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Inshore trawl survey of Canterbury Bight and Pegasus Bay April–June 2012, (KAH1207)

New Zealand Fisheries Assessment Report 2013/36

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In April–June 2012 a bottom trawl survey of the east coast South Island (ECSI) in 30–400 m was carried out using R.V. *Kaharoa* (KAH1207). This survey was the ninth in the winter ECSI inshore time series (1991–94, 1996, 2007–2009, 2012). Four strata in 10 to 30 m were also surveyed to monitor elephantfish and red gurnard in their full depth range. The 10–30 m strata were previously surveyed in 2007 to 2009, but these were not a priority and only the 2007 survey completed all required stations.

The survey was a stratified random trawl survey with a two-phase design optimised for the target species dark ghost shark, giant stargazer, red cod, sea perch, spiny dogfish, and tarakihi in 30–400 m (core strata), and elephantfish and red gurnard in 10–400 m (core plus shallow strata). A total of 84 stations (82 phase 1 and two phase 2) was completed from 17 core strata, and 20 stations from the four shallow 10 to 30 m strata (18 phase 1 and two phase 2). Biomass estimates and coefficients of variation (c.v.) for the target species in the core strata were: dark ghost shark 10 704 t (29%), elephantfish 1351 t (39%), giant stargazer 643 t (16%), red cod 11 821 t (79%), red gurnard 1680 t (28%), sea perch 1964 t (26%), spiny dogfish 35 546 t (31%), and tarakihi 1661 t (25%). Biomass estimates and c.v.s for elephantfish and red gurnard in the core plus shallow strata were 3781 t (31%), and 3515 t (17%), respectively, with the shallow strata accounting for 64% of the biomass of elephantfish and 52% of the biomass of red gurnard.

Dorsal spines were collected for spiny dogfish (387) and elephantfish (412), and otoliths for red gurnard (289), tarakihi (254), sea perch (245), and giant stargazer (310). A total of 241 rough skate, 102 smooth skate, 40 school shark, and 51 rig were tagged, length and weight recorded, and released during the survey.

Macro-invertebrates collected on the survey were identified to species level, where possible, and a complete qualitative list presented.

Data are presented on catch rates, biomass, spatial distribution, and length frequencies for the eight target and eight non-target QMS species. An analysis of mean rankings of species across all surveys in the time-series showed no evidence for significant catchability effects in 2012.

1. INTRODUCTION

1.1 The 2012 ECSI survey

This report presents the findings of the 2012 east coast South Island (ECSI) bottom trawl survey in 10–400 m from late April to early June using R.V. *Kaharoa* (KAH1207). This survey was the ninth in the winter ECSI time series in 30–400 m. Previous surveys were carried out in 1991–1994, 1996, 2007, 2008, and 2009 (Beentjes & Wass 1994, Beentjes 1995a, 1995b, 1998a, 1998b, Beentjes & Stevenson 2008, 2009, Beentjes et al. 2010). In the 2012 survey, red gurnard (*Chelidonichthys kumu*) and elephantfish (*Callorhinchus milii*) were added to the target species bringing the total to eight (existing target species were dark ghost shark, *Hydrolagus novaezelandiae;* giant stargazer, *Kathetostoma giganteum*; red cod, *Pseudophycis bachus*; sea perch, *Helicolenus percoides*; spiny dogfish, *Squalus acanthius*; and tarakihi, *Nemadactylus macropterus*).

1.2 Background to ECSI inshore trawl surveys

The main target species for the first five ECSI winter trawl surveys (1991 to 1994, and 1996) was red cod (pre-recruited and recruited), although the following commercial species were also of interest (giant stargazer, barracouta, spiny dogfish, tarakihi, sea perch, ling, elephantfish, rig, dark ghost shark, and red gurnard). After 1996 the winter time series was discontinued because it was considered that red gurnard and elephantfish were not being adequately monitored and that these species would be more appropriately surveyed in summer, and in shallower depths. Consequently the winter survey was replaced by a summer time series (five consecutive surveys from 1996 to 2000). The summer trawl surveys used a finer codend mesh (28 mm compared to 60 mm in winter), the minimum depth range was reduced from 30 m to 10 m, and the target species were elephantfish, red gurnard, giant stargazer, pre-recruit red cod, and juvenile rig (later dropped as a target). The summer time series was reviewed by Beentjes & Stevenson (2001).

The summer time series was discontinued after the fifth in the time series (2000) because of the extreme fluctuations in catchability between surveys (Francis et al. 2001). Of the four surveys examined, three were deemed to have "extreme catchability". The biomass estimates for the target species were therefore not providing reliable abundance indices, some of which at the time, 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, in 1996 and 2000 respectively, there was no means of effectively monitoring many of the commercial ECSI inshore fish stocks. Further, since 1996, several new species had been introduced into the QMS (e.g., skates, dark ghost shark, sea perch, and spiny dogfish). ECSI surveys also provided 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).

An MPI workshop, held in May 2005 (SITS-REV-2012-07), to discuss ways of monitoring inshore species concluded that a winter survey time series would provide reliable information on long-term trends in abundance for a number of inshore species. The 2007 survey marked the reinstatement of the winter survey time series, eleven years after the time series was discontinued. The time series up to 2006 was reviewed by Beentjes & Stevenson (2000). Following reinstatement, the 2007 to 2009 surveys retained the 30–400 m depth range and stratification (Figure 1), but also included four additional survey ancillary strata in 10–30 m. There were, however, no target species specified, nor additional days added to the survey to accommodate the extra stations in the 10–30 m shallow strata. Consequently, the allocated stations in 10–30 m strata were not always completed due to time and resource constraints, and because they were outside the 30–400 m core strata used in the historical winter time series, priority was low. In 2012, the ECSI survey range was formally expanded to include four strata in the 10–30 m depth range primarily to monitor elephantfish and red gurnard.

Following reinstatement of the surveys in 2007, the intention was to carry out three consecutive winter surveys from 2007 to 2009 and then move to biennial surveys. The three year gap between 2009 and 2012 was to align the ECSI survey with the west coast South Island survey so that they run in alternate years.

1.3 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 surveys since 2007 have had an objective of tagging rough skate, smooth skate, school shark, and rig.

Skates

Two species of skate are commonly caught on the ECSI surveys; the rough skate (*Zearaja nasuta*) which is more common inshore, and the larger smooth skate (*Dipturus innominatus*), which is more common in deeper water. There is very little known about the biological stocks of either species, and a tagging programme may provide information on movements, home range, and possibly growth. At the time of writing, there have been eight tag returns from rough skate and two from smooth skate tagged on the ECSI winter surveys.

School shark

New Zealand school shark are assumed to comprise a single biological stock (Ministry for Primary Industries 2012). School shark tend to be more common in water less than 200 m deep and also move inshore during summer to pup. Tagging school shark during the east coast South Island trawl survey 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 indicated 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. A recent review of tagging data by Francis (2010) updates the number of NIWA tagged school shark to 4506 and recaptures at 320, and the conclusions on movement are generally consistent with the results of Hurst et al. (1999). At the time of writing, there have been 30 tag returns from school shark tagged on the ECSI winter surveys.

Rig

Like school shark, rig tend to be more common in shallow water (under 200 m) and also move inshore during summer to pup. 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). Analyses of these data suggested limited movement compared to school shark, and evidence to suggest separate east and west coast South Island stocks (Francis 1988). Including some additional tagging from 1986 to 1988, there have been 2386 rig tagged from commercial set nets and research trawls, mainly around the South Island, with about 437 recaptures (Francis 2010). In a review of all data, Francis (2010) showed that recaptures of males were made predominantly within the QMA in which they were tagged. Females, however, are more mobile with about 30% moving outside the tagging QMA within 2–5 years, but mostly to adjacent QMAs. Tagging rig on the east coast South Island trawl surveys since 2007 complements a similar programme as part of the west coast South Island trawl surveys, and also the earlier tagging study of Francis (1988). At the time of writing, there have been four tag returns from rig tagged on the ECSI winter surveys.

1.4 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 was 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). This objective was removed from the 2009 and 2012 surveys because of the lack of recaptures and the potential loss of information on sex and age from stargazer that are tagged and released. At the time of writing, there have been two tag returns from giant stargazer tagged on the ECSI winter survey.

1.5 Objectives

This report fulfils the final reporting requirement for Objectives 1–6 of MPI Research Project INT2011/01. Objective 7 is reported in Beentjes & MacGibbon (2013).

Overall objective

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

Specific objectives

1. To determine the relative abundance and distribution of red cod, stargazer, sea perch, tarakihi, elephantfish, red gurnard, dark ghost shark and spiny dogfish off the east coast of the South Island from the Waiau River to Shag Point 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%) elephantfish (20–30%), red gurnard (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, elephantfish, red gurnard and dark ghost shark.

3. To collect otoliths from giant stargazer, sea perch, red gurnard and tarakihi; and spines from spiny dogfish and elephantfish.

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 identify benthic macro-invertebrates collected during the trawl survey.

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

2. METHODS

2.1 Survey area and design

The 2012 survey (KAH1207) in the 30–400 m depth range (hereafter referred to as the ‘core strata’) 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 23 339 km^2, including untrawlable foul ground (2018 km^2), was divided into 17 strata, identical to those used in the last five winter surveys (1994, 1996, 2007, 2008, and 2009) (Figure 1, Table 1). Nine strata were used in the first three winter surveys (1991, 1992, and 1993), and these were subdivided into 17 strata in 1994 to reduce c.v.s for the target species red cod, as well other the other important commercial species. These strata subdivisions were made across depth (i.e., perpendicular to the coastline) and there were no changes to strata depth ranges or of the total survey area (see strata boundaries in Beentjes 1998a).

The 2012 survey included the same four 10 to 30 m ancillary strata surveyed (or part thereof) from 2007 to 2009 (Figure 1, Table 1). The only difference is that a smaller 28 mm codend was used in 2007 and 2008, and this was changed to the 60 mm in 2009, consistent with that used in the core strata. The core plus shallow strata survey area was 26 918 km^2, including untrawlable foul ground (2244 km^2).

Consistent with previous winter surveys, a two-phase random stratified station survey design was used (Francis 1984). To determine the theoretical number of stations required in each of the 21 strata to achieve the specified c.v.s for the eight target species, simulations using NIWA’s Optimal Station Allocation Programme (allocate) were carried out using catch rates for the eight target species from the last three winter surveys (2007, 2008 and 2009). For the winter survey target species, simulations using the minimum and maximum of the c.v. range and requiring a minimum of three stations per stratum were carried out for strata within 30 to 400 m. Similarly for elephantfish and red gurnard, simulations were carried out for strata within 30 to 100 m, the depth range for which was initially considered to be appropriate for these species. In 10 to 30 m the allocation was nominal, and was based on inspection of elephantfish and red gurnard catches from each of the four strata over the 2007 to 2009 surveys, but with a minimum of three stations per strata. The sum of the stratum maximum for each target species indicated that 165 stations were theoretically required to achieve the lower target c.v. range (Table 2). The number of stations that were likely to be completed within the survey timeframe, based on average tows per day from previous surveys, was about 120 and hence the phase 1 target was 100 stations, leaving 20 stations for phase 2 (i.e., an allocation of 80% phase 1). To achieve this number, the average across each stratum was calculated and this was prorated to 100 stations to achieve the number of phase 1 stations for the survey (Table 2).

Sufficient trawl stations to cover both first and second phase stations were generated for each stratum using the NIWA random station generator program (Rand_stn v2.1), with the constraint that stations were at least 3 n. miles apart. Phase 2 stations were allocated using the NIWA program *SurvCalc*. The program calculates the phase 1 station catch rate variance for each species in each strata and outputs a table of gains for each species by strata (algorithm from Francis 1984). It also outputs an optimal station allocation across species and strata, and projected c.v.s based on any given allocation scenario. Hence, *SurvCalc* allows for phase 2 optimisation of more than one species. The final phase 2 allocation is adjusted according to factors such as time available, steaming distance, achieved c.v. for each species, and species priority, where the order in decreasing importance for the winter target species is tarakihi, stargazer, sea perch, red cod, dark ghost shark, and spiny dogfish (MPI defined). Phase 2 stations for elephantfish and red gurnard were allocated in the 10 to 100 m strata, and *a priori*, five stations were set aside for this purpose.

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, and capable of trawling to depths of about 500 m. The two-panel bottom trawl net was constructed in 1991, specifically for the South Island trawl surveys; there are two nets (A and B), complete with ground rope and flotation. The nets fish hard down and achieve a headline height of about 4–5 m. Rectangular 'V' trawl doors fitted with Scanmar sensors were used and these achieve a doorspread of about 80 m. For both the 10–30 m and 30–400 m depth ranges, 60 mm (knotless) codend mesh, standard for winter surveys, was used. A bottom contact sensor was deployed on the ground rope, and a net sonde monitor (Furuno CN22) attached to the headline to measure headline height. A Seabird Microcat CTD (conductivity, temperature, depth) data logger was also attached to the headline to record depth (by measuring pressure), water temperature, and salinity on all tows. All trawl gear was overhauled and specifications checked before the 2012 survey. Updated gear specifications are documented in Appendix 1.

2.3 Timetable and survey plan

Following mobilisation, the R.V. *Kaharoa* departed Wellington on 24 April 2012 and steamed to Lyttelton to pick up fish boxes and ice. Trawling began on 26 April, north east of Banks Peninsula in strata 17 and 13, and completed all phase 1 tows (10–400 m) north of and around Banks Peninsula before heading generally southward to complete tows in the southern part of the ECSI survey area (Figure 2). This is the standard survey plan followed for ECSI surveys. The 10 to 30 m strata were surveyed along with the 30 to 400 m strata in the most efficient manner to reduce steaming time and to survey shallow strata when weather was too rough to survey the deeper strata. Catch was initially landed into Lyttelton, and then into Timaru as the southern stations were surveyed. The first leg was completed on 16 May when the vessel discharged fish at Timaru and there was a change of scientific staff. The last tow was on 5 June and after discharging the catch into Lyttelton, the vessel steamed to Wellington, arriving on 7 June for demobilisaton.

2.4 Trawling procedure

Trawling procedures adhered strictly to those documented by Stevenson & Hanchet (1999) and to the protocols from previous surveys in the time series. All tows were carried out in daylight (shooting and hauling) between 0730 and 1700 hours NZST. Tows were standardised at 1 hour long at a speed of 3.0 knots resulting in a tow length of about 3 n. miles. For some areas, large catches of dogfish and barracouta made tows unmanageable and the standard towing time was reduced, usually to about 40 min, but with a minimum acceptable tow length of 1.5 n. miles. Potentially large catches were indicated by fish moving under the net sonde monitor and changes in the doorspread. Timing began when the net reached the bottom and settled, as indicated by the net monitor, and finished when hauling began. Standardised optimal warp/depth ratio for different depths was strictly adhered to (Appendix 1). 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 they were 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 that radius, the next alternative random station was selected. Doorspread (Scanmar monitor*)* and headline height (net sonde sensors) were monitored 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.

At the end of the tow, immediately after the gear came on deck, the ground contact sensor and CTD data files were downloaded. Bottom and surface water temperatures were taken from the CTD output data with surface temperatures at a depth of 5 m and bottom temperatures about 5 m above the sea floor where 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 subsample of about 100 randomly selected fish. All data were captured electronically from scales or digitised measuring boards that connect to the "*trawl coordinator*" program in real time allowing live error checking.

For each tow, biological information was obtained from a sample of up to 20 fish (sub-sampled from the random length frequency sample) for each target species, 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 from finfish and dorsal spines from dogfish and elephantfish. Gonad stages were also recorded for all target species (Appendix 2). To ensure that the full range of sizes was adequately sampled, especially large or small fish were sometimes selected from the random length frequency sample for biological analyses.

For the finfish target species giant stargazer, red gurnard, sea perch, and tarakihi, at least five sagittal otoliths per centimetre size class per sex were removed, if available. Otoliths were stored clean and dry in small paper envelopes marked with the survey trip code, species, fish number, length, and sex. Otoliths were collected across the entire survey area ensuring that individual length bins were not all filled from the first strata surveyed, for example those around Banks Peninsula.

Spiny dogfish spines were excised from the second dorsal fin and elephantfish spines from the first dorsal fin, ensuring that the spine was removed from about 1 cm beneath the skin. We aimed to collect at least five spines per centimetre size class for each sex. Spiny dogfish spines were placed into plastic vials and filled with 70% ethanol, and elephantfish spines were placed into zip-lock plastic bags and frozen with details of station number, fish length, and sex. As with otoliths, we attempted to spread the collection of spines across the survey area.

Macro-invertebrates that could not be clearly identified on deck, were retained and preserved for later identification at Greta Point laboratories to the lowest possible taxonomic level.

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, and rig. Sharks 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 and these data were added to the biological record for the tow.

2.7 Data storage

All catch, biological, and length frequency data were entered into the *trawl* research database and tagging data into the *tag* research database at NIWA Greta Point after the survey was completed. Data from fish for which otoliths were removed or sharks for which dorsal spines were removed were entered into the *age* research database, and the otoliths and spines were stored at NIWA, Greta Point. After identification of invertebrates data were entered into the *trawl* database. The parameters used in *SurvCalc* for estimating biomass and length frequency from the 2012 and earlier surveys, have been archived under the project INT2011-01.

2.8 Analysis of data

Relative biomass and coefficients of variation were estimated by the area-swept method described by Francis (1981, 1989) using the NIWA program *SurvCalc* (Francis & Fu 2012). 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.

The combined biomass and length frequency analysis option in SurvCalc 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.

For the eight target species (dark ghost shark (GSH), elephantfish (ELE), giant stargazer (GIZ), red cod (RCO), red gurnard (GUR), sea perch (SPE), spiny dogfish (SPD), tarakihi (NMP)), estimates of total biomass, pre-recruited, recruited, and immature, and mature biomass were calculated and compared to previous surveys in the ECSI time-series. Total biomass estimates are also presented for eight key QMS species (barracouta (BAR), lemon sole (LSO), ling (LIN), rough skate (RSK), smooth skate (SSK), rig (SPO), silver warehou (SWA)) as recommended by Beentjes and MacGibbon (2013).

Separate analyses of total biomass, were carried out for the core strata (30–400 m), and core plus the shallow strata (10–400 m). These are plotted on the same figures to show the contribution of biomass made by the 10 to 30 m shallow strata. For the core strata (30–400 m), time series of total, pre-recruited, and recruited biomass for the target species are tabulated and plotted by survey to show temporal trends. Size at recruitment to the fishery were presumed to be: ELE, 50 cm; GUR, 30 cm; GSH, 55 cm; RCO, 40 cm; STA, 30 cm; SPD, 50 cm; SPE, 20 cm; TAR, 25 cm.

Time series biomass equal to and above length-at-50% maturity, and below length-at-50% maturity, were also tabulated and plotted for 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 elasmobranchs, 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 GUR, RCO, GIZ, and NMP for males and females combined, but for males and females separately for GSH and SPD, and ELE. The cut-off lengths used were: GUR, 22 cm; RCO, 51 cm; STA, 45 cm; TAR, 31 cm; GSH males 52 cm, females 62 cm; SPD males 58 cm, females 72 cm; ELE males 51, females 70 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 50% in the 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.

Catch rates (kg km^{-2}) for the target and key QMS species were tabulated by stratum and plotted on the survey strata map for each tow to show areas of relative density throughout the survey area. For the core strata (30–400 m), 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.

Scaled length frequency distributions are plotted for the target species and key QMS species, and also by depth range for the target species. Length-weight coefficients for 2012 were determined for all eight target species 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.

Note that biomass estimates and length frequency distributions for ECSI winter surveys in 1991 to 1994 in this report and in the review of the time series (Beentjes & Stevenson 2000) may differ from those in the original survey reports (Beentjes & Wass 1994, Beentjes 1995a, 1995b, 1998b) 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 from the 1996 surveys onward where doorspread was measured directly.

2.9 Survey representativeness

Representativeness refers to the survey catchability and whether the biomass estimate from a range of species is within an acceptable range (representative) or extreme (non-representative). This approach derives from the work by Francis et al. (2001) who examined data from 17 trawl survey time series including the ECSI winter survey time series from 1991 to 1996. The method involves ranking species in order of increasing biomass index, and then averaging across species to obtain a mean rank for each year. This analysis was updated for the ECSI winter surveys including the last four surveys from 2007 to 2012. Species included in the ranking calculations were the eight target species and 10 other species that are most commonly caught on these surveys (barracouta, carpet shark, New Zealand sole, lemon sole, pigfish, scaly gurnard, school shark, rig, blue warehou, witch).

3. RESULTS

3.1 Trawling details

In the winter survey core strata (30–400 m), 87 tows were carried out, of which 84 had gear performance of 1 or 2 and these were used in length frequency and biomass estimation (Table 1, Appendix 3). All planned phase-one tows in core strata were completed (N = 82). 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 3). Station density ranged from one station per 76 km^2 in stratum 14 to one station per 722 km^2 in stratum 6, with an overall average density of one station per 252 km^2 (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 3.

In the shallow strata (10–30 m), 20 tows with gear performance of 1 or 2 were carried out, and these were used in length frequency and biomass estimation (Table 1, Appendix 3). All planned phase 1 tows in core strata were completed (N = 18). Trawlable ground represented 94% 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 3.

Only four of the planned 20 phase 2 tows were achieved, due to lost time caused by vessel winch problems, and unsuitable weather and sea conditions. One phase 2 tow was allocated to stratum 5 to reduce c.v.s for spiny dogfish, with one in stratum 1 and two in stratum 19 to reduce c.v.s for elephantfish (Table 1, Appendix 3).

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, means for doorspread, headline height, distance towed, and warp to depth ratio were 80.1 m, 4.8 m, 2.7 n. miles, and 3.4:1, respectively (Appendix 4). For the depth range 10–30 m, means for doorspread, headline height, distance towed, and warp to depth ratio were 73.3 m, 5.1 m, 3.0 n. miles, and 9.3:1, respectively (Appendix 4). Net-A was used on all tows.

Surface and bottom temperatures for each station are shown in Appendix 3. Problems with the CTD resulted in missing temperatures for several stations.

3.2 Catch composition

The total catch from the core strata (30–400 m) was 154 t from the 84 biomass tows. Catches were highly variable, ranging from 27 to 10 322 kg per tow, with an average of 1832 kg. Vertebrate fish species caught included 13 chondrichthyans, and 62 teleosts (Appendix 5). There were also many invertebrate species caught including octopus and one squid species. Catch weights, percent catch, occurrence, and depth range of all species identified during the survey are given in Appendix 5. The catches were dominated by barracouta, spiny dogfish, dark ghost shark and red cod and with catches of 48 t, 46 t, 17 t and 14 t representing 31%, 30%, 11%, and 9% respectively, of the total catch. These four species, and the next eight most abundant species, arrow squid, sea perch, elephantfish, red gurnard, tarakihi, smooth skate, rough skate, and carpet shark, made up 93% of the total catch (Appendix 5). The percentage of the catch represented by the eight winter survey target species was as follows: dark ghost shark 11%; elephantfish 2%, giant stargazer 1%; red cod 9%; red gurnard 2%, sea perch 2%; spiny dogfish 30%; tarakihi 1%, making a combined total of 57%. Spiny dogfish was caught in 98% and barracouta in 86% of tows. Other non-target species commonly caught included arrow squid (91% of tows), witch (87% of tows), and carpet shark (83% of tows) (Appendix 5).

The total catch in 10–30 m depth range was 28.5 t from the 20 biomass tows. Catches were highly variable, ranging from 240 to 4284 kg per tow, with an average of 1424 kg. Vertebrate fish species caught included 8 chondrichthyans and 36 teleosts (Appendix 5). There were also many invertebrate species caught including arrow squid. Catch weights, percent catch, occurrence, and depth range of all species identified during the survey are given in Appendix 5. The catches were dominated by spiny dogfish, elephantfish, barracouta, leatherjacket, and red gurnard with catches of 6.9 t, 5.6 t, 5.1 t, 4.1 t, and 3.9 t, representing 24%, 20%, 18%, 14% and 14%, respectively, of the total catch. These five species, and the next six most abundant species, rough skate, red cod, globefish, rig, blue warehou, and carpet shark made up 98% of the total catch (Appendix 5). The percent of the catch represented by the eight winter survey target species was as follows: dark ghost shark 0%; elephantfish 20%, giant stargazer 0%; red cod 2%; red gurnard 14%, sea perch 0%; spiny dogfish 24%; tarakihi 0.2%, making a combined total of 60% (Appendix 5).

Invertebrate species from the catch identified after the survey are given in Appendix 6.

3.3 Biomass estimates

Core strata (30–400 m)

Biomass estimates and c.v.s for the target species and the eight key QMS species in the core strata (30–400 m) are given in Table 3 (Panel A). Of the target species, spiny dogfish had by far the largest total biomass at 35 546 t, followed by red cod (11 821 t), dark ghost shark (10 704 t), sea perch (1964 t), red gurnard (1680 t), tarakihi (1661 t), elephantfish (1351 t), and giant stargazer (643 t). Coefficients of variation for the target species were spiny dogfish 31%, red cod 79%, dark ghost shark 29%, sea perch 26%, red gurnard 28%, tarakihi 25%, elephantfish 39%, and giant stargazer 16%

(Table 3, panel A). These c.v.s were within the project objectives specified range for dark ghost shark, tarakihi, and giant stargazer, and within about 10% for spiny dogfish, sea perch and tarakihi (see Section 1.5 Objectives). For red cod the c.v. was 54% above the upper target limit of 25%. There were no target c.v.s for red gurnard and elephantfish in the core strata, although this is not explicit in the objectives.

The breakdown of biomass for target species by sex indicates a few unbalanced sex ratios: spiny dogfish total biomass was 80% male, dark ghost shark 40% male, and giant stargazer 42% male. For the other target species biomass by sex was more balanced (Table 3, panel A).

Of the eight key QMS species, barracouta had the largest biomass of all species, including the target species, at 34 325 t and a c.v. of 17% (Table 3, panel A). Other species with substantial biomass included rough skate (1133 t, c.v. = 20%) and smooth skate (1025 t, c.v. = 35%).

Recruited biomass estimates and c.v.s for the target species and the eight key QMS species are shown in Table 3. For the target species the percentage of total biomass that was recruited fish was spiny dogfish 89%, dark ghost shark 65%, tarakihi 65%, sea perch 97%, red cod 41%, and giant stargazer 96%.

Core plus shallow strata (10–400 m)

Biomass estimates and c.v.s in the core plus shallow strata (10–400 m) for elephantfish and red gurnard, as well as target species and key QMS species that were caught in less than 30 m in 2012, are given in Table 3 (panel B). Of the target species, spiny dogfish had by far the largest total biomass at 38 821 t, followed by red cod (12 032 t), elephantfish (3780 t), and red gurnard (3515 t). Coefficients of variation for the target species were spiny dogfish 28%, red cod 78%, elephantfish 31%, and red gurnard 17% (Table 3, panel B). For red gurnard the c.v. of 17% was less than the target of 20% and for elephantfish it was 1% above the upper limit of 30%. There were no target c.v.s for the other target species in the core plus shallow strata.

The breakdown of biomass for target species by sex indicates that elephantfish male biomass comprises only 29% of the total biomass, a marked departure from the value of 54% for the core strata (Table 3 (panels A and B). For red gurnard the proportion of males is closer to parity at 44% male, but is less than in the core strata where it was 50%. For red cod and spiny dogfish the sex ratios are almost the same as in the core strata.

Of the five key QMS species caught in less than 30 m, barracouta had the largest biomass of all species at 36 526 t and a c.v. of 16% (Table 3, panel B). The only other species with substantial biomass was rough skate (1414 t, c.v. = 16%).

Recruited biomass estimates and c.v.s for the target species and the key QMS species are shown in Table 3 (panel B). For elephantfish the percentage of total biomass that was recruited fish was 85% compared to 95% for the core strata. Similarly, for red gurnard it was 79% compared with 88% for the core strata. For red cod and spiny dogfish the recruited biomass proportions are almost the same as in the core strata.

3.4 Strata catch rates, biomass, and distribution

For the eight target and eight key QMS species catch rates by stratum are given in Table 4, and catch rates by station are plotted in Figures 3 and 4. Biomass by stratum is given in Table 5. Note that strata with the highest catch rates are not always the same as those with the highest biomass because biomass is scaled by the area of the stratum.

Dark ghost shark was predominantly caught in waters deeper than 100 m throughout the survey core strata (30–400 m) in 37% of tows, with the shallowest catch in 80 m and the deepest in 383 m. Highest catch rates and biomass estimates were in 100 to 200 m strata 10 and 11 (Appendix 5, Figure 3, Tables 4 and 5).

Elephantfish was caught in the survey core strata (30–400 m) between 30 and 126 m, in 38% of tows. Highest catch rates were in 30 to 100 m stratum 1, and 100 to 200 m stratum 8. Highest biomass estimates were also in these strata as well as stratum 8 (Appendix 5, Figure 3, Tables 4 and 5). In the shallow 10 to 30 m strata, elephantfish was caught from 15 to 30 m and in 85% of tows. The highest elephantfish catch rates and biomass estimates within the core plus shallow strata (10 to 400 m) were in the shallow 10 to 30 m strata 18 to 20.

Giant stargazer was predominantly caught in waters deeper than about 50 m throughout the survey core strata (30–400 m) in 74% of tows, with the shallowest catch in 32 m and the deepest in 383 m. Highest catch rates were in 30 to 100 stratum 6, and 100 to 200 m strata 9 and 13. The highest biomass estimates were in 30 to 100 m strata 5 and 6, and 100 to 200 m strata 9 and 13 (Appendix 5, Figure 3, Tables 4 and 5).

Red cod was caught in all depth ranges throughout the survey core strata (30–400 m) in 70% of tows, with the shallowest catch in 30 m and the deepest in 362 m. The highest catch rates and biomass estimates were in 100 to 200 m stratum 11, and 200 to 400 m stratum 14 (Appendix 5, Figure 3, Tables 4 and 5). Red cod was also caught in the 10–30 m depth range from 15 to 30 m in 85% of tows.

Red gurnard was caught in the survey core strata (30–400 m) between 30 and 128 m, in 58% of tows. Highest catch rates and biomass estimates were in 30 to 100 m strata 2, 4, and 7 (Appendix 5, Figure 3, Tables 4 and 5). In the shallow 10 to 30 m strata, red gurnard was caught from 15 to 30 m and in all tows. The highest red gurnard catch rates and biomass estimates within the core plus shallow strata (10 to 400 m) were in the shallow 10 to 30 m strata 18 to 20.

Sea perch was predominantly caught in waters deeper than about 50 m throughout the survey core strata (30–400 m) in 71% of tows, with the shallowest catch in 30 m and the deepest in 362 m. The highest catch rates and biomass estimates were in 100 to 200 m strata 8, 10, 11, and 13 (Appendix 5, Figure 3, Tables 4 and 5).

Spiny dogfish was caught in all depth ranges throughout the survey core strata (30–400 m) from 98% of tows with the shallowest catch in 30 m and the deepest in 383 m. The highest catch rates were in 30 to 100 m stratum 5, and 200 to 400 m strata 15 and 16. The highest biomass estimates were in 30 to 100 m strata 4, 5 and 7, and 100 to 200 m stratum 16 (Appendix 5, Figure 3, Tables 4 and 5). Spiny dogfish was also caught in the 10–30 m depth range from 15 to 30 m in all tows.

Tarakihi was predominantly caught in waters between about 50 and 100 m throughout the survey core strata (30–400 m) in 63% of tows, with the shallowest catch in 30 m and the deepest in 323 m. The highest catch rates and biomass estimates were in 30 to 100 m strata 3 to 5 (Appendix 5, Figure 3, Tables 4 and 5).

3.5 Biological and length frequency data

Details of length frequency and biological data recorded for each species are given in Table 6. Just over 42 000 length frequency and nearly 9000 biological records were taken from 45 species. This included otoliths from 310 giant stargazer, 289 red gurnard, 245 sea perch, and 254 tarakihi. Dorsal spines were collected from 412 elephantfish, and 387 spiny dogfish.

Scaled length frequency distributions of the target species dark ghost shark, giant stargazer, red cod, sea perch, spiny dogfish, and tarakihi are plotted from core strata (30–400 m) as well as for the depth ranges 10–30 m (where appropriate), 30–100 m, 100–200 m, and 200–400 (Figure 5). For the new target species elephantfish and red gurnard, distributions are shown for the core plus shallow (10–400 m) and also for the four depth ranges. For the key QMS species, scaled length frequency distributions in the core strata (30–400 m) and the 10 to 30 m depth range are plotted in Figure 6. The length-weight coefficients used to scale the length frequency data are shown in Appendix 7.

The length frequency distribution for dark ghost shark males shows a clear mode at about 50 cm whereas for females no clear modes are present (Figure 5). The largest fish (over 60 cm) are mostly females. The male mode (47–63 cm) comprises about half pre-recruited fish (under 55 cm) and is prevalent in the 100–200 m depth range. The equivalent female fish in 100 to 200 m (about 42–70 cm) are mainly recruited. The 200 to 400 m depth range has a wide size distribution, but is dominated by the small pre-recruited fish. The overall scaled numbers sex ratio (males:females) in the core strata (30–400 m) is close to 0.9:1 (Figure 5).

The length frequency distributions for elephantfish show strong juvenile modes for both males and females centred at about 25 cm (1+), with indications of a less defined mode at about 30 cm (2+) (Figure 5). Female length distribution has a wider right hand tail indicating that the largest fish are mostly females. The two juvenile modes are dominant in the 10 to 30 m strata with larger recruited fish more common in 30 to 200 m. The overall scaled numbers sex ratio (males:females) in core plus shallow (10–400 m) is 0.8:1, and 1.4:1 in the core strata (10–400 m).

The length frequency distributions for giant stargazer males and females have no clear modes and the length distributions comprise multiple cohorts (Sutton 1999) (Figure 5). The female length distribution has a wider right hand tail indicating that the largest fish are mostly females. For both sexes the length distributions were generally similar in 30 to 200 m, with some indication that, while less common, fish are larger in the 200 to 400 m depth range. The overall scaled numbers sex ratio (males:females) in 30–400 m is 1.1:1.

The length frequency distribution for male red cod shows a well-defined mode at 30–40 cm (1+). There are indications of a 0+ mode (19 cm), while modes of the older fish (2+, 3+, and older) cannot be easily distinguished (Figure 5). The female length distribution is similar to that for males, but the 1+ mode is less defined and the mode is slightly larger as females grow faster (Horn 1996, Beentjes 2000). The bulk of the red cod were found in 100 to 200 m with a few large fish in 200 to 400 m. The overall scaled numbers sex ratio (males:females) in 30–400 m is 2.3:1.

The length frequency distributions for red gurnard male and female have two clear modes centred at about 25 cm and 35 cm (unsexed), but neither mode represents a single cohort and based on ageing, the distribution comprises ages from about 1 to 13 years (Sutton 1997) (Figure 5). The smaller mode, however, is likely to be mainly 1+ and 2+ fish. Female length distribution has a wider right hand tail indicating that the largest fish are mostly females. Red gurnard were caught mainly in 10 to 100 m with indications that the smaller fish are more common in the shallower 10 to 30 m. The overall scaled numbers sex ratio (males:females) in core plus shallow (10–400 m) is 1:1, and 1.6:1 in the core strata (10–400 m).

The length frequency distribution for sea perch is unimodal with peaks at about 25 cm for males and females, and the largest fish were about 43 cm (Figure 5). The bulk of fish were caught in 100–200 m with no separation of size by depth. The overall sex ratio (males:females) in 30–400 m is 1:1.

The length frequency distributions for spiny dogfish are bimodal with peaks at about 42 cm and 60 cm for males, and 40 cm and 45 cm for females (Figure 5). Spiny dogfish were caught in all depth ranges, including the shallow 10 to 30 m, but the bulk of fish were in 30–100 m, with the larger fish in deeper than 100 m. The overall sex ratio (males:females) in 30–400 m was strongly skewed to males at 3:1.

The length frequency distribution for tarakihi shows the appearance of three juvenile modes for both males and females, although these are not well defined (Figure 5). There were few fish over 35 cm, the largest of which was 50 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 close to 1:1.

Details of the gonad stages for the target species are given in Table 7. Giant stargazer were mostly resting/immature, although 13% of males were classified as ripening. Red cod and tarakihi were predominantly immature/resting. Sea perch females were predominantly immature/resting, whereas males displayed all five stages, and mainly the ripening stage. Red gurnard were predominantly immature/resting, although but there were reasonable numbers of fish that were spent, particularly females. Dark ghost shark showed all gonad stages and about half of males and females were mature with 5% of females in the spawning condition. Spiny dogfish showed a mix of stages with all stages present for both sexes, and 42% of females classified as pregnant (i.e., with large yolked eggs in the ovary). Elephantfish showed high proportions of mature stage males (69%), although the bulk of the females were either immature or maturing.

3.6 Tagging

A total of 434 individual skates and sharks from four species was tagged, length and weight recorded, and released during the survey (see Table 6). The total included 241 rough skate, 102 smooth skate, 40 school shark, and 51 rig.

4. DISCUSSION

4.1 2012 survey

The 2012 survey was successful in meeting all the project objectives and the c.v.s were within the specified range in core strata (30–400 m) for target species dark ghost shark, tarakihi, and giant stargazer, and within about 10% for spiny dogfish, sea perch and tarakihi (see Section 1.5 Objectives). For red cod the c.v. was 54% above the upper target limit 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. This is because red cod tends to form aggregations of cohorts and catches are often highly variable among tows which are characterised by many zero catch tows and the occasional very large catch. Further, in years of high red cod abundance (or recruitment) low c.v.s becomes even more difficult to achieve and this has proven to be the case in 2012 with a very strong 1+ cohort dominating the red cod catch.

For the new target species in the core plus shallow strata, the c.v for red gurnard of 17% was less than the target of 20%, and for elephantfish the c.v. of 31% was close to the upper limit of 30%.

4.2 Time series trends in biomass, distribution, and size

Implicit in our interpretation of trends in biomass, geographic distribution, and length distribution is that we have no information on these variables over the 11 year interval between the 1996 and 2007 surveys, and three years between the 2009 and 2012 surveys.

In the discussion below, unless explicitly stated, we refer to the core strata (30–400 m).

4.2.1 Target species

Dark ghost shark

Dark ghost shark total biomass in the core strata increased markedly between 1992 and 1993, was stable to increasing up to 2009, and then in 2012 increased markedly by more than 2-fold (Table 8, Figure 7). All surveys have a large component of pre-recruited biomass ranging from 30–62% (Table 9, Figure 8) — in 2012 the pre-recruit biomass was relatively low at 35% 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, and in 2012 the juvenile biomass was 39% of total biomass. (Table 10, Figure 9).

Dark ghost shark was present in 27–57% of core strata tows, with the highest occurrence in the 2009 survey and a clear trend of increasing occurrence until 2009, after which the percent occurrence declined to 37% (Table 11). Dark ghost shark have made up 2–11% of the total catch on the surveys, with indications of an increasing trend, and the highest value recorded in 2012 (Table 11). 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 from 2007 to 2012 is commensurate with a slightly expanded distribution throughout the survey area in this depth range and into Pegasus Bay (Figure 10).

The size distributions of dark ghost shark in each of the last six surveys (1993–2009) are similar and generally bimodal (Figure 11). The 2012 length frequency is distinct from previous years with relatively large numbers of adults or mature fish. 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.

There was no dark ghost shark caught in the 10–30 m strata in 2007 and 2012 and hence the addition of the shallow strata is of no value for monitoring dark ghost shark.

Elephantfish

Elephantfish total biomass in the core strata increased markedly in 1996 and although it has fluctuated since then it has remained high with 2012 biomass 29% above the post-1994 average of 1049 t (Table 8, Figure 7). The post 1994 average biomass is about three-fold greater than that of the early 1990s, indicating that the large increase in biomass between 1994 and 1996 has been sustained. The proportion of pre-recruited biomass in the core strata has varied greatly among surveys ranging from 50% in 2007 to only 5% in 2012, the latter value reflecting the high numbers of large fish present in 2012 (Table 9, Figure 8). Similarly, the proportion of juvenile biomass (based on the length-at-50% maturity) in 2012 was the lowest of all surveys at 23% (Table 10, Figure 9).

Elephantfish were present in 30–47 % of core strata tows (38% in 2012) and have consistently made up 1–2% of the total catch on the surveys, with no clear trend (Table 11). The distribution of elephantfish hot spots varies, but overall this species is consistently well represented over the entire survey area from 10 to 100 m, but is most abundant in the shallow 10 to 30 m (Figure 10).

The size distributions of elephantfish are inconsistent among the nine core strata surveys and generally characterised by a wide right hand tail of 3+ and older fish (up to about 10 years) based on the ageing of Francis (1997), and the occasional poorly represented 1+ and 2+ cohort modes (see 2007 and 2008 surveys) (Figure 11).

The additional elephantfish biomass captured in the 10–30 m depth range accounted for 44% and 64% of the biomass in the core plus shallow strata (10–400 m) for 2007 and 2012 respectively, indicating that in terms of biomass, it is essential to monitor the shallow strata for elephantfish (Table 8, Figure 7). Further, the addition of the 10–30 m depth range has had a significant effect on the shape of the length frequency distributions with the appearance of strong 1+ and 2+ cohorts, otherwise poorly represented in the core strata (Figures 5 and 11). The proportion of pre-recruited biomass in the core plus shallow strata is also greater than that of the core strata alone (i.e., 64% compared to 50% in 2007, and 15% compared to 5% in 2012), a reflection of the larger numbers of smaller elephantfish found in the shallow strata (Table 9, Figure 12). The sex ratio also favours females in the shallow strata, whereas males dominate in the core strata (Figure 11).

The time series length frequency distributions in the shallow plus core strata (10–400) includes only the 2007 and 2012 surveys, and have similar distributions, showing clearly the juvenile cohorts (Figure 13).

Giant stargazer

Biomass for giant stargazer in 2012 from the core strata was 35% greater than in 2009 and is close to the average biomass estimate over the nine survey time series (2012 biomass 643 t, average 592 t) (Table 8, Figure 7). Overall there is no consistent trend in giant stargazer biomass. Pre-recruited biomass is a small component of the total biomass estimate on all surveys (range 2–5% of total biomass) and in 2012 it was 4% (Table 9, Figure 8). 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 10, Figure 9), however in 2012 biomass was only 35% juvenile.

Giant stargazer were present in 70–92% of core strata tows (74% in 2012) and have consistently made up 1–2% of the total catch on the surveys, with no trend (Table 11). 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 10).

The size distributions of giant stargazer in each of the nine surveys are similar and generally have one large mode comprising multiple age classes and in some years a small juvenile mode, although both modes are less defined for females (Figure 11). 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.

There was no giant stargazer caught in the 10–30 m strata in 2007 or 2012 and hence the addition of the shallow strata is of no value for monitoring giant stargazer.

Red cod

Biomass for red cod from 2007 to 2009 core strata was largely unchanged and remained low relative to the period between 1991 and 1994. In contrast the biomass in 2012 is more than six-fold greater than in 2009 (Table 8, Figure 7). The relatively high biomass in 1994 and the low biomass in 2007–09 are consistent with the magnitude of commercial landings in RCO 3, a fishery in which cyclical fluctuating catches are characteristic (Beentjes & Renwick 2001). The large biomass in 2012, which is predominantly contributed by 1+ fish, indicates that commercial red cod catches in 2012–13, and the next few years, are likely to be very high, assuming average mortality of the 2012 1+ cohort. The proportion of pre-recruited biomass has varied greatly among surveys ranging from 7 to 59% of the total biomass and in 2012 it was the highest at 59%, reflecting the strong 1+ cohort (Table 9, Figure 8). The proportion of juvenile biomass (based on the length-at-50% maturity) has also varied greatly among surveys from 27 to 80% and in 2012 it was 70% (Table 10, Figure 9).

Red cod was present in 63–89 % of core strata tows with indications of a declining trend of red cod occurrence over the time series (Table 11). Red cod made up 2–28% of the total catch from the survey core strata, with the lowest proportions from 1996 to 2012 reflecting the low biomass compared to earlier surveys in the 1990s and the relative increase in biomass of other species such as dark ghost shark, red gurnard, and elephantfish, and non-target species such as barracouta and rough skate (Table 11). 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, but is also found in waters shallower than 30 m (Figure 10).

The size distributions of red cod in each of the nine 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 11). The 1996 to 2009 surveys show poor recruitment of 1+ fish compared to earlier surveys. The 2012 1+ cohort is the largest of all nine surveys and may results in large commercial catches in the next few 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.

The additional red cod biomass captured in the 10–30 m depth range accounted for only 4% and 2% of the biomass in the core plus shallow strata (10–400 m) for 2007 and 2012 respectively, indicating that in terms of biomass, it is informative but, probably not essential to monitor the shallow strata for red cod (Table 8, Figure 7). Further, the addition of the 10–30 m depth range had little effect on the shape of the length frequency distributions (Figures 5 and 11).

Red gurnard

In the 1990s, red gurnard biomass in the core strata averaged 422 t and this increased nearly four-fold to an average of 1541 t from 2007 to 2012 (Table 8, Figure 7). There is no trend since 2007 and biomass has been relatively stable. The proportion of pre-recruited biomass in the core strata has varied greatly among surveys, but is generally low – ranging from 2% to 20% and in 2012 was 11% (Table 9, Figure 8). Similarly, the proportion of juvenile biomass (based on the length-at-50% maturity) is almost zero for all surveys (Table 10, Figure 9).

Red gurnard was present in 24–58 % of core strata tows (58% in 2012), but have made up only 1 to 2% of the total catch on the surveys, with no trend (Table 11). The distribution of red gurnard hot spots varies, but overall this species is consistently well represented over the entire survey area from 10 to 100 m, but is most abundant in the shallow 10 to 30 m (Figure 10).

The size distributions of red gurnard have become more consistent over the last four core strata surveys as the biomass has increased. Over this period, based on the ageing analyses of Sutton (1997), they are characterised by a single mode representing multiple age classes ranging from 1+ to about 15+ (Figure 11).

The additional red gurnard biomass captured in the 10–30 m depth range accounted for 29% and 52% of the biomass in the core plus shallow strata (10–400 m) for 2007 and 2012 respectively, indicating that in terms of biomass, it is essential to monitor the shallow strata for red gurnard (Table 8, Figure 7). Further, the addition of the 10–30 m depth range has had a significant effect on the shape of the length frequency distributions with the appearance of strong 1+ cohort, otherwise poorly represented in the core strata (Figures 5 and 11). The sex ratio also favours females in the shallow strata, whereas the sex ratio is at parity in the core strata (Figure 11). The time series length frequency distributions in the shallow plus core strata (10–400) includes only the 2007 and 2012 surveys, and have similar distributions with indications of a 1+ mode distinct from the older aged cohorts (Figure 13). The proportion of pre-recruited biomass in the core plus shallow strata is also greater than that of the core strata alone (i.e., 24% compared to 20 % in 2007, and 21% compared to 11% in 2012), a reflection of the larger numbers of smaller red gurnard found in the shallow strata, particularly in 2012 (Table 9, Figure 12).

Sea perch

Biomass for sea perch in 2012 (1964 t) is in the middle range of estimates for the nine surveys and was only 1% below the average biomass (1991 t) with no trend in biomass over the time series (Table 8, Figure 7). Pre-recruited biomass is a very small and reasonably constant component of the total biomass estimate on all surveys (range 3–7% of total biomass) (Table 9, Figure 8). The juvenile to adult biomass ratio (based on length-at-50% maturity) has been relatively constant over the time series with juvenile biomass 23–35% of total biomass (Table 10, Figure 9).

Sea perch were present in 59–82% of tows and have constituted 2–6% of the total catch on the surveys, with no trends in either variable (see Table 11). 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 to 300 m (see Figure 10).

The size distributions of sea perch on each of the eight surveys are similar and generally unimodal with a right hand tail reflecting the large number of age classes (Paul & Francis 2002) (Figure 11). 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.

There was no sea perch caught in the 10–30 m strata in 2007 and 2012 and hence the addition of the shallow strata is of no value for monitoring sea perch.

Spiny dogfish

Spiny dogfish biomass in the core strata increased markedly in 1996 and although it fluctuated since then it has remained high with 2012 biomass 11% above the post-1994 average of 31 978 t (Table 8, Figure 7). The post 1994 average biomass is about 2.5 times greater than that of the early 1990s, indicating that the large increase 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 at 1–3% of total biomass, but since 1996 it has ranged from 7 to 16%, and in 2012 it was 11% (Table 9, Figure 8). This is also reflected in the biomass of juvenile spiny dogfish (based on the length-at-50% maturity) which increased markedly from about 14% of total biomass before 1996, to between 33 and 57% in the last five surveys (Table 10, Figure 9).

Spiny dogfish are consistently the most commonly caught species on the ECSI trawl survey occurring in 96–100% of tows (98% average), and comprising 23–46% of the total catch on the surveys (Table 11). Spiny dogfish has also had the largest biomass of any species on these surveys with the exception of barracouta in some years (Table 8). 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 (Figure 10).

The size distributions of spiny dogfish in the 1992 to 1994 surveys are similar and generally bimodal for males, and less defined for females (Figure 11). From 1996 onwards the length distributions were dominated by smaller fish, particularly females where the proportions of large fish have declined. In 2009 and 2012, unlike previous years, there were signs of a strong juvenile cohort recruiting to the population. 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.

The additional spiny dogfish biomass captured in the 10–30 m depth range accounted for 5% and 8% of the biomass in the core plus shallow strata (10–400 m) for 2007 and 2012 respectively, indicating that in terms of biomass, it may be useful to monitor the shallow strata for spiny dogfish (Table 8, Figure 7). Further, the addition of the 10–30 m depth range may be important for monitoring the small fish, as was evident in 2012 (Figures 5 and 11).

Tarakihi

Biomass for tarakihi in 2012 was 12% below the survey average (1884 t), although this is inflated by the large biomass estimate of 1993, partly the result of a single large catch off Timaru, which is reflected in the very high survey c.v. in this year of 55% (Table 8, Figure 10). There is no apparent trend in biomass over the time series (Table 8, Figure 7). Pre-recruited biomass is a major component of tarakihi total biomass estimates on all surveys, ranging from 18 to 60% of total biomass, and in 2012 it was 35% (Table 9, Figure 8). 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 ranging from about 60 to 80%, and in 2012 it was 70% (Table 10, Figure 9).

Tarakihi were present in 52–71% of tows and made up 1–5% of the total catch on the surveys, with no trends in either variable (Table 11). The distribution of tarakihi hotspots varies, but overall this species is consistently well represented over the entire survey area, most commonly from 30 to about 150 m (Figure 10).

The size distributions of tarakihi in each of the nine surveys are similar and they tend to be multi-modal, with smaller modes representing individual cohorts (Figure 11). In 2012, particularly the 0+, 1+, 2+, and possibly 3+ cohorts are evident (Beentjes et al. 2012). Tarakihi on the ECSI, overall, are generally smaller than those from the west coast South Island (Stevenson & Hanchet 2000) and the east coast North Island (Parker & Fu 2011), suggesting that this area may be an important nursery ground for juvenile tarakihi.

There was virtually no tarakihi caught in the 10–30 m strata in 2007 and 2012 and hence the addition of the shallow strata is of no value for monitoring tarakihi.

4.2.2 Key non-target QMS species

Time series of biomass estimates for the eight key non-target QMS species (barracouta, lemon sole, ling, rough skate, smooth skate, school shark, rig, and silver warehou) are presented in Figure 14. Time series plots of catch rate distributions and scaled length frequency distributions for these species were presented and discussed by Beentjes & MacGibbon (2013).

4.3 Survey representativeness

The representativeness analysis showing the mean species ranking for each of the ECSI nine winter trawl surveys in core strata is shown in Figure 15. All survey species mean rankings fall inside the 95% confidence intervals and hence can be considered to be representative, with no obvious catchability effect in 2012.

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

Stratum	Depth (m)	Area (km^2)	Description	Foul ground (km^2)	No. stations Phase 1	No. stations Phase 2	Station density (km^2 per station)
1	30–100	984	Shag Point	202	4	1	156.4
2	30–100	1 242	Oamaru	0	5		248.4
3	30–100	3 023	Timaru	0	10		302.3
4	30–100	2 703	Rakaia	0	10		270.3
5	30–100	2 485	Banks Pen.	0	6	1	355.0
6	30–100	2 373	Pegasus	208	3		721.7
7	30–100	2 089	Conway	871	6		203.0
8	100–200	628	Shag Point	17	4		152.8
9	100–200	1 163	Oamaru	0	6		193.8
10	100–200	1 191	Timaru	0	4		297.8
11	100–200	1 468	Banks Pen.	0	4		367.0
12	100–200	764	Pegasus	132	3		210.7
13	100–200	999	Conway	406	4		148.3
14	200–400	322	Oamaru Crack	17	4		76.3
15	200–400	430	Timaru	0	3		143.3
16	200–400	751	Banks Pen.	0	3		250.3
17	200–400	724	Conway	165	3		186.3
Sub total (average)		**23 339**		**2 018**	**82**	**2**	**251.9**
18	10–30	1 276	Pegasus	0	5		255.2
19	10–30	986	Rakaia	0	5	2	140.9
20	10–30	797	Timaru	0	5		159.4
21	10–30	520	Oamaru	226	3		98.0
Sub total (average)		**3 579**		**226**	**18**	**2**	**163.3**
Total (average)		**26 918**		**2 244**	**100**	**4**	**235.1**

Table 2: Simulated number of stations required to achieve the lower range target coefficients of variation (c.v.) for each species for the 2012 winter survey. For SPE, STA, SPD, and GUR there is no range and the c.v. is 20%. Right hand columns show the maximum stations of any species, and the phase 1 allocation prorated from the average of all eight to achieve 100 stations.

		Number of stations required to achieve lower target c.v.								Stations required.	
Depth (m)	Stratum	GSH (20)	RCO (20)	SPE (20)	SPD (20)	STA (20)	TAR (20)	ELE (20)	GUR (20)	for 8 species maximum	Phase 1 stations (average)
30–100	1	3	3	4	3	3	4	5	3	5	4
30–100	2	3	3	3	3	3	4	6	5	6	4
30–100	3	3	7	5	10	3	13	10	19	19	10
30–100	4	3	6	3	15	4	19	4	20	20	10
30–100	5	3	4	3	11	3	8	8	3	11	6
30–100	6	3	3	3	3	4	3	3	3	4	3
30–100	7	3	6	4	4	3	3	4	19	19	6
100–200	8	3	3	5	3	3	3	–	–	5	4
100–200	9	6	17	4	3	3	3	–	–	17	6
100–200	10	3	3	8	3	3	3	–	–	8	4
100–200	11	5	3	4	4	3	3	–	–	5	4
100–200	12	3	3	3	3	3	3	–	–	3	3
100–200	13	3	3	3	3	3	5	–	–	5	4
200–400	14	3	11	3	3	3	3	–	–	11	5
200–400	15	3	3	3	3	3	3	–	–	3	3
200–400	16	3	3	3	3	3	3	–	–	3	3
200–400	17	3	3	3	3	3	3	–	–	3	3
10–30	18	–	–	–	–	–	–	5	5	5	5
10–30	19	–	–	–	–	–	–	5	5	5	5
10–30	20	–	–	–	–	–	–	5	5	5	5
10–30	21	–	–	–	–	–	–	3	3	3	3
	Total	56	84	64	80	53	86	57	92	165	100

Table 3: Catch and estimated biomass for the target species (in bold) and the key QMS species in 30–400 m (A), and for elephantfish, red gurnard and selected species in 10–400 m (B). –, not sexed; –, no information on recruited length.

A (30–400 m)		Males		Females		All fish		Recruited		
Common name	Catch (kg)	Biomass (t)	c.v. (%)	Biomass (t)	c.v. (%)	Biomass (t)	c.v. (%)	Size (cm)	Biomass (t)	c.v. (%)
Dark ghost shark	17 432	4 334	26	6 370	32	10 704	29	55	6 988	31
Elephantfish	2 596	732	53	620	34	1 351	39	50	1 285	39
Giant stargazer	851	272	18	371	16	643	16	30	617	16
Red cod	13 632	7 505	91	4 315	60	11 821	79	30	4 806	55
Red gurnard	2 361	877	31	803	25	1 680	28	40	1 487	27
Sea perch	3 179	1 067	25	896	28	1 964	26	20	1 898	27
Spiny dogfish	46 503	28 408	36	7 123	23	35 546	31	50	31 742	34
Tarakihi	1 893	753	24	887	26	1 661	25	25	1 077	29
Barracouta	47 974	16 958	18	17 044	16	34 325	17	50	32 341	17
Lemon sole	131	7	30	58	19	65	18	25	56	20
Ling	567	106	20	159	22	265	21	65	98	28
Rig	248	106	71	65	49	171	62	90	58	61
Rough skate	1 638	537	19	592	21	1 133	20	40	1 061	20
School shark	348	137	22	155	22	292	20	90	89	49
Silver warehou	911	175	56	198	53	434	46	25	379	53
Smooth skate	1 635	556	29	468	51	1 025	35	40	1 000	36

B (10–400 m)		Males		Females		All fish		Recruited		
Common name	Catch (kg)	Biomass (t)	c.v. (%)	Biomass (t)	c.v. (%)	Biomass (t)	c.v. (%)	Size (cm)	Biomass (t)	c.v. (%)
Elephantfish	8 176	1 082	37	2 698	38	3 780	31	50	3 199	36
Red cod	14 178	7 516	91	4 514	57	12 032	78	30	5 010	53
Red gurnard	6 298	1 537	20	1 977	15	3 515	17	40	2 773	16
Spiny dogfish	53 446	30 302	34	8 491	20	38 821	28	50	33 562	32
Barracouta	53 086	17 854	17	18 339	16	36 526	16	50	34 448	17
Rig	579	165	48	150	28	315	37	90	80	45
Rough skate	2 240	659	16	751	17	1 414	16	40	1 311	16
School shark	384	146	20	164	20	310	19	90	89	49
Silver warehou	922	175	56	198	53	438	46	25	379	53

Table 4: Catch rates (kg.km^{-2}) by stratum for the target species (A) and key QMS species (B). Strata 1–17, 30–400 m; strata 18–21, 10–30 m. Species codes are given in Appendix 5.

A (Target species)

	Target species							
Stratum	GSH	ELE	GIZ	GUR	RCO	SPE	SPD	NMP
1	0	546	8	88	312	1	130	36
2	0	18	14	100	408	4	108	34
3	0	10	18	38	34	28	1 050	143
4	72	140	22	245	15	9	1 835	248
5	0	35	31	6	8	28	4 575	104
6	0	0	57	16	33	16	342	34
7	0	42	6	300	122	37	2 522	3
8	463	326	20	3	1	633	50	0
9	107	0	61	1	522	71	134	8
10	2 248	2	9	3	55	340	326	6
11	3 366	0	17	3	6 358	296	1 294	2
12	3	0	35	0	6	21	2 763	95
13	281	0	84	0	4	276	36	42
14	1 679	0	4	0	1 373	0	55	0
15	946	0	7	0	23	3	3 595	0
16	478	0	42	0	6	9	4 434	0
17	1 222	0	18	0	55	62	247	6
18	0	741	0	591	16	0	1 234	0
19	0	980	0	535	68	0	1 093	6
20	0	636	0	527	152	0	580	1
21	0	21	0	255	5	0	308	32

Table 4 – *continued*

B (key QMS species)

	Key QMS species							
Stratum	BAR	LSO	LIN	SPO	RSK	SCH	SWA	SSK
1	262	17	18	4	39	5	0	19
2	1 429	4	11	0	57	6	0	16
3	3 789	3	2	5	100	13	5	75
4	2 502	2	0	42	66	13	6	24
5	1 122	1	0	0	56	7	2	20
6	317	1	0	4	6	25	1	13
7	296	2	0	12	102	31	1	14
8	971	4	3	4	38	15	3	0
9	3 960	0	10	0	45	7	45	60
10	2 276	0	3	0	0	18	115	6
11	700	1	1	0	33	7	2	230
12	843	6	19	0	26	2	0	0
13	197	0	2	0	6	11	1	24
14	9	14	10	0	10	0	3	43
15	4	0	108	0	17	0	309	241
16	156	0	108	0	4	0	84	33
17	0	7	82	0	17	0	1	7
18	230	0	0	45	87	10	0	0
19	232	0	0	68	65	4	1	7
20	169	0	0	25	87	2	4	4
21	2 970	1	0	1	71	2	0	36

Table 5: Estimated biomass (t) and coefficient of variation by stratum for the target species in 30–400 m (A) and 10–30 m (B), and for the key QMS species in 30–400 m (C) and 10–30 m (D). Strata 1–17, 30–400 m; strata 18–21, 10–30 m. Species codes are given in Appendix 5.

A (target species in 30–400 m)

		Target species							
Stratum		GSH	ELE	GIZ	GUR	RCO	SPE	SPD	NMP
1	Biomass	0	538	8	87	307	1	128	35
	c.v.%	0	78	71	27	67	100	17	84
2	Biomass	0	22	17	124	507	6	134	42
	c.v.%	0	36	73	27	87	100	39	61
3	Biomass	0	30	53	116	102	83	3 174	431
	c.v.%	0	34	41	44	27	55	60	54
4	Biomass	194	377	61	662	40	24	4 962	671
	c.v.%	94	62	43	42	30	83	78	44
5	Biomass	0	88	78	15	21	69	11 368	258
	c.v.%	0	33	41	53	70	78	80	55
6	Biomass	0	0	134	38	77	38	812	82
	c.v.%	0	0	46	52	88	98	74	48
7	Biomass	0	89	13	627	256	78	5 268	7
	c.v.%	0	31	100	58	54	58	63	76
8	Biomass	291	205	12	2	0	398	32	0
	c.v.%	96	99	57	100	100	73	41	0
9	Biomass	125	0	71	1	607	82	156	9
	c.v.%	98	0	42	64	67	47	33	78
10	Biomass	2 678	3	10	4	65	405	389	7
	c.v.%	29	100	29	58	69	29	37	59
11	Biomass	4 941	0	25	4	9 333	435	1 900	2
	c.v.%	59	0	46	41	100	88	61	100
12	Biomass	2	0	27	0	4	16	2 112	72
	c.v.%	100	0	34	100	56	44	96	67
13	Biomass	281	0	84	0	4	276	36	42
	c.v.%	53	0	52	0	71	36	53	58
14	Biomass	541	0	1	0	442	0	18	0
	c.v.%	99	0	100	0	100	58	66	0
15	Biomass	407	0	3	0	10	1	1 546	0
	c.v.%	63	0	53	0	27	84	35	0
16	Biomass	359	0	32	0	4	7	3 332	0
	c.v.%	16	0	69	0	50	51	32	0
17	Biomass	885	0	13	0	40	45	179	4
	c.v.%	48	0	90	0	42	49	12	87
Total	Biomass	**10 704**	**1 351**	**643**	**1 680**	**11 821**	**1 964**	**35 546**	**1 661**
	c.v.%	**29**	**39**	**16**	**28**	**79**	**26**	**31**	**25**

Table 5 – *continued*

B (target species in 10–30 m)

Stratum		GSH	ELE	GIZ	GUR	RCO	SPE	SPD	NMP
								Target species	
18	Biomass	0	945	0	754	20	0	1 574	0
	c.v.%	0	92	0	44	54	0	25	0
19	Biomass	0	967	0	528	67	0	1 078	6
	c.v.%	0	56	0	22	70	0	25	40
20	Biomass	0	507	0	420	121	0	462	0
	c.v.%	0	35	0	29	53	0	26	100
21	Biomass	0	11	0	132	3	0	160	16
	c.v.%	0	95	0	69	93	0	19	55
Total	Biomass	**0**	**2 429**	**0**	**1 834**	**211**	**0**	**3 275**	**23**
	c.v.%	**0**	**43**	**0**	**21**	**38**	**0**	**15**	**41**

C (Key QMS species in 30–400 m)

Stratum		BAR	LSO	LIN	SPO	RSK	SCH	SWA	SSK
								Key QMS species	
1	Biomass	258	17	18	4	38	5	0	19
	c.v.%	51	48	43	70	54	66	63	62
2	Biomass	1 775	6	14	0	71	8	0	20
	c.v.%	49	61	86	0	61	56	0	63
3	Biomass	11 452	8	7	17	301	41	15	225
	c.v.%	35	54	51	49	56	56	28	69
4	Biomass	6 765	7	0	114	179	35	17	66
	c.v.%	42	36	0	92	35	47	48	47
5	Biomass	2 787	3	0	0	140	18	4	50
	c.v.%	55	61	0	0	54	83	67	54
6	Biomass	752	2	0	9	14	60	2	31
	c.v.%	50	53	0	100	55	50	24	100
7	Biomass	618	5	0	25	212	65	2	28
	c.v.%	18	27	0	58	30	53	49	100
8	Biomass	610	2	2	2	24	9	2	0
	c.v.%	59	60	100	57	70	53	74	0
9	Biomass	4 607	0	12	0	53	8	52	70
	c.v.%	42	0	65	0	96	54	65	79
10	Biomass	2 712	0	4	0	0	21	136	7
	c.v.%	34	0	75	0	0	60	98	35
11	Biomass	1 028	2	2	0	49	10	3	337
	c.v.%	62	67	66	0	65	100	73	92
12	Biomass	644	4	14	0	20	2	0	0
	c.v.%	83	70	100	0	67	100	63	0
13	Biomass	196	0	2	0	6	11	1	24
	c.v.%	16	100	100	0	100	86	52	46
14	Biomass	3	4	3	0	3	0	1	14

Table 5 – *continued*

	c.v.%	100	90	81	0	58	0	37	73
15	Biomass	2	0	46	0	7	0	133	104
	c.v.%	100	0	80	0	39	0	100	54
16	Biomass	117	0	81	0	3	0	63	25
	c.v.%	100	0	26	0	100	0	100	84
17	Biomass	0	5	59	0	12	0	1	5
	c.v.%	0	53	45	0	66	0	100	52
Total	Biomass	**34 325**	**65**	**265**	**171**	**1 133**	**292**	**434**	**1 025**
	c.v.%	**17**	**18**	**21**	**62**	**20**	**20**	**46**	**35**

D (key QMS species in 10–30 m)

		Key QMS species							
Stratum		BAR	LSO	LIN	SPO	RSK	SCH	SWA	SSK
18	Biomass	294	0	0	58	111	12	0	0
	c.v.%	55	0	0	51	39	32	0	0
19	Biomass	229	0	0	67	64	4	1	7
	c.v.%	37	100	92	52	20	41	36	100
20	Biomass	135	0	0	20	69	2	3	3
	c.v.%	42	100	0	75	22	49	64	100
21	Biomass	1 543	0	0	0	37	1	0	19
	c.v.%	93	66	0	100	12	100	100	100
Total	Biomass	**2 201**	**1**	**0**	**145**	**281**	**18**	**4**	**28**
	c.v.%	**66**	**54**	**92**	**33**	**17**	**23**	**53**	**71**

Table 6: Number of length frequency, biological, 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 5.

	Length frequency data			Biological data+			Tagging	
Species code	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	90	8 801					
BCO	2	20	210	1	1			
BNS	1	1	1					
BRI	2	2	3					
CAS	2	5	568					
CBI	2	3	148					
CBO	2	3	173					
ELE	1	49	2 049	46	598	412		
EMA	1	2	2					
ESO	2	18	251					
GFL	2	4	16					
GIZ	2	62	608	62	568	310		
GSH	G	31	2 261	31	494			
GUR	2	69	4 002	63	868	289		
HAK	2	2	9					
HAP	2	36	104					
HOK	2	9	517					
JAV	2	1	131					
JDO	2	4	4					
JMD	1	21	61					
JMM	1	9	24					
JMN	1	2	3					
KAH	1	11	13					
LDO	2	3	50					
LEA	2	23	1 605					
LIN	2	35	613					
LSO	2	43	364					
MOK	1	11	30					
NMP	1	62	3 200	56	977	254		
RCO	2	76	2 270	73	944			
RSK	5	69	826	66	731		241	28–71
SAM	1	2	2					
SBW	1	1	28					
SCH	2	59	277	57	265		40	58–110
SCI	B	4	34	4	34			
SFL	2	22	290					
SPD	2	102	6 859	97	1 798	387		
SPE	2	60	3 308	60	874	245		
SPO	2	34	542	31	319		51	53–111
SRB	1	2	19					
SSK	5	49	371	47	295		102	31–133
SWA	1	56	1 096					
TRU	1	1	1					
WAR	1	25	498					
WWA	1	5	70					
Totals		**1 198**	**42 312**	**694**	**8 766**	**1 897**	**434**	

Table 7: Gonad stages of target species in 30–400 m, and for elephantfish and red gurnard in 10 to 30 m. See Appendix 2 for gonad stage definitions. NA, not applicable.

Species	Sex	No. of fish	% Gonad stage					
			1	2	3	4	5	
30–400 m								
Giant stargazer	Males	309	53	32	13	1	1	
	Females	255	91	8	0	0	0	
Red cod	Males	300	89	3	2	1	5	
	Females	397	94	6	0	0	0	
Red gurnard	Males	288	82	7	1	0	11	
	Females	214	48	10	0	0	43	
Sea perch	Males	440	6	16	58	15	6	
	Females	389	86	5	1	0	7	
Tarakihi	Males	400	94	1	0	0	5	
	Females	415	95	1	0	0	3	
			% Gonad state					
			1	2	3	4		
Dark ghost shark	Males	236	31	14	54	NA		
	Females	257	30	23	43	5		
			% Gonad state					
			1	2	3	4	5	6
Elephantfish	Males	127	13	18	69	NA	NA	NA
	Females	149	30	65	2	0	0	3
Spiny dogfish	Males	1005	8	5	87	NA	NA	NA
	Females	414	22	24	9	2	42	1
			% Gonad state					
10–30 m			1	2	3	4	5	6
Elephantfish	Males	116	88	2	10	NA	NA	NA
	Females	205	63	23	10	0	0	4
			% Gonad state					
			1	2	3	4	5	
Red gurnard	Males	122	95	2	0	0	2	
	Females	239	79	2	0	0	19	

Table 8: Estimated biomass (t) and coefficient of variation (c.v.) for the target species (in bold) and key QMS species for all ECSI winter surveys in the core strata (30–400 m) (A), and core plus shallow strata (10 to 400 m) in 2007 and 2012 for species found in less than 30 m (B). Biomass estimates for 1991 have been adjusted to allow for non-sampled strata (7 and 9 equivalent to current strata 13, 16 and 17). * Rough and smooth skates not separated in 1991 (combined biomass 1993 t, c.v. 25%). Species in order of common name. NA, not applicable.

A (30–400 m)

	1991		1992		1993		1994		1996		2007		2008		2009		2012	
Species code	Biom. (t)	c.v. (%)	Biom. (t)	c.v. (%)	Biom. (t)	c.v. (%)	Biom. (t)	c.v. (%)	Biom. (t)	c.v. (%)	Biom. (t)	c.v. (%)	Biom. (t)	c.v. (%)	Biom. (t)	c.v. (%)	Biom . (t)	c.v. (%)
GSH	962	42	934	44	2 911	42	2 702	25	3 176	23	4 483	25	3 763	20	4 329	24	10 704	29
ELE	300	40	176	32	481	33	164	32	858	30	1 034	32	1 404	35	596	23	1 351	39
GIZ	672	17	669	16	609	14	439	17	466	11	755	18	606	14	475	14	643	16
RCO	3 760	40	4 527	40	5 601	30	5 637	35	4 619	30	1 486	25	1 824	49	1 871	40	11 821	79
GUR	763	33	142	30	576	31	123	34	505	27	1 453	35	1 309	34	1 725	30	1 680	28
SPE	1 716	30	1 934	28	2 948	32	2 342	29	1 671	26	1 954	22	1 944	23	1 444	25	1 964	26
SPD	12 873	22	10 787	26	13 949	17	14 530	10	35 169	15	35 386	27	28 476	22	25 311	31	35 546	31
NMP	1 712	33	932	26	3 805	55	1 219	31	1 656	24	2 589	24	1 863	29	1 519	36	1 661	25
BAR	8 361	29	11 672	23	18 197	22	6 965	34	16 848	19	21 132	17	25 544	16	33 360	16	34 325	17
LSO	NA	NA	57	18	121	19	77	21	49	33	74	26	116	25	55	27	65	18
LIN	1 009	35	525	17	651	27	488	19	488	21	283	27	351	22	262	19	265	21
SPO	175	30	66	18	67	30	54	29	63	37	134	37	280	23	125	26	171	62
RSK	*	*	224	24	340	21	517	20	177	20	878	22	858	19	1 029	30	1 133	20
SCH	100	30	104	21	369	42	155	36	202	18	538	22	411	20	254	18	292	20
SWA	29	21	32	22	256	44	35	28	231	32	445	44	319	32	446	42	434	46
SSK	*	*	609	18	670	24	306	25	385	24	709	20	554	18	736	23	1 025	35

Table 8 – *continued*

B (10–400 m)

	2007		2012	
Species code	Biom. (t)	c.v. (%)	Biom. (t)	c.v. (%)
ELE	1 859	24	3 781	31
GUR	2 048	27	3 515	17
RCO	1 552	24	12 032	78
SPD	37 299	26	38 821	28
BAR	24 939	19	36 526	16
RSK	1 261	16	1 414	16
SCH	552	21	310	19
SPO	192	30	315	37
SWA	451	43	438	46

Table 9: Estimated biomass (t), and coefficient of variation (c.v.) of recruited and pre-recruited target species in core strata (30–400 m) for all surveys (A), and core plus shallow strata (10 to 400 m) for elephantfish and red gurnard in 2007 and 2012 (B). Biomass estimates for 1991 have been adjusted to allow for non-sampled strata (7 and 9 equivalent to current strata 13, 16 and 17). The sum of pre-recruit and recruited biomass values do not always match the total biomass (Table 8) for the earlier surveys because at several stations length frequencies were not measured, affecting the biomass calculations for length intervals. Biom, biomass; Pre-rec., pre-recruited biomass; Rec., recruited biomass; – , not measured; NA, not applicable.

A (30–400 m)

Target species (recruited length)

		GSH (55 cm)		ELE (50 cm)		GIZ (30 cm)		GUR (30 cm)		RCO (40 cm)		SPE (20 cm)		SPD (50 cm)		NMP (25 cm)	
		Pre-rec.	Rec.	Pre-rec.	Rec.	Pre-rec.	Rec.	Pre-rec.	Rec.	Pre-rec.	Rec.	Pre-rec.	Rec.	Pre-rec.	Rec.	Pre-rec.	Rec.
1991	Biom.	292	668	NA	NA	26	646	NA	NA	1 823	2 054	70	1 483	–	–	305	1 414
	c.v. (%)	68	40	NA	NA	22	17	NA	NA	45	37	44	30	–	–	38	33
1992	Biom.	574	361	54	122	35	634	21	121	2 089	2 438	51	1 441	266	9 212	288	614
	c.v. (%)	54	31	83	28	14	16	58	30	50	33	28	28	27	31	26	28
1993	Biom.	1 058	1814	60	421	19	591	26	551	1 025	4 469	178	2 770	343	13 122	2 282	1 522
	c.v. (%)	40	53	56	34	16	14	45	31	51	27	76	30	72	17	62	46
1994	Biom.	1 312	1 390	22	142	10	429	2	121	3 338	2 299	78	2 264	205	14 325	494	725
	c.v. (%)	35	22	51	34	25	17	42	34	40	36	24	29	49	10	31	35
1996	Biom.	1 195	1 981	338	520	13	452	8	496	590	4 029	58	1 613	3 412	31 757	519	1 137
	c.v. (%)	30	23	40	26	34	11	44	26	31	34	45	25	23	16	30	27
2007	Biom.	1 854	2 629	516	518	33	722	298	1 155	190	1 295	74	1 880	5 831	29 554	822	1 766
	c.v. (%)	46	26	59	21	24	18	40	35	33	25	18	22	46	27	30	24
2008	Biom.	1 644	2119	627	777	13	592	100	1 210	129	1 695	144	1 800	1 886	26 590	739	1 123
	c.v. (%)	23	29	57	27	28	14	59	33	36	50	20	24	50	22	44	25
2009	Biom.	1 965	2 364	210	387	10	464	62	1 663	833	1 038	82	1 363	2 398	22 913	525	994
	c.v. (%)	21	33	38	25	34	15	34	30	50	41	18	26	30	32	42	42
2012	Biom.	3 716	6 988	66	1 285	26	617	193	1 487	7 015	4 806	66	1 898	3 804	31 742	584	1 077
	c.v. (%)	27	31	46	39	22	16	40	27	97	55	25	27	58	34	34	29

Table 9 – *continued*

A (10–400 m)

		Target species (recruited length)			
		ELE (50 cm)		GUR (30 cm)	
		Pre-rec.	Rec.	Pre-rec.	Rec.
2007	Biom.	1 201	658	494	1 554
	c.v. (%)	36	20	32	27
2012	Biom.	581	3 199	742	2 773
	c.v. (%)	25	36	31	16

Table 10: Estimated juvenile and adult biomass (t) by sex, 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 finfish target species from core strata (30–400 m) for all surveys (A), elasmobranch species from core strata (30–400 m) for all surveys (B), and elephantfish and red gurnard from core plus shallow strata (10–400 m) for 2007 and 2012 (C). Biomass estimates for 1991 have been adjusted to allow for non-sampled strata (7 and 9) and are shown for both sexes combined for finfish. The sum of juvenile and adult biomass values do not always match the total biomass (Table 8) for the earlier surveys because at several stations length frequencies were not measured, affecting the biomass calculations for length intervals. Juv, juvenile biomass; – , not measured; NA, not applicable.

A (Finfish, 30–400 m)

		Finfish target species (length at maturity, cm)									
		GIZ M =45 cm, (F=45 cm)		GUR M =22 cm, (F=22 cm)		RCO M =51 cm, (F=51 cm)		SPE M =26 cm, (F=26 cm)		NMP M =31 cm, (F=31 cm)	
		Juv.	Adult	Juv.	Adult	Juv.	Adult	Juv.	Adult	Juv.	Adult
1991	Biomass	305	347	NA	NA	3 119	768	579	1136	1094	591
	c.v. (%)	19	20	NA	NA	39	32	33	30	36	30
1992	Biomass	178 (109)	69 (208)	0 (2)	49 (91)	1 752 (1 364)	456 (954)	224 (221)	640 (406)	292 (274)	163 (171)
	c.v. (%)	25 (26)	25 (17)	66 (58)	38 (30)	50 (47)	34 (25)	28 (30)	28 (33)	26 (24)	30 (34)
1993	Biomass	133 (121)	92 (252)	0 (0)	254 (321)	1 399 (1 466)	880 (1 645)	548 (375)	1 062 (899)	496 (403)	382 (245)
	c.v. (%)	13 (16)	23 (18)	100 (57)	32 (34)	39 (47)	30 (31)	67 (55)	24 (19)	30 (29)	56 (32)
1994	Biomass	106 (83)	83 (167)	0 (0)	48 (48)	1 167 (848)	536 (401)	232 (303)	938 (763)	295 (332)	93 (155)
	c.v. (%)	21 (21)	22 (21)	0 (0)	51 (35)	34 (36)	33 (21)	24 (27)	27 (37)	42 (50)	32 (32)
1996	Biomass	139 (85)	72 (168)	0 (0)	280 (224)	650 (535)	1 176 (2 258)	232 (340)	651 (405)	566 (435)	214 (232)
	c.v. (%)	16 (18)	20 (15)	100 (71)	27 (27)	25 (27)	34 (39)	39 (37)	24 (22)	28 (27)	34 (33)
2007	Biomass	106 (106)	34 (208)	1 (0)	793(659)	393 (278)	188 (626)	256 (242)	882 (573)	1 046 (1 017)	186 (336)
	c.v. (%)	13 (18)	33 (30)	51 (75)	34 (36)	38 (29)	34 (32)	18 (16)	24 (28)	28 (27)	22 (21)
2008	Biomass	152 (136)	60 (200)	0 (1)	587 (717)	431 (628)	214 (549)	320 (314)	764 (535)	661 (714)	140 (319)
	c.v. (%)	19 (17)	23 (17)	66 (58)	40 (32)	63 (71)	47 (23)	27 (24)	28 (26)	32 (35)	25 (23)
2009	Biomass	91 (79)	66 (239)	0 (0)	864 (858)	825 (522)	112 (412)	180 (212)	620 (423)	518 (500)	263 (238)
	c.v. (%)	20 (17)	32 (16)	100 (85)	32 (27)	54 (56)	33 (42)	19 (19)	30 (29)	43 (39)	48 (32)
2012	Biomass	140 (91)	132 (280)	0 (0)	877 (803)	5 870 (2 469)	1 635 (1 846)	212 (248)	855 (648)	536 (595)	216 (292)
	c.v. (%)	16 (16)	26 (20)	0 (100)	31 (25)	96 (92)	75 (36)	20 (23)	30 (32)	28 (32)	40 (30)

Table 10 – *continued*

B (Elasmobranchs, 30–400 m)

		Elasmobranch target species (length at maturity, cm)					
		GSH M=52, (F=62)		ELE M=51, (F=70)		SPD M=58, (F=72)	
		Juv.	Adult	Juv.	Adult	Juv.	Adult
1991	Biomass	90 (265)	194 (411)	–	–	–	–
	c.v. (%)	73 (57)	52 (47)	–	–	–	–
1992	Biomass	252 (414)	135 (134)	25 (66)	35 (50)	471 (887)	4 645 (3 475)
	c.v. (%)	62 (50)	36 (32)	81 (45)	40 (34)	28 (22)	18 (69)
1993	Biomass	340 (697)	913 (922)	39 (114)	213 (114)	603 (1 250)	7 178 (4 414)
	c.v. (%)	50 (37)	49 (54)	56 (29)	37 (65)	63 (50)	17 (34)
1994	Biomass	403 (975)	674 (650)	12 (47)	43 (62)	604 (1 135)	9 721 (3 057)
	c.v. (%)	47 (29)	25 (25)	46 (38)	38 (41)	24 (20)	10 (30)
1996	Biomass	261 (1 042)	978 (892)	187 (378)	166 (127)	3 924 (7 829)	21 195 (2 221)
	c.v. (%)	39 (36)	31 (20)	41 (32)	31 (30)	21 (28)	16 (18)
2007	Biomass	521 (1 468)	1 175 (1 316)	278 (362)	165 (225)	7 926 (12 247)	14 326 (886)
	c.v. (%)	52 (39)	21 (42)	60 (41)	30 (30)	37 (35)	26 (22)
2008	Biomass	676 (1 021)	820 (1 235)	328 (512)	234 (325)	4 029 (5 690)	17 594 (1 124)
	c.v. (%)	28 (19)	25 (34)	55 (44)	46 (26)	37 (26)	22 (16)
2009	Biomass	753 (1 208)	1 038 (1 326)	131 (173)	206 (86)	5 526 (6 797)	12 073 (910)
	c.v. (%)	29 (20)	29 (37)	35 (32)	29 (42)	42 (30)	32 (22)
2012	Biomass	1 015 (3 207)	3 319 (3162)	39 (267)	693 (353)	5 702 (5 640)	22 705 (1 483)
	c.v. (%)	24 (34)	28 (36)	51 (32)	54 (40)	36 (26)	40 (30)

Table 10 – *continued*

C (10–400 m)

		Target species (length at maturity, cm)			
		ELE M=51, (F=70)		GUR M=22, (F=22)	
		Juv.	Adult	Juv.	Adult
2007	Biomass	574 (863)	194 (225)	8 (5)	1 008 (1 028)
	c.v. (%)	34 (30)	29 (30)	54 (67)	28 (26)
2012	Biomass	278 (1 013)	804 (1 685)	14 (18)	1 523 (1 958)
	c.v. (%)	28 (23)	47 (49)	71 (69)	20 (15)

Table 11: 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 all ECSI winter surveys in core strata (30–400 m) (A), and the core strata plus shallow (10 to 400 m) for ELE and GUR in 2007 and 2012 (B). Values of zero are less than 1%.

A (30–400 m)

	Target species percent occurrence and percent of total catch																
	ELE		GIZ		GSH		GUR		NMP		RCO		SPE		SPD		All target species
	% Occ.	% catch	% Occ.	% catch	% Occ.	% catch	% Occ.	% catch	% Occ.	% catch	% Occ.	% catch	% Occ.	% catch	% Occ.	% catch	% catch
1991	35	1	85	1	27	2	49	1	71	4	89	10	82	4	96	31	55
1992	30	0	82	2	28	3	24	0	61	2	89	15	76	6	99	25	53
1993	31	1	92	1	38	9	24	1	62	5	81	13	70	4	99	23	56
1994	31	1	83	1	30	9	32	0	63	2	75	28	76	4	96	28	73
1996	31	1	70	1	44	6	30	1	63	1	84	7	58	3	98	46	64
2007	37	1	83	1	50	7	56	2	66	3	71	2	65	3	100	39	57
2008	47	1	77	1	45	7	55	1	62	2	66	3	72	3	100	39	58
2009	39	1	78	1	57	10	45	2	52	2	63	9	67	3	100	24	51
2012	38	2	74	1	37	11	58	2	63	1	70	9	71	2	98	30	57

B (10 to 400 m)

	Target species percent occurrence and percent of total catch				
	ELE		GUR		GUR and ELE
	% Occ.	% catch	% Occ.	% catch	% catch
2007	47	2	70	2	4
2012	54	5	76	4	9

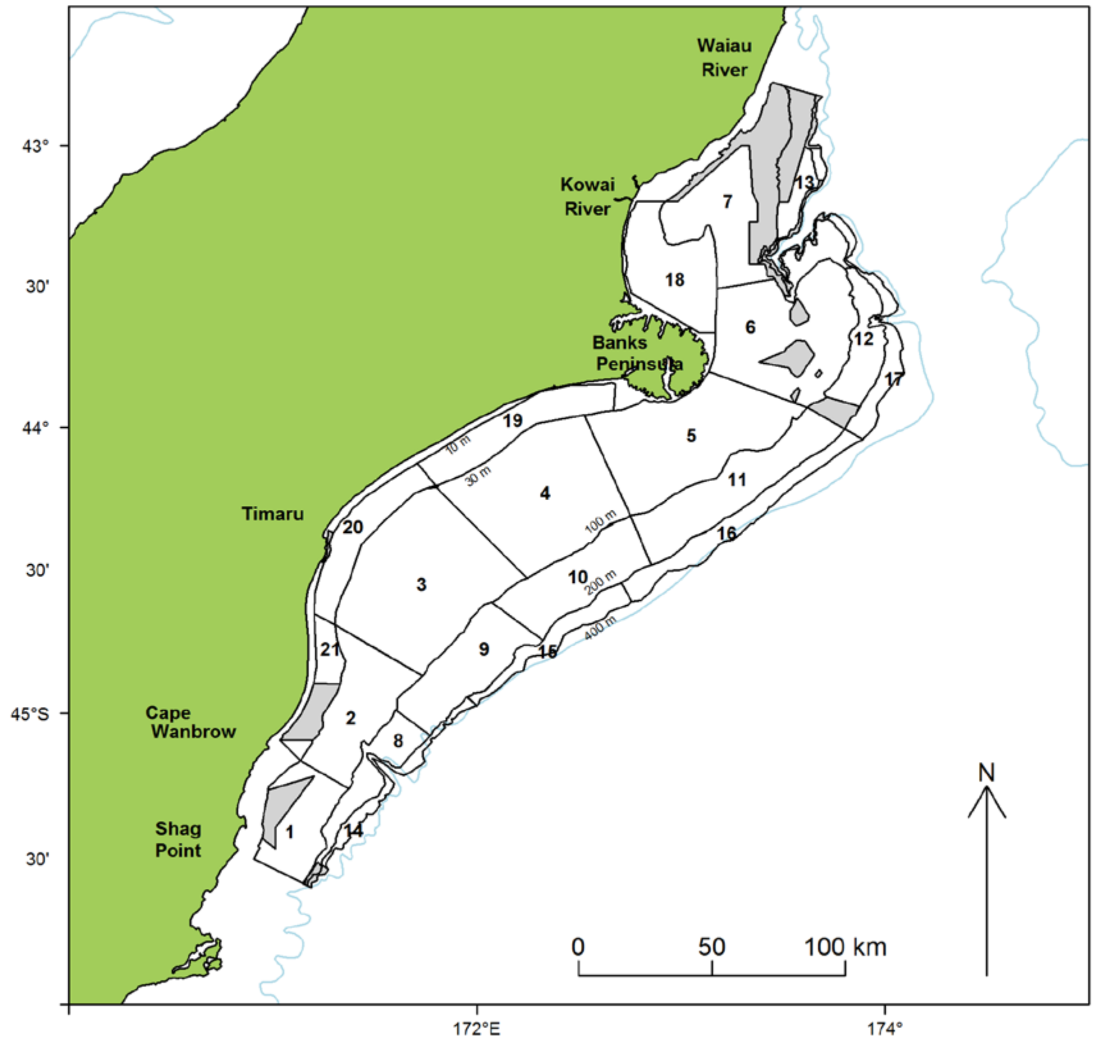


Figure 1: Strata used in the 2012 ECSI trawl survey in 10–400 m. Shaded areas are foul ground.

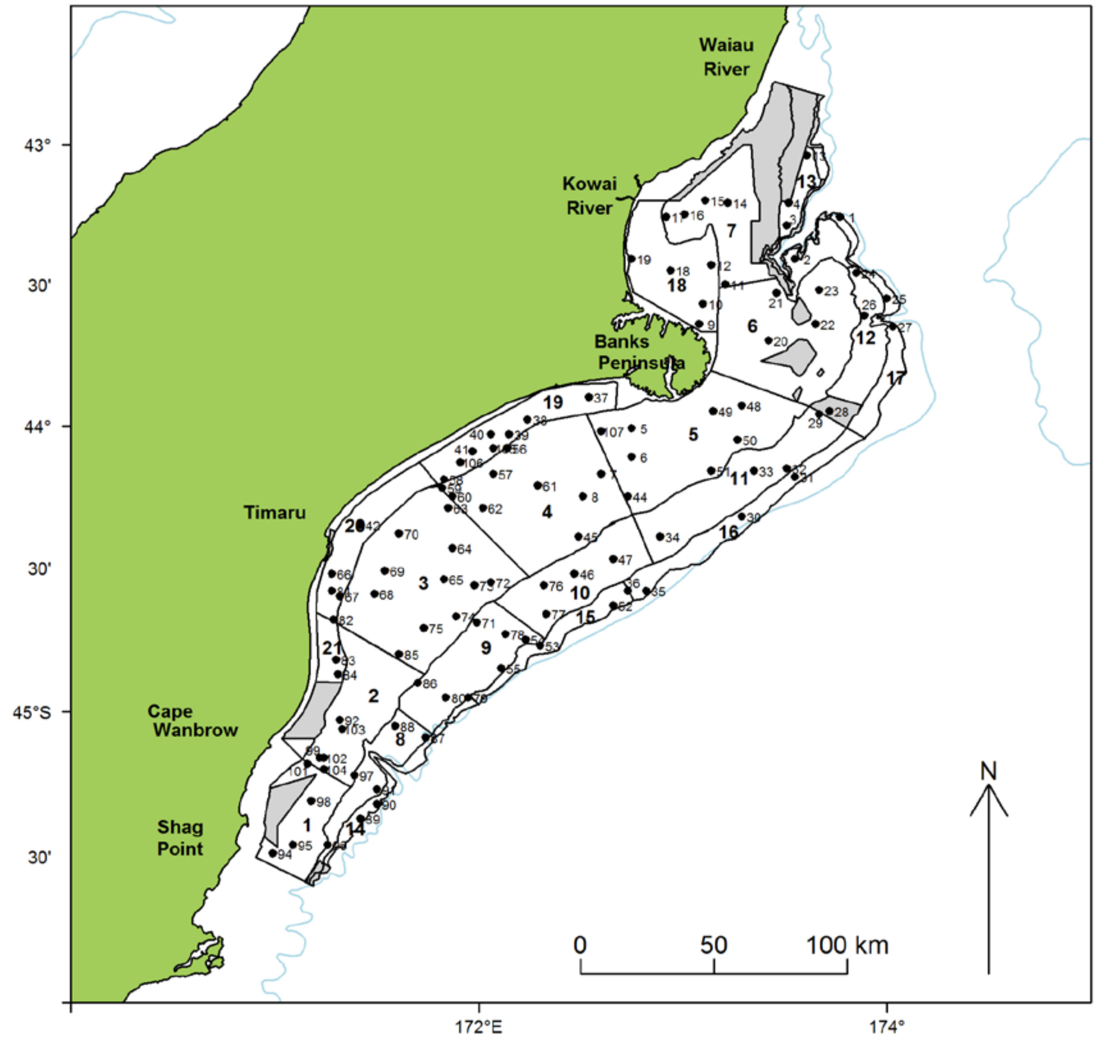


Figure 2: All tows and tow numbers from the 2012 ECSI survey. Shaded areas are foul ground.

Dark ghost shark

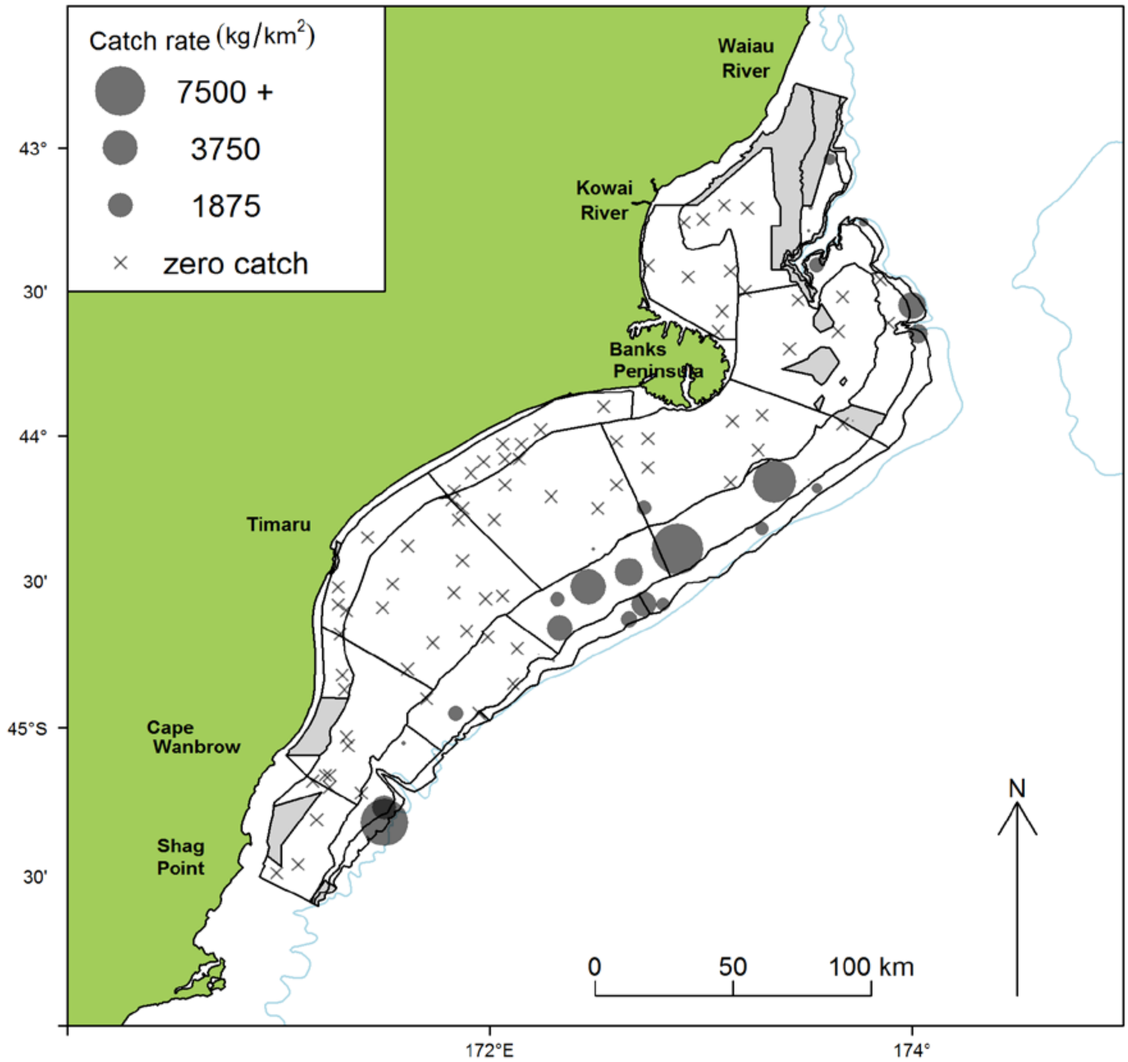


Figure 3: Catch rates (kg.km^{-2}) of target species for the 2012 ECSI survey. The legend indicates the circle size that corresponds to three catch rates; on the figure, circle size is continuous and proportional to the catch rate. Crosses indicate no catch at that station. Grey shaded areas are foul ground.

Elephantfish

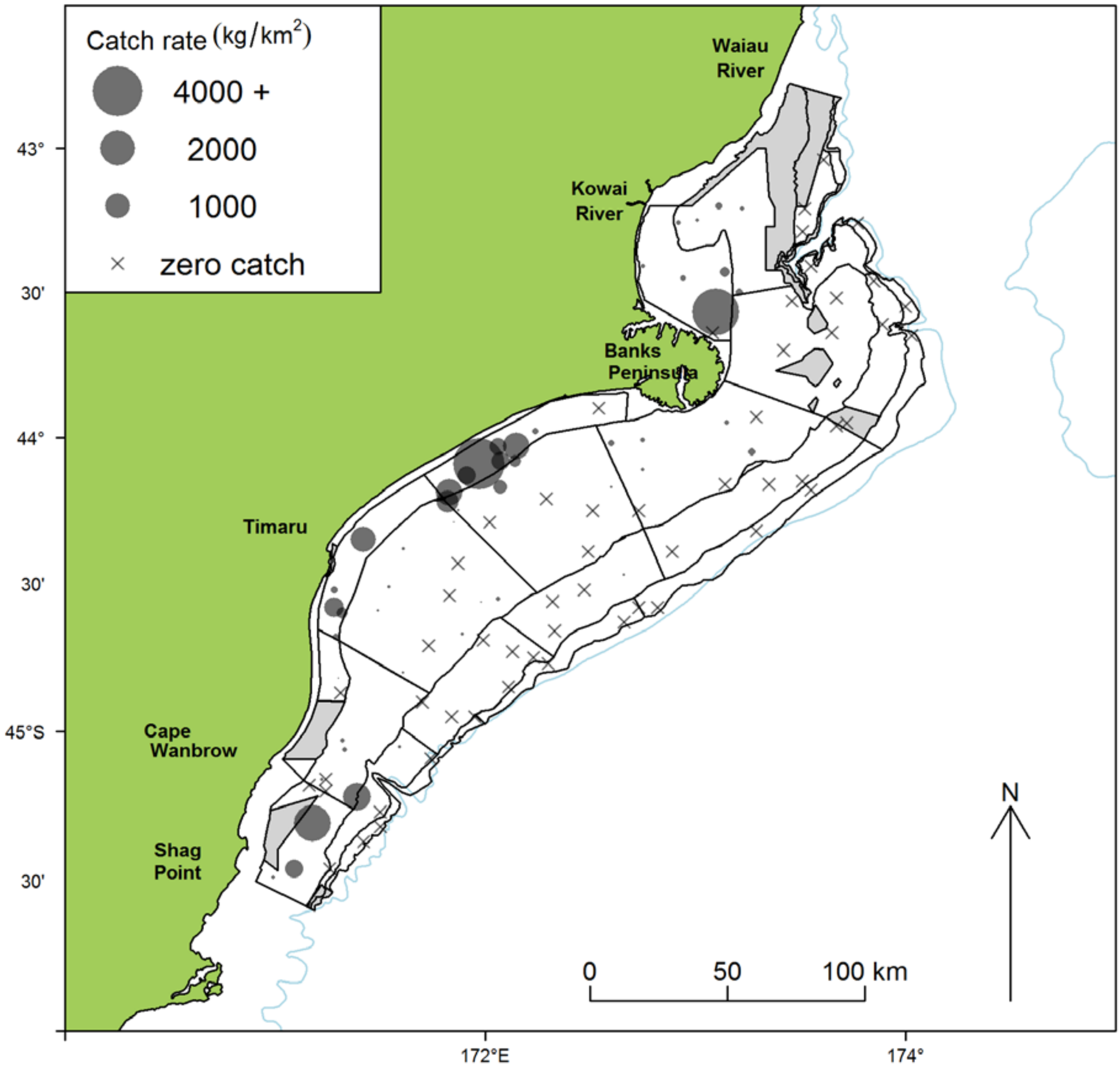


Figure 3–*continued*

Giant stargazer

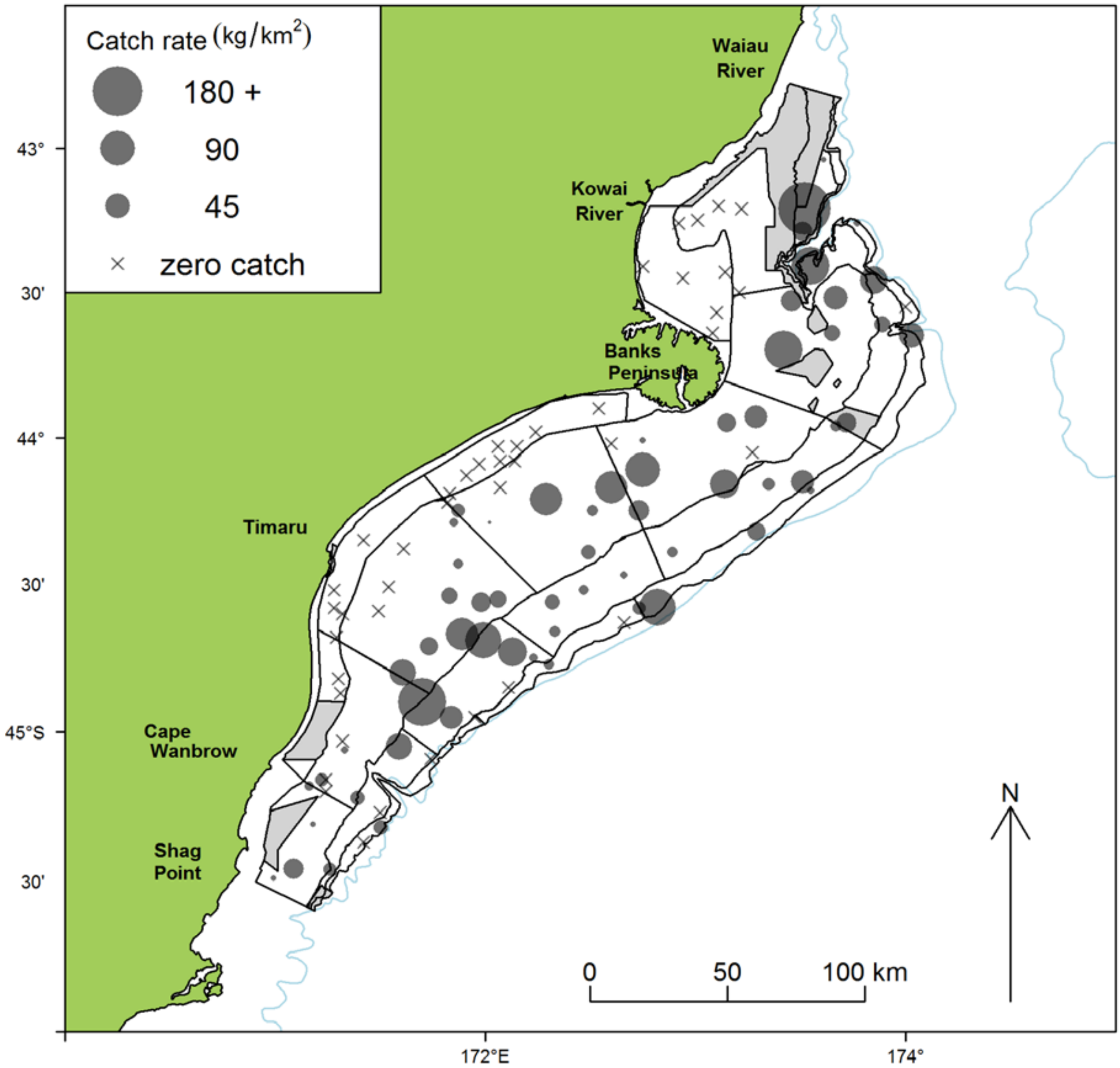


Figure 3–*continued*

Red Gurnard

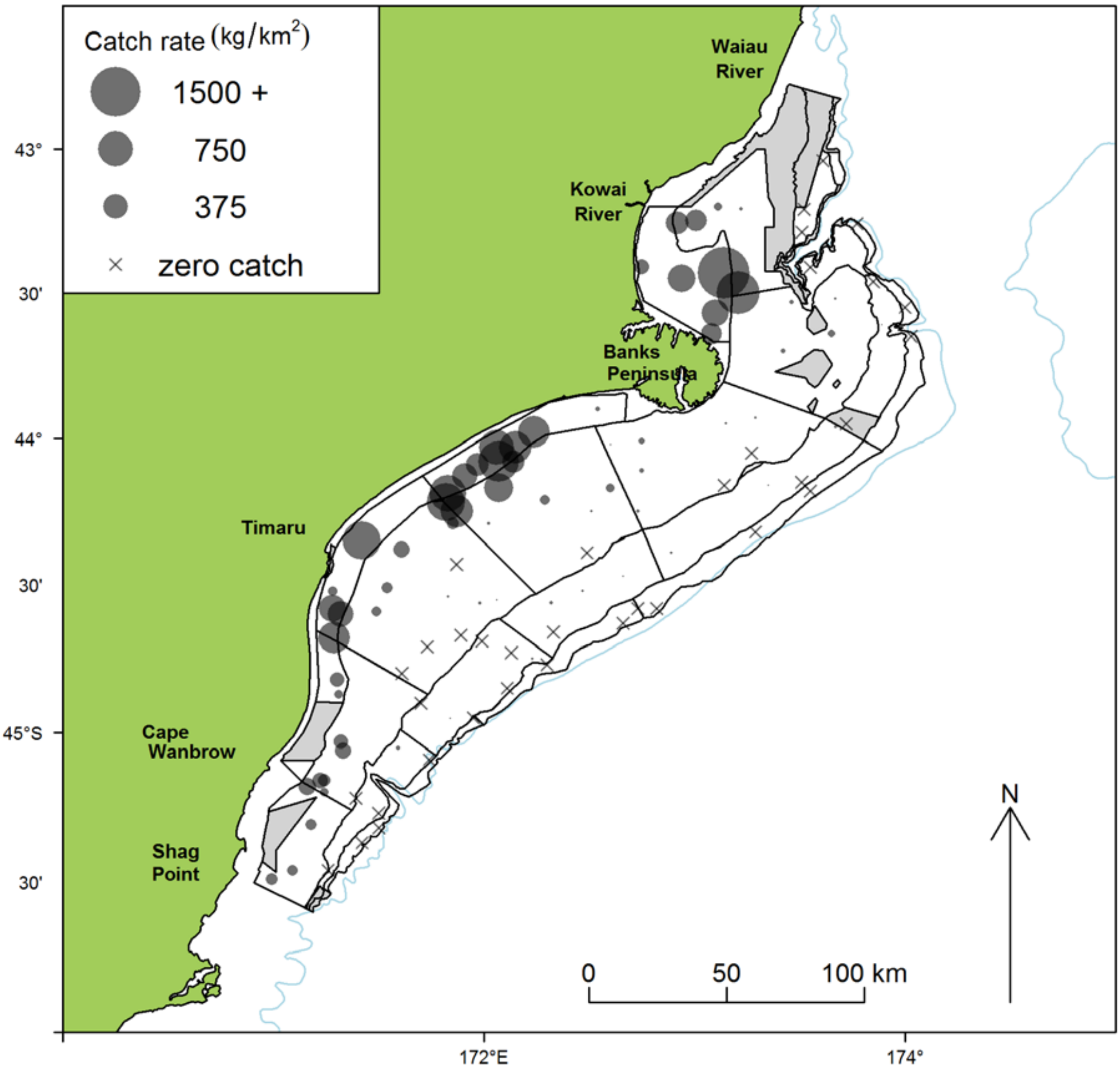


Figure 3–*continued*

Red cod

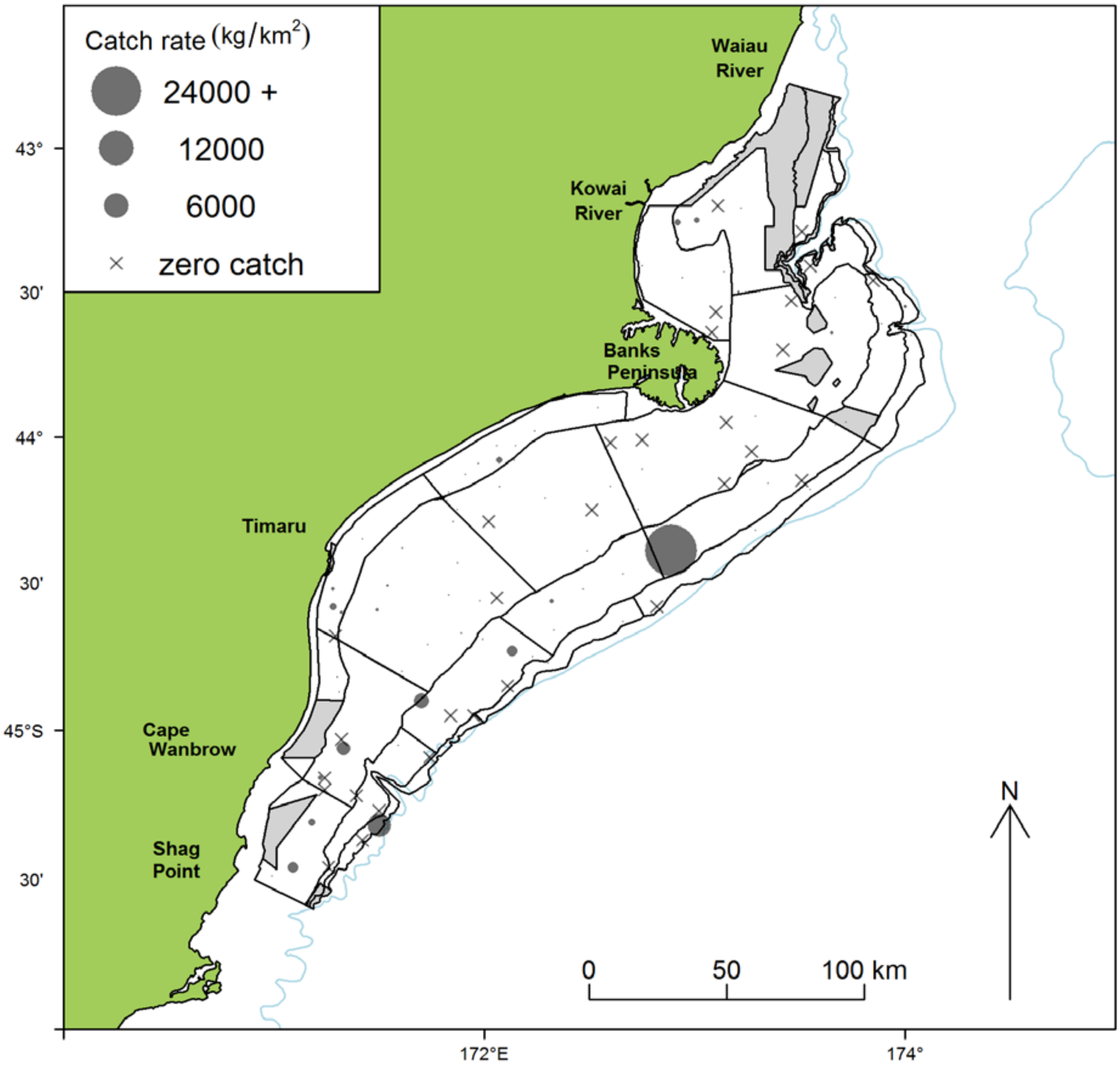


Figure 3–*continued*

Sea perch

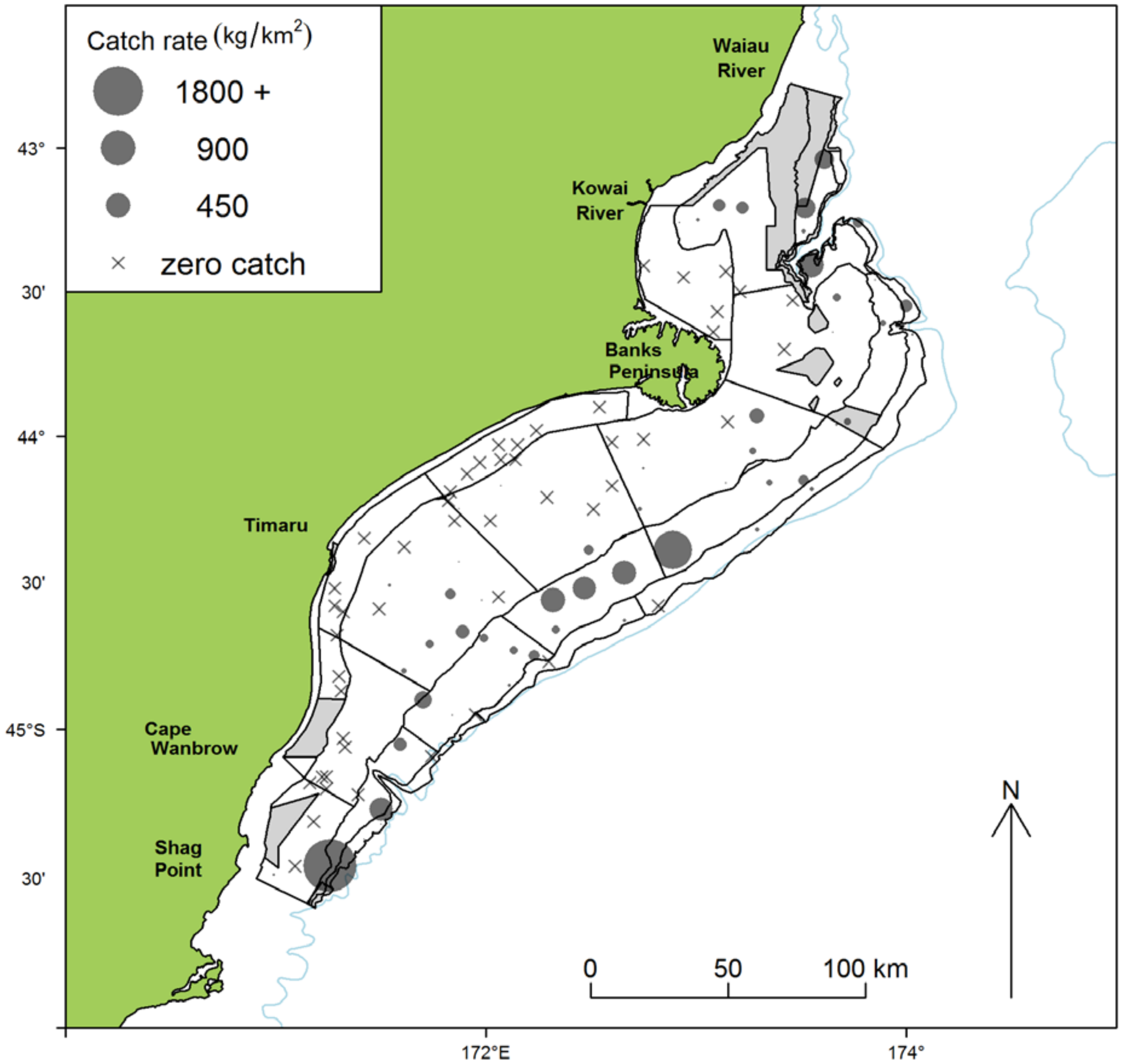


Figure 3–*continued*

Spiny dogfish

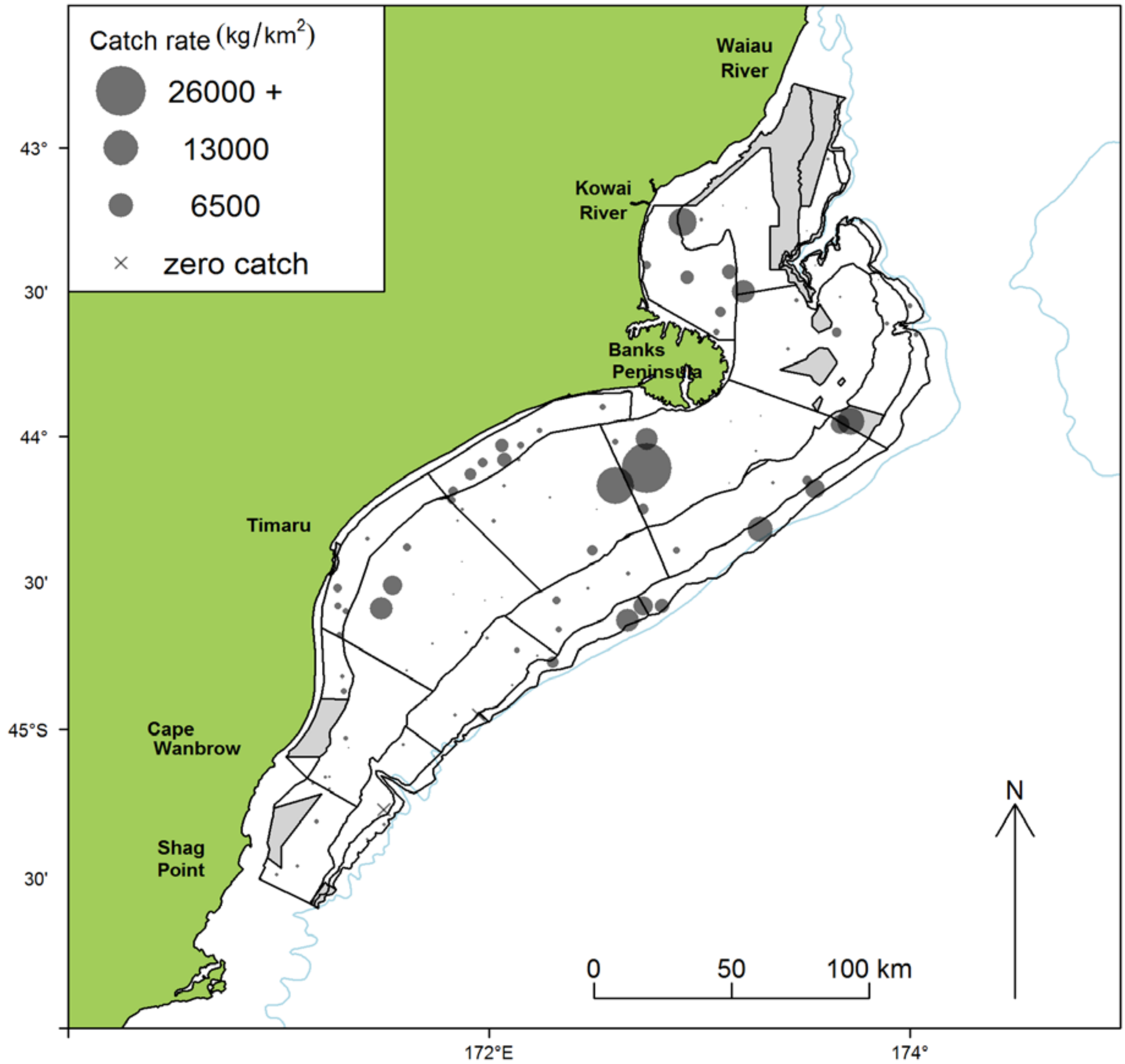


Figure 3–*continued*

Tarakihi

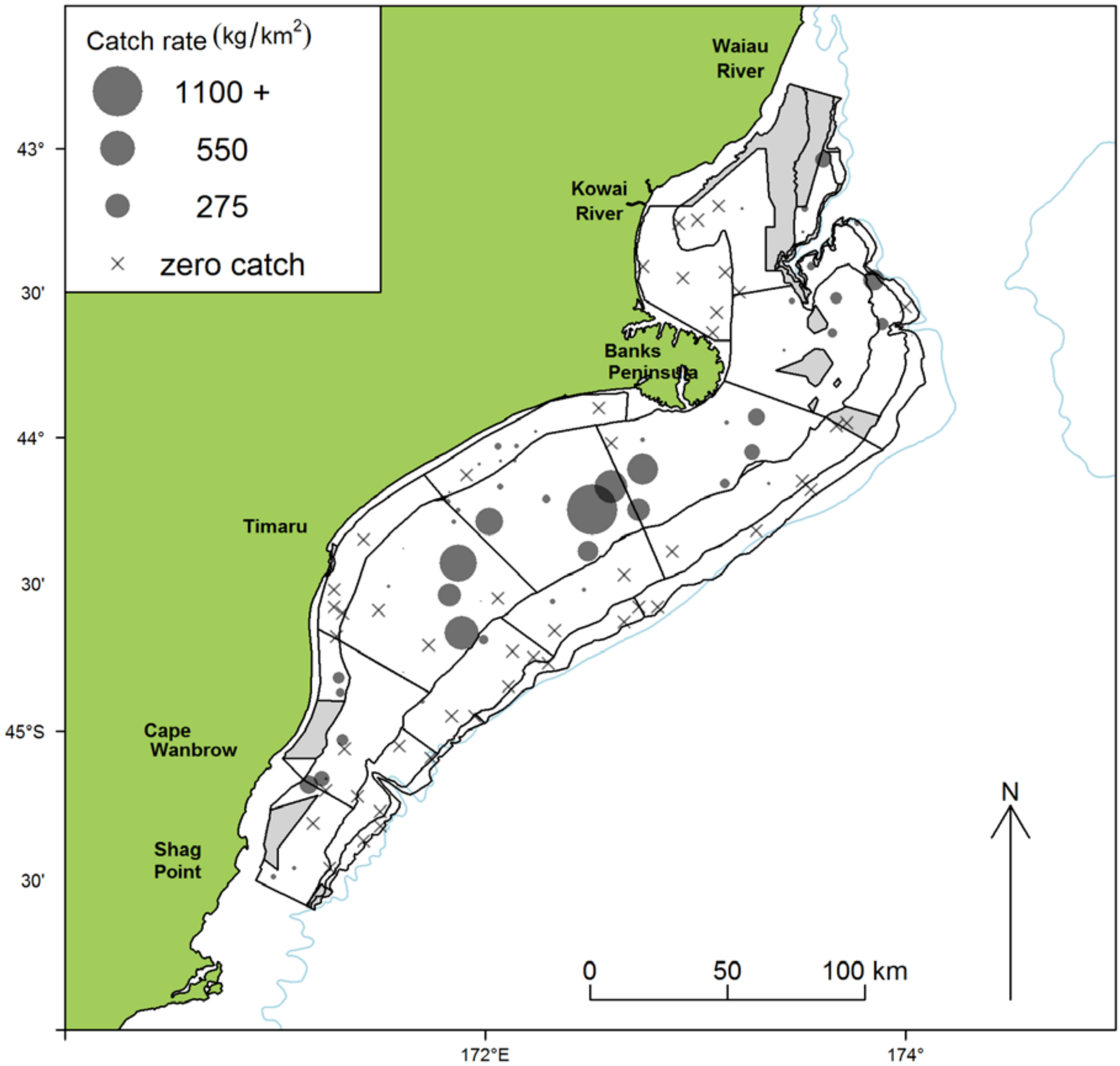
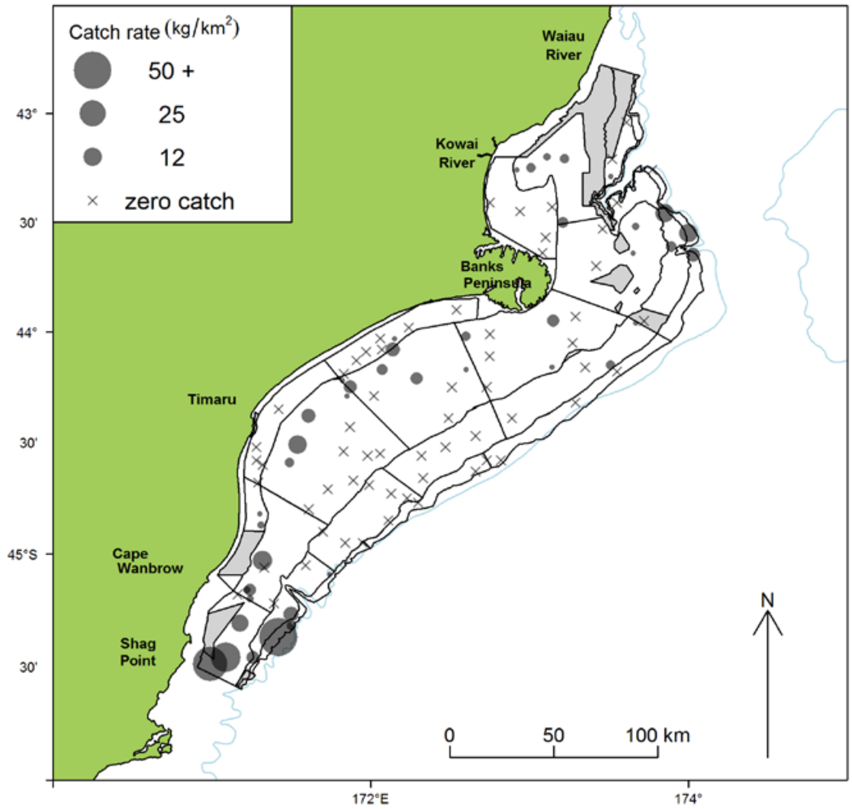


Figure 3–*continued*

Barracouta



Lemon sole

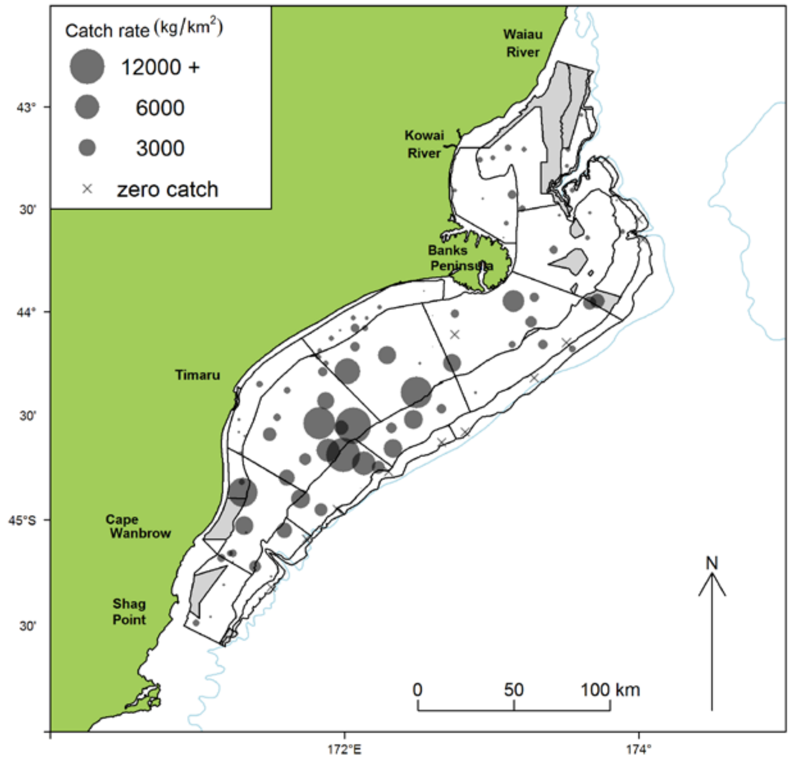
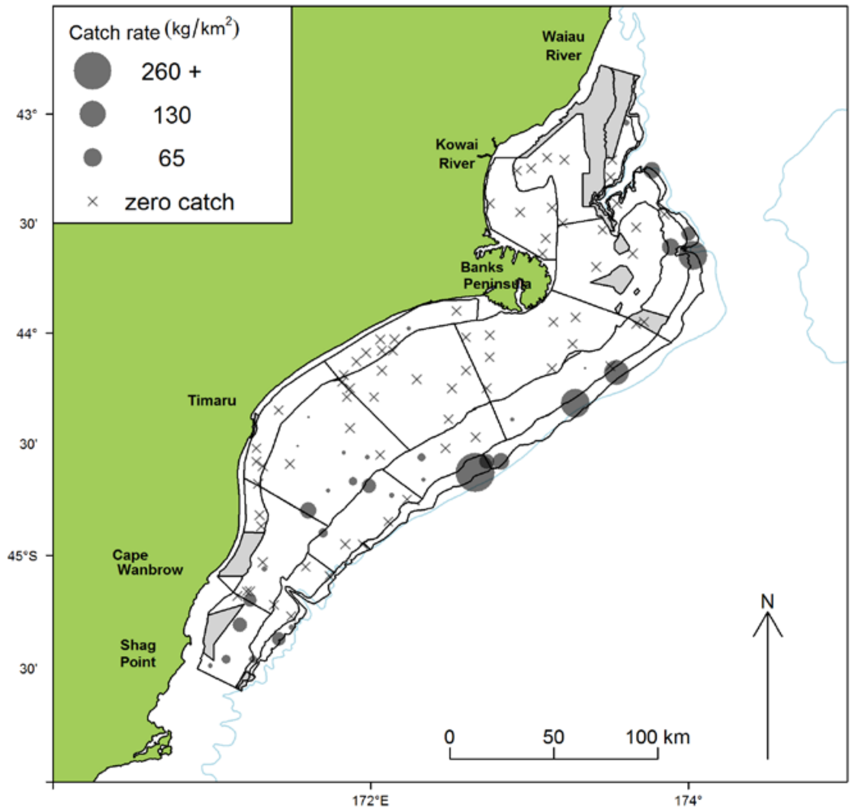


Figure 4: Catch rates (kg.km^{-2}) of key non-target QMS species for the 2012 ECSI survey. The legend indicates the circle size that corresponds to three catch rates; on the figure, circle size is continuous and proportional to the catch rate. Crosses indicate no catch at that station. Grey areas are foul ground.

Ling



Rig

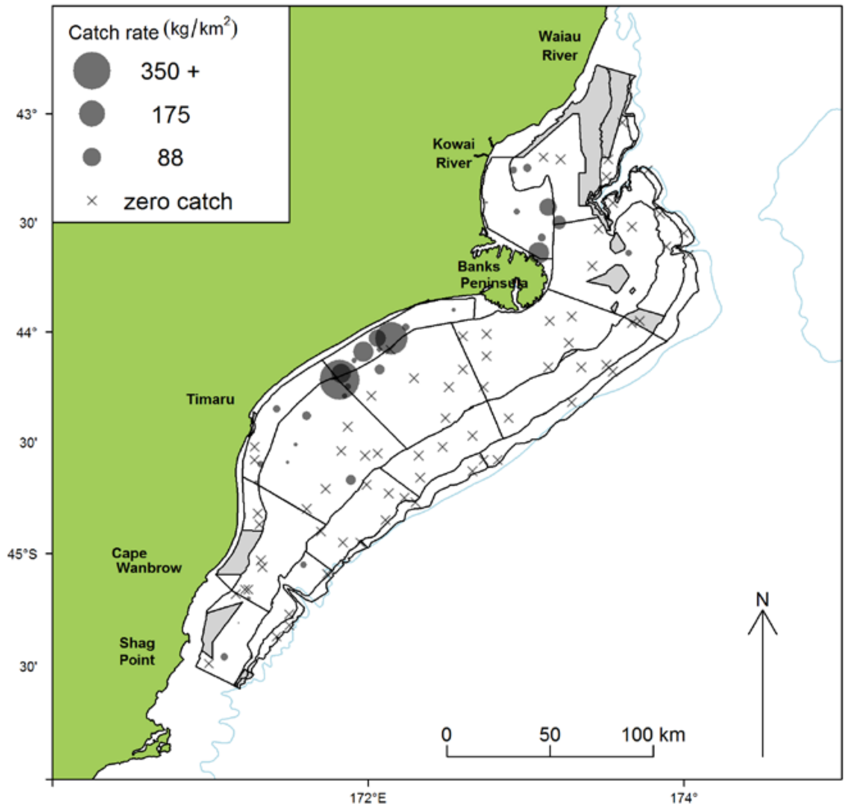
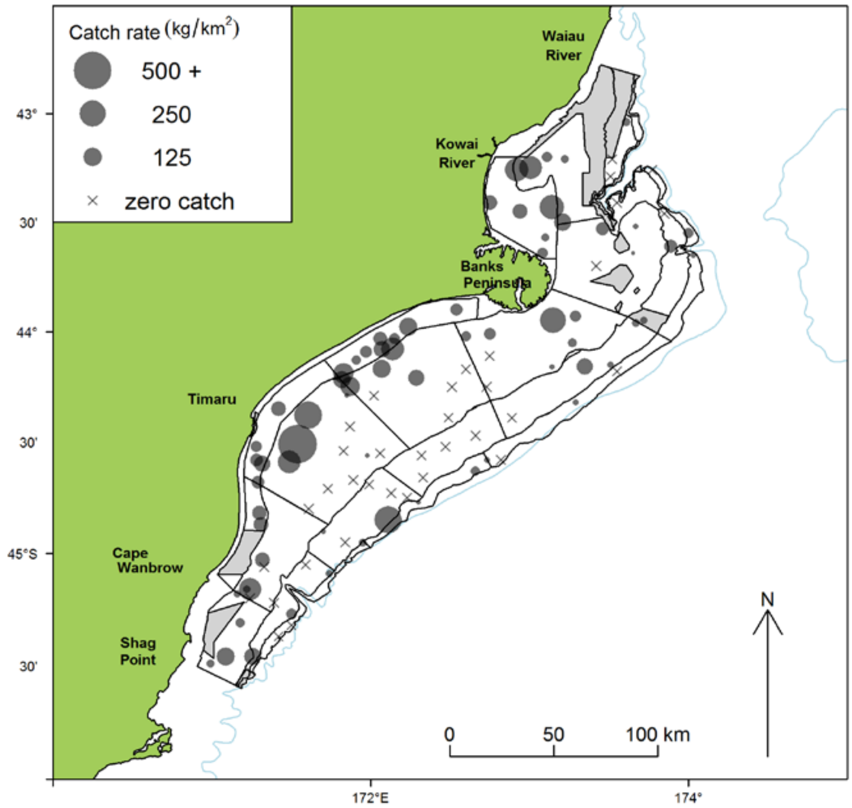


Figure 4–*continued*

Rough skate



School shark

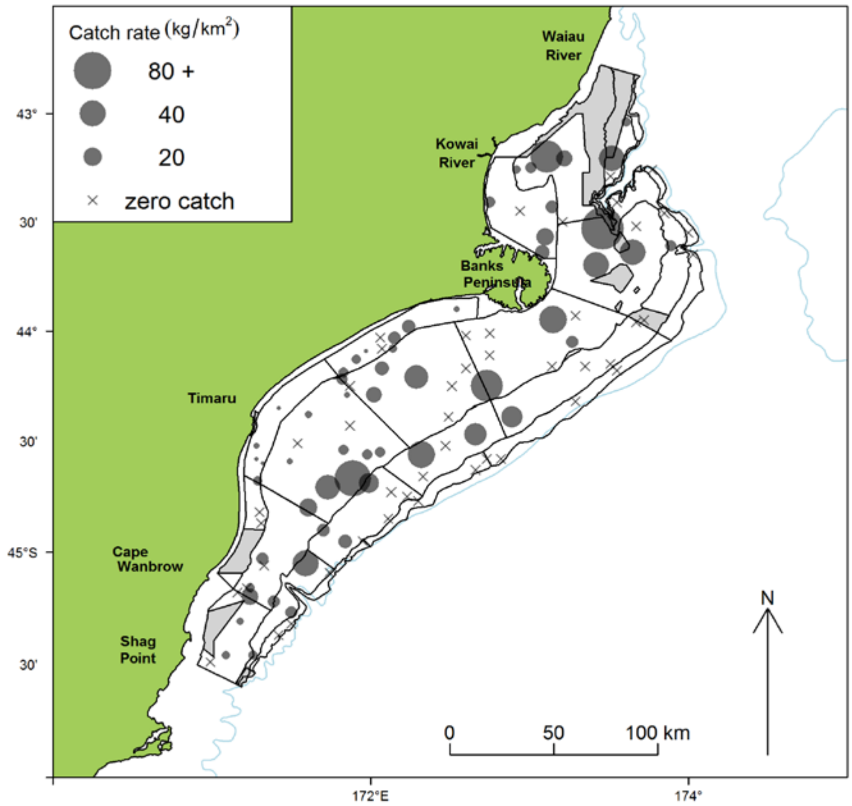
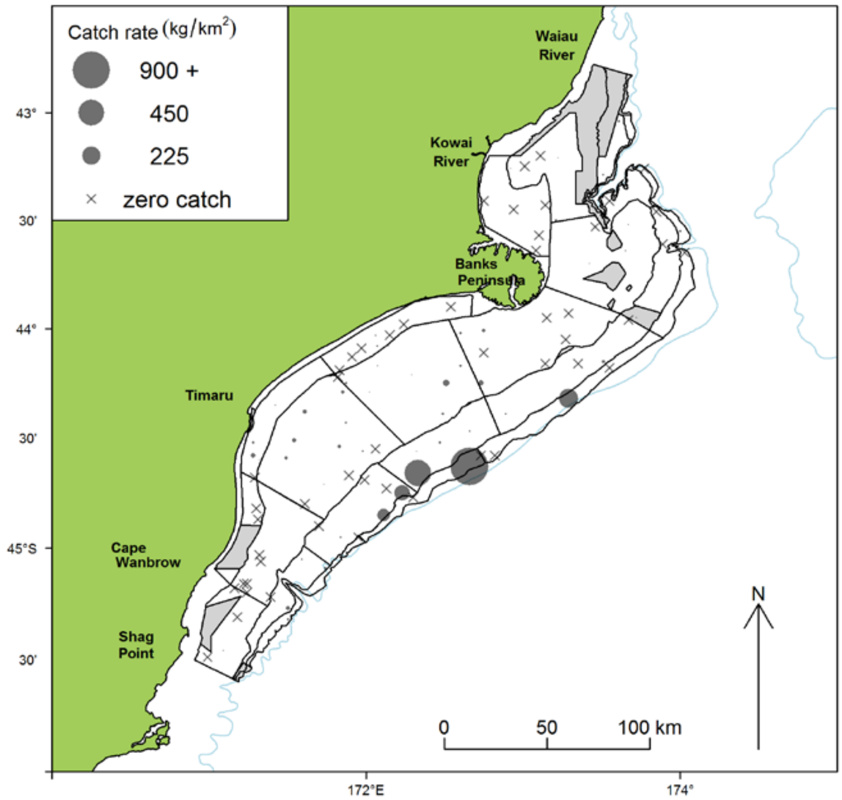


Figure 4–*continued*

Silver warehou



Smooth skate

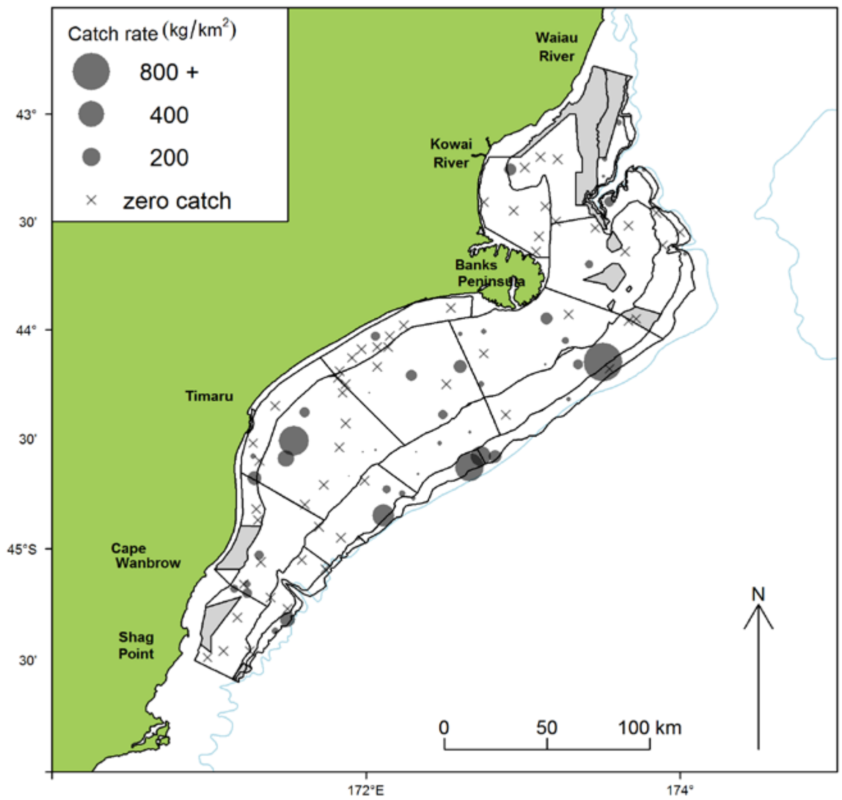


Figure 4–*continued*

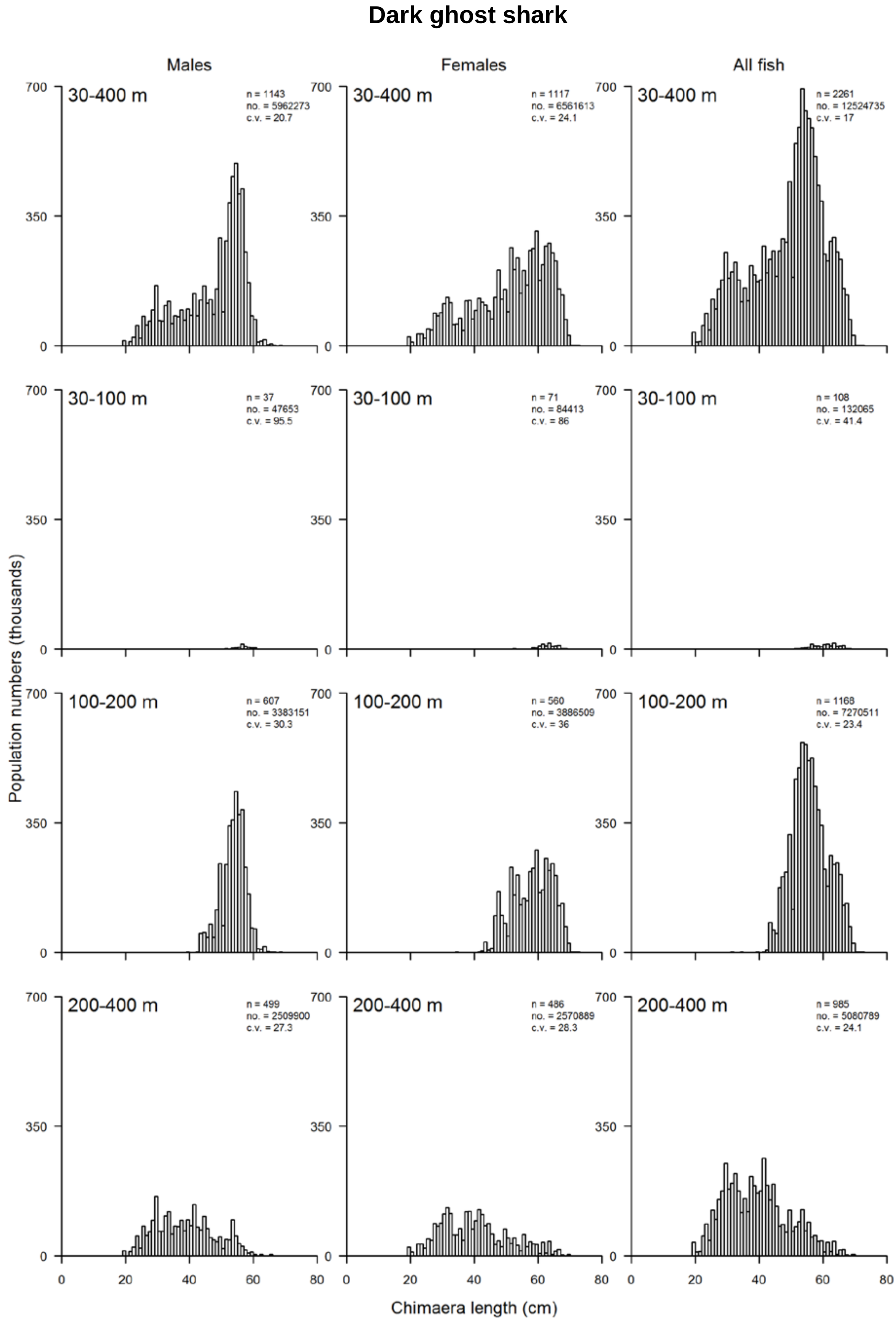


Figure 5: Scaled length frequency distributions for the target species by depth range for the 2012 survey. Population estimates are in thousands of fish.

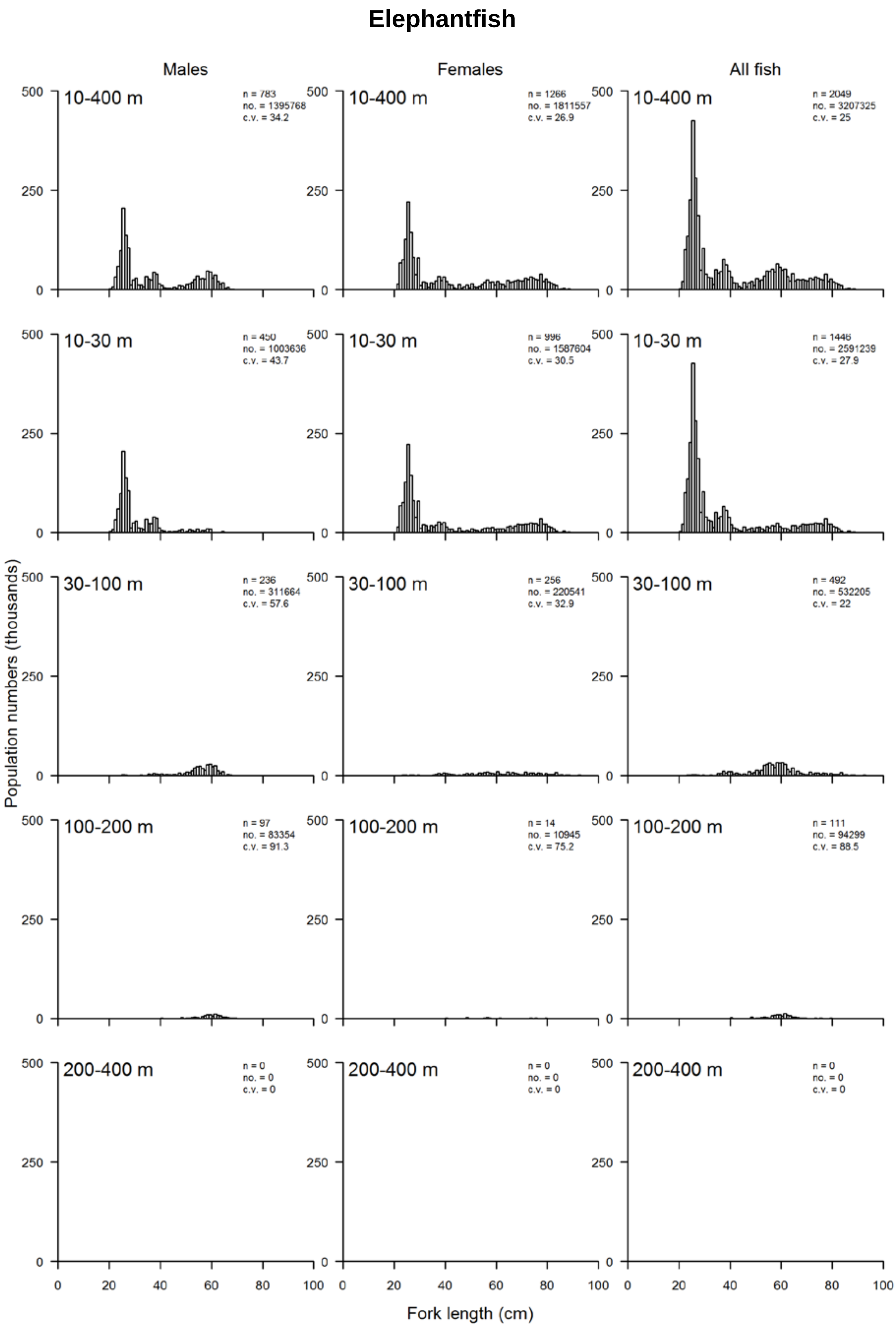


Figure 5–*continued*

Giant stargazer

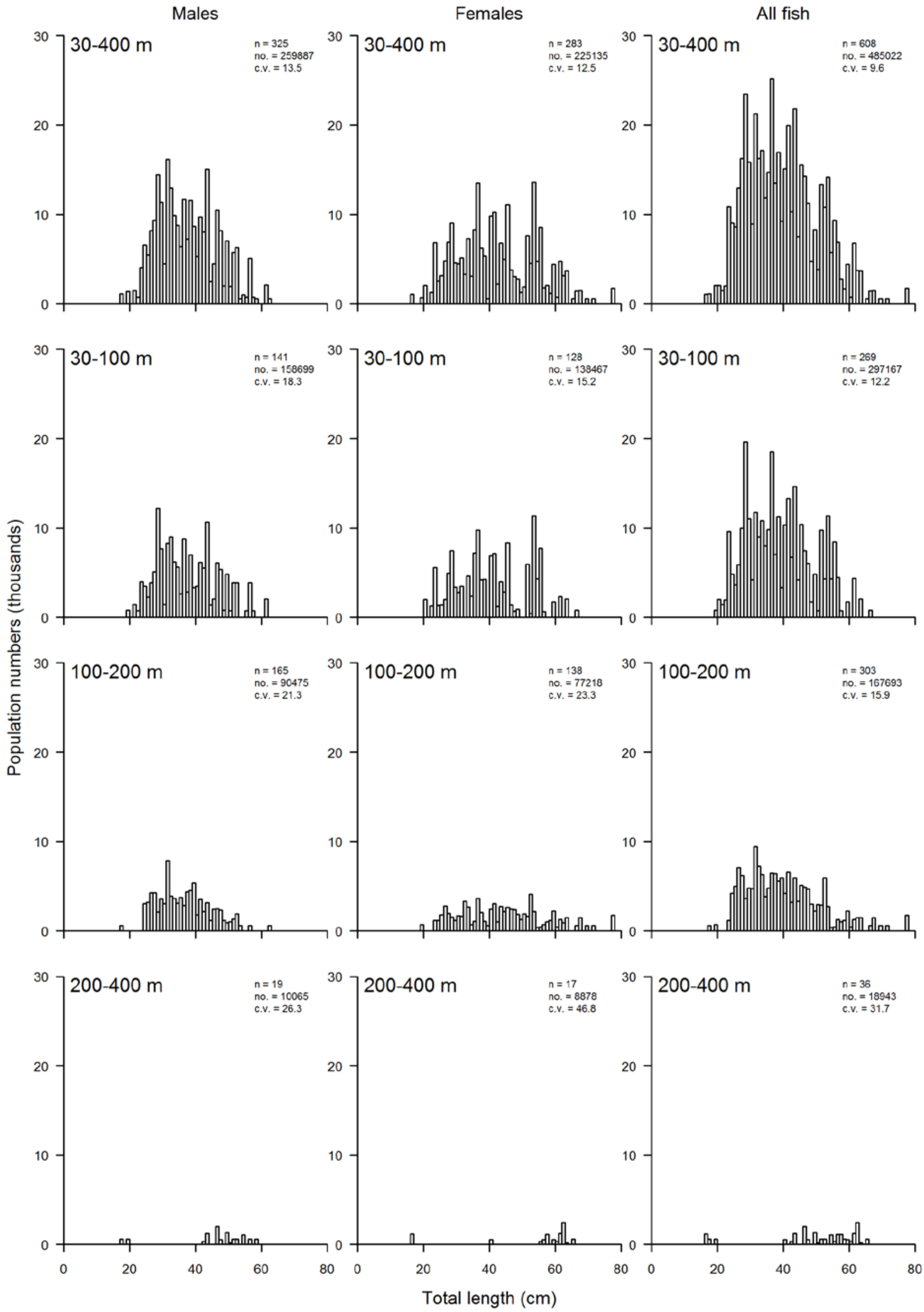


Figure 5–*continued*

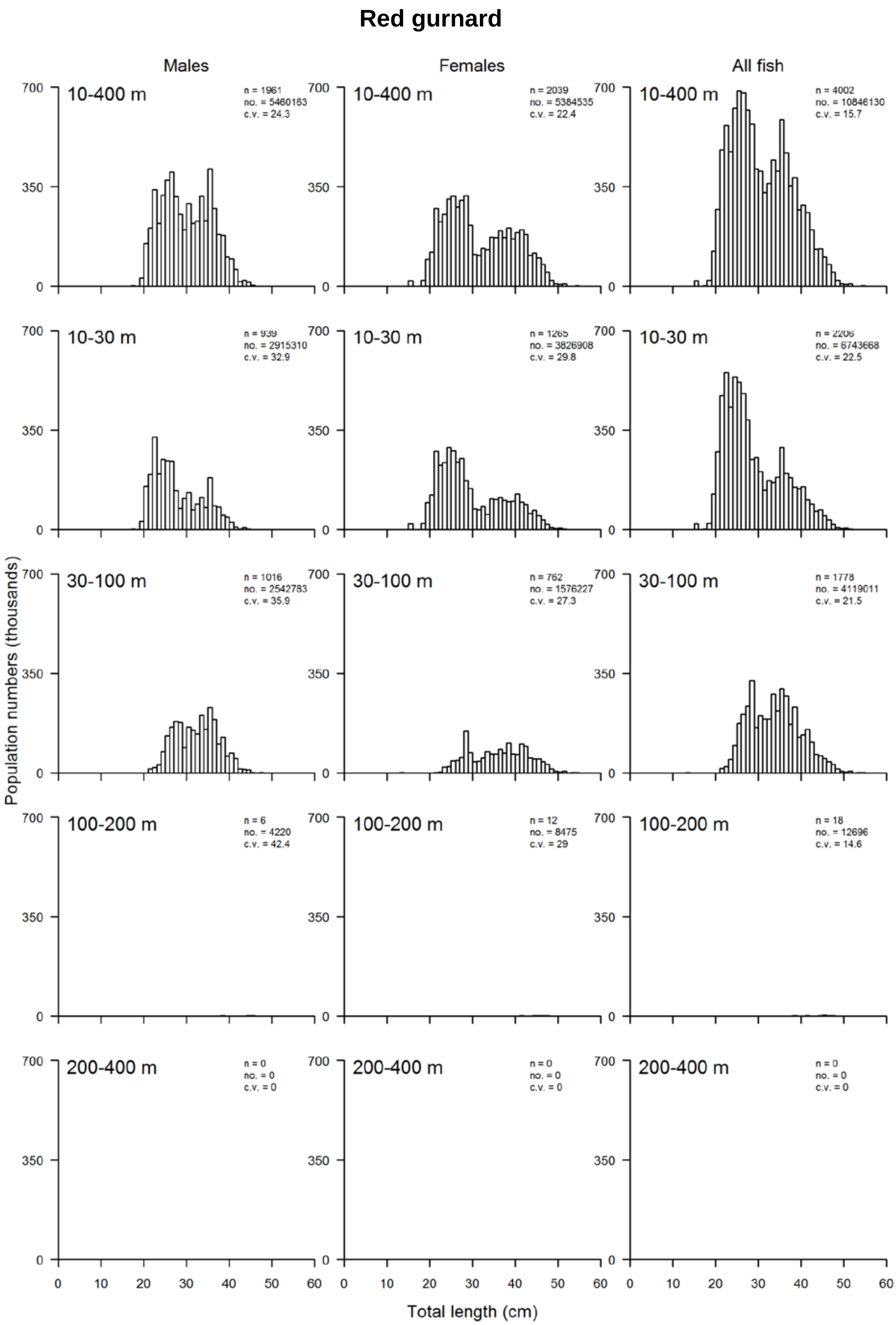


Figure 5–*continued*

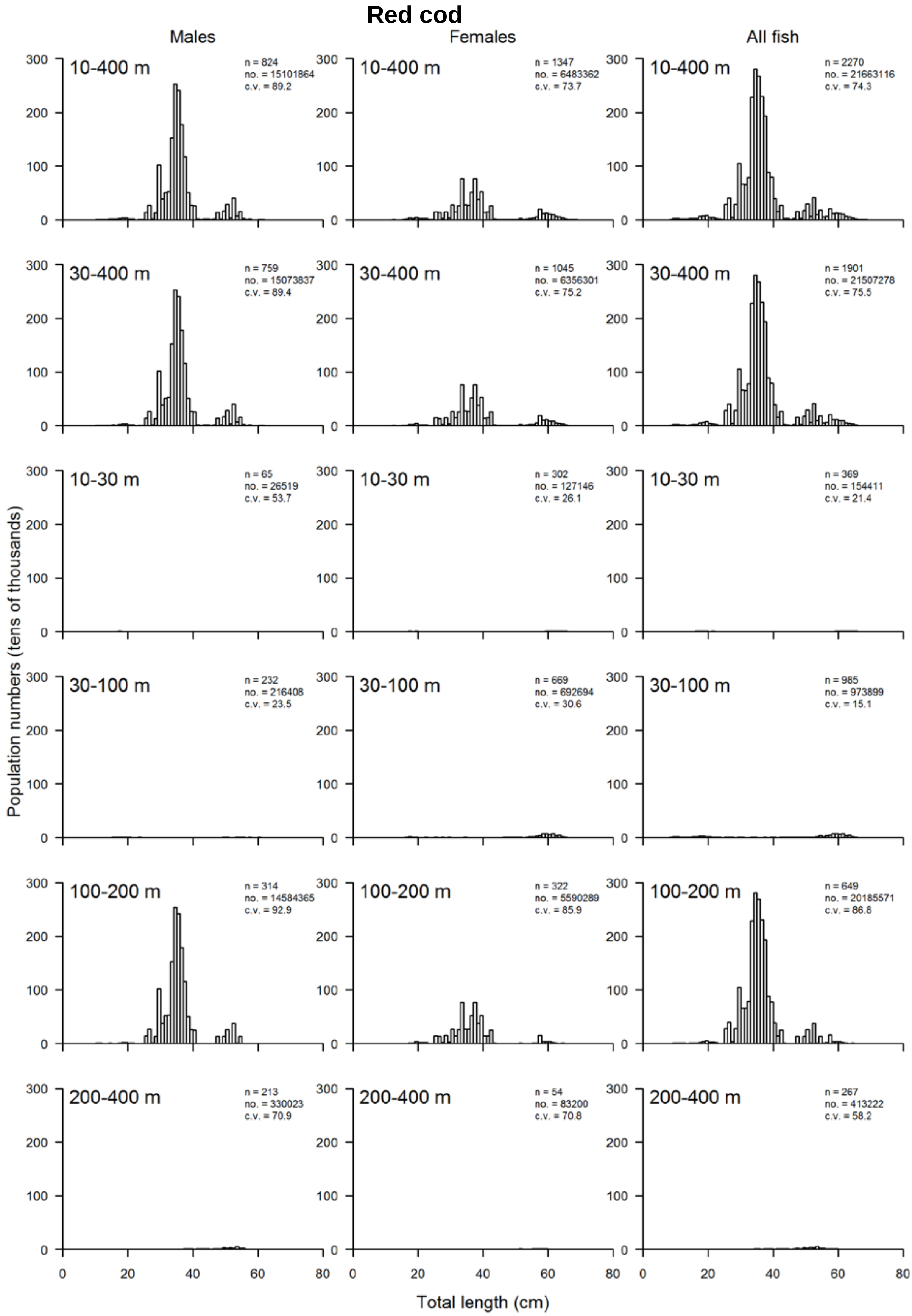


Figure 5–*continued*

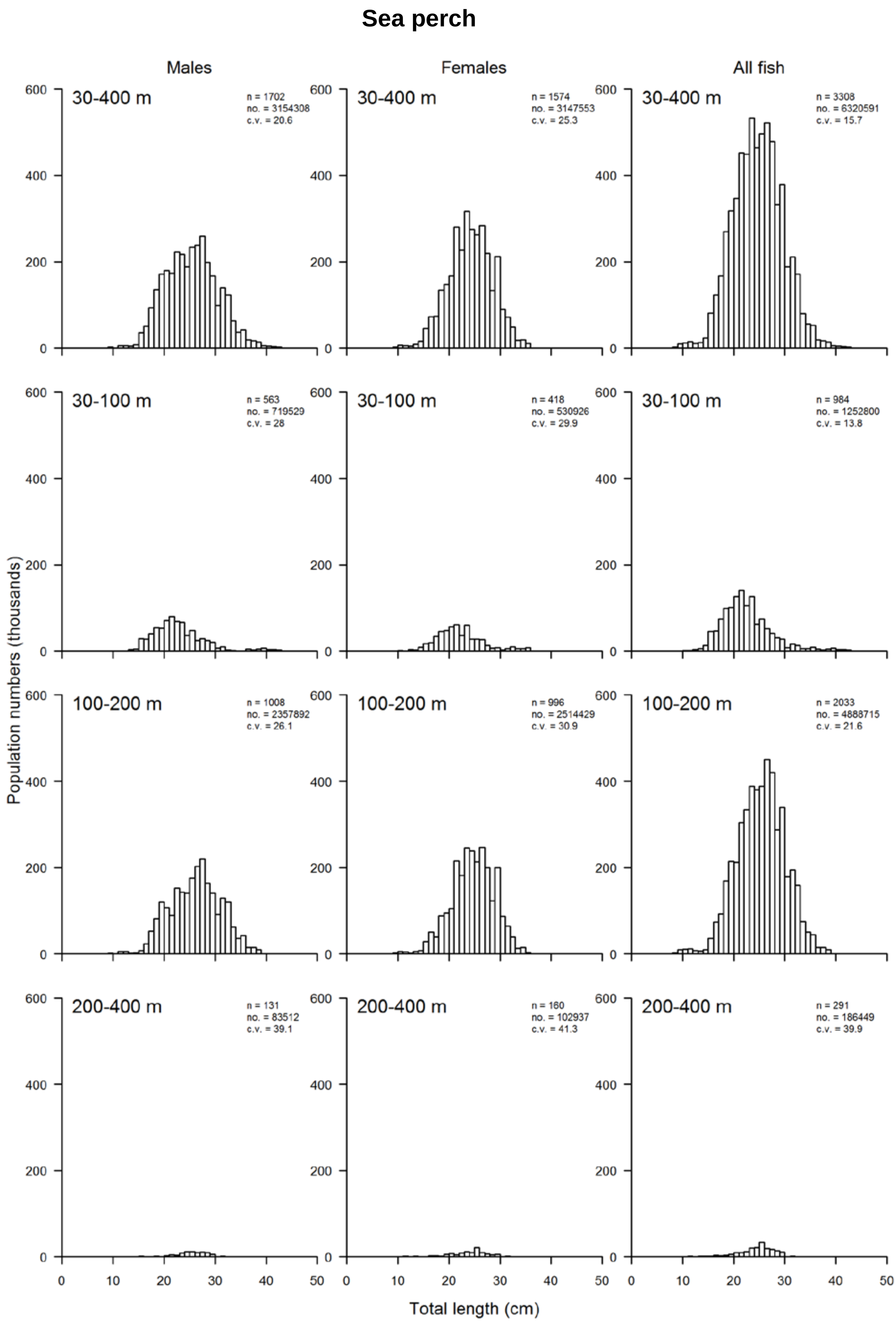


Figure 5 – *continued*

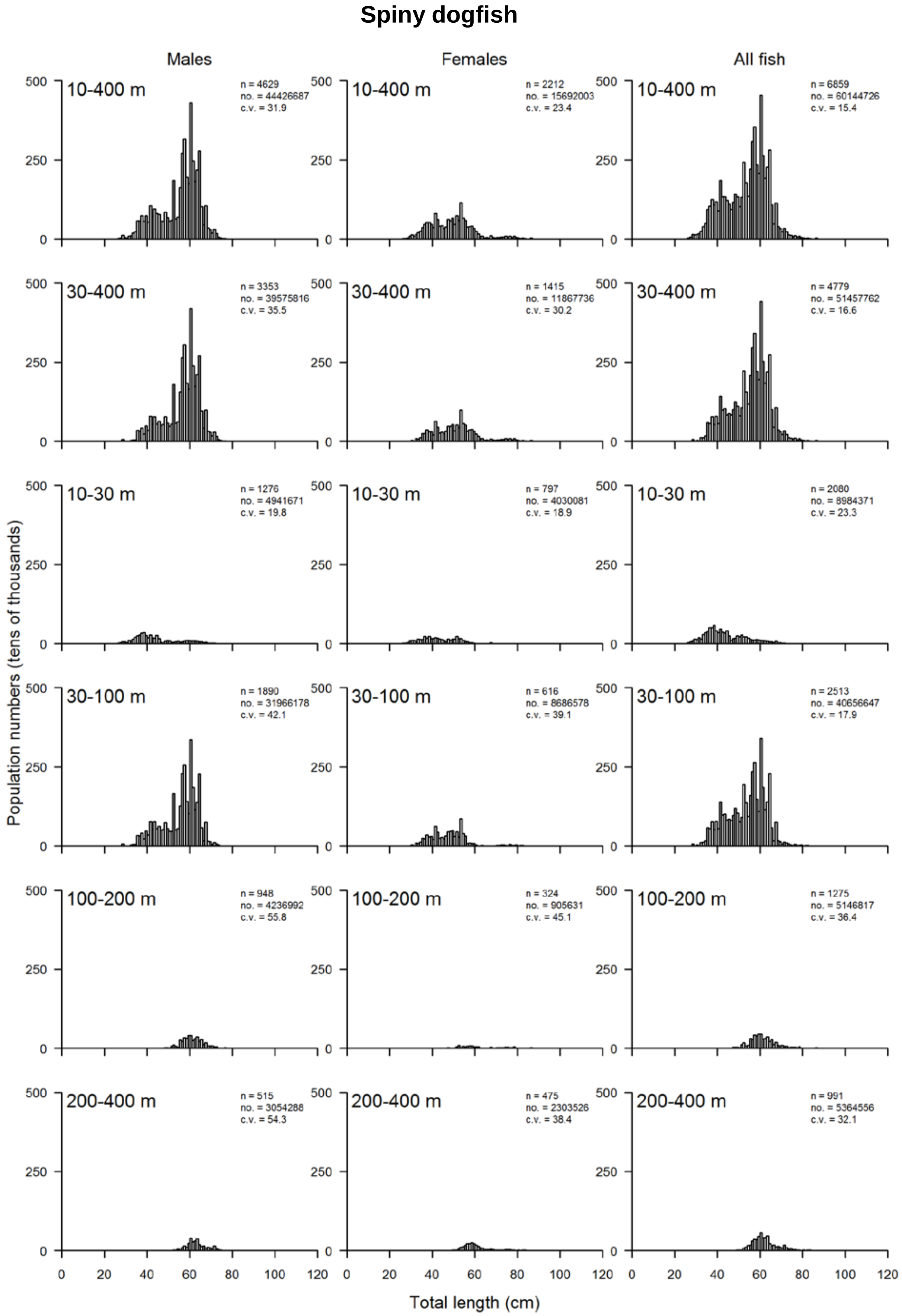


Figure 5–*continued*

Tarakihi

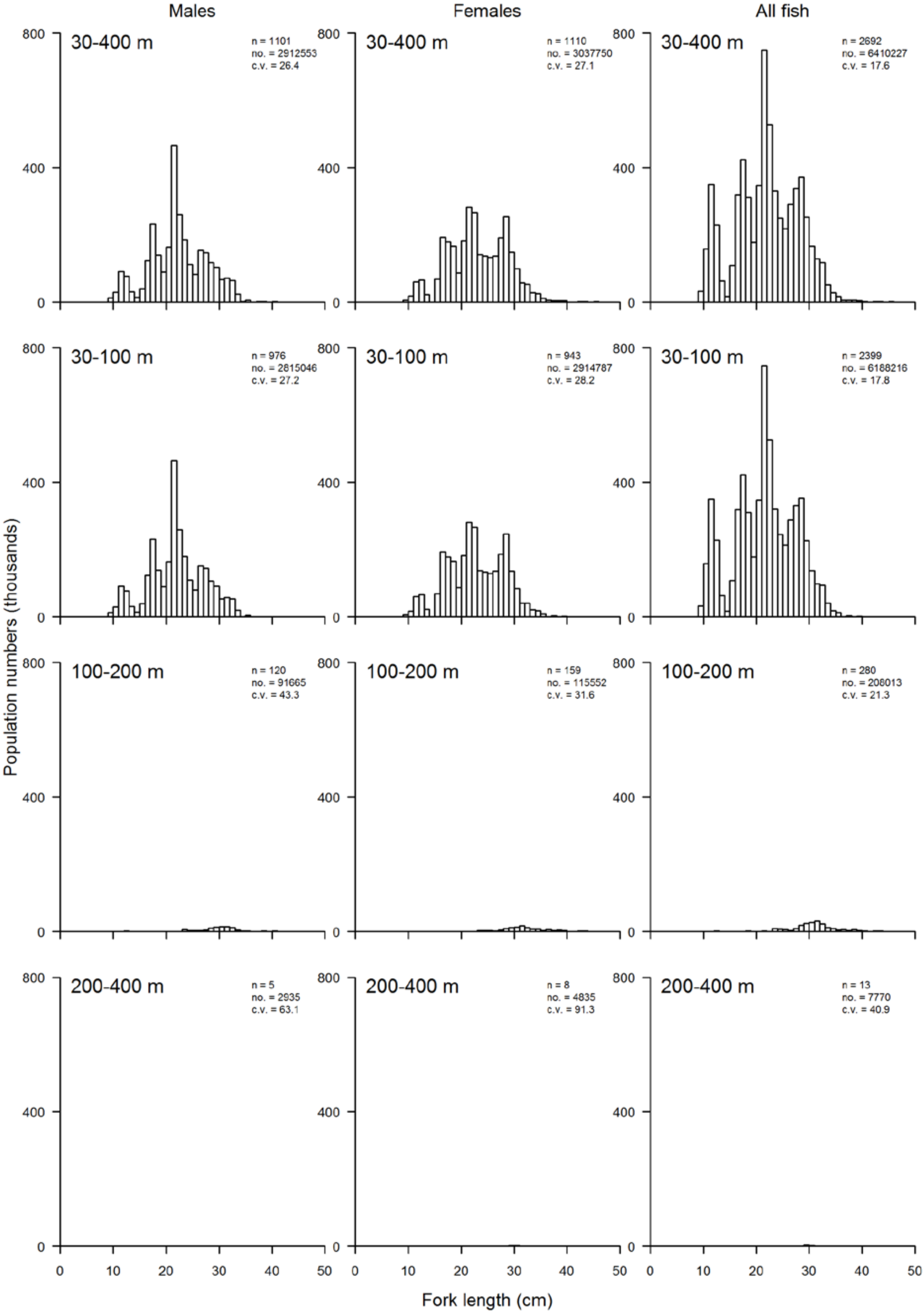


Figure 5–*continued*

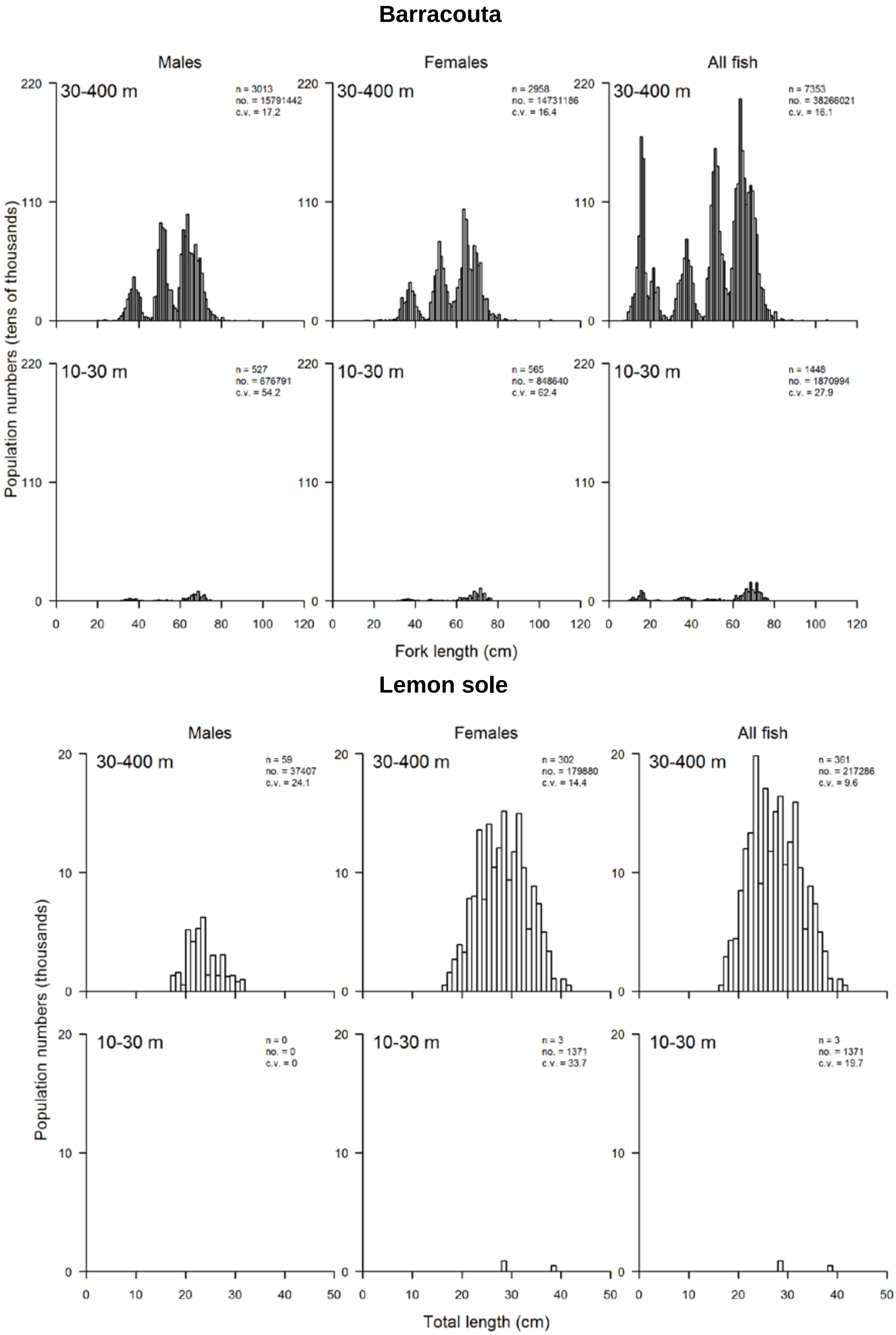
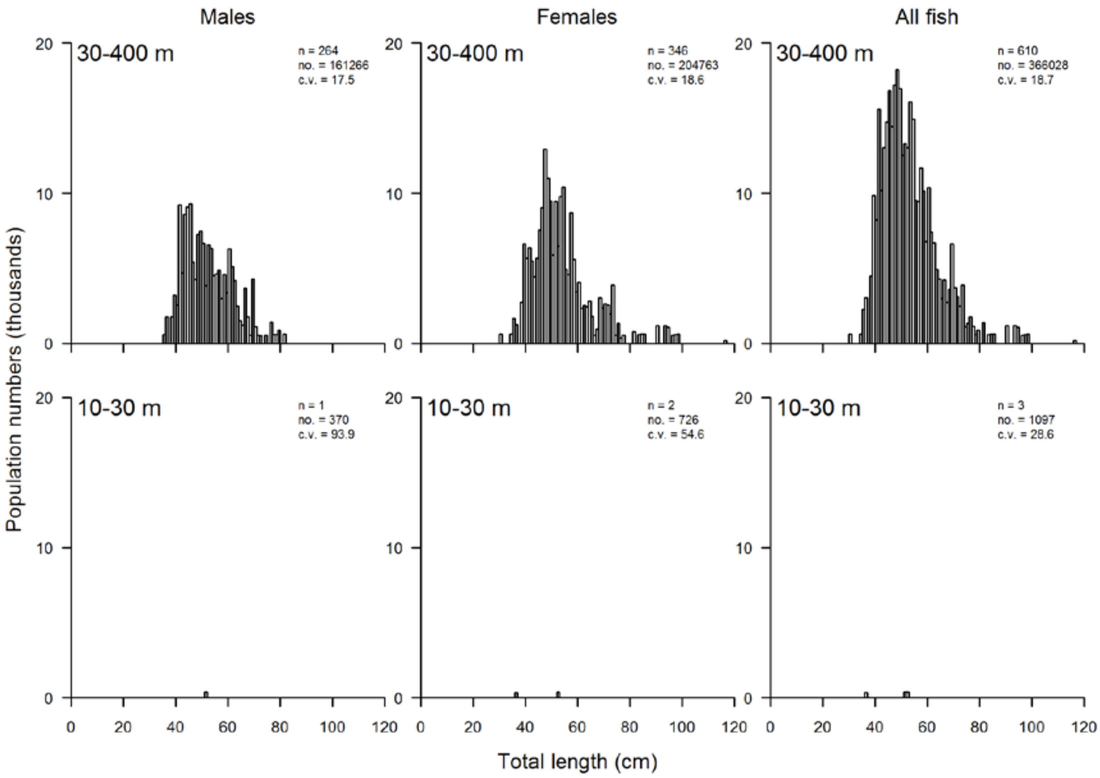


Figure 6: Scaled length frequency distributions for the key QMS species in 30–400 m, and 10–30 m for the 2012 survey. Population estimates are in thousands of fish.

Ling



Rig

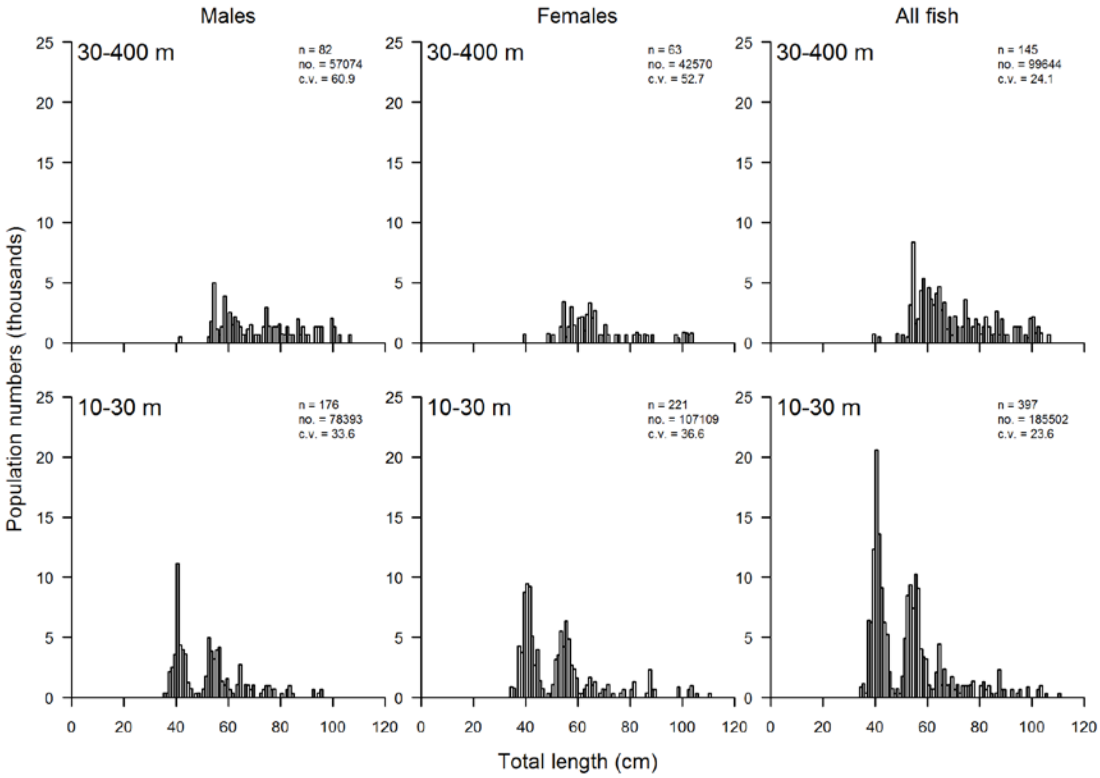
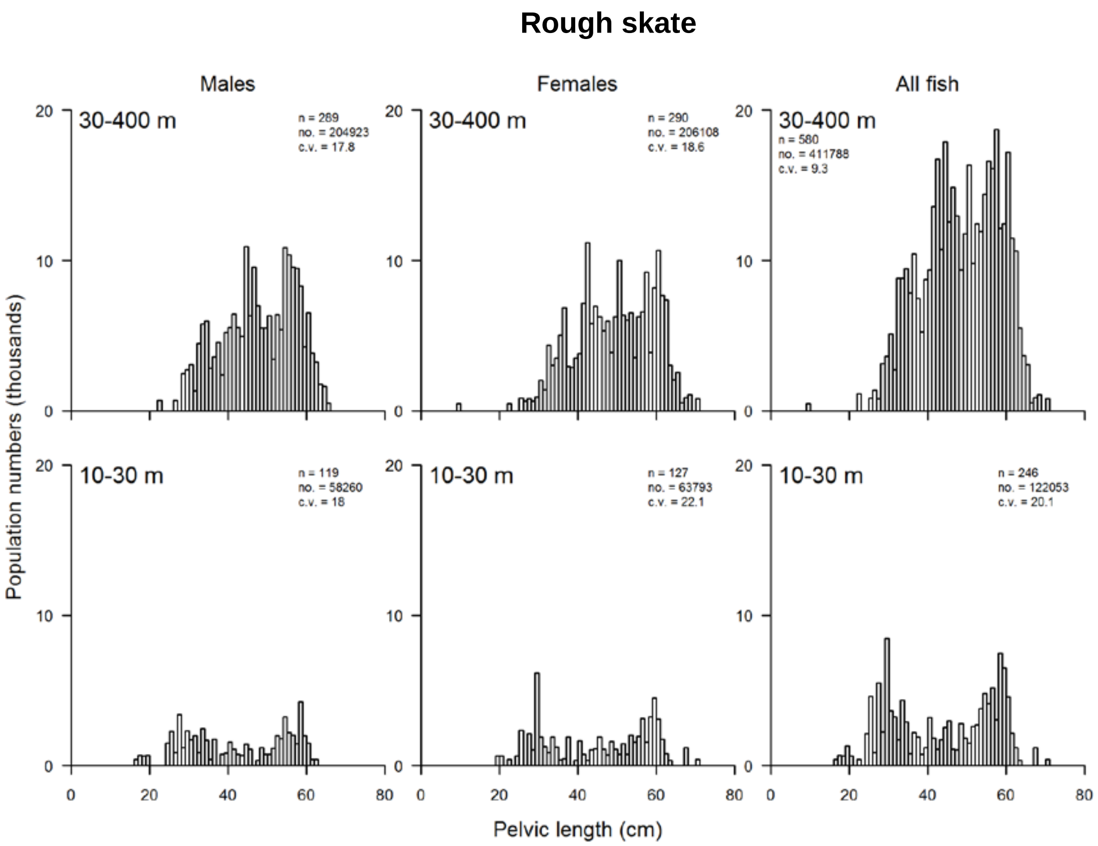


Figure 6 – *continued*



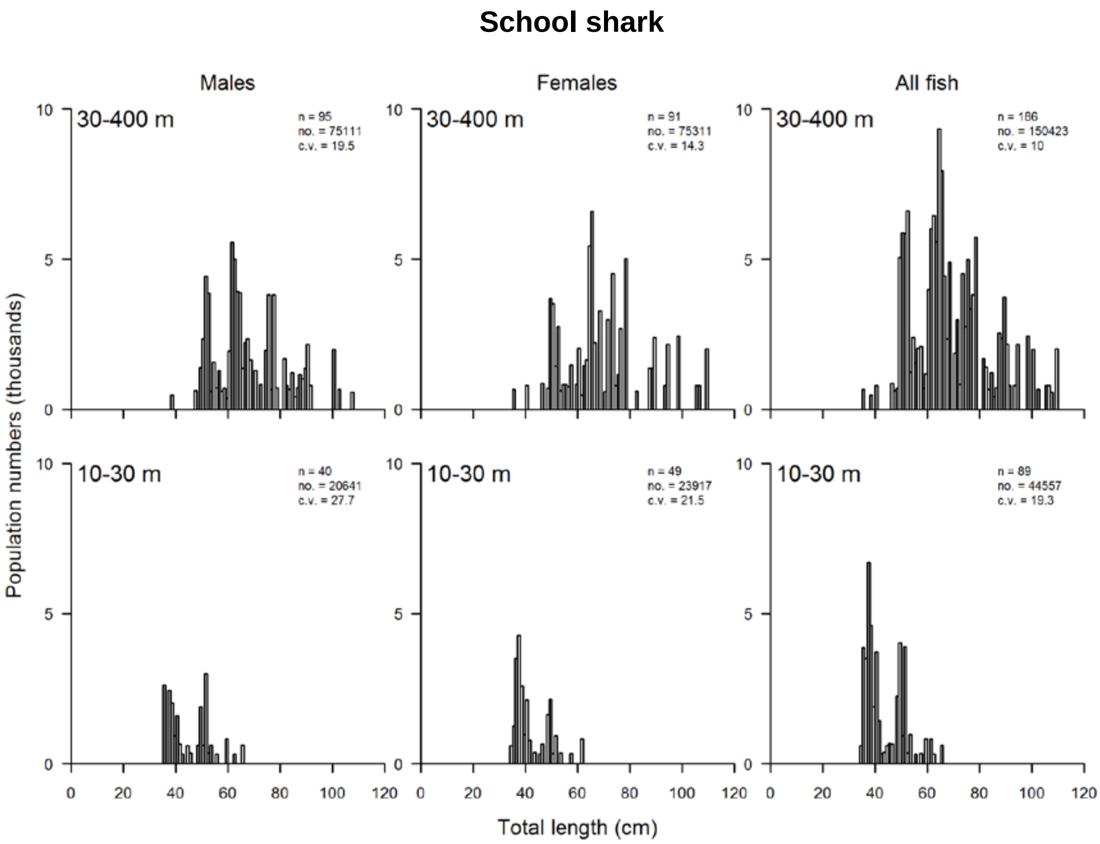
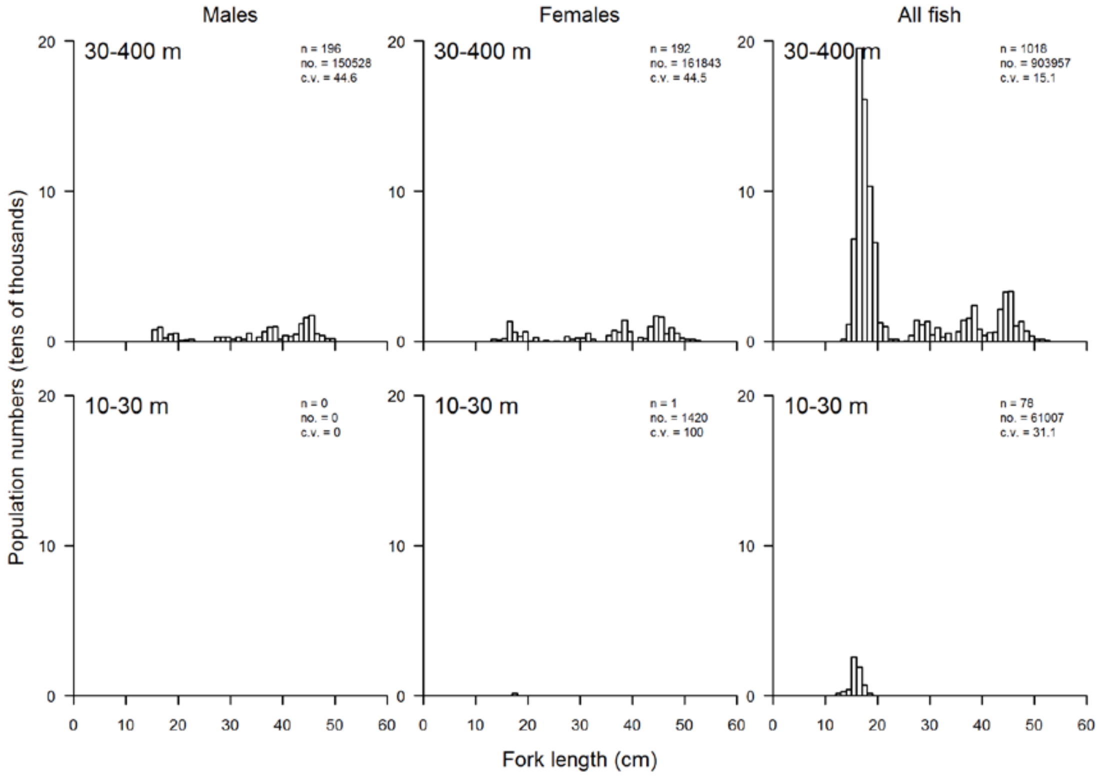


Figure 6 – *continued*

Silver warehou



Smooth skate

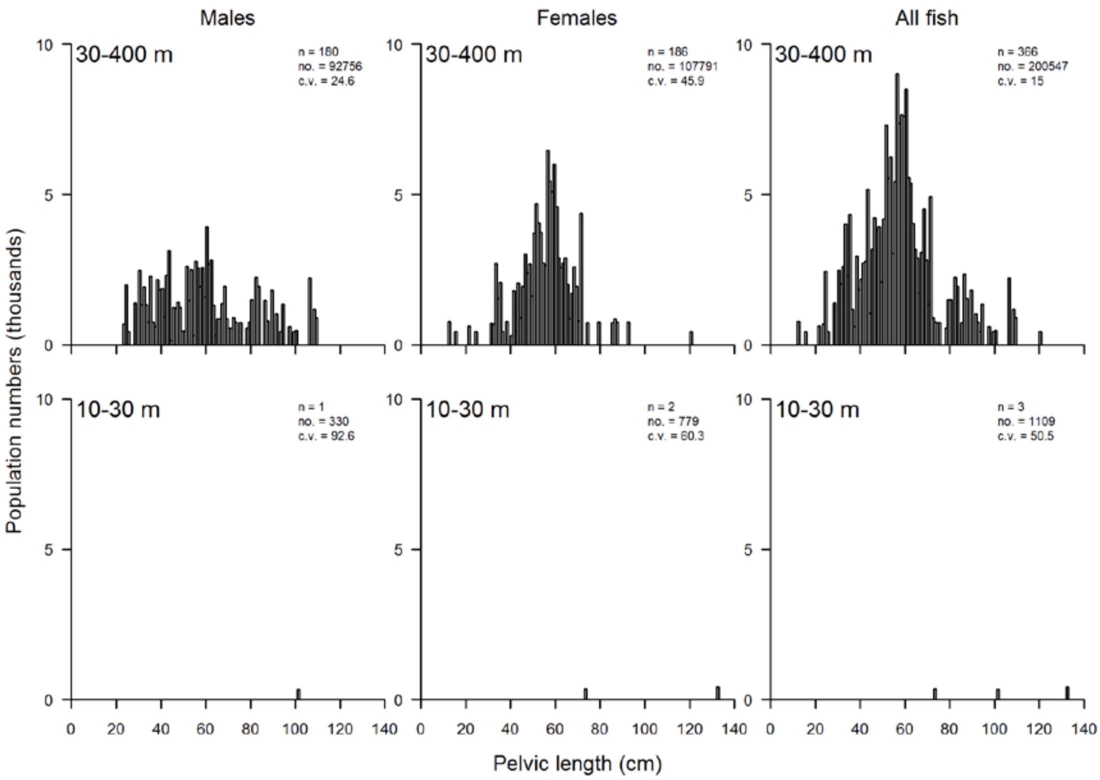
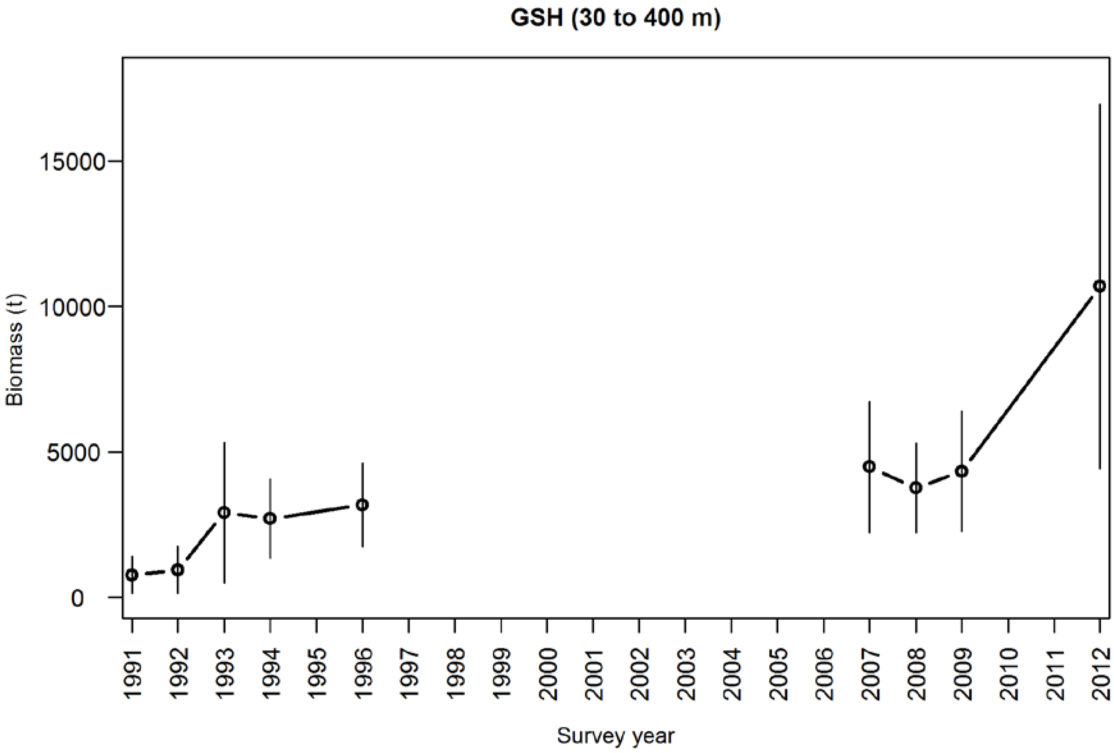


Figure 6 – ***continued***



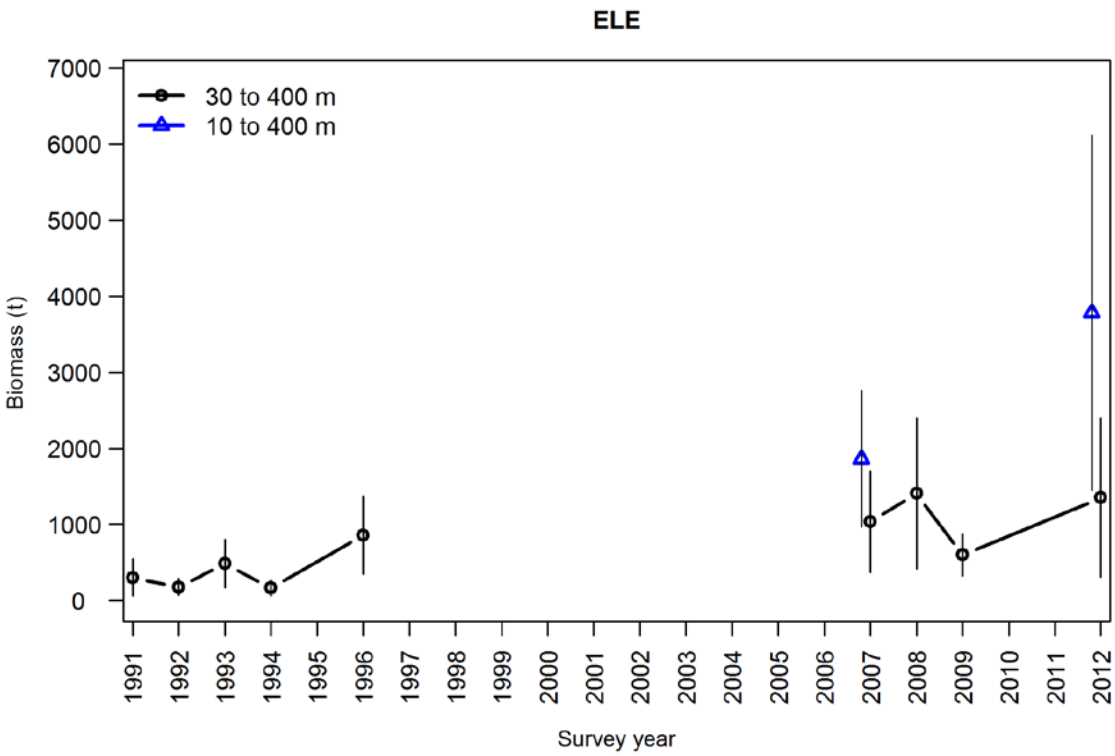
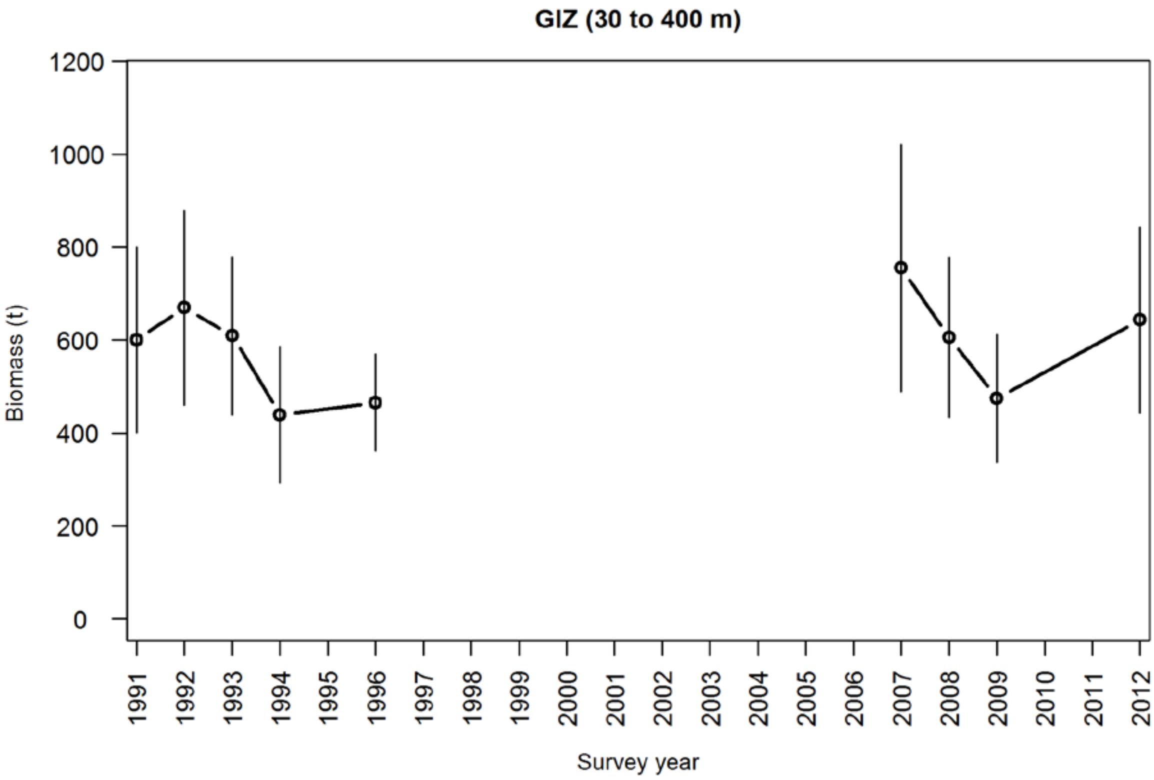


Figure 7: Target species total biomass and 95% confidence intervals for the all ECSI winter surveys in core strata (30–400 m), and core plus shallow strata (10–400 m) for species found in less than 30 m in 2007 and 2012.



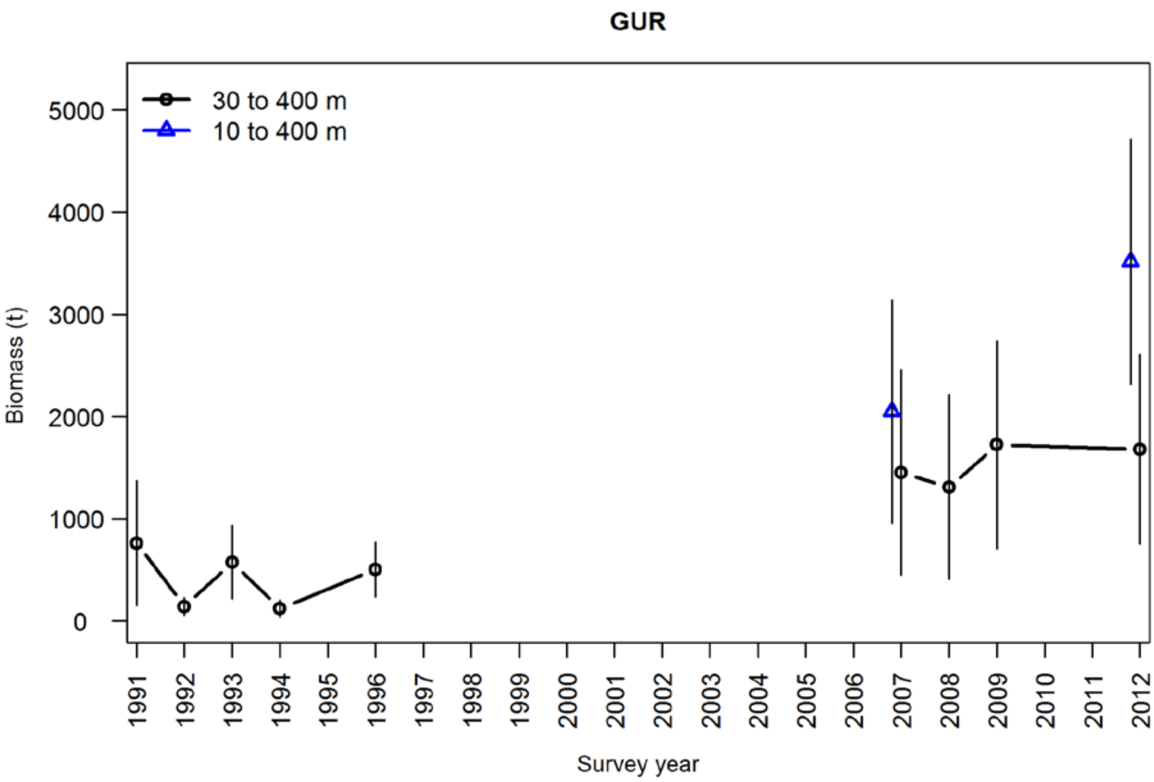
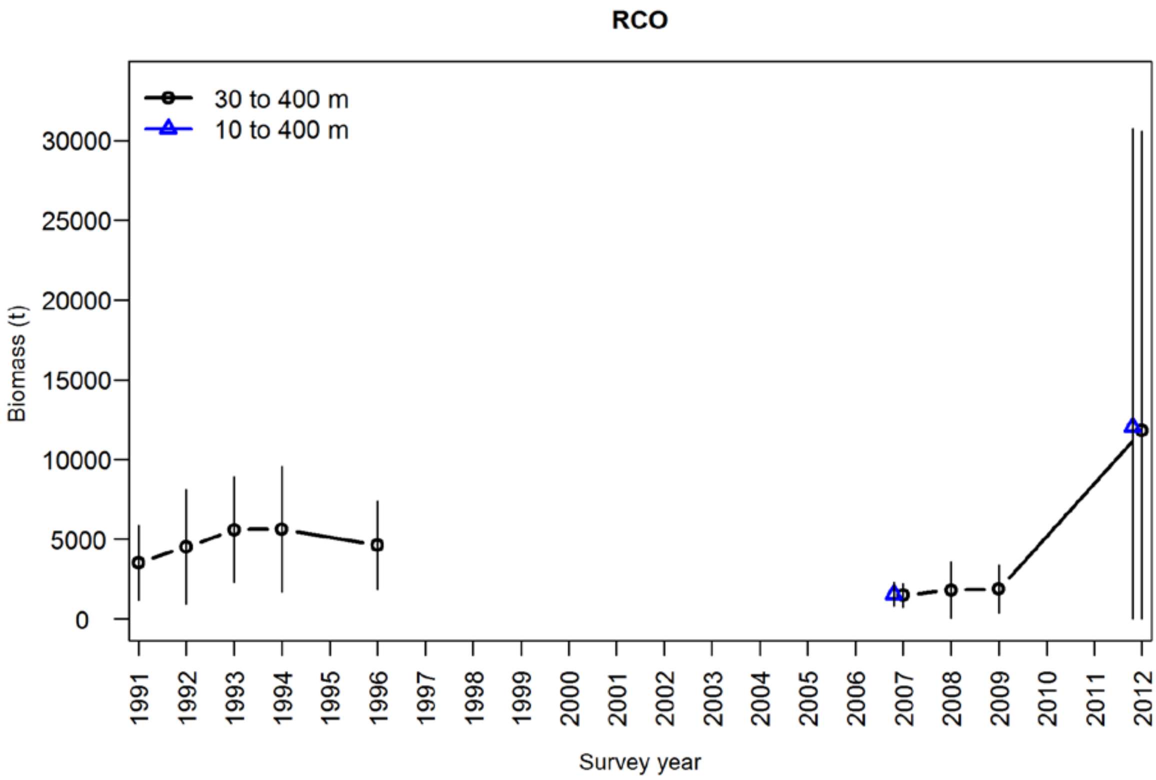


Figure 7 – ***continued***



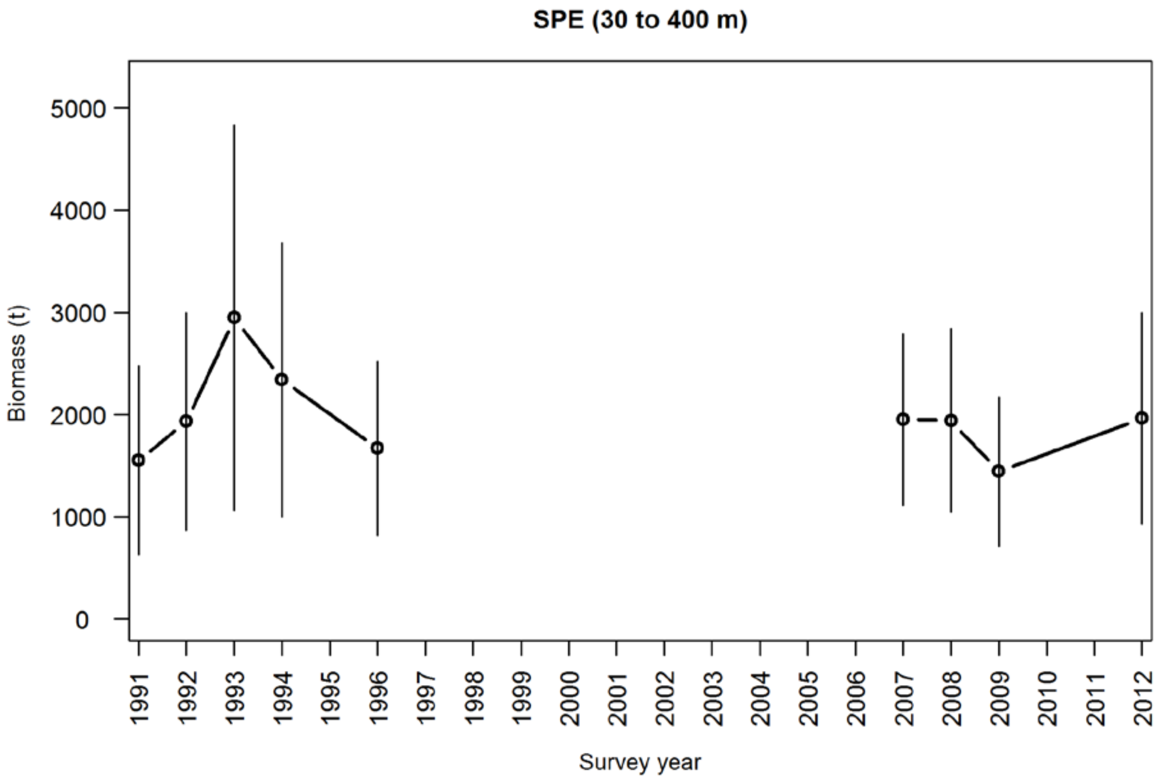
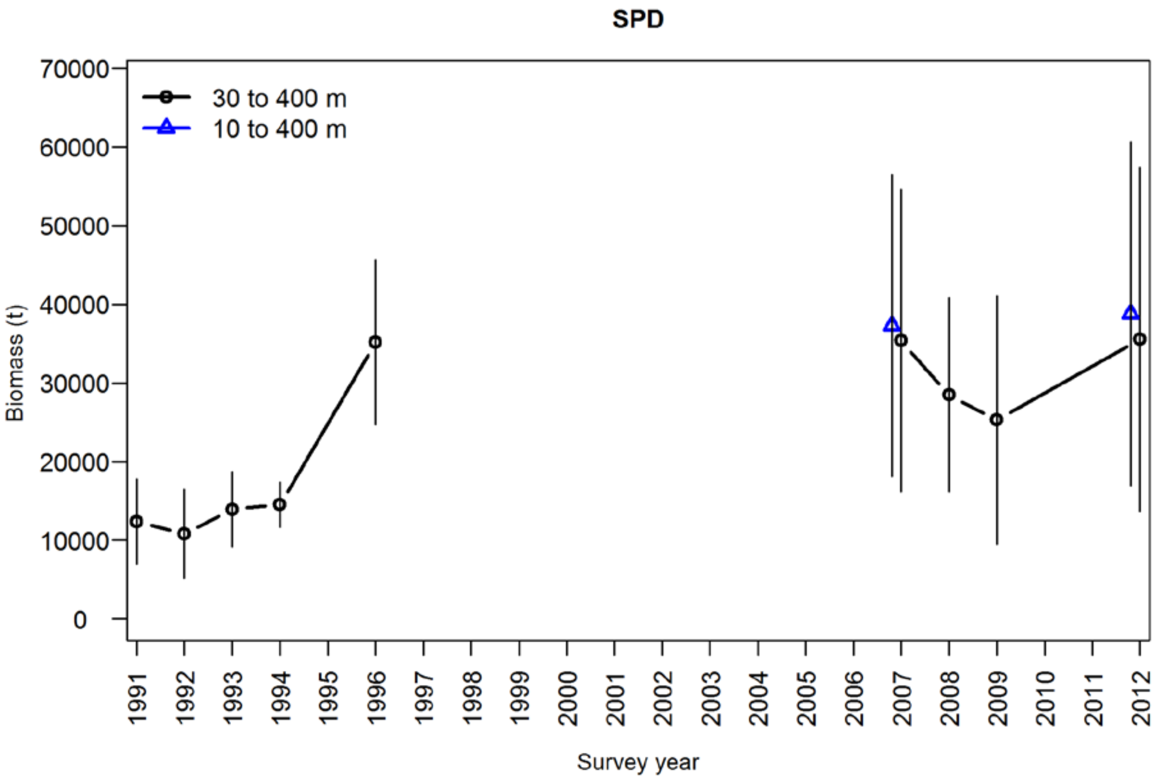


Figure 7 – ***continued***



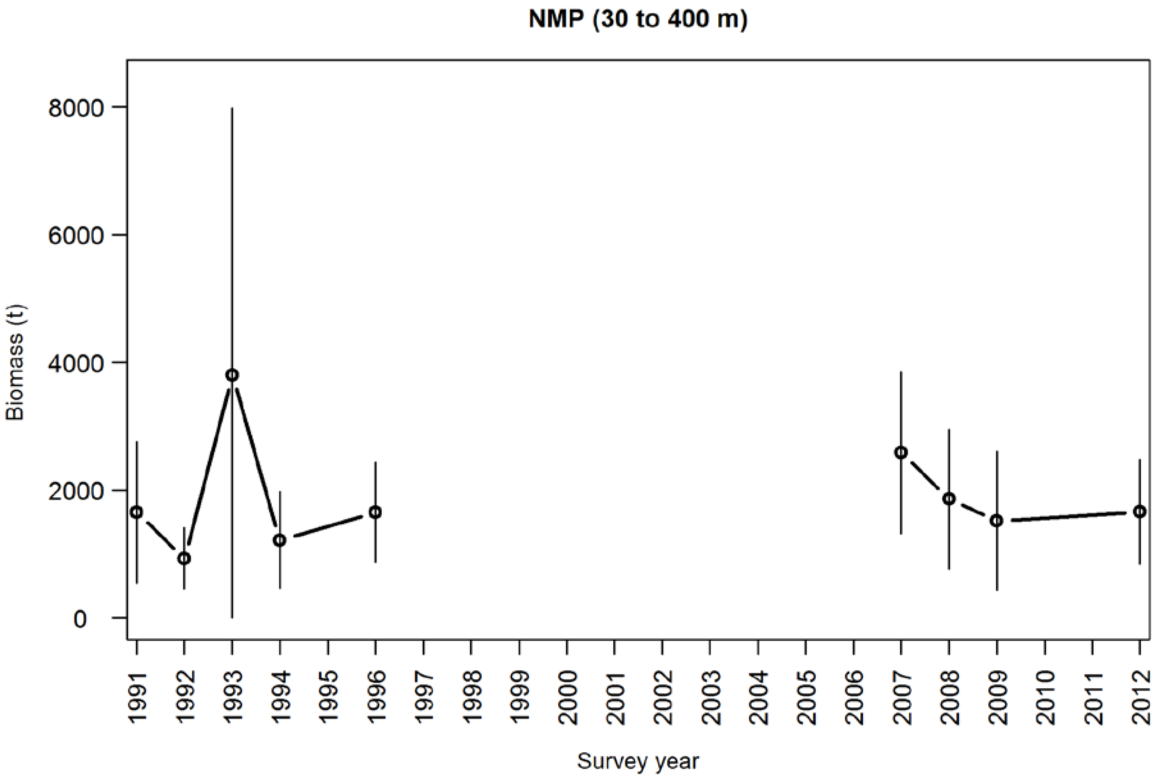


Figure 7 – ***continued***

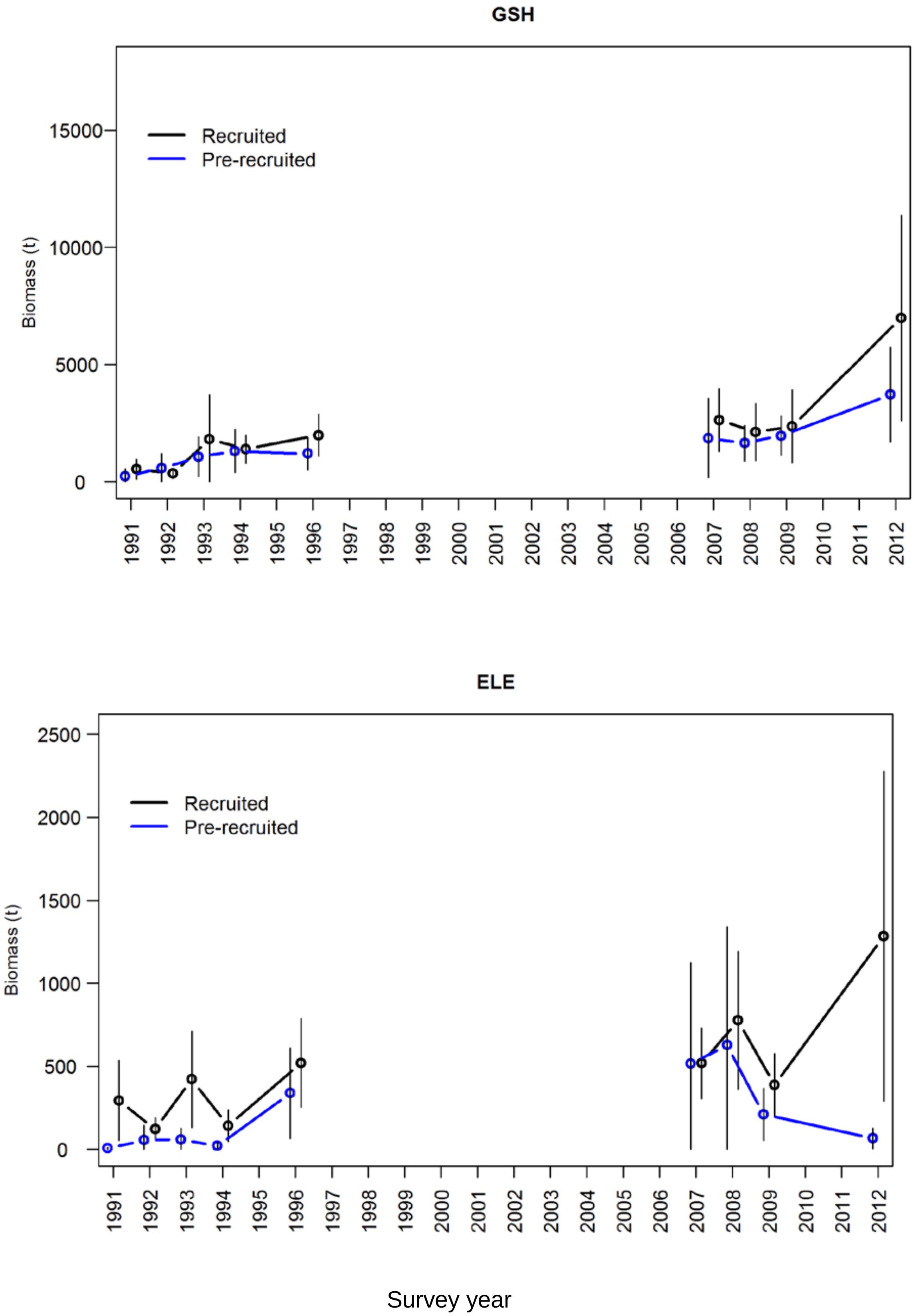
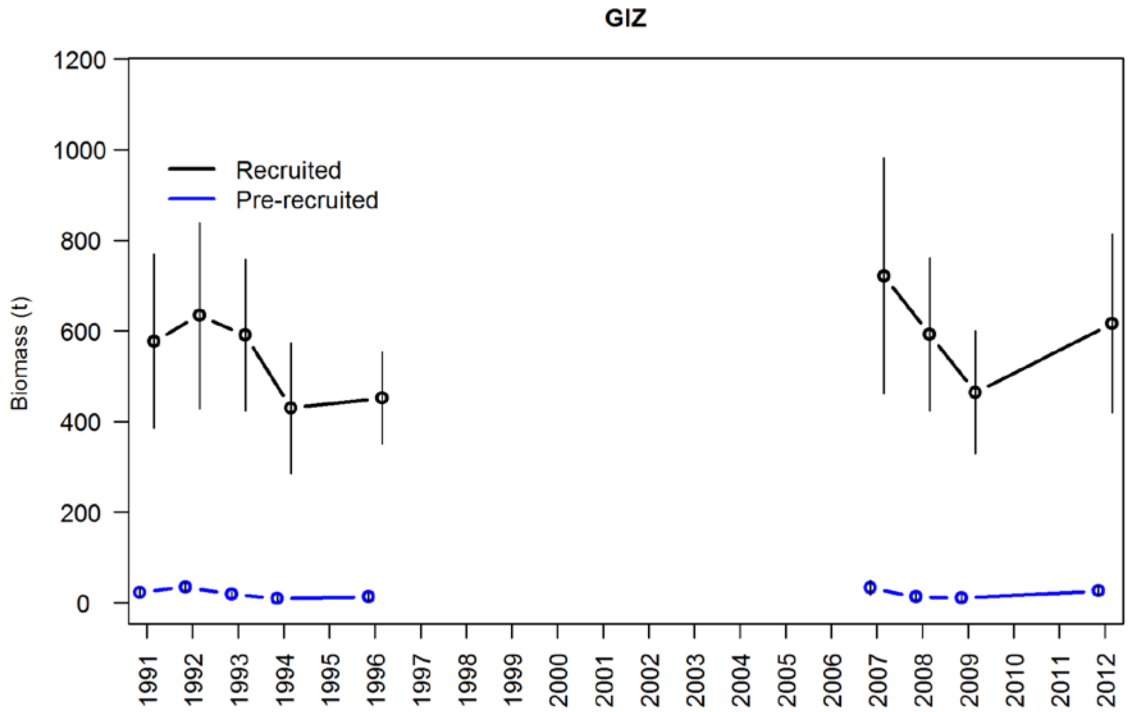


Figure 8: Target species recruited and pre-recruited biomass and 95% confidence intervals for all ECSI winter surveys in core strata (30–400 m).



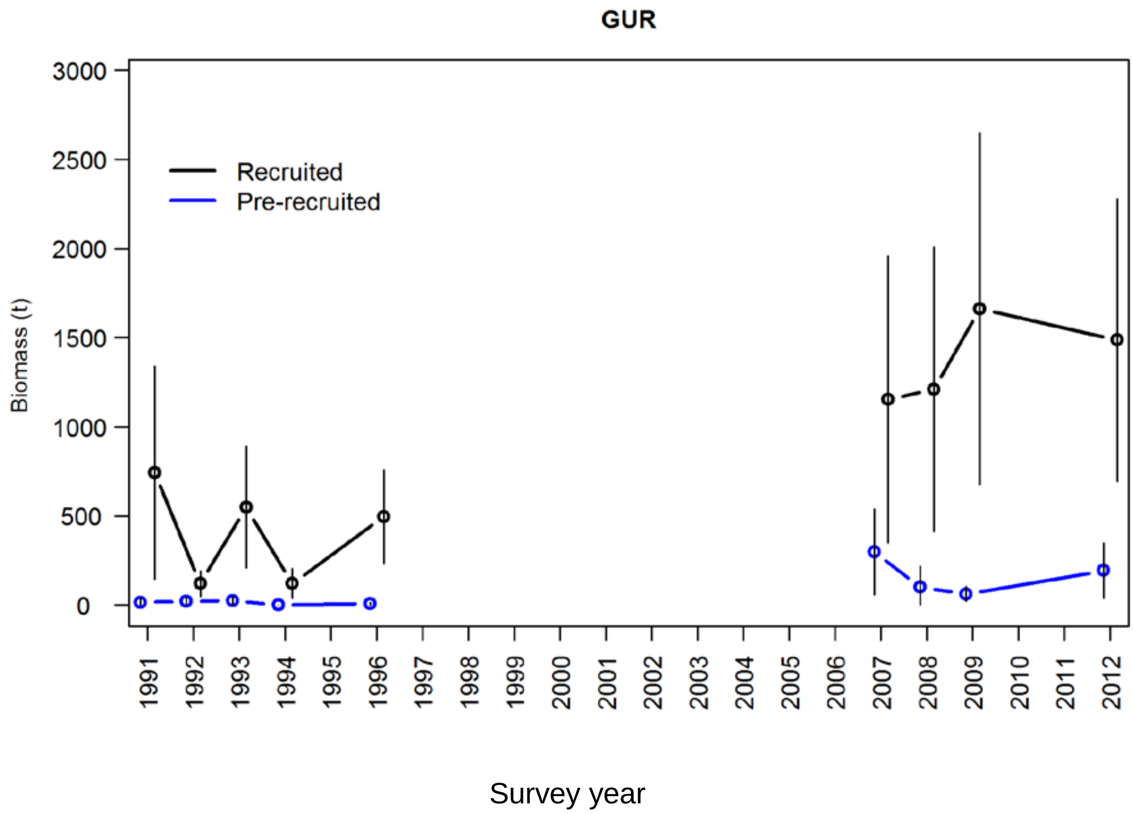


Figure 8 – ***continued***

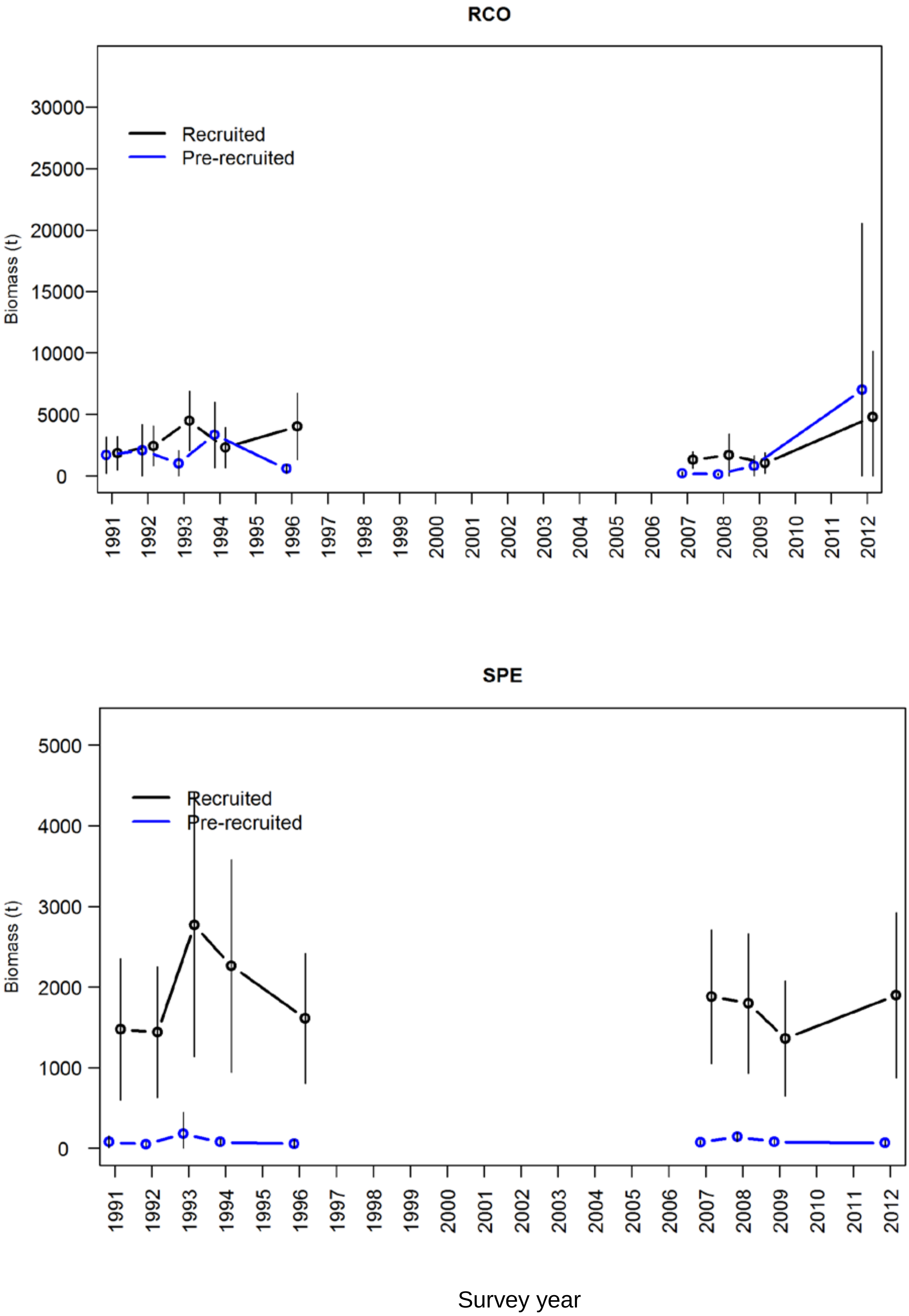
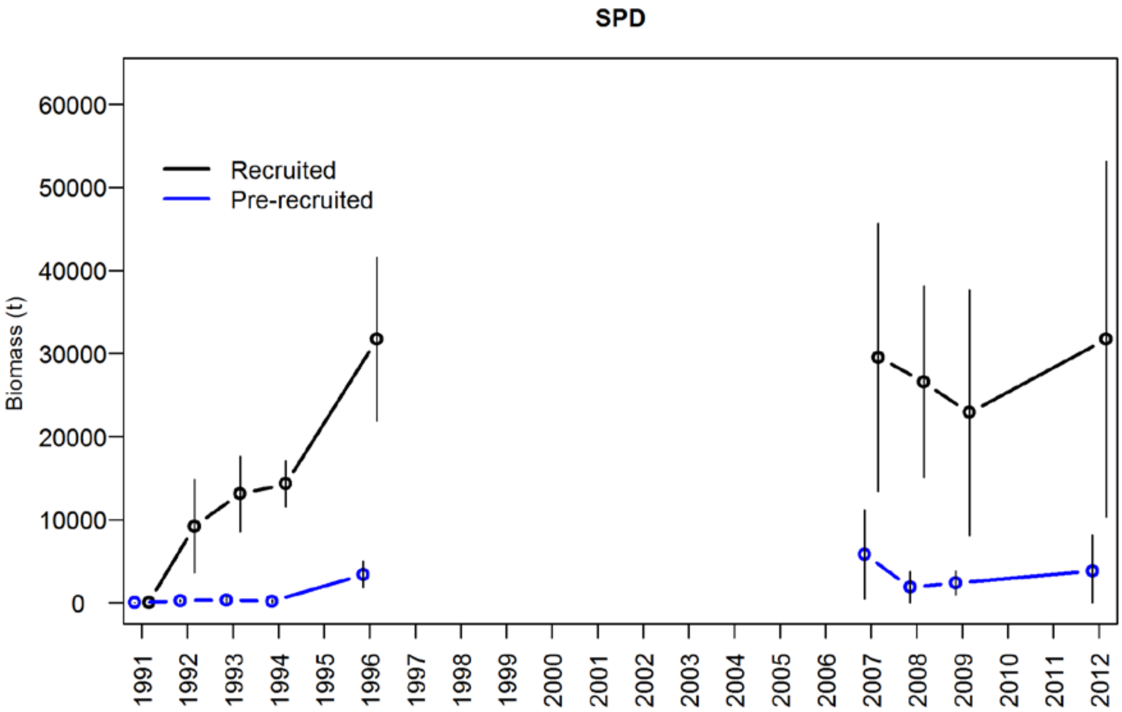
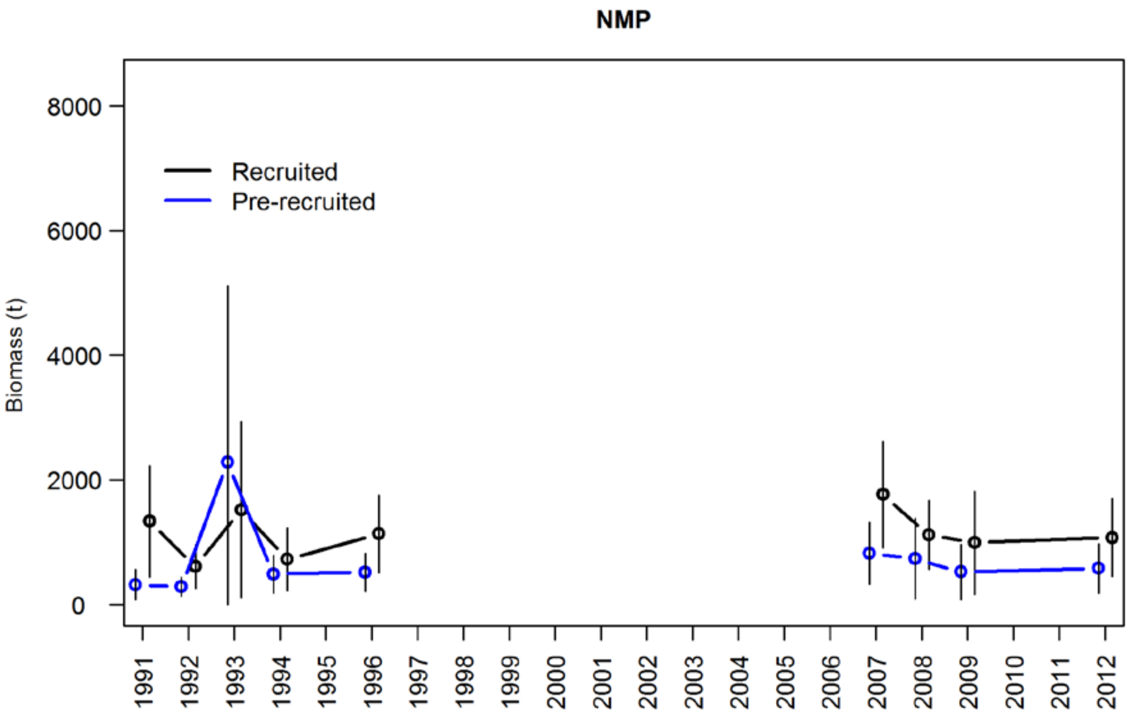


Figure 8 – *continued*





Survey year

Figure 8 – ***continued***

Survey year

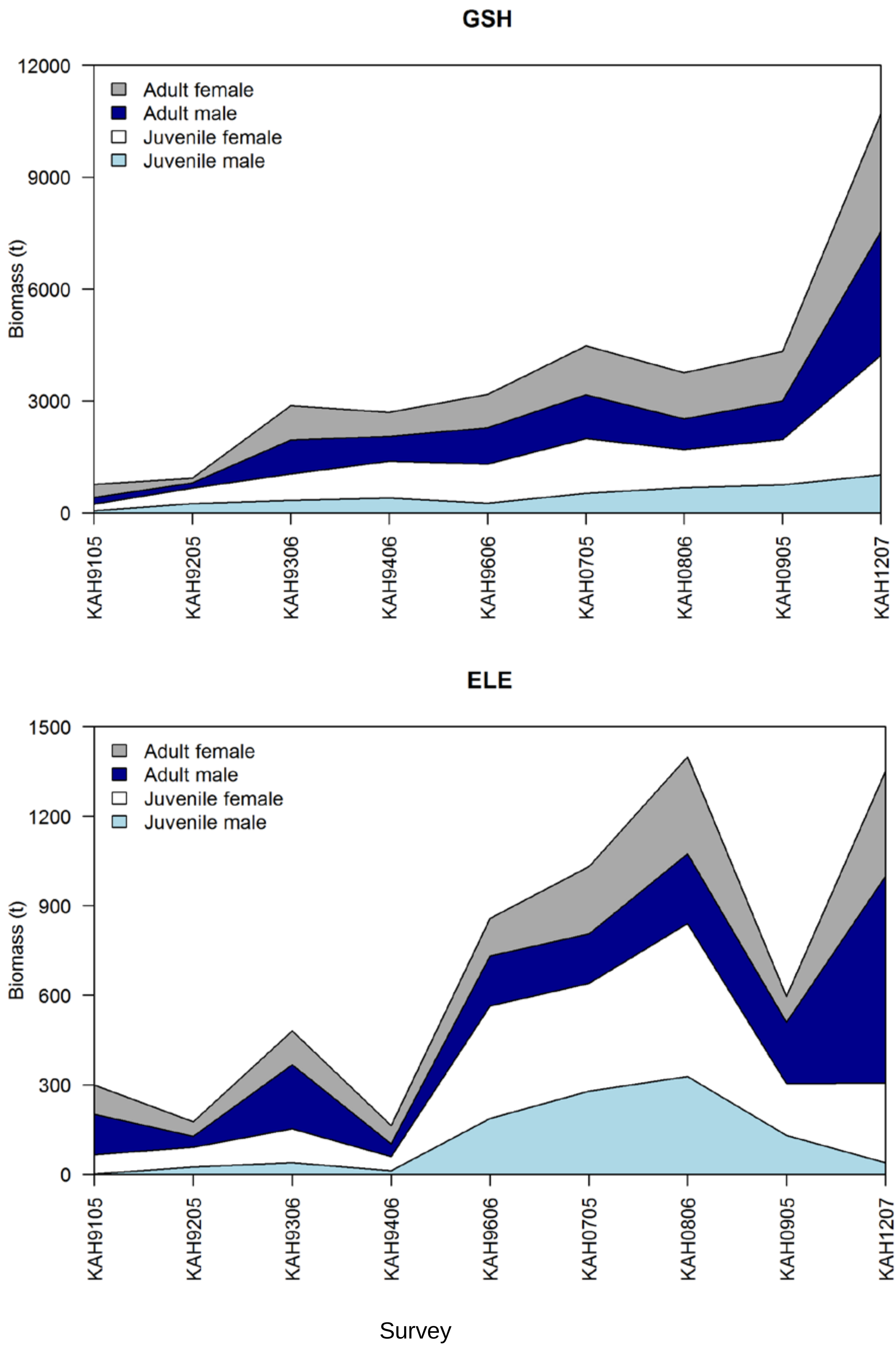
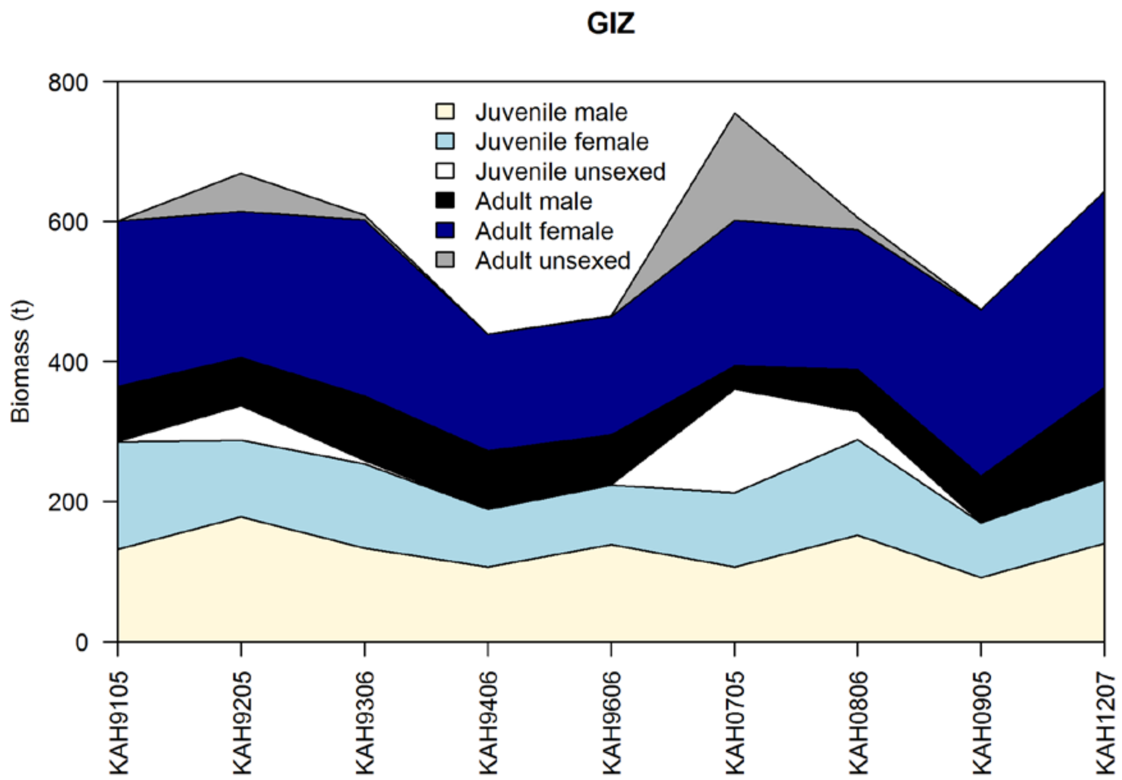


Figure 9: Target species juvenile and adult biomass for ECSI winter surveys in core strata (30–400 m), where juvenile is below and adult is equal to or above length at which 50% of fish are mature.



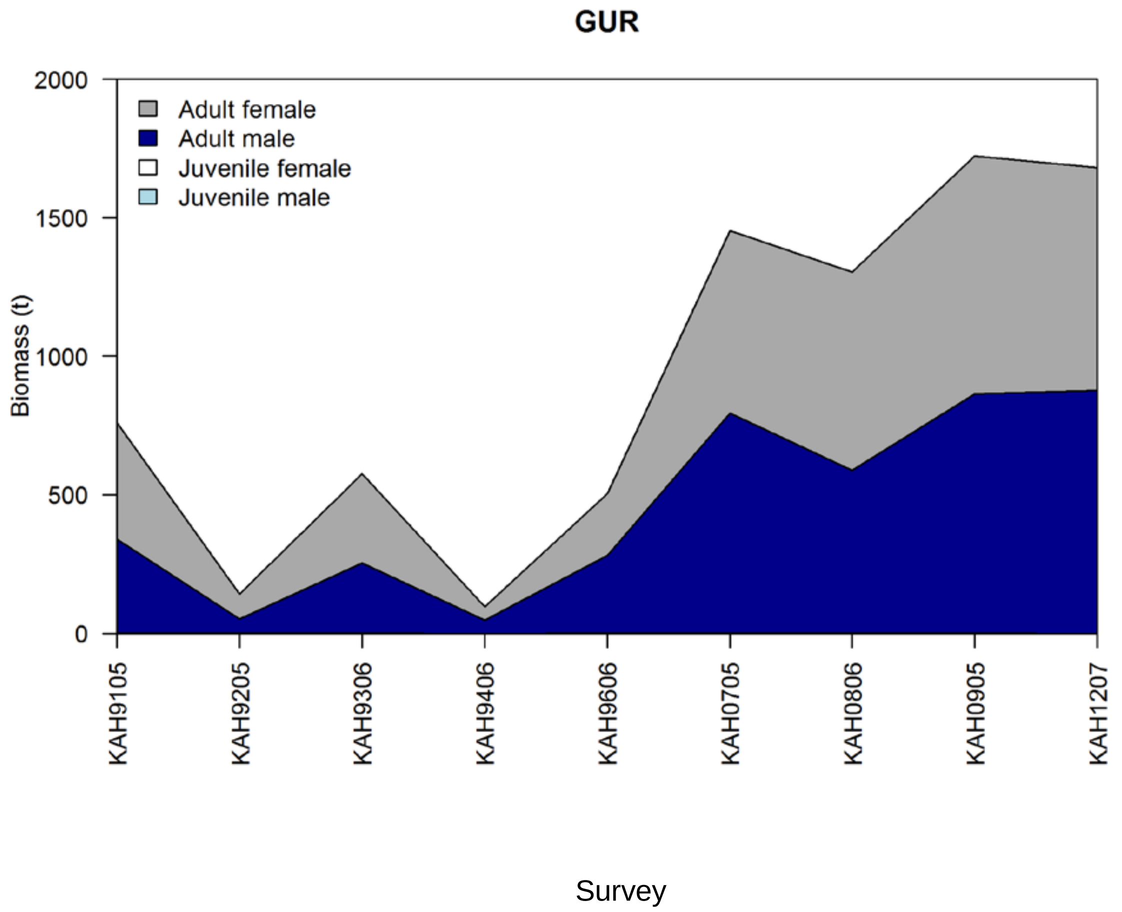
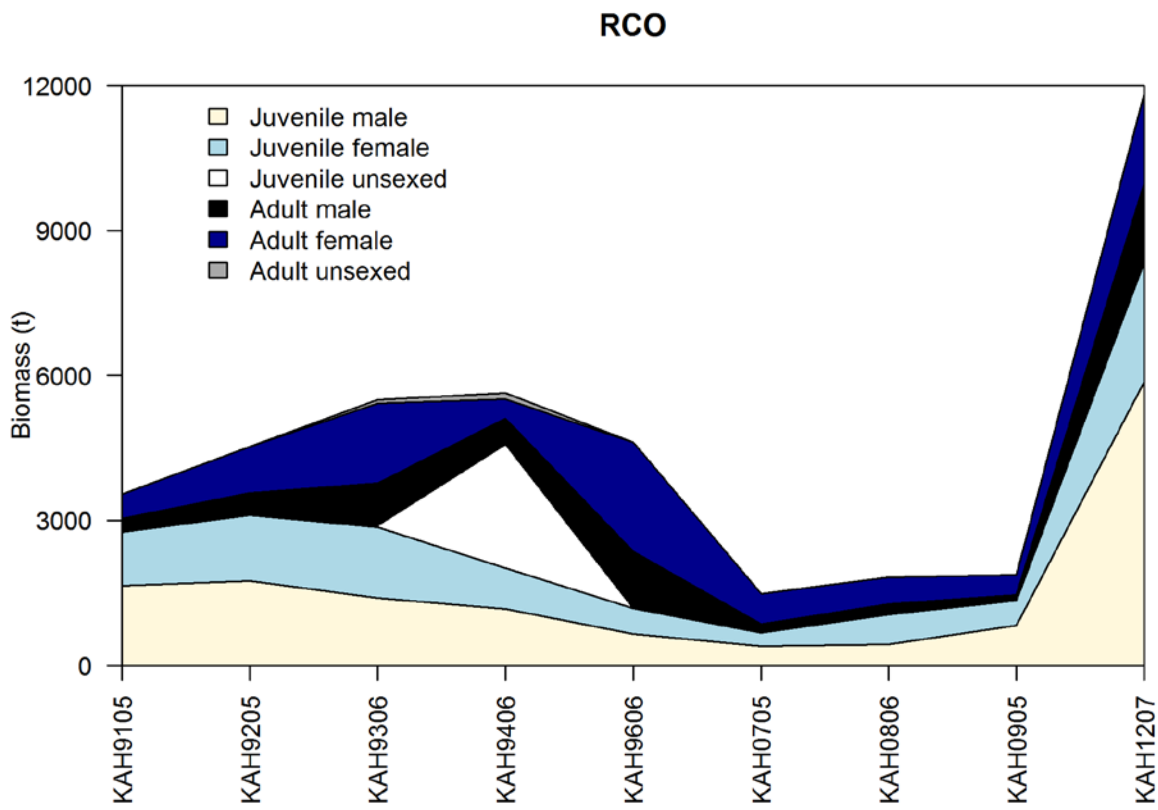


Figure 9 – ***continued***



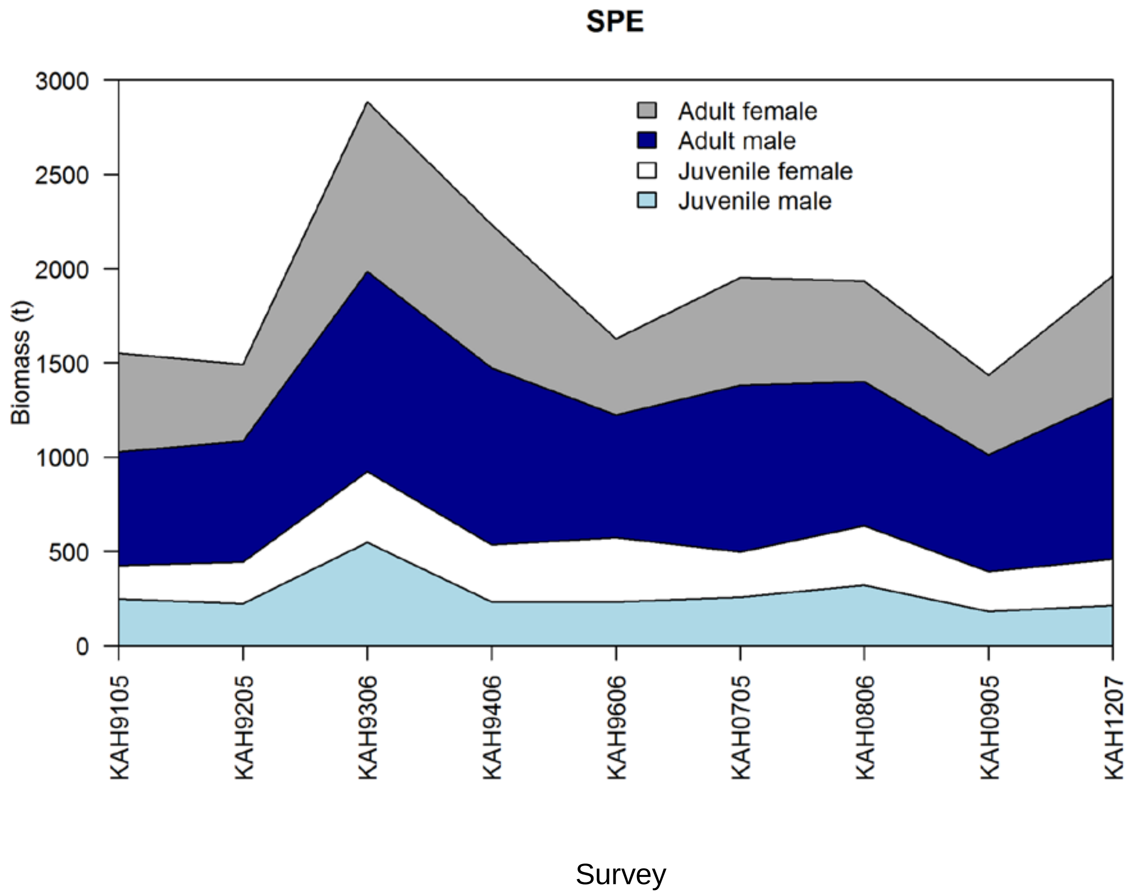
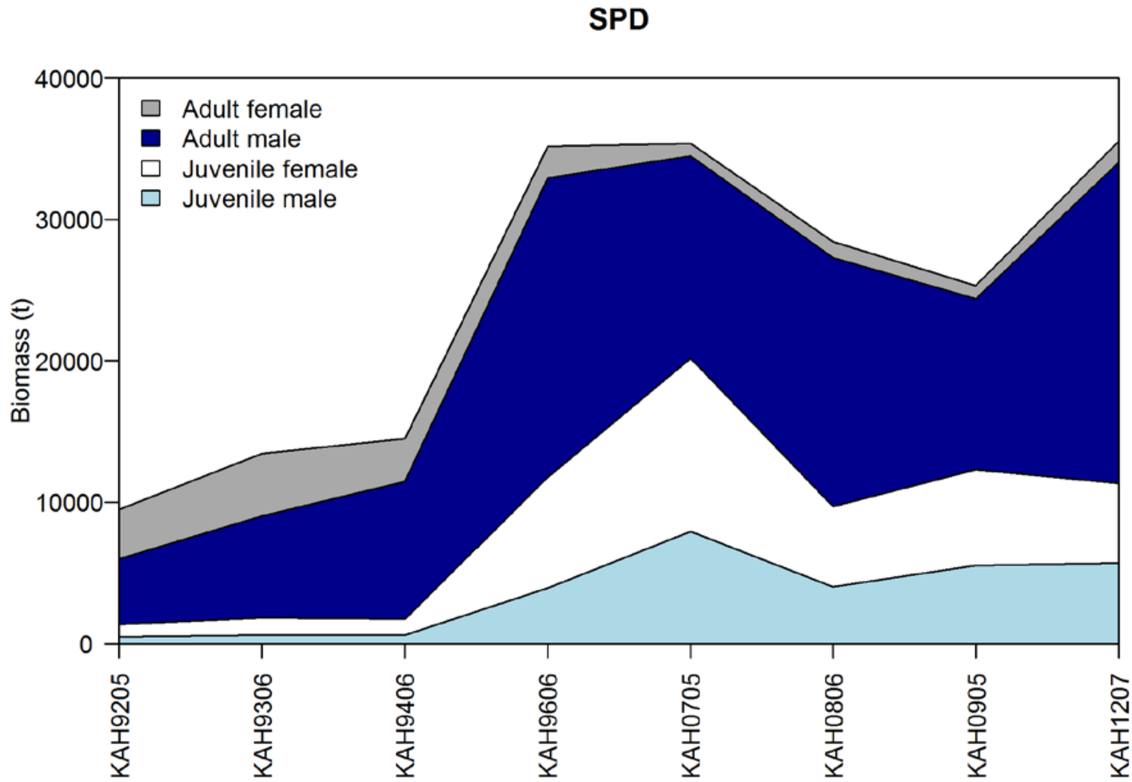


Figure 9 – ***continued***



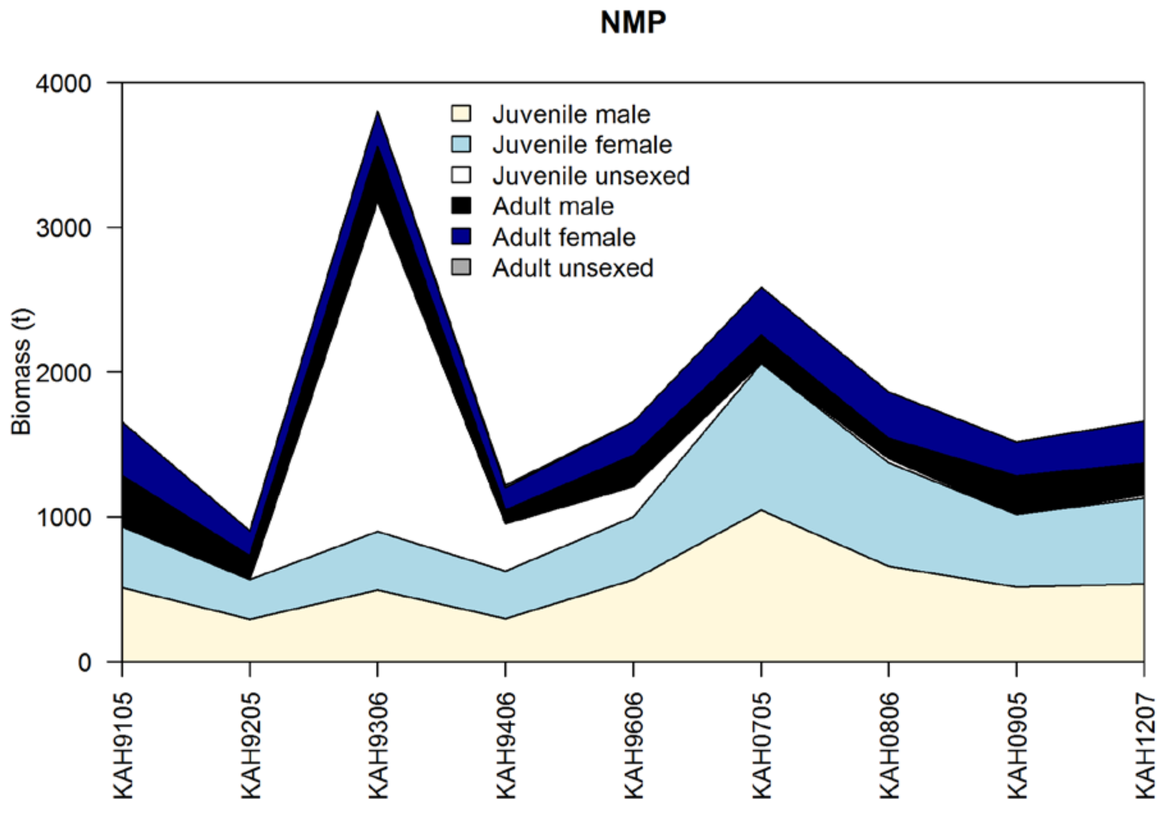


Figure 9 – *continued*.

Dark ghost shark (1991 to 1996)

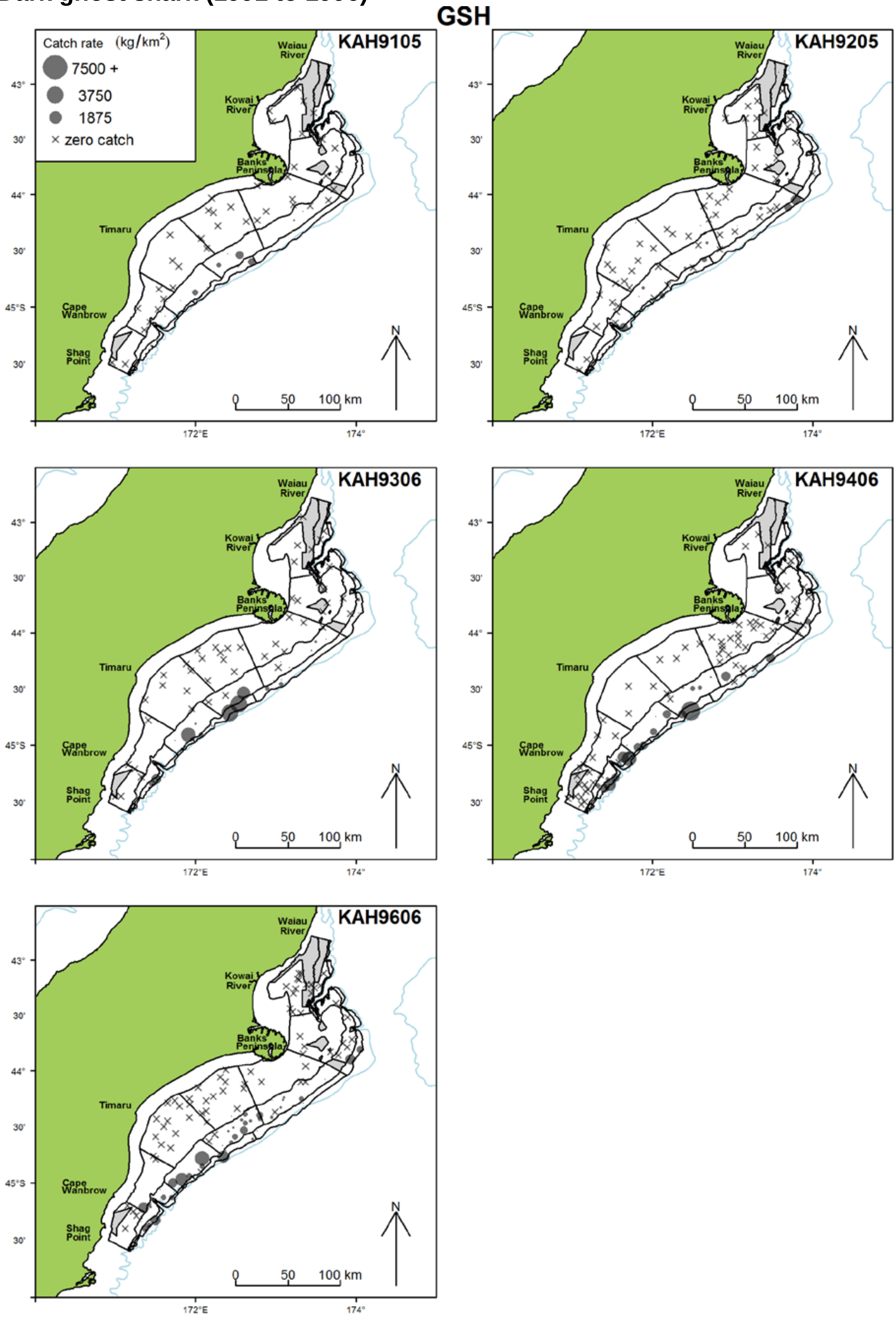


Figure 10: Target species catch rates (kg.km^{-2}) by tow plotted for the nine ECSI winter trawl surveys.

Dark ghost shark (2007 to 2012)

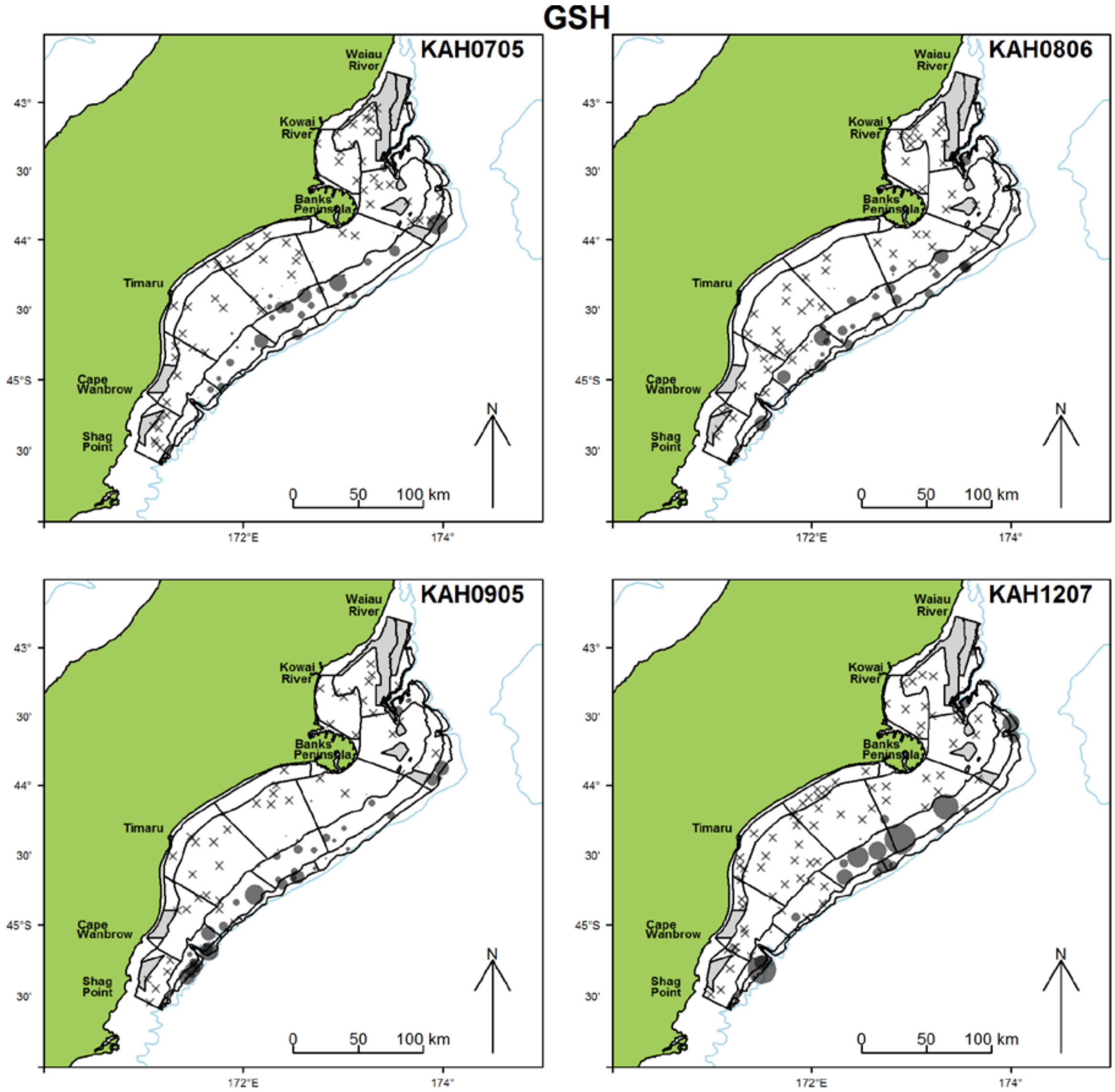


Figure 10 – ***continued***

Elephantfish (1991 to 1996)

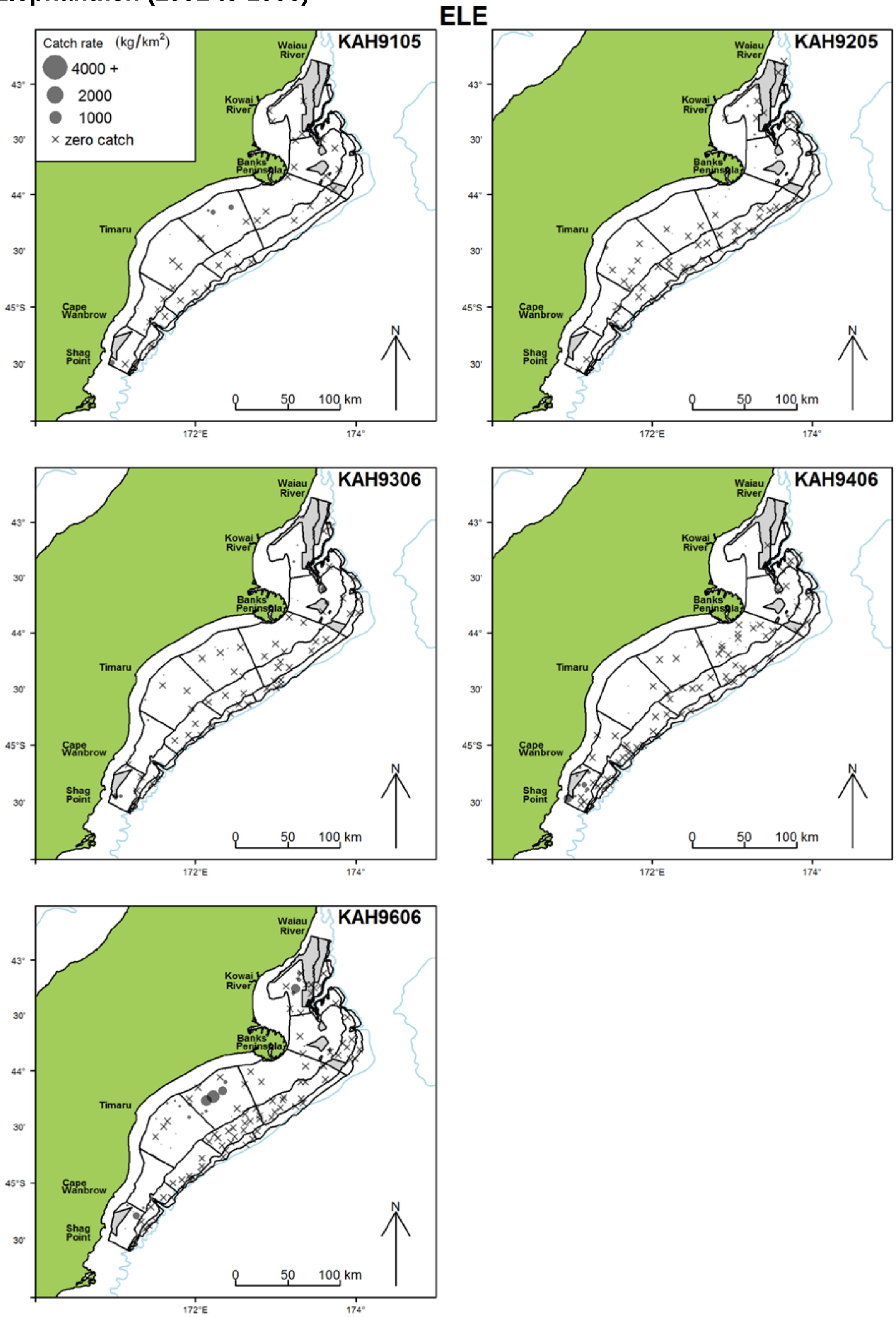


Figure 10 – ***continued***

Elephantfish (2007 to 2012)

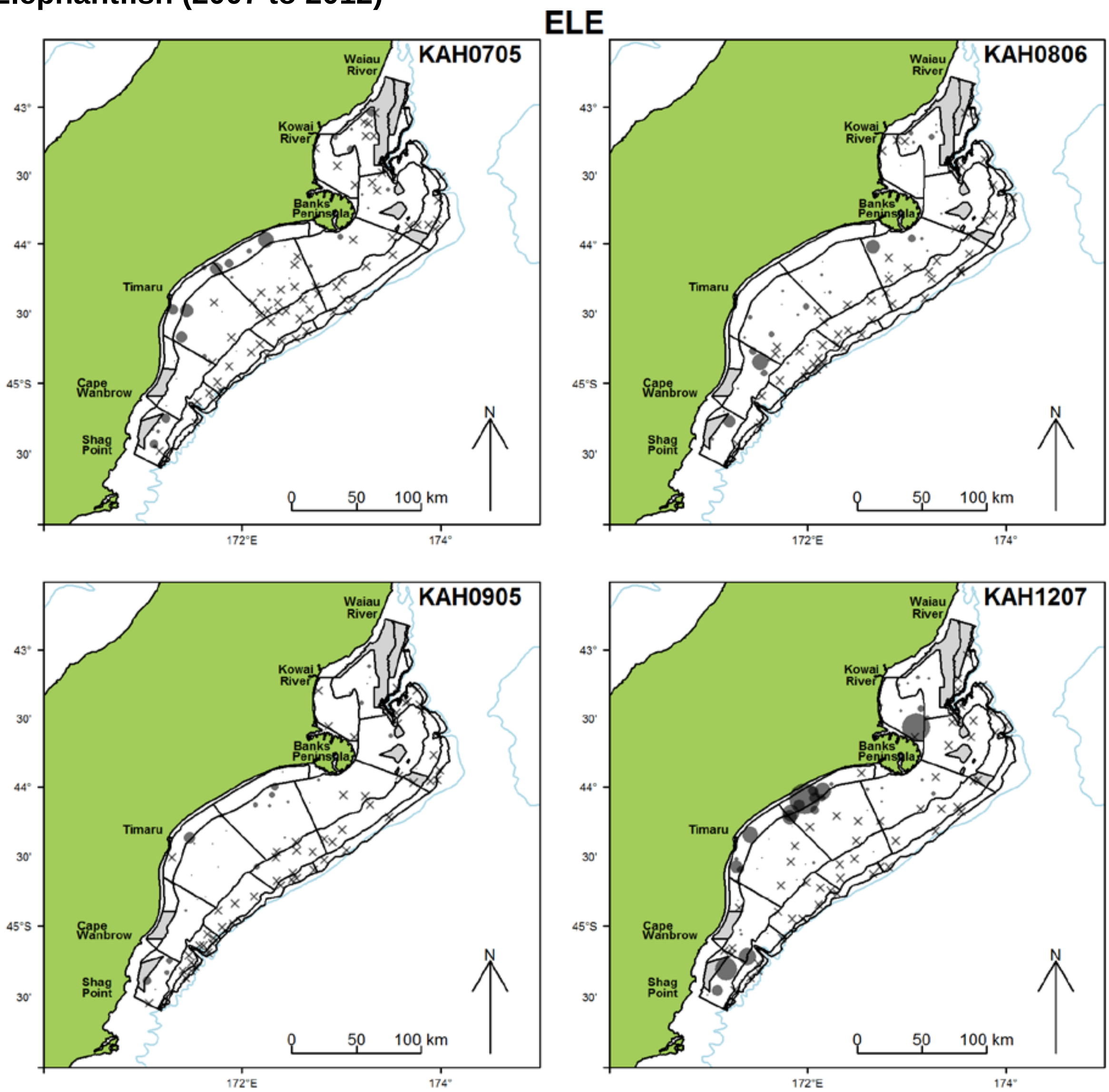


Figure 10 – ***continued***

Giant stargazer (1991 to 1996)

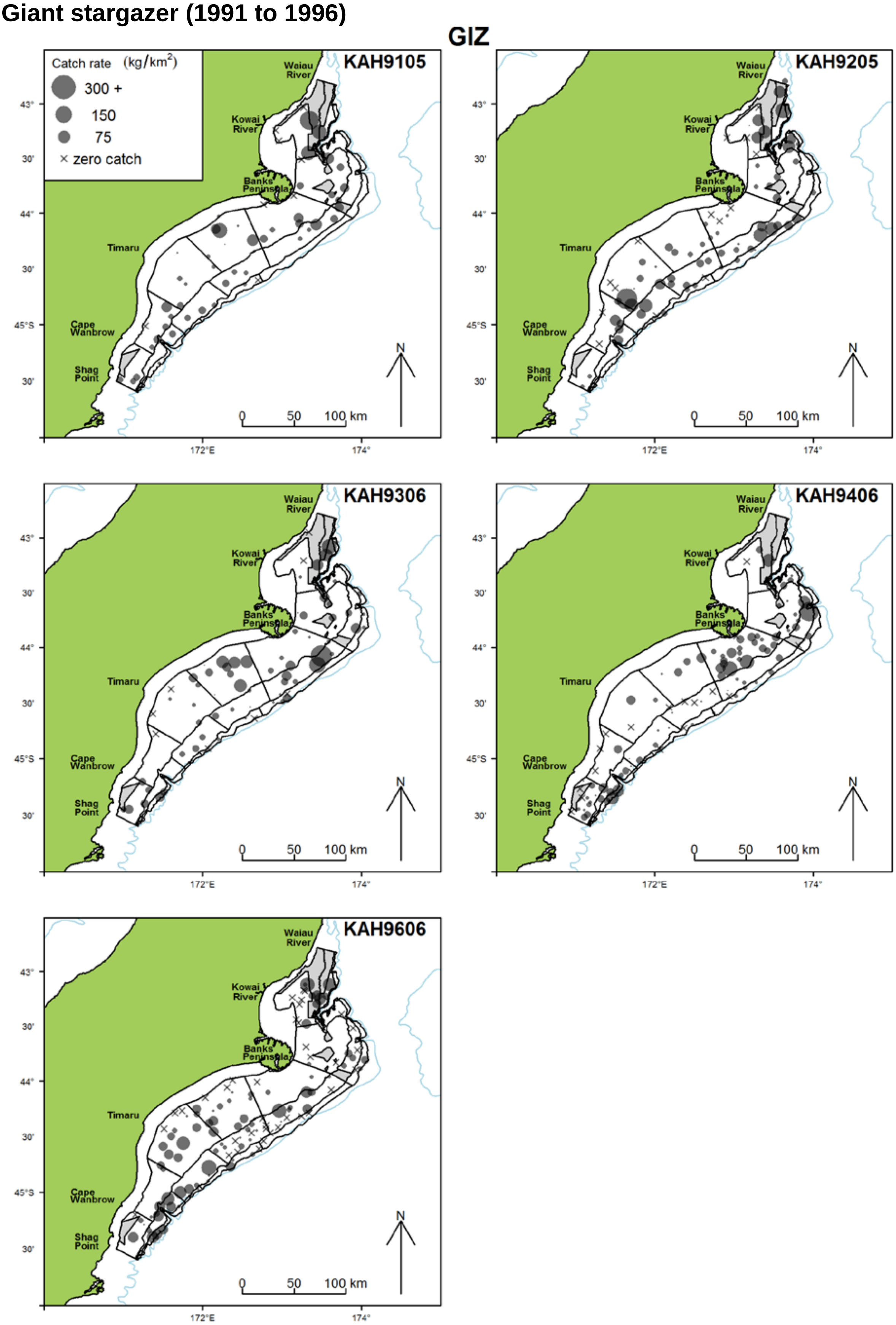


Figure 10 – ***continued***

Giant stargazer (2007 to 2012)

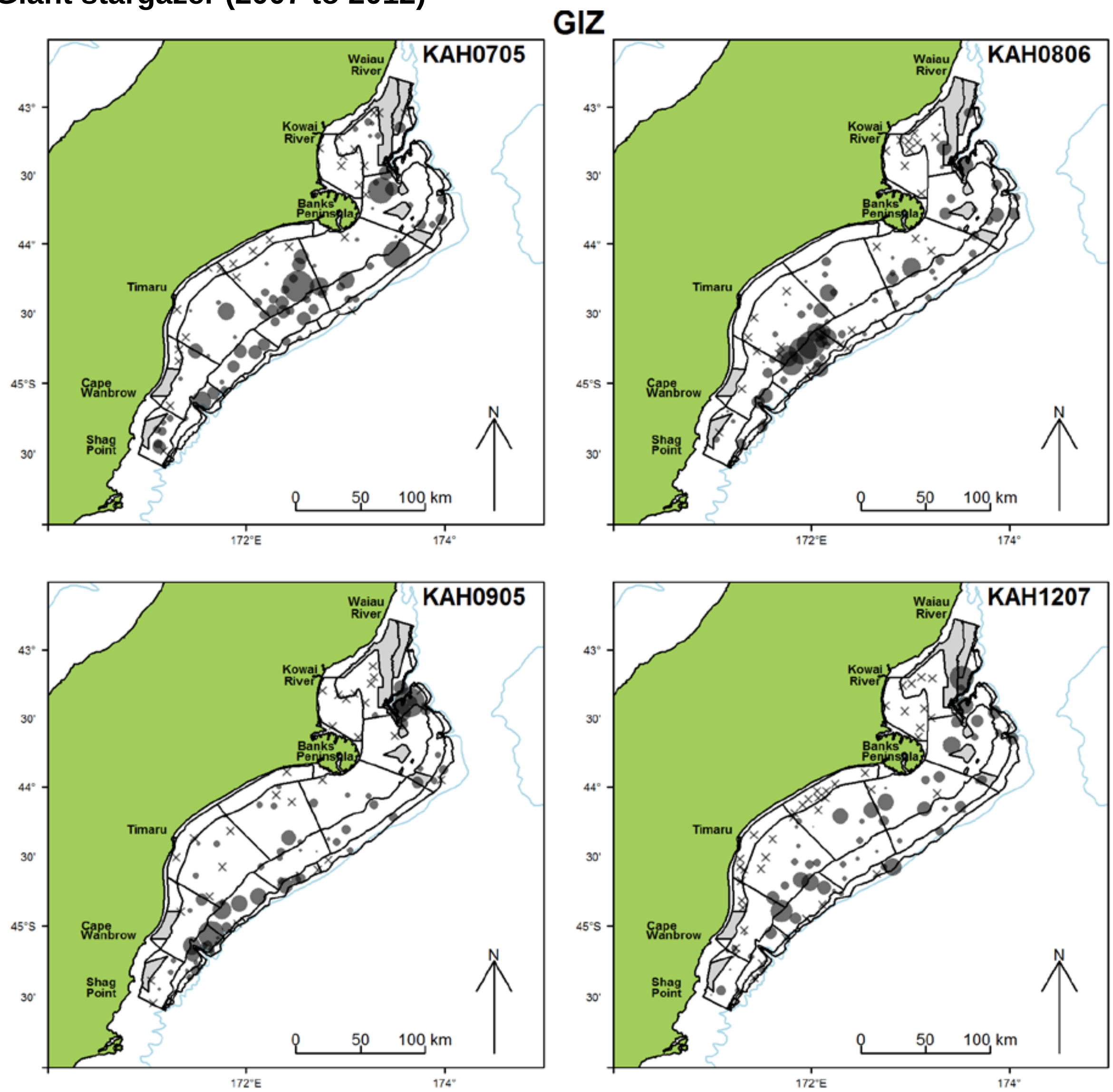


Figure 10 – ***continued***

Red gurnard (1996 to 1996)

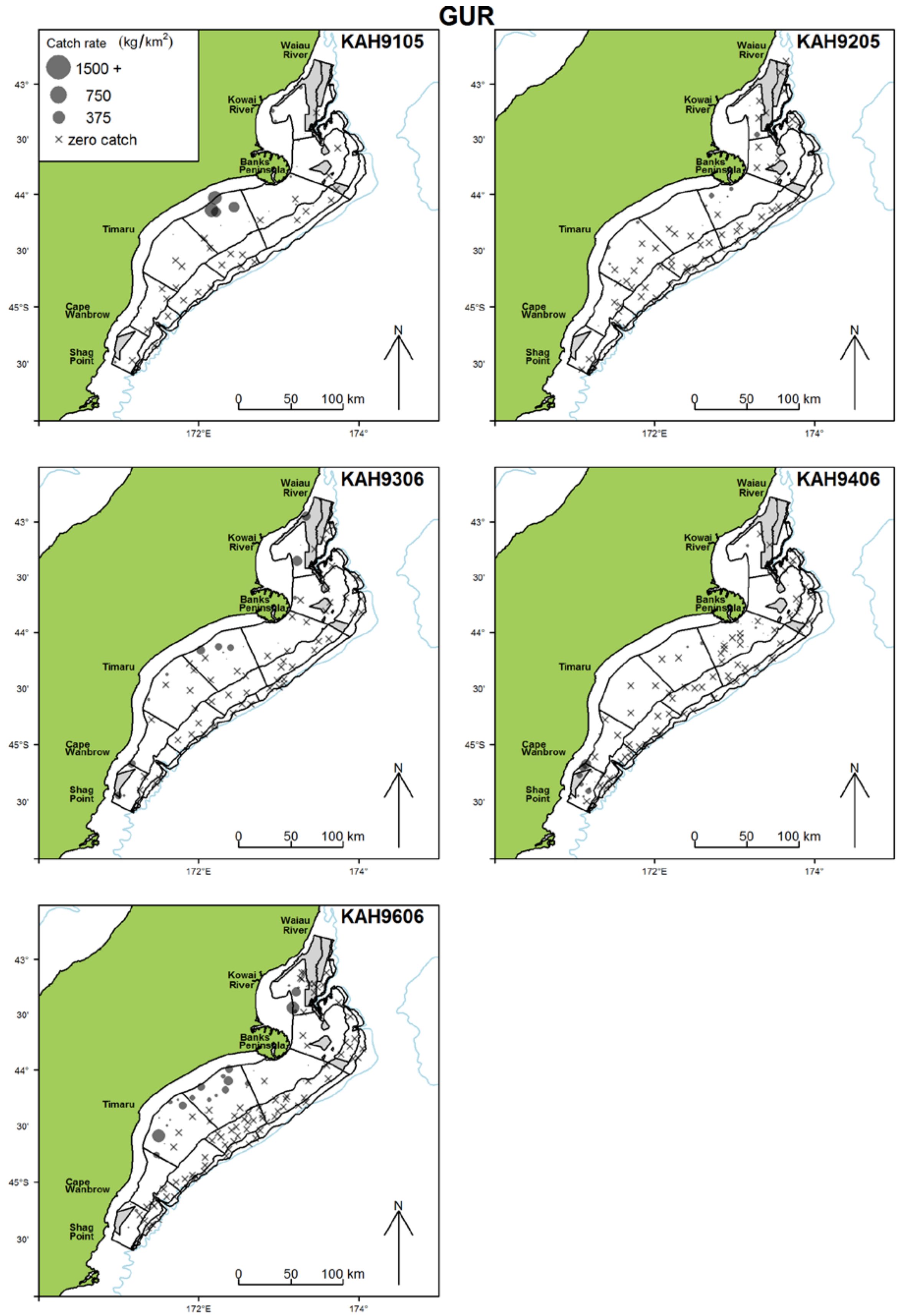


Figure 10 – *continued*

Red gurnard (2007 to 2012)

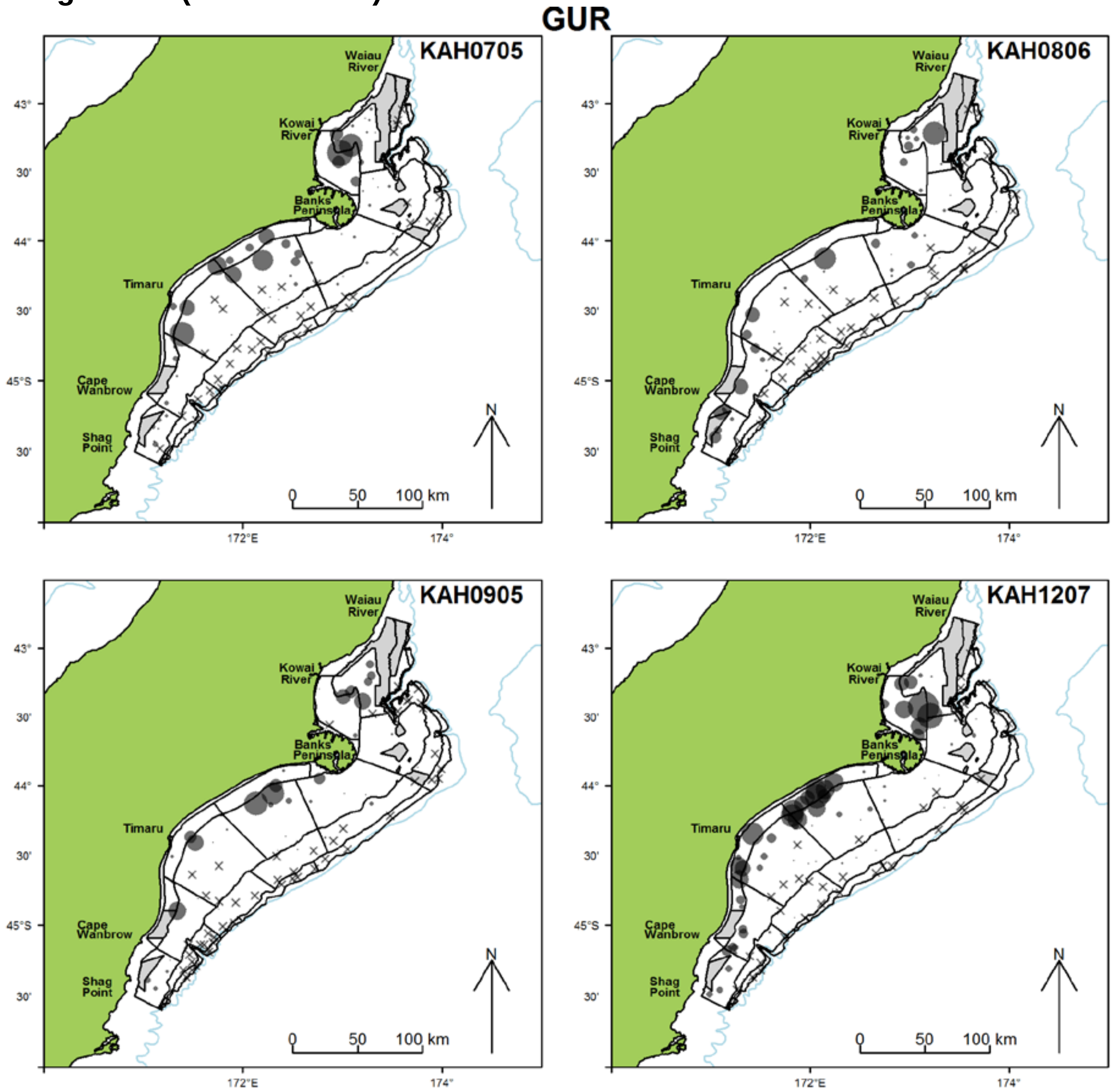


Figure 10 – ***continued***

Red cod (1991–1996)

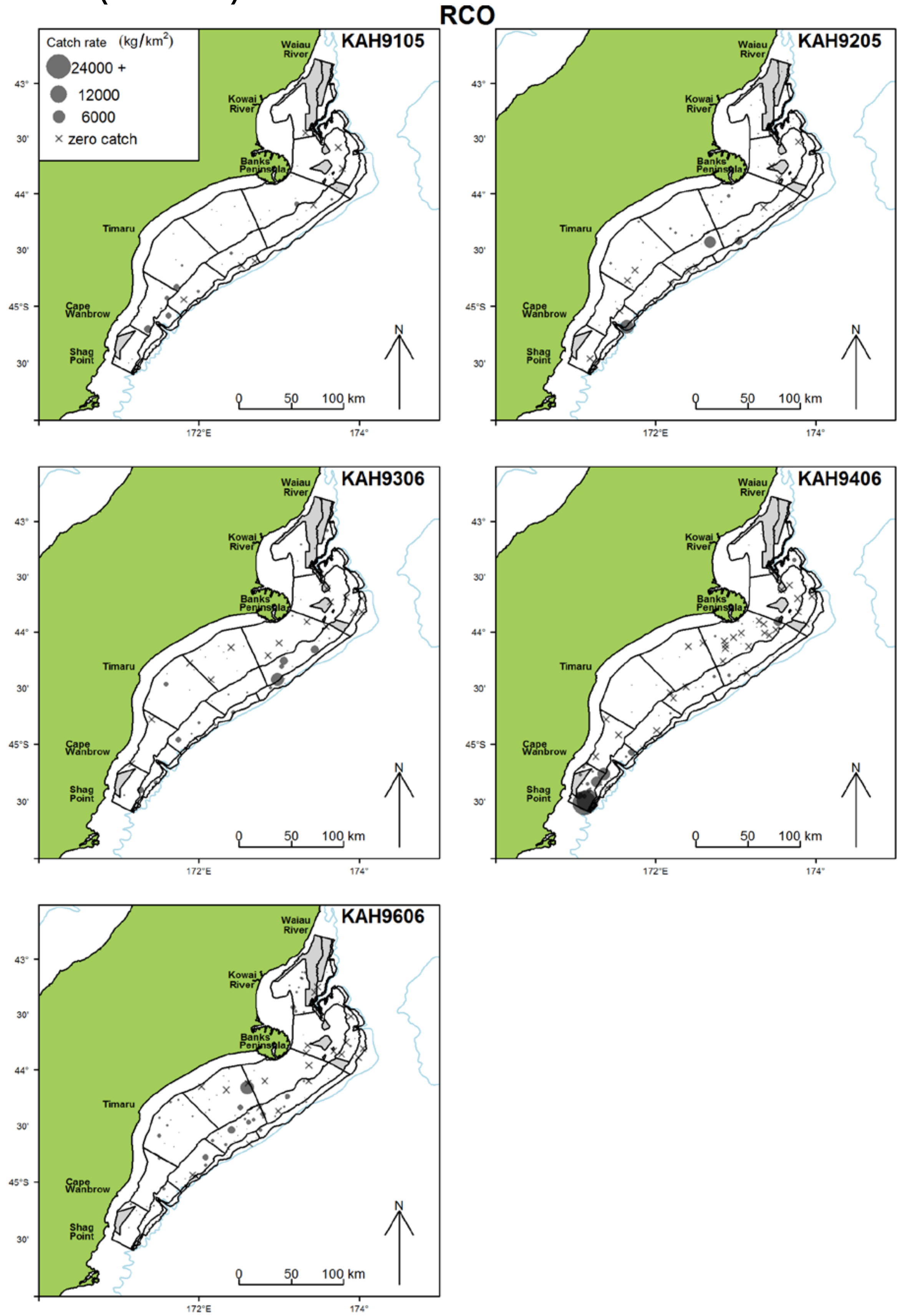


Figure 10 – ***continued***

Red cod (2007 to 2012)

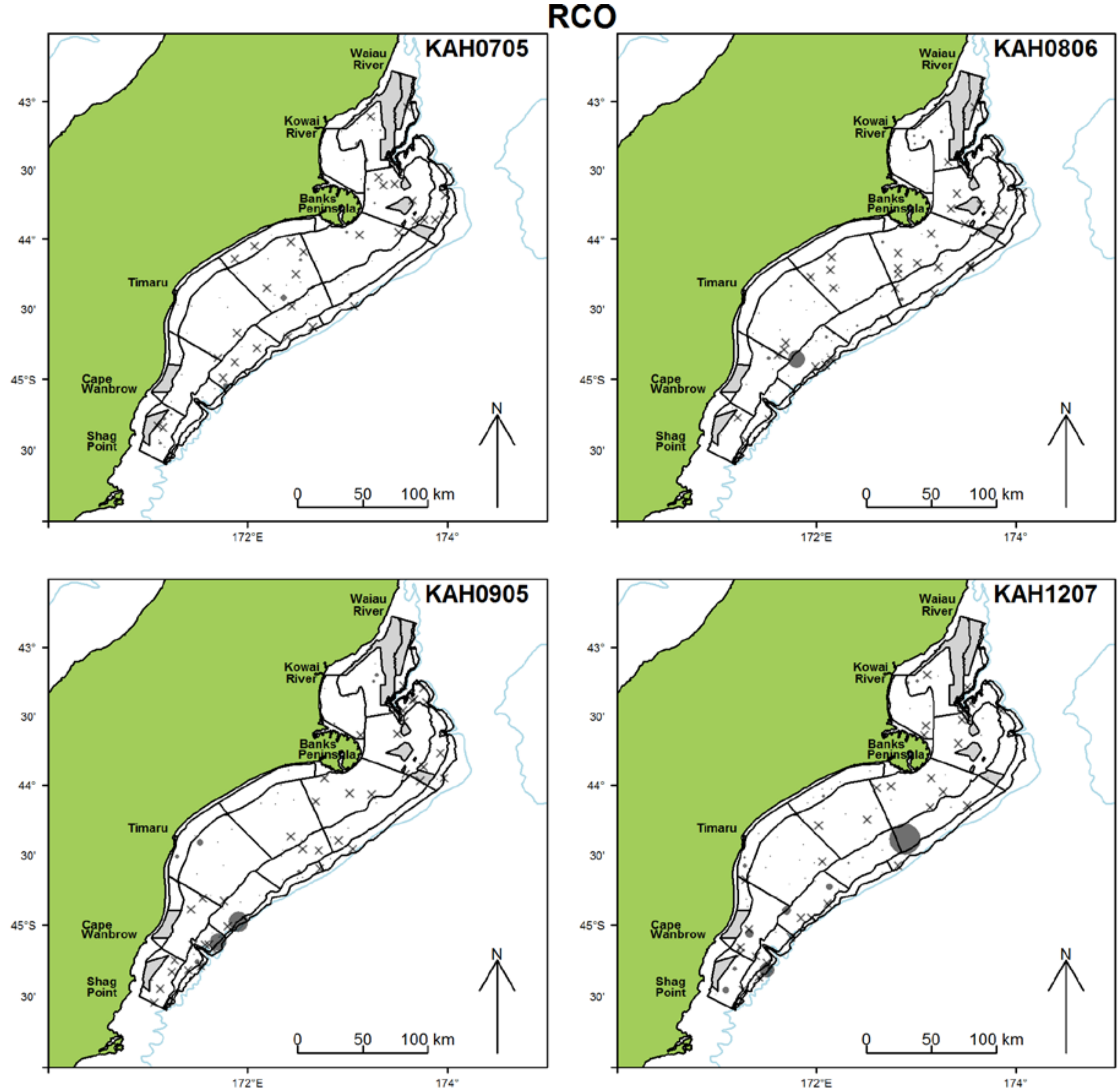


Figure 10 – *continued*

Sea perch (1991 to 1996)

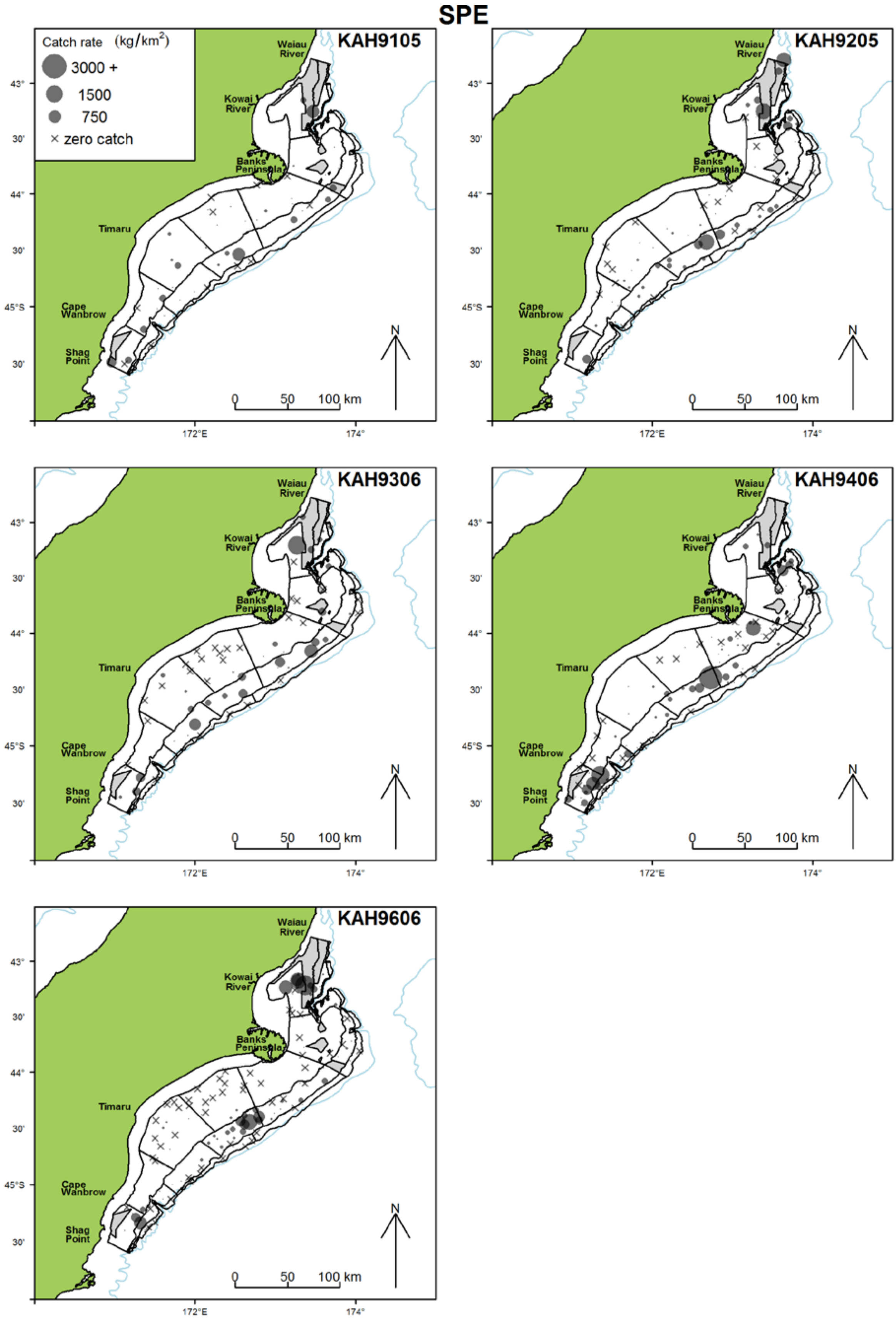


Figure 10 – ***continued***

Sea perch (2007 to 2012)

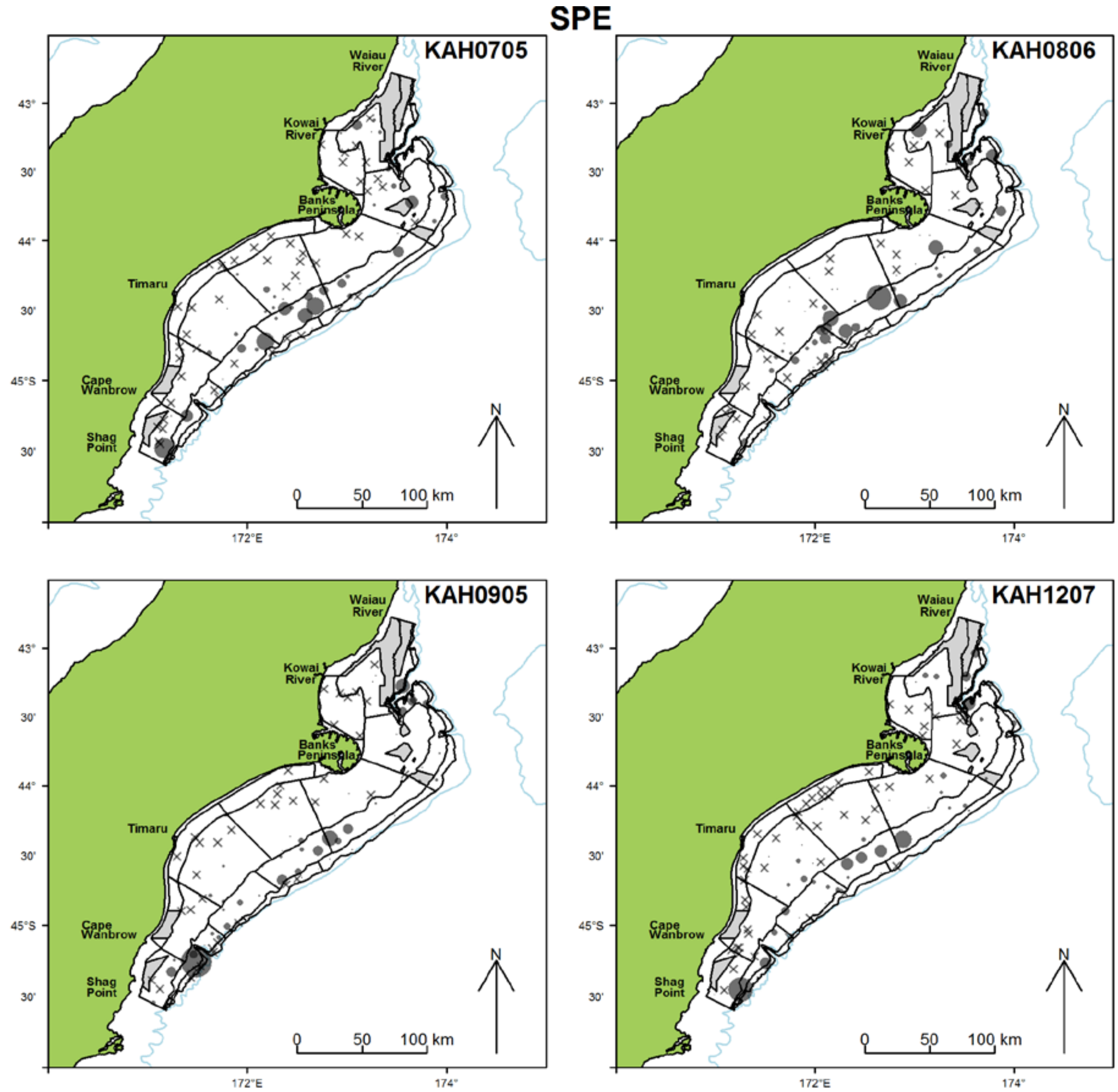


Figure 10 – *continued*

Spiny dogfish (1991 to 1996)

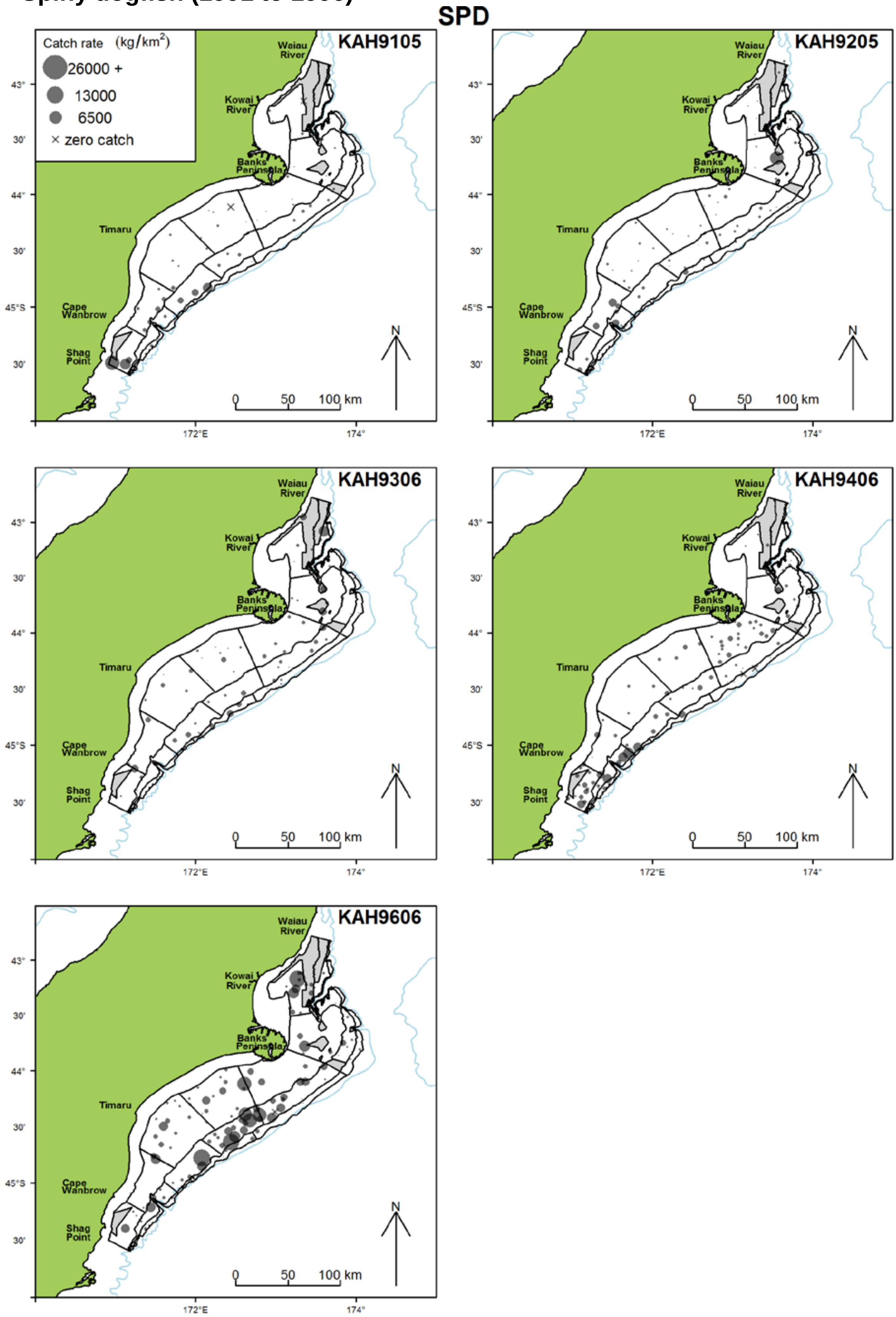


Figure 10 – ***continued***

Spiny dogfish (2007 to 2012)

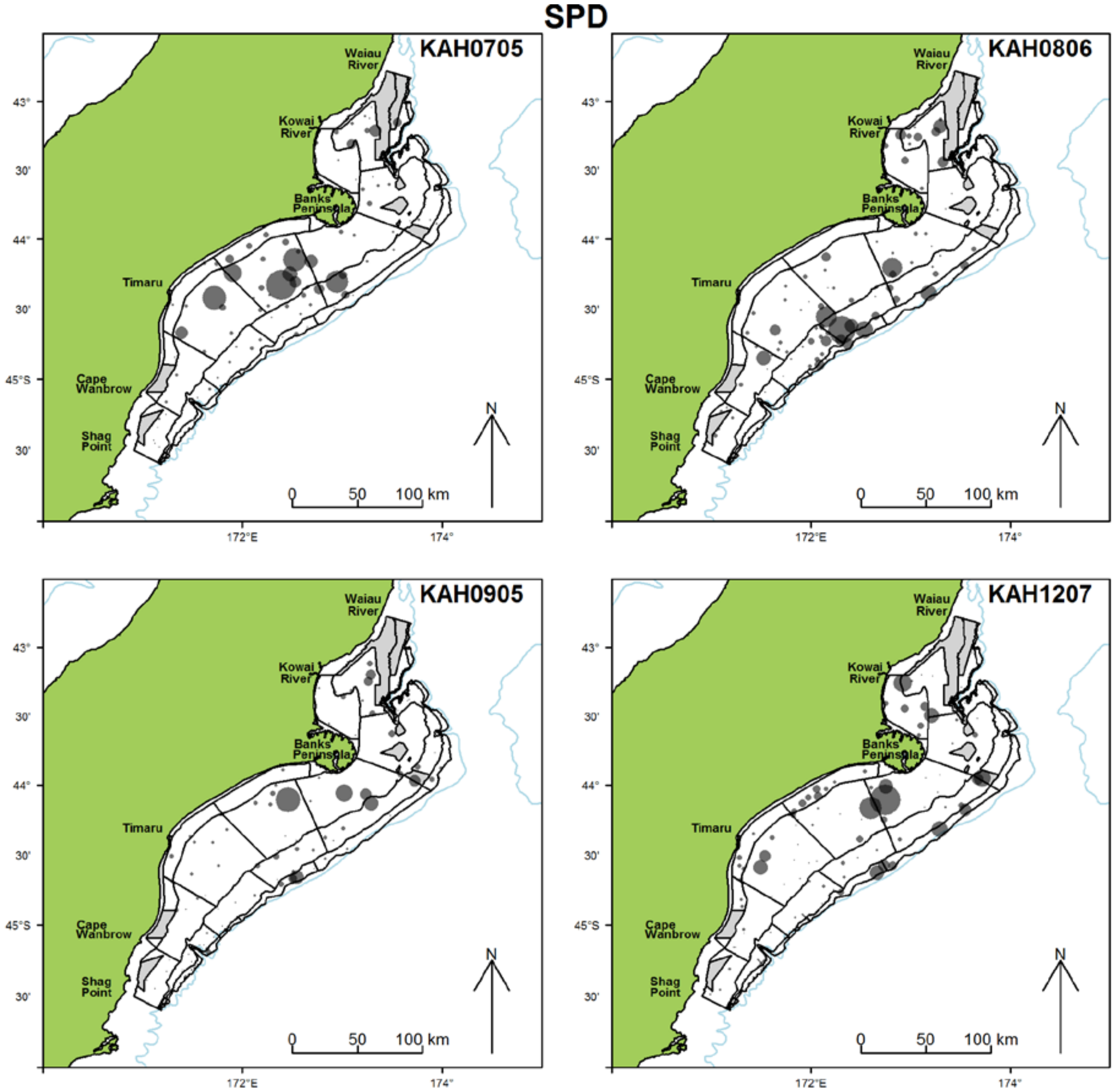


Figure 10 – ***continued***

Tarakihi (1991–1996)

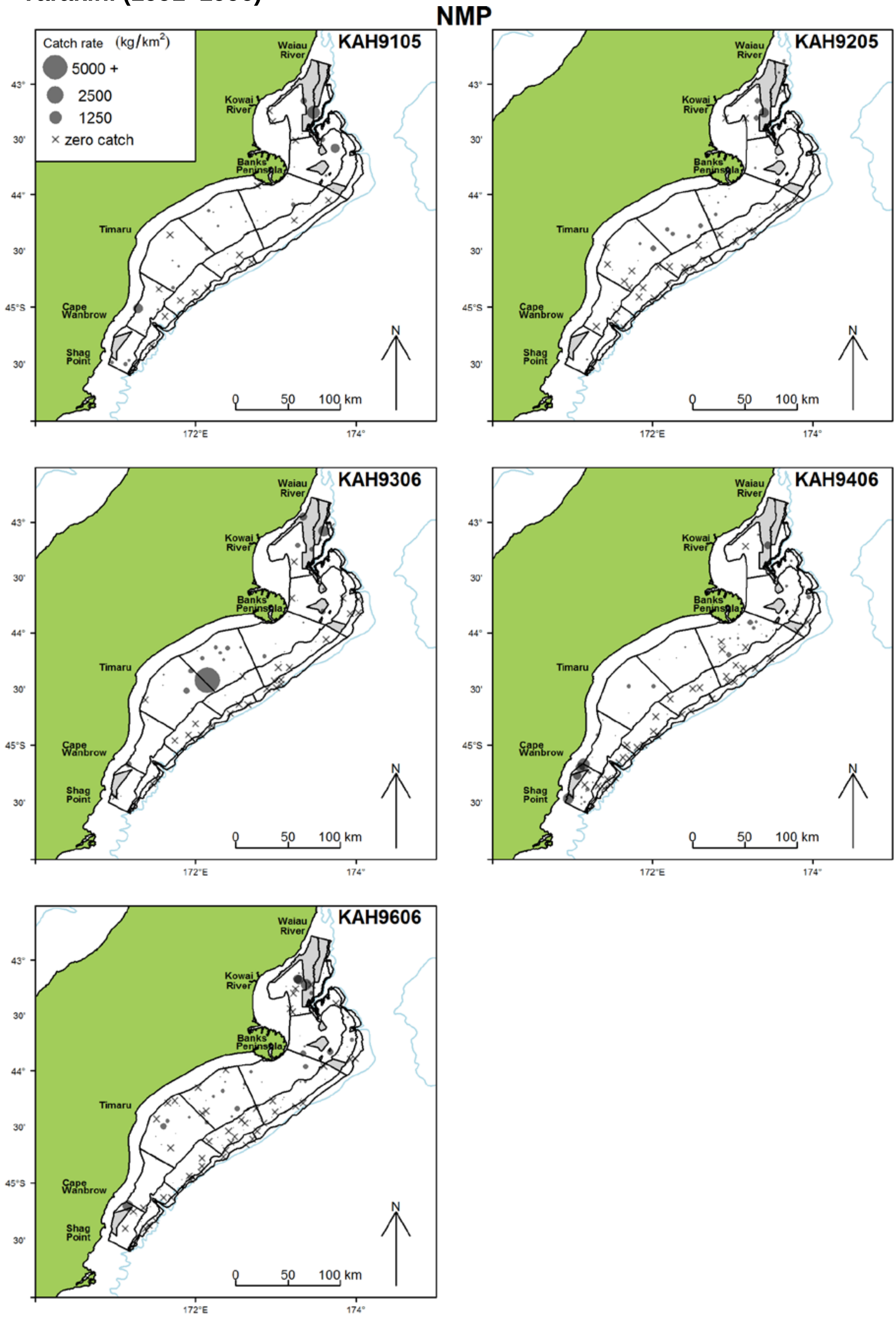


Figure 10 – *continued*

Tarakihi (2007–2012)

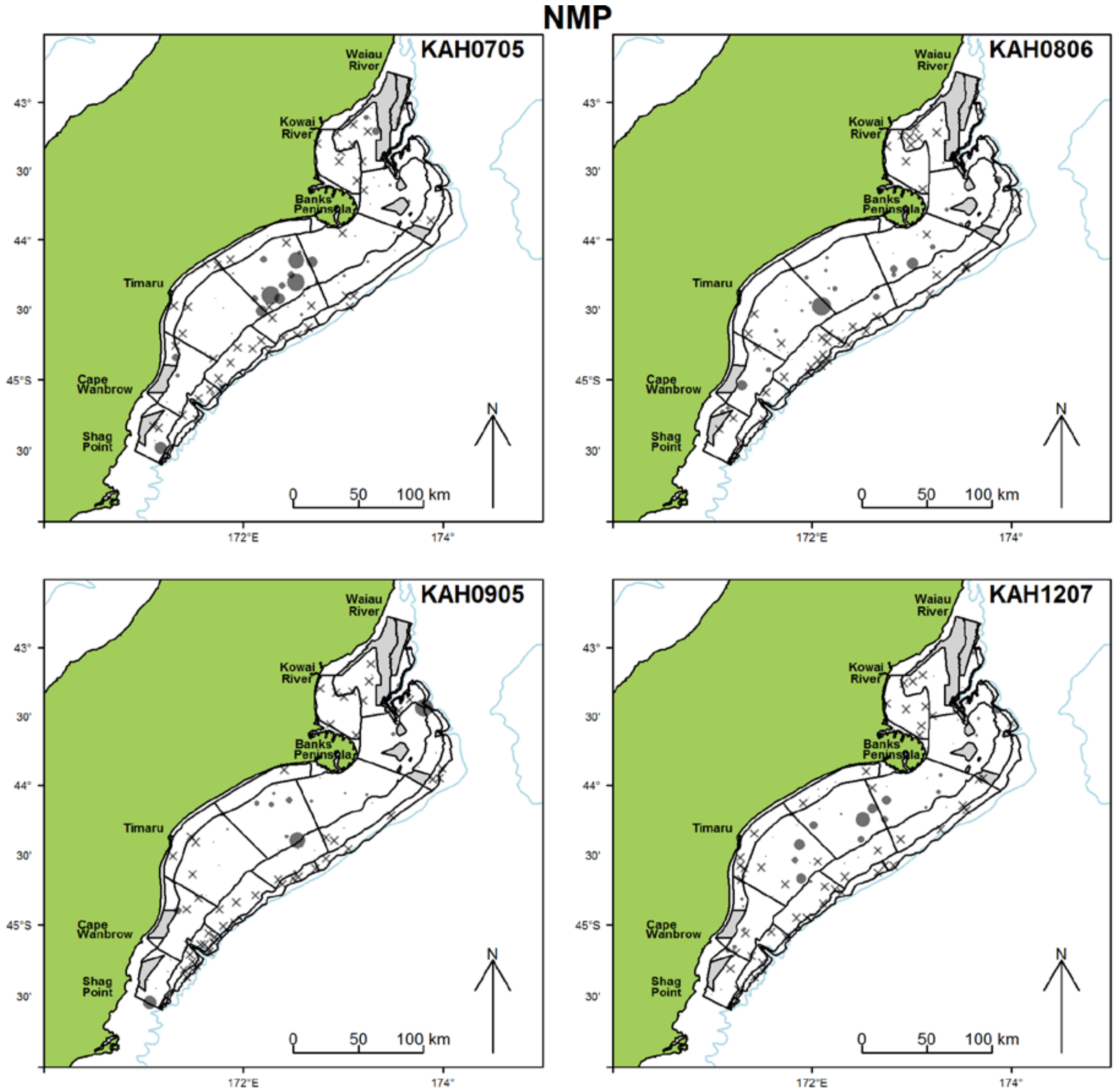


Figure 10 – *continued*

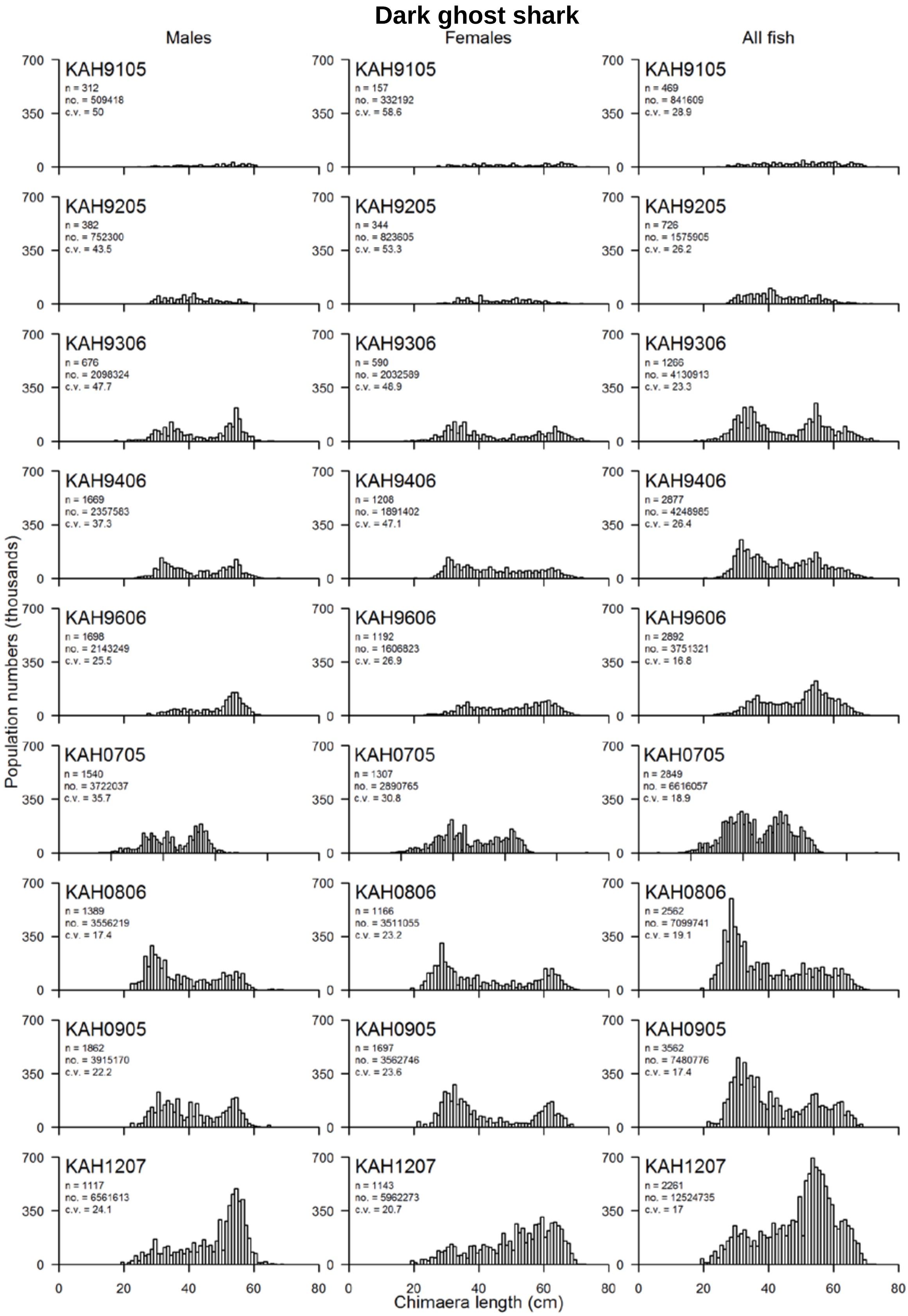


Figure 11: Scaled length frequency distributions for the target species in core strata (30–400 m) for all nine the ECSI winter surveys. The length distribution is also shown in the 10–30 m depth strata for the 2007 and 2012 surveys overlayed (not stacked) in light grey for ELE, GUR, RCO, and SPD. Population estimates are for the core strata only, in thousands of fish. Scales are the same for males, females and unsexed, except for NMP where total has a different scale.

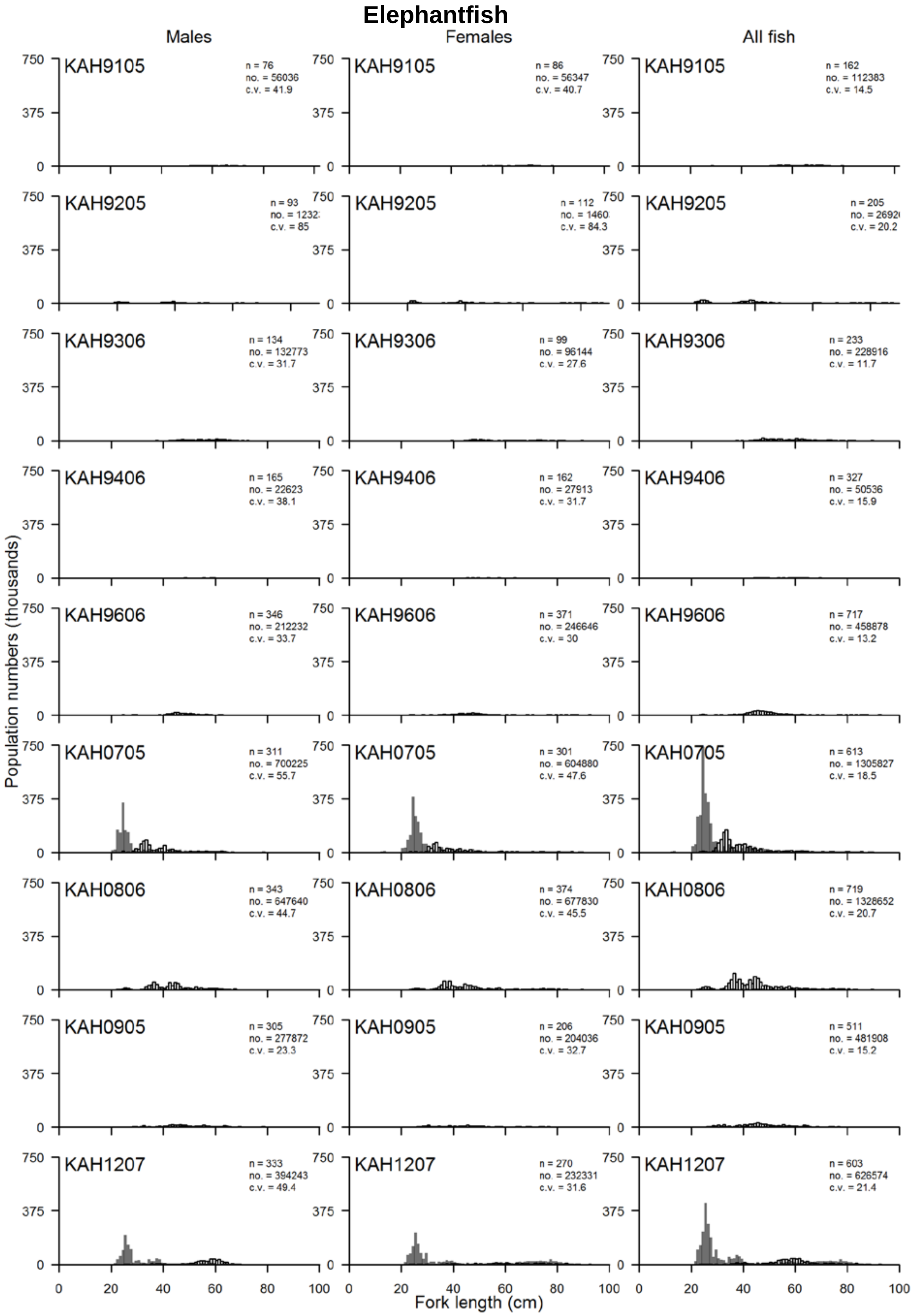


Figure 11 – ***continued***

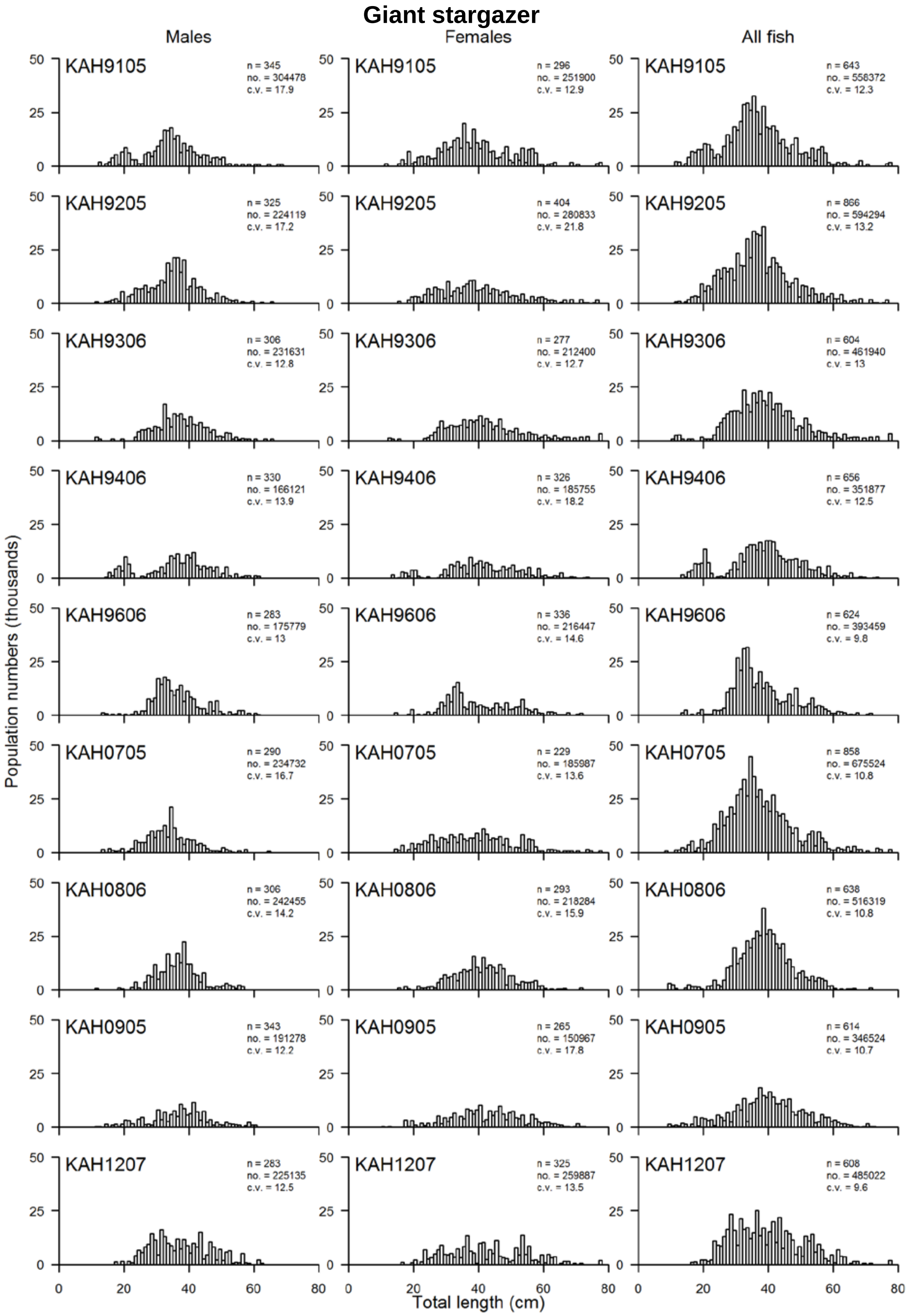


Figure 11 – *continued*

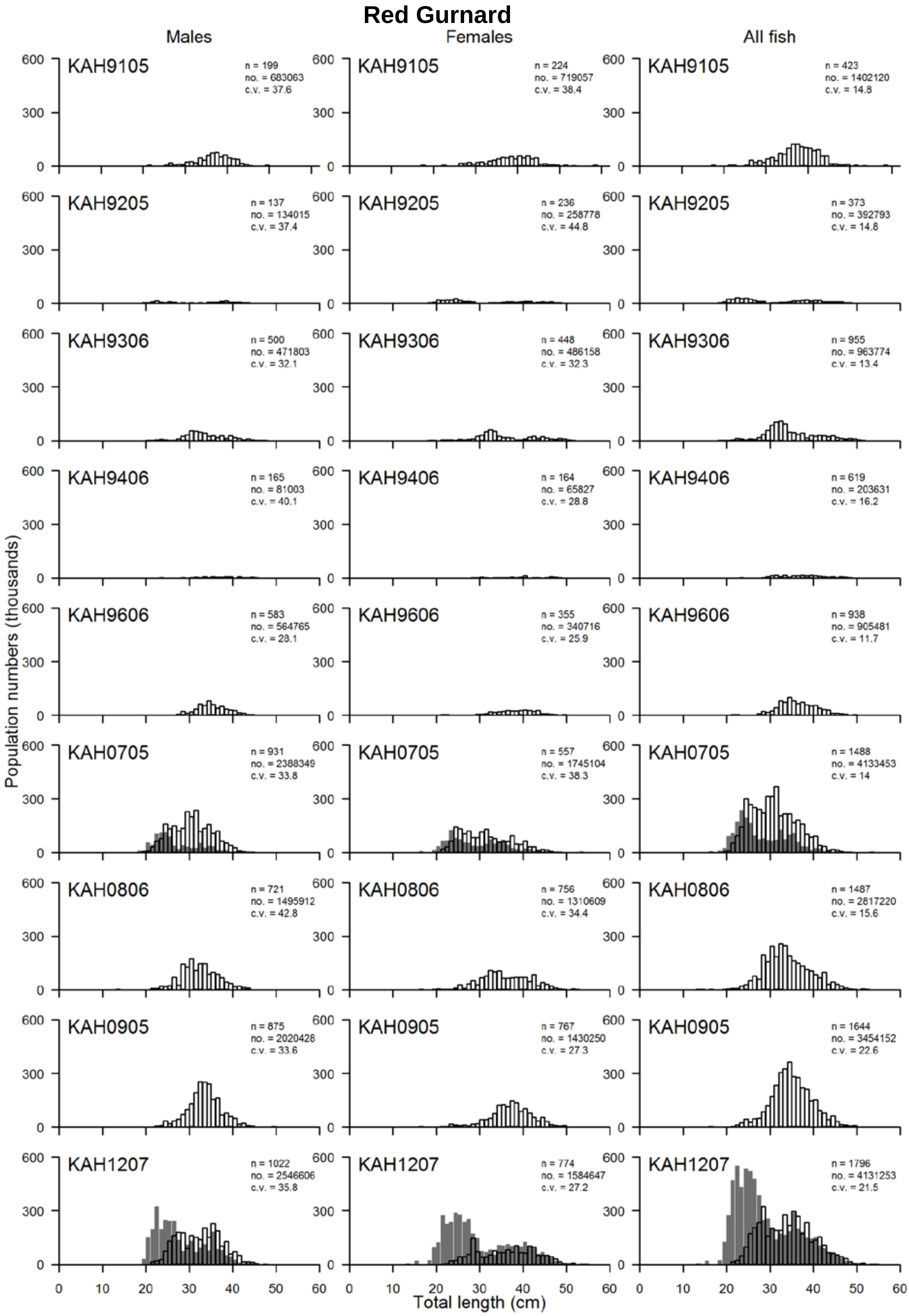


Figure 11 – ***continued***

Red cod

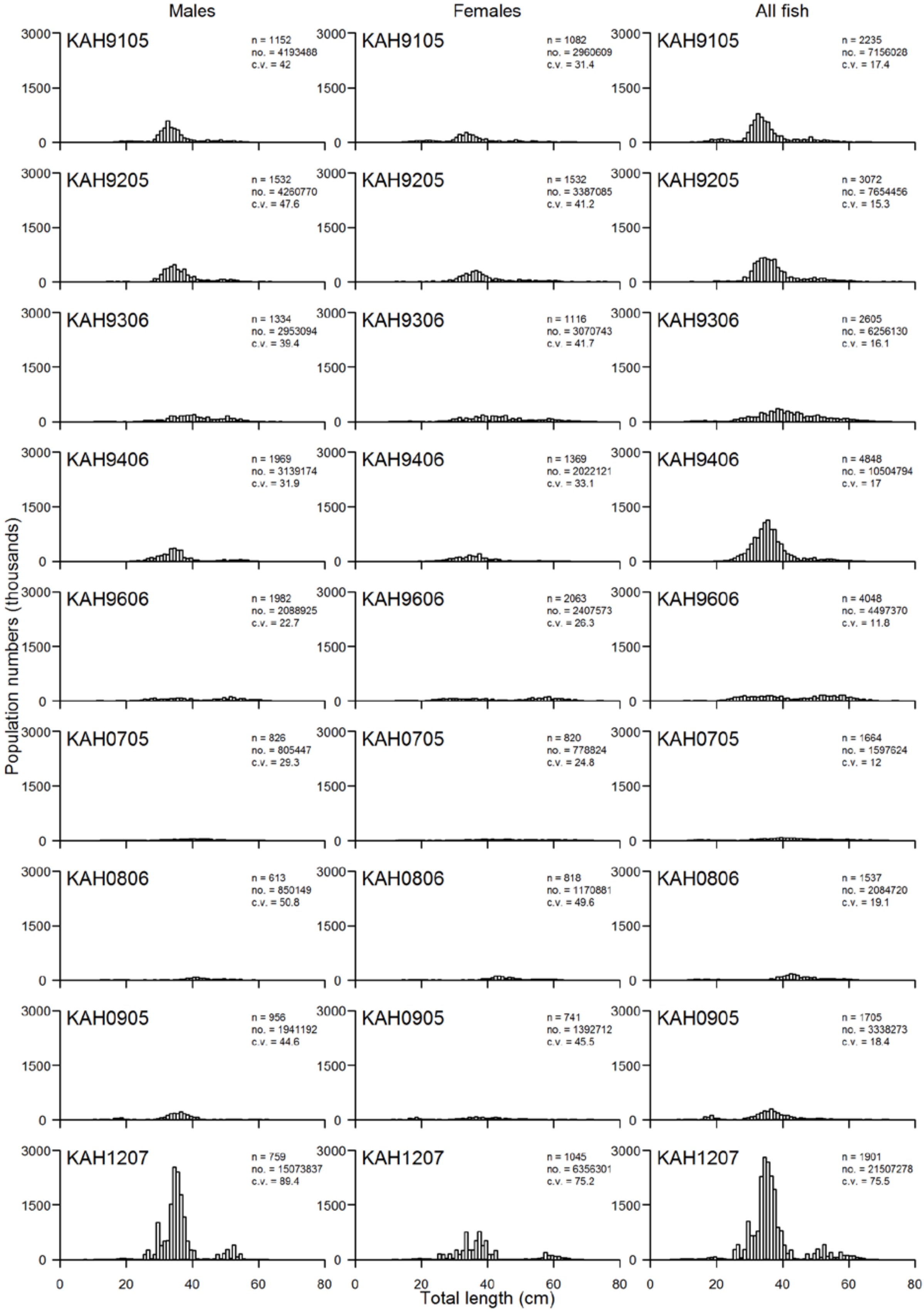


Figure 11 – ***continued***

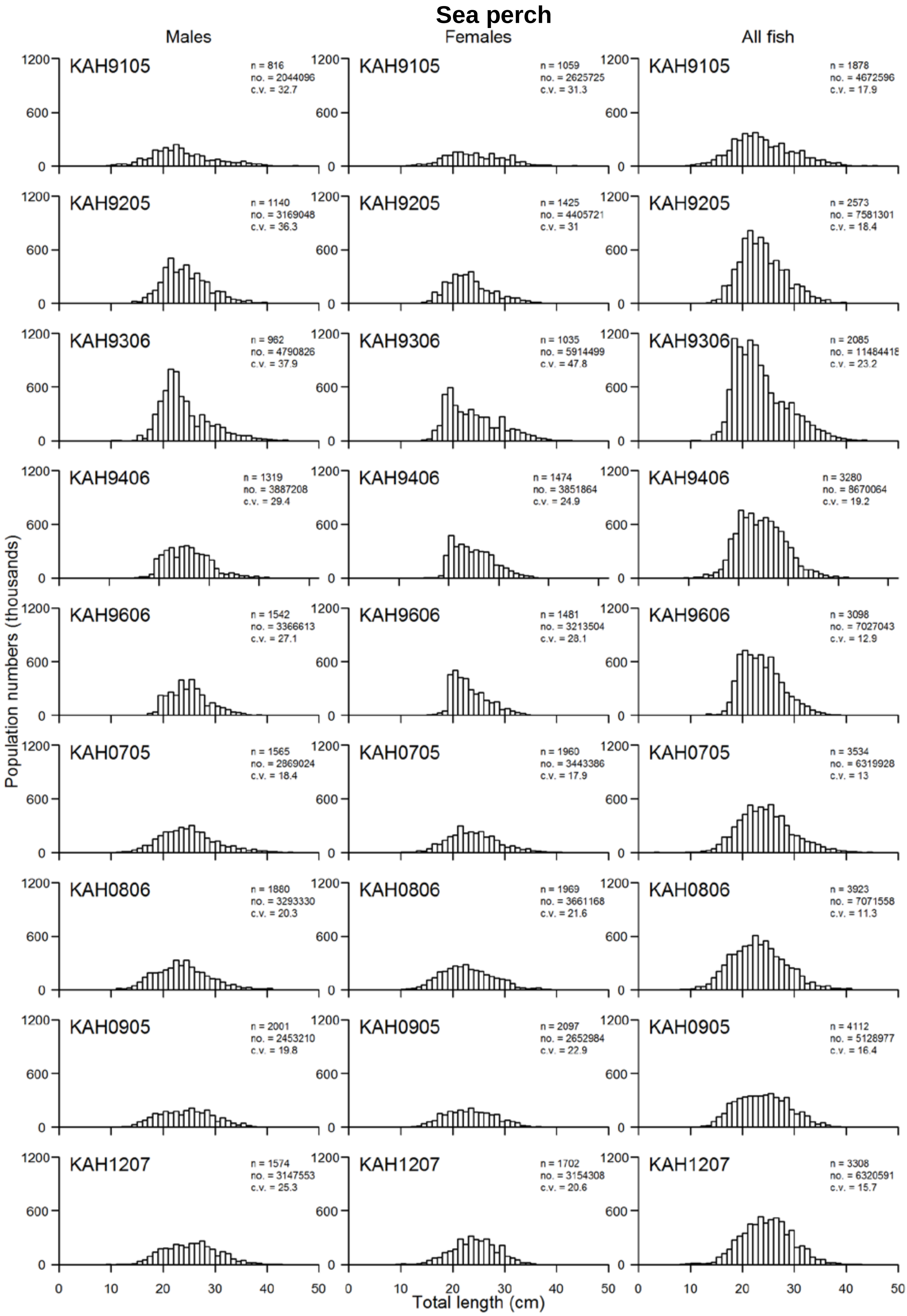


Figure 11 – *continued*

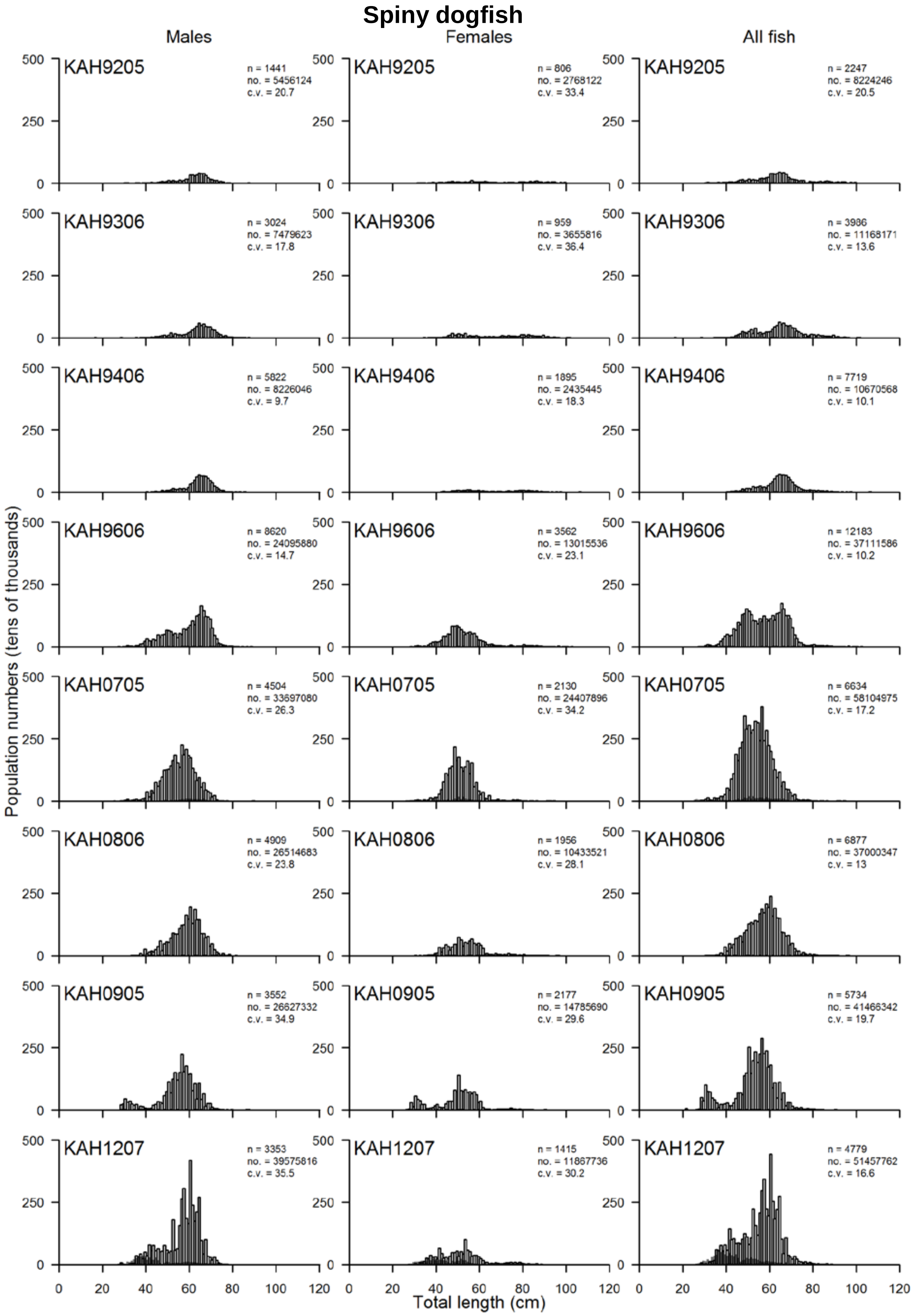


Figure 11– ***continued***

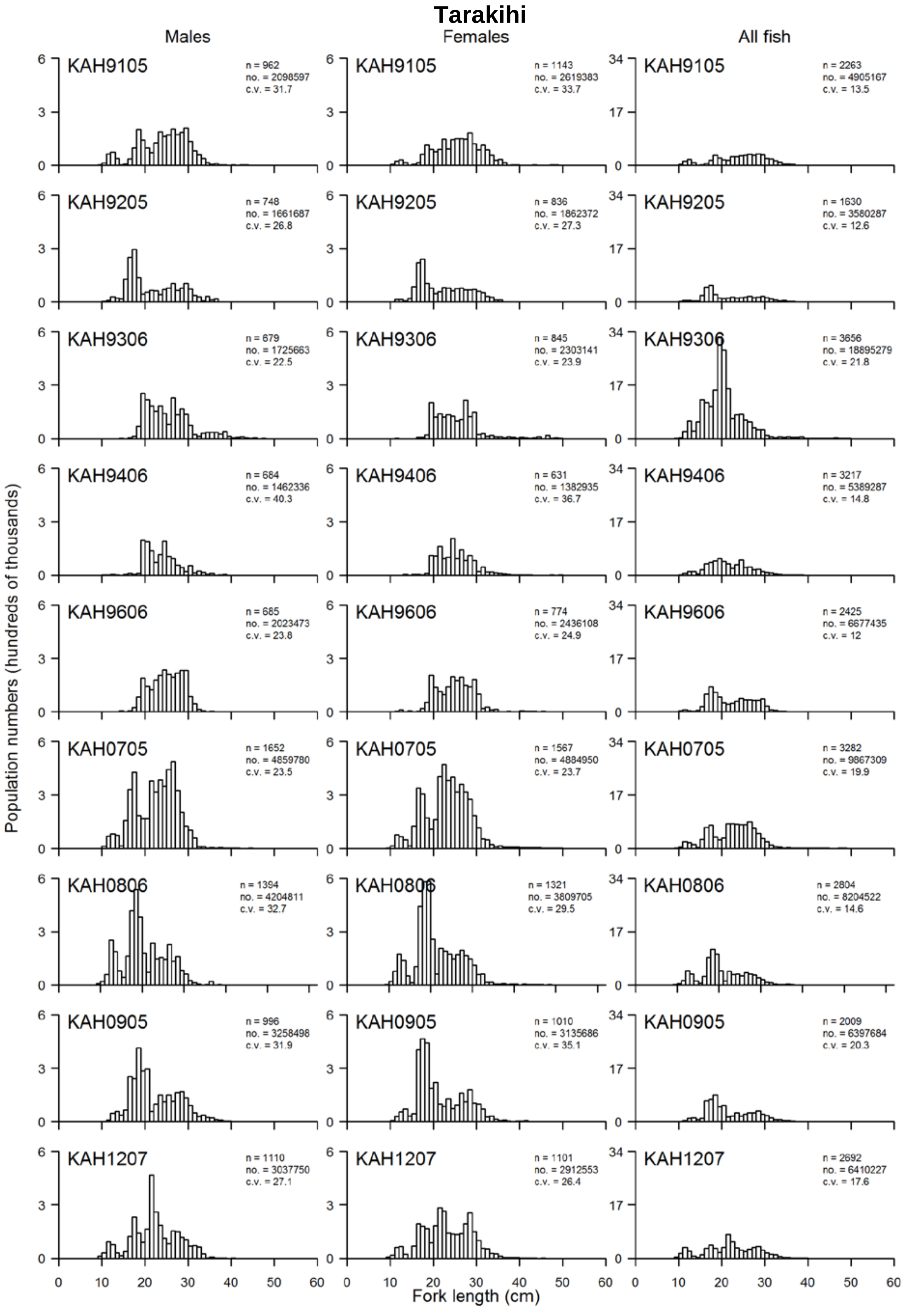


Figure 11 – ***continued***

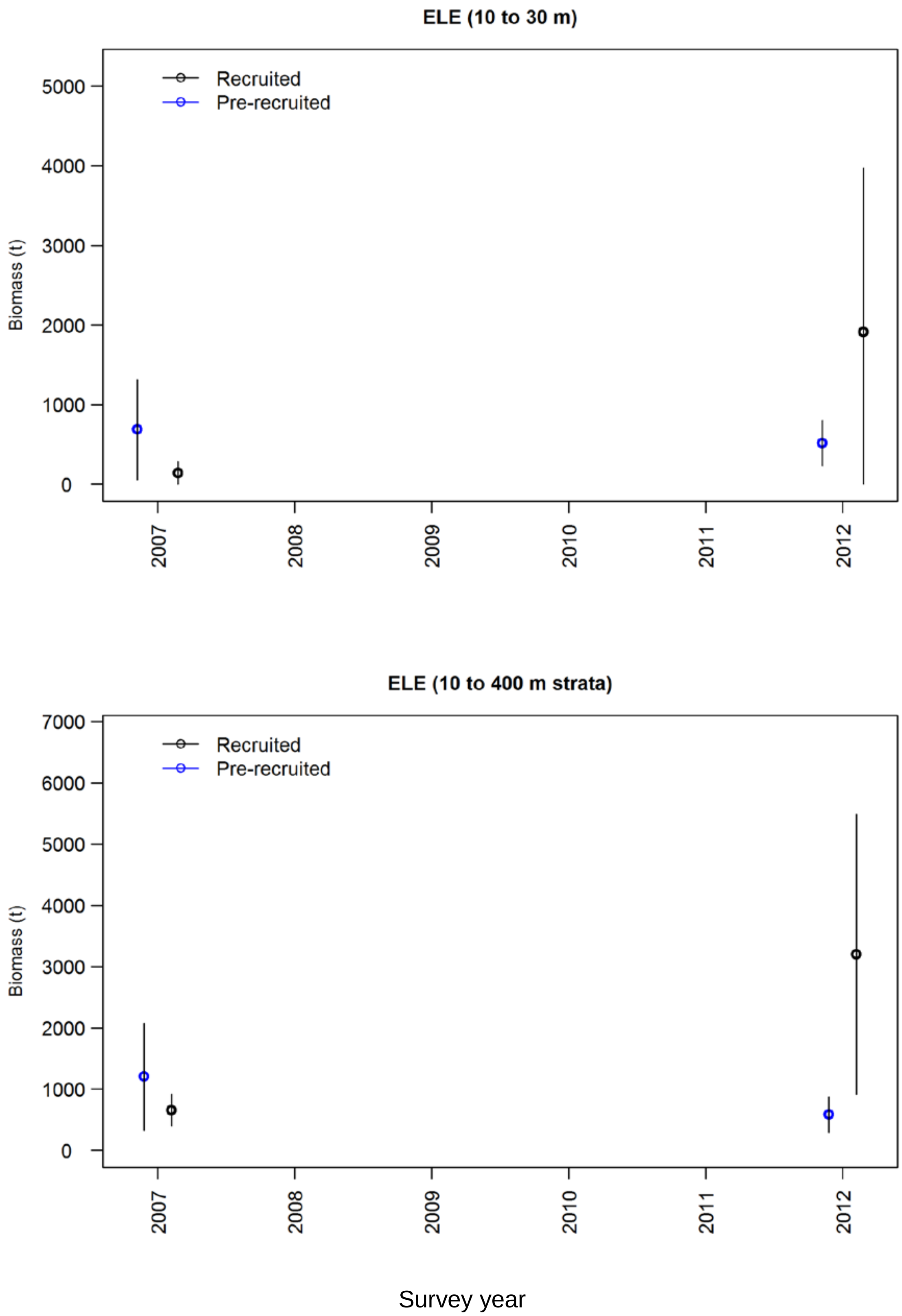
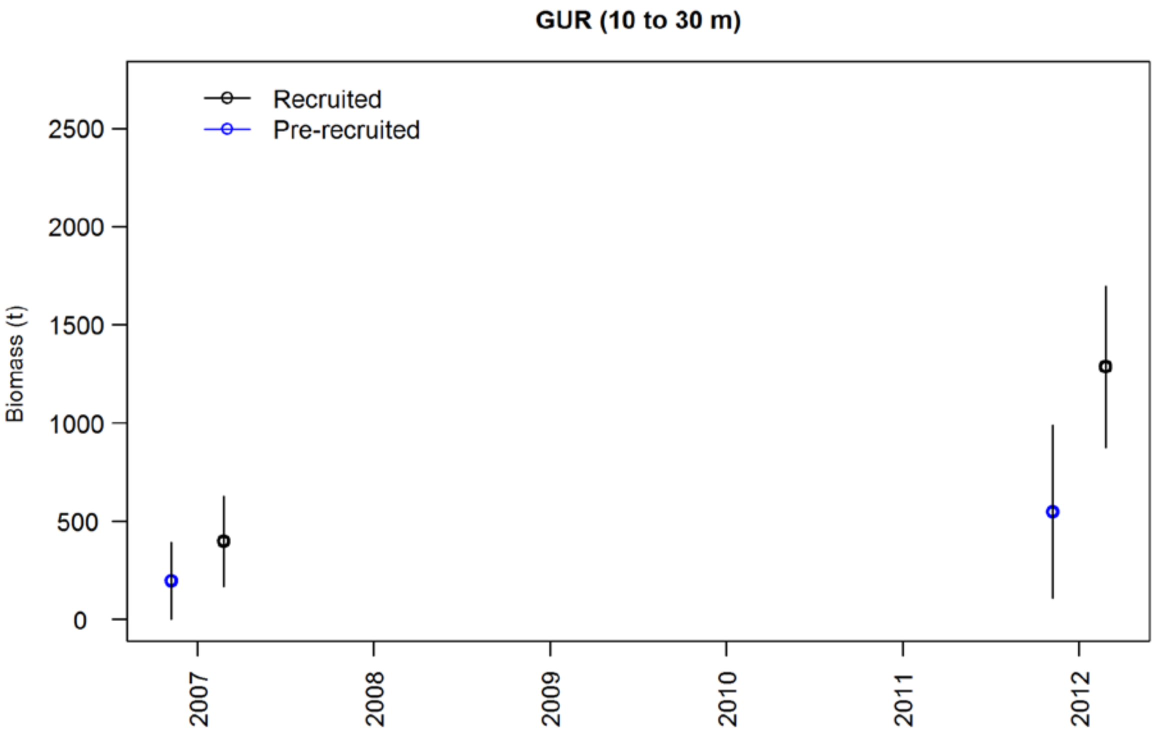


Figure 12: Elephantfish and red gurnard recruited and pre-recruited biomass and 95% confidence intervals for 2007 and 2012 ECSI surveys in 10–30 m and core plus shallow strata (10–400 m).



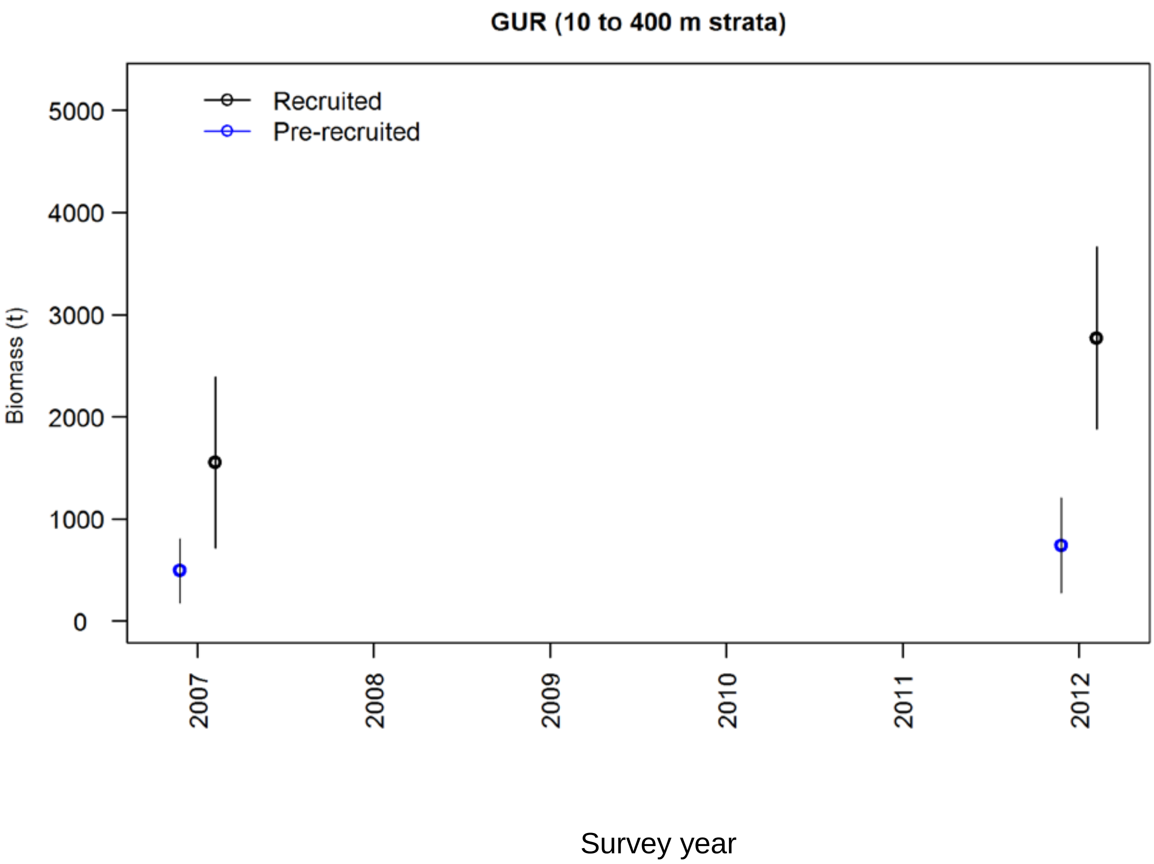


Figure 12 – *continued*.

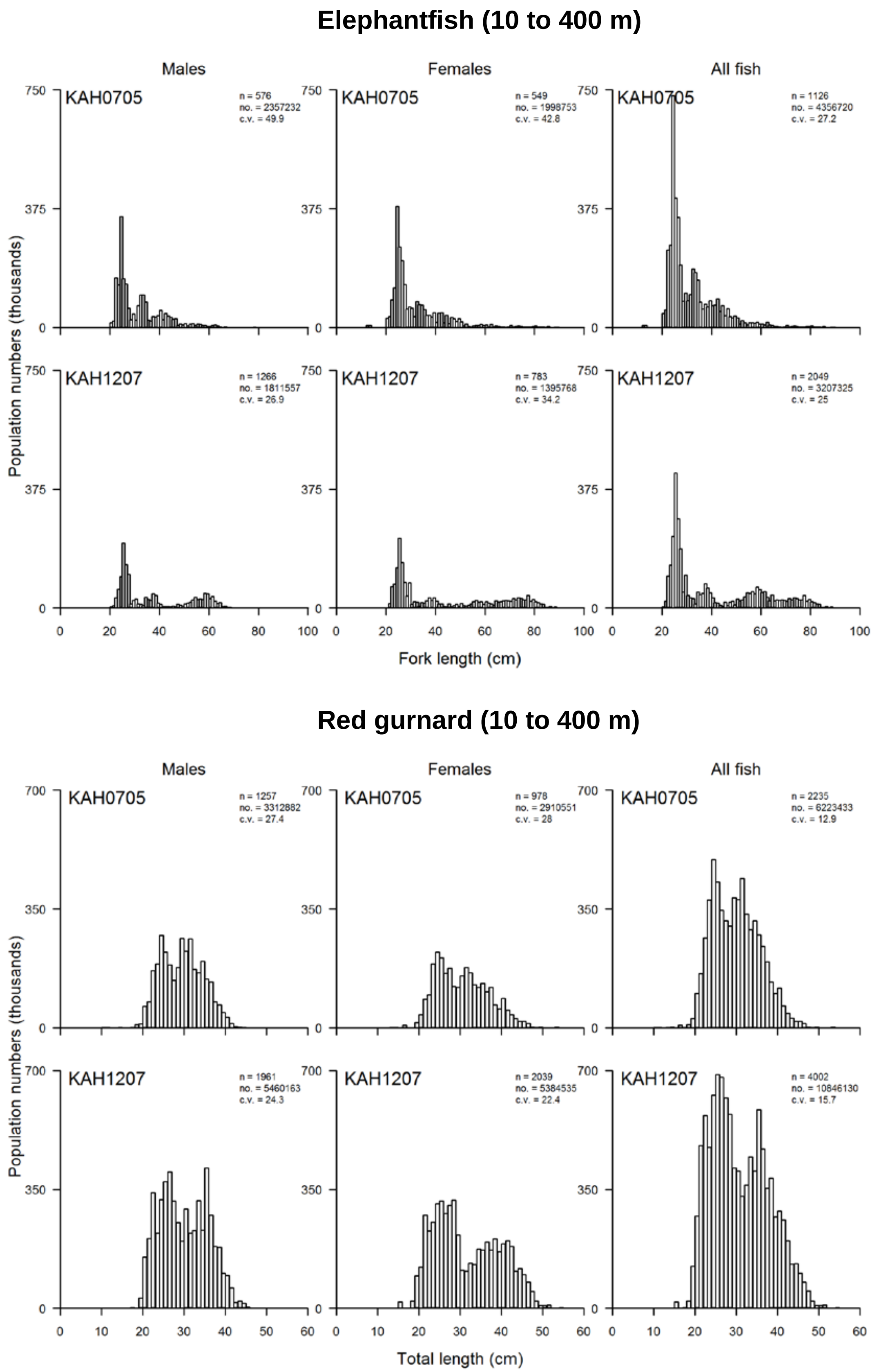
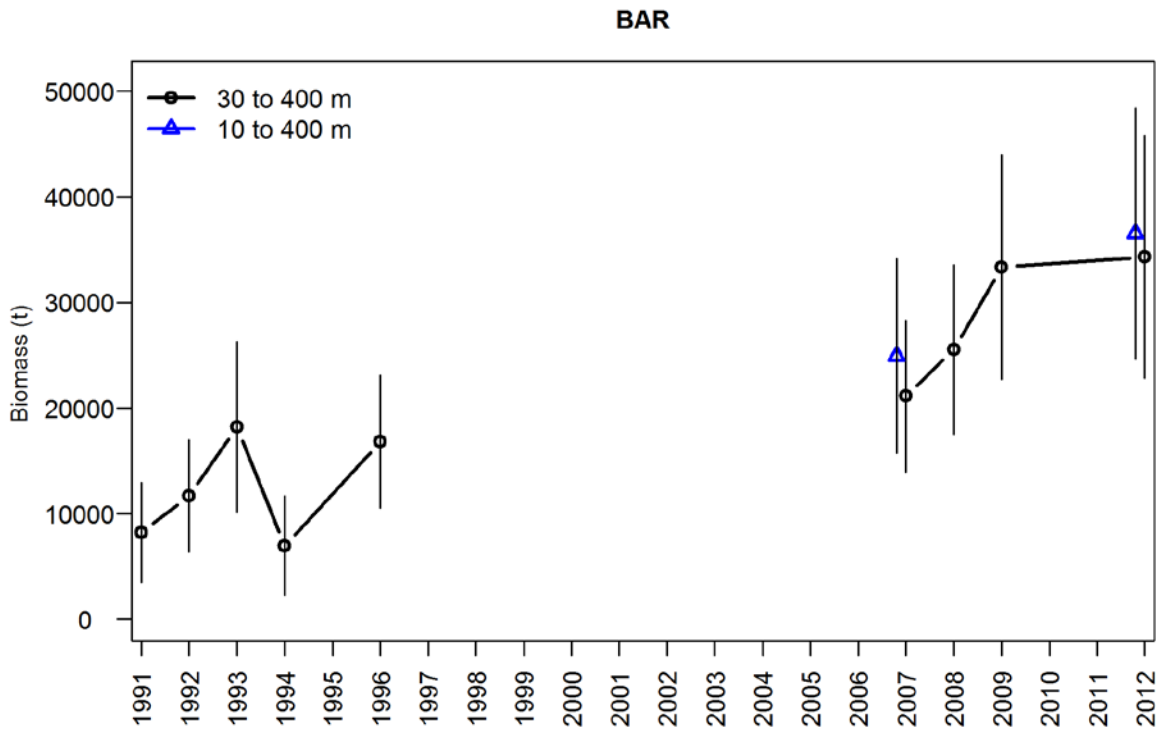


Figure 13: Scaled length frequency distributions for elephantfish and red gurnard in core plus shallow strata (10–400 m), for 2007 and 2012 ECSI surveys. Population estimates are in thousands of fish.



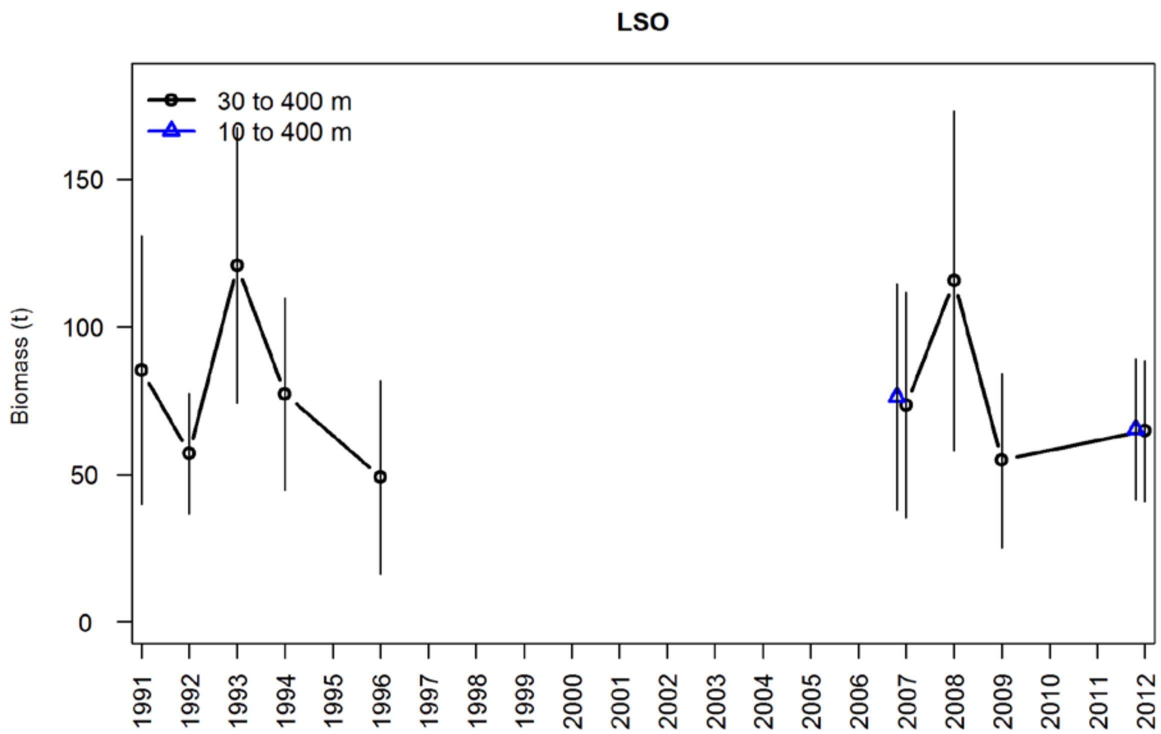
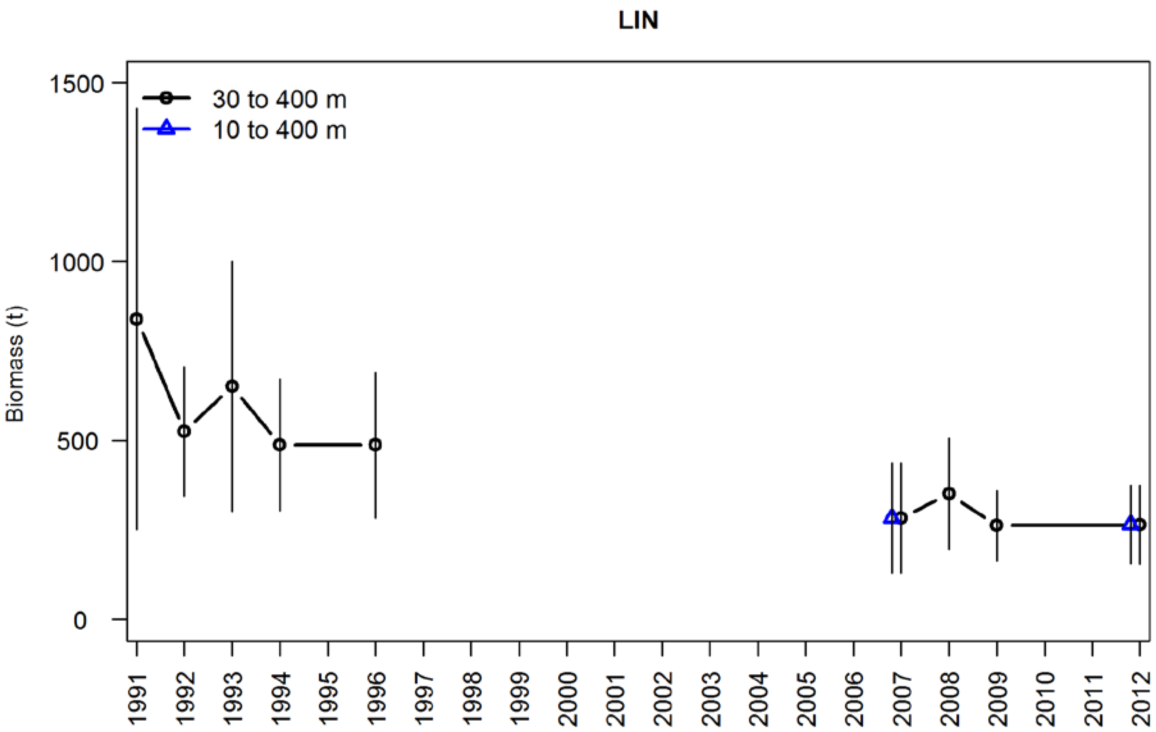


Figure 14: Key non-target QMS species total biomass and 95% confidence intervals for the all ECSI winter surveys in core strata (30–400 m), and core plus shallow strata (10–400 m) in 2007 and 2012.



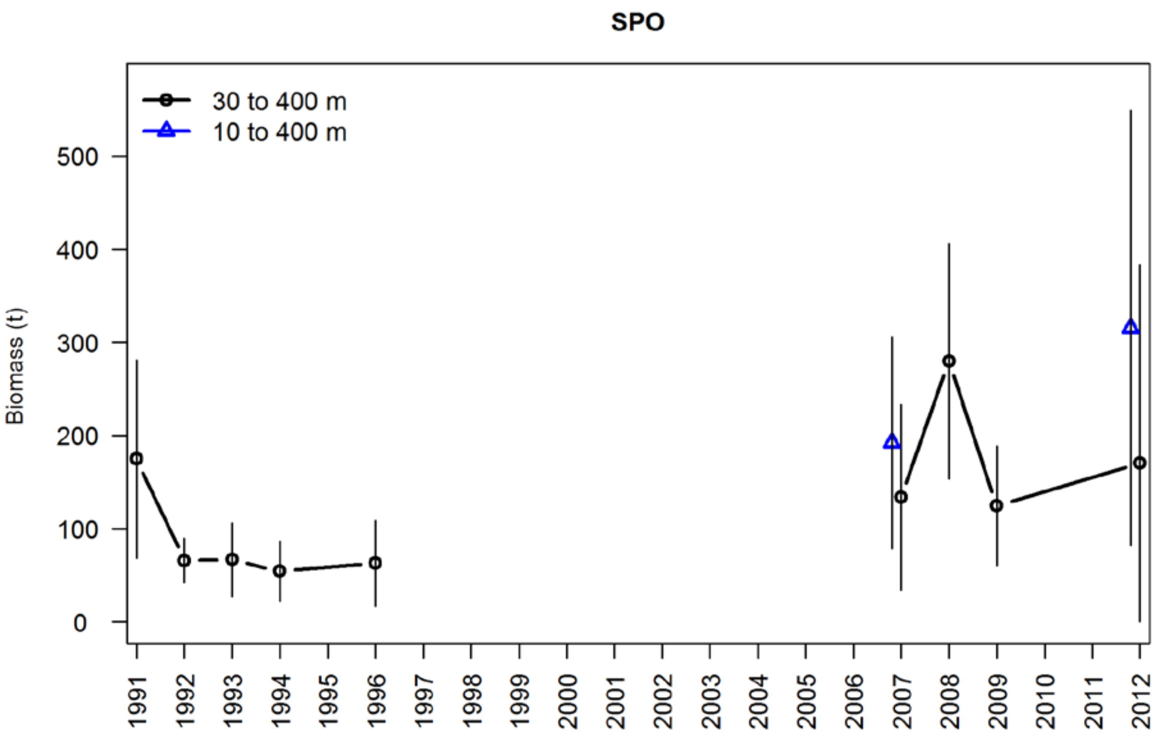
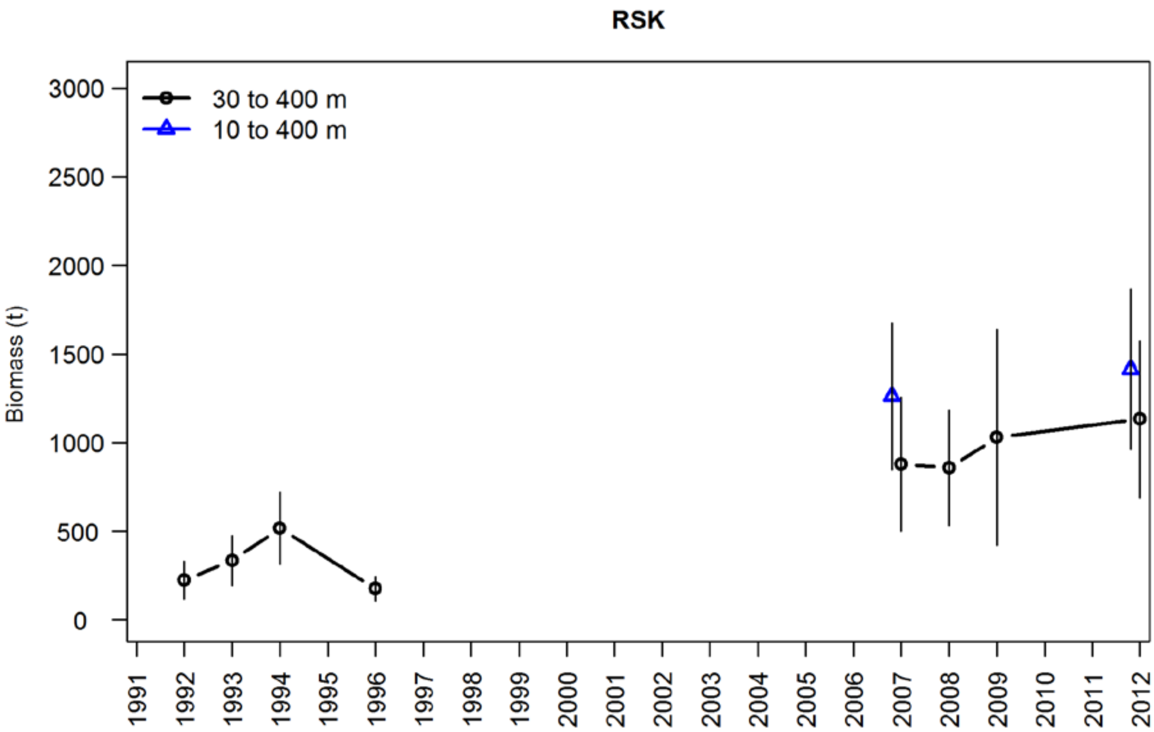


Figure 14 – ***continued***



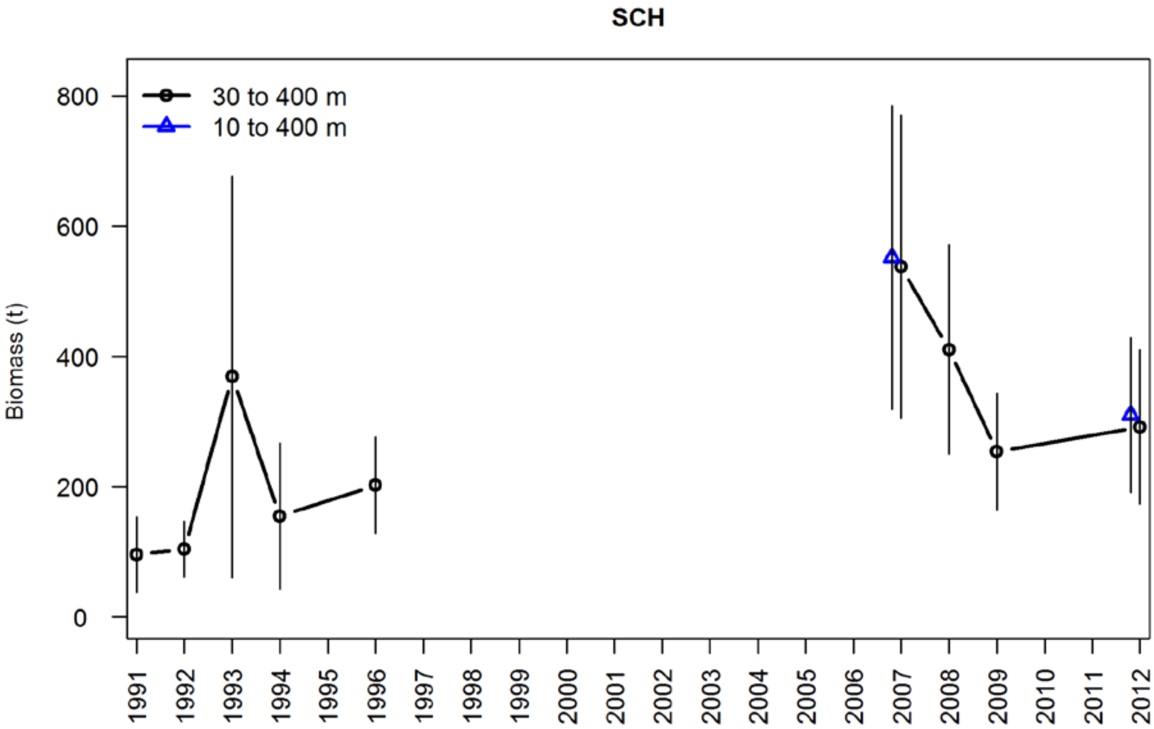
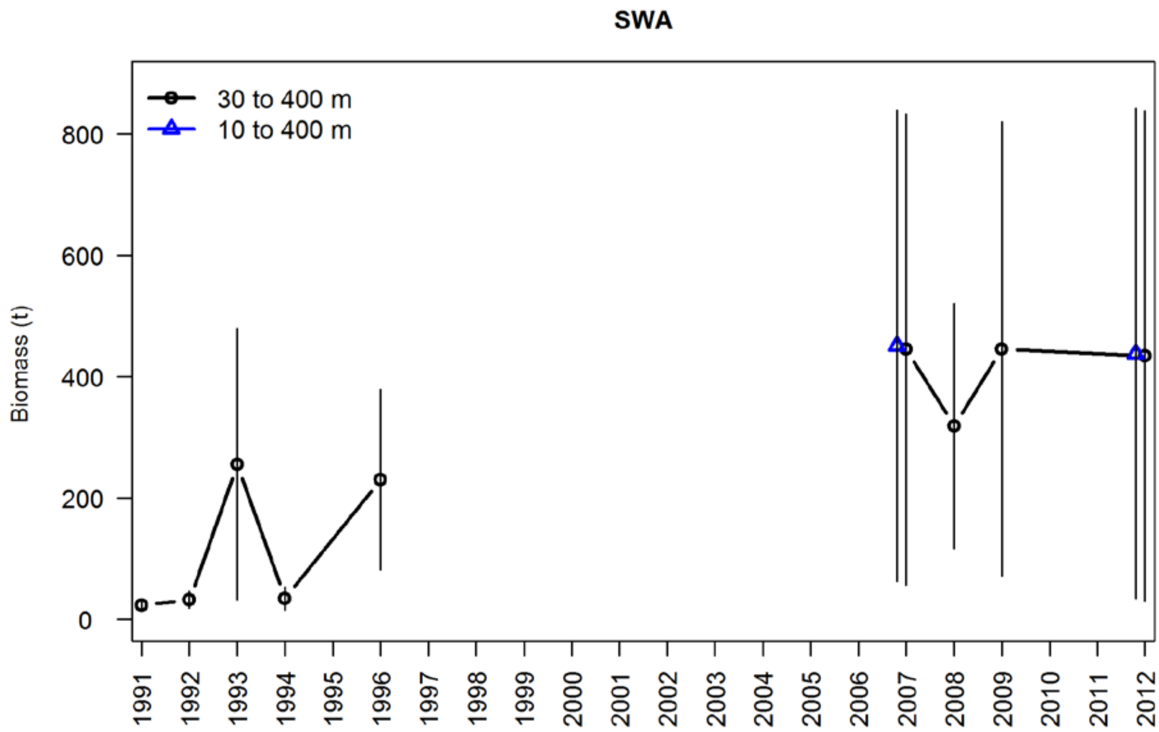


Figure 14 – ***continued***



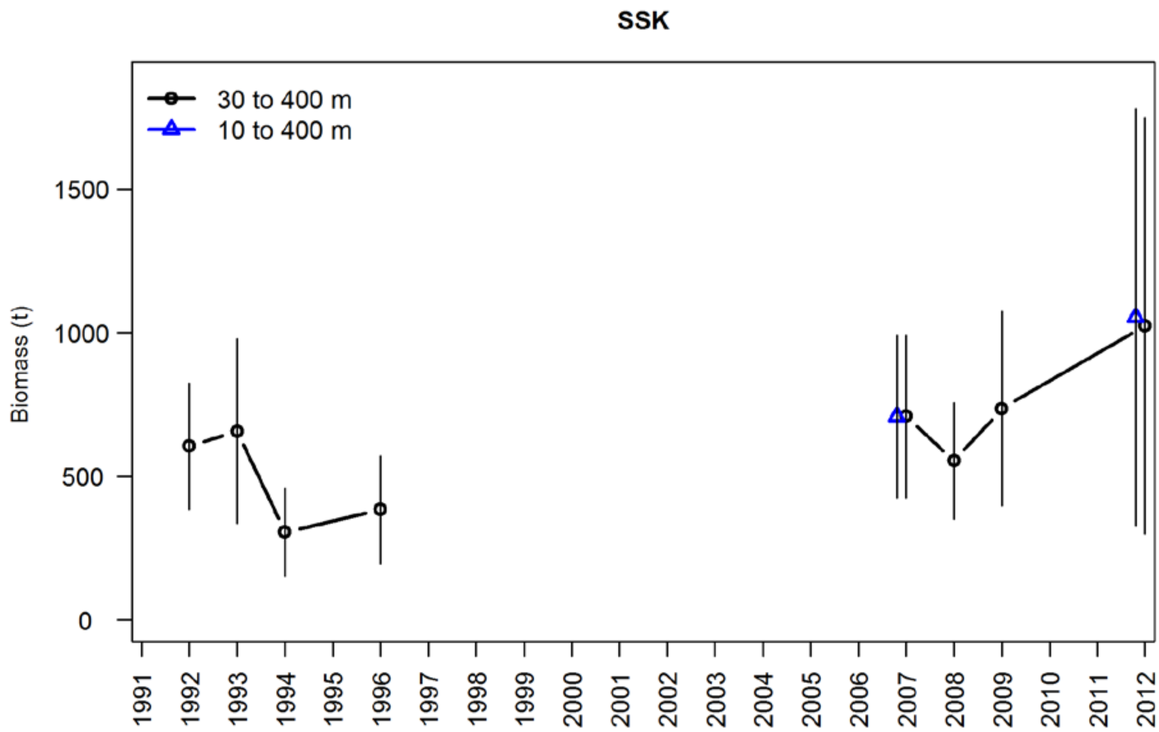


Figure 14 – ***continued***

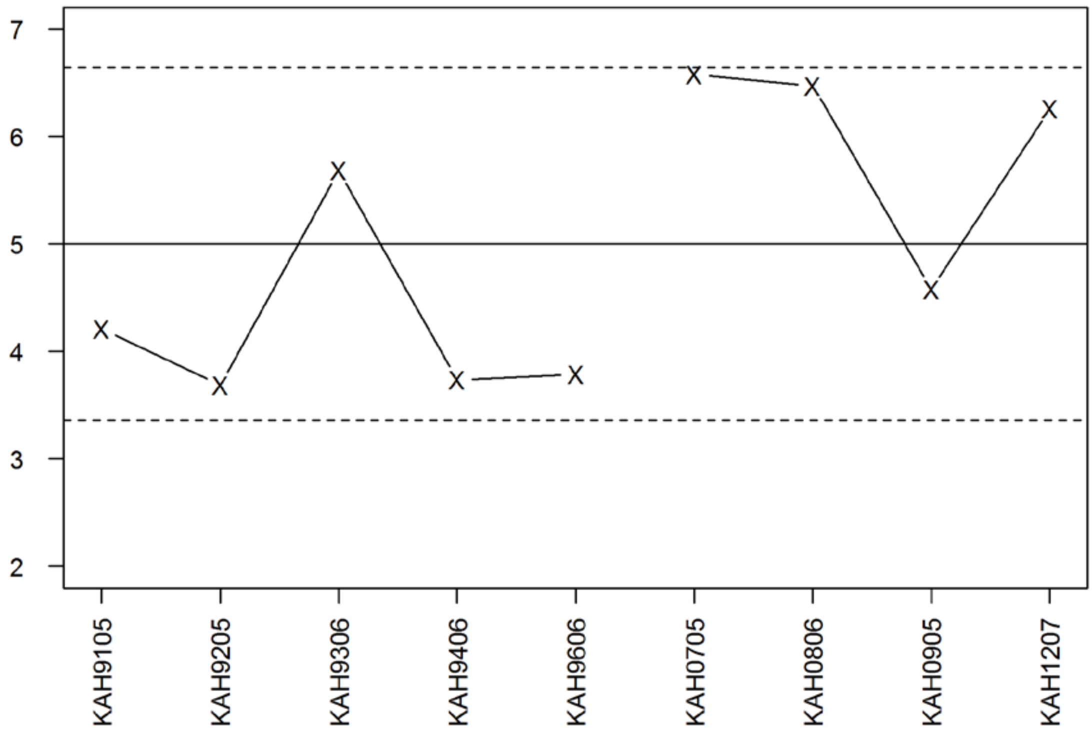


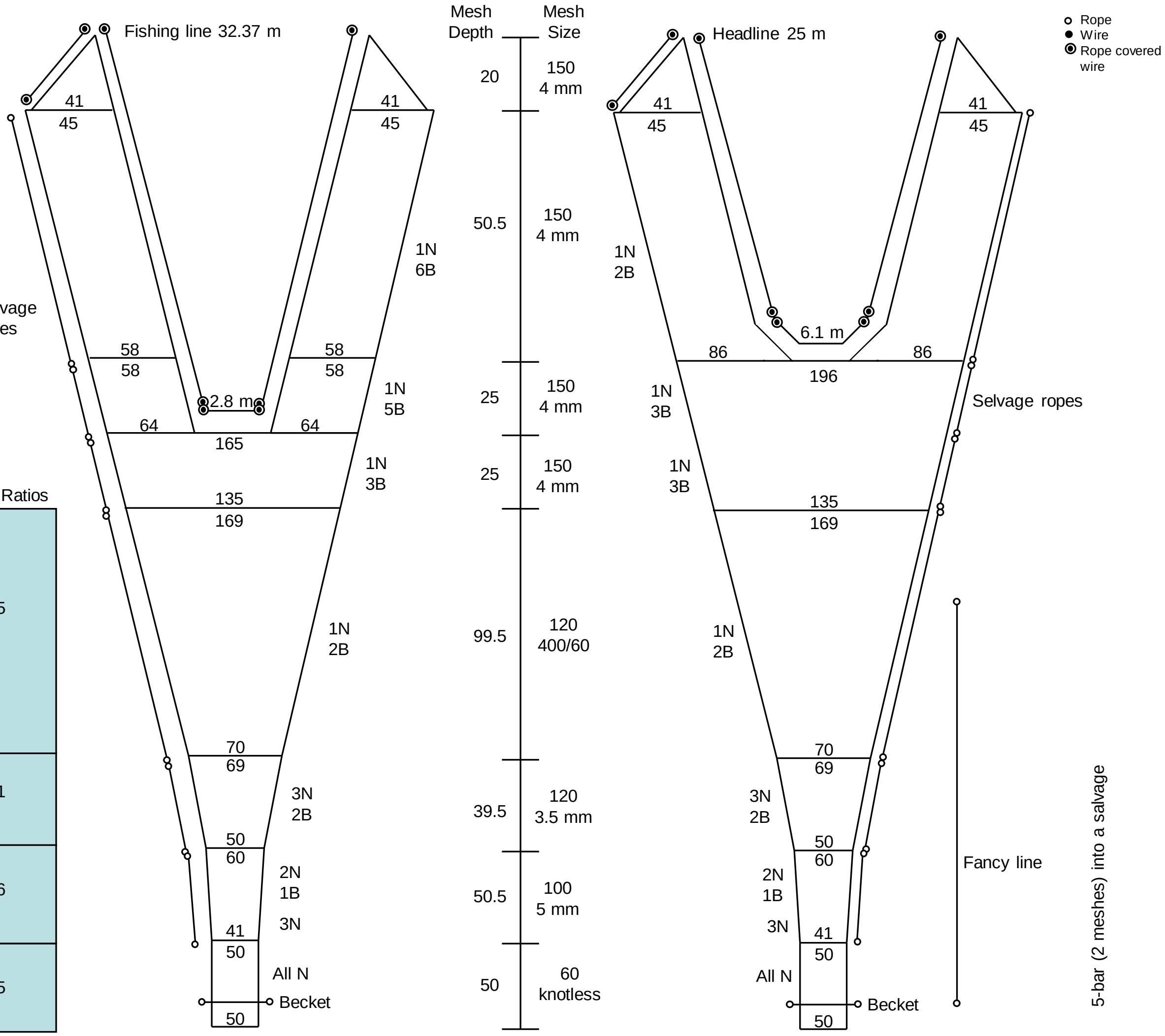
Figure 15: Mean ranks for the ECSI winter trawl surveys (core strata). The solid line indicates the overall mean rank. Mean ranks outside the broken lines (95% confidence intervals) have extreme catchability.

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

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^o @ 69.4 m
			16^o @ 77.4 m
			19^o @ 89.4 m
Flotation	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

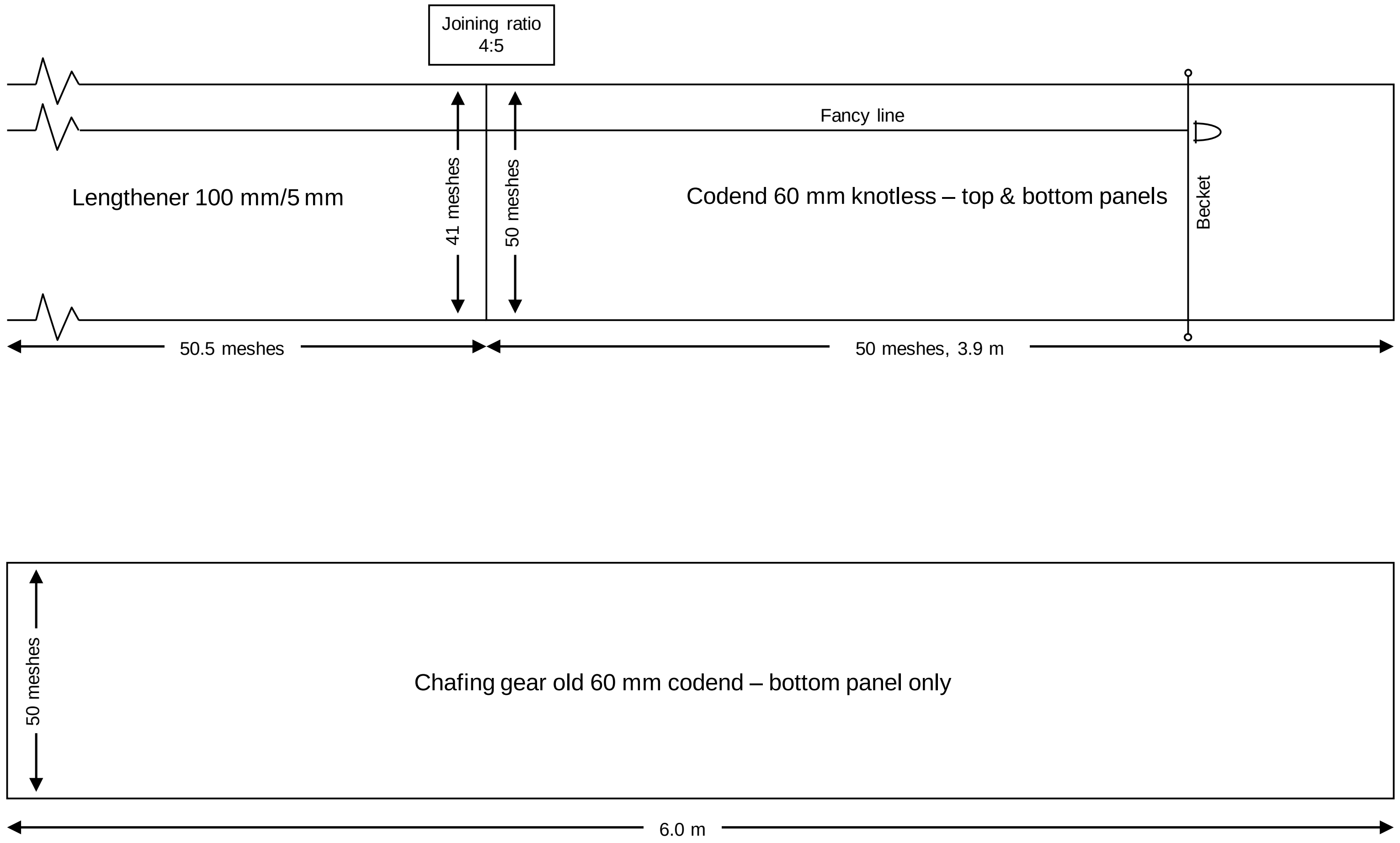
Net Plan: R.V. *Kaharoa* Bottom Trawl

Mesh and twine size	No. meshes deep	Selvage ropes nylon 26 mm	Joining Ratios
150 mm 4 mm (Olivene)	20	V-lines 24 mm Hi-man superline 6.4 m	
150 mm 4 mm (Olivene)	50.5	6.3 m	
150 mm 4 mm (Olivene)	25	3.3 m	
150 mm 4 mm (Olivene)	25	3.3 m	
4.5" (117 mm) 400/60 (pe)	99.5	10.8 m	4:5
120 mm 3.5 mm (Olivene)	39.5	4.0 m	1:1
100 mm 5 mm (Olivene)	50.5	4.2 m	5:6
60 mm knotless (type)	50	-	4:5



Appendix 1 – *continued*

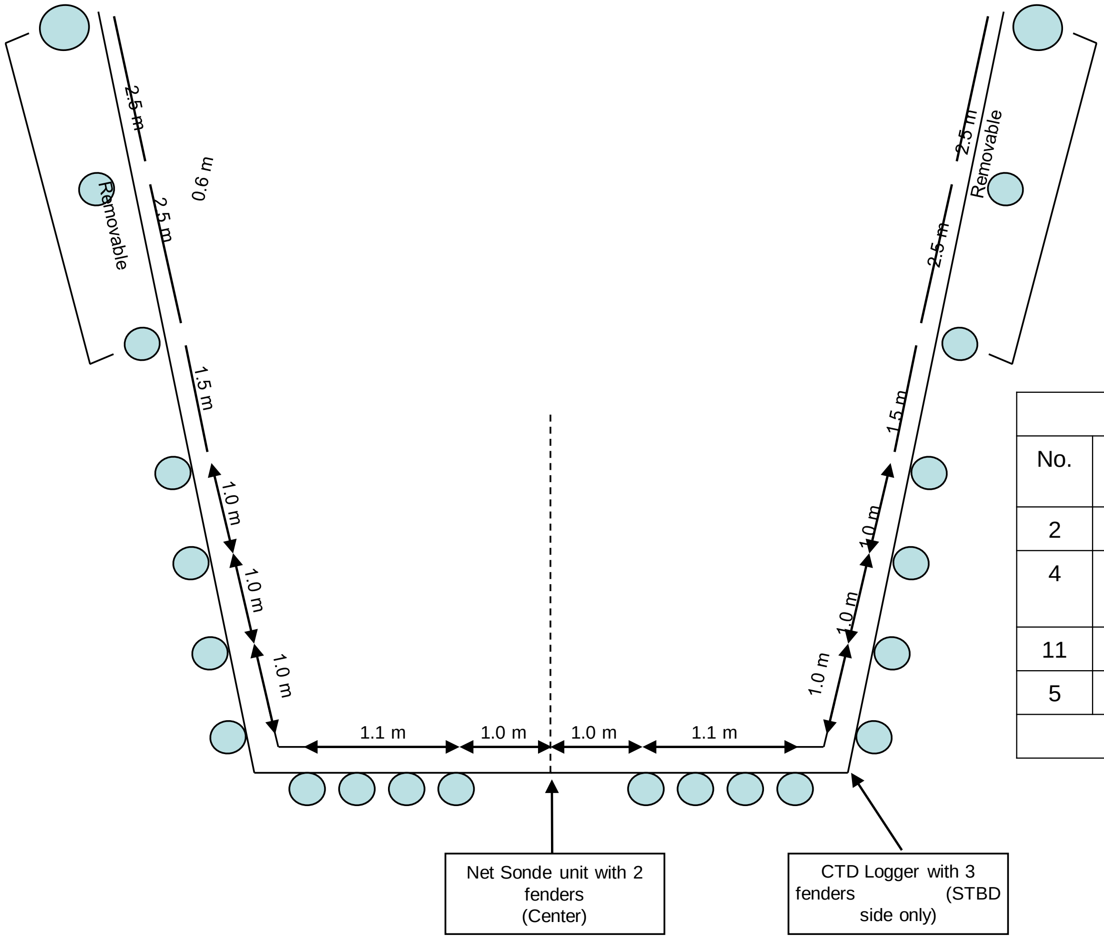
Codend for ECSI Inshore trawl survey (10 – 400 m)



Appendix 1 – *continued*

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

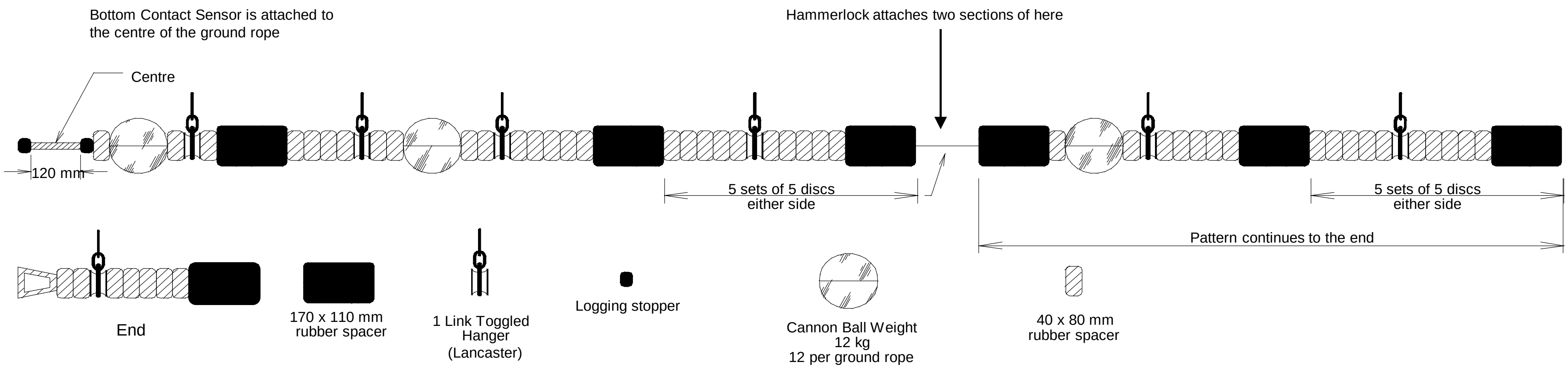
Total Floats: 22 on headline



Floats			
No.	Diameter (mm)	Buoyancy (kg)	Rated depth (m)
2	330	~11 kg	removable
4	300	9.7	Removable, rated to 800 m
11	300	9.7	rated to 800 m
5	300	10.8	rated to 500 m
Total Buoyancy = 221 kg			

Appendix 1– ***continued***

Ground Rope Assembly: R.V. *Kaharoa* Bottom Trawl

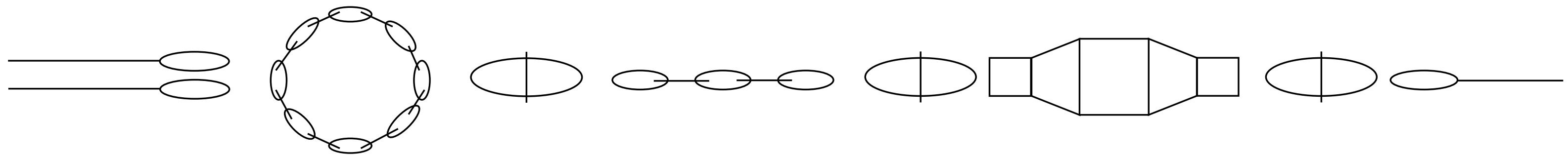


31.95 m x 18 mm 6/19 wire + 1 x 13 mm H/lock & 3 links of 13 mm mid-link chain each end

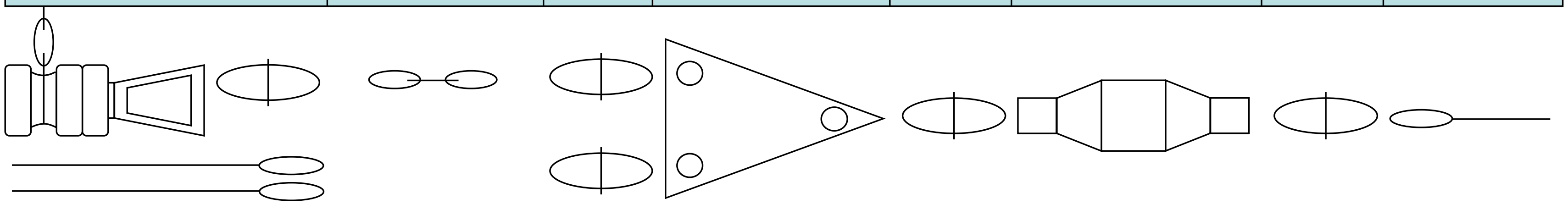
Appendix 1 – *continued*

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

<table>
<tr><td colspan="8">Top bridle</td></tr>
<tr><td>Headline – rope covered wire 25.05 m</td><td rowspan="2">Chain loop</td><td rowspan="2">10 mm Hammerlock</td><td rowspan="2">Chain link + 150 mm layback</td><td rowspan="2">8 mm Hammerlock</td><td rowspan="2">1.5 tonne swivel</td><td rowspan="2">8 mm Hammerlock</td><td rowspan="2">Top bridle 12 mm wire 55 m</td></tr>
<tr><td>V-line – 24 mm rope 6.4 m</td></tr>
</table>

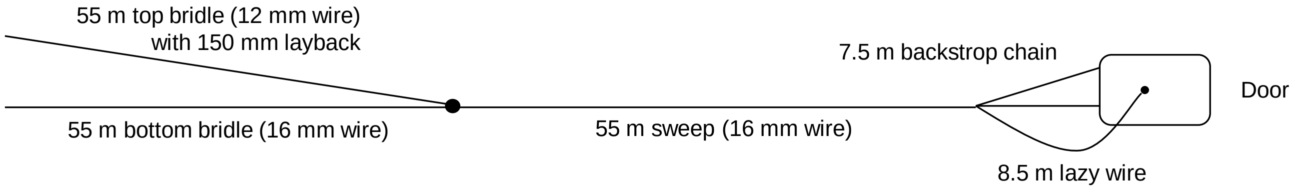


<table>
<tr><td colspan="9">Bottom bridle</td></tr>
<tr><td>Groundrope 18 mm wire 35 m</td><td>13 mm hammerlock</td><td>13 mm midlink chain for squaring groundrope</td><td>13 mm hammerlock</td><td rowspan="3">150 mm delta plate</td><td rowspan="3">20 mm hammerlock</td><td rowspan="3">5 tonne swivel</td><td rowspan="3">20 mm hammerlock</td><td rowspan="3">Bottom bridle 16 mm wire 55 m</td></tr>
<tr><td colspan="2">V-line – 24 mm rope</td><td rowspan="2"></td><td rowspan="2">20 mm hammerlock</td></tr>
<tr><td colspan="2">Fishing line – rope covered wire 32.37 m</td></tr>
</table>



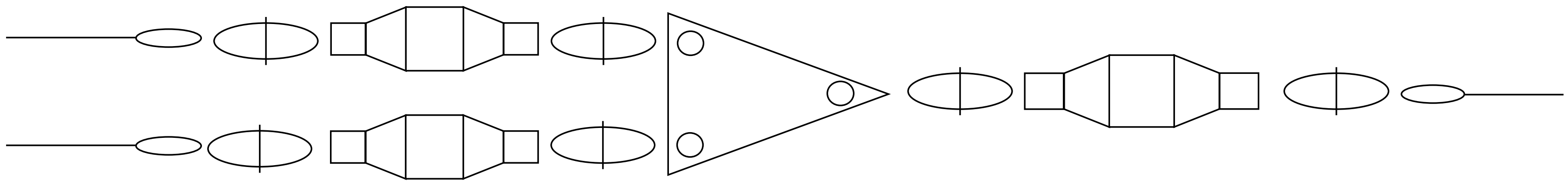
Appendix 1 – *continued*

Sweeping Gear: R.V. *Kaharoa* Bottom Trawl



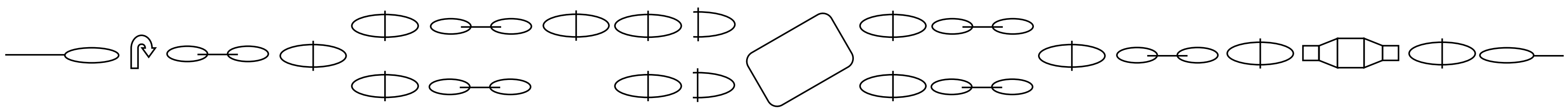
Bridle to sweep connection

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

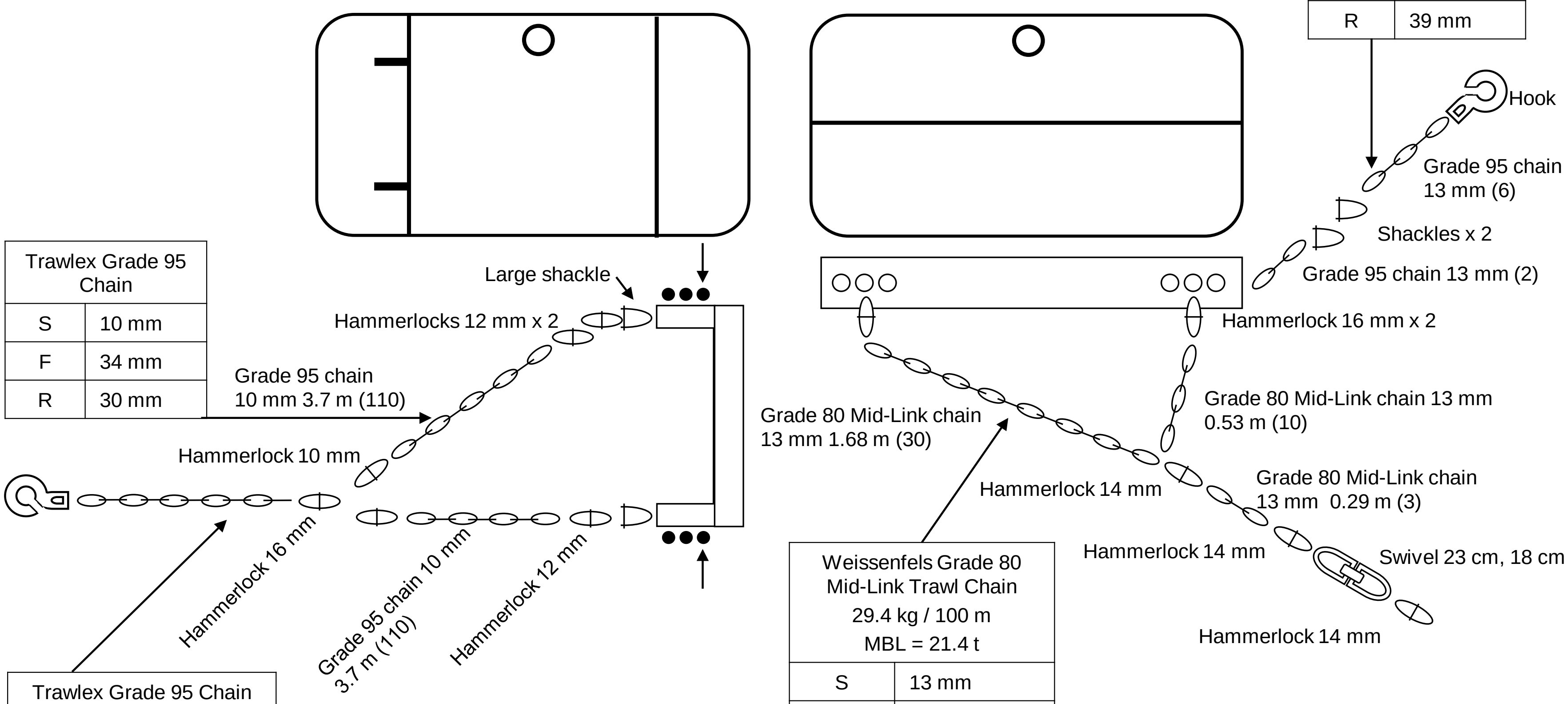
Sweep wire 55 m 16 mm	Hook	Chain	14 mm H/L	10 mm H/L	Chain	10 mm H/L	10 mm H/L	Shackle	Door Rectangular V 2.4 m x 1.5 m 3.2 m² 630 kg	16 mm H/L	Chain	14 mm H/L	Chain	14 mm H/L	Dry swivel	14 mm H/L	Trawl warp wire 16 mm
				10 mm H/L	Chain		10 mm H/L	Shackle		16 mm H/L	Chain						



Appendix 1 – *continued*

Door rigging for R.V. *Kaharoa* Bottom Trawl

‘Rectangular V’ 2.4 m x 1.5 m, 3.2 m^2, 630 kg



Trawlex Grade 95 Chain	
S	13 mm
F	50 mm
R	39 mm

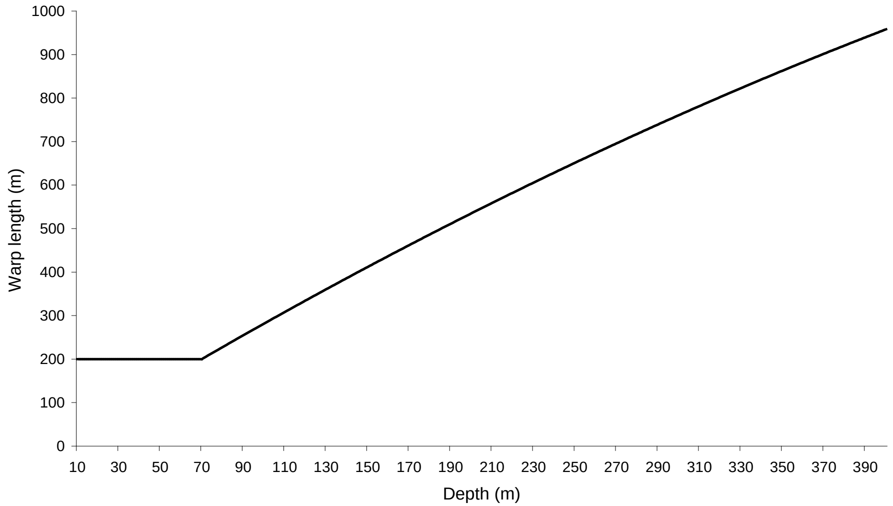
Trawlex Grade 95 Chain	
S	10 mm
F	34 mm
R	30 mm

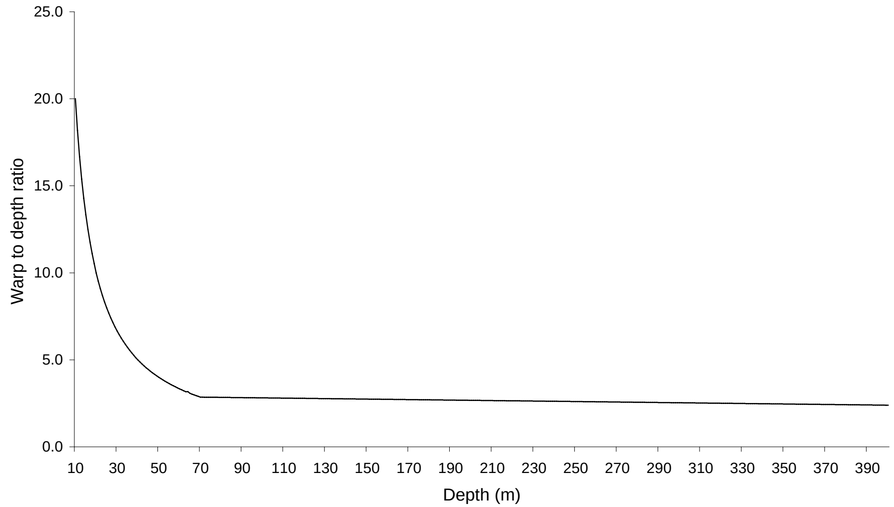
Trawlex Grade 95 Chain	
S	13 mm
F	50 mm
R	39 mm

Weissenfels Grade 80 Mid-Link Trawl Chain 29.4 kg / 100 m MBL = 21.4 t	
S	13 mm
F	46 mm
R	52 mm

Warp length for depth, and warp:depth ratio for R.V. *Kaharoa* Bottom Trawl

ECSI inshore (10 – 400 m) trawl instructions
Use 60 % pitch, 700 rpm, 3.0 knots (approx)
Trawling for 1 hour
Net on bottom for 3 nautical miles





Appendix 2: Gonad stage definitions.

Finfish

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).

Spiny dogfish

Males: 1, immature (claspers shorter than pelvic fins, soft and uncalcified, unable or difficult to splay open); 2, maturing (claspers longer than pelvic fins, soft and uncalcified, unable or difficult to splay open or rotate forwards); 3, mature (claspers longer than pelvic fins, hard and calcified, able to splay open and rotate forwards to expose clasper spine).

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).

Dark ghost shark and elephantfish

Males

1. Immature – Pelvic claspers short (less than half the length of pelvic fins), tips not swollen, cartilages uncalcified, claspers soft and flexible. Frontal tenaculum not erupted. Posterior reproductive tract undeveloped. No coiling of epididymis.
2. Maturing – Pelvic claspers beginning to elongate but not reaching pelvic fin posterior margin, tips not swollen, or if swollen, without embedded prickles; cartilages not completely calcified and may be soft and flexible or partially rigid. Frontal tenaculum erupted, but not fully developed, with hooks absent or uncalcified. Posterior reproductive tract beginning to thicken. Epididymis enlarged, but with few coils.
3. Mature – Pelvic claspers elongated, reaching or almost reaching posterior margin of pelvic fins; claspers mostly rigid with enlarged bulbous tips and embedded prickles; cartilages fully calcified. Frontal tenaculum fully developed with calcified hooks. Epididymis with many tight coils near testis.

Females

1. Immature – Oocytes small and translucent white. Uterus threadlike. Oviducal gland marked by a minor widening of the oviduct.
2. Maturing or Mature/Resting* – Oocytes of varying sizes (up to and sometimes larger than pea-sized), white to cream or pale yellow. Uterus broader especially near oviducal gland. Oviducal gland swollen (about 10–20 mm diameter) and clearly differentiated from uterus.
3. Mature – Some oocytes large and bright yellow. Uterus wide and uterine wall thick, especially near oviducal gland and vaginae where it is muscular. Oviducal gland large (greater than 20 mm diameter) and bulbous.
4. Mature and gravid – As for stage 3, plus fully or partially developed egg case present in one or both uteri.

* When not reproductively active, mature females lack large yellow oocytes (except possibly a few flaccid resorbing oocytes) and they cannot be distinguished from maturing females.

Appendix 3: Summary of station data. NA, no data; gear perf, gear performance (1–5).

				Lat/long start of tow		Lat/ long end of tow		Gear depth (m)		Dist. trawled	Headline	Door spread		Temperature (°C)	
Station	Stratum	Date	Time	° ' S	° ' E	° ' S	° ' E	Min.	Max.	(n. miles)	height (m)	(m)	Gear perf.	Surface	Bottom
1	17	26-Apr-12	731	43 15 80	173 46 10	43 17 86	173 48 69	295	323	2.79	4.7	81.9	1	14.8	9.8
2	13	26-Apr-12	1038	43 24 77	173 32 81	43 27 72	173 33 69	115	118	3.01	4.7	82	1	13.2	11.5
3	13	26-Apr-12	1314	43 17 51	173 30 65	43 14 64	173 29 89	104	104	2.92	4.3	83.2	1	13.7	11.8
4	13	26-Apr-12	1454	43 12 60	173 31 43	43 09 82	173 32 76	113	115	2.94	4.7	80.7	1	13.7	11.8
5	5	27-Apr-12	715	44 00 54	172 45 10	44 02 62	172 41 99	59	60	3.05	4.1	75.5	1	14.2	12.7
6	5	27-Apr-12	939	44 06 47	172 44 96	44 08 52	172 41 98	70	70	2.96	4.2	70.5	1	14.6	12.5
7	4	27-Apr-12	1329	44 09 97	172 35 97	44 11 03	172 34 06	65	65	1.73	4.7	72.8	1	14.2	12.5
8	4	27-Apr-12	1529	44 14 94	172 30 44	44 16 44	172 29 97	66	70	1.53	4.4	75	1	14.2	12.8
9	18	28-Apr-12	723	43 38 38	173 04 86	43 35 32	173 05 54	17	19	3.09	5	69.8	1	14.4	13.9
10	18	28-Apr-12	922	43 34 45	173 06 30	43 31 45	173 07 10	19	20	3.05	5.2	69.9	1	13.9	13.8
11	7	28-Apr-12	1301	43 30 28	173 12 33	43 27 28	173 13 17	36	36	3.06	5	74.4	1	14.6	13.5
12	18	28-Apr-12	1610	43 25 67	173 08 44	43 23 53	173 09 10	24	24	2.19	4.6	72.9	1	13.8	13.7
13	13	29-Apr-12	707	43 02 31	173 36 55	43 04 20	173 35 53	126	129	2.03	4.3	86.9	1	13.4	11.7
14	7	29-Apr-12	1003	43 12 41	173 13 43	43 15 36	173 13 14	38	43	2.95	4.5	77.6	1	13.6	13.1
15	7	29-Apr-12	1219	43 11 97	173 06 38	43 14 68	173 08 49	34	41	3.11	4.7	81.9	1	13.6	13.5
16	7	29-Apr-12	1422	43 15 03	173 00 71	43 17 64	173 02 83	31	36	3.03	4.5	76.3	1	14	13.7
17	7	30-Apr-12	720	43 15 51	172 55 06	43 17 65	172 57 76	30	33	2.9	4.6	76.3	1	NA	NA
18	18	30-Apr-12	1014	43 27 27	172 56 31	43 24 29	172 55 99	25	26	2.98	4.8	73.7	1	13.9	13.8
19	18	30-Apr-12	1245	43 24 47	172 45 24	43 27 45	172 46 00	15	16	3.03	4.7	67.8	1	14.3	14.3
20	6	2-May-12	1302	43 41 81	173 25 05	43 40 28	173 25 06	79	79	1.53	5.3	74	1	12.6	12.5
21	7	2-May-12	1447	43 31 55	173 27 69	43 28 78	173 26 18	87	88	2.97	4.9	80.4	1	12.5	12.4
22	6	3-May-12	712	43 38 39	173 39 12	43 35 58	173 39 55	85	86	2.82	4.6	76.4	1	NA	NA
23	6	3-May-12	918	43 31 00	173 40 42	43 28 21	173 39 74	83	84	2.83	4.6	75.4	1	11.7	11.7
24	12	3-May-12	1141	43 27 74	173 50 77	43 30 34	173 51 84	103	109	2.71	4.6	79.5	1	11.4	11.3
25	17	3-May-12	1405	43 32 76	174 00 19	43 30 00	173 58 62	280	280	2.98	4.8	96.7	1	11.9	9.8
26	12	4-May-12	703	43 36 74	173 53 36	43 39 80	173 53 11	101	102	3.06	4.9	85.8	1	NA	NA
27	17	4-May-12	930	43 38 72	174 01 99	43 41 70	174 01 69	297	314	2.98	4.4	89.6	1	11.9	9.2
28	12	4-May-12	1343	43 56 71	173 43 04	43 54 31	173 45 44	108	111	2.95	4.8	84.9	1	11.2	10.9
29	11	4-May-12	1613	43 57 59	173 39 97	43 58 97	173 38 84	108	109	1.6	4.5	76	1	11.2	11.1

Appendix 3– *continued*

Station	Stratum	Date	Time	Lat/long start of tow ° ' S	Lat/long start of tow ° ' E	Lat/ long end of tow ° ' S	Lat/ long end of tow ° ' E	Gear depth (m) Min.	Gear depth (m) Max.	Dist. trawled (n. miles)	Headline height (m)	Door spread (m)	Gear perf.	Temperature (ºC) Surface	Temperature (ºC) Bottom
30	16	5-May-12	720	44 19 30	173 17 55	44 17 42	173 20 67	NA	NA	2.91	4.1	89.6	1	11	10.4
31	16	5-May-12	1010	44 11 02	173 32 84	44 09 70	173 34 94	350	350	2	4.6	91.9	1	11.1	10.1
32	11	5-May-12	1223	44 09 24	173 30 50	44 11 11	173 27 39	155	157	2.91	4.3	80.3	1	11.4	10.9
33	11	5-May-12	1417	44 09 67	173 20 83	44 11 04	173 17 26	113	114	2.9	4.5	79.5	1	12.1	11.6
34	11	6-May-12	714	44 23 52	172 53 65	44 24 50	172 51 72	128	128	1.69	4.6	87.1	1	11.8	11
35	16	6-May-12	1132	44 34 86	172 48 96	44 36 52	172 45 69	380	383	2.85	4.3	86.7	1	10.9	7.8
36	15	6-May-12	1442	44 34 56	172 43 69	44 36 07	172 40 09	298	303	2.97	4.3	85.7	1	11.5	8.8
37	19	7-May-12	708	43 53 94	172 32 11	43 55 08	172 28 24	17	17	3.01	5.3	70.7	1	12.2	13.3
38	19	7-May-12	929	43 58 64	172 14 53	44 00 43	172 11 22	24	25	2.97	5	73.4	1	12.4	13.4
39	19	7-May-12	1112	44 01 79	172 08 72	44 03 46	172 05 19	23	23	3.03	5	74.9	1	12.7	13.4
40	19	7-May-12	1317	44 01 85	172 03 64	44 03 67	172 00 42	18	19	2.94	4.9	74.9	1	13.4	13.2
41	19	7-May-12	1542	44 05 59	171 58 42	44 07 53	171 55 39	22	23	2.91	4.8	75.1	1	13.4	13.2
42	20	9-May-12	1541	44 21 26	171 25 50	44 23 57	171 23 03	20	20	2.9	4.8	73.5	1	NA	NA
43	4	10-May-12	712	44 14 27	172 44 14	44 14 85	172 43 27	80	80	0.85	4.7	77.8	3	12.3	12
44	4	10-May-12	806	44 14 71	172 44 06	44 16 00	172 41 79	80	83	2.07	4.6	80.1	1	NA	NA
45	4	10-May-12	1020	44 23 57	172 29 68	44 25 48	172 26 41	86	91	3.01	4.7	79.4	1	11.4	11.4
46	10	12-May-12	1319	44 31 47	172 28 11	44 32 69	172 25 86	117	117	2.01	4.7	85.8	1	11.8	11.3
47	10	10-May-12	1549	44 28 19	172 39 44	44 30 28	172 36 41	126	129	3	4.6	83.3	1	12	10.6
48	5	11-May-12	704	43 55 67	173 17 66	43 55 77	173 15 38	71	73	1.64	4.8	74	1	12.4	12
49	5	11-May-12	824	43 57 13	173 09 18	43 57 54	173 05 12	69	70	2.95	4.7	72.6	1	12.6	12.3
50	5	11-May-12	1104	44 02 82	173 16 09	44 02 97	173 11 89	78	81	3.02	4.7	81.7	1	12.3	11.8
51	5	11-May-12	1314	44 09 68	173 08 65	44 10 40	173 04 65	90	93	2.95	4.8	89.5	1	12.5	11.5
52	15	12-May-12	715	44 37 75	172 39 66	44 39 21	172 36 36	352	362	2.76	4.4	91.2	1	11.4	8.5
53	15	12-May-12	1036	44 46 34	172 18 10	44 48 19	172 14 93	278	290	2.91	4.2	85.1	1	11.5	8.5
54	9	12-May-12	1256	44 45 18	172 14 03	44 46 47	172 11 92	123	138	1.97	4.5	81.9	1	11.7	11
55	9	12-May-12	1434	44 51 27	172 06 62	44 52 90	172 03 15	149	150	2.95	4.4	80.3	1	11.8	10.8
56	4	13-May-12	701	44 05 05	172 08 53	44 07 05	172 05 60	32	34	2.9	4.6	73.4	1	12.3	12.9
57	4	13-May-12	852	44 10 14	172 04 38	44 10 24	172 00 10	37	42	3.07	4.2	76.5	1	12.6	12.8
58	20	13-May-12	1055	44 11 69	171 50 08	44 12 24	171 45 91	27	30	3.03	4.4	74.7	1	12.7	13.1
59	4	13-May-12	1312	44 13 40	171 49 16	44 12 78	171 53 18	33	34	2.94	4.6	76.5	1	13.1	13

Appendix 3 – *continued*

				Lat/long start of tow		Lat/ long end of tow		Gear depth (m)		Dist. trawled	Headline	Door spread		Temperature (°C)	
Station	Stratum	Date	Time	° ' S	° ' E	° ' S	° ' E	Min.	Max.	(n. miles)	height (m)	(m)	Gear perf.	Surface	Bottom
60	4	13-May-12	1515	44 15 27	171 52 46	44 14 64	171 56 46	42	43	2.93	4.7	74.8	1	13	12.8
61	4	14-May-12	701	44 12 61	172 17 18	44 13 47	172 15 47	54	54	1.49	4.5	73.7	1	12.4	12.4
62	4	14-May-12	857	44 17 16	172 01 50	44 19 09	171 58 22	52	55	3.03	4.6	73.6	1	12.6	12.5
63	3	14-May-12	1102	44 17 60	171 50 92	44 19 74	171 47 86	48	48	3.06	4.6	74	1	12.7	12.7
64	3	14-May-12	1308	44 25 82	171 52 43	44 27 85	171 52 10	60	64	2.04	4.7	74.4	1	12.4	12.3
65	3	14-May-12	1440	44 32 26	171 49 78	44 30 87	171 53 45	68	70	2.96	4.8	75	1	12.4	11.9
66	20	24-May-12	734	44 31 18	171 16 77	44 33 79	171 14 72	17	19	2.99	5.4	72.4	1	15.2	10.9
67	20	24-May-12	920	44 36 22	171 18 98	44 33 75	171 21 48	25	25	3.04	5.4	72.4	1	11.4	11.4
68	3	24-May-12	1114	44 35 37	171 29 60	44 35 02	171 33 70	47	53	2.94	4.8	76.3	1	12.4	13.2
69	3	24-May-12	1336	44 30 84	171 32 19	44 28 20	171 34 08	47	47	2.96	5	74.6	1	15.7	13
70	3	24-May-12	1536	44 23 07	171 36 88	44 20 20	171 36 43	36	42	2.88	5.4	72.7	1	15	13.2
71	9	25-May-12	817	44 41 56	171 59 47	44 39 43	171 59 90	100	106	2.15	5.1	84.8	1	15.6	11.4
72	3	25-May-12	1022	44 32 74	172 03 43	44 30 98	172 04 42	81	86	1.89	4.9	84.6	1	11.7	11.3
73	3	25-May-12	1210	44 33 80	171 58 94	44 35 70	171 55 71	84	86	2.98	4.8	81.2	1	12.6	12.1
74	3	25-May-12	1359	44 40 05	171 53 33	44 41 98	171 50 13	93	94	2.98	5	78.3	1	12.2	12.1
75	3	25-May-12	1600	44 42 48	171 43 65	44 41 00	171 46 41	83	86	2.45	5	82	1	13.3	11.8
76	10	26-May-12	736	44 33 55	172 19 27	44 36 59	172 19 49	110	128	3.04	5	80.4	1	15.6	11.7
77	10	26-May-12	940	44 39 40	172 19 74	44 41 02	172 16 35	134	136	2.9	4.9	80	1	13	11.9
78	9	26-May-12	1148	44 43 77	172 07 51	44 45 01	172 03 75	126	129	2.94	5	82	1	14.1	12.2
79	14	26-May-12	1449	44 57 25	171 57 26	44 58 47	171 55 00	208	226	2.01	5	85.4	2	14.4	12.1
80	9	26-May-12	1616	44 57 09	171 50 29	44 54 57	171 48 08	120	128	2.96	5.1	81	1	13.3	12.3
81	20	27-May-12	801	44 35 01	171 16 64	44 38 05	171 16 07	23	24	3.06	5.3	74	1	17.9	12.4
82	21	27-May-12	1002	44 40 59	171 17 62	44 43 54	171 17 78	26	28	2.95	5.3	72.7	1	13.3	12.8
83	21	27-May-12	1322	44 49 11	171 18 03	44 51 99	171 16 81	18	23	3	5.5	75.6	1	15.8	12.5
84	21	27-May-12	1514	44 52 40	171 18 62	44 55 38	171 18 41	25	27	2.98	5.5	75.7	1	13.2	12.6
85	2	28-May-12	739	44 48 00	171 36 70	44 50 77	171 35 21	72	74	2.96	5	75.7	1	17.5	11.8
86	9	28-May-12	945	44 54 01	171 42 13	44 56 70	171 40 29	103	106	2.98	5	83	1	12.7	11.6
87	14	28-May-12	1224	45 05 36	171 44 45	45 07 66	171 41 96	215	240	2.89	5	82.6	1	NA	NA
88	8	28-May-12	1434	45 02 96	171 35 36	45 04 79	171 32 04	105	109	2.97	4.9	75.5	1	NA	NA
89	14	29-May-12	742	45 22 24	171 25 17	45 20 12	171 28 23	235	258	3.01	4.9	94.7	1	14.4	10

Appendix 3 – *continued*

Station	Stratum	Date	Time	Lat/long start of tow ° ' S	° ' E	Lat/ long end of tow ° ' S	° ' E	Gear depth (m) Min.	Max.	Dist. trawled (n. miles)	Headline height (m)	Doorspread (m)	Gear perf.	Temperature. (°C) Surface	Bottom
90	14	29-May-12	941	45 19 42	171 29 82	45 16 84	171 32 33	292	328	3.12	5.3	94.7	1	10.3	10.2
91	8	29-May-12	1313	45 16 47	171 30 22	45 13 88	171 32 25	134	145	2.95	5.3	84	1	12.3	10.8
92	2	29-May-12	1605	45 01 97	171 18 98	44 59 06	171 19 08	38	43	2.91	5.2	76.3	1	11.7	10.6
93	1	31-May-12	744	45 30 06	170 58 80	45 27 82	171 00 60	44	44	2.57	5.2	75.4	4	NA	NA
94	1	2-Jun-12	730	45 29 68	170 59 64	45 26 62	170 59 87	39	45	3.06	5.4	74.9	1	17.2	11.6
95	1	2-Jun-12	921	45 27 46	171 05 16	45 24 43	171 05 60	50	55	3.04	5.4	73.9	1	12.9	11.6
96	8	2-Jun-12	1223	45 27 44	171 15 78	45 25 21	171 18 55	111	120	2.95	5.4	85.2	1	11.3	11.8
97	8	2-Jun-12	1511	45 13 50	171 23 65	45 10 66	171 24 77	103	105	2.94	5.4	81.5	1	13	12.3
98	1	3-Jun-12	733	45 18 56	171 11 01	45 15 71	171 12 19	50	51	2.96	5.2	76.4	1	18.1	11.8
99	2	3-Jun-12	1141	45 09 43	171 13 02	45 11 97	171 10 66	40	44	3.03	5	79.1	2	11.4	10.9
100	1	3-Jun-12	1337	45 13 59	171 08 01	45 10 91	171 09 69	34	38	2.92	5.4	74.3	3	11.6	10.5
101	1	4-Jun-12	741	45 10 90	171 09 68	45 13 86	171 07 83	32	35	3.23	5.2	75.1	2	14.5	9.9
102	2	4-Jun-12	1030	45 09 57	171 14 19	45 06 57	171 15 06	43	46	3.06	5.5	75.7	1	9.2	10.9
103	2	4-Jun-12	1220	45 03 60	171 20 00	45 06 29	171 18 04	53	55	3.02	5.3	73	1	11.1	11
104	1	4-Jun-12	1529	45 12 02	171 14 31	45 14 93	171 12 95	53	54	3.06	5.3	73.8	1	14.1	11.1
105	19	5-Jun-12	742	44 04 53	172 04 19	44 06 28	172 00 82	24	25	2.98	5.5	74.5	1	NA	NA
106	19	5-Jun-12	1005	44 07 85	171 54 61	44 09 47	171 51 22	22	23	2.92	5.4	76.6	1	NA	NA
107	5	5-Jun-12	1454	44 01 50	172 35 88	44 00 17	172 39 64	52	54	3.01	5.5	75.8	1	NA	NA

Appendix 4: Gear parameters for biomass stations by depth range. N, number of stations; s.d., standard deviation.

	N	Mean	s.d.	Range
All stations				
Headline height (m)	104	4.8	0.37	4.1–5.5
Doorspread (m)	104	78.8	5.95	67.8–96.7
Distance (n. miles)	104	2.8	0.43	1.5–3.2
Warp:depth ratio	104	4.5	2.63	2.2–13.3
Core survey (30–400 m)				
30–400 m				
Headline height (m)	84	4.8	0.35	4.1–5.5
Doorspread (m)	84	80.1	5.81	70.5–96.7
Distance (n. miles)	84	2.7	0.46	1.5–3.2
Warp:depth ratio	84	3.4	1.02	2.2–6.7
30–100 m				
Headline height (m)	46	4.8	0.35	4.1–5.5
Doorspread (m)	46	76.4	3.56	70.5–89.5
Distance (n. miles)	46	2.8	0.49	1.5–3.2
Warp:depth ratio	46	3.9	1.1	2.8–6.7
100–200 m				
Headline height (m)	25	4.8	0.33	4.3–5.4
Doorspread (m)	25	82.2	3.02	75.5–87.1
Distance (n. miles)	25	2.7	0.47	1.6–3.1
Warp:depth ratio	25	2.8	0.18	2.2–3.2
200–400 m				
Headline height (m)	13	4.6	0.37	4.1–5.3
Doorspread (m)	13	88.9	4.78	81.9–96.7
Distance (n. miles)	13	2.8	0.36	2–3.1
Warp:depth ratio	13	2.5	0.12	2.3–2.8
Shallow strata (10–30 m)				
Headline height (m)	20	5.1	0.33	4.4–5.5
Doorspread (m)	20	73.3	2.26	67.8–76.6
Distance (n. miles)	20	3	0.19	2.2–3.1
Warp:depth ratio	20	9.3	1.71	6.7–13.3

Appendix 5: Species codes, common names, scientific names, total catch, percent of total catch, percent occurrence, depth range and number stations caught for core strata (30–400 m) (A) and shallow (10–30 m) (B) in 2012. In order of catch weight.

(A) 30–400 m

Species code	Common name	*Scientific name*	Catch (kg)	% catch	% occ.	Depth (m)		Stations
						Min	Max	
BAR	Barracouta	*Thyrsites atun*	47 973.5	31.2	85.7	30	350	72
SPD	Spiny dogfish	*Squalus acanthias*	46 503.3	30.2	97.6	30	383	82
GSH	Ghost shark	*Hydrolagus novaezealandiae*	17 432.3	11.3	36.9	80	383	31
RCO	Red cod	*Pseudophycis bachus*	13 632.2	8.9	70.2	30	362	59
NOS	NZ southern arrow squid	*Nototodarus sloanii*	3 221.7	2.1	91.7	30	383	77
SPE	Sea perch	*Helicolenus spp.*	3 179.3	2.1	71.4	30	362	60
ELE	Elephantfish	*Callorhinchus milii*	2 595.7	1.7	38.1	30	126	32
GUR	Gurnard	*Chelidonichthys kumu*	2 361.0	1.5	58.3	30	128	49
NMP	Tarakihi	*Nemadactylus macropterus*	1 892.9	1.2	63.1	30	323	53
SSK	Smooth skate	*Dipturus innominatus*	1 661.9	1.1	54.8	30	383	46
RSK	Rough skate	*Zearaja nasuta*	1 637.5	1.1	58.3	30	362	49
CAR	Carpet shark	*Cephaloscyllium isabellum*	1 402.1	0.9	83.3	30	314	70
SWA	Silver warehou	*Seriolella punctata*	911.4	0.6	61.9	30	362	52
CAS	Oblique banded rattail	*Coelorinchus aspercephalus*	880.6	0.6	14.3	86	383	12
GIZ	Giant stargazer	*Kathetostoma giganteum*	851.2	0.6	73.8	32	383	62
WIT	Witch	*Arnoglossus scapha*	849.4	0.6	86.9	30	362	73
SCG	Scaly gurnard	*Lepidotrigla brachyoptera*	720.4	0.5	70.2	32	155	59
CBI	Two saddle rattail	*Coelorinchus biclinozonalis*	713.9	0.5	15.5	30	350	13
LEA	Leatherjacket	*Meuschenia scaber*	582.2	0.4	17.9	30	52	15
LIN	Ling	*Genypterus blacodes*	567.2	0.4	39.3	42	383	33
HOK	Hoki	*Macruronus novaezelandiae*	534.0	0.3	10.7	47	383	9

JAV	Javelin fish	*Lepidorhynchus denticulatus*	375.3	0.2	6.0	280	383	5
SCH	School shark	*Galeorhinus galeus*	355.3	0.2	51.2	30	143	43
PIG	Pigfish	*Congiopodus leucopaecilus*	326.4	0.2	60.7	30	383	51
HAP	Hapuku	*Polyprion oxygeneios*	312.9	0.2	39.3	32	278	33
SAL	Salps		259.7	0.2	33.3	84	383	28
SPO	Rig	*Mustelus lenticulatus*	248.1	0.2	21.4	30	112	18
BCO	Blue cod	*Parapercis colias*	217.3	0.1	26.2	33	155	22
FHD	Deepsea flathead	*Hoplichthys haswelli*	177.9	0.1	10.7	155	383	9
CBO	Bollons rattail	*Coelorinchus bollonsi*	137.6	0.1	4.8	128	383	4
LSO	Lemon sole	*Pelotretis flavilatus*	130.9	0.1	51.2	30	323	43
JMD	Greenback jack mackerel	*Trachurus declivis*	104.3	0.1	28.6	32	128	24
PYR	Pyrosoma atlanticum	*Pyrosoma atlanticum*	89.2	0.1	32.1	84	383	27
ERA	Electric ray	*Torpedo fairchildi*	79.2	0.1	8.3	33	221	7
SSI	Silverside	*Argentina elongata*	64.9	0.0	42.9	60	383	36
WOD	Wood	Wood	60.3	0.0	6.0	30	93	5
OCT	Octopus	*Pinnoctopus cordiformis*	57.5	0.0	16.7	32	300	14
SFL	Sand flounder	*Rhombosolea plebeia*	51.7	0.0	8.3	30	53	7
MOK	Moki	*Latridopsis ciliaris*	49.7	0.0	11.9	32	114	10
LDO	Lookdown dory	*Cyttus traversi*	46.9	0.0	3.6	314	383	3
SDO	Silver dory	*Cyttus novaezealandiae*	46.4	0.0	35.7	32	155	30
CBE	Crested bellowsfish	*Notopogon lilliei*	43.1	0.0	31.0	60	155	26
CON	Conger eel	*Conger spp.*	41.6	0.0	3.6	36	45	3
JMM	Slender jack mackerel	*Trachurus murphyi*	36.7	0.0	11.9	42	118	10
WAR	Common warehou	*Seriolella brama*	36.6	0.0	14.3	30	106	12
WWA	White warehou	*Seriolella caerulea*	33.7	0.0	6.0	278	383	5
SHW	Short-finned pilot whale	*Globicephala macrorhynchus*	31.4	0.0	1.2	303	303	1
SRB	Southern rays bream	*Brama australis*	27.5	0.0	3.6	323	383	3
BRA	Short-tailed black ray	*Dasyatis brevicaudata*	25	0.0	1.2	43	43	1
SEO	Seaweed		22.2	0.0	7.1	70	362	6

SPR	Sprats	*Sprattus antipodum, S. muelleri*	21.8	0.0	8.3	30	47	7
SCC	Sea cucumber	*Stichopus mollis*	21.1	0.0	40.5	32	362	34
KIN	Kingfish	*Seriola lalandi*	19.3	0.0	1.2	43	43	1
COF	Flabellum coral	*Flabellum spp.*	17.9	0.0	3.6	278	383	3
ESO	N.Z. sole	*Peltorhamphus novaezeelandiae*	17.9	0.0	7.1	30	42	6
BTA	Smooth deepsea skate	*Brochiraja asperula*	15.8	0.0	4.8	300	383	4
KAH	Kahawai	*Arripis trutta, A. xylabion*	13.9	0.0	6.0	32	48	5
HMT	Deepsea anemone	Hormathiidae	13.5	0.0	27.4	78	383	23
TOD	Dark toadfish	*Neophrynichthys latus*	12.4	0.0	27.4	32	383	23
ACS	Deepsea anemone	*Actinostolidae*	10.9	0.0	19.0	80	300	16
SCO	Swollenhead conger	*Bassanago bulbiceps*	10.3	0.0	2.4	362	383	2
DAP	Antlered crab	*Dagnaudus petterdi*	9.8	0.0	1.2	323	323	1
DEA	Dealfish	*Trachipterus trachypterus*	9.4	0.0	1.2	323	323	1
STY	Spotty	*Notolabrus celidotus*	8.5	0.0	4.8	30	43	4
YCO	Yellow cod	*Parapercis gilliesi*	7.5	0.0	6.0	84	126	5
SBW	Southern blue whiting	*Micromesistius australis*	7.4	0.0	2.4	300	383	2
FMA	*Fusitriton magellanicus*	*Fusitriton magellanicus*	6.7	0.0	27.4	86	383	23
SMO	Cross-fish	*Sclerasterias mollis*	6.6	0.0	23.8	41	314	20
ONG	Sponges	Porifera (Phylum)	6.3	0.0	14.3	43	280	12
GON	*Gonorynchus forsteri & G. Greyi*	*Gonorynchus forsteri & G. greyi*	6	0.0	6.0	42	323	5
BAM	Bathyplotes spp.	*Bathyplotes spp.*	4.8	0.0	4.8	87	129	4
LLC	Long-legged masking crab	*Leptomithrax longipes*	4.8	0.0	17.9	47	155	15
ASC	Sea squirt	Ascidiacea	4.5	0.0	6.0	70	323	5
SAM	Quinnat salmon	*Oncorhynchus tshawytscha*	4.4	0.0	2.4	30	41	2
EMA	Blue mackerel	*Scomber australasicus*	4.3	0.0	2.4	32	54	2
SCI	Scampi	*Metanephrops challengeri*	4.1	0.0	7.1	300	383	6
JDO	John dory	*Zeus faber*	3.9	0.0	3.6	33	46	3
ROK	Rocks stones	Geological specimens	3.7	0.0	1.2	280	280	1
DIR	Pagurid	*Diacanthurus rubricatus*	3.5	0.0	22.6	30	280	19
BNS	Bluenose	*Hyperoglyphe antarctica*	3.4	0.0	1.2	300	300	1

COU	Coral (unspecified)		3.2	0.0	2.4	87	300	2
HAK	Hake	*Merluccius australis*	3.2	0.0	2.4	30	36	2
JFI	Jellyfish		3	0.0	2.4	110	314	2
NUD	Nudibranchia	*Nudibranchia (Order)*	3	0.0	4.8	78	126	4
MDO	Mirror dory	*Zenopsis nebulosa*	2.7	0.0	2.4	280	323	2
PRU	*Pseudechinaster rubens*	*Pseudechinaster rubens*	2.7	0.0	4.8	104	323	4
TRU	Trumpeter	*Latris lineata*	2	0.0	1.2	109	109	1
CIC	Orange frond sponge	*Crella incrustans*	1.6	0.0	6.0	43	54	5
CRS	Airy finger sponge	*Callyspongia ramosa*	1.6	0.0	6.0	32	53	5
PSI	Geometric star	*Psilaster acuminatus*	1.6	0.0	3.6	128	314	3
ATA	*Alcithoe arabica*	*Alcithoe arabica*	1.4	0.0	6.0	66	126	5
BER	Numbfish	*Typhlonarke spp.*	1.3	0.0	1.2	87	87	1
JMN	Yellowtail jack mackerel	*Trachurus novaezelandiae*	1.1	0.0	1.2	30	30	1
CDO	Capro dory	*Capromimus abbreviatus*	0.9	0.0	9.5	54	383	8
DMG	*Dipsacaster magnificus*	*Dipsacaster magnificus*	0.9	0.0	1.2	362	362	1
TOP	Pale toadfish	*Ambophthalmos angustus*	0.9	0.0	2.4	150	300	2
DCS	Dawson's catshark	*Bythaelurus dawsoni*	0.8	0.0	3.6	118	383	3
OYS	Oysters dredge	*Ostrea chilensis*	0.8	0.0	3.6	33	68	3
TRE	Trevally	*Pseudocaranx georgianus*	0.8	0.0	1.2	32	32	1
OPA	Opalfish	*Hemerocoetes spp.*	0.7	0.0	8.3	47	362	7
PNE	*Proserpinaster neozelanicus*	*Proserpinaster neozelanicus*	0.7	0.0	1.2	323	323	1
PTB	*Pteraster bathamae*	*Pteraster bathamae*	0.7	0.0	2.4	128	280	2
BIV	Bivalves unidentified	Bivalvia	0.6	0.0	1.2	113	113	1
BTS	Prickly deepsea skate	*Brochiraja spinifera*	0.6	0.0	1.2	350	350	1
ECN	Echinoid (sea urchin)		0.6	0.0	3.6	32	42	3
QSC	Queen scallop	*Zygochlamys delicatula*	0.6	0.0	2.4	109	143	2
CAC	Cancer crab	*Cancer novaezelandiae*	0.5	0.0	4.8	30	114	4
MUS	Mussels		0.5	0.0	1.2	33	33	1
ASR	Asteroid (starfish)		0.4	0.0	2.4	33	280	2

BBE	Banded bellowsfish	*Centriscops humerosus*	0.4	0.0	2.4	104	314	2
CSS	Maurea	*Calliostoma selectum*	0.4	0.0	3.6	41	112	3
LHC	Long-handed masking crab	*Leptomithrax longimanus*	0.4	0.0	1.2	109	109	1
LMI	Masking crabs	*Leptomithrax spp.*	0.4	0.0	3.6	102	111	3
NCA	Hairy red swimming crab	*Nectocarcinus antarcticus*	0.4	0.0	4.8	32	108	4
ASH	Circular saw shell	*Astraea heliotropium*	0.3	0.0	2.4	42	45	2
CPT	Chaetopterus	*Chaetopterus*	0.3	0.0	2.4	84	93	2
ODT	Pentagonal tooth-star	*Odontaster spp.*	0.3	0.0	1.2	314	314	1
POL	Polychaete	Polychaeta	0.3	0.0	2.4	47	53	2
RHY	Common roughy	*Paratrachichthys trailli*	0.3	0.0	1.2	113	113	1
COZ	Bryozoan	Bryozoa (Phylum)	0.2	0.0	2.4	84	109	2
CRB	Crab		0.2	0.0	1.2	118	118	1
EGC	Egg case		0.2	0.0	1.2	135	135	1
KWH	Knobbed whelk	*Austrofucus glans*	0.2	0.0	2.4	85	86	2
MSL	Starfish	*Mediaster sladeni*	0.2	0.0	2.4	102	300	2
OMA	Red snakestar	*Ophiopsammus maculata*	0.2	0.0	2.4	44	51	2
PAG	Pagurid	*Paguroidea*	0.2	0.0	1.2	150	150	1
PHU	Sea urchin	*Pseudechinus huttoni*	0.2	0.0	1.2	86	86	1
APT	*Argobuccinum pustulosum tumidum*	*Argobuccinum pustulosum tumidum*	0.1	0.0	1.2	112	112	1
BRN	Barnacle	Cirripedia (Class)	0.1	0.0	1.2	42	42	1
GPA	Sea urchin	*Goniocidaris parasol*	0.1	0.0	1.2	278	278	1
HDR	Hydroid	Hydrozoa (Class)	0.1	0.0	1.2	143	143	1
MNI	Munida unidentified	*Munida spp.*	0.1	0.0	1.2	208	208	1
OPE	Orange perch	*Lepidoperca aurantia*	0.1	0.0	1.2	102	102	1
RSC	Red scorpion fish	*Scorpaena papillosa*	0.1	0.0	1.2	43	43	1
Total			153 922.6					

(B) 10–30 m

Species code	Common name	Scientific name	Catch (kg)	% catch	% occ.	Depth (m)		Stations
						Min	Max	
SPD	Spiny dogfish	*Squalus acanthias*	6 942.8	24.4	100	15	30	20
ELE	Elephantfish	*Callorhinchus milii*	5 580.6	19.6	85	15	30	17
BAR	Barracouta	*Thyrsites atun*	5 112.4	18.0	100	15	30	20
LEA	Leatherjacket	*Meuschenia scaber*	4 108.1	14.4	75	15	30	15
GUR	Gurnard	*Chelidonichthys kumu*	3 936.8	13.8	100	15	30	20
RSK	Rough skate	*Zearaja nasuta*	602.5	2.1	100	15	30	20
RCO	Red cod	*Pseudophycis bachus*	545.8	1.9	85	15	30	17
GLB	Globefish	*Contusus richei*	353.7	1.2	25	15	25	5
SPO	Rig	*Mustelus lenticulatus*	330.6	1.2	80	15	30	16
WAR	Common warehou	*Seriolella brama*	180.8	0.6	70	15	30	14
CAR	Carpet shark	*Cephaloscyllium isabellum*	110.5	0.4	75	17	30	15
NOS	NZ southern arrow squid	*Nototodarus sloanii*	80.7	0.3	100	15	30	20
ERA	Electric ray	*Torpedo fairchildi*	77.6	0.3	20	15	25	4
SSK	Smooth skate	*Dipturus innominatus*	70.2	0.2	15	18	26	3
SFL	Sand flounder	*Rhombosolea plebeia*	65.7	0.2	90	15	30	18
NMP	Tarakihi	*Nemadactylus macropterus*	59.5	0.2	45	18	30	9
SPR	Sprats	*Sprattus antipodum, S. muelleri*	43.4	0.2	80	15	30	16
CON	Conger eel	*Conger spp.*	41.4	0.1	20	17	25	4
SCH	School shark	*Galeorhinus galeus*	35.2	0.1	80	15	30	16
ESO	N.Z. sole	*Peltorhamphus novaezeelandiae*	31.7	0.1	75	15	30	15
POP	Porcupine fish	*Allomycterus jaculiferus*	20.2	0.1	5	17	17	1
ROK	Rocks stones	*Geological specimens*	19.7	0.1	5	18	18	1
KAH	Kahawai	*Arripis trutta, A. xylabion*	19.5	0.1	30	15	24	6
HAP	Hapuku	*Polyprion oxygeneios*	12.4	0.0	15	25	26	3
PAD	Paddle crab	*Ovalipes catharus*	12.3	0.0	15	15	19	3

SWA	Silver warehou	*Seriolella punctata*	10.1	0.0	60	18	30	12
GFL	Greenback flounder	*Rhombosolea tapirina*	9.2	0.0	20	15	25	4
MOK	Moki	*Latridopsis ciliaris*	7.2	0.0	5	23	23	1
WIT	Witch	*Arnoglossus scapha*	6.8	0.0	40	18	30	8
BRI	Brill	*Colistium guntheri*	6.5	0.0	15	20	25	3
SPZ	Spotted stargazer	*Genyagnus monopterygius*	6.4	0.0	10	15	19	2
STY	Spotty	*Notolabrus celidotus*	4.7	0.0	10	23	25	2
JFI	Jellyfish		3.6	0.0	10	17	25	2
WOD	Wood	Wood	3.5	0.0	10	17	20	2
SAM	Quinnat salmon	*Oncorhynchus tshawytscha*	2.3	0.0	5	25	25	1
JDO	John dory	*Zeus faber*	2.2	0.0	5	23	23	1
PIG	Pigfish	*Congiopodus leucopaecilus*	1.7	0.0	35	18	30	7
LSO	Lemon sole	*Pelotretis flavilatus*	1.6	0.0	20	23	25	4
LIN	Ling	*Genypterus blacodes*	1.4	0.0	10	23	25	2
XPP	Spotted shag	*Phalacrocorax punctatus*	1.3	0.0	5	23	23	1
BRN	Barnacle	Cirripedia (Class)	1.2	0.0	10	18	22	2
BCO	Blue cod	*Parapercis colias*	1.1	0.0	10	22	25	2
FZE	Sand dollar	*Fellaster zelandiae*	1.1	0.0	25	17	25	5
PCO	Ahuru	*Auchenoceros punctatus*	1.1	0.0	20	19	25	4
TOD	Dark toadfish	*Neophrynichthys latus*	1.1	0.0	20	19	30	4
ASR	Asteroid (starfish)		0.6	0.0	10	22	25	2
JMD	Greenback jack mackerel	*Trachurus declivis*	0.4	0.0	5	20	20	1
PSN	Sea urchin	*Pseudechinus novaezealandiae*	0.4	0.0	5	23	23	1
SDO	Silver dory	*Cyttus novaezealandiae*	0.3	0.0	10	25	26	2
ASC	Sea squirt	Ascidiacea	0.2	0.0	10	19	23	2
CAC	Cancer crab	*Cancer novaezelandiae*	0.2	0.0	10	18	24	2
SCA	Scallop	*Pecten novaezelandiae*	0.2	0.0	5	30	30	1
SCC	Sea cucumber	*Stichopus mollis*	0.2	0.0	5	23	23	1
DIR	Pagurid	*Diacanthurus rubricatus*	0.1	0.0	5	19	19	1
FMA	*Fusitriton magellanicus*	*Fusitriton magellanicus*	0.1	0.0	5	20	20	1

HOK	Hoki	*Macruronus novaezelandiae*	0.1	0.0	5	15	15	1
JMN	Yellowtail jack mackerel	*Trachurus novaezelandiae*	0.1	0.0	5	18	18	1
OPA	Opalfish	*Hemerocoetes spp.*	0.1	0.0	5	22	22	1
SAZ	Sand stargazer	*Crapatalus novaezelandiae*	0.1	0.0	5	15	15	1
SCG	Scaly gurnard	*Lepidotrigla brachyoptera*	0.1	0.0	5	23	23	1
Total			28 471.4					

Appendix 6: Macro-invertebrates collected on the 2012 survey not included in Appendix 5.

Phylum	Class	Order	Family	Taxon	Station ID	Count
Annelida	Oligochaeta (includes leeches)	Euhirudinea		*Euhirudinea*	KAH1207/69	1
Annelida	Polychaeta	Spionida	Chaetopteridae	*Spiochaetopterus*	KAH1207/23	1
Annelida	Polychaeta	Spionida	Chaetopteridae	*Spiochaetopterus*	KAH1207/23	10
Annelida	Polychaeta	Spionida	Chaetopteridae	*Spiochaetopterus*	KAH1207/95	50
Arthropoda	Malacostraca	Decapoda	Homolidae	*Dagnaudus petterdi*	KAH1207/1	1
Arthropoda	Malacostraca	Decapoda	Paguridae	*Diacanthurus spinulimanus*	KAH1207/2	1
Bryozoa	Gymnolaemata	Cheilostomatida	Arachnopusiidae	*Arachnopusia unicornis*	KAH1207/23	1
Bryozoa	Gymnolaemata	Cheilostomatida	Beaniidae	*Beania discodermiae*	KAH1207/23	1
Bryozoa	Gymnolaemata	Cheilostomatida	Buffonellodidae	*Aimulosia marsupium*	KAH1207/23	1
Bryozoa	Gymnolaemata	Cheilostomatida	Calloporidae	*Crassimarginatella cucullata*	KAH1207/23	3
Bryozoa	Gymnolaemata	Cheilostomatida	Candidae	*Caberea rostrata*	KAH1207/23	2
Bryozoa	Gymnolaemata	Cheilostomatida	Cellariidae	*Cellaria tenuirostris*	KAH1207/23	2
Bryozoa	Gymnolaemata	Cheilostomatida	Celleporidae	*Celleporina hemiperistomata*	KAH1207/23	2
Bryozoa	Gymnolaemata	Cheilostomatida	Celleporidae	*Galeopsis polyporus*	KAH1207/23	2
Bryozoa	Gymnolaemata	Cheilostomatida	Celleporidae	*Galeopsis porcellanicus*	KAH1207/23	2
Bryozoa	Gymnolaemata	Cheilostomatida	Chaperiidae	*Chaperiopsis lanceola*	KAH1207/23	16
Bryozoa	Gymnolaemata	Cheilostomatida	Cribrilinidae	*'Figularia' huttoni*	KAH1207/23	22
Bryozoa	Gymnolaemata	Cheilostomatida	Escharinidae	*Hippomenella vellicata*	KAH1207/23	17
Bryozoa	Gymnolaemata	Cheilostomatida	Foveolariidae	*Odontionella cyclops*	KAH1207/23	2
Bryozoa	Gymnolaemata	Cheilostomatida	Microporellidae	*Microporella agonistes*	KAH1207/23	3
Bryozoa	Gymnolaemata	Cheilostomatida	Romancheinidae	*Escharella spinosissima*	KAH1207/23	72
Bryozoa	Stenolaemata	Cyclostomatida	Diaperoeciidae	*Diaperoecia purpurascens*	KAH1207/23	2
Cnidaria	Anthozoa	Actiniaria	Actinostolidae	Actinostolidae	KAH1207/2	1
Cnidaria	Anthozoa	Scleractinia	Flabellidae	*Flabellum knoxi*	KAH1207/30	2
Cnidaria	Hydrozoa	Anthoathecata		Anthoathecata	KAH1207/91	2

Appendix 6 – *continued*

Cnidaria	Hydrozoa	Leptothecata	Syntheciidae	*Synthecium megathecum*	KAH1207/23	1
Echinodermata	Asteroidea	Valvatida	Odontasteridae	*Diplodontias miliaris*	KAH1207/96	1
Echinodermata	Echinoidea	Temnopleuroida	Temnopleuridae	*Pseudechinus novaezealandiae*	KAH1207/56	3
Echinodermata	Holothuroidea (Class)	Aspidochirotida	Synallactidae	*Bathyplotes cf. moseleyi*	KAH1207/2	1
Foraminifera	Polythalamea	Rotaliida	Acervulinidae	*Acervulina inhaerens*	KAH1207/23	2
Mollusca	Bivalvia			Bivalvia	KAH1207/4	2
Mollusca	Bivalvia	Ostreoida	Pectinidae	Pectinidae	KAH1207/91	3
Mollusca	Bivalvia	Ostreoida	Pectinidae	Pectinidae	KAH1207/23	2
Mollusca	Gastropoda Prosobranchia	Neogastropoda	Volutidae	Alcithoe	KAH1207/8	1
Mollusca	Gastropoda Prosobranchia	Vetigastropoda	Calliostomatidae	Calliostoma	KAH1207/3	1
Porifera	Demospongiae	Haplosclerida	Callyspongiidae	*Callyspongia Callyspongia* n. sp. 12	KAH1207/97	1
Porifera	Demospongiae	Haplosclerida	Callyspongiidae	*Callyspongia Callyspongia* n. sp. 12	KAH1207/94	2
Porifera	Demospongiae	Haplosclerida	Callyspongiidae	*Dactylia palmata*	KAH1207/96	2
Porifera	Demospongiae	Poecilosclerida	Crellidae	*Crella (Pytheas) fristedti*	KAH1207/91	1
Porifera	Demospongiae	Poecilosclerida	Crellidae	*Crella incrustans*	KAH1207/92	1

Appendix 7: Length weight coefficients used to scale length frequencies. – data missing. DB, MPI trawl database. W = aL^b where W is weight (g) and L is length (cm).

Species	*a*	*b*	n	Range Min.	Range Max.	Data source
Barracouta	0.0055	2.9812	429	23.8	87.2	DB, KAH9701
Blue cod	0.0122	3.0746	2137	12	47	DB, LHR9501
Blue warehou	0.0144	3.105	338	27.4	69.6	DB, TAN9604
Chilean jack mackerel	0.0171	3.27	488	30.7	62	DB, TAN9502
Dark ghost shark	0.0015	3.352	494	20.3	72.4	This survey
Elephantfish	0.0065	3.0997	598	22.5	93.6	This survey
Giant stargazer	0.0108	3.1114	568	17.4	78.6	This survey
Hapuku	0.0078	3.14	307	49	107	DB, TAN9301
Hoki	0.0046	2.884	525	22	110	DB, SHI8301
Leather jacket	0.0088	3.211	-	-	-	DB, IKA8003
Lemon sole	0.0080	3.1278	524	14.6	41.2	DB, KAH9809
Ling	0.0013	3.2801	179	32.2	123.7	DB, KAH0004
Red cod	0.0095	2.9997	888	7.1	76.1	This survey
Red gurnard	0.0047	3.1841	867	10.3	54.1	This survey
Rig	0.0037	3.031	296	36.1	111	This survey
Rough skate	0.0334	2.8821	730	10.3	71	This survey
School shark	0.0018	3.2392	262	35.4	110.7	This survey
Sea perch	0.0102	3.1621	874	10.3	42.6	This survey
Silver warehou	0.0048	3.38	262	16.6	57.8	DB, TAN9502
Smooth skate	0.0375	2.8604	293	13.2	133	This survey
Spiny dogfish	0.0023	3.1161	1798	28.8	100.4	This survey
Tarakihi	0.0133	3.1072	920	9.9	46.3	This survey