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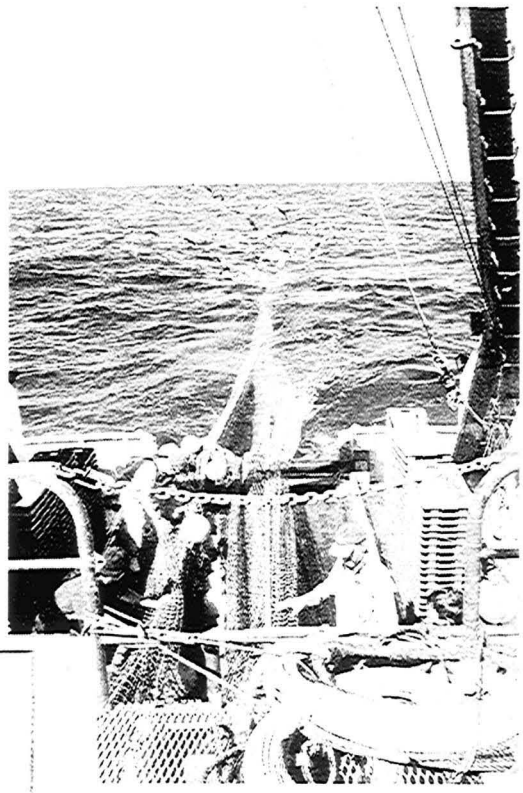
Inshore trawl survey of the west coast South Island and Tasman and Golden Bays, March–April 2000 (KAH0004)

M. L. Stevenson



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Abstract

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The results of the fifth in a series of inshore trawl surveys along the west coast of the South Island from Farewell Spit to the Haast River mouth and within Tasman and Golden Bays at depths from 20 to 400 m by RV *Kaharoa* are reported.

The survey was a two-phase design optimised for giant stargazer, red cod, red gurnard, and tarakihi. Biomass estimates, catch distribution, and population length frequencies for the major species are described.

The biomass estimates and coefficient of variation (c.v.) for the target species were giant stargazer, 1023 t and 11.7% (target c.v. 20%); red gurnard, 625 t and 14.4% (20%), red cod, 414 t and 25.7% (20–25%); and tarakihi 964 t and 18.9% (20%).

Other commercial species with biomass estimates having a c.v. was less than 15% were spiny dogfish, dark ghost shark, barracouta, school shark, and arrow squid.

The estimates of total biomass for giant stargazer, red cod, and tarakihi were the lowest for any survey in the series, but the estimate for red gurnard was higher than for any previous survey in the series. The biomass estimates for several other species were also the lowest for any survey in the series. The reason for the low estimates is not known.

Introduction

This report presents results from the fifth in a time series of stratified random trawl surveys with RV *Kaharoa* in waters between 20 and 400 m off the west coast of the South Island, and within Tasman and Golden Bays. The survey was optimised for giant stargazer (*Kathetostoma* spp.), red cod (*Pseudophycis bachus*), red gurnard (*Chelidonichthys kumu*), and tarakihi (*Nemadactylus macropterus*). The results of earlier surveys in this series have been reported separately (Drummond & Stevenson 1995a, 1995b, 1996, Stevenson 1998) and the series was reviewed by Stevenson & Hanchet (2000). Surveys were scheduled to occur biennially following completion of the third survey in the series in 1995, but this survey was postponed for one year to allow for the review of the series.

The principal objective of the surveys is to develop a time series of relative abundance indices for giant stargazer, red cod, red gurnard, and tarakihi for the inshore waters of the west coast of the South Island and within Tasman and Golden Bays. A standardised index of relative abundance estimates for key inshore species will assist with stock assessment and management strategies. In particular, for giant stargazer (fishstock STA 7) and red gurnard (GUR 7) which were placed in the Adaptive Management Programme (AMP) in the 1991–92 fishing year (Annala et al. 2000).

This report details the survey design and methods, and provides relevant stock assessment data for commercially important Individual Transferable Quota (ITQ) and non-ITQ species.

This report fulfils in part the requirements of Ministry of Fisheries contract INT1999/03, "Estimation of fish abundance off the west coast of the South Island from Farewell Spit to the Haast River mouth, and within Tasman Bay and Golden Bay using trawl surveys".

Programme objective

To determine the relative abundance and distribution of inshore finfish off the west coast of the South Island, and Tasman Bay and Golden Bay, focusing on red cod (*Pseudophycis bachus*), red gurnard (*Chelidonichthys kumu*), giant stargazer (*Kathetostoma giganteum*), and tarakihi (*Nemadactylus macropterus*).

Specific objectives (2000)

1. To determine the relative abundance and distribution of red cod, red gurnard, stargazer, and tarakihi off the west coast of the South Island from Farewell Spit to the Haast River mouth, and within Tasman Bay and Golden Bay by carrying out a trawl survey. The target coefficients of variation (c.v.s) of the biomass estimates for these species are as follows: red cod (20–25%), red gurnard (20%), giant stargazer (20%), and tarakihi (20%).

2. To collect the data and determine the length frequency, length-weight relationship, and reproductive condition of red cod, red gurnard, giant stargazer, and tarakihi.

3. To collect otoliths from red cod, red gurnard, giant stargazer, and tarakihi.

4. To collect the data and determine the length frequencies of all other Quota Management System (QMS) species.

5. To collect and identify benthic macroinvertebrates collected during the survey.

Timetable and personnel

RV *Kaharoa* departed Wellington on 17 March and scientific staff boarded in Nelson on 18 March 2000. Trawling started on 18 March. *Kaharoa* berthed in Westport on 27 March to unload fish and pick up supplies. The vessel unloaded fish in Nelson on 31 March and three science staff were replaced. The vessel departed Nelson on 1 April and trawling resumed on 2 April. Trawling finished on 9 April and science staff disembarked in Nelson that evening. *Kaharoa* returned to Wellington on 11 April.

Michael Stevenson was project and voyage leader and was responsible for final database editing. Skipper for the voyage was Arthur Muir.

Methods

Survey area and design

The survey area (Figure 1) covered depths of 20–400 m off the west coast of the South Island from Farewell Spit to Haast River mouth (25–400 m south of Karamea), and within Tasman and Golden Bays inside a line drawn between Farewell Spit and Stephens Island. The maximum depth on the west coast north of Karamea was limited to 200 m because of historically low catch rates in the 200–400 m range.

The survey area of 25 594 km^2, including untrawlable ground, was divided into 16 strata by area and depth (Table 1, Figure 1). Depth ranges were 20–100 m (except 25–100 m south of Karamea), 100–

200 m, and 200–400 m. Strata were identical to those used in previous surveys. The trawlable ground within the survey area represented 85% of the total survey area.

Phase 1 station allocation was optimised to achieve the target c.v.s. Stratum area and catch rate data from the four previous *Kaharoa* trawl surveys in the series were used to simulate optimal allocation. 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). Simulations were run for each target species separately. Results indicated that 88 stations and a two-phase design (after Francis 1984) were required to achieve the predicted coefficients of variation (c.v.s) with about 82% of stations allocated to phase 1.

Before the survey began, sufficient trawl stations to cover both first and second phase stations were randomly generated for each stratum by the computer programme 'Rand_stn v2.1' (Vignaux 1994). The stations were required to be a minimum of 5.6 km (3 n. miles) apart. Non-trawlable ground was identified before the voyage from data collected during previous trawl surveys in the area. The distribution of non-trawlable ground is given in Table 1 and shown in Figures 1a and 1b.

Vessel, gear, and trawling procedure

RV *Kaharoa* is a 28 m stern trawler with a beam of 8.2 m, displacement of 302 t, engine power of 522 kW, capable of trawling to depths of 500 m. The two-panel trawl net used during the survey was designed and constructed in 1991 specifically for South Island inshore trawl surveys and is based on an 'Alfredo' design. The net was fitted with a 74 mm (inside measurement) knotless codend. Details of the net design were given by Drummond & Stevenson (1995a).

Gear specifications were the same as for previous surveys (see Drummond & Stevenson 1996). Doorspread and headline height measurements were read off Scanmar monitoring equipment and an average taken of five readings at 15 min. intervals during each tow. For tows where no direct readout was possible, doorspread value was calculated as being equal to the mean of the doorspread from stations within the same depth range where direct readings were available.

Procedures followed those recommended by Stevenson & Hanchet (1999). All tows were undertaken in daylight, and four to six tows a day were planned. For each tow the vessel steamed to the station position and, if necessary, the bottom was checked with the depth sounder. Once the tow was considered trawlable, the gear was set away so that the midpoint of the tow would coincide as nearly as possible with the station position. The direction of the tow was influenced by a combination of factors including weather conditions, tides, bottom contours, and the location of the next tow.

If the station was found to be in an area of foul or the depth was out of the stratum range, an area within 5 km of the station was searched for a replacement. If the search was unsuccessful, the station was abandoned and the next alternative from the random station list was chosen. Standard tows were of 1 h duration at a speed over the ground of 3 kn and the distance covered was measured by GPS. The tow was deemed to have started when the net monitor indicated the net was on the bottom, and was completed when hauling began.

A warp length of 200 m was used for all tows at less than 70 m depth. At greater depths, the warp to depth ratio decreased linearly to 2.3:1 at 400 m.

Water temperatures

The surface temperature at each station was recorded from a hull-mounted sensor. Calibration readings were taken on an earlier voyage in December using a Brannan 75 mm mercury immersion thermometer with a range of –1 to 51 °C. Results indicated the hull sensor readings were 0.1–0.2 °C higher than the calibration temperatures at 15 °C. Bottom temperatures were recorded by the Scanmar net monitor, with an average of five readings recorded at 10–15 min intervals during each tow.

Catch and biological sampling

The catch from each tow was sorted into species on deck and weighed on 100 kg electronic motion-compensating Seaway scales to the nearest 0.1 kg. Finfish, squids, and crustaceans (except crabs) were classified by species: crabs, shellfish, and other invertebrate species were preserved in 10% buffered formalin or 70% isopropyl alcohol for later identification because of difficulty in identifying individual species and the limited sorting time available between tows.

Length, to the nearest whole centimetre below the actual length, and sex (where possible) were recorded for all ITQ species, either for the whole catch or a randomly selected subsample of up to 200 fish per tow.

Individual fish weights and/or reproductive state were collected for the target species and rough skate, smooth skate, frostfish, and ling. Individual fish weights were measured to enable length-weight relationships to be determined for scaling length frequency data and calculation of biomass for length intervals. Samples were selected non-randomly from the random length frequency sample to ensure a wide range was obtained for each species. Up to four otoliths per sex per centimetre size class were collected from length frequency samples for giant stargazer, red cod, red gurnard, tarakihi, frostfish, turbot, and brill.

Reproductive maturity stages for rough skate, and smooth skate were recorded. For males the stages were: immature (1), claspers short (not extending beyond the pelvic fins) and uncalcified; maturing (2), claspers extend beyond pelvic fins but soft and uncalcified (rarely some calcification may have begun); mature (3), claspers extend well beyond pelvic fins and are rigid and calcified. For females the stages were: immature (1), ovary invisible or contains only small (pinhead size) ova that have no trace of yellow or orange yolk; maturing (2), ovary contains medium (pinhead to pea-sized) ova that may be yellow or orange, uteri may have visible swellings at anterior or posterior ends but no uterine eggs present; mature (3), ovary contains large (greater than pea-sized) yellow or orange ova, uteri enlarged (over 1 cm diameter) and may contain eggs.

Data analysis

Relative biomass estimates and scaled length-frequency distributions were estimated by the area-swept method (Francis 1981, 1989) using the TrawlSurvey Analysis Program (Vignaux 1994). All data were entered into the Ministry of Fisheries *trawl* database.

The following assumptions were made for extracting biomass estimates with the TrawlSurvey Analysis Programme.

1. The area swept during each tow equalled the distance between the doors multiplied by the distance towed.

2. Vulnerability was 1.0. This assumes that all fish in the volume swept were caught and there was no escapement.
3. Vertical availability was 1.0. This assumes that all fish in the water column were below the headlne height and available to the net.
4. Areal availability was 1.0. This assumes that the fishstock being sampled was entirely within the survey area at the time of the survey.
5. Within the survey area, fish were evenly distributed over both trawlable andnon-trawlable ground.

Although these assumptions are unlikely to be correct, their adoption provides the basis for a time series of relative biomass estimates (Stevenson & Hanchet 1999). All assumptions listed are consistent with those used for previous surveys in the series.

All stations where the gear performance code was 1 or 2 (84 of 85 stations) were used for biomass estimation. This excluded station 28 where the net was ripped. The c.v. associated with estimates of biomass was calculated by the method of Vignaux (1994).

A combined biomass and length frequency analysis (TrawlSurvey Analysis Program, Vignaux 1994) was used to estimate biomass and to derive scaled length frequency distributions. The geometric mean functional relationship was used to calculate the length-weight coefficients. For coefficients chosen from the database, a selection was made on the basis of whether coefficients were available from previous surveys in the series or on the best match between the size range of the fish used to calculate the coefficients and the sample size range from this survey (Appendix 1). All length frequencies were scaled by the percentage of catch sampled, area swept, and stratum area using the TrawlSurvey Analysis Program.

Sex ratios were calculated using scaled population numbers and are expressed as the ratio of males to females.

Results

Survey area, design, and gear performance

A total of 84 stations was successfully completed, 72 in phase 1 and 12 in phase 2. Station density ranged from one station per 53 km^2 in stratum 16 to one station per 626 km^2 in stratum 9, with an average station density of one station per 305 km^2 (see Table 1). At least three stations were completed in all 16 strata and all project and survey objectives were achieved. The survey area, with stratum boundaries and station positions, is shown in Figures 1a and 1b and individual station data are given in Appendix 2.

Phase two stations were targeted at red cod and tarakihi to reduce their c.v.s towards the target levels. Five phase 2 stations were allocated to stratum 6 where the highest catch rates of red cod and tarakihi occurred, three stations were allocated to stratum 16 for red cod, and 4 stations were allocated to stratum 2 for tarakihi. Catch rates of giant stargazer and red gurnard were not used for allocation of phase 2 stations because the c.v.s for these species were within target levels. Sixteen phase 2 stations were planned, but weather changes required extra steaming time and only 12 phase 2 stations were completed. Although stations allocated for phase 2 were completed each day, an average of only three stations per day could be completed because of the extra steaming time.

Tow and gear parameters by depth are shown in Table 2. Doorspread ranged from 69.8 to 95.6 m and headline height ranged between 4.5 and 6.1 m (Table 2, Appendix 2). Measurements of headline height and doorspread, together with observations that the doors and trawl gear were polishing well, indicate

that the gear was operating correctly. Gear parameters were similar to those on previous surveys indicating consistency between surveys (Stevenson & Hanchet 2000).

Trawling began in Tasman and Golden Bays and after two days working continued on the west coast in a generally north to south direction. One day was lost to bad weather and three days were used in unloading fish and exchanging scientific staff.

Catch composition

A total of about 30 t of fish was caught during the 85 tows at an average of 356 kg per tow (range 68.2–1040.8 kg). Amongst the vertebrate fish catch, 1 agnathan, 18 elasmobranchs, and 71 teleosts were recorded. Species codes, common names, scientific names, and catch weights of all species identified during the survey are given in Appendix 3. Total catches from all stations were weighed and samples from each catch were measured. Other bivalves, crustaceans, and echinoderms caught were identified after the survey at Greta Point.

Invertebrate species identified from the catch are given in Appendix 4.

The most abundant species by weight was spiny dogfish with 6.9 t caught (22.8% of the total catch). The top three species, spiny dogfish, barracouta, and dark ghost shark, made up 40.7% of the total. Giant stargazer, red cod, red gurnard, tarakihi and made up 5.3, 3.8, 3.3, and 4.6% of the catch, respectively. Arrow squid, barracouta, carpet shark, school shark, spiny dogfish, and witch flounder were all caught in over 80% of the tows.

Catch rates and species distribution

Distribution and catch rates for the 20 most abundant commercially important species are shown in Figures 2a–2t. Catch rates are given in terms of kilograms per square kilometre. On average a standard tow covers 0.44 km^2, therefore a catch rate of 100 $kg.km^{-2}$ equates to a catch of 44 kg.

Mean catch rates for the 20 most abundant commercially important species by stratum are given in Table 3.

Biomass estimation

Relative biomass estimates for all species of which more than 100 kg was caught, excluding thresher shark, are given by sub-area in Table 4 in order of descending total biomass. Spiny dogfish had the largest estimated biomass, followed by dark ghost shark and barracouta. Coefficients of variation for the target species were: giant stargazer, 11.7%; red cod, 25.7%; red gurnard, 14.4%; and tarakihi, 18.9%.

Biomass estimates of recruited fish are presented for barracouta, blue warehou, giant stargazer, hoki, John dory, lemon sole, red cod, red gurnard, rig, sand flounder, school shark, silver warehou, and tarakihi in Table 5. For the target species giant stargazer, red cod, red gurnard, and tarakihi, the percentage of total biomass that was recruited fish was 98%, 39%, 71%, and 90% respectively.

Biomass estimates by year class (where discernable from the length frequency distributions) for barracouta, blue warehou, hake, hoki, jack mackerel (*Trachurus declivis* and *T. novaezelandiae*), red cod, red gurnard, school shark, silver warehou, and tarakihi are given in Table 6. For red cod, the 1+

cohort made up 62% of the total red cod biomass. For red gurnard, the 2+ cohort made up 22% of the total biomass estimate and for tarakihi the 2+ cohort made up 11% of the total (see Table 6).

The relative biomass estimates for the 20 most abundant, commercially important species by stratum are given in Table 7 in order of catch abundance.

Water temperatures

Isotherms estimated from surface temperature recordings are shown in Figure 3 and from bottom temperature recordings in Figure 4. Surface temperatures were generally warmer in all areas than during previous surveys (see Stevenson & Hanchet 2000).

Length frequency and biological data

The numbers of length frequency and biological samples taken during the survey are given in Table 8. Scaled length frequency distributions (by depth range where appropriate) for the 21 most abundant ITQ species, rough skate, smooth skate, and spiny dogfish are shown in Figure 5 in alphabetical order by common name.

Length-weight coefficients were determined for giant stargazer, red cod, red gurnard, tarakihi, frostfish, ling, rough skate, and smooth skate using the geometric mean functional relationship and are given in Appendix 1.

Details of gonad stages for giant stargazer, red cod, red gurnard, and tarakihi are given in Table 9.

Target species

Giant stargazer

Giant stargazer were caught at 38% of stations in Tasman and Golden Bays and 97% of stations along the west coast with the highest catch rates south of Greymouth in strata 12, 14, and 15 (see Figure 2f, Table 3). Sixty-two percent of the relative biomass estimate was south of Cape Foulwind, and 71% was within the 100–200 m depth range (see Table 7). Only one giant stargazer larger than 45 cm was caught in Tasman and Golden Bays (see Figure 5) and no clear year class modes were apparent in the length frequency distributions. The sex ratios (male:female) along the west coast were 0.63:1 at depths less than 100 m, 1.75:1, at 100–200 m, 0.99:1 at 200–400 m, and 1.44:1 overall (see Figure 5). Virtually all females under 50 cm total length were immature or had resting gonads. Above this size, most had maturing gonads but for males, fish under 40 cm were immature or resting while most males longer than 40 cm were maturing (Table 9).

Red cod

Red cod were caught at 46% of stations in Tasman and Golden Bays and 66% of stations along the west coast, with the highest catch rates in stratum 16, whilst the proportion of the estimated biomass in Tasman and Golden Bays was 2% (see Figure 2l, Tables 3 & 4). Seventy-seven percent of the estimated biomass on the west coast was in depths less than 200 m (see Table 7). The length frequency data show a dominant 1+ cohort (19–31 cm) present on the west coast at the time of the survey. A small mode (10–19 cm) represents 0+ fish (see Figure 5). The sex ratio in Tasman and

Golden Bays favoured females (0.83:1), while on the west coast it varied considerably with depth (0.57:1 inside 100 m, 1.49:1 at 100–200 m, and 11.4:1 at 200–400 m) (see Figure 5). Most red cod examined had immature or resting gonads, and a few fish were at later stages of reproductive development (see Table 9).

Red gurnard

Red gurnard were caught at all stations in Tasman and Golden Bays and at 59% of stations along the west coast (see Figure 2m). The highest catch rates were in strata 11, 14, 18, and 19 (see Table 3). The relative biomass estimate of 625 t (c.v. = 14.4%) was evenly divided between Tasman and Golden Bays (301 t) and the west coast (324 t) (see Table 4). There was a significant difference in the length frequency distributions between the sub-areas with most of the pre-recruit biomass (74.6%) occurring in Tasman and Golden Bays (see Figure 5). The recruited biomass estimate (30 cm or over) was 310 t (71% of the total) with 278 t occurring on the west coast. Ninety-six percent of red gurnard biomass was at depths less than 100 m and none occurred at depths greater than 200 m (see Table 7). Sex ratios favoured females 0.96:1 in Tasman and Golden Bays, but males predominated on the west coast 2.34:1 (see Figure 5). Most red gurnard longer than 30 cm and some smaller males had developing or mature gonads (see Table 9).

Tarakihi

Tarakihi were caught at 85% of stations in Tasman and Golden Bays and 76% of stations along the west coast. Ninety percent of the relative biomass estimate was recruited fish (25 cm or over) (see Tables 4 and 5). The length frequency data for Tasman and Golden Bays showed two clear modes at 10–16 and 17–22 cm, probably the 1+ and 2+ cohorts. There is a weaker mode at 23–27 cm which could be 3+ fish, but otoliths from the survey would need to be read to confirm this. Almost no tarakihi longer than 30 cm were caught in Tasman and Golden Bays. These year classes were also present on the west coast (see Figure 5), but the modes occurred at slightly shorter lengths (10–13, 16–20, and 21–25. Average size increased with increasing depth on the west coast (see Figure 2t). Of the total tarakihi biomass, 96% was on the west coast, and 342 t (36.9%) of this was at 100–200 m depth (see Table 7). The sex ratios on the west coast were 0.44:1 inside 100 m, 0.50:1 at 100–200 m, and 2.07:1 at 200–400 m (see Figure 5). There was little reproductive development in tarakihi under 30 cm FL, but for bigger fish a full range of gonad stages was recorded (see Table 9).

Discussion

The mean catch per station of 356 kg was the lowest for any survey in the series (579 kg in 1992, 735 kg in 1994, 1047 kg in 1995, and 693 kg in 1997). The biomass estimates for red cod, giant stargazer, and tarakihi were the lowest for any survey in the series (see Stevenson & Hanchet 2000). Red cod had the greatest decline to 414 t from the 1997 estimate of 2546 t, the previous lowest estimate. Commercial catch of red cod was also very low for the 1999–2000 fishing year for the RCO 7 fishstock due to poor recruitment in recent years (Beentjes 2000) and was predicted from the environmental model of Beentjes & Renwick (2000). For tarakihi, the biomass estimate for the west coast was slightly higher than the 1997 estimate, but the estimate for Tasman and Golden Bays was only 36 t compared to 222 t in 1997. Red gurnard was the only target species to show an increase in estimated biomass from the previous surveys.

The biomass estimates for most species were lower than in 1997 (see Stevenson 1998), whilst the estimates for arrow squid, barracouta, hoki, lemon sole, sand flounder, school shark, smooth skate,

and witch were lower than for any previous survey (Drummond & Stevenson 1996, Stevenson 1998). In addition, the biomass estimates for Chilean jack mackerel, hake, and N. Z. sole were also the lowest for any survey in the series, but are not listed here because the catch was less than 100 kg (25, 36, and 31 kg respectively).

For the fifth successive survey the c.v.s associated with the biomass estimates for giant stargazer, red gurnard, and tarakihi were below 20%. The c.v. associated with the biomass estimate for red cod (25.6%) was slightly higher than on previous surveys. The low overall catch resulted in moderate catches (less than 200 kg) strongly influencing the c.v. Despite the slightly higher c.v. for red cod in this survey, I believe the survey design provides satisfactory indices of abundance for all the target species. For giant stargazer, the length frequency data suggest that fish less than 30 cm long are not well sampled.

The best precision (c.v. less than 15%) for other commercial species was associated with the relative biomass estimates for spiny dogfish, dark ghost shark, barracouta, school shark, and arrow squid. Spiny dogfish was once again the species caught in the greatest quantity (4.8 t or 15.8% of the total catch).

It is not known whether the low biomass estimates indicate actual reductions in abundance for all the species or whether environmental factors had an effect on availability (e.g., water temperatures were higher than during previous surveys). Evaluation and discussion of the possible causes for the low catch and biomass estimates is beyond the scope of this report. It may be advisable to allow additional time during future surveys to sample environmental parameters such as conductivity and temperature by depth. The additional data could then be included and analysed in a future review of the series.

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Table 1: **Stratum depth ranges, survey area, non-trawlable area, number of successful phase 1 and phase 2 stations, and station density.**

Stratum	Depth (m)	Area (km^2)	Non-trawlable area (km^2)	Number of stations		Station density (km^2 per station)
				Phase 1	Phase 2	
1	20–100	1 343	102	4	0	336
2	100–200	4 302	300	4	4	538
5	25–100	1 224	0	3	0	408
6	100–200	3 233	238	3	5	404
7	25–100	927	0	5	0	185
8	100–200	2 354	214	5	0	471
9	200–400	1 877	1 456	3	0	626
11	25–100	1 438	63	7	0	205
12	100–200	2 054	501	7	0	293
13	200–400	1 101	466	5	0	220
14	25–100	851	36	6	0	142
15	100–200	881	373	4	0	220
16	200–400	319	35	3	3	53
17	20–33	307	27	3	0	102
18	20–42	947	30	4	0	237
19	20–70	2 436	193	6	0	406
Total (average)		25 594	3 841	72	12	(305)

Table 2: **Gear parameters by depth range (*n*, number of stations; s.d., standard deviation).**

	n	Mean	s.d.	Range
All stations				
Headline height (m)	85	5.3	0.24	4.5–6.1
Doorspread (m)	85	77.9	4.99	69.8–95.6
Distance (n. miles)	85	2.98	0.08	2.79–3.4
Warp:depth ratio	85	3.15	1.39	1.90–7.69
Tasman/Golden Bays				
20-70 m				
Headline height (m)	13	5.3	0.3	4.6–5.6
Doorspread (m)	13	73.6	2.31	69.8–77.5
Distance (n. miles)	13	2.96	0.03	2.92–3.03
Warp:depth ratio	13	4.99	1.57	3.03–7.69
West coast				
20–400 m				
Headline height (m)	72	5.3	0.2	4.5–6.1
Doorspread (m)	72	78.7	4.96	71.2–95.6
Distance (n. miles)	72	2.98	0.08	2.79–3.4
Warp:depth ratio	72	2.82	1.06	1.90–7.14
20–100 m				
Headline height (m)	25	5.4	0.2	5.1–5.6
Doorspread (m)	25	77.3	2.77	73.6–84.7
Distance (n. miles)	25	3.00	0.11	2.84–3.4
Warp:depth ratio	25	3.81	1.32	2.5–7.1
100–200 m				
Headline height (m)	32	5.3	0.3	4.5–6.1
Doorspread (m)	32	77.1	3.49	71.2–87.7
Distance (n. miles)	32	2.98	0.06	2.84–3.13
Warp:depth ratio	32	2.31	0.12	2.08–2.6
200–400 m				
Headline height (m)	15	5.2	0.2	4.9–5.5
Doorspread (m)	15	84.4	6.39	74.0–95.6
Distance (n. miles)	15	2.97	0.07	2.79–3.03
Warp:depth ratio	15	2.26	0.16	1.90–2.46

Table 3: **Mean catch rates (kg.km^{-2}) with standard deviations (in parentheses) by stratum for the 20 most abundant commercially important species*.**

		Species code								
Stratum	SPD	BAR	GSH	STA	TAR	SCH	RCO	GUR	SQU	SPO
1	229	44	8	0	32	14	21	44	2	26
	(167)	(48)	(15)	(1)	(100)	(11)	(35)	(50)	(2)	(30)
2	86	37	154	17	149	22	+	2	15	0
	(84)	(43)	(80)	(28)	(93)	(18)	(1)	(2)	(11)	
5	190	126	68	2	18	26	9	23	14	44
	(159)	(104)	(41)	(1)	(47)	(23)	(4)	(5)	(11)	(51)
6	142	62	139	29	210	50	12	1	23	1
	(97)	(55)	(68)	(49)	(40)	(57)	(34)	(2)	(7)	(3)
7	323	62	135	34	8	23	58	27	10	27
	(404)	(46)	(139)	(35)	(67)	(28)	(41)	(18)	(9)	(20)
8	407	53	115	66	140	53	20	2	13	0
	(439)	(34)	(94)	(17)	(13)	(40)	(36)	(4)	(12)	
9	0	2	286	1	42	0	0	0	102	0
		(4)	(57)	(2)	(100)				(46)	
11	229	201	0	58	13	15	63	92	3	23
	(257)	(112)		(54)	(45)	(16)	(94)	(71)	(3)	(28)
12	159	56	6	143	109	47	10	4	15	9
	(114)	(35)	(10)	(98)	(14)	(47)	(17)	(6)	(9)	(16)
13	174	33	42	43	66	70	16	0	25	7
	(138)	(45)	(35)	(38)	(31)	(61)	(32)		(14)	(7)
14	145	155	0	111	17	9	24	62	6	55
	(111)	(205)		(73)	(41)	(7)	(17)	(77)	(5)	(50)
15	100	67	23	135	115	15	9	1	8	4
	(83)	(45)	(25)	(73)	(48)	(9)	(13)	(2)	(4)	(5)
16	117	36	132	7	9	7	217	0	17	4
	(97)	(69)	(146)	(11)	(45)	(9)	(504)		(11)	(4)
17	177	151	0	0	5	57	+	29	1	44
	(137)	(176)			(96)	(34)	(+)	(29)	(+)	(29)
18	435	160	0	0	15	94	3	85	11	21
	(183)	(92)			(40)	(119)	(5)	(77)	(12)	(13)
19	241	76	0	11	16	50	2	87	16	30
	(126)	(89)		(12)	(55)	(41)	(3)	(58)	(18)	(34)

* Species codes are given in Appendix 3.
+ < 0.5

Table 3—continued

Stratum	WAR	Species code LIN	FRO	SPE	HOK	SSK	RSK	LEA	JMN	JMD
1	8	0	6	+	+	24	24	41	3	1
	(16)		(9)	(1)	(+)	(33)	(26)	(81)	(6)	(2)
2	0	+	1	2	0	9	6	0	+	1
		(+)	(3)	(3)		(19)	(16)		(+)	(3)
5	2	2	29	+	1	6	0	0	4	20
	(4)	(2)	(21)	(1)	(1)	(10)			(3)	(15)
6	0	4	5	3	3	1	0	0	0	2
		(11)	(8)	(5)	(7)	(2)				(3)
7	8	1	25	+	1	3	7	0	0	6
	(10)	(1)	(33)	(+)	(1)	(7)	(9)			(8)
8	36	2	37	48	4	2	6	0	0	3
	(73)	(2)	(37)	(40)	(6)	(3)	(5)			(3)
9	0	0	4	3	0	0	2	0	0	0
			(6)	(5)			(3)			
11	15	2	8	0	+	8	41	0	0	2
	(16)	(2)	(12)		(1)	(13)	(34)			(2)
12	22	1	36	41	1	1	3	0	0	7
	(36)	(1)	(20)	(54)	(2)	(2)	(4)			(9)
13	0	29	36	39	43	16	1	0	0	1
		(66)	(35)	(57)	(96)	(23)	(3)			(1)
14	98	3	1	+	+	0	28	0	0	9
	(165)	(6)	(2)	(+)	(+)		(57)			(10)
15	17	+	2	21	2	1	2	0	0	16
	(21)	(1)	(3)	(23)	(2)	(3)	(4)			(12)
16	0	106	8	3	89	55	4	0	0	5
		(206)	(7)	(4)	(145)	(86)	(7)			(9)
17	+	5	0	17	0	0	0	6	17	1
	(+)	(4)		(30)				(7)	(12)	(1)
18	+	0	0	1	0	0	0	5	67	+
	(+)			(1)				(6)	(86)	(+)
19	+	0	0	3	0	0	5	71	47	30
	(+)			(5)			(6)	(104)	(80)	(53)

* Species codes are given in Appendix 3.
+ < 0.5

Table 4: **Relative doorspread biomass estimates by sub–area for all species where more than 100 kg was caught excluding thresher shark, in order of decreasing total biomass.**

	Tasman and Golden Bays		West coast		Total survey area	
Common name	Biomass (t)	c.v. (%)	Biomass (t)	c.v. (%)	Biomass (t)	c.v. (%)
Spiny dogfish	1 053	14.7	3 724	15.5	4 777	12.5
Dark ghost shark	0		2 259	8.8	2 259	8.8
Barracouta	384	26.9	1 403	11.7	1 787	10.8
Giant stargazer	26	45.1	997	12.0	1 023	11.7
Tarakihi	36	32.3	928	19.6	964	18.9
School shark	228	30.6	668	14.6	896	13.4
Silver dory	0		846	30.3	846	30.3
Carpet shark	336	13.0	451	10.7	786	8.3
Red gurnard	301	22.7	324	18.1	625	14.4
Two saddle rattail	+	100.0	614	36.4	614	36.4
Arrow squid (*Nototodarus sloanii & N. gouldi*)	50	38.2	473	11.8	523	11.3
Red cod	8	51.4	406	26.1	414	25.7
Rig	106	33.2	227	21.9	333	18.3
Frostfish	0		316	16.4	316	16.4
Sea perch	14	55.0	289	23.4	302	22.4
Blue warehou	+	58.9	272	37.1	272	37.1
Northern spiny dogfish	0		256	17.7	256	17.7
Leatherjacket	181	57.1	55	100.0	236	49.6
Scaly gurnard	52	37.0	151	14.1	203	14.1
Jack mackerel (*Trachurus novaezelandiae*)	185	48.4	9	50.5	194	46.2
Rough skate	13	44.3	173	24.0	186	22.5
Jack mackerel (*T. declivis*)	73	71.9	95	17.1	168	32.8
Cucumber fish	+	100.0	144	22.0	144	22.0
Electric ray	33	38.6	111	33.7	143	27.5
John dory	88	20.0	53	27.2	141	16.1
Smooth skate	0		140	29.1	140	29.1
Gemfish	0		120	30.2	120	30.2
Hapuku	3	100.0	104	36.3	107	35.3
Witch	26	26.3	81	18.7	107	15.5
Hoki (all)	0		103	50.4	103	50.4
Silver warehou	42	68.0	57	30.7	99	33.9
Ling	1	52.9	94	46.9	95	46.2
Sand flounder	61	22.5	1	69.0	62	22.1
Lemon sole	28	21.9	31	30.4	59	19.1
All species					20 336	6.5

+ < 0.5 t

Table 5: **Recruited biomass estimates (t).**

Species	Recruited length (cm)	Tasman and Golden Bays Biomass	Tasman and Golden Bays c.v.%	West coast Biomass	West coast c.v.%	Total survey area Biomass	Total survey area c.v.%
Barracouta	50	268	25.2	1 177	12.2	1 481	10.9
Blue warehou	45	0		266	37.9	266	37.9
Giant stargazer	30	24	43.1	982	12.1	1 006	11.8
Hoki	65	0		4	63.7	4	63.7
John dory	25	87	19.9	53	27.2	140	16.1
Lemon sole	25	14	30.0	23	31.3	36	22.6
Red cod	40	2	73.5	160	24.4	162	24.2
Red gurnard	30	166	25.5	278	18.3	444	14.9
Rig	90	30	51.3	107	27.2	137	24.0
Sand flounder	25	39	23.8	1	69.0	41	23.1
School shark	90	50	39.2	422	18.2	471	16.8
Silver warehou	25	0		42	40.3	42	40.3
Tarakihi	25	6	74.0	861	16.9	867	16.8

Table 6: **Biomass estimates by year class estimated from length frequency distributions.**

Species	Year class	Length range (cm)	Biomass (t)	c.v.%
Barracouta	0+	< 28	102.8	31
	1+	28–36	11.8	40
	2+	37–48	188.9	25
	3+	49–58	42.8	29
Blue warehou	0+	< 19	4.7	51
	1+	19–29	1.4	42
Hake	0+	<24	1.7	52
	1+	24–42	9.2	47
Hoki	0+	16–28	24.7	38
	1+	29–46	12.7	49
Jack mackerel				
Trachurus declivis	0+	<13	0.9	45
	1+	13–21	66.4	77
T. novaezelandiae	1+	11–19	125.1	56
	2+	20–26	28.7	67
Red cod	0+	<20	2.6	39
	1+	20–40	257	36.6
Red gurnard	2+	16–28	139.9	19
School shark	0+	< 41	6.6	35
	1+	41–55	23.2	29
Silver warehou	1+	14–24	57.2	51
	2+	25–34	14.8	45
Tarakihi	0+	< 15	2.9	11
	1+	15–20	29.5	49
	2+	21–26	102.2	62

Table 7: **Estimated biomass (and *c.v.* %) by stratum for the 20 most abundant commercially important species*.**

Stratum	Species code									
	SPD	BAR	GSH	STA	TAR	SCH	RCO	GUR	SQU	SPO
1	307	60	10	1	24	19	28	59	2	35
	(37)	(53)	(100)	(100)	(48)	(40)	(86)	(58)	(47)	(58)
2	372	160	663	72	35	94	1	8	65	0
	(34)	(41)	(18)	(58)	(91)	(28)	(100)	(28)	(25)	
5	232	154	83	2	15	31	11	28	17	54
	(48)	(48)	(34)	(20)	(12)	(51)	(23)	(11)	(47)	(66)
6	459	200	449	93	65	160	40	4	76	4
	(24)	(31)	(17)	(61)	(74)	(41)	(98)	(41)	(11)	(69)
7	299	58	125	31	8	22	53	25	9	25
	(56)	(33)	(46)	(47)	(13)	(53)	(32)	(30)	(42)	(34)
8	958	125	270	156	59	124	47	5	30	0
	(48)	(29)	(37)	(11)	(17)	(34)	(82)	(1)	(43)	
9	0	4	537	2	22	0	0	0	192	0
		(100)	(12)	(100)	(39)				(26)	
11	330	288	0	83	9	21	90	133	5	33
	(42)	(21)		(36)	(11)	(41)	(57)	(29)	(35)	(46)
12	327	115	13	294	53	97	21	7	32	18
	(27)	(24)	(60)	(26)	(20)	(37)	(63)	(63)	(21)	(72)
13	192	36	46	47	60	77	17	0	28	7
	(35)	(61)	(37)	(40)	(41)	(39)	(91)		(25)	(45)
14	123	132	0	94	20	8	20	53	5	47
	(31)	(54)		(27)	(20)	(29)	(30)	(50)	(32)	(37)
15	88	59	20	119	130	13	8	1	7	3
	(42)	(34)	(53)	(27)	(125)	(31)	(70)	(70)	(26)	(58)
16	37	12	42	2	27	2	69	0	6	1
	(34)	(78)	(45)	(66)	(30)	(51)	(95)		(25)	(46)
17	54	46	0	0	18	18	+	9	+	14
	(45)	(67)			(30)	(34)	(50)	(59)	(3)	(38)
18	412	152	0	0	16	89	3	80	10	20
	(21)	(29)			(13)	(63)	(100)	(45)	(57)	(32)
19	587	186	0	26	6	121	5	212	39	72
	(21)	(48)		(45)	(9)	(34)	(60)	(27)	(46)	(47)

* Species codes are given in Appendix 3

\+ < 0.5 t.

Table 7—continued

Stratum	Species code WAR	LIN	FRO	SPE	HOK	SSK	RSK	LEA	JMN	JMD
1	11 (100)	0	9 (70)	1 (100)	+ (100)	33 (67)	32 (56)	55 (100)	4 (100)	1 (100)
2	0	1 (100)	6 (78)	9 (53)	0	40 (71)	25 (100)	0	1 (100)	5 (81)
5	3 (100)	2 (69)	36 (42)	+ (100)	2 (45)	7 (100)	0	0	4 (42)	25 (44)
6	0	13 (93)	16 (58)	11 (47)	10 (82)	2 (100)	0	0	0	7 (42)
7	8 (52)	1 (61)	23 (59)	+ (63)	+ (72)	3 (100)	6 (62)	0	0	6 (59)
8	84 (91)	4 (52)	87 (44)	113 (37)	10 (60)	6 (51)	13 (41)	0	0	8 (43)
9	0	0	8 (82)	6 (96)	0	0	3 (100)	0	0	0
11	22 (39)	2 (42)	11 (58)	0	1 (82)	11 (60)	59 (31)	0	0	3 (35)
12	45 (62)	1 (68)	75 (21)	85 (50)	3 (62)	2 (74)	7 (51)	0	0	15 (46)
13	0	32 (100)	40 (44)	43 (66)	48 (99)	18 (64)	1 (100)	0	0	1 (41)
14	84 (68)	3 (66)	1 (100)	+ (80)	+ (100)	0	24 (82)	0	0	7 (47)
15	15 (59)	0 (100)	2 (95)	19 (54)	1 (73)	1 (100)	2 (100)	0	0	14 (39)
16	0	34 (80)	3 (37)	1 (49)	28 (66)	17 (64)	1 (67)	0	0	2 (76)
17	+ (100)	1 (53)	0	5 (100)	0	0	0	2 (67)	5 (40)	+ (86)
18	+ (100)	0	0	+ (100)	0	0	0	5 (52)	64 (64)	+ (49)
19	+ (100)	0	0	8 (67)	0	0	13 (44)	174 (59)	116 (69)	73 (72)

* Species codes are given in Appendix 3

\+ < 0.5 t.

Table 8: **Numbers of length frequency and biological samples collected (species codes are given in Appendix 3).**

		Length frequency data				Biological data+		
Species code	Measure-ment method	No. of samples	No. of fish	No. of males	No. of females	No. of samples	No. of fish	No. of otoliths
BAR	1	83	4 030	1 204	1 168	0	0	0
BAS	2	1	1	0	1	0	0	0
BCO	2	11	69	29	38	0	0	0
BNS	2	2	2	1	1	0	0	0
BRI	2	5	17	11	6	5	17	17
BRZ	2	5	12	7	5	0	0	0
BTH	5	1	1	0	1	0	0	0
ELE	1	4	24	9	15	0	0	0
EMA	1	3	5	3	2	0	0	0
ESO	2	13	144	–	–	0	0	0
FRO	1	43	594	135	264	43	594	345
GSH	G	49	2 486	1 138	1 347	0	0	0
GUR	1	55	2 894	1 701	1 191	55	2 894	237
HAK	2	18	145	23	25	0	0	0
HAP	2	15	21	9	12	0	0	0
HEP	2	1	1	0	1	0	0	0
HOK	2	27	910	185	173	0	0	0
JDO	2	31	220	90	130	0	0	0
JGU	1	3	4	3	1	0	0	0
JMD	1	56	601	110	106	0	0	0
JMM	1	9	23	17	5	0	0	0
JMN	1	19	1 254	83	65	0	0	0
KAH	1	1	1	0	1	0	0	0
KIN	1	1	1	1	0	0	0	0
LDO	2	3	63	11	52	0	0	0
LEA	2	14	946	–	–	0	0	0
LIN	2	30	182	76	106	29	179	0
LSK	5	2	8	7	1	0	0	0
LSO	2	31	564	–	–	0	0	0
MDO	2	4	4	1	2	0	0	0
NSD	2	27	147	72	75	0	0	0
OPE	2	2	105	37	68	0	0	0
RBY	1	3	46	21	25	0	0	0
RCO	2	53	1 569	948	621	53	1 497	287
RSK	5	29	154	74	80	28	153	0
SCH	2	73	590	306	284	0	0	0
SEV	2	2	2	0	2	0	0	0
SFL	2	13	652	–	–	0	0	0
SKI	1	13	149	63	86	0	0	26
SLS	2	2	2	–	–	0	0	0
SNA	1	4	7	3	4	0	0	0
SPD	2	80	5 308	3 084	2 223	0	0	0
SPE	2	49	2 262	641	619	0	0	0
SPO	2	46	305	210	95	0	0	0
SPZ	2	2	2	1	1	0	0	0

Table 8—continued

		Length frequency data				Biological data+		
Species code	Measurement method	No. of samples	No. of fish	No. of males	No. of females	No. of samples	No. of fish	No. of otoliths
SQU	4	83	2 005	666	1 251	0	0	0
SSH	2	5	78	13	65	0	0	0
SSK	5	23	59	23	36	23	59	0
STA	2	60	677	382	294	60	677	381
SWA	1	40	528	69	76	0	0	0
TAR	1	66	2 123	894	1 229	66	2 123	279
THR	2	7	8	7	1	0	0	0
TRE	1	1	1	1	0	0	0	0
TUR	2	2	3	1	2	2	3	3
WAR	1	33	362	127	98	0	0	0
YBF	2	1	11	–	–	0	0	0
YCO	2	1	3	2	1	0	0	0

Measurement methods: 1, fork length; 2, total length; 4, mantle length; 5, pelvic length; G total length excluding tail filament;

+ Data include one or more of the following: fish length, fish weight, gonad stage, otoliths.

– Not sexed

Table 9: **Numbers of the four target species sampled at each reproductive stage (small fish of undetermined sex are not included).**

Total length (cm)	Males Gonad stage 1	2	3	4	5	Females Gonad stage 1	2	3	4	5	
Giant stargazer											
11–20	2	0	0	0	0	3	0	0	0	0	
21–30	47	1	0	0	0	33	0	0	0	0	
31–40	47	7	2	0	2	45	1	0	0	0	
41–50	23	62	25	2	17	33	2	0	0	1	
51–60	8	42	38	4	25	20	30	2	1	3	
61–70	1	9	6	2	5	6	64	11	0	13	
71–80	0	0	0	0	0	0	15	4	0	3	
Total	128	120	71	8	49	140	112	17	1	20	666
Red cod											
11–20	18	0	0	0	0	49	0	0	0	0	
21–30	219	15	4	0	2	140	0	0	0	0	
31–40	32	28	6	18	12	52	0	0	0	1	
41–50	6	2	3	5	3	14	0	0	0	0	
51–60	0	2	15	8	5	68	17	3	1	6	
61–70	0	0	0	0	0	10	0	0	0	0	
Total	275	47	28	31	22	333	17	3	1	7	764
Red gurnard											
11–20	26	0	0	0	0	16	0	0	0	0	
21–30	120	75	7	10	23	138	8	3	0	5	
31–40	12	104	59	87	79	79	63	30	1	13	
41–50	1	7	6	1	5	7	31	13	2	6	
51–60	0	0	0	0	0	0	1	0	0	0	
Total	159	186	72	98	107	240	103	46	3	24	1 038
Tarakihi											
11–20	104	0	0	0	0	89	0	0	0	0	
21–30	93	13	1	2	4	121	5	1	0	2	
31–40	12	28	16	89	48	113	202	37	6	18	
41–50	0	4	1	33	13	10	90	23	0	16	
51–60	0	0	0	0	0	0	1	0	0	0	
Total	105	45	18	124	65	244	298	61	6	36	1 002

Gonad stages used were: 1, immature or resting; 2, maturing (oocytes visible in females); 3, mature (hyaline oocytes in females, milt expressible in males); 4, running ripe (eggs and milt free flowing); 5, spent.

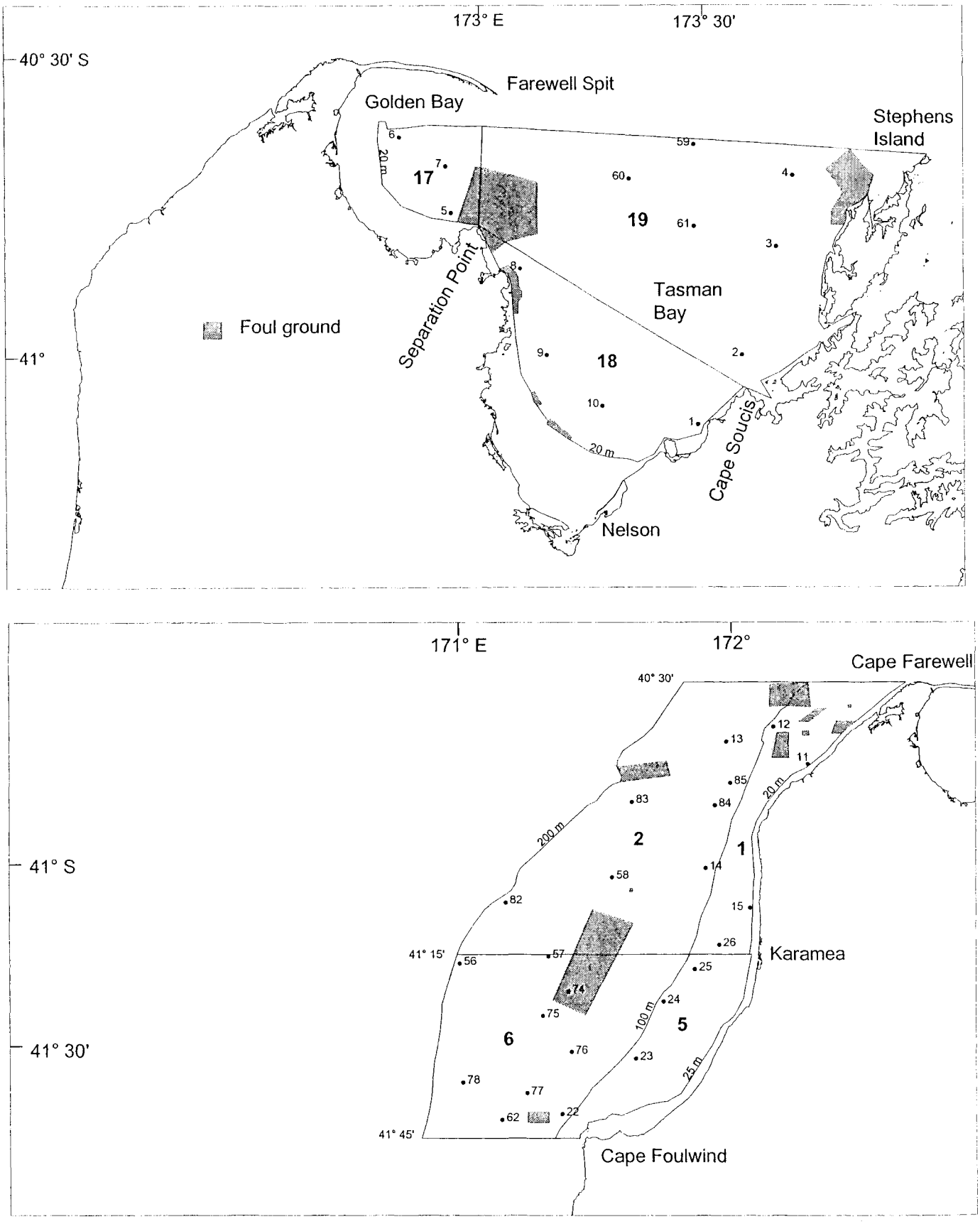

Figure 1a: **Survey area showing stratum boundaries and numbers (bold type) for Tasman and Golden Bays (top) and west coast north of Cape Foulwind (bottom) with station positions and numbers.**

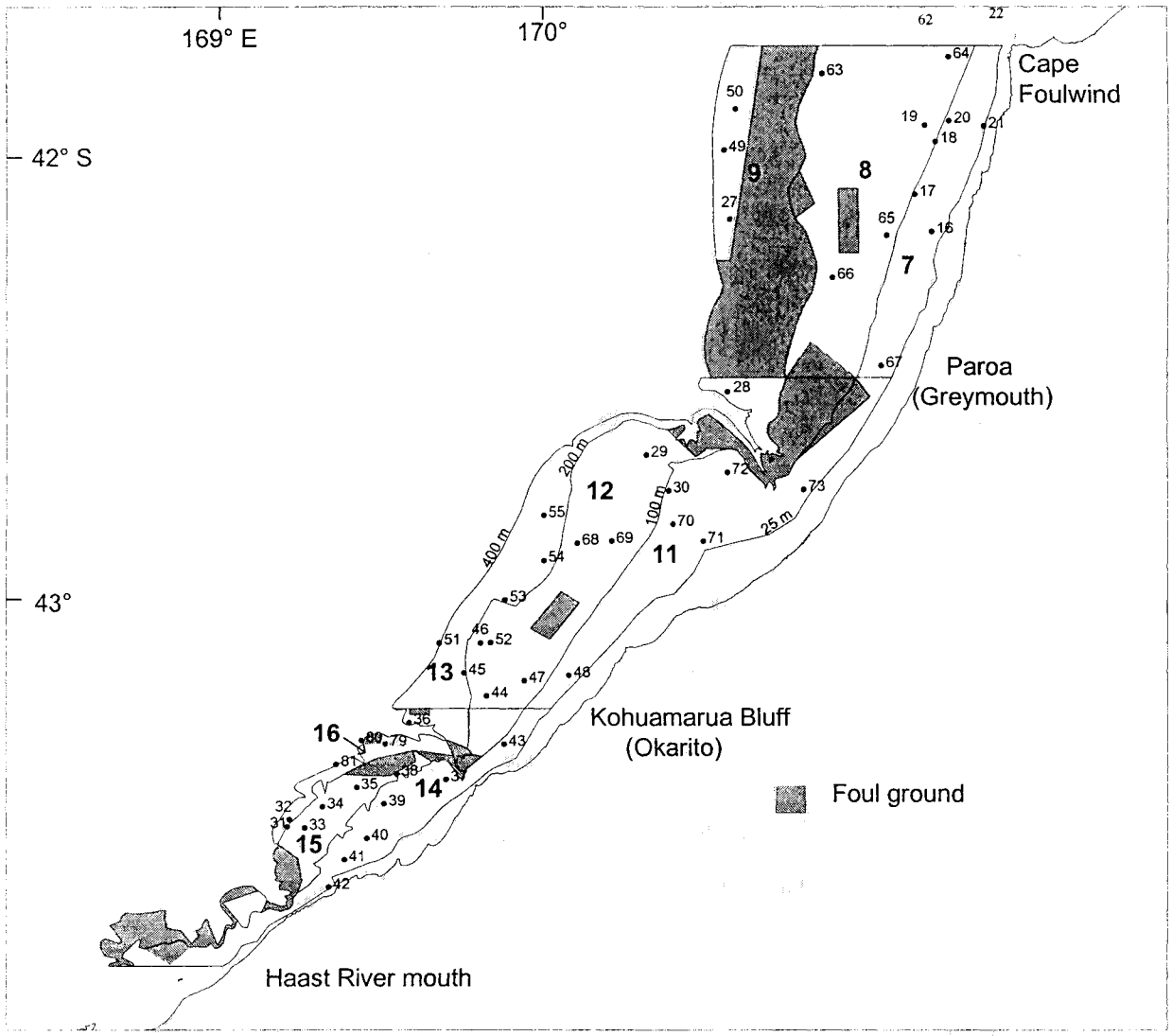

Figure 1b: **Stratum boundaries and number (bold type) for the west coast south of Cape Foulwind with station positions and numbers.**

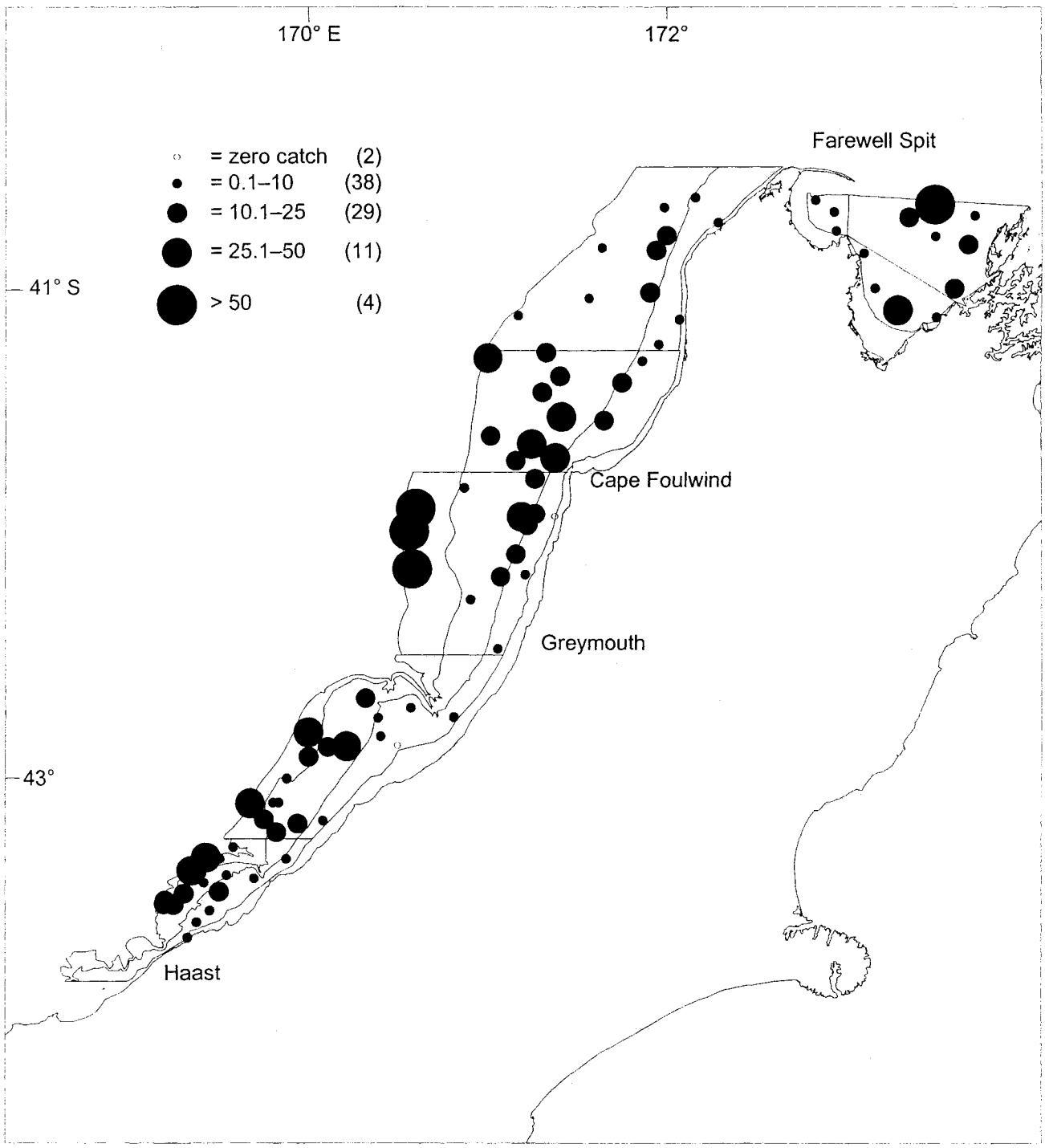

Figure 2: **Catch rates (kg.km^{-2}) for the 20 most abundant commercially important species (numbers in parentheses are the number of stations at the given catch rate).**
***a*: Arrow squid (maximum catch rate 148 kg.km^{-2})**

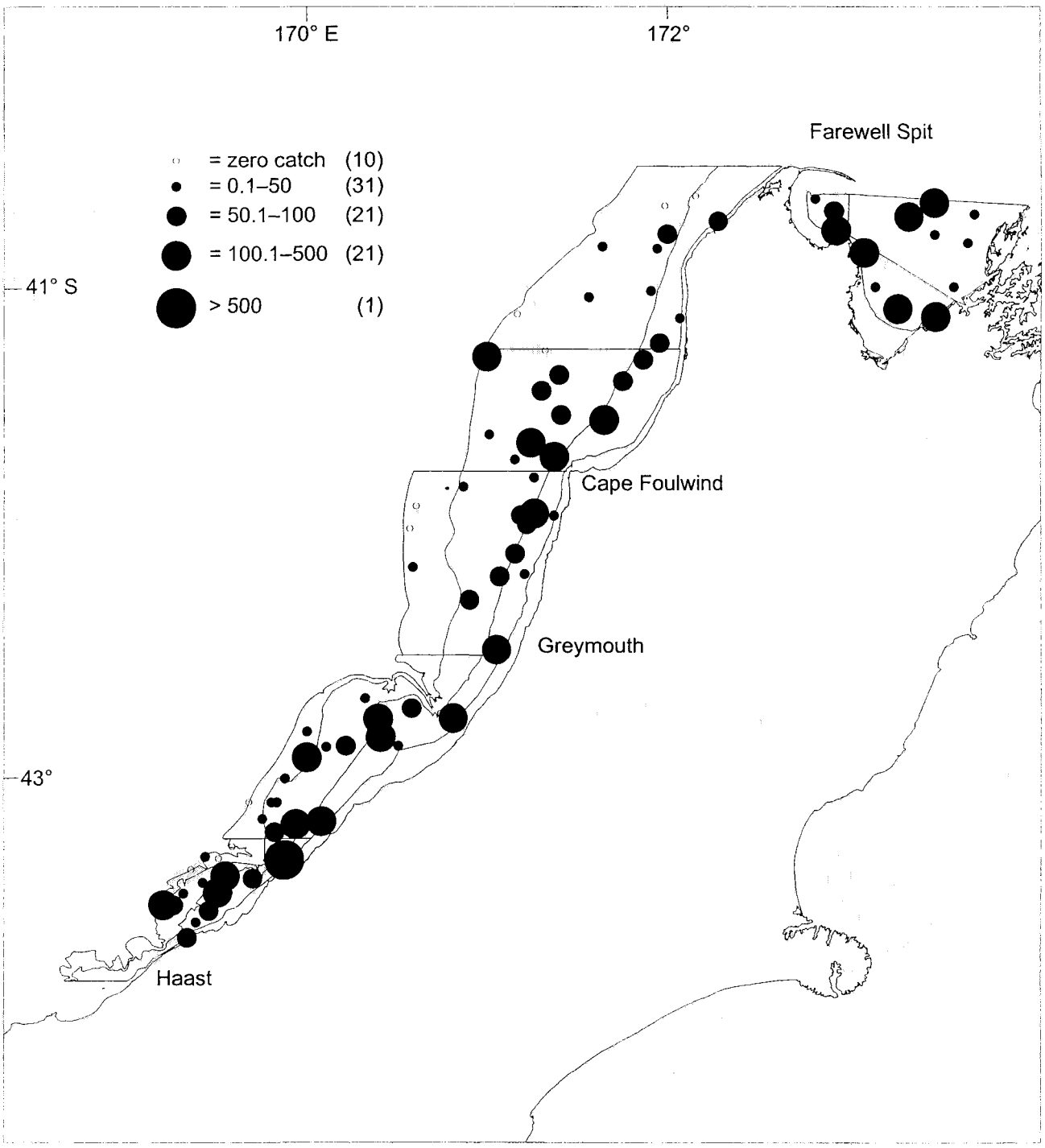

Figure 2b: **Barracouta (maximum catch rate 567 kg.km^{-2})**

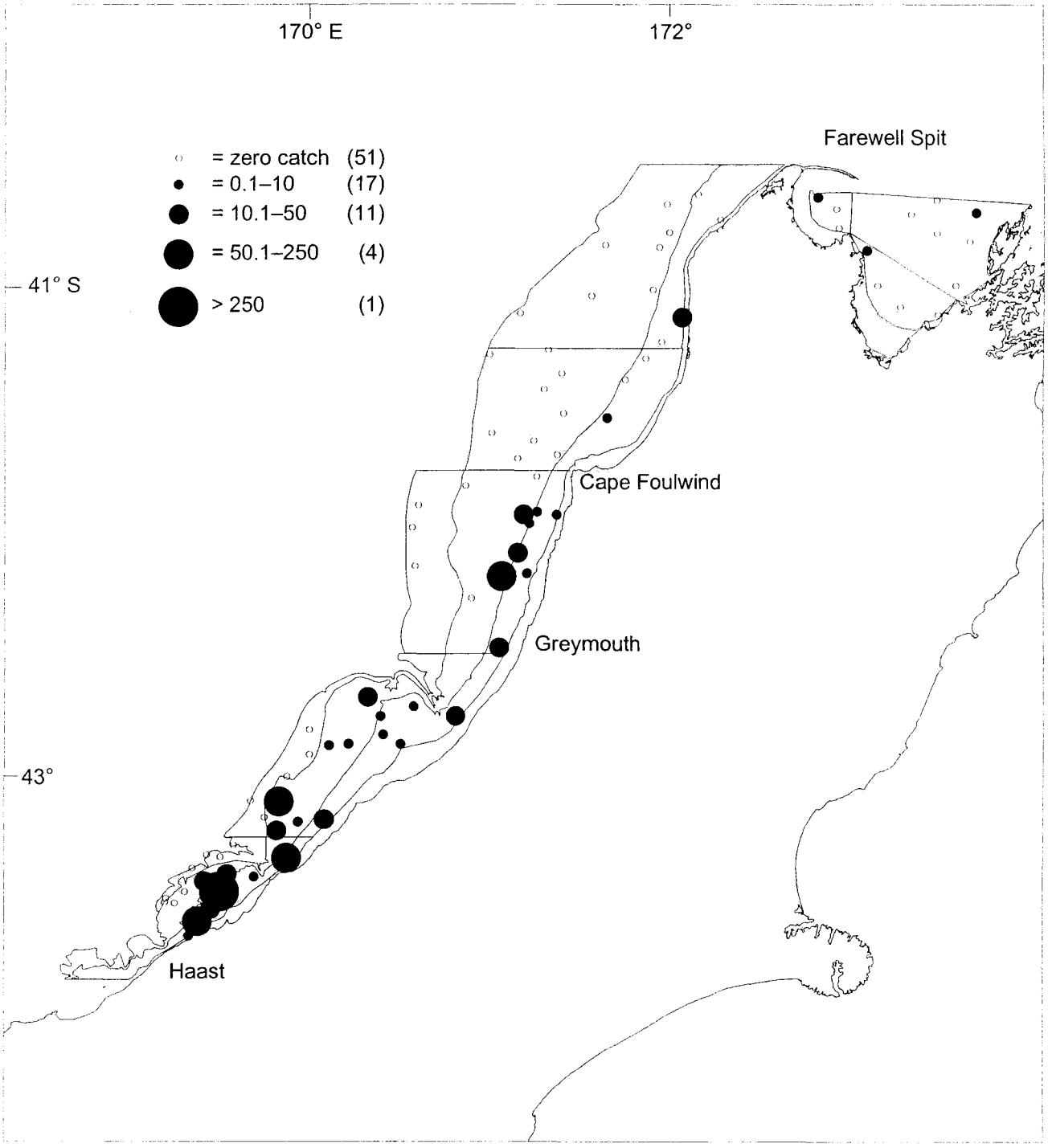

Figure 2c : **Blue warehou (maximum catch rate 429 kg.km^{-2})**

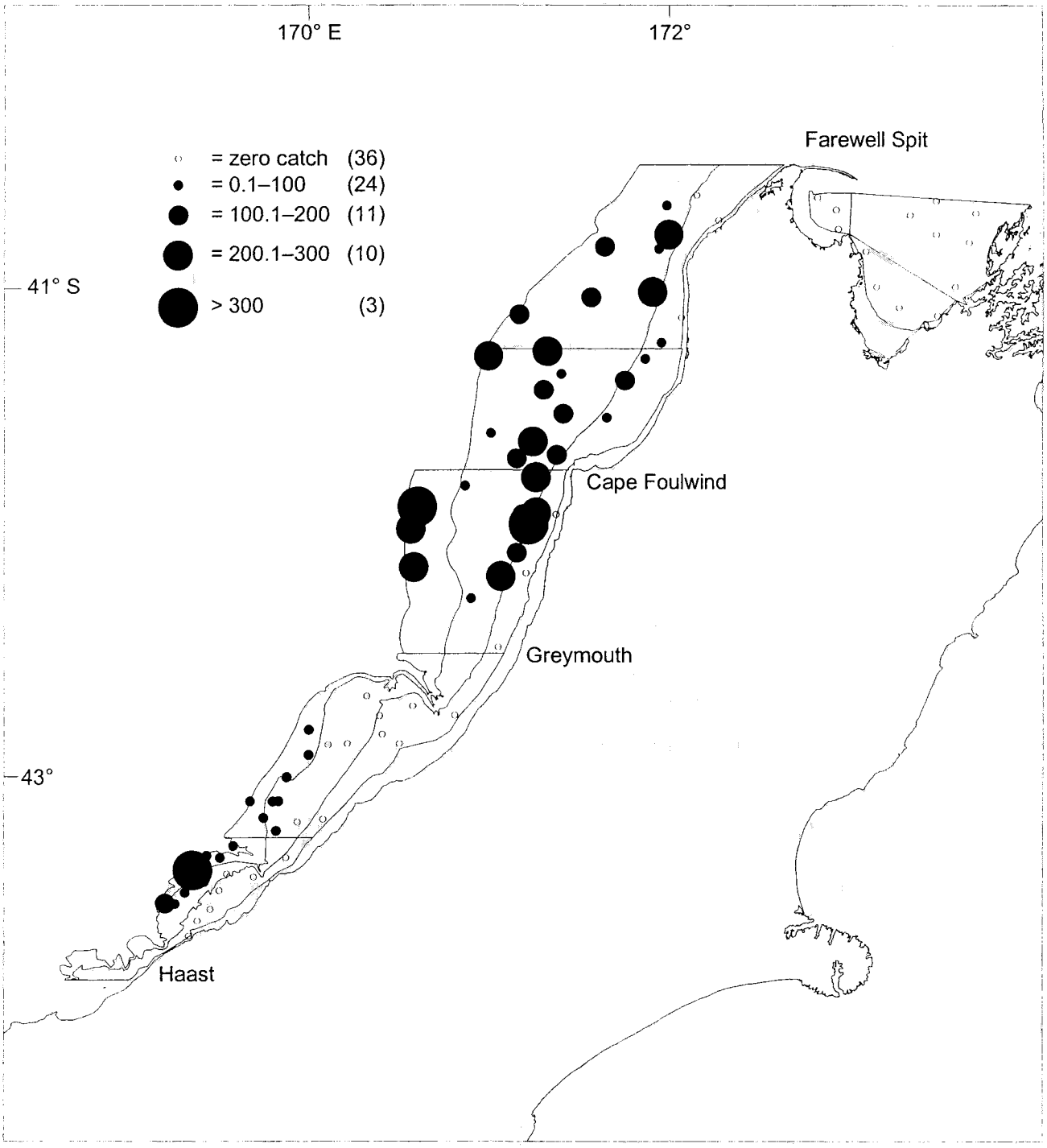

Figure 2d: **Dark ghost shark (maximum catch rate 423 kg.km^{-2})**

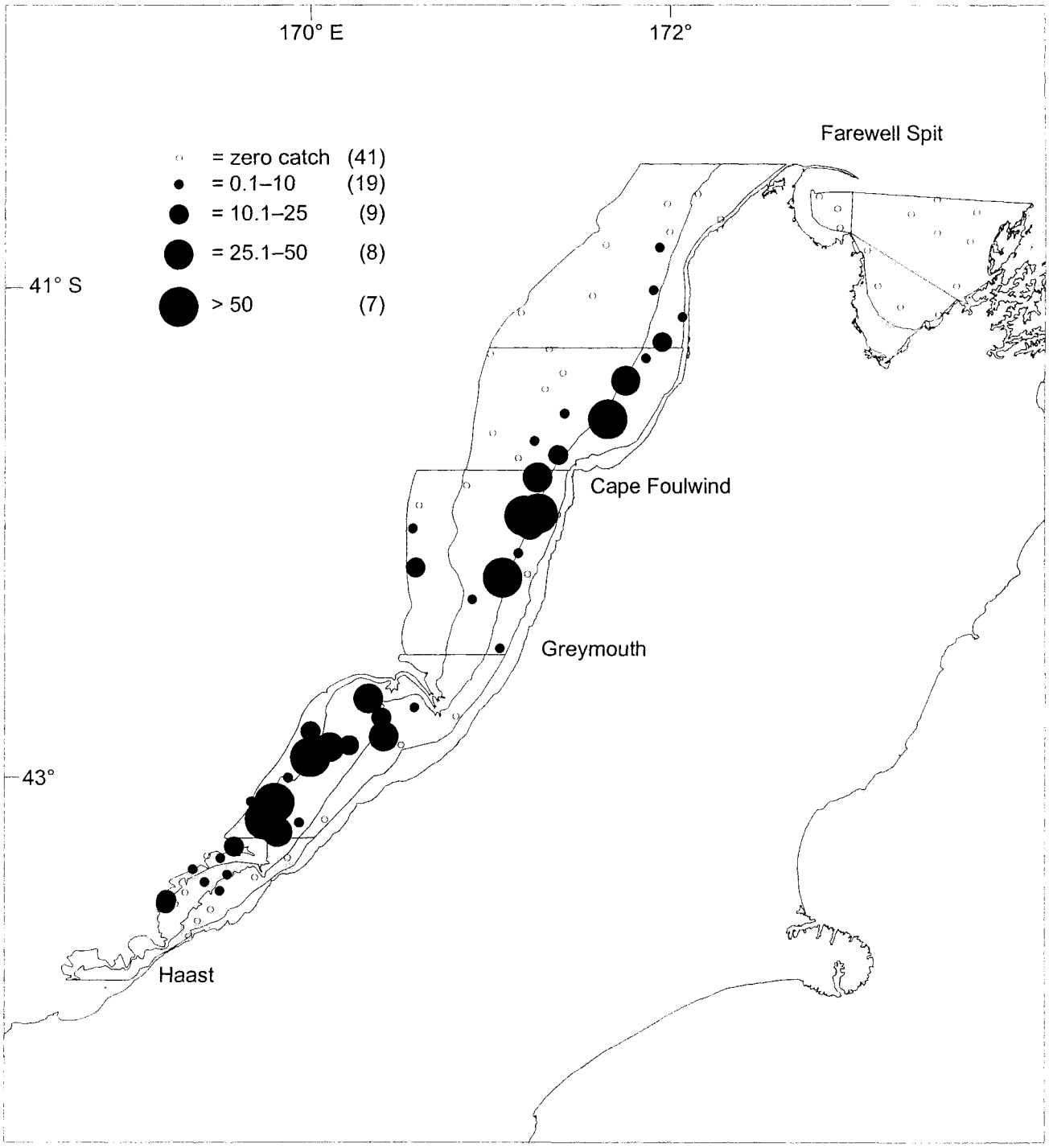

Figure 2e : **Frostfish (maximum catch rate 87 kg.km $^{-2}$)**

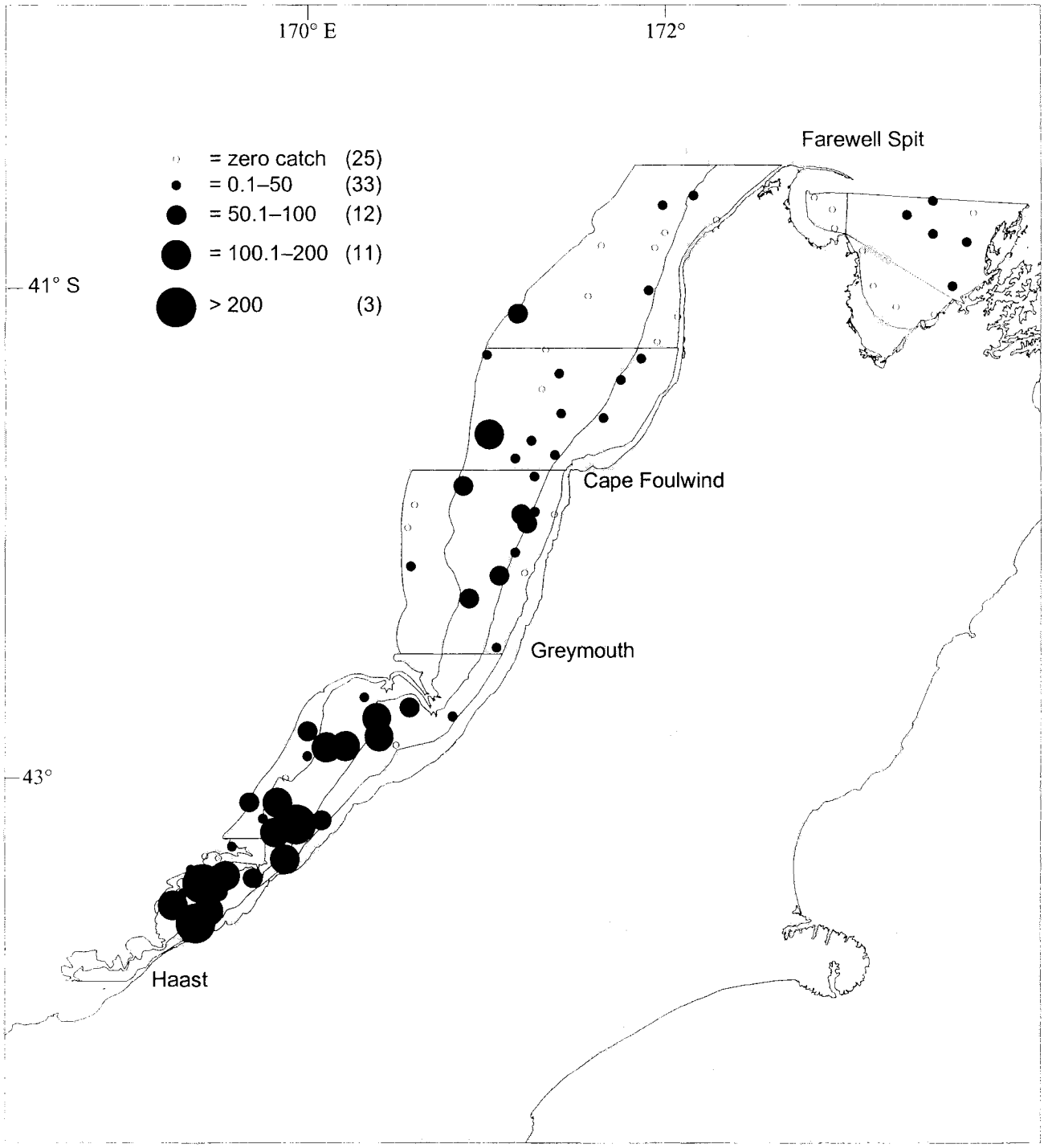

Figure 2f : **Giant stargazer (maximum catch rate 331 kg.km^{-2})**

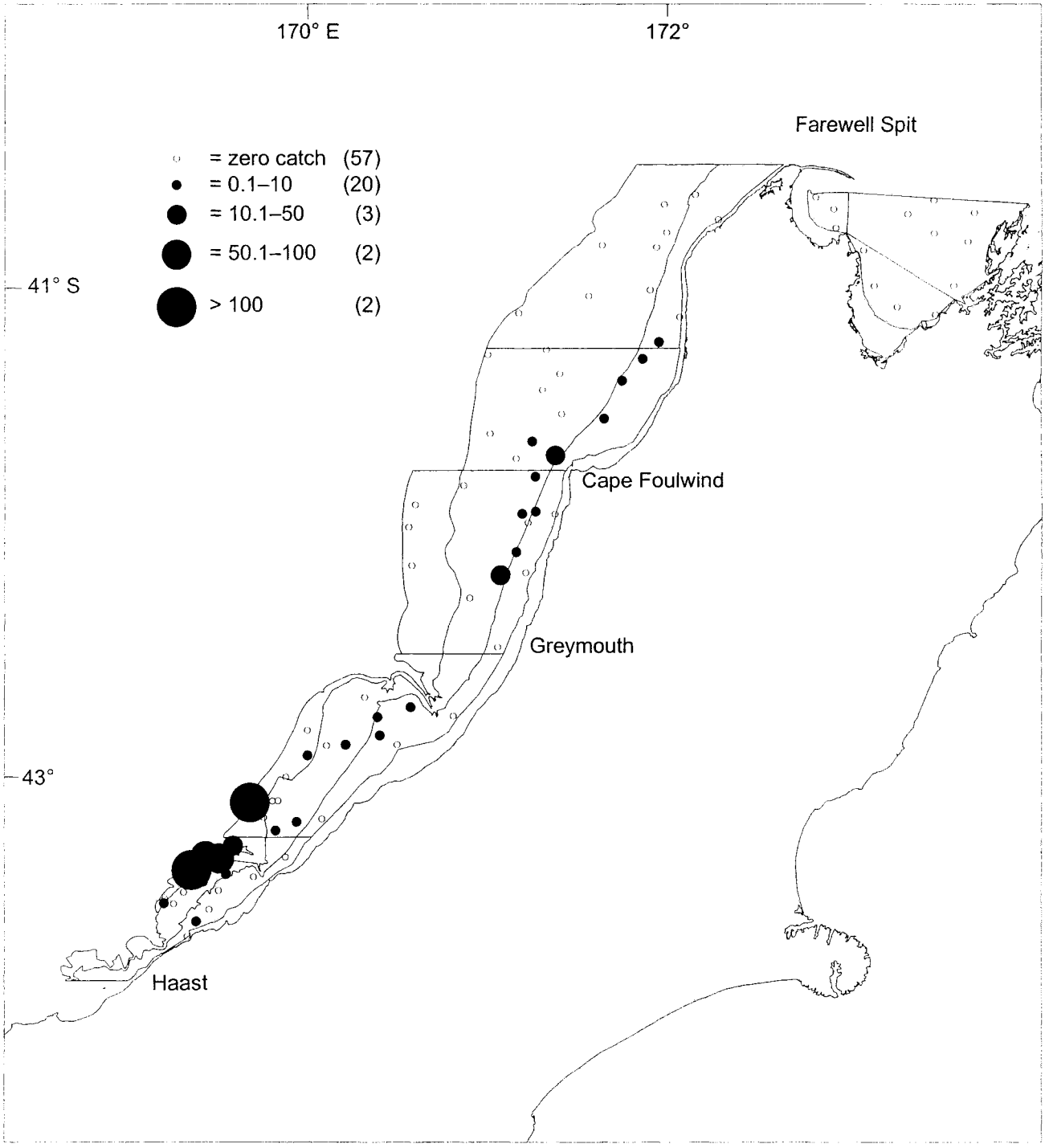

Figure 2g: **Hoki (maximum catch rate 376 kg.km^{-2})**

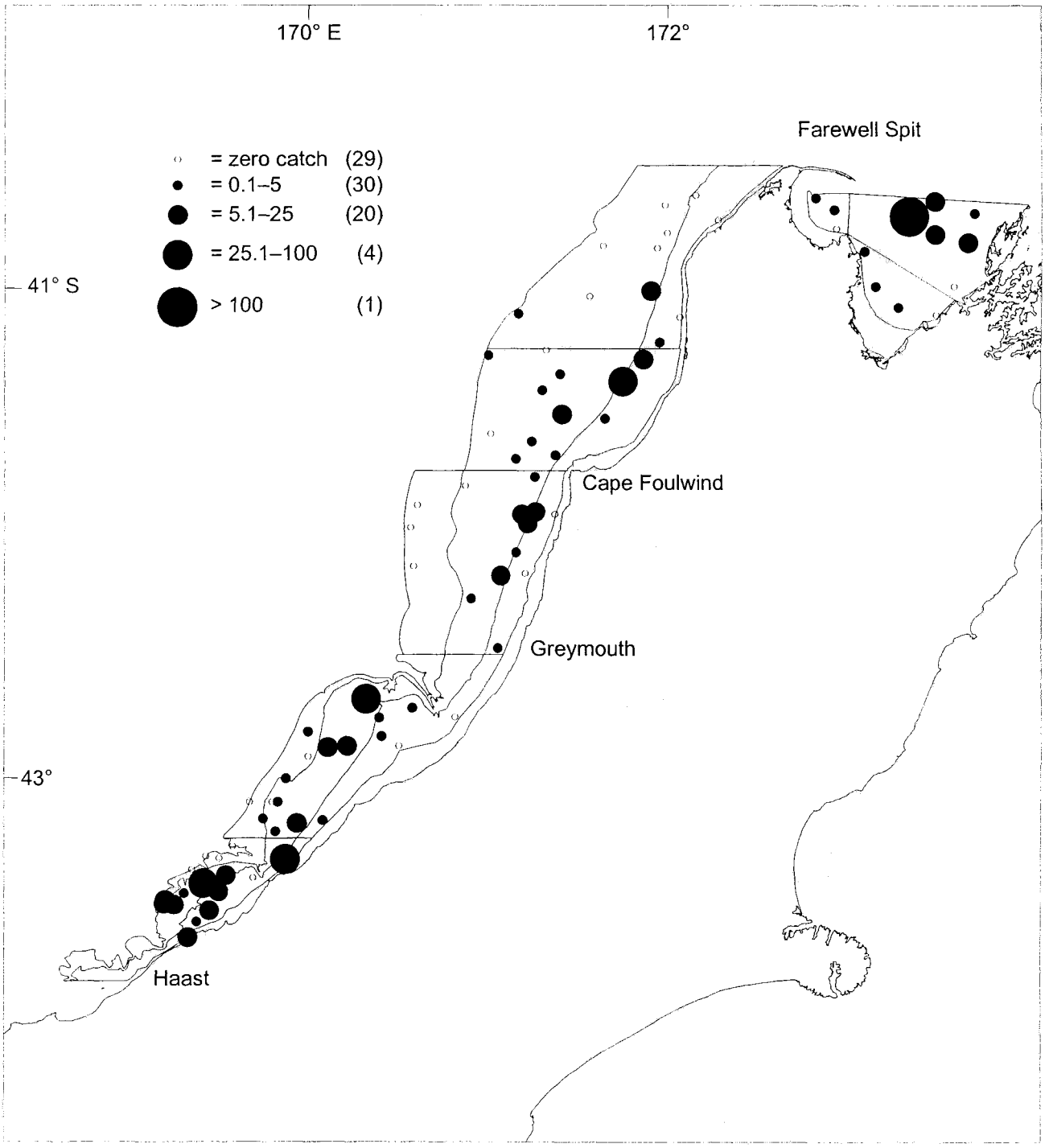

Figure 2h: **Jack mackerel (*Trachurus declivis*) (maximum catch rate 137 kg.km^{-2})**

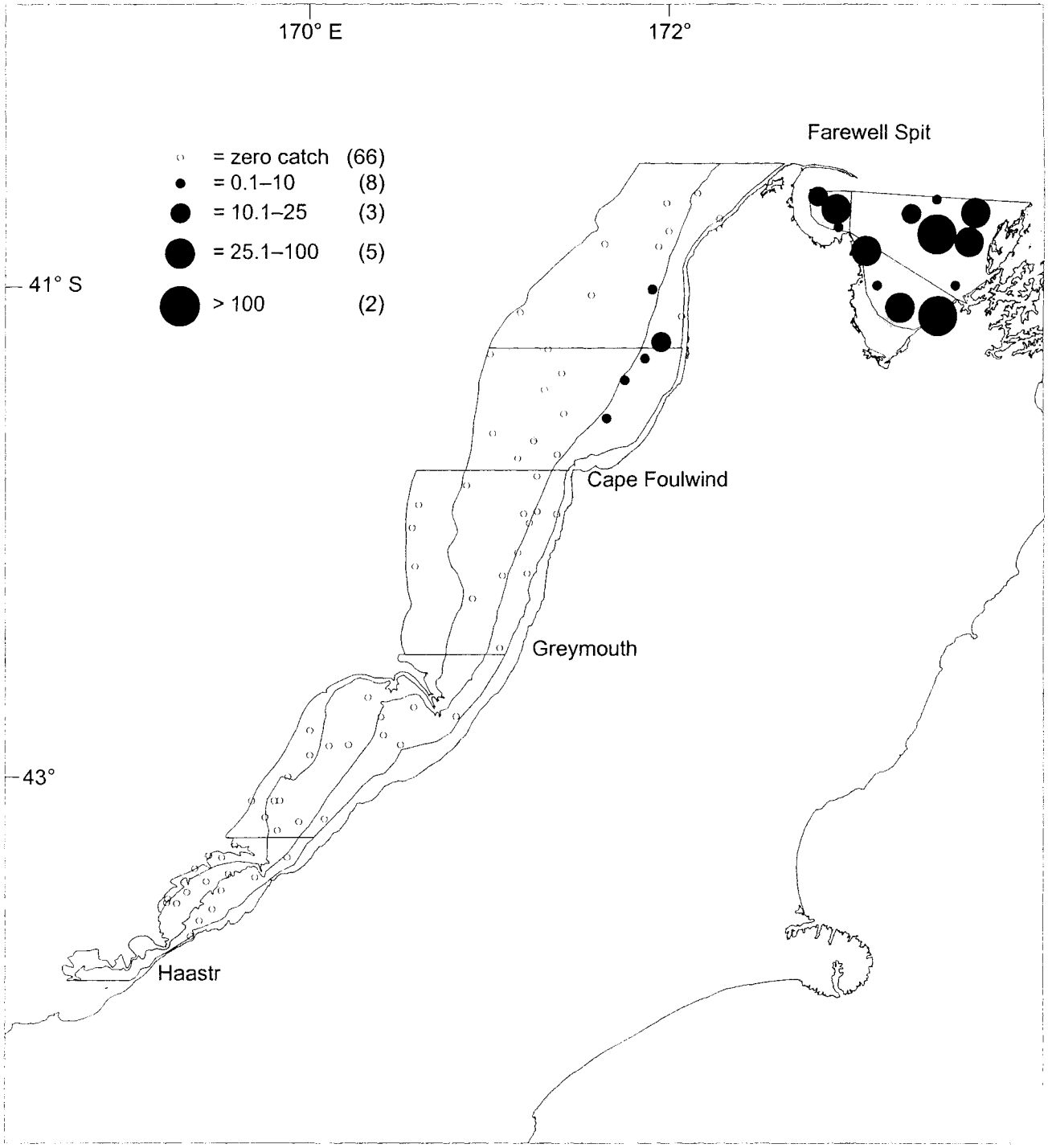

***Figure 2i*: Jack mackerel (*Trachurus novaezelandiae*) (maximum catch rate 209 kg.km^{-2})**

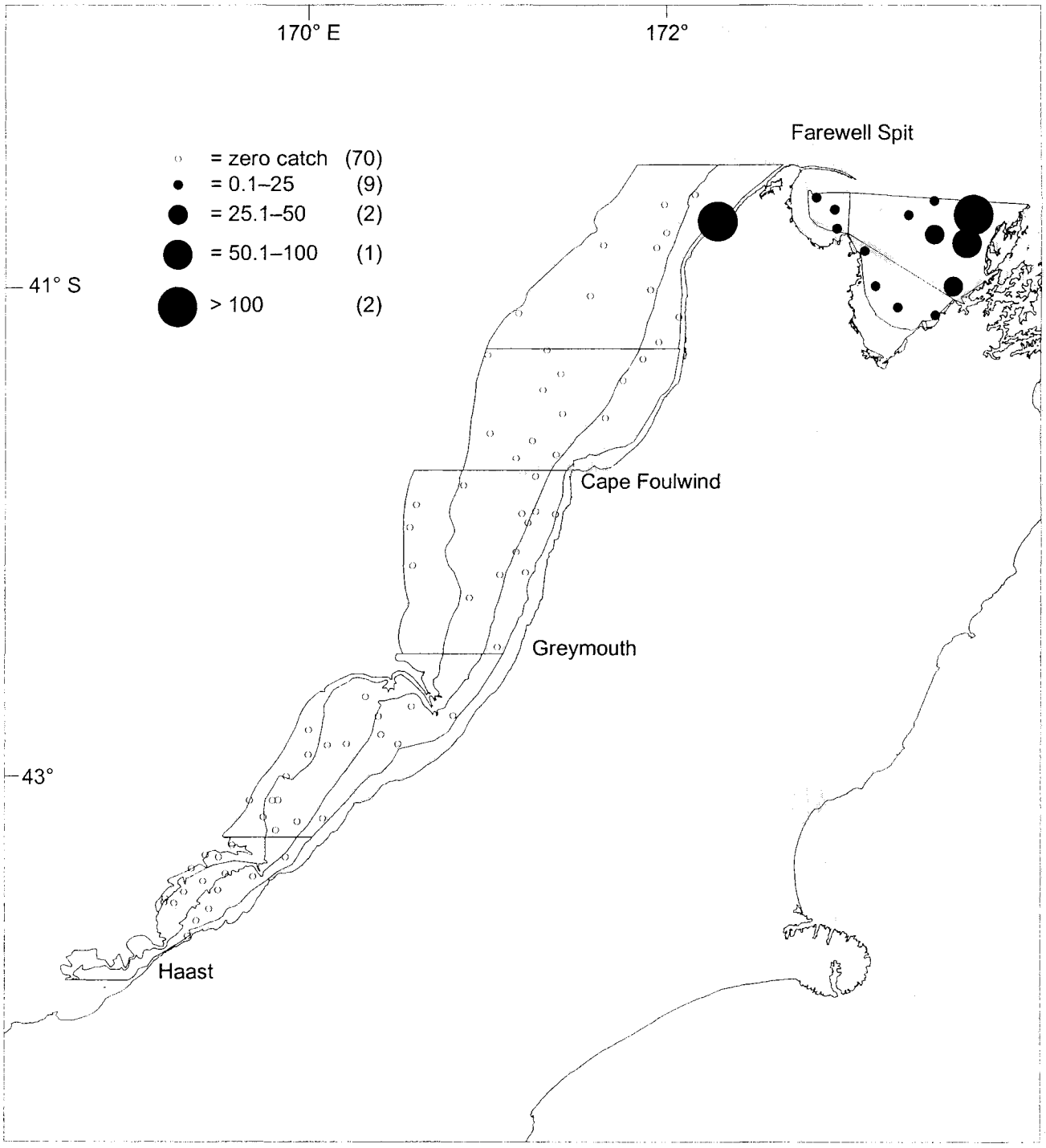

Figure 2j: **Leatherjacket (maximum catch rate 209 kg.km^{-2})**

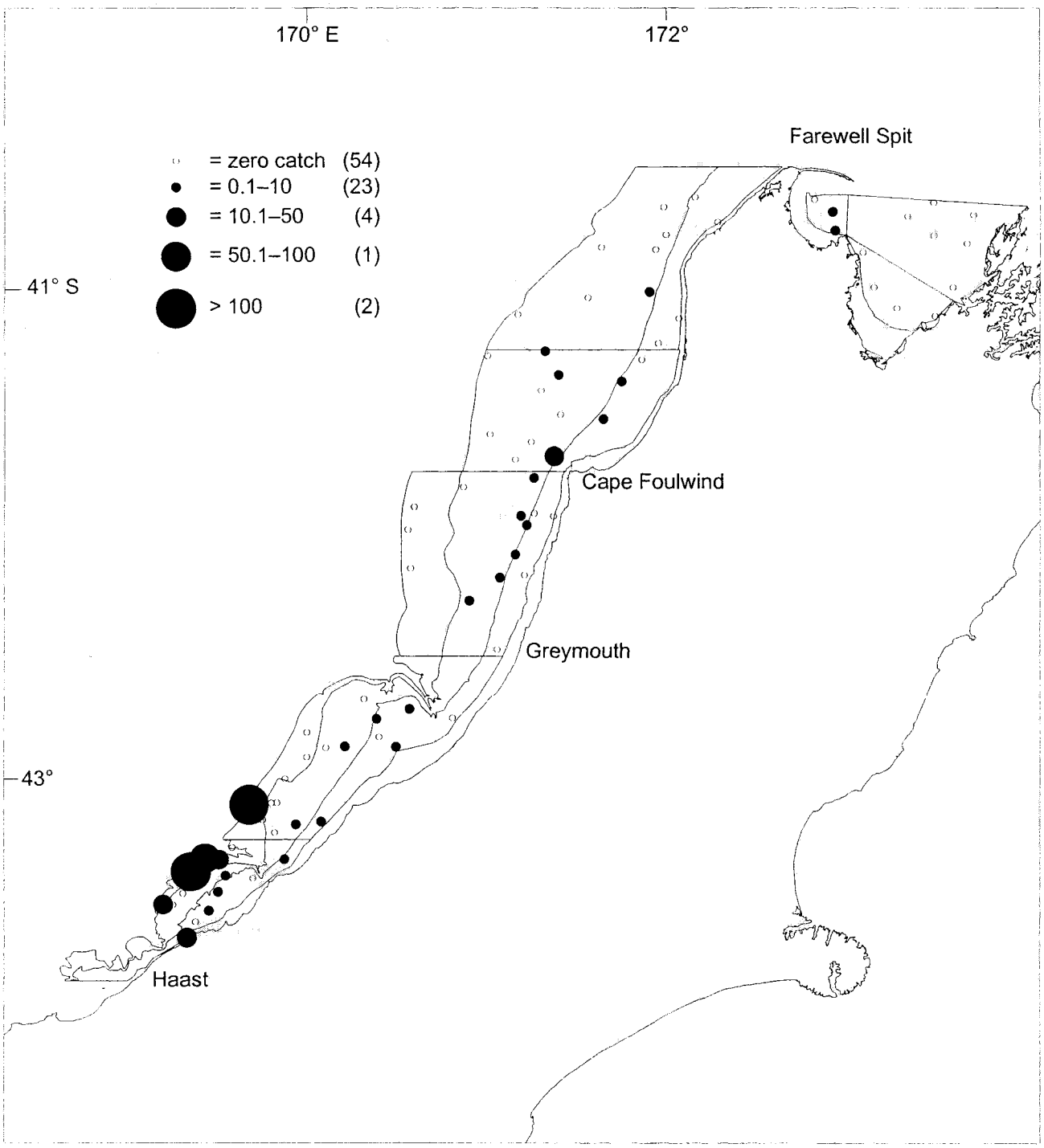

Figure 2k: **Ling (maximum catch rate 524 kg.km^{-2})**

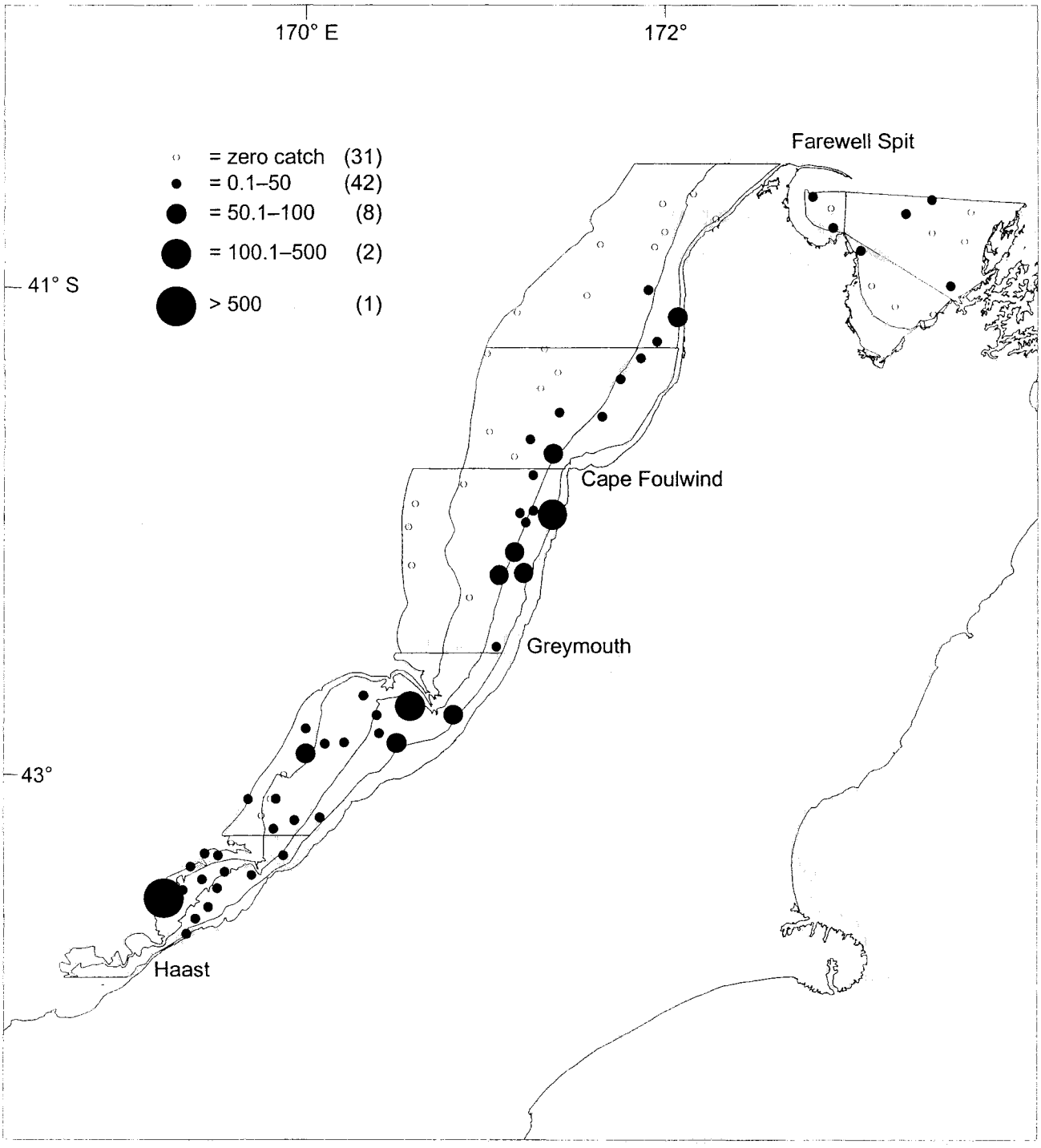

Figure 2l: **Red cod (maximum catch rate 1246 kg.km^{-2})**

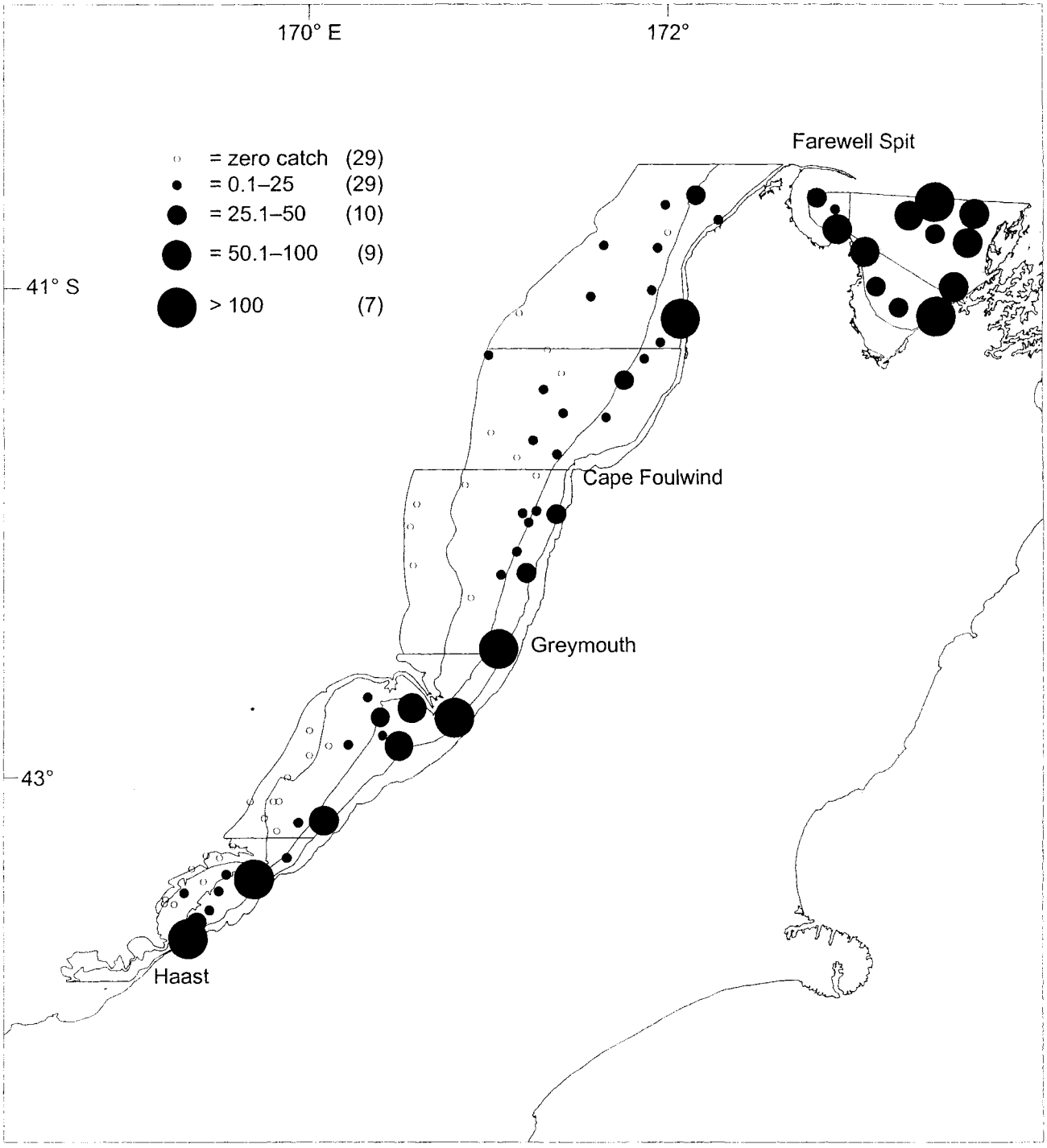

Figure 2m: **Red gurnard (maximum catch rate 217 kg.km^{-2})**

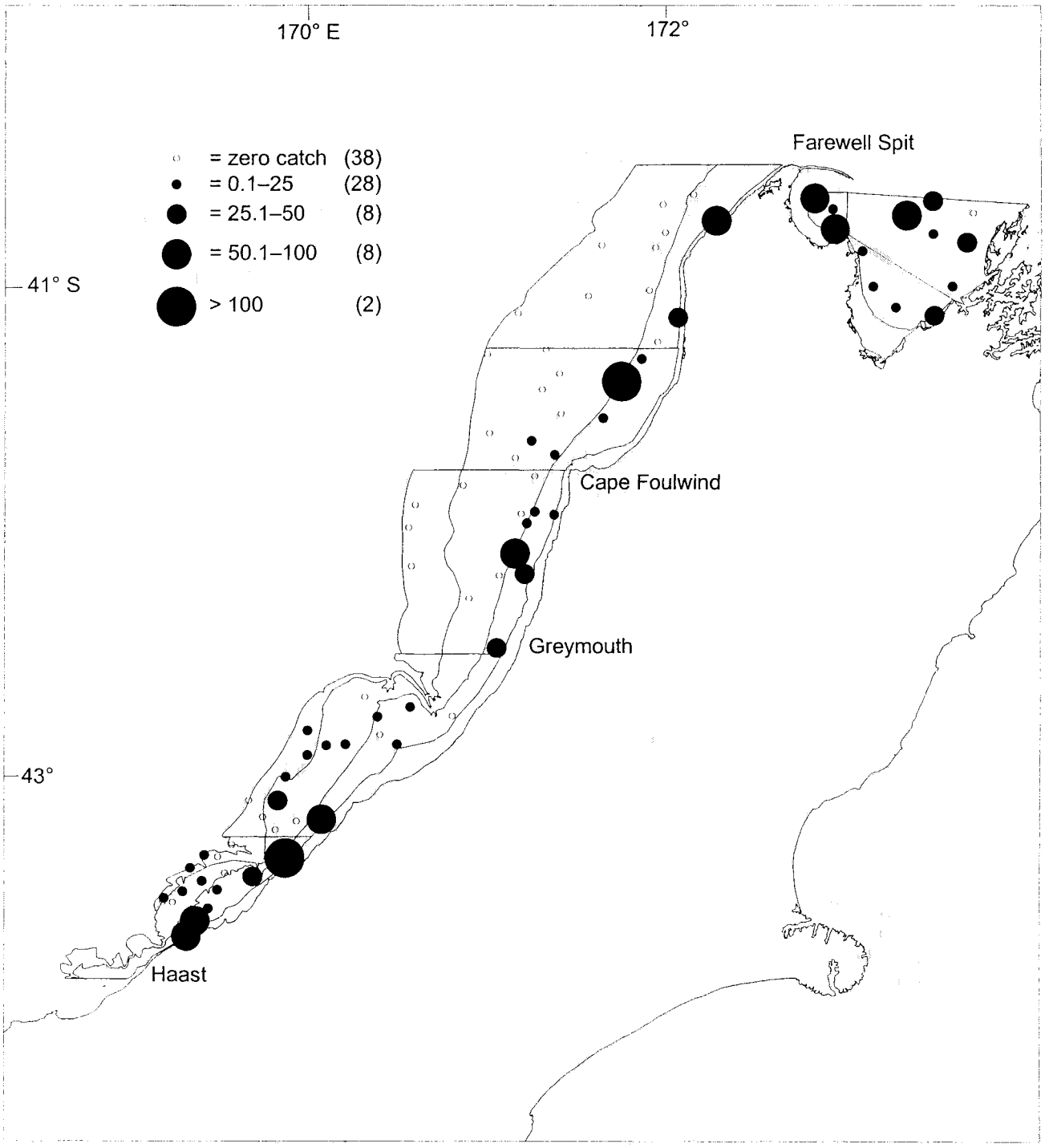

Figure 2n: **Rig (maximum catch rate 149 kg.km^{-2})**

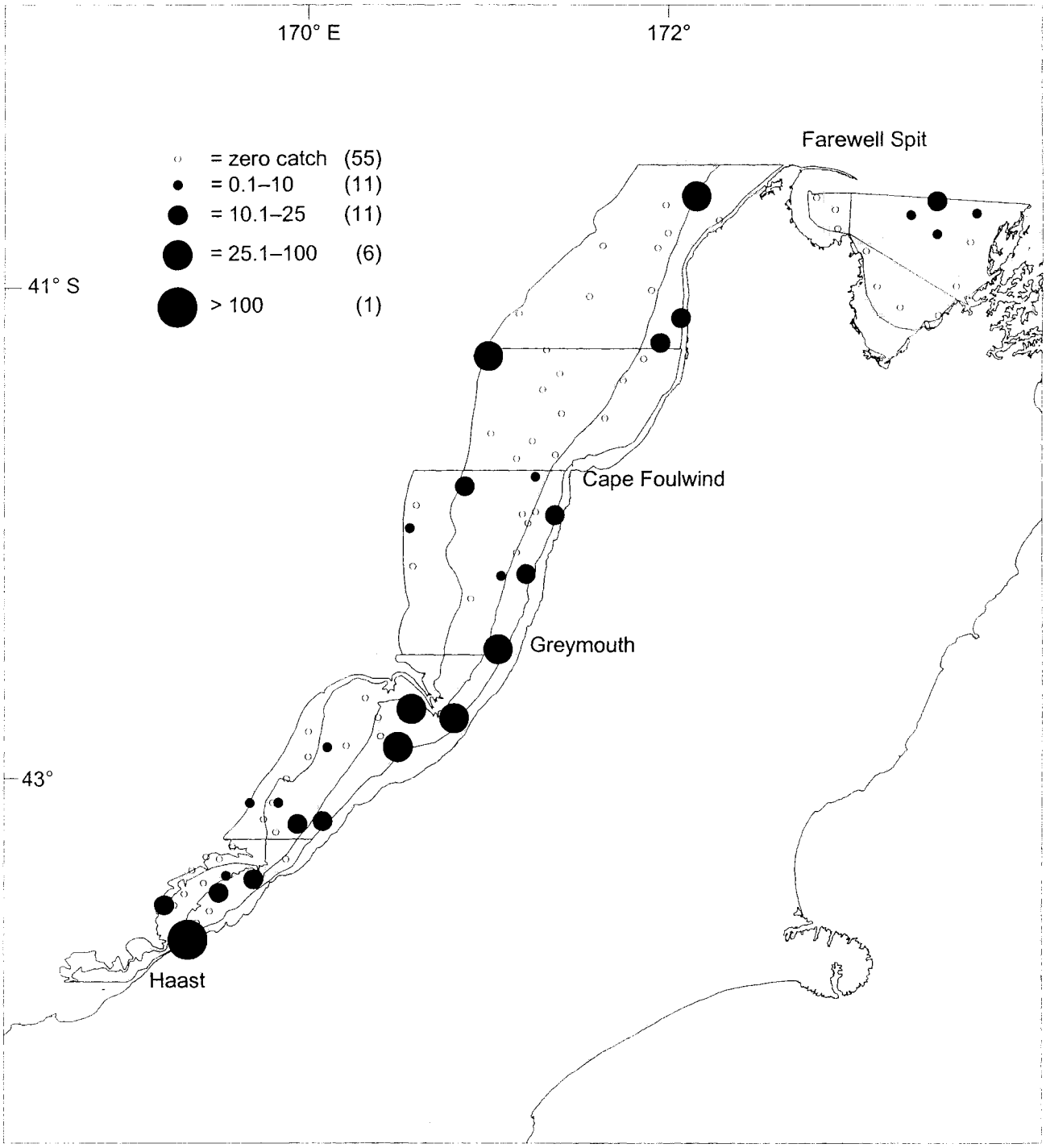

Figure 2o: **Rough skate (maximum catch rate 149 kg.km^{-2})**

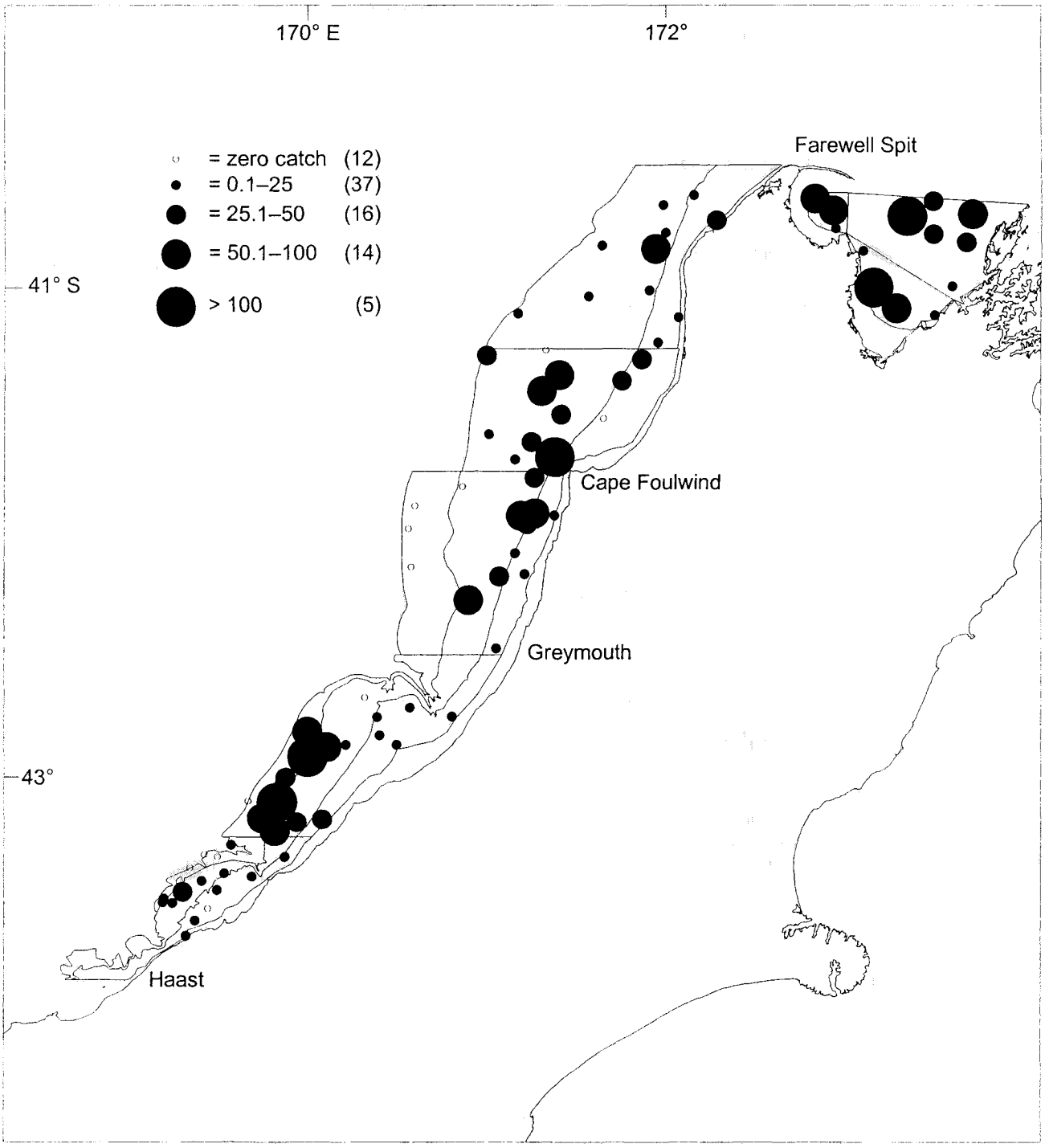

Figure 2p: **School shark (maximum catch rate 265 kg.km^{-2})**

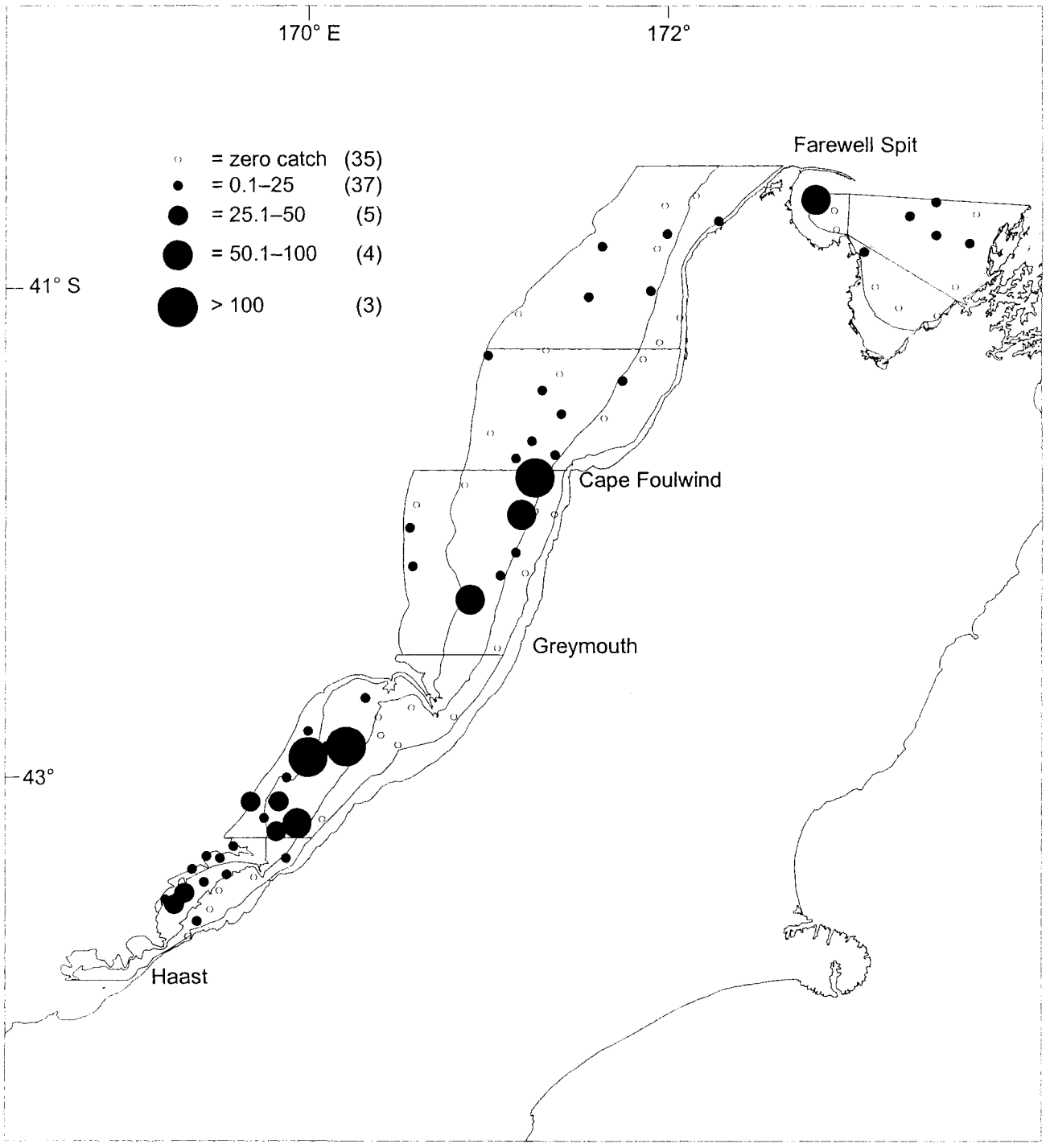

Figure 2q: **Sea perch (maximum catch rate 156 kg.km^{-2})**

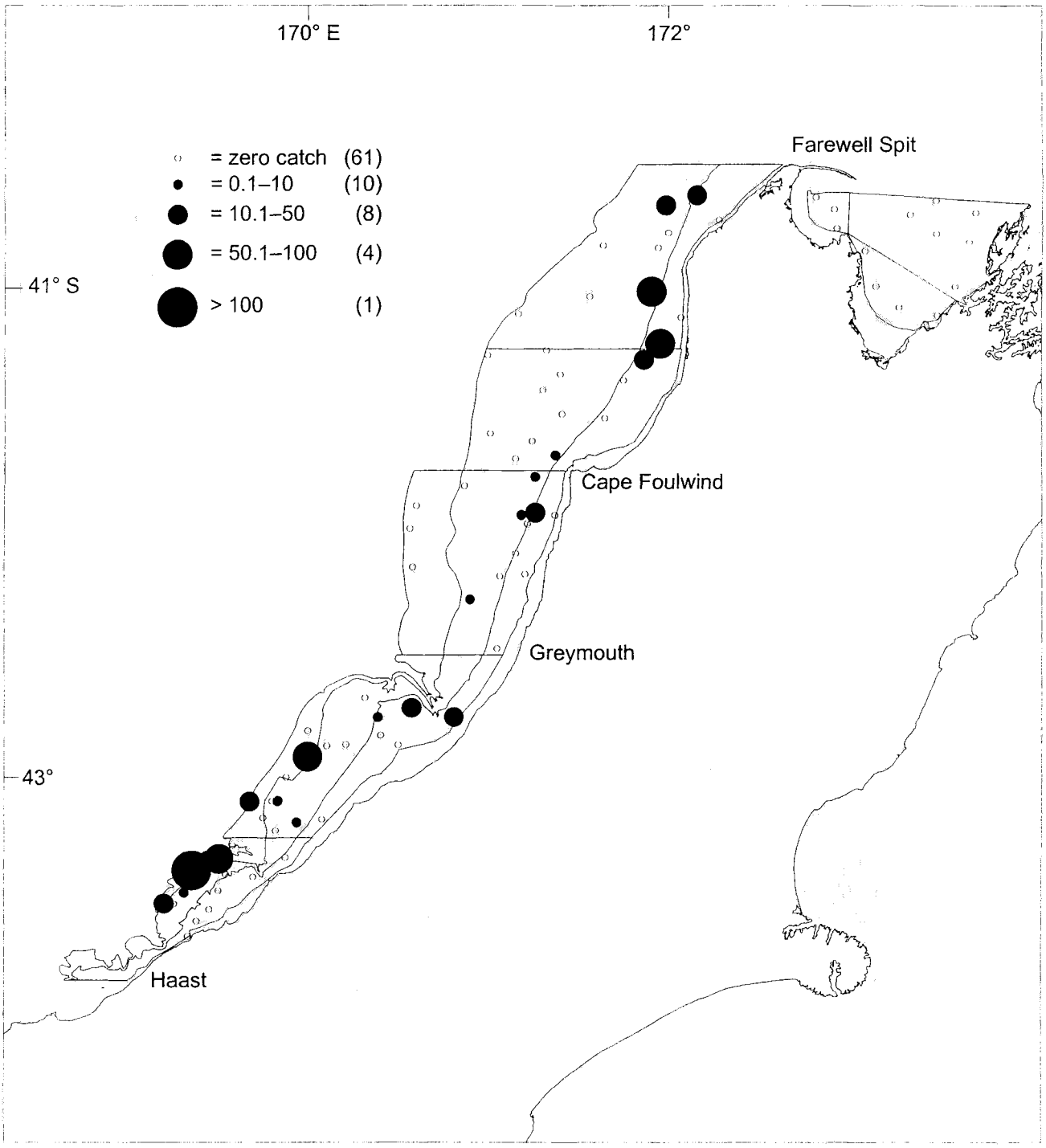

Figure 2r: **Smooth skate (maximum catch rate 223 kg.km^{-2})**

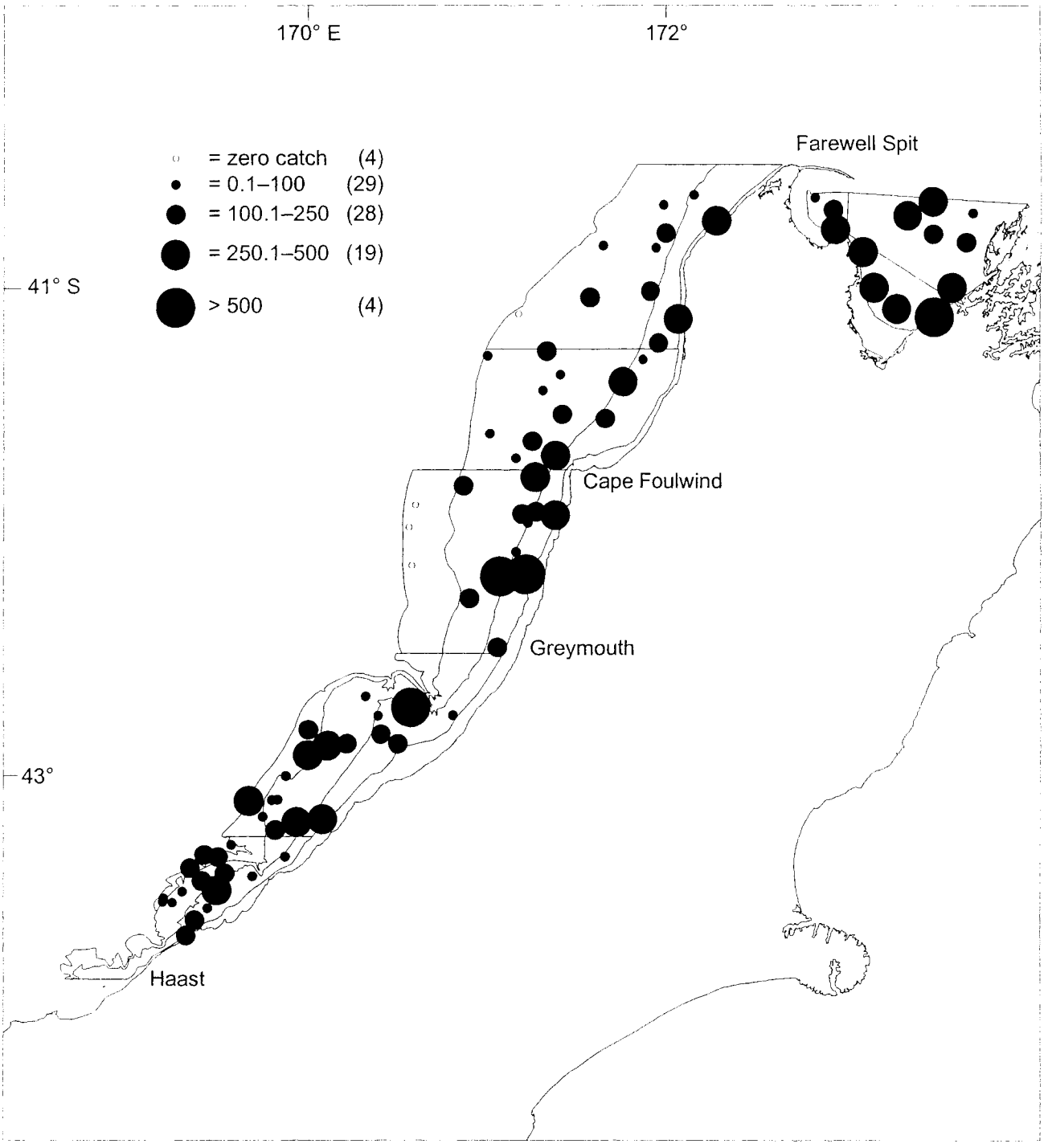

Figure 2s: **Spiny dogfish (maximum catch rate 1191 kg.km^{-2})**

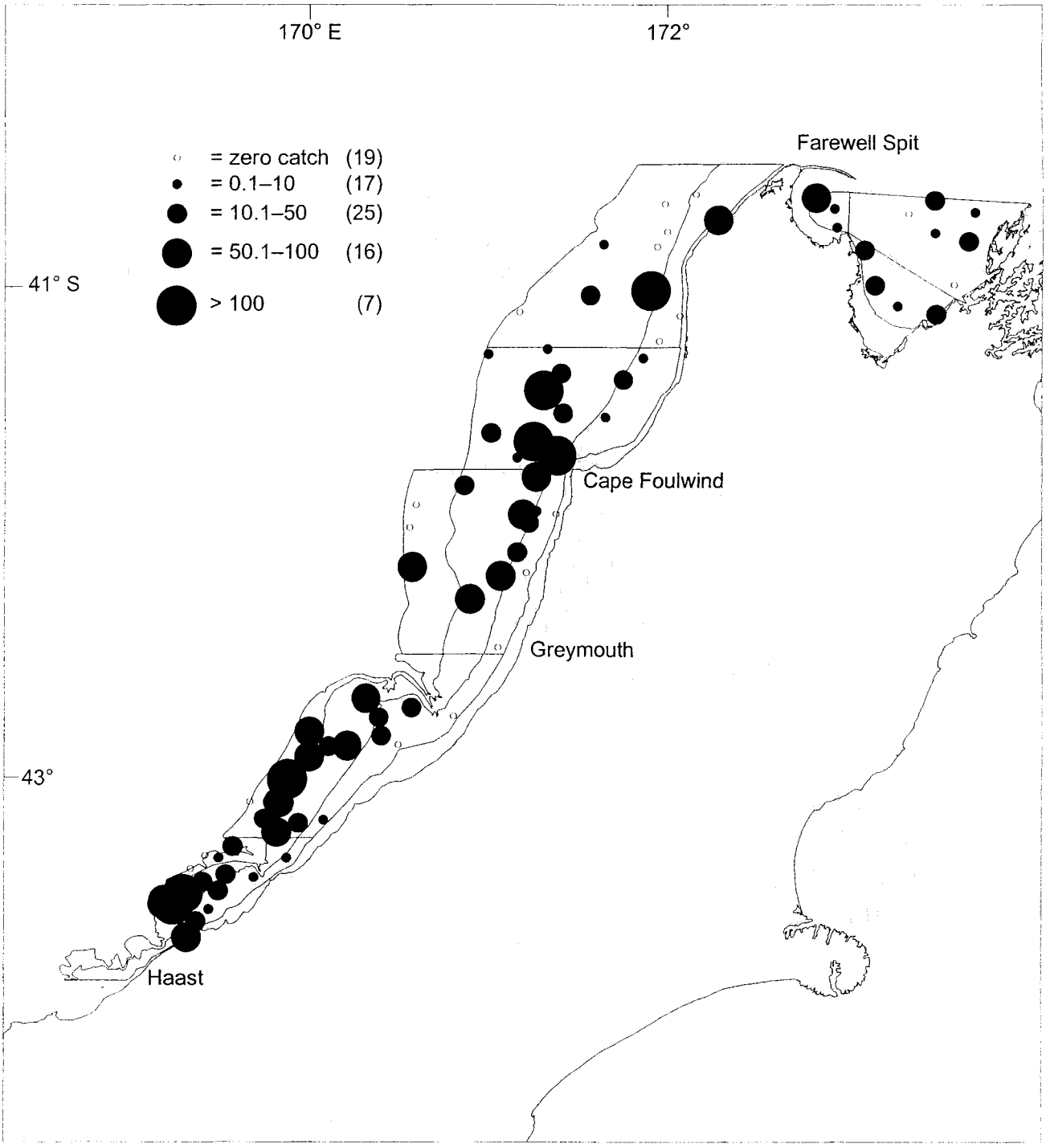

Figure 2t: **Tarakihi (maximum catch rate 293 kg.km^{-2})**

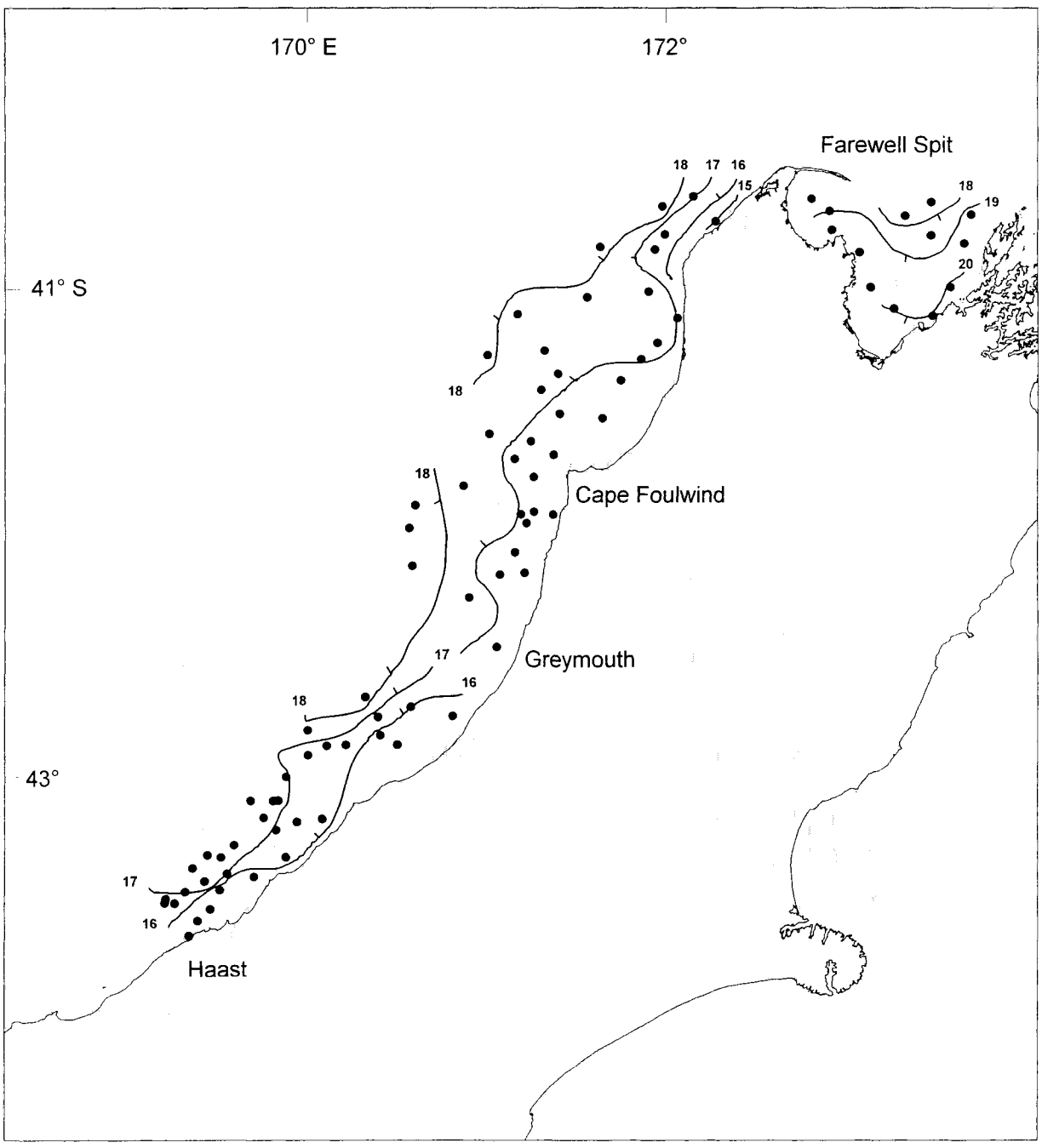

Figure 3: **Positions of sea surface temperature recordings and isotherms estimated from the temperature recordings.**

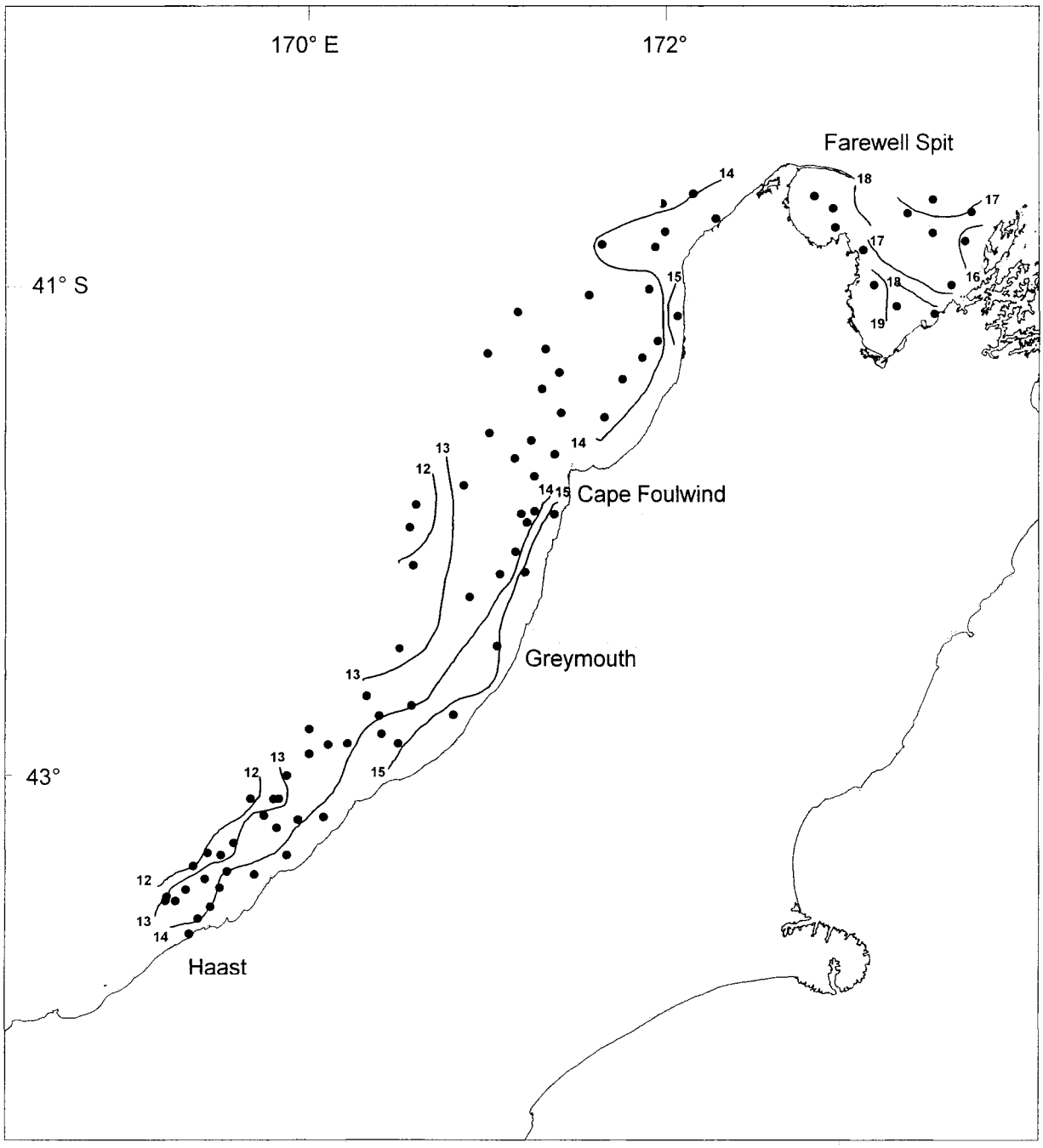

Figure 4: **Positions of bottom temperature recordings and isotherms estimated from the temperature recordings.**

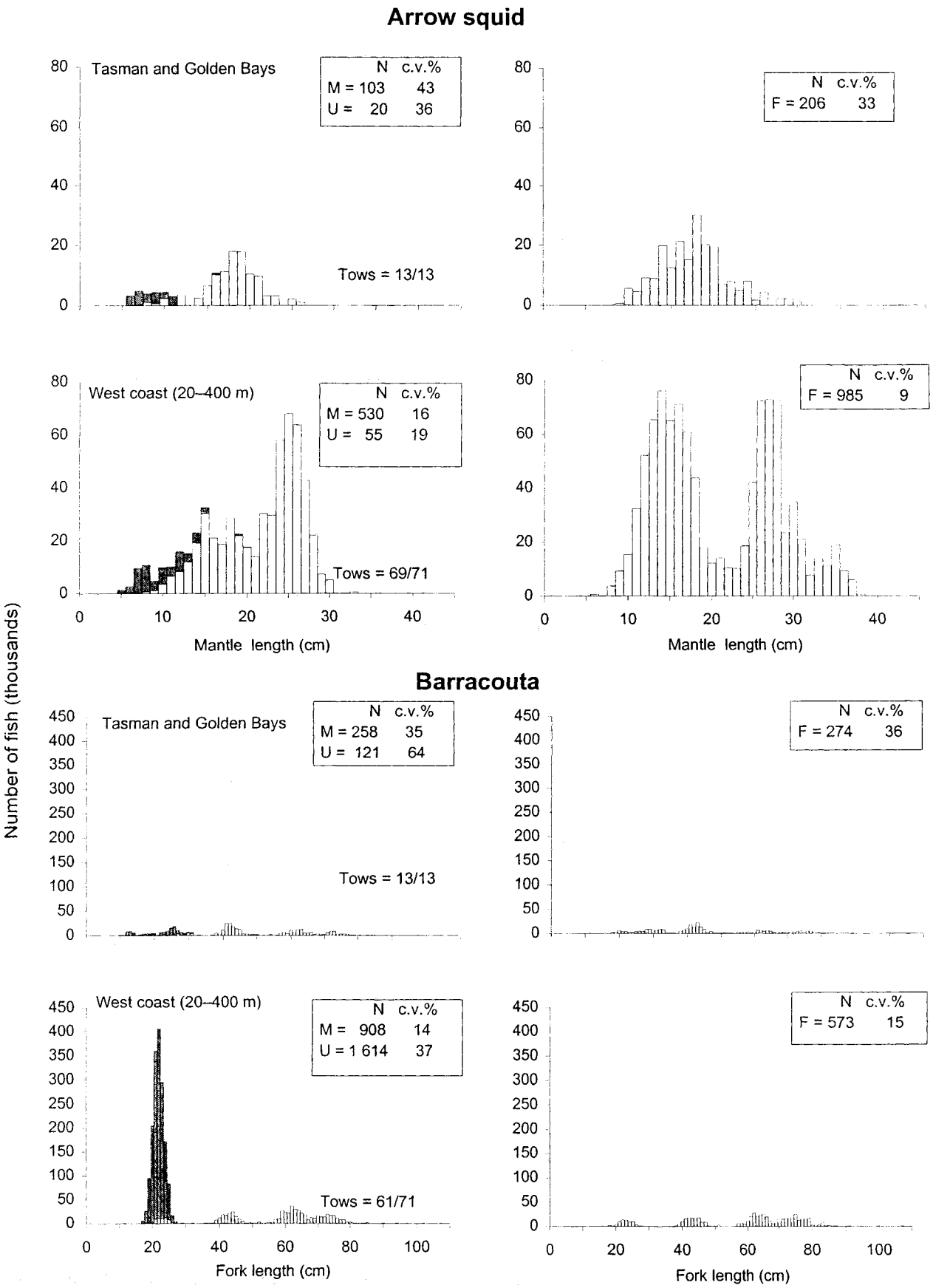

Figure 5: Length frequency distributions for the major commercial species (by depth where appropriate). N, estimated population (scaled, thousands); M, male; F, female; U, unsexed (shaded); Tows, number of stations where species was caught/total number of stations in area.

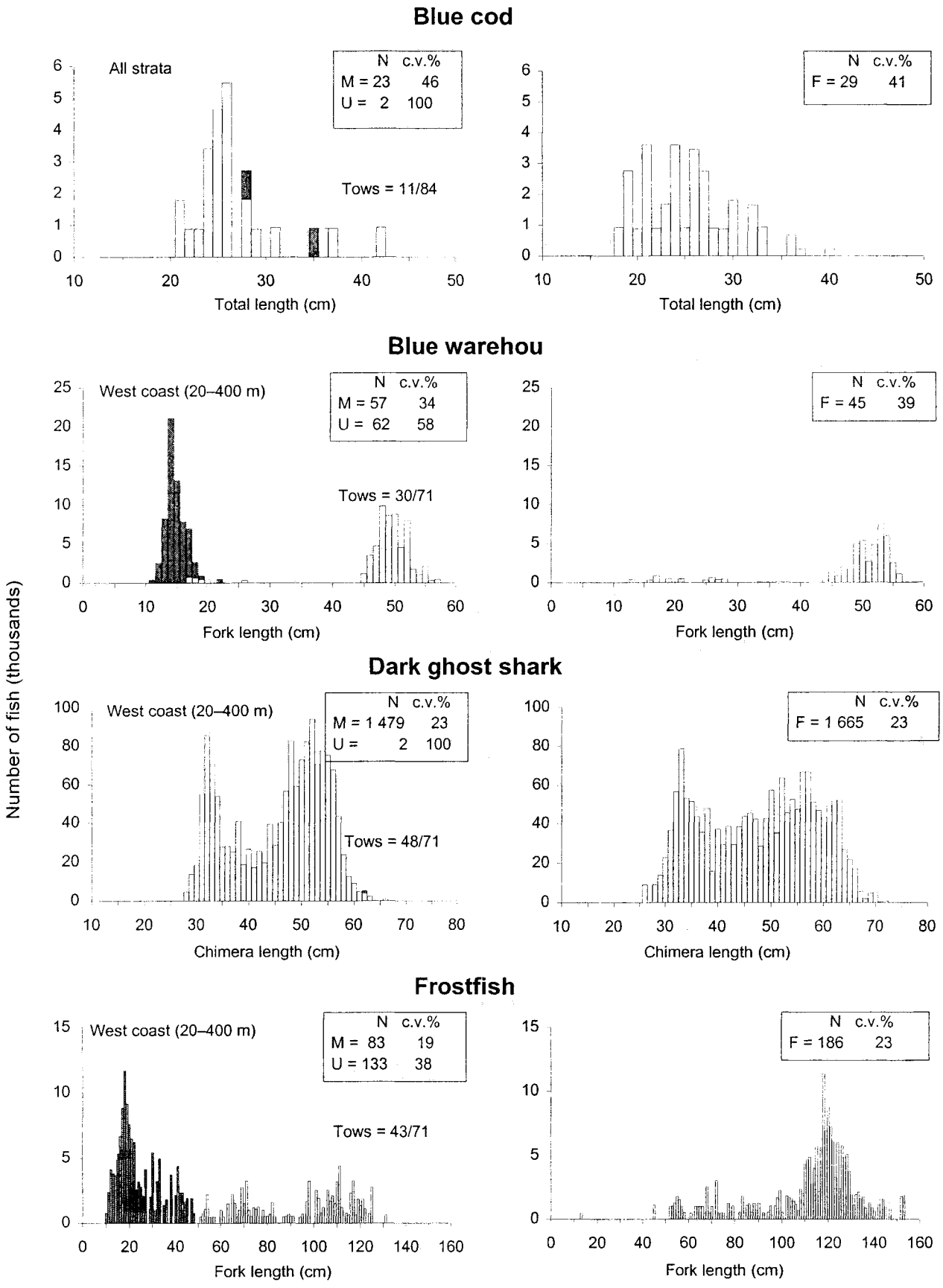

Figure 5—continued

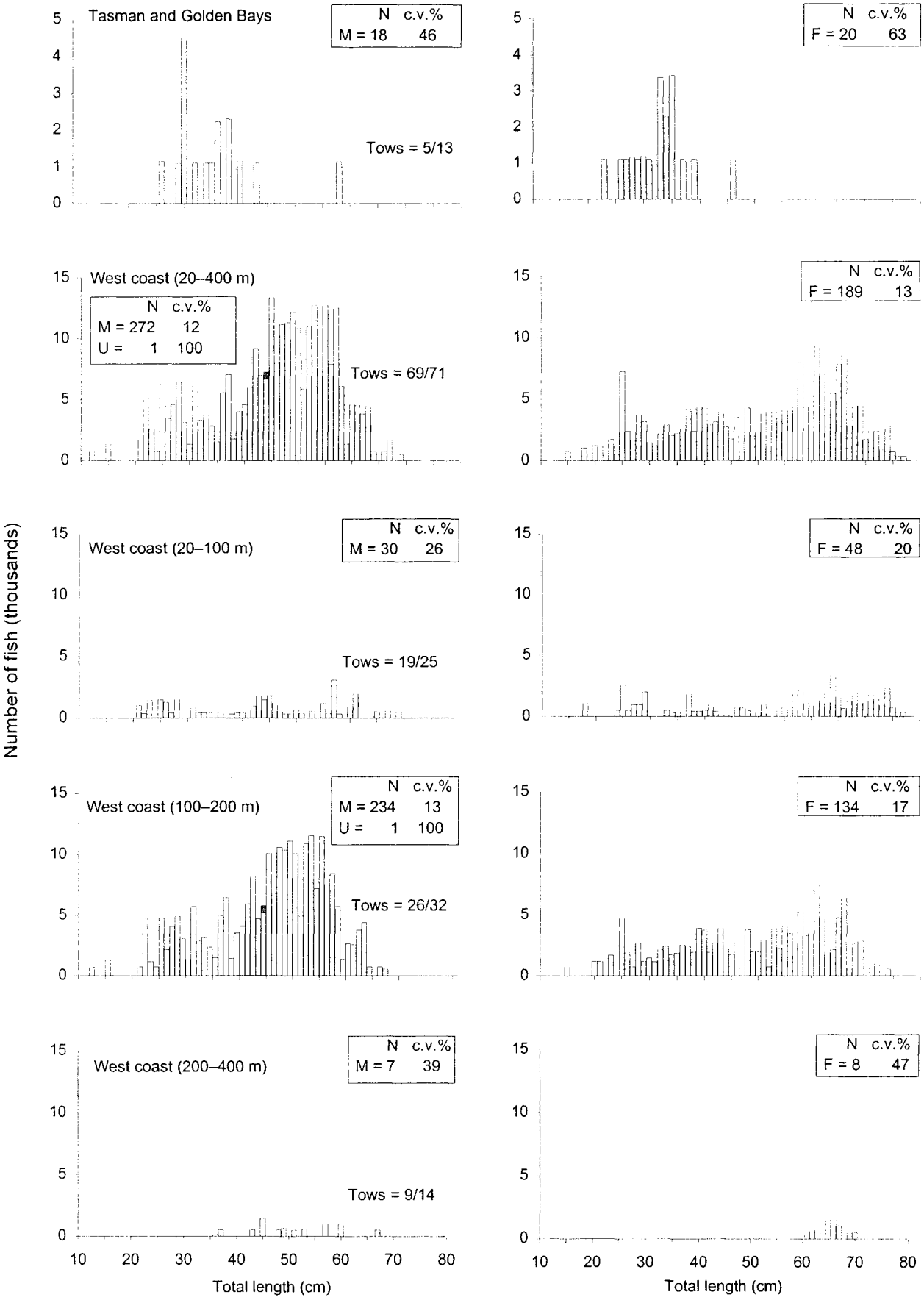

Figure 5–continued

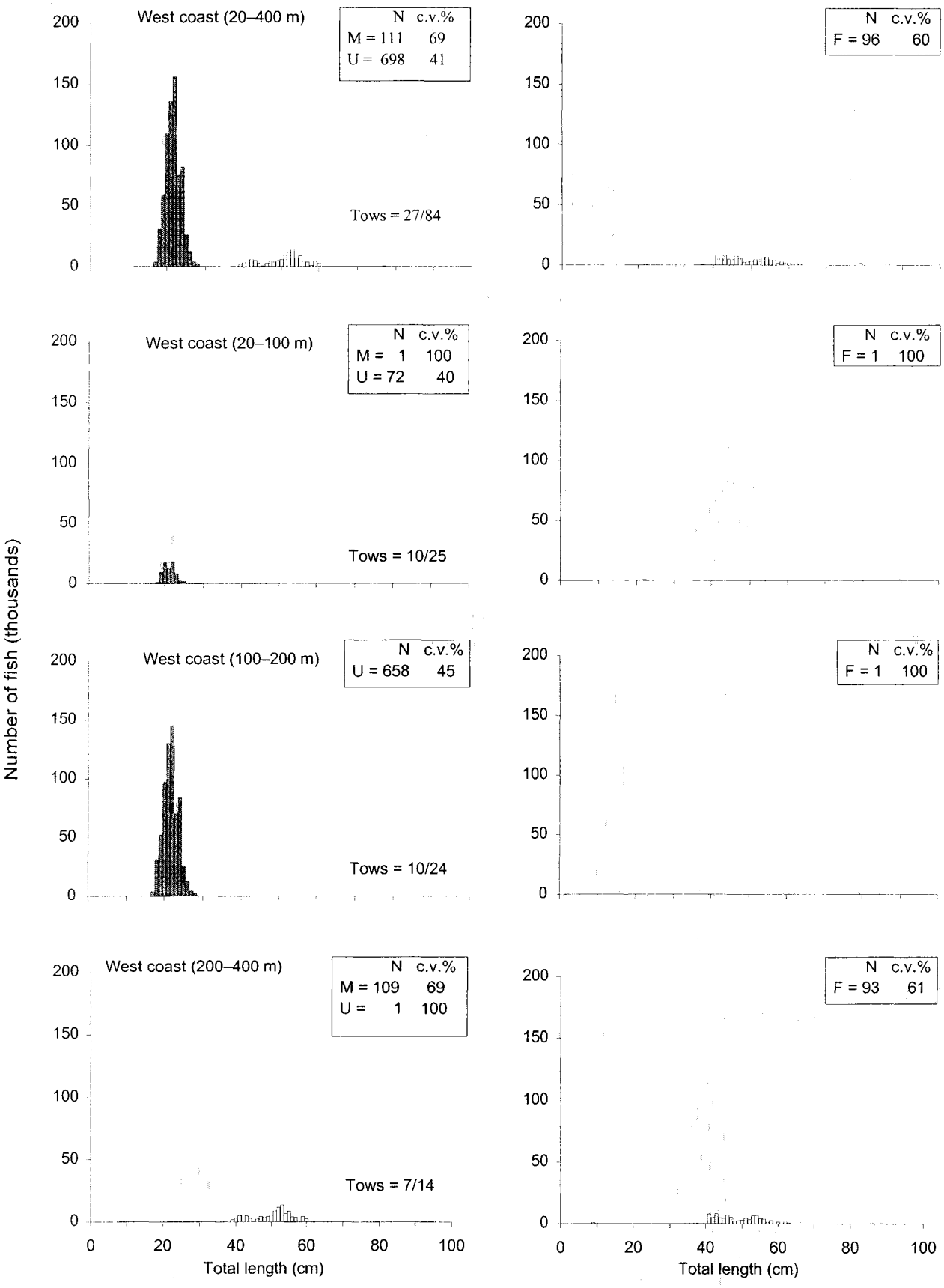

Figure 5—continued

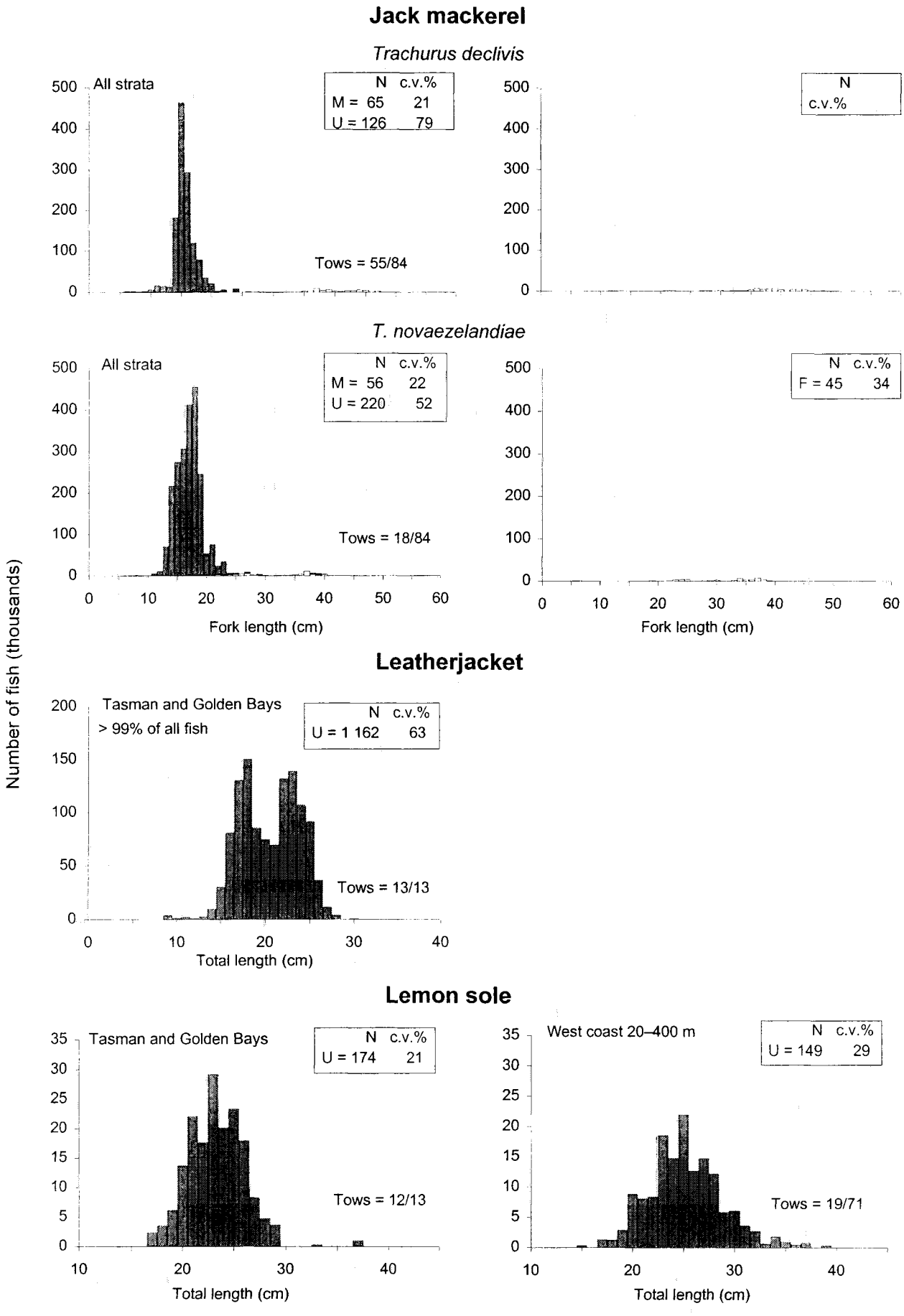

Figure 5—continued

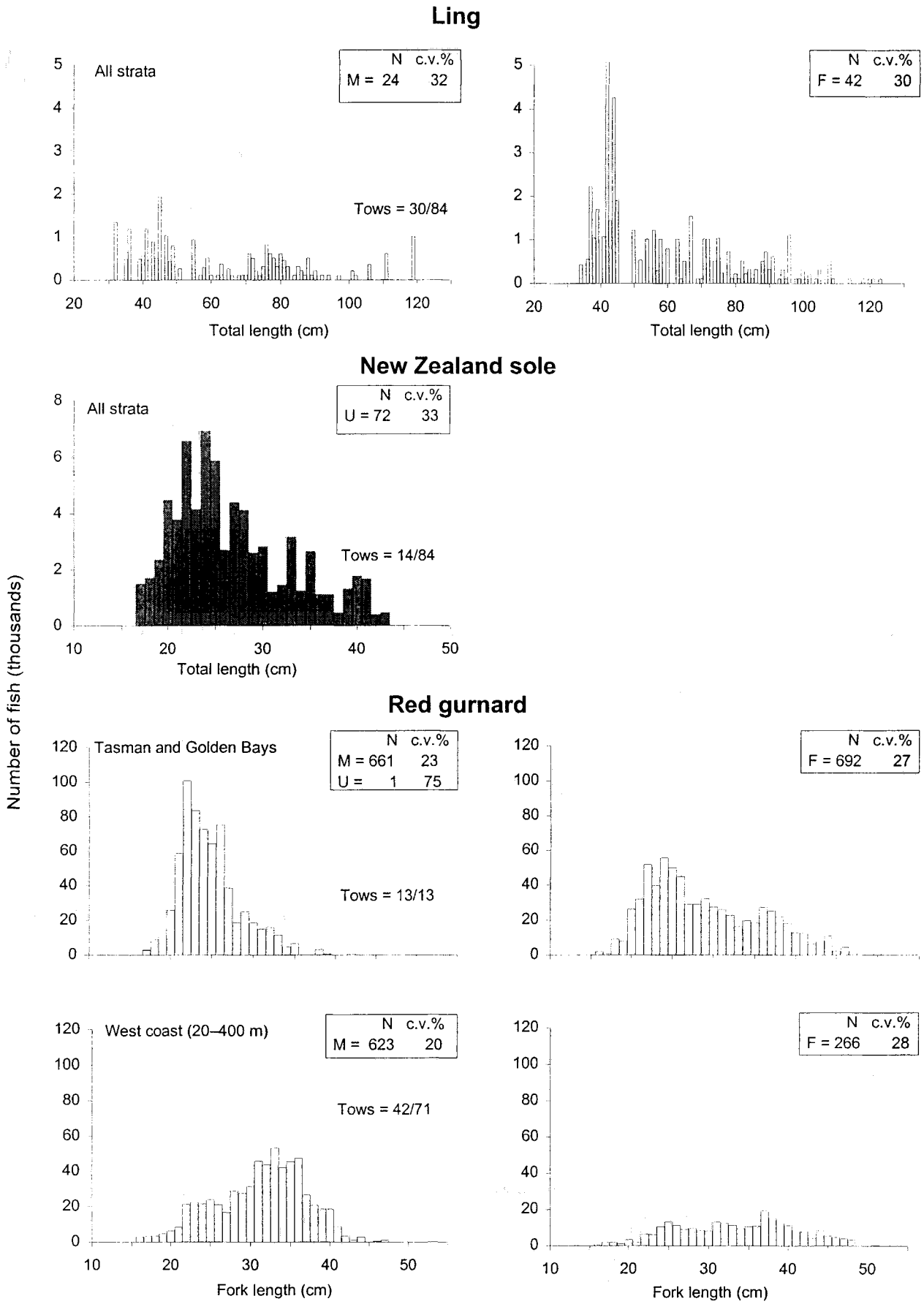

Figure 5—continued

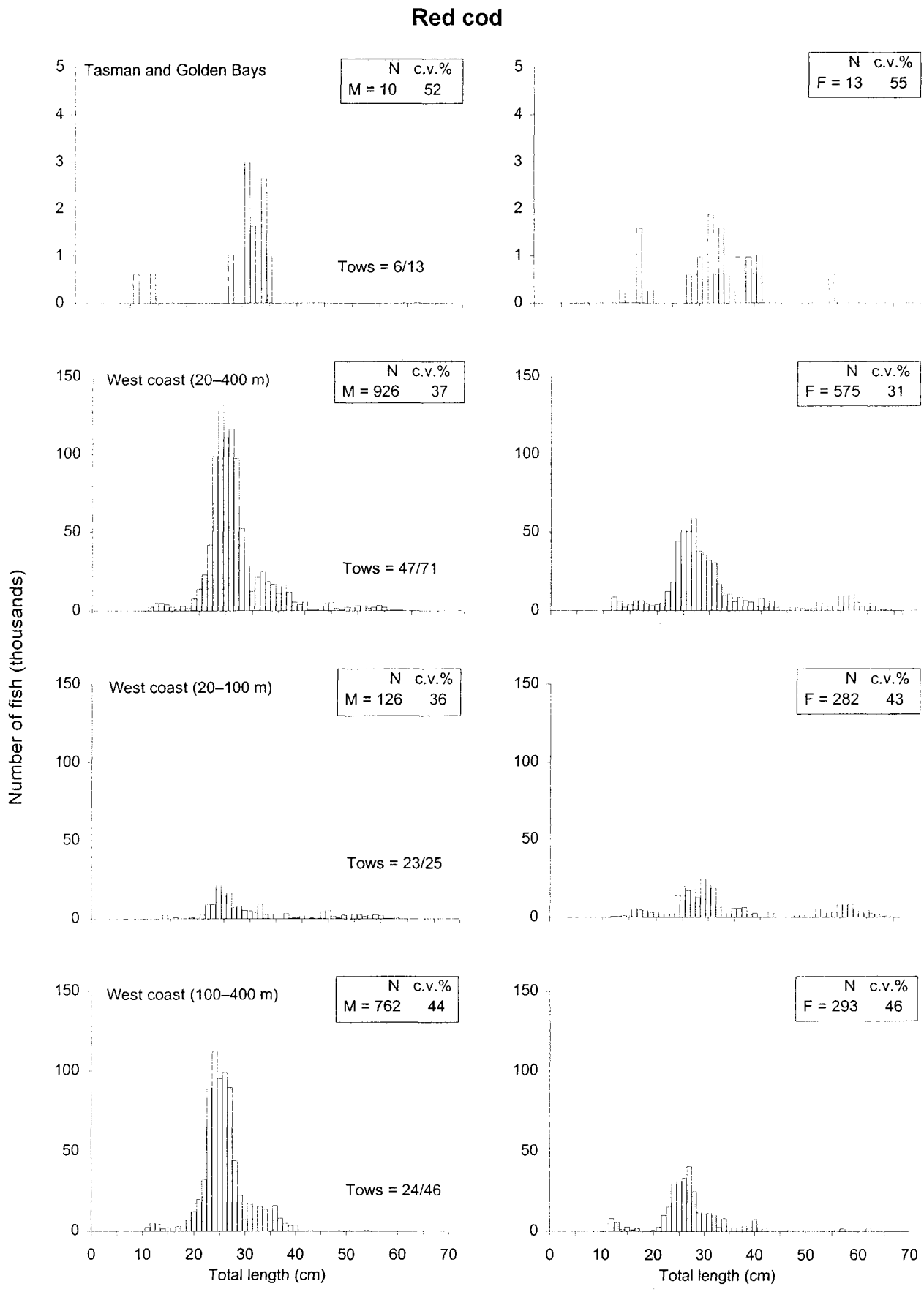

Figure 5—continued **(Note the y-axis values vary).**

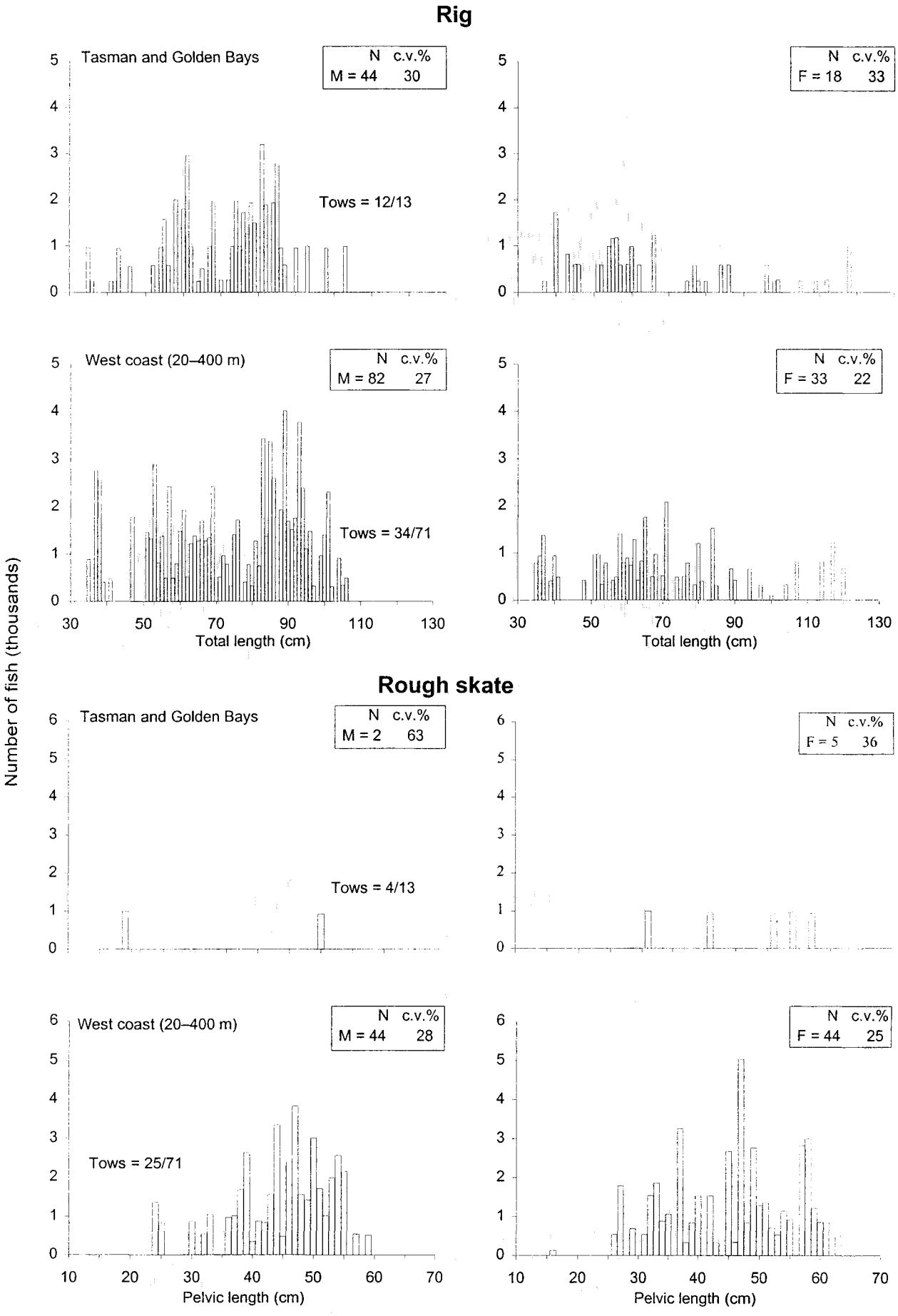

Figure 5—continued

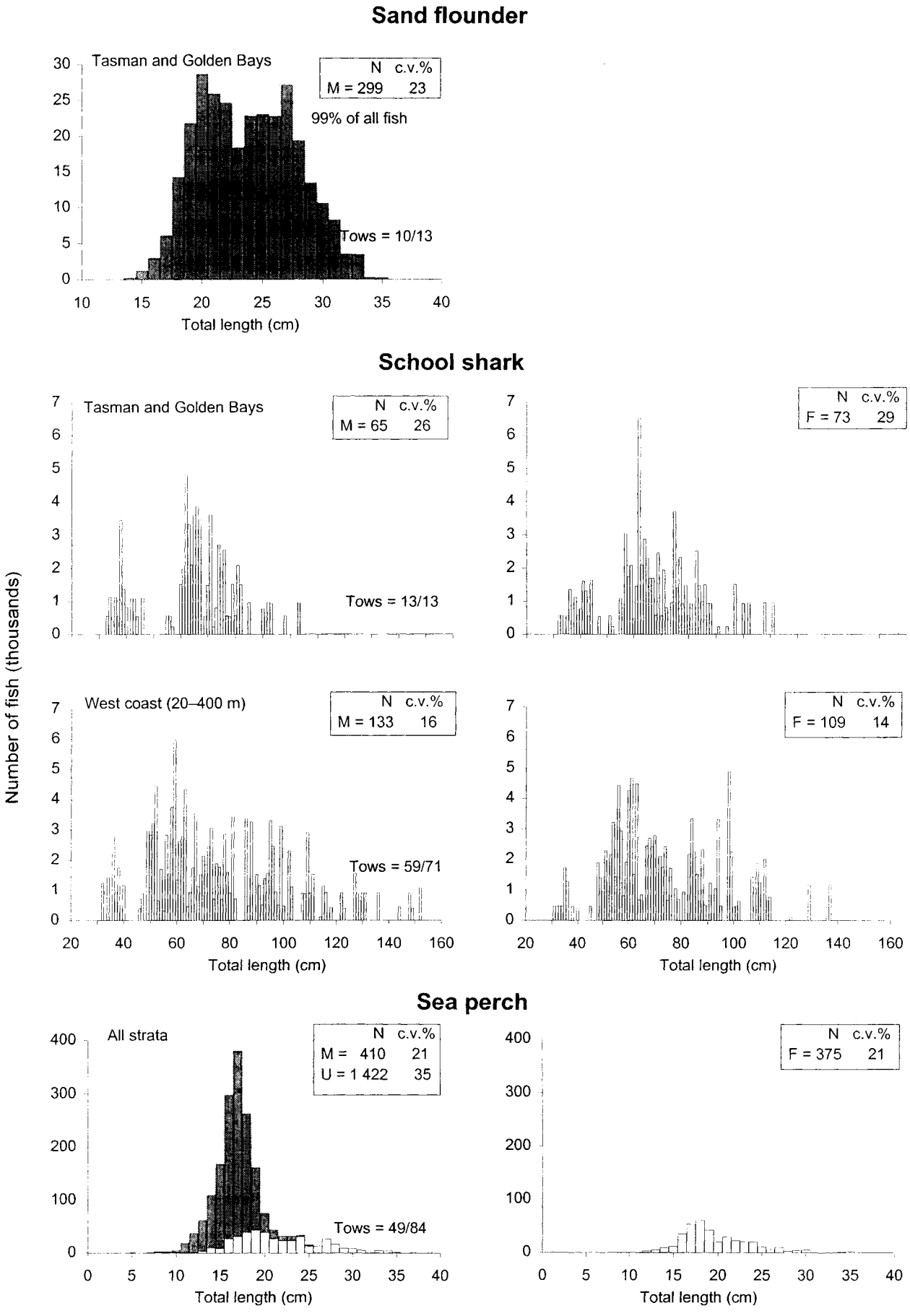

Figure 5—continued

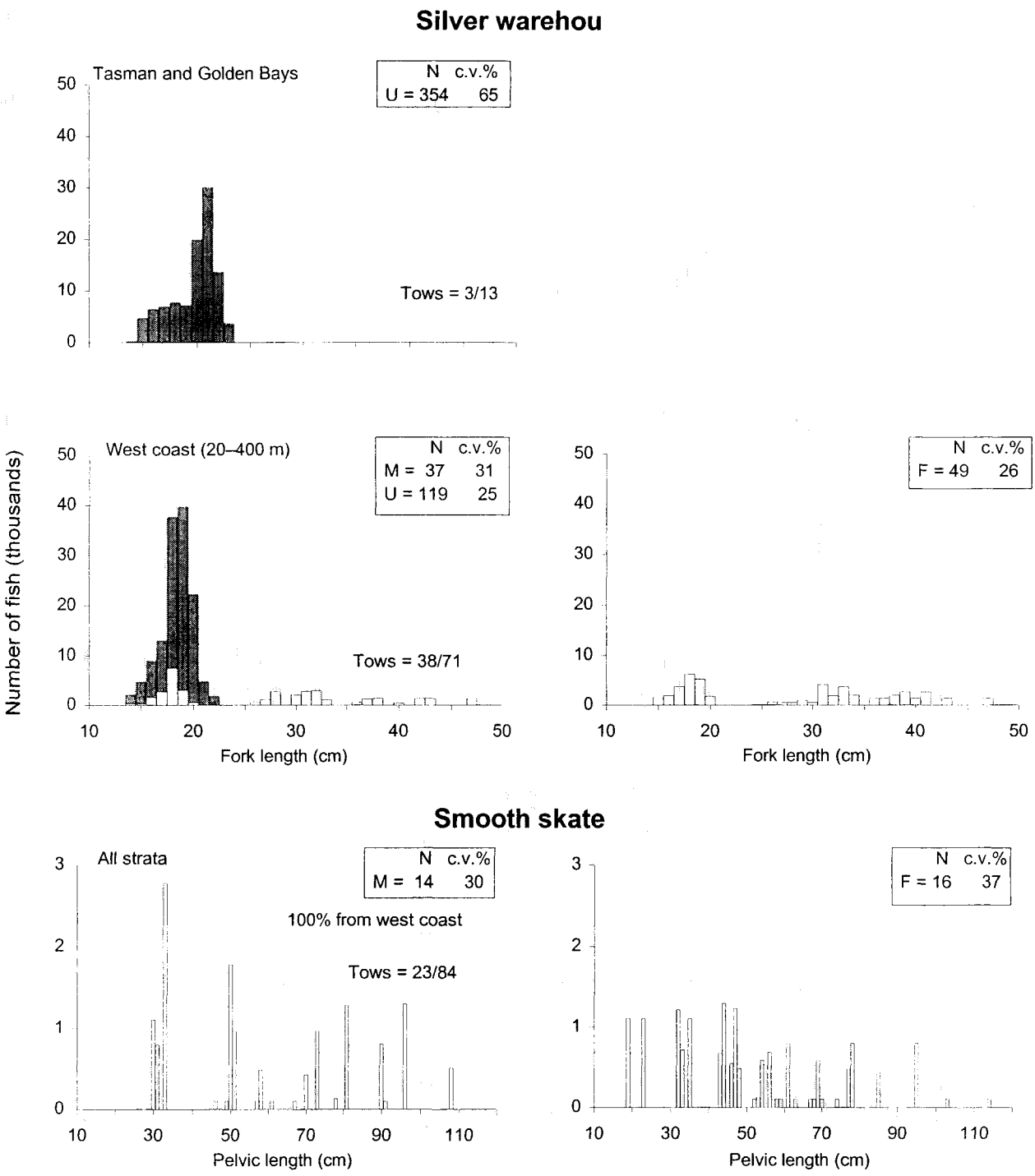

Figure 5—continued

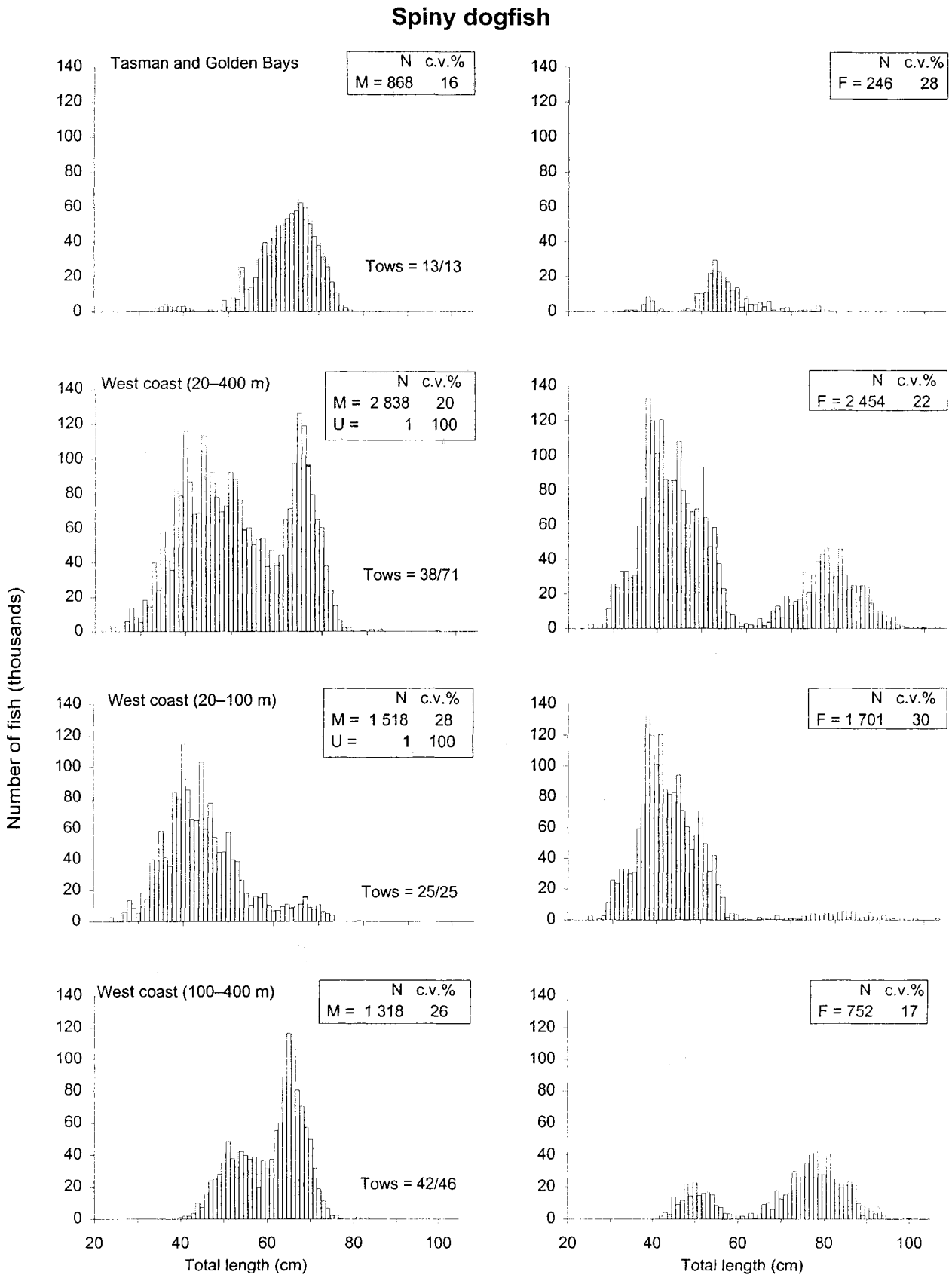

Figure 5—continued

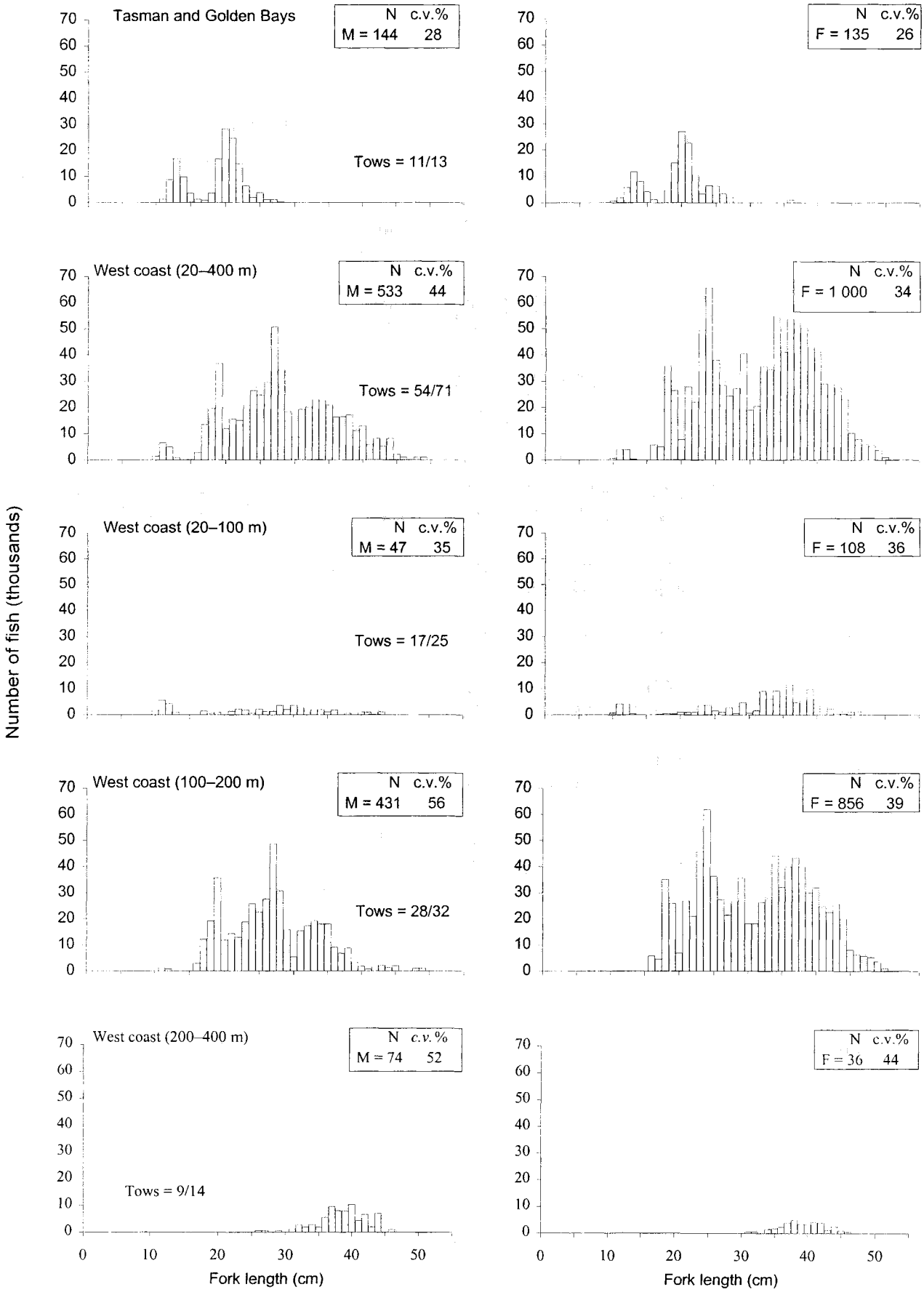

Figure 5—continued

Appendix 1: Length-weight relationship parameters used to scale length frequencies and calculate length class biomass estimates. (DB, Ministry of Fisheries trawl database; –, no data; n, sample size.)

Group A: $W = a L^b$ where W is weight (g) and L is length (cm);

Species	*a*	*b*	n	Range Min.	Range Max.	Data source
Barracouta	0.0052	2.9800	919	15	96	DB, TAN9301
Blue cod	0.0122	3.0700	2 137	12	47	DB, LHR9501
Blue warehou	0.0144	3.1050	338	27.4	69.6	DB, TAN9604
Dark ghost shark	0.0014	3.3733	296	26	71.2	DB, KAH9809
Elephantfish	0.0049	3.1654	378	13.4	91	DB, KAH9618
Frostfish	0.0004	3.1629	450	10.4	153	This survey
Gemfish	0.0017	3.3419	391	32	107	DB, KAH9304, KAH9602
Giant stargazer	0.0119	3.1100	662	13	78	This survey
Hake	0.0020	3.2900	420	37	123	DB, TAN9301
Hoki	0.0046	2.8840	525	22	110	DB, SHI8301
Jack mackerel						
(*Trachurus declivis*)	0.0165	2.9300	200	15	53	DB, COR9001
(*T. novaezelandiae*)	0.0163	2.9230	200	15	40	DB, COR9001
John dory	0.0028	3.4822	324	16.7	54.2	KAH9915
Leatherjacket	0.0088	3.2110	—	—	—	DB, IKA8003
Lemon sole	0.0080	3.1278	524	14.6	41.2	DB, KAH9809
Ling	0.0013	3.2801	179	32.2	123.7	This survey
Red cod	0.0112	2.9379	757	11.4	64.1	This survey
Red gurnard	0.0061	3.1408	1 044	16.3	51.3	This survey
Rig	0.0033	3.0500	134	17	135	DB, KAH9701
Rough skate	0.0517	2.7556	153	16.7	63.2	This survey
Sand flounder	0.0207	2.8768	282	13.5	44.5	DB, KAH9809
School shark	0.0042	3.0300	523	32	154	DB, KAH9701
Sea perch	0.0262	2.9210	210	7	42	DB, KAH9618
Silver warehou	0.0048	3.3800	262	16.6	57.8	DB, TAN502
Smooth skate	0.0192	2.9889	59	19.3	114	This survey
Spiny dogfish	0.0038	3.0108	441	26.6	93.1	DB, KAH9917
Tarakihi	0.0129	3.0854	1 219	10.2	50.2	This survey

Group B: $W = a L^b L^{c(\ln L)}$

	a	*b*	*c*	n	Range (cm)	Data source
Arrow squid	0.2777	1.4130	0.2605	2 792	3–45	DB, *James Cook*, east coast South Island, 1982–83

Appendix 2: Summary of station data

Station	Stratum	Start of tow				End of tow		Gear depth (m)		Distance trawled	Headline	Doorspread	Surface temp	Bottom temp
		Date	Time	° ' S	° ' E	° ' S	° ' E	Min.	Max.	(n. miles)	height (m)	(m)	(°C)	(°C)
1	18	18-Mar-00	0946	41 06.76	173 29.24	41 04.21	173 31.21	30	35	2.96	5.4	72.9	20	17.9
2	19	18-Mar-00	1132	40 59.73	173 35.15	40 57.46	173 37.59	45	47	2.92	5.5	76	20	16.6
3	19	18-Mar-00	1335	40 48.94	173 39.77	40 46.55	173 42.05	59	66	2.95	5.5	73.6	19.1	15.6
4	19	18-Mar-00	1520	40 41.85	173 41.96	40 39.35	173 44.20	59	64	3.03	4.6	73.3	19.1	17.1
5	17	19-Mar-00	0605	40 45.61	172 56.17	40 44.52	172 52.58	26	26	2.93	5.6	69.8	19	18.4
6	17	19-Mar-00	0808	40 38.01	172 49.34	40 38.55	172 53.22	30	33	3	5.3	74.5	18.7	18.5
7	17	19-Mar-00	0946	40 40.93	172 55.46	40 42.08	172 59.01	35	37	2.94	5.5	77.5	19.1	18.2
8	18	19-Mar-00	1203	40 51.12	173 05.37	40 53.85	173 07.02	33	35	3	5.6	70.1	19.6	17.1
9	18	19-Mar-00	1353	40 59.73	173 08.92	41 02.62	173 09.79	28	28	2.96	5.2	72.7	19.6	19.3
10	18	19-Mar-00	1539	41 04.88	173 16.55	41 05.81	173 20.25	33	33	2.95	5	76	20	18.5
11	1	20-Mar-00	0604	40 43.51	172 16.77	40 41.79	172 19.96	25	28	2.97	5.6	74.3	15	14.2
12	1	20-Mar-00	0839	40 37.36	172 09.27	40 40.10	172 07.36	96	98	3.4	5.2	77	17	14
13	2	20-Mar-00	1036	40 39.82	171 58.94	40 42.32	171 56.92	140	141	2.94	5.6	77.7	18.1	13.9
14	2	20-Mar-00	1339	41 00.70	171 54.32	41 03.60	171 53.89	103	107	2.92	5	77.6	17.2	13.7
15	1	20-Mar-00	1546	41 07.27	172 04.01	41 10.28	172 03.93	33	34	3.01	5.1	75.3	17.4	15.4
16	7	21-Mar-00	0608	42 10.12	171 12.68	42 07.38	171 14.43	42	44	3.03	5.2	79.7	16.3	15.6
17	7	21-Mar-00	0801	42 05.07	171 09.49	42 02.45	171 11.20	95	98	2.91	5.3	84.7	16.6	13.5
18	7	21-Mar-00	0947	41 57.89	171 13.35	41 55.32	171 15.01	99	99	2.85	5.5	76.6	16.8	13.9
19	8	21-Mar-00	1131	41 55.66	171 11.39	41 52.79	171 12.24	130	139	2.93	5.1	76.7	17	13.4
20	7	21-Mar-00	1328	41 55.10	171 15.89	41 52.34	171 17.57	89	90	3.03	5.1	77.9	16.6	13.5
21	7	21-Mar-00	1525	41 55.80	171 22.41	41 52.93	171 23.91	33	35	3.08	5.4	76.8	16.6	15.5
22	6	22-Mar-00	0624	41 41.10	171 22.59	41 38.90	171 25.21	117	120	2.95	5.7	77.1	16.8	13.4
23	5	22-Mar-00	0854	41 32.02	171 39.03	41 29.51	171 41.20	76	78	2.99	5.5	82.9	16.6	13.9
24	5	22-Mar-00	1054	41 22.72	171 45.09	41 20.24	171 47.19	99	100	2.94	5.6	76.1	16.3	13.7
25	5	22-Mar-00	1236	41 17.43	171 51.90	41 14.81	171 53.92	82	84	3.03	5.5	76	17	13.7
26	1	22-Mar-00	1425	41 13.41	171 57.24	41 11.10	171 59.81	61	66	3.02	5.6	76	17.2	13.9
27	9	23-Mar-00	0623	42 08.44	170 34.99	42 11.32	170 34.23	349	350	2.94	5.2	84.6	18.3	12.3
28 *	13	23-Mar-00	1020	42 31.92	170 34.63	42 32.81	170 38.55	277	282	3.03	5.1	85.1	18.1	12.5
29	12	23-Mar-00	1343	42 40.53	170 19.31	42 42.73	170 16.54	132	137	3	6.1	82.1	18.1	13.8

Appendix 2—*continued*

Station	Stratum	Start of tow				End of tow		Gear depth (m)		Distance trawled	Headline	Doorspread	Surface temp	Bottom temp
		Date	Time	° ' S	° ' E	° ' S	° ' E	Min.	Max.	(n. miles)	height (m)	(m)	(°C)	(°C)
30	11	23-Mar-00	1545	42 45.39	170 23.57	42 42.96	170 25.59	95	96	2.84	5.6	74.8	17.4	14
31	16	24-Mar-00	0619	43 31.03	169 12.53	43 33.66	169 11.23	194	220	2.79	5.4	80.5	16.6	13
32	16	24-Mar-00	0803	43 30.05	169 12.92	43 27.99	169 15.81	214	234	2.94	5.4	79.8	16.6	13
33	15	24-Mar-00	0953	43 31.17	169 15.79	43 29.03	169 18.45	133	134	2.88	5.3	72.8	15.9	13.3
34	15	24-Mar-00	1124	43 28.38	169 19.18	43 26.25	169 21.97	133	134	2.93	5	74.8	16.3	13.3
35	15	24-Mar-00	1303	43 25.74	169 25.58	43 24.42	169 29.34	127	133	3.05	5	71.3	17.2	13.7
36	16	24-Mar-00	1541	43 16.88	169 35.33	43 14.40	169 37.60	308	312	2.98	5.5	79.4	17.8	12.5
37	14	25-Mar-00	0615	43 24.66	169 42.20	43 24.86	169 38.08	47	51	2.99	5.4	78	15.3	15
38	15	25-Mar-00	0837	43 23.92	169 33.07	43 25.29	169 29.46	103	103	2.97	5.4	74.8	17.2	14.8
39	14	25-Mar-00	1017	43 27.96	169 30.65	43 30.32	169 27.80	70	76	3.14	5.3	78.6	15.9	14.4
40	14	25-Mar-00	1153	43 32.57	169 27.51	43 34.43	169 24.46	63	69	2.89	5.3	80.8	15.9	14
41	14	25-Mar-00	1326	43 35.47	169 23.30	43 37.56	169 20.27	65	67	3.02	5.6	80.7	16.1	14.4
42	14	25-Mar-00	1457	43 39.17	169 20.37	43 40.64	169 16.76	35	52	3.01	5.6	75.7	15.9	14.9
43	14	26-Mar-00	0622	43 19.82	169 52.89	43 17.47	169 55.40	73	74	2.98	5.4	73.6	16.6	14.8
44	12	26-Mar-00	0815	43 13.20	169 49.60	43 10.33	169 48.89	175	190	2.92	5.4	73.1	17.4	13.1
45	13	26-Mar-00	0956	43 10.08	169 45.49	43 07.01	169 45.15	198	211	3.02	5.4	74	17.8	13.3
46	12	26-Mar-00	1142	43 06.00	169 48.57	43 08.97	169 48.49	188	192	2.96	5.5	75.9	17.6	12.4
47	12	26-Mar-00	1342	43 11.16	169 56.64	43 08.72	169 58.92	141	145	2.95	5.4	75.8	17	13.5
48	11	26-Mar-00	1528	43 10.43	170 05.10	43 08.20	170 07.63	49	52	2.9	5.2	76.2	16.6	14.7
49	9	27-Mar-00	0633	41 59.03	170 33.94	41 56.12	170 35.07	388	396	3.03	5.1	83.8	18.5	11.2
50	9	27-Mar-00	0822	41 53.47	170 36.05	41 50.55	170 35.62	386	393	2.92	5.2	87.2	18.3	11.2
51	13	29-Mar-00	0633	43 05.98	169 40.96	43 03.49	169 43.18	382	388	2.97	5.1	83.2	17.8	11.6
52	12	29-Mar-00	0839	43 05.95	169 50.38	43 03.30	169 52.07	184	189	2.92	5.1	80.1	17.6	13.3
53	13	29-Mar-00	1021	43 00.12	169 53.05	42 58.44	169 56.24	227	236	2.88	5.1	78.1	17.6	13.4
54	13	29-Mar-00	1300	42 54.79	170 00.28	42 51.94	170 01.65	233	241	3.02	5	78.3	16.9	13.4
55	13	29-Mar-00	1503	42 48.71	170 00.26	42 51.40	169 58.70	268	277	2.89	4.9	89.4	17.8	13.1
56	2	30-Mar-00	0654	41 16.47	171 00.07	41 13.85	171 02.06	194	195	3.02	5	81	18.1	13.7
57	6	30-Mar-00	0940	41 15.31	171 19.59	41 12.56	171 21.45	154	157	3.08	4.9	83.8	17	13.5
58	2	30-Mar-00	1226	41 02.17	171 33.91	40 59.67	171 36.16	140	140	3.02	5.4	79.6	17.4	13.9

Appendix 2—*continued*

Station	Stratum	Start of tow Date	Time	° ' S	° ' E	End of tow ° ' S	° ' E	Gear depth (m) Min.	Max.	Distance trawled (n. miles)	Headline height (m)	Doorspread (m)	Surface temp (°C)	Bottom temp (°C)
59	19	31-Mar-00	0637	40 38.78	173 28.77	40 39.49	173 24.96	57	62	2.99	5	75.6	17.8	16.4
60	19	31-Mar-00	0825	40 42.20	173 20.19	40 43.90	173 23.35	55	55	2.93	5.3	73.8	17.6	17
61	19	31-Mar-00	1008	40 46.93	173 28.78	40 49.81	173 27.97	52	53	2.94	5.3	71.5	18.1	17.2
62	6	2-Apr-00	1207	41 42.01	171 09.35	41 44.62	171 07.06	154	154	3.13	5.3	71.2	16.8	
63	8	2-Apr-00	1444	41 48.71	170 52.11	41 51.56	170 52.14	185	191	2.84	4.5	87.7	17.6	13.1
64	8	3-Apr-00	0653	41 46.46	171 15.80	41 49.12	171 14.03	138	140	2.97	5.2	76.6	16	13.3
65	8	3-Apr-00	1027	42 10.62	171 04.25	42 13.44	171 02.87	118	119	2.99	5.3	73.5	16.8	13.5
66	8	3-Apr-00	1315	42 16.29	170 54.10	42 19.16	170 52.97	172	175	2.98	5	78	17.6	13.6
67	11	3-Apr-00	1542	42 28.34	171 03.26	42 30.97	171 01.61	42	46	2.89	5.3	73.8	16.3	14.8
68	12	4-Apr-00	0644	42 52.45	170 06.59	42 49.98	170 09.01	163	173	3.04	5.1	74.3	17	13.8
69	12	4-Apr-00	0644	42 52.18	170 12.94	42 49.69	170 15.26	131	137	3.02	5.5	76	16.3	14.1
70	11	5-Apr-00	0841	42 49.88	170 24.41	42 47.03	170 25.44	75	80	2.95	5.4	79	15.7	14.7
71	11	5-Apr-00	1037	42 52.21	170 30.13	42 49.45	170 31.73	35	40	2.99	5.3	75.2	15.7	12.7
72	11	5-Apr-00	1240	42 42.92	170 34.56	42 44.01	170 38.39	60	61	3.05	5.3	76	15.9	14.1
73	11	5-Apr-00	1445	42 45.25	170 48.63	42 42.89	170 51.14	42	54	3	5.3	76	15.9	15.2
74	6	6-Apr-00	0641	41 21.12	171 24.07	41 23.73	171 22.10	143	145	3	5.2	79	17.2	13.8
75	6	6-Apr-00	0823	41 25.07	171 18.32	41 27.73	171 16.50	148	150	2.99	5.3	76.6	17.4	13.7
76	6	6-Apr-00	1035	41 30.98	171 24.71	41 33.05	171 21.85	136	139	2.98	5.4	78.1	16.3	13.7
77	6	6-Apr-00	1239	41 37.67	171 14.76	41 40.10	171 12.21	151	152	3.08	5.1	77	16.3	13.4
78	6	6-Apr-00	1534	41 35.88	171 00.78	41 38.86	171 00.61	166	174	2.98	5.2	77	17.2	13.7
79	16	7-Apr-00	0918	43 19.83	169 30.91	43 21.02	169 27.10	302	303	3.03	5.2	90.7	17.2	12.5
80	16	7-Apr-00	1230	43 19.32	169 26.46	43 21.25	169 23.25	371	397	3.03	5.2	95.6	17.2	12.1
81	16	7-Apr-00	1434	43 22.59	169 21.68	43 24.59	169 18.59	336	350	3.01	5.1	95.6	17.2	11.8
82	2	8-Apr-00	1051	41 06.33	171 10.22	41 04.25	171 13.02	192	192	2.97	5.3	76.7	17.8	13.9
83	2	8-Apr-00	1434	40 49.80	171 38.33	40 47.71	171 41.13	160	162	2.98	4.9	79.3	18.5	14
84	2	9-Apr-00	0643	40 50.37	171 56.40	40 47.87	171 58.60	116	117	3.01	5.3	78.7	16.3	14
85	2	9-Apr-00	0808	40 46.64	171 59.75	40 44.20	172 02.04	109	110	3.01	5.5	73.7	16.8	14

* Station not used for biomass calculations because of poor gear performance

– No data

Appendix 3: Species caught, total weight, percentage of total catch, occurrence (Occ.), and depth range of all species caught.

Species code	Common name	Scientific name	Catch (kg)	% of total catch	Occ.	Depth (m) Min.	Depth (m) Max.
ANC	Anchovy	*Engraulis australis*	2	*	7	33	61
BAR	Barracouta	*Thyrsites atun*	2 860.5	9.5	74	25	397
BAS	Bass	*Polyprion americanus*	6.1	*	1	349	350
BCO	Blue cod	*Parapercis colias*	20.7	0.1	11	25	66
BNS	Bluenose	*Hyperoglyphe antarctica*	5.4	*	2	277	350
BRI	Brill	*Colistium guntheri*	9.9	*	5	33	66
BRZ	Brown stargazer	*Xenocephalus armatus*	2.3	*	5	28	62
BSQ	Broad squid	*Sepioteuthis australis*	13.5	*	2	25	98
BTH	Bluntnose skate	*Bathyraja* sp.	0.7	*	1	336	350
CAR	Carpet shark	*Cephaloscyllium isabella*	1 077.6	3.6	71	25	396
CBE	Crested bellowsfish	*Notopogon lilliei*	0.3	*	1	277	282
CBI	Two saddle rattail	*Caelorinchus biclinozonalis*	843.2	2.8	46	33	397
CBO	Bollon's rattail	*C. bollonsi*	2.5	*	3	336	397
CCX	Small banded rattail	*C. parvifasciatus*	16.1	0.1	9	227	396
CDO	Capro dory	*Capromimus abbreviatus*	94.7	0.3	31	73	397
CON	Conger eel	*Conger* spp.	56.8	0.2	6	33	66
CUC	Cucumberfish	*Chlorophthalmus nigripinnis*	136.6	0.5	30	59	282
EGR	Eagle ray	*Myliobatis tenuicaudatus*	29	0.1	7	25	64
ELE	Elephantfish	*Callorhinchus milii*	92.8	0.3	4	35	54
EMA	Blue mackerel	*Scomber australasicus*	6.9	*	3	35	139
ERA	Electric ray	*Torpedo fairchildi*	267.2	0.9	20	28	350
ESO	N.Z. sole	*Peltorhamphus novaezelandiae*	31.2	0.1	14	26	66
FHD	Deepsea flathead	*Hoplichthys haswelli*	4.6	0.0	3	336	397
FRO	Frostfish	*Lepidopus caudatus*	444	1.5	43	33	396
GLB	Globefish	*Contusus richei*	33.2	0.1	6	33	54
GSH	Dark ghost shark	*Hydrolagus novaezelandiae*	2 595.6	8.6	49	61	397
GUR	Red gurnard	*Chelidonichthys kumu*	1 001.5	3.3	55	25	195
HAG	Hagfish	*Eptatretus cirrhatus*	3.1	*	2	386	396
HAK	Hake	*Merluccius australis*	36	0.1	18	35	388
HAP	Hapuku	*Polyprion oxygeneios*	131.1	0.4	15	35	303
HCO	Hairy conger	*Bassanago hirsutus*	1.8	*	1	382	388
HEP	Sharpnose sevengill shark	*Heptranchias perlo*	2.6	*	1	336	350
HOK	Hoki	*Macruronus novaezelandiae*	410.7	1.4	27	60	397
JAV	Javelinfish	*Lepidorhynchus denticulatus*	45.1	0.1	10	233	397
JDO	John dory	*Zeus faber*	168	0.6	32	26	175
JGU	Spotted gurnard	*Pterygotrigla picta*	2.3	*	3	160	350
JMD	N.Z. jack mackerel	*Trachurus declivis*	223.4	0.7	55	28	277
JMM	Chilean jack mackerel	*T. symmetricus murphyi*	25	0.1	9	26	236
JMN	N.Z. jack mackerel	*T. novaezelandiae*	251.4	0.8	18	26	107
KAH	Kahawai	*Arripis trutta*	2.1	*	1	35	40
KIN	Kingfish	*Seriola lalandi*	15.4	0.1	1	45	47
LAN	Lanternfish	Myctophidae	0.1	*	1	308	312
LDO	Lookdown dory	*Cyttus traversi*	51.7	0.2	3	336	397
LEA	Leatherjacket	*Parika scaber*	258.1	0.9	14	25	66
LIN	Ling	*Genypterus blacodes*	446.5	1.5	30	26	397
LSK	Softnose skate	*Arhynchobatis asperrimus*	6.3	0.0	2	349	393
LSO	Lemon sole	*Pelotretis flavilatus*	106.4	0.4	31	26	241
MDO	Mirror dory	*Zenopsis nebulosus*	5.2	*	4	233	388
NSD	Northern spiny dogfish	*Squalus mitsukuri*	260	0.9	27	109	396
OCT	Octopus	*Octopus cordiformis*	23.5	0.1	7	30	66

Appendix 3—*continued*

Species Code	Common name	Scientific name	Catch (kg)	% of total catch	Occ.	Depth (m) Min.	Max.
ONG	Sponges	Porifera (Phylum)	2.1	*	2	59	66
OPA	Opalfish	*Hemerocoetes* spp.	0.6	*	5	55	175
OPE	Orange perch	*Lepidoperca aurantia*	53.9	0.2	2	277	350
PAD	Paddle crab	*Ovalipes catharus*	0.4	*	1	33	35
PCO	Ahuru	*Auchenoceros punctatus*	2	*	5	33	54
PIG	Pigfish	*Congiopodus leucopaecilus*	1.1	*	6	95	282
PIP	Pipefish	Syngnathidae	0.1	*	1	116	117
POP	Porcupine fish	*Allomycterus jaculiferus*	30.9	0.1	6	25	162
PRK	Prawn killer	*Ibacus alticrenatus*	0.7	*	2	140	350
RBT	Redbait	*Emmelichthys nitidus*	19.2	0.1	9	103	211
RBY	Ruby fish	*Plagiogeneion rubiginosus*	85.3	0.3	3	277	396
RCO	Red cod	*Pseudophycis bachus*	1159	3.8	53	26	397
RHY	Common roughy	*Paratrachichthys trailli*	57.1	0.2	7	188	350
RMU	Red mullet	*Upeneichthys lineatus*	0.2	*	1	33	35
RSK	Rough skate	*Raja nasuta*	324.6	1.1	29	33	396
SCA	Scallop	*Pecten novaezelandiae*	0.9	*	2	26	37
SCG	Scaly gurnard	*Lepidotrigla brachyoptera*	308.7	1.0	63	30	211
SCH	School shark	*Galeorhinus galeus*	1 210.1	4.0	73	25	312
SDO	Silver dory	*Cyttus novaezelandiae*	1 328.7	4.4	40	63	396
SDR	Spiny seadragon	*Solegnathus spinosissimus*	0.9	*	6	57	211
SEV	Broadnose sevengill shark	*Notorynchus cepedianus*	27.5	0.1	2	99	350
SFI	Starfish	Asteroidea & Ophiuroidea	0.3	*	1	59	66
SFL	Sand flounder	*Rhombosolea plebeia*	126	0.4	13	26	62
SKI	Gemfish	*Rexea solandri*	207	0.7	13	175	397
SLS	Slender sole	*Peltorhamphus tenuis*	0.2	*	2	35	52
SNA	Snapper	*Pagrus auratus*	35	0.1	4	25	66
SPD	Spiny dogfish	*Squalus acanthias*	6 903.8	22.8	80	25	397
SPE	Sea perch	*Helicolenus* spp.	414.9	1.4	50	25	397
SPO	Rig	*Mustelus lenticulatus*	581.6	1.9	46	25	397
SPR	Sprat	*Sprattus antipodum*, *S. muelleri*	7.6	*	11	33	74
SPZ	Spotted stargazer	*Genyagnus monopterygius*	0.8	*	2	26	53
SQU	Arrow squid	*Nototodarus sloanii*, *N. gouldi*	606.4	2.0	83	25	397
SSH	Slender smoothhound	*Gollum attenuatus*	176.4	0.6	5	277	397
SSI	Silverside	*Argentina elongata*	6	*	29	33	396
SSK	Smooth skate	*Raja innominata*	329.7	1.1	23	42	397
STA	Giant stargazer	*Kathetostoma giganteum*	1 619.8	5.4	60	35	388
STR	Stingray	*Dasyatis* sp.	25	0.1	1	160	162
STY	Spotty	*Notolabrus celidotus*	20.7	0.1	6	26	35
SWA	Silver warehou	*Seriolella punctata*	111.5	0.4	41	33	396
TAR	Tarakihi	*Nemadactylus macropterus*	1 386.9	4.6	66	25	350
THR	Thresher shark	*Alopias vulpinus*	223.3	0.7	7	28	103
TOD	Dark toadfish	*Neophrynichthys latus*	0.6	*	2	151	396
TRE	Trevally	*Pseudocaranx dentex*	1.7	*	1	57	62
TUR	Turbot	*Colistium nudipinnis*	3.3	*	2	33	51
WAR	Blue warehou	*Seriolella brama*	512.7	1.7	33	30	190
WIT	Witch	*Arnoglossus scapha*	206.6	0.7	75	25	397
YBF	Yellowbelly flounder	*Rhombosolea leporina*	5.4	*	1	30	35
YCO	Yellow cod	*Parapercis gilliesi*	0.7	*	1	194	195
			30 258.6				

* Less than 0.05 %

Appendix 4: Invertebrates (excluding arrow squid) collected during the survey. Identification is to the lowest possible taxonomic level

	No. of stations
Echinodermata: Asteroidea	
Coscinasterias muricata	4
Dipsachaster magnificus	1
Mediaster sladeni	1
Proserpinaster neozelanicus	4
Psilaster acuminatus	22
Echinodermata: Echinoidea	
Paramaretia peloria	1
Pseudechinus albocinctus	4
Spatangus multispinus	13
Echinodermata: Holothuroidea	
Stichopus mollis	3
Echinodermata: Crinoidea	
Clarkomanthus plectrophorum	2
Echinodermata: Ophiuroidea	
Astroceras elegans	1
Astrothorax waitei	1
Mollusca: Gastropoda	
Alcithoe arabica	4
Alcithoe lutea	1
Alcithoe ostenfeldi	9
Astraea heliotropium	2
Austrofusus glans	9
Calliostoma selecta	2
Charonia lampas capax	1
Crepidula monoxyla	5
Malluvium calcareus	13
Monoplex parthenopius	2
Penion cuvieranus	10
Ranella olearium	5
Semicassis pyrum	2
Sigapatella novaezelandiae	2
Zegalerus tenuis	4
Mollusca: Cephalopoda	
Octopus huttoni	2
Octopus kaharoa	3
Pinnoctopus cordiformis	6
Sepioteuthis australis	1
Mollusca: Bivalvia	
Aulacomya ater maoriana	2
Barbatia novaezelandiae	2
Cardita aoteana	2
Chlamys gemmulata	5
Chlamys zelandiae	3
Chlamys dieffenbachi	1
Hiatella arctica	4
Limaria orientalis	2

Appendix 4—*continued.*

	No. of stations
Mollusca: Bivalvia (continued)	
Modiolarca impacta	6
Modiolus areolatus	1
Monia zelandica	2
Ostrea lutaria	5
Pecten novaezelandiae	10
Crustacea: Anomura	
Diacanthurus rubricatus	22
Galathea pusilla	2
Galathea sp.	1
Lophopagurus (Australeremus) sp. 1	2
Lophopagurus (Australeremus) cristatus	4
Lophopagurus thompsoni	2
Pagurus novaezelandiae	2
Paguristes barbatus	11
Paguristes pilosus	5
Sympagurus dimorphus	2
Crustacea: Cirripedia	
Arcoscalpellum pedunculatum	3
Balanus decorus	13
Calantica spinilatera	3
Calantica villosa	1
Crustacea: Isopoda	
Cirolanidae	4
Crustacea: Brachyura	
Neommatocarcinus huttoni	2
Ovalipes catharus	1
Trichopeltarion fantasticum	1
Crustacea: Palinura	
Ibacus alticrenatus	12
Metanephrops challengeri	2
Crustacea: Stomatopoda	
Lysiosquilla sp.	1
Cnidaria: Zoantharia	
Bathyzoanthus sp.	16
Cnidaria: Pennatulacea	
Halipteris sp.	2
Anthoptilum murrayi	2
Cnidaria: Actinaria	
Hormathia lacunifera	15
Phlyctenactis sp.	1
"ring" anemone	2
Cnidaria: Hydrozoa	
indet	3
Nemertesia elongata	2
Nemertesia cymodocea	2
Cnidaria: Gorgonacea	
Acanthogorgia sp.	1
Plexauridae indet.	1

Appendix 4—continued.

	No. of stations
Cnidaria: Alcyonacea	
Clavularia sp.	1
Brachiopoda	
Neothyris lenticularis	1
Gyrothyris mawsoni	4
Urochordata	
Ascidian (mixed taxa)	12
Okamia sp.	1
Didemnum sp.	3
Annelida: Hirudinea	
Pontobdella benhami	4
Annelida: Polychaeta	
?*Chaetopterus* sp.	2
Chielonereis peristomialis	1
F: Sabellidae	4
Eunice sp.	1
Galeolaria sp.	1
Bryozoa: Gymnolaemata	4
Penetrantia parva	
Bryozoa: Cheilostomata	
Aetea truncata	3
Aimulosia marsupium	2
Akatopora circumsaepta E	2
Amphiblestrum blandum E	1
Arachnopusia unicornis	3
Beania discodermiae	3
Bitectipora mucronifera E	1
Bitectipora rostrata	2
Buffonellaria turbula E	1
Caberea rostrata	2
Caberea zelandica E	1
Canda filifera	1
Cellaria immersa	1
Cellaria tenuirostris	1
Celleporina sinuata E	3
Chaperiopsis rubida E	2
Crassimarginatella fossa E	1
Crepidacantha crinispina	2
Escharoides excavata E	1
Exochella conjuncta	1
Fenestrulina disjuncta E	1
Fenestrulina gelasinoides E	2
Figularia spinea E	1
Galeopsis polyporus E	3
Galeopsis porcellanicus E	3
Hemismittoidea hexaspinosa	2

Appendix 4—*continued.*

	No. of stations
Hippomenella vellicata E	2
Hippothoa flagellum	3
Leptinatella gordoni E	2
Macropora cf. spinifera E	1
Micropora elegans	1
Microporella agonistes E	3
Microporella discors E	1
Odontionella cyclops	1
Opaeophora lepida E	2
Opaeophora monopia E	3
Parasmittina delicatula	1
Parkermavella punctigera	1
Phonicosia circinata	1
Rhynchozoon larreyi	3
Schizomavella aotearoa E	1
Schizosmittina cinctipora E	3
Schizosmittina conjuncta E	1
Smittina rosacea E	3
Smittina torques E	2
Smittoidea maunganuiensis	3
Stephanollona longispinata	1
Bryozoa: Stenolaemata	
Diaperoecia purpurascens E	3
Disporella novaehollandiae	1
Disporella pristis	3
Favosipora candida E	1
Hornera robusta	1
Idmidronea sp. 1 E	1
Reptotubigera sp.	1
Telopora lobata E	2
Tubulipora sp.	2
Porifera	
Aaptos sp.	2
Crella incrustans	1
Callispongia ramosa	4
Ectyodoryx sp.	1
Geodea sp.	1
Warty solitary tunicate	2

E = endemic bryozoan

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