Fisheries New Zealand

Tini a Tangaroa

Inshore trawl survey of Canterbury Bight and Pegasus Bay, May–June 2022 (KAH2204)

New Zealand Fisheries Assessment Report 2023/35

M.P. Beentjes,
D.J. MacGibbon,
P. Escobar-Flores

ISSN 1179-5352 (online)
ISBN 978-1-991087-25-6 (online)

July 2023

Te Kāwanatanga o Aotearoa
New Zealand Government

Disclaimer

Requests for further copies should be directed to:

Fisheries Science Editor
Fisheries New Zealand
Ministry for Primary Industries
PO Box 2526
Wellington 6140
NEW ZEALAND

Email: Fisheries-Science.Editor@mpi.govt.nz
Telephone: 0800 00 83 33

This publication is also available on the Ministry for Primary Industries websites at:
http://www.mpi.govt.nz/news-and-resources/publications
http://fs.fish.govt.nz go to Document library/Research reports

Please cite this report as:

Beentjes, M.P.; MacGibbon, D.J.; Escobar-Flores, P. (2023). Inshore trawl survey of Canterbury Bight and Pegasus Bay, May–June 2022 (KAH2204). *New Zealand Fisheries Assessment Report 2023/35.* 147 p.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Beentjes, M.P.[1]; MacGibbon, D.J.; Escobar-Flores, P. (2023). Inshore trawl survey of Canterbury Bight and Pegasus Bay, April–June 2022 (KAH2204).

New Zealand Fisheries Assessment Report 2023/35. **147 p.**

A bottom trawl survey of the east coast South Island (ECSI) at 10–400 m depths was carried out using R.V. *Kaharoa* (trip code KAH2204) from 2 May to 23 June 2022. The core strata (30–400 m) survey was the fourteenth in the winter ECSI inshore time series (1991–1994, 1996, 2007–2009, 2012, 2014, 2016, 2018, 2021, and 2022). Four shallow strata (10–30 m), included in 2007, 2012, 2014, 2016, 2018, and 2021, were again surveyed in 2022 to monitor elephantfish and red gurnard over their full depth range. The full depth range surveys (10–400 m) are referred to as core plus shallow. To improve tarakihi survey precision, before beginning the 2022 survey, strata 3 and 4 were subdivided along the 55 m depth contour, increasing the total number of strata from 21 to 23.

A two-phase, stratified random trawl survey design was optimised for the target species dark ghost shark (*Hydrolagus novaezelandiae*), giant stargazer (*Kathetostoma giganteum*), red cod (*Pseudophycis bachus*), sea perch (*Helicolenus percoides*), spiny dogfish (*Squalus acanthias*), and tarakihi (*Nemadactylus macropterus*) in the core strata; and elephantfish (*Callorhinchus milii*) and red gurnard (*Chelidonichthys kumu*) in the core plus shallow strata. A total of 99 valid stations or tows (gear performance of 1 or 2) were completed and of these, 87 (80 phase one and 7 phase two) were in the core strata, and 12 were in the shallow strata (3 phase one in each of the four strata). Biomass estimates and coefficients of variation (CV) for the target species in the core strata were: dark ghost shark 12 519 t (27%); elephantfish 798 t (36%); giant stargazer 1092 t (16%); red cod 1943 t (25%); red gurnard 3410 t (30%); sea perch 2164 t (30%); spiny dogfish 27 030 t (33%); and tarakihi 1049 t (25%). Biomass estimates and CVs for elephantfish and red gurnard in the core plus shallow strata were 987 t (29%) and 5472 t (20%), respectively, with the shallow strata (10–30 m) accounting for 19% of the biomass of elephantfish and 38% of the biomass of red gurnard. The non-target species rig (*Mustelus lenticulatus*) and rough skate (*Zearaja nasuta*) were also caught in any significant quantities inside 10–30 m. Otoliths were collected from the target species giant stargazer (*n* = 633), red cod (*n* = 878), red gurnard (*n* = 905), sea perch (*Helicolenus percoides*) (*n* = 592), tarakihi (*n* = 612); as well as bigeye sea perch (*H. barathri*) (*n* = 83), slender jack mackerel (*Trachurus murphyi*) (*n* = 1), yellowtail jack mackerel (*T. novaezelandiae*) (*n* = 69), and greenback jack mackerel (*T. declivis*) (*n* = 58).

Data are presented on the 2022 survey catch rates, biomass, spatial distribution, and length frequencies for the eight target and eight non-target Quota Management System (QMS) species. Survey time series plots of spatial distribution are presented, as well as biomass and length frequency distribution plots for core strata species, and for core plus shallow strata for red gurnard, elephantfish, and key non-target species rig and rough skate. Trends in biomass and size distributions are discussed in the report.

An analysis of mean rankings for the eight target species, plus the eight key non-target QMS species across all fourteen core strata surveys in the time series showed catchability of the 1992 and 1994 surveys was just below the lower 95% confidence interval and the 2014 survey was close to the upper the confidence interval; by definition, the 1992 and 1994 surveys had extreme low catchability. However, when only the eight target species were examined, all surveys were within the confidence intervals and cannot be regarded as having extreme catchability. The representativeness analyses for the eight target species for the seven core plus shallow strata ECSI winter trawl all surveys fell well within the 95% confidence intervals and hence, by definition, no survey was regarded as extreme.

[1] All authors: National Institute of Water and Atmospheric Research Ltd (NIWA), New Zealand.

1. INTRODUCTION

1.1 The 2022 east coast South Island inshore trawl survey

This report describes the results of the 2022 east coast South Island (ECSI) winter bottom trawl survey in 10–400 m depth, conducted from 2 May to 22 June using R.V. *Kaharoa* (trip code KAH2204), and also includes survey time series outputs in biomass, length frequency, and spatial distribution. The 2022 survey was the fourteenth in the ECSI winter time series for the core strata (30–400 m), and the seventh in the core plus shallow strata (10–400 m). Previous surveys were carried out in 1991–1994, 1996, 2007–2009, 2012, 2014, 2016, 2018, 2021, and 2022 (Beentjes & Wass 1994, Beentjes 1995a, 1995b, 1998a, 1998b, Beentjes & Stevenson 2008, 2009, Beentjes et al. 2010, Beentjes et al. 2013, 2015, MacGibbon et al. 2019, Beentjes et al. 2022). The eight target species in 2022 were: dark ghost shark, *Hydrolagus novaezelandiae*; elephantfish, *Callorhinchus milii*; giant stargazer, *Kathetostoma giganteum*; red cod, *Pseudophycis bachus*; red gurnard, *Chelidonichthys kumu*; sea perch, *Helicolenus percoides*; spiny dogfish, *Squalus acanthias*; and tarakihi, *Nemadactylus macropterus*.

1.2 Background to east coast South Island inshore trawl surveys

The ECSI winter trawl survey time series is the key tool for monitoring abundance, spatial distribution, reproductive condition, and size/age composition of commercially important ECSI finfish and elasmobranch species. Many of these stocks have no comprehensive stock assessments and these surveys provide trends in abundance and recruitment that serve as proxies for stock status and fishing intensity via Partial Quantitative Assessments (Fisheries New Zealand 2022). The Fisheries New Zealand Medium Term Research Plan for inshore finfish, specifies that an ECSI winter trawl survey should be carried out every two years. The ECSI winter trawl survey time series was reviewed by an international panel in October 2012, which concluded that the survey design and methods conform to international best standards and practices (Smith et al. 2012).

The main target species for the first five ECSI winter trawl surveys in 30–400 m (1991 to 1994 and 1996) was red cod (pre-recruit and recruit-sized fish), although other commercial species were also of interest including giant stargazer, barracouta (*Thyrsites atun*), spiny dogfish, tarakihi, sea perch, ling (*Genypterus blacodes*), elephantfish, rig (*Mustelus lenticulatus*), dark ghost shark, and red gurnard. After the 1996 survey, the winter time series was replaced by summer trawl surveys that included the shallower 10–30 m depth range, and it was anticipated that this timing would be more effective in monitoring red gurnard and elephantfish. The summer surveys were, however, discontinued after five consecutive surveys from 1996 to 2000 because three of the four surveys showed extreme fluctuations in catchability between surveys (Francis et al. 2001). 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 at that time.

The winter survey time series was subsequently reinstated in 2007 after an eleven-year interval. The first three surveys (2007, 2008, and 2009) also included additional survey strata in 10–30 m, which were to be sampled opportunistically if time allowed. However, these shallow strata were not completed in 2008 and 2009 due to time and resource constraints. Following a monitoring review (Parker et al. 2009), the ECSI winter survey range was formally expanded in 2012 to include four strata in the 10–30 m depth range to more effectively monitor elephantfish and red gurnard, which were previously not target species, and extra days were added to the survey to allow for completion of these strata. Hence from 2012 onward, there were eight target species: dark ghost shark, giant stargazer, red cod, sea perch, spiny dogfish, tarakihi, red gurnard, and elephantfish. There are now two winter survey time series: core strata (30–400 m) from 1991 onward; and core plus shallow strata (10–400 m), which includes 2007 and the surveys from 2012 onward. All winter surveys were conducted between April and June (Table 1).

Following reinstatement of the winter surveys in 2007, three consecutive annual surveys from 2007 to 2009 were carried out and it was then the intention to move to biennial surveys (every second year).

The three-year gap between 2009 and 2012, however, was to ensure that the ECSI and west coast South Island surveys were phased to run in alternate years. Nine surveys have been completed since the winter time series was reinstated (2007, 2008, 2009, 2012, 2014, 2016, 2018, 2021, and 2022). The three-year gap between 2018 and 2021 was a result of postponement of the 2020 survey because of COVID-19 restrictions in April 2020. The 2022 survey was back in phase and the next survey is scheduled for 2024.

1.3 Objectives

This report fulfils the final reporting requirement for Objectives 1–5 of Fisheries New Zealand Research Project INT2021-01.

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 acanthias*), 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, spiny dogfish, dark ghost shark, elephantfish, and red gurnard 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 (CVs) of the biomass estimates for these species are as follows: red cod (30%), sea perch (20%), giant stargazer (20%), tarakihi (20%), spiny dogfish (20%) elephantfish (30%), red gurnard (20%), and dark ghost shark (30%).
2. To collect the necessary 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, red cod, and tarakihi.
4. To collect the data to determine the length frequencies and catch weight of all other Quota Management System (QMS) species.
5. To identify benthic macro-invertebrates collected during the trawl survey.

2. METHODS

2.1 Survey area

2.1.1 Timeline of strata changes

Nine strata in 30–400 m were used in the first three winter surveys (1991, 1992, and 1993), and in 1994 these were subdivided into 17 strata to reduce the coefficient of variation (CV) for the target species red cod, as well as the other important commercial species (Beentjes 1998a) (Figure 1, Table 1). These strata subdivisions were made across depth (i.e., perpendicular to the coastline) and there were no changes to stratum depth ranges or to the total survey area. There were no further changes to strata boundaries until 2007 when four inshore strata in 10–30 m were added to the survey area (formally introduced in 2012), bringing the total number of strata to 21 (Figure 1, Table 1).

To improve tarakihi survey precision, in 2022, strata 3 and 4 were subdivided along the 55 m depth contour following investigations into spatial catch of tarakihi over the last eight surveys before 2022. The revised stratification increased the total number of strata from 21 to 23, with stratum 3 subdivided into 3A and 3B and stratum 4 into 4A and 4B (Figure 2, Table 1).

Core strata (30–400 m)

The 2022 core strata survey covered the same area as the previous 1991 to 2021 winter surveys, extending from the Waiau River in the north to Shag Point in the south in 30–400 m. The core strata survey area is 23 339 km^2, including untrawlable foul ground (2018 km^2) (Figure 2, Table 2).

Core plus shallow strata (10–400 m)

The combined area including all 23 strata in the 10–400 m depth range is referred to as the 'core plus shallow strata'. The 2022 core plus shallow strata survey covered the same area as the previous 2007 to 2021 winter surveys in 10–400 m (Figure 2, Table 2). The core plus shallow strata survey area is 26 918 km^2, including untrawlable foul ground (2224 km^2) (Figure 2, Table 2).

2.2 Survey design

Consistent with previous winter surveys, a two-phase random stratified survey design was used (Francis 1984). NIWA's Optimal Station Allocation Programme (*allocate*) (Francis 2006) was used to determine the theoretical number of stations required in each stratum to achieve the specified survey CV around biomass (see Section 1.3 Objectives). For the 19 core strata, catch rates (station kg km^{-2}) of dark ghost shark (GSH), stargazer (GIZ), red cod (RCO), sea perch (HPC), spiny dogfish (SPD), and tarakihi (NMP) from the last eight winter surveys (2007–2021) were used as input data in the simulations. Simulations were constrained to achieve the stated target CV and have a minimum of three stations per stratum for the 19 core strata (Table 3). For elephantfish (ELE) and red gurnard (GUR), the same approach was used to optimise allocation in the 23 core plus shallow strata, using catch rates (station kg km^{-2}) from the last five surveys (2012–2021) and 2007; the 2008 and 2009 surveys were not included because the sampling was considered to be inadequate in the four 10–30 m strata in those years. Before the simulations, catch rates for all species from previous surveys were reassigned to the new strata, i.e., from 3 to 3A or 3B, and from 4 to 4A or 4B. The sum of the stratum station maximum for each target species indicated that 103 stations were theoretically required to achieve the target CVs for the re-stratified survey area (Table 3). However, optimisation using the original 21 strata, indicated that 115 stations were required and, as a safeguard, this number of stations was targeted on the survey. The station maximum of 103 stations across each stratum (excluding red cod where CVs were usually very high) was prorated down to 92 stations to achieve the number of phase-1 stations for the survey, with 23 additional stations (20%) planned in phase 2 (Table 3).

Sufficient trawl station positions to cover both first- and second-phase stations were generated for each stratum using the NIWA random station generator program (*Rand_stn* v1.00-2014-07-21), with the constraint that stations were at least 3 n. miles apart and that each stratum had a minimum of three stations. Phase-2 stations were allocated using the NIWA program *SurvCalc* (Francis & Fu 2012). The program calculates the phase-1 station catch rate variance for each species in each stratum and outputs a table of estimated gains for each species by stratum (algorithm from Francis 1984). It also outputs an optimal station allocation across species, strata, and projected CVs based on any given allocation scenario. Hence, *SurvCalc* allows for phase-2 optimisation of more than one species. The final phase-2 allocation was adjusted according to factors such as time availability, steaming distance, achieved CV for each target species, and species priority. The priority target species in descending order, were tarakihi, red gurnard, and sea perch, as agreed at the Fisheries New Zealand Inshore Working Group on 5 April 2022. Tarakihi and sea perch phase-2 stations were allocated from core strata catch rates, whereas red gurnard allocation was from catch rates in the core plus shallow strata. Giant stargazer is the only target species that does not usually require phase-two allocation, whereas acceptable CVs for red cod are virtually unobtainable without considerably more effort than is practical – neither species was included in the priority list.

2.3 Vessel and gear

The R.V. *Kaharoa* was used for the 2022 survey, as in all previous 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 2022 survey trawl gear was identical to that used on all previous winter surveys. Gear specifications were documented by Beentjes et al. (2013). 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 on the bottom and achieve a headline height of about 4–5 m. Rectangular 'V' trawl doors fitted with Marport sensors were used and these achieve a doorspread of about 80 m on average. The codend mesh was 60 mm (knotless), standard for winter surveys, and was used throughout the survey in all strata. A bottom contact sensor was deployed on the ground rope and a Marport net monitor was attached to the headline to measure headline height. A Seabird Microcat CTD (conductivity, temperature, and depth) data logger was also attached to the headline to record depth (by measuring pressure), water temperature, and salinity on all tows. Acoustic data were collected continuously during the survey using a Simrad ES60 echosounder and R.V. *Kaharoa*'s hull-mounted 38 kHz transducer. Acoustic data were collected between the transducer's face and the seabed. All trawl gear was overhauled and specifications were checked before the 2022 survey commenced.

2.4 Timetable and personnel

Following mobilisation and unforeseen repairs, the R.V. *Kaharoa* departed Wellington three days later than scheduled on 2 May 2022 and began fishing in Pegasus Bay in stratum 7 on 3 May. On 6 May, the starboard trawl winch failed and the vessel berthed in Lyttelton to carry out repairs. Essential parts had to be sourced from Norway and the survey was suspended for ten days to allow time for the parts to arrive and repairs to be made. During this time scientific staff disembarked the vessel. The survey resumed on 16 May and progressively moved south after completing all phase 1 stations north of Banks Peninsula. The first leg of the survey was completed on 30 May, when there was a changeover of scientific staff in Port Timaru. After completion of the 92 phase-1 stations, sampling of phase-2 stations began on 19 June. Four phase-2 stations were allocated to stratum 7 to reduce the CV for red gurnard and three stations to stratum 10 to reduce the CV for sea perch (Figure 2, Table 2). The last phase-2 station was completed on the afternoon of 21 June and the vessel steamed to Wellington, arriving on 22 June where the final catch was unloaded. Demobilisation took place on the 22–23 June. During the survey, saleable fish were landed into Talley's Ltd, Timaru and Wellington. About nine days were lost to bad weather. Twelve vessel days were added to the survey schedule by NIWA to offset the time lost to mechanical breakdowns at the start and during the survey.

Pablo Escobar-Flores was voyage leader on leg 1; Dan MacGibbon was voyage leader on leg 2 and was also responsible for final database editing. Lindsay Copland was the voyage skipper and Mike Beentjes the project manager.

2.5 Trawling procedure

Trawling procedures were consistent with previous surveys and followed those documented by Stevenson & Hanchet (1999). All tows were carried out in daylight (shooting and hauling) between 0650 and 1700 hours NZST. Standardised tows were for 1 hour duration at a speed of 3.0 knots over the ground, resulting in tow lengths of about 3 n. miles. Tows were shortened when there were indications on the net monitor or ship sounder of large catches entering the net, or unexpected foul ground was encountered. If catches were consistently large and unmanageable in an area, standard towing duration was reduced from 1 hour to 30 minutes. The minimum acceptable tow length was 1.5 n. miles. Tow start time began when the net reached the bottom and settled, as indicated by the net monitor, and the finish time was recorded when hauling commenced. Standardised optimal warp:depth ratios for different depths were strictly adhered to (with a minimum warp length of 200 m). Tow direction was generally along depth contours and/or towards the next 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 in both depth and trawlable bathymetry. Surveying tow paths was typically done at night by the officers of R.V. *Kaharoa* to maximise daylight hours for trawling. If 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 station on the random station list was selected. Doorspread and headline height were monitored continuously during the tow, recorded manually at 10–15 minute intervals, and averaged over the tow. Immediately after the gear came on deck, the bottom contact sensor and CTD data files were downloaded. At each trawl station, the following environmental observations were collected: sea surface temperature, bottom temperature, and salinity (CTD); barometric pressure; wind direction and speed; sea condition and colour; and swell height and direction.

2.6 Catch and biological sampling

The catch from each tow was sorted by species, boxed, and weighed on motion-compensated 100 kg Marel scales to the nearest 0.1 kg. Fish length was measured to the nearest centimetre below actual length, and sex was recorded for all QMS and selected non-QMS species, for either the whole catch or, for larger catches, a sub-sample of up to about 100 randomly selected fish. All data were captured electronically from scales or digitised measuring boards that connect to the *Trawl Coordinator Access Database* in real time.

Biological information was obtained for all target species from a random sample of up to 20 fish for all tows on which they were caught. The following records were taken: sex, length to the nearest millimetre below actual length, individual fish weight to the nearest 10 g (using motion-compensating 5 kg Marel scales), gonad stage[2] (finfish) or maturity (sharks) (Appendix 1). Both sagittal otoliths were collected from the random sample for the five finfish target species on all tows where they were caught, avoiding any possible spatial bias. Otoliths were also collected for other species of interest. Otoliths were stored clean and dry in small paper envelopes labelled with the survey trip code, station number, species, and fish number.

Individual weights were also recorded for 15 non-target QMS species.

Macro-invertebrates that could not be clearly identified were retained and preserved for later identification in the NIWA Invertebrate Collection in Wellington.

2.7 Data storage

All catch, biological, and length frequency data were entered into the Fisheries New Zealand *trawl* research database after the survey was completed. Data from fish for which otoliths were removed were entered into the *age* research database and the otoliths were stored at NIWA, Greta Point, Wellington. Ageing of these otoliths was not part of this project. Acoustic data files were stored in the NIWA Fisheries acoustics database, 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 2022 and earlier surveys were archived under the project INT2021-01.

2.8 Analysis of data and outputs

2.8.1 Survey data analyses

Relative biomass and CVs were estimated by the area-swept method described by Francis (1981, 1989) using *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.

---

[2] This was the second survey in the time series to use the 7-stage middle depths staging methods for finfish. Previous surveys used the 5-stage stock monitoring method.

The combined biomass and length frequency analysis option in *SurvCalc* was used to derive scaled length frequency distributions and biomass estimates. All length frequencies were scaled by the percentage of catch sampled, area swept, and stratum area.

Biomass estimates were calculated for pre-recruit and recruit-sized fish based on sizes at recruitment to the fishery as follows: ELE, 50 cm; GUR, 30 cm; GSH, 55 cm; RCO, 40 cm; GIZ 30 cm; SPD, 50 cm; HPC 20 cm; NMP 25 cm; BAR (barracouta), 50 cm; LSO (Lemon sole, *Pelotretis flavilatus*), 25 cm; SPO (rig), 90 cm; RSK (rough skate), 40 cm; SCH (school shark, *Galeorhinus galeus*), 90 cm; and SWA (silver warehou, *Seriolella punctata*), 25 cm; SSK (smooth skate, *Dipturus innominatus*), 40 cm.

Biomass estimates were calculated for juvenile and adult fish based on length-at-50% maturity (equal to and above) for the target species only. The length-at-50% maturity cut-offs were taken from Hurst et al. (2000) for all target species except (HPC), where it was estimated from the cumulative length frequencies of all the mature stages from the 2008 survey. Hurst et al. (2000) averaged the size at maturity between males and females for the teleosts because they were similar, but, for the elasmobranchs, where it varied 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, NMP, and HPC for males and females combined, but for males and females separately for GSH, SPD, and ELE. The cut-off lengths used were: GUR, 22 cm; RCO, 51 cm; GIZ, 45 cm; NMP, 31 cm; HPC, 26 cm; GSH males 52 cm, females 62 cm; SPD males 58 cm, females 72 cm; ELE males 51, females 70 cm.

Species length-weight coefficients were used to scale length frequencies and to calculate pre-recruit, recruit, juvenile, and adult biomasses. Coefficients were determined by regressing natural log weight against natural log length ($W=aL^b$).

Survey representativeness was calculated for each survey and refers to the survey catchability and whether the biomass estimate from a range of species was within an acceptable range (representative) or was extreme (non-representative). This approach was derived from the work by Francis et al. (2001) who examined data from 17 trawl survey time series, including the 1991 to 1996 ECSI winter survey surveys. The method ranks each species in order of increasing biomass index across all surveys, and then averages across all species to obtain a mean species rank for each year. This yearly mean rank can change each time a new survey is added to the time series. If the mean rank falls outside the 95% confidence intervals, the survey is considered to have extreme catchability or to be less representative of the true biomass than other surveys.

2.8.2 Remarks on previous analyses

The 1991 survey did not include the original strata[3] 7 and 9 due to time constraints, and hence the biomass estimates for this survey in those strata were assumed to be equivalent to the mean proportion of total survey biomass for each species, contributed by strata 7 and 9, from the 1992 to 1996 surveys.

Biomass estimates and length frequency distributions for ECSI winter surveys between 1991 and 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 but assumed to be 79 m for all tows. The biomass estimates from those 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.

Sea perch (*Helicolenus percoides*) have historically been recorded under the species code SPE on all ECSI winter trawl surveys before 2021, with the assumption that there was only one species in New Zealand waters. The recent finding that there are two species of sea perch which can identified on

[3] In 1994 onward the original stratum 9 was subdivided into strata 16 &17; and the original stratum 7 became stratum 13.

surveys has changed the species codes used, with the shallower dwelling inshore species (*Helicolenus percoides*), common on the ESCI trawl surveys, recorded as HPC and the deeper dwelling species known as bigeye sea perch (*Helicolenus barathri*) recorded as HBA. Before the 2021 survey, both species were nominally recorded as SPE, but because HBA is uncommon off the ECSI in less than 400 m, all pre-2021 survey catches of sea perch on the ECSI surveys were assumed to be *Helicolenus percoides*. Hence, the sea perch time series now includes the catches previously recorded as SPE before 2021 combined with those recorded as HPC from 2021 onward.

2.8.3 2022 survey report outputs

The 2022 survey station data were tabulated and include the station number, date, tow start time, position, minimum and maximum gear depth, tow distance, headline height, doorspread, and surface and bottom water temperature. Trawl gear summary statistics included the headline height, doorspread, tow distance, and warp to depth ratio mean, standard deviation, and range for valid tows included in the biomass estimates. These were summarised for the core strata, core plus shallow strata, and for depth ranges 10–30 m, 30–100 m, 100–200 m, and 200–400 m.

The 2022 survey catch (kg) for each species caught, along with the proportion of the catch, the percent and number of stations where it occurred, and the depth range, were summarised.

Survey catch rates (kg km^{-2}) and biomass for the target and key non-target QMS species were tabulated by stratum, and catch rates were also plotted on the survey strata map for each tow to show areas of relative density throughout the survey area.

The 2022 survey estimated biomass and CV (%) in the core strata (30–400 m) were tabulated for males, females, all fish, and recruited fish for the eight target species and eight key non-target QMS species: barracouta (BAR), lemon sole (LSO), ling (LIN), rough skate (RSK), school shark (SCH), smooth skate (SSK), rig (SPO), and silver warehou (SWA)—as recommended by Beentjes & MacGibbon (2013). Estimated biomass and CV (%) for males, females, all fish and recruited fish were also estimated for the core plus shallow strata (10–400 m) for elephantfish, red gurnard, red cod, spiny dogfish, and selected non-target species that are found in less than 30 m.

The 2022 survey scaled population length frequency distributions were plotted for the appropriate survey area (core strata or core plus shallow strata) and by depth range for the target species, and for the core strata and in 10–30 m for the key non-target QMS species.

The 2022 survey gonad stages of all eight target species in 30–400 m, and for elephantfish and red gurnard in 10 to 30 m were tabulated and presented as percentage of fish in each stage.

2.8.4 Survey time series outputs

Total biomass and CV (%) were tabulated for all fourteen surveys (1991–2022) in the core strata (30–400 m) time series for the eight target and the eight key non-target QMS species, and in the core plus shallow strata (10–400 m) in 2007, 2012, 2014, 2016, 2018, 2021, and 2022 for species commonly found in less than 30 m. The biomass estimates for the core plus shallow biomass estimates were compared to the core strata estimates to show the contribution made by the shallow strata (10–30 m) to the core plus shallow biomass estimate.

Recruit and pre-recruit biomass and CV (%) were estimated for all fourteen surveys (1991–2022) in the core strata (30–400 m) time series for the eight target and the eight key non-target QMS species, and in the core plus shallow strata (10–400 m) in 2007, 2012, 2014, 2016, 2018, 2021, and 2022 for elephantfish and red gurnard. These biomass estimates for each species were compared to show the relative contribution made by recruits and pre-recruits to the total biomass estimate.

Juvenile and adult biomass and CV (%) were tabulated for all fourteen surveys (1991–2022) in the core strata (30–400 m) time series for the eight target and the eight key non-target QMS species, and in the core plus shallow strata (10–400 m) in 2007, 2012, 2014, 2016, 2018, 2021, and 2022 for elephantfish and red gurnard.

Catch rates (kg km^{-2}) by tow for the target species for all fourteen surveys (1991–2022) were plotted on the survey strata map to show spatial and temporal patterns in relative density throughout the survey area. For the core strata, the percent occurrence (i.e., the percentage 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 population length frequency distributions were plotted for each target species for all fourteen surveys (1991–2022) in the core strata (30–400 m), with the length distribution in the 10–30 m overlaid for surveys that covered this depth range in 2007, 2012, 2014, 2016, 2018, 2021, and 2022. Similarly, the length frequency distributions were plotted for red gurnard and elephantfish for surveys in 2007, 2012, 2014, 2016, 2018, 2021, and 2022 in the core plus shallow strata (10–400 m).

Survey representativeness was updated and the mean ranks plotted for each of the fourteen winter surveys in the core strata (30–400 m), and the seven core plus shallow surveys. Species included in the core strata survey ranking calculations were the eight target species plus the eight key non-target QMS species. In addition, the analysis was run with only the eight target species for both the core strata and core plus shallow strata surveys.

3. RESULTS

3.1 Trawling details (2022)

Core strata (30–400 m)

In total, 87 stations were carried out in the core strata, all having satisfactory gear performance with the shallowest tow in 15 m and the deepest in 393 m (Appendix 2). All 80 planned phase one stations were successfully completed with a further 7 stations carried out in phase two (Table 2). The 87 valid stations were used in length frequency and biomass estimation for all species. At least three successful stations were completed in each of the 19 core strata (Table 2). Station density ranged from one station per 89.7 km^2 in stratum 8 to one station per 791.0 km^2 in stratum 6, with an overall average density of one station per 268.3 km^2 (Table 2). All 87 valid core strata station positions are plotted in Figure 3; and individual station data, are tabulated in Appendix 2. Surface and bottom temperatures for each station are shown in Appendix 2.

Shallow strata (10–30 m)

All 12 planned phase-1 stations in the shallow strata were successfully completed with no stations carried out under phase-2 (Table 2). All 12 stations had satisfactory gear performance and were used to estimate scaled length frequencies and biomasses (Table 2, Appendix 2). All 12 shallow strata station positions and numbers are shown in Figure 3 and individual station data in Appendix 2. Surface and bottom temperatures for each station are shown in Appendix 2.

Trawl gear performance

Headline height, doorspread monitoring, and observation of polishing on the doors and ground-rope bobbins indicated that the gear was fishing correctly (with assumed constant bottom contact) and efficiently throughout the survey. Gear parameters (doorspread, headline height, distance towed, and warp to depth ratio) by depth range are described in Appendix 3 and all were within acceptable limits.

3.2 Catch composition (2022)

Core strata (30–400 m)

The total catch from the core strata was 133 t from the 87 successful biomass tows (phase 1 and 2 stations) (Appendix 4). Catches from the 87 tows were highly variable (143–10 424 kg per tow), with an average of 1528 kg per tow. Catch weights, percent catch, occurrence, and depth range of all taxa identified during the survey are given in Appendix 4. These included 67 teleosts, 12 chondrichthyans, 6 cephalopods, 72 invertebrates, and 3 species of seaweed (Appendix 4). The catches were dominated by five species: spiny dogfish (35.5 t), dark ghost shark (24.9 t), barracouta (20.9 t), two saddle rattail (*Coelorinchus biclinozonalis,* CBI) (11.1 t), and crested bellowsfish (*Notopogon lilliei,* CBE) (9.4 t), together representing 76.7% of the total core strata catch. These five species, and the next five most abundant species (red gurnard, sea perch, red cod, giant stargazer, and tarakihi) made up 88% of the total core strata catch (Appendix 4). The percentage of the catch represented by the eight target species was as follows: spiny dogfish 26.7%, dark ghost shark 18.7%, red gurnard 3.8%, sea perch 3.5%, red cod 1.8%, giant stargazer 1.2%, tarakihi 1.1%, and elephantfish 0.8%, making a combined total of 54.7%. The most commonly caught species were spiny dogfish in 98% of tows, witch (*Arnoglossus scapha*, WIT) in 97% of tows, and barracouta and giant stargazer both caught in 87% of tows. Other species commonly caught included carpet shark (*Cephaloscyllium isabellum*, CAR) (83% of tows), scaly gurnard (*Lepidotrigla brachyoptera*, SCG) (78% of tows), red gurnard and red cod (72% of tows), silver warehou (71% of tows), school shark (68 % of tows), tarakihi (64% of tows), and sea perch (63% of tows) (Appendix 4).

Shallow strata (10–30 m)

The total catch in the shallow strata was 13.0 t from the 12 biomass tows (Appendix 4). Catches were highly variable (364–2169 kg per tow) with an average of 1081 kg per tow. These included 45 teleosts, 10 chondrichthyans, 5 cephalopods, and 19 invertebrate taxa (Appendix 4). Catch weights, percent catch, occurrence, and depth range of all species identified during the survey are given in Appendix 4. The shallow catches were dominated by spiny dogfish (4.5 t), red gurnard (2.9 t), red cod (1.7 t), leatherjacket (1.5 t) and barracouta (0.6 t), representing 35%, 22%, 13%, 12%, and 4%, respectively, of the total shallow catch. These and the next five most abundant species (elephantfish, rough skate, rig, spotty, and silver warehou) made up 94% of the total catch (Appendix 4). The percentage of the total catch represented by the eight target species was as follows: spiny dogfish 35%, red gurnard 22%, red cod 13%, elephantfish 2%, tarakihi <0.1%, dark ghost shark 0%, giant stargazer 0%, and sea perch 0%, making a combined total of 72.2% (Appendix 4). Spiny dogfish, red gurnard, red cod, and barracouta were caught on all tows.

3.3 Biomass estimates (2022)

Core strata (30–400 m)

Core strata biomass estimates and CVs for target species and the eight key non-target QMS species are given in Table 4 (Panel A). Of the target species, spiny dogfish and dark ghost shark dominated with biomasses of 27 030 t and 12 519 t, respectively. The CVs were less than or within 5% of the specified target in the project objectives for dark ghost shark, giant stargazer, red cod, and tarakihi (see Section 1.3 Objectives), but were 10% higher than the target for sea perch and 15% higher for spiny dogfish. There were no target CVs specified for red gurnard and elephantfish in the core strata.

Barracouta had the largest biomass of the non-target species at 16 999 t (Table 4, panel A). Other species with substantial biomass included rough skate (998 t) and smooth skate (641 t).

Core plus shallow strata (10–400 m)

Core plus shallow biomass estimates and CVs for elephantfish and red gurnard, as well as target species and key non-target QMS species that are common in less than 30 m are given in Table 4 (panel B). Of the target species, spiny dogfish dominated the biomass with 30 819 t. Red gurnard and elephantfish CVs were both within the targets of 20% and 30%, respectively. There were no CVs specified for the other six target species in the core plus shallow strata. Relatively low CVs were achieved for non-target QMS species rig (25%), rough skate (20%), and school shark (16%) (Table 4B).

Barracouta had the largest biomass of the five key non-target QMS species caught in the core plus shallow strata, with 17 442 t (Table 4B). The only other species with substantial biomass was rough skate (1219 t).

3.4 Strata catch rates and biomass estimates (2022)

Catch rates by stratum for the eight target and eight key non-target QMS species are given in Table 5 and catch rates by station for the target species are plotted in Figure 4. Biomass estimates by stratum for the eight target and eight key non-target QMS species are given in Table 6. Strata with the highest catch rates were not always the same as those with the highest biomass because biomass was scaled by the area of the stratum. The percentage of tows and depth range that each species was present are tabulated in Appendix 4. Catch rates by station are plotted for key non-target species, but are not discussed in this report (Appendix 5). Results for individual target species are discussed under target species summaries (Section 3.6).

3.5 Biological and length frequency data (2022)

Details of length frequency and biological data recorded for each species are given in Table 7. Just over 41 000 length frequency and 9000 biological records were taken from 45 species. This included otoliths from 633 giant stargazer, 878 red cod, 905 red gurnard, 592 sea perch (HPC), 612 tarakihi, 83 bigeye sea perch (HBA), 1 slender jack mackerel (JMM), 69 yellowtail jack mackerel (JMN), and 58 greenback jack mackerel (JMD).

Scaled population length frequency distributions for the target species are presented by depth range to determine the distribution across the shelf and slope and to also determine if juvenile and adult fish have different depth preferences. Dark ghost shark, giant stargazer, red cod, sea perch, spiny dogfish, and tarakihi length frequency distributions are plotted for 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 m (Figure 5). For the shallow dwelling elephantfish and red gurnard, length frequency distributions are shown for the core plus shallow (10–400 m) and for the above four depth ranges. Results for individual target species are discussed under target species summaries (Section 3.6).

The length-weight coefficients used to scale the length frequency data are given in Appendix 6.

Scaled length frequency distributions for the key non-target QMS species in the core and the shallow strata are presented in Appendix 7, but are not discussed in this report.

3.6 Target species summaries

3.6.1 Dark ghost shark

2022 survey

There was no dark ghost shark catch in the shallow 10–30 m depth range in 2022 (or other years) indicating that the core strata biomass estimate is an appropriate relative abundance index for this species, although the survey may not extend to the full depth range of the species (McMillan et al. 2019). Dark ghost shark core strata (30–400 m) total biomass of 12 519 t was the second highest of the target and non-target key species in the core strata on the 2022 survey, and, of this, 64% was recruited fish and 45% was male (Table 4).

Dark ghost shark were predominantly caught in strata deeper than 100 m off Banks Peninsula and Canterbury Bight, occurring in 46% of core tows, with the shallowest catch at 66 m and the deepest at 392 m (deepest survey tow) (Figure 4, Table 5A, Table 6A, Appendix 4).

The 2022 survey dark ghost shark male length frequency distribution in the core strata (30–400 m) showed a strong mode at about 50–60 cm, most prominent in 100–200 m, but no clear juvenile modes (Figure 5). The smaller males, below about 40 cm, were present almost exclusively in the deeper 200–400 m depth range. The female distribution was similar, although the strong mode was less defined; the largest size class extended to about 70 cm, and there were more fish over 60 cm than for males. The bulk of the males and females were pre-recruit fish (under 55 cm) particularly in 200–400 m. The overall proportion male, calculated from the scaled population numbers in the core strata (30–400 m), was 51.5% (Figure 5).

Most dark ghost shark males and females were mature, with 2% of females in the mature-gravid state with fully formed egg cases (Table 8, see gonad stages in Appendix 1). This indicates that most males and some females were in an advanced reproductive state during the survey period in 2022.

Dark ghost shark time series trends (core strata 30–400 m)

Dark ghost shark total biomass increased 16-fold between 1992 and 2016, before a 57% decline in 2018, and an 85% increase in 2021, with little change in 2022 (Figure 6, Table 9). Despite the decline in 2018, biomass has been consistently much higher than pre-2012. All surveys included a large component of pre-recruit biomass, ranging from 30–61%, and in 2022 the pre-recruit biomass was 36% of total biomass (Figure 7, Appendix 8). The juvenile biomass (based on length-at-50% maturity) of both sexes combined has generally comprised less than about half of the total biomass, and in 2022 it was 34% (Appendix 9).

The dark ghost shark size distributions in each of the surveys from 1993 to 2009 were similar and generally bimodal (Figure 8). The 2012, 2014, and 2016 length frequency distributions were distinct from previous years, with the appearance of relatively larger numbers of adults or mature fish, commensurate with the large biomass increase over this period. These larger fish still accounted for a high proportion of the total biomass in 2018, and particularly in 2021 and 2022, although overall numbers are lower than in the 2016 peak biomass (Figure 8).

Over the fourteen core strata surveys, dark ghost shark were present in 27–57% of tows, with higher occurrence after 1996, and showing a variable but generally increasing trend of increasing occurrence (Table 10). Dark ghost shark comprised 2–23% of the total catch on these surveys, with a clear increasing trend, peaking in 2021 (Table 10). The spatial distribution of dark ghost shark has been similar over the time series surveys and confined to the outer continental shelf and slope edge, with the largest catch rates more often off Timaru (Figure 9).

3.6.2 Elephantfish

2022 survey

The elephantfish biomass in the shallow 10–30 m depth range accounted for 19% of the core plus shallow biomass in 2022, indicating that the core plus shallow biomass estimate is the most appropriate abundance index for this species (see below). In 2022, elephantfish core plus shallow biomass was 987 t, the sixth highest of the nine key species that also occur in 10–30 m (Table 4). Of this, 61% was recruited fish and 39% was male.

Elephantfish were caught in less than 100 m in 2022 without pattern along the entire coastline with the shallowest catch in 15 m (shallowest survey tow) and the deepest in 118 m (Figure 4, Table 5A, Table 6A, Appendix 4). They were caught in 49% of core plus shallow tows. The two largest catches were in the Canterbury Bight.

The 2022 survey elephantfish male and female length frequency distributions showed two strong juvenile modes centred around 25 cm (1+) and 40 cm, but no clear adult modes (Figure 5). There were few males over 60 cm, whereas the right-hand tail of the female distribution was much longer with some fish over 80 cm in length (Figure 5). For both sexes, most fish were in the 30–100 m depth range, very few elephantfish were deeper than 100 m, and none deeper than 200 m. The smallest males and females (less than 20 cm) were almost exclusively caught in the shallow 10–30 m depth range. The overall proportion male from scaled population numbers in the core plus shallow (10–400 m) was 51% (Figure 5).

Most elephantfish males in the 30–400 m core strata in 2022 were fully mature, with 8% of females in the mature-gravid state with fully formed egg cases (Table 8, see gonad stages in Appendix 1). This was similar in the shallow 10–30 m strata, but there were proportionately less mature males and females as the smallest elephantfish were found in this depth range (see Figure 5). This indicates that high numbers of male and fewer female elephantfish were in an advanced reproductive state during the survey period in 2022.

Elephantfish time series trends (core strata 30–400 m)

Although the core plus shallow strata surveys are considered to be the most appropriate for elephantfish, analyses of the longer core strata survey time series are provided for completeness.

Elephantfish biomass in the fourteen core strata surveys increased markedly in 1996 and, although it fluctuated over the next five surveys, it remained high, with an average of 1032 t between 1996 and 2014, three-fold greater than the early 1990s (Figure 6, Table 9). Biomass then fluctuated greatly with the largest of the time series of nearly 7000 t in 2016 (one particularly large catch resulting in a survey CV of 68%), to the 2021 estimate of 170 t which was the second lowest of the series. The 2022 biomass estimate of 798 t was 23% below the 1996 to 2014 average (Figure 6, Table 9). The proportion of pre-recruited biomass in the core strata has varied among surveys, from 50% in 2007 to 1% in 2016, noting that the 2016 value was biased by the single large catch which was comprised of mainly large fish (Figure 7, Appendix 8). In 2022, pre-recruit biomass was 33% of the total elephantfish biomass. The proportion of juvenile biomass (based on the length-at-50% maturity) in 2022 was 40%, equivalent to the time series mean (Appendix 9).

The size distributions of elephantfish were not consistent among the fourteen core strata surveys, particularly for juvenile fish, but were generally characterised by a wide right-hand tail of 3+ and older fish (up to about 10 years), based on the ageing by Francis (1997) (Figure 8). In 2007 and 2012, strong 1+ and 2+ cohort modes were present. The 2022 survey core strata size distribution was similar to those of recent years (Figure 8, see Figure 5).

Over the time series, elephantfish were present in 26–49% of core strata tows with large fluctuations and no clear trend (Table 10). In 2022, it was present in 49% of tows, more than any other survey. Elephantfish have consistently made up 1–2% of the total catch on all surveys, except in 2016, when it was 12%, the result of the high numbers of adult fish in a single large catch (Table 10, Figure 8). The spatial distribution of elephantfish aggregations varies over the time series, but, overall, this species was consistently well represented from 30 to 100 m in the core strata, along the entire survey coastline (Figure 9).

Elephantfish time series trends (core plus shallow strata 10–400 m)

Biomass trends in the seven core plus shallow strata surveys (2007 and 2012 onward) were similar to those in the core strata, with the exception of 2007 and 2012, where biomass was relatively higher due to the presence of strong 1+ and 2+ cohorts in the 10–30 m (Figure 6, Table 9, Figure 8).

The proportion of pre-recruited biomass in the core plus shallow strata has varied among the seven surveys from 64% in 2007 to 2% in 2016, noting again that the 2016 value was biased by the single large catch which comprised mainly large fish (Figure 10, Appendix 8). Pre-recruit biomass in 2022 was 39% of the total elephantfish biomass. The proportion of juvenile biomass (based on the length-at-50% maturity) in 2022 was 46%, similar to the time series mean of 40% (Appendix 9).

The biomass in the 10–30 m depth range has varied greatly between the seven surveys, comprising from 7 to 64% of the core plus shallow biomass, averaging 40% (Figure 6, Table 9); in 2022 it was 19%. This indicates that the shallow strata are important habitat for elephantfish, but there is variability in the inshore/offshore spatial distribution at this time of year. Further, the 10–30 m depth range has different length frequency distributions than those in the core strata, particularly in 2007, 2012, and 2021, with the appearance of 1+ and 2+ cohorts, otherwise poorly represented in the core strata (Figure 8).

The time series of elephantfish length frequency distributions in the core plus shallow strata surveys clearly showed the juvenile 1+ and 2+ cohorts apparent in the first 3 surveys, but their presence decreased with time (Figure 11). By 2016, the 3+ and older fish dominated. In the last three surveys, the numbers of fish were relatively low overall, but modes were again visible for the 1+ and 2+ cohorts.

Elephantfish were present in 34–51% of core plus shallow strata tows with no trend and, in 2022, it was present in 49% of tows (Table 10). Elephantfish have comprised from 1–4% of the total catch on all surveys without trend, except 2016 when it was 11%, the result of the high numbers of mature fish in a single large catch (Table 10, see Figure 8). The spatial distribution of elephantfish aggregations varies over the time series, but overall this species is consistently well represented from 10 to 100 m in the core plus shallow strata, along the entire survey coastline (Figure 9).

3.6.3 Giant stargazer

2022 survey

There was no giant stargazer catch in the shallow 10–30 m depth range in 2022 (or other years) indicating that the core strata biomass estimate may provide an appropriate relative abundance index for this species, although this species is found deeper than the extent of the survey (McMillan et al. 2019). Giant stargazer core strata (30–400 m) total biomass of 1092 t was the seventh highest of the target and non-target key species on the 2022 survey, and, of this, 91% was recruited fish and 43.4% was male (Table 4).

Giant stargazer were distributed, without pattern, along the entire coastline, deeper than about 50 m with the shallowest catch at 39 m and the deepest at 392 m (deepest survey tow). They occurred in 87% of core tows (Figure 4, Table 5A, Table 6A, Appendix 4).

The length frequency distributions had a single mode centred at about 30 cm for both sexes with a long right-hand tail (Figure 5). Based on ageing (Sutton 1999), the mode comprised ages from about 2 to 5 years, and the tail of ages from about 5 to 17 years. The female length distribution had a wider right-hand tail, indicating that the largest fish were mostly females. For both sexes, distributions were generally similar in the three depth ranges (30–100 m, 100–200 m, and 200–400), although there were proportionally less smaller sizes in the deeper depth ranges. Giant stargazer were equally common in 30–100 m and 100–200 m, with less than 2% of the population found in the 200–400 m interval. The overall scaled numbers in the core strata were 50.3% male.

Most giant stargazer were immature, resting, or ripening, but almost a quarter of males were ripe or running ripe (Table 8, see gonad stages in Appendix 1). This indicates that while some males were in an advanced reproductive state during the survey period in 2022, this was not the case for females and active spawning was not occurring to any extent during the survey period in 2022.

Giant stargazer time series trends (core strata 30–400 m)

Giant stargazer biomass was variable with no clear trend over the time series up to 2018 (Figure 6, Table 9). In 2021, however, the biomass estimate was the highest in the time series, 48% higher than the previous estimate in 2018, and in 2022 the estimate was slightly higher. This may or may not indicate the beginning of a trend of increasing biomass since 2018, but nonetheless it does show that, compared with any previous survey, biomass has been exceptionally high over the last two years. Pre-recruited biomass has been a small, but consistent component of the total biomass estimates on all surveys (range 2–9% of total biomass) and was the highest of the time series in 2021 and 2022, at 9% (Figure 7, Appendix 8). The juvenile to adult biomass ratio (based on length-at-50% maturity) was relatively constant over the time series at about 1:1 for most surveys and, in 2022, biomass was 50% juvenile fish (Appendix 9).

The length frequency distributions of giant stargazer in each of the fourteen surveys were broadly similar; most surveys had one large mode comprising multiple age classes, with smaller juvenile modes discernible in some years (Figure 8). The 2016 survey had an especially strong juvenile mode around 15–25 cm, which appears to have tracked through to 2018 and 2021. The 2021 survey also had a strong juvenile mode at around 15–25 cm. The sustained high biomass in 2022 was likely a result of this 2016 strong recruitment, as well as that in 2021 (Figure 8).

Over the fourteen core strata surveys, giant stargazer were present in 71–92% of tows (77% in 2022), with no trend, but made up only 1–2% of the total catch on all surveys (Table 10). The spatial distribution of giant stargazer hot spots varied, but, overall, this species was consistently well represented over the entire survey area, most commonly from 30 m to about 200 m (Figure 9).

3.6.4 Red cod

2022 survey

The core strata biomass estimate is the most appropriate abundance index for red cod (see below). The 2022 survey core strata (30–400 m) total biomass was 1943 t and was the sixth highest of the target and non-target key species in the core strata on the 2022 survey; of this, 11% was recruited fish, and 39% was male (Table 4).

Red cod were distributed, without pattern, along the entire coastline, mostly in less than about 100 m depth. They occurred in 72% of core tows, with the shallowest catch at 15 m and the deepest at 392 m (deepest survey tow) (Figure 4, Table 5A, Table 6A, Appendix 4).

The 2022 core survey length frequency distributions for all red cod showed three well defined modes for males at around 10–25 cm (0+), 26–45 cm (1+), and 45–60 cm (2+ and older) (Figure 5). These same modes were also evident for the female distributions, although they were shifted slightly to the right because red cod are fast growing and females grow faster than males (Horn 1996, Beentjes 2000). Red cod were caught in all depth ranges, but were most common in 30–100 m, whereas 36% were in 10–30 m, and only 4% of fish were in 200–400 m. The 1+ mode was virtually absent in the 10–30 m (Figure 5). The overall scaled population numbers were 48% male in the core strata (30–400 m).

Nearly all red cod were immature or resting, with only 5% of males in ripe condition (Table 8, see gonad stages in Appendix 1). This indicates that while some males were in an advanced reproductive state, this was not the case for females and active spawning was not occurring during the 2022 survey period.

Red cod time series trends (core strata 30–400 m)

Following the resumption of the winter surveys in 2007, red cod core strata biomass was low relative to the period in the 1990s, except for large estimates in the 2012 and 2021 surveys, which were a result of a few large catches associated with inflated CVs (Figure 6, Table 9). The biomass in 2021 increased by 10-fold and was the highest in the time series following the lowest in 2018, although the associated CVs were very high for both of these surveys (2018 = 83%; 2021 = 69%). The 2022 biomass was of similar magnitude to the surveys from 2007 onward, excluding the two extreme values in 2012 and 2021 (Figure 7, Table 9). The proportion of pre-recruit biomass in the core strata has varied substantially, from 6% in 2021 to 59% in both 1994 and 2012; and in 2022, it was relatively low with 11% pre-recruit (Figure 7, Appendix 8). The proportion of juvenile biomass (based on the length-at-50% maturity) also varied greatly among surveys, with corresponding peaks in 1994 and 2012 of about 70% juvenile; in 2022, juvenile biomass was relatively low at 11% (Appendix 9).

The size distributions of red cod in each of the fourteen core strata surveys were similar in that they were generally characterised by 0+ (10–20 cm) and 1+ modes (30–40 cm) of variable strength, and a less defined right-hand tail comprised predominantly 2+ and 3+ fish (Figure 8). The 1996 to 2009 surveys showed poor recruitment of 1+ fish compared with earlier surveys, followed by the strongest 1+ cohort of all surveys in 2012, and then by weak recruitment in 2014 to 2018. In 2021, the 1+ cohort was the strongest since 2012 but less distinct, merging into the older cohorts. In the 2022 survey, all cohorts were relatively weak.

Over the fourteen core strata surveys red cod were present in 54–89 % of tows, with a declining trend of occurrence until 2018, followed by an increase in the last two surveys; in 2022, red cod was caught in 76%

of core tows (Table 10). Over the time series, red cod made up 2–28% of the total catch from the survey core strata, with a marked drop post-1994, with the exception of 2021 when it increased to 15%, before dropping back to 3% of the total catch in 2022 (Table 10). The spatial distribution of red cod aggregations (large catches) varied geographically among surveys and was in contrast to more frequent zero or very small catches (Figure 9). Overall, however, this species was consistently well represented over the entire survey area, most commonly from 30 m to about 300 m (Figure 9).

The red cod biomass captured in the 10–30 m depth range accounted for 5% or less of the biomass in five of the seven core plus shallow strata (10–400 m) surveys. However, in 2014 and 2022, it accounted for substantially more (44% and 34%, respectively) of the total biomass, indicative of the variable geographic nature of red cod catches and the sporadic importance of shallow strata for red cod (Figure 6, Table 9). The addition of the 10–30 m depth range had little effect on the shape of the length frequency distributions except in 2014, when the largest female fish (over 60 cm) were in less than 30 m (Figures 5 and 8). Further, the inclusion of the 10–30 m depth range did not alter the temporal biomass pattern observed in the core strata to any extent (Figure 6). For these reasons the core strata surveys in 30–400 m are probably adequate for monitoring red cod on the ECSI, although it is prudent to monitor red cod in both the core strata and core plus shallow strata surveys.

3.6.5 Red gurnard

2022 survey

The red gurnard biomass in the shallow 10–30 m depth range accounted for 38% of the core plus shallow biomass in 2022, indicating that the core plus shallow biomass estimate is the most appropriate abundance index for red gurnard (see below). The 2022 survey core plus shallow strata (10–400 m) total biomass was 5472 t and was third highest of the nine key species that also occur in 10–30 m, after spiny dogfish and barracouta (Table 4). Of this, 95% was recruited fish and 43% was male.

Red gurnard were distributed, without pattern, along the entire coastline, mostly in less than about 75 m. They occurred in 76% of core plus shallow tows, with the shallowest catch at 15 m and the deepest at 137 m (Figure 4, Table 5A, Table 6A, Appendix 4).

The 2022 survey red gurnard length frequency distributions in the core plus shallow strata (10–400 m) were bimodal for both males and females, with a weak juvenile mode centred around 14 cm (0+ fish) and a large mode around 35 cm for males and 39 cm for females (Figure 5). The large mode is unlikely to represent a single cohort and, based on ageing of red gurnard (Sutton 1997), comprised ages from about 1 to 13 years. The female length distribution had a wider right-hand tail than males with more fish over 40 cm, indicating that the largest fish in the population were mostly females. Red gurnard were caught almost exclusively in 10–100 m with few fish caught in 100–200 m and none in the 200–400 m depth range (Figure 5). Fish of the 14 cm mode were more abundant in the shallow 10 to 30 m depth range. The overall scaled population numbers were 49% male in the core plus shallow strata (Figure 5).

Most male and female red gurnard gonads in the core strata in 2022 were resting and ripening, with smaller numbers of spent fish. However, 11% of males were either ripe or running ripe (Table 8, see gonad stages in Appendix 1). This was similar in the shallow 10–30 m strata. This indicates that some spawning activity was occurring during the survey period in 2022.

Red gurnard time series trends (core strata 30–400 m)

Although the core plus shallow strata surveys are considered to be the most appropriate for red gurnard, analyses of the longer core strata survey time series are provided for completeness.

Red gurnard biomass in the 1990s averaged 422 t in the core strata, increased more than three-fold in 2007, after which it has generally increased with the exception of 2016, when biomass more than halved (Figure 6, Table 9). Further, the 2021 and 2022 biomass estimates were the two highest in the time series, with the 2022 estimate 39% higher than in 2021. The proportion of pre-recruit biomass in the core strata varied greatly among surveys, from 2 to 20%, and was 3% in 2022 (Figure 7, Appendix 8). The proportion of juvenile biomass (based on the length-at-50% maturity) was close to zero for all surveys, including 2022, when it was 0.1% (Appendix 9).

The size distributions of red gurnard in the core strata were more consistent from 2007 onward, as the biomass increased (Figure 8). Over this period, they were characterised by a one or two large modes and the occasional juvenile mode, which together represent multiple age classes ranging from 0+ to about 15+ years (Sutton 1997) (Figure 8).
Red gurnard were present in 23–76% of core strata tows, with a clear increasing trend from 1993 onward and the highest occurrence of 76% in 2022 (Table 10). Although common, red gurnard made up only 1–2% of the total catch on the surveys, but in 2022 this increased to 5% (Table 10). The spatial distribution of red gurnard aggregations varies over the time series, but overall this species was consistently well represented from 30 to about 75 m in the core strata, along the entire survey coastline (Figure 9).

Red gurnard time series trends (core plus shallow strata 10–400 m)

Total biomass trends in the seven core plus shallow strata surveys (2007 and 2012 onward) were similar to those in the core strata with the same trend of increasing biomass from 2007 to 2022, except that biomass was higher (Figure 6, Table 9).

The proportion of pre-recruited (30 cm and below) red gurnard biomass in the core plus shallow strata has varied among the seven surveys, from 24% in 2007 to 5% in 2022, and does not follow the trend of increasing recruited biomass (Figure 12, Appendix 8). The proportion of juvenile biomass (based on the length-at-50% maturity) in 2022 was very low at 0.1%, and less than the time series mean of 0.5% (Appendix 9).

The proportion of red gurnard biomass in the 10–30 m depth range has varied greatly between the seven core plus shallow strata (10–400 m) surveys comprising between 29% and 61% of the total biomass, averaging 44%; in 2022 it was 38% (Figure 6, Table 9). This indicates that the shallow strata are important habitat for red gurnard, but there is some variability in the inshore/offshore spatial distribution at this time of year. The length frequency distributions in the 10–30 m depth range are not noticeably different to those in the core strata in some years (2007, 2014, 2018), but they showed notable differences in others: i.e., in 2012 and 2016, there were abundant 1+ cohorts in 10–30 m that were poorly represented in the core strata, and a 0+ cohort (13–18 cm) is apparent in the 10–30 m depth range in 2021 and 2022 (Figure 8).

The red gurnard time series of length frequency distributions in the seven core plus shallow strata (10–400 m) are reasonably consistent over time with clear adult modes, but variable 0+ mode and 1+ modes (Figure 13).

Red gurnard were present in 61–76% of core plus shallow strata tows without trend (Table 10), although in 2022, they were present in 76% of tows, the highest of the time series. Red gurnard have comprised 2–5% of the total catch on all surveys, without trend, but were highest in 2022 (Table 10). The spatial distribution of red gurnard aggregations varies over the time series, but overall this species is consistently well represented from about 10 to 75 m in the core plus shallow strata, along the entire survey coastline with many of the largest survey catches in less than 30 m (Figure 9). The inclusion of the 10–30 m depth range has thus been valuable for monitoring red gurnard.

3.6.6 Sea perch

2022 survey

There was no sea perch catch in the shallow 10–30 m depth range in 2022 (and in other years) indicating that the core strata biomass estimate is the appropriate abundance index for this species. Sea perch core strata (30–400 m) total biomass of 2164 t was the fifth highest of the target and non-target key species on the 2022 survey, and, of this, 96% was recruited fish and 57.3% was male (Table 4).

Sea perch were distributed, without pattern, along the entire coastline, mostly in about 100–200 m. They occurred in 63% of core tows, with the shallowest catch at 32 m and the deepest at 251 m (Appendix 4, Figure 4, Table 5A).

The length frequency distribution in 30–400 m depth was unimodal with peaks at about 25 cm for males and females, with little difference between sexes (Figure 5); however, in the 30–100 m depth, the distribution was bimodal. Although found from 30–400 m they were most common in 100–200 m, with no separation of size by depth. The overall scaled numbers sex ratio in 30–400 m was 54% male.

Sea perch are ovoviviparous with internal fertilisation and, after mating, females release developing larvae contained in a gelatinous/buoyant medium. The seven-stage finfish gonad classification may therefore be less appropriate for females of this species. Nonetheless, nearly all female sea perch gonads were immature or resting, whereas 60% of males were ripe and 2% were running ripe (Table 8, see gonad stages in Appendix 1). This indicates that there was minimal spawning activity occurring during the survey period in 2022.

Sea perch time series (core strata 30–400 m)

Sea perch biomass shows no consistent trend over the core strata time series, but it has fluctuated two-fold with peaks in 1993 and 2016 and troughs in 2009 and 2021 (Figure 6, Table 9). The 2022 biomass of 2164 t was close to the time series average of 2054 t (Table 9). Pre-recruit biomass has comprised a small and relatively constant component of the total biomass estimate on all surveys (3–8% of total biomass) and in 2022 it was 4%, just below the average of 5% (Figure 7, Appendix 8). The juvenile to adult biomass proportion (based on length-at-50% maturity) was relatively constant over the time series at 15–36%, and in 2022 it was 20%, just below the average of 27% (Appendix 9).

The size distributions of sea perch on each of the fourteen surveys were similar, generally unimodal, and either symmetrical or with a right-hand tail before 2008 (Figure 8). Ageing of ECSI sea perch (Paul & Horn 2009) indicates that the ages in the length frequency distributions ranged from about 2 to 25 years, and the strong peaks correspond to about age 8.

Sea perch were present in 54–82% of core strata tows with a downward trend and the lowest percentage recorded in 2021; in 2022, it was only slightly higher at 56% (Table 10). Although common, sea perch constituted just 2–6% of the total catch on the surveys with no trend, and in 2022 it was 3% (Table 10). The spatial distribution of sea perch aggregations varied over the time series, but overall this species was consistently well represented from about 70 to 200 m in the core strata, along the entire survey coastline (Figure 9).

3.6.7 Spiny dogfish

2022 survey

The core strata biomass estimate was the most appropriate abundance index for spiny dogfish cod with only 8% on average of the biomass in the 10–30 m strata (see below). The 2022 survey core strata (30–400 m) total biomass was 27 030 t, the highest of the nine core strata species and, of this, 88.5% was recruited fish and 62% was male (Table 4).

Spiny dogfish were caught in all depth ranges throughout the survey area from 15 to 392 m (shallowest and deepest tows), although few were caught south off Timaru in 2022. They were present in 98% of core tows and all 10–30 m tows (Figure 4, Table 5A, Table 6A, Appendix 4).

The spiny dogfish core strata length frequency distributions were unimodal with peaks at about 60 cm for males and 55 cm for females; however, the 10–30 m depth shows a bimodal distribution (Figure 5). Distributions have long left-hand tails for both sexes, whereas females also have a clear right-hand tail and more fish over 70 cm (Figure 5). They were caught in all depth ranges, including the shallow strata, but the bulk of fish were in 30–100 m, followed by 100–200 m. The smallest fish (under 40 cm) were more common in 10–30 m and rare in waters deeper than 100 m (Figure 5). The overall scaled population numbers in the core strata were 61% male.

Most spiny dogfish males were mature, with calcified claspers, and a third of females were gravid or pregnant with yolked eggs or embryos visible in the uterus. (Table 8, see gonad stages in Appendix 1). This indicates that both sexes were in a reproductive state during the survey period in 2022.

Spiny dogfish time series (core strata 30–400 m)

Spiny dogfish biomass in the core strata increased markedly in 1996, and since 2007 it has fluctuated but with a clear declining trend to the lowest observed level in 2021, followed by a more than three-fold increase in 2022 (Figure 6, Table 9). Pre-recruited biomass was initially a small component (1–3%) of the total biomass estimates in the 1992 to 1994 surveys, but then increased from 7% to 52%. In 2022, it was 15%, similar to the post-1994 average of 19% (Figure 7, Appendix 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 32 and 63% in the last ten surveys; in 2022, it was 47% (Appendix 9).

The size distributions of spiny dogfish in the 1992 to 1994 surveys were generally bimodal for males, but less defined and with more fish over 80 cm for females (Figure 8). From 1996 onwards, the distributions changed as biomass increased, with the addition of many smaller fish (under 40 cm). Distributions were also less consistent between years, with high variability in the strength of recruiting juveniles (Figure 8). The decrease in biomass in 2021 was partially associated with a marked drop off in numbers of larger fish over 50 cm, which subsequently reappeared in 2022, concurrent with the three-fold biomass increase (Figure 8, see Figure 6). Females were less numerous than males throughout the core strata time series (Figure 8).

Spiny dogfish were consistently the most commonly caught species on the ECSI core strata surveys and occurred with no trend in 94–100% of tows, despite marked changes in biomass over time (Table 12, see Figure 6). In 2022, it was caught in 98% of tows, which is also the average over all surveys. Spiny dogfish comprised 10–46% of the total catch on the surveys. This amount has declined from 1996 to a low in 2021 of 10%, before increasing again in 2022 to 27%, which was also the average of all surveys (Table 12). Spiny dogfish had the largest biomass of the target species on all surveys except 2021, when biomass was higher for dark ghost shark and red cod (Table 9). The spatial distribution of spiny dogfish aggregations varied geographically over the core strata time series, but overall this species was consistently well represented over the entire survey area, most commonly present between 30 m and about 350 m (Figure 9).

The spiny dogfish biomass captured in the shallow water strata (10–30 m) accounted for, on average, 8% of the of the biomass in the core plus shallow strata (10–400 m) with a range of 5–13%; in 2022, it was 12% (Figure 6, Table 9). The addition of the 10–30 m depth range had little effect on the shape of the spiny dogfish length frequency distributions with the exception of 2022, when the smallest fish were caught in less than 30 m (Figures 5 and 8). Further, the inclusion of the 10–30 m depth range did not alter the temporal biomass pattern observed in the core strata to any extent (Figure 6). For these reasons the core strata surveys in 30–400 m are likely adequate for monitoring spiny dogfish off the ECSI.

3.6.8 Tarakihi

2022 survey

There was negligible catch of tarakihi in the shallow 10–30 m depth range in 2022 (or in other years), indicating that the core strata (30–400 m) biomass estimate is the appropriate abundance index for this species. The 2022 survey core strata total biomass was 1049 t, the eighth highest of the core strata species and, of this, 75.3% was recruited fish and 49.4% was male (Table 4).

Tarakihi were caught in depths of 15–145 m, but they were mostly caught between about 50 and 150 m throughout the survey area, without pattern (Figure 4). They were caught in 64% of core tows and 33% of shallow tows (Table 5A, Table 6A, Appendix 4).

The 2022 core strata length frequency distribution showed modes at about 13 cm, 18 cm, and 25 cm, with a long right-hand tail for both sexes, and contained few fish over 35 cm, especially for males (Figure 5). Based on ageing of tarakihi (Beentjes 2011), the three modes were likely to be 0+, 1+, and 2+ fish. A few fish were caught in 10–30 m, whereas most were caught in 30–100 m, followed by 100–200 m, and no fish were caught in 200–400 m. The smaller fish (0+ and 1+) were largely confined to less than 100 m and fish over 25 cm were distributed in 30–200 m depth. The overall scaled population numbers in the core strata (30–400 m) were 51.9% male.

Nearly all male and female tarakihi gonads in the core strata were immature or resting with only a few fish in the ripe or running ripe condition (Table 8, see gonad stages in Appendix 1). This indicates that there was negligible spawning activity occurring during the survey period in 2022.

Tarakihi time series (core strata 30–400 m)
Tarakihi core strata biomass peaked in 1993 due to a single large catch off Timaru, which resulted in a high CV of 55% (Figure 6, Table 9). Since 2007, the biomass has been trending down and the 2021 biomass estimate was the lowest in the last nine surveys; 2022 was only slightly higher and the second lowest. Pre-recruit biomass was a major but variable component of tarakihi total biomass on all surveys, ranging from 18% to 60% of total biomass (Figure 7, Appendix 8). In 2022, it was 25%, just below the time series average of 33%. Similarly, juvenile biomass (based on length-at-50% maturity) was also a large component of total biomass, between 56% and 80%; in 2022, this was 61% (Appendix 9).

The size distributions of tarakihi in each of the fourteen surveys were similar and multi-modal, with smaller modes representing individual cohorts (Figure 8). The 0+, 1+, and sometimes the 2+ cohorts were evident in most surveys (Beentjes et al. 2012). While the 0+ and 1+ cohorts were present in the two last surveys as well as the 2+ cohort in 2022, there were fewer larger fish over 25 cm than for any previous survey.

Tarakihi were present in 51–71% of tows and made up 1–5% of the total catch on the surveys, with no trends in either metric (Table 10). The distribution of tarakihi aggregations varied, but overall this species was consistently well represented over the entire survey area in the 30 to 150 m depth range (Figure 9).

3.6.9 Key non-target QMS species

Time series of biomass estimates in the core and core plus shallow strata for the eight key non-target QMS species (barracouta, BAR; lemon sole, LSO; ling, LIN; rig, SPO; rough skate, RSK; school shark, SCH; silver warehou, SWA; smooth skate, SSK) are presented in Figure 14 and tabulated in Table 9. Only rig and rough skate were caught in any significant quantities inside 10–30 m and hence, the core plus shallow strata biomass index should only be used for these two species. Biomass of barracouta was the highest of any species in six of the fourteen core strata surveys and the second highest in all others after spiny dogfish (Table 6). Barracouta biomass in the core strata showed a strong increasing trend from 1996 to 2014, followed by a steep decline with a biomass decline of 49% in 2021, followed by only a slight increase in 2022 (Figure 14). However, barracouta are thought to migrate out of the survey area to spawn in the north at the time the survey is carried out, and hence the biomass trend may be misleading. Biomass of the seven other key non-target QMS species in the core strata can be summarised as follows: biomass of lemon sole and smooth skate were variable with no trend; biomass of ling showed a slowly declining trend over the entire time series; biomass of rig was low in the 1990s, higher but stable since 2007 until a large increase in 2021, which was only slightly less in 2022; rough skate biomass increased gradually until 2021, when it doubled, followed by a large decline in 2022; school shark and silver warehou had lower biomass in the 1990s and stable but variable biomass from

2007 (Figure 14). Patterns in the core plus shallow time series for rig and rough skate were similar to the core strata series.

The 2022 survey catch rate distributions and scaled length frequency distributions for these species are presented in Appendices 5 and 7 for completeness, but are not discussed in this report. Time series catch rate distributions and scaled length frequency distributions for these species up to and including 2012 were presented and discussed by Beentjes & MacGibbon (2013).

3.7 Survey representativeness

The representativeness analyses, showing the mean species ranking for each of the fourteen ECSI winter trawl surveys in the core strata, are shown in Figures 15 and 16. When the eight target species plus the eight key non-target QMS species were included, 1992 and 1994 survey mean rankings were just below the lower 95% confidence interval and the 2014 survey was close to the upper the 95% confidence interval (Figure 15); by the definition of Francis et al. (2001), if a survey is outside the 95% confidence interval, it is considered to represent extreme catchability. However, when only the eight target species were included, all core strata surveys fell within the 95% confidence intervals and hence, by definition, no survey was regarded as extreme (Figure 16). The Francis et al. (2001) method assumes that abundances of species are uncorrelated and that particularly high (or low) estimates across a range of species in a given survey are due to a change to the trawl catchability. In this survey time series, there appeared to be an overall trend of increasing abundance for most inshore species, which has resulted in a higher ranking overall for surveys from 2007 compared with the earlier period of 1991–1996. Hence, it is possible that the 2014 survey may not be extreme, but instead reflects general increased abundance of inshore species.

The representativeness analyses for the eight target species, showing the mean species ranking for each of the seven core plus shallow strata ECSI winter trawl surveys are shown in Figures 17. All core plus shallow strata surveys fell well within the 95% confidence intervals and hence, by definition, no survey was regarded as extreme (Figure 17).

4. DISCUSSION

The ECSI winter core strata (30–400 m) time series spans 33 years from 1991 to 2022 and includes fourteen biomass surveys with an eleven-year hiatus between 1996 and 2007. Implicit in the interpretation of trends in biomass, geographic distribution, and length distribution is that no information on these variables exists in the 11-year interval between the 1996 and 2007 surveys. The core strata surveys are informative for monitoring biomass and size composition of the target species, dark ghost shark, giant stargazer, and sea perch, which are found exclusively deeper than 30 m; tarakihi, which is almost exclusively found deeper than 30 m; and red cod and spiny dogfish, which are mostly found deeper than 30 m (see Figure 9). These core strata surveys display indications of extreme catchability for the 1992 and 1994 surveys, but not for the target species in isolation (see Figures 15 and 16).

Similarly, the ECSI winter core plus shallow strata (10–400 m) time series, designed to monitor red gurnard and elephantfish, now spans 15 years from 2007 to 2022, and includes seven biomass surveys. This is developing into an informative time series for monitoring biomass and size composition of red gurnard which is consistently well represented in the 10–30 m depth range. However, elephantfish show high variability between surveys in spatial distribution and in the proportion of the biomass in the shallow strata during the survey period. Length frequency distributions for elephantfish also do not track consistently between surveys, probably a result of cohort schooling into spatially confined aggregations. The core plus shallow surveys are also proving useful for monitoring non-target species rough skate and rig, which are found in the 10–30 m depth range.

4.1 ECSI 2022 survey

The fourteenth ECSI winter survey in 2022 was successful in meeting all the project objectives and in completing most of the theoretical number of stations required to achieve the target CVs (99 of 103 stations). In the core strata, the CVs were less than or within 5% of the specified target for dark ghost shark, giant stargazer, red cod, and tarakihi (see Section 1.3 Objectives), but they were 10% higher than the target for sea perch and 15% higher for spiny dogfish (Table 4). The target CVs specified for red gurnard and elephantfish implicitly refer to the core plus shallow strata.

The CV of 25% for red cod is the lowest of all surveys in the time series for this species, except for 2007, when the same CV was obtained. Historically, achieving low CVs for red cod has been difficult, even during the early surveys when it was the only target species (see Table 9). These inflated CVs result from the tendency for red cod to form schooling cohort aggregations (Beentjes 1992) causing catches to be highly variable among tows with many zero or low catches and the occasional very large catch (see Figure 9). In 2021, for example, the catches of red cod were generally very low or zero, except for three very large catches in three tows resulting in a high CV of 69%. In contrast, in 2022 red cod catches tended to be uniformly small, resulting in a low CV of 25%. Hence, the red cod target CV is, in practice, nominal and applying more effort is unlikely to reduce the CV to any extent.

The red gurnard target CV of 20% was met in the core plus shallow strata and the elephantfish CV of 29% was just below the target of 30% (Table 4). The target CVs for red gurnard have been achieved on all but one of the seven surveys (see Table 9). In contrast, elephantfish survey precision is highly variable (CV range 20–63%). Large CVs often occur in surveys that record mainly very low or zero catches with an occasionally very large catch, as was the case in 2016 and 2021 when the CVs were both over 50% (see Figure 9).

4.2 Remarks on target species trends

Dark ghost shark – Dark ghost shark core strata total biomass has shown a marked increase over the time series and this was commensurate with the appearance of relatively larger numbers of adults or mature fish (see Figures 6 and 8) and a trend of increasing occurrence. Biomass of dark ghost shark also increased in other areas, including on the Southland and Sub-Antarctic surveys from 2011, and the Chatham Rise after 1995 (Stevens et al. 2022). Size compositions in these areas were also similar to the ECSI survey. The spatial distribution of dark ghost shark has been similar over the ECSI time series surveys. The species is common on the continental slope and is found at the deepest stations, indicating that there is likely to be biomass of dark ghost shark deeper than the outer survey depth range of 400 m (see Table 10). McMillan et al. (2019) report that dark ghost shark can be found as deep as 600 m.

Elephantfish – Elephantfish total core strata biomass increased markedly in 1996 and, although variable, has remained high compared to the 1990s (see Figure 6). This is consistent with progressively increasing commercial landings and multiple TACC increases in ELE 3 beginning in the mid-1990s (Fisheries New Zealand 2022). The core plus shallow strata biomass time series, although shorter, mirrors the pattern in the core strata for overlapping years. As described above, the occasional large CVs and erratic length distributions for elephantfish indicate that the survey biomass index should be viewed with caution.

Giant stargazer – The core strata total biomass was variable with no clear trend over the time series until 2021, when it increased by almost a half. This appears to have been due to an especially strong juvenile mode in 2016 and high pre-recruit biomass in both 2021 and 2022 (see Figures 6 and 8). Larger females (over 60 cm) are relatively more abundant in both the west coast South Island and Chatham Rise trawl surveys than in the ECSI trawl surveys (Stevens et al. 2021, MacGibbon et al. 2022) which could be due to growth differences, or to movement of large females out of the ECSI survey area.

Red cod – The core strata biomass estimates were broadly consistent with the magnitude of commercial landings in RCO 3, notwithstanding the 63% TACC reduction in 2007–08 that has constrained catches in some years (Fisheries New Zealand 2022). The cyclical fluctuating nature of red cod commercial catches, characteristic of this species, is caused by fast growth, high mortality, and variable recruitment (Beentjes & Renwick 2001). The large biomass in 2012 was predominantly contributed to by 1+ fish (see Figure 8) and appears to have resulted in within-season increase adjustments to the TACCs in the following fishing years (2012–13 and 2013–14) (Fisheries New Zealand 2022). In contrast, the record 2021 survey biomass estimate was composed mainly of larger older fish (2+ and older) (see Figure 8), but there was no associated increased commercial catch in 2020–21, and it remains to be seen if there will be a within-season adjustment to the TACC for coming years. The high variability in pre-recruit and juvenile biomass is consistent with the fast growing, high mortality, and variable recruitment characteristics of red cod (Beentjes 1992).

Red gurnard – The core strata biomass has generally been increasing since the 1990s and the 2021 and 2022 biomass estimates were the second highest and highest in the time series, respectively (see Figure 6). Total biomass trends in the seven core plus shallow strata surveys mirrored those in the core strata, except that biomass was much higher (see Figure 6). The time series length frequency distributions from 2007 onward indicate that recruitment of juvenile cohorts had strengthened and this will have contributed to the increasing biomass trend. The strong trend of increasing abundance is consistent with progressively increasing commercial landings and multiple TACC increases in GUR 3 beginning in about 2001 (Fisheries New Zealand 2022) and with a GUR 3 CPUE analyses up to 2020–21 fishing year (Langley 2022).

Sea perch – Sea perch core strata biomass has fluctuated about two-fold, but shows no trend over the time series; size distributions of sea perch on each of the fourteen surveys were similar and generally unimodal (see Figures 6 and 8). There are two different species commonly referred to as sea perch[4] around New Zealand, *Helicolenus percoides* and *H. barathri* (Roberts et al. 2015). *Helicolenus percoides* (HPC) occur in water shallower than about 250 m depth, with a peak at around 150 m, whereas *H. barathri* (HBA) occur from around 300 to 1000 m depth, with a peak at around 600 m (Bentley et al. 2014). In the 2022 ECSI survey, the maximum depth for HPC was 251 m and the minimum depth of HBA was 340 m (Appendix 4). The 2020 Chatham Rise trawl survey, where both species were correctly identified, showed that the catch of HBA was more than eight times that of HPC (Stevens et al. 2021). No distinction was made between *H. percoides* and *H. barathri* on ECSI surveys before 2021; however, nearly all the sea perch caught on the ECSI winter time series was likely to have been *H. percoides* because only small numbers of *H. barathri* were caught in 2021 and 2022, and only at depths greater than 330 m. In 2022, for example, only 71 kg of HBA was caught in 5 stations in 340–392 m (Appendix 4).

Spiny dogfish – Spiny dogfish biomass in the core strata increased markedly by about three-fold in 1996 and remained high until 2012, before it declined steadily (Figure 6, Table 9). A similar increase in biomass was observed in 1996 and 1997 in the Chatham Rise surveys, but the biomass there has remained high, albeit variable (Stevens et al. 2021). Spiny dogfish sampled on the ECSI surveys tend to be smaller overall than those from the Chatham Rise, Southland, and the sub-Antarctic (Bagley & Hurst 1996, O'Driscoll & Bagley 2001, Stevens et al. 2021, Stevens et al. 2022), suggesting that this area could be an important nursery ground for juvenile spiny dogfish and there may be movement of juveniles out of the ECSI survey area. Further, unlike the Chatham Rise, where females dominate the catch (Stevens et al. 2021), in the ECSI and sub-Antarctic (Stevens et al. 2022) males are the dominant gender (see Figure 8).

In 1996 the spiny dogfish size distribution changed dramatically with the appearance of a strong juvenile mode and increased numbers of adults, commensurate with the biomass increase. This pattern, although variable, persisted for all subsequent surveys, with the exception of 2021 when there were relatively fewer adult fish. The large variation in ECSI size distributions from year to year suggests that some spiny dogfish may be immigrating from outside this area.

[4] The species *Helicolenus percoides* (HPC) is now referred to as sea perch and *H. barathri* (HBA) as bigeye sea perch.

Tarakihi – Tarakihi biomass has been trending down since 2007, with 2021 and 2022 surveys biomass estimates the lowest in the last nine years; much of the biomass comprised juvenile fish (see Figures 6 and 8). The trend is consistent with declining commercial catch and TACC reductions in TAR 3 since 2016–17 (Fisheries New Zealand 2022). Tarakihi in the ECSI (TAR 3) are part of an New Zealand eastern stock that includes the eastern Cook Strait, TAR 2, and the eastern part of TAR 1 (Langley 2019, McKenzie et al. 2021). There is also a western stock that includes TAR 7, TAR 8, and western TAR 1. There is evidence for ontogenetic movement of eastern stock tarakihi from the south to north, with east Northland as the terminal destination of older and larger fish (McKenzie et al. 2021). The Canterbury Bight is considered to be an important nursery ground for the eastern stock and tarakihi tend be smaller overall than those from off the west coast South Island (Stevenson & Hanchet 2000, MacGibbon et al. 2022) and the east coast North Island (McKenzie et al. 2021).

5. POTENTIAL RESEARCH

The surveys could be used as a routine method to monitor seabird species presence/absence and potential abundance using static onboard video cameras with Artificial Intelligence (AI) technology used to identify species and quantify numbers. Further, the quantitative bird sightings data could be related to the survey catch and environmental variables such as sea productivity (satellite-based Chlorophyll a data), sea colour, salinity, water temperature, or acoustics data using multivariate modelling statistical methods. A pilot study to train and subsequently determine the efficacy of AI to correctly identify the different bird species from video footage would be the first step toward achieving this objective.

6. ACKNOWLEDGEMENTS

This research was funded by Fisheries New Zealand under Project INT2021-01. Thank you to all NIWA scientific staff on board, the skipper Lindsay Copland, and the crew of *Kaharoa* for their valuable contribution. Thanks also to Darren Stevens, Jennifer Devine, and Richard O'Driscoll (NIWA) for reviewing the manuscript, and Marc Griffiths and Suze Baird (Fisheries New Zealand) for editorial comments.

7. REFERENCES

Bagley, N.W.; Hurst, R.J. (1996). Trawl survey of middle depth and inshore bottom species off Southland, February-March 1995 (TAN9502). *New Zealand Fisheries Data Report No. 73.* 48 p.

Beentjes, M.P. (1992). Assessment of red cod based on recent trawl survey and catch sampling data. Fisheries Assessment Research Document 92/16. 40 p. (Unpublished report held by NIWA library, Wellington.)

Beentjes, M.P. (1995a). Inshore trawl survey of the Canterbury Bight and Pegasus Bay, May-June 1992 (KAH9205). *New Zealand Fisheries Data Report No. 55*. 58 p.

Beentjes, M.P. (1995b). Inshore trawl survey of the Canterbury Bight and Pegasus Bay, May-June 1993 (KAH9306). *New Zealand Fisheries Data Report No. 56*. 78 p.

Beentjes, M.P. (1998a). Inshore trawl survey of the Canterbury Bight and Pegasus Bay, May-June 1994 (KAH9406). *NIWA Technical Report 20*. 65 p.

Beentjes, M.P. (1998b). Inshore trawl survey of the Canterbury Bight and Pegasus Bay, May-June 1996 (KAH9606). *NIWA Technical Report 21*. 66 p.

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

Beentjes, M.P. (2011). TAR 3 catch sampling in 2009–10 and a characterisation of the commercial fishery (1989–90 to 2009–10). *New Zealand Fisheries Assessment Report 2011/52*. 71 p.

Beentjes, M.P.; Lyon, W.S.; Stevenson, M.L. (2010). Inshore trawl survey of Canterbury Bight and Pegasus Bay, May–June 2009 (KAH0905). *New Zealand Fisheries Assessment Report 2010/29*.

Beentjes, M.P.; MacGibbon, D.J. (2013). Review of QMS species for inclusion in the east coast South Island winter trawl survey reports. *New Zealand Fisheries Assessment Report 2013/35*. 102 p.

Beentjes, M.P.; MacGibbon, D.J.; Ladroit, Y. (2022). Inshore trawl survey of Canterbury Bight and Pegasus Bay, April–June 2021 (KAH2104). *New Zealand Fisheries Assessment Report 2022/23*. 147 p.

Beentjes, M.P.; MacGibbon, D.J.; Lyon, W.S. (2013). Inshore trawl survey of Canterbury Bight and Pegasus Bay, April–June 2012 (KAH1207). *New Zealand Fisheries Assessment Report 2013/36*. 135 p.

Beentjes, M.P.; MacGibbon, D.J.; Lyon, W.S. (2015). Inshore trawl survey of Canterbury Bight and Pegasus Bay, April–June 2014 (KAH1402). *New Zealand Fisheries Assessment Report 2015/14*. 136 p.

Beentjes, M.P.; Parker, S.; Fu, D. (2012). Characterisation of TAR 2 & TAR 3 fisheries and age composition of landings in 2010/11. *New Zealand Fisheries Assessment Report 2012/25*. 68 p.

Beentjes, M.P.; Renwick, J.A. (2001). The relationship between red cod, *Pseudophycis bachus*, recruitment and environmental variables in New Zealand. *Environmental Biology of Fishes 61*: 315–328.

Beentjes, M.P.; Stevenson, M.L. (2000). Review of the east coast South Island winter trawl survey time series, 1991–96. *NIWA Technical Report 86*. 64 p.

Beentjes, M.P.; Stevenson, M.L. (2008). Inshore trawl survey of Canterbury Bight and Pegasus Bay, May-June 2007 (KAH0705). *New Zealand Fisheries Assessment Report 2008/38*. 95 p.

Beentjes, M.P.; Stevenson, M.L. (2009). Inshore trawl survey of Canterbury Bight and Pegasus Bay, May–June 2008 (KAH0806). *New Zealand Fisheries Assessment Report 2009/57*. 105 p.

Beentjes, M.P.; Wass, R. (1994). Inshore trawl survey of the Canterbury Bight and Pegasus Bay, May-June 1991 (KAH9105). *New Zealand Fisheries Data Report No. 48*. 49 p.

Bentley, N.; Kendrick, T.H.; MacGibbon, D.J. (2014). Fishery characterisation and catch-per-unit-effort analyses for sea perch (*Helicolenus* spp.) in New Zealand, 1989–90 to 2009–10. *New Zealand Fisheries Assessment Report 2014/27*. 181 p.

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

Fisheries New Zealand (2022). F*isheries Assessment Plenary, May 2022: stock assessments and stock status*. Compiled by the Fisheries Science Team, Fisheries New Zealand, Wellington, New Zealand. 1886 p.

Francis, M.P. (1997). Spatial and temporal variation in the growth rate of elephantfish (*Callorhinchus milii*). *New Zealand Journal of Marine and Freshwater Research 31*: 9–23.

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

Francis, R.I.C.C. (1984). An adaptive strategy for stratified random trawl surveys. *New Zealand Journal of Marine and Freshwater Research 18*: 59–71.

Francis, R.I.C.C. (1989). A standard approach to biomass estimation from bottom trawl surveys. New Zealand Fisheries Assessment Research Document 89/3. 3 p. (Unpublished report held in NIWA library, Wellington.)

Francis, R.I.C.C. (2006). Optimum allocation of stations to strata in trawl surveys. *New Zealand Fisheries Assessment Report 2006/23*. 50 p.

Francis, R.I.C.C.; Fu, D. (2012). SurvCalc User Manual v1.2-2011-09-28. *NIWA Technical Report 134*. 54 p.

Francis, R.I.C.C.; Hurst, R.J.; Renwick, J.A. (2001). An evaluation of catchability assumptions in New Zealand stock assessments. *New Zealand Fisheries Assessment Report 2001/1*. 37 p.

Horn, P.L. (1996). An ageing methodology, and growth parameters for red cod (*Pseudophycis bachus*) off the southeast coast of the South Island, New Zealand. New Zealand Fisheries Assessment Research Document 95/6. 15 p. (Unpublished report held by NIWA library, Wellington.)

Hurst, R.J.; Bagley, N.W.; Anderson, O.F.; Francis, M.P.; Griggs, L.H.; Clark, M.R.; Paul, L.J.; Taylor, P.R. (2000). Atlas of juvenile and adult fish and squid distributions from bottom and midwater trawls and tuna longlines in New Zealand waters. *NIWA Technical Report 84*. 162 p.

Langley, A. (2019). An update of the assessment of the eastern stock of tarakihi for 2019. *New Zealand Fisheries Assessment Report 2019/41*. 29 p.

Langley, A. (2022). A stock assessment of red gurnard in GUR 3 for 2022 *New Zealand Fisheries Assessment Report 2022/21*. 56 p.

MacGibbon, D.J.; Beentjes, M.P.; Lyon, W.L.; Ladroit, Y. (2019). Inshore trawl survey of Canterbury Bight and Pegasus Bay, April–June 2018 (KAH1803). *New Zealand Fisheries Assessment Report 2019/03*. 136 p.

MacGibbon, D.J.; Walsh, C.; Buckthought, D.; Bian, R. (2022). Inshore trawl survey off the west coast South Island and in Tasman Bay and Golden Bay, March April 2021 (KAH2103). *New Zealand Fisheries Assessment Report 2022/11*. 97 p.

McKenzie, J.R.; Beentjes, M.; Armiger, H. et al. (2021). Fishery characterisation and age composition of tarakihi in TAR 1, 2, 3, 5, 7, and 8, for 2018–19 and 2019–20. *New Zealand Fisheries Assessment Report 2021/79*. 118 p.

McMillan, P.J.; Francis, M.P.; James, G.D. et al. (2019). New Zealand fishes. A field guide to common species caught by bottom, midwater, and surface fishing. *New Zealand Aquatic Environment and Biodiversity 208*. 298 p.

O'Driscoll, R.L.; Bagley, N.W. (2001). Review of summer and autumn trawl survey time series from the Southland and Sub-Antarctic areas, 1991–98. *NIWA Technical Report 102*. 115 p.

Parker, S.J.; Hurst, R.J.; Francis, R.I.C.C. (2009). Design options for an elephantfish, red gurnard, and flatfish complex trawl survey of the East Coast of the South Island. *New Zealand Fisheries Assessment Report 2009/59*. 22 p.

Paul, L.J.; Horn, P.L. (2009). Age and growth of sea perch (*Helicolenus percoides*) from two adjacent areas off the east coast of the South Island, New Zealand. *Fisheries Research 95*: 169–180.

Roberts, C.D.; Stewart, A.L.; Struthers, C.D. (eds.) (2015). *The fishes of New Zealand*. In 4 volumes. Te Papa Press, Wellington. 2008 p. [Vol. 1: S1–S256; vol. 2: 1–576; vol. 3: 577–1152; vol. 4: 1153–1748]

Smith, S.; Gabriel, W.; Armstrong, M. (2012). Expert Review Panel Report. Review of the New Zealand South Island trawl surveys. 26 October 2012. 13 p. (Unpublished report held by Fisheries New Zealand, Wellington.)

Stevens, D.W.; MacGibbon, D.J.; Ballara, S.L.; Escobar-Flores, P.C.; O'Driscoll, R.L. (2022). Trawl survey of hoki and middle depth species in the Southland and Sub-Antarctic areas, November–December 2020 (TAN2014). *New Zealand Fisheries Assessment Report 2022/08*. 107 p.

Stevens, D.W.; O'Driscoll, R.L.; Ballara, S.L.; Schimel, A.C.G. (2021). Trawl survey of hoki and middle depth species on the Chatham Rise, January 2020 (TAN2001). *New Zealand Fisheries Assessment Report 2021/33*. 107 p.

Stevenson, M.L.; Hanchet, S. (1999). Design and data analysis procedures for inshore trawl surveys. *NIWA Technical Report 53*. 18 p.

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

Sutton, C.P. (1997). Growth parameters, and estimates of mortality for red gurnard (*Chelidonichthys kumu*) from the east and west coasts of the South Island. New Zealand Fisheries Assessment Research Document 97/1. 15 p. (Unpublished report held by NIWA library, Wellington.)

Sutton, C.P. (1999). Ageing methodology, growth parameters, and estimates of mortality for giant stargazer (*Kathetostoma giganteum*) from the east and south coasts of the South Island. New Zealand Fisheries Assessment Research Document 99/15. 19 p. (Unpublished report held by NIWA library, Wellington.)

8. TABLES

Table 1: East coast South Island winter trawl survey strata and dates of surveys, including the 2022 survey (KAH2204). Core strata: nine strata used from 1991 to 1993, subdivided into 17 strata in 1994, and then strata 3 and 4 and were subdivided into 3A, 3B, 4A, 4B in 2022, resulting in 19 strata. Core plus shallow strata: the same as the core strata but included four new inshore strata in 10–30 m from 2007. Survey dates are from departure from and return to Wellington.

Year	Core strata (30–400 m)	Core plus shallow strata (10–400 m)	Survey dates
1991	1–9	–	15 May–1 June 1991
1992	1–9	–	13 May–7 June 1992
1993	1–9	–	7 May–6 June 1993
1994	1–17	–	7 May–11 June 1994
1996	1–17	–	7 May–11 June 1996
2007	1–17	1–21	4 May–6 June 2007
2008	1–17	1–21	3 May–6 June 2008
2009	1–17	1–21	3 May–6 June 2009
2012	1–17	1–21	23 April–7 June 2012
2014	1–17	1–21	24 April–6 June 2014
2016	1–17	1–21	24 April–6 June 2016
2018	1–17	1–21	23 April–6 June 2018
2021	1–17	1–21	28 April–12 June 2021
2022	1–2, 3A, 3B, 4A, 4B, 5–17	1–2, 3A, 3B, 4A, 4B, 5–21	2 May–23 June 2022

Table 2: **Stratum depth ranges, survey area, non-trawlable area, number of successful phase 1 and phase 2 stations (i.e., gear performance of 1 or 2), and station density for the 2022 ECSI trawl survey. Strata 1–17 are the core strata and strata 1–21, the core plus shallow strata.**

Stratum	Depth (m)	Area (km²)	Non-trawlable Area (km²)	Phase 1 stations (*N*)	Phase 2 stations (*N*)	Station density km² per station
1	30–100	984	202	5		196.8
2	30–100	1 242	0	3		414.0
3A	30–55	1 330	0	3		443.3
3B	55–100	1 693	0	6		282.2
4A	30–55	1 108	0	3		369.3
4B	55–100	1 595	0	10		159.5
5	30–100	2 485	0	6		414.2
6	30–100	2 373	208	3		791.0
7	30–100	2 089	871	5	4	232.1
8	100–200	628	17	7		89.7
9	100–200	1 163	0	3		387.7
10	100–200	1 191	0	5	3	148.9
11	100–200	1 468	0	3		489.3
12	100–200	764	132	3		254.7
13	100–200	999	406	3		333.0
14	200–400	322	17	3		107.3
15	200–400	430	0	3		143.3
16	200–400	751	0	3		250.3
17	200–400	724	165	3		241.3
18	10–30	1 276	0	3		425.3
19	10–30	986	0	3		328.7
20	10–30	797	0	3		265.7
21	10–30	520	226	3		173.3
Core total		23 339	2 018	80	7	268.3
Core plus shallow total		26 918	2 244	92	7	271.9

Table 3: Theoretical number of stations per stratum required to achieve the target coefficients of variation (CV, %) for each species for the 2022 ECSI trawl survey from *allocate*. The number of phase-one stations was calculated by prorating the species maximum down to the 92 achievable stations. The species max excluded red cod (RCO). Species codes are given in Appendix 4. –, not applicable.

Depth (m)	Stratum	GSH (30)	RCO (30)	SPE (20)	SPD (20)	GIZ (20)	NMP (20)	ELE (30)	GUR (20)	Species max	Phase 1 (pro-rated)
30–100	1	3	3	5	3	3	6	7	3	7	5
30–100	2	3	3	3	3	3	3	3	3	3	3
30–100	3A	3	3	3	4	3	3	3	3	4	3
30–100	3B	3	3	3	3	3	6	3	3	6	6
30–100	4A	3	3	3	3	3	3	3	3	3	3
30–100	4B	3	3	3	3	3	10	3	3	10	10
30–100	5	3	3	3	9	3	6	3	3	9	6
30–100	6	3	3	3	3	3	3	3	3	3	3
30–100	7	3	3	3	4	3	3	3	4	4	5
100–200	8	3	3	11	3	3	3	3	3	11	7
100–200	9	3	3	3	3	3	3	3	3	3	3
100–200	10	3	3	6	3	3	3	3	3	6	5
100–200	11	3	15	3	3	3	3	3	3	3	3
100–200	12	3	3	3	3	3	3	3	3	3	3
100–200	13	3	3	3	3	3	4	3	3	4	3
200–400	14	3	3	3	3	3	3	3	3	3	3
200–400	15	3	3	3	3	3	3	3	3	3	3
200–400	16	3	3	3	3	3	3	3	3	3	3
200–400	17	3	3	3	3	3	3	3	3	3	3
10–30	18	–	–	–	–	–	–	3	3	3	3
10–30	19	–	–	–	–	–	–	3	3	3	3
10–30	20	–	–	–	–	–	–	3	3	3	3
10–30	21	–	–	–	–	–	–	3	3	3	3
	Total	**57**	**69**	**70**	**65**	**57**	**74**	**73**	**70**	**103**	**92**

Table 4: Catch, estimated biomass for all fish and recruited fish, and CV (%) for the target species (in bold) and the key non-target QMS species in 30–400 m (A), and for elephantfish, red gurnard, and selected species in 10–400 m (B) for the 2022 ECSI trawl survey. Recruited lengths are given in parentheses beside species names.

A (30–400 m)		Males		Females		All fish		Recruited		
Common name	Catch (kg)	Biomass (t)	CV	Biomass (t)	CV	Biomass (t)	CV	Size (cm)	Biomass (t)	CV
Dark ghost shark (55 cm)	24 917	5 565	26	6 954	30	12 519	27	55	7 968	30
Elephantfish (50 cm)	1 060	321	41	477	34	798	36	50	535	32
Giant stargazer (30 cm)	1 536	473	18	616	16	1 092	16	30	994	16
Red cod (40 cm)	2 434	760	23	1 183	29	1 943	25	30	1 731	27
Red gurnard (30 cm)	5 057	1 734	36	1 676	25	3 410	30	40	3 299	30
Sea perch (20 cm)	4 710	1 241	32	923	28	2 164	30	20	2 069	31
Spiny dogfish (50 cm)	35 520	16 742	35	10 286	32	27 030	33	50	23 909	36
Tarakihi (25 cm)	1 418	518	26	530	24	1 049	25	25	790	23
Barracouta (50 cm)	20 983	9 018	40	7 865	32	16 999	35	50	15 824	37
Lemon sole (25 cm)	72	6	24	40	26	46	23	25	36	26
Ling (65 cm)	421	75	22	124	22	199	20	65	80	30
Rig (90 cm)	599	195	42	267	30	462	33	90	149	37
Rough skate (40 cm)	1 193	408	24	588	25	998	24	40	973	24
School shark (90 cm)	472	208	18	204	19	411	16	90	201	22
Silver warehou (25 cm)	1 208	216	46	207	45	423	44	25	308	60
Smooth skate (40 cm)	1 006	417	30	225	39	641	32	40	626	32

B (10–400 m)		Males		Females		All fish		Recruited		
Common name	Catch (kg)	Biomass (t)	CV	Biomass (t)	CV	Biomass (t)	CV	Size (cm)	Biomass (t)	CV
Elephantfish (50 cm)	1 335	382	35	603	28	987	29	50	606	28
Red cod (40 cm)	4 134	974	20	1 975	20	2 951	19	30	2 687	20
Red gurnard (30 cm)	7 948	2 335	28	3 112	15	5 472	20	40	5 199	20
Spiny dogfish (50 cm)	40 009	19 983	30	10 834	31	30 819	29	50	26 754	32
Barracouta (50 cm)	21 565	9 182	39	8 136	31	17 442	34	50	16 106	37
Rig (90 cm)	859	305	30	388	24	693	25	90	244	30
Rough skate (40 cm)	1 460	498	20	718	21	1 219	20	40	1 183	20
School shark (90 cm)	487	215	18	210	19	424	16	90	201	22
Silver warehou (25 cm)	1 210	216	46	207	45	425	44	25	308	60

Table 5: Catch rates (kg km^{-2}) by stratum for the target species (A) and key non-target QMS species (B) for the 2022 ECSI trawl survey. GSH, dark ghost shark, ELE, elephant fish; GIZ, giant stargazer; RCO, red cod; GUR, red gurnard; HPC, sea perch; SPD, spiny dogfish; NMP, tarakihi. (Continued on next page)

A (Target species)

		Target species catch rates (kg km^{-2})							
Stratum	Depth range (m)	GSH	ELE	GIZ	RCO	GUR	HPC	SPD	NMP
1	30–100	0	185	18	313	89	253	85	268
2	30–100	0	27	26	31	15	9	16	112
3A	30–55	0	49	8	409	279	2	99	1
3B	55–100	1	6	35	67	10	18	20	78
4A	30–55	0	247	21	360	436	0	433	2
4B	55–100	149	26	59	72	101	11	358	51
5	30–100	0	5	34	27	55	17	1 176	45
6	30–100	0	21	62	59	87	6	1 527	9
7	30–100	0	61	12	69	912	5	1 144	8
8	100–200	950	0	126	<1	8	319	8	16
9	100–200	1 221	0	173	5	5	233	30	33
10	100–200	1 922	4	7	4	7	673	419	7
11	100–200	1 342	0	59	21	1	67	252	4
12	100–200	3 647	0	36	<1	6	67	4 240	138
13	100–200	0	0	165	0	0	368	6 578	111
14	200–400	3 108	0	49	40	0	<1	395	0
15	200–400	885	0	3	22	0	0	1 407	0
16	200–400	1 557	0	12	3	0	0	5 890	0
17	200–400	916	0	9	14	0	0	1 234	0
18	10–30	0	21	0	49	652	0	154	0
19	10–30	0	1	0	248	232	0	2 967	0
20	10–30	0	152	0	327	645	0	806	2
21	10–30	0	75	0	847	937	0	31	1

Table 5 – ***continued***

B (Key QMS species)

		Key non-target QMS species catch rates (kg km^{-2})							
Stratum	Depth range (m)	BAR	LSO	LIN	SPO	RSK	SCH	SWA	SSK
1	30–100	676	22	36	132	14	28	4	4
2	30–100	2 169	0	4	55	0	27	1	23
3A	30–55	3 872	2	0	14	210	2	<1	28
3B	55–100	719	0	23	13	5	22	9	14
4A	30–55	172	4	3	16	50	2	0	39
4B	55–100	791	1	6	18	41	9	19	21
5	30–100	327	1	1	15	32	8	14	72
6	30–100	47	1	0	15	88	47	1	0
7	30–100	1 275	1	1	20	99	5	3	34
8	100–200	178	1	2	3	3	7	48	78
9	100–200	275	0	0	0	0	14	<1	28
10	100–200	865	0	<1	4	0	10	9	8
11	100–200	113	0	0	0	4	38	6	43
12	100–200	724	1	4	68	67	24	1	0
13	100–200	45	6	0	4	0	40	1	3
14	200–400	17	1	70	0	0	0	400	40
15	200–400	0	0	77	0	0	14	320	0
16	200–400	0	0	34	0	0	0	15	0
17	200–400	0	<1	24	0	36	0	3	69
18	10–30	139	1	0	62	81	2	<1	0
19	10–30	5	0	1	31	60	4	<1	0
20	10–30	241	0	2	136	50	9	2	0
21	10–30	132	4	1	24	37	<1	0	18

Table 6: Stratum and survey estimated biomass (t), and survey coefficient of variation (CV %) for the 2022 ECSI trawl survey for the target species in core strata 30–400 m (A) and shallow strata 10–30 m (B); and for the key non-target QMS species in core strata 30–400 m (C) and shallow strata 10–30 m (D). GSH, dark ghost shark, ELE, elephant fish; GIZ, giant stargazer; RCO, red cod; GUR, red gurnard; HPC, sea perch; SPD, spiny dogfish; NMP, tarakihi; BAR, barracouta; LSO, lemon sole; LIN, ling; SPO, rig; RSK, rough skate; SCH, school shark; SWA, silver warehou; SSK, smooth skate. (Continued on next page)

A (Target species in core strata 30–400 m)

		Target species biomass (t)							
Stratum	Depth range (m)	GSH	ELE	GIZ	RCO	GUR	HPC	SPD	NMP
1	30–100	0	182	17	308	88	249	83	264
2	30–100	0	33	32	38	19	11	20	139
3A	30–55	0	65	10	544	371	3	132	1
3B	55–100	2	11	59	113	17	30	34	131
4A	30–55	0	274	23	399	483	0	480	2
4B	55–100	238	41	94	115	160	18	572	81
5	30–100	0	12	85	66	137	41	2 921	112
6	30–100	0	49	146	140	206	14	3 625	22
7	30–100	0	127	24	144	1 905	10	2 390	18
8	100–200	597	0	79	0	5	200	5	10
9	100–200	1 420	0	201	6	5	271	35	38
10	100–200	2 290	4	8	4	8	802	499	8
11	100–200	1 969	0	86	30	1	98	370	6
12	100–200	2 787	0	27	<1	4	51	3 241	106
13	100–200	0	0	164	0	0	367	6 572	111
14	200–400	1 001	0	16	13	0	<1	127	0
15	200–400	380	0	2	9	0	0	605	0
16	200–400	1 170	0	9	2	0	0	4 426	0
17	200–400	664	0	6	10	0	0	894	0
Total	Biomass	12 519	798	1 092	1 943	3 410	2 164	27 030	1 049
	CV	27	36	16	25	30	30	33	25

B (Target species in shallow strata 10–30 m)

		Target species biomass (t)							
Stratum	Depth range (m)	GSH	ELE	GIZ	RCO	GUR	HPC	SPD	NMP
18	10–30	0	27	0	63	831	0	196	0
19	10–30	0	2	0	245	230	0	2 935	0
20	10–30	0	121	0	260	514	0	642	1
21	10–30	0	39	0	440	487	0	16	1
Total	Biomass	0	189	0	1 008	2 062	0	3 789	2
	CV	–	29	–	27	18	–	28	65

Table 6 – *continued*

C (Key QMS species in core strata 30–400 m)

		Key QMS non-target species biomass (t)							
Stratum	Depth range (m)	BAR	LSO	LIN	SPO	RSK	SCH	SWA	SSK
1	30–100	665	21	35	130	14	28	4	4
2	30–100	2 694	0	5	68	0	34	1	29
3A	30–55	5 150	3	0	19	279	2	<1	37
3B	55–100	1 216	0	40	23	8	37	15	24
4A	30–55	191	4	3	18	55	2	0	44
4B	55–100	1 262	1	9	29	65	14	31	34
5	30–100	812	2	3	38	78	20	35	179
6	30–100	112	3	0	35	208	111	2	0
7	30–100	2 665	2	1	41	207	10	6	71
8	100–200	112	1	1	2	2	5	30	49
9	100–200	320	0	0	0	0	16	0	33
10	100–200	1 031	0	<1	4	0	12	11	10
11	100–200	166	0	0	0	5	56	8	63
12	100–200	553	1	3	52	51	18	<1	0
13	100–200	45	6	0	4	0	40	1	3
14	200–400	5	0	23	0	0	0	129	13
15	200–400	0	0	33	0	0	6	138	0
16	200–400	0	0	25	0	0	0	11	0
17	200–400	0	<1	18	0	26	0	2	50
Total	Biomass	16 999	46	199	462	998	411	423	641
	CV	35	23	20	33	24	16	44	32

D (Key QMS species in shallow strata 10–30 m)

		Key QMS non-target species biomass (t)							
Stratum	Depth range (m)	BAR	LSO	LIN	SPO	RSK	SCH	SWA	SSK
18	10–30	177	1	0	79	103	2	<1	0
19	10–30	5	0	1	31	59	4	<1	0
20	10–30	192	0	2	108	40	7	1	0
21	10–30	68	2	1	12	19	<1	0	10
Total	Biomass	443	3	3	230	221	13	2	10
	CV	33	66	52	34	10	34	38	100

Table 7: Number of length frequency and biological records collected on the ECSI 2022 trawl survey. Measurement methods: 1, fork length; 2, total length; 5, pelvic length; B, carapace length; G, total length excluding tail filament. + Data include one or more of the following: fish weight, gonad stage, otoliths, or spines. Species codes are defined in Appendix 4.

		Length frequency data		Biological data+		
Species code	Measurement method	No. of samples	No. of fish	No. of samples	No. of fish	No. of otoliths or spines
ATT	1	10	43	7	25	–
BAR	1	88	7 843	1	22	–
BCO	2	20	154	11	86	–
BRI	2	2	5	1	3	–
CBI	2	1	21	1	21	–
ELE	1	49	874	48	338	–
EMA	1	4	10	3	9	–
ESO	2	18	248	–	–	–
FRO	1	2	2	1	1	–
GIZ	2	76	1 440	76	806	633
GSH	G	40	3 915	39	697	–
GUR	2	75	4 414	75	1 095	905
HAK	2	5	16	2	11	–
HAP	2	19	32	11	22	–
HBA	2	5	97	5	87	83
HOK	2	9	562	6	130	–
HPC	2	55	3 164	55	807	592
JAV	2	1	88	–	–	–
JDO	2	3	3	3	3	–
JMD	1	28	114	15	61	58
JMM	1	1	1	1	1	1
JMN	1	11	148	6	82	69
KIN	1	3	3	2	2	–
LDO	2	7	80	5	63	–
LEA	2	28	1 378	12	223	–
LIN	2	42	444	21	121	–
LSO	2	39	322	–	–	–
MOK	1	8	18	5	15	–
NMP	1	59	2 363	59	769	612
RBT	1	4	7	–	–	–
RCO	2	75	2 853	75	1 069	878
RSK	5	51	411	35	282	–
RSO	1	17	97	8	74	–
SAM	1	1	1	1	1	–
SCH	2	68	270	35	141	–
SCI	B	5	11	3	9	–
SFL	2	9	116	5	13	–
SPD	2	97	6 585	93	1 493	–
SPO	2	52	593	27	256	–
SRB	1	30	370	13	142	–
SSI	1	12	389	–	–	–
SSK	5	39	150	16	40	–
SWA	1	66	1 231	8	73	–
WAR	1	35	673	6	22	–
YBF	2	3	8	1	2	–
Totals	–	1 272	41 567	797	9 117	3 831

Table 8: ECSI 2022 trawl survey gonad stages of target species in 30–400 m, and for elephantfish and red gurnard in 10 to 30 m. See Appendix 1 for gonad stage definitions. NA, not applicable.

Species	Sex	No. of fish	% Gonad stage						
			1	2	3	4	5	6	7
30–400 m									
Giant stargazer	Males	388	49	20	9	18	4	0	<1
	Females	409	47	47	5	1	0	0	0
Red cod	Males	417	33	57	4	5	0	0	<1
	Females	403	21	78	<1	<1	0	0	0
Red gurnard	Males	475	5	57	17	5	6	7	3
	Females	374	6	63	22	0	0	0	9
Sea perch (HPC)	Males	423	8	21	9	60	2	0	0
	Females	380	19	78	1	1	0	0	0
Tarakihi	Males	362	56	39	3	2	<1	0	0
	Females	347	44	55	<1	0	<1	0	<1
			% Gonad stage						
			1	2	3	4			
Dark ghost shark	Males	271	23	21	56	NA	NA		
	Females	426	26	10	60	2	3		
			% Gonad stage						
			1	2	3	4			
Elephantfish	Males	99	39	8	53	NA			
	Females	118	33	59	8	0			
			% Gonad stage						
			1	2	3	4	5	6	
Spiny dogfish	Males	800	28	11	62	NA	NA	NA	
	Females	470	53	11	4	3	30	<1	
			% Gonad stage						
10–30 m			1	2	3	4			
Elephantfish	Males	55	89	0	11	NA			
	Females	53	75	19	6	0			
			% Gonad stage						
			1	2	3	4	5	6	7
Red gurnard	Males	73	18	48	29	3	1	1	0
	Females	169	8	65	20	0	0	0	7

Table 9: Estimated biomass (Biom.) and coefficient of variation (CV, %) for the target species and key non-target QMS species for all ECSI winter surveys in the core strata (A), and core plus shallow strata in 2007, 2012, 2014, 2016, 2018, 2021, and 2022 for species found in less than 30 m (B). Biomass estimates for 1991 were adjusted to allow for non-sampled strata (7 and 9, equivalent to current strata 13, 16, and 17). Rough skate and smooth skate were not separated in 1991 (combined biomass 1993 t, CV 25%). Species in order of common name. Species codes defined in Appendix 4. –, not applicable. (Continued on next page)

A (Core strata). Target species

	GSH		ELE		GIZ		RCO		GUR		HPC		SPD		NMP	
Survey	Biom. (t)	CV	Biom. (t)	CV	Biom. (t)	CV	Biom. (t)	CV	Biom. (t)	CV	Biom. (t)	CV	Biom. (t)	CV	Biom. (t)	CV
1991	962	42	300	40	672	17	3 760	33	763	33	1 716	30	12 873	22	1 712	33
1992	934	44	176	32	669	16	4 527	40	142	30	1 934	28	10 787	26	932	26
1993	2 911	42	481	33	609	14	5 601	30	576	31	2 948	32	13 949	17	3 805	55
1994	2 702	25	164	32	439	17	5 637	35	123	34	2 342	29	14 530	10	1 219	31
1996	3 176	23	858	30	466	11	4 619	30	505	27	1 671	26	35 169	15	1 656	24
2007	4 483	25	1 034	32	755	18	1 486	25	1 453	35	1 954	22	35 386	27	2 589	24
2008	3 763	20	1 404	35	606	14	1 824	49	1 309	34	1 944	23	28 476	22	1 863	29
2009	4 329	24	596	23	475	14	1 871	40	1 725	30	1 444	25	25 311	31	1 519	36
2012	10 704	29	1 351	39	643	16	11 821	79	1 680	28	1 964	26	35 546	31	1 661	25
2014	13 137	26	951	34	790	14	2 096	39	2 063	25	2 168	25	19 949	31	2 380	23
2016	15 271	25	6 812	68	565	17	2 268	54	941	30	3 032	29	26 063	41	1 462	31
2018	6 485	23	807	21	738	18	1 500	83	2 043	19	2 023	29	24 758	28	1 409	26
2021	12 004	27	170	32	1 090	13	15 096	69	2 068	32	1 453	25	7 857	32	775	38
2022	12 519	27	798	36	1 092	16	1 943	25	3 410	30	2 164	30	27 030	33	1 049	25

A (Core strata). Non-target QMS species

	BAR		LSO		LIN		SPO		RSK		SCH		SWA		SSK	
Survey	Biom.	CV	Biom.	CV	Biom.	CV	Biom.	CV	Biom.	CV	Biom.	CV	Biom.	CV	Biom.	CV
1991	8 354	29	92	27	1 009	35	175	30	–	–	100	30	30	21	–	–
1992	11 672	23	57	18	525	17	66	18	224	24	104	21	32	22	609	18
1993	18 197	22	121	19	651	27	67	30	340	21	369	42	256	44	670	24
1994	6 965	34	77	21	488	19	54	29	517	20	155	36	35	28	306	25
1996	16 848	19	49	33	488	21	63	37	177	20	202	18	231	32	385	24
2007	21 132	17	74	26	283	27	134	37	878	22	538	22	445	44	709	20
2008	25 544	16	116	25	351	22	280	23	858	19	411	20	319	32	554	18
2009	33 360	16	55	27	262	19	125	26	1 029	30	254	18	446	42	736	23
2012	34 325	17	65	18	265	21	171	62	1 133	20	292	20	434	46	1 025	35

Table 9 – *continued*.

Survey	BAR Biom. (t)	BAR CV	LSO Biom. (t)	LSO CV	LIN Biom. (t)	LIN CV	SPO Biom. (t)	SPO CV	RSK Biom. (t)	RSK CV	SCH Biom. (t)	SCH CV	SWA Biom. (t)	SWA CV	SSK Biom. (t)	SSK CV
2014	46 563	19	107	27	230	21	194	48	1 153	38	529	36	626	83	637	20
2016	19 708	27	91	15	489	48	181	39	1 142	30	369	21	428	53	663	17
2018	29 926	23	44	20	121	30	98	28	978	16	251	20	191	42	664	22
2021	15 245	34	107	22	161	26	506	90	2 097	22	276	26	788	88	909	28
2022	16 999	35	46	23	199	20	462	33	998	24	411	16	423	44	641	32

B (Core plus shallow strata). Target species found in < 30 m

Survey	ELE Biom. (t)	ELE CV	RCO Biom. (t)	RCO CV	GUR Biom. (t)	GUR CV	SPD Biom. (t)	SPD CV
2007	1 859	24	1 552	24	2 048	27	37 299	26
2012	3 780	31	12 032	78	3 515	17	38 821	28
2014	1 600	21	3 714	41	3 215	17	22 188	28
2016	7 299	63	2 360	52	2 420	15	27 300	39
2018	1 118	20	1 584	78	3 831	17	26 049	26
2021	655	51	15 177	69	3 724	19	9 010	29
2022	987	29	2951	19	5 472	20	30 819	29

B (Core plus shallow strata). Non-target QMS species found in < 30 m

Survey	BAR Biom. (t)	BAR CV	RSK Biom. (t)	RSK CV	SCH Biom. (t)	SCH CV	SPO Biom. (t)	SPO CV	SWA Biom. (t)	SWA CV
2007	24 938	18	1 261	16	552	21	192	30	451	43
2012	36 526	16	1 414	16	310	19	315	37	438	46
2014	46 903	19	1 597	28	547	35	320	31	626	83
2016	23 007	24	1 576	22	379	21	255	29	428	53
2018	31 733	22	1 213	14	255	20	287	29	191	42
2021	16 281	32	2 486	19	319	24	728	63	790	88
2022	17 442	34	1 219	20	424	16	693	25	425	44

Table 10: Percent occurrence (% of stations where 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 (A), and the core strata plus shallow for ELE and GUR in 2007, 2012, 2014, 2016, 2018, 2021, and 2022 (B).

A (Core strata

	GSH		ELE		GIZ		RCO		GUR		HPC		SPD		NMP		All target species
	% Occ.	% catch	% Occ.	% catch	% Occ.	% catch	% Occ.	% catch	% Occ.	% catch	% Occ.	% catch	% Occ.	% catch	% Occ.	% catch	%
1991	27	2	35	1	85	1	89	10	49	1	82	4	96	31	71	4	55
1992	28	3	29	<1	84	2	89	15	23	<1	76	6	99	25	61	2	53
1993	38	9	32	1	92	1	81	13	25	1	70	4	99	23	62	5	56
1994	29	9	31	1	83	1	75	28	32	<1	76	4	96	28	64	2	73
1996	44	6	32	1	71	1	84	7	30	1	57	3	98	46	63	1	64
2007	49	7	38	1	83	1	71	2	56	2	65	2	100	39	66	3	57
2008	44	7	47	1	77	1	65	4	56	1	72	3	100	36	62	2	56
2009	58	10	38	1	78	1	64	9	44	2	66	3	100	24	51	2	51
2012	37	11	38	2	74	1	70	9	58	2	71	2	98	30	63	1	57
2014	49	17	42	1	79	1	67	2	60	2	73	4	99	18	66	3	48
2016	40	22	32	12	78	1	66	3	61	1	66	5	98	20	70	2	67
2018	49	13	38	1	80	1	54	3	59	2	61	3	99	28	67	2	53
2021	35	23	26	<1	89	2	63	15	56	2	54	4	94	10	64	2	57
2022	41	17	49	1	77	1	76	3	76	5	56	3	98	27	61	1	59

B (Core plus shallow strata)

	ELE		GUR		GUR and ELE
	% Occ.	% catch	% Occ.	% catch	% catch
2007	41	2	61	2	4
2012	47	4	66	3	8
2014	50	2	68	3	4
2016	40	10	68	2	13
2018	44	1	63	4	5
2021	34	1	64	5	6
2022	49	1	76	5	6

9. FIGURES

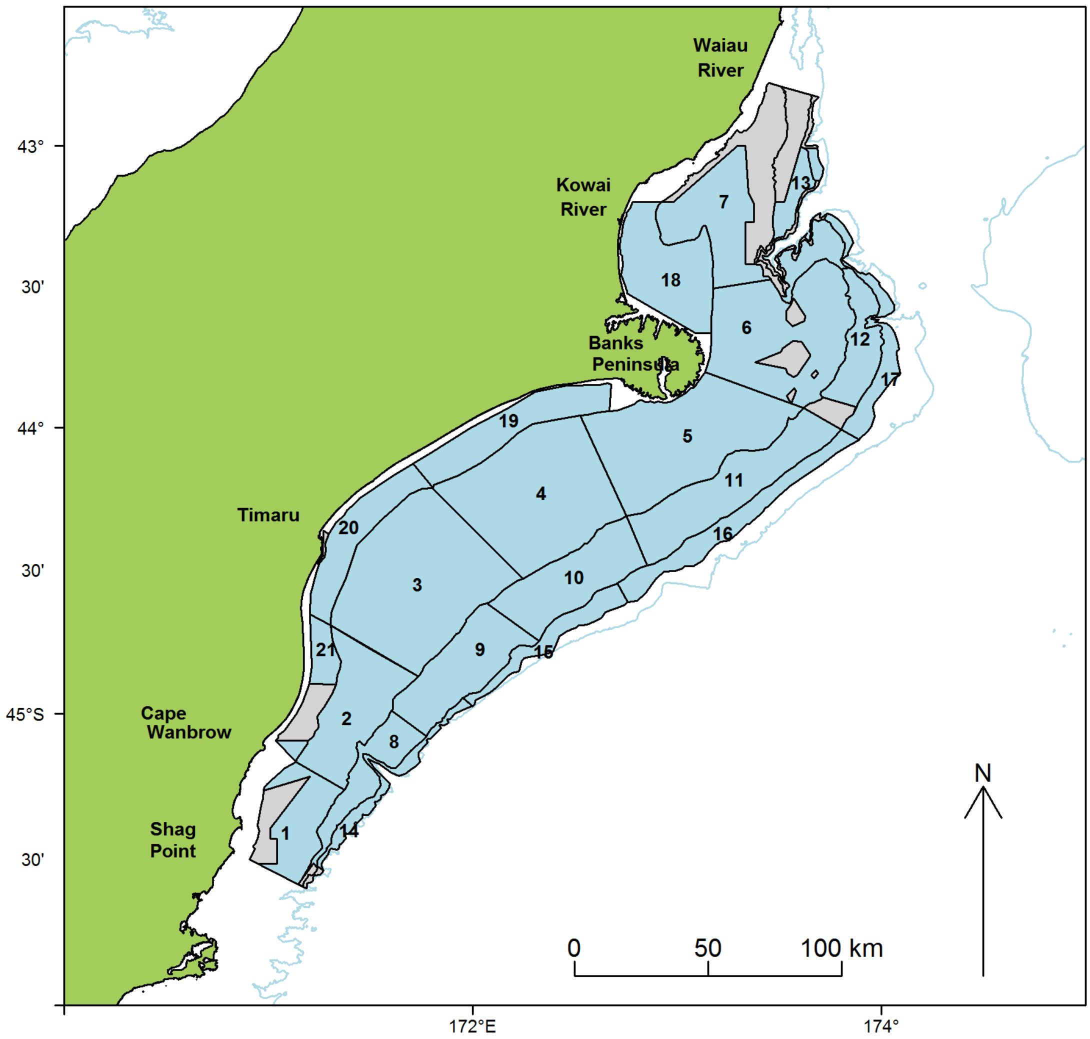


Figure 1: Strata used in the 2007 to 2021 ECSI trawl surveys in 10–400 m. Before 2007, there were no inshore strata in 10–30 m (i.e., strata 18–21). For strata boundaries before 1994, see Beentjes (1998a). Grey areas are foul ground. Strata depth ranges are 10–30 m, 30–100 m, 100–200 m, and 200–400 m. Outer depth contour in blue is 500 m.

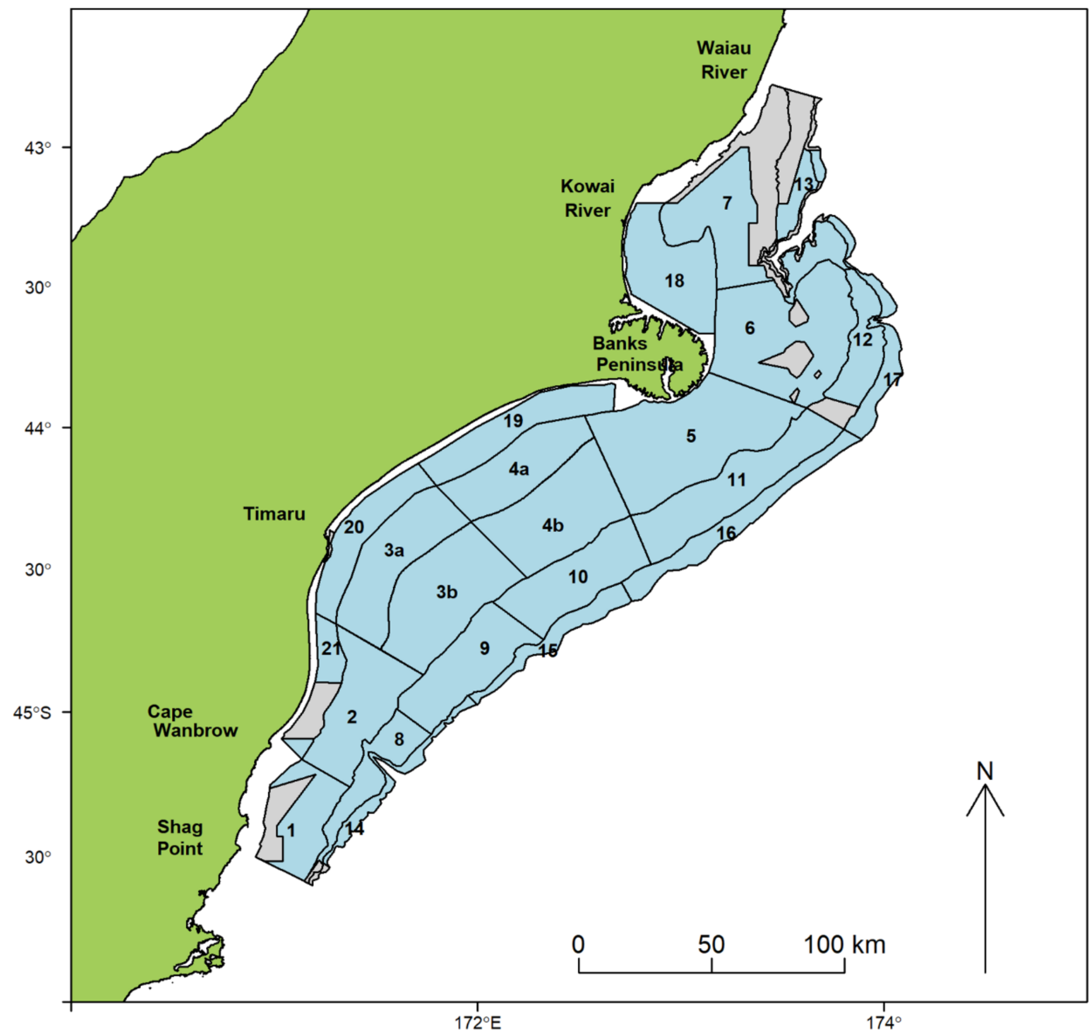


Figure 2: Strata used in the 2022 ECSI trawl survey. Core strata (30–400 m) include 1–17, and core plus shallow strata (10–400 m) include 1–21. Grey areas are foul untrawlable ground. Strata depth ranges are 10–30 m, 30–100 m, 100–200 m, and 200–400 m.

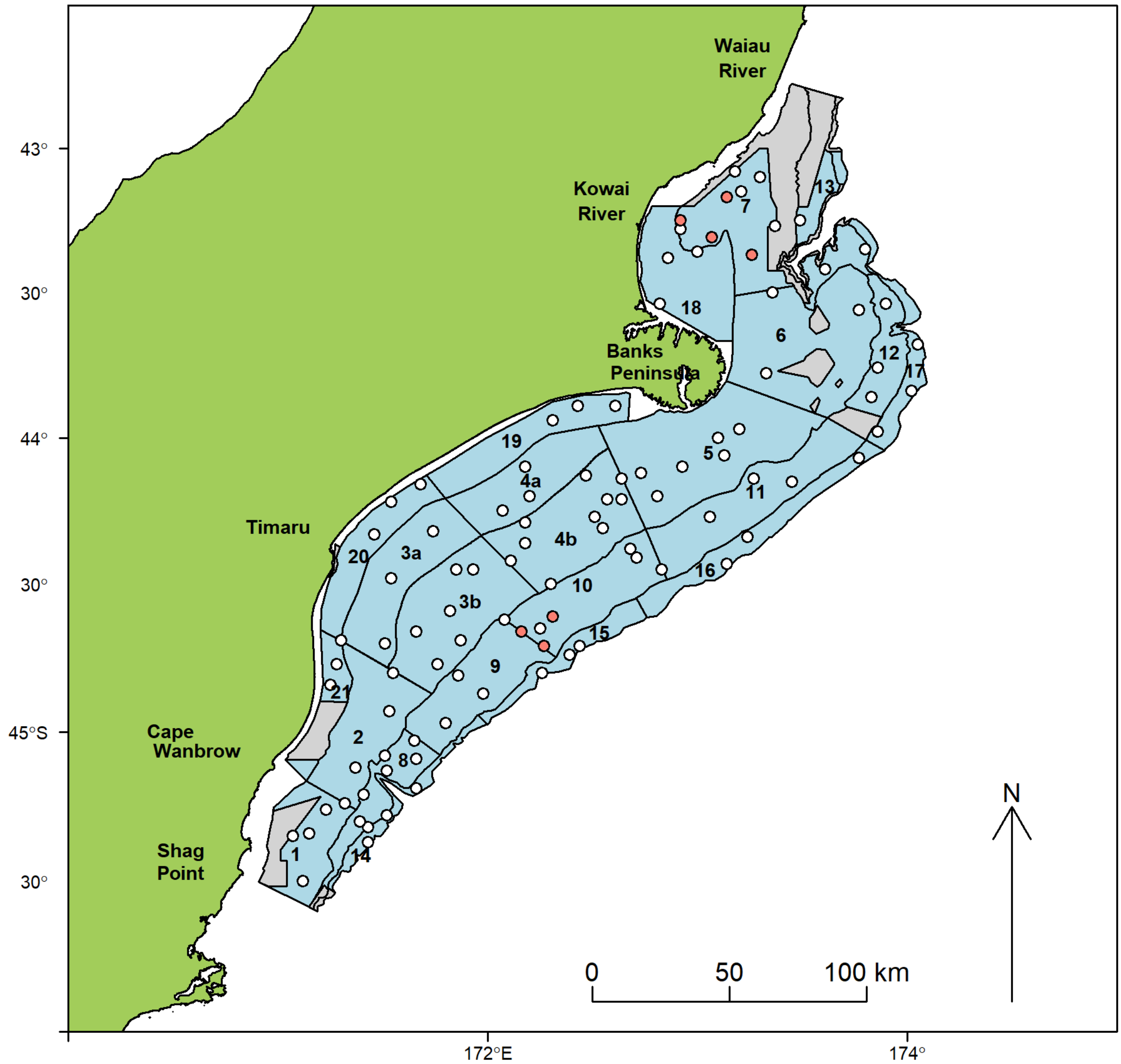


Figure 3: All 99 valid biomass stations from the 2022 ECSI survey. White circles are phase 1 stations and red circles are phase 2. Grey areas are foul ground.

Dark ghost shark

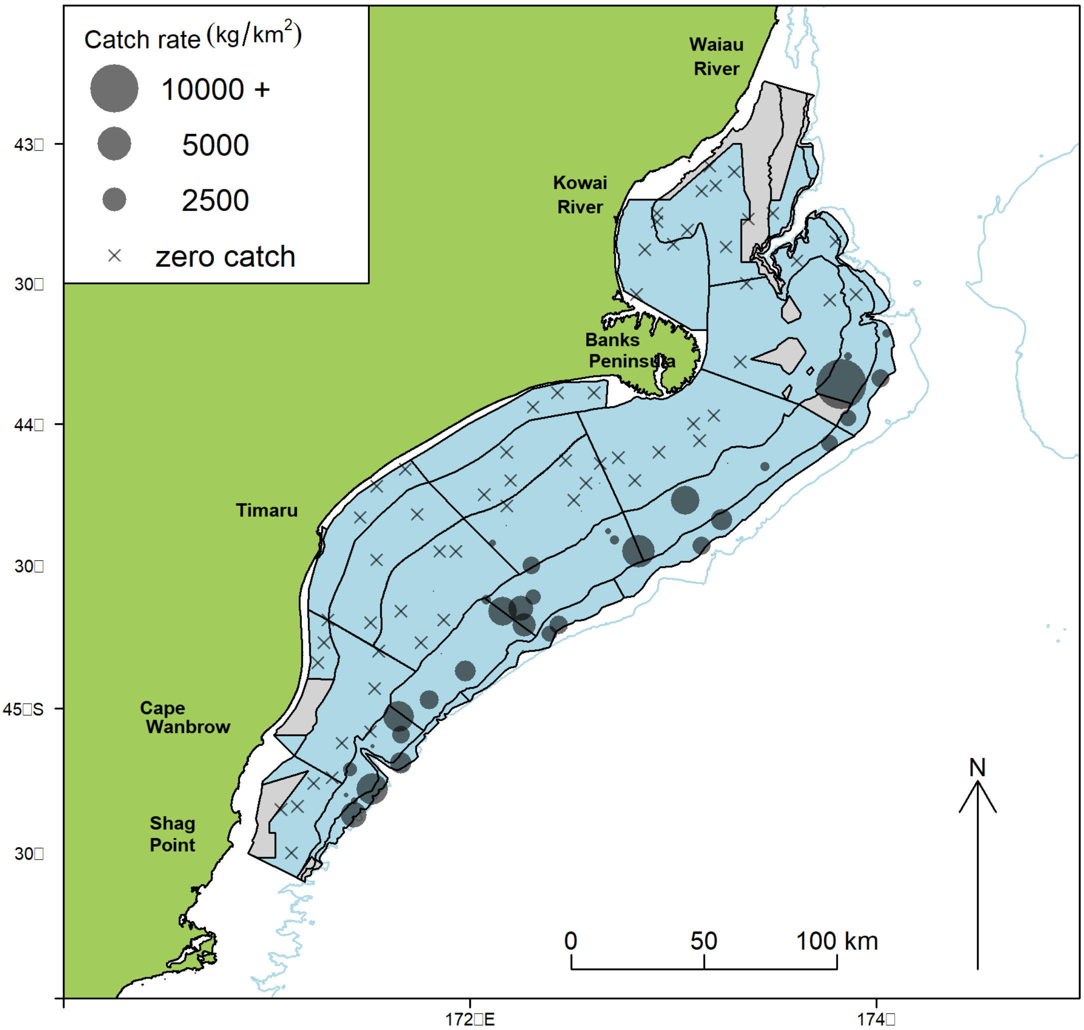


Figure 4: Catch rates (kg km^{-2}) of eight target species for the 2022 ECSI trawl survey. The legend indicates the circle size that corresponds to catch rates; on the figure, circle size is continuous and proportional to the catch rate. Crosses indicate no catch of the given species at that station. Grey areas are foul ground. The depth contour is 500 m.

Elephantfish

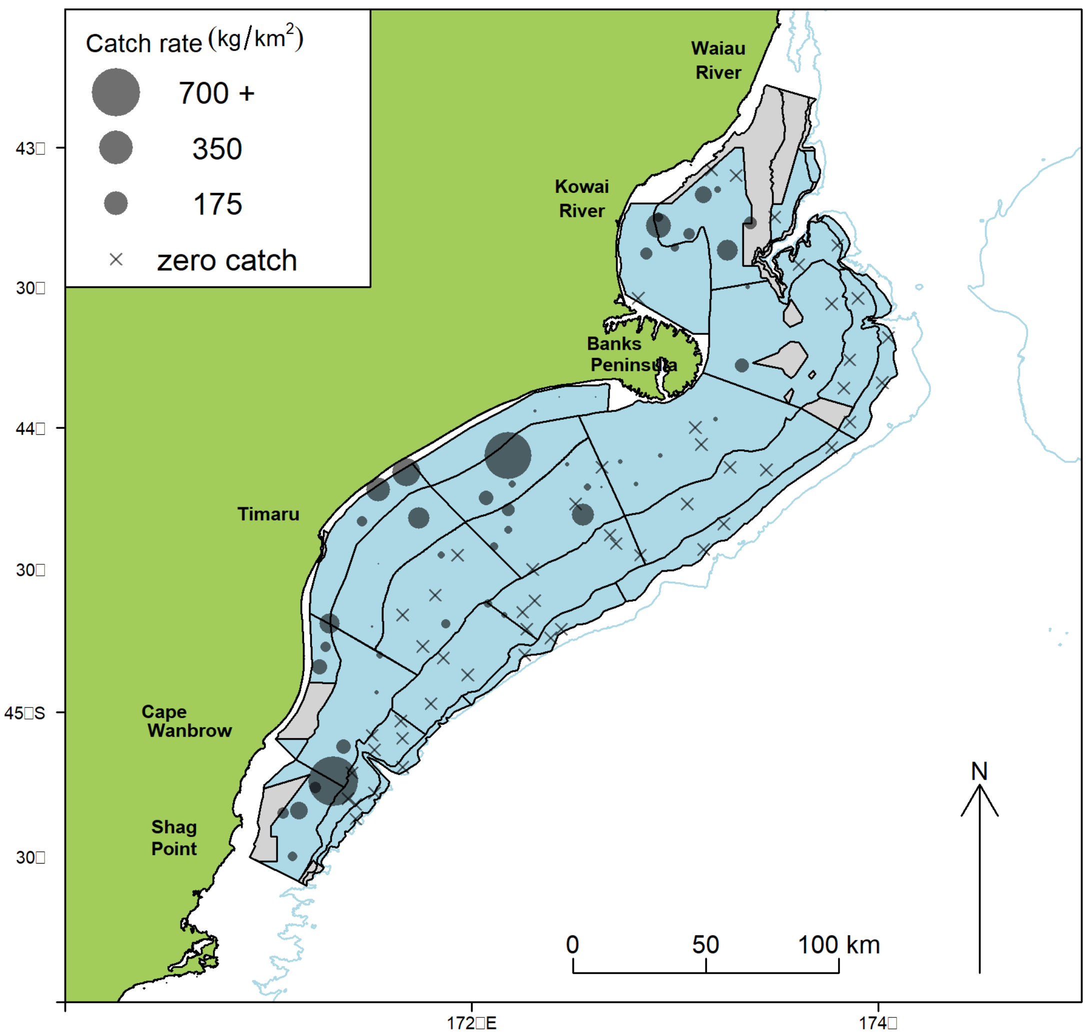


Figure 4 – *continued.*

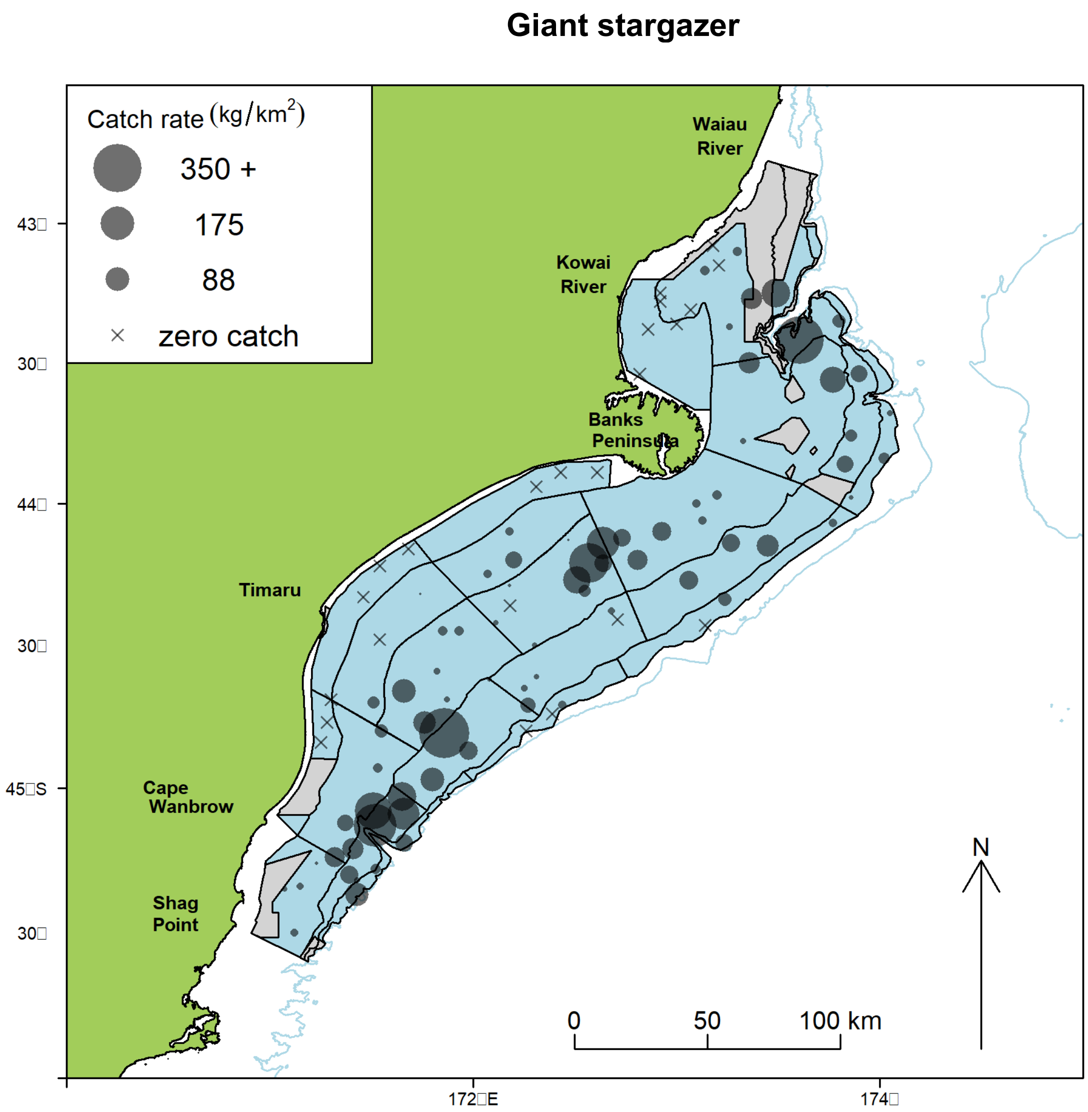


Figure 4 – *continued.*

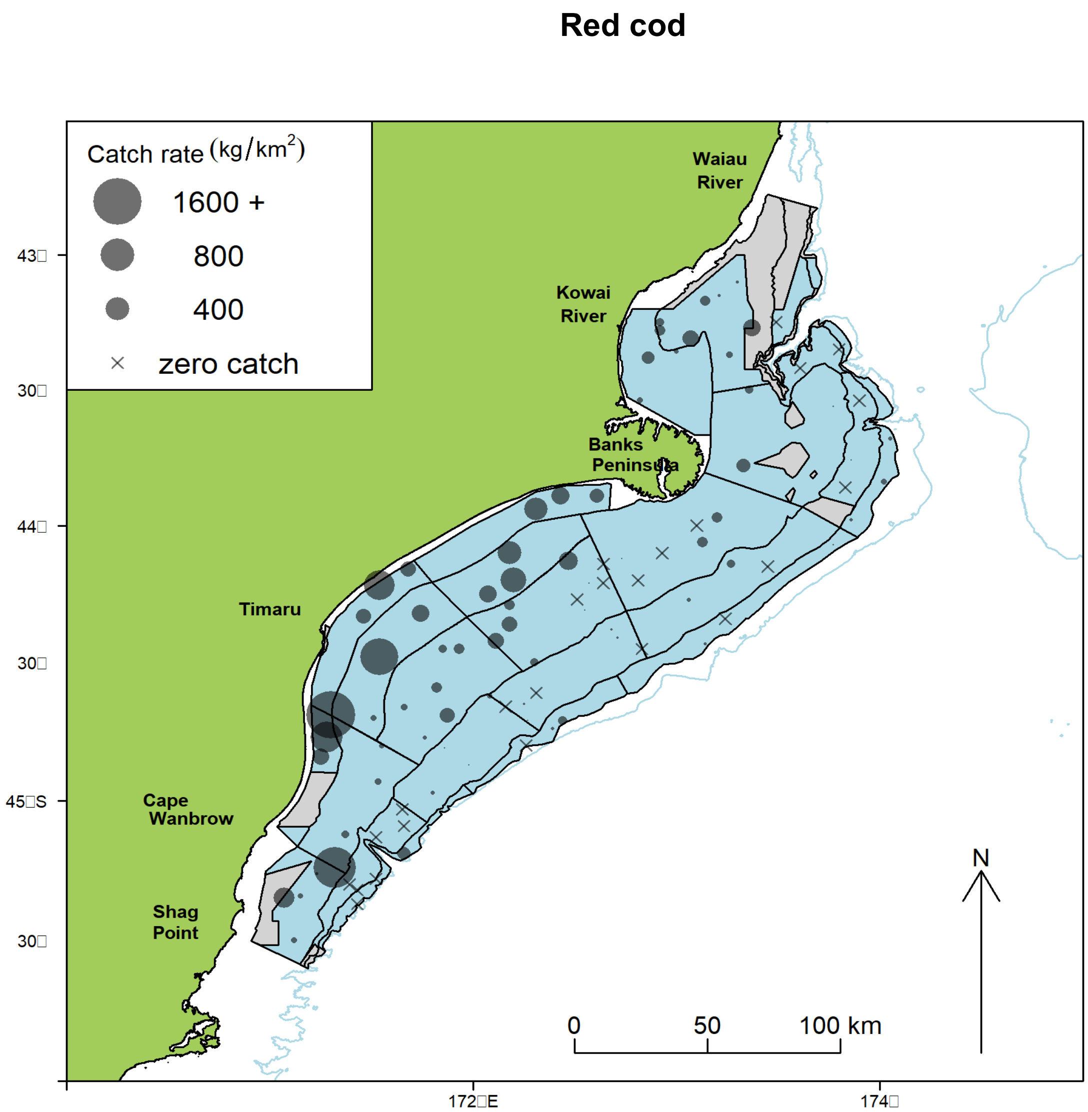


Figure 4 – ***continued.***

Red gurnard

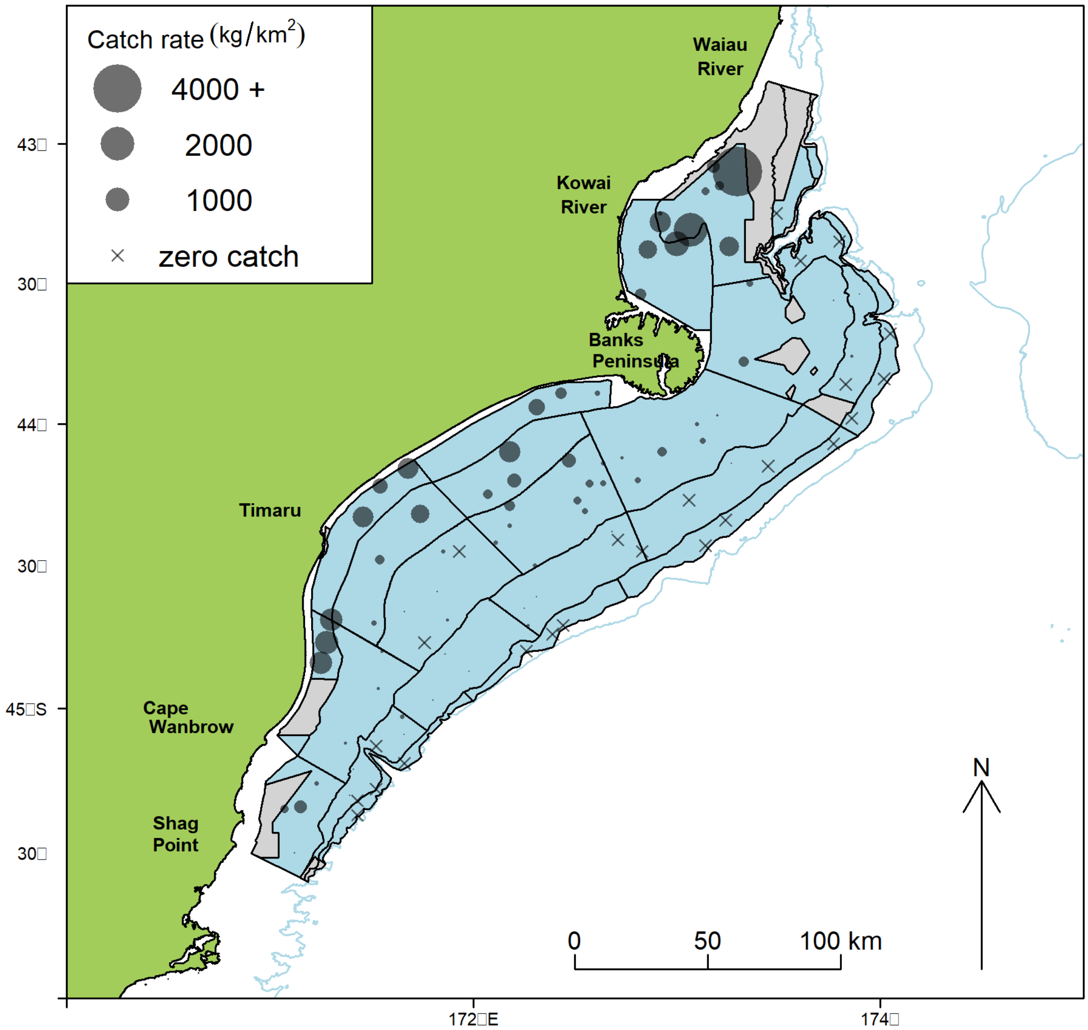


Figure 4 – ***continued.***

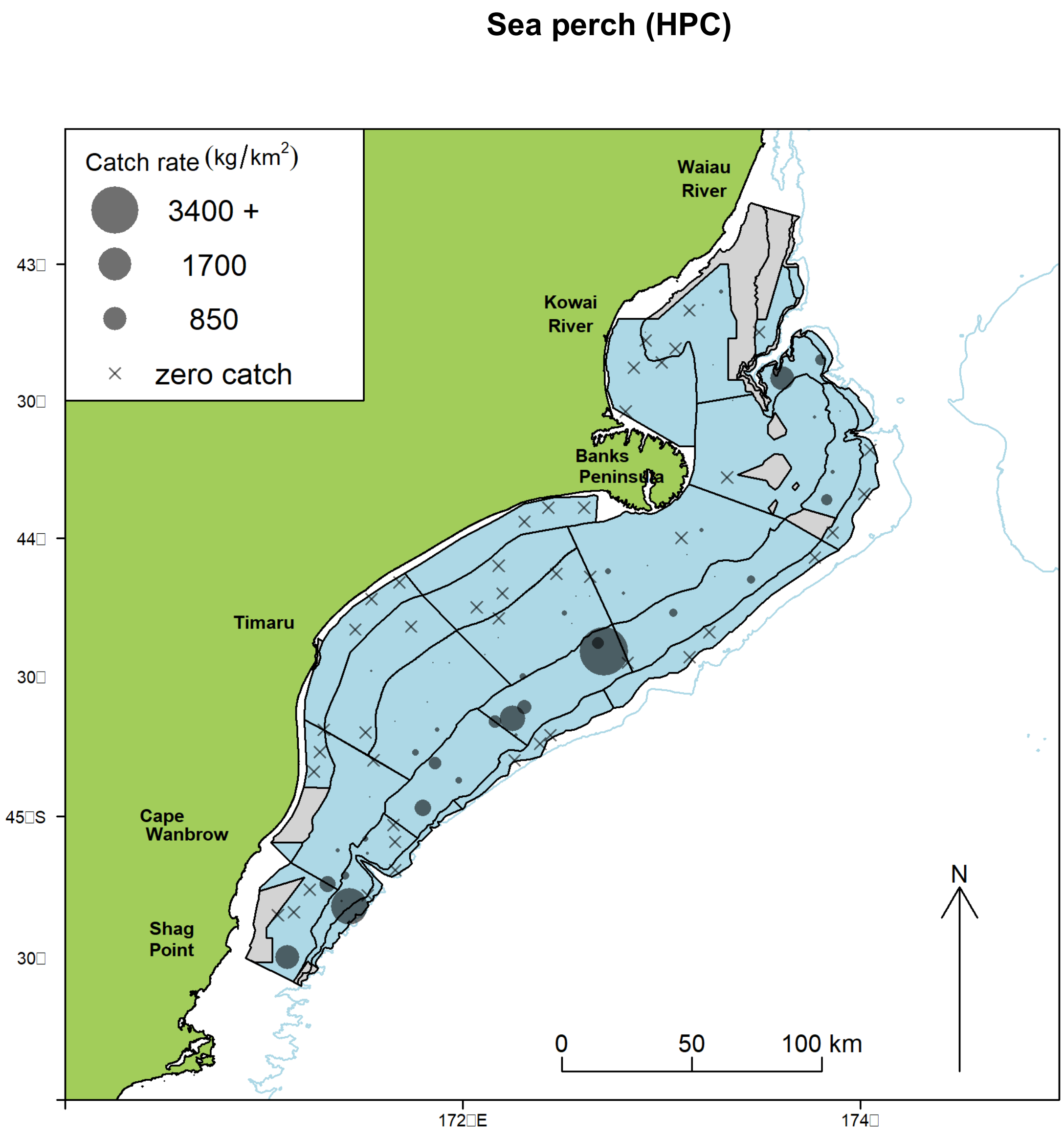


Figure 4 – ***continued.***

Spiny dogfish

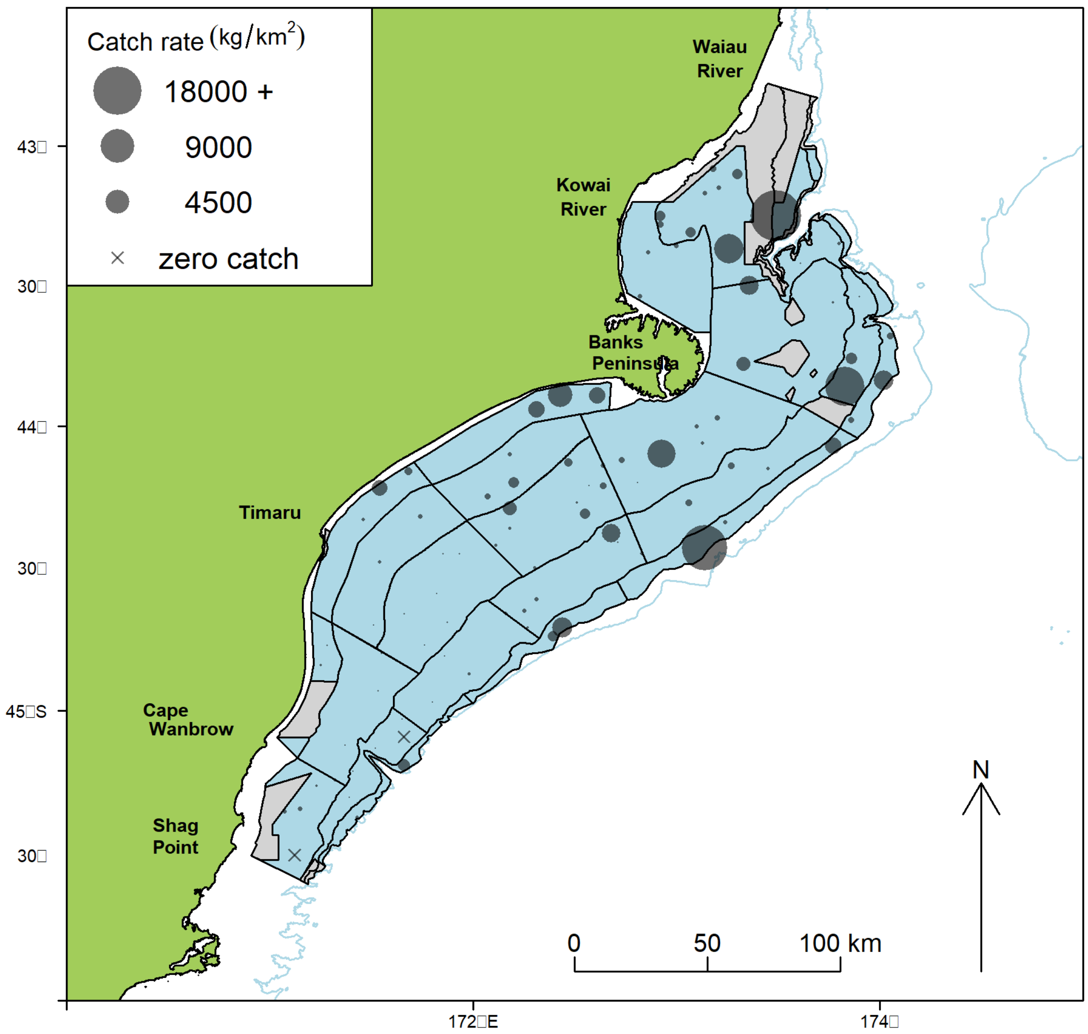


Figure 4 – ***continued.***

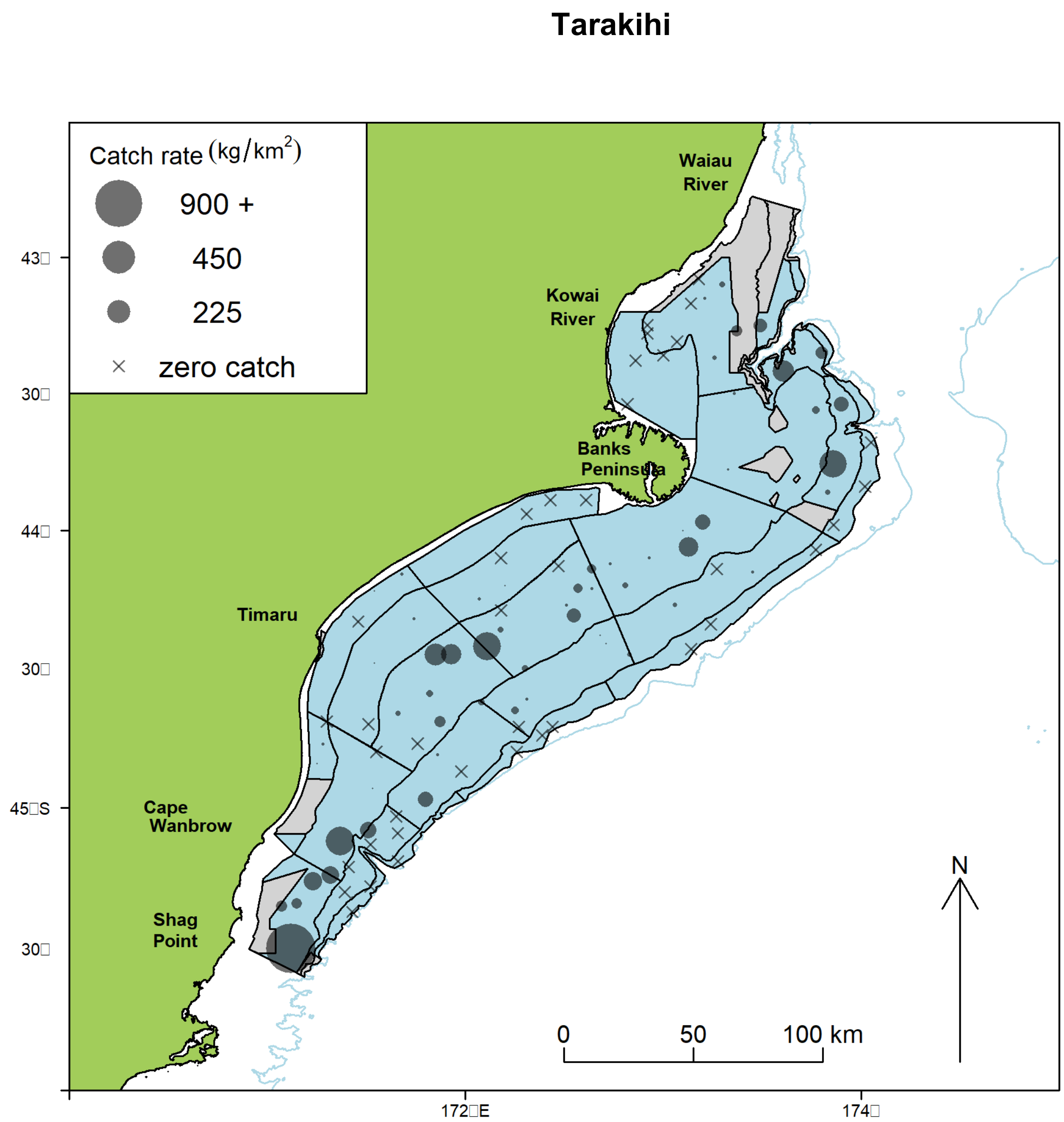


Figure 4 – *continued.*

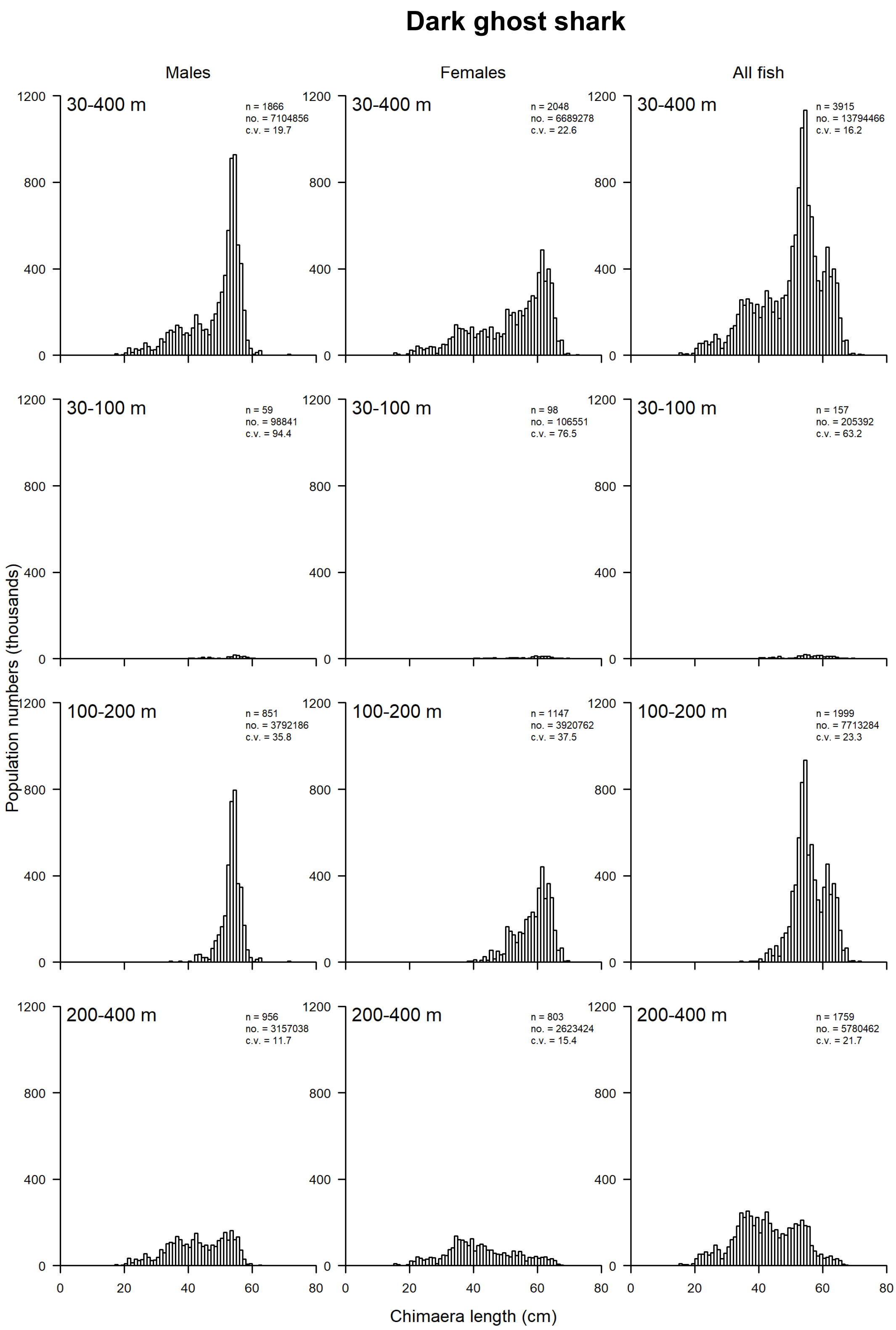


Figure 5: Scaled length frequency distributions for the target species by depth range for the 2022 ECSI trawl survey. Population estimates for each species are in the units given on the y-axis. The 'All fish' length distribution includes unsexed fish. n, number of fish sampled; no., scaled number of fish; c.v. (%).

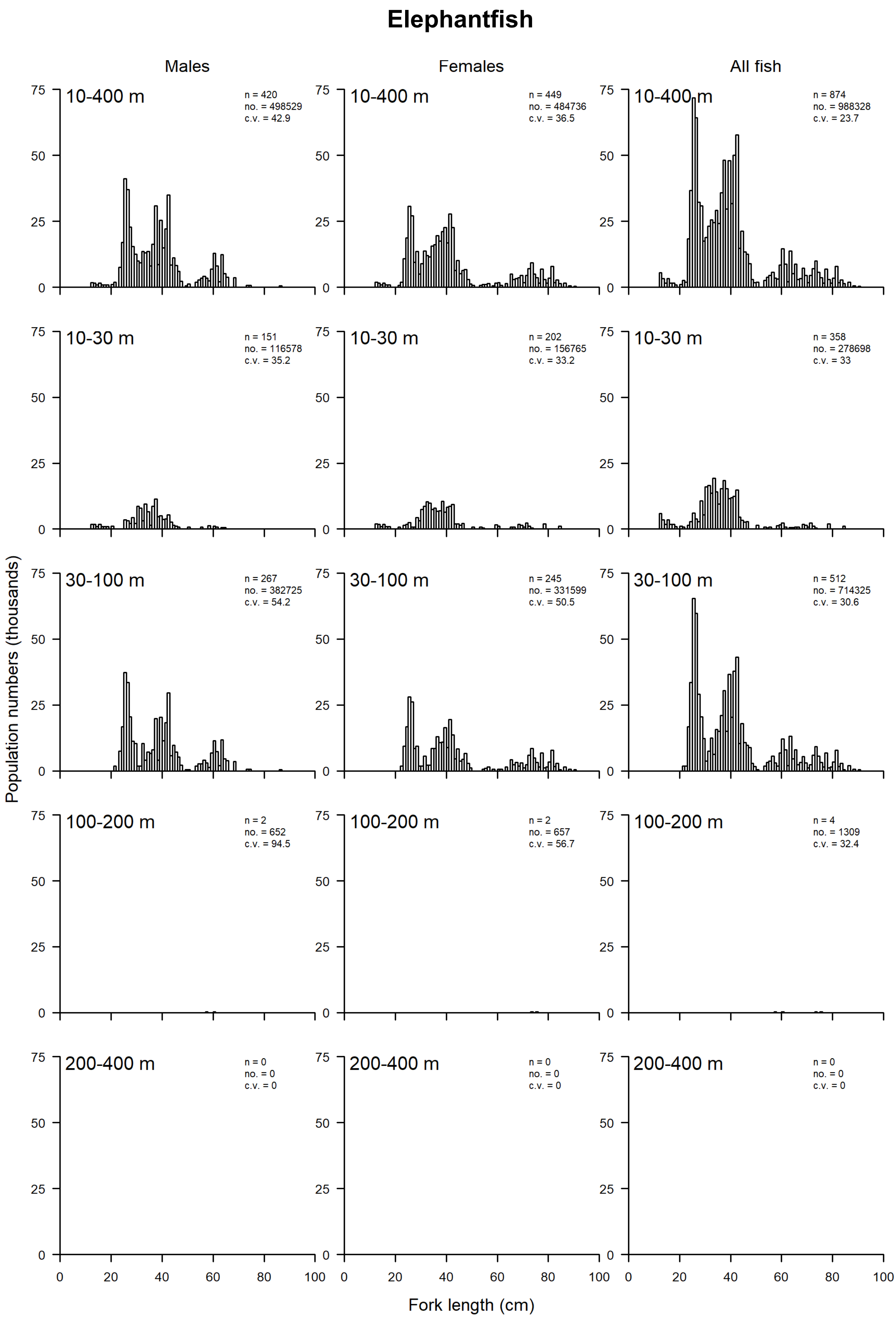


Figure 5 – *continued.*

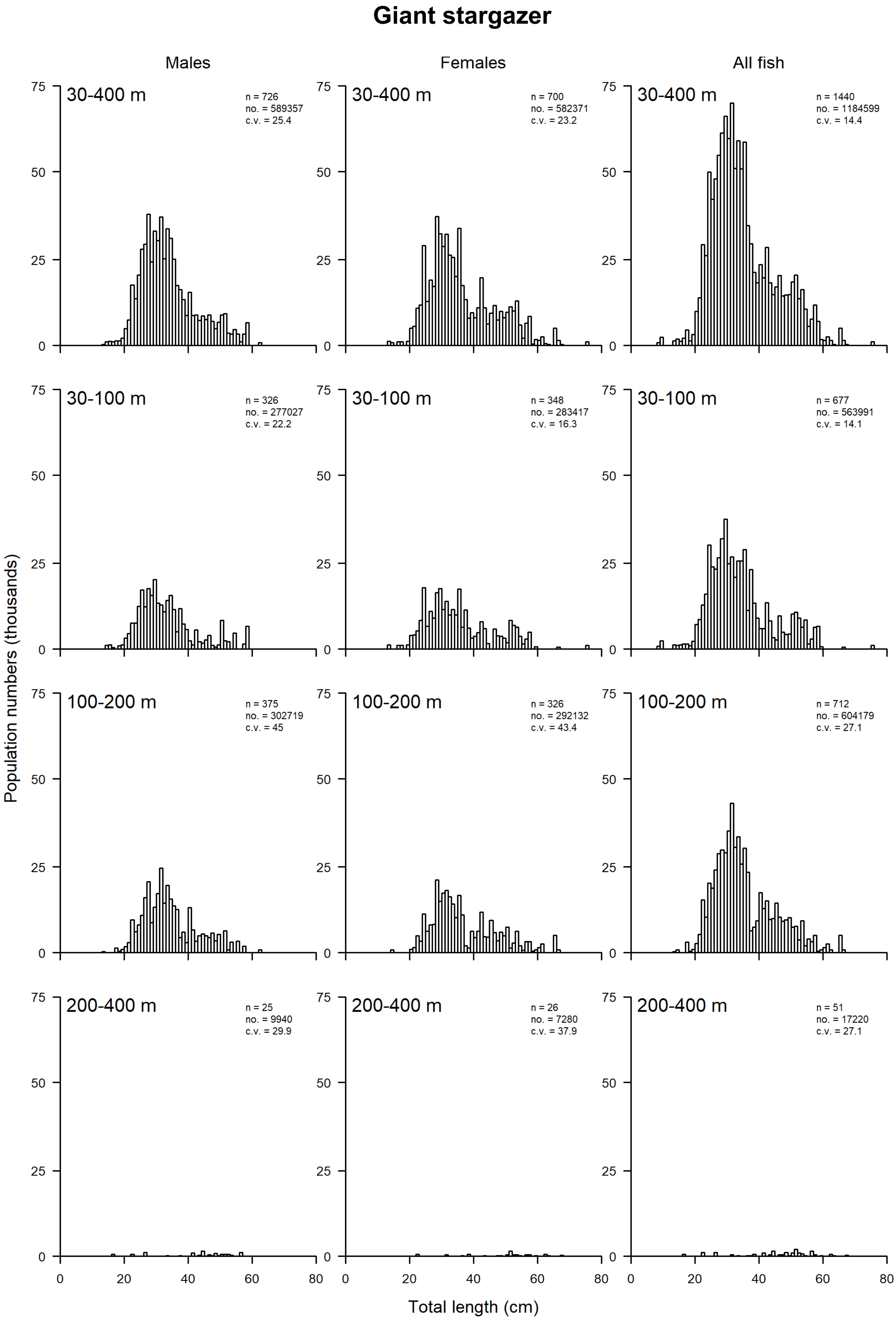


Figure 5 – ***continued.***

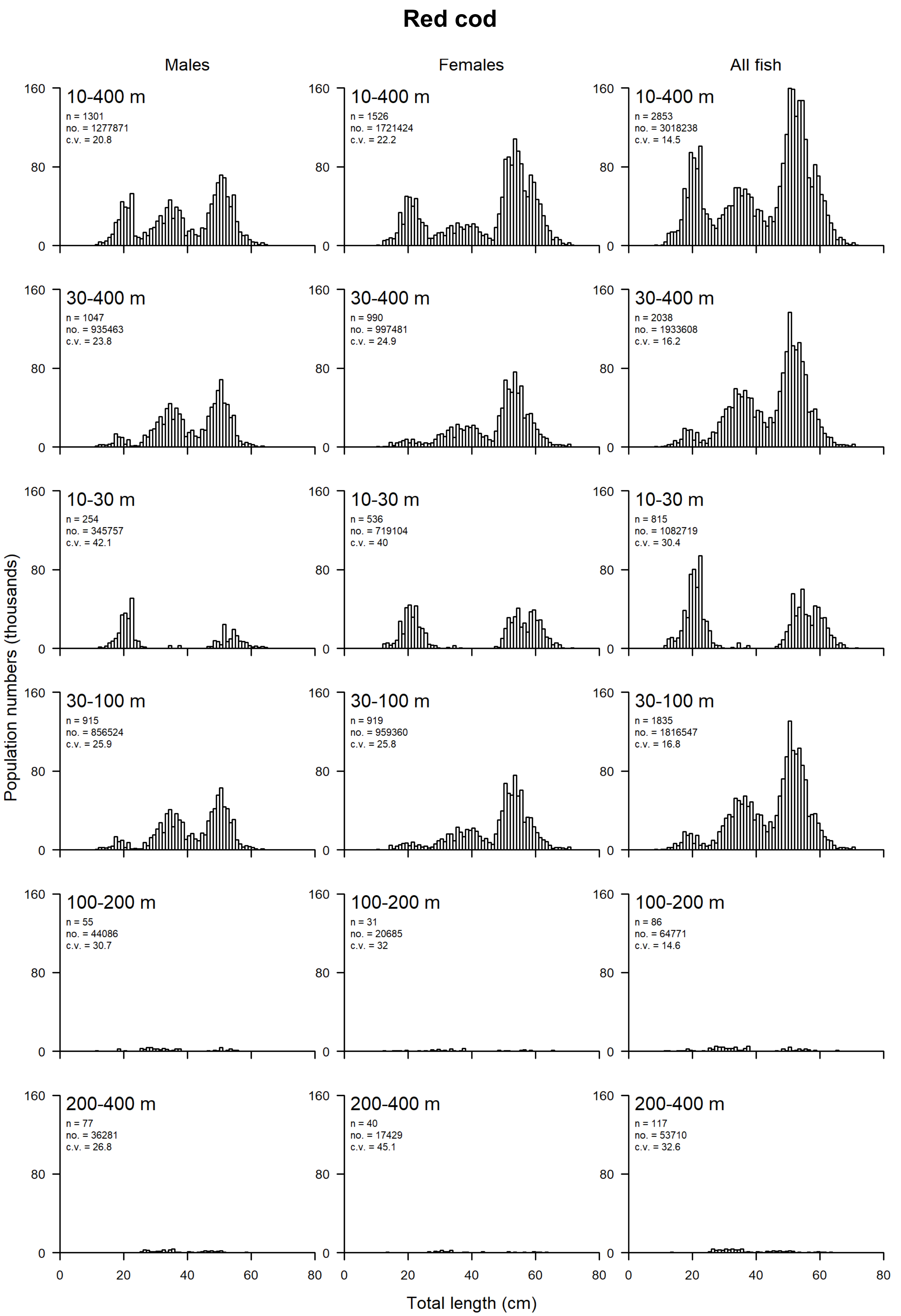


Figure 5 – *continued.*

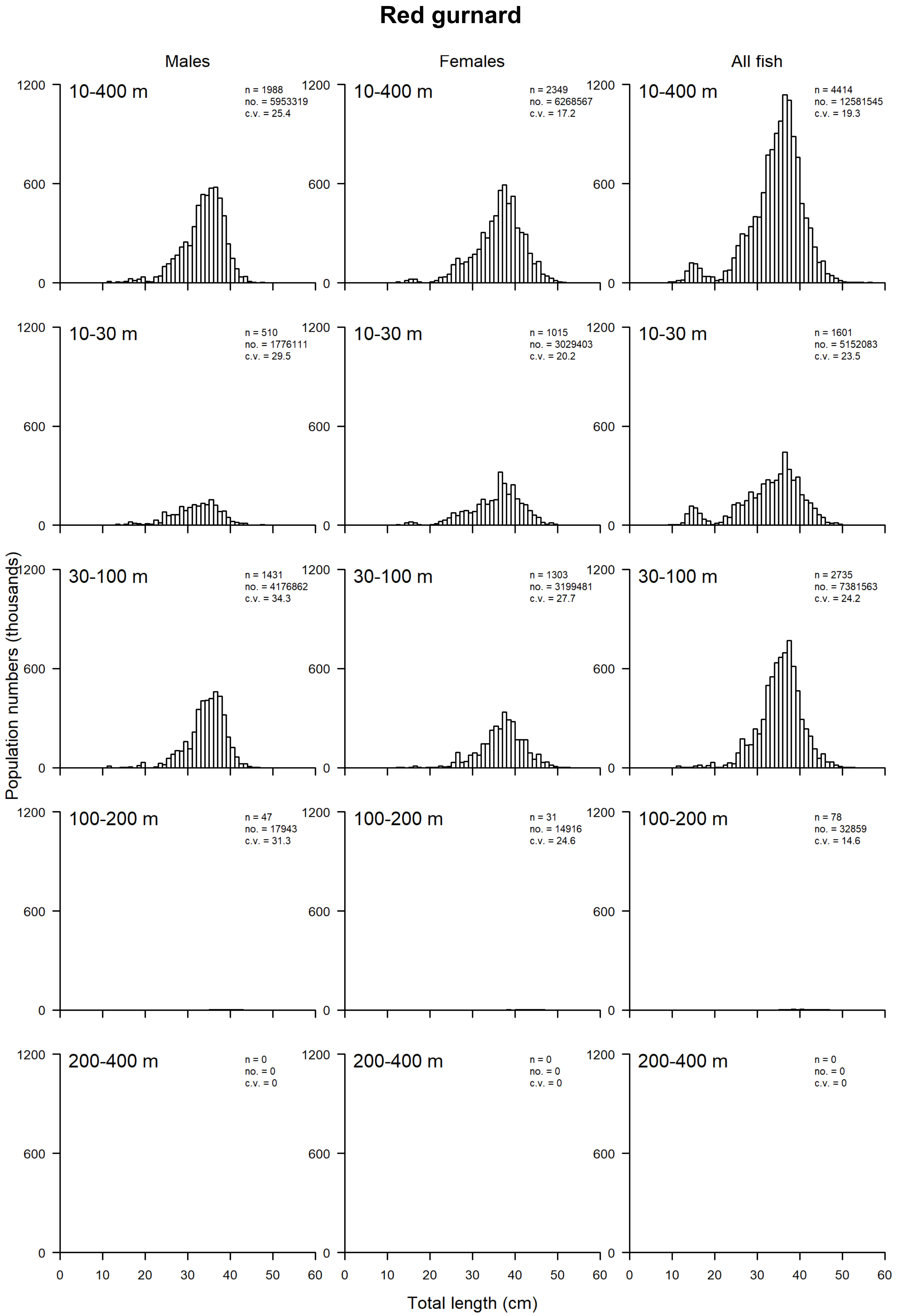


Figure 5 – ***continued.***

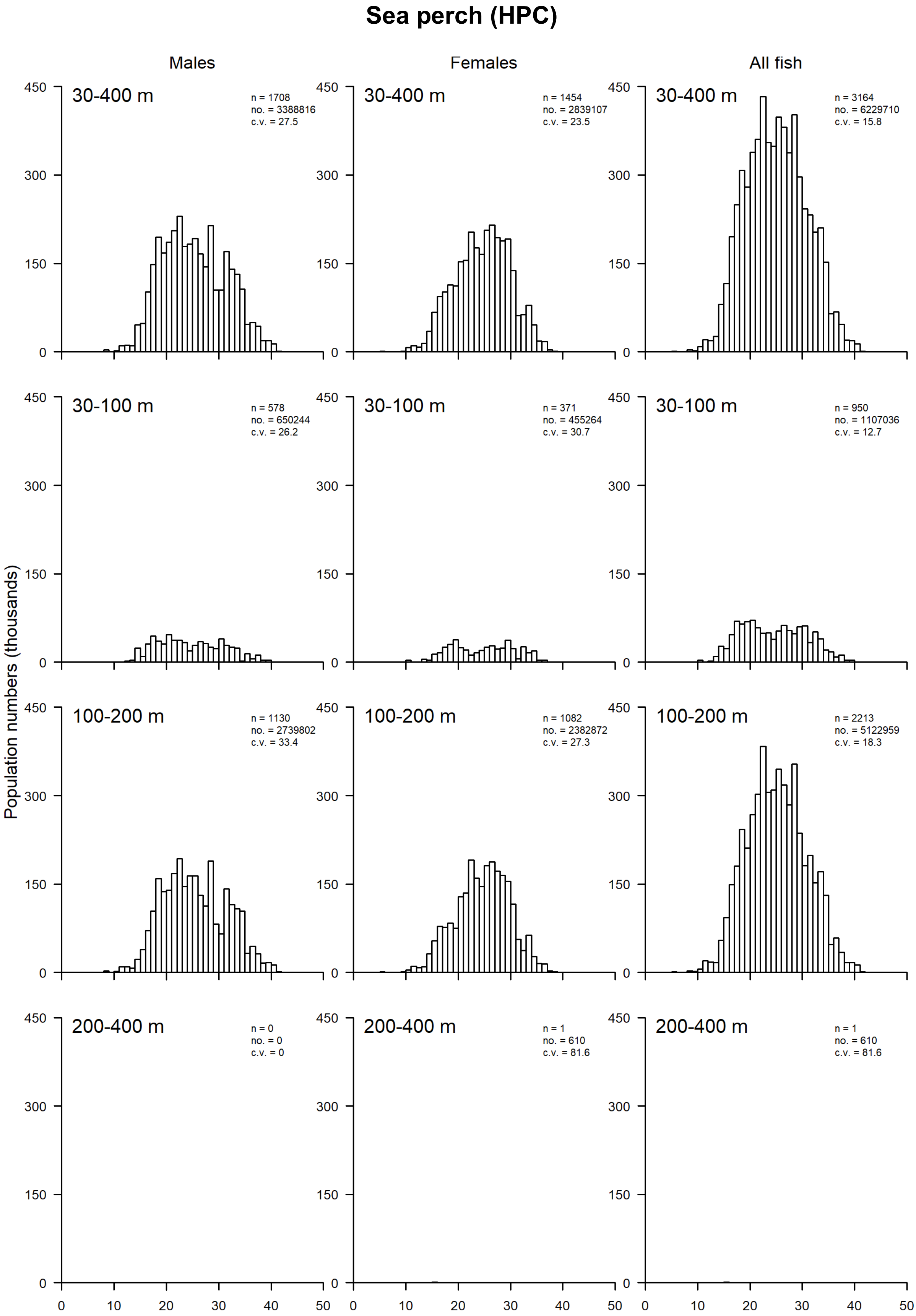


Figure 5 – *continued.*

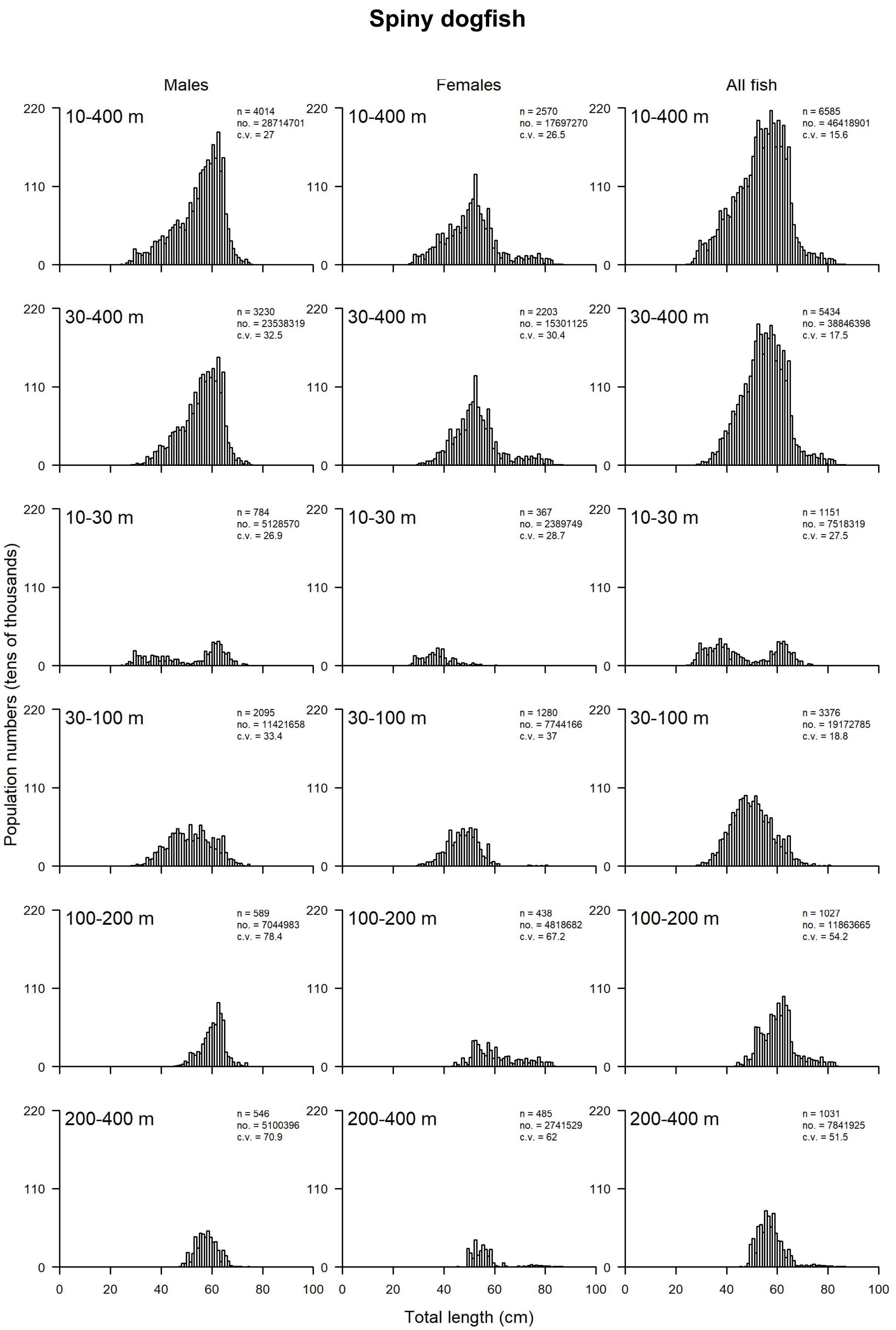


Figure 5 – *continued.*

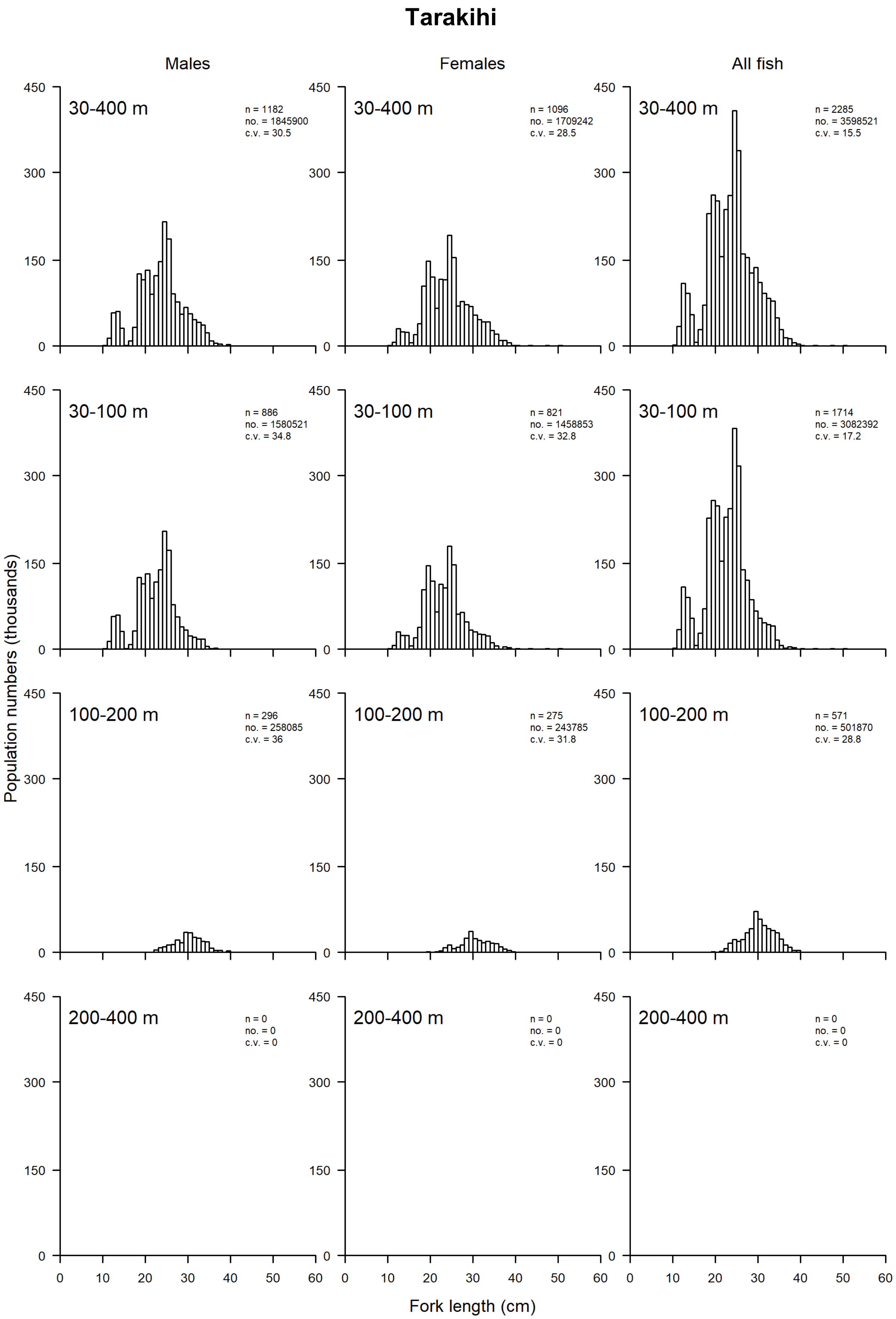
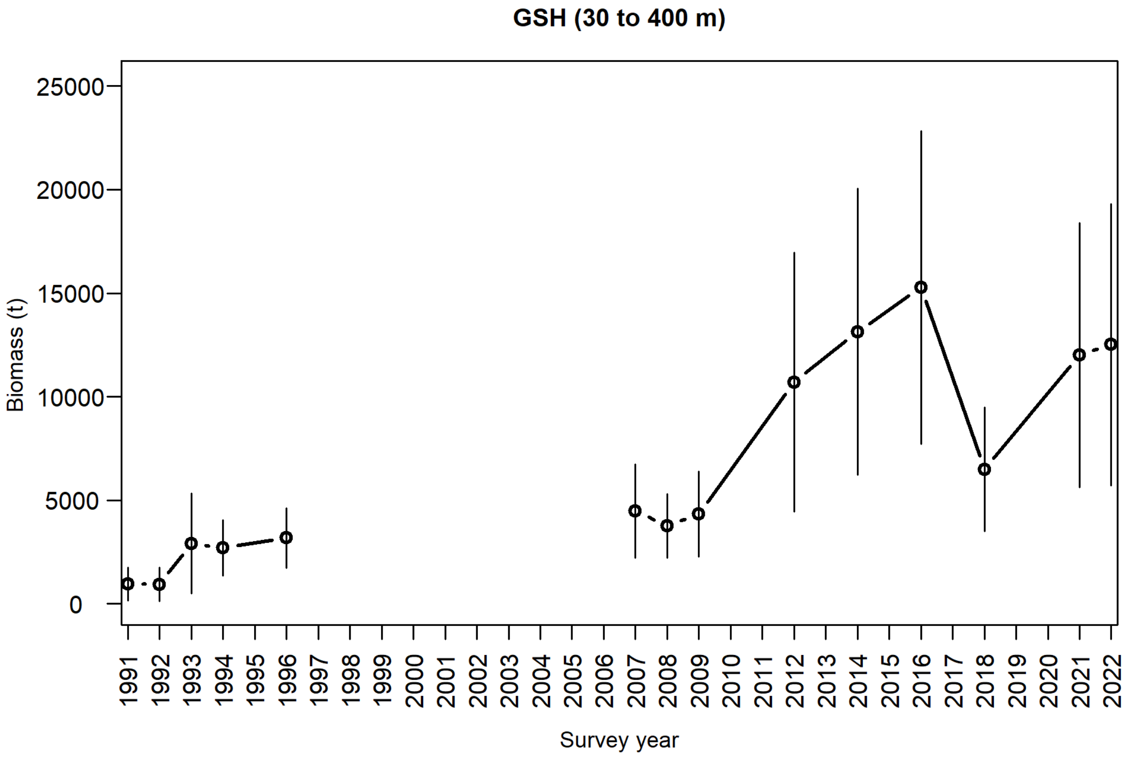


Figure 5 – *continued.*



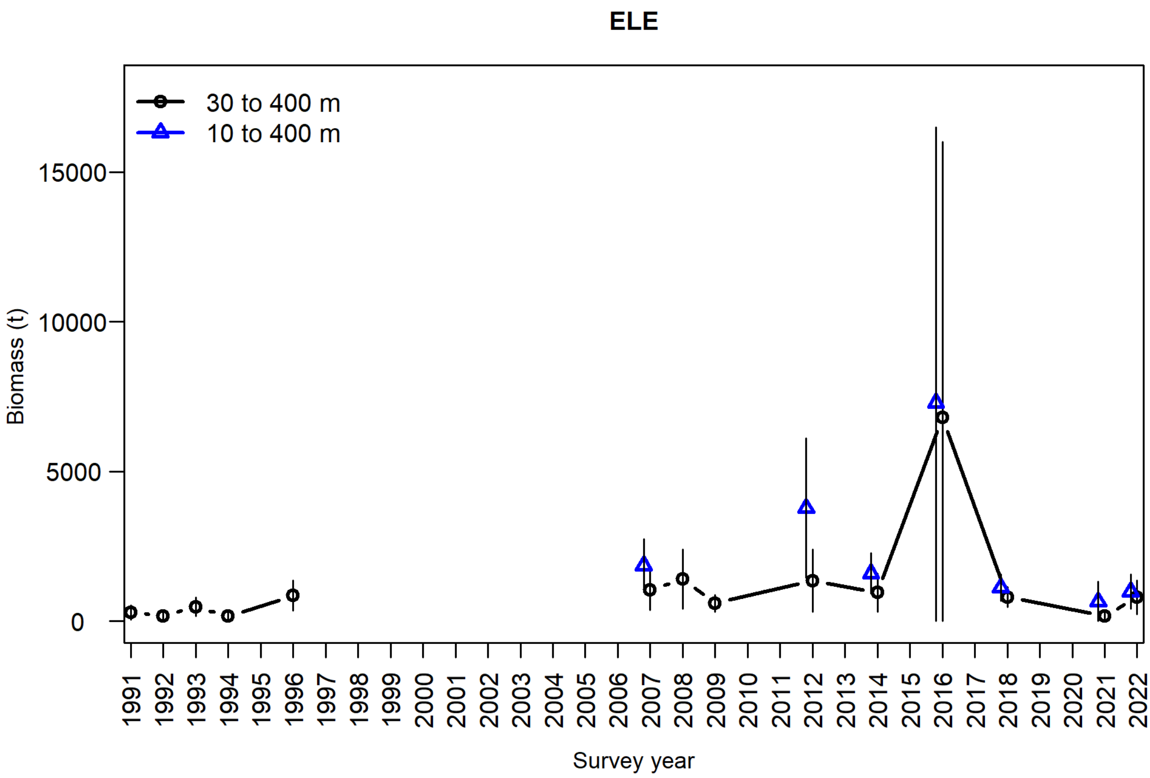
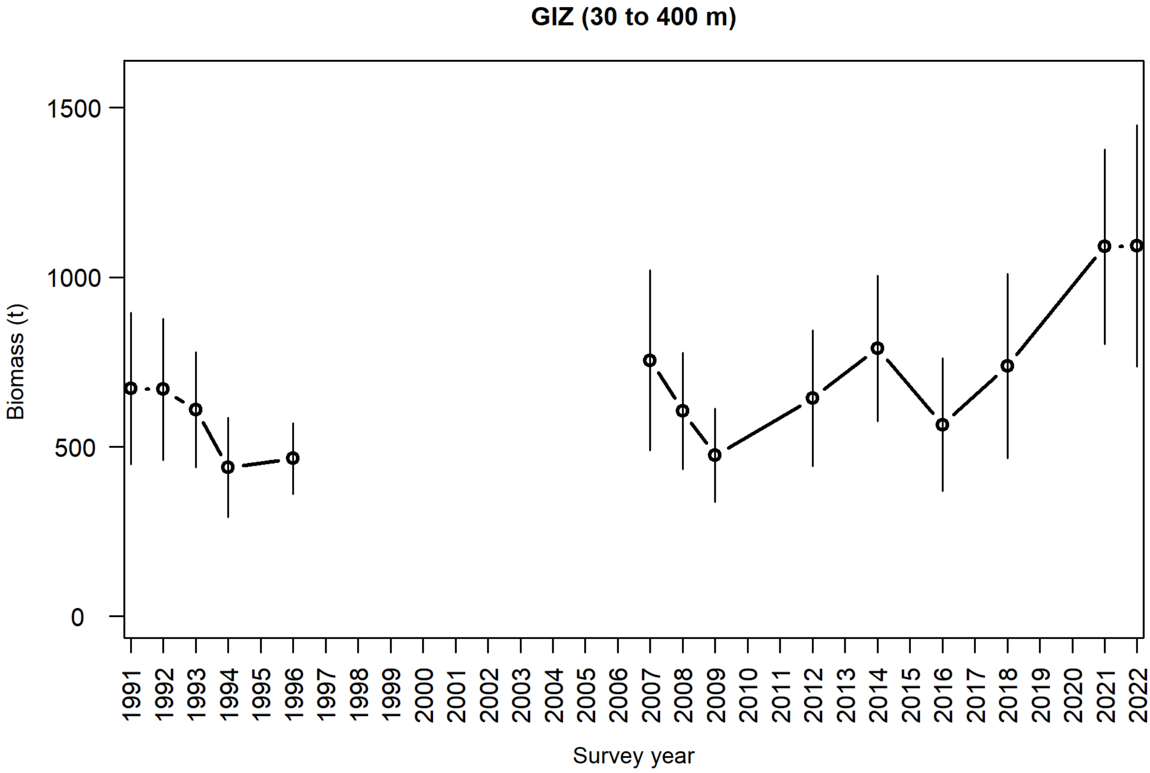


Figure 6: Target species total biomass for all ECSI winter surveys in core strata (30–400 m) and core plus shallow strata (10–400 m) for species found in less than 30 m in 2007, 2012, 2014, 2016, 2018, 2021, and 2022. Error bars are +/- two standard errors.



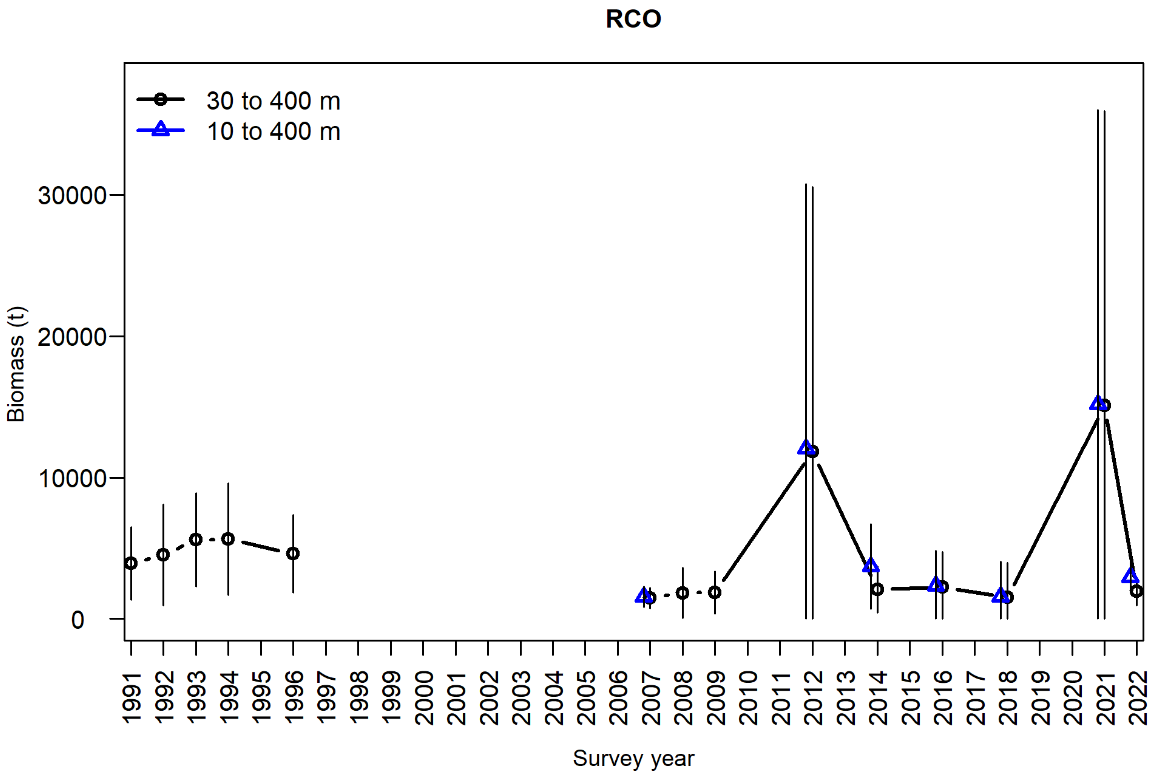
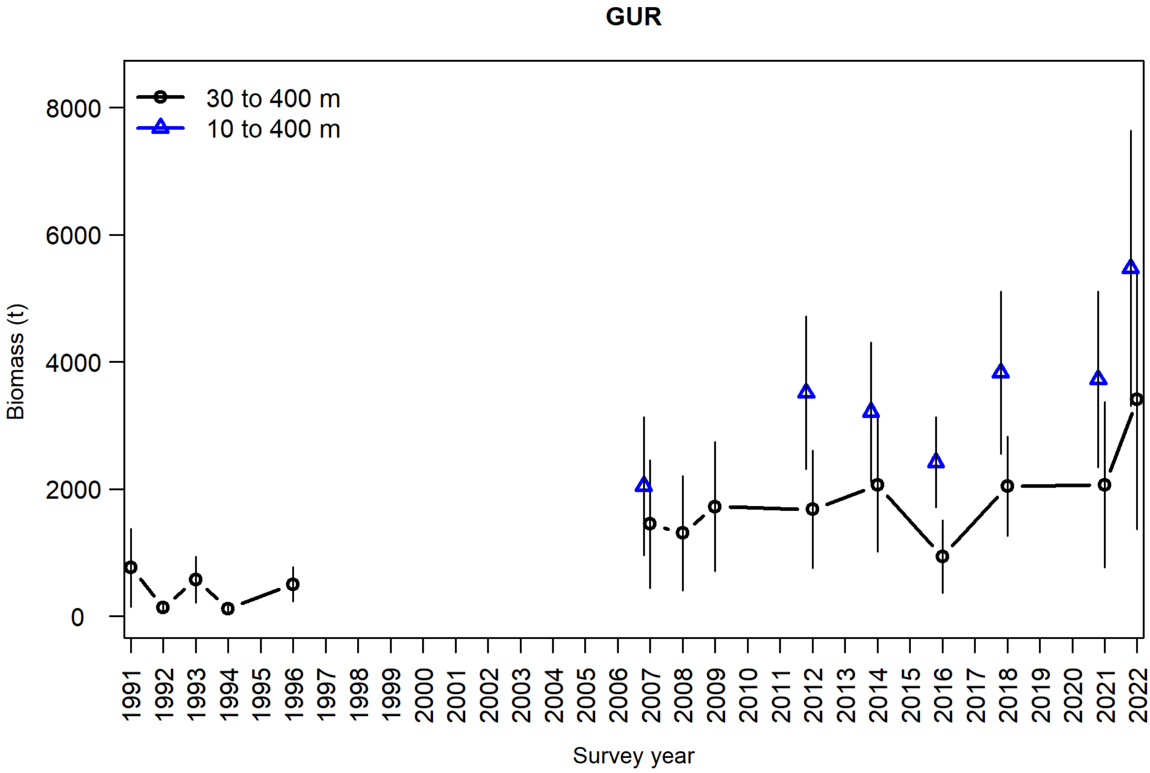


Figure 6 – ***continued.***



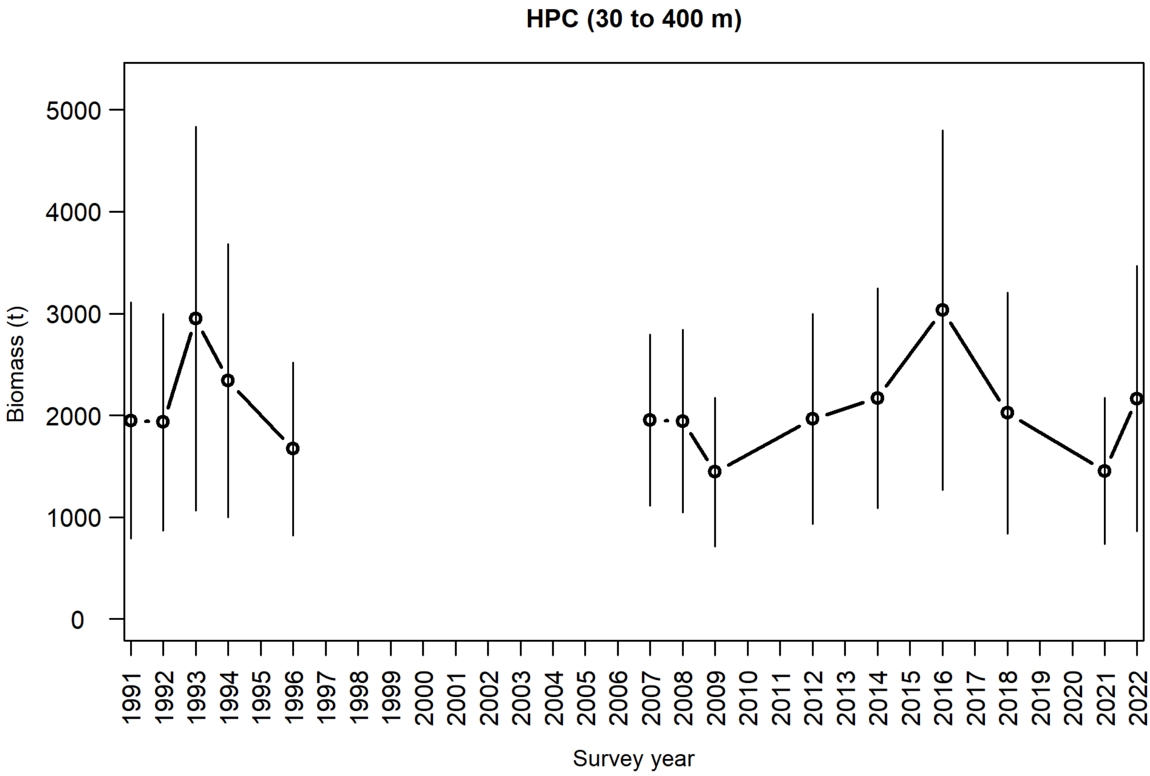
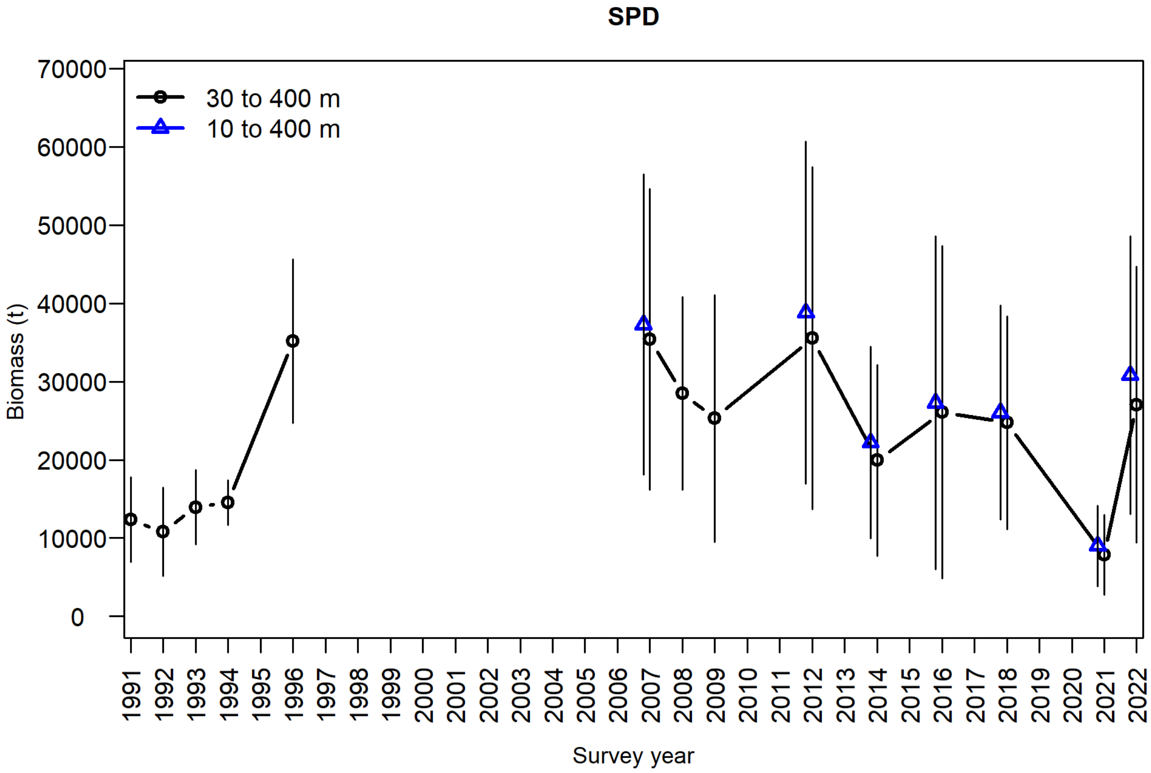


Figure 6 – ***continued.***



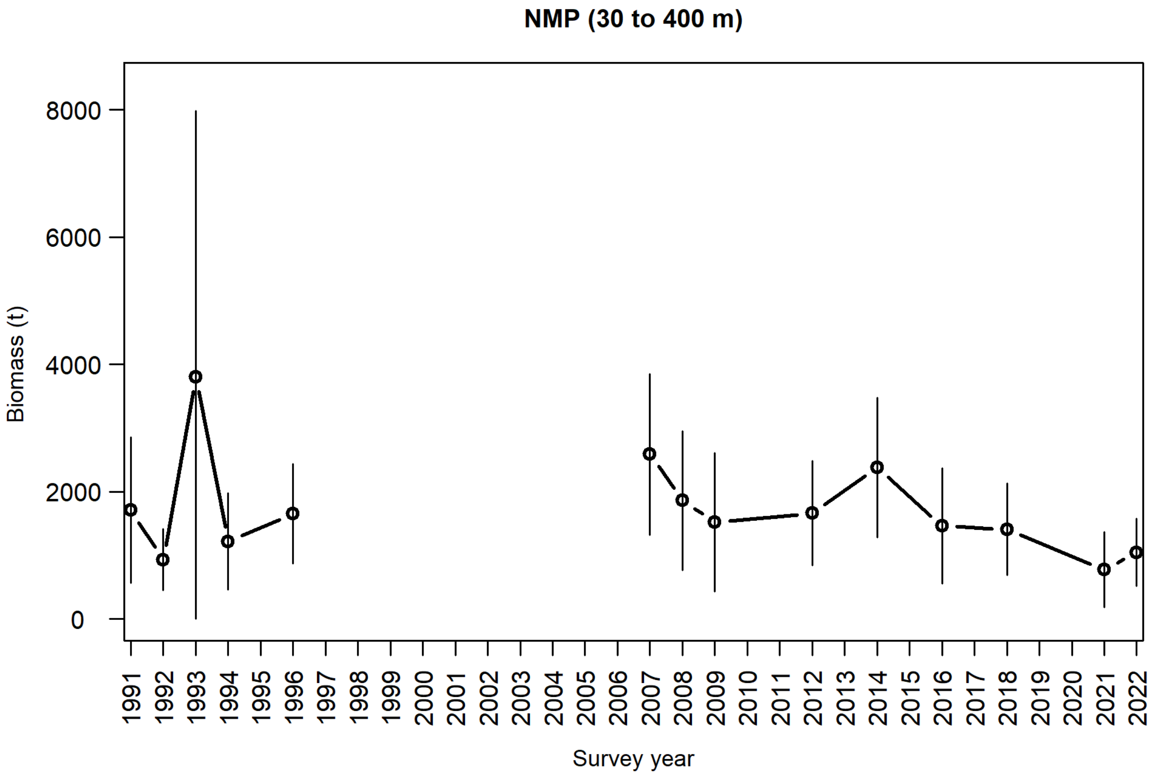


Figure 6 – *continued.*

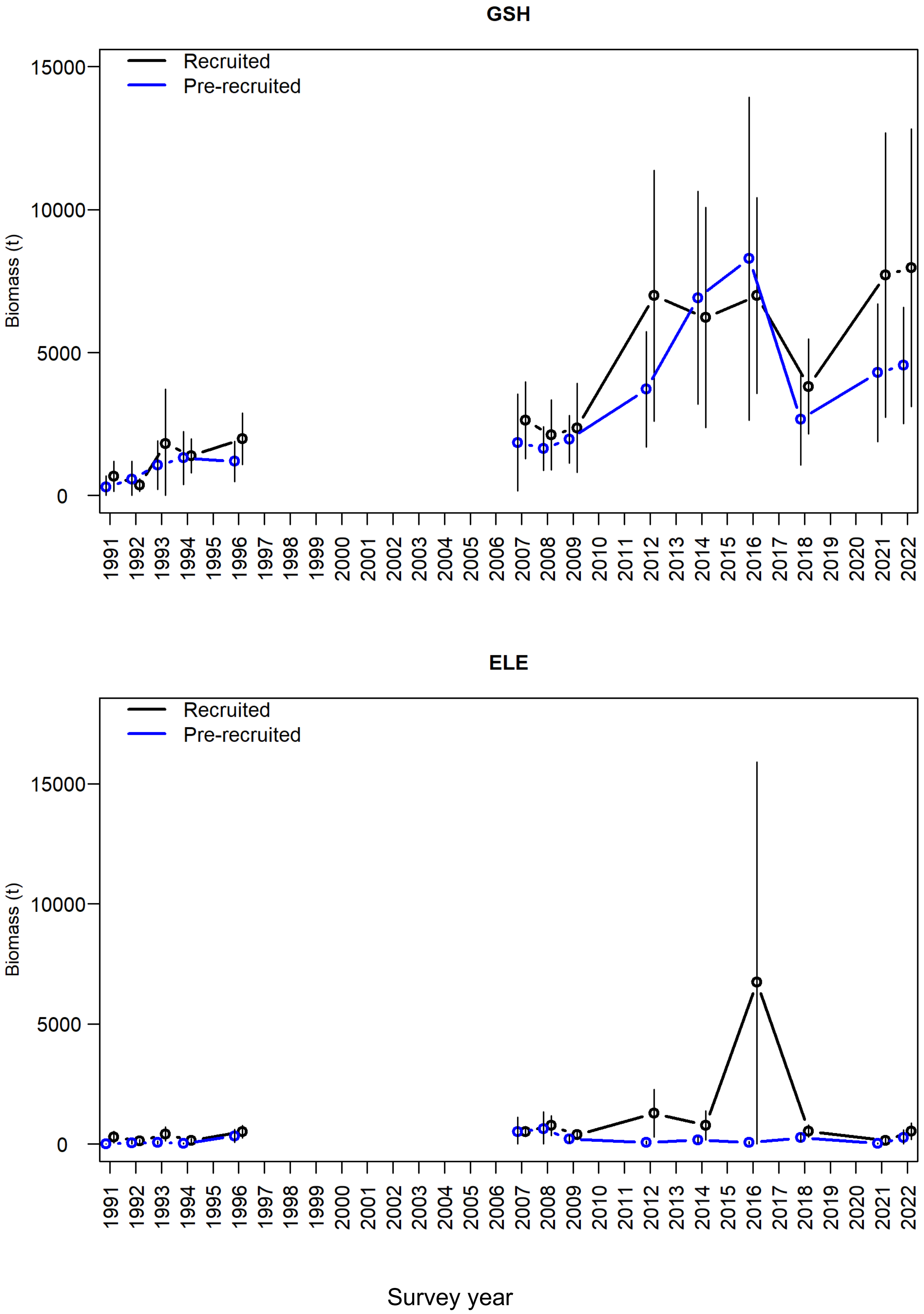


Figure 7: Target species recruited and pre-recruited biomass and 95% confidence intervals for all ECSI winter surveys in core strata (30–400 m). Error bars are +/- two standard errors.

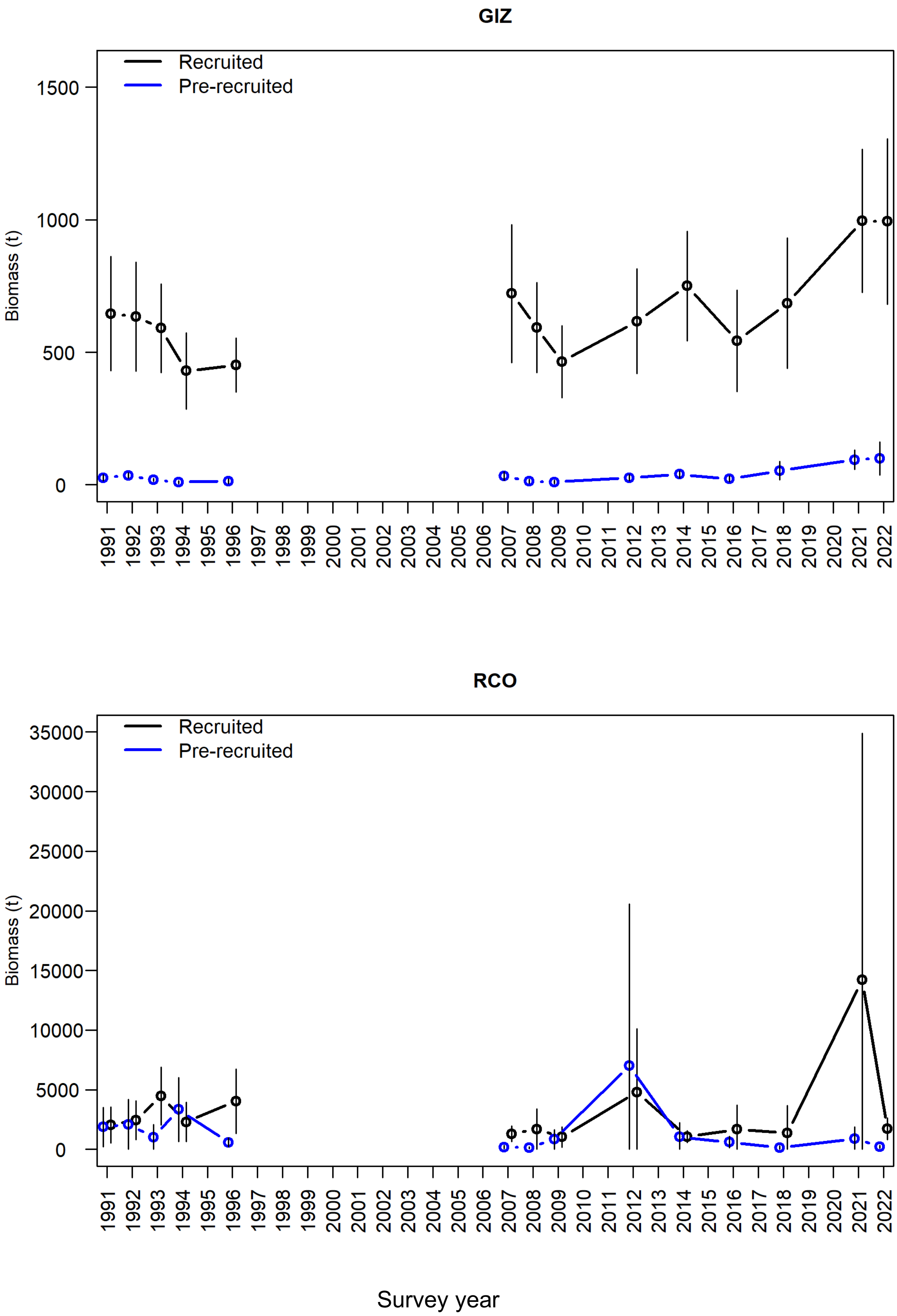


Figure 7 – ***continued.***

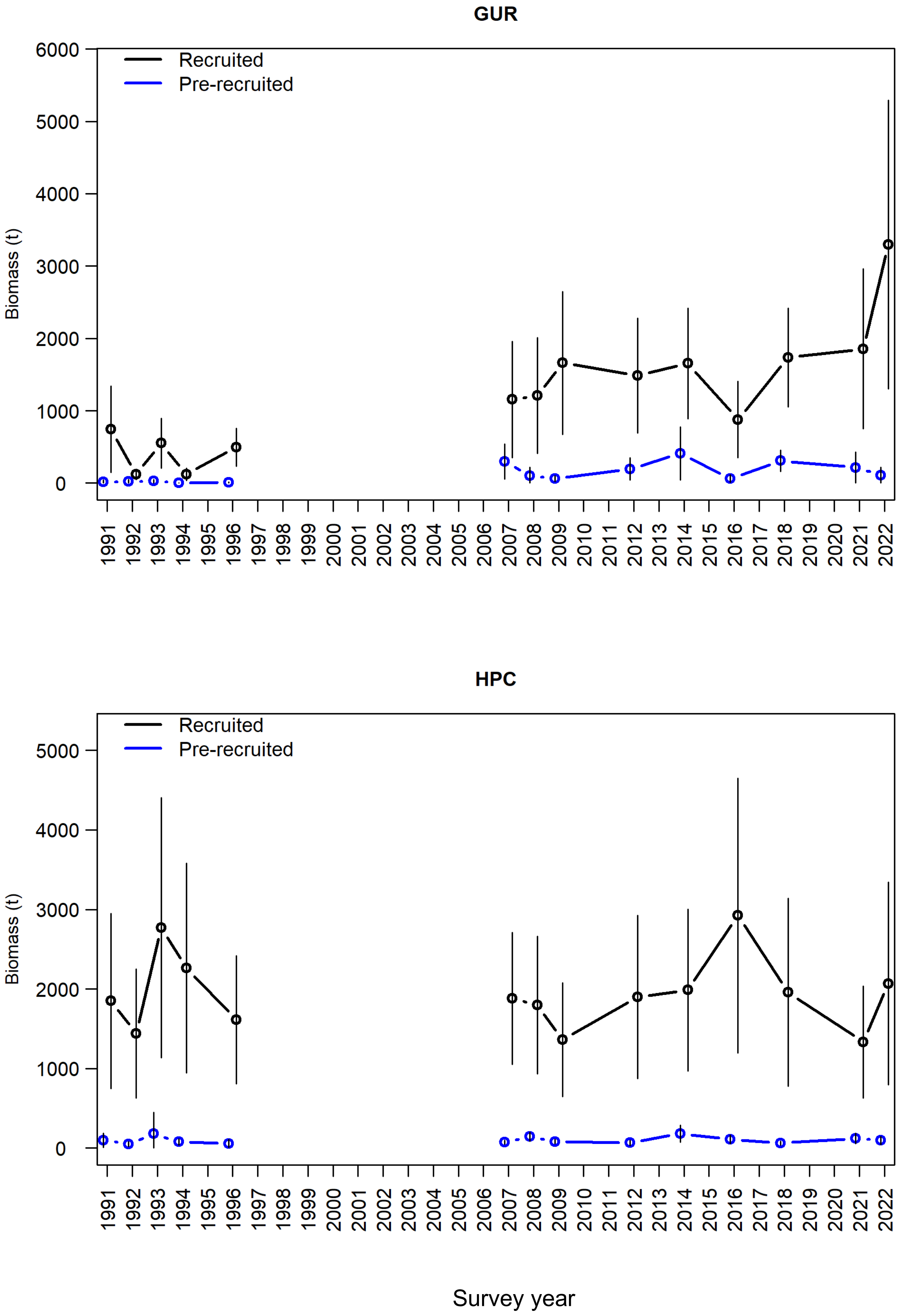


Figure 7 – ***continued.***

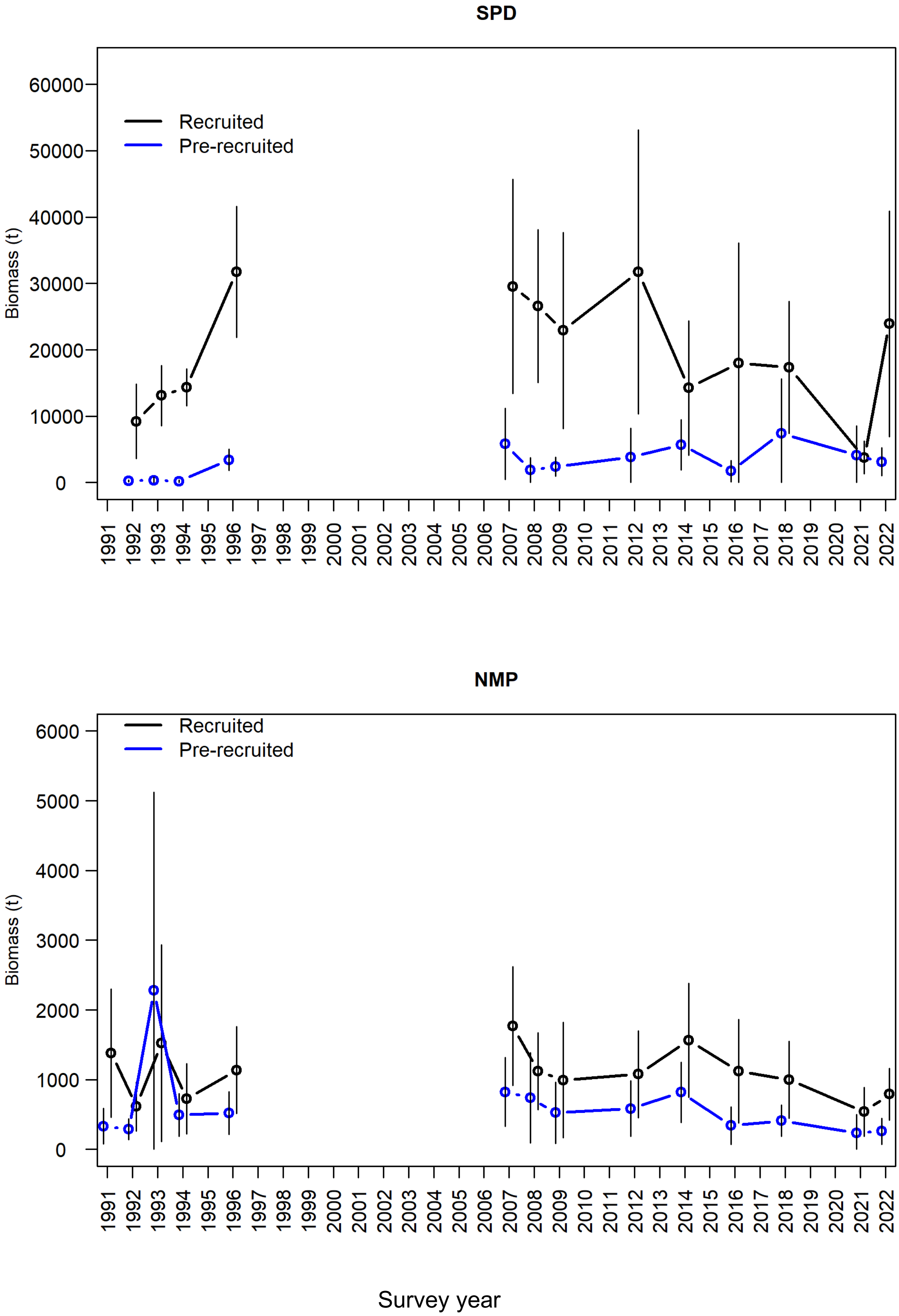


Figure 7 – ***continued.***

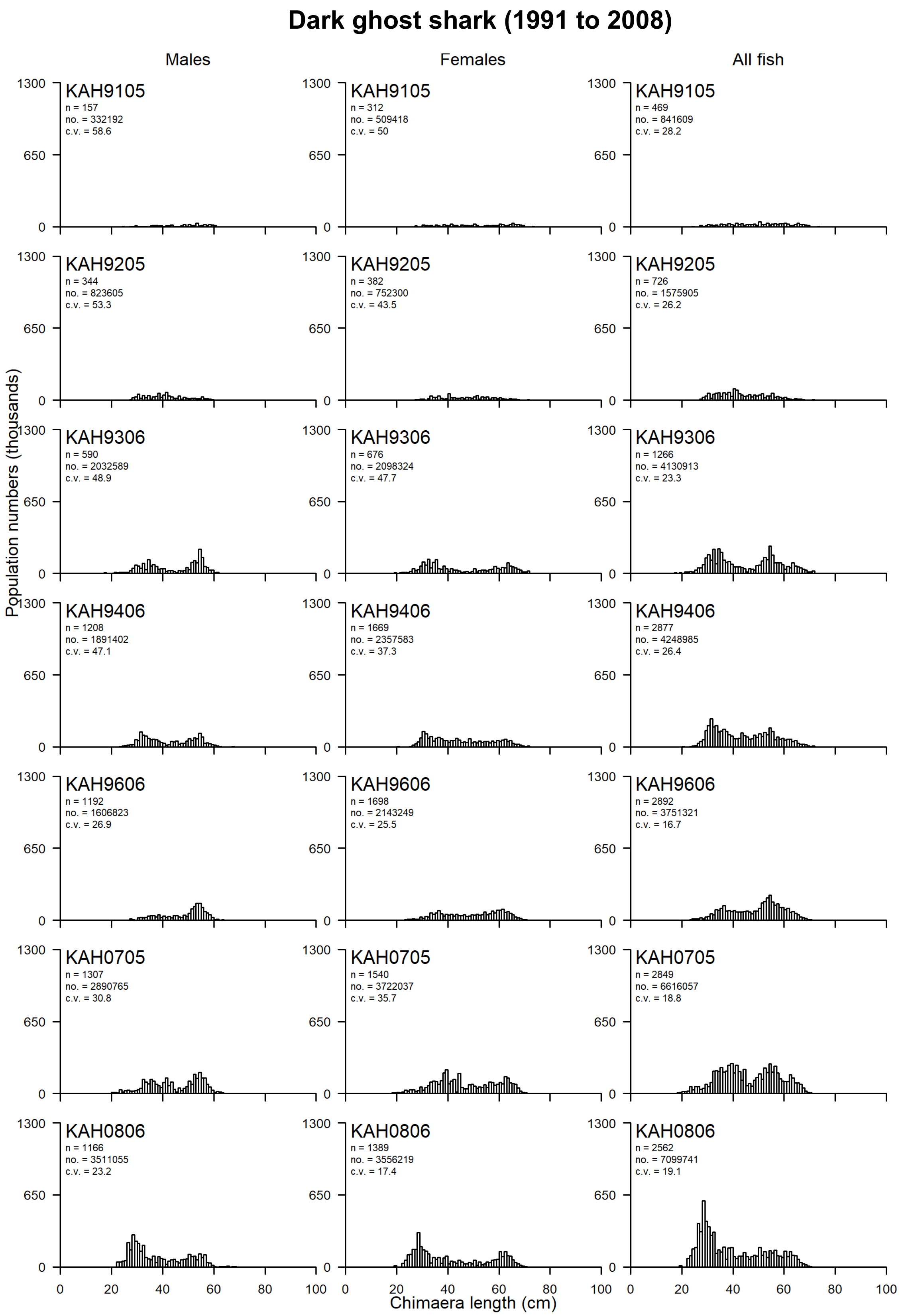


Figure 8: Scaled population length frequency distributions for the target species in core strata (30–400 m) for the ECSI winter time series (1991 to 2022). The length distribution is also shown in the 10–30 m depth strata for the 2007, 2012, 2014, 2016, 2018, 2021, and 2022 surveys overlaid (not stacked) in red 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.

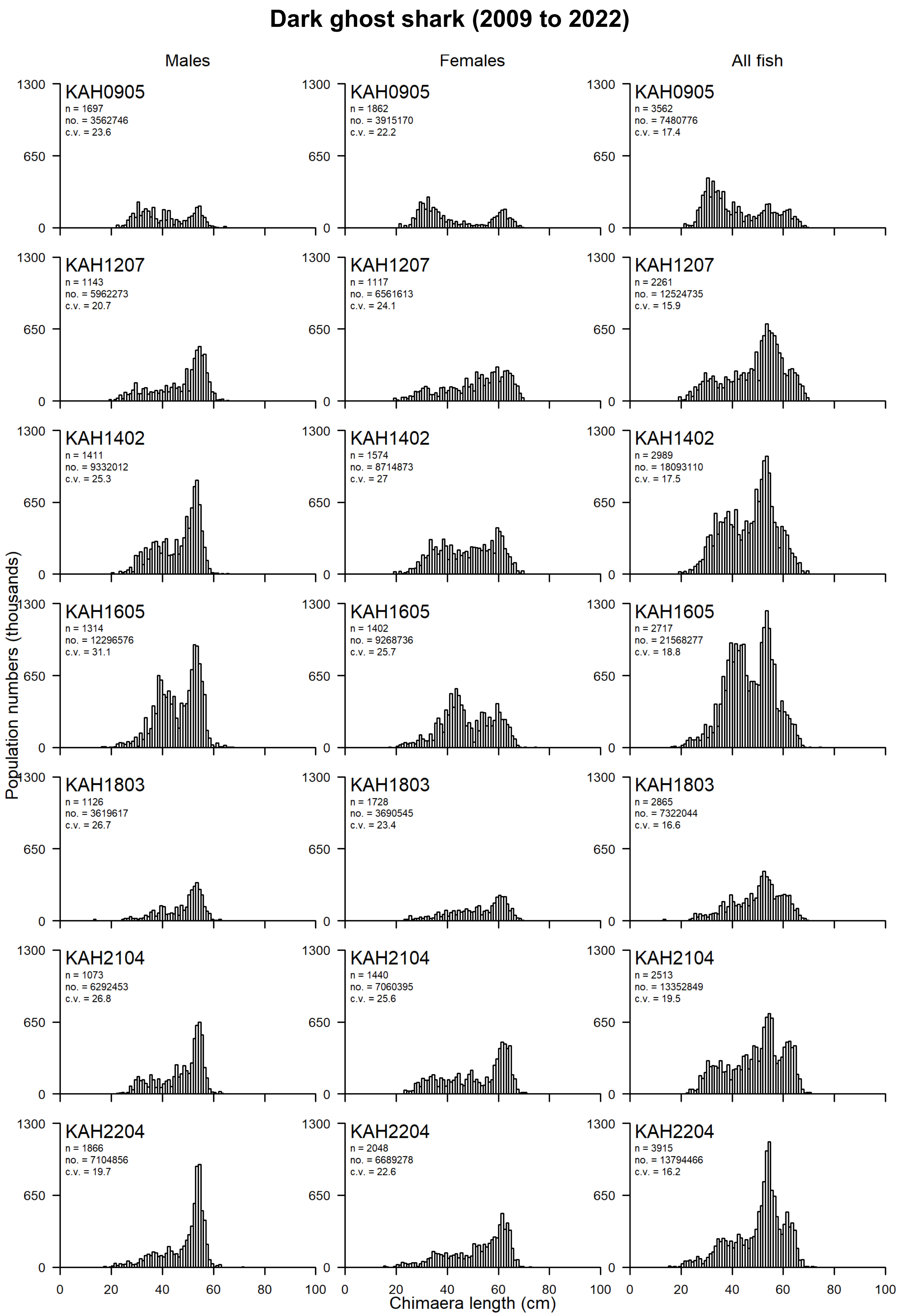


Figure 8 – *continued.*

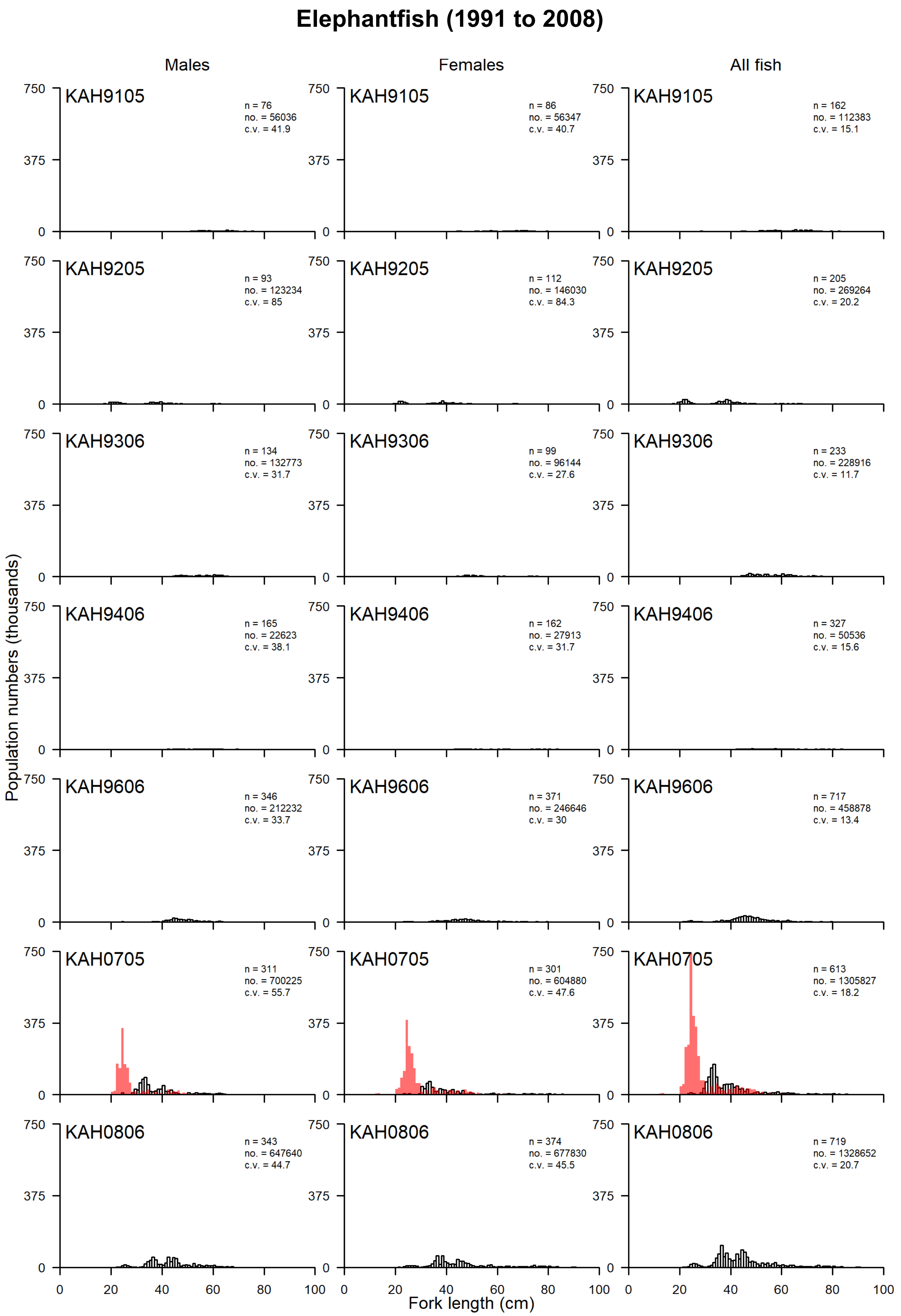


Figure 8 – ***continued.***

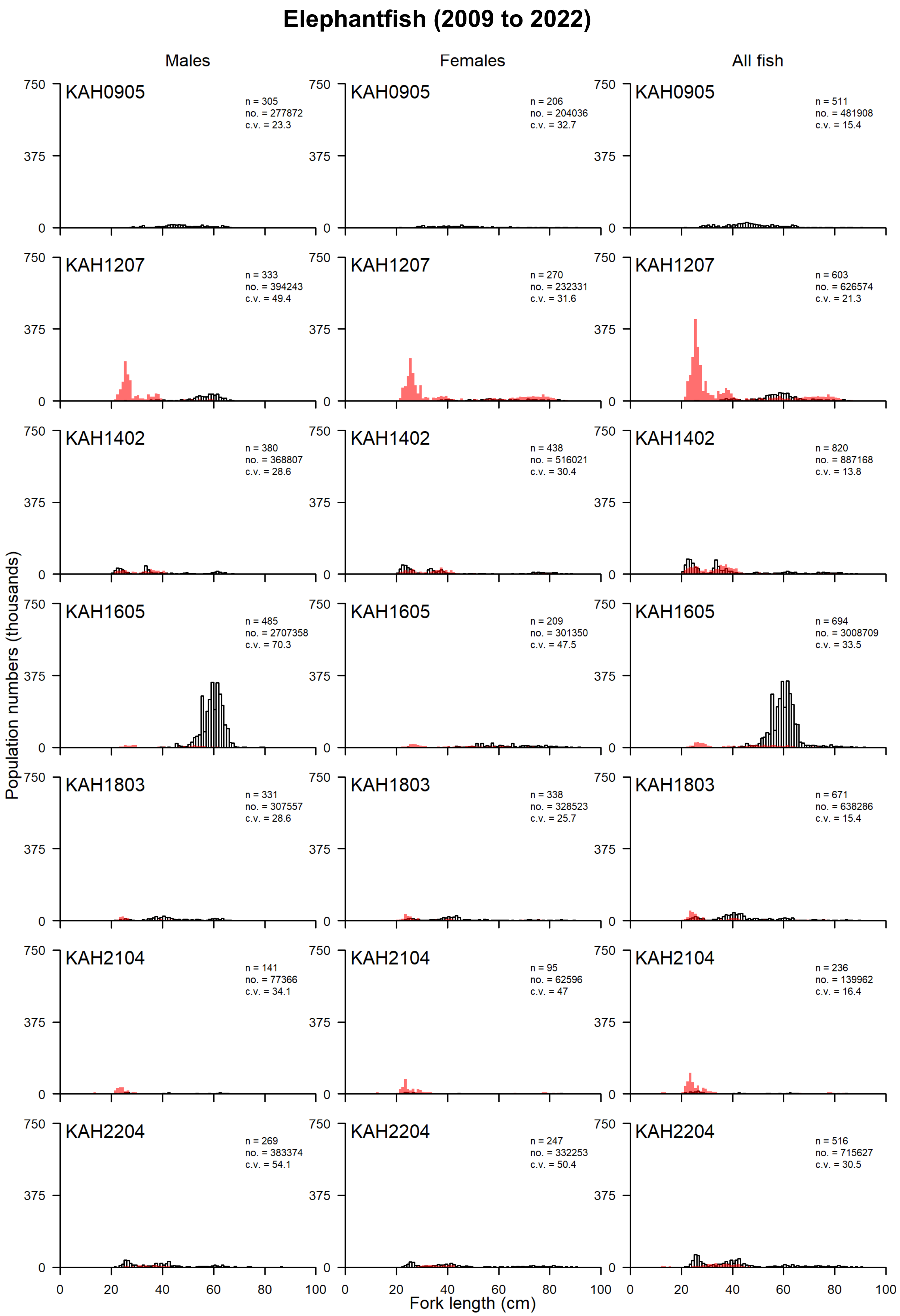


Figure 8 – ***continued.***

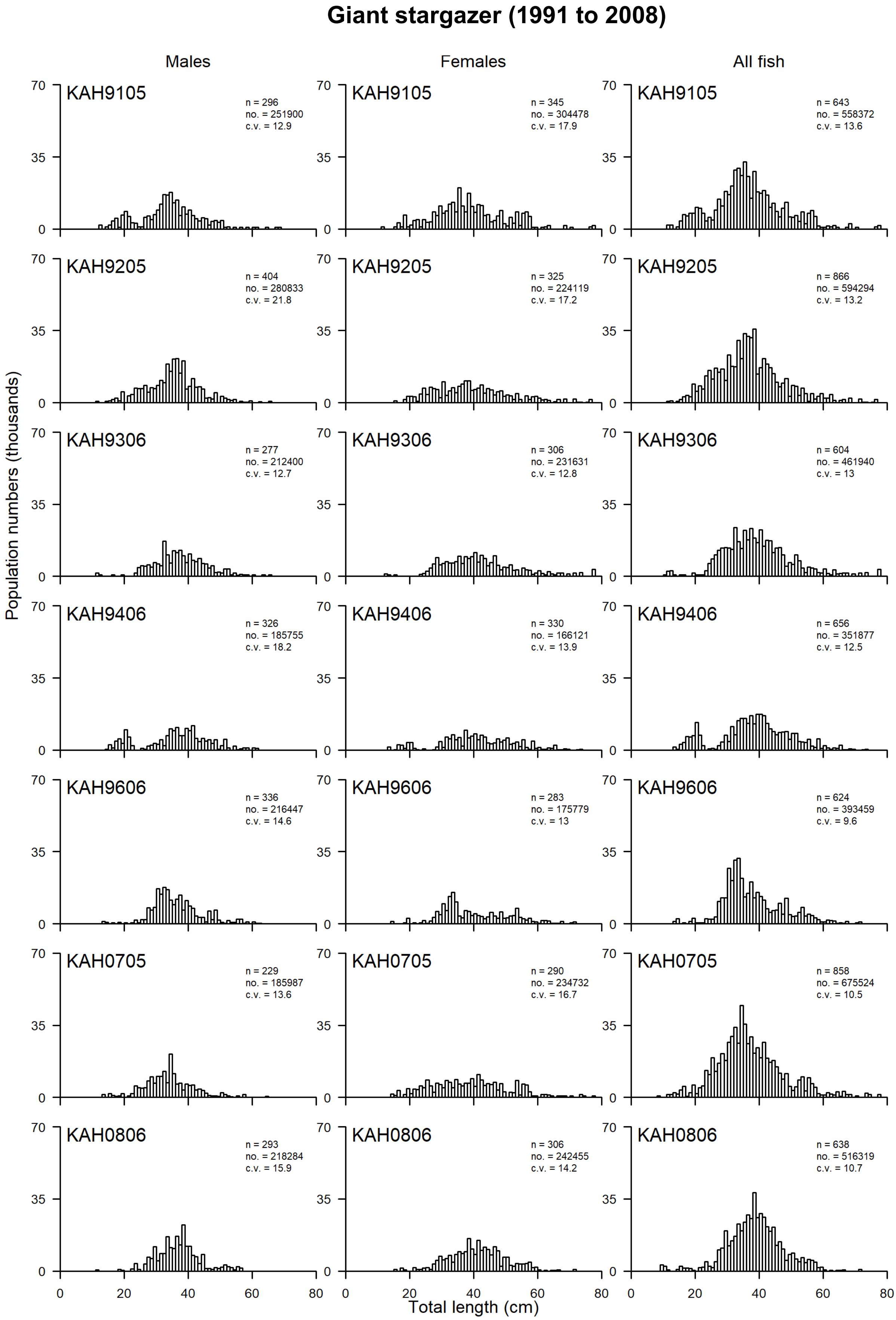


Figure 8 – *continued.*

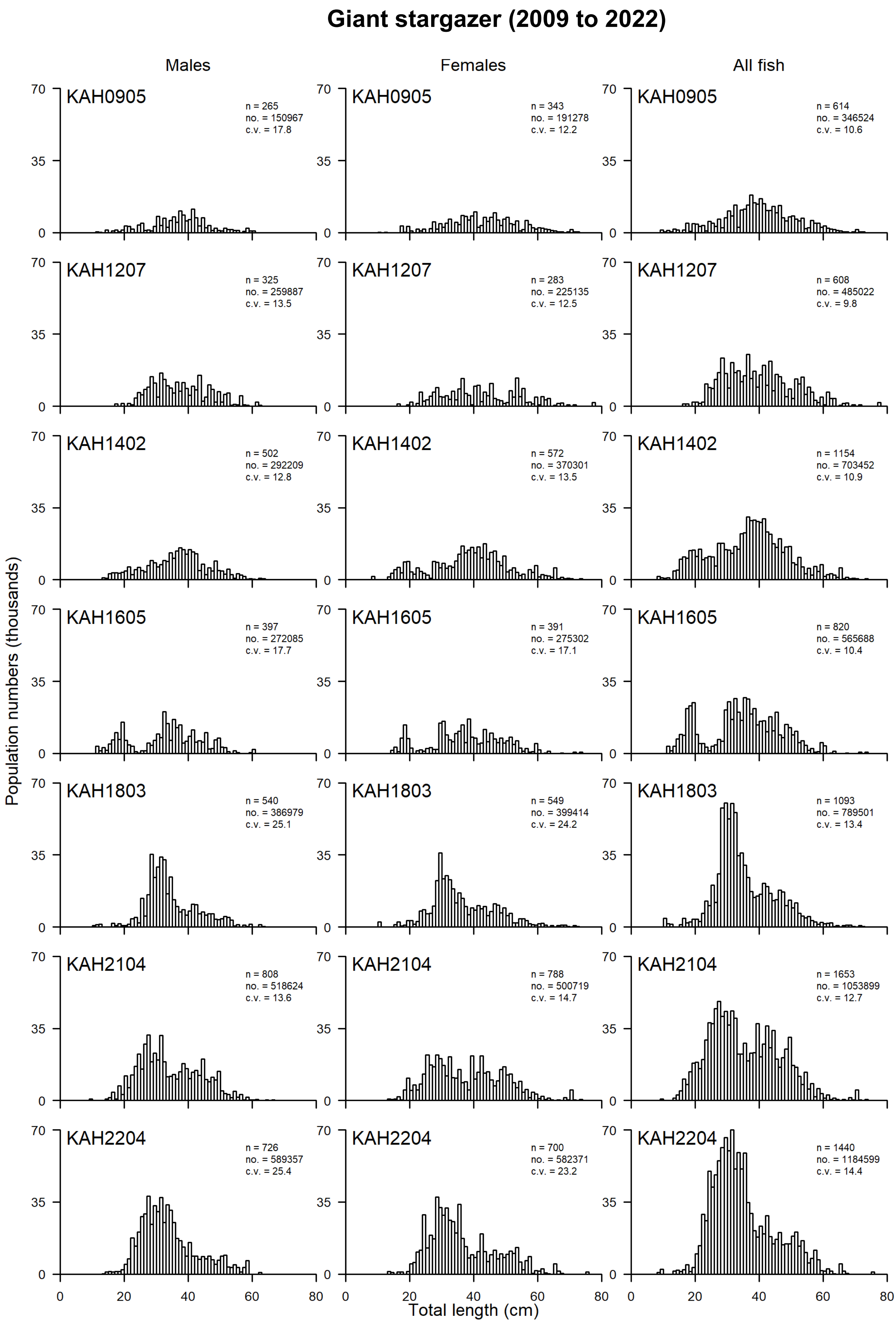


Figure 8 –*continued.*

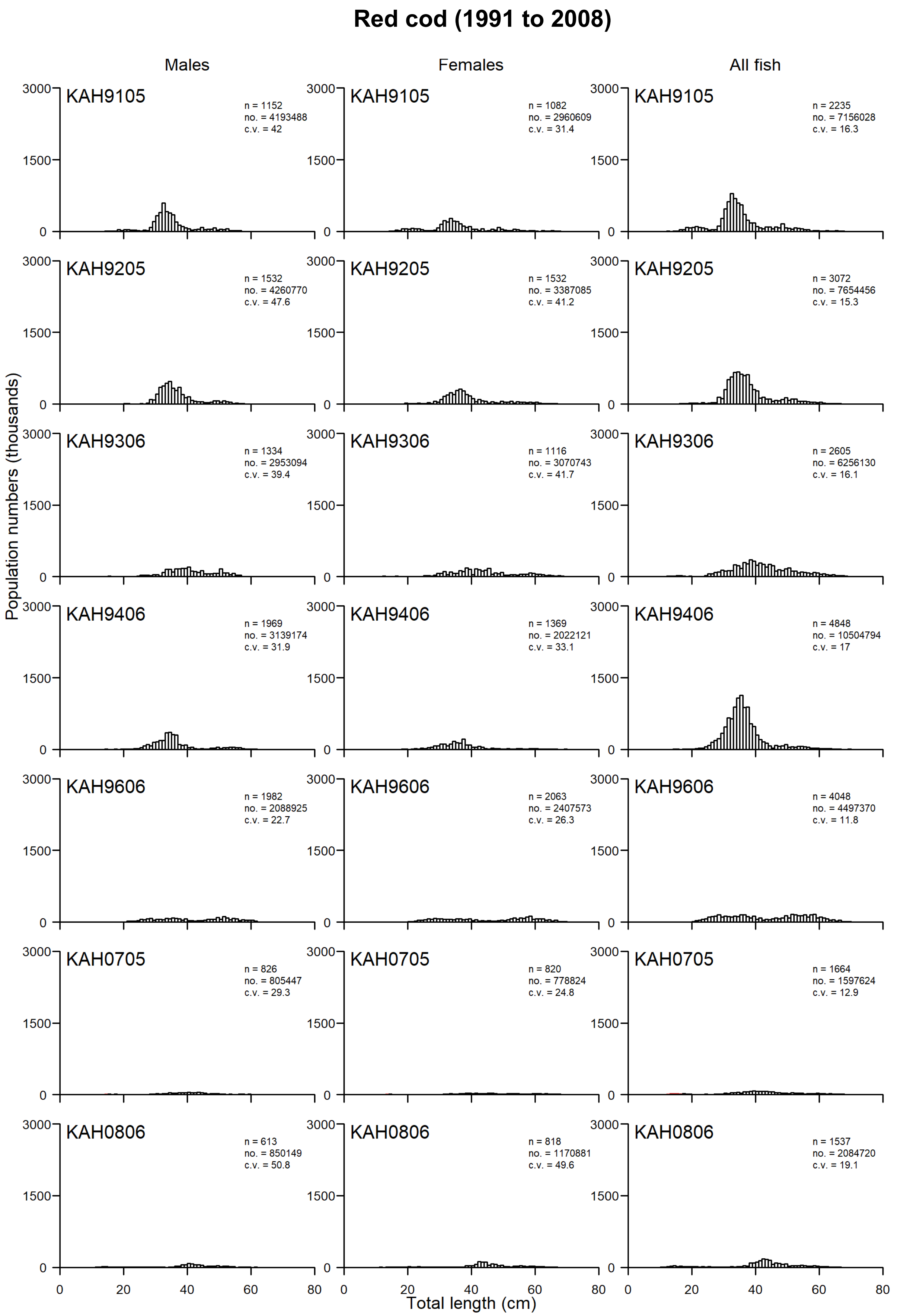


Figure 8 – ***continued.***

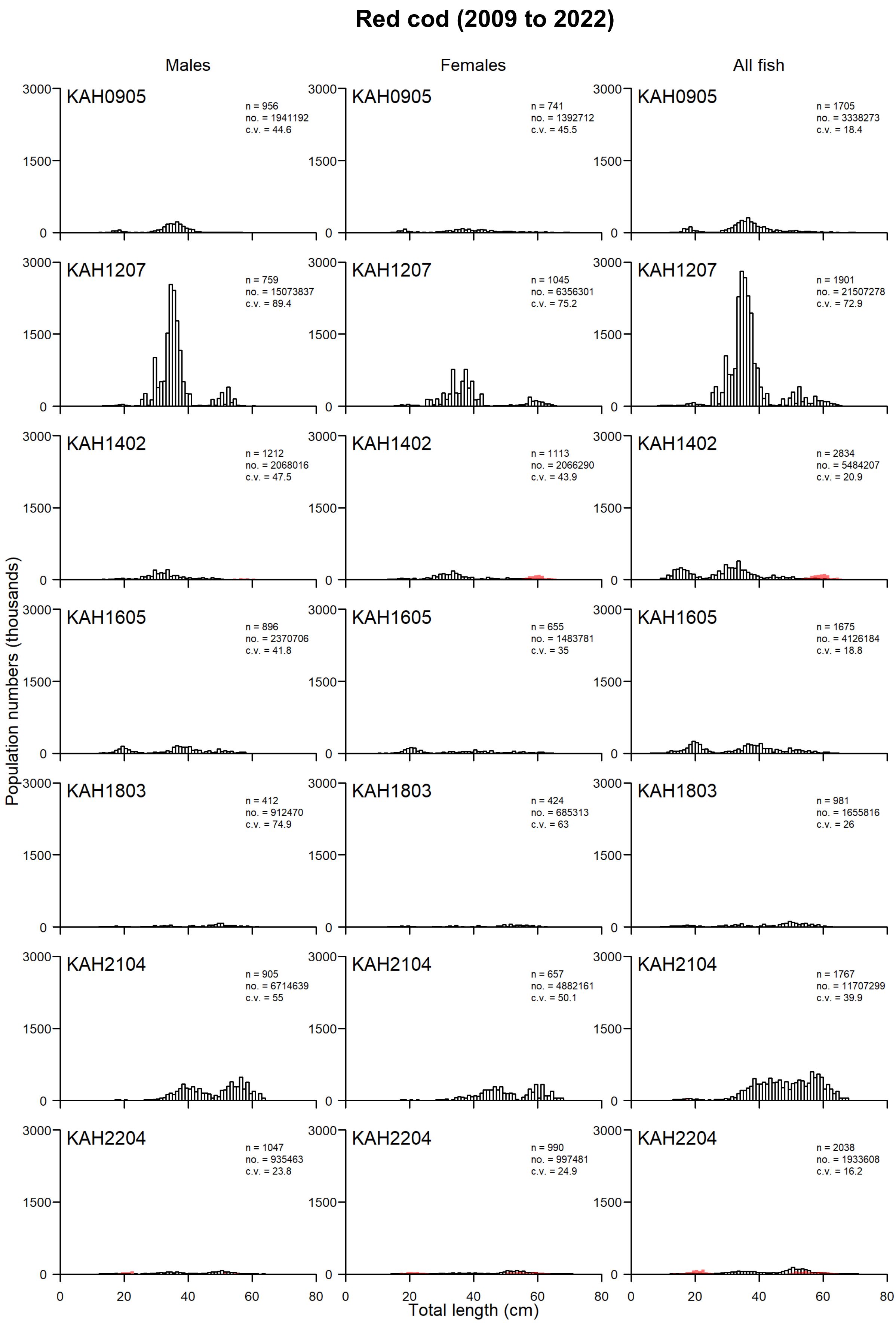


Figure 8 – *continued*.

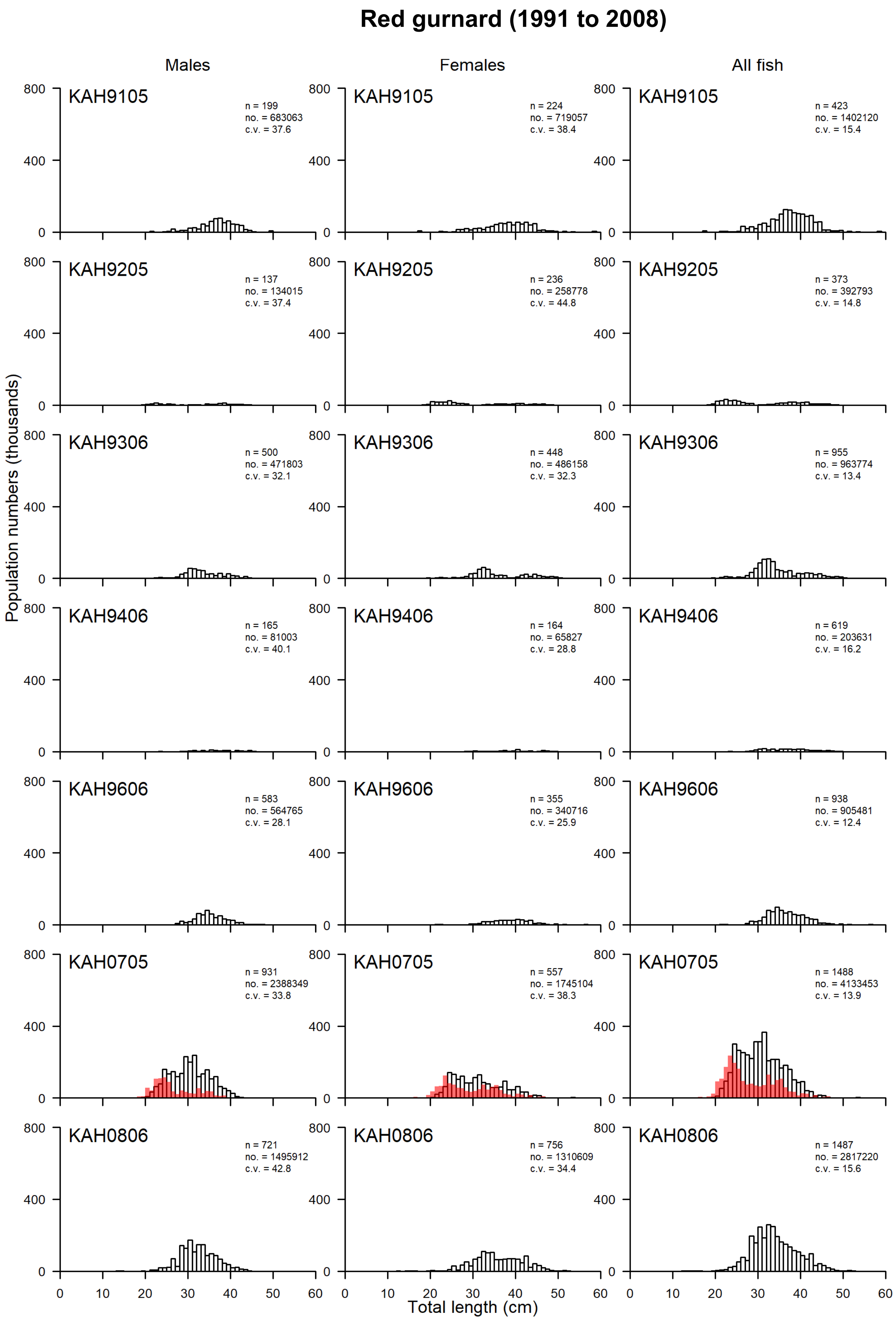


Figure 8 – ***continued.***

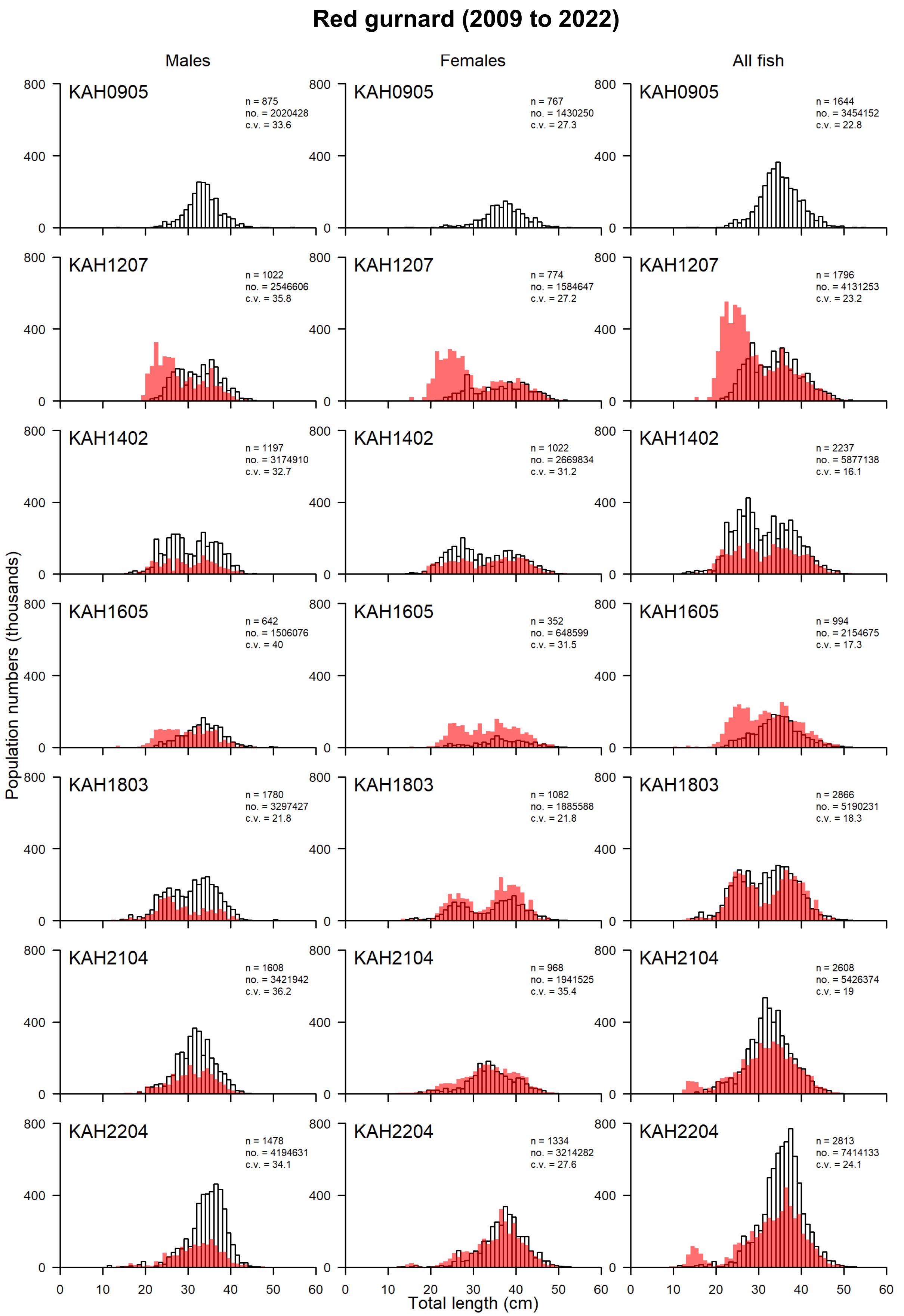


Figure 8 – ***continued.***

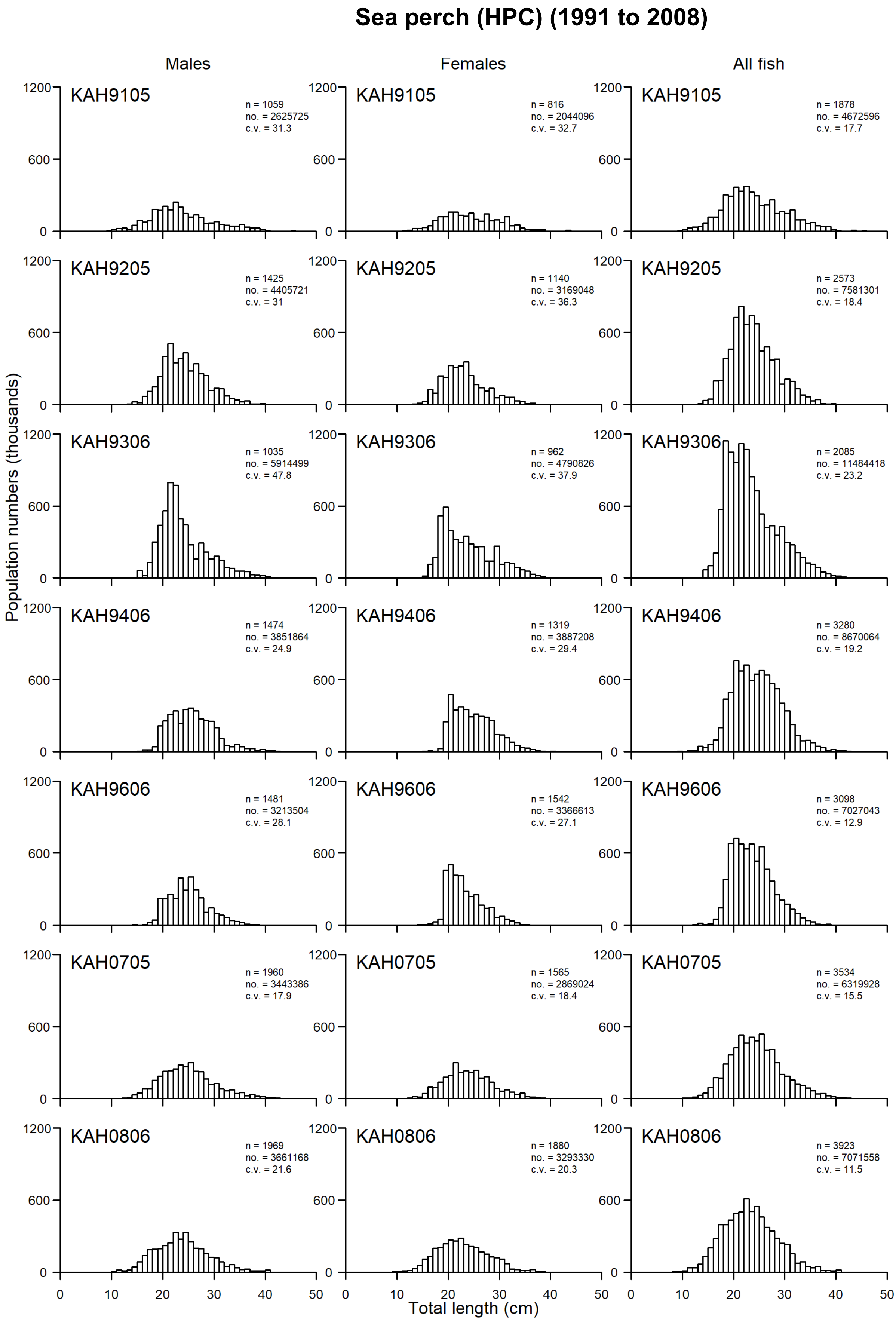


Figure 8 – *continued.*

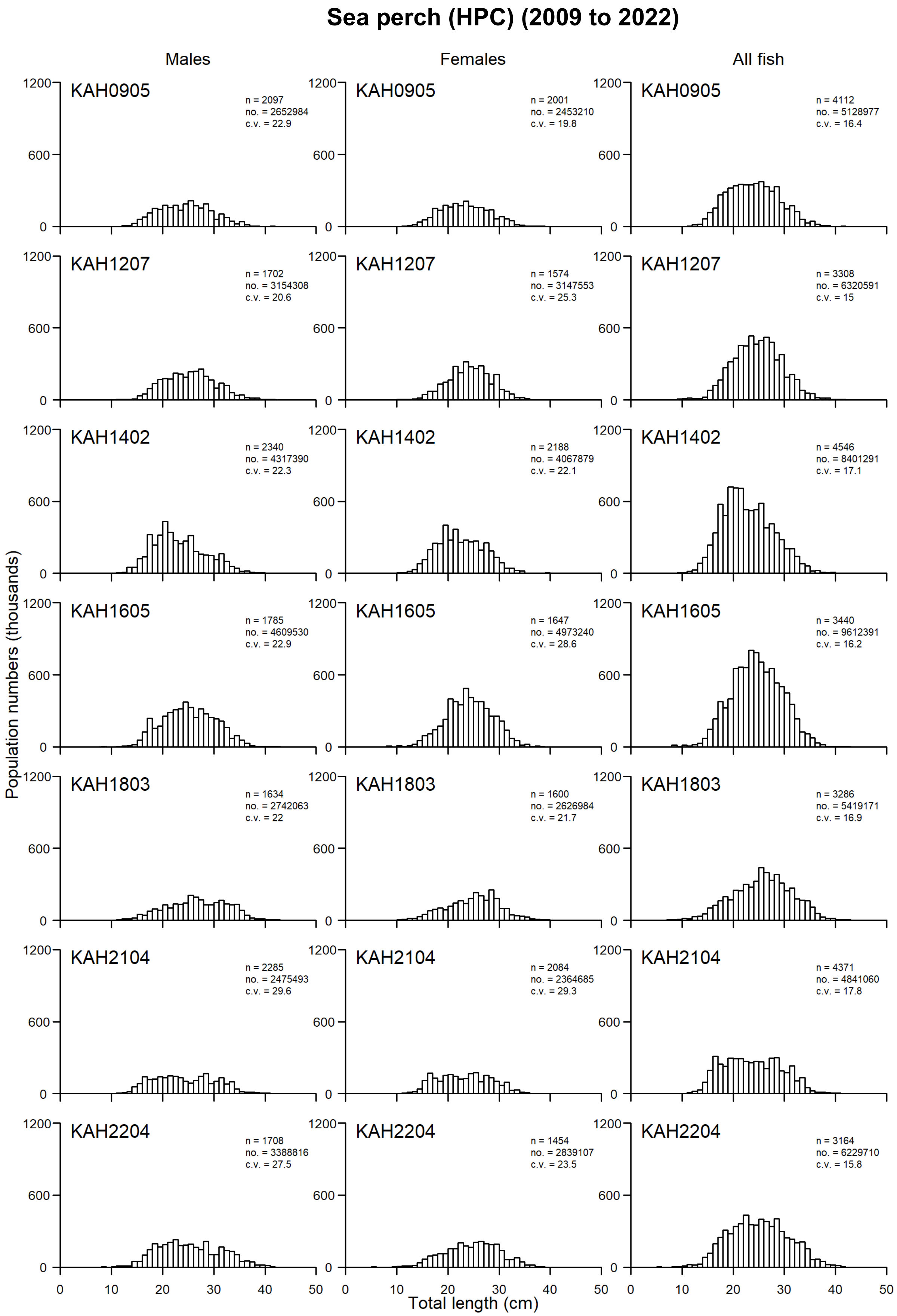


Figure 8 – ***continued.***

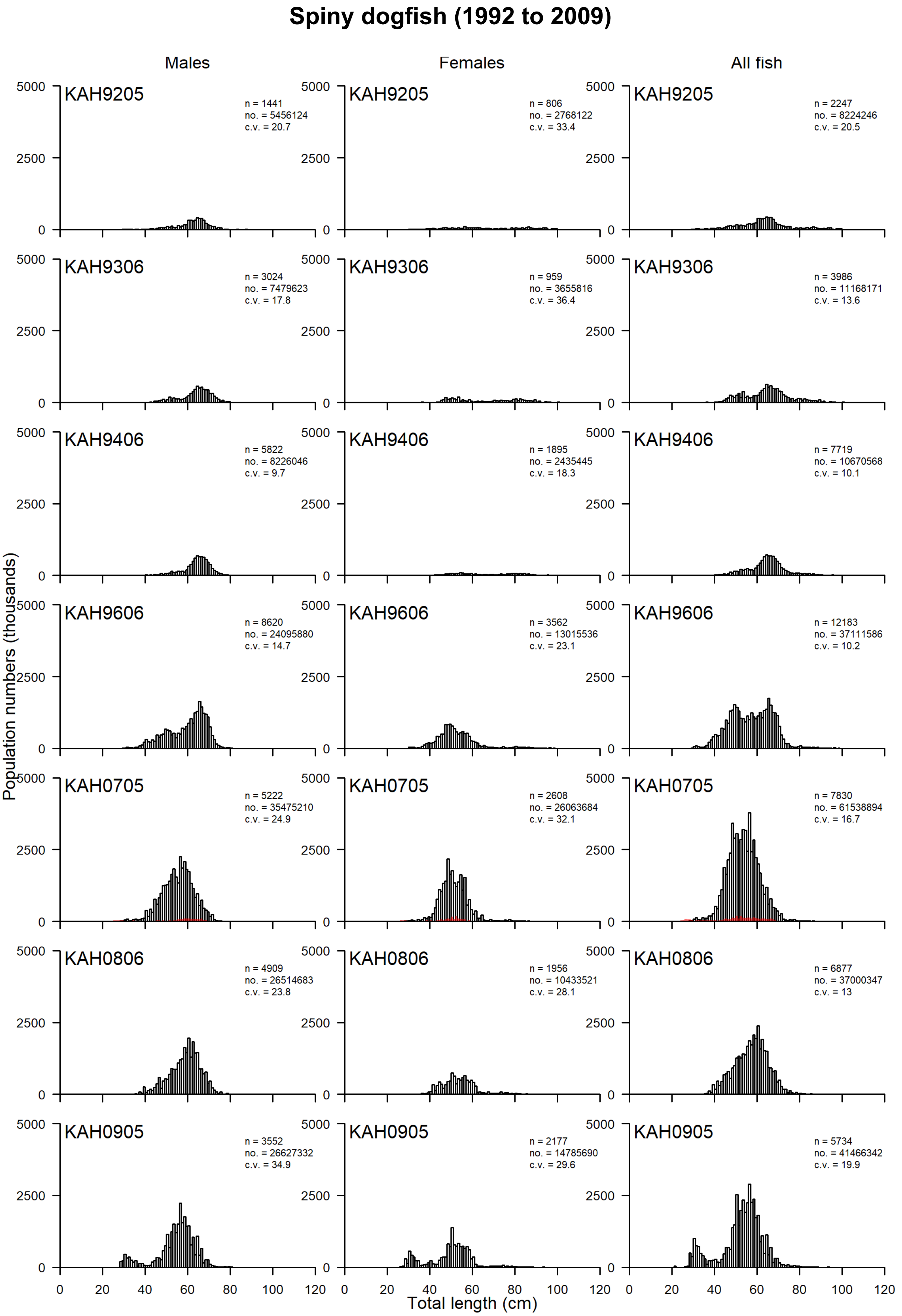


Figure 8– ***continued.***

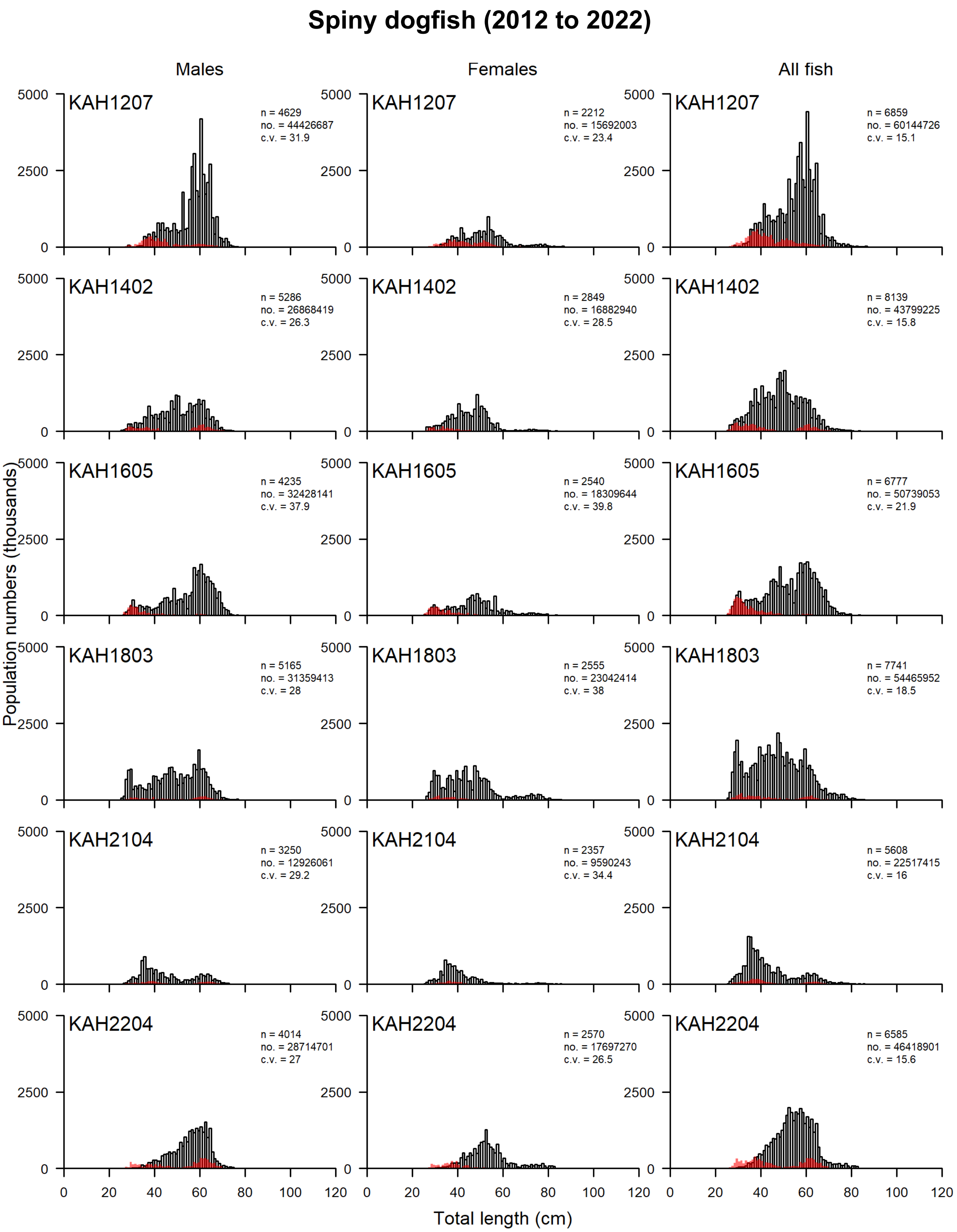


Figure 8 – *continued.*

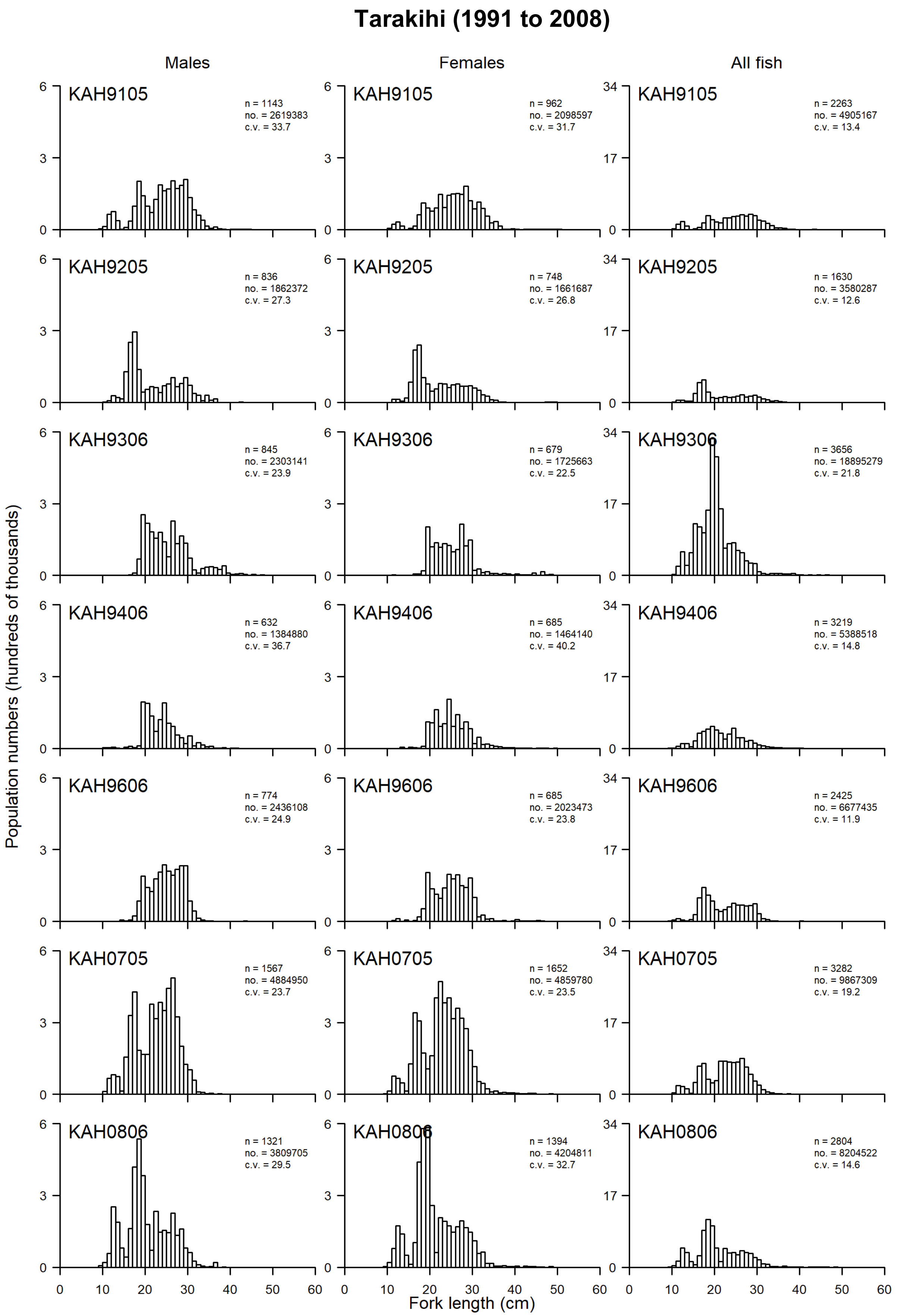


Figure 8 – ***continued.***

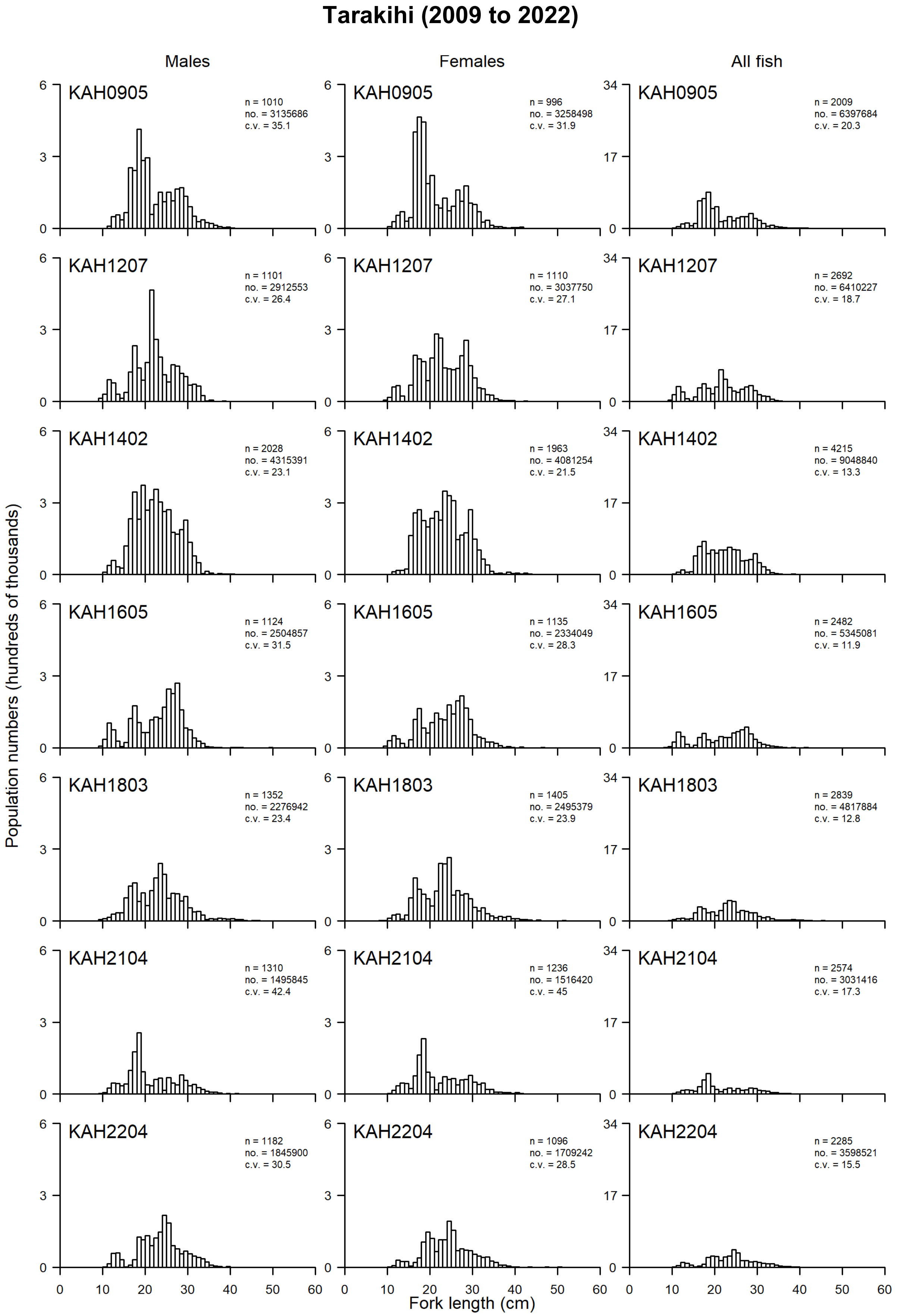


Figure 8 – ***continued.***

Dark ghost shark

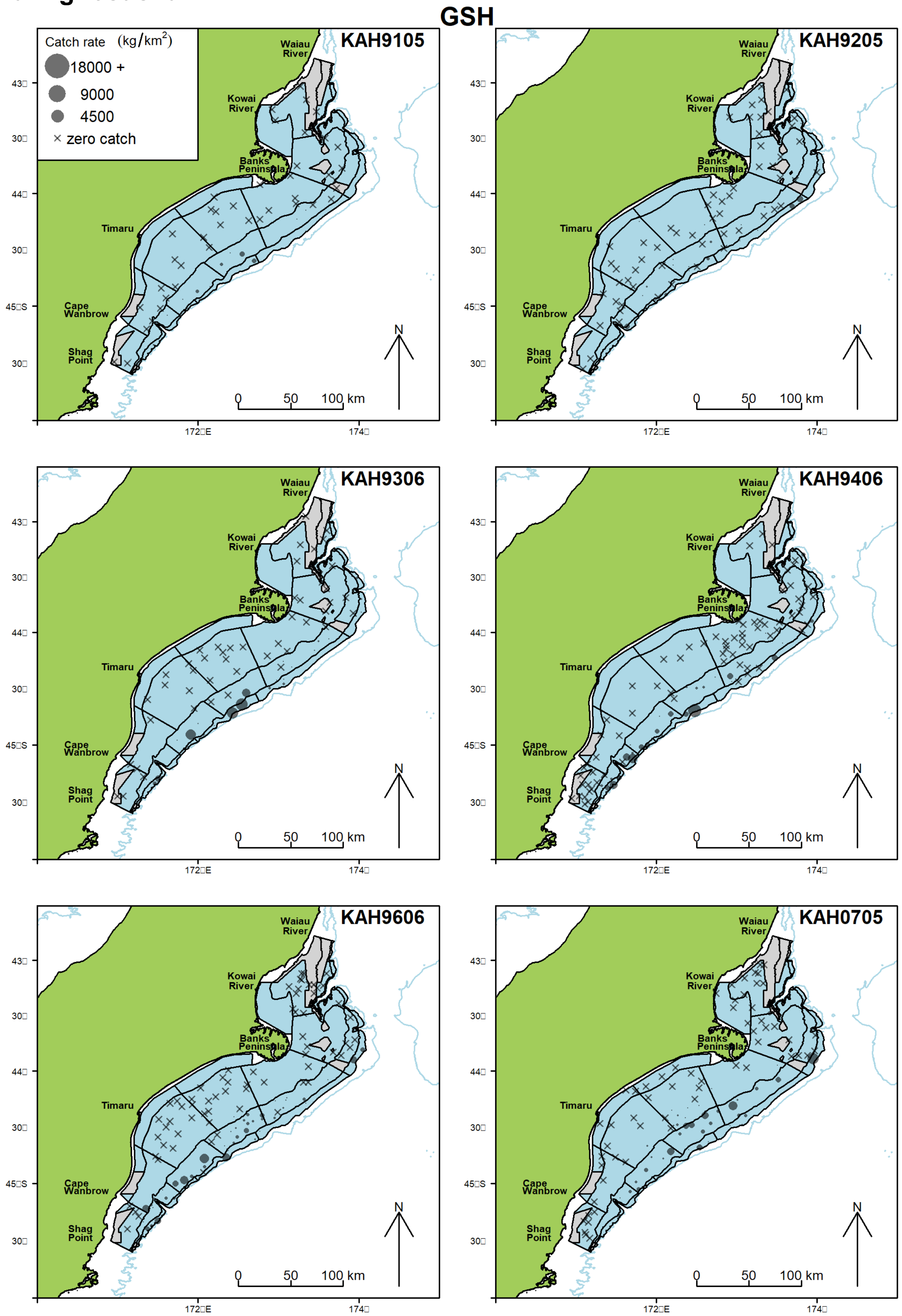


Figure 9: Target species catch rates (kg km^{-2}) by tow plotted for the ECSI winter trawl surveys time series. The legend indicates the circle size that corresponds to catch rates; on the figure, circle size is continuous and proportional to the catch rate. Crosses indicate no catch at that station. Grey areas are foul ground. The depth contour is 500 m.

Dark ghost shark

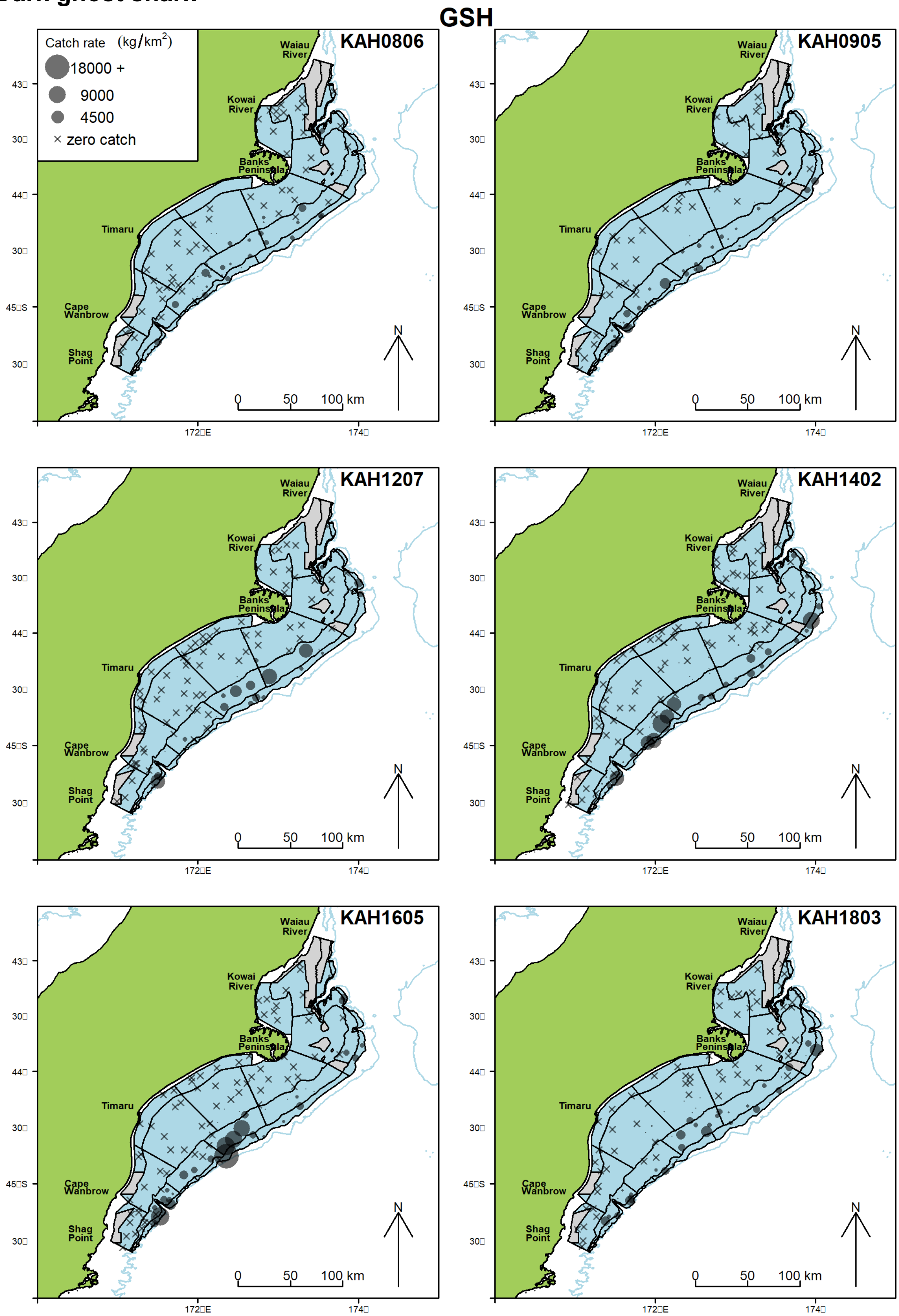


Figure 9 – *continued.*

Dark ghost shark

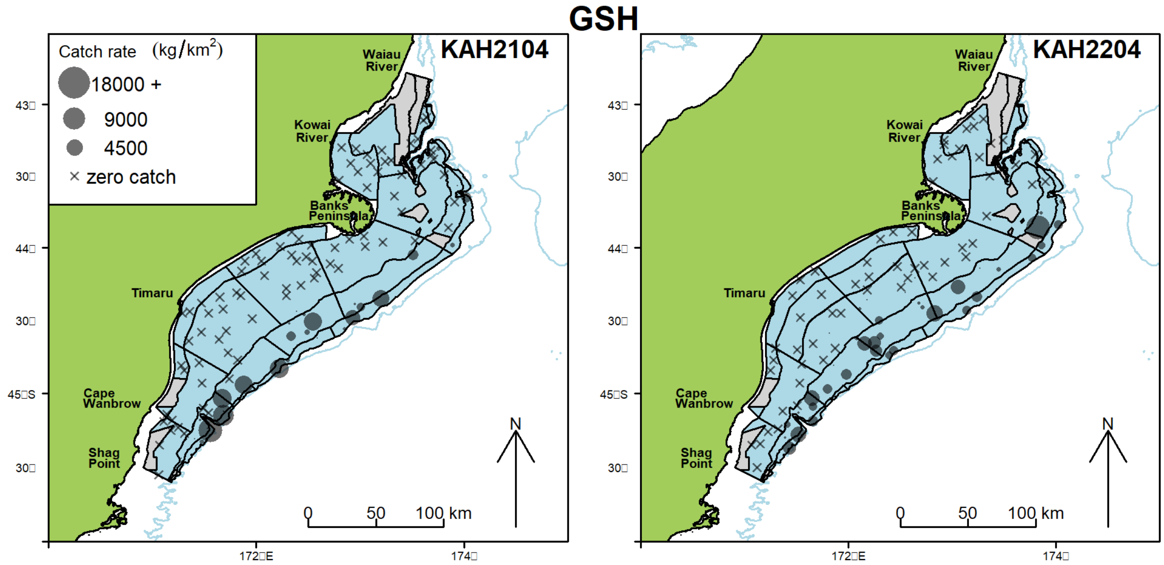


Figure 9 – *continued.*

Elephantfish

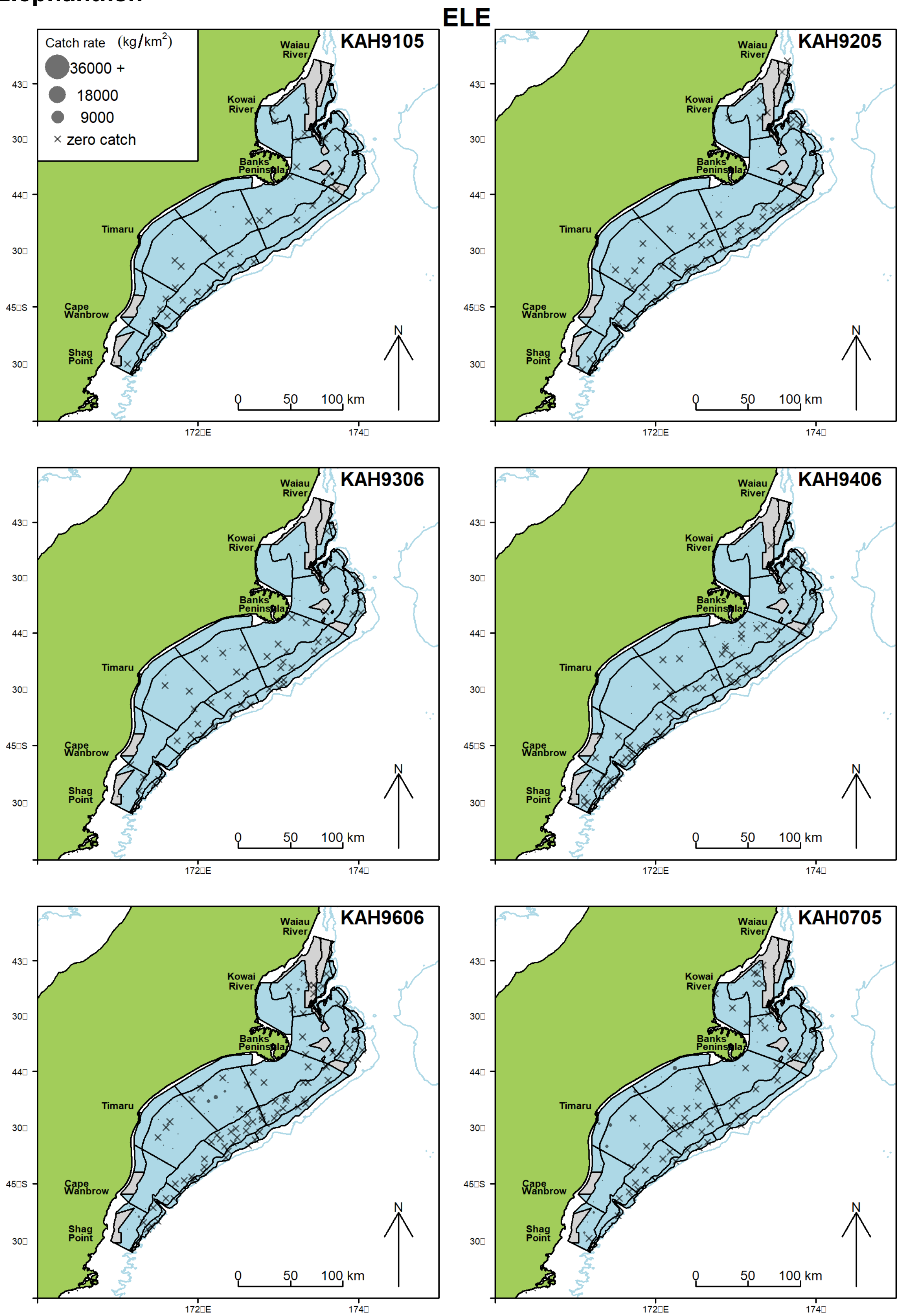


Figure 9 – *continued.*

Elephantfish

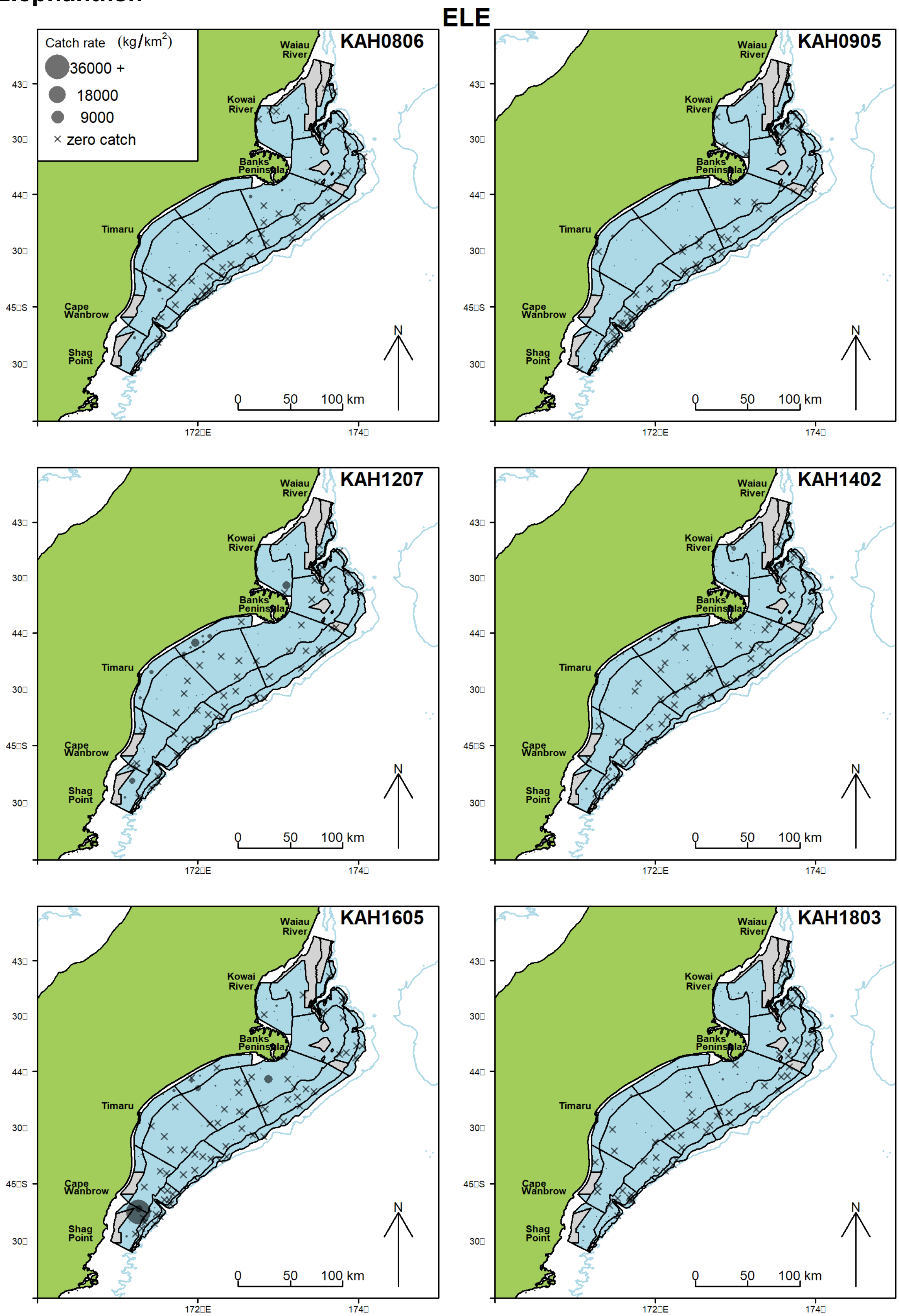


Figure 9 – ***continued.***

Elephantfish

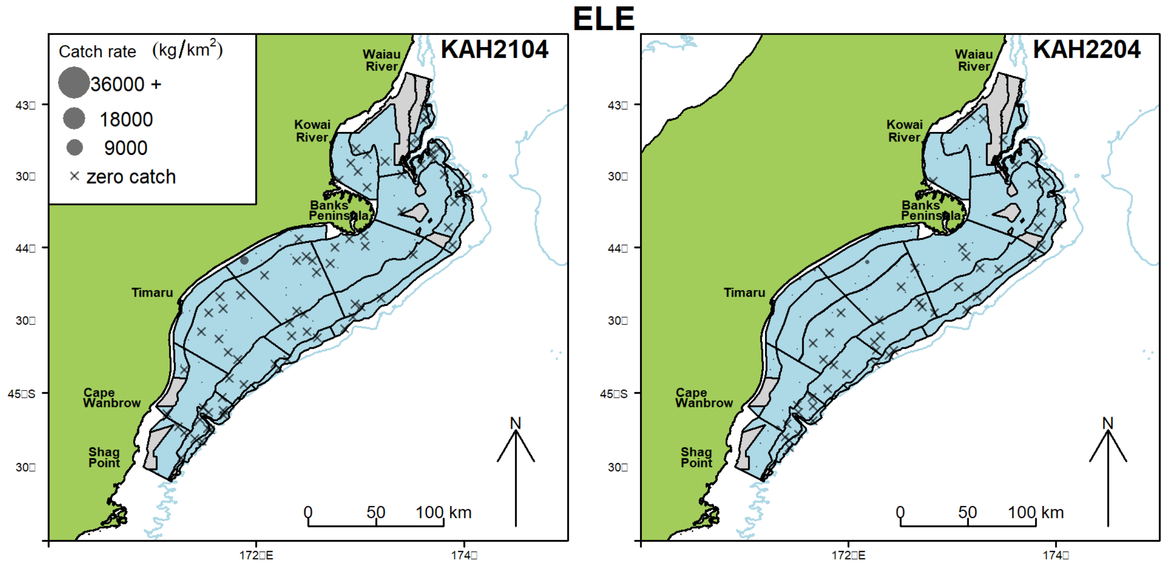


Figure 9 – *continued.*

Giant stargazer

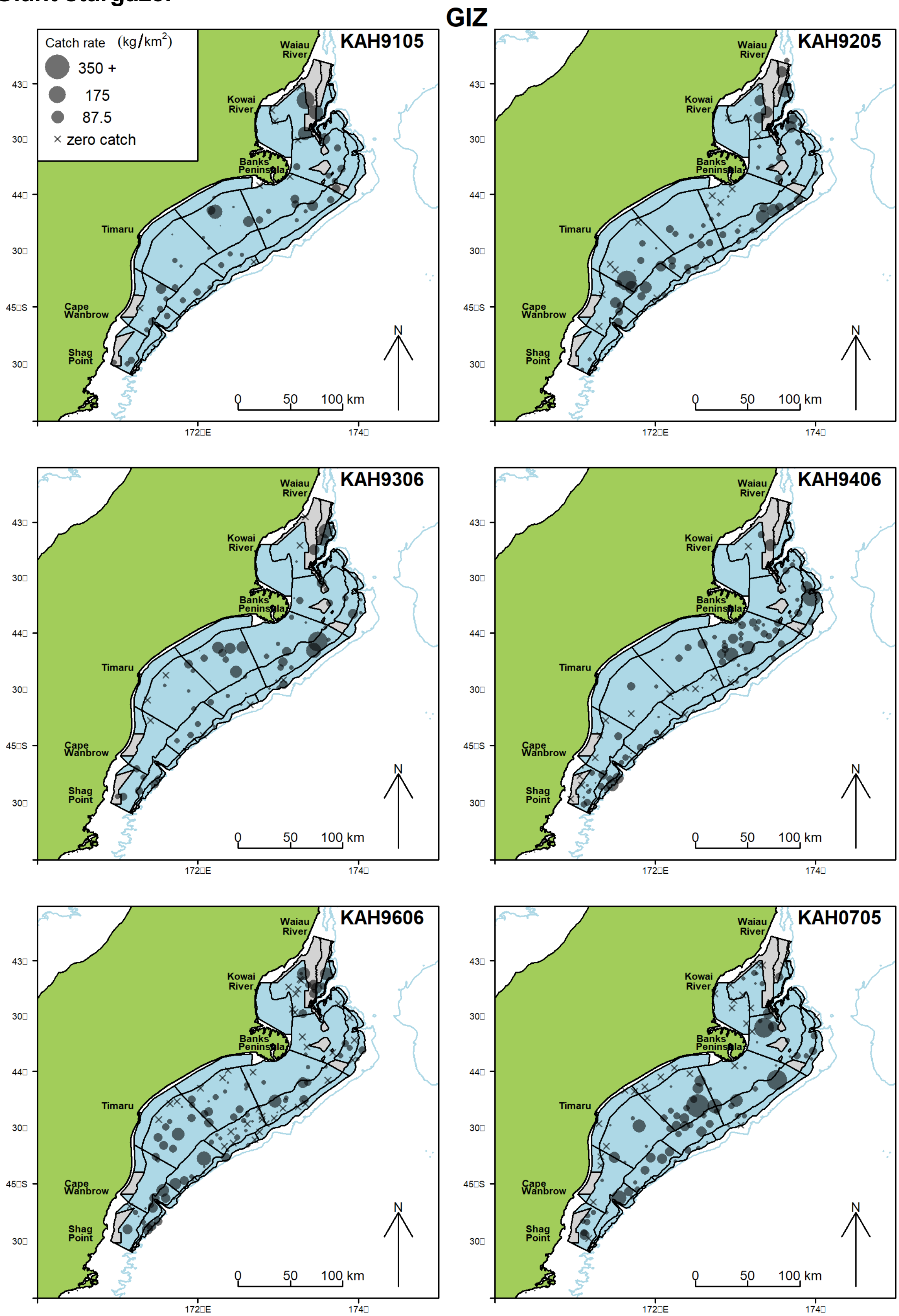


Figure 9 – *continued.*

Giant stargazer

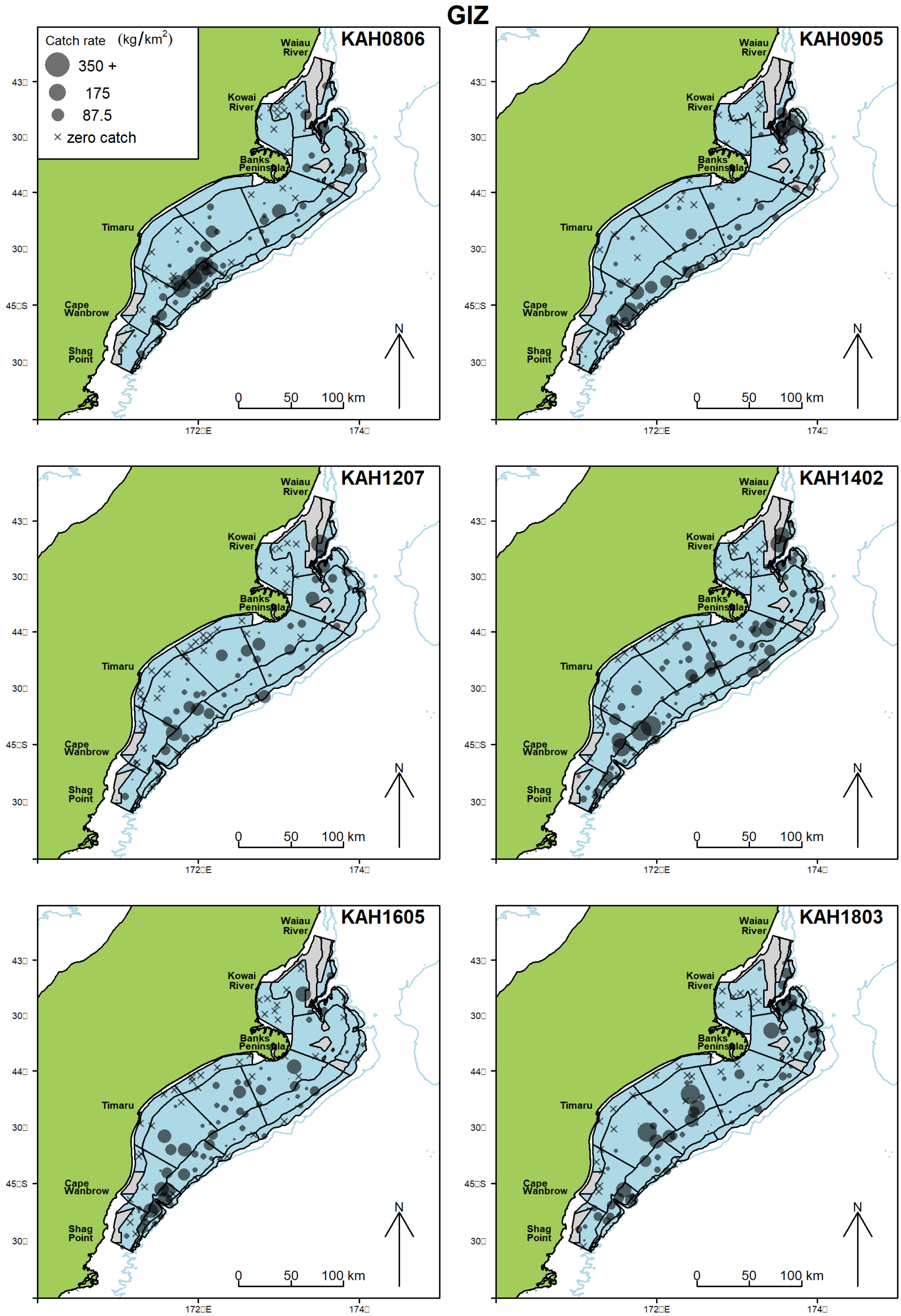


Figure 9 – ***continued.***

Giant stargazer

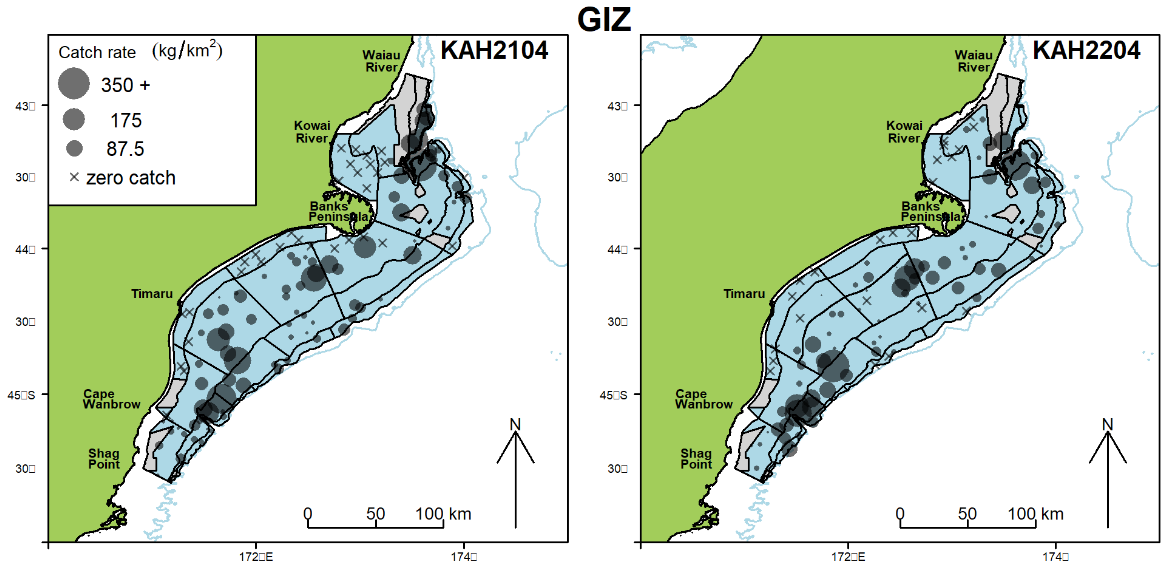


Figure 9 – *continued.*

Red cod

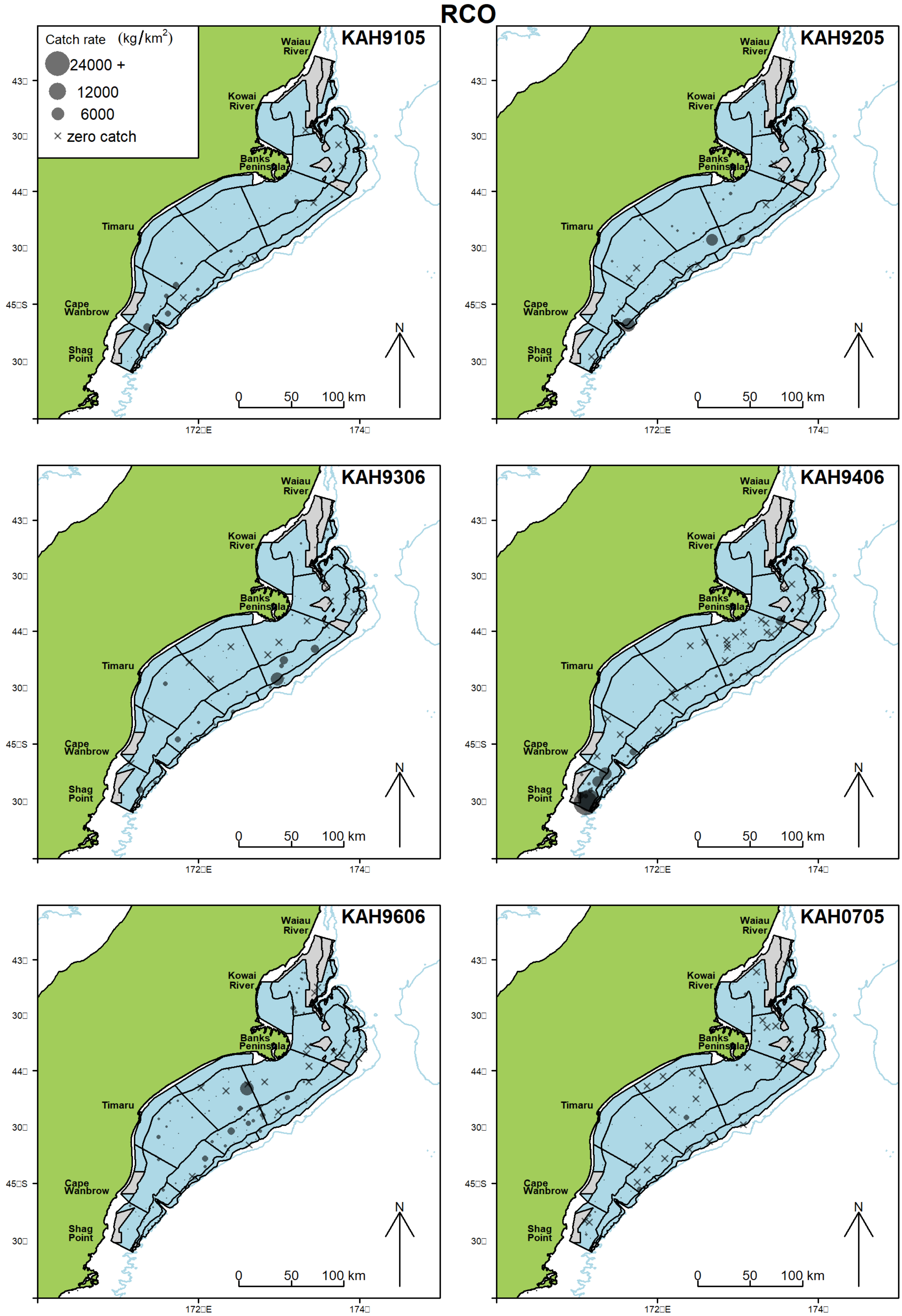


Figure 9 – *continued.*

Red cod

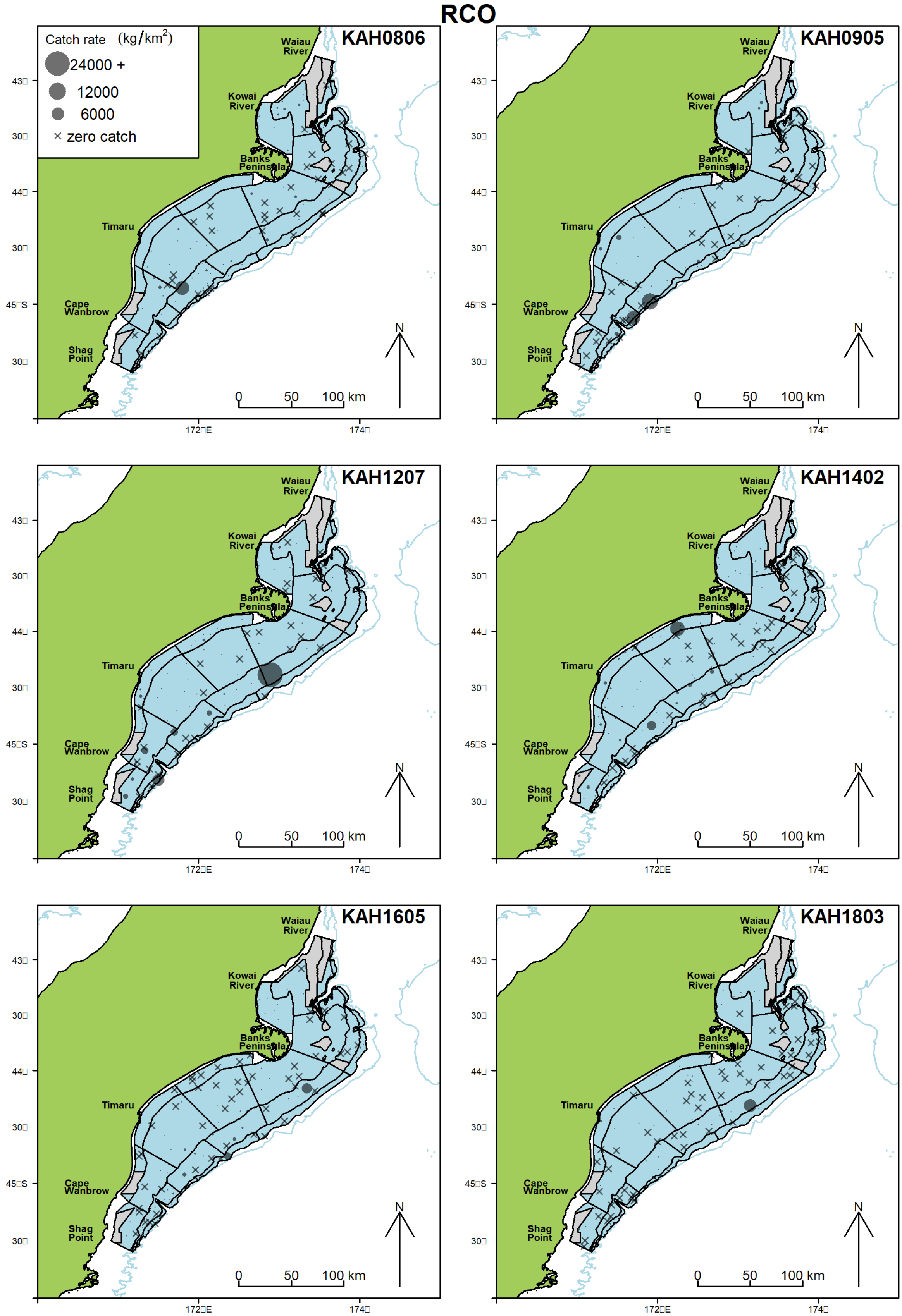


Figure 9 – *continued.*

Red cod

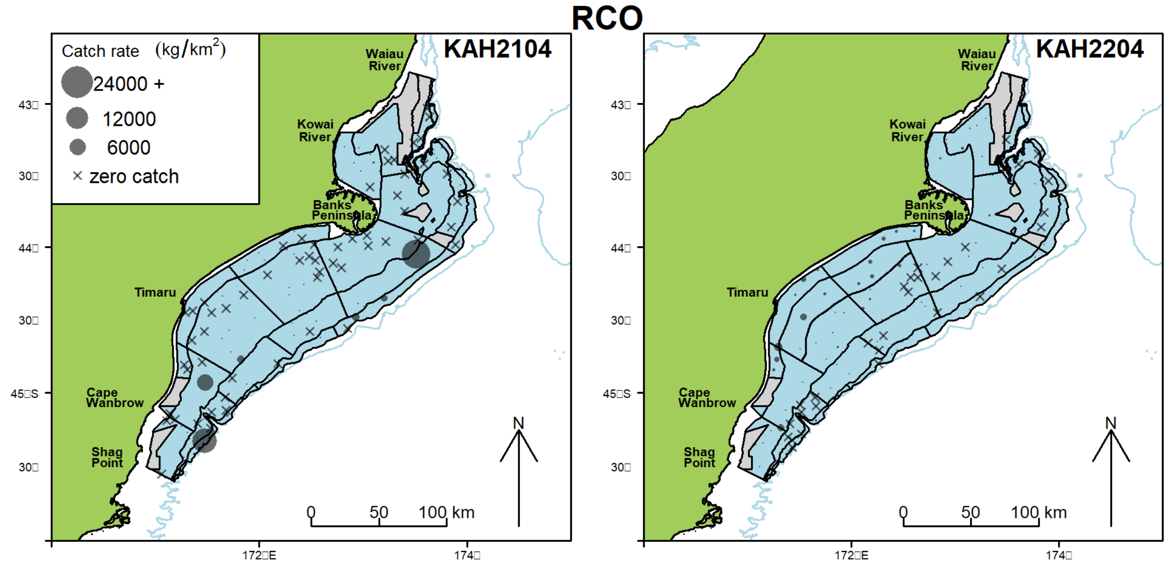


Figure 9 – *continued.*

Red gurnard

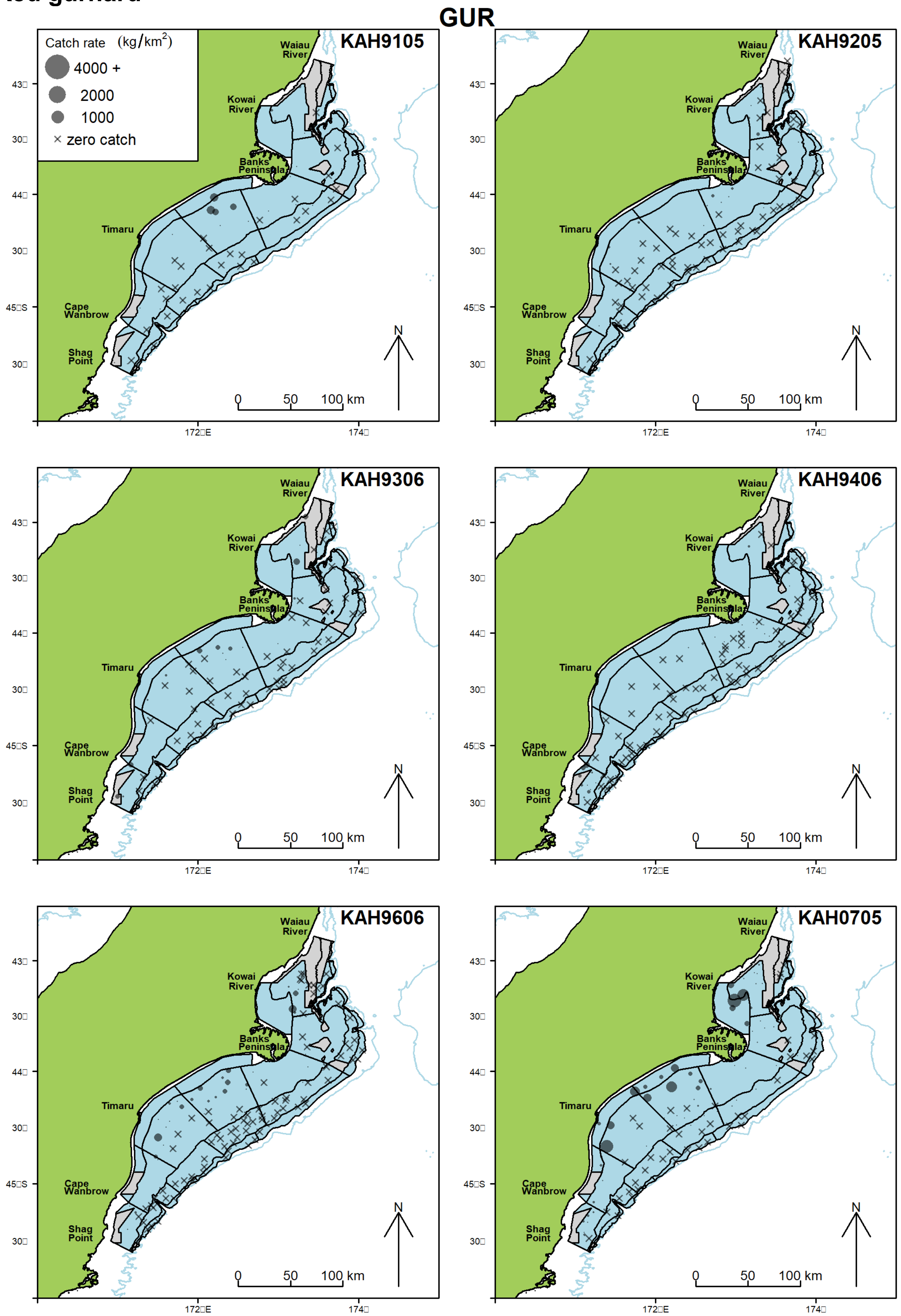


Figure 9 – ***continued.***

Red gurnard

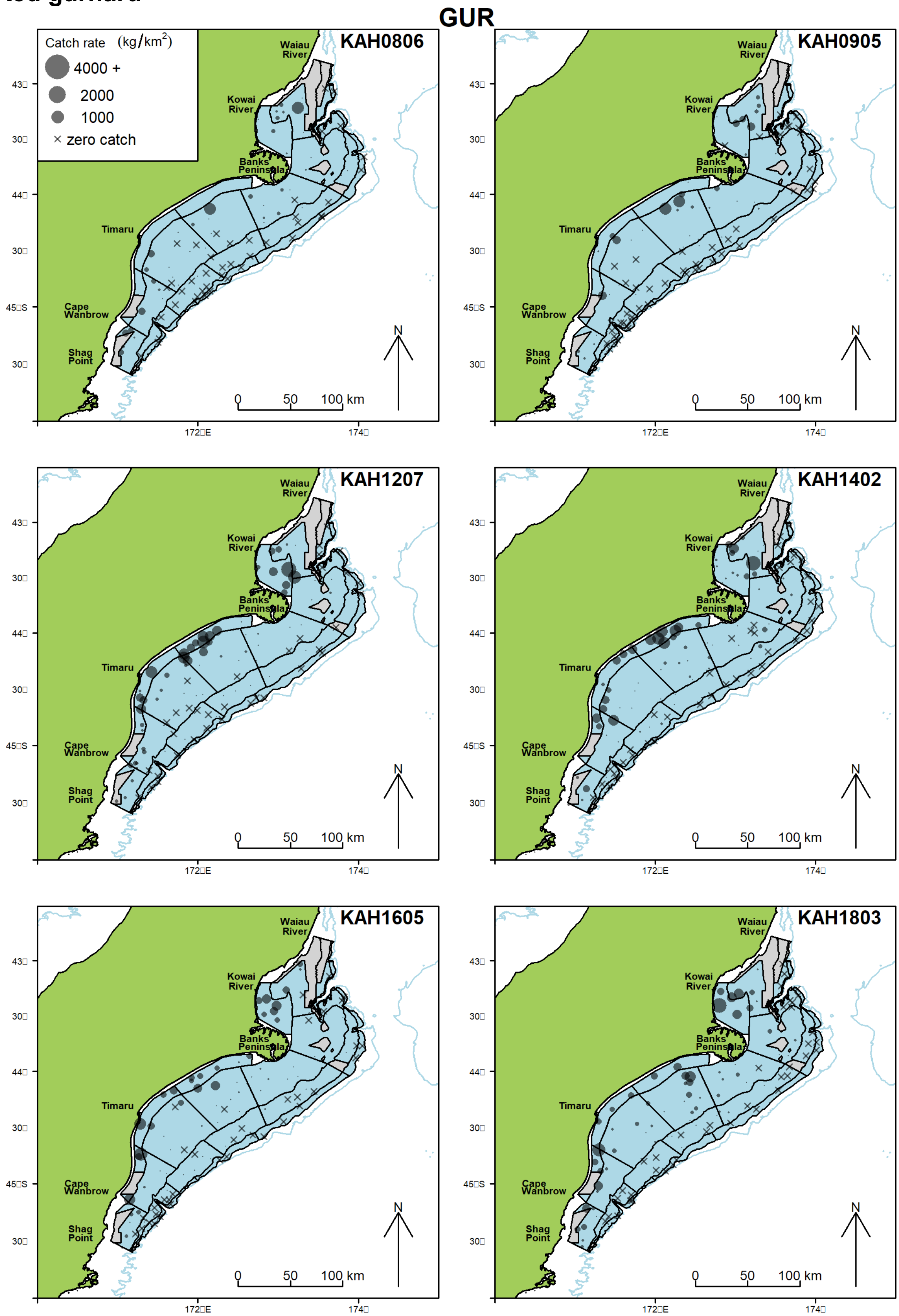


Figure 9 – *continued.*

Red gurnard

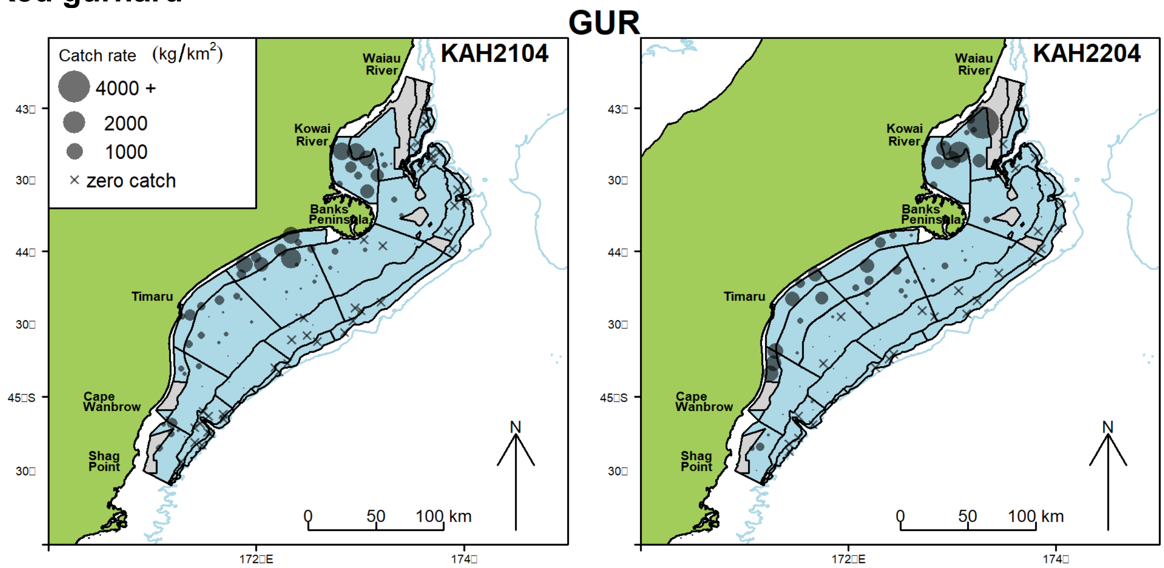


Figure 9 – *continued.*

Sea perch

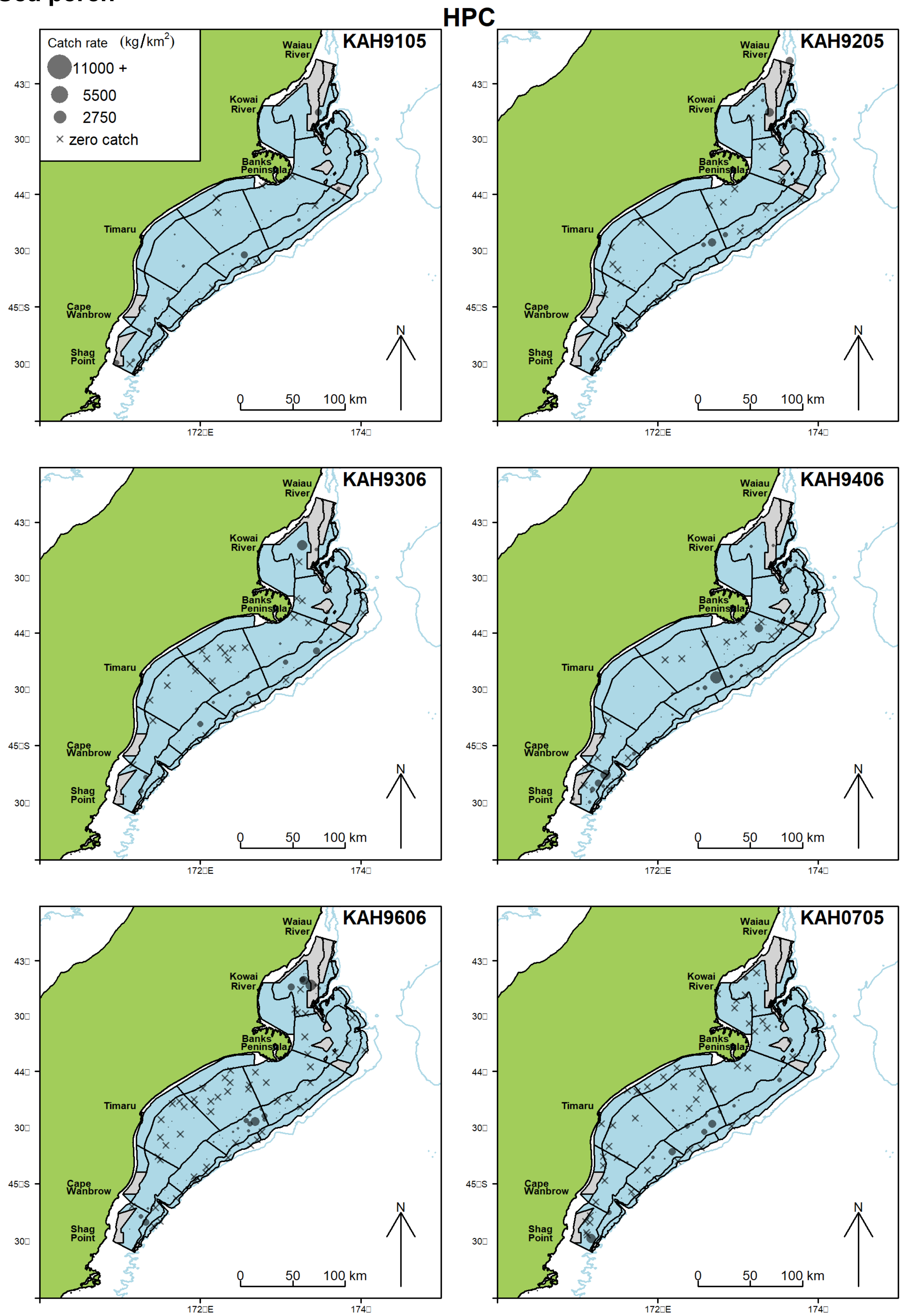


Figure 9 – *continued.*

Sea perch

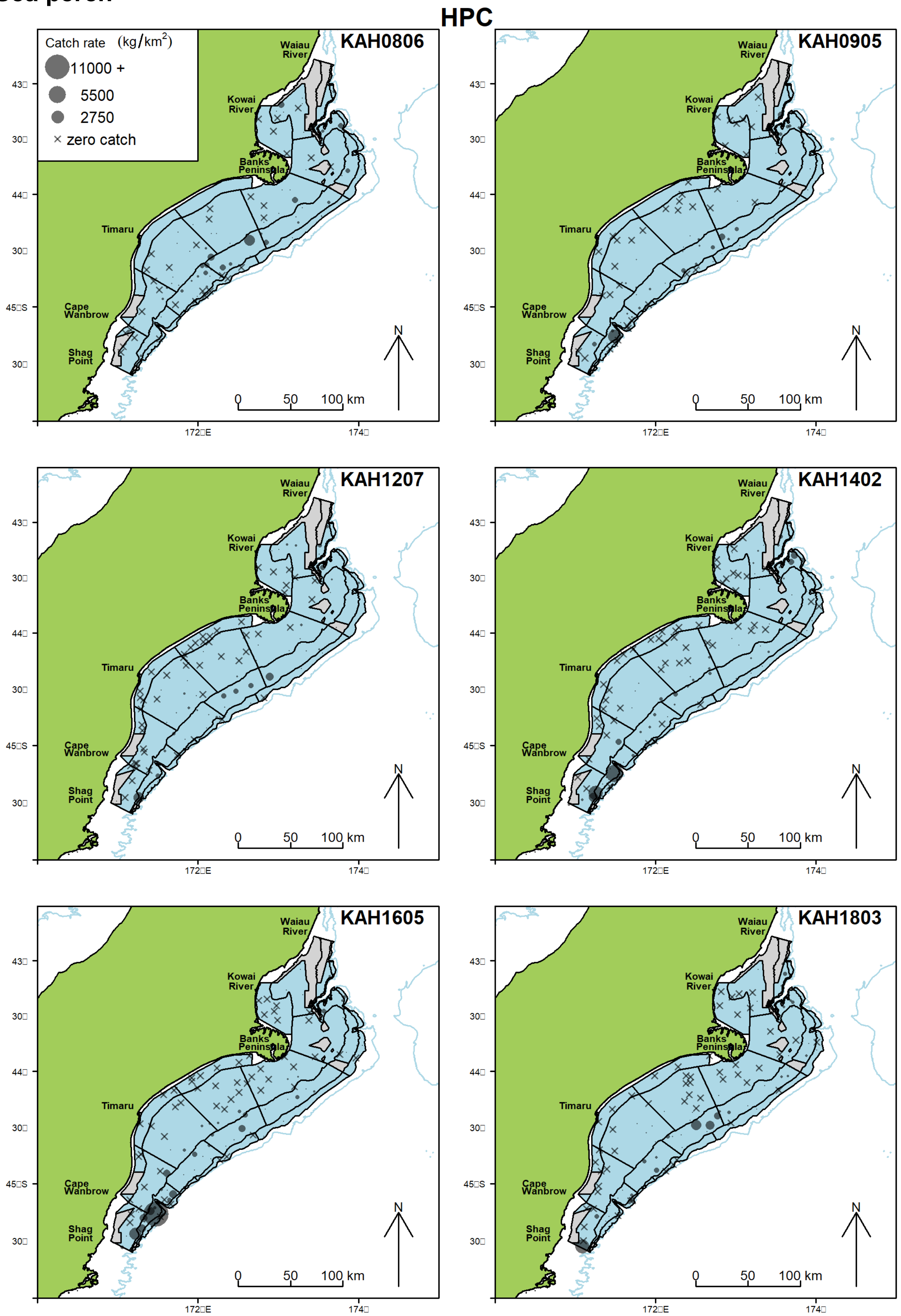


Figure 9 – *continued.*

Sea perch

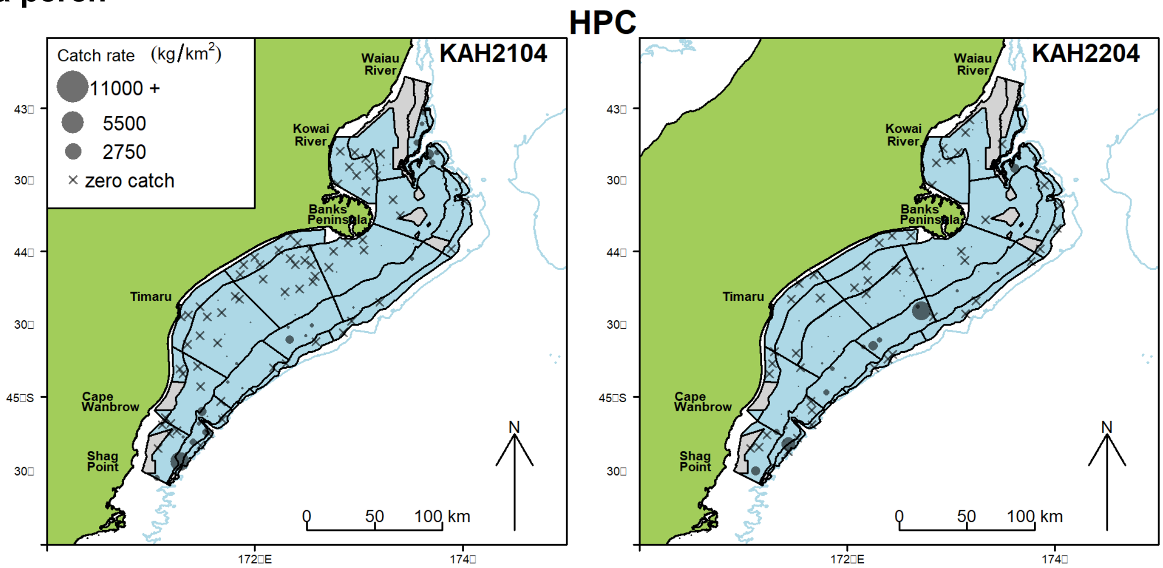


Figure 9 – ***continued.***

Spiny dogfish

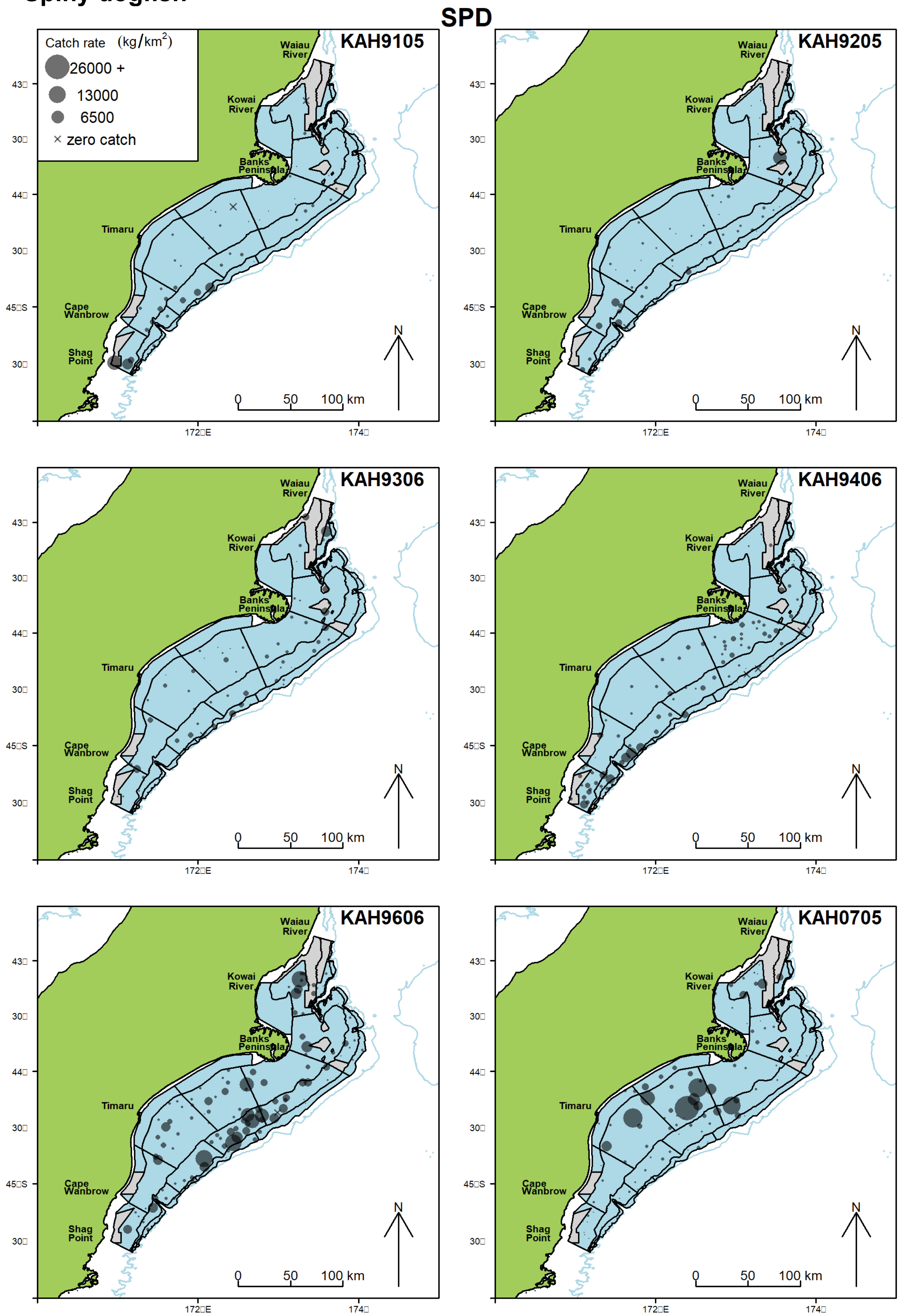


Figure 9 – *continued.*

Spiny dogfish

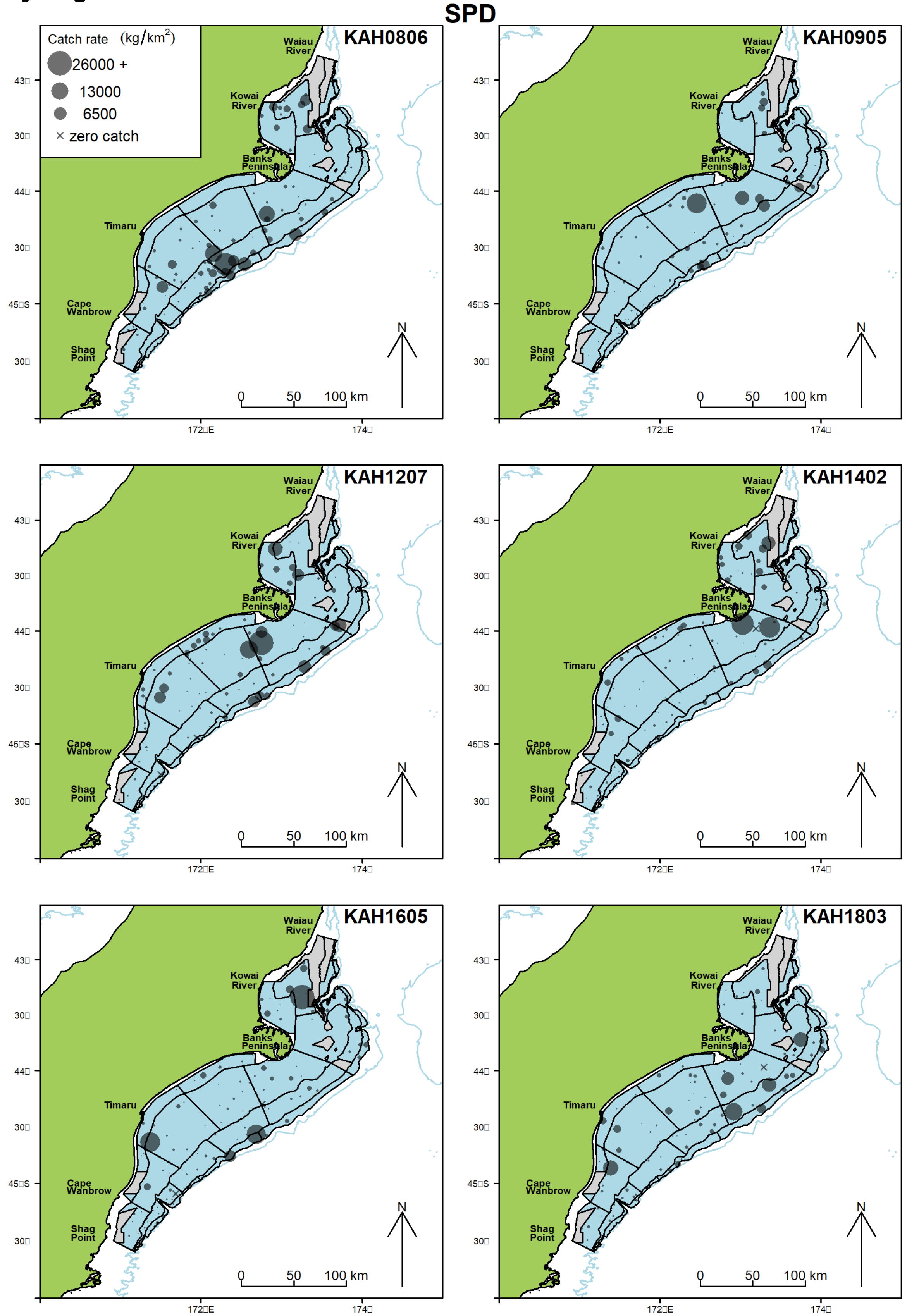


Figure 9 – ***continued.***

Spiny dogfish

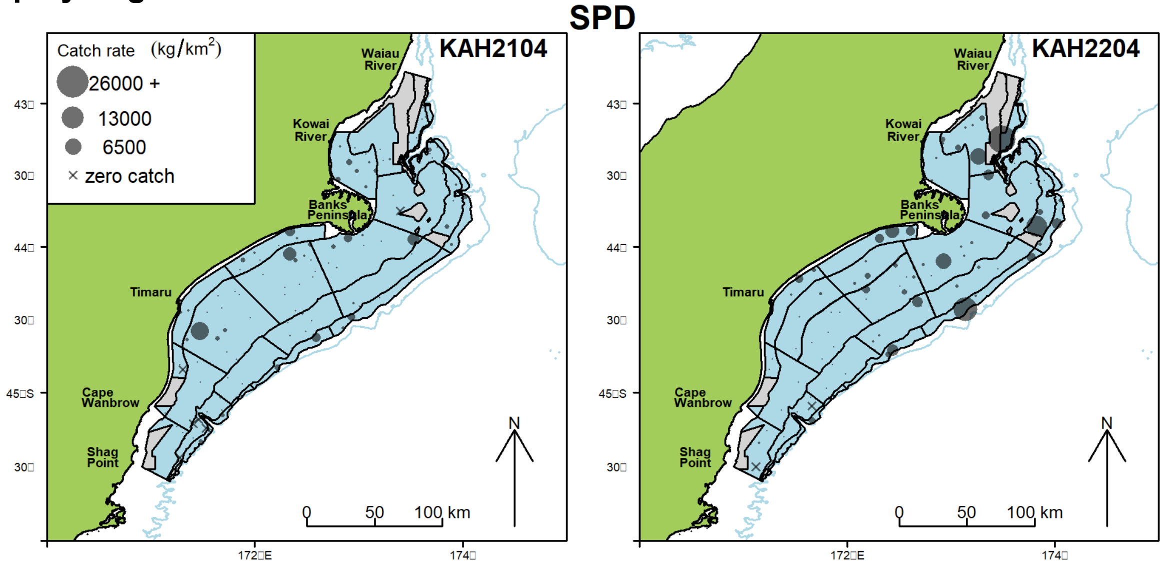


Figure 9 – ***continued.***

Tarakihi

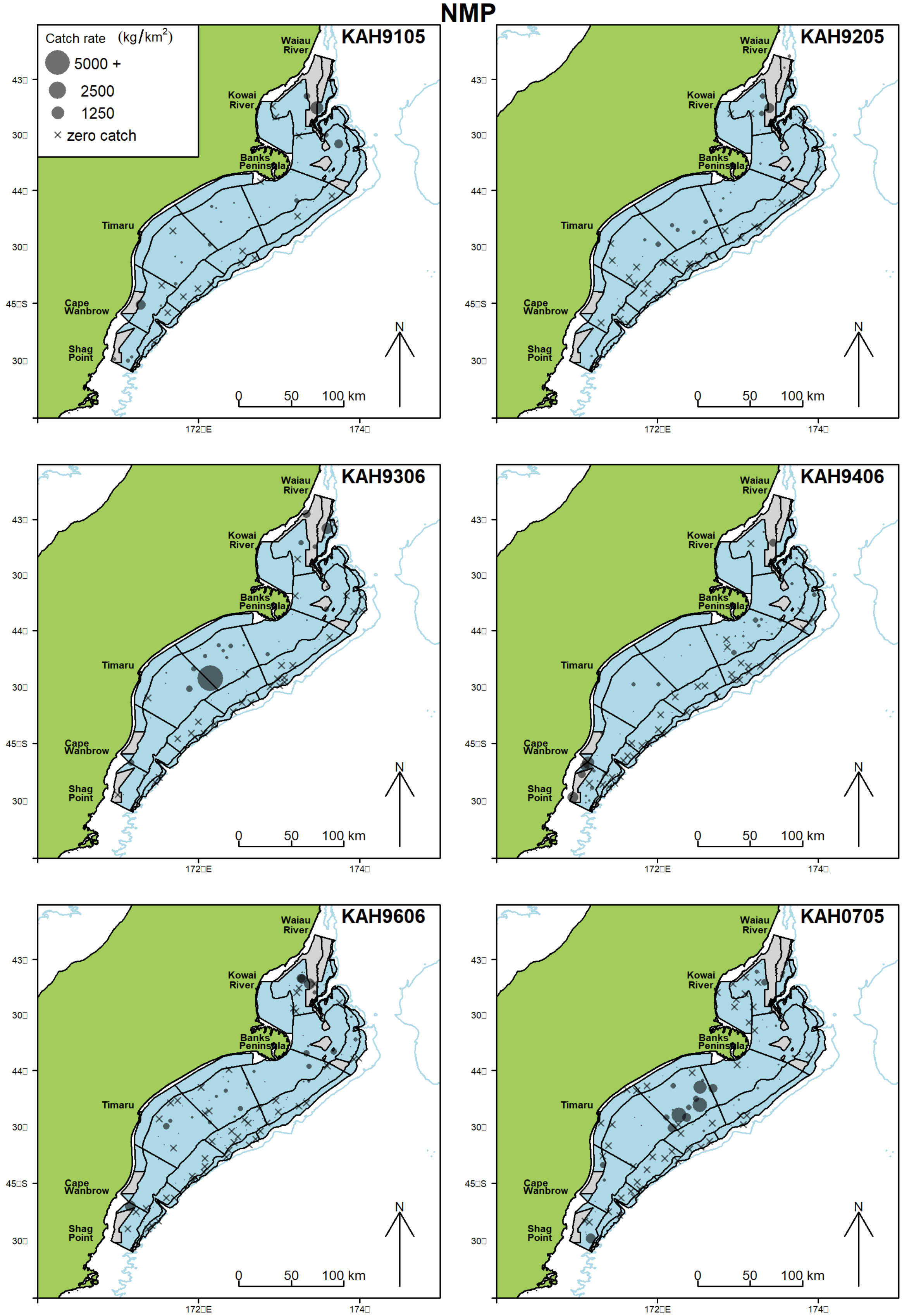


Figure 9 – *continued.*

Tarakihi

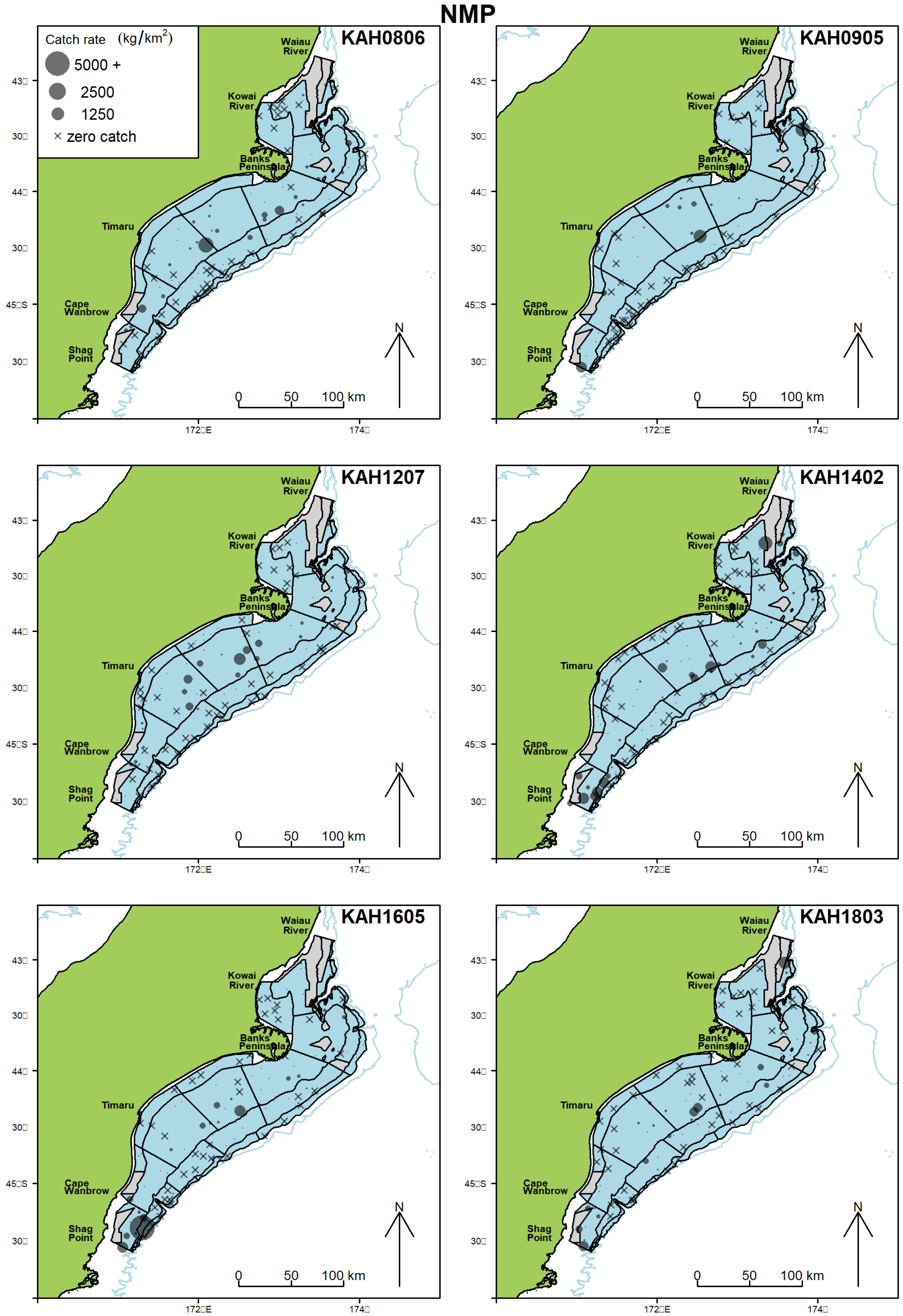


Figure 9 – *continued.*

Tarakihi

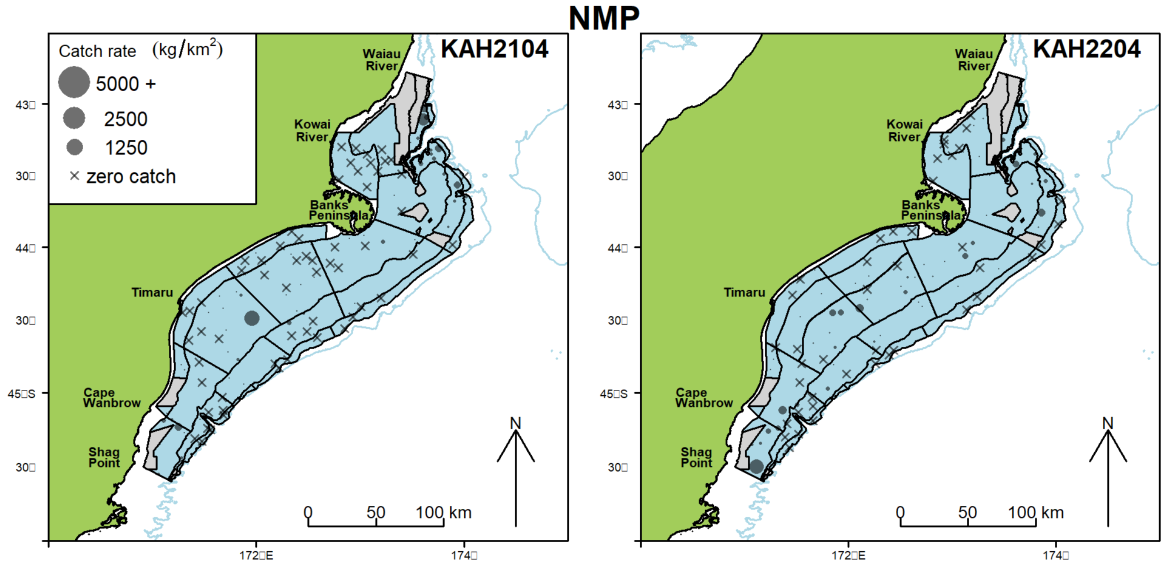


Figure 9 – ***continued.***

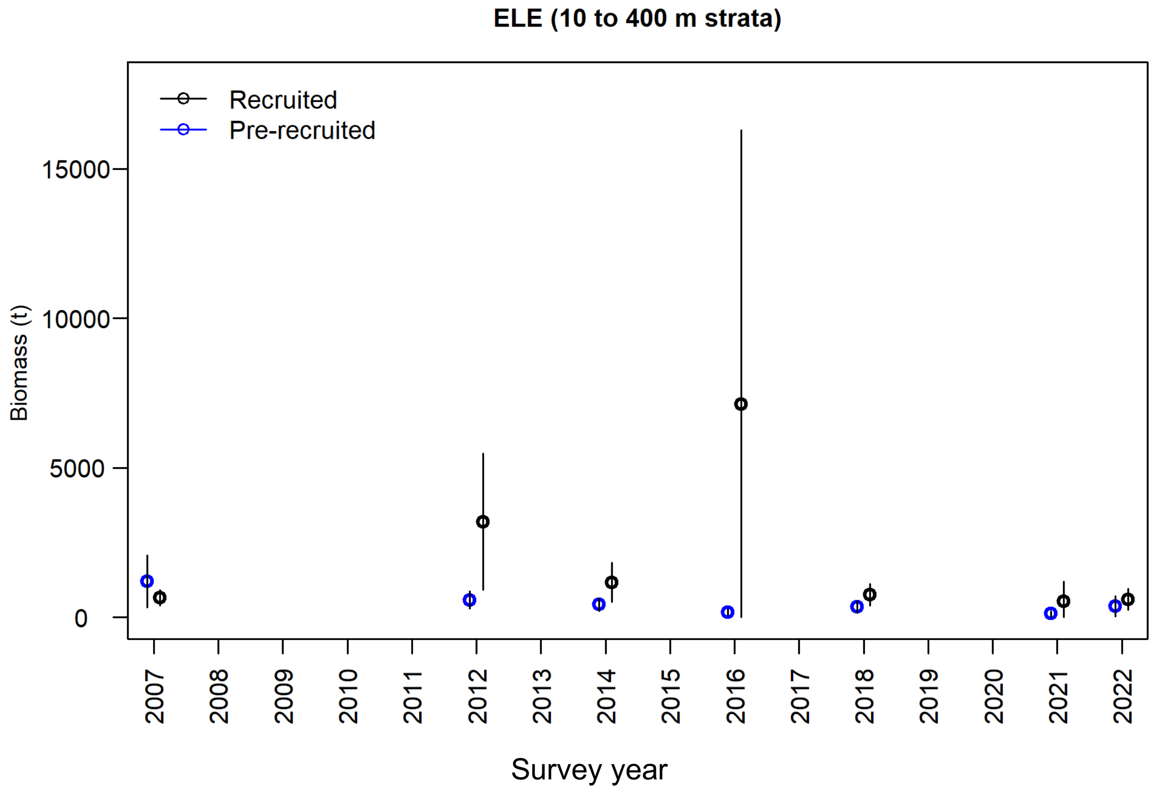


Figure 10: Elephantfish recruited and pre-recruited biomass for the seven ECSI core plus shallow strata surveys in 10–400 m (2007, 2012, 2014, 2016, 2018, 2021, and 2022). Error bars are +/- two standard errors.

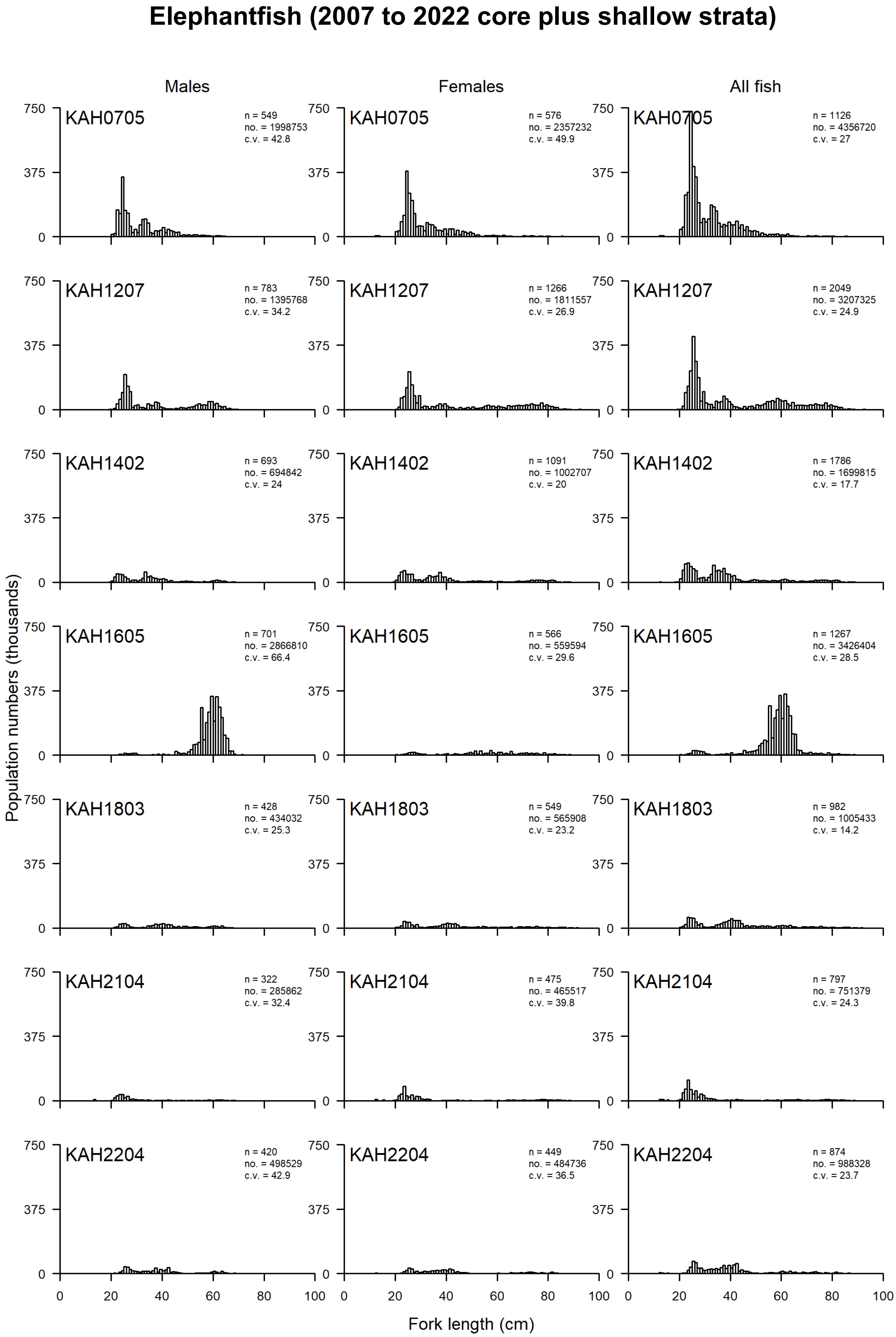


Figure 11: Scaled length frequency distributions for elephantfish in the seven ECSI core plus shallow strata in 10–400 m (2007, 2012, 2014, 2016, 2018, 2021, and 2022). Population estimates are in thousands of fish, n, number of fish sampled; no., scaled number of fish; c.v. (%).

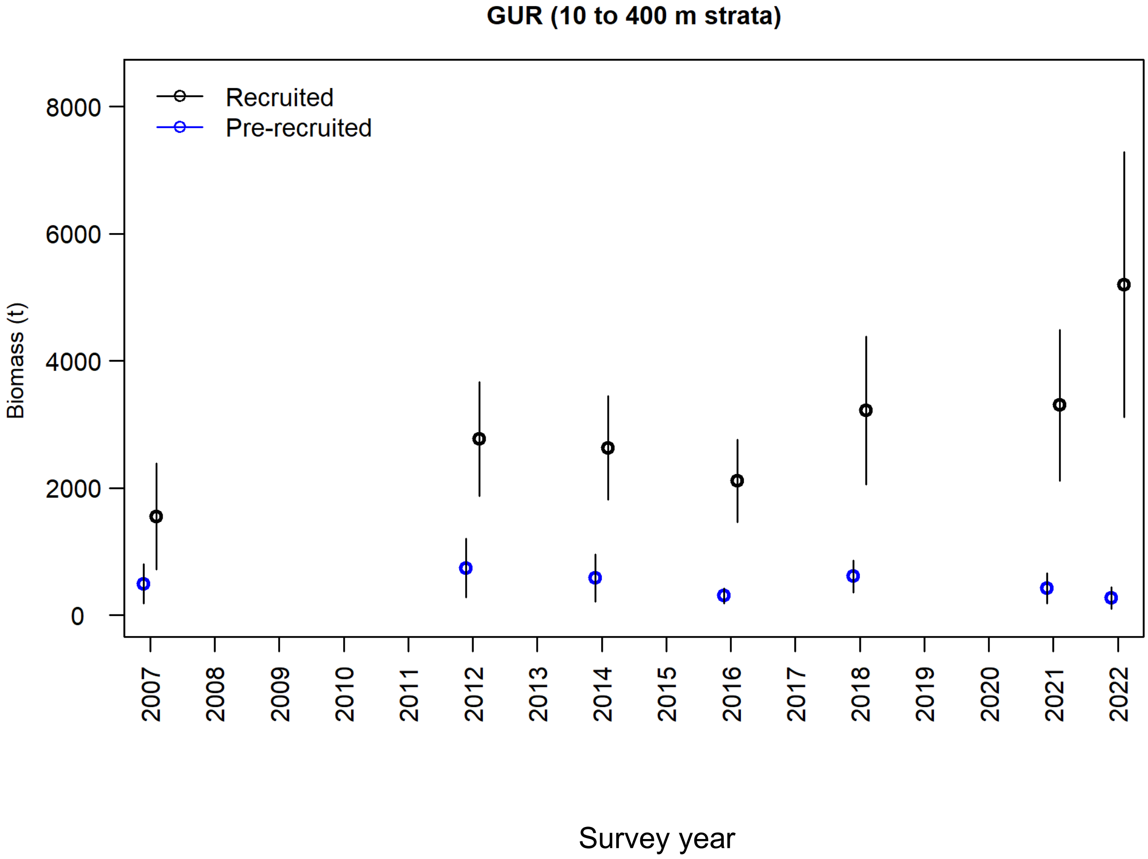


Figure 12: Red gurnard recruited and pre-recruited biomass for the seven ECSI core plus shallow strata surveys in 10–400 m (2007, 2012, 2014, 2016, 2018, 2021, and 2022). Error bars are +/- two standard errors.

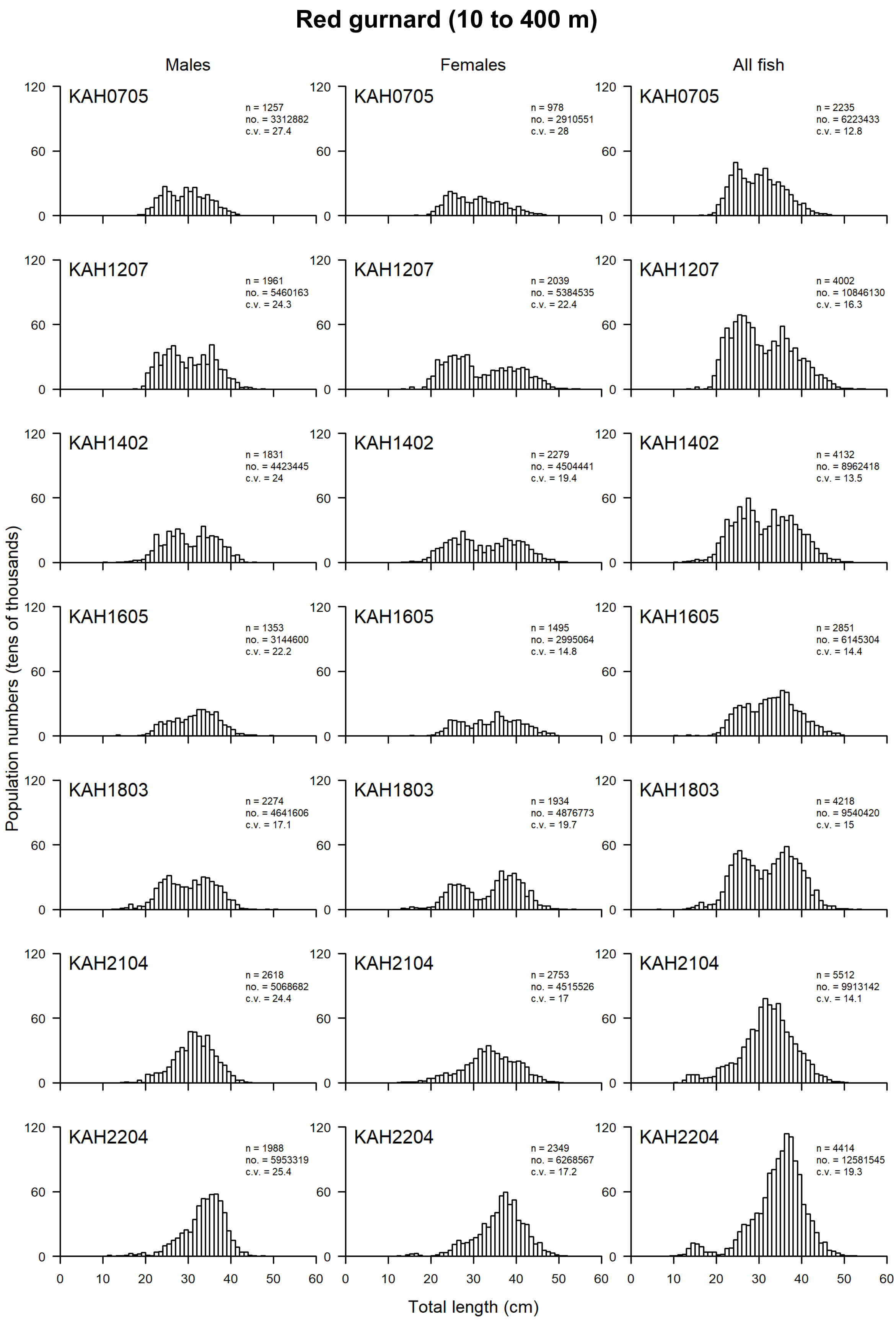
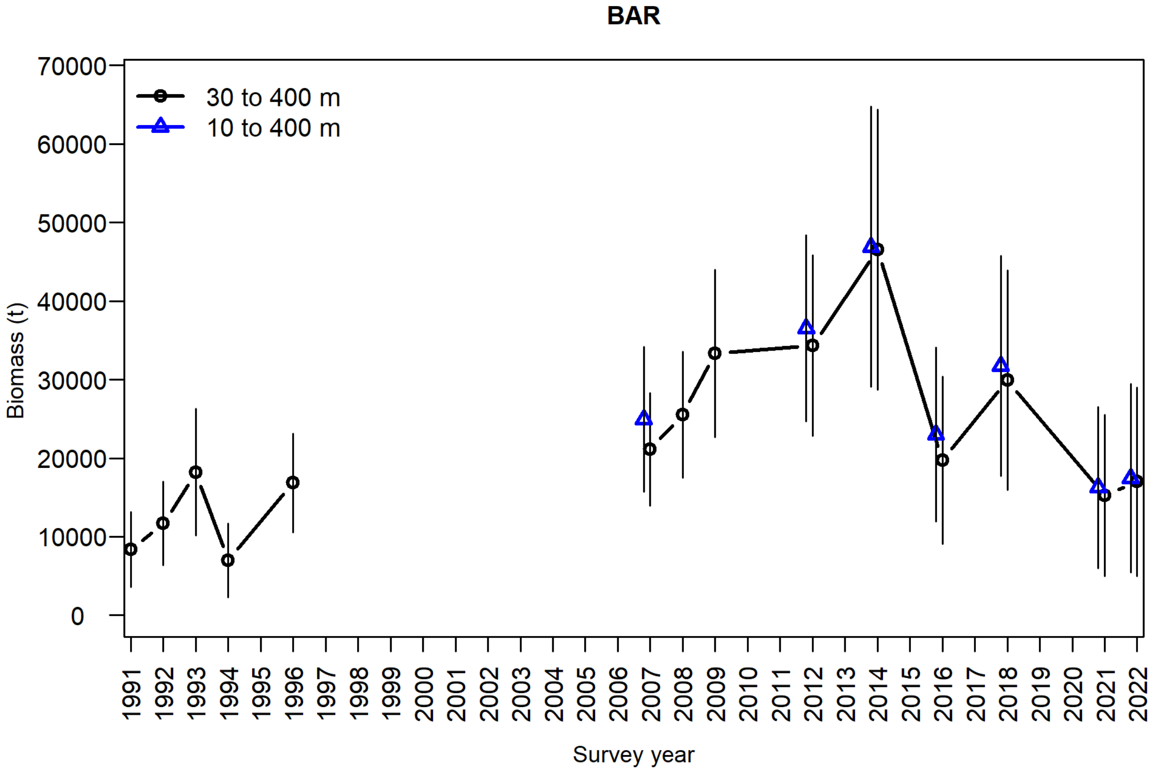


Figure 13: Scaled length frequency distributions for red gurnard in the seven ECSI core plus shallow strata surveys in 10–400 m (2007, 2012, 2014, 2016, 2018, 2021, and 2022). Population estimates are in thousands of fish, n, number of fish sampled; no., scaled number of fish; c.v. (%).



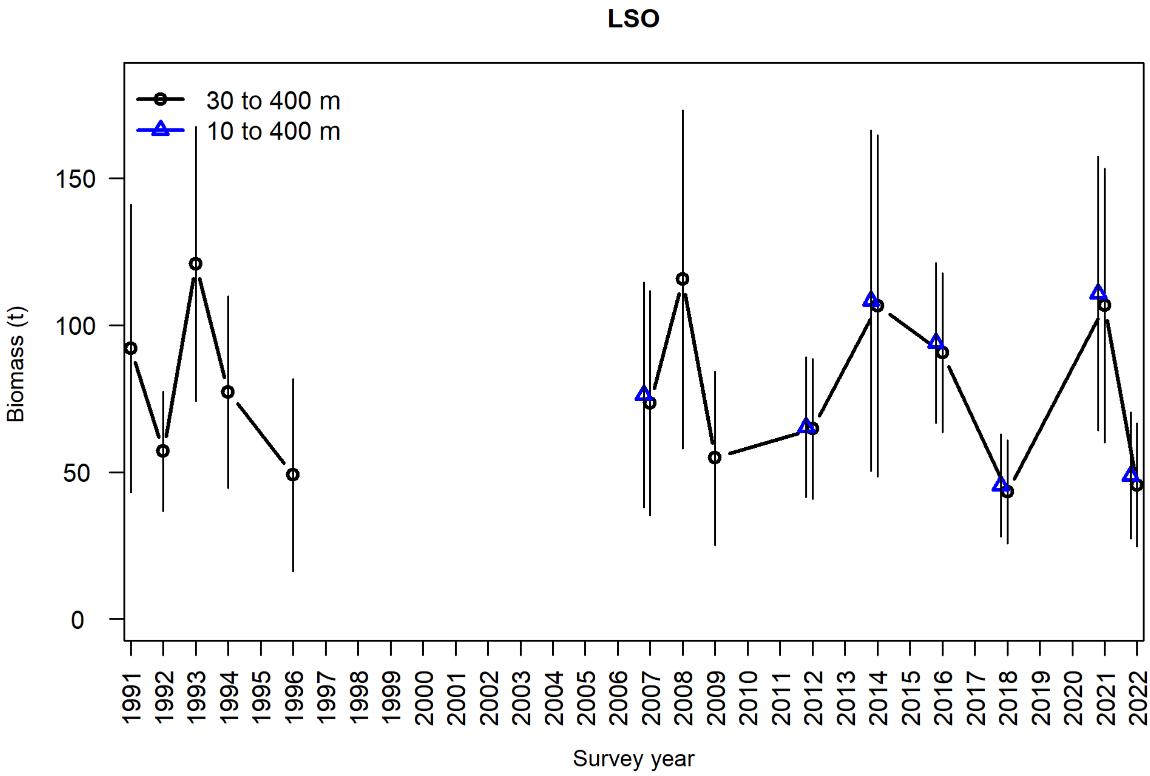
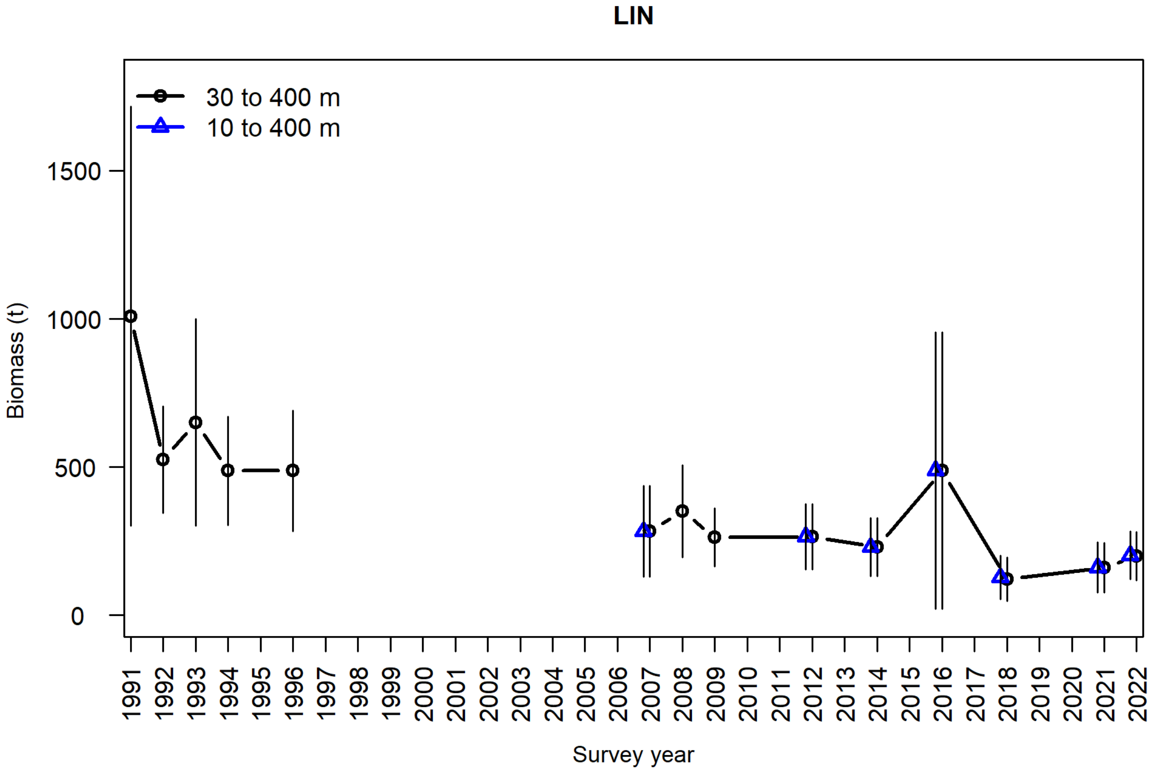


Figure 14: Key non-target QMS species total biomass for all ECSI winter surveys in core strata (30–400 m) and core plus shallow strata (10–400 m) in 2007, 2012, 2014, 2016, 2018, 2021, and 2022. Error bars are +/- two standard deviations.



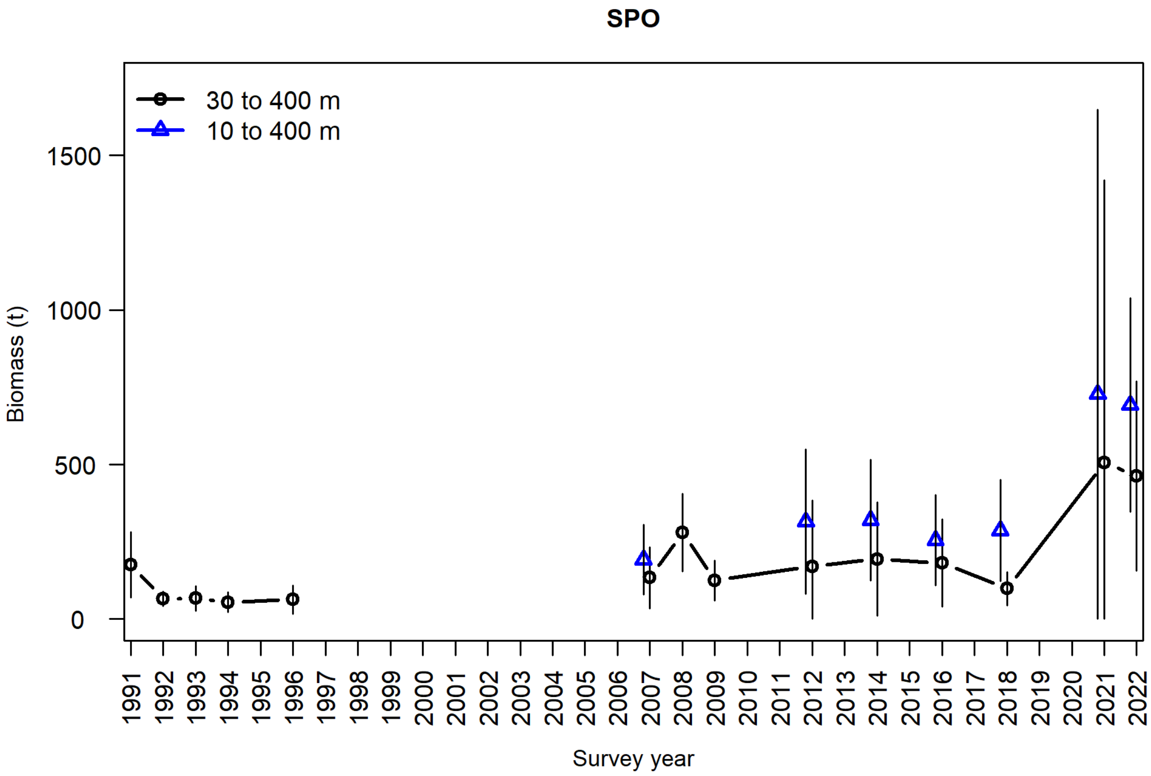
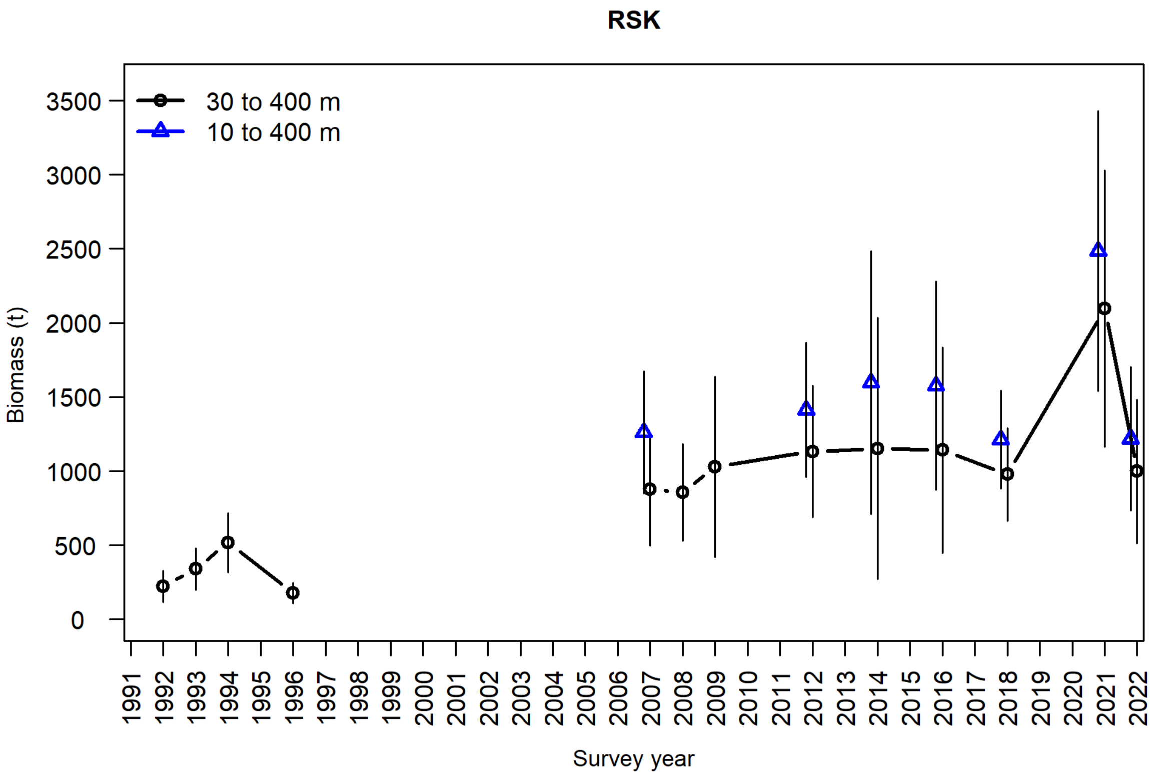


Figure 14 – ***continued.***



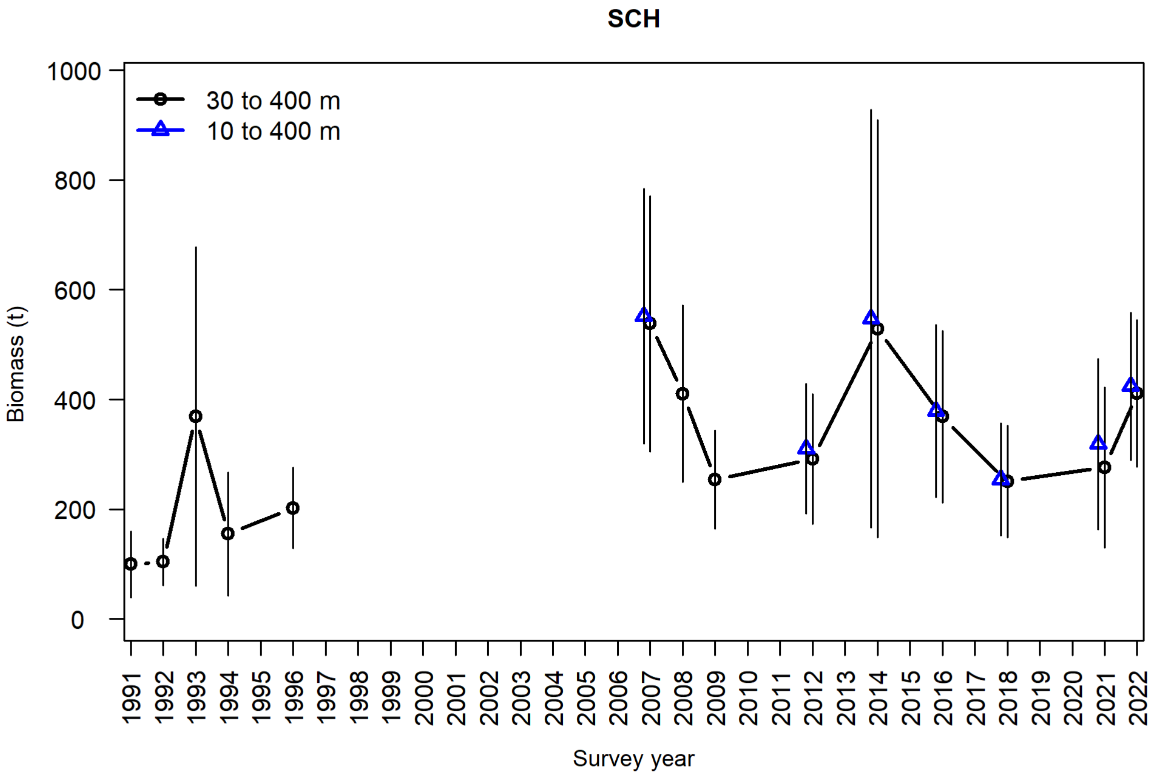
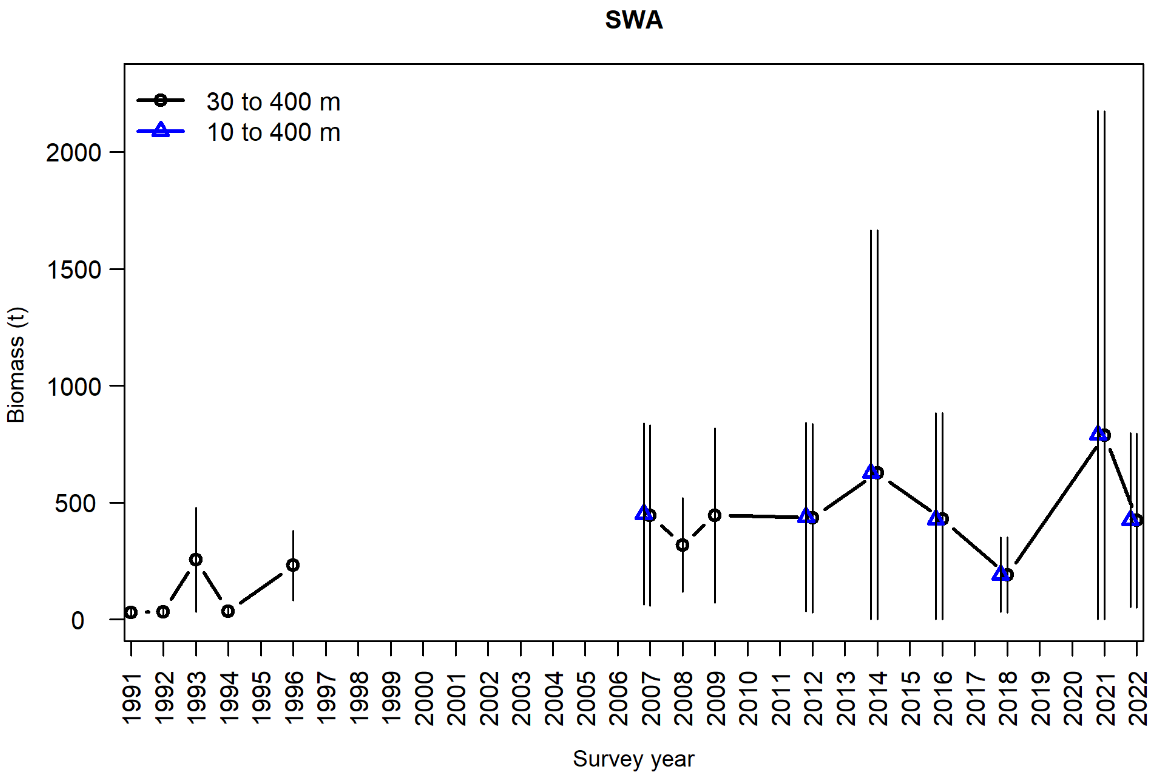


Figure 14 – ***continued.***



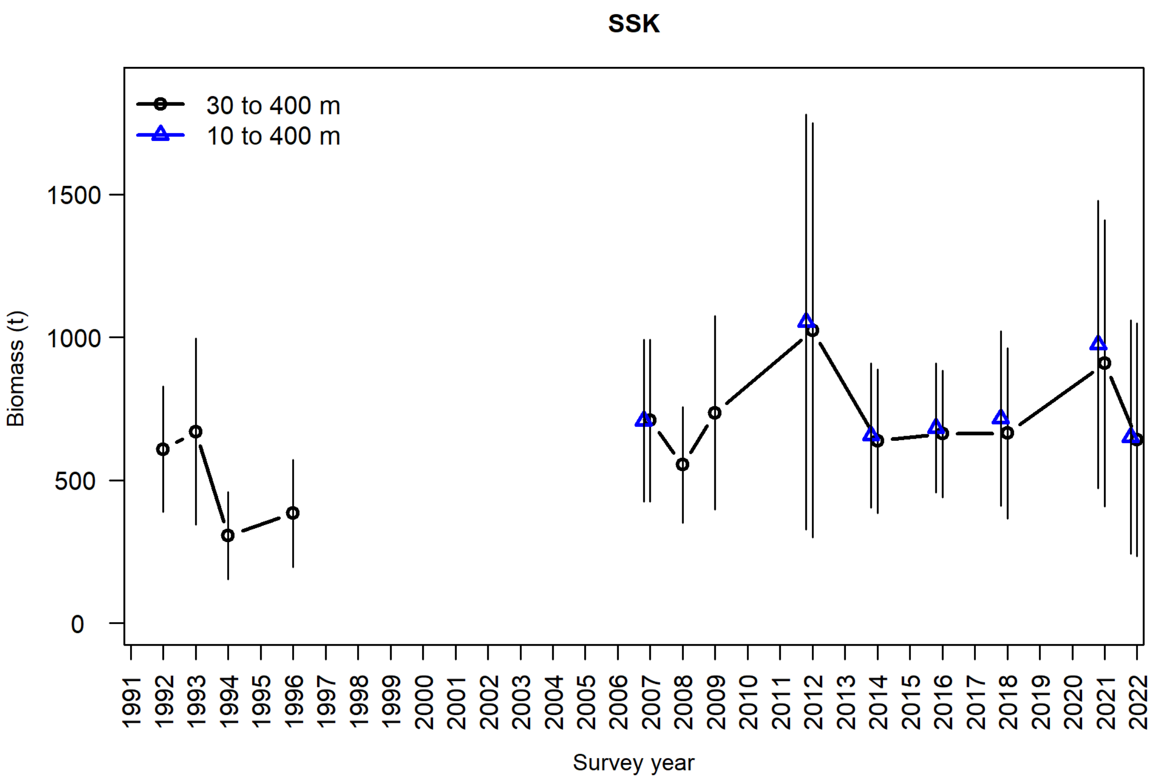


Figure 14 – ***continued.***

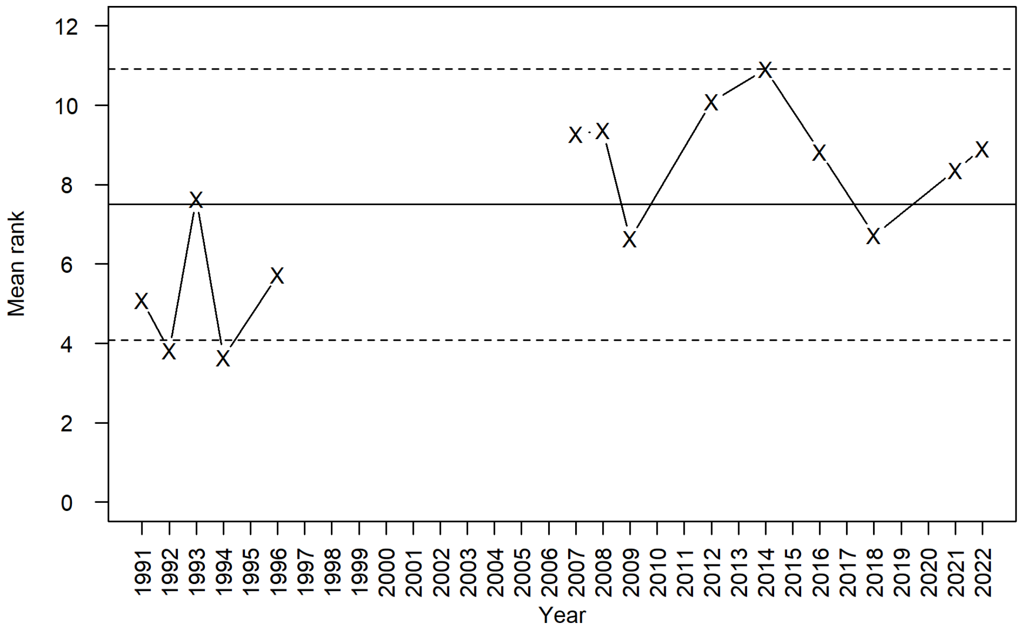


Figure 15: Mean ranks for the ECSI winter trawl surveys (core strata) for the eight target species, plus the eight key non-target QMS species. The solid line indicates the overall mean rank. Mean ranks outside the broken lines (95% confidence intervals) have extreme catchability.

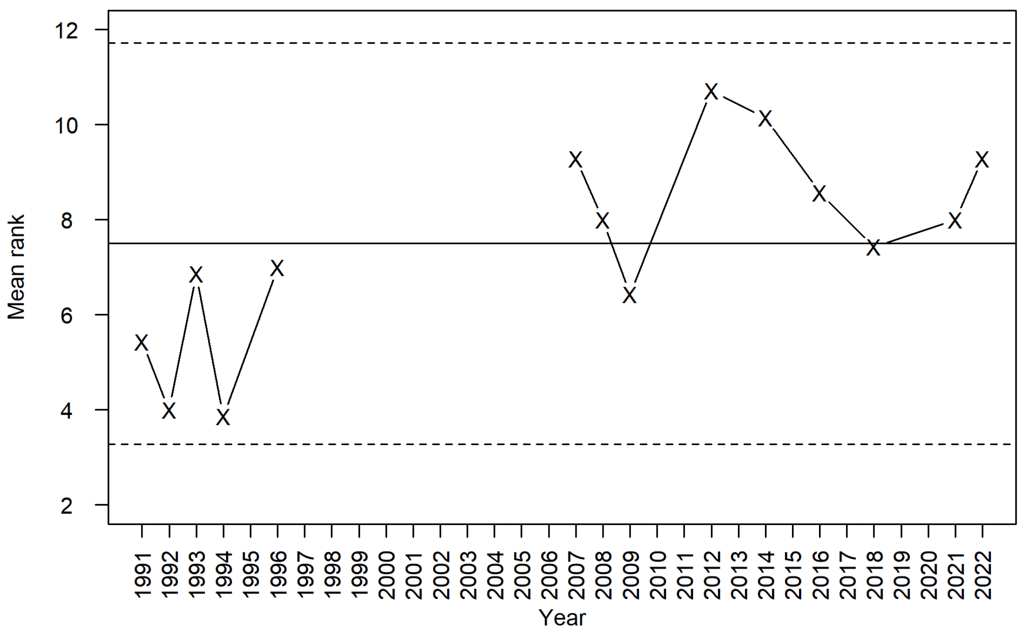


Figure 16: Mean ranks for the ECSI winter trawl surveys (core strata) for the eight target species. The solid line indicates the overall mean rank. Mean ranks outside the broken lines (95% confidence intervals) have extreme catchability.

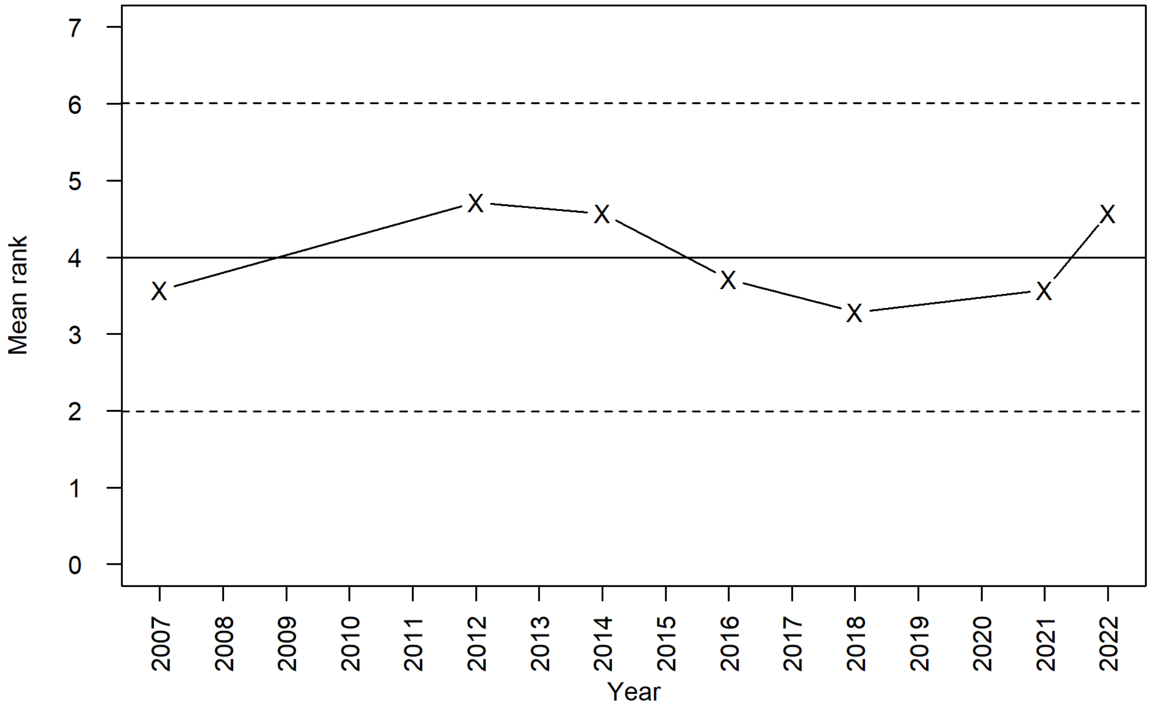


Figure 17: Mean ranks for the ECSI winter trawl surveys (core plus shallow strata) for the eight target species. The solid line indicates the overall mean rank. Mean ranks outside the broken lines (95% confidence intervals) have extreme catchability.

10. APPENDICES

Appendix 1: Gonad stage definitions. (Continued on next page)

Finfish (middle depths gonad stages)

Gonad stage		Males	Females
1	Immature	Testes small and translucent; threadlike or narrow membranes.	Ovaries small and translucent. No developing oocytes.
2	Resting	Testes thin and flabby; white or transparent.	Ovaries developed, but no developing eggs visible.
3	Ripening	Testes firm and well developed, but milt is present.	Ovaries contain visible developing eggs, but no hyaline eggs present.
4	Ripe	Testes large, well developed; milt is present and flows when testis is cut, but not when body is squeezed.	Some or all eggs hyaline, but eggs not extruded when body is squeezed.
5	Running ripe	Testis is large, well formed; milt flows easily under pressure on the body.	Eggs flow freely from the ovary when it is cut or the body is pressed.
6	Partially spent	Testis somewhat flabby and may be slightly bloodshot, but milt still flows freely under pressure on the body.	Ovary partially deflated, often bloodshot. Some hyaline and ovulated eggs present and flowing from a cut ovary or when the body is squeezed.
7	Spent	Testis is flabby and bloodshot. No milt in most of testes, but there may be some remaining near the lumen. Milt not easily expressed, even when present.	Ovary bloodshot; ovary wall may appear thick and white. Some residual ovulated eggs may still remain, but will not flow when body is squeezed.

Spiny dogfish stages

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 stages

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 2: Summary of station data for the 2022 survey. Gear perf, gear performance (1–5). NA, no data. (Continued on next 3 pages)

				Latitude / longitude start of tow		Latitude / longitude end of tow		Gear depth (m)		Distance trawled	Headline height	Door spread		Temperature (ºC)	
Station	Stratum	Date	Time	º ' S	º ' E	º ' S	º ' E	Min.	Max.	(n. miles)	(m)	(m)	Gear perf.	Surface	Bottom
1	7	3-May-22	1005	430502	1731089	430294	1731374	39	46	2.94	4.8	76.1	1	14.6	13.7
2	7	3-May-22	1248	430608	1731800	430897	1731759	52	55	2.9	4.6	75.1	1	14.7	13.7
3	13	4-May-22	716	432515	1733672	432362	1734018	108	116	2.94	4.4	76.5	1	13.9	13.5
4	13	4-May-22	932	432127	1734785	432419	1734709	121	132	2.97	4.5	77.3	1	15.7	11.5
5	12	4-May-22	1153	433218	1735399	433511	1735420	111	115	2.93	4.7	81.0	1	15.9	12.5
6	17	4-May-22	1417	434090	1740310	434386	1740296	345	352	2.96	4.4	83.0	1	14.3	8.1
7	7	5-May-22	715	430884	1731290	431055	1731393	47	50	1.86	4.3	75.7	1	15.0	13.6
8	18	16-May-22	1106	433261	1724947	432974	1724823	16	17	3.00	4.4	74.5	1	14.2	14.9
9	18	16-May-22	1318	432257	1725160	431975	1725271	24	27	2.93	4.5	73.8	1	14.3	14.6
10	7	16-May-22	1524	431660	1725514	431925	1725669	32	32	2.88	4.5	76.4	1	14.4	14.3
11	18	17-May-22	720	432162	1725979	432115	1730375	27	29	2.91	4.6	73.4	1	14.4	14.3
12	7	17-May-22	1009	431632	1732215	431336	1732205	70	73	2.96	4.3	70.5	1	14.1	13.7
13	13	17-May-22	1222	431495	1732959	431789	1733041	102	103	3.00	4.4	74.5	1	14.6	13.0
14	6	18-May-22	714	433358	1734608	433609	1734724	92	94	2.64	4.4	74.4	1	13.8	13.3
15	12	18-May-22	927	434555	1735187	434831	1735018	103	105	3.01	4.7	82.2	1	13.1	11.5
16	17	18-May-22	1201	435038	1740104	435289	1735901	345	358	2.90	4.1	87.6	1	12.0	8.4
17	12	18-May-22	1443	435165	1734980	435334	1734788	112	116	2.18	4.2	71.9	1	14.0	12.0
18	5	19-May-22	719	440020	1730620	440161	1730417	74	78	2.02	4.6	68.8	1	14.1	13.1
19	5	19-May-22	905	440593	1725576	440823	1725325	72	74	2.92	4.7	71.1	1	13.7	13.0
20	5	19-May-22	1116	441191	1724873	441348	1724648	77	78	2.25	4.6	75.8	1	13.8	13.2
21	5	19-May-22	1347	440738	1724359	441016	1724481	68	73	2.91	4.5	73.2	1	14.1	13.2
22	4B	19-May-22	1547	441277	1723842	441553	1723690	71	75	2.96	4.6	70.9	1	14.0	13.2
23	20	20-May-22	727	440974	1714061	441148	1713727	16	18	2.96	4.3	73.5	1	13.6	14.7
24	20	20-May-22	1040	441302	1713253	441421	1713010	15	15	2.10	4.7	69.3	2	13.7	14.7
25	20	23-May-22	1008	441977	1712743	441767	1713026	22	23	2.91	4.6	73.0	1	13.2	13.3
26	3A	23-May-22	1246	442882	1713211	442674	1713488	46	46	2.86	4.2	75.5	1	13.4	13.3
27	3A	23-May-22	1515	441921	1714442	441790	1714796	43	45	2.85	4.4	73.2	1	13.7	13.5
28	3B	24-May-22	719	442692	1715107	442510	1715439	61	64	2.98	4.6	74.1	1	13.1	13.2
29	3B	24-May-22	903	442718	1715608	442525	1715923	69	69	2.96	4.7	72.0	1	13.1	13.1

Station	Stratum	Date	Time	Latitude / longitude start of tow ° ' S	° ' E	Latitude / longitude end of tow ° ' S	° ' E	Gear depth (m) Min.	Max.	Distance trawled (n. miles)	Headline height (m)	Door spread (m)	Gear perf.	Temperature (°C) Surface	Bottom
30	4B	24-May-22	1057	442540	1720669	442339	1720983	70	72	3.01	4.6	75.6	1	13.1	13.0
31	4B	24-May-22	1300	442142	1721064	442008	1721426	66	67	2.91	4.5	72.1	1	13.4	13.2
32	4B	24-May-22	1455	441737	1721104	441543	1721396	58	61	2.85	4.5	73.0	1	13.5	13.4
33	4A	25-May-22	718	441530	1720406	441383	1720765	50	51	2.96	4.5	74.2	1	13.3	13.3
34	4A	25-May-22	900	441206	1721185	441070	1721547	51	52	2.93	4.6	72.6	1	13.6	13.6
35	4B	25-May-22	1116	440751	1722813	440583	1723166	55	56	3.04	4.6	73.8	1	13.6	13.6
36	6	27-May-22	713	432980	1732154	433263	1732288	72	76	2.99	4.6	72.0	1	13.0	13.1
37	6	27-May-22	957	434663	1731962	434934	1731830	72	73	2.87	4.6	70.4	1	13.3	12.9
38	5	27-May-22	1223	435833	1731209	440089	1731015	75	76	2.91	4.5	72.0	1	13.2	13.0
39	5	27-May-22	1432	440381	1730800	440634	1730591	77	83	2.94	4.6	75.2	1	13.4	12.7
40	17	28-May-22	721	435884	1735183	440079	1734873	340	344	2.96	4.4	94.2	1	12.4	10.7
41	16	28-May-22	950	440404	1734614	440602	1734332	392	396	2.83	4.3	90.2	1	12.0	9.0
42	11	28-May-22	1302	440895	1732683	441083	1732382	134	136	2.86	4.4	80.1	1	12.8	11.3
43	11	28-May-22	1506	440866	1731634	441050	1731304	105	108	2.99	4.5	81.6	1	12.9	11.6
44	16	29-May-22	724	442047	1731416	442220	1731090	270	273	2.90	4.4	85.7	1	12.4	10.8
45	16	29-May-22	948	442555	1730815	442672	1730547	344	348	2.24	4.3	85.5	1	9.8	8.8
46	11	29-May-22	1316	441629	1730382	441809	1730056	118	120	2.94	4.6	73.9	1	12.3	11.5
47	10	29-May-22	1550	442726	1725001	442864	1724624	140	145	3.02	4.4	78.4	1	10.7	11.5
48	19	31-May-22	833	435368	1723672	435526	1723319	19	20	2.99	4.6	73.9	1	12.5	13.2
49	19	31-May-22	1036	435344	1722568	435489	1722211	16	18	2.95	4.8	71.6	2	12.9	13.1
50	19	31-May-22	1325	435653	1721831	435817	1721494	22	27	2.92	4.5	74.5	1	12.8	13.4
51	4A	31-May-22	1545	440605	1721109	440760	1720752	38	40	2.99	4.5	74.7	1	13.3	13.2
52	1	2-Jun-22	727	451460	1711895	451654	1711807	84	85	2.03	4.4	75.2	1	12.4	12.4
53	1	2-Jun-22	1035	451566	1711354	451834	1711179	55	56	2.94	4.4	71.8	1	12.4	12.4
54	1	2-Jun-22	1245	452060	1710895	452343	1710818	50	53	2.88	4.2	73.5	1	12.4	12.6
55	1	2-Jun-22	1507	452086	1710441	452372	1710315	42	44	2.99	4.2	75.6	1	12.5	12.6
56	1	4-Jun-22	722	453020	1710749	452886	1710857	77	78	1.53	4.7	75.9	2	12.6	12.6
57	14	4-Jun-22	936	452202	1712552	451985	1712860	234	251	3.06	4.3	93.0	1	11.7	11.4
58	14	4-Jun-22	1242	451706	1713139	451446	1713344	237	253	2.97	4.5	94.8	1	11.7	10.9

				Latitude / longitude start of tow		Latitude / longitude end of tow		Gear depth (m)		Distance trawled	Headline height	Door spread		Temperature (°C)	
Station	Stratum	Date	Time	° ' S	° ' E	° ' S	° ' E	Min.	Max.	(n. miles)	(m)	(m)	Gear perf.	Surface	Bottom
59	14	4-Jun-22	1515	451119	1713979	450950	1714208	343	349	2.33	4.5	99.0	1	11.6	10.3
60	3B	5-Jun-22	727	443976	1713972	444250	1713814	70	71	2.96	4.6	73.7	1	12.4	12.7
61	3A	5-Jun-22	1048	444216	1713034	444440	1712988	49	50	2.26	4.7	76.1	1	12.0	12.4
62	2	5-Jun-22	1359	444800	1713279	445009	1713108	56	57	2.41	4.6	75.9	1	12.2	12.2
63	4B	6-Jun-22	725	440863	1723827	441004	1723578	64	67	2.27	4.5	69.9	1	12.8	12.5
64	4B	6-Jun-22	918	441248	1723417	441429	1723082	64	72	3.00	4.7	70.2	1	NA	NA
65	4B	6-Jun-22	1117	441614	1723038	441827	1722743	69	70	2.99	4.9	71.2	1	12.7	12.3
66	4B	6-Jun-22	1304	441862	1723303	442047	1723637	72	88	3.02	4.6	74.4	1	12.5	12.3
67	10	6-Jun-22	1501	442282	1724099	442423	1723728	107	107	3.00	4.6	83.4	1	12.3	12.3
68	2	8-Jun-22	729	450700	1712231	450893	1712088	74	75	2.17	4.4	72.6	1	11.6	12.3
69	8	8-Jun-22	907	451246	1712443	451531	1712321	105	107	2.97	4.4	77.2	1	12.4	12.0
70	8	8-Jun-22	1109	451773	1712315	452029	1712129	111	112	2.87	4.1	82.4	1	12.4	11.8
71	8	8-Jun-22	1305	451897	1712567	451710	1712860	119	122	2.78	4.6	82.6	1	12.2	11.4
72	8	8-Jun-22	1550	450798	1713130	450666	1713266	112	117	1.63	4.6	82.2	1	12.4	12.1
73	15	9-Jun-22	731	444451	1722319	444609	1722040	340	348	2.53	4.3	90.8	1	12	10.2
74	15	9-Jun-22	948	444789	1721535	444951	1721241	278	306	2.64	4.7	88.2	1	11.6	10.5
75	9	9-Jun-22	1244	445249	1715906	445398	1715631	127	130	2.45	4.2	78.8	1	12.1	11.5
76	9	9-Jun-22	1453	444835	1715135	445051	1714835	108	109	3.03	4.3	77.4	1	12.0	12.0
77	21	10-Jun-22	735	444156	1711803	444455	1711833	27	30	2.99	4.5	73.9	1	11.9	12.1
78	21	10-Jun-22	952	444606	1711668	444907	1711724	22	23	3.03	4.4	75.4	1	NA	NA
79	21	10-Jun-22	1249	445053	1711484	445307	1711438	15	15	2.56	4.6	74.2	1	11.8	11.9
80	8	15-Jun-22	741	450462	1713071	450318	1713290	101	102	2.11	4.6	81.9	1	12.1	12.1
81	2	15-Jun-22	1333	445570	1713196	445304	1713360	73	73	2.90	4.8	77.0	1	12.0	12.1
82	3B	16-Jun-22	735	443546	1714948	443835	1715083	77	87	3.04	4.7	78.5	1	11.6	11.9
83	3B	16-Jun-22	918	444111	1715218	443921	1715554	94	95	3.05	4.6	82.5	1	11.8	12.0
84	10	16-Jun-22	1125	443707	1720504	443520	1720822	101	102	2.93	4.6	85.1	1	12.0	12.0
85	10	16-Jun-22	1350	443908	1721484	443817	1721794	129	132	2.38	4.7	90.7	1	11.9	11.6
86	4B	16-Jun-22	1601	443009	1721788	442820	1721998	96	99	2.41	4.4	82.6	1	11.9	12.0
87	15	17-Jun-22	737	444260	1722643	444151	1722907	327	330	2.17	4.5	100.6	1	9.4	10.6

				Latitude / longitude start of tow		Latitude / longitude end of tow		Gear depth (m)		Distance trawled	Headline height	Door spread		Temperature (°C)	
Station	Stratum	Date	Time	° ' S	° ' E	° ' S	° ' E	Min.	Max.	(n. miles)	(m)	(m)	Gear perf.	Surface	Bottom
88	10	17-Jun-22	1055	442480	1724266	442317	1724610	114	115	2.94	4.4	83.4	1	11.8	11.9
89	8	18-Jun-22	733	450206	1713895	450341	1713767	120	121	1.62	4.4	79.7	1	11.9	11.7
90	8	18-Jun-22	927	450534	1713950	450287	1714180	123	129	2.95	4.3	80.5	1	11.7	11.7
91	9	18-Jun-22	1146	445805	1714791	445551	1715014	122	126	2.99	4.5	79.8	1	11.6	11.4
92	3B	18-Jun-22	1414	444636	1714561	444440	1714879	94	96	2.99	4.4	79.8	1	11.9	12.0
93	10	19-Jun-22	734	444249	1721622	444057	1721940	136	139	2.96	4.3	87.4	1	11.3	11.1
94	10	19-Jun-22	1020	443950	1720949	443785	1721298	117	119	2.98	4.3	82.5	1	11.9	11.0
95	10	19-Jun-22	1300	443687	1721853	443508	1722193	121	126	3.01	4.4	89.3	1	11.7	11.0
96	7	21-Jun-22	734	432198	1731532	431910	1731656	48	53	3.01	4.7	76.6	1	NA	NA
97	7	21-Jun-22	1010	431831	1730417	431818	1730014	31	33	2.93	4.6	73.7	1	NA	NA
98	7	21-Jun-22	1303	431504	1725500	431272	1725751	32	35	2.95	4.6	76.9	1	11.4	11.6
99	7	21-Jun-22	1520	431039	1730861	430783	1731068	45	53	2.97	4.5	78.0	1	11.5	11.8

Appendix 3: Gear parameters for stations with satisfactory gear performance by depth range for the 2022 survey. *N*, number of stations; s.d., standard deviation.

		N	Mean	s.d.	Range
Core plus shallow strata					
10–400 m	headline height (m)	99	4.5	0.16	4.1–4.9
10–400 m	doorspread (m)	99	78.0	6.70	68.8–100.6
10–400 m	distance (n. miles)	99	2.8	0.36	1.5–3.1
10–400 m	warp:depth ratio	99	4.0	2.61	2.4–13.3
Core strata					
30–400 m	headline height (m)	87	4.5	0.17	4.1–4.9
30–400 m	doorspread (m)	87	78.7	6.89	68.8–100.6
30–400 m	distance (n. miles)	87	2.8	0.37	1.5–3.1
30–400 m	warp:depth ratio	87	3.2	0.83	2.4–6.5
30–100 m					
30–100 m	headline height (m)	48	4.5	0.15	4.2–4.9
30–100 m	doorspread (m)	48	74.4	2.95	68.8–82.6
30–100 m	distance (n. miles)	48	2.8	0.36	1.5–3.0
30–100 m	warp:depth ratio	48	3.6	0.94	2.7–6.5
100–200 m					
100–200 m	headline height (m)	27	4.4	0.16	4.1–4.7
100–200 m	doorspread (m)	27	80.8	4.36	71.9–90.7
100–200 m	distance (n. miles)	27	2.8	0.41	1.6–3.0
100–200 m	warp:depth ratio	27	2.8	0.06	2.7–2.9
200–400 m					
200–400 m	headline height (m)	12	4.4	0.15	4.1–4.7
200–400 m	doorspread (m)	12	91	5.45	83–100.6
200–400 m	distance (n. miles)	12	2.7	0.32	2.2–3.1
200–400 m	warp:depth ratio	12	2.5	0.06	2.4–2.6
Shallow strata					
10–30 m	headline height (m)	12	4.5	0.14	4.3–4.8
10–30 m	doorspread (m)	12	73.4	1.59	69.3–75.4
10–30 m	distance (n. miles)	12	2.9	0.27	2.1–3.0
10–30 m	warp:depth ratio	12	10.4	2.35	7.1–13.3

Appendix 4: Species codes, common names, scientific names, total catch (kg), percent of total catch, percent occurrence (% occ.), depth range, and number stations caught for core strata (30–400 m) (A) and shallow strata (10–30 m) (B) in 2022. Tables are in order of catch weight. Values of zero for % catch and % occurrence are less than 0.1. All invertebrate species preserved and later identified on land are included. (Continued on next 8 pages)

(A) 30–400 m

Species code	Common name	Scientific name	Catch (kg)	% catch	% occ.	Min.	Max.	Stations
SPD	Spiny dogfish	*Squalus acanthias*	35 519.9	26.7	97.7	31	392	85
GSH	Dark ghost shark	*Hydrolagus novaezealandiae*	24 916.7	18.7	46.0	66	392	40
BAR	Barracouta	*Thyrsites atun*	20 982.8	15.8	87.4	31	253	76
CBI	Two saddle rattail	*Coelorinchus biclinozonalis*	11 069.7	8.3	37.9	32	351	33
CBE	Crested bellowsfish	*Notopogon lilliei*	9 444.3	7.1	21.8	55	137	19
GUR	Red gurnard	*Chelidonichthys kumu*	5 056.6	3.8	72.4	31	137	63
HPC	Sea perch	*Helicolenus percoides*	4 709.7	3.5	63.2	32	251	55
RCO	Red cod	*Pseudophycis bachus*	2 433.9	1.8	72.4	31	392	63
GIZ	Giant stargazer	*Kathetostoma giganteum*	1 536.1	1.2	87.4	39	392	76
NMP	Tarakihi	*Nemadactylus macropterus*	1 417.6	1.1	64.4	42	145	56
SCG	Scaly gurnard	*Lepidotrigla brachyoptera*	1 382.8	1.0	78.2	39	145	68
CAR	Carpet shark	*Cephaloscyllium isabellum*	1 333.5	1.0	82.8	31	347	72
SWA	Silver warehou	*Seriolella punctata*	1 208.4	0.9	71.3	31	347	62
RSK	Rough skate	*Zearaja nasuta*	1 193.2	0.9	46.0	31	351	40
WIT	Witch	*Arnoglossus scapha*	1 163.9	0.9	96.6	32	392	84
ELE	Elephant fish	*Callorhinchus milii*	1 060.0	0.8	43.7	31	118	38
SSK	Smooth skate	*Dipturus innominatus*	1 005.5	0.8	44.8	32	351	39
HOK	Hoki	*Macruronus novaezelandiae*	820.8	0.6	11.5	72	392	10
SDO	Silver dory	*Cyttus novaezealandiae*	757.4	0.6	43.7	55	253	38
NOS	NZ southern arrow squid	*Nototodarus sloanii*	682.4	0.5	43.7	32	392	38
SPO	Rig	*Mustelus lenticulatus*	599.1	0.5	48.3	31	120	42
SCH	School shark	*Galeorhinus galeus*	472.3	0.4	67.8	32	347	59
LIN	Ling	*Genypterus blacodes*	420.7	0.3	44.8	32	392	39
LEA	Leatherjacket	*Meuschenia scaber*	366.8	0.3	21.8	31	69	19
PIG	Pigfish	*Congiopodus leucopaecilus*	353.7	0.3	55.2	42	145	48
SQU	Arrow squid	*Nototodarus sloanii & N. gouldi*	353.3	0.3	44.8	31	347	39

Species code	Common name	Scientific name	Catch (kg)	% catch	% occ.	Min.	Max.	Stations
SRB	Southern Ray's bream	*Brama australis*	239.1	0.2	35.6	55	351	31
WAR	Common warehou	*Seriolella brama*	186.1	0.1	28.7	31	102	25
FHD	Deepsea flathead	*Hoplichthys haswelli*	180.3	0.1	8.0	340	392	7
JMD	Greenback jack mackerel	*Trachurus declivis*	129.2	0.1	34.5	31	145	30
CBO	Bollons' rattail	*Coelorinchus bollonsi*	117.8	0.1	3.4	340	392	3
OCP	Octopod	NA	117.4	0.1	20.7	32	392	18
RSO	Gemfish	*Rexea solandri*	116.0	0.1	19.5	103	392	17
HMT	Deepsea anemone	Hormathiidae	115.9	0.1	42.5	55	392	37
JAV	Javelin fish	*Lepidorhynchus denticulatus*	100.0	0.1	5.7	340	392	5
HAP	Hapuku	*Polyprion oxygeneios*	99.9	0.1	21.8	69	273	19
CVR	Southern conger	*Conger verreauxi*	97.5	0.1	2.3	32	45	2
BCO	Blue cod	*Parapercis colias*	80.5	0.1	19.5	61	134	17
SSI	Silverside	*Argentina elongata*	78.9	0.1	43.7	69	392	38
LDO	Lookdown dory	*Cyttus traversi*	78.4	0.1	8.0	340	392	7
CAS	Oblique banded rattail	*Coelorinchus aspercephalus*	76.0	0.1	13.8	74	392	12
LSO	Lemon sole	*Pelotretis flavilatus*	72.5	0.1	43.7	32	340	38
MOK	Moki	*Latridopsis ciliaris*	72.4	0.1	9.2	46	137	8
HBA	Bigeye sea perch	*Helicolenus barathri*	71.1	0.1	5.7	340	392	5
JFI	Jellyfish	NA	44.4	0.0	18.4	31	392	16
BBE	Banded bellowsfish	*Centriscops humerosus*	40.3	0.0	16.1	69	351	14
SFL	Sand flounder	*Rhombosolea plebeia*	34.9	0.0	3.4	32	45	3
BRA	Short-tailed black ray	*Dasyatis brevicaudata*	34.3	0.0	2.3	46	50	2
CON	Conger eel	*Conger* spp.	29.8	0.0	2.3	31	75	2
ERA	Electric ray	*Torpedo fairchildi*	28.5	0.0	4.6	32	115	4
PHA	Brown seaweed	Phaeophyta	26.8	0.0	25.3	46	392	22
KIN	Kingfish	*Seriola lalandi*	26.6	0.0	3.4	46	72	3
RHY	Common roughy	*Paratrachichthys trailli*	25.1	0.0	6.9	61	129	6
SCC	Sea cucumber	*Stichopus mollis*	24.4	0.0	18.4	48	251	16
OCT	Octopus	*Pinnoctopus cordiformis*	22.5	0.0	9.2	32	251	8
EMA	Blue mackerel	*Scomber australasicus*	22.4	0.0	4.6	39	83	4
JMN	Yellowtail jack mackerel	*Trachurus novaezelandiae*	19.0	0.0	13.8	39	83	12

Species code	Common name	Scientific name	Catch (kg)	% catch	% occ.	Min.	Max.	Stations
HTH	Sea cucumber	Holothurian unidentified	14.7	0.0	25.3	46	345	22
ACS	Smooth deepsea anemones	Actinostolidae	13.3	0.0	25.3	72	345	22
SEO	Seaweed	NA	12.9	0.0	10.3	73	347	9
CRB	Crab	NA	12.5	0.0	2.3	107	340	2
CRM	Airy finger sponge	*Callyspongia* cf. *ramosa*	12.1	0.0	12.6	42	273	11
EZE	Yellow octopus	*Enteroctopus zealandicus*	10.9	0.0	1.1	126	126	1
ASC	Sea squirt	Ascidiacea	10.7	0.0	6.9	46	392	6
GSC	Giant spider crab	*Jacquinotia edwardsii*	10.1	0.0	8.0	115	351	7
WOD	Wood	Wood	9.7	0.0	12.6	31	346	11
MIQ	Warty squid	*Moroteuthopsis ingens*	9.6	0.0	3.4	103	347	3
ESO	New Zealand sole	*Peltorhamphus novaezeelandiae*	8.3	0.0	11.5	31	72	10
DMG	*Dipsacaster magnificus*	*Dipsacaster magnificus*	7.8	0.0	6.9	92	392	6
SMO	Cross-fish	*Sclerasterias mollis*	7.1	0.0	31.0	45	351	27
ZFO	Rubbish fishing other	NA	7.0	0.0	1.1	69	69	1
ATT	Kahawai	*Arripis trutta*	6.7	0.0	3.4	32	51	3
NUD	Nudibranchs	*Nudibranchia*	6.5	0.0	6.9	61	351	6
ROK	Rocks stones	*Geological specimens*	6.3	0.0	2.3	84	126	2
JDO	John dory	*Zeus faber*	6.1	0.0	3.4	74	76	3
CUP	Stony cup corals	Flabellidae, Fungiacyathidae	5.7	0.0	2.3	273	346	2
ZVA	*Thetys vagina*	*Thetys vagina*	5.5	0.0	5.7	72	273	5
CDO	Capro dory	*Capromimus abbreviatus*	5.3	0.0	16.1	72	392	14
ZFT	Rubbish fishing textiles	NA	5.2	0.0	4.6	69	392	4
FMA	*Fusitriton magellanicus*	*Fusitriton magellanicus*	5.2	0.0	24.1	46	392	21
RHO	Red seaweed	Rhodophyta	4.9	0.0	5.7	43	134	5
TOD	Dark toadfish	*Neophrynichthys latus*	4.6	0.0	20.7	43	115	18
SAL	Salps	NA	4.2	0.0	5.7	103	345	5
DIR	Pagurid	*Diacanthurus rubricatus*	4.2	0.0	31.0	46	392	27
SPM	Sprat	*Sprattus muelleri*	4.1	0.0	4.6	31	72	4
JMM	Slender jack mackerel	*Trachurus murphyi*	3.9	0.0	1.1	116	116	1
YCO	Yellow cod	*Parapercis gilliesi*	3.8	0.0	4.6	116	132	4
FRO	Frostfish	*Lepidopus caudatus*	3.4	0.0	3.4	50	340	3

Species code	Common name	Scientific name	Catch (kg)	% catch	% occ.	Min.	Max.	Stations
ALL	*Alcithoe larochei*	*Alcithoe larochei*	3.3	0.0	11.5	39	126	10
BTA	Smooth deepsea skate	*Brochiraja asperula*	3.2	0.0	3.4	345	392	3
OMA	Red snakestar	*Ophiopsammus maculata*	3.1	0.0	4.6	50	78	4
CRS	Airy finger sponge	*Callyspongia ramosa*	2.9	0.0	6.9	50	351	6
PYR	*Pyrosoma atlanticum*	*Pyrosoma atlanticum*	2.8	0.0	2.3	115	351	2
GMC	Garrick’s masking crab	*Leptomithrax garricki*	2.8	0.0	9.2	69	328	8
SMX	Mixed shell	NA	1.8	0.0	10.3	32	392	9
POP	Porcupine fish	*Allomycterus jaculiferus*	1.6	0.0	2.3	43	46	2
OPA	Opalfish	*Hemerocoetes* spp.	1.6	0.0	13.8	32	117	12
NCA	Hairy red swimming crab	*Nectocarcinus antarcticus*	1.5	0.0	9.2	43	117	8
HAK	Hake	*Merluccius australis*	1.5	0.0	3.4	31	32	3
CRA	Rock lobster	*Jasus edwardsii*	1.5	0.0	1.1	75	75	1
ASR	Asteroid (starfish)	NA	1.5	0.0	2.3	78	346	2
ASH	Circular saw shell	*Astraea heliotropium*	1.5	0.0	3.4	55	107	3
PCH	*Penion chathamensis*	*Penion chathamensis*	1.4	0.0	5.7	107	347	5
KWH	Knobbed whelk	*Austrofucus glans*	1.3	0.0	11.5	50	145	10
EGC	Egg case	NA	1.3	0.0	10.3	61	347	9
PNE	*Proserpinaster neozelanicus*	*Proserpinaster neozelanicus*	1.2	0.0	1.1	345	345	1
COZ	Bryozoan	Bryozoa	1.2	0.0	1.1	45	45	1
SDR	Spiny seadragon	*Solegnathus spinosissimus*	1.1	0.0	5.7	61	84	5
SCI	Scampi	*Metanephrops challengeri*	1.1	0.0	5.7	328	351	5
PCO	Ahuru	*Auchenoceros punctatus*	1.1	0.0	9.2	31	116	8
MSL	Starfish	*Mediaster sladeni*	1.1	0.0	8.0	50	351	7
CTU	Cooks turban shell	*Cookia sulcata*	1.1	0.0	8.0	46	107	7
TUL	Sea tulip	*Pyura pachydermatina*	1.0	0.0	4.6	43	102	4
TOP	Pale toadfish	*Ambophthalmos angustus*	1.0	0.0	1.1	351	351	1
HOR	Horse mussel	*Atrina zelandica*	1.0	0.0	1.1	78	78	1
DAP	Antlered crab	*Dagnaudus petterdi*	1.0	0.0	2.3	345	351	2
RUB	Rubbish other than fish	NA	0.8	0.0	1.1	137	137	1
PRU	*Pseudechinaster rubens*	*Pseudechinaster rubens*	0.8	0.0	1.1	351	351	1
POL	Polychaete	Polychaeta	0.8	0.0	8.0	50	392	7

Species code	Common name	Scientific name	Catch (kg)	% catch	% occ.	Min.	Max.	Stations
GAS	Gastropods	Gastropoda	0.8	0.0	4.6	78	119	4
SPF	Scarlet wrasse	*Pseudolabrus miles*	0.7	0.0	1.1	119	119	1
DPP	*Diplopteraster* spp.	*Diplopteraster* spp.	0.7	0.0	3.4	132	351	3
ANT	Anemones	Anthozoa	0.7	0.0	3.4	61	340	3
GVE	Ostrich egg sponge	*Geodia vestigifera*	0.6	0.0	1.1	84	84	1
ZFP	Rubbish fishing plastics	NA	0.5	0.0	5.7	46	145	5
SPS	Speckled sole	*Peltorhamphus latus*	0.5	0.0	3.4	31	32	3
SDM	Pagurid	*Sympagurus dimorphus*	0.5	0.0	2.3	116	351	2
RBT	Redbait	*Emmelichthys nitidus*	0.5	0.0	5.7	125	145	5
PSI	Geometric star	*Psilaster acuminatus*	0.5	0.0	4.6	125	251	4
ONG	Sponges	Porifera	0.5	0.0	2.3	72	107	2
PRE	Cushion starfish	*Patiriella regularis*	0.4	0.0	2.3	39	78	2
FOE	Orange dragonet	*Foetorepus* spp.	0.4	0.0	1.1	117	117	1
DSP	Deepsea pigfish	*Congiopodus coriaceus*	0.4	0.0	2.3	118	126	2
DGT	Dragonets	Callionymidae	0.4	0.0	3.4	116	346	3
BHE	*Bathypectinura heros*	*Bathypectinura heros*	0.4	0.0	1.1	392	392	1
APD	Seamice	Aphroditidae	0.4	0.0	4.6	32	95	4
OYS	Oysters dredge	*Ostrea chilensis*	0.3	0.0	2.3	32	70	2
ODT	Pentagonal tooth-star	*Odontaster* spp.	0.3	0.0	3.4	46	115	3
MNI	Munida unidentified	*Munida* spp.	0.3	0.0	3.4	74	107	3
DCS	Dawson’s catshark	*Bythaelurus dawsoni*	0.3	0.0	2.3	351	392	2
SUR	Kina	*Evechinus chloroticus*	0.3	0.0	1.1	55	55	1
SLT	Orange fat finger sponge	*Stelletta* spp.	0.3	0.0	1.1	74	74	1
IRC	Grey sponge	*Ircinia* spp.	0.3	0.0	1.1	103	103	1
COF	Flabellum coral	*Flabellum* spp.	0.3	0.0	1.1	347	347	1
CIC	Orange frond sponge	*Crella incrustans*	0.3	0.0	1.1	72	72	1
ZOT	Rubbish other use textiles	NA	0.2	0.0	1.1	345	345	1
SPT	Heart urchin	*Spatangus multispinus*	0.2	0.0	1.1	351	351	1
SPA	Slender sprat	*Sprattus antipodum*	0.2	0.0	2.3	46	72	2
SHO	Seahorse	*Hippocampus abdominalis*	0.2	0.0	2.3	43	46	2
BPE	Butterfly perch	*Caesioperca lepidoptera*	0.2	0.0	1.1	50	50	1

Species code	Common name	Scientific name	Catch (kg)	% catch	% occ.	Min.	Max.	Stations
ATA	Arabic volute	*Alcithoe arabica*	0.2	0.0	2.3	61	83	2
WHE	Whelks	NA	0.1	0.0	1.1	61	61	1
SSQ	Bobtail squid	*Sepioloidea* spp.	0.1	0.0	1.1	346	346	1
SBP	Bogue lanternfish	*Symbolophorus boops*	0.1	0.0	1.1	392	392	1
ROC	Rock cod	*Lotella rhacinus*	0.1	0.0	1.1	107	107	1
QSC	Queen scallop	*Zygochlamys delicatula*	0.1	0.0	1.1	92	92	1
NCV	Blueband hagfish	*Neomyxine caesiovitta*	0.1	0.0	1.1	32	32	1
MSG	Green-lipped mussel	*Perna canaliculus*	0.1	0.0	1.1	46	46	1
LNO	Longsnout pipefish	*Leptonotus norae*	0.1	0.0	1.1	55	55	1
LEH	Leech - generic	Hirudinea	0.1	0.0	1.1	129	129	1
HTU	Quill worm	*Hyalinoecia tubicola*	0.1	0.0	1.1	345	345	1
HDR	Hydroid	Hydrozoa	0.1	0.0	1.1	103	103	1
GVO	Golden volute	*Provocator mirabilis*	0.1	0.0	1.1	345	345	1
GPA	Sea urchin	*Goniocidaris parasol*	0.1	0.0	1.1	392	392	1
DCO	Dwarf cod	*Notophycis marginata*	0.1	0.0	1.1	347	347	1
CTN	*Calliostoma turnerarum*	*Calliostoma turnerarum*	0.1	0.0	1.1	50	50	1
CSS	Maurea	*Calliostoma selectum*	0.1	0.0	1.1	48	48	1
BPD	Lamp shells	Brachiopoda	0.1	0.0	1.1	43	43	1
ANC	Anchovy	*Engraulis australis*	0.1	0.0	1.1	50	50	1
Total			132 964.9					

(B) 10–30 m

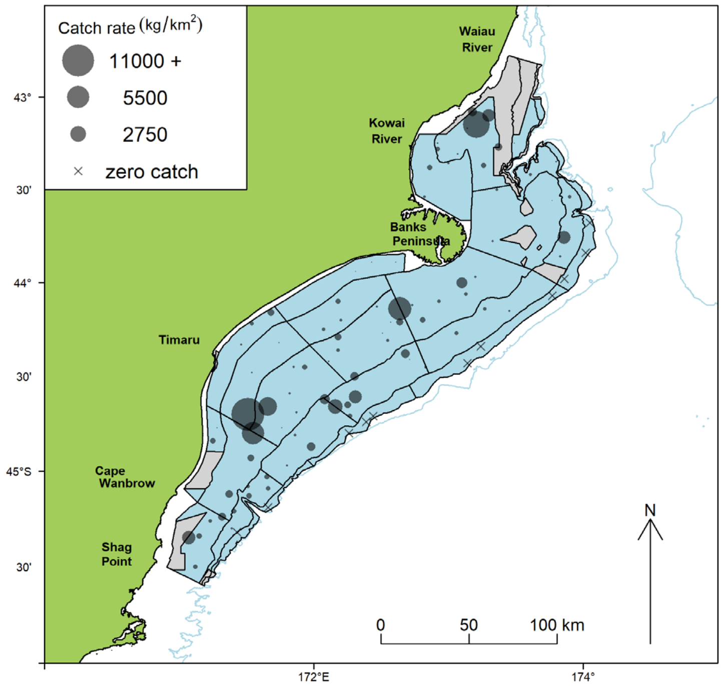
Species code	Common name	Scientific name	Catch (kg)	% catch	% occ.	Min.	Max.	Stations
SPD	Spiny dogfish	*Squalus acanthias*	4 489.2	34.6	100	15	28	12
GUR	Red gurnard	*Chelidonichthys kumu*	2 891.2	22.3	100	15	28	12
RCO	Red cod	*Pseudophycis bachus*	1 699.9	13.1	100	15	28	12
LEA	Leatherjacket	*Meuschenia scaber*	1 510.5	11.6	91.7	15	28	11
BAR	Barracouta	*Thyrsites atun*	582.4	4.5	100	15	28	12
ELE	Elephant fish	*Callorhinchus milii*	275.3	2.1	91.7	15	28	11
RSK	Rough skate	*Zearaja nasuta*	266.3	2.1	91.7	15	28	11
SPO	Rig	*Mustelus lenticulatus*	260.1	2.0	83.3	15	28	10
STY	Spotty	*Notolabrus celidotus*	125.0	1.0	41.7	15	23	5
WAR	Common warehou	*Seriolella brama*	116.4	0.9	91.7	15	28	11
ATT	Kahawai	*Arripis trutta*	96.1	0.7	58.3	15	24	7
CAR	Carpet shark	*Cephaloscyllium isabellum*	69.7	0.5	83.3	15	28	10
TUL	Sea tulip	*Pyura pachydermatina*	64.4	0.5	25.0	15	22	3
ERA	Electric ray	*Torpedo fairchildi*	53.9	0.4	25.0	15	27	3
RHO	Red seaweed	Rhodophyta	50.0	0.4	8.3	15	15	1
POP	Porcupine fish	*Allomycterus jaculiferus*	43.5	0.3	41.7	15	24	5
EGA	*Euciroa galatheae*	*Euciroa galatheae*	35.9	0.3	8.3	16	16	1
BRA	Short-tailed black ray	*Dasyatis brevicaudata*	35.0	0.3	8.3	15	15	1
WOD	Wood	Wood	30.2	0.2	50.0	15	24	6
SFL	Sand flounder	*Rhombosolea plebeia*	24.1	0.2	50.0	15	24	6
SSK	Smooth skate	*Dipturus innominatus*	22.5	0.2	8.3	27	27	1
ESO	New Zealand sole	*Peltorhamphus novaezeelandiae*	21.9	0.2	66.7	15	28	8
ROK	Rocks stones	*Geological specimens*	20.8	0.2	16.7	15	22	2
CON	Conger eel	*Conger* spp.	20.0	0.2	16.7	19	28	2
SCH	School shark	*Galeorhinus galeus*	14.9	0.1	75.0	15	24	9
CRA	Rock lobster	*Jasus edwardsii*	11.8	0.1	8.3	15	15	1
ROC	Rock cod	*Lotella rhacinus*	11.6	0.1	16.7	15	16	2
JFI	Jellyfish	NA	10.4	0.1	41.7	15	28	5

Species code	Common name	Scientific name	Catch (kg)	% catch	% occ.	Min.	Max.	Stations
CVR	Southern conger	*Conger verreauxi*	10.1	0.1	8.3	19	19	1
SPM	Sprat	*Sprattus muelleri*	8.8	0.1	91.7	15	27	11
RTR	Rainbow trout	*Oncorhynchus mykiss*	8.3	0.1	16.7	15	16	2
JMN	Yellowtail jack mackerel	*Trachurus novaezelandiae*	8.2	0.1	16.7	15	16	2
WIT	Witch	*Arnoglossus scapha*	6.5	0.1	50.0	15	28	6
YBF	Yellowbelly flounder	*Rhombosolea leporina*	6.0	0.0	25.0	16	16	3
PCO	Ahuru	*Auchenoceros punctatus*	6.0	0.0	50.0	15	22	6
LSO	Lemon sole	*Pelotretis flavilatus*	5.8	0.0	25.0	24	28	3
LIN	Ling	*Genypterus blacodes*	4.7	0.0	33.3	15	23	4
BRI	Brill	*Colistium guntheri*	4.2	0.0	16.7	16	19	2
SQU	Arrow squid	*Nototodarus sloanii* & *N. gouldi*	4.1	0.0	25.0	19	27	3
BCO	Blue cod	*Parapercis colias*	3.7	0.0	25.0	15	23	3
NMP	Tarakihi	*Nemadactylus macropterus*	3.6	0.0	33.3	15	23	4
PHA	Brown seaweed	Phaeophyta	3.4	0.0	25.0	15	16	3
OCT	Octopus	*Pinnoctopus cordiformis*	3.1	0.0	8.3	27	27	1
OCP	Octopod	NA	3.0	0.0	16.7	16	16	2
SPA	Slender sprat	*Sprattus antipodum*	2.6	0.0	41.7	16	24	5
SLS	Slender sole	*Peltorhamphus tenuis*	2.4	0.0	25.0	16	22	3
SWA	Silver warehou	*Seriolella punctata*	2.0	0.0	41.7	15	28	5
SAM	Quinnat salmon	*Oncorhynchus tshawytscha*	1.7	0.0	8.3	15	15	1
ZHP	Rubbish household plastics	NA	1.6	0.0	8.3	16	16	1
GLB	Globefish	*Contusus richei*	1.6	0.0	16.7	16	22	2
PIG	Pigfish	*Congiopodus leucopaecilus*	1.5	0.0	33.3	15	27	4
BPE	Butterfly perch	*Caesioperca lepidoptera*	1.5	0.0	33.3	16	23	4
SUR	Kina	*Evechinus chloroticus*	1.4	0.0	8.3	23	23	1
SMX	Mixed shell	NA	1.3	0.0	16.7	16	28	2
SHO	Seahorse	*Hippocampus abdominalis*	1.1	0.0	25.0	15	22	3
NOS	NZ southern arrow squid	*Nototodarus sloanii*	0.9	0.0	16.7	22	24	2
CBI	Two saddle rattail	*Coelorinchus biclinozonalis*	0.9	0.0	25.0	16	24	3
SPZ	Spotted stargazer	*Genyagnus monopterygius*	0.8	0.0	8.3	16	16	1

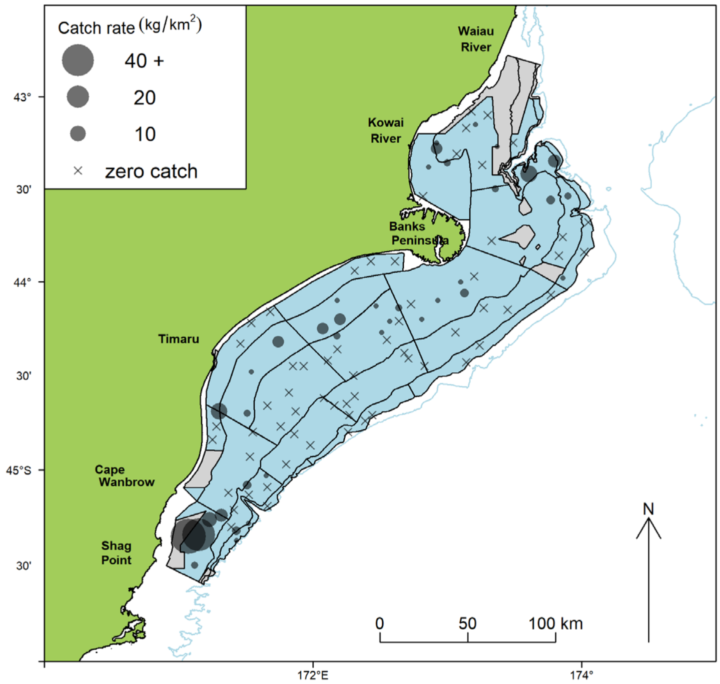
Species code	Common name	Scientific name	Catch (kg)	% catch	% occ.	Min.	Max.	Stations
SLZ	Slender stargazer	*Crapatalus angusticeps*	0.8	0.0	16.7	16	19	2
GLM	Green-lipped mussel	*Perna canaliculus*	0.7	0.0	8.3	15	15	1
RSC	Red scorpion fish	*Scorpaena papillosa*	0.5	0.0	8.3	15	15	1
FZE	Sand dollar	*Fellaster zelandiae*	0.5	0.0	16.7	16	19	2
ANC	Anchovy	*Engraulis australis*	0.5	0.0	25.0	15	16	3
HAK	Hake	*Merluccius australis*	0.4	0.0	16.7	16	16	2
TOD	Dark toadfish	*Neophrynichthys latus*	0.3	0.0	16.7	16	19	2
SPS	Speckled sole	*Peltorhamphus latus*	0.3	0.0	25.0	15	22	3
OPA	Opalfish	*Hemerocoetes* spp.	0.3	0.0	25.0	16	23	3
MOK	Moki	*Latridopsis ciliaris*	0.3	0.0	8.3	16	16	1
PRE	Cushion starfish	*Patiriella regularis*	0.2	0.0	16.7	15	16	2
HTH	Sea cucumber	Holothurian unidentified	0.2	0.0	8.3	16	16	1
DIR	Pagurid	*Diacanthurus rubricatus*	0.2	0.0	16.7	16	28	2
CCM	Eleven-arm seastar	*Coscinasterias muricata*	0.2	0.0	8.3	16	16	1
ZVA	*Thetys vagina*	*Thetys vagina*	0.1	0.0	8.3	19	19	1
SQX	Squid	NA	0.1	0.0	8.3	22	22	1
PZL	King clam	*Panopea zelandica*	0.1	0.0	8.3	19	19	1
NCA	Hairy red swimming crab	*Nectocarcinus antarcticus*	0.1	0.0	8.3	16	16	1
LOF	Large ostrich foot	*Struthiolaria papulosa*	0.1	0.0	8.3	19	19	1
GIL	Triplefin	*Gilloblennius* spp.	0.1	0.0	8.3	15	15	1
FLA	Flatfish	NA	0.1	0.0	8.3	22	22	1
EMA	Blue mackerel	*Scomber australasicus*	0.1	0.0	8.3	16	16	1
CTU	Cook’s turban shell	*Cookia sulcata*	0.1	0.0	8.3	23	23	1
CRB	Crab	NA	0.1	0.0	8.3	15	15	1
ASH	Circular saw shell	*Astraea heliotropium*	0.1	0.0	8.3	23	23	1
Total			12 970.3					

Appendix 5: Catch rates (kg km^{-2}) of eight key non-target QMS species for the 2022 ECSI trawl 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. The depth contour is 500 m.

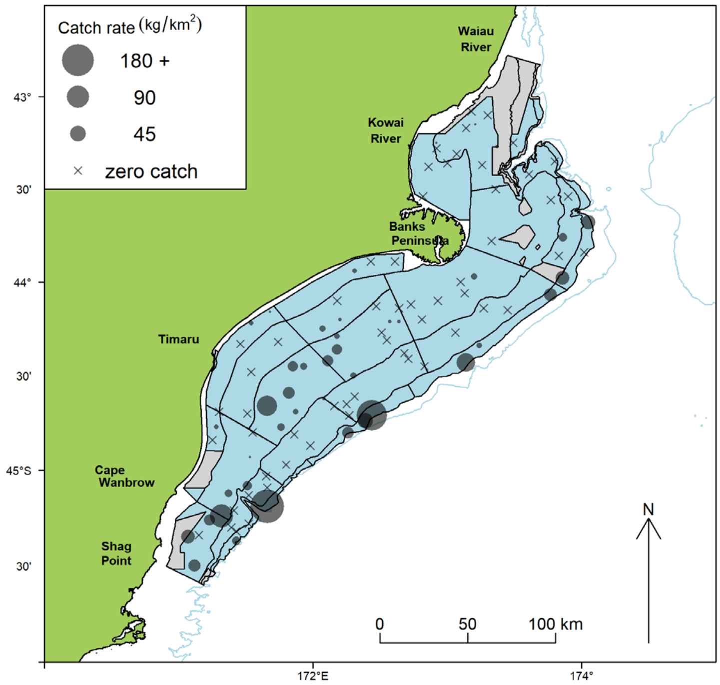
Barracouta



Lemon sole

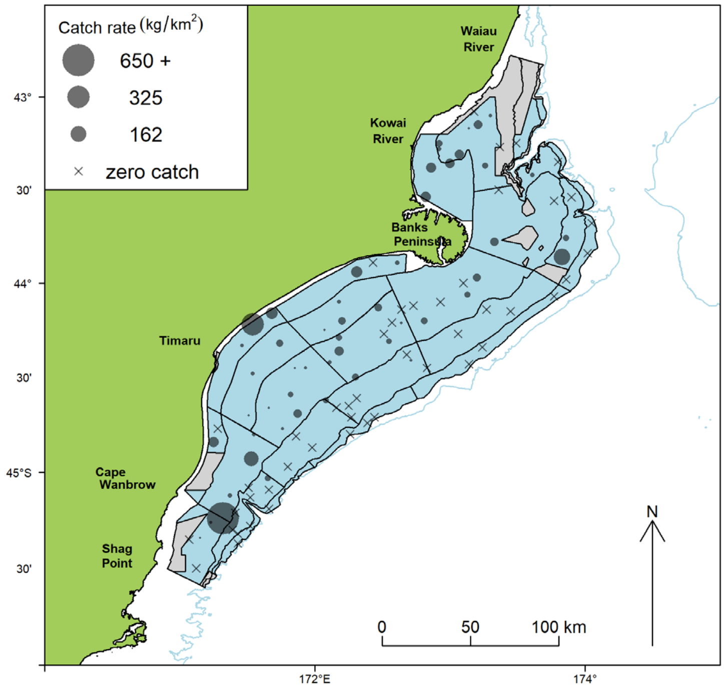


Ling



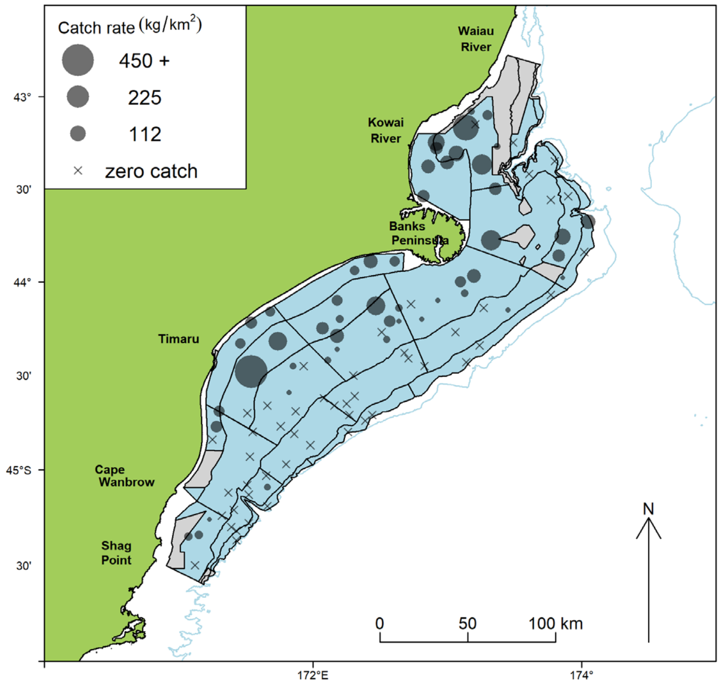
Catch rate (kg/km²)
180 +
90
45
zero catch
Waiau River
Kowai River
Banks Peninsula
Timaru
Cape Wanbrow
Shag Point
43°
30'
44°
30'
45°S
30'
172°E
174°
N
0
50
100 km

Rig

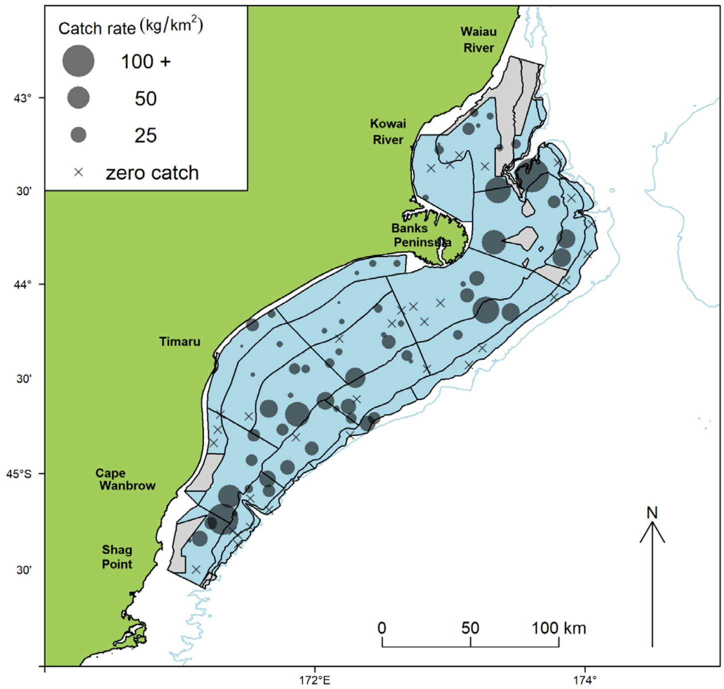


Catch rate (kg/km²)
650 +
325
162
zero catch
Waiau River
Kowai River
Banks Peninsula
Timaru
Cape Wanbrow
Shag Point
43°
30'
44°
30'
45°S
30'
172°E
174°
N
0
50
100 km

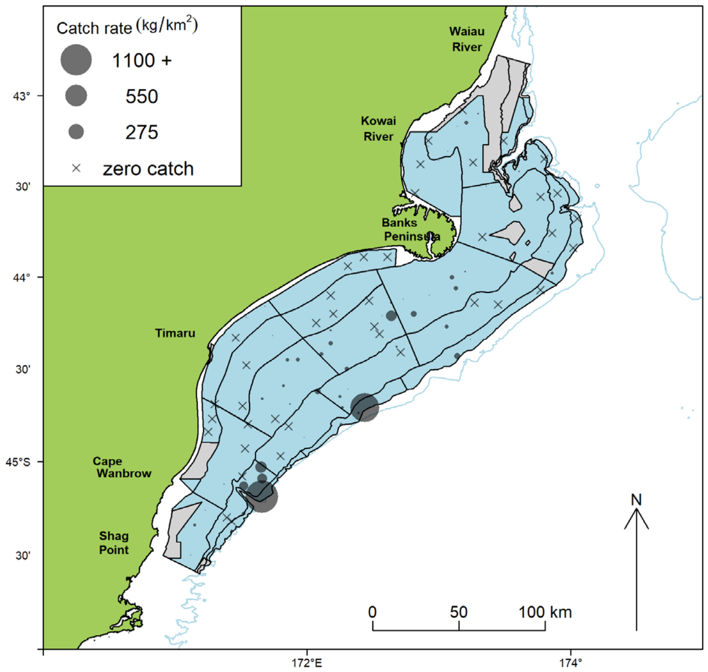
Rough skate



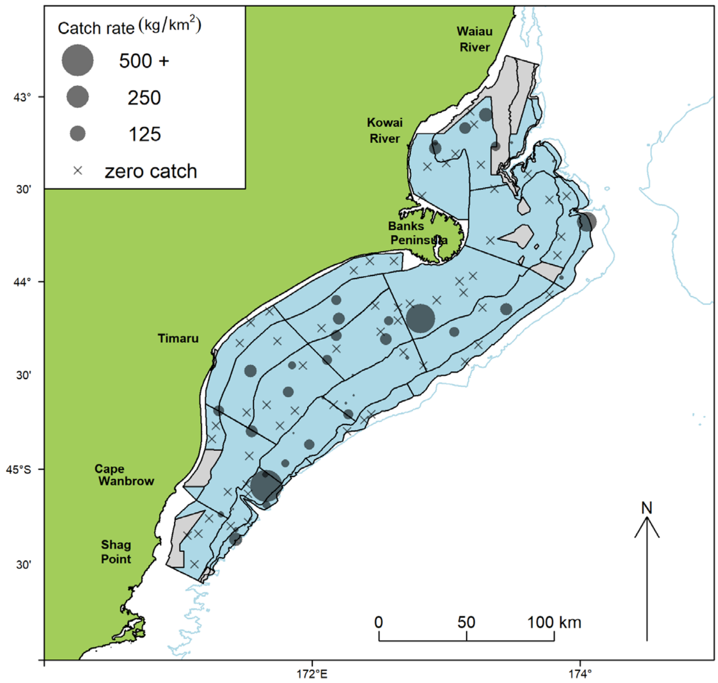
School shark



Silver warehou



Smooth skate

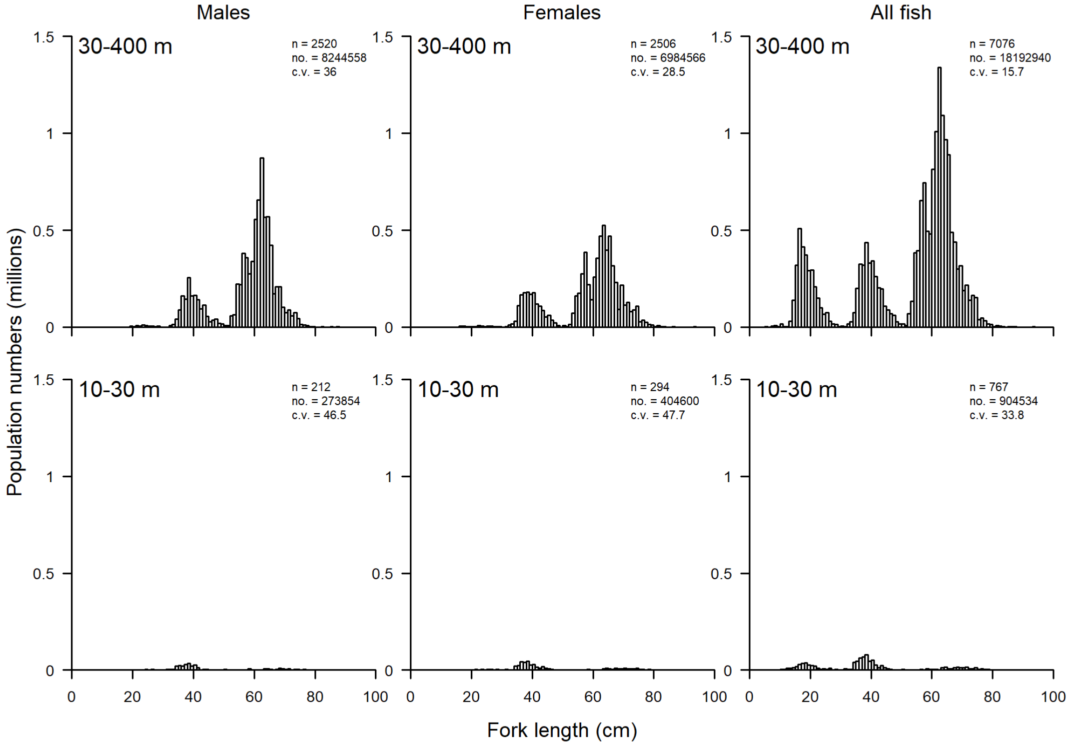


Appendix 6: Length-weight coefficients used to scale length frequencies for the 2022 ECSI survey. $W = aL^b$ where W is weight (g) and L is length (cm). DB, MPI *Trawl* database.

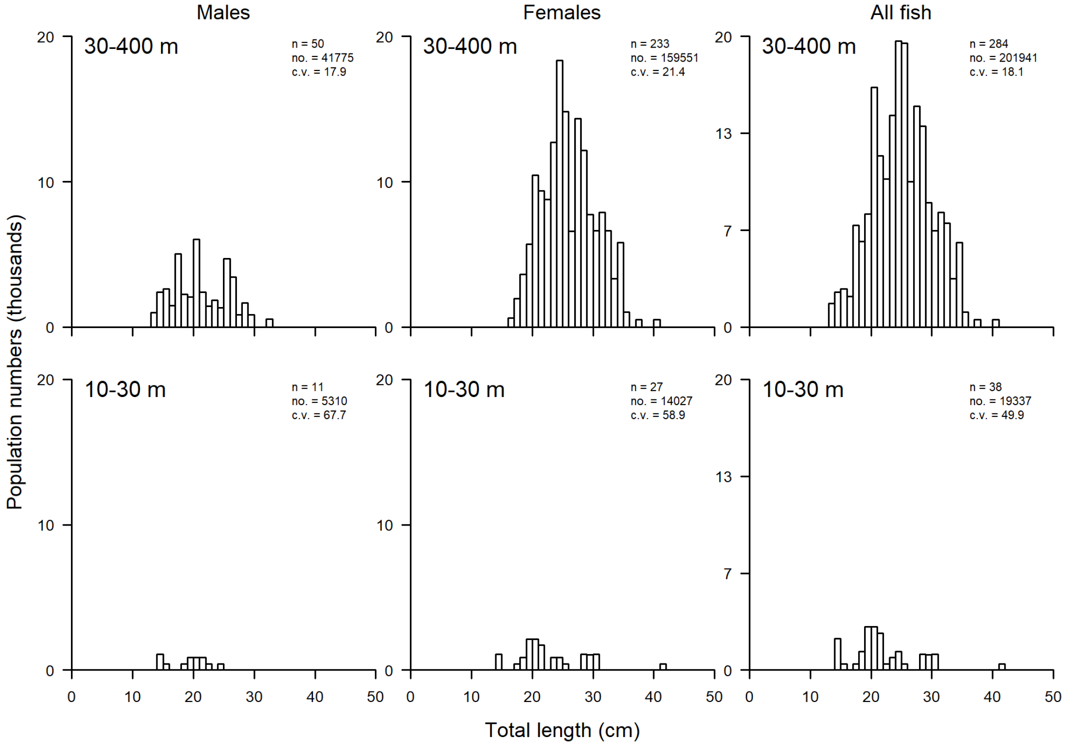
Species common name	Species code	*a*	*b*	n	Length (cm) Min.	Max.	Data source
Barracouta	BAR	0.005500	2.981200	429	23.8	87.2	DB, KAH9701
Blue cod	BCO	0.006842	3.229154	70	19.5	49.4	This survey
Elephantfish	ELE	0.004880	3.188328	337	13	91.1	This survey
Giant stargazer	GIZ	0.012898	3.066740	805	9.7	76.1	This survey
Dark ghost shark	GSH	0.001806	3.302505	695	22.1	70.1	This survey
Red gurnard	GUR	0.005360	3.153239	1 092	12.4	52.5	This survey
Bigeye sea perch	HBA	0.009268	3.177118	87	14.5	43.3	This survey
Hoki	HOK	0.008187	2.761354	130	18	85.1	This survey
Sea perch	HPC	0.009813	3.183214	806	9.3	40.1	This survey
Greenback jack mackerel	JMD	0.009668	3.090779	60	18.7	53.8	This survey
Yellowtail jack mackerel	JMN	0.073751	2.459532	66	16.3	36.0	This survey
Lookdown dory	LDO	0.040202	2.834025	62	20.2	41.4	This survey
Leatherjacket	LEA	0.014385	3.023454	203	8.7	30.6	This survey
Ling	LIN	0.001247	3.309406	121	31.7	102.4	This survey
Lemon sole	LSO	0.008000	3.127800	524	14.6	41.2	DB,KAH9809
Tarakihi	NMP	0.009676	3.182605	768	11.7	51.1	This survey
Red cod	RCO	0.009078	3.008740	1 057	9.3	72.0.	This survey
Rough skate	RSK	0.059102	2.732923	246	8.5	66.3	This survey
Gemfish	RSO	0.002143	3.294465	74	45.3	88.6	This survey
School shark	SCH	0.002950	3.116682	141	34.3	119.0	This survey
Spiny dogfish	SPD	0.003916	2.995027	1 487	28.5	88.9	This survey
Rig	SPO	0.005291	2.947013	240	34.4	120.0	This survey
Southern Ray's bream	SRB	0.016174	3.015500	119	27.5	51.2	This survey
Smooth skate	SSK	0.029113	2.913244	40	25.4	131.0	This survey
Silver warehou	SWA	0.010759	3.135245	63	14.1	52.3	This survey

Appendix 7: Scaled length frequency distributions for the key non-target QMS species in 30–400 m and 10–30 m for the 2022 ECSI trawl survey. Population estimates for each species are in the units given on the y-axis. n, number of fish sampled; no., scaled number of fish; c.v. (%).

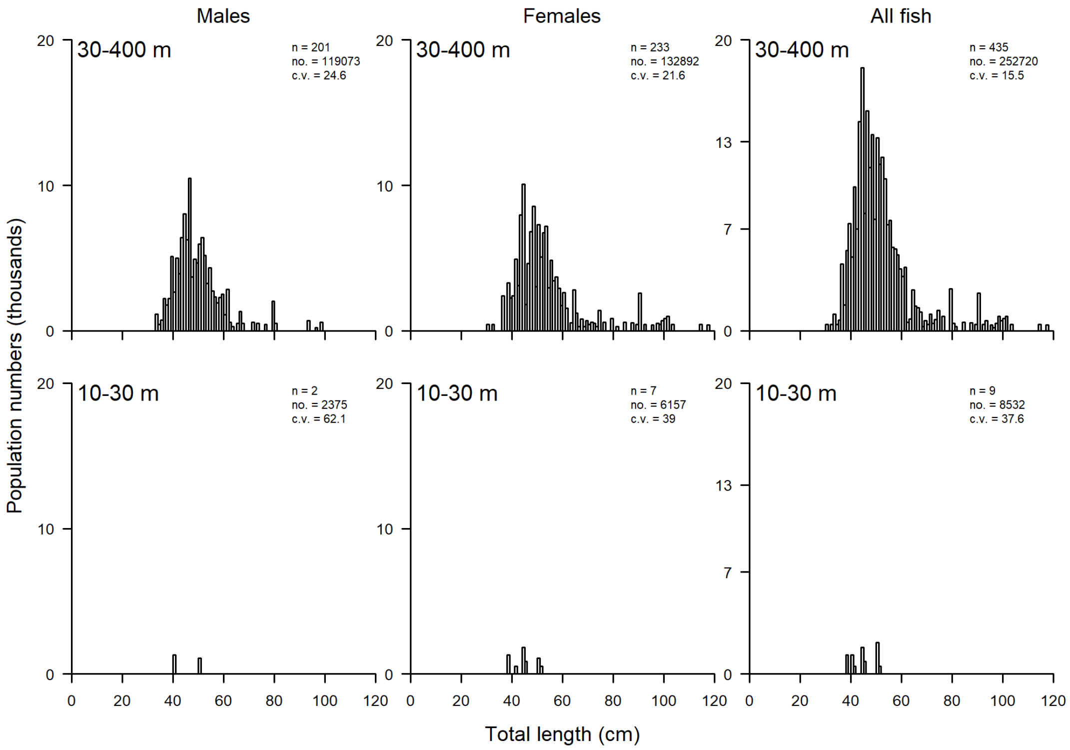
Barracouta



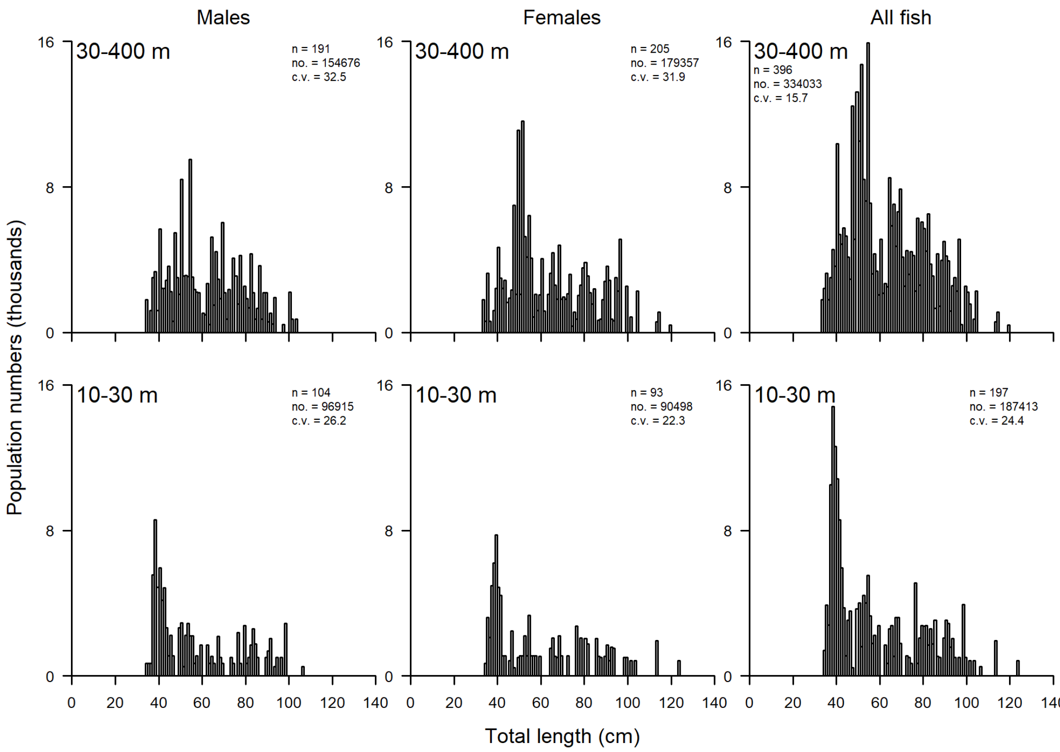
Lemon sole



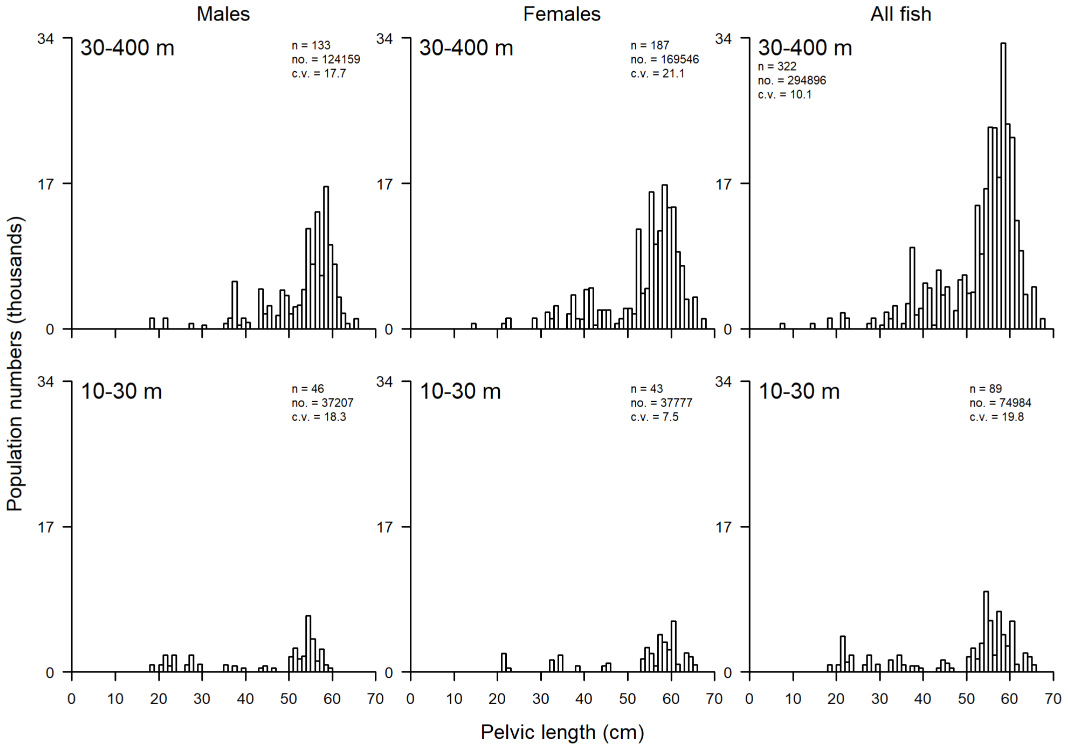
Ling


Males
Females
All fish
30-400 m
n = 201
no. = 119073
c.v. = 24.6
n = 233
no. = 132892
c.v. = 21.6
n = 435
no. = 252720
c.v. = 15.5
10-30 m
n = 2
no. = 2375
c.v. = 62.1
n = 7
no. = 6157
c.v. = 39
n = 9
no. = 8532
c.v. = 37.6
Population numbers (thousands)
Total length (cm)

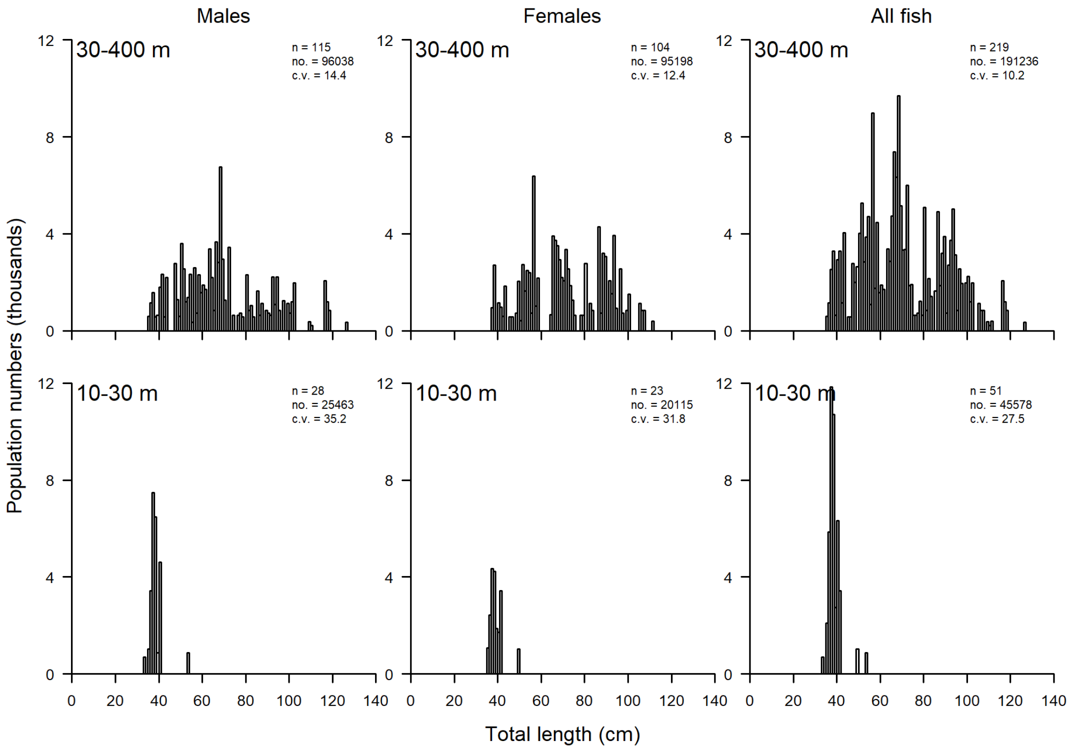
Rig


Males
Females
All fish
30-400 m
n = 191
no. = 154676
c.v. = 32.5
n = 205
no. = 179357
c.v. = 31.9
n = 396
no. = 334033
c.v. = 15.7
10-30 m
n = 104
no. = 96915
c.v. = 26.2
n = 93
no. = 90498
c.v. = 22.3
n = 197
no. = 187413
c.v. = 24.4
Population numbers (thousands)
Total length (cm)

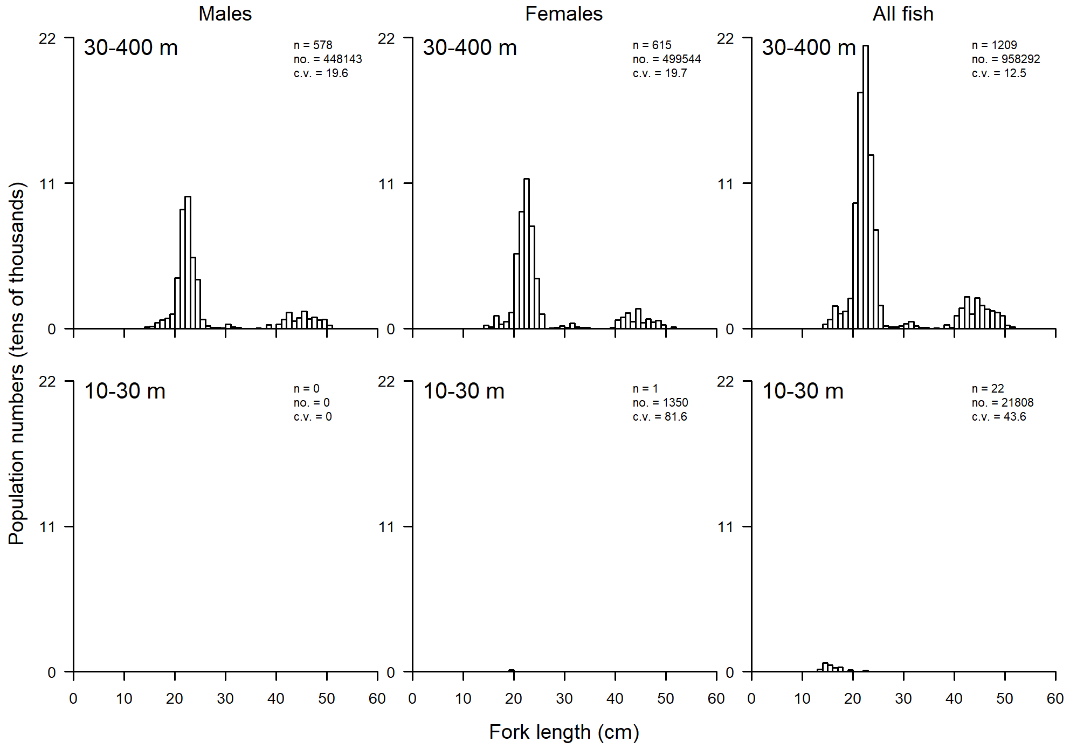
Rough skate



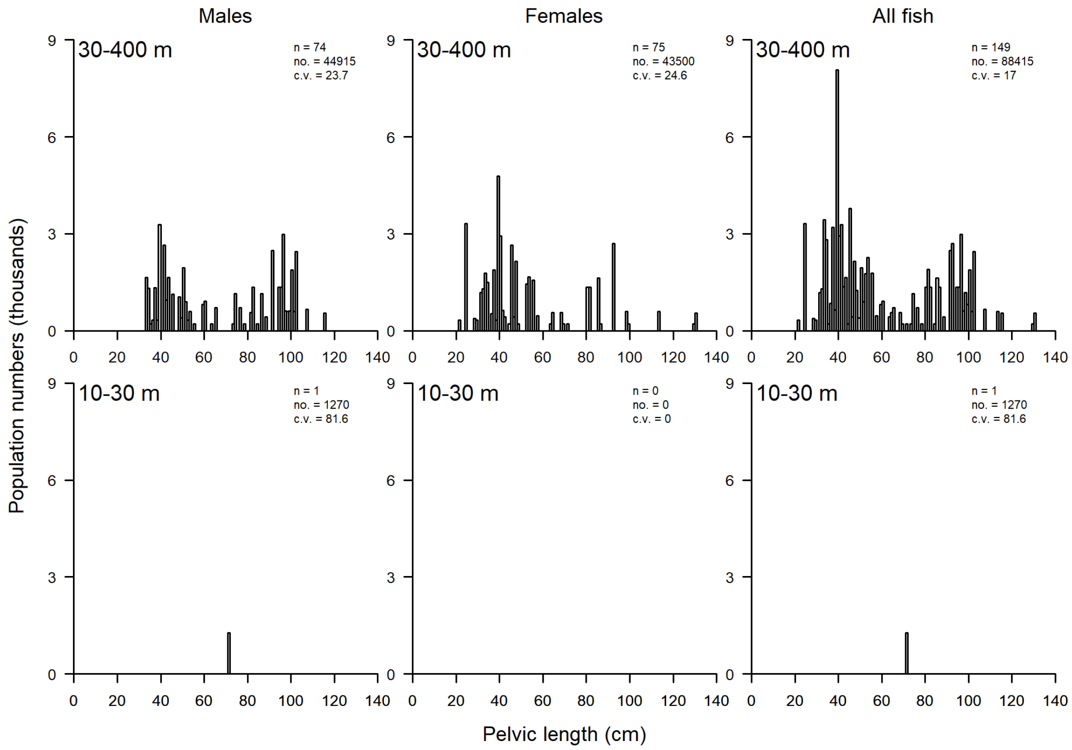
School shark



Silver warehou



Smooth skate



Appendix 8: **Estimated biomass (t) and coefficient of variation (CV %) of recruit (length in parentheses) and pre-recruit target species in the core strata for all surveys (A), and core plus shallow strata for elephantfish and red gurnard in 2007, 2012, 2014, 2016, 2018, 2021, and 2022 (B). Biomass estimates for 1991 were adjusted to allow for non-sampled strata (7 and 9, equivalent to current strata 13, 16 and 17). The sum of pre-recruit and recruit biomass does not always match the total biomass (Table 9) for the earlier surveys because length frequencies were not measured at several stations, affecting the biomass calculations for length intervals. Biom, biomass; Pre., pre-recruit biomass; Rec., recruit biomass; –, not applicable. (Continued on next page)**

A (Core strata)

Target species (recruited length)

		GSH (55 cm)		ELE (50 cm)		GIZ (30 cm)		RCO (40 cm)	
		Pre.	Rec.	Pre.	Rec.	Pre.	Rec.	Pre.	Rec.
1991	Biom.	292	668	5	294	26	646	1 823	2 054
	CV	68	40	66	41	22	17	45	37
1992	Biom.	574	361	54	122	35	634	2 089	2 438
	CV	54	31	83	28	14	16	50	33
1993	Biom.	1 058	1 814	60	421	19	591	1 025	4 469
	CV	40	53	56	34	16	14	51	27
1994	Biom.	1 312	1 390	22	142	10	429	3 338	2 299
	CV	35	22	51	34	25	17	40	36
1996	Biom.	1 195	1981	338	520	13	452	590	4 029
	CV	30	23	40	26	34	11	31	34
2007	Biom.	1 854	2 629	516	518	33	722	190	1 295
	CV	46	26	59	21	24	18	33	25
2008	Biom.	1 644	2 119	627	777	13	592	129	1 695
	CV	23	29	57	27	28	14	36	50
2009	Biom.	1 965	2 364	210	387	10	464	833	1 038
	CV	21	33	38	25	34	15	50	41
2012	Biom.	3 716	6 988	66	1 285	26	617	7 015	4 806
	CV	27	31	46	39	22	16	97	55
2014	Biom.	6 912	6 225	174	777	39	751	1 038	1 057
	CV	27	31	32	40	17	14	58	23
2016	Biom.	8 283	6 988	62	6 750	22	543	597	1 670
	CV	34	24	43	68	24	18	40	61
2018	Biom.	2 670	3 815	266	541	53	685	137	1 363
	CV	30	22	34	23	33	18	60	86
2021	Biom.	4 296	7 708	29	141	95	996	896	14 200
	CV	28	32	38	39	20	14	56	73
2022	Biom.	4 550	7 968	263	535	99	994	212	1 731

		GUR (30 cm)		HPC (20 cm)		SPD (50 cm)		NMP (25 cm)	
		Pre.	Rec.	Pre.	Rec.	Pre.	Rec.	Pre.	Rec.
1991	Biom.	16	744	70	1 483	–	–	305	1 414
	CV	77	40	44	30	–	–	38	33
1992	Biom.	21	121	51	1 441	266	9 212	288	614
	CV	58	30	28	28	27	31	26	28
1993	Biom.	26	551	178	2 770	343	13 122	2 282	1 522
	CV	45	31	76	30	72	17	62	46
1994	Biom.	2	121	78	2 264	205	14 325	494	725
	CV	42	34	24	29	49	10	31	35
1996	Biom.	8	496	58	1 613	3 412	31 757	519	1 137
	CV	44	26	45	25	23	16	30	27
2007	Biom.	298	1 155	74	1 880	5 831	29 554	822	1 766
	CV	40	35	18	22	46	27	30	24
2008	Biom.	100	1 210	144	1 800	1 886	26 590	739	1 123
	CV	59	33	20	24	50	22	44	25
2009	Biom.	62	1 663	82	1 363	2 398	22 913	525	994
	CV	34	30	18	26	30	32	42	42
2012	Biom.	193	1 487	66	1 898	3 804	31 742	584	1 077
	CV	40	27	25	27	58	34	34	29
2014	Biom.	409	1 654	182	1 986	5 683	14 266	818	1 562
	CV	45	23	29	26	34	36	26	26
2016	Biom.	63	877	109	2 923	2 639	18 299	342	1 121
	CV	41	30	25	30	34	50	40	33
2018	Biom.	308	1 735	64	1 959	7 423	17 336	409	1 000
	CV	24	20	19	30	55	29	28	28
2021	Biom.	215	1 854	120	1 333	4 099	3 758	236	539
	CV	50	30	28	26	54	33	56	33
2022	Biom.	110	3 299	96	2 069	3 121	23 909	258	791

CV	22	31	64	32	32	16	29	27	49	30	27	31	34	36	37	23

B (Core plus shallow strata)

		Target species (recruited length)			
		ELE (50 cm)		GUR (30 cm)	
		Pre.	Rec.	Pre.	Rec.
2007	Biom.	1 201	658	494	1 554
	CV	36	20	32	27
2012	Biom.	581	3 199	742	2 773
	CV	25	36	31	16
2014	Biom.	429	1 171	585	2 630
	CV	25	28	32	16
2016	Biom.	167	7 132	306	2 114
	CV	30	64	19	15
2018	Biom.	356	761	610	3 221
	CV	28	24	21	18
2021	Biom.	120	536	422	3 302
	CV	38	63	28	18
2022	Biom.	381	606	273	5 199
	CV	45	29	32	20

Appendix 9: Estimated juvenile and adult biomass (t) by sex and coefficient of variation (CV, %) (where juvenile was below and adult was equal to or above the length at which 50% of fish were mature) for bony fish target species from core strata for all ECSI surveys (A), elasmobranch species from core strata for all surveys (B), and elephantfish and red gurnard from core plus shallow strata for 2007, 2012, 2014, 2016, 2018, and 2021 (C). Biomass estimates for 1991 were adjusted to allow for non-sampled strata (7 and 9). The sum of juvenile and adult biomass values did not always match the total biomass (Table 9) for the earlier surveys because length frequencies were not measured at several stations, affecting the biomass calculations for length intervals. Biom, biomass; Juv, juvenile biomass; –, not measured. (Continued on next 3 pages)

A (Teleosts, core strata)

Finfish target species (length at maturity, cm)

		GIZ M =45 cm, (F=45 cm)		RCO M =51 cm, (F=51 cm)		GUR M =22 cm, (F=22 cm)		HPC M =26 cm, (F=26 cm)		NMP M =31 cm, (F=31 cm)	
		Juv.	Adult	Juv.	Adult	Juv.	Adult	Juv.	Adult	Juv.	Adult
1991	Biom	148 (171)	87 (264)	1 789 (1205)	292 (550)	0 (<1)	340 (420)	275 (194)	668 (551)	530 (434)	352 (384)
	CV	14 (25)	25 (22)	41 (38)	42 (29)	0 (100)	42 (40)	34 (32)	28 (33)	39 (37)	34 (29)
1992	Biom	178 (109)	69 (208)	1 752 (1364)	456 (954)	0 (2)	49 (91)	224 (221)	640 (406)	292 (274)	163 (171)
	CV	25 (26)	25 (17)	50 (47)	34 (25)	66 (58)	38 (30)	28 (30)	28 (33)	26 (24)	30 (34)
1993	Biom	133 (121)	92 (252)	1 399 (1 466)	880 (1645)	0 (0)	254 (321)	548 (375)	1 062 (899)	496 (403)	382 (245)
	CV	13 (16)	23 (18)	39 (47)	30 (31)	100 (57)	32 (34)	67 (55)	24 (19)	30 (29)	56 (32)
1994	Biom	106 (83)	83 (167)	1 167 (848)	536 (401)	0 (0)	48 (48)	232 (303)	938 (763)	296 (332)	93 (155)
	CV	21 (21)	22 (21)	34 (36)	33 (21)	0 (0)	51 (35)	24 (27)	27 (37)	42 (50)	32 (32)
1996	Biom	139 (85)	72 (168)	650 (535)	1 176 (2 258)	0 (0)	280 (224)	232 (340)	651 (405)	566 (435)	214 (232)
	CV	16 (18)	20 (15)	25 (27)	34 (39)	100 (71)	27 (27)	39 (37)	24 (22)	28 (27)	34 (33)
2007	Biom	106 (106)	34 (208)	393 (278)	188 (626)	1 (0)	793 (659)	256 (242)	882 (573)	1 046 (1 017)	186 (336)
	CV	13 (18)	33 (30)	38 (29)	34 (32)	51 (75)	34 (36)	18 (16)	24 (28)	28 (27)	22 (21)
2008	Biom	152 (136)	60 (200)	431 (628)	214 (549)	0 (1)	587 (717)	320 (314)	764 (535)	661 (714)	140 (319)
	CV	19 (17)	23 (17)	63 (71)	47 (23)	66 (58)	40 (32)	27 (24)	28 (26)	32 (35)	25 (23)
2009	Biom	91 (79)	66 (239)	825 (522)	112 (412)	0 (0)	864 (858)	180 (212)	620 (423)	518 (500)	263 (238)
	CV	20 (17)	32 (16)	54 (56)	33 (42)	100 (85)	32 (27)	19 (19)	30 (29)	43 (39)	48 (32)
2012	Biom	140 (91)	132 (280)	5 870 (2 469)	1 635 (1 846)	0 (0)	877 (803)	212 (248)	855 (648)	536 (595)	216 (292)
	CV	16 (16)	26 (20)	96 (92)	75 (36)	0 (100)	31 (25)	20 (23)	30 (32)	28 (32)	40 (30)

Finfish target species (length at maturity, cm)

		GIZ M =45 cm, (F=45 cm)		RCO M =51 cm, (F=51 cm)		GUR M =22 cm, (F=22 cm)		HPC M =26 cm, (F=26 cm)		NMP M =31 cm, (F=31 cm)	
		Juv.	Adult	Juv.	Adult	Juv.	Adult	Juv.	Adult	Juv.	Adult
2014	Biom	167 (181)	126 (308)	757 (679)	123 (480)	6 (6)	1 021 (1028)	392 (388)	782 (605)	794 (744)	319 (436)
	CV	17 (17)	20 (16)	49 (58)	30 (17)	43 (50)	30 (24)	30 (27)	27 (34)	24 (22)	33 (35)
2016	Biom	139 (133)	92 (199)	884 (419)	491 (458)	0 (0)	575 (366)	315 (409)	1 247 (1 055)	575 (517)	148 (199)
	CV	20 (22)	24 (20)	57 (42)	63 (63)	0 (0)	34 (30)	28 (34)	27 (40)	38 (32)	33 (26)
2018	Biom	207 (198)	118 (215)	289 (145)	493 (570)	8 (4)	1 136 (893)	142 (163)	1 006 (710)	411 (460)	235 (300)
	CV	26 (28)	22 (19)	84 (67)	92 (79)	44 (51)	20 (20)	18 (20)	34 (32)	30 (31)	30 (36)
2021	Biom	253 (227)	206 (400)	2 161 (1 961)	5 969 (4 998)	4 (4)	1 181 (876)	211 (208)	591 (444)	215 (216)	144 (198)
	CV	14 (18)	15 (18)	53 (64)	97 (83)	54 (81)	33 (30)	19 (22)	31 (33)	52 (54)	27 (30)
2022	Biom	276 (265)	197 (351)	332 (206)	428 (977)	3 (1)	1731 (1 675)	242 (198)	1 000 (725)	336 (306)	182 (224)
	CV	24 (26)	25 (22)	32 (25)	24 (32)	75 (52)	36 (25)	29 (25)	34 (32)	36 (34)	23 (23)

B (Elasmobranchs, core strata)

		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	Biom	72 (226)	213 (449)	1 (64)	136 (97)	–	–
	CV	77 (61)	52 (45)	73 (52)	46 (40)	–	–
1992	Biom	252 (414)	135 (134)	25 (66)	35 (50)	471 (887)	4 645 (3 475)
	CV	62 (50)	36 (32)	81 (45)	40 (34)	28 (22)	18 (69)
1993	Biom	340 (697)	913 (922)	39 (114)	213 (114)	603 (1 250)	7 178 (4 414)
	CV	50 (37)	49 (54)	56 (29)	37 (65)	63 (50)	17 (34)
1994	Biom	403 (975)	674 (650)	12 (47)	43 (62)	604 (1135)	9 721 (3 057)
	CV	47 (29)	25 (25)	46 (38)	38 (41)	24 (20)	10 (30)

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
1996	Biom	261 (1 042)	978 (892)	187 (378)	166 (127)	3 924 (7 829)	21 195 (2 221)
	CV	39 (36)	31 (20)	41 (32)	31 (30)	21 (28)	16 (18)
2007	Biom	521 (1 468)	1 175 (1 316)	278 (362)	165 (225)	7 926 (12 247)	14 326 (886)
	CV	52 (39)	21 (42)	60 (41)	30 (30)	37 (35)	26 (22)
2008	Biom	676 (1 021)	820 (1 235)	328 (512)	234 (325)	4 029 (5 690)	17 594 (1 124)
	CV	28 (19)	25 (34)	55 (44)	46 (26)	37 (26)	22 (16)
2009	Biom	753 (1 208)	1 038 (1 326)	131 (173)	206 (86)	5 526 (6 797)	12 073 (910)
	CV	29 (20)	29 (37)	35 (32)	29 (42)	42 (30)	32 (22)
2012	Biom	1 015 (3 207)	3 319 (3 162)	39 (267)	693 (353)	5 702 (5 640)	2 2705 (1 483)
	CV	24 (34)	28 (36)	51 (32)	54 (40)	36 (26)	40 (30)
2014	Biom	2 078 (4 361)	4 032 (2 619)	88 (176)	179 (508)	5 761 (5 656)	7 599 (920)
	CV	32 (29)	31 (31)	31 (31)	31 (51)	42 (37)	43 (15)
2016	Biom	2 737 (4 808)	5 267 (2 455)	49 (370)	5 875 (518)	2 887 (3 919)	13 086 (1 045)
	CV	50 (27)	27 (27)	44 (49)	75 (71)	39 (28)	53 (30)
2018	Biom	693 (1 889)	1 972 (1 917)	138 (233)	191 (244)	6 306 (7 170)	8 837 (2 364)
	CV	28 (30)	32 (21)	35 (27)	37 (27)	36 (38)	27 (46)
2021	Biom	1 279 (2 880)	3 408 (4 438)	14 (23)	77 (55)	2 384 (2 586)	2 359 (528)
	CV	35 (26)	29 (36)	39 (35)	51 (47)	45 (47)	45 (17)
2022	Biom	1 114 (3 183)	4 451 (3 771)	143 (175)	178 (302)	4 943 (7 851)	11 799 (2 434)
	CV	16 (35)	30 (27)	65 (48)	44 (31)	31 (35)	42 (60)

C (Core plus shallow strata)

		Target species (length at maturity, cm)			
		ELE M=51, (F=70)		GUR M=22, (F=22)	
		Juv.	Adult	Juv.	Adult
2007	Biom	574 (863)	194 (225)	8 (5)	1 008 (1 028)
	CV	34 (30)	29 (30)	54 (67)	28 (26)
2012	Biom	278 (1013)	804 (1 685)	14 (18)	1 523 (1 958)
	CV	28 (23)	47 (49)	71 (69)	20 (15)
2014	Biom	199 (436)	192 (773)	11 (15)	1 376 (1 811)
	CV	25 (19)	29 (36)	25 (23)	23 (15)
2016	Biom	93 (592)	5 975 (639)	3 (2)	1 050 (1 366)
	CV	29 (35)	74 (58)	36 (40)	20 (13)
2018	Biom	174 (351)	206 (383)	14 (7)	1 532 (2 273)
	CV	30 (22)	34 (30)	27 (33)	16 (21)
2021	Biom	52 (140)	89 (374)	9 (10)	1 722 (1 970)
	CV	32 (38)	45 (75)	31 (38)	23 (16)
2022	Biom	193 (262)	190 (342)	7 (3)	2 328 (3 109)
	CV	49 (34)	41 (28)	50 (51)	28 (15)