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Inshore trawl survey of Canterbury Bight
and Pegasus Bay, May–June 2008 (KAH0806)

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**Inshore trawl survey of Canterbury Bight and Pegasus Bay,
May–June 2008 (KAH0806)**

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EXECUTIVE SUMMARY

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In May–June 2008 a bottom trawl survey of the east coast South Island (ECSI) in 30–400 m was carried out using R.V. *Kaharoa* (KAH0806). This survey represents the seventh survey in the winter time series (1991–94, 1996, 2007). A supplementary survey was also carried out in 10–30 m to improve sampling of various species.

The main survey in 30–400 m was a two-phase design optimised for the target species dark ghost shark, giant stargazer, red cod, sea perch, spiny dogfish, and tarakihi. A total of 96 successful stations was completed from 17 strata using a 60 mm codend. Biomass estimates, catch distribution, population length frequencies, and reproductive condition for the major species are described. Coefficients of variation for the target species were spiny dogfish 22%, dark ghost shark 20%, tarakihi 29%, sea perch 23%, red cod 49%, and giant stargazer 14%. These c.v.s were within the specified range in the project objectives for dark ghost shark, giant stargazer, and tarakihi, and within a few percent for sea perch and spiny dogfish. For red cod the c.v. was nearly double that of the upper range.

Dorsal spines were collected for spiny dogfish (417) and dark ghost shark (307), and otoliths for red cod (385), tarakihi (226), sea perch (265), and giant stargazer (271).

A total of 212 rough skate, 76 smooth skate, 80 school shark, and 40 rig were tagged, length and weight recorded, and released during the survey. In addition, 32 giant stargazer were double tagged, length and weight recorded, injected with oxytetracycline (OTC) and released.

This survey also collected qualitative data on the presence of macro-invertebrates from catches.

Dark ghost shark – Biomass in 2008 was the second highest of the seven surveys after 2007, but is still high compared with that before 1996. All surveys have a large component of pre-recruited biomass ranging from 30 to 62%. The juvenile and adult biomass (based on length at 50% maturity) of both sexes have generally increased proportionately over the time series. Dark ghost shark were present in 22 to 50 % of tows with the highest occurrence in the last three surveys, and have made up 2 to 9 % of the total catch. The size distributions of dark ghost shark in each of the last five surveys are similar.

Giant stargazer – Biomass in 2008 was in the mid range of those of previous surveys with no trend in biomass over the time series. Pre-recruited biomass is a small component of the total biomass estimate on all surveys (range 2 to 5% of total biomass). The juvenile to adult biomass ratio (based on length at 50% maturity) has been relatively constant over the time series at about 1 to 1. Giant stargazer were present in 70 to 92% of tows and have made up 1 to 2 % of the total catch on the surveys, with no trend in either. The size distributions of giant stargazer in each of the seven surveys are similar.

Red cod – Biomass in 2008 was the second lowest of the six surveys after 2007 (23% more than 2007), but is three-fold less than the peak biomass of 1994. Pre-recruited biomass was a small component of the total biomass in the 1996, 2007, and 2008 surveys (13%, 13%, and 7%) compared to 1994 when pre-recruited biomass was 59%. Juvenile biomass (based on the length at 50% maturity) was also a smaller component of total biomass in the last three surveys. Red cod were present in 65 to 89 % of tows and have made up 2 to 30% of the total catch on the surveys; both of these variables were lowest in 2007 and 2008 reflecting, the low biomass compared to earlier surveys in the 1990s. The size distributions of red cod in each of the seven surveys are similar, but the 1+ cohort varies in strength.

Sea perch – Biomass in 2008 was very close to that of 2007, and in the mid range of previous surveys with is no trend over the time series. Pre-recruited biomass is a very small component of the total biomass on all surveys (range 3 to 7% of total biomass). The juvenile to adult biomass ratio (based on length at 50% maturity) has been relatively constant over the time series with juvenile biomass about 30 to 45 % of total biomass. Sea perch were present in 59 to 82 % of tows and have made up 3 to 6 % of the total catch on the surveys, with no trends in either variable. The size distributions of sea perch in each of the seven surveys are similar.

Spiny dogfish – Biomass for spiny dogfish in 2008 was 19% less than 2007, but is still more than double that of the early 1990s, indicating that the quantum leap in biomass between 1994 and 1996 has been sustained. Pre-recruited biomass was a small component of the total biomass estimate in the 1992 to 1994 surveys (1 to 3% of total biomass), but increased commensurate with biomass in 1996 (7–16%). Biomass of juvenile spiny dogfish (based on the length at 50% maturity) also increased from about 15% before to 1996 to one to two-thirds in the last three surveys. Dogfish were present in 94 to 100 % of tows and have made up 22 to 45% of the total catch on the surveys with indications that this species has become both more widespread and abundant on the ECSI since 1996. Spiny dogfish has had the largest biomass of all species with the exception of barracouta in 1992 and 1993. The size distributions of spiny dogfish in each of the 1992 to 1994 surveys are similar, but in 1996, 2007, and 2008 the distributions are dominated by smaller fish, particularly females.

Tarakihi – Biomass is 28% less than 2007 and in the mid range of those of previous surveys with no apparent trend over the time series. Pre-recruited biomass is a major component of the total biomass estimate on all surveys (ranging from 18 to 59%). Juvenile biomass (based on length at 50% maturity) is also a large component of total biomass but the proportion is relatively constant over the time series. Tarakihi were present in 61 to 75% of tows and have made up 1 to 5% of the total catch on the surveys, with no trends in either variable. The size distributions of tarakihi in each of the six surveys are similar.

The areas of high density of all target species over the six surveys varied, but overall these species were consistently well represented over the entire survey area within their preferred depth range. There was, however, an area of consistently high catch rates ('hotspot') for many species southeast of Timaru in about 100 m.

In the supplementary survey in 10–30 m, three stations were successfully completed from a single stratum (18) using a 28 mm codend.

1. INTRODUCTION

We report the findings of the 2008 east coast South Island (ECSI) bottom trawl survey in May–June 2008 using R.V. *Kaharoa* (KAH0806) in 30–400 m. This survey represents the seventh in the winter time series. Previous surveys were carried out in 1991, 1992, 1993, 1994, 1996, and 2007 (Beentjes & Wass 1994, Beentjes 1995a, 1995b, 1998a, 1998b, Beentjes & Stevenson 2008). The 2007 survey marked the reinstatement of the winter survey time series which was discontinued after 1996. This time series was reviewed by Beentjes & Stevenson (2000). The 2007 and 2008 survey also included additional survey strata in 10–30 m.

1.1 Background to east coast South Island inshore trawl surveys

The ECSI winter trawl survey time series was discontinued after the 1996 survey and replaced by a summer time series (five surveys from 1996 to 2000) (Beentjes & Stevenson 2001). The summer trawl surveys used a finer codend mesh (28 mm) to sample pre-recruit red cod and the minimum depth range was reduced to 10 m to include the distribution of red gurnard and elephantfish. The summer time series was reviewed by Beentjes & Stevenson (2001).

The summer time series was discontinued after 2000 because of the extreme fluctuations in catchability between surveys (Francis et al. 2001). The biomass estimates for the target species were not providing reliable abundance indices, some of which were incorporated in the ‘Decision Rules’ for AMP species such as giant stargazer (STA 3), elephantfish (ELE 3), and red gurnard (GUR 3) (Ministry of Fisheries 2006). With the discontinuation of both the winter and summer surveys there was no means of effectively monitoring many of the commercial ECSI inshore fish stocks. Further, since 1996, several new species have been introduced into the QMS (e.g., skates, dark ghost shark, sea perch, and spiny dogfish). ECSI surveys also provide a useful comparison with Chatham Rise and sub-Antarctic middle depth trawl surveys because many of the species found on the ECSI tend to be smaller than elsewhere, indicating that this may be an important nursery ground (Beentjes et al. 2004).

A workshop, held in May 2005, to discuss ways of monitoring inshore species concluded that reinstating the winter survey time series would be the best way to monitor long-term trends in abundance, but the minimum depth of 30 m should be reduced to 10 m to improve sampling of various species.

1.2 Elasmobranch tagging

Trawl surveys provide a relatively inexpensive opportunity to tag elasmobranchs, and recaptures should provide information on movement patterns, stock structure, and growth. The survey aimed to tag rough skate, smooth skate, school shark, and rig.

Two species of skate are commonly caught on the ECSI surveys; the rough skate (*Dipturus nasuta*) more common inshore, and the larger smooth skate (*D. innominatus*), more common in deeper water. There is very little known about the biological stocks of either species and hence a tagging programme should provide information on movements, home range, and possibly growth.

New Zealand school shark are assumed to comprise a single biological stock. School shark tend to be more common in shallow water under 200 m and also move inshore during summer to pup. Tagging school shark on the east coast of the South Island complements a similar programme on the west coast as part of the west coast South Island (WCSI) trawl survey, and also the long-term opportunistic tagging of school shark that has occurred from most inshore research trawl surveys dating back to 1985 (Hurst et al. 1999). From 1985 to 1997 nearly 4000 school shark were tagged, with 207

recaptures. Results indicate that about half of the school sharks were recaptured within the same QMA in which they were tagged, but this proportion declined over time (Hurst et al. 1999). A significant number (23%) were recaptured in Australia.

Although there may have been the occasional opportunistic tagging of rig during research trawl surveys, there has only been one directed rig tagging programme between 1978 and 1985 (Francis 1988). About 2000 rig were tagged from commercial set nets and research trawls, mainly around the South Island, with about 400 recaptures. Rig move less than school shark, but there was movement of over 50 km for half the recaptures. There was evidence of separate east and west coast South Island stocks. Like school shark, rig tend to be more common in shallow water (under 200 m) and also move inshore during summer to pup. Tagging rig on the east coast of the South Island complements a similar programme as part of the WCSI trawl surveys, and also the earlier tagging study of Francis (1988).

1.3 Giant stargazer tagging

A further objective of the 2007 and 2008 ECSI trawl surveys was to tag, mark with oxytetracycline, and release giant stargazer. The purpose is to validate the annual deposition of growth zones on otoliths, and secondarily to gather information on growth and movement. The true stock structure of giant stargazer in New Zealand waters is unknown (Ministry of Fisheries 2008).

Giant stargazer ages are estimated from counts of growth zones present in the sagittal otoliths, assumed to form annually, although this method is not validated (Sutton 1999, Manning & Sutton 2007). Oxytetracycline (OTC) is commonly used to chemically mark fish otoliths by chelating the calcium and magnesium present in the otolith. Recaptured fish otoliths are examined under ultra-violet light for the position of the fluorescent check on the otolith, providing a powerful method of validating age estimates from otoliths (Campana 2001). A chemical labelling (using OCT), tagging, and release study of giant stargazer was carried out on the Chatham Rise during the R.V. *Tangaroa* trawl surveys in January 2005 and January 2006 (Stevens & O'Driscoll 2006, 2007).

There have been no tag returns from Chatham Rise *Tangaroa* trawl surveys, or the 2007 and 2008 ECSI surveys at the time of writing (October 2009). The lack of returns prompted the Southern Inshore Working Group to recommend that for the 2008 survey, only giant stargazer caught in less than 50 m depth be tagged to avoid potential mortality resulting from trauma associated with being brought to surface from greater depths.

1.4 Objectives

Overall objective

To determine the relative abundance and distribution of inshore finfish species off the east coast of the South Island in 2008 and 2009; focusing on red cod (*Pseudophycis bachus*), giant stargazer (*Kathetostoma giganteum*), sea perch (*Helicolenus percoides*), tarakihi (*Nemadactylus macropterus*), spiny dogfish (*Squalus acanthius*), and dark ghost shark (*Hydrolagus novaezelandiae*).

Specific objectives

1. To determine the relative abundance and distribution of red cod, stargazer, sea perch, tarakihi, spiny dogfish, and dark ghost shark off the east coast of the South Island from Shag Point to Waiau River by carrying out a trawl survey over the depth range 10 to 400 m. The target coefficients of variation (c.v.s) of the biomass estimates for these species are as follows: red cod

(20–25%), sea perch (20%), giant stargazer (20%), tarakihi (20–30%), spiny dogfish (20%) and dark ghost shark (20–30%).

2. To collect the data and determine the length frequency, length-weight relationship and reproductive condition of red cod, giant stargazer, sea perch, tarakihi, spiny dogfish and dark ghost shark.
3. To collect otoliths from red cod, giant stargazer, sea perch, and tarakihi; and spines from spiny dogfish.
4. To collect the data to determine the length frequencies and catch weight of all other Quota Management System (QMS) species.
5. To tag and release live skate, rig, and school shark.
6. To tag and inject giant stargazer with oxytetracycline to validate growth zones in the otoliths.
7. To identify benthic macro-invertebrates collected during the trawl survey.

Note that although the overall objective covers both the 2008 and 2009 surveys, the specific objectives refer only to the 2008 survey.

2. METHODS

2.1 Survey area and design

30–400 m depth range

The 2008 survey (KAH0806) in the 30–400 m depth range covered the same area as the previous winter surveys, extending from the Waiau River in the north to Shag Point in the south. The survey area of 23 357 km², including untrawlable (foul) ground, was divided into 17 strata, identical to those used in the 1996 (KAH9606) and 2007 (KAH0705) winter surveys (Figure 1, Table 1).

To determine the theoretical number of stations required in each of the 17 strata to achieve the required c.v. for the target species, simulations using NIWA's Optimal Station Allocation Programme were carried out using catch rates for the six target species for all six previous winter surveys. For those surveys before 1994 that used nine strata, the stations were assigned to the equivalent strata used from 1994 onward. Simulations using the minimum and maximum of the c.v. range and requiring a minimum of three stations per stratum, were carried out. The results indicated that to achieve the lower range c.v.s, 109 stations were required in the 30–400 m depth.

As for all previous winter surveys, a two-phase random stratified station survey design was used. This design has a better chance of achieving the target c.v.s, especially when species distributions change. Sufficient trawl stations to cover both first and second phase stations were generated for each stratum using the computer program Rand_stn v2.1, with the constraint that stations were at least 3 n. miles apart. We allocated 80% (N = 88) of the 109 stations to phase 1 with a minimum of 3 stations and a maximum of 10 stations per stratum. A weighted allocation was then applied on the basis of species priority (in consultation with MFish), where the order in decreasing importance was tarakihi, stargazer, sea perch, red cod, dark ghost shark, and spiny dogfish. Allocation of phase 1 takes into account the spatial distribution and biomass of the key species over the previous five winter surveys. Phase 2 stations were allocated to strata with the highest variance for each species on the 2008 survey, where the c.v. was above the required target c.v, also based on this species priority.

10–30 m depth range

The extension of the winter surveys into 10 m from 2007, in effect, constituted a new survey in 10–30 m, and in terms of biomass estimates, is treated as an adjunct to the existing survey time series in 30 to 400 m. This is necessary because calculation of relative total biomass of the ECSI for each species is proportional to the survey area, and increasing the total area surveyed during the time series introduces additional biomass to the estimates. Further, a smaller 28 mm codend was used in the shallow depth range (compared with 60 mm in 30–400 m).

The survey area of 3577 km², including untrawlable (foul) ground, was divided into four strata, identical to those used in the ECSI summer surveys (Figure 1, Table 1). Station allocation in the 10–30 m survey was not optimised, but 3 stations were nominally allocated in each of the four strata, resulting in 12 stations. Time constraints on the survey and the large number of target species prevented allocation of more stations and/or a phase 2 component. The 10–30 m survey was given a lower priority than the 30–400 m survey.

2.2 Vessel and gear

The vessel and trawl gear specifications were the same as for all previous ECSI winter surveys. R.V. *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 ‘Alfredo’ design net was constructed in 1991, specifically for the South Island trawl surveys; there are two nets (A and B), complete with ground rope and floatation. This net fishes hard down and achieves a headline height of about 4–5 m. Rectangular ‘V’ trawl doors fitted with Scanmar sensors were used. For the 10–30 m and 30–400 m surveys the codend inside measurement was 28 mm (knotless), and 60 mm (knotless), respectively. A bottom contact sensor was deployed on the ground rope, and a net sonde monitor (CN22) was attached to the headline to measure headline height on all tows. All trawl gear was overhauled and specifications checked before the 2008 survey. Gear specifications are documented in Appendix 1.

2.3 Timetable

R.V. *Kaharoa* departed Lyttelton on 4 May 2008 and trawling began on 5 May, north of Banks Peninsula, moving progressively south until all phase 1 tows (30–400 m) in and around Banks Peninsula had been completed. At this stage stratum 18 (10–30 m) was also surveyed. Catch was initially landed into Lyttelton, but once the survey was south of Banks Peninsula catches were landed into Timaru. The first leg was completed on 20 May when the vessel discharged fish at Timaru and there was a change of scientific staff. The three 10–30 m strata (19, 20, and 21) south of Banks Peninsula were not surveyed because of time constraints. The survey was completed on 5 June and the vessel steamed to Wellington, arriving on 6 June 2008. The voyage leaders were Michael Stevenson (leg 1) and Derek Parkinson (leg 2), and the skippers Lindsay Copeland and Neil Pestell.

2.4 Trawling procedure

Trawling procedures adhered strictly to those documented by Stevenson & Hanchet (1999). All tows were carried out in daylight (shooting and hauling) between 0730 and 1700 hours NZST. Tows were initially 1 hour duration at a speed of 3.0 knots over the ground, and tow length was about 3 n. miles. The minimum acceptable tow length was about 1.5 n. miles. Timing began when the net reached the bottom and settled, as indicated by the net monitor, and finished when hauling began. In some strata, large catches of dogfish made tows increasingly unmanageable and the standard towing time was reduced, usually to about 40 min. Standardised optimal warp/depth ratio for different depths was strictly adhered to. Tow direction was generally along depth contours and/or towards the nearest

random station position, but was also dependent on wind direction and bathymetry. Some tow paths, particularly those on the slope in 200–400 m, were surveyed before towing to ensure that it was acceptable, both in depth and trawlable bathymetry. When untrawlable ground was encountered, an area within a 2 n. mile radius of the station was searched for suitable ground. If no suitable ground was found within the radius, the next alternative random station was selected. The ground contact sensor data files were downloaded at the end of the tow immediately the gear came on deck and loaded into *Boxcar*, a dedicated computer program that checks that the gear was in contact with the bottom throughout the tow. If contact was considered to be unsatisfactory, the tow was not included in the biomass estimation.

Doorspread (Scanmar monitor) and headline height (net sonde sensors) were measured continuously during the tow and the signals transmitted remotely to the ship. Both parameters were recorded at 10–15 minute intervals, and averaged over the tow.

A CTD (conductivity, temperature, and depth) monitor was attached to the headline and the data were downloaded at the end of the tow and loaded into *Seabird*, a dedicated computer program written for CTD data. Bottom and surface water temperatures were taken from the CTD data. Surface temperatures were taken at a depth of 5 m and bottom temperatures about 5 m above the sea floor because the CTD is attached to the net just behind the headline.

2.5 Catch and biological sampling

The catch from each tow was sorted by species, boxed, and weighed on motion-compensating 100 kg Seaway scales to the nearest 0.1 kg. Length, to the nearest centimetre below actual length, and sex were recorded for all QMS and selected non-QMS species, either for the whole catch or, for larger catches, on a sub-sample of about 100 randomly selected fish.

For each tow, biological information was obtained from a random sample of up to 20 fish for target species red cod, giant stargazer, sea perch, tarakihi, spiny dogfish, and dark ghost shark during which the following records or samples were taken: sex, length to the nearest centimetre below actual length, individual fish weight to the nearest 5 g (using motion-compensating 5 kg Seaway scales), otoliths and gonad stage of finfish (standard five-stage method.), and dorsal spines of sharks.

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 flaccid and bloodshot).

For each of the target species red cod, sea perch, tarakihi, and stargazer a maximum of five sagittal otoliths per cm size class per sex were removed. Otoliths were stored clean and dry in small paper envelopes marked with the survey trip code, species, fish number, length, and sex. After the survey, otoliths were catalogued and are held for MFish at NIWA, Greta Point.

Spiny dogfish spines were excised from the second dorsal fin and dark ghost shark spines from the first dorsal fin, ensuring that the spine was removed from about 1 cm beneath the skin. We aimed to collect a minimum of five spines per centimetre size class for each sex. Spiny dogfish spines were placed into plastic vials and filled with 70% ethanol, and dark ghost shark spines were placed into zip-lock plastic bags and frozen with details of station number, fish length, and sex. After the survey, spines were catalogued and are held for MFish at NIWA, Greta Point.

If present, macro-invertebrates were collected and preserved for later identification at Greta Point laboratories to the lowest possible taxonomic level.

All catch, biological, and length frequency data were entered into *trawl* database after the survey was completed.

2.6 Tagging procedures

As soon as the catch was on deck, it was immediately searched for the tagging candidate species rough skate, smooth skate, school shark, rig, and giant stargazer. Only giant stargazer caught in less than 50 m depth were considered for tagging. Sharks and giant stargazer in a lively condition were placed into a 700 l Dolav box pallet tank supplied with running sea water and aeration to facilitate recovery. Once recovered, skates, school shark, and rig were individually removed from the tank, tagged using a single small dart tag (Hallprint, Australia), and carefully released. Length, weight, sex, and release position (tow number) were recorded.

Similarly, after recovery, giant stargazer were removed individually from the tank, injected with the appropriate quantity (dose relative to body weight) of OTC intramuscularly, double tagged with external T-bar anchor tags, (Hallprint, Australia), length and weight recorded, then carefully released. The tags were positioned posteriorly along the dorsal fin as giant stargazers bury themselves in the benthos. Because giant stargazer was a target species with a requirement to collect otoliths from about 400 fish, as well as determine sex and reproductive condition, priority was given in the initial stages of the survey to the biological objectives and later in the survey we tagged and injected a greater number of giant stargazer.

Following the completion of the survey, all tagging details were entered into the *tag* database at NIWA, Greta Point.

2.7 Analysis of data

2.7.1 2008 survey

Relative biomass was estimated by the area-swept method described by Francis (1981, 1989) using the Trawlsurvey Analysis Program (Vignaux 1994). All tows for which the gear performance was satisfactory (code 1 or 2) were used for biomass estimation. Biomass estimates assume that: the area swept on each tow equals the distance between the doors multiplied by the distance towed; all fish within the area swept are caught and there is no escapement; all fish in the water column are below the headline height and available to the net; there are no target species outside the survey area; and fish distribution over foul ground is the same as that over trawlable ground.

Coefficients of variation (c.v.) were calculated as follows:

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

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

For the 10–30 m and 30–400 m surveys, biomass, catch rates, and length frequency were analysed separately. A combined biomass and length frequency analysis was used for deriving scaled length frequency distributions and biomass estimates. All length frequencies were scaled by the percentage of catch sampled, area swept, and stratum area. Biomass estimates included total, male, and female biomass for target and important QMS species, and recruited biomass for the target species and selected QMS species.

Catch rates (kg per square km) for the target and main QMS species were tabulated by strata and plotted for each tow to show areas of relative density throughout the survey area. Total biomass by strata was also tabulated for the target and main QMS species.

Scaled length frequency distributions are plotted for the target species and main QMS species, and also by depth range for the target species.

Length-weight coefficients were determined for the target species red cod, giant stargazer, sea perch, tarakihi, spiny dogfish, and dark ghost shark, and also rig, rough skate, school shark, and smooth skate. Coefficients were determined by regressing natural log weight against natural log length ($W=aL^b$). These length weight coefficients were used to scale length frequencies, and potentially to calculate recruited and pre-recruited biomass. For other species, the most appropriate length weight coefficients in the *trawl* database were used.

2.7.2 Time series analyses

For the target species only, catch rates for each of the seven winter surveys are plotted over the survey strata area map to show temporal and spatial patterns in distribution.

Time series of total, pre-recruited, and recruited biomass are tabulated and plotted to show temporal trends. Target species size at recruitment to the fishery were presumed to be: GSH, 55 cm; RCO, 40 cm; STA, 30 cm; SPD, 50 cm; SPE, 20 cm; TAR, 25 cm.

Biomass estimates for all species reported in the standalone winter trawl survey reports for 1991 to 1994 (Beentjes & Wass 1994, Beentjes 1995a, 1995b, 1998b) differ from those shown in the review of the time series (Beentjes & Stevenson 2000) and in this report because doorspread was not measured on those surveys and was assumed to be 79 m for all tows. The biomass estimates from these surveys were later recalculated using the relationship between doorspread (measured using Scanmar) and depth determined by Drummond & Stevenson (1996). Scanmar was subsequently used on the 1996, 2007, and 2008 surveys where doorspread was measured directly.

Time series of biomass equal to and above length at 50% maturity, and below length at 50% maturity, are also tabulated and plotted for the target species. The lengths at 50% maturity were taken from Hurst et al. (2000) for all target species except sea perch, where it was not given. Hurst et al. (2000) averaged the size at maturity between males and females for the teleosts because they are similar, but for the sharks, where it varies more than 10 cm between sexes, values are provided for both males and females. Hence we estimated teleost 50% maturity biomass for RCO, STA, and TAR for males and females combined, but for males and females separately for GSH and SPD. The cut-off lengths used were: RCO, 51 cm; STA, 45 cm; TAR, 31 cm; GSH males 52 cm, females 62 cm; SPD males 58 cm, females 72 cm. For sea perch, length at 50% maturity was estimated from the cumulative length frequencies of all the mature stages from the 2008 survey. Size corresponding to the 50% cumulative distribution was taken as the 50% maturity value. The values were 25.5 cm for males and 26 cm for females, and therefore 26 cm was used for both sexes combined.

The percent occurrence or proportion of tows with non-zero catch of each target species was tabulated for each survey. Similarly the catch of each target species as a percent of the catch of all species from each survey was tabulated.

For the target species only, length frequencies in 30–400 m for each of the six winter surveys are plotted together to show temporal patterns in size distribution.

3. RESULTS

3.1 Trawling details

In 30–400 m (strata 1–17), 97 tows were carried out and, of these, 96 were deemed successful and used in length frequency and biomass estimation (Table 1, Appendix 2). Of the 96 successful stations there were 80 phase one and 16 phase two stations (Table 1). Phase two stations were allocated to strata 3, 5, and 10 to reduce c.v.s for sea perch, spiny dogfish, and tarakihi, and in stratum 9 to reduce the c.v. of red cod (Table 1). Time constraints prevented the allocation of more phase 2 stations aimed at red cod although the c.v. was reduced by 20% after the completions of phase 2. The survey covered the same total area as the previous winter surveys with at least three successful stations completed in each of the 17 strata. (Table 1, Appendix 2). Station density ranged from 1 station per 107 km² in stratum 14 to 1 station per 593 km² in stratum 6, with an overall average density of 1 station per 243 km² (Table 1). Trawlable ground represented 91% of the total survey area. Station positions and tow numbers are plotted in Figure 2 and individual station data tabulated in Appendix 2.

In 10–30 m (strata 18–21), three tows were carried out in stratum 18 and all three were used in the biomass estimation (Table 1, Appendix 2). There were no tows completed in strata 19 to 21 because of time constraints and there was no phase 2 component for the survey in the 10–30 m depth range. Station density in stratum 18 was 1 station per 425 km² (Table 1). Trawlable ground represented 97% of the total survey area of the four strata. Station positions and tow numbers are shown in Figure 2 and individual station data in Appendix 2.

Monitoring of headline height and doorspread, observations that the doors and trawl gear were polishing well, and information from the ground contact sensors, indicated that the gear was fishing hard down and efficiently throughout the survey. For the depth range 30–400 m, mean doorspread, headline height, distance towed, and warp to depth ratio were 4.8 m, 76.5 m, 2.3 n. miles, and 3.3:1, respectively (Appendix 3). Tow distance tended to be shorter in the 100–200 m depth range where catches were largest. Net A was used on all tows.

3.2 Water temperatures

Isotherms estimated from CTD surface and bottom temperature recordings from *Kaharoa* are shown in Figures 3 and 4, respectively. There was little difference between the bottom and surface water temperatures inshore, but offshore, bottom temperatures were about 2 °C cooler than surface water. Surface temperatures were generally warmer closer inshore and further north. The surface temperature throughout most of the survey area was 12 °C, ranging from 13 °C north of Banks Peninsula to 10 °C east of Timaru in 200–400 m. Bottom water temperatures also showed a slight north-south cline in temperature, but a greater inshore to offshore range of 5 °C (range 13 °C to 8 °C). The coolest bottom waters were in the deepwater east of Banks Peninsula. Temperature regimes were similar to those of the 2007 survey.

3.3 Catch composition

30–400 m depth range

The total catch from the survey in 30–400 m depth range was 103 t from the 96 biomass tows. Catches were highly variable, ranging from 42.6 kg to 7919.5 kg per tow, with an average of 1057.0 kg. Vertebrate fish species caught included 1 agnathan, 12 chondrichthyans, and 71 teleosts. There were also many invertebrate species caught including octopus and three squid species. Catch weights, percent catch, occurrence, and depth range of all species identified during the survey are given in Appendix 4. The catches were dominated by spiny dogfish and barracouta with catches of 41 t and

26 t, representing 39% and 25%, respectively, of the total catch. These two species, and the next five most abundant species, dark ghost shark, red cod, sea perch, tarakihi, and hoki, made up 81% of the total catch (Appendix 4). The percent of the catch represented by the six target species was as follows: dark ghost shark 7%, giant stargazer 1%, red cod 3%; sea perch 3%; spiny dogfish 39%; tarakihi 2%, making a combined total of 55%. Spiny dogfish was caught in all but one tow and barracouta in 88% of tows. Other common non-target species caught included arrow squid (92%), witch (89%), and carpet shark (81%) (Appendix 4)

Invertebrate species from the catch identified after the survey are given in Appendix 5.

10–30 m depth range

The total catch from the survey in the 10–30 m depth range was 1.45 t from three biomass tows (stratum 18, Pegasus Bay). Catches in 10–30 m ranged from 270.8 kg to 708.5 kg per tow, with an average of 482.5 kg. Twenty-seven vertebrate fish species were identified (6 chondrichthyans and 21 teleosts), as well as squid. Catch weights, percent catch, occurrence, and depth range of all species in 10–30 m are given in Appendix 4. The catches were dominated by spiny dogfish, representing 72% of the total catch. This species, and the next five most abundant species, red cod, rough skate, red gurnard, blue warehou, and barracouta, made up 95% of the total catch (Appendix 4). The percent of the catch represented by the six target species was as follows: spiny dogfish 72%; tarakihi 0%, red cod 6%, dark ghost shark 0%; giant stargazer 0%; and sea perch 0%, making a combined total of 40%.

Invertebrate species from the catch identified after the survey are given in Appendix 5.

3.4 Biomass estimates

30–400 m depth range

Biomass estimates and c.v.s for the 20 most abundant commercial species in 30–400 m, including the target species, are given in Table 2. Of the target species, spiny dogfish had by far the largest biomass at 28 476 t, followed by dark ghost shark (3763 t), sea perch (1944 t), tarakihi (1863 t), red cod (1824 t), and giant stargazer (606 t). Coefficients of variation for the target species were spiny dogfish 22%, dark ghost shark 20%, tarakihi 29%, sea perch 23%, red cod 49%, and giant stargazer 14% (Table 2). These c.v.s were within the specified range in the project objectives for dark ghost shark, giant stargazer, and tarakihi, and within a few percent for sea perch and spiny dogfish (see objectives). For red cod, the c.v. was nearly double that of the upper range.

The breakdown of biomass by sex indicates that female red cod biomass is nearly double that of males, and for dogfish, biomass of males is over three times that of females. For the other target species biomass by sex is similar (Table 2).

Of the non-target species, barracouta had the second largest biomass of all species, including the target species, at 25 544 t and a c.v. of 16% (Table 2). Other species with substantial biomass included elephantfish (1401 t, c.v. = 35%), red gurnard (1309 t, c.v. = 34%), and arrow squid (998 t, c.v. = 19%).

Recruited biomass estimates and c.v.s for the target species and 11 of the non-target species are shown in Table 2. For the target species the percentage of total biomass that was recruited fish was spiny dogfish 93%, dark ghost shark 56%, tarakihi 60%, sea perch 93%, red cod 93%, and giant stargazer 98%.

10–30 m depth range

Biomass was estimated only for stratum 18 because other 10–30 m strata were not surveyed in 2008 (see Section 3.5)

3.5 Stratum catch rates, biomass, and distribution

Catch rates by stratum (strata 1–18) for the 20 most abundant commercially important species, including the target species, are given in Table 3, and catch rates of target species by station are shown in Figure 5. Biomass by stratum (strata 1–18) for the 20 most abundant commercially important species, including the target species, are given in Table 4. Strata with the highest catch rates are not always the same as those with the highest biomass because biomass is scaled by area of the strata.

In 10–30 m (stratum 18), of the target species, only spiny dogfish (biomass = 1125 t, c.v. = 34%) and red cod (biomass = 94 t, c.v. = 19%) were represented in the catch (Appendix 4).

3.5.1 Target species (30–400 m)

Dark ghost shark was predominantly caught in waters deeper than 100 m throughout the survey area in 44% of tows, with the shallowest catch in 63 m and the deepest in 392 m. Highest stratum catch rates were in 100 to 200 m strata 9, 10, and 11, and 200 to 400 m strata 14, 15, and 16. The highest stratum biomass estimates were in 100 to 200 m strata 9, 10 and 11, and 200 to 400 m stratum 16 (Appendix 4, Figure 5, Tables 3 and 4).

Giant stargazer was predominantly caught in waters deeper than about 50 m throughout the survey area in 76% of tows, with the shallowest catch in 29 m and the deepest in 392 m. Highest stratum catch rates were in 100 to 200 m strata 8, 9, and 13. The highest stratum biomass estimates were in 30 to 100 m strata 3, 4 and 5, and 100 to 200 m stratum 9 (Appendix 4, Figure 5, Tables 3 and 4).

Red cod was caught in all depth ranges throughout the survey area in 65% of tows, with the shallowest catch in 15 m and the deepest in 347 m. Highest stratum catch rates were in 30 to 100 m stratum 2, and 100 to 200 m in strata 9 and 10. The highest stratum biomass estimates were in 30 to 100 m strata 2 and 5, and 100 to 200 strata 7 and 9 (Appendix 4, Figure 5, Tables 3 and 4).

Sea perch was predominantly caught in waters deeper than about 50 m throughout the survey area in 71% of tows, with the shallowest catch in 27 m and the deepest in 392 m. Highest stratum catch rates were in 100 to 200 m strata 10 and 13. The highest stratum biomass estimates were in 30 to 100 m stratum 2, and 100 to 200 m strata 10 and 13 (Appendix 4, Figure 5, Tables 3 and 4).

Spiny dogfish was caught in all depth ranges throughout the survey area from all but one tow (99% of tows), with the shallowest catch in 15 m and the deepest in 392 m. Highest stratum catch rates were in 100 to 200 m stratum 10, and 200 to 400 m strata 13 and 15. The highest stratum biomass estimates were in 30 to 100 m strata 3 and 5, and 100 to 200 m stratum 10 (Appendix 4, Figure 5, Tables 3 and 4).

Tarakihi was predominantly caught in waters between about 30 and 150 m throughout the survey area in 62% of tows, with the shallowest catch in 29 m and the deepest in 255 m. Highest stratum catch rates and biomass estimates were in 30 to 100 m strata 2, 3, and 5 (Appendix 4, Figure 5, Tables 3 and 4).

In 2008, for all target species except tarakihi, as well as barracouta, there was a “hotspot” or area where catch rates were consistently high. The area was southeast of Timaru in about 100 m depth, near the intersection of strata 3, 9, and 10.

3.5.2 Other species

Catch rates of the more abundant non-target species by station are shown in Figure 6 and Table 3. Barracouta were caught mainly between 30 and 200 m throughout the survey area, with shallowest catch in 15 m and the deepest in 351 m, with consistently high catch rates in the central Canterbury Bight east of Timaru in strata 3 and 8. Elephantfish and red gurnard were caught mainly in the 30 to 100 m strata throughout the survey area.

3.6 Biological and length frequency data

Details of length frequency and biological data recorded for each species are given in Table 5. Nearly 37 000 length frequency and over 11 000 biological records were taken from 42 species. This included otoliths from 385 red cod, 265 sea perch, 271 giant stargazer, and 226 tarakihi. Dorsal spines were collected from 417 spiny dogfish and 307 dark ghost shark.

Scaled length frequency distributions of the target species over the 30–400 m depth range as well as for the depth ranges 10–30 m, 30–100 m, 100–200 m, and 200–400 m are plotted in Figure 7. Scaled length frequency distributions of the more abundant non-target species over the 30–400 m depth range are plotted in Figure 8. The length-weight coefficients used to scale the length frequency data are shown in Appendix 6.

The length frequency distribution for dark ghost shark is bimodal for both sexes (Figure 7), although the larger mode is further to the right for females, indicating that the largest fish are mostly female. The large male mode (45–60 cm) comprises mainly pre-recruited fish (under 55 cm) and is prevalent in the 30–200 m and particularly the 100–200 m depth range. The larger female mode (55–70 cm) is mainly recruited fish and these sized fish were also caught mainly in the 30 to 200 m depth range. The smaller mode (25–35 cm for both sexes) are all pre-recruited fish and were dominant in the deeper 200–400 m strata. The overall scaled numbers sex ratio (males:females) in 30–400 m is close to 1:1.

The length frequency distribution for giant stargazer for males shows one strong mode at 20–55 cm, and indications of a mode of small unsexed fish at about 10–20 cm (Figure 7). The large number of unsexed fish represents those that were tagged and released. Female length distribution is also unimodal but with wider left and right hand tails. For both sexes the distributions were similar in all depth ranges, but relatively few fish were caught in 200–400 m. The overall scaled numbers sex ratio (males:females) in 30–400 m is 0.9:1.

The length frequency distribution for male red cod shows two well defined modes at 10–20 cm (0+), and 35–45 cm (2+), but based on knowledge of age and growth (Beentjes 1992, Horn 1996) there are less defined modes at 20–35 cm representing 1+ fish, and 45–60 cm representing 3+ fish. The female length distribution is similar to that for males, but the modes are larger as females grow faster and there is likely to be a small proportion of 4+ female fish over 65 cm. (Figure 7). Smaller red cod (0+) were more common in the shallow 10–30 and 30–100 m depth ranges and larger fish in 100–200 m. The overall sex ratio (males:females) in 30–400 m is 0.7:1.

The length frequency distribution for sea perch is unimodal with peaks at about 25 cm for males and 23 cm for females, and the largest fish were about 40 cm (Figure 7). The bulk of fish were caught in 30–100 m and 100–200 m with no separation of size by depth. The overall sex ratio (males:females) in 30–400 m is 1.1:1.

The length frequency distribution for spiny dogfish is unimodal with peaks at about 56 cm for males and 43 cm for females, although males have a strong left hand tail and females a strong right hand tail (Figure 7). Spiny dogfish were caught in all depth ranges, but the bulk of fish were in 30–100 m and

large fish tended to be caught between 100 and 400 m and the smallest fish in the 10–30 m depth range. The overall sex ratio (males:females) in 30–400 m was strongly skewed to males at 2.5:1.

The length frequency distributions for tarakihi show three distinct modes, with similar shapes for both males and females (Figure 7). The first mode (10–15 cm) has a peak at about 13 cm, the second (15–21 cm) at about 18 cm, and the third (20–33 cm) at about 26 cm. There were few fish over 35 cm and these were mostly females, the largest of which was 49 cm. The bulk of the tarakihi were caught at 30–100 m, but those caught in the 100–200 m were larger. The overall sex ratio (males:females) in 30–400 m was 0.9:1.

Details of the gonad stages for the target species are given in Table 6. None of the four teleost species, were spawning, but there were small proportions of fish in the maturing stages for giant stargazer, red cod, and sea perch. Dark ghost shark were mainly mature, and spiny dogfish a mix between stage 3 (mature) and stage 4 (males in with claspers in the mating condition and gravid females).

3.7 Tagging

A total of 408 individual skates and sharks from four species were tagged, length and weight recorded, and released during the survey (see Table 5). The total included 212 rough skate, 76 smooth skate, 80 school shark, and 40 rig. In addition, 32 giant stargazer were double tagged, length and weight recorded, injected with OTC, and released.

4. DISCUSSION

4.1 2008 survey

We report the results of the 2008 ECSI bottom trawl survey in May–June 2008 using R.V. *Kaharoa* (KAH0806) in 30–400 m. This is the second survey following the reinstatement of the discontinued winter time series (1991 to 1996) in 2007. The 2008 survey was successful in meeting all the project objectives and the c.v.s were within the target range for dark ghost shark, giant stargazer, and tarakihi, and within a few percent for sea perch and spiny dogfish. For red cod the c.v. was nearly double that of the upper range (c.v. achieved = 49%, target upper range 25%). It has historically been difficult to achieve low c.v.s for red cod, even during the early surveys when it was the only target species and all phase 2 stations were allocated to red cod. This is because it tends to form aggregations of cohorts and catches are often highly variable among tows which are characterised by many zero tows and the occasional very large catch.

The ancillary inshore survey in 10–30 m included only one of the four planned strata (stratum 18, Pegasus Bay) because of time constraints and partly because of gear failure resulting in the loss of several days which had been allocated to these strata. We provide species biomass estimates for stratum 18 with only target species red cod and spiny dogfish represented.

All target species were quite well distributed throughout the survey area within their preferred depth range, apart from the tendency to display the highest catch rates southeast of Timaru in about 100 m depth (see Figure 5). These “hotspots” of distribution are a common phenomenon on the ECSI surveys, possibly reflecting localised areas of high productivity — in 2007, for example, there was a hotspot northeast of Timaru in about 100 m depth for most of the target species (Beentjes & Stevenson 2008).

4.2 Trends in biomass, distribution and size

Implicit in our interpretation of trends in biomass, geographic distribution, and length distribution is the 11 year interval separating the 1991 to 1996, and the 2007 and 2008 surveys. During this period we have no information on these variables.

Dark ghost shark

Biomass for dark ghost shark was the second highest of the seven surveys, and although 16% less than 2007, biomass is still high compared with that in the early 1990s (Table 7, Figure 9). For example, the 2007 and 2008 biomass estimates are about four-fold greater than in 1991. All surveys have a large component of pre-recruited biomass ranging from 30% to 62%. (Table 8, Figure 10) — in the last two surveys pre-recruited biomass is about 40% of total biomass. The juvenile and adult biomass (based on length at 50% maturity) of both sexes have generally increased proportionately over the time series (Table 9, Figure 11).

Dark ghost shark were present in 22% to 50% of tows with the highest occurrence in the last three surveys, and have made up 2% to 9% of the total catch on the surveys, with no clear trend (Table 10). The distribution of dark ghost shark over the time series is similar and was confined to the continental slope and edge mainly in the Canterbury Bight, although the larger biomass in 2007 and 2008 is commensurate with a slightly expanded distribution throughout the survey area in this depth and into Pegasus Bay (Figure 12).

The size distributions of dark ghost shark in each of the last five surveys are similar and generally bimodal (Figure 13). The distributions differ from those of the Chatham Rise and Southland/Sub-Antarctic surveys (O'Driscoll & Bagley 2001, Livingston et al. 2002) in that ECSI has a large component of juvenile fish suggesting that this area may be an important nursery ground for dark ghost shark.

Giant stargazer

Biomass for giant stargazer was 20% less than 2007 and is very close to the average biomass estimate over the seven survey time series (2008 biomass 606 t, average = 602 t) (see Table 7, Figure 9). Pre-recruited biomass is a small component of the total biomass estimate on all surveys (range 2% to 5% of total biomass) (see Table 8, Figure 10). The juvenile to adult biomass ratio (based on length at 50% maturity) has been relatively constant over the time series at about 1 to 1 (Table 9, Figure 11).

Giant stargazer were present in 70% to 92% of tows and have consistently made up 1 to 2% of the total catch on the surveys, with no trend (Table 10). The distribution of giant stargazer hotspots varies, but overall this species is consistently well represented over the entire survey area, most commonly from 30 m to about 200 m (Figure 12).

The size distributions of giant stargazer in each of the seven surveys are similar and generally have one large mode comprising multiple age classes and a small juvenile mode, although both modes are less defined for females (Figure 13). Giant stargazer on the ECSI sampled during these surveys overall are smaller than those from the Chatham Rise, Southland, and WCSI surveys (Bagley & Hurst 1996, Stevenson & Hanchet 2000, Livingston et al. 2002), suggesting that this area may be an important nursery ground for juvenile giant stargazer.

Red cod

Biomass for red cod was the second lowest of the six surveys after 2007 (23% greater than 2007), but is three-fold less than that in 1994 when it peaked (see Table 7, Figure 9). The high biomass in 1994 and the very low biomass in 2007 and 2008 are consistent with the size of concurrent commercial landings in

RCO 3, a fishery in which cyclical fluctuating catches are characteristic (Beentjes & Renwick 2001). Pre-recruited biomass was a small component of the total biomass in the 1996, 2007, and 2008 surveys (13%, 13%, and 7%) compared to 1994 when pre-recruited biomass was 59% of total biomass (Table 8, Figure 10), indicating that recruitment has been poor in recent years and in 1996. Correspondingly, juvenile biomass (based on the length at 50% maturity) is a smaller component of total biomass in the last three surveys (see Table 9, Figure 11).

Red cod were present in 65% to 89 % of tows and made up 2% to 30% of the total catch on the surveys; both of these variables were lowest in 2007 and 2008 reflecting the low biomass compared to earlier surveys in the 1990s (Table 10). The distribution of red cod hot spots varies, but overall this species is consistently well represented over the entire survey area, most commonly from 30 m to about 300 m (see Figure 12), but is also found in waters shallower than 30 m.

The size distributions of red cod in each of the seven surveys are similar and generally characterised by a 0+ mode (10–20 cm), 1+ mode (30–40 cm), and a less defined right hand tail comprised predominantly of 2+ and 3+ fish (Figure 13). The 1996 and particularly the 2007 and 2008 surveys show very poor recruitment of 1+ fish compared to earlier surveys. In contrast the 1994 survey indicated the presence of a very strong 1+ cohort which resulted in high commercial catches in the following years. Red cod on the ECSI, sampled during these surveys, are generally smaller than those from Southland (Bagley & Hurst 1996), suggesting that this area may be an important nursery ground for juvenile red cod.

Sea perch

Biomass for sea perch in 2008 is very close to that of 2007, and in the mid range of previous surveys with no trend in biomass over the time series (see Table 7, Figure 9). Pre-recruited biomass is a very small component of the total biomass estimate on all surveys (range 3% to 7% of total biomass) (Table 8, Figure 10). The juvenile to adult biomass ratio (based on length at 50% maturity) has been relatively constant over the time series with juvenile biomass about 30% to 45% of total biomass (see Table 9, Figure 11).

Sea perch were present in 59% to 82% of tows and have constituted 3% to 6% of the total catch on the surveys, with no trends in either variable (see Table 10). The distribution of sea perch hot spots varies, but overall this species is consistently well represented over the entire survey area, most commonly from about 70 m to 300 m (see Figure 12).

The size distributions of sea perch on each of the seven surveys are similar and generally unimodal with a right hand tail reflecting the large number of age classes (Paul & Francis 2002)(Figure 13). Sea perch from the ECSI sampled on these surveys are generally smaller than those from the Chatham Rise and Southland surveys (Bagley & Hurst 1996, Livingston et al. 2002). This suggests that this area may be an important nursery ground for juvenile sea perch and/or that sea perch tend to be larger at greater depths (Beentjes et al. 2007) and the ECSI survey does not extend to the full depth range of sea perch which are found as deep as 800 m.

Spiny dogfish

Biomass for spiny dogfish in 2008 was 19% less than 2007, but is still more than double that of the early 1990s, indicating that the quantum leap in biomass between 1994 and 1996 has been sustained (see Table 7, Figure 9). Pre-recruited biomass was a small component of the total biomass estimate in the 1992 to 1994 surveys (1% to 3% of total biomass), increased markedly to 10% in 1996, 16% in 2007, but dropped in 2008 to 7% (see Table 8, Figure 10). This is also reflected in the biomass of juvenile spiny dogfish (based on the length at 50% maturity) which has increased from about 15% before 1996 to one, to two-thirds in the last three surveys (see Table 9, Figure 11).

Dogfish were present in 94% to 100% of tows and have made up 22% to 45% of the total catch on the surveys, with indications that this species has become both more widespread and abundant on the ECSI since 1996 (see Table 10). Spiny dogfish has had the largest biomass of all species with the exception of barracouta in 1992 and 1993 (See Table 7). The distribution of spiny dogfish hotspots varies, but overall this species is consistently well represented over the entire survey area, most commonly from 30 m to about 350 m (see Figure 12), but is also common in waters shallower than 30 m.

The size distributions of spiny dogfish in each of the 1992 to 1994 surveys are similar and generally bimodal for males, and less defined for females (Figure 13). In 1996, 2007, and 2008 the distributions were dominated by smaller fish, particularly females where the proportions of large fish have declined. Spiny dogfish on the ECSI sampled on these surveys are considerably smaller than those from the Chatham Rise, Southland, and the sub-Antarctic surveys (Bagley & Hurst 1996, O'Driscoll & Bagley 2001, Livingston et al. 2002), suggesting that this area may be an important nursery ground for juvenile spiny dogfish.

Tarakihi

Biomass for tarakihi is 28% less than 2007, and in the mid range of those of previous surveys with no apparent trend in biomass over the time series (see Table 7, Figure 9). Pre-recruited biomass is a major component of the total biomass estimate on all surveys (ranging from 18% to 59% of total biomass) (see Table 8, Figure 10). Similarly, juvenile biomass (based on length at 50% maturity) is also a large component of total biomass but the proportion is relatively constant over the time series (see Table 9, Figure 11).

Tarakihi were present in 61% to 75% of tows and have made up 1% to 5% of the total catch on the surveys, with no trends in either variable (see Table 10). The distribution of tarakihi hotspots varies, but overall this species is consistently well represented over the entire survey area, most commonly from 30 m to about 150 m (see Figure 12); it was not caught in the 10–30 m stratum 18.

The size distributions of tarakihi in each of the six surveys are similar, particularly in 2007 and 2008. They tend to be multi-modal, representing individual cohorts in the smaller modes (Figure 13). Tarakihi on the ECSI, overall, are generally smaller than those from the west coast South Island (Stevenson & Hanchet 2000), suggesting that this area may be an important nursery ground for juvenile tarakihi.

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

Stratum	Depth (m)	Area (km ²)	Description	Foul ground (km ²)	No. stations		Station density (km ² per station)
					Phase 1	Phase 2	
1	30–100	984	Shag Point	202	5	0	197
2	30–100	1 247	Oamaru	0	3	0	416
3	30–100	3 023	Timaru	0	7	7	216
4	30–100	2 703	Rakaia	0	6	0	451
5	30–100	2 485	Banks Pen.	0	6	2	311
6	30–100	2 373	Pegasus	208	4	0	593
7	30–100	2 089	Conway	871	10	0	209
8	100–200	628	Shag Point	17	3	0	209
9	100–200	1 163	Oamaru	0	6	4	116
10	100–200	1 191	Timaru	0	6	3	132
11	100–200	1 482	Banks Pen.	0	5	0	296
12	100–200	764	Pegasus	132	3	0	255
13	100–200	999	Conway	406	3	0	333
14	200–400	321	Oamaru Crack	17	3	0	107
15	200–400	430	Timaru	0	4	0	108
16	200–400	751	Banks Pen.	0	3	0	250
17	200–400	724	Conway	165	3	0	241
Sub total (average)		23 357		2 018	80	16	(243)
18	10–30	1 276	Pegasus	0	3	0	425
19	10–30	987	Rakaia	0	0	0	
20	10–30	794	Timaru	0	0	0	
21	10–30	520	Oamaru	226	0	0	
Sub total (average)		3 577		226	3	0	(1192)
Total (average)		26 934		2 244	83	16	(272)

Table 2: Catch and estimated biomass for top 20 commercial species, including target species (bold) in 30–400 m. * no measured. –, not information on recruited length.

Common name	Catch (kg)	Males		Females		All fish		Recruited		
		Biomass (t)	c.v. (%)	Biomass (t)	c.v. (%)	Biomass (t)	c.v. (%)	Size (cm)	Biomass (t)	c.v. (%)
Dark ghost shark	6 818	1 496	20.7	2 256	22.9	3 763	20.5	55	2 119	28.8
Giant stargazer	832	212	15.9	336	15.3	606	14.2	30	592	14.3
Red cod	3 673	645	56.8	1 177	45.1	1 824	48.9	40	1 695	50.1
Sea perch	3 356	1 084	24.3	850	22.3	1 944	23.1	20	1 800	24.0
Spiny dogfish	41 489	21 623	22.1	6 814	21.9	28 476	21.6	55	26 590	21.7
Tarakihi	1 881	800	29.1	1 034	29.0	1 863	29.4	25	1 123	24.6
Arrow squid	1 555	*		*		998	19.4	–	–	–
Barracouta	25 734	12 228	15.3	13 057	16.9	25 544	15.7	50	23 368	16.9
Blue warehou	1 138	229	86.3	256	91.3	507	86.9	45	79	97.0
Elephantfish	1 196	562	40.2	837	34.0	1 404	35.4	50	777	26.7
Hapuku	160	49	22.4	58	26.2	109	20.9	40	109	20.9
Hoki	1 693	421	51.1	407	56.6	837	53.2	65	246	32.3
Lemon sole	129	9	26.5	98	26.9	85	26.4	25	116	24.9
Ling	651	127	25.3	216	21.2	351	22.1	65	156	27.1
Red gurnard	1 464	587	39.8	717	32.0	1 309	34.5	30	1 209	33.0
Rig	358	124	28	156	21.4	280	22.6	90	132	29.3
Rough skate	1 119	400	19.8	455	20.8	858	19.1	–	–	–
School shark	458	184	20.1	221	22.5	411	19.6	90	118	35.2
Silver warehou	690	150	31.0	168	32.4	319	31.7	25	253	38.9
Smooth skate	894	319	23.6	233	22.5	554	18.3	–	–	–

* Not sexed

Table 3: Catch rates (kg.km⁻²) and standard deviation () by stratum (1–18) for the 20 most abundant commercial species, including target species. Species codes are given in Appendix 4. * less than 0.5 kg.km⁻².

Stratum	Target species						Other species		
	GSH	RCO	SPD	SPE	STA	TAR	BAR	HOK	NOS
1	0	21 (18)	263 (90)	0	5 (4)	49 (67)	1 630 (1 347)	0	27 (26)
2	0	149 (208)	2 153 (3 192)	26 (46)	13 (20)	240 (284)	1 713 (2 457)	0	43 (37)
3	17 (65)	44 (46)	1 470 (3 342)	76 (213)	22 (44)	162 (546)	1 663 (1 526)	* (*)	24 (26)
4	113 (257)	6 (11)	693 (830)	5 (7)	25 (31)	67 (46)	3 199 (2 835)	0	20 (23)
5	56 (128)	72 (111)	1 881 (4 036)	87 (238)	25 (44)	166 (246)	946 (558)	0	29 (35)
6	3 (7)	0	89 (60)	2 (2)	22 (16)	72 (55)	201 (180)	0	23 (23)
7	0	93 (85)	1 796 (1 767)	95 (231)	8 (21)	14 (23)	653 (854)	* (*)	43 (87)
8	2 (3)	1 (0)	50 (37)	51 (62)	53 (19)	1 (2)	2 142 (2 021)	0	47.839 12.268
9	408 (697)	797 (2 366)	664 (823)	116 (137)	96 (106)	1 (3)	888 (816)	0	14.299 12.715
10	498 (311)	121 (134)	4 102 (6 858)	456 (655)	25 (32)	27 (72)	635 (688)	0	10 (12)
11	457 (773)	2 (2)	425 (356)	74 (66)	18 (10)	26 (28)	251 (147)	0	5 (2)
12	24 (32)	0	126 (81)	136 (192)	41 (22)	149 (178)	124 (193)	0	10 (2)
13	321 (481)	6 (10)	75 (74)	255 (246)	43 (46)	47 (57)	254 (244)	0	158 (200)
14	638 (1 098)	30 (40)	58 (39)	3 (6)	17 (18)	* (*)	8 (14)	0	223 (343)
15	502 (575)	8 (9)	3 768 (3 429)	0	22 (36)	0	11 (22)	81 (163)	347 (199)
16	853 (337)	0	3 167 (3 644)	7 (4)	16 (4)	0	112 (114)	174 (119)	153 (244)
17	160 (139)	3 (4)	114 (9)	89 (128)	24 (21)	0	0	925 (1 054)	11 (8)
18	0	74 (25)	882 (513)	0	0	0	34 (21)	0	* (*)

Table 3—continued

Stratum	Other species										
	GUR	ELE	WAR	RSK	SSK	SWA	LIN	SCH	SPO	HAP	LSO
1	161 (114)	148 (271)	0	95 (88)	10 (23)	1 (1)	18 (40)	1 (2)	0	12 (16)	25 (39)
2	141 (202)	427 (565)	0	101 (161)	0 (1)	0	49 (69)	60 (60)	57 (62)	3 (5)	5 (7)
3	52 (105)	64 (83)	* (1)	30 (59)	28 (51)	4 (7)	9 (10)	30 (47)	22 (24)	2 (5)	5 (17)
4	155 (336)	17 (19)	0	46 (69)	14 (28)	1 (2)	2 (3)	9 (9)	6 (16)	1 (3)	9 (13)
5	44 (51)	144 (282)	* (1)	38 (24)	38 (55)	1 (1)	0	13 (17)	9 (16)	3 (4)	3 (5)
6	7 (10)	12 (11)	0	20 (18)	7 (13)	1 (1)	0	25 (24)	0	1 (2)	1 (1)
7	126 (279)	40 (49)	31 (40)	95 (70)	8 (16)	4 (3)	2 (2)	33 (51)	48 (51)	12 (20)	8 (12)
8	0	0	0	50 (64)	0	* (1)	0	0	0	0	6 (2)
9	2 (3)	10 (17)	0	6 (12)	97 (138)	28.593 (52)	8 (11)	22 (48)	2 (6)	0	1 (2)
10	1 (2)	4 (9)	370 (1108)	3 (6)	62 (62)	18 (44)	6 (8)	6 (7)	1 (4)	5 (8)	1 (3)
11	3 (4)	0	0	3 (6)	47 (54)	8 (14)	0 (0)	2 (4)	0	20 (20)	* (*)
12	4 (1)	0	0	38 (40)	7 (12)	0	0	4 (7)	0	1 (2)	1 (2)
13	0	0	0	0	5 (5)	2.979 (4)	0	24 (42)	0	7 (6)	6 (7)
14	0	0	0	0	3 (5)	6 (5)	26 (30)	0	0	0	1 (1)
15	0	0	0	3 (6)	43 (86)	149 (167)	232 (249)	0	0	15 (29)	0
16	0	0	0	5 (9)	7 (8)	201 (207)	100 (11)	0	0	0	0
17	0	0	0	7 (8)	4 (3)	6 (11)	54 (38)	0	0	0	5 (6)
18	50 (51)	1 (1)	44 (34)	70 (25)	0	0	0	1 (1)	10 (4)	0	* (*)

Table 4: Estimated biomass (t) and coefficient of variation () by stratum (1–18) for the 20 most abundant commercial species, including target species. Species codes are given in Appendix 4. * less than 0.5 t.

Stratum	Target species						Other species		
	GSH	RCO	SPD	SPE	STA	TAR	BAR	HOK	NOS
1	0 (0)	21 (38)	259 (15)	33 (100)	5 (40)	49 (61)	1 604 (37)	0	26 (43)
2	0 (0)	185 (81)	2 674 (86)	230 (75)	16 (90)	298 (68)	2 129 (83)	0	53 (50)
3	52 (100)	133 (28)	4 443 (61)	14 (55)	66 (54)	490 (90)	5 028 (25)	* (60)	72 (30)
4	305 (93)	16 (74)	1 874 (49)	215 (97)	69 (50)	181 (28)	8 648 (36)	0	53 (47)
5	139 (81)	179 (54)	4 673 (76)	4 (57)	61 (63)	412 (52)	2 351 (21)	0	73 (43)
6	8 (100)	0	211 (34)		53 (36)	170 (38)	477 (45)	0	55 (49)
7	0 (0)	195 (29)	3 753 (31)	199 (77)	16 (85)	29 (52)	1 364 (41)	* (100)	90 (64)
8	1 (100)	* (52)	32 (43)	32 (70)	33 (21)	1 (100)	1 345 (54)	0	30.05 15
9	475 (54)	927 (94)	773 (39)	135 (37)	111 (35)	2 (68)	1 033 (29)	0	16.63 28
10	594 (21)	144 (37)	4 888 (56)	544 (48)	30 (43)	32 (90)	757 (36)	0	12 (39)
11	672 (76)	3 (45)	624 (37)	108 (40)	27 (23)	38 (48)	369 (26)	0	8 (19)
12	18 (77)	0	96 (37)	104 (82)	32 (31)	114 (69)	95 (90)	0	8 (9)
13	321 (86)	6 (100)	75 (57)	254 (56)	43 (61)	47 (70)	254 (56)	0	158 (73)
14	206 (99)	10 (76)	19 (38)	1 (96)	5 (63)	* (100)	3 (100)	0	72 (89)
15	216 (57)	3 (60)	1 621 (45)	0	9 (84)	0	5 (100)	81 (163)	149 (29)
16	641 (23)	0	2 380 (66)	5 (36)	12 (15)	0	84 (58)	174 (119)	115 (92)
17	116 (50)	2 (87)	83 (5)	65 (83)	17 (51)	0	0	925 (1054)	8 (43)
18	0	94 (19)	1 125 (34)	0	0	0	44 (36)	0	* (50)
Total (strata 1–17)	3 763 (20)	1 824 (49)	28 476 (22)	1 944 (23)	606 (14)	1 863 (29)	25 544 (16)	837 (53)	998 (19)

Table 4—continued

Stratum	Other species										
	GUR	ELE	WAR	RSK	SSK	SWA	LIN	SCH	SPO	HAP	LSO
1	159 (32)	146 (82)	0	94 (41)	10 (100)	1 (38)	18 (100)	1 (100)	0	12 (62)	25 (69)
2	175 (83)	531 (76)	0	125 (92)	1 (100)	0	60 (82)	74 (58)	71 (63)	3 (100)	6 (89)
3	158 (54)	193 (35)	1 (66)	92 (52)	86 (48)	11 (52)	26 (31)	91 (42)	66 (30)	7 (60)	17 (83)
4	419 (88)	47 (46)	0	123 (61)	39 (80)	3 (57)	4 (71)	24 (41)	17 (100)	3 (100)	26 (58)
5	110 (41)	359 (69)	1 (100)	93 (22)	95 (52)	2 (48)	0	31 (47)	22 (65)	7 (49)	7 (57)
6	16 (70)	29 (44)	0	47 (45)	15 (100)	2 (39)	0	59 (49)	0	3 (100)	2 (59)
7	263 (70)	83 (39)	65 (41)	199 (23)	16 (68)	9 (21)	3 (41)	68 (49)	101 (33)	25 (52)	17 (46)
8	0	0	0	31 (74)	0	* (100)	0	0	0	0	4 (21)
9	2 (53)	12 (55)	0	7 (68)	113 (45)	33.27 (57)	10 (40)	25 (70)	2 (100)	0	1 (96)
10	1 (55)	5 (69)	441 (100)	3 (66)	73 (33)	21 (84)	7 (46)	7 (41)	1 (100)	6 (57)	1 (100)
11	4 (65)	0	0	4 (100)	69 (51)	12 (80)	0 (100)	3 (100)	0	29 (45)	* (100)
12	3 (15)	0	0	29 (62)	5 (100)	0	0	3 (100)	0	1 (100)	1 (100)
13	0	0	0	0	5 (63)	3 (75)	0	24 (100)	0	7 (52)	6 (67)
14	0	0	0	0	1 (100)	2 (42)	8 (68)	0	0	0	* (100)
15	0	0	0	1 (100)	18 (100)	64 (56)	100 (54)	0	0	6 (100)	0
16	0	0	0	4 (100)	5 (67)	151 (60)	75 (6)	0	0	0	0
17	0	0	0	5 (66)	3 (52)	5 (100)	39 (41)	0	0	0	3 (77)
18	64 (59)	1 (61)	56 (45)	89 (21)	0	0	0	2 (51)	13 (25)	0	* (100)
Total (strata 1–17)	1 309 (34)	1 404 (35)	507 (87)	858 (19)	554 (18)	319 (32)	351 (22)	411 (20)	280 (23)	109 (21)	116 (25)

Table 5: Number of biological, length frequency, and tagging records. 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. Species codes are defined in Appendix 4.

Species code	Length frequency data			Biological data+			Tagging	
	Measurement method	No. of samples	No. of fish	No. of samples	No. of fish	No. of otoliths or spines	No. of fish	Size range (cm)
BAR	1	107	9 533					
BAS	2	1	1					
BCO	2	16	101					
BRI	2	1	2					
ELE	1	45	721					
EMA	1	1	1					
ESO	2	12	60					
GFL	2	1	2					
GSH	G	43	2 562	42	1 131	307		
GUR	2	54	1 606					
HAK	2	4	4	1	1	1		
HAP	2	28	57					
HOK	2	11	713					
JDO	2	1	1					
JMD	1	18	48					
JMM	1	8	25					
JMN	1	3	23					
KAH	1	1	17					
LDO	2	8	72					
LEA	2	15	644					
LIN	2	51	675					
LSO	2	39	429					
MOK	1	2	6					
RCO	2	66	1 621	65	1 111	385		
RSK	5	50	417	48	354		212	24–71
SCH	2	45	218	39	200		80	41–112
SCI	B	2	14	1	13			
SEV	2	1	1	1	1			
SFL	2	9	52					
SKI	1	1	1					
SPD	2	99	7 279	99	4 118	417		
SPE	2	69	3 923	69	2 028	265		
SPO	2	28	145	26	134		40	54–144
SSK	5	48	277	47	276		76	27–127
STA	2	74	638	74	524	271	32	31–54
SWA	1	69	1 350					
TAR	1	59	2 804	59	1241	226		
TRE	1	1	0 003					
TRU	1	3	3					
WAR	1	15	923					
WWA	1	3	10					
YCO	2	2	6					
Total			36 988		11 132		440	

Table 6: Gonad stages of finfish target species.

Species	Sex	No. of fish	% Gonad state					
			1	2	3	4	5	
30–400 m								
Giant stargazer	Males	382	24	48	28	0	0	
	Females	353	44	52	4	0	0	
Red cod	Males	463	33	58	6	3	0	
	Females	586	54	45	1	0	0	
Sea perch	Males	1 122	9	71	14	6	0	
	Females	657	46	52	2	0	0	
Tarakihi	Males	403	74	24	0	0	2	
	Females	462	77	21	1	0	1	
			% Gonad state					
			1	2	3	4	5	6
Dark ghost shark	Males	622	20	5	76	–	–	–
	Females	1 124	10	7	77	6	–	–
Spiny dogfish	Males	4 507	3	2	52	43	–	–
	Females	7 035	4	9	36	30	21	2

Teleost gonad stage for males and females: stage 1– immature/resting; 2– maturing; 3– ripening; 4– running ripe; 5– spent.

Dark ghost shark gonad stages. Males: 1– immature (claspers short and soft), 2– maturing (claspers longer than pelvic fins but soft, not calcified), 3– mature (claspers calcified). Females: 1– immature (no visible eggs in the ovary), 2– maturing (visible eggs in ovary but no yolk), 3– mature (large yolked eggs in the ovary), 4– Spawning (egg cases developing in the uterus).

Spiny dogfish gonad stages. Males: 1– immature (claspers soft and shorter than pelvic fins), 2– claspers as long as or longer than the pelvic fins but soft, not calcified), 3– mature (claspers calcified), 4– mating (claspers calcified, sperm exudes with light pressure on abdomen). Females: 1– immature (no visible eggs in the ovary), 2– maturing (visible eggs in ovary but no yolk), 3– mature (large yolked eggs in the ovary), 4– gravid (yolked eggs in the uterus but no embryos visible, 5–pregnant (embryos visible in the uterus), 6– spent (uterus flabby and bloodshot, yolked eggs may be in the ovary).

Table 7: Estimated biomass (t) and coefficient of variation (c.v.) for the target species (bold) and major commercial species for ECSI winter surveys. Biomass estimates for 1991 have been adjusted to allow for non-sampled strata (7 & 9). * Rough and smooth skates not separated in 1991; combined biomass = 1 993 t (c.v. 25%).

Species	1991		1992		1993		1994		1996		2007		2008	
	Biomass	c.v. (%)	Biomass	c.v. (%)	Biomass	c.v. (%)	Biomass	c.v. (%)	Biomass	c.v. (%)	Biomass	c.v. (%)	Biomass	c.v. (%)
Dark ghost shark	962	42	934	44	2 911	42	2 702	25	3 176	23	4 483	25	3 763	20
Giant stargazer	672	17	669	16	609	14	439	17	465	11	755	18	606	14
Red cod	3 760	33	4 527	40	5 601	30	5 637	35	4 619	30	1 486	25	1 824	49
Sea perch	1 716	30	1 934	28	2 948	32	2 342	29	1 671	25	1 954	22	1 944	23
Spiny dogfish	12 873	22	10 787	26	13 949	17	14 530	10	35 169	15	35 386	27	28 476	22
Tarakihi	1 712	33	932	26	3 805	55	1 219	31	1 656	24	2 589	24	1 863	29
Arrow squid	443	22	1 303	32	1 062	17	1 421	25	1 204	30	1 242	23	998	19
Barracouta	8 361	29	11 672	23	18 197	22	6 965	34	16 848	19	21 132	17	25 544	16
Blue warehou	104	90	116	43	50	39	165	78	238	64	1 418	79	507	87
Chilean jack mackerel	47	26	200	31	225	28	155	38	1 585	34	18	37	21	38
Elephantfish	300	40	176	32	481	33	164	32	858	30	1 034	32	1 404	35
Hapuku	186	24	104	35	177	31	54	32	102	19	248	28	109	21
Hoki	61	93	108	75	413	32	125	49	460	32	134	62	837	53
Leatherjacket	44	57	14	76	7	58	29	60	10	58	96	44	40	36
Ling	1009	35	525	17	651	27	488	19	488	21	283	27	351	22
Red gurnard	763	40	142	30	576	31	123	34	505	27	1 453	35	1 309	34
Rig	175	30	66	18	67	30	54	29	63	37	134	37	280	23
Rough skate	*	*	224	24	335	21	517	20	177	19	878	22	858	19
School shark	100	30	104	21	369	42	155	36	202	18	538	22	411	20
Silver warehou	29	21	32	22	256	44	35	28	231	32	445	44	319	32
Smooth skate	*	*	605	18	658	25	306	25	385	24	705	20	554	18

Table 8: Estimated biomass (t), and coefficient of variation (c.v.) of recruited and pre-recruited target species for ECSI winter surveys in 30–400 m. Biomass estimates for 1991 have been adjusted to allow for non-sampled strata (7 & 9). – , not measured. The sum of Pre-recruit and recruited biomass values do not always match the total biomass (Table 7) for the earlier surveys because at several stations length frequencies were not measured affecting the biomass calculations for length intervals.

		Target species (recruited length)											
		Dark ghost shark (55 cm)		Giant stargazer (30 cm)		Red cod (40 cm)		Sea perch (20 cm)		Spiny dogfish (50 cm)		Tarakihi (25 cm)	
		Pre- recruit	Recruited	Pre- recruit	Recruited	Pre- recruit	Recruited	Pre- recruit	Recruited	Pre- recruit	Recruited	Pre- recruit	Recruited
1991	Biomass	292	668	26	646	1 823	2 054	70	1 483	—		305	1 414
	c.v. (%)	68	40	22	17	45	37	44	30			38	33
1992	Biomass	576	358	34	635	2 089	2 438	49	1 443	300	9 177	273	630
	c.v. (%)	54	31	14	16	50	33	28	28	26	31	26	28
1993	Biomass	1 064	1 808	19	590	1 026	4 468	178	2 770	367	13 098	2 234	1 571
	c.v. (%)	40	53	16	14	51	27	76	30	71	17	62	47
1994	Biomass	1 314	1 388	10	430	3 342	2 296	70	2 272	208	14 322	493	726
	c.v. (%)	35	22	25	17	40	36	24	29	49	10	31	35
1996	Biomass	1 195	1 981	13	452	584	4 036	52	1 619	3 444	31 725	519	1 137
	c.v. (%)	30	23	34	11	31	33	45	25	23	16	30	27
2007	Biomass	1 857	2 626	33	722	190	1 295	73	1 880	5 830	29 555	823	1 766
	c.v. (%)	46	26	24	18	33	25	18	22	46	27	30	24
2008	Biomass	1 644	2 119	13	592	129	1 695	144	1 800	1 886	26 590	739	1 123
	c.v. (%)	23	29	28	14	36	50	20	24	50	22	44	25

Table 9: Estimated juvenile and adult biomass (t), and coefficient of variation (c.v) (where juvenile is below and adult is equal to or above length at which 50% of fish are mature) for target species for ECSI winter surveys in 30–400 m. Biomass estimates for 1991 have been adjusted to allow for non-sampled strata (7 & 9). –, not measured. The sum of juvenile and adults biomass values do not always match the total biomass (Table 7) for the earlier surveys because at several stations length frequencies were not measured affecting the biomass calculations for length intervals.

		Target species (length at maturity, cm)											
		GSH M=52, F=62		STA both sexes 45		RCO both sexes 51		SPE both sexes 26		SPD M=58, F=72		TAR both sexes 31	
		Juv.	Adult	Juv.	Adult	Juv.	Adult	Juv.	Adult	Juv.	Adult	Juv.	Adult
1991	Biomass	90 (265)	194 (411)	305	347	3 119	768	579	1 136	–	–	1 094	591
	c.v. (%)	73 (57)	52 (47)	19	20	39	32	33	30	–	–	36	30
1992	Biomass	259 (444)	126 (106)	336	333	3 297	1 230	576	916	577 (949)	4 545 (3 407)	636	266
	c.v. (%)	60 (48)	37 (34)	21	14	48	23	28	30	27 (21)	18 (70)	25	32
1993	Biomass	362 (740)	886 (884)	262	348	3 139	2 355	1 223	1 725	697 (1 414)	7 175 (4 159)	3 305	500
	c.v. (%)	47 (37)	49 (54)	13	17	42	27	59	20	57 (45)	17 (34)	62	52
1994	Biomass	457 (1033)	618 (594)	189	250	4 720	917	774	1 568	726 (1 193)	9 614 (2 984)	1 012	207
	c.v. (%)	45 (27)	25 (24)	21	19	40	26	24	32	23 (20)	10 (30)	32	31
1996	Biomass	307 (1171)	924 (771)	226	240	1 360	3 259	744	926	4 376 (7918)	20 729 (2 146)	1 416	240
	c.v. (%)	35 (33)	30 (20)	15	13	25	38	35	22	21 (28)	17 (18)	25	31
2007	Biomass	607 (1597)	1 089 (1184)	364	391	714	772	640	1 314	9 439 (12 310)	12 799 (837)	2 226	363
	c.v. (%)	46 (36)	20 (41)	15	27	31	30	18	26	34 (35)	26 (22)	26	22
2008	Biomass	767 (1225)	729 (1031)	329	277	1 153	671	793	1 150	4 946 (5 691)	16 621 (1 092)	1 528	335
	c.v. (%)	26 (19)	25 (34)	17	15	67	24	24	27	35 (25)	22 (16)	32	22

Table 10: Percent occurrence (% of stations where it was caught) for each target species, and percent total catch (% of all species caught on the survey) for each target species and for all target species combined for ECSI winter surveys in 30–400 m.

	Target species percent occurrence and percent of total catch												
	Dark ghost shark		Giant stargazer		Red cod		Sea perch		Spiny dogfish		Tarakihi		All target species
	% Occ.	% catch	% Occ.	% catch	% Occ.	% catch	% Occ.	% catch	% Occ.	% catch	% Occ.	% catch	% catch
1991	27	2	85	1	89	9	82	4	94	31	71	4	51
1992	22	3	82	2	89	15	76	6	98	25	61	2	53
1993	38	9	92	1	81	13	70	4	99	22	62	5	54
1994	29	9	82	1	75	30	75	4	95	27	75	3	74
1996	44	6	70	1	83	6	59	3	99	45	63	1	62
2007	50	7	85	1	71	2	65	3	100	39	66	3	55
2008	44	7	76	1	65	3	71	3	99	39	62	2	55

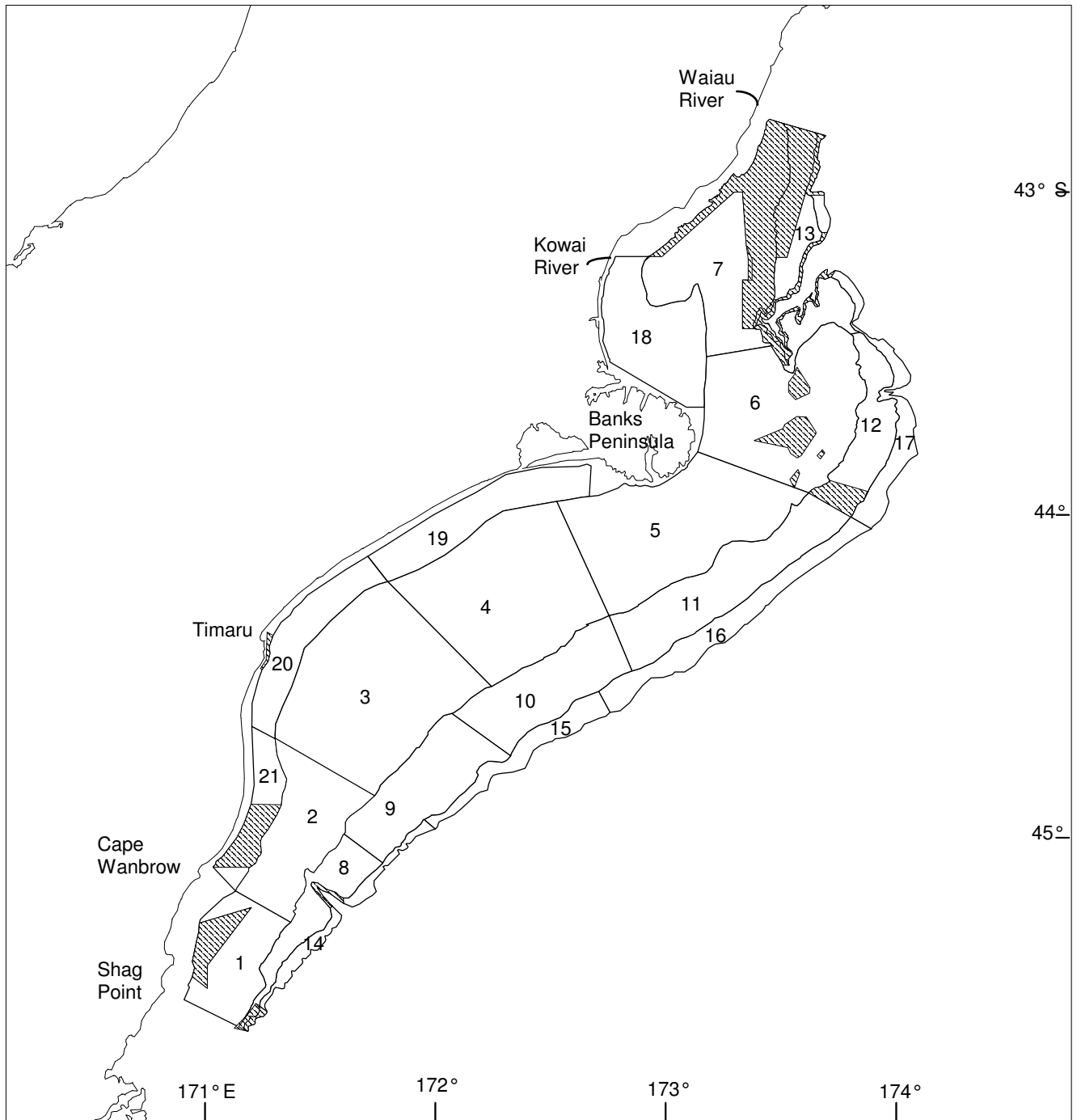


Figure 1: Strata used in ECSI winter trawl surveys in 2008 (30–400 m, strata 1–17) and shallow strata in 10–30 m (strata 18–21). Hashed areas are foul ground.

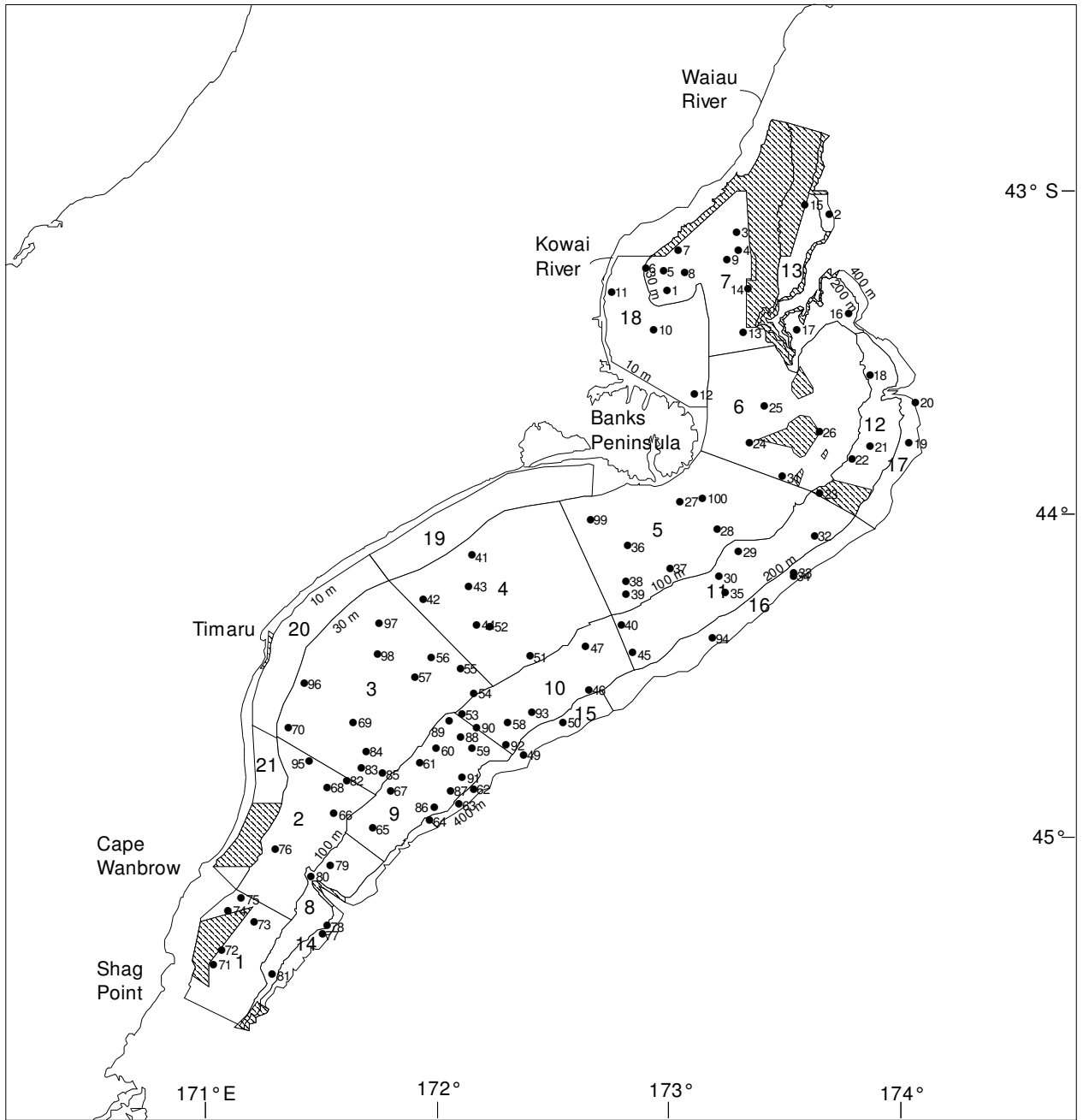


Figure 2: All tows and tow numbers from the 2008 ECSI survey. Hashed areas are foul ground.

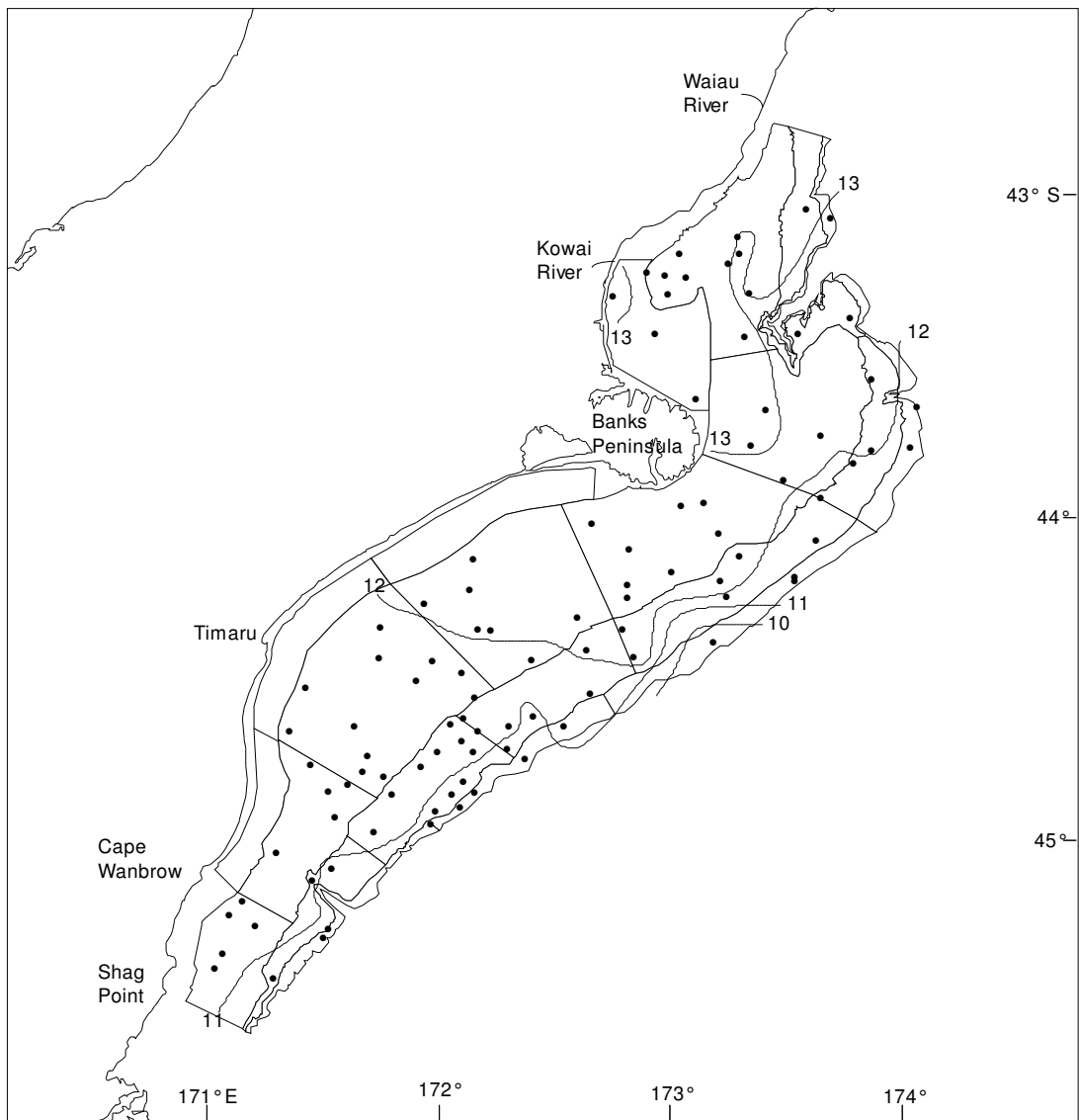


Figure 3: Positions of CTD surface temperature recordings from *Kaharoa* during the 2008 survey and estimated isotherms.

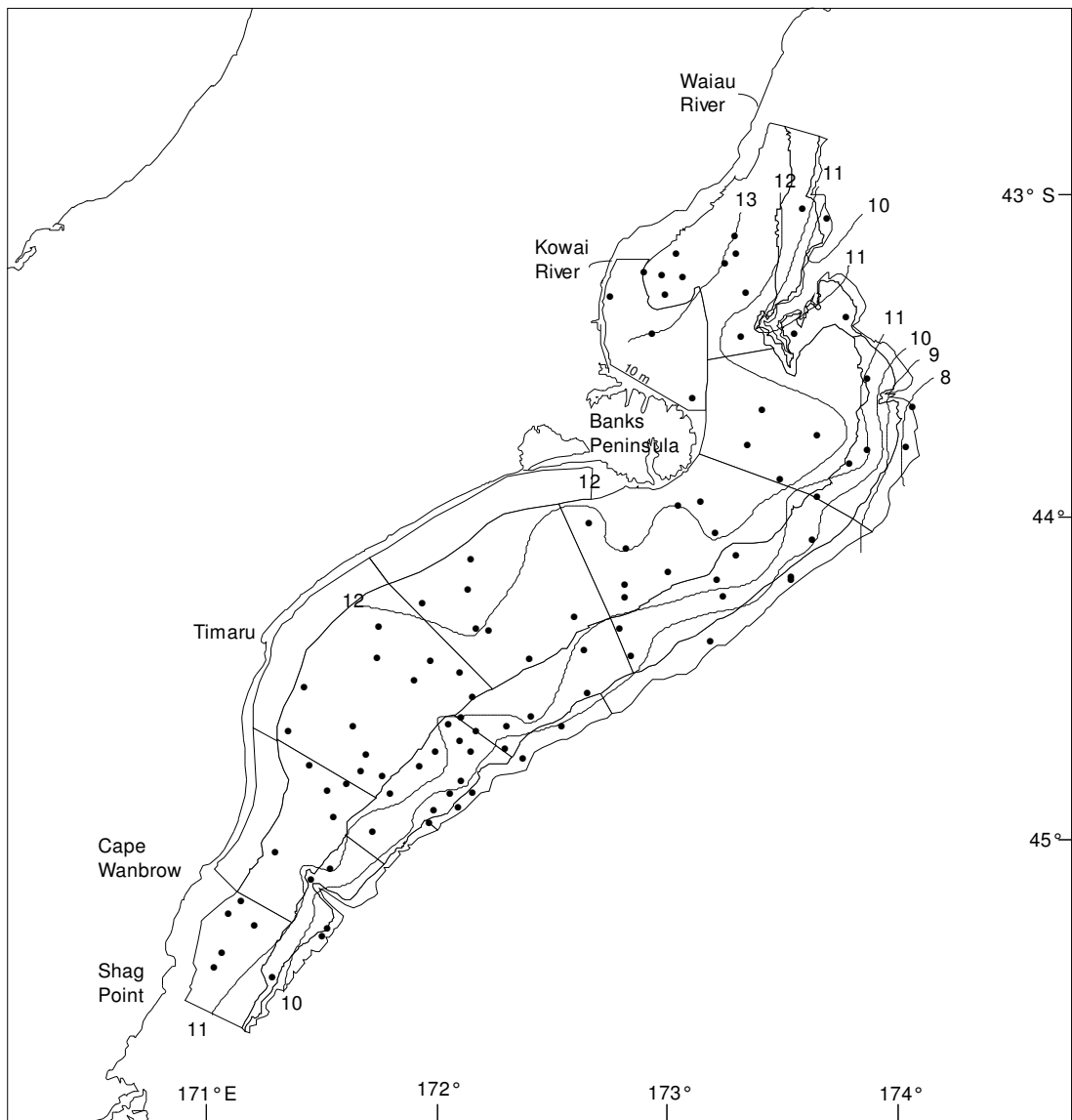


Figure 4: Positions of CTD bottom temperature recordings from *Kaharoa* during the 2008 survey and estimated isotherms.

Dark ghost shark

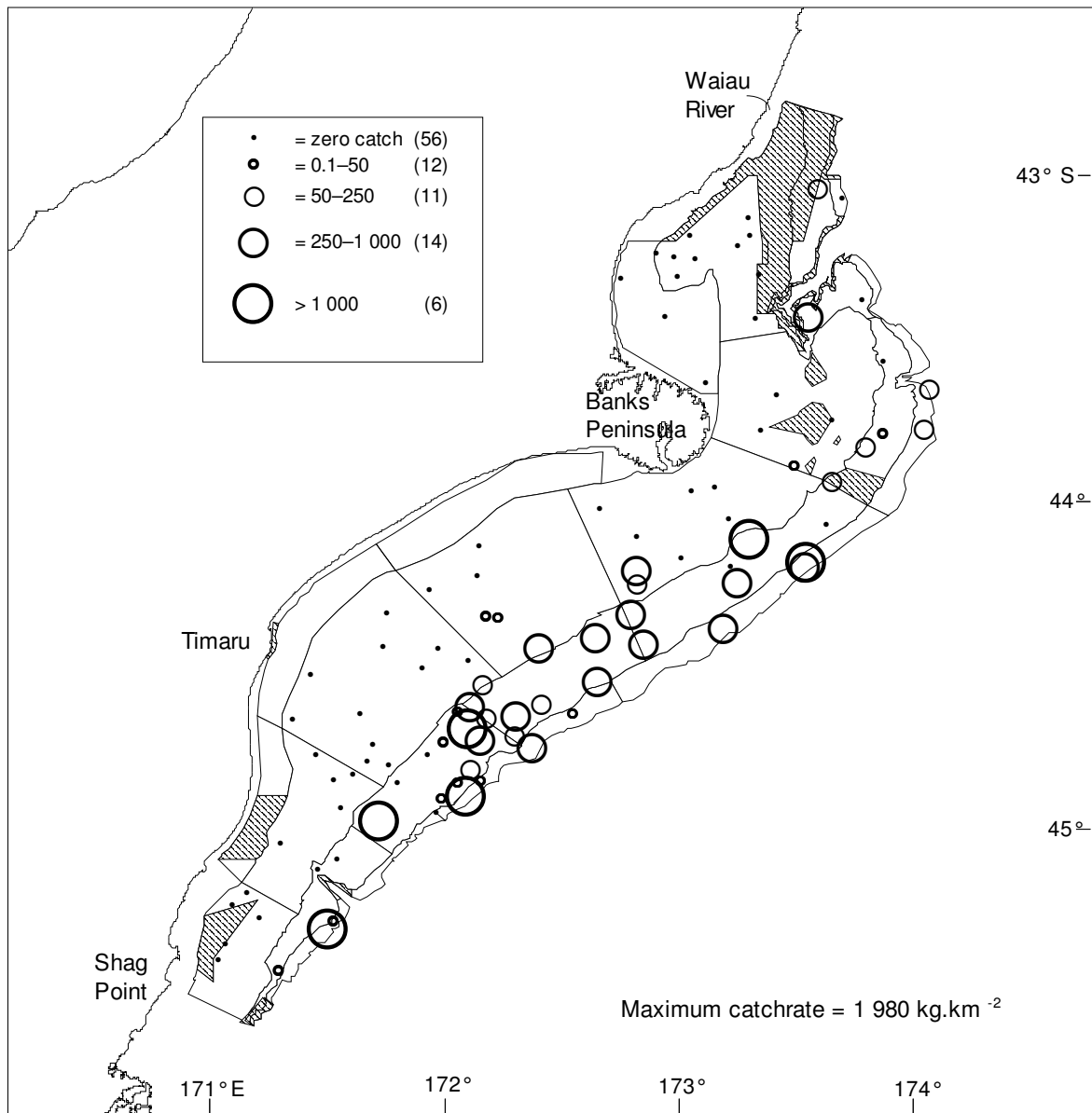


Figure 5: Catch rates (kg.km⁻²) of target species. Number of stations in parentheses. Hashed areas are foul ground.

Giant stargazer

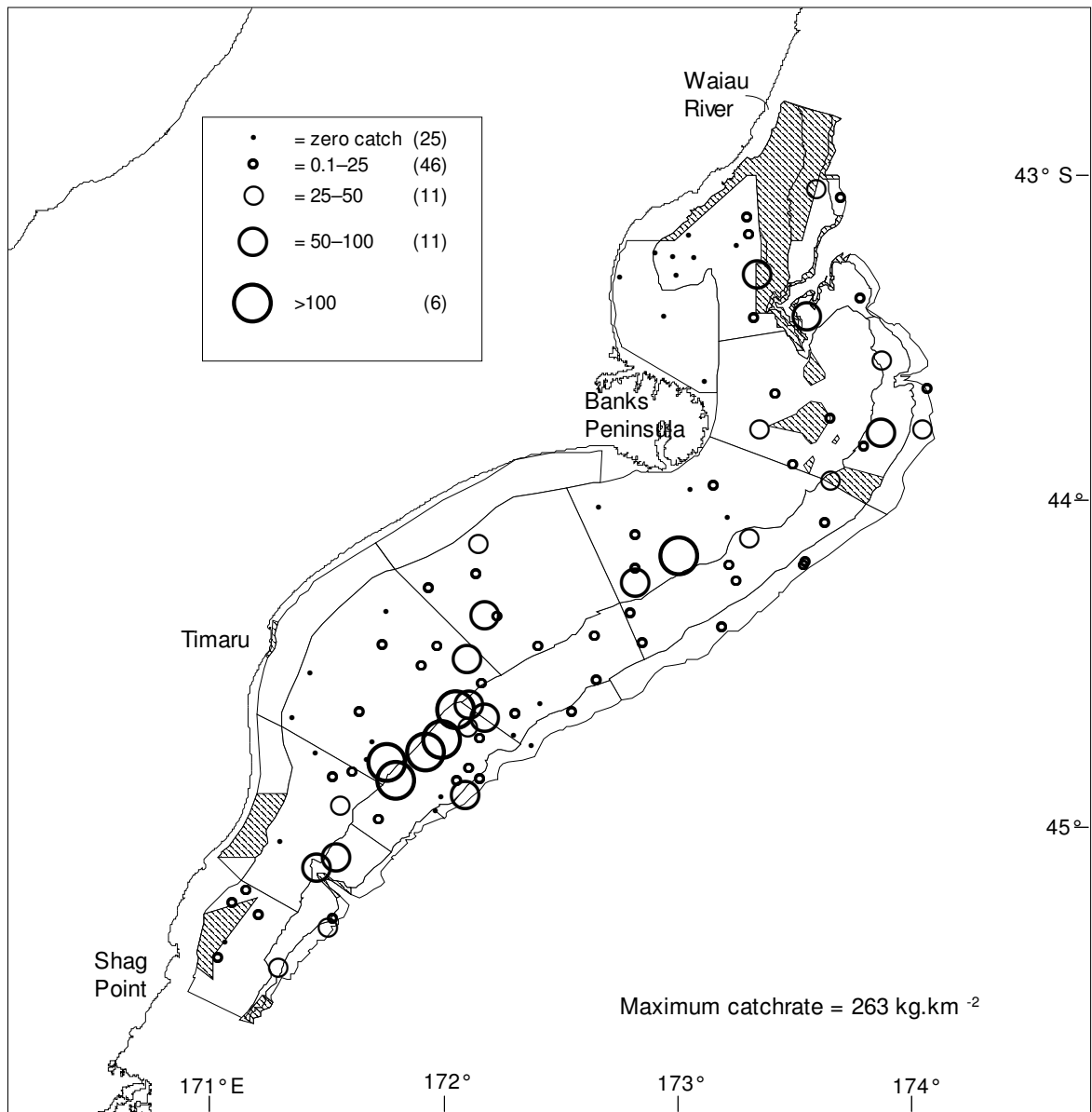


Figure 5—continued

Red cod

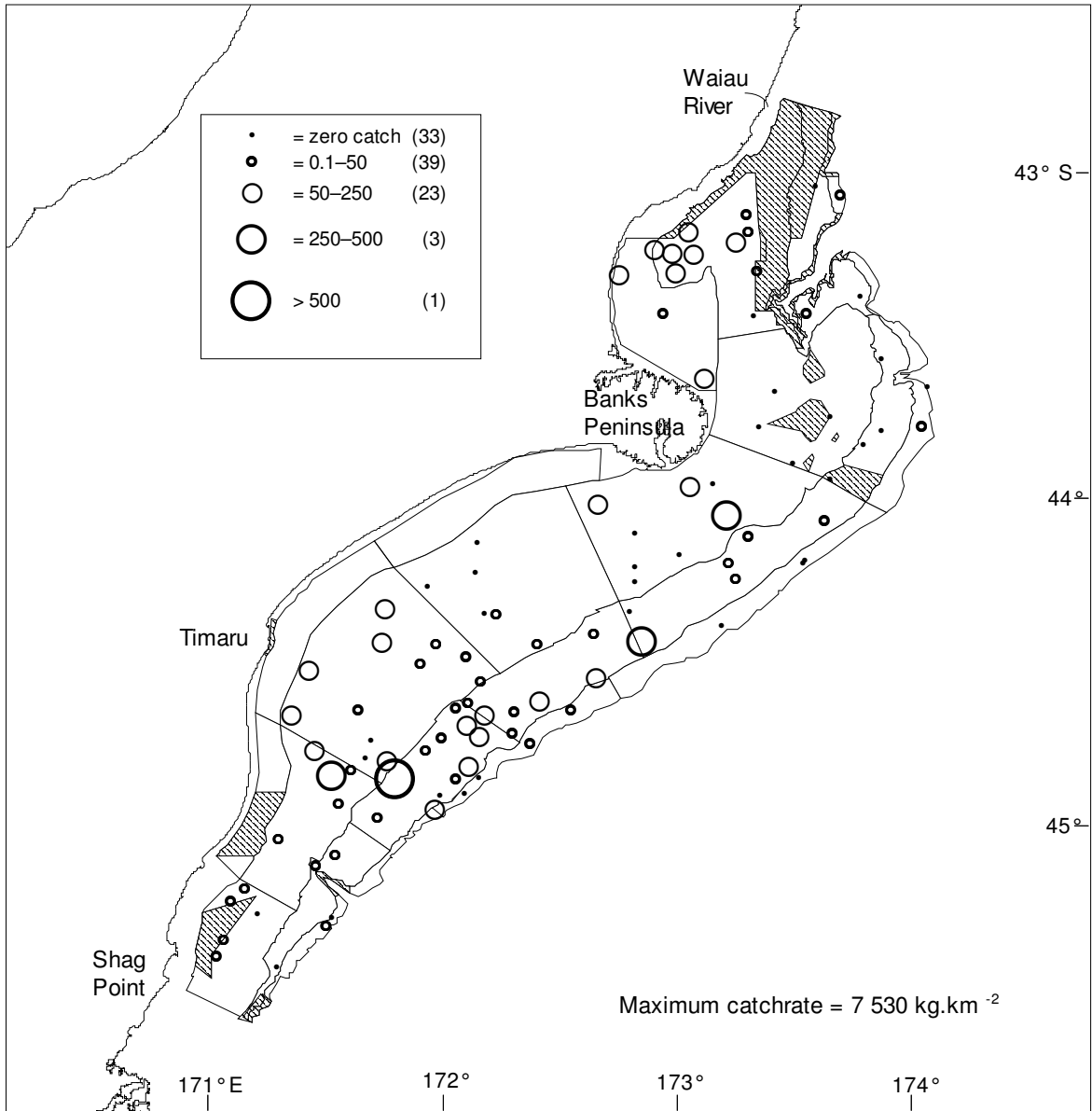


Figure 5—continued

Sea perch

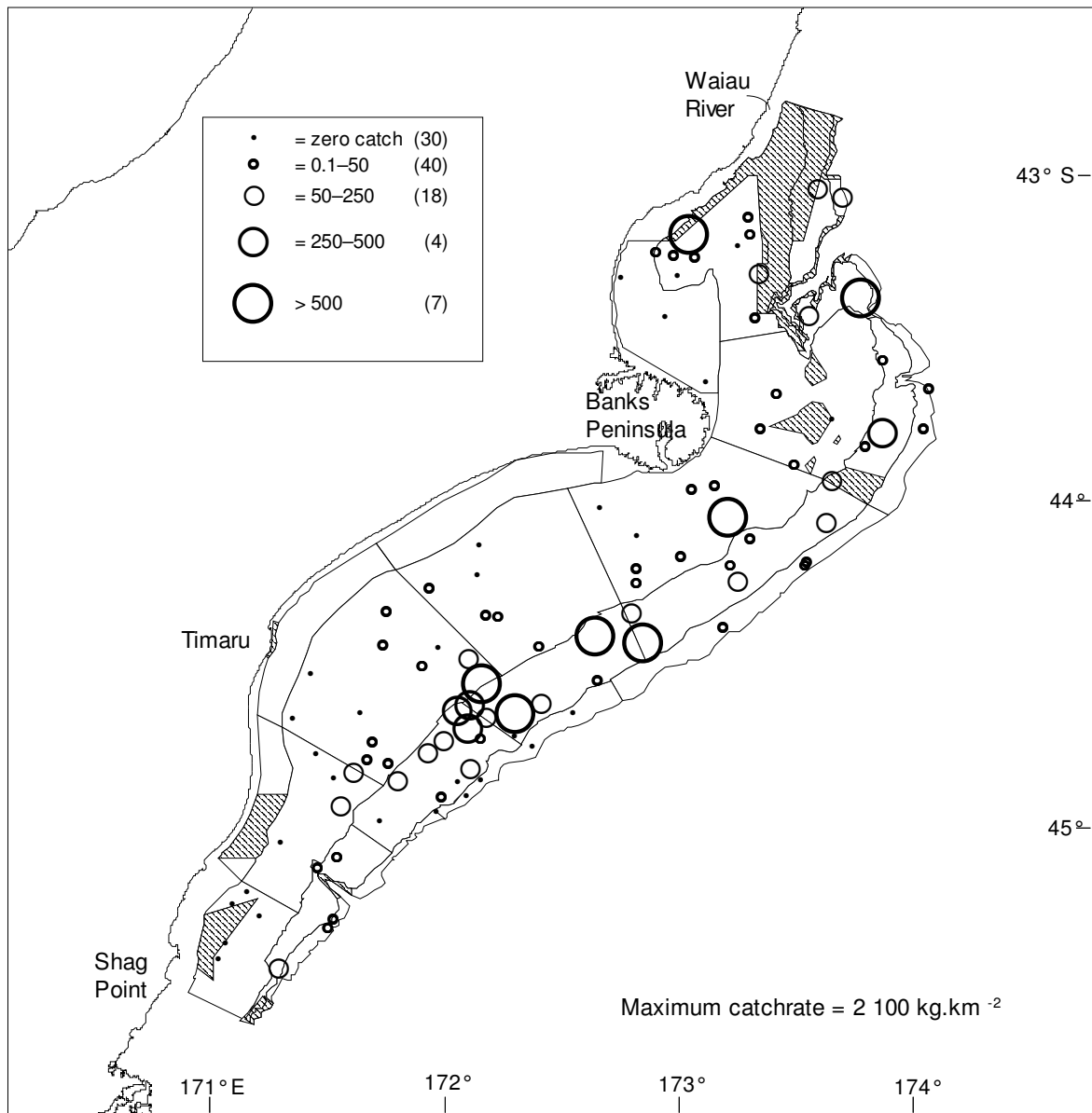


Figure 5—continued

Spiny dogfish

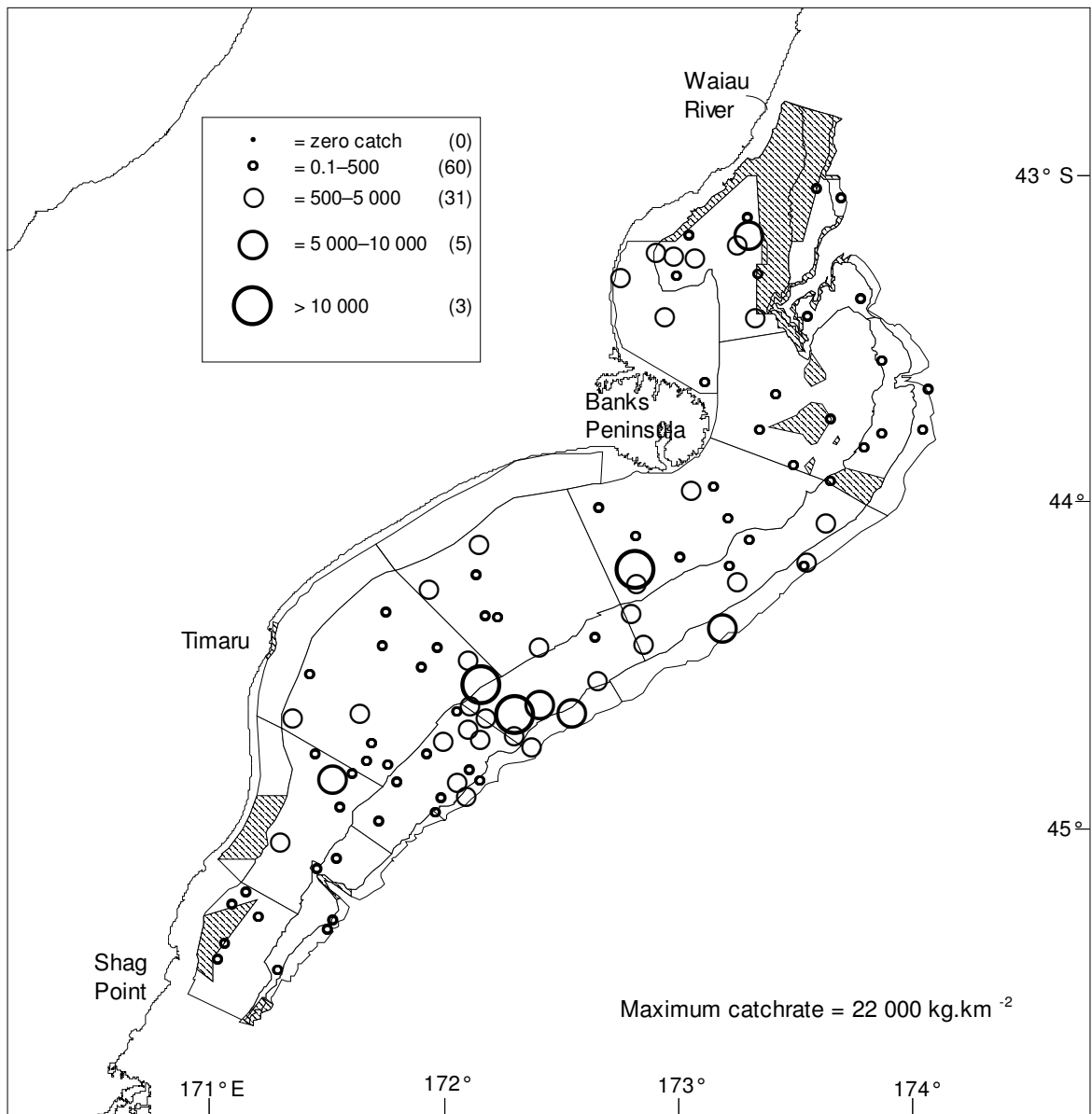


Figure 5—continued

Tarakihi

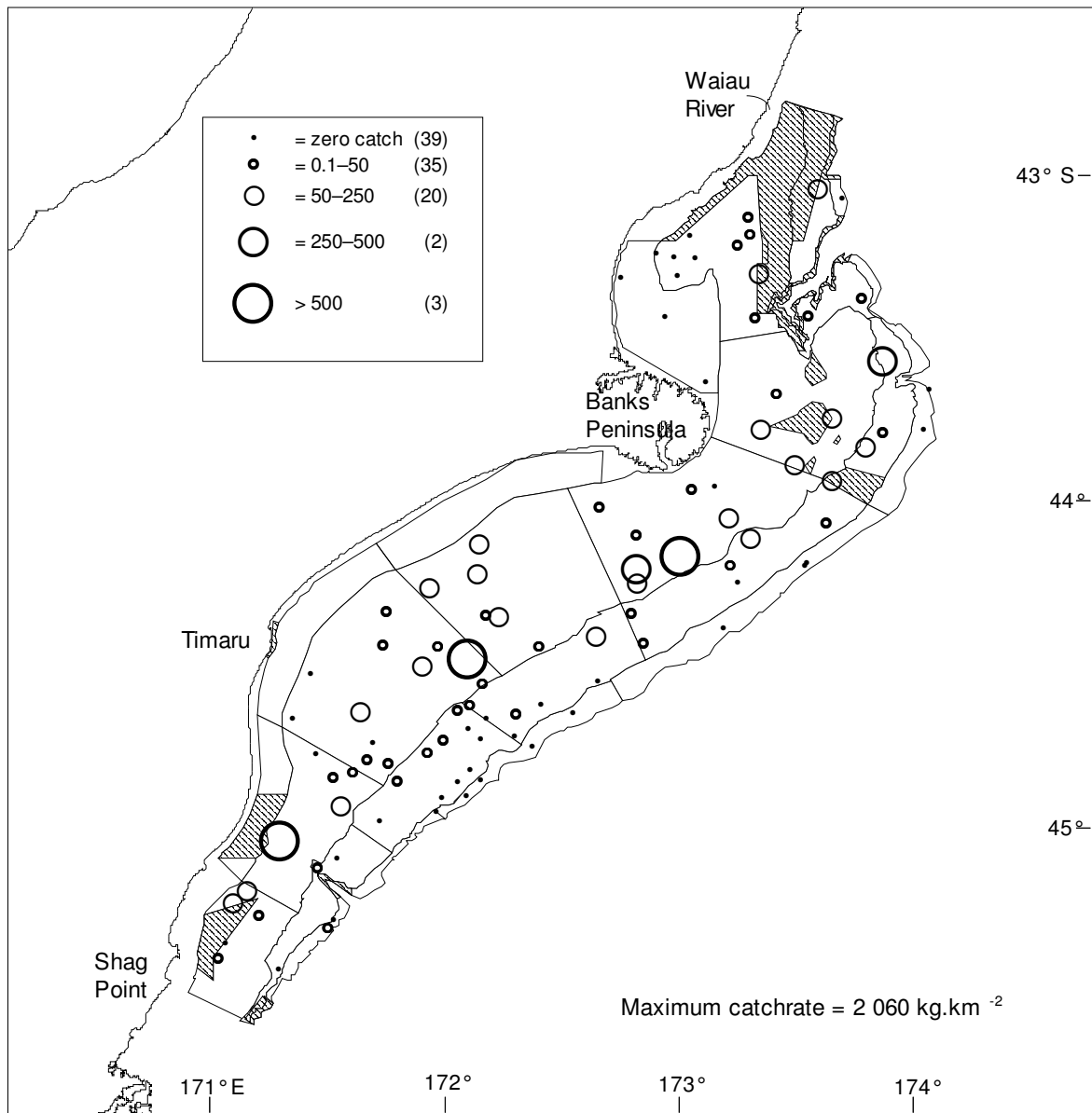
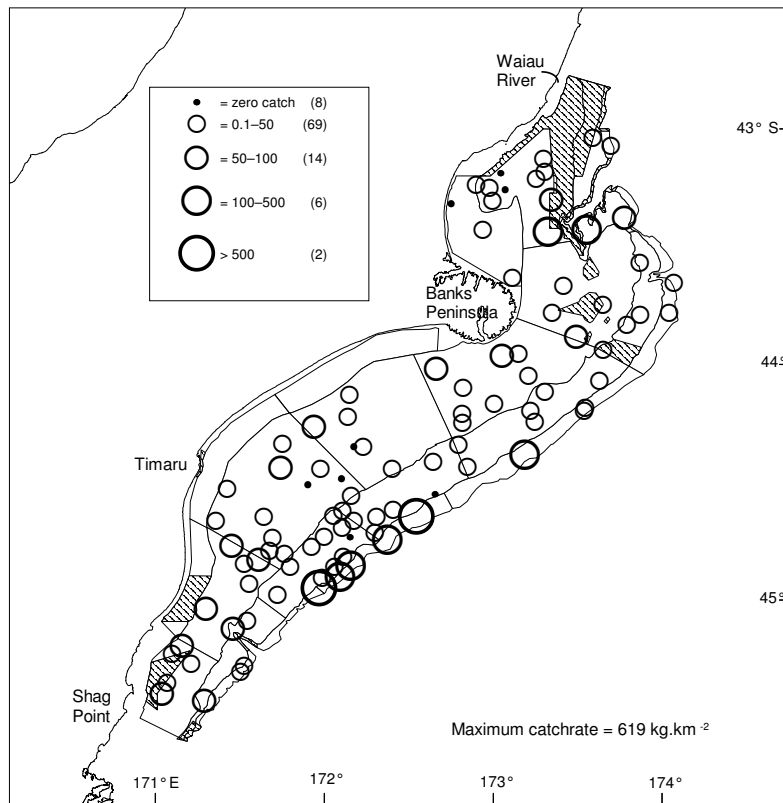


Figure 5—continued

Arrow squid



Barracouta

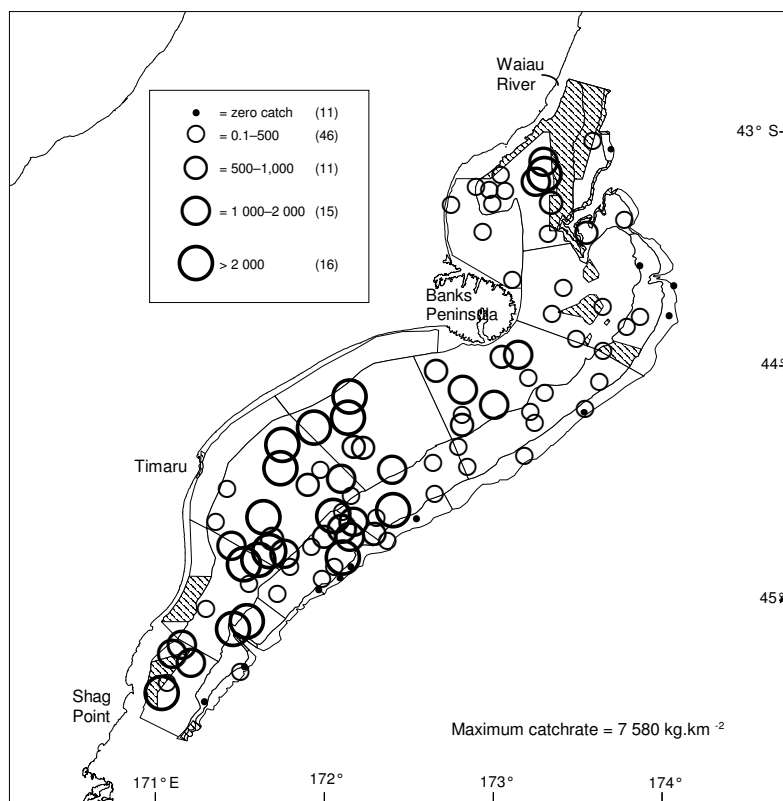
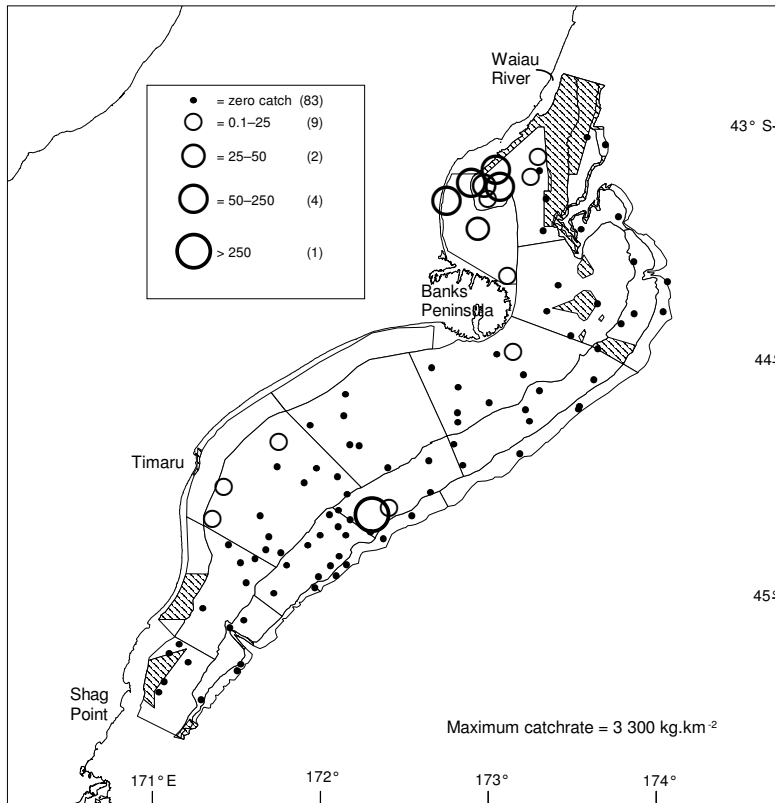


Figure 6: Catch rates (kg.km⁻²) of non-target species. Number of stations in parentheses. Hashed areas are foul ground.

Blue warehou



Elephantfish

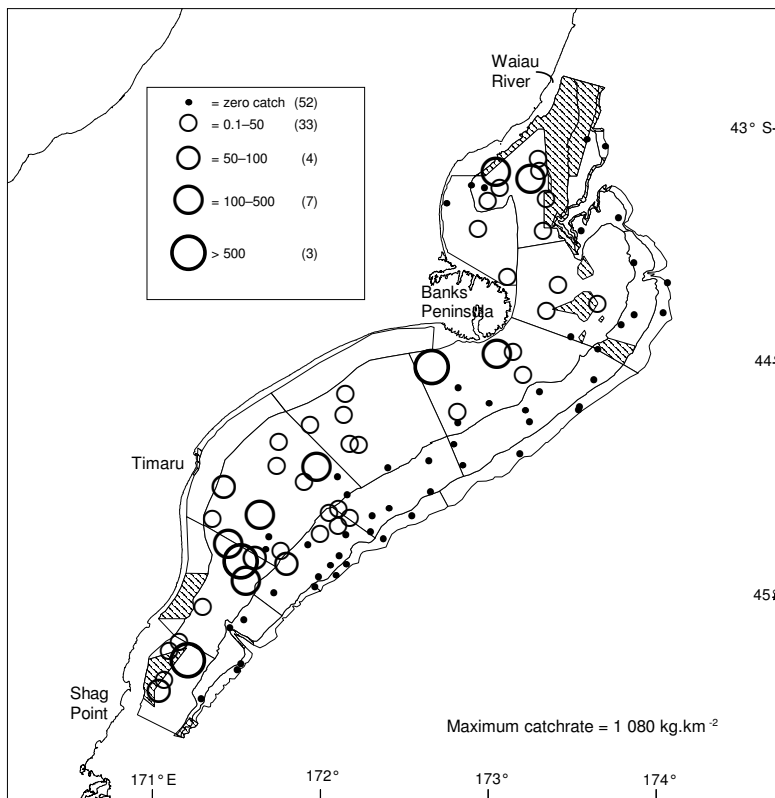
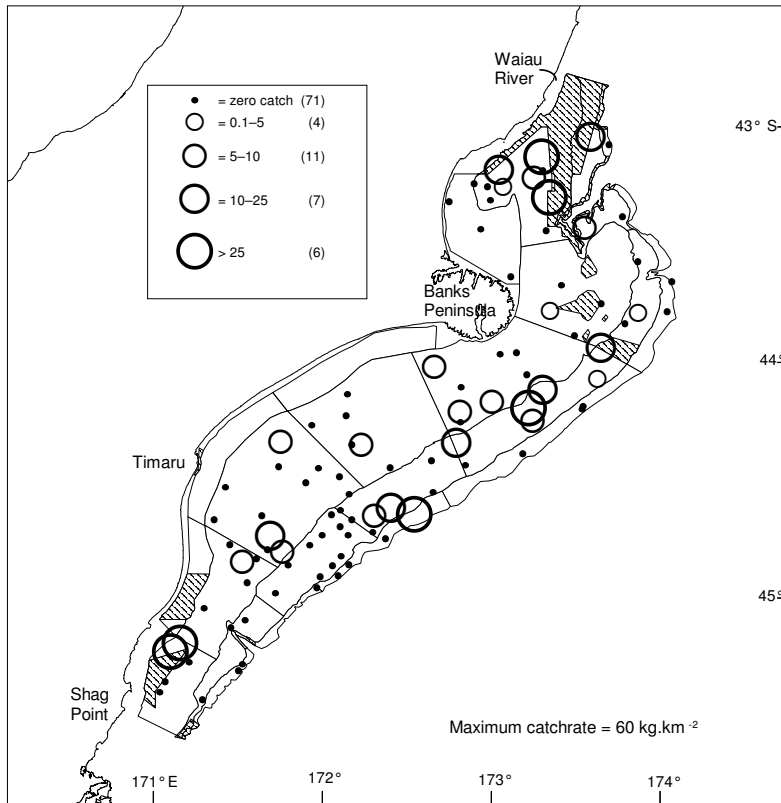


Figure 6-continued

Hapuku



Hoki

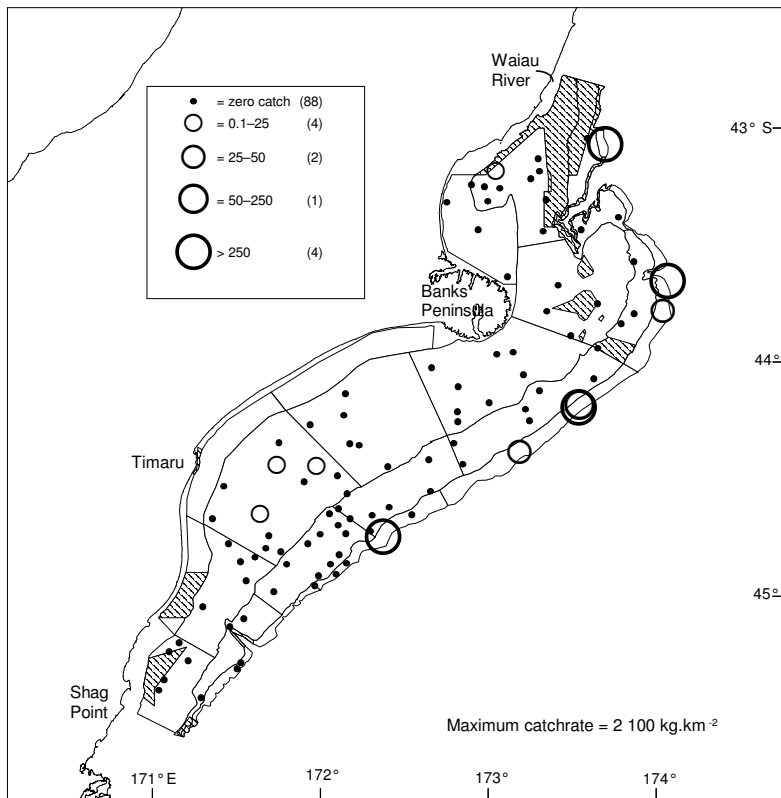
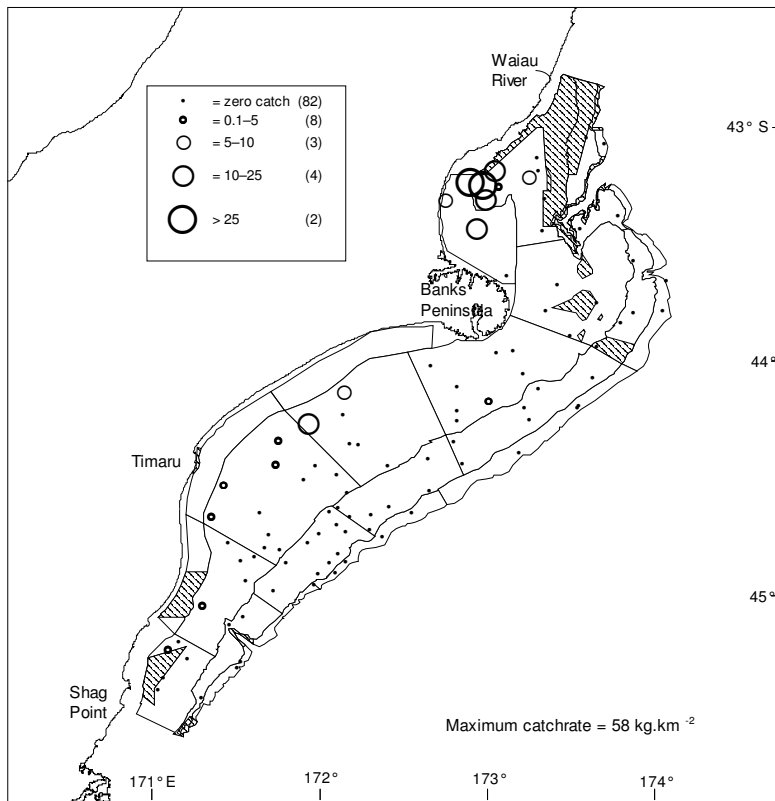


Figure 6-continued

Leatherjacket



Lemon sole

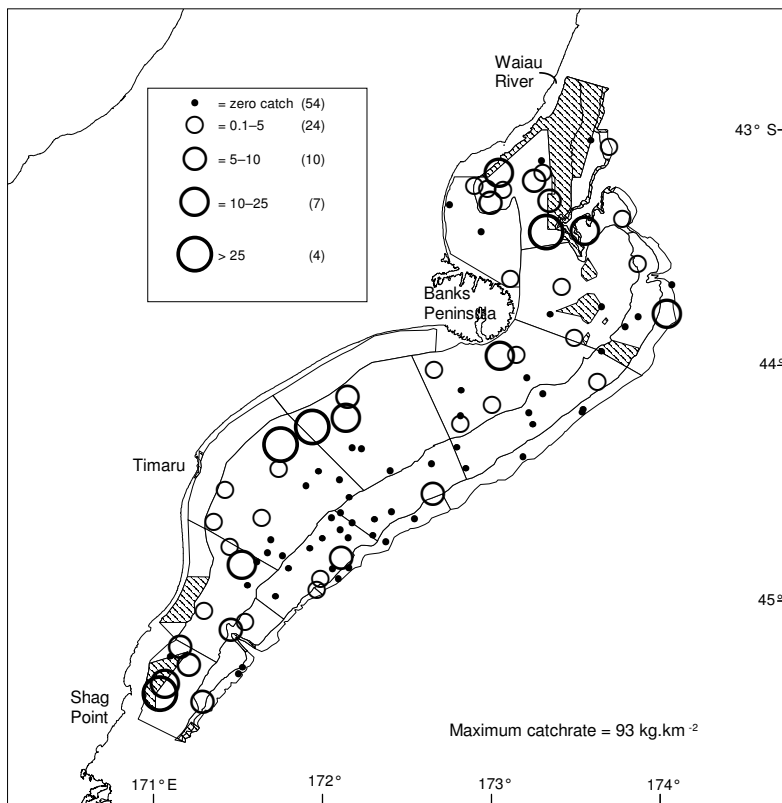
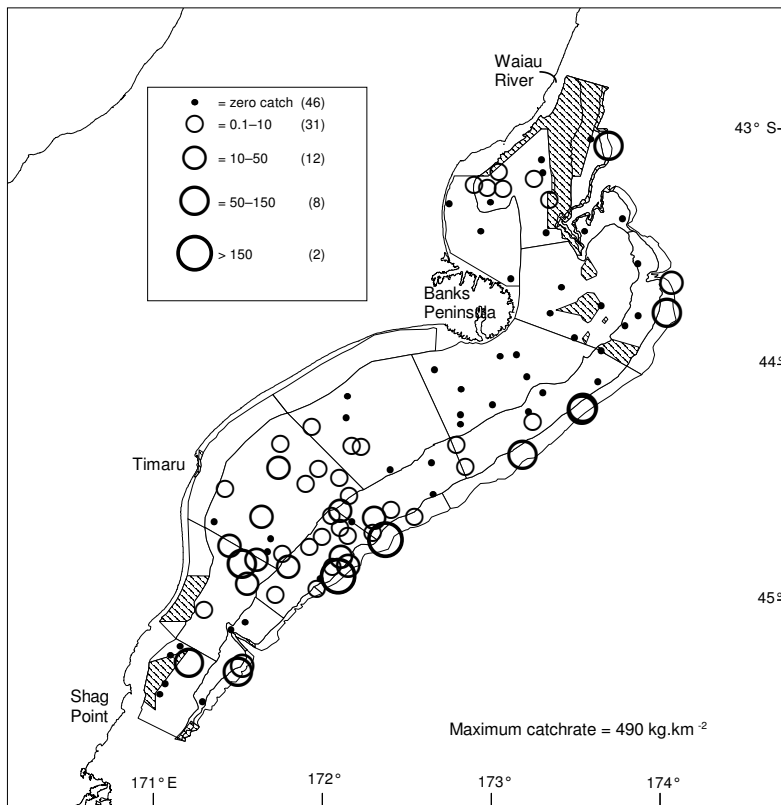


Figure 6-continued

Ling



Red gurnard

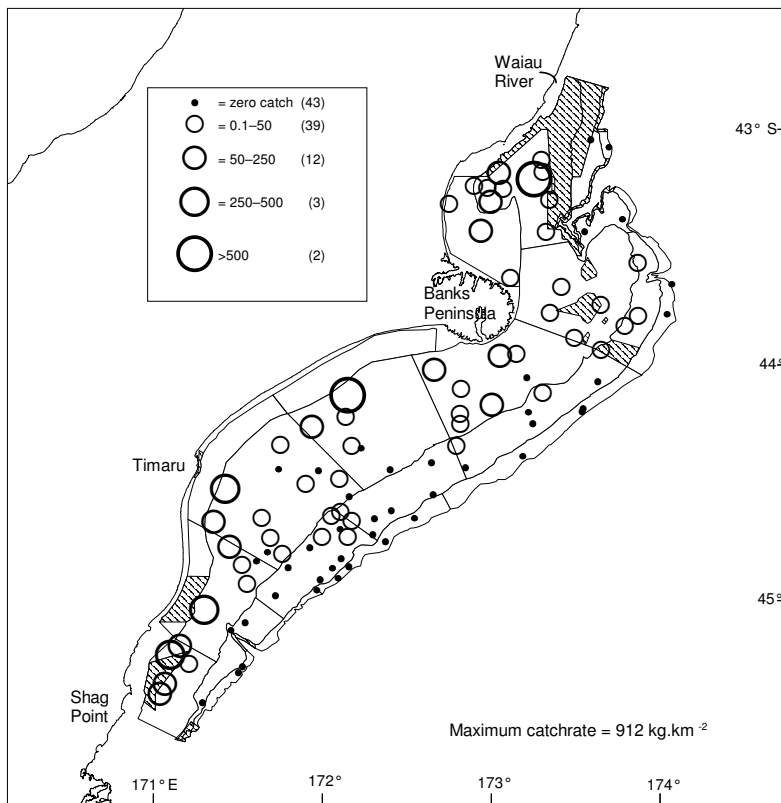
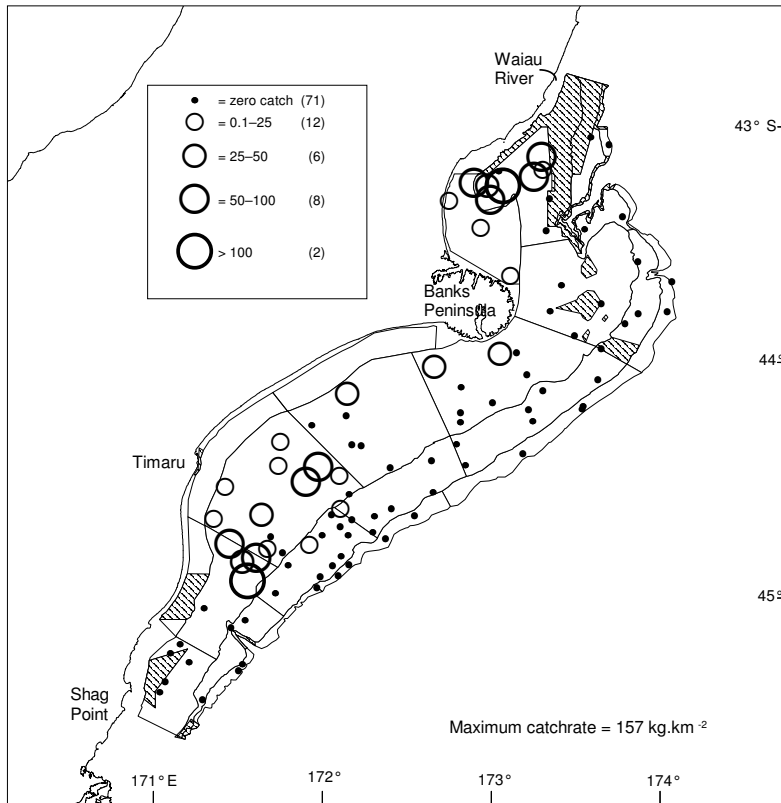


Figure 6—continued

Rig



Rough skate

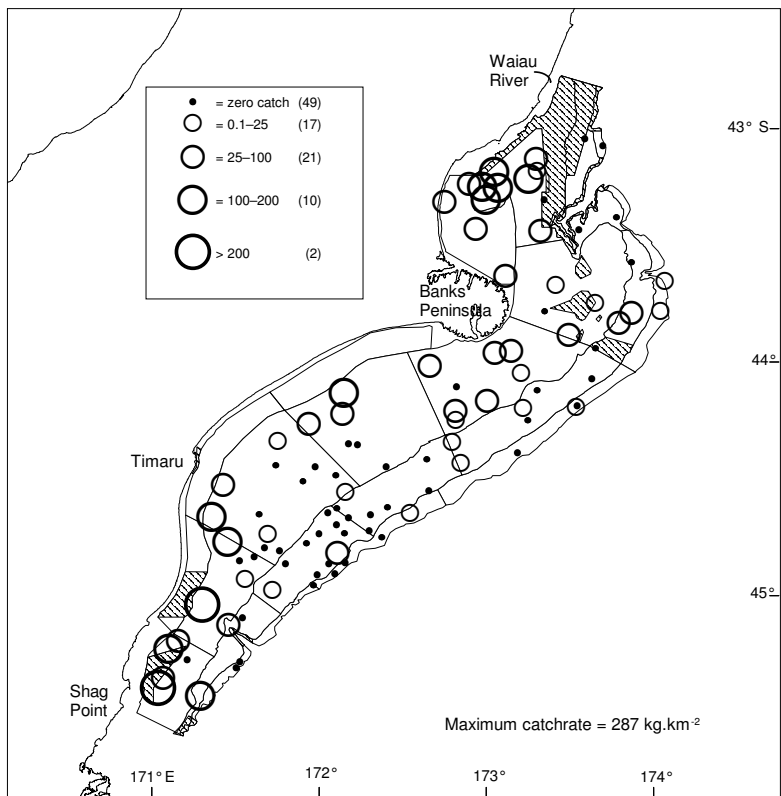
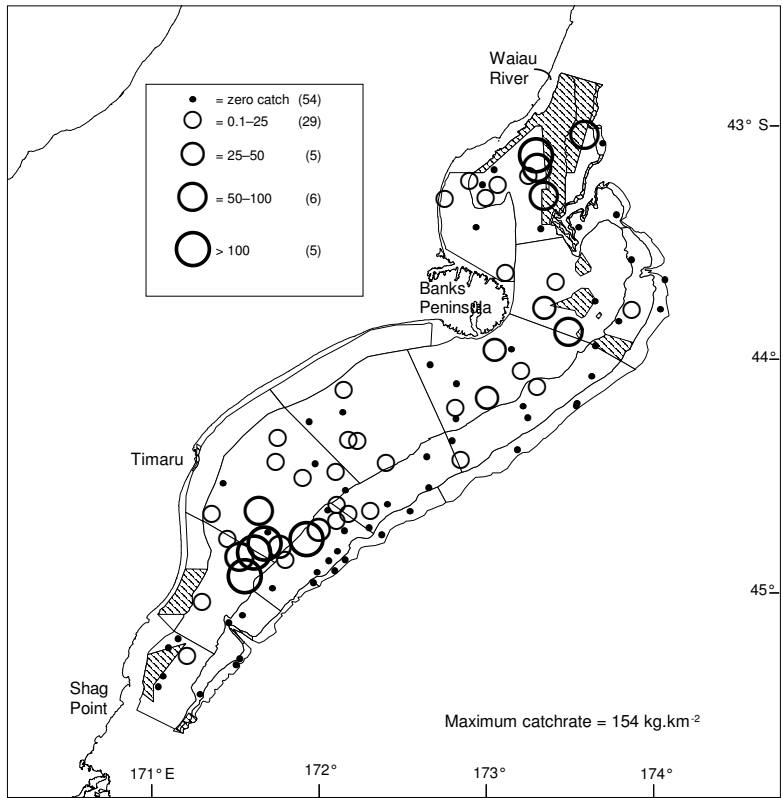


Figure 6–continued

School shark



Silver warehou

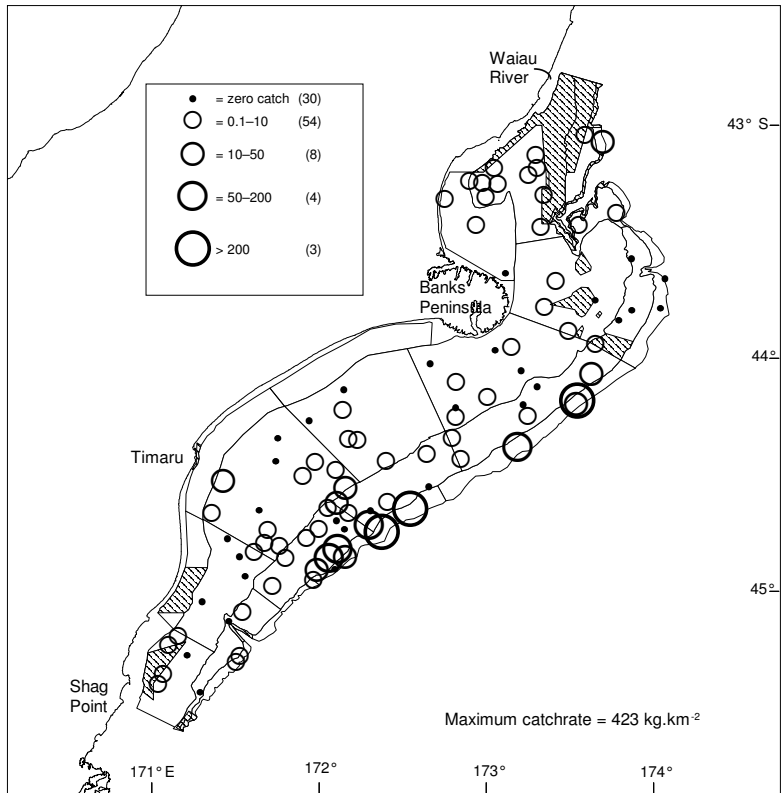


Figure 6—continued

Smooth skate

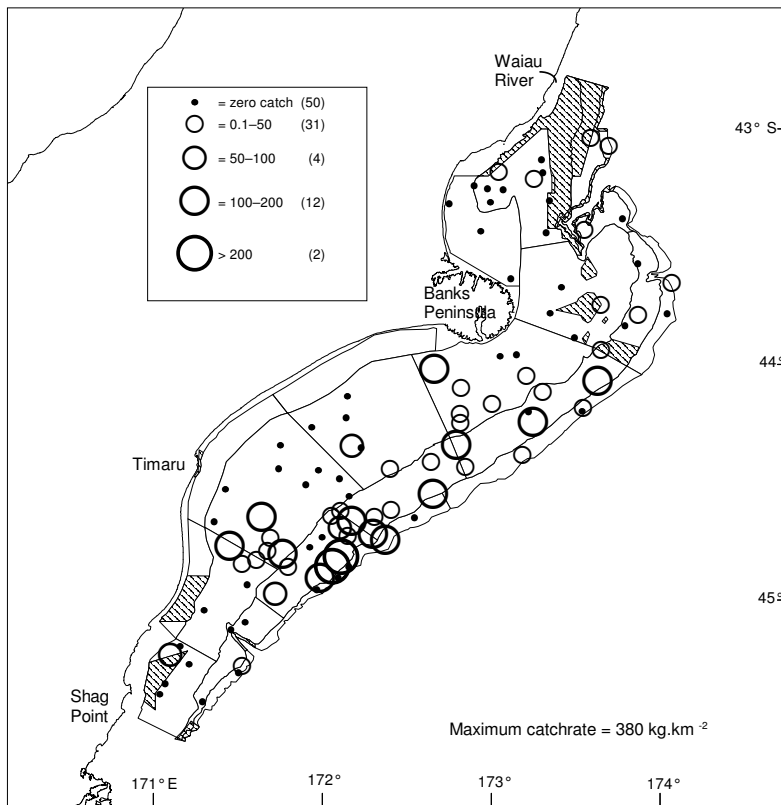
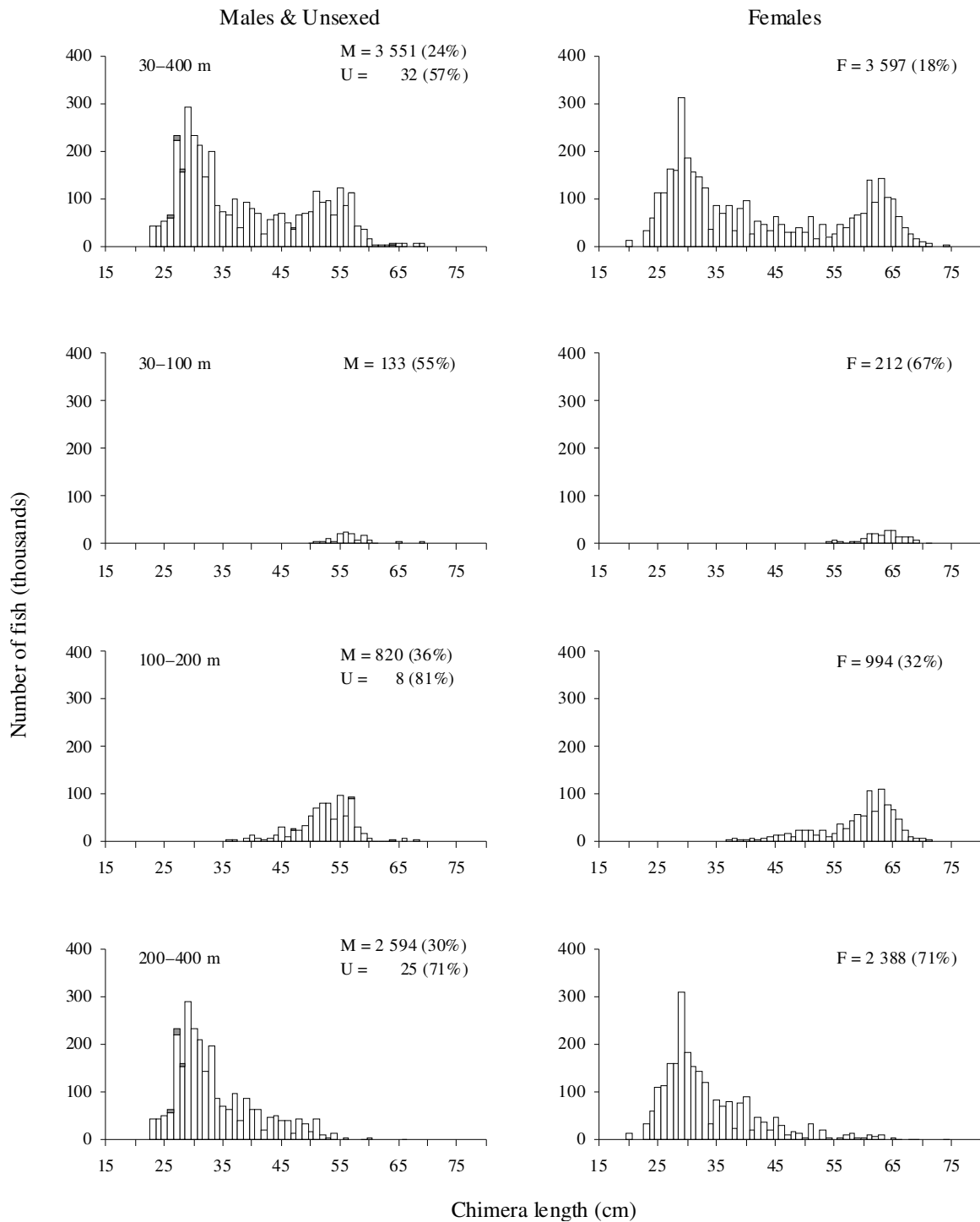


Figure 6—continued

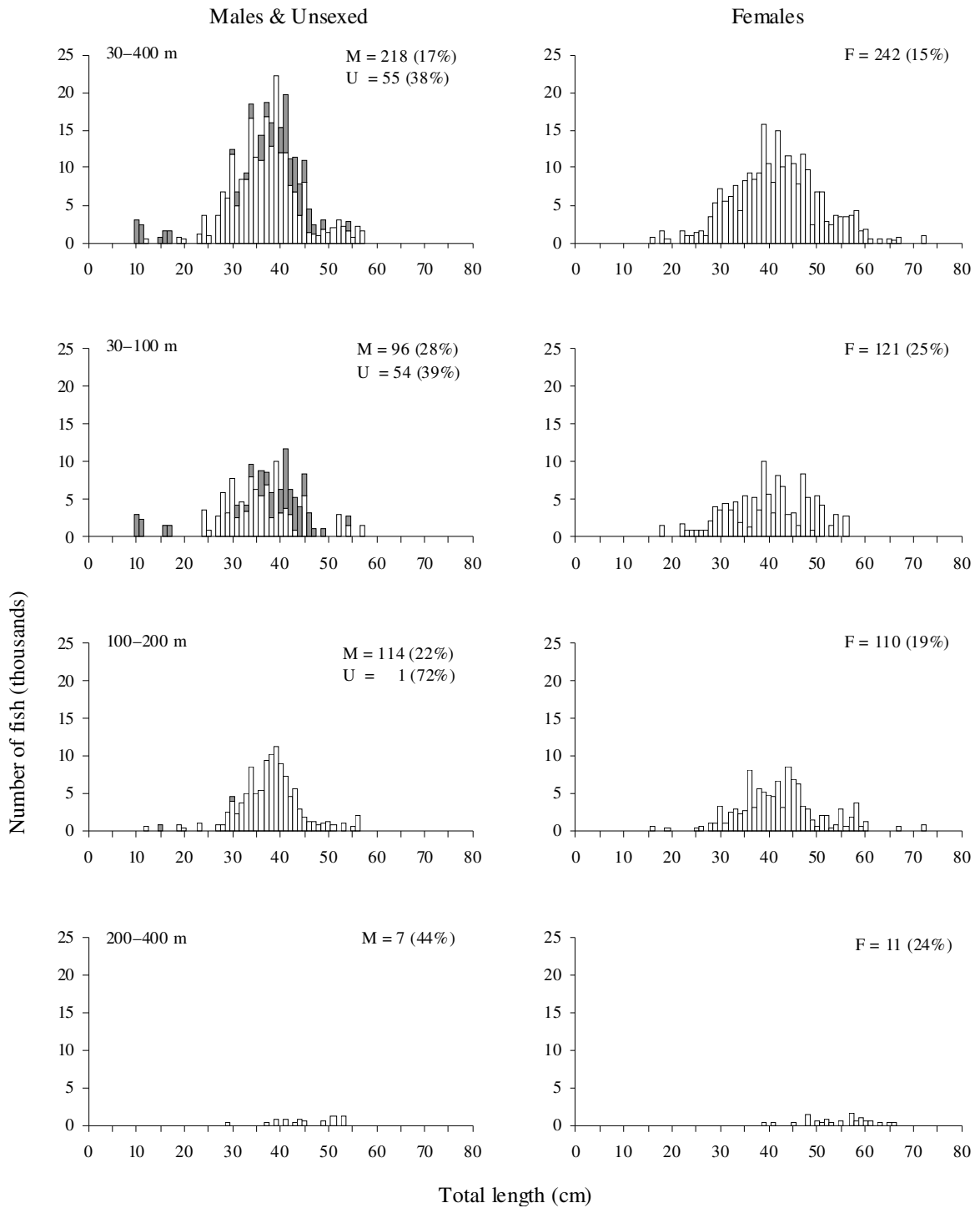
Dark ghost shark



10–30 m
No catch

Figure 7: Scaled length frequency distributions for the target species by depth range for the 2008 survey. Population estimates are in thousands of fish. M, number of males; F, number of females; U, unsexed; (), c.v. Shaded areas represent unsexed fish.

Giant stargazer



10-30 m
No catch

Figure 7-continued

Red cod

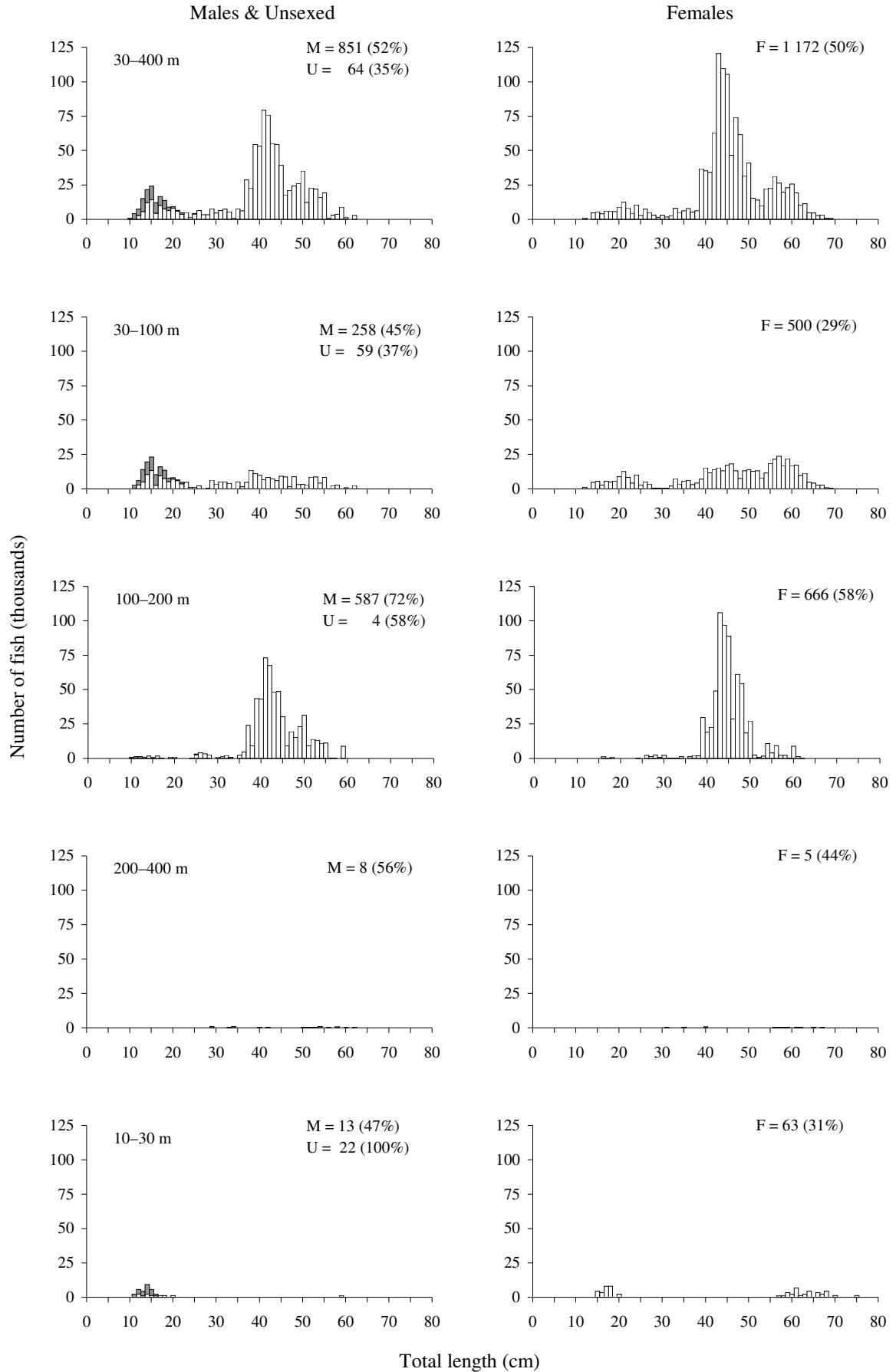
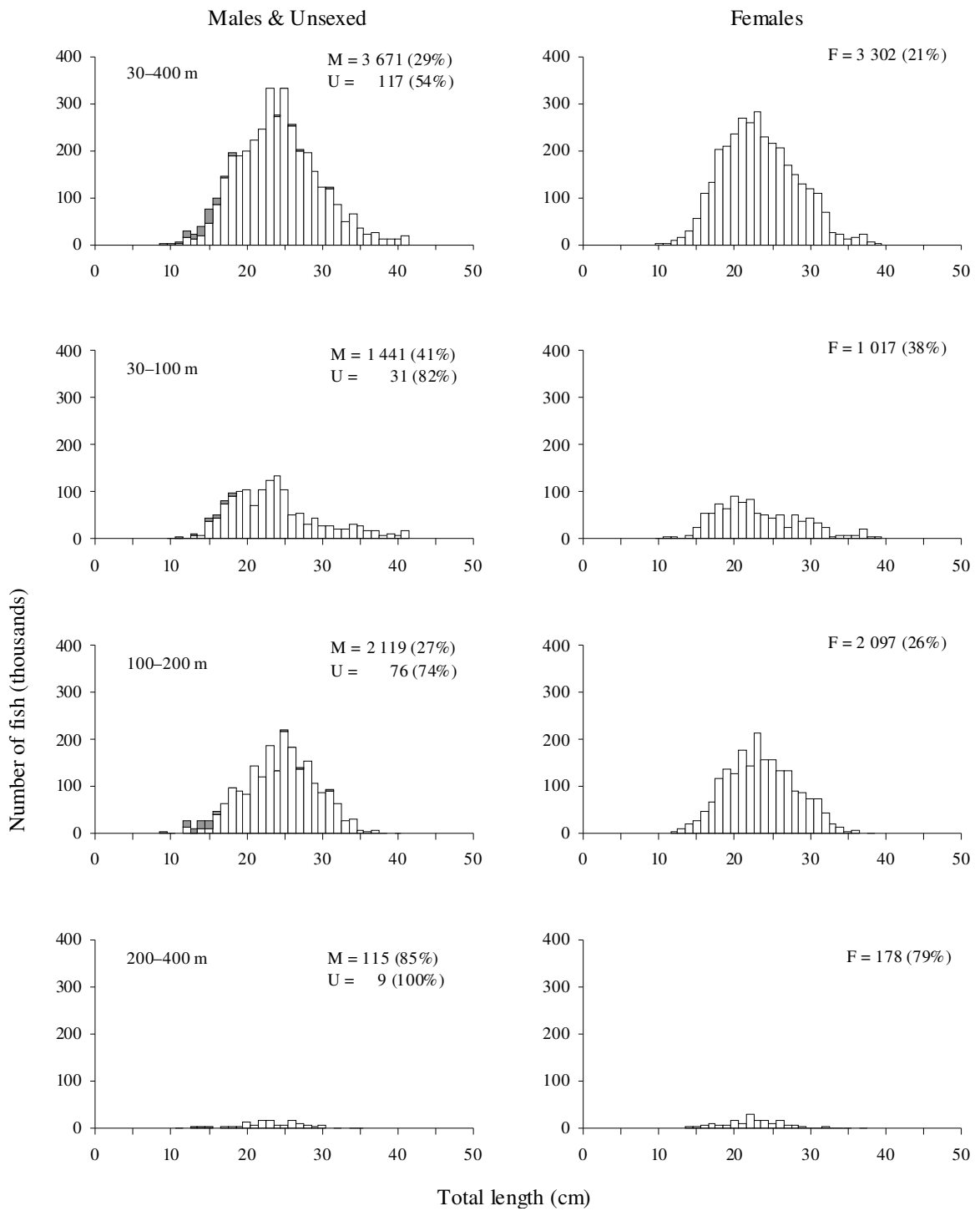


Figure 7-continued

Sea perch



10-30 m
No catch

Figure 7-continued

Spiny dogfish

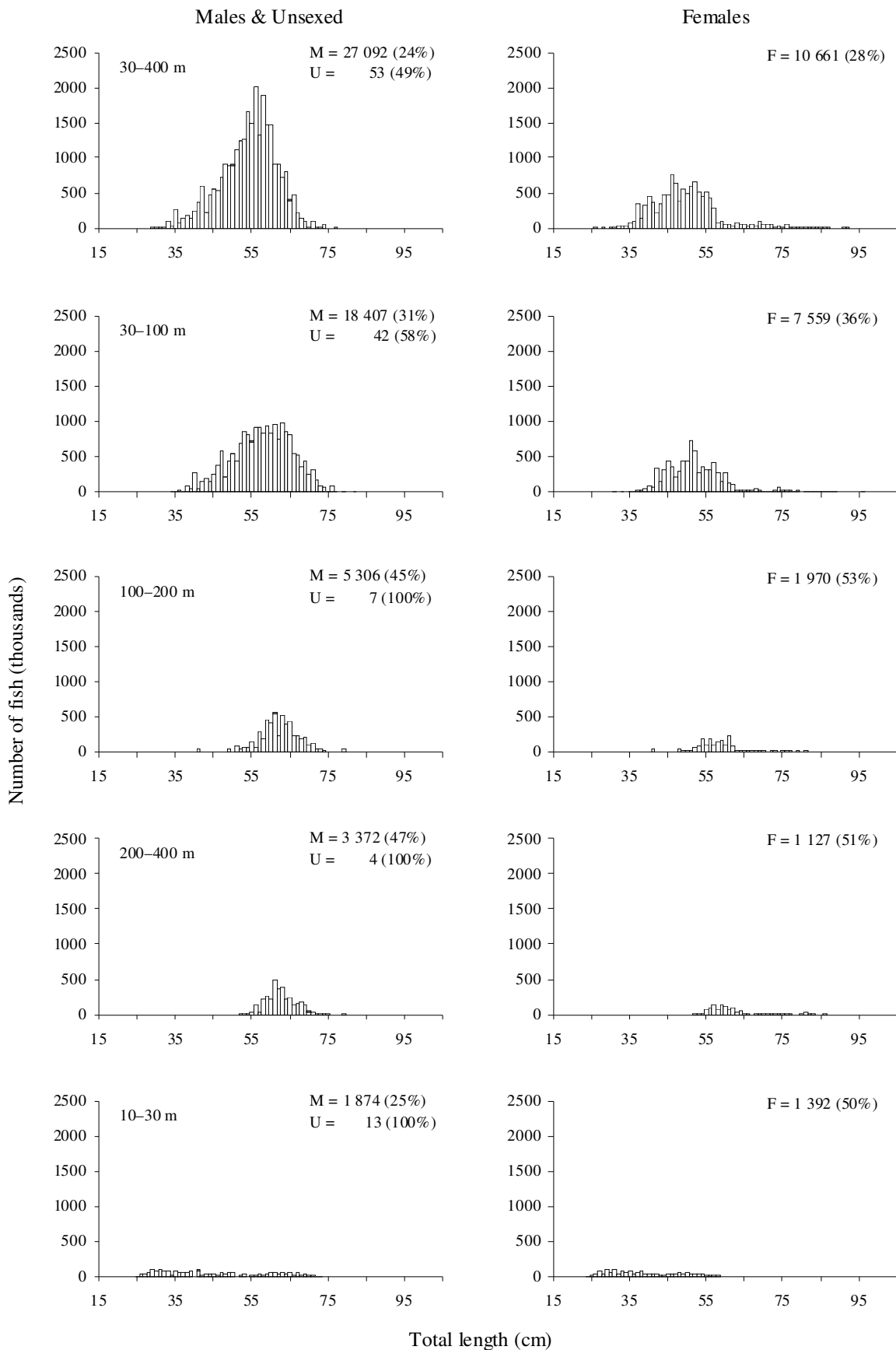


Figure 7-continued

Tarakihi

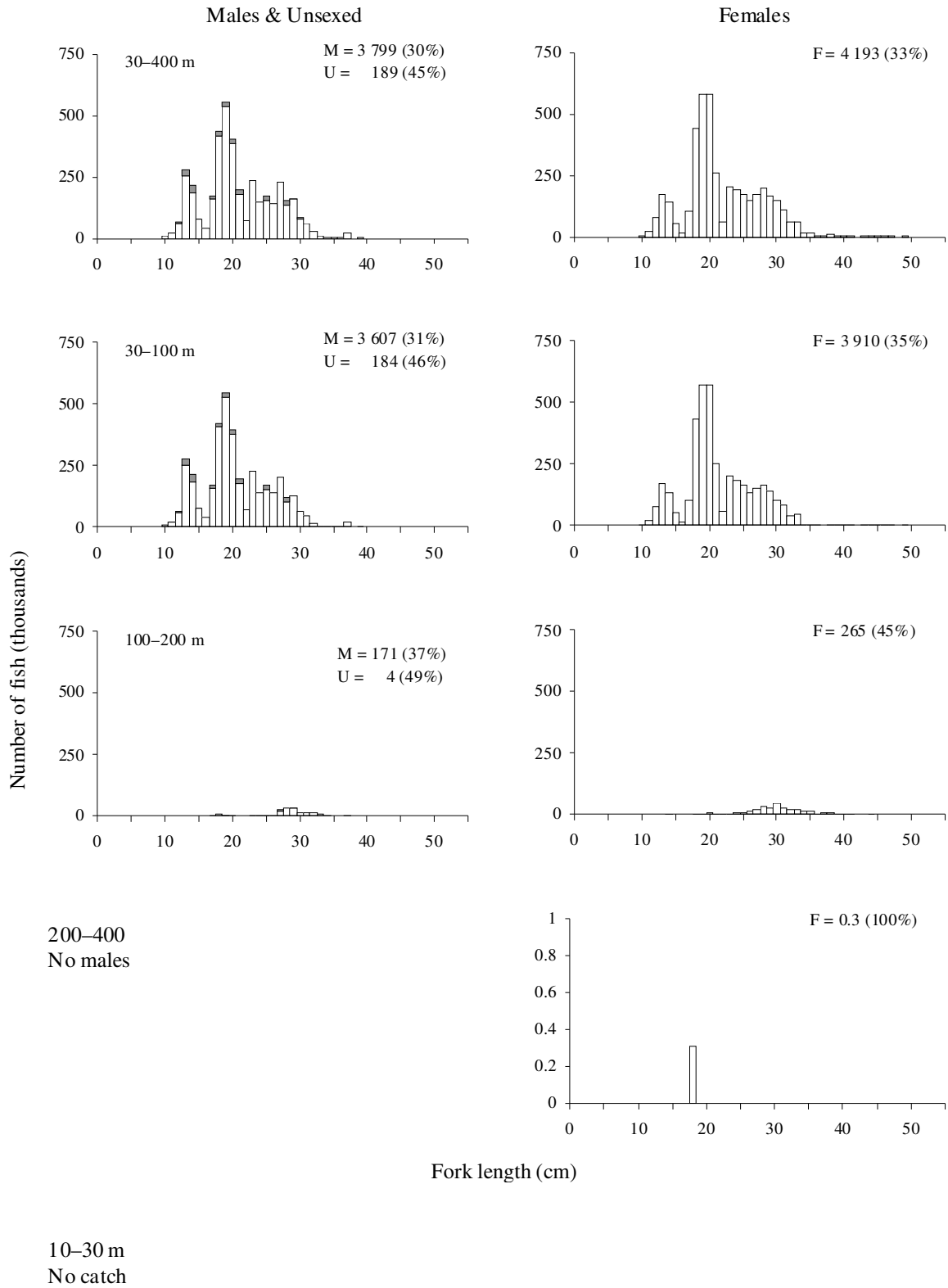


Figure 7–continued

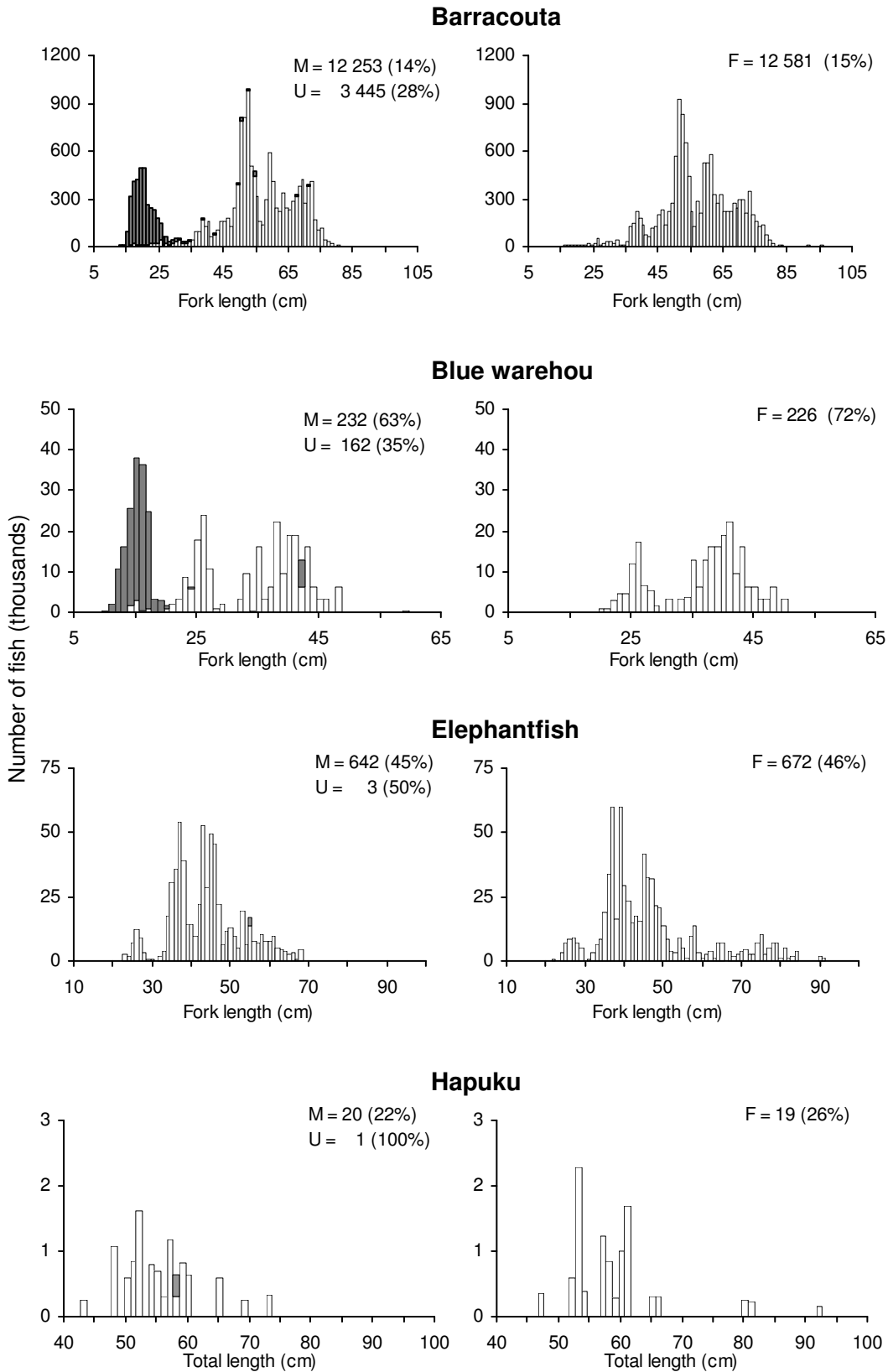


Figure 8: Scaled length frequency distributions for the main non-target species in 30–400 m for the 2008 survey. Population estimates are in thousands of fish. M, number of males; F, number of females; U, unsexed; (), c.v. Shaded areas represent unsexed fish.

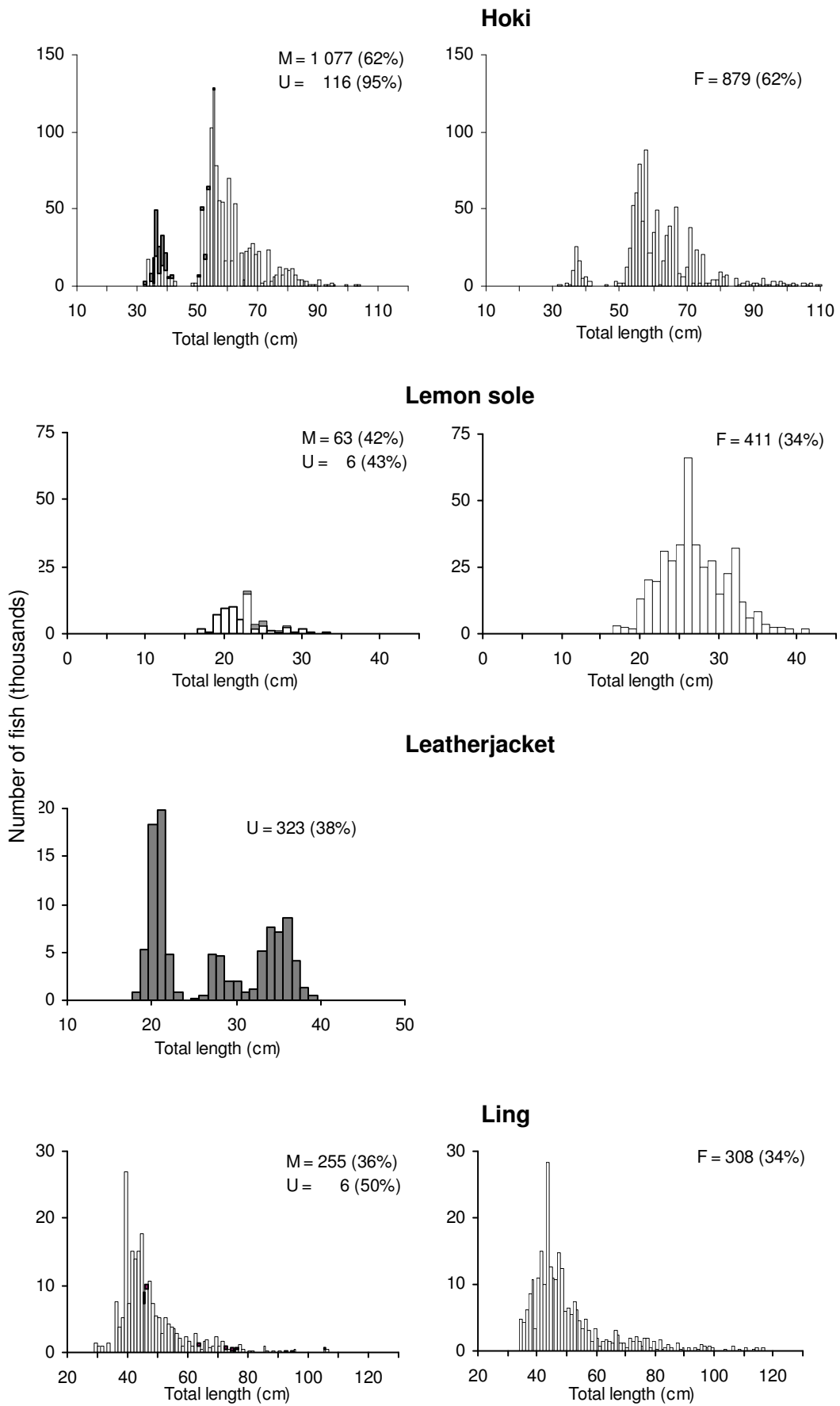
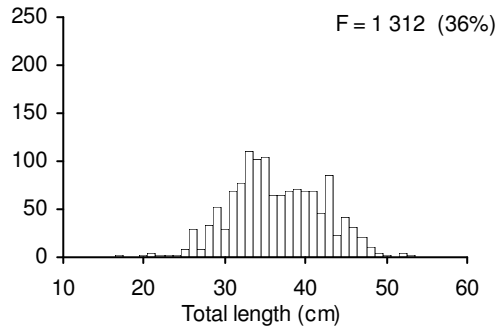
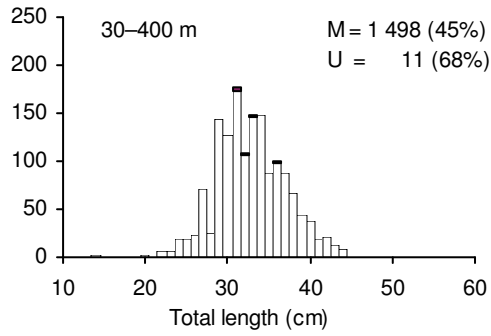
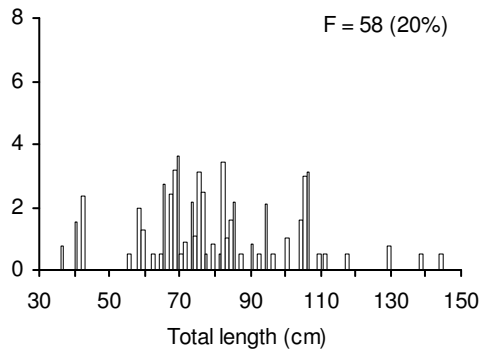
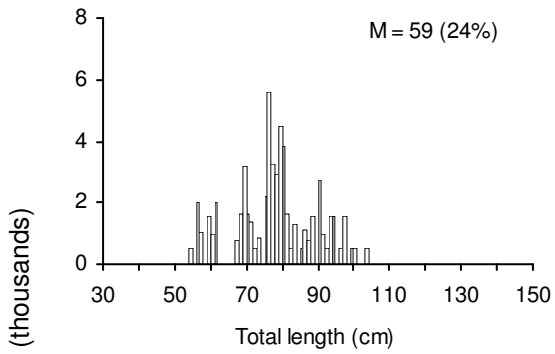


Figure 8—continued

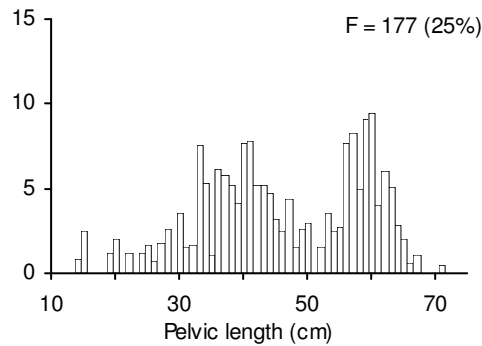
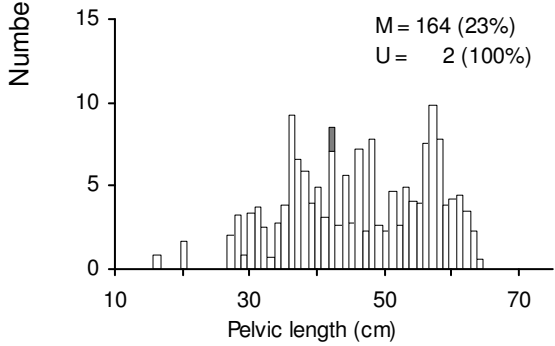
Red gurnard



Rig



Rough skate



School shark

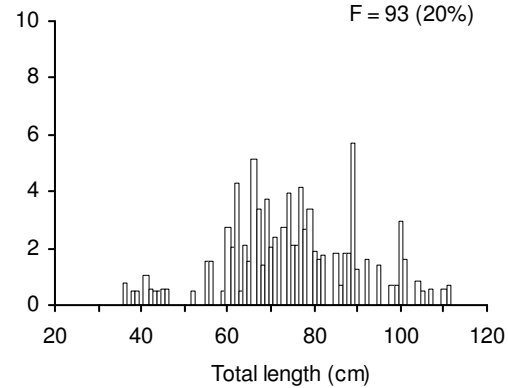
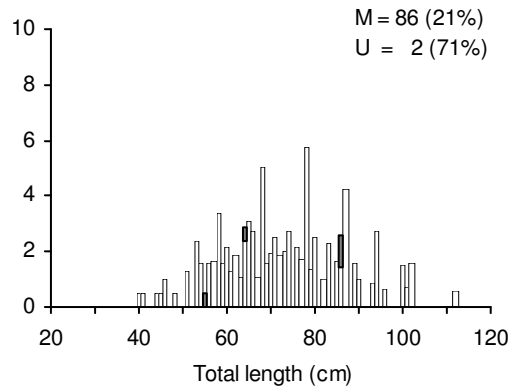


Figure 8-continued

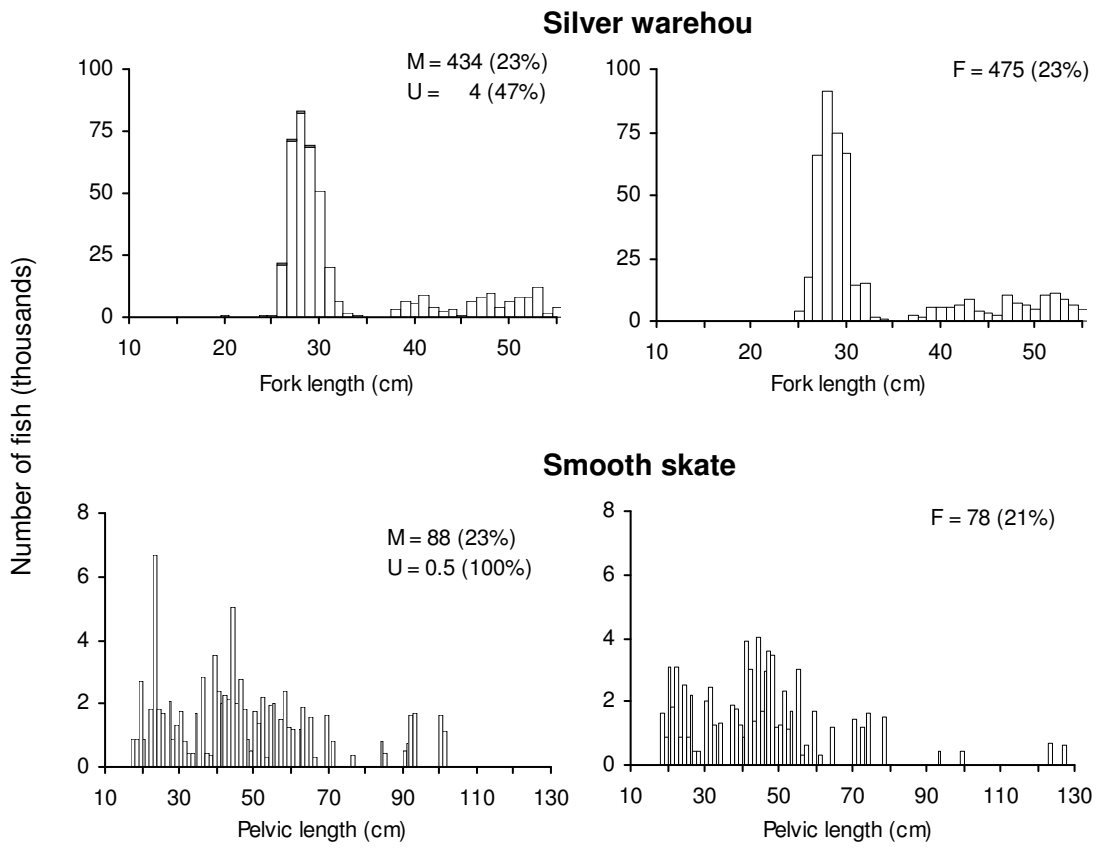


Figure 8—continued

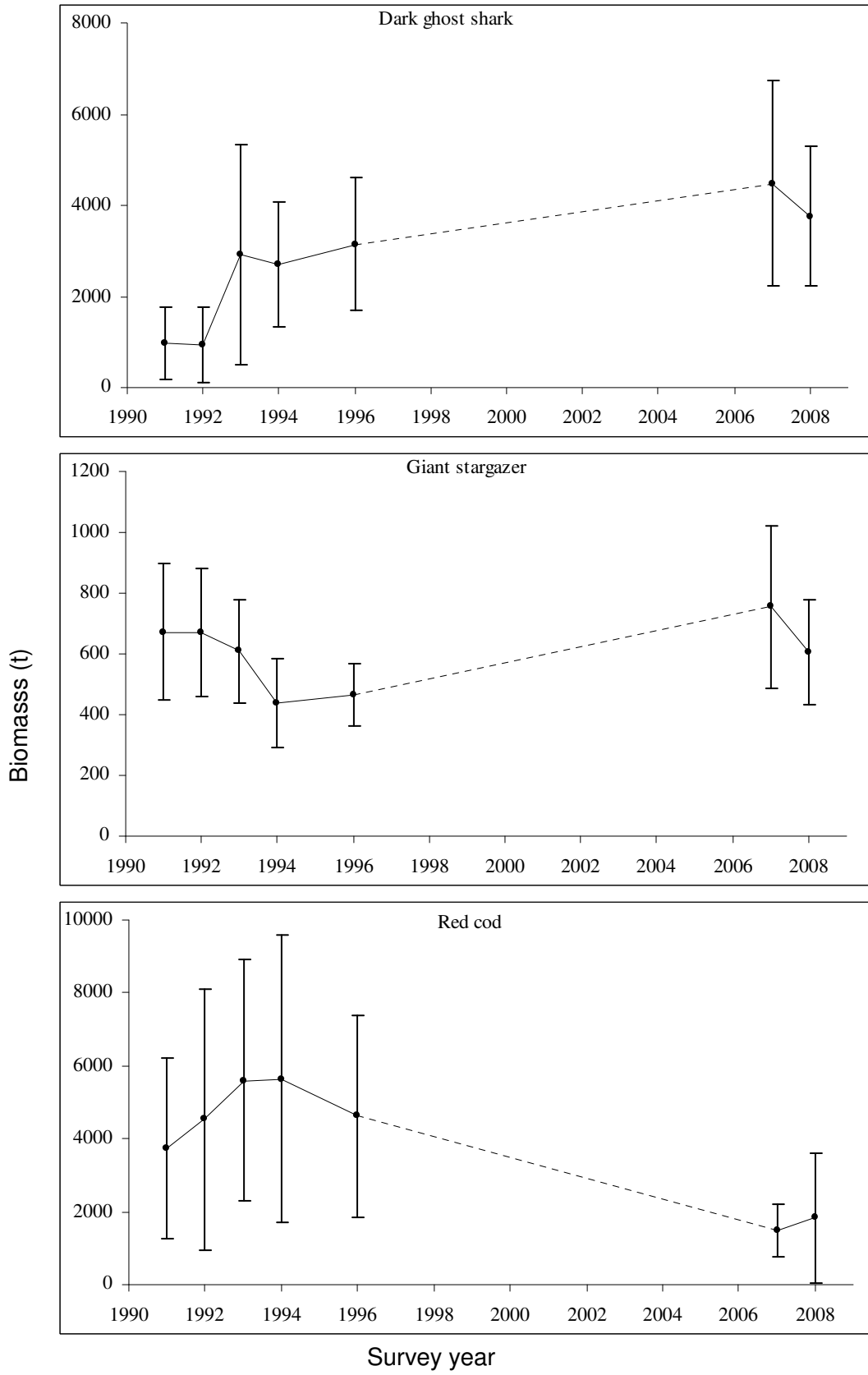
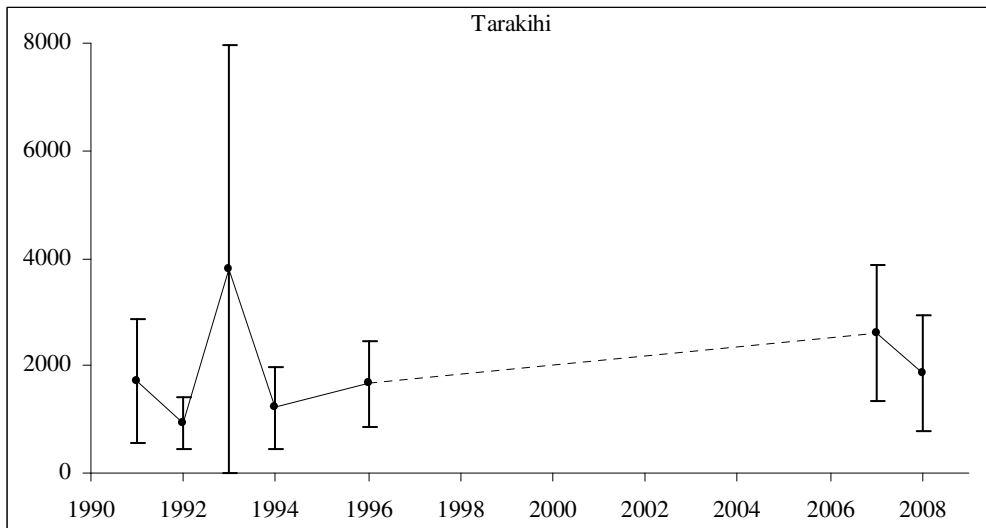
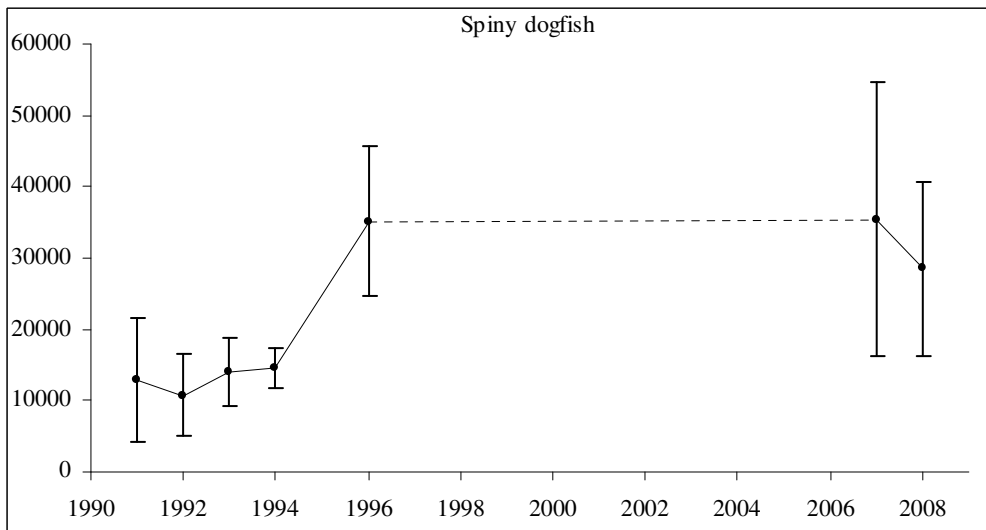
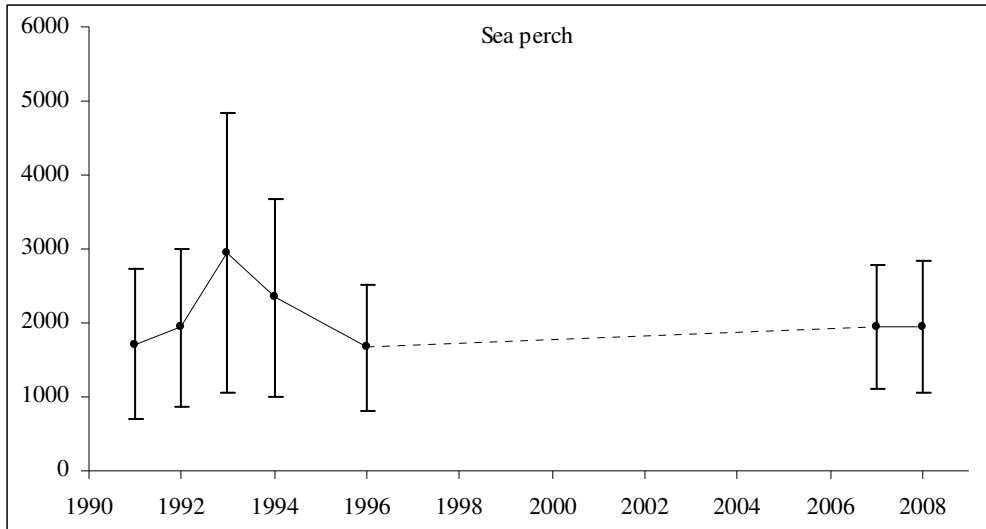


Figure 9: Target species biomass and 95% confidence intervals for the seven ECSI winter surveys.



Survey year

Figure 9 – continued.

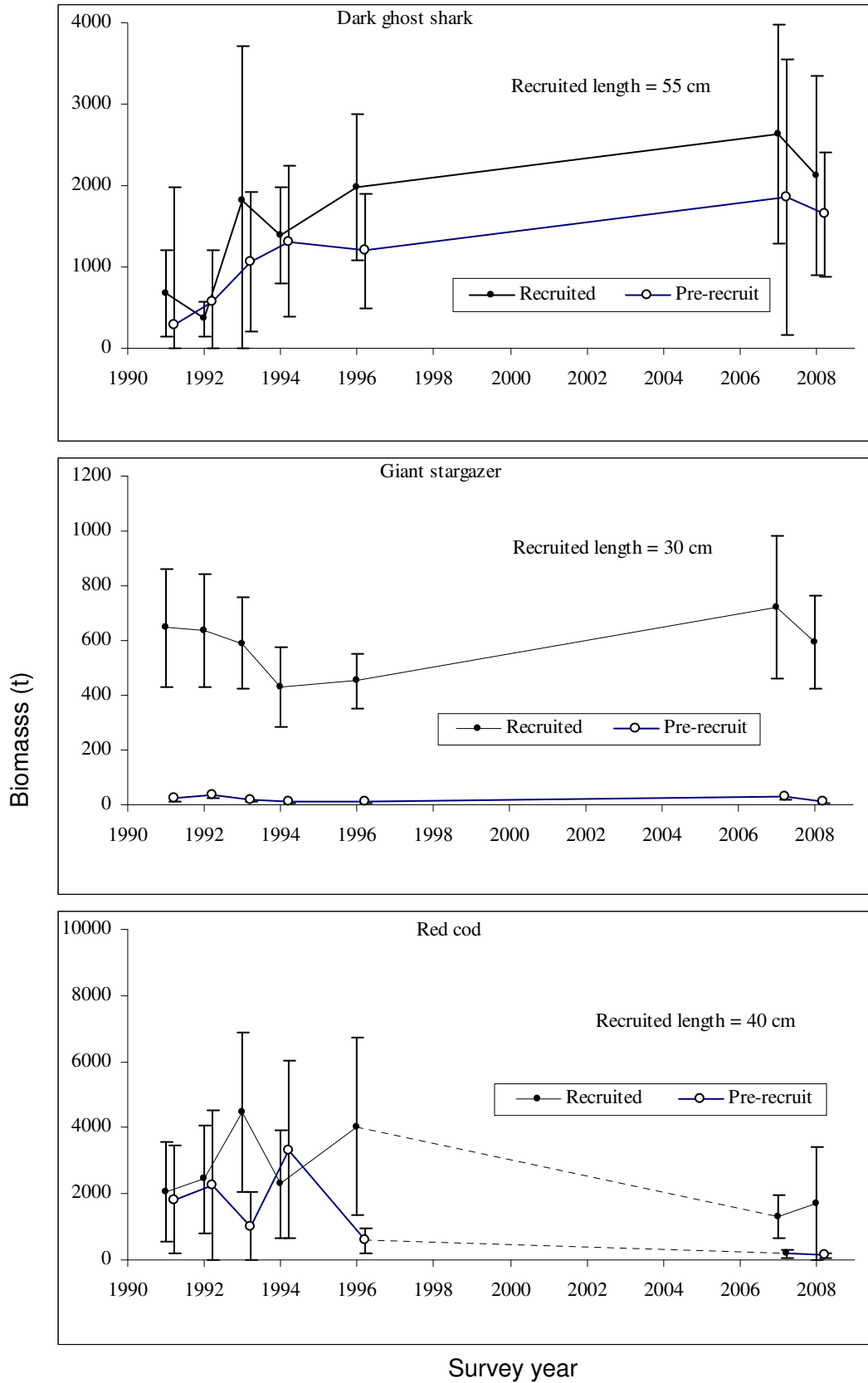
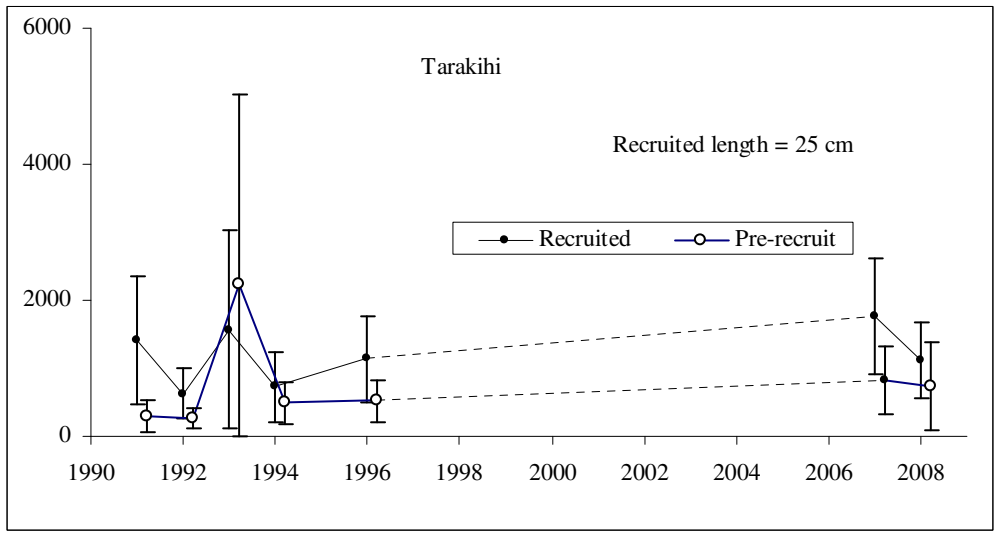
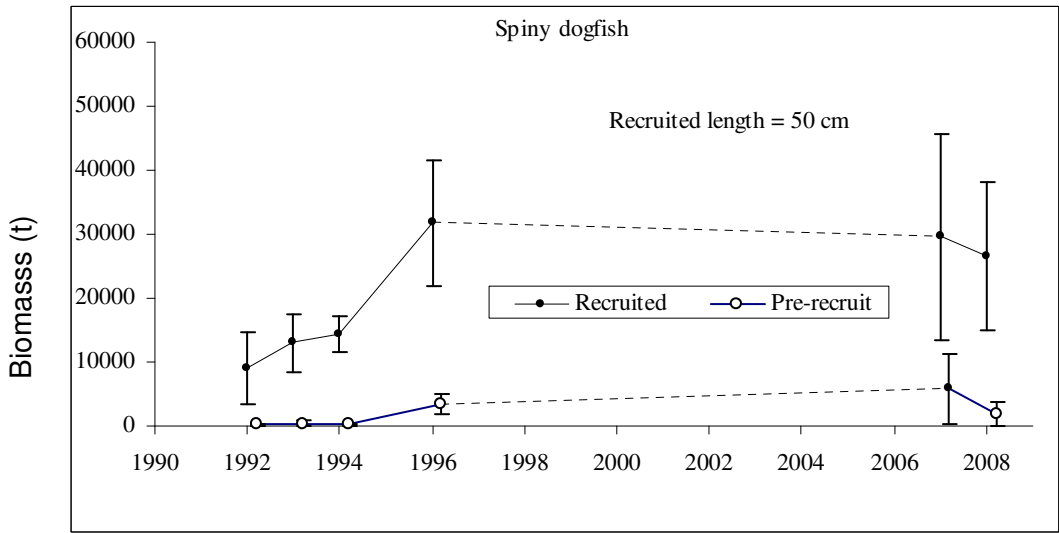
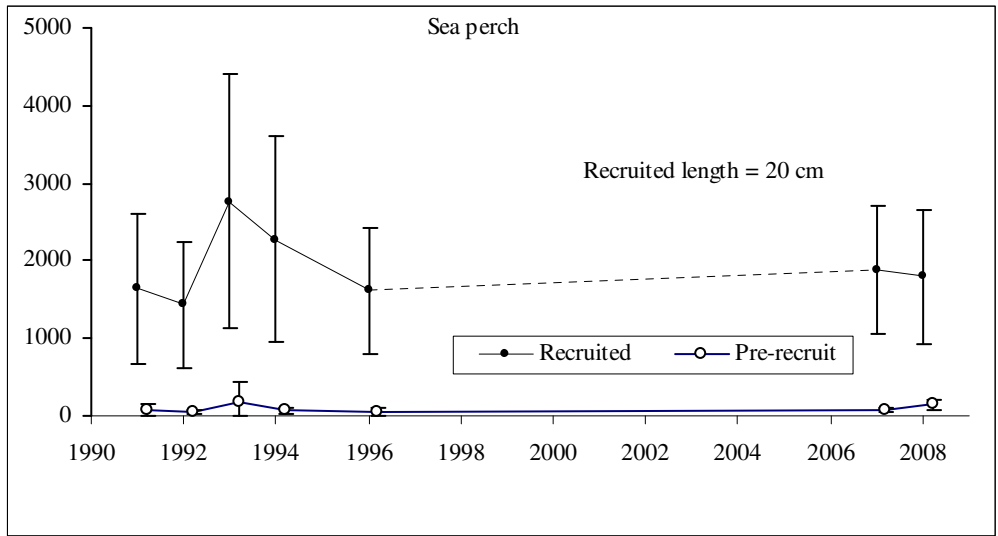


Figure 10: Target species recruited and pre-recruited biomass, and 95% confidence intervals for the seven ECSI winter surveys.



Survey year

Figure 10 – continued.

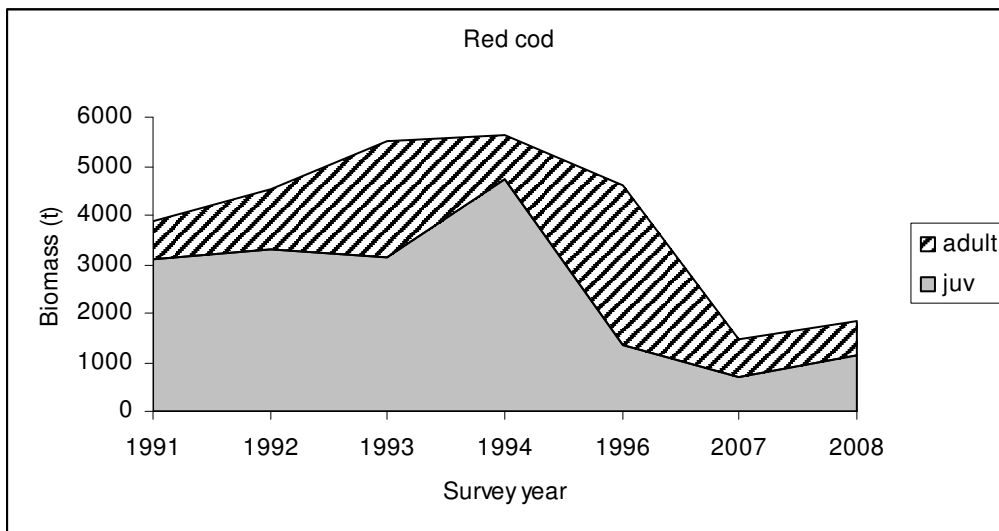
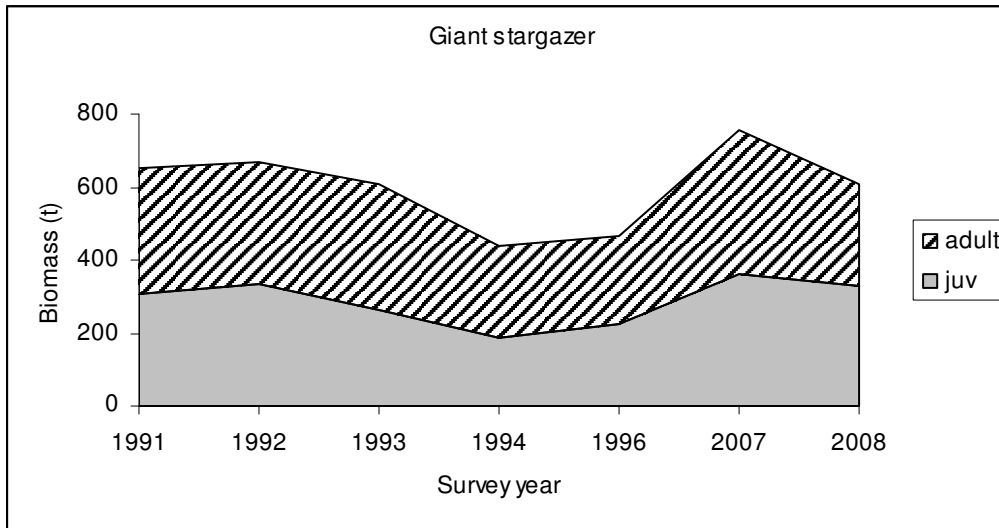
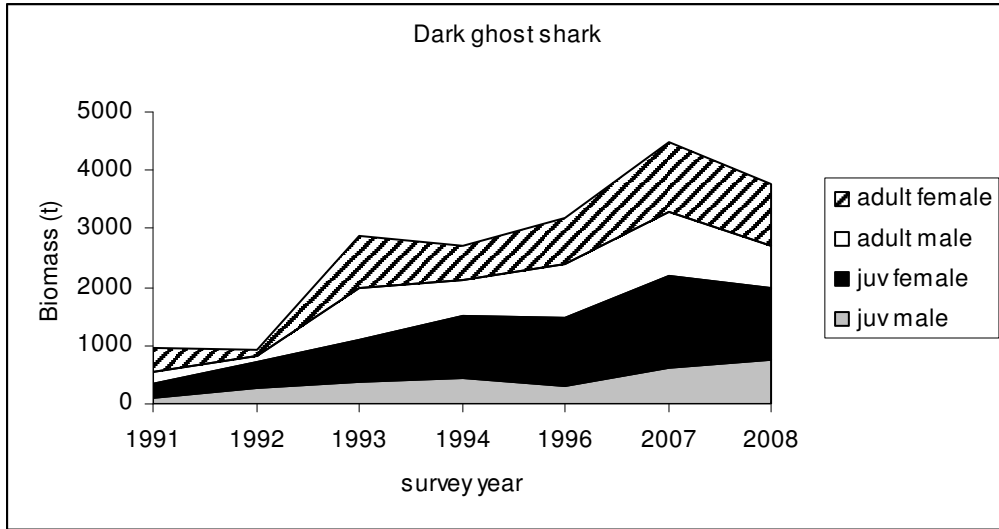


Figure 11: Target species juvenile and adult biomass for ECSI winter surveys, where juvenile is below and adult is equal to or above length at which 50% of fish are mature.

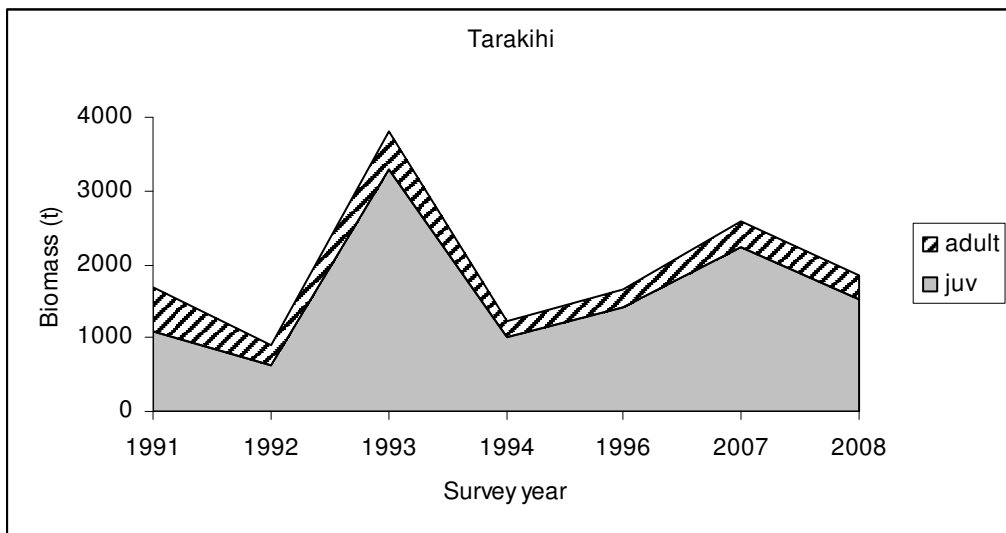
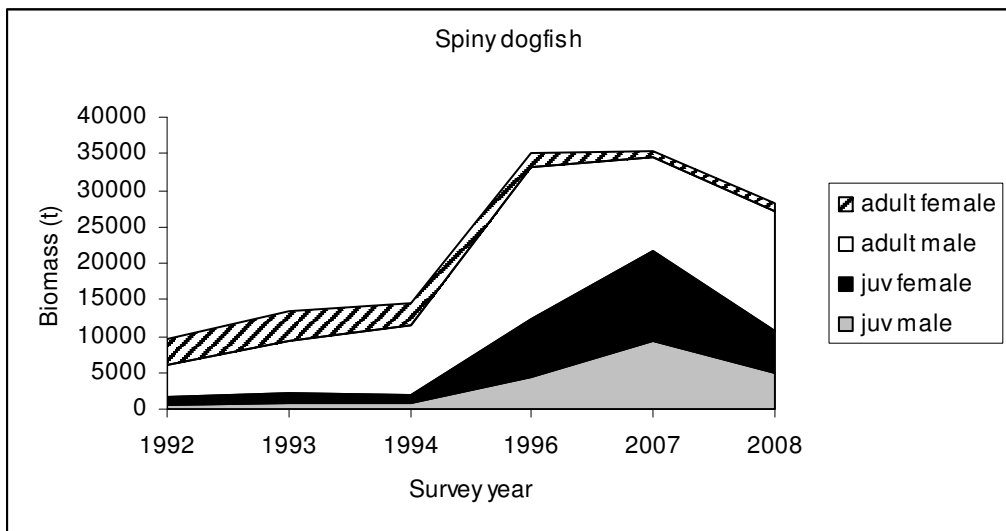
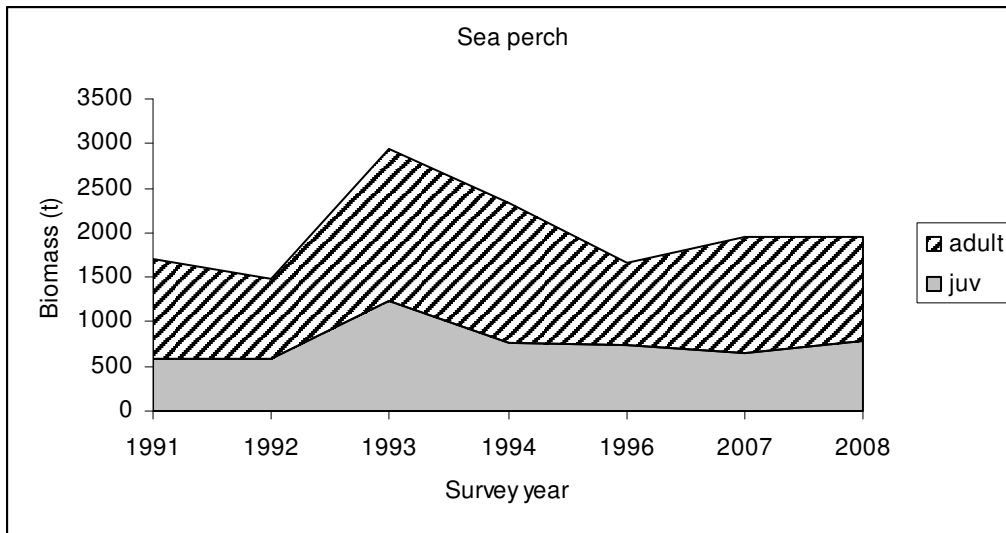


Figure 11 – continued

Dark ghost shark (1991 to 1994)

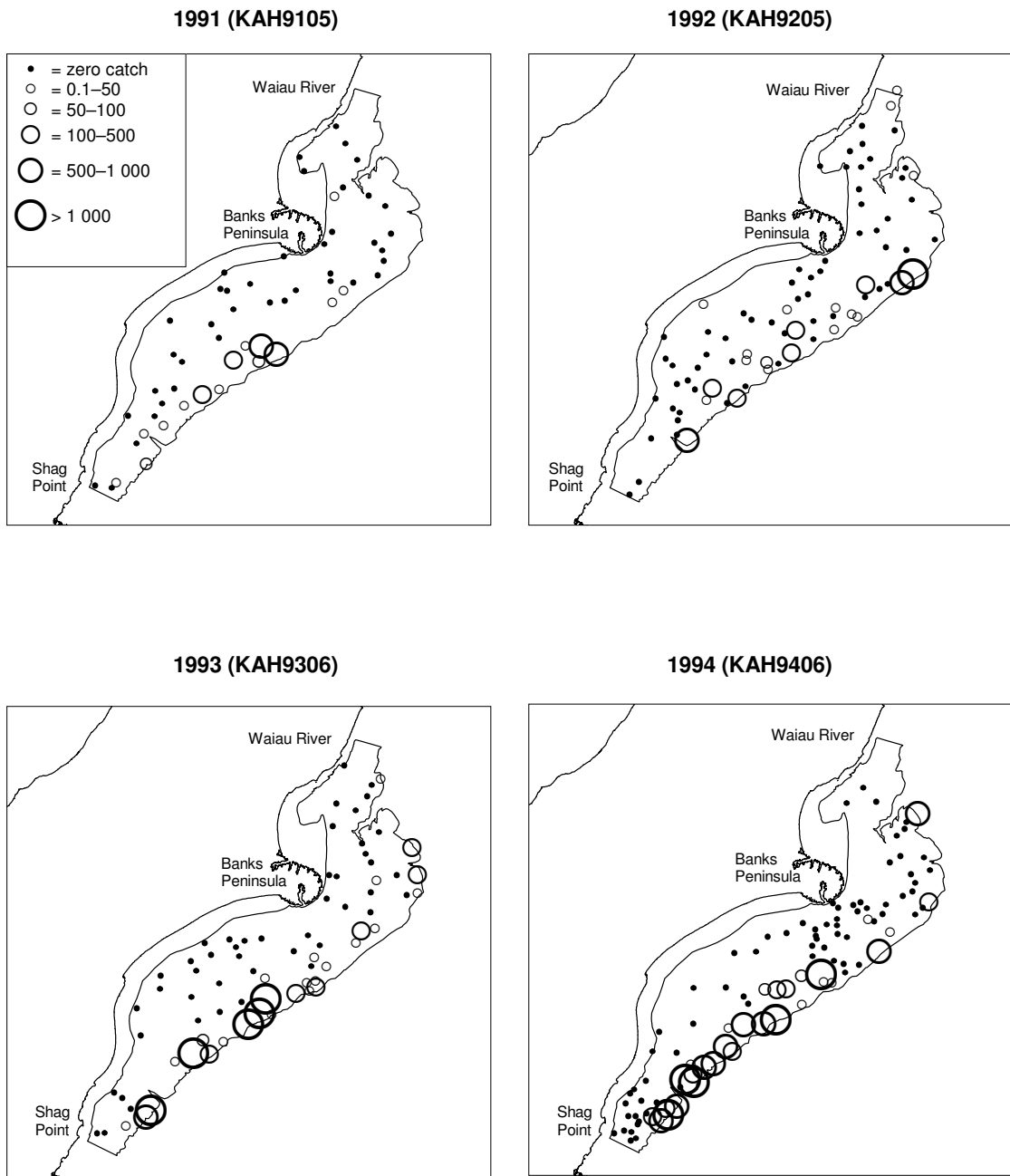


Figure 12: Catch rates (kg.km^{-2}) of target species for the seven ECSI winter trawl surveys in 30–400 m.

Dark ghost shark (1996 to 2008)

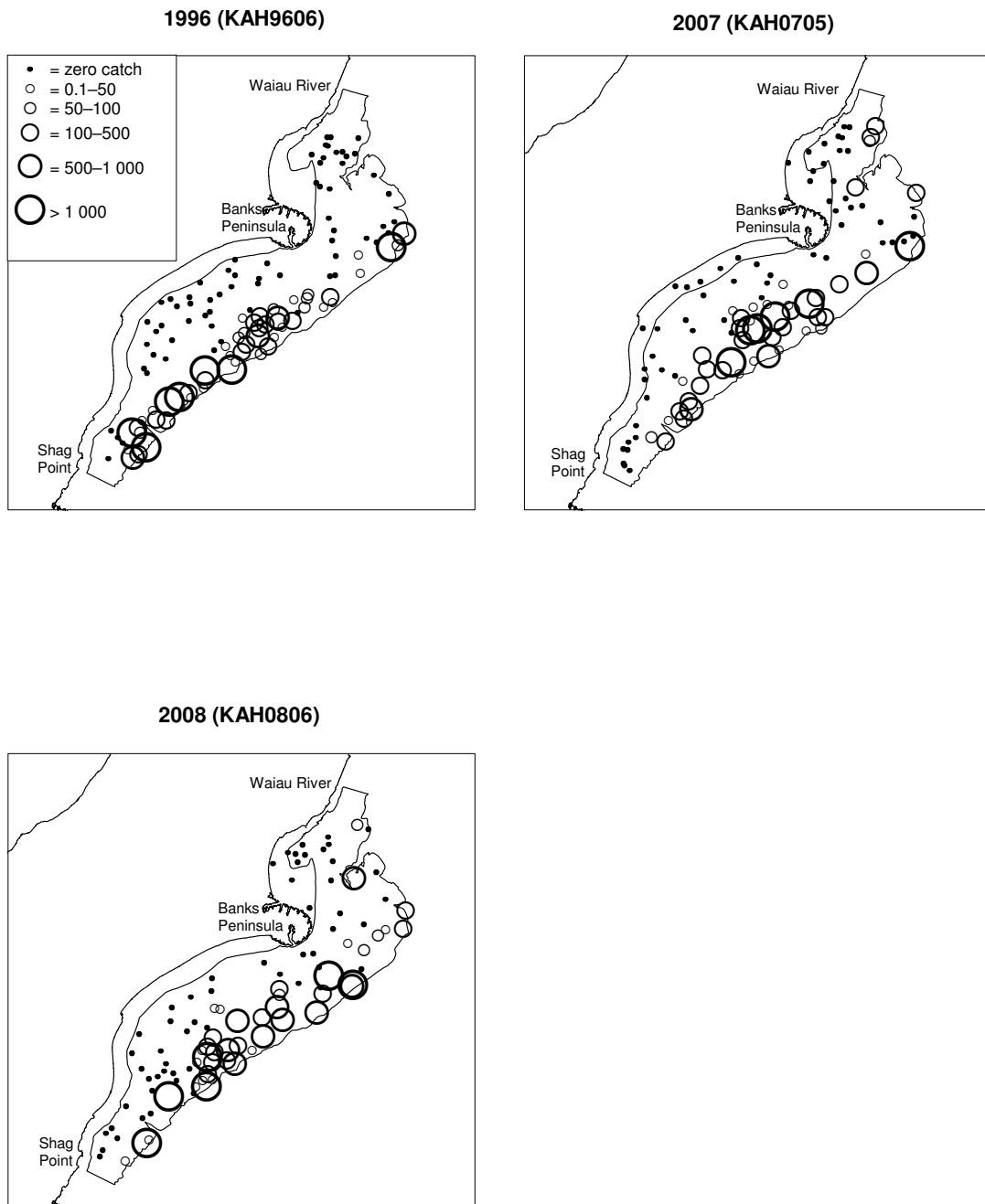


Figure 12—continued

Giant stargazer (1996 to 2008)

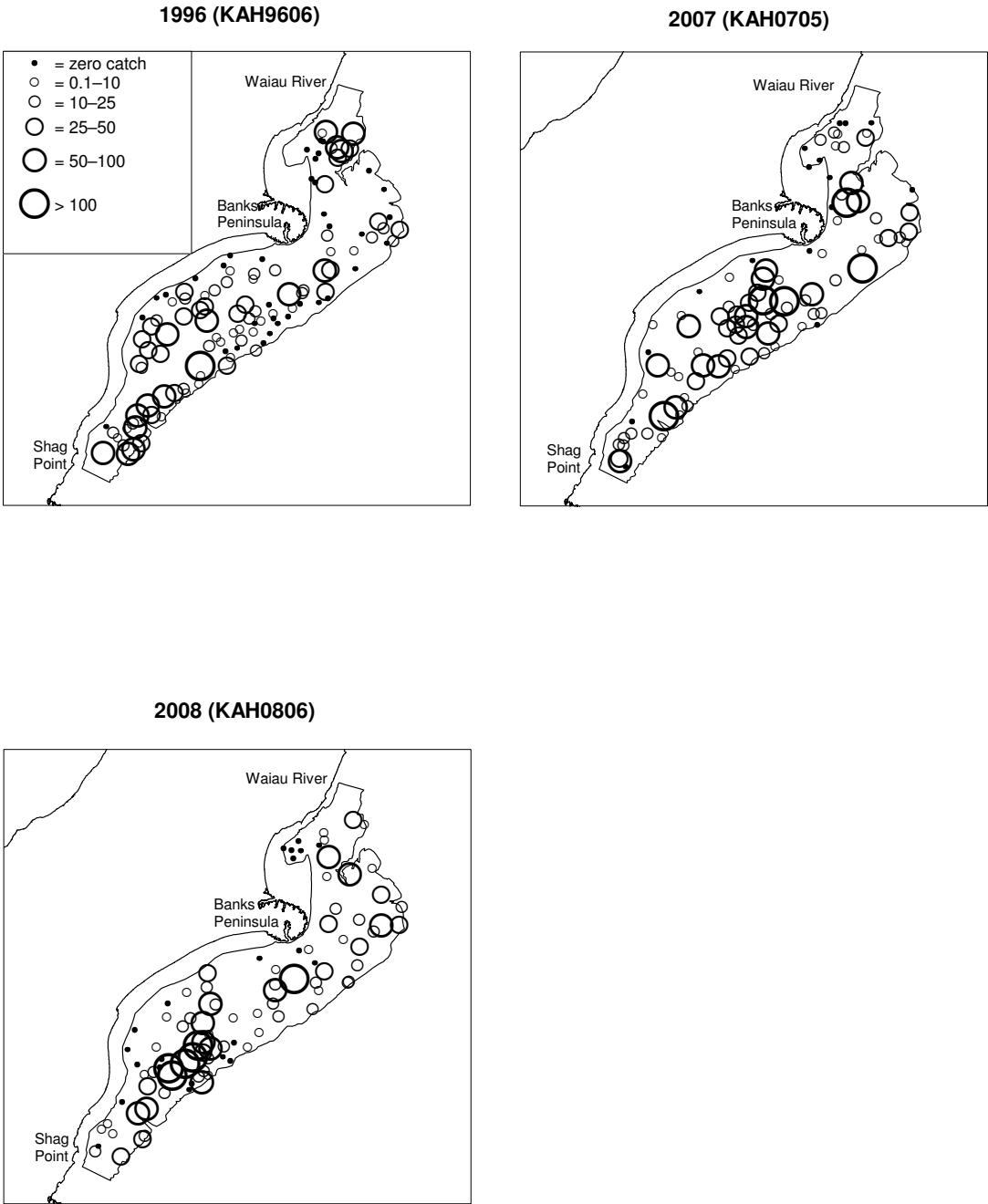


Figure 12—continued

Red cod (1991–1994)

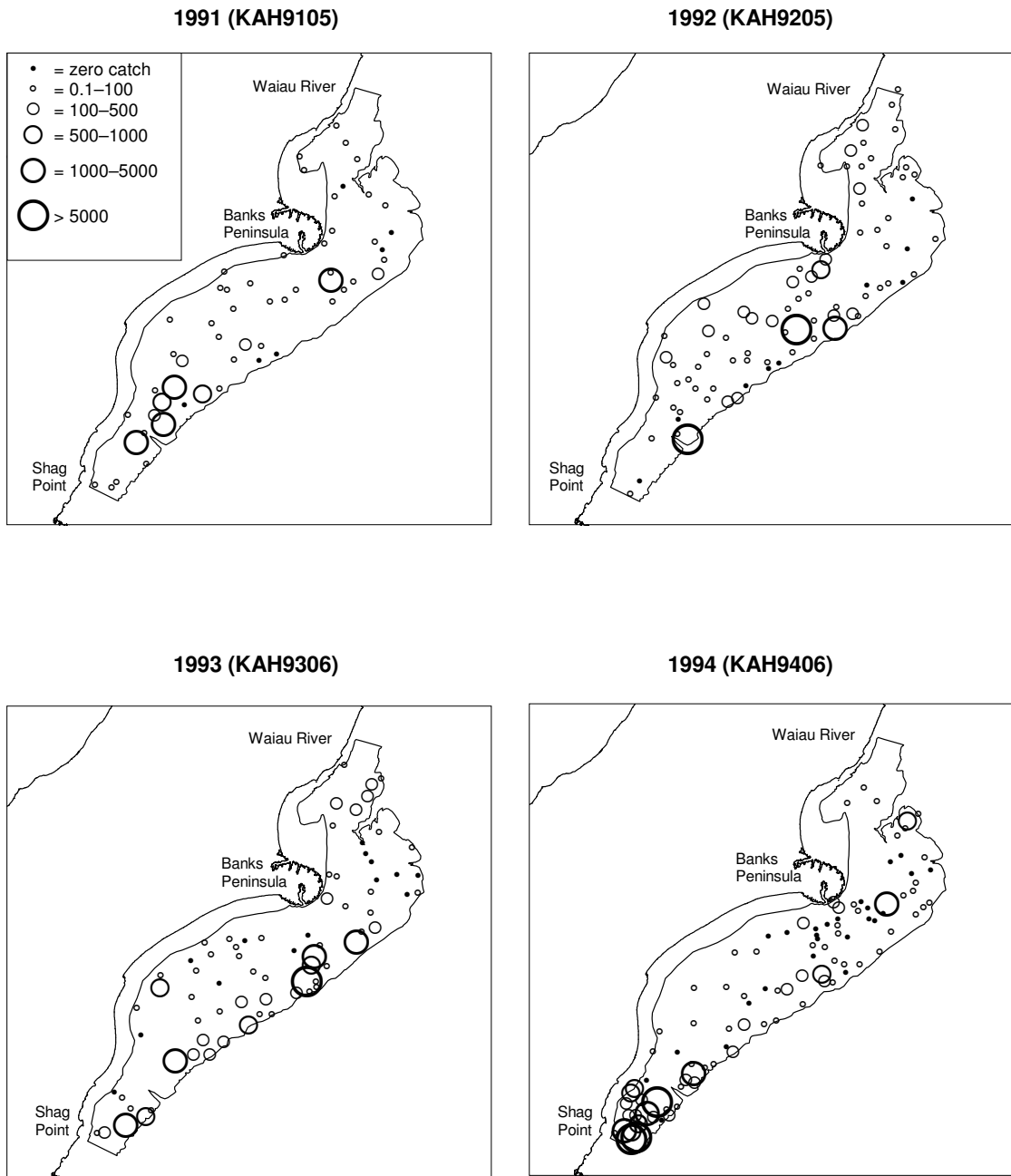


Figure 12—continued

Red cod (1996 to 2008)

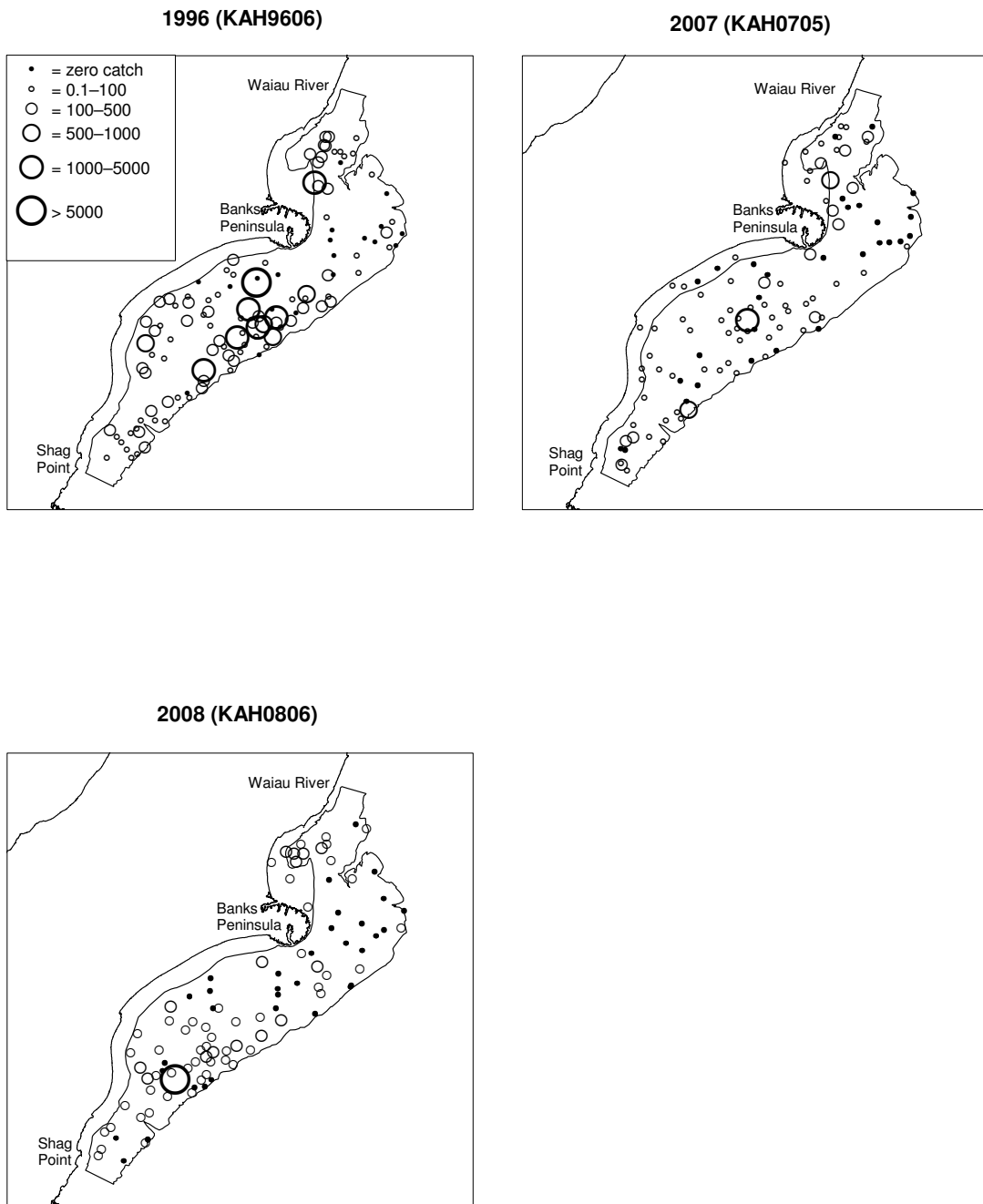


Figure 12—continued

Sea perch (1991 to 1994)

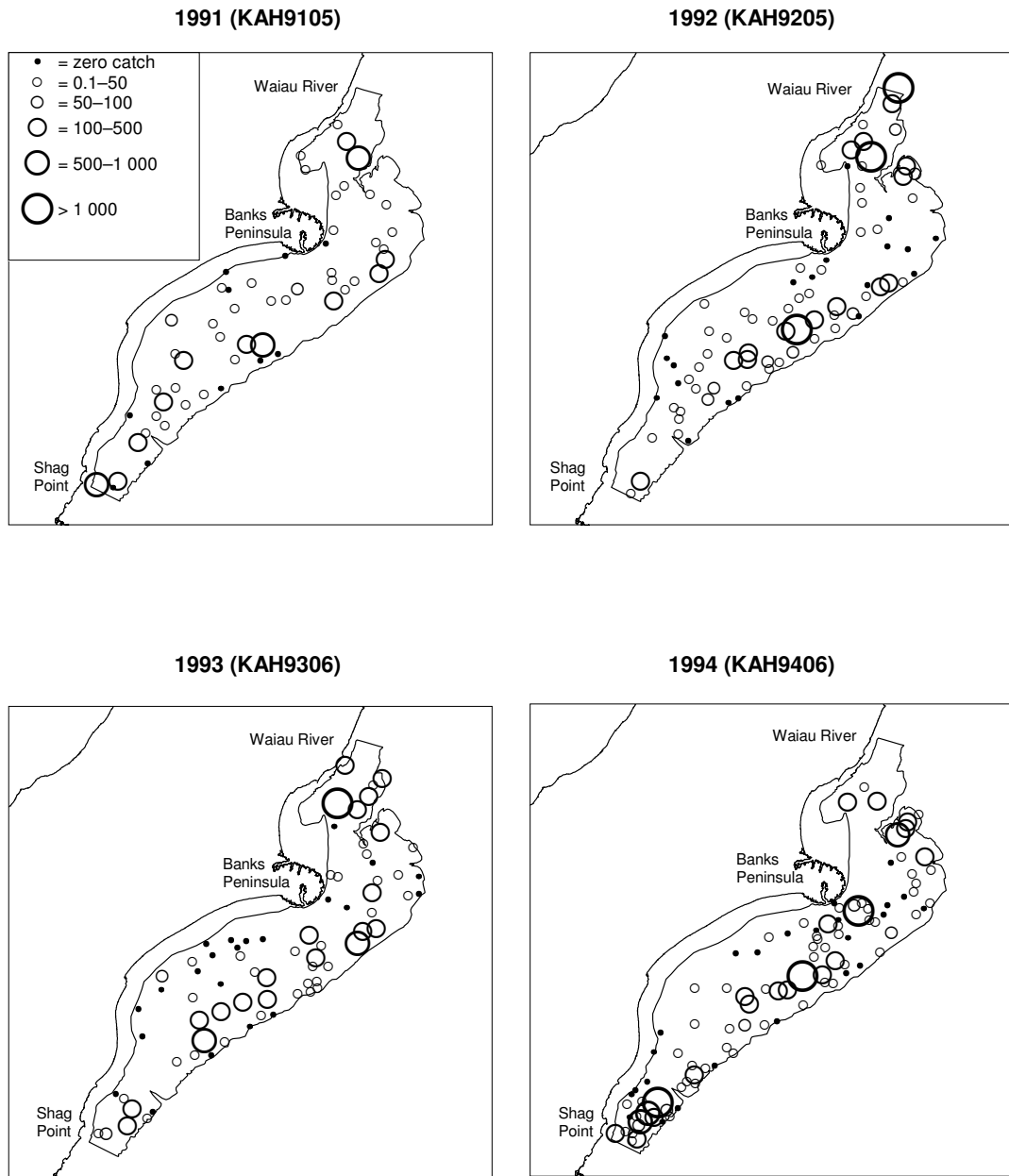


Figure 12—continued

Spiny dogfish (1991 to 1994)

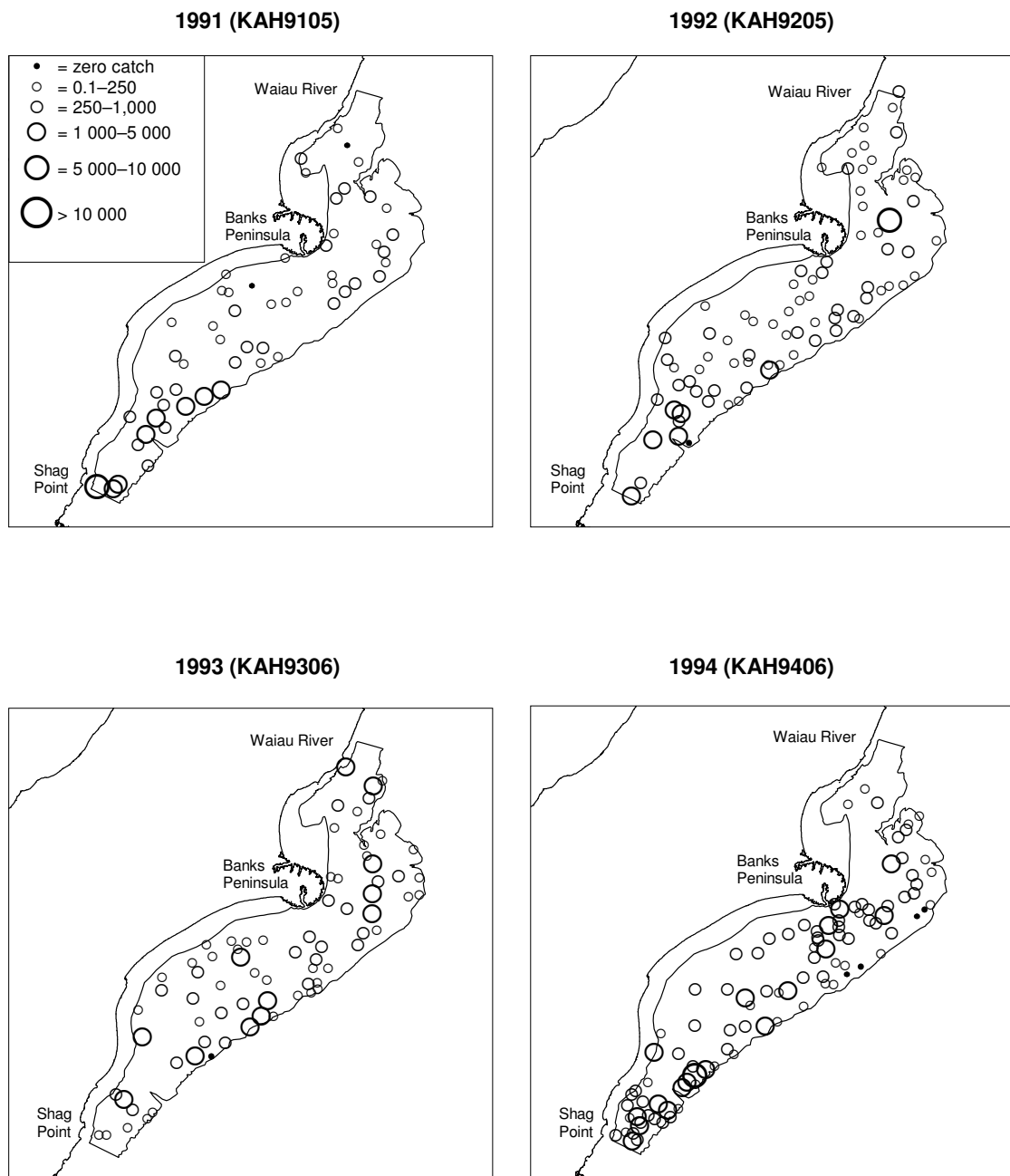


Figure 12—continued

Spiny dogfish (1996 to 2008)



Figure 12—continued

Tarakihi (1991–1994)

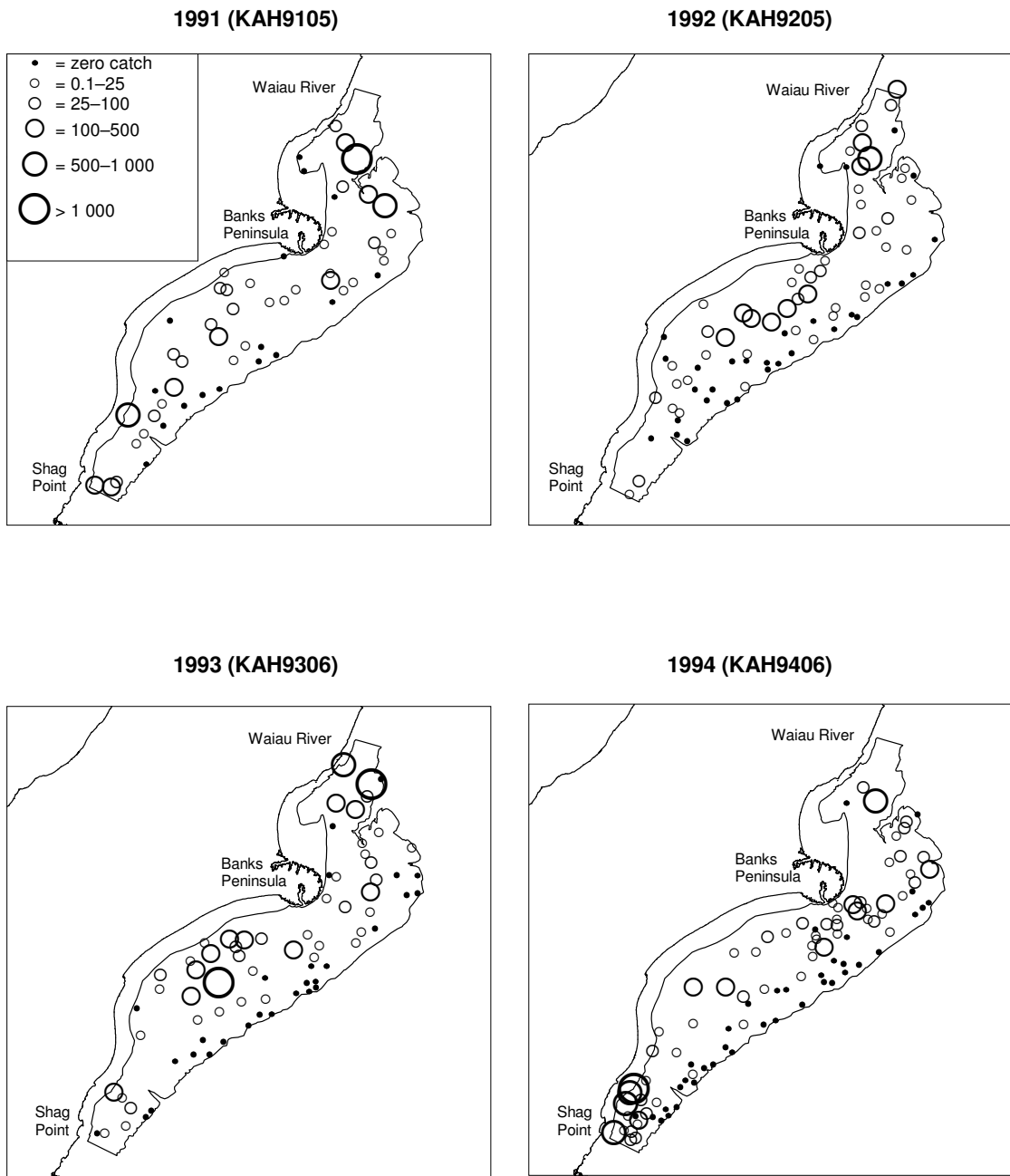


Figure 12–continued

Tarakihi (1996–2008)

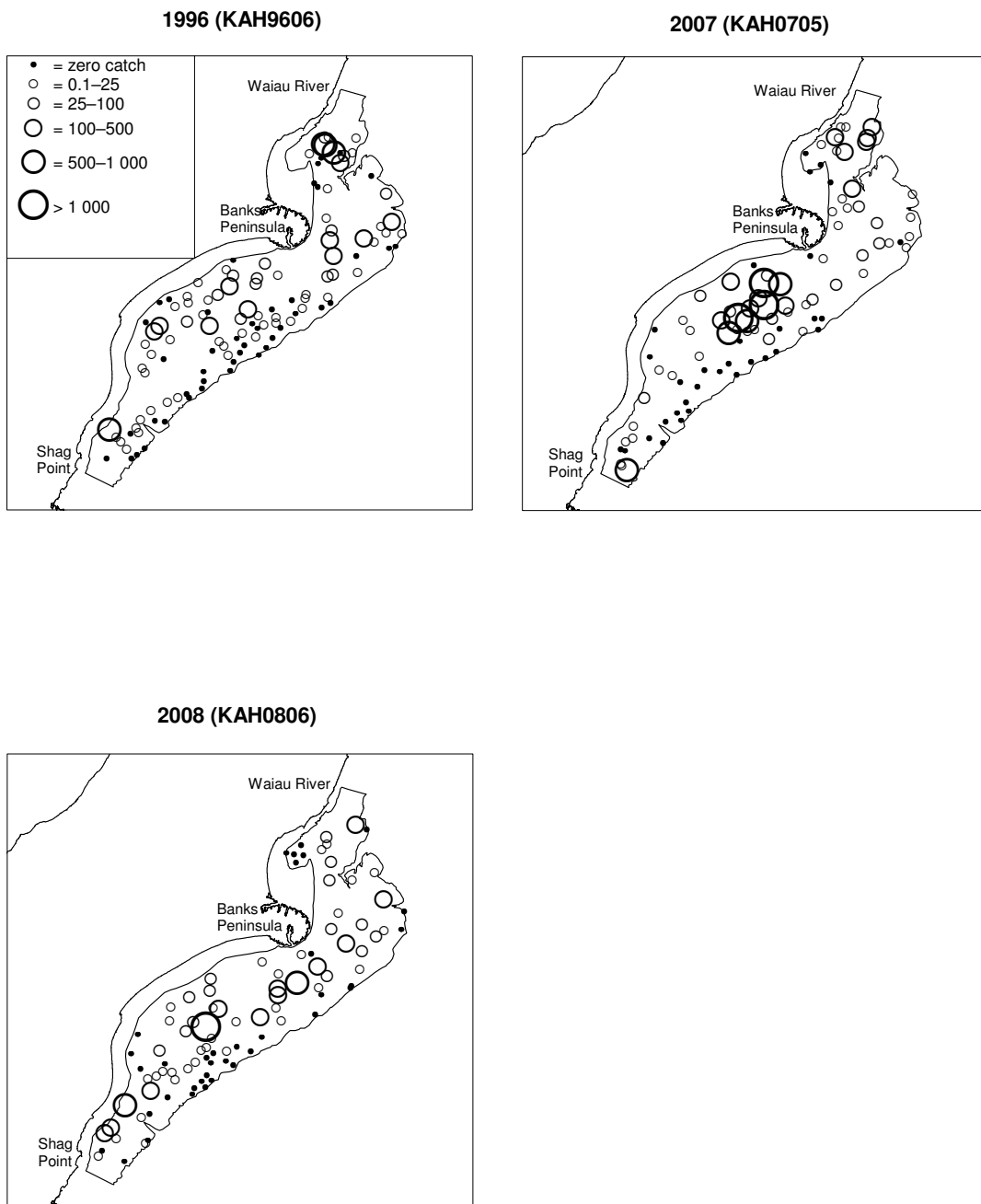


Figure 12–continued

Dark ghost shark

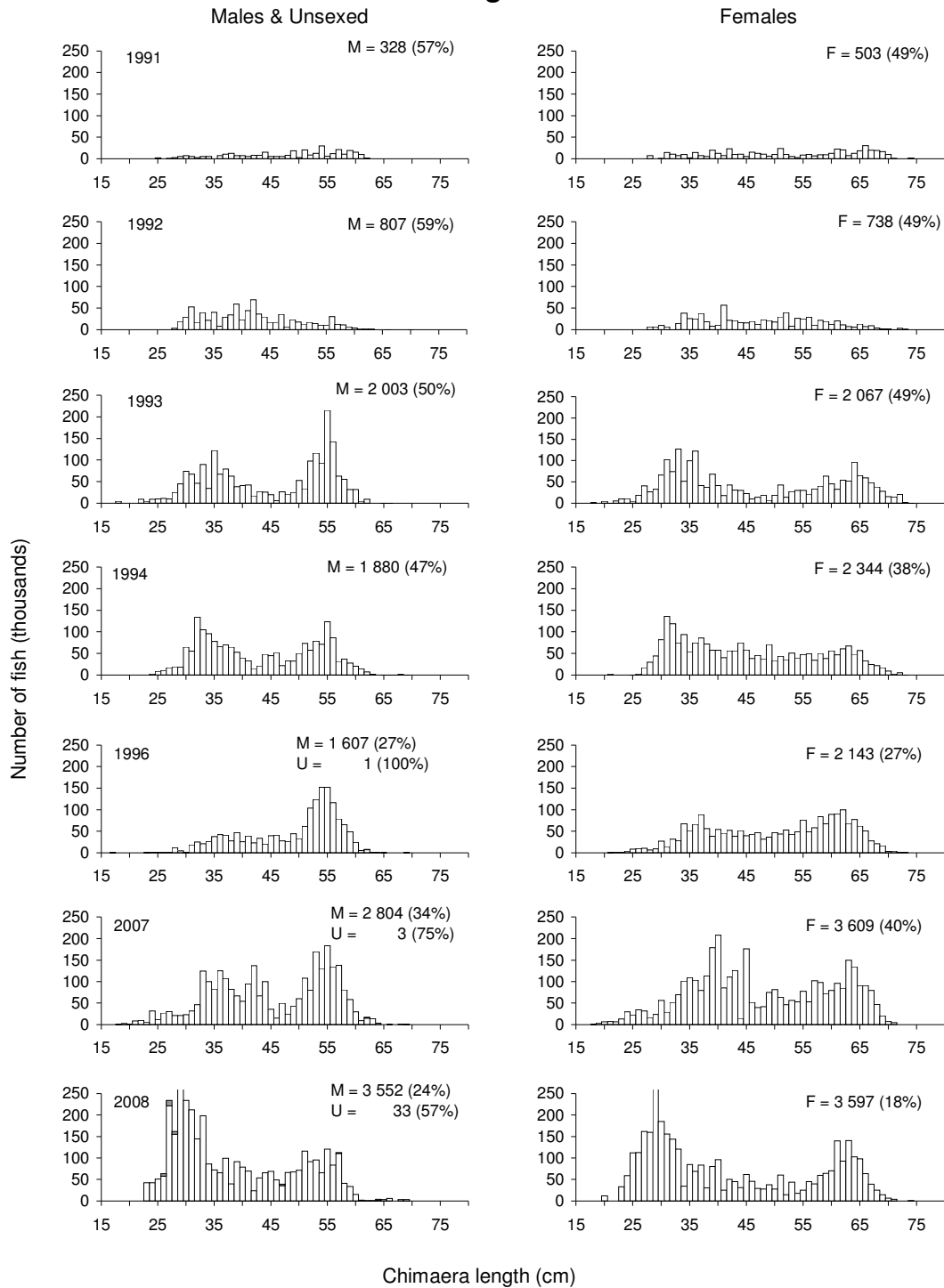


Figure 13: Scaled length frequency distributions for the target species in 30–400 m, for all six winter ECSI surveys. Population estimates are in thousands of fish. M, males; F, females; U, unsexed; (), c.v. Shaded areas represent unsexed fish.

Giant stargazer

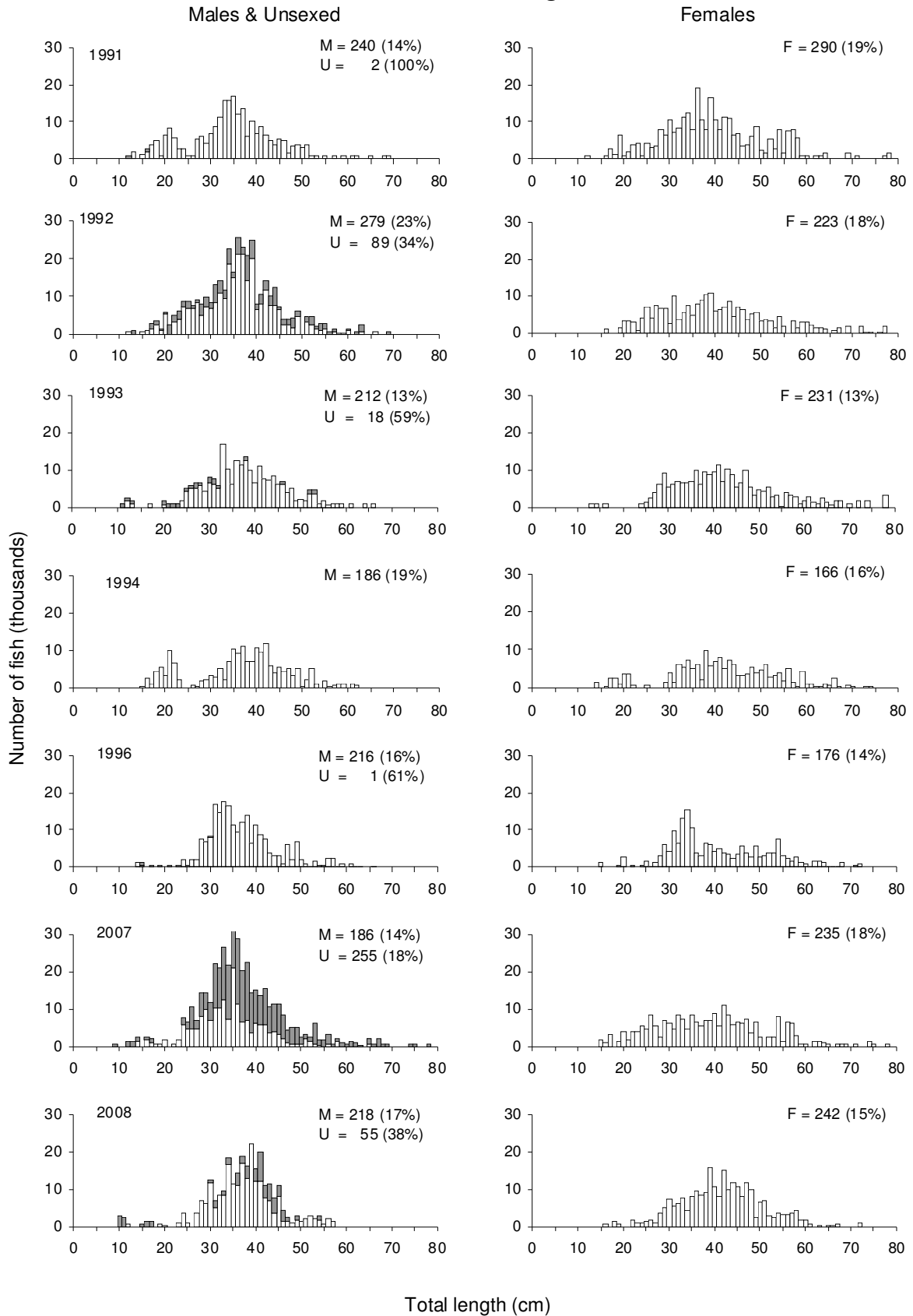


Figure 13—continued

Red cod

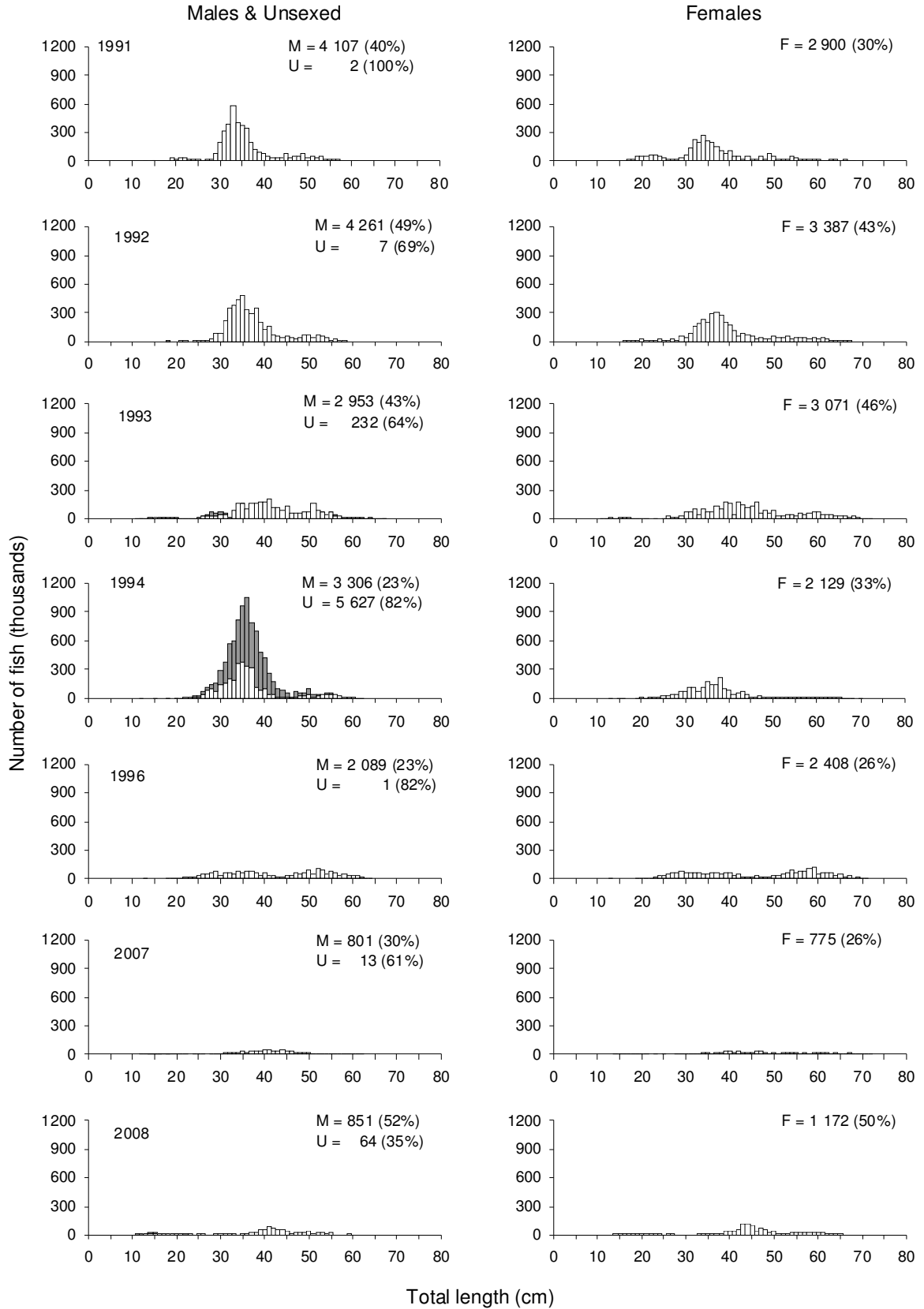


Figure 13—continued

Sea perch

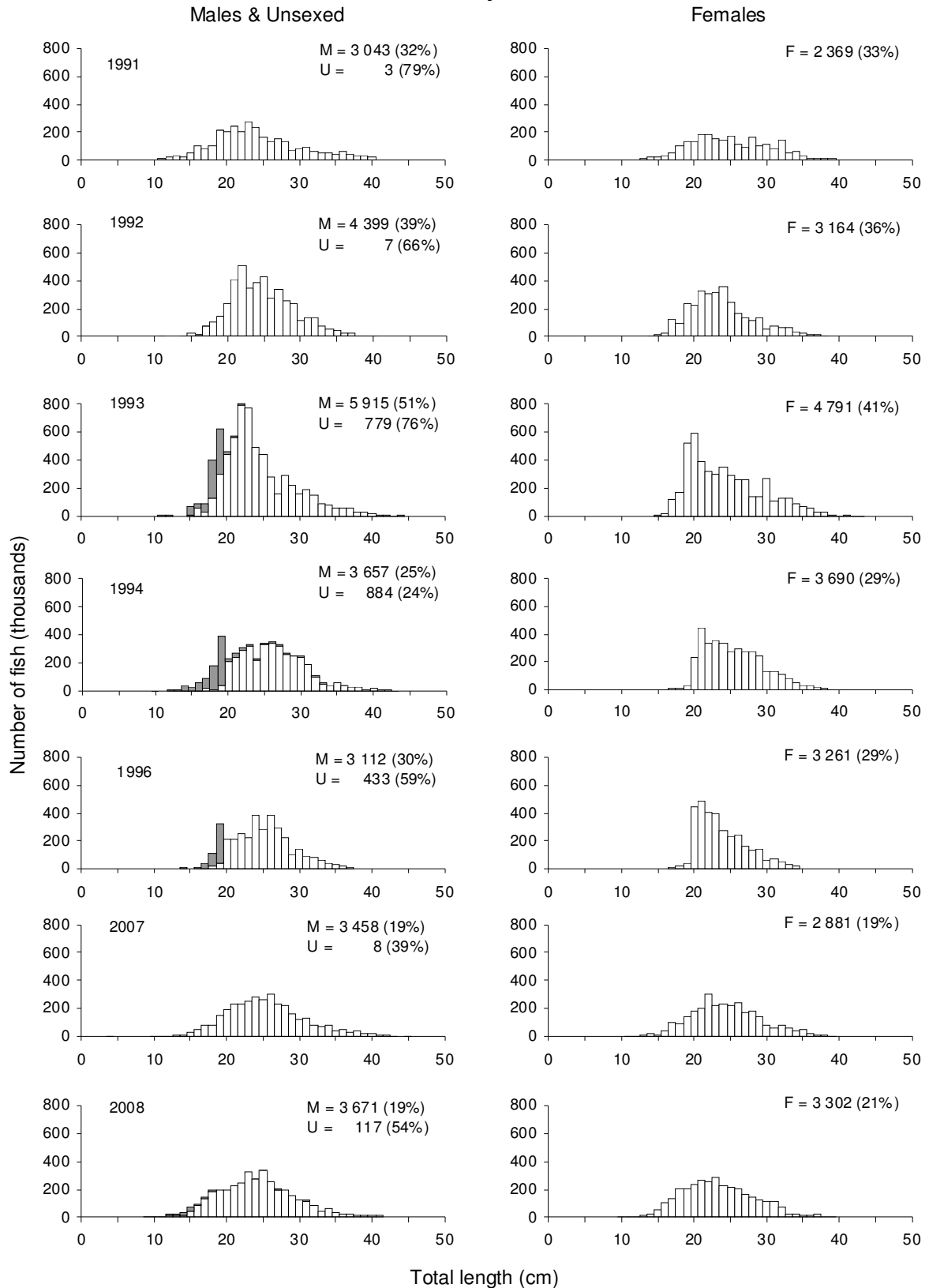


Figure 13—continued

Spiny dogfish

Males & Unsexed

Females

1991
Not measured

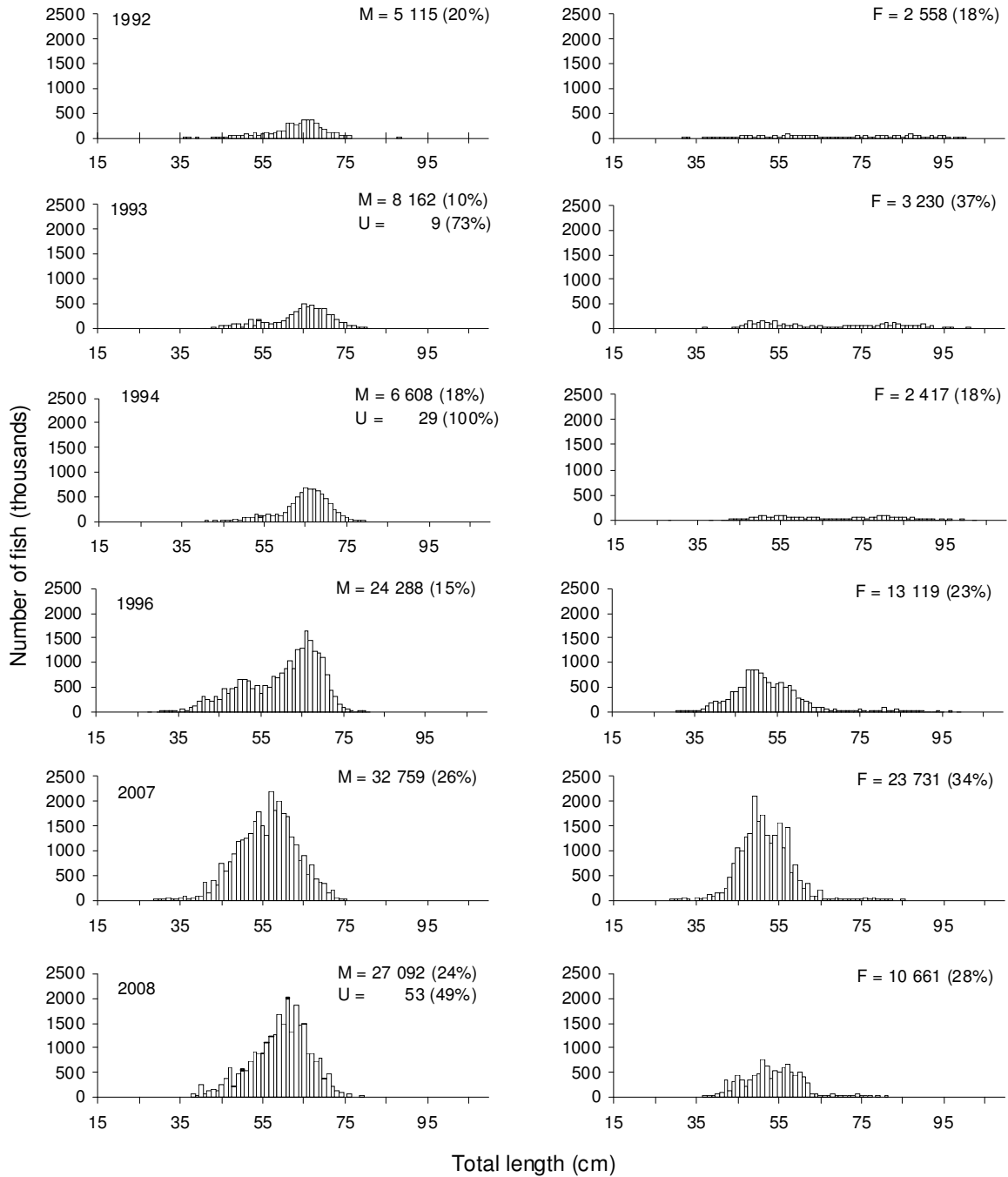


Figure 13—continued

Tarakihi

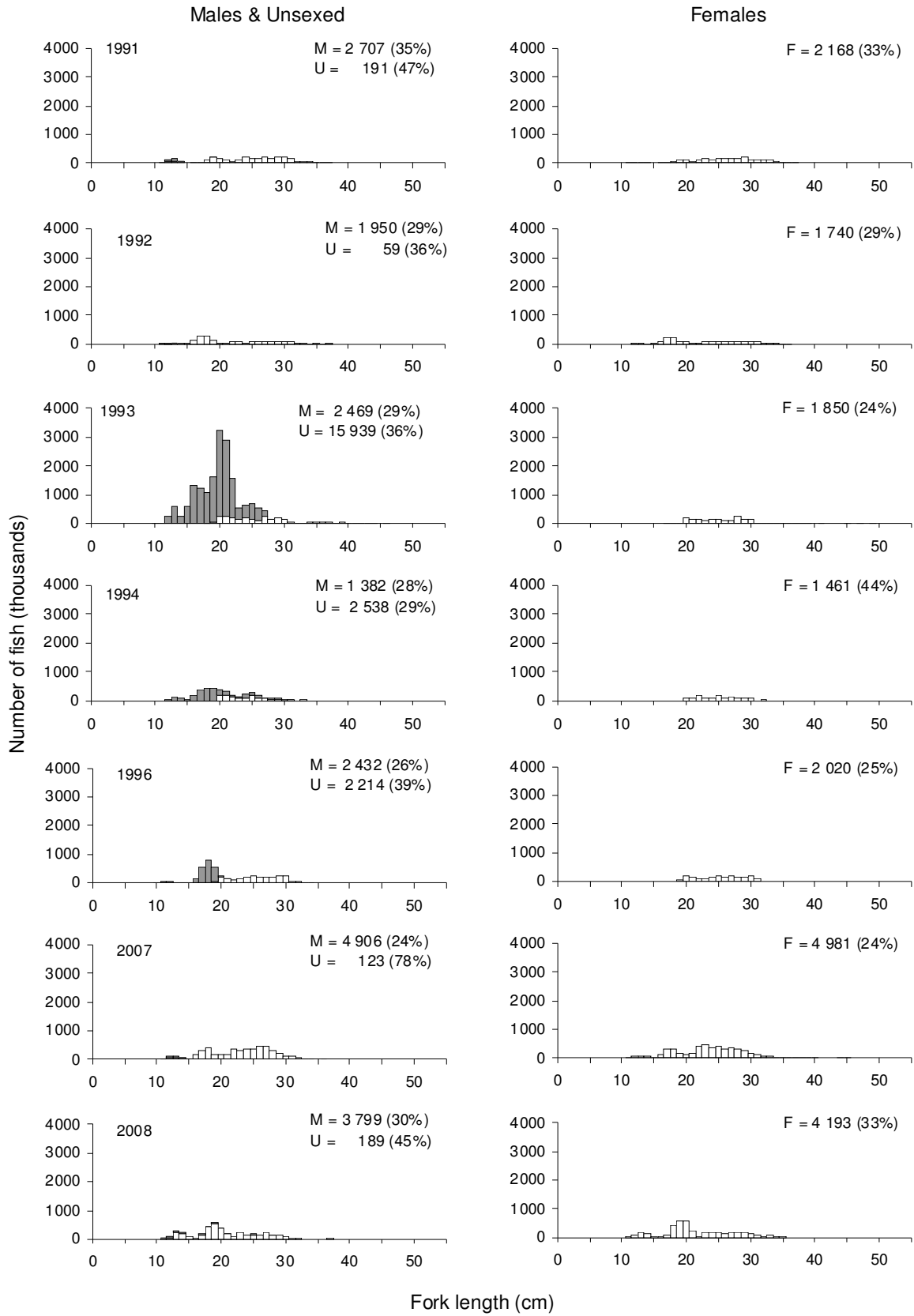


Figure 13—continued

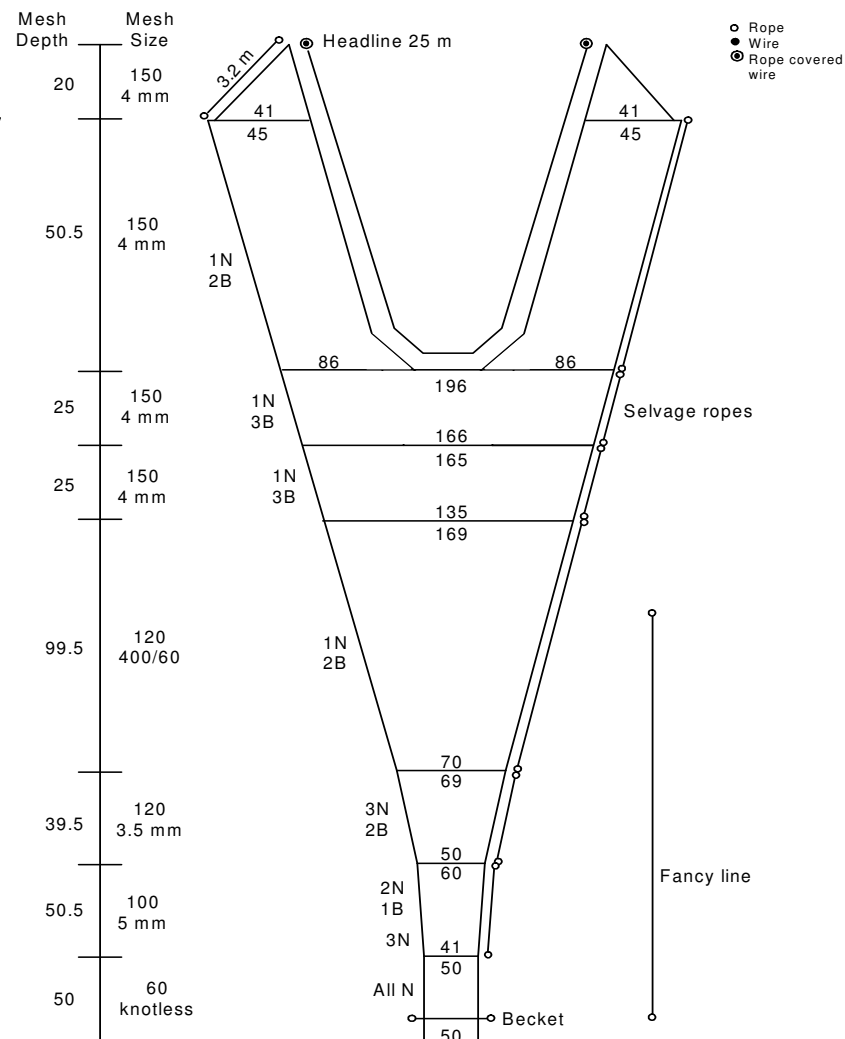
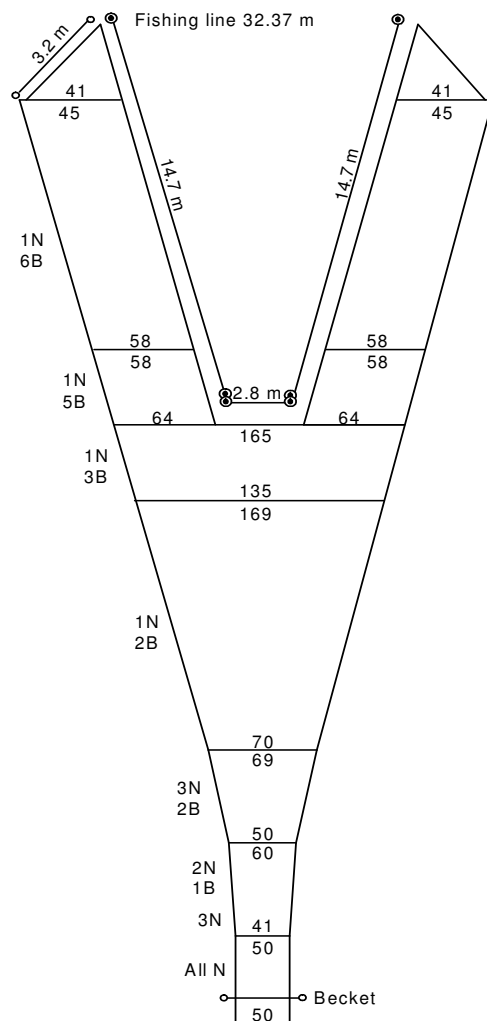
Appendix 1: R.V. Kaharoa bottom trawl gear specifications, and details of net plan, codend, flotation, ground rope, sweeps, and bridals.

Trawl warp		16 mm, 6 x 19 PPC
Trawl doors – rectangular V		3.2 m ² 630 kg
Backstrop length		7.5 m
Sweep length		55 m
Bridle length	top	12 mm 55 m
	bottom	16 mm 55 m
Layback		150 mm
Approximate doorspread		60 – 90 m
Optimum wingspread	Using (Prado 1990)	12.35 m
Angle of attack of sweeps and bridles		14° @ 69.4 m
		16° @ 77.4 m
		19° @ 89.4 m
Flotation	Net A	
	headline	2 330 mm diameter floats
		20 300 mm diameter floats
	net sonde	2 fender floats
	CTD logger	3 fender floats
	total buoyancy	~ 250 kg
Ground rope specifications	wire rope	35 m 18 mm (6 x 19)
	rubber rollers	48 110 x 170 mm
	rubber spacers	464 40 x 80 mm
	steel balls	12 150 mm diameter, 12 kg
	toggled hangers	50
Net attachments	BCS	7.1 kg
	Net sonde	15 kg
	CTD logger	15 kg
	total weight	~ 280 kg
V-line specifications	‘Hi-man’ Superline	24 mm, 6.4 m
Headline specifications	Rope covered wire	25.05 m
Fishing line specifications	Rope covered wire	2 x 14.7 m, 1 x 2.8 m

Appendix 1—continued

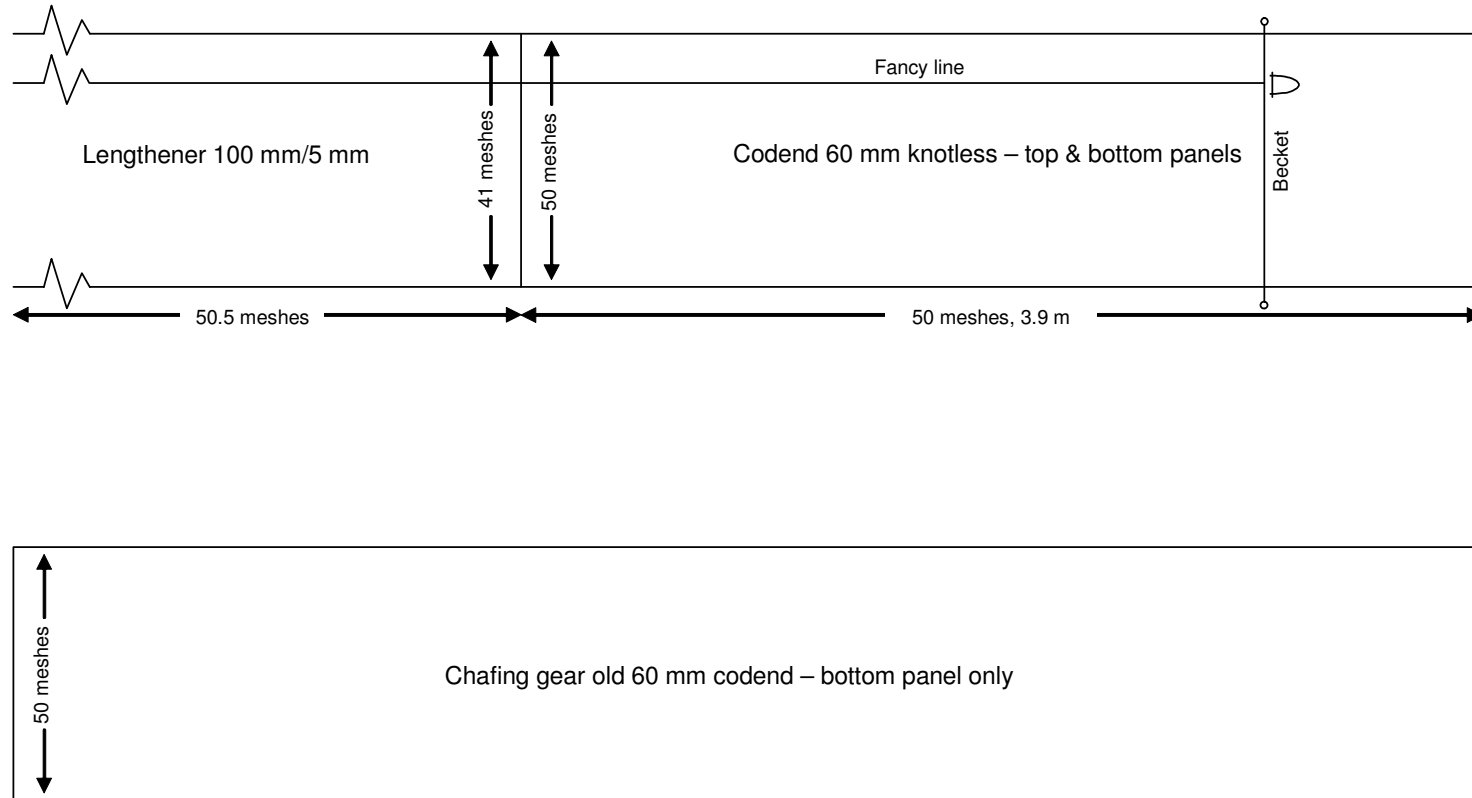
Net Plan: R.V. Kaharoa Bottom Trawl

Mesh and twine size	No. meshes deep	Selvage ropes nylon 26 mm
150 mm 4 mm (type)	20	V-lines 24 mm Hi-man superline 6.4 m
150 mm 4 mm (type)	50.5	6.3 m
150 mm 4 mm (type)	25	3.3 m
150 mm 4 mm (type)	25	3.3 m
120 mm 400/60 (pe)	99.5	10.8 m
120 mm 3.5 mm (type)	39.5	4.0 m
100 mm 5 mm (type)	50.5	4.2 m
60 mm knotless (type)	50	-



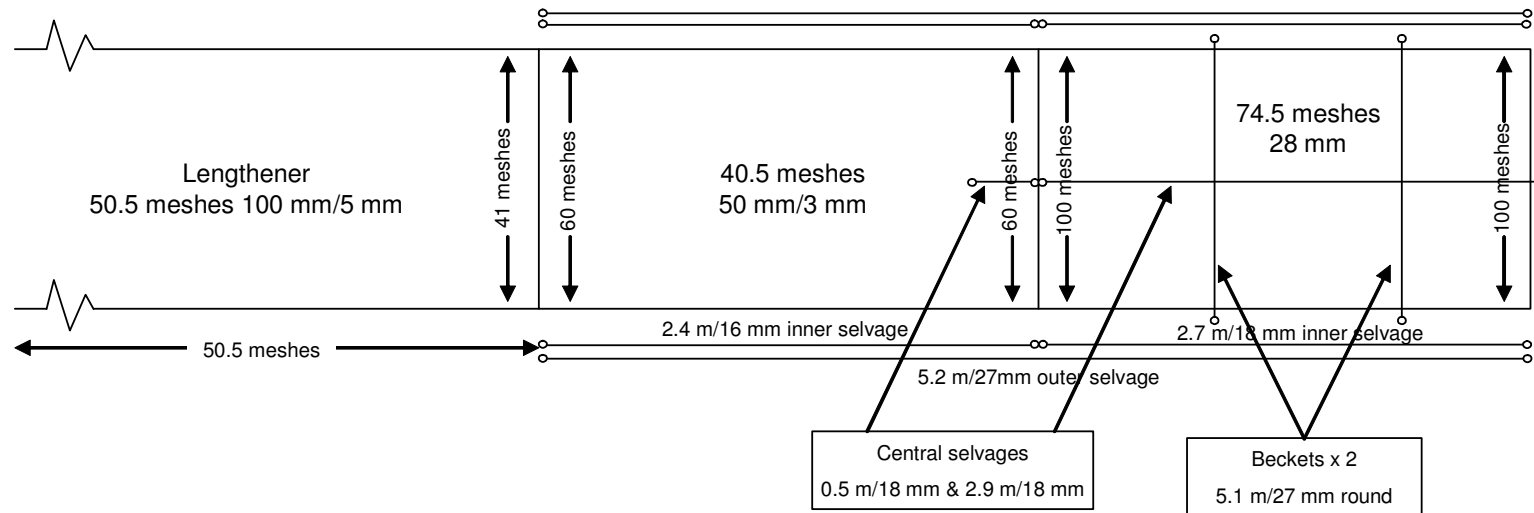
Appendix 1 –continued

Codend for ECSI Inshore (30 – 400 m) trawl survey



Appendix 1—continued

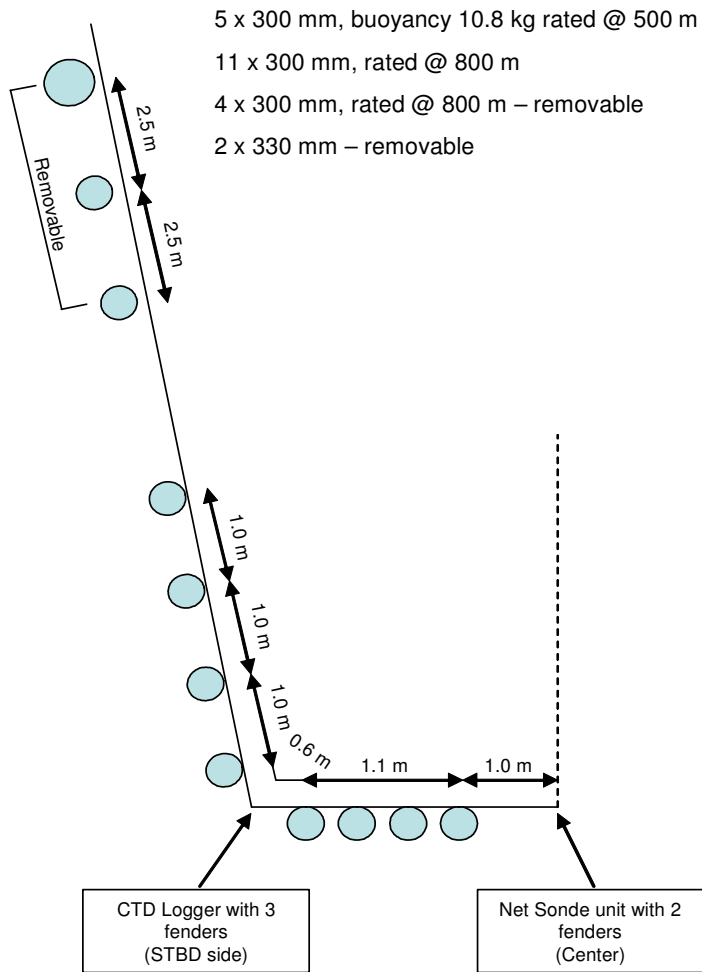
Codend for ECSI Inshore (10 – 30 m) trawl survey



Appendix 1 –continued

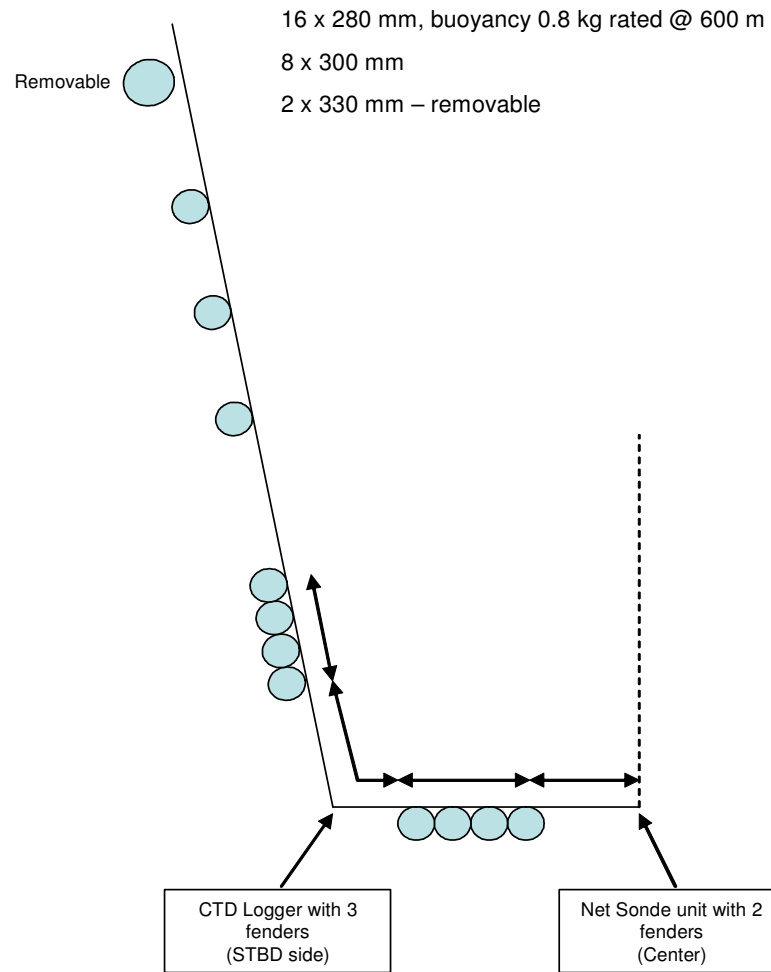
Float Plan: R.V. *Kaharoa* Bottom Trawl Net A

Total Floats: 22 on headline



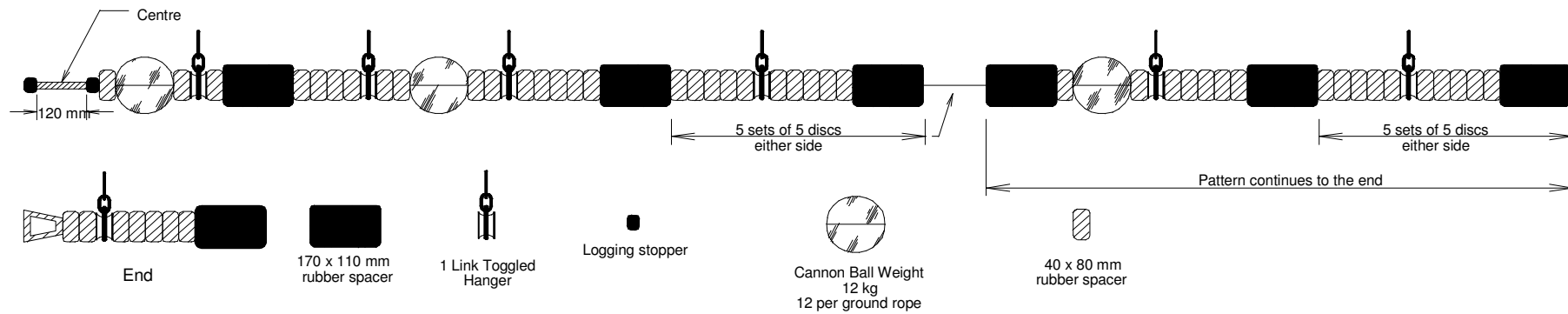
Float Plan: R.V. *Kaharoa* Bottom Trawl Net B

Total Floats: 26 on headline



Appendix 1—continued

Ground Rope Assembly: R.V. Kaharoa Bottom Trawl

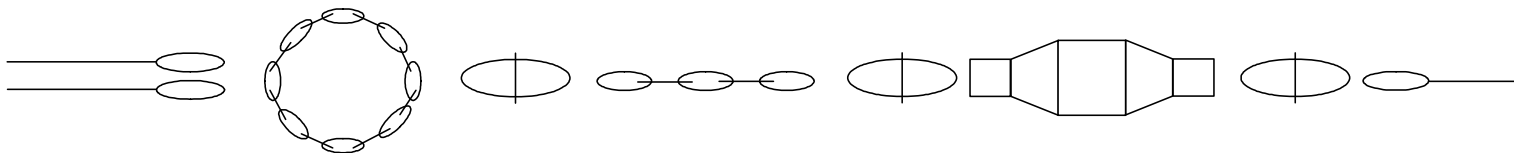


31.950 m x 18 mm 6/19 wire + 1 x 13 mm H/lock & 3 links of 13 mm midlink chain each end

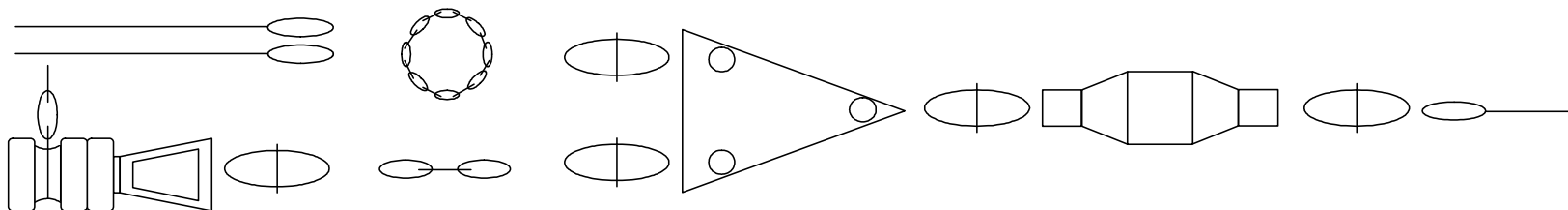
Appendix 1—continued

Net to Bridal Assembly: R.V. Kaharoa Bottom Trawl with 150 mm layback

Top bridal								
Headline – rope covered wire 25.05 m		Chain loop	10 mm Hammerlock	Chain link + 150 mm layback	8 mm Hammerlock	1.5 tonne swivel	8 mm Hammerlock	Top bridal 12 mm wire 55 m
V-line – 24 mm rope 6.4 m								

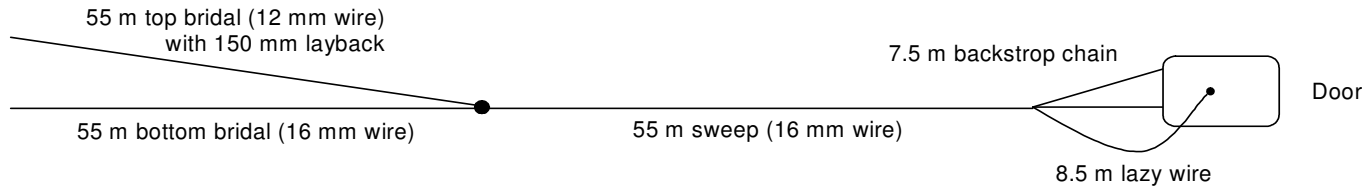


Bottom bridal								
V-line – 24 mm rope		Chain loop	13 mm hammerlock	150 mm delta plate	20 mm hammerlock	5 tonne swivel	20 mm hammerlock	Bottom bridal 16 mm wire 55 m
Fishing line – rope covered wire 32.37 m								
Groundline 18 mm wire 35 m	13 mm hammerlock	3 links of 13 mm midlink chain	13 mm hammerlock					

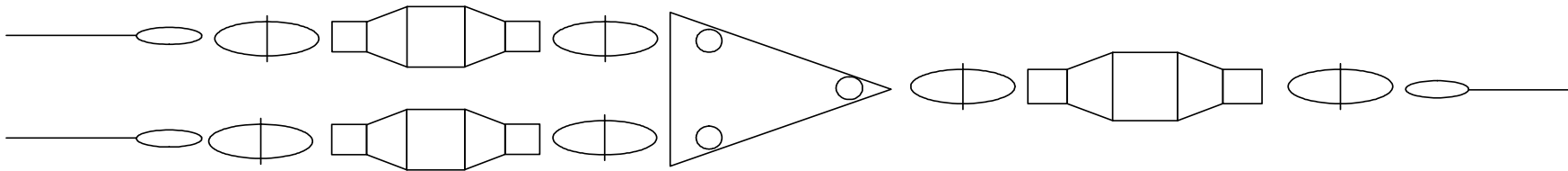


Appendix 1—continued

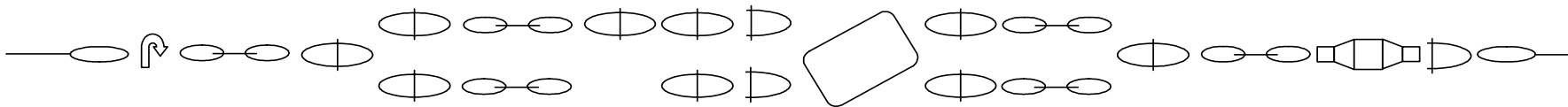
Sweeping Gear: R.V. Kaharoa Bottom Trawl



Bridal to sweep connection								
Top bridal 55 m 12 mm wire	13 mm hammerlock	3 tonne swivel	16 mm hammerlock	150 mm delta plate	16 mm hammerlock	5 tonne swivel	16 mm hammerlock	Sweep wire 55 m 16 mm
Bottom bridal 55 m 16 mm wire	13 mm hammerlock	3 tonne swivel	16 mm hammerlock					



Trawl door setting																
Sweep wire 55 m 16 mm	Hook	Chain	14 mm H/L	10 mm H/L	Chain	10 mm H/L	10 mm H/L	Shackle	Door Rectangular V 2.4 m x 1.5 m 3.2 m ² 630 kg	16 mm H/L	Chain	14 mm H/L	Chain	Dry swivel	Shackle	Trawl warp wire 16 mm
				10 mm H/L	Chain	10 mm H/L	Shackle	16 mm H/L		Chain						



Appendix 2: Summary of station data. *Not used for biomass estimates because of poor gear performance.

Station	Stratum	Date	Start of tow				End of tow				Gear depth (m)		Dist. trawled (n. miles)	Headline height (m)	Doorspread (m)	Surface temp. (°C)	Bottom temp. (°C)	
			Time	°	'	S	°	'	E	°	'	S						°
1	7	4-May-08	1517	43	18.61	172	59.69	43	16.18	173	02.11	31	35	3.02	4.6	71.9	13.1	13.1
2	17	5-May-08	722	43	04.39	173	41.76	43	01.51	173	41.48	330	343	2.93	4.6	89.6	13.6	9.8
3	7	5-May-08	1122	43	07.86	173	17.78	43	04.93	173	18.23	52	58	2.98	4.6	71.3	13	13
4	7	5-May-08	1346	43	11.02	173	18.20	43	08.15	173	18.69	53	56	2.94	4.6	73.2	13	12.9
5	7	6-May-08	704	43	15.08	172	58.53	43	17.40	172	55.86	32	35	2.99	4.6	73.2	13.2	13.1
6	7	6-May-08	859	43	14.38	172	53.89	43	11.96	172	56.28	27	32	2.98	4.6	72.5	13.2	13.1
7	7	6-May-08	1119	43	11.18	173	02.67	43	13.80	173	00.45	38	39	3.08	4.9	75	13.1	13
8	7	6-May-08	1320	43	15.33	173	04.07	43	14.53	173	08.04	34	36	3.02	4.6	71.6	13.2	13.1
9	7	6-May-08	1531	43	12.97	173	15.11	43	15.97	173	14.55	44	44	3.06	4.7	73	13.1	13
10	18	7-May-08	700	43	25.95	172	56.27	43	23.02	172	55.48	27	28	2.98	5	72.1	13.1	13
11	18	7-May-08	936	43	18.99	172	45.05	43	22.08	172	44.98	15	15	3.04	5.1	68.4	12.3	13.3
12	18	7-May-08	1411	43	38.03	173	06.79	43	40.62	173	08.36	15	18	2.91	4.7	72	13.2	12.9
13	7	8-May-08	655	43	26.33	173	19.50	43	24.84	173	18.81	67	69	1.6	4.7	72.8	13	11.1
14	7	8-May-08	834	43	18.20	173	20.61	43	16.69	173	21.08	70	73	1.6	4.6	66.3	12.9	12.5
15	13	8-May-08	1146	43	02.56	173	35.26	43	05.63	173	34.97	123	124	3.05	4.8	81.7	12.6	11.3
16	13	8-May-08	1525	43	22.77	173	46.54	43	21.30	173	43.08	116	118	2.9	4.7	78	12.8	11.3
17	13	9-May-08	658	43	25.92	173	33.16	43	24.62	173	36.85	118	123	3	4.8	76	12.8	11.4
18	12	9-May-08	1034	43	34.27	173	51.96	43	37.34	173	53.19	101	103	3.16	4.9	79.9	12.6	11
19	17	9-May-08	1429	43	47.00	174	02.42	43	44.27	174	02.76	338	346	2.81	4.8	80.3	11.9	7.5
20	17	10-May-08	830	43	39.38	174	04.00	43	42.34	174	04.99	378	392	3.01	4.5	84.9	13.2	7.3
21	12	10-May-08	1119	43	47.55	173	52.13	43	50.46	173	50.56	113	115	3.07	4.7	78	12.1	11.5
22	12	10-May-08	1310	43	50.08	173	47.42	43	52.62	173	45.00	102	103	3.06	4.8	76.6	11.4	11.5
23	11	10-May-08	1511	43	56.35	173	39.05	43	58.33	173	35.97	103	104	3	4.7	76.7	10.7	10.5
24	6	11-May-08	944	43	46.87	173	20.81	43	43.63	173	20.84	74	76	3.23	4.7	70.6	13.1	13.1
25	6	11-May-08	1133	43	40.19	173	24.89	43	37.22	173	26.72	79	84	3.26	5	71.4	13.1	12.9
26	6	11-May-08	1439	43	44.91	173	38.96	43	42.01	173	39.74	88	90	2.97	4.9	73.1	12.5	12.1
27	5	12-May-08	648	43	57.83	173	03.07	43	56.70	173	05.47	72	73	2.08	5	70.6	12.9	12.7
28	5	12-May-08	925	44	03.12	173	12.47	44	01.35	173	16.07	77	87	3.12	5.1	76.9	12.8	12.8
29	11	12-May-08	1143	44	07.15	173	18.20	44	09.89	173	15.83	106	106	3.18	4.7	77.5	12.2	11.7
30	11	12-May-08	1354	44	11.92	173	13.19	44	09.81	173	16.34	107	110	3.12	4.9	80.1	12.3	11.7

Appendix 2—continued

Station	Stratum	Date	Time	Start of tow				End of tow				Gear depth (m)		Dist. trawled (n. miles)	Headline height (m)	Doorspread (m)	Surface temp. (°C)	Bottom temp. (°C)
				°	'	S	°	'	E	°	'	S	°					
31	6	14-May-08	658	43	53.19	173	29.48	43	50.38	173	31.00	87	88	3.05	4.8	74.5	12.6	12.5
32	11	14-May-08	1038	44	04.21	173	37.72	44	02.28	173	41.10	149	151	3.08	5.3	87.8	11.5	10.7
33	16	14-May-08	1504	44	11.12	173	32.55	44	09.11	173	35.71	343	351	3.04	4.7	91.3	12	9.8
34	16	15-May-08	656	44	11.81	173	32.20	44	13.81	173	29.33	363	370	2.84	4.9	81.5	11.5	8.8
35	11	15-May-08	946	44	14.88	173	14.72	44	16.40	173	11.31	131	132	2.85	4.5	79.7	12	10.9
36	5	19-May-08	723	44	06.20	172	49.22	44	06.26	172	52.06	70	72	2.04	4.8	69.8	12.6	12.2
37	5	19-May-08	918	44	10.22	173	00.31	44	11.52	172	58.04	78	80	2.06	4.8	70.2	12.6	11.7
38	5	19-May-08	1145	44	12.67	172	48.93	44	12.87	172	46.07	77	78	2.06	4.8	67.8	12.5	11.7
39	5	19-May-08	1417	44	15.12	172	49.02	44	16.61	172	49.02	85	87	1.47	4.8	73.2	12.6	11.8
40	10	19-May-08	1538	44	20.75	172	47.63	44	20.82	172	44.82	103	103	2.02	4.8	77.8	12.4	10.4
41	4	21-May-08	714	44	08.01	172	08.86	44	09.06	172	06.40	38	40	2.02	4.6	72.4	11.9	12.6
42	4	21-May-08	1025	44	15.96	171	56.27	44	17.27	171	54.06	45	46	2.04	4.6	70.5	12.4	12.6
43	4	21-May-08	1326	44	13.49	172	08.34	44	14.91	172	06.15	48	51	2.12	4.7	72.6	12.5	12.5
44	4	21-May-08	1529	44	20.82	172	10.43	44	22.15	172	08.14	63	65	2.11	4.8	69.9	12.3	12.2
45	10	22-May-08	718	44	26.07	172	50.80	44	27.22	172	48.22	135	140	2.17	4.6	84.7	12.4	10.3
46	10	22-May-08	1025	44	32.95	172	39.27	44	33.86	172	36.56	131	145	2.13	4.7	83.8	11.7	10.2
47	10	22-May-08	1305	44	24.87	172	38.58	44	23.86	172	41.08	100	111	2.05	4.8	81.8	12.1	10.4
48*	4	22-May-08	1537	44	18.66	172	36.00	44	17.50	172	38.40	80	82	2.07	4.8	63.3	12.4	11
49	15	23-May-08	723	44	44.91	172	22.39	44	43.69	172	24.67	339	347	2.02	4.8	93.6	11.3	9
50	15	23-May-08	1031	44	38.96	172	32.58	44	37.82	172	34.99	271	278	2.05	4.7	91.2	11.5	10
51	4	23-May-08	1425	44	26.69	172	24.01	44	25.73	172	25.58	90	94	1.47	4.8	75.9	11.5	11.3
52	4	23-May-08	1632	44	21.17	172	13.69	44	20.50	172	15.59	66	69	1.51	5.2	70	11.7	11.8
53	10	24-May-08	724	44	37.52	172	06.33	44	36.24	172	08.56	103	105	2.02	4.7	79.3	11.7	11.1
54	3	24-May-08	950	44	33.54	172	09.45	44	32.88	172	11.02	96	99	1.32	4.8	75.7	11.3	11.1
55	3	24-May-08	1143	44	29.01	172	05.99	44	27.83	172	08.25	77	78	1.99	4.8	70.9	11.6	11.7
56	3	24-May-08	1408	44	26.80	171	58.51	44	27.97	171	56.24	68	70	1.99	4.6	70.2	11.7	11.7
57	3	24-May-08	1536	44	30.51	171	54.09	44	29.37	171	56.43	69	70	2.02	4.8	68.4	11.8	11.8
58	10	25-May-08	724	44	39.08	172	18.39	44	40.41	172	16.37	133	135	1.95	4.8	79.7	11.3	10.7
59	9	25-May-08	1259	44	43.90	172	09.00	44	44.95	172	07.43	129	131	1.53	4.7	81.8	11.3	10.9
60	9	25-May-08	1450	44	43.95	171	59.89	44	44.84	171	58.16	113	115	1.51	4.8	78.8	11.8	11.5

Appendix 2—continued

Station	Strata	Date	Time	Start of tow		End of tow		Gear depth (m)		Dist. trawled (n. miles)	Headline height (m)	Doorspread (m)	Surface temp. (°C)	Bottom temp. (°C)				
				°	' S	°	' E	°	' S						°	' E	Min.	Max.
61	9	25-May-08	1610	44	46.47	171	55.38	44	47.35	171	53.76	111	114	1.44	4.8	79	11.9	11.4
62	15	26-May-08	747	44	51.36	172	09.26	44	52.57	172	06.92	261	279	2.05	4.9	84	10.6	9.6
63	15	26-May-08	945	44	54.22	172	05.53	44	55.08	172	03.32	337	347	1.78	4.7	83.4	10.9	8.5
64	14	26-May-08	1153	44	57.21	171	57.95	44	58.42	171	55.46	243	250	2.13	4.5	77.6	10.3	10.1
65	9	26-May-08	1358	44	58.69	171	43.25	44	59.77	171	40.94	116	119	1.95	4.8	80.2	11	10.7
66	2	26-May-08	1547	44	55.96	171	33.30	44	57.27	171	31.16	74	80	2	4.8	69.3	12	12
67	9	27-May-08	725	44	51.59	171	47.83	44	50.25	171	49.93	108	111	2	4.7	79.4	11.4	11.3
68	2	27-May-08	1024	44	50.96	171	31.39	44	49.83	171	32.87	56	60	1.54	4.8	71.4	11.9	11.9
69	3	27-May-08	1307	44	38.96	171	38.36	44	37.67	171	37.19	61	63	1.53	4.7	69.4	12	11.9
70	3	28-May-08	1455	44	39.99	171	21.36	44	42.06	171	21.58	32	34	2.07	4.9	71	10.6	11
71	1	29-May-08	730	45	23.92	171	02.18	45	22.06	171	02.18	35	42	1.86	4.3	70.3	11.5	11.6
72	1	29-May-08	847	45	21.29	171	03.98	45	19.44	171	05.45	40	42	2.11	4.8	70.5	11.5	11.5
73	1	29-May-08	1021	45	16.29	171	12.56	45	14.33	171	13.16	52	53	2	5.1	71.9	11.6	11.6
74	1	29-May-08	1229	45	13.98	171	05.93	45	12.14	171	07.15	29	33	2.03	5.2	71.7	11.6	11.5
75	1	29-May-08	1417	45	11.72	171	09.39	45	09.76	171	10.12	31	33	2.02	5.2	71.5	11.6	11.6
76	2	29-May-08	1610	45	02.53	171	17.93	45	00.72	171	19.41	40	41	2.09	5	73.3	11.6	11.6
77	14	30-May-08	731	45	18.39	171	30.08	45	16.72	171	31.80	243	255	2.06	4.7	86.8	9.7	9.5
78	14	30-May-08	921	45	16.86	171	31.47	45	14.77	171	33.00	227	245	2.35	4.8	86.2	10.7	9.5
79	8	30-May-08	1134	45	05.57	171	32.48	45	06.92	171	31.48	107	109	1.52	4.5	74.7	10.9	11.3
80	8	30-May-08	1310	45	07.57	171	27.47	45	09.06	171	25.44	103	104	2.06	4.6	73.6	11.5	10.7
81	8	30-May-08	1611	45	25.87	171	17.32	45	27.45	171	15.50	111	114	2.03	4.3	74.6	10.4	10.3
82	3	31-May-08	730	44	49.89	171	36.56	44	48.03	171	37.48	72	77	1.97	4.8	67.4	11.4	11.5
83	3	31-May-08	904	44	47.60	171	40.38	44	45.68	171	41.47	84	85	2.1	4.8	63.2	11.6	11.5
84	3	31-May-08	1044	44	44.29	171	41.50	44	42.49	171	42.86	81	83	2.02	4.8	72.4	11.6	11.6
85	3	31-May-08	1255	44	48.41	171	45.79	44	47.15	171	47.99	98	100	2	4.8	77.9	11.5	11.1
86	9	31-May-08	1517	44	54.59	171	59.18	44	52.84	172	00.62	138	144	2.02	4.9	84.5	10.6	9.6
87	9	1-Jun-08	739	44	51.70	172	03.45	44	50.28	172	04.42	134	140	1.57	5	84.7	10.7	10
88	9	1-Jun-08	932	44	41.74	172	06.21	44	40.54	172	07.57	119	120	1.54	4.9	81.4	11.4	10.9
89	9	1-Jun-08	1143	44	38.66	172	03.12	44	37.28	172	05.09	102	104	1.96	4.7	80.5	11.5	10.9
90	10	1-Jun-08	1343	44	39.94	172	10.45	44	38.67	172	12.60	122	124	1.98	5	81.6	11.5	10.8

Appendix 2—continued

Station	Strata	Date	Time	Start of tow		End of tow		Gear depth (m)		Dist. trawled (n. miles)	Headline height (m)	Doorspread (m)	Surface temp. (°C)	Bottom temp. (°C)
				° ' S	° ' E	° ' S	° ' E	Min.	Max.					
91	9	2-Jun-08	727	44 49.23	172 06.56	44 48.01	172 08.90	130	135	2.06	5	83.2	10.7	10.6
92	10	2-Jun-08	950	44 43.16	172 17.87	44 42.01	172 20.24	136	139	2.03	5	83.6	10.3	9.6
93	10	2-Jun-08	1144	44 37.09	172 24.41	44 35.86	172 26.76	130	138	2.07	4.8	83.5	10.2	11.6
94	16	2-Jun-08	1625	44 23.14	173 11.10	44 22.01	173 13.46	312	318	2.03	5	92.7	9.3	8.6
95	3	3-Jun-08	733	44 46.39	171 27.02	44 44.40	171 27.65	42	43	2.03	4.8	72.9	10.8	11.5
96	3	3-Jun-08	1005	44 31.71	171 25.48	44 29.86	171 26.71	33	35	2.04	4.8	71	10.6	11.4
97	3	3-Jun-08	1256	44 20.44	171 45.09	44 19.29	171 47.39	45	48	2	4.7	72.3	11.4	11.7
98	3	3-Jun-08	1507	44 26.41	171 44.36	44 25.61	171 47.05	48	55	2.08	4.7	72.2	11.8	11.8
99	5	4-Jun-08	828	44 01.25	172 39.70	43 59.98	172 40.74	53	53	1.47	4.8	71.2	11.8	11.7
100	5	4-Jun-08	1214	43 57.37	173 08.89	43 55.77	173 11.00	70	73	2.2	4.9	73.1	11.7	11.5

Appendix 3: Gear parameters for biomass stations by depth range. N, number of stations; s.d., standard deviation.

	<i>N</i>	Mean	s.d.	Range
All stations				
Headline height (m)	99	4.8	0.18	4.3–5.3
Doorspread (m)	99	76.4	6.38	63.2–93.6
Distance (n. miles)	99	2.3	0.56	1.32–3.26
Warp:depth ratio	99	3.5	1.75	2.34–13.33
Standard survey (30–400 m)				
30–400 m				
Headline height (m)	96	4.8	0.17	4.3–5.3
Doorspread (m)	96	76.5	6.39	63.2–93.6
Distance (n. miles)	96	2.3	0.55	1.32–3.26
Warp:depth ratio	96	3.3	1.08	2.34–6.78
30–100 m				
Headline height (m)	50	4.8	0.18	4.3–5.2
Doorspread (m)	50	71.6	2.55	63.2–77.9
Distance (n. miles)	50	2.2	0.55	1.32–3.26
Warp:depth ratio	50	3.9	1.26	2.37–6.78
100–200 m				
Headline height (m)	33	4.8	0.18	4.3–5.3
Doorspread (m)	33	80.1	3.30	73.6–87.8
Distance (n. miles)	33	2.3	0.59	1.44–3.18
Warp:depth ratio	33	2.8	0.06	2.69–2.95
200–400 m				
Headline height (m)	13	4.7	0.15	4.5–5.0
Doorspread (m)	13	86.4	5.04	77.6–93.6
Distance (n. miles)	13	2.4	0.46	1.78–3.04
Warp:depth ratio	13	2.5	0.11	2.34–2.66
Inshore survey (10–30 m)				
Headline height (m)	3	4.9	0.21	4.7–5.1
Doorspread (m)	3	70.8	2.11	68.4–72.1
Distance (n. miles)	3	3.0	0.07	2.91–3.04
Warp:depth ratio	3	10.9	3.21	7.27–13.33

Appendix 4: Species codes, common names, scientific names, total catch, Percent of total catch, percent occurrence, and depth range for stations in 30–400 m and 10–30 m, in order of catch weight.

Species code	Common name	Scientific name	Catch (kg)	% of catch	% Occ.	Depth range (m)	
						Min.	Max.
30–400 m							
SPD	Spiny dogfish	<i>Squalus acanthias</i>	40 450.7	39	99	31	392
BAR	Barracouta	<i>Thyrstites atun</i>	25 694.4	25	88	31	351
GSH	Dark ghost shark	<i>Hydrolagus novaezealandiae</i>	6 818.2	7	44	63	392
RCO	Red cod	<i>Pseudophycis bachus</i>	3 586.9	3	65	31	347
SPE	Sea perch	<i>Helicolenus</i> spp.	3 356.0	3	71	27	392
TAR	Tarakihi	<i>Nemadactylus macropterus</i>	1 880.9	2	62	29	255
HOK	Hoki	<i>Macruronus novaezealandiae</i>	1 693.0	2	11	38	392
NOS	NZ southern arrow squid	<i>Nototodarus sloanii</i>	1 555.0	2	92	31	392
GUR	Red gurnard	<i>Chelidonichthys kumu</i>	1 405.3	1	55	31	131
SDO	Silver dory	<i>Cyttus novaezealandiae</i>	1 367.6	1	35	70	347
ELE	Elephantfish	<i>Callorhynchus milii</i>	1 195.4	1	47	31	124
CBI	Two saddle rattail	<i>Caelorinchus biclinozonalis</i>	1 139.9	1	12	27	346
SCG	Scaly gurnard	<i>Lepidotrigla brachyoptera</i>	1 096.1	1	70	33	151
WAR	Blue warehou	<i>Seriolella brama</i>	1 086.5	1	13	31	138
CAR	Carpet shark	<i>Cephaloscyllium isabellum</i>	1 059.7	1	81	27	351
RSK	Rough skate	<i>Dipturus nasutus</i>	1 036.5	1	48	31	392
SSK	Smooth skate	<i>Dipturus innominatus</i>	893.9	1	51	29	392
STA	Giant stargazer	<i>Kathetostoma giganteum</i>	831.6	1	76	29	392
WIT	Witch	<i>Arnoglossus scapha</i>	803.4	1	89	31	392
CBE	Crested bellowsfish	<i>Notopogon lilliei</i>	727.2	1	35	48	151
SWA	Silver warehou	<i>Seriolella punctata</i>	688.9	1	69	31	370
CBO	Bollons's rattail	<i>Caelorinchus bollonsi</i>	671.2	1	11	52	392
LIN	Ling	<i>Genypterus blacodes</i>	651.1	1	55	27	392
SCH	School shark	<i>Galeorhinus galeus</i>	456.0	<0.5	44	31	140
PIG	Pigfish	<i>Congiopodus leucopaecilus</i>	359.6	<0.5	57	29	318
SPO	Rig	<i>Mustelus lenticulatus</i>	346.2	<0.5	29	31	114
CAS	Oblique banded rattail	<i>Caelorinchus aspercephalus</i>	302.7	<0.5	11	107	392
JAV	Javelinfinch	<i>Lepidorhynchus denticulatus</i>	220.1	<0.5	7	312	392
FHD	Deepsea flathead	<i>Hoplichthys haswelli</i>	167.0	<0.5	10	42	392
CON	Conger eel	<i>Conger</i> spp.	166.1	<0.5	5	31	39
HAP	Hapuku	<i>Polyprion oxygeneios</i>	160.0	<0.5	29	29	278
ERA	Electric ray	<i>Torpedo fairchildi</i>	147.9	<0.5	6	31	44
LSO	Lemon sole	<i>Pelotretis flavilatus</i>	128.6	<0.5	46	15	346
BCO	Blue cod	<i>Parapercis colias</i>	76.2	<0.5	19	31	151
LDO	Lookdown dory	<i>Cyttus traversi</i>	63.0	<0.5	9	116	392
LEA	Leatherjacket	<i>Parika scaber</i>	61.1	<0.5	14	31	80
JMD	N.Z. jack mackerel	<i>Trachurus declivis</i>	60.3	<0.5	21	56	140
SSI	Silverside	<i>Argentina elongata</i>	51.4	<0.5	29	72	392
OCT	Octopus	<i>Pinnoctopus cordiformis</i>	45.7	<0.5	12	27	343
JMM	Chilean jack mackerel	<i>Trachurus symmtricus murphyi</i>	38.0	<0.5	9	38	140
ONG	Sponges	Porifera (Phylum)	30.7	<0.5	26	35	346
SEV	Broadnose sevengill shark	<i>Notorynchus cepedianus</i>	21.5	<0.5	1	34	36
JMN	N.Z. jack mackerel	<i>Trachurus novaezealandiae</i>	16.3	<0.5	3	27	44
SFL	Sand flounder	<i>Rhombosolea plebeia</i>	15.5	<0.5	8	31	44
TOD	Dark toadfish	<i>Neophrynichthys latus</i>	14.9	<0.5	21	27	140
MOK	Moki	<i>Latridopsis ciliaris</i>	14.0	<0.5	2	77	131
HAK	Hake	<i>Merluccius australis</i>	12.4	<0.5	4	45	392
WWA	White warehou	<i>Seriolella caerulea</i>	8.9	<0.5	3	312	392

Appendix 4—continued

Species code	Common name	Scientific name	Catch (kg)	% of catch	% Occ.	Depth range (m)	
						Min.	Max.
30–400 m							
ESO	N.Z. sole	<i>Peltorhamphus novaezeelandiae</i>	7.5	<0.5	9	31	48
HAG	Hagfish	<i>Eptatretus cirrhatus</i>	7.4	<0.5	3	27	70
WOD	Wood	Wood	5.7	<0.5	2	31	39
BTA	Smooth deepsea skate	<i>Notoraja asperula</i>	5.2	<0.5	4	312	392
JFI	Jellyfish		5.1	<0.5	5	31	346
ETL	Lucifer dogfish	<i>Etmopterus lucifer</i>	5.0	<0.5	1	330	343
HMT	Deepsea anemone	Hormathiidae	4.2	<0.5	14	78	145
SCI	Scampi	<i>Metanephrops challengeri</i>	4.2	<0.5	5	330	392
BAS	Bass groper	<i>Polyprion americanus</i>	4.0	<0.5	1	330	343
SPR	Sprats	<i>Sprattus antipodum</i> , <i>S. muelleri</i>	3.7	<0.5	6	32	63
SCC	Sea cucumber	<i>Stichopus mollis</i>	3.6	<0.5	9	52	151
PCO	Ahuru	<i>Auchenoceros punctatus</i>	3.4	<0.5	7	31	44
MIQ	Warty squid	<i>Moroteuthis ingens</i>	3.1	<0.5	2	337	392
DSP	Deepsea pigfish	<i>Congiopodus coriaceus</i>	2.9	<0.5	4	118	151
HTH	Sea cucumber	Holothurian unidentified	2.9	<0.5	10	38	392
SQU	Arrow squid	<i>Nototodarus sloanii</i> & <i>N. gouldi</i>	2.9	<0.5	1	129	131
TUR	Turbot	<i>Colistium nudipinnis</i>	2.4	<0.5	2	33	43
ANT	Anemones	Anthozoa	2.1	<0.5	7	63	124
EMA	Blue mackerel	<i>Scomber australasicus</i>	2.0	<0.5	1	27	32
BBE	Banded bellowsfish	<i>Centriscomps humerosus</i>	1.9	<0.5	1	378	392
YCO	Yellow cod	<i>Parapercis gilliesi</i>	1.9	<0.5	2	101	123
PAD	Paddle crab	<i>Ovalipes catharus</i>	1.8	<0.5	9	33	114
SAL	Salps		1.7	<0.5	5	103	392
ACS	Deepsea anemone	Actinostolidae	1.6	<0.5	5	77	392
SAM	Quinnat salmon	<i>Oncorhynchus tshawytscha</i>	1.5	<0.5	1	27	32
GON	Sandfish	<i>Gonorynchus forsteri</i> & <i>G. greyi</i>	1.3	<0.5	1	101	103
TOP	Pale toadfish	<i>Amblophthalmos angustus</i>	1.2	<0.5	3	135	392
SKI	Gemfish	<i>Rexea solandri</i>	1.1	<0.5	1	271	278
SMO	Crossfish	<i>Sclerasterias mollis</i>	1.1	<0.5	8	38	118
DCS	Dawson's catchark	<i>Halaelurus dawsoni</i>	1.0	<0.5	3	330	370
XSH	Sooty shearwater	<i>Puffinus griseus</i>	1.0	<0.5	1	103	104
BER	Numbfish	<i>Typhlonarke</i> spp.	0.9	<0.5	1	113	115
ETB	Baxter's lantern dogfish	<i>Etmopterus baxteri</i>	0.9	<0.5	1	363	370
GFL	Greenback flounder	<i>Rhombosolea tapirina</i>	0.9	<0.5	1	38	40
CRB	Crab	Decapoda	0.8	<0.5	7	38	123
JDO	John dory	<i>Zeus faber</i>	0.8	<0.5	1	40	41
SCO	Swollenhead conger	<i>Bassanago bulbiceps</i>	0.8	<0.5	1	330	343
GMC	Garrick's masking crab	<i>Leptomithrax garricki</i>	0.7	<0.5	4	130	144
PIL	Pilchard	<i>Sardinops neopilchardus</i>	0.7	<0.5	2	33	43
SPA	Slender sprat	<i>Sprattus antipodum</i>	0.7	<0.5	4	27	58
ASR	Starfish	Asteroidea	0.6	<0.5	4	31	132
BRI	Brill	<i>Colistium guntheri</i>	0.5	<0.5	1	38	40
GAS	Gastropod	Gastropoda	0.5	<0.5	4	70	124
PSI	Geometric star	<i>Psilaster acuminatus</i>	0.4	<0.5	2	131	392
QSC	Queen scallop	<i>Zygochlamys delicatula</i>	0.4	<0.5	2	102	114
SPM	Sprat	<i>Sprattus muelleri</i>	0.4	<0.5	2	32	58
CDO	Capro dory	<i>Capromimus abbreviatus</i>	0.3	<0.5	1	116	119
CRU	Crustacean	Crustacea	0.3	<0.5	3	27	87
HCO	Hairy conger	<i>Bassanago hirsutus</i>	0.3	<0.5	1	330	343

Appendix 4—continued

Species code	Common name	Scientific name	Catch (kg)	% of catch	% Occ.	Depth range (m)	
						Min.	Max.
30–400 m							
KWH	Knobbed whelk	<i>Austrofucus glans</i>	0.3	<0.5	3	69	138
OPA	Opalfish	<i>Hemerocoetes</i> spp.	0.3	<0.5	3	48	78
STY	Spotty	<i>Notolabrus celidotus</i>	0.3	<0.5	2	27	36
CCX	Small banded rattail	<i>Caelorinchus parvifasciatus</i>	0.2	<0.5	1	330	343
COZ	Bryozoan	Bryozoa (Phylum)	0.2	<0.5	2	69	124
ECN	Sea urchin	Echinoidea	0.2	<0.5	2	28	114
FMA	Whelk	<i>Fusitriton magellanicus</i>	0.2	<0.5	2	69	346
HDR	Hydroid	Hydrozoa (Class)	0.2	<0.5	2	101	115
NUD	Sea slug	Nudibranchia	0.2	<0.5	1	101	103
PAG	Hermit crab	Paguroidea	0.2	<0.5	2	103	123
POL	Sea worm	Polychaeta	0.2	<0.5	2	69	347
SBR	Southern bastard cod	<i>Pseudophycis barbata</i>	0.2	<0.5	1	330	343
ANC	Anchovy	<i>Engraulis australis</i>	0.1	<0.5	1	34	36
BHE	Brittlestar	<i>Bathypectinura heros</i>	0.1	<0.5	1	52	53
BRN	Barnacle	Arthropoda: Maxillipoda	0.1	<0.5	1	118	123
CRM	Airy finger sponge	<i>Callyspongia</i> cf <i>ramosa</i>	0.1	<0.5	1	52	58
CUC	Cucumber fish	<i>Chlorophthalmus nigripinnis</i>	0.1	<0.5	1	135	140
DGT	Dragonets	Callionymidae	0.1	<0.5	1	78	80
FIS	Fish (unspecified)		0.1	<0.5	1	27	32
GLM	Green-lipped mussel	<i>Perna canaliculus</i>	0.1	<0.5	1	69	70
LEH	Leech	Hirudinea	0.1	<0.5	1	98	100
MSL	Sladden's star	<i>Mediaster sladeni</i>	0.1	<0.5	1	131	145
MUN	Munida gregaria	<i>Munida gregaria</i>	0.1	<0.5	1	135	140
PYC	Sea spiders	Pycnogonida	0.1	<0.5	1	363	370
SBW	Southern blue whiting	<i>Micromesistius australis</i>	0.1	<0.5	1	312	318
SDR	Spiny seadragon	<i>Solegnathus spinosissimus</i>	0.1	<0.5	1	78	80
SHO	Seahorse	<i>Hippocampus abdominalis</i>	0.1	<0.5	1	33	35
SPH	Tusk shell	Scaphopoda	0.1	<0.5	1	84	85
SQX	Squid	Cephalapoda	0.1	<0.5	1	363	370
SRH	Silver roughy	<i>Hoplostethus mediterraneus</i>	0.1	<0.5	1	330	343
TAM	Tam o shanter urchin	Echinothuriidae & Phormosomatidae	0.1	<0.5	1	330	343

Total catch 30–400 m

102 783.4

Species code	Common name	Scientific name	Catch (kg)	% of catch	% Occ.	Depth range (m)	
						Min.	Max.
10–30 m							
SPD	Spiny dogfish	<i>Squalus acanthias</i>	1 038.7	72	100	15	28
RCO	Red cod	<i>Pseudophycis bachus</i>	86.3	6	100	15	28
RSK	Rough skate	<i>Dipturus nasutus</i>	82.0	6	100	15	28
GUR	Red gurnard	<i>Chelidonichthys kumu</i>	59.1	4	100	15	28
WAR	Blue warehou	<i>Seriolella brama</i>	51.1	4	100	15	28
BAR	Barracouta	<i>Thyrsites atun</i>	39.9	3	100	15	28
ERA	Electric ray	<i>Torpedo fairchildi</i>	19.5	1	33	15	15
SPO	Rig	<i>Mustelus lenticulatus</i>	11.5	<0.5	100	15	28
ESO	N.Z. sole	<i>Peltorhamphus novaezeelandiae</i>	9.6	<0.5	100	15	28

Appendix 4—continued

Species code	Common name	Scientific name	Catch (kg)	% of catch	% Occ.	Depth range (m)	
						Min.	Max.
10–30 m							
JFI	Jellyfish		9.6	<0.5	100	15	28
LEA	Leatherjacket	<i>Parika scaber</i>	9.1	<0.5	67	15	28
CON	Conger eel	<i>Conger</i> spp.	5.2	<0.5	33	15	15
SAZ	Sand stargazer	<i>Crapatalus novaezelandiae</i>	3.3	<0.5	67	15	18
KAH	Kahawai	<i>Arripis trutta</i>	3.0	<0.5	33	15	15
BRI	Brill	<i>Colistium guntheri</i>	2.6	<0.5	33	15	15
PCO	Ahuru	<i>Auchenoceros punctatus</i>	2.5	<0.5	100	15	28
SPR	Sprats	<i>Sprattus antipodum</i> , <i>S. muelleri</i>	2.3	<0.5	67	15	28
SCH	School shark	<i>Galeorhinus galeus</i>	1.6	<0.5	67	15	18
TUR	Turbot	<i>Colistium nudipinnis</i>	1.6	<0.5	33	15	18
PAD	Paddle crab	<i>Ovalipes catharus</i>	1.5	<0.5	67	15	18
SPA	Slender sprat	<i>Sprattus antipodum</i>	1.5	<0.5	33	15	15
SPM	Sprat	<i>Sprattus muelleri</i>	1.5	<0.5	33	15	15
ELE	Elephantfish	<i>Callorhynchus milii</i>	1.0	<0.5	67	15	28
GLB	Globefish	<i>Contusus richiei</i>	1.0	<0.5	100	15	28
SWA	Silver warehou	<i>Seriolella punctata</i>	0.9	<0.5	67	15	28
SFL	Sand flounder	<i>Rhombosolea plebeia</i>	0.5	<0.5	33	15	18
ECN	Sea urchin	Echinoidea	0.2	<0.5	33	15	18
NOS	NZ southern arrow squid	<i>Nototodarus sloanii</i>	0.2	<0.5	67	15	18
WIT	Witch	<i>Arnoglossus scapha</i>	0.2	<0.5	33	27	28
ASC	Sea squirt	Ascidiacea	0.1	<0.5	33	27	28
LSO	Lemon sole	<i>Pelotretis flavilatus</i>	0.1	<0.5	33	15	18
ONG	Sponges	Porifera (Phylum)	0.1	<0.5	33	27	28
SHO	Seahorse	<i>Hippocampus abdominalis</i>	0.1	<0.5	33	15	15
TRE	Trevally	<i>Pseudocaranx dentex</i>	0.1	<0.5	33	15	15

Total catch 10–30 m

1447.5

Appendix 5: Macro-invertebrates collected on the 2008 survey.

Taxon	Occurrence
Porifera	
<i>Arenosclera</i> n. sp. 2	2
<i>Callyspongia</i> n. sp. 2	14
<i>Callyspongia</i> n. sp. 12	6
<i>Callyspongia</i> cf <i>bathami</i>	4
<i>Chondropsis</i> cf n. sp. 4	1
<i>Dactylia</i> n. sp. 1	4
<i>Dactylia palmata</i>	3
<i>Euryspongia</i> n. sp. 4	1
<i>Iophon proximum</i>	1
<i>Psammocinia</i> n. sp. 1	3
<i>Paraesperella</i> n. sp. 2	1
<i>Tedania diversirhaphidiophora</i> (Brondsted, 1923)	1
Cnidaria: Anthozoa	
Actiniaria	6
Cnidaria: Hydrozoa	
Hydrozoa	2
Mollusca: Gastropoda	
<i>Astraea heliotropium</i>	1
<i>Austrofuscus glans</i>	1
Nudibranchia	3
<i>Semicassis pyrum</i>	1
Mollusca: Bivalvia	
<i>Zygochlamys delicatula</i>	1
Mollusca: Cephalopoda	
Sepioloidea	1
Annelida: Polychaeta	
<i>Chloeia inermis</i>	1
<i>Pseudopotamilla pseudopotamilla-B</i>	1
Annelida: Hirudinea	
Hirudinea	2
Arthropoda: Chelicerata	
<i>Colossendeis</i> sp.	1
Crustacea: Stomatopoda	
<i>Pterygosquilla schizodontia</i> (Richardson, 1953)	3
Crustacea: Sessilia	
<i>Notomegabalanus decorus</i>	
Crustacea: Decapoda	
<i>Leptomithrax longipes</i>	3
<i>Nectocarcinus antarcticus</i>	8

Appendix 5 – continued

<i>Notomegabalanus decorus</i>	1
<i>Pagurus novizealandiae</i>	1
<i>Paguristes subpilosus</i>	1
<i>Thacanophrys filholi</i>	3
<i>Uroptychus</i> sp.	1
Bryozoa:	
<i>Arachnopusia unicornis</i>	1
<i>Celleporina hemiperistomata</i>	1
<i>Celleporina sinuata</i>	1
<i>Diaperoecia purpurascens</i>	1
<i>Figularia huttoni</i>	1
<i>Galeopsis polyporus</i>	1
<i>Hippomenella vellicata</i>	2
<i>Microporella agonistes</i>	1
<i>Odontionella cyclops</i>	1
<i>Smittoidea maunganuiensis</i>	1
Echinodermata: Echinoidea	
<i>Fellaster zelandiae</i>	1
<i>Pseudechinus huttoni</i>	2
Echinodermata: Asteroidea	
<i>Sclerasterias mollis</i>	1
<i>Pteraster (Apterodon) bathamae</i>	1
<i>Diplodontias miliaris</i>	1
<i>Coscinasterias muricata</i>	1
Echinodermata: Holothuroidea	
<i>Bathyploetes moselyi</i>	10
Echinodermata: Ophiuroidea	
<i>Ophiopsammus maculata</i>	1
Chordata: Ascidacea	
<i>Pyura pachydermatina</i>	1

Appendix 6: Length weight coefficients used to scale length frequencies. $W = aL^b$ where W is weight (g) and L is length (cm);* data missing. DB, NIWA trawl database.

Species	<i>a</i>	<i>b</i>	n	Range		Data source
				Min.	Max.	
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	0.0014	3.3732	751	23.1	71.8	This survey
Elephantfish	0.0049	3.1654	378	13.4	91	DB, KAH9618
Giant stargazer	0.0175	2.9910	509	10.1	72.2	This survey
Hapuku	0.0078	3.1400	307	49	108	DB, TAN9301
Hoki	0.0046	2.8840	525	22	110	DB, SHI8301
Leatherjacket	0.0088	3.2110				DB, IKA8003
Lemon sole	0.0080	3.1278	524	14.6	41.2	DB, KAH8909
Ling	0.0013	3.2801	179	32.2	123.7	DB, KAH0004
Red cod	0.0093	3.0080	765	10.7	75	This survey
Red gurnard	0.0087	3.0540	384	27	57	DB, KAH9606
Rig	0.0030	3.0814	133	36.8	144	This survey
Rough skate	0.0396	2.8476	353	14.6	71	This survey
School shark	0.0024	3.1685	198	38.7	112	This survey
Sea perch	0.0158	3.0394	1 075	9.6	41.4	This survey
Silver warehou	0.0048	3.3800	262	16.6	57.8	DB, TAN502
Smooth skate	0.0245	2.9671	276	17.2	127	This survey
Spiny dogfish	0.0017	3.1941	2 316	25.5	99.4	This survey
Tarakihi	0.0115	3.1588	766	11.5	49.4	This survey