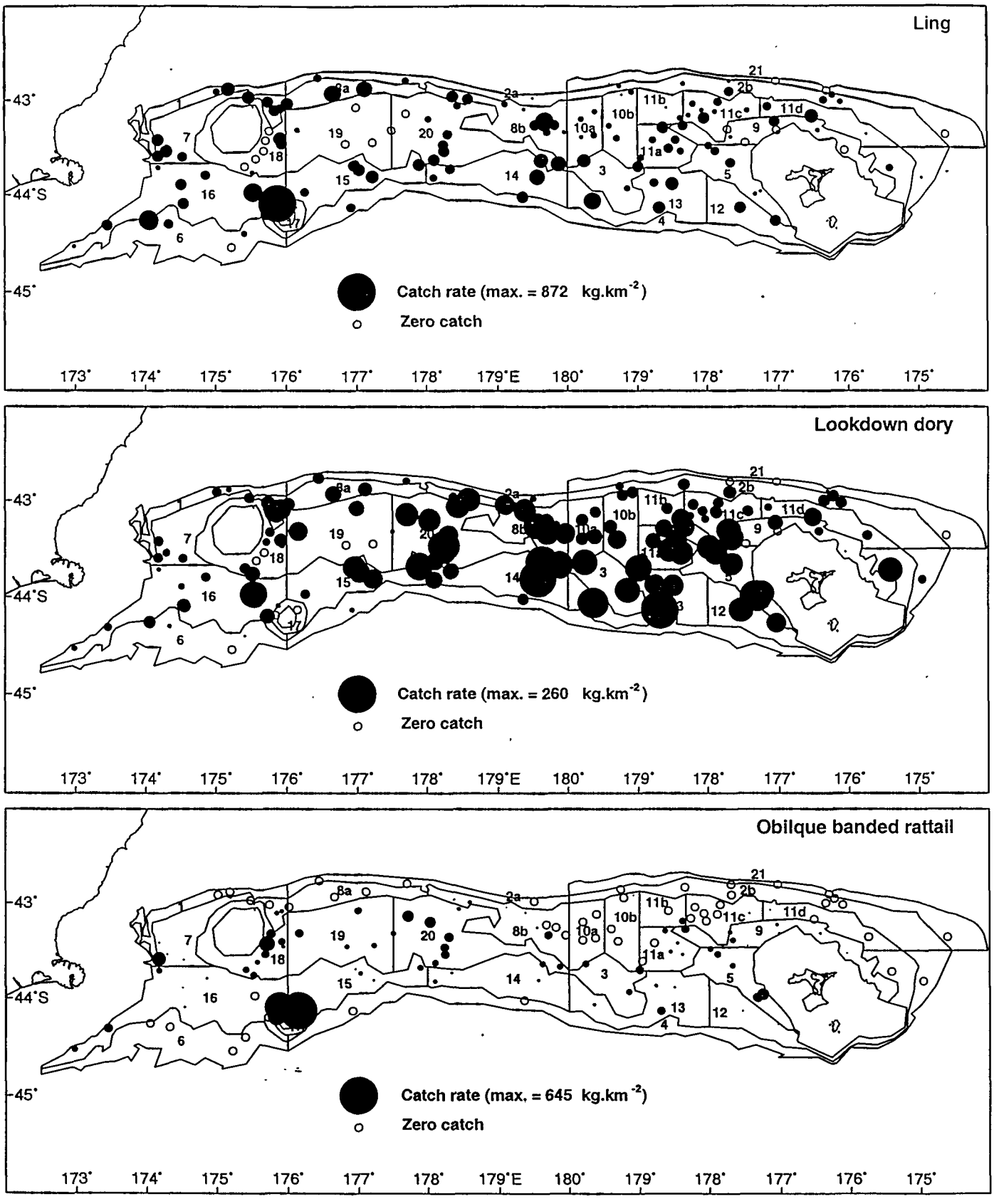


Figure 4 – *continued*

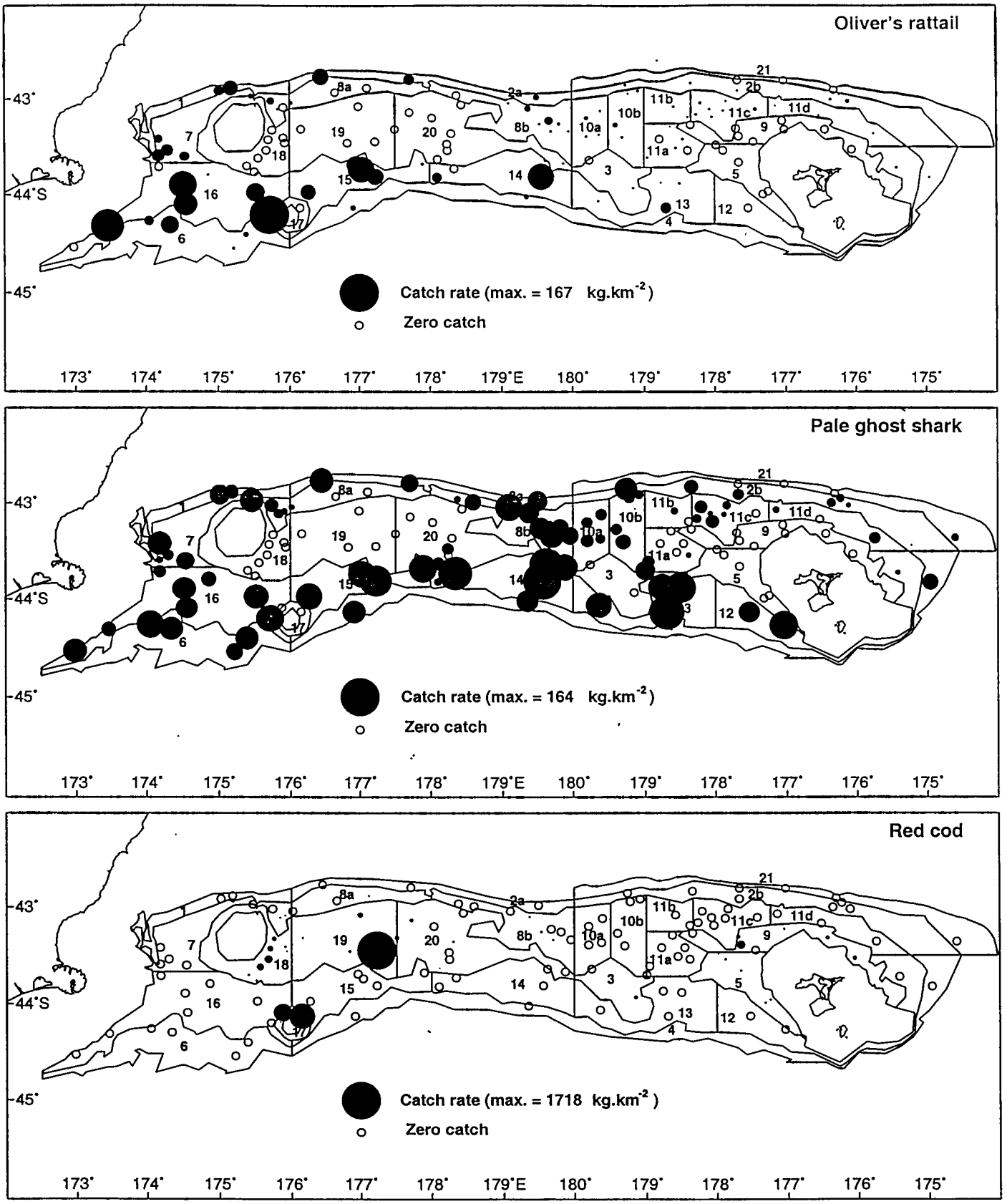


Figure 4 – *continued*

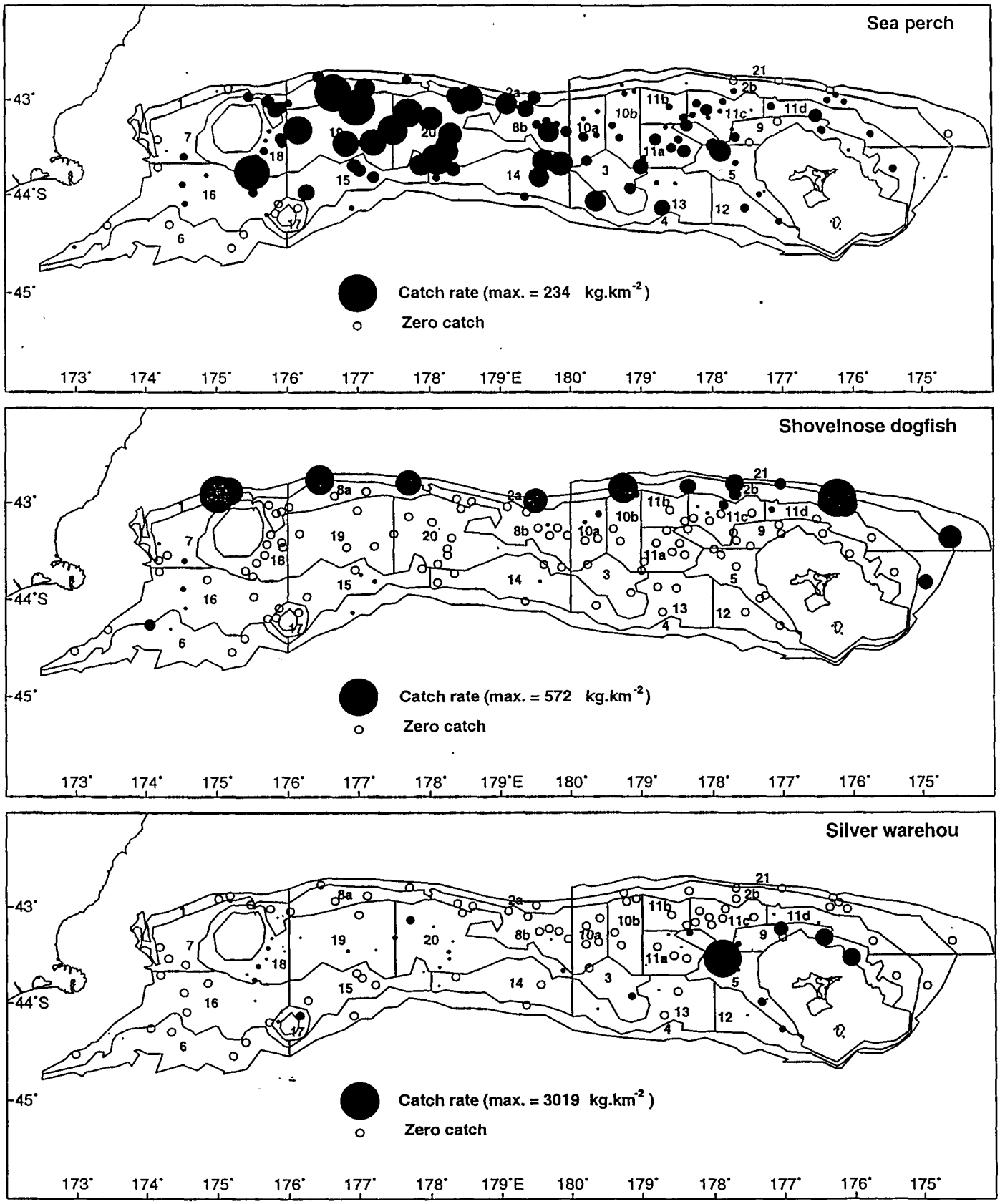


Figure 4 – *continued*

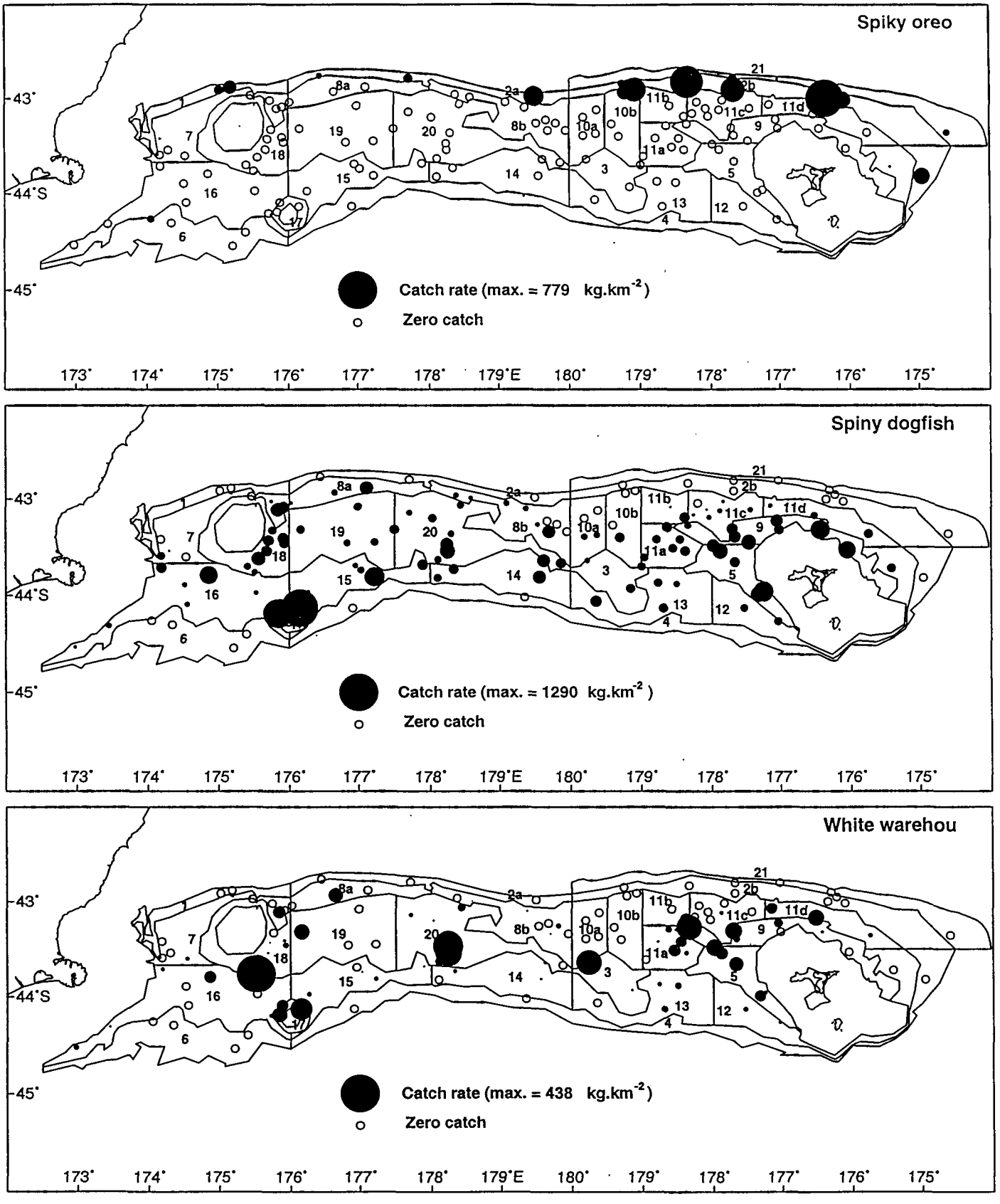


Figure 4 – *continued*

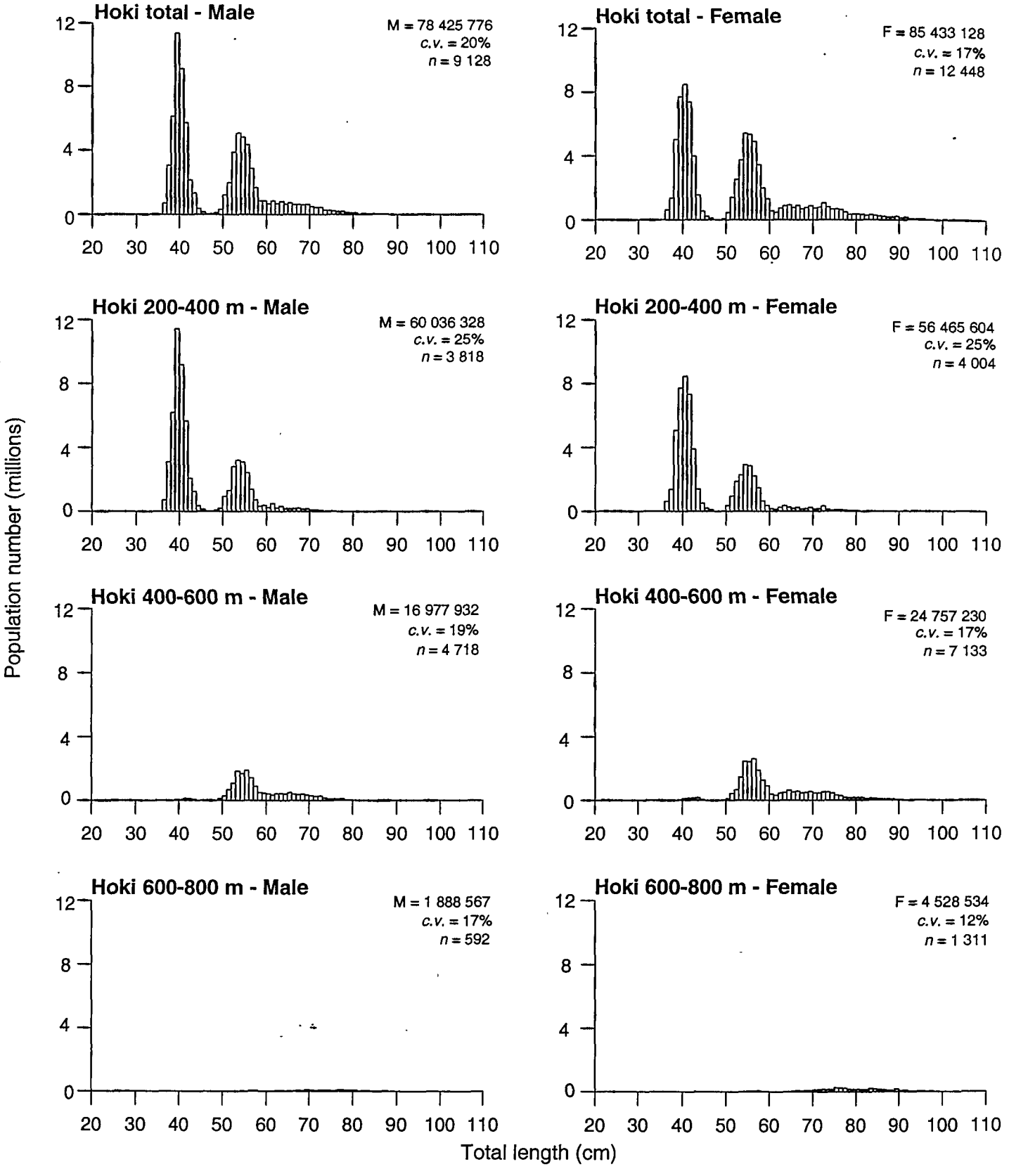


Figure 5a: Scaled length frequencies for hoki, by sex and depth zone (200-400, 400-600, 600-800). (M, estimated male population; F, estimated female population; *c.v.*, coefficent of variation of the estimated numbers of fish; *n*, numbers of fish measured).

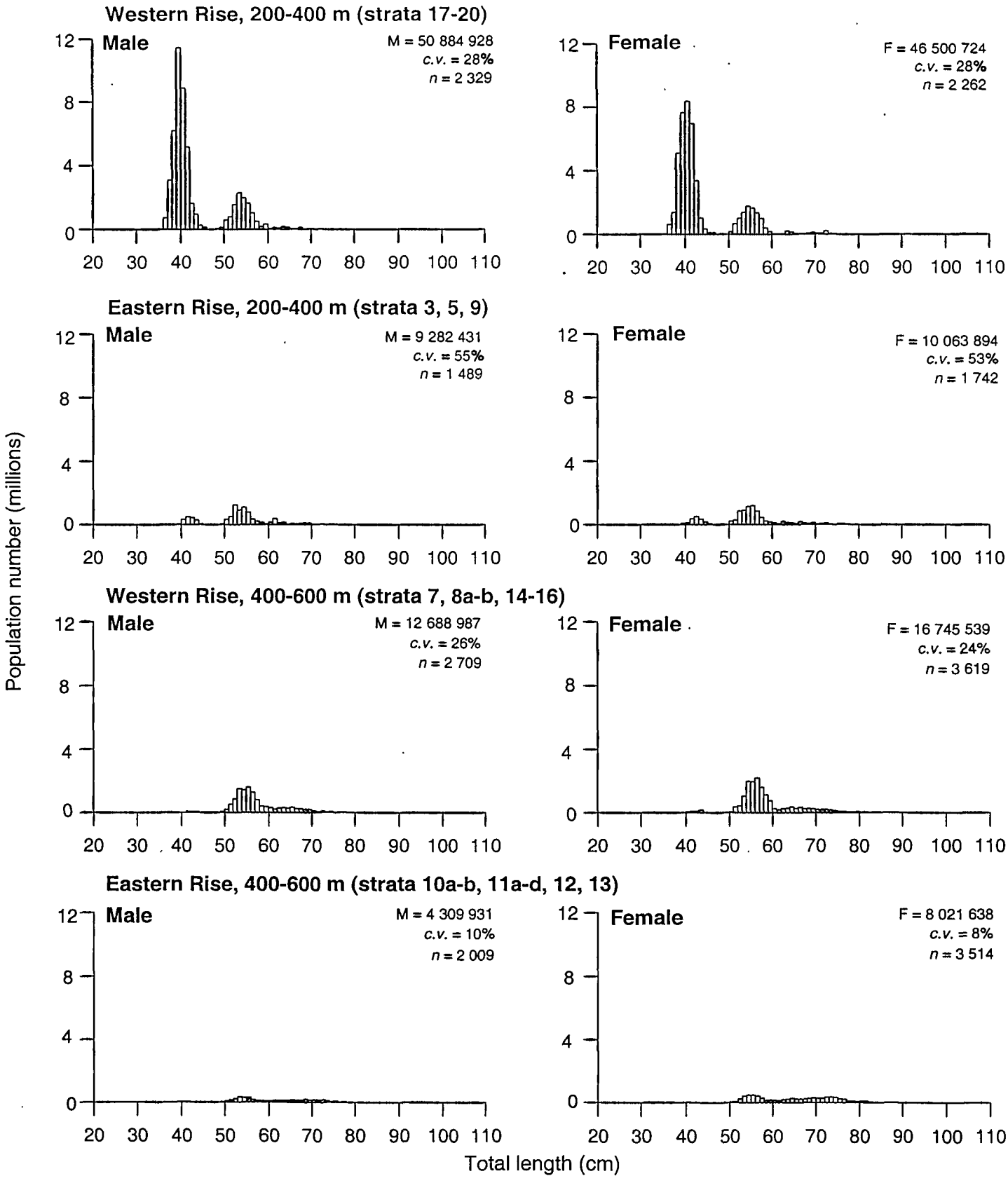


Figure 5b: Scaled length frequencies for hoki, by sex and depth zone (200-400, 400-600, 600-800). (M, estimated male population; F, estimated female population; c.v., coefficent of variation of the estimated numbers of fish; numbers of fish measured).

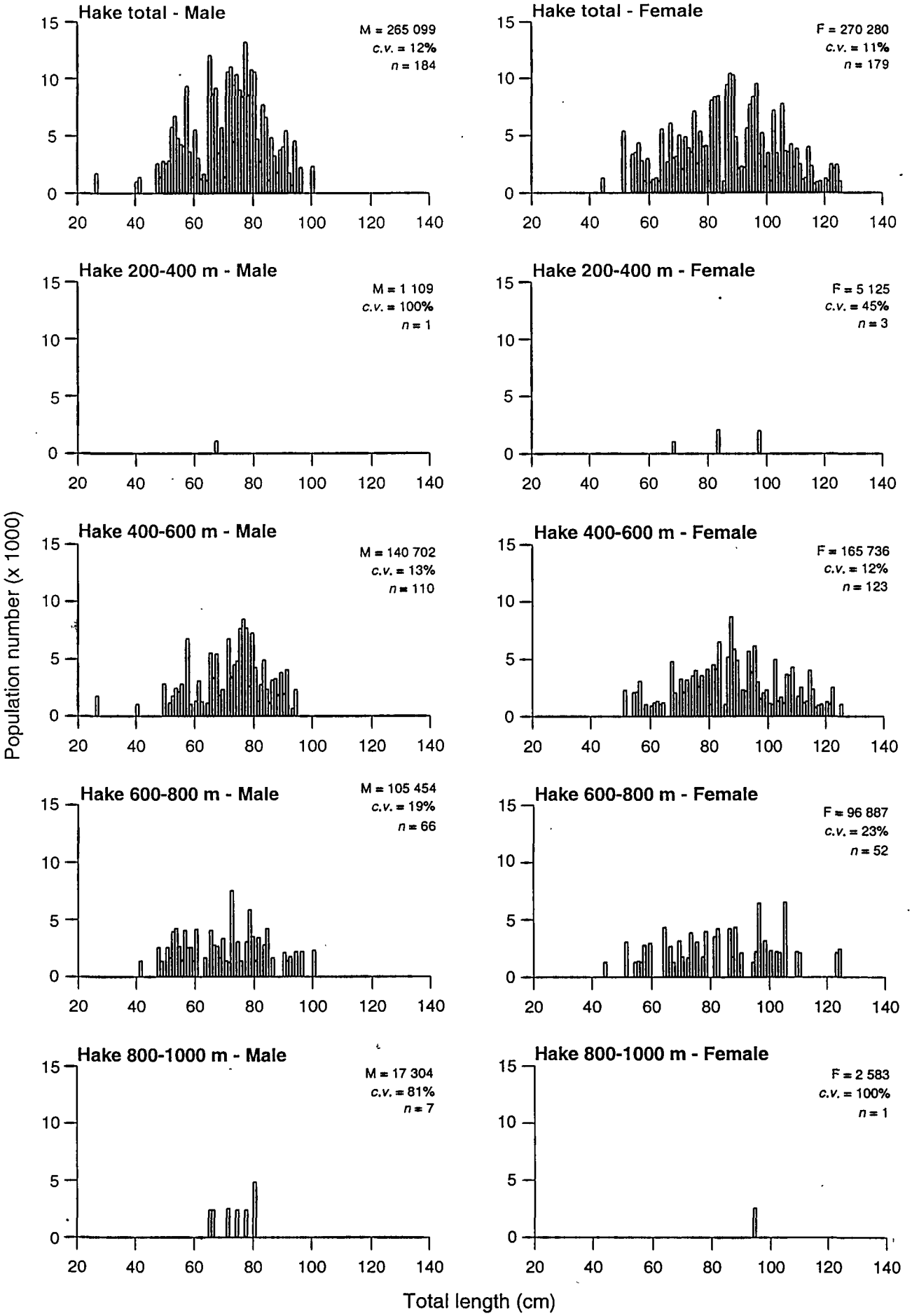


Figure 6: Scaled length frequencies for hake, by sex and depth zone (200-400, 400-600, 600-800, 800-1000). (M, estimated male population; F, estimated female population; *c.v.*, coefficent of variation of the estimated numbers of fish; n, number of fish measured).

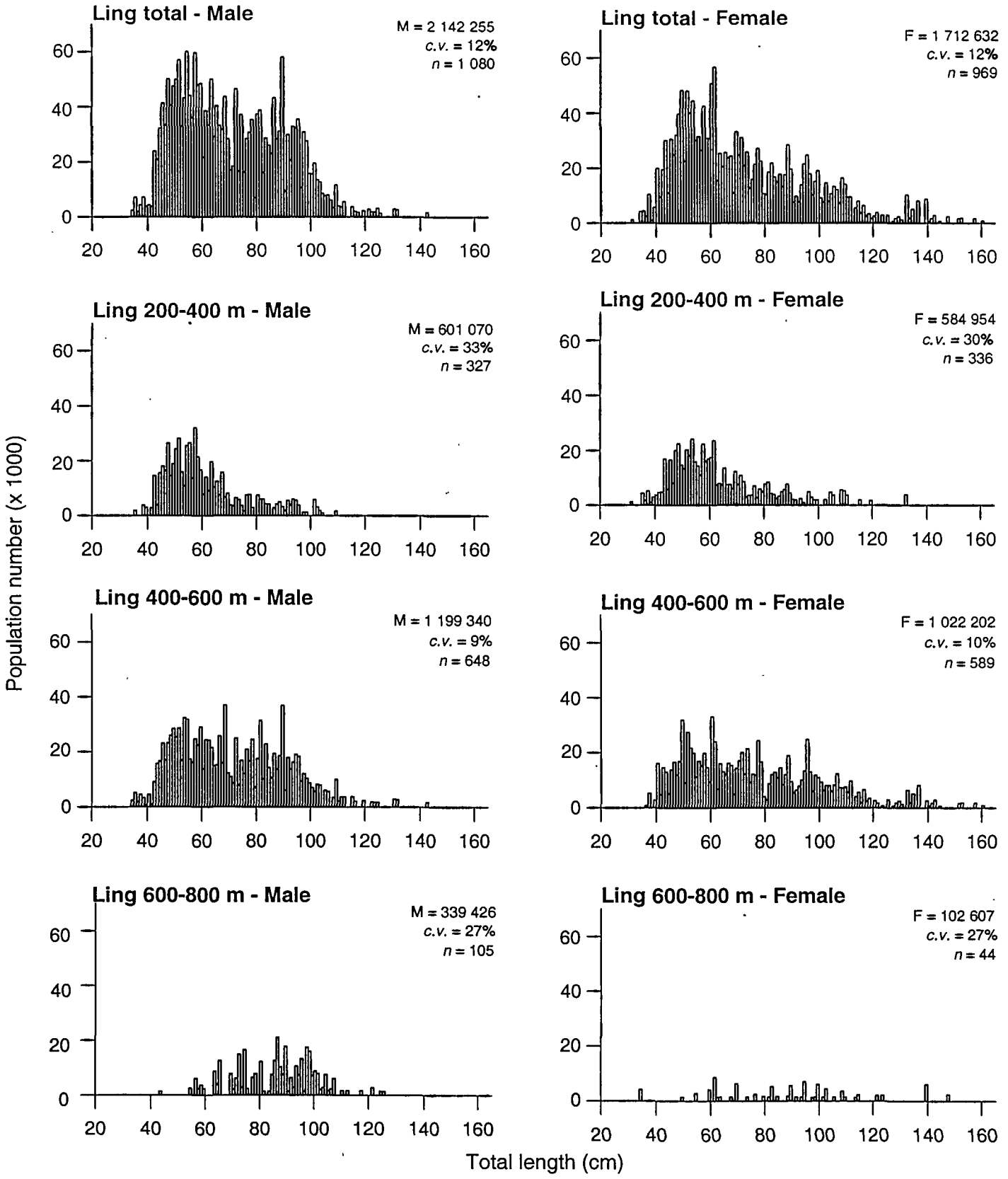


Figure 7: Scaled length frequencies for ling, by sex and depth zone (200-400, 400-600, 600-800). (M, estimated male population; F, estimated female population; c.v., coefficent of variation of the estimated numbers of fish; numbers of fish measured).

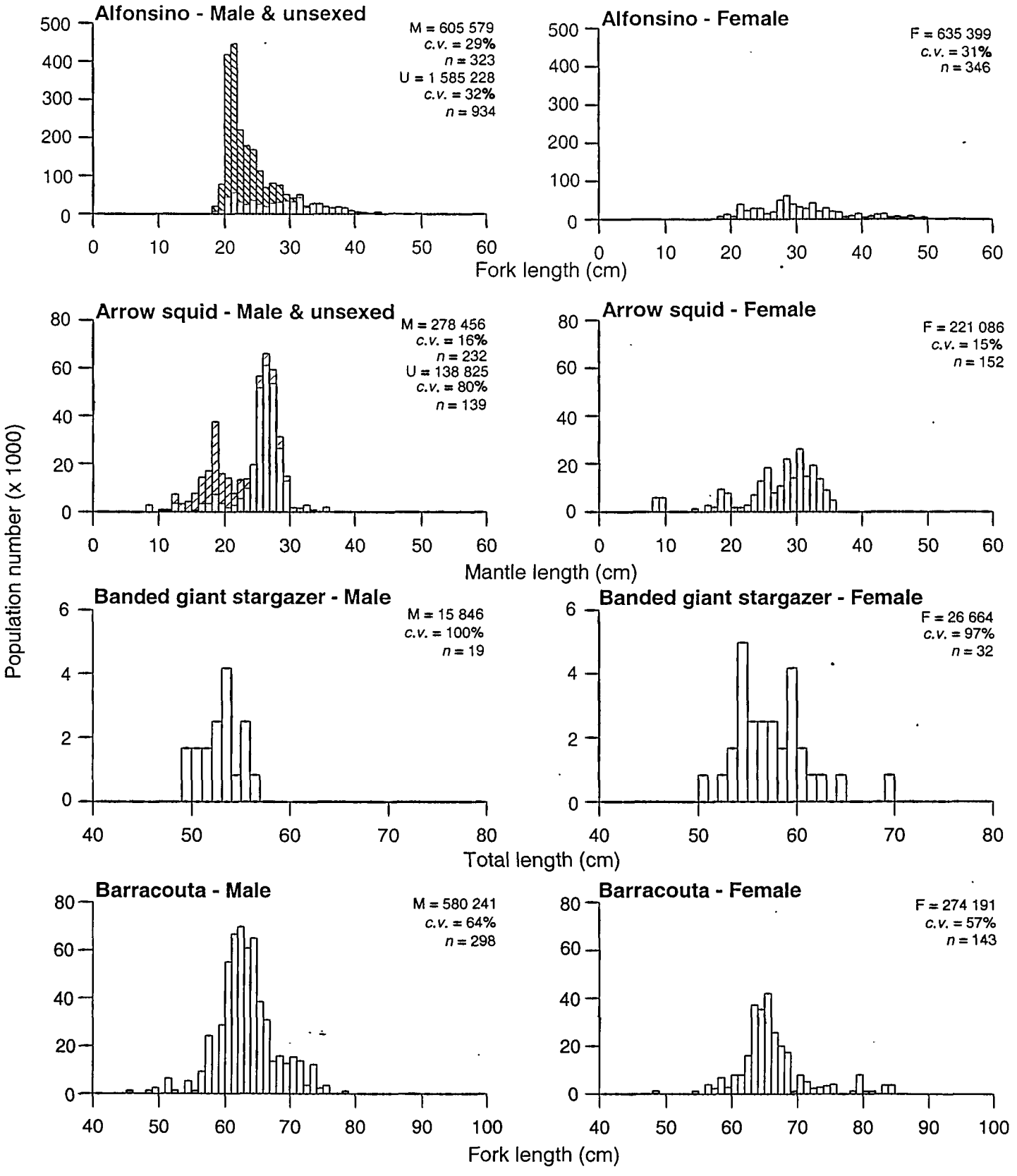


Figure 8: Scaled length frequencies for the major species, by sex. (M, estimated male population; F, estimated female population; U, estimated unsexed population (hatched bars); *c.v.* coefficient of variationof the estimated numbers of fish; n, number of fish measured).

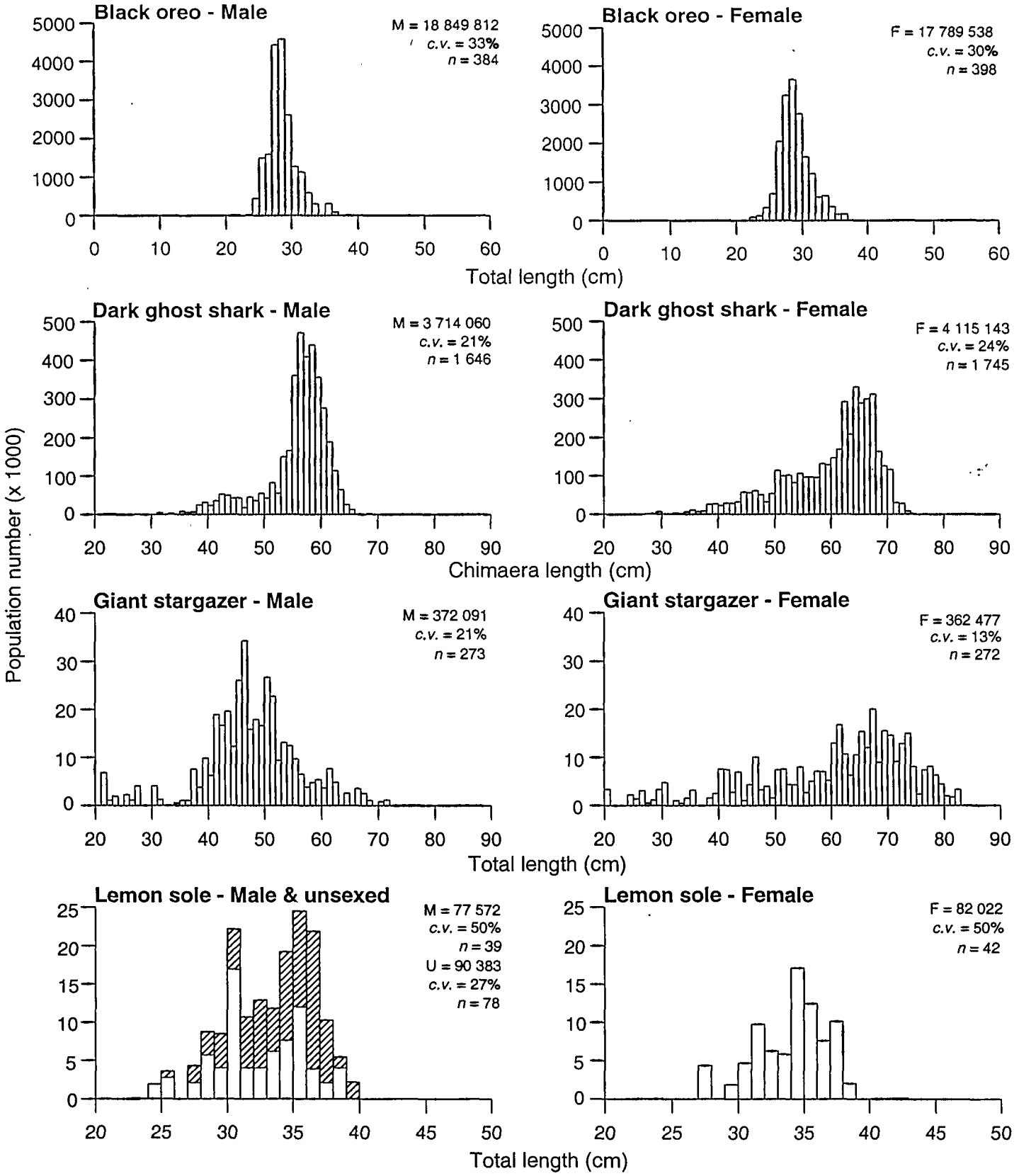


Figure 8 - *continued*

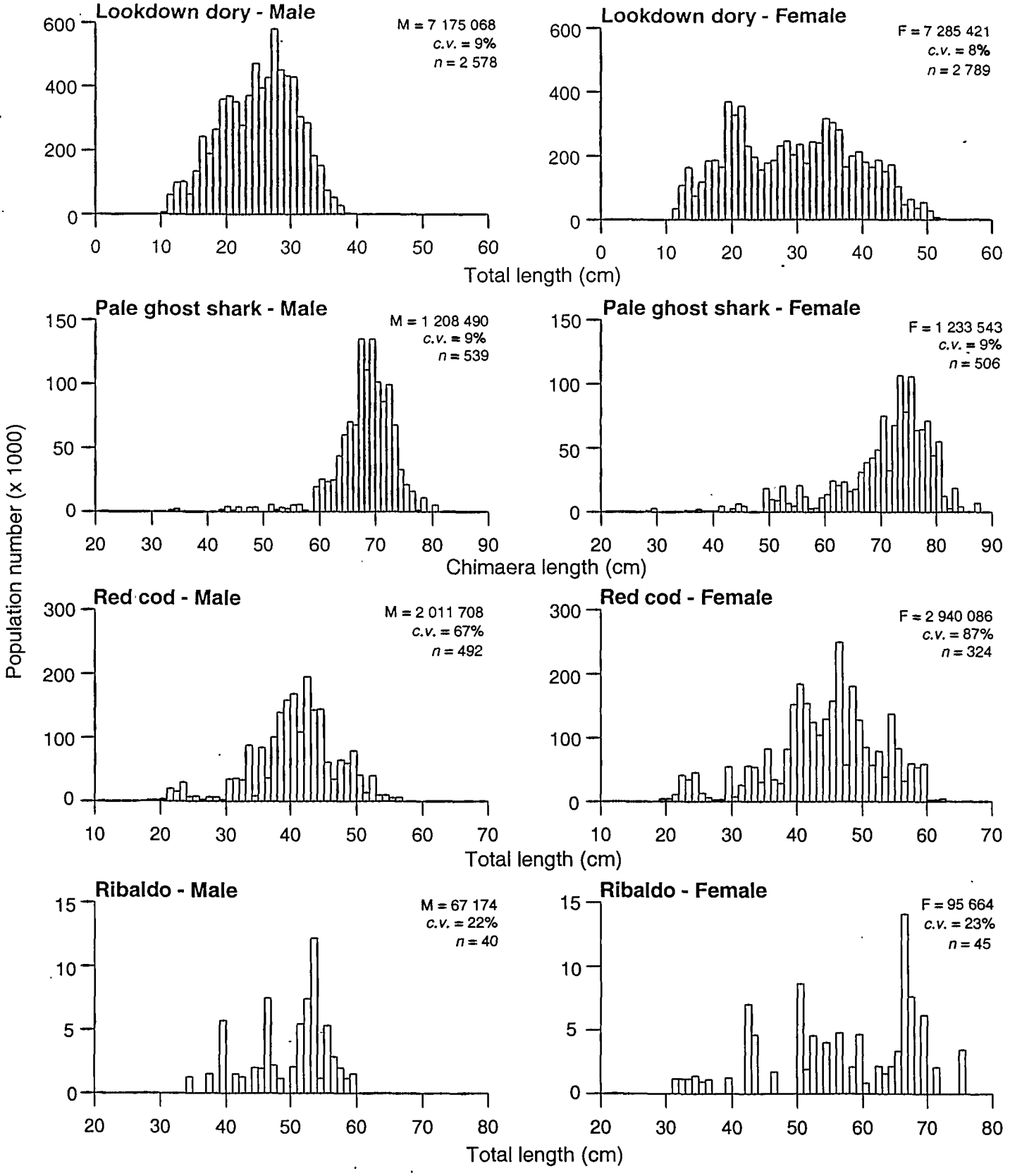


Figure 8 - *continued*

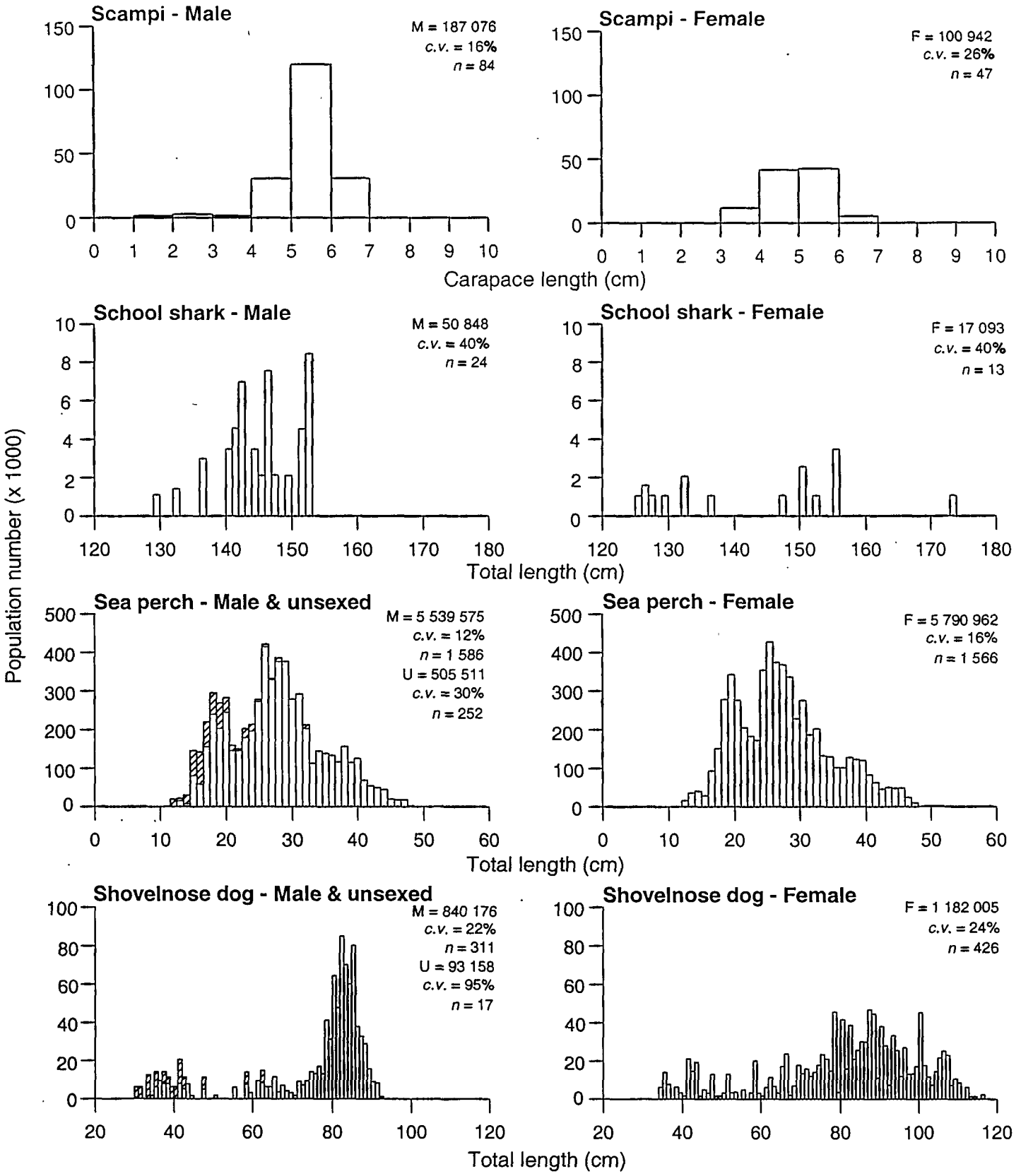


Figure 8 - *continued*

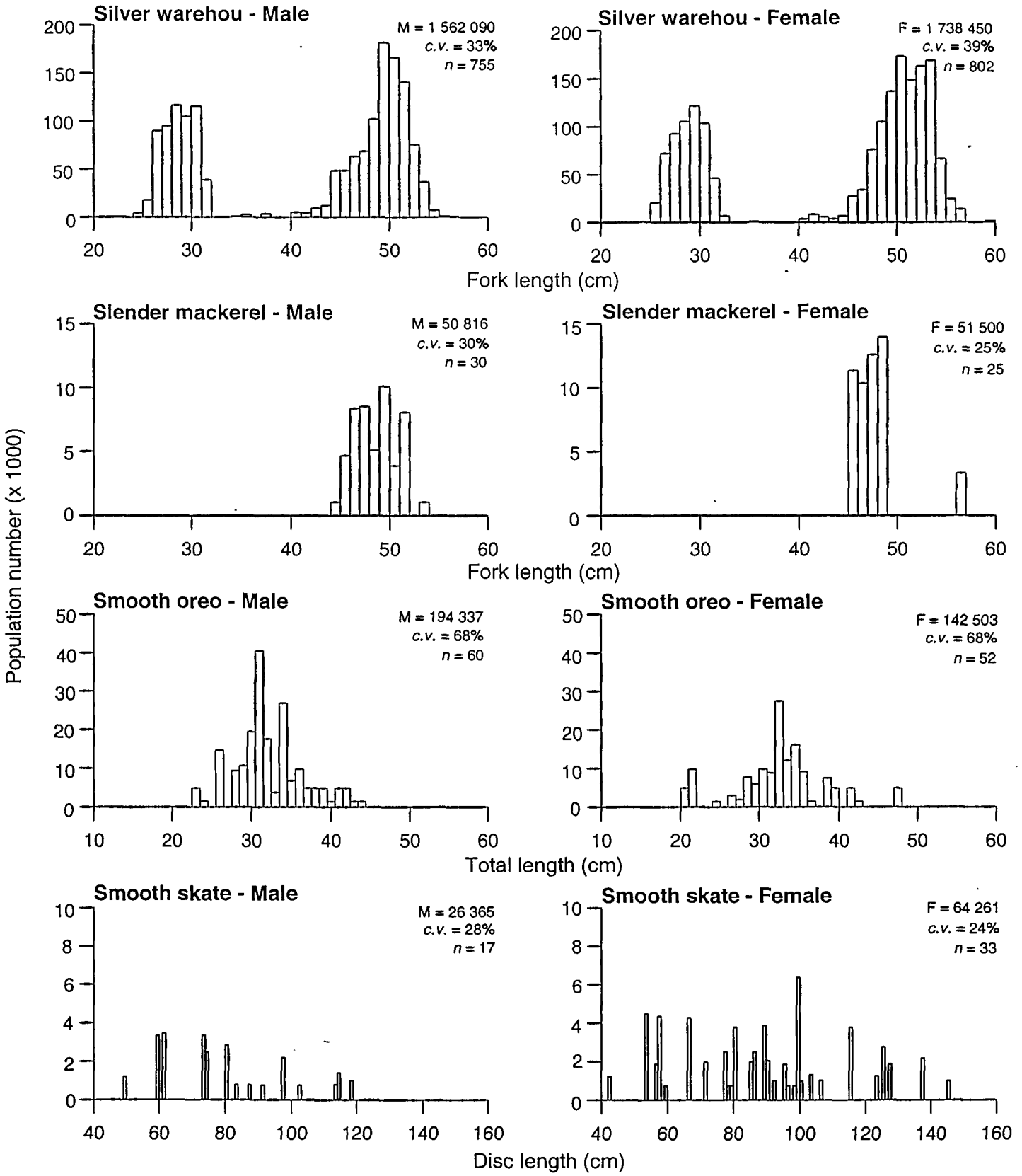


Figure 8 - *continued*

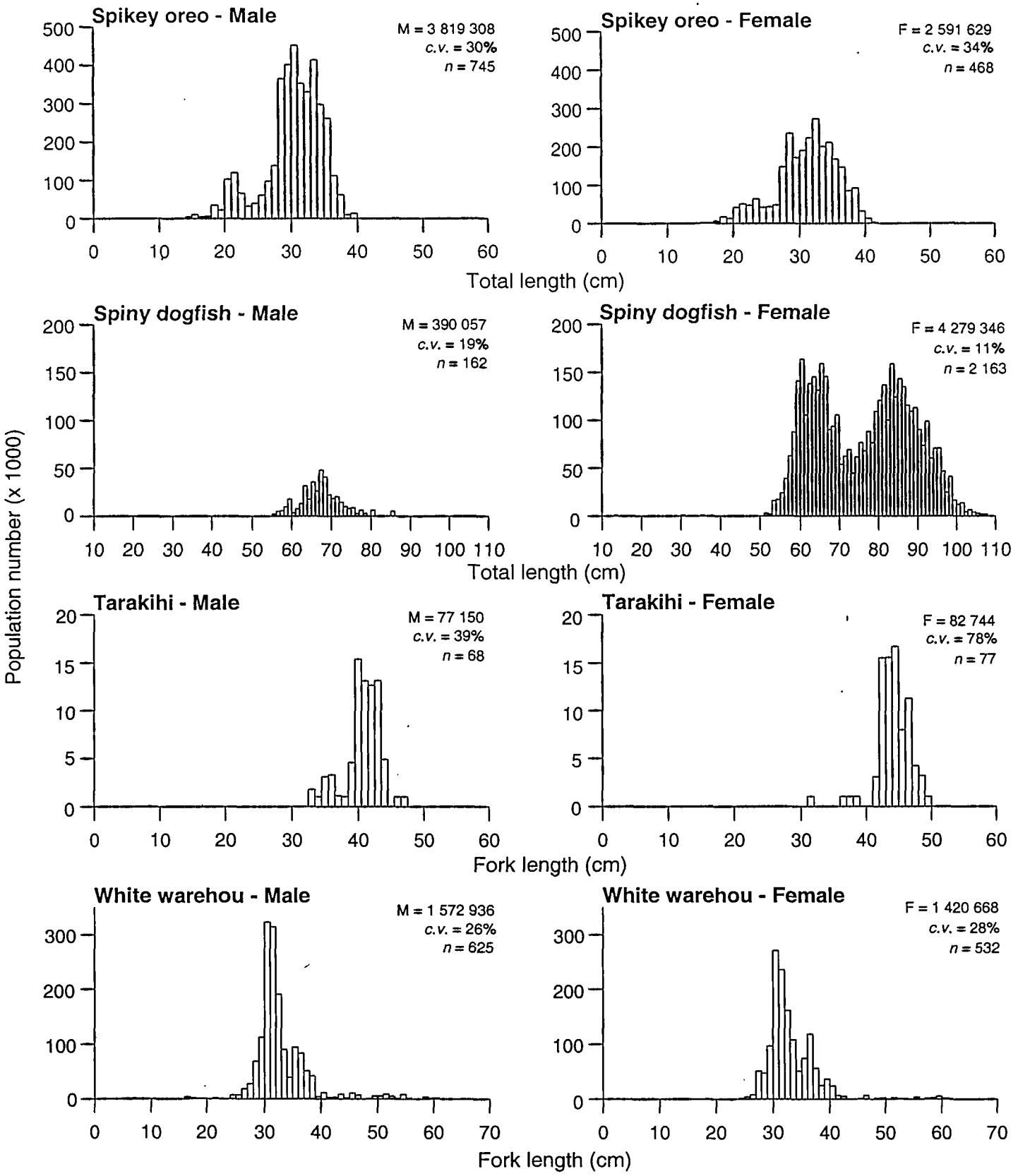


Figure 8 - *continued*

Table 1: **Stratum description and stations completed**

Stratum	Area (km^2)	Number of stations Phase 1	Phase 2	Total	Station density (km^2 per station)	Depth range (m)
1	2 439	3	0	3	813	600–800
2a	3 253	3	0	3	1 084	600–800
2b	8 503	6	0	6	1 417	600–800
3	3 499	3	0	3	1 166	200–400
4	11 315	3	0	3	3 772	600–800
5	4 078	5	0	5	815	200–400
6	8 266	3	0	3	2 755	600–800
7	5 232	8	0	8	654	400–600
8a	3 286	3	0	3	1 095	400–600
8b	5 722	3	6	9	636	400-600
9	5 136	3	5	8	642	200–400
10a	2 958	4	0	4	740	400–600
10b	3 363	4	0	4	841	400-600
11a	2 966	6	0	6	494	400–600
11b	2 072	2	0	2	1 036	400-600
11c	3 342	7	0	7	477	400-600
11d	3 368	3	0	3	1 123	400-600
12	6 578	3	0	3	2 192	400–600
13	6 681	4	0	4	1 670	400–600
14	5 928	4	0	4	1 482	400–600
15	5 842	5	0	5	1 168	400–600
16	11 522	8	0	8	1 440	400–600
17	865	3	0	3	288	200–400
18	4 687	6	2	8	586	200–400
19	9 012	4	1	5	1 802	200–400
20	9 584	8	0	8	1 198	200–400
21	6 263	4	0	4	1 566	800-1000
Total	145 760	118	14	132	1 395	200-1000

Table 2: **Tow and gear parameters by depth range. Values shown are sample size (*n*), and for each parameter the mean, standard deviation (*s.d.*), and range**

	n	Mean	*s.d.*	Range
Tow parameters				
Tow length (n. mile)	132	3.0	0.22	2.00–3.18
Tow speed (knots)	132	3.5	0.07	3.3–3.8
Gear parameters (m)				
200–400 m				
Headline height	40	7.0	0.30	5.9–7.5
Doorspread	37	111.6	6.50	99.8–124.7
400–600 m				
Headline height	69	6.9	0.29	5.8–7.4
Doorspread	68	115.8	5.62	104.0–127.5
600–800 m				
Headline height	18	7.1	0.30	6.5–7.6
Doorspread	18	114.1	5.85	105.9–129.9
800-1000 m				
Headline height	4	7.4	0.05	7.4–7.5
Doorspread	4	114.6	2.97	110.9–117.9
All depths				
Headline height	131	7.0	0.31	5.8–7.6
Doorspread	127	114.3	6.08	99.8–129.9

Table 3: **Estimated total biomass (t), with *c.v.* in parentheses, and catch of all ITQ species, important commercial non-ITQ species (biomass > 30 t), and major non-commercial species (biomass > 800 t). Biomass estimates excluding stratum 21 are comparable to previous surveys. incl. 21, including stratum 21; excl. 21, excluding stratum 21; - not sexed**

	Species Code	Biomass (incl. 21) All fish	Biomass (excl. 21) All fish*	Females	Males	Catch (kg)
ITQ species						
Hoki	HOK	72 151 (12.3)	71 740 (12.3)	41 970 (11.3)	29 713 (14.4)	45 377
Black oreo	BOE	17 693 (31.2)	17 692 (31.2)	8 779 (29.9)	8 913 (32.5)	3 493
Dark ghost shark	GSH	9 154 (25.2)	9 154 (25.2)	5 441 (28.0)	3 709 (21.6)	9 302
Ling	LIN	8 348 (7.8)	8 330 (7.8)	4 101 (8.8)	4 216 (9.0)	5 015
Silver warehou	SWA	5 424 (45.5)	5 424 (45.5)	3 068 (48.0)	2 353 (42.8)	4 197
Pale ghost shark	GSP	4 903 (7.6)	4 892 (7.6)	2 635 (9.6)	2 252 (8.5)	2 236
Sea perch	SPE	4 776 (7.9)	4 776 (7.9)	2 327 (9.0)	2 391 (7.3)	2 526
Spiky oreo	SOR	4 389 (28.4)	4 244 (29.3)	1 793 (31.1)	2 433 (29.3)	2 060
Red cod	RCO	3 854 (79.7)	3 854 (79.7)	2 523 (88.2)	1 325 (64.5)	1 971
White warehou	WWA	2 384 (23.8)	2 384 (23.8)	1 116 (25.5)	1 208 (23.6)	1 553
Giant stargazer	STA	2 148 (13.2)	2 148 (13.2)	1 470 (13.9)	675 (19.3)	1 734
Hake	HAK	2 152 (9.2)	2 090 (9.3)	1 426 (11.6)	665 (11.7)	1 482
Alfonsino	BYS	1 216 (19.4)	1 216 (19.4)	462 (24.0)	353 (29.1)	940
Barracouta	BAR	990 (59.7)	990 (59.7)	348 (52.8)	641 (63.8)	657
School shark	SCH	923 (36.3)	923 (36.3)	233 (40.9)	690 (39.8)	536
Ribaldo	RIB	387 (20.8)	351 (22.9)	245 (29.7)	105 (23.4)	174
Arrow squid	NOS	307 (14.2)	307 (14.2)	136 (13.4)	137 (15.6)	223
Smooth oreo	SSO	285 (66.4)	268 (70.5)	109 (70.5)	146 (69.1)	103
Tarakihi	TAR	226 (52.2)	226 (52.2)	128 (75.1)	98 (39.8)	200
Slender mackerel	JMM	110 (31.9)	110 (31.9)	53 (37.6)	54 (32.0)	64
Lemon sole	LSO	109 (30.2)	109 (30.2)	37 (51.4)	31 (51.1)	76
Bluenose	BNS	94 (41.3)	94 (41.3)	53 (56.9)	41 (59.7)	81
Hapuku	HAP	56 (39.3)	56 (39.3)	46 (44.2)	9 (57.9)	68
Black cardinalfish	EPT	32 (63.9)	32 (63.9)	11 (76.4)	15 (68.7)	27
Orange roughy	ORH	246 (79.0)	8 (60.7)	4 (72.5)	3 (75.7)	100
Trumpeter	TRU	5 (100)	5 (100)	5 (100)	0	4
Jack mackerel	JMD	1 (100)	1 (100)	0	1 (100)	1
Rubyfish	RBY	1 (100)	1 (100)	1 (100)	0	1
Commercial non-ITQ species (where biomass > 30 t)						
Spiny dogfish	SPD	8 905 (8.6)	8 905 (8.6)	8 426 (8.6)	479 (17.7)	6 316
Lookdown dory	LDO	7 655 (7.0)	7 650 (7.0)	4 994 (7.0)	2 650 (9.9)	4 290
Shovelnose dogfish	SND	5 301 (16.0)	4 420 (18.7)	3 142 (19.1)	2 100 (13.8)	2 698
Smooth skate	SSK	1 368 (23.3)	1 368 (23.3)	1 093 (27.9)	275 (28.0)	819
Ray's bream	RBM	652 (55.5)	652 (55.5)	-	-	358
Banded giant stargazer	BGZ	259 (95.9)	259 (95.9)	177 (95.0)	81 (97.9)	246
Non-commercial species (where biomass > 800 t)						
Bollons' rattail	CBO	12 142 (8.4)	12 137 (8.4)	-	-	6 659
Javelinfish	JAV	11 150 (13.0)	10 965 (13.2)	-	-	5 727
Oblique-banded rattail	CAS	1 672 (11.5)	1 672 (11.5)	-	-	1 498
Oliver's rattail	COL	1 406 (21.9)	1 406 (21.9)	-	-	650
Banded bellowsfish	BBE	1 287 (25.6)	1 287 (25.6)	-	-	810
Silver dory	SDO	1 114 (28.4)	1 114 (28.4)	-	-	934
Longnose chimaera	LCH	944 (24.0)	929 (24.3)	-	-	312
Longnose velvet dogfish	CYP	1 727 (42.8)	919 (55.9)	-	-	886
Baxter's dogfish	ETB	857 (28.6)	809 (30.0)	-	-	285
Orange perch	OPE	803 (35.6)	803 (35.6)	-	-	524
Total						128 888

* Differences between the total biomass and the sum of males and females are juvenile fish not sexed.

Table 4: **Estimated biomass (t), with coefficient of variation in parentheses, of hoki by age group* and stratum**

Stratum	Total hoki		1+ cohort (< 47 cm TL)		2+ cohort (47–61 cm TL)		3++ (> 61 cm TL)	
1	1 116	(20)	0		123	(82)	994	(20)
2a	357	(5)	0		0.9	(100)	356	(5)
2b	1 833	(21)	0		0		1 833	(21)
3	1 495	(16)	15	(72)	404	(26)	1 077	(13)
4	4 454	(18)	0		4	(100)	4 450	(18)
5	1 283	(20)	100	(26)	719	(20)	463	(26)
6	989	(45)	0		173	(100)	816	(34)
7	3 438	(41)	95	(90)	2 522	(48)	821	(26)
8a	1 097	(19)	6	(88)	789	(15)	301	(35)
8b	4 649	(55)	8	(54)	2 955	(65)	1 686	(42)
9	6 887	(79)	660	(94)	4 537	(91)	1 690	(82)
10a	741	(11)	0		138	(26)	603	(15)
10b	1 181	(25)	1	(100)	213	(29)	967	(30)
11a	1 261	(18)	61	(33)	705	(21)	494	(18)
11b	447	(54)	2	(100)	296	(90)	149	(18)
11c	513	(12)	0		141	(23)	373	(12)
11d	500	(39)	0		81	(17)	419	(43)
12	1 585	(9)	0		74	(61)	1 511	(7)
13	3 727	(27)	0.8	(100)	713	(55)	3 013	(44)
14	2 475	(48)	1	(59)	383	(47)	2 090	(59)
15	2 084	(21)	36	(88)	1 058	(14)	991	(30)
16	4 128	(48)	40	(54)	2 609	(79)	1 479	(13)
17	53	(81)	10	(100)	14	(98)	29	(69)
18	8 186	(18)	4 061	(28)	3 643	(32)	481	(41)
19	11 325	(40)	6 450	(55)	4 008	(58)	867	(44)
20	5 935	(53)	2 867	(94)	1 936	(36)	1 133	(29)
21	411	(56)	0		0		411	(56)
Total	72 151	(12.3)	14 415	(32.4)	28 238	(20.7)	29 497	(9.1)

* hoki are spawned in July-August and their ages are estimated by length range. 1+, designates a fish between 1 and 2 years old; 2+, designates a fish between 2 and 3 years old; 3++, designates all hoki 3 years and older.

Table 5: **Estimated biomass (t) and *c.v.* (%) of the 18 most abundant species*, other than hoki, by stratum**

Stratum	Species code																	
	BOE		CBO		JAV		GSH		SPD		LIN		LDO		SWA		GSP	
1	0		220	(85)	340	(14)	0		0		335	(47)	43	(37)	0		127	(35)
2a	0		58	(48)	801	(39)	0		0		92	(41)	48	(33)	0		169	(19)
2b	0		143	(50)	410	(14)	0		0		269	(21)	212	(10)	0		168	(42)
3	0		400	(32)	701	(14)	644	(27)	204	(26)	261	(34)	430	(4)	148	(96)	51	(100)
4	9 124	(50)	243	(22)	811	(32)	0		0		588	(47)	166	(40)	0		550	(19)
5	0		30	(41)	46	(39)	1 372	(41)	887	(22)	147	(31)	490	(13)	2 789	(86)	0	
6	8 567	(36)	100	(47)	311	(43)	0		0		244	(61)	12	(63)	0		431	(17)
7	0		700	(10)	646	(28)	31	(61)	249	(51)	453	(8)	192	(30)	9	(58)	144	(31)
8a	0		145	(39)	841	(50)	111	(64)	232	(60)	494	(16)	131	(11)	0		4	(100)
8b	0		438	(30)	311	(56)	27	(57)	181	(49)	399	(31)	419	(17)	7	(100)	243	(20)
9	0		5	(100)	50	(45)	654	(23)	872	(20)	107	(53)	226	(38)	1 319	(43)	0	
10a	0		43	(42)	44	(26)	1	(100)	57	(58)	63	(16)	90	(15)	0		42	(10)
10b	0		44	(27)	52	(18)	0		74	(100)	73	(28)	126	(25)	0		55	(20)
11a	0		422	(24)	225	(29)	207	(27)	223	(8)	153	(17)	218	(18)	13	(66)	10	(81)
11b	0		105	(83)	96	(81)	88	(100)	107	(92)	29	(61)	101	(50)	0		6	(100)
11c	0		75	(48)	38	(15)	24	(65)	47	(29)	111	(30)	64	(11)	0		31	(32)
11d	0		81	(25)	27	(26)	18	(100)	161	(35)	196	(57)	101	(53)	51	(54)	24	(65)
12	0		496	(13)	235	(39)	34	(87)	448	(7)	455	(22)	629	(13)	261	(82)	326	(53)
13	0		1 499	(24)	2 085	(55)	21	(87)	521	(21)	760	(25)	1 001	(28)	13	(59)	686	(15)
14	0		1 188	(29)	682	(55)	7	(64)	686	(19)	598	(29)	815	(37)	18	(80)	633	(32)
15	0		2 303	(19)	469	(20)	3	(66)	642	(55)	516	(11)	475	(24)	4	(100)	469	(16)
16	1	(100)	1 791	(31)	774	(34)	31	(100)	815	(49)	935	(29)	372	(47)	13	(65)	567	(17)
17	0		0		0		2 293	(96)	620	(48)	252	(100)	1	(100)	63	(69)	0	
18	0		140	(82)	70	(48)	848	(16)	432	(17)	122	(61)	77	(32)	136	(29)	0	
19	0		115	(100)	127	(59)	1 088	(18)	559	(11)	39	(100)	206	(60)	206	(50)	0	
20	0		1 341	(28)	759	(47)	1 645	(15)	881	(26)	627	(25)	994	(13)	370	(47)	143	(69)
21	1	(100)	5	(71)	184	(34)	0		0		17	(100)	4	(100)	0		11	(100)
Total	17 693	(31)	12 142	(8)	11 150	(13)	9 154	(25)	8 905	(8)	8 348	(7)	7 655	(7)	5 424	(45)	4 903	(7)

Table 5 — *continued*

Stratum	Species code SPE		SND		SOR		RCO		WWA		STA		HAK		CAS		COL	
1	2	(51)	751	(46)	158	(35)	0		0		9	(100)	182	(6)	0		43	(31)
2a	81	(19)	932	(12)	329	(64)	0		0		25	(100)	138	(49)	0		60	(48)
2b	52	(20)	2 143	(31)	2 765	(38)	0		0		70	(100)	312	(25)	0		9	(25)
3	101	(25)	0		0		19	(100)	228	(97)	54	(79)	22	(61)	86	(20)	+	(60)
4	79	(59)	391	(89)	608	(96)	0		0		0		17	(100)	0		30	(35)
5	104	(56)	0		0		20	(15)	204	(27)	180	(80)	0		125	(30)	0	
6	0		9	(100)	0		0		0		0		89	(100)	0		112	(82)
7	87	(33)	15	(66)	2	(100)	1	(70)	34	(89)	69	(28)	245	(27)	77	(79)	44	(29)
8a	346	(63)	0		0		1	(100)	73	(100)	0		41	(60)	0		2	(100)
8b	277	(25)	4	(100)	0		3	(51)	5	(87)	0		118	(40)	28	(67)	12	(48)
9	40	(44)	0		0		96	(54)	213	(59)	282	(35)	2	(100)	45	(45)	0	
10a	25	(34)	19	(66)	0		0		0		0		131	(28)	0		3	(41)
10b	28	(19)	52	(58)	365	(69)	0		0		12	(100)	228	(15)	+	(100)	3	(62)
11a	48	(26)	0		0		0		48	(46)	143	(45)	38	(44)	15	(42)	1	(44)
11b	23	(21)	0		0		0		52	(100)	48	(100)	72	(4)	24	(100)	1	(37)
11c	31	(30)	23	(78)	0		0		2	(100)	17	(47)	98	(17)	+	(100)	3	(20)
11d	59	(39)	19	(100)	0		0		139	(50)	0		54	(82)	+	(100)	+	(26)
12	78	(14)	0		14	(100)	0		25	(61)	24	(98)	50	(51)	1	(68)	2	(82)
13	215	(53)	0		0		0		54	(40)	0		64	(90)	77	(61)	28	(82)
14	294	(33)	9	(100)	0		0		14	(44)	10	(100)	25	(63)	49	(40)	141	(82)
15	251	(24)	19	(62)	0		0		17	(52)	72	(31)	21	(50)	33	(52)	211	(35)
16	65	(33)	29	(72)	0		0		96	(66)	100	(45)	131	(33)	115	(50)	690	(37)
17	0		0		0		345	(58)	77	(38)	106	(33)	0		342	(36)	0	
18	191	(59)	0		0		117	(38)	267	(95)	493	(30)	1	(100)	155	(35)	0	
19	1 328	(13)	0		0		3 224	(95)	141	(97)	292	(29)	0		170	(22)	0	
20	961	(12)	0		0		23	(81)	685	(57)	133	(39)	0		321	(20)	+	(100)
21	0		880	(23)	144	(53)	0		0		0		62	(64)	0		+	(100)
Total	4 776	(7)	5 301	(16)	4 389	(28)	3 854	(79)	2 384	(23)	2 148	(13)	2 152	(9)	1 672	(11)	1 406	(21)

* Species codes are given in Table 3.

\+ Biomass less then 0.5 tonnes.

Table 6: **Length-weight relationship parameters* a and b used in the Trawlsurvey Analysis Program to calculate biomass by sex and length frequencies**

	a	b	n	r^2	Range	Data source
Alfonsino	0.024446	2.971760	145	0.99	19-50	This survey
Dark ghost shark	0.001532	3.327454	292	0.98	27-76	This survey
Giant stargazer	0.009574	3.129751	318	0.98	20-82	This survey
Hake	0.001975	3.285028	360	0.99	26-125	This survey
Hoki	0.002837	3.005508	2 274	0.99	33-113	This survey
Lemon sole	0.005307	3.228744	98	0.91	24-39	This survey
Ling	0.001133	3.316120	1 852	0.99	31-160	This survey
Lookdown dory	0.020961	3.002427	347	0.99	12-55	This survey
Pale ghost shark	0.005726	3.008041	170	0.98	28-87	This survey
Scampi	0.669353	2.961841	122	0.93	2.7-6.6	This survey
Sea perch	0.005705	3.304976	174	0.99	14-49	This survey
Shovelnose dogfish	0.001551	3.205074	181	0.99	30-116	This survey
Silver warehou	0.006552	3.270693	199	0.99	25-55	This survey
Spiny dogfish	0.002365	3.130318	256	0.96	55-101	This survey
White warehou	0.013459	3.123951	186	0.99	27-61	This survey
Arrow squid	0.0290	3.00	-	-	-	Annala (1993)
Barracouta	0.003929	3.026534	155	0.92	50-112	Bagley & Livingston (2000)
Banded stargazer	0.01300	3.25	143	0.98	22-69	Bagley & Hurst (1996)
Black cardinalfish	0.0269	2.870105	213	0.96	33-75	Tracey, et al. 2000
Black oreo	0.0248	2.950	9 790	0.98	11-44	DB, Chat. Rise, Nov-Mar
Bluenose	0.00963	3.173	-	-	-	Horn (1988)
Hapuku	0.014230	2.998	1 644	-	50-130	Johnston (1983)
Jack mackerel	0.016500	2.93000	200	-	15-53	DB, COR9001
Orange roughy	0.0687	2.792	7 880	0.99	9-44	DB, Chat. Rise, Nov-Mar
Ray's bream	0.012004	3.107050	107	0.97	28-49	All records on DB
Red cod	0.0092	3.003	923	0.98	13-72	Beentjes (1992)
Ribaldo	0.002025	3.450293	58	0.98	30-70	Bagley & Livingston (2000)
Rubyfish	0.027018	2.906400	68	-	31-49	DB, WNK8503
School shark	0.00702	2.91	804	-	30-166	Seabrook-Davison, Unp.
Slender mackerel	0.139276	2.313501	48	0.73	45-55	Bagley & Livingston (2000)
Smooth oreo	0.0309	2.895	9 147	0.98	10-57	DB, Chat. Rise, Nov-Mar
Smooth skate	0,017677	3.024078	54	0.98	61-155	DB, TAN9701
Spiky oreo	0.037289	2.854037	459	0.96	13-44	Bagley & Livingston (2000)
Tarakihi	0.02	2.98	-	-	-	Annala (1993)

* $W = aL^b$ where W is weight (g) and L is length (cm); n, sample number; r^2 is correlation coefficient; Range, length range of fish (cm); DB., Ministry of Fisheries trawl survey database; Unp., unpublished data.

Table 7: **Catch rates (kg.km^{-2}) with standard deviations (in parentheses) by stratum for the 20 most abundant species ***

Stratum	Species code									
	HOK	BOE	CBO	JAV	GSH	SPD	LIN	LDO	SWA	GSP
1	457	0	90	139	0	0	137	17	0	51
	(160)		(133)	(33)			(113)	(11)		(31)
2a	109	0	18	246	0	0	28	14	0	52
	(8)		(14)	(166)			(20)	(8)		(17)
2b	215	0	16	48	0	0	31	24	0	19
	(108)		(20)	(16)			(16)	(6)		(20)
3	427	0	114	200	184	58	74	122	42	14
	(121)		(63)	(48)	(85)	(26)	(44)	(8)	(70)	(25)
4	393	806	21	71	0	0	51	14	0	48
	(123)	(701)	(8)	(40)			(42)	(10)		(15)
5	314	0	7	11	336	217	36	120	683	0
	(144)		(6)	(10)	(306)	(104)	(25)	(35)	(1307)	
6	119	1 036	12	37	0	0	29	1	0	52
	(92)	(648)	(9)	(28)			(31)	(1)		(15)
7	657	0	133	123	6	47	86	36	1	27
	(759)		(36)	(99)	(10)	(68)	(19)	(31)	(3)	(23)
8a	333	0	44	256	33	70	150	40	0	1
	(109)		(30)	(223)	(37)	(73)	(42)	(7)		(2)
8b	812	0	76	54	4	31	69	73	1	42
	(1 334)		(70)	(92)	(8)	(46)	(65)	(36)	(3)	(25)
9	1 341	0	1	9	127	169	20	44	256	0
	(3 010)		(3)	(12)	(82)	(95)	(31)	(47)	(309)	
10a	250	0	14	15	0.4	19	21	30	0	14
	(56)		(12)	(7)	(0.9)	(22)	(6)	(9)		(2)
10b	351	0	13	15	0	22	21	37	0	16
	(177)		(7)	(5)		(44)	(12)	(18)		(6)
11a	425	0	142	76	69	74	51	73	4	3
	(182)		(84)	(54)	(45)	(14)	(21)	(32)	(7)	(7)
11b	215	0	50	46	42	51	14	48	0	3
	(164)		(59)	(53)	(60)	(67)	(12)	(34)		(4)
11c	153	0	22	11	7	14	33	19	0	9
	(48)		(28)	(4)	(12)	(10)	(26)	(5)		(8)
11d	148	0	24	8	5	47	58	30	15	7
	(99)		(10)	(3)	(9)	(29)	(57)	(27)	(14)	(8)
12	240	0	75	35	5	68	69	95	39	49
	(39)		(17)	(24)	(7)	(7)	(25)	(21)	(56)	(45)
13	557	0	224	312	3	78	113	149	1	102
	(298)		(107)	(341)	(5)	(33)	(56)	(84)	(2)	(30)
14	417	0	200	115	1	115	101	137	3	106
	(403)		(116)	(126)	(1)	(44)	(58)	(102)	(5)	(68)
15	356	0	394	80	0.5	110	88	81	0.7	80
	(169)		(171)	(36)	(0.7)	(136)	(20)	(43)	(1)	(29)
16	358	0.08	155	67	2.6	70	81	32	1	49
	(486)	(0.2)	(137)	(65)	(7.6)	(97)	(65)	(43)	(2)	(23)
17	61	0	0	0	2 651	717	291	1	72	0
	(86)				(4 395)	(595)	(503)	(2)	(86)	
18	1 746	0	30	15	180	92	26	16	29	0
	(913)		(69)	(20)	(80)	(43)	(44)	(15)	(23)	
19	1 256	0	12	14	120	62	4	22	22	0
	(1 119)		(28)	(18)	(49)	(15)	(9)	(30)	(25)	
20	619	0	139	79	171	91	65	103	38	14
	(926)		(110)	(104)	(74)	(67)	(46)	(37)	(51)	(29)
21	65	0.1	0.8	29	0	0	2	0.6	0	1
	(73)	(0.2)	(1)	(19)			(5)	(1)		(3)

Table 7 — continued

Stratum	Species code									
	SPE	SND	SOR	RCO	WWA	STA	HAK	CAS	COL	SSK
1	0.8	307	65	0	0	3	75	0	17	0
	(0.7)	(247)	(39)			(6)	(7)		(9)	
2a	25	286	101	0	0	7	42	0	18	0
	(8)	(61)	(112)			(13)	(35)		(15)	
2b	6	252	325	0	0	8	36	0	1	15
	(3)	(188)	(301)			(20)	(22)		(0.7)	(36)
3	29	0	0	5	65	15	6	24	0.1	0
	(12)			(9)	(109)	(21)	(6)	(8)	(0.1)	
4	7	34	53	0	0	0	1	0	2	10
	(7)	(53)	(89)				(2)		(1)	(17)
5	25	0	0	5	50	44	0	30	0	3
	(32)			(1)	(30)	(79)		(20)		(3)
6	0	1	0	0	0	0	10	0	13	0
	(0)	(2)					(18)		(19)	
7	16	2	0.4	0.3	6	13	46	14	8	17
	(15)	(5)	(1)	(0.6)	(16)	(10)	(36)	(32)	(7)	(32)
8a	105	0	0	0.4	22	0	12	0	0.8	3
	(115)			(0.7)	(38)		(13)		(1)	(6)
8b	48	0.7	0	0.6	0.9	0	205	5	2	16
	(36)	(2)		(1)	(2)		(24)	(10)	(3)	(33)
9	7	0	0	18	41	54	0.3	8	0	1
	(9)			(28)	(70)	(54)	(1)	(11)		(2)
10a	8	6	0	0	0	0	44	0	1	10
	(5)	(8)					(24)		(0.9)	(21)
10b	8	15	108	0	0	3	67	0.1	1	13
	(3)	(18)	(149)			(7)	(21)	(0.2)	(1)	(26)
11a	16	0	0	0	16	48	13	5	0.5	37
	(10)				(18)	(53)	(14)	(5)	(0.5)	(31)
11b	11	0	0	0	25	23	34	11	0.7	8
	(3)				(35)	(32)	(1)	(16)	(0.3)	(12)
11c	9	7	0	0	0.6	5	29	0.2	1	3
	(7)	(14)			(1)	(6)	(13)	(0.5)	(0.5)	(10)
11d	17	5	0	0	41	0	16	0.05	0.2	0
	(12)	(9)			(36)		(23)	(0.08)	(0.08)	
12	11	0	2	0	3	3	7	0.2	0.4	20
	(2)		(3)		(4)	(6)	(6)	(0.2)	(0.6)	(35)
13	32	0	0	0	8	0	9	11	4	9
	(34)				(6)		(17)	(13)	(6)	(19)
14	49	1	0	0	2	1	4	8	23	6
	(33)	(3)			(2)	(3)	(5)	(6)	(38)	(12)
15	42	3	0	0	2	12	3	5	36	24
	(22)	(4)			(3)	(8)	(4)	(6)	(28)	(54)
16	5	2	0	0	8	8	11	10	59	5
	(5)	(5)			(15)	(11)	(10)	(14)	(62)	(11)
17	0	0	0	399	89	123	0	396	0	0
				(404)	(59)	(70)		(248)		
18	40	0	0	25	57	105	0.3	33	0	10
	(68)			(26)	(154)	(88)	(0.9)	(33)		(30)
19	147	0	0	357	15	32	0	18	0	12
	(41)			(760)	(34)	(20)		(9)		(22)
20	100	0	0	2	71	13	0	33	0.1	9
	(35)			(5)	(114)	(15)		(18)	(0.2)	(15)
21	0	140	23	0	0	0	9	0	0.04	0
		(64)	(24)				(12)		(0.08)	

* Species codes are given in Table 3.

Table 8: **Species measured or selected for length frequencies and biological analysis, showing numbers of samples and numbers of fish examined. -, no data**

Species	Length frequency samples				Biological samples	
	No. of fish measured			No. of samples	No. of fish	No. of samples
	Total†	Male	Female			
Alfonsino	1 603	323	346	51	145 *	7
Arrow squid	523	232	152	65	168 *	25
Banded giant stargazer	51	19	32	2	51 *	2
Barracouta	441	298	143	12	-	-
Black oreo	783	385	398	7	-	-
Bluenose	10	4	6	7	3 *	1
Dark ghost shark	3 395	1 646	1 745	71	293 *	4
Deepsea cardinalfish	61	23	13	6	1 *	1
Giant stargazer	550	273	272	67	322	37
Hake	363	184	179	74	363	74
Hapuku	13	3	10	7	10 *	4
Hoki	21 685	9 137	12 523	130	2 277	115
Jack mackerel	1	1	0	1	-	-
Lemon sole	159	39	42	20	99 *	10
Ling	2 057	1 081	970	113	1 862	112
Lookdown dory	5 376	2580	2 789	119	351 *	9
Northern spiny dogfish	3	0	3	2	-	-
Orange perch	419	160	257	22	101 *	5
Orange roughy	127	73	46	6	-	-
Pale ghost shark	1 048	539	508	83	170 *	20
Redbait	48	26	22	5	-	-
Red cod	819	492	324	37	89 *	5
Ribaldo	96	50	46	33	17 *	6
Rubyfish	1	0	1	1	-	-
Scampi	133	84	47	52	133 *	52
School shark	37	24	13	18	35 *	16
Sea perch	3 404	1 586	1 566	116	174 *	8
Shovelnose dogfish	911	406	487	32	181 *	11
Silverside	1	0	0	1	-	-
Silver warehou	1 559	755	802	54	199 *	7
Slender mackerel	56	30	25	16	-	-
Smooth oreo	122	64	55	11	-	-
Smooth skate	50	17	33	32	-	-
Southern blue whiting	14	7	7	4	-	-
Spiky oreo	1 327	798	520	20	-	-
Spiny dogfish	2 325	162	2 163	98	258 *	9
Tarakihi	145	68	77	10	26 *	2
Todarodes filippovae	6	0	5	2	-	-
Trumpeter	1	0	1	1	-	-
White warehou	1 230	625	532	67	186 *	12

* Length, sex, and weight data only collected.

† Total is sometimes greater than the sum of male and female fish due to the sex of some fish not recorded.

Table 9: **Numbers of male and female hake, hoki, and ling at each reproductive stage***

	Hake		Hoki		Ling	
Stage	Male	Female	Male	Female	Male	Female
1	63	13	360	358	450	496
2	23	76	475	1 047	315	289
3	4	62	2	0	83	2
4	10	3	0	0	9	0
5	42	0	0	0	0	0
6	34	6	0	0	0	0
7	8	19	0	0	0	0
Total	184	179	837	1 405	857	787

* Stage: 1, immature; 2, resting; 3, ripening; 4, ripe; 5, running ripe; 6, partially spent; 7, spent. (after Hurst *et al.*, 1992).

Appendix 1: Individual station data for all stations conducted during the survey. P1, phase 1 stations; P2, phase 2 stations

			Start of tow					Depth (m)		Dist.	Catch (kg)		
			Date	Time	Latitude	Longitude				towed	hoki	hake	ling
Stn.	Type	Stratum	1999	NZDT	° ′S	° ′	E/W	min.	max.	(n.mile)			
1	P1	2A	28-Dec-99	1237	42 47.51	177 42.23	E	662	688	3.05	76.3	39.3	23.8
2	P1	8B	28-Dec-99	1618	42 57.70	178 22.39	E	420	434	2.89	2 651.3	14.9	59.3
3	P1	20	28-Dec-99	1800	43 03.73	178 26.33	E	327	348	2.37	243.6	0	18.6
4	P1	2A	29-Dec-99	523	42 58.65	179 30.16	E	607	614	3.18	76.5	1.1	4.1
5	P1	8B	29-Dec-99	848	43 14.05	179 41.09	E	481	487	3	108.5	11.1	159.1
6	P1	8B	29-Dec-99	1049	43 15.53	179 49.38	E	484	485	3.01	105.6	12.5	47.8
7	P1	10A	29-Dec-99	1333	43 11.76	179 47.86	W	516	519	2.98	124.3	33.4	13.5
8	P1	10A	29-Dec-99	1528	43 07.05	179 36.82	W	519	520	2.99	210.7	10.9	13.8
9	P1	10B	29-Dec-99	1745	43 16.24	179 23.81	W	493	502	3.03	83.1	63.9	17.2
10	P1	2B	30-Dec-99	538	42 50.99	179 15.72	W	687	700	3.03	77.9	11.6	12
11	P1	10B	30-Dec-99	758	42 56.44	179 13.01	W	557	560	3	375.2	28.9	3.2
12	P1	10B	30-Dec-99	1001	42 54.82	179 04.77	W	560	579	2.99	227.4	41.1	15.9
13	P1	2B	30-Dec-99	1403	42 49.95	178 20.47	W	644	645	3.02	189.9	41.2	11.9
14	P1	21	30-Dec-99	1750	42 48.16	177 40.76	W	880	902	3.01	20.6	0	7.2
15	P1	21	31-Dec-99	531	42 48.19	177 01.79	W	939	940	3	20	0	0
16	P1	21	31-Dec-99	938	42 54.28	176 18.73	W	828	829	3	114.9	17.4	0
17	P1	2B	31-Dec-99	1151	42 56.87	176 13.83	W	754	763	3.03	51.3	3.5	19.1
18	P1	2B	31-Dec-99	1352	43 00.03	176 21.23	W	652	656	3.06	126.7	38.8	28.4
19	P1	2B	31-Dec-99	1724	43 01.29	176 06.89	W	653	666	3	153.8	24	13.7
20	P1	21	1-Jan-00	526	43 21.64	174 35.79	W	825	834	3.03	14.6	8.2	0
21	P1	4	1-Jan-00	936	43 48.92	174 56.84	W	667	672	3.03	168	2.9	4.3
22	P1	12	1-Jan-00	1314	43 43.24	175 24.34	W	484	531	3.03	170.5	7.9	23.7
23	P1	11D	1-Jan-00	1646	43 21.80	175 44.64	W	484	503	3.18	75.8	4	3.9
24	P1	9	2-Jan-00	515	43 31.50	176 02.87	W	270	274	3.06	5 401.4	0	0
25	P1	9	2-Jan-00	800	43 19.19	176 26.03	W	319	320	3	209	0	9.9
26	P1	11D	2-Jan-00	1042	43 10.43	176 31.32	W	433	440	3.01	47	0	81
27	P1	9	2-Jan-00	1341	43 13.90	177 03.06	W	336	370	3.01	95.3	0	48.5
28	P1	11D	2-Jan-00	1557	43 04.47	177 08.95	W	487	509	2.94	174.9	28.7	33.1
29	P1	11C	2-Jan-00	1806	43 06.42	177 25.59	W	450	467	2.97	73.9	8.5	12.7
30	P1	11C	3-Jan-00	521	43 09.54	178 15.47	W	475	510	3.04	76.5	28.4	12.5
31	P1	11C	3-Jan-00	722	43 02.26	178 12.07	W	527	534	2.99	101.2	25.7	19.9
32	P1	11C	3-Jan-00	916	43 06.58	178 04.45	W	495	506	3	67.5	29	10.2
33	P1	11C	3-Jan-00	1108	43 11.46	178 02.25	W	464	466	3	151.4	10.1	59.2
34	P1	11C	3-Jan-00	1304	43 07.34	177 52.85	W	466	477	3	130	10.5	10.9
35	P1	11C	3-Jan-00	1457	43 01.11	177 50.55	W	497	525	3.06	112.9	26	30.2
36	P1	2B	3-Jan-00	1715	42 54.78	177 40.88	W	610	616	3	217	22.7	35.1
37	P1	11B	4-Jan-00	518	43 04.88	178 34.72	W	503	521	3	67.6	22.8	3.8
38	P1	11B	4-Jan-00	735	43 11.33	178 23.04	W	435	444	2.11	141.7	15.5	9.7
39	P1	11A	4-Jan-00	1025	43 17.66	178 37.78	W	410	434	3.01	245.4	6.4	59.1
40	P1	11A	4-Jan-00	1222	43 25.48	178 26.94	W	425	431	2.99	250.9	8.7	31.8
41	P1	11A	4-Jan-00	1403	43 32.55	178 22.61	W	415	423	3.01	177.5	0	22.2
42	P1	11A	4-Jan-00	1601	43 30.45	178 33.27	W	417	425	3	489	0	39.4
43	P1	11A	4-Jan-00	1802	43 24.99	178 46.76	W	435	440	3.02	191.2	11.8	23.3
44	P1	10A	5-Jan-00	516	43 23.15	179 47.98	W	462	473	3	128.9	20.3	8
45	P1	10A	5-Jan-00	707	43 22.29	179 37.43	W	464	474	3	175.5	47.6	18.9
46	P1	10B	5-Jan-00	939	43 23.75	179 18.06	W	458	464	3	252.5	48.3	22
47	P1	11A	5-Jan-00	1228	43 36.38	178 57.05	W	447	453	3	292.3	24.5	25.4
48	P1	3	5-Jan-00	1434	43 41.87	178 59.10	W	386	393	3	195.4	8.4	51.3
49	P1	13	5-Jan-00	1800	43 52.63	178 29.73	W	445	453	2.4	183.4	18.7	61.1
50	P1	5	6-Jan-00	522	43 32.56	177 52.89	W	364	366	3	131.3	0	33.3

Appendix 1 — *continued*

Stn.	Type	Stratum	Start of tow: Date 1999	Time NZDT	Latitude ° ′S	Longitude ° ′E/W		Depth (m): min.	max.	Dist. towed (n.mile)	Catch (kg): hoki	hake	ling
51	P1	5	6-Jan-00	709	43 29.01	177 58.68	W	359	364	3	187.2	0	24.1
52	P1	5	6-Jan-00	959	43 39.84	177 39.65	W	380	386	3	176.2	0	41.7
53	P1	5	6-Jan-00	1351	43 59.37	177 19.22	W	354	362	3.05	379.2	0	9.4
54	P1	12	6-Jan-00	1617	44 07.86	177 31.81	W	455	466	3.03	136.4	6.5	57.1
55	P1	5	7-Jan-00	522	43 57.83	177 15.29	W	321	333	2.22	99.3	0	3.6
56	P1	12	7-Jan-00	1553	44 16.20	177 02.57	W	415	430	3	141.2	0	49.8
57	P1	13	8-Jan-00	517	43 52.35	178 45.88	W	425	438	3	220.5	0	31
58	P1	13	8-Jan-00	842	44 07.97	178 41.54	W	460	476	3	317.9	0	59.7
59	P1	3	8-Jan-00	1203	43 55.81	179 08.83	W	300	364	2.99	242.8	0	15.9
60	P1	13	8-Jan-00	1604	44 03.69	179 38.39	W	422	432	3.04	626.1	1.9	119.5
61*	P1	3	8-Jan-00	1803	43 52.80	179 42.35	W	392	395	0.57	NR	NR	NR
62	P1	3	9-Jan-00	521	43 38.55	179 45.83	W	366	374	3	336.6	3.5	70.5
63	P1	20	9-Jan-00	840	43 40.11	179 52.82	E	398	402	3	150.3	0	94.8
64	P1	14	9-Jan-00	1100	43 38.58	179 37.94	E	403	418	2.99	649.8	3.8	87.6
65	P1	14	9-Jan-00	1337	43 48.48	179 34.21	E	466	486	2.99	109.2	0	103.1
66	P1	4	9-Jan-00	1627	44 00.90	179 21.37	E	607	674	3.01	250.3	0	58.4
67	P1	14	10-Jan-00	516	43 43.57	178 20.38	E	408	423	3.04	128	0	44.1
68	P1	14	10-Jan-00	912	43 48.98	178 05.88	E	500	506	3	201	7.6	27.3
69	P1	15	10-Jan-00	1120	43 40.72	177 53.33	E	449	462	3	418	5.7	63.7
70	P1	20	10-Jan-00	1350	43 37.55	178 06.39	E	368	373	3.04	75	0	63.9
71	P1	20	10-Jan-00	1829	43 32.63	178 14.82	E	352	359	2	51.6	0	37.1
72	P1	20	11-Jan-00	517	43 27.91	178 14.19	E	330	350	2.93	557.3	0	44.6
73	P1	20	11-Jan-00	715	43 21.45	178 18.02	E	349	354	3	100.2	0	38.1
74	P1	20	11-Jan-00	932	43 11.80	178 01.66	E	342	348	2.01	68.7	0	13.4
75	P1	20	11-Jan-00	1444	43 08.46	177 42.74	E	314	325	3.01	1 778.6	0	0
76	P1	19	11-Jan-00	1743	43 19.01	177 29.83	E	248	256	3.01	887.5	0	0
77	P1	19	12-Jan-00	520	43 27.08	177 12.97	E	245	258	3.01	134.2	0	0
78	P1	19	12-Jan-00	745	43 27.59	176 50.55	E	244	260	3	2.6	0	0
79	P1	15	12-Jan-00	1011	43 41.55	176 57.59	E	461	470	3	238.4	4.7	56.9
80	P1	15	12-Jan-00	1209	43 44.56	177 02.00	E	481	487	3.02	201.1	1.3	56.6
81	P1	15	12-Jan-00	1400	43 48.73	177 13.27	E	499	516	3.01	167	0	68.1
82	P1	4	12-Jan-00	1724	44 07.85	176 55.06	E	670	693	3	316.2	0	35
83	P1	15	13-Jan-00	518	43 58.37	176 16.30	E	490	494	3.01	114.3	0	34.2
84	P1	17	13-Jan-00	739	44 08.05	176 08.89	E	237	260	3	0	0	1.4
85	P1	17	13-Jan-00	937	44 05.35	175 52.64	E	325	335	3.01	14.7	0	541.9
86	P1	17	13-Jan-00	1108	44 11.65	175 50.28	E	273	308	2.99	96.3	0	0
87	P1	16	13-Jan-00	1255	44 11.97	175 43.01	E	570	589	2.99	128.7	5.1	49.2
88	P1	6	13-Jan-00	1552	44 24.20	175 24.29	E	662	707	3	59.1	0	16.8
89	P1	6	13-Jan-00	1813	44 32.62	175 13.18	E	738	782	3	27.3	0	0
90	P1	18	14-Jan-00	513	43 19.65	175 45.83	E	295	302	3.01	1 789.6	0	0
91	P1	18	14-Jan-00	645	43 26.09	175 42.62	E	273	281	3	295.5	0	0
92	P1	18	14-Jan-00	822	43 32.12	175 40.79	E	260	272	3.03	658.6	0	0
93	P1	18	14-Jan-00	1002	43 37.03	175 34.44	E	275	289	2.99	1 278.6	0	0
94	P1	18	14-Jan-00	1144	43 41.78	175 24.88	E	328	354	3.01	385.8	0	0
95	P1	18	14-Jan-00	1401	43 45.31	175 31.01	E	357	375	2.04	949.4	0	6.1
96	P1	16	14-Jan-00	1559	43 57.99	175 32.02	E	481	493	3.02	80.1	14.8	147
97	P1	16	15-Jan-00	522	44 31.98	172 58.50	E	415	467	3.02	143	0	8.1
98	P1	16	15-Jan-00	815	44 18.50	173 27.13	E	432	450	3	156.1	0	47.4
99	P1	6	15-Jan-00	1224	44 18.27	174 20.36	E	644	644	3.01	148.2	21.7	41.5
100	P1	16	15-Jan-00	1500	44 05.30	174 32.77	E	553	562	3	89.4	12	53.5

Appendix 1 — *continued*

Stn.	Type	Stratum	Start of tow Date 1999	Time NZDT	Latitude ° ′S	Longitude ° ′	E/W	Depth (m) min.	Depth (m) max.	Dist. towed (n.mile)	Catch (kg) hoki	Catch (kg) hake	Catch (kg) ling
101	P1	16	15-Jan-00	1713	43 53.19	174 31.42	E	548	549	3	73.6	14.7	50.3
102	P1	16	16-Jan-00	518	43 47.11	174 51.37	E	462	471	3.01	918.6	9.8	36.1
103	P1	7	16-Jan-00	753	43 36.09	174 32.14	E	542	544	3	106.4	43.1	41.1
104	P1	16	16-Jan-00	1031	43 42.36	174 11.46	E	454	489	2.06	91.7	0	8.2
105	P1	7	16-Jan-00	1217	43 35.16	174 10.95	E	495	514	3	80.3	21	53.4
106	P1	7	16-Jan-00	1413	43 32.11	174 17.86	E	545	552	3.01	58.8	12.1	71.3
107	P1	7	16-Jan-00	1605	43 24.90	174 11.03	E	562	569	3.01	102.7	33.2	59.6
108	P1	1	16-Jan-00	1811	44 15.35	174 03.14	E	607	629	3.01	160.8	48.8	152
109	P1	1	17-Jan-00	527	42 54.34	175 01.10	E	681	702	3.01	351.7	48	20.8
110	P1	1	17-Jan-00	719	42 52.56	175 10.60	E	697	708	3	329	40.2	73.2
111	P1	7	17-Jan-00	945	42 57.90	175 28.00	E	499	573	2.99	610.6	66.1	69.5
112	P1	7	17-Jan-00	1153	43 01.14	175 44.33	E	499	506	2.98	211.8	7.6	52.7
113	P1	7	17-Jan-00	1342	43 06.70	175 50.38	E	431	446	3	1 452.3	53.2	54.3
114	P1	7	17-Jan-00	1539	43 05.59	175 54.79	E	421	427	2.26	557.6	0	26.2
115	P1	8A	17-Jan-00	1715	43 02.53	176 01.23	E	470	477	3	272.1	17.4	64.9
116	P1	2A	18-Jan-00	526	42 45.79	176 27.05	E	641	649	3.01	70.7	41.7	27.4
117	P1	8A	18-Jan-00	752	42 55.56	176 39.58	E	410	415	2.99	137.2	6.3	117.8
118	P1	19	18-Jan-00	1025	43 05.05	176 59.49	E	318	349	3.01	1 801.4	0	0
119	P1	8A	18-Jan-00	1238	42 52.63	177 06.67	E	407	413	3.05	226.3	0.7	104.1
120	P2	9	19-Jan-00	521	43 15.91	178 20.12	W	384	393	3.05	89.7	2	40.5
121	P2	9	19-Jan-00	839	43 18.67	177 41.80	W	341	345	3	671.8	0	0
122	P2	9	19-Jan-00	1027	43 23.10	177 39.71	W	335	346	3.01	148.2	0	6.2
123	P2	9	19-Jan-00	1222	43 26.92	177 27.75	W	266	280	3	1.5	0	0
124*	P2	9	19-Jan-00	1430	43 17.04	177 16.44	W	275	281	1.15	NR	NR	NR
125	P2	9	19-Jan-00	1726	43 18.91	177 01.25	W	230	288	3	0	0	0
126	P2	8B	20-Jan-00	518	43 20.13	179 57.40	E	445	448	3	504.4	53.5	7.7
127	P2	8B	20-Jan-00	719	43 20.66	179 42.44	E	428	465	3	58.5	4.2	27.1
128	P2	8B	20-Jan-00	935	43 15.33	179 32.67	E	431	434	3	141.6	0	46
129	P2	8B	20-Jan-00	1210	43 05.84	179 22.52	E	446	459	3.02	75.9	23.5	6.9
130	P2	8B	20-Jan-00	1417	43 02.66	179 06.14	E	465	470	3.01	48.8	0	17.7
131	P2	8B	20-Jan-00	1747	42 59.49	178 35.53	E	427	433	3	1 174.2	5.6	53.6
132	P2	18	21-Jan-00	520	43 27.77	175 55.63	E	351	363	3.01	1 492.9	1.7	49.5
133	P2	18	21-Jan-00	730	43 24.74	175 54.50	E	353	370	2.75	1 172.8	0	67.7
134	P2	19	21-Jan-00	934	43 18.90	176 09.40	E	342	366	2.99	1 173.3	0	14.7

* Foul trawl station
NR Catch not recorded on foul trawl stations

Appendix 2: Scientific and common names, and species caught from successful biomass stations. The occurrence (Occ.) of each species in the 100 successful biomass tows is also shown.

Scientific name	Common name	Code	Occ.
Porifera	sponges	ONG	29
Coelenterata			
Anthozoa	sea anemones	ANT	49
Anthozoa	corals	COU	15
Scyphozoa	jellyfishes	JFI	1
Crustacea			
Decapoda (Natantia)			
Acanthephyra pelagica	prawn	APE	1
Lipkius holthuisi	omega prawn	LHO	7
Notopandalus magnoculus	prawn	NMA	1
Pasiphaea barnardi	prawn	PBA	2
Crab (Anomura+Brachyura)	species not identified	CRB	7
Anomura			
Galatheidae			
Munida sp.		MUN	1
Lithodidae			
Lithodes murrayi	southern stone crab	LMU	4
Neolithodes brodiei	southern stone crab	NEB	
Paralomis zelandica	stone crab	PHS	2
Brachyura			
Homolidae			
Paromola petterdi	antlered crab	ATC	7
Majidae			
Leptomithrax australis	giant masking crab	SSC	3
Nephropidae			
Metanephrops challengeri	scampi	SCI	53
Mollusca			
Gastropoda	gastropod	GAS	13
Cephalopoda			
squid			
Cranchiidae	cranchiid squid	CHQ	4
Histioteuthidae			
Histioteuthis miranda	violet squid	VSQ	1
Ommastrephidae			
Nototodarus sloanii	arrow squid	NOS	66
Todarodes filippovae	Antarctic flying squid	TSQ	38
Onychoteuthidae			
Moroteuthis ingens	warty squid	MIQ	46
octopods	octopus	OCT	
Graneledone spp	deepwater octopus	DWO	3
Octopus cordiformis	octopus	OCT	6

Appendix 2 — *continued*

Scientific name	Common name	Code	Occ.
Echinodermata		ECH	25
Asteroidea	starfishes	SFI	98
Holothuroidea	sea cucumbers	SCC	23
Ophiuroidea	brittle stars	OPH	6
Echinodea	urchins		
Echinidae			
Gracilechinus multidentatus	sea urchin	GRM	5
Echinothuriidae			
Araeosoma coriaceum	Tam-o-shanter	ACO	33
Agnatha (jawless fishes)			
Myxinidae: hagfishes			
Eptatretus cirrhatus	hagfish	HAG	1
Chondrichthyes (cartilagenous fishes)			
Chlamydoselachidae: frill shark			
Chlamydoselachus anguineus	frill shark	FRS	1
Hexanchidae: cow sharks			
Hexanchus griseus	sixgill shark	HEX	2
Squalidae: dogfishes			
Centrophorus squamosus	deepwater spiny dogfish	CSQ	11
Centroscymnus coelolepis		CYL	1
C. crepidater	longnose velvet dogfish	CYP	11
C. owstoni	Owston's dogfish	CYO	8
C. plunketi	Plunket's shark	PLS	12
Deania calcea	shovelnose dogfish	SND	36
Etmopterus baxteri	Baxter's dogfish	ETB	21
E. lucifer	Lucifer dogfish	ETL	79
Scymnorhinus licha	seal shark	BSH	39
Squalus acanthias	spiny dogfish	SPD	98
S. mitsukurii	northern spiny dogfish	NSD	9
Oxynotidae: rough sharks			
Oxynotus bruniensis	prickly dogfish	PDG	12
Lamnidae: mackerel sharks			
Isurus oxyrinchus	mako shark	MAK	1
Lamna nasus	porbeagle shark	POS	2
Scyliorhinidae: cat sharks			
Apristurus spp.	deepsea catsharks	APR	7
Cephaloscyllium isabellum	carpet shark	CAR	2
Halaelurus dawsoni	Dawson's catshark	DCS	3
Triakidae: smoothhounds			
Galeorhinus galeus	school shark	SCH	18
Torpedinidae: electric rays			
Torpedo fairchildi	electric ray	ERA	1
Narkidae: blind electric rays			
Typhlonarke spp.	numbfish	BER	5
Rajidae: skates			
Notoraja asperula	smooth bluntnosed skate	BTA	27
N. spinifera	prickly bluntnosed skate	BTS	5
Dipturus innominatus	smooth skate	SSK	35
Chimaeridae: chimaeras, ghost sharks			
Hydrolagus novaezelandiae	dark ghost shark	GSH	71
Hydrolagus sp. B	pale ghost shark	GSP	84
Rhinochimaeridae: longnosed chimaeras			
Harriotta raleighana	longnose chimaera	LCH	39
Rhinochimaera pacifica	widenose chimaera	RCH	4

Appendix 2 — *continued*

Scientific name	Common name	Code	Occ.
Osteichthyes (bony fishes)			
Notacanthidae: spiny eels			
Notacanthus sexspinis	spineback	SBK	37
Synaphobranchidae: cutthroat eels			
Diastobranchus capensis	basketwork eel	BEE	2
Congridae: conger eels			
Bassanago bulbiceps	swollenheaded conger	SCO	35
B. hirsutus	hairy conger	HCO	27
Gonorynchidae: sandfish			
Gonorynchus spp.	sandfish	GON	2
Argentinidae: silversides			
Argentina elongata	silverside	SSI	77
Alepocephalidae: slickheads			
Xenodermichthys socialis	black slickhead	BSL	5
Photichthyidae: lighthouse fishes			
Photichthys argenteus	lighthouse fish	PHO	8
Chauliodontidae: viperfishes			
Chauliodus sloani	viperfish	CHA	2
Melanostomiidae: scaleless black dragonfishes			
Opostomias micripnus		OMI	1
Idiacanthidae: black dragonfishes			
Idiacanthus spp.		IDI	1
Notosudidae: waryfishes			
Scopelosaurus sp.		SPL	1
Paralepididae: barracudinas			
Paralepididae	barracudinas	PAL	1
Myctophidae: lanternfishes			
Species not identified	lanternfish	LAN	1
Moridae: morid cods			
Austrophycis marginata	dwarf cod	DCO	4
Halargyreus johnsoni	slender cod	HJO	9
Lepidion microcephalus	small headed cod	SMC	2
Mora moro	ribaldo	RIB	33
Pseudophycis bachus	red cod	RCO	37
Tripterophycis gilchristi	grenadier cod	GRC	2
Gadidae: true cods			
Micromesistius australis	southern blue whiting	SBW	4
Merlucciidae: hakes			
Macruronus novaezelandiae	hoki	HOK	130
Merluccius australis	hake	HAK	74
Macrouridae: rattails, grenadiers			
Caelorinchus aspercephalus	oblique banded rattail	CAS	81
C. biclinozonalis	two saddle rattail	CBI	14
C. bollonsi	bigeyed rattail	CBO	109
C. fasciatus	banded rattail	CFA	34
C. innotabilis	notable rattail	CIN	8
C. matamua	Mahia rattail	CMA	11
C. oliverianus	Oliver's rattail	COL	82
C. parvifasciatus	small banded rattail	CCX	25
Coryphaenoides serrulatus	serrulate rattail	CSE	11
C. subserrulatus	four rayed rattail	CSU	10
Coryphaenoides sp. B	long barbel rattail	CBA	5
Lepidorhynchus denticulatus	javelinfish	JAV	126
Macrourus carinatus	ridge scaled rattail	MCA	1
Trachyrincus aphyodes	unicorn rattail	WHX	7
Ventrifossa nigromaculata	blackspot rattail	VNI	23

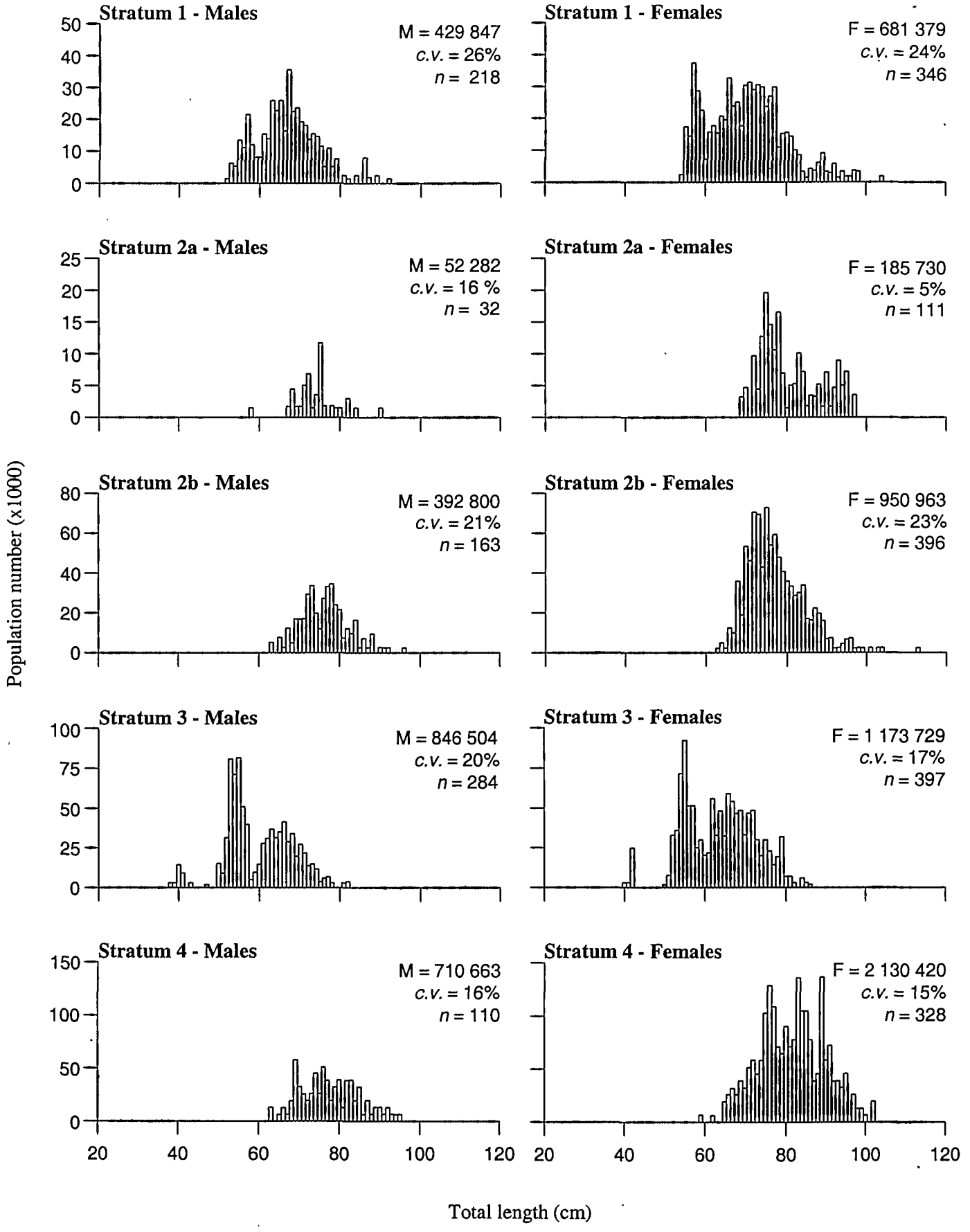
Appendix 2 — *continued*

Scientific name	Common name	Code	Occ.
Ophidiidae: cusk eels			
Genypterus blacodes	ling	LIN	113
Trachipteridae: dealfishes			
Trachipterus trachypterus	dealfish	DEA	1
Regalecidae: oarfishes			
Agrostichthys parkeri	ribbonfish	AGR	1
Trachichthyidae: roughies			
Hoplostethus atlanticus	orange roughy	ORH	6
Hoplostethus mediterraneus	silver roughy	SRH	33
Paratrachichthys trailli	common roughy	RHY	12
Berycidae: alfonsinos			
Beryx splendens	slender beryx	BYS	51
Zeidae: dories			
Capromimus abbreviatus	capro dory	CDO	19
Cyttus novaezelandiae	silver dory	SDO	24
C. traversi	lookdown dory	LDO	120
Zenopsis nebulosus	mirror dory	MDO	3
Oreosomatidae: oreos			
Allocyttus niger	black oreo	BOE	7
Neocyttus rhomboidalis	spiky oreo	SOR	22
Pseudocyttus maculatus	smooth oreo	SSO	11
Macrorhamphosidae: snipefishes			
Centriscops humerosus	banded bellowsfish	BBE	91
Notopogon lilliei	crested bellowsfish	CBE	3
Scorpaenidae: scorpionfishes			
Helicolenus spp.	sea perch	SPE	116
Congiopodidae: pigfishes			
Alertichthys blacki	alert pigfish	API	3
Congiopodus coriaceus	deepsea pigfish	DSP	3
Triglidea: gurnards			
Lepidotrigla brachyoptera	scaly gurnard	SCG	13
Hoplichthyidae: ghostflatheads			
Hoplichthys haswelli	deepsea flathead	FHD	37
Psychrolutidae: toadfishes			
Amblophthalmus angustus	pale toadfish	TOP	40
Cottunculus nudus	bonyskull toadfish	COT	1
Percichthyidae: temperate basses			
Polyprion oxygeneios	hapuku	HAP	7
Serranidae: sea perches			
Lepidoperca aurantia	orange perch	OPE	24
Apogonidae: cardinalfishes			
Epigonus denticulatus	white cardinalfish	EPD	3
E. lenimen	bigeye cardinalfish	EPL	14
E. robustus	robust cardinalfish	EPR	7
E. telescopus	black cardinalfish	EPT	6
Carangidae: jacks, trevallies, kingfishes			
Trachurus symmetricus	slender mackerel	JMM	17
T. declivis	jack mackerel	JMD	1
Bramidae: pomfrets			
Brama brama	Ray's bream	RBM	34
Taractes asper		TAS	1
Taraticthhys longipinnis	big scaled pomfret	BSP	1
Emmelichthyidae: bonnetmouths, rovers			
Emmelichthys nitidus	redbait	RBT	8
Plagiogeneion rubiginosus	rubyfish	RBY	1

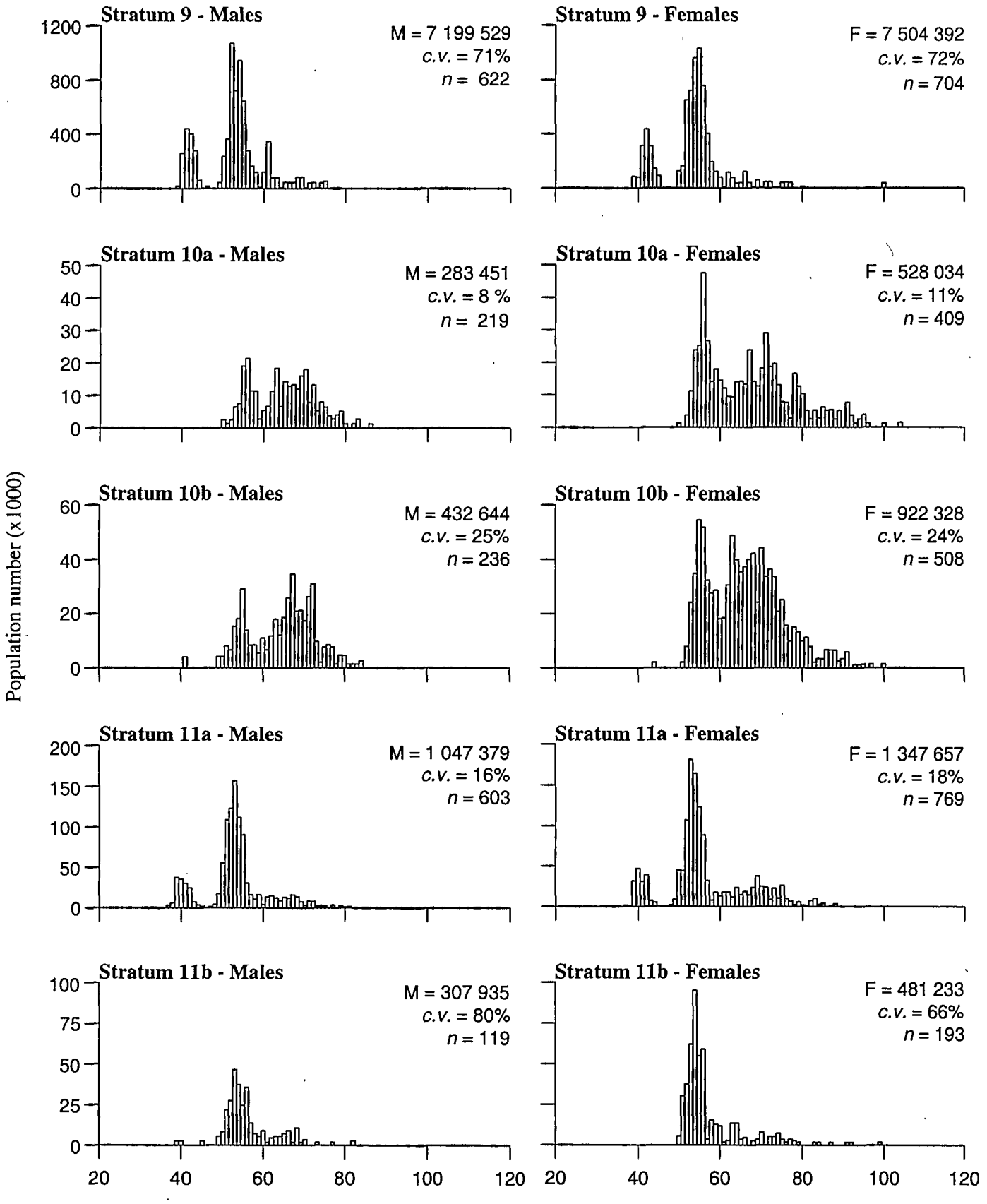
Appendix 2 — *continued*

Scientific name	Common name	Code	Occ.
Cheilodactylidae: tarakihi, morwongs			
Nemadactylus macropterus	tarakihi	TAR	10
Latrididae: moki, trumpeters			
Latris lineata	trumpeter	TRU	1
Uranoscopidae: armourhead stargazers			
Kathetostoma giganteum	giant stargazer	STA	67
Kathetostoma sp.	banded giant stargazer	BGZ	3
Percophidae: opalfishes			
Hemerocoetes spp.	opalfish	OPA	1
Pinguipedidae: weavers			
Parapercis gilliesi	yellow weaver	YCO	1
Gempylidae: snake mackerels			
Ruvettus pretiosus	oilfish	OFH	1
Thyrsites atun	barracouta	BAR	12
Centrolophidae: raftfishes, medusafishes			
Centrolophus niger	rudderfish	RUD	29
Hyperoglyphe antarctica	bluenose	BNS	7
Schedophilus huttoni		SUH	12
Seriolella caerulea	white warehou	WWA	67
S. punctata	silver warehou	SWA	54
Tubbia tasmanica		TUB	1
Bothidae: lefteyed flounders			
Arnoglossus scapha	witch	WIT	27
Neoachiropsetta milfordi	finless flounder	MAN	2
Pleuronectidae: righteyed flounders			
Azygopus pinnifasciatus	spotted flounder	SDF	2
Pelotretis flavilatus	lemon sole	LSO	22

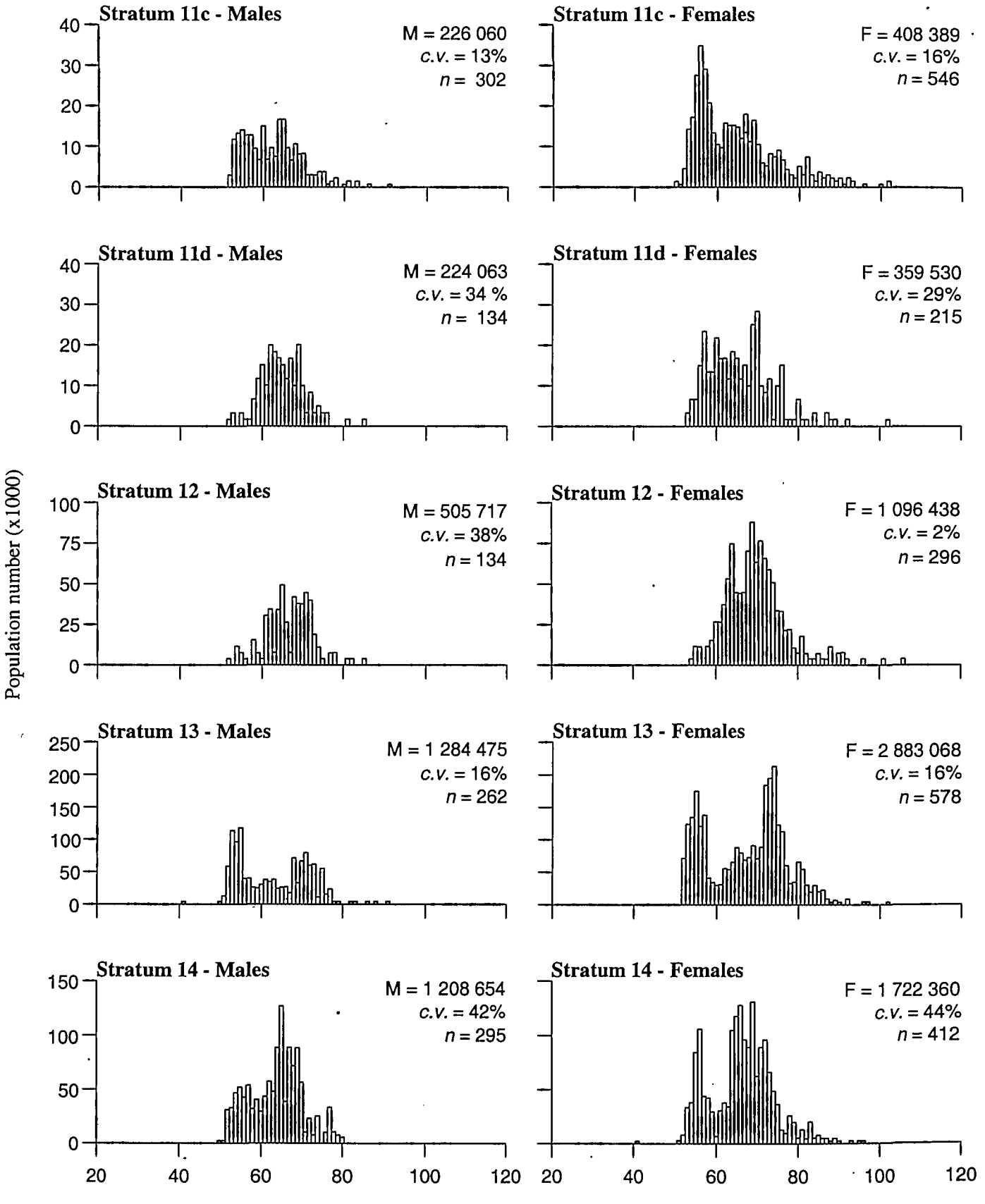
Appendix 3: Scaled length frequencies of hoki, by stratum and sex. (M, estimated male population; F, estimated female population; *c.v.*, coefficient of variation of the estimated numbers of fish; n, number of fish measured).



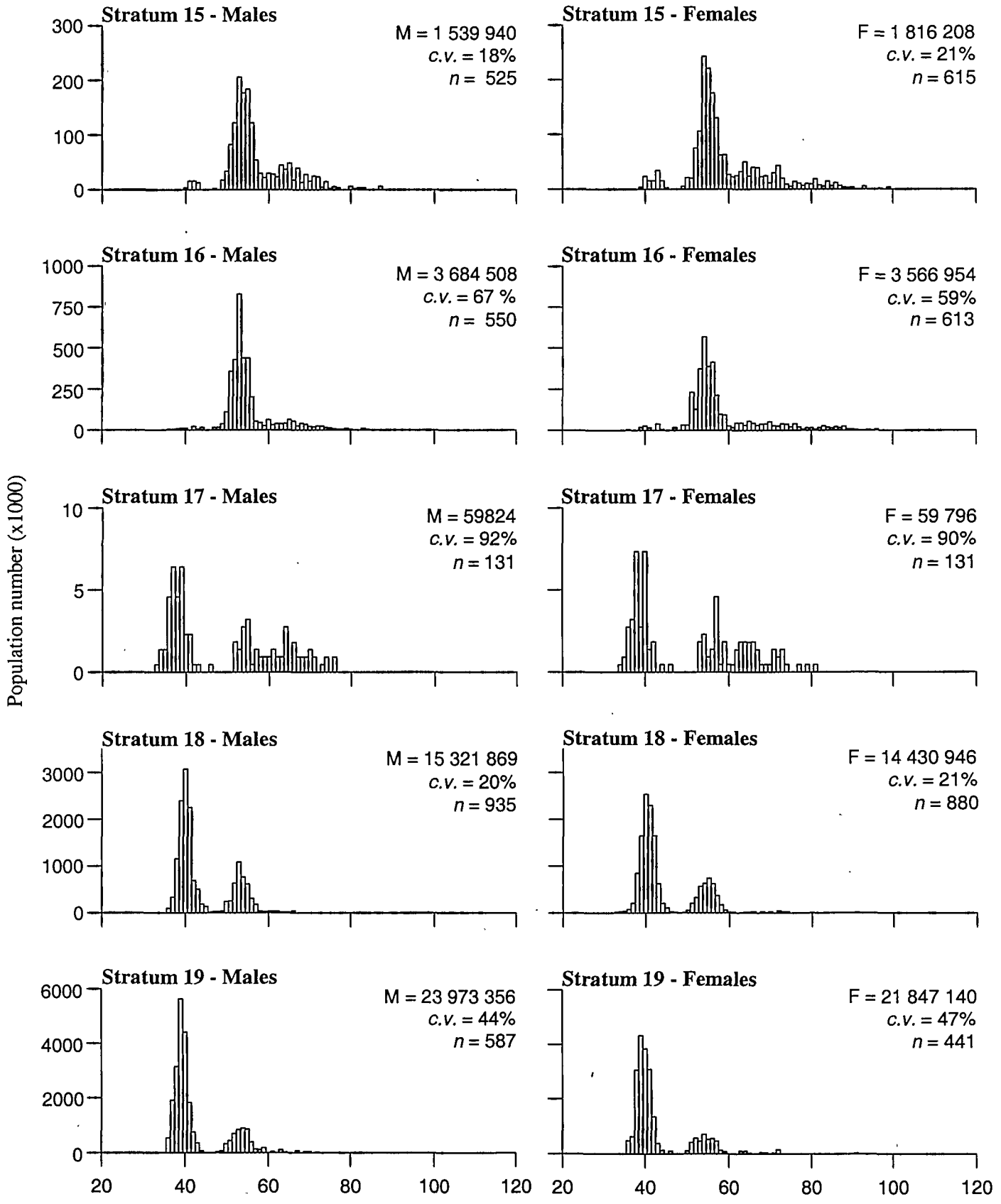
Appendix 3 - *continued*



Appendix 3 - *continued*



Appendix 3 - *continued*



Appendix 3 - *continued*