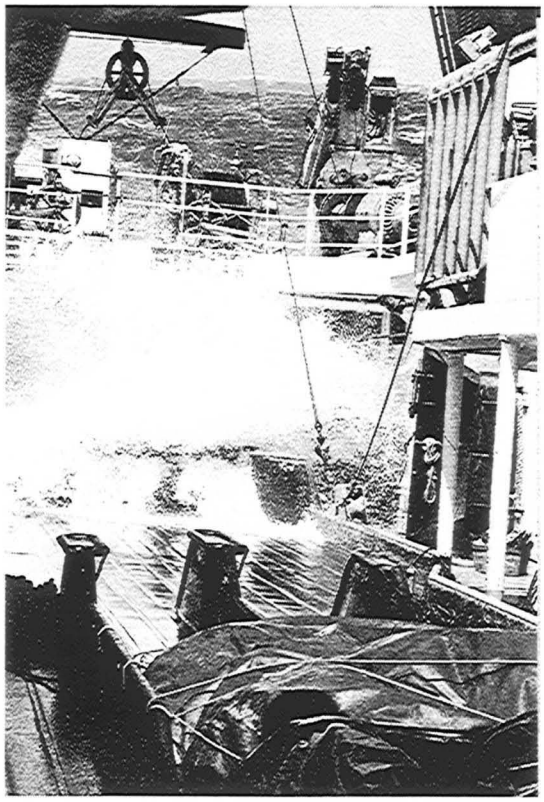
NIWA
Taihoro Nukurangi

Trawl survey of hoki and middle depth species on the Chatham Rise, January 2001 (TAN0101)

D. W. Stevens
M. E. Livingston
N. W. Bagley



NIWA Technical Report 116
ISSN 1174-2631
2002

Trawl survey of hoki and middle depth species on the Chatham Rise, January 2001 (TAN0101)

D. W. Stevens
M. E. Livingston
N. W. Bagley

NIWA Technical Report 116
2002

Published by NIWA
Wellington
2002

Edited and produced by
Science Communication, NIWA,
P O Box 14901, Wellington, New Zealand

ISSN 1174-2631
ISBN 0-478-23257-8

© NIWA 2002

Citation:
Stevens, D.W.; Livingston, M.E.; Bagley, N.W. (2002).
Trawl survey of hoki and middle depth species on the Chatham Rise,
January 2001 (TAN0101).
NIWA Technical Report 116. 61 p.

Cover photograph by Peter Marriott

The National Institute of Water and Atmospheric Research
is New Zealand's leading provider
of atmospheric, marine,
and freshwater science

Visit NIWA's website at http://www.niwa.co.nz

Contents

Abstract

Stevens, D.W.; Livingston, M.E.; Bagley, N.W. (2002). Trawl survey of hoki and middle depth species on the Chatham Rise, January 2001 (TAN0101).
***NIWA Technical Report 116.* 61 p.**

The tenth trawl survey of the Chatham Rise was successfully completed in January 2001. The results show that the total biomass of hoki and of recruited hoki (3+ and older) were at the lowest level since 1992, and continue a downward trend that has been evident since 1993. The 2+ index for the 1998 year class is almost identical to the 1997 year class surveyed as 2+ fish last year, and are both in the middle of the range for 2+ hoki throughout the time series. The 1+ index is the lowest since the series began, and suggests poor recruitment in 1999.

The biomass index for hake has also declined (by 22%) since January 2000. Most of the decline was in the deeper strata (600–800 m). The ling biomass was slightly higher than in 2000. The coefficients of variation (c.v.) for both hake and ling were below the target c.v.s of 20%.

Introduction

In January 2001, the tenth in a time series of annual random trawl surveys on the Chatham Rise to estimate relative abundance indices for hoki and a range of other middle depth species was completed. This and all previous surveys in the series have been carried out from R.V. *Tangaroa* and form the most comprehensive time series of species abundance in water depths of 200 to 800 m in New Zealand's 200 mile Exclusive Economic Zone. The surveys follow a random stratified design, with stratification by depth and longitude across the Chatham Rise to ensure full coverage of the area. In 2001, the stratification used was the same as that in 2000 (Stevens et al. 2001) in depths of 200–800 m. The deeper stratum at 800–1000 m sampled for hake in 2000 was excluded this year.

Earlier surveys in this time series have been documented by Horn (1994a, 1994b), Schofield & Horn (1994), Schofield & Livingston (1995, 1996, 1997), Bagley & Hurst (1998), Bagley & Livingston (2000), and Stevens et al. (2001). Comparisons of the first four surveys in the time series (1992 to 1995) were made by Livingston & Schofield (1996). Surveys of the Chatham Rise carried out before 1992 by a range of different vessels in different seasons were summarised by Schofield & Livingston (1995).

The survey results presented here are part of an ongoing research programme to estimate the abundance of hoki and other middle depth species for stock assessment. As well as abundance, the survey provided information on the population size structure of those species, and their distribution across the Chatham Rise. Otoliths from a range of Individual Transferable Quota (ITQ) species were also collected for ageing and use in stock assessments (Annala et al. 2001). Other work carried out concurrently with the survey included acoustic data collection and some target strength work (Objective 3 below), the results of which have been documented by O'Driscoll (2001).

This report summarises the catches, catch distributions, length frequency distributions, and biomass estimates of the ITQ species, and more abundant non-ITQ species, caught during the survey. Also summarised are the sea temperature data collected during the survey.

Objectives

1. To continue the time series of relative abundance indices of recruited hoki (eastern stock) and other middle depth species, particularly hake and ling, on the Chatham Rise using trawl surveys. The target c.v. for recruited hoki was 15%.

2. To determine the relative year class strengths of hoki juveniles (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.

3. To study the vertical and horizontal distribution of hoki juveniles and adults using acoustic methods to determine the validity of the trawl survey methodology.

This report presents the results of Objectives 1 and 2.

Timetable and personnel

The survey was carried out from 28 December 2000 to 25 January 2001 using RV *Tangaroa*. D.W. Stevens (NIWA, Wellington) was voyage leader and was responsible for data collection. N.W. Bagley (NIWA, Wellington) carried out the final editing of the database. M.E. Livingston (NIWA, Wellington) was project leader.

Methods

Survey area and design

As in previous years, the survey followed a two-phase random design (after Francis 1984). The survey area (Figure 1) was divided into the same strata used in 2000 (Stevens et al. 2001), excluding stratum 21 in 800–1000 m northwest of the Chatham Islands. 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 nine previous *Tangaroa* trawl surveys were used to simulate the optimal allocation. Optimisation used bootstrap simulation to allocate phase 1 stations to strata with high catch rates, based on the same principle as the phase 2 station allocation of Francis (1984). A minimum of 116 random stations was 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 obtained in phase 1.

All station positions were determined 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.

Trawling procedure

Trawling was carried out between sunrise and sunset (earliest start time, 0506 h, latest finish time, 1924 h NZST). If time was running short at the end of the day, the vessel steamed towards the last station and the trawl was shot 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.

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 for all 119 valid biomass tows.

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

Hydrology

The Chatham Rise hydrology is characterised by the presence of the Subtropical Front (STF) that lies more or less east–west along the crest of the Rise. The precise location of the STF is difficult to ascertain, however, Subtropical Water to the north is typically warmer than the Sub-Antarctic Water which lies to the south of the STF. In this study, water temperature data collected from the surface and seabed were used to determine the distribution of these water masses during the survey. Surface temperatures were obtained at the start of each tow from a temperature sensor mounted on the hull at a depth of about 5 m. Bottom temperatures were obtained 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. Surface and bottom temperatures were plotted to estimate isotherms on the Chatham Rise and ascertain which water masses were affecting the area during the survey.

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 subsampling, i.e., a subsample was sorted and weighed by species and the total catch was scaled according to the percentage weight of each species in the subsample.

From each tow, samples of up to 200 hoki and 50–200 of other commercial species were randomly selected from the catch to measure length (to the nearest centimetre) and determine sex. 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 included length (to the nearest millimetre), weight, sex, gonad stage and weight, stomach fullness, stomach contents, and prey digestion state.

Length, weight, and sex data were also collected from a number of species, including samples of alfonsino, banded giant and giant stargazer, spiky oreo, dark and pale ghost shark, lookdown dory, ribaldo, scampi, sea perch, shovelnose dogfish, silver warehou, smooth skate, southern spiny dogfish, and white warehou (see Appendix 2 for scientific names). These data were used to calculate length-weight relationships to enable more accurate scaling of the length frequencies for these species.

Otoliths from hoki and other middle depth species were routinely collected for other studies on age, growth, and stock separation.

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 was calculated by:

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

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) were used to estimate biomass.

Scaled length frequencies and biomass estimates 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 equalled 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) cohorts of hoki were also calculated using the Trawlsurvey Analysis Programme.

Results

Survey coverage

One hundred and fifteen phase 1 stations were successfully completed (Table 1). Four phase 2 stations were completed in strata 5 and 11d in an attempt to improve the c.v. for hoki. The station density in individual strata ranged from 1:288 in stratum 17 (Veryan Bank) to 1:2829 km^2 in stratum 4 (600–800 m depth on the south Chatham Rise). Mean station density over the whole survey area was 1:1172 km^2. The positions of all 115 successfully completed trawl survey stations are plotted in Figure 1. Individual station data, foul shots, and acoustic trawls are given in Appendix 1.

Gear performance

Gear configuration remained relatively constant over the 200–800 m depth range: mean doorspread measurements by 200 m depth intervals ranged from 113.3 to 120.1 m and headline height from 6.8 to 7.1 m, all within the optimal range (Hurst et al. 1992) (Table 2). The mean doorspread for all depths ranged from 98.8 to 129.9 m and the optimal range 100 to 130 m. Stations 71, 76, 79, 81, and 97 were given a poor gear performance code (i.e., the net came fast; catch affected by a large quantity of sponge; tow hauled early due to foul ground) and were excluded from all analyses.

Hydrology

Surface temperatures were recorded for all 119 biomass stations and ranged from 13.0 to 18.3 °C (Figure 2a). Bottom temperatures were recorded for all 119 biomass stations and ranged from 5.7 to 11.7 °C (Figure 2b).

Higher surface temperatures appear to be associated with an influx of warmer Subtropical water from the north over the central portion of the Chatham Rise. Lower temperatures were recorded from the strata in the southwest part of the survey area. Higher bottom temperatures were generally associated with shallower depths to the north of the Chatham Islands and on the Mernoo Bank, as in previous years. The STF, typically associated with closer isotherms, appears to have been just south of the crest of the Rise during the survey.

Catch composition

One hundred and ninety-seven species or species groups were recorded: 101 teleosts, 27 elasmobranchs, 17 crustaceans, 12 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 141.5 t, of which 35.0 t (24.8%) was hoki, 21.6 t (15.3%) was common roughy, 7.2 t (5.1%) was javelinfish, 7.2 t (5.1%) was dark ghost shark, 7.0 t (5.0%) was bigeyed rattail, and 5.8 t (4.1%) was black oreo (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++ cohorts in Table 4. Estimates of biomass by stratum of the 19 next most abundant species and hake 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 and sex are given in Table 6.

Hoki was the most abundant species, with 50% of the biomass being smaller fish in the 1+ and 2+ cohorts. Black oreo, dark ghost shark, ling, spiky oreo, pale ghost shark, sea perch, alfonsino, white warehou, barracouta, silver 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 and common roughy, was also estimated (see Table 3).

Species distribution

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

Hoki were caught at 115 of the 119 successful biomass stations. The largest individual station catch rate of hoki (2794 $kg.km^{-2}$) occurred in stratum 11d and consisted of 2+ and older fish. Strata 17, 18, and 19 (to the east of Mernoo Bank) yielded the highest catch rates of 1+ hoki and contributed 96% of the biomass of this cohort. Two year old hoki were also most abundant in shallow (200–400 m) strata (5, 9, 18, 19, and 20) (60% of 2+ biomass) and in the deeper (400–600 m) strata 7, 11d, and 16 (16% of 2+ biomass). Larger 3++ hoki were distributed in 200–800 m depths throughout the survey area. The largest catch was taken in stratum 16 to the south of the Mernoo Bank in 400–600 m depths.

Catches of hake were small, with most hake taken in the hake spawning area in strata 8b, 10a, 10b, 11a, 11b, and 11c, northwest of the Chatham Islands including the largest catch rate of 150 $kg.km^{-2}$. Few hake were taken at depths of 200–400 m. Ling catches were evenly distributed over the Chatham Rise between 200 and 600 m. The largest catch of ling (283 $kg.km^{-2}$) was taken in stratum 13 (southwest of the Chatham Islands).

Lookdown dory, seaperch, bigeyed 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 shovelnose dogfish and spiky oreo were generally taken at the same depth range on the north Chatham Rise, except for the largest catch of spiky oreo taken in strata 12 (571 m) to the south of the Chatham Islands. Dark ghost shark occurred mainly in the 200–400 m strata with one large catch (1490 $kg.km^{-2}$) 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 catch of both species taken as a mixed bag in stratum 17 on the southern edge of the Veryan Bank. Occasional catches of alfonsino were made in shallow (200–400 m) strata. One very large catch of common roughy (34 088 $kg.km^{-2}$) and barracouta (3650 $kg.km^{-2}$) was made in stratum 5 to the west of 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 of hake and ling by sex and depth range (200–400 m, 400–600 m, and 600–800 m) are given in Figures 6 and 7. Scaled length frequency histograms by sex of the other major commercial species are given in Figure 8. These length frequencies represent the population structure for the survey area as sampled by bottom trawl.

The 2+ cohort dominated scaled length frequencies and calculated numbers at age for hoki (Figure 5a). Catches of the 1+ cohort (less than 49 cm) were very low. No 1+ and few 2+ hoki were caught deeper than 600 m (Figure 5b).

Overall sex ratios (male:female population numbers presented in the top panel of Figure 5b) of hoki were 1:1.2 (males to females) with more females (1:3) in 600–800 m and 1:1.4 at 400–600 m. Sex ratios were about even for most other species, except for hake and spiny dogfish which were predominantly female (sex ratios exceeded 1:1.5 M:F), and barracouta, scampi, school shark, Murphy's mackerel, and tarakihi 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 (70% of males and 61% of females) ripening to partially spent (stages 3–6); adult ling showed 48% of males and 2% of females with active spawning reproductive stages. Otoliths were collected from 1693 hoki, 1212 ling, 269 hake, and 186 ribaldo for other studies.

Discussion

The survey c.v. of 8.7% achieved for adult hoki was well within the target precision level of 15%. The survey c.v. of 15.9 % for 2+ hoki was also within the target precision level of 20%. The c.v. for 2+ hoki in strata at the eastern end of the Chatham Rise was relatively high early on in the survey resulting in phase 2 stations being carried out opportunistically in anticipation of having to return to the area after phase 1. The c.v. at the completion of phase 1 however, had already met the target precision requirements. Although the phase 2 stations directed at 2+ hoki, primarily in strata 5 and 11d, lowered the c.v. for 2+ hoki from 16.7% to 15.9%, it raises the issue of whether or not anything is gained by adopting this procedure. We suspect that it is better to adopt the original plan of completing phase 1 before allocating phase 2 stations, but ensuring that there is time built in to the survey to allow sampling in eastern strata if necessary.

The estimated total biomass of hoki was the lowest since the time series began in 1992 and it continues a downward trend evident since the peak in 1993. The numbers of 1+ hoki were the lowest in the time series, and are indicative of poor recruitment in the 1999 year class. The hake biomass is also lower than last year, but the ling biomass was higher due to higher juvenile recruitment.

Acknowledgments

Thanks to all the scientific staff and the Master, officers, and crew of *Tangaroa* who contributed to the success of this voyage. Thanks also to Brian Bull for optimising the phase 1 station allocation and Mike Beentjes for providing constructive comments on this manuscript. This work was carried out by NIWA under contract to the Ministry of Fisheries (Project HOK2000/02).

References

Annala, J.H. (comp.) (1993). Report from the Fishery Assessment Plenary, May 1993: stock assessments and yield estimates: 241 p. (Unpublished report held in NIWA library, Wellington.)

Annala, J.H.; Sullivan, K.J.; O'Brien, C.J.; Smith, N.W.McL. (comps.) 2001: Report from the Fishery Assessment Plenary, May 2001: stock assessments and yield estimates: 515 p. (Unpublished report held in NIWA library, Wellington.)

Bagley, N.W.; Hurst, R.J. (1996). Trawl survey of middle depth and inshore bottom species off Southland, February-March 1995 (TAN9502). *New Zealand Fisheries Data Report No. 73.* 50 p.

Bagley, N.W.; Hurst, R.J. (1998). Trawl survey of hoki and middle depth species on the Chatham Rise, January 1998 (TAN9801). *NIWA Technical Report 44.* 54 p.

Bagley, N.W.; Livingston, M.E. (2000). Trawl survey of hoki and middle depth species on the Chatham Rise, January 1999 (TAN9901). *NIWA Technical Report 81.* 52 p.

Beentjes, M. (1992). Assessment of red cod based on recent trawl survey and catch sampling data. New Zealand Fisheries Assessment research Document 92/16. 40 p. (Draft report held in NIWA library, Wellington.)

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

Francis, R.I.C.C. (1989). A standard approach to biomass estimation from bottom trawl surveys. New Zealand Fisheries Assessment Research Document 89/3. 3 p. (Draft report held in NIWA library, Wellington.)

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

Horn, P.L. (1988). Age and growth of bluenose, *Hyperoglyphe antarctica* (Pisces: Stromateoidei) from the lower east coast, North Island, New Zealand. *New Zealand Journal of Marine and Freshwater Research 22:* 369–378.

Horn, P.L. (1994a). Trawl survey of hoki and middle depth species on the Chatham Rise, December 1991-January 1992 (TAN9106). *New Zealand Fisheries Data Report No. 43.* 38 p.

Horn, P.L. (1994b). Trawl survey of hoki and middle depth species on the Chatham Rise, December 1992-January 1993 (TAN9212). *New Zealand Fisheries Data Report No. 44.* 43 p.

Hurst, R.J.; Bagley, N.W. (1994). Trawl survey of middle depth and inshore bottom species off Southland, February-March 1993 (TAN9301). *New Zealand Fisheries Data Report No. 52.* 58 p.

Hurst, R.J.; Bagley, N.; Chatterton, T.; Hanchet, S.; Schofield, K.; Vignaux, M. (1992). Standardisation of hoki/middle depth time series trawl surveys. MAF Fisheries Greta Point Internal Report No. 194. 89 p. (Draft report held in NIWA library, Wellington.)

Johnston, A.D. (1983). The southern Cook Strait groper fishery. *Fisheries Technical Report No. 159.* 33 p.

Livingston, M.E.; Schofield, K.A. (1996). Annual changes in the abundance of hoki year classes on the Chatham Rise (January 1992–95) and the Southern Plateau (December 1991–93). New Zealand Fisheries Assessment Research Document 96/14. 35 p. (Draft report held in NIWA library, Wellington.)

O'Driscoll, R.L. (2001). Analysis of acoustic data collected on the Chatham Rise trawl survey, January 2001 (TAN0101). Final Research Report for Ministry of Fisheries Research Project HOK2000/02, Objective 3. 25 p. (Unpublished report held by Ministry of Fisheries, Wellington.)

Schofield, K.A.; Horn, P.L. (1994). Trawl survey of hoki and middle depth species on the Chatham Rise, January 1994 (TAN9401). *New Zealand Fisheries Data Report No. 53.* 54 p.

Schofield, K.A.; Livingston, M.E. (1995). Trawl survey of hoki and middle depth species on the Chatham Rise, January 1995 (TAN9501). *New Zealand Fisheries Data Report No. 59.* 53 p.

Schofield, K.A.; Livingston, M.E. (1996). Trawl survey of hoki and middle depth species on the Chatham Rise, January 1996 (TAN9601). *New Zealand Fisheries Data Report No. 71.* 50 p.

Schofield, K.A.; Livingston, M.E. (1997). Trawl survey of hoki and middle depth species on the Chatham Rise, January 1997 (TAN9701). *NIWA Technical Report 6.* 51 p.

Stevens, D.W.; Livingston, M.E.; Bagley, N.W. (2001). Trawl survey of hoki and middle depth species on the Chatham Rise, January 2000 (TAN0001). *NIWA Technical Report 104.* 55 p.

Stevenson, M.L.; Beentjes, M.P. (1999). Inshore trawl survey of the Canterbury Bight and Pegasus Bay, December 1998–January 1999 (KAH9809). *NIWA Technical Report 63.* 66 p.

Tracey, D.M.; George, K.; Gilbert, D.J. (2000). Estimation of age, growth, and mortality parameters of black cardinalfish *(Epigonus telescopus)* in QMA2 (east coast North Island). *New Zealand Fisheries Assessment Report 2000/27.* 21 p.

Vignaux, M. (1994). Documentation of Trawlsurvey Analysis Program. MAF Fisheries Greta Point Internal Report No. 225. 44 p. (Draft report held in NIWA library, Wellington.)

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

Stratum	Area (km^2)	Number of stations			Station density (km^2 per station)	Depth range (m)
		Phase 1	Phase 2	Total		
1	2 439	3	0	3	813	600–800
2a	3 253	3	0	3	1 084	600–800
2b	8 503	5	0	5	1 700	600–800
3	3 499	3	0	3	1 166	200–400
4	11 315	4	0	4	2 829	600–800
5	4 078	5	1	6	680	200–400
6	8 266	3	0	3	2 755	600–800
7	5 233	8	0	8	654	400–600
8a	3 286	3	0	3	1 095	400–600
8b	5 722	5	0	5	1 144	400-600
9	5 136	5	0	5	1 027	200–400
10a	2 958	3	0	3	986	400–600
10b	3 363	4	0	4	841	400-600
11a	2 966	6	0	6	494	400–600
11b	2 072	3	0	3	691	400-600
11c	3 342	3	0	3	1 114	400-600
11d	3 368	3	3	6	561	400-600
12	6 578	3	0	3	2 193	400–600
13	6 681	4	0	4	1 670	400–600
14	5 928	3	0	3	1 976	400–600
15	5 842	5	0	5	1 168	400–600
16	11 522	9	0	9	1 280	400–600
17	865	3	0	3	288	200–400
18	4 687	6	0	6	781	200–400
19	9 012	5	0	5	1 802	200–400
20	9 584	8	0	8	1 198	200–400
Total	139 498	115	4	119	1 172	200-800

Table 2: **Tow and gear parameters by depth range for valid biomass stations. 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)	119	2.9	0.25	1.99–3.04
Tow speed (knots)	119	3.5	0.11	3.1–3.8
Gear parameters (m)				
200–400 m				
Headline height	36	7.0	0.40	6.0–8.0
Doorspread	36	113.3	7.70	98.8–127.8
400–600 m				
Headline height	65	6.8	0.28	6.2–7.5
Doorspread	65	120.1	4.17	110–129
600–800 m				
Headline height	18	7.1	0.36	6.5–7.8
Doorspread	18	119.0	4.17	109–125.4
All depths				
Headline height	119	6.9	0.36	6.0–8.0
Doorspread	119	117.9	6.24	98.8–129.9

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). - not sexed.**

	Species code	Biomass						Catch (kg)
		All fish		Females		Males		
ITQ species								
Hoki	HOK	60 330	(9.7)	35 825	(8.5)	24 436	(12.6)	35 042
Black oreo	BOE	25 595	(46.0)	13 068	(43.7)	12 497	(48.6)	5 844
Dark ghost shark	GSH	10 356	(11.7)	6 246	(13.6)	4 065	(10.1)	7 234
Ling	LIN	9 352	(7.5)	4 833	(8.6)	4 519	(9.7)	4 944
Spiky oreo	SOR	7 300	(64.9)	3 483	(63.8)	3 815	(66.1)	2 464
Pale ghost shark	GSP	7 094	(9.1)	3498	(9.2)	3 336	(10.0)	3 055
Sea perch	SPE	6 310	(9.6)	2 774	(9.9)	3 457	(10.2)	3 174
Alfonsino	BYS	4 867	(59.5)	2 043	(67.9)	2 165	(66.8)	2 814
White warehou	WWA	4 262	(36.2)	1 993	(35.0)	2 267	(37.6)	4 231
Barracouta	BAR	3 664	(67.3)	1 660	(75.1)	1 980	(60.7)	3 031
Silver warehou	SWA	2 728	(22.0)	1 387	(24.0)	1340	(23.5)	2 112
Giant stargazer	STA	1 772	(15.7)	1 236	(16.4)	535	(22.5)	1 193
Hake	HAK	1 589	(12.7)	1 168	(13.6)	421	(16.4)	1 066
Smooth oreo	SSO	907	(73.8)	448	(71.7)	458	(76.1)	233
Ribaldo	RIB	762	(18.3)	480	(24.0)	282	(15.4)	346
Arrow squid	NOS	512	(23.3)	271	(24.2)	239	(23.8)	385
Red cod	RCO	441	(23.5)	275	(29.9)	159	(22.5)	273
School shark	SCH	258	(33.7)	81	(67.0)	177	(43.3)	137
Tarakihi	TAR	218	(26.1)	76.5	(46.9)	141.7	(23.7)	139
Orange roughy	ORH	213	(72.3)	124	(72.1)	89	(73.1)	81
Hapuku	HAP	195	(60.3)	87	(61.9)	108	(61.5)	151
Frostfish	FRO	135	(79.7)	73	(66.4)	61	(100)	115
Bluenose	BNS	124	(68.2)	66	(100)	58	(46.6)	66
Murphy's mackerel	JMM	120	(57.1)	36	(70.1)	84	(52.4)	93
Lemon sole	LSO	59	(35.9)	28	(31.5)	29	(44.5)	50
Black cardinalfish	EPT	35	(51.6)	28	(62.7)	2	(60.1)	18
Trumpeter	TRU	17	(100)	0		17	(100)	7
Red gurnard	GUR	16	(100)	7	(100)	9	(100)	15
Rubyfish	RBY	4	(45.7)	2	(71.8)	1	(68.5)	4
Commercial non-ITQ species (where biomass > 30 t)								
Southern spiny dogfish	SPD	9 586	(9.1)	8 980	(8.7)	606	(19.3)	5 467
Lookdown dory	LDO	7 713	(6.5)	4 952	(7.3)	2 752	(8.8)	3 873
Shovelnose dogfish	SND	4 190	(17.7)	2 608	(20.9)	1 548	(16.8)	1 936
Smooth skate	SSK	2 321	(18.8)	1 295	(23.0)	1 026	(31.6)	1 369
Banded giant stargazer	BGZ	678	(99.9)	402	(99.8)	276	(100)	263
Ray's bream	RBM	500	(50.2)	245	(57.8)	244	(45.8)	349
Southern blue whiting	SBW	110	(100)	40	(100)	69	(100)	236
Rough skate	RSK	72	(58.5)	72	(58.5)	0		33
Northern spiny dogfish	NSD	61	(26.0)	1	(100)	60	(25.1)	38
Scampi	SCI	61	(17.0)	16	(21.4)	43	(18.1)	38
Redbait	RBT	54	(28.8)	18	(35.4)	20	(37.3)	32
Non-commercial species (where biomass > 800 t)								
Common roughy	RHY	26 350	(88.4)	-		-		21 631
Javelinfish	JAV	15 520	(8.6)	-		-		7 274
Bollons' rattail	CBO	14 036	(10.0)	-		-		7 008
Oliver's rattail	COL	3 373	(23.7)	-		-		1 191
Silver dory	SDO	1 756	(58.6)	-		-		1 224
Longnose chimaera	LCH	1 595	(26.0)	-		-		566
Banded bellowsfish	BBE	1 230	(10.3)	-		-		864
Oblique-banded rattail	CAS	1 227	(17.0)	-		-		766
Orange perch	OPE	1 166	(65.7)	-		-		477
Baxter's dogfish	ETB	854	(26.9)	-		-		286
Total								141 547

* 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 (< 49 cm TL)		2+ cohort (49–60 cm TL)		3++ (> 60 cm TL)	
1	513	(49)	0		34	(82)	479	(46)
2a	396	(3)	0		4	(100)	392	(2)
2b	1 140	(25)	0		0		1 140	(25)
3	1 188	(67)	0		465	(63)	723	(71)
4	1 381	(9)	0		0		1 381	(9)
5	3 392	(40)	0		2 550	(44)	842	(36)
6	1 040	(26)	3	(100)	19	(100)	1 017	(27)
7	2 992	(40)	0		2 110	(53)	882	(24)
8a	611	(37)	0		196	(94)	414	(17)
8b	1 018	(24)	0		51	(43)	967	(23)
9	3 519	(63)	0		1 082	(68)	2 437	(79)
10a	1 969	(41)	0		626	(75)	1 342	(28)
10b	968	(16)	0		71	(48)	897	(18)
11a	1 552	(14)	0		753	(10)	799	(19)
11b	576	(8)	0		21	(33)	555	(9)
11c	704	(14)	0		108	(97)	596	(4)
11d	2 365	(60)	0		1 123	(96)	1 242	(30)
12	2 663	(11)	0		236	(94)	2 426	(21)
13	1 725	(51)	0		85	(100)	1 640	(48)
14	3 930	(28)	0		36	(43)	3 894	(28)
15	3 128	(16)	1	(100)	654	(53)	2 472	(16)
16	5 390	(42)	4	(58)	1 660	(78)	3 725	(29)
17	93	(100)	49	(100)	29	(100)	14	(100)
18	2 474	(42)	265	(97)	1 920	(44)	288	(60)
19	10 199	(25)	35	(53)	8 432	(31)	1 731	(39)
20	5 392	(49)	1	(70)	3 991	(62)	1 398	(35)
Total	60 330	(9.7)	362	(72.9)	29 919	(15.9)	30 048	(8.7)

* 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 19 most abundant species* (other than hoki) and hake by stratum. See Table 3 for species names.**

Stratum	Species code RHY		BOE		JAV		CBO		GSH		SPD		LIN		LDO		SOR		GSP	
1	0		0		318	(48)	148	(62)	0		0		106	(16)	26	(57)	50	(54)	91	(38)
2a	0		0		427	(47)	50	(22)	0		0		386	(62)	54	(18)	248	(50)	178	(10)
2b	0		0		1 263	(34)	184	(47)	0		0		233	(29)	103	(34)	853	(25)	162	(41)
3	0		0		122	(52)	88	(87)	1 812	(41)	600	(31)	93	(50)	176	(59)	0		11	(100)
4	0		17 388	(66)	966	(36)	242	(40)	0		13	(100)	535	(23)	152	(19)	1 191	(85)	671	(46)
5	23 177	(100)	0		153	(38)	110	(67)	1 643	(13)	903	(23)	251	(41)	294	(28)	0		0	
6	0		8 207	(30)	1 131	(37)	106	(52)	0		0		436	(50)	15	(100)	0		1 174	(27)
7	0		0		702	(31)	378	(23)	67	(57)	481	(51)	512	(15)	149	(14)	1	(100)	281	(36)
8a	0		0		322	(37)	84	(60)	50	(100)	10	(100)	303	(37)	62	(34)	119	(85)	160	(56)
8b	0		0		160	(6)	99	(30)	4	(66)	45	(43)	195	(39)	156	(35)	46	(84)	185	(37)
9	2 178	(100)	0		231	(46)	9	(100)	863	(39)	462	(22)	118	(78)	96	(56)	0		0	
10a	0		0		436	(82)	157	(45)	140	(54)	556	(54)	209	(22)	180	(48)	0		63	(34)
10b	0		0		94	(6)	27	(28)	0		46	(47)	115	(34)	77	(38)	74	(100)	87	(46)
11a	0		0		296	(30)	338	(26)	227	(33)	168	(20)	148	(31)	237	(23)	0		33	(56)
11b	0		0		57	(9)	17	(26)	1	(100)	8	(100)	49	(55)	34	(17)	0		37	(44)
11c	0		0		77	(33)	152	(42)	13	(100)	38	(100)	99	(38)	60	(22)	23	(100)	49	(28)
11d	10	(100)	0		265	(49)	214	(14)	64	(75)	69	(59)	255	(27)	204	(39)	68	(91)	31	(40)
12	0		0		352	(20)	984	(55)	24	(100)	416	(32)	512	(38)	930	(26)	4 623	(100)	442	(42)
13	0		0		1 025	(32)	579	(52)	16	(100)	877	(34)	848	(41)	637	(23)	4	(100)	581	(38)
14	0		0		3 898	(20)	2 598	(9)	2	(100)	1 125	(43)	1 108	(23)	1 596	(11)	0		947	(10)
15	0		0		1 013	(27)	2 753	(29)	14	(44)	302	(27)	588	(15)	465	(14)	0		713	(4)
16	0		0		901	(7)	2 814	(22)	27	(77)	432	(30)	1 374	(15)	601	(19)	0		724	(16)
17	0		0		+	(100)	+	(100)	520	(75)	28	(56)	15	(96)	1	(100)	0		2	(100)
18	1	(100)	0		265	(63)	59	(65)	1 400	(24)	1079	(13)	98	(60)	145	(33)	0		257	(100)
19	985	(100)	0		74	(34)	733	(55)	1 263	(40)	1 038	(33)	254	(27)	305	(35)	0		181	(67)
20	0		0		974	(43)	1 114	(45)	2 208	(21)	890	(10)	510	(28)	957	(27)	0		34	(100)
Total	26 350	(88)	25 595	(46)	15 520	(9)	14 036	(10)	10 356	(12)	9 586	(9)	9 352	(8)	7 713	(7)	7 300	(65)	7 094	(9)

Table 5 — continued

Stratum		SPE		BYS		WWA		SND		BAR		COL		SWA		SSK		STA		Species code HAK	
1	13	(59)	0		4	(100)	428	(20)	0		54	(46)	0		0		8	(100)	39	(48)
2a	128	(12)	0		0		152	(96)	0		19	(76)	0		0		0		48	(36)
2b	34	(34)	0		0		1 904	(26)	0		47	(67)	0		43	(100)	38	(100)	89	(64)
3	184	(74)	1 311	(96)	8	(75)	0		17	(68)	+	(100)	99	(62)	32	(100)	21	(100)	0	
4	121	(51)	0		12	(100)	967	(51)	0		25	(35)	0		69	(100)	0		140	(100)
5	25	(52)	94	(40)	248	(52)	0		2 904	(83)	+	(100)	383	(24)	48	(48)	331	(36)	0	
6	5	(100)	0		12	(100)	17	(100)	0		954	(72)	0		100	(100)	0		71	(57)
7	96	(18)	0		121	(60)	287	(43)	0		71	(40)	14	(62)	214	(55)	39	(42)	183	(27)
8a	191	(35)	17	(100)	0		189	(50)	0		18	(70)	0		0		0		42	(83)
8b	161	(30)	13	(44)	12	(62)	0		0		11	(40)	0		0		40	(100)	26	(61)
9	83	(96)	698	(88)	194	(49)	0		324	(48)	0		320	(30)	34	(100)	268	(35)	0	
10a	100	(37)	3	(56)	32	(77)	0		0		42	(100)	3	(100)	69	(100)	7	(100)	40	(60)
10b	42	(12)	33	(85)	1	(100)	34	(87)	0		5	(6)	1	(100)	22	(100)	0		141	(19)
11a	76	(23)	25	(56)	64	(38)	0		0		3	(81)	22	(60)	56	(43)	23	(61)	160	(38)
11b	36	(39)	9	(56)	0		15	(55)	0		1	(56)	0		68	(53)	0		80	(29)
11c	52	(34)	20	(56)	0		20	(100)	0		5	(53)	0		82	(100)	1	(100)	62	(19)
11d	70	(37)	60	(44)	13	(86)	54	(52)	1	(100)	3	(46)	4	(100)	91	(59)	20	(96)	50	(53)
12	168	(15)	0		76	(60)	29	(100)	0		21	(75)	19	(100)	0		122	(60)	121	(11)
13	381	(45)	0		41	(39)	18	(73)	0		65	(42)	34	(64)	105	(91)	30	(100)	52	(67)
14	516	(11)	2	(100)	497	(77)	0		0		1 380	(24)	8	(100)	193	(52)	11	(100)	91	(51)
15	435	(18)	0		95	(32)	0		0		145	(58)	42	(54)	205	(63)	117	(38)	39	(52)
16	314	(63)	0		156	(31)	75	(64)	0		504	(39)	177	(76)	299	(61)	141	(47)	88	(39)
17	17	(96)	0		1 338	(100)	0		0		0		353	(100)	10	(100)	41	(55)	0	
18	280	(76)	0		231	(94)	0		418	(98)	1	(64)	251	(75)	80	(47)	281	(64)	0	
19	1 042	(24)	10	(78)	307	(32)	0		0		0		418	(66)	188	(95)	96	(31)	8	(61)
20	1 741	(21)	2 573	(98)	801	(76)	0		0		+	(100)	582	(50)	314	(61)	139	(44)	20	(74)
Total	6 310	(10)	4 867	(60)	4 262	(36)	4 190	(18)	3 664	(67)	3 373	(24)	2 728	(22)	2 321	(19)	1 772	(16)	1 589	(13)

+ 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	0.025637	2.970389	372	0.99	18–51	This survey
Dark ghost shark	0.001842	3.292118	1 121	0.98	24–72	This survey
Giant stargazer	0.008100	3.172980	222	0.99	23–81	This survey
Hake	0.001728	3.320535	265	0.98	42–124	This survey
Hoki	0.004088	2.926636	2 357	0.98	38–113	This survey
Ling	0.001367	3.274187	1 762	0.99	30–159	This survey
Lookdown dory	0.025911	2.949984	1 058	0.99	11–57	This survey
Pale ghost shark	0.007470	2.937547	869	0.97	21–88	This survey
Ribaldo	0.004182	3.257220	188	0.98	27–72	This survey
Scampi	0.727837	2.830888	317	0.89	2.9–7.2	This survey
Sea perch	0.007209	3.234593	835	0.99	10–49	This survey
Shovelnose dogfish	0.001777	3.162243	771	0.99	29–114	This survey
Silver warehou	0.010588	3.131576	635	0.99	24–57	This survey
Smooth skate	0.024538	2.948367	93	0.99	34–134	This survey
Southern spiny dogfish	0.001856	3.193229	991	0.96	48–105	This survey
Spiky oreo	0.025360	2.964571	420	0.97	18–43	This survey
White warehou	0.013570	3.119643	517	0.98	14–65	This survey
Arrow squid	0.0290	3.00	-	-	-	Annala et al. (2001)
Banded giant stargazer	0.01030	3.25	143	0.98	22–69	Bagley & Hurst (1996)
Barracouta	0.003929	3.026534	155	0.92	50–112	Bagley & Livingston (2000)
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)
Frostfish	0.000368	3.176903	962	1.00	11–176	All records on DB
Hapuku	0.014230	2.998	1 644	-	50–130	Johnston (1983)
Lemon sole	0.005307	3.228744	98	0.91	24–39	Stevens et al. 2001
Northern spiny dogfish	0.004610	3.003424	207	0.95	44–90	All records on DB
Orange roughy	0.0687	2.792	7 880	0.99	9–44	DB, Chat. Rise, Nov-Mar
Ray's bream	0.011561	3.117988	273	0.97	28–50	All records on DB
Redbait	0.005099	3.249131	122	0.99	13–41	Allrecords on DB
Red cod	0.0092	3.003	923	0.98	13–72	Beentjes (1992)
Red gurnard	0.001626	3.223728	846	-	13–54	Stevenson & Beentjes (1999)
Rubyfish	0.027018	2.906400	68	-	31–49	DB, WNK8503
School shark	0.00702	2.91	804	-	30–166	Seabrook-Davison, Unp.
Murphy's 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
Southern blue whiting	0.003	3.2	444	-	19–55	Hatanaka et al. (1989)
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, correlation coefficient; Range, length range of fish (cm); DB., Ministry of Fisheries trawl survey database; Unp., unpublished data.

Table 7: **Mean catch rates (kg.km^{-2}) with standard deviations (in parentheses) by stratum for the 20 most abundant species * and hake. Species names are given in Table 3.**

	Species code										
Stratum	HOK	RHY	BOE	JAV	CBO	GSH	SPD	LIN	LDO	SOR	GSP
1	211	0	0	130	61	0	0	44	11	20	37
	(178)			(108)	(65)			(12)	(10)	(19)	(25)
2a	122	0	0	131	15	0	0	119	17	76	55
	(7)			(106)	(6)			(129)	(5)	(66)	(9)
2b	134	0	0	149	22	0	0	27	12	100	19
	(75)			(112)	(23)			(18)	(9)	(57)	(18)
3	340	0	0	35	25	518	172	26	50	0	3
	(396)			(32)	(38)	(364)	(91)	(23)	(51)		(5)
4	122	0	1 537	85	21	0	1	47	13	105	59
	(23)		(2 032)	(61)	(17)		(2)	(22)	(5)	(178)	(55)
5	832	5 683	0	38	27	403	221	62	72	0	0
	(809)	(13 916)		(35)	(44)	(126)	(123)	(62)	(49)		
6	126	0	993	137	13	0	0	53	2	0	142
	(57)		(518)	(89)	(12)			(46)	(3)		(67)
7	572	0	0	134	72	13	92	98	28	0.2	54
	(642)			(117)	(46)	(21)	(132)	(41)	(11)	(0.7)	(55)
8a	186	0	0	98	26	15	3	92	19	36	49
	(121)			(62)	(27)	(26)	(5)	(59)	(10)	(53)	(47)
8b	178	0	0	28	17	0.6	8	34	27	8	32
	(94)			(3)	(11)	(0.9)	(9)	(30)	(21)	(15)	(27)
9	685	424	0	45	2	168	90	23	19	0	0
	(970)	(948)		(46)	(4)	(146)	(44)	(40)	(24)		
10a	666	0	0	147	53	47	188	71	61	0	21
	(473)			(209)	(41)	(44)	(176)	(28)	(50)		(13)
10b	288	0	0	28	8	0	14	34	23	22	26
	(91)			(3)	(4)		(13)	(23)	(17)	(44)	(24)
11a	524	0	0	100	114	77	57	50	80	0	11
	(179)			(73)	(72)	(62)	(28)	(38)	(45)		(16)
11b	278	0	0	28	8	0.3	4	24	17	0	18
	(39)			(4)	(4)	(0.5)	(6)	(22)	(5)		(14)
11c	211	0	0	23	45	4	11	30	18	7	15
	(52)			(13)	(33)	(7)	(20)	(20)	(7)	(12)	(7)
11d	702	3	0	78	63	19	20	76	60	20	9
	(1 032)	(7)		(95)	(23)	(35)	(30)	(51)	(58)	(45)	(9)
12	405	0	0	53	150	4	63	78	141	703	67
	(77)			(19)	(143)	(6)	(35)	(52)	(63)	(1 217)	(49)
13	258	0	0	153	87	2	131	127	95	0.6	87
	(262)			(99)	(90)	(5)	(90)	(105)	(45)	(1.1)	(66)
14	663	0	0	658	438	0.4	190	187	269	0	160
	(318)			(229)	(67)	(0.7)	(142)	(74)	(53)		(27)
15	535	0	0	173	471	2	52	101	80	0	122
	(193)			(103)	(309)	(2)	(31)	(34)	(25)		(11)
16	468	0	0	78	244	2	38	119	52	0	63
	(596)			(17)	(162)	(5)	(34)	(55)	(30)		(30)
17	108	0	0	0.4	1	601	32	17	2	0	3
	(187)			(0.7)	(1)	(784)	(31)	(23)	(3)		(5)
18	528	0.2	0	56	13	299	230	21	31	0	55
	(542)	(0.4)		(87)	(20)	(179)	(75)	(31)	(25)		(134)
19	1 132	109	0	8	81	140	115	28	34	0	20
	(644)	(244)		(6)	(101)	(125)	(84)	(17)	(26)		(30)
20	563	0	0	102	116	230	93	53	100	0	4
	(782)			(122)	(148)	(137)	(27)	(43)	(76)		(10)

Table 7 — continued

Stratum	Species code									
	SPE	BYS	WWA	SND	BAR	COL	SWA	SSK	STA	HAK
1	5	0	1	176	0	22	0	0	3	16
	(5)		(3)	(59)		(18)			(5)	(13)
2a	39	0	0	47	0	6	0	0	0	15
	(8)			(78)		(8)				(9)
2b	4	0	0	224	0	6	0	5	4	11
	(3)			(130)		(8)		(11)	(10)	(15)
3	52	375	2	0	5	0.1	28	9	6	0
	(67)	(623)	(3)		(6)	(0.1)	(31)	(16)	(10)	
4	11	0	1	85	0	2	0	6	0	12
	(11)		(2)	(87)		(2)		(12)		(25)
5	6	23	61	0	712	0.1	94	12	81	0
	(8)	(22)	(77)		(1 456)	(0.1)	(55)	(14)	(71)	
6	0.6	0	1	2	0	115	0	12	0	9
	(1)		(3)	(4)		(144)		(21)		(8)
7	18	0	23	55	0	14	3	41	7	35
	(9)		(39)	(67)		(15)	(5)	(64)	(9)	(27)
8a	58	5	0	58	0	5	0	0	0	13
	(35)	(9)		(50)		(7)				(19)
8b	28	2	2	0	0	2	0	0	7	5
	(19)	(2)	(3)			(2)			(16)	(6)
9	16	136	38	0	63	0	62	7	52	0
	(35)	(267)	(42)		(68)		(42)	(15)	(40)	
10a	34	1	11	0	0	14	0.9	23	2	13
	(22)	(1)	(15)			(25)	(1.5)	(40)	(4)	(14)
10b	13	10	0.2	10	0	2	0.2	6	0	42
	(3)	(17)	(0.4)	(17)		(0.2)	(0.4)	(13)		(16)
11a	26	8	22	0	0	1	7	19	8	54
	(15)	(11)	(20)			(2)	(11)	(20)	(11)	(51)
11b	17	4	0	7	0	0.5	0	33	0	39
	(12)	(4)		(7)		(0.5)		(30)		(19)
11c	16	6	0	6	0	1	0	24	0.1	19
	(9)	(6)		(11)		(1)		(42)	(0.3)	(6)
11d	21	18	4	16	0.3	0.9	1	27	6	15
	(19)	(19)	(8)	(21)	(0.8)	(1)	(3)	(39)	(14)	(19)
12	26	0	12	4	0	3	3	0	19	18
	(6)		(12)	(8)		(4)	(5)		(19)	(3)
13	57	0	6	3	0	10	5	16	4	8
	(51)		(5)	(4)		(8)	(6)	(29)	(9)	(10)
14	87	0.4	84	0	0	233	1	33	2	15
	(17)	(0.6)	(112)			(98)	(2)	(30)	(3)	(13)
15	75	0	16	0	0	25	7	35	20	7
	(31)		(12)			(32)	(9)	(50)	(17)	(8)
16	27	0	14	7	0	44	15	26	12	8
	(52)		(13)	(13)		(51)	(35)	(47)	(17)	(9)
17	19	0	1 546	0	0	0	408	11	47	0
	(31)		(2 669)				(702)	(19)	(45)	
18	60	0	49	0	89	0.1	54	17	60	0
	(111)		(114)		(215)	(0.2)	(98)	(20)	(94)	
19	116	1	34	0	0	0	46	21	11	0.8
	(62)	(2)	(24)				(68)	(44)	(7)	(1)
20	182	268	84	0	0	0.1	61	33	15	2
	(109)	747	(179)			(0.1)	(85)	(57)	(18)	(4)

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	No. of	No. of
	Total†	Male	Female	samples	fish	samples
Alfonsino	1 507	497	440	42	621	23
Arrow squid	707	391	310	80	4 #	2
Banded giant stargazer	57	25	32	2	56 *	1
Barracouta	504	316	177	15	90	5
Barracudina	8	-	-	2	7 #	1
Bigeyed rattail	424	-	2	1	-	-
Big-scale pomfret	2	1	1	1	-	-
Black oreo	1 153	565	587	6	449 *	4
Bluenose	9	7	2	7	7	5
Common roughy	36	-	-	1	36 #	1
Dark ghost shark	4 051	1 955	2 074	72	1 160	25
Deepsea cardinal fish	81	5	11	10	6 *	6
Deepsea flathead	1	-	-	1	-	-
Frostfish	93	49	43	4	6 *	2
Giant stargazer	421	210	203	65	224	30
Hairy conger	3	-	-	1	-	-
Hake	270	114	156	72	270 *	72
Hapuku	31	18	13	7	8	5
Hoki	21 481	8 951	12 265	132	2 376	122
Javelinfish	553	0	5	2	2	1
Lampanyctodes hectoris	5	0	0	1	5 #	1
Lantern fish	1 238	-	-	6	1238 #	6
Lemon sole	116	60	56	13	13 *	3
Ling	2 508	1 242	1 230	116	1 783	106
Lighthouse fish	1	-	-	1	1	1
Longfinned beryx	1	1	0	1	1 *	1
Longnose chimaera	16	-	-	1	-	-
Lookdown dory	5 053	2 201	2 739	121	1 083 *	29
Lucifer dogfish	1	-	-	1	-	-
Northern spiny dogfish	17	16	1	9	12 *	8
Oblique banded rattail	12	-	-	1	-	-
Orange perch	269	142	127	14	214 *	5
Orange roughy	116	52	61	4	8 *	1
Pale ghost shark	1 639	845	752	90	872 *	47
Pale toadfish	3	-	-	1	-	-
Pavoraja asperula	1	-	-	1	-	-
Pavoraja spinifera	2	-	-	1	-	-
Pearlside	1 022	-	-	5	1 022 #	5
Ray's bream	248	127	117	39	100	11
Redbait	82	18	16	14	66	6
Red cod	398	205	190	39	110	11
Red gurnard	16	9	7	1	-	-
Ribaldo	201	112	89	45	188	42
Ridge scaled rattail	10	3	7	1	-	-
Rough skate	6	0	6	3	6 *	3
Rubyfish	5	1	2	4	4	3
Rudderfish	1	1	0	1	1	1
Scampi	335	207	121	65	334 *	65
School shark	13	9	4	11	11 *	9
Sea perch	3 785	1 835	1 667	115	839 *	33
Shovelnose dogfish	1 104	492	612	33	776 *	23
Silverside	1 401	771	460	70	1 *	1
Silver dory	729	0	2	3	576 *	2

Table 8 — continued

Species	Length frequency samples: No. of fish measured: Total†	Male	Female	No. of samples	Biological samples: No. of fish	No. of samples
Silver warehou	1 671	874	786	61	637	25
Murphy's mackerel (JMM)	108	61	38	19	28	4
Smooth oreo	226	124	102	13	127 *	8
Smooth skate	99	44	55	49	93 *	46
Southern blue whiting	91	59	31	1	-	-
Southern spiny dogfish	2 475	197	2 278	92	1 001 *	46
Spiky oreo	1 783	948	832	26	420 *	8
Tarakihi	110	75	35	10	62 *	5
Todarodes filippovae	1	0	1	1	1 #	1
Trumpeter	1	1	0	1	1 *	1
White warehou	1 699	935	756	77	518 *	35

\# Length data only collected.

* 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*.**

Stage	Hake: Male	Female	Hoki: Male	Female	Ling: Male	Female
1	28	28	258	97	278	301
2	25	49	554	1 247	303	517
3	6	69	0	8	28	8
4	20	2	0	0	254	2
5	32	2	0	0	2	0
6	3	2	0	0	2	0
7	0	4	1	12	0	0
Total	114	156	813	1 364	867	828

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

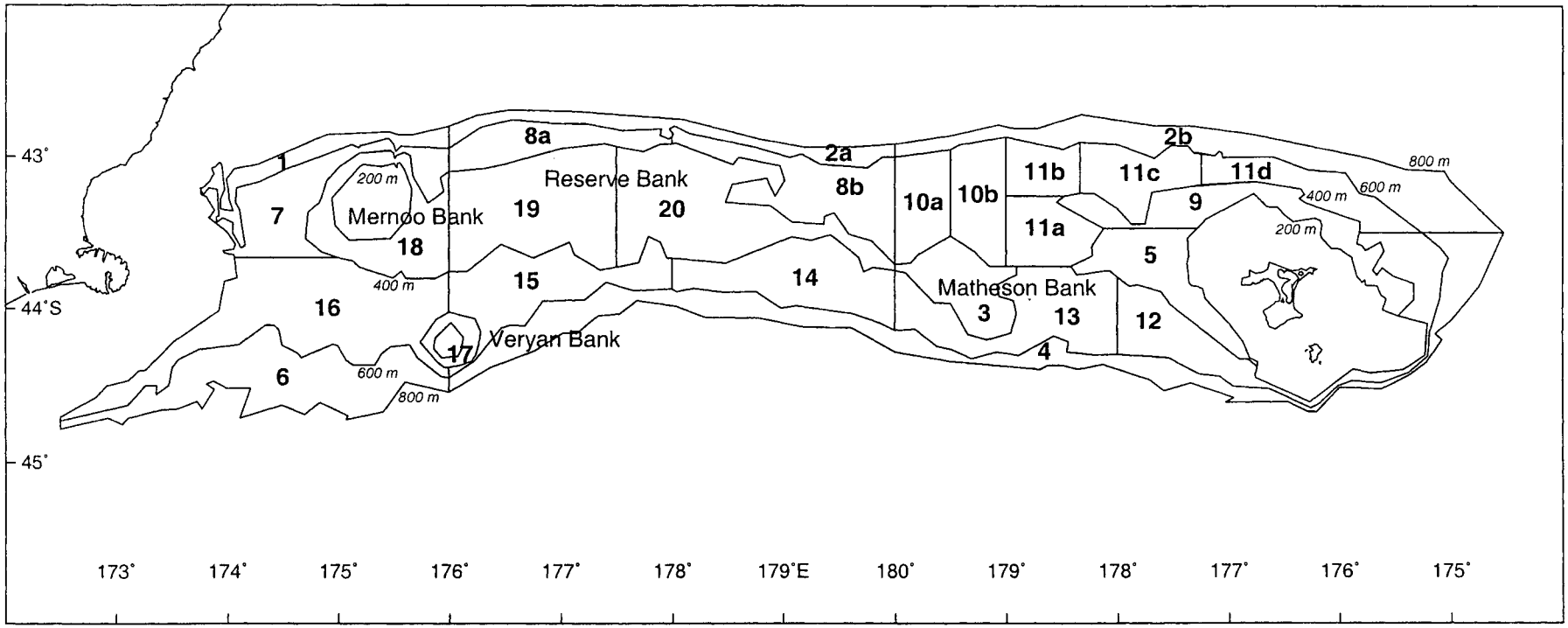


Figure 1a: **Chatham Rise showing survey area and strata.**

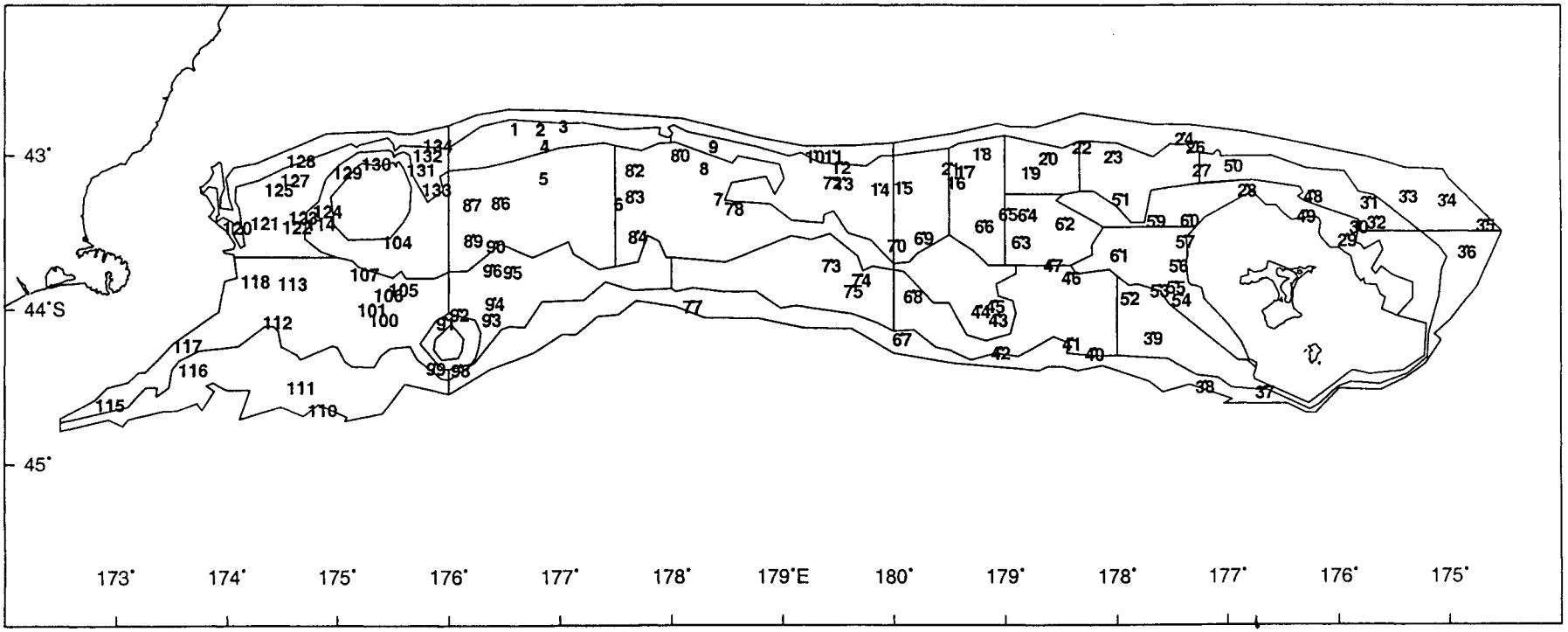


Figure 1b: **Chatham Rise trawl survey station positions.**

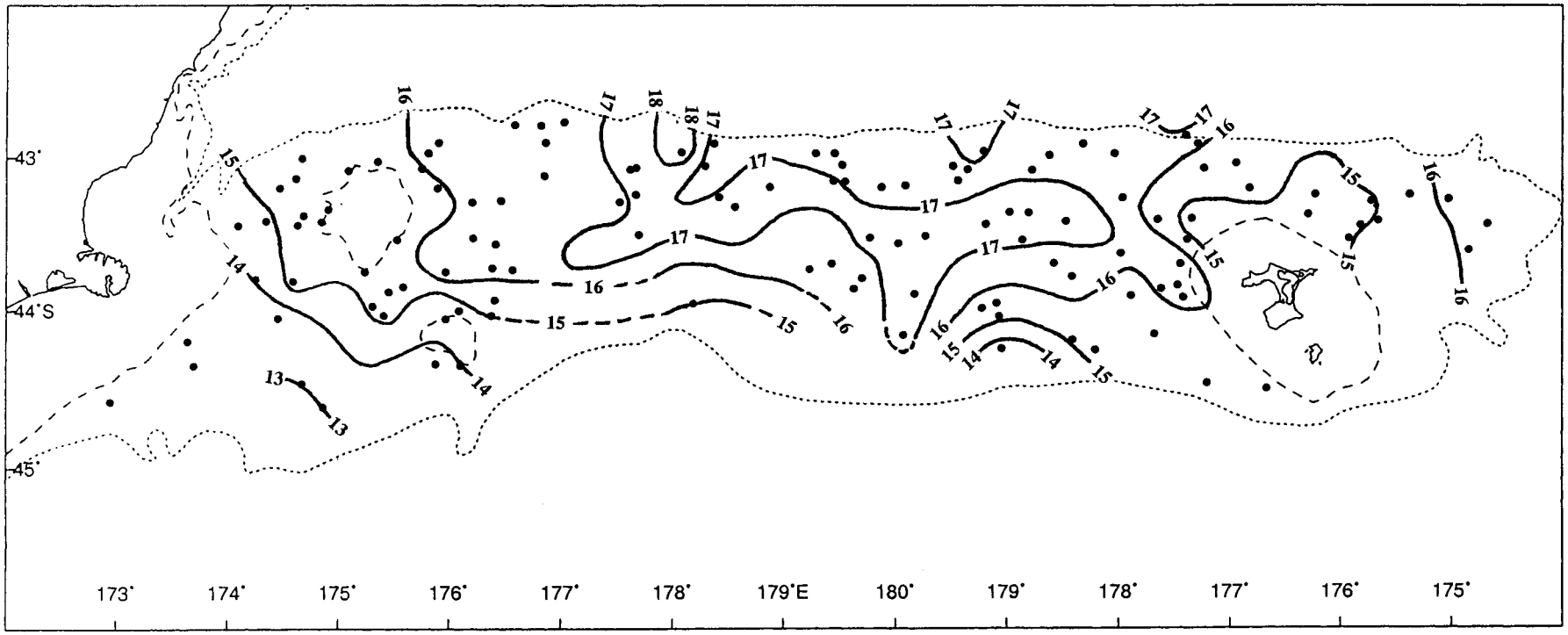


Figure 2a: **Positions of sea surface temperature recordings and isotherms estimated from these data.**

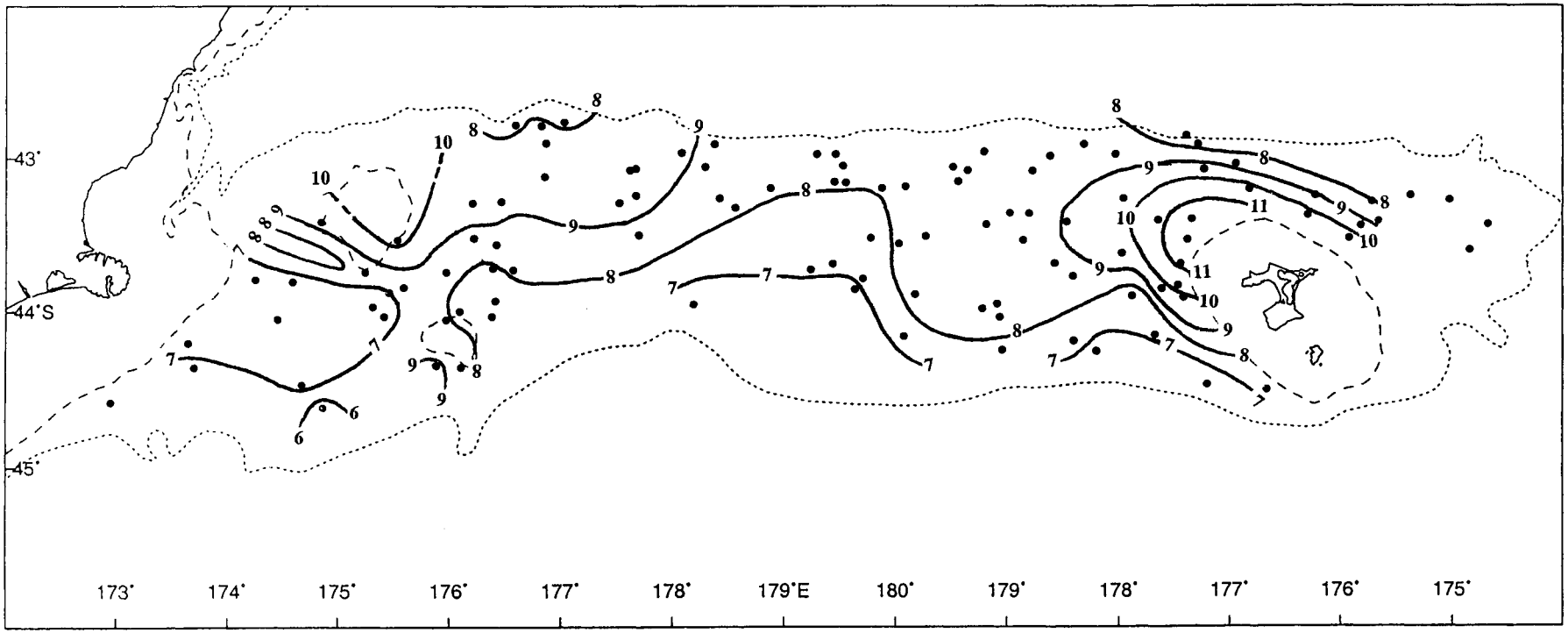


Figure 2b: **Positions of bottom temperature recordings and isotherms estimated from these data.**

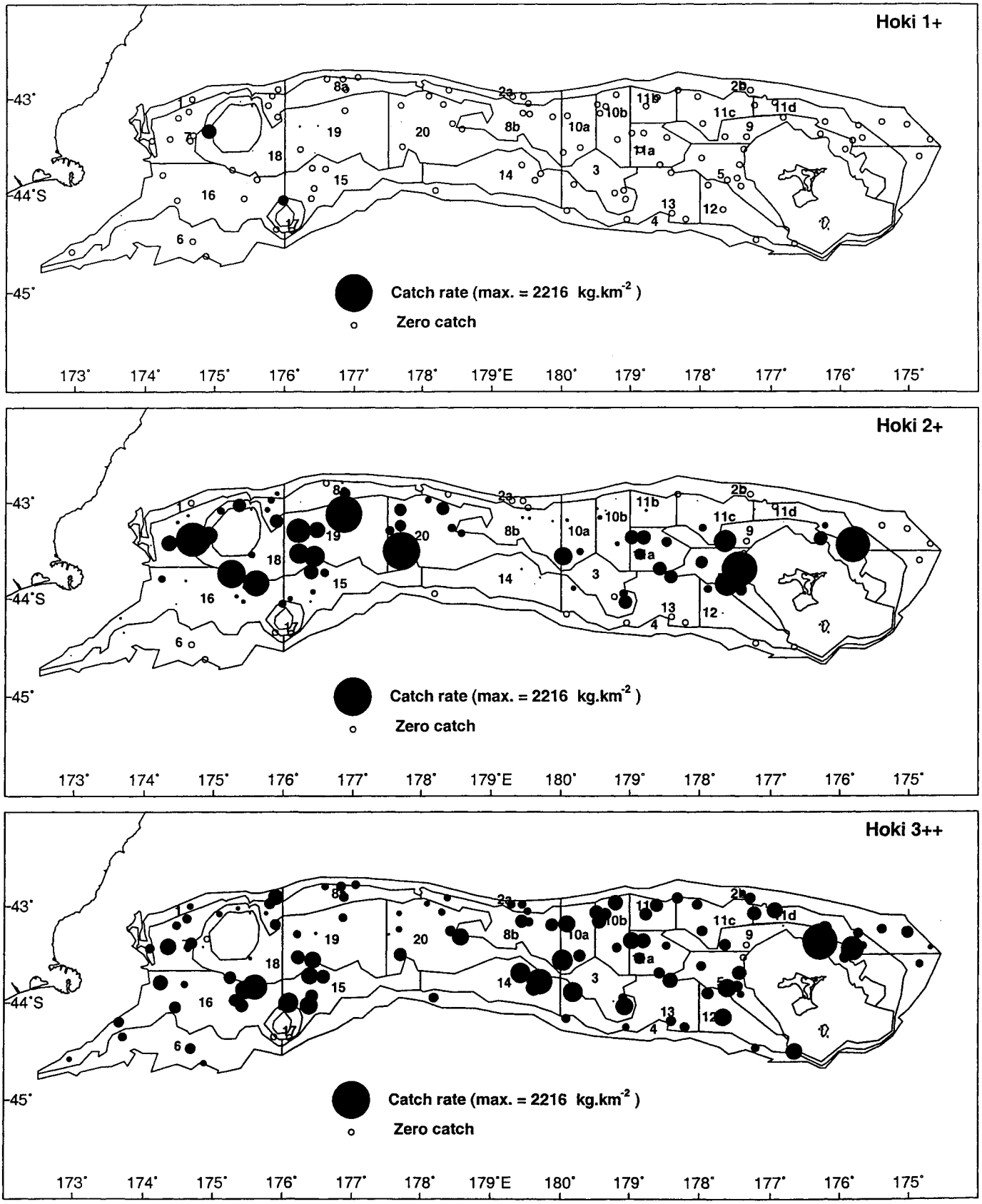


Figure 3: **Catch rates (kg.km^{-2}) of cohort 1, cohort 2, and cohort 3 and older hoki. Circle area is proportional to catch rate. (max., maximum catch rate)**

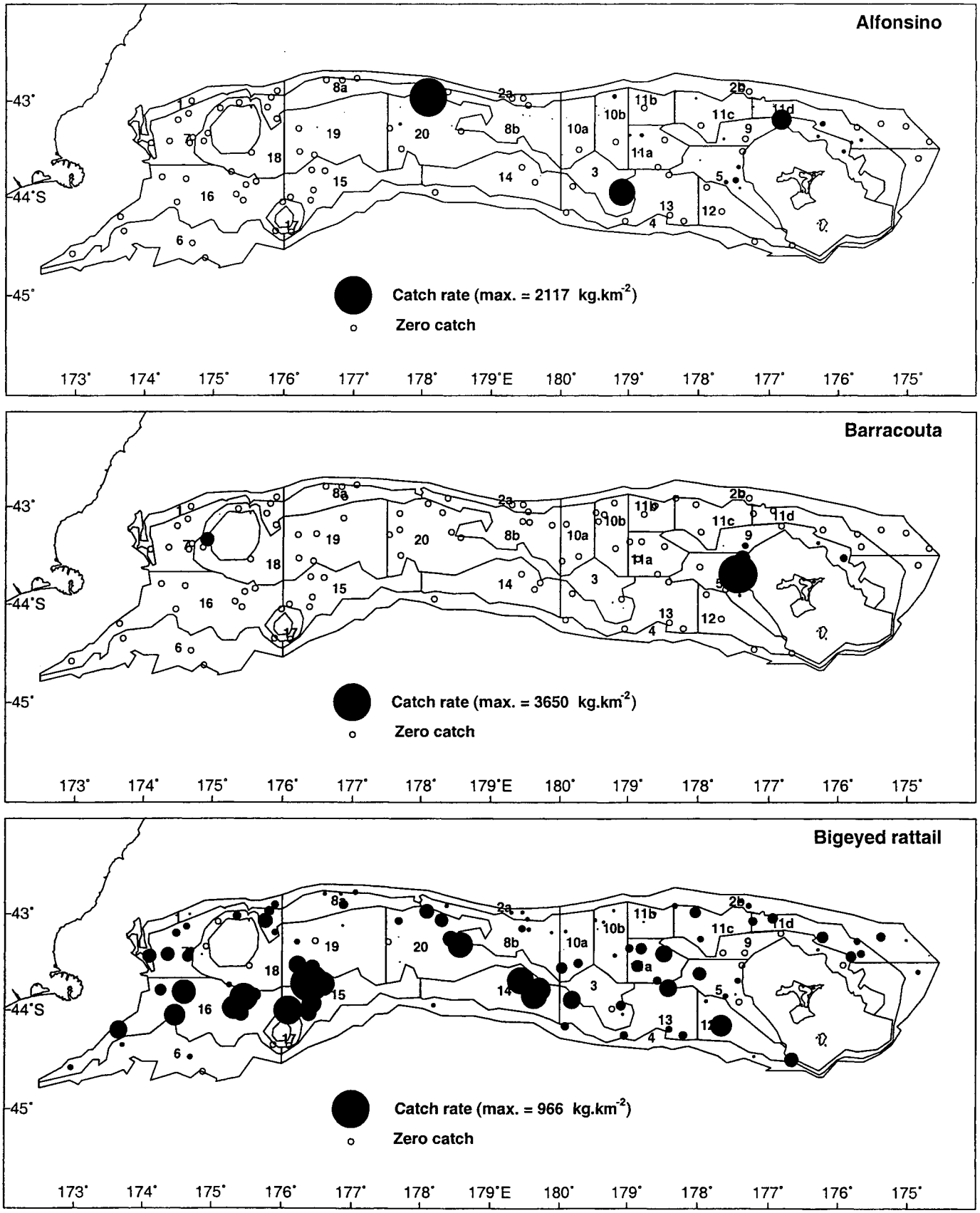


Figure 4: **Catch rates (kg.km-2) of the most abundant species (after hoki). Circle area is proportional to catch rate. (max., maximum catch rate)**

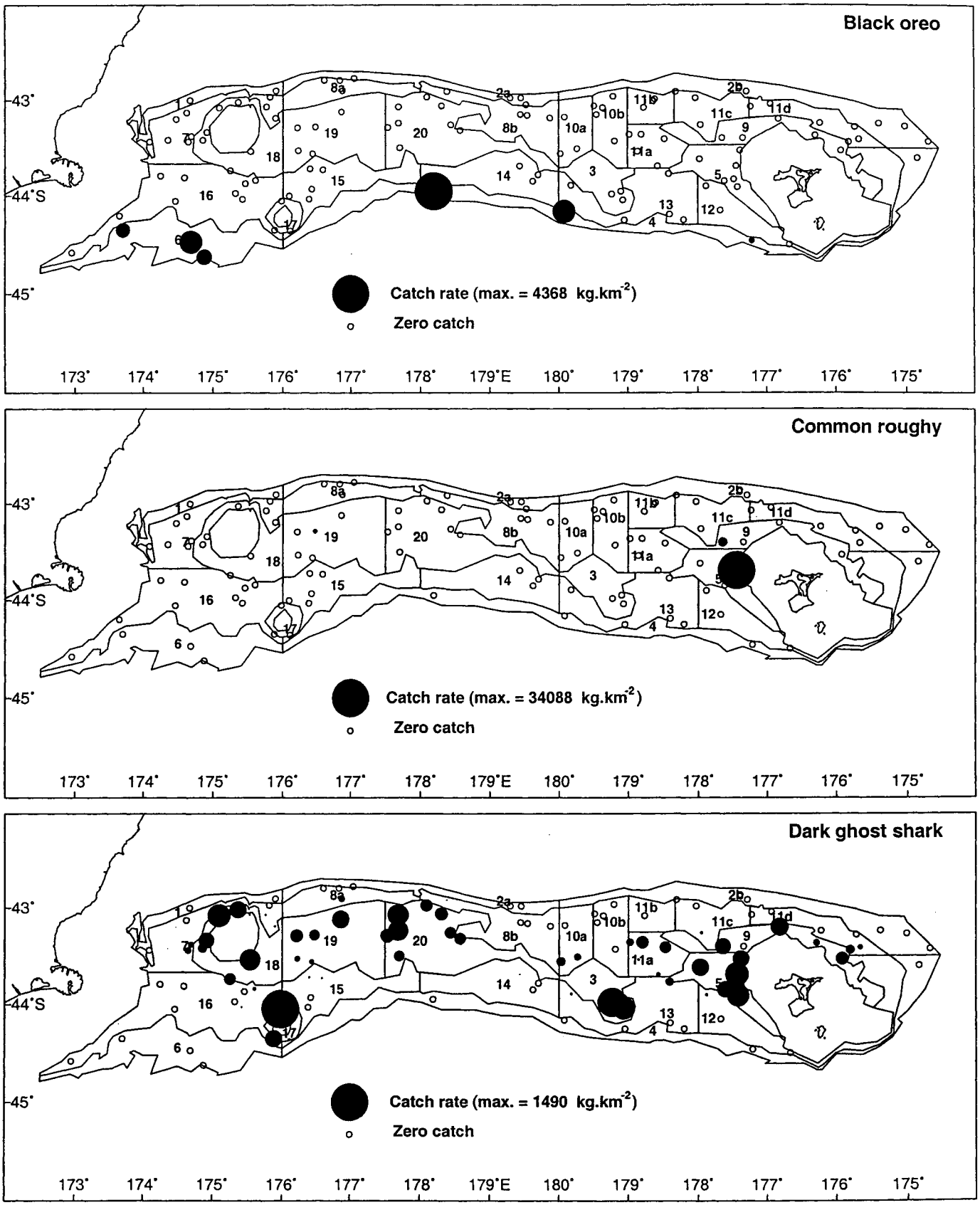
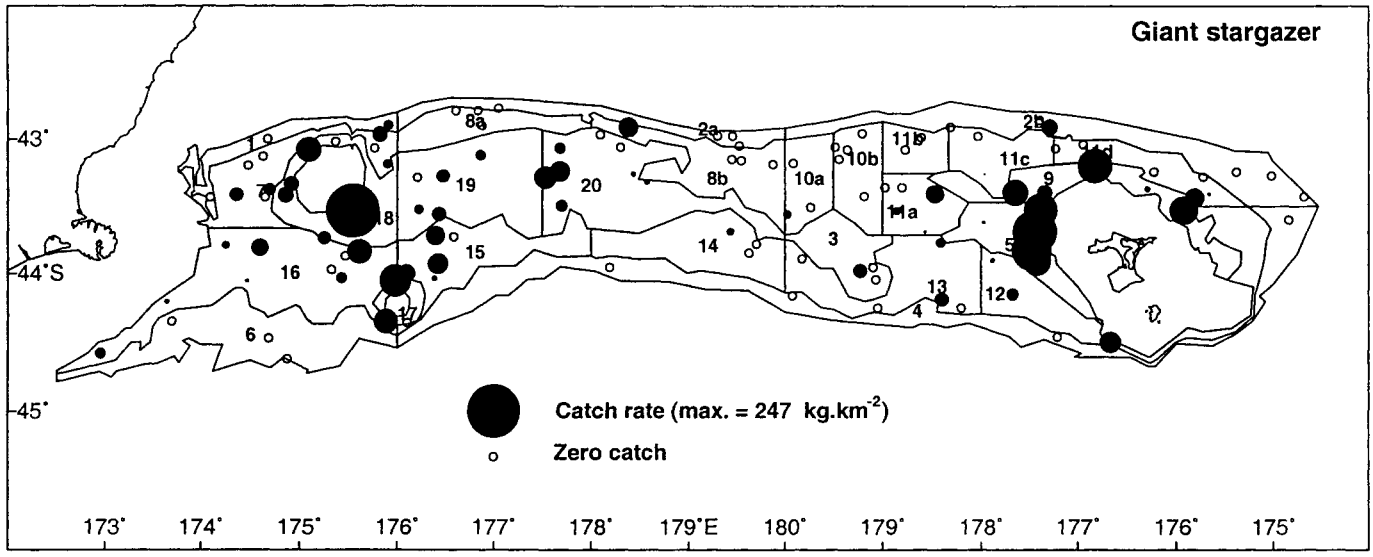
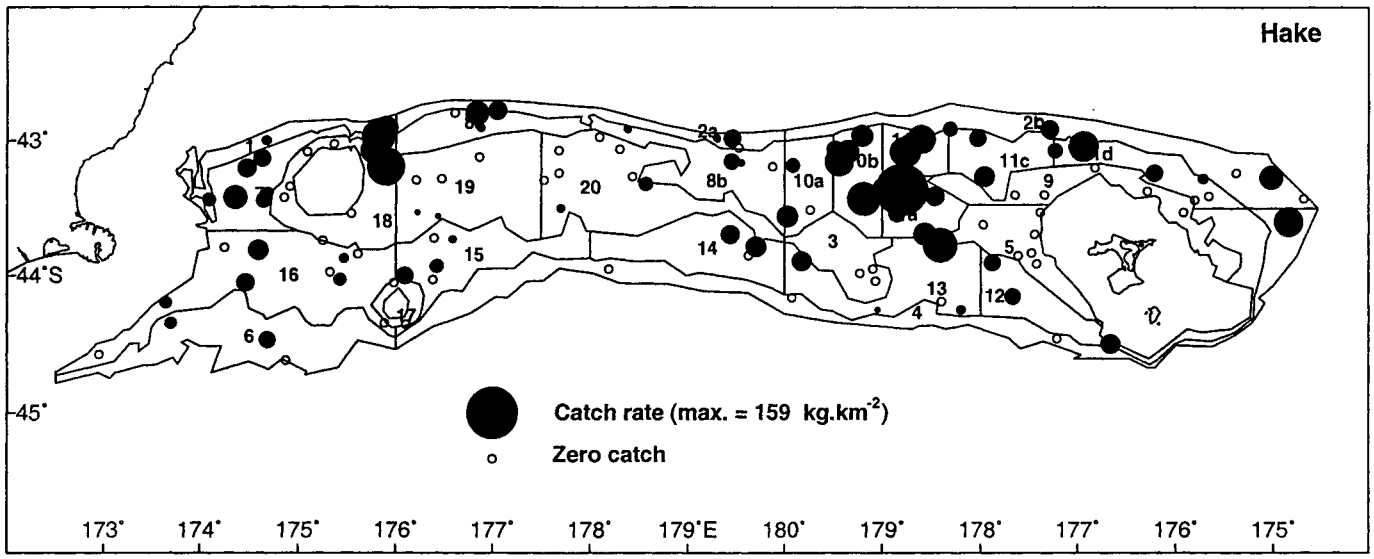


Figure 4 – continued





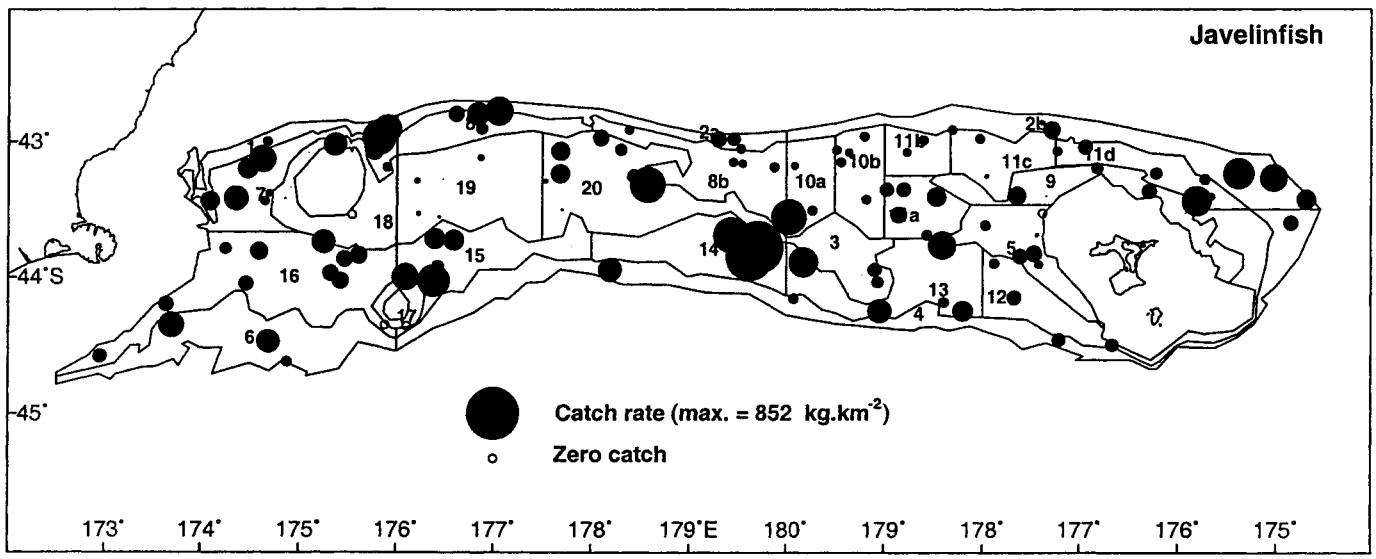


Figure 4 – continued

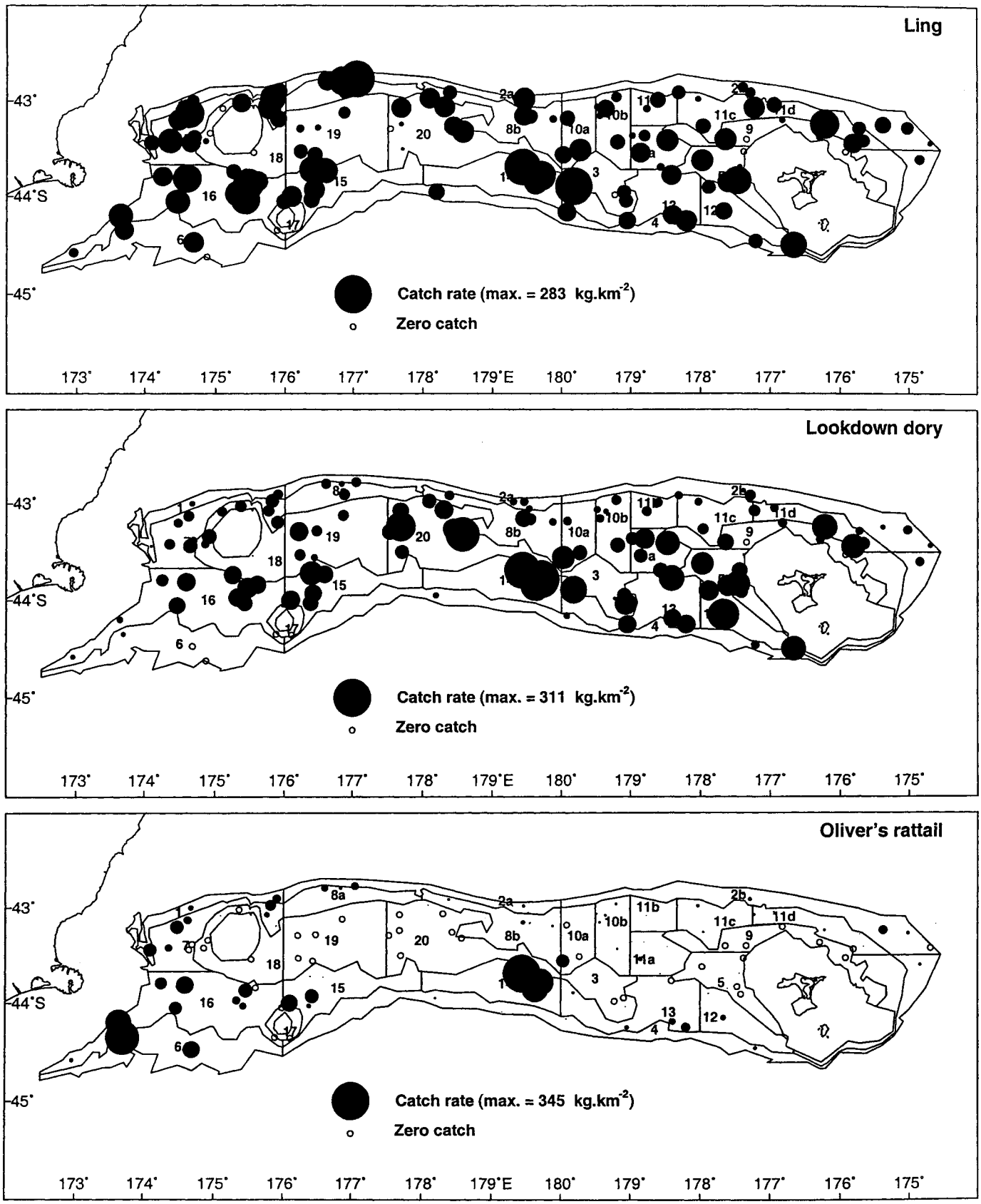
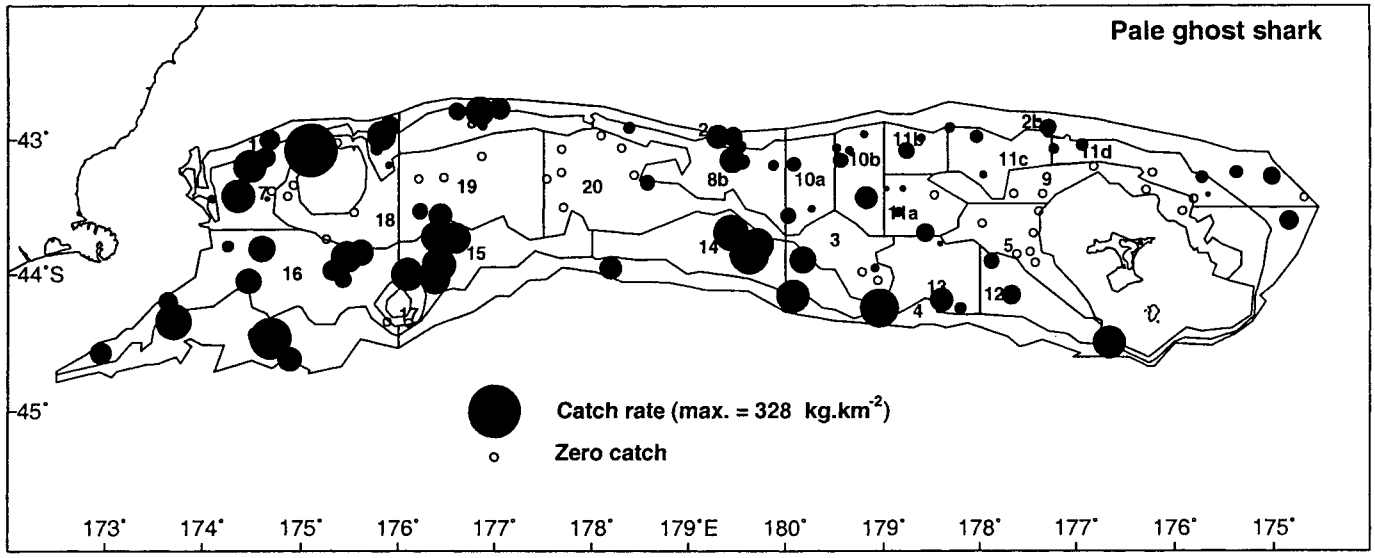
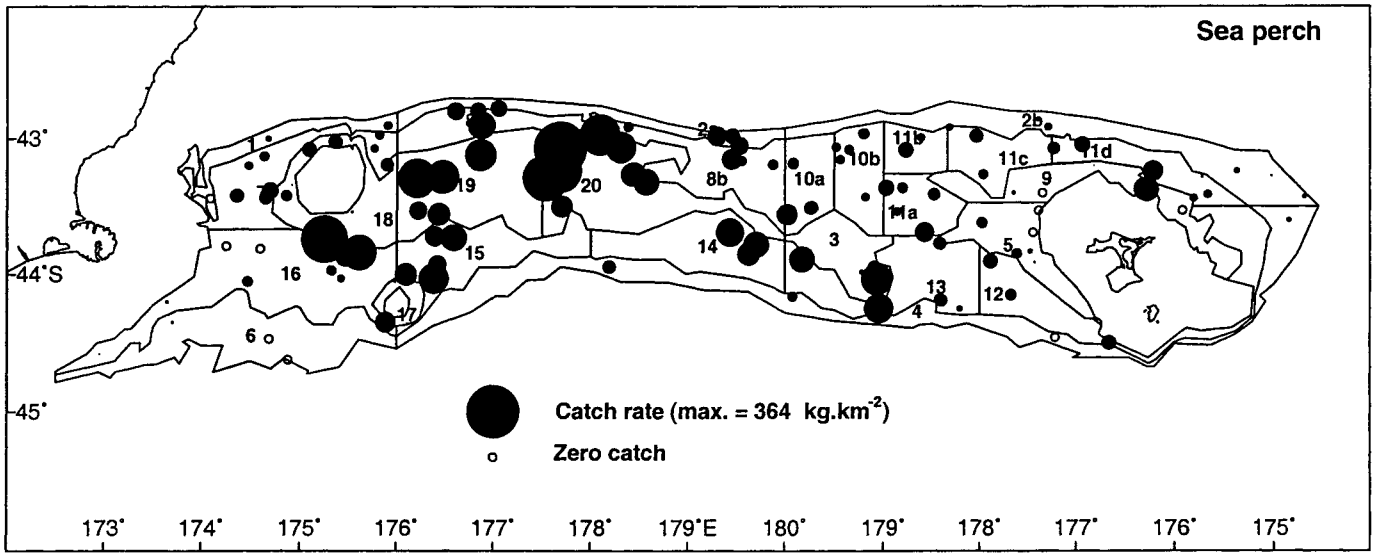


Figure 4 – continued





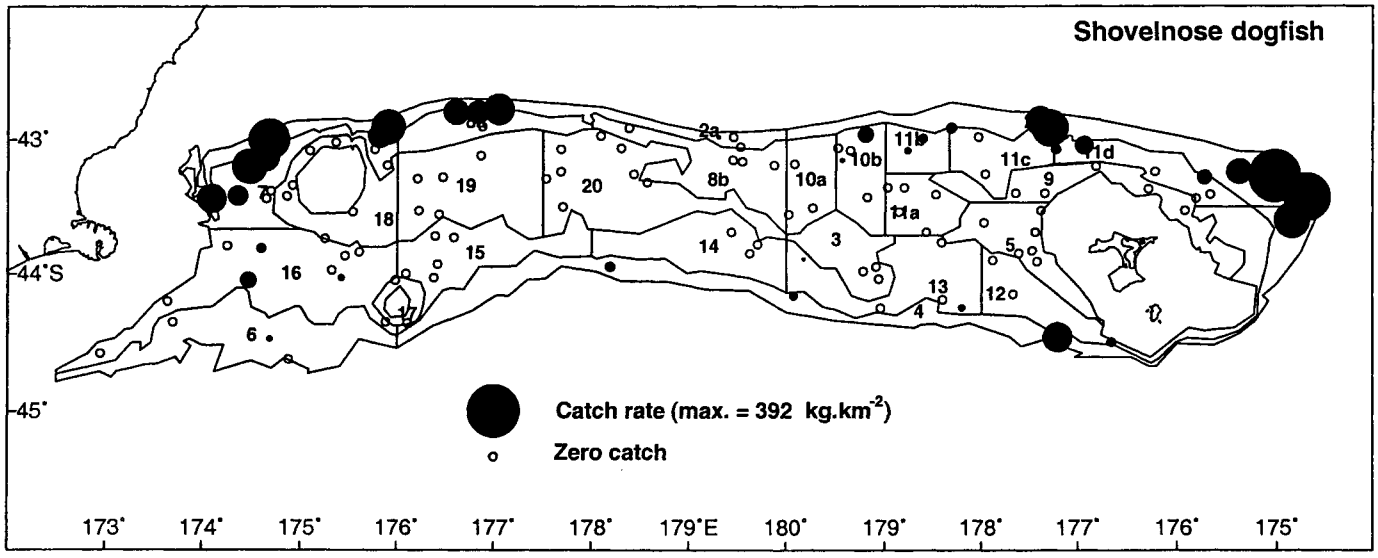


Figure 4 – continued

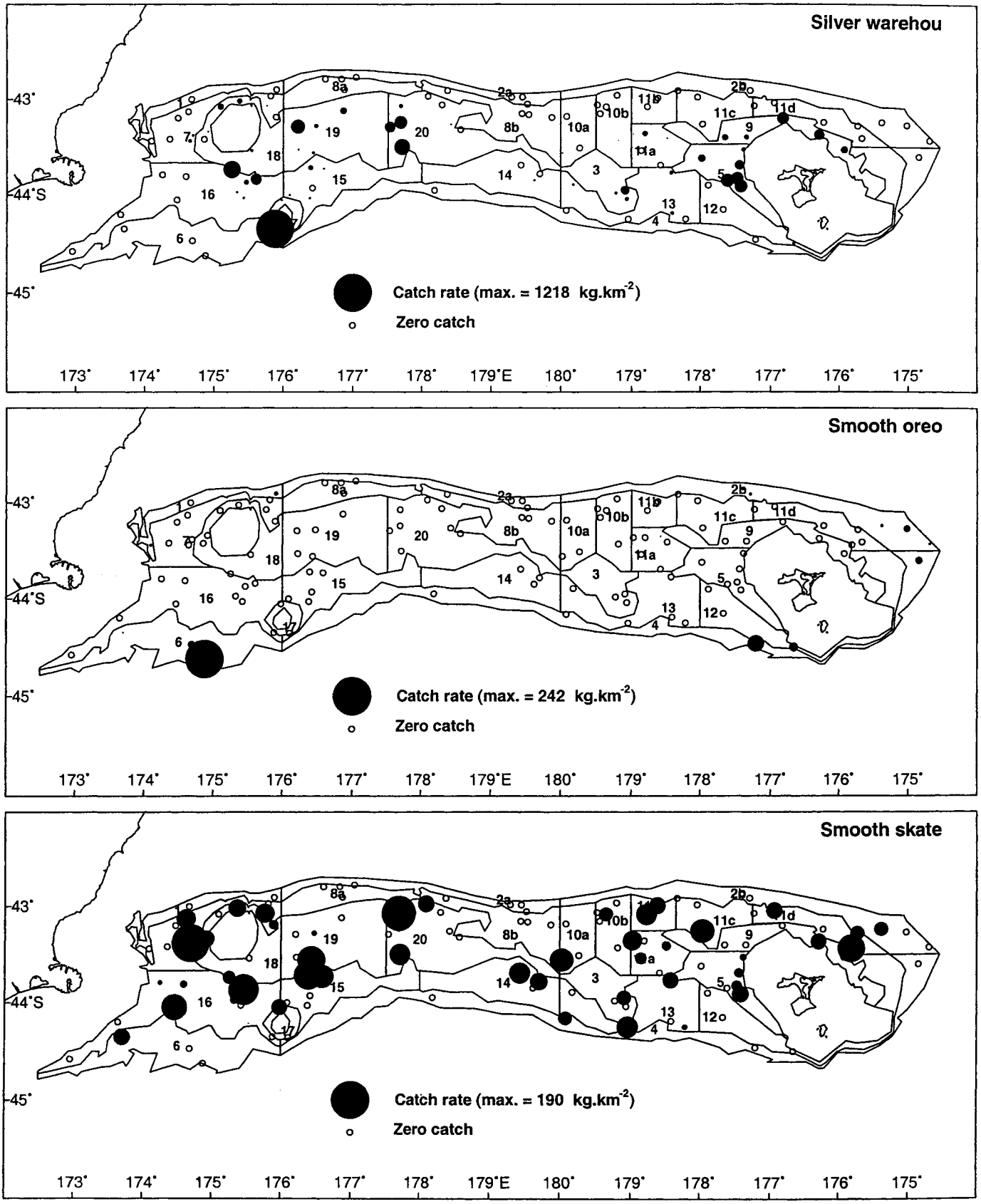


Figure 4 – continued

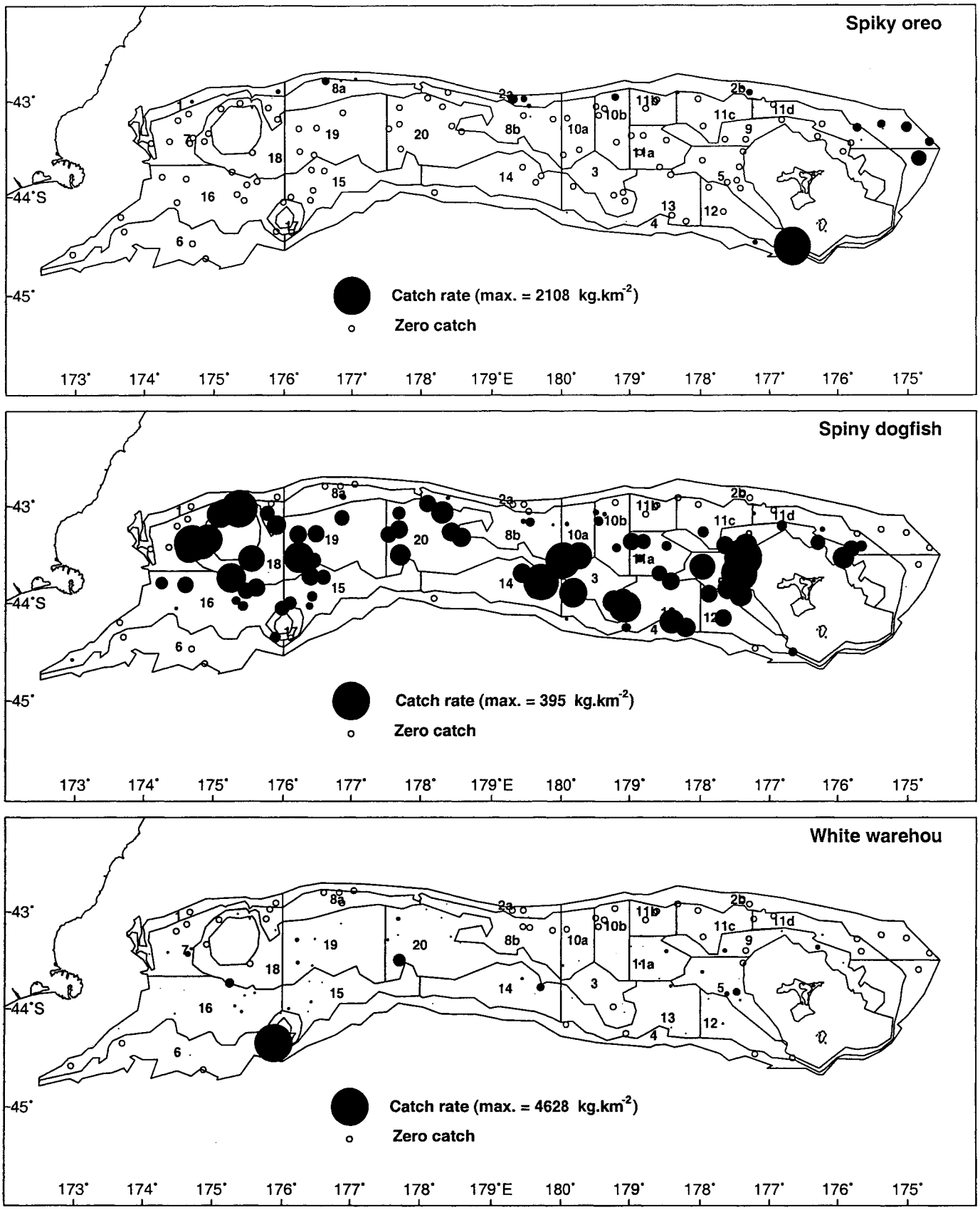


Figure 4 – continued

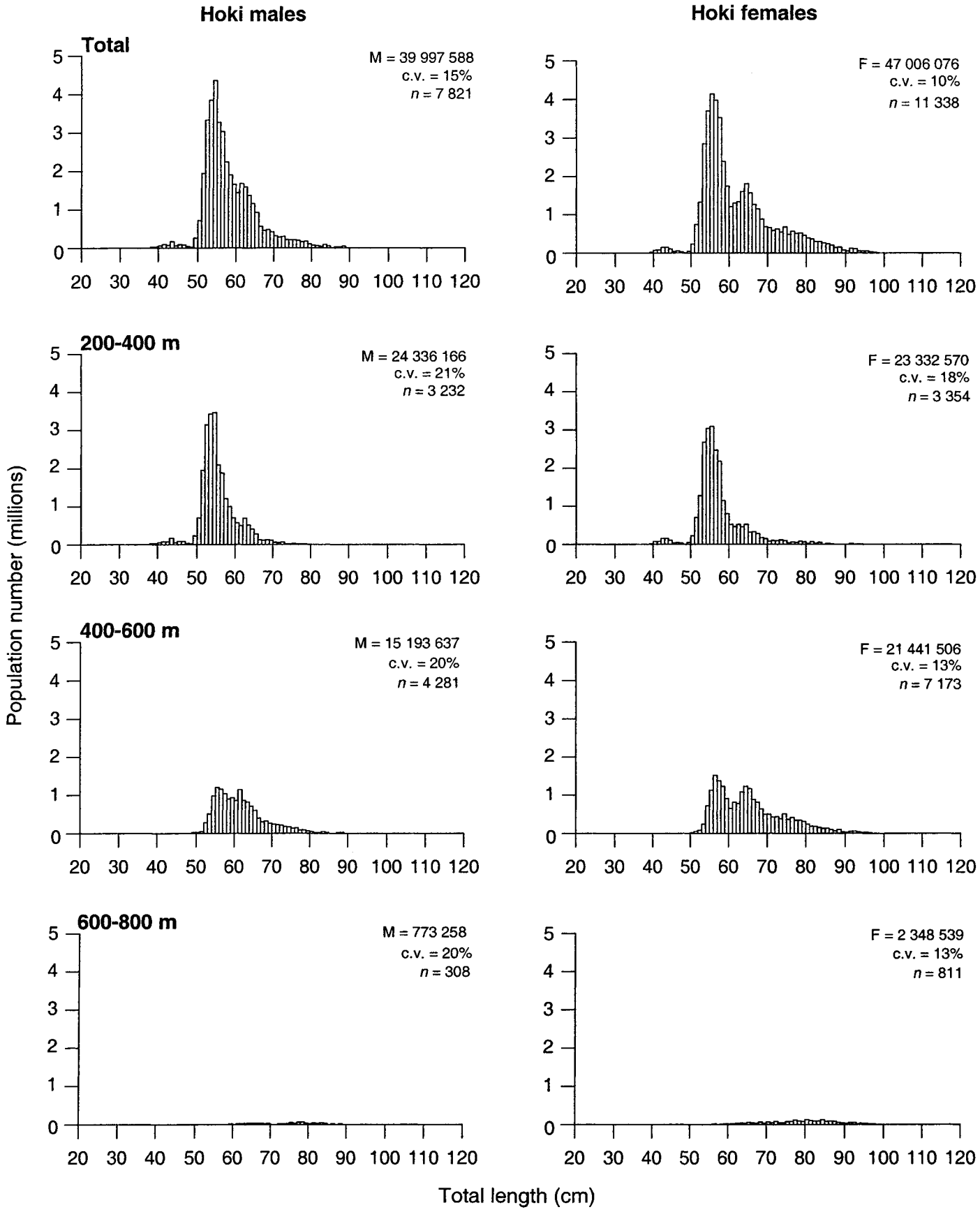


Figure 5a: **Scaled length frequencies for hoki, by sex and depth zone (200-400, 400-600, 600-800 m) (M, estimated male population; F, estimated female population; c.v., coefficent of variation of the estimated numbers of fish; *n*, numbers of fish measured)**

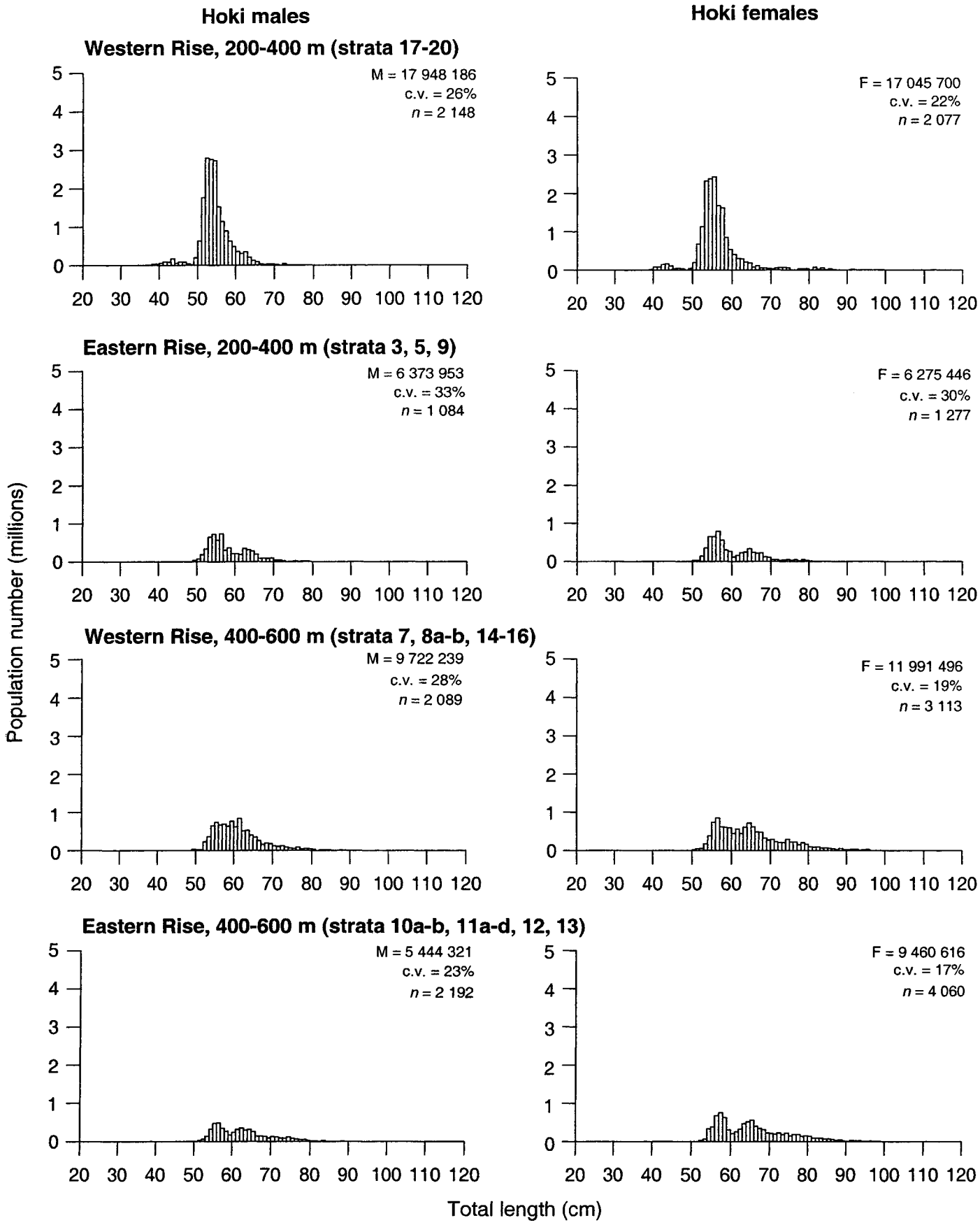


Figure 5b: **Scaled length frequencies for hoki, by sex, depth zone (200-400, 400-600 m) and area (M, estimated male population; F, estimated female population; c.v., coefficent of variation of the estimated numbers of fish; *n*, numbers of fish measured)**

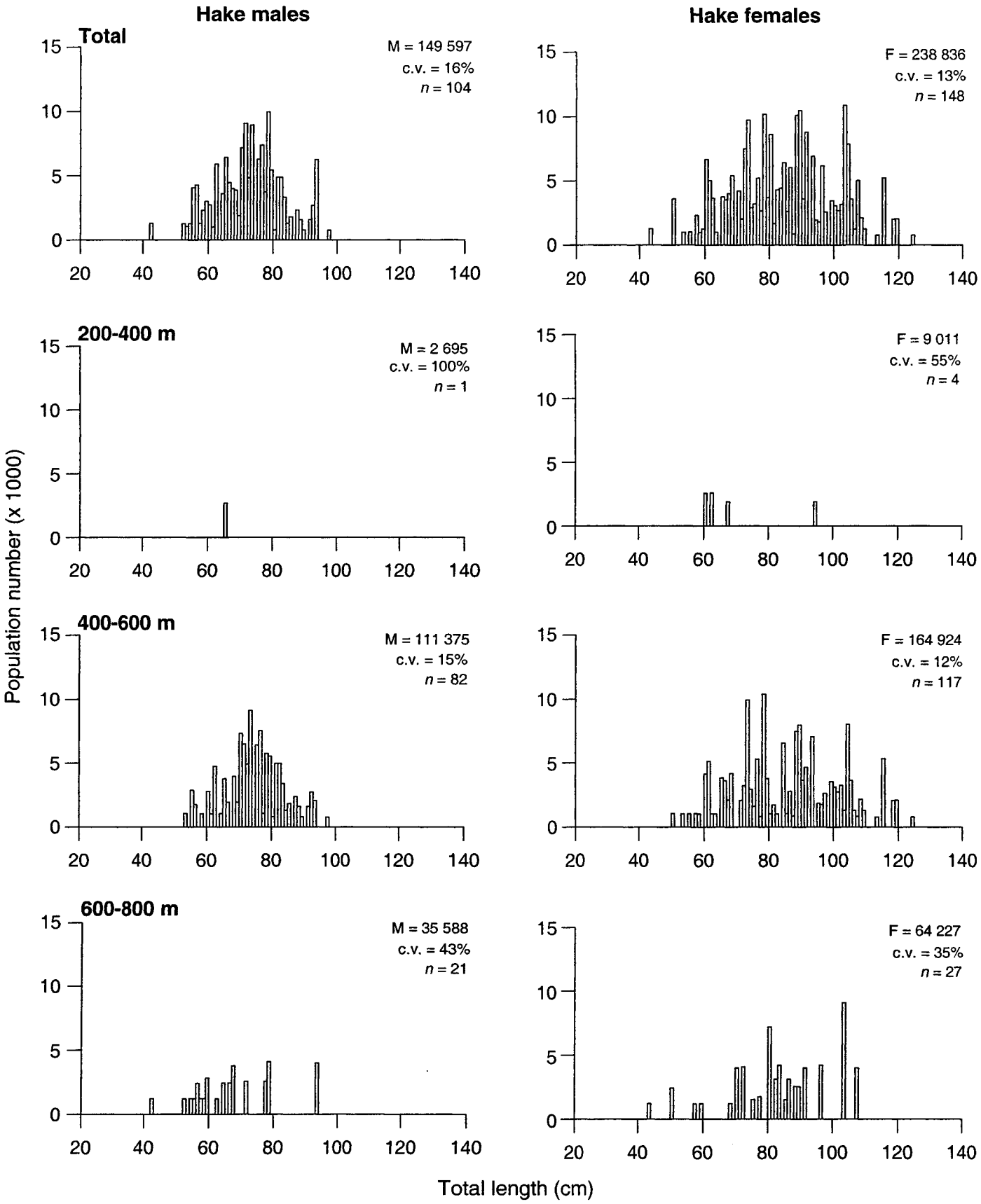


Figure 6: **Scaled length frequencies for hake, by sex and depth zone (200-400, 400-600, 600-800m) (M, estimated male population; F, estimated female population; c.v., coefficent of variation of the estimated numbers of fish; *n*, numbers of fish measured)**

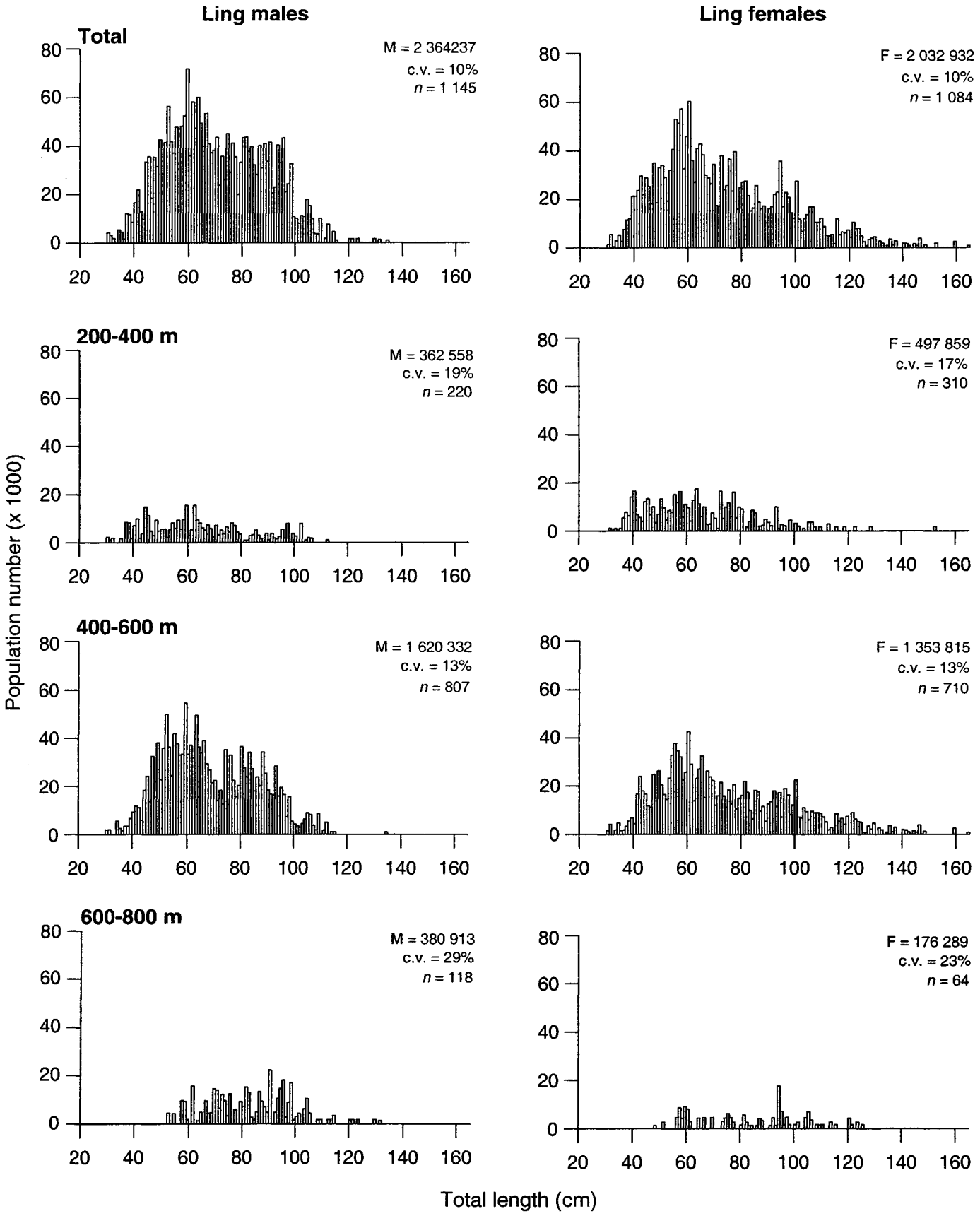


Figure 7: **Scaled length frequencies for ling, by sex and depth zone (200-400, 400-600, 600-800 m) (M, estimated male population; F, estimated female population; c.v., coefficent of variation of the estimated numbers of fish; *n*, numbers of fish measured)**

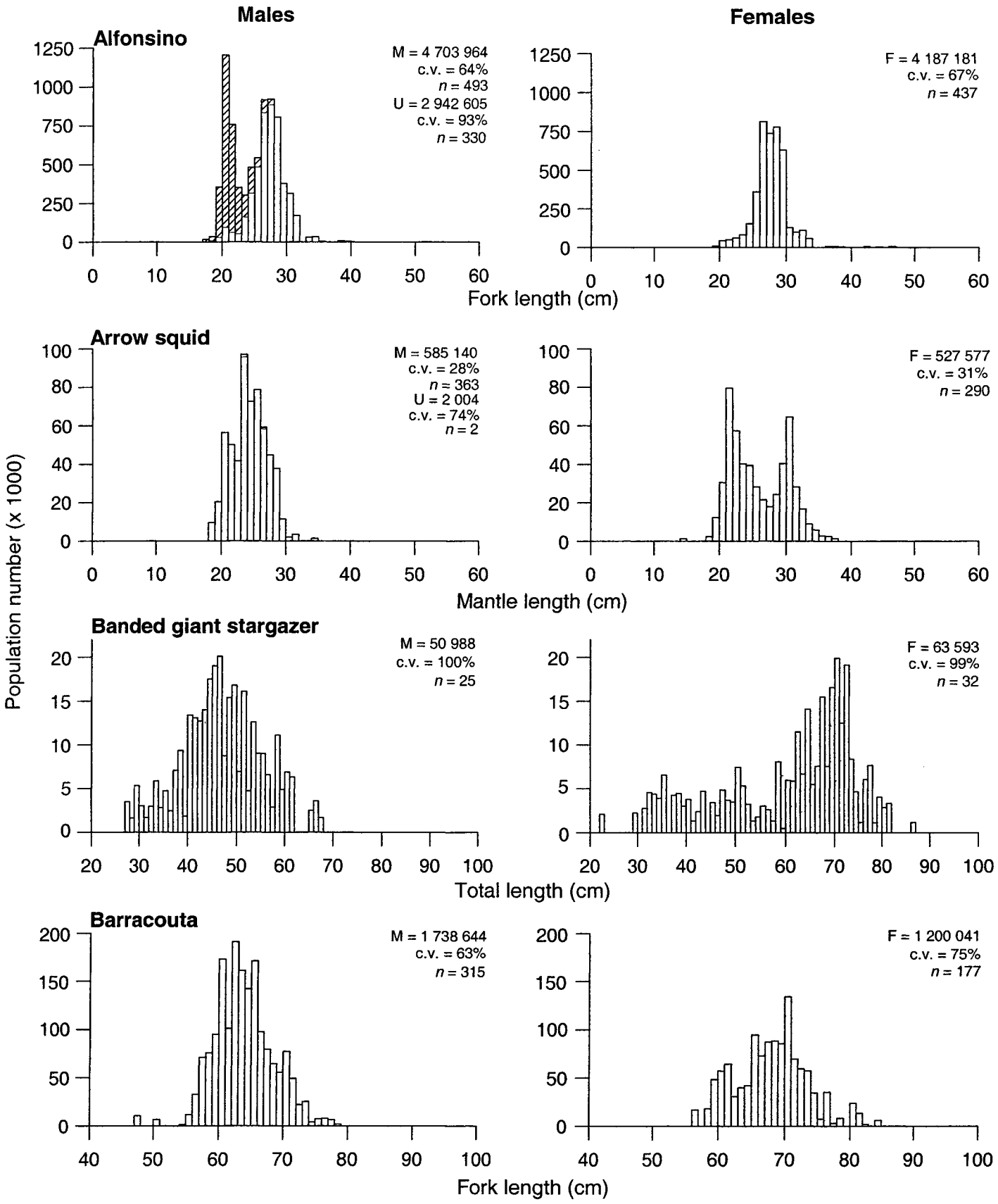


Figure 8: **Scaled length frequencies for the major species, by sex (M, estimated male population; F, estimated female population; U, estimated unsexed population (hatched bars); c.v. coefficient of variation of the estimated numbers of fish; n, number of fish measured)**

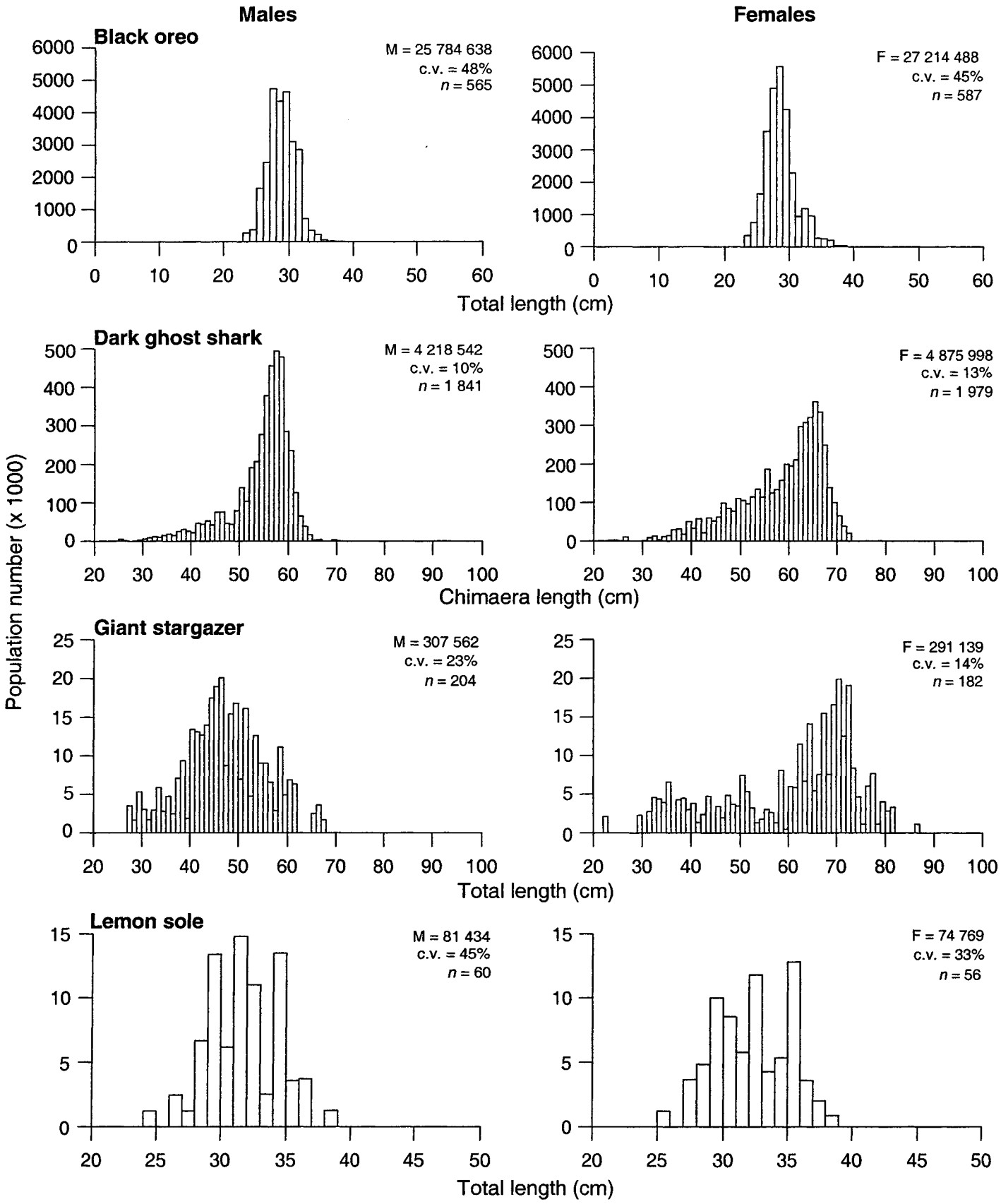


Figure 8 - continued

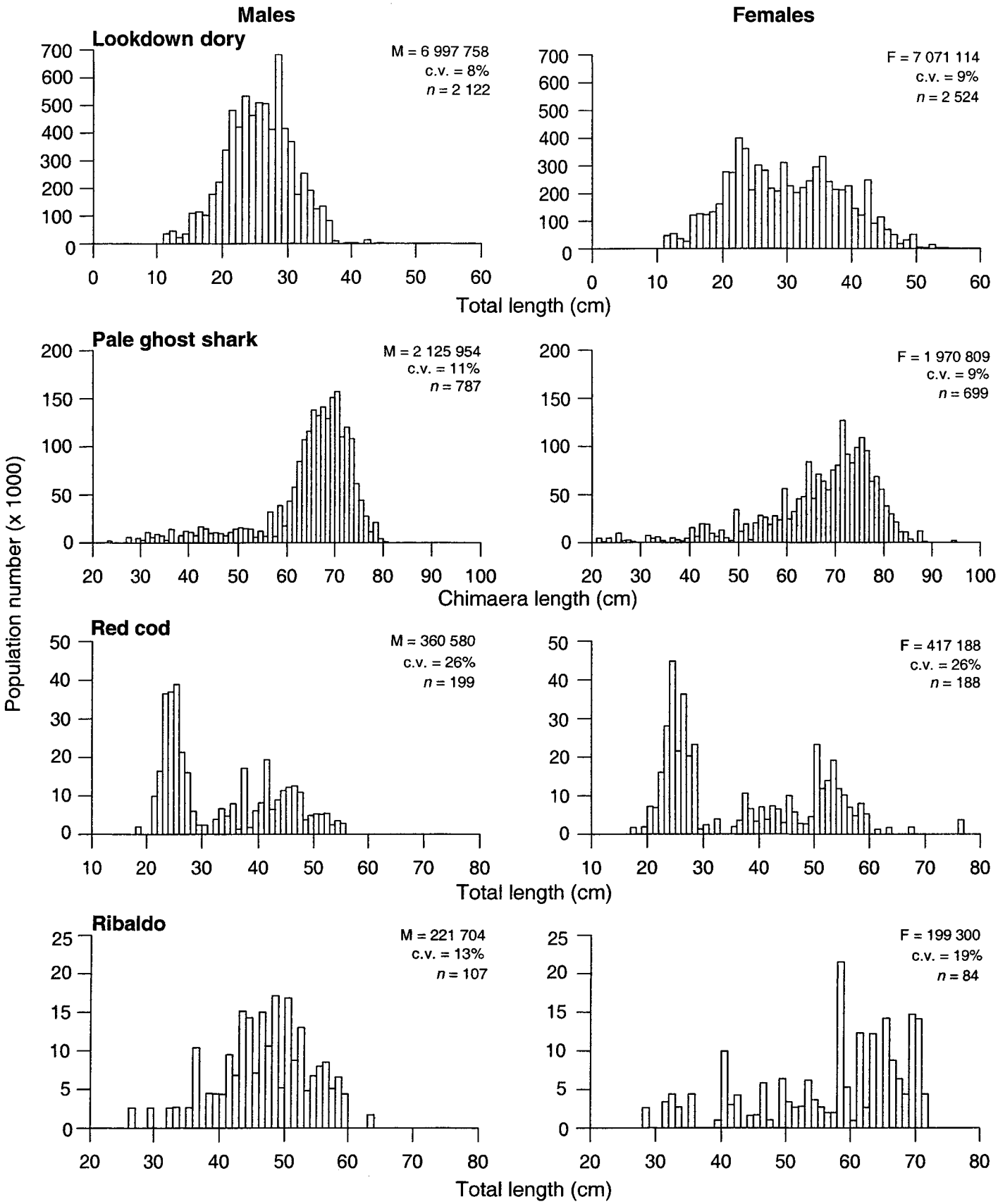


Figure 8 - continued

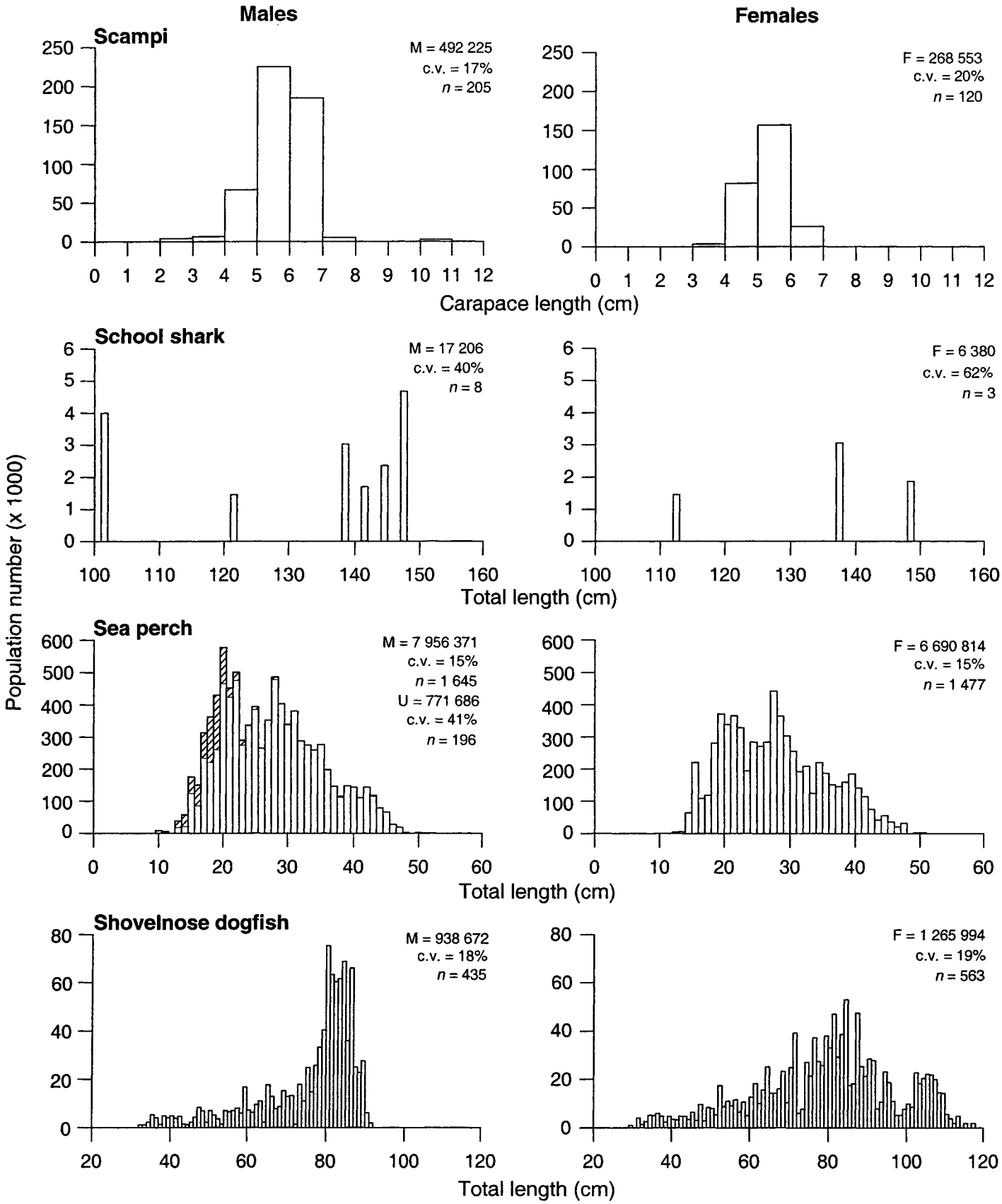


Figure 8 - continued

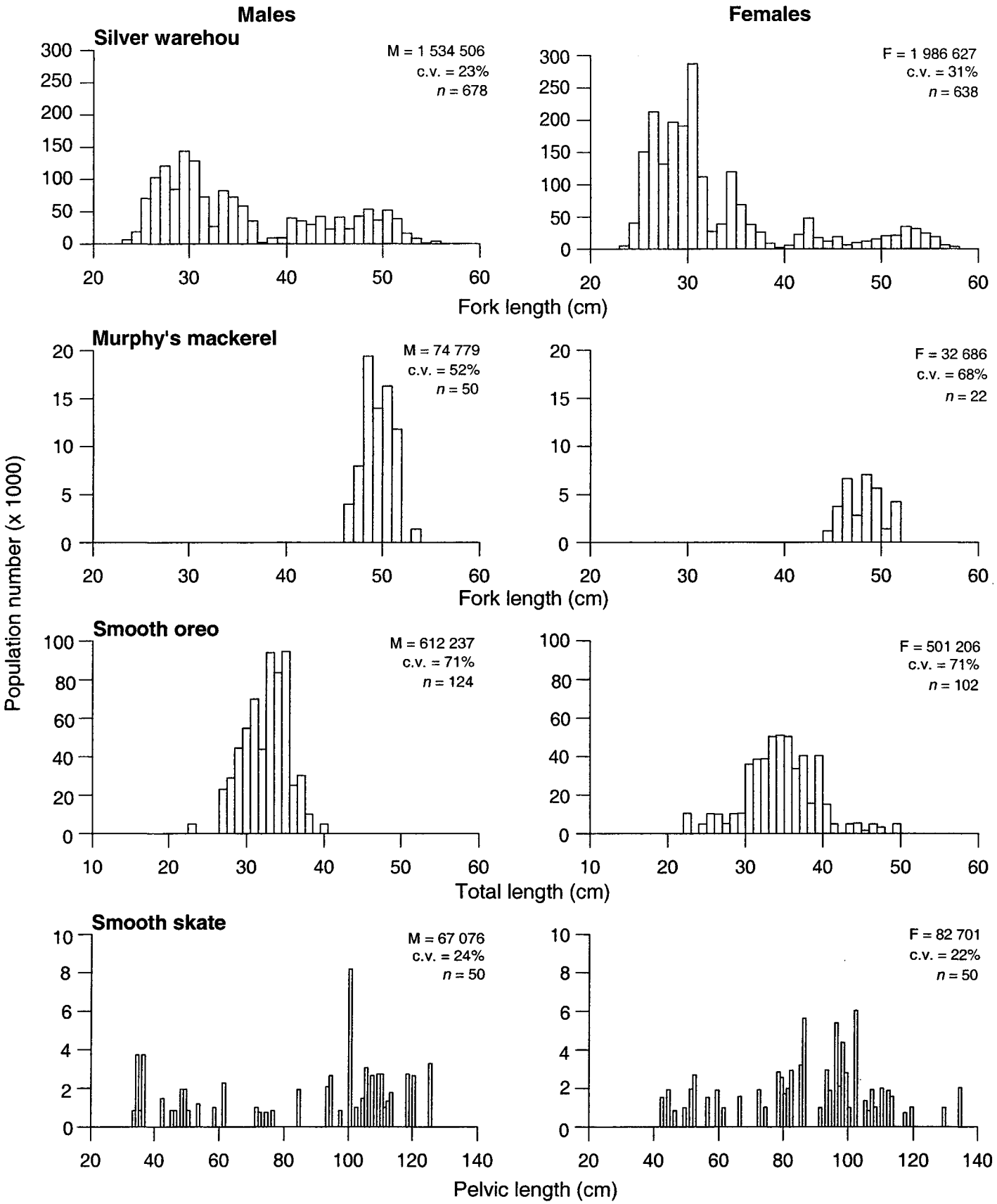


Figure 8 - continued

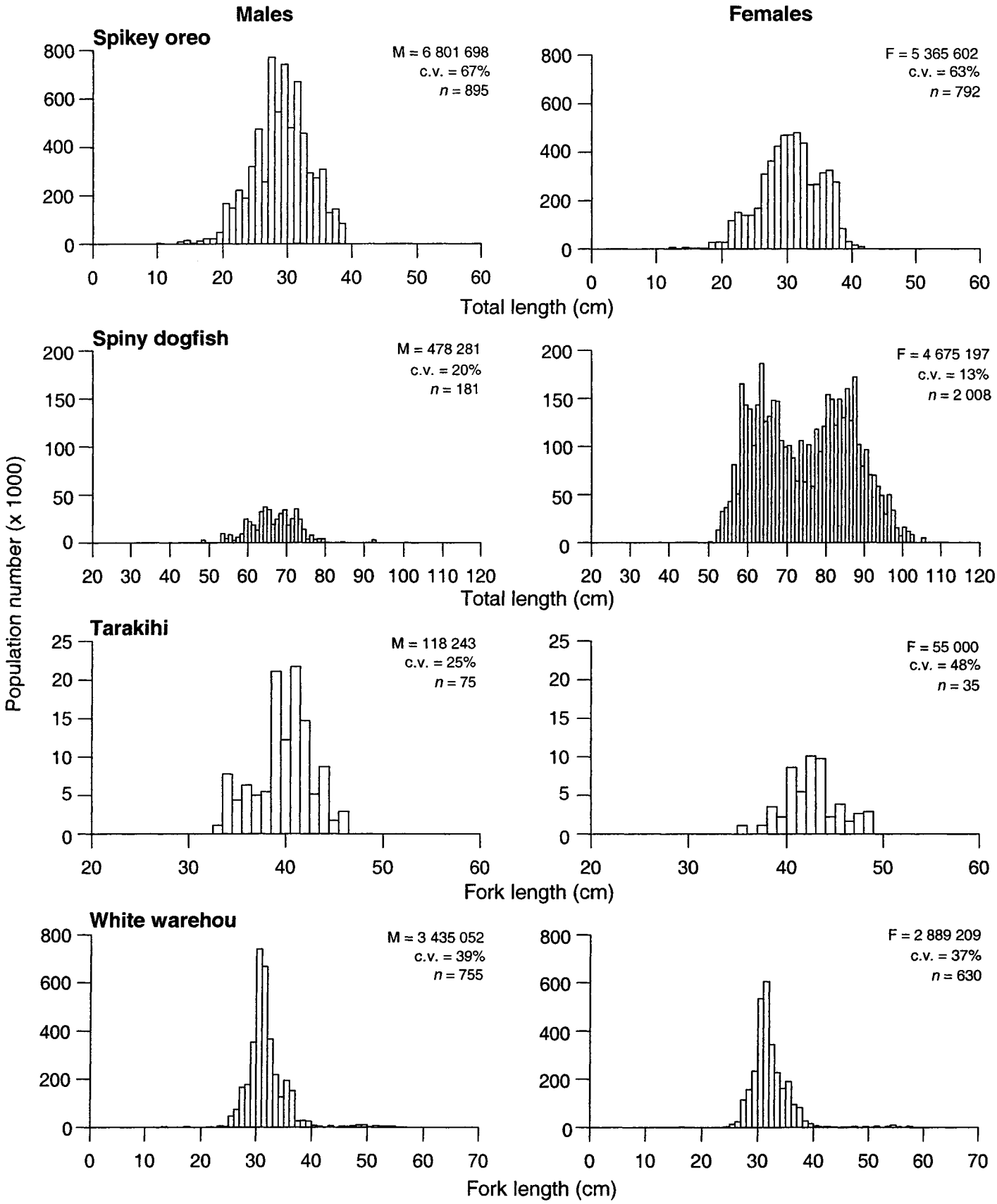


Figure 8 - continued

Appendix 1: **Individual station data for all stations conducted during the survey. P1, phase 1 trawl survey biomass stations; P2, phase 2 trawl survey biomass stations; HC, daytime hoki catchability bottom or midwater acoustic station; ID, nighttime target identification midwater acoustic station.**

			Start of tow					Depth (m)		Dist.	Catch (kg)		
Stn.	Type	Stratum	Date	Time	Latitude	Longitude				towed	hoki	hake	ling
				NZST	° ' S	° '	E/W	min.	max.	(n. mile)			
1	P1	8A	29-Dec-00	0519	42 47.37	176 35.91	E	559	571	3.01	51.8	0	45.3
2	P1	8A	29-Dec-00	0727	42 47.64	176 49.75	E	552	560	3.02	103.6	22.9	106.5
3	P1	2A	29-Dec-00	0932	42 46.42	177 02.23	E	612	635	3.02	85.4	14.2	169.3
4	P1	8A	29-Dec-00	1208	42 54.27	176 52.30	E	404	405	3	220.7	3.1	30.4
5	P1	19	29-Dec-00	1434	43 07.14	176 51.71	E	302	315	3	1438.7	0	19.3
6	P1	20	29-Dec-00	1806	43 17.45	177 31.83	E	254	267	3	81.8	0	0
7	P1	20	30-Dec-00	0515	43 15.65	178 25.51	E	374	392	3.01	184.3	0	46.1
8	P1	20	30-Dec-00	0855	43 03.43	178 17.90	E	336	341	3.02	230.9	0	57.7
9	P1	8B	30-Dec-00	1124	42 54.87	178 22.82	E	530	547	3	57.7	2.8	27.5
10	P1	2A	30-Dec-00	1548	42 58.63	179 17.85	E	601	605	3.02	80.6	2.9	1
11	P1	2A	30-Dec-00	1739	42 58.50	179 27.74	E	604	613	3	84.3	12.7	68.8
12	P1	8B	31-Dec-00	0517	43 03.00	179 31.90	E	493	520	3.04	70.4	0	0
13	P1	8B	31-Dec-00	0722	43 09.40	179 33.22	E	470	481	2.99	105.8	2.5	27.4
14	P1	8B	31-Dec-00	0939	43 11.54	179 52.54	E	500	505	2.99	175.3	0	8.1
15	P1	10A	31-Dec-00	1138	43 10.94	179 54.54	W	513	521	2.95	305.8	8.1	31
16	P1	10B	31-Dec-00	1428	43 08.89	179 26.11	W	522	527	3.02	255.1	31.9	6.8
17	P1	10B	31-Dec-00	1616	43 04.65	179 20.84	W	532	533	2.99	165.5	22.1	42.3
18	P1	10B	31-Dec-00	1810	42 57.56	179 12.09	W	547	548	3.01	248.6	18.7	14.7
19	P1	11B	1-Jan-01	0517	43 05.08	178 46.08	W	505	513	3	176.3	37.7	8.2
20	P1	11B	1-Jan-01	0713	42 59.25	178 36.64	W	531	535	2.99	181	31.3	34.1
21	P1	11B	1-Jan-01	0901	43 03.47	179 28.79	W	523	528	3.01	220.4	11.5	6.7
22	P1	11C	1-Jan-01	1128	42 54.76	178 18.78	W	557	573	3	134.4	8.9	25.2
23	P1	11C	1-Jan-01	1346	42 58.65	178 01.75	W	525	534	3	115.1	11.9	5.2
24	P1	2B	1-Jan-01	1728	42 51.54	177 23.52	W	752	757	3	44	0	14.4
25	ID		2-Jan-01	0014	43 13.48	176 43.72	W	175	278	2.8	10.2	0	0
26	P1	2B	2-Jan-01	0519	42 54.82	177 17.13	W	665	672	3	122	13.1	13.9
27	P1	11D	2-Jan-01	0747	43 04.22	177 13.91	W	484	497	3.01	203.4	9	61.5
28	P1	9	2-Jan-01	1029	43 12.10	176 49.05	W	312	363	3	4.4	0	4.8
29	P1	9	2-Jan-01	1544	43 31.51	175 55.15	W	308	311	3.01	123.2	0	0
30	P1	11D	2-Jan-01	1751	43 26.43	175 48.89	W	418	434	3	1934.2	0	51.8
31	P1	11D	3-Jan-01	0511	43 16.85	175 43.17	W	582	592	3.01	109.7	4.5	25.3
32	P2	11D	3-Jan-01	0708	43 24.62	175 39.53	W	467	493	3	80	0	22.2
33	P1	2B	3-Jan-01	0956	43 14.51	175 22.53	W	686	692	3.01	96.9	0	35.7
34	P1	2B	3-Jan-01	1232	43 16.16	175 01.50	W	747	760	3	145.8	21.3	21.6
35	P1	2B	3-Jan-01	1517	43 25.87	174 40.67	W	781	782	2.99	30.8	0	4.3
36	P1	4	3-Jan-01	1804	43 36.10	174 50.61	W	692	716	3	67.9	34.2	14.9
37	P1	12	4-Jan-01	0524	44 30.07	176 39.71	W	531	571	3	277.5	14.7	90.2
38	P1	4	4-Jan-01	0939	44 27.89	177 12.35	W	687	709	3.01	76.7	0	28.6
39	P1	12	4-Jan-01	1337	44 09.07	177 40.49	W	477	480	3	324.4	10.8	40.2
40	P1	13	4-Jan-01	1653	44 15.25	178 12.16	W	549	575	3	92.3	3.7	57.3
41	P1	13	4-Jan-01	1850	44 11.37	178 24.06	W	489	500	1.99	66.1	0	30.7
42	P1	13	5-Jan-01	0518	44 14.82	179 02.28	W	519	530	3	51.5	1.5	38.3
43	P1	3	5-Jan-01	0806	44 02.20	179 03.66	W	306	328	3.02	465.6	0	23.3
44	P1	3	5-Jan-01	1039	43 58.83	179 13.14	W	209	265	2.99	3	0	0
45	P1	3	5-Jan-01	1216	43 56.91	179 05.11	W	371	382	3	136.8	0	23.4

Appendix 1 – continued

Stn.	Type	Stratum	Start of tow					Depth (m)		Dist. towed	Catch (kg)		
			Date	Time	Latitude	Longitude	E/W	min.	max.	(n. mile)	hoki	hake	ling
				NZST	° ' S	° '							
46	P1	11A	5-Jan-01	1601	43 46.07	178 24.33	W	410	415	2.99	395.9	42.7	49.5
47	P1	11A	5-Jan-01	1756	43 41.16	178 34.07	W	430	448	3	306.4	19.3	8
48	P2	11D	6-Jan-01	0507	43 14.49	176 13.34	W	458	463	3.02	288.2	11.3	111.1
49	P1	9	6-Jan-01	0744	43 22.19	176 17.26	W	323	335	3.01	1516.5	0	8.8
50	P2	11D	6-Jan-01	1135	43 02.39	176 56.58	W	542	542	3	266.4	35.1	32.3
51	P1	11C	6-Jan-01	1708	43 15.51	177 57.33	W	437	452	3	179.7	16.8	30.2
52	P1	12	7-Jan-01	0506	43 53.91	177 52.85	W	412	430	3	214.7	11.6	25.5
53	P1	5	7-Jan-01	0829	43 51.01	177 36.89	W	378	385	3.01	958.6	0	57.8
54	P1	5	7-Jan-01	1025	43 54.54	177 25.10	W	347	353	2.99	186.3	0	16.2
55	P1	5	7-Jan-01	1227	43 49.69	177 28.04	W	359	363	2.99	477.8	0	98
56	P1	5	7-Jan-01	1408	43 41.35	177 26.61	W	302	311	3	1265.1	0	4
57	P1	5	7-Jan-01	1713	43 31.96	177 22.96	W	223	230	3	0	0	0
58	ID		8-Jan-01	2112	43 13.79	177 20.90	W	144	150	2.08	7.3	0	0
59	P1	9	8-Jan-01	0507	43 24.11	177 38.62	W	318	332	3.02	593	0	59.2
60	P1	9	8-Jan-01	0722	43 23.86	177 20.33	W	233	246	2.11	0	0	0
61	P2	5	9-Jan-01	0510	43 37.18	177 58.47	W	372	381	3	249.5	0	63.3
62	P1	11A	9-Jan-01	0809	43 24.89	178 27.92	W	425	426	2.99	181.3	14.6	64.3
63	P1	11A	9-Jan-01	1052	43 32.15	178 51.28	W	441	448	3	262.1	10.7	52.9
64	P1	11A	9-Jan-01	1342	43 21.65	178 47.79	W	423	433	3	427.9	99.1	17.3
65	P1	11A	9-Jan-01	1533	43 21.31	178 58.01	W	433	437	3	518.3	26.7	6
66	P1	10B	9-Jan-01	1801	43 25.96	179 10.96	W	453	456	3	123.6	42.3	30.2
67	P1	4	10-Jan-01	0520	44 09.53	179 55.37	W	627	637	3.02	77.7	0	45
68	P1	13	10-Jan-01	0814	43 53.21	179 49.32	W	405	409	3	437	15.5	191
69	P1	10A	10-Jan-01	1138	43 30.62	179 43.66	W	415	425	3	215.4	0	68.6
70	P1	10A	10-Jan-01	1336	43 33.40	179 58.20	W	400	410	3	782.8	17.9	40.9
71*	P1	8B	10-Jan-01	1617	43 31.15	179 46.60	E	403	415	2.99	NR	13.1	NR
72	P1	8B	11-Jan-01	0518	43 09.09	179 27.17	E	442	457	3	189.1	10	51.1
73	P1	14	11-Jan-01	0921	43 41.40	179 26.22	E	447	463	3	388.7	12.9	164.4
74	P1	14	11-Jan-01	1140	43 47.01	179 42.45	E	434	444	2	448.3	11.3	79.5
75	P1	14	11-Jan-01	1317	43 51.15	179 37.98	E	477	488	2	168.5	0	54.8
76*	P1	14	11-Jan-01	1543	43 43.63	179 14.39	E	470	479	2	258	7.1	59.4
77	P1	4	12-Jan-01	0523	43 57.02	178 11.67	E	681	688	3	96.6	0	33.4
78	P1	20	12-Jan-01	1036	43 19.31	178 34.09	E	378	398	3.01	344.6	7.9	63.1
79*	P1	20	12-Jan-01	1502	43 11.65	178 53.06	E	380	400	3	NR	7.8	NR
80	P1	20	13-Jan-01	0523	42 58.10	178 05.34	E	350	382	3.01	92.3	0	56.7
81*	P1	20	13-Jan-01	0858	43 04.86	177 37.61	E	324	327	1.23	NR	0	NR
82	P1	20	13-Jan-01	1017	43 04.03	177 40.82	E	316	326	2.02	131.9	0	35.3
83	P1	20	13-Jan-01	1236	43 14.58	177 40.78	E	302	317	3.01	180	0	3.3
84	P1	20	13-Jan-01	1811	43 30.11	177 42.13	E	345	360	2	1117.6	2.1	1.3
85	ID		13-Jan-01	2229	43 36.01	177 05.94	E	158	162	1.98	4.8	0	0
86	P1	19	14-Jan-01	0634	43 16.98	176 28.18	E	263	281	2.28	215.4	0	4.1
87	P1	19	14-Jan-01	0918	43 17.59	176 12.78	E	323	346	3.02	662.6	0	8.8
88	HC		14-Jan-01	1156	43 17.54	176 12.10	E	277	295	1.91	0	0	0
89	P1	19	14-Jan-01	1524	43 31.52	176 13.33	E	373	381	3.01	644.7	1.5	29.7
90	P1	19	14-Jan-01	1748	43 33.78	176 25.57	E	386	394	2.99	783.8	1.5	33.9

Appendix 1 – continued

Stn.	Type	Stratum	Start of tow					Depth (m)		Dist. towed	Catch (kg)		
			Date	Time NZST	Latitude ° ' S	Longitude ° '	E/W	min.	max.	(n. mile)	hoki	hake	ling
91	P1	17	15-Jan-01	0515	44 03.25	175 58.62	E	302	384	3	200.2	0	30.6
92	P1	15	15-Jan-01	0706	43 59.87	176 05.62	E	471	489	2.99	414.5	11.1	55.5
93	P1	15	15-Jan-01	0922	44 01.95	176 22.93	E	514	560	3.01	343.8	0	36.5
94	P1	15	15-Jan-01	1102	43 55.76	176 25.01	E	504	522	2.99	191.4	7.4	58.2
95	P1	15	15-Jan-01	1359	43 43.70	176 34.56	E	430	438	3	263.1	2.6	79.3
96	P1	15	15-Jan-01	1552	43 43.16	176 23.66	E	406	414	3	490.1	0	90.4
97*	P1	18	15-Jan-01	1829	43 44.56	175 58.48	E	378	385	1.47	NR	0	NR
98	P1	17	1-Jan-01	0512	44 21.35	176 06.29	E	205	241	3	0	0	0.8
99	P1	17	17-Jan-01	0801	44 20.70	175 53.08	E	224	285	3	0	0	0
100	P1	16	17-Jan-01	1209	44 01.81	175 25.05	E	490	514	3	214.6	6.9	118.5
101	P1	16	17-Jan-01	1439	43 58.19	175 18.99	E	466	477	3	175.3	0	95.9
102	HC		17-Jan-01	1747	43 57.93	175 18.74	E	340	402	1.92	18.7	0	0
103	ID		18-Jan-01	0339	43 38.14	175 35.88	E	80	85	2.33	0	0	0
104	P1	18	18-Jan-01	0512	43 32.23	175 32.50	E	230	259	3	64.8	0	0
105	P1	16	18-Jan-01	0829	43 50.61	175 35.78	E	419	430	3	1349	0	53.2
106	P1	16	18-Jan-01	1010	43 52.43	175 27.74	E	440	458	3	418	3.9	127.5
107	P1	18	18-Jan-01	1321	43 44.62	175 14.90	E	387	400	3	999.9	0	30.4
108	HC		18-Jan-01	1526	43 48.48	175 27.70	E	411	422	3	2069.5	0	64.3
109	HC		18-Jan-01	1801	43 50.26	175 36.39	E	348	362	1.74	100.3	0	0
110	P1	6	19-Jan-01	0525	44 37.11	174 51.97	E	770	793	3	44.8	0	0
111	P1	6	19-Jan-01	0742	44 28.28	174 40.52	E	694	707	3	114	10.8	52.3
112	P1	16	19-Jan-01	1125	44 02.91	174 27.41	E	566	577	3	146.3	12.3	74.9
113	P1	16	19-Jan-01	1420	43 48.38	174 35.62	E	526	539	3	70.2	16.8	110
114	P1	18	19-Jan-01	1840	43 25.13	174 51.15	E	317	325	2.03	112.3	0	3.4
115	P1	16	20-Jan-01	0521	44 34.96	172 57.17	E	479	527	3	33.3	0	11.8
116	P1	6	20-Jan-01	0910	44 21.22	173 41.92	E	654	663	3.01	89.2	5.9	50.7
117	P1	16	20-Jan-01	1132	44 12.01	173 38.74	E	459	464	3	135.3	6.7	86.5
118	P1	16	20-Jan-01	1527	43 47.53	174 15.28	E	500	524	3	306.1	0	50.7
119	HC		20-Jan-01	1832	43 54.59	174 02.97	E	423	427	3.01	481.4	0	27.8
120	P1	1	21-Jan-01	0537	43 26.68	174 05.50	E	709	739	3.01	99.6	7.1	30.8
121	P1	7	21-Jan-01	0806	43 24.95	174 20.86	E	531	575	3.01	535.2	21.5	79.1
122	P1	7	21-Jan-01	1039	43 26.39	174 38.22	E	416	456	2.99	427.6	9.6	47.6
123	P1	7	21-Jan-01	1238	43 22.69	174 41.42	E	404	407	3	1373	4.1	28.1
124	P1	18	21-Jan-01	1443	43 20.33	174 54.64	E	280	292	3	509.9	0	0
125	P1	7	21-Jan-01	1754	43 11.76	174 28.42	E	555	574	3	91.6	13.5	56
126	ID		22-Jan-01	0248	43 07.06	174 53.11	E	133	145	3.19	16.1	0	0
127	P1	7	22-Jan-01	0542	43 08.02	174 37.16	E	522	547	3	102.9	12	109.5
128	P1	1	23-Jan-01	0739	43 00.28	174 40.44	E	664	674	2.09	32.2	2.8	13.9
129	P1	18	22-Jan-01	1009	43 05.05	175 05.70	E	259	270	3.03	85.6	0	0
130	P1	18	22-Jan-01	1308	43 01.40	175 21.59	E	327	354	2.99	185.1	0	43.8
131	P1	7	22-Jan-01	1552	43 04.01	175 45.55	E	477	478	3	54.5	27.1	73.4
132	P1	7	22-Jan-01	1750	42 58.19	175 48.77	E	550	552	3	175.4	42.1	87.3
133	P1	7	23-Jan-01	0516	43 11.69	175 53.68	E	410	441	3	306.1	55.2	38.7
134	P1	1	23-Jan-01	0803	42 54.17	175 54.21	E	606	610	2.99	268.8	20.2	35.1
135	HC		23-Jan-01	1027	42 55.33	175 51.01	E	585	587	2.99	133.2	14.3	64.1

Appendix 1 – continued

Stn.	Type	Stratum	Start of tow Date	Time	Latitude	Longitude		Depth (m)		Dist. towed	Catch (kg) hoki	hake	ling
				NZST	° ' S	° '	E/W	min.	max.	(n. mile)			
136	ID		23-Jan-01	2008	43 43.99	175 35.51	E	121	200	1.77	4.4	0	0
137	ID		24-Jan-01	0043	43 50.51	175 37.67	E	255	285	2	52.2	0	0
138	HC		24-Jan-01	0736	43 48.16	175 27.20	E	409	419	3	694.1	0	82
139	HC		24-Jan-01	1021	43 44.55	175 14.89	E	394	400	3	283.1	0	25.8
140	HC		24-Jan-01	1313	43 41.15	175 07.07	E	380	384	3	2209.6	0	26.4
141	HC		24-Jan-01	1558	43 48.10	175 27.25	E	339	356	1.76	0	0	0
142	HC		24-Jan-01	1907	43 41.13	175 06.90	E	218	304	2.41	2.4	0	0
143	HC		25-Jan-01	0737	43 55.49	175 26.80	E	454	470	3	152.8	3	118.2
144	HC		25-Jan-01	0916	43 49.94	175 19.22	E	427	432	3	1036.4	22.5	79

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

Appendix 2: **Scientific and common names, and species caught from valid biomass stations. The occurrence (Occ.) of each species (number of tows in which caught) in the 119 valid biomass tows is also shown.**

Scientific name	Common name	Code	Occ.
Seaweed		SEO	1
Porifera (sponges)		ONG	42
Cnidaria			
Scyphozoa (jellyfish)		JFI	6
Anthozoa			
Octocorallia (corals)	unspecified corals	COU	28
Gorgonacea (gorgonian corals)		GOC	3
Stylasterina (red corals)		COR	1
Zoanthidea			
Anctinaria (sea anemones)		ANT	53
Tunicata			
Thaliacea (salps)		SAL	21
Mollusca		MOL	1
Gastropoda	unspecified gastropods	GAS	33
Fusitriton magellanicus		FMA	20
Volutidae	volute	VOL	2
Bivalva	unspecified bivalves	BIV	1
Cephalopoda			
Teuthoidea: squids	unspecified squids	SQX	1
Cranchiidae	cranchiid squid	CHQ	4
Histioteuthidae			
Histioteuthis miranda	violet squid	VSQ	2
Ommastrephidae			
Ommastrephes bartrami	red squid	RSQ	4
Nototodarus sloanii	arrow squid	NOS	75
Todarodes filippovae	Antarctic flying squid	TSQ	26
Onychoteuthidae			
Moroteuthis ingens	warty squid	MIQ	44
Moroteuthis robsoni	warty squid	MRQ	6
Octopoda: octopods	octopus	OCP	1
Octopodidae			
Graneledone spp.	deepwater octopus	DWO	5
Octopus cordiformis		OCT	2
Opisthoteuthididae			
Opisthoteuthis spp.	umbrella octopus	OPI	7

Appendix 2 – continued

Crustacea			
Caridea (Natantia)			
Camplyonotus rathbonae	sabre prawn	CAM	1
Lipkius holthuisi	omega prawn	LHO	11
Oplophorus novaezeelandiae	prawn	ONO	1
Pasiphaea spp.	prawn	PAS	1
Sergestes spp.	prawn	SER	1
Astacidea			
Nephropidae			
Metanephrops challengeri	scampi	SCI	68
Palinura			
Palinuridae			
Jasus spp.	rock lobster phyllosoma	PHY	1
Scyllaridae			
Ibacus alticrenatus	prawn killer	PRK	7
Crab (Anomura + Brachyura)	unspecified crabs	CRB	24
Anomura			
Galatheidae			
Munida sp.		MUN	3
Lithodidae			
Lithodes murrayi	southern stone crab	LMU	2
Neolithodes brodiei		NEB	1
Paralomis hystrix		PHS	4
Paralomis zelandica		PZE	1
Parapaguridae			
Parapagurus dimorphus		PDI	16
Brachyura			
Homolidae			
Paromola petterdi	antlered crab	ATC	15
Majidae			
Leptomithrax australis	giant masking crab	SSC	14
Echinodermata			
starfish (Asteroidea + Ophiuroidea)		SFI	32
Asteroidea (starfishes)		ASR	20
Asteriidae			
Cosmasterias dyscrita		CDY	13
Goniasteridae			
Hippasteria trojana	Trojan star	HTR	12
Mediaster sladeni	Sladen's star	MSL	9
Pillsburiaster aoteanus		PAO	2
Odontasteridae			
Odontaster spp.	pentagonal tooth-star	ODT	1
Korethrasteridae			
Peribolaster lictor		PLI	2

Appendix 2 – continued

Solasteridae			
Crossaster japonicus	sun star	CJA	44
Zoroasteridae			
Zoroaster spp.	rattail star	ZOR	39
Astropectinidae			
Dipsachaster magnificus		DMG	25
Plutonaster spp.		PLT	25
Psilaster acuminatus	geometric star	PSI	53
Holothuroidea (sea cucumbers)			
Stichopodidae			
Stichopus mollis		SCC	36
Ophiuroidea (basket and brittle stars)			
Euryalina (basket stars)			
Gorgonocephalidae			
Gorgonocephalus sp.		GOR	7
Ophiurida (brittle stars)			
Ophiodermatidae			
Bathypectinura heros		BHE	1
Echinodea (sea urchins)		ECN	12
Regularia			
Cidaridae: cidarids			
Goniocidaris parasol		GPA	1
Poriocidaris sp.		PCD	5
Echinothuriidae: Tam-o-shanter urchins		TAM	51
Pedinidae			
Caenopedina alanbakeri		CAL	4
Temnopleuridae			
Pseudechinus flemingi		PFL	1
Echinidae			
Gracilechinus multidentatus		GRM	12
Dermechinus horridus		DHO	1
Irregularia			
Spatangidae: heart urchins			
Spatangus multispinus		SPT	4
Paramaretia multituberculata		PMU	21
Agnatha (jawless fishes)			
Myxinidae: hagfishes			
Eptatretus cirrhatus	hagfish	HAG	1
Chondrichthyes (cartilagenous fishes)			
Hexanchidae: cow sharks			
Hexanchus griseus	sixgill shark	HEX	2

Appendix 2 – continued

Squalidae: dogfishes			
Centrophorus squamosus	deepwater spiny dogfish	CSQ	18
Centroscymnus crepidater	longnose velvet dogfish	CYP	13
C. owstoni	Owston's dogfish	CYO	6
C. plunketi	Plunket's shark	PLS	6
Deania calcea	shovelnose dogfish	SND	35
Etmopterus baxteri	Baxter's dogfish	ETB	20
E. lucifer	Lucifer dogfish	ETL	75
Scymnorhinus licha	seal shark	BSH	38
Squalus acanthias	spiny dogfish	SPD	86
S. mitsukurii	northern spiny dogfish	NSD	9
Oxynotidae: rough sharks			
Oxynotus bruniensis	prickly dogfish	PDG	16
Scyliorhinidae: cat sharks			
Apristurus spp.	deepsea catsharks	APR	4
Cephaloscyllium isabellum	carpet shark	CAR	5
Halaelurus dawsoni	Dawson's catshark	DCS	2
Triakidae: smoothhounds			
Galeorhinus galeus	school shark	SCH	9
Torpedinidae: electric rays			
Torpedo fairchildi	electric ray	ERA	1
Narkidae: blind electric rays			
Typhlonarke spp.	numbfish	BER	12
Rajidae: skates			
Notoraja asperula		BTA	28
N. spinifera		BTS	19
Bathyraja shuntovi	longnosed deepsea skate	PSK	1
Dipturus innominatus	smooth skate	SSK	47
D. nasutus	rough skate	RSK	3
Chimaeridae: chimaeras, ghost sharks			
Hydrolagus novaezealandiae	dark ghost shark	GSH	65
Hydrolagus sp. B	pale ghost shark	GSP	84
Rhinochimaeridae: longnosed chimaeras			
Harriotta raleighana	longnose chimaera	LCH	52
Rhinochimaera pacifica	widenose chimaera	RCH	3
Osteichthyes (bony fishes)			
Halosauridae: halosaurs			
Halosaurus pectoralis	common halosaur	HPE	2
Notacanthidae: spiny eels			
Notacanthus sexspinis	spineback	SBK	50
Congridae: conger eels			
Bassanago bulbiceps	swollenhead conger	SCO	42
B. hirsutus	hairy conger	HCO	43
Gonorynchidae: sandfish			
Gonorynchus gonorynchus	sandfish	GON	5
Argentinidae: silversides			
Argentina elongata	silverside	SSI	73
Bathylagidae: deepsea smelts			
Bathylagus spp	deepsea smelt	DSS	2

Appendix 2 – continued

Alepocephalidae: slickheads			
Alepocephalus australis	smallscaled brown slickhead	SSM	1
Xenodermichthys socialis	black slickhead	BSL	5
Gonostomatidae: lightfishes			
Diplophos spp		DIP	1
Photichthyidae: lighthouse fishes			
Photichthys argenteus	lighthouse fish	PHO	13
Paralepididae: barracudinas	unspecified barracudinas	PAL	2
Magnisudis prionosa	barracudina	BCA	2
Myctophidae: lanternfishes	unspecified lanternfishes	LAN	7
Lampanyctodes hectoris		LHE	1
Moridae: morid cods			
Austrophycis marginata	dwarf cod	DCO	7
Halargyreus johnsonii	Johnson's cod	HJO	12
Gadella norops		GNO	3
Lepidion microcephalus	small-headed cod	SMC	3
Mora moro	ribaldo	RIB	43
Pseudophycis bachus	red cod	RCO	37
Tripterophycis gilchristi	grenadier cod	GRC	1
Euclichthyidae: eucla cod			
Euclichthys polynemus	eucla cod	EUC	1
Gadidae: true cods			
Micromesistius australis	southern blue whiting	SBW	1
Merlucciidae: hakes			
Macruronus novaezelandiae	hoki	HOK	115
Merluccius australis	hake	HAK	66
Macrouridae: rattails, grenadiers	unspecified rattails	RAT	1
Caelorinchus aspercephalus	oblique banded rattail	CAS	68
C. biclinozonalis	two saddle rattail	CBI	9
C. bollonsi	bigeyed rattail	CBO	104
C. fasciatus	banded rattail	CFA	27
C. innotabilis	notable rattail	CIN	7
C. matamua	Mahia rattail	CMA	8
C. oliverianus	Oliver's rattail	COL	81
C. parvifasciatus	small banded rattail	CCX	23
Coryphaenoides murrayi	abyssal rattail	CMU	1
C. serrulatus	serrulate rattail	CSE	5
C. subserrulatus	four rayed rattail	CSU	5
Coryphaenoides dossenus	long barbel rattail	CBA	1
Lepidorhynchus denticulatus	javelinfish	JAV	115
Macrourus carinatus	ridge scaled rattail	MCA	2
Trachyrincus aphyodes	unicorn rattail	WHX	7
Ventrifossa nigromaculata	blackspot rattail	VNI	26
Ophidiidae: cusk eels			
Genypterus blacodes	ling	LIN	108
Linophrynidae: linophrynids			
Linophryne arborifer	black anglerfish	BAF	1
Trachipteridae: dealfishes			
Trachipterus trachypterus	dealfish	DEA	1
Regalecidae: oarfishes			
Agrostichthys parkeri	ribbonfish	AGR	1

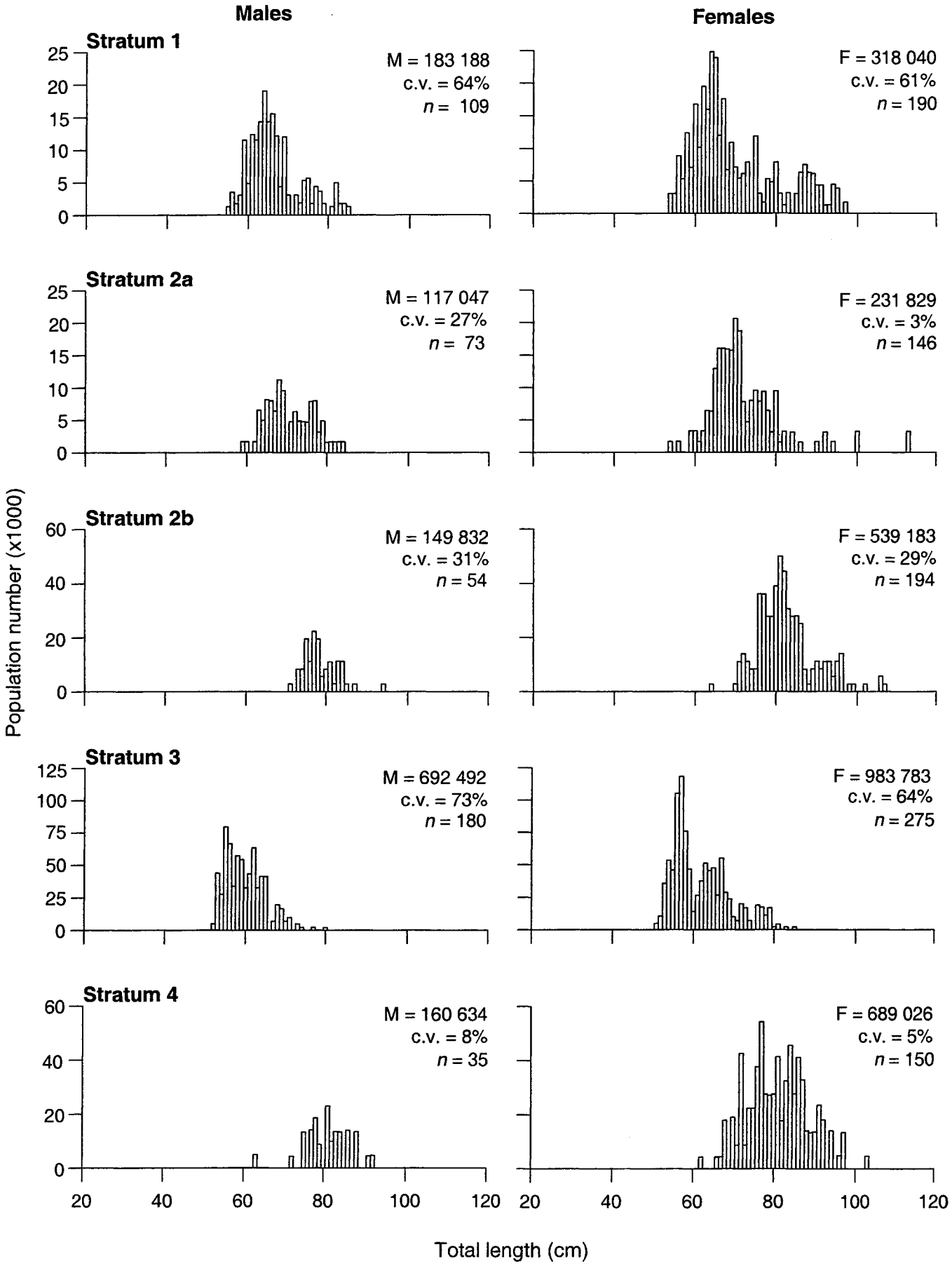
Appendix 2 – continued

Trachichthyidae: roughies			
Hoplostethus atlanticus	orange roughy	ORH	4
H. mediterraneus	silver roughy	SRH	28
Paratrachichthys trailli	common roughy	RHY	9
Berycidae: alfonsinos			
Beryx decadactylus	longfinned beryx	BYD	1
B. splendens	alfonsino	BYS	40
Zeidae: dories			
Capromimus abbreviatus	capro dory	CDO	19
Cyttus novaezealandiae	silver dory	SDO	23
C. traversi	lookdown dory	LDO	113
Zenopsis nebulosus	mirror dory	MDO	1
Oreosomatidae: oreos			
Allocyttus niger	black oreo	BOE	6
Neocyttus rhomboidalis	spiky oreo	SOR	26
Pseudocyttus maculatus	smooth oreo	SSO	13
Macrorhamphosidae: snipefishes			
Centriscops humerosus	banded bellowsfish	BBE	87
Notopogon lilliei	crested bellowsfish	CBE	3
Scorpaenidae: scorpionfishes			
Helicolenus spp.	sea perch	SPE	109
Congiopodidae: pigfishes			
Alertichthys blacki	alert pigfish	API	2
Triglidea: gurnards			
Chelidonichthys kumu	red gurnard	GUR	1
Lepidotrigla brachyoptera	scaly gurnard	SCG	14
Hoplichthyidae: ghostflatheads			
Hoplichthys haswelli	deepsea flathead	FHD	49
Psychrolutidae: toadfishes			
Cottunculus nudus	bonyskull toadfish	COT	1
Neophrynichthys angustus	pale toadfish	TOP	50
Percichthyidae: temperate basses			
Polyprion oxygeneios	hapuku	HAP	7
Serranidae: sea perches			
Lepidoperca aurantia	orange perch	OPE	21
Apogonidae: cardinalfishes			
Epigonus lenimen	bigeye cardinalfish	EPL	15
E. robustus	robust cardinalfish	EPR	12
E. telescopus	black cardinalfish	EPT	9
Carangidae: jacks, trevallies, kingfishes			
Trachurus symmetricus	Murphy's mackerel	JMM	14
Bramidae: pomfrets			
Brama brama	Ray's bream	RBM	28
Taratichthys longipinnis	big-scale pomfret	BSP	1
Caristiidae: manefishes			
Platyberyx sp.		PLA	1
Emmelichthyidae: bonnetmouths, rovers			
Emmelichthys nitidus	redbait	RBT	18
Plagiogeneion rubiginosus	ruby fish	RBY	5
Pentacerotidae: boarfishes, armourfishes			
Pentaceros decacanthus	yellow boarfish	YBO	2

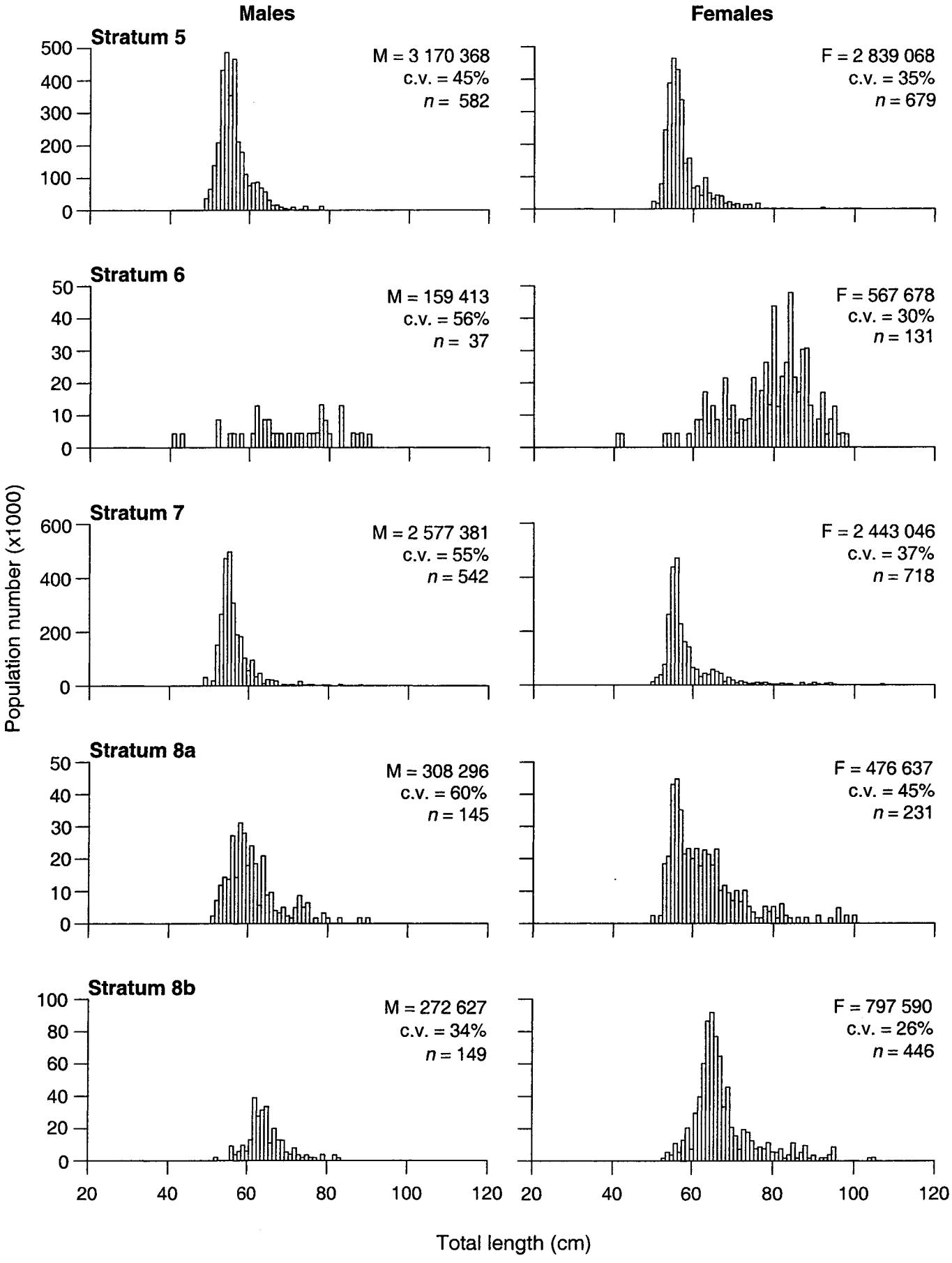
Appendix 2 – continued

Cheilodactylidae: tarakihi, morwongs			
Nemadactylus macropterus	tarakihi	TAR	10
Latrididae: moki, trumpeters			
Latris lineata	trumpeter	TRU	1
Uranoscopidae: armourhead stargazers			
Kathetostoma giganteum	giant stargazer	STA	60
Kathetostoma sp.	banded giant stargazer	BGZ	2
Percophidae: opalfishes			
Hemerocoetes spp.	opalfish	OPA	1
Pinguipedidae: weavers			
Parapercis gilliesi	yellow weaver	YCO	1
Gempylidae: snake mackerels			
Benthodesmus elongatus	bigeye scabbard fish	BNE	1
B. tenuis	scabbard fish	BNT	1
Lepidopus caudatus	frostfish	FRO	4
Thyrsites atun	barracouta	BAR	14
Centrolophidae: raftfishes, medusafishes			
Centrolophus niger	rudderfish	RUD	15
Hyperoglyphe antarctica	bluenose	BNS	7
Schedophilus huttoni		SUH	1
Schedophilus sp.		SUS	1
Seriolella caerulea	white warehou	WWA	70
S. punctata	silver warehou	SWA	53
Nomeidae: eyebrowfishes, driftfishes			
Cubiceps spp.	cubehead	CUB	2
Bothidae: lefteyed flounders			
Arnoglossus scapha	witch	WIT	18
Neoachiropsetta milfordi	finless flounder	MAN	1
Pleuronectidae: righteyed flounders			
Azygopus pinnifasciatus	spotted flounder	SDF	2
Pelotretis flavilatus	lemon sole	LSO	16

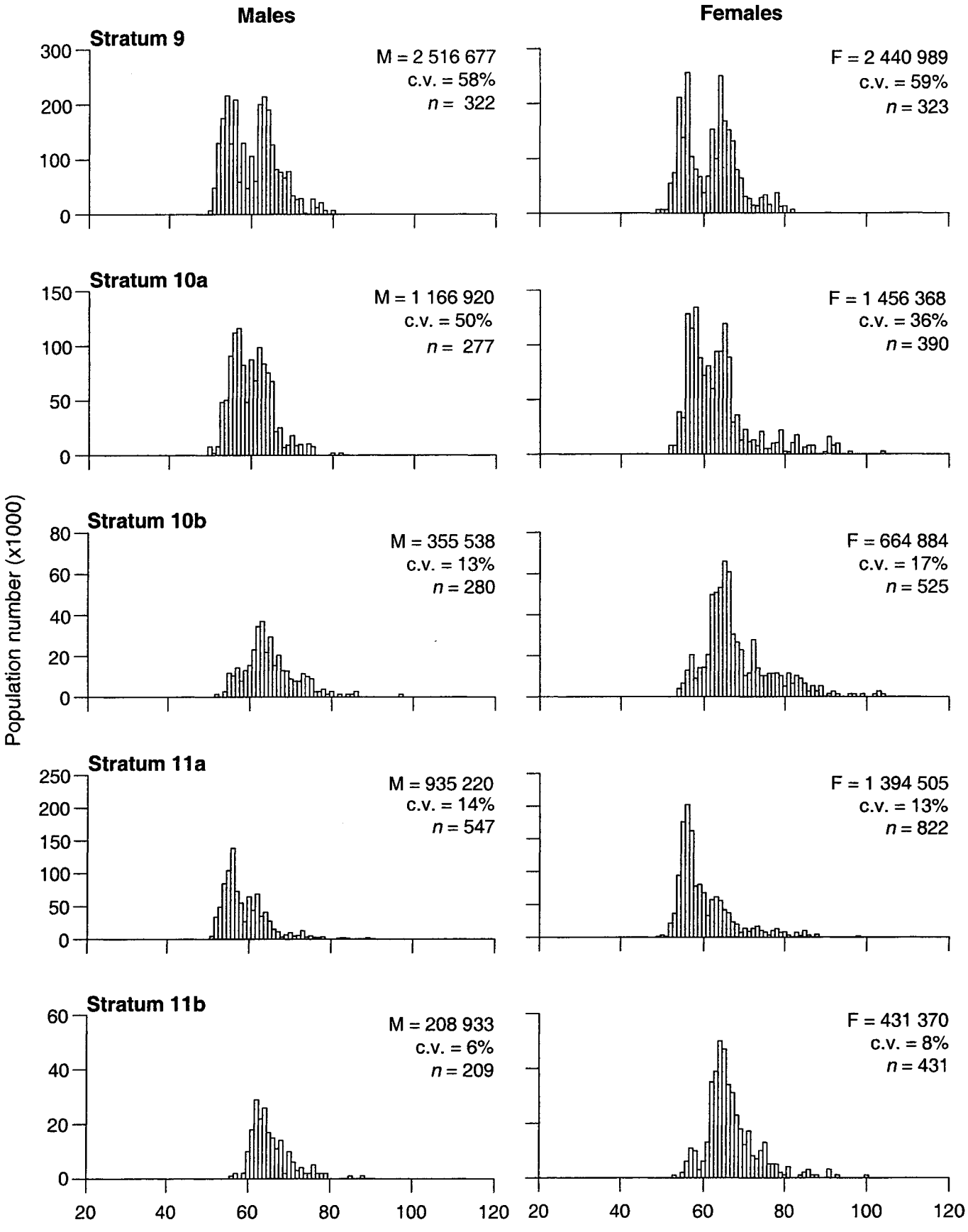
Appendix 3: **Scaled length frequencies of hoki, by stratum and sex. (M, estimated male population; F, estimated female population; c.v., coefficient of variation of the estimated numbers of fish; n, number of fish measured)**



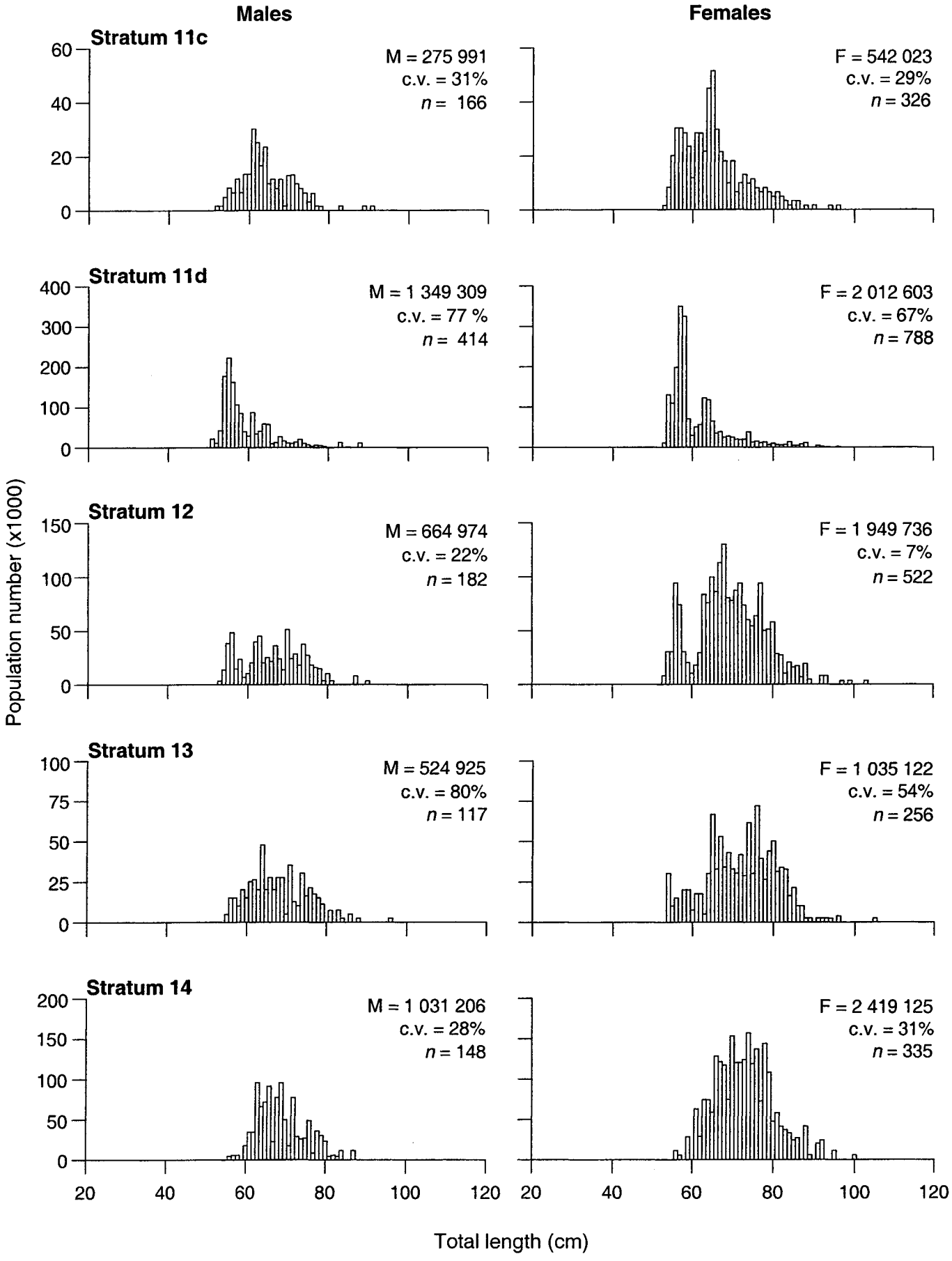
Appendix 3 - continued



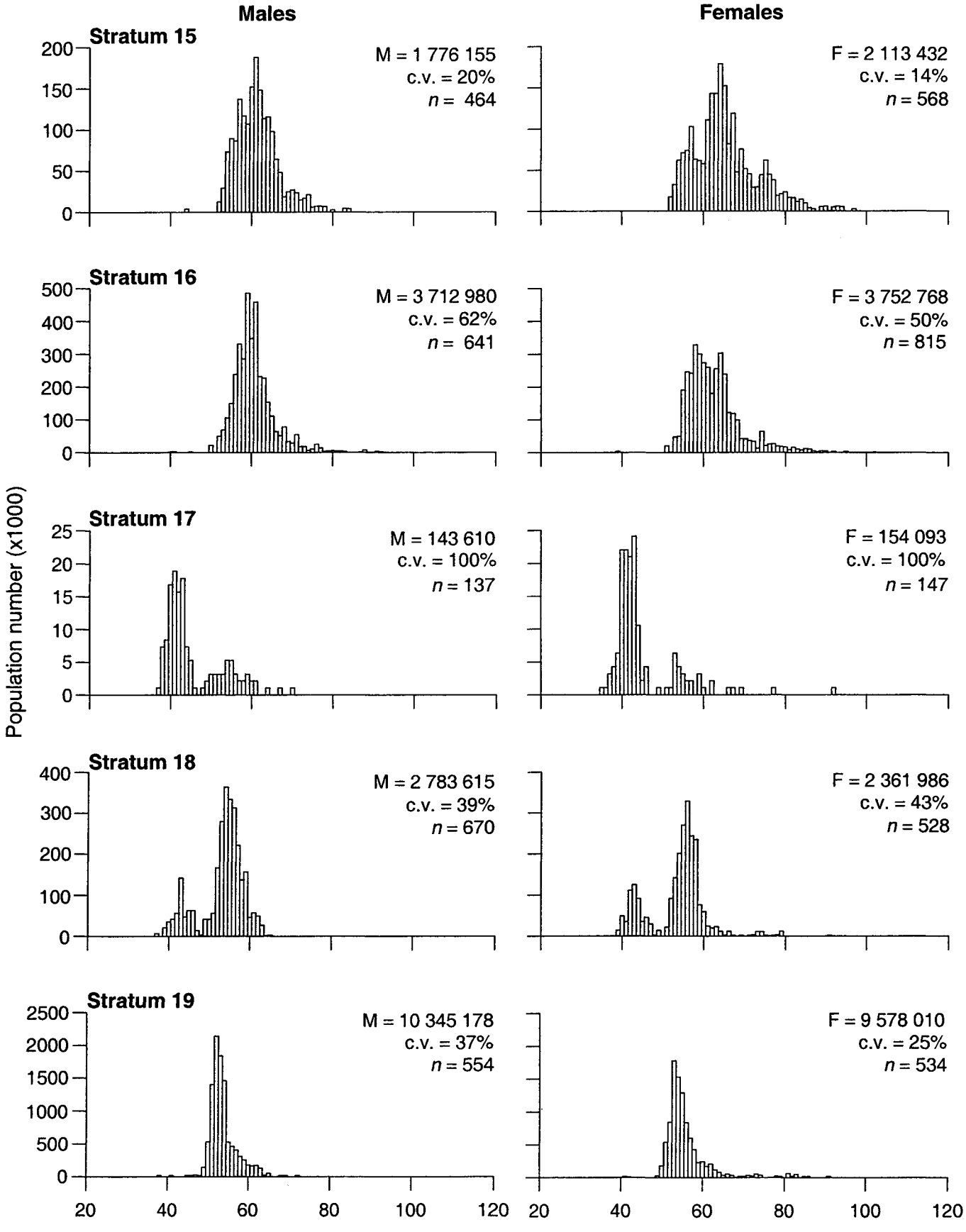
Appendix 3 - continued



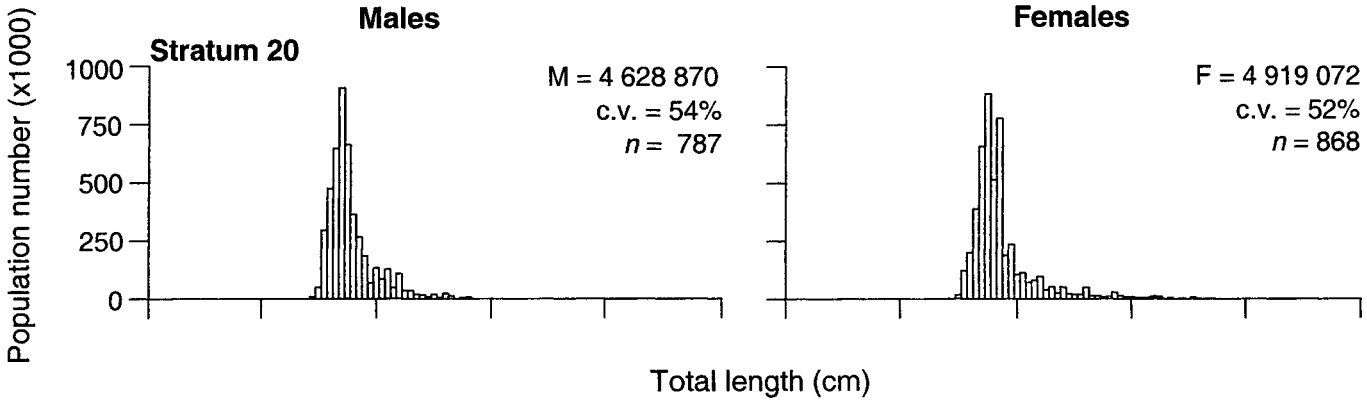
Appendix 3 - continued



Appendix 3 - continued



Appendix 3 - continued



National Institute of
Water & Atmospheric
Research Ltd