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EXECUTIVE SUMMARY

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This report gives the results of the eighth 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 took place in March-April 2007. It used a two-phase design optimised for giant stargazer, red cod, red gurnard, spiny dogfish, 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, 1603 t (12%); red gurnard, 553 t (17%); red cod, 1638 t (19%); spiny dogfish, 6291 t (14%); and tarakihi, 1189 t (21%). Target c.v.s were 20–25% for red cod and 20% for the other species.

Other commercial species with c.v.s less than 20% were barracouta, gemfish, sea perch, and arrow squid.

The estimates of total biomass for giant stargazer, red gurnard, and spiny dogfish were higher than for the previous survey in 2005 and for giant stargazer were the highest for any survey in the series.

A total of 112 school shark, 31 rig, 56 rough skate, and 7 smooth skate were tagged during the survey. In addition, 773 tarakihi were tagged during two days at the end of the survey which were reserved for tagging juvenile tarakihi in Tasman Bay to clarify stock affiliations.

1. INTRODUCTION

This report presents results from the eighth in a time series of stratified random trawl surveys using RV *Kaharoa* in waters between 20 and 400 m deep 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*), spiny dogfish (*Squalus acanthias*), and tarakihi (*Nemadactylus macropterus*). The results of earlier surveys in this series were reported by Drummond & Stevenson (1995a, 1995b, 1996) and Stevenson (1998, 2002, 2004). The series was reviewed by Stevenson & Hanchet (2000) and species to be included in future reports were reviewed by Stevenson and Hanchet (2007)

The principal objective of the surveys is to develop a time series of relative abundance indices for giant stargazer, red cod, red gurnard, spiny dogfish, and tarakihi for the inshore waters of the west coast of the South Island and within Tasman and Golden Bays. Changes in the relative abundance and length frequency distributions over time should reflect changes in the abundance and size distributions of the underlying fish populations. A standardised index of relative abundance estimates for key inshore species will therefore provide the basis for stock assessment and management strategies. This is particularly important for giant stargazer (STA 7) and rig (SPO 7) which are currently in the Adaptive Management Programme (AMP) (Ministry of Fisheries 2007).

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.

1.1 Programme objective

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

Specific objectives (2007)

2. To determine the relative abundance and distribution of red cod, red gurnard, spiny dogfish, giant 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%), tarakihi (20%) and spiny dogfish (20%).

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

4. To collect otoliths from red cod, red gurnard, giant stargazer, and tarakihi, and spines from spiny dogfish.

5. To collect the data to determine the length frequencies and catch weight of all other Quota Management System (QMS) species.

6. To tag live skate, school shark, and rig.

7. To determine stock affiliation of pre-recruit tarakihi in Tasman/Golden Bay nursery area using mark recapture.

8. To identify benthic macro-invertebrates collected during the trawl survey.

9. To review data collected by the WCSI series to determine for which species relative abundance trends and size composition information should be provided in each survey report.

1.3 Timetable and personnel

RV *Kaharoa* departed Wellington on 22 March 2007 and trawling started on 23 March. *Kaharoa* berthed in Westport on 4 April to unload fish, pick up supplies, and change science staff. Trawling finished on 12 April and *Kaharoa* returned to Nelson to pick up supplies for the tarakihi tagging and change science staff. Additional MFish staff joined the vessel on 15 and 16 April to assist with the tagging work. Tagging commenced on 15 April and concluded on 16 April. The vessel returned to Nelson on 17 April where science staff disembarked. *Kaharoa* remained in Nelson for maintenance

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

2. METHODS

2.1 Survey area and design

The survey area (Figures 1a and b) covered depths of 20–200 m off the west coast of the South Island from Cape Farewell to Karamea; 25–400 m from Karamea 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, Figures 1a and b). Strata were identical to those used in previous surveys. The trawlable ground within the survey area represented 84% of the total survey area.

Phase 1 station allocation was optimised to achieve the target c.v.s using the R program *allocate*. Stratum area and catch rate data from previous *Kaharoa* trawl surveys were used to simulate optimal allocation and simulations were run for each target species separately. Results indicated that 68 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. Results also showed that gurnard and red cod required the most effort to achieve the target predicted c.v.s, with 55 and 59 stations required, respectively. The proposed phase 1 survey design of 68 stations was based on the maximum number of stations required for each species in each stratum.

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 and excluded from the station allocation program. 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 60 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 stratum depth range for which direct readings were available.

A Seabird conductivity, temperature, and depth (CTD) sensor was used to record sea temperatures, conductivity, and water pressure. A Mac Marine Bottom Contact Sensor (BCS) was mounted at the centre of the groundrope and used to determine net contact with the sea floor. If the graphic output (see Stevenson & Hanchet (2006) for examples) showed the net had not maintained good bottom contact, it was reviewed and a determination made on the suitability of the tow for inclusion in estimating biomass.

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 but was usually in the direction 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 (10–2.8). At greater depths, the warp to depth ratio decreased linearly to about 2.4:1 at 400 m.

2.3 Water temperatures

The surface and bottom temperatures at each station were recorded by the CTD unit. Surface temperatures were taken at a depth of 5 m and bottom temperatures when the net settled on the bottom. Bottom temperatures were taken at about 5 m above the sea floor because the CTD rests on the net just behind the headline.

2.4 Elasmobranch tagging

As soon as the net was brought on board, lively rig (*Mustelus lenticulatus*), school shark (*Galeorhinus galeus*), and rough (*Dipturus nasutus*) and smooth (*D. innominatus*) skate were separated from the catch and tagged with a single Hallprint dart tag. Sharks were tagged in the dorsal muscle at the rear of the dorsal fin and skates were tagged near the centre of the left wing. Length, weight, and sex were recorded for each tagged fish and the fish immediately returned to the water.

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, squid, and crustaceans (scampi) were classified by species: crabs, shellfish, and other invertebrate species not readily identified were frozen for later identification because of difficulty in identifying individual species and the limited sorting time available between tows. Unidentified specimens were placed in sealed plastic bags with a label noting the trip code and station number.

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 were collected for the target species, rig, rough skate, smooth skate, and school shark and reproductive state for the target species. 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, spiny dogfish, and tarakihi. Similarly, up to five second dorsal spines per sex per centimetre size class were collected from spiny dogfish.

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 estimating biomass 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 area 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 69 stations) were used for biomass estimation. The c.v. associated with estimates of biomass was calculated by the method of 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 sufficient length-weight data were collected on this survey. For other species, coefficients were chosen from the *trawl* database and 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).

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

2.7 Tarakihi tagging

At the end of the standard survey, the vessel returned to Tasman Bay where the greatest number of small tarakihi were caught during the regular survey (station 19). The CTD and BCS were not deployed for this portion of the project. Tow duration was reduced to 10 minutes and at the end of the tow the codend was immediately lowered into an aerated tank to minimise the time fish spent out of the water. Usually, tagging began after the tarakihi were sorted from the rest of the catch and placed in a second aerated tank. However, for three large catches of tarakihi, tagging began immediately without sorting. Tagged fish were released before travelling to the next station.

3. RESULTS

Results are presented slightly differently in this report compared to those from previous surveys in accordance with a recent review to determine for which species relative abundance trends and size composition information should be provided in each survey report (Stevenson & Hanchet, 2007). Biomass estimates and c.v. s by stratum and catch rates by stratum are given for the 20 most abundant commercially important species. Trends in biomass and comparative length frequency distributions are presented for the target species and for those species for which it is thought the surveys could be monitoring adults and/or pre-recruit abundance. Length frequency distributions for other species are given for this survey only if the species is one of the 20 most abundant commercially important species. Catch rate figures are given only for the target species.

3.1 Survey area, design, and gear performance

Trawling began in Tasman and Golden Bays and after 4 days working continued on the west coast in a generally north to south direction. Two days were lost to bad weather, two days were lost because of equipment problems, and one day was used unloading fish.

Sixty-nine stations were successfully completed, 67 in phase 1 and 2 in phase 2. Station density ranged from one station per 102 km^2 in stratum 17 to one station per 1078 km^2 in stratum 2, with an average density of one station per 371 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.

The two phase 2 stations in stratum 12 were allocated to reduce the tarakihi c.v. towards the target levels. Catch rates of the remaining target species were not used for allocation of phase 2 stations because the c.v.s for these species were within target levels.

Tow and gear parameters by depth are shown in Table 2. Doorspread varied from 67.5 to 91.5 m and headline height varied between 4.1 and 5.7 m (Table 2, Appendix 2). Measurements of headline height and doorspread, together with BCS output and observations that the doors and trawl gear were polishing well, indicated that the gear was, in general, operating correctly. Gear parameters were similar to those of previous surveys, indicating consistency between surveys (Stevenson & Hanchet 2000).

3.2 Catch composition

A total of about 39.2 t of fish was caught from the 69 biomass tows at an average of 568 kg per tow (range 94.1–3558.2 kg). Amongst the chordate fish catch, 1 agnathan, 19 species of elasmobranchs, and 65 teleost species were recorded. Species codes, common names, scientific names, and catch weights of all species identified during the survey are given in Appendix 3.

The most abundant species by weight was spiny dogfish with 8.4 t caught (21.4% of the total catch). The top four species, spiny dogfish, barracouta, red cod, and two-saddle rattail made up 45% of the total. Giant stargazer, red cod, red gurnard, and tarakihi made up 6.2, 7.6, 2.3, and 4.4% of the catch, respectively. Arrow squid, barracouta, spiny dogfish, and scaly gurnard occurred in over 80% of the tows (see Appendix 3).

Eighty-two species of invertebrates were identified from retained specimens (Appendix 4). This compares to 40 species in 2005, 45 species in 2003, and over 150 in 2000. However, the numbers of invertebrate species does not necessarily indicate the level of abundance or biodiversity in the survey area because the gear is not designed to collect benthic macroinvertebrates. In addition, station location strongly influences the incidence of some groups (e.g., bryozoans).

3.3 Catch rates and species distribution

Distribution by stratum and catch rates for the target species are shown in Figures 2a–2e (biomass tows only). 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 ITQ species are given in Table 4. Spiny dogfish had the largest estimated biomass followed by barracouta, dark ghost shark, red cod, and giant stargazer. Biomass and c.v.s for the target species were: giant stargazer, 1603 t (12%); red gurnard, 553 t (17%); red cod, 1638 t (19%); spiny dogfish, 6291 t (14%); and tarakihi, 1189 t (21%) (Table 4).

Biomass estimates of recruited fish for barracouta, blue warehou, giant stargazer, hoki, John dory, 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 98%, 47%, 78%, and over 89% respectively.

Biomass estimates by year class (where discernible from the length frequency distributions) for barracouta, blue warehou, hake, hoki, jack mackerel, red cod, red gurnard, school shark, silver warehou, and tarakihi are given in Table 6. For red cod, the 1+ cohort made up about 48% of the total biomass. For red gurnard, the 2+ cohort made up 3% of the total biomass, and for tarakihi the 2+ cohort made up 11% of the total (Table 6).

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

Survey time series trends in biomass for the target species and for those species where the surveys are likely to be monitoring adult and/or pre-recruit abundance are shown in Figure 3.

3.5 Water temperatures

Isotherms estimated from CTD surface and bottom temperature recordings are shown in Figures 4 and 5 respectively. Temperatures can not be directly compared to surveys before 2005 because earlier data were not taken from calibrated recordings. Both surface and bottom temperatures were generally lower than in 2005.

3.6 Length frequency and biological data

The numbers of length frequency and biological samples taken during the survey are given in Table 8. Comparative scaled length frequency distributions for the target species and for the eight other species the surveys may be monitoring are shown in Figures 6a–m in alphabetical order by common name. Scaled length frequency distributions from this survey for other commercial species where more than 100 fish were measured are shown in Figure 7 in alphabetical order by common name.

Length-weight coefficients were determined for giant stargazer, red cod, red gurnard, spiny dogfish, tarakihi, rig, rough skate, and school shark from data collected on this survey (Appendix 1).

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

3.7 Elasmobranch tagging

A total of 112 school shark was tagged (52 females and 60 males) ranging in length from 37 cm to 141 cm. In addition, 31 rig (10 females, 21 males), 56 rough skate (34 females, 22 males), and 7 smooth skate (4 females, 3 males) were tagged.

3.8 Tarakihi tagging

The juvenile tarakihi tagging was very successful with the use of two aerated holding tanks providing good survival. Locating a concentration of juveniles during the regular survey enabled maximum use of the time available. Most tarakihi did not require venting even when trawled from a depth of 50 m. A total of 773 tarakihi ranging from 10 to 34 cm fork length were tagged over two days at the end of the regular survey. This is at the upper end of the estimate (250–800) of the number of fish that would be tagged. Two fish were known to not survive (one was eaten by a mollymawk on release) but most swam away vigorously.

3.9 Target species

3.9.1 Giant stargazer

Giant stargazer were caught at 77% of all stations with the highest catch rates south of Cape Foulwind in depths of 100–200 m (strata 8, 12, and 15) (Figure 2a, Table 3). The total estimated biomass of 1630 t was the highest in the series. Ninety-two percent of the relative biomass estimate was south of Cape Foulwind, and 79% (1288 t) was within the 100–200 m depth range (Table 7). There were more fish less than 45 cm caught on this survey than in previous years (Figure 6d), but no clear year class modes were apparent in the length frequency distribution. The sex ratio (male:female) of 1.6:1 overall was the highest of the series (see Figure 6d). The low numbers of large females (over 70 cm) continues the pattern first noted in 2000. Virtually all females under 50 cm total length were immature or had resting gonads, but above this size, most had maturing gonads. Most males under 40 cm were immature or resting, and most males over 40 cm were maturing (Table 9).

3.9.2 Red cod

Red cod were caught at over 75% of all stations, with the highest catch rates in strata 7, 11, 14, and 16 (Figure 2b, Table 3). Over 80% of the total biomass was south of Cape Foulwind and 94% (1545 t) was from depths less than 200 m (Table 7). The length frequency data show a dominant 1+ cohort (24–38 cm) present at the time of the survey. Only a few fish in the 10–20 cm range were caught which would represent 0+ fish. However, this mode is slightly stronger than in 2003 and 2005 (Figure 6h). The sex ratio (male:female) of 1.1:1 was the most even of any of the surveys (see Figure 6h). Most red cod examined had immature or resting gonads, and a few fish were at later stages of reproductive development (Table 9).

3.9.3 Red gurnard

Red gurnard were caught at all stations in Tasman and Golden Bay and at all but one station in depths less than 100 m along the west coast (Figure 2c). The highest catch rates were in strata 7 and 19 (Table 3). The relative biomass estimate of 553 t was higher than the previous two surveys (Table 4, Figure 3). There was a substantial difference in the length frequency distributions between this survey and 2003 and 2005 with considerably higher numbers of pre-recruit fish caught in 2007 (Figure 6i). The recruited biomass estimate (30 cm or over) was 432 t (78% of the total) with 189 t occurring on the west coast (Table 5). Almost 99% of red gurnard biomass was at depths less than 100 m and no gurnard were caught deeper than 200 m (Table 7). The overall sex ratio (male:female) was 1.6:1 which was the highest for any survey in the series (see Figure 6i). Most red gurnard over 30 cm had developing or mature gonads (Table 9).

3.9.4 Spiny dogfish

Spiny dogfish were caught at over 88% of all stations with the highest catch rates in strata 15, 11, and 12 (Table 3, Figure 2d). The relative biomass estimate of 6175 t was similar to that of 2005 (Table 4, Figure 3). There were considerably fewer fish less than 50 cm caught on this survey than from previous surveys where spiny dogfish were measured (Figure 6l). Over 99% of the estimated biomass was at depths less than 200 m (Table 7). The sex ratio of (male:female) 0.87:1 was similar to the previous two surveys but lower than in 1997 and 2000 (see Figure 6l).

3.9.5 Tarakihi

Tarakihi were caught at 68% of stations with the highest catch rates in strata 12, and 15 (Table 3, Figure 2e). Almost 89% of the biomass estimate was recruited fish (25 cm and over) (Tables 4 and 5). The length frequency data exhibit a strong mode at 17–23 cm of 2+ fish. There is a weak mode at 10–15 cm of 0+ fish and a few fish at 26–29 cm, probably 3+ fish (Figure 6m). These are the strongest pre-recruit modes since 1997. Of the total tarakihi biomass (1189 t), over 89% was on the west coast, and over 62% (744 t) of this was at depths between 100 to 200 m (Table 7). The sex ratio for the estimated population was 0.87:1 (see Figure 6m). 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).

3.9.6 Other species

Barracouta
Barracouta were caught at over 84% of all stations and represented 8.4% of the total catch (Appendix 3). The highest catch rates were in strata 12 and 19 (Table 3). Over 92% of the total biomass estimate was recruited fish (50 cm and over) (Tables 4 and 5) and the length frequency distribution was similar to that in 2005 except for a mode at 5–15 cm which was stronger than for any previous survey (Figure 6a).

Blue warehou
Blue warehou were caught at 33% of all biomass stations with the highest catch rates in stratum 15 (Table 3). Less than 55% of the total biomass was recruited fish (54 cm or over) (Tables 4 and 5). The length frequency distribution shows three pre-recruit modes at 10–23 cm, 23–30 cm, and 30–39 cm. The mode at 30–39 cm is the most evident this year class (2+) has been in any survey in the series (Figure 6b).

Gemfish
Gemfish were caught at only 10 stations and in low numbers (Appendix 3, Table 8). The strong mode present in 2003 and 2005 is no longer apparent in the length frequency distribution (Figure 6c).

Jack mackerel (*Trachurus declivis*)
Trachurus declivis was caught at 29 stations but in low numbers (Appendix 3, Table 8). The biomass estimate of 62 t was the lowest of any survey in the series (Table 4). The length frequency distribution is similar to those from 2003 and 2005, with few small fish and a weak adult mode (Figure 6e).

John dory
John dory were caught at 21 biomass stations with the highest catch rates in stratum 19 (Table 3, Appendix 3). The biomass estimate of 171 t is lower than 2003 and 2005 but higher than for any other survey (Table 4). The length frequency distribution shows few small fish but good numbers of large females (Figure 6f).

Ling
Ling were caught at just over half of all stations with the highest catch rates in stratum 16 (Appendix 3, Table 3). Although the biomass estimate is lower than for 2005, the estimated population is higher because of greater numbers of fish less than 70 cm total length, especially males (Figure 6g).

Rig
Rig were caught at just over half of the stations, with the highest catch rates in strata 7 and 8 (Appendix 3, Table 3). The estimated biomass of 383 t is the highest in the series except for 1995, but the c.v. was the highest in the series (Table 4, Figure 3). The length frequency distribution shows good numbers of fish less than 100 cm total length but few fish over that size (Figure 6j).

School shark
School shark were caught at about 74% of all biomass stations with the highest catch rates in strata 12 and 15 (Appendix 3, Table 3). The estimated biomass of 816 t was higher than in 2003 and 2005 but still lower than all earlier surveys (Table 4, Figure 3). The length frequency distribution shows a reasonably strong mode at 38–48 cm compared to previous surveys, but there were few fish caught greater than 110 cm (Figure 6k).

3.9.7 Invertebrates

The amount and diversity of invertebrates was greater than in 2003 and 2005 but less than in 2000 (Stevenson 2002, 2004, 2006). There were no rare or invasive species identified (Appendix 4).

4. DISCUSSION

Following the recommendations of a review of the previous seven surveys in the series (Stevenson & Hanchet, 2007), results in this report include information on species where it is thought the surveys may be monitoring adult or pre-recruit abundance.

The 2007 survey was the eighth the March-April *Kaharoa* time series for the west coast of the South Island and Tasman and Golden Bays, the first of which was in 1992. Sixty-nine biomass stations and 17 tarakihi tagging tows were successfully completed. The mean catch per station of 567 kg is similar to that in 2005 (597 kg), but less than the first four surveys in the series.

The c.v.s associated with the biomass estimates for the target species were all lower than or very close to the target c.v.s. Other commercial species with c.v.s of 20% or less were arrow squid (9%), barracouta (14%), gemfish (19%), school shark (20%), and silver warehou (20%). As in all previous years, spiny dogfish was the species caught in the greatest quantity (8.4 t or 21.4% of the total catch), and had the highest biomass estimate.

The biomass estimate for giant stargazer was the highest in the series (Table 4, Figure 3). Although the large mode of adult females at 60–70 cm is again apparent, the low numbers of females greater than 70 cm and males greater than 60 cm total length is consistent with the previous three surveys.

The total biomass estimate for red gurnard was higher than in 2005 and the abundance in Tasman and Golden Bays has recovered to the levels seen in the first four surveys (Table 4). The biomass estimate of pre-recruit red gurnard was almost twice that of 2005 and the highest since 2000.

The length frequency distribution for spiny dogfish shows very few fish under 50 cm. This is in contrast to all previous surveys on which spiny dogfish were measured where there is a strong mode in the length frequency distributions at 40–50 cm. It is not known if this is a result of availability/catchability factors or indicates an actual absence of smaller fish.

The biomass estimate for tarakihi declined from the very high level of 2005 and is now similar to estimates from the 1990s. The mode at 15–23 cm is the strongest for this age class since the first survey in 1992 (Figure 6m). It is difficult to track year classes through the research survey series in recent years, partly because of the intermittent nature of the series and partly because of the merging of modes as the fish grow. To determine if the 2+ year class provides strong recruitment to the TAR 7 stock would require ageing of the commercial catch over the next 2–5 years.

The strong mode at 60–70 cm in the gemfish length frequency in 2005 is no longer apparent and the gemfish catch was well below that of the previous two surveys. For John dory, the biomass estimate was down only slightly from 2005 (Table 4). However, the current estimate is for fewer and larger fish and the strong modes of smaller fish (less than 35 cm) seen in 2000 and 2003 are again absent. There were few large ling, rig, or school shark caught compared to earlier surveys, but there were more smaller fish (Figures 6g, 6j, and 6k). The numbers of pre-recruit hake was similar to that in 2005 but the number of pre-recruit hoki was about one-third those of 2005 (Figure 7).

There was an increase in the number of pre-recruits caught for blue cod, giant stargazer, ling, red gurnard, tarakihi, rig, school shark, and silver warehou compared to 2005. For rig, the numbers were the highest since 1995 and for school shark they were the highest for any survey. In contrast, few pre-recruits were caught for John dory or jack mackerel (*T. declivis*) compared to earlier surveys.

5. RECOMMENDATIONS

The MFish medium term-research plan calls for another survey in this series in 2009. The review of non-target species has shown the need for additional ageing studies for barracouta, blue warehou, hake, hoki, jack mackerel (both *T. declivis* and *T. novaezelandiae*), and silver warehou to determine if the sub-adult catch on these surveys is indicative of year-class strength.

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Table 1: Stratum depth ranges, survey area, non-trawlable area, number of successful phase 1 and phase 2 biomass 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	6	0	717
5	25–100	1 224	0	3	0	408
6	100–200	3 233	238	3	0	1078
7	25–100	927	0	4	0	232
8	100–200	2 354	214	4	0	589
9	200–400	1 877	1 456	3	0	626
11	25–100	1 438	63	9	0	160
12	100–200	2 054	501	6	2	257
13	200–400	1 101	466	3	0	367
14	25–100	851	36	4	0	213
15	100–200	881	373	3	0	294
16	200–400	319	35	3	0	106
17	20–33	307	27	3	0	102
18	20–42	947	30	3	0	316
19	20–70	2 436	193	6	0	406
Total (average)		25 594	4 034	67	2	(371)

Table 2: Gear parameters for bimass stations by depth range (n, number of stations; s.d., standard deviation). Data for gear trials shown separately.

	n	Mean	s.d.	Range
All stations	69			
Headline height (m)		4.7	0.30	4.1–5.7
Doorspread (m)		79.1	7.07	67.5–91.5
Distance (n. miles)		2.9	0.24	2.16–3.38
Warp:depth ratio		3.7	1.53	2.35–8.89
Tasman/Golden Bays				
20–70 m	12			
Headline height (m)		5.0	0.55	4.2–5.7
Doorspread (m)		72.4	2.46	67.5–75.6
Distance (n. miles)		3.0	0.13	2.82–3.38
Warp:depth ratio		5.7	1.85	3.41–8.89
West coast				
20–400 m	57			
Headline height (m)		4.6	0.17	4.1–5
Doorspread (m)		80.6	6.91	67.6–91.5
Distance (n. miles)		2.9	0.26	2.16–3.09
Warp:depth ratio		3.3	1.04	2.35–7.55
20–100 m	24			
Headline height (m)		4.7	0.15	4.4–5
Doorspread (m)		73.6	3.36	67.6–84.3
Distance (n. miles)		3.0	0.16	2.25–3.09
Warp:depth ratio		4.0	1.25	2.76–7.55
100–200 m	24			
Headline height (m)		4.6	0.19	4.1–4.8
Doorspread (m)		84.5	3.03	76.6–89.3
Distance (n. miles)		2.9	0.25	2.23–3.06
Warp:depth ratio		2.8	0.08	2.63–2.93
200–400 m	9			
Headline height (m)		4.6	0.05	4.5–4.6
Doorspread (m)		88.8	2.95	85–91.5
Distance (n. miles)		2.7	0.40	2.16–3.07
Warp:depth ratio		2.6	0.15	2.35–2.8

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	GSH	RCO	STA	NOS	TAR	SCH	HOK	GUR
1	303	177	45	57	18	27	1	19	+	4
	(219)	(135)	(72)	(63)	(34)	(30)	(1)	(36)	(1)	(9)
2	125	17	214	0	8	38	3	9	0	0
	(105)	(37)	(189)		(18)	(29)	(6)	(12)		
5	162	43	102	129	33	15	4	12	1	3
	(192)	(34)	(153)	(120)	(45)	(14)	(5)	(14)	(1)	(34)
6	270	69	136	+	3	100	23	2	0	1
	(112)	(51)	(41)	(+)	(5)	(15)	(33)	(4)		(1)
7	420	69	238	275	35	64	4	18	13	4
	(293)	(79)	(243)	(255)	(50)	(75)	(8)	(14)	(25)	(21)
8	251	155	124	4	130	48	23	35	3	2
	(169)	(158)	(213)	(5)	(43)	(31)	(22)	(24)	(6)	(2)
9	0	0	3	0	0	22	0	28	0	0
			(5)			(33)		(31)		
11	550	137	25	276	68	71	34	23	0	7
	(248)	(91)	(71)	(325)	(74)	(79)	(58)	(23)		(65)
12	517	282	13	82	410	79	200	136	291	1
	(320)	(204)	(15)	(80)	(247)	(64)	(218)	(153)	(553)	(1)
13	33	85	6	19	57	32	175	5	5	0
	(36)	(40)	(5)	(18)	(49)	(18)	(153)	(8)	(9)	
14	33	48	0	245	46	16	23	0	0	3
	(36)	(57)		(488)	(62)	(14)	(29)			(27)
15	973	153	5	167	108	22	217	114	76	0
	(1337)	(226)	(8)	(60)	(49)	(15)	(131)	(171)	(15)	
16	12	73	286	268	68	26	138	6	254	0
	(17)	(127)	(372)	(313)	(31)	(9)	(150)	(10)	(92)	
17	7	12	0	16	3	19	4	18	0	3
	(9)	(13)		(8)	(4)	(11)	(5)	(11)		(122)
18	27	7	0	55	1	23	+	55	0	3
	(19)	(5)		(53)	(1)	(17)	(+)	(61)		(119)
19	204	203	0	26	10	42	53	41	0	6
	(275)	(171)		(50)	(10)	(22)	(128)	(47)		(86)

+ < 0.5 kg.km^{-2}

Table 3—*continued*

										Species code
Stratum	FRO	SPO	HAK	WAR	RSK	LEA	JMN	LIN	JDO	SWA
1	11	27	66	10	9	19	0	17	1	3
	(15)	(44)	(131)	(19)	(14)	(38)		(30)	(2)	(5)
2	0	0	0	0	0	0	0	0	2	1
									(5)	(2)
5	17	27	48	8	9	0	0	11	4	+
	(29)	(35)	(80)	(12)	(16)			(11)	(8)	(+)
6	0	0	0	0	0	0	0	+	14	6
								(+)	(17)	(5)
7	3	44	85	4	46	0	1	8	0	25
	(2)	(31)	(123)	(7)	(57)		(1)	(15)		(29)
8	13	48	+	0	3	0	+	2	8	8
	(21)	(95)	(1)		(5)		(+)	(2)	(9)	(13)
9	0	0	0	0	1	0	0	1	0	10
					(2)			(2)		(13)
11	+	19	47	79	23	0	3	7	0	10
	(+)	(27)	(73)	(121)	(30)		(6)	(12)		(9)
12	153	7	16	1	0	0	0	13	1	5
	(217)	(13)	(23)	(2)				(17)	(3)	(5)
13	115	0	0	0	0	0	0	22	0	+
	(198)							(38)		(1)
14	+	7	31	6	28	0	0	6	0	17
	(+)	(11)		(12)	(50)			(11)		(17)
15	4	12	0	147	0	0	0	6	0	2
	(6)	(21)		(254)				(9)		(3)
16	60	0	26	0	0	0	0	166	0	1
	(81)		(15)					(170)		(2)
17	0	12	1	21	0	33	24	19	9	+
		(17)	(1)	(7)		(32)	(33)	(12)	(4)	(+)
18	0	14	0	4	9	17	35	0	14	10
		(11)		(4)	(16)	(16)	(45)		(2)	(16)
19	0	36	1	+	48	82	69	1	31	10
		(29)	(1)	(1)	(41)	(97)	(130)	(2)	(28)	(12)

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

Table 4: Relative biomass estimates and c.v.s by trip from the entire survey area for ITQ species.

	KAH9204		KAH9404		KAH9504		KAH9701		KAH0004		KAH0304		KAH0503		KAH0704	
Species	Biomass	cv%	Biomass	cv%	Biomass	cv%	Biomass	cv%	Biomass	cv%	Biomass	cv%	Biomass	cv%	Biomass	cv%
Arrow squid	2 960	18	1 199	9	3 450	14	966	13	523	11	2 255	12	889	9	1 228	9
Barracouta	2 478	14	5 298	16	4 480	13	2 993	19	1 787	11	4 485	20	2 763	13	2 582	14
Blue warehou	123	40	80	22	115	29	842	31	272	37	191	66	116	40	286	50
Dark ghost shark	271	24	722	14	767	24	1 591	21	2 259	9	544	15	832	22	2 215	21
Elephantfish	21	42	167	33	85	35	94	32	42	63	48	34	59	33	28	53
Frostfish	25	32	27	23	89	31	259	32	316	16	494	22	423	45	529	39
Gemfish	145	19	68	29	21	55	704	83	120	30	137	23	474	49	101	19
Giant stargazer	1 302	12	1 350	17	1 551	16	1 450	15	1 023	12	834	15	1 458	19	1 630	12
Hake	391	25	99	31	5 244	27	1 019	46	15	36	55	47	1 673	30	359	35
Hoki	405	17	826	49	3 616	21	1 100	25	103	50	233	22	701	55	772	52
Jack mackerel																
Trachurus declivis	92	24	99	26	106	20	162	19	168	33	87	21	118	21	62	23
T. novaezelandiae	281	58	69	23	57	29	363	27	194	46	126	49	98	20	214	62
John dory	102	29	59	26	27	36	17	31	141	16	288	19	222	14	174	26
Leatherjacket	203	29	230	23	153	34	231	34	236	50	254	18	139	20	252	40
Lemon sole	88	18	77	25	126	21	68	21	59	19	2	44	21	42	119	46
Ling	286	19	261	20	367	16	151	30	95	46	150	33	274	37	180	27
New Zealand sole	68	33	68	16	39	30	45	29	16	32	21	57	27	45	39	71
Northern spiny dogfish	146	20	159	21	86	28	164	46	256	18	111	27	180	22	134	29
Red cod	2 719	13	3 169	18	3 123	15	2 546	23	414	26	906	24	2 610	18	1 638	19
Red gurnard	573	16	559	15	584	19	471	13	625	14	270	20	442	17	553	17
Rig	288	14	380	10	490	10	308	18	333	18	144	22	153	19	383	33
Rough skate	173	27	196	23	251	22	185	30	186	23	43	34	58	30	256	23
Sand flounder	100	31	203	23	132	28	106	28	62	22	10	33	62	25	67	47
School shark	933	22	1 151	41	1 204	35	1 432	25	896	13	655	18	774	14	816	20
Sea perch	242	22	426	18	667	23	338	14	302	22	76	25	150	20	163	19
Silver warehou	292	38	66	35	38	20	204	20	99	34	69	27	72	28	165	20
Smooth skate	339	19	341	18	315	20	302	26	140	29	91	79	80	30	55	44
Spiny dogfish	3 919	15	7 145	7	8 370	10	5 275	13	4 777	12	4 446	15	6 175	12	6 291	14
Tarakihi	1 409	14	1 394	13	1 389	10	1 087	12	964	19	912	20	2 050	12	1 189	21

Table 5: Recruited biomass estimates (t).

Species	Recruited length (cm)	Tasman and Golden Bays		West coast		Total survey area	
		Biomass	c.v.%	Biomass	c.v.%	Biomass	c.v.%
Barracouta	50	430	36	1 950	15	2 380	14
Blue warehou	45	0		156	56	156	56
Giant stargazer	30	7	72	1 586	13	1 604	13
Hoki	65	0		45	64	45	64
John dory	25	91	31	83	42	174	26
Ling	65	1	55	110	33	111	33
Red cod	40	61	69	709	25	769	24
Red gurnard	30	243	25	189	25	432	18
Rig	90	33	39	132	51	164	42
Sand flounder	25	27	43	1	100	28	41
School shark	90	7	72	179	25	186	24
Silver warehou	25	0		48	36	48	36
Tarakihi	25	8	100	1 055	20	1 055	20

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

Species	Year class	Length range (cm)	Biomass	c.v.%
Barracouta	0+	<15	1	57
	1+	15– 29	46	36
	2+	29–39	8	31
	3+	39–53	154	35
Blue warehou	0+	< 23	12	25
	1+	23–30	12	37
	2+	30–39	71	78
Hake	0+	<18	2	47
	1+	18–31	17	56
	2+	31–45	307	38
Hoki	0+	17–36	670	60
	1+	36–53	40	46
Jack mackerel (*T. novaezelandiae)*	1+	14–25	113	77
Red cod	0+	<23	7	30
	1+	23–38	782	25
Red gurnard	2+	18–24	19	33
School shark	0+	< 42	28	62
	1+	42–55	13	38
Silver warehou	1+	15–23	116	23
Tarakihi	1+	10–16	1	55
	2+	16–23	126	92
	3+	23–30	35	44

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	GSH	RCO	STA	NOS	TAR	SCH	HOK	GUR
1	407	237	61	77	24	37	1	25	1	12
	(36)	(38)	(79)	(55)	(93)	(55)	(52)	(94)	(100)	(65)
2	539	73	919	0	35	165	11	40	0	0
	(34)	(88)	(36)		(89)	(31)	(100)	(55)		
5	184	49	116	146	37	17	4	14	1	39
	(69)	(46)	(87)	(54)	(79)	(55)	(74)	(64)	(100)	(64)
6	873	222	439	1	9	324	75	7	0	2
	(24)	(43)	(18)	(100)	(96)	(9)	(81)	(100)		(100)
7	389	64	220	255	32	59	4	17	12	20
	(35)	(57)	(51)	(46)	(72)	(59)	(91)	(41)	(100)	(46)
8	592	364	291	10	307	113	55	82	7	4
	(34)	(51)	(86)	(54)	(16)	(32)	(47)	(34)	(100)	(60)
9	0	0	6	0	0	42	0	52	0	0
			(100)			(85)		(64)		
11	790	197	36	397	97	102	48	33	0	93
	(15)	(22)	(95)	(39)	(37)	(37)	(58)	(33)		(35)
12	####	578	26	169	843	162	411	279	598	1
	(22)	(26)	(42)	(34)	(21)	(29)	(39)	(40)	(67)	(100)
13	37	94	7	20	63	35	192	5	5	0
	(63)	(27)	(52)	(56)	(49)	(33)	(51)	(100)	(100)	
14	28	41	0	208	39	13	20	0	0	23
	(55)	(59)		(100)	(68)	(45)	(62)			(94)
15	859	135	4	148	95	20	192	101	67	0
	(79)	(85)	(100)	(21)	(26)	(39)	(35)	(86)	(11)	
16	4	23	91	85	22	8	44	2	81	0
	(82)	(100)	(75)	(68)	(26)	(20)	(63)	(100)	(21)	
17	2	4	0	5	1	6	1	5	0	38
	(76)	(59)		(31)	(64)	(33)	(79)	(37)		(39)
18	26	6	0	52	1	22	+	52	0	113
	(40)	(44)		(55)	(100)	(43)	(65)	(64)		(32)
19	498	494	0	64	25	103	129	101	0	209
	(55)	(34)		(78)	(40)	(21)	(99)	(46)		(35)

Table 7—*continued*

Stratum	Species code									
	FRO	SPO	HAK	WAR	RSK	LEA	JMN	LIN	JDO	SWA
1	15	37	88	13	12	26	0	22	2	4
	(67)	(81)	(100)	(97)	(76)	(100)		(92)	(81)	(94)
2	0	0	0	0	0	0	0	0	10	5
									(100)	(64)
5	19	31	55	9	10	0	0	12	5	+
	(99)	(74)	(96)	(85)	(100)			(58)	(100)	(100)
6	0	0	0	0	0	0	0	+	46	19
								(100)	(67)	(51)
7	2	41	79	4	43	0	1	7	0	24
	(46)	(35)	(72)	(90)	(62)		(100)	(98)		(58)
8	29	112	1	0	6	0	+	4	18	18
	(82)	(100)	(100)		(100)		(100)	(62)	(57)	(88)
9	0	0	0	0	3	0	0	2	0	19
					(87)			(100)		(78)
11	0	27	67	113	33	0	5	10	0	14
	(54)	(49)	(53)	(51)	(44)		(67)	(58)		(32)
12	314	14	33	2	0	0	0	27	2	10
	(50)	(66)	(50)	(100)				(46)	(100)	(39)
13	126	0	0	0	0	0	0	24	0	+
	(100)							(100)		(100)
14	0	6	26	5	24	0	0	5	0	15
	(100)	(79)	(100)	(100)	(89)			(92)		(47)
15	3	11	0	129	0	0	0	5	0	2
	(100)	(100)		(100)				(93)		(86)
16	19	0	8	0	0	0	0	53	0	+
	(78)		(34)					(59)		(100)
17	0	4	0	6	0	10	7	6	3	+
		(82)	(100)	(19)	(67)	(56)	(81)	(37)	(26)	(52)
18	0	13	0	4	9	17	33	0	13	10
		(49)		(50)	(100)	(53)	(76)		(7)	(87)
19	0	88	2	1	117	199	168	2	75	25
		(33)	(70)	(100)	(35)	(48)	(77)	(86)	(37)	(49)

Table 8: Number of biological and length frequency records.

		Length frequency data		Biological data+			
Species code	Measurement method	No. of samples	No. of fish	No. of samples	No. of fish	No. of otoliths or spines	No. of tagged fish
BAR	1	60	2 998				
BCO	2	10	183				
BRI	2	7	15				
CBI	2	27	1 869				
ELE	1	7	13				
EMA	1	1	1				
ESO	2	12	202				
FRO	1	27	844				
GSH	G	37	1 288				
GUR	1	37	1 911	37	555	240	
HAK	2	25	844				
HAP	2	4	6				
HOK	2	19	1 696				
JAV	2	2	168				
JDO	2	21	78				
JMD	1	29	112				
JMM	1	8	14				
JMN	1	15	648				
KAH	1	1	3				
LDO	2	1	1				
LEA	2	12	1 199				
LIN	2	35	319				
LSK	5	2	3				
LSO	2	33	711				
MDO	2	1	1				
NOS	4	67	2 903				
NSD	2	15	38	1	1		
OPE	2	1	4				
POS	2	1	1				
RCO	2	52	3 039	47	960	359	
RSK	5	22	184	12	73		56
SCH	2	51	658	32	291		112
SCI	B	1	1				
SFL	2	7	529				
SKI	2	10	29				
SNA	1	6	16				
SPD	2	61	3 402	58	1968	322	
SPE	2	37	1 372				
SPO	2	34	221	14	102		31
SSH	2	2	31				
SSK	5	13	23	3	7		7
STA	2	53	1 024	52	938	385	
SWA	1	44	1 475				
TAR	1	47	1 688	45	884	270	773
THR	2	2	2	2	2		
TUR	2	1	1				
WAR	1	23	640				
YBF	2	1	1				

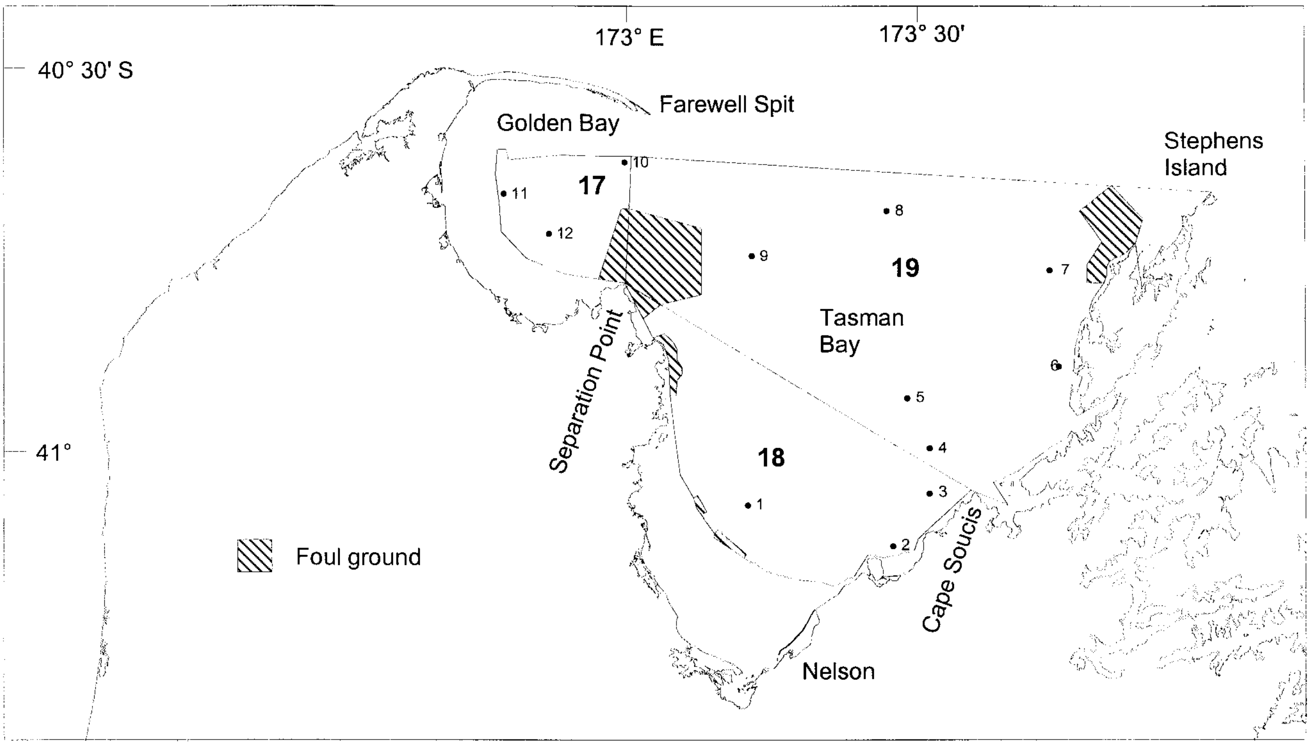
Measurement methods: 1, fork length; 2, total length; 4, mantle length; 5, pelvic length;
B, carapace length; G, total length excluding tail filament

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

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	17	2	3	4	5	9	0	0	0	0	
21–30	56	0	0	0	0	41	0	0	0	0	
31–40	67	19	2	0	0	47	2	1	0	0	
41–50	19	116	19	3	1	41	6	0	0	0	
51–60	1	91	23	6	2	15	45	8	0	1	
61–70	0	12	1	0	0	1	65	27	0	1	
> 70	0	0	0	0	0	0	7	1	0	0	
Total	160	238	48	13	8	154	125	37	0	2	785
Red cod											
11–20	13	0	0	0	0	47	0	0	0	0	
21–30	157	6	0	0	0	85	2	0	0	0	
31–40	82	33	4	0	0	105	4	0	0	0	
41–50	2	37	20	12	0	40	11	1	0	0	
51–60	0	14	7	6	0	30	48	11	3	7	
> 60	0	0	1	1	0	4	18	0	0	3	
Total	254	90	32	19	0	311	83	12	3	10	814
Red gurnard											
21–30	50	26	2	0	0	58	2	0	0	0	
31–40	23	133	19	1	9	42	33	15	2	3	
41–50	0	13	3	0	0	3	33	21	1	5	
Total	73	172	24	1	9	103	68	36	3	8	497
Tarakihi											
11–20	60	0	0	0	0	42	0	0	0	0	
21–30	23	9	1	0	0	34	2	0	0	0	
31–40	0	101	55	68	0	38	226	23	8	1	
41–50	0	7	7	5	1	2	78	6	7	3	
Total	83	117	63	73	1	116	306	29	15	4	807

Gonad stages used were: 1, immature or resting; 2, maturing (oocytes visible in females, thickening gonad but no milt expressible in males); 3, mature (hyaline oocytes in females, milt expressible in males); 4, running ripe (eggs and milt free flowing); 5, spent (gonads flacid and bloodshot)



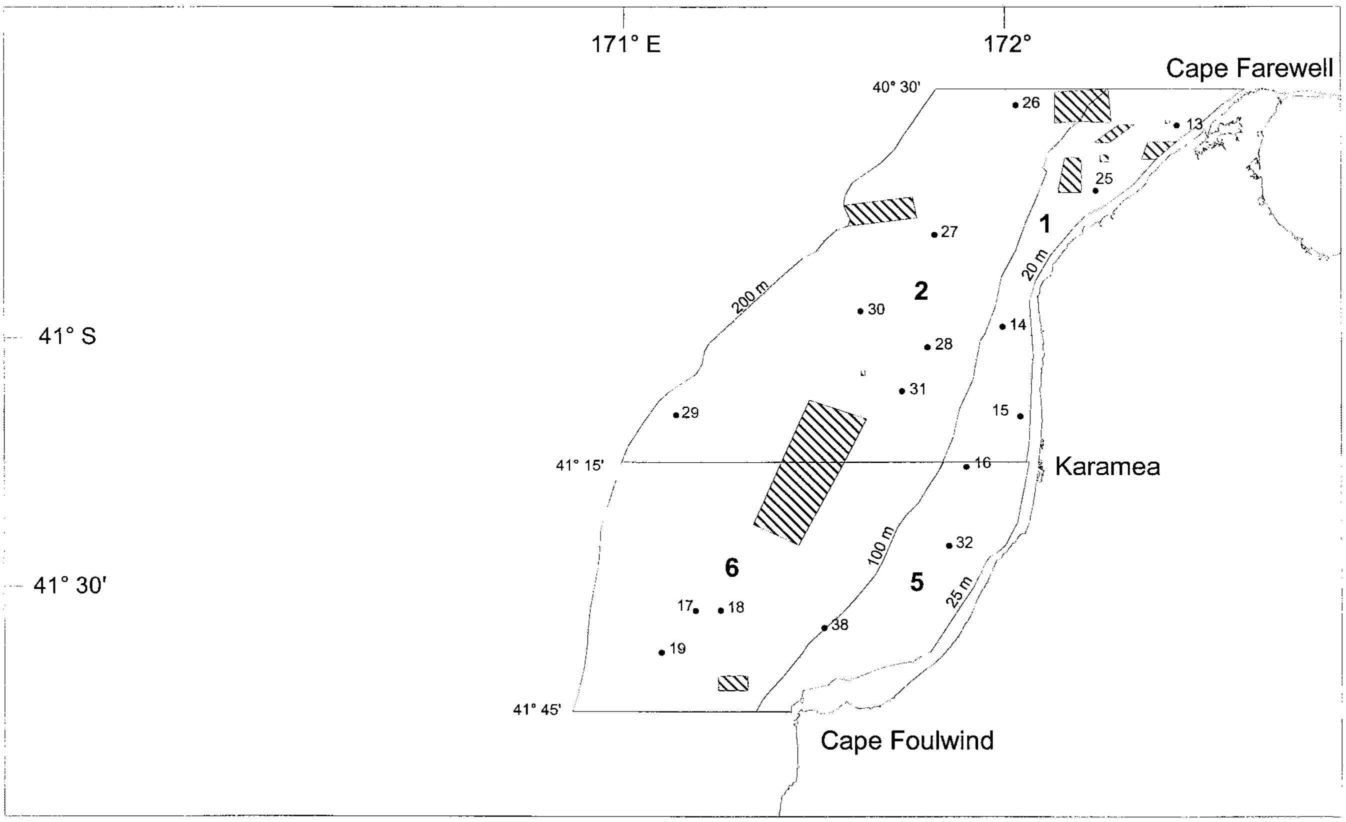


Figure 1a: Survey area showing stratum boundaries and numbers (bold type) for Tasman and Golden Bays (top) and west coast north of Cape Foulwind (bottom) with station positions and numbers.

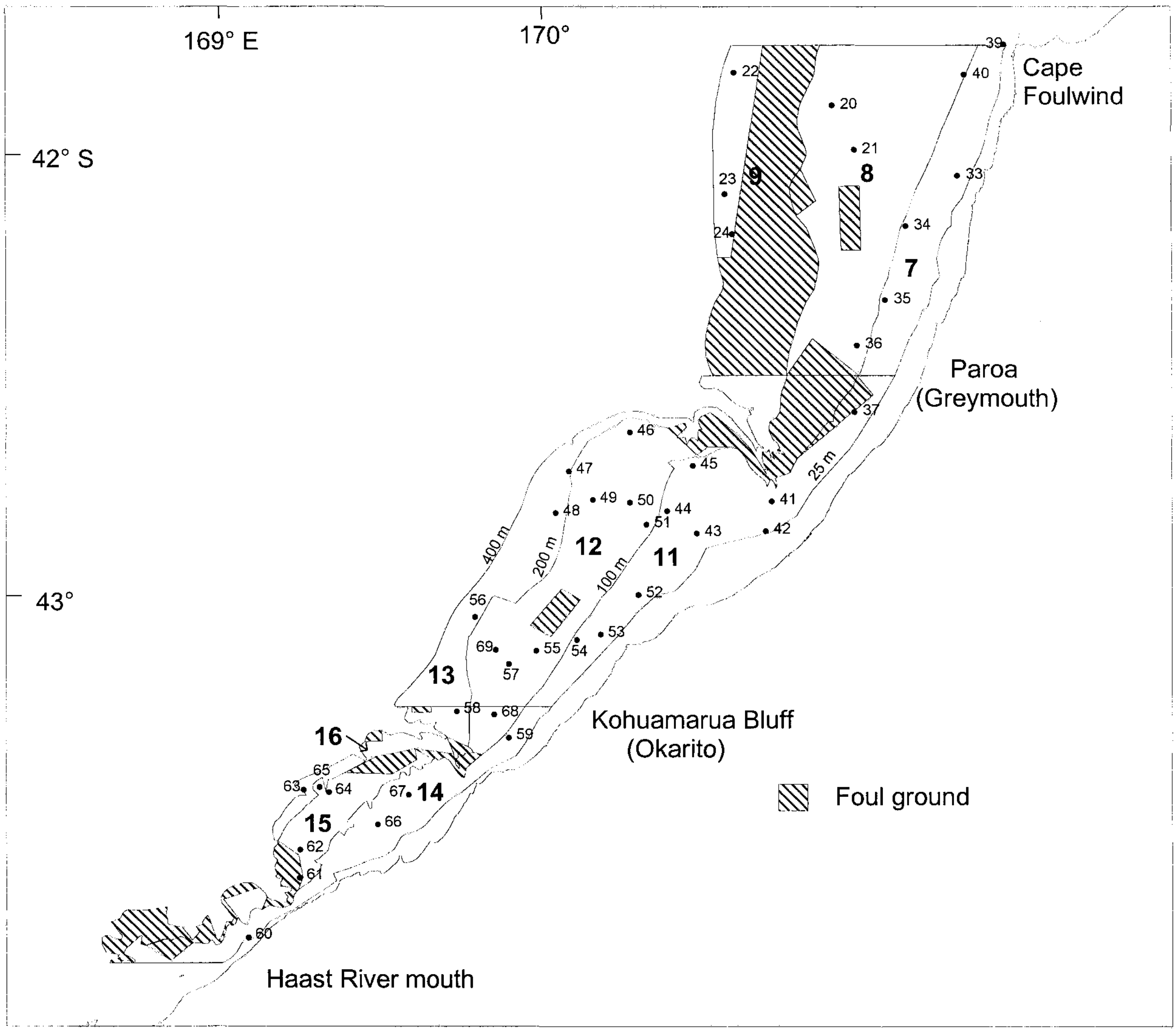


Figure 1b: Stratum boundaries and number (bold type) for the west coast south of Cape Foulwind with station positions and numbers.

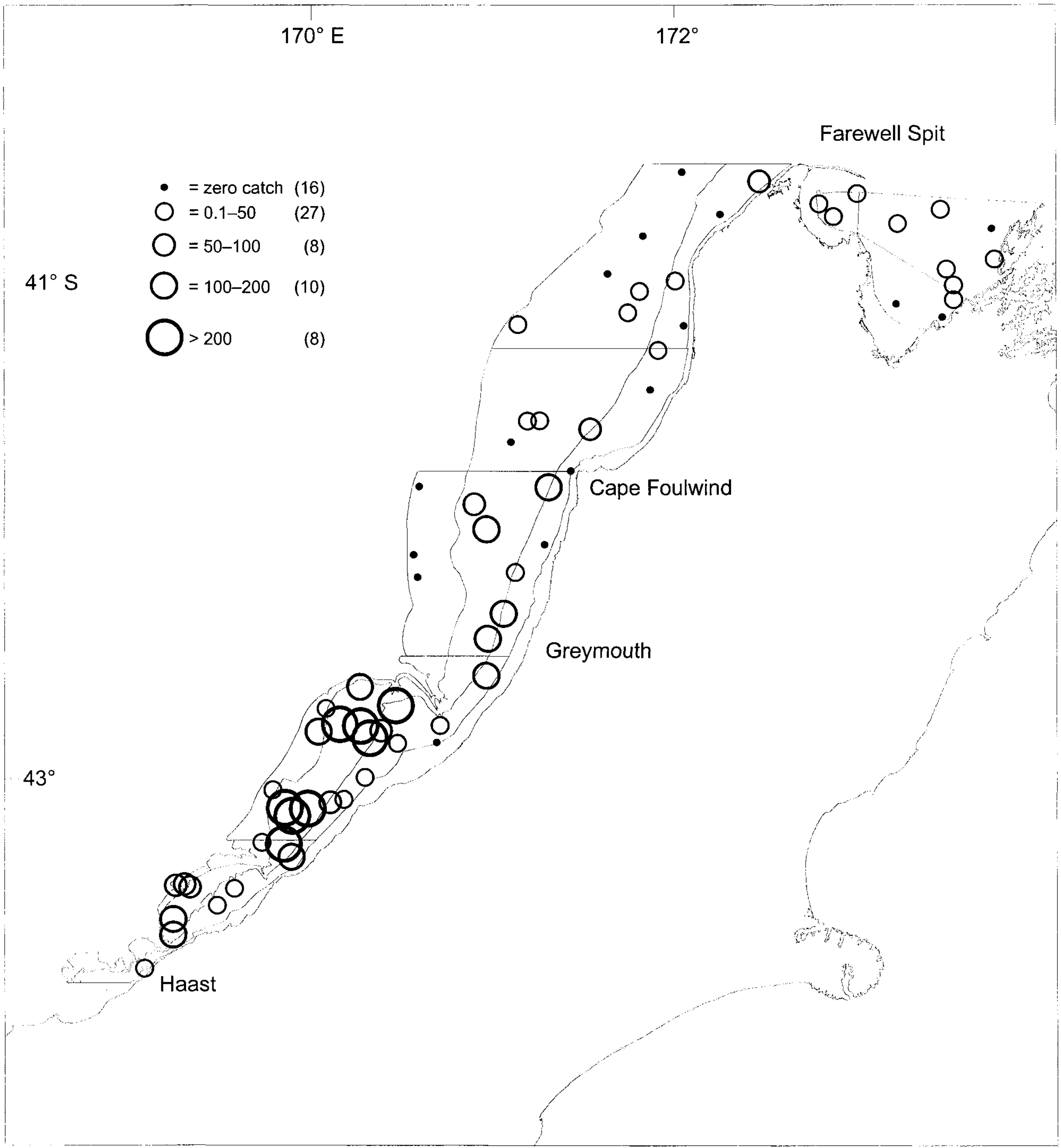


Figure 2: Catch rates (kg.km^{-2}) for the target species in alphabetical order by common name (numbers in parenthesis are the number of catches within the given range).
a: Giant stargazer (maximum catch rate = 912 kg.km^{-2})

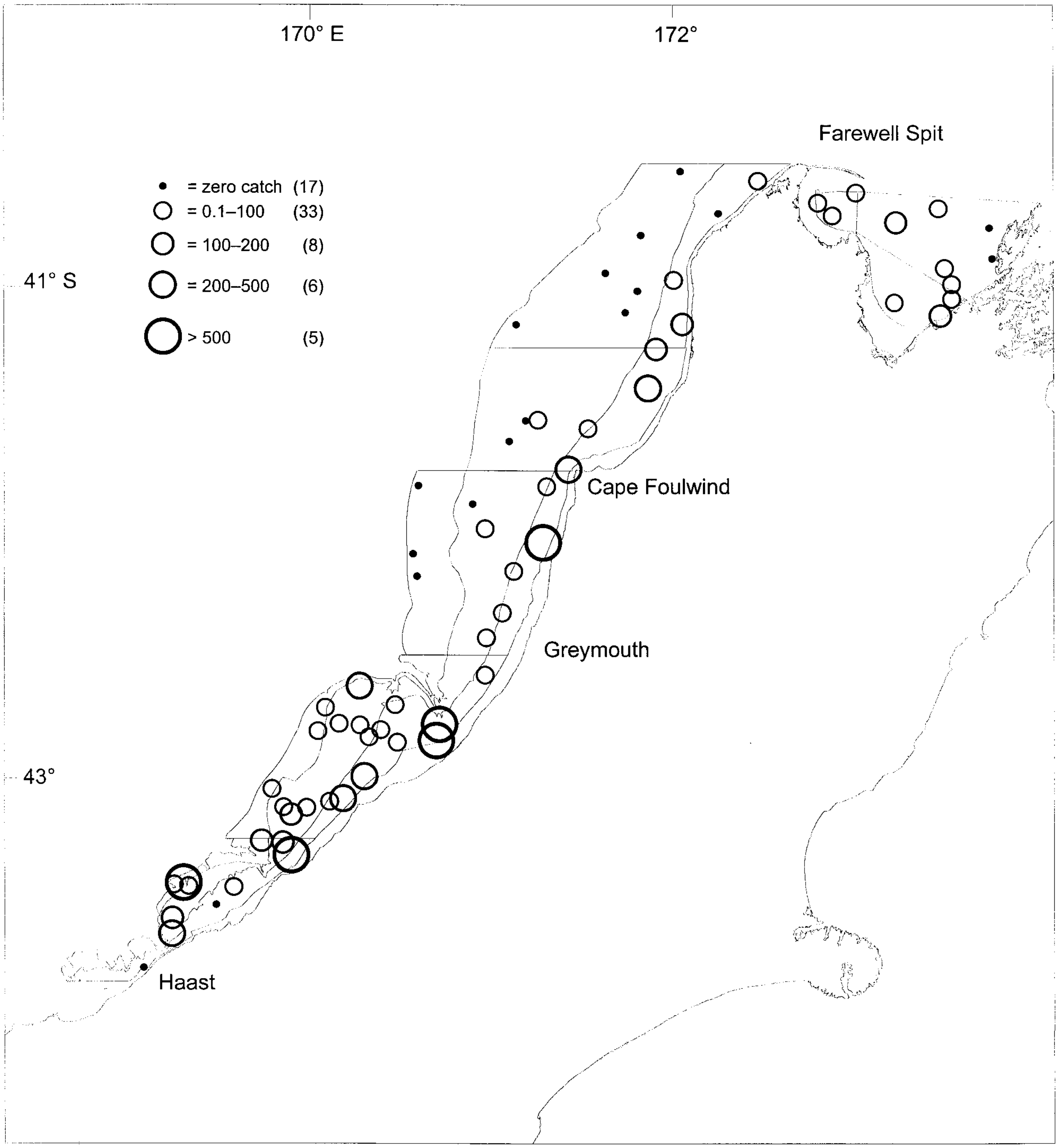


Figure 2b: Red cod (maximum catch rate = 977 kg.km^{-2})

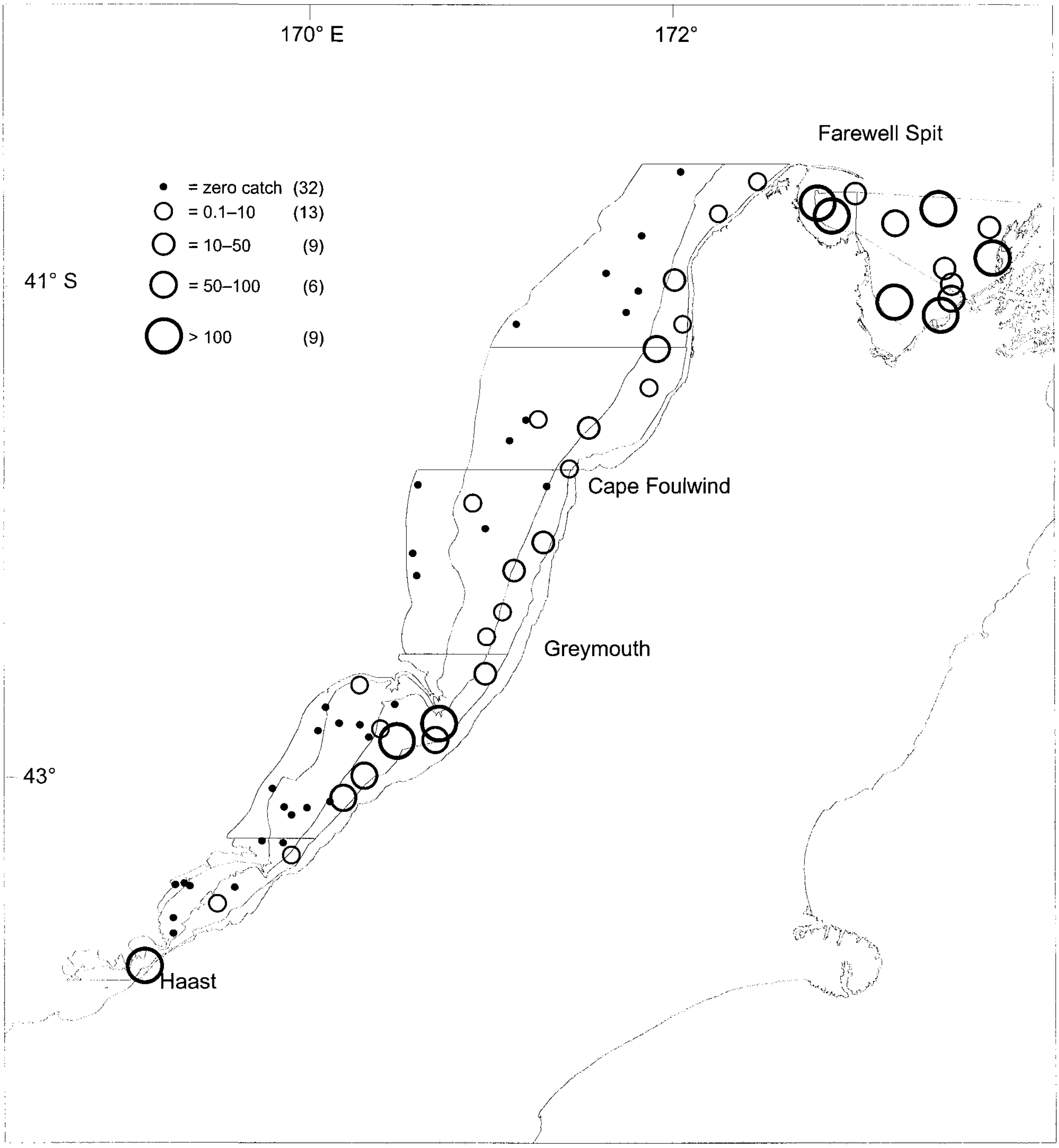


Figure 2c: Red gurnard (maximum catch rate = 221 kg.km^{-2})

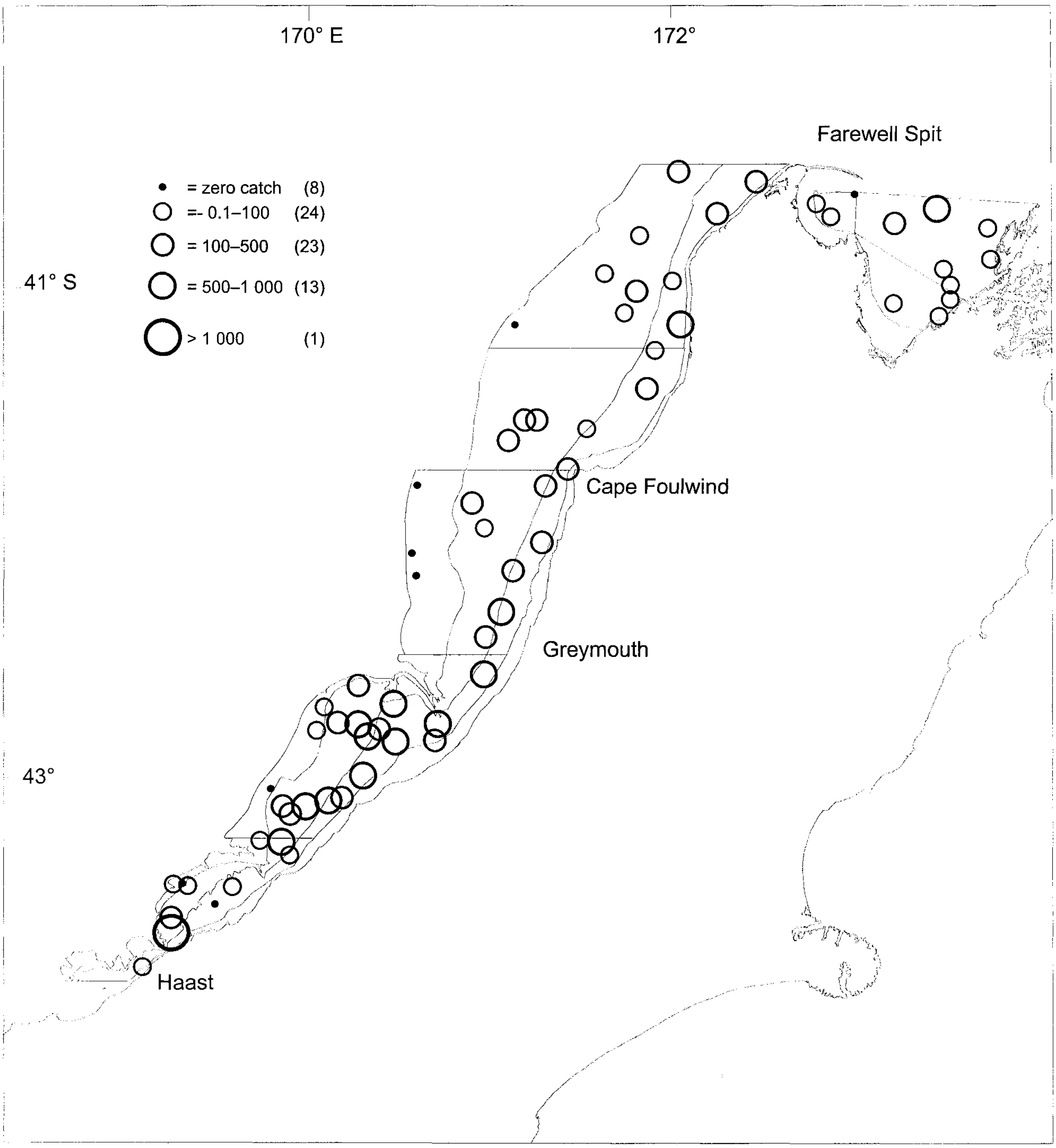


Figure 2d: Spiny dogfish (maximum catch rate = 2 510 kg.km^{-2})

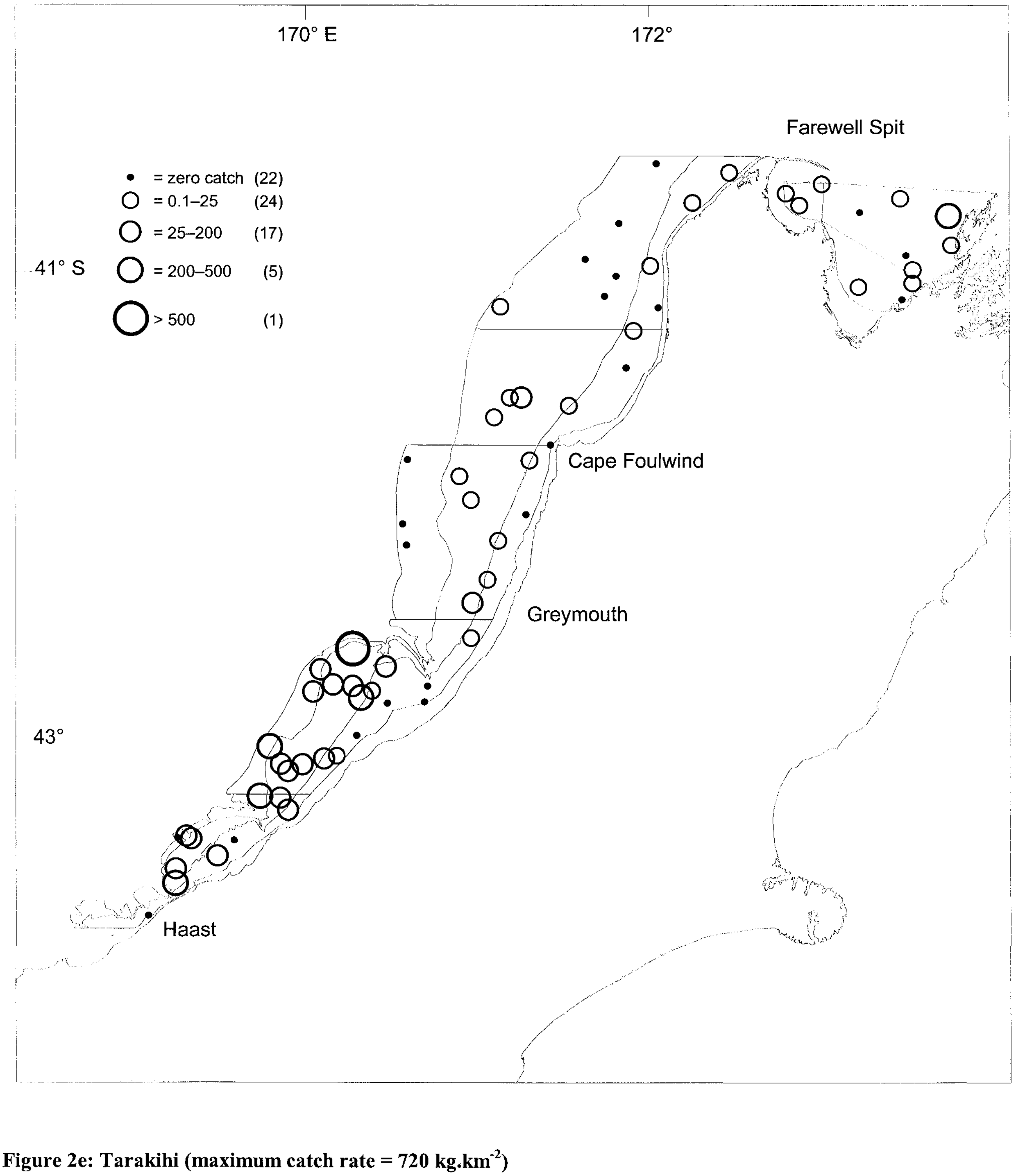


Figure 2e: Tarakihi (maximum catch rate = 720 kg.km^{-2})

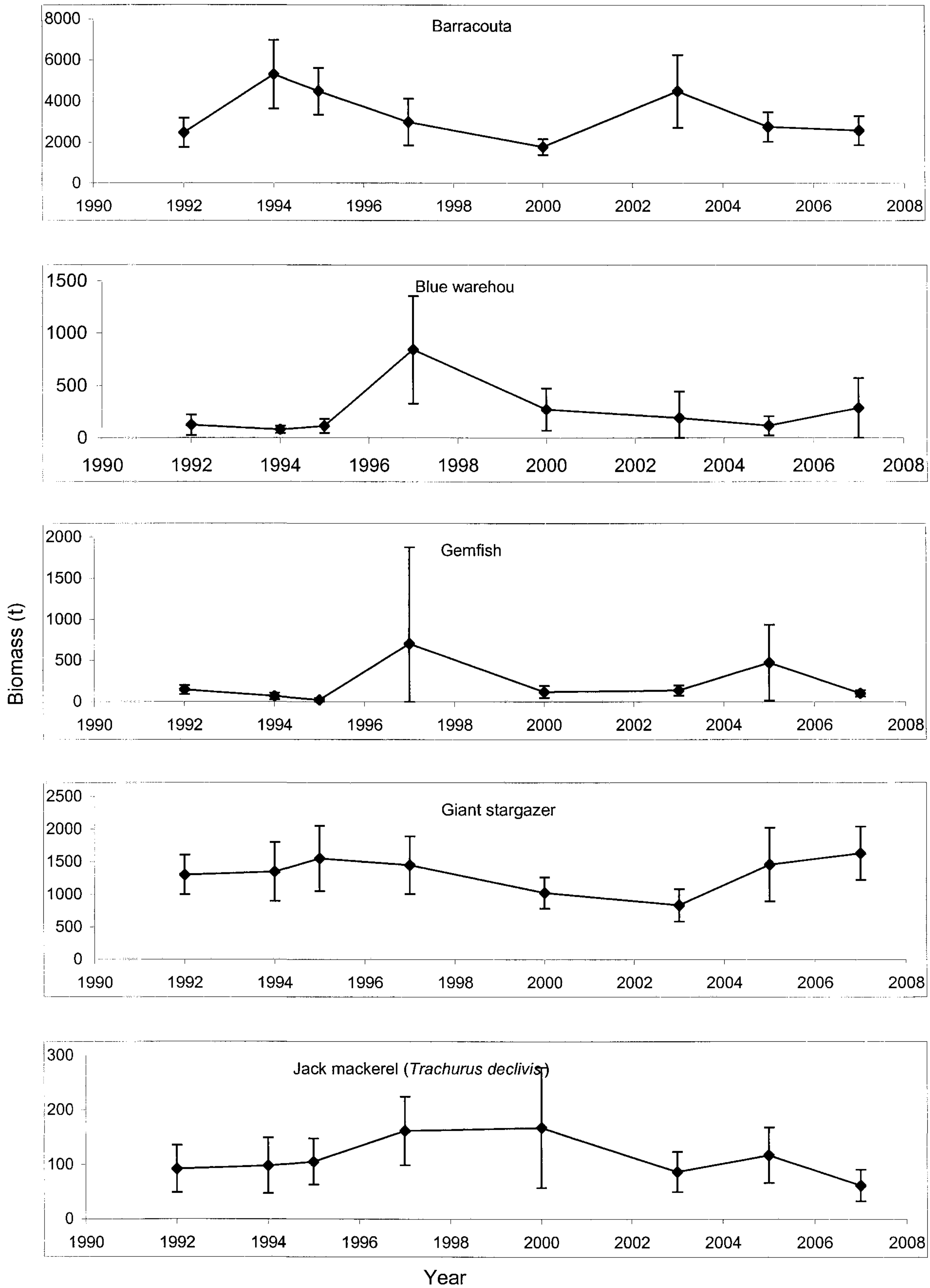


Figure 3: Trends in total biomass for the target species and other species for which the survey time series is likely to bemonitoring adult or pre-recruit abundance.

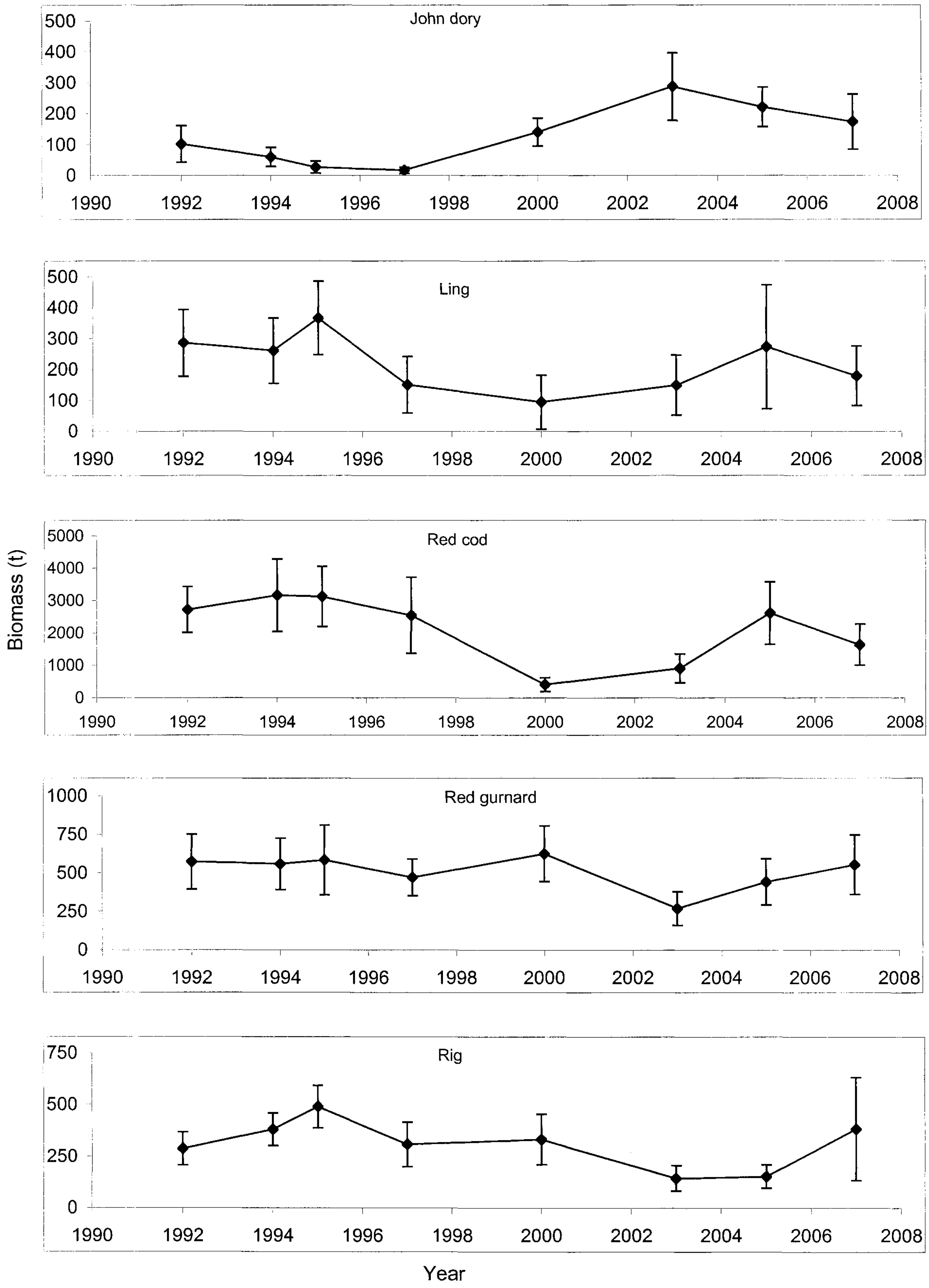


Figure 3—continued

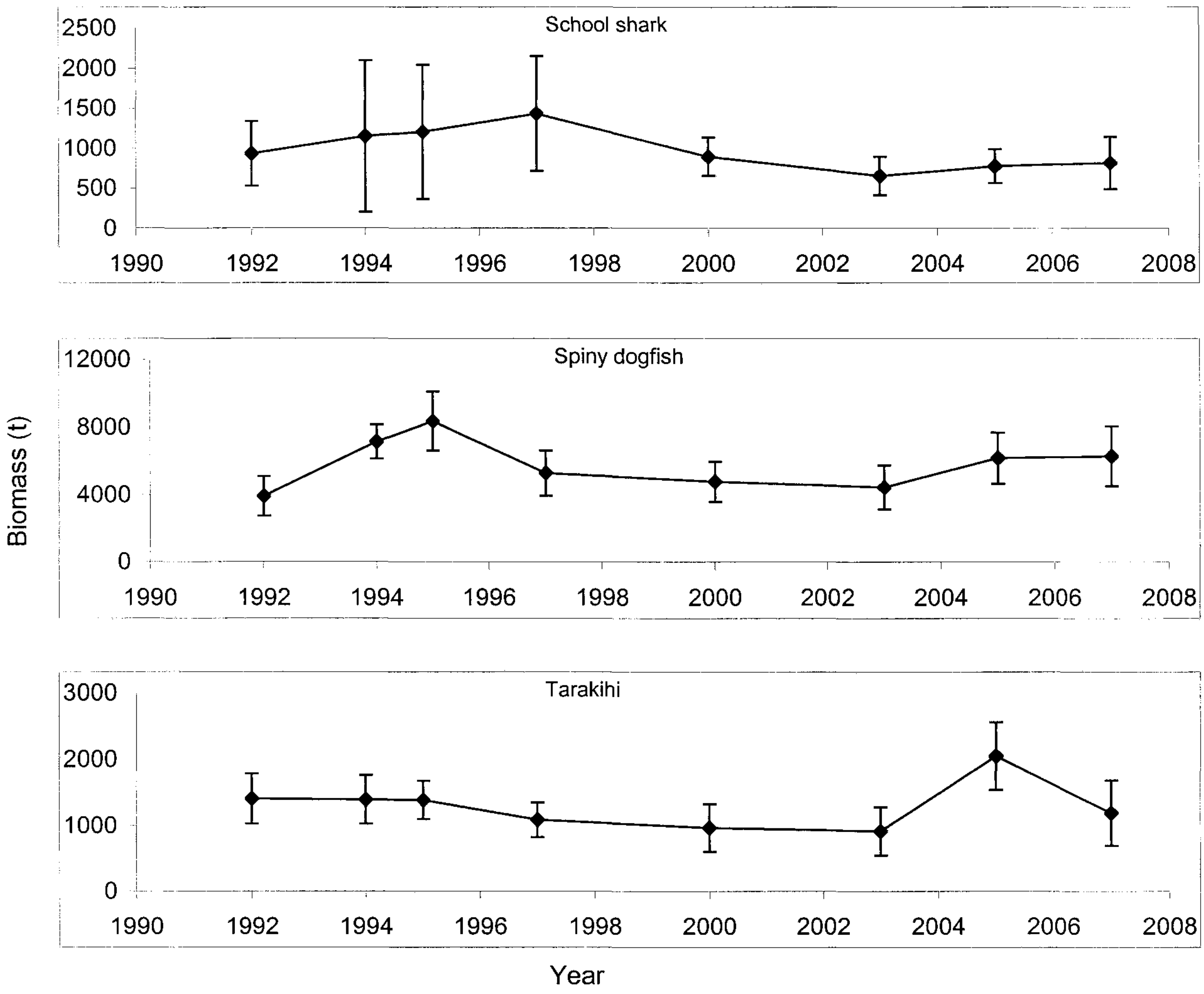


Figure 3—continued

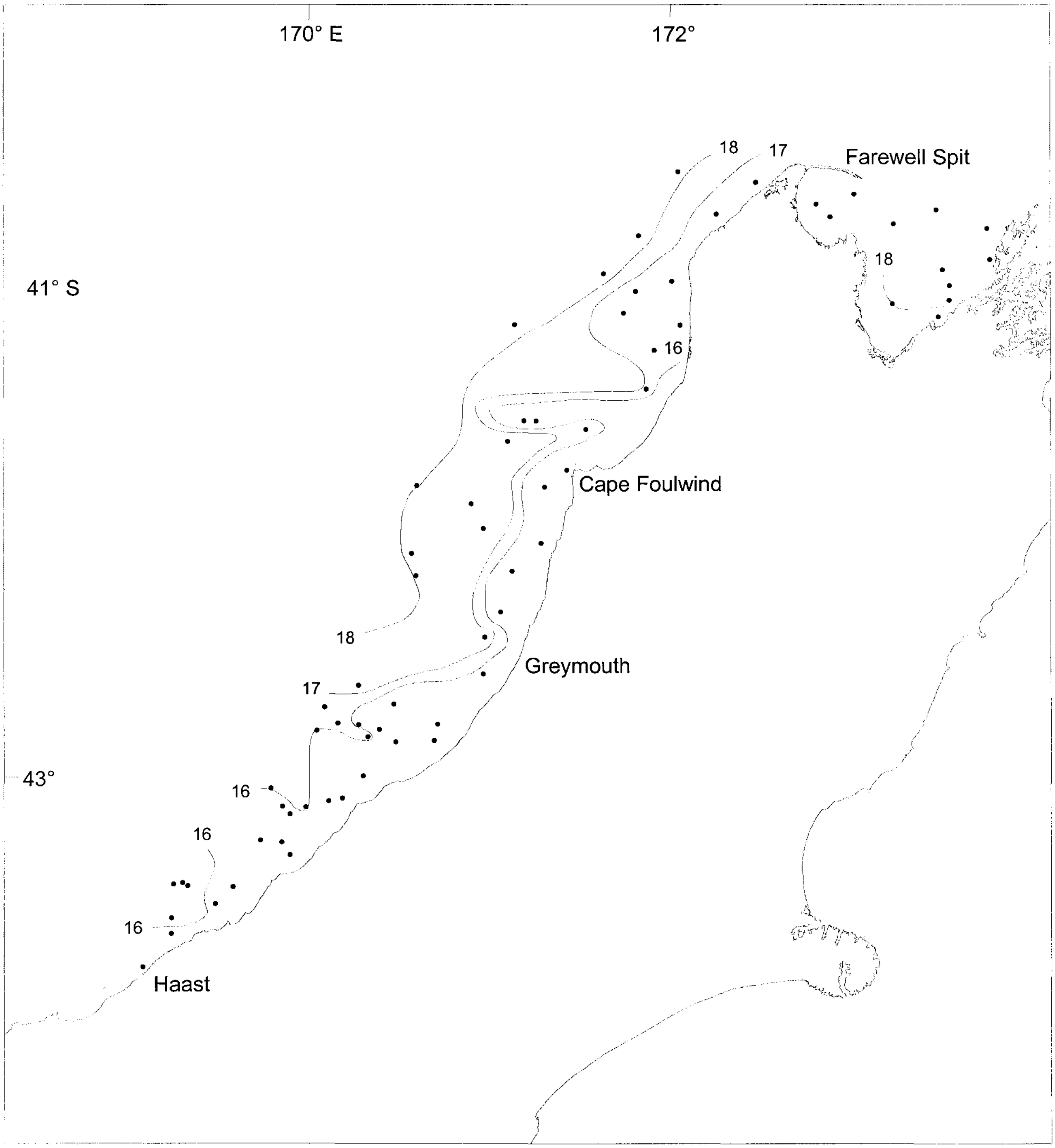


Figure 4: Positions of CTD sea surface temperature recordings and isotherms estimated from the temperature recordings.

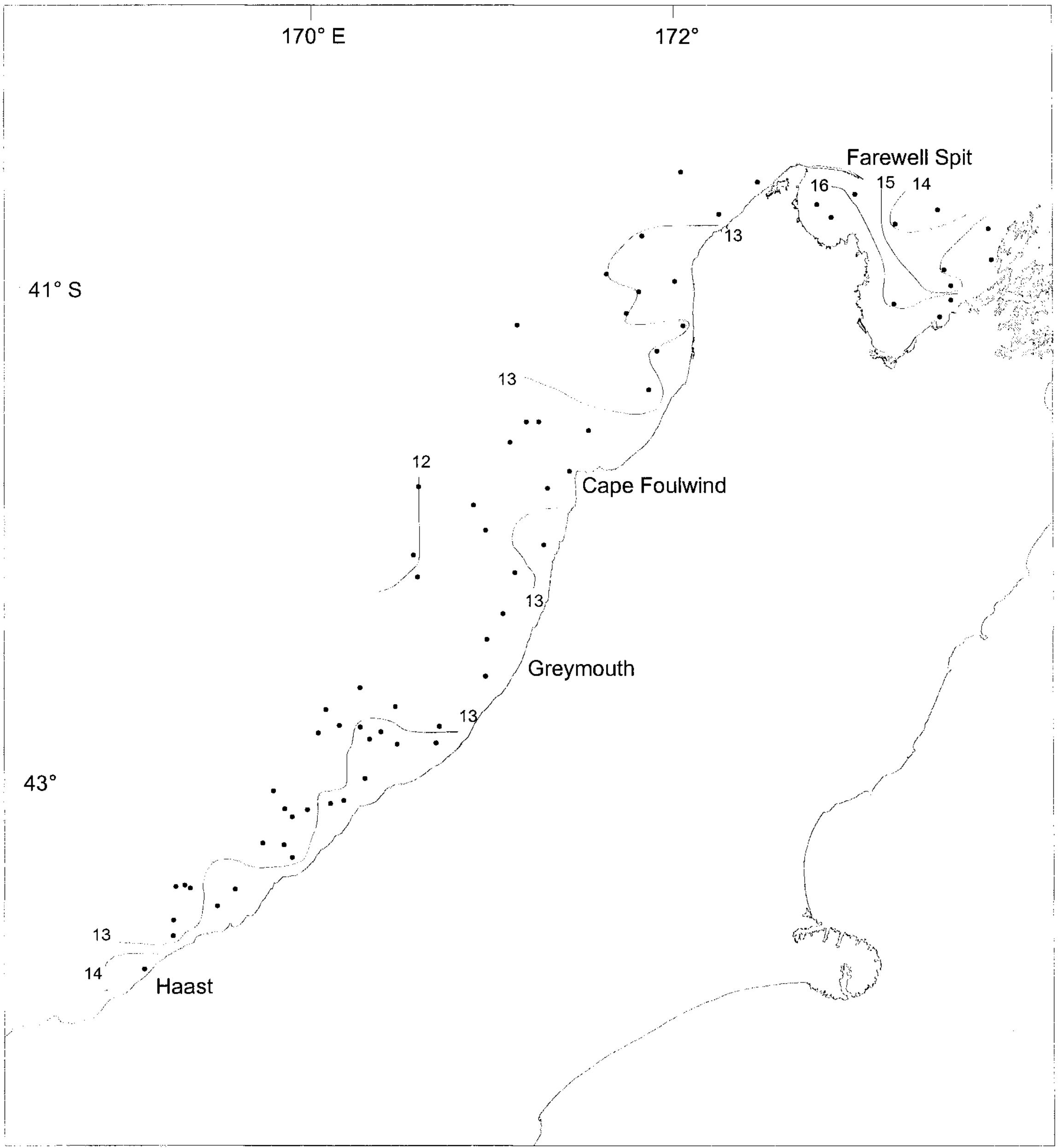


Figure 5: Positions of CTD bottom temperature recordings and isotherms estimated from the temperature recordings.

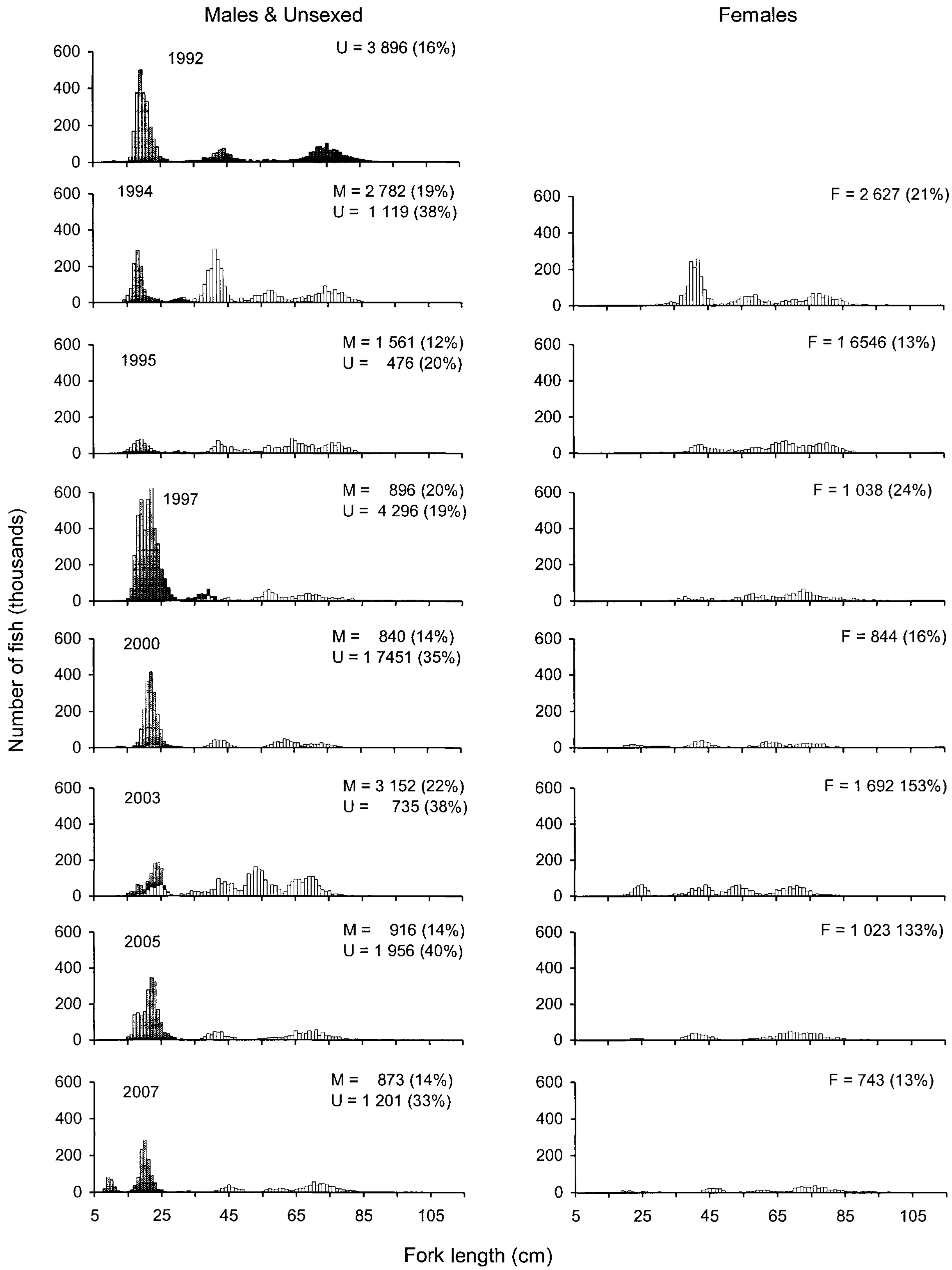


Figure 6: Comparative scaled length frequencies for the target species and those species where the surveys are monitoring adult or pre-recruit abundance. Estimated population in thousands and c.v.%. (M, males; F, females; U, unsexed)

a: Barracouta

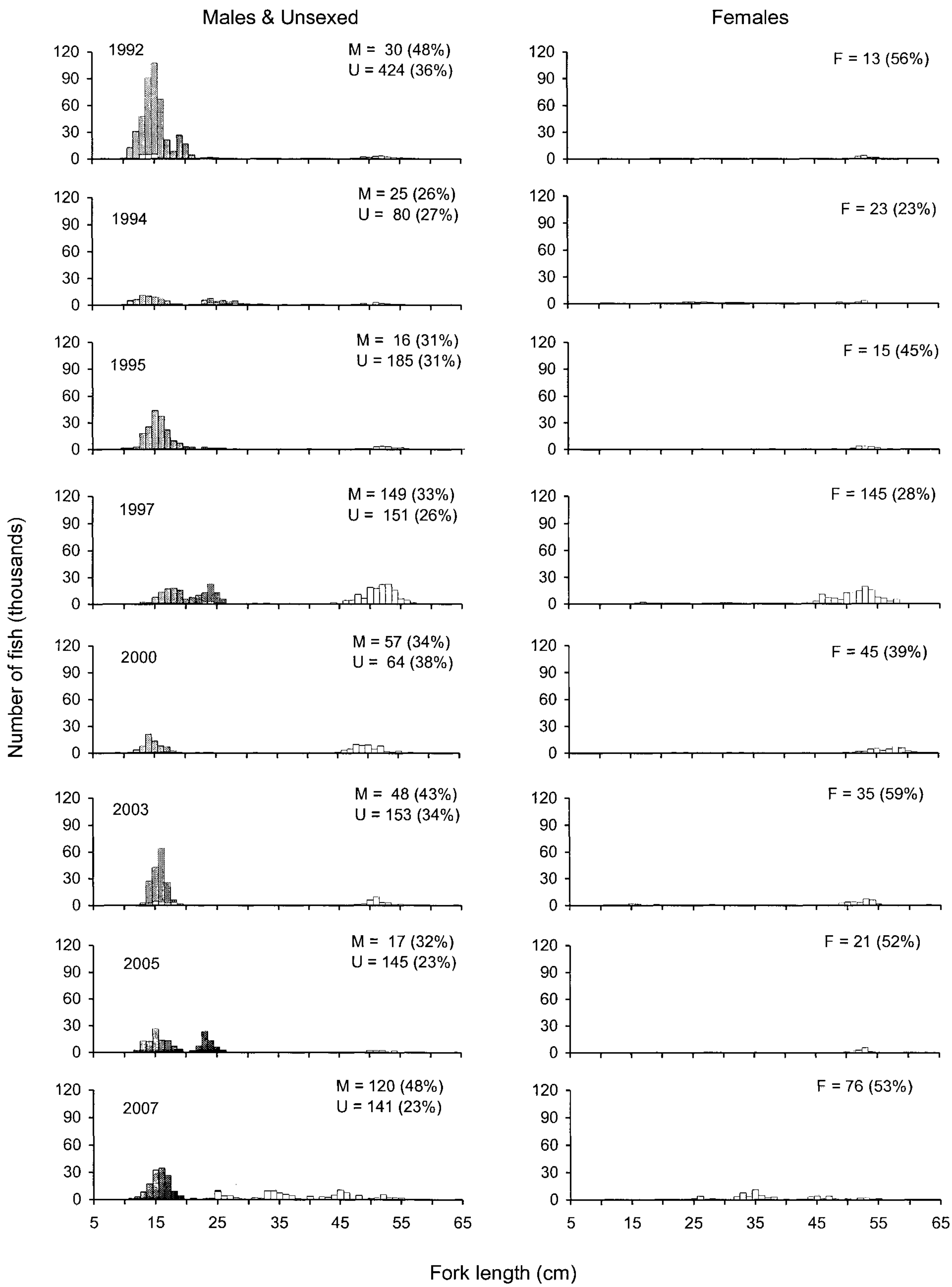


Figure 6b: Blue warehou.

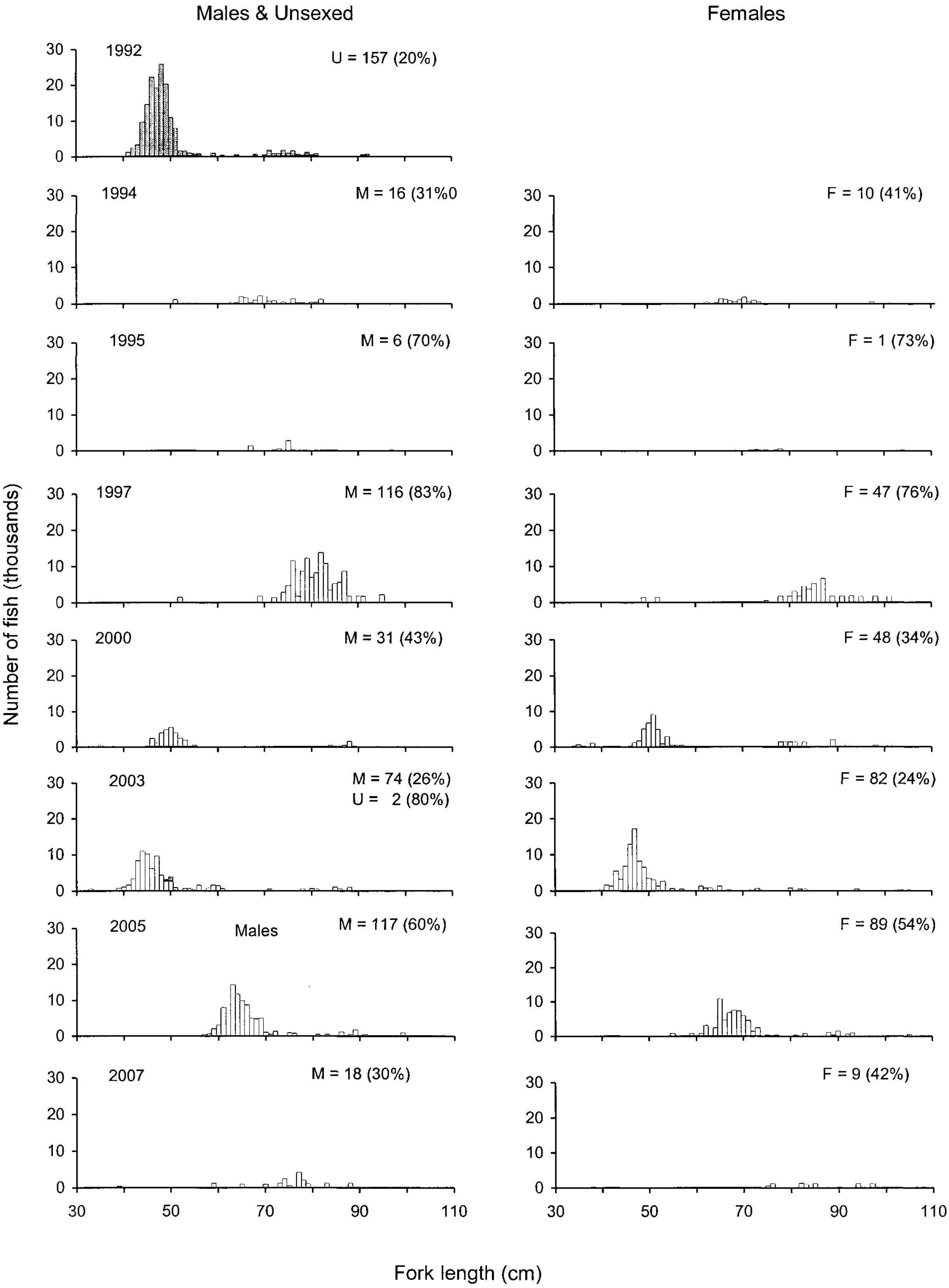


Figure 6c: Gemfish (100% of fish from the west coast).

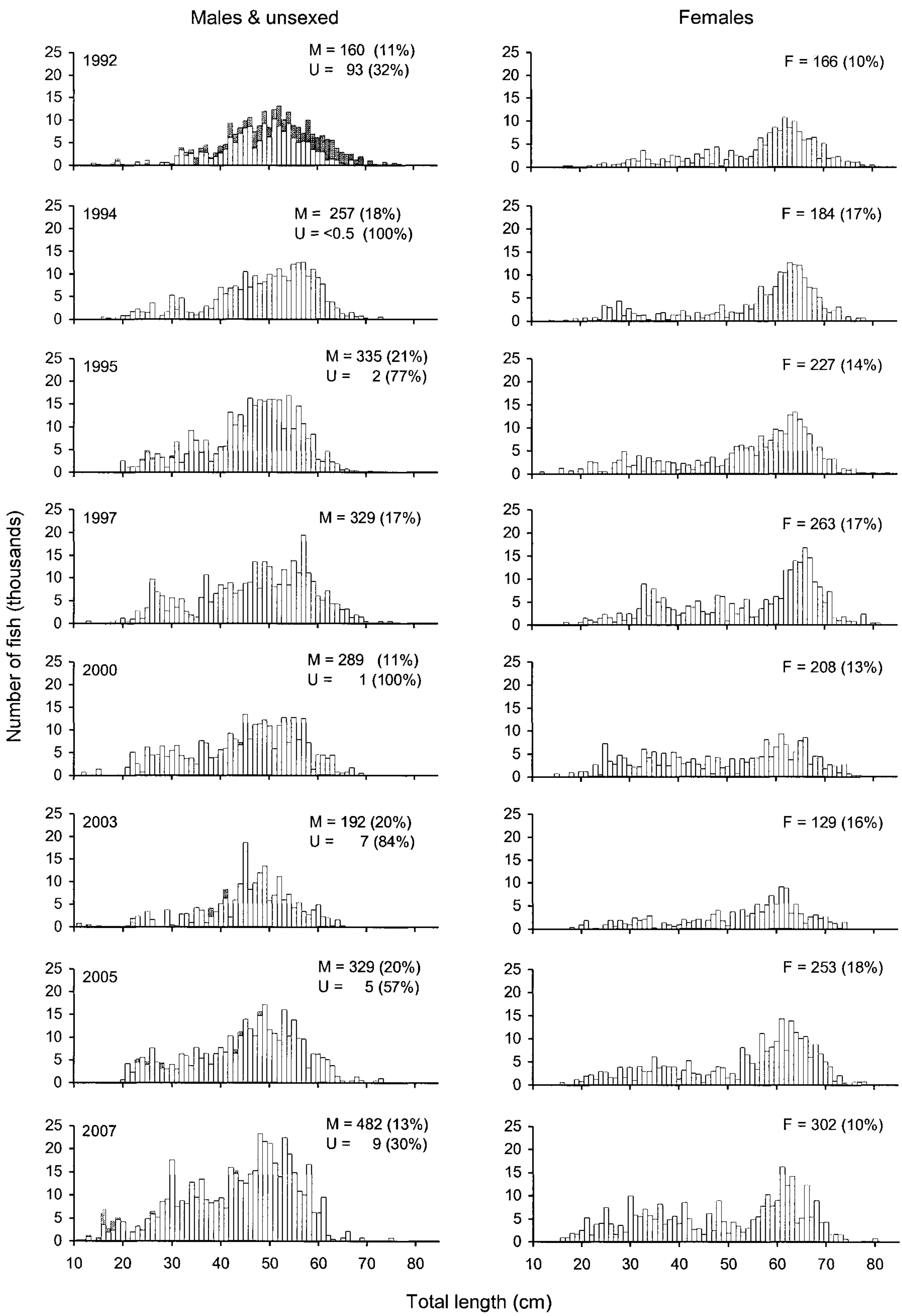


Figure 6d: Giant stargazer.

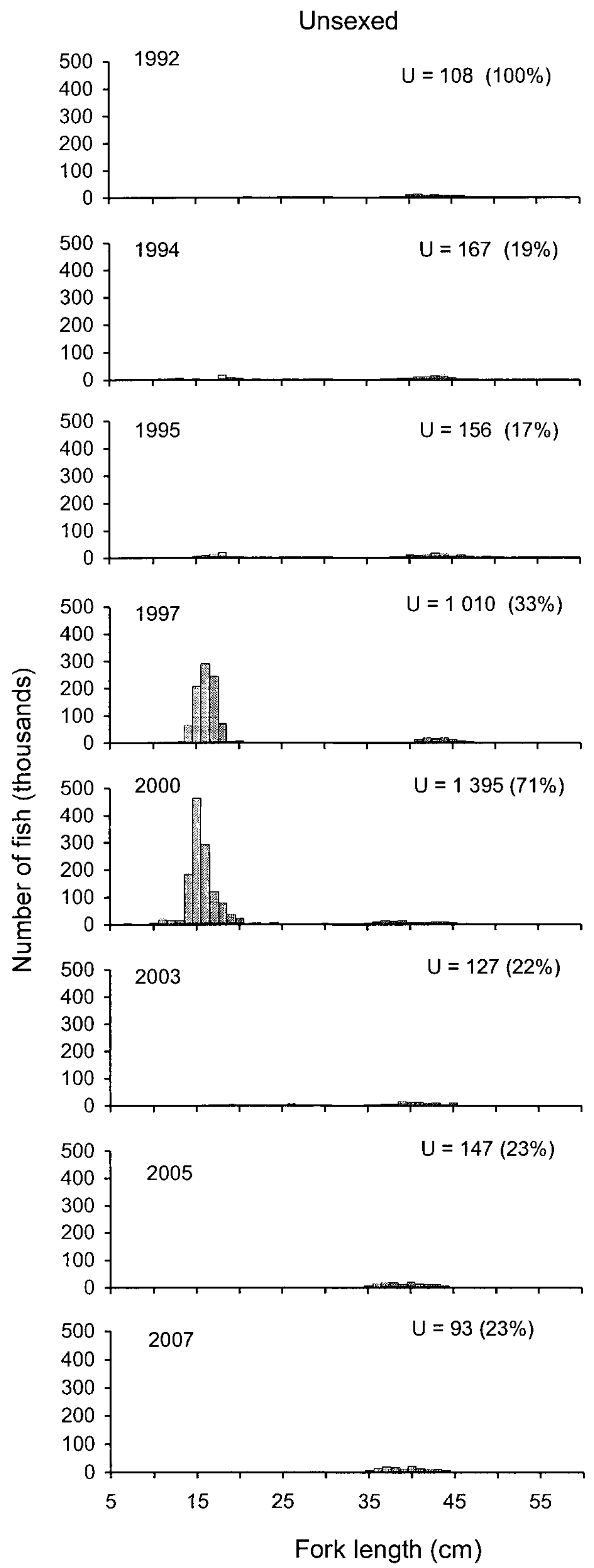


Figure 6e: Jack mackerel (*Trachurus declivis*). Fish were not sexed for some years so all years are plotted as unsexed for better comparison.

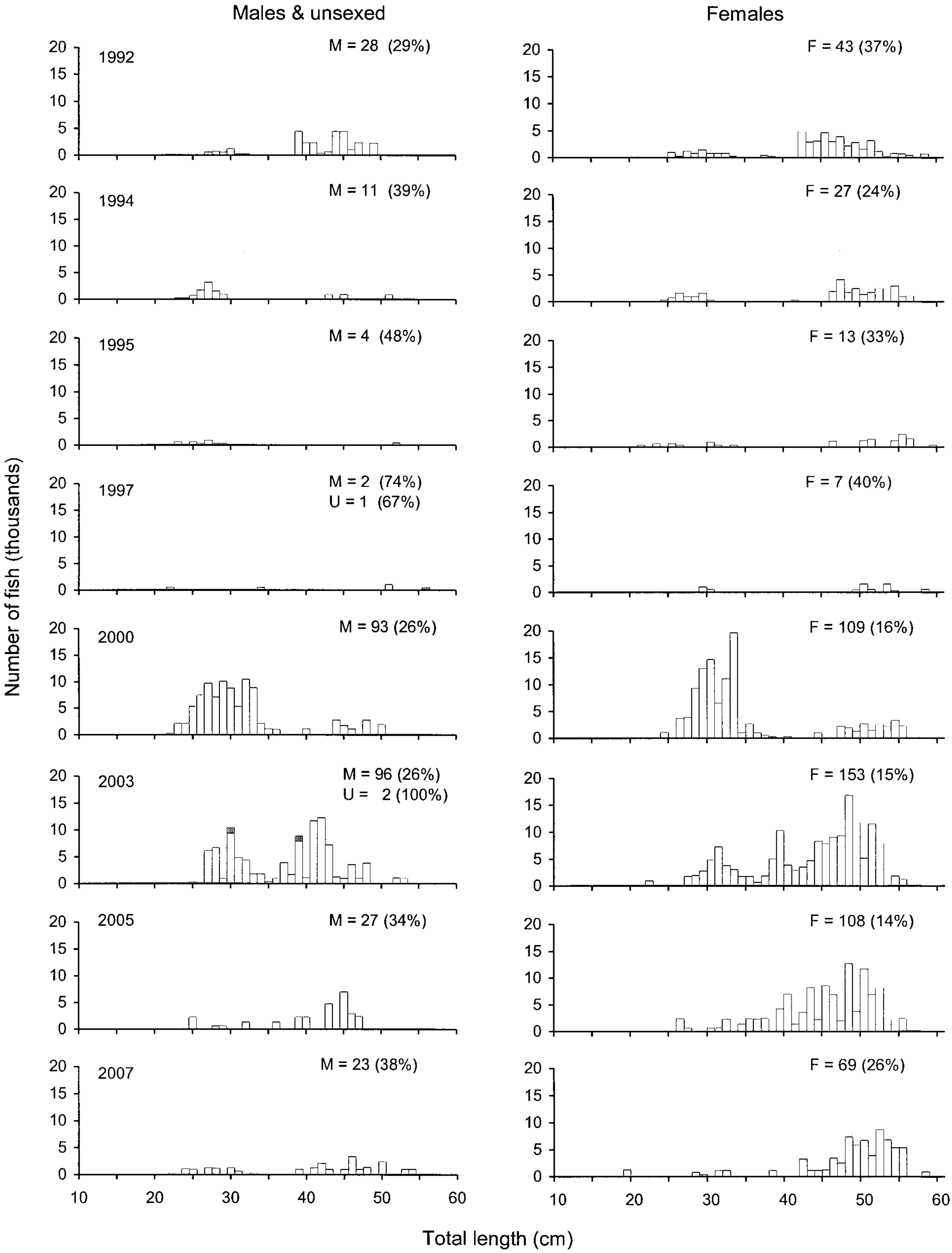


Figure 6f: John dory.

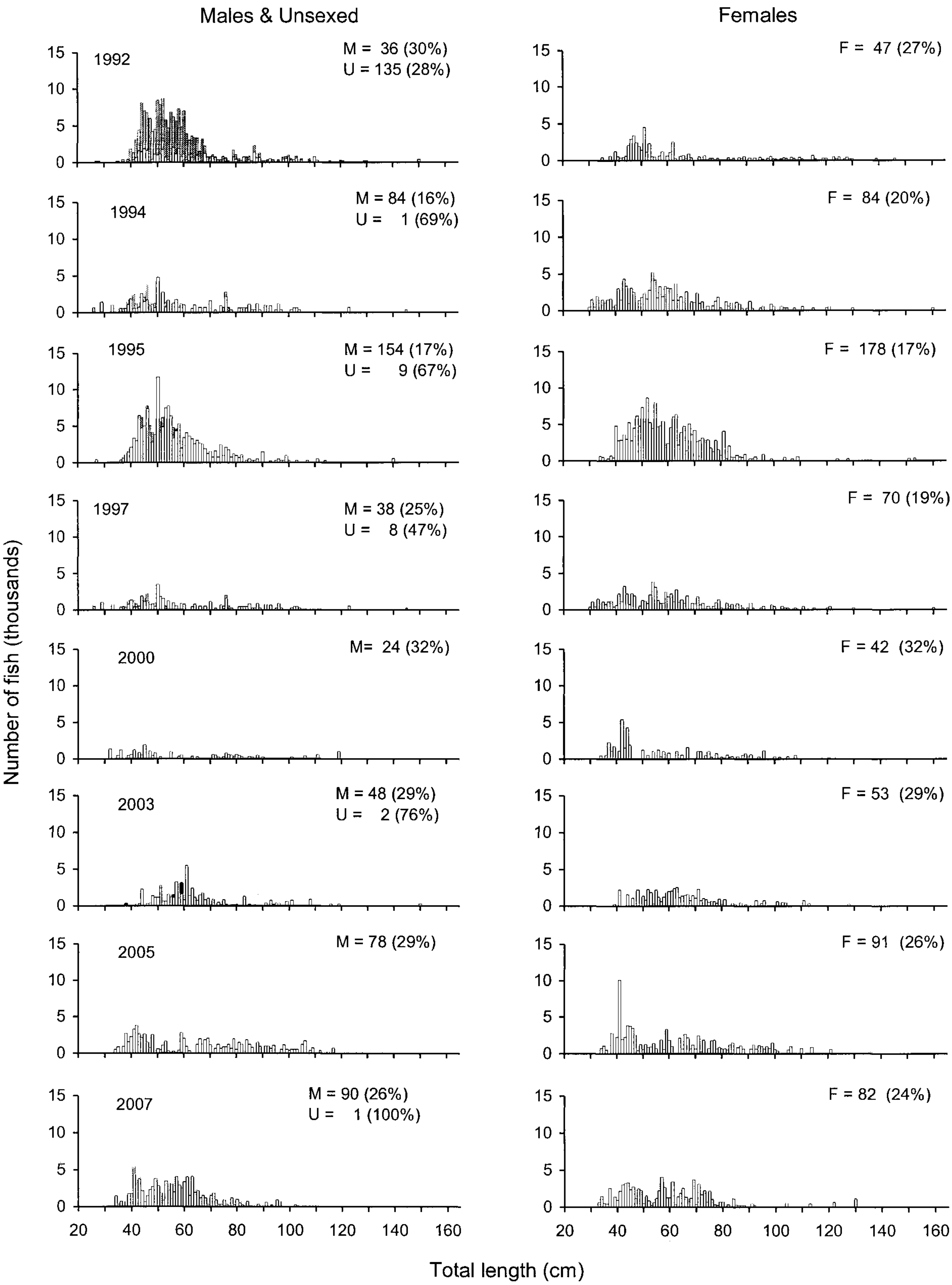


Figure 6g: Ling.

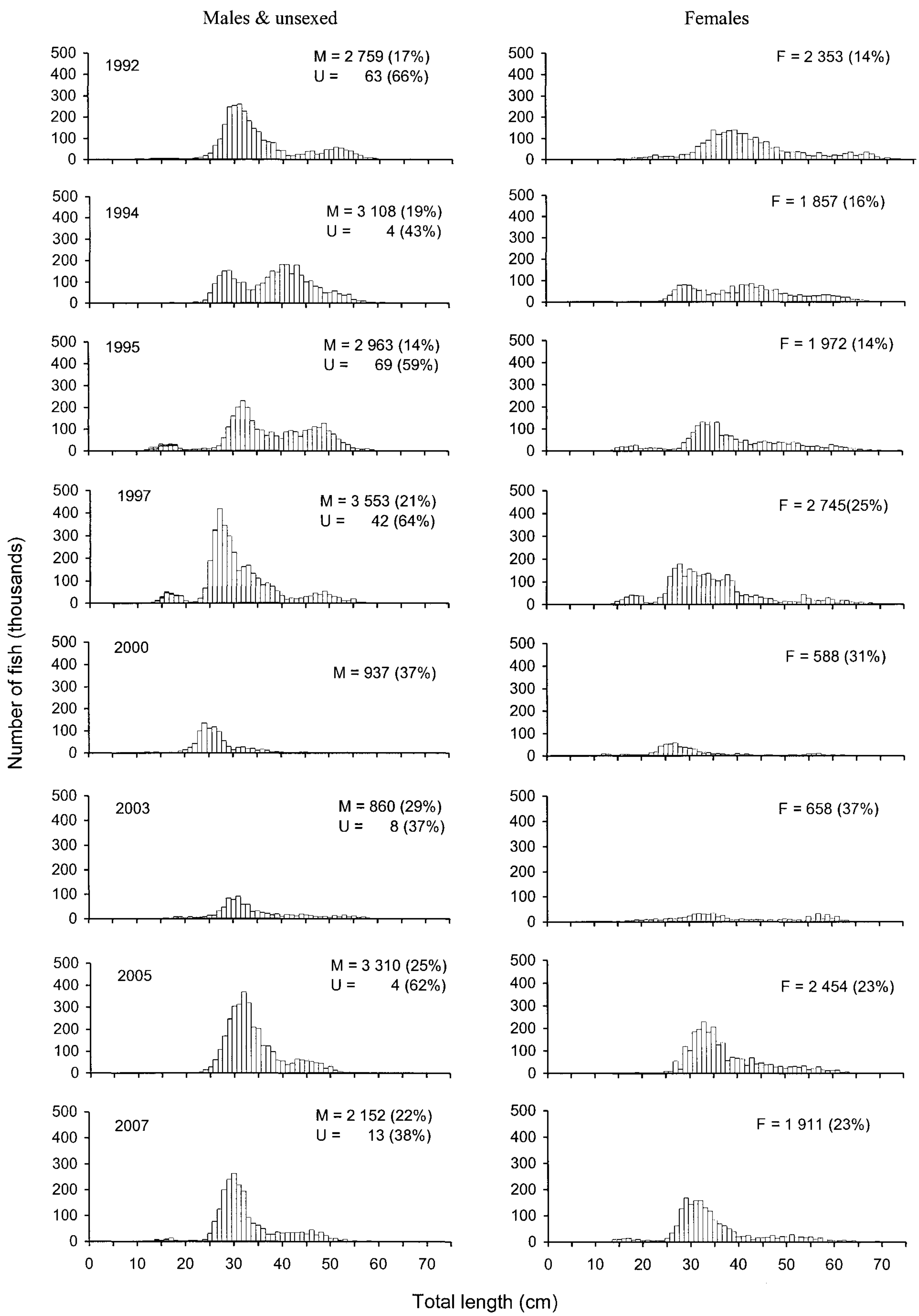


Figure 6h: Red cod

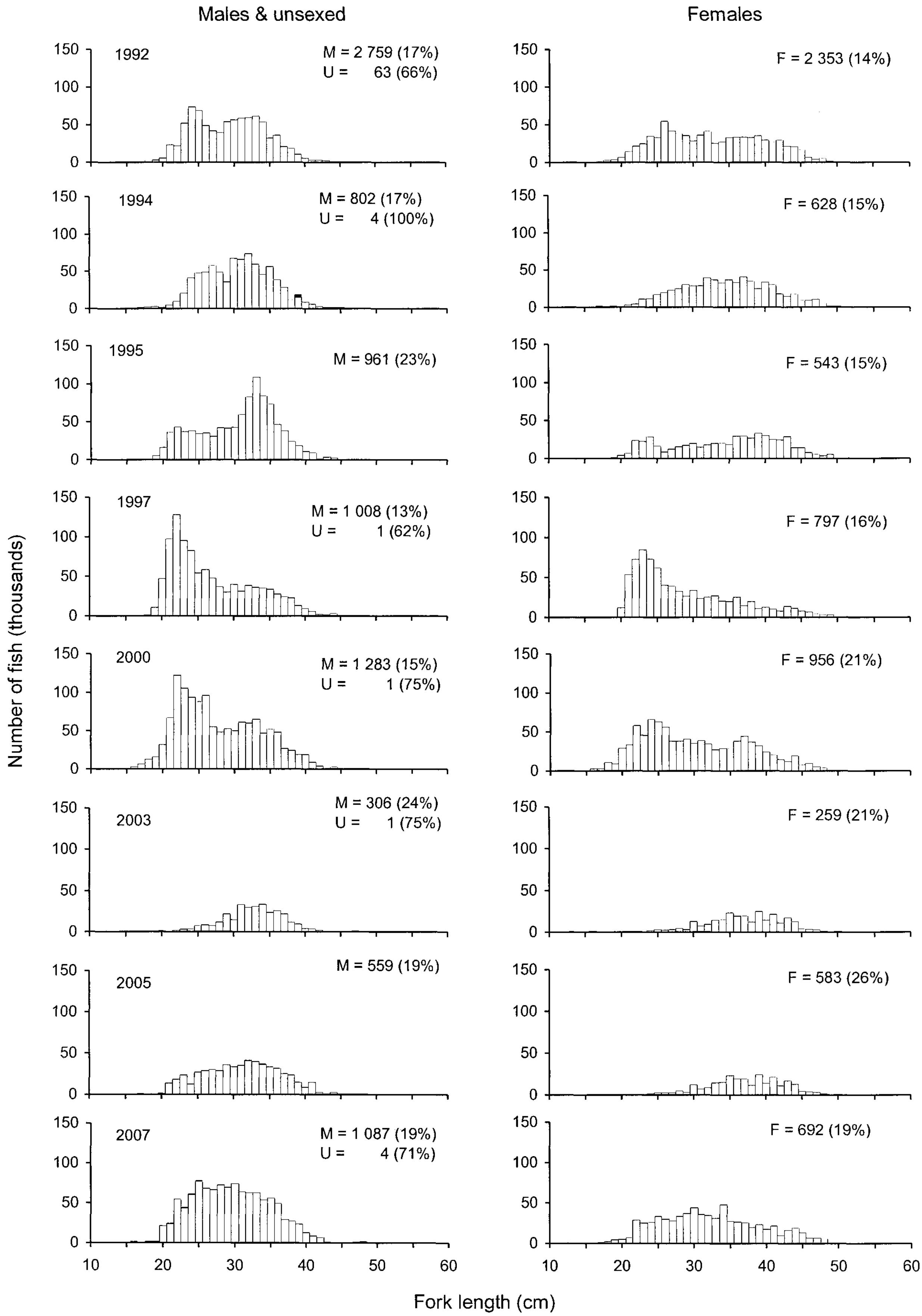


Figure 6i: Red gurnard.

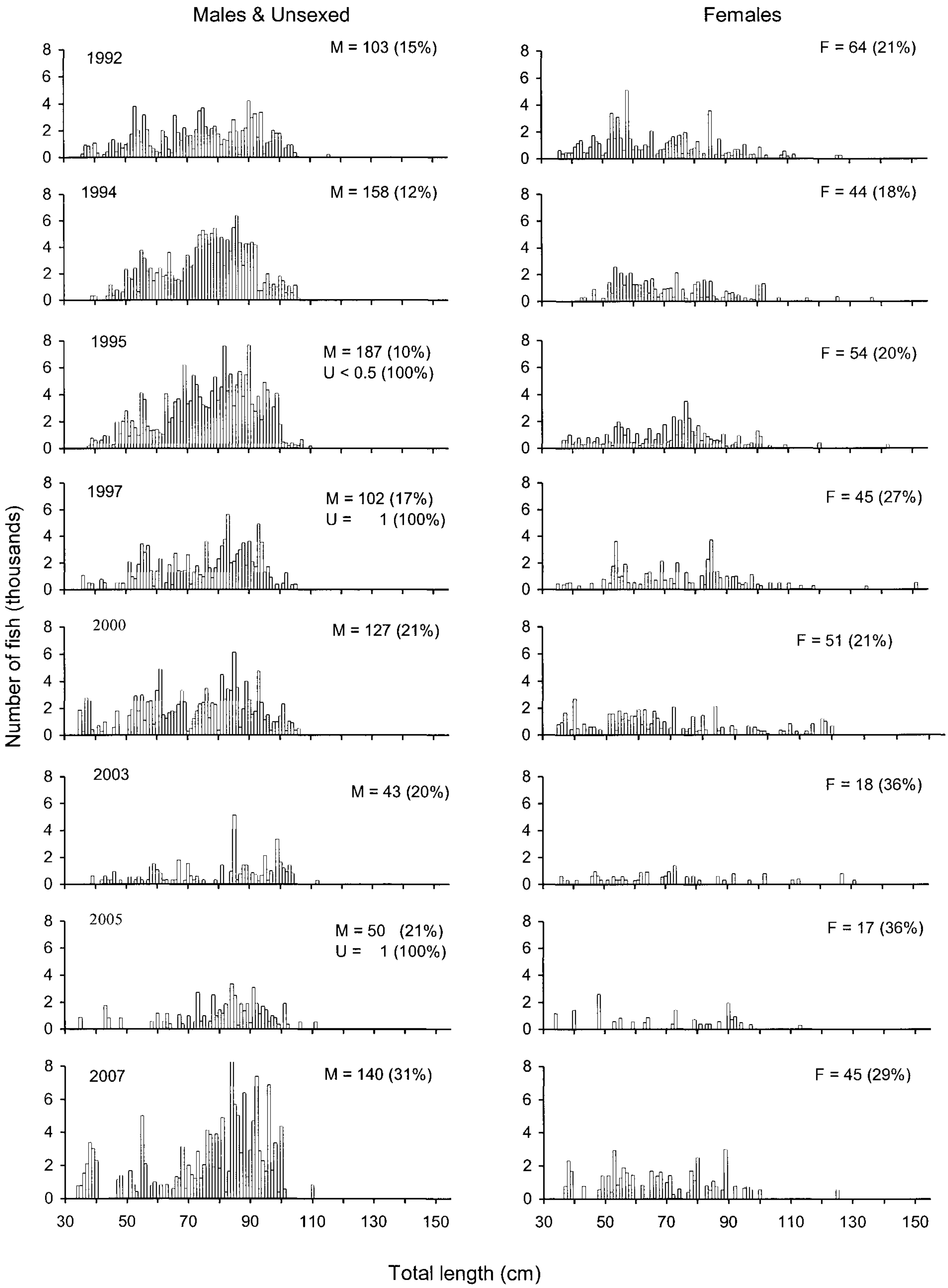


Figure 6j: Rig

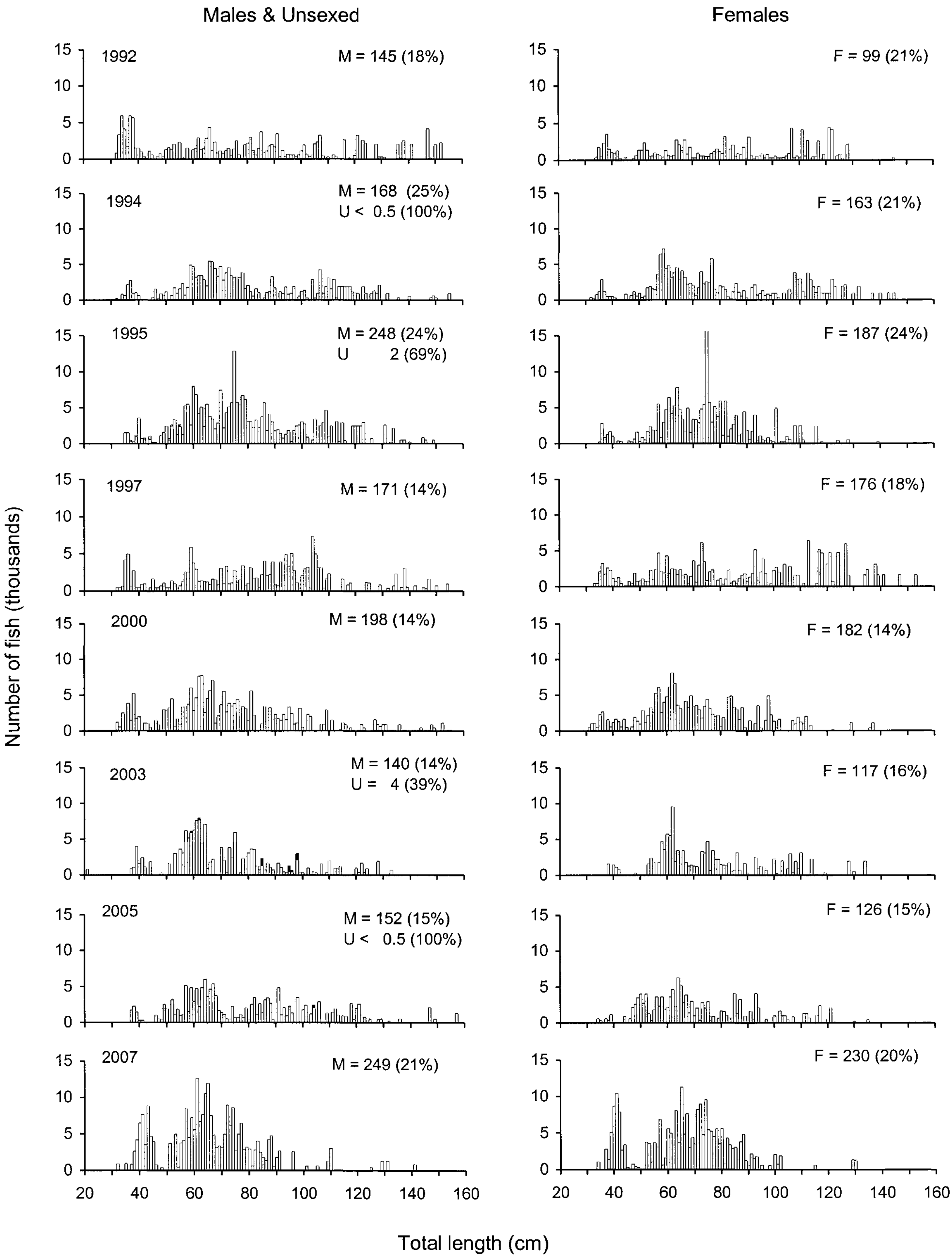
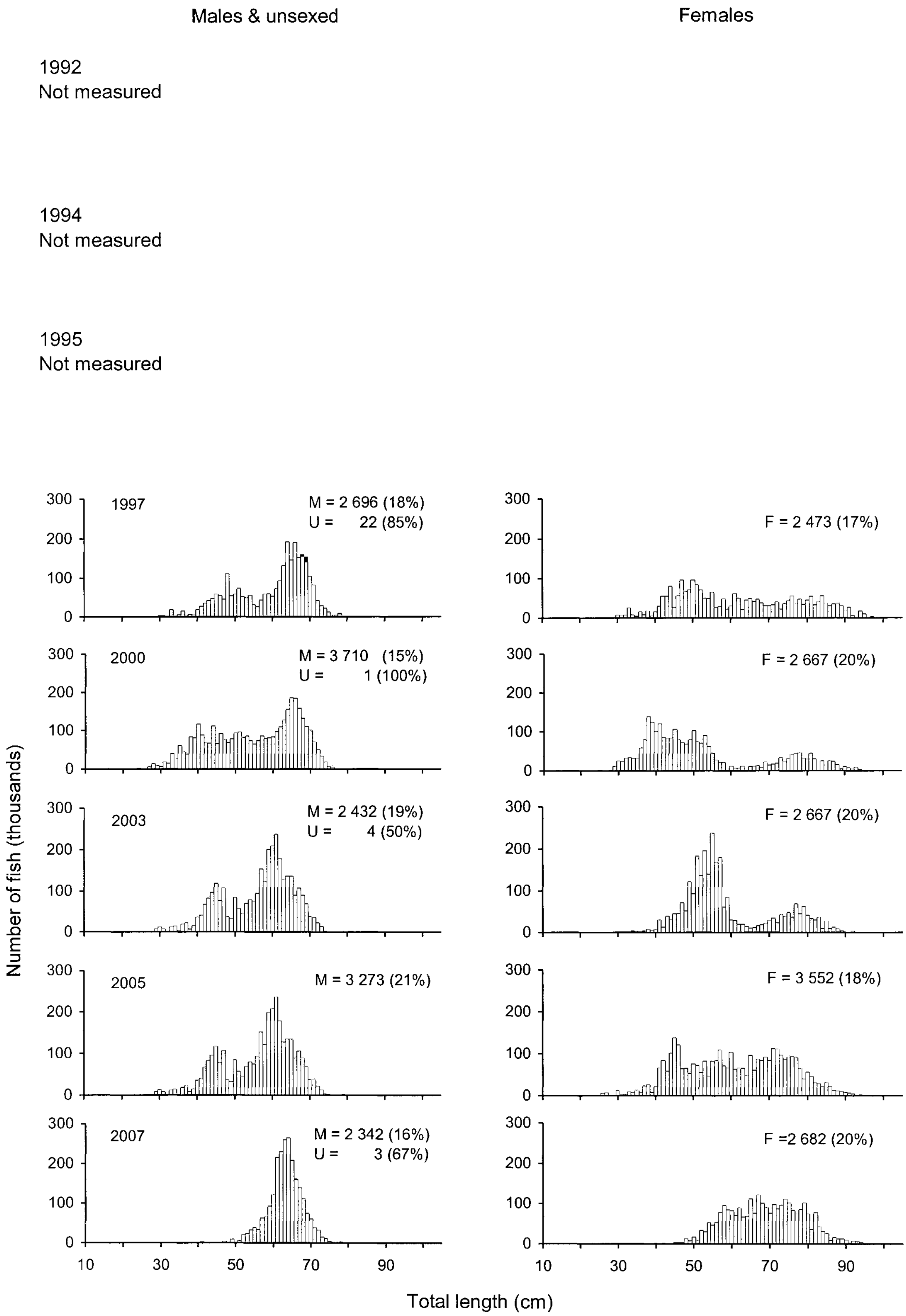


Figure 6k: School shark



ure 6l: Spiny dogfish

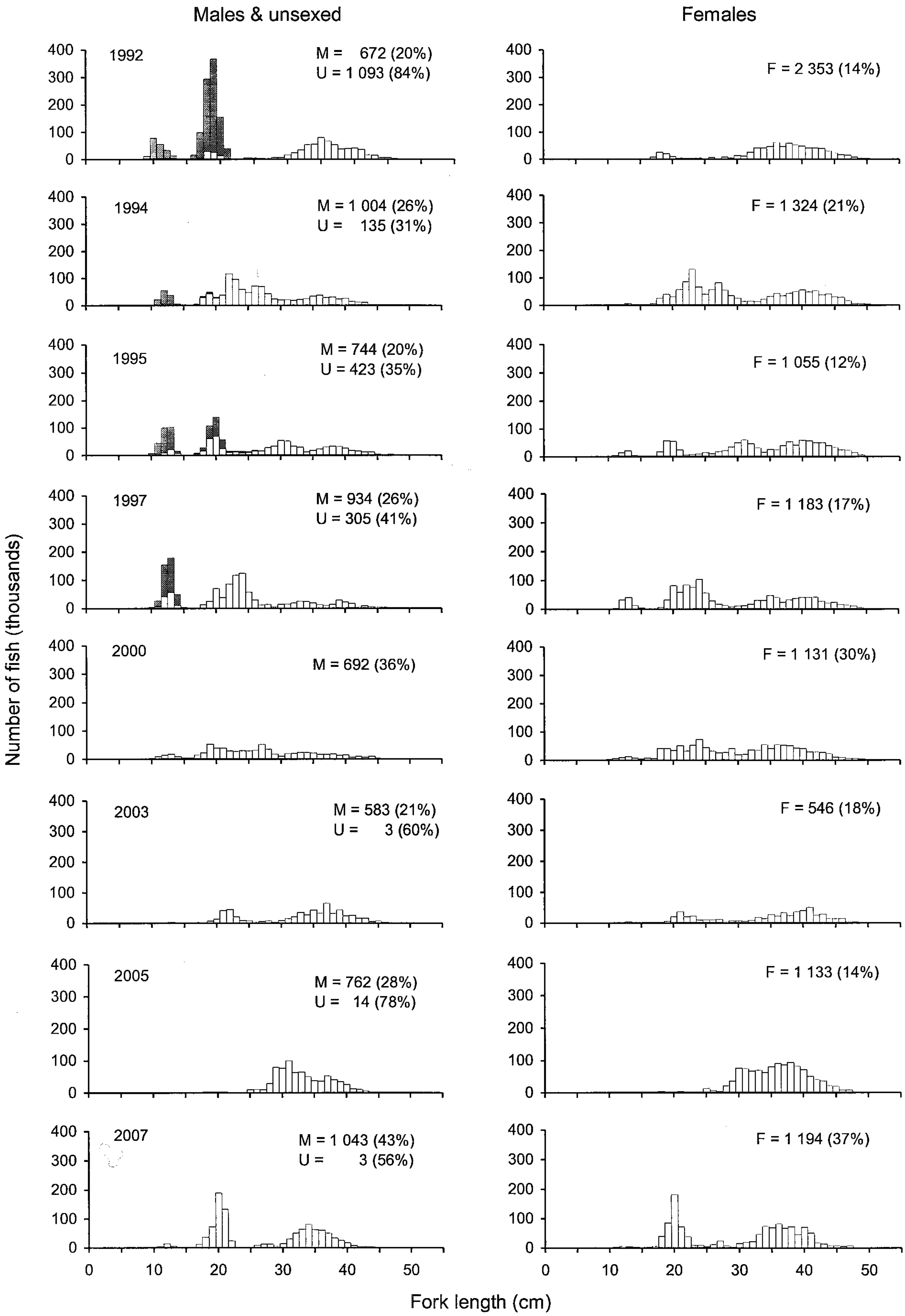


Figure 6m: Tarakihi.

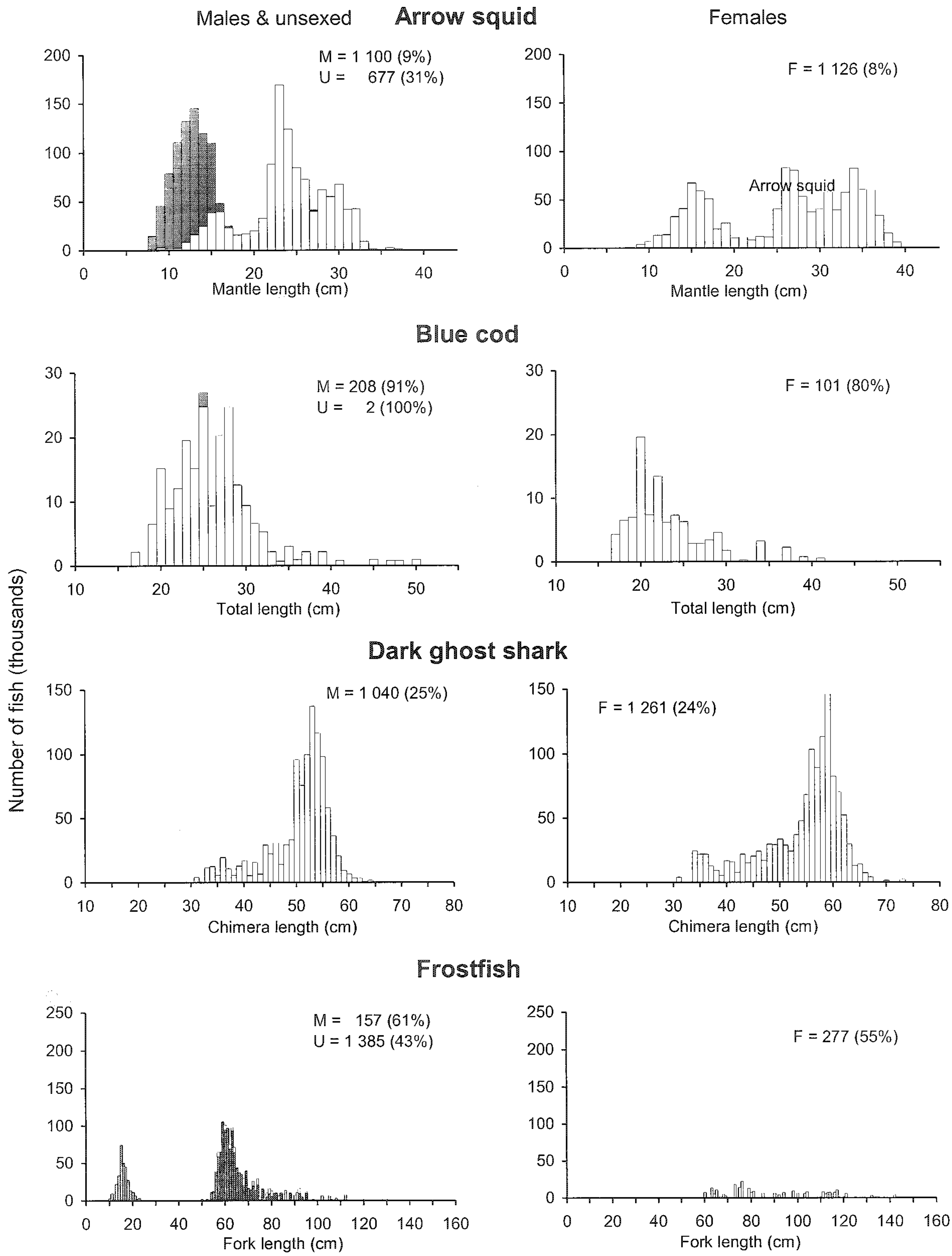


Figure 7: Scaled length frequency distributions for the non-monitored commercial species where more than 100 fish were measured. Estimated population in thousands and c.v.%. M, male; F, female; U, unsexed (shaded).

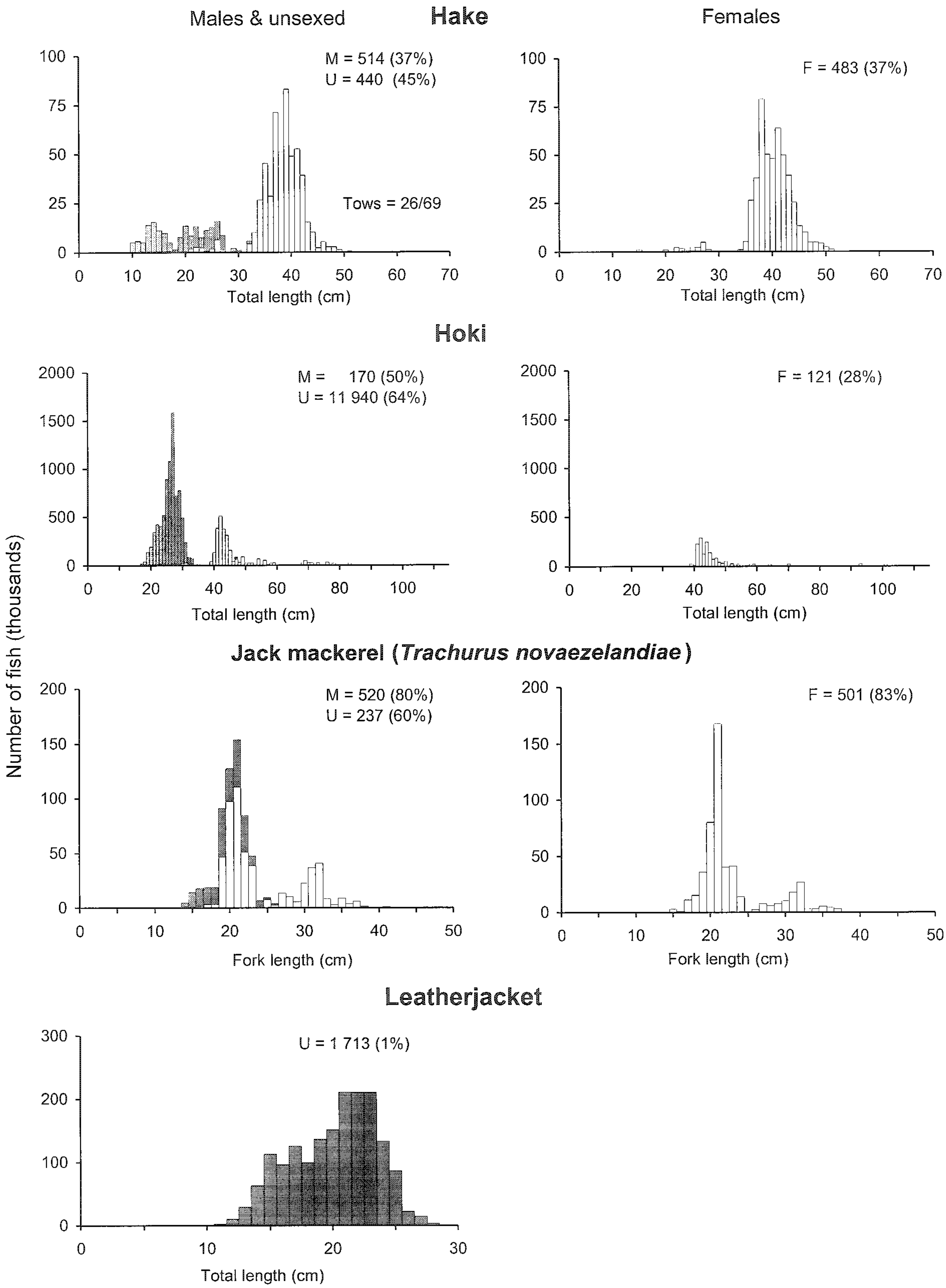


Figure 7—*continued*

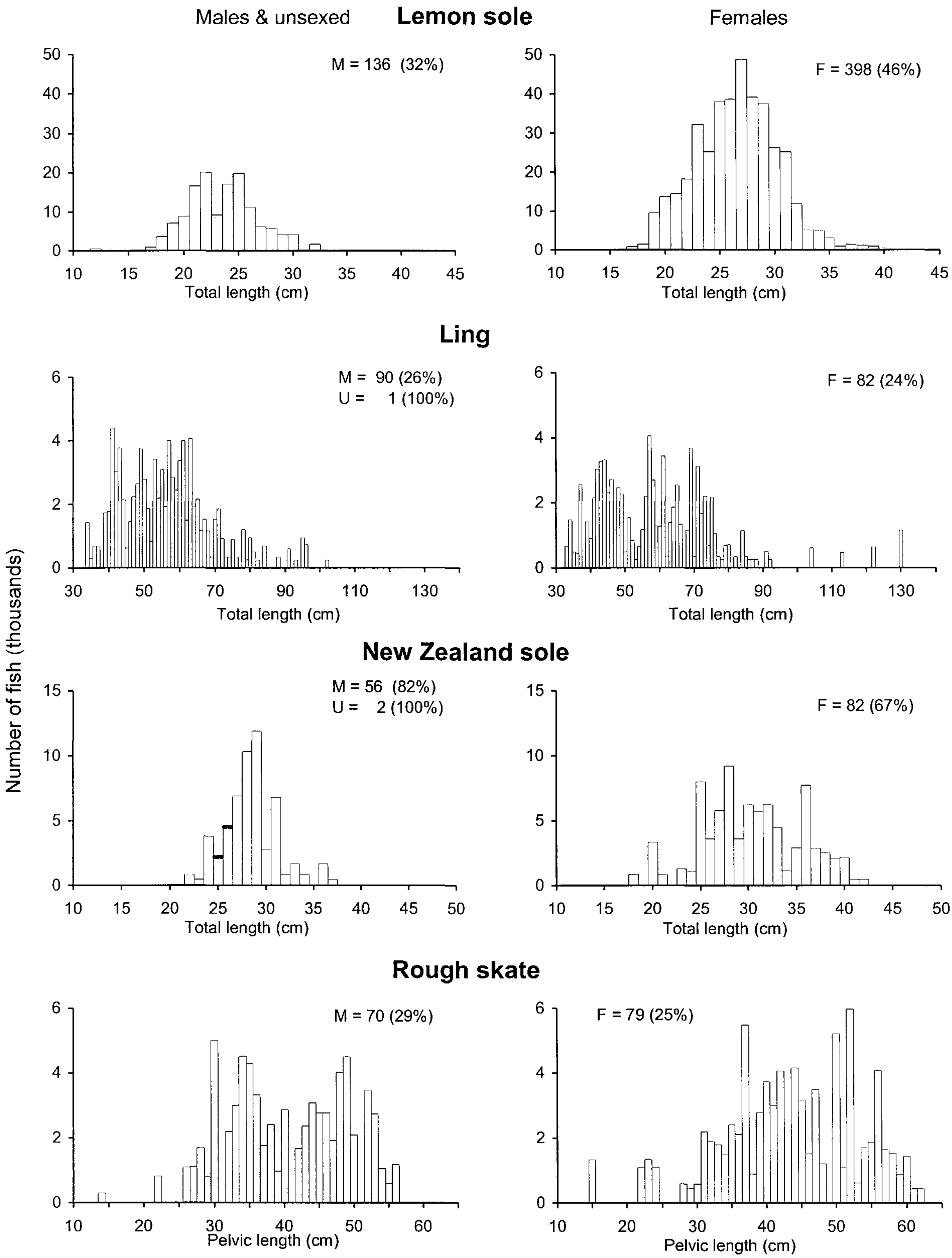


Figure 7—*continued*

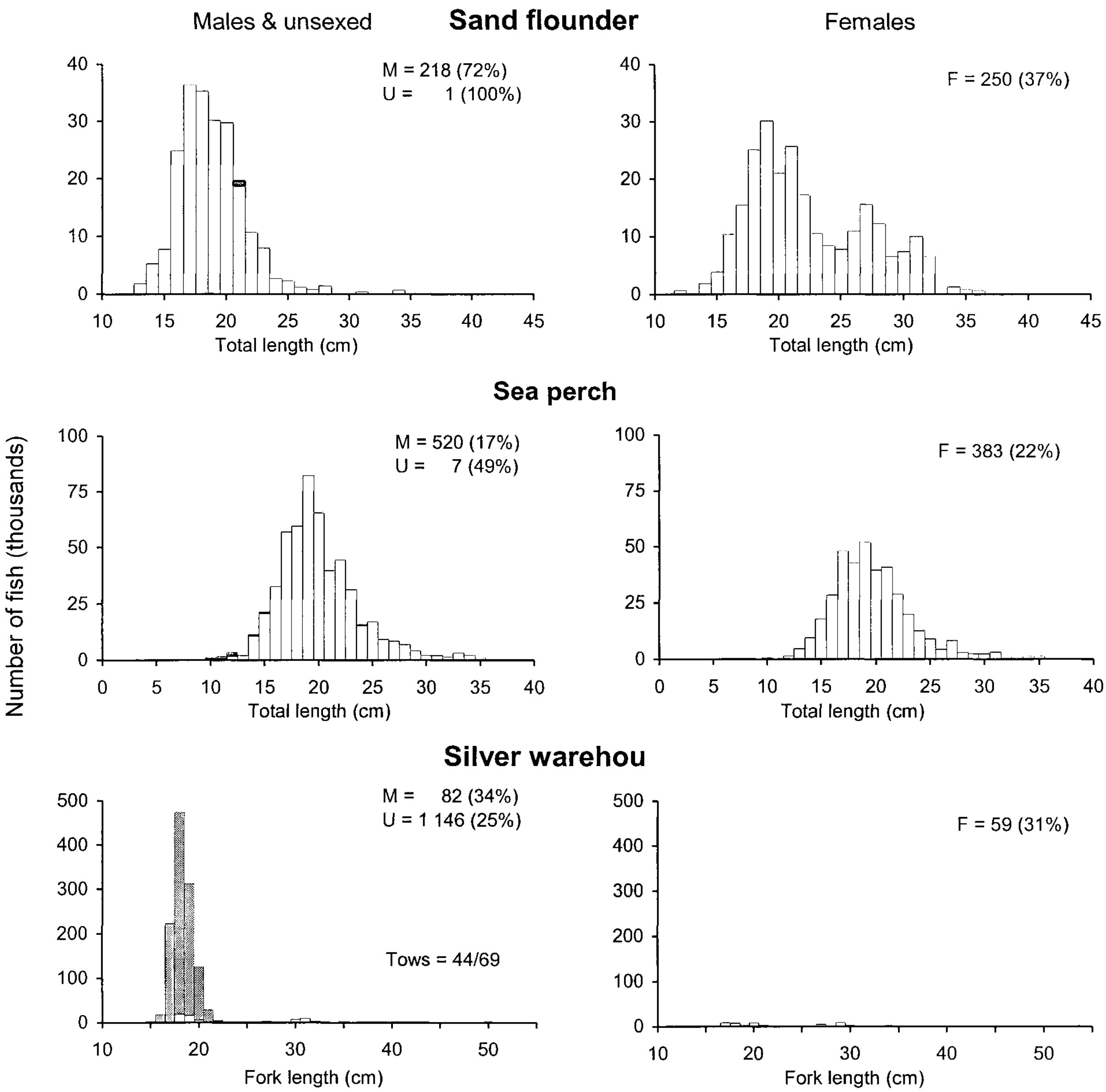


Figure 7—*continued*

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	Length range (cm) Min.	Max.	Data source
Barracouta	0.0055	2.9812	429	23.8	87.2	DB, KAH9701
Blue cod	0.0122	3.0746	2 137	12	47	DB, LHR9501
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	0.0123	3.0910	769	11.1	74.5	This survey
Hake	0.0014	3.3770	333	33	123	DB, TAN9601
Hapuku	0.0078	3.1400	307	49	108	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	0.0065	3.2499	352	18.4	54.3	DB, KAH9902
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	DB, KAH0004
New Zealand sole	0.0049	3.2151	114	20	48	DB, KAH0304
Northern spiny dogfish	0.0034	3.0781	207	43	90.3	DB, combined surveys
Red cod	0.0103	2.9541	815	11	69.4	This survey
Red gurnard	0.0035	3.2893	500	17.1	50.8	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	0.0035	3.0731	226	37	141	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	0.0292	2.8978	70	23	134	DB, KAH9701
Spiny dogfish	0.0003	3.5895	1 899	29.3	97.4	This survey
Tarakihi	0.0153	3.0380	818	10.9	49.2	This survey
Two-saddle rattail	0.0010	3.43	383	24.6	58.3	DB, KAH0304

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	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	25-Mar-07	1034	41 04.21	173 12.37	41 01.66	173 10.26	28	28	3	4.2	75.6	18	15.9
2	18	25-Mar-07	1417	41 07.42	173 27.40	41 05.31	173 30.12	25	30	2.94	5.6	72.9	18.1	16.8
3	18	25-Mar-07	1602	41 03.29	173 31.08	41 00.35	173 30.54	34	41	2.96	5.7	74.3	17.9	16.4
4	19	26-Mar-07	637	40 59.76	173 31.12	40 57.41	173 28.65	43	46	2.99	5.7	74	17.6	14.8
5	19	26-Mar-07	821	40 55.85	173 28.83	40 53.35	173 30.85	47	50	2.92	5.6	73.2	17.6	15.1
6	19	27-Mar-07	641	40 53.39	173 44.33	40 50.42	173 44.48	41	42	2.97	5.1	73.1	17.6	15.6
7	19	27-Mar-07	849	40 45.82	173 43.39	40 43.15	173 42.18	52	65	2.82	4.4	70.2	17.4	15.6
8	19	27-Mar-07	1125	40 41.20	173 26.78	40 41.26	173 22.32	53	53	3.38	4.6	73	17.5	13.9
9	19	27-Mar-07	1355	40 44.70	173 12.85	40 41.97	173 11.45	44	44	2.92	4.7	74.8	17.4	13.9
10	17	27-Mar-07	1637	40 37.40	172 59.69	40 37.25	172 55.80	28	32	2.95	4.5	71.8	17.6	15.2
11	17	28-Mar-07	640	40 39.85	172 47.24	40 42.59	172 48.59	22	23	2.92	4.7	68.7	17.8	16.3
12	17	28-Mar-07	844	40 42.97	172 51.90	40 44.90	172 54.90	23	25	2.98	4.8	67.5	17.4	16.6
13	1	28-Mar-07	1459	40 34.44	172 27.62	40 35.35	172 23.96	55	57	2.92	4.8	70.7	16	13.5
14	1	29-Mar-07	916	40 58.69	172 00.09	41 01.37	171 58.35	85	89	2.98	4.7	76	16	12.8
15	1	29-Mar-07	1159	41 09.50	172 02.83	41 12.54	172 02.44	46	50	3.05	4.8	72.5	16.1	13.2
16	5	29-Mar-07	1401	41 15.61	171 54.33	41 18.23	171 52.58	67	70	2.93	4.8	71.9	16.6	12.9
17	6	30-Mar-07	637	41 32.89	171 11.23	41 30.16	171 12.86	146	148	2.99	4.7	86	15.4	12.6
18	6	30-Mar-07	859	41 32.85	171 15.27	41 35.58	171 13.60	147	148	3	4.8	85.6	15.5	12.6
19	6	30-Mar-07	1127	41 37.94	171 05.80	41 40.48	171 03.91	151	154	2.9	4.8	86.8	17.6	12.6
20	8	30-Mar-07	1426	41 53.25	170 53.67	41 56.20	170 54.33	173	177	2.99	4.5	84.8	17.9	12.9
21	8	30-Mar-07	1622	41 59.31	170 57.76	42 01.28	171 00.67	164	177	2.93	4.7	85.3	18.3	12.9
22	9	31-Mar-07	643	41 48.76	170 35.62	41 51.71	170 35.97	390	393	2.96	4.5	91.5	18.1	12
23	9	31-Mar-07	1213	42 05.37	170 33.87	42 08.34	170 34.35	364	371	2.99	4.5	91.5	17.9	11.9
24	9	31-Mar-07	1415	42 10.84	170 35.23	42 13.69	170 34.44	317	319	2.9	4.6	90.9	18	12.6
25	1	1-Apr-07	631	40 42.29	172 14.84	40 40.38	172 17.92	34	45	3.01	4.5	74.5	16.5	13.5
26	2	1-Apr-07	943	40 31.98	172 02.25	40 34.58	172 00.59	137	139	2.88	4.5	83	18.1	13.3
27	2	1-Apr-07	1300	40 47.56	171 49.38	40 49.48	171 46.50	139	141	2.9	4.5	80.4	18.2	12.9
28	2	1-Apr-07	1618	41 01.19	171 48.27	40 58.33	171 49.19	120	121	2.94	4.8	87.9	16.6	13
29	2	2-Apr-07	635	41 09.35	171 08.15	41 06.68	171 09.85	184	188	2.96	4.8	89.3	18.1	13.3
30	2	2-Apr-07	1104	40 56.84	171 37.67	40 59.83	171 37.81	138	142	2.99	4.8	86.5	18.2	13
31	2	2-Apr-07	1322	41 06.46	171 44.26	41 09.41	171 44.48	117	121	2.95	4.6	84	16	13

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)
32	5	2-Apr-07	1627	41 25.11	171 51.64	41 28.09	171 51.66	36	40	2.98	4.7	74.1	17	13.6
33	7	3-Apr-07	718	42 02.86	171 16.85	42 05.58	171 15.18	45	46	2.98	4.7	74	15.8	13.5
34	7	3-Apr-07	927	42 09.75	171 07.24	42 12.55	171 06.04	91	94	2.93	4.6	73.6	15.3	12.7
35	7	3-Apr-07	1156	42 19.78	171 03.40	42 22.68	171 02.36	87	90	3	4.6	76.8	15.6	12.8
36	8	3-Apr-07	1358	42 25.93	170 58.17	42 28.86	170 58.17	112	117	2.93	4.5	79.7	17.5	12.8
37	11	3-Apr-07	1604	42 35.01	170 57.69	42 37.18	170 54.93	67	78	2.97	4.5	67.6	15.9	12.7
38	5	4-Apr-07	649	41 34.95	171 31.79	41 32.93	171 34.67	96	100	2.95	4.7	84.3	16.3	12.7
39	7	5-Apr-07	1505	41 44.91	171 25.41	41 46.85	171 23.86	45	53	2.25	5	74.3	15.2	12.9
40	8	5-Apr-07	1643	41 49.07	171 18.09	41 51.71	171 16.35	100	101	2.94	4.7	83.5	15.7	12.7
41	11	6-Apr-07	620	42 47.19	170 42.44	42 46.66	170 38.52	40	47	2.92	4.7	72.2	15.2	12.7
42	11	6-Apr-07	828	42 51.19	170 41.33	42 51.49	170 37.32	26	27	2.95	4.9	68.4	15	13.1
43	11	6-Apr-07	1029	42 51.52	170 28.52	42 53.97	170 26.03	40	43	3.05	4.5	70.1	15.1	13.3
44	11	6-Apr-07	1257	42 48.49	170 23.09	42 45.85	170 24.94	85	88	2.96	4.4	73.8	16.2	13.1
45	11	6-Apr-07	1502	42 42.30	170 27.83	42 44.42	170 25.06	85	90	2.93	4.8	78.5	15.1	12.9
46	12	7-Apr-07	630	42 37.76	170 16.22	42 40.56	170 15.08	149	150	2.92	4.4	83.5	17.4	12.6
47	13	7-Apr-07	854	42 43.05	170 04.91	42 45.90	170 03.34	216	217	3.07	4.6	85	16.7	12.7
48	13	7-Apr-07	1052	42 48.75	170 02.42	42 51.65	170 01.75	220	229	2.94	4.6	85	16	12.6
49	12	7-Apr-07	1316	42 46.95	170 09.33	42 44.03	170 09.86	154	158	2.94	4.5	85	16.5	12.8
50	12	7-Apr-07	1535	42 47.33	170 16.24	42 49.96	170 14.09	130	135	3.06	4.5	79.2	15.3	13
51	12	8-Apr-07	624	42 50.31	170 19.29	42 52.83	170 17.06	105	108	3	4.4	76.6	16.4	13
52	11	8-Apr-07	842	42 59.87	170 17.76	43 02.13	170 14.99	43	46	3.03	4.5	71.9	14.9	13.3
53	11	8-Apr-07	1058	43 05.27	170 10.74	43 07.37	170 07.90	40	49	2.95	4.6	72.6	14.7	13.2
54	11	8-Apr-07	1304	43 06.02	170 06.28	43 08.67	170 04.23	81	84	3.04	4.7	75.3	14.6	13.1
55	12	8-Apr-07	1502	43 07.50	169 58.74	43 09.59	169 55.91	144	153	2.93	4.6	85.6	16.3	12.5
56	13	9-Apr-07	631	43 02.87	169 47.38	43 04.86	169 46.23	207	221	2.16	4.6	90.9	16	12.4
57	12	9-Apr-07	834	43 09.26	169 53.67	43 11.16	169 52.00	168	173	2.25	4.2	84.1	15.6	12.6
58	16	9-Apr-07	1302	43 15.67	169 43.91	43 17.82	169 43.43	210	219	2.17	4.5	85.5	15.3	12.5
59	14	9-Apr-07	1511	43 19.23	169 53.61	43 21.54	169 50.93	66	74	3.02	4.7	74.3	15.3	12.9
60	14	10-Apr-07	645	43 46.57	169 05.29	43 44.48	169 08.21	26	33	2.96	4.7	71.2	15.4	14.6
61	15	10-Apr-07	849	43 38.40	169 14.68	43 35.87	169 16.88	115	124	2.98	4.1	87.1	15.7	12.8
62	15	10-Apr-07	1129	43 34.56	169 14.73	43 33.00	169 16.93	129	130	2.23	4.4	85.1	16.8	12.9

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)
63	16	10-Apr-07	1352	43	26.35	169	15.45	43	24.39	169	18.45	343	347	2.93	4.5	91	16.1	12.2
64	15	10-Apr-07	1559	43	26.71	169	20.11	43	25.52	169	22.78	136	138	2.27	4.6	83.4	16.3	12.8
65	16	11-Apr-07	720	43	26.01	169	18.37	43	24.50	169	20.50	242	251	2.16	4.6	87.5	16.2	12.8
66	14	11-Apr-07	1114	43	31.15	169	29.13	43	29.22	169	32.46	53	62	3.09	4.6	74.5	15.1	13.2
67	14	11-Apr-07	1311	43	27.02	169	34.90	43	25.19	169	38.18	49	53	3	4.9	73.1	15.5	13.8
68	12	11-Apr-07	1621	43	16.12	169	50.89	43	13.98	169	52.88	152	154	2.58	4.4	85.9	15.2	12.6
69	12	12-Apr-07	644	43	07.35	169	51.20	43	04.90	169	53.47	183	185	2.95	4.7	88.5	15.2	12.7
70 *	19	15-Apr-07	1031	40	46.31	173	43.96	40	45.82	173	43.75	63	68	0.51	4.5	75		
71 *	19	15-Apr-07	1114	40	44.73	173	43.68	40	44.27	173	43.52	67	68	0.47	4.5	75		
72 *	19	15-Apr-07	1152	40	43.46	173	43.43	40	43.05	173	43.12	53	58	0.47	4.5	75		
73 *	19	15-Apr-07	1339	40	43.94	173	42.30	40	43.49	173	42.02	53	54	0.49	4.5	75		
74 *	19	15-Apr-07	1422	40	44.28	173	42.31	40	44.73	173	42.61	61	65	0.5	4.5	75		
75 *	19	15-Apr-07	1516	40	45.12	173	41.35	40	45.57	173	41.58	65	66	0.48	4.5	75		
76 *	19	15-Apr-07	1613	40	46.58	173	40.10	40	47.07	173	40.29	67	67	0.51	4.5	75		
77 *	19	15-Apr-07	1721	40	42.81	173	44.40	40	42.42	173	44.01	55	57	0.48	4.5	75		
78 *	19	16-Apr-07	703	40	42.03	173	37.51	40	42.31	173	38.05	62	62	0.49	4.5	75		
79 *	19	16-Apr-07	752	40	43.10	173	40.02	40	42.96	173	40.58	60	60	0.44	4.5	75		
80 *	19	16-Apr-07	906	40	41.96	173	42.37	40	41.77	173	42.97	62	62	0.49	4.5	75		
81 *	19	16-Apr-07	1108	40	41.15	173	44.10	40	41.40	173	44.70	60	62	0.51	4.5	75		
82 *	19	16-Apr-07	1146	40	42.09	173	45.81	40	42.53	173	46.06	56	65	0.47	4.5	75		
83 *	19	16-Apr-07	1247	40	40.50	173	42.83	40	40.69	173	42.06	61	62	0.61	4.5	75		
84 *	19	16-Apr-07	1334	40	41.58	173	40.94	40	41.84	173	40.42	60	61	0.47	4.5	75		
85 *	19	16-Apr-07	1421	40	44.06	173	39.39	40	44.30	173	40.01	55	55	0.52	4.5	75		
86 *	19	16-Apr-07	1523	40	45.72	173	38.90	40	45.94	173	38.34	52	52	0.47	4.5	75		

* Tow for tarakihi tagging, not used for biomass estimates

Appendix 3: Catch summary in alphebetical order by species code (Occ. = number of stations).

Species code	Common name	Scientific name	Catch (kg)	% of total catch	Occ.	Depth (m) Min.	Depth (m) Max.
ANC	Anchovy	*Engraulis australis*	0.3	*	2	28	46
ANT	Anemones	Anthozoa	1.5	*	2	41	65
ASC	Sea squirt	Ascidiacea	17.3	*	4	22	32
BAR	Barracouta	*Thyrsites atun*	3 300.6	8	58	22	229
BCO	Blue cod	*Parapercis colias*	86.2	*	10	28	150
BRA	Short-tailed black ray	*Dasyatis brevicaudata*	103.5	*	2	23	28
BRI	Brill	*Colistium guntheri*	8.6	*	7	26	50
BTA	Smooth deepsea skate	*Notoraja asperula*	2.3	*	1	343	347
CAR	Carpet shark	*Cephaloscyllium isabellum*	1 295.1	3	62	22	371
CBI	Two saddle rattail	*Caelorinchus biclinozonalis*	2 760.6	7	36	26	251
CBO	Bollons's rattail	*Caelorinchus bollonsi*	31.8	*	2	210	347
CCX	Small banded rattail	*Caelorinchus parvifasciatus*	8.5	*	3	136	347
CDO	Capro dory	*Capromimus abbreviatus*	11.9	*	20	66	229
CON	Conger eel	*Conger* spp.	84.7	*	8	26	65
COU	Coral (unspecified)		0.7	*	1	138	142
CRU	Crustacea		0.1	*	1	67	70
CUC	Cucumberfish	*Chlorophthalmus nigripinnis*	94.4	*	23	53	319
EGR	Eagle ray	*Myliobatis tenuicaudatus*	4.7	*	2	28	41
ELE	Elephantfish	*Callorhinchus milii*	42.8	*	7	26	65
EMA	Blue mackerel	*Scomber australasicus*	1.7	*	1	85	89
ERA	Electric ray	*Torpedo fairchildi*	99.7	*	12	22	347
ESO	N.Z. sole	*Peltorhamphus novaezeelandiae*	73.9	*	12	22	50
EUC	Eucla cod	*Euclichthys polynemus*	0.1	*	1	390	393
FHD	Deepsea flathead	*Hoplichthys haswelli*	1.9	*	1	343	347
FLL	Shell fragments		15.2	*	1	23	25
FRO	Frostfish	*Lepidopus caudatus*	799.5	2	29	36	347
GAS	Gastropods	Gastropoda	4.0	*	11	26	347
GLB	Globefish	*Contusus richei*	74.5	*	2	26	40
GSH	Dark ghost shark	*Hydrolagus novaezealandiae*	2 078.8	5	37	36	393
GUR	Red gurnard	*Chelidonichthys kumu*	861.4	2	37	22	177
HAG	Hagfish	*Eptatretus cirrhatus*	1.9	*	1	343	347
HAK	Hake	*Merluccius australis*	600.8	2	26	26	347
HAP	Hapuku	*Polyprion oxygeneios*	59.1	*	4	151	393
HDR	Hydroid	Hydrozoa (Class)	17.1	*	1	52	65
HOK	Hoki	*Macruronus novaezelandiae*	1 309.7	3	17	85	347
HTH	Sea cucumber	Holothurian unidentified	0.8	*	3	22	65
JAV	Javelinfish	*Lepidorhynchus denticulatus*	9.5	*	3	343	393
JDO	John dory	*Zeus faber*	154.8	*	21	22	177
JFI	Jellyfish		36.1	*	6	22	53
JMD	N.Z. jack mackerel	*Trachurus declivis*	87.9	*	29	28	221
JMM	Chilean jack mackerel	*Trachurus symmrtricus murphyi*	19.1	*	8	43	217
JMN	N.Z. jack mackerel	*Trachurus novaezelandiae*	248.5	1	16	22	117
KAH	Kahawai	*Arripis trutta*	1.0	*	1	28	28
LDO	Lookdown dory	*Cyttus traversi*	0.5	*	1	343	347
LEA	Leatherjacket	*Parika scaber*	282.8	1	12	23	65
LFB	Longfinned boarfish	*Zanclistius elevatus*	3.5	*	1	23	25
LIN	Ling	*Genypterus blacodes*	390.1	1	35	22	393
LSK	Softnose skate (Longtail skate)	*Arhynchobatis asperrimus*	2.9	*	2	364	393
LSO	Lemon sole	*Pelotretis flavilatus*	181.2	*	33	22	251
MDO	Mirror dory	*Zenopsis nebulosus*	5.7	*	1	390	393

Appendix 3—continued

Species code	Common name	Scientific name	Catch (kg)	% of total catch	Occ.	Depth (m) Min.	Max.
NOS	NZ southern arrow squid	*Nototodarus sloanii*	1 344.8	3	68	22	393
NSD	Northern spiny dogfish	*Squalus mitsukurii*	89.0	*	15	34	393
OCT	Octopus	*Pinnoctopus cordiformis*	21.9	*	11	22	108
ONG	Sponges	Porifera (phylum)	19.7	*	9	22	89
OPA	Opalfish	*Hemerocoetes* spp.	0.4	*	4	28	124
OPE	Orange perch	*Lepidoperca aurantia*	1.7	*	1	207	221
PAD	Paddle crab	*Ovalipes catharus*	7.9	*	1	26	27
PAG	Hermit crab	Paguroidea	1.0	*	7	23	229
PCO	Ahuru	*Auchenoceros punctatus*	2.3	*	8	26	89
PDG	Prickly dogfish	*Oxynotus bruniensis*	6.4	*	1	242	251
PIG	Pigfish	*Congiopodus leucopaecilus*	2.3	*	6	28	217
PIL	Pilchard	*Sardinops neopilchardus*	0.1	*	1	43	46
POP	Porcupine fish	*Allomycterus jaculiferus*	91.5	*	4	34	142
POS	Porbeagle shark	*Lamna nasus*	29.1	*	1	66	74
PRK	Prawn killer	*Ibacus alticrenatus*	7.3	*	15	34	371
PSI	Geomwetric star	*Psilaster acuminatus*	0.3	*	3	96	121
RBT	Redbait	*Emmelichthys nitidus*	0.1	*	1	91	94
RCO	Red cod	*Pseudophycis bachus*	2 980.1	8	52	22	347
RHY	Common roughy	*Paratrachichthys trailli*	1.1	*	1	207	221
RMU	Red mullet	*Upeneichthys lineatus*	0.5	*	2	28	32
RSK	Rough skate	*Dipturus nasutus*	354.5	1	22	23	393
SAL	Salps		24.7	*	8	26	393
SBR	Southern bastard cod	*Pseudophycis barbata*	1.1	*	1	149	150
SCA	Scallop	*Pecten novaezelandiae*	0.1	*	1	28	32
SCG	Scaly gurnard	*Lepidotrigla brachyoptera*	722.6	2	56	23	221
SCH	School shark	*Galeorhinus galeus*	1 084.0	3	51	22	371
SCI	Scampi	*Metanephrops challengeri*	0.1	*	1	390	393
SDO	Silver dory	*Cyttus novaezealandiae*	1 976.5	5%	32	81	371
SDR	Spiny seadragon	*Solegnathus spinosissimus*	1.0	*	5	52	219
SFI	Starfish	*Asteroidea & ophiuroidea*	4.2	*	6	22	177
SFL	Sand flounder	*Rhombosolea plebeia*	152.3	*	8	22	57
SHR	Sea hare	Order Aplysiomorpha	0.1	*	1	23	25
SKI	Gemfish	*Rexea solandri*	105.1	*	10	168	393
SNA	Snapper	*Pagrus auratus*	82.8	*	6	22	65
SND	Shovelnose spiny dogfish	*Deania calcea*	10.0	*	1	343	347
SPD	Spiny dogfish	*Squalus acanthias*	8 371.3	21	61	22	347
SPE	Sea perch	*Helicolenus* spp.	236.1	1	38	28	393
SPM	Sprat	*Sprattus muelleri*	6.0	*	14	26	90
SPO	Rig	*Mustelus lenticulatus*	475.2	1	35	22	154
SPR	Sprats	*Sprattus antipodum, S. muelleri*	0.1	*	1	43	46
SPS	Speckled sole	*Peltorhamphus latus*	0.5	*	5	22	32
SPT	Heart urchin	*Spatangus multispinus*	6.4	*	5	96	347
SPZ	Spotted stargazer	*Genyagnus monopterygius*	2.1	*	2	22	25
SSH	Slender smoothhound	*Gollum attenuatus*	48.3	*	2	364	393
SSI	Silverside	*Argentina elongata*	46.0	*	34	41	371
SSK	Smooth skate	*Dipturus innominatus*	121.0	*	13	44	393
STA	Giant stargazer	*Kathetostoma giganteum*	2 411.6	6	53	22	347
STY	Spotty	*Notolabrus celidotus*	99.7	*	7	22	46
SWA	Silver warehou	*Seriolella punctata*	210.6	1	44	22	393
TAR	Tarakihi	*Nemadactylus macropterus*	1 716.2	4	47	22	251

Appendix 3—continued

Species code	Common name	Scientific name	Catch (kg)	% of total catch	Occ.	Depth (m) Min.	Max.
THR	Thresher shark	*Alopias vulpinus*	35.4	*	2	43	46
TOD	Dark toadfish	*Neophrynichthys latus*	0.8	*	6	144	393
TUR	Turbot	*Colistium nudipinnis*	2.5	*	1	40	43
UNI	Unidentified		2.2	*	4	22	89
WAR	Blue warehou	*Seriolella brama*	559.3	1	23	22	124
WHE	Whelks		0.1	*	1	147	148
WIT	Witch	*Arnoglossus scapha*	397.5	1	55	22	393
YBF	Yellow-belly flounder	*Rhombosolea leporina*	0.3	*	1	25	30
YEM	Yellow-eyed mullet	*Aldrichetta forsteri*	12.8	*	4	23	41
			Total 39167.9				

* less than 0.5%

Appendix 4. Benthic macro-invertebrates taken as by catch during the survey.

Taxon	No. of stations
Porifera (Demospongiae)	
Amorphinopsis n. sp. 1	1
Crella incrustans (Carter, 1885) sensu Bergquist & Fromont (1988)	1
Dactylia palmata Carter, 1885 sensu Bergquist & Warne (1980)	7
Dactylia n. sp. 1	3
Suberites affinis Brondsted, 1923	2
Callyspongia (Callyspongia) sp. nov. 11	1
Actiniaria	
Actiniaria	2
Annelida: Polynoidae	
Eunice laticeps	1
Pseudopotamilla laciniosa	4
Annelida:Hirudinea	
Stibarobdella?	1
Cnidaria: Pennatulacean	
Funiculina sp.	2
Bryozoa: Cheilostomata	
Aetea truncata (Landsborough, 1852)	1
Akatopora circumsaepta (Uttley, 1951)	1
Aimulosia marsupium (MacGillivray, 1869)	1
Arachnopusia unicornis (Hutton, 1873)	3
Beania magellanica (Busk, 1852)	1
Beania sp.	1
Bitectipora rostrata (MacGillivray, 1887)	2
Bugula sp.	1
Caberea rostrata Busk, 1884	2
Caberea zelandica (Gray, 1843)	2
Calloporina angustipora (Hincks, 1885)	1
Cellaria immersa (Tenison-Woods, 1880)	1
Cellaria tenuirostris (Busk, 1852)	1
Celleporaria agglutinans (Hutton, 1873)	1
Celleporina sinuata Gordon, 1989	1
Crassimarginatella cucullata (Waters, 1898)	1
Diaperoecia purpurascens (Hutton, 1873)	1
Entalophoroecia sp.	1
Exochella conjuncta Brown, 1952	1
Galeopsis polyporus (Brown, 1952)	1
Galeopsis porcellanicus (Hutton, 1873)	1
Hippothoa flagellum Manzoni, 1870	1
Leptinatella gordoni Cook & Bock, 1999	1
Microporella agonistes Gordon, 1989	1
Microporella discors Uttley & Bullivant, 1972	1

Appendix 4—continued

Taxon	No. of stations
Bryozoa: Cheilostomata (cont.)	
Odontionella cyclops (Busk, 1854)	1
Opaeophora lepida (Hincks, 1881)	1
Parasmittina delicatula (Busk, 1884)	1
Schizosmittina cinctipora (Hincks, 1883)	2
Smittina purpurea (Hincks, 1881)	2
Smittina rosacea Powell, 1967	2
Smittina torques Powell, 1967	2
Smittoidea maunganuiensis (Waters, 1906)	1
Bryozoa: Cyclostomata:	
Telopora lobata Tenison-Woods, 1880	1
Tubulipora sp.1	1
Tubulipora sp.2	1
Tubulipora sp.3	1
Crustacea: Palinura	
Ibaccus alticrenatus	15
Crustaces: Decapoda	
Metanephrops challengeri	1
Crustacea: Paguridae	
Diacanthurus rubricatus (Henderson, 1888)	4
Paguristes subpilosus (Henderson, 1888)	2
Paguristes pilosus (H. Milne Edwards, 1836)	1
Crustacea: Stomatopoda	
Pterygosquilla schizodontia (Richardson, 1953)	1
Crustacea: Isopoda	
Elthusa raynaudii (Milne Edwards, 1840);	2
Nerocila orbignyi *(Guérin-Menéville, 1832)*	1
Crustacea: Anomura	
Phylladiorhynchus pusillus Baba 1969	2
Porcellanidae	1
Ovalipes catharus	1
Crustacea: Stomatopoda	
Squillidae	1
Arthropoda: Cirripedia	
Calantica studeri	1
Arcoscalpellum pedunculatum	1
Brachiopoda	
Brachiopoda	1

Appendix 4—continued

Taxon	No. of stations
Mollusca: Bivalvia	
Pecten novaezelandiae	1
Talochlamys zelandiae (Gray, 1843)	2
Hiatella arctica (Linnaeus, 1767)	1
Mollusca: Gastropoda	
Alcithoe ostenfeldi (Iredale, 1937)	5
Alcithoe arabica (Gmelin, 1791)	2
Astrea heliotropium (martyn, 1784)	1
Austrofusus glans (Röding, 1798)	2
Penion cuvierianus (Powell, 1927)	2
Mollusca: Cephalopoda	
Pinnoctopus cordiformis	11
Tunicata: Ascidiacea	
Cnemidocarpa nisiotus	4
Cnemidocarpa nisiotus	1
Stolidobranchia	1
Styela? picta?	2
Aplousobranchia	1
Echinodermata :Astreoidea	
Psilaster acuminatus	1
Coscinasterias muricata	5
Echinodermata :Ophiuroidea	
Ophiuroidea	2
Echinodermata:Echinoidea	
Spatangus multispinus	1
Echinodermata: Holothuroidea	
Stichopus mollis	3