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Tini a Tangaroa

Trawl survey of hoki and middle-depth species in the Southland and Sub-Antarctic areas, November–December 2020 (TAN2014)

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The nineteenth *Tangaroa* trawl survey of the Sub-Antarctic summer series was conducted from 24 November to 23 December 2020. Previous summer surveys were in 1991–93, 2000–09, 2011, 2012, 2014, 2016, and 2018. Species monitored by the trawl survey include important commercial species such as hoki, hake, and ling, as well as a wide range of non-commercial fish and invertebrate species. A total of 73 of the 83 planned phase one stations were completed in 20 strata. There was insufficient time to complete all planned phase one stations or any phase two stations due to bad weather. All strata were surveyed.

Biomass estimates and coefficients of variation (CVs) for all strata (300–1000 m) were 37 992 t (12.3%) for hoki, 22 355 t (12.4%) for ling, and 1619 t (18.9%) for hake. For the core strata (300–800 m), the hoki biomass was 37 851 t (12.3%), the ling biomass was 22 343 t (12.4%), and the hake biomass was 1310 t (23.2%). This was a 22% increase for hoki, a slight decrease (3%) for hake, and a slight increase (5%) for ling when compared with the 2018 core biomass estimates. The estimated biomass of southern blue whiting (*Micromesistius australis*) in 2020 was 20 660 t (28.7%), a similar estimate to that in 2018.

The hoki length frequency in 2020 was dominated by the 2019 year class (fish under 46 cm) followed by a broad mode of fish greater than 50 cm. Most male hoki were between 1 and 10 years old and most females between 1 and 15 years old. The hake length distribution was broad, with adult fish up to about 90 cm for males and 125 cm for females. Most male hake were between 3 and 8 years old and most females between 3 and 17 years old. The ling length distribution was also broad, with few males over 95 cm and few females over 120 cm. Most ling of both sexes were between 4 and 15 years old.

Acoustic data were also collected during the trawl survey. Data quality in 2020 was below average due to poor weather conditions and only 66% of acoustic files were suitable for quantitative analysis. The acoustic index of mesopelagic fish abundance was around 24% lower than that in 2018, but still above the average of the time series. There was a statistically significant positive correlation between acoustic density from demersal marks and trawl catch rates.

As well as supporting the stock assessments for hoki, hake, and ling, the trawl survey provides information on a number of bycatch species. A total of 211 species or species groups were caught, 29 254 fish, elasmobranchs, or squid of 90 different species were measured, and 11 940 fish were individually weighed during the 2020 survey. The liver condition of 1036 hoki was recorded. Otoliths were collected from 1430 hoki, 195 hake, and 874 ling.

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1. INTRODUCTION

Trawl surveys of the Southland and Sub-Antarctic region (often collectively referred to as the 'Southern Plateau') provide fishery-independent abundance indices for hoki (*Macruronus novaezelandiae*), hake (*Merluccius australis*), and ling (*Genypterus blacodes*). Hoki is New Zealand's largest fishery, with a current annual commercial catch limit of 110 000 t, reduced from 115 000 t on 1 October 2021. The Southland and Sub-Antarctic region is the principal residence area for the hoki that spawn off the west coast of the South Island (WCSI) in winter ('western' stock). Annual catches of hoki from the Southern Plateau (including Puysegur) peaked at over 35 000 t in 1999–2000 to 2001–02, but have been variable since, ranging from around 6000 to 20 000 t over the past 15 years (Ballara & O'Driscoll 2021). Hoki are managed as a single stock throughout the Exclusive Economic Zone (EEZ), but there is an agreement to split the catch between western and eastern areas. The agreed catch limit for hoki from western areas in 2020–21 (including the Southern Plateau) was 55 000 t, with the remaining 60 000 t allocated to the eastern fishery. From 1 October 2021, the western catch allowance was reduced to 45 000 t and the eastern limit increased to 65 000 t. Hake and ling are also important commercial species in Southland and the Sub-Antarctic. In 2019–20, catches of hake in the southern areas were 1005 t (HAK 1, includes the western Chatham Rise) and for ling were 3672 t (LIN 5, Southland) and 3568 t (LIN 6, Sub-Antarctic) (Fisheries New Zealand 2021).

Two time series of trawl surveys have been carried out from RV *Tangaroa* in the Southland and Sub-Antarctic region (subsequently referred to as the Sub-Antarctic survey series): a summer series in November–December 1991–93, 2000–09, 2011, 2012, 2014, 2016, and 2018; and an autumn series in March–June 1992, 1993, 1996, and 1998 (reviews by O'Driscoll & Bagley 2001, Bagley et al. 2013a). The main focus of the early surveys (1991–93) was to estimate the abundance of hoki. The surveys in 1996 and 1998 were developed primarily for hake and ling. The autumn season was chosen for these species because the biomass estimates were generally higher and more precise at that time of year. Autumn surveys also allowed the proportion of maturing hoki to be estimated (Livingston et al. 1997, Livingston & Bull 2000). However, interpretation of trends in the autumn trawl survey series was complicated by the possibility that different proportions of the hoki adult biomass may have already left the survey area to spawn. The timing of the trawl survey was moved back to November–December in 2000 to obtain an estimate of total adult hoki biomass at a time when abundance should be at a maximum in the Southland and the Sub-Antarctic areas.

Hoki biomass estimates from the four surveys in 2003 to 2006 were the lowest observed in either the summer or autumn Sub-Antarctic trawl time series. Hoki abundance estimates increased threefold between the 2006 and 2007 trawl surveys (Bagley et al. 2009). This biomass increase was sustained in 2008 (O'Driscoll & Bagley 2009), with further increases in 2009 (Bagley & O'Driscoll 2012) and 2012 (Bagley et al. 2014). The estimated hoki biomass from the 2014 survey decreased by 43% from 2012, the lowest since 2006 (Bagley et al. 2017), and this was interpreted by the 2016 hoki assessment model as observation error. There is some evidence for variable catchability in this survey series (O'Driscoll et al. 2015). Recent hoki assessments have been unable to fit the observations well and this led to relatively high process error being estimated for the Sub-Antarctic trawl surveys by the assessment model (McKenzie 2019); however, the most recent hoki assessment was able to fit the Sub-Antarctic trawl survey to the model (McGregor et al. in press).

Other middle depth species monitored by this survey time series include commercial species such as hake, ling, lookdown dory, and ribaldo, as well as a wide range of non-commercial fish and invertebrate species. For most of these species, the trawl survey is the only fisheries-independent estimate of abundance in the Sub-Antarctic, and the survey time series fulfils an important 'ecosystem monitoring' role (e.g., Tuck et al. 2009), as well as providing inputs into single-species stock assessments. The most recent review of all the summer Sub-Antarctic *Tangaroa* trawl survey time series gave distributions, biomass estimates, and trends for 134 species, and catch rates and population scaled length frequencies for a subset of 35 species (Bagley et. al. 2013a).

Acoustic data have been recorded during trawl tows and while steaming between stations on all trawl surveys in the Sub-Antarctic since 2000. Data from previous surveys were analysed to describe mark types (O'Driscoll 2001, O'Driscoll & Bagley 2003a, 2003b, 2004, 2006a, 2006b, 2008, 2009, Bagley & O'Driscoll 2012, Bagley et al. 2009, 2013b, 2014, 2017), to provide estimates of the ratio of acoustic vulnerability to trawl catchability for hoki and other species (O'Driscoll 2002, 2003), and to estimate abundance of mesopelagic fish (McClatchie & Dunford 2003, O'Driscoll et al. 2009, 2011, Bagley & O'Driscoll 2012, Bagley et al. 2013b, 2014, 2017, O'Driscoll et al. 2018, MacGibbon et al. 2019). Acoustic data also provide qualitative information on the amount of backscatter that is not available to the bottom trawl, either through being off the bottom, or over areas of foul ground, and were an important part of a review of Sub-Antarctic trawl survey catchability (O'Driscoll et al. 2015).

The continuation of the time series of trawl surveys in Southland and in the Sub-Antarctic is a high priority for providing information required to update the assessment of hoki and other middle depth species. The survey is now carried out biennially. The 2020 survey provided the nineteenth summer estimate of western hoki biomass in time for the 2021 stock assessment.

1.1 Project objectives

This report is the final reporting requirement for the 2020 survey that comes under Fisheries New Zealand Research Project MID2018-01.

The overall objective of this project is to continue a time series of relative abundance indices for hoki (*Macruronus novaezelandiae*), hake (*Merluccius australis*) and ling (*Genypterus blacodes*) in the Southland and Sub-Antarctic area (December 2018, 2020). The specific objectives are as follows:

1. To carry out trawl surveys in December 2018 and December 2020 to continue the time series of relative abundance indices for hoki, hake (HAK 1), and ling (LIN 5 and 6) on the Southern Plateau.
2. To collect data for determining the population age and size structure of hoki, hake, and ling.
3. To collect data to underpin the development of assessment and monitoring capabilities for biodiversity and ecosystems.
4. To collect and preserve specimens of unidentified organisms taken during the trawl survey and identify them later ashore.

2. METHODS

2.1 Survey design

A key aspect of the survey design was to ensure consistency with previous surveys in the time series. This required the survey to be carried out from *Tangaroa* using the same trawl gear used for previous surveys.

The 2020 survey was carried out from 24 November to 23 December 2020 and followed a two-phase stratified random design (after Francis 1984). The survey area was divided into 20 strata by area and depth (300–600, 600–800, and 800–1000 m) (Figure 1). There are 17 core strata ranging in depth from 300–800 m that have been surveyed in all previous summer and autumn surveys (Table 1). Strata 3 and 5 were subdivided in 2000 to increase the coverage in the region where hake and ling aggregations were thought to occur (Bull et al. 2000). Deeper 800–1000 m strata (strata 25–28) have been surveyed since 1996. Stratum 26, at 800–1000 m depth, south of Campbell Island, was dropped in 2012 due to a reduction in the number of survey days. There is also no 800–1000 m stratum along the eastern side of the survey area because catches of hake, hoki, and ling from the adjacent strata are small. Known areas of extensive foul ground were excluded from the survey. Trawls were conducted in the Campbell East Deep Benthic Protection Area (BPA). Written approval to sample within this BPA was granted by Fisheries New Zealand (letter to NIWA dated 29 October 2020).

The allocation of stations in phase 1 was based on a statistical analysis of catch rate data from previous summer surveys using the *allocate* procedure of Bull et al. (2000), as modified by Francis (2006). Allocation of stations for hoki was based on the 2007–18 surveys, because these better reflect recent changes in hoki distribution and abundance. Allocations of stations for hake and ling were based on all surveys from 2000. A minimum of three stations per stratum was used. As in previous years, conservative target coefficients of variation (CVs) of 17% for hake and 12% for hoki and ling were used in the statistical analysis to increase the chance that the Fisheries New Zealand target CVs of 20% for hake and 15% for hoki and ling would be met. A total of 83 stations was planned for phase 1 (Table 1). Seventy-four stations were required to meet the target CVs and an additional six stations were added outside the statistical framework because of the need to focus effort on covering the full distributional range of hake age classes. Three more stations were added to strata 3a and 4 to reduce the CV for hoki in the Stewart-Snares shelf area. Phase two stations were to be allocated at sea to improve CVs for hoki, hake, and ling, and to increase the number of hake sampled. However, there was insufficient time for any phase two stations to be carried out, and time constraints due to bad weather meant that ten of the planned phase one stations were not completed. However, all strata were surveyed.

2.2 Vessel and equipment

RV *Tangaroa* is a purpose-built research stern trawler of 70 m overall length, a beam of 14 m, 3000 kW (4000 hp) of power, and a gross tonnage of 2282 t. The survey used the same eight-seam hoki trawl (see Hurst et al. 1992 for net plan) that was used on previous surveys in the series. This net has 100 m sweeps, 50 m bridles, 12 m backstrops, 58.8 m groundrope, 45 m headline, and 60 mm codend mesh. The trawl doors were Super Vee type with an area of 6.1 m^2.

2.3 Trawling procedure and biological sampling

Random trawling followed the standardised procedures described by Hurst et al. (1992). Station positions were generated randomly before the voyage using NIWA's RandomStation program (Francis & Fu 2012). A minimum distance between tows of 3 n. miles was used. If a station was found to be on foul ground, a search was made for suitable ground within 3 n. miles of the station position. If no suitable ground could be found, the station was abandoned, and another random position was substituted. Random bottom tows were only carried out during daylight hours, with all random tows carried out between 0457 h and 1840 h NZST. At each station the trawl was towed for 3 n. miles at a speed over the ground of 3.5 knots. If foul ground was encountered, or the trawl was hauled early due to reducing daylight or strong marks on the net monitor, the tow was included as valid only if the tow distance was at least 2 n. miles. If time ran short at the end of the day and it was not possible to reach the last station, the vessel headed towards the next station and the trawl was shot on that course before 1900 h NZST, if at least 50% of the steaming distance to that station had been covered.

Measurements of doorspread and headline height (from a Simrad TV80 Trawl Eye net monitoring system) and vessel speed (GPS speed over the ground, cross checked against distance travelled during the tow) were recorded every 5 min during each tow and average values were calculated. Towing speed and gear configuration for random tows were maintained as constant as possible during the survey, following the guidelines given by Hurst et al. (1992). Acoustic recordings were made for all tows using the multi-frequency hull-mounted transducers.

From each tow, all items in the catch were sorted to species and weighed on Marel motion-compensating electronic scales, which resolved to about 0.1 kg. Where possible, finfish, squid, and crustaceans were identified to species and other benthic fauna were identified to species, genus, or family. Unidentified organisms were collected and frozen at sea for subsequent identification ashore.

An approximately random sample of up to 200 individuals of each commercial and some common non-commercial species from every successful tow were measured and sex-determined where possible. More detailed biological data were also collected on a subset of species and included fish weight, length, sex, gonad stage, gonad weight, and occasional observations on stomach fullness, contents, and prey condition.

Otoliths were taken from hake, hoki, and ling for age determination. Otoliths were also taken from ribaldo (*Mora moro*) for future aging work. A description of the macroscopic gonad stages used for teleosts and chondrichthyans is given in Appendix 1. Liver and gutted weights were recorded from up to 20 hoki per tow to determine condition indices.

2.4 Other data collection

Temperature and salinity data were collected using a calibrated Seabird SM-37 Microcat CTD datalogger mounted on the headline of the trawl. Data were collected at 5 s intervals throughout the trawl, providing vertical profiles. Surface values were read off the vertical profile at the beginning of each tow at a depth of about 5 m, which corresponded to the depth of the hull temperature sensor used in surveys prior to the use of the CTD (conductivity, temperature, and depth instrument). Bottom values were from about 7.0 m above the seabed (i.e., the height of the trawl headline).

Acoustic data were collected during trawling and while steaming between trawl stations (both day and night) with the *Tangaroa* multi-frequency (18, 38, 70, 120, and 200 kHz) Simrad EK60 and EK80 echosounders with hull-mounted transducers. All frequencies were regularly calibrated following standard procedures (Demer et al. 2015), with the most recent calibration on 29 August 2019 in Resolution Bay, Marlborough Sounds. The time series of system and calibration parameters are given in appendix 1 of Ladroit et al. (2020a).

2.5 Trawl data analysis

Doorspread biomass was estimated by the swept area method of Francis (1981, 1989) as implemented in the trawl survey analysis program *SurvCalc* (Francis 2009). Total survey abundance was estimated for all species in the catch. Only data from random trawl tows where the gear performance was satisfactory were included for estimating abundance. Survey biomass and CV by stratum were estimated for the top 50 species in the catch by weight.

Scaled length frequencies were calculated with *SurvCalc* using length-weight parameters derived from data collected on this survey, where possible. Where there were insufficient data (i.e., fewer than 50 fish weighed, estimated r^2 of the length-weight regression less than 90%, or the length range of fish was too narrow), length-weight data from all Sub-Antarctic summer series were used. Length-weight parameters used to scale length frequencies are given in Table 2.

Sub-samples of hoki and ling otoliths, and all available hake otoliths, were selected for ageing. Hoki, ling, and hake otoliths were prepared and aged using validated ageing methods (hoki, Horn & Sullivan (1996) as modified by Cordue et al. (2000); ling, Horn (1993); hake, Horn (1997)). Ageing was carried out under Fisheries New Zealand research project MID2020-01. Numbers-at-age were calculated from observed length frequencies from successful random tows and age-length keys using custom NIWA catch-at-age software (Bull & Dunn 2002). For hoki, this software also applied the 'consistency scoring' method of Francis (2001), which uses otolith ring radii measurements to improve the consistency of age estimation. Sub-samples for hoki and ling were derived by randomly selecting otoliths from each of a series of 1 cm length bins covering the bulk of the catch, and then systematically selecting additional otoliths to ensure the tails of the length distribution were represented. The chosen sample size approximates that necessary to produce a mean weighted CV of less than 20% across all age classes.

2.6 Acoustic data analysis

Quantitative analysis was based on 38 kHz acoustic data from daytime trawl and night steam recordings. The 38 kHz data were used as this frequency was the only one available (other than uncalibrated 12 kHz data) for surveys before 2008 that used the old CREST acoustic system (Coombs et al. 2003). Analysis was carried out using the software ESP3 (Ladroit et al. 2020b). The calibration parameters used for analysis of 38 kHz data were obtained from the January 2019 calibration, with transducer peak gain G0 = 26.32 dB and corrective factor Sa,corr = -0.56 dB (Ladroit et al. 2020a).

ESP3 includes an algorithm to identify 'bad pings' in each acoustic recording. Bad pings are defined as pings for which backscatter data were significantly different from surrounding pings, usually due to bubble aeration or noise spikes. Only acoustic data files where the proportion of bad pings was less than 30% of all pings in the file were considered suitable for quantitative analysis.

Estimates of the mean acoustic backscatter per square kilometre from bottom-referenced marks were calculated for each recording based on integration heights of 10 m, 50 m, and 100 m above the bottom. Total acoustic backscatter was also integrated throughout the water column in 50 m depth bins. Acoustic density estimates (square metre per square kilometre) from bottom-referenced marks were compared with trawl catch rates (kilogram per square kilometre). No attempt was made to scale acoustic estimates by target strength, correct for differences in catchability, or carry out species decomposition (O'Driscoll 2002, 2003).

O'Driscoll et al. (2009, 2011, 2015) developed a time series of relative abundance estimates for mesopelagic fish in the Sub-Antarctic based on the component of the acoustic backscatter that migrates into the upper 200 m of the water column at night (nyctoepipelagic backscatter). This survey updated the mesopelagic time series to include data from 2020. The methods were the same as those used by O'Driscoll et al. (2015, 2018) and MacGibbon et al. (2019). Day estimates of total backscatter were calculated using total mean area backscattering coefficients estimated from each trawl recording. Night estimates of demersal backscatter were based on data recorded while steaming between 2000 h and 0500 h NZST. Estimated mesopelagic indices were calculated by multiplying the total backscatter observed at each daytime trawl station by the estimated proportion of night-time backscatter in the same subarea and year that was observed in the upper 200 m. Mesopelagic indices were summarised in four broad regions based on trawl survey strata as recommended by O'Driscoll et al. (2015):

1. Puysegur (strata 1–2, and 25);
2. West Sub-Antarctic (strata 6–7 and 9–10);
3. East Sub-Antarctic (strata 11–15 and 27);
4. Stewart-Snares (strata 3–5, 8, and 28).

2.7 Gear performance

Gear parameters by depth for valid trawl survey tows are summarised in Table 3. Headline height was obtained for all successful tows. Door sensors were not working on station 44 and mean doorspread for the stratum depth range from previous surveys was used. Recorded doorspread was used on all other stations.

The headline height values were higher on average than those in 2018 and slightly higher than in 2016, but within the range of those obtained on other voyages of *Tangaroa* in this area when the same gear was used. Doorspread values were similar to those from the 2018 survey and within values seen on past surveys (Table 4). Mean doorspread values and headline heights for the Sub-Antarctic surveys were also consistent with those from the *Tangaroa* hoki and middle depths time series surveys on the Chatham Rise (e.g., Stevens et al. 2021).

3. RESULTS

3.1 Data collection

A total of 73 successful trawl survey stations were completed in 20 strata (Table 1, Figure 2). A further two tows were not used for biomass estimation: station 57 came fast on the seafloor and the net sustained significant damage; and on station 51, quantifying the catch was not possible after catching a large basking shark (*Cetorhinus maximus*) in the trawl.

Individual station details from all trawl stations including the catch of hoki, hake, and ling are listed in Appendix 2. Five trawls were conducted in the Campbell East Benthic Protection Area (BPA) (see Figures 1 and 2). These trawls were carried out on the closest known trawl path to each randomly generated station as per the agreed exemption so as not to cause any new benthic impact to the BPA.

3.2 Catch

The top 50 species by catch weight and the total weight of all species caught is given in Table 5. A total of 211 species or species groups were caught, of which 91 were teleosts, 30 were chondrichthyans, 15 were squids or octopuses, and 16 were crustaceans, and the remainder comprised assorted benthic and pelagic animals (Appendix 3). Hoki accounted for 23.6%, ling 15.2%, and hake 1.8% of the total catch from all trawls (Table 5). A basking shark that was released shortly after the net was retrieved was estimated to weigh 4 t, 9.0% of the total catch.

A total of 144 sample lots (individual samples or groups of samples within a single station) were inventoried and preserved including 23 lots of unusual or unidentified organisms retained for identification ashore (3 invertebrates to be identified under proposed Ministry for Primary industries contract DAE2018/04, and 20 fish specimens for Te Papa). Other sample lots included stomachs from a variety of deepwater sharks for a PhD student from Victoria University of Wellington (66 lots), various tissues from elasmobranchs for biomimetic work with overseas researchers (45 lots), and cephalopod samples for Auckland University of Technology researchers (10 lots).

3.3 Trawl abundance estimates

Abundance estimates and the trawl survey catch for the core (300–800 m depth range) and for all (300–1000 m) strata are given in Table 6. Estimated abundance and coefficients of variation (CVs in parentheses) for core strata were 37 851 t (12.3%) for hoki, 22 343 t (12.4%) for ling, and 1310 t (23.2%) for hake. Target CVs of 15% were met for hoki and ling, but the target CV of 20% for hake was not met. Estimated abundance and CVs (in parentheses) for all strata were 37 992 t (12.3%) for hoki, 22 355 t (12.4%) for ling, and 1619 t (18.9%) for hake. Of the other species in the top 50 by biomass, CVs were below 20% for javelinfish, pale ghost shark, Baxter’s lantern dogfish, warty squid, banded rattail, ribaldo, lookdown dory, and Lucifer dogfish.

Abundance estimates by stratum are given in Table 7 and plotted in Figure 3. For the core strata, hoki were spread over the survey area. Strata 3A, 3B, and 4 (Stewart Snares shelf) accounted for 24% of the hoki abundance in 2020, more than the contribution of these strata in 2018 (17%), but less than the contribution from the 2016 survey (32%). The western Campbell Plateau (strata 9 and 10), Pukaki Rise (strata 11 and 12), and eastern Campbell Plateau (strata 13–15) contributed 18%, 18%, and 21% of estimated hoki biomass in 2020, respectively. Ling were caught in all core strata, although strata 1 and 12–13 accounted for about half of the biomass in 2020; 75% of ling were caught in the 300–600 m strata. In core depths, hake were mainly caught in 600–800 m strata, in particular strata 4–5 and 7–8, and no hake were caught in strata 3 or 9–14.

Core trawl estimates from 2020 were compared with those from previous surveys in the summer Sub-Antarctic time series in Table 8 and Figure 4. The core hoki biomass index was 22% higher than the 2018 estimate and very close to the 2016 estimate. Estimates of hoki abundance from 2014 to 2020 were lower than core estimates from 2007 to 2012 surveys, but higher than those from the ‘four low years’ in 2003–06 (Figure 4, Table 8). The core ling biomass estimate in 2020 was about the same (5% higher) as the 2018 estimate. The 2018 and 2020 estimates for ling are the lowest since 2006 and among the lowest estimates in the time series. The core estimate for hake in 2020 was about the same (3% lower) as the 2018 estimate. Hake abundance has fluctuated somewhat over the time series but overall has been relatively stable since 2014. Southern blue whiting were particularly abundant in 2016 (which had the second highest estimate in the time series); they were much less abundant in 2018 (19 666 t) and 2020 (20 660 t), but these estimates were still above average for the time series.

For the nine other key species, biomass estimates were higher in 2020 than in 2018 for black oreo, javelinfish, lookdown dory, pale ghost shark, and ribaldo (Table 8, Figure 4). Estimated biomass in 2020 was lower for dark ghost shark, spiny dogfish, and white warehou. The 2020 biomass estimates for dark ghost shark, javelinfish, and southern blue whiting were well above the time series means, while pale ghost shark and white warehou were lower. Black oreo biomass estimates remained at low levels compared with 2000–05 estimates.

3.4 Species distribution

Hoki were widespread throughout the core survey area, occurring in 68 of the 73 valid biomass stations (Figure 5, Appendix 2). Hoki catch rates were generally higher in the west, with the largest catch coming from the top of the Stewart-Snares shelf in stratum 3A. Catches of 1+ hoki were high compared with 2+ hoki, with both being caught only in stratum 3A.

Catch rates of the other main species are plotted in Figure 6. Ling were caught on 61 of the 73 valid biomass stations, with highest catches at the Puysegur Trench in stratum 1 and higher catches in the western strata compared with eastern strata. Hake were caught on 26 of the 73 valid biomass stations and showed a similar distribution to previous years. Hake were concentrated in the Puysegur Trench in stratum 25, between the Auckland Islands and Stewart-Snares shelf in strata 5A, 5B, and 8, and south of the Auckland Islands (strata 6 and 7). Catch rates for many other species were also higher in western strata and at the southern edge of the Stewart-Snares shelf (see also Figure 3). Long-nosed chimaera, finless flounder, and silverside had higher catch rates in eastern strata, whereas pale ghost shark, and javelinfish were widespread (Figure 6).

3.5 Biological data

A total of 29 254 fish and squid of 90 different species were measured and, of these, 11 940 fish were also individually weighed (Table 9). Additional data on fish condition (liver and gutted weight) were recorded from 1036 hoki. Pairs of otoliths were removed from 1430 hoki, 874 ling, and 195 hake. Sub-samples of 781 hoki and 607 ling otoliths were selected for ageing. All 195 hake otoliths were aged. In addition, 184 ribaldo otoliths were removed for potential future ageing work.

Population scaled length frequency distributions for hoki, hake, and ling, calculated using length-weight data in Table 2, are compared with those observed in previous summer surveys in Figures 7a–c. Scaled age frequency distributions for hoki, ling, and hake are presented in Figure 8.

The hoki length frequency distribution in 2020 was dominated by the mode of 1+ fish (2019 year class, under 46 cm) (Figure 7a). There were very few 1+ fish in 2018, but relatively strong 1+ cohorts have been observed in some previous surveys (e.g., 2003–08). There was a weak mode of 2+ fish (2018 year class) from 46 to 60 cm and a broad distribution of adult fish, up to about 100 cm for males and 110 cm for females. Few hoki were caught in the deeper strata but these tended to be larger fish. Almost all male hoki were aged between 1 and 10 years of age (Figure 8a). For females, the age distribution was broader, with nearly all fish being between 1 and 14 years of age. The age frequency for both male and female hoki was dominated by one-year-olds. For both sexes, fish aged 5 years and older were more prevalent in before 2000.

The hake length distribution was broad, with adult fish up to about 90 cm for males and 125 cm for females (Figure 7b). Throughout the time series there are few fish of both sexes less than 50 cm, with few males larger than 90 cm. Females up to 120 cm are relatively common with a small number larger than this. Hake are often found in the deeper strata, but these are rarely fish greater than 100 cm. Most hake were between 3 and 8 years old for males and between 3 and 17 years old for females (Figure 8b). From 2008 to 2012 there appeared to be relatively large numbers of fish aged about 3 to 10 years. From 2014 there were fewer fish of these ages. The age distribution of hake in 2020 was similar to that in 2018 and 2014 (no fish were aged in 2016 due to insufficient numbers).

The length frequency distribution of ling was broad with few males over 95 cm or females over 120 cm, with the overall length frequency similar to that in 2018, except that there appear to be fewer fish less than 60 cm (see Figure 7c). Most ling of both sexes were between 3 and 15 years old (Figure 8c). There were fewer ling over 15 years of age in 2020 compared with 2018, and indeed with the rest of the time series.

Population scaled length frequency distributions for other main species (calculated using length-weight data in Table 2) for the 2020 survey are presented in Figure 9. Most southern blue whiting were between 28 and 55 cm, with modal peaks of 35 cm for males and 38 cm for females (Figure 9). Female javelinfish and oblique banded rattails were larger and more commonly caught than males (the smaller males may escape through the trawl meshes), whereas male and female banded rattails, Bollon's rattails, and Oliver's rattails were of a similar size. Female ribaldo were also larger and more commonly captured than males. Male spiny dogfish were more common than females. Male white warehou had a strong modal peak at 28 cm.

Gonad staging of fish and chondrichthyans showed that many species were immature or resting during the survey (Table 10). About 36% of hoki were immature, with most of these being 1+ hoki (less than 46 cm). Most adult hoki were in the resting phase, although a very small number (1.1%) of hoki were macroscopically staged as partially spent or spent. Female ling were mostly resting (69%), whereas 35% of male ling were either ripening or ripe. About 71% of female hake were immature or resting and 26% were maturing; 74% of male hake were immature or resting and 22% were ripening or ripe.

3.6 Hoki condition indices

Liver and gutted weights were recorded from 1032 hoki in 2020. Both liver condition (Table 11) and somatic condition (measured as the estimated weight of a 75 cm hoki) were higher in 2020 than in 2018 (MacGibbon et al. 2019), and slightly above average for the time series going back to 2000 (Figure 10). Hoki condition indices in the Sub-Antarctic were consistently lower than those from the Chatham Rise survey, but this pattern is less apparent since the surveys became biennial in 2012 (Figure 10).

3.7 Acoustic data

Over 118 GB of acoustic data, split into 242 data files, were collected. Files recorded for system testing, during transits to and from the survey areas, and 'junk' data (files presenting technical issues) were excluded from analyses. A total of 220 files remained (75 recorded during trawls, 87 during daytime steams, and 58 during night-time steams). Thirty-four percent of the files (i.e., 26 trawls files, 30 daytime steam files, and 19 night-time steam files) were found to be unsuitable for quantitative analysis because the data had too many bad pings (Table 12).

The distribution of total acoustic backscatter from good and marginal quality recordings observed during daytime trawls and night steams are shown in Figure 11. Spatial distribution of total backscatter in the survey area was generally similar to that observed in previous years (MacGibbon et al. 2019), with highest acoustic densities at Puysegur and the Stewart-Snares shelf. Low densities were widely distributed across the Sub-Antarctic region with no clear patterns observed.

The vertical distribution of acoustic backscatter in 2020 was compared with the average vertical distribution from all previous years in the Sub-Antarctic time series in Figure 12. As in previous years, the proportion of backscatter in the upper 200 m increased at night. The component of acoustic backscatter that vertically migrates upward at dusk is assumed to be dominated by mesopelagic fish (McClatchie & Dunford 2003, O'Driscoll et al. 2009). In 2020, there were several peaks in daytime vertical distribution: close to the surface (shallower than 50 m), and at about 350 m, 550 m, and 700 m depths. A daytime layer at 300–400 m depth was a consistent feature in previous surveys (Figure 12).

The time series of day estimates of total acoustic backscatter are plotted in Figure 13. Total daytime backscatter in the water column (from 10 m below the transducer to the seabed) in 2020 was 20% lower than that recorded in 2018 but was still the fifth highest in the time series. Backscatter within 10 m, 50 m, and 100 m from the seabed were the second highest for the time series (Figure 13B). These bottom values were influenced by a high value in a single trawl (station number 2) in the Stewart-Snares shelf region and were uncertain due to the small sample size.

There was a significant positive correlation between acoustic backscatter in the bottom 50 m during the day and trawl catch rates in 2020 (Spearman correlation coefficient, rho = 0.41, p-value <0.01) (Figure 14). Removing the unusually high value from trawl station 2 did not change the correlation or its significance level. Significant positive correlations between backscatter and catches ($p < 0.05$) have been observed in previous surveys in 2000, 2001, 2003, 2005, 2007, 2008, 2009, and 2011 (O'Driscoll 2002, O'Driscoll & Bagley 2003a, 2004, 2006b, 2009, Bagley et al. 2009, Bagley & O'Driscoll 2012, Bagley et al. 2013b), but not in 2002, 2004, 2006, 2012, 2014, 2016, or 2018 (O'Driscoll & Bagley 2003b, 2006a, 2008, Bagley et al. 2014, 2017, O'Driscoll et al. 2018, MacGibbon et al. 2019). Near-bottom layers may also contain mesopelagic species, which contribute to the acoustic backscatter, but which are not sampled by the bottom trawl (e.g., O'Driscoll et al. 2009), and conversely some fish caught by the trawl may not be measured acoustically (e.g., species close to bottom in acoustic deadzone).

Estimates of the proportion of total daytime backscatter (which are assumed to be mesopelagic fish) are presented in Table 13. Estimated mesopelagic indices by region are summarised in Table 14 and plotted in Figure 15. As in previous years, the mesopelagic indices were similar to estimates of total backscatter for the Sub-Antarctic (see Figure 13). The overall estimate of mesopelagic backscatter in 2020 (10.9 $m^2\ km^{-2}$) was around 25% lower than that in 2018 but this was still higher than the average for the time series (9.0 $m^2\ km^{-2}$). Mesopelagic indices decreased from 2018 in the eastern and western Sub-Antarctic (by 34 and 28% respectively), were similar on the Stewart-Snares shelf, but increased at Puysegur (by 48%). The mesopelagic backscatter index at Puysegur was the highest value since 2002 (Figure 15).

3.8 Hydrological data

Temperature profiles were available from 70 CTD casts. Surface (5 m depth) temperatures in the survey area ranged between 7.9 and 13.5 °C (Figure 16), and bottom temperatures were between 4.7 and 10.1 °C (Figure 17). The highest surface and bottom temperatures were in shallow water at Puysegur, with lowest surface temperatures recorded from waters to the south of Campbell Island, and lowest bottom temperatures in deep water on the northern Campbell Plateau. As in previous years, there was a general trend of increasing surface water temperatures towards the north and west (Figure 16).

The average surface temperature in 2020 of 9.8 °C was 1.1 °C cooler than in 2018 (10.9 °C; the highest in the time series) and only slightly higher than that observed in the three previous surveys in 2016 (9.5 °C), 2014 (9.4 °C), and 2012 (9.6 °C). However, the average bottom temperature in 2020 (7.1 °C) was the same as that observed in 2018, 2016, 2014, and 2012, and slightly higher than average bottom temperatures observed from 2002 to 2011 (6.7–7.0 °C). It is difficult to compare temperatures with those observed on Sub-Antarctic surveys before 2002 because temperature sensors were uncalibrated.

4. DISCUSSION AND CONCLUSIONS

The hoki biomass estimate for the core strata in 2020 was 22% higher than the 2018 estimate and very similar to the 2016 estimate. The survey methodology was consistent with previous years, but age data from the time series showed large annual changes in numbers-at-age that could not be explained by changes in abundance and were suggestive of a change in catchability for the survey (O'Driscoll et al. 2015). Recent stock assessments for hoki have had difficulty fitting the survey indices to the model, which has resulted in high process error being estimated for this survey (McKenzie 2019), but the recently revised model was able to fit observations of the Sub-Antarctic trawl survey (McGregor et al. in press). The uncertainty of the western stock biomass (Fisheries New Zealand 2021) and the utility of inputs from the Sub-Antarctic trawl survey into the stock assessment (proportions at age data, abundance indices) support the continuation of the time series.

Ling biomass estimates increased from 2009 to 2014 but decreased by 11% in 2016 and by another 20% in 2018. The 2020 ling estimate is slightly higher (5%) than the 2018 estimate but is still one of the lowest in the time series. Ling continue to show a broad length and age distribution, but fewer fish aged over 15 y were caught in 2020 compared with earlier surveys in the time series.

The core estimate for hake was about the same (3% lower) as the 2018 estimate, which was 35% higher than the 2016 estimate. The 2018 and 2020 estimates were similar to estimates in the early to mid-2000s, but still below the time series mean. The hake length and age distributions in 2020 were broad and similar to those in 2018.

For the nine other key species, biomass estimates were higher in 2020 than in 2018 for black oreo, javelinfish, lookdown dory, pale ghost shark, and ribaldo (Table 8, Figure 4). Estimated biomass was lower for dark ghost shark, spiny dogfish, and white warehou in 2020 than in 2018 and about the same for southern blue whiting. Although the southern blue whiting biomass in 2020 was only slightly more than half the 2016 estimate, it was still the fourth highest in the time series.

For most Tier 2 species, the trawl survey provides the only fisheries-independent estimate of abundance in the Southland and Sub-Antarctic area, as well as providing biological data (length, sex, reproductive condition, age). It is difficult to assess the ‘quality’ of trawl estimates for many of these species, because there are often no alternative indices of abundance (either from stock assessment or reliable catch-per-unit-effort (CPUE) indices). However, the relatively good precision (CVs) of survey estimates, consistency of abundance estimates and length-frequency distributions between surveys, and appropriate spatial and depth distribution suggest that the Sub-Antarctic survey provides potential for monitoring species, including lookdown dory, javelinfish, pale ghost shark, and ribaldo (Bagley et al. 2013a).

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7. TABLES

Table 1: Stratum areas, depths, phase 1 allocations, and number of successful biomass stations from the November–December 2020 Southland and Sub-Antarctic trawl survey. Stratum boundaries are shown in Figure 1, and station positions are plotted in Figure 2. Allocation includes six additional hake stations and three additional hoki stations as part of the phase 1 survey design.

Stratum	Name	Depth (m)	Area (km^2)	Phase 1 allocation	Completed stations
1	Puysegur Bank	300–600	2 150	4	3
2	Puysegur Bank	600–800	1 318	4	3
3a	Stewart-Snares	300–600	4 548	6	6
3b	Stewart-Snares	300–600	1 556	4	2
4	Stewart-Snares	600–800	21 018	5	5
5a	Snares-Auckland	600–800	2 981	5	3
5b	Snares-Auckland	600–800	3 281	4	3
6	Auckland Is.	300–600	16 682	3	3
7	South Auckland	600–800	8 497	3	3
8	N.E. Auckland	600–800	17 294	4	4
9	N. Campbell Island	300–600	27 398	5	4
10	S. Campbell Island	600–800	11 288	3	3
11	N.E. Pukaki Rise	600–800	23 008	4	4
12	Pukaki	300–600	45 259	6	6
13	N.E. Camp. Plateau	300–600	36 051	5	5
14	E. Camp. Plateau	300–600	27 659	3	3
15	E. Camp. Plateau	600–800	15 179	3	3
25	Puysegur Bank	800–1 000	1 928	5	3
27	N.E. Pukaki Rise	800–1 000	12 986	3	3
28	E. Stewart Is.	800–1 000	8 336	4	4
Total			288 417	83	73

Table 2: Length-weight regression parameters* used to scale length frequencies for the 2020 survey. Where data source is given as 'All SUBA surveys', length-weight parameters were estimated from combined data from all previous surveys. * $W = aL^b$ where W is weight (g) and L is length (cm); r^2 is the correlation coefficient, *n* is the number of samples.

Common name	Code	*a*	*b*	r^2	N	Length range	Source
Arrow squid	NOS	0.025302	2.99	88.4	2100	15.7–40.3	All SUBA surveys
Australasian slender cod	HAS	0.003565	3.13	96.7	102	24.2–46.3	tan2014
Banded rattail	CFA	0.003458	3.07	90.2	8282	12.7-–38.4	All SUBA surveys
Barracouta	BAR	0.008557	2.86	92.3	62	53.1–85.8	All SUBA surveys
Basketwork eel	BEE	0.000104	3.53	94.7	123	59.1–123.6	tan2014
Baxter's lantern dogfish	ETB	0.002757	3.16	98.1	338	23.8–79.2	tan2014
Bigeye cardinalfish	EPL	0.016628	2.97	87.6	65	17.5–33.7	All SUBA surveys
Black javelinfish	BJA	0.022752	2.54	82.1	320	38.6–81.3	All SUBA surveys
Black oreo	BOE	0.011498	3.17	92.6	167	22.4–37.5	tan2014
Blackspot rattail	VNI	0.000499	3.38	81.1	126	21.9–32.5	All SUBA surveys
Bollon's rattail	CBO	0.000736	3.54	96.9	133	30.8–69.8	tan2014
Bronze bream	BBR	0.009836	3.16	92.8	64	34.6–52.3	tan2014
Dark ghost shark	GSH	0.002072	3.27	96.6	101	27.2–70.5	tan2014
Dawson's catshark	DCS	0.002068	3.18	81.8	32	28.8–41	All SUBA surveys
Deepsea cardinalfish	EPT	0.018542	2.96	97.3	264	14–49.1	All SUBA surveys
Finless flounder	MAN	0.014273	2.87	91.5	60	35.3–59.5	tan2014
Four-rayed rattail	CSU	0.003744	2.82	85.7	2380	12.9–40.7	All SUBA surveys
Gemfish	RSO	0.004254	3.11	99.5	88	29.2–94.2	tan2014
Gemfish	SKI	0.004254	3.11	99.5	88	29.2–94.2	tan2014
Giant stargazer	GIZ	0.006819	3.23	95.0	53	31.5–75.6	tan2014
Giant stargazer	STA	0.006819	3.23	95.0	53	31.5–75.6	tan2014
Hairy conger	HCO	0.000015	4.15	93.6	66	58.9–93	tan2014
Hake	HAK	0.007733	2.98	96.9	130	54.7–108.1	tan2014
Hoki	HOK	0.003368	2.97	98.5	1386	32.2–114.2	tan2014
Javelinfish	JAV	0.000719	3.31	96.5	1113	18.7–60.8	tan2014
Johnson's cod	HJO	0.003565	3.13	96.7	102	24.2–46.3	tan2014
Kaiyomaru rattail	CKA	0.001362	3.20	94.5	57	16.8–38.9	tan2014
Leafscale gulper shark	CSQ	0.001131	3.35	99.4	895	25–142.5	All SUBA surveys
Ling	LIN	0.001737	3.23	96.9	869	12.4–131.6	tan2014
Long-nosed chimaera	LCH	0.002745	3.03	96.3	197	26.7–96.6	tan2014
Longnose velvet dogfish	CYP	0.000728	3.45	98.1	114	33.7–98.6	tan2014
Lookdown dory	LDO	0.017461	3.08	97.6	168	17.4–51.2	tan2014
Lucifer dogfish	ETL	0.001127	3.29	95.9	288	15.9–51.2	tan2014
Mahia rattail	CMA	0.001335	3.29	95.8	55	33.1–70.5	All SUBA surveys
Notable rattail	CIN	0.004654	2.79	80.1	488	18.5–36.6	All SUBA surveys
Oblique banded rattail	CAS	0.001019	3.43	96.5	318	18.5–46.5	tan2014
Oliver's rattail	COL	0.017023	2.46	80.4	5394	12.2–40.3	All SUBA surveys
Orange roughy	ORH	0.038739	2.97	99.3	60	8.3–35.9	tan2014
Pale ghost shark	GSP	0.01196	2.82	97.0	815	23.6–84.6	tan2014
Plunket's shark	PLS	0.01145	2.84	98.0	72	34.7–111	All SUBA surveys
Ray's bream	RBM	0.009836	3.16	92.8	64	34.6–52.3	tan2014
Red cod	RCO	0.017005	2.83	97.0	1084	15.5–72	All SUBA surveys
Ribaldo	RIB	0.004709	3.22	98.9	220	23.6–72.9	tan2014
Ridge scaled rattail	MCA	0.004479	3.04	97.0	210	37.4–94.9	tan2014
Rough skate	RSK	0.031389	2.90	98.2	129	29.5–72.5	All SUBA surveys
Rudderfish	RUD	0.02041	2.90	97.3	58	53.3–100.3	All SUBA surveys
Seal shark	BSH	0.00102	3.38	99.4	225	38.8–153.6	All SUBA surveys
Serrulate rattail	CSE	0.00151	3.24	87.4	283	25.3–50.1	All SUBA surveys
Shovelnose dogfish	SND	0.001101	3.28	96.6	160	44.1–115.3	tan2014
Silver dory	SDO	0.030457	2.80	94.5	586	14.3–28.5	All SUBA surveys
Silver warehou	SWA	0.007586	3.24	96.4	61	30.7–54.1	tan2014
Silverside	SSI	0.014905	2.75	84.4	5877	13.6–35.3	All SUBA surveys
Small-headed cod	SMC	0.00323	3.18	94.6	113	20–47.1	All SUBA surveys

Table 2: continued.

Common name	Code	*a*	*b*	r^2	N	Length range	Source
Smallscaled brown slickhead	SSM	0.005088	3.14	95.6	136	34.2–66.5	tan2014
Smooth deepsea skate	BTA	2.050984	1.70	66.3	27	25.4–35	All SUBA surveys
Smooth oreo	SSO	0.029652	2.91	99.1	145	15.9–48	tan2014
Smooth skate	SSK	0.016528	3.04	99.3	147	36.1–135	All SUBA surveys
Smooth skin dogfish	CYO	0.003621	3.10	99.1	345	28.3–118.2	All SUBA surveys
Southern blue whiting	SBW	0.002033	3.31	96.5	358	24.8–55.1	tan2014
Southern Ray's bream	SRB	0.009836	3.16	92.8	64	34.6–52.3	tan2014
Spiky oreo	SOR	0.053088	2.75	97.9	352	12.9–40	All SUBA surveys
Spineback	SBK	0.001555	3.04	81.9	1171	42–80.5	All SUBA surveys
Spiny dogfish	SPD	0.002239	3.16	91.5	204	49.9–92.6	tan2014
Swollenhead conger	SCO	0.0001	3.70	93.6	393	52.8–106.5	All SUBA surveys
Violet cod	VCO	0.001188	3.47	96.1	61	21.9–39.4	tan2014
White rattail	WHX	0.000504	3.61	98.3	405	27.3–92.9	All SUBA surveys
White warehou	WWA	0.016017	3.07	99.2	68	23.4–56.9	tan2014
Widenosed chimaera	RCH	0.000721	3.19	98.0	386	28.6–155.6	All SUBA surveys

Table 3: Survey tow and gear parameters (recorded values only) from the November–December 2020 Southland and Sub-Antarctic trawl survey. Values are number of tows (n), and the mean, standard deviation (s.d.), and range of observations for each parameter.

	Depth of bottom (m)	n	Mean	s.d.	Range
Tow parameters					
Tow length (n. miles)		73	2.98	0.14	2.20–3.09
Tow speed (knots)		73	3.50	0.04	3.4–3.6
Gear parameters (m)					
Headline height	300–600	32	7.2		
	600–800	31	7.0		
	800–1000	10	7.4		
	All depths	73	7.1	0.33	6.6–8.0
Doorspread	300–600	32	120.0		
	600–800	31	124.6		
	800–1000	10	117.8		
	All depths	72	121.8	8.34	101.0–135.1

Table 4: Comparison of doorspread and headline measurements from all surveys in the summer *Tangaroa* Southland and Sub-Antarctic time series. Values are the mean and standard deviation (S.D.). The number of tows with measurements (*n*) and range of observations are also given for doorspread.

	Doorspread (m)					Headline height (m)	
Survey	*n*	Mean	S.D.	Min	Max	Mean	S.D.
1991	152	126.5	7.05	106.5	145.5	6.6	0.31
1992	127	121.4	6.03	105.0	138.4	7.4	0.38
1993	138	120.7	7.14	99.9	133.9	7.1	0.33
2000	68	121.4	5.22	106.0	132.4	7.0	0.20
2001	95	117.5	5.19	103.5	127.6	7.1	0.25
2002	97	120.3	5.92	107.0	134.5	6.8	0.14
2003	13	123.1	3.80	117.3	129.7	7.0	0.22
2004	85	120.0	6.11	105.0	131.8	7.1	0.28
2005	91	117.1	6.53	104.0	134.4	7.2	0.22
2006	85	120.5	4.82	104.0	129.7	7.0	0.24
2007	94	114.3	7.43	97.5	130.8	7.2	0.23
2008	92	115.5	5.05	103.8	128.3	6.9	0.22
2009	81	116.6	7.07	93.8	129.7	7.0	0.21
2011	95	120.0	6.39	101.2	133.2	6.9	0.26
2012	91	116.8	6.77	99.3	130.1	7.1	0.30
2014	86	122.6	6.62	106.5	133.9	7.0	0.20
2016	56	124.3	5.64	111.5	139.7	6.9	0.27
2018	82	122.3	5.89	109.6	134.2	6.5	0.28
2020	72	121.8	8.34	101.0	135.1	7.1	0.33

Table 5: Total catch of the top 50 species from all tows during the survey. NB: 'Total' is the total catch of all species caught on the survey.

Species	Common name	Scientific name	Catch (kg)
HOK	Hoki	*Macruronus novaezelandiae*	10 447.4
LIN	Ling	*Genypterus blacodes*	6 741.4
BSK	Basking shark	*Cetorhinus maximus*	4 000.0
JAV	Javelinfish	*Lepidorhynchus denticulatus*	2 867.8
GSP	Pale ghost shark	*Hydrolagus bemisi*	2 071.6
SBW	Southern blue whiting	*Micromesistius australis*	2 012.8
SWA	Silver warehou	*Seriolella punctata*	1 468.0
SND	Shovelnose dogfish	*Deania calcea*	1 337.6
BOE	Black oreo	*Allocyttus niger*	1 319.7
GSH	Dark ghost shark	*Hydrolagus novaezealandiae*	1 037.8
MCA	Ridge scaled rattail	*Macrourus carinatus*	1 037.0
HAK	Hake	*Merluccius australis*	805.5
SPD	Spiny dogfish	*Squalus acanthias*	587.3
ETB	Baxter's lantern dogfish	*Etmopterus baxteri*	542.6
SSM	Smallscaled brown slickhead	*Alepocephalus antipodianus*	522.3
CYP	Longnose velvet dogfish	*Centroscymnus crepidater*	455.1
RIB	Ribaldo	*Mora moro*	396.0
CBO	Bollon's rattail	*Coelorinchus bollonsi*	395.3
SRB	Southern Ray's bream	*Brama australis*	380.9
HYA	Floppy tubular sponge	*Hyalascus* sp.	373.0
MIQ	Warty squid	*Moroteuthopsis ingens*	364.1
CFA	Banded rattail	*Coelorinchus fasciatus*	308.5
LCH	Long-nosed chimaera	*Harriotta raleighana*	294.4
CSQ	Leafscale gulper shark	*Centrophorus squamosus*	284.2
SSI	Silverside	*Argentina elongata*	278.8
PYR	*Pyrosoma atlanticum*	*Pyrosoma atlanticum*	253.2
CAS	Oblique banded rattail	*Coelorinchus aspercephalus*	249.3
SBK	Spineback	*Notacanthus sexspinis*	243.5
COL	Oliver's rattail	*Coelorinchus oliverianus*	239.3
GIZ	Giant stargazer	*Kathetostoma giganteum*	229.2
BEE	Basketwork eel	*Diastobranchus capensis*	199.5
LDO	Lookdown dory	*Cyttus traversi*	198.9
CSU	Four-rayed rattail	*Coryphaenoides subserrulatus*	190.7
RSO	Gemfish	*Rexea solandri*	185.6
NOS	Arrow squid	*Nototodarus sloanii*	139.0
RCH	Widenosed chimaera	*Rhinochimaera pacifica*	123.6
SSK	Smooth skate	*Dipturus innominatus*	122.1
ETL	Lucifer dogfish	*Etmopterus lucifer*	97.7
TAG	*Todarodes angolensis*	*Todarodes angolensis*	92.9
WWA	White warehou	*Seriolella caerulea*	90.7
SCO	Swollenhead conger	*Bassanago bulbiceps*	89.1
HCO	Hairy conger	*Bassanago hirsutus*	85.4
BSH	Seal shark	*Dalatias licha*	72.4
MAN	Finless flounder	*Neoachiropsetta milfordi*	70.4
SSO	Smooth oreo	*Pseudocyttus maculatus*	69.4
BJA	Black javelinfish	*Mesobius antipodum*	67.2
HAS	Australasian slender cod	*Halargyreus* sp.	43.3
RUD	Rudderfish	*Centrolophus niger*	43.2
ORH	Orange roughy	*Hoplostethus atlanticus*	36.1
ACS	Smooth deepsea anemones	Actinostolidae	35.1
Total	–	–	44 336.4

Table 6: **Catch (kg) and abundance estimates (t) of all species from core strata (300–800 m) and all strata (300–1000 m), with coefficient of variation (CV in parentheses), ranked in order of decreasing abundance in the 2020 survey. –, no data**

		Catch (kg)		Biomass (t)	
Common name	**Code**	**Core**	**All**	**Core**	**All**
Hoki	HOK	10 314	10 401	37 851 (12.3)	37 992 (12.3)
Ling	LIN	6 697	6 708	22 343 (12.4)	22 355 (12.4)
Southern blue whiting	SBW	1 951	1 951	20 660 (28.7)	20 660 (28.7)
Javelinfish	JAV	2 494	2 861	16 471 (14.8)	16 923 (14.4)
Pale ghost shark	GSP	1 892	2 025	12 464 (13.9)	12 879 (13.5)
Black oreo	BOE	608	1 319	3 923 (87.7)	6 688 (55.8)
Ridge scaled rattail	MCA	217	1 037	1 160 (40.6)	5 642 (33.5)
Floppy tubular sponge	HYA	361	373	3 054 (43.4)	3 128 (42.4)
Silverside	SSI	272	272	2 754 (29.1)	2 754 (29.1)
Silver warehou	SWA	1 399	1 399	2 642 (92.0)	2 642 (92.0)
Long-nosed chimaera	LCH	248	284	2 166 (21.1)	2 304 (20.0)
Baxter's lantern dogfish	ETB	331	542	1 381 (24.8)	2 292 (16.5)
Spiny dogfish	SPD	576	576	2 222 (22.5)	2 222 (22.5)
Warty squid	MIQ	248	364	1 539 (14.1)	1 893 (11.9)
Smallscaled brown slickhead	SSM	–	522	–	1 740 (24.2)
Banded rattail	CFA	213	308	1 301 (16.4)	1 675 (13.7)
Dark ghost shark	GSH	1 037	1 037	1 623 (64.9)	1 623 (64.9)
Hake	HAK	540	805	1 310 (23.2)	1 619 (18.9)
Oblique banded rattail	CAS	246	246	1 364 (25.3)	1 364 (25.3)
Shovelnose dogfish	SND	1 061	1 337	898 (27.7)	1 185 (22.6)
Ribaldo	RIB	359	396	1 128 (17.2)	1 167 (16.6)
Longnose velvet dogfish	CYP	214	455	341 (54.2)	1 130 (27.8)
Oliver's rattail	COL	237	239	1 115 (24.4)	1 118 (24.4)
Spineback	SBK	227	243	1 046 (38.2)	1 094 (36.6)
Smooth skate	SSK	122	122	803 (59.9)	803 (59.9)
Bollon's rattail	CBO	392	395	798 (52.8)	801 (52.6)
Basketwork eel	BEE	7	199	46 (96.8)	774 (29.1)
Lookdown dory	LDO	193	193	753 (18.3)	753 (18.3)
Southern Ray’s bream	SRB	380	380	732 (49.5)	732 (49.5)
Finless flounder	MAN	68	70	639 (23.9)	645 (23.7)
Four-rayed rattail	CSU	7	190	41 (45.1)	611 (50.8)
Widenosed chimaera	RCH	27	123	189 (60.0)	569 (28.3)
Swollenhead conger	SCO	89	89	552 (21.4)	552 (21.4)
Hairy conger	HCO	84	85	535 (25.5)	538 (25.4)
Todarodes angolensis	TAG	65	88	420 (43.3)	520 (35.2)
Giant stargazer	GIZ	229	229	505 (36.1)	505 (36.1)
White warehou	WWA	90	90	429 (35.9)	429 (35.9)
Leafscale gulper shark	CSQ	259	284	400 (38.6)	427 (36.3)
Pyrosoma atlanticum	PYR	248	253	409 (41.9)	416 (41.2)
Lucifer dogfish	ETL	88	97	272 (19.2)	283 (18.5)
Smooth oreo	SSO	7	69	23 (54.0)	258 (22.0)
Arrow squid (*Nototodarus sloanii*)	NOS	133	139	234 (23.1)	240 (22.6)
Rudderfish	RUD	43	43	240 (42.5)	240 (42.5)
Gemfish	RSO	185	185	233 (38.9)	233 (38.9)
Black javelinfish	BJA	–	67	–	223 (55.1)
Pale toadfish	TOP	24	32	190 (23.5)	218 (24.2)
Shortspine lanternshark	ETU	–	32	–	213 (82.6)
Smooth deepsea anemones	ACS	21	35	147 (26.6)	195 (20.4)
Orange roughy	ORH	–	36	<1 (100.0)	154 (57.5)
Umbrella octopus	OPI	14	15	141 (76.7)	142 (75.9)
Pseudostichopus mollis	PMO	18	29	104 (33.4)	134 (26.8)
Rough skate	RSK	15	15	130 (57.1)	130 (57.1)

Table 6: continued.

Common name	Code	Catch (kg) Core	All	Biomass (t) Core	All
Warty squid	MRQ	11	23	80 (51.4)	128 (42.1)
Giant chimaera	CHG	14	22	95 (100.0)	123 (80.4)
Giant spider crab	GSC	13	13	118 (99.2)	118 (99.2)
Australasian slender cod	HAS	–	43	1 (47.1)	114 (33.3)
New Zealand king crab	LAO	21	26	94 (48.4)	103 (44.5)
Red cod	RCO	12	12	98 (73.8)	98 (73.8)
Tam O’Shanter urchin	TAM	13	21	49 (37.1)	81 (27.8)
Rat-tail star	ZOR	9	9	70 (27.5)	73 (26.6)
Plunket's shark	PLS	20	21	69 (82.8)	71 (80.7)
Mahia rattail	CMA	6	20	25 (56.0)	70 (34.7)
Jellyfish	JFI	8	10	66 (43.3)	69 (41.2)
Deepsea anemone	HMT	6	8	54 (48.1)	67 (40.5)
Violet cod	VCO	–	13	–	66 (54.5)
Humpback rattail (slender rattail)	CBA	11	16	55 (45.2)	65 (39.9)
Seaweed	SEO	5	5	59 (100.0)	59 (100.0)
Seal shark	BSH	60	72	42 (96.0)	54 (74.6)
Ragfish	RAG	–	8	–	50 (63.9)
Deepwater octopus	GTA	4	10	27 (52.3)	49 (31.1)
Deepwater spiny skate (arctic skate)	DSK	–	12	–	45 (78.4)
Brown chimaera	CHP	–	9	–	44 (74.6)
Smallscaled cod	SCD	3	3	41 (100.0)	41 (100.0)
Longnosed deepsea skate	PSK	2	8	18 (100.0)	36 (70.7)
Prickly deepsea skate	BTS	4	4	33 (59.9)	33 (59.9)
Kaiyomaru rattail	CKA	–	8	–	33 (43.6)
Yellow octopus	EZE	8	8	33 (77.0)	33 (77.0)
Smooth deepsea skate	BTA	5	5	28 (72.2)	29 (71.5)
Trojan starfish	HTR	4	5	22 (37.8)	26 (32.6)
White rattail	WHX	–	23	–	25 (47.7)
Serrulate rattail	CSE	–	6	–	24 (30.6)
Omega prawn	LHO	4	6	21 (28.2)	24 (25.2)
Dana octopus squid	TDQ	2	9	4 (100.0)	24 (51.8)
New Zealand catshark	AEX	1	6	9 (100.0)	23 (53.5)
Dipsacaster magnificus	DMG	3	4	19 (46.5)	20 (45.1)
Blobfish	PSY	–	5	–	19 (100.0)
Barracouta	BAR	12	12	18 (88.0)	18 (88.0)
Pigfish	PIG	1	1	18 (100.0)	18 (100.0)
Cross-fish	SMO	10	10	18 (87.4)	18 (87.4)
Notable rattail	CIN	–	5	1 (86.1)	16 (14.1)
Deepsea cardinalfish	EPT	12	12	16 (53.3)	16 (53.3)
Spiky oreo	SOR	6	17	4 (92.5)	16 (70.1)
Muusoctopus spp.	BNO	2	2	15 (67.9)	16 (67.1)
Pillsburiaster aoteanus	PAO	2	4	13 (36.3)	16 (30.3)
Fleshy club sponge	SUA	2	2	16 (39.1)	16 (38.4)
Smooth skin dogfish	CYO	–	14	<1 (100.0)	15 (71.3)
Todarodes filippovae	TSQ	4	16	3 (51.3)	15 (35.1)
Dawson's catshark	DCS	1	1	14 (51.3)	14 (51.3)
School shark	SCH	9	9	13 (100.0)	13 (100.0)
Blackspot rattail	VNI	3	4	12 (32.3)	13 (29.7)
Lighthouse fish	PHO	1	2	10 (21.4)	13 (18.4)
Furry oval sponge	TLD	–	3	–	12 (36.8)
Carpet shark	CAR	8	8	11 (100.0)	11 (100.0)
Lyconus pinnatus	LYC	–	3	<1 (100.0)	11 (84.0)
Prickly dogfish	PDG	8	8	10 (100.0)	10 (100.0)
Bathyplotes spp.	BAM	1	1	9 (83.9)	9 (83.9)
Barracudina	BCA	1	1	9 (100.0)	9 (100.0)

Table 6: continued.

Common name	Code	Catch (kg)		Biomass (t)	
		Core	All	Core	All
Dealfish	DEA	10	10	9 (70.7)	9 (70.7)
Fusitriton magellanicus	FMA	2	2	9 (40.3)	9 (40.3)
Grey fibrous massive sponge	PHB	1	1	9 (49.9)	9 (49.9)
Small-headed cod	SMC	1	4	2 (77.2)	8 (27.5)
Deepsea anemone	BOC	1	1	8 (90.1)	8 (90.1)
Pentagon star	CPA	–	3	4 (60.4)	8 (38.5)
Deepsea flathead	FHD	2	2	7 (78.1)	7 (78.1)
Freckled catshark	ASI	–	1	–	6 (100.0)
Sea cucumber	HTH	–	–	6 (100.0)	6 (90.6)
Silver dory	SDO	4	4	5 (100.0)	5 (100.0)
Brisingida (Order)	BRG	–	–	–	5 (82.6)
Sea urchin	GRM	–	5	–	5 (100.0)
Rock star	LNV	1	1	4 (49.3)	5 (38.9)
Rocky dumpling sponge	PAZ	–	–	5 (85.9)	5 (85.9)
Prickly king crab	PZE	3	3	5 (48.6)	5 (48.6)
Solaster torulatus	SOT	–	–	2 (100.0)	5 (60.2)
Violet squid	VSQ	–	1	4 (55.8)	5 (49.1)
Small banded rattail	CCX	3	3	4 (89.0)	4 (89.0)
Bigeye cardinalfish	EPL	3	3	4 (38.5)	4 (38.5)
Scampi	SCI	–	–	4 (95.8)	4 (95.8)
Geometric star	PSI	–	1	3 (75.6)	4 (63.7)
Laetmogone spp.	LAG	1	1	3 (71.4)	3 (71.4)
Deepsea anemone	LIP	–	–	3 (100.0)	3 (100.0)
Robertson's king crab	LRO	–	–	–	3 (100.0)
Pasiphaea barnardi	PBA	–	–	–	3 (31.0)
Scaly dragonfish	SBB	–	–	1 (100.0)	3 (37.1)
Sea devil	SDE	–	–	3 (100.0)	3 (100.0)
Scopelosaurus hamiltoni	SHM	–	1	–	3 (100.0)
Banded bellowsfish	BBE	–	–	2 (100.0)	2 (100.0)
Sub-Antarctic ruby prawn	ACA	–	–	–	2 (76.1)
Sabre prawn	CAM	–	–	2 (70.3)	2 (70.3)
Viper fish	CHA	–	–	1 (91.2)	2 (57.9)
Sun star	CJA	–	–	2 (44.9)	2 (44.9)
Coral–like anemones	CLM	–	–	2 (77.1)	2 (59.2)
Airy finger sponge	CRM	1	1	2 (100.0)	2 (100.0)
Dwarf cod	DCO	–	–	2 (80.6)	2 (80.6)
Sea urchin	GPA	–	–	1 (100.0)	2 (60.5)
Curling stone sponge	GRE	–	–	–	2 (100.0)
Southern blacktip lanternfish	GYP	–	–	1 (89.7)	2 (69.6)
Pagurid	PAG	–	–	2 (48.9)	2 (48.9)
Common tubeshoulder	PER	–	–	<1 (100.0)	2 (36.0)
Primnoidae	PRI	–	–	2 (71.2)	2 (71.2)
Pagurid	SDM	–	–	2 (50.5)	2 (50.5)
Spiny masking crab	SMK	–	–	2 (71.5)	2 (71.5)
Silver roughy	SRH	2	2	2 (66.5)	2 (66.5)
Bristle ball sponge	TTL	–	–	2 (50.0)	2 (50.0)
Tasmanian ruffe	TUB	1	1	2 (100.0)	2 (100.0)
Giant hatchetfish	AGI	–	–	1 (100.0)	1 (100.0)
Fewpore snipe eel	APA	–	–	–	1 (100.0)
Alert pigfish	API	–	–	1 (100.0)	1 (100.0)
Anthomastus (*Bathyalcyon*) *robustus*	ARO	–	–	1 (62.7)	1 (62.7)
Parin's deepsea smelt	BPA	–	–	–	1 (100.0)
Big-scale pomfret	BSP	2	2	1 (100.0)	1 (100.0)
Discfish	DIS	–	–	–	1 (100.0)

Table 6: continued.

Common name	Code	Catch (kg) Core	All	Biomass (t) Core	All
Smooth lanternshark	ETP	–	–	1 (100.0)	1 (100.0)
Golden volute	GVO	–	–	1 (87.0)	1 (87.0)
Gymnoscopelus spp.	GYM	–	–	1 (100.0)	1 (73.0)
Prickly anglerfish	HIM	–	1	–	1 (100.0)
Cripplefin lanternfish	LAC	–	–	–	1 (100.0)
Intricate lanternfish	LIT	–	–	–	1 (45.5)
Brodie's king crab	NEB	–	–	–	1 (100.0)
Giant red mysid	NEI	–	–	–	1 (100.0)
Sponges	ONG	–	–	1 (89.4)	1 (89.4)
Ophiuroid (brittle star)	OPH	–	–	1 (100.0)	1 (100.0)
Pannychia moseleyi	PAM	–	–	1 (66.8)	1 (66.8)
False frostfish	PDS	–	–	1 (100.0)	1 (100.0)
Psammocinia cf. *hawere*	PHW	–	–	1 (100.0)	1 (100.0)
Abyssal star	PKN	–	–	1 (100.0)	1 (100.0)
Proserpinaster neozelanicus	PNE	–	–	1 (81.1)	1 (81.1)
Pseudechinaster rubens	PRU	–	–	1 (100.0)	1 (100.0)
Bogue lanternfish	SBP	–	–	1 (100.0)	1 (100.0)
Brachioteuthis sp.	SQB	–	–	–	1 (57.7)
Common sawtooth eel	SSA	–	–	1 (100.0)	1 (100.0)

Table 7: Estimated biomass (t) and CVs (%, below in parentheses) by stratum of the top 50 species in descending order of abundance in the 2020 survey. Species codes are given in Appendix 3. Subtotals include biomass calculated from survey for core strata (0001–0015), core including Puysegur (0001–0015, 0025), and total (0001–0015, 0025, 0027–0028). Codes are defined in Table 5. –, no data

						Species code
Stratum	**HOK**	**LIN**	**SBW**	**JAV**	**GSP**	**BOE**
0001	446 (16.4)	3 914 (51.0)	–	49 (71.4)	13 (81.7)	–
0002	222 (52.9)	138 (59.3)	–	66 (17.0)	33 (45.8)	–
003A	6 403 (38.0)	1 582 (46.2)	1 (77.4)	76 (20.0)	167 (81.5)	–
003B	350 (91.9)	34 (41.7)	<1 (100.0)	1 (100.0)	–	–
0004	2 465 (58.8)	1 700 (38.2)	–	2 637 (29.2)	1 951 (26.5)	3 920 (87.8)
005A	943 (34.7)	218 (36.2)	–	212 (32.1)	102 (18.4)	–
005B	111 (19.3)	276 (16.3)	–	389 (18.8)	465 (12.2)	–
0006	1 250 (50.2)	637 (59.5)	1 966 (49.1)	83 (58.1)	40 (51.0)	–
0007	790 (46.3)	288 (56.9)	–	389 (5.5)	156 (55.8)	–
0008	3 312 (33.1)	1 190 (34.8)	–	1 304 (33.6)	930 (32.2)	–
0009	4 375 (18.4)	1 566 (46.4)	3 989 (93.9)	902 (43.1)	1 429 (33.4)	–
0010	2 494 (55.9)	545 (47.7)	–	425 (20.5)	172 (43.1)	–
0011	3 096 (40.3)	717 (54.3)	589 (100.0)	1 339 (50.8)	315 (24.8)	–
0012	3 732 (64.3)	4 685 (19.9)	8 949 (36.4)	3 584 (37.8)	3 904 (36.3)	–
0013	2 884 (42.6)	2 491 (24.9)	1 133 (44.6)	3 704 (43.2)	2 103 (28.8)	–
0014	3 311 (17.1)	1 855 (31.1)	4 032 (74.5)	620 (46.4)	566 (9.3)	–
0015	1 665 (18.8)	507 (28.3)	–	692 (20.5)	118 (22.5)	3 (100.0)
Subtotal (core)	37 851 (12.3)	22 343 (12.4)	20 660 (28.7)	16 471 (14.8)	12 464 (13.9)	3 923 (87.7)
0025	71 (78.0)	12 (63.9)	–	345 (24.6)	18 (35.3)	–
Subtotal (core plus puys)	37 922 (12.3)	22 355 (12.4)	20 660 (28.7)	16 816 (14.5)	12 482 (13.9)	3 923 (87.7)
0027	47 (100.0)	–	–	47 (95.8)	55 (50.0)	1 120 (96.1)
0028	24 (34.5)	–	–	60 (90.8)	342 (12.1)	1 645 (59.3)
Total	37 992 (12.3)	22 355 (12.4)	20 660 (28.7)	16 923 (14.4)	12 879 (13.5)	6 688 (55.8)

						Species code
Stratum	**MCA**	**HYA**	**SSI**	**SWA**	**LCH**	**ETB**
0001	–	–	–	–	–	–
0002	–	–	–	–	1 (100.0)	–
003A	–	–	22 (57.6)	2 525 (96.2)	8 (53.2)	1 (100.0)
003B	–	–	–	–	–	–
0004	122 (64.3)	23 (100.0)	16 (66.3)	33 (100.0)	284 (35.8)	318 (42.3)
005A	8 (100.0)	–	–	–	–	<1 (100.0)
005B	–	33 (14.3)	–	–	12 (34.5)	237 (22.0)
0006	–	–	70 (40.2)	–	–	–
0007	300 (100.0)	–	<1 (100.0)	–	8 (20.6)	15 (100.0)
0008	75 (63.8)	20 (100.0)	25 (23.4)	–	133 (36.5)	425 (67.2)
0009	–	145 (58.3)	482 (84.0)	83 (79.4)	56 (100.0)	–
0010	321 (100.0)	16 (100.0)	–	–	–	54 (100.0)
0011	24 (100.0)	1 615 (73.5)	–	–	167 (63.2)	209 (34.2)
0012	82 (100.0)	118 (75.1)	570 (39.7)	–	911 (37.3)	14 (100.0)
0013	–	1 083 (53.2)	1 025 (50.6)	–	559 (46.0)	–
0014	–	–	544 (73.3)	–	–	–
0015	229 (50.7)	–	–	–	28 (51.5)	107 (77.6)
Subtotal (core)	1 160 (40.6)	43 (–)	2 754 (29.1)	2 642 (92.0)	2 166 (21.1)	1 381 (24.8)
0025	28 (50.6)	–	–	–	3 (60.0)	6 (61.5)
Subtotal (core plus puys)	1 188 (39.7)	43 (–)	2 754 (29.1)	2 642 (92.0)	2 169 (21.1)	1 387 (24.7)
0027	3 921 (46.5)	74 (97.5)	–	–	48 (59.4)	513 (28.1)
0028	533 (27.1)	–	<1 (100.0)	–	87 (53.8)	392 (17.9)
Total	5 642 (33.5)	42 (–)	2 754 (29.1)	2 642 (92.0)	2 304 (20.0)	2 292 (16.5)

Table 7: continued.

Stratum	SPD	MIQ	SSM	CFA	GSH	HAK	CAS
							Species code
0001	31 (100.0)	–	–	<1 (100.0)	23 (95.0)	83 (100.0)	<1 (100.0)
0002	–	–	–	2 (65.9)	–	10 (24.1)	–
003A	595 (55.3)	22 (43.3)	–	2 (100.0)	1 048 (97.1)	–	180 (38.0)
003B	22 (71.1)	–	–	<1 (100.0)	294 (85.4)	–	7 (100.0)
0004	73 (55.3)	256 (25.0)	–	530 (34.2)	53 (100.0)	157 (60.1)	–
005A	–	19 (50.2)	–	16 (71.9)	3 (100.0)	428 (39.7)	<1 (100.0)
005B	6 (100.0)	60 (15.6)	–	20 (20.4)	–	62 (90.9)	–
0006	–	12 (89.8)	–	–	125 (40.7)	83 (70.3)	46 (36.5)
0007	–	18 (25.3)	–	55 (80.2)	–	161 (76.7)	–
0008	55 (61.8)	42 (33.5)	–	177 (36.3)	–	267 (58.2)	–
0009	107 (54.6)	113 (40.1)	–	65 (31.9)	78 (86.2)	–	182 (97.2)
0010	–	108 (31.7)	–	87 (32.1)	–	–	–
0011	25 (100.0)	279 (48.9)	–	85 (43.6)	–	–	5 (64.7)
0012	113 (37.0)	181 (27.3)	–	122 (42.3)	–	–	729 (37.1)
0013	539 (29.9)	140 (28.2)	–	71 (33.1)	–	–	111 (38.9)
0014	649 (50.1)	151 (74.6)	–	4 (56.9)	–	–	105 (84.5)
0015	6 (100.0)	139 (42.7)	–	66 (31.8)	–	58 (70.9)	–
Subtotal (core)	2 222 (22.5)	1 539 (14.1)	–	1 301 (16.4)	1 623 (64.9)	1 310 (23.2)	1 364 (25.3)
0025	–	32 (78.5)	71 (50.5)	2 (53.5)	–	262 (12.8)	–
Subtotal (core plus puys)	2 222 (22.5)	1 571 (13.9)	71 (50.5)	1 303 (16.3)	1 623 (64.9)	1 572 (19.5)	1 364 (25.3)
0027	–	113 (29.2)	435 (65.3)	142 (32.9)	–	–	–
0028	–	210 (20.6)	1 234 (25.1)	230 (30.1)	–	47 (36.8)	–
Total	2 222 (22.5)	1 893 (11.9)	1 740 (24.2)	1 675 (13.7)	1 623 (64.9)	1 619 (18.9)	1 364 (25.3)

Stratum	SND	RIB	CYP	COL	SBK	SSK	CBO
							Species code
0001	250 (58.8)	26 (75.8)	4 (100.0)	9 (55.2)	–	–	29 (20.1)
0002	514 (38.4)	71 (33.6)	118 (70.7)	8 (61.2)	<1 (100.0)	8 (100.0)	19 (60.8)
003A	–	–	–	1 (75.0)	–	27 (61.0)	342 (90.1)
003B	–	–	–	–	–	–	–
0004	17 (100.0)	104 (34.3)	195 (83.5)	140 (93.5)	212 (46.9)	22 (100.0)	362 (79.2)
005A	68 (17.7)	111 (40.9)	–	1 (76.3)	57 (60.6)	11 (100.0)	23 (59.1)
005B	–	9 (53.9)	–	19 (21.2)	93 (29.5)	20 (100.0)	14 (63.2)
0006	–	–	–	3 (29.2)	–	–	–
0007	–	105 (55.4)	–	401 (47.6)	35 (52.0)	–	–
0008	–	164 (76.2)	–	158 (14.4)	205 (58.7)	–	10 (100.0)
0009	–	32 (100.0)	–	146 (77.8)	–	540 (82.7)	–
0010	9 (100.0)	207 (33.2)	23 (100.0)	128 (55.1)	9 (63.5)	–	–
0011	22 (100.0)	126 (37.5)	–	56 (53.6)	402 (90.4)	–	–
0012	–	–	–	2 (63.2)	6 (100.0)	–	–
0013	–	25 (100.0)	–	2 (61.3)	–	175 (100.0)	–
0014	–	–	–	3 (50.0)	–	–	–
0015	18 (100.0)	148 (50.0)	–	39 (92.4)	26 (100.0)	–	–
Subtotal (core)	898 (27.7)	1 128 (17.2)	341 (54.2)	1 115 (24.4)	1 046 (38.2)	803 (59.9)	798 (52.8)
0025	286 (33.8)	38 (28.8)	26 (28.6)	2 (92.6)	8 (58.6)	–	2 (100.0)
Subtotal (core plus puys)	1 185 (22.6)	1 167 (16.6)	366 (50.5)	1 118 (24.4)	1 054 (37.9)	803 (59.9)	801 (52.6)
0027	–	–	139 (80.9)	–	32 (71.8)	–	–
0028	–	–	625 (36.4)	–	7 (39.3)	–	–
Total	1 185 (22.6)	1 167 (16.6)	1 130 (27.8)	1 118 (24.4)	1 094 (36.6)	803 (59.9)	801 (52.6)

Table 7: continued.

Stratum	BEE	LDO	SRB	MAN	CSU	RCH	SCO
							Species code
0001	–	20 (90.4)	–	–	–	–	10 (53.6)
0002	–	6 (36.0)	1 (100.0)	–	1 (100.0)	–	2 (100.0)
003A	1 (100.0)	105 (36.4)	473 (68.0)	–	–	–	2 (100.0)
003B	–	19 (86.0)	15 (33.4)	–	–	–	–
0004	45 (98.2)	24 (100.0)	–	21 (61.5)	29 (58.9)	139 (73.2)	23 (100.0)
005A	–	17 (40.0)	–	–	–	–	–
005B	–	–	4 (100.0)	–	1 (61.8)	–	8 (54.5)
0006	–	91 (68.5)	–	–	–	–	13 (100.0)
0007	–	6 (100.0)	–	15 (55.9)	1 (100.0)	–	62 (35.3)
0008	–	–	–	16 (61.3)	5 (100.0)	–	77 (39.0)
0009	–	44 (68.6)	–	82 (78.9)	–	–	10 (100.0)
0010	–	7 (100.0)	–	26 (31.0)	5 (100.0)	–	4 (100.0)
0011	–	46 (100.0)	–	9 (100.0)	–	50 (100.0)	65 (63.2)
0012	–	321 (27.8)	239 (69.8)	162 (53.3)	–	–	117 (67.3)
0013	–	34 (100.0)	–	45 (62.0)	–	–	55 (45.5)
0014	–	13 (100.0)	–	201 (50.1)	–	–	42 (100.0)
0015	–	–	–	62 (27.8)	–	–	61 (59.4)
Subtotal (core)	46 (96.8)	753 (18.3)	732 (49.5)	639 (23.9)	41 (45.1)	189 (60.0)	552 (21.4)
0025	9 (100.0)	–	–	–	49 (49.8)	3 (100.0)	–
Subtotal (core plus puys)	55 (82.2)	753 (18.3)	732 (49.5)	639 (23.9)	90 (34.1)	192 (59.0)	552 (21.4)
0027	247 (51.6)	–	–	–	140 (73.9)	148 (31.8)	–
0028	473 (38.2)	–	–	5 (100.0)	382 (76.2)	229 (45.6)	–
Total	774 (29.1)	753 (18.3)	732 (49.5)	645 (23.7)	611 (50.8)	569 (28.3)	552 (21.4)

Stratum	HCO	TAG	GIZ	WWA	CSQ	PYR	ETL
							Species code
0001	5 (100.0)	3 (100.0)	43 (50.7)	29 (50.0)	94 (88.7)	8 (98.0)	15 (37.8)
0002	1 (100.0)	–	4 (59.4)	–	48 (36.8)	3 (60.0)	5 (26.3)
003A	5 (66.9)	3 (100.0)	204 (35.7)	28 (57.9)	–	183 (90.4)	2 (78.4)
003B	1 (100.0)	–	12 (89.7)	5 (64.8)	–	143 (25.2)	–
0004	27 (69.2)	47 (43.9)	38 (100.0)	22 (100.0)	–	15 (49.1)	41 (41.3)
005A	6 (60.9)	–	–	–	102 (64.2)	–	18 (28.8)
005B	3 (100.0)	3 (100.0)	–	–	–	–	30 (54.1)
0006	16 (100.0)	–	52 (100.0)	5 (100.0)	–	1 (100.0)	–
0007	47 (53.6)	5 (100.0)	–	–	71 (100.0)	19 (94.0)	39 (81.6)
0008	45 (48.5)	22 (63.9)	–	–	–	–	18 (41.5)
0009	12 (100.0)	–	152 (100.0)	36 (100.0)	–	8 (85.7)	3 (100.0)
0010	13 (10.9)	55 (35.6)	–	–	86 (100.0)	18 (50.0)	36 (52.8)
0011	113 (88.1)	73 (46.4)	–	–	–	2 (57.7)	48 (52.8)
0012	109 (44.0)	–	–	97 (93.3)	–	–	4 (100.0)
0013	66 (86.2)	18 (100.0)	–	84 (92.6)	–	–	–
0014	27 (100.0)	–	–	–	–	1 (100.0)	–
0015	39 (57.6)	192 (91.2)	–	123 (68.4)	–	7 (35.9)	14 (41.1)
Subtotal (core)	535 (25.5)	420 (43.3)	505 (36.1)	429 (35.9)	400 (38.6)	42 (5.0)	272 (19.2)
0025	<1 (100.0)	–	–	–	26 (46.2)	5 (60.7)	9 (32.7)
Subtotal (core plus puys)	535 (25.5)	420 (43.3)	505 (36.1)	429 (35.9)	427 (36.3)	41 (5.0)	282 (18.6)
0027	2 (100.0)	54 (10.8)	–	–	–	–	1 (100.0)
0028	–	46 (50.0)	–	–	–	2 (80.6)	–
Total	538 (25.4)	520 (35.2)	505 (36.1)	429 (35.9)	427 (36.3)	41 (5.0)	283 (18.5)

Table 7: continued.

Stratum	SSO	NOS	RUD	RSO	BJA	TOP	ETU
							Species code
0001	–	13 (43.4)	–	114 (69.4)	–	–	–
0002	–	11 (28.8)	–	–	–	–	–
003A	–	71 (39.9)	–	102 (43.8)	–	<1 (100.0)	–
003B	–	51 (60.9)	–	18 (19.9)	–	–	–
0004	6 (100.0)	18 (42.9)	94 (66.1)	–	–	–	–
005A	6 (100.0)	5 (57.4)	–	–	–	–	–
005B	2 (100.0)	–	8 (100.0)	–	–	6 (100.0)	–
0006	–	13 (100.0)	–	–	–	11 (58.2)	–
0007	–	–	–	–	–	–	–
0008	–	–	93 (71.7)	–	–	13 (100.0)	–
0009	–	26 (100.0)	–	–	–	84 (34.0)	–
0010	–	–	44 (100.0)	–	–	–	–
0011	8 (100.0)	6 (100.0)	–	–	–	37 (59.4)	–
0012	–	21 (66.0)	–	–	–	33 (62.6)	–
0013	–	–	–	–	–	1 (100.0)	–
0014	–	–	–	–	–	5 (100.0)	–
0015	–	–	–	–	–	–	–
Subtotal (core)	23 (54.0)	234 (23.1)	240 (42.5)	233 (38.9)	–	24 (–)	–
0025	2 (100.0)	5 (51.1)	–	–	–	–	–
Subtotal (core plus puys)	25 (50.4)	240 (22.6)	240 (42.5)	233 (38.9)	–	24 (–)	–
0027	78 (47.4)	–	–	–	18 (100.0)	–	213 (82.6)
0028	156 (26.7)	–	–	–	204 (59.4)	28 (100.0)	–
Total	258 (22.0)	240 (22.6)	240 (42.5)	233 (38.9)	223 (55.1)	24 (–)	83 (–)

Stratum	ACS	ORH	OPI
			Species code
0001	1 (100.0)	–	–
0002	–	<1 (100.0)	–
003A	<1 (100.0)	–	–
003B	–	–	–
0004	–	–	–
005A	2 (100.0)	–	–
005B	4 (26.3)	–	–
0006	4 (100.0)	–	–
0007	–	–	–
0008	18 (57.8)	–	–
0009	15 (100.0)	–	–
0010	–	–	–
0011	37 (33.8)	–	22 (100.0)
0012	10 (100.0)	–	105 (100.0)
0013	18 (46.6)	–	–
0014	27 (100.0)	–	–
0015	11 (100.0)	–	14 (100.0)
Subtotal (core)	147 (26.6)	<1 (100.0)	77 (–)
0025	3 (51.3)	2 (48.3)	1 (100.0)
Subtotal (core plus puys)	151 (26.0)	2 (47.1)	76 (–)
0027	20 (14.6)	78 (100.0)	–
0028	24 (23.8)	73 (56.6)	–
Total	195 (20.4)	154 (57.5)	76 (–)

Table 8: Time series of trawl abundance estimates (t) and coefficients of variation (% in parentheses) for selected species for the core strata (300–800 m) and all strata (300–1000 m) from the surveys of the summer *Tangaroa* time series sorted alphabetically by species code. Biomass estimates from 2016 are scaled to account for missing strata. * indicates scaled biomass for core strata in 2016 unable to be calculated as not enough data from old surveys (O'Driscoll et al. 2018). Species codes are defined in Figure 4 and Appendices 3 and 4. – indicates zero biomass, or not calculated (all strata in 2016).

	BEE		BOE		CAS	
Year	**Core**	**All**	**Core**	**All**	**Core**	**All**
1991	–	10 (57.8)	4 123 (97.3)	4 123 (97.3)	1 543 (31.0)	1 543 (31.0)
1992	–	1 (100.0)	1 959 (97.1)	1 959 (97.1)	1 862 (24.2)	1 863 (24.2)
1993	12 (82.6)	23 (51.2)	–	–	3 038 (14.3)	3 038 (14.3)
2000	–	633 (23.6)	10 063 (97.3)	13 096 (75.7)	1 749 (14.2)	1 749 (14.2)
2001	–	622 (16.9)	6 (83.9)	17 276 (57.8)	1 277 (20.3)	1 280 (20.3)
2002	8 (100.0)	660 (11.8)	12 (66.9)	19 719 (95.7)	1 418 (34.1)	1 418 (34.1)
2003	15 (100.0)	219 (32.3)	4 642 (99.8)	21 525 (71.1)	905 (25.1)	905 (25.1)
2004	14 (71.9)	195 (30.3)	198 (100.0)	867 (66.5)	1 752 (16.1)	1 752 (16.1)
2005	17 (87.4)	679 (32.4)	41 986 (100.0)	42 887 (97.9)	755 (17.4)	755 (17.4)
2006	17 (66.5)	457 (27.7)	482 (100.0)	6 802 (70.3)	1 352 (56.1)	1 352 (56.1)
2007	31 (93.8)	665 (24.5)	1 979 (95.1)	2 675 (71.9)	2 223 (22.4)	2 223 (22.4)
2008	7 (100.0)	481 (29.8)	2 708 (87.3)	7 848 (48.9)	1 805 (28.1)	1 806 (28.1)
2009	9 (85.1)	583 (27.8)	1 042 (76.3)	4 888 (52.3)	871 (23.4)	871 (23.4)
2011	21 (52.8)	444 (21.4)	125 (51.6)	2 038 (35.7)	755 (26.8)	755 (26.8)
2012	–	514 (25.5)	84 (55.6)	1 279 (36.1)	2 085 (26.1)	2 085 (26.1)
2014	–	581 (17.3)	508 (97.2)	1 229 (42.9)	574 (22.2)	574 (22.2)
2016	–	–	2 (100.0)	–	1 513 (26.0)	–
2018	1 (100.0)	363 (40.0)	33 (57.8)	1 524 (69.6)	1 676 (47.7)	1 676 (47.7)
2020	46 (96.8)	774 (29.1)	3 923 (87.7)	6 688 (55.8)	1 364 (25.3)	1 364 (25.3)

	CBA		CBO		CFA	
Year	**Core**	**All**	**Core**	**All**	**Core**	**All**
1991	5 (100.0)	5 (100.0)	326 (21.1)	329 (20.9)	349 (12.4)	349 (12.4)
1992	21 (53.9)	22 (49.8)	413 (28.4)	415 (28.2)	170 (17.9)	175 (17.6)
1993	66 (39.1)	66 (39.1)	186 (29.4)	186 (29.3)	949 (10.3)	952 (10.2)
2000	–	–	667 (40.8)	670 (40.7)	1 164 (10.4)	1 608 (13.6)
2001	–	3 (100.0)	599 (27.7)	610 (27.2)	883 (14.4)	1 338 (12.2)
2002	20 (71.1)	69 (59.7)	336 (32.8)	336 (32.8)	391 (36.6)	696 (23.9)
2003	18 (100.0)	32 (62.5)	173 (41.5)	173 (41.5)	694 (18.9)	826 (16.1)
2004	22 (63.1)	37 (48.7)	208 (22.8)	220 (22.0)	812 (21.9)	1 015 (20.1)
2005	37 (61.4)	116 (56.3)	159 (17.8)	159 (17.8)	835 (20.8)	1 130 (17.6)
2006	15 (87.9)	16 (83.5)	166 (52.0)	180 (48.3)	1 230 (11.6)	1 534 (10.4)
2007	53 (59.2)	78 (46.3)	347 (25.4)	347 (25.4)	484 (13.6)	630 (11.6)
2008	74 (52.9)	114 (38.9)	551 (43.4)	552 (43.3)	1 855 (16.2)	2 305 (13.7)
2009	39 (56.0)	39 (56.0)	454 (19.2)	458 (19.0)	1 006 (14.1)	1 359 (13.6)
2011	85 (36.8)	126 (37.5)	245 (26.3)	245 (26.3)	822 (12.9)	993 (11.4)
2012	34 (70.9)	64 (51.5)	459 (59.1)	466 (58.3)	1 717 (16.3)	2 349 (12.3)
2014	30 (70.9)	42 (52.7)	627 (34.8)	628 (34.7)	993 (11.9)	1 462 (12.1)
2016	–	–	185 (39.0)	–	174 (19.0)	–
2018	18 (79.7)	19 (75.0)	303 (16.2)	303 (16.2)	297 (17.7)	444 (16.6)
2020	55 (45.2)	65 (39.9)	798 (52.8)	801 (52.6)	1 301 (16.4)	1 675 (13.7)

Table 8: continued.

	CHG		COL		CSQ	
Year	Core	All	Core	All	Core	All
1991	–	–	565 (17.6)	567 (17.6)	541 (32.2)	542 (32.1)
1992	25 (64.6)	25 (64.6)	168 (11.9)	170 (11.8)	341 (30.5)	346 (30.1)
1993	36 (71.2)	36 (71.2)	1 173 (13.5)	1 173 (13.5)	631 (28.7)	653 (27.8)
2000	–	22 (100.0)	1 185 (12.3)	1 191 (12.3)	819 (38.0)	832 (37.4)
2001	25 (100.0)	128 (82.9)	1 611 (36.9)	1 620 (36.7)	575 (35.4)	627 (32.8)
2002	–	–	555 (22.5)	556 (22.4)	197 (36.2)	214 (33.4)
2003	–	–	1 407 (24.8)	1 407 (24.8)	348 (51.2)	375 (47.5)
2004	–	–	1 823 (31.2)	1 824 (31.2)	376 (48.9)	404 (45.6)
2005	88 (100.0)	88 (100.0)	2 284 (23.3)	2 302 (23.2)	560 (28.8)	594 (27.2)
2006	–	–	3 776 (16.7)	3 779 (16.7)	810 (36.0)	831 (35.2)
2007	58 (100.0)	337 (84.5)	1 587 (32.4)	1 587 (32.4)	1 135 (25.8)	1 155 (25.3)
2008	56 (100.0)	56 (100.0)	2 663 (16.4)	2 663 (16.4)	785 (26.7)	813 (25.9)
2009	–	51 (100.0)	2 451 (17.7)	3 058 (24.2)	1 079 (34.8)	1 104 (34.0)
2011	–	–	1 323 (31.2)	1 324 (31.2)	664 (32.0)	680 (31.3)
2012	9 (100.0)	9 (100.0)	4 489 (16.9)	4 491 (16.9)	804 (26.8)	833 (26.0)
2014	12 (100.0)	12 (100.0)	3 033 (17.2)	3 034 (17.2)	467 (35.4)	489 (33.9)
2016	–	–	644 (48.0)	–	872 (67.0)	–
2018	112 (100.0)	112 (100.0)	1 172 (41.1)	1 172 (41.0)	538 (27.7)	564 (26.8)
2020	95 (100.0)	123 (80.4)	1 115 (24.4)	1 118 (24.4)	400 (38.6)	427 (36.3)

	CYP		ETB		ETL	
Year	Core	All	Core	All	Core	All
1991	283 (85.0)	656 (53.7)	410 (22.2)	410 (22.2)	96 (17.7)	96 (17.6)
1992	3 (100.0)	126 (47.0)	686 (50.9)	686 (50.9)	381 (66.2)	383 (65.9)
1993	563 (34.5)	713 (28.1)	1 223 (22.3)	1 224 (22.3)	167 (18.7)	169 (18.4)
2000	61 (58.0)	1 482 (18.6)	1 004 (23.9)	2 540 (16.0)	102 (21.4)	109 (20.2)
2001	18 (74.9)	2 049 (68.1)	695 (31.0)	1 781 (15.7)	153 (20.5)	158 (19.9)
2002	13 (83.2)	2 293 (13.4)	734 (28.6)	2 334 (15.8)	156 (20.1)	161 (19.5)
2003	405 (87.9)	2 112 (28.3)	764 (30.2)	1 665 (25.3)	120 (24.0)	123 (23.4)
2004	193 (52.6)	2 241 (37.8)	994 (25.7)	1 628 (21.0)	246 (17.3)	256 (16.8)
2005	396 (41.0)	2 260 (21.2)	1 196 (33.6)	2 144 (22.0)	201 (14.4)	213 (13.9)
2006	1 102 (84.6)	2 343 (42.9)	1 942 (30.8)	3 318 (19.5)	301 (24.1)	304 (23.9)
2007	224 (45.5)	2 176 (26.3)	1 407 (32.1)	2 583 (20.4)	113 (21.5)	115 (21.0)
2008	29 (99.3)	1 780 (19.5)	831 (20.1)	2 269 (21.0)	153 (15.9)	167 (14.9)
2009	467 (36.9)	2 575 (24.4)	1 081 (22.4)	3 008 (16.8)	210 (23.4)	235 (21.9)
2011	614 (69.5)	2 723 (42.1)	3 136 (34.6)	5 088 (27.6)	247 (24.2)	255 (23.6)
2012	4 (100.0)	909 (23.0)	1 068 (20.4)	2 128 (13.6)	259 (12.7)	275 (12.9)
2014	69 (56.5)	888 (26.2)	1 039 (22.5)	1 830 (16.8)	235 (23.2)	237 (23.1)
2016	–	–	382 (26.0)	–	94 (21.0)	–
2018	268 (44.1)	1 622 (28.9)	899 (24.3)	1 387 (17.1)	198 (16.4)	200 (16.2)
2020	341 (54.2)	1 130 (27.8)	1 381 (24.8)	2 292 (16.5)	272 (19.2)	283 (18.5)

Table 8: continued.

Year	GIZ Core	GIZ All	GSC Core	GSC All	GSH Core	GSH All
1991	365 (21.6)	365 (21.6)	464 (85.9)	464 (85.9)	1 067 (25.6)	1 067 (25.6)
1992	342 (26.9)	344 (26.8)	3 (100.0)	4 (82.0)	715 (42.8)	716 (42.7)
1993	196 (29.4)	196 (29.4)	130 (85.3)	130 (85.3)	1 085 (33.3)	1 086 (33.3)
2000	211 (31.8)	211 (31.8)	241 (58.1)	241 (58.1)	1 459 (89.6)	1 459 (89.6)
2001	397 (41.3)	407 (40.3)	48 (85.3)	48 (85.3)	1 391 (35.7)	1 391 (35.7)
2002	409 (24.6)	409 (24.6)	3 (47.5)	3 (47.5)	175 (37.7)	175 (37.7)
2003	252 (43.2)	252 (43.2)	2 (70.9)	2 (70.9)	382 (48.9)	382 (48.9)
2004	294 (12.7)	298 (12.6)	67 (51.5)	67 (51.5)	843 (41.7)	843 (41.7)
2005	333 (33.8)	352 (32.1)	3 (70.8)	3 (70.8)	517 (40.2)	517 (40.2)
2006	187 (34.7)	214 (31.4)	88 (82.4)	88 (82.4)	354 (32.0)	354 (32.0)
2007	250 (24.6)	259 (23.9)	5 (100.0)	5 (100.0)	659 (37.2)	659 (37.2)
2008	371 (35.0)	371 (35.0)	73 (63.0)	73 (63.0)	1 128 (32.1)	1 128 (32.1)
2009	554 (32.7)	567 (31.9)	3 (100.0)	3 (100.0)	433 (43.1)	433 (43.1)
2011	290 (42.6)	291 (42.4)	32 (100.0)	32 (100.0)	3 709 (75.0)	3 709 (75.0)
2012	292 (28.8)	292 (28.8)	11 (86.2)	11 (86.2)	1 794 (68.3)	1 794 (68.3)
2014	461 (38.1)	461 (38.1)	18 (57.9)	18 (57.9)	1 400 (46.7)	1 400 (46.7)
2016	*	–	–	–	808 (69.0)	–
2018	193 (35.4)	193 (35.4)	225 (94.4)	225 (94.4)	2 299 (50.1)	2 299 (50.1)
2020	505 (36.1)	505 (36.1)	118 (99.2)	118 (99.2)	1 623 (64.9)	1 623 (64.9)

Year	GSP Core	GSP All	HAK Core	HAK All	HCO Core	HCO All
1991	11 287 (6.1)	11 291 (6.1)	6 134 (47.5)	6 447 (45.2)	392 (22.0)	397 (21.7)
1992	4 795 (7.2)	4 797 (7.2)	1 860 (12.0)	2 146 (11.7)	181 (21.2)	181 (21.2)
1993	11 703 (9.4)	11 706 (9.4)	2 348 (12.3)	3 007 (14.7)	480 (13.4)	480 (13.4)
2000	16 937 (12.9)	17 823 (12.4)	2 194 (17.0)	3 102 (14.4)	555 (19.3)	574 (18.9)
2001	10 407 (9.3)	11 219 (8.8)	1 831 (24.0)	2 360 (19.1)	416 (17.7)	425 (17.5)
2002	8 971 (9.6)	9 297 (9.3)	1 283 (19.8)	2 037 (16.3)	427 (20.7)	443 (20.0)
2003	10 172 (8.8)	10 360 (8.7)	1 335 (24.1)	1 898 (20.6)	366 (26.2)	378 (25.5)
2004	8 215 (10.7)	8 549 (10.3)	1 250 (26.7)	1 774 (20.1)	360 (72.4)	361 (72.1)
2005	9 069 (10.5)	9 416 (10.2)	1 133 (19.9)	1 624 (17.3)	184 (22.3)	206 (22.6)
2006	12 142 (9.8)	12 619 (9.6)	998 (22.1)	1 588 (16.6)	129 (28.8)	130 (28.7)
2007	12 739 (10.9)	13 107 (10.6)	2 188 (17.0)	2 622 (15.3)	440 (24.7)	453 (24.2)
2008	9 334 (13.4)	10 097 (12.6)	1 074 (22.6)	2 354 (15.6)	720 (19.8)	731 (19.6)
2009	13 147 (9.1)	13 553 (8.8)	992 (22.0)	1 602 (18.2)	306 (20.0)	309 (19.8)
2011	11 677 (9.6)	12 579 (9.1)	1 434 (30.0)	2 004 (22.8)	179 (46.2)	185 (44.7)
2012	16 181 (12.6)	16 814 (12.2)	1 943 (23.4)	2 443 (22.4)	459 (23.6)	468 (23.2)
2014	11 725 (10.1)	12 134 (9.8)	1 101 (31.7)	1 485 (25.0)	700 (23.7)	705 (23.5)
2016	4 160 (11.0)	–	1 000 (25.0)	–	403 (22.0)	–
2018	6 331 (20.7)	6 518 (20.1)	1 354 (28.5)	1 785 (23.6)	375 (31.4)	375 (31.4)
2020	12 464 (13.9)	12 879 (13.5)	1 310 (23.2)	1 619 (18.9)	535 (25.5)	538 (25.4)

Table 8: continued.

	HOK		JAV		JFI	
Year	Core	All	Core	All	Core	All
1991	81 631 (6.8)	81 816 (6.8)	13 728 (12.6)	14 118 (12.3)	–	–
1992	88 053 (6.1)	88 384 (6.1)	5 365 (7.9)	5 517 (7.7)	18 (43.1)	18 (43.1)
1993	100 629 (9.2)	101 112 (9.2)	13 276 (11.4)	13 558 (11.1)	42 (59.4)	42 (59.4)
2000	55 663 (12.6)	56 407 (12.4)	18 340 (12.5)	18 773 (12.3)	44 (35.0)	145 (33.8)
2001	38 145 (15.5)	39 396 (15.0)	13 469 (12.8)	14 313 (12.1)	8 (49.0)	43 (39.3)
2002	39 890 (13.7)	40 502 (13.5)	7 118 (11.2)	7 525 (10.7)	136 (35.0)	160 (30.5)
2003	14 318 (12.9)	14 723 (12.6)	7 165 (10.6)	7 713 (10.1)	19 (78.7)	37 (62.3)
2004	17 593 (11.8)	18 114 (11.6)	16 515 (23.5)	17 517 (22.2)	17 (73.6)	20 (64.2)
2005	20 440 (12.8)	20 680 (12.7)	12 793 (10.0)	14 390 (9.7)	45 (58.7)	99 (43.1)
2006	14 336 (10.7)	14 747 (10.5)	13 928 (29.1)	14 573 (27.8)	21 (100.0)	24 (88.1)
2007	45 876 (15.8)	46 003 (15.7)	11 475 (12.0)	12 065 (11.8)	13 (100.0)	15 (87.2)
2008	46 981 (13.9)	48 341 (13.6)	45 605 (15.9)	48 695 (14.9)	3 (100.0)	7 (62.6)
2009	65 017 (16.2)	66 157 (16.0)	19 194 (17.5)	21 663 (16.1)	–	151 (99.1)
2011	46 070 (14.7)	46 757 (14.5)	8 860 (25.5)	9 140 (24.8)	–	4 (82.0)
2012	55 739 (15.2)	56 131 (15.1)	13 722 (12.4)	15 241 (12.0)	42 (48.7)	80 (44.9)
2014	31 329 (12.9)	31 727 (12.8)	7 695 (14.2)	8 220 (13.3)	12 (69.6)	33 (52.4)
2016	37 992 (17.0)	–	6 152 (15.0)	–	24 (50.0)	–
2018	31 098 (11.3)	31 476 (11.2)	9 407 (19.2)	9 788 (18.5)	108 (40.5)	119 (37.0)
2020	37 851 (12.3)	37 992 (12.3)	16 471 (14.8)	16 923 (14.4)	66 (43.3)	69 (41.2)

	LAO		LCH		LDO	
Year	Core	All	Core	All	Core	All
1991	–	–	746 (13.4)	746 (13.4)	1 095 (12.8)	1 095 (12.8)
1992	–	–	694 (21.2)	694 (21.2)	1 048 (11.1)	1 048 (11.1)
1993	–	–	1 867 (15.2)	1 875 (15.1)	821 (13.2)	821 (13.2)
2000	–	–	1 606 (22.7)	1 720 (21.5)	921 (15.2)	921 (15.2)
2001	–	–	796 (20.2)	1 090 (21.6)	566 (19.7)	567 (19.6)
2002	–	–	1 179 (12.6)	1 242 (12.6)	446 (22.1)	446 (22.1)
2003	–	–	727 (30.2)	751 (29.2)	636 (23.7)	636 (23.7)
2004	–	–	435 (21.4)	517 (21.7)	614 (27.9)	614 (27.9)
2005	–	–	451 (20.2)	488 (18.9)	703 (19.1)	707 (18.9)
2006	–	–	1 178 (15.7)	1 219 (15.3)	513 (35.1)	514 (35.0)
2007	–	–	993 (25.5)	1 028 (24.7)	725 (20.0)	748 (19.6)
2008	–	–	625 (39.7)	697 (36.0)	811 (24.7)	813 (24.7)
2009	–	–	1 264 (18.2)	1 316 (17.5)	820 (25.1)	822 (25.1)
2011	12 (100.0)	12 (96.2)	726 (21.9)	862 (19.6)	349 (33.0)	349 (33.0)
2012	69 (57.4)	79 (51.8)	1 797 (15.8)	1 894 (15.0)	436 (29.1)	438 (29.0)
2014	–	3 (66.5)	889 (28.6)	985 (26.1)	352 (28.3)	352 (28.3)
2016	11 (100.0)	–	764 (24.0)	–	675 (24.0)	–
2018	44 (65.6)	47 (61.8)	1 070 (27.0)	1 087 (26.6)	358 (28.2)	358 (28.2)
2020	94 (48.4)	103 (44.5)	2 166 (21.1)	2 304 (20.0)	753 (18.3)	753 (18.3)

Table 8: continued.

Year	LIN Core	LIN All	MAN Core	MAN All	MCA Core	MCA All
1991	24 395 (6.8)	24 434 (6.7)	552 (14.7)	552 (14.7)	706 (38.7)	716 (38.1)
1992	21 633 (6.2)	21 652 (6.2)	453 (11.8)	453 (11.8)	180 (21.0)	183 (20.7)
1993	30 031 (11.4)	30 045 (11.4)	1 058 (12.7)	1 058 (12.7)	579 (35.9)	620 (33.8)
2000	33 023 (6.9)	33 033 (6.9)	1 064 (29.0)	1 064 (29.0)	695 (32.0)	9 278 (10.9)
2001	25 059 (6.5)	25 168 (6.5)	826 (18.4)	866 (17.7)	811 (39.0)	12 356 (29.3)
2002	25 628 (10.1)	25 635 (10.1)	843 (29.4)	847 (29.3)	620 (51.8)	12 892 (11.5)
2003	22 174 (10.2)	22 192 (10.2)	351 (17.2)	351 (17.2)	812 (41.9)	1 511 (25.6)
2004	23 744 (12.2)	23 794 (12.2)	530 (17.4)	537 (17.2)	248 (28.7)	888 (28.5)
2005	19 685 (8.5)	19 756 (8.5)	439 (17.8)	439 (17.8)	338 (35.5)	12 377 (59.0)
2006	19 637 (12.0)	19 661 (12.0)	870 (40.3)	874 (40.1)	827 (36.5)	2 581 (16.5)
2007	26 486 (8.3)	26 492 (8.3)	1 028 (19.3)	1 028 (19.3)	437 (42.6)	8 544 (19.1)
2008	22 832 (9.6)	22 880 (9.5)	1 164 (23.9)	1 195 (23.5)	951 (32.7)	11 198 (37.0)
2009	22 713 (9.7)	22 772 (9.6)	1 335 (25.6)	1 373 (25.0)	698 (54.3)	7 610 (28.0)
2011	23 178 (11.8)	23 336 (11.7)	523 (22.7)	524 (22.7)	1 321 (46.1)	9 913 (25.2)
2012	27 010 (11.3)	27 036 (11.3)	1 249 (34.7)	1 250 (34.7)	355 (31.5)	2 518 (41.6)
2014	30 005 (8.8)	30 011 (8.8)	513 (18.5)	513 (18.5)	672 (63.9)	2 492 (23.2)
2016	26 656 (16.0)	–	833 (20.0)	–	296 (39.0)	–
2018	21 270 (10.4)	21 286 (10.4)	368 (14.8)	368 (14.8)	632 (35.3)	1 258 (24.1)
2020	22 343 (12.4)	22 355 (12.4)	639 (23.9)	645 (23.7)	1 160 (40.6)	5 642 (33.5)

Year	NOS Core	NOS All	ONG Core	ONG All	PLS Core	PLS All
1991	283 (32.3)	286 (32.0)	–	–	186 (38.4)	186 (38.4)
1992	105 (21.7)	106 (21.5)	1 328 (26.3)	1 328 (26.3)	134 (54.9)	134 (54.9)
1993	353 (53.7)	354 (53.6)	551 (21.9)	551 (21.9)	156 (46.9)	157 (46.8)
2000	328 (56.5)	331 (56.0)	5 598 (45.4)	5 843 (43.7)	–	3 (100.0)
2001	973 (21.2)	988 (20.9)	1 534 (19.1)	1 657 (18.2)	4 (74.2)	23 (78.7)
2002	298 (30.1)	303 (29.7)	2 484 (23.8)	2 693 (23.0)	322 (54.6)	327 (53.6)
2003	324 (40.4)	325 (40.3)	4 939 (74.8)	4 975 (74.3)	99 (76.2)	153 (57.7)
2004	232 (28.5)	232 (28.4)	1 628 (39.9)	1 641 (39.6)	6 (76.5)	11 (50.1)
2005	988 (35.6)	995 (35.3)	1 283 (20.0)	1 329 (19.5)	107 (73.8)	108 (73.2)
2006	235 (32.5)	239 (31.9)	33 653 (92.8)	33 690 (92.7)	103 (68.9)	114 (62.4)
2007	2 160 (85.9)	2 161 (85.9)	1 806 (34.1)	4 142 (58.2)	123 (67.9)	125 (66.8)
2008	388 (37.1)	396 (36.3)	7 011 (34.7)	7 603 (32.8)	<1 (100.0)	13 (86.5)
2009	561 (65.5)	563 (65.3)	5 635 (49.8)	5 803 (48.4)	197 (38.7)	202 (37.7)
2011	131 (15.0)	131 (15.0)	1 225 (20.0)	1 260 (19.5)	344 (47.5)	354 (46.1)
2012	707 (41.6)	711 (41.4)	1 240 (25.8)	1 255 (25.5)	158 (65.3)	203 (54.9)
2014	141 (19.1)	142 (19.0)	755 (29.7)	759 (29.6)	81 (58.4)	85 (55.6)
2016	531 (44.0)	–	1 136 (24.0)	–	65 (84.0)	–
2018	1 033 (61.9)	1 033 (61.9)	1 136 (23.8)	1 301 (55.1)	188 (81.9)	225 (69.8)
2020	234 (23.1)	240 (22.6)	1 297 (55.3)	3 176 (41.8)	69 (82.8)	71 (80.7)

Table 8: continued.

	RBM		RCH		RCO	
Year	**Core**	**All**	**Core**	**All**	**Core**	**All**
1991	1 (100.0)	1 (100.0)	–	–	103 (51.4)	103 (51.4)
1992	31 (70.8)	31 (70.8)	–	3 (100.0)	72 (43.3)	72 (43.3)
1993	2 (100.0)	2 (100.0)	47 (78.6)	47 (78.6)	253 (62.1)	253 (62.1)
2000	88 (36.8)	88 (36.8)	17 (100.0)	408 (32.2)	38 (43.3)	38 (43.3)
2001	37 (62.8)	49 (53.3)	69 (100.0)	563 (46.3)	1 018 (79.7)	1 018 (79.7)
2002	58 (53.7)	95 (50.7)	87 (72.3)	378 (35.4)	60 (35.5)	60 (35.5)
2003	69 (71.8)	69 (71.8)	16 (100.0)	178 (41.1)	140 (49.3)	140 (49.3)
2004	104 (43.6)	121 (39.7)	223 (64.6)	1 077 (38.3)	2 765 (96.9)	2 765 (96.9)
2005	47 (54.6)	54 (49.3)	62 (100.0)	446 (39.5)	179 (49.4)	179 (49.4)
2006	82 (58.8)	82 (58.8)	432 (86.8)	762 (51.5)	72 (50.2)	72 (50.2)
2007	384 (45.6)	386 (45.5)	134 (89.1)	448 (41.6)	585 (85.9)	585 (85.9)
2008	132 (50.7)	132 (50.7)	282 (57.0)	1 019 (40.3)	332 (57.9)	332 (57.9)
2009	64 (44.2)	65 (43.6)	164 (91.6)	719 (53.9)	23 (48.3)	23 (48.3)
2011	137 (36.4)	155 (34.2)	250 (50.9)	961 (45.5)	65 (34.7)	65 (34.7)
2012	82 (51.4)	86 (49)	56 (100.0)	328 (42.3)	119 (58.0)	119 (58.0)
2014	244 (30.8)	249 (30.4)	5 (100.0)	332 (35.8)	147 (36.9)	147 (36.9)
2016	382 (54.0)	–	–	–	*	–
2018	895 (80.6)	904 (79.8)	44 (63.4)	314 (41.7)	82 (50.3)	82 (50.3)
2020	732 (49.5)	732 (49.5)	189 (60.0)	569 (28.3)	98 (73.8)	98 (73.8)

	RIB		RSK		RSO	
Year	**Core**	**All**	**Core**	**All**	**Core**	**All**
1991	1 095 (10.9)	1 140 (10.6)	42 (72.8)	42 (72.8)	53 (30.0)	53 (30.0)
1992	535 (20.5)	589 (18.9)	52 (68.8)	52 (68.8)	12 (72.7)	12 (72.7)
1993	1 147 (12.6)	1 213 (12.2)	133 (56.9)	133 (56.9)	38 (43.1)	38 (43.1)
2000	873 (14.0)	938 (13.4)	201 (56.4)	201 (56.4)	4 (100.0)	4 (100.0)
2001	1 117 (14.6)	1 250 (13.3)	158 (51.3)	158 (51.3)	8 (94.2)	8 (94.2)
2002	656 (17.5)	722 (16.1)	55 (47.4)	83 (44.8)	5 (68.6)	5 (68.6)
2003	653 (18.9)	696 (17.9)	78 (42.9)	78 (42.9)	6 (61.3)	6 (61.3)
2004	951 (16.5)	1 091 (15.1)	25 (72.4)	25 (72.4)	10 (66.0)	10 (66.0)
2005	721 (14.6)	833 (13.4)	116 (45.9)	116 (45.9)	9 (63.4)	9 (63.4)
2006	780 (16.4)	936 (14.5)	159 (74.1)	159 (74.1)	–	–
2007	1 062 (13.5)	1 086 (13.2)	115 (67.3)	123 (63.5)	19 (100.0)	19 (100.0)
2008	658 (18.0)	786 (16.0)	362 (56.9)	362 (56.9)	4 (100.0)	4 (100.0)
2009	1 056 (13.4)	1 255 (12.9)	190 (52.4)	190 (52.4)	10 (100.0)	10 (100.0)
2011	1 017 (17.2)	1 050 (16.7)	106 (61.6)	106 (61.6)	23 (82.9)	23 (82.9)
2012	787 (16.7)	914 (15.9)	68 (75.4)	68 (75.4)	5 (100.0)	5 (100.0)
2014	813 (16.0)	849 (15.5)	11 (93.4)	11 (93.4)	13 (75.3)	13 (75.3)
2016	276 (29.0)	–	6 (100.0)	–	*	–
2018	624 (23.7)	656 (22.6)	466 (89.6)	466 (89.6)	24 (37.3)	24 (37.3)
2020	1 128 (17.2)	1 167 (16.6)	130 (57.1)	130 (57.1)	233 (38.9)	233 (38.9)

Table 8: continued.

	RUD		SBK		SBW	
Year	Core	All	Core	All	Core	All
1991	339 (47.4)	339 (47.4)	353 (35.7)	356 (35.4)	6 153 (27.3)	6 153 (27.3)
1992	252 (32.7)	252 (32.7)	81 (20.0)	84 (19.5)	7 611 (23.2)	7 611 (23.2)
1993	263 (41.4)	263 (41.4)	616 (27.2)	623 (26.9)	9 315 (24.1)	9 315 (24.1)
2000	363 (32.1)	363 (32.1)	583 (32.6)	632 (30.1)	17 491 (15.2)	17 492 (15.2)
2001	271 (39.4)	271 (39.4)	866 (40.9)	1 012 (35.5)	9 809 (26.1)	9 809 (26.1)
2002	109 (53.4)	109 (53.4)	319 (18.8)	394 (16.8)	6 517 (38.2)	6 517 (38.2)
2003	91 (97.7)	91 (97.7)	575 (63.1)	655 (56.0)	3 058 (28.8)	3 058 (28.8)
2004	142 (53.9)	147 (52.2)	273 (23.3)	395 (21.3)	3 346 (36.1)	3 346 (36.1)
2005	246 (53.6)	246 (53.6)	317 (33.3)	451 (29.6)	4 146 (38.0)	4 146 (38.0)
2006	24 (91.3)	24 (91.3)	462 (35.8)	532 (31.6)	6 962 (51.9)	6 962 (51.9)
2007	100 (64.7)	103 (62.7)	424 (33.4)	478 (30.1)	8 165 (23.8)	8 165 (23.8)
2008	247 (43.4)	247 (43.4)	714 (27.0)	1 038 (21.1)	15 269 (13.8)	15 269 (13.8)
2009	182 (42.6)	185 (41.7)	280 (24.2)	424 (20.6)	51 860 (74.7)	51 860 (74.7)
2011	277 (42.2)	277 (42.2)	490 (18.6)	536 (17.7)	7 642 (31.2)	7 642 (31.2)
2012	13 (74.0)	13 (74.0)	1 214 (17.6)	1 294 (16.9)	21 483 (35.0)	21 485 (35.0)
2014	49 (51.3)	49 (51.3)	484 (38.1)	504 (36.6)	9 960 (28.8)	9 960 (28.8)
2016	145 (82.0)	–	220 (27.0)	–	36 057 (13.0)	–
2018	41 (67.5)	41 (67.5)	415 (27.3)	453 (25.3)	19 666 (28.5)	19 666 (28.5)
2020	240 (42.5)	240 (42.5)	1 046 (38.2)	1 094 (36.6)	20 660 (28.7)	20 660 (28.7)

	SCC		SCO		SEO	
Year	Core	All	Core	All	Core	All
1991	–	–	482 (12.8)	482 (12.8)	–	–
1992	230 (13.4)	230 (13.4)	344 (20.9)	344 (20.9)	–	–
1993	287 (23.3)	287 (23.3)	902 (15.8)	902 (15.8)	3 (83.1)	3 (83.1)
2000	1 026 (24.6)	1 167 (22.0)	722 (22.7)	739 (22.3)	<1 (100.0)	<1 (100.0)
2001	617 (22.4)	785 (19.2)	497 (25.2)	504 (24.9)	–	–
2002	220 (30.9)	306 (23.6)	435 (16.2)	451 (15.8)	5 (90.0)	5 (90.0)
2003	335 (29.7)	354 (28.3)	395 (27.6)	395 (27.6)	<1 (100.0)	<1 (100.0)
2004	88 (22.0)	119 (17.9)	446 (56.7)	447 (56.6)	4 (62.2)	4 (62.2)
2005	311 (26.2)	400 (26)	170 (20.3)	197 (20.7)	–	–
2006	684 (32.0)	713 (30.7)	344 (15.1)	349 (15.0)	–	–
2007	313 (37)	365 (33)	471 (25.2)	471 (25.2)	–	–
2008	406 (27.6)	501 (23.8)	1 302 (30.6)	1 308 (30.4)	–	–
2009	1 241 (28.4)	1 434 (25.2)	602 (16.1)	624 (15.7)	–	–
2011	519 (18.8)	749 (17)	837 (27.2)	848 (26.8)	–	–
2012	567 (24.4)	613 (22.7)	604 (25.8)	617 (25.3)	–	–
2014	218 (23.3)	241 (21.5)	630 (22.7)	630 (22.7)	1 (100.0)	1 (100.0)
2016	213 (34.0)	–	572 (22.0)	–	–	–
2018	128 (29.8)	133 (28.8)	391 (27.4)	391 (27.4)	5 (100.0)	5 (100.0)
2020	123 (29.4)	153 (24.3)	552 (21.4)	552 (21.4)	59 (100.0)	59 (100.0)

Table 8: continued.

	SFI		SND		SPD	
Year	Core	All	Core	All	Core	All
1991	–	–	493 (25.4)	656 (21.3)	8 908 (53.9)	8 908 (53.9)
1992	204 (10.5)	204 (10.5)	203 (24.5)	327 (16.4)	1 158 (15.5)	1 158 (15.5)
1993	235 (20.2)	236 (20.1)	596 (27.9)	768 (22.9)	1 649 (22.5)	1 649 (22.5)
2000	517 (12.4)	586 (12.1)	62 (34.7)	131 (21.7)	4 173 (11.6)	4 173 (11.6)
2001	500 (16.8)	538 (15.7)	360 (25.7)	612 (20.9)	8 528 (30.7)	8 528 (30.7)
2002	365 (14.9)	389 (14.1)	436 (34.4)	524 (28.9)	3 505 (18.8)	3 505 (18.8)
2003	198 (15.5)	207 (15)	190 (28.3)	263 (22.0)	2 317 (16.8)	2 317 (16.8)
2004	248 (23.4)	277 (21.5)	636 (19.5)	738 (17.4)	3 376 (27.3)	3 378 (27.3)
2005	374 (14.9)	397 (14.1)	480 (25.1)	583 (21.2)	4 344 (18.9)	4 344 (18.9)
2006	443 (10.2)	479 (9.7)	683 (25.9)	827 (21.7)	3 039 (19.3)	3 039 (19.3)
2007	273 (10.9)	323 (11.3)	196 (40.4)	261 (31.9)	3 589 (16.6)	3 589 (16.6)
2008	202 (16)	218 (15)	777 (30.4)	910 (26.3)	3 080 (19.1)	3 084 (19.0)
2009	538 (17.3)	597 (15.9)	697 (34.2)	999 (28.0)	4 296 (33.5)	4 296 (33.5)
2011	382 (26.8)	456 (23.2)	1 017 (15.0)	1 082 (14.4)	1 941 (18.9)	1 941 (18.9)
2012	316 (11.2)	380 (10)	428 (21.1)	724 (32.8)	843 (12.3)	843 (12.3)
2014	114 (12.2)	136 (11.4)	888 (12.7)	1 054 (15.1)	4 259 (28.7)	4 262 (28.7)
2016	45 (25.0)	–	*	–	3 524 (41.0)	–
2018	73 (23.4)	79 (22)	564 (32.1)	707 (27.7)	9 192 (53.9)	9 208 (53.8)
2020	161 (17.7)	186 (15.7)	898 (27.7)	1 185 (22.6)	2 222 (22.5)	2 222 (22.5)

	SQX		SSI		SSK	
Year	Core	All	Core	All	Core	All
1991	1 643 (7.8)	1 661 (7.8)	522 (14.4)	522 (14.4)	386 (23.0)	386 (23.0)
1992	2 077 (7.9)	2 086 (7.9)	396 (10.8)	396 (10.8)	119 (45.0)	119 (45.0)
1993	2 047 (8.6)	2 061 (8.6)	1 430 (18.0)	1 430 (18.0)	118 (43.3)	123 (42.0)
2000	2 302 (9.4)	3 124 (9.1)	1 810 (15.4)	1 810 (15.4)	435 (66.2)	495 (59.0)
2001	1 542 (13)	2 717 (11.4)	1 563 (38.6)	1 565 (38.6)	636 (43.4)	636 (43.4)
2002	1 448 (12.8)	1 953 (14.7)	1 404 (17.9)	1 407 (17.8)	299 (65.3)	299 (65.3)
2003	1 811 (12.9)	2 116 (11.7)	1 252 (11.0)	1 252 (11.0)	475 (60.3)	475 (60.3)
2004	1 759 (13.5)	2 286 (11.5)	1 330 (20.3)	1 330 (20.3)	331 (51.5)	331 (51.5)
2005	1 565 (11.6)	1 984 (10.2)	1 136 (48.5)	1 136 (48.5)	34 (85.6)	37 (78.8)
2006	1 522 (9.9)	1 718 (9.2)	2 615 (23.8)	2 616 (23.8)	995 (43.2)	999 (43.0)
2007	1 343 (15.2)	2 250 (14)	2 114 (22.4)	2 114 (22.4)	483 (52.3)	483 (52.3)
2008	1 485 (14.4)	2 375 (13.5)	1 932 (11.7)	1 932 (11.7)	1 406 (50.8)	1 406 (50.8)
2009	1 658 (11.8)	2 105 (10.5)	1 360 (27.1)	1 360 (27.1)	648 (75.7)	648 (75.7)
2011	1 831 (13.2)	2 439 (11)	1 541 (20.3)	1 541 (20.3)	1 660 (79.1)	1 684 (78.0)
2012	2 196 (10.8)	2 479 (9.9)	2 938 (12.7)	2 939 (12.7)	680 (74.1)	680 (74.1)
2014	1 575 (15.2)	1 815 (13.5)	3 490 (23.4)	3 490 (23.4)	1 012 (36.5)	1 012 (36.5)
2016	1 628 (11.0)	–	446 (24.0)	–	323 (50.0)	–
2018	1 208 (13.3)	1 625 (11.4)	1 449 (26.8)	1 449 (26.8)	141 (92.0)	141 (92.0)
2020	2 050 (14)	2 585 (11.4)	2 754 (29.1)	2 754 (29.1)	803 (59.9)	803 (59.9)

Table 8: continued.

	SWA		TOA		WWA	
Year	Core	All	Core	All	Core	All
1991	1 113 (46.7)	1 113 (46.7)	327 (17.9)	327 (17.9)	1 599 (58.3)	1 605 (58.1)
1992	225 (63.8)	225 (63.8)	343 (20.7)	343 (20.7)	242 (25.8)	243 (25.7)
1993	164 (63.4)	164 (63.4)	401 (24.9)	401 (24.9)	282 (28.7)	293 (27.9)
2000	21 (65.0)	21 (65.0)	577 (18.2)	679 (18.3)	266 (38.7)	266 (38.7)
2001	1 069 (58.5)	1 069 (58.5)	150 (28.2)	186 (27.4)	2 429 (53.8)	2 433 (53.7)
2002	141 (62.1)	141 (62.1)	333 (25.9)	426 (23)	853 (24.1)	863 (23.9)
2003	22 (71.8)	22 (71.8)	300 (23.5)	343 (21.6)	709 (58.4)	709 (58.4)
2004	171 (33.9)	171 (33.9)	239 (28.5)	368 (25.9)	1 061 (30.8)	1 061 (30.8)
2005	1 198 (98.8)	1 198 (98.8)	252 (31.3)	376 (23.1)	538 (38.5)	538 (38.5)
2006	71 (56.0)	71 (56.0)	400 (44.4)	464 (39.5)	642 (25.9)	646 (25.8)
2007	514 (38.2)	514 (38.2)	168 (34)	316 (33.4)	1 706 (61.4)	1 707 (61.3)
2008	4 122 (54.9)	4 122 (54.9)	229 (34.9)	274 (30.3)	2 283 (39.8)	2 293 (39.6)
2009	3 620 (98.0)	3 620 (98.0)	303 (36.8)	369 (31.1)	2 093 (35.3)	2 093 (35.3)
2011	136 (61.0)	136 (61.0)	332 (35)	499 (34.3)	390 (26.7)	393 (26.5)
2012	13 (75.0)	13 (75.0)	319 (24.7)	398 (21.5)	1 259 (28.7)	1 259 (28.7)
2014	29 (71.6)	29 (71.6)	167 (28.8)	251 (23.2)	211 (39.5)	211 (39.5)
2016	85 (115.0)	–	122 (51.0)	–	609 (65.0)	–
2018	2 694 (41.1)	2 694 (41.1)	194 (25.1)	213 (24.5)	781 (34.8)	781 (34.8)
2020	2 642 (92.0)	2 642 (92.0)	190 (23.5)	237 (23.7)	429 (35.9)	429 (35.9)

Table 9: **Numbers of fish for which length, sex, and biological data were collected from the November–December 2020 Southland and Sub-Antarctic trawl survey. Total is sometimes greater than the sum of male and female fish because the sex of some fish was not recorded.**

Common name	Species code	Number measured			Number of biological samples
		Males	Females	Total	
Alert pigfish	API	–	1	1	1
Arrow squid	NOS	154	80	235	166
Australasian slender cod	HAS	57	91	149	102
Banded rattail	CFA	806	1 413	2 288	832
Barracouta	BAR	6	2	8	8
Barracudina	BCA	–	1	1	1
Basketwork eel	BEE	98	100	200	140
Baxter's lantern dogfish	ETB	235	232	469	347
Big-scale pomfret	BSP	1	–	1	1
Bigeye cardinalfish	EPL	4	17	21	14
Black javelinfish	BJA	46	65	117	45
Black oreo	BOE	387	396	790	170
Blackspot rattail	VNI	28	38	76	58
Blobfish	PSY	2	–	2	2
Bollon's rattail	CBO	81	117	199	145
Brown chimaera	CHP	–	1	1	1
Carpet shark	CAR	–	2	2	2
Dark ghost shark	GSH	130	198	328	101
Dawson's catshark	DCS	5	2	7	7
Dealfish	DEA	–	2	2	2
Deepsea cardinalfish	EPT	6	6	46	46
Deepwater spiny skate (arctic skate)	DSK	2	–	2	2
Finless flounder	MAN	41	16	61	61
Four-rayed rattail	CSU	253	408	764	241
Freckled catshark	ASI	–	1	1	1
Gemfish	RSO	34	59	93	88
Giant chimaera	CHG	–	2	2	2
Giant stargazer	GIZ	12	41	53	53
Hairy conger	HCO	37	32	69	67
Hake	HAK	54	147	201	199
Hoki	HOK	1 948	3 010	4 963	1 415
Humpback rattail (slender rattail)	CBA	–	9	9	9
Javelinfish	JAV	975	3 619	4 616	1 167
Kaiyomaru rattail	CKA	61	49	122	62
Leafscale gulper shark	CSQ	23	28	51	51
Ling	LIN	835	938	1 775	892
Long-nosed chimaera	LCH	96	107	204	203
Longnose velvet dogfish	CYP	46	100	146	118
Longnosed deepsea skate	PSK	–	3	3	3
Lookdown dory	LDO	50	122	172	172
Lucifer dogfish	ETL	238	184	422	314
Lyconus pinnatus	LYC	–	3	4	4
Mahia rattail	CMA	7	21	28	28
New Zealand catshark	AEX	3	6	9	9
Notable rattail	CIN	19	53	104	91
Oblique banded rattail	CAS	48	684	813	334
Oliver's rattail	COL	482	937	1 445	534
Orange roughy	ORH	30	30	61	61
Pale ghost shark	GSP	607	689	1 296	838
Pale toadfish	TOP	2	1	3	3
Pigfish	PIG	–	–	12	12
Plunket's shark	PLS	2	4	6	6
Prickly deepsea skate	BTS	3	–	3	3
Prickly dogfish	PDG	3	–	3	3
Ragfish	RAG	–	2	2	2
Red cod	RCO	7	10	17	17

Table 9 continued.

Common name	Species code	Number measured Males	Females	Total	Number of biological samples
Ribaldo	RIB	48	174	222	221
Ridge scaled rattail	MCA	261	256	518	216
Rough skate	RSK	2	4	6	6
Rudderfish	RUD	–	7	7	7
Scampi	SCI	3	3	7	7
School shark	SCH	–	1	1	1
Seal shark	BSH	8	6	14	14
Serrulate rattail	CSE	5	17	22	21
Shortspine lanternshark	ETU	38	20	58	28
Shovelnose dogfish	SND	169	311	480	163
Silver dory	SDO	4	42	47	20
Silver roughy	SRH	8	7	16	15
Silver warehou	SWA	52	88	140	70
Silverside	SSI	192	203	1 096	391
Small-headed cod	SMC	2	1	12	11
Small banded rattail	CCX	14	10	24	5
Smallscaled brown slickhead	SSM	185	236	422	140
Smallscaled cod	SCD	1	2	3	3
Smooth deepsea skate	BTA	6	2	8	8
Smooth lanternshark	ETP	–	1	1	1
Smooth oreo	SSO	117	90	207	145
Smooth skate	SSK	4	6	10	9
Smooth skin dogfish	CYO	3	3	6	6
Southern blue whiting	SBW	1 021	960	1 988	386
Southern Ray's bream	SRB	97	107	207	64
Spiky oreo	SOR	25	21	46	46
Spineback	SBK	36	497	535	269
Spiny dogfish	SPD	289	114	403	210
Swollenhead conger	SCO	35	42	78	78
Tasmanian ruffe	TUB	–	1	1	1
Violet cod	VCO	36	26	63	63
White rattail	WHX	10	5	15	14
White warehou	WWA	39	28	68	–
Widenosed chimaera	RCH	27	18	45	45
Total	–	10 701	17 388	29 254	11 940

Table 10: Gonad stages (see Appendix 1) for all species where gonad data was collected from the November–December 2020 Southland and Sub-Antarctic trawl survey. - indicates zero, * indicates gonad stage not relevant for this species/sex.

Species code	Common name	Sex	Staging method	Reproductive stage							
				1	2	3	4	5	6	7	Total
AEX	New Zealand catshark	Female	MD	6	-	-	-	-	*	*	6
		Male		1	-	2	*	*	*	*	3
ASI	Freckled catshark	Female	MD	-	-	-	1	-	*	*	1
		Male		-	-	-	*	*	*	*	-
BAR	Barracouta	Female	MD	-	1	1	-	-	-	-	2
		Male		-	-	-	6	-	-	-	6
BCA	Barracudina	Female	MD	-	1	-	-	-	-	-	1
		Male		-	-	-	-	-	-	-	-
BEE	Basketwork eel	Female	MD	11	27	7	-	-	-	-	45
		Male		30	10	-	-	-	-	-	40
BJA	Black javelinfish	Female	MD	3	7	-	-	1	-	-	11
		Male		6	3	-	-	-	-	-	9
BOE	Black oreo	Female	MD	24	65	21	23	5	-	-	138
		Male		41	54	2	3	1	11	6	118
BSH	Seal shark	Female	SS	3	-	1	-	-	*	*	4
		Male		8	-	-	*	*	*	*	8
BTA	Smooth deepsea skate	Female	SS	-	-	2	-	-	*	*	2
		Male		-	-	6	*	*	*	*	6
BTS	Prickly deepsea skate	Female	SS	-	-	-	-	-	*	*	-
		Male		-	1	2	*	*	*	*	3
CAS	Oblique banded rattail	Female	MD	8	96	14	-	1	-	-	119
		Male		3	1	-	-	-	-	-	4
CBA	Humpback rattail (slender rattail)	Female	MD	-	6	1	-	-	-	-	7
		Male		-	-	-	-	-	-	-	-
CBO	Bollon's rattail	Female	MD	-	12	-	-	1	-	5	18
		Male		-	1	-	-	-	-	1	2
CFA	Banded rattail	Female	MD	9	73	3	-	-	-	-	85
		Male		3	32	-	-	-	-	-	35
CHG	Giant chimaera	Female	MD	-	1	1	-	-	*	*	2
		Male		-	-	-	*	*	*	*	-
CHP	Brown chimaera	Female	SS	-	-	1	-	-	*	*	1
		Male		-	-	-	*	*	*	*	-
CIN	Notable rattail	Female	MD	-	4	-	-	-	-	-	4
		Male		1	-	-	-	-	-	-	1
CMA	Mahia rattail	Female	MD	-	5	-	6	4	-	1	16
		Male		-	3	-	-	-	1	-	4
COL	Oliver's rattail	Female	MD	7	18	-	-	-	-	-	25
		Male		-	12	-	-	-	-	-	12
CSE	Serrulate rattail	Female	MD	-	8	2	-	-	-	-	10
		Male		-	1	-	-	-	-	1	2
CSQ	Leafscale gulper shark	Female	SS	13	1	3	-	-	*	*	17
		Male		8	-	10	*	*	*	*	18
CSU	Four-rayed rattail	Female	MD	2	21	3	-	-	-	1	27
		Male		12	9	-	-	-	-	-	21
CYO	Smooth skin dogfish	Female	SS	2	1	-	-	-	*	*	3
		Male		2	-	1	*	*	*	*	3
CYP	Longnose velvet dogfish	Female	SS	13	16	28	21	11	*	*	89
		Male		11	1	34	*	*	*	*	46
DCS	Dawson's catshark	Female	SS	-	-	-	-	-	*	*	-
		Male		-	-	3	*	*	*	*	3
DSK	Deepwater spiny skate (arctic skate)	Female	SS	-	-	-	-	-	*	*	-
		Male		1	-	1	*	*	*	*	2
EPT	Deepsea cardinalfish	Female	MD	-	2	-	-	-	-	-	2
		Male		-	1	-	-	-	-	-	1
ETB	Baxter's lantern dogfish	Female	SS	72	65	40	17	9	*	*	203
		Male		37	28	129	*	*	*	*	194
ETL	Lucifer dogfish	Female	SS	38	48	25	7	-	*	*	118
		Male		13	25	125	*	*	*	*	163

Table 10: continued.

Species code	Common name	Sex	Staging method	Reproductive stage							
				1	2	3	4	5	6	7	Total
ETU	Shortspine lanternshark	Female	MD	5	1	-	-	-	*	*	6
		Male		1	4	10	*	*	*	*	15
GIZ	Giant stargazer	Female	MD	3	17	9	-	2	2	3	36
		Male		1	7	-	1	-	-	2	11
GSH	Dark ghost shark	Female	MD	32	12	10	-	-	*	*	54
		Male		11	11	25	*	*	*	*	47
GSP	Pale ghost shark	Female	MD	204	154	116	13	-	*	*	487
		Male		101	29	305	*	*	*	*	435
HAK	Hake	Female	MD	31	74	38	1	-	2	1	147
		Male		16	24	5	7	2	-	-	54
HAS	Australasian slender cod	Female	MD	6	42	1	-	-	-	-	49
		Male		14	6	-	-	-	-	-	20
HCO	Hairy conger	Female	MD	-	8	2	-	-	-	-	10
		Male		2	12	7	1	-	-	-	22
HOK	Hoki	Female	SS	825	1 965	-	1	1	5	3	2 800
		Male		819	945	1	-	1	38	7	1 811
JAV	Javelinfish	Female	SS	27	204	1	-	-	-	1	233
		Male		15	25	-	-	-	-	-	40
LCH	Long-nosed chimaera	Female	SS	30	20	54	1	-	*	*	105
		Male		15	16	64	*	*	*	*	95
LDO	Lookdown dory	Female	MD	-	25	71	1	-	3	2	102
		Male		3	22	5	6	-	-	-	36
LIN	Ling	Female	MD	92	637	114	73	-	1	10	927
		Male		43	390	139	154	6	90	10	832
LYC	*Lyconus pinnatus*	Female	MD	-	1	1	1	-	-	-	3
		Male		-	-	-	-	-	-	-	-
MAN	Finless flounder	Female	MD	-	4	-	-	1	-	-	5
		Male		-	10	1	-	-	-	2	13
MCA	Ridge scaled rattail	Female	MD	3	17	32	4	2	4	3	65
		Male		5	21	1	2	-	-	1	30
ORH	Orange roughy	Female	SS	8	17	-	-	-	-	-	25
		Male		18	9	3	-	-	-	-	30
PDG	Prickly dogfish	Female	MD	-	-	-	-	-	*	*	-
		Male		-	-	3	*	*	*	*	3
PLS	Plunket's shark	Female	MD	4	-	-	-	-	*	*	4
		Male		1	-	1	*	*	*	*	2
PSK	Longnosed deepsea skate	Female	MD	1	1	1	-	-	*	*	3
		Male		-	-	-	*	*	*	*	-
RCH	Widenosed chimaera	Female	MD	11	4	3	-	-	*	*	18
		Male		9	2	14	*	*	*	*	25
RCO	Red cod	Female	SS	2	2	5	-	1	-	-	10
		Male		1	-	2	2	-	1	-	6
RIB	Ribaldo	Female	MD	17	153	2	-	-	1	1	174
		Male		12	32	3	-	-	-	-	47
RSK	Rough skate	Female	SS	1	-	-	-	-	*	*	1
		Male		-	1	1	*	*	*	*	2
RSO	Gemfish	Female	SS	11	21	8	-	-	-	-	40
		Male		4	14	7	-	-	-	5	30
RUD	Rudderfish	Female	SS	-	1	5	-	-	-	-	6
		Male		-	-	-	-	-	-	-	-
SBK	Spineback	Female	SS	1	23	93	-	-	-	-	117
		Male		-	2	2	-	-	-	-	4
SBW	Southern blue whiting	Female	MD	7	487	1	-	-	6	7	508
		Male		3	337	-	-	-	-	16	356
SCD	Smallscaled cod	Female	SS	-	2	-	-	-	-	-	2
		Male		-	1	-	-	-	-	-	1
SCO	Swollenhead conger	Female	SS	-	17	2	-	-	-	-	19
		Male		1	16	3	-	-	-	-	20

Table 10: continued.

Species code	Common name	Sex	Staging method	Reproductive stage							
				1	**2**	**3**	**4**	**5**	**6**	**7**	**Total**
SND	Shovelnose dogfish	Female	MD	73	46	12	1	1	*	*	133
		Male		8	7	74	*	*	*	*	89
SOR	Spiky oreo	Female	MD	16	2	2	-	-	-	-	20
		Male		17	7	-	-	-	-	-	24
SPD	Spiny dogfish	Female	MD	33	23	3	11	11	*	*	81
		Male		1	24	104	*	*	*	*	129
SRB	Southern Ray’s bream	Female	MD	-	14	14	1	1	-	-	30
		Male		1	14	13	-	-	-	-	28
SSI	Silverside	Female	MD	2	10	-	-	1	-	-	13
		Male		-	14	-	-	-	-	-	14
SSK	Smooth skate	Female	MD	2	1	1	-	-	*	*	4
		Male		2	1	1	*	*	*	*	4
SSM	Smallscaled brown slickhead	Female	MD	3	37	15	3	1	-	-	59
		Male		5	16	13	4	-	-	-	38
SSO	Smooth oreo	Female	SS	65	5	2	-	-	-	-	72
		Male		64	6	-	6	7	6	-	89
SWA	Silver warehou	Female	SS	-	19	3	-	-	-	-	22
		Male		1	11	4	1	-	-	-	17
TUB	Tasmanian ruffe	Female	SS	-	-	1	-	-	-	-	1
		Male		-	-	-	-	-	-	-	-
VCO	Violet cod	Female	MD	18	1	-	-	-	-	-	19
		Male		27	-	-	-	-	-	-	27
VNI	Blackspot rattail	Female	MD	-	2	1	2	-	-	-	5
		Male		-	1	-	-	-	-	-	1
WHX	White rattail	Female	MD	-	3	-	-	-	-	-	3
		Male		-	3	-	-	-	-	-	3
WWA	White warehou	Female	MD	12	8	3	-	-	-	-	23
		Male		20	9	-	1	-	-	-	30

Table 11: Time series of hoki liver condition indices (LCI) for the Sub-Antarctic and each of three subareas: Puysegur 165°–168° E, 46–48° S; West 165–169° E, 48°–54° S; East 169°–176° E, 46–54° S. –, too few observations were available to estimate hoki LCI from Puysegur in 2016.

	All areas		East		Puysegur		West	
Year	Mean	CV	Mean	CV	Mean	CV	Mean	CV
2001	2.94	1.7	3.45	2.3	2.48	3.8	2.49	2.8
2002	2.73	1.8	3.11	2.9	1.99	3.5	2.68	2.6
2003	2.76	2.2	3.17	3.4	2.24	5.6	2.55	3.0
2004	3.07	2.0	3.45	3.3	2.28	5.9	2.99	2.8
2005	3.10	1.6	3.20	2.6	2.27	3.9	3.36	2.4
2006	2.88	1.7	3.01	3.4	2.27	4.3	3.02	2.2
2007	3.15	1.6	3.42	2.5	2.07	4.5	3.34	2.1
2008	2.63	1.6	2.96	2.2	1.87	4.7	2.58	2.6
2009	2.49	1.7	2.74	2.5	1.96	5.5	2.34	2.5
2011	2.91	1.7	3.31	2.5	2.21	3.9	2.74	2.4
2012	2.53	1.8	2.68	2.8	2.28	3.8	2.46	2.7
2014	2.40	1.8	2.57	2.9	1.92	3.9	2.41	2.6
2016	3.36	2.0	3.41	2.7	–	–	3.37	3.1
2018	2.75	1.9	3.04	2.6	1.95	4.4	2.64	3.2
2020	2.99	2.2	3.19	3.0	2.44	6.3	2.82	3.5
Mean	2.82	0.5	3.10	0.7	2.14	1.2	2.78	0.7

Table 12: Quality of acoustic data collected during trawl surveys in the Sub-Antarctic between 2000 and 2020. In 2000–14, the quality of each recording was subjectively categorised as "good", "marginal", or "poor" based on the appearance of the 38 kHz echograms (see appendix 2 of O'Driscoll & Bagley (2004) for examples). In 2016, the subjective definition was replaced by an equivalent quantitative metric where "good" was defined as fewer than 10% bad pings, "marginal" was defined as 10–30% bad pings, and "poor" was defined as greater than 30% bad pings.

Year	Number of recordings	% of recordings		
		Good	Marginal	Poor
2000	234	57	21	22
2001	221	65	20	15
2002	202	78	12	10
2003	169	37	25	38
2004*	163	0	0	100
2005	197	75	16	9
2006	195	46	25	29
2007	194	63	16	20
2008	235	61	28	11
2009	319	46	33	20
2011	261	47	35	18
2012**	294	18	22	60
2014	258	30	31	39
2016	229	40	33	27
2018	261	75	18	7
2020***	242	43	23	34

* There was a problem with synchronisation of scientific and ship's echosounders on TAN0414 (O'Driscoll & Bagley 2006a), so data from this survey were not suitable for quantitative analysis due to the presence of acoustic interference.
** For 19% of all files in TAN1215, the scientific and ship's echosounders were not synchronised, hence acoustic interference occurred. These files were treated as poor recordings and were not suitable for quantitative analysis.
*** Multibeam echosounder was used without synchronisation and the interference from this system made data quality of four trawl files of poor quality.

Table 13: **Estimates of the proportion of total daytime backscatter in the Sub-Antarctic, which is assumed to be mesopelagic fish. Estimates were derived from the observed proportion of night backscatter in the upper 200 m in three subareas with no correction for the surface acoustic deadzone (see O'Driscoll et al. 2011 for details). –, the 2012 survey did not produce any data suitable for acoustic analysis from Puysegur.**

	Region		
Year	East	Puysegur	West & Stewart-Snares
2000	0.64	0.66	0.58
2001	0.56	0.39	0.57
2002	0.54	0.77	0.60
2003	0.60	0.66	0.67
2005	0.59	0.38	0.54
2006	0.55	0.32	0.56
2007	0.56	0.46	0.51
2008	0.63	0.58	0.62
2009	0.58	0.78	0.63
2011	0.58	0.37	0.54
2012	0.50	–	0.56
2014	0.61	0.54*	0.62
2016	0.56	0.54*	0.59
2018	0.62	0.52	0.53
2020	0.58	0.54*	0.55

*No night time data were available for Puysegur in 2014, 2016, or 2020. Proportion was estimated as the average of 2000–11 (0.54) for the 2014–16 period and as the average of 2000–11 and 2018 (0.54) for 2020.

Table 14: **Mesopelagic indices for the Sub-Antarctic. Indices were derived by multiplying daytime estimates of total backscatter by the estimated proportion of night backscatter in the upper 200 m and calculating averages in each region. Total indices were obtained as the weighted average of region estimates, where weighting was the proportional area of the region (East 55.5% of total area, Puysegur 1.9%, Stewart-Snares 20.5%, West 22.1%). –, the 2012 survey did not produce any data suitable for acoustic analysis from Puysegur; *, there was only one data point at Puysegur in 2016.**

	Acoustic index (m^2/km^2)									
	East		Puysegur		Stewart-Snares		West		Total	
Year	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
2000	8.37	15.9	28.80	9.9	14.97	18.1	10.97	13.2	10.68	9.2
2001	9.12	22.0	29.90	44.9	12.34	15.8	11.41	13.0	10.68	11.8
2002	7.05	14.9	31.19	28.4	8.35	8.8	8.64	11.6	8.13	8.2
2003	7.90	31.5	18.92	14.9	9.52	6.8	8.35	17.2	8.54	16.7
2005	7.45	14.8	6.04	7.1	8.51	12.8	8.60	14.9	7.90	9.0
2006	4.09	15.7	3.38	13.3	5.12	9.4	4.84	12.4	4.45	8.8
2007	5.54	19.0	7.26	12.2	6.88	13.3	4.74	14.0	5.67	11.1
2008	8.03	15.2	13.26	11.9	11.49	24.1	6.57	14.0	8.52	10.7
2009	7.43	16.2	17.23	13.2	10.01	23.7	6.17	15.1	7.86	10.8
2011	13.81	12.1	10.61	8.8	13.18	7.6	9.15	7.2	12.59	7.6
2012	5.21	16.8	–	–	9.79	9.6	5.44	25.0	6.10	9.9
2014	10.27	11.2	19.70	16.6	19.14	11.2	11.10	18.0	12.08	7.4
2016	5.91	13.5	21.10	*	7.18	15.5	13.13	9.8	8.06	7.1
2018	13.64	20.6	18.14	10.5	17.66	13.1	12.30	13.3	14.25	11.7
2020	9.03	18.8	26.86	15.8	16.91	11.3	8.86	3.5	10.94	9.4

8. FIGURES

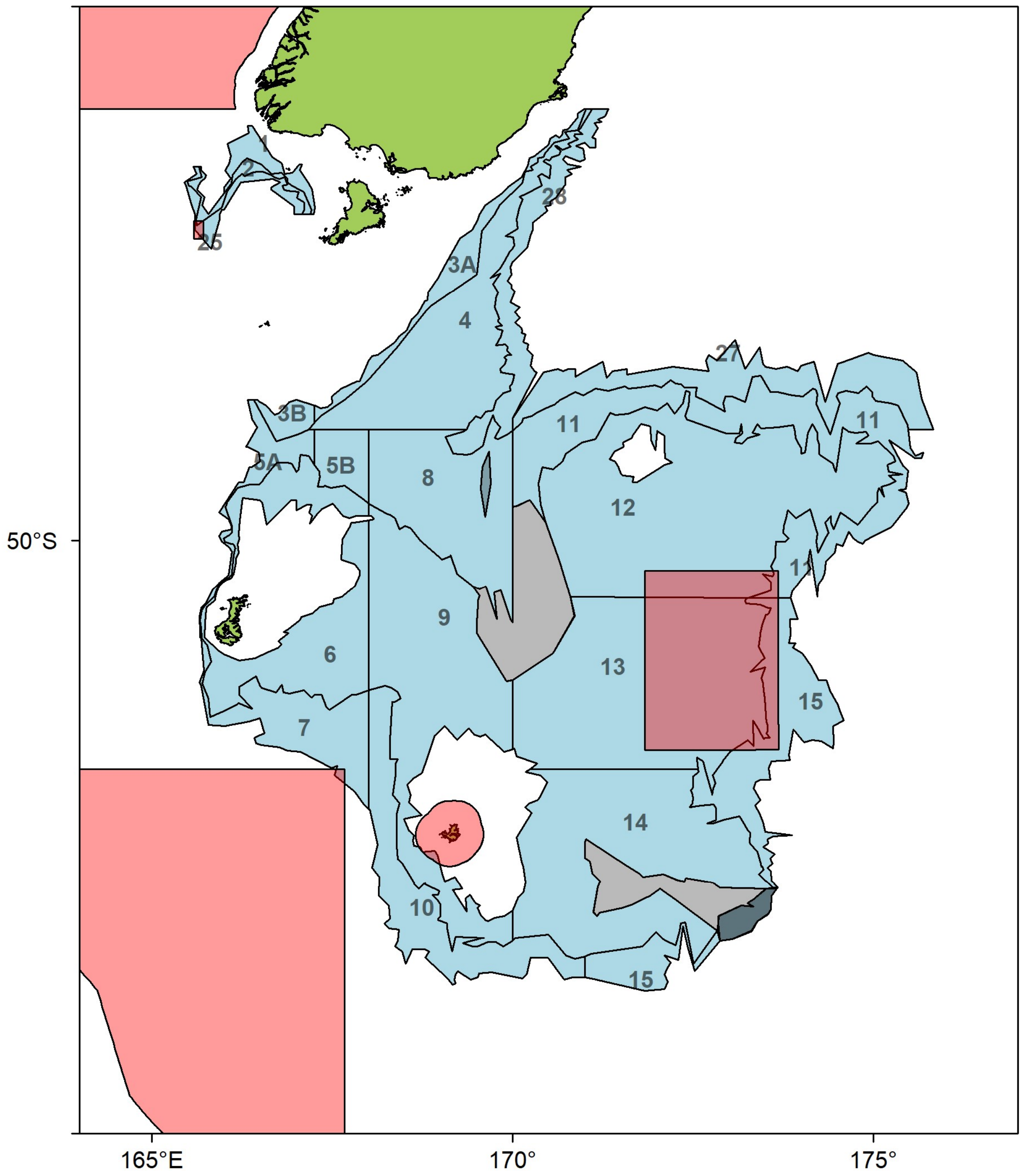


Figure 1: Stratum boundaries from the November–December 2020 Southland and Sub-Antarctic trawl survey. Stratum areas are given in Table 1. Red areas are benthic protection areas.

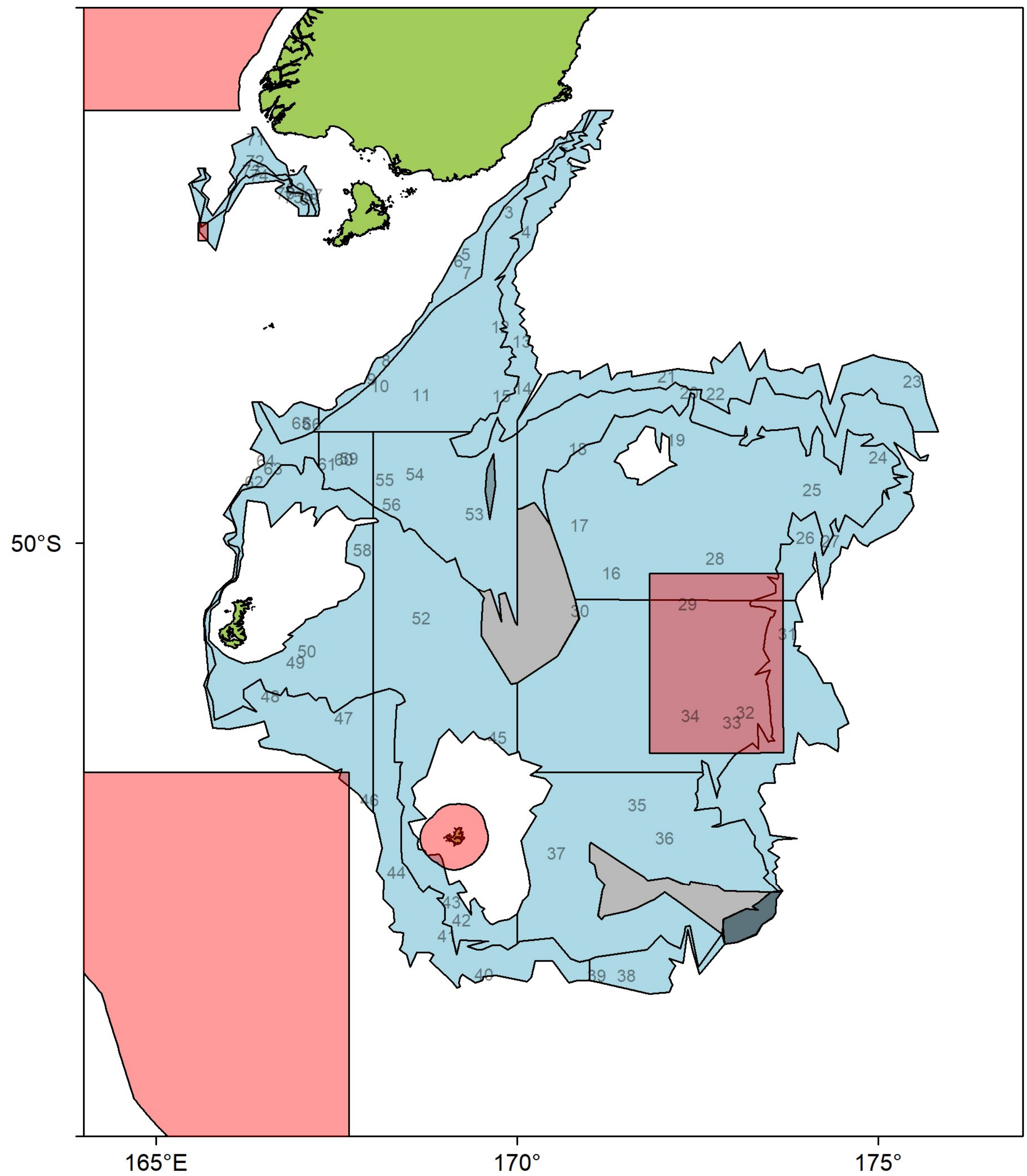


Figure 2: Valid trawl tow start positions from the November–December 2020 Southland and Sub-Antarctic trawl survey. Labels show station numbers. Station details are given in Appendix 2. Red areas are benthic protection areas.

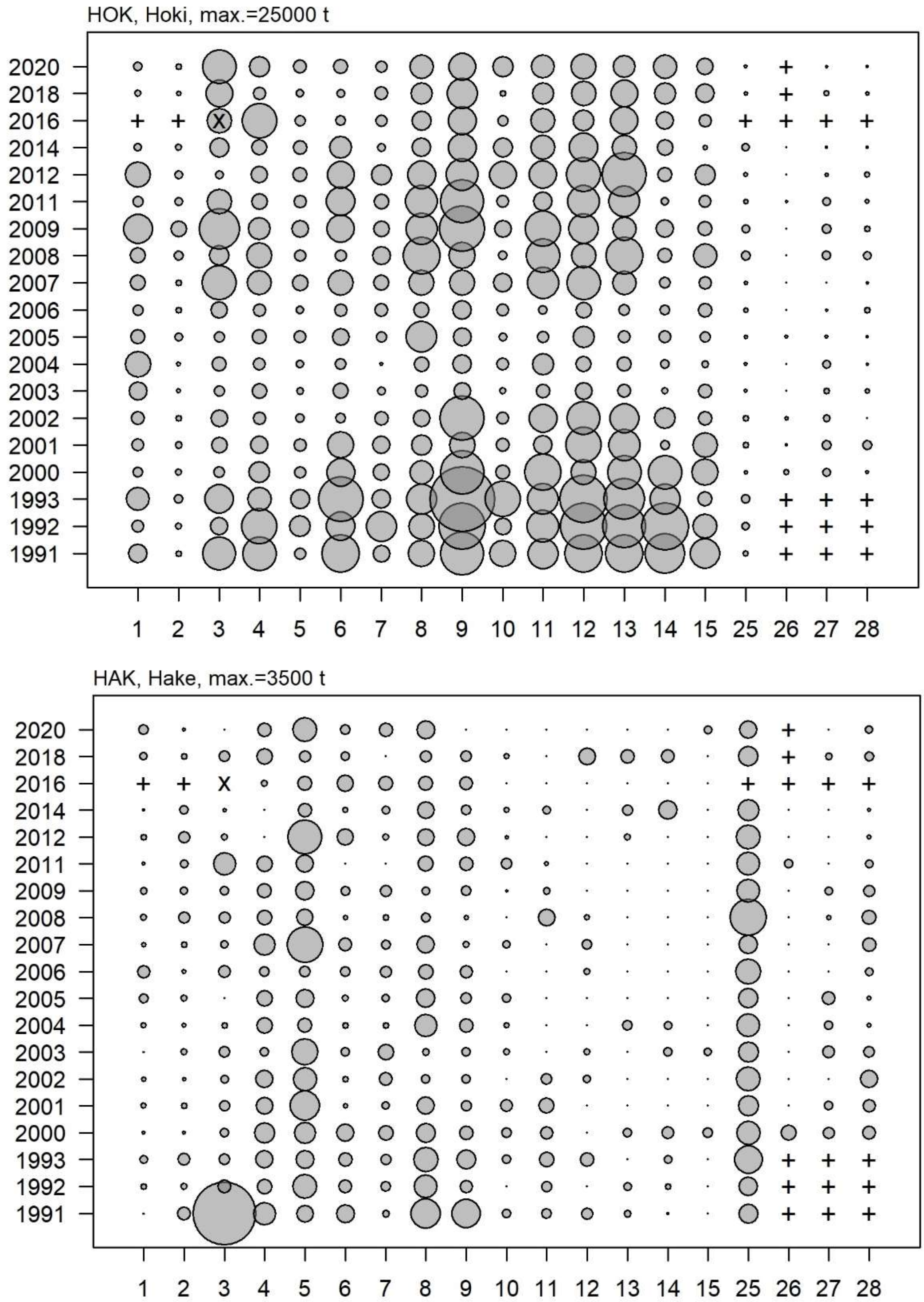
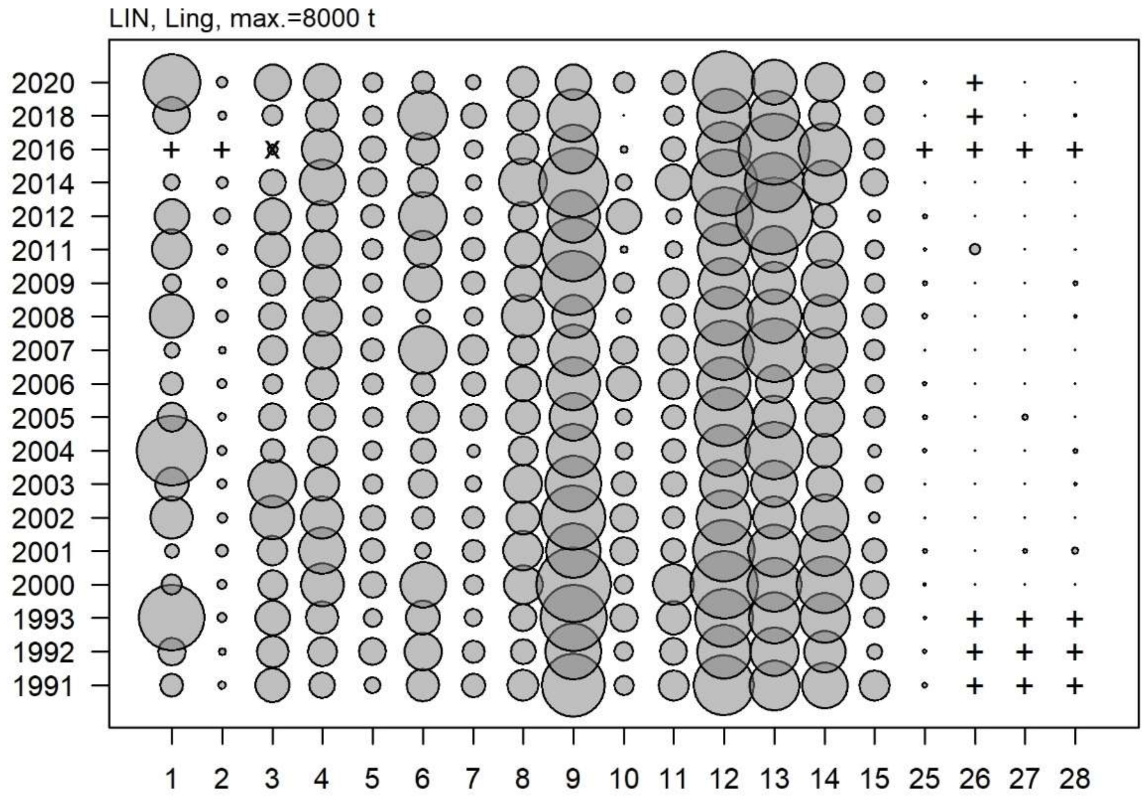


Figure 3: **Relative biomass estimates by strata for selected species sampled from the Southland and Sub-Antarctic November–December *Tangaroa* surveys. +, stratum not surveyed in that year; ×, Strata 003A and 003B were combined into stratum 3, and in 2016 stratum 003A was not sampled.**



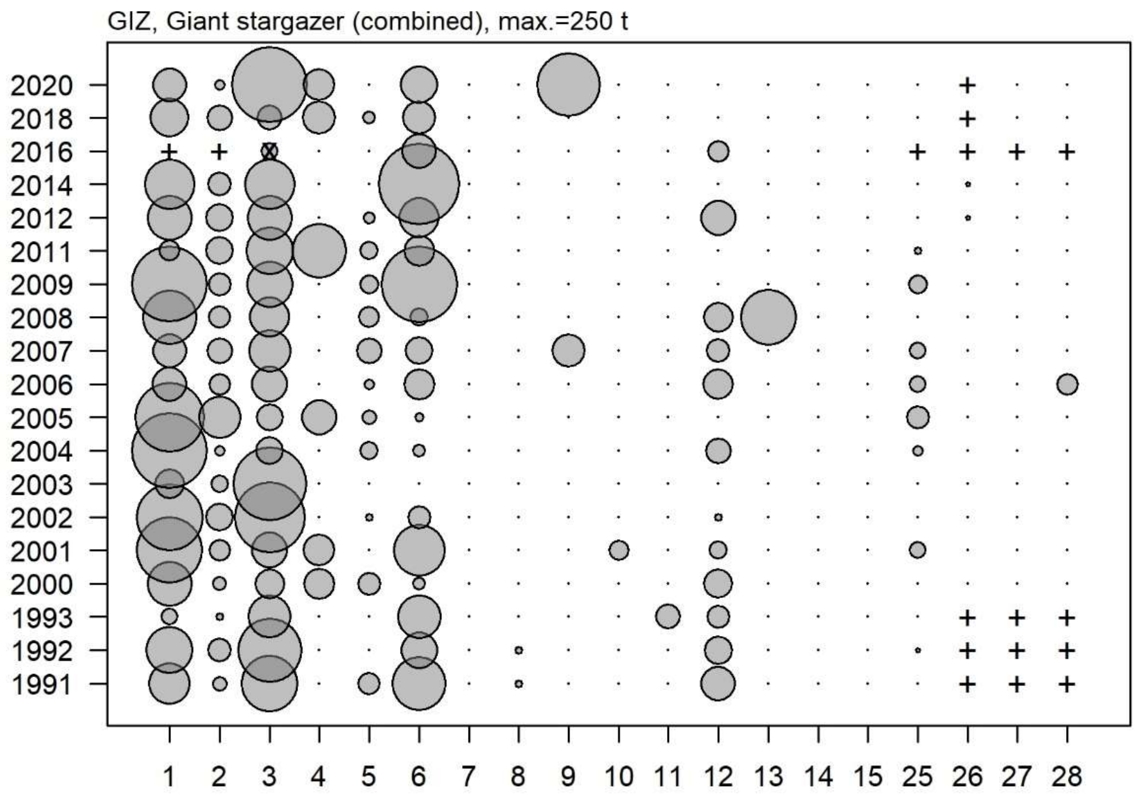
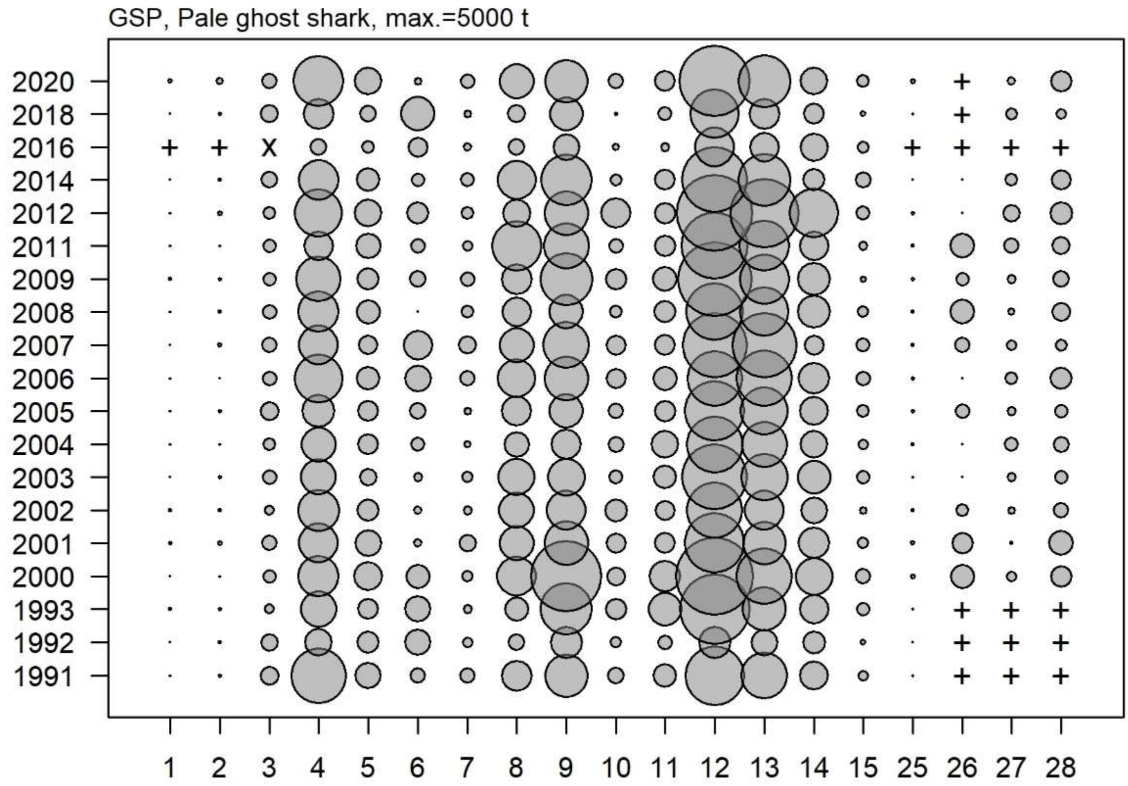


Figure 3: continued.



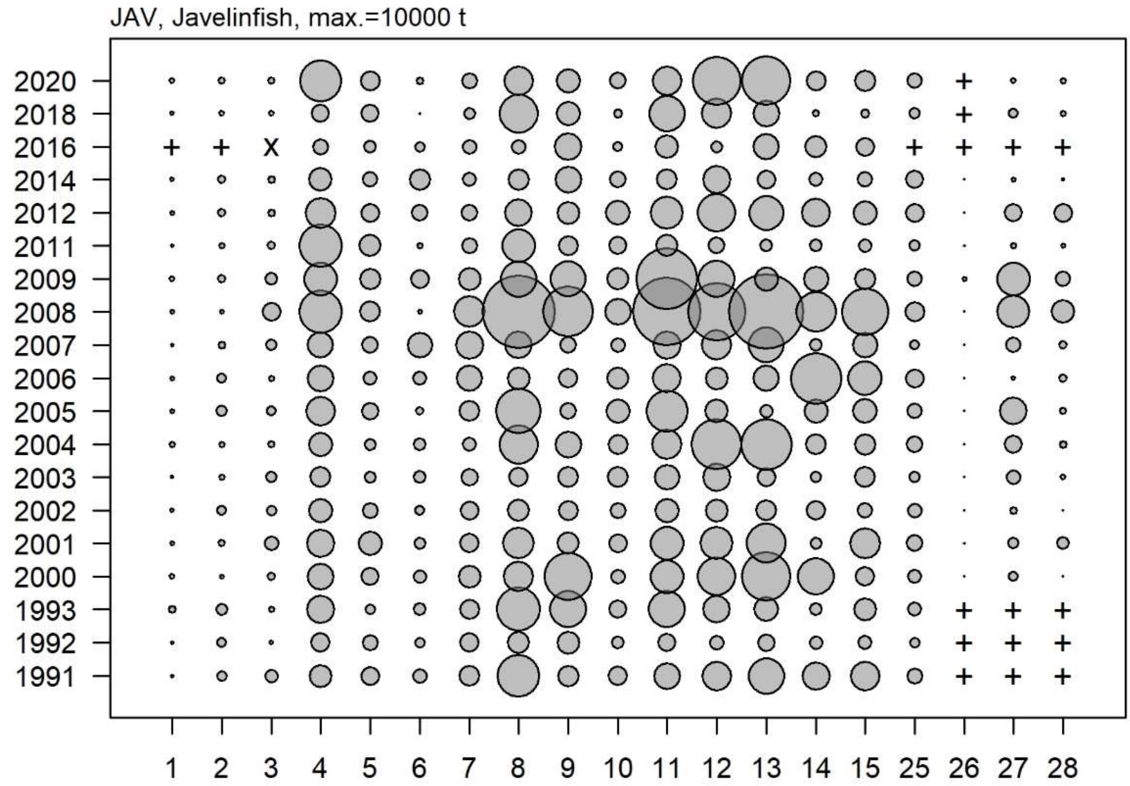
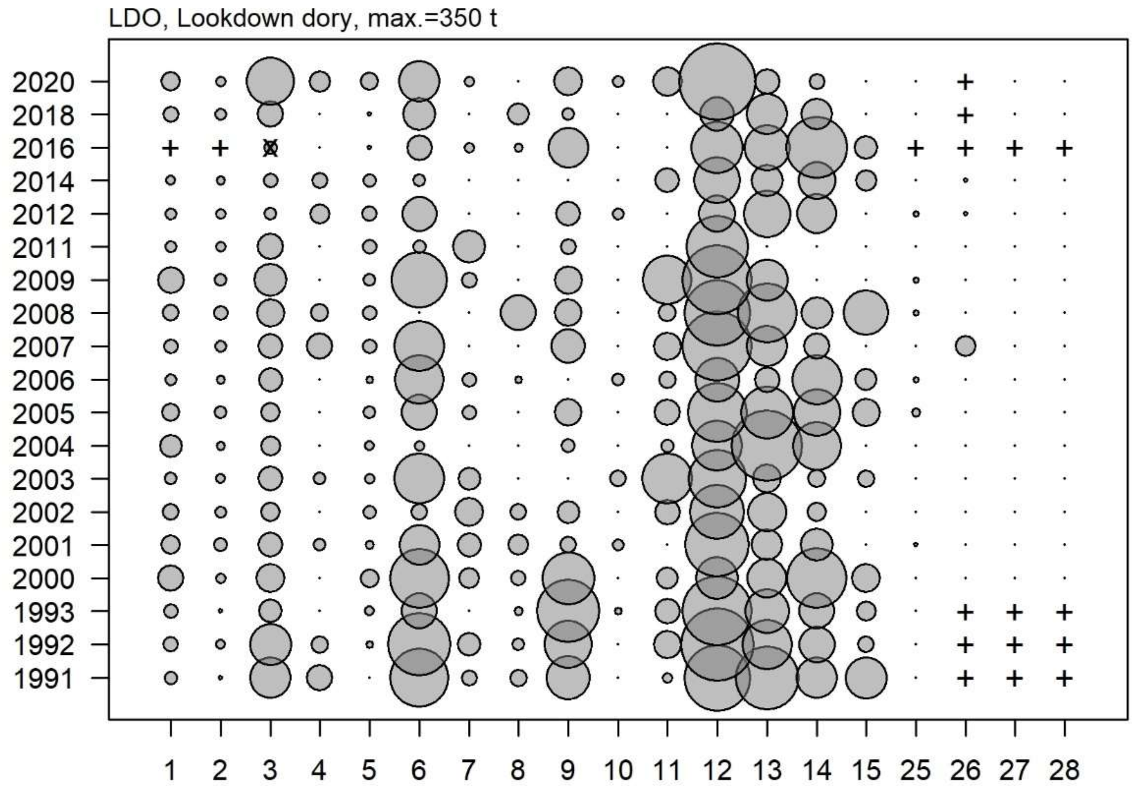


Figure 3: continued.



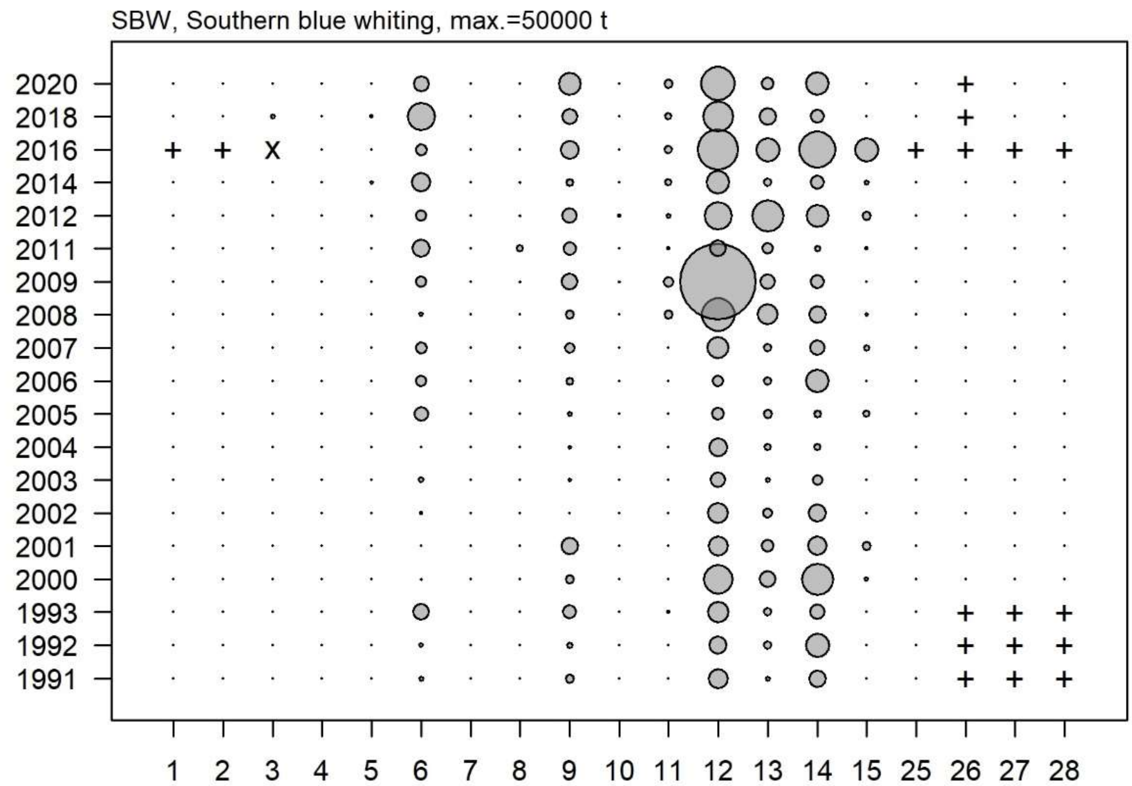
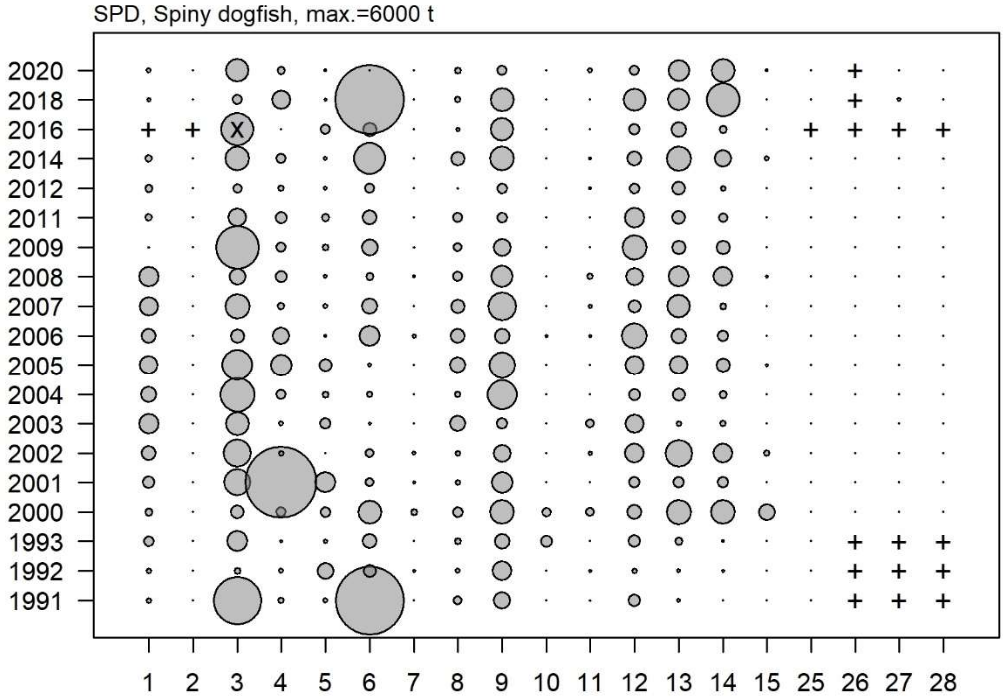


Figure 3: continued.



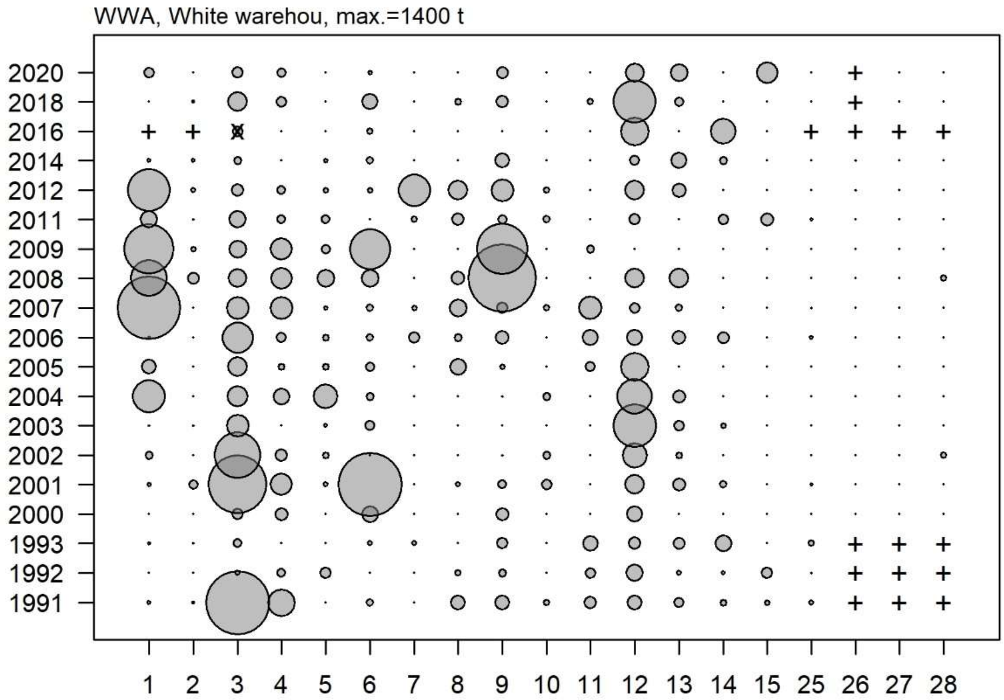


Figure 3: **continued.**

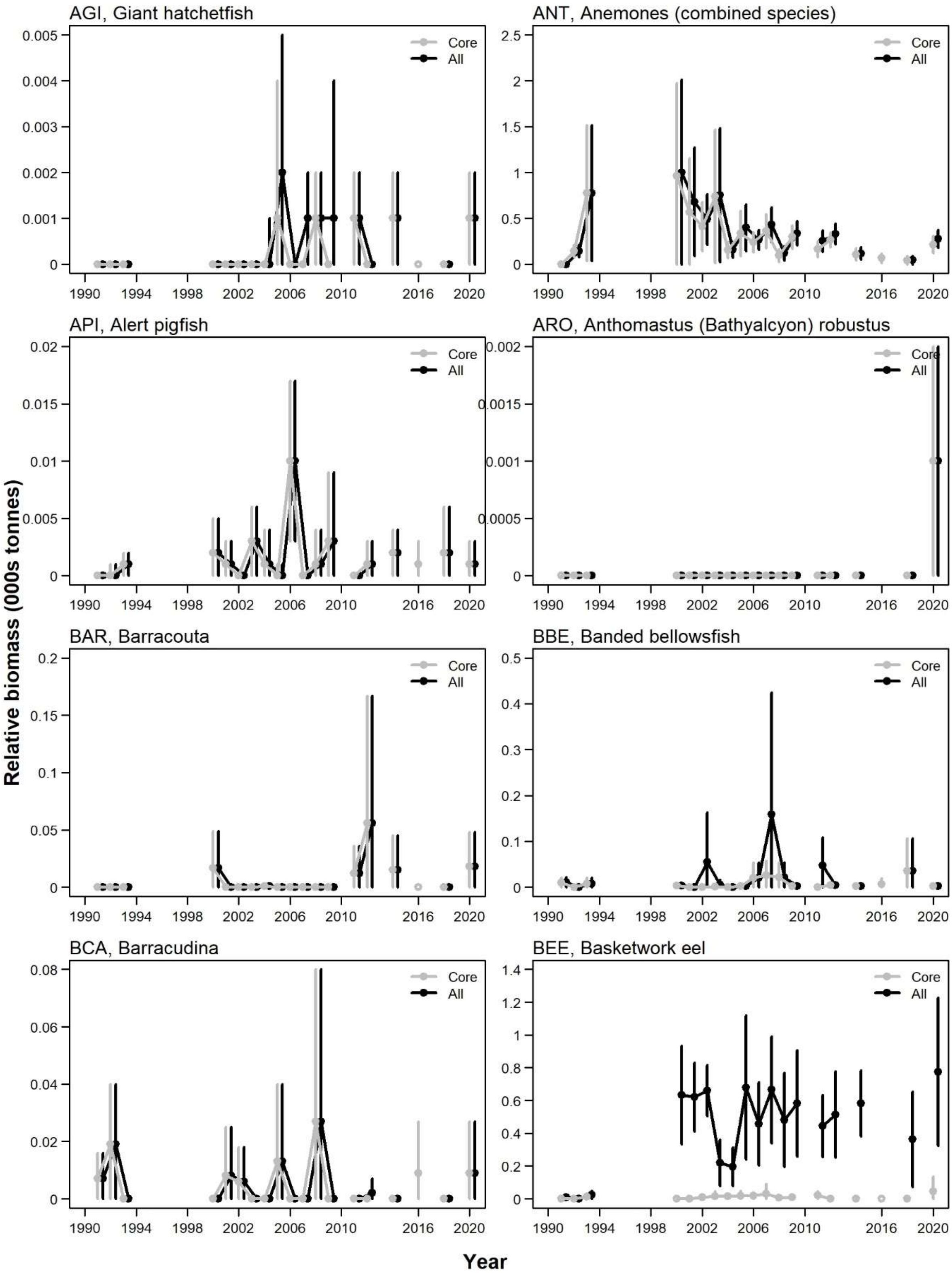
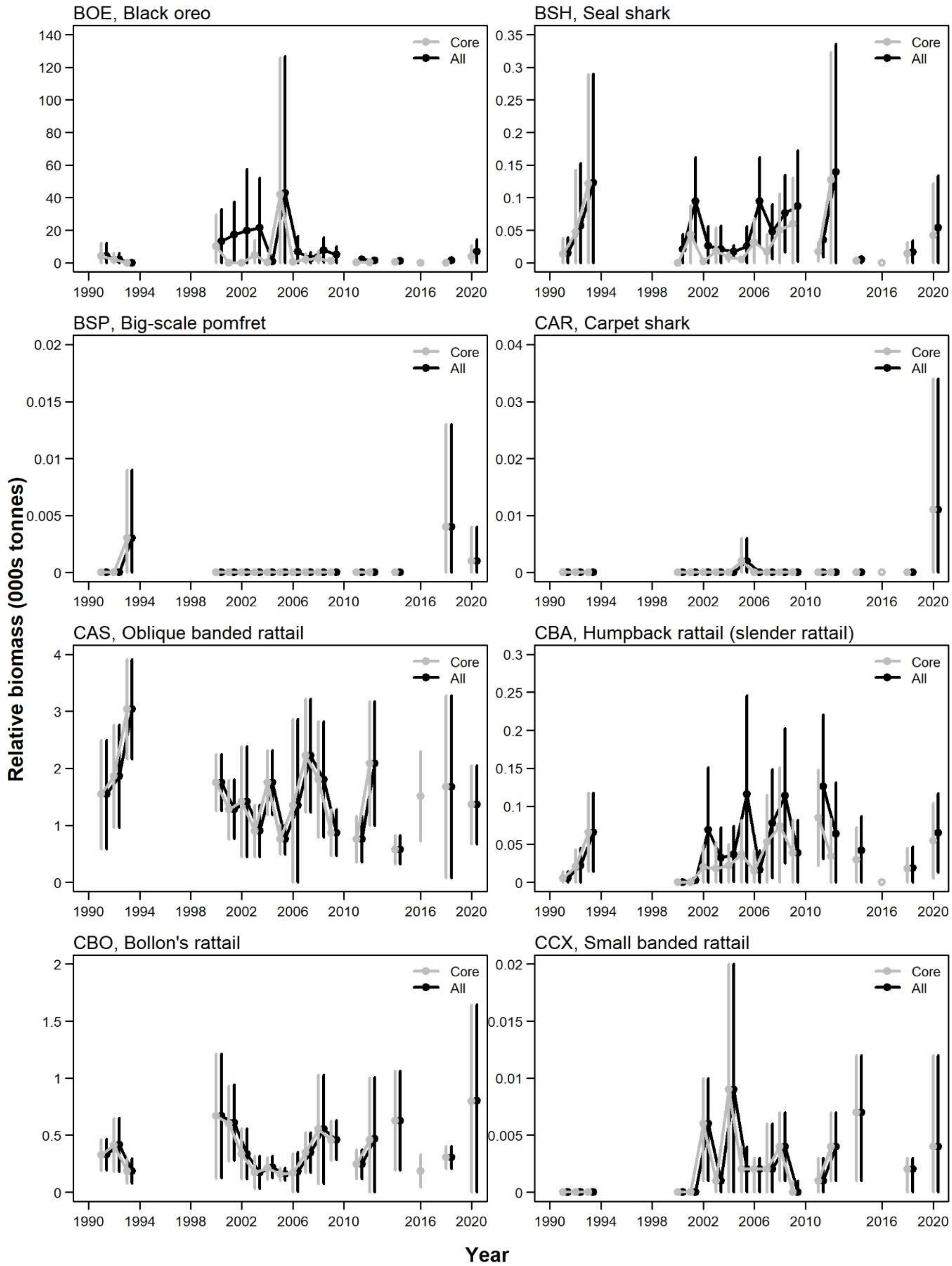


Figure 4: Time series of relative biomass estimates (thousands of tonnes) for selected species, sorted alphabetically by research code, sampled on the Southland and Sub-Antarctic November–December *Tangaroa* surveys. Grey lines show fish from core (300–800 m) strata; black lines show fish from all strata (300–1000 m). Error bars show ± 2 standard errors. 2016 core biomass estimates are scaled to account for reduced sampling.



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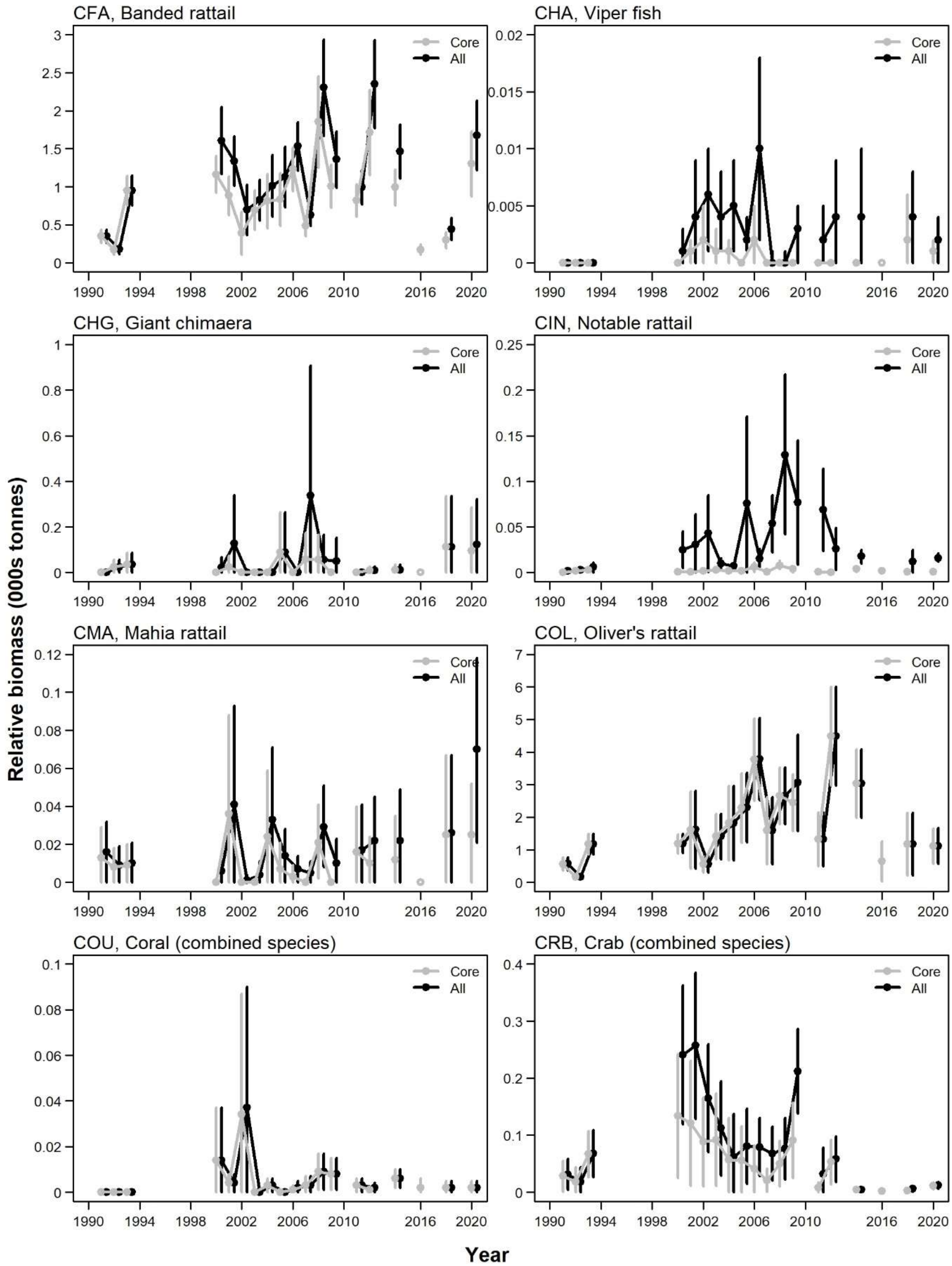

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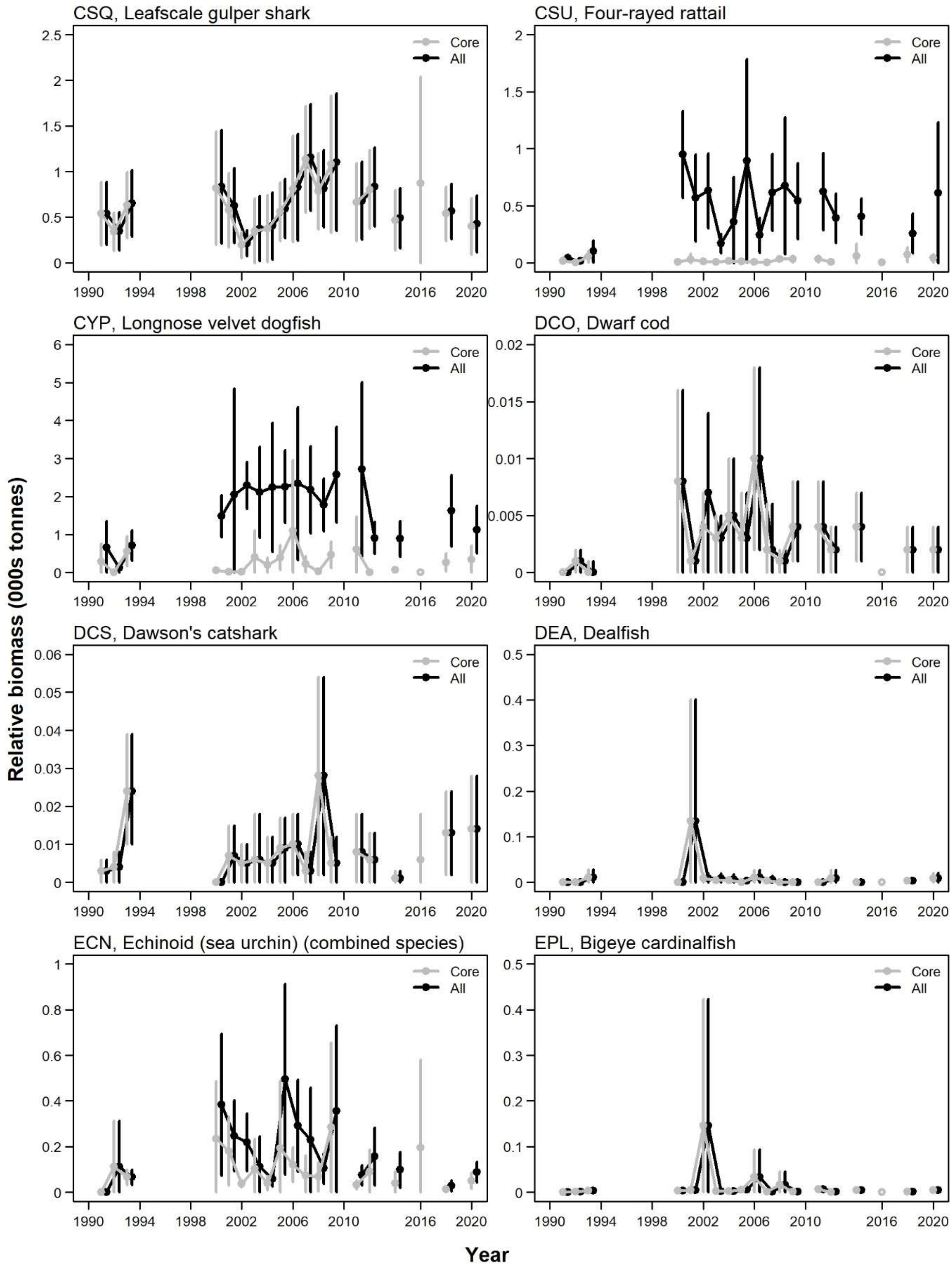

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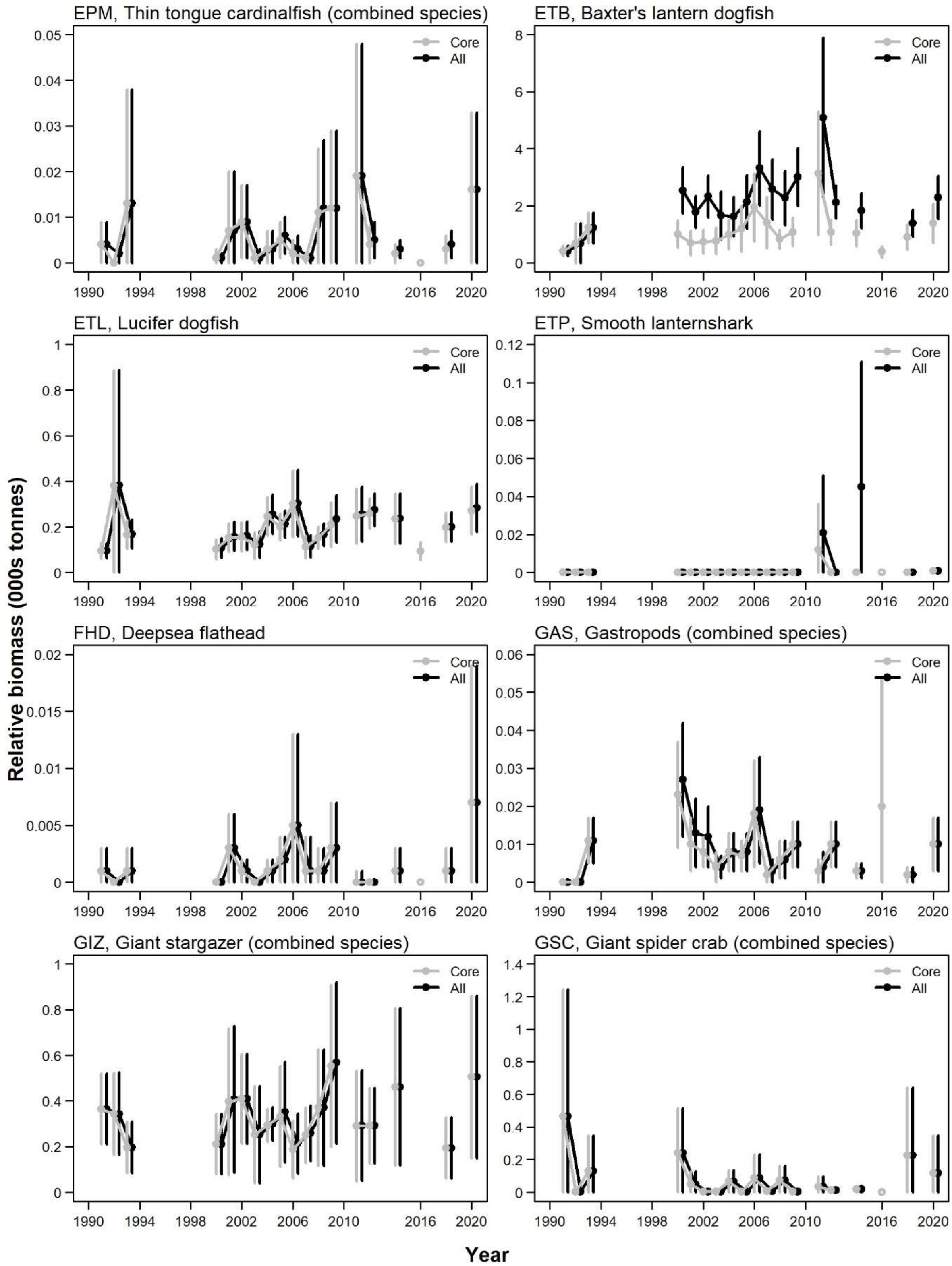
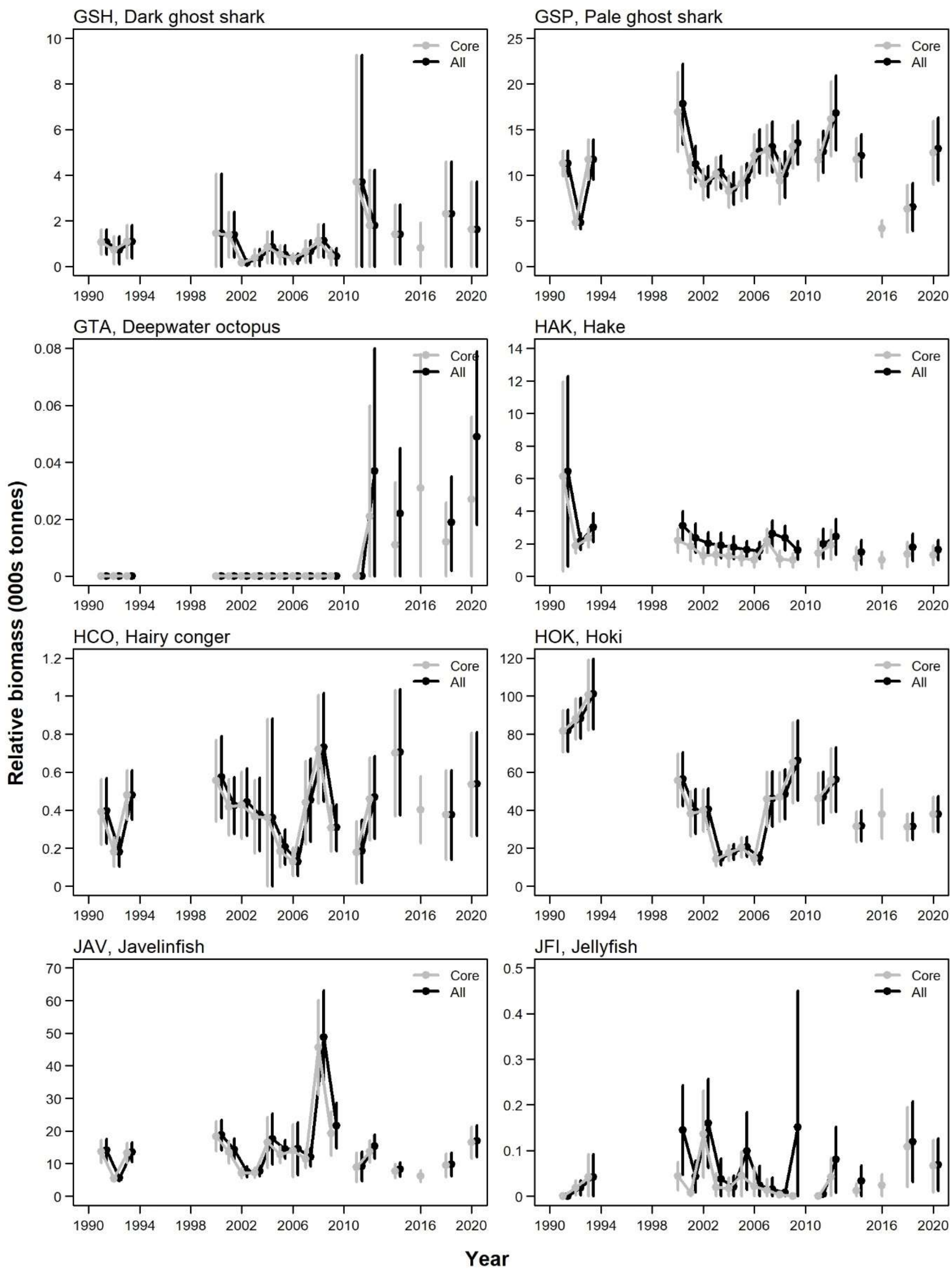


Figure 4: continued.



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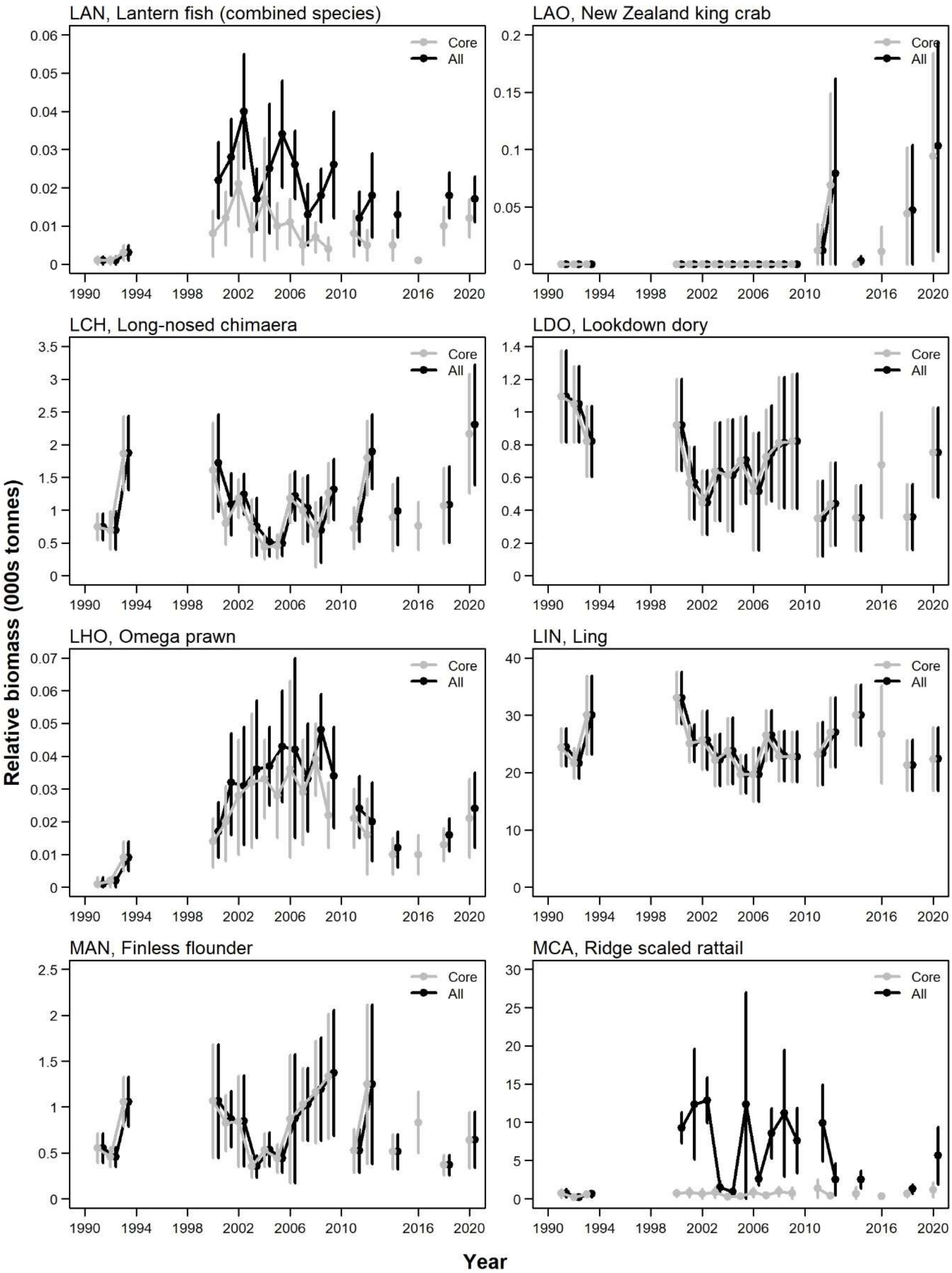

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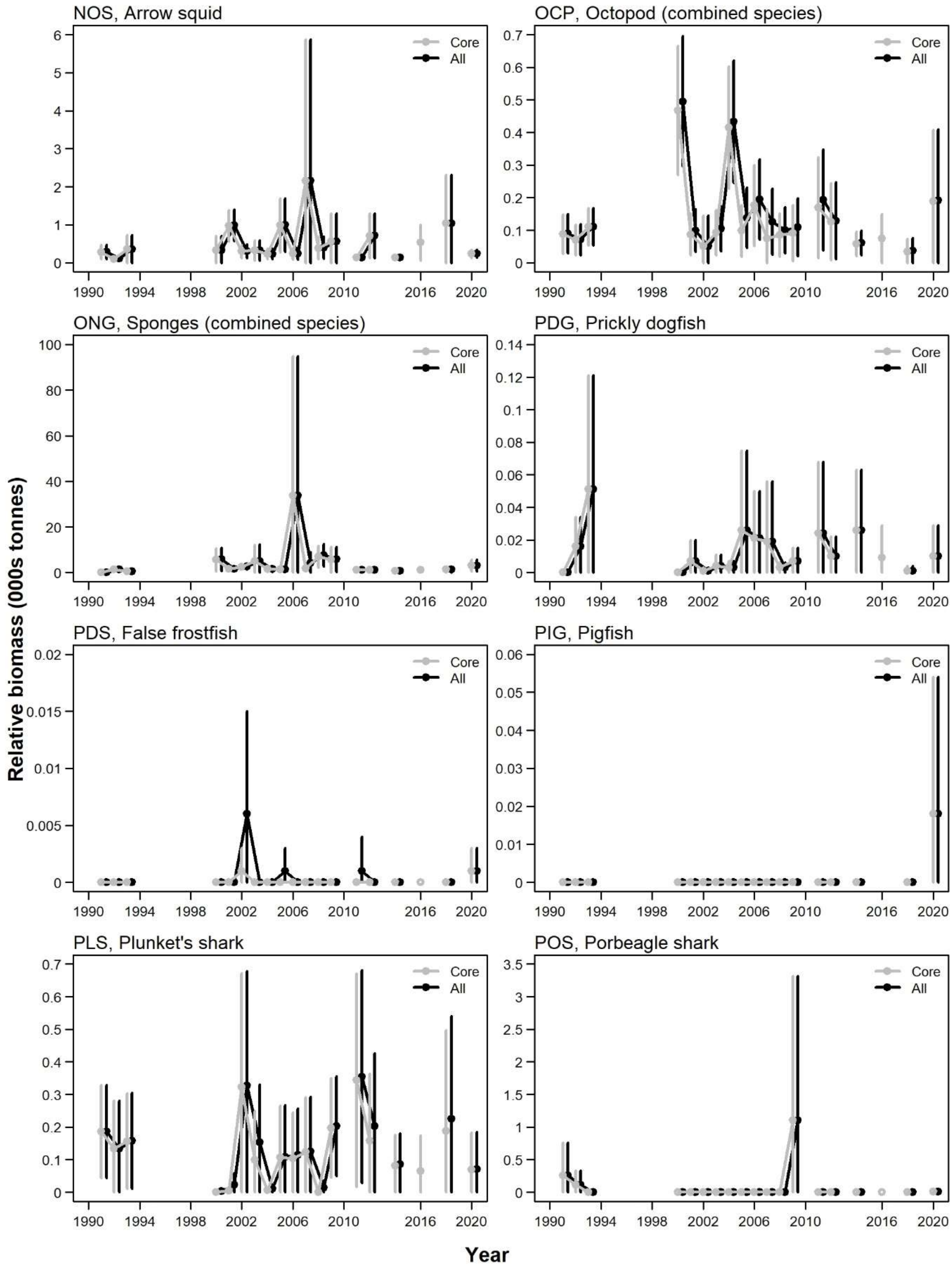

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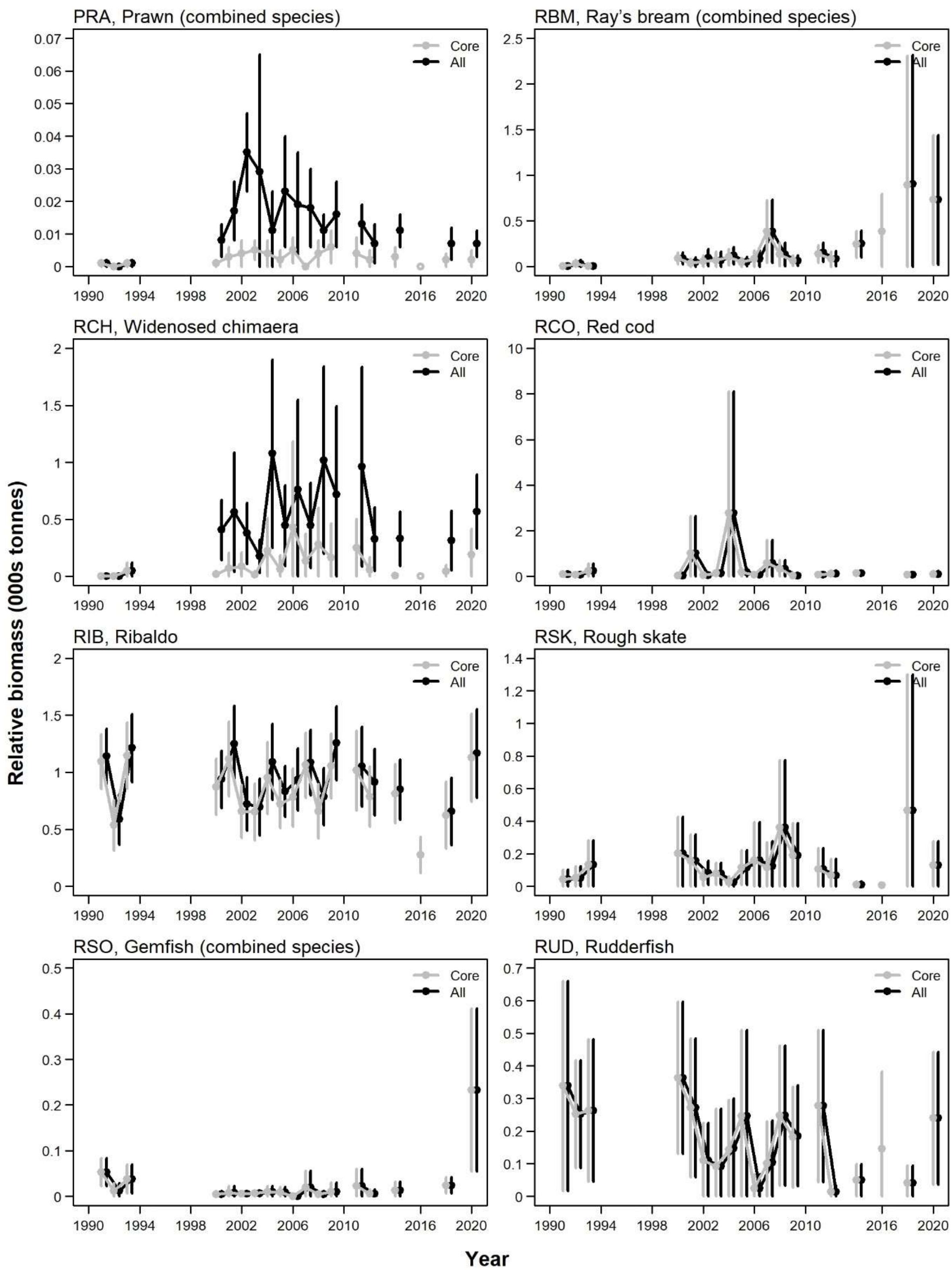

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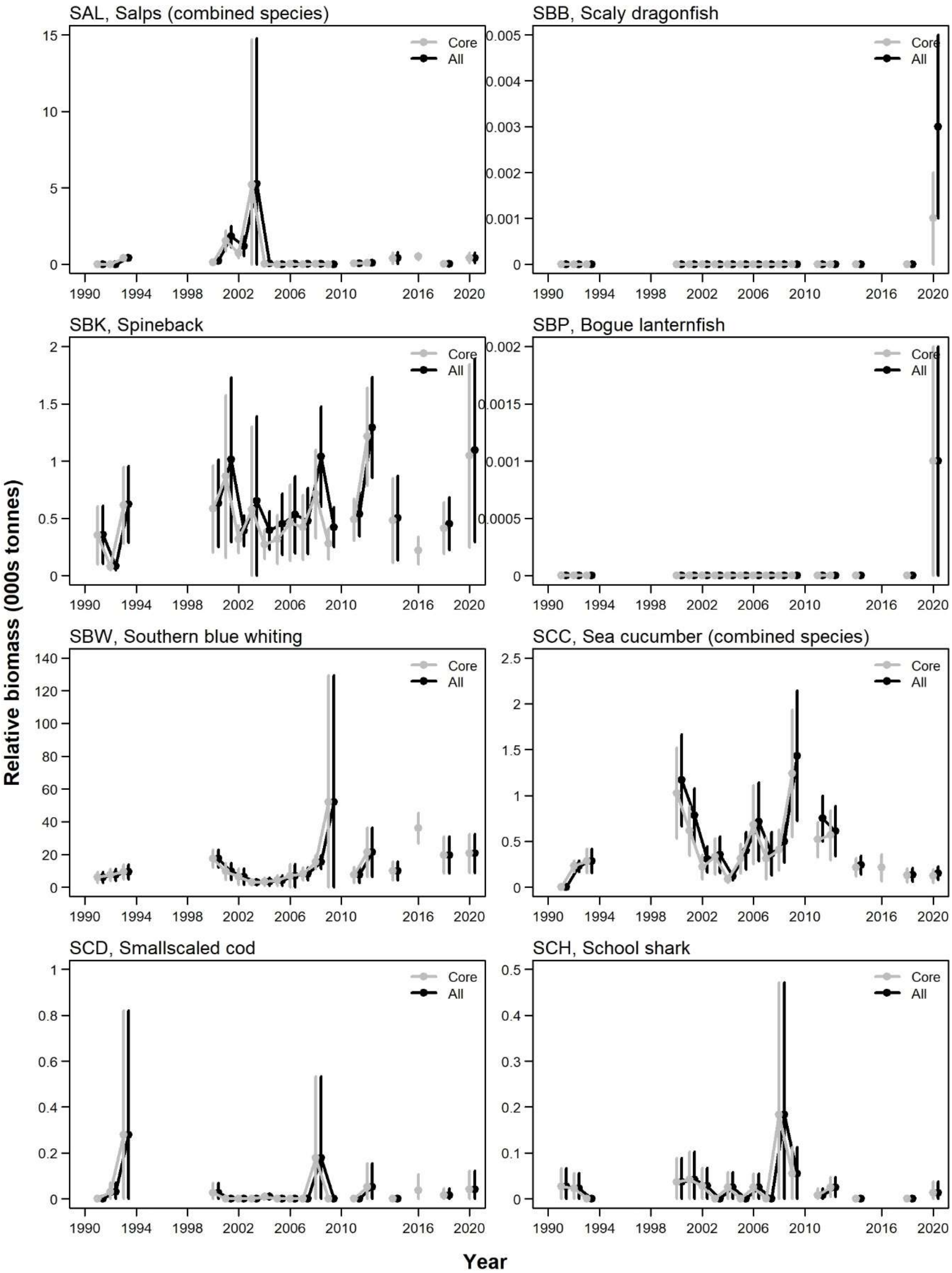


Figure 4: continued.

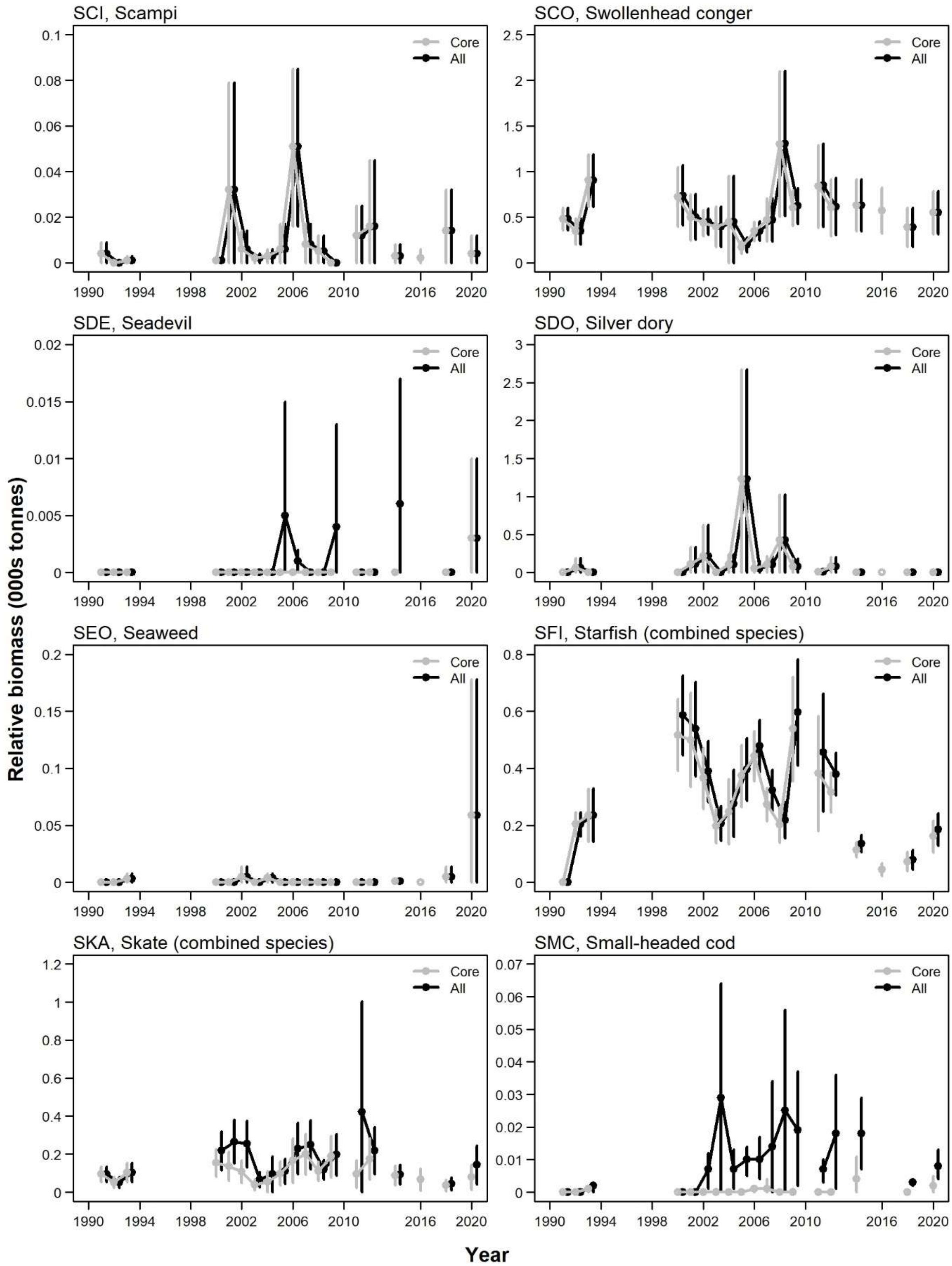
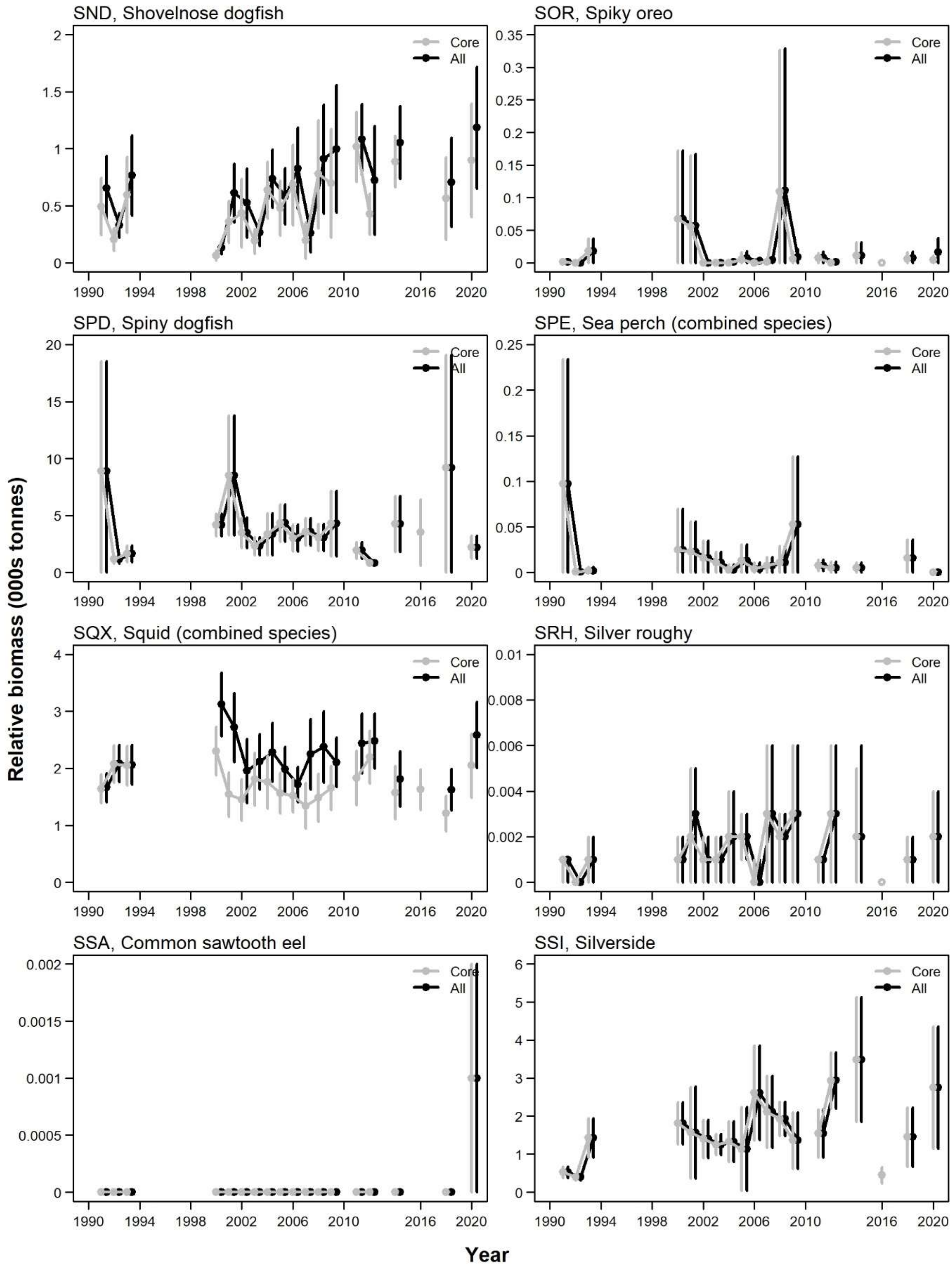


Figure 4: continued.



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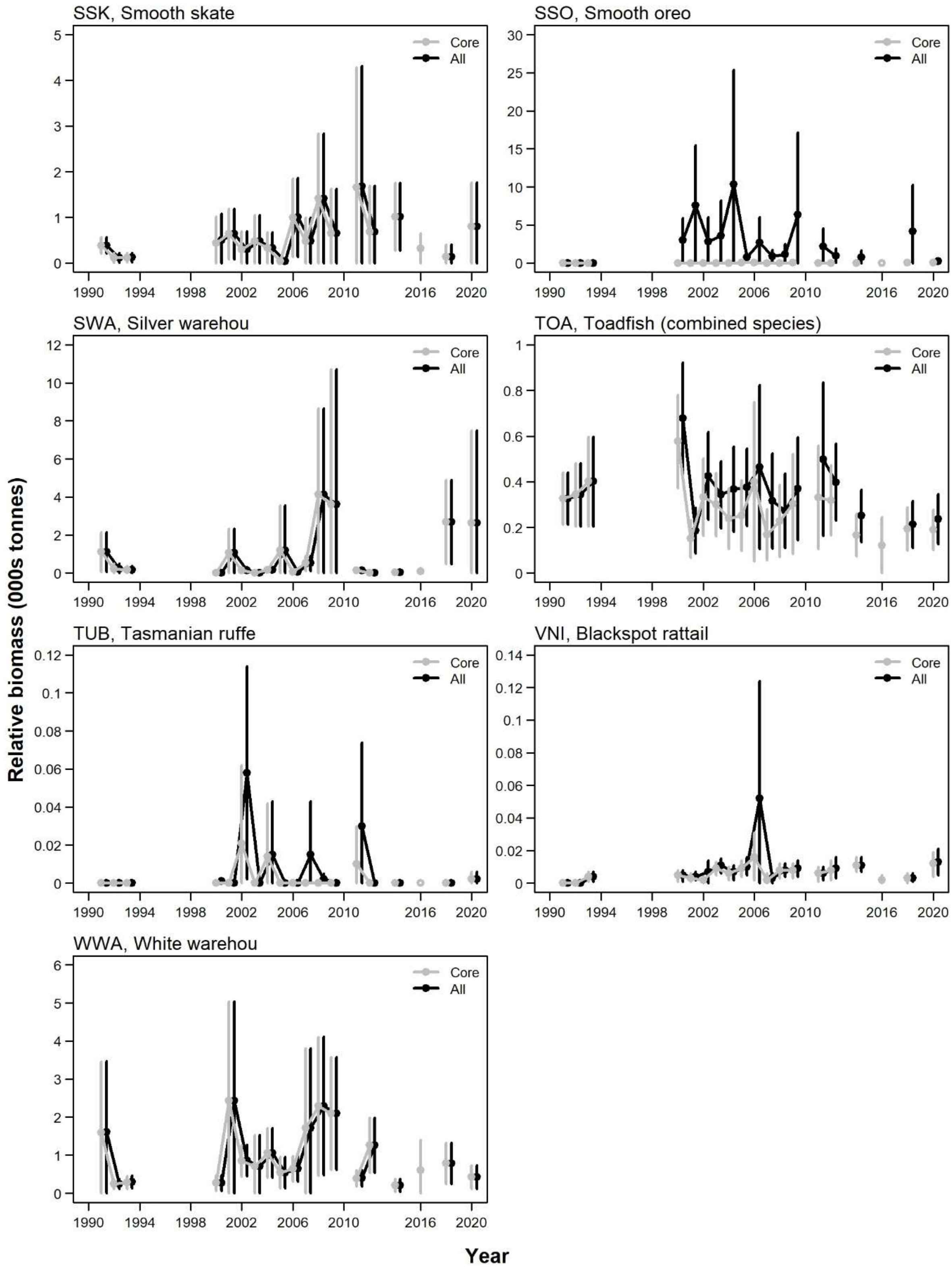


Figure 4: continued.

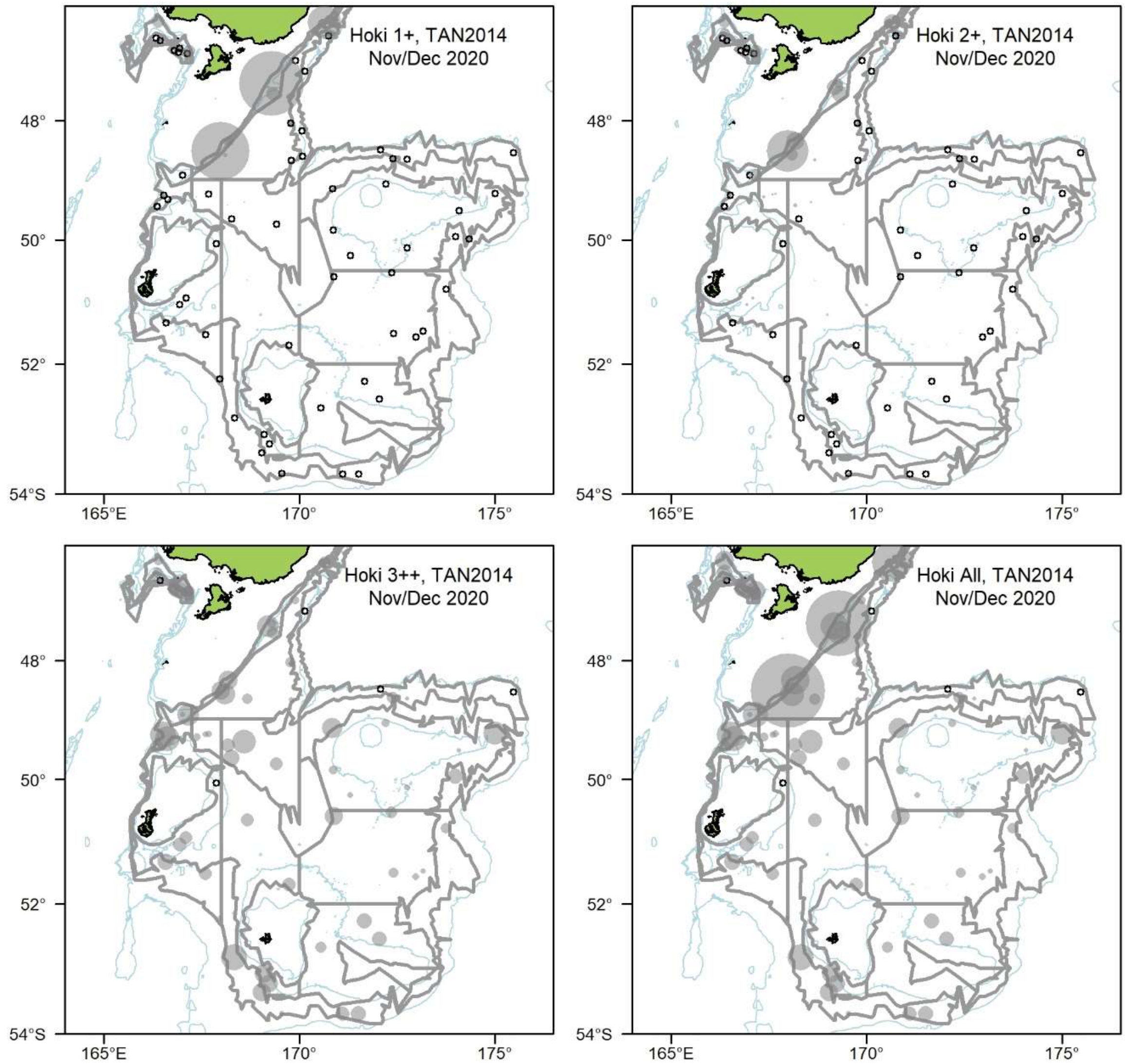


Figure 5: Distribution and catch rates in kg per km^2 of 1+ (less than 46 cm), 2+ (46 to less than 60 cm), 3++ year old (more than 60 cm), and all hoki from the November–December 2020 Southland and Sub-Antarctic trawl survey. Circle area is proportional to catch rate, maximum circle size is 500+ kg per km^2. Open circles indicate zero catches.

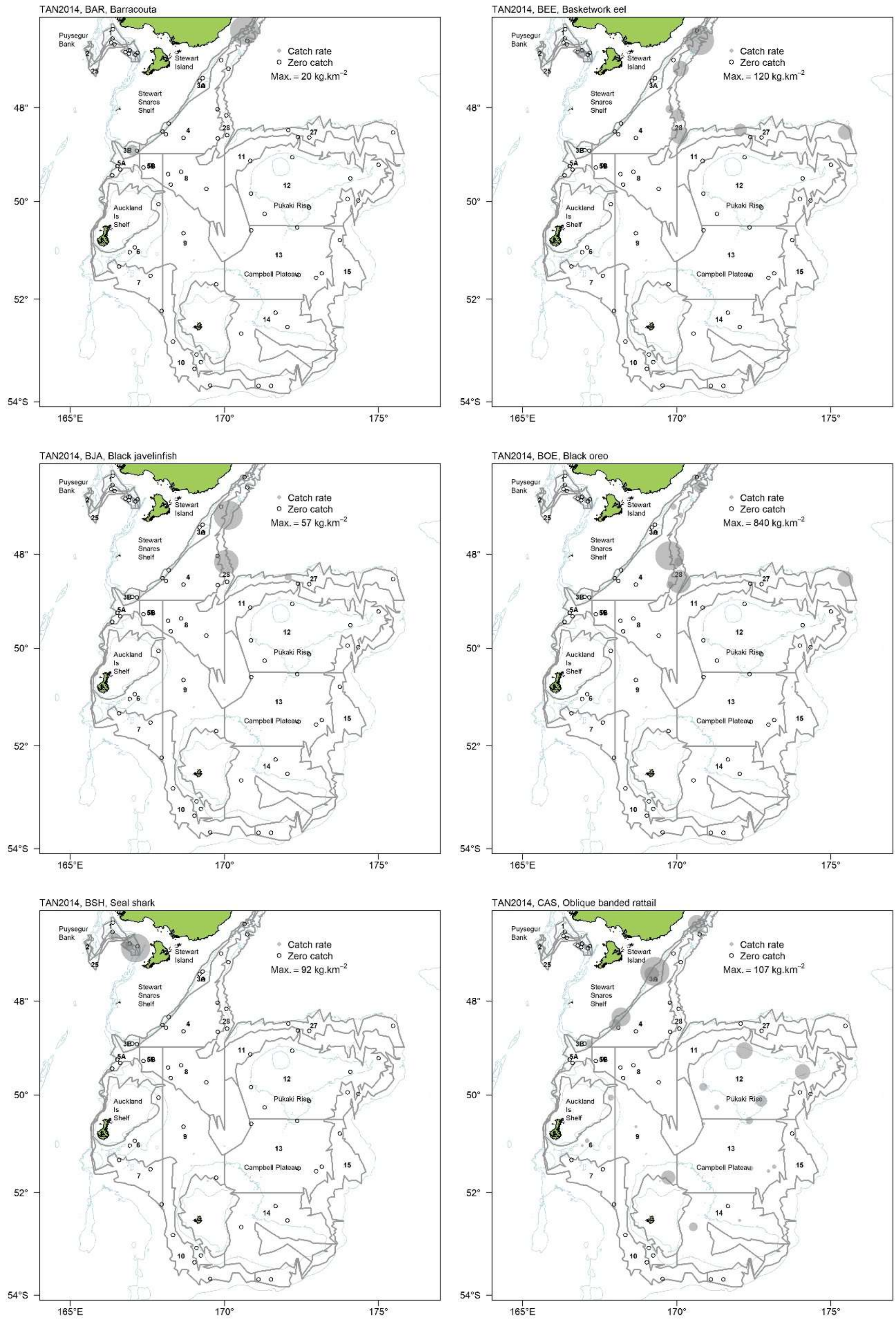


Figure 6: Distribution and catch rates of selected species, sorted alphabetically by research code, from the November–December 2020 Southland and Sub-Antarctic trawl survey. Circle area is proportional to catch rate. Open circles indicate zero catches.

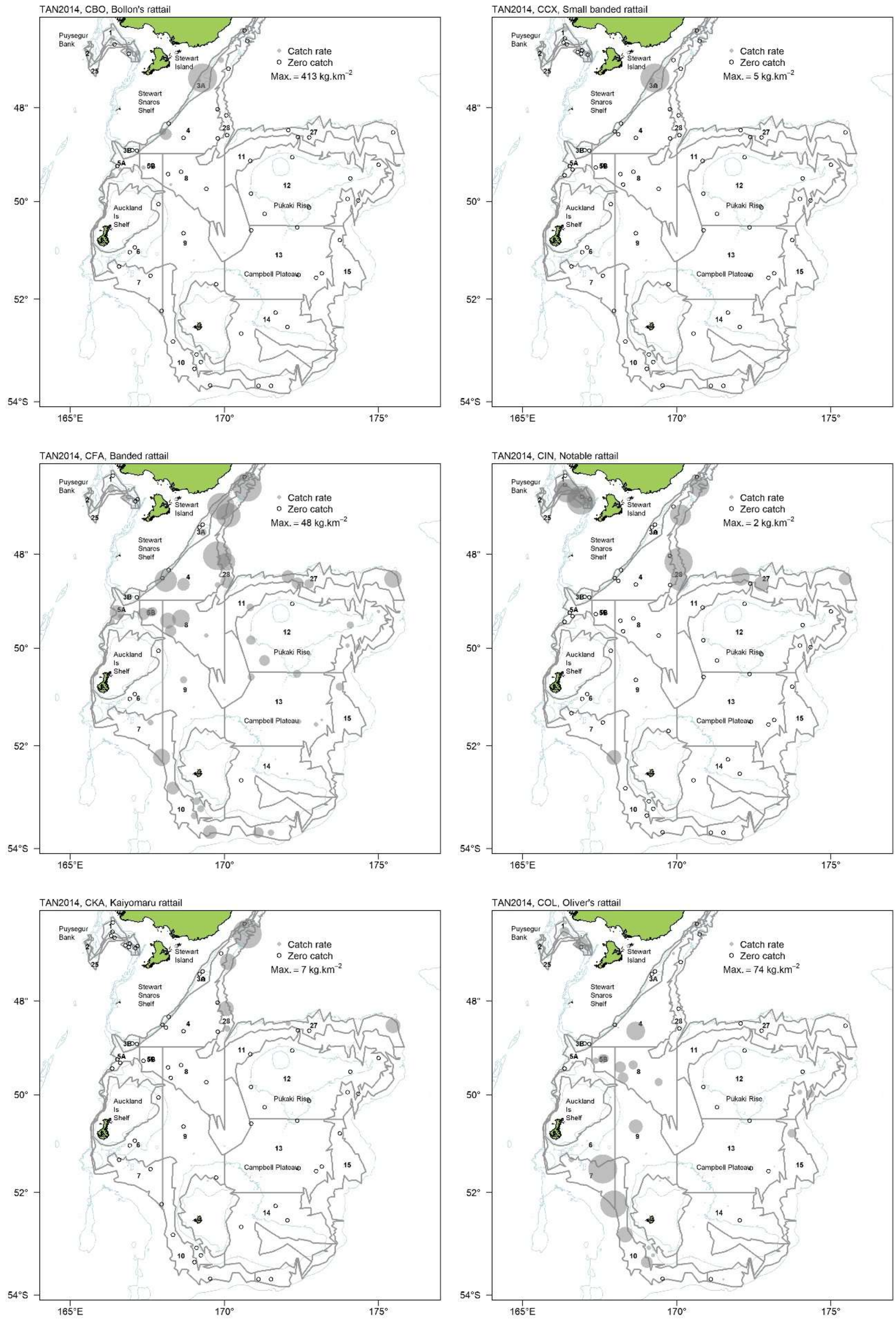
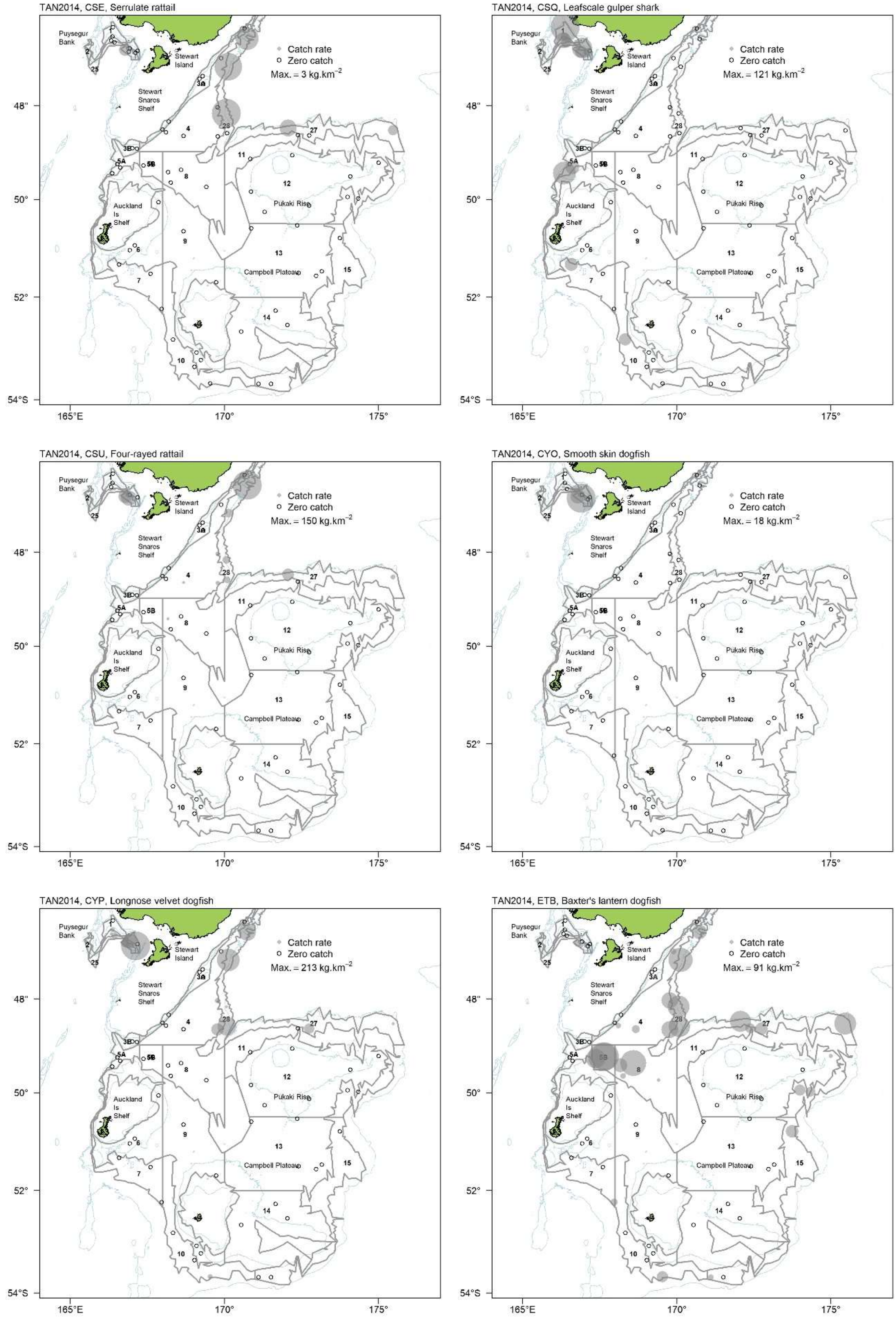


Figure 6: continued.



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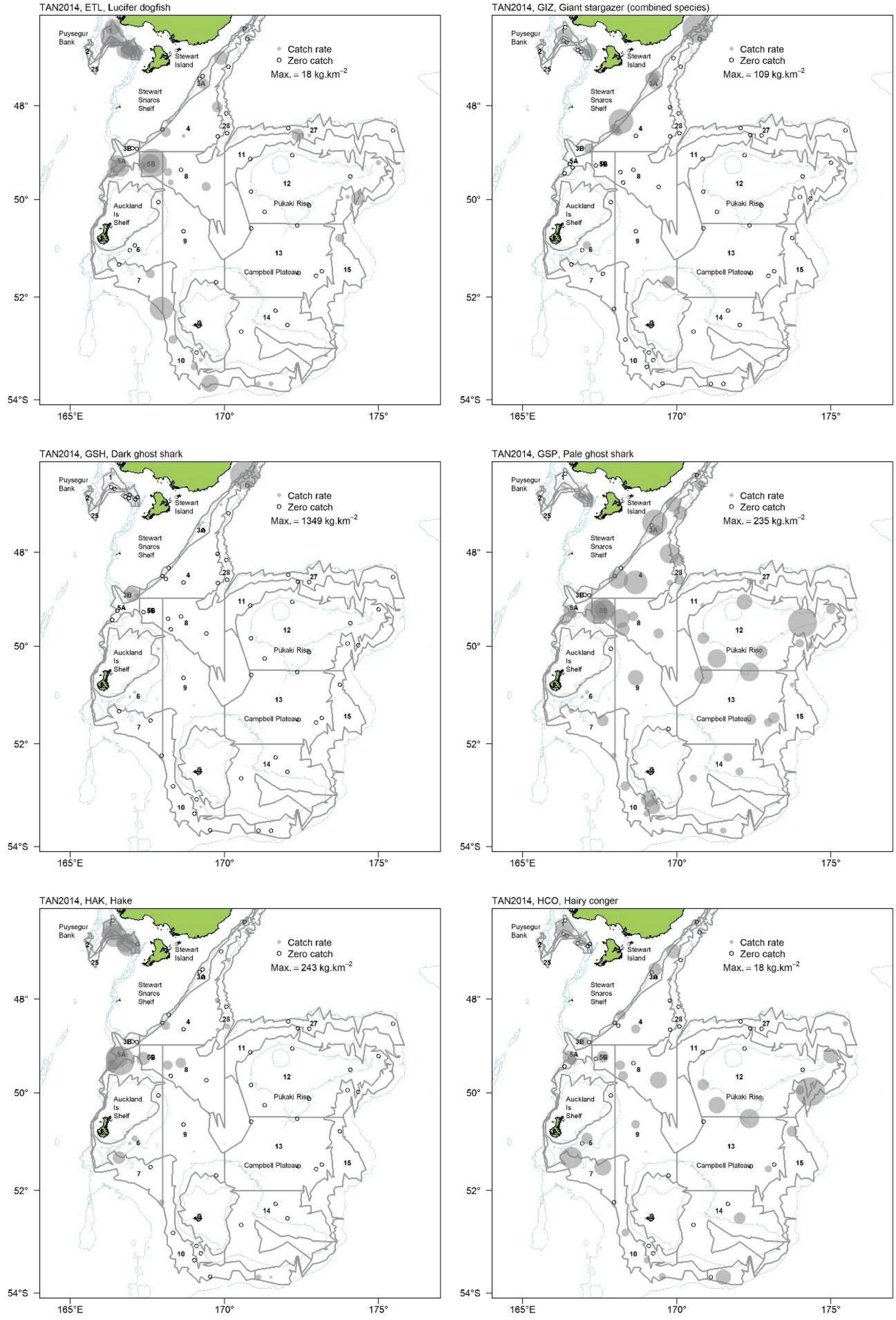

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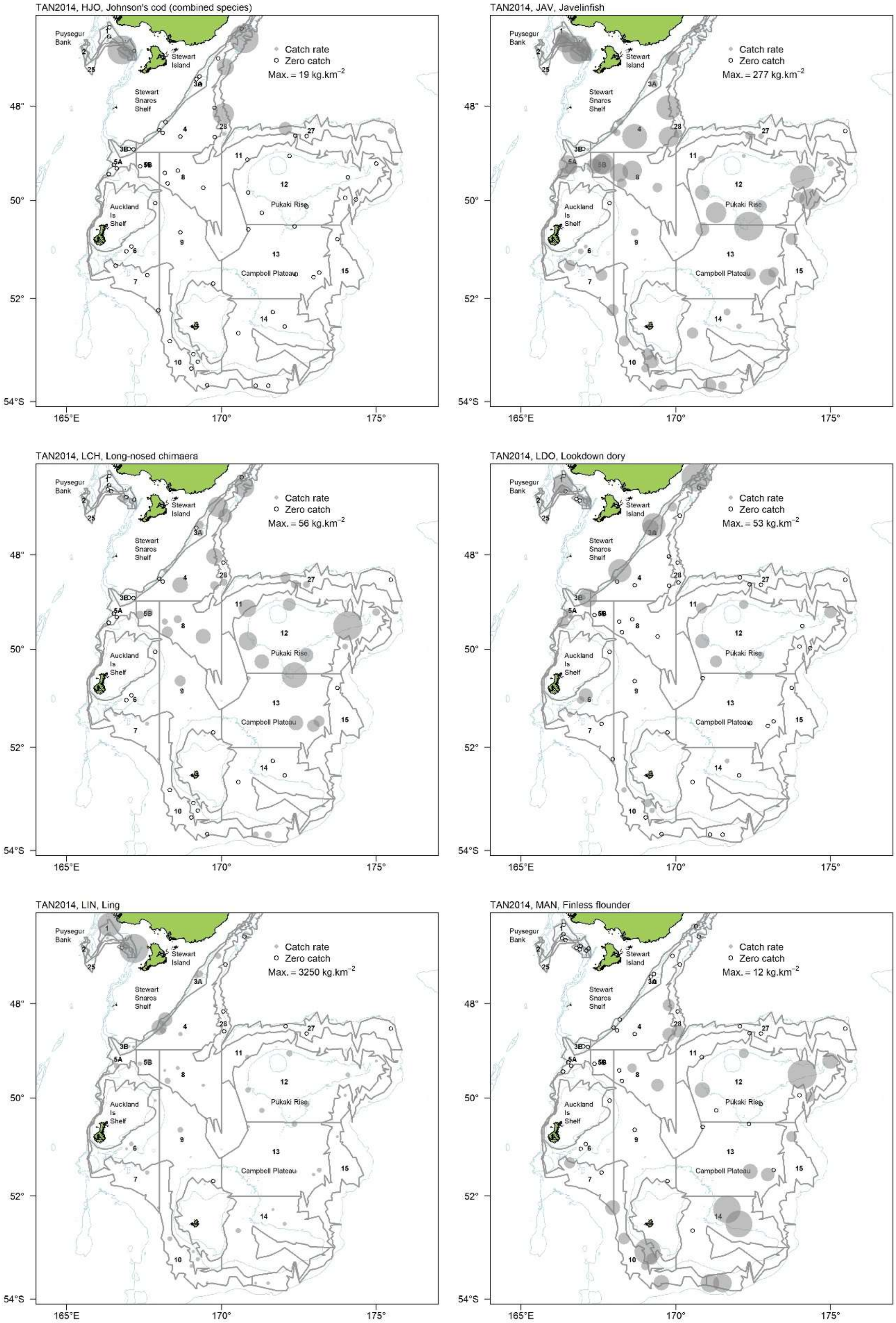

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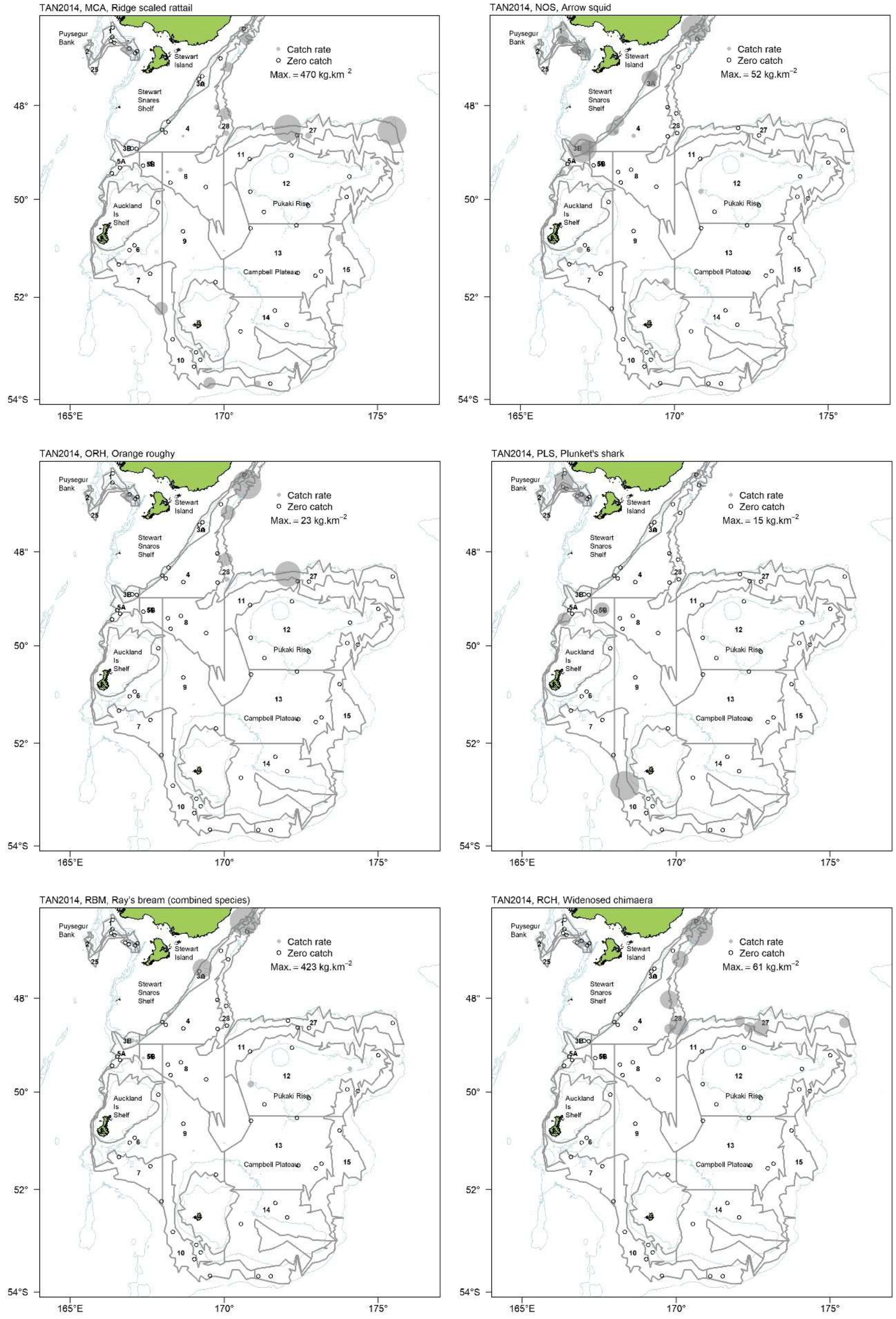

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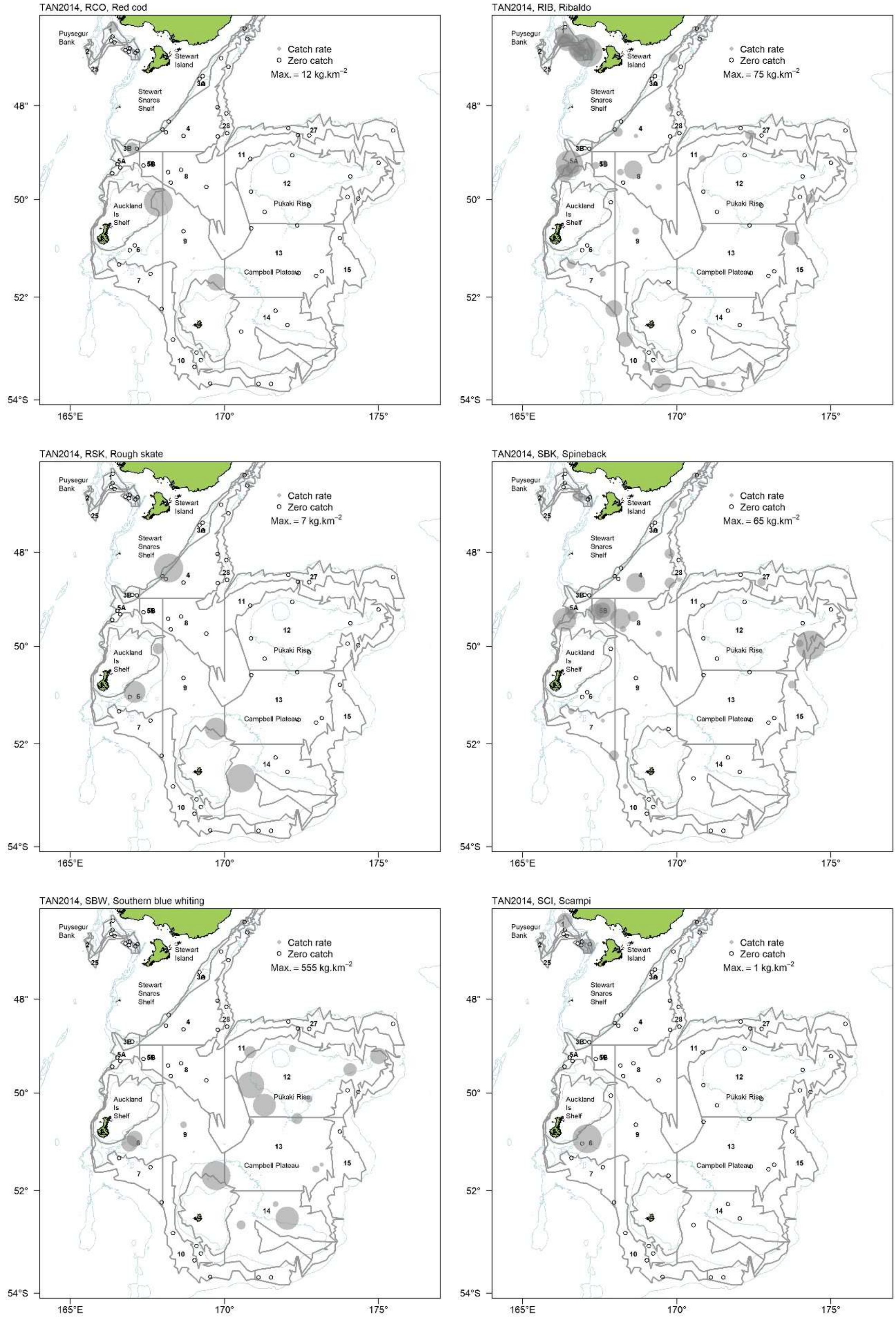
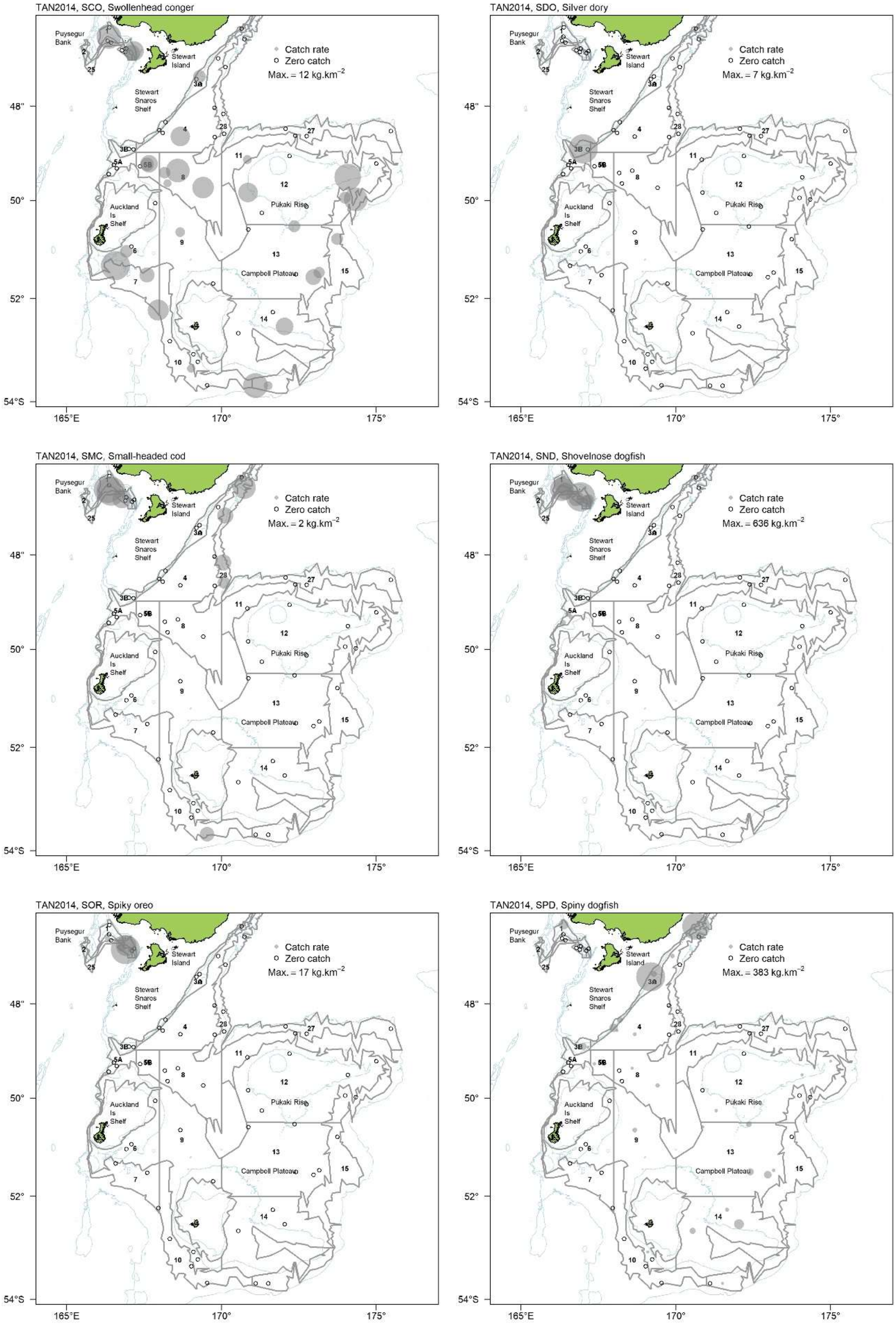


Figure 6: continued.



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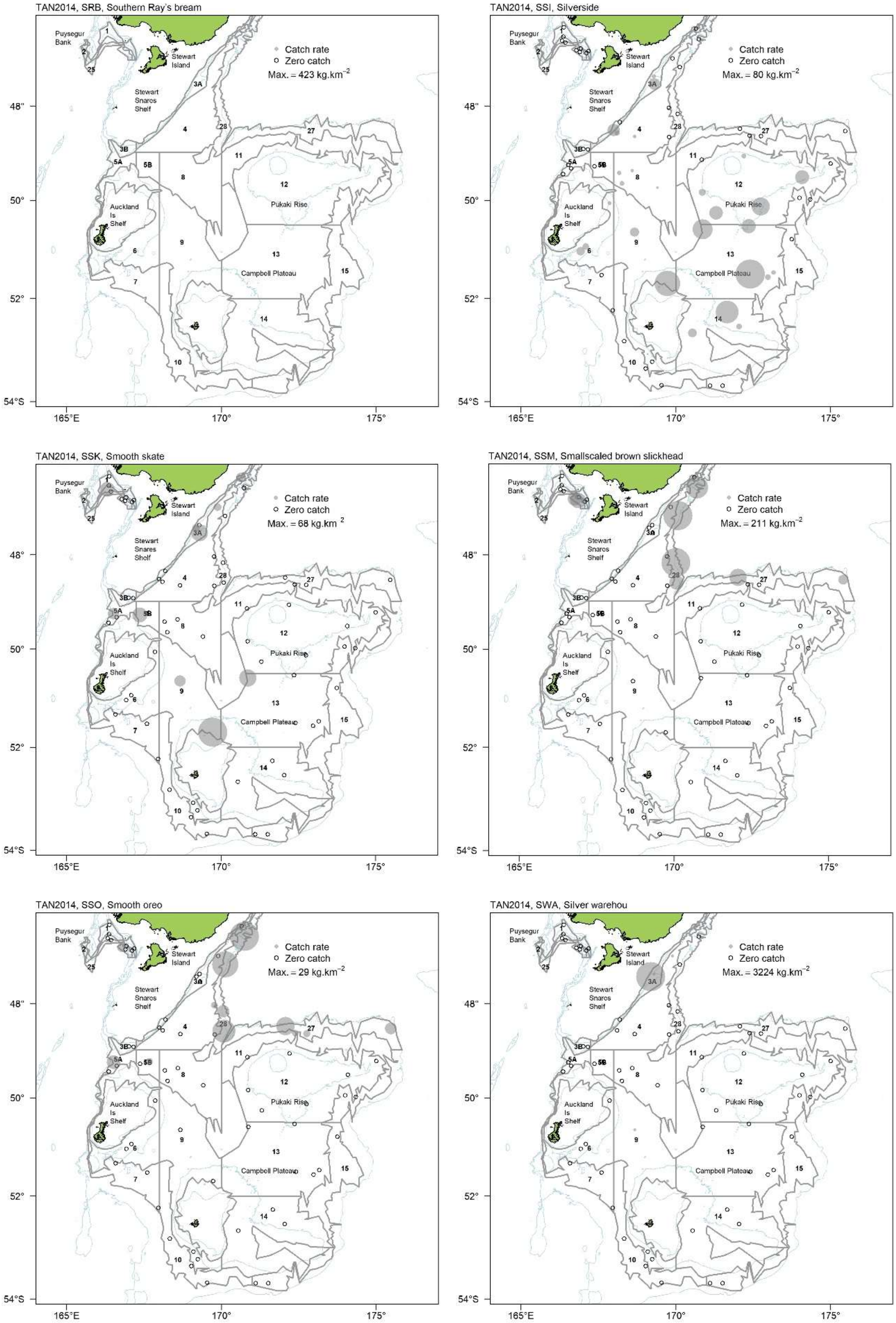


Figure 6: continued.

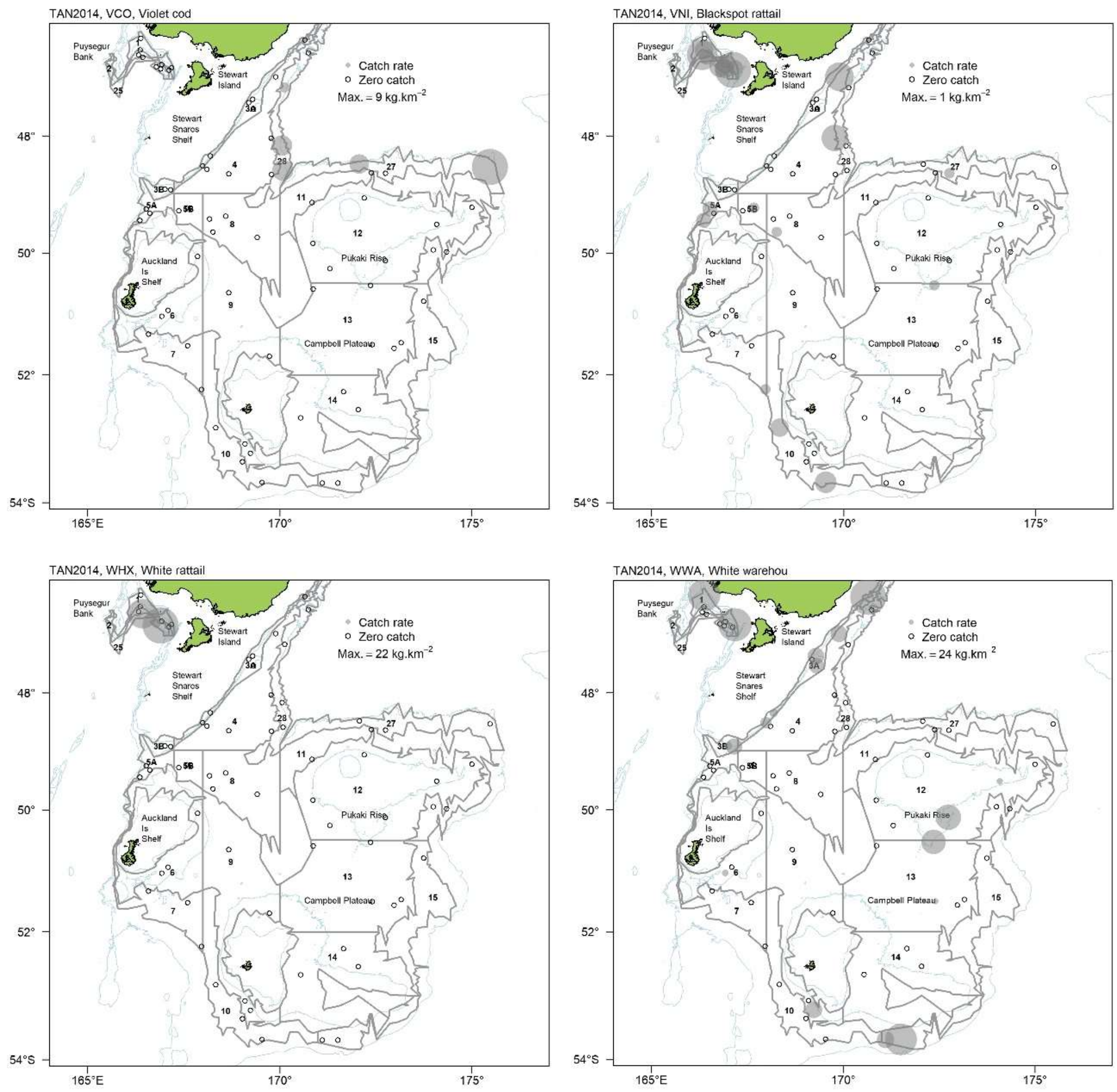


Figure 6: continued.

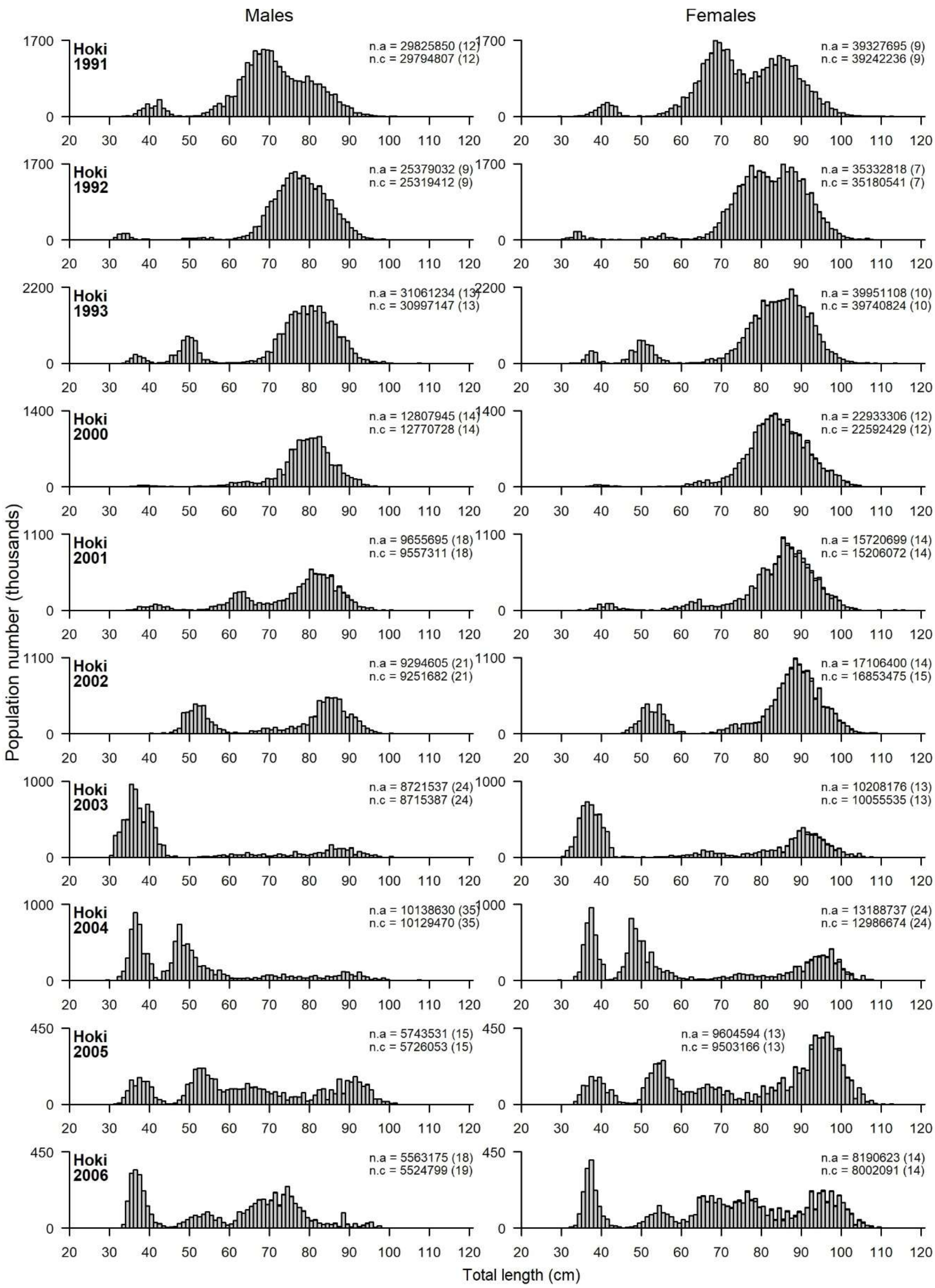


Figure 7: (a) Length frequency distributions by sex of hoki for core (grey) and all (light blue) strata from all Southland and Sub-Antarctic November–December *Tangaroa* surveys. n.a, estimated scaled total number of fish for all strata; n.c, estimated scaled total number of fish for core strata; and CV, the coefficient of variation (in parentheses).

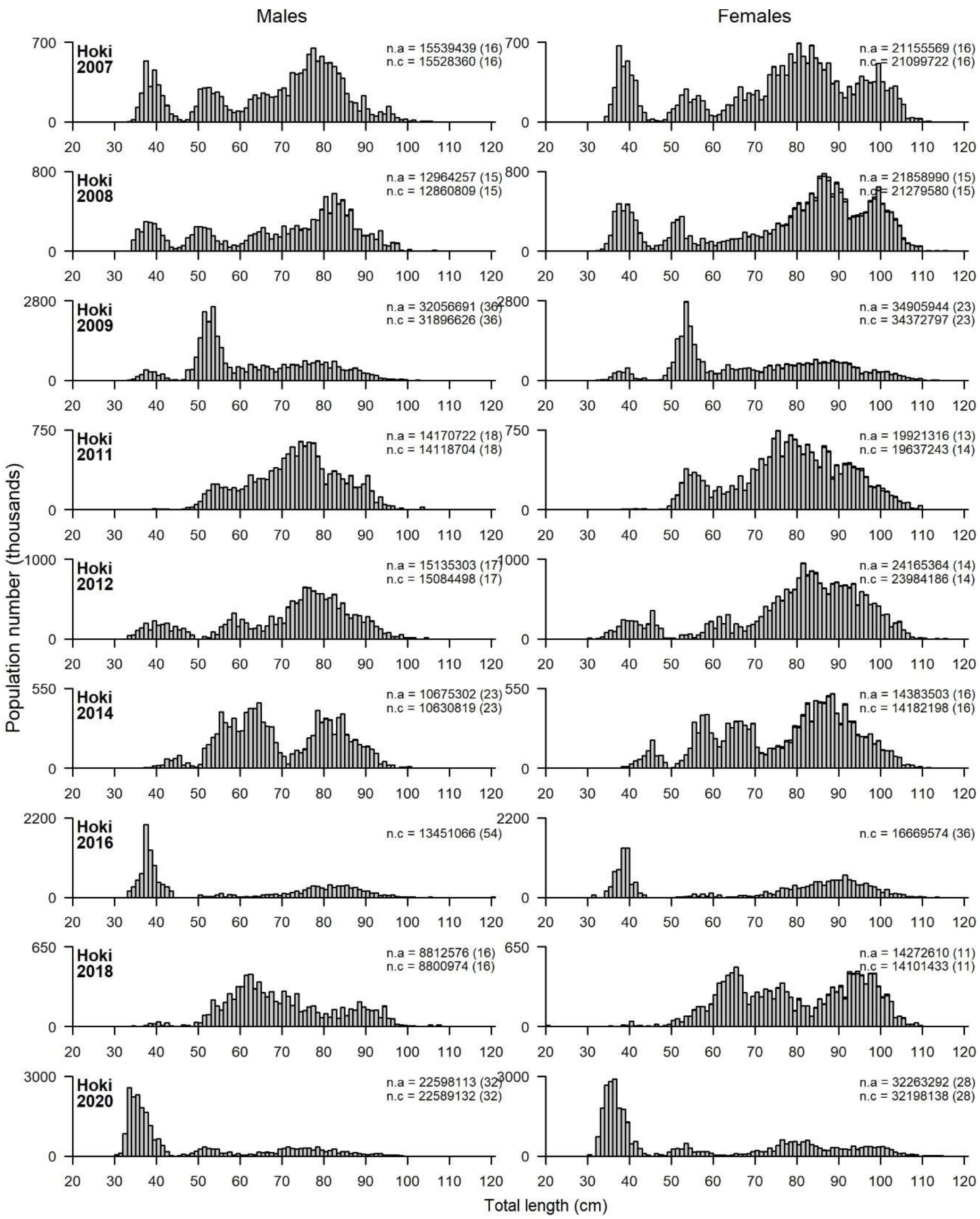


Figure 7: (a) continued.

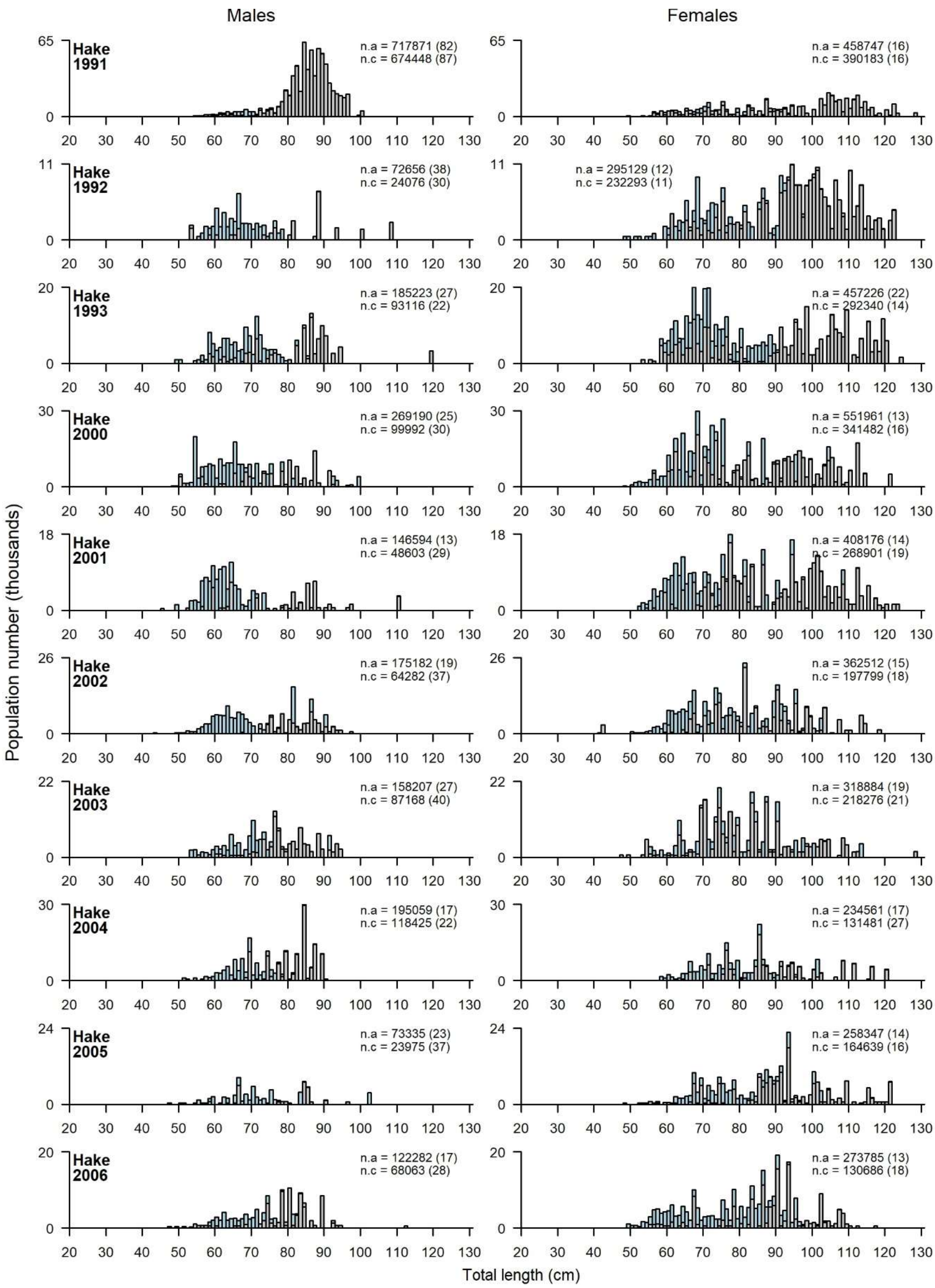


Figure 7: **(b) Length frequency distributions by sex of hake for core (grey) and all (light blue) strata from all Southland and Sub-Antarctic November–December trawl surveys. n.a, estimated scaled total number of fish for all strata; n.c, estimated scaled total number of fish for core strata; and CV, the coefficient of variation (in parentheses).**

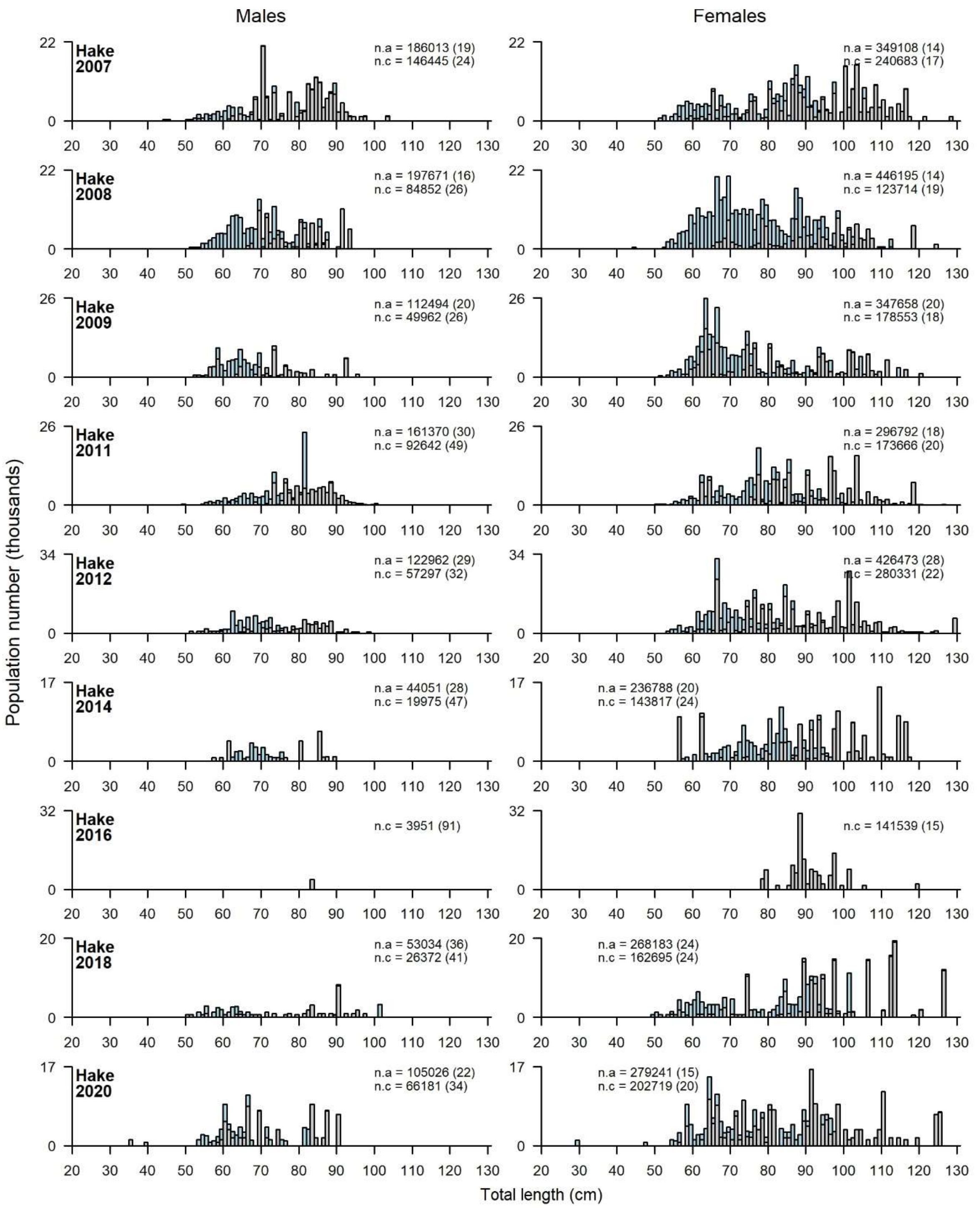


Figure 7: (b) continued.

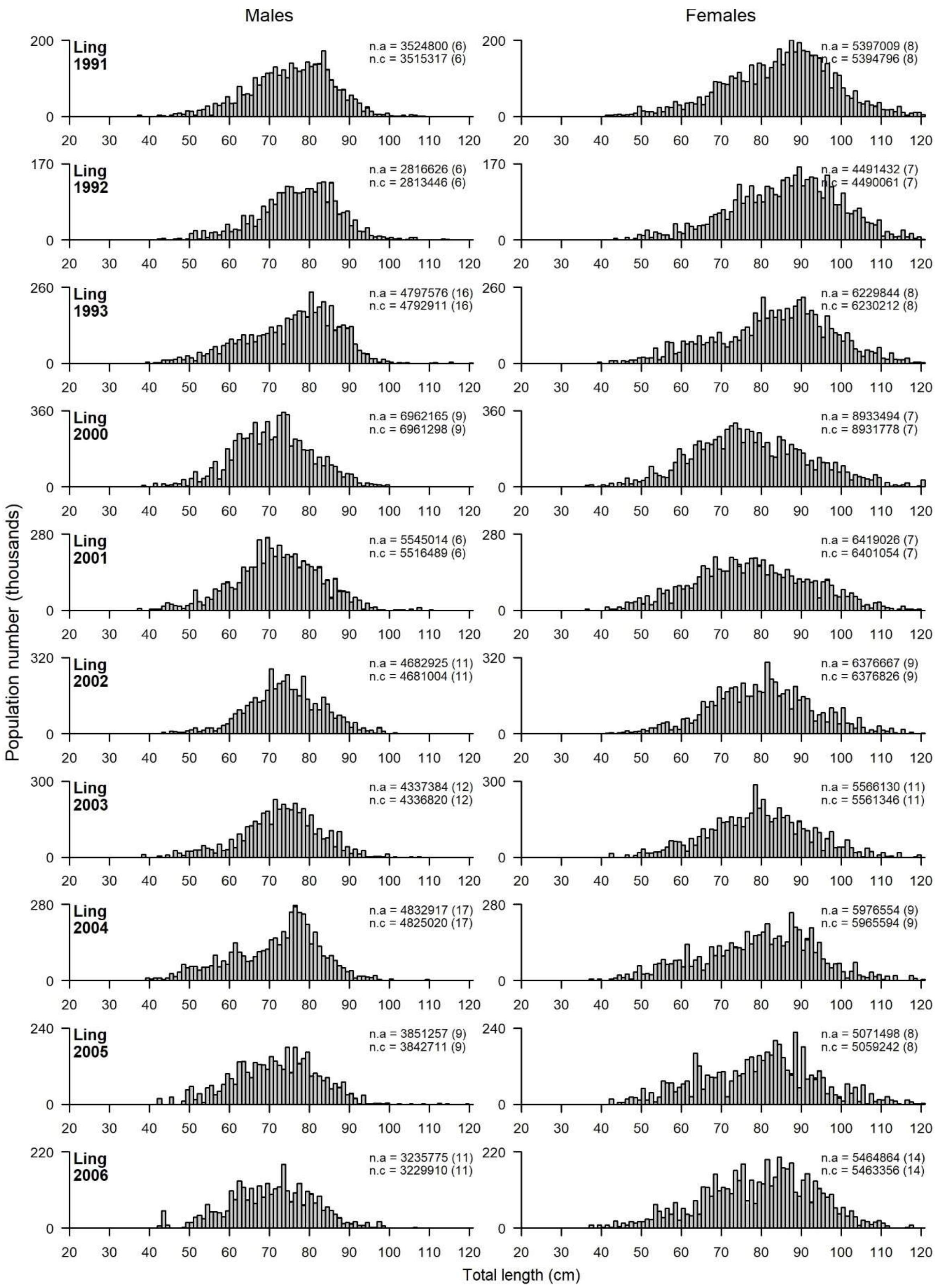


Figure 7: (c) Length frequency distributions by sex of ling for core (grey) and all (light blue) strata from all Southland and Sub-Antarctic November–December trawl surveys. n.a, estimated scaled total number of fish for all strata; n.c, estimated scaled total number of fish for core strata; and CV, the coefficient of variation (in parentheses).

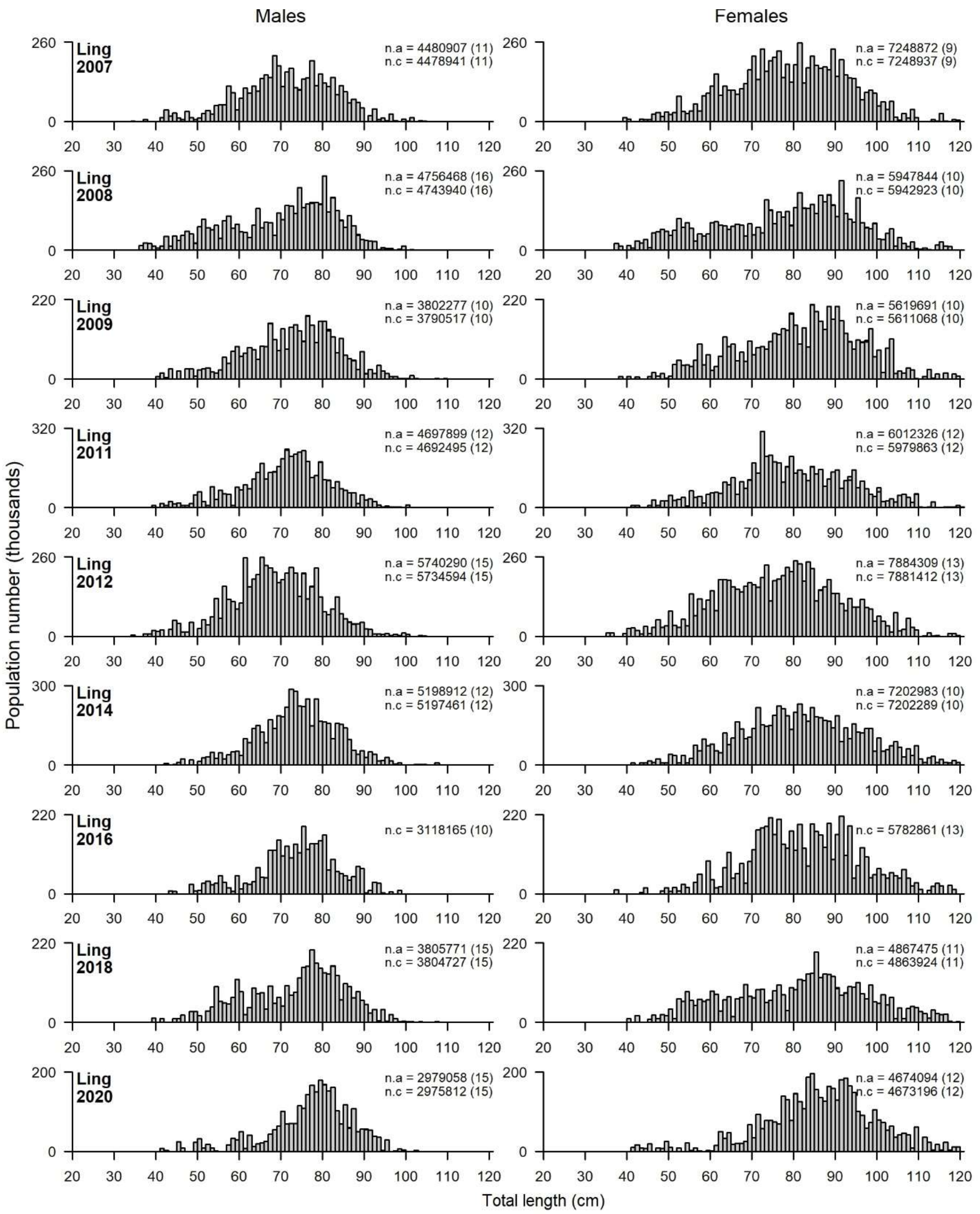


Figure 7: (c) continued.

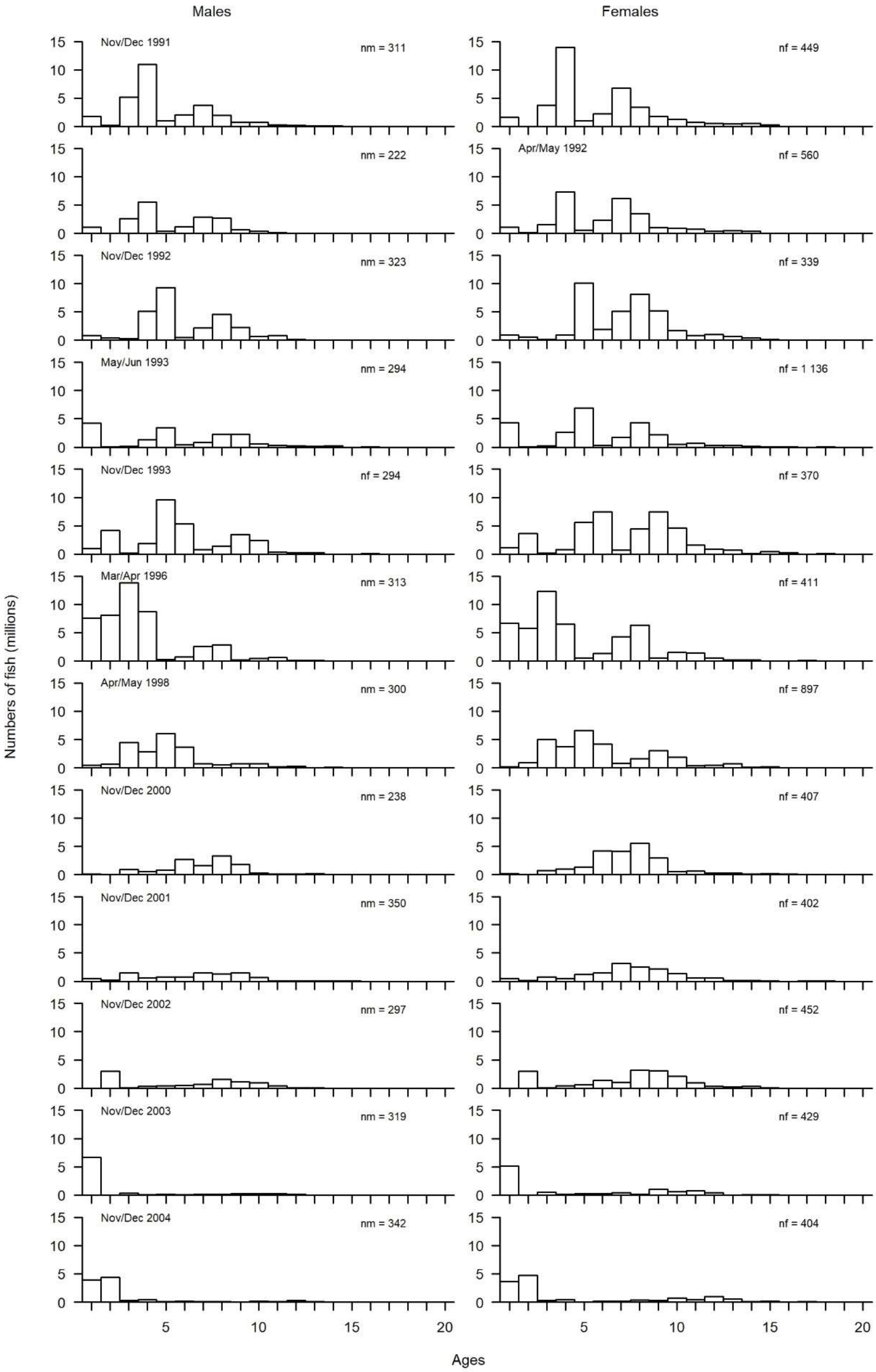


Figure 8: (a) Scaled age frequency distributions by sex for hoki in core strata from the Southland and Sub-Antarctic November–December *Tangaroa* surveys. Number of fish aged are indicated by nm (males) or nf (females).

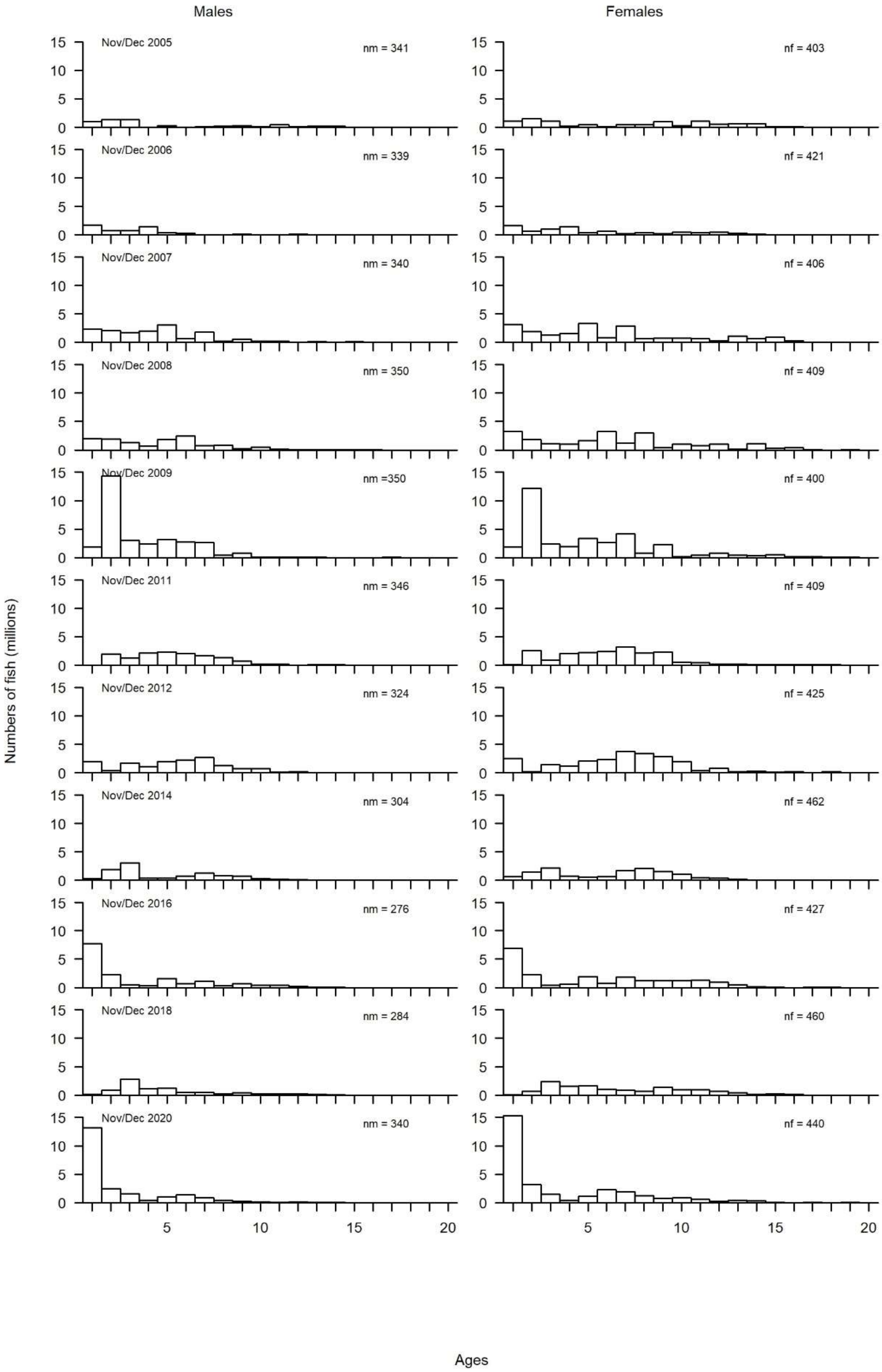


Figure 8a: Hoki continued.

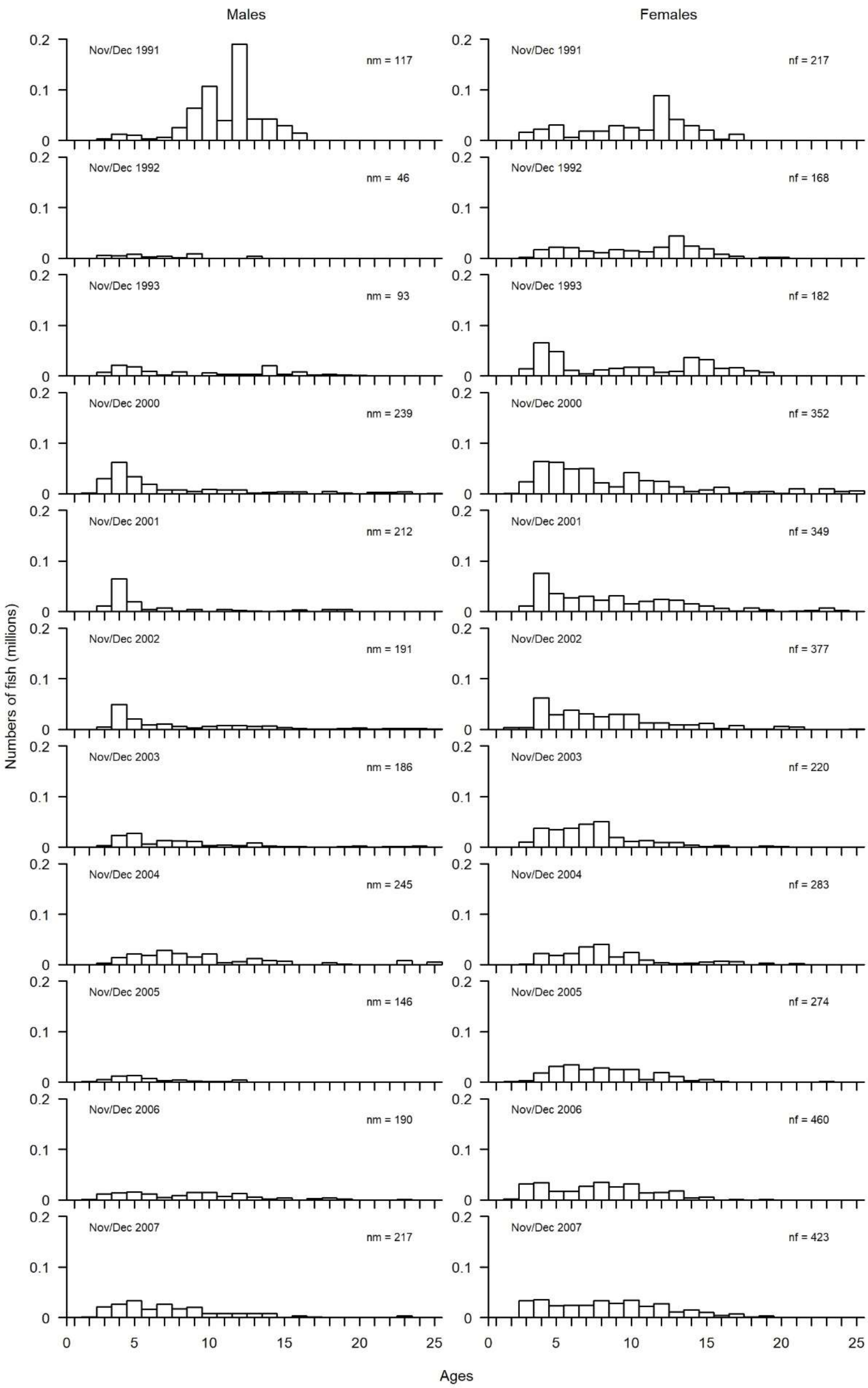


Figure 8: (b) Scaled age frequency distributions by sex for hake in core plus Puysegur strata from the Southland and Sub-Antarctic November–December *Tangaroa* surveys.

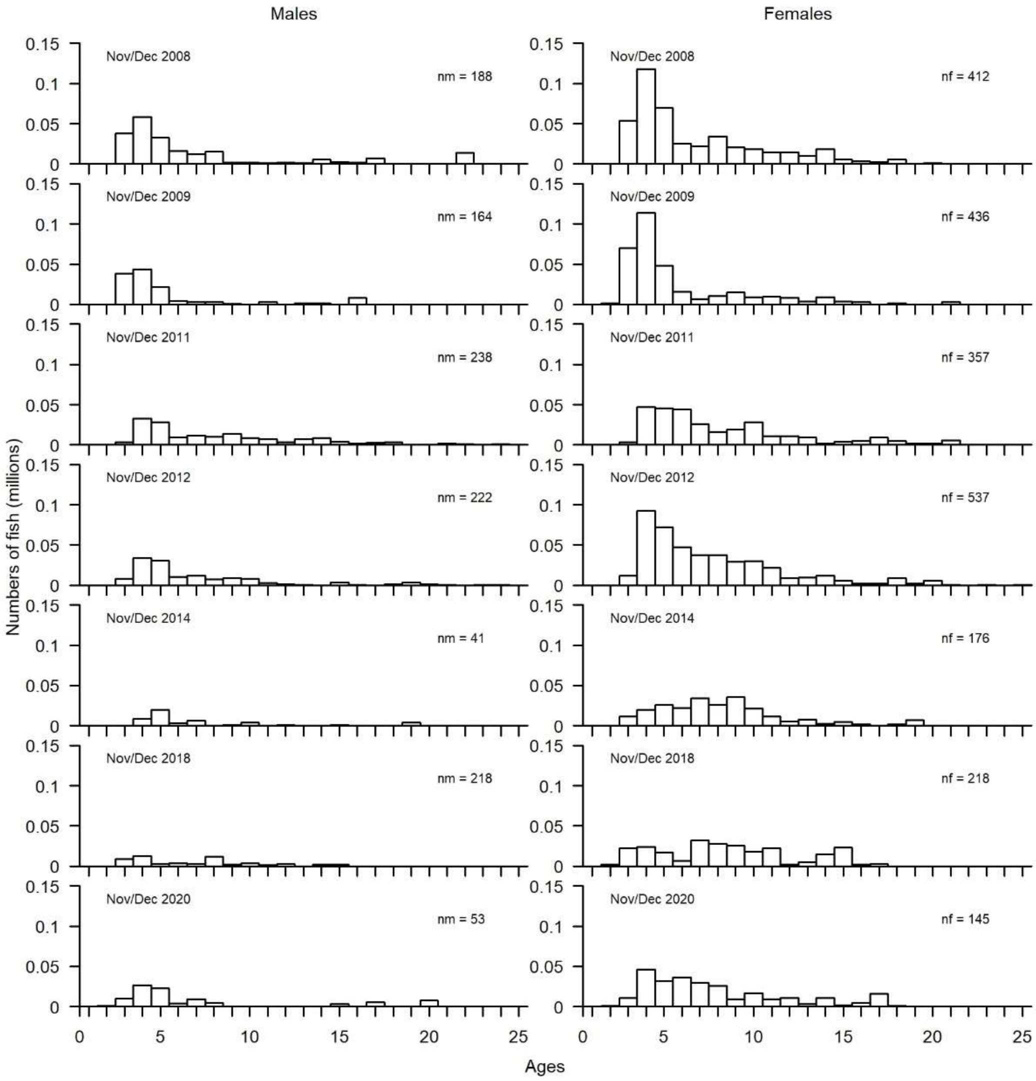


Figure 8: (b) Hake continued. NB: No age data for hake exist for the 2016 survey.

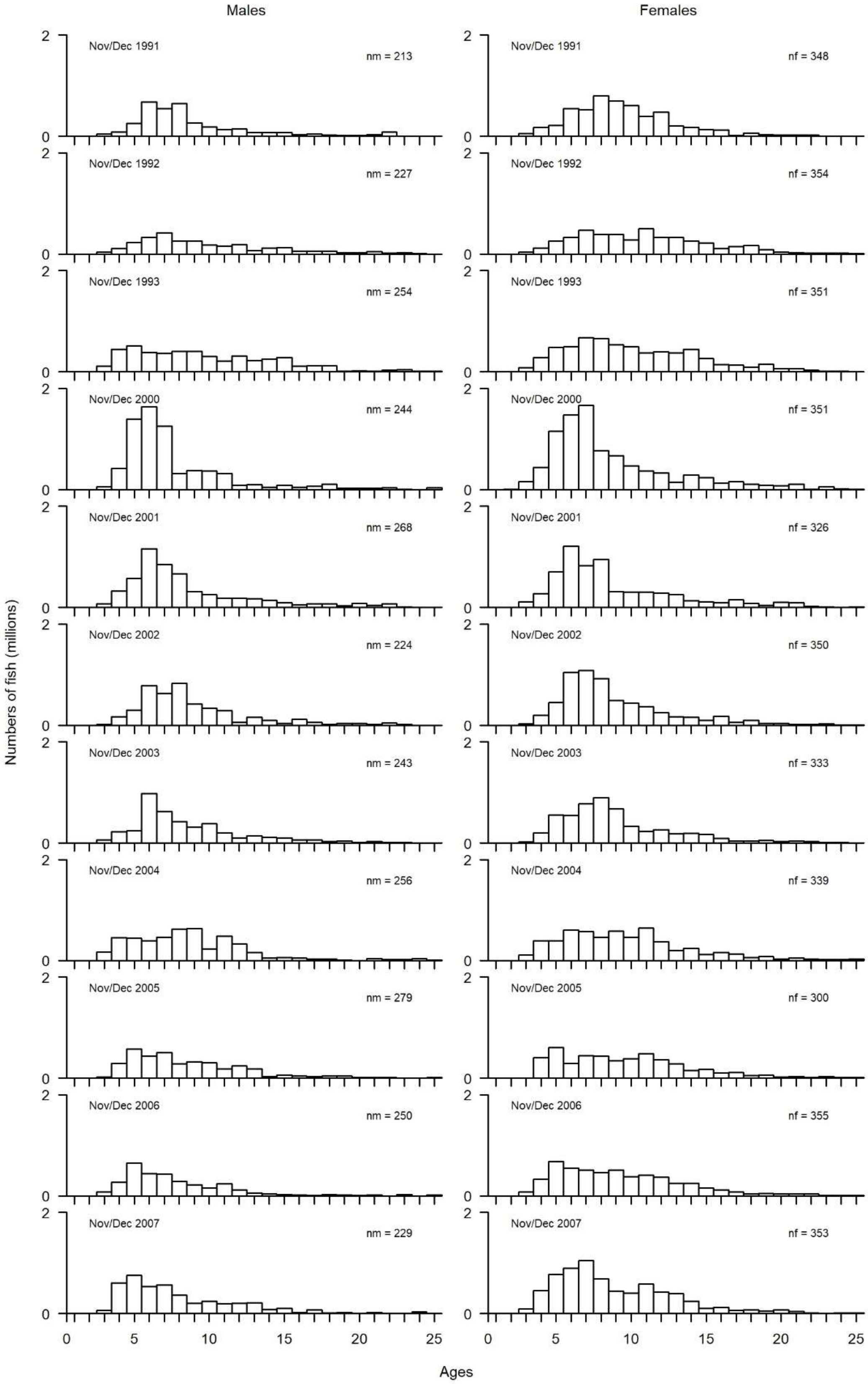


Figure 8: (c) Scaled age frequency distributions by sex for ling in core strata from the Southland and Sub-Antarctic November–December *Tangaroa* surveys.

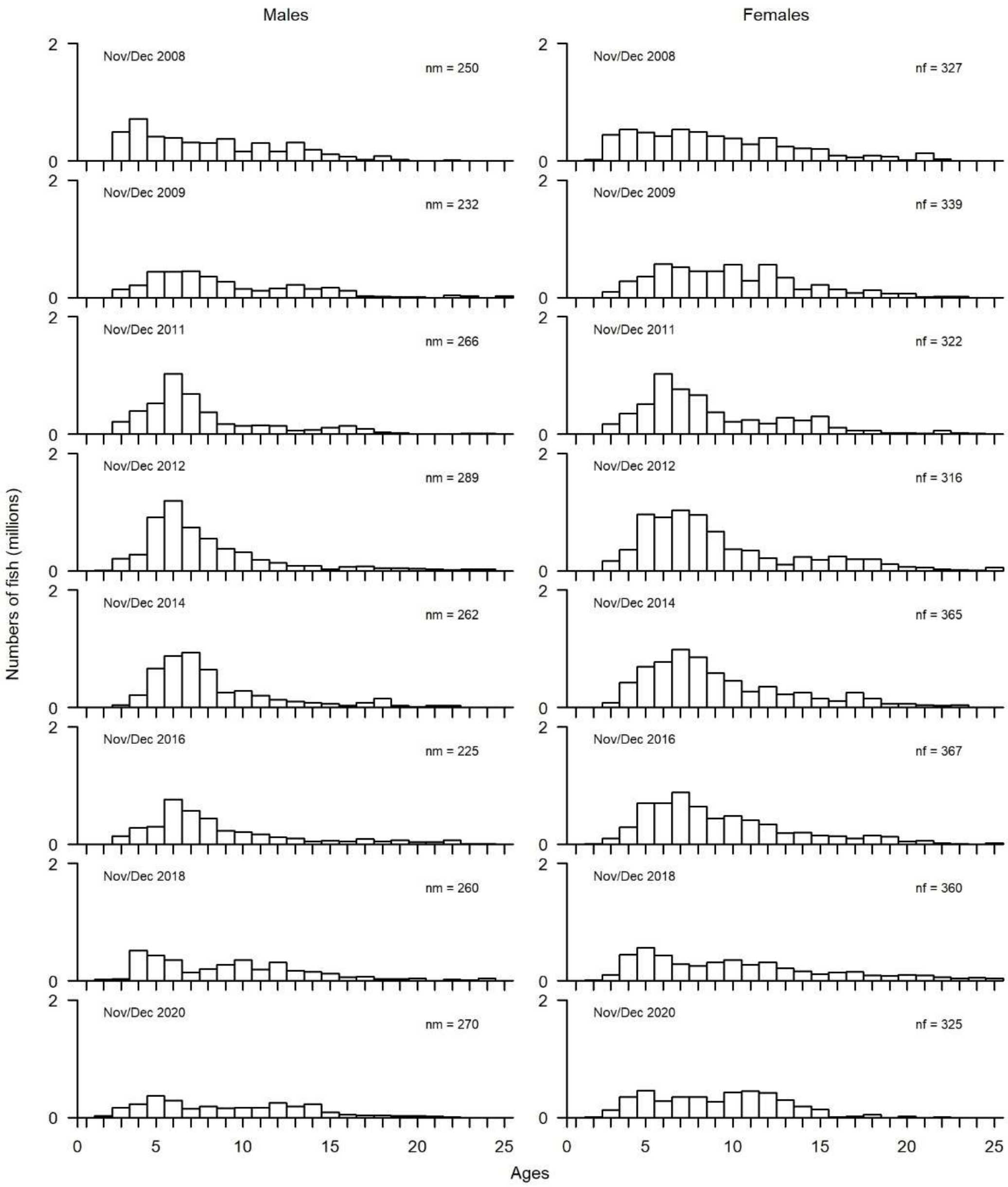


Figure 8: (c) Ling continued.

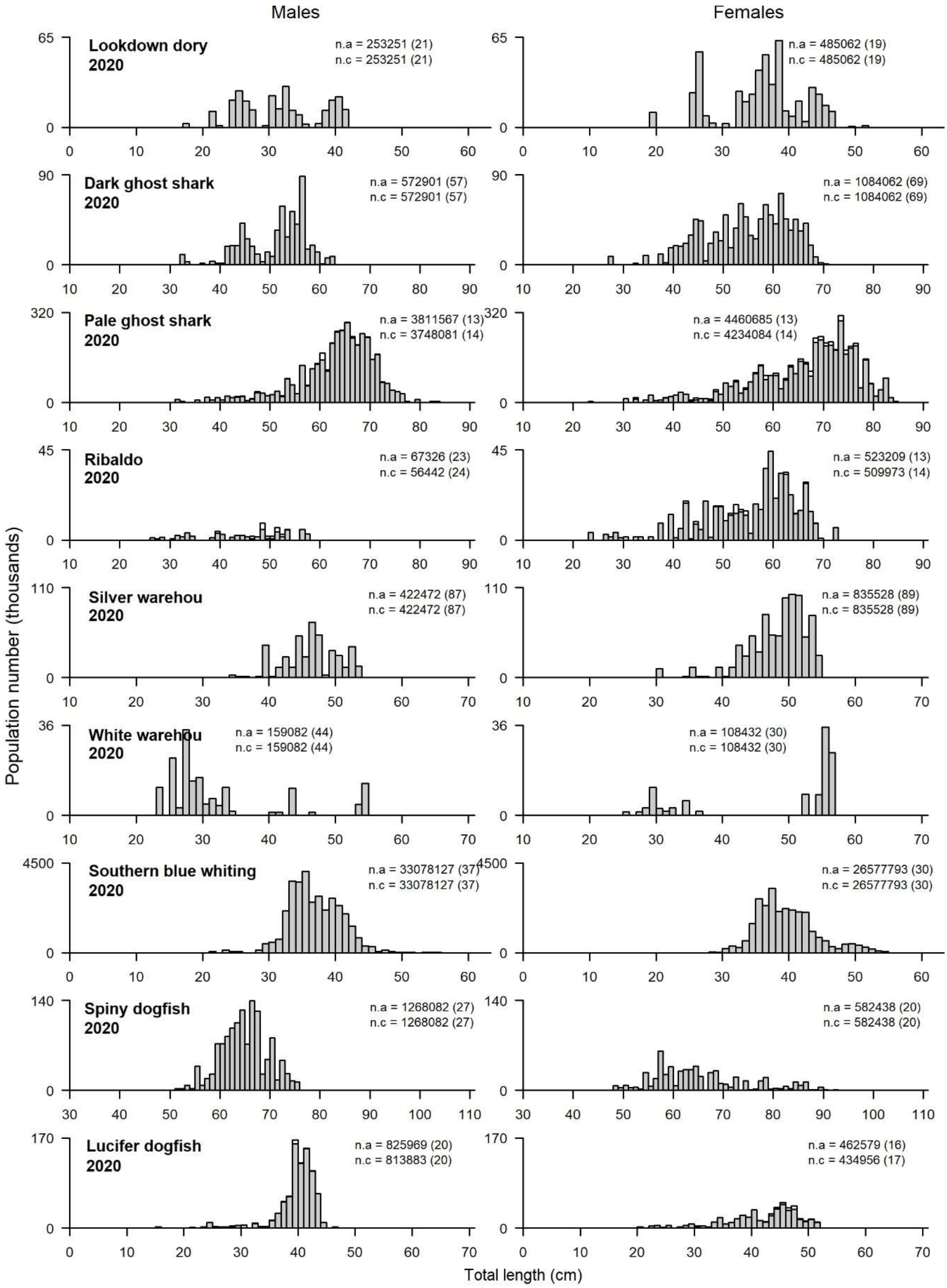


Figure 9: Length frequency distributions by sex for selected species for core (grey) and all (white) strata from the November–December 2020 Southland and Sub-Antarctic trawl survey. n.c, estimated scaled total number of fish for core strata; n.a, estimated scaled total number of fish for all strata; and CV (in parentheses), the coefficient of variation for core and all.

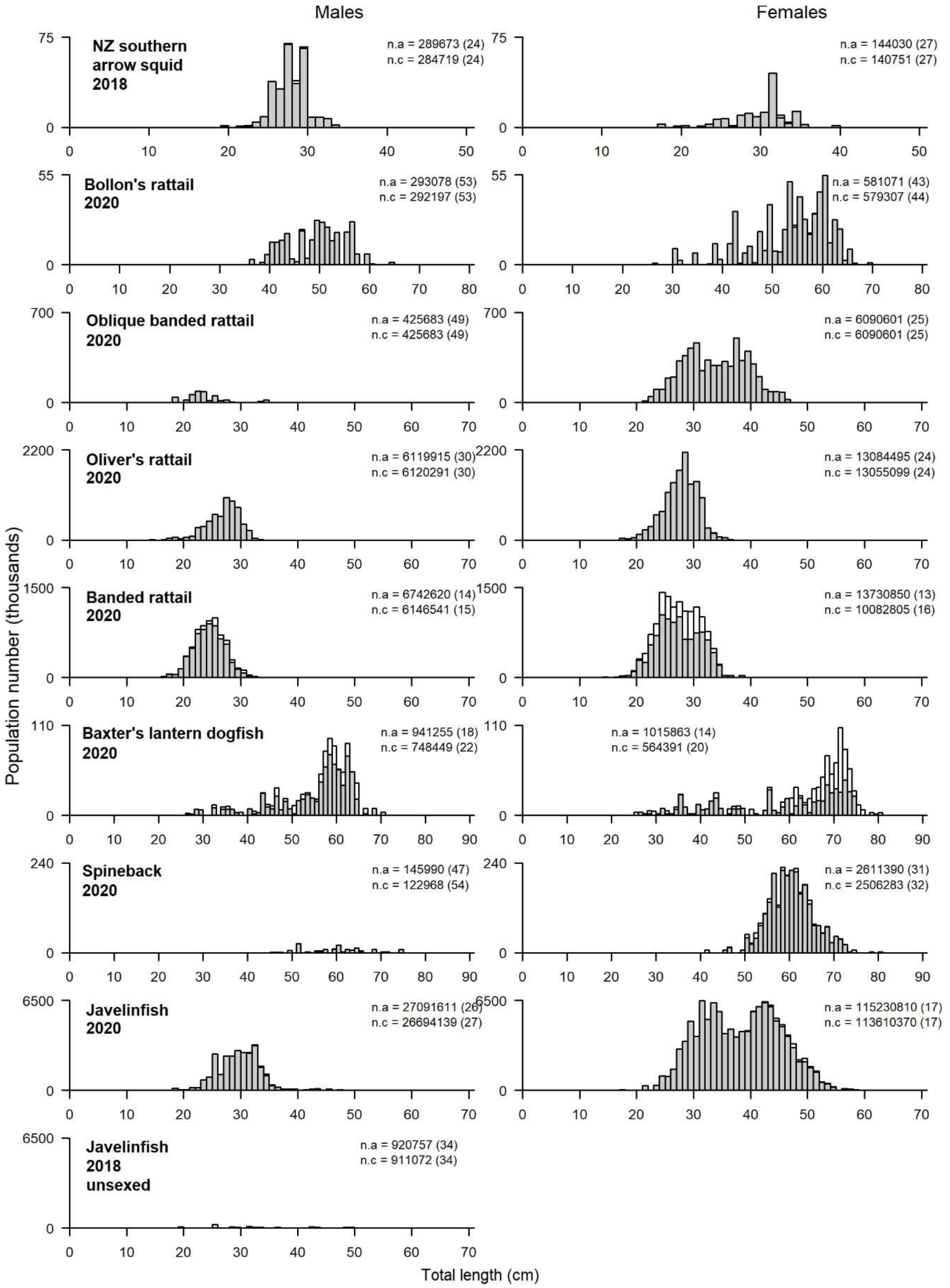


Figure 9: continued.

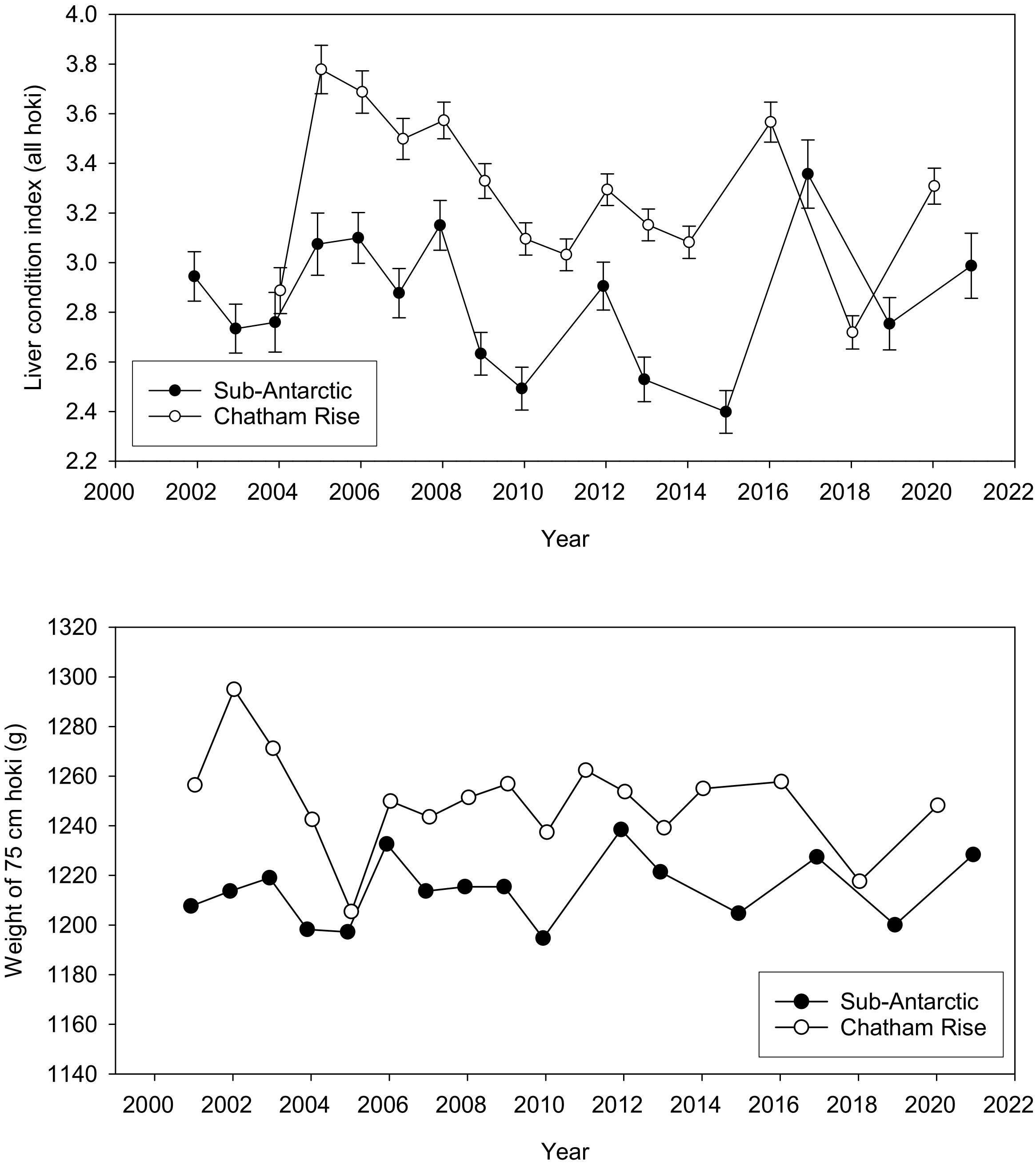


Figure 10: Liver (upper panel) and somatic (lower panel) condition indices of hoki sampled in the Sub-Antarctic summer trawl surveys since 2000. Condition indices are compared with those from the Chatham Rise survey (from Stevens et al. 2021).

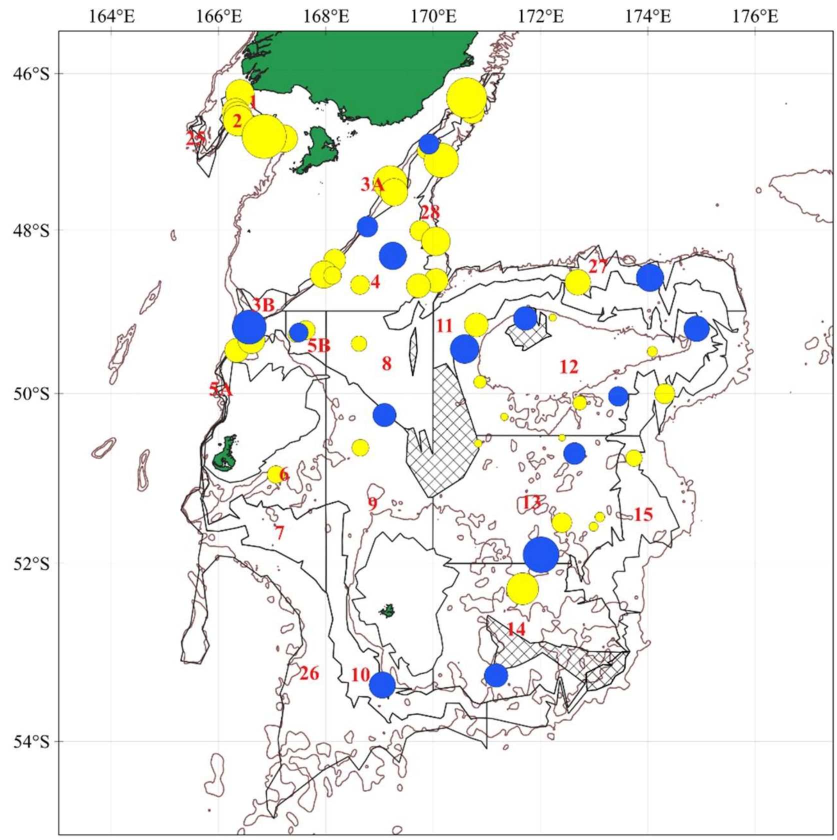
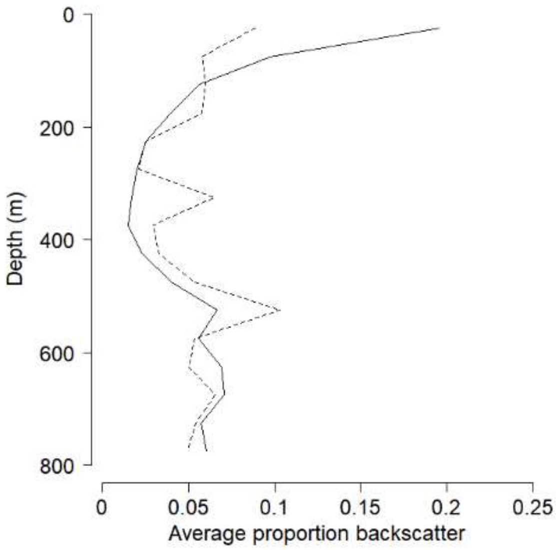


Figure 11: **Spatial distribution of total acoustic backscatter (m^2 km^{-2}) in the Sub-Antarctic observed during day trawl stations (yellow bubbles) and night steams (blue bubbles), using mean latitude and longitude for each type of acoustic recording. Circle area is proportional to the acoustic backscatter. Maximum circle size is 85 m^2 km^{-2}. Depth contours are at 500 and 1000 m. Trawl survey strata area indicated in red numbers.**



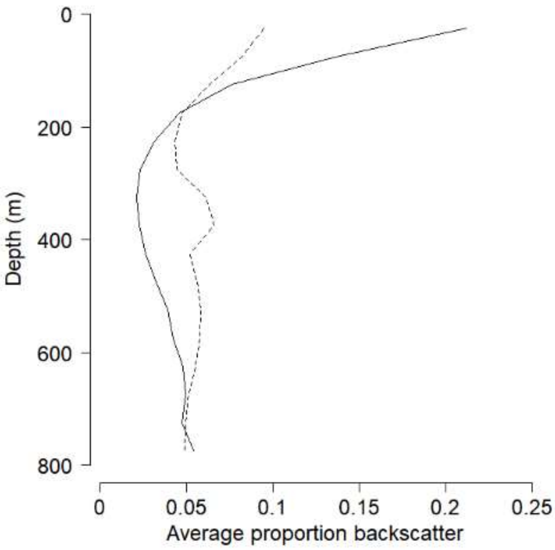


Figure 12: **Distribution of total acoustic backscatter integrated in 50 m depth bins on the Sub-Antarctic observed during the day (dashed lines) and at night (solid lines) in 2020 (left panel) and average distribution from 2000 to 2018 (right panel).**

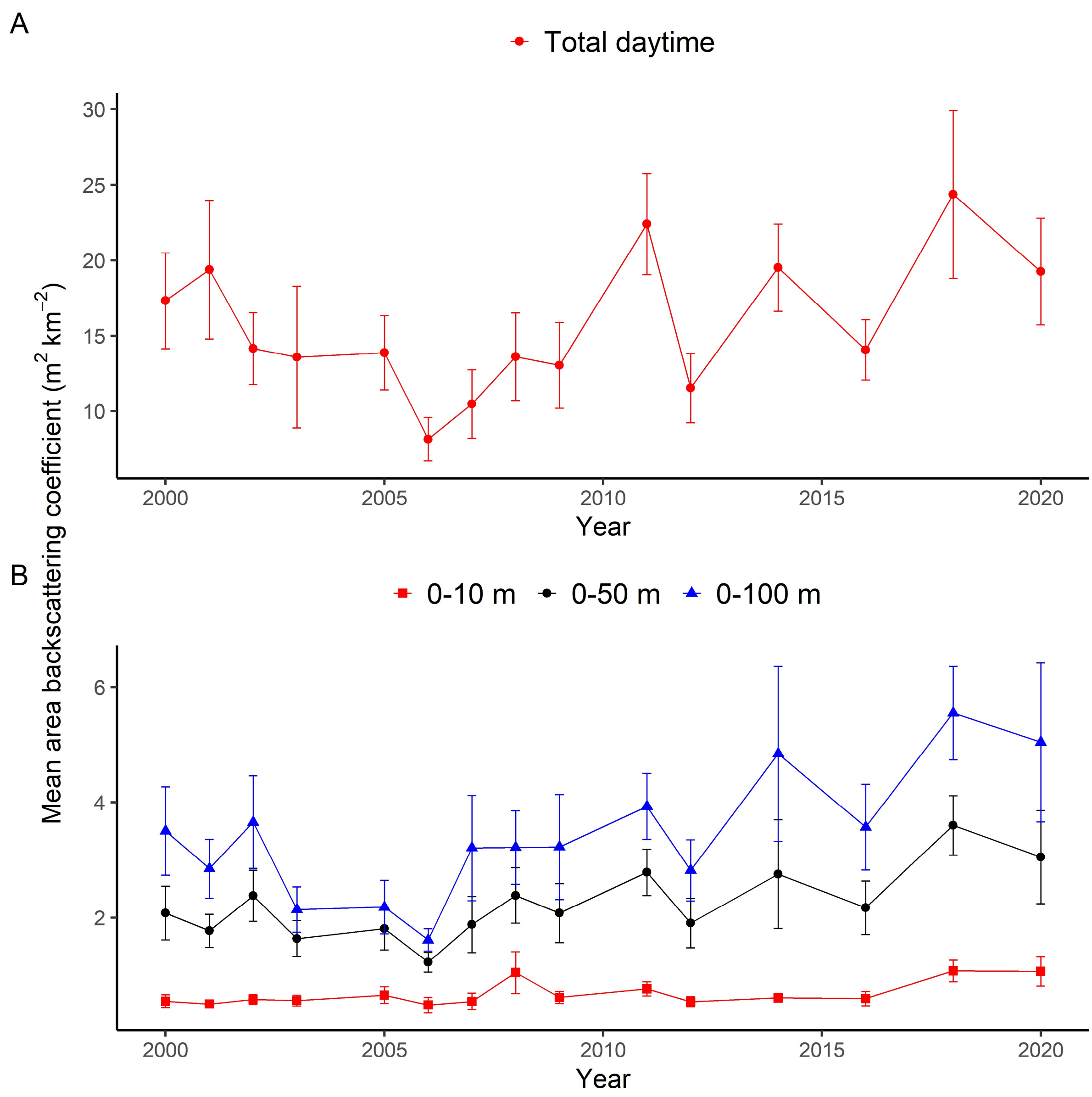


Figure 13: (A) Estimates of total acoustic backscatter; and (B) backscatter in the bottom 10, 50, and 100 m from 38 kHz data collected during daytime trawls in 2000–20. Error bars are ± 2 standard errors. Total backscatter estimates were obtained as the sum weighted average of the subareas estimates, where weighting was the proportional area (subareas: East 65.9%, Puysegur 1.5%, and West (including Stewart-Snares) 32.6%).

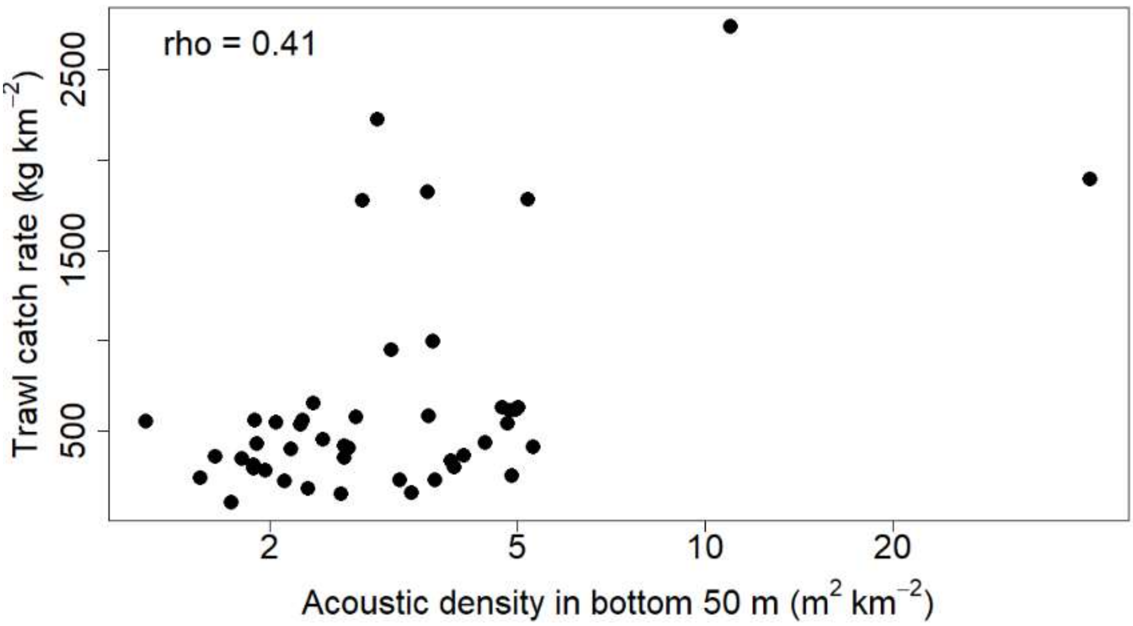


Figure 14: Relationship between total trawl catch rate (all species excluding benthic invertebrates) and acoustic backscatter recorded during the trawl in the Sub-Antarctic in 2020. Rho value is the Spearman's rank correlation coefficient.

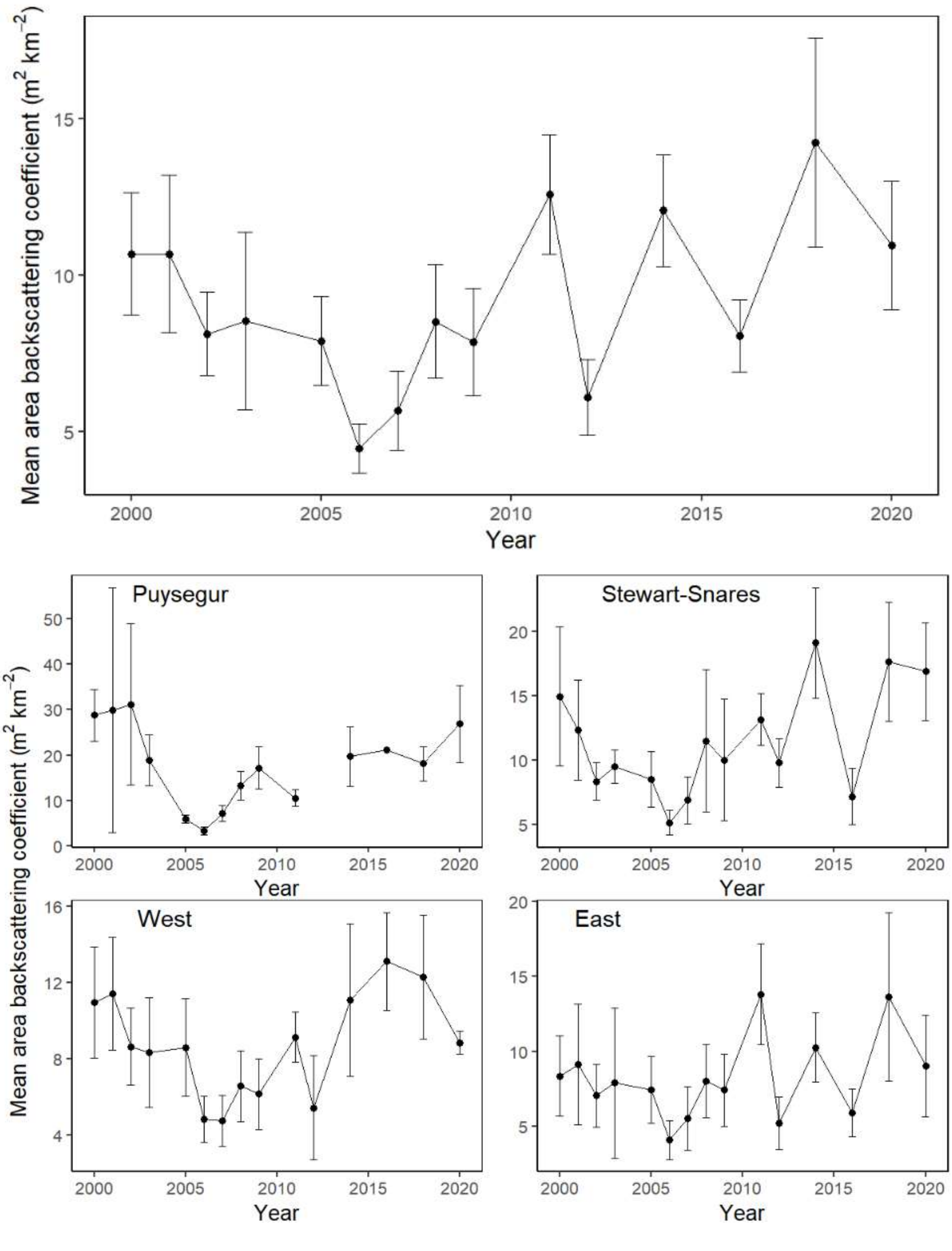


Figure 15: Time series of mesopelagic indices for the Sub-Antarctic (top panel) and by region (lower four panels). Mesopelagic indices for the Sub-Antarctic region (top panel) were obtained as the weighted average of region estimates, where weighting was the proportional area of the region (East 55.5% of total area, Puysegur 1.9%, Stewart-Snares 20.5%, West 22.1%). Error bars are ± 2 standard errors. Note that the 2012 survey did not produce any data suitable for acoustic analysis from Puysegur and there was only one data point for Puysegur in 2016.

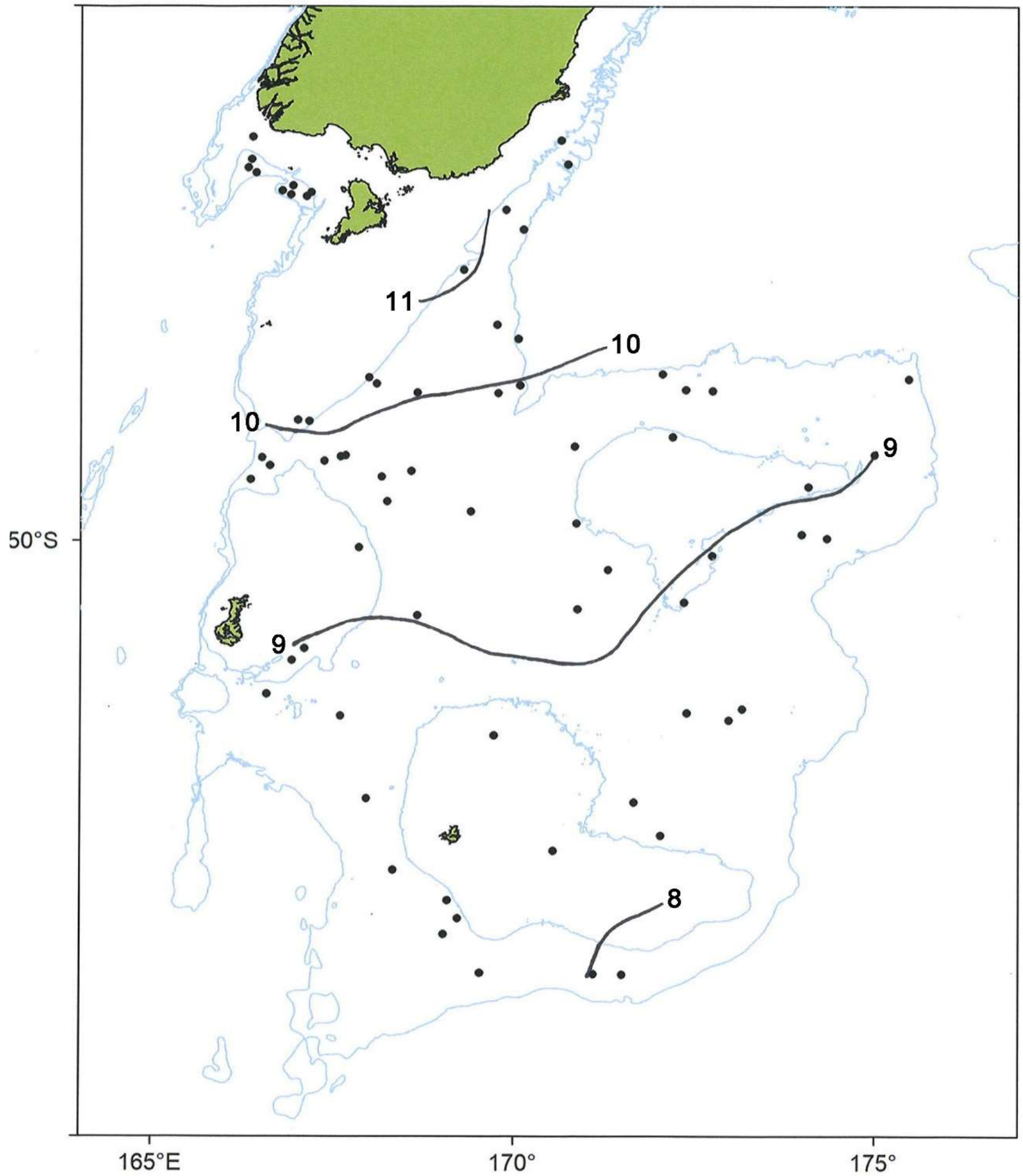


Figure 16: Surface water temperatures (°C). Points indicate station positions. Contours show isotherms estimated by eye.

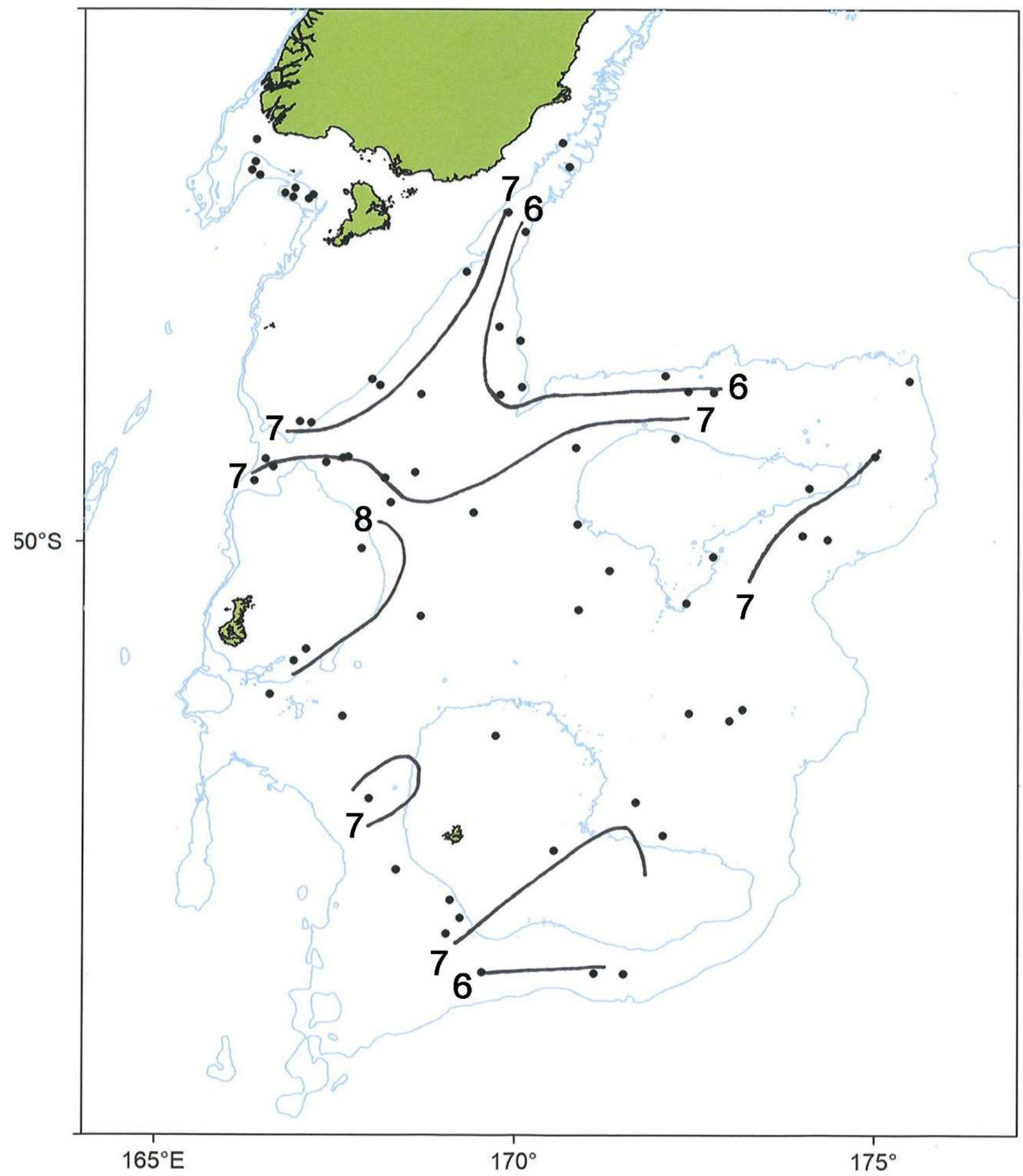


Figure 17: Bottom water temperatures (°C). Points indicate station positions. Contours show isotherms estimated by eye.

APPENDIX 1: Description of gonad staging for teleosts and elasmobranchs

Teleosts (Middle Depths method, MD)

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

Elasmobranchs (Generalised shark and skate stage method, SS)

Research gonad stage		Males	Females
1	Immature	Claspers shorter than pelvic fins, soft and uncalcified, unable or difficult to splay open Testes small.	Ovaries small and undeveloped. Oocytes not visible, or small (pin-head sized) and translucent, whitish.
2	Maturing	Claspers longer than pelvic fins, soft and uncalcified, unable or difficult to splay open or rotate forwards.	Some oocytes enlarged, up to about pea-sized or larger, and white to cream.
3	Mature	Claspers longer than pelvic fins, hard and calcified, able to splay open and rotate forwards to expose clasper spine.	Some oocytes large (greater than pea-sized) and yolky (bright yellow).
4	Gravid I	-	Uteri contain eggs or egg cases but no embryos are visible.
5	Gravid II	-	Uteri contain visible embryos. Not applicable to egg laying sharks and skates.
6	Post-partum	-	Uteri flaccid and vascularised. Indicating recent birth.

APPENDIX 2: Station details and catch of hoki, ling, and hake. *, foul trawl station

Station	Date	Stratum	Start Latitude (S)	Start Longitude (E)	Distance (n. mile)	Hoki (kg)	Ling (kg)	Hake (kg)
1	27-Nov-20	0028	46 31.91	170 44.52	2.98	1.9	-	3.6
2	27-Nov-20	003A	46 18.30	170 39.25	2.66	526.3	22.6	-
3	28-Nov-20	0004	46 57.85	169 53.45	3.04	23.5	84.4	-
4	28-Nov-20	0028	47 09.04	170 08.03	3.04	-	-	4.3
5	28-Nov-20	003A	47 21.87	169 17.53	2.96	1 532.5	105.4	-
6	28-Nov-20	003A	47 24.99	169 11.15	2.20	199.3	28.3	-
7	28-Nov-20	003A	47 31.65	169 18.56	3.00	208.3	54.2	-
8	29-Nov-20	003A	48 20.95	168 11.65	3.03	329.3	490.9	-
9	29-Nov-20	003A	48 31.46	167 59.68	2.98	2 086.2	555.8	-
10	29-Nov-20	0004	48 35.04	168 06.07	2.99	254.1	106.8	15.8
11	29-Nov-20	0004	48 39.74	168 40.40	3.04	47.5	43.3	-
12	30-Nov-20	0004	48 02.49	169 46.12	3.09	42.3	18.3	5.4
13	30-Nov-20	0028	48 10.05	170 03.86	2.98	2.6	-	-
14	30-Nov-20	0028	48 35.81	170 04.88	2.97	3.0	-	6.8
15	30-Nov-20	0004	48 40.18	169 46.70	3.01	11.8	3.1	3.1
16	1-Dec-20	0012	50 15.64	171 18.24	3.01	15.7	75.1	-
17	1-Dec-20	0012	49 50.59	170 51.58	2.96	34.1	75.8	-
18	1-Dec-20	0011	49 09.21	170 50.20	3.01	186.6	53.5	-
19	2-Dec-20	0012	49 04.19	172 12.17	3.06	27.0	101.0	-
20	2-Dec-20	0011	48 38.49	172 23.03	3.00	62.4	8.7	-
21	2-Dec-20	0027	48 29.62	172 03.98	2.98	-	-	-
22	2-Dec-20	0027	48 38.80	172 44.77	3.03	7.4	-	-
23	3-Dec-20	0027	48 32.51	175 28.36	3.00	-	-	-
24	5-Dec-20	0012	49 13.94	174 59.85	3.02	248.2	11.7	-
25	5-Dec-20	0012	49 31.08	174 05.06	2.98	10.0	57.0	-
26	5-Dec-20	0011	49 56.79	173 59.54	3.02	106.0	19.8	-
27	5-Dec-20	0011	49 58.81	174 20.43	3.02	17.1	3.5	-
28	6-Dec-20	0012	50 08.04	172 44.28	3.02	15.2	107.6	-
29	6-Dec-20	0013	50 32.65	172 21.44	3.04	56.3	91.3	-
30	6-Dec-20	0013	50 36.27	170 52.48	3.02	138.4	33.9	-
31	7-Dec-20	0015	50 48.01	173 44.37	3.01	46.5	14.9	-
32	7-Dec-20	0013	51 28.55	173 09.76	3.02	12.4	58.1	-
33	7-Dec-20	0013	51 34.19	172 58.47	2.92	20.5	27.9	-
34	7-Dec-20	0013	51 30.47	172 24.01	3.02	43.8	26.9	-
35	8-Dec-20	0014	52 16.17	171 39.90	3.00	103.3	24.1	-
36	8-Dec-20	0014	52 33.05	172 02.59	3.00	100.4	46.1	-
37	8-Dec-20	0014	52 40.52	170 32.67	2.99	54.7	72.8	-
38	9-Dec-20	0015	53 41.90	171 30.55	3.09	104.1	39.1	1.8
39	9-Dec-20	0015	53 41.71	171 06.15	3.00	90.2	19.2	6.8
40	9-Dec-20	0010	53 41.15	169 32.33	3.01	13.4	4.3	-
41	10-Dec-20	0010	53 22.02	169 02.06	3.03	149.9	40.4	-
42	10-Dec-20	0009	53 14.14	169 14.01	3.00	135.0	49.6	-
43	10-Dec-20	0009	53 05.47	169 05.31	3.02	172.2	26.7	-
44	10-Dec-20	0010	52 50.20	168 20.10	2.99	322.8	61.7	-
45	11-Dec-20	0009	51 42.03	169 43.84	3.04	73.8	-	-
46	11-Dec-20	0007	52 14.09	167 57.79	3.01	9.8	6.4	6.6
47	12-Dec-20	0007	51 32.00	167 35.83	3.01	76.1	53.1	-
48	13-Dec-20	0007	51 20.69	166 35.09	3.01	120.8	15.5	35.5
49	14-Dec-20	0006	51 03.16	166 55.58	3.02	85.1	24.2	2.3

Appendix 2 (continued).

Station	Date	Stratum	Start Latitude (S)	Start Longitude (E)	Distance (n. mile)	Hoki (kg)	Ling (kg)	Hake (kg)
50	14-Dec-20	0006	50 57.00	167 05.66	3.03	73.4	55.0	8.1
51*	14-Dec-20	0009	50 26.38	168 09.24	3.02	45.7	33.1	-
52	14-Dec-20	0009	50 39.70	168 40.42	2.99	77.0	89.0	-
53	15-Dec-20	0008	49 44.53	169 24.35	3.01	72.7	29.7	-
54	15-Dec-20	0008	49 22.76	168 35.13	3.03	269.8	45.1	24.1
55	15-Dec-20	0008	49 25.65	168 10.46	3.02	92.8	24.6	21.0
56	16-Dec-20	0008	49 38.84	168 15.32	3.00	117.6	99.4	-
57*	16-Dec-20	0006	49 43.40	167 52.10	3.02	-	-	-
58	16-Dec-20	0006	50 03.49	167 51.42	3.02	-	0.8	-
59	17-Dec-20	005B	49 14.20	167 40.10	3.02	21.1	77.3	-
60	17-Dec-20	005B	49 14.90	167 35.82	3.00	17.7	46.0	2.5
61	17-Dec-20	005B	49 17.31	167 22.11	3.00	33.1	55.4	38.1
62	17-Dec-20	005A	49 27.28	166 21.31	3.01	61.8	20.3	29.1
63	17-Dec-20	005A	49 19.66	166 37.11	3.04	263.6	79.3	157.6
64	18-Dec-20	005A	49 15.40	166 30.99	3.01	286.2	41.5	90.8
65	18-Dec-20	003B	48 55.00	167 00.33	3.02	11.9	8.2	-
66	18-Dec-20	003B	48 55.56	167 09.68	3.06	292.2	20.7	-
67	19-Dec-20	0001	46 47.97	167 10.99	2.27	117.5	1 592.0	-
68	19-Dec-20	0002	46 50.29	167 07.03	2.73	84.7	31.4	2.9
69	19-Dec-20	0002	46 44.36	166 56.07	3.05	235.3	159.2	7.6
70	19-Dec-20	0025	46 46.93	166 47.27	2.98	62.3	-	67.6
71	20-Dec-20	0001	46 16.46	166 22.77	3.02	157.8	1 382.4	-
72	20-Dec-20	0001	46 29.08	166 22.05	3.00	91.5	52.7	76.4
73	20-Dec-20	0002	46 33.94	166 18.99	3.01	23.5	24.1	5.0
74	20-Dec-20	0025	46 36.73	166 25.55	2.98	-	2.9	89.2
75	20-Dec-20	0025	46 49.31	166 53.88	3.01	10.4	8.3	93.5

APPENDIX 3: The occurrence (Occ., number of tows that caught each species)

Note that species codes are continually updated on the database following this and other surveys.

Scientific name	Common name	Species	Occ.
Algae	unspecified seaweed	SEO	1
Porifera	unspecified sponges	ONG	2
Demospongiae (siliceous sponges)			
Astrophorida (sandpaper sponges)			
Geodiidae			
Geodia regina	curling stone sponge	GRE	1
Pachymatisma sp.	rocky dumpling sponge	PAZ	2
Dictyoceratida (rubber sponges)			
Irciniidae			
Psammocinia cf. *hawere*	rubber sponge	PHW	1
Hadromerida (woody sponges)			
Suberitidae			
Suberites affinis	fleshy club sponge	SUA	15
Haplosclerida (air sponges)			
Callyspongiidae			
Callyspongia sp.	airy finger sponge	CRM	1
Poecilosclerida (bright sponges)			
Hymedesmiidae			
Phorbas sp.	grey fibrous massive sponge	PHB	6
Spirophorina (spiral sponges)			
Tetillidae			
Antarctotetilla leptoderma	furry oval sponge	TLD	5
Tetilla australis	bristle ball sponge	TTL	3
Hexactinellida (glass sponges)			
Lyssacinosida (tubular sponges)			
Rossellidae			
Hyalascus sp.	floppy tubular sponge	HYA	18
Cnidaria			
Scyphozoa	unspecified jellyfish	JFI	12
Anthozoa			
Actinaria (anemones)	unspecified anemone	ANT	1
Actiniidae			
Bolocera spp.	deepsea anemone	BOC	3
Liponematidae			
Liponema spp.	deepsea anemone	LIP	1
Actinostolidae (smooth deepsea anemones)		ACS	29
Hormathiidae (warty deepsea anemones)		HMT	22
Alcyonacea (soft corals)			
Alcyoniidae			
Anthomastus (*Bathyalcyon*) *robustus*	gigantic coral	ARO	2
Primnoidae	unspecified primnoid	PRI	2
Thourella spp.	bottlebrush coral	THO	1
Corallimorpharia (coral-like anemones)			
Corallimorphidae	coral-like anemones	CLM	4
Pennatulacea (sea pens)			
Pteroeididae			
Gyrophyllum sibogae	siboga sea pen	GYS	2
Hexacorallia			
Zoanthidea (zoanthids)			
Epizoanthidae			
Epizoanthus sp.		EPZ	1

Appendix 3 (continued).

Scientific name	Common name	Species	Occ.
Scleractinia (stony corals)			
Caryophyllidae			
Stephanocyathus platypus	solitary bowl coral	STP	1
Flabellidae			
Flabellum spp.	flabellum coral	COF	1
Thaliacea			
Pyrosomida (pyrosomes)			
Pyrosomatidae			
Pyrosoma atlanticum		PYR	33
Salpida (salps)	unspecified salps	SAL	4
Salpidae			
Thetys vagina		ZVA	3
Mollusca			
Gastropoda (gastropods)	unspecified gastropod	GAS	1
Littorinimorpha			
Ranellidae (tritons)			
Fusitriton magellanicus		FMA	14
Neogastropoda			
Volutidae (volutes)			
Provocator mirabilis	golden volute	GVO	2
Nudibranchia	unspecified nudibranch	NUD	2
Cephalopoda			
Teuthoidea (squids)			
Oegopsida			
Brachioteuthidae			
Brachioteuthis/Slosarczykovia sp.		SQB	2
Histioteuthidae (violet squids)			
Histioteuthis spp.	violet squid	VSQ	7
Lycoteuthidae			
Lycoteuthis lorigera		LSQ	1
Octopoteuthidae			
Taningia danae	Dana octopus squid	TDQ	1
Taningia fimbria		TDQ	1
Taningia spp.		TDQ	1
Ommastrephidae			
Nototodarus sloanii	Sloan's arrow squid	NOS	26
Todarodes angolensis		TAG	25
T. filippovae		TSQ	5
Onychoteuthidae			
Moroteuthopsis ingens	warty squid	MIQ	58
Onykia robsoni + *O.* sp. A	warty squid	MRQ	5
Octopodiformes			
Octopoda	unspecified octopus	OCP	1
Cirrata (cirrate octopus)			
Opisthoteuthidae			
Opisthoteuthis spp.	umbrella octopus	OPI	4
Incirrata (incirrate octopus)			
Octopodidae			
Enteroctopus zealandicus	yellow octopus	EZE	3
Graneledone taniwha	deepwater octopus	GTA	8
Muusoctopus spp.	octopus	BNO	4
Arthropoda			
Pycnogonida	unspecified sea spider	PYC	1

Appendix 3 (continued).

Scientific name	Common name	Species	Occ.
Crustacea			
Malacostraca			
Decapoda			
Dendrobranchiata/Pleocyemata			
Dendrobranchiata			
Sergestidae			
Sergia potens		SEP	4
Pleocyemata			
Caridea			
Campylonotidae			
Campylonotus rathbunae	sabre prawn	CAM	3
Oplophoridae			
Acanthephyra spp.	Sub-Antarctic ruby prawn	ACA	2
Pasiphaeidae			
Pasiphaea barnardi	deepwater prawn	PBA	6
Nematocarcinidae			
Lipkius holthuisi	omega prawn	LHO	26
Achelata			
Astacidea			
Nephropidae (clawed lobsters)			
Metanephrops challengeri	scampi	SCI	4
Anomura			
Lithodoidea			
Lithodidae (king crabs)			
Lithodes aotearoa	New Zealand king crab	LAO	10
L. robertsoni	Robertson's king crab	LRO	1
Neolithodes brodiei	Brodie's king crab	NEB	1
Paralomis zealandica	Prickly king crab	PZE	3
Paguroidea (Pagurid and parapagurid hermit crabs)		PAG	7
Parapaguridae (Parapagurid hermit crabs)			
Sympagurus dimorphus	hermit crab	SDM	5
Lophogastrida			
Gnathophausiidae			
Neognathophausia ingens	giant red mysid	NEI	1
Brachyura (true crabs)			
Majidae (spider crabs)			
Jacquinotia edwardsii	giant spider crab	GSC	2
Leptomithrax garricki	Garrick's masking crab	GMC	1
Teratomaia richardsoni	spiny masking crab	SMK	2
Echinodermata			
Asteroidea (starfish)			
Asteriidae			
Pseudechinaster rubens	starfish	PRU	1
Sclerasterias mollis	cross-fish	SMO	4
Astropectinidae			
Dipsacaster magnificus	magnificent sea-star	DMG	10
Plutonaster knoxi	abyssal star	PKN	1
Proserpinaster neozelanicus	starfish	PNE	2
Psilaster acuminatus	geometric star	PSI	3
Brisingida	unspecified brisingid	BRG	2
Goniasteridae			
Ceramaster patagonicus	pentagon star	CPA	8
Hippasteria phrygiana	trojan starfish	HTR	16
Lithosoma novaezelandiae	rock star	LNV	11
Pillsburiaster aoteanus	starfish	PAO	15

Appendix 3 (continued).

Scientific name	Common name	Species	Occ.
Odontasteridae			
Odontaster spp.	pentagonal tooth-star	ODT	1
Solasteridae			
Crossaster multispinus	sun star	CJA	6
Solaster torulatus	chubby sun-star	SOT	3
Pterasteridae			
Diplopteraster sp.	starfish	DPP	1
Zoroasteridae			
Zoroaster spp.	rat-tail star	ZOR	26
Ophiuroidea (basket and brittle stars)	unspecified brittle star	OPH	1
Echinoidea (sea urchins)			
Regularia			
Cidaridae			
Goniocidaris parasol	parasol urchin	GPA	3
Echinothuriidae/Phormosomatidae	unspecified Tam O'Shanter urchin	TAM	18
Echinidae			
Dermechinus horridus	deepsea urchin	DHO	1
Gracilechinus multidentatus	deepsea kina	GRM	1
Holothuroidea	unspecified holothurian	HTH	2
Aspidochirotida			
Synallactidae			
Bathyplotes sp.	sea cucumber	BAM	4
Pseudostichopus mollis	sea cucumber	PMO	27
Elasipodida			
Laetmogonidae			
Laetmogone sp.	sea cucumber	LAG	2
Pannychia moseleyi	sea cucumber	PAM	3
Chondrichthyes (cartilaginous fishes)			
Chimaeridae: chimaeras, ghost sharks			
Chimaera carophila	brown chimaera	CHP	2
C. lignaria	giant chimaera	CHG	2
Hydrolagus bemisi	pale ghost shark	GSP	65
H. novaezealandiae	dark ghost shark	GSH	14
Rhinochimaeridae: longnosed chimaeras			
Harriotta raleighana	longnose spookfish	LCH	44
Rhinochimaera pacifica	Pacific spookfish	RCH	11
Cetorhinidae: basking sharks			
Cetorhinus maximus	basking shark	BSK	1
Scyliorhinidae: cat sharks			
Apristurus exsanguis	New Zealand catshark	AEX	4
A. cf. *sinensis*	freckled catshark	ASI	1
Bythaelurus dawsoni	Dawson's catshark	DCS	4
Cephaloscyllium isabella	carpet shark	CAR	1
Triakidae: smoothhounds			
Galeorhinus galeus	school shark	SCH	1
Squalidae: dogfishes			
Squalus acanthias	spiny dogfish	SPD	32
Centrophoridae: gulper sharks			
Centrophorus squamosus	leafscale gulper shark	CSQ	12
Deania spp.	shovelnose spiny dogfish	SND	16
Etmopteridae: lantern sharks			
Etmopterus granulosus	Baxter's dogfish	ETB	31
E. lucifer	lucifer dogfish	ETL	38
E. pusillus	smooth lanternshark	ETP	1
E. unicolor	shortspine dogfish	ETU	3

Appendix 3 (continued).

Scientific name	Common name	Species	Occ.
Somniosidae: sleeper sharks			
Centroselachus crepidater	longnose velvet dogfish	CYP	17
Centroscymnus owstoni	Owston's dogfish	CYO	3
Proscymnodon plunketi	Plunket's shark	PLS	5
Dalatiidae: kitefin sharks			
Dalatias licha	seal shark	BSH	5
Oxynotidae: rough sharks			
Oxynotus bruniensis	prickly dogfish	PDG	1
Rajidae: skates			
Amblyraja hyperborea	deepwater spiny skate	DSK	2
Dipturus innominatus	smooth skate	SSK	10
Zearaja nasuta	rough skate	RSK	5
Arhynchobatidae: softnose skates			
Bathraja shuntovi	longnosed deepsea skate	PSK	2
Brochiraja asperula	smooth deepsea skate	BTA	6
B. spinifera	prickly deepsea skate	BTS	3
Osteichthyes (bony fishes)			
Notocanthidae: spiny eels			
Notacanthus sexspinis	spineback	SBK	33
Synaphobranchidae: cutthroat eels			
Diastobranchus capensis	basketwork eel	BEE	10
Nemichthyidae: snipe eels			
Labichthys yanoi	Yano's snipe eel	LAY	1
Nemichthys curvirostris	snipe eel	NCU	1
Congridae: conger eels			
Bassanago bulbiceps	swollenhead conger	SCO	29
B. hirsutus	hairy conger	HCO	33
Serrivomeridae: sawtooth eels			
Serrivomer samoensis	common sawtooth eel	SSA	1
Gonorynchidae: sandfishes			
Gonorhynchus forsteri	sandfish	GON	1
Argentinidae: silversides			
Argentina elongata	silverside	SSI	32
Opisthoproctidae: spookfishes			
Winteria telescopa	slender spookfish	WNT	1
Bathylagidae: deepsea smelts			
Bathylagichthys parini	Parin's deepsea smelt	BPA	1
Platytroctidae: tubeshoulders			
Persparsia kopua	common tubeshoulder	PER	7
Alepocephalidae: slickheads			
Alepocephalus antipodianus	smallscaled brown slickhead	SSM	8
Phosichthyidae: lighthouse fishes			
Phosichthys argenteus	lighthouse fish	PHO	21
Sternoptychidae: hatchetfishes			
Argyropelecus gigas	giant hatchetfish	AGI	1
Stomiinae: scaly dragonfishes			
Stomias boa	scaly dragonfish	SBB	6
Chauliodontinae: viperfishes			
Chauliodus sloani	viperfish	CHA	4
Idiacanthinae: black dragonfishes			
Idiacanthus atlanticus	common black dragonfish	IAT	1
Malacosteinae: loosejaws			
Malacosteus australis	southern loosejaw	MAU	1
Notosudidae: waryfishes			
Scopelosaurus hamiltoni	giant waryfish	SHM	1

Appendix 3 (continued)

Scientific name	Common name	Species	Occ.
Paralepididae: barracudinas			
Magnisudis prionosa	giant barracudina	BCA	1
Myctophidae: lanternfishes	unspecified lanternfish		
Gymnoscopelus fraseri	Fraser's lanternfish	GYF	1
G. hintonoides	false-midas lanternfish	GYH	1
G. piabilis	southern blacktip lanternfish	GYP	3
G. spp.	lanternfish	GYM	2
Lampanyctus australis	austral lanternfish	LAU	2
L. intricarius	intricate lanternfish	LIT	4
Nannobrachium achirus	cripplefin lanternfish	LAC	1
Symbolophorus boops	bogue lanternfish	SBP	1
Trachipteridae: dealfishes			
Trachipterus trachypterus	dealfish	DEA	2
Carapidae: pearlfishes			
Echiodon cryomargarites	messmate fish	ECR	1
Ophidiidae: cuskeels			
Genypterus blacodes	ling	LIN	65
Himantolophidae: prickly anglerfishes			
Himantolophus spp.	prickly anglerfishes	HIM	1
Ceratiidae: sea devils			
Cryptopsaras couesii	warty sea devil	SDE	1
Macrouridae: rattails			
Coelorinchus aspercephalus	oblique banded rattail	CAS	29
C. bollonsi	Bollons' rattail	CBO	18
C. fasciatus	banded rattail	CFA	59
C. innotabilis	notable rattail	CIN	13
C. kaiyomaru	Kaiyomaru rattail	CKA	6
C. matamua	Mahia rattail	CMA	9
C. oliverianus	Oliver's rattail	COL	48
C. parvifasciatus	small banded rattail	CCX	4
Coryphaenoides dossenus	humpback rattail	CBA	7
C. serrulatus	serrulate rattail	CSE	6
C. subserrulatus	four-rayed rattail	CSU	19
Lepidorhynchus denticulatus	javelinfish	JAV	71
Lucigadus nigromaculatus	blackspot rattail	VNI	19
Macrourus carinatus	ridge scaled rattail	MCA	21
Mesobius antipodum	black javelinfish	BJA	3
Trachyrincidae: rough rattails			
Trachyrincus aphyodes	white rattail	WHX	3
Moridae: morid cods			
Antimora rostrata	violet cod	VCO	5
Halargyreus sp.	Australasian slender cod	HAS	12
Lepidion microcephalus	small-headed cod	SMC	8
Mora moro	ribaldo	RIB	34
Notophycis marginata	dwarf cod	DCO	2
Pseudophycis bachus	red cod	RCO	4
Merlucciidae: hakes			
Lyconus pinnatus	fangtooth hoki	LYC	3
Macruronus novaezelandiae	hoki	HOK	69
Merluccius australis	hake	HAK	26
Gadidae: true cods			
Micromesistius australis	southern blue whiting	SBW	24
Diretmidae: discfishes			
Diretmus argenteus	discfish	DIS	1

Appendix 3 (continued).

Scientific name	Common name	Species	Occ.
Trachichthyidae: roughies, slimeheads			
Hoplostethus atlanticus	orange roughy	ORH	9
H. mediterraneus	silver roughy	SRH	3
Cyttidae: cyttid dories			
Cyttus novaezealandiae	silver dory	SDO	1
C. traversi	lookdown dory	LDO	31
Zeniontidae: armoureye dories			
Capromimus abbreviatus	capro dory	CDO	2
Oreosomatidae: oreos			
Allocyttus niger	black oreo	BOE	10
Neocyttus rhomboidalis	spiky oreo	SOR	4
Pseudocyttus maculatus	smooth oreo	SSO	12
Macrorhamphosidae: snipefishes			
Centriscops humerosus	banded bellowsfish	BBE	1
Congiopodidae: pigfishes			
Alertichthys blacki	alert pigfish	API	1
Congiopodus leucopaecilus	pigfish	PIG	1
Hoplichthyidae: ghostflatheads			
Hoplichthys cf. *haswelli*	deepsea flathead	FHD	3
Psychrolutidae: toadfishes			
Ambophthalmos angustus	pale toadfish	TOP	18
Psychrolutes microporos	blobfish	PSY	1
Epigonidae: deepwater cardinalfishes			
Epigonus lenimen	bigeye cardinalfish	EPL	5
E. telescopus	deepsea cardinalfish	EPT	7
Bramidae: pomfrets			
Brama australis	southern Ray's bream	SRB	9
Taractichthys longipinnis	big-scale pomfret	BSP	1
Nototheniidae: ice cods			
Notothenia microlepidota	smallscale cod	SCD	1
Uranoscopidae: armourhead stargazers			
Kathetostoma giganteum	giant stargazer	GIZ	15
Gempylidae: snake mackerels			
Paradiplospinus gracilis	false frostfish	PDS	1
Rexea solandri	gemfish	RSO	10
Thyrsites atun	barracouta	BAR	2
Centrolophidae: raftfishes, medusafishes			
Centrolophus niger	rudderfish	RUD	6
Pseudoicichthys australis	ragfish	RAG	3
Seriolella caerulea	white warehou	WWA	18
S. punctata	silver warehou	SWA	9
Tubbia tasmanica	Tasmanian ruffe	TUB	1
Bothidae: lefteyed flounders			
Arnoglossus scapha	witch	WIT	1
Achiropsettidae: finless flounders			
Neoachiropsetta milfordi	finless flounder	MAN	24

APPENDIX 4: Species code changes or combined species groupings

Combined species names or groups	Combined species code	Species codes that are grouped together
Giant stargazer	GIZ	STA, GIZ
Gemfish	RSO	SKI, RSO
Tarakihi	NMP	TAR, NMP
Combined Catsharks	APR	APR, AEX, AAM, AGK, AML, APN, ASI
Johnson’s cod	HJO	HJO, HAS, HJC
Sea perch	SPE	SPE, HBA, HPC
Ray’s Bream	RBM	BBR, RBM, SRB
Anemones	ANT	ACS, ANT, BOC, HMT, LIP, CLM
Crabs	CRB	ATC, CRB, CVI, DAP, DIR, GMC, KCU, LLT, PAG, PZE, SDM, SMK, SPI, LMU, NCB, NEB, NEC, OVM, PHS
Cardinalfish	EPM	EPM, EPR, ERB, EPT
Combined Corals	COU	ATP, BOO, BTP, CAY, CBR, CHR, CIR, CLG, CLL, COB, COF, COO, COR, COU, CRE, CRY, CTP, CUP, DDI, DEN, ERO, ERR, FUG, GDU, GOC, HDR, IRI, ISI, JAA, LEI, LIL, LLE, LPP, LPT, LSE, MIN, MOC, MTL, NAR, OVI, PAB, PAN, PLE, PLL, PML, PMN, PRI, PTP, SIA, SOC, SPN, STI, STL, STP, STS, SVA, THO, TPT, TRH
Sea cucumbers	SCC	BAM, HTH, LAG, PAM, PMO, SCC
Urchins	ECN	ARA, DHO, ECH, ECN, GPA, GRM, PBU, PMU, SPT, TAM, ACO, CID, ECT, GOU, HIS, OBE, PCD, PSA, STC, SUR, URO
Gastropod molluscs	GAS	AER, AWI, GVO, VOL, GAS, FMA
Giant spider crab	GSC	GSC, SSC
Octopuses	OCP	DWO, EZE, OCP, OCT, OPI, AMP, BNO, OHU
Sponges	ONG	ANZ, GLS, HYA, ONG, SUA, APU, CIC, CPG, CRM, CRS, DSO, ERE, GVE, PAZ, PHB, PHW, THN, TLD, TTL
Prawns	PRA	ACA, AFO, APE, ARI, CAM, FUN, HSI, NAU, NMA, ONO, OPP, PAS, PBA, PED, PLM, PRA, PTA, SEP, SER
Salps	SAL	SAL, PYR, ZVA
Starfishes	SFI	ASR, CDY, CJA, DMG, GOR, HTR, MSL, OPH, PKN, PLT, PRU, PSI, SFI, SMO, SOT, ZOR, BCH, BES, BPI, BRG, CMP, CPA, DPP, HEC, LNV, MAT, ODT, PAO, PHM, PLI, PNE, RGR, ZAT, ZSU
Squid	SQU	LSQ, OPO, RSQ, SQX, VSQ, CHQ, PSQ, RSQ, SEQ, SQU, TAG, TPE, TSQ, OSQ, TDQ, MIQ, MRQ, WSQ
Lanternfishes	LAN	DIA, GYM, GYP, LAN, LHE, LPA, LPD, SYM, MMU, PHO, PRO, ELC, GYB, LIT, PGE
Toadfishes	TOA	COT, PSY, TOA, TOD, TOP, VST
Skates (not RSK or SSK)	SKA	BTA, BTH, BTS, PSK, SKA, DSK, RIS

APPENDIX 5: Scientific and common names of invertebrates identified following the voyage.

NIWA No.	Cruise/Station_no.	Class	Order	Family	Genus	Species
156972	TAN2014/13	Hydrozoa	Siphonophora	Rhodaliidae		
157218	TAN2014/14	Cephalopoda	Oegopsida	Brachioteuthidae	*Brachioteuthis*	
157307	TAN2014/74	Cephalopoda	Oegopsida	Octopoteuthidae	*Taningia*	
157220	TAN2014/59	Cephalopoda	Oegopsida	Octopoteuthidae	*Taningia*	*danae*?
157219	TAN2014/4	Cephalopoda	Oegopsida	Octopoteuthidae	*Taningia*	*fimbria*
157207	TAN2014/31	Cephalopoda	Oegopsida	Ommastrephidae	*Todarodes*	*angolensis*
157209	TAN2014/18	Cephalopoda	Oegopsida	Ommastrephidae	*Todarodes*	*angolensis*
157210	TAN2014/18	Cephalopoda	Oegopsida	Ommastrephidae	*Todarodes*	*angolensis*
157211	TAN2014/18	Cephalopoda	Oegopsida	Ommastrephidae	*Todarodes*	*angolensis*
157214	TAN2014/31	Cephalopoda	Oegopsida	Ommastrephidae	*Todarodes*	*angolensis*
157215	TAN2014/40	Cephalopoda	Oegopsida	Ommastrephidae	*Todarodes*	*angolensis*
157222	TAN2014/31	Cephalopoda	Oegopsida	Ommastrephidae	*Todarodes*	*angolensis*
157223	TAN2014/31	Cephalopoda	Oegopsida	Ommastrephidae	*Todarodes*	*angolensis*
157224	TAN2014/31	Cephalopoda	Oegopsida	Ommastrephidae	*Todarodes*	*angolensis*
157225	TAN2014/31	Cephalopoda	Oegopsida	Ommastrephidae	*Todarodes*	*angolensis*
157226	TAN2014/31	Cephalopoda	Oegopsida	Ommastrephidae	*Todarodes*	*angolensis*
157228	TAN2014/31	Cephalopoda	Oegopsida	Ommastrephidae	*Todarodes*	*angolensis*
157229	TAN2014/40	Cephalopoda	Oegopsida	Ommastrephidae	*Todarodes*	*angolensis*
157206	TAN2014/70	Cephalopoda	Oegopsida	Ommastrephidae	*Todarodes*	*filippovae*
157208	TAN2014/75	Cephalopoda	Oegopsida	Ommastrephidae	*Todarodes*	*filippovae*
157212	TAN2014/70	Cephalopoda	Oegopsida	Ommastrephidae	*Todarodes*	*filippovae*
157213	TAN2014/70	Cephalopoda	Oegopsida	Ommastrephidae	*Todarodes*	*filippovae*