Ministry for Primary Industries
Manatū Ahu Matua

Inshore trawl survey of the west coast South Island and Tasman and Golden Bays, March-April 2015 (KAH1503)

New Zealand Fisheries Assessment Report 2015/67

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ISSN 1179-5352 (online)
ISBN 978-1-77665-086-6 (online)

October 2015

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EXECUTIVE SUMMARY

Stevenson, M.L.; MacGibbon, D.J. (2015). Inshore trawl survey of the west coast South Island and Tasman and Golden Bays, March-April 2015 (KAH1503)

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This report presents the results of the twelfth inshore trawl survey along the west coast of the South Island, from Farewell Spit to the Haast River mouth, and within Tasman and Golden Bays at depths from 20 to 400 m using RV *Kaharoa*.

The survey took place from 28 March to 17 April 2015 and used a two-phase design optimised for giant stargazer, red cod, red gurnard, spiny dogfish, and tarakihi. A total of 60 phase one stations were successfully completed. Unfavourable weather conditions meant that there was no time for phase two stations. Trends in relative biomass estimates, catch distribution for the target species, and population length frequencies for the major species are presented.

The biomass estimates for the target species were: giant stargazer, 1984 t; red gurnard, 1776 t; red cod, 989 t; spiny dogfish, 7613 t; and tarakihi, 1060 t. Target coefficients of variation (CVs) of 20% were met for giant stargazer (11%), red gurnard (16%), and tarakihi (17%). The CV for spiny dogfish (21%) was slightly higher than the target (20%). One large catch of red cod (approximately 2 t) combined with generally low catches elsewhere meant that the CV (45%) was substantially higher than the target for this species of 20–25%. Other commercial species with CVs less than 20% were john dory, gemfish, and school shark.

The biomass estimate for red gurnard was the highest for any survey in the series. The biomass estimate for spiny dogfish was in the middle of the range for the series. The red cod and tarakihi biomass estimates were the third lowest of the time series. The biomass for giant stargazer was down slightly from the high of 2013 but was still the second highest of the time series.

1. INTRODUCTION

This report presents results from the twelfth stratified random trawl survey using RV *Kaharoa* at depths of 20–400 m off the west coast of the South Island, and in Tasman and Golden Bays. Other surveys have taken place in 1992, 1994, 1995, 1997, 2000, 2003, 2005, 2007, 2009, 2011 and 2013. The survey design was optimised to estimate the relative biomass of giant stargazer (*Kathetostoma giganteum*), red cod (*Pseudophycis bachus*), red gurnard (*Chelidonichthys kumu*), spiny dogfish (*Squalus acanthias*), and tarakihi (*Nemadactylus macropterus*). The results of earlier surveys in this series were reported by Drummond & Stevenson (1995a, 1995b, 1996), Stevenson (1998, 2002, 2004, 2006, 2007a, 2012), Stevenson & Hanchet (2010), and MacGibbon & Stevenson (2013). The first four surveys in the series were reviewed by Stevenson & Hanchet (2000). Additional analyses of the non-target species was completed to determine for which species relative abundance trends and size comparison information should be provided in each survey report (Stevenson 2007b)

The principal objective of the surveys was to develop a time series of relative biomass indices for giant stargazer, red cod, red gurnard, spiny dogfish, and tarakihi for the inshore waters off the west coast of the South Island and in Tasman and Golden Bays. Changes in the relative biomass and length frequency distributions over time should reflect changes in the absolute biomass and size distributions of the fish populations.

This report details the 2015 trawl survey design and methods and provides relative biomass estimates for commercially important species managed under the Quota Management System (QMS) and non-QMS species. The trawl survey time series of relative biomass estimates for key inshore species provide information used for stock assessment and fisheries management advice.

This report fulfils the final reporting requirement of Ministry for Primary Industries project INT2014-01.

1.1 Programme objective

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

Specific objectives

1. To determine the relative abundance and distribution of inshore finfish species off the west coast of the South Island, and Tasman Bay and Golden Bay; focusing on red cod, red gurnard, giant stargazer, tarakihi, spiny dogfish, and john dory from Farewell Spit to the Haast river mouth and within Tasman Bay and Golden Bay by carrying out a trawl survey. The target coefficients of variation (CV) of the biomass estimates of these species were as follows: red cod (20–25%), red gurnard (20%), giant stargazer (20%), tarakihi, and spiny dogfish (20%). No target CV was set for john dory.
2. To collect the data and determine the length frequency, length-weight relationship and reproductive condition of red cod, red gurnard, giant stargazer, tarakihi, spiny dogfish, and john dory.
3. To collect otoliths from red cod, red gurnard, giant stargazer, and tarakihi.
4. To collect the data to determine the length frequencies for all other Quota Management System (QMS) species.
5. To tag viable smooth and rough skates, school shark, and rig.
6. To identify benthic macro-invertebrates collected during the trawl survey.

7. To present biomass trends and size composition information for all QMS species for which the survey reliably monitors relative abundance trends.

2. METHODS

2.1 Survey area and design

The survey was a two-phase stratified random survey after Francis (1984). The survey area covered depths of 20–200 m off the west coast of the South Island from Cape Farewell to Karamea; 25–400 m from Karamea to Cape Foulwind; 20–400 m from Cape Foulwind to the Haast River mouth; and 20–70 m within Tasman and Golden Bays inside a line drawn between Farewell Spit and Stephens Island (Figure 1a–b). The maximum depth on the west coast north of Karamea was limited to 200 m because of historically low catch rates in the 200–400 m range.

The survey area of 25 595 km^2, including untrawlable ground, was divided into 16 strata by area and depth (Table 1, Figure 1a–b). Strata were identical to those used in previous surveys in the time series. The trawlable ground within the survey area represented 84% of the total survey area.

Phase 1 station allocation was optimised using the R (R Core Team 2012) function *allocate* (Francis 2006) to achieve the target CVs. The *allocate* function uses stratum area and catch rate data from previous trawl surveys in the time series to simulate optimal station allocation. Simulations were run for each target species separately. Based on the simulation results, the original survey plan was to carry out 68 phase one stations with the intention of obtaining a 20% CV for all target species including red cod (as agreed by the Southern Inshore Working Group on 6 November 2014). An alternative station allocation of 59 phase one stations was also presented to the working group which the optimization process suggested would give a CV of 25% for red cod and 20% for all other target species. After several days of bad weather that prevented survey work being carried out, it became apparent that 68 stations would not be obtainable in the time remaining, and it was decided to adopt the alternative station allocation of 59 phase one stations. A total of 60 stations were completed because one extra station required in stratum 19 under the original 68 station scenario had already been carried out before the decision was made to adopt the 59 station scenario. The data from this extra station has been included in the biomass estimates and other summary data reported here.

Before the survey began, sufficient trawl stations to cover both first and second phase stations were randomly generated for each stratum by the computer program 'SurvCalc' (Francis & Fu 2012). The stations were required to be a minimum of 5.6 km (3 nautical miles) apart. Non-trawlable ground was identified before the voyage from data collected during previous trawl surveys in the area and that ground was excluded from the station allocation program. The area and distribution of non-trawlable ground are given in Table 1 and Figures 1a and 1b respectively.

2.2 Vessel, gear, and trawling procedure

RV *Kaharoa* is a 28 m stern trawler with a beam of 8.2 m, displacement of 302 t, engine power of 522 kW, capable of trawling to depths of 500 m. The two-panel trawl net used during the survey was designed and constructed in 1991 specifically for South Island inshore trawl surveys and is based on an 'Alfredo' design. The net was fitted with a 60 mm (inside measurement) knotless codend. Details of the net design were given by Beentjes & Stevenson (2008). Gear specifications were the same as for previous surveys (Drummond & Stevenson 1996).

Procedures followed those recommended by Stevenson & Hanchet (1999). All tows were undertaken in daylight, and four to six tows a day were planned. For each tow the vessel steamed to the station

position and, if necessary, the bottom was checked with the echosounder. Once the station was considered trawlable, the gear was shot away so that the midpoint of the tow would coincide as closely as possible with the station position. The direction of the tow was influenced by a combination of factors including weather conditions, tides, bottom contours, and the location of the next tow, but was usually in the direction of the next station.

If the station was found to be in an area of foul ground or the depth was out of the stratum range, an area within 5 km of the station was searched for a replacement tow path. If the search was unsuccessful, the station was abandoned and the next alternative station within the stratum was chosen from the random station list. Standard tows were one hour duration at a speed over the ground of 3 knots and the distance covered was measured by GPS. The tow was deemed to have started when the net monitor indicated that the net was on the bottom, and was completed when hauling began.

A warp length of 200 m was used for all tows at less than 70 m depth. At greater depths, the warp to depth ratio decreased linearly to about 2.4:1 at 400 m.

2.3 Water temperatures

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

2.4 Catch and biological sampling

The catch from each tow was sorted into species on deck and weighed on 100 kg electronic motion-compensating Seaway scales to the nearest 0.1 kg. All species not readily identified were placed in sealed plastic bags with a label noting the trip code and station number and frozen for later identification.

Length, to the nearest whole centimetre below the actual length, and sex (where possible) were recorded for all species managed under the QMS, either for the whole catch or a randomly selected subsample of up to 200 fish per tow.

Individual fish weights and/or reproductive state were collected for the target species as well as john dory (*Zeus faber*), silver warehou (*Seriolella punctata*), carpet shark (*Cephaloscyllium isabellum*), rig (*Mustelus lenticulatus*), rough skate (*Zearaja nasutus*), smooth skate (*Dipturus innominatus*), and school shark (*Galeorhinus galeus*). Individual fish weights were taken to enable length-weight relationships to be calculated for scaling length frequency data and calculation of abundance for length intervals. Samples were selected non-randomly from the random length frequency sample to ensure that a wide range was obtained for each species.

Up to 20 otoliths per station were collected for the target finfish species (no otoliths were collected for john dory). Otoliths for tarakihi and red gurnard were placed in 0.5 mL vials to reduce breakage.

2.5 Data analysis

Biomass estimates and scaled length-frequency distributions and their associated CVs were estimated by the area-swept method (Francis 1981, 1989) using the SurvCalc Program (Francis & Fu 2012). All data were entered into the Ministry for Primary Industries *trawl* database.

The following assumptions were made for calculating biomass estimates with the SurvCalc Program:

1. The area swept during each tow equalled the distance between the doors multiplied by the distance towed.
2. Vulnerability was 1.0. This assumes that all fish in the area swept were caught and there was no escapement.
3. Vertical availability was 1.0. This assumes that all fish in the water column were below the headline height and available to the net.
4. Areal availability was 1.0. This assumes that the fishstock being sampled was entirely within the survey area at the time of the survey.
5. Within the survey area, fish were evenly distributed over both trawlable and non-trawlable ground.

All these assumptions are unlikely to be correct, but were adopted for all the trawl survey time series of relative biomass (Stevenson & Hanchet 1999).

All 60 stations were used for biomass estimation as gear performance was satisfactory on all tows.

Length frequency distributions were scaled by the percentage of catch sampled, area swept, and stratum area. The geometric mean functional relationship was used to calculate the length-weight coefficients for species where sufficient length-weight data were collected on this survey. For other species, coefficients were chosen from the *rdb* database and a selection made on the basis of whether coefficients were available from previous surveys in the series or on the best match between the size range of the fish used to calculate the coefficients and the sample size range from this survey (Appendix 1).

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

Catchability of the survey was evaluated using the mean ranking methodology of Francis et al. (2001) to determine whether biomass estimates may be considered extremely high or low.

2.6 Elasmobranch tagging

As soon as the net was brought on board, whenever possible, lively rig, school shark, rough skate, and smooth skate were separated from the catch, placed in an aerated tank of seawater, and tagged with Hallprint dart tags. Length, weight, and sex were recorded for each tagged fish. Maturity stage was recorded for male elasmobranchs as this can easily be done externally without causing harm. This is not possible for females.

3. RESULTS AND DISCUSSION

3.1 Timetable and personnel

RV *Kaharoa* departed Wellington on 27 March and berthed in Nelson on 28 March to offload some equipment, pick up an additional science staff, and take on ice and fish bins. Trawling began on the afternoon of 28 March. All 12 phase one stations in Tasman and Golden Bays were completed by 31 March after which fish was offloaded to Talley's Nelson. Fishing recommenced on the west coast of the South Island on 1 April and continued until 6 April when the vessel docked in Westport to unload fish and exchange one scientific staff member. Fishing resumed on 8 April when weather conditions improved. Unfavourable weather conditions disrupted fishing operations for some or all of the days on 6–8 and 12–14 April and only allowed for the completion of phase one, so no phase two stations were completed. The final phase one station was completed on the afternoon of 17 April. R.V. *Kaharoa* docked in Nelson on 18 April to discharge fish, pick up spare trawl gear, and drop off two scientific staff members. The vessel docked in Wellington on 19 April for demobilization.

Dan MacGibbon was voyage leader and was responsible for final database editing. The skipper was Lindsay Copland. The project manager was Michael Stevenson.

3.2 Survey area, design, and gear performance

Sixty phase one stations were successfully completed. Station density ranged from one station per 102 km^2 in stratum 17 to one station per 1078 km^2 in stratum 6, with an overall density of one station per 427 km^2 (Table 1). At least three stations were completed in all 16 strata. The survey area, with stratum boundaries and station positions, is shown in Figures 1a and 1b and individual station data are given in Appendix 2.

A summary of gear and tow parameters by depth are shown in Table 2. Doorspread varied from 70.1 to 93.3 m and headline height varied between 4.0 and 4.9 m (Table 2, Appendix 2). Measurements of headline height and doorspread, together with bottom contact sensor output and observations that the doors and trawl gear were polishing well, indicated that the gear was in general operating correctly. Overall, gear parameters were similar to those of previous surveys indicating consistency between surveys (Stevenson & Hanchet 2000).

3.3 Catch composition

A total of about 36.4 t of fish and invertebrates were caught from the 60 valid biomass tows at an average of 606.7 kg per tow. Amongst the fish catch, 13 elasmobranch, and 68 teleost species were recorded. Species codes, common names, scientific names, and catch weights of all species identified during the survey are given in Appendix 3. Invertebrate species identified from the catch are given in Appendix 4.

The most abundant species by weight was spiny dogfish with 8.4 t caught (23% of the total catch). The top four species, spiny dogfish, barracouta (*Thyrsites atun*), hoki (*Macruronus novaezelandiae*), and giant stargazer, made up 45% of the total. The target species giant stargazer, red cod, red gurnard, spiny dogfish and tarakihi made up 42% of the catch. Barracouta, arrow squid, witch, and spiny dogfish occurred in over 80% of the tows.

Forty-five species or species groups of invertebrates were identified during the survey or from retained specimens (Appendix 4). The numbers of invertebrate species does not necessarily reflect biodiversity in the survey area because the gear is not designed to collect benthic macroinvertebrates. In addition, station location strongly influences the incidence of some groups (e.g., some bryozoans prefer hard substrate).

3.4 Catch rates and species distribution

Distribution by stratum and catch rates for the target species are shown in Figures 2a–2e. Catch rates are given in kilograms per square kilometre.

Giant stargazer catch rates were highest in the 100–200 m strata (Figure 2a), south of Cape Foulwind. Catches in the Tasman and Golden Bay region were low.

Red cod catch rates were highest in the 30–100 m strata on the west coast (Figure 2b), followed by 100–200 m strata. Catch rates in Tasman and Golden Bays and in the 200–400 m strata on the west coast were low in comparison.

Red gurnard catch rates were highest in the 30–100 m strata on the west coast and in Tasman and Golden Bay (Figure 2c). Catch rates in the 100–200 and 200–400 m strata were low to non-existent.

The highest catch rates for spiny dogfish were from the 30–100 m strata on the west coast (Figure 2d). Catch rates were lower in the 100–200 m strata, and lowest in the 200–400 m strata.

Highest catch rates for tarakihi were in the south of the west coast area between Greymouth and Haast in the 200–400 m strata (Figure 2e). Catch rates were very low in the north of the west coast compared to the previous survey.

Mean catch rates by stratum for the 20 most abundant commercially important species are given in Table 3.

3.5 Biomass estimation

References to 'biomass' are to relative abundance estimates unless otherwise stated.

Biomass estimates for species managed under the QMS caught in all surveys in the series are given in Table 4. Estimated biomass and coefficients of variation for the target species in 2015 were: giant stargazer, 1984 t (11%); red gurnard, 1776 t (16%); red cod, 989 t (46%); spiny dogfish, 7613 t (21%); and tarakihi, 1060 t (17%) (Table 4). Target CVs were 20% for giant stargazer, tarakihi, red gurnard, and spiny dogfish whilst the target CV for red cod was 20–25%. These values were chosen during the initial planning for the series because it was felt they would provide information accurate enough to detect trends in relative abundance for the target species.

Recruited lengths and biomass estimates for the following species are given in Table 5: barracouta, blue warehou (*Seriolella brama*), giant stargazer, hoki, john dory, ling (*Genypterus blacodes)*, red cod, red gurnard, rig, sand flounder (*Rhombosolea plebeia*), school shark, silver warehou (*Seriolella punctata*), and tarakihi. Estimates of total recruited biomass for giant stargazer, red cod, red gurnard, and tarakihi were 92%, 49%, 75%, and 88% of the total respectively. Recruited lengths were determined following discussions with the commercial fishing industry and reflect the minimum lengths considered desirable for sale to the public and are often the lengths previously set as minimum lengths by fishery management.

Biomass estimates by year class (where they were discernible from the length frequency distributions) for barracouta, blue warehou, hake, hoki, jack mackerel (*Trachurus novaezelandiae*), red cod, red gurnard, school shark, silver warehou, and tarakihi are given in Table 6. For red cod, the 1+ cohort made up only 7% of the total biomass whereas in previous surveys the 1+ year class usually made up more than 60% of the total biomass. For red gurnard, the 1+ cohort made up 17% of the total biomass and for tarakihi the 1+ and 2+ cohorts made up 1% and 6% of the total respectively.

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

Trends in biomass for selected species are shown in Figure 3 and discussed in Section 3.6.

The Francis ranking method (Francis et al. 2001) was used to determine whether this survey produced an anomalous result as was done in 2000 (Stevenson 2002) and 2011 (Stevenson 2012). Biomass estimates for selected species were compared between surveys for Tasman and Golden Bays and for the west coast South Island separately. If the estimates were uniformly higher or lower than other surveys in the time series then the survey was deemed to be 'extreme'. For Tasman and Golden Bays the updated calculations show that the 2009 survey had extreme catchability resulting in high biomass estimates but all other surveys are not considered to have extreme estimates (Appendix 6). The 2015 survey is very close to the mean rank for the time series. For the west coast South Island updated calculations show that the 2003 survey had

extreme catchability resulting in low biomass estimates but all other surveys are not considered to have extreme estimates (Appendix 6). The 2015 survey is very close to the mean rank for the time series.

3.6 Length frequency and biological data

Length frequency distributions for other species are given for the 2015 survey only if the species is commercially important and more than 100 fish were measured. The numbers of length frequency and biological samples taken during the survey are given in Table 8. Comparative scaled length frequency distributions for the target species and for the eight other species monitored by the survey are shown in Figures 5a–m with separate distributions for i) Tasman and Golden Bays, and ii) west coast South Island. Length frequency distributions are presented in alphabetical order by common name. Scaled length frequency distributions from this survey for other commercial species where more than 100 fish were measured are shown in Figure 6 in alphabetical order by common name.

Length-weight coefficients were determined for carpet shark, giant stargazer, red cod, red gurnard, spiny dogfish, tarakihi, rig, rough skate, school shark, and silver warehou from data collected on this survey (Appendix 1). Individual length, weight, and gonad maturity data for carpet shark were collected in conjunction with a project to examine stomach contents, and length-weight data for silver warehou were collected to obtain length-weight coefficients specific to the region.

Ageing material collected included 387 pairs of otoliths from giant stargazer, 359 from red cod, 397 from red gurnard, and 459 from tarakihi (Table 8).

Details of gonad stages for giant stargazer, red cod, red gurnard, and tarakihi are given in Table 9a and maturity stage details for spiny dogfish are given in Table 9b and are discussed in Section 3.6.

3.7 Trends in target species

3.7.1 Giant stargazer

Giant stargazer were caught at 46 stations with the highest catch rates south of Cape Foulwind at depths of 100–200 m (strata 8, 12, and 15) (Figure 2a, Table 3). The biomass was fairly constant for the first four surveys but declined in 2000 and again in 2003 to a low of 834 t. The biomass has steadily increased since then with the highest estimate (2118 t) in 2013, and the second highest estimate in the series (1983 t) from the latest survey (Table 4, Figure 3). Most of the biomass was from the west coast South Island region, with Tasman and Golden Bays contributing little of the total biomass (Figure 4). Sixty-five percent of the biomass was south of Cape Foulwind, and 71% was from the 100–200 m depth range (Table 7). Biomass of adult fish (over 45 cm) was 1821 t and juveniles were about 8% of the total (Table 5, Figure 5, Figure 7). Figure 8 shows that males make up slightly more of the juvenile biomass than females do, and females make up slightly more of the adult biomass than do males. Adult and juvenile indices track each other fairly closely.

There were fewer fish under 45 cm caught on the 2015 survey than in 2009, 2011 and 2013 (Figure 5d). Few fish grow larger than 40 cm in the Tasman and Golden Bay region (Figure 5d). No obvious year class modes were apparent in the length frequency distribution. The sex ratio (male:female) was 1.27:1 overall (Figure 5d), a decrease from the 2013 survey (1.63:1) but very similar to 2011 (1.24:1). All females under 50 cm total length were immature or had resting gonads, but above this size, most had maturing gonads. Most males under 40 cm were immature or resting, and most males over 40 cm were maturing (Table 9a). The survey takes place in autumn; the spawning period of giant stargazer is believed to be in winter.

3.7.2 Red cod

Red cod were caught at 39 stations, with the highest catch rates in strata 7 and 5 (Figure 2b, Table 3). Total biomass estimates were fairly stable for the first four surveys varying from 2546 t to 3370 t. There was a sharp decline in 2000 to 414 t but the biomass gradually recovered to 2782 t in 2009. The biomass estimate of 989 t from the 2015 survey was the third lowest in the series, down from 1247 t in 2013 (the fourth lowest estimate in the time series) and continues a declining trend since 2009 (Table 4, Figure 3). The greatest decline was in the biomass from the west coast with little change in the biomass from the Tasman and Golden Bay region (Figure 4).

Population numbers also declined by almost 50% from 2013 after dropping around 40% from 2011 to 2013, with fewer fish over 20 cm (Figure 5h). The lack of 1+ fish (25–40 cm) from this survey may be significant for the commercial fishery in 2015–16 given the dependence on recruitment (Beentjes 2000). The decrease of biomass from stratum 1 also continued with 579 t in 2011, down to just 3 t in 2013 and no catch in 2015. The estimated biomass in Tasman and Golden Bays totalled 11.5 t. Seventy-two percent of the total biomass was from two strata (5 and 7) and 98% was from depths less than 200 m (Table 7). Adult biomass (over 51 cm) was 483 t, almost 50% of the total (Table 5, Figures 6, and 8). In most years juvenile males have been more abundant than juvenile females and adults of both sexes (Figure 8). Adult males have historically contributed the least to total biomass. Adult and juvenile indices previously tracked each other fairly closely. More fish in the 10–20 cm range (0+ fish) were caught than in any previous survey (Figure 5h). The sex ratio was 0.99:1 overall (Figure 5h). Almost all red cod examined had immature or resting gonads but a few larger fish were ripening or spent (Table 9a). Only eight males and one female were running ripe. Since red cod spawn from late winter to spring (Ministry of Fisheries 2009), fish with maturing or ripe gonads were not expected during the survey.

3.7.3 Red gurnard

Red gurnard were caught at all stations in Tasman and Golden Bays, and all stations in depths less than 100 m along the west coast (Figure 2c). The highest catch rates were in strata 11, 14 and 19 (Table 3). The biomass estimates were consistent from 1992–2000 but showed a sharp decline in 2003. There was a steady increase over the last five surveys and the estimate for 2015 (1776 t) was the highest in the time series, 66% higher than the previous high in 2011 (1070 t) (Table 4, Figure 3). A significant proportion of the biomass has always occurred in the Tasman and Golden Bay region, although for the last three surveys markedly more was from the west coast South Island (Figure 4).

The length frequency distribution was similar to 2013, with large numbers of fish less than 30 cm (Figure 5i). As in all previous surveys, there were larger numbers of smaller fish from the Tasman and Golden Bay region, and larger numbers of bigger fish from the west coast. The estimate of combined recruited and adult biomass (30 cm or over) was 1335 t (75% of the total biomass) with 952 t of that (71%) occurring on the west coast (Table 5, Figure 7). Juvenile males contribute more to the biomass than do juvenile females, but adult biomass is fairly even between the sexes (Figure 8). Adult and juvenile indices track each other fairly closely. Ninety-seven percent of the red gurnard biomass was in depths less than 100 m and no gurnard were caught deeper than 200 m (Table 7). The overall sex ratio was 1.46:1 (Figure 5i). Most red gurnard longer than 30 cm and a few smaller fish had developing or mature gonads (Table 9a). Red gurnard have a long spawning period and ripe individuals can be found in the Hauraki Gulf throughout the year (Ministry of Fisheries 2009).

3.7.4 Spiny dogfish

Spiny dogfish were caught at 56 stations with the highest catch rates in strata 1, 7 and 15 (Table 3, Figure 2d). The biomass estimates were relatively stable from 1992 to 2007 but there was a sharp increase in 2009 to 10 270 t (Table 4, Figure 3). The 2011 biomass was similar to the rest of the time

series, decreasing to 6154 t, the 2013 estimate was the highest in the time series at 15 086 t, and the biomass for 2015 decreased to 7613 t. The associated CV for the 2015 biomass estimate is (21%). Very little of the total biomass was from the Tasman and Golden Bay region (Figure 4).

There was a decrease in the proportion of fish greater than 70 cm and overall the numbers decreased from 2013 (Figure 5l). Adult fish made up about 58% of the total biomass (Table 5, Figure 7). Juvenile males have historically made up the smallest portion of the total biomass (Figure 8). Adult and juvenile indices track each other fairly closely through the time series. Almost 96% of the biomass was at depths less than 200 m (Table 7). The sex ratio was 0.90:1 overall (Figure 5l). Gonad stages for spiny dogfish are shown in Table 9b. For males overall, the majority are mature (approximately 74%). For females overall most were mature (approximately 71%). More than half of all females contained pups. All males less than 40 cm and all females less than 50 cm were immature whilst all but 1 fish greater than 60 cm were developing or mature.

3.7.5 Tarakihi

Tarakihi were caught at 45 stations with the highest catch rates in strata 12, 13 and 15 (Table 3, Figure 2e). The biomass estimates show a gradually declining trend until 2003 with a sharp increase in 2005 and a subsequent drop in the last five surveys to levels similar to that seen from 1997 to 2003 (Table 4, Figure 3). The majority of the biomass was always from the west coast region, with little from Tasman and Golden Bays. Almost 95% of the biomass estimate was recruited fish (25 cm or over) while the adult biomass (over 31 cm) was 88% or 935 t (Table 5). The juvenile biomass decreased as a proportion of the total since the 2011 survey and is now similar to previous years (Figure 7). Adult females have historically contributed the majority of the total biomass, followed by adult males (Figure 8).

The length frequency data shows far fewer fish between 16 and 20 cm compared with any previous survey. There are also fewer fish between 27 and 32 cm compared to 2013 (Figure 5m). There were distinct modes at 10–14 cm (0+ fish), and at about 21–24 cm (2+ fish). The majority of fish under 25 cm were from Tasman and Golden Bays (Figure 5m). The majority of fish over 20 cm were from the west coast. Of the total tarakihi biomass (1060 t), over 95% was on the west coast (1013 t), and over 72% (771 t) of the total was at depths between 100 and 200 m (Table 7). The sex ratio for the estimated population was 0.55:1 (Figure 5m). There was little reproductive development in tarakihi under 30 cm FL, but for bigger fish the full range of gonad stages was recorded, although the majority were still resting or starting to mature (Table 9a). A large majority (84%) of males greater than 30 cm were spent as were over 25% of the adult females.

3.7.6 Trends in other species

Barracouta

Barracouta were caught at 48 stations and represented 8% of the total catch (Appendix 3). The highest catch rates were in strata 1 and 7 (Table 3). The biomass has varied almost 3-fold during the series but does not show a consistent trend (Table 4, Figure 3). The majority of the biomass came from the west coast region, with little from Tasman and Golden Bays (Figure 4). The 2015 estimate of 2662 t was the third lowest in the series. In most years that had a strong 0+ mode, a large proportion of these fish were from the Tasman and Golden Bay region (Figure 6a). In 2013 however, this mode was almost entirely made up of fish from the west coast. We note that similar to 1992, 1997, and 2011, the smaller fish in this mode have come from Tasman and Golden Bays. Also, there were usually distinct modes centred at about 45 and 55 cm in most years, both of which were all but absent in 2013 and are again weak in 2015.

Blue warehou

Blue warehou were caught at 23 stations with the highest catch rates in strata 11 and 15 (Table 3). The biomass estimate for 2015 was slightly lower than that for 2013 and is in the mid-range of the series estimates (Table 4, Figure 3). The majority of the biomass has always been from the west coast region (Figure 4). There was a strong mode in the length frequency distribution for 2015 at 10–20 cm (0+ fish). While not as strong as that seen in 2009 or 2013, it is stronger than that for 2011 (Figure 5b). Stevenson & Hanchet (2000) noted that because of the poor precision in the biomass estimates the surveys are probably not suitable for monitoring adult or pre-recruit blue warehou. However, Stevenson (2007b) suggested that the survey may be able to provide information on year class strengths, but ageing of the commercial catch would be required to show if this is the case.

Carpet shark

Carpet sharks are probably the most abundant non-commercial species in the survey area, and particularly in the Tasman and Golden Bay strata. Biomass estimates for the survey series are listed in Appendix 5. Biological data were collected in this survey primarily to provide information on diet, a requirement for an ecosystem model being developed for the Nelson Bays region. Males ranged between 30 and 76 cm TL, and females were 34–91 cm TL (Figure 6). Carpet sharks have been routinely measured in only one other survey in this series (KAH0904).

Gemfish

Gemfish were only caught in low numbers at 11 stations (Appendix 3, Table 8). The biomass estimates from the series do not show any particular trend (Table 4, Figure 3). No gemfish have ever been caught in the Tasman and Golden Bay region (Figure 4). The length frequency distributions occasionally showed apparently strong year classes (Figure 5c). No strong year classes have been observed in the last five surveys.

Hake

Hake were taken in small quantities from 21 stations (Table 8) and almost all fish were under 50 cm (Figure 6). The biomass estimate of 81 t was the higher than the previous two surveys, but the biomass estimates have varied widely throughout the time series (Figure 3, Table 4).

Hoki

Hoki were taken from 21 stations, all on the west coast south of Cape Foulwind (Tables 3 and 8). The length frequency distribution for hoki showed a strong mode at 21–31 cm (0+ fish) and a much weaker mode at around 36–44 cm (1+) (Figure 6). In 2011 the strongest mode was for 1+ fish for the first time in the time series, but in 2013 and again in 2015 the stronger mode had reverted to 0+ fish. The biomass estimate of 2128 t was the second highest in the series and may indicate a stronger than average 0+ year class.

Jack mackerel (*Trachurus declivis*)

T. declivis was caught at 14 stations (Appendix 3). The biomass estimate of 43 t was the lowest in the series (Figure 3, Table 4). Most of the biomass was from the west coast. There were no obvious modes in the length frequency plot (Figure 5e).

NB: *T. novaezelandiae* are not presented as, apart from juveniles, they were found to be not well monitored by the survey (Stevenson 2007b) in a 2007 review of species for inclusion in reports for the time series. Overall biomass for *T. novaezelandiae* was found to vary widely between surveys with high CVs whether biomass estimates were high or low.

John dory

John dory were caught at 27 stations with the highest catch rates in strata 1 and 18 (Appendix 3, Table 3). The biomass estimate of 487 t was the highest in the time series, more than 22% higher than the previous high in 2011 (Table 4, Figure 3). In some years, more biomass was from the Tasman and Golden Bay region, but in most years more has been from the west coast (Figure 4), mostly north of Cape Foulwind (Table 7). In 2015, less than 30% was from the Tasman and Golden Bay region. The length frequency distribution showed a mode at 23–33 cm (1+ fish), which was stronger than the 1+ mode from 2011 and 2013, and almost as strong as that from 2009 (Figure 5f). Most of the smaller fish were from the Tasman and Golden Bay region, which is typical of most years (Figure 5f).

Ling

Ling were caught at 31 stations with the highest catch rates in strata 12, 13 and 16 (Appendix 3, Table 3). The biomass estimate of 472 t was the highest in the time series. Whilst there does not appear to be any consistent trend over the series, a relatively steady increase since 2000 is apparent (Table 4, Figure 3). As in all other surveys, the vast majority of the biomass in 2015 was from the west coast region, with little from Tasman and Golden Bays (Figure 4). The scaled length frequency distribution for 2011 showed a strong mode at 36–48 cm for both sexes, but this mode was weaker in 2013 and 2015 (Figure 5g). There was a relatively large number of fish from 70–110 cm (as seen in 2013), and the relatively high numbers of fish greater than 100 cm would account for the higher biomass estimate for 2015.

Rig

Rig were caught at 32 stations, with the highest catch rates in strata 5, 14 and 18 (Appendix 3, Table 3). The estimated biomass of 622 t was the highest for any survey in the series (Table 4, Figure 3). Biomass from the Tasman and Golden Bay regions accounted for just over a third of the total in 2015 (Figure 4). The length frequency distributions for 2015 showed a strong mode at 54–64 cm which was present for both males and females and another weaker mode at about 80–86 cm (Figure 5j). There were far fewer females greater than about 70 cm, which may indicate that the survey does not sample adult female rig well.

School shark

School shark were caught at 45 stations with the highest catch rates in strata 17 and 18 (Appendix 3, Table 3). The estimated biomass of 788 t was the third lowest of the series but is comparable to estimates recorded since 2000 (Table 4, Figure 3). Most of the biomass was from the west coast (Figure 4). The length frequency distribution for 2015 showed three modes at around 34–41, 45–55 and 55–65 cm for both sexes, whereas only the smallest mode was seen in 2013 (Figure 5k). There were no obvious size differences between the Tasman and Golden Bay region and the west coast (Figure 5k).

Snapper

A large number of 1+ snapper (around 14–19 cm) were caught on the 2009 survey (Figure 6) (Stevenson & Hanchet 2010) and this appeared to indicate a strong year class of fish spawned over the summer of 2007–08. In 2013, a large number of 5+ fish (around 30–42 cm) were caught, and the very strong mode between 35 and 48 cm in 2015 confirms that this is a strong year class. In addition, a market sampling programme in 2013–14 found that this year class comprised over 60% of the commercial fishery. This survey is not optimised for snapper but the strength of this year class has markedly increased the catch of snapper.

3.8 Tagging

316 elasmobranchs were tagged and released during the 2015 survey (Table 8). Of these, 142 were school shark (80 males, 62 females, 50–144 cm), 97 were rig (49 males, 48 females, 44–126 cm), 39 were rough skate (14 males, 25 females, 29–61 cm), and 38 were smooth skate (25 males, 13 females, 18–117 cm).

A total of 2563 elasmobranchs have been tagged and released since the beginning of the time series, (Table 10). Of these, 71 have been returned (Table 11). Release positions of tagged elasmobranchs are shown in Figure 9 and are the same as the hauling positions of the stations at which they were caught. Note that several individuals of a given species may often be released at one site. Recapture positions are shown in Figure 10.

1793 school shark have been tagged since the beginning of the time series with the largest number coming from the 2011 survey (233 individuals). To date, 69 school shark tags have been returned, with more returns coming from those tagged on the 2009 survey than any other. The majority of the recaptured sharks have been taken on the west coast of the South Island and in Golden and Tasman Bays, suggesting that movement for most individuals is fairly limited. However, some recaptures have also occurred in Cook Strait, North Taranaki Bight, North Cape, and off the Canterbury and Otago coasts, indicating that at least some individuals can travel reasonable distances. Further, some have also been recaptured in Australian waters on both the northern and southern coasts of Tasmania, and in the Great Australian Bight. It is believed that there is regular interchange of school sharks between Australian and New Zealand populations (Hurst et al. 1999, Francis 2010) although the exact nature and extent is not currently known.

Tagging of rig began in 2007 and since then 257 individuals have been tagged and released with more released from the 2015 survey than any other (97 individuals). To date there has been one returned rig tag, tagged in 2011. Unfortunately, the location of the recapture was not supplied with the return.

Rough skate tagging began on the 2003 survey and since then 403 individuals have been tagged and released with over half from the 2011 and 2013 surveys (116 and 106 tags respectively). To date two rough skate tags have been returned, one from the west coast of the South Island near Haast, the other with locality data no more specific than the west coast of the South Island.

Smooth skate tagging also began on the 2003 survey with a total of 110 individuals tagged and released. More were tagged and released on the 2015 survey than any other (38 individuals). To date, no smooth skate tags have been returned.

4. CONCLUSIONS

The 2015 (12th) survey successfully extended the March-April RV *Kaharoa* time series for the west coast of the South Island and Tasman and Golden Bays. The 2015 results show that the series continues to monitor the target species and adults and/or pre-recruits and juveniles of several other species. The biomass estimates for red gurnard and john dory were the highest in the series, whilst those for giant stargazer, spiny dogfish, and tarakihi were within the range of previous surveys. The biomass for red cod was also within the range of previous surveys but was strongly influenced by one large catch and had a correspondingly high CV. The lack of 1+ fish in the length frequency distribution for red cod is exceptional for the series and may indicate a reduced catch in the following commercial fishing season. The high numbers of 1+ fish seen in the length frequency for john dory indicates that the increase in abundance since 2000 should continue for at least another two years. The survey did not demonstrate extremely high or low catchability in either Tasman and Golden Bays or the west coast South Island, with both areas having a rank close to the mean for the time series.

5. ACKNOWLEDGMENTS

This project was funded by the Ministry for Primary Industries under project INT2012-01. We thank the skipper of RV *Kaharoa,* Lindsay Copland, and his crew for their active cooperation and enthusiastic assistance during the trawl survey. The other scientific staff who participated in the survey were Brent Wood, Peter McMillan, Derrick Parkinson, and Warrick Lyon. Their hard work and dedication were much appreciated. Thanks also to the NIWA invertebrate group for identification of invertebrate specimens. Peter Horn provided a useful review of the document.

6. REFERENCES

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

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

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

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

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

Francis, M.P. (2010). Movement of tagged rig and school shark among QMAs, and implication for stock management boundaries. *New Zealand Fisheries Assessment Report 2010/3*. 24 p.

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

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

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

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's Manual v1.2-2011-09-28 *NIWA Technical Report 134*. 54p.

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.

Hurst, R.J.; Bagley, N.W.; McGregor, G.A.; Francis, M.P. (1999). Movements of the New Zealand school shark, *Galeorhinus galeus*, from tag returns. *New Zealand Journal of Marine and Freshwater Research 33(1)*: 29–48.

MacGibbon, D.J.; Stevenson, M.L. (2013). Inshore trawl survey of the west coast South Island and Tasman and Golden Bays, March-April 2013 (KAH1305). *New Zealand Fisheries Assessment Report 2013/66.* 115 p.

Ministry of Fisheries (2009). Report from the Fishery Assessment Plenary, May 2009: stock assessments and yield estimates. Ministry of Fisheries, Wellington, New Zealand, 1036 p. (Unpublished report held in NIWA library, Wellington.)

R Core Team (2012). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL http://www.R-project.org/.

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

Stevenson, M.L. (2002). Inshore trawl survey of west coast South Island and Tasman and Golden Bays, March-April 2000 (KAH0004). *NIWA Technical Report 115.* 71 p.
Stevenson, M.L. (2004). Inshore trawl survey of the west coast South Island and Tasman and Golden Bays, March-April 2003 (KAH0304). *New Zealand Fisheries Assessment Report 2004/04.* 69 p.
Stevenson, M.L. (2006). Inshore trawl survey of the west coast South Island and Tasman and Golden Bays, March-April 2005 (KAH0504). *New Zealand Fisheries Assessment Report 2006/04.* 69 p.
Stevenson, M.L. (2007a). Inshore trawl survey of the west coast South Island and Tasman and Golden Bays, March-April 2007 (KAH0704). *New Zealand Fisheries Assessment Report 2007/41.* 64 p.
Stevenson, M.L. (2007b). Review of data collected by the WCSI series to determine for which species relative abundance trends and size comparison information should be provided in each survey report. Final Research Report for the Ministry of Fisheries Research Project INT2006-01. (Unpublished report held in NIWA Wellington library.)
Stevenson, M.L. (2012). Inshore trawl survey of the west coast South Island and Tasman and Golden Bays, March-April 2011 (KAH1104). *New Zealand Fisheries Assessment Report 2012/50.* 77 p.
Stevenson, M.L.; Hanchet, S.M. (Comps.) (1999). Trawl survey design and data analysis procedures for inshore fisheries research. *NIWA Technical Report 53*. 20 p.
Stevenson, M.L.; Hanchet, S.M. (2000). Review of the inshore trawl survey series of the west coast of the South Island and Tasman and Golden Bays, 1992–97. *NIWA Technical Report 82.* 79 p.
Stevenson, M.L.; Hanchet, S.M (2010). Inshore trawl survey of the west coast South Island and Tasman and Golden Bays, March-April 2009. *New Zealand Fisheries Assessment Report 2010/11.* 77 p.

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

Stratum	Depth (m)	Area (km^2)	Non-trawlable area (km^2)	Station allocation	Successful stations		Station density (km^{-2})
					Phase 1	Phase 2	
1	20–100	1 343	102	4	3	0	448
2	100–200	4 302	300	6	6	0	717
5	25–100	1 224	0	3	3	0	408
6	100–200	3 233	238	3	3	0	1 078
7	25–100	927	0	4	3	0	309
8	100–200	2 354	214	5	5	0	471
9	200–400	1 877	1 456	3	3	0	626
11	25–100	1 438	63	10	5	0	288
12	100–200	2 054	501	5	5	0	411
13	200–400	1 101	466	3	3	0	367
14	25–100	851	36	4	3	0	284
15	100–200	881	373	3	3	0	294
16	200–400	319	35	3	3	0	106
17	20–33	307	27	3	3	0	102
18	20–42	947	30	3	3	0	316
19	20–70	2 436	193	6	6	0	406
Total		25 594	4 034	68	60	0	427

Table 2: Gear parameters for biomass stations by depth range (n, number of stations; s.d., standard deviation).

	n	Mean	s.d.	Range
All stations	60			
Headline height (m)		4.7	0.18	4.0–4.9
Doorspread (m)		81.0	7.48	70.1–93.3
Distance (n. miles)		2.9	0.22	1.9–3.1
Warp:depth ratio		3.5	1.4	2.4–8.3
Tasman and Golden Bays				
20–70 m	12			
Headline height (m)		4.6	0.15	4.3–4.8
Doorspread (m)		73.0	1.8	70.3–76.2
Distance (n. miles)		2.8	0.37	1.9–3.1
Warp:depth ratio		5.1	1.37	3.2–8.3
West coast				
20–400 m	48			
Headline height (m)		4.7	0.19	4–4.9
Doorspread (m)		83	7.01	70.1–93.3
Distance (n. miles)		2.9	0.16	2.1–3.1
Warp:depth ratio		3.1	1.11	2.4–8.0
20–100 m	27			
Headline height (m)		4.8	0.08	4.6–4.9
Doorspread (m)		75	3.69	70.1–83.0
Distance (n. miles)		3.0	0.07	2.9–3.1
Warp:depth ratio		3.9	1.62	2.80–8.0
100–200 m	31			
Headline height (m)		4.7	0.20	4.1–4.9
Doorspread (m)		85.9	3.63	75.7–92.5
Distance (n. miles)		2.9	0.2	2.1–3.1
Warp:depth ratio		2.8	0.05	2.70–2.80
200–400 m	9			
Headline height (m)		4.5	0.24	4.0–4.8
Doorspread (m)		90.7	1.60	88.2–93.3
Distance (n. miles)		2.9	0.11	2.7–3.0
Warp:depth ratio		2.5	0.04	2.40–2.50

Table 3: Mean catch rates (kg km^{-2}) by stratum for the 20 most abundant commercially important species in order of catch abundance. Species codes are given in Appendix 3. –, less than 0.5 kg km^{-2}.

	Species									
Stratum	SPD	BAR	HOK	GIZ	GUR	SNA	RCO	NMP	GSH	SCH
1	916	314	–	1	9	1	–	–	–	12
2	113	79	–	3	8	8	–	3	179	17
5	156	78	–	–	205	11	182	–	–	33
6	2 813	33	–	66	4	2	–	34	42	20
7	1 328	344	–	48	202	–	513	12	19	66
8	303	76	284	176	2	–	7	64	52	75
9	–	8	–	3	–	–	–	10	–	–
11	479	112	8	104	233	–	26	5	3	33
12	285	63	180	253	–	–	32	178	32	43
13	245	31	58	192	–	–	19	174	26	5
14	222	96	51	94	286	–	74	10	–	29
15	844	184	1 052	286	4	–	80	152	35	35
16	142	–	142	221	–	–	7	7	105	–
17	9	216	–	3	153	524	2	11	–	86
18	108	134	–	–	209	336	10	31	–	94
19	93	175	–	3	184	124	1	6	–	18

	Species									
	LIN	SPO	JMN	JDO	SSK	FRO	SQU	WAR	RSO	LEA
1	–	–	–	50	12	–	12	–	–	–
2	–	–	2	46	18	5	14	–	–	–
5	–	107	5	–	17	–	–	9	–	–
6	2	2	–	21	10	9	23	–	–	–
7	–	45	2	17	1	–	1	2	–	–
8	51	2	–	3	1	2	12	–	3	–
9	–	–	–	–	33	–	74	–	14	–
11	14	12	–	–	–	10	6	70	–	–
12	129	2	–	–	18	60	8	2	6	–
13	57	–	–	–	52	40	39	–	113	–
14	6	226	–	–	–	–	1	32	–	–
15	35	12	–	–	3	114	15	79	–	–
16	239	–	–	–	104	4	12	–	54	–
17	1	53	108	49	–	–	1	13	–	21
18	–	107	232	53	–	–	3	4	–	103
19	1	39	50	27	–	–	5	–	–	55

Table 4: Relative biomass estimates (t) and CVs by trip from the entire survey area for species managed under the QMS.

	KAH9204		KAH9404		KAH9504		KAH9701		KAH0004		KAH0304	
Species	Biomass	CV%	Biomass	CV%	Biomass	CV%	Biomass	CV%	Biomass	CV%	Biomass	CV%
Arrow squid	2 765	18	1 195	9	3 467	14	966	13	523	11	2 255	12
Barracouta	2 420	15	5 228	16	4 474	13	2 993	19	1 787	11	4 485	20
Blue warehou	123	40	80	22	113	29	842	31	272	37	191	66
Dark ghost shark	380	17	722	14	767	24	1 591	21	2 259	9	544	15
Elephant fish	21	42	167	33	84	35	94	33	42	63	48	34
Frostfish	24	33	27	23	89	31	259	32	316	16	494	22
Gemfish	130	19	68	29	21	55	704	83	120	30	137	23
Giant stargazer	1 450	14	1 358	17	1 556	16	1 450	15	1 023	12	834	15
Hake	390	25	99	31	5 197	27	1 019	46	15	36	55	47
Hoki	404	16	826	49	3 611	21	1 100	25	103	50	233	22
Jack mackerel												
Trachurus declivis	90	24	97	26	106	20	162	19	168	33	87	21
T. novaezelandiae	258	57	68	23	57	29	363	27	194	46	126	49
John dory	101	29	73	27	27	36	17	31	141	16	288	19
Leather jacket	185	30	230	23	153	34	231	34	236	50	254	18
Lemon sole	86	19	77	25	124	21	68	21	59	19	2	44
Ling	280	19	261	20	373	16	151	30	95	46	150	33
New Zealand sole	68	33	68	16	38	31	45	29	16	32	21	57
Northern spiny dogfish	130	19	159	21	89	28	164	46	256	18	111	27
Red cod	2 690	13	3 370	18	3 077	15	2 546	23	414	26	906	24
Red gurnard	564	16	551	14	577	19	470	13	625	14	270	20
Rig	286	14	378	10	487	10	308	18	333	18	144	22
Rough skate	171	25	198	22	250	22	185	31	186	23	43	34
Sand flounder	98	30	203	23	132	28	106	28	62	22	10	33
School shark	975	21	1 176	40	1 201	35	1 432	25	896	13	655	18
Sea perch	233	21	425	18	667	23	338	14	302	22	76	25
Silver warehou	267	37	64	35	39	19	204	20	99	34	69	27
Smooth skate	330	18	336	18	315	20	302	26	140	29	91	79
Spiny dogfish	3 856	15	7 093	7	8 370	10	5 275	13	4 777	13	4 446	15
Tarakihi	1 351	13	1 403	13	1 417	10	1 087	12	964	19	912	20

Table 4 – continued

	KAH0503		KAH0704		KAH0904		KAH1104		KAH1305		KAH1503	
Species	Biomass	CV%	Biomass	CV%	Biomass	CV%	Biomass	CV%	Biomass	CV%	Biomass	CV%
Arrow squid	889	9	1 228	9	402	16	153	14	308	14	419	21
Barracouta	2 763	13	2 582	14	3 512	17	4 958	21	3 423	16	2 662	21
Blue warehou	116	40	286	50	175	27	263	27	248	22	222	36
Dark ghost shark	832	22	2 215	21	900	17	2 348	23	981	23	1 211	55
Elephant fish	59	33	28	53	185	83	169	53	110	26	72	45
Frostfish	423	45	529	39	835	35	251	29	424	24	341	34
Gemfish	474	49	101	19	143	29	101	34	113	28	186	17
Giant stargazer	1 458	19	1 630	13	1 952	19	1 620	16	2 118	9	1 984	11
Hake	1 673	30	359	35	212	56	44	36	36	41	80.6	37
Hoki	701	55	772	52	1 302	46	1 527	61	1 545	43	2 128	36
Jack mackerel												
Trachurus declivis	118	22	62	23	79	23	217	37	106	43	43	40
T. novaezelandiae	98	21	214	62	399	24	95	39	56	35	399	38
John dory	222	14	174	26	269	23	327	18	231	21	487	16
Leather jacket	139	20	252	40	323	27	111	20	231	19	239	30
Lemon sole	21	42	119	46	62	16	62	16	43	37	90	22
Ling	274	37	180	27	291	37	234	43	405	44	472	53
New Zealand sole	27	45	39	71	75	32	26	42	25	26	92	40
Northern spiny dogfish	180	22	134	29	189	28	368	29	211	26	259	22
Red cod	2 610	18	1 638	19	2 782	25	2 055	28	1 247	38	989	45
Red gurnard	442	17	553	17	651	18	1 070	17	754	12	1 776	16
Rig	153	19	383	33	274	26	264	20	278	20	622	27
Rough skate	58	30	256	23	114	22	261	21	243	24	150	20
Sand flounder	62	25	67	47	170	32	71	23	48	52	84	33
School shark	774	14	816	20	1 085	16	1 099	14	912	12	788	17
Sea perch	150	20	163	19	336	20	548	39	161	20	191	21
Silver warehou	72	28	165	20	80	24	69	32	68	28	109	32
Smooth skate	80	30	55	44	67	61	180	34	188	29	342	25
Spiny dogfish	6 175	12	6 291	14	10 270	19	6 154	14	15 086	57	7 613	21
Tarakihi	2 050	12	1 189	21	1 088	22	1 331	15	1 272	22	1 060	17

Table 5: Recruited biomass estimates and target species adult biomass estimates (t). –, less than 0.5 t.

Species	Recruited length (cm)	Tasman and Golden Bays		West coast		Total survey area		50% maturity length (cm)	Total survey area	
		Biomass	CV %	Biomass	CV %	Biomass	CV %		Biomass	CV %
Barracouta	50	597	44	1 949	24	2 546	21			
Blue warehou	45	–	–	203	40	203	40			
Giant stargazer	30	7	31	1 969	11	1976	11	45	1 822	11
Hoki	65	–	–	7	81	7	81			
John dory	25	129	19	356	21	485	16			
Ling	65	–	–	419	60	419	60			
Red cod	40	6	76	836	54	843	53	50	483	50
Red gurnard	30	383	26	952	24	1 335	19	30	1 335	19
Rig	90	31	40	138	35	170	29			
Sand flounder	25	54	36	2	62	56	35			
Spiny dogfish								58	2 546	34
								72	1 836	24
School shark	90	62	69	370	25	432	24			
Silver warehou	25	–	–	16	37	16	37			
Tarakihi	25	16	49	991	18	1 007	18	31	935	19

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

Species	Year class	Length range (cm)	Biomass	CV (%)
Barracouta	0 +	<15	<0.1	54.7
	1 +	15–25	31.8	45
	2 +	26–36	1.7	46.8
	3 +	37–52	95	48.1
Blue warehou	0 +	<21	15.4	36.3
	1 +	22–31	1.6	60.4
	2 +	32–42	<0.1	100
Hake	0 +	<19	13.5	42.5
	1 +	19–28	36.7	49.5
	2 +	29–42	11.3	74.3
Hoki	0 +	15–30	2 039	37.2
	1 +	31–44	55.6	53.7
Jack mackerel *T. novaezelandiae*	1 +	13–20	239.2	42.9
Red cod	0 +	<20	41.9	48
	1 +	21–35	67.3	24.8
Red gurnard	0 +	<17	40.6	51.4
	1 +	17–27	299.6	42.9
School shark	0 +	<44	26.8	32.7
	1 +	44–54	44.8	43.6
Silver warehou	1 +	13–23	91.6	36.7
Tarakihi	0 +	10–14	18.5	20.6
	1 +	15–21	11.6	39.9
	2 +	22–28	67.5	29.2

Table 7: Estimated biomass (t) (and % CV) by stratum for the 20 most abundant commercially important species in order of catch abundance. Species codes are given in Appendix 3. –, no data, + less than 0.5 t.

	Species code									
Stratum	SPD	BAR	HOK	GIZ	GUR	SNA	RCO	NMP	GSH	SCH
1	1 230	421	–	1	13	2	–	+	–	16
	(89)	(78)	(0)	(100)	(28)	(100)	(0)	(50)	(0)	(82)
2	487	338	–	14	33	34	–	13	771	75
	(29)	(91)	(0)	(52)	(30)	(41)	(0)	(56)	(85)	(51)
5	190	95	–	–	251	13	223	–	–	40
	(70)	(39)	(0)	(0)	(21)	(64)	(77)	(0)	(0)	(51)
6	910	910	–	212	13	6	–	108	136	64
	(44)	(44)	(0)	(24)	(76)	(100)	(0)	(6)	(59)	(61)
7	1 231	319	–	44	187	–	476	11	18	61
	(68)	(38)	(0)	(55)	(42)	(0)	(84)	(96)	(94)	(61)
8	713	179	668	415	4	–	16	150	124	177
	(53)	(44)	(95)	(28)	(100)	(0)	(69)	(41)	(49)	(47)
9	–	16	–	6	–	–	–	20	–	–
	(0)	(72)	(0)	(59)	(0)	(0)	(0)	(100)	(0)	(0)
11	689	160	11	149	334	–	38	8	4	47
	(45)	(29)	(84)	(50)	(32)	(0)	(65)	(52)	(100)	(62)
12	585	130	370	520	1	–	67	366	67	88
	(16)	(39)	(44)	(23)	(100)	(0)	(23)	(20)	(29)	(36)
13	270	34	63	212	–	–	21	192	28	5
	(22)	(69)	(36)	(36)	(0)	(0)	(13)	(77)	(62)	(100)
14	189	82	44	80	243	–	63	9	–	24
	(15)	(34)	(100)	(61)	(84)	(0)	(93)	(92)	(0)	(42)
15	744	162	927	252	4	–	71	134	31	31
	(46)	(28)	(41)	(5)	(70)	(0)	(32)	(31)	(57)	(24)
16	45	–	45	71	–	–	3	2	34	–
	(59)	0	(62)	(10)	(0)	(0)	(67)	(100)	(24)	(0)
17	3	66	–	1	47	161	0.5	4	–	26
	(29)	(99)	(0)	(71)	(27)	(33)	(64)	(52)	(0)	(68)
18	102	127	–	+	198	319	9	29	–	89
	(75)	(25)	(0)	(100)	(15)	(45)	(83)	(70)	(0)	(69)
19	226	426	–	7	448	302	2	14	–	44
	(28)	(58)	(0)	(34)	(27)	(71)	(62)	(31)	(0)	(51)

Table 7–continued.

	Species code									
Stratum	LIN	SPO	JMN	JDO	SSK	FRO	SQU	WAR	RSO	LEA
1	–	–	–	67	11	47	–	–	56	–
	(0)	(0)	(0)	(60)	(75)	(100)	(0)	(0)	(21)	(0)
2	1	–	10	76	47	13	–	–	73	36
	(72)	(0)	(100)	(85)	(29)	(54)	(0)	(0)	(47)	(69)
5	–	131	6	21	0.5	26	7	–	–	4
	(0)	(55)	(41)	(100)	(100)	(57)	(51)	(0)	(0)	(100)
6	7	–	–	–	36	4	–	–	22	55
	(63)	(0)	(0)	(0)	(73)	(100)	(0)	(0)	(100)	(59)
7	–	11	2	15	2	16	23	–	2	6
	(0)	(67)	(61)	(100)	(39)	(75)	(10)	(0)	(100)	(100)
8	2	2	–	–	35	18	–	–	10	20
	(59)	(100)	(0)	(0)	(26)	(56)	(0)	(0)	(46)	(63)
9	1	–	–	–	41	18	–	–	–	0.5
	(100)	(0)	(0)	(0)	(13)	(50)	(0)	(0)	(0)	(100)
11	20	67	7	–	12	45	74	–	–	0.5
	(65)	(34)	(71)	(0)	(51)	(40)	(38)	(0)	(0)	(100)
12	265	2	–	–	43	7	–	–	–	26
	(92)	(100)	(0)	(0)	(22)	(72)	(0)	(0)	(0)	(57)
13	63	4	–	–	14	2	–	–	2	29
	(50)	(100)	(0)	(0)	(50)	(100)	(0)	(0)	(100)	(100)
14	5	51	+	–	7	13	2	–	–	–
	(24)	(86)	(100)	(0)	(80)	(78)	(100)	(0)	(0)	(0)
15	30	94	–	–	26	2	–	–	–	4
	(86)	(21)	(0)	(0)	(13)	(100)	(0)	(0)	(0)	(50)
16	76	–	–	–	6	–	–	–	–	5
	(48)	(0)	(0)	(0)	(45)	(0)	(0)	(0)	(0)	(53)
17	+	+	33	15	+	+	+	15	2	1
	(100)	(31)	(75)	(43)	(50)	(100)	(100)	(92)	(48)	(100)
18	–	–	219	50	1	12	–	83	30	–
	(0)	(0)	(53)	(27)	(100)	(39)	(0)	(39)	(56)	(0)
19	–	5	121	66	28	20	4	134	35	–
	(0)	(79)	(74)	(29)	(80)	(47)	(100)	(21)	(41)	(0)

Table 8: Number of biological and length frequency records. Measurement methods; 1, fork length; 2, total length; 5, pelvic length; G, chimaera length. †, data includes one or more of the following: fish length, fish weight, gonad stage, otoliths, spines. Species codes are given in Appendix 3.

		Length frequency data		Biological data (†)			
Species code	Measurement method	No. of samples	No. of fish	No. of samples	No. of fish	No. of otoliths or spines	No. of tagged fish
ATT	1	5	114				
BAR	1	46	1 689				
BCO	2	2	10				
BRI	2	6	24				
CAR	2	42	232	42	232		
ELE	1	8	37				
EMA	1	1	3				
ESO	2	9	413				
FRO	1	20	436				
GFL	2	1	2				
GIZ	2	46	859	41	545	387	
GSH	G	35	587				
GUR	1	41	2 461	41	573	397	
HAK	2	16	396				
HAP	2	7	9				
HEP	2	1	2				
HEX	2	1	1				
HOK	2	20	1 189				
JDO	2	27	374	27	337		
JGU	1	2	4				
JMD	1	13	52				
JMM	1	1	1				
JMN	1	24	700				
KIN	1	6	7				
LEA	2	8	656				
LIN	2	31	354				
LSO	2	22	471				
NMP	1	45	1 728	45	743	459	
NSD	2	12	146	3	80		
PCO	2	1	5	1	5		
RBM	1	2	2				
RCO	2	39	1 207	39	552	357	
RSK	5	25	92	25	92		39
RSO	1	11	77				
SBR	2	1	12	1	12		
SCH	2	45	531	45	436		142
SDO	2	1	91				
SFL	2	10	344				
SNA	1	20	574				
SPD	2	56	3 362	54	931		
SPE	2	35	886				
SPO	2	32	474	32	321		97
SSK	5	24	68	24	68		38
SWA	1	32	528	18	146		
THR	2	1	1	1	1		
TRU	1	1	1				
TUR	2	1	1				
WAR	1	20	375	1	1		

Table 9: Numbers of the four target species sampled at each reproductive stage (small fish of undetermined sex were not included). –; no data.

a) Teleosts

	Male gonad stages					Female gonad stages					
Length (cm)	1	2	3	4	5	1	2	3	4	5	Total
Giant stargazer											
11–20	6	–	–	–	–	6	–	–	–	–	11
21–30	6	–	–	–	–	8	–	–	–	–	14
31–40	20	5	4	–	–	13	–	–	–	–	42
41–50	31	27	30	9	24	27	2	–	–	–	150
51–60	10	25	2284	6	21	36	36	–	–	1	163
61–70	1	3	3	1	10	21	100	3	–	12	154
>70	–	–	–	–	–	–	9	1	–	1	11
Total	74	60	65	16	55	110	147	5	0	13	545
Red cod											
11–20	67	–	–	–	–	69	–	–	–	–	136
21–30	65	–	1	–	–	37	–	–	–	–	103
31–40	76	5	15	5	–	45	–	–	–	–	146
41–50	37	2	8	1	1	33	–	–	–	–	146
51–60	6	–	2	–	–	61	1	1	1	–	82
>60	–	–	–	–	–	5	–	2	–	3	10
Total	251	7	26	6	1	250	1	3	1	3	549
Red gurnard											
<21	21	–	–	–	–	8	–	–	–	–	24
21–30	35	19	7	17	28	45	6	1	–	4	291
31–40	3	1	9	68	61	25	70	16	1	37	291
>40	–	1	1	14	4	3	35	9	1	18	86
Total	54	21	17	99	93	81	111	26	2	59	563
Tarakihi											
11–20	95	–	–	–	–	115	–	–	–	–	210
21–30	38	–	–	–	17	77	1	–	–	–	133
31–40	3	–	3	15	72	67	105	4	2	40	311
>40	–	–	–	1	10	2	21	3	–	31	68
Total	136	0	3	16	99	261	127	7	2	71	722

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

Table 9—continued.

b) Elasmobranchs

	Male gonad stages			Female gonad stages						
Length (cm)	1	2	3	1	2	3	4	5	6	Total
Spiny dogfish										
<=40	18	–	–	25	–	–	–	–	–	43
41–50	32	2	–	39	–	–	–	–	–	73
51–60	5	40	93	25	44	–	–	–	–	207
61–70	1	6	193	–	19	24	13	96	10	362
71–80	–	–	8	–	1	4	23	146	16	198
>80	–	–	–	–	–	–	4	37	1	42
Total	56	48	294	89	64	28	40	279	27	925

Maturity stages used were:

Males
1. Immature (claspers shorter than the pelvic fins)
2. Maturing (Claspers at least as long as the pelvic fins but soft)
3. Mature (claspers longer than the pelvic fins and hard and firm)

Females
1. Immature (No eggs visible in the ovary)
2. Maturing (Non-yolked eggs visible in the ovary);
3. Mature (Yolked eggs in the ovary, uterus small and firm);
4. Ripe ('Candle' of eggs in the uterus, no embryos visible)
5. Running ripe (embryos visible in the uterus);
6. Spent (Uterus flabby and may be bloodshot. Yolked eggs may be present in the ovary)

Table 10: Number of tagged and released elasmobranchs by species for each survey.

Trip	RSK	SCH	SPO	SSK	Total
KAH9204	–	195	–	–	195
KAH9404	–	131	–	–	131
KAH9504	–	209	–	–	209
KAH9701	–	158	–	–	158
KAH0004	–	–	–	–	0
KAH0304	21	144	–	9	174
KAH0503	25	141	–	16	182
KAH0704	56	112	31	7	206
KAH0904	40	151	29	3	223
KAH1104	116	233	45	17	411
KAH1305	106	177	55	20	358
KAH1503	39	142	97	38	316
Total	403	1 793	257	110	2 563

Table 11: Number of returns from tagged and released elasmobranchs by species for each survey.

Trip	RSK	SCH	SPO	SSK	Total
KAH9204	–	–	–	–	0
KAH9404	–	–	–	–	0
KAH9504	–	4	–	–	4
KAH9701	–	2	–	–	2
KAH0004	–	–	–	–	0
KAH0304	–	1	–	–	1
KAH0503	1	13	–	–	14
KAH0704	–	12	–	–	11
KAH0904	–	25	–	–	24
KAH1104	1	9	–	–	0
KAH1305	–	3	–	–	0
KAH1503					
Total	2	69	0	0	71

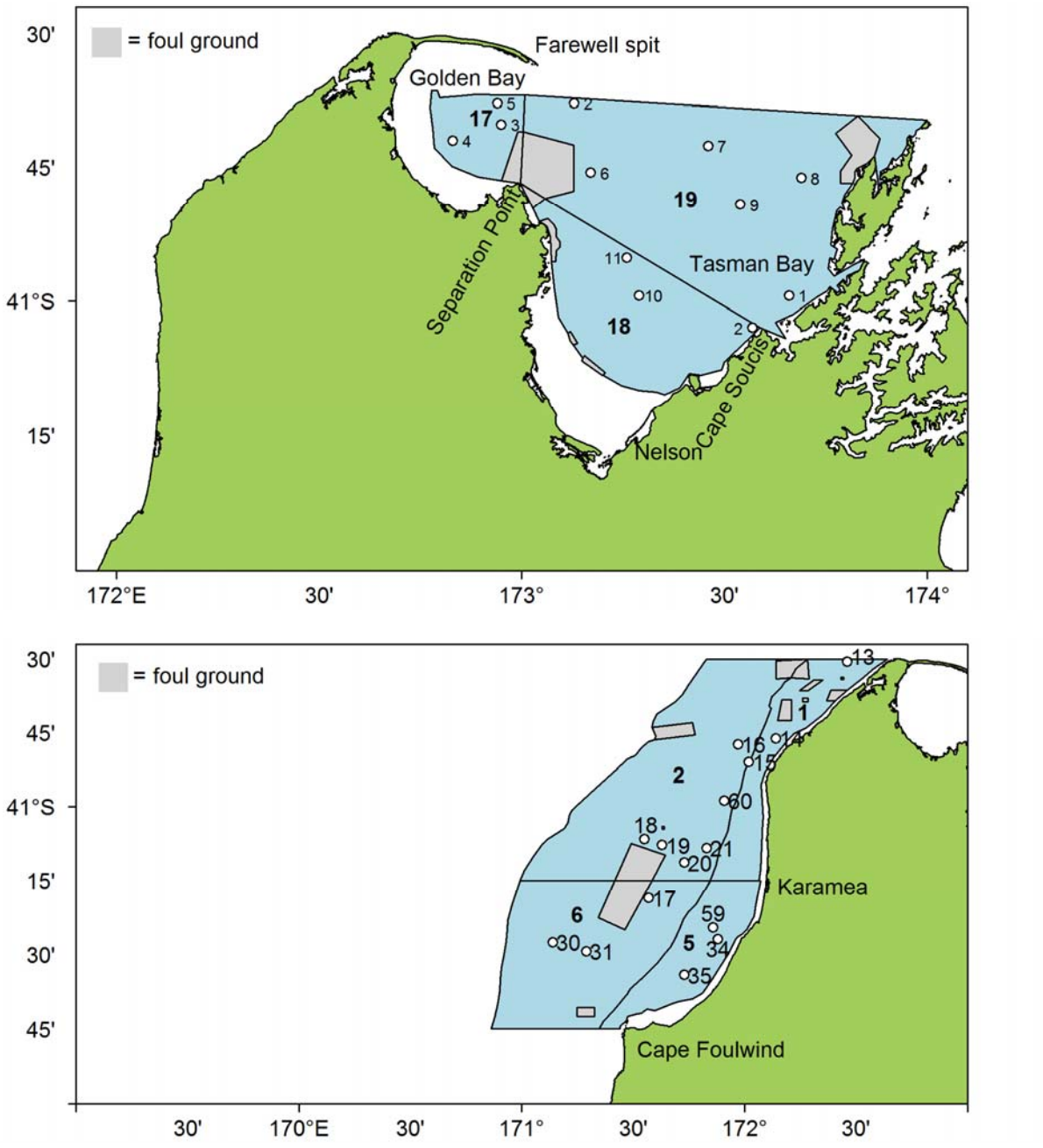


Figure 1a: Survey area showing stratum boundaries and numbers (bold type) for Tasman and Golden Bays (top) and the west coast north of Cape Foulwind (bottom), with station positions (white circles) and numbers.

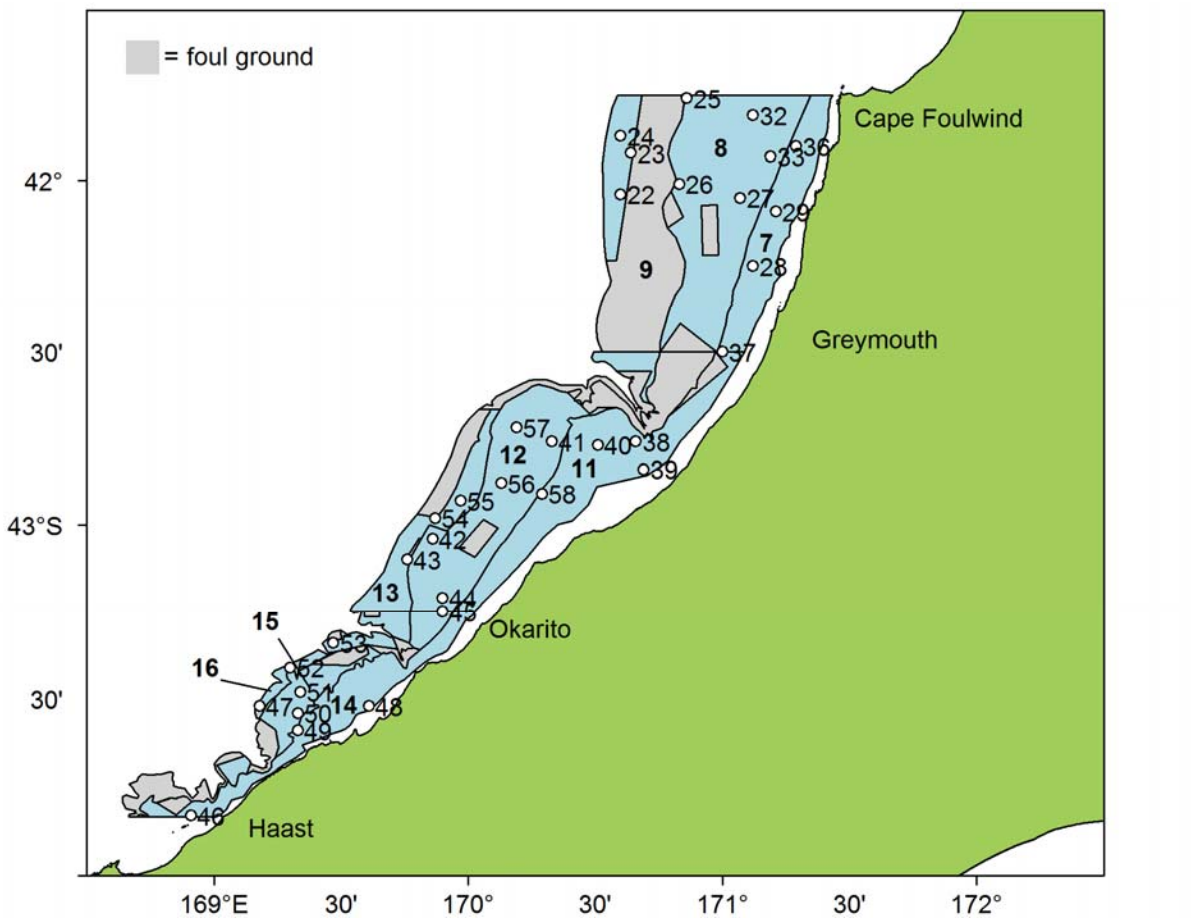
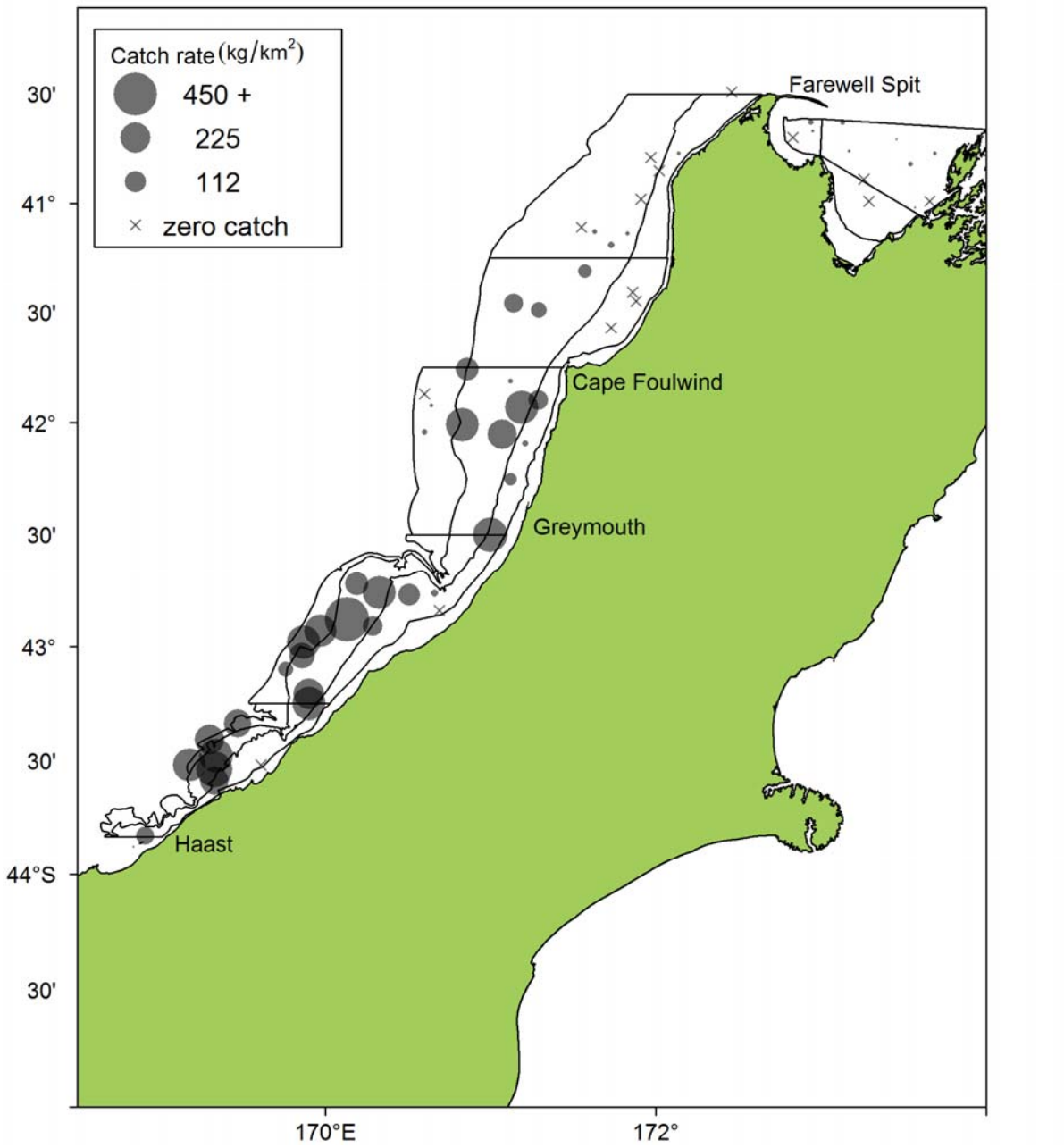


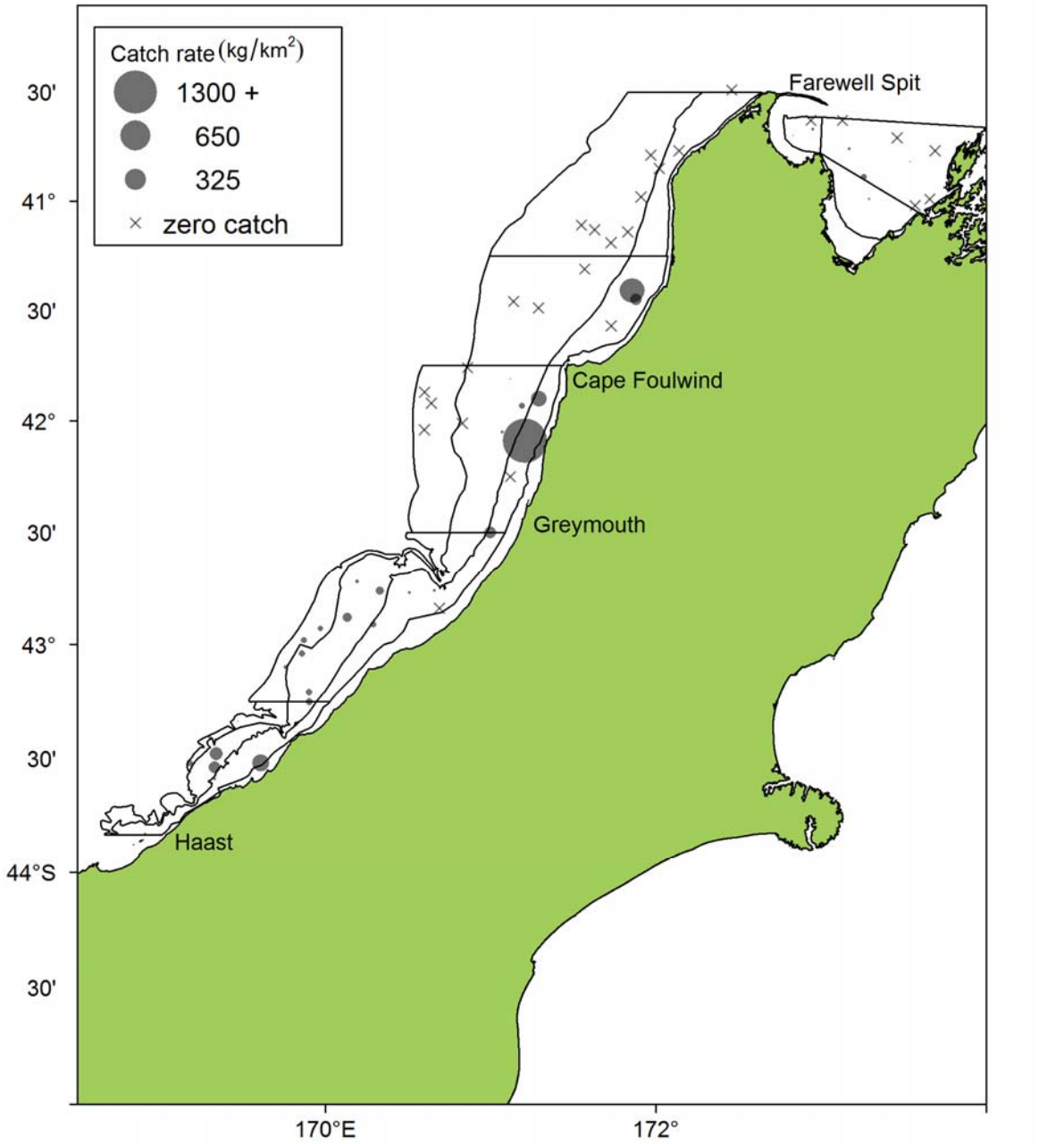
Figure 1b: Strata boundaries and numbers (bold type) south of Cape Foulwind with station positions (white circles) and numbers.

Figure 2: Catch rates (kg km^{-2}) and distribution for the target species in alphabetical order by common name.



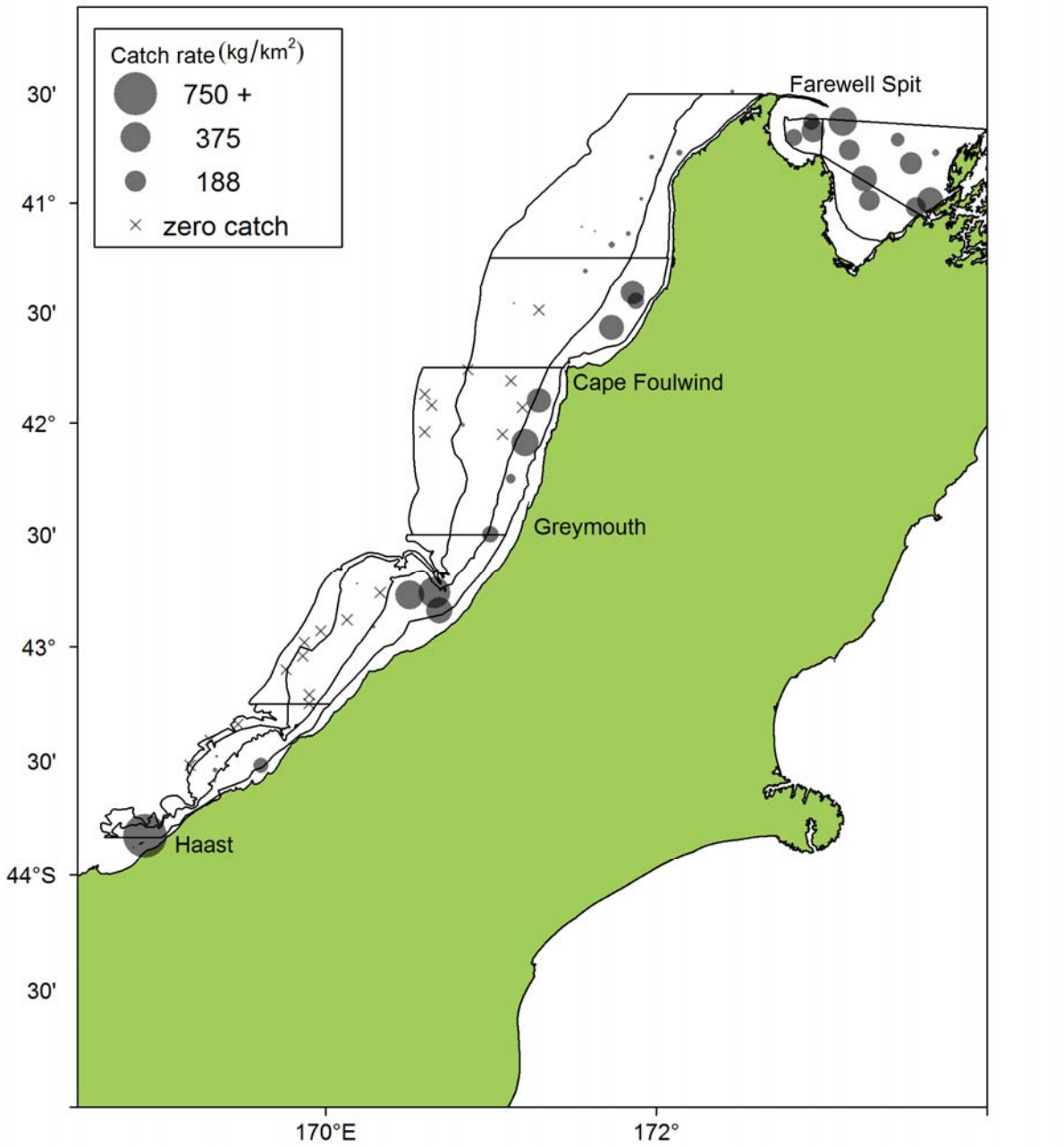
a: Giant stargazer (maximum catch rate = 466 kg km^{-2}).

Figure 2—continued.



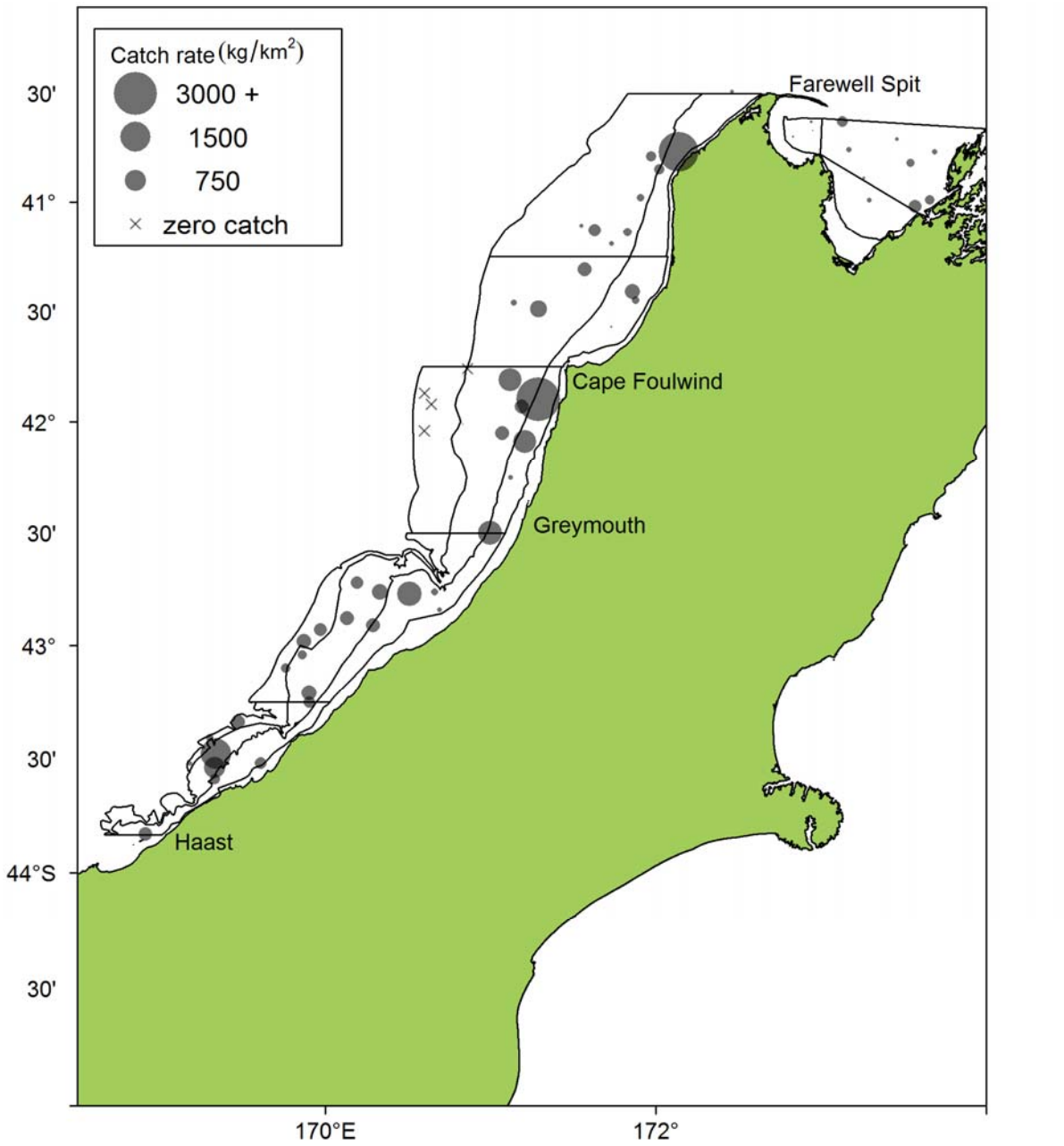
b: Red cod (maximum catch rate = 1 370 kg km^{-2}).

Figure 2—continued.



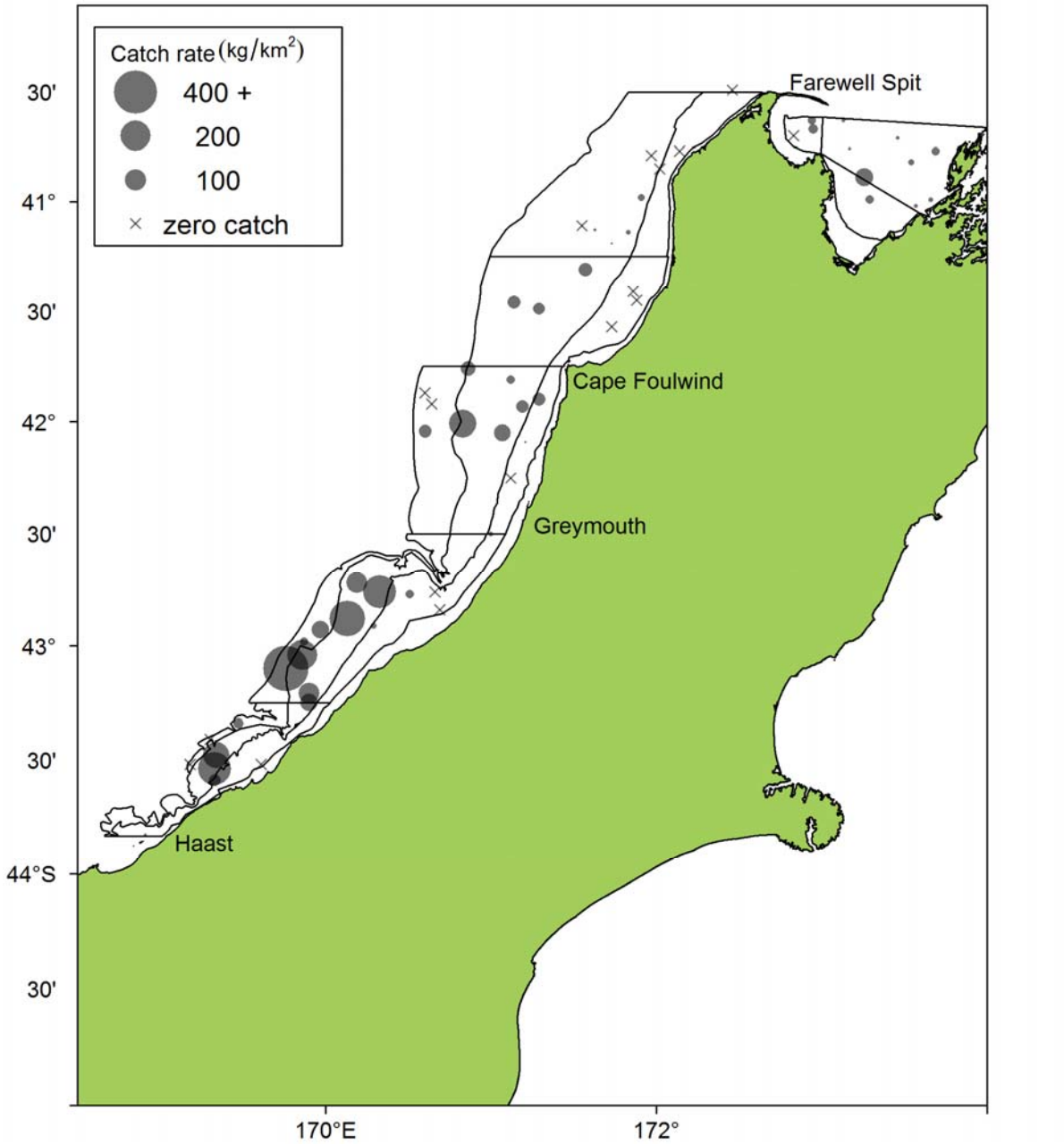
c: Red gurnard (maximum catch rate = 766 kg km^{-2}).

Figure 2—continued.



d: Spiny dogfish (maximum catch rate = 3 057 kg km^{-2}).

Figure 2—continued.



e: Tarakihi (maximum catch rate = 439 kg km^{-2}).

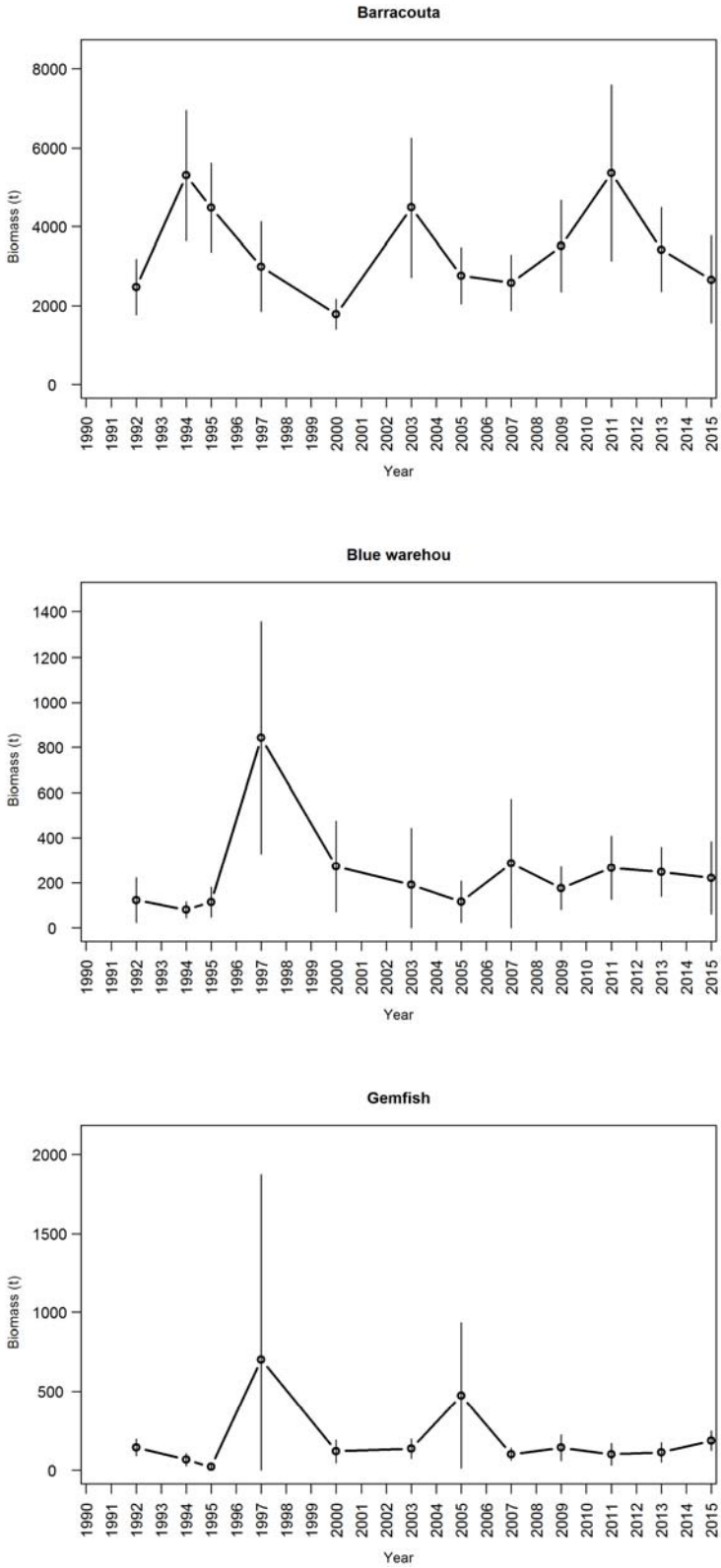
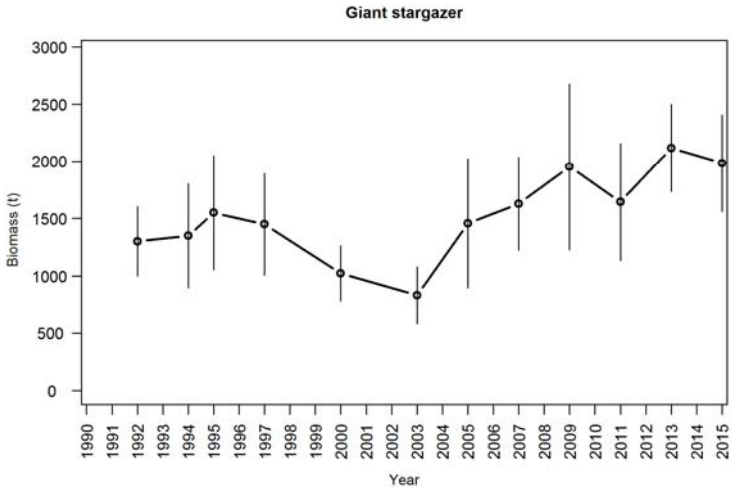
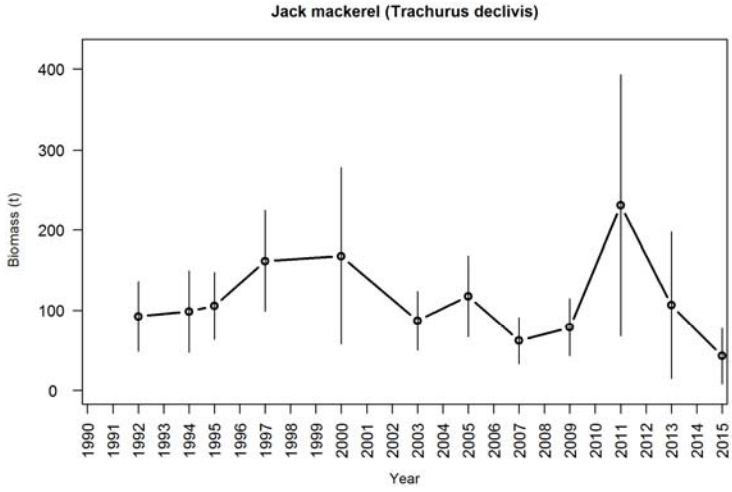


Figure 3: Trends in total biomass for the target species and other species reliably monitored by the survey time series. Arranged in alphabetical order by common name.





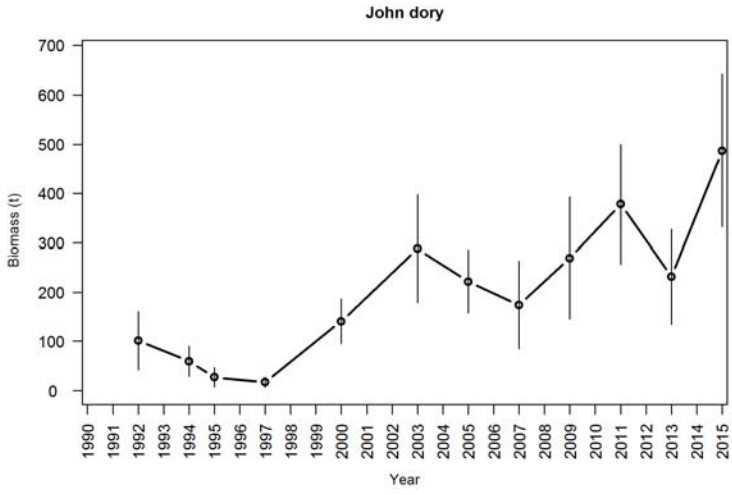
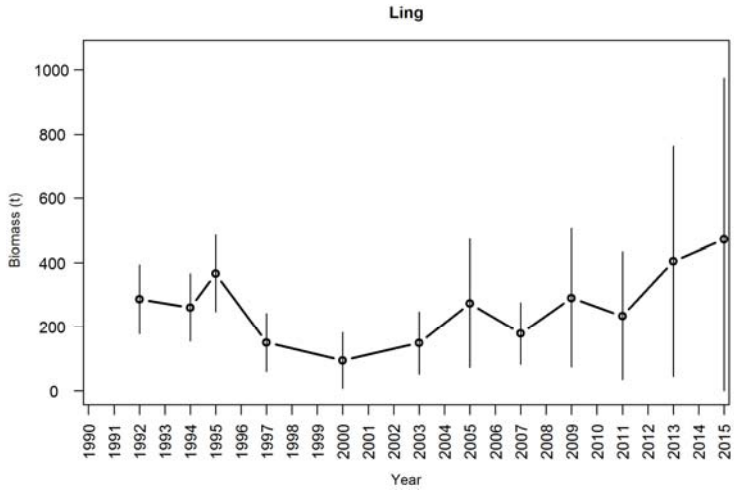
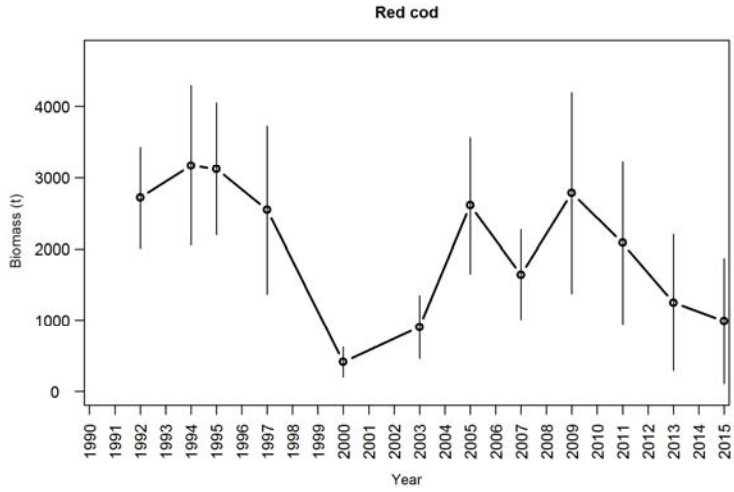


Figure 3—continued.





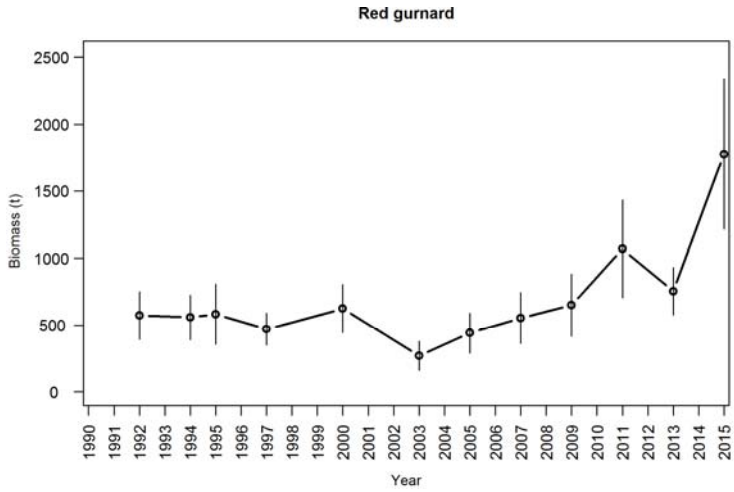


Figure 3—continued.

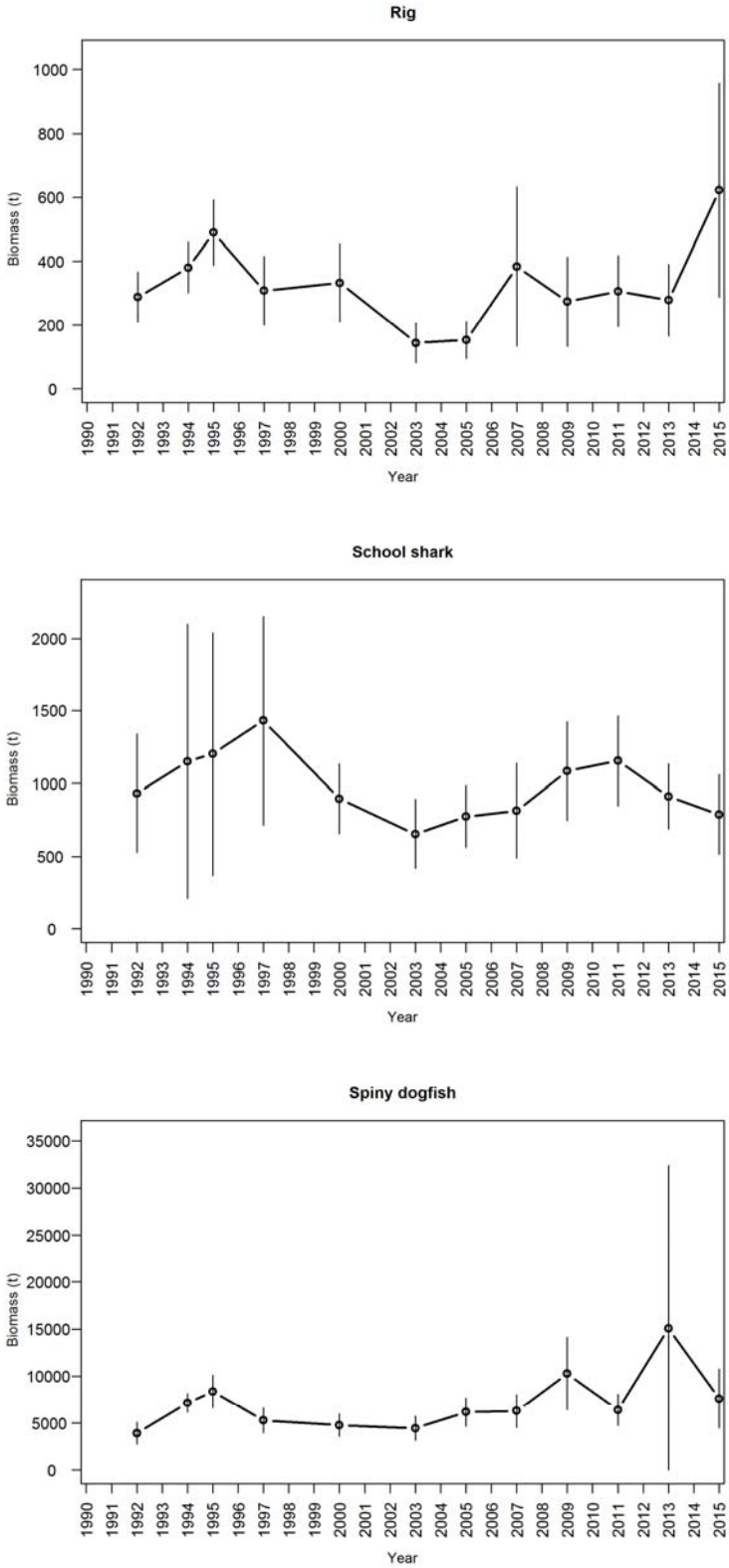


Figure 3—continued.

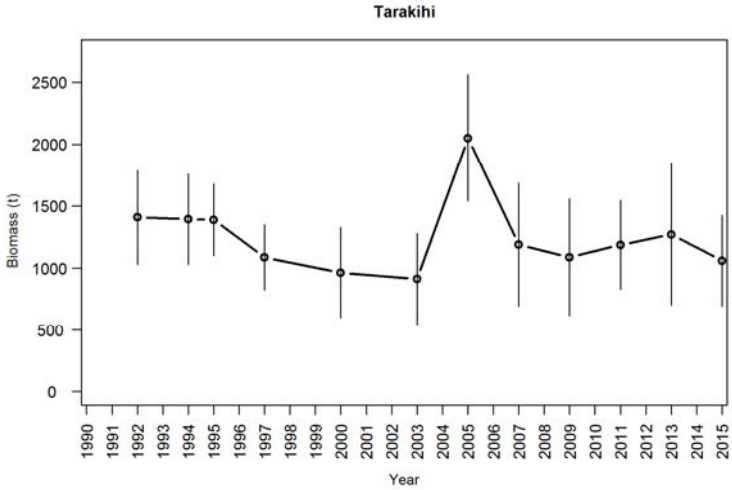


Figure 3—continued.

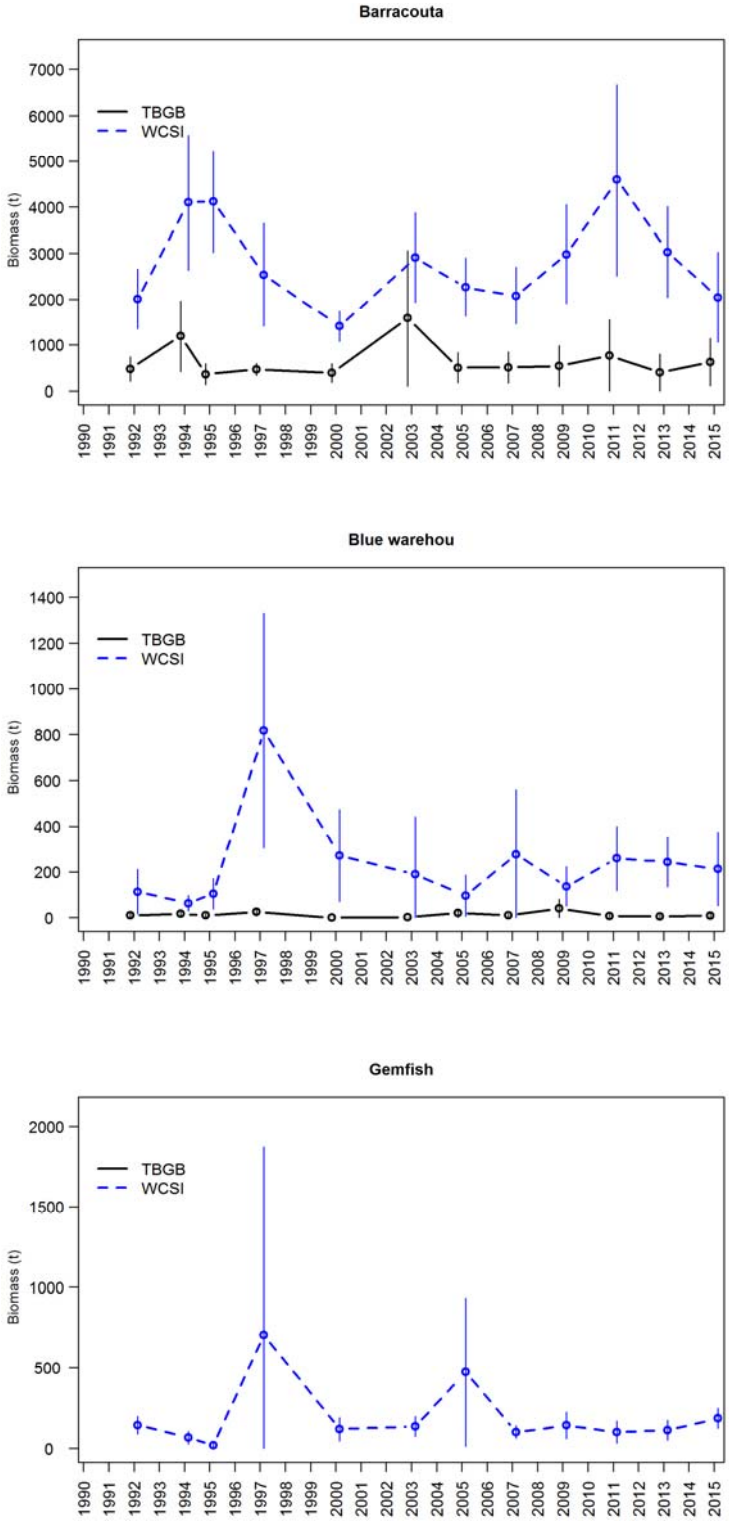
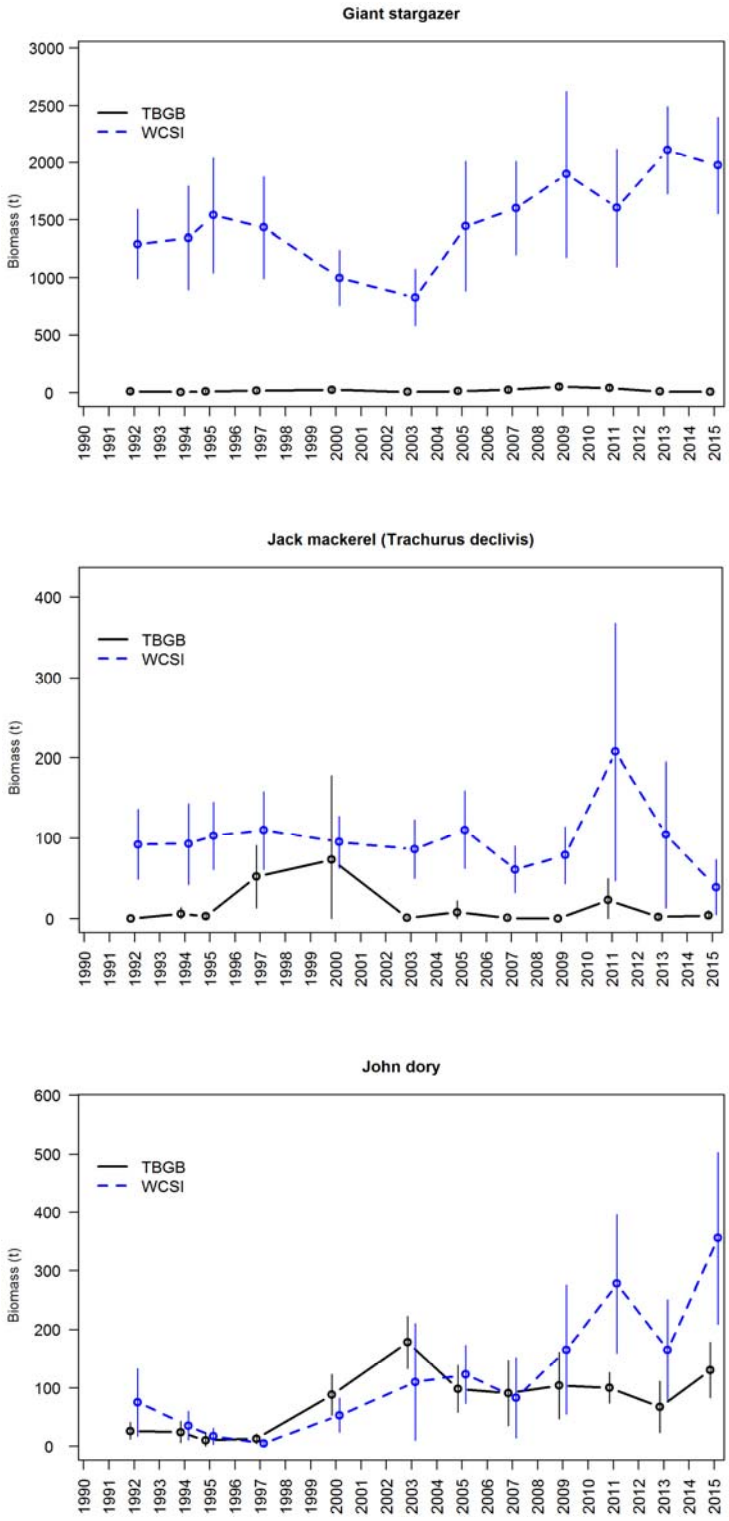


Figure 4: Trends in total biomass for the target species and other species for which the survey time series is likely to be monitoring adult or pre-recruit abundance, separated by Tasman and Golden Bays (TBGB), and the west coast South Island (WCSI).



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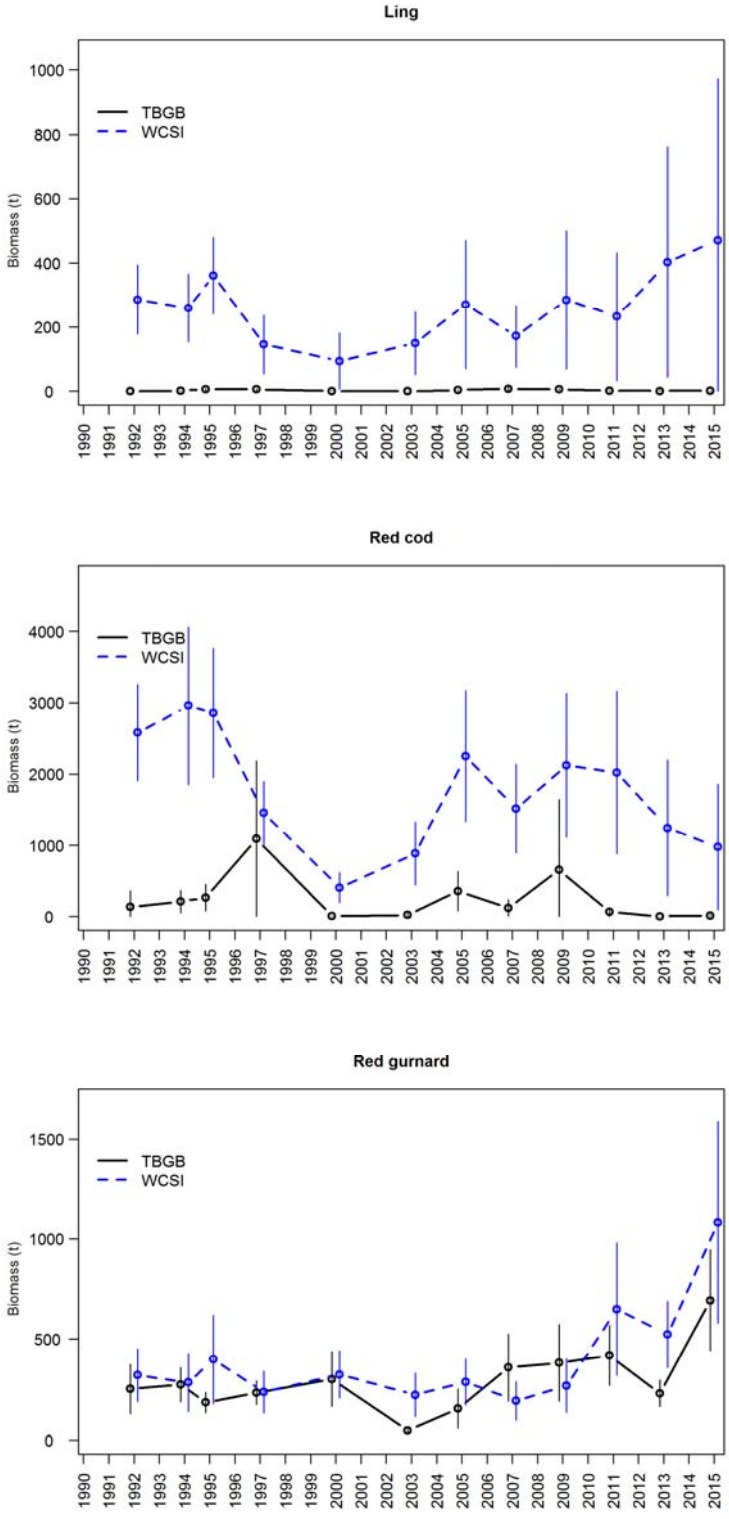

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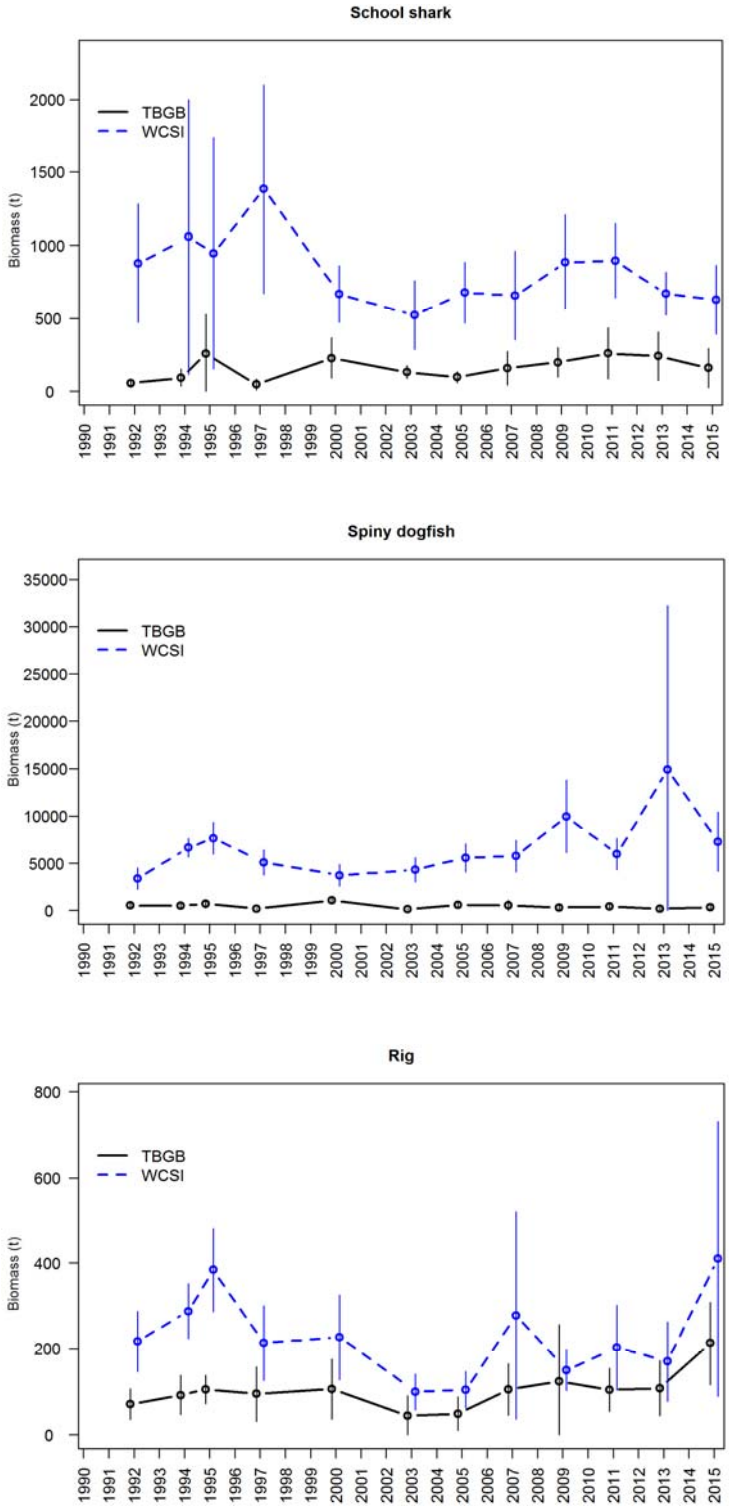

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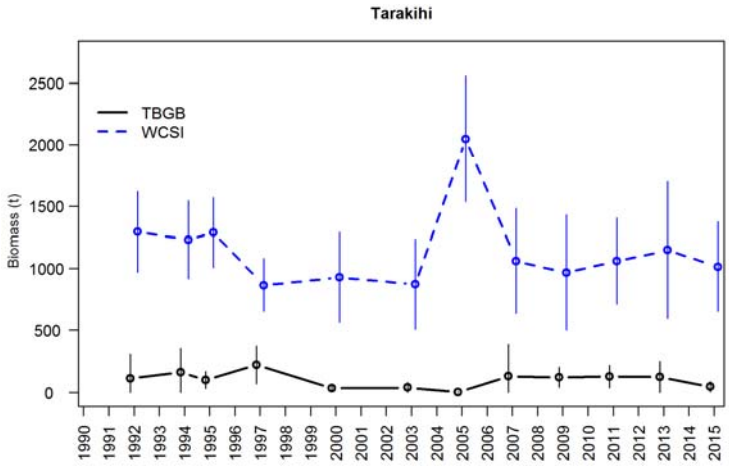

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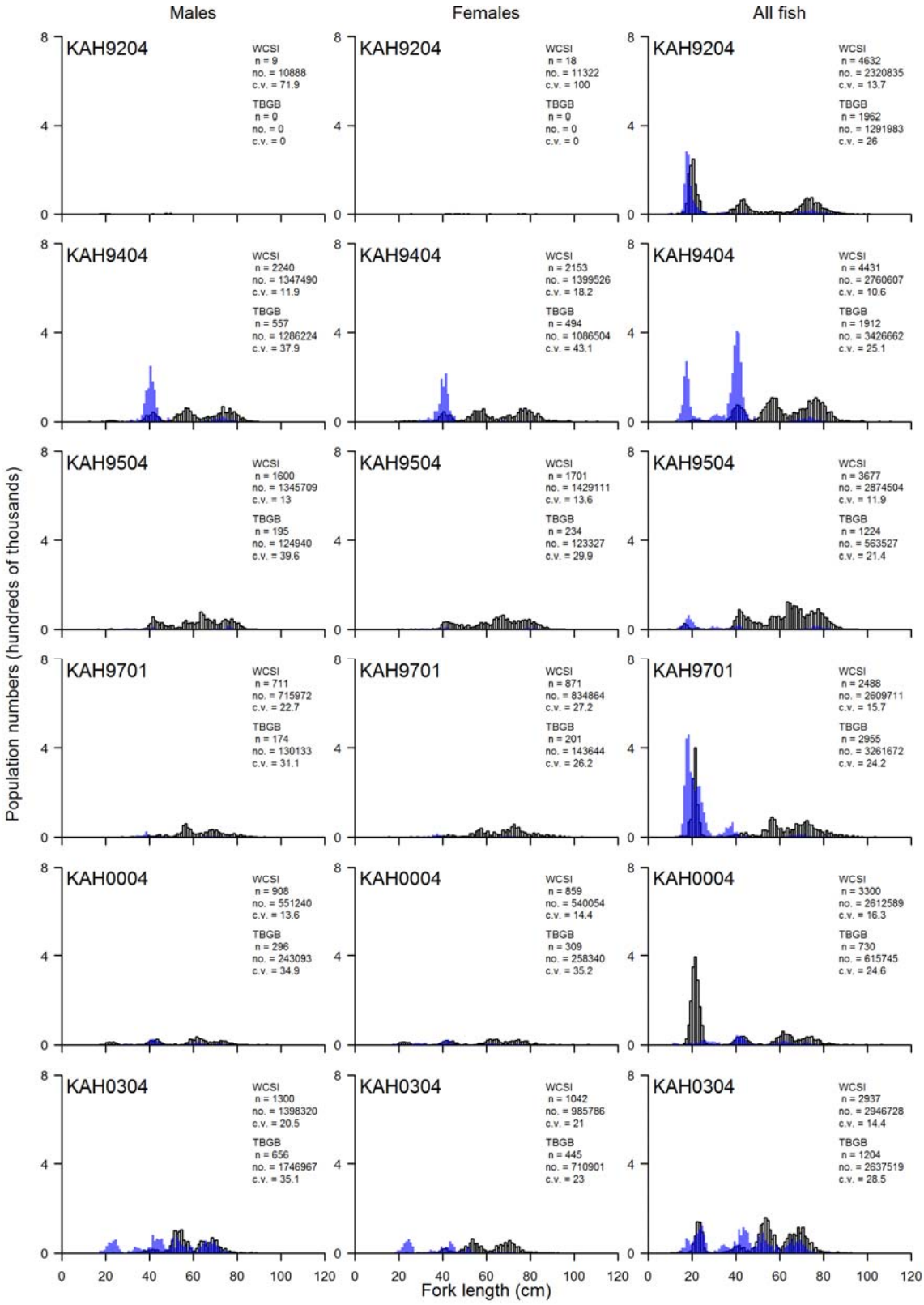


Figure 5: Comparative scaled length frequencies with Tasman and Golden Bays and west coast South Island plotted separately for the target species and those species where the surveys are monitoring adult or pre-recruit abundance. n = number of fish measured, no. = scaled population number, CV = coefficient of variation. 'All fish' includes any unsexed fish. Blue bars = Tasman and Golden Bays, black bars = west coast South Island. a) Barracouta.

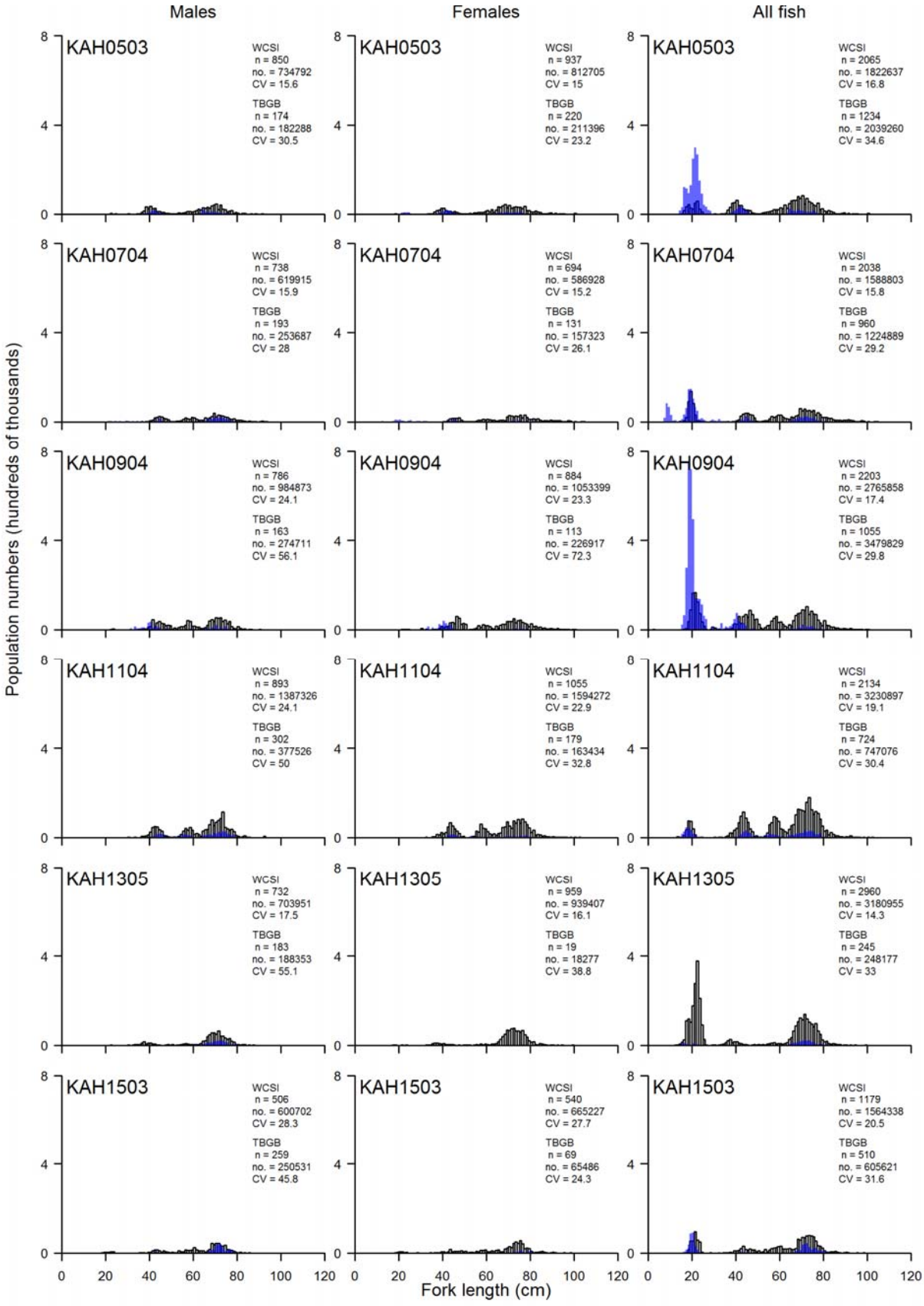


Figure 5a—continued.

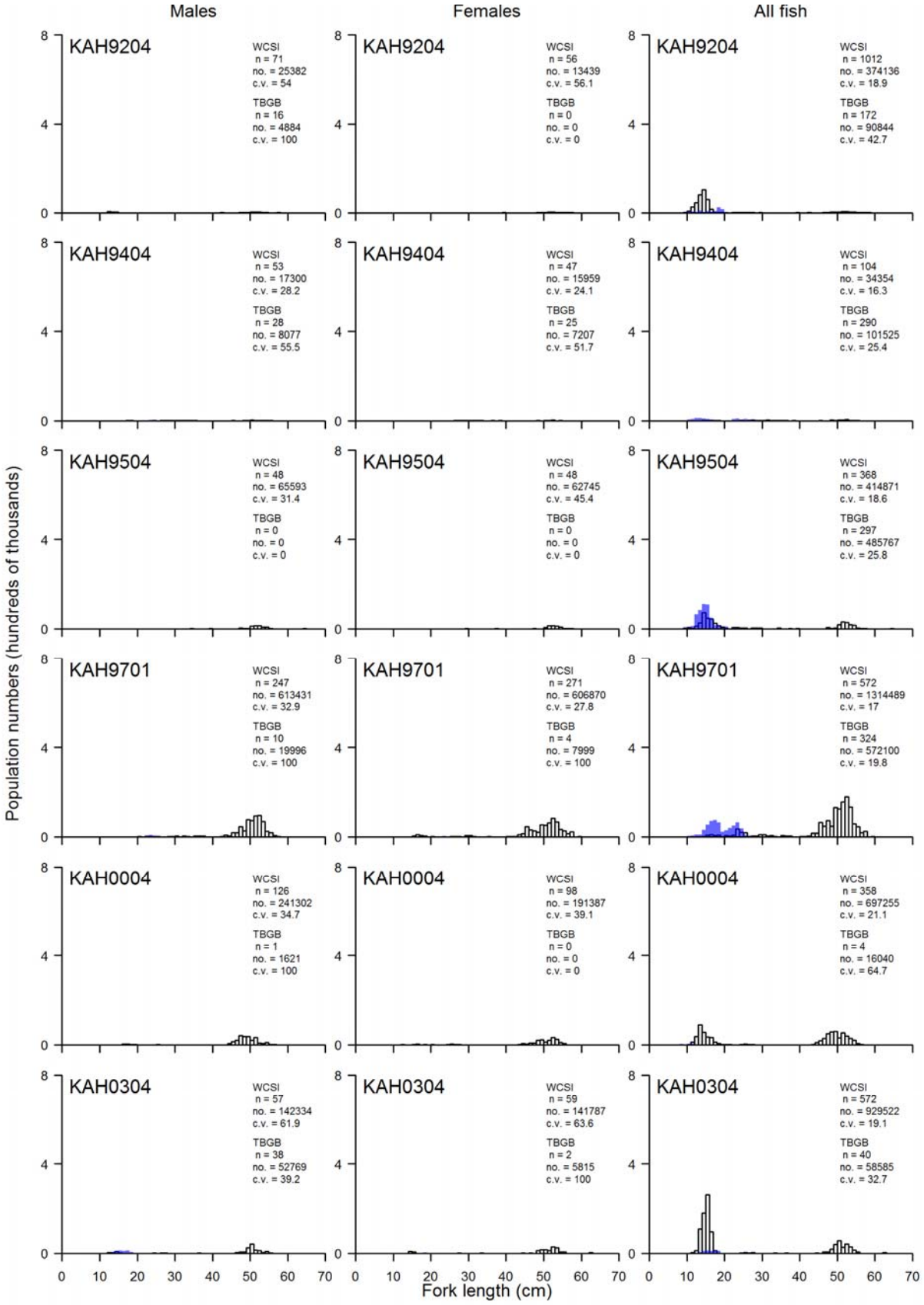
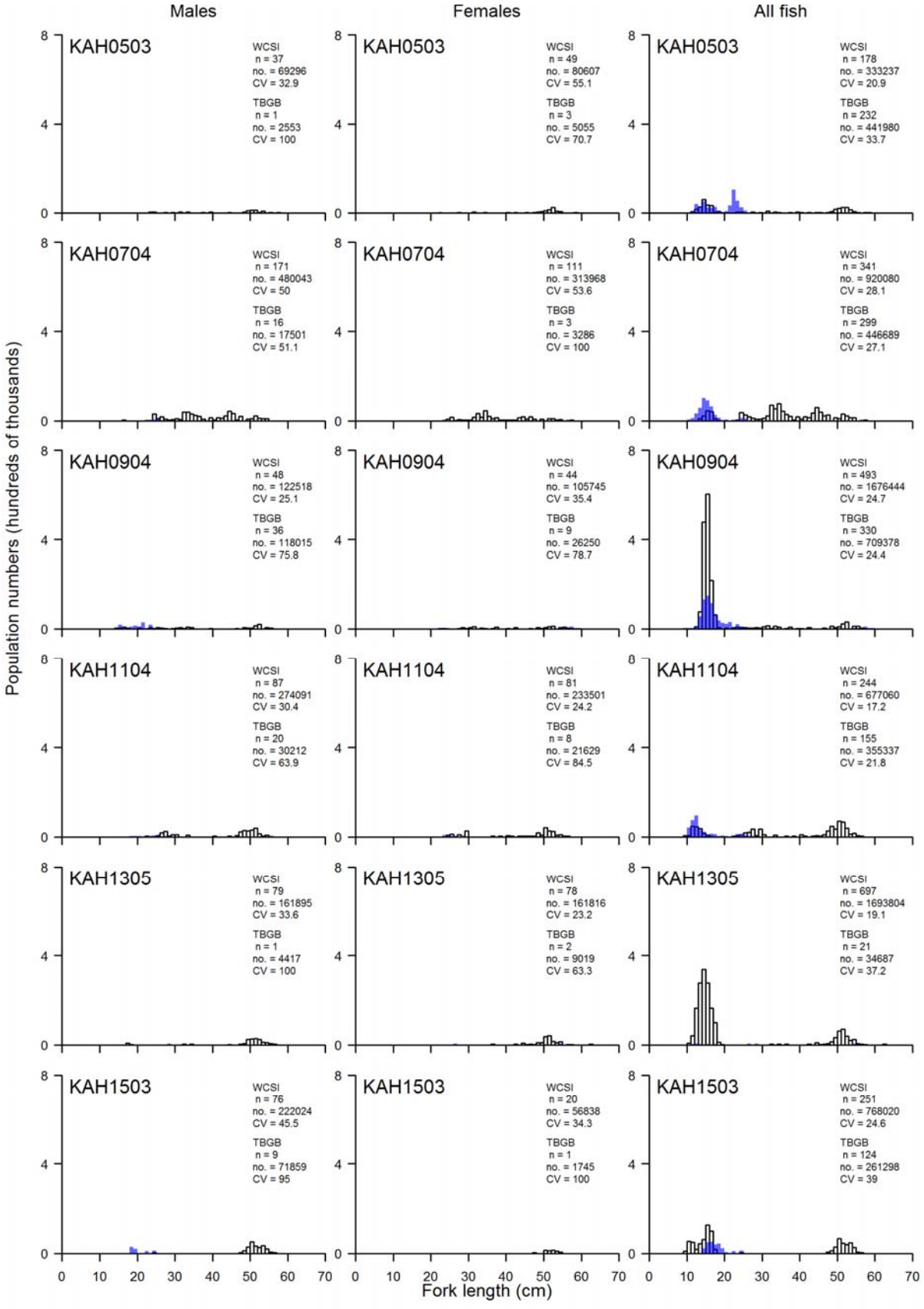


Figure 5b: Blue warehou.



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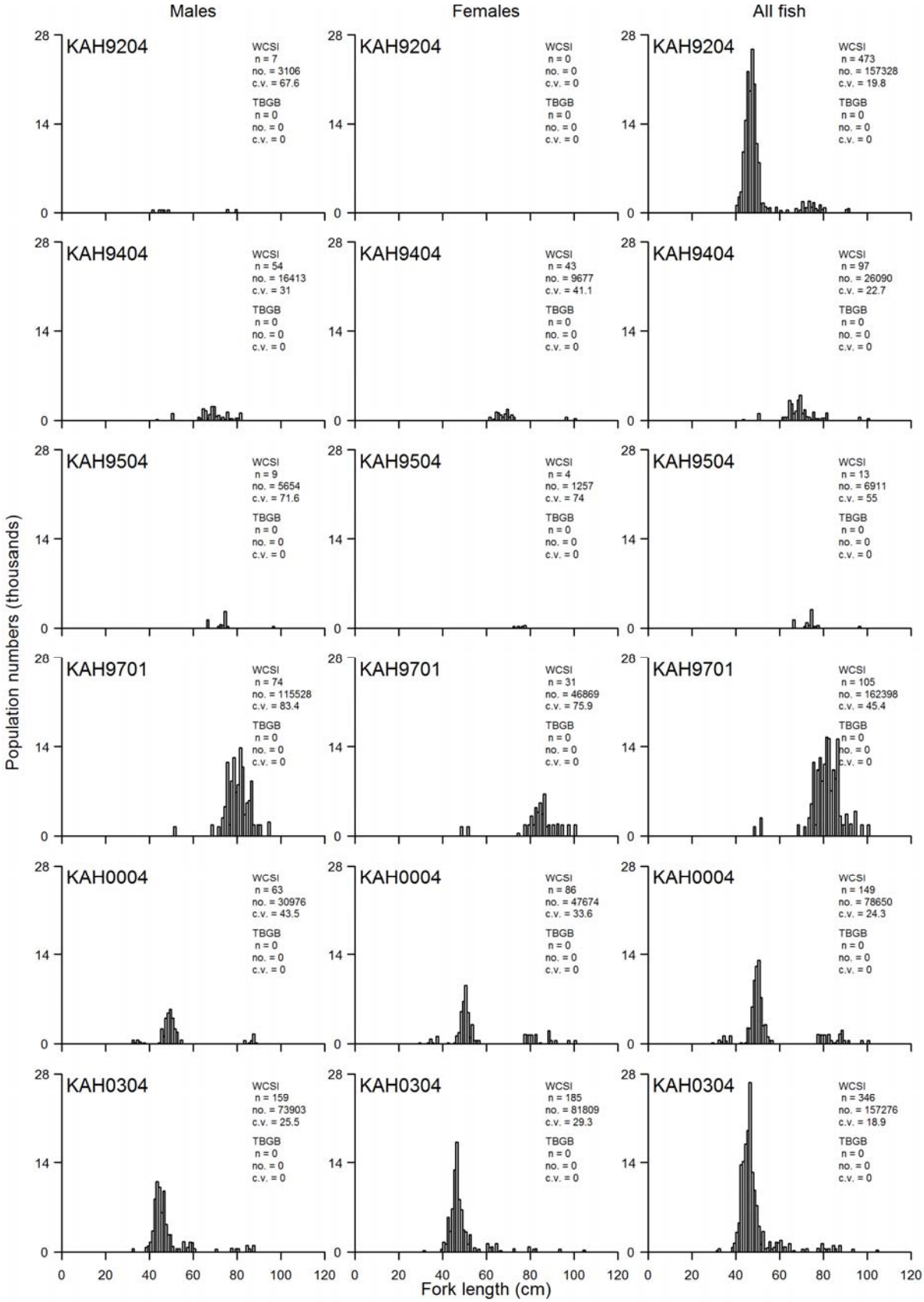
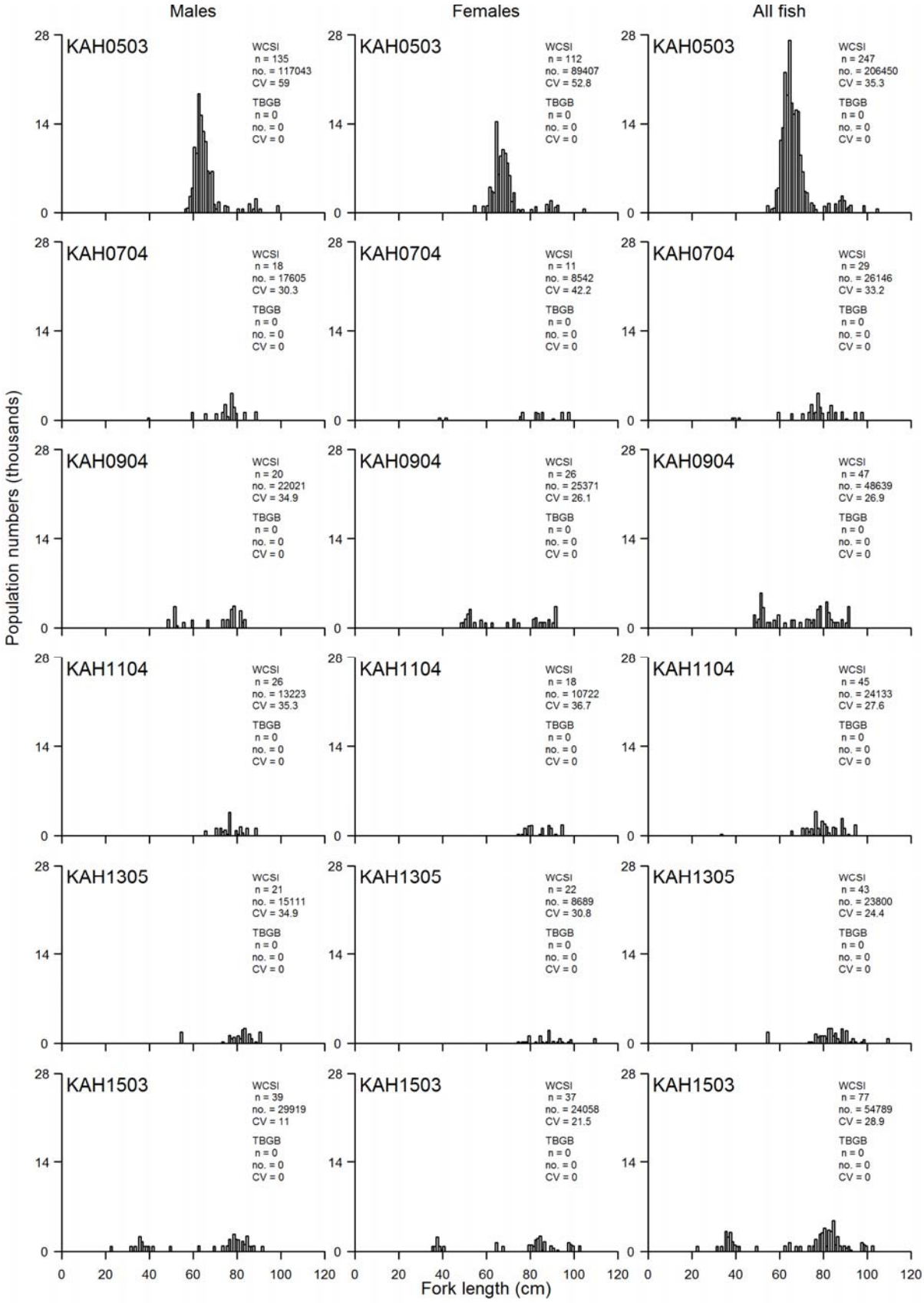


Figure 5c: Gemfish (100% of fish from the west coast).



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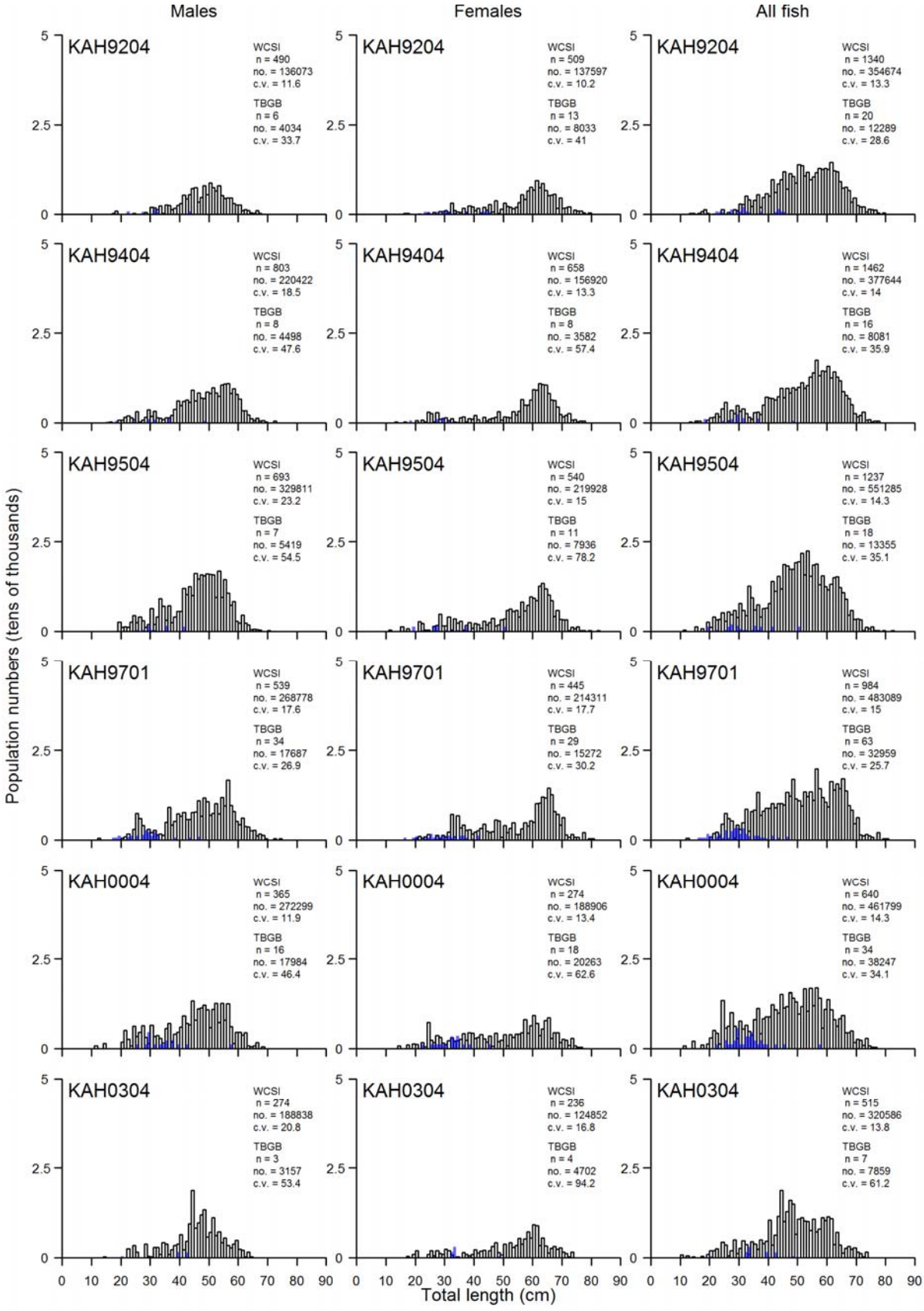


Figure 5d: Giant stargazer.

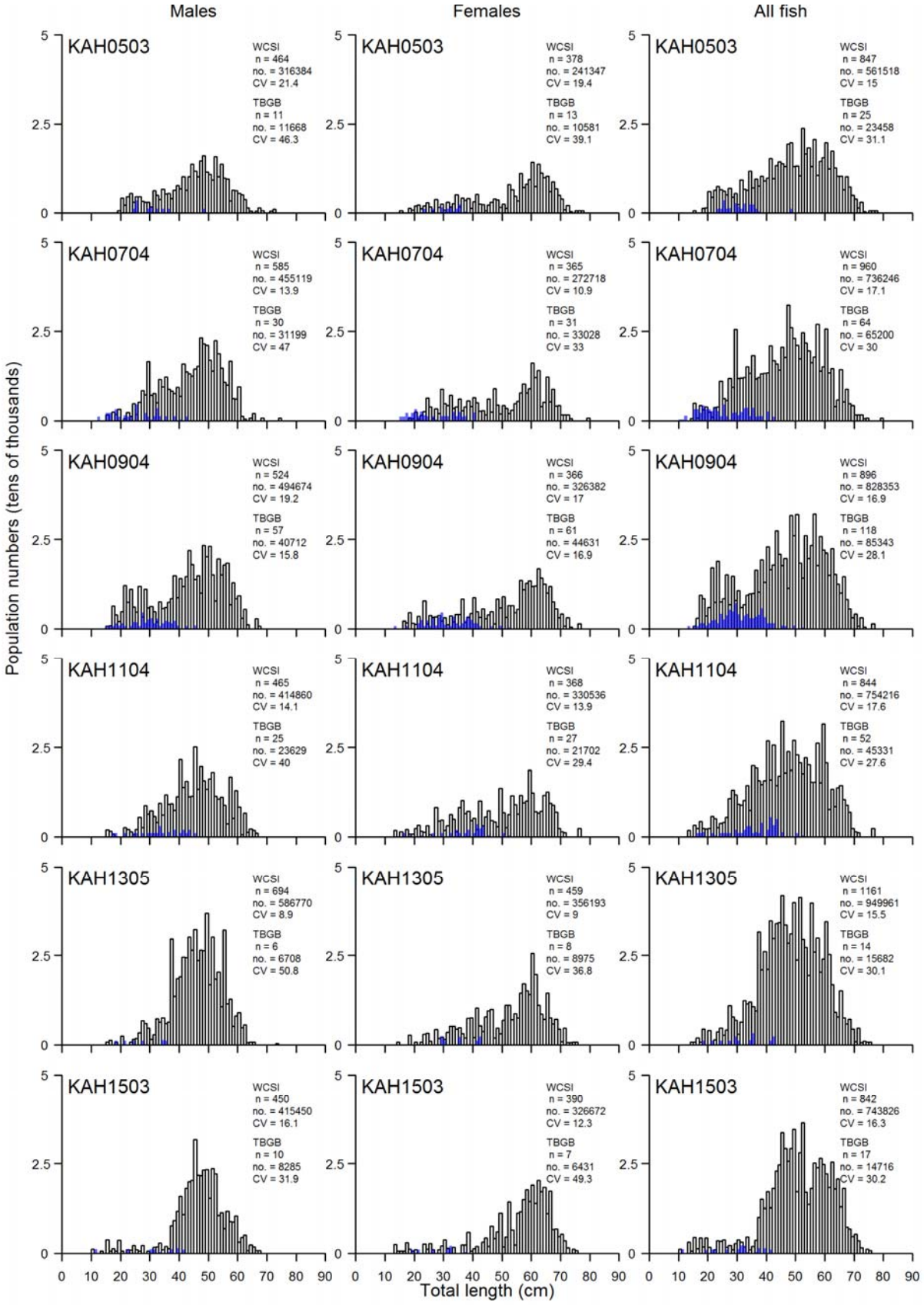


Figure 5d–continued.

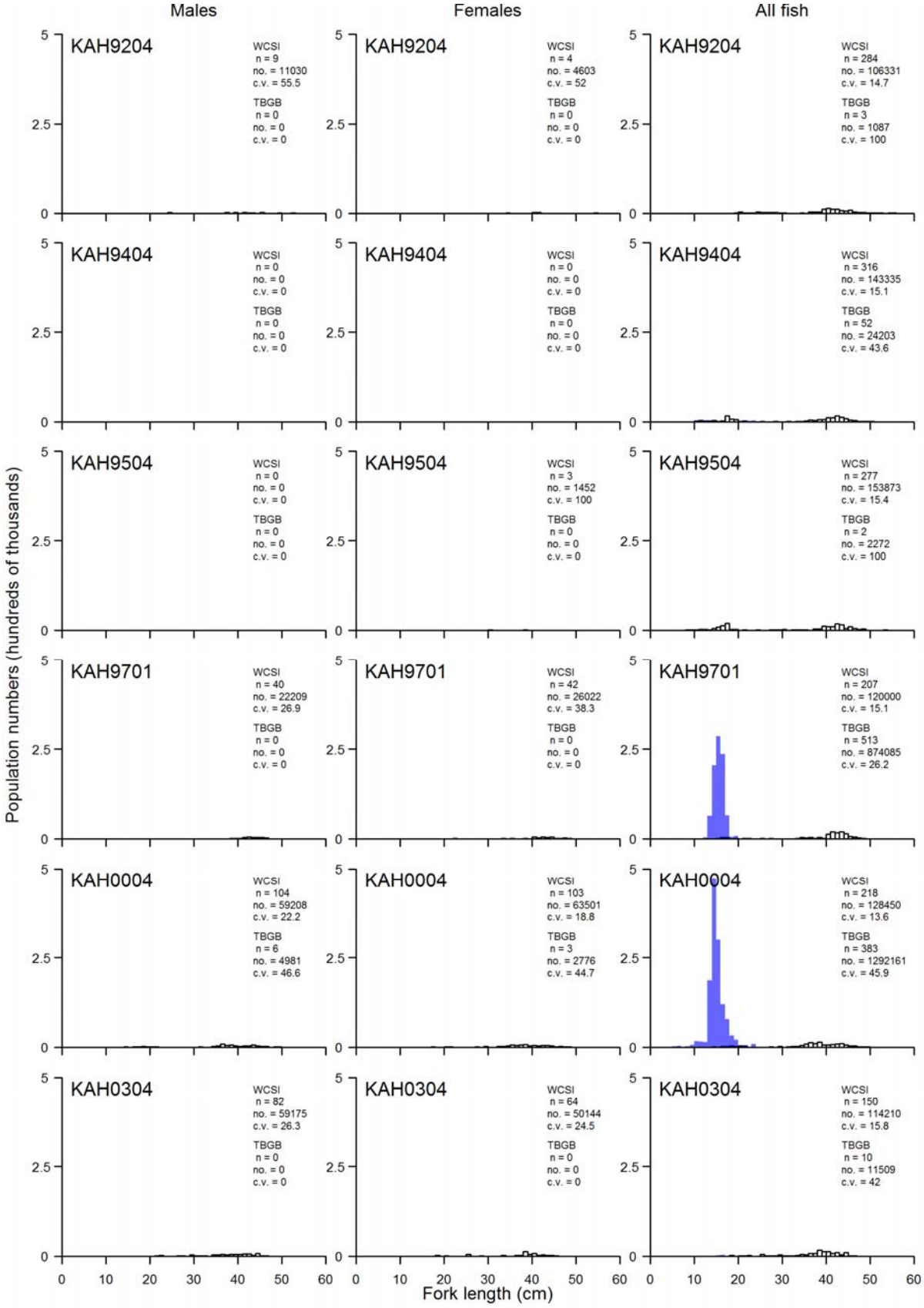


Figure 5e: Jack mackerel (*Trachurus declivis*).

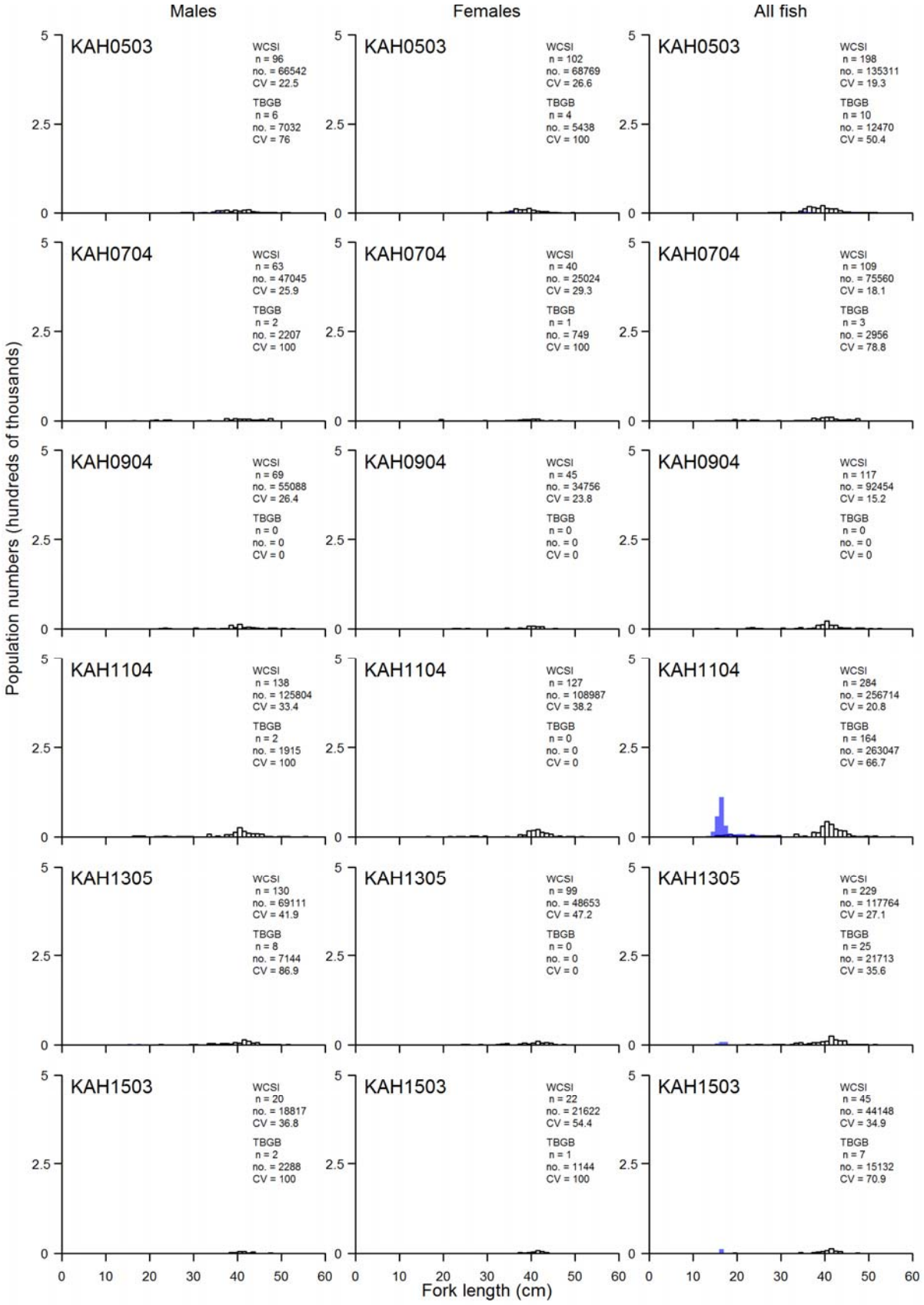


Figure 5e–continued.

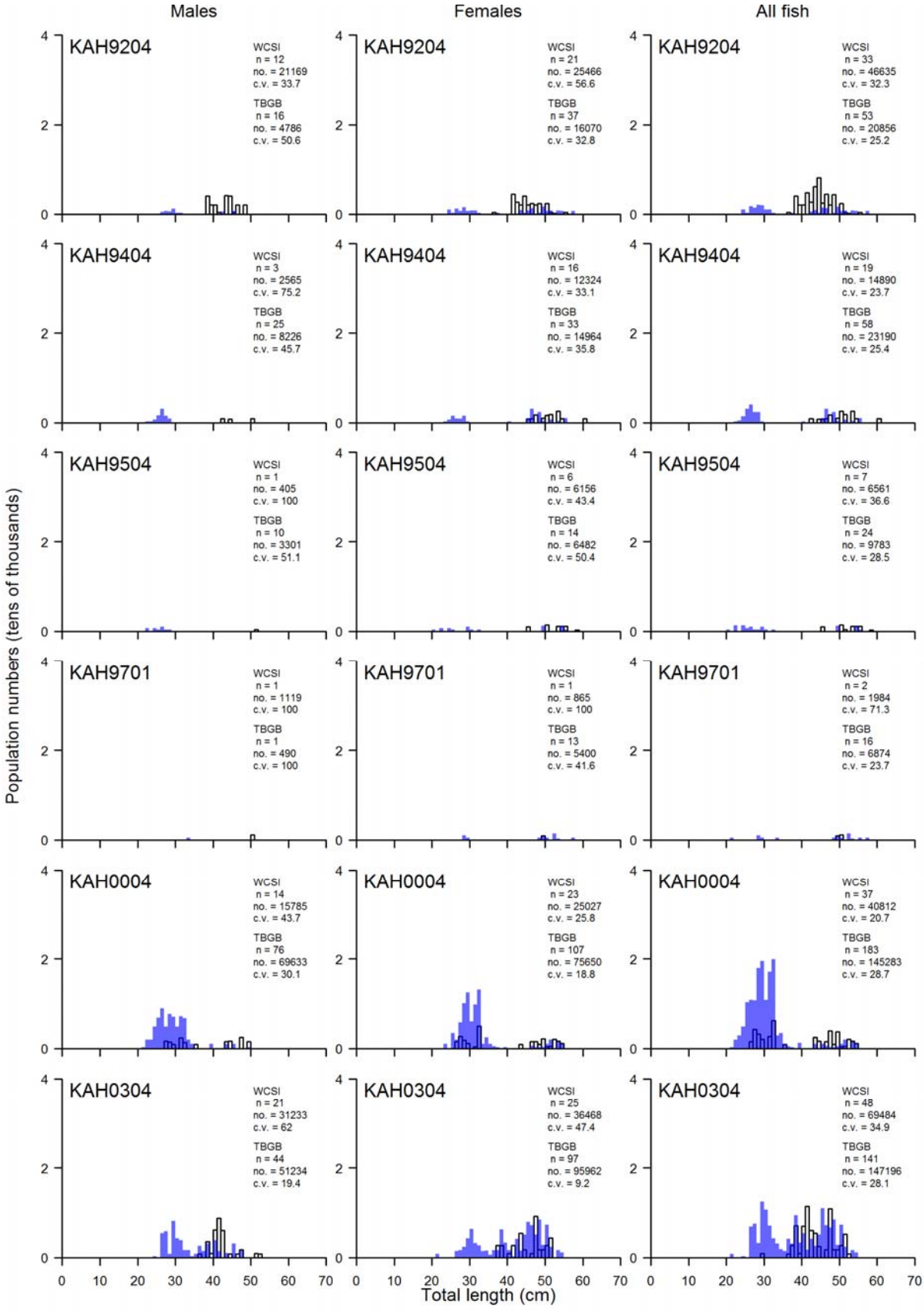


Figure 5f: John dory.

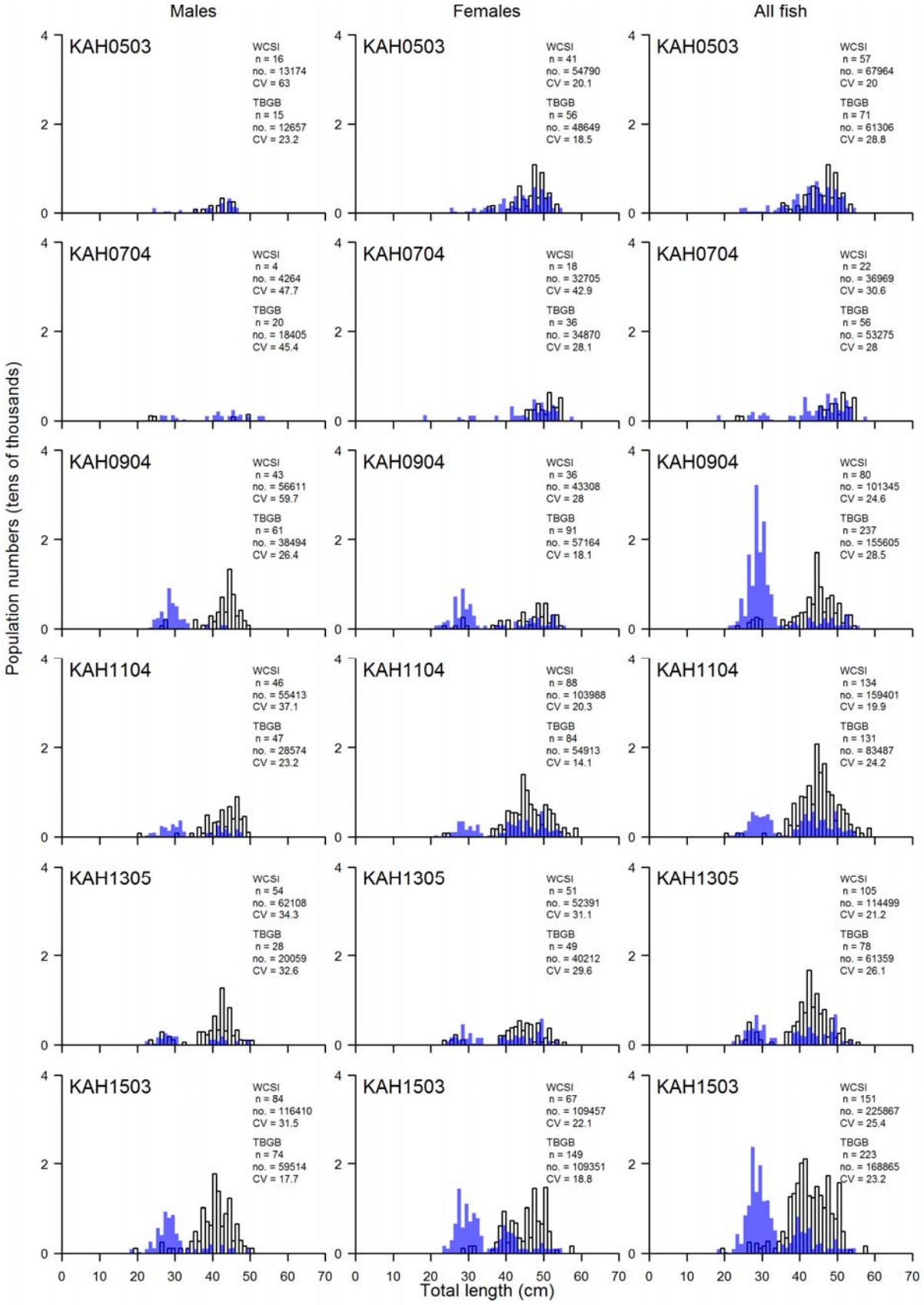


Figure 5f—continued.

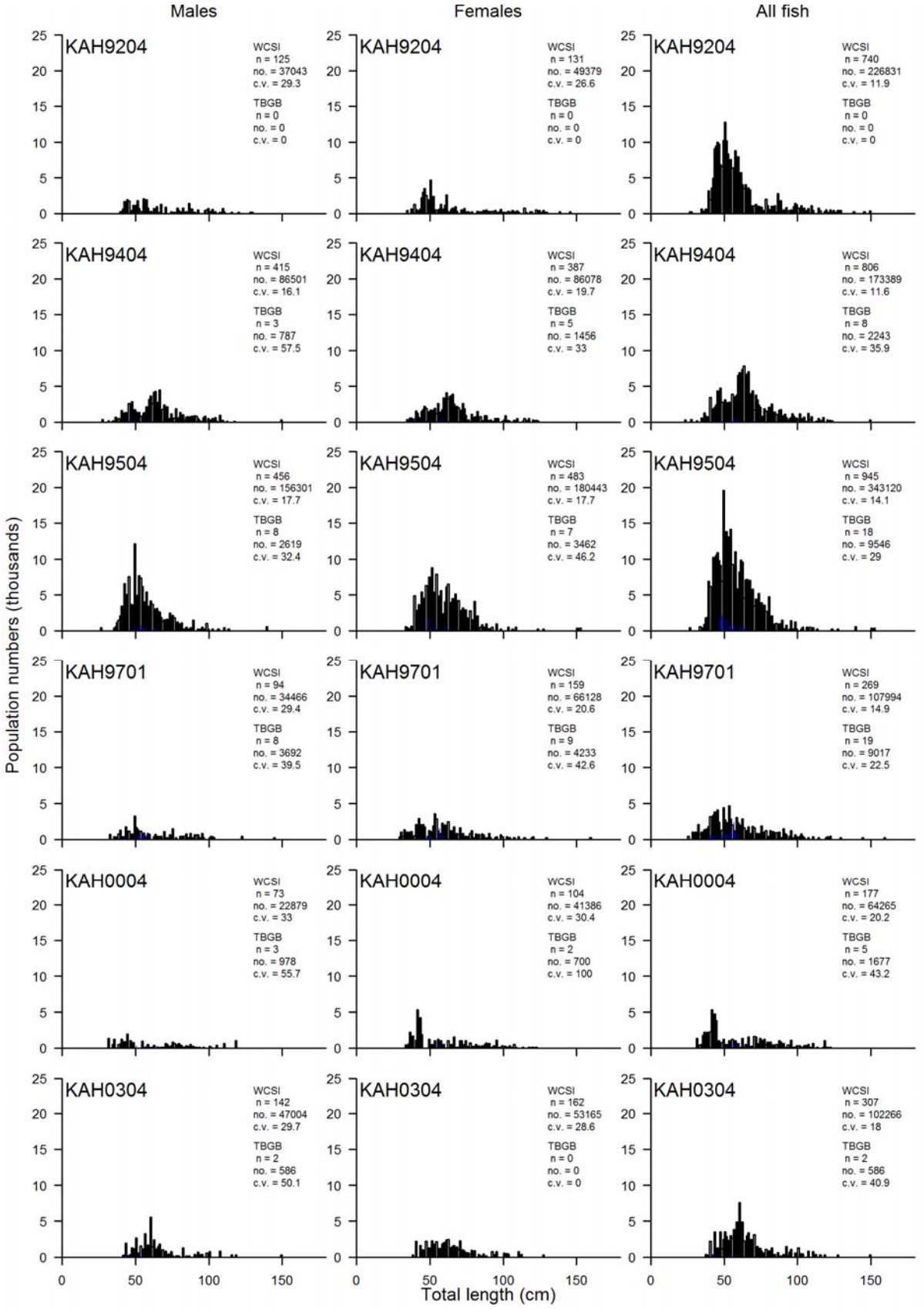


Figure 5g: Ling.

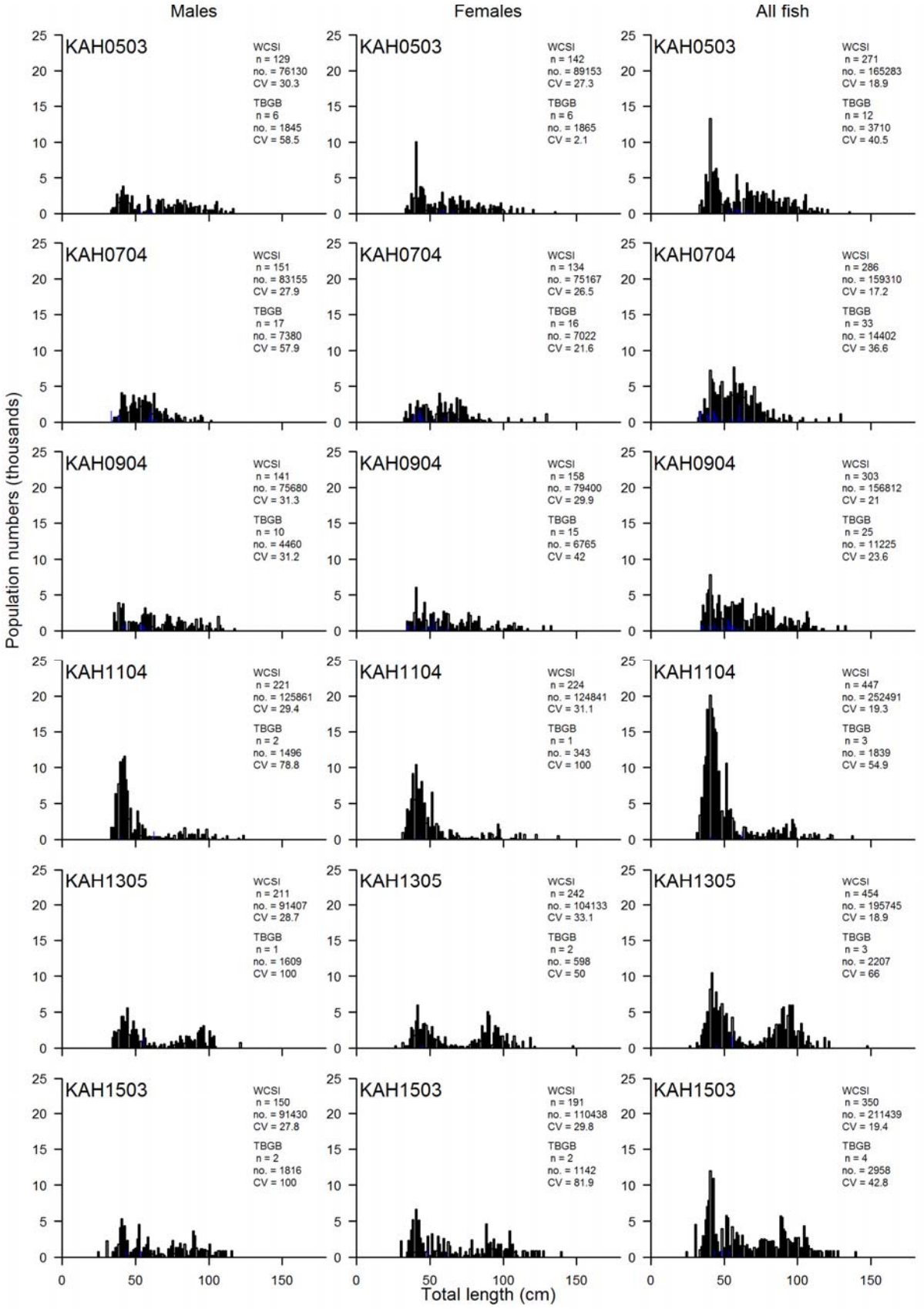


Figure 5g—continued.

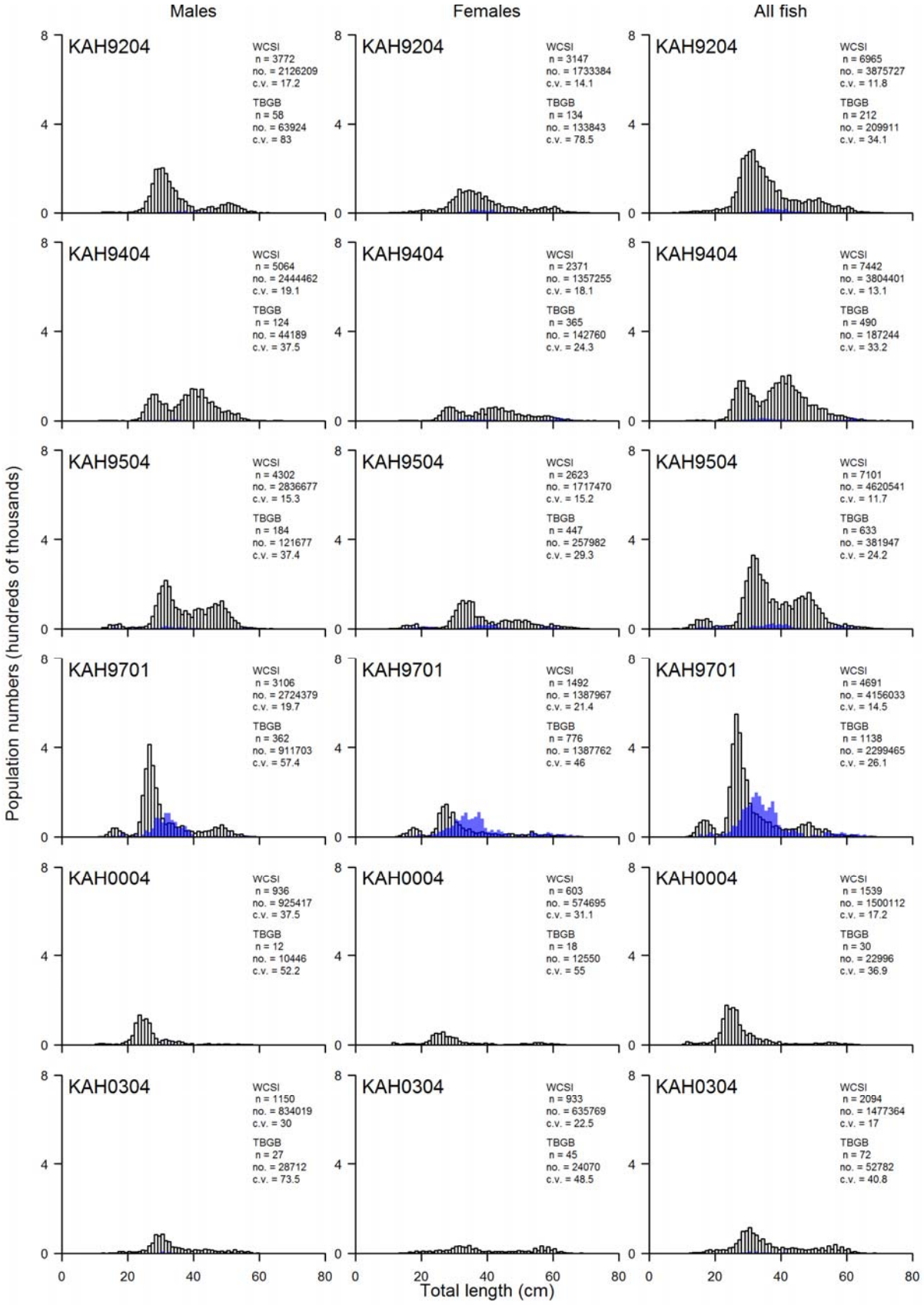


Figure 5h: Red cod.

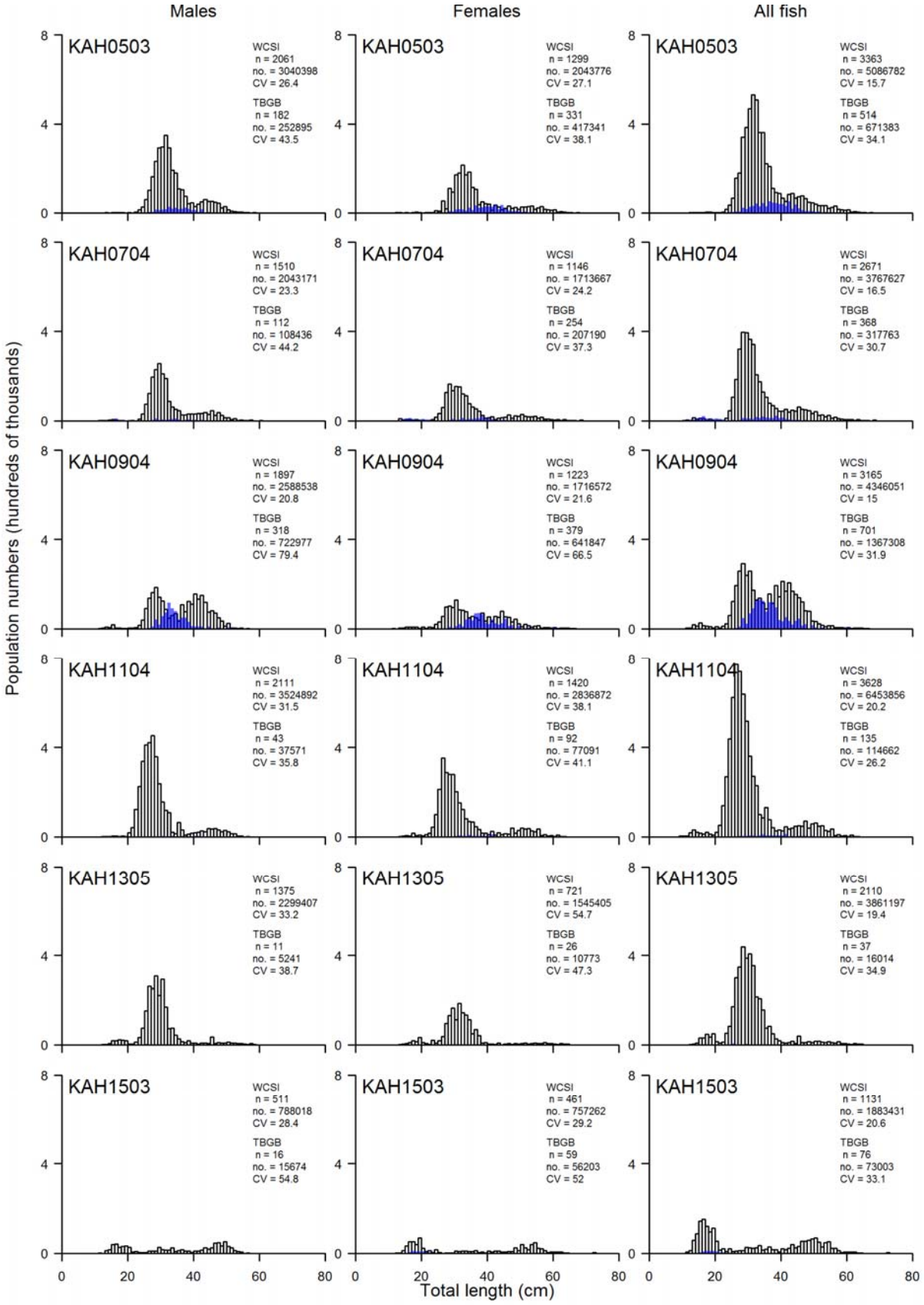


Figure 5h—continued.

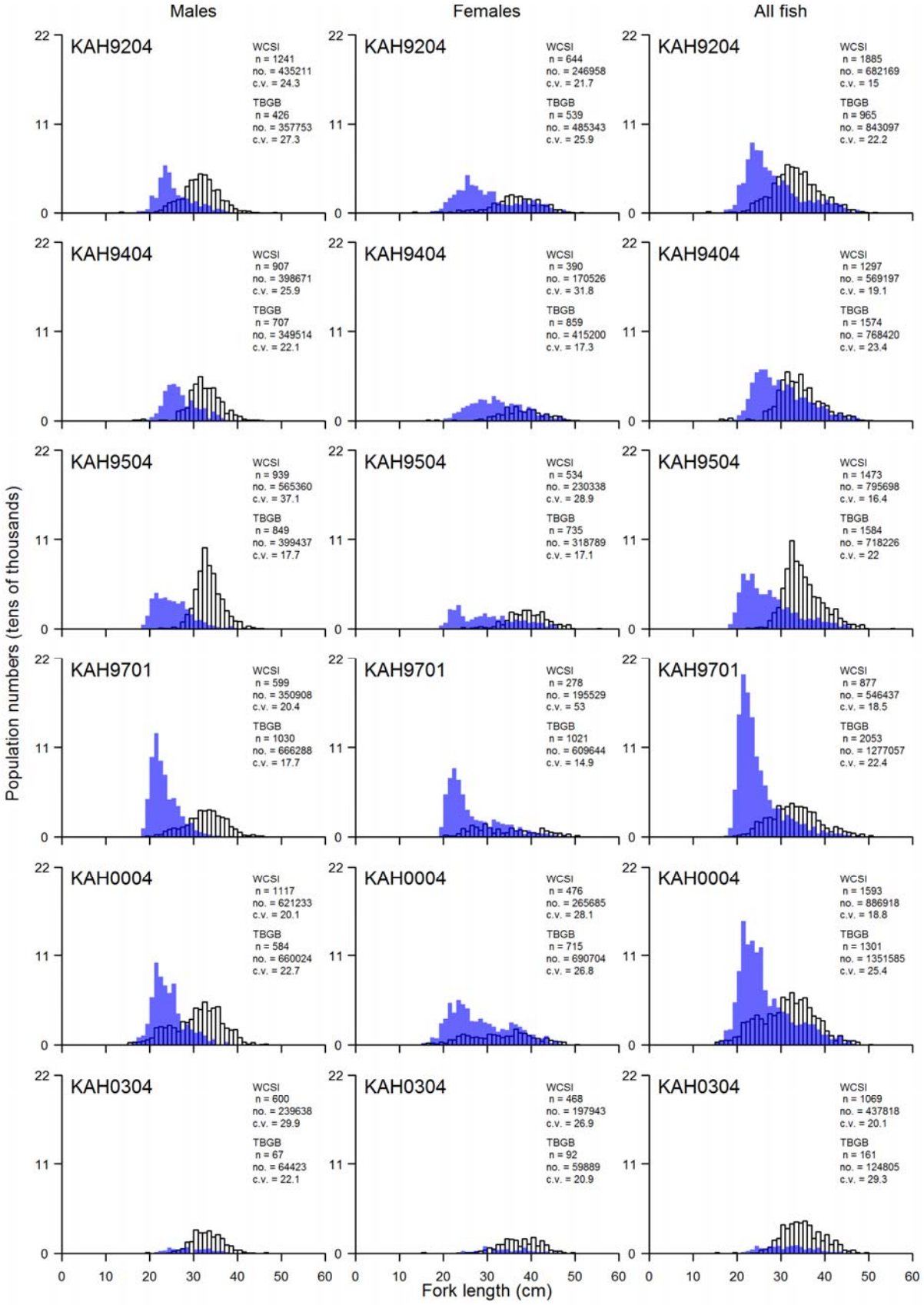


Figure 5i: Red gurnard.

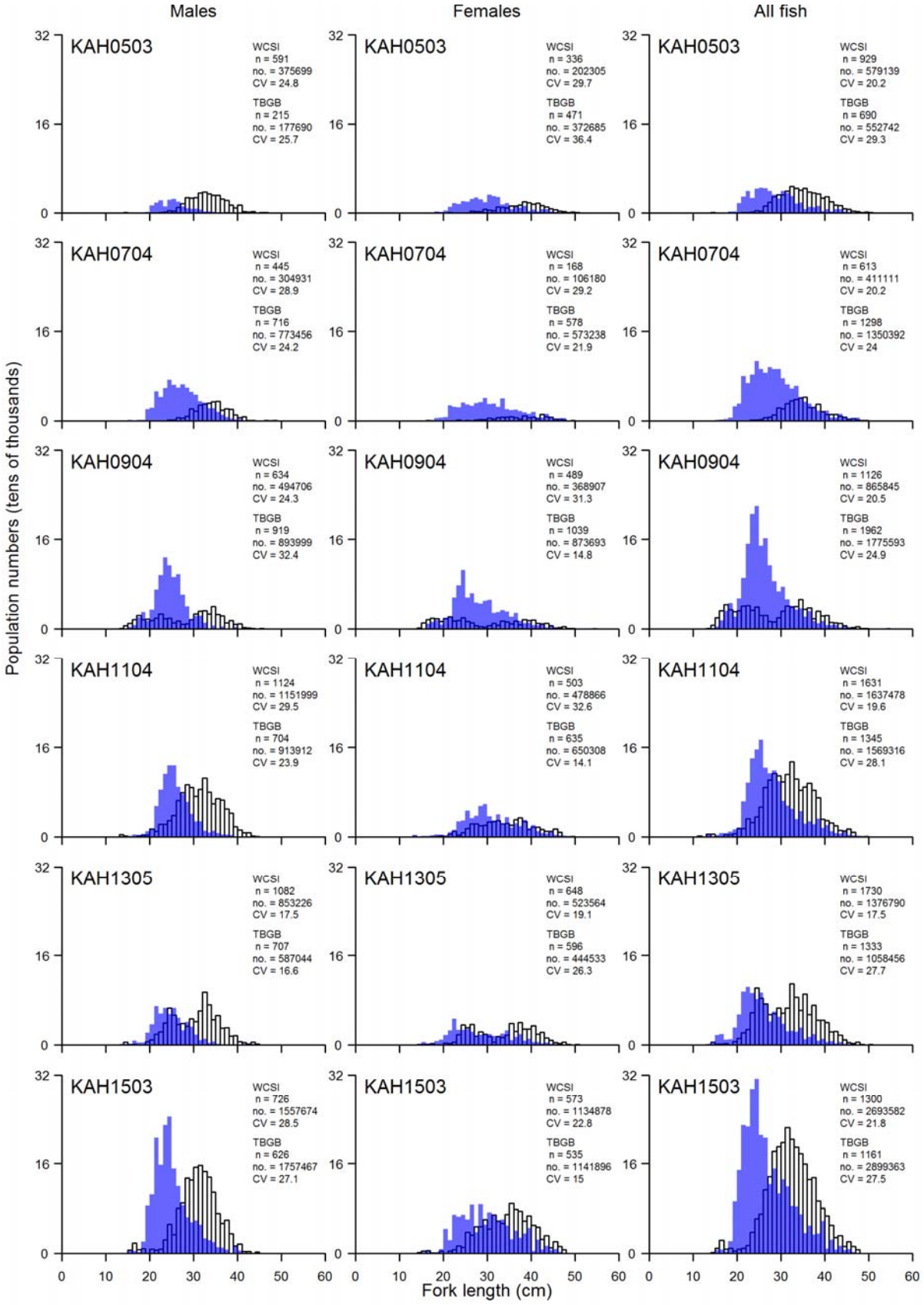


Figure 5i—continued.

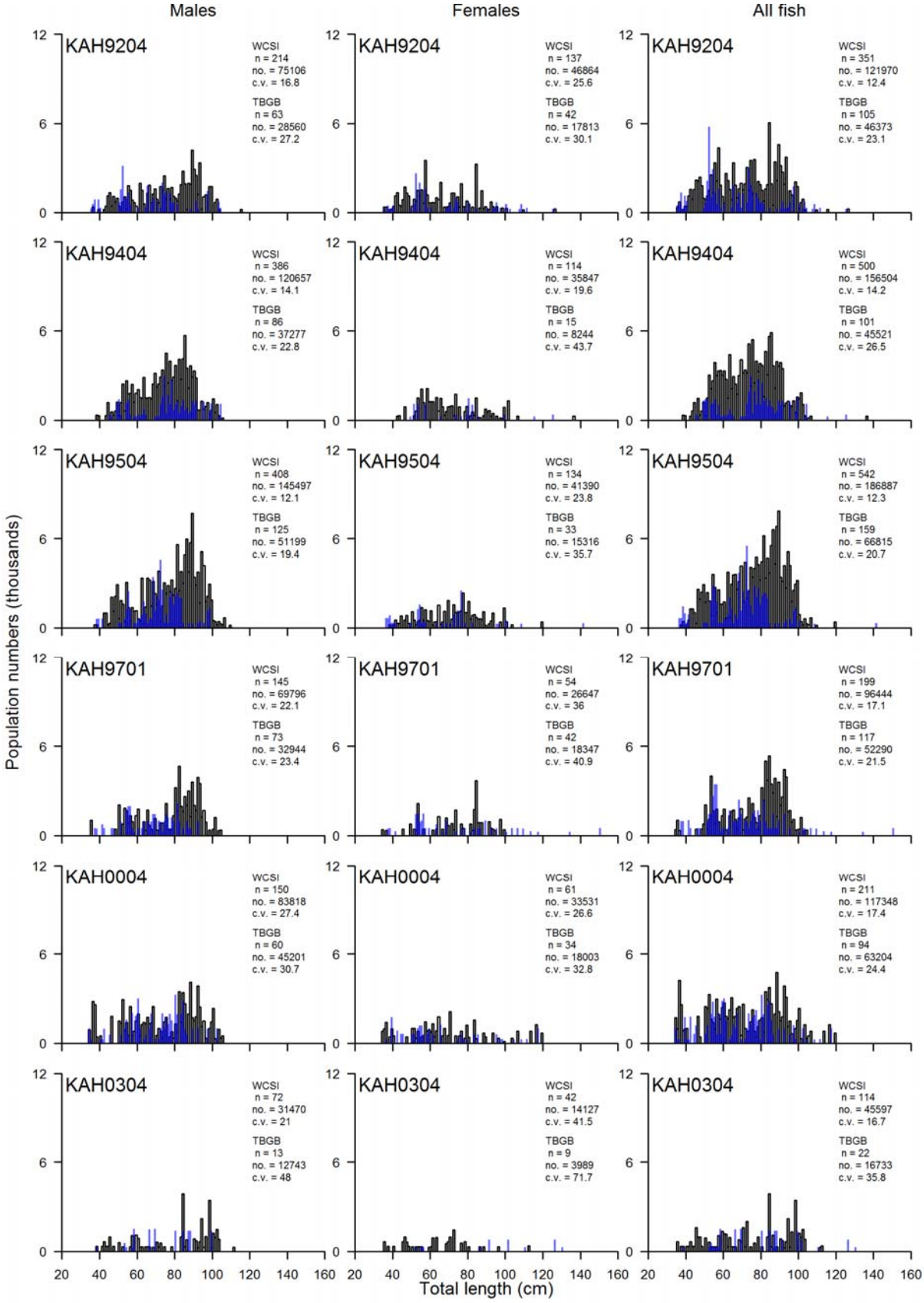
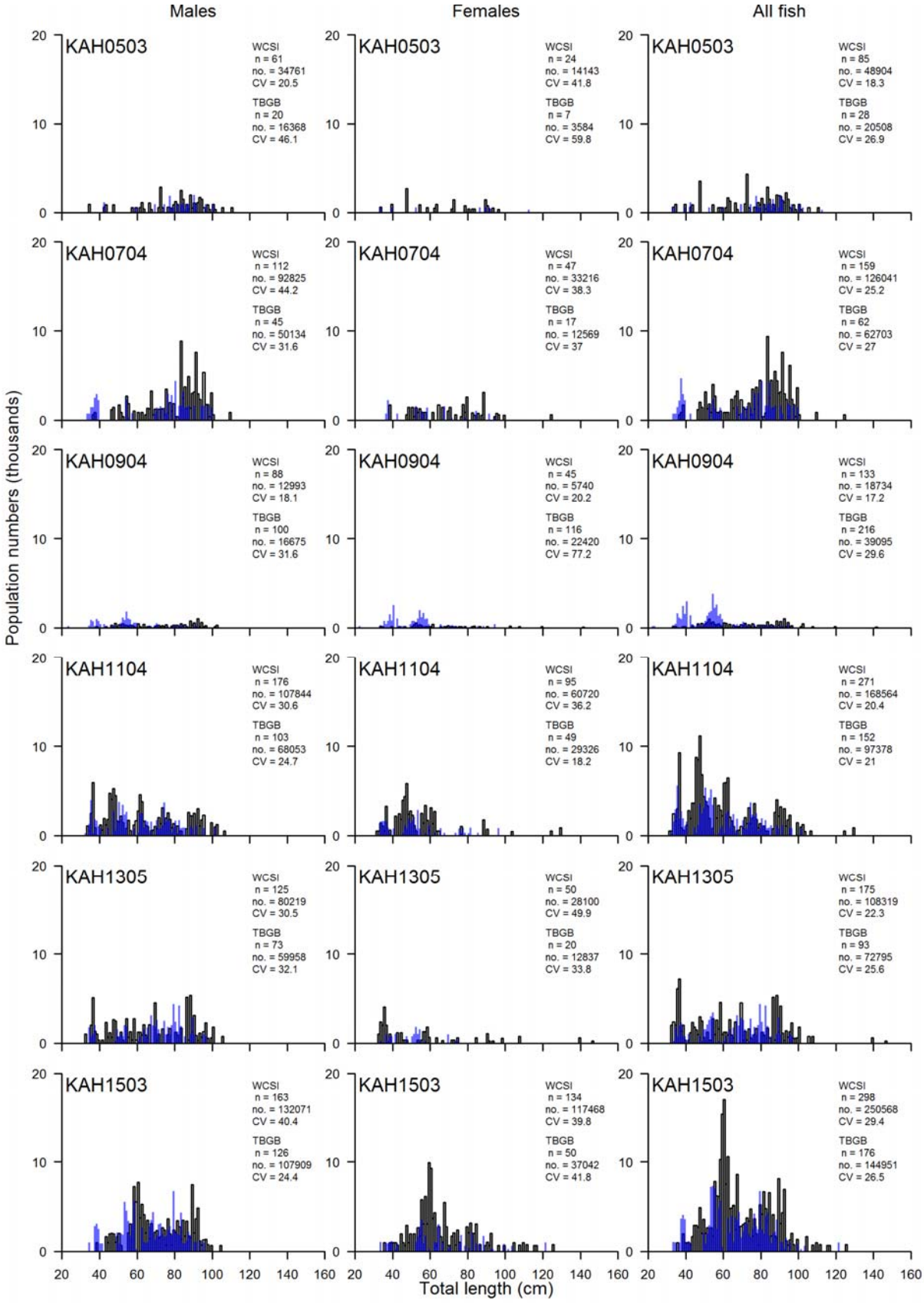


Figure 5j: Rig.



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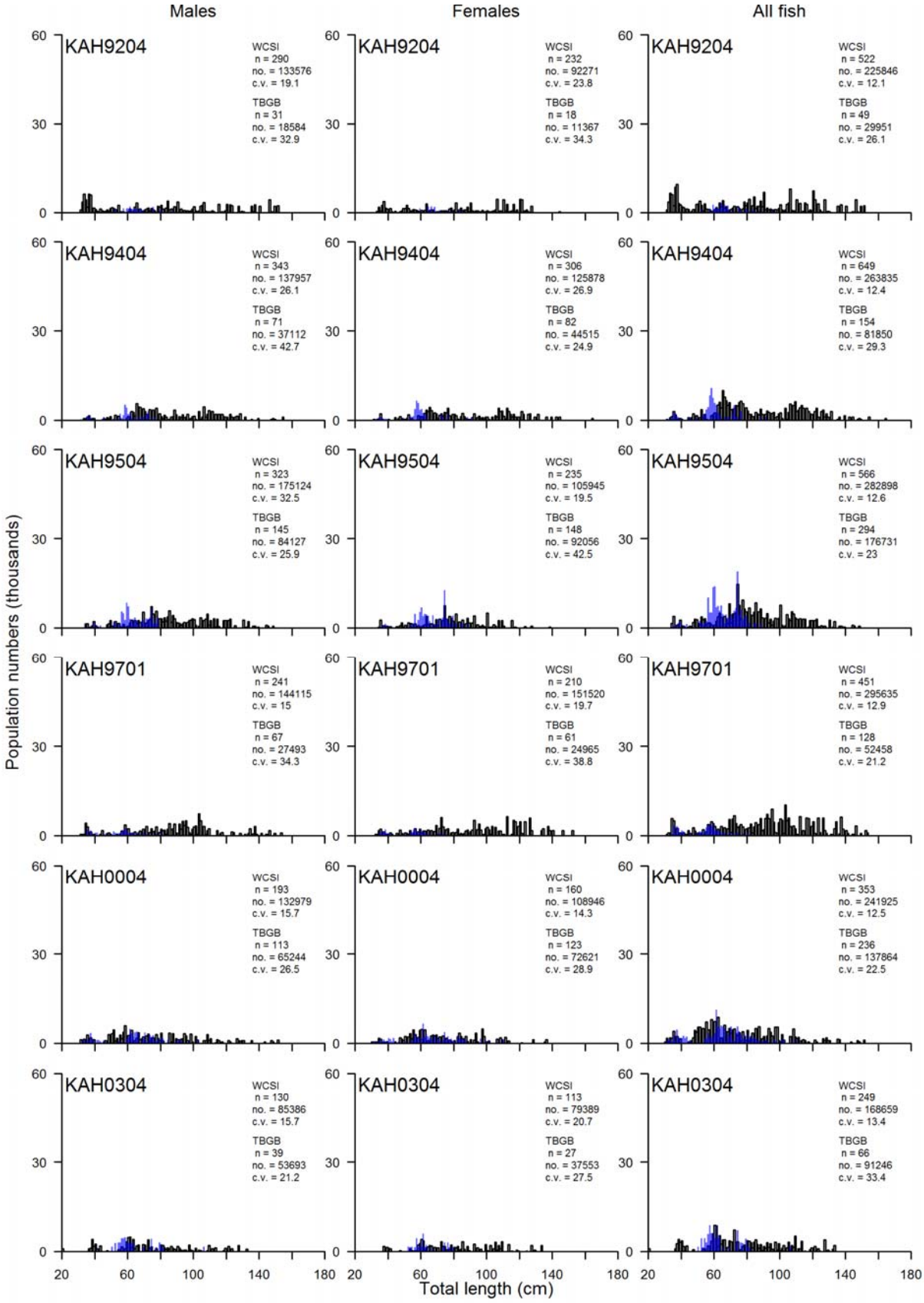


Figure 5k: School shark.

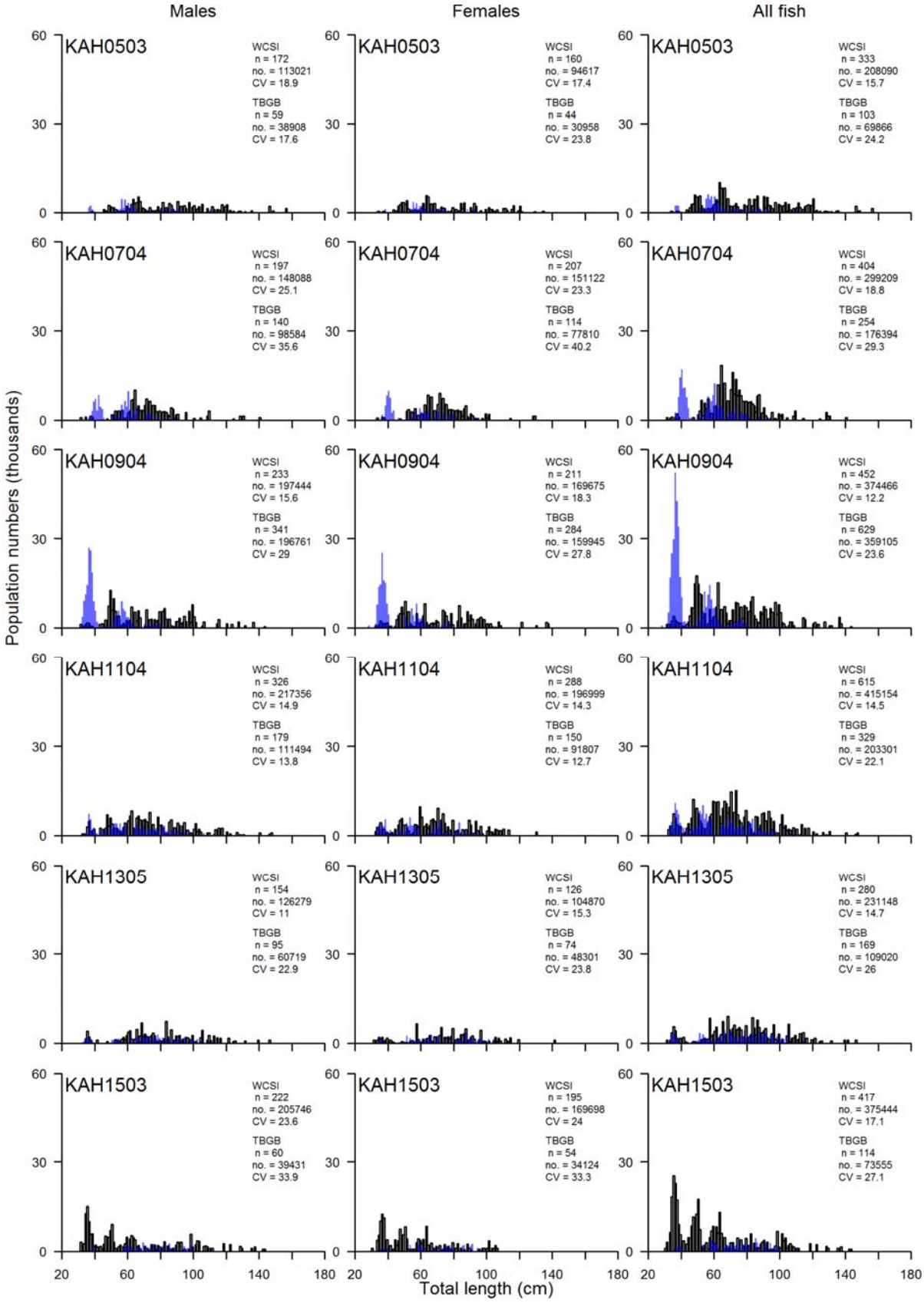


Figure 5k—continued.

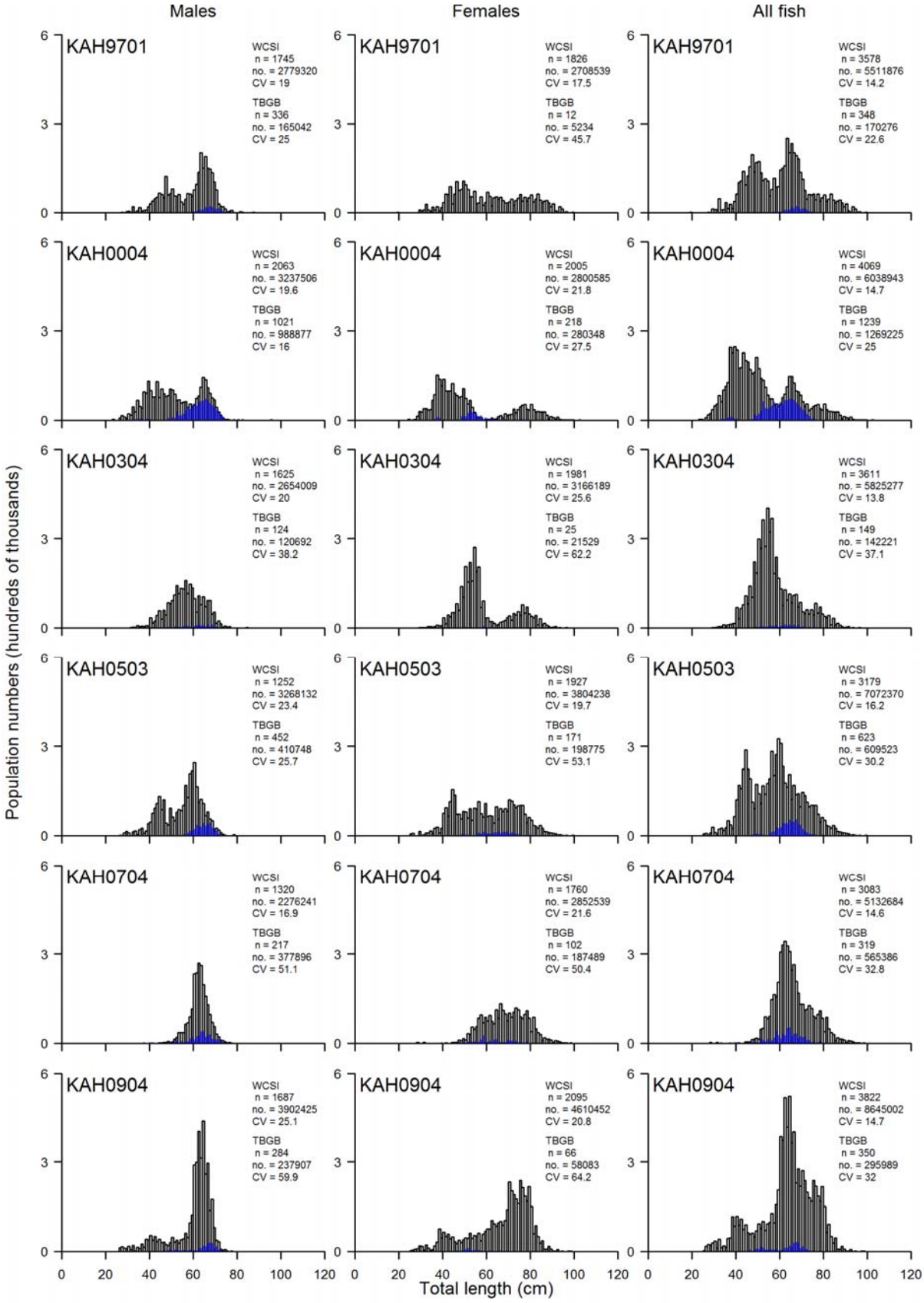


Figure 5l: Spiny dogfish. NB: no spiny dogfish were measured before 1997.

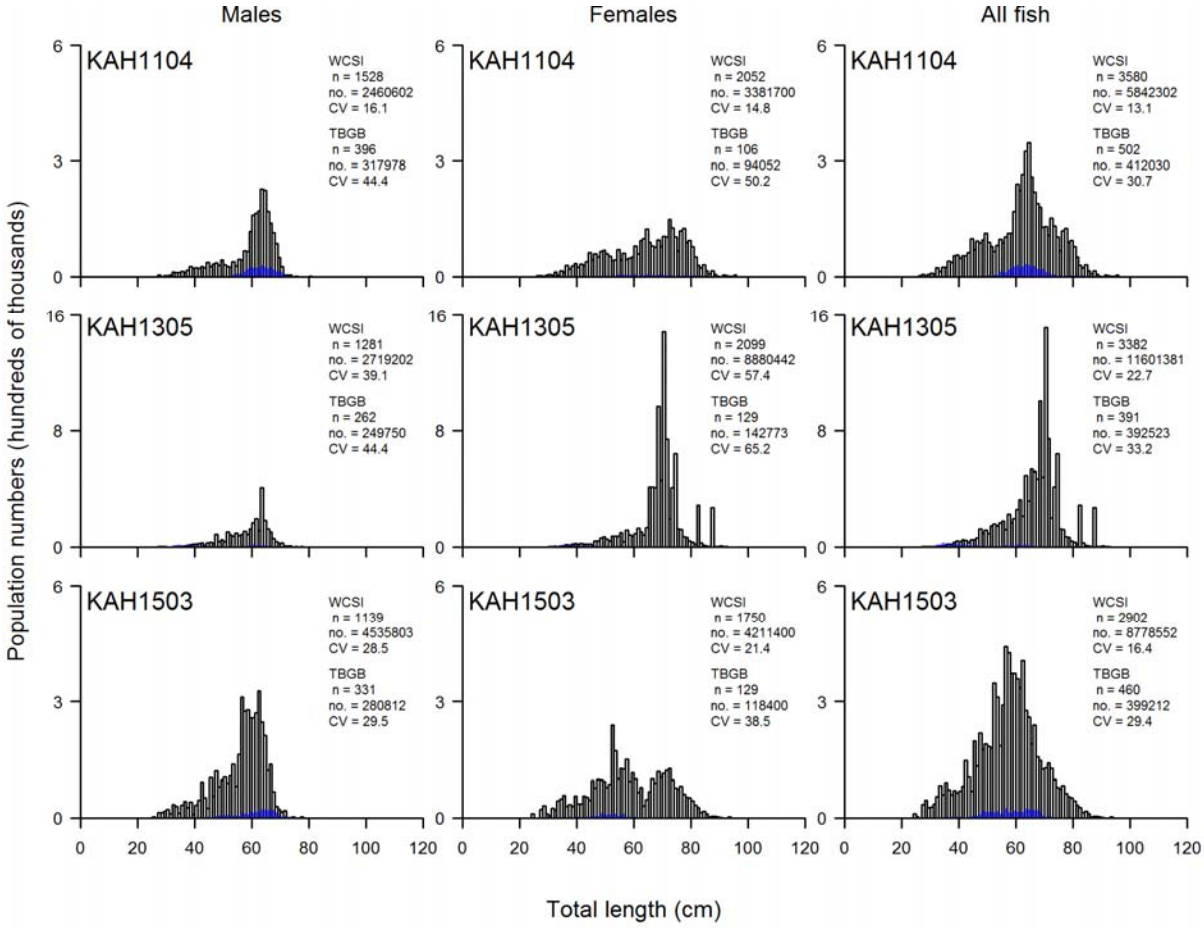


Figure 5l–continued.

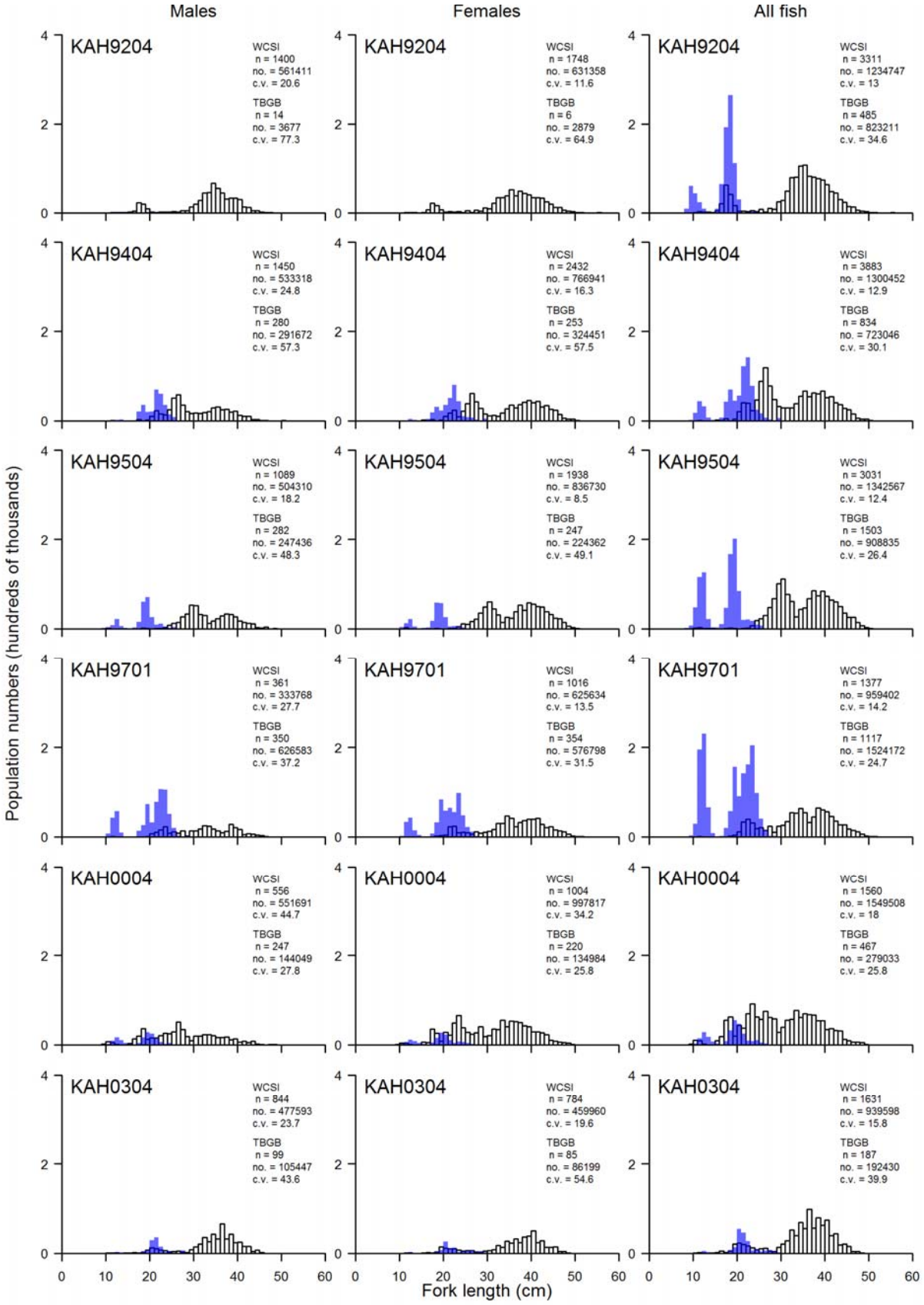


Figure 5m: Tarakihi.

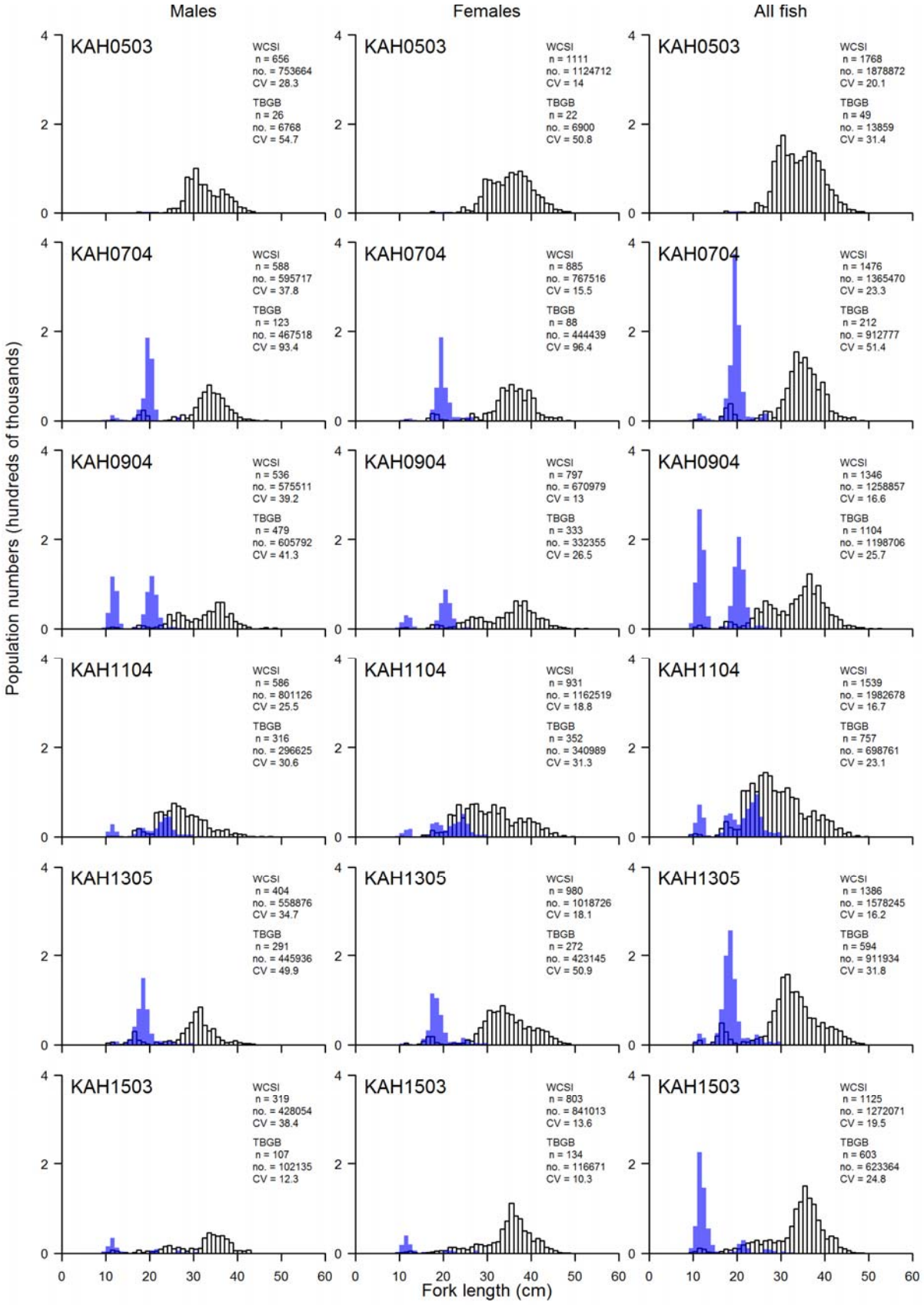
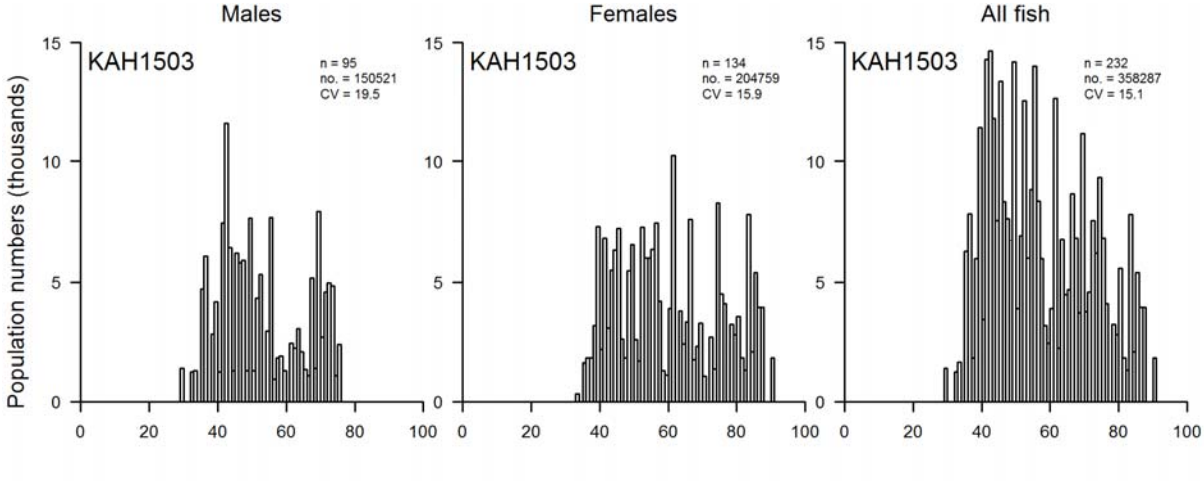
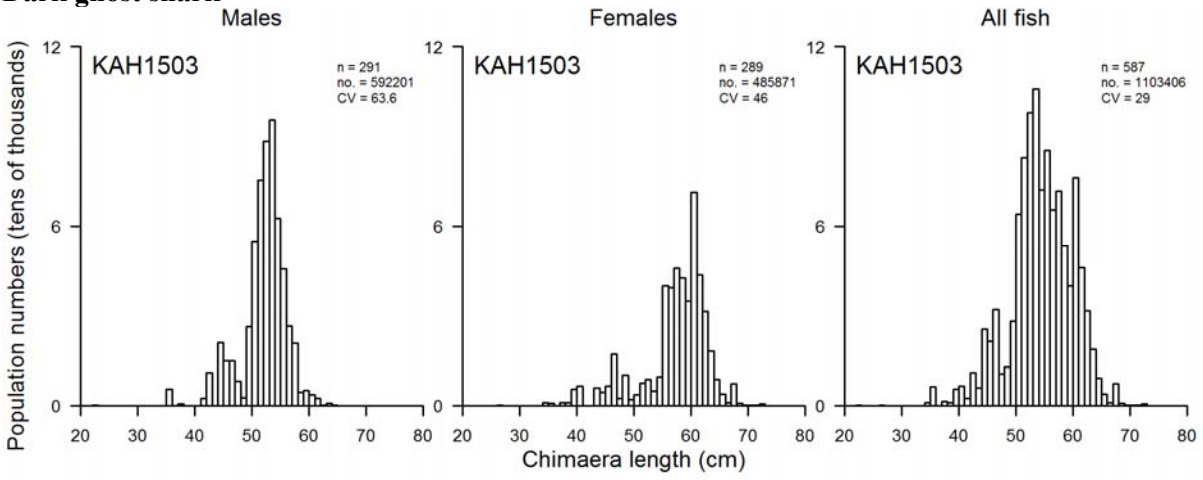


Figure 5m—continued.

Carpet shark



Dark ghost shark



Frostfish

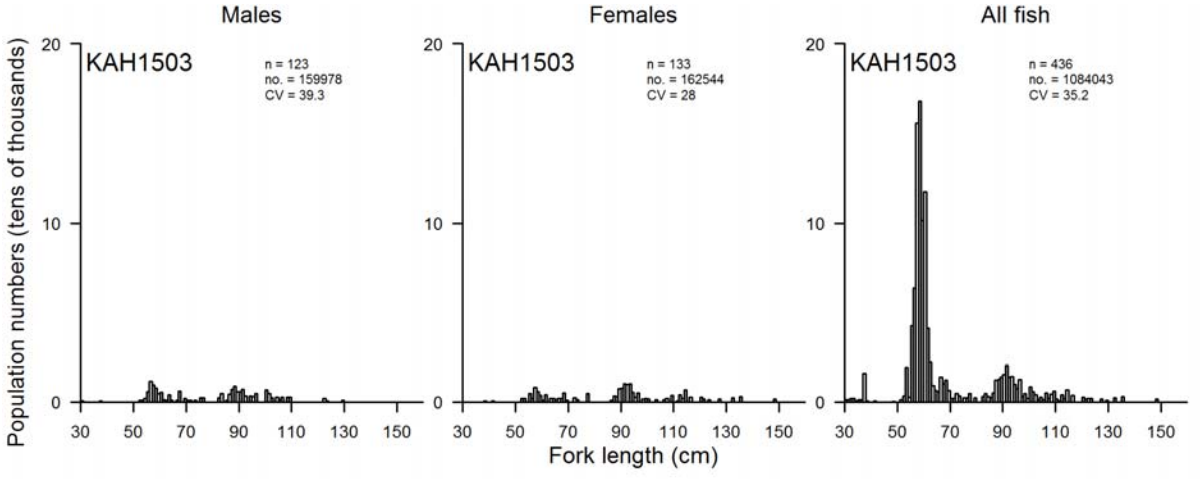
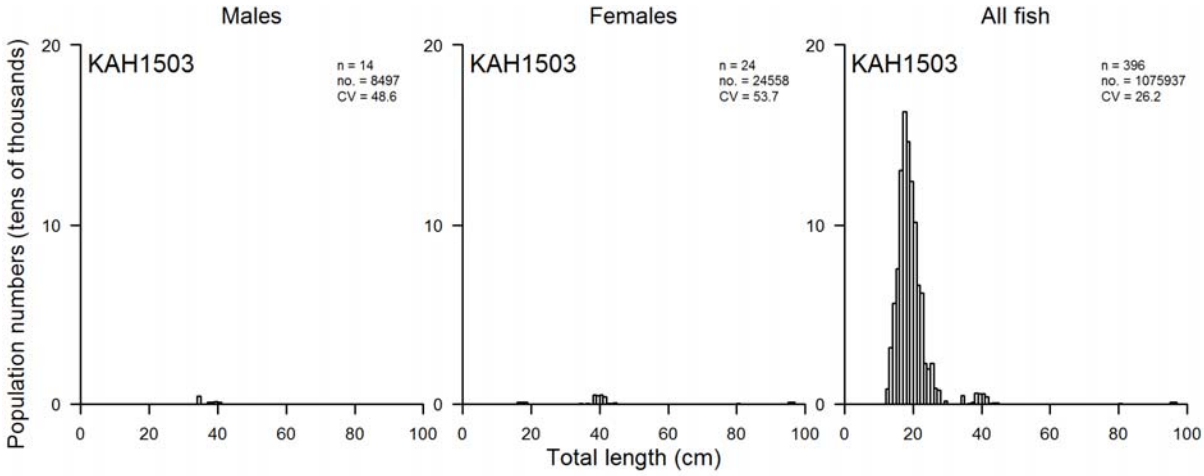
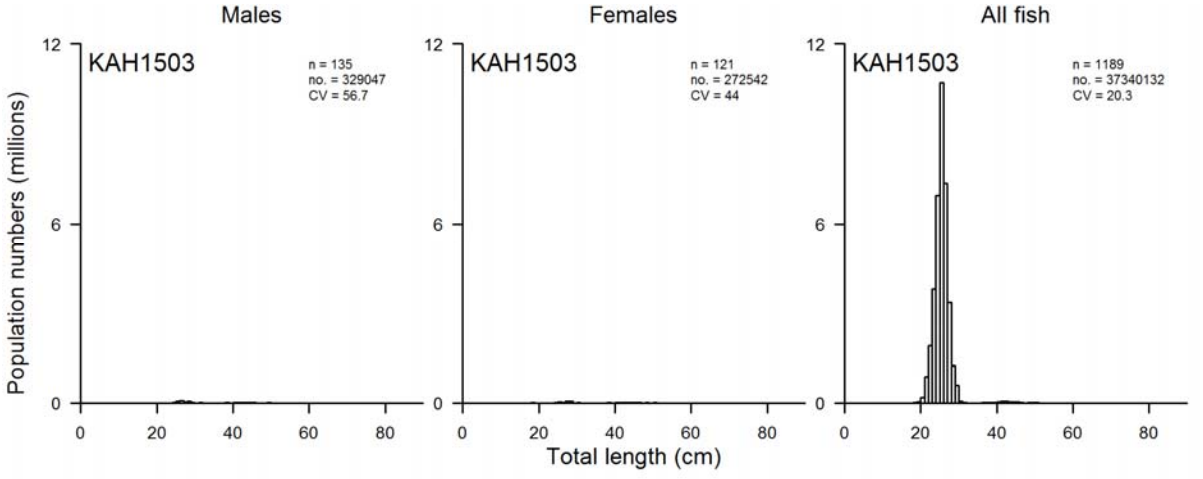


Figure 6: Scaled length frequency distributions for the other commercial species where more than 100 fish were measured and carpet shark. n = number of fish measured, no. = scaled population number, CV = coefficient of variation.

Hake



Hoki



Jack mackerel (*Trachurus novaezelandiae*)

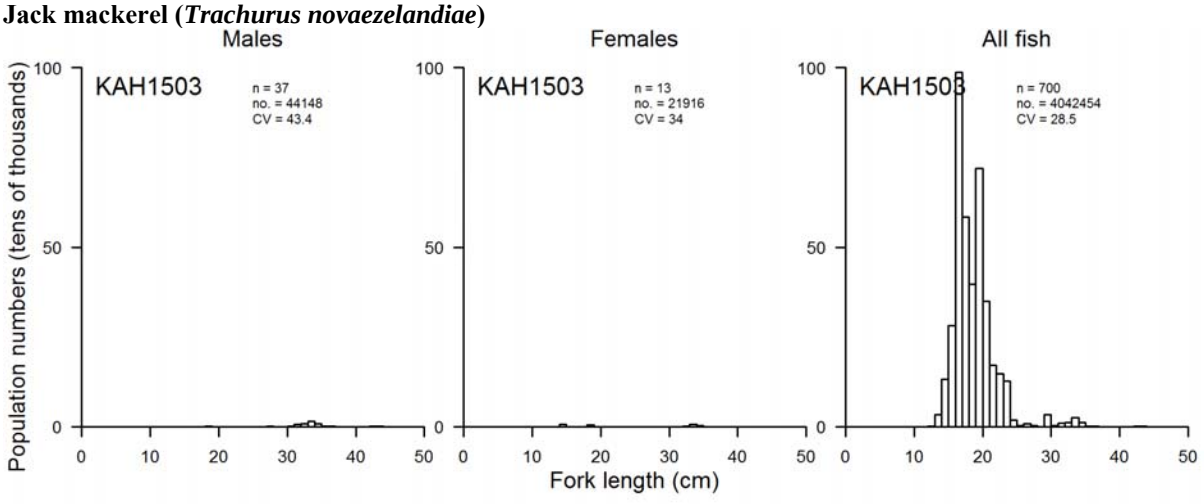
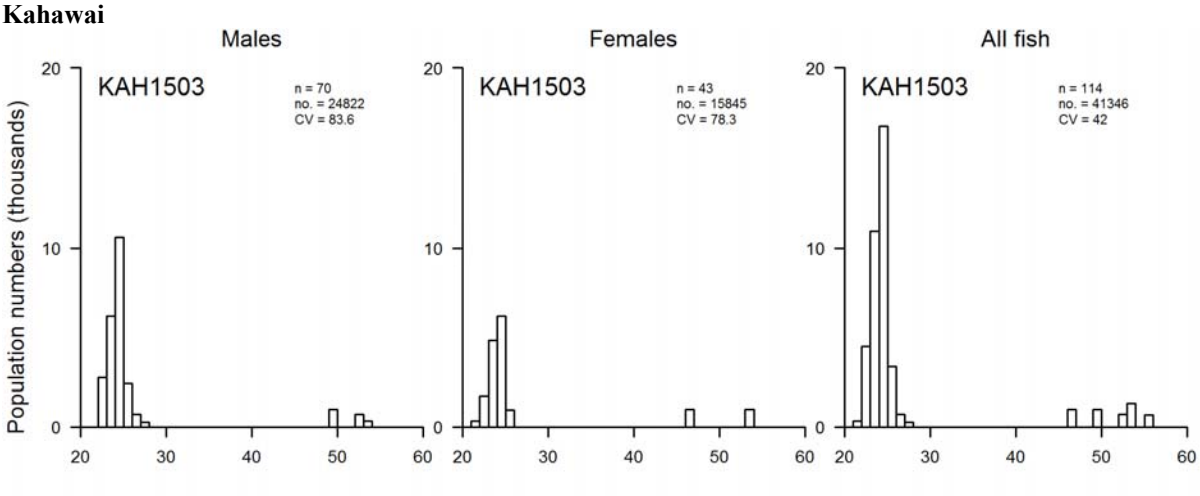
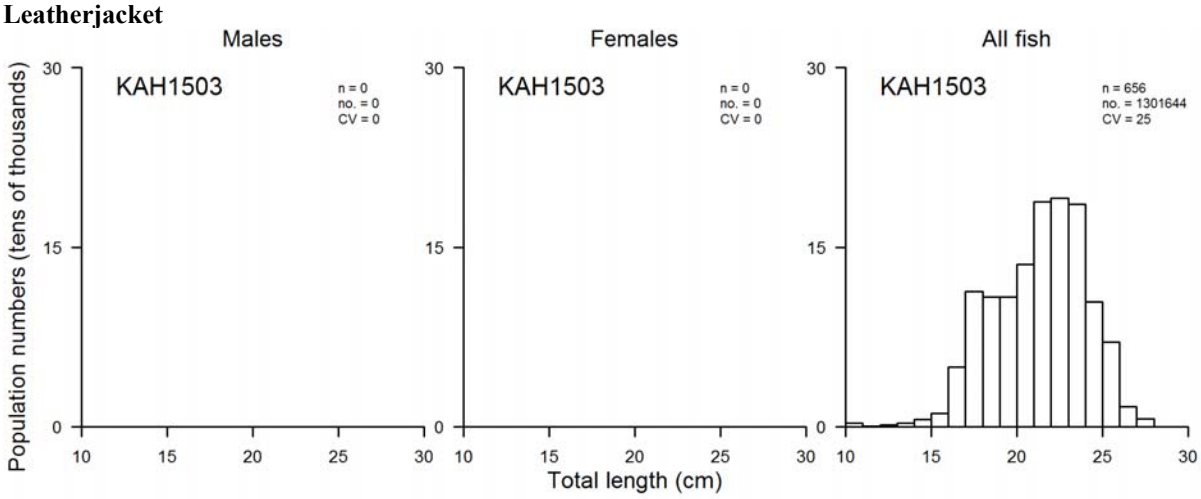


Figure 6—continued.

Kahawai



Leatherjacket



Lemon sole

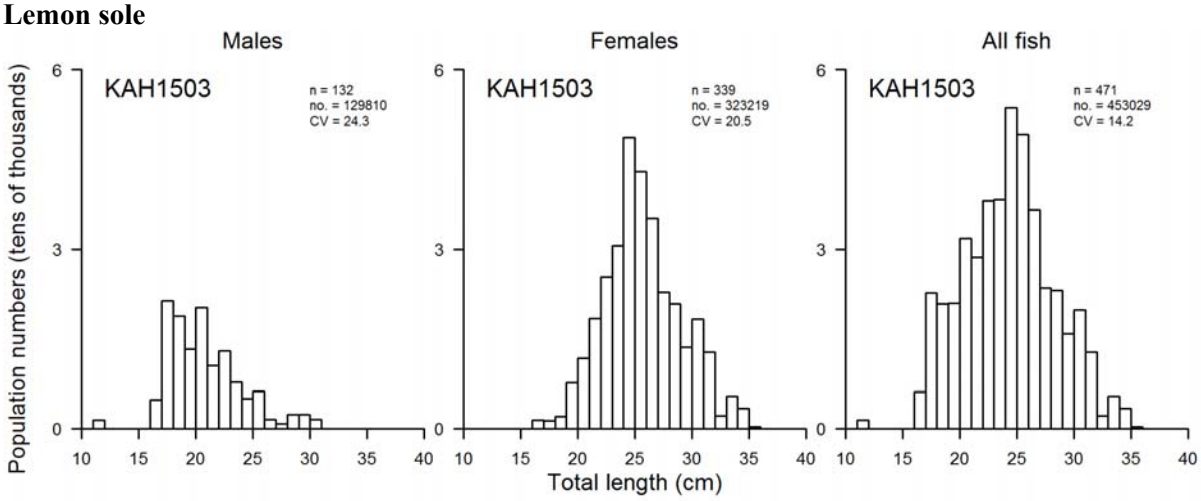
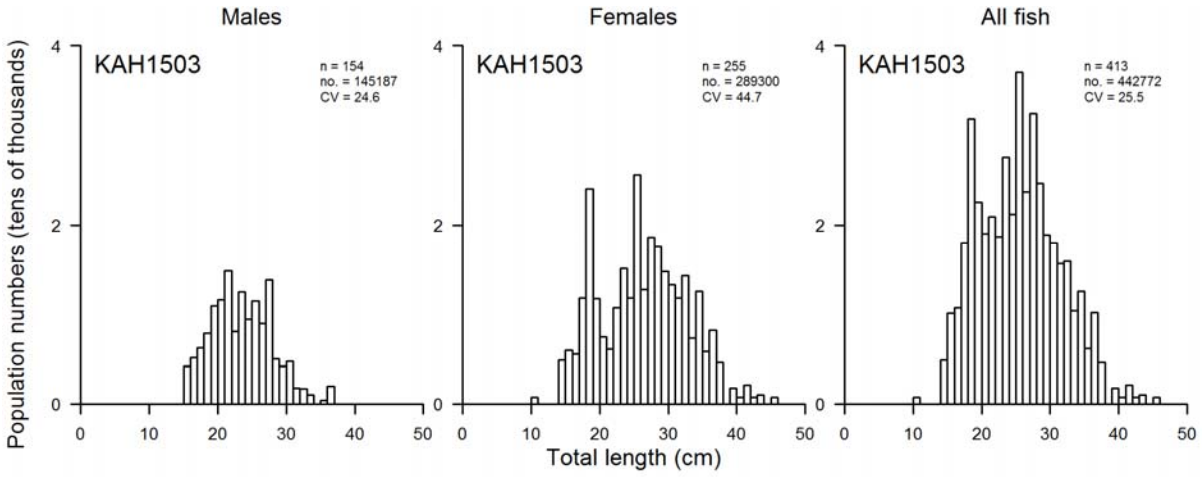
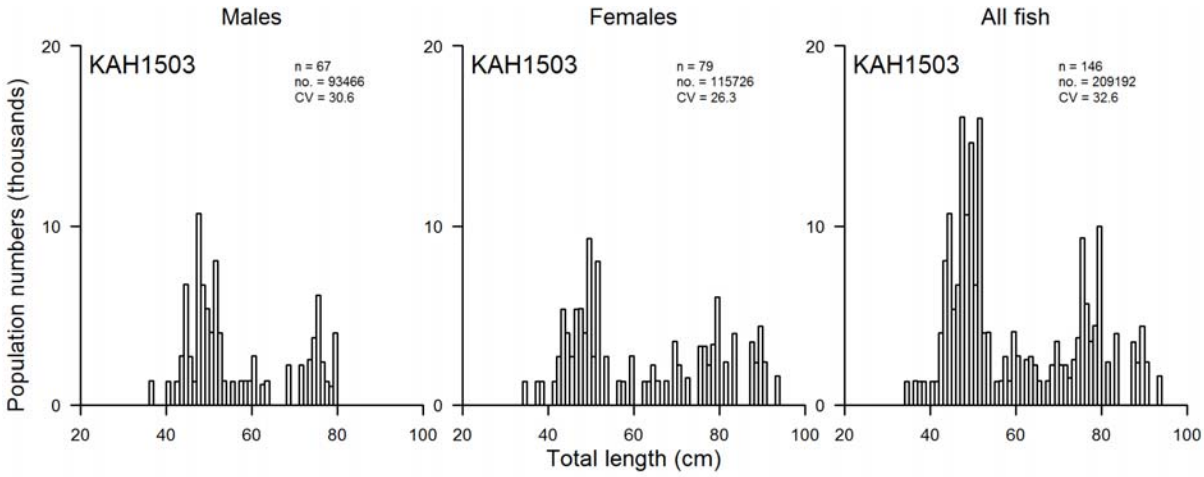


Figure 6—continued.

New Zealand sole



Northern spiny dogfish



Sand flounder

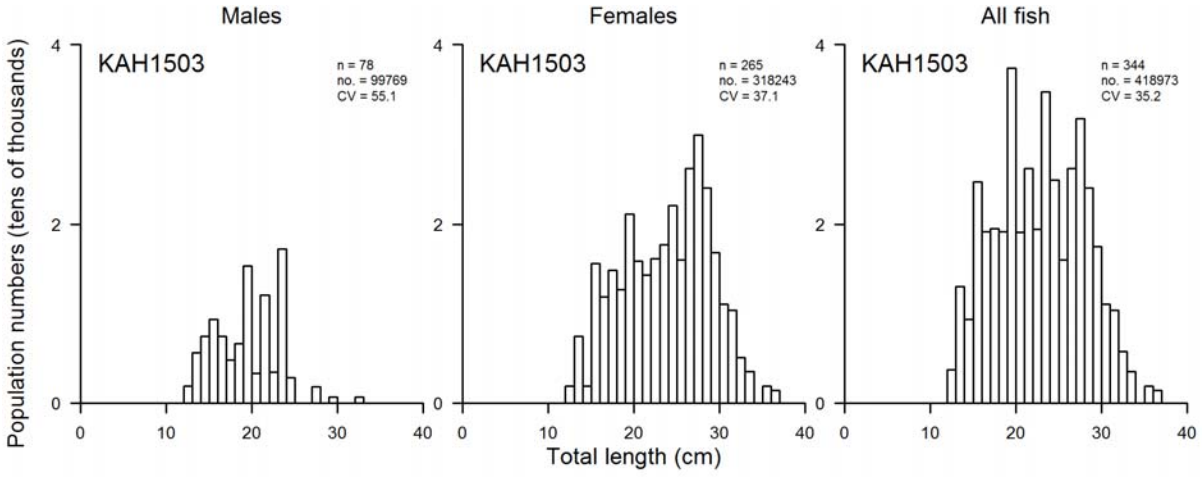
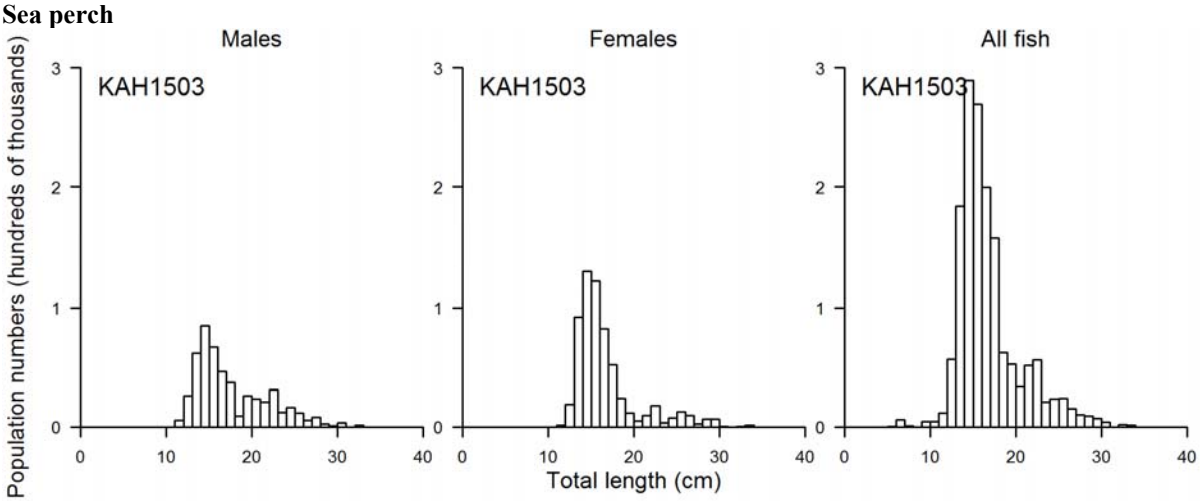


Figure 6—continued.

Sea perch



Silver warehou

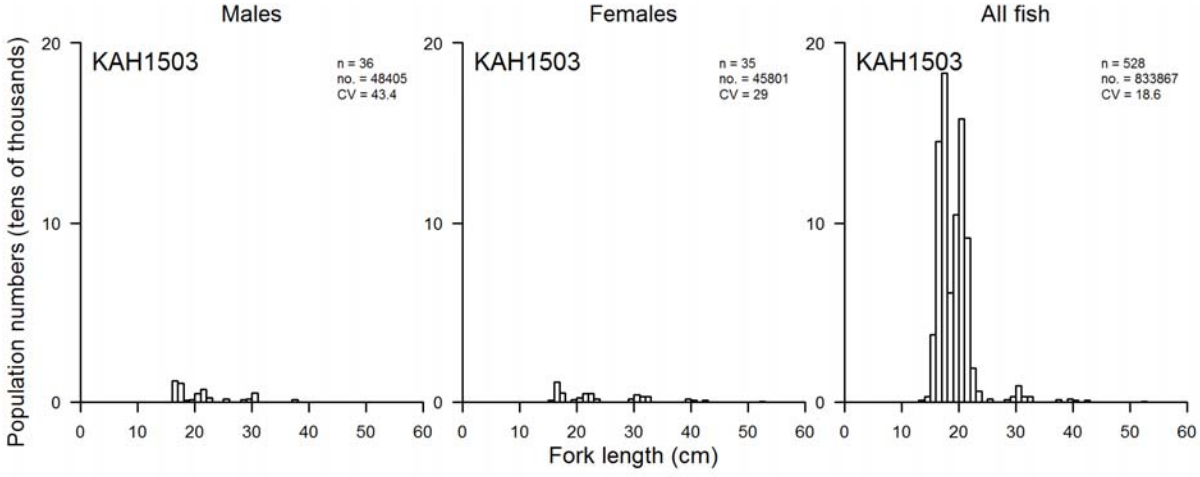


Figure 6—continued.

Snapper

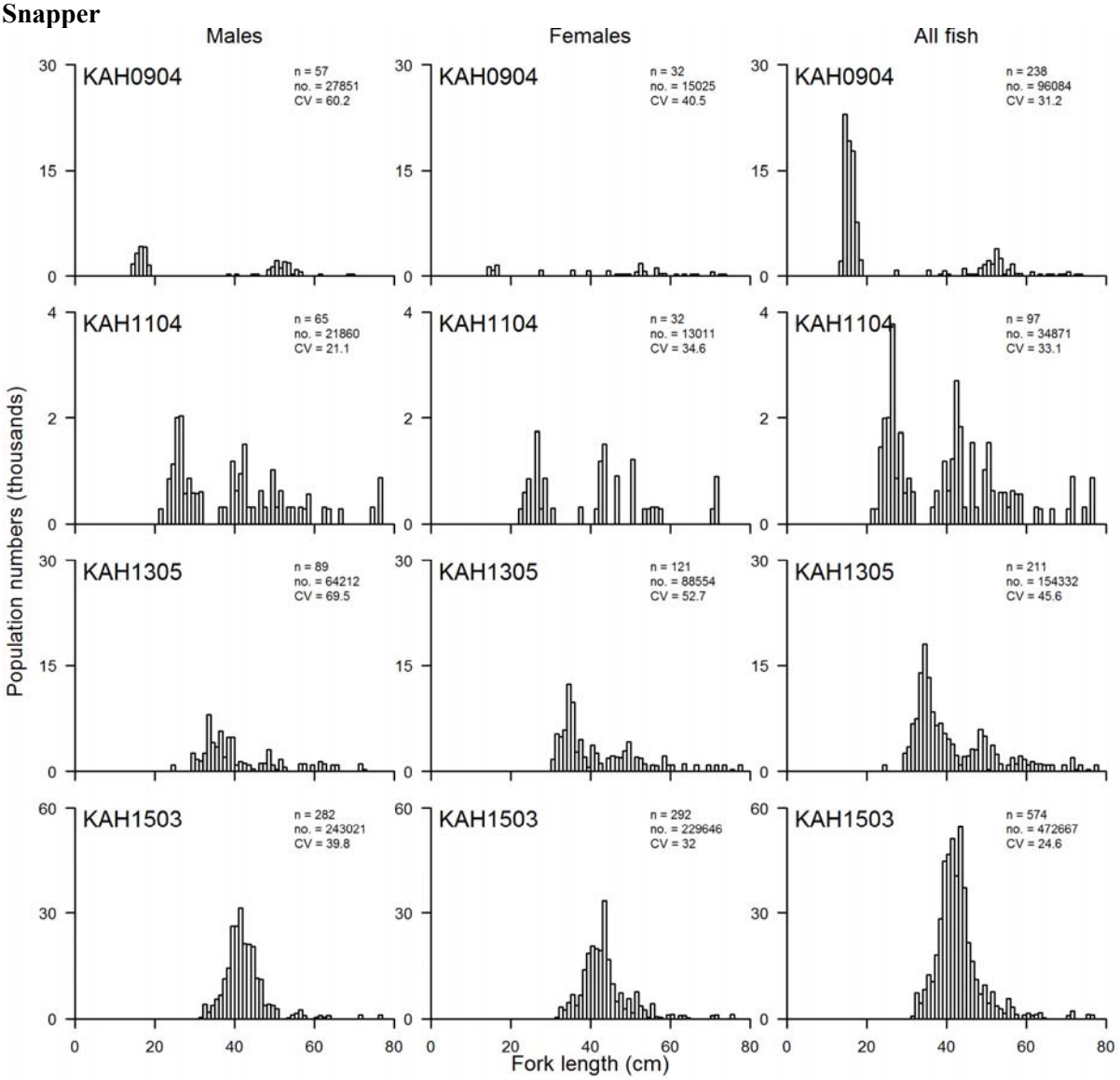


Figure 6—continued.

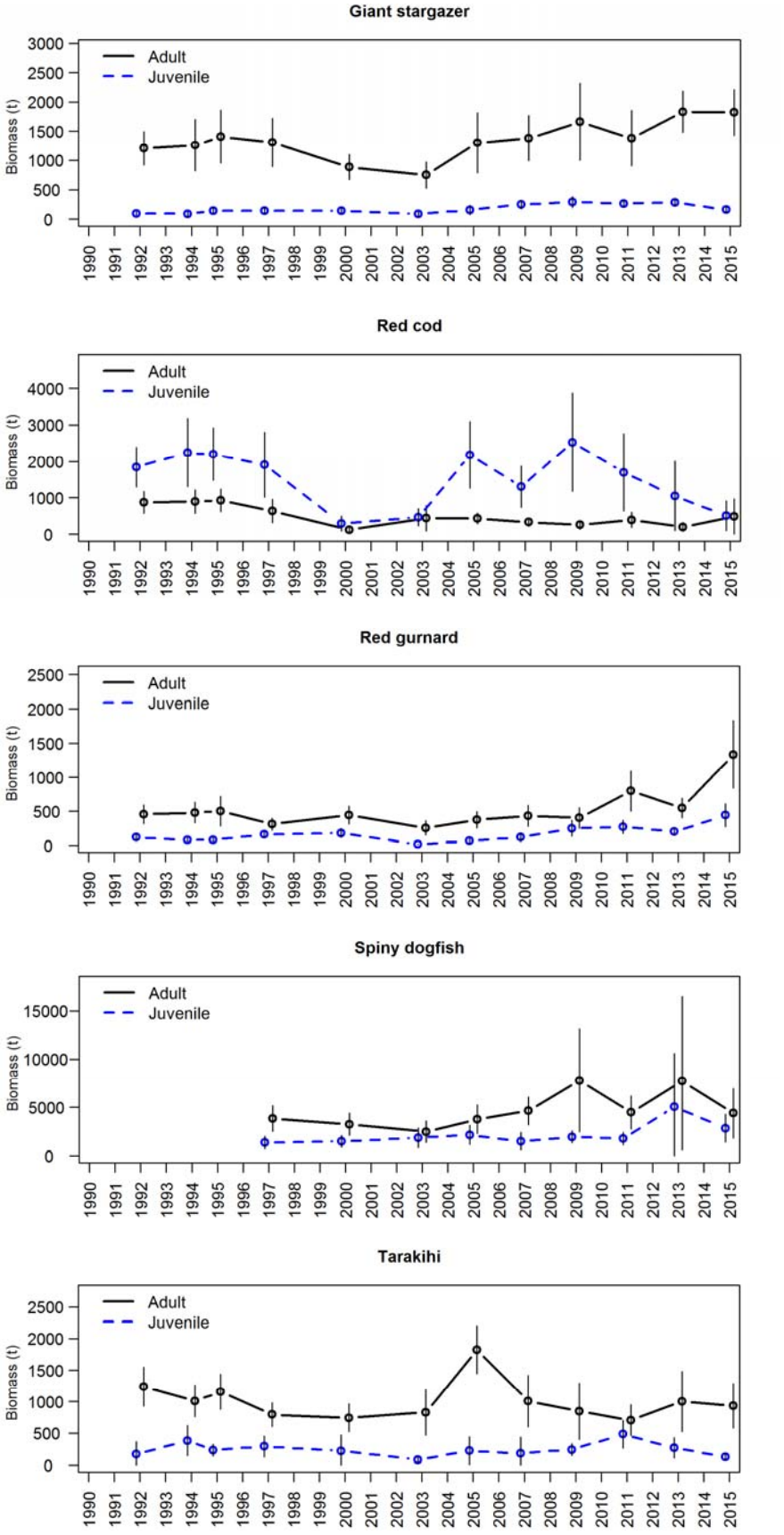


Figure 7: Biomass trends with 95% confidence intervals for juveniles (dashed blue lines) and adults (solid black lines) for the target species (all sexes combined) from all surveys in the series. For 50% maturity lengths, see Table 5.

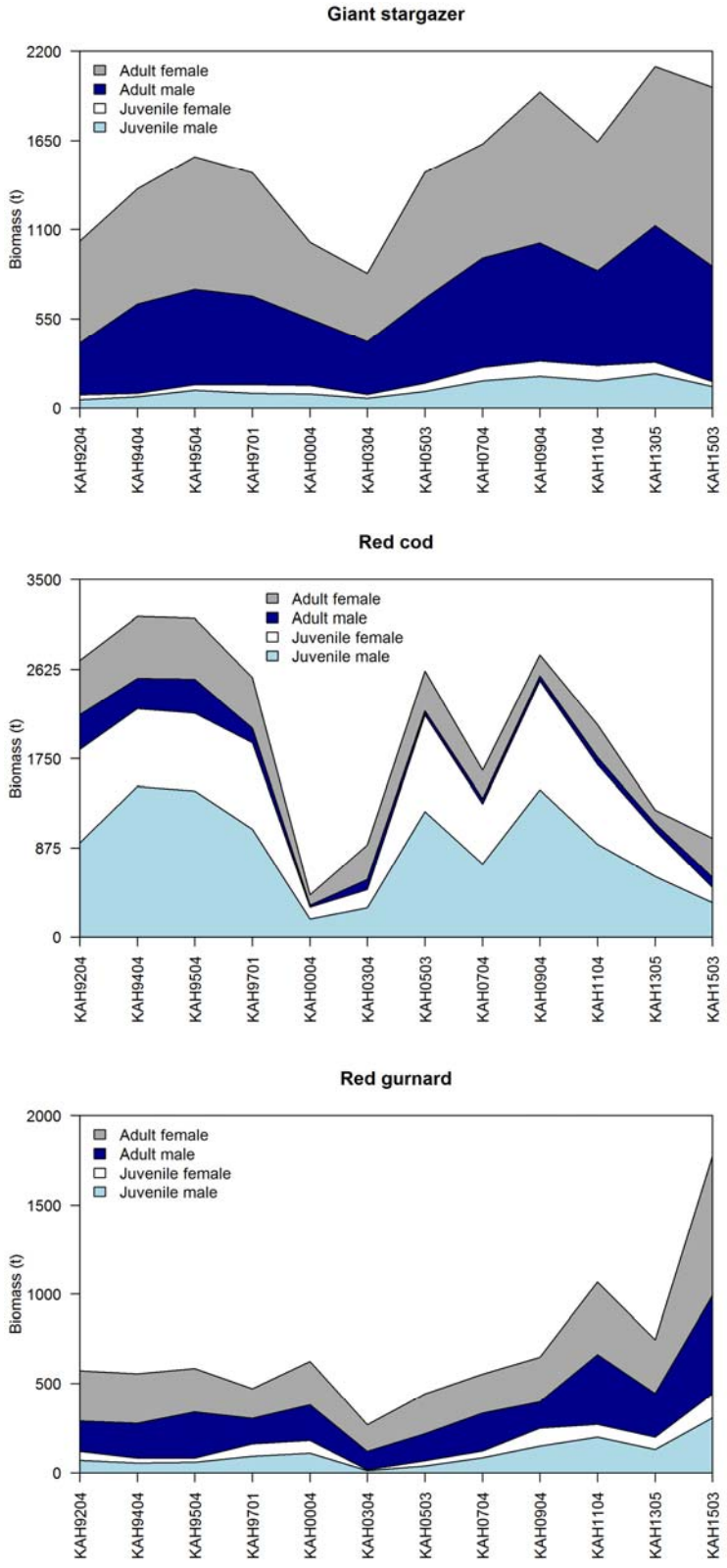


Figure 8: Biomass trends for juveniles and adults by sex for the target species for all surveys in the series. For 50% maturity lengths, see Table 5.

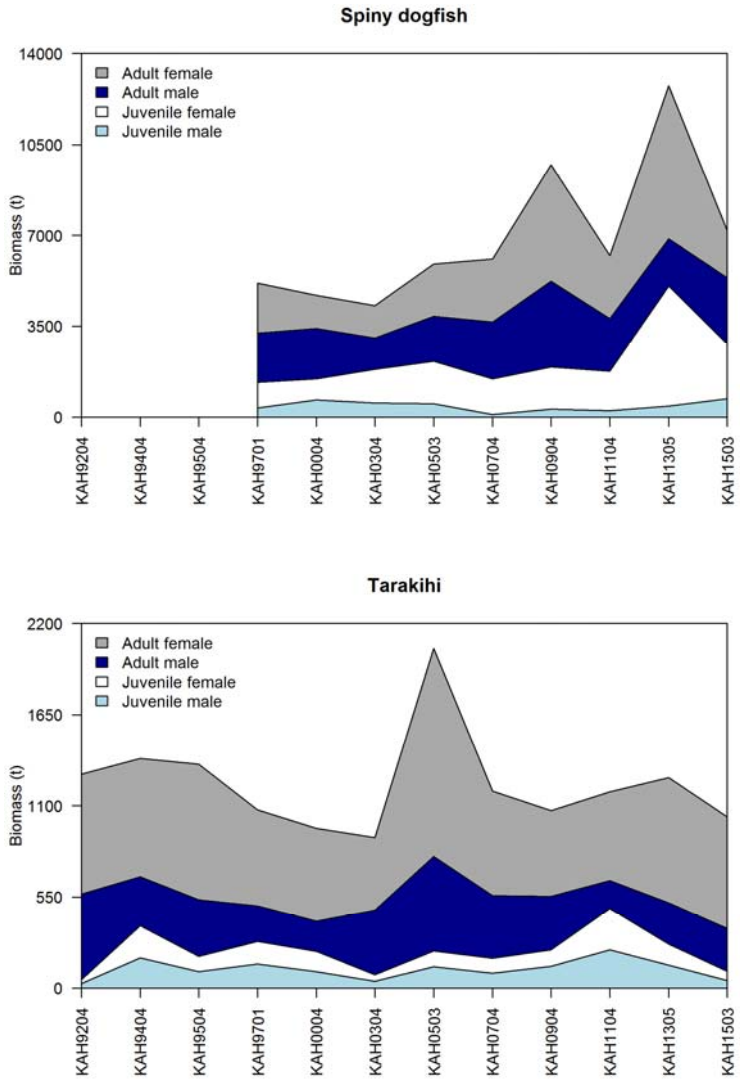


Figure 8 continued.

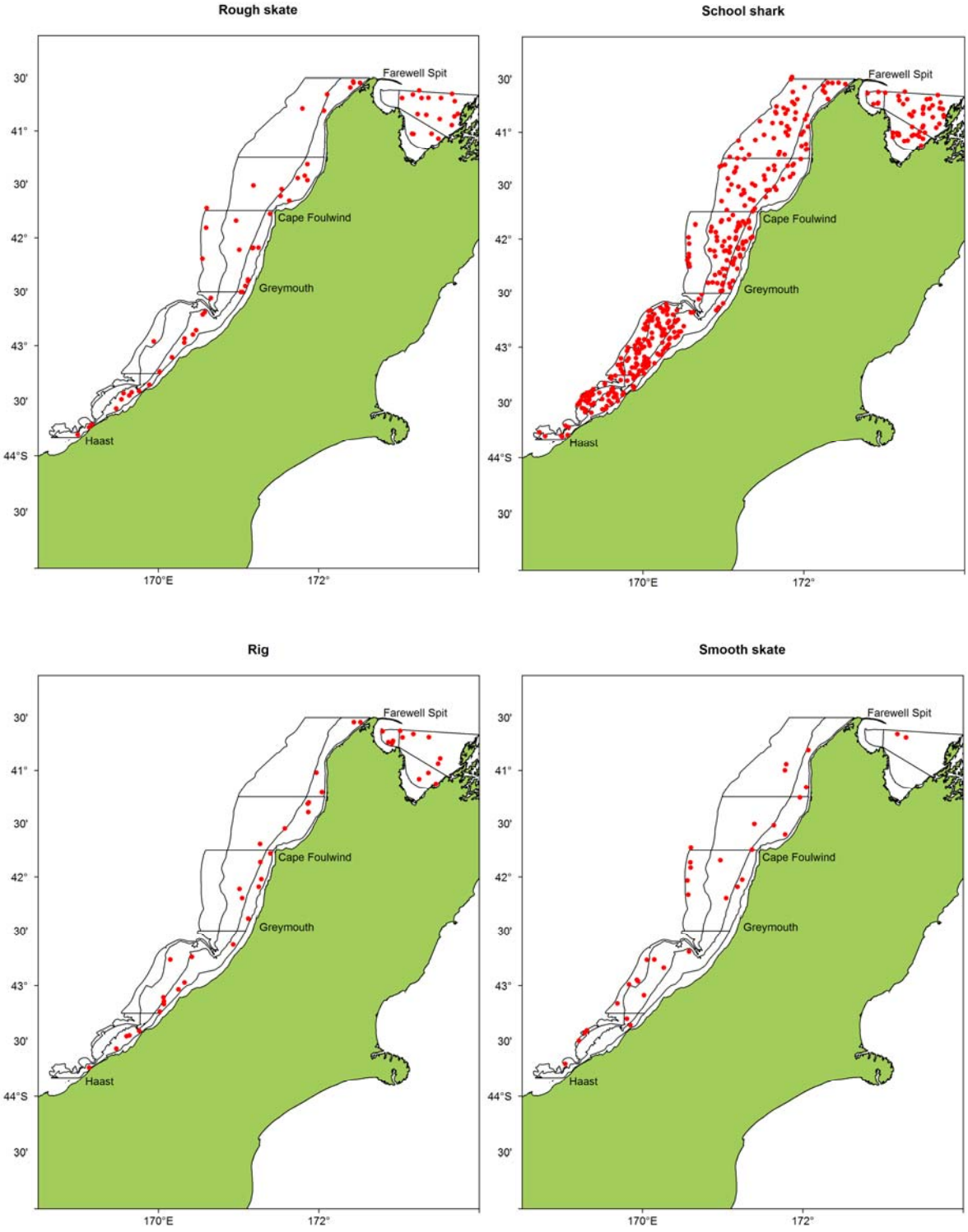


Figure 9: Release positions of tagged elasmobranchs by species for all surveys in the time series. Note that release positions often include more than one individual of a species.

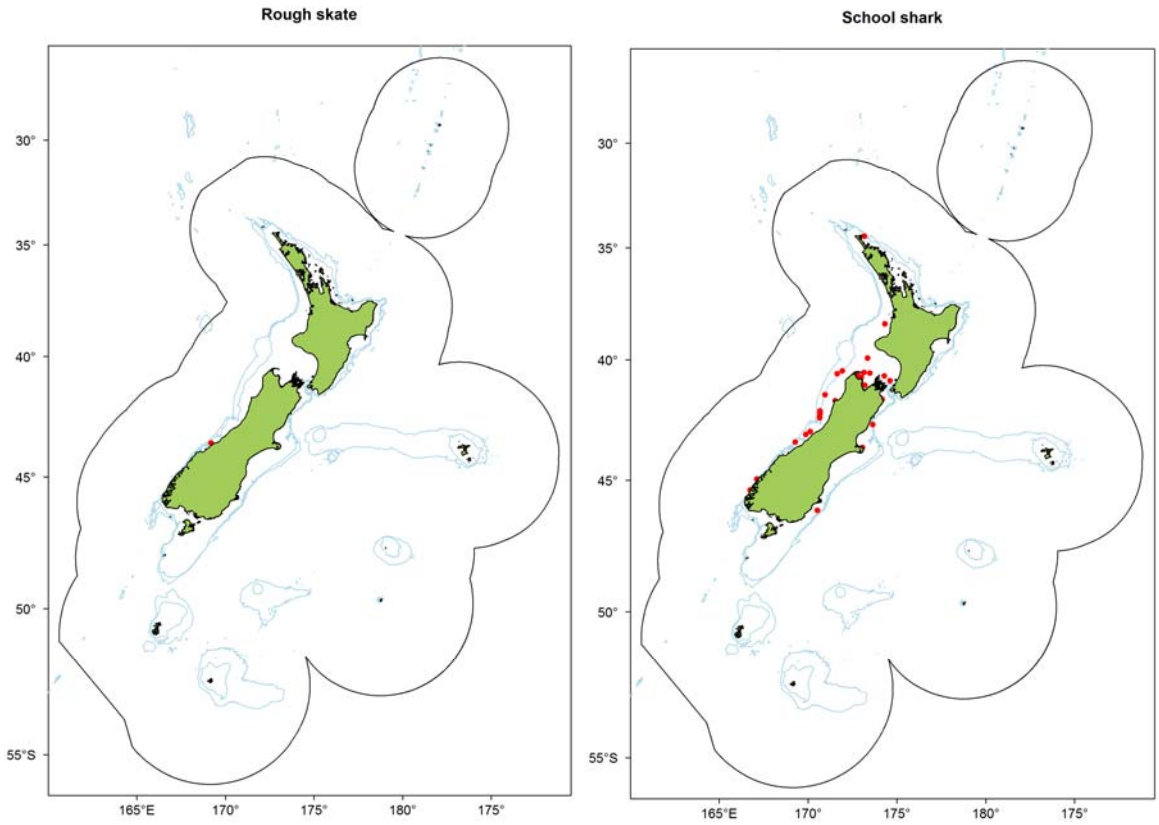


Figure 10: Positions of returned elasmobranch tags (NB: to date, no tags have been returned for smooth skate, and no location data provided by fishers for rig).

Appendix 1: Length-weight relationship parameters used to scale length frequencies and calculate length class biomass estimates. (Ministry for Primary Industries *trawl* database; –, no data; n, sample size.)

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

Species	*a*	*b*	n	Length range (cm) Min.	Max.	Data source
Barracouta	0.0056	2.9766	408	13.2	91.4	KAH1305
Blue cod	0.0089	3.1285	109	20	50.1	KAH1305
Blue warehou	0.0144	3.1050	338	27.4	69.6	TAN9604
Carpet shark	0.0018	3.2854	199	30.5	91.2	This survey
Dark ghost shark	0.0015	3.3611	332	21.2	67.9	KAH9704
Elephantfish	0.0049	3.1654	378	13.4	91	KAH9618
Frostfish	0.0004	3.1629	450	10.4	153	KAH0004
Gemfish	0.0017	3.3419	391	32	107	KAH9304 KAH9602
Giant stargazer	0.0116	3.0991	545	11.2	76.9	This survey
Hake	0.0049	3.1072	260	10.7	45.2	KAH1104
Hapuku	0.0078	3.1400	307	49	108	TAN9301
Hoki	0.0046	2.8840	525	22	110	SHI8301
Jack mackerel						
(*Trachurus declivis*)	0.0165	2.9300	200	15	53	COR9001
(*T. novaezelandiae*)	0.0163	2.9230	200	15	40	COR9001
John dory	0.0142	3.0708	337	19.9	58.9	This survey
Leatherjacket	0.0088	3.2110				IKA8003
Lemon sole	0.0080	3.1278	524	14.6	41.2	KAH9809
Ling	0.0016	3.2477	232	27	122	KAH1305
New Zealand sole	0.0049	3.2151	114	20	48	KAH0304
Northern spiny dogfish	0.0034	3.0781	207	43	90.3	combined surveys
Red cod	0.0124	2.9162	552	11.4	65.9	This survey
Red gurnard	0.0076	3.0893	572	14.4	47.2	This survey
Rig	0.0046	2.9781	321	34.6	126	This survey
Rough skate	0.0257	2.9454	206	17	62	This survey
Sand flounder	0.0207	2.8768	282	13.5	44.5	KAH9809
School shark	0.0036	3.0775	436	31.9	144	This survey
Sea perch	0.0262	2.9210	210	7	42	KAH9618
Silver dory	0.0191	2.9650	506	13.2	27.5	KAH0904
Silver warehou	0.0058	3.3279	146	15.8	43.2	TAN502
Smooth skate	0.0254	2.9279	52	21.2	105	This survey
Snapper	0.0447	2.7930	780	8	71	Paul, FRD Bull. 13
Spiny dogfish	0.0015	3.2254	931	28.8	90.6	This survey
Tarakihi	0.0163	3.0346	727	11.2	49.1	This survey
Two-saddle rattail	0.0015	3.31	605	18	55.8	KAH0904

Appendix 2: Summary of station data.

Station	Stratum	Date	Start of tow Time	Start of tow ° ' S	Start of tow ° ' E	End of tow ° ' S	End of tow ° ' E	Gear depth (m) Min.	Gear depth (m) Max.	Distance trawled (n. miles)	Headline height (m)	Doorspread (m)	Surface temp (°C)	Bottom temp (°C)	Warp length
1	**19**	28 Mar 15	1236	40 59.25	173 39.57	40 58.53	173 43.21	39	39	2.84	4.6	72.9	19.0	17.1	200
2	18	28 Mar 15	1357	41 01.32	173 34.15	41 03.62	173 31.78	33	38	2.91	4.8	72.9	18.9	17.6	200
3	19	29 Mar 15	712	40 37.75	173 07.71	40 40.14	173 10.21	42	46	3.05	4.7	74.0	18.3	16.3	200
4	17	29 Mar 15	947	40 40.30	172 57.19	40 42.49	172 59.74	31	32	2.92	4.8	71.8	18.6	17.6	200
5	17	29 Mar 15	1347	40 42.15	172 50.04	40 43.77	172 52.12	24	24	2.26	4.3	70.3	18.7	18.2	200
6	17	29 Mar 15	1441	40 37.79	172 56.37	40 37.84	173 00.44	30	34	3.08	4.5	70.6	18.6	17.6	200
7	19	30 Mar 15	616	40 45.78	173 10.12	40 44.41	173 13.72	41	44	3.05	4.8	74.3	18.6	16.4	200
8	19	30 Mar 15	840	40 42.88	173 27.44	40 41.64	173 31.15	51	53	3.07	4.6	76.2	18.7	16.8	200
9	19	30 Mar 15	1059	40 46.27	173 41.15	40 47.93	173 44.43	56	63	2.98	4.7	74.4	18.5	17.1	200
10	19	30 Mar 15	1332	40 49.37	173 32.17	40 51.58	173 34.85	49	54	2.99	4.7	74.4	19.0	16.6	200
11	18	31 Mar 15	618	40 53.57	173 15.85	40 56.32	173 16.63	38	39	2.81	4.6	70.9	18.6	17.0	200
12	18	31 Mar 15	841	40 59.69	173 17.37	41 01.55	173 17.76	38	39	1.88	4.5	73.2	18.7	16.6	200
13	1	1 Apr 15	627	40 29.33	172 27.44	40 30.99	172 24.21	83	84	2.96	4.9	77.8	17.9	14.2	240
14	1	1 Apr 15	954	40 46.49	172 08.15	40 49.19	172 06.43	72	75	2.99	4.8	73.4	17.4	14.1	208
15	1	1 Apr 15	1200	40 51.22	172 01.48	40 53.95	171 59.91	94	95	2.97	4.9	78.1	18.8	13.9	275
16	2	1 Apr 15	1401	40 47.56	171 58.44	40 44.61	171 59.67	109	111	3.09	4.8	84.7	19.1	14.1	315
17	6	2 Apr 15	634	41 18.61	171 34.30	41 16.04	171 36.41	126	128	3.01	4.5	83.4	18.6	13.6	350
18	2	2 Apr 15	857	41 06.47	171 33.00	41 03.72	171 34.57	132	137	2.99	4.5	85.2	18.8	14.0	380
19	2	2 Apr 15	1112	41 07.86	171 38.02	41 10.64	171 36.47	129	133	3.01	4.7	83.4	–	–	365
20	2	2 Apr 15	1318	41 11.11	171 43.92	41 08.36	171 45.42	115	117	2.97	4.9	82.7	–	–	330
21	2	2 Apr 15	1506	41 08.14	171 49.91	41 10.80	171 51.57	101	106	2.93	4.1	84.8	18.9	13.8	300
22	9	3 Apr 15	621	42 02.16	170 35.82	41 59.38	170 36.78	308	318	2.87	4.8	90.6	18.7	11.9	800
23	9	3 Apr 15	826	41 55.13	170 38.34	41 52.35	170 39.10	314	322	2.83	4.0	90.2	18.7	12.1	805
24	9	3 Apr 15	1034	41 52.42	170 35.91	41 49.47	170 35.68	391	395	2.95	4.5	88.2	18.5	11.3	950
25	8	3 Apr 15	1334	41 45.88	170 51.87	41 48.73	170 51.00	194	195	2.92	4.2	90.5	18.7	13.1	530
26	8	4 Apr 15	630	42 00.48	170 50.04	42 03.31	170 50.60	184	188	2.86	4.8	84.3	18.5	12.9	500
27	8	4 Apr 15	915	42 03.09	171 04.10	42 06.04	171 03.94	137	144	2.95	4.5	87.4	18.4	13.0	400
28	7	4 Apr 15	1149	42 15.15	171 07.13	42 12.60	171 09.27	58	67	3.00	4.7	70.5	18.3	14.9	200
29	7	4 Apr 15	1358	42 05.62	171 12.89	42 03.81	171 16.27	45	60	3.09	4.8	70.1	18.2	14.7	200
30	6	5 Apr 15	627	41 27.50	171 08.37	41 25.04	171 10.50	164	164	2.93	4.8	92.5	18.6	13.0	455
31	6	5 Apr 15	850	41 29.56	171 17.35	41 27.09	171 19.34	142	147	2.88	4.8	82.5	18.6	13.1	400

Appendix 2—*continued*

Station	Stratum	Date	Start of tow Time	Start of tow ° ' S	Start of tow ° ' E	End of tow ° ' S	End of tow ° ' E	Gear depth (m) Min.	Gear depth (m) Max.	Distance trawled (n. miles)	Headline height (m)	Doorspread (m)	Surface temp (°C)	Bottom temp (°C)	Warp length
32	8	5 Apr 15	1251	41 48.63	171 07.08	41 51.48	171 06.21	153	157	2.92	4.8	91.5	18.5	12.9	440
33	8	5 Apr 15	1453	41 55.81	171 11.19	41 57.74	171 10.09	124	126	2.09	4.6	86.3	18.5	13.0	350
34	5	6 Apr 15	624	41 27.29	171 52.76	41 29.98	171 50.85	35	35	3.04	4.7	74.5	18.4	16.9	200
35	5	6 Apr 15	825	41 34.41	171 43.57	41 36.63	171 40.64	37	38	3.11	4.7	73.9	18.4	16.4	200
36	7	8 Apr 15	1320	41 54.08	171 17.11	41 57.01	171 15.70	77	79	3.11	4.8	73.1	18.3	14.1	220
37	11	9 Apr 15	629	42 29.99	170 59.87	42 32.65	170 58.18	78	80	2.93	4.8	75.4	18.4	14.8	230
38	11	9 Apr 15	940	42 45.40	170 39.88	42 46.48	170 36.06	40	54	3.00	4.7	75.0	17.7	16.7	200
39	11	9 Apr 15	1140	42 50.33	170 41.63	42 51.85	170 38.00	27	30	3.06	4.9	74.1	17.6	18.1	200
40	11	9 Apr 15	1353	42 46.01	170 30.42	42 46.94	170 26.48	50	64	3.03	4.8	72.1	18.0	16.1	200
41	12	9 Apr 15	1546	42 45.56	170 20.08	42 47.12	170 16.55	111	125	3.02	4.6	87.1	17.7	13.4	350
42	12	10 Apr 15	641	43 02.53	169 51.56	43 04.94	169 49.33	178	183	2.90	4.7	89.4	17.6	13.0	500
43	13	10 Apr 15	929	43 06.05	169 45.58	43 08.25	169 42.75	217	242	3.01	4.5	90.0	17.7	12.9	600
44	12	10 Apr 15	1253	43 12.68	169 53.85	43 14.66	169 50.66	149	160	3.05	4.8	86.4	17.9	13.0	430
45	15	10 Apr 15	1516	43 15.16	169 53.78	43 17.34	169 50.89	132	135	3.02	4.8	89.7	–	–	375
46	14	11 Apr 15	630	43 49.77	168 54.32	43 48.82	168 58.15	37	46	2.92	4.7	71.1	17.4	16.7	–
47	16	11 Apr 15	1008	43 31.06	169 10.55	43 28.95	169 13.43	280	301	2.96	4.6	91.4	17.2	12.8	750
48	14	12 Apr 15	703	43 31.00	169 36.34	43 32.82	169 33.01	25	25	3.02	4.8	75.4	17.7	17.6	200
49	14	14 Apr 15	1142	43 35.40	169 19.91	43 33.67	169 23.20	85	90	2.94	4.8	83.0	15.9	13.1	255
50	15	14 Apr 15	1346	43 32.17	169 19.98	43 29.72	169 22.37	113	117	3.00	4.8	85.0	16.8	13.3	330
51	15	15 Apr 15	636	43 28.80	169 20.39	43 27.05	169 23.68	120	127	2.96	4.7	87.5	16.9	13.3	350
52	16	15 Apr 15	933	43 24.81	169 17.98	43 23.11	169 21.05	326	330	2.80	4.8	93.3	16.3	11.6	840
53	16	15 Apr 15	1151	43 20.58	169 28.29	43 19.47	169 31.87	278	299	2.83	4.6	92.3	16.5	11.9	750
54	13	15 Apr 15	1612	42 58.95	169 52.04	42 57.37	169 55.17	301	311	2.78	4.5	91.3	17.0	12.9	780
55	13	16 Apr 15	650	42 55.53	169 58.07	42 53.48	170 00.41	250	279	2.67	4.6	88.9	16.9	13.1	700
56	12	16 Apr 15	901	42 52.50	170 07.61	42 50.39	170 09.88	156	164	2.68	4.7	84.7	16.8	13.2	440
57	12	16 Apr 15	1117	42 43.39	170 11.28	42 41.37	170 14.05	145	149	2.86	4.7	85.2	17.3	13.2	410
58	11	16 Apr 15	1402	42 54.81	170 17.11	42 57.29	170 14.87	94	95	2.97	4.7	82.7	17.1	13.6	270
59	5	17 Apr 15	634	41 24.45	171 51.70	41 22.08	171 53.86	43	45	2.87	4.6	75.3	17.1	15.6	200
60	2	17 Apr 15	1025	40 58.51	171 54.35	40 55.96	171 56.45	107	108	3.00	4.6	75.7	17.0	14.2	300

Appendix 3: Catch summary in order by weight. * = less than 0.5%.

Species code	Catch (kg)	Common name	Scientific name	% of catch	No. of stations	% occurrence	Depth (m) Min	Depth (m) Max
SPD	8406.4	Spiny dogfish	*Squalus acanthias*	22.7	56	93.3	24	327
BAR	2991.2	Barracouta	*Thyrsites atun*	8.1	48	80	24	318
HOK	2945.4	Hoki	*Macruronus novaezelandiae*	7.9	21	35	50	327
GIZ	2477.5	Giant stargazer	*Kathetostoma giganteum*	6.7	46	76.7	30	327
GUR	2202	Gurnard	*Chelidonichthys kumu*	5.9	41	68.3	24	185
SNA	1277.2	Snapper	*Pagrus auratus*	3.4	20	33.3	24	164
RCO	1249.3	Red cod	*Pseudophycis bachus*	3.4	39	65	24	327
NMP	1212.3	Tarakihi	*Nemadactylus macropterus*	3.3	45	75	30	318
GSH	1015.6	Ghost shark	*Hydrolagus novaezealandiae*	2.7	28	46.7	67	327
SDO	918.1	Silver dory	*Cyttus novaezealandiae*	2.5	23	38.3	63	392
SCH	888.6	School shark	*Galeorhinus galeus*	2.4	45	75	25	279
LIN	835.8	Ling	*Genypterus blacodes*	2.3	31	51.7	25	327
SPO	792.6	Rig	*Mustelus lenticulatus*	2.1	32	53.3	24	185
SCG	768.2	Scaly gurnard	*Lepidotrigla brachyoptera*	2.1	47	78.3	30	318
ZFO	701.7	Rubbish fishing other	NA	1.9	2	3.3	128	194
CAR	582.1	Carpet shark	*Cephaloscyllium isabellum*	1.6	46	76.7	30	318
CUC	488.8	Cucumber fish	*Paraulopus nigripinnis*	1.3	27	45	63	392
CDO	485.2	Capro dory	*Capromimus abbreviatus*	1.3	25	41.7	79	392
JMN	473.4	Yellowtail jack mackerel	*Trachurus novaezelandiae*	1.3	24	40	24	107
JDO	421.5	John dory	*Zeus faber*	1.1	27	45	24	194
FRO	421.3	Frostfish	*Lepidopus caudatus*	1.1	20	33.3	90	311
SSK	420.9	Smooth skate	*Dipturus innominatus*	1.1	25	41.7	43	392
SQU	363	Arrow squid	*Nototodarus sloanii & N. gouldi*	1	52	86.7	31	392
WAR	334.8	Common warehou	*Seriolella brama*	0.9	23	38.3	24	150
POP	287.6	Porcupine fish	*Allomycterus jaculiferus*	0.8	14	23.3	38	142
RSO	275.5	Gemfish	*Rexea solandri*	0.7	11	18.3	150	392
LEA	270	Leatherjacket	*Meuschenia scaber*	0.7	10	16.7	30	63
ONG	259.3	Sponges	*Porifera (Phylum)*	0.7	7	11.7	38	134
SPE	251	Sea perch	*Helicolenus spp.*	0.7	37	61.7	30	392
WIT	250.9	Witch	*Arnoglossus scapha*	0.7	50	83.3	24	392
RUB	220.4	Rubbish other than fish	NA	0.6	4	6.7	39	41

CBI	207.3	Two saddle rattail	*Coelorinchus biclinozonalis*	0.6	16	26.7	43	279
NSD	175.1	Northern spiny dogfish	*Squalus griffini*	0.5	14	23.3	95	392
SFL	174	Sand flounder	*Rhombosolea plebeia*	0.5	11	18.3	24	43
RSK	158.9	Rough skate	*Zearaja nasuta*	*	26	43.3	35	185
WOD	147.6	Wood	*Wood*	*	9	15	38	327
GLB	129.4	Globefish	*Contusus richei*	*	6	10	30	60
SWA	125.8	Silver warehou	*Seriolella punctata*	*	35	58.3	38	327
HAK	113.9	Hake	*Merluccius australis*	*	21	35	24	327
LSO	112.3	Lemon sole	*Pelotretis flavilatus*	*	23	38.3	24	164
ESO	105.6	N.Z. sole	*Peltorhamphus novaezeelandiae*	*	10	16.7	24	60
ELE	96.2	Elephant fish	*Callorhinchus milii*	*	8	13.3	25	79
JAV	95.8	Javelin fish	*Lepidorhynchus denticulatus*	*	5	8.3	279	392
HAP	64.6	Hapuku	*Polyprion oxygeneios*	*	7	11.7	95	217
CCX	58.1	Small banded rattail	*Coelorinchus parvifasciatus*	*	9	15	90	392
BCO	55.4	Blue cod	*Parapercis colias*	*	11	18.3	30	63
RHY	54	Common roughy	*Paratrachichthys trailli*	*	3	5	180	311
SSI	49.4	Silverside	*Argentina elongata*	*	28	46.7	78	311
JMD	44.5	Greenback jack mackerel	*Trachurus declivis*	*	14	23.3	30	142
KIN	41.3	Kingfish	*Seriola lalandi*	*	8	13.3	30	90
OCT	40.6	Octopus	*Pinnoctopus cordiformis*	*	8	13.3	30	327
ATT	40.1	Kahawai	*Arripis trutta*	*	5	8.3	24	53
ERA	39.9	Electric ray	*Torpedo fairchildi*	*	6	10	24	327
CBO	36.4	Bollons rattail	*Coelorinchus bollonsi*	*	2	3.3	301	327
CON	35.4	Conger eel	*Conger spp.*	*	9	15	25	51
EGR	33.8	Eagle ray	*Myliobatis tenuicaudatus*	*	5	8.3	24	39
CRM	30.3	Airy finger sponge	*Callyspongia cf ramosa*	*	10	16.7	24	83
THR	27.1	Thresher shark	*Alopias vulpinus*	*	1	1.7	53	53
FHD	25	Deepsea flathead	*Hoplichthys haswelli*	*	4	6.7	296	327
HEP	22.1	Sharpnose sevengill shark	*Heptranchias perlo*	*	3	5	316	392
PRK	19.4	Prawn killer	*Ibacus alticrenatus*	*	16	26.7	95	318
COL	16.7	Olivers rattail	*Coelorinchus oliverianus*	*	2	3.3	301	327
JGU	15.8	Spotted gurnard	*Pterygotrigla picta*	*	6	10	164	327
BRI	14.4	Brill	*Colistium guntheri*	*	6	10	25	60
SBR	12.6	Southern bastard cod	*Pseudophycis barbata*	*	3	5	180	217
SCC	12.2	Sea cucumber	*Stichopus mollis*	*	7	11.7	38	72

RBT	12	Redbait	*Emmelichthys nitidus*	*	7	11.7	129	318
OPE	11.5	Orange perch	*Lepidoperca aurantia*	*	4	6.7	164	392
SPT	10.5	Heart urchin	*Spatangus multispinus*	*	7	11.7	116	301
COZ	8.6	Bryozoan	*Bryozoa (Phylum)*	*	2	3.3	51	63
SSH	8.4	Slender smooth-hound	*Gollum attenuatus*	*	1	1.7	392	392
EMA	5.9	Blue mackerel	*Scomber australasicus*	*	1	1.7	25	25
SPR	5.5	Sprats	*Sprattus antipodum S. muelleri*	*	4	6.7	25	95
ASC	5	Sea squirt	*Ascidiacea*	*	1	1.7	39	39
BTS	4.4	Prickly deepsea skate	*Brochiraja spinifera*	*	3	5	194	327
TRU	4.3	Trumpeter	*Latris lineata*	*	1	1.7	217	217
ROK	4.2	Rocks stones	*Geological specimens*	*	2	3.3	83	217
PAG	3.9	Pagurid	*Paguroidea*	*	5	8.3	90	301
ALL	3.8	Alcithoe larochei	*Alcithoe larochei*	*	12	20	39	301
BSQ	3.1	Broad squid	*Sepioteuthis australis*	*	7	11.7	30	63
MDO	3	Mirror dory	*Zenopsis nebulosa*	*	2	3.3	279	296
RBM	2.9	Rays bream	*Brama brama*	*	2	3.3	90	132
PCO	2.8	Ahuru	*Auchenoceros punctatus*	*	6	10	35	79
RMU	2.3	Red mullet	*Upeneichthys lineatus*	*	1	1.7	39	39
SCA	2.2	Scallop	*Pecten novaezelandiae*	*	5	8.3	30	46
STY	2.1	Spotty	*Notolabrus celidotus*	*	2	3.3	24	30
CDY	2.1	Cosmasterias dyscrita	*Cosmasterias dyscrita*	*	5	8.3	24	51
HEX	1.4	Sixgill shark	*Hexanchus griseus*	*	1	1.7	126	126
SPM	1.2	Sprat	*Sprattus muelleri*	*	6	10	30	90
RAN	1.2	Ranella olearium	*Ranella olearium*	*	1	1.7	111	111
TUR	1.1	Turbot	*Colistium nudipinnis*	*	1	1.7	37	37
JMM	1.1	Slender jack mackerel	*Trachurus murphyi*	*	1	1.7	180	180
PSI	0.9	Geometric star	*Psilaster acuminatus*	*	7	11.7	116	194
NUD	0.9	Nudibranchia	*Nudibranchia (Order)*	*	2	3.3	39	49
JFI	0.9	Jellyfish	NA	*	1	1.7	25	25
GFL	0.9	Greenback flounder	*Rhombosolea tapirina*	*	1	1.7	30	30
BRN	0.9	Barnacle	*Cirripedia (Class)*	*	4	6.7	132	392
WHE	0.8	Whelks	NA	*	4	6.7	78	301
SEO	0.8	Seaweed	NA	*	3	5	41	72
SPS	0.8	Speckled sole	*Peltorhamphus latus*	*	2	3.3	24	39
HDR	0.7	Hydroid	*Hydrozoa (Class)*	*	5	8.3	24	63

BRZ	0.7	Brown stargazer	*Xenocephalus armatus*	*	1	1.7	128	128
SDR	0.6	Spiny seadragon	*Solegnathus spinosissimus*	*	3	5	51	217
SPZ	0.5	Spotted stargazer	*Genyagnus monopterygius*	*	1	1.7	24	24
SPP	0.5	Splendid perch	*Callanthias spp.*	*	1	1.7	217	217
SIW	0.5	Siphon whelk	*Penion cuvieranus & P. sulcatus*	*	2	3.3	41	49
SCI	0.5	Scampi	*Metanephrops challengeri*	*	2	3.3	279	327
DIR	0.5	Pagurid	*Diacanthurus rubricatus*	*	5	8.3	95	327
YEM	0.4	Yellow-eyed mullet	*Aldrichetta forsteri*	*	1	1.7	39	39
OPA	0.4	Opalfish	*Hemerocoetes spp.*	*	3	5	31	46
ANC	0.4	Anchovy	*Engraulis australis*	*	2	3.3	35	49
TOD	0.3	Dark toadfish	*Neophrynichthys latus*	*	2	3.3	128	392
LNV	0.3	Rock star	*Lithosoma novaezelandiae*	*	3	5	144	392
KWH	0.3	Knobbed whelk	*Austrofucus glans*	*	2	3.3	39	164
FMA	0.3	Fusitriton magellanicus	*Fusitriton magellanicus*	*	2	3.3	194	318
SPA	0.2	Slender sprat	*Sprattus antipodum*	*	2	3.3	35	37
SHO	0.2	Seahorse	*Hippocampus abdominalis*	*	2	3.3	30	39
PIL	0.2	Pilchard	*Sardinops sagax*	*	1	1.7	24	24
PIG	0.2	Pigfish	*Congiopodus leucopaecilus*	*	1	1.7	90	90
NAT	0.2	Natant decapod	NA	*	1	1.7	194	194
LEH	0.2	Leech - generic	*Hirudinea*	*	2	3.3	153	392
BAM	0.2	Bathyplotes spp.	*Bathyplotes spp.*	*	1	1.7	316	316
YCO	0.1	Yellow cod	*Parapercis gilliesi*	*	1	1.7	180	180
YBO	0.1	Yellow boarfish	*Pentaceros decacanthus*	*	1	1.7	301	301
SMO	0.1	Cross-fish	*Sclerasterias mollis*	*	1	1.7	327	327
SAR	0.1	Squilla armata	*Squilla armata*	*	1	1.7	164	164
RCK	0.1	Rockfish	*Acanthoclinidae*	*	1	1.7	194	194
PUP	0.1	Pyura pulla	*Pyura pulla*	*	1	1.7	51	51
PTM	0.1	Dells spider crab	*Platymaia maoria*	*	1	1.7	392	392
PRA	0.1	Prawn	NA	*	1	1.7	301	301
POL	0.1	Polychaete	*Polychaeta*	*	1	1.7	41	41
PEP	0.1	Pentagonaster pulchellus	*Pentagonaster pulchellus*	*	1	1.7	39	39
PAM	0.1	Pannychia moseleyi	*Pannychia moseleyi*	*	1	1.7	392	392
OPH	0.1	Ophiuroid (brittle star)	NA	*	1	1.7	38	38
NMA	0.1	Notopandalus magnoculus	*Notopandalus magnoculus*	*	1	1.7	392	392

NHU	0.1	Policeman crab	*Neommatocarcinus huttoni*	*	1	1.7	39	39
GIL	0.1	Triplefin	*Gilloblennius sp.*	*	1	1.7	39	39
GAS	0.1	Gastropods	*Gastropoda*	*	1	1.7	327	327
EHI	0.1	Echiurans	*Echiura*	*	1	1.7	24	24
ASH	0.1	Circular saw shell	*Astraea heliotropium*	*	1	1.7	51	51

Appendix 4: Benthic macro-invertebrates taken as bycatch during the survey.

Species code	Taxon	Common name	Scientific name	No. of stations
POL	Annelida	Polychaete	*Polychaeta*	1
EHI	Annelida: Echiura	Echiurans	*Echiura*	1
LEH	Annelida: Hirudinea	Leech - generic	*Hirudinea*	2
PRA	Arthropoda	Prawn	*NA*	1
PUP	Arthropoda: Ascidiacea	Pyura pulla	*Pyura pulla*	1
BRN	Arthropoda: Cirripedia	Barnacle	*Cirripedia (Class)*	4
PTM	Arthropoda: Decapoda	Dells spider crab	*Platymaia maoria*	1
NAT	Arthropoda: Decapoda	Natant decapod	*NA*	1
DIR	Arthropoda: Decapoda	Pagurid	*Diacanthurus rubricatus*	5
PAG	Arthropoda: Decapoda	Pagurid	*Paguroidea*	5
SCI	Arthropoda: Decapoda	Scampi	*Metanephrops challengeri*	2
NMA	Arthropoda: Malacostraca	Notopandalus magnoculus	*Notopandalus magnoculus*	1
NHU	Arthropoda: Malacostraca	Policeman crab	*Neommatocarcinus huttoni*	1
SAR	Arthropoda: Malacostraca	Squilla armata	*Squilla armata*	1
PRK	Arthropoda: Palinura	Prawn killer	*Ibacus alticrenatus*	16
COZ	Bryozoa	Bryozoan	*Bryozoa (Phylum)*	2
HDR	Cnidaria: Anthozoa	Hydroid	*Hydrozoa (Class)*	5
JFI	Cnidaria: Scyphozoa	Jellyfish	*NA*	1
CDY	Echinodermata: Asteroidea	Cosmasterias dyscrita	*Cosmasterias dyscrita*	5
PSI	Echinodermata: Asteroidea	Geometric star	*Psilaster acuminatus*	7
PEP	Echinodermata: Asteroidea	Pentagonaster pulchellus	*Pentagonaster pulchellus*	1
LNV	Echinodermata: Asteroidea	Rock star	*Lithosoma novaezelandiae*	3
SPT	Echinodermata: Echinoidea	Heart urchin	*Spatangus multispinus*	7
BAM	Echinodermata: Holothuroidea	Bathyplotes spp.	*Bathyplotes spp.*	1
PAM	Echinodermata: Holothuroidea	Pannychia moseleyi	*Pannychia moseleyi*	1
SCC	Echinodermata: Holothuroidea	Sea cucumber	*Stichopus mollis*	7
OPH	Echinodermata: Ophiuroidea	Ophiuroid (brittle star)	*NA*	1
SCA	Mollusca: Bivalvia	Scallop	*Pecten novaezelandiae*	5
SQU	Mollusca: Cephalopoda	Arrow squid	*Nototodarus sloanii & N. gouldi*	52
BSQ	Mollusca: Cephalopoda	Broad squid	*Sepioteuthis australis*	7
OCT	Mollusca: Cephalopoda	Octopus	*Pinnoctopus cordiformis*	8
ALL	Mollusca: Gastropoda	Alcithoe larochei	*Alcithoe larochei*	12
ASH	Mollusca: Gastropoda	Circular saw shell	*Astraea heliotropium*	1
FMA	Mollusca: Gastropoda	Fusitriton magellanicus	*Fusitriton magellanicus*	2
GAS	Mollusca: Gastropoda	Gastropods	*Gastropoda*	1

KWH	Mollusca: Gastropoda	Knobbed whelk	*Austrofucus glans*	2
NUD	Mollusca: Gastropoda	Nudibranchia	*Nudibranchia (Order)*	2
RAN	Mollusca: Gastropoda	Ranella olearium	*Ranella olearium*	1
SIW	Mollusca: Gastropoda	Siphon whelk	*Penion cuvieranus & P. sulcatus*	2
WHE	Mollusca: Gastropoda	Whelks	*NA*	4
ONG	Porifera	Sponges	*Porifera (Phylum)*	7
CRM	Porifera: Demospongiae	Airy finger sponge	*Callyspongia cf ramosa*	10
ASC	Tunicata	Sea squirt	*Ascidiacea*	1

Appendix 5: Carpet shark — relative biomass estimates (t) and CVs by trip from the entire survey area, and separately for the west coast South Island and Tasman and Golden Bay areas.

Survey	Total area		Tasman and Golden Bays		West coast South Island	
	Biomass	CV (%)	Biomass	CV (%)	Biomass	CV (%)
kah9204	642	20	40	31	602	21
kah9404	722	9	24	35	698	9
kah9504	852	11	101	24	752	12
kah9701	790	11	196	26	594	12
kah0004	786	8	336	13	451	11
kah0304	449	14	239	25	210	11
kah0503	402	13	134	15	268	18
kah0704	1 009	14	299	26	710	17
kah0904	704	13	316	21	389	17
kah1104	833	11	285	18	549	14
kah1305	748	16	272	15	476	24
kah1503	506	16	117	33	389	19

Appendix 6: Update mean ranks for Tasman and Golden Bays, and the west coast South Island.