MINISTRY OF FISHERIES
Te Tautiaki i nga tini a Tangaroa

ISSN 1175-1584

Trawl survey of the west coast of the South Island and Tasman and Golden Bays, March–April 2003 (KAH0304)

M. L. Stevenson

New Zealand Fisheries Assessment Report 2004/4
January 2004

Trawl survey of the west coast of the South Island and Tasman and Golden Bays, March–April 2003 (KAH0304)

M. L. Stevenson

NIWA
P O Box 893
Nelson

New Zealand Fisheries Assessment Report 2004/4
January 2004

Published by Ministry of Fisheries
Wellington
2004

ISSN 1175-1584

Citation:
Stevenson, M.L. (2004).
Trawl survey of the west coast of the South Island and Tasman and Golden Bays, March–April 2003 (KAH0304).
New Zealand Fisheries Assessment Report 2004/4. 69 p.

This series continues the informal
New Zealand Fisheries Assessment Research Document series
which ceased at the end of 1999.

EXECUTIVE SUMMARY

Stevenson, M.L. (2004). Trawl survey of the west coast of the South Island and Tasman and Golden Bays, March–April 2003 (KAH0304).

New Zealand Fisheries Assessment Report 2004/4. **69 p.**

This report gives the results of the sixth 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.*

The survey was of 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, 834 t (15%); red gurnard, 270 t (20%), red cod, 906 t (24%), and tarakihi, 912 t (20%). All c.v.s were either better than or equal to the target c.v.s.

Other commercial species with c.v.s less than 15% were spiny dogfish and arrow squid.

The estimates of total biomass for giant stargazer, red gurnard, and tarakihi were the lowest for any survey in the series although the estimate for red cod was more than twice the estimate for the 2000 survey. The numbers of large giant stargazer females were low, a continuation of the situation in 2000.

1. INTRODUCTION

This report presents results from the sixth 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 were reported by Drummond & Stevenson (1995a, 1995b, 1996) and Stevenson (1998, 2002) and the series was reviewed by Stevenson & Hanchet (2000a).

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, particularly for giant stargazer (STA 7) and rig (SPO 7) which were placed in the Adaptive Management Programme (AMP) (Annala et al. 2003).

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 INT200202.

1.1 Programme objective

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

1.2 Specific objectives (2003)

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.

6. To tag lively school shark, rough skate, and smooth skate.

1.3 Timetable and personnel

RV *Kaharoa* departed Wellington on 22 March and scientific staff boarded in Nelson on 23 March 2003. Trawling started on 23 March. *Kaharoa* berthed in Westport on 4 April to unload fish. Trawling finished on 13 April and science staff disembarked in Nelson. *Kaharoa* returned to Wellington on 14 April.

Michael Stevenson was project and voyage leader and was responsible for final database editing. The skipper was Evan Solly.

2. Methods

2.1 Survey area and design

The survey area (Figure 1) covered depths of 20–200 m off the west coast of the South Island from Farewell Spit to Karamea; 25–200 m from Karamea to Cape Foulwind; 20–400 m from Cape Foulwind to the Haast River mouth 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). Stratum depth ranges on the west coast 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 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 86 stations and a two-phase design (after Francis 1984) were required to achieve the predicted c.v.s with about 80% 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.

2.2 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 (Drummond & Stevenson 1996). Doorspread and headline height measurements were recorded from Scanmar monitoring equipment and an average taken of five readings at 10–15 min intervals during each tow. When 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 for which 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 station 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 about 2.2:1 at 400 m.

2.3 Water temperatures

The surface temperature at each station was recorded from a hull-mounted sensor. Bottom temperatures were recorded by the Scanmar net monitor.

2.4 Tagging

As soon as the net was brought on board, lively school shark and rough and smooth skate were separated from the catch and tagged with Hallprint dart tags whenever possible. Length, weight, and sex were recorded for each tagged fish.

2.5 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 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 (*Raja nasuta*), smooth skate (*R. innominata*), school shark (*Galeorhinus galeus*), two-saddle rattail (*Caelorinchus biclinozonalis*), lemon sole (*Pelotretis flavilatus*), and New Zealand sole (*Peltorhamphus novaezelandiae*). 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 five otolith pairs per sex per centimetre size class were collected from length frequency samples for giant stargazer, red cod, red gurnard, tarakihi, lemon sole, and New Zealand sole.

2.6 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 headline 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 and non-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 (all 86 stations) were used for biomass estimation. The c.v. associated with estimates of biomass was calculated by the method of Vignaux (1994).

Biomass and scaled length frequency distributions were derived using the TrawlSurvey Analysis Program (Vignaux 1994). Length frequencies were scaled by the percentage of catch sampled, area swept, and stratum area. The geometric mean functional relationship was used to calculate the length-weight coefficients for species where length-weight data were collected on this survey. For other species, coefficients were chosen from the *trawl* database and a selection 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).

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

3. RESULTS

3.1 Survey area, design, and gear performance

Trawling began in Tasman and Golden Bays and after 2 days working continued on the west coast in a generally north to south direction. No time was lost to bad weather, but one day was lost because of equipment problems and one day was used unloading fish.

A total of 86 stations was successfully completed, 69 in phase 1 and 17 in phase 2. Station density ranged from one station per 80 km^2 in stratum 16 to one station per 1076 km^2 in stratum 2, with an average density of one station per 298 km^2 (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 allocated to red cod, red gurnard, and tarakihi to reduce their c.v.s towards the target levels. Nine phase 2 stations were allocated to stratum 11 where the highest catch rates of red cod and red gurnard occurred, two stations were allocated to stratum 14 for red gurnard, and 5 stations were allocated to stratum 9, and one in stratum 2 for tarakihi. Catch rates of giant stargazer were not used for allocation of phase 2 stations because the c.v. for this species was within target levels.

Tow and gear parameters by depth are shown in Table 2. Doorspread varied from 59.3 to 94 m and headline height varied between 5.1 and 5.7 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 of previous surveys indicating consistency between surveys (Stevenson & Hanchet 2000a).

3.2 Catch composition

A total of about 32 t of fish was caught during the 86 tows at an average of 376 kg per tow (range 22.9–1927.1 kg). Amongst the vertebrate fish catch, 17 elasmobranchs and 61 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 by NIWA staff.

Invertebrate species identified from the catch are given in Appendix 4. Large colonies of bryozoans found in Golden Bay have been identified as an introduced species, *Biflustra savartii*.

The most abundant species by weight was spiny dogfish with 7.7 t caught (23.6% of the total catch). The top four species, spiny dogfish, barracouta, arrow squid, and red cod, made up 59.5% of the total. Giant stargazer, red cod, red gurnard, and tarakihi made up 4.8, 7.6, 2.1, and 5.6% of the catch, respectively. Arrow squid, barracouta, and spiny dogfish occurred in over 80% of the tows.

3.3 Catch rates and species distribution

Distribution by stratum and catch rates for the 15 most abundant commercially important species are shown in Figures 2a–2p. Catch rates are given in 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.

3.4 Biomass estimation

Relative biomass estimates for all species where more than 100 kg was caught, excluding thresher shark, are given by sub-area in Table 4. Barracouta had the largest estimated biomass followed, by spiny dogfish and arrow squid. Coefficients of variation for the target species were: giant stargazer, 15%; red cod, 24%; red gurnard, 20%; and tarakihi, 20% (Table 4).

Biomass estimates of recruited fish for barracouta, blue warehou, giant stargazer, hoki, John dory, lemon sole, New Zealand sole, red cod, red gurnard, rig, sand flounder, school shark, silver warehou, and tarakihi are given in Table 5. For the target species giant stargazer, red cod, red gurnard, and tarakihi, the percentages of total biomass that were recruited fish were 99%, 63%, 94%, and 95% respectively.

Biomass estimates by year class (where discernible 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 about 19% of the total red cod biomass. For red gurnard, the 2+ cohort made up 2% of the total biomass estimate and for tarakihi the 2+ cohort made up 6% of the total (Table 6).

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

3.5 Water temperatures

Isotherms estimated from surface temperature recordings are shown in Figure 3. Isotherms estimated from bottom temperature recordings are shown in Figure 4. Surface temperatures were considerably warmer than previous surveys (Stevenson 2002, Stevenson & Hanchet 2000a).

3.6 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 16 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, New Zealand sole, school shark, and two saddle rattail using the geometric mean functional relationship (Appendix 1).

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

3.7 Tagging

Of the 144 school shark tagged, there were 66 females and 78 males ranging in length from 53 cm to 134 cm. In addition 21 rough skate (13 females, 8 males), and 9 smooth skate (4 females, 5 males)

As of 20 September 2003, 4 school shark tagged during the survey had been recaptured. The greatest distance travelled was 340 km by a 110 cm female that had been at liberty for 115 days. There have been no reported recoveries for either skate species.

3.8 Target species

3.8.1 Giant stargazer

Giant stargazer were caught at 30% of stations in Tasman and Golden Bays and 63% of stations along the west coast, with the highest catch rates south of Greymouth in strata 12, 14, and 15 (Figure 2g, Table 3). Eighty-three percent of the relative biomass estimate was south of Cape Foulwind, and almost 80% (667 t) was within the 100–200 m depth range (Table 7). Only one giant stargazer longer than 45 cm was caught in Tasman and Golden Bays (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 0.7:1 at depths less than 100 m, 1.8:1, at 100–200 m, 0.8:1 at 200–400 m, and 1.5:1 overall (Figure 5). Virtually all females under 50 cm total length were immature or had resting gonads, but above this size, most had maturing gonads. Males under 40 cm were immature or resting, and most males over 40 cm were maturing (Table 9).

3.8.2 Red cod

Red cod were caught at 60% of stations in Tasman and Golden Bays and 64% of stations along the west coast, with the highest catch rates in stratum 11. However, the proportion of the estimated biomass in Tasman and Golden Bays was only 2% (Figure 2k, Tables 3 and 4). Most of the estimated biomass on the west coast was in depths less than 200 m (Table 7). The length frequency data show a dominant 1+ cohort (26–40 cm) present on the west coast at the time of the survey. A small mode (10–19 cm) represents 0+ fish (Figure 5). The sex ratio in Tasman and Golden Bays favoured females (1.2:1), while on the west coast it varied considerably with depth (0.9:1 inside 100 m, 1.9:1 at 100–200 m, and 10.2:1 at 200–400 m) (Figure 5). Most red cod examined had immature or resting gonads, and a few fish were at later stages of reproductive development (Table 9).

3.8.3 Red gurnard

Red gurnard were caught at all stations in Tasman and Golden Bay and at 39% of stations along the west coast (Figure 2l). The highest catch rates were in strata 7, 11, and 149 (Table 3). Unlike previous surveys, the relative biomass estimate of 270 t was not evenly divided between Tasman and Golden Bays (47 t) and the west coast (223 t) (Table 4). There was a significant difference in the length frequency distributions between the sub-areas (Figure 5) with the pre-recruit biomass (15.9 t) evenly divided between areas (Table 5). The recruited biomass estimate (30 cm or over) was 254 t (94% of the total) with 215 t occurring on the west coast. Over 98% of red gurnard biomass was at depths less than 100 m and none occurred at depths greater than 200 m (Table 7). Sex ratios were 1.1:1 in Tasman and Golden Bays and 1.2:1 on the west coast (Figure 5). Most red gurnard longer than 30 cm and some smaller males had developing or mature gonads (Table 9).

3.8.4 Tarakihi

Tarakihi were caught at 70% of stations in both Tasman and Golden Bays and along the west coast. The highest catch rates were in strata 9, 15, and 12. This represents a shift in distribution in the northern west coast strata to deeper water. Previously, catch rates in stratum 9 (200–400 m) were relatively low, and strata 2 and 6 (100–200 m) had higher catch rates. Ninety-four percent of the relative biomass estimate was recruited fish (25 cm or over) (Tables 4 and 5). The length frequency data for Tasman and Golden Bays showed one clear mode 19–24 cm of 2+ fish. There is a weak mode at 13–14 cm of 0+ fish and another mode at 25–27 cm, which could be 3+ fish. Almost no tarakihi longer than 30 cm were caught in Tasman and Golden Bays. These year classes were also present on the west coast (Figure 5), but the first three modes occurred at slightly shorter lengths (11–13, 16–19, and 21–25 cm). There was a lack of fish in the 26–30 cm range indicating a poor 2000 year class (3+ fish). Average size increased with increasing depth on the west coast (Figure 2s). Of the total tarakihi biomass, 96% was on the west coast, and half (457 t) of this was at depths greater than 200 m (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 (Figure 5). There was little reproductive development in tarakihi under 30 cm FL, but for bigger fish the full range of gonad stages was recorded (Table 9).

4. DISCUSSION

The 2003 survey successfully continued the March-April *Kaharoa* time series for the west coast of the South Island and Tasman and Golden Bays. Eighty-six stations were successfully completed and no days were lost to bad weather. The mean catch per station of 376 kg is higher than in 1997 and 2000, but is lower than on the first three surveys.

The c.v.s associated with the biomass estimates for the target species were all either lower than, or equal to, the target c.v.s and within the range of previous surveys. This continues the good precision this series has provided for the biomass estimates for the target species. The best precision for other commercial species was associated with the relative biomass estimates for arrow squid (12%), spiny dogfish (15%), and dark ghost shark (15%). Spiny dogfish was once again the species caught in the greatest quantity (7.7 t or 23.7% of the total catch).

The catch of all species from Tasman and Golden Bays was noticeably lower than on previous years. However, sea surface and bottom temperatures were higher that in previous surveys (Stevenson & Hanchet 2000a, Stevenson 2002) which may have affected availability in this area. Inshore trawl series off the east coast of the North Island (February-March) and east coast of the South Island (December-January) showed some evidence of a negative relationship between water temperature and availability (Stevenson & Hanchet 2000b, Beentjes & Stevenson 2001).

The biomass estimates for most benthic fish species were lower than from earlier surveys in the series (Stevenson & Hanchet 2000a, Stevenson 2002). The amount and diversity of invertebrates was also considerably lower than in 1997 or 2000, the only other surveys on which benthic macroinvertebrates were collected (Stevenson 1998, 2002). The gear was inspected after each tow and the ground gear was found to be polishing well. The net monitor indicated good bottom contact on all tows. There was no other evidence of any change in gear performance (e.g. headline height, doorspread) which could have caused a decrease in trawl catching ability. However, the use of a tilt sensor to monitor net contact with the bottom, as used by the National Oceanographic and Atmospheric Administration (NOAA) in the United States (Stuart Hanchet, NIWA, pers. comm. 2002), would confirm the bottom contact of the gear and might allow a comparison of vulnerability between surveys, particularly for benthic species.

The biomass estimate for giant stargazer continued to show a decline from the high of 1515 t in 1995 (Table 10). The large mode of adult females at 60–70 cm in the first four surveys has almost completely disappeared. A similar trend is apparent for males but is not as pronounced. The decline in biomass, particularly the reduction in numbers of larger females (Figure 6a), is consistent with the increase in commercial catch since 1997–98 (Annala et al. 2002).

The estimate for red cod was more than double the 2000 estimate, but still considerably less than in earlier years (Table 10). The reason is the decline in the large adult modes, especially males, present from 1992 to 1997 (Figure 6b). Also, the 1+ year class does not appear any stronger than in 2000. The weak 1+ year class and low biomass recorded in 2000 was consistent with low commercial catch in

1999–2000 (Annala et al. 2002). The low numbers of 1+ fish indicate the commercial catch in the next fishing year is also likely to be poor (Beentjes 2000).

The biomass estimate for red gurnard was the lowest for any survey in the series (Table 10). The decline in abundance was predominately in Tasman and Golden Bays (Table 11) with a drastic reduction in numbers of fish less than 30 cm (Figure 6c). This is of concern for recruitment for the next few years, particularly because the commercial fishery is based on only a few year classes.

The biomass estimate for tarakihi has declined since 1995 (Table 10). There was a change in the depth distribution of adult tarakihi, with over half of the biomass coming from the 200–400 m depth range. Previously, most was from the 100–200 m depth range. The difference in biomass between this year and 2000 is mainly because of the low numbers of 1+ and 3+ fish (Figure 6d), and suggests a period of poor recruitment. Although the commercial catch has fluctuated around the TACC of 1087 t for this stock since 1996 (Annala et al. 2002), the weak year classes found in this survey indicate the situation should be monitored closely.

5. RECOMMENDATIONS

The last two surveys in this series have been at 3-year intervals. The continued reduction in numbers of large giant stargazer and red cod and the implications for recruitment for red gurnard and tarakihi from this year's survey reinforce the recommendation of Stevenson & Hanchet (2000) that surveys in this series should be conducted at least every two years.

The use of a tilt sensor to monitor net contact with the bottom as used by the National Oceanographic and Atmospheric Administration (NOAA) in the United States (Stuart Hanchet, NIWA, pers. comm. 2002) would confirm the bottom contact of the gear and may allow a comparison of vulnerability between surveys, particularly for benthic species.

Invertebrate monitoring could be improved with the deployment of a small benthic sampling net as used by the NOAA on the west coast of the United States (Stuart Hanchet, NIWA, pers. Comm. 2002).

6. ACKNOWLEDGMENTS

I thank the skipper of RV *Kaharoa,* E. Solly, and his crew for their active cooperation and enthusiastic assistance during the trawl survey. Other scientific staff were Michael Manning, Ron Blackwell, Ralph Dickson, and Doug Griffin. Their hard work and dedication were much appreciated. Thanks also to the NIWA invertebrate group for identification of invertebrate specimens. Michael Beentjes provided very useful comments as referee.

7. REFERENCES

Annala, J.H.; Sullivan, K.J.; O'Brien, C.J.; Smith, N.W.McL.; Varian, S.J.A. (comps.) (2002). Report from the Fishery Assessment Plenary, May 2000: stock assessments and yield estimates. 495 p. (Unpublished report held in NIWA library, Wellington.)

Beentjes, M.P. 2000: Assessment of red cod stocks (RCO 3 and RCO 7) for 1999. *New Zealand Fisheries Assessment Report 2000/25.* 78 p.

Beentjes, M.P.; Stevenson, M.L. (2001). Review of the east coast South Island summer trawl survey time series 1996–97 to 1999–2000. *NIWA Technical Report 108.* 92 p.

Drummond, K.L.; Stevenson, M.L. (1995a). Inshore trawl survey of the west coast South Island and Tasman and Golden Bays, March-April 1992 (KAH9204). *New Zealand Fisheries Data Report No. 63.* 58 p.

Drummond, K.L.; Stevenson, M.L. (1995b). Inshore trawl survey of the west coast South Island and Tasman and Golden Bays, March-April 1994 (KAH9404). *New Zealand Fisheries Data Report No. 64.* 55 p.

Drummond, K.L.; Stevenson, M.L. (1996). Inshore trawl survey of the west coast South Island and Tasman and Golden Bays, March-April 1995 (KAH9504). *New Zealand Fisheries Data Report No. 74.* 60 p.

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

Francis, R.I.C.C. (1984). An adaptive strategy for stratified random trawl surveys. *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. (Unpublished report held in NIWA library, Wellington.)

Stevenson, M.L. (1998). Inshore trawl survey of west coast South Island and Tasman and Golden Bays, March-April 1997 (KAH9701). *NIWA Technical Report 12.* 70 p.

Stevenson, M.L. (2002). Inshore trawl survey of west coast South Island and Tasman and Golden Bays, March-April 2000 (KAH0004). *NIWA Technical Report 115.* 71 p.

Stevenson, M.L.; Hanchet, S.M. (Comps.) (1999). Trawl survey design and data analysis procedures for inshore fisheries research. *NIWA Technical Report 53.* 20 p.

Stevenson, M.L.; Hanchet, S.M. (2000a). Review of the inshore trawl survey series of the west coast of the South Island and Tasman and Golden Bays, 1992–97. *NIWA Technical Report 82.* 79 p.

Stevenson, M.L.; Hanchet, S.M. (2000b). Review of the inshore trawl survey series of the east coast of the North Island, 1993–96. *NIWA Technical Report 85.* 58 p.

Vignaux, M. (1994). Documentation of Trawlsurvey Analysis Program. MAF Fisheries Greta Point Internal Report No. 255. 44 p. (Unpublished report held in NIWA library, Wellington.)

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 Phase 1	Number of stations Phase 2	Station density (km^2 per station)
1	20–100	1 343	102	4	0	336
2	100–200	4 302	300	3	1	1 076
5	25–100	1 224	0	3	0	408
6	100–200	3 233	238	4	0	808
7	25–100	927	0	3	0	309
8	100–200	2 354	214	6	0	392
9	200–400	1 877	1 456	3	5	235
11	25–100	1 438	63	5	9	103
12	100–200	2 054	501	7	0	293
13	200–400	1 101	466	7	0	157
14	25–100	851	36	5	2	122
15	100–200	881	373	5	0	176
16	200–400	319	35	4	0	80
17	20–33	307	27	3	0	102
18	20–42	947	30	3	0	316
19	20–70	2 436	193	4	0	609
Total (average)		25 594	4 034	69	17	(298)

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)	86	5.3	0.12	5.1–5.7
Doorspread (m)	86	77.4	7.51	59.3–94
Distance (n. miles)	86	2.94	0.24	1.96–3.14
Warp:depth ratio	86	3.30	1.49	2.07–8.16
Tasman/Golden Bays				
20–70 m				
Headline height (m)	10	5.4	0.2	5.2–5.7
Doorspread (m)	10	79.8	7.68	73–93
Distance (n. miles)	10	3.01	0.11	2.74–3.11
Warp:depth ratio	10	5.37	1.89	3.39–8.16
West coast				
20–400 m				
Headline height (m)	76	5.3	0.1	5.1–5.6
Doorspread (m)	76	77.1	9.12	59.3–94
Distance (n. miles)	76	2.93	0.33	1.96–3.14
Warp:depth ratio	76	3.03	0.11	2.07–7.14
20–100 m				
Headline height (m)	31	5.4	0.1	5.1–5.6
Doorspread (m)	31	75.5	5.76	65.9–89.4
Distance (n. miles)	31	2.95	0.25	1.97–3.13
Warp:depth ratio	31	3.96	1.42	2.22–7.14
100–200 m				
Headline height (m)	26	5.3	0.1	5.1–5.6
Doorspread (m)	26	77.8	7.90	59.3–91.2
Distance (n. miles)	26	2.93	0.18	2.49–3.14
Warp:depth ratio	26	2.38	0.15	2.07–2.75
200–400 m				
Headline height (m)	19	5.3	0.1	5.1–5.5
Doorspread (m)	19	78.8	9.12	63.4–94
Distance (n. miles)	19	2.90	0.33	1.96–3.06
Warp:depth ratio	19	2.39	0.11	2.13–2.57

Table 3: Mean catch rates (kg.km^{-2}) with standard deviations (in parentheses) by stratum for the 20 most abundant commercially important species in order of catch abundance. Species codes are given in Appendix 3.

	Species code									
Stratum	SPD	BAR	NOS	RCO	TAR	STA	SCH	FRO	GUR	HOK
1	120	4	3	0	0	0	10	0	3	0
	(103)	(7)	(4)				(12)		(4)	
2	190	21	53	0	22	+	1	5	0	0
	(88)	(41)	(68)		(40)	(+)	(1)	(9)		
5	162	113	31	0	0	0.3	1	8	11	0
	(117)	(89)	(51)			0.6	(2)	(14)	(13)	
6	96	81	70	2	14	40	46	10	1	0
	(53)	(124)	(47)	(4)	(11)	(47)	(58)	(14)	(1)	
7	308	452	25	20	1	33	54	0	30	+
	(372)	(555)	(22)	(23)	(1)	(31)	(82)		(43)	(1)
8	338	382	436	86	22	59	50	108	1	2
	(171)	(225)	(194)	(112)	(27)	(36)	(45)	(87)	(2)	(6)
9	0	8	98	0	167	1	4	0.7	0	0
		(21)	(96)		(222)	(2)	(8)	(2)		
11	448	195	24	306	17	58	3	1	87	31
	(532)	(160)	(29)	(491)	(28)	(81)	(6)	(3)	(116)	(65)
12	164	169	47	44	41	111	42	21	0	1
	(106)	(198)	(19)	(20)	(29)	(96)	(35)	(20)		(1)
13	34	41	89	1	111	24	45	107	0	0
	(34)	(41)	(40)	(2)	(99)	(14)	(47)	(135)		
14	818	302	43	66	19	71	26	+	57	2
	(1 563)	(446)	(53)	(84)	(36)	(77)	(41)	(+)	(54)	(5)
15	64	166	50	65	114	125	11	11	0	2
	(53)	(92)	(37)	(34)	(70)	(75)	(10)	(6)		(2)
16	7	44	42	34	68	58	21	14	0	0
	(13)	(84)	(19)	(44)	(55)	(67)	(11)	(9)		
17	42	86	15	18	4	2	1	0	21	0
	(7)	(110)	(7)	(31)	(7)	(3)	(2)		(21)	
18	25	778	56	2	10	0	2	0	7	0
	(31)	(1 175)	(31)	(3)	(16)		(4)		(5)	
19	34	335	60	5	12	3	53	0	14	0
	(31)	(301)	(25)	(8)	(16)	(4)	(18)		(5)	

+ < 0.5 kg.km^{-2}

Table 3—*continued*

Stratum	GSH	LIN	WAR	SKI	SPO	JDO	LEA	HAK	NSD	JMN
	Species code									
1	0	0	0	0	1 (2)	29 (35)	0	0	0	0
2	70 (29)	0.7 (1)	0	0	0	12 (20)	0	0	7 (8)	0
5	4 (6)	0	1 (1)	0	18 (18)	0	0	0	0	3 (5)
6	33 (29)	+ (+)	0	0	3 (4)	3 (2)	0	0	4 (6)	0
7	4 (6)	0	2 (3)	0	7 (4)	0	0	+ (1)	0	0
8	28 (14)	2 (2)	0	2 (2)	1 (3)	4 (6)	0	2 (6)	7 (14)	0
9	7 (13)	3 (5)	0	27 (26)	0	0	0	0	20 (23)	0
11	0	44 (112)	33 (68)	0	17 (20)	0	0	31 (65)	+ (2)	0
12	0.5 (1)	9 (20)	0	7 (9)	5 (9)	0	0	1 (1)	0	0
13	7 (13)	2 (6)	0	54 (59)	2 (6)	0	0	0	8 (20)	0
14	0	14 (21)	9 (12)	0	23 (32)	0	0	2 (5)	0	0
15	2 (2)	15 (26)	148 (312)	2 (5)	2 (4)	0	0	2 (2)	0	0
16	121 (132)	79 (58)	0	20 (13)	0	0	0	0	2 (5)	0
17	0	1 (1)	2 (2)	0	22 (38)	41 (10)	3 (5)	0	0	51 (14)
18	0	0	1 (1)	0	14 (24)	51 (9)	35 (29)	0	0	17 (13)
19	0	0	0	0	10 (15)	48 (18)	90 (35)	0	0	38 (50)

+ < 0.5 $kg.km^{-2}$

Table 4: Relative doorspread biomass estimates by sub–area for all species where more than 100 kg were caught excluding thresher shark, in order of decreasing total biomass in order of descending 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. (%)
Barracouta	1 579	47	2 907	17	4 485	20
Spiny dogfish	119	35	4 327	15	4 446	15
Arrow squid (*Nototodarus sloanii*)	205	17	2 050	13	2 255	12
Silver dory	0.1	100	985	36	985	36
Tarakihi	40	52	872	21	912	20
Red cod	21	54	886	25	906	24
Giant stargazer	7	63	827	15	834	15
School shark	131	17	523	22	655	18
Dark ghost shark	0		544	15	544	15
Frostfish	0		494	22	494	22
Carpet shark	239	25	210	11	449	14
John dory	178	13	110	45	288	19
Red gurnard	47	16	223	24	270	20
Leatherjacket	254	18	254	18	254	18
Hoki	0		233	22	233	22
Two saddle rattail	0		212	26	212	26
Blue warehou	2	51	189	67	191	66
Ling	0.3	65	150	33	150	33
Rig	44	52	96	22	144	22
Gemfish	0		137	23	137	23
Jack mackerel (*Trachurus novaezelandiae*)	123	50	3	100	126	49
Northern spiny dogfish	0		111	27	111	27
Smooth skate	0		91	79	91	79
Jack mackerel (*T. declivis*)	1	59	86	21	87	21
Common roughy	0		79	79	79	79
Sea perch	5	42	71	27	76	25
Silver warehou	14	56	55	31	69	27
Electric ray	17	52	42	40	59	32
Hake	0		55	47	55	47
Rough skate	1	100	42	35	43	34
New Zealand sole	0		21	57	21	57
Sand flounder	9	35	1	100	10	33
Lemon sole	+	77	2	44	2	44

\+ < 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	1 187	50	2 762	17	3 949	19
Blue warehou	45	0	—	175	72	175	72
Giant stargazer	30	7	64	821	15	828	15
Hoki	65	0	—	4	44	4	44
John dory	25	178	13	110	45	288	19
Lemon sole	25	0.3	85	1	60	2	51
New Zealand sole	25	0	—	20	57	20	57
Red cod	40	7	57.5	612	31	619	31
Red gurnard	30	39	14	215	25	254	21
Rig	90	23	64	59	24	82	25
Sand flounder	25	8	36.4	1	100	9	34
School shark	90	9	100	337	33	345	32
Silver warehou	25	0	—	27	32	27	32
Tarakihi	25	11	96	852	21	863	21

Table 6: Biomass estimates (t)by year class estimated from length frequency distributions.

Species	Year class	Length range (cm)	Biomass	c.v.%
Barracouta	0+	< 29	84	33
	1+	29–39	52	32
	2+	39–48	344	42
	3+	48–60	1211	29
Blue warehou	0+	< 20	1	44
	1+	20–30	0.3	100
Hake	0+	<18	0.4	37
	1+	18–32	39	61
Hoki	0+	14–32	211	23
	1+	32–49	8	55
Jack mackerel				
Trachurus declivis	1+	14–20	1	54
	2+	20–26	0.5	79
T. novaezelandiae	0+	< 15	30	26
	1+	15–21	77	82
Red cod	0+	<24	8	36
	1+	24–40	279	32
Red gurnard	2+	16–28	6	29
School shark	0+	< 36	<0.05	100
	1+	36–50	6	79
Silver warehou	1+	14–23	37	34
	2+	23–33	21	38
Tarakihi	1+	10–15	0.4	47
	2+	15–20	2	43
	3+	20–26	51	31

Table 7: **Estimated biomass (t) (and c.v.%) by stratum for the 20 most abundant commercially important species in order of catch abundance. Species codes are given in Appendix 3**

	Species code									
Stratum	SPD	BAR	NOS	RCO	TAR	STA	SCH	FRO	GUR	HOK
1	161	5	4	0	0	0	14	0	4	0
	(43)	(100)	(76)				(59)		(68)	
2	816	89	227	0	94	0	3	20	0	0
	(23)	(100)	(64)		(91)	(100)	(100)	(100)		
5	184	128	35	0	0	+	1	10	13	0
	(42)	(46)	(95)			(100)	(100)	(100)	(66)	
6	311	261	226	6	45	130	150	32	2	0
	(28)	(77)	(33)	(100)	(39)	(58)	(62)	(73)	(100)	
7	286	419	24	19	1	30	50	0	28	9
	(70)	(71)	(51)	(67)	(100)	(55)	(87)		(84)	(72)
8	797	900	1026	203	52	138	118	254	3	63
	(21)	(24)	(18)	(53)	(50)	(25)	(37)	(33)	(72)	(25)
9	0	15	185	0	313	1	8	1	0	0
		(93)	(34)		(47)	(100)	(67)	(100)		
11	644	281	35	441	24	84	5	2	126	49
	(32)	(22)	(32)	(43)	(46)	(37)	(47)	(63)	(35)	(82)
12	336	347	97	91	84	227	86	43	0	19
	(25)	(44)	(15)	(17)	(27)	(33)	(31)	(35)		(51)
13	37	45	98	1	122	27	50	118	0	1
	(38)	(38)	(17)	(48)	(34)	(21)	(39)	(48)		(71)
14	696	257	37	56	16	60	22	+	48	13
	(72)	(56)	(47)	(48)	(71)	(41)	(60)	(100)	(36)	(96)
15	57	146	44	57	100	110	10	10	0	59
	(37)	(25)	(34)	(24)	(28)	(27)	(40)	(24)		(30)
16	2	14	13	11	22	18	7	4	0	20
	(100)	(96)	(23)	(64)	(41)	(58)	(26)	(31)		(65)
17	13	27	5	6	1	1	+	0	6	0
	(9)	(73)	(28)	(100)	(100)	(100)	(65)		(56)	
18	23	737	53	2	10	0	2	0	7	0
	(72)	(87)	(31)	(80)	(89)		(100)		(43)	
19	83	815	146	13	29	7	129	0	34	0
	(46)	(45)	(21)	(74)	(65)	(69)	(17)		(18)	

\+ < 0.5 t.

Table 7—*continued*

Stratum	GSH	LIN	WAR	SKI	SPO	JDO	LEA	HAK	NSD	JMN
										Species code
1	0	0	0	0	1 (100)	39 (61)	0	0	0	0
2	302 (20)	3 (100)	0	0	0	53 (82)	0	0	31 (58)	0
5	4 (100)	0	1 (100)	0	21 (58)	0	0	0	0	3 (100)
6	108 (44)	+ (100)	0	0	11 (63)	10 (38)	0	0	14 (64)	0
7	3 (100)	0	2 (100)	0	6 (37)	0	0	+ (100)	0	0
8	66 (20)	5 (39)	0	4 (46)	3 (100)	8 (64)	0	6 (100)	17 (81)	0
9	12 (68)	5 (66)	0	51 (34)	0	0	0	0	38 (40)	0
11	0	64 (68)	48 (54)	0	24 (32)	0	0	44 (57)	1 (100)	0
12	1 (100)	19 (83)	0	15 (46)	10 (66)	0	0	1 (87)	0	0
13	7 (75)	3 (100)	0	59 (42)	3 (100)	0	0	0	9 (91)	0
14	0	12 (56)	8 (48)	0	19 (53)	0	0	2 (91)	0	0
15	1 (63)	13 (80)	131 (94)	2 (100)	2 (100)	0	0	2 (54)	0	0
16	39 (54)	25 (37)	0	7 (32)	0	0	0	0	1 (100)	0
17	0	+ (65)	1 (53)	0	7 (100)	13 (15)	1 (89)	0	0	16 (16)
18	0	0	1 (79)	0	13 (100)	49 (11)	33 (49)	0	0	16 (43)
19	0	0	0	0	25 (73)	117 (19)	220 (19)	0	0	92 (67)

+ < 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	Measurement method	No. of samples	No. of fish	No. of males	No. of females	No. of samples	No. of fish	No. of otoliths
BAR	1	74	4 141	1 956	1 487	0	0	0
BCO	2	3	4	3	1	0	0	0
BNS	2	1	1	1	0	0	0	0
BRI	2	4	4	3	1	0	0	0
CBI	2	22	540	221	316	20	385	0
EGR	5	3	4	4	0	3	4	0
ELE	1	12	33	8	25	0	0	0
EMA	1	2	3	1	0	0	0	0
ESO	2	8	169	84	85	8	124	91
FRO	1	41	758	237	334	0	0	0
GLB	2	1	2	0	2	1	2	0
GSH	G	31	537	232	302	1	13	0
GUR	1	40	1 230	667	560	40	677	220
HAK	2	23	429	24	25	0	0	0
HAP	2	8	9	4	5	0	0	0
HEP	2	1	1	0	1	0	0	0
HEX	2	1	1	0	1	0	0	0
HOK	2	35	2 252	131	89	0	0	0
JDO	2	20	189	65	122	0	0	0
JGU	1	1	2	0	2	0	0	0
JMD	1	37	160	82	64	0	0	0
JMM	1	7	7	5	1	0	0	0
JMN	1	12	1 253	162	133	0	0	0
KAH	1	1	3	0	0	0	0	0
LDO	2	3	14	0	13	0	0	0
LIN	2	35	309	144	162	1	2	0
LSO	2	13	32	7	25	13	32	30
MDO	2	2	10	0	8	0	0	0
NOS	4	81	4 988	2 825	2 031	0	0	0
NSD	2	16	88	28	60	0	0	0
OPE	2	2	30	23	7	0	0	0
RBY	1	2	15	10	5	0	0	0
RCO	2	55	2 166	1 177	978	55	969	406
RSK	5	19	44	18	26	19	44	0
SCH	2	55	315	169	140	53	312	0
SEV	2	1	1	0	1	0	0	0
SFL	2	7	89	5	74	0	0	0
SKI	1	26	346	159	185	0	0	0
SNA	1	4	9	4	5	2	7	4
SPD	2	73	3 760	1 749	2 006	0	0	0
SPE	2	39	741	380	317	0	0	0
SPO	2	31	136	85	51	1	5	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
SSH	2	6	39	1	37	3	12	0
SSK	5	6	14	7	7	6	14	0
STA	2	51	522	277	240	51	522	300
SWA	1	37	493	143	93	0	0	0
TAR	1	60	1 818	943	869	60	986	305
THR	2	4	5	3	2	0	0	0
WAR	1	27	612	95	61	2	2	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.

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	1	0	0	0	0	1	0	0	0	0	
21–30	9	0	0	0	0	8	0	0	0	0	
31–40	19	4	0	1	0	16	0	0	0	0	
41–50	43	36	45	0	0	24	2	0	0	0	
51–60	9	32	58	0	0	27	37	1	0	0	
61–70	1	11	7	1	0	9	96	0	1	0	
> 70	0	0	0	0	0	3	14	0	0	0	
Total	82	83	110	2	0	88	149	1	1	0	516
Red cod											
11–20	18	0	0	0	0	19	0	0	0	0	
21–30	112	0	0	0	0	83	0	0	0	0	
31–40	215	5	8	0	0	126	0	0	0	0	
41–50	59	3	17	3	1	72	0	0	0	0	
51–60	6	3	38	17	1	83	11	8	0	1	
> 60	1	0	0	0	0	40	3	3	0	1	
Total	411	11	63	20	2	423	14	11	0	2	957
Red gurnard											
11–20	0	0	0	0	0	1	0	0	0	0	
21–30	46	14	3		18	20	1	0	0	7	
31–40	75	11	9	2	177	44	33	7	2	79	
41–50	1	1	1	0	13	5	17	17	3	66	
> 50	0	0	0	0	0	0	1	0	0	0	
Total	122	26	13	2	208	70	52	24	5	152	674
Tarakihi											
11–20	16	0	0	0	0	18	0	0	0	0	
21–30	88	2	3	0	0	99	0	0	0	0	
31–40	5	19	127	82	8	56	117	20	7	4	
41–50	0	2	31	38	9	6	125	23	9	2	
> 50	0	0	0	0	0	0	0	0	0	0	
Total	93	23	161	120	17	161	242	43	16	6	882

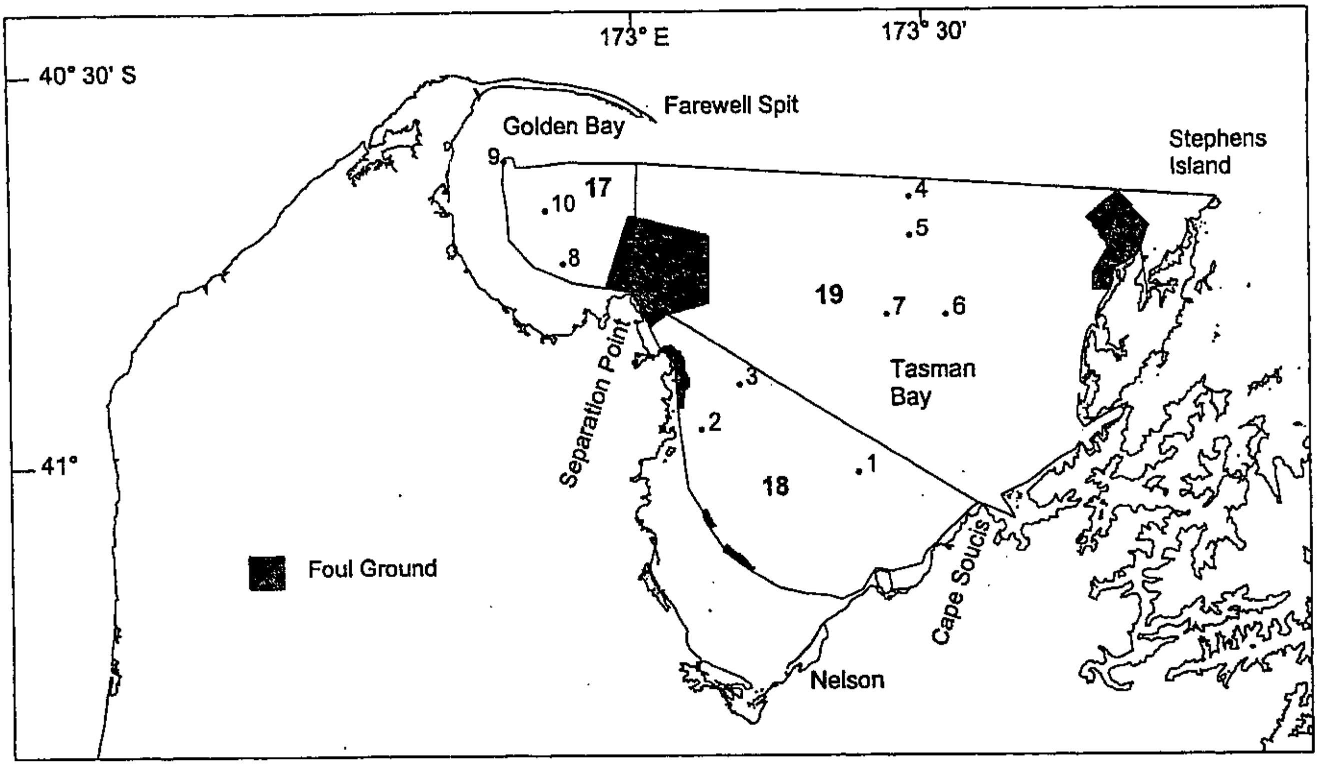
Gonad stages used were: 1, immature or resting; 2, maturing (oocytes visible in females); 3, mature (hyaline oocytes in females, milt expressible in males); 4, running ripe (eggs and milt free flowing); 5, spent.

Table 10: Estimated biomass (t) and coefficient of variation (c.v.%) for the target species, all years

	KAH9204		KAH9404		KAH9504		KAH9701		KAH0004		KAH0304	
	Biomass	c.v. (%)	Biomass	c.v. (%)	Biomass	c.v. (%)	Biomass	c.v. (%)	Biomass	c.v. (%)	Biomass	c.v. (%)
Giant stargazer	1 302	12	1 350	17	1 551	16	1 450	15	1 023	12	834	15
Red cod	2 719	13	3 169	18	3 123	15	2 546	23	414	26	906	24
Red gurnard	573	16	559	15	584	19	471	13	625	14	270	20
Tarakihi	1 409	14	1 394	13	1 389	10	1 087	12	964	19	912	20

Table 11:Biomass (t) by area for red gurnard, all years

	KAH9204		KAH9404		KAH9504		KAH9701		KAH0004		KAH0304	
	Biomass	c.v. (%)	Biomass	c.v. (%)	Biomass	c.v. (%)	Biomass	c.v. (%)	Biomass	c.v. (%)	Biomass	c.v. (%)
Tasman/Golden Bays	252	24	274	16	185	14	233	12	301	23	47	16
West coast	321	20	285	25	399	28	237	22	324	18	223	24



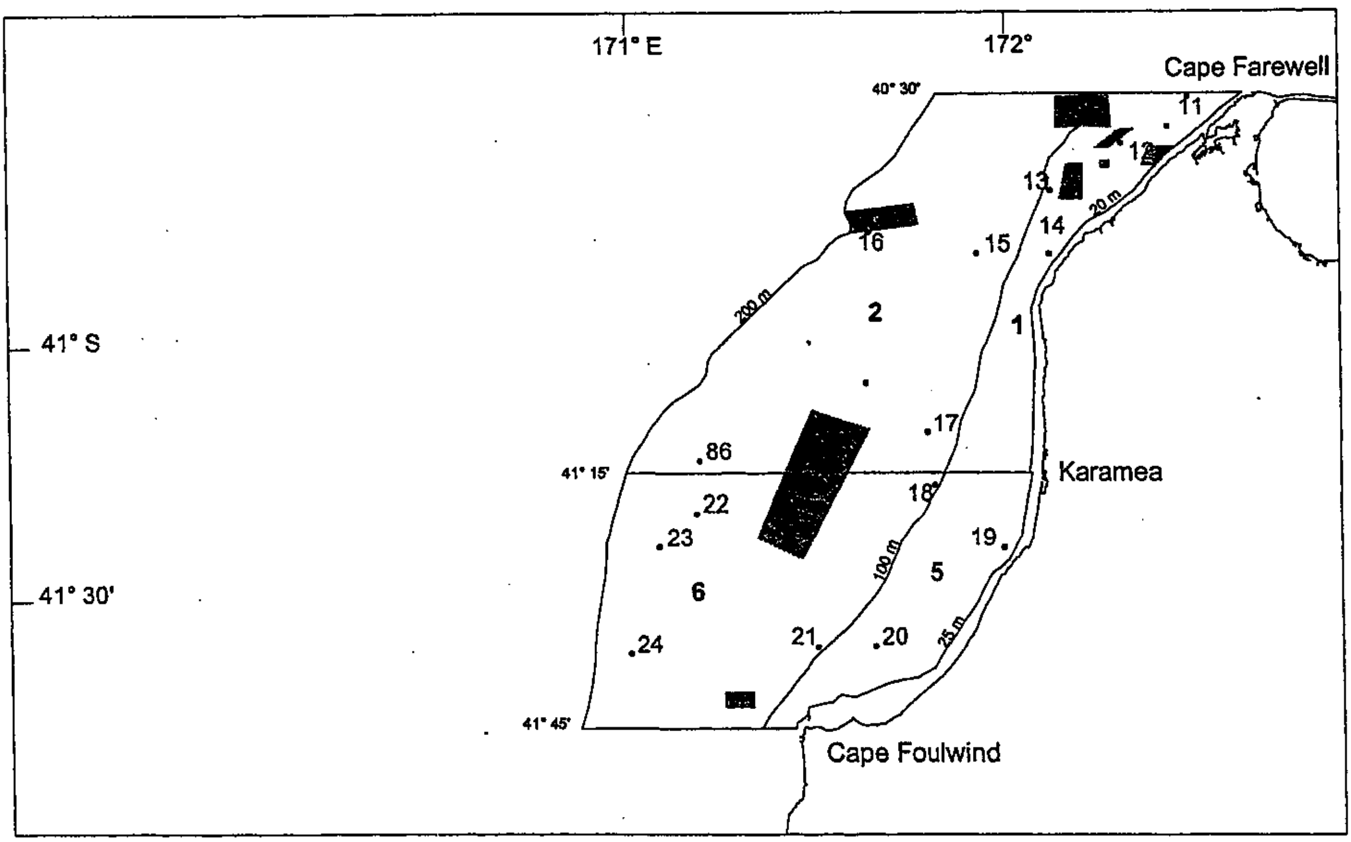


Figure 1a: Survey area showing stratum boundaries and numbers (bold type) for Tasman and Golden Bays (top) and west coast north of Cape Foulwind (bottom) with station positions and numbers.

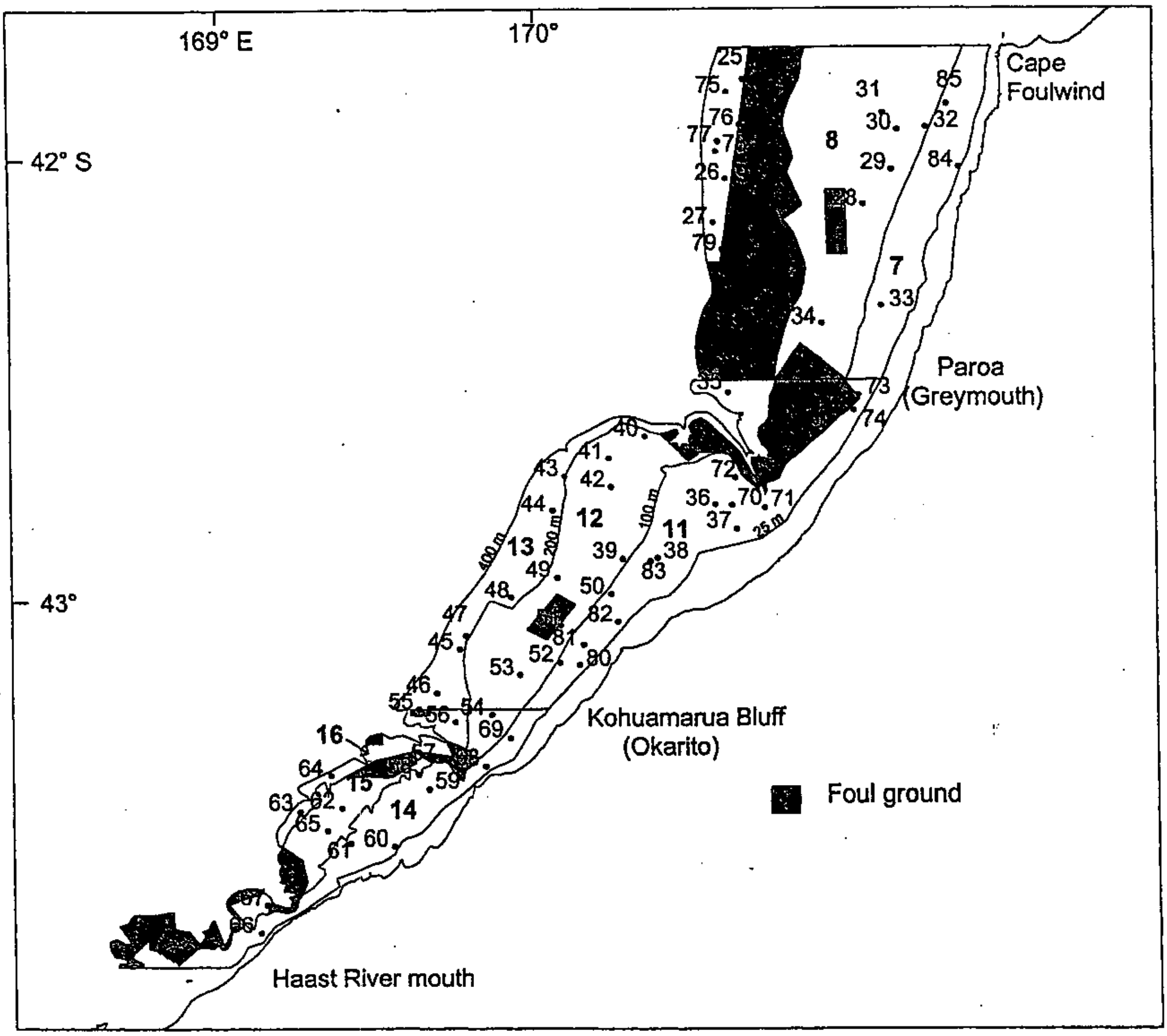


Figure 1b: Stratum boundaries and number (bold type) for the west coast south of Cape Foulwind with station positions and numbers.

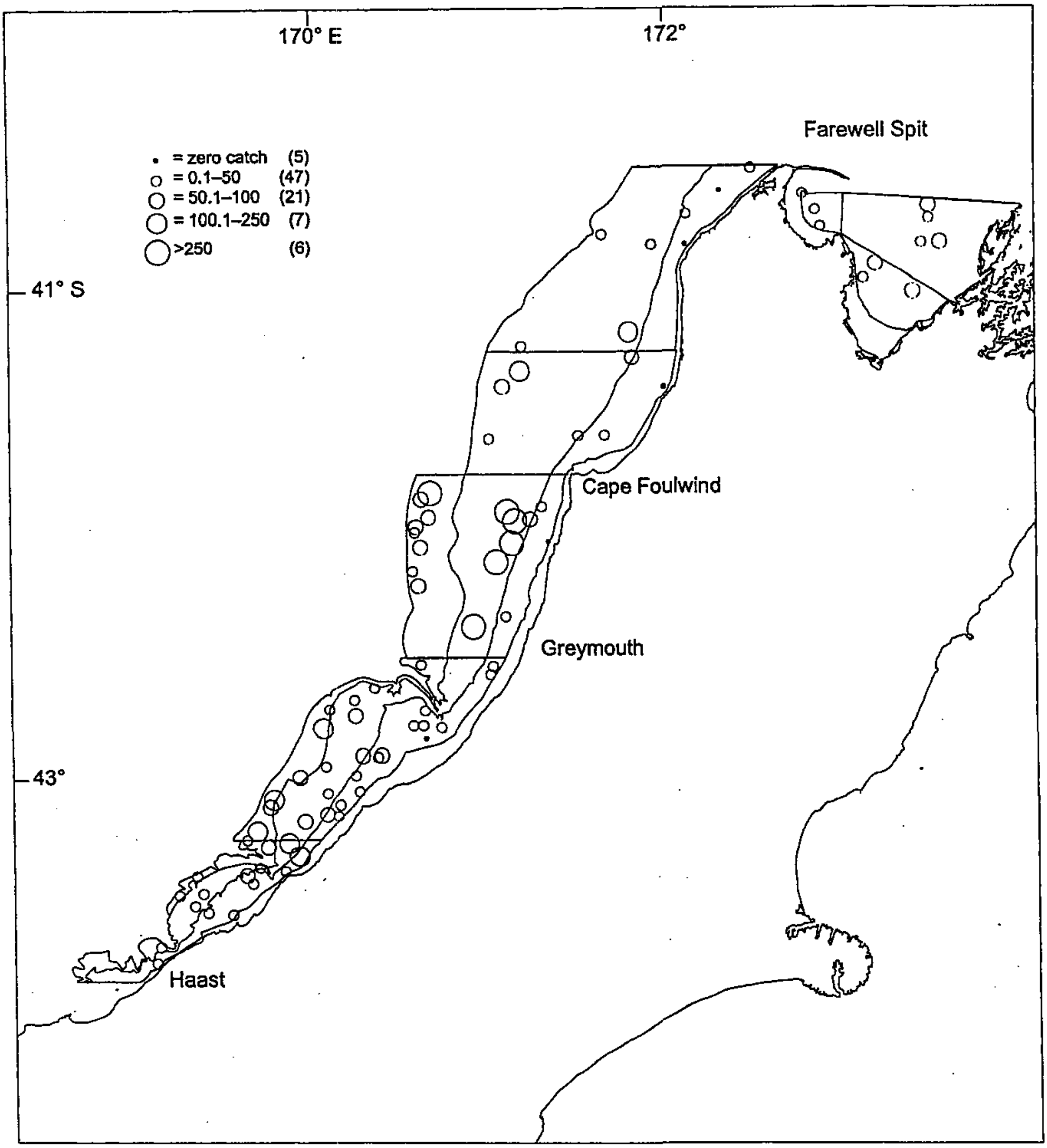


Figure 2: Catch rates (kg.km⁻²) for the 15 most abundant commercial species in alphabetical order by common name (numbers in parenthesis are the number of catches within the given range).
a: Arrow squid (maximum catch rate 605 kg.km⁻²)

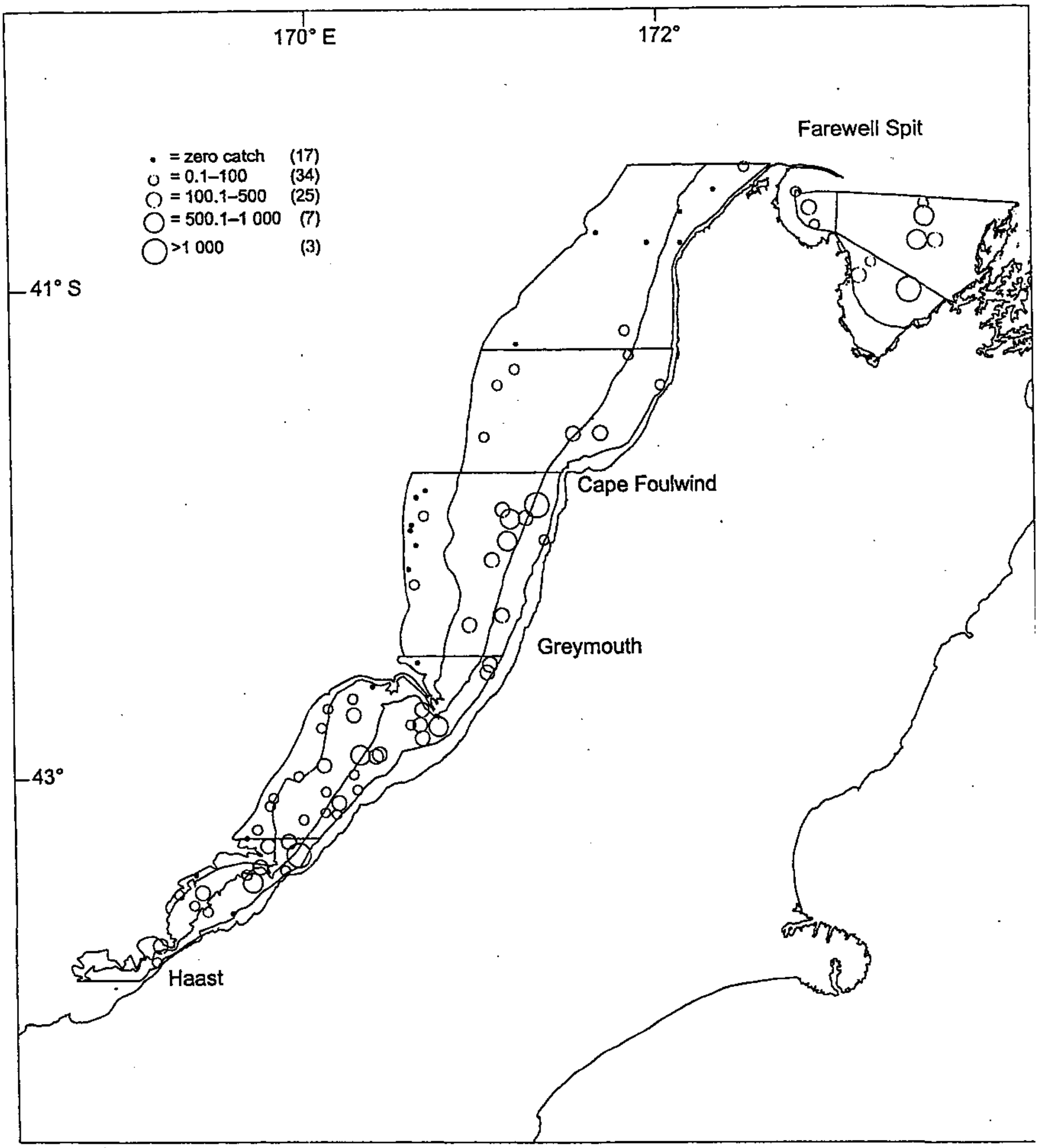


Figure 2b: Barracouta (maximum catch rate 2 140 kg.km⁻²)

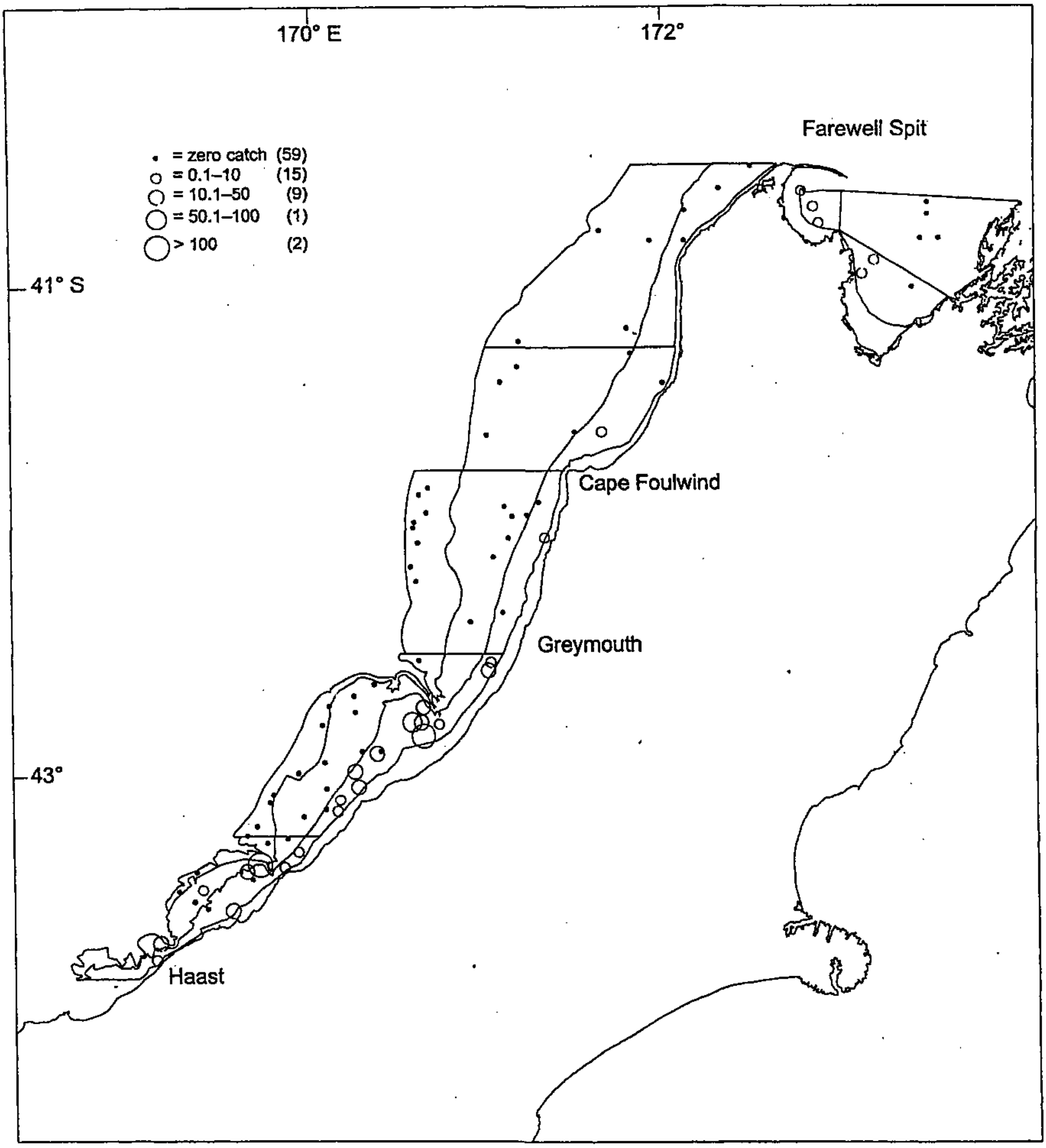


Figure 2c: Blue warehou (maximum catch rate 707 kg.km^{-2})

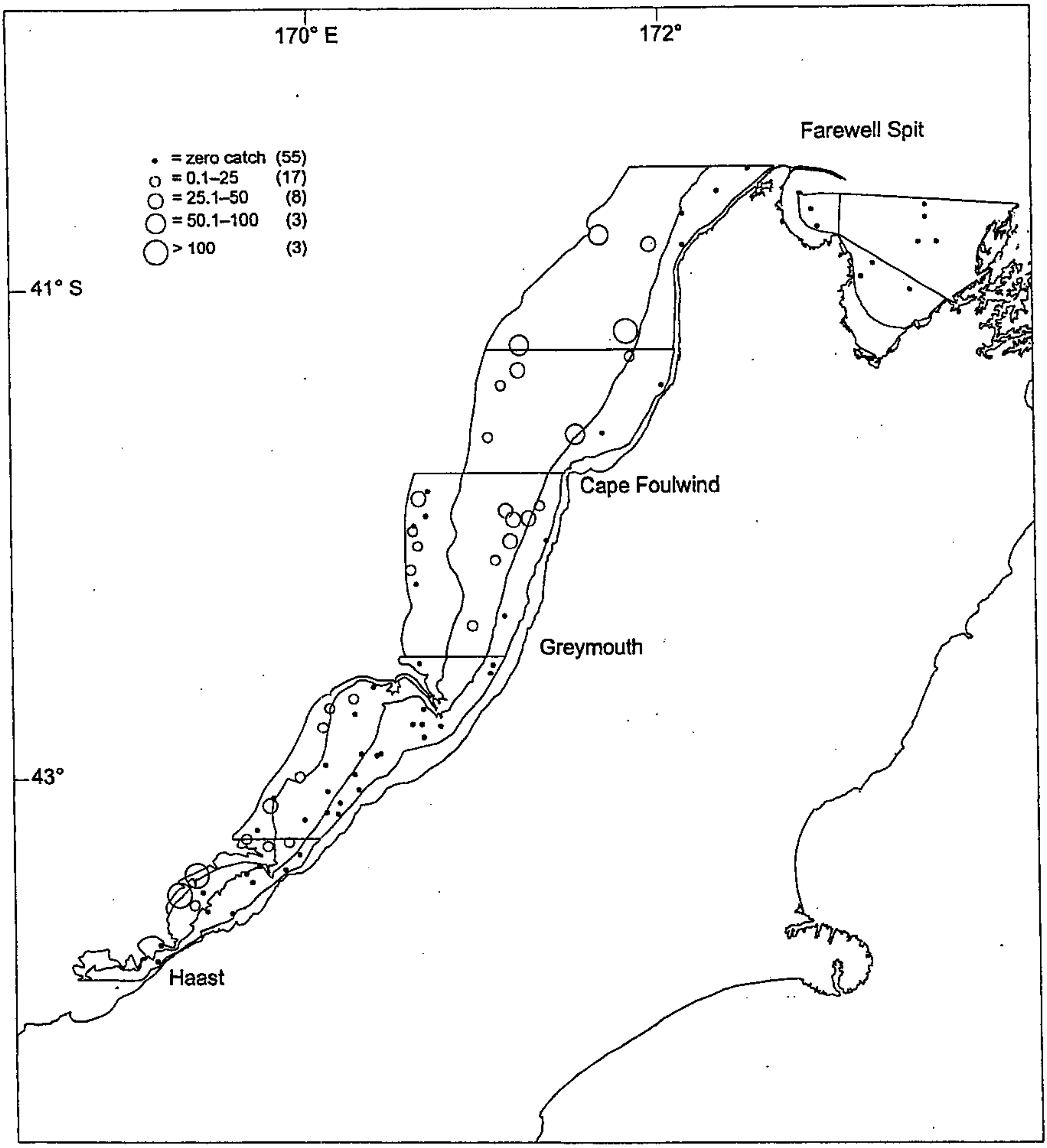


Figure 2d: Dark ghost shark (maximum catch rate 285 kg.km⁻²)

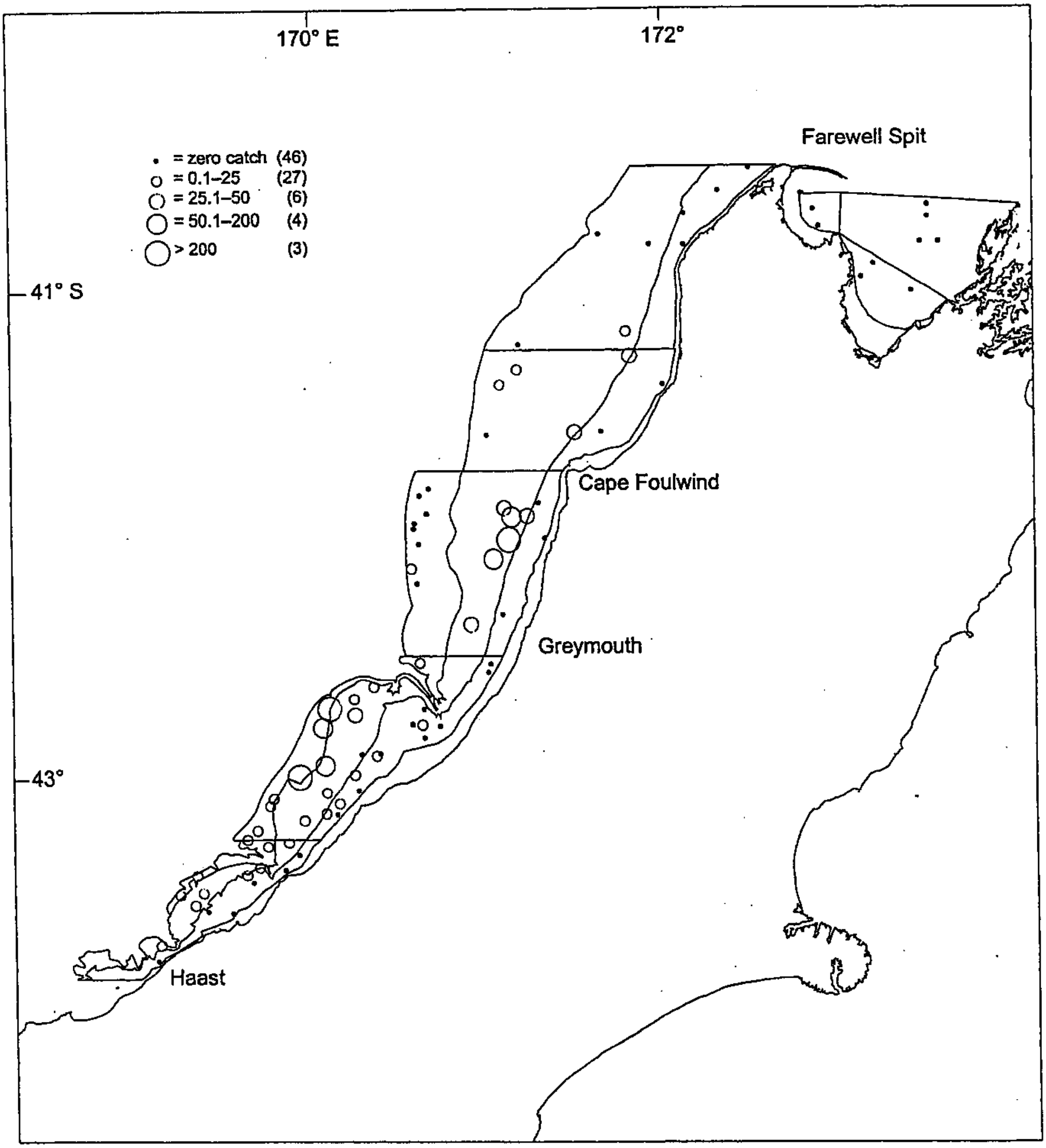


Figure 2e: Frostfish (maximum catch rate 316 kg.km^{-2})

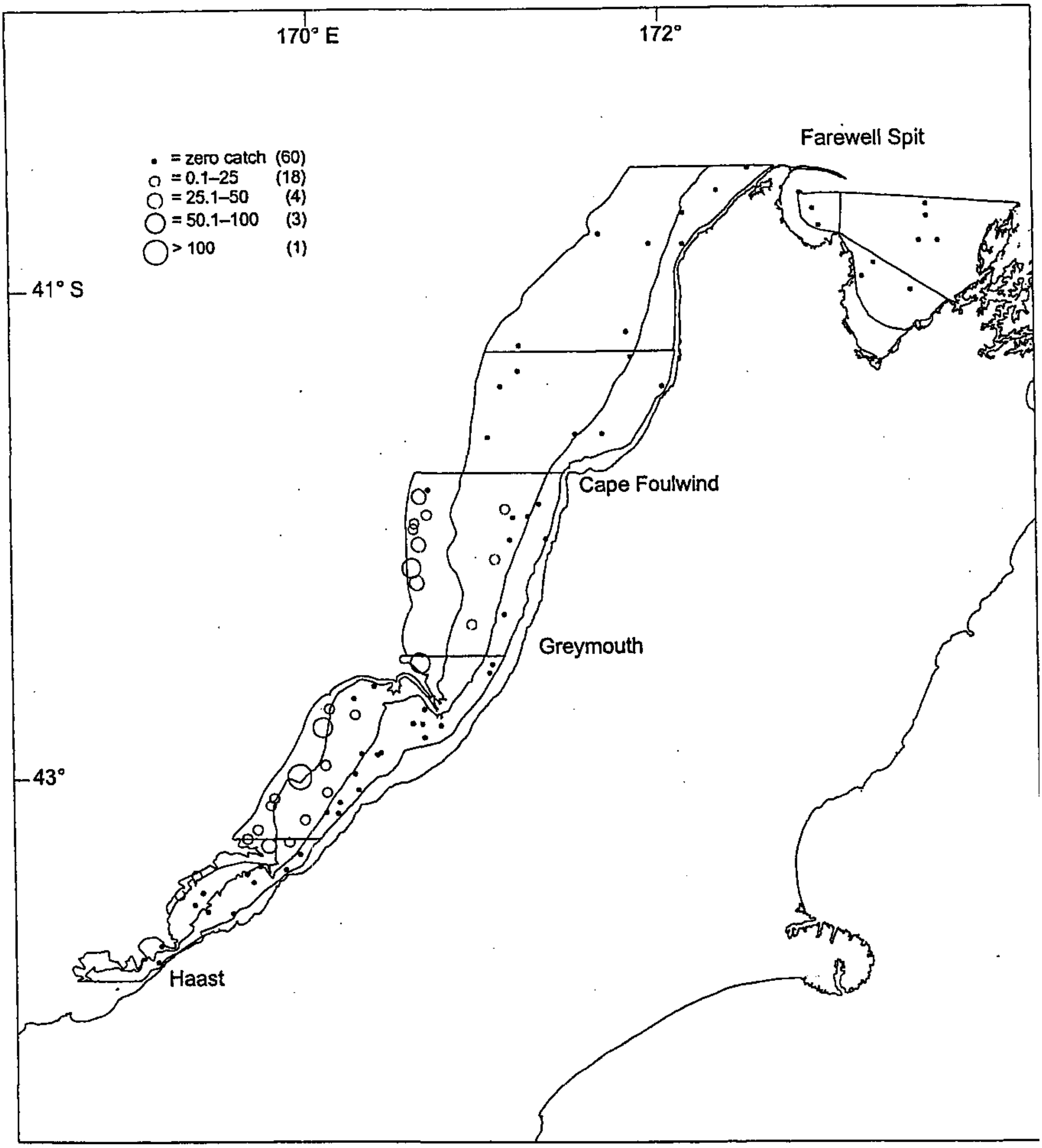


Figure 2f : Gemfish (maximum catch rate 168 kg.km⁻²)

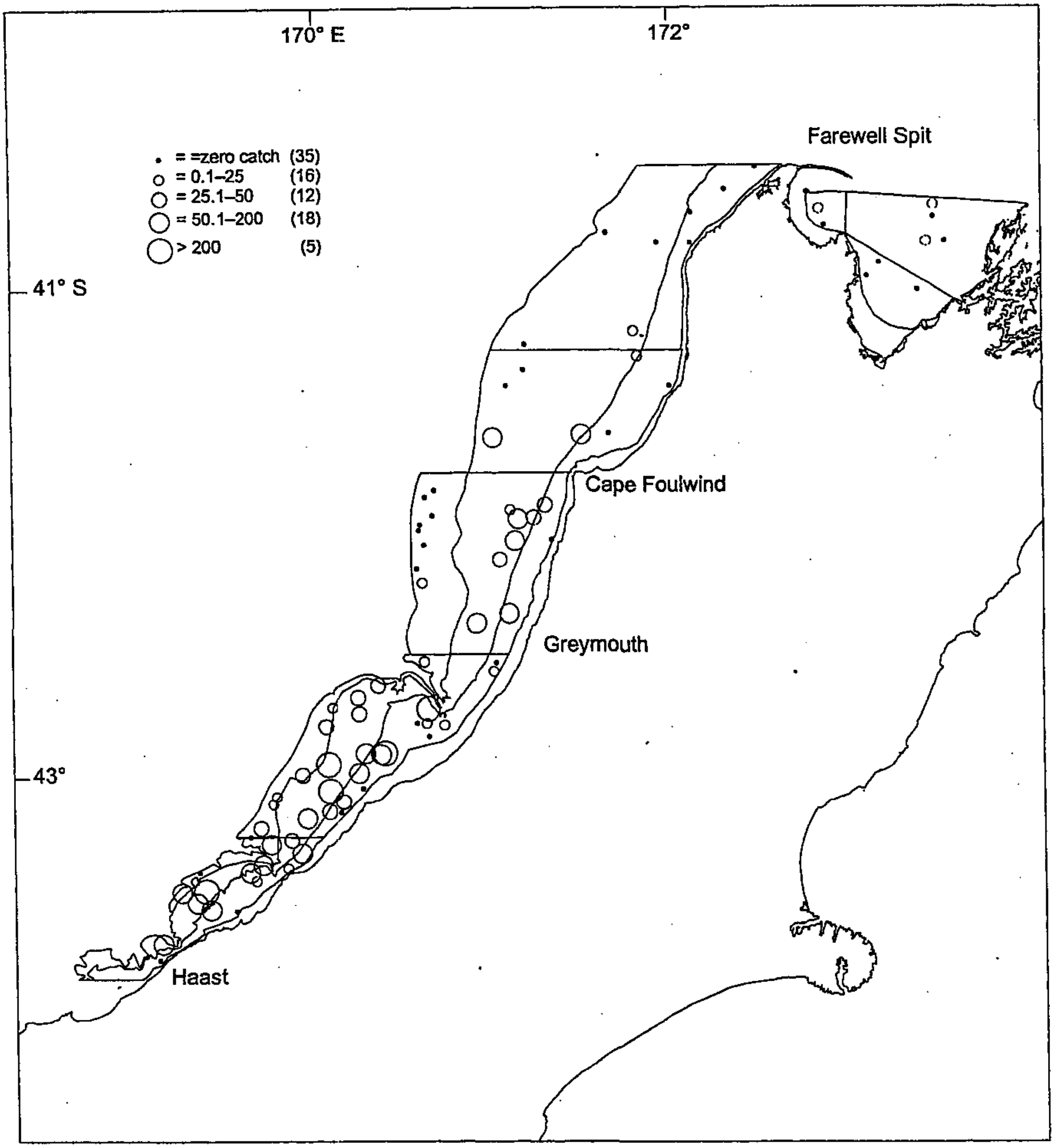


Figure 2g: Giant stargazer (maximum catch rate 253 kg.km⁻²)

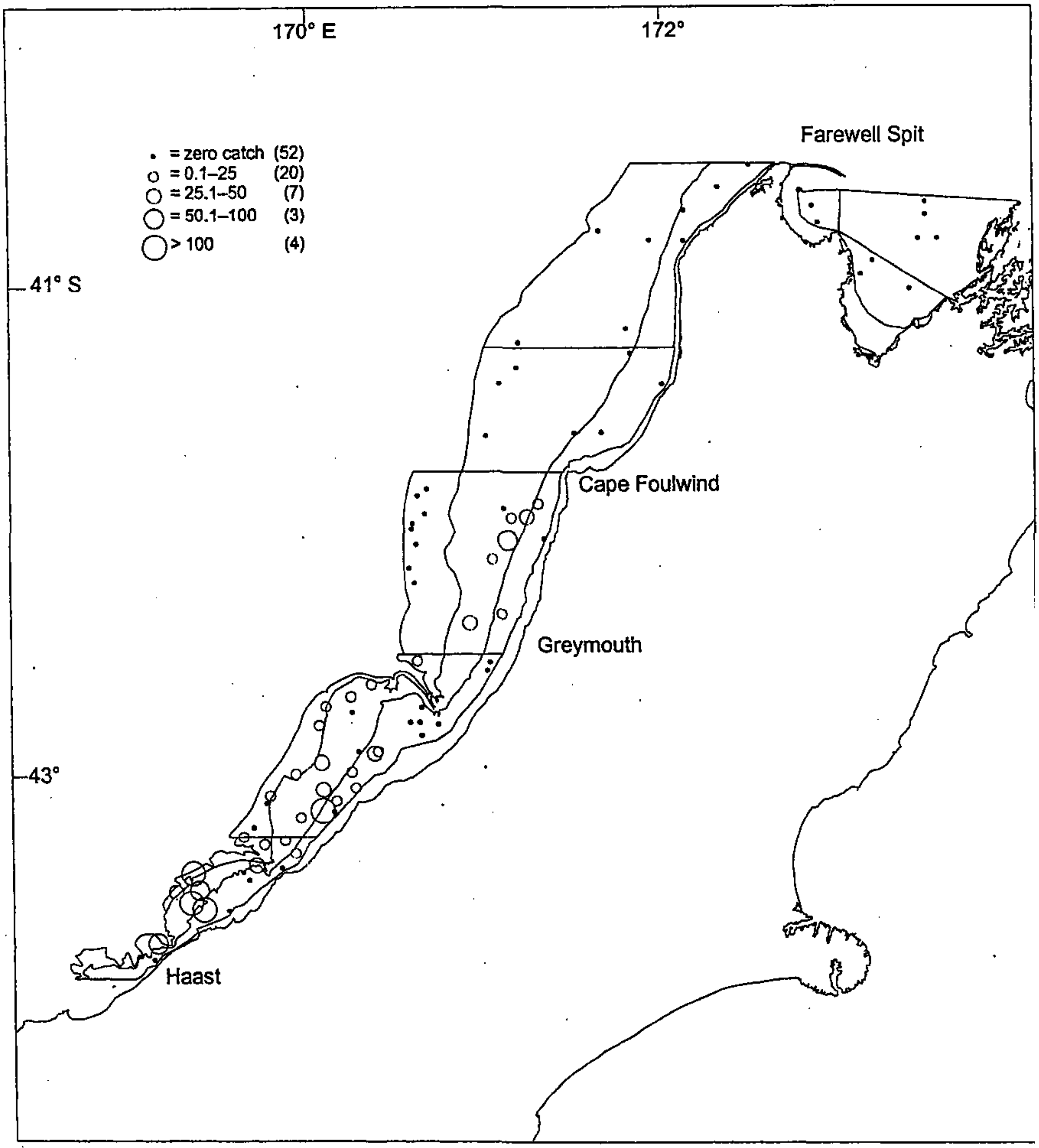


Figure 2h: Hoki (maximum catch rate 392 kg.km⁻²)

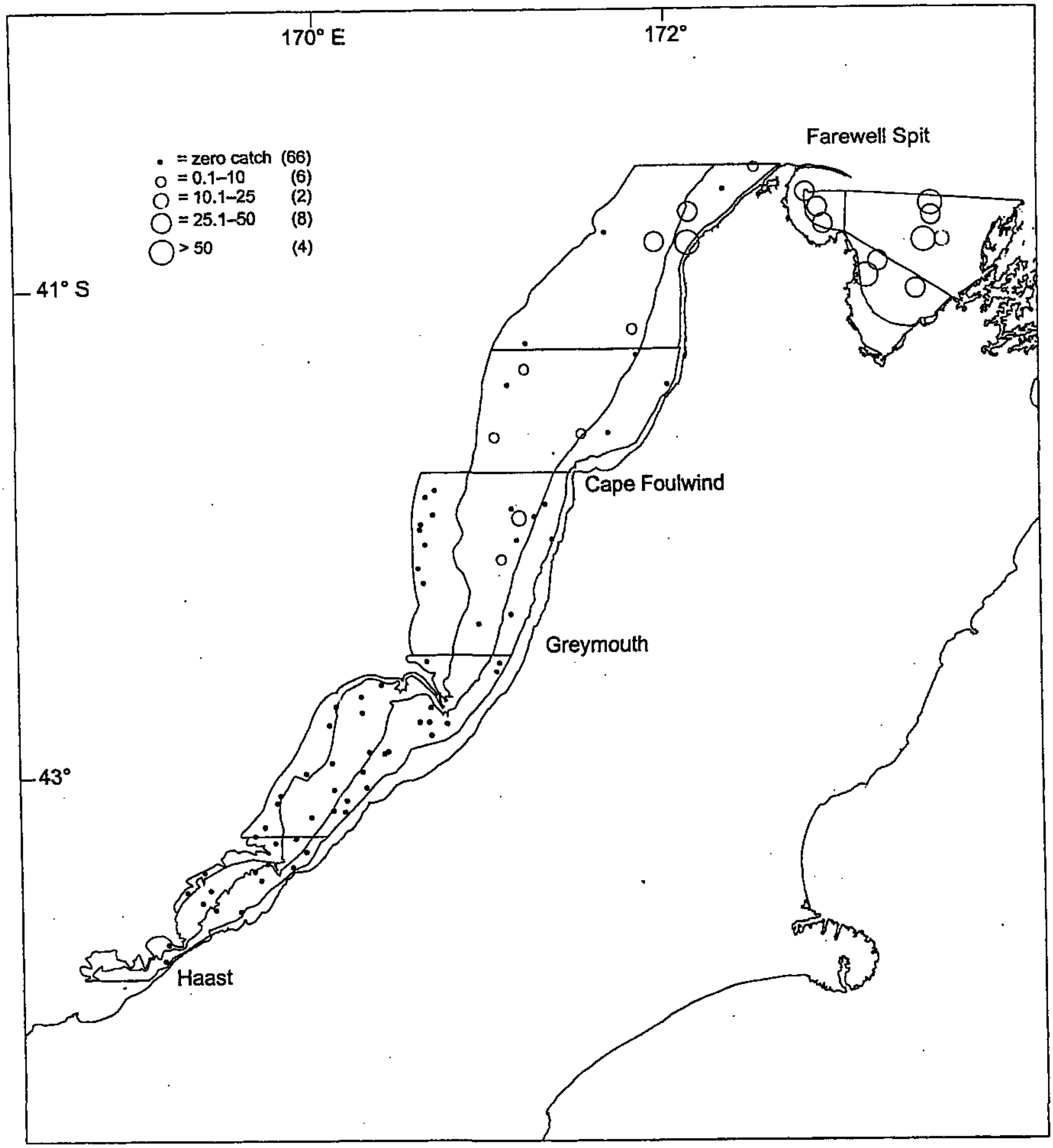


Figure 2i : John dory (maximum catch rate 75 kg.km⁻²)

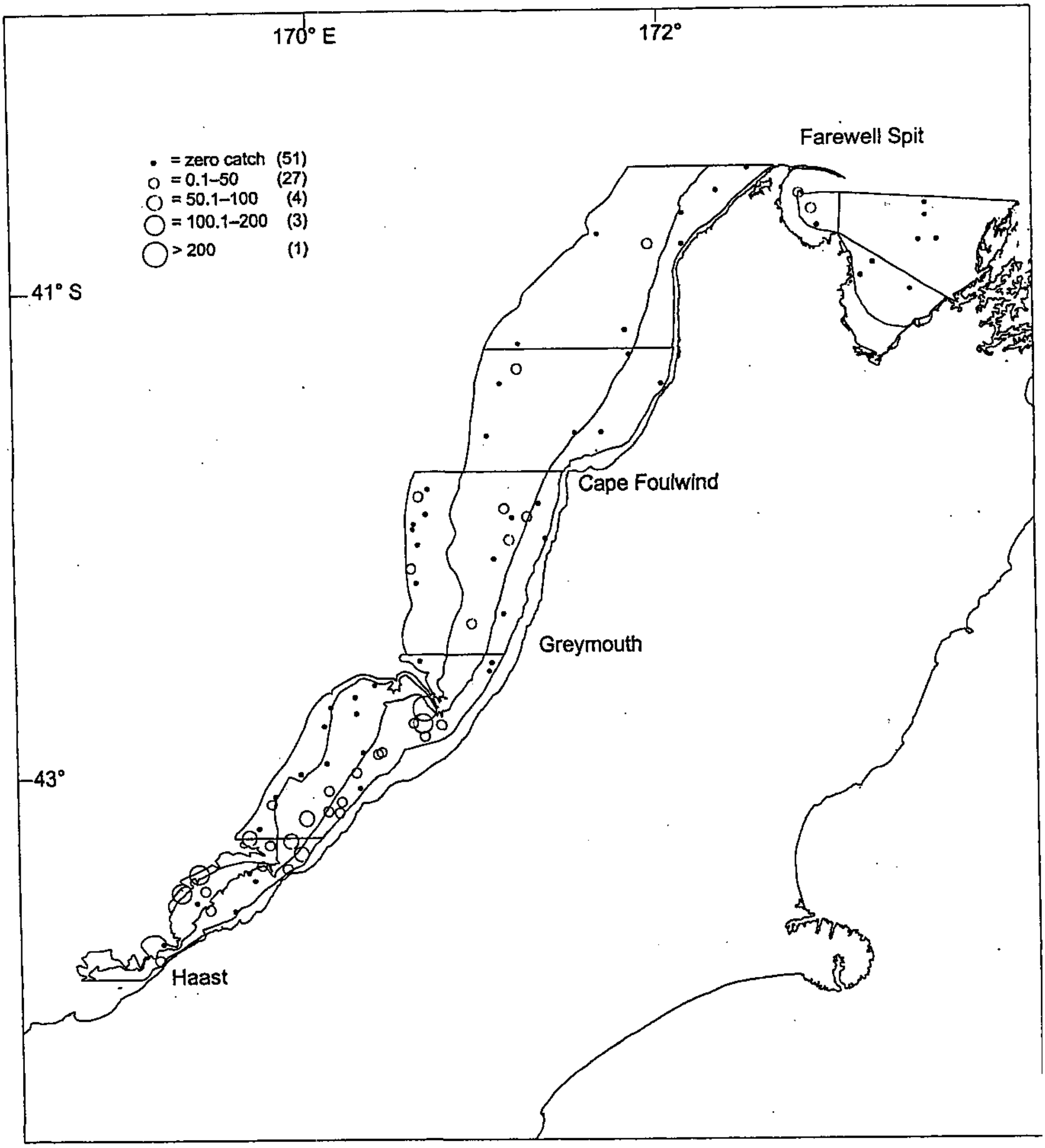


Figure 2j : Ling (maximum catch rate 418 kg.km⁻²)

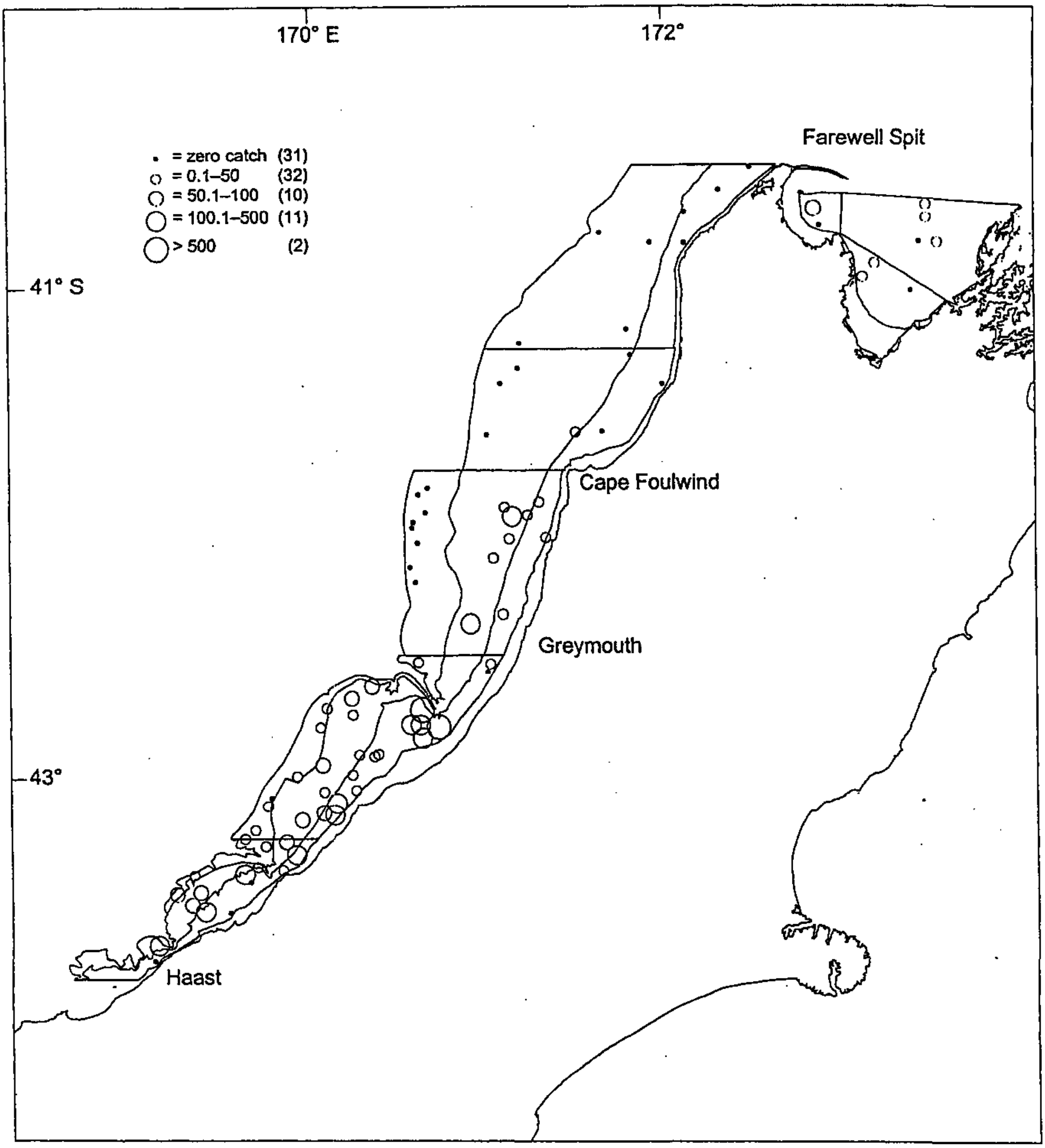


Figure 2k: Red cod (maximum catch rate 1 740 kg.km⁻²)

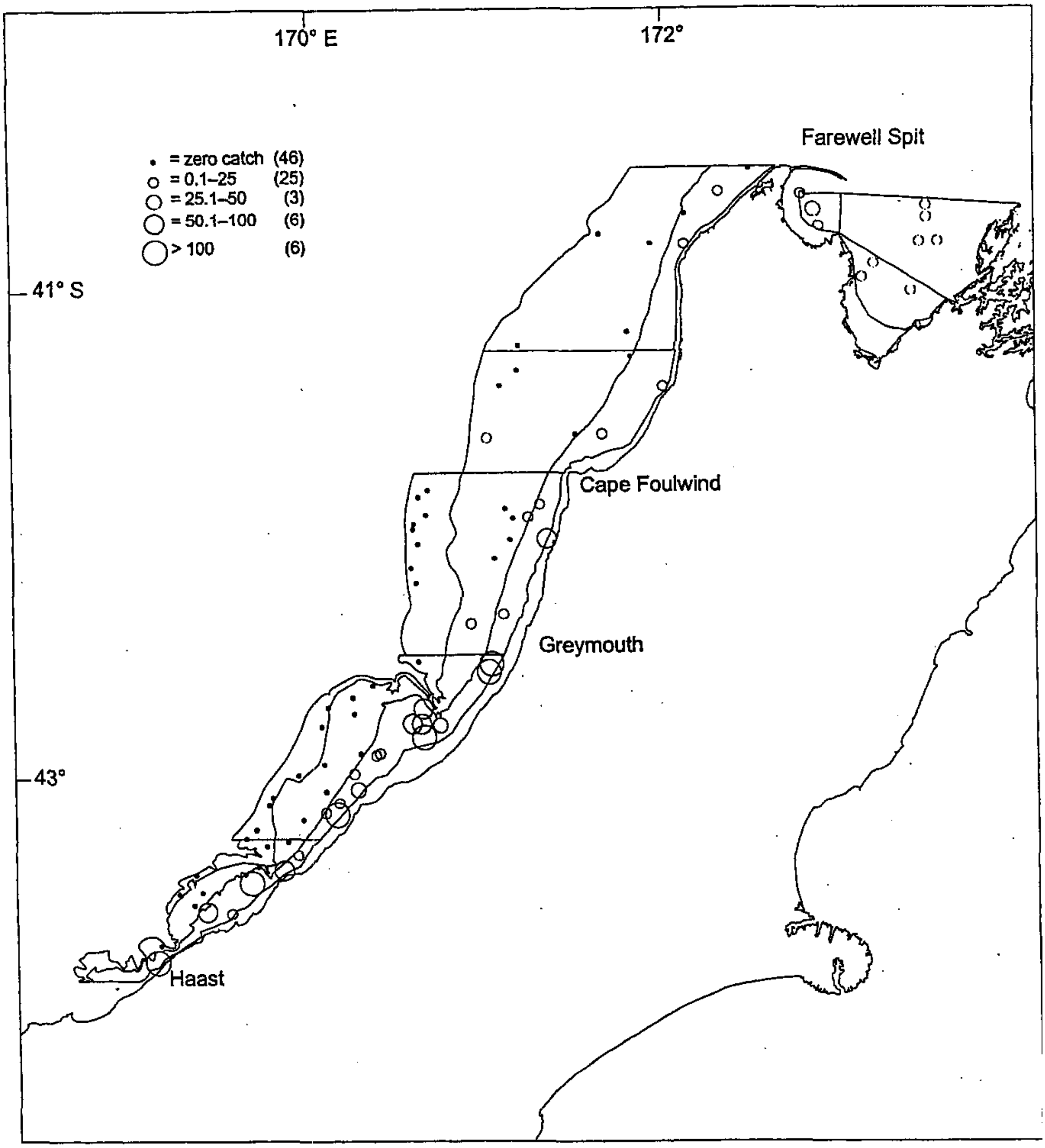


Figure 21 : Red gurnard (maximum catch rate 440 kg.km^{-2})

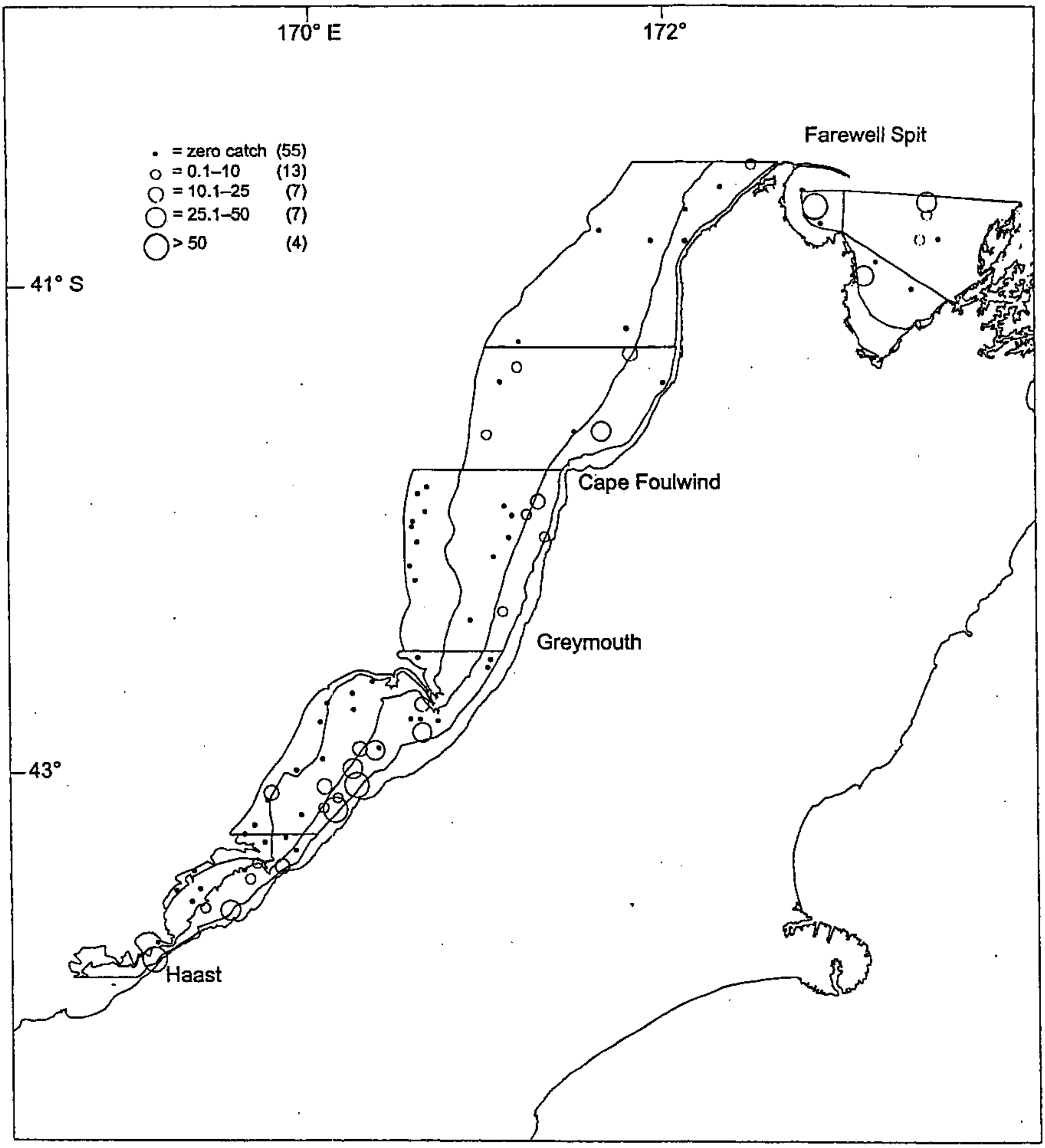


Figure 2m: Rig (maximum catch rate 86 kg.km⁻²)

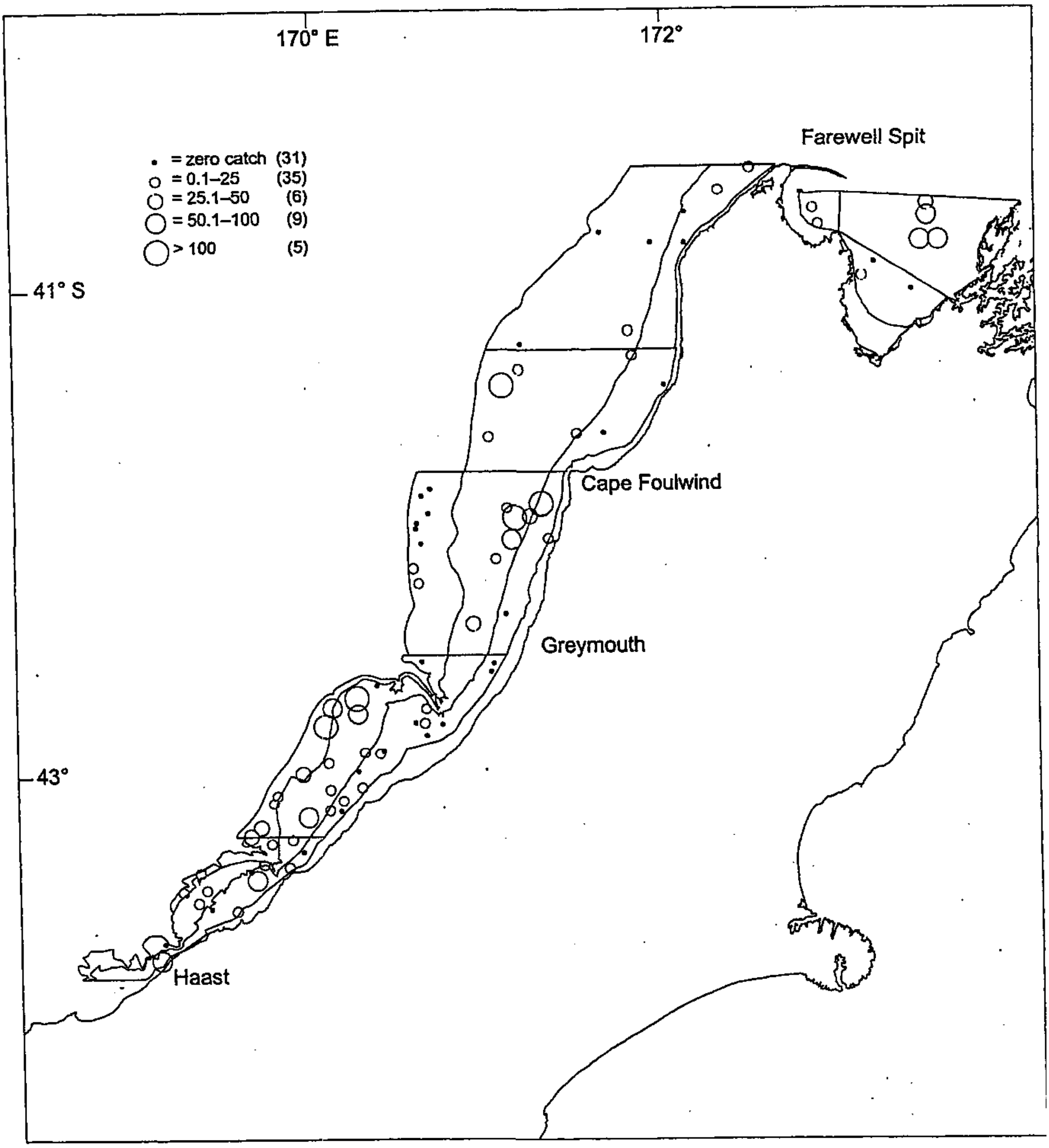


Figure 2n: School shark (maximum catch rate 148 kg.km^{-2})

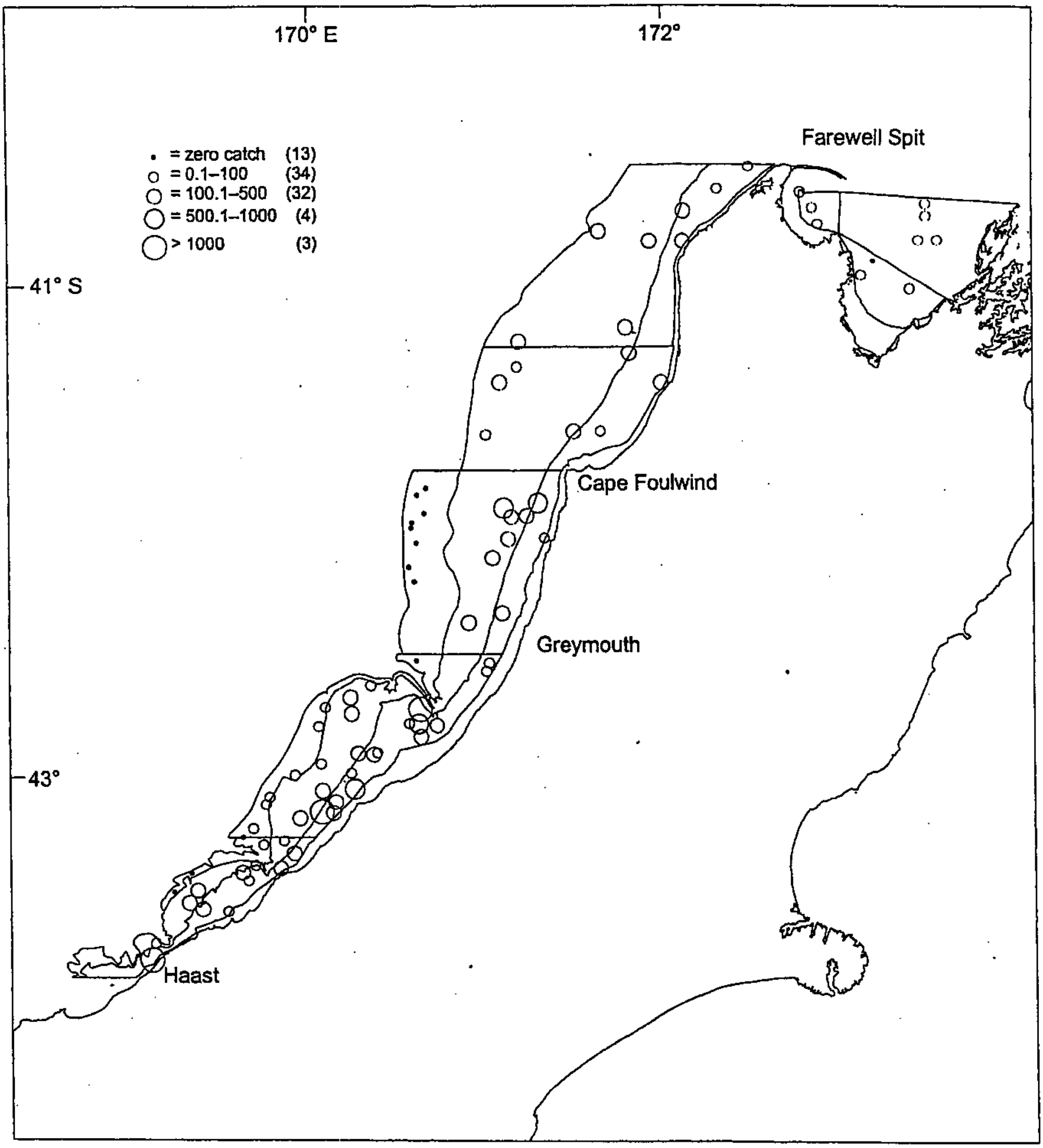


Figure 2o : Spiny dogfish (maximum catch rate 4 350 kg.km^{-2})

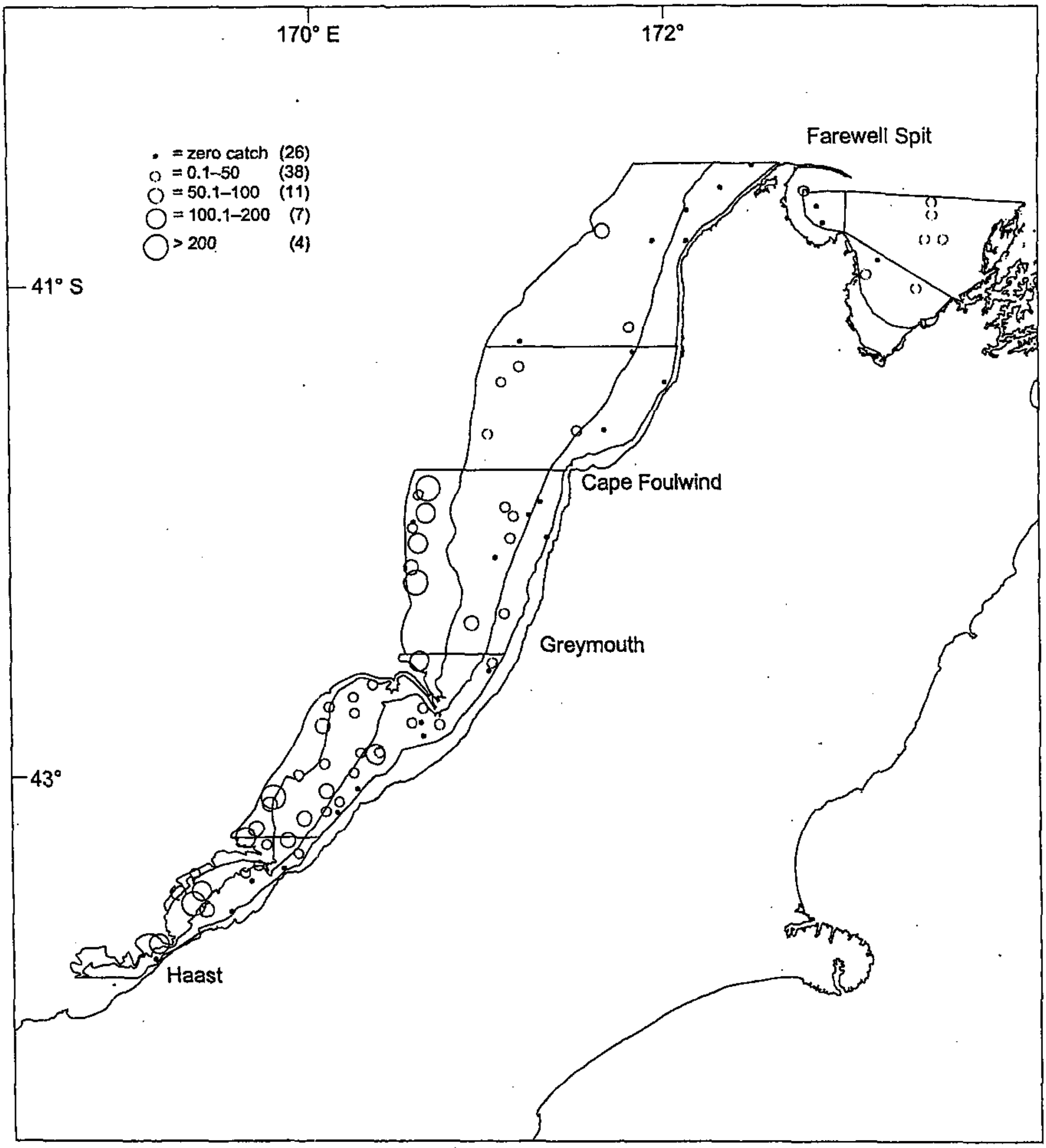


Figure 2p: Tarakihi (maximum catch rate 654 kg.km⁻²)

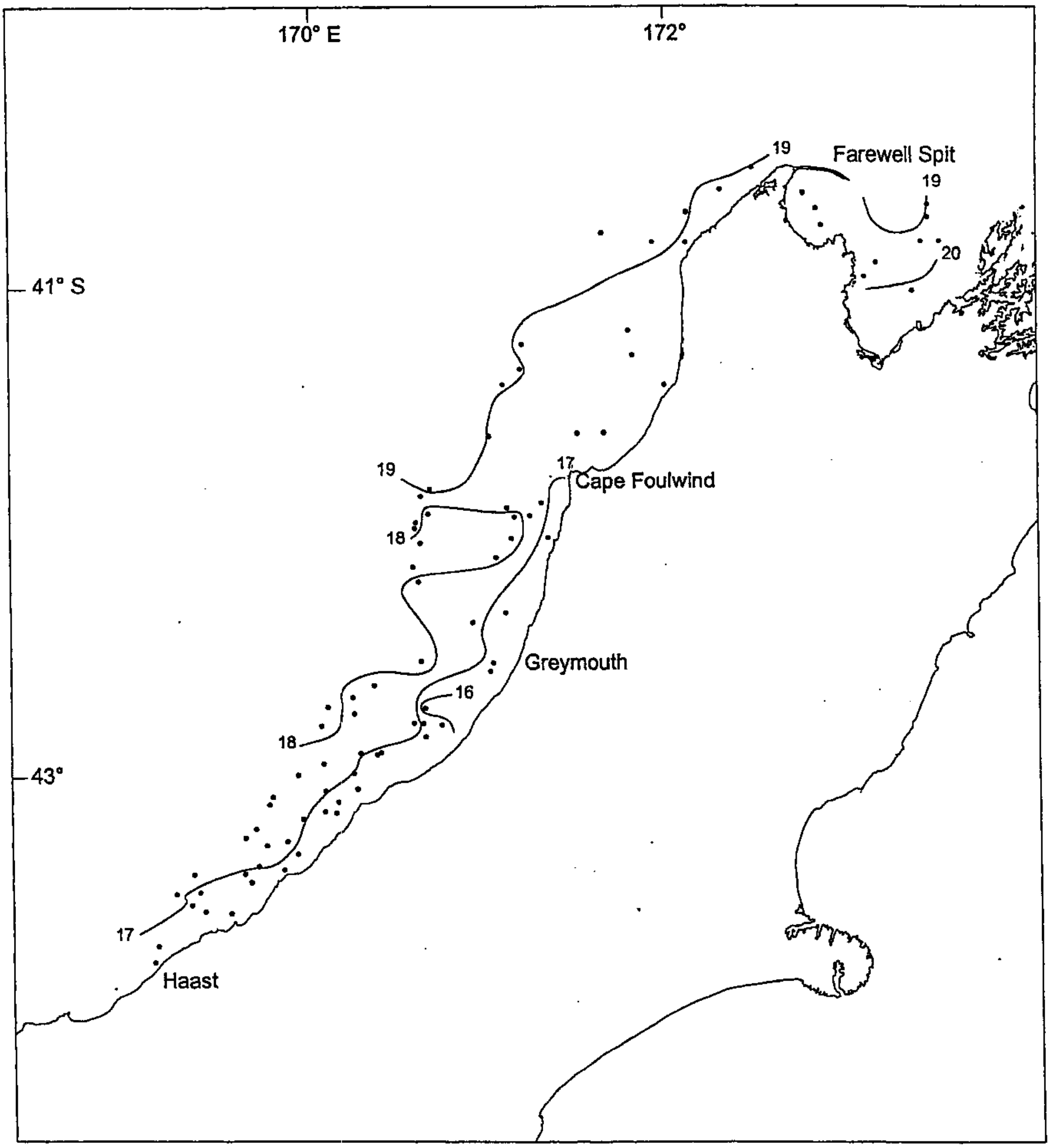


Figure 3: Positions of sea surface temperature recordings and isotherms estimated from the temperature recordings.

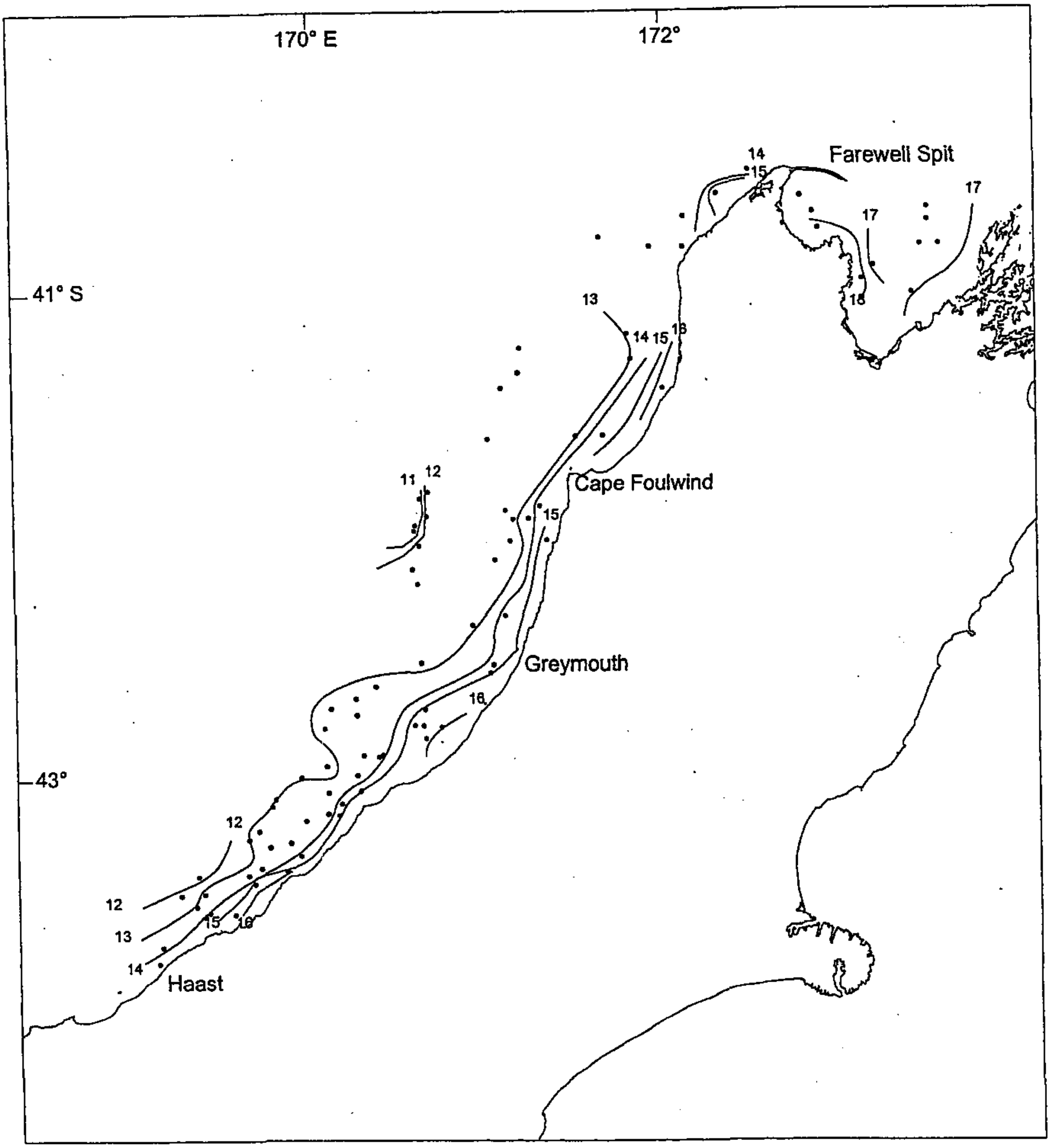


Figure 4: Positions of bottom temperature recordings and isotherms estimated from the temperature recordings.

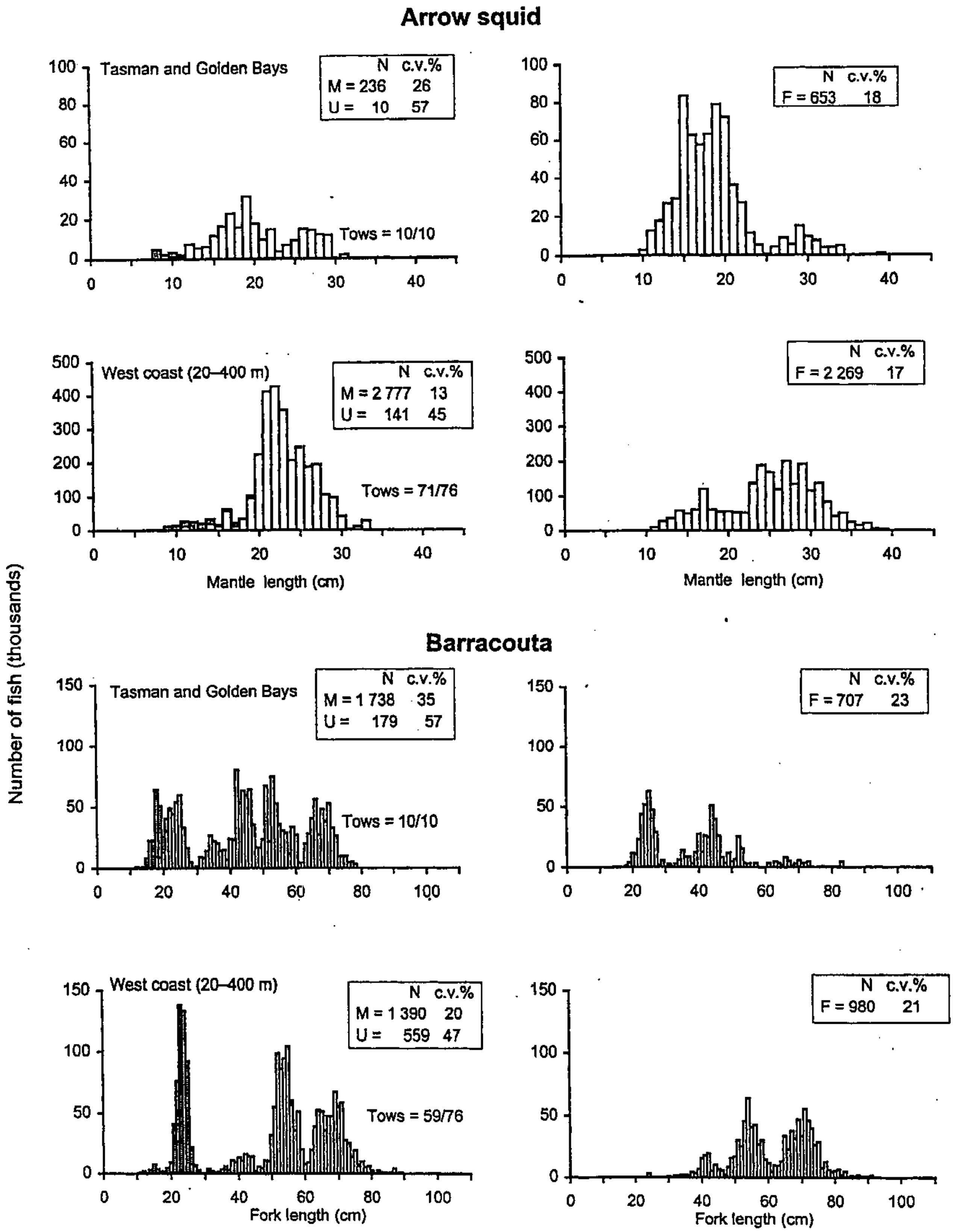


Figure 5: Length frequency distributions for the major commercial species in alphebetical order by common name (by depth where appropriate). N, estimated population (scaled, thousands); M, male; F, female; U, unsexed (shaded); Tows, number of stations where species was caught/total number of stations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

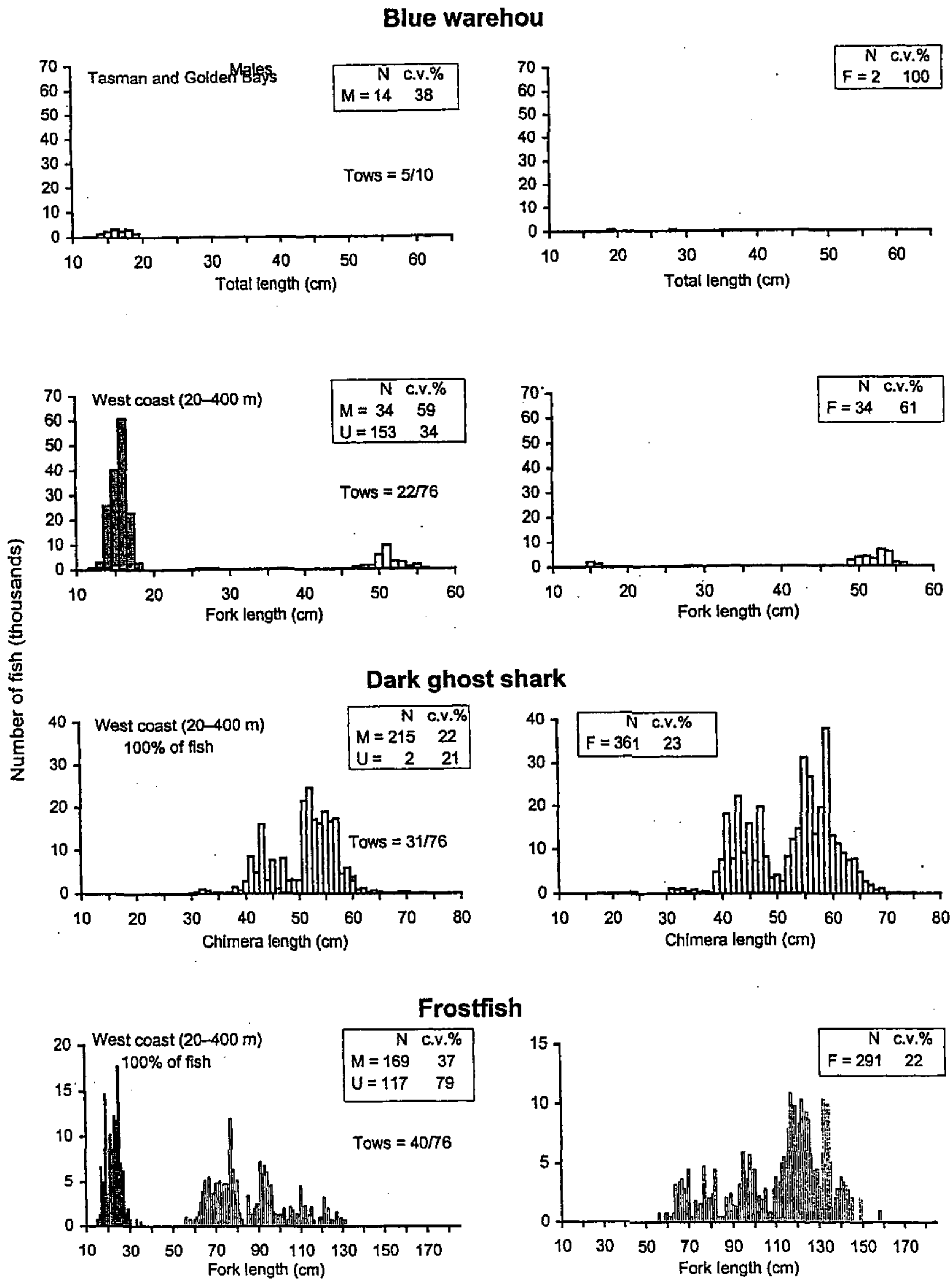


Figure 5—*continued*

Giant stargazer

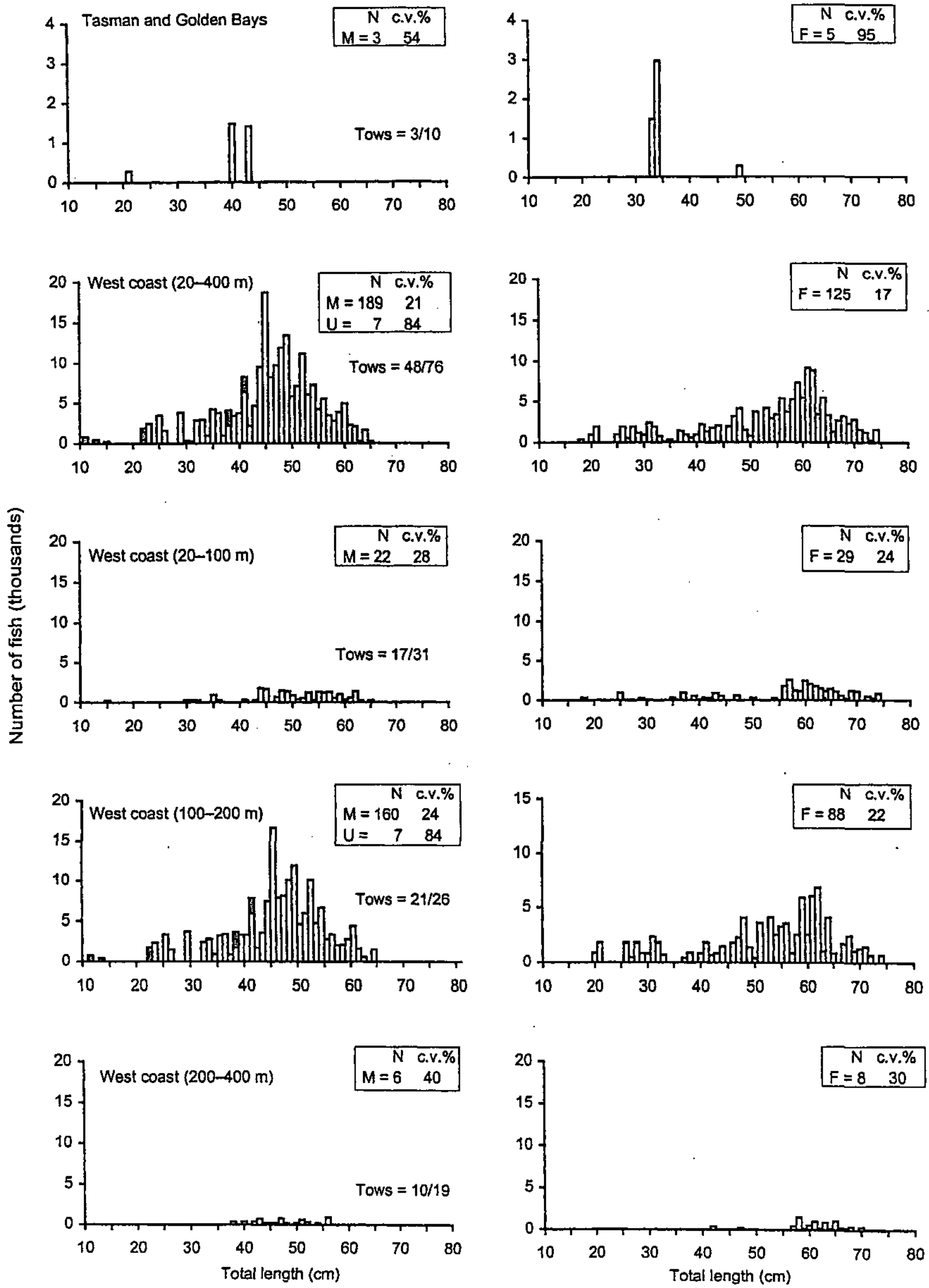


Figure 5–*continued*

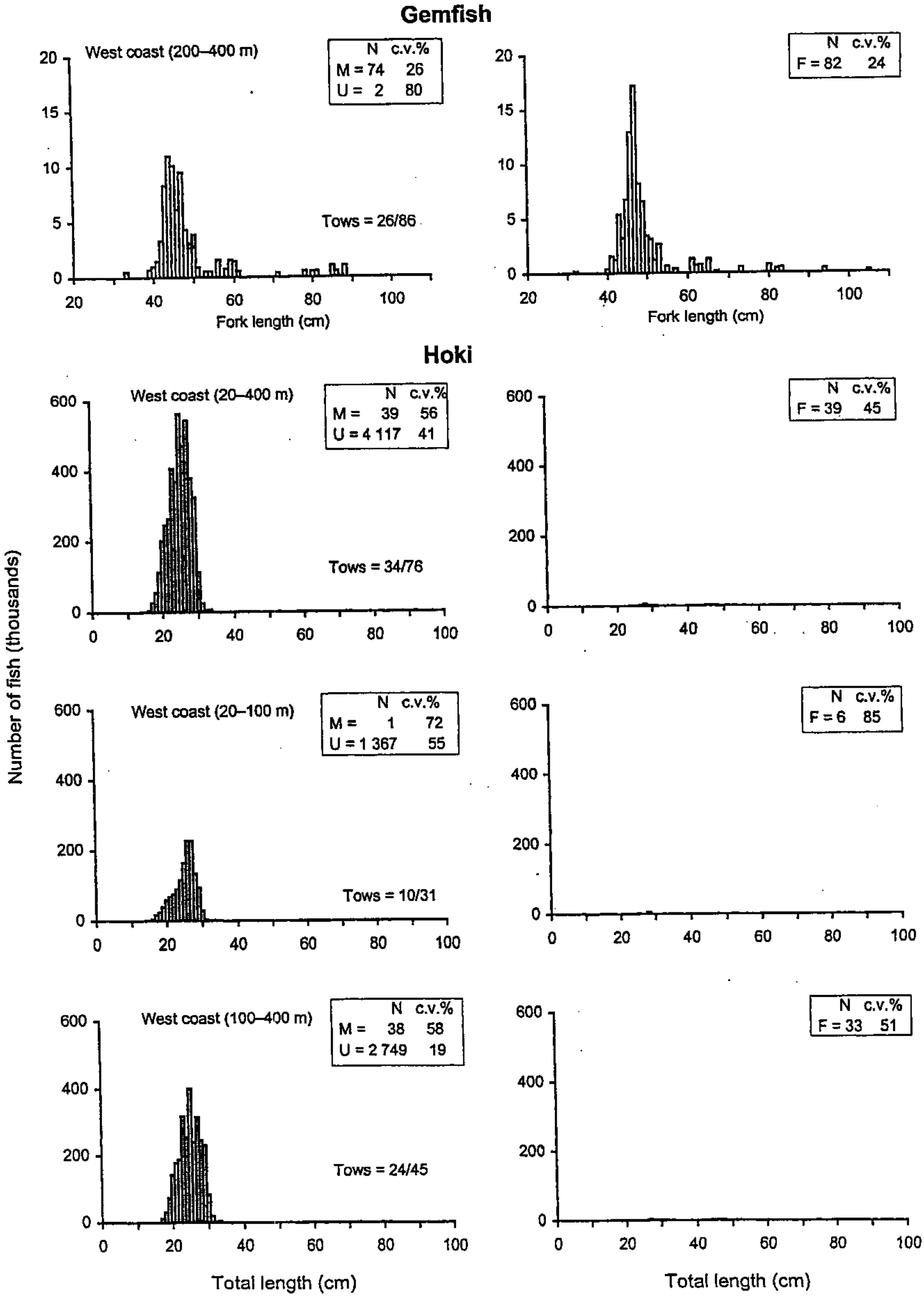


Figure 5—*continued*

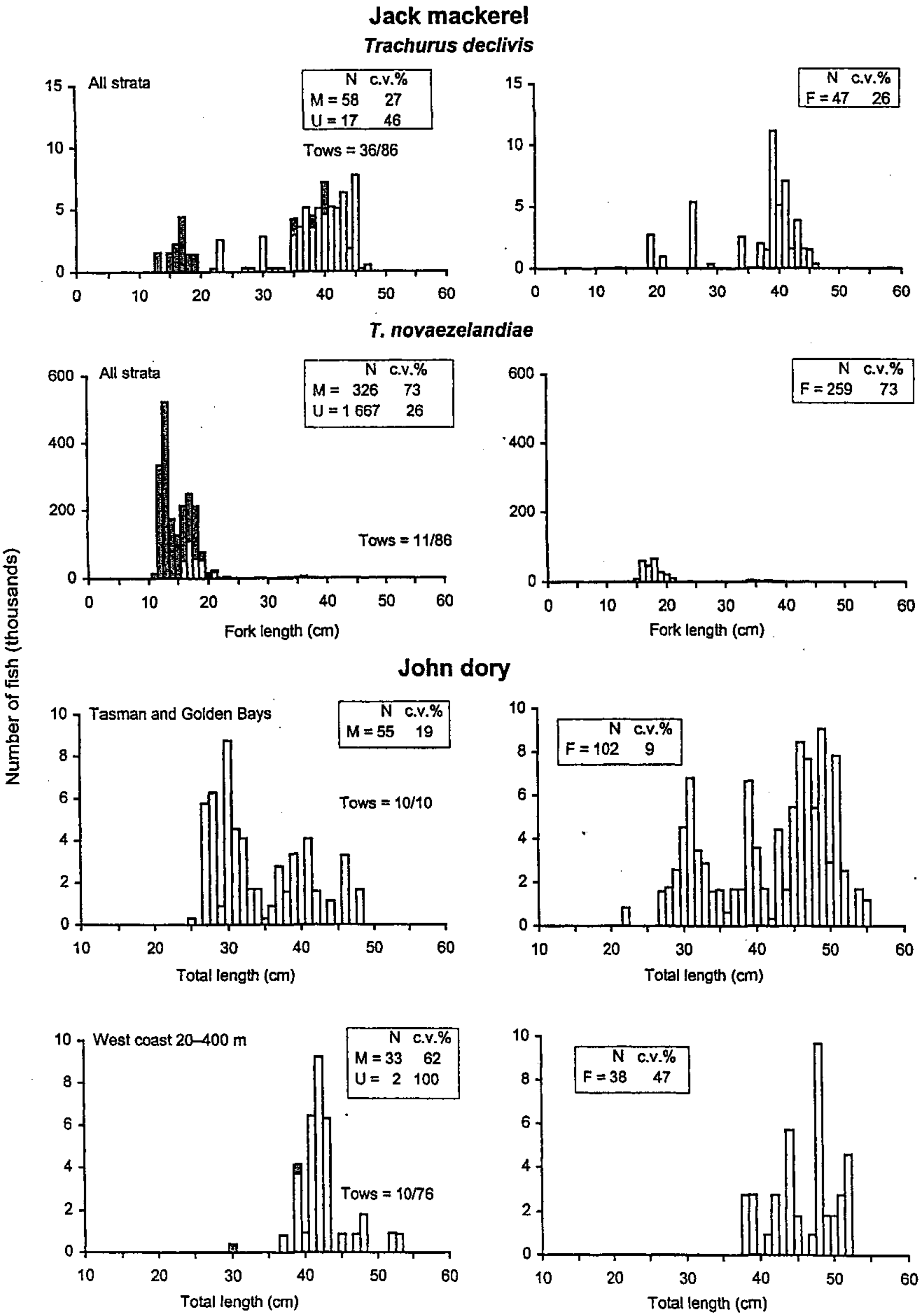


Figure 5—*continued*

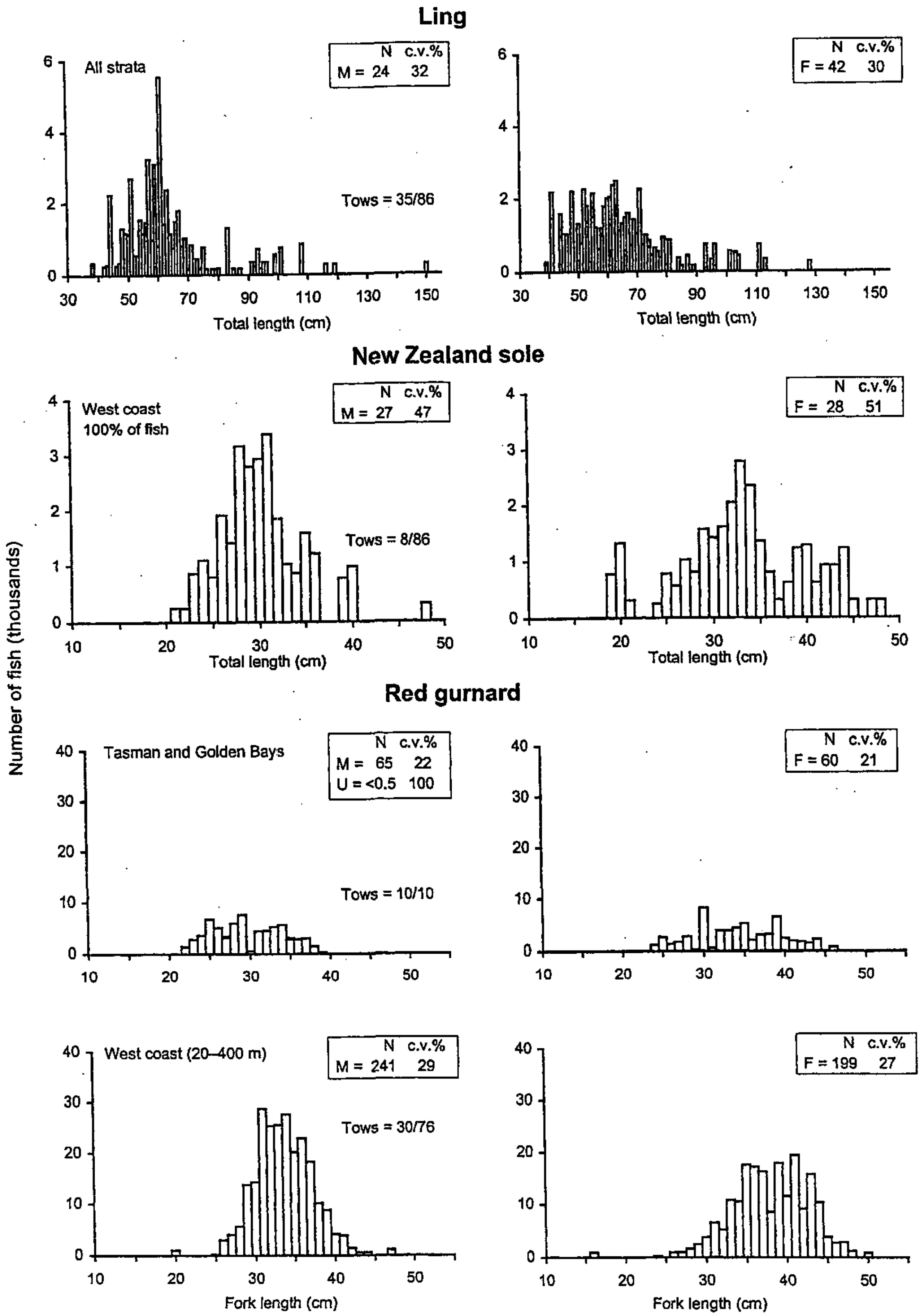


Figure 5—*continued*

Red cod

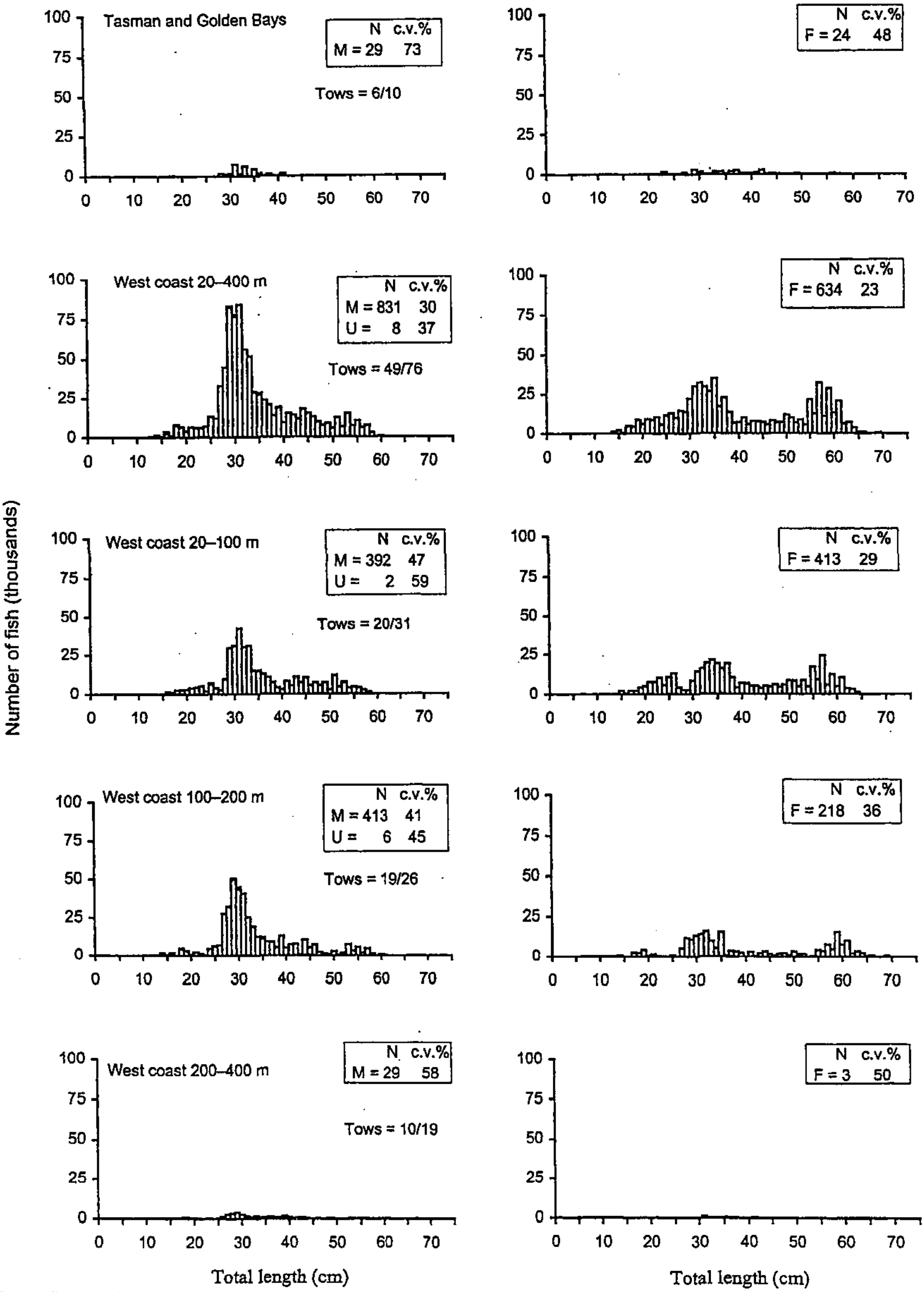


Figure 5—*continued*

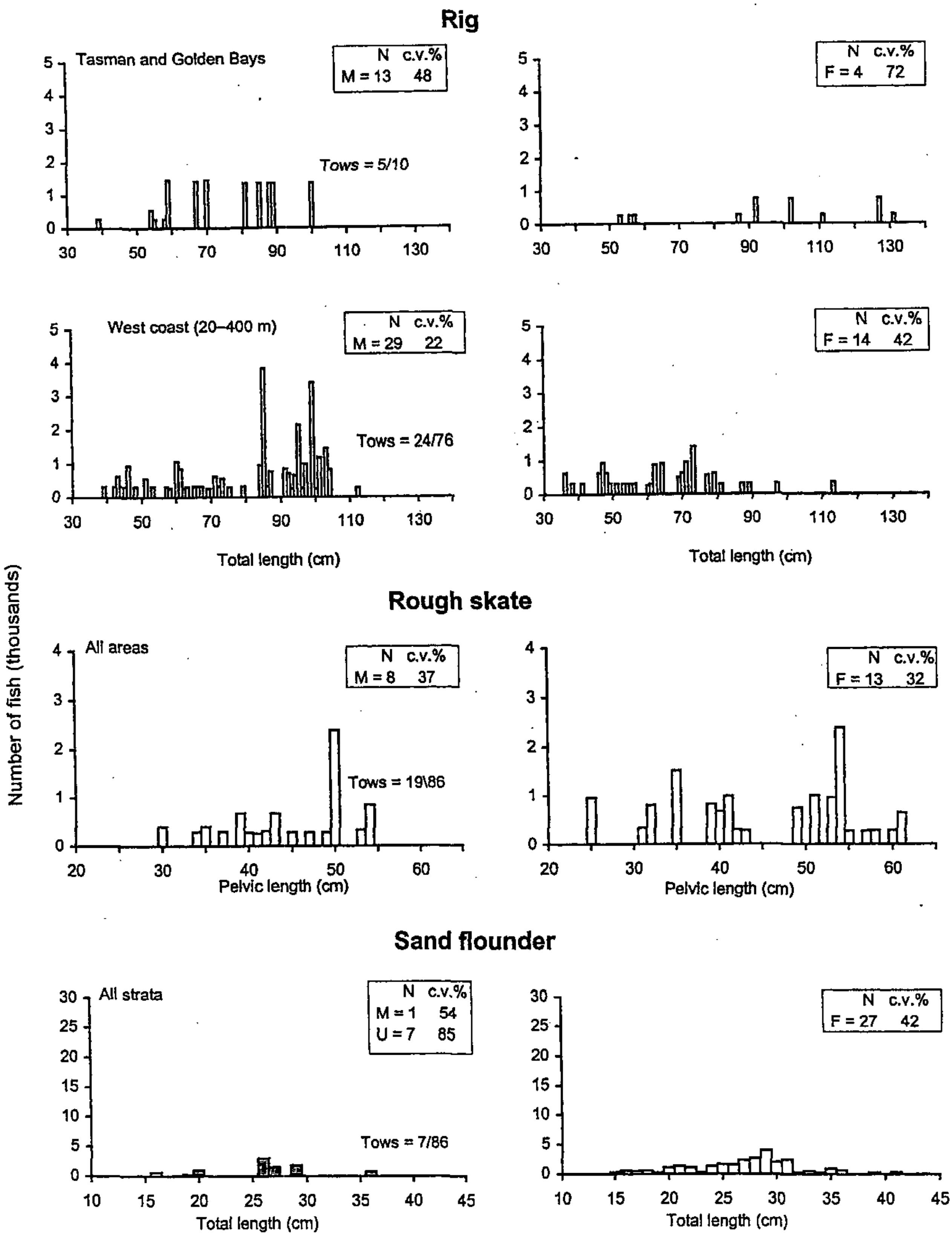


Figure 5—*continued*

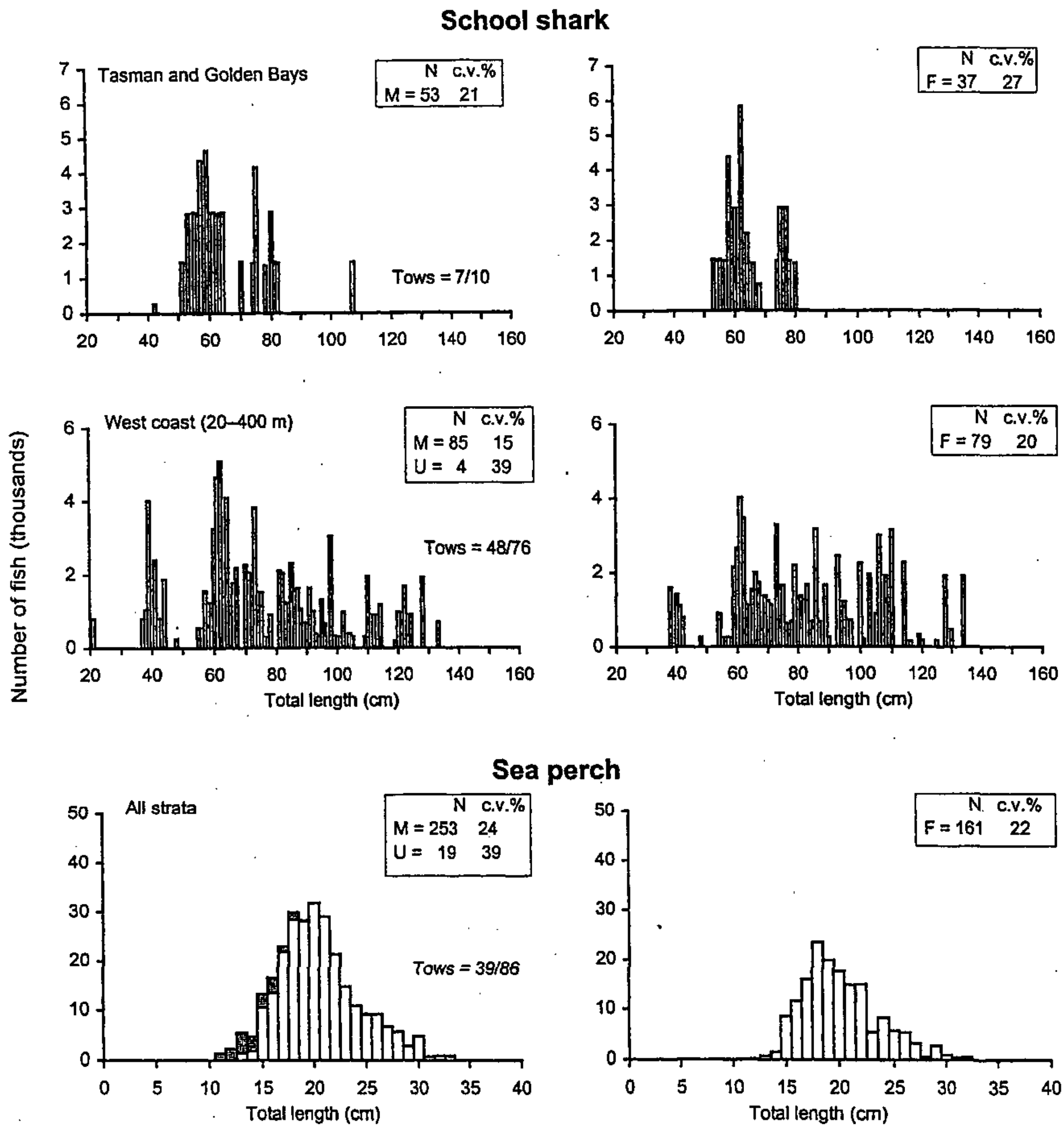
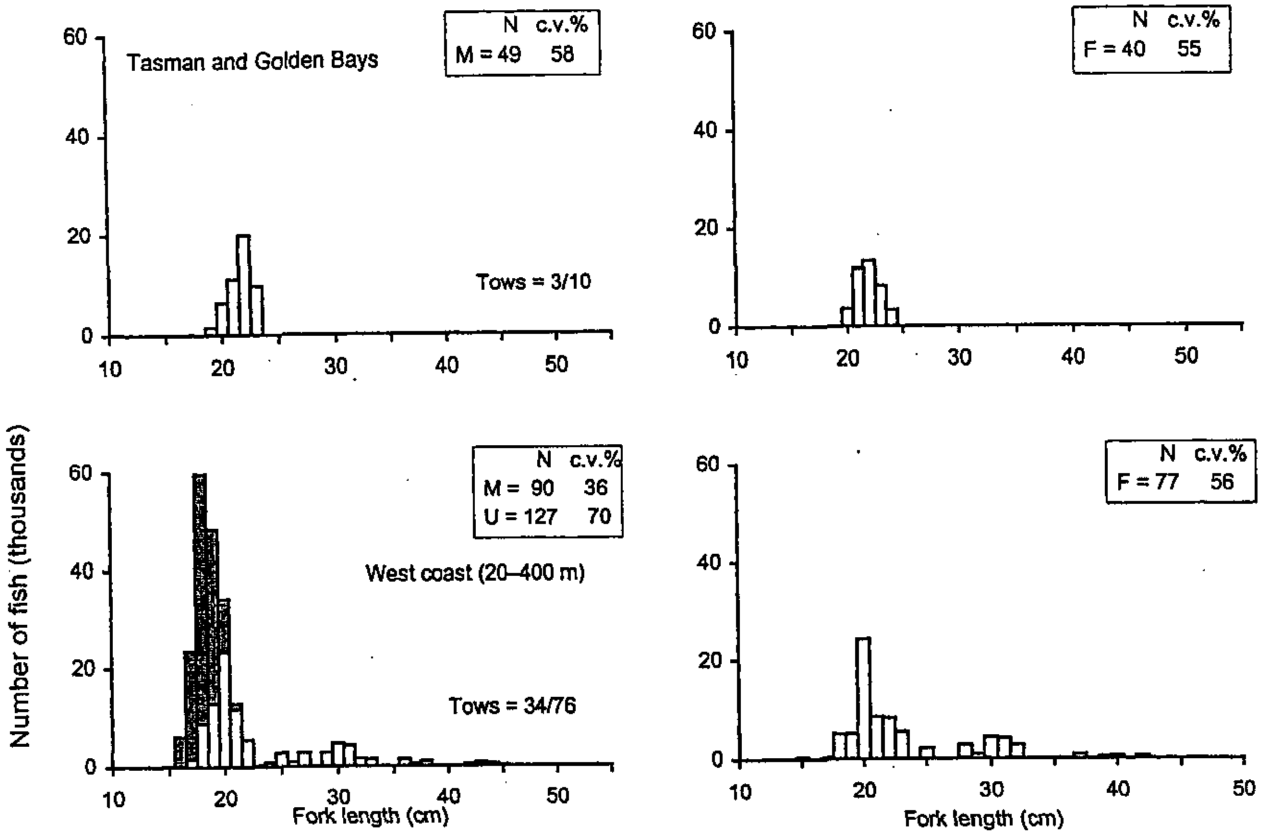


Figure 5—*continued*

Silver warehou



Smooth skate

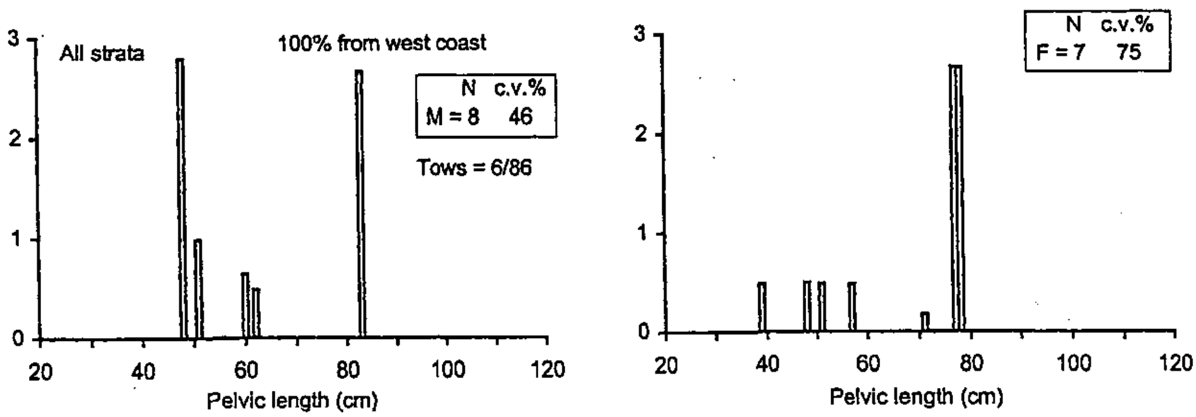


Figure 5—*continued*

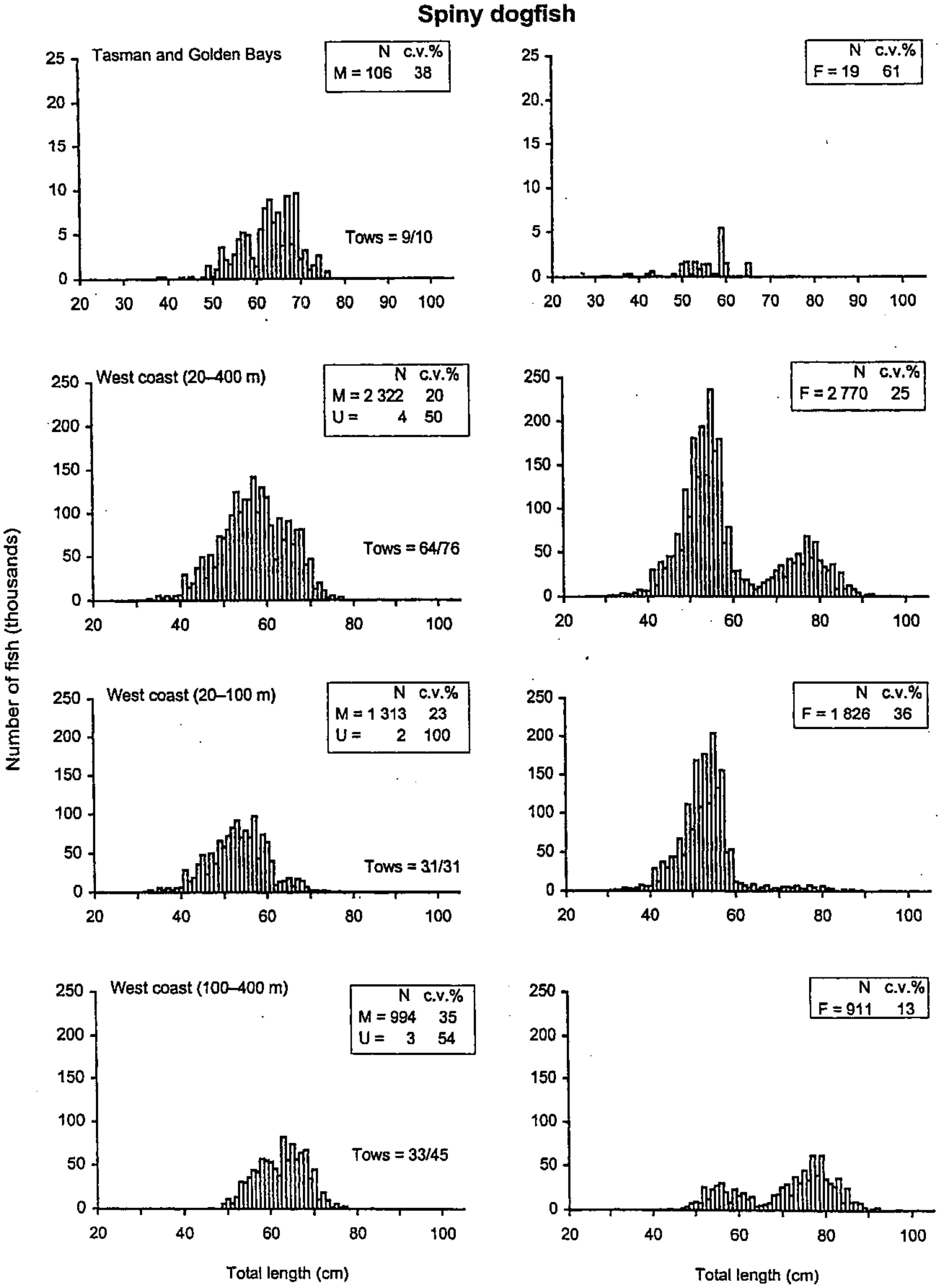


Figure 5—*continued*

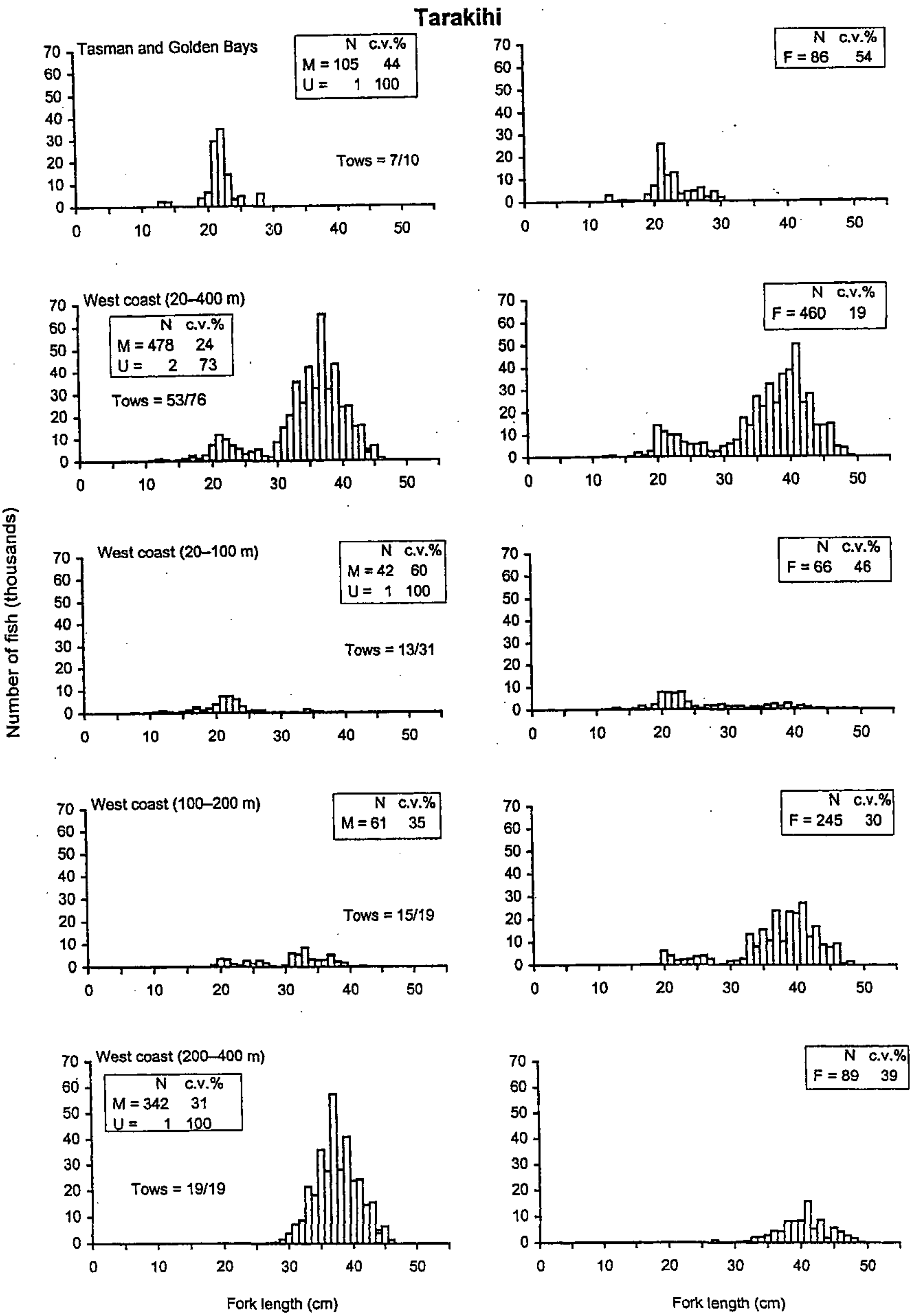


Figure 5—*continued*

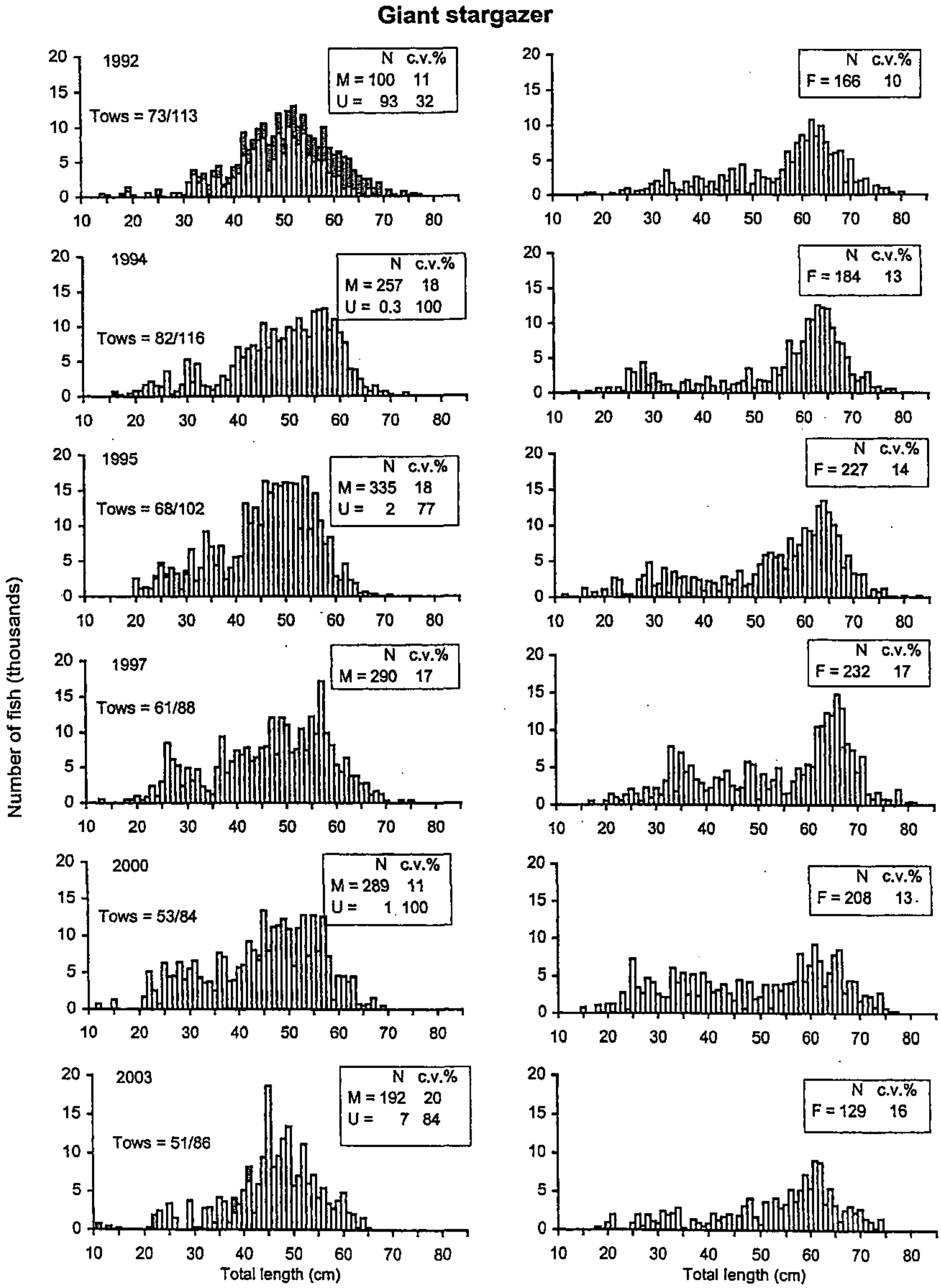


Figure 6: Scaled length frequencies (all areas combined) for the target species from all surveys in the series.
a: Giant stargazer

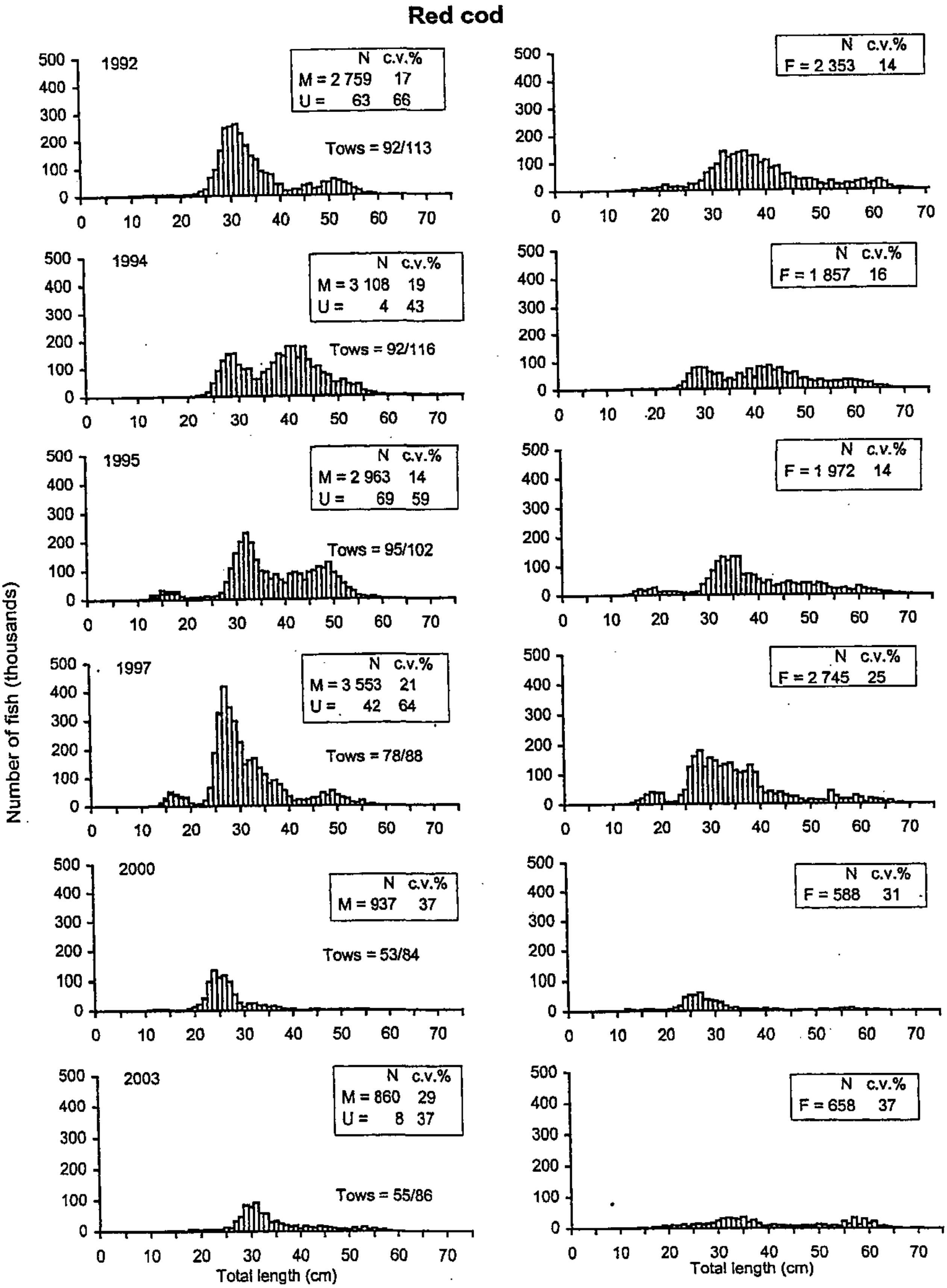


Figure 6b: Red cod

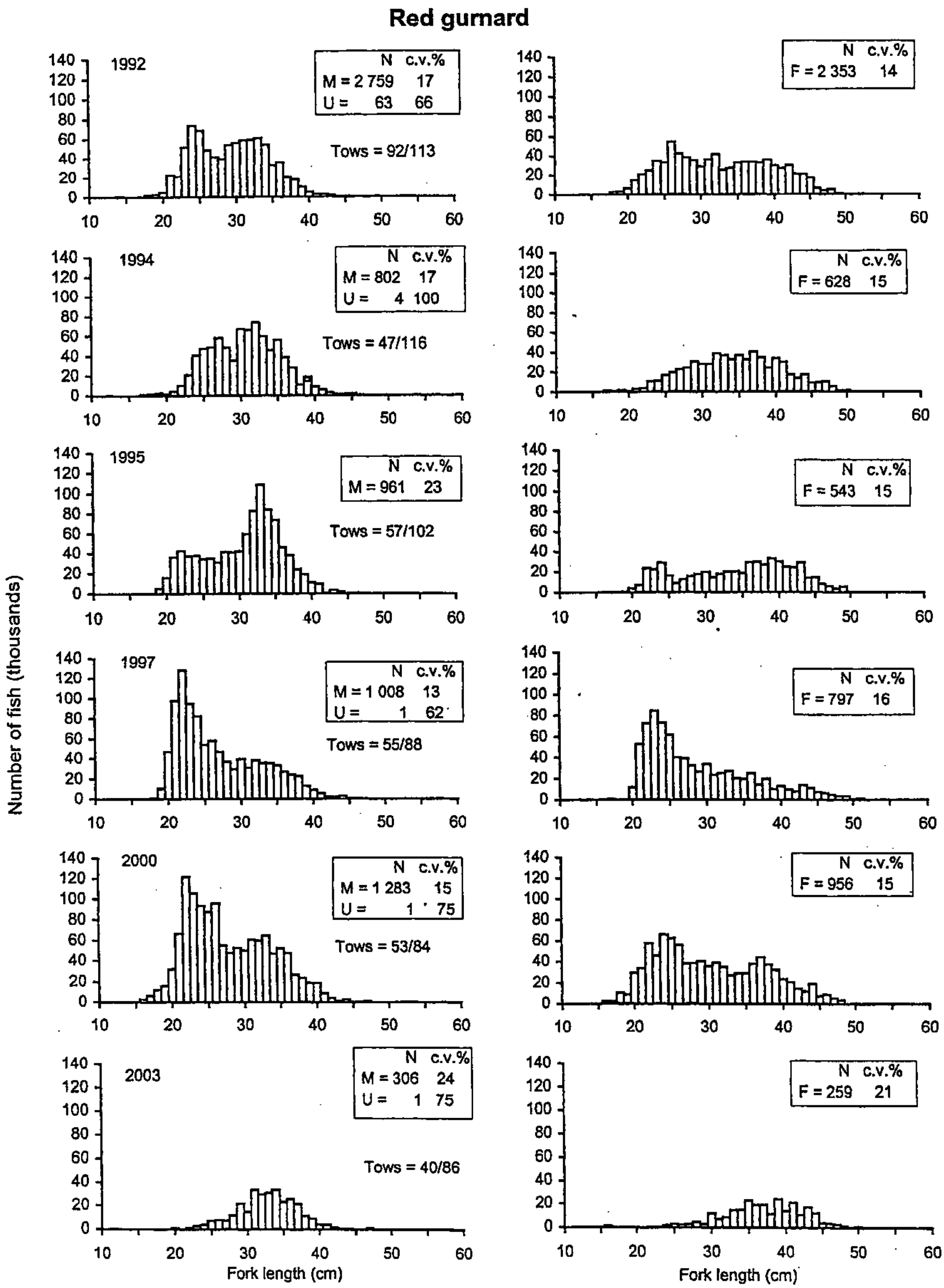


Figure 6c: Red gurnard

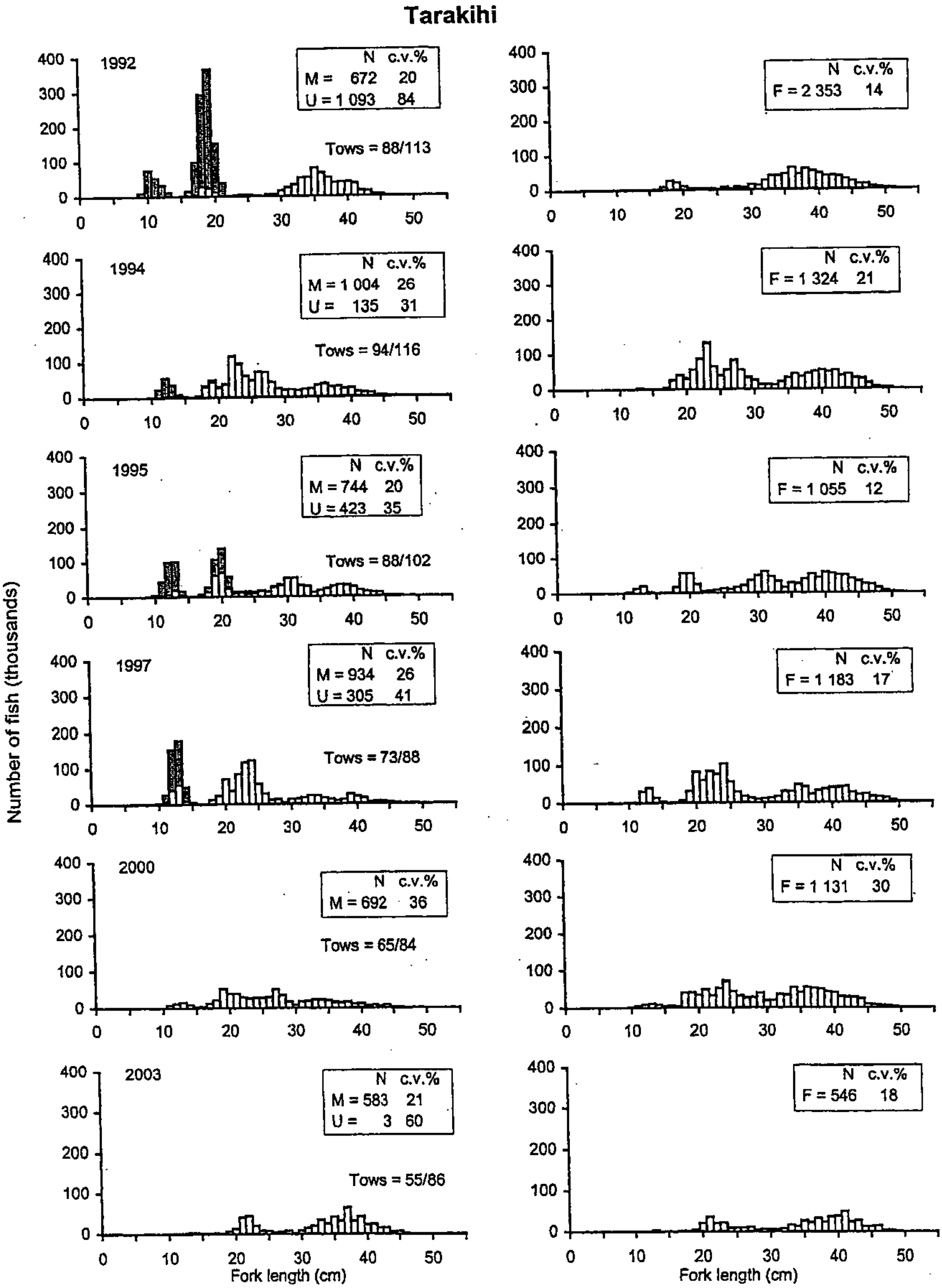


Figure 6d: Tarakihi

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

Species	*a*	*b*	n	Range Min.	Range Max.	Data source
Arrow squid	0.0505	2.8004	2 792	3	45	DB, *James Cook*, east coast South Island, 1982–83
Barracouta	0.0055	2.9812	429	23.8	87.2	DB, KAH9701
Blue warehou	0.0144	3.1050	338	27.4	69.6	DB, TAN9604
Dark ghost shark	0.0015	3.3611	332	21.2	67.9	DB, KAH9704
Frostfish	0.0004	3.1629	450	10.4	153	DB, KAH0004
Gemfish	0.0017	3.3419	391	32	107	DB, KAH9304, KAH9602
Giant stargazer	0.0082	3.2079	516	11	74	This survey
Hake	0.0014	3.3770	333	33	123	DB, TAN9601
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	0.0065	3.2499	352	18.4	54.3	DB, KAH9902
Lemon sole	0.0080	3.1278	524	14.6	41.2	DB, KAH9809
Ling	0.0013	3.2801	179	32.2	123.7	DB, KAH0004
New Zealand sole	0.0049	3.2151	114	20	48	This survey
Red cod	0.0096	2.9862	964	13	69	This survey
Red gurnard	0.0049	3.2176	655	16.2	50.1	This survey
Rig	0.0033	3.0529	251	35	135	DB, KAH9701
Rough skate	0.0517	2.7556	153	16.7	63.2	DB, KAH0004
Sand flounder	0.0207	2.8768	282	13.5	44.5	DB, KAH9809
School shark	0.0050	2.9981	274	21.6	134	This survey.
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	DB, KAH0004
Spiny dogfish	0.0038	3.0108	441	26.6	93.1	DB, KAH9917
Tarakihi	0.0170	3.0255	942	11	48.2	This survey
Two saddle rattail	0.0010	3.43	383	24.6	58.3	This survey

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

	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	Date	Time	Start of tow ° ' S	Start of tow ° ' E	End of tow ° ' S	End of tow ° ' E	Gear depth (m) Min.	Gear depth (m) Max.	Distance trawled (n. miles)	Headline height (m)	Doorspread (m)	Surface temp (°C)	Bottom temp (°C)
1	18	23-Mar-03	1326	41 00.57	173 23.17	40 57.90	173 25.29	45	47	3.11	5.5	75.1	20.6	16.0
2	18	23-Mar-03	1626	40 57.25	173 06.87	41 00.26	173 06.62	26	29	3.01	5.7	73.0	19.8	18.5
3	18	24-Mar-03	1614	40 53.89	173 10.88	40 51.06	173 09.39	40	41	3.04	5.4	75.3	19.5	16.9
4	19	25-Mar-03	604	40 39.62	173 28.51	40 41.33	173 31.91	58	60	3.13	5.3	76.0	19.0	16.2
5	19	25-Mar-03	808	40 42.62	173 28.54	40 45.55	173 29.59	54	54	3.03	5.3	72.8	19.0	16.6
6	19	25-Mar-03	1003	40 48.61	173 32.26	40 46.87	173 29.12	53	54	2.94	5.3	75.2	19.3	16.5
7	19	25-Mar-03	1139	40 48.60	173 26.12	40 48.36	173 22.19	52	52	2.98	5.3	76.0	19.7	16.4
8	17	25-Mar-03	1535	40 44.67	172 52.52	40 42.91	172 49.26	27	27	3.03	5.3	68.1	19.8	18.1
9	17	26-Mar-03	605	40 36.72	172 46.60	40 39.50	172 48.11	22	27	3	5.4	72.1	19.3	17.9
10	17	26-Mar-03	1112	40 40.58	172 50.71	40 40.76	172 54.36	30	33	2.77	5.3	72.3	19.8	17.8
11	1	26-Mar-03	1632	40 30.43	172 29.53	40 32.02	172 26.09	82	83	3.06	5.3	77.1	19.0	13.5
12	1	27-Mar-03	642	40 35.94	172 18.90	40 37.52	172 15.95	48	53	2.74	5.4	74.0	18.3	15.2
13	1	27-Mar-03	843	40 41.43	172 07.43	40 44.02	172 05.40	93	98	3.01	5.4	73.8	19.1	13.7
14	1	27-Mar-03	1032	40 48.94	172 07.20	40 51.38	172 04.86	70	75	3.01	5.4	68.9	18.4	13.9
15	2	27-Mar-03	1240	40 48.86	171 55.80	40 51.08	171 53.12	121	125	3	5.2	74.8	19.4	13.5
16	2	27-Mar-03	1515	40 46.38	171 38.77	40 49.02	171 36.70	159	168	3.07	5.5	87.9	19.8	13.5
17	2	28-Mar-03	622	41 10.21	171 47.78	41 12.93	171 45.91	113	117	3.06	5.3	77.0	18.3	13.0
18	5	27-Mar-03	812	41 16.37	171 48.97	41 19.38	171 48.07	99	108	3.08	5.3	73.3	18.3	13.0
19	5	28-Mar-03	1035	41 23.61	171 59.72	41 26.11	171 57.68	27	34	2.93	5.4	72.4	18.4	16.3
20	5	28-Mar-03	1331	41 35.37	171 39.20	41 37.56	171 36.45	51	52	3	5.4	73.5	18.8	14.6
21	6	28-Mar-03	1529	41 35.48	171 30.08	41 33.02	171 32.45	111	116	3.03	5.4	74.7	18.5	13.1
22	6	29-Mar-03	628	41 19.69	171 10.62	41 22.38	171 08.71	182	184	3.04	5.2	89.0	19.0	12.7
23	6	29-Mar-03	832	41 23.54	171 04.69	41 26.48	171 03.45	196	197	3.08	5.5	77.0	19.0	14.8
24	6	29-Mar-03	1057	41 36.22	171 00.01	41 39.10	170 58.69	178	180	3.04	5.2	86.2	19.0	13.3
25	9	29-Mar-03	1415	41 49.29	170 39.63	41 52.36	170 39.24	304	312	3.08	5.2	93.0	19.1	12.9
26	9	29-Mar-03	1644	42 02.75	170 36.15	42 05.69	170 35.15	312	333	3.03	5.3	92.3	18.8	12.9
27	9	30-Mar-03	707	42 08.63	170 33.65	42 11.70	170 33.13	381	392	3.09	5.3	89.4	18.5	12.7
28	8	30-Mar-03	1105	42 06.29	171 02.14	42 04.38	171 05.28	137	152	3.01	5.4	70.7	18.1	12.6
29	8	30-Mar-03	1248	42 01.58	171 07.40	41 59.07	171 09.65	127	131	3.01	5.1	81.0	18.3	12.8
30	8	30-Mar-03	1443	41 56.16	171 08.53	41 53.74	171 10.75	143	150	2.93	5.4	76.9	18.3	12.6

Appendix 2—*continued*

Station	Stratum	Date	Time	Start of tow ° ' S	Start of tow ° ' E	End of tow ° ' S	End of tow ° ' E	Gear depth (m) Min.	Gear depth (m) Max.	Distance trawled (n. miles)	Headline height (m)	Doorspread (m)	Surface temp (°C)	Bottom temp (°C)
31	8	30-Mar-03	646	41 53.90	171 05.88	41 51.79	171 07.08	159	164	2.29	5.4	73.3	17.8	12.8
32	8	31-Mar-03	847	41 55.85	171 13.73	41 58.77	171 12.34	105	108	3.09	5.4	75.1	17.8	13.2
33	7	31-Mar-03	1209	42 19.93	171 05.23	42 22.90	171 04.20	65	69	3.06	5.3	80.8	16.6	14.2
34	8	31-Mar-03	1430	42 22.27	170 54.11	42 25.17	170 52.66	160	161	3.09	5.3	74.7	17.0	12.8
35	13	01-Apr-03	649	42 31.62	170 36.23	42 33.62	170 39.41	284	327	3.08	5.4	82.0	18.3	12.8
36	11	01-Apr-03	943	42 46.78	170 33.63	42 48.10	170 37.38	40	45	3.05	5.4	75.7	17.2	15.4
37	11	01-Apr-03	1117	42 50.07	170 37.62	42 51.40	170 34.79	32	35	2.46	5.6	74.1	17.1	16.4
38	11	01-Apr-03	1344	42 54.00	170 22.62	42 56.05	170 19.66	66	72	2.98	5.2	73.7	16.6	14.4
39	12	01-Apr-03	1541	42 54.18	170 16.09	42 56.62	170 13.59	108	112	3.05	5.2	66.8	17.0	13.2
40	12	02-Apr-03	629	42 37.40	170 20.47	42 37.61	170 17.80	151	160	1.97	5.6	65.9	17.8	13.2
41	12	02-Apr-03	817	42 40.40	170 13.60	42 38.74	170 17.11	151	160	3.06	5.5	78.3	17.8	13.3
42	12	02-Apr-03	1026	42 44.35	170 13.94	42 46.89	170 11.90	145	153	2.94	5.2	76.8	17.5	13.2
43	13	02-Apr-03	1407	42 42.80	170 05.20	42 45.61	170 03.58	206	222	3.05	5.3	90.6	18.4	13.5
44	13	02-Apr-03	1601	42 47.50	170 02.91	42 50.46	170 02.26	216	223	2.99	5.2	87.5	18.5	13.4
45	13	03-Apr-03	632	43 06.74	169 45.02	43 09.23	169 44.31	216	224	2.54	5.4	85.7	17.4	13.0
46	13	03-Apr-03	847	43 12.71	169 40.56	43 09.77	169 41.37	255	275	2.99	5.5	80.6	17.6	13.2
47	13	03-Apr-03	1053	43 04.84	169 46.20	43 02.19	169 48.11	213	222	2.99	5.3	81.9	17.5	13.0
48	13	03-Apr-03	1249	42 59.45	169 54.86	42 58.14	169 57.99	224	230	2.63	5.2	83.2	17.7	13.0
49	12	03-Apr-03	1428	42 56.77	170 03.61	42 55.03	170 06.98	162	173	3.01	5.1	79.0	17.6	12.7
50	11	03-Apr-03	1626	42 59.04	170 13.79	43 02.05	170 12.56	69	91	3.14	5.4	79.2	17.0	13.7
51	12	05-Apr-03	1015	43 03.41	170 04.15	43 06.02	170 01.76	134	137	3.13	5.3	72.0	17.1	13.2
52	11	05-Apr-03	1209	43 08.57	170 03.94	43 11.13	170 01.84	87	91	2.98	5.6	62.6	17.0	13.7
53	12	05-Apr-03	1403	43 10.24	169 56.41	43 12.61	169 53.79	153	156	3.04	5.2	78.8	17.3	13.0
54	15	05-Apr-03	1550	43 15.74	169 51.02	43 17.85	169 49.18	142	154	2.49	5.5	77.1	17.6	13.0
55	16	06-Apr-03	638	43 14.91	169 37.09	43 17.48	169 34.74	308	320	3.08	5.4	87.4	17.4	13.0
56	16	06-Apr-03	941	43 16.72	169 44.05	43 14.41	169 45.60	202	216	2.57	5.3	80.9	17.3	12.9
57	15	06-Apr-03	1151	43 21.90	169 41.29	43 22.03	169 37.58	114	135	2.7	5.2	79.1	17.2	13.2
58	14	06-Apr-03	1317	43 23.77	169 36.89	43 23.82	169 41.02	59	74	3	5.3	73.7	16.9	15.1
59	14	06-Apr-03	1451	43 25.81	169 38.92	43 27.89	169 35.94	45	49	3	5.2	73.4	16.9	16.6
60	14	07-Apr-03	625	43 33.43	169 32.13	43 35.13	169 28.65	26	30	3.04	5.5	72.7	15.5	16.4

Appendix 2—*continued*

			Start of tow			End of tow		Gear depth (m)		Distance trawled	Headline	Doorspread	Surface temp	Bottom temp
Station	Stratum	Date	Time	° ' S	° ' E	° ' S	° ' E	Min.	Max.	(n. miles)	height (m)	(m)	(°C)	(°C)
61	14	07-Apr-03	806	43 33.00	169 23.75	43 30.48	169 26.02	90	90	3	5.4	67.1	16.3	14.5
62	15	07-Apr-03	947	43 28.31	169 22.18	43 30.09	169 18.90	124	133	2.97	5.2	71.7	16.5	13.4
63	16	07-Apr-03	1146	43 28.72	169 14.21	43 26.53	169 17.04	254	267	3	5.3	83.8	17.4	12.8
64	16	07-Apr-03	1347	43 23.92	169 20.12	43 25.81	169 16.78	309	327	3.07	5.3	91.2	17.8	11.9
65	15	07-Apr-03	1549	43 31.35	169 19.32	43 34.11	169 17.85	117	128	2.95	5.2	74.9	17.0	13.4
66	14	08-Apr-03	631	43 45.36	169 06.64	43 47.64	169 03.92	27	38	3	5.2	72.3	16.5	17.2
67	15	08-Apr-03	913	43 41.39	169 07.82	43 42.88	169 04.25	116	125	2.98	5.4	59.3	16.6	13.2
68	14	08-Apr-03	1409	43 22.75	169 49.79	43 21.20	169 53.35	38	49	3.01	5.3	77.3	16.8	16.4
69	14	08-Apr-03	1539	43 18.92	169 54.50	43 16.43	169 56.82	67	70	3	5.2	71.7	16.6	14.4
70	11	09-Apr-03	622	42 46.81	170 36.82	42 46.79	170 40.93	42	49	3.01	5.2	73.5	16.1	15.5
71	11	09-Apr-03	806	42 47.19	170 43.07	42 45.86	170 46.61	47	53	2.91	5.3	71.0	16.1	15.3
72	11	09-Apr-03	1015	42 43.06	170 37.46	42 42.82	170 33.38	62	63	3	5.3	73.4	15.9	15.6
73	11	09-Apr-03	1516	42 32.02	171 00.96	42 30.18	171 01.99	49	49	1.99	5.3	76.1	17.0	14.5
74	11	09-Apr-03	1634	42 34.00	171 00.03	42 35.87	170 59.19	42	46	1.96	5.3	74.1	16.8	15.3
75	9	10-Apr-03	641	41 50.94	170 36.46	41 53.96	170 36.39	382	387	3.02	5.1	91.6	17.6	10.7
76	9	10-Apr-03	908	41 55.37	170 38.95	41 58.38	170 38.19	286	306	3.06	5.2	90.4	18.1	13.0
77	9	10-Apr-03	1109	41 57.68	170 34.74	41 54.85	170 36.08	386	387	3	5.3	90.8	17.6	10.8
78	9	10-Apr-03	1311	41 59.01	170 34.35	42 02.01	170 33.76	383	386	3.03	5.1	94.0	17.8	10.3
79	9	10-Apr-03	1544	42 12.26	170 35.41	42 15.25	170 34.97	305	305	3	5.3	90.3	17.8	12.2
80	11	11-Apr-03	623	43 08.90	170 07.74	43 06.50	170 10.22	37	41	3	5.4	75.4	16.0	15.4
81	11	11-Apr-03	757	43 06.15	170 08.53	43 03.61	170 10.86	57	65	3.05	5.2	77.8	15.9	15.1
82	11	11-Apr-03	940	43 02.89	170 14.97	43 01.49	170 18.66	31	39	3.03	5.2	74.6	16.1	15.2
83	11	11-Apr-03	1144	42 54.47	170 21.33	42 51.80	170 23.37	71	73	3.05	5.5	70.5	16.3	15.1
84	7	12-Apr-03	634	42 01.33	171 19.79	41 58.75	171 21.88	28	35	3	5.4	72.3	17.0	15.2
85	7	12-Apr-03	832	41 52.73	171 17.58	41 49.89	171 18.87	86	89	2.99	5.2	63.4	17.2	14.3
86	2	12-Apr-03	1342	41 13.58	171 11.23	41 11.23	171 13.74	178	185	3.01	5.2	89.4	18.7	13.3

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

Species code	Common name	Scientific name	Catch (kg)	% of total catch	Occ.	Depth (m) Min.	Max.
ANC	Anchovy	*Engraulis australis*	3.4	*	4	31	70
ASR	Asteroidea (strafish)	Asteroidea	0.4	*	2	82	117
BAR	Barracouta	*Thyrsites atun*	6365	19.7	69	22	306
BCO	Blue cod	*Parapercis colias*	3.1	*	3	52	60
BNS	Bluenose	*Hyperoglyphe antarctica*	3.5	*	1	383	386
BOA	Sowfish	*Paristiopterus labiosus*	0.8	*	2	27	34
BRI	Brill	*Colistium guntheri*	2.9	*	4	27	49
BSQ	Broad squid	*Sepioteuthis australis*	1.7	*	2	26	54
CAR	Carpet shark	*Cephaloscyllium isabella*	457	1.4	55	22	387
CBI	Two saddle rattail	*Caelorinchus biclinozonalis*	444	1.4	33	47	327
CBO	Bollons's rattail	*C. bollonsi*	3.3	*	6	116	392
CDO	Capro dory	*Capromimus abbreviatus*	14.6	*	24	87	392
COL	Oliver's rattail	*Caelorinchus oliverianus*	0.1	*	1	254	267
CON	Conger eel	*Conger* spp.	23.6	0.1	7	28	91
CRB	Crab	Decapoda	0.8	*	4	305	392
CUC	Cucumberfish	*Chlorophthalmus nigripinnis*	8.2	*	9	113	392
EGR	Eagle ray	*Myliobatis tenuicaudatus*	2.8	*	3	22	33
ELE	Elephantfish	*Callorhinchus milii*	142.8	0.4	12	26	73
EMA	Blue mackerel	*Scomber australasicus*	5.2	*	2	87	161
ERA	Electric ray	*Torpedo fairchildi*	113.8	0.4	16	27	267
ESO	N.Z. sole	*Peltorhamphus novaezelandiae*	62.6	0.2	8	27	49
EUC	Eucla cod	*Euclichthys polynemus*	0.1	*	1	383	386
FHD	Deepsea flathead	*Hoplichthys haswelli*	0.3	*	2	309	386
FIS	Fish		0.2	*	2	308	333
FRO	Frostfish	*Lepidopus caudatus*	776.1	2.4	40	42	392
GLB	Globefish	*Contusus richei*	67.3	0.2	3	27	35
GSH	Dark ghost shark	*Hydrolagus novaezelandiae*	557.6	1.7	31	86	392
GUR	Red gurnard	*Chelidonichthys kumu*	684.3	2.1	40	22	180
HAK	Hake	*Merluccius australis*	191	0.6	23	28	161
HAP	Hapuku	*Polyprion oxygeneios*	65	0.2	8	27	312
HEP	Sharpnose sevengill shark	*Heptranchias perlo*	12.7	*	1	381	392
HEX	Sixgill shark	*Hexanchus griseus*	1.3	*	1	37	41
HOK	Hoki	*Macruronus novaezelandiae*	573.8	1.8	34	31	327
JAV	Javelinfish	*Lepidorhynchus denticulatus*	19.4	0.1	10	224	392
JDO	John dory	*Zeus faber*	273.7	0.8	20	22	184
JFI	Jellyfish		51.1	0.2	9	28	91
JGU	Spotted gurnard	*Pterygotrigla picta*	0.8	*	1	284	327
JMD	N.Z. jack mackerel	*Trachurus declivis*	125.2	0.4	37	27	312
JMM	Chilean jack mackerel	*T. symmetricus murphyi*	10	*	7	47	306
JMN	N.Z. jack mackerel	*T. novaezelandiae*	148.5	0.5	11	22	60
KAH	Kahawai	*Arripis trutta*	5.6	*	1	31	39
LDO	Lookdown dory	*Cyttus traversi*	19.6	0.1	3	254	327
LEA	Leatherjacket	*Parika scaber*	198.4	0.6	9	22	60
LIN	Ling	*Genypterus blacodes*	529.9	1.6	35	22	392
LSK	Softnose skate	*Arhynchobatis asperrimus*	2.5	*	4	286	392
LSO	Lemon sole	*Pelotretis flavilatus*	8	*	13	22	90

Appendix 3—*continued*

Species code	Common name	Scientific name	Catch (kg)	% of total catch	Occ.	Depth (m) Min.	Max.
MDO	Mirror dory	*Zenopsis nebulosus*	19.6	0.1	2	305	320
NOS	Arrow squid	*Nototodarus sloanii*	2787.9	8.6	81	22	392
NSD	Northern spiny dogfish	*Squalus mitsukuri*	151.4	0.5	17	62	387
OCT	Octopus	*Octopus cordiformis*	10.2	*	5	26	54
ONG	Sponges	Porifera (Phylum)	2.7	*	6	27	125
OPE	Orange perch	*Lepidoperca aurantia*	17.3	0.1	2	213	224
PCO	Ahuru	*Auchenoceros punctatus*	1.1	*	5	28	70
PIG	Pigfish	*Congiopodus leucopaecilus*	0.9	*	5	22	222
POP	Porcupine fish	*Allomycterus jaculiferus*	29.9	0.1	10	26	137
PRK	Prawn killer	*Ibacus alticrenatus*	1.2	*	11	151	387
RBT	Redbait	*Emmelichthys nitidus*	1.3	*	2	86	90
RBY	Ruby fish	*Plagiogeneion rubiginosus*	33.4	0.1	2	284	392
RCO	Red cod	*Pseudophycis bachus*	2449.8	7.6	55	26	327
RHY	Common roughy	*Paratrachichthys traill*i	152.1	0.5	8	116	327
RSK	Rough skate	*Raja nasuta*	95.7	0.3	19	32	392
SAL	Salps		100	0.3	1	308	320
SCA	Scallop	*Pecten novaezelandiae*	0.2	*	1	27	27
SCC	Sea cucumber	*Stichopus mollis*	0.1	*	1	27	27
SCG	Scaly gurnard	*Lepidotrigla brachyoptera*	19.5	0.1	36	26	197
SCH	School shark	*Galeorhinus galeus*	828.6	2.6	55	26	392
SDO	Silver dory	*Cyttus novaezelandiae*	943.1	2.9	38	58	387
SDR	Spiny seadragon	*Solegnathus spinosissimus*	0.3	*	3	114	216
SEV	Broadnose sevengill shark	*Notorynchus cepedianus*	1.8	*	1	127	131
SFL	Sand flounder	*Rhombosolea plebeia*	27.4	0.1	7	22	47
SKI	Gemfish	*Rexea solandri*	343.1	1.1	26	134	392
SNA	Snapper	*Pagrus auratus*	12.1	*	4	22	34
SPD	Spiny dogfish	*Squalus acanthias*	7654.3	23.6	73	22	275
SPE	Sea perch	*Helicolenus* spp.	134	0.4	39	22	392
SPO	Rig	*Mustelus lenticulatus*	285.7	0.9	31	26	222
SPR	Sprat	*Sprattus antipodum*, *S. muelleri*	4.7	*	9	28	72
SPS	Speckled sole	*Peltorhamphus latus*	0.1	*	1	22	27
SRH	Silver roughy	*Hoplostethus mediterraneus*	0.1	*	1	254	267
SSH	Slender smoothhound	*Gollum attenuatus*	95.5	0.3	6	304	392
SSI	Silverside	*Argentina elongata*	1.2	*	10	69	267
SSK	Smooth skate	*Raja innominata*	67.6	0.2	6	113	392
STA	Giant stargazer	*Kathetostoma giganteum*	1543.3	4.8	51	30	327
STY	Spotty	*Notolabrus celidotus*	8.8	*	4	22	47
SWA	Silver warehou	*Seriolella punctata*	109.9	0.3	37	27	392
TAR	Tarakihi	*Nemadactylus macropterus*	1812.1	5.6	60	22	392
THR	Thresher shark	*Alopias vulpinus*	80.8	0.2	4	22	41
UNI	Unidentified		17.4	0.1	1	255	275
WAR	Blue warehou	*Seriolella brama*	496.6	1.5	27	22	135
WIT	Witch	*Arnoglossus scapha*	43	0.1	41	22	392
YBO	Yellow boarfish	*Pentaceros decacanthus*	0.8	*	1	308	320
			32369				

* 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
Porifera	
Callyspongia ramosa	2
Dactylia palmata	1
Crella incrustans	1
Suberites australiensis	1
Echinodermata: Asteroidea	
Psilaster acuminatus	1
Coscinasterias muricata	3
Echinodermata:Ophiuroidea	
Astrothorax waitei	2
Amphiura correcta	2
Ophiocentrus novaezealandiae	1
indet arms	3
Echinodermata:Echinoidea	
Pseudechinus albocinctus	1
Echinodermata: Holothuroidea	
Stichopus mollis	1
Mollusca: Bivalvia	
Chlamys dieffenbachi	1
Modiolarca impacta	1
Mollusca: Cephalopoda	
Octopus sp.	8
Crustacea: Cirripedia	
Cirripedia sp.stalked	1
Crustacea:Palinura	
Ibaccus alticrenatus	11
Crustacea: Brachyura	
Platymaia maoria	6
Ovalipes sp.	1
Crustacea:Paguridea	
Pagurid sp.	1
Cnidaria:Hydrozoa	
Hydroid A	7
Hydroid B	2
Hydroid C	4
Cnidaria: Zoanthinaria	
Zoanththinaria sp.	1
Cnidaria:Actinaria	
White	3
Cnidaria: Pennatulacea	
Pennatulid A	1
Pennatulid B	9
Pennatulid C	1
Cnidaria: Alcyonacea	
Clavularia sp.	1

Appendix 4—*continued*

Brachiopoda	
Neothyris lenticularis	2
Annelida:Echiuroida	
Echiurid sp.	1
Annelida: Sipunculoida	
Sipunculoid sp.	1
Annelida: Polychaeta	
Eunicidae	
Eunice australis	1
Terebellidae	2
Glyceridae	
Glycera sp.	2
Serpulidae	
Serpula sp	1
Maldanidae	
Maldane theodori	1
Bryozoa: Gymnolaemata	
Penetrantia parva	
Bryozoa: Cheilostomata	
Galeopsis porcellanicus	1
Smittoidea maunganuiensis	1
Cellaria immersa	1
Cellaria tenuirostris	1
Biflustra savartii *	1
Bitectipora rostrata	1
Tunicata: Stolidobranchia	
Cnemidocarpa bicornuta	1
Cnemidocarpa nisctus	1
Asterocarpa cerea	1

* Introduced species