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Tini a Tangaroa

Trawl survey of hoki and middle-depth species in the Southland and Sub-Antarctic areas, November–December 2018 (TAN1811)

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The eighteenth *Tangaroa* trawl survey of the Sub-Antarctic summer series was conducted from 23 November to 22 December 2018. Previous summer surveys were in 1991–1993, 2000–2009, 2011, 2012, 2014 and 2016. 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. All 81 planned phase one stations were completed in 20 strata. There was insufficient time to carry out any phase two stations.

Biomass estimates (and CVs) for all strata (300–1000 m) were 31 476 t (11.2%) for hoki, 21 286 t (10.4%) for ling, and 1785 t (23.6%) for hake. For the core strata (300–800 m) the hoki biomass was 31 098 t (11.3%), the ling biomass was 21 270 t (10.4%), and the hake biomass was 1354 t (28.5%). This was an 18% decrease for hoki, a 20% decrease for ling, and a 35% increase for hake when compared to the 2016 biomass estimates. The estimated biomass of southern blue whiting in 2018 was 19 666 t (28.5%), a 45% decrease from the 2016 estimate.

The hoki length frequency in 2018 showed a broad mode of fish greater than 50 cm. Modal ages for hoki were 3, 5, and 7 years which correspond to the 1, 3, and 5 year old fish seen in 2016. The hake length distribution was broad and showed modes at about 50–70 cm and 80–90 cm. Most male hake were between 3 and 8 years old and most females between 3 and 15. The ling length distribution was also broad with few males over 95 cm and few females over 120 cm. Most ling were between 4 and 17 years old.

Acoustic data were also collected during the trawl survey. Data quality in 2018 was very good overall, and 94% of acoustic files were suitable for quantitative analysis. Total daytime backscatter in the water column was 70% higher than that recorded in 2016, and the highest in the time-series. The acoustic index of mesopelagic fish abundance was also the highest in the time series, driven by large increases in mesopelagic backscatter in the eastern Sub-Antarctic and on the Stewart-Snares shelf. Mesopelagic backscatter in the western Sub-Antarctic and at Puysegur in 2018 were lower than the 2016 values for these subareas. There was no 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 204 species or species groups were caught, 24 560 fish, elasmobranchs, or squid of 90 different species were measured, and 11 648 fish were individually weighed during the 2018 survey. The liver condition of 1129 hoki were recorded. Otoliths were collected from 1476 hoki, 287 hake, and 1058 ling.

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, hake, and ling. Hoki is New Zealand's largest fishery, with a TACC of 150 000 t in 2018–19, although 20 000 t was 'shelved' by industry agreement. 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 Southland and Sub-Antarctic (including Puysegur) peaked at over 35 000 t in 1999–00 to 2001–02 but have since declined and were about 16 500 t in 2017–18. Hoki are managed as a single stock throughout the 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 2018–19 (including Southland and Sub-Antarctic) was 70 000 t with the remaining 60 000 t allocated to the eastern fishery. Hake and ling are also important commercial species in Southland and Sub-Antarctic. In 2017–18 catches of hake in the southern areas were 1349 t (HAK 1, includes the western Chatham Rise) and for ling were 4034 t (LIN 5, Southland), and 4846 t (LIN 6, Sub-Antarctic).

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, 2011–12, 2014, and 2016; and an autumn series in March–June 1992, 1993, 1996 and 1998 (reviews by O'Driscoll & Bagley 2001 and 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 as the biomass estimates were generally higher and more precise at this time of year. Autumn surveys also allowed the proportion of hoki maturing to spawn 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. There was a large (threefold) increase in estimates of hoki abundance 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 was down by 43% from 2012 and 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).

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 assessment. The most recent review of all the summer Sub-Antarctic trawl survey *Tangaroa* 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 trawls and while steaming between stations on all trawl surveys of 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). 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 on the Sub-Antarctic is a high priority to provide information required to update the assessment of hoki and other middle depth species. The survey is now carried out biennially. The 2018 survey provided the eighteenth summer estimate of western hoki biomass in time for the 2019 stock assessment.

1.1 Project objectives

This report is the final reporting requirement for 2018 survey that comes under Fisheries New Zealand Research Project MID2018-01. The 2020 survey will be carried out in November–December 2020.

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 2018 survey was carried out from 23 November to 22 December 2018 and followed a two-phase stratified random design (after Francis 1984). The survey area was divided into 20 strata by depth (300–600, 600–800, and 800–1000 m) and area (Figure 1). There are 15 core 300–800 m strata (Strata 1 to 15) which 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 as catches of hake, hoki, and ling from adjacent strata are small. Known areas of extensive foul ground were excluded from the survey. Trawls were conducted in the Campbell East and Sub-Antarctic Deep Benthic Protected Areas (BPAs). Written approval to sample within these BPAs was granted by Fisheries New Zealand (letter to NIWA dated 14 November 2018).

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 2007–16 surveys, as these best reflect the recent pattern of distribution of hoki. Allocation of stations for hake and ling was based on all surveys from 2000. A minimum of three stations per stratum was used. As in previous years, conservative target 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 81 stations was planned for phase 1 (Table 1). Seventy-five stations were required to meet the target CVs and an additional six stations were added outside of the statistical framework because of the need to focus effort on covering the full distributional range of hake age classes. 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.

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. 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 0500 h and 1944 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 hauled early due to reducing daylight or strong marks on the net monitor, the tow was included as valid only if at least 2 n. miles was covered. 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 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 into 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 for future ageing 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 previous surveys. Bottom values were from about 7 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 echosounders with hull-mounted transducers. All frequencies were regularly calibrated following standard procedures (Demer et al. 2015), with the most recent calibration on 18 January 2019 in Antarctica. The time-series of system and calibration parameters are given in Appendix F of O'Driscoll et al. (2019).

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 programme *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 (codes 1 or 2) 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 data from this survey, where possible. Where there were insufficient data (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) then length-weight data from all Sub-Antarctic summer series was used (Table 2).

Hoki and ling otoliths were prepared and aged using validated ageing methods (hoki, Horn & Sullivan (1996) as modified by Cordue et al. (2000); and ling, Horn (1993)). Otoliths were removed from 1476 hoki, 1058 ling, and 287 hake, and sub-samples of 745 hoki and 613 ling otoliths were selected for ageing. All hake otoliths were selected for ageing. 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 custom analysis software ESP3 (Ladroit 2017). The calibration parameters used for analysis of 38 kHz data were obtained from the January 2019 calibration, with transducer peak gain G_0 = 26.32 dB and corrective factor Sa,corr = -0.56 dB (O'Driscoll et al. 2019).

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 km^2 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 (m^2 per km^2) from bottom-referenced marks were compared with trawl catch rates (kg per km^2). 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, 2018) developed a time series of relative abundance estimates for mesopelagic fish on the Sub-Antarctic based on that component of the acoustic backscatter that migrates into the upper 200 m of the water column at night (nyctoepipelagic backscatter). We updated the mesopelagic time series to include data from 2018. The methods were the same as those used by O'Driscoll et al. (2015, 2018). 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. 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).

3. RESULTS

3.1 Data collection

A total of 81 successful trawl survey stations were completed in 20 strata (Figure 2, Table 1). The first five stations were gear trial shots testing the new Simrad TV80 Trawl Eye net monitoring system and not used for biomass estimation. A further four shots were not used for biomass estimation due to poor gear performance: station 26 hauled early due to a steep drop off; station 62 had no net monitor picture; and stations 84 and 88 came fast on the sea floor. Station 64 had a tow distance longer than the target of 3.0 n. miles (3.99 n miles) due to the winch not engaging on hauling. However, this station has still been included in estimates of biomass.

Individual station details from all trawl stations, including the catch of hoki, hake and ling are listed in Appendix 2. One trawl was conducted in the Campbell East Benthic Protected Area (BPA) (see Figure 1). This trawl was carried out on the closest known trawl path to the randomly generated station as per the dispensation. Two other stations that were planned in the Campbell East BPA were towed outside of the BPA as these were the closest previously towed trawl lines to the randomly generated stations.

3.2 Gear performance

Gear parameters by depth for valid trawl survey tows are summarised in Table 3. Headline height and doorspread were obtained for all successful tows. The headline height values were slightly lower than past values, but this is likely to be due to the new Simrad TV80 Trawl Eye system used for the first time on this survey. Tows where the Trawl Eye was used side by side with the Furuno CN22 net monitor used on past surveys found that the CN22 consistently gave readings of around 0.2–0.3 m higher than the Trawl Eye. Door spread values were within values seen on past surveys (Table 4). Overall, measured gear parameters in 2018 were generally within the range of those obtained on other voyages of *Tangaroa* in this area when the same gear was used. Mean doorspread distances 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. 2017).

3.3 Catch

A total catch of 31.7 t was recorded from all trawl stations (Table 5). From the 203 species or species groups caught, 100 were teleosts, 25 were chondrichthyans, 13 were squids or octopuses, and 14 were crustaceans, with the remainder comprising assorted benthic and pelagic animals (Appendix 3). The green weight of the top 50 species is given in Table 5 with hoki accounting for 30.5%, ling 16.9%, and hake 3.6% of the total catch from all trawls. A total of 54 sample lots were retained from the catch for identification, or to confirm identification ashore. These were mainly benthic invertebrates including sea-stars, corals, molluscs, and sponges.

3.4 Trawl abundance estimates

Abundance estimates and the trawl survey catch for the core 300–800 m depth range and for all (300–1000) strata are given in Table 6. Estimated abundance and CVs (in parentheses) for core strata were

31 098 t (11.3%) for hoki, 21 270 t (10.4%) for ling, and 1354 t (28.5%) 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 31 476 t (11.2%) for hoki, 21 286 t (10.4%) for ling, and 1785 t (23.6%) for hake. Of the other species in the top 50 by biomass, CVs were below 20% for javelinfish, warty squid, banded rattail, finless flounder, Bollon's rattail, 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 17% of the hoki abundance in 2018, less than the contribution from these strata 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%, 20%, and 29% of estimated hoki biomass in 2018 respectively, similar to 2016 except for an increase in the contribution of the eastern Campbell Plateau (22% in 2016). Ling were caught in all core strata except for stratum 10, although strata 6, 9, and 12–13 accounted for most of the biomass in 2018, and 77% of ling were caught in the core strata. Hake were caught in all core strata except for strata 7 and 11 with strata 4, and 12–14 being the most important.

Core trawl estimates from 2018 were compared to previous surveys in the summer Sub-Antarctic time series in Table 8 and Figure 4. The core hoki biomass index was down 18% from the 2016 estimate and very close to the 2014 estimate. Estimates of hoki abundance from 2014–2018 were lower than core estimates from 2007–12 surveys, but higher than those from the 'four low years' in 2003–06 (Figure 4, Table 8). The core ling biomass estimate in 2018 was down by 20% from the 2016 estimate. This is the lowest estimate since 2006 and is the third lowest in the time series. The core estimate for hake in 2018 was a 35% increase from the 2016 estimate. Although 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 (a 45% decrease). The estimate of 19 666 t is still higher than has been seen in most years.

3.5 Species distribution

Hoki were widespread throughout the core survey area, occurring in 80 of the 81 valid biomass stations (Figure 5). Hoki catch rates were generally higher in the west, with the largest catch coming from the bottom of the Stewart/Snares shelf in stratum 3B, but stratum 3A was also important. Catches of 1+ hoki were very low compared with 2+ hoki, with both being caught only in stratum 3B.

Catch rates of the other main species are plotted in Figure 6. Hake were caught on 35 of the 81 valid biomass stations and showed a similar distribution to previous years. Hake were concentrated in the Puyesgur Trench in stratum 25 and between the Auckland Islands and Stewart/Snares shelf in strata 3B, 5A and 5B. There were some catches of hake out to the east and south of the survey area which is unusual. Ling were caught on 66 of the 81 valid biomass stations, with highest catches at the Puysegur Trench in stratum 1 and higher catches in the western strata compared with eastern strata. Catch rates for many other species were also higher in western strata, and at the bottom of the Stewart/Snares shelf (see also Figure 3). However, long-nosed chimaera, javelinfish, silverside, and warty squid had higher catch rates in eastern strata, and pale ghost shark, finless flounder, and javelinfish were widespread (Figure 6).

3.6 Biological data

A total of 24 560 fish and squid of 90 different species were measured and of these, 11 648 fish were also individually weighed (Table 9). Additional data on fish condition (liver and gutted weight) were recorded from 1132 hoki. Pairs of otoliths were removed from 1476 hoki, 1058 ling, and 287 hake. In addition, 157 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 to those observed in previous summer surveys in Figure 7. Scaled age frequency distributions for hoki, ling, and hake are presented in Figure 8.

The hoki length frequency in 2018 showed a very weak mode of 1+ fish (under 46 cm) which was considerably weaker than the 1+ year class in 2016 (Figure 7a). No other year classes were easily discernible in the length distribution which shows a broad mode of older fish greater than 50 cm. The modal ages for hoki were 3 (2015 year-class), 5 (2013 year-class), and 9 (2009 year-class) (see Figure 8a). The 2015 and 2009 year-classes were also apparent in the 2016 survey as modes at ages 1 and 7 respectively, but 2016 also saw a relatively strong number of 5-year-olds (2011 year-class) which were not apparent as 7-year-olds in 2019. The 2013 year-class was relatively weak at age 3 in 2016 but were stronger at age 5 in 2018.

The hake length distribution was broad and shows modes at about 50–70 cm and 80–90 cm in 2018. Too few hake were caught on the 2016 survey to construct an informative length frequency, in particular due to a lack of stations in the deeper 800–1000 m strata, so no useful comparison can be made with the 2018 distribution. Both smaller and larger fish were caught in 2018 compared with 2016. Most hake were between 3 and 8 years old for males and between 3 and 15 years old for females (Figure 8c).

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 2016, although overall numbers are lower (see Figure 7c). Most ling were between 4 and 15 years old for males and 4 and 17 years old with a mode at 5 years for females (see Figure 8b).

Population scaled length frequencies using calculated using length-weight data in Table 2 for other main species for the 2018 survey are presented in Figure 9. Most southern blue whiting were between 26 and 55 cm, with modal peaks of 31 and 39 cm for males, and 32 and 44 cm for females (Figure 9). Other points of interest in Figure 9 included: a broad range in the length distribution for female javelinfish with fewer and generally smaller males; the high proportion of and larger size of female ribaldo compared with males; a strong modal peak at 28 cm for male white warehou; strong modal peaks for pale ghost shark, between 60 and 70 cm for males and 65–78 cm for females; strong modal peaks for silver warehou at 50 cm for males and 53 cm for females; and the high proportion of male spiny dogfish compared with females.

Gonad staging of fish and chondrichthyans showed that many species were immature or resting during the survey (Table 10). About 25% of hoki were immature, and these were typically fish smaller than 70 cm. Most adult hoki were in the resting phase. Very few (only 0.01%) hoki were macroscopically staged as partially spent or spent in 2018. Female ling were mostly resting (58%), immature (19%), or ripe (18%), but 66% of male ling were ripe or running ripe. About 62 % of female hake were immature or resting and 33% were maturing, while 62% of male hake were immature or resting, and 29% were ripening or ripe.

A total of 54 sample lots were retained from the catch and frozen at sea to confirm identification ashore. These were mainly invertebrates including sea-stars, corals, molluscs, and sponges.

3.7 Hoki condition indices

Liver and gutted weights were recorded from 1129 hoki in 2018. Both liver condition (Table 11) and somatic condition (measured as the estimated average weight of a 75 cm hoki) were lower in 2018 than those recorded in 2016, and slightly lower than average condition indices in the time-series going back to 2000 (Figure 10). Hoki condition indices in the Sub-Antarctic were usually consistently lower than those from the Chatham Rise survey, but this pattern is less apparent since the surveys became biennial in 2012 (Figure 10). The liver condition index (LCI) of hoki from the Sub-Antarctic in November-December 2018 was similar to that on the Chatham Rise in January 2018 (Figure 10).

3.8 Acoustic data

Acoustic data were collected continuously throughout the survey with the multi-frequency (18, 38, 70, 120, and 200 kHz) hull-mounted EK60 systems, leading to a total of over 77 GB of acoustic data split into 272 data files. Excluding data files acquired for system testing, during transits to and from the survey areas, and "junk" data (presenting technical issues), there were 261 files recorded (90 during trawls, 97 during day-time steams, and 74 during night-time steams), 7% of which (i.e., 10 trawls files, 5 day-time steam files and 2 night-time steam files) were found to be unsuitable for quantitative analysis because the data had too many bad pings (Table 12).

Expanding symbol plots of 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 (O'Driscoll et al. 2011), with highest acoustic densities on the Stewart/Snares shelf and the north western side of the Campbell Plateau and lowest densities in the south eastern Sub-Antarctic.

The vertical distribution of acoustic backscatter in 2018 is compared to 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 2018, there were peaks in daytime vertical distribution close to the surface, and at about 550 m and 700 m depth. The daytime layer often observed at 300–400 m depth in previous surveys was not apparent in 2018 (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 2018 was 70% higher than that recorded in 2016, and the highest in the time-series. Backscatter within 10 m, 50 m and 100 m from the seabed were also the highest for the time series (Figure 13).

There was a no significant correlation between acoustic backscatter in the bottom 50 m during the day and trawl catch rates in 2018 (Figure 14). 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, or 2016 (O'Driscoll & Bagley 2003b, 2006a, 2008, Bagley et al. 2014, 2017, O'Driscoll et al. 2018). 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 the bottom in an acoustic deadzone).

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 (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 2018 was 77% higher than that in 2016 due to large increases in the eastern Sub-Antarctic and on the Stewart-Snares shelf (Figure 15). Conversely, mesopelagic backscatter indices decreased slightly in the western Sub-Antarctic strata and at Puysegur. The overall mesopelagic index was the highest in the time-series.

3.9 Hydrological data

Temperature profiles were available from 86 CTD casts (including two gear trial tows). Surface (5 m depth) temperatures in the survey area ranged between 8.4 and 14.0 °C (Figure 16), while bottom temperatures were between 4.6 and 9.6 °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 Islands, 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 2018 of 10.9 °C was 1.3–1.5 °C warmer than that observed in the three most recent surveys in 2016 (9.5 °C), 2014 (9.4 °C), and 2012 (9.6 °C), and the highest observed in the time-series (average surface temperatures from 2002–11 of 8.8–10.3 °C). However, the average bottom temperature in 2018 (7.1 °C) was the same as that observed in 2016, 2014, and 2012, and only slightly higher than average bottom temperatures observed from 2002–11 (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.

In general, there is a negative correlation between surface temperature and depth of the thermocline, with cooler surface temperatures in years when the thermocline is deep (e.g., 2003), and warm surface temperatures when there is a shallow mixed layer (e.g., 2002, 2012). In 2018, there was a strongly stratified water column east of the Auckland Islands, extending to over 100 m depth, with very warm temperatures in the upper 20 m (Figure 18). From 100–500 m depths temperatures were much more similar between years but were still relatively warm in 2018 (Figure 18).

4. DISCUSSION AND CONCLUSIONS

The hoki biomass estimate for the core strata in 2018 was 18% lower than the 2016 estimate (scaled to account for missing strata) and is similar to the 2014 estimate. The modal ages for hoki in 2018 were 3, 5, and 9, corresponding to fish from the 2015, 2013, and 2009 year-classes. The current estimate is the lowest since the ‘four low years’ of 2003–2006. The survey methodology was consistent with previous years, but there is some evidence that there have been changes in trawl catchability in the Sub-Antarctic summer time series (O’Driscoll et al. 2015). Age data from the time series showed large annual changes in numbers-at-age which could not be explained by changes in abundance and were suggestive of a change in catchability for the survey. Recent stock assessments for hoki have had difficulty fitting the survey indices to the model and has resulted in high process error being estimated for this survey (McKenzie 2019).

Of the two main models presented for the western stock assessment in 2019, model 1.17 estimated a relatively high process error of 35% for the Sub-Antarctic trawl survey time-series (McKenzie 2019). Under this model the western stock was estimated to have been stable for the last nine years at 52% of B_0 and was projected to increase over the next five years at current catch levels. The alternative model run for the western stock (model 1.34) set the Sub-Antarctic trawl survey process error at zero. This model suggested that the biomass has been declining since 2013 and is currently below 35% of B_0. Analyses to resolve these differences are ongoing.

Ling biomass estimates increased from 2009 to 2014 but decreased by 11% in 2016 and by another 20% in 2018. The 2018 ling estimate was the lowest since 2006 and is the third lowest in the time series. Ling continue to show a broad length and age distribution.

The core estimate for hake increased by 35% from 2016 to 2018. The 2018 estimate was more similar to estimates for hake seen in the early to mid-2000s but still below the time series mean. The hake length and age distributions were broad but cannot be compared with 2016 when so few hake were caught that scaled length and age distributions could not be calculated. Compared with 2014, the length and age distributions were similar in 2018.

For the nine other key species, biomass estimates were higher in 2018 than in 2016 for black oreo, dark ghost shark, pale ghost shark, javelinfish, ribaldo, spiny dogfish, and white warehou. Lookdown dory and southern blue whiting both decreased, with lookdown dory being more similar to levels seen from 2011–14. While the southern blue whiting biomass was just over half the 2016 estimate the latter was the second highest in the time series and the current estimate is still well above the time series mean. The dark ghost shark estimate was nearly three times the 2014 estimate but has a high associated CV (50%). Changes in biomass for javelinfish, pale ghost shark, ribaldo, and white warehou were within levels of sampling uncertainty.

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, etc.). It is difficult to assess the “quality” of trawl estimates for many of these species, as 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, and number of successful biomass stations from the November–December 2018 Southland and Sub-Antarctic trawl survey. Stratum boundaries are shown in Figure 1, and station positions are plotted in Figure 2. Allocation includes six hake stations added 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	4
2	Puysegur Bank	600–800	1 318	4	4
3a	Stewart-Snares	300–600	4 548	4	4
3b	Stewart-Snares	300–600	1 556	4	4
4	Stewart-Snares	600–800	21 018	4	4
5a	Snares-Auckland	600–800	2 981	5	5
5b	Snares-Auckland	600–800	3 281	4	4
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 Is.	300–600	27 398	5	5
10	S. Campbell Is.	600–800	11 288	3	3
11	N.E. Pukaki Rise	600–800	23 008	5	5
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	5
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	81	81

Table 2: Length-weight regression parameters* used to scale length frequencies. Where data source is given as 'All surveys' length-weight parameters were estimated from combined data from 1991–1993, and 2000–2009, 2011, 2012, 2014, 2016, and 2018 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-squared	n	length range	source
Arrow squid	NOS	0.024732	2.993122	88.41	1940	15.7–40.3	All surveys
Australasian slender cod	HAS	0.000982	3.461063	96.89	91	23.1–50.7	TAN1811
Banded rattail	CFA	0.00316	3.100805	90.37	509	16–36.7	TAN1811
Basketwork eel	BEE	0.000393	3.230998	92.67	121	65.5–127	TAN1811
Baxter's lantern dogfish	ETB	0.002546	3.170321	98.6	223	20.2–83.6	TAN1811
Bigeye cardinalfish	EPL	0.016475	2.964904	90.7	51	17.5–33.7	All surveys
Bigeye sea perch	HBA	0.024535	2.922992	97.67	287	16.5–54.4	All surveys
Black javelinfish	BJA	0.021914	2.54755	82.36	288	38.6–81.3	All surveys
Black oreo	BOE	0.02013	3.015416	93.99	124	22.2–41.4	TAN1811
Blackspot rattail	VNI	0.000439	3.427022	84.69	73	21.9–32.5	All surveys
Bollon's rattail	CBO	0.00091	3.47967	96.2	145	30.5–72.2	TAN1811
Bronze bream	BBR	0.011849	3.103925	96.47	366	31.1–56.2	All surveys
Dark ghost shark	GSH	0.003008	3.18619	98.02	111	32–69.1	TAN1811
Dawson's catshark	DCS	0.00044	3.607258	90.9	27	27.5–41	All surveys
Deepsea cardinalfish	EPT	0.011194	3.103793	98.54	226	14–49.1	All surveys
Finless flounder	MAN	0.009031	2.980106	94.52	357	29.4–63.1	All surveys
Four–rayed rattail	CSU	0.004046	2.800147	85.66	2165	12.9–40.7	All surveys
Gemfish	RSO	0.005689	3.037617	98.96	75	32.7–103.8	All surveys
Giant stargazer	GIZ	0.00732	3.208103	96.84	981	26.2–79.2	All surveys
Hairy conger	HCO	0.000116	3.670992	93.68	53	54–91.7	TAN1811
Hake	HAK	0.002974	3.199341	98.18	268	49.4–126.9	TAN1811
Hoki	HOK	0.003771	2.934696	97.08	1469	39.9–110.2	TAN1811
Javelinfish	JAV	0.000774	3.28378	97.13	1238	18.4–60.2	TAN1811
Johnson's cod	HJO	0.000982	3.461063	96.89	91	23.1–50.7	TAN1811
Kaiyomaru rattail	CKA	0.004436	2.862294	90.83	472	14.5–41.7	All surveys
Leafscale gulper shark	CSQ	0.001129	3.35049	99.35	850	25–142.5	All surveys
Ling	LIN	0.001564	3.249295	96.33	1099	42.3–159	TAN1811
Long–nosed chimaera	LCH	0.002416	3.073524	97.86	94	23.7–91	TAN1811
Longnose velvet dogfish	CYP	0.000972	3.365589	98.7	248	32.7–102.1	TAN1811
Lookdown dory	LDO	0.021398	3.00958	98.61	106	16.5–53.3	TAN1811
Lucifer dogfish	ETL	0.001473	3.206564	95.94	343	21.9–49.7	TAN1811
Mahia rattail	CMA	0.000721	3.442537	95.07	30	33.1–70.5	All surveys
Notable rattail	CIN	0.006831	2.678025	78.65	408	18.5–36.6	All surveys
Oblique banded rattail	CAS	0.00056	3.600762	96.22	339	19.8–48.5	TAN1811
Oliver's rattail	COL	0.018657	2.433003	79.93	4938	12.2–40.3	All surveys
Orange roughy	ORH	0.045114	2.928863	98.61	93	8.5–38.4	TAN1811
Pale ghost shark	GSP	0.012674	2.80945	96.13	499	25.9–84.9	TAN1811
Plunket's shark	PLS	0.011692	2.834533	98.1	66	34.7–110.4	All surveys
Ray's bream	RBM	0.011849	3.103925	96.47	366	31.1–56.2	All surveys
Red cod	RCO	0.018775	2.804499	96.67	1065	18.3–72	All surveys
Ribaldo	RIB	0.004146	3.239496	98.48	155	20.4–72.7	TAN1811
Ridge scaled rattail	MCA	0.008082	2.895316	96.66	148	35.5–95.2	TAN1811
Rough skate	RSK	0.032083	2.891266	98.17	123	29.5–72.5	All surveys
Scampi	SCI	1.177508	2.563614	81.63	141	2.9–6.9	All surveys
Sea perch	SPE	0.024535	2.922992	97.67	287	16.5–54.4	All surveys
Sea perch	HPC	0.024535	2.922992	97.67	287	16.5–54.4	All surveys
Seal shark	BSH	0.000999	3.382272	99.33	213	38.8–153.6	All surveys
Serrulate rattail	CSE	0.001528	3.232605	87.28	262	25.3–49.3	All surveys
Shovelnose dogfish	SND	0.000979	3.29288	98.09	194	36.6–115	TAN1811
Silver warehou	SWA	0.009654	3.16152	90.65	146	29.4–55.5	TAN1811
Silverside	SSI	0.015172	2.742314	83.79	5506	13.6–35.3	All surveys
Small banded rattail	CCX	0.004673	2.856019	81.65	141	20.9–31.5	All surveys
Smallscaled brown slickhead	SSM	0.006729	3.067079	97.18	79	26.4–60.3	TAN1811
Smooth deepsea skate	BTA	0.517988	2.109272	57.74	22	26.3–31.5	All surveys
Smooth oreo	SSO	0.017212	3.074012	97.16	75	16.6–35.9	TAN1811

Table 2: continued.

Common name	Code	a	b	r-squared	n	length range	source
Smooth skin dogfish	CYO	0.003621	3.102266	99.09	340	28.3–118.2	All surveys
Southern blue whiting	SBW	0.002858	3.21316	97.57	407	26.9–55.3	TAN1811
Southern Ray's bream	SRB	0.011849	3.103925	96.47	366	31.1–56.2	All surveys
Spiky oreo	SOR	0.062	2.707748	97.9	309	9.9–40	All surveys
Spineback	SBK	0.001492	3.043756	81.71	941	42–80.4	All surveys
Spiny dogfish	SPD	0.001095	3.316719	93.85	6249	46–102.9	All surveys
Swollenhead conger	SCO	0.000095	3.708125	93.63	68	60.2–94.5	TAN1811
Todarodes angolensis	TAG	0.011925	3.153921	90.86	36	29.2–50.8	All surveys
Violet cod	VCO	0.00125	3.441173	96.47	277	19–40.4	All surveys
Warty squid	MIQ	0.089862	2.706157	97.76	175	10.5–47.2	TAN1811
White rattail	WHX	0.000518	3.607284	98.27	393	27.3–92.9	All surveys
White warehou	WWA	0.024456	2.944904	98.62	112	25.5–63.7	TAN1811
Widenosed chimaera	RCH	0.000699	3.19539	97.99	342	28.6–155.6	All surveys

Table 3: Survey tow and gear parameters (recorded values only) from the November–December 2018 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)		82	2.97	0.21	2.11–3.99
Tow speed (knots)		82	3.5	0.03	3.4–3.6
Gear parameters (m)					
Headline height	300–600	35	6.5		
	600–800	35	6.5		
	800–1000	12	6.7		
	All depths	82	6.5	0.28	6.0–7.3
Doorspread	300–600	35	122.3		
	600–800	35	123.2		
	800–1000	12	122.6		
	All depths	82	122.3	5.89	109.6–134.2

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 is 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

Table 5: Total catch of the top 50 species from all tows during the survey.

Code	Common name	Scientific name	Catch (kg)
HOK	Hoki	*Macruronus novaezelandiae*	9 690.7
LIN	Ling	*Genypterus blacodes*	5 349.7
JAV	Javelinfish	*Lepidorhynchus denticulatus*	2 106.3
SBW	Southern blue whiting	*Micromesistius australis*	2 017.6
HAK	Hake	*Merluccius australis*	1 150.2
SSO	Smooth oreo	*Pseudocyttus maculatus*	1 149.2
GSP	Pale ghost shark	*Hydrolagus bemisi*	1 051.1
SPD	Spiny dogfish	*Squalus acanthias*	999.4
SND	Shovelnose dogfish	*Deania calcea*	990.7
CYP	Longnose velvet dogfish	*Centroscymnus crepidater*	622.4
SWA	Silver warehou	*Seriolella punctata*	483.4
CSQ	Leafscale gulper shark	*Centrophorus squamosus*	379.1
MCA	Ridge scaled rattail	*Macrourus carinatus*	341.2
GSH	Dark ghost shark	*Hydrolagus novaezealandiae*	335.4
ETB	Baxter's lantern dogfish	*Etmopterus granulosus*	292.5
BOE	Black oreo	*Allocyttus niger*	287.0
RIB	Ribaldo	*Mora moro*	270.2
COL	Oliver's rattail	*Coelorinchus oliverianus*	266.5
CAS	Oblique banded rattail	*Coelorinchus aspercephalus*	253.2
SSM	Smallscaled brown slickhead	*Alepocephalus antipodianus*	218.3
MIQ	Warty squid	*Onykia ingens*	196.0
HYA	Floppy tubular sponge	*Hyalascus* sp.	169.6
SSI	Silverside	*Argentina elongata*	164.9
NOS	Arrow squid	*Nototodarus sloanii*	163.1
WWA	White warehou	*Seriolella caerulea*	157.2
CBO	Bollon's rattail	*Coelorinchus bollonsi*	152.0
CSU	Four-rayed rattail	*Coryphaenoides subserrulatus*	147.3
GIZ	Giant stargazer	*Kathetostoma giganteum*	141.4
CFA	Banded rattail	*Coelorinchus fasciatus*	122.6
LCH	Long-nosed chimaera	*Harriotta raleighana*	121.0
BEE	Basketwork eel	*Diastobranchus capensis*	116.8
SBK	Spineback	*Notacanthus sexspinis*	109.4
LDO	Lookdown dory	*Cyttus traversi*	106.0
SRB	Southern Ray’s bream	*Brama australis*	103.0
SSK	Smooth skate	*Dipturus innominatus*	97.2
ETL	Lucifer dogfish	*Etmopterus lucifer*	92.5
RCH	Widenosed chimaera	*Rhinochimaera pacifica*	85.0
TAM	Tam O shanter urchin	*Echinothuriidae & Phormosomatidae*	83.7
SCO	Swollenhead conger	*Bassanago bulbiceps*	83.2
TAG	*Todarodes angolensis*	*Todarodes angolensis*	77.0
PLS	Plunket's shark	*Centroscymnus plunketi*	71.3
HCO	Hairy conger	*Bassanago hirsutus*	56.7
RSK	Rough skate	*Zearaja nasuta*	54.5
MAN	Finless flounder	*Neoachiropsetta milfordi*	51.9
MRQ	Warty squid	*Onykia robsoni*	48.2
ORH	Orange roughy	*Hoplostethus atlanticus*	39.5
TOP	Pale toadfish	*Ambophthalmos angustus*	39.2
RSO	Gemfish	*Rexea solandri*	33.0
BJA	Black javelinfish	*Mesobius antipodum*	32.6
CYO	Smooth skin dogfish	*Centroscymnus owstoni*	32.2
Total			31 714.0

Table 6: Catch (kg) and abundance estimates (t) from core strata (300–800 m) and all strata (300–1100 m) with coefficient of variation (CV in parentheses) of species ranked in order of decreasing abundance in the 2018 survey.

		Catch (kg)		Biomass (t)	
Common name	Code	Core	All	Core	All
Hoki	HOK	9 183	9 403	31 098 (11.3)	31 476 (11.2)
Ling	LIN	5 151	5 165	21 270 (10.4)	21 286 (10.4)
Southern blue whiting	SBW	2 018	2 018	19 666 (28.5)	19 666 (28.5)
Javelinfish	JAV	1 716	2 081	9 407 (19.2)	9 788 (18.5)
Spiny dogfish	SPD	991	994	9 192 (53.9)	9 208 (53.8)
Pale ghost shark	GSP	976	1 027	6 331 (20.7)	6 518 (20.1)
Smooth oreo	SSO	2	1 149	13 (100.0)	4 187 (72.5)
Silver warehou	SWA	483	483	2 694 (41.1)	2 694 (41.1)
Dark ghost shark	GSH	335	335	2 299 (50.1)	2 299 (50.1)
Hake	HAK	431	1 005	1 354 (28.5)	1 785 (23.6)
Oblique banded rattail	CAS	242	242	1 676 (47.7)	1 676 (47.7)
Longnose velvet dogfish	CYP	173	622	268 (44.1)	1 622 (28.9)
Black oreo	BOE	4	284	33 (57.8)	1 524 (69.6)
Silverside	SSI	164	164	1 449 (26.8)	1 449 (26.8)
Baxter's lantern dogfish	ETB	176	292	899 (24.3)	1 387 (17.1)
Floppy tubular sponge	HYA	169	170	1 285 (55.8)	1 287 (55.7)
Ridge scaled rattail	MCA	104	341	632 (35.3)	1 258 (24.1)
Oliver's rattail	COL	264	264	1 172 (41.1)	1 172 (41.0)
Long-nosed chimaera	LCH	117	121	1 070 (27.0)	1 087 (26.6)
Arrow squid	NOS	162	163	1 033 (61.9)	1 033 (61.9)
Smallscaled brown slickhead	SSM	2	218	1 (100.0)	990 (88.9)
Warty squid	MIQ	130	186	824 (13.0)	968 (11.2)
Southern Ray’s bream	SRB	98	101	881 (81.9)	890 (81.0)
White warehou	WWA	153	153	781 (34.8)	781 (34.8)
Shovelnose dogfish	SND	741	983	564 (32.1)	707 (27.7)
Ribaldo	RIB	216	269	624 (23.7)	656 (22.6)
Leafscale gulper shark	CSQ	319	362	538 (27.7)	564 (26.8)
Rough skate	RSK	53	53	466 (89.6)	466 (89.6)
Spineback	SBK	86	109	415 (27.3)	453 (25.3)
Banded rattail	CFA	78	118	297 (17.7)	444 (16.6)
Swollenhead conger	SCO	82	82	391 (27.4)	391 (27.4)
Todarodes angolensis	TAG	43	77	254 (31.7)	388 (22.5)
Hairy conger	HCO	57	57	375 (31.4)	375 (31.4)
Finless flounder	MAN	43	43	368 (14.8)	368 (14.8)
Basketwork eel	BEE	0	117	1 (100.0)	363 (40.0)
Lookdown dory	LDO	88	88	358 (28.2)	358 (28.2)
Widenosed chimaera	RCH	10	85	44 (63.4)	314 (41.7)
Bollon's rattail	CBO	147	148	303 (16.2)	303 (16.2)
Four-rayed rattail	CSU	17	147	71 (44.2)	257 (33.7)
Plunket's shark	PLS	50	71	188 (81.9)	225 (69.8)
Giant spider crab	GSC	30	30	225 (94.4)	225 (94.4)
Warty squid	MRQ	22	48	115 (62.6)	221 (40.7)
Lucifer dogfish	ETL	83	87	198 (16.4)	200 (16.2)
Giant stargazer	GIZ	139	139	193 (35.4)	193 (35.4)
Pale toadfish	TOP	39	39	189 (25.6)	189 (25.6)
Black javelinfish	BJA	-	33	-	164 (79.0)
Smooth skate	SSK	93	93	141 (92.0)	141 (92.0)
Pseudostichopus mollis	PMO	16	19	126 (30.3)	131 (29.2)
Jellyfish	JFI	11	18	108 (40.5)	119 (37.0)
Giant chimaera	CHG	17	17	112 (100.0)	112 (100.0)
Orange roughy	ORH	2	40	12 (100.0)	96 (26.6)
Red cod	RCO	17	17	82 (50.3)	82 (50.3)
Australasian slender cod	HAS	-	24	-	58 (70.1)
New Zealand king crab	LAO	9	14	44 (65.6)	47 (61.8)
Rudderfish	RUD	26	26	41 (67.5)	41 (67.5)
Whale bone (unspecified)	WHU	0	13	1 (100.0)	39 (98.3)
Banded bellowsfish	BBE	4	4	36 (99.5)	36 (99.5)
Dipsacaster magnificus	DMG	4	4	35 (44.7)	35 (44.7)
Smooth deepsea anemones	ACS	8	8	31 (72.0)	32 (69.4)

Table 6: continued.

Common name	Code	Catch (kg) Core	All	Biomass (t) Core	All
	CYO	-	32	-	27 (43.3)
White rattail	WHX	-	32	-	27 (46.2)
Mahia rattail	CMA	10	11	25 (81.6)	26 (80.3)
Prickly deepsea skate	BTS	3	3	24 (53.2)	24 (53.2)
Gemfish	RSO	32	32	24 (37.3)	24 (37.3)
Umbrella octopus	OPI	2	6	19 (90.0)	22 (78.0)
Kaiyomaru rattail	CKA	-	7	-	21 (41.6)
Deepsea pigfish	DSP	2	2	20 (100.0)	20 (100.0)
Tam O shanter urchin	TAM	10	12	11 (65.6)	20 (46.8)
Humpback rattail (slender rattail)	CBA	3	5	18 (79.7)	19 (75.0)
Deepwater octopus	GTA	8	11	12 (60.8)	19 (43.5)
Psychrolutes	PSY	-	3	-	19 (100.0)
Rat-tail star	ZOR	3	3	19 (26.2)	19 (26.2)
Violet squid	VSQ	2	3	11 (46.9)	18 (43.5)
Seal shark	BSH	8	13	14 (63.7)	16 (53.2)
Omega prawn	LHO	4	6	13 (18.5)	16 (16.2)
Serrulate rattail	CSE	0	11	1 (100.0)	15 (42.0)
Sea perch	HPC	27	27	15 (66.4)	15 (66.4)
Violet cod	VCO	-	4	-	15 (51.8)
Blue-eye lantern shark	EVI	1	2	5 (100.0)	15 (73.7)
Smallscaled cod	SCD	2	2	15 (100.0)	15 (100.0)
Bronze bream	BBR	2	2	14 (100.0)	14 (100.0)
Scampi	SCI	2	2	14 (70.2)	14 (70.2)
Dawson's catshark	DCS	1	1	13 (43.0)	13 (43.0)
Notable rattail	CIN	0	7	1 (88.9)	12 (53.1)
Smooth deepsea skate	BTA	5	5	11 (63.3)	11 (63.3)
Lyconus sp	LYC	-	2	-	11 (99.4)
Deepsea anemone	HMT	2	2	10 (63.8)	10 (63.8)
Trojan starfish	HTR	2	3	7 (54.0)	10 (44.1)
Salps	SAL	0	2	1 (100.0)	10 (61.6)
Fleshy club sponge	SUA	2	2	10 (60.0)	10 (58.3)
Wood	WOD	11	11	10 (100.0)	10 (100.0)
Deepwater octopus	DWO	1	1	9 (100.0)	9 (100.0)
Curling stone sponge	GRE	1	1	9 (91.4)	9 (91.4)
Giant lepidion	LPI	-	14	-	9 (100.0)
Longnosed deepsea skate	PSK	-	3	-	8 (100.0)
Spiky oreo	SOR	8	9	6 (90.2)	7 (79.0)
Benthoctopus spp.	BNO	2	3	7 (84.2)	7 (75.8)
Sea urchin	DHO	-	11	-	7 (100.0)
Lighthouse fish	PHO	1	1	5 (19.9)	6 (18.6)
Thetys vagina	ZVA	1	2	5 (66.8)	6 (61.1)
Pillsburiaster aoteanus	PAO	0	1	3 (48.8)	5 (45.1)
Pyrosoma atlanticum	PYR	1	1	4 (50.4)	5 (45.1)
Ragfish	RAG	-	1	-	5 (100.0)
Seaweed	SEO	0	0	5 (100.0)	5 (100.0)
Variable spotted toadfish	VST	1	1	5 (100.0)	5 (100.0)
Deepsea cardinalfish	EPT	4	6	3 (49.4)	4 (39.2)
Big-scale pomfret	BSP	6	6	4 (100.0)	4 (100.0)
Viper fish	CHA	0	1	2 (71.0)	4 (49.3)
Gonorynchus forsteri & *G. Greyi*	GON	0	0	4 (100.0)	4 (100.0)
Bolin's lanternfish	GYB	0	1	1 (100.0)	4 (47.1)
Intricate lanternfish	LIT	0	1	1 (100.0)	4 (21.1)
Octopoteuthis spp.	OPO	0	0	4 (100.0)	4 (100.0)
Pasiphaea spp	PAS	0	1	- (100.0)	4 (45.5)
Common tubeshoulder	PER	0	1	2 (74.5)	4 (44.4)
Rocks stones	ROK	7	7	4 (100.0)	4 (100.0)
Small-headed cod	SMC	-	5	-	3 (22.8)
Blackspot rattail	VNI	2	2	3 (42.6)	3 (39.1)
Sun star	CJA	0	0	3 (51.7)	3 (51.7)
Pentagon star	CPA	1	1	3 (43.2)	3 (43.2)

Table 6: continued.

Common name	Code	Catch (kg)		Biomass (t)	
		Core	All	Core	All
Dealfish	DEA	4	4	3 (100.0)	3 (100.0)
Rock star	LNV	0	1	3 (48.6)	3 (43.7)
Brodie's king crab	NEB	-	2	-	3 (72.4)
Oarfish	OAR	-	4	-	3 (100.0)
Small banded rattail	CCX	2	2	2 (37.6)	2 (37.6)
Alert pigfish	API	0	0	2 (100.0)	2 (100.0)
Sabre prawn	CAM	0	0	2 (63.4)	2 (63.4)
Flabellum coral	COF	0	0	2 (76.3)	2 (76.3)
Dwarf cod	DCO	0	0	2 (66.8)	2 (66.8)
Furry oval sponge	TLD	-	0	-	2 (71.8)
Bigeye cardinalfish	EPL	1	1	1 (63.8)	1 (63.8)
Bigeye sea perch	HBA	2	2	1 (100.0)	1 (100.0)
Prickly dogfish	PDG	2	2	1 (100.0)	1 (100.0)
Subantarctic ruby prawn	ACA	-	0	-	1 (91.9)
New Zealand catshark	AEX	-	1	-	1 (74.1)
Bathyplotes spp.	BAM	0	0	1 (100.0)	1 (100.0)
Southern snaggletooth	BAN	-	0	-	1 (100.0)
Deepsea anemone	BOC	0	0	1 (100.0)	1 (100.0)
Coral-like anemones	CLM	0	0	1 (100.0)	1 (70.9)
Pagurid	DIR	0	0	1 (87.3)	1 (87.3)
Discfish	DIS	0	0	1 (100.0)	1 (61.3)
Carlsberg’s lanternfish	ELC	0	0	1 (100.0)	1 (100.0)
Brown sabretooth	EVB	-	0	-	1 (57.7)
Deepsea flathead	FHD	2	2	1 (60.4)	1 (60.4)
Fish	FIS	-	0	-	1 (100.0)
Fusitriton magellanicus	FMA	0	0	1 (63.5)	1 (63.5)
Gastropods	GAS	0	0	1 (100.0)	1 (100.0)
Gymnoscopelus spp	GYM	-	0	-	1 (100.0)
Histocidaris spp.	HIS	0	0	1 (70.7)	1 (70.7)
Black dragonfishes	IDI	-	0	-	1 (91.2)
Bladder kelp	KBB	0	0	1 (100.0)	1 (100.0)
Cripplefin lanternfish	LAC	-	0	-	1 (100.0)
Laetmogone spp.	LAG	1	1	1 (80.6)	1 (80.6)
Lissodendoryx bifacialis	LBI	-	0	-	1 (100.0)
Notal lanternfish	LNT	-	0	-	1 (100.0)
Lycoteuthis lorigera	LSQ	0	0	1 (100.0)	1 (100.0)
Melanostomias spp	MEN	0	0	1 (100.0)	1 (100.0)
Sponges	ONG	0	0	1 (57.7)	1 (57.7)
Pagurid	PAG	0	0	1 (94.1)	1 (94.1)
Gemmate lanternfish	PGE	0	0	1 (100.0)	1 (100.0)
Protomyctophum spp	PRO	0	0	1 (100.0)	1 (100.0)
Sawtooth eel	SAW	0	0	1 (100.0)	1 (70.9)
Spiny masking crab	SMK	0	0	1 (100.0)	1 (100.0)
Solaster torulatus	SOT	-	0	-	1 (100.0)
Scopelosaurus sp	SPL	0	0	1 (100.0)	1 (100.0)
Squid	SQX	-	0	-	1 (74.9)
Silver roughy	SRH	1	1	1 (36.0)	1 (36.0)
Pelagic butterfish	SUM	-	0	-	1 (100.0)
Cape scorpionfish	TRS	-	2	-	1 (100.0)
Bristle ball sponge	TTL	0	0	1 (87.0)	1 (87.0)
Yellow boarfish	YBO	0	0	1 (100.0)	1 (100.0)
Velvet dogfish	ZAS	-	1	-	1 (62.1)

Table 7: Estimated biomass (t) and CVs (%, below in parentheses) by stratum of the top 50 species in descending order of abundance in 2018 survey. Species codes are given in Appendix 3. Subtotal, biomass calculated from survey for core strata (0001–0015); core including Puysegur (0001–0015, 0025).

						Species
Stratum	HOK	LIN	SBW	JAV	SPD	GSP
0001	249 (22.7)	1 699 (36.5)	-	27 (74.9)	20 (62.0)	1 (100.0)
0002	132 (45.3)	95 (11.6)	-	43 (9.1)	-	10 (43.5)
003A	1 931 (83.9)	330 (10.5)	177 (100.0)	44 (58.7)	88 (94.2)	248 (54.7)
003B	2 319 (36.8)	175 (34.6)	-	6 (58.9)	20 (51.8)	1 (100.0)
0004	944 (28.0)	1 327 (30.0)	-	478 (14.1)	409 (20.6)	716 (26.0)
005A	124 (16.7)	212 (26.9)	-	38 (21.1)	5 (100.0)	39 (33.1)
005B	203 (37.4)	261 (6.8)	51 (100.0)	453 (38.3)	4 (64.7)	172 (20.6)
0006	412 (54.2)	2 981 (38.8)	6 067 (60.3)	8 (49.9)	5 551 (88.5)	899 (100.0)
0007	1 027 (30.6)	792 (19.5)	-	212 (21.6)	-	40 (50.0)
0008	2 686 (13.2)	1 240 (35.2)	1 (100.0)	2 364 (25.2)	40 (60.8)	235 (31.1)
0009	5 491 (27.7)	3 373 (43.3)	1 899 (60.6)	898 (42.6)	650 (47.6)	870 (57.0)
0010	224 (41.3)	-	-	124 (56.1)	-	9 (66.8)
0011	2 669 (52.2)	488 (41.4)	376 (100.0)	2 039 (62.2)	-	145 (27.3)
0012	3 629 (31.1)	3 551 (16.7)	7 376 (50.7)	1 393 (55.4)	575 (25.5)	1 882 (36.9)
0013	4 249 (31.2)	3 063 (11.7)	2 283 (65.3)	1 072 (67.4)	543 (27.8)	710 (46.9)
0014	2 716 (33.7)	1 238 (20.5)	1 436 (38.4)	79 (45.7)	1 288 (39.3)	333 (20.9)
0015	2 094 (34.2)	444 (60.1)	-	129 (33.5)	-	22 (46.3)
Subtotal (core)	31 098 (11.3)	21 270 (10.4)	19 666 (28.5)	9 407 (19.2)	9 192 (53.9)	6 331 (20.7)
0025	90 (50.2)	6 (61.4)	-	193 (48.2)	-	4 (70.9)
Subtotal (core plus puys)	31 188 (11.3)	21 276 (10.4)	19 666 (28.5)	9 600 (18.9)	9 192 (53.9)	6 335 (20.7)
0027	190 (35.6)	-	-	135 (54.6)	16 (100.0)	99 (56.1)
0028	98 (44.5)	10 (100.0)	-	53 (40.8)	-	84 (47.4)
Total	31 476 (11.2)	21 286 (10.4)	19 666 (28.5)	9 788 (18.5)	9 208 (53.8)	6 518 (20.1)

						Species
Stratum	SSO	SWA	GSH	HAK	CAS	CYP
0001	-	-	23 (77.8)	52 (91.2)	1 (79.7)	3 (100.0)
0002	-	-	-	32 (57.8)	-	100 (55.6)
003A	-	258 (58.5)	1 (100.0)	56 (57.9)	80 (65.1)	-
003B	-	27 (74.5)	36 (57.0)	46 (91.9)	16 (46.1)	-
0004	-	828 (86.2)	-	210 (71.9)	-	-
005A	-	4 (100.0)	-	49 (57.4)	-	4 (100.0)
005B	-	1 (100.0)	-	57 (36.6)	1 (85.0)	-
0006	-	1 528 (54.4)	2 232 (51.6)	63 (100.0)	876 (88.9)	-
0007	-	-	-	-	-	-
0008	-	-	7 (100.0)	111 (63.4)	1 (100.0)	-
0009	-	43 (100.0)	-	104 (65.8)	227 (47.1)	-
0010	-	5 (100.0)	-	25 (100.0)	-	17 (50.3)
0011	13 (100.0)	-	-	-	-	86 (100.0)
0012	-	-	-	237 (100.0)	353 (33.9)	58 (100.0)
0013	-	-	-	163 (100.0)	117 (60.4)	-
0014	-	-	-	150 (100.0)	5 (100.0)	-
0015	-	-	-	-	-	-
Subtotal (core)	13 (100.0)	2 694 (41.1)	2 299 (50.1)	1 354 (28.5)	1 676 (47.7)	268 (44.1)
0025	1 (48.6)	-	-	320 (51.0)	-	99 (41.0)
Subtotal (core plus puys)	13 (94.7)	2 694 (41.1)	2 299 (50.1)	1 675 (25.0)	1 676 (47.7)	366 (34.1)
0027	1 457 (100.0)	-	-	40 (100.0)	-	824 (51.7)
0028	2 717 (98.1)	-	-	70 (33.6)	-	432 (35.7)
Total	4 187 (72.5)	2 694 (41.1)	2 299 (50.1)	1 785 (23.6)	1 676 (47.7)	1 622 (28.9)

Table 7: continued.

Stratum	BOE	SSI	ETB	HYA	MCA	COL	LCH
							Species
0001	-	- (100.0)	-	1 (100.0)	-	15 (56.7)	-
0002	-	-	-	-	-	6 (50.9)	1 (100.0)
003A	-	3 (39.7)	4 (100.0)	-	-	5 (85.4)	21 (100.0)
003B	-	-	-	-	-	- (100.0)	-
0004	-	40 (52.0)	106 (42.7)	-	26 (100.0)	314 (47.6)	44 (45.6)
005A	-	-	7 (100.0)	-	-	1 (100.0)	1 (100.0)
005B	-	- (100.0)	38 (62.5)	9 (52.1)	-	101 (51.4)	-
0006	-	29 (100.0)	-	-	-	3 (100.0)	80 (100.0)
0007	-	3 (79.4)	-	-	-	80 (21.4)	11 (60.0)
0008	-	20 (91.2)	42 (65.0)	1 (100.0)	-	99 (23.5)	18 (66.3)
0009	-	718 (48.6)	-	55 (54.5)	-	11 (92.9)	38 (43.4)
0010	-	-	266 (20.0)	2 (100.0)	232 (53.0)	2 (57.0)	-
0011	16 (100.0)	-	236 (58.5)	767 (91.2)	276 (63.2)	474 (95.6)	28 (62.5)
0012	15 (67.6)	151 (38.5)	21 (88.9)	97 (50.4)	25 (100.0)	1 (100.0)	619 (41.9)
0013	-	382 (31.3)	-	293 (48.6)	-	13 (67.7)	120 (63.4)
0014	-	103 (94.4)	5 (100.0)	59 (53.4)	-	16 (38.3)	75 (60.3)
0015	2 (100.0)	-	174 (85.4)	1 (100.0)	74 (73.4)	32 (49.3)	14 (58.1)
Subtotal (core)	33 (57.8)	1 449 (26.8)	899 (24.3)	56 (-)	632 (35.3)	1 172 (41.1)	1 070 (27.0)
0025	1 (100.0)	-	9 (40.7)	-	59 (40.0)	-	-
Subtotal (core plus puys)	34 (56.5)	1 449 (26.8)	909 (24.1)	56 (-)	691 (32.4)	1 172 (41.1)	1 070 (27.0)
0027	1 278 (82.9)	-	358 (24.5)	1 (50.0)	310 (30.7)	-	7 (50.6)
0028	212 (23.2)	-	120 (19.5)	1 (100.0)	257 (70.2)	1 (100.0)	9 (60.6)
Total	1 524 (69.6)	1 449 (26.8)	1 387 (17.1)	56 (-)	1 258 (24.1)	1 172 (41.0)	1 087 (26.6)

Stratum	NOS	SSM	MIQ	SRB	WWA	SND	RIB
							Species
0001	15 (21.7)	-	1 (100.0)	-	-	77 (58.0)	12 (100.0)
0002	5 (63.2)	1 (100.0)	- (100.0)	-	2 (100.0)	352 (45.2)	34 (30.6)
003A	8 (45.0)	-	18 (62.2)	24 (100.0)	86 (73.2)	-	11 (65.3)
003B	15 (24.0)	-	1 (100.0)	1 (100.0)	17 (54.4)	-	-
0004	-	-	49 (39.8)	-	30 (100.0)	64 (100.0)	190 (58.0)
005A	2 (34.1)	-	2 (100.0)	1 (100.0)	-	18 (77.8)	45 (34.5)
005B	1 (100.0)	-	12 (59.5)	-	-	5 (100.0)	9 (73.7)
0006	908 (70.4)	-	65 (100.0)	742 (96.7)	66 (78.1)	-	-
0007	3 (100.0)	-	26 (24.3)	-	-	20 (100.0)	71 (57.1)
0008	-	-	30 (62.6)	-	13 (100.0)	-	88 (74.8)
0009	-	-	12 (64.8)	-	42 (48.0)	-	-
0010	-	-	144 (14.3)	-	-	-	55 (19.3)
0011	-	-	110 (39.7)	-	10 (100.0)	-	50 (87.9)
0012	69 (36.6)	-	169 (21.5)	48 (63.7)	490 (52.2)	-	-
0013	6 (65.9)	-	104 (44.8)	64 (100.0)	24 (61.6)	-	-
0014	-	-	51 (30.7)	-	-	-	28 (100.0)
0015	-	-	29 (46.6)	-	-	28 (100.0)	31 (56.9)
Subtotal (core)	1 033 (61.9)	1 (100.0)	824 (13.0)	881 (81.9)	781 (34.8)	564 (32.1)	624 (23.7)
0025	- (100.0)	30 (72.6)	14 (37.8)	-	-	143 (51.5)	32 (39.0)
Subtotal (core plus puys)	1 033 (61.9)	31 (70.2)	838 (12.9)	881 (81.9)	781 (34.8)	707 (27.7)	656 (22.6)
0027	-	879 (100.0)	62 (20.7)	-	-	-	-
0028	-	80 (41.1)	69 (11.5)	9 (100.0)	-	-	-
Total	1 033 (61.9)	990 (88.9)	968 (11.2)	890 (81.0)	781 (34.8)	707 (27.7)	656 (22.6)

Table 7: continued.

Stratum	CSQ	RSK	SBK	CFA	SCO	TAG	HCO
							Species
0001	50 (57.7)	-	-	1 (60.1)	15 (85.7)	-	2 (100.0)
0002	17 (34.4)	-	-	- (49.0)	5 (58.0)	1 (100.0)	1 (100.0)
003A	-	-	-	15 (88.4)	2 (100.0)	-	5 (57.7)
003B	42 (100.0)	-	- (100.0)	- (100.0)	1 (100.0)	2 (58.1)	-
0004	-	-	102 (43.7)	40 (54.6)	-	-	-
005A	107 (26.2)	-	1 (65.2)	16 (33.4)	2 (43.9)	-	2 (100.0)
005B	-	-	34 (38.4)	18 (35.9)	2 (100.0)	-	1 (100.0)
0006	-	415 (100.0)	-	-	7 (100.0)	-	34 (62.5)
0007	114 (52.0)	-	7 (56.2)	5 (53.7)	22 (29.4)	11 (100.0)	-
0008	208 (59.4)	9 (59.1)	21 (40.1)	85 (31.1)	165 (49.3)	9 (100.0)	200 (48.6)
0009	-	41 (100.0)	-	20 (57.6)	9 (100.0)	-	-
0010	-	-	48 (2.9)	6 (49.7)	-	35 (50.4)	4 (100.0)
0011	-	-	190 (54.1)	47 (57.7)	45 (30.6)	144 (49.5)	5 (100.0)
0012	-	-	4 (100.0)	26 (78.3)	-	-	87 (65.9)
0013	-	-	-	13 (57.4)	20 (63.2)	-	7 (100.0)
0014	-	-	-	1 (100.0)	89 (72.0)	24 (100.0)	29 (87.1)
0015	-	-	8 (65.7)	2 (0.6)	5 (100.0)	28 (64.5)	-
Subtotal (core)	538 (27.7)	466 (89.6)	415 (27.3)	297 (17.7)	391 (27.4)	254 (31.7)	375 (31.4)
0025	25 (90.8)	-	9 (49.8)	1 (65.7)	-	4 (42.2)	-
Subtotal (core plus puys)	564 (26.8)	466 (89.6)	425 (26.7)	298 (17.6)	391 (27.4)	258 (31.3)	375 (31.4)
0027	-	-	7 (74.5)	62 (66.3)	-	98 (23.0)	-
0028	-	-	22 (73.9)	84 (37.4)	-	32 (76.2)	-
Total	564 (26.8)	466 (89.6)	453 (25.3)	444 (16.6)	391 (27.4)	388 (22.5)	375 (31.4)

Stratum	MAN	BEE	LDO	RCH	CBO	CSU	PLS
							Species
0001	-	-	13 (39.2)	-	28 (26.0)	-	1 (100.0)
0002	-	-	7 (23.2)	-	17 (49.9)	- (100.0)	-
003A	1 (100.0)	-	29 (55.0)	6 (100.0)	84 (48.3)	-	9 (100.0)
003B	-	-	8 (47.3)	-	-	-	7 (100.0)
0004	18 (84.3)	-	-	-	146 (15.9)	2 (58.0)	-
005A	- (100.0)	-	1 (100.0)	-	16 (30.2)	- (100.0)	18 (52.7)
005B	2 (100.0)	-	-	-	4 (57.9)	5 (100.0)	-
0006	-	-	59 (100.0)	-	-	-	-
0007	11 (51.0)	-	-	-	-	-	-
0008	8 (100.0)	-	25 (100.0)	-	-	-	-
0009	54 (41.6)	-	8 (53.7)	-	-	1 (100.0)	-
0010	4 (100.0)	1 (100.0)	-	17 (100.0)	-	63 (49.3)	-
0011	34 (49.0)	-	-	21 (100.0)	8 (100.0)	1 (100.0)	-
0012	100 (29.0)	-	63 (60.5)	-	-	-	-
0013	18 (54.7)	-	91 (46.0)	-	-	-	-
0014	102 (25.7)	-	52 (96.3)	-	-	-	154 (100.0)
0015	15 (100.0)	-	-	-	-	-	-
Subtotal (core)	368 (14.8)	1 (100.0)	358 (28.2)	44 (63.4)	303 (16.2)	71 (44.2)	188 (81.9)
0025	-	25 (70.5)	-	6 (100.0)	- (100.0)	58 (49.4)	7 (81.0)
Subtotal (core plus puys)	368 (14.8)	26 (67.8)	358 (28.2)	50 (56.7)	303 (16.2)	129 (33.0)	196 (78.9)
0027	-	214 (65.2)	-	144 (69.7)	-	43 (62.3)	-
0028	-	123 (28.9)	-	120 (66.2)	-	85 (82.6)	30 (100.0)
Total	368 (14.8)	363 (40.0)	358 (28.2)	314 (41.7)	303 (16.2)	257 (33.7)	225 (69.8)

Table 7: continued.

Stratum	GSC	MRQ	ETL	GIZ	TOP	BJA	SSK
							Species
0001	-	-	16 (10.6)	57 (50.9)	-	-	9 (100.0)
0002	-	-	8 (15.9)	25 (53.6)	-	-	2 (100.0)
003A	-	-	1 (77.6)	22 (80.4)	3 (100.0)	-	129 (100.0)
003B	3 (100.0)	-	7 (89.4)	1 (100.0)	5 (74.3)	-	-
0004	-	-	31 (54.6)	41 (100.0)	17 (100.0)	-	-
005A	-	-	5 (25.1)	6 (62.6)	-	-	-
005B	-	-	16 (85.0)	-	15 (59.2)	-	-
0006	212 (100.0)	-	-	41 (100.0)	13 (100.0)	-	-
0007	-	-	1 (100.0)	-	-	-	-
0008	-	-	9 (53.6)	-	-	-	-
0009	10 (100.0)	-	1 (100.0)	-	46 (61.3)	-	-
0010	-	115 (62.6)	67 (25.6)	-	-	-	-
0011	-	-	23 (57.7)	-	21 (100.0)	-	-
0012	-	-	3 (100.0)	-	-	-	-
0013	-	-	4 (72.0)	-	69 (33.5)	-	-
0014	-	-	-	-	-	-	-
0015	-	-	6 (100.0)	-	-	-	-
Subtotal (core)	94 (-)	115 (62.6)	198 (16.4)	193 (35.4)	26 (-)	-	141 (92.0)
0025	-	2 (100.0)	3 (40.7)	-	-	-	-
Subtotal (core plus puys)	94 (-)	117 (61.5)	200 (16.2)	193 (35.4)	26 (-)	-	141 (92.0)
0027	-	71 (60.0)	-	-	-	128 (100.0)	-
0028	-	33 (100.0)	-	-	-	36 (52.8)	-
Total	94 (-)	221 (40.7)	200 (16.2)	193 (35.4)	26 (-)	164 (79.0)	141 (92.0)

Stratum	PMO	JFI	CHG
			Species
0001	- (100.0)	-	-
0002	- (64.5)	-	-
003A	-	-	-
003B	-	-	-
0004	-	1 (100.0)	-
005A	-	- (100.0)	-
005B	-	1 (75.9)	-
0006	-	-	-
0007	-	-	-
0008	-	9 (91.1)	-
0009	7 (62.3)	-	-
0010	14 (47.7)	-	-
0011	17 (100.0)	19 (76.8)	112 (100.0)
0012	53 (52.6)	30 (78.1)	-
0013	25 (68.2)	9 (100.0)	-
0014	-	39 (80.8)	-
0015	10 (72.1)	-	-
Subtotal (core)	30 (-)	40 (-)	112 (100.0)
0025	1 (100.0)	2 (61.4)	-
Subtotal (core plus puys)	30 (-)	40 (-)	112 (100.0)
0027	-	3 (100.0)	-
0028	4 (65.7)	6 (100.0)	-
Total	29 (-)	37 (-)	112 (100.0)

Table 8: Trawl abundance estimates (t) and coefficients of variation (in parentheses) comparisons for main species for the core strata (300–800 m), and all strata (300–1000 m) from the surveys in the summer *Tangaroa* time series. Estimates from 2016 are scaled core biomass. Species are from the list of the top 50 in the 2018 survey where there were enough data from previous surveys, sorted alphabetically by species code. Species codes are defined in Figure 4 and Appendices 3 and 4.

	ANT		BBE		CAS	
Year	Core	All	Core	All	Core	All
1991	-	-	10 (53.5)	11 (49.5)	1 543 (31.0)	1 543 (31.0)
1992	145 (22.9)	145 (22.9)	- (100.0)	- (100.0)	1 862 (24.2)	1 863 (24.2)
1993	775 (48.8)	775 (48.8)	8 (76.6)	8 (76.6)	3 038 (14.3)	3 038 (14.3)
2000	964 (53.6)	1 001 (51.7)	3 (88.9)	3 (88.9)	1 749 (14.2)	1 749 (14.2)
2001	566 (53.0)	681 (44.3)	- (100.0)	- (100.0)	1 277 (20.3)	1 280 (20.3)
2002	410 (33.2)	489 (28.6)	-	55 (98.1)	1 418 (34.1)	1 418 (34.1)
2003	739 (50.2)	753 (49.3)	1 (80.3)	6 (80.3)	905 (25.1)	905 (25.1)
2004	155 (28.6)	160 (27.8)	-	-	1 752 (16.1)	1 752 (16.1)
2005	336 (37.0)	398 (32.6)	2 (74.4)	2 (74.4)	755 (17.4)	755 (17.4)
2006	241 (22.6)	266 (20.6)	21 (74.6)	21 (74.6)	1 352 (56.1)	1 352 (56.1)
2007	360 (26.2)	430 (22.6)	26 (59.2)	159 (83.9)	2 223 (22.4)	2 223 (22.4)
2008	94 (37.5)	120 (33.4)	22 (73.2)	22 (73.2)	1 805 (28.1)	1 806 (28.1)
2009	296 (21.9)	338 (19.9)	2 (72.5)	2 (66.3)	871 (23.4)	871 (23.4)
2011	162 (27.0)	253 (23.2)	-	47 (66.5)	755 (26.8)	755 (26.8)
2012	265 (15.4)	332 (17.2)	4 (63.7)	4 (63.7)	2 085 (26.1)	2 085 (26.1)
2014	108 (31.8)	118 (29.5)	2 (58.2)	2 (58.2)	574 (22.2)	574 (22.2)
2016	66 (39.0)	-	7 (83.0)	-	1 513 (26.0)	-
2018	42 (55.3)	43 (53.8)	36 (99.5)	36 (99.5)	1 676 (47.7)	1 676 (47.7)

	CBO		CFA		CHG	
Year	Core	All	Core	All	Core	All
1991	326 (21.1)	329 (20.9)	349 (12.4)	349 (12.4)	-	-
1992	413 (28.4)	415 (28.2)	170 (17.9)	175 (17.6)	25 (64.6)	25 (64.6)
1993	186 (29.4)	186 (29.3)	949 (10.3)	952 (10.2)	36 (71.2)	36 (71.2)
2000	667 (40.8)	670 (40.7)	1 164 (10.4)	1 608 (13.6)	-	22 (100.0)
2001	599 (27.7)	610 (27.2)	883 (14.4)	1 338 (12.2)	25 (100.0)	128 (82.9)
2002	336 (32.8)	336 (32.8)	391 (36.6)	696 (23.9)	-	-
2003	173 (41.5)	173 (41.5)	694 (18.9)	826 (16.1)	-	-
2004	208 (22.8)	220 (22.0)	812 (21.9)	1 015 (20.1)	-	-
2005	159 (17.8)	159 (17.8)	835 (20.8)	1 130 (17.6)	88 (100.0)	88 (100.0)
2006	166 (52.0)	180 (48.3)	1 230 (11.6)	1 534 (10.4)	-	-
2007	347 (25.4)	347 (25.4)	484 (13.6)	630 (11.6)	58 (100.0)	337 (84.5)
2008	551 (43.4)	552 (43.3)	1 855 (16.2)	2 305 (13.7)	56 (100.0)	56 (100.0)
2009	454 (19.2)	458 (19.0)	1 006 (14.1)	1 359 (13.6)	-	51 (100.0)
2011	245 (26.3)	245 (26.3)	822 (12.9)	993 (11.4)	-	-
2012	459 (59.1)	466 (58.3)	1 717 (16.3)	2 349 (12.3)	9 (100.0)	9 (100.0)
2014	627 (34.8)	628 (34.7)	993 (11.9)	1 462 (12.1)	12 (100.0)	12 (100.0)
2016	185 (39.0)	-	174 (19.0)	-	-	-
2018	303 (16.2)	303 (16.2)	297 (17.7)	444 (16.6)	112 (100.0)	112 (100.0)

	COL		CSQ		CSU	
Year	Core	All	Core	All	Core	All
1991	565 (17.6)	567 (17.6)	541 (32.2)	542 (32.1)	17 (78.0)	40 (40.0)
1992	168 (11.9)	170 (11.8)	341 (30.5)	346 (30.1)	4 (45.9)	14 (42.2)
1993	1 173 (13.5)	1 173 (13.5)	631 (28.7)	653 (27.8)	54 (49.4)	100 (48.1)
2000	1 185 (12.3)	1 191 (12.3)	819 (38.0)	832 (37.4)	8 (52.6)	949 (20.1)
2001	1 611 (36.9)	1 620 (36.7)	575 (35.4)	627 (32.8)	30 (80.6)	569 (33.5)
2002	555 (22.5)	556 (22.4)	197 (36.2)	214 (33.4)	12 (72.7)	631 (25.8)
2003	1 407 (24.8)	1 407 (24.8)	348 (51.2)	375 (47.5)	7 (40.5)	168 (24.5)
2004	1 823 (31.2)	1 824 (31.2)	376 (48.9)	404 (45.6)	15 (41.5)	358 (55.0)
2005	2 284 (23.3)	2 302 (23.2)	560 (28.8)	594 (27.2)	13 (63.6)	894 (50.0)
2006	3 776 (16.7)	3 779 (16.7)	810 (36.0)	831 (35.2)	8 (52.6)	242 (31.6)
2007	1 587 (32.4)	1 587 (32.4)	1 135 (25.8)	1 155 (25.3)	5 (77.9)	616 (27.3)
2008	2 663 (16.4)	2 663 (16.4)	785 (26.7)	813 (25.9)	31 (32.5)	677 (44.4)
2009	2 451 (17.7)	3 058 (24.2)	1 079 (34.8)	1 104 (34.0)	33 (43.5)	541 (30.8)
2011	1 323 (31.2)	1 324 (31.2)	664 (32.0)	680 (31.3)	33 (43.3)	625 (27.1)
2012	4 489 (16.9)	4 491 (16.9)	804 (26.8)	833 (26.0)	8 (66.0)	392 (27.5)
2014	3 033 (17.2)	3 034 (17.2)	467 (35.4)	489 (33.9)	58 (91.5)	405 (19.5)
2016	644 (48.0)	-	872 (67.0)	-	2 (78.0)	-
2018	1 172 (41.1)	1 172 (41.0)	538 (27.7)	564 (26.8)	71 (44.2)	257 (33.7)

Table 8: continued.

	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)

	GIZ		GSC		GSH	
Year	Core	All	Core	All	Core	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)

	GSP		HAK		HCO	
Year	Core	All	Core	All	Core	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)

Table 8: continued.

Year	HOK Core	HOK All	JAV Core	JAV All	JFI Core	JFI 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)

Year	LAO Core	LAO All	LCH Core	LCH All	LDO Core	LDO 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)

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)

Table 8: continued.

	NOS		OCP		ONG	
Year	Core	All	Core	All	Core	All
1991	283 (32.3)	286 (32.0)	88 (34.6)	90 (33.9)	-	-
1992	105 (21.7)	106 (21.5)	70 (34.2)	71 (33.8)	1 328 (26.3)	1 328 (26.3)
1993	353 (53.7)	354 (53.6)	110 (26.6)	111 (26.4)	551 (21.9)	551 (21.9)
2000	328 (56.5)	331 (56.0)	467 (21.6)	495 (20.6)	5 598 (45.4)	5 843 (43.7)
2001	973 (21.2)	988 (20.9)	87 (37.7)	99 (33.4)	1 534 (19.1)	1 657 (18.2)
2002	298 (30.1)	303 (29.7)	51 (94.1)	51 (94.1)	2 484 (23.8)	2 693 (23.0)
2003	324 (40.4)	325 (40.3)	92 (38)	105 (33.8)	4 939 (74.8)	4 975 (74.3)
2004	232 (28.5)	232 (28.4)	415 (23.1)	433 (22.2)	1 628 (39.9)	1 641 (39.6)
2005	988 (35.6)	995 (35.3)	98 (41.1)	138 (34.0)	1 283 (20.0)	1 329 (19.5)
2006	235 (32.5)	239 (31.9)	176 (35.9)	194 (32.4)	33 617 (92.9)	33 655 (92.8)
2007	2 160 (85.9)	2 161 (85.9)	74 (62.1)	126 (41.0)	1 806 (34.1)	4 142 (58.2)
2008	388 (37.1)	396 (36.3)	85 (39.5)	100 (35.7)	7 011 (34.7)	7 603 (32.8)
2009	561 (65.5)	563 (65.3)	91 (47.9)	109 (41.2)	5 635 (49.8)	5 803 (48.4)
2011	131 (15.0)	131 (15.0)	169 (46.5)	193 (40.9)	1 225 (20.0)	1 260 (19.5)
2012	707 (41.6)	711 (41.4)	126 (47.7)	129 (46.5)	1 240 (25.8)	1 255 (25.5)
2014	141 (19.1)	142 (19.0)	58 (33)	61 (31.8)	755 (29.7)	759 (29.6)
2016	531 (44.0)	-	74 (51.0)	-	1 136 (24.0)	-
2018	1 033 (61.9)	1 033 (61.9)	35 (57.7)	38 (52.9)	1 297 (55.3)	1 301 (55.1)

	PLS		RBM		RCH	
Year	Core	All	Core	All	Core	All
1991	186 (38.4)	186 (38.4)	1 (100.0)	1 (100.0)	-	-
1992	134 (54.9)	134 (54.9)	31 (70.8)	31 (70.8)	-	3 (100.0)
1993	156 (46.9)	157 (46.8)	2 (100.0)	2 (100.0)	47 (78.6)	47 (78.6)
2000	-	3 (100.0)	88 (36.8)	88 (36.8)	17 (100.0)	408 (32.2)
2001	4 (74.2)	23 (78.7)	37 (62.8)	49 (53.3)	69 (100.0)	563 (46.3)
2002	322 (54.6)	327 (53.6)	58 (53.7)	95 (50.7)	87 (72.3)	378 (35.4)
2003	99 (76.2)	153 (57.7)	69 (71.8)	69 (71.8)	16 (100.0)	178 (41.1)
2004	6 (76.5)	11 (50.1)	104 (43.6)	121 (39.7)	223 (64.6)	1 077 (38.3)
2005	107 (73.8)	108 (73.2)	47 (54.6)	54 (49.3)	62 (100.0)	446 (39.5)
2006	103 (68.9)	114 (62.4)	82 (58.8)	82 (58.8)	432 (86.8)	762 (51.5)
2007	123 (67.9)	125 (66.8)	384 (45.6)	386 (45.5)	134 (89.1)	448 (41.6)
2008	- (100.0)	13 (86.5)	132 (50.7)	132 (50.7)	282 (57.0)	1 019 (40.3)
2009	197 (38.7)	202 (37.7)	64 (44.2)	65 (43.6)	164 (91.6)	719 (53.9)
2011	344 (47.5)	354 (46.1)	137 (36.4)	155 (34.2)	250 (50.9)	961 (45.5)
2012	158 (65.3)	203 (54.9)	82 (51.4)	86 (49.0)	56 (100.0)	328 (42.3)
2014	81 (58.4)	85 (55.6)	244 (30.8)	249 (30.4)	5 (100.0)	332 (35.8)
2016	65 (84.0)	-	382 (54.0)	-	-	-
2018	188 (81.9)	225 (69.8)	895 (80.6)	904 (79.8)	44 (63.4)	314 (41.7)

	RCO		RIB		RSK	
Year	Core	All	Core	All	Core	All
1991	103 (51.4)	103 (51.4)	1 095 (10.9)	1 140 (10.6)	42 (72.8)	42 (72.8)
1992	72 (43.3)	72 (43.3)	535 (20.5)	589 (18.9)	52 (68.8)	52 (68.8)
1993	253 (62.1)	253 (62.1)	1 147 (12.6)	1 213 (12.2)	133 (56.9)	133 (56.9)
2000	38 (43.3)	38 (43.3)	873 (14.0)	938 (13.4)	201 (56.4)	201 (56.4)
2001	1 018 (79.7)	1 018 (79.7)	1 117 (14.6)	1 250 (13.3)	158 (51.3)	158 (51.3)
2002	60 (35.5)	60 (35.5)	656 (17.5)	722 (16.1)	55 (47.4)	83 (44.8)
2003	140 (49.3)	140 (49.3)	653 (18.9)	696 (17.9)	78 (42.9)	78 (42.9)
2004	2 765 (96.9)	2 765 (96.9)	951 (16.5)	1 091 (15.1)	25 (72.4)	25 (72.4)
2005	179 (49.4)	179 (49.4)	721 (14.6)	833 (13.4)	116 (45.9)	116 (45.9)
2006	72 (50.2)	72 (50.2)	780 (16.4)	936 (14.5)	159 (74.1)	159 (74.1)
2007	585 (85.9)	585 (85.9)	1 062 (13.5)	1 086 (13.2)	115 (67.3)	123 (63.5)
2008	332 (57.9)	332 (57.9)	658 (18.0)	786 (16.0)	362 (56.9)	362 (56.9)
2009	23 (48.3)	23 (48.3)	1 056 (13.4)	1 255 (12.9)	190 (52.4)	190 (52.4)
2011	65 (34.7)	65 (34.7)	1 017 (17.2)	1 050 (16.7)	106 (61.6)	106 (61.6)
2012	119 (58.0)	119 (58.0)	787 (16.7)	914 (15.9)	68 (75.4)	68 (75.4)
2014	147 (36.9)	147 (36.9)	813 (16.0)	849 (15.5)	11 (93.4)	11 (93.4)
2016	*	-	276 (29.0)	-	6 (100.0)	-
2018	82 (50.3)	82 (50.3)	624 (23.7)	656 (22.6)	466 (89.6)	466 (89.6)

Table 8: continued.

Year	RUD Core	RUD All	SBK Core	SBK All	SBW Core	SBW 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)

Year	SCC Core	SCC All	SCO Core	SCO All	SFI Core	SFI All
1991	-	-	482 (12.8)	482 (12.8)	-	-
1992	230 (13.4)	230 (13.4)	344 (20.9)	344 (20.9)	204 (10.5)	204 (10.5)
1993	287 (23.3)	287 (23.3)	902 (15.8)	902 (15.8)	235 (20.2)	236 (20.1)
2000	1 026 (24.6)	1 167 (22.0)	722 (22.7)	739 (22.3)	517 (12.4)	586 (12.1)
2001	617 (22.4)	785 (19.2)	497 (25.2)	504 (24.9)	500 (16.8)	538 (15.7)
2002	220 (30.9)	306 (23.6)	435 (16.2)	451 (15.8)	365 (14.9)	389 (14.1)
2003	335 (29.7)	354 (28.3)	395 (27.6)	395 (27.6)	198 (15.5)	207 (15.0)
2004	88 (22.0)	119 (17.9)	446 (56.7)	447 (56.6)	248 (23.4)	277 (21.5)
2005	311 (26.2)	400 (26.0)	170 (20.3)	197 (20.7)	374 (14.9)	397 (14.1)
2006	684 (32.0)	713 (30.7)	344 (15.1)	349 (15.0)	443 (10.2)	479 (9.7)
2007	313 (37)	365 (33)	471 (25.2)	471 (25.2)	273 (10.9)	323 (11.3)
2008	406 (27.6)	501 (23.8)	1 302 (30.6)	1 308 (30.4)	202 (16.0)	218 (15)
2009	1 241 (28.4)	1 434 (25.2)	602 (16.1)	624 (15.7)	538 (17.3)	597 (15.9)
2011	519 (18.8)	749 (16.9)	837 (27.2)	848 (26.8)	382 (26.8)	456 (23.2)
2012	567 (24.4)	613 (22.7)	604 (25.8)	617 (25.3)	316 (11.2)	380 (10.0)
2014	218 (23.3)	241 (21.5)	630 (22.7)	630 (22.7)	114 (12.2)	136 (11.4)
2016	213 (34.0)	-	572 (22.0)	-	45 (25.0)	-
2018	128 (29.8)	133 (28.8)	391 (27.4)	391 (27.4)	73 (23.4)	79 (22.0)

Year	SND Core	SND All	SPD Core	SPD All	SQX Core	SQX All
1991	493 (25.4)	656 (21.3)	8 908 (53.9)	8 908 (53.9)	1 643 (7.8)	1 661 (7.8)
1992	203 (24.5)	327 (16.4)	1 158 (15.5)	1 158 (15.5)	2 077 (7.9)	2 086 (7.9)
1993	596 (27.9)	768 (22.9)	1 649 (22.5)	1 649 (22.5)	2 047 (8.6)	2 061 (8.6)
2000	62 (34.7)	131 (21.7)	4 173 (11.6)	4 173 (11.6)	2 302 (9.4)	3 124 (9.1)
2001	360 (25.7)	612 (20.9)	8 528 (30.7)	8 528 (30.7)	1 542 (13.0)	2 717 (11.4)
2002	436 (34.4)	524 (28.9)	3 505 (18.8)	3 505 (18.8)	1 448 (12.8)	1 953 (14.7)
2003	190 (28.3)	263 (22.0)	2 317 (16.8)	2 317 (16.8)	1 811 (12.9)	2 116 (11.7)
2004	636 (19.5)	738 (17.4)	3 376 (27.3)	3 378 (27.3)	1 759 (13.5)	2 286 (11.5)
2005	480 (25.1)	583 (21.2)	4 344 (18.9)	4 344 (18.9)	1 565 (11.6)	1 984 (10.2)
2006	683 (25.9)	827 (21.7)	3 039 (19.3)	3 039 (19.3)	1 522 (9.9)	1 718 (9.2)
2007	196 (40.4)	261 (31.9)	3 589 (16.6)	3 589 (16.6)	1 343 (15.2)	2 250 (14.0)
2008	777 (30.4)	910 (26.3)	3 080 (19.1)	3 084 (19.0)	1 485 (14.4)	2 375 (13.5)
2009	697 (34.2)	999 (28.0)	4 296 (33.5)	4 296 (33.5)	1 658 (11.8)	2 105 (10.5)
2011	1 017 (15.0)	1 082 (14.4)	1 941 (18.9)	1 941 (18.9)	1 831 (13.2)	2 439 (11.0)
2012	428 (21.1)	724 (32.8)	843 (12.3)	843 (12.3)	2 196 (10.8)	2 479 (9.9)
2014	888 (12.7)	1 054 (15.1)	4 259 (28.7)	4 262 (28.7)	1 575 (15.2)	1 815 (13.5)
2016	*	-	3 524 (41.0)	-	1 628 (11.0)	-
2018	564 (32.1)	707 (27.7)	9 192 (53.9)	9 208 (53.8)	1 204 (12.6)	1 596 (10.4)

Table 8: continued.

Year	SSI Core	SSI All	SSK Core	SSK All	SWA Core	SWA All
1991	522 (14.4)	522 (14.4)	386 (23.0)	386 (23.0)	1 113 (46.7)	1 113 (46.7)
1992	396 (10.8)	396 (10.8)	119 (45.0)	119 (45.0)	225 (63.8)	225 (63.8)
1993	1 430 (18.0)	1 430 (18.0)	118 (43.3)	123 (42.0)	164 (63.4)	164 (63.4)
2000	1 810 (15.4)	1 810 (15.4)	435 (66.2)	495 (59.0)	21 (65.0)	21 (65.0)
2001	1 563 (38.6)	1 565 (38.6)	636 (43.4)	636 (43.4)	1 069 (58.5)	1 069 (58.5)
2002	1 404 (17.9)	1 407 (17.8)	299 (65.3)	299 (65.3)	141 (62.1)	141 (62.1)
2003	1 252 (11.0)	1 252 (11.0)	475 (60.3)	475 (60.3)	22 (71.8)	22 (71.8)
2004	1 330 (20.3)	1 330 (20.3)	331 (51.5)	331 (51.5)	171 (33.9)	171 (33.9)
2005	1 136 (48.5)	1 136 (48.5)	34 (85.6)	37 (78.8)	1 198 (98.8)	1 198 (98.8)
2006	2 615 (23.8)	2 616 (23.8)	995 (43.2)	999 (43.0)	71 (56.0)	71 (56.0)
2007	2 114 (22.4)	2 114 (22.4)	483 (52.3)	483 (52.3)	514 (38.2)	514 (38.2)
2008	1 932 (11.7)	1 932 (11.7)	1 406 (50.8)	1 406 (50.8)	4 122 (54.9)	4 122 (54.9)
2009	1 360 (27.1)	1 360 (27.1)	648 (75.7)	648 (75.7)	3 620 (98.0)	3 620 (98.0)
2011	1 541 (20.3)	1 541 (20.3)	1 660 (79.1)	1 684 (78.0)	136 (61.0)	136 (61.0)
2012	2 938 (12.7)	2 939 (12.7)	680 (74.1)	680 (74.1)	13 (75.0)	13 (75.0)
2014	3 490 (23.4)	3 490 (23.4)	1 012 (36.5)	1 012 (36.5)	29 (71.6)	29 (71.6)
2016	446 (24.0)	-	323 (50.0)	-	85 (115.0)	-
2018	1 449 (26.8)	1 449 (26.8)	141 (92.0)	141 (92.0)	2 694 (41.1)	2 694 (41.1)

Year	TOA Core	TOA All	WWA Core	WWA All
1991	327 (17.9)	327 (17.9)	1 599 (58.3)	1 605 (58.1)
1992	343 (20.7)	343 (20.7)	242 (25.8)	243 (25.7)
1993	401 (24.9)	401 (24.9)	282 (28.7)	293 (27.9)
2000	577 (18.2)	679 (18.3)	266 (38.7)	266 (38.7)
2001	150 (28.2)	186 (27.4)	2 429 (53.8)	2 433 (53.7)
2002	333 (25.9)	426 (23.0)	853 (24.1)	863 (23.9)
2003	300 (23.5)	343 (21.6)	709 (58.4)	709 (58.4)
2004	239 (28.5)	368 (25.9)	1 061 (30.8)	1 061 (30.8)
2005	252 (31.3)	376 (23.1)	538 (38.5)	538 (38.5)
2006	400 (44.4)	464 (39.5)	642 (25.9)	646 (25.8)
2007	168 (34)	316 (33.4)	1 706 (61.4)	1 707 (61.3)
2008	229 (34.9)	274 (30.3)	2 283 (39.8)	2 293 (39.6)
2009	303 (36.8)	369 (31.1)	2 093 (35.3)	2 093 (35.3)
2011	332 (35)	499 (34.3)	390 (26.7)	393 (26.5)
2012	319 (24.7)	398 (21.5)	1 259 (28.7)	1 259 (28.7)
2014	167 (28.8)	251 (23.2)	211 (39.5)	211 (39.5)
2016	122 (51.0)	-	609 (65.0)	-
2018	189 (25.6)	208 (25.0)	781 (34.8)	781 (34.8)

Table 9: Numbers of fish for which length, sex, and biological data were collected from the November–December 2018 Southland and Sub-Antarctic trawl survey.

Common name	Length frequency data				Length-weight data	
	Males measured	Females measured	Total † measured	No. of samples	No. of fish	No. of samples
Alert pigfish	-	1	2	1	2	1
Arrow squid	120	105	225	28	127	28
Australasian slender cod	47	43	91	9	91	9
Banded bellowsfish	-	-	5	1	5	1
Banded rattail	386	696	1 097	51	573	42
Basketwork eel	62	91	155	11	134	11
Baxter's lantern dogfish	121	107	228	34	226	34
Big-scale pomfret	1	1	2	1	2	1
Bigeye cardinalfish	1	6	7	3	7	3
Bigeye sea perch	1	-	1	1	1	1
Black javelinfish	23	25	54	4	40	4
Black oreo	237	242	479	13	137	13
Blackspot rattail	7	15	26	6	17	5
Blue-eye lantern shark	3	1	4	2	4	2
Bollon's rattail	54	110	172	24	154	21
Bronze bream	-	1	1	1	1	1
Cape scorpionfish	-	2	2	1	2	1
Capro dory	-	-	8	1	8	1
Dark ghost shark	146	155	301	12	111	12
Dawson's catshark	5	1	6	4	6	4
Dealfish	1	-	1	1	1	1
Deepsea cardinalfish	4	6	10	5	10	5
Deepsea flathead	1	-	1	1	1	1
Deepsea pigfish	-	4	16	1	16	1
Finless flounder	15	19	38	25	38	25
Four-rayed rattail	288	534	858	17	212	12
Gemfish	8	13	21	8	21	8
Giant chimaera	-	1	1	1	1	1
Giant lepidion	-	1	1	1	1	1
Giant stargazer	8	26	34	15	34	15
Gonorynchus forsteri & *G. Greyi*	-	-	1	1	1	1
Hairy conger	21	35	56	18	56	18
Hake	66	221	288	38	288	38
Hoki	1 562	2 593	4 157	81	1 500	81
Humpback rattail (slender rattail)	-	3	3	3	3	3
Javelinfish	949	2 966	3 980	79	1 304	68
Kaiyomaru rattail	19	44	67	8	38	4
Leafscale gulper shark	19	22	41	19	41	19
Ling	1 019	882	1 901	67	1 128	67
Long-nosed chimaera	53	44	97	30	97	30
Longnose velvet dogfish	70	183	253	20	253	20
Longnosed deepsea skate	-	1	1	1	1	1
Lookdown dory	41	77	118	31	118	31
Lucifer dogfish	214	184	398	47	359	47
Mahia rattail	-	6	6	2	6	2
New Zealand catshark	3	2	5	2	5	2
Notable rattail	33	32	148	7	10	2
Oblique banded rattail	46	795	854	28	386	25
Oliver's rattail	708	862	1 626	37	544	31
Orange roughy	60	63	133	12	94	12
Pale ghost shark	325	300	625	65	506	65
Pale toadfish	-	1	1	1	1	1
Plunket's shark	6	7	13	9	13	9
Prickly deepsea skate	1	3	4	4	4	4
Prickly dogfish	1	-	1	1	1	1
Red cod	10	9	19	7	19	7
Ribaldo	27	130	157	37	157	37
Ridge scaled rattail	53	117	171	21	148	20
Rough skate	10	15	25	4	25	4
Rudderfish	1	3	4	3	4	3

Table 9 continued:

Common name	Length frequency data				Length-weight data	
	Males measured	Females measured	Total † measured	No. of samples	No. of fish	No. of samples
Scabbardfish	-	1	1	1	1	1
Scampi	9	6	15	3	14	3
Sea perch	9	15	24	2	24	2
Seal shark	9	7	16	12	16	12
Serrulate rattail	29	19	48	8	45	7
Shovelnose dogfish	109	229	338	20	196	20
Silver roughy	-	13	13	2	13	2
Silver warehou	80	124	204	15	146	15
Silverside	166	297	784	25	354	22
Small banded rattail	9	18	28	4	22	3
Smallscaled brown slickhead	77	81	159	7	79	7
Smallscaled cod	-	-	2	1	2	1
Smooth deepsea skate	3	3	6	6	6	6
Smooth oreo	186	194	380	10	76	10
Smooth skate	2	4	6	4	6	4
Smooth skin dogfish	19	9	28	5	28	5
Southern blue whiting	975	1 120	2 096	24	410	23
Southern Ray's bream	11	41	52	10	37	10
Spiky oreo	9	9	18	4	18	4
Spineback	16	249	266	32	229	31
Spiny dogfish	360	145	505	39	349	39
Swollenhead conger	36	35	71	27	71	27
Todarodes angolensis	1	32	36	16	36	16
Velvet dogfish	2	-	2	2	-	2
Violet cod	10	7	17	4	17	4
Warty squid	67	106	186	49	186	49
Warty squid	2	2	4	2	4	2
White rattail	20	11	31	5	31	5
White warehou	129	66	198	22	113	22
Widenosed chimaera	10	16	26	9	26	9
Total	9 211	14 665	24 560	1 336	11 648	1 281

† Total is sometimes greater than the sum of male and female fish because the sex of some fish was not recorded.

Table 10: Gonad stages (see Appendix 1) for species with more than 20 observations from the November–December 2018 Southland and Sub-Antarctic trawl survey. – indicates gonad stage not relevant for this species.

Species code	Common name	Sex	Staging method	1	2	3	4	5	6	7	Total
AEX	New Zealand catshark	Female	SS	2	-	-	-	-	-	-	2
		Male		3	-	-	-	-	-	-	3
BBR	Bronze bream	Female	MD	-	1	-	-	-	-	-	1
		Male		-	-	-	-	-	-	-	-
BEE	Basketwork eel	Female	MD	9	36	6	-	-	-	-	51
		Male		2	12	4	-	-	-	-	18
BOE	Black oreo	Female	MD	90	24	12	12	3	-	1	142
		Male		103	15	1	10	5	-	-	134
BSH	Seal shark	Female	SS	7	-	-	-	-	-	-	7
		Male		9	-	-	-	-	-	-	9
BSP	Big-scale pomfret	Female	MD	-	1	-	-	-	-	-	1
		Male		-	-	-	-	-	-	-	-
BTA	Smooth deepsea skate	Female	SS	1	-	2	-	-	-	-	3
		Male		-	2	1	-	-	-	-	3
BTS	Prickly deepsea skate	Female	SS	1	-	2	-	-	-	-	3
		Male		-	-	1	-	-	-	-	1
CAS	Oblique banded rattail	Female	MD	7	93	11	-	-	-	-	111
		Male		1	11	-	-	1	-	-	13
CBA	Humpback rattail (slender rattail)	Female	MD	-	1	-	-	-	-	-	1
		Male		-	-	-	-	-	-	-	-
CBO	Bollon's rattail	Female	MD	1	14	-	-	-	1	3	19
		Male		-	4	-	-	-	-	-	4
CFA	Banded rattail	Female	MD	1	7	2	-	-	-	-	10
		Male		-	4	-	-	-	-	-	4
CHG	Giant chimaera	Female	MD	-	-	1	-	-	-	-	1
		Male		-	-	-	-	-	-	-	-
CIN	Notable rattail	Female	MD	-	2	3	-	-	-	-	5
		Male		-	8	-	-	-	-	-	8
CKA	Kaiyomaru rattail	Female	MD	-	-	1	-	-	-	-	1
		Male		-	-	-	-	-	-	-	-
CMA	Mahia rattail	Female	MD	-	3	3	-	-	-	-	6
		Male		-	-	-	-	-	-	-	-
COL	Oliver's rattail	Female	MD	3	26	-	-	-	-	-	29
		Male		1	17	-	-	-	-	-	18
CSE	Serrulate rattail	Female	MD	-	-	1	-	-	-	-	1
		Male		1	-	-	-	-	-	-	1
CSQ	Leafscale gulper shark	Female	SS	4	2	14	2	-	-	-	22
		Male		4	-	15	-	-	-	-	19
CSU	Four-rayed rattail	Female	MD	-	-	-	-	-	-	-	-
		Male		-	3	-	-	-	-	-	3
CYO	Smooth skin dogfish	Female	SS	8	1	-	-	-	-	-	9
		Male		16	-	3	-	-	-	-	19
CYP	Longnose velvet dogfish	Female	SS	39	60	45	29	8	2	-	183
		Male		34	4	32	-	-	-	-	70
DCS	Dawson's catshark	Female	SS	-	-	1	-	-	-	-	1
		Male		-	4	1	-	-	-	-	5
DEA	Dealfish	Female	MD	-	-	-	-	-	-	-	-
		Male		-	1	-	-	-	-	-	1
EPL	Bigeye cardinalfish	Female	MD	1	5	-	-	-	-	-	6
		Male		-	-	-	-	-	-	-	-
EPT	Deepsea cardinalfish	Female	MD	4	1	-	-	-	-	-	5
		Male		3	1	-	-	-	-	-	4
ETB	Baxter's lantern dogfish	Female	SS	18	53	18	14	4	-	-	107
		Male		21	22	78	-	-	-	-	121
ETL	Lucifer dogfish	Female	SS	24	109	33	3	1	1	-	171
		Male		23	122	62	-	-	-	-	207
EVI	Blue-eye lantern shark	Female	MD	1	-	-	-	-	-	-	1
		Male		-	-	3	-	-	-	-	3
GIZ	Giant stargazer	Female	MD	1	8	9	-	-	2	2	22
		Male		-	8	-	-	-	-	-	8

Table 10: continued.

Species code	Common name	Sex	Staging method	1	2	3	4	5	6	7	Total
GSH	Dark ghost shark	Female	SS	13	23	28	-	-	-	-	64
		Male		2	14	48	-	-	-	-	64
GSP	Pale ghost shark	Female	SS	46	123	65	21	-	-	-	255
		Male		63	38	174	-	-	-	-	275
HAK	Hake	Female	MD	54	84	74	1	1	2	5	221
		Male		19	22	4	15	6	-	-	66
HAS	Australasian slender cod	Female	MD	2	7	-	-	-	-	-	9
		Male		22	-	-	-	-	-	-	22
HBA	Bigeye sea perch	Female	MD	-	-	-	-	-	-	-	-
		Male		-	-	1	-	-	-	-	1
HCO	Hairy conger	Female	MD	-	1	-	-	-	-	-	1
		Male		-	1	-	-	-	-	-	1
HOK	Hoki	Female	MD	489	1 992	24	1	1	1	16	2 524
		Male		527	972	9	9	2	8	9	1 536
HPC	Sea perch	Female	MD	-	-	-	4	-	-	-	4
		Male		-	3	-	-	-	-	-	3
JAV	Javelinfish	Female	MD	15	33	1	-	-	-	-	49
		Male		9	5	-	-	-	-	-	14
LCH	Long-nosed chimaera	Female	SS	10	10	22	1	1	-	-	44
		Male		14	4	34	-	-	-	-	52
LDO	Lookdown dory	Female	MD	5	21	13	4	6	-	1	50
		Male		7	13	-	5	2	-	-	27
LIN	Ling	Female	MD	161	499	30	161	4	1	-	856
		Male		92	166	86	521	144	-	-	1 009
LPI	Giant lepidion	Female	MD	-	1	-	-	-	-	-	1
		Male		-	-	-	-	-	-	-	-
MAN	Finless flounder	Female	MD	-	1	-	-	-	-	2	3
		Male		-	-	-	-	-	-	-	-
MCA	Ridge scaled rattail	Female	MD	-	12	42	-	-	3	6	63
		Male		-	3	4	8	4	-	-	19
ORH	Orange roughy	Female	MD	27	7	6	-	-	-	-	40
		Male		43	2	-	-	-	-	-	45
PDG	Prickly dogfish	Female	SS	-	-	-	-	-	-	-	-
		Male		-	-	1	-	-	-	-	1
PLS	Plunket's shark	Female	SS	5	1	-	-	-	-	-	6
		Male		4	-	2	-	-	-	-	6
PSK	Longnosed deepsea skate	Female	SS	-	-	1	-	-	-	-	1
		Male		-	-	-	-	-	-	-	-
RCH	Widenosed chimaera	Female	SS	6	1	5	2	-	-	-	14
		Male		1	-	9	-	-	-	-	10
RCO	Red cod	Female	MD	5	2	2	-	-	-	-	9
		Male		1	-	-	4	3	-	-	8
RIB	Ribaldo	Female	MD	19	80	-	-	-	-	20	119
		Male		11	12	2	-	-	1	-	26
RSK	Rough skate	Female	MD	-	1	-	-	-	-	-	1
		Male		2	1	-	-	-	-	-	3
RSO	Gemfish	Female	MD	1	11	-	-	-	-	-	12
		Male		-	3	-	-	-	-	-	3
RUD	Rudderfish	Female	MD	-	2	-	-	-	-	-	2
		Male		-	-	-	-	-	-	-	-
SBK	Spineback	Female	MD	1	14	12	3	8	-	-	38
		Male		-	-	-	-	-	-	-	-
SBW	Southern blue whiting	Female	MD	96	585	2	-	-	-	4	687
		Male		82	390	-	-	-	-	1	473
SCO	Swollenhead conger	Female	MD	2	6	9	-	-	-	-	17
		Male		1	6	5	-	-	-	-	12
SND	Shovelnose dogfish	Female	SS	25	108	13	1	-	1	-	148
		Male		4	16	62	-	-	-	-	82
SOR	Spiky oreo	Female	MD	2	4	3	-	-	-	-	9
		Male		9	-	-	-	-	-	-	9

Table 10: continued.

Species code	Common name	Sex	Staging method	1	2	3	4	5	6	7	Total
SPD	Spiny dogfish	Female	SS	20	76	8	15	7	-	-	126
		Male		3	19	221	-	-	-	-	243
SRB	Southern Ray's bream	Female	MD	1	25	13	-	-	-	-	39
		Male		1	10	-	-	-	-	-	11
SSI	Silverside	Female	MD	-	4	-	-	-	-	-	4
		Male		3	-	-	-	-	-	-	3
SSK	Smooth skate	Female	SS	1	3	-	-	-	-	-	4
		Male		1	1	-	-	-	-	-	2
SSM	Smallscaled brown slickhead	Female	MD	-	9	8	1	-	-	-	18
		Male		2	9	-	-	-	-	-	11
SSO	Smooth oreo	Female	MD	43	33	-	-	-	-	-	76
		Male		43	20	1	3	-	-	-	67
SWA	Silver warehou	Female	MD	3	109	12	-	-	-	-	124
		Male		2	67	7	2	-	1	-	79
TRS	Cape scorpionfish	Female	MD	-	2	-	-	-	-	-	2
		Male		-	-	-	-	-	-	-	-
VNI	Blackspot rattail	Female	MD	-	-	4	-	-	-	-	4
		Male		-	-	-	-	-	-	-	-
WHX	White rattail	Female	MD	1	4	-	-	-	-	1	6
		Male		9	7	-	-	-	-	-	16
WWA	White warehou	Female	MD	23	10	4	-	-	-	-	37
		Male		56	10	-	5	-	-	-	71
ZAS	Velvet dogfish	Female	MD	-	-	-	-	-	-	-	-
		Male		-	-	2	-	-	-	-	2

Table 11: 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
Mean	2.81	0.5	3.09	0.7	2.13	1.2	2.77	0.7

Table 12: Quality of acoustic data collected during trawl surveys in the Sub-Antarctic between 2000 and 2018. 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 more 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

* There was a problem with synchronisation of scientific and ship's echosounders in 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 recording and were not suitable for quantitative analysis.

Table 13: Estimates of the proportion of total day 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).

			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

*No night time data were available for Puysegur in 2014 or 2016 so proportion was estimated as the average of 2000–11 = 0.54.

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

8. FIGURES

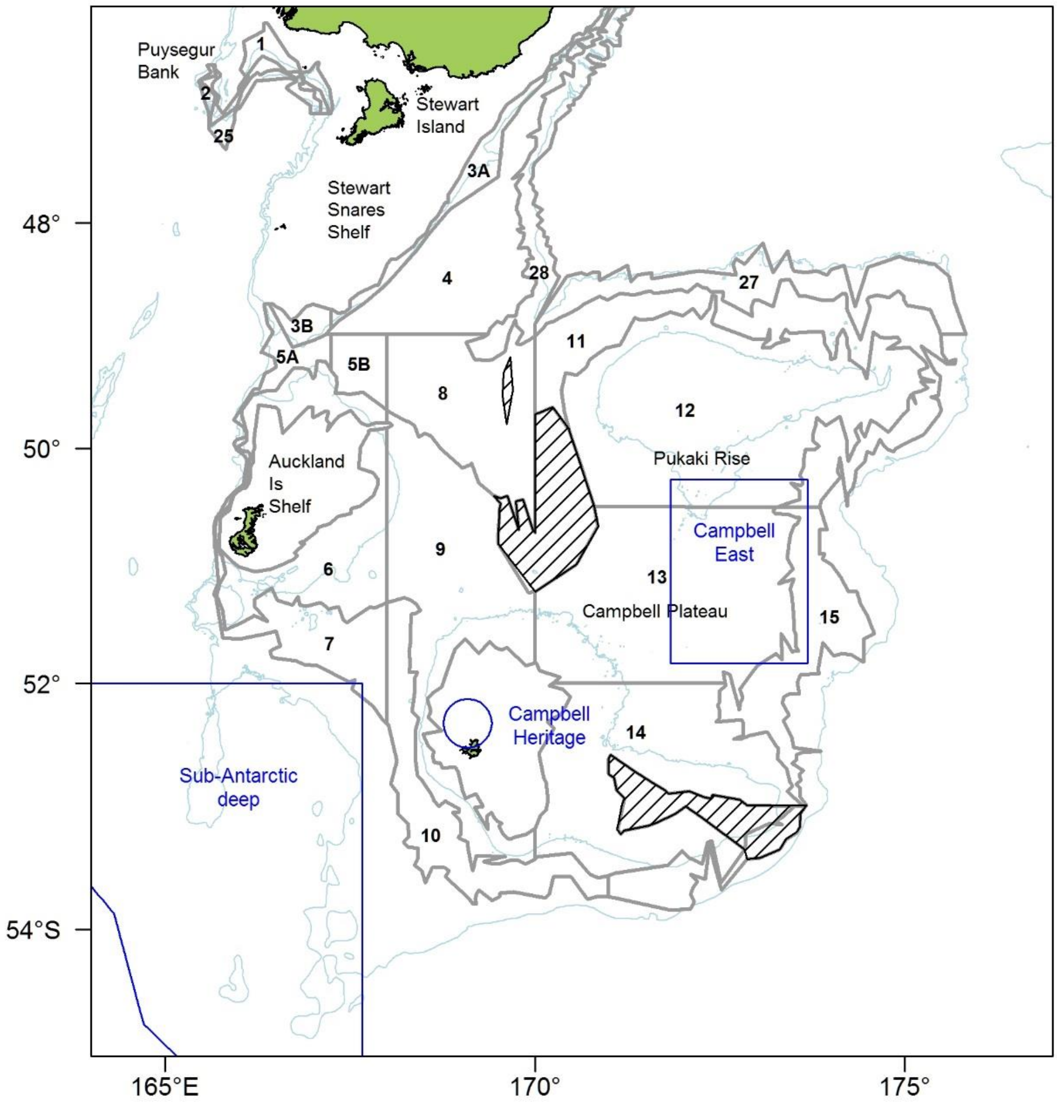


Figure 1: Stratum boundaries from the November–December 2018 Southland and Sub-Antarctic trawl survey. Stratum areas are given in Table 1. Blue areas are benthic protected areas.

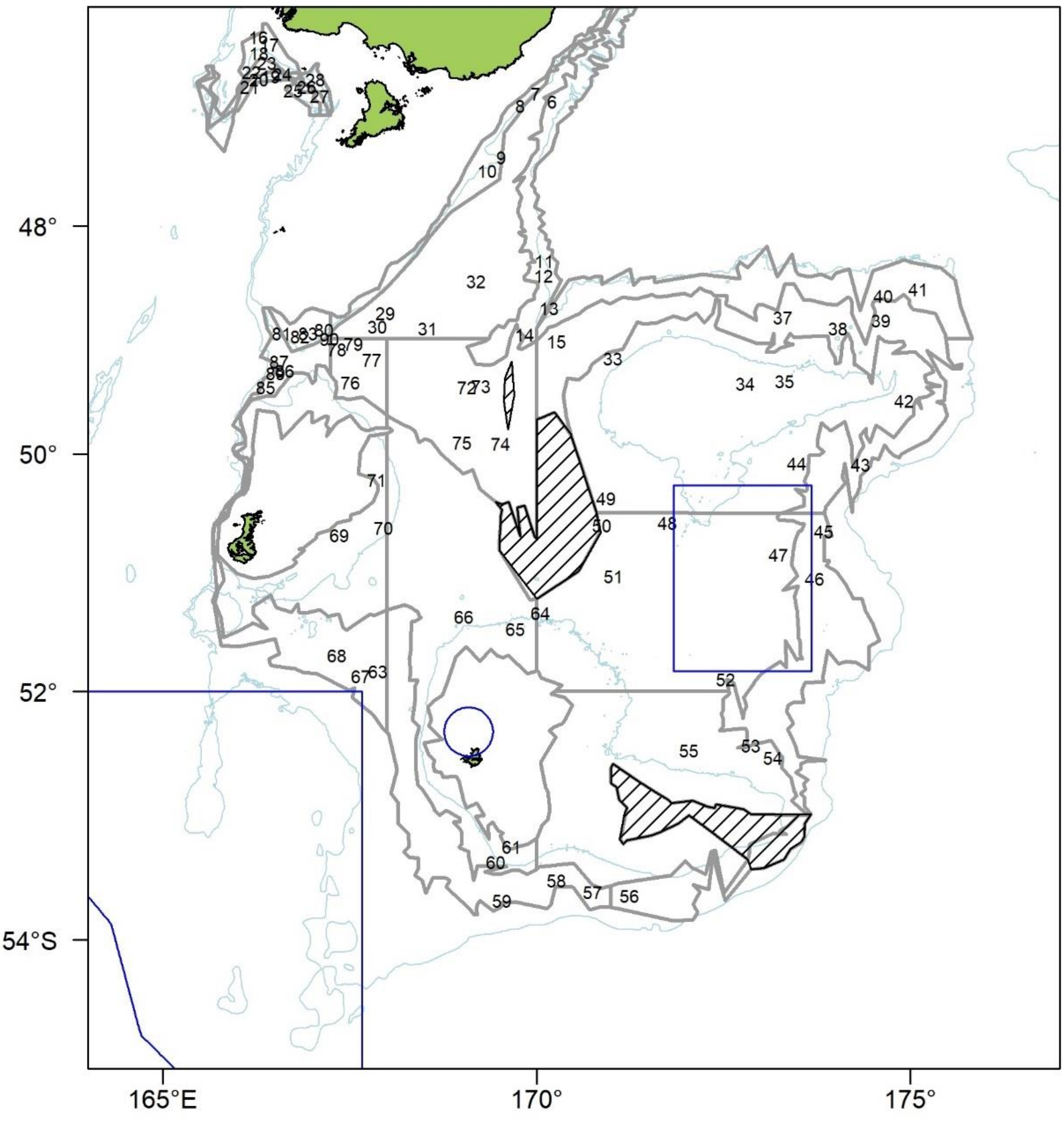


Figure 2: Trawl tow positions from the November–December 2018 Southland and Sub-Antarctic trawl survey. Labels show station numbers. Station details are given in Appendix 2. Blue areas are benthic protected areas. Stations that were gear trials or gear performance 3 or 4 are not shown.

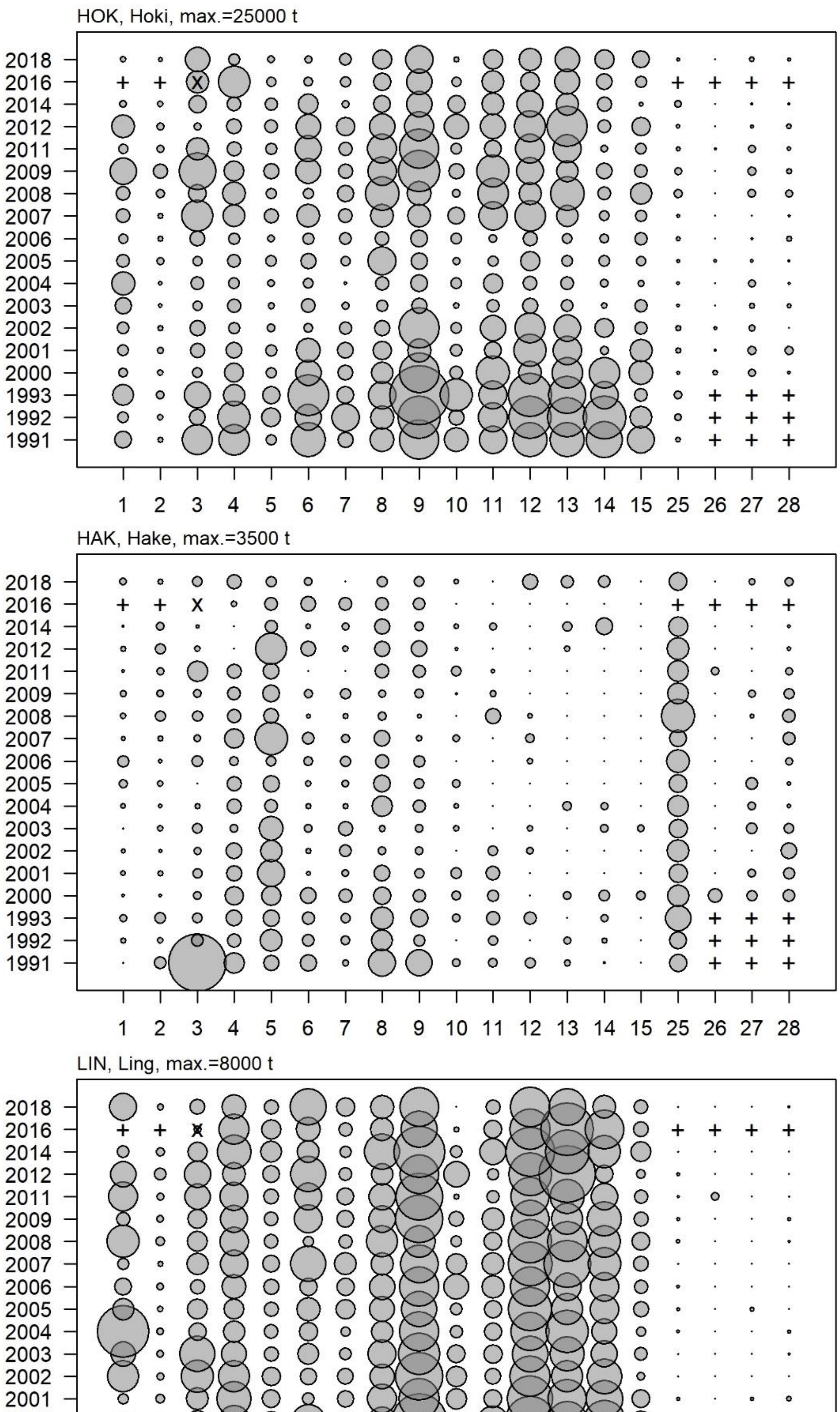
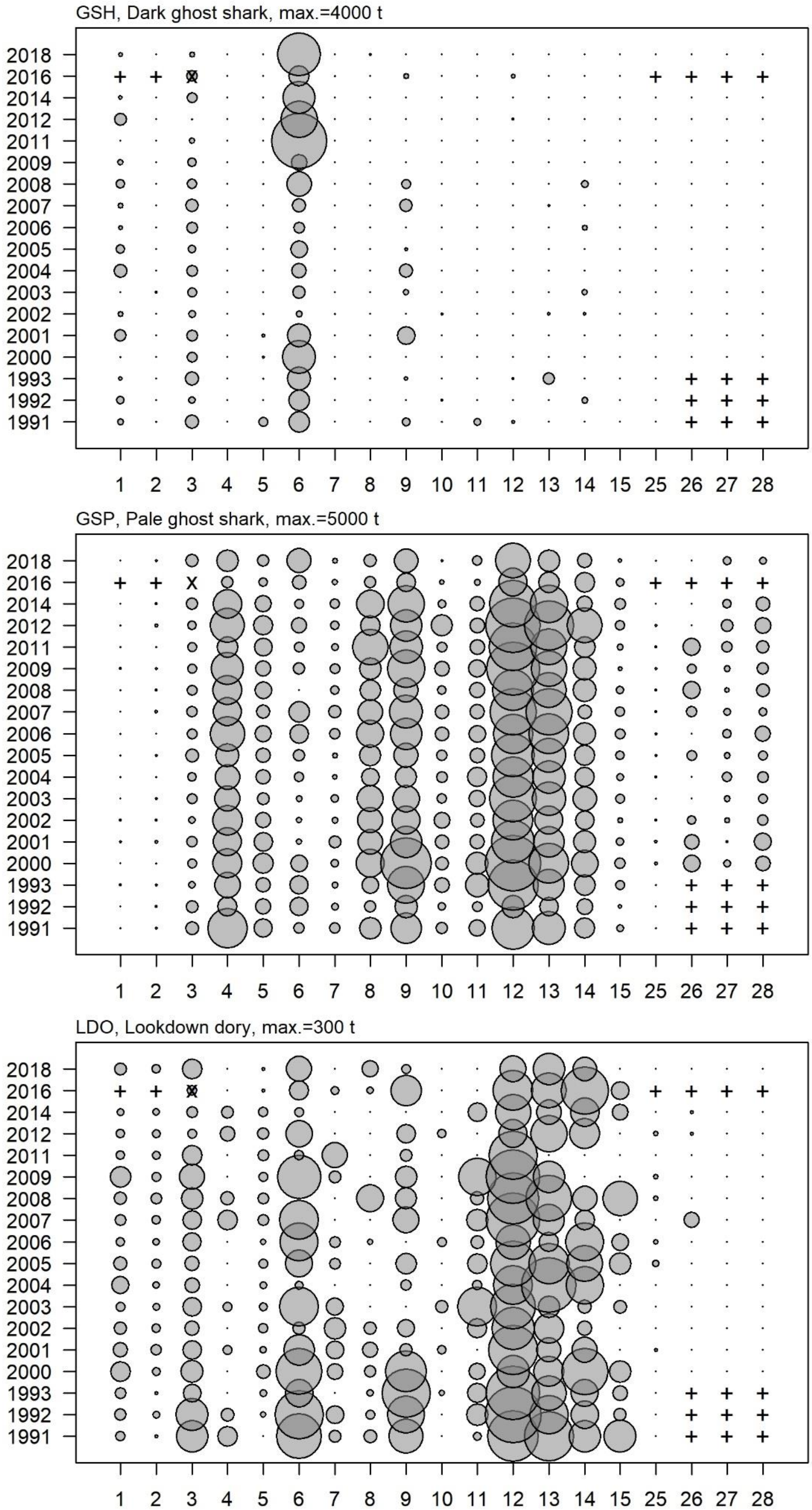


Figure 3: Relative biomass estimates by strata for selected species sampled from the Southland and Sub-Antarctic November–December *Tangaroa* surveys. +, stratum not surveyed in that year; ×, Strata 003A and 003B were combined into stratum 3, and in 2016 stratum 003A was not sampled.



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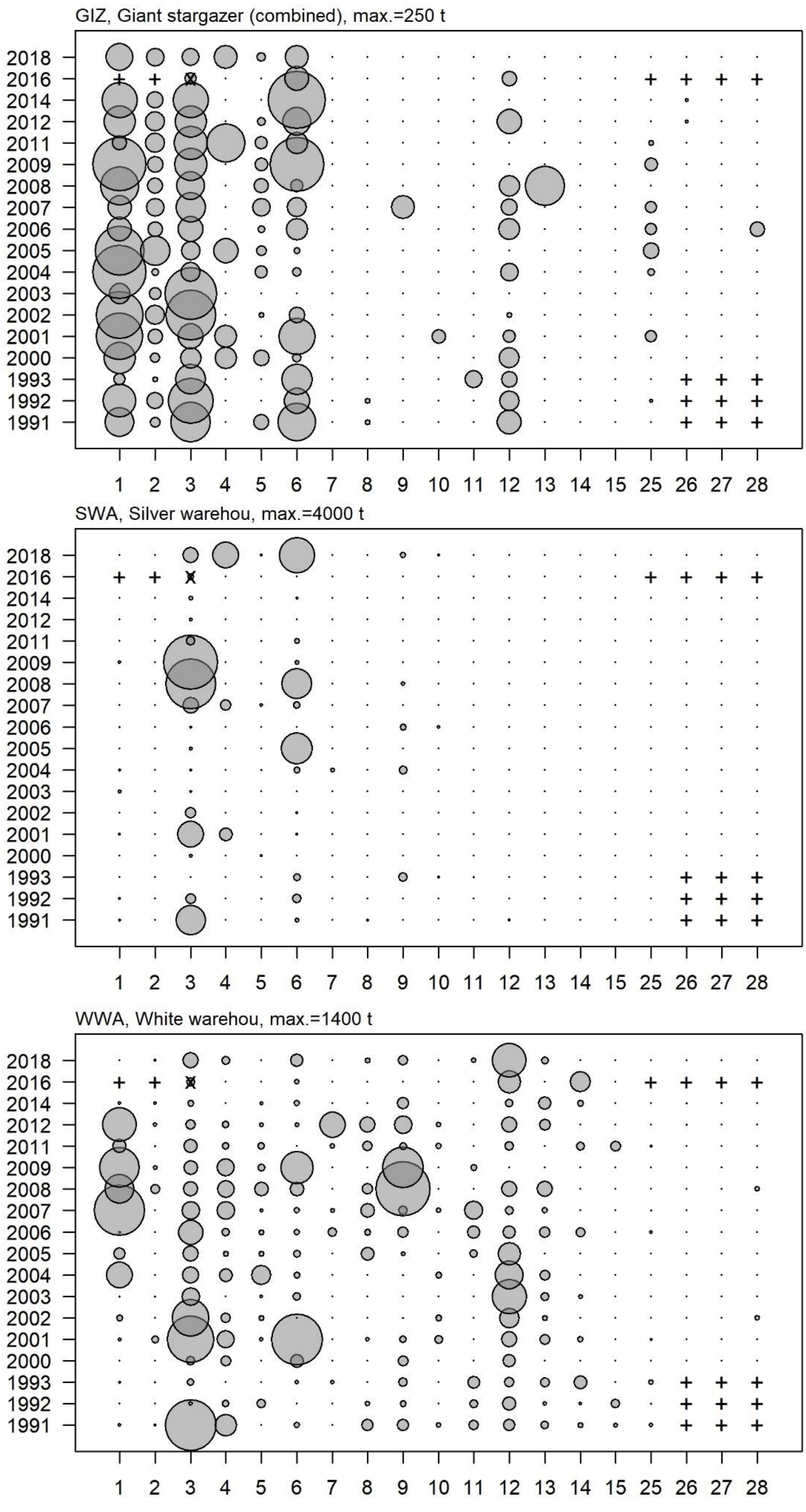

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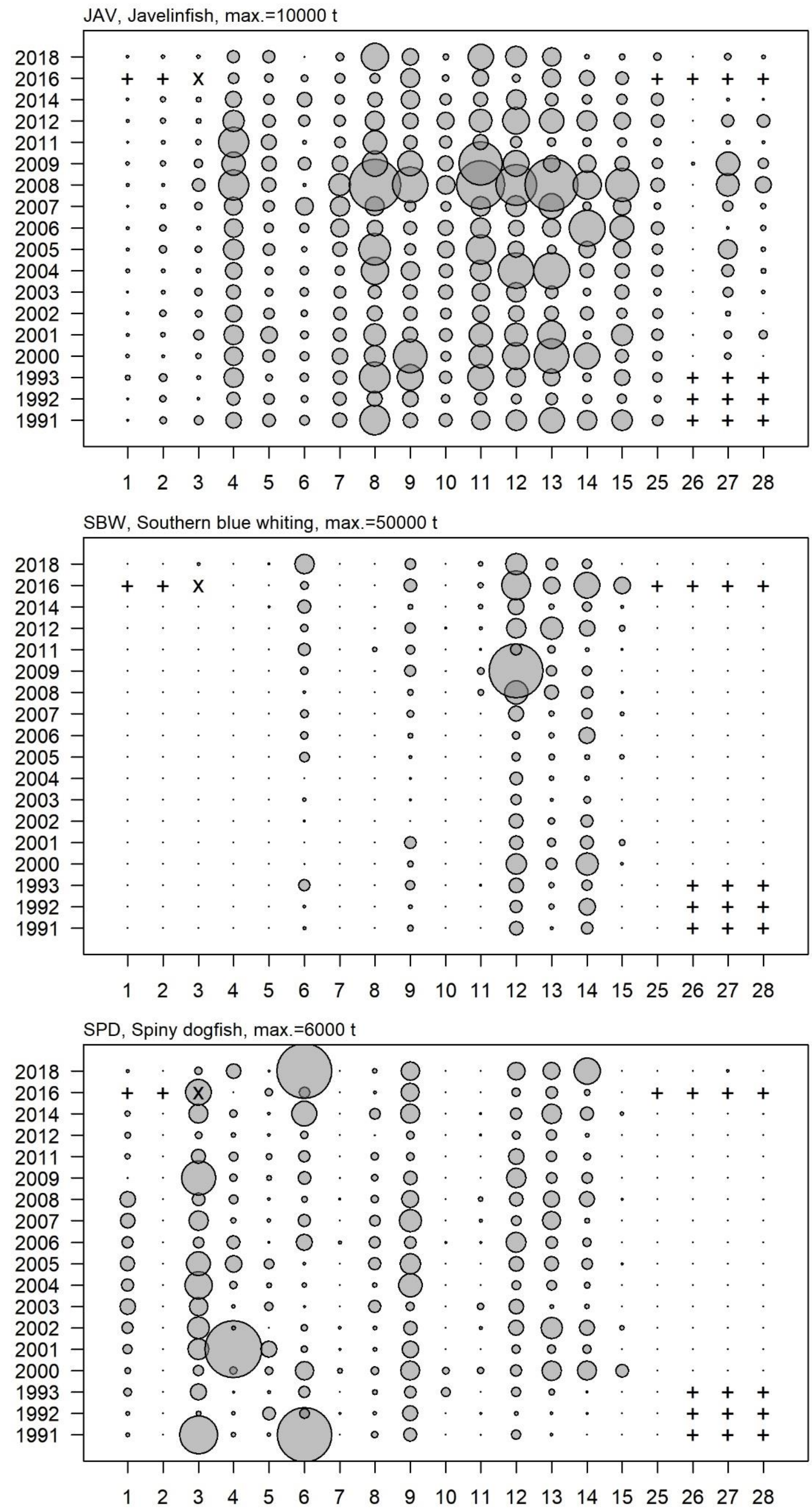

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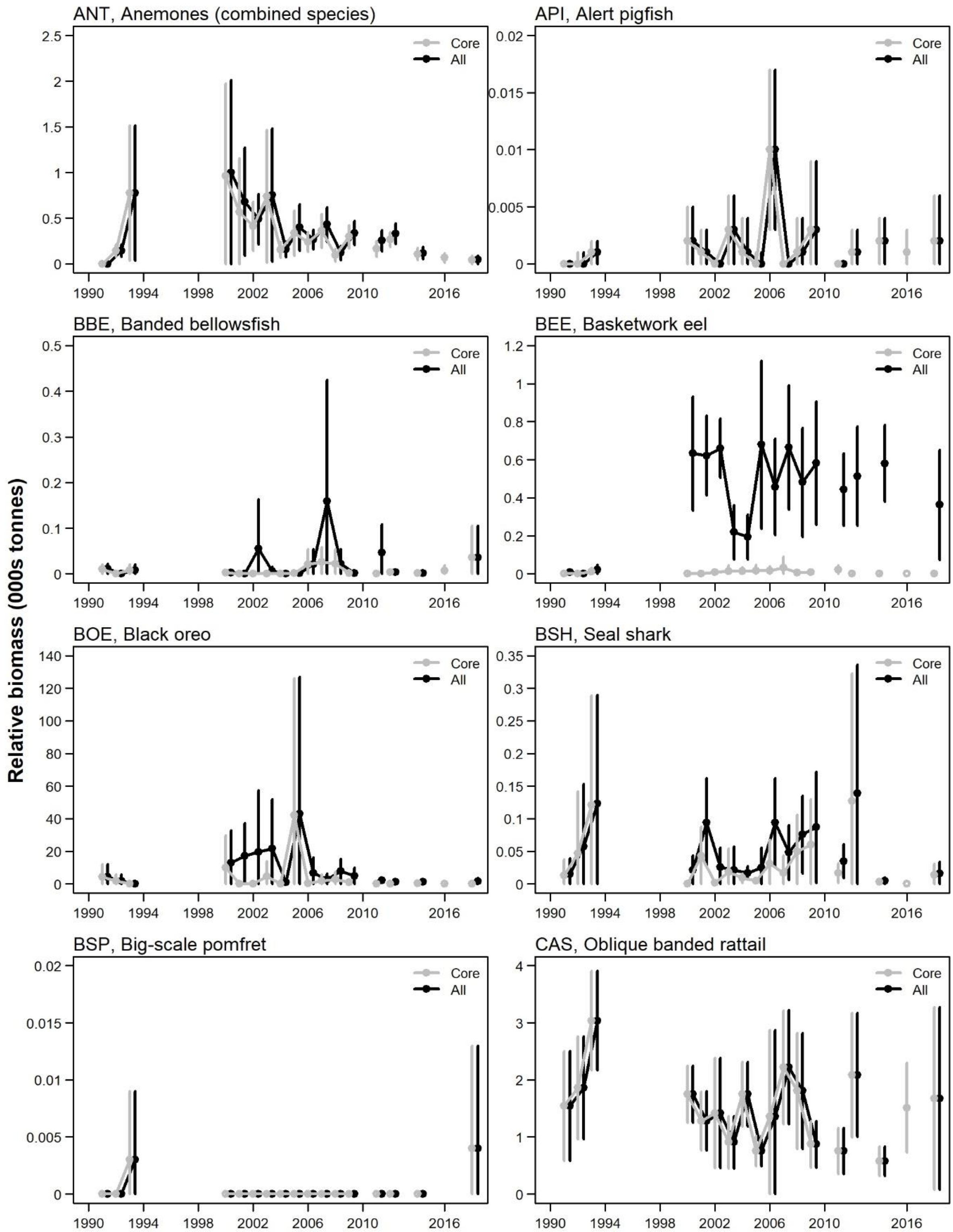
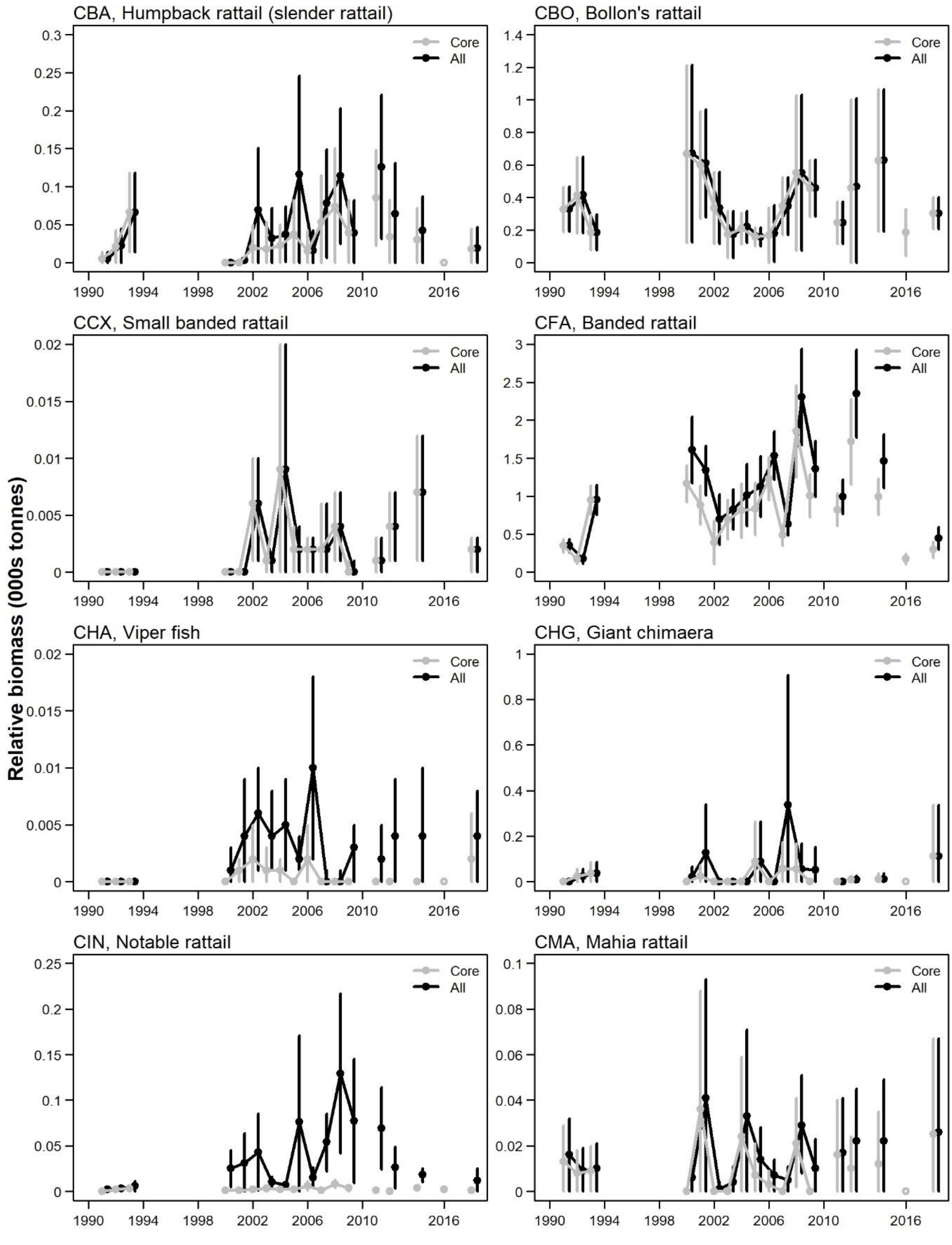


Figure 4: Relative biomass estimates (thousands of tonnes) of selected species sorted alphabetically by research code sampled by the Southland and Sub-Antarctic November–December *Tangaroa* surveys. Grey lines show fish from core (300–800 m) strata, black lines show fish from all strata (300–1000 m). Error bars show ± 2 standard errors. 2016 biomass is scaled core biomass only.



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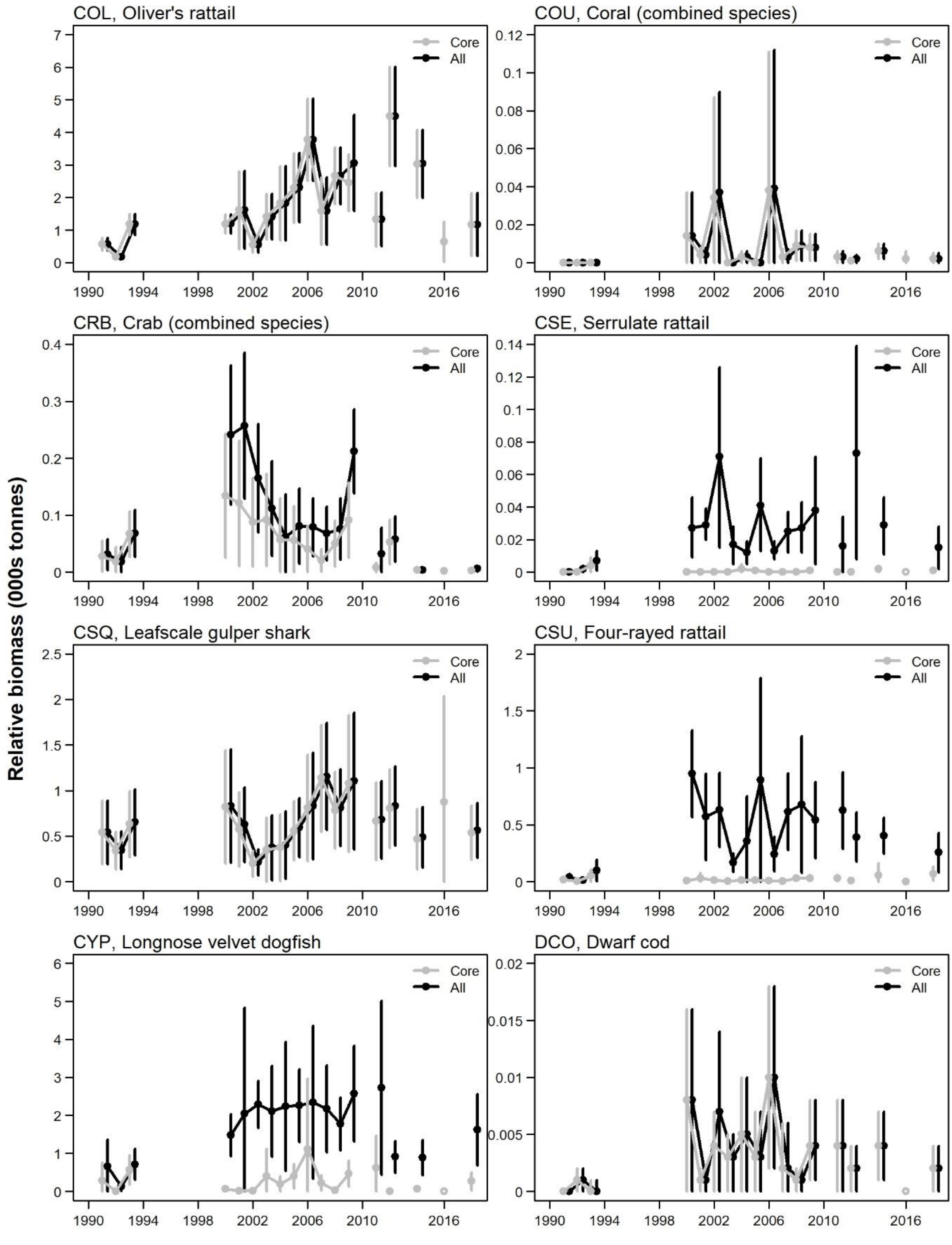

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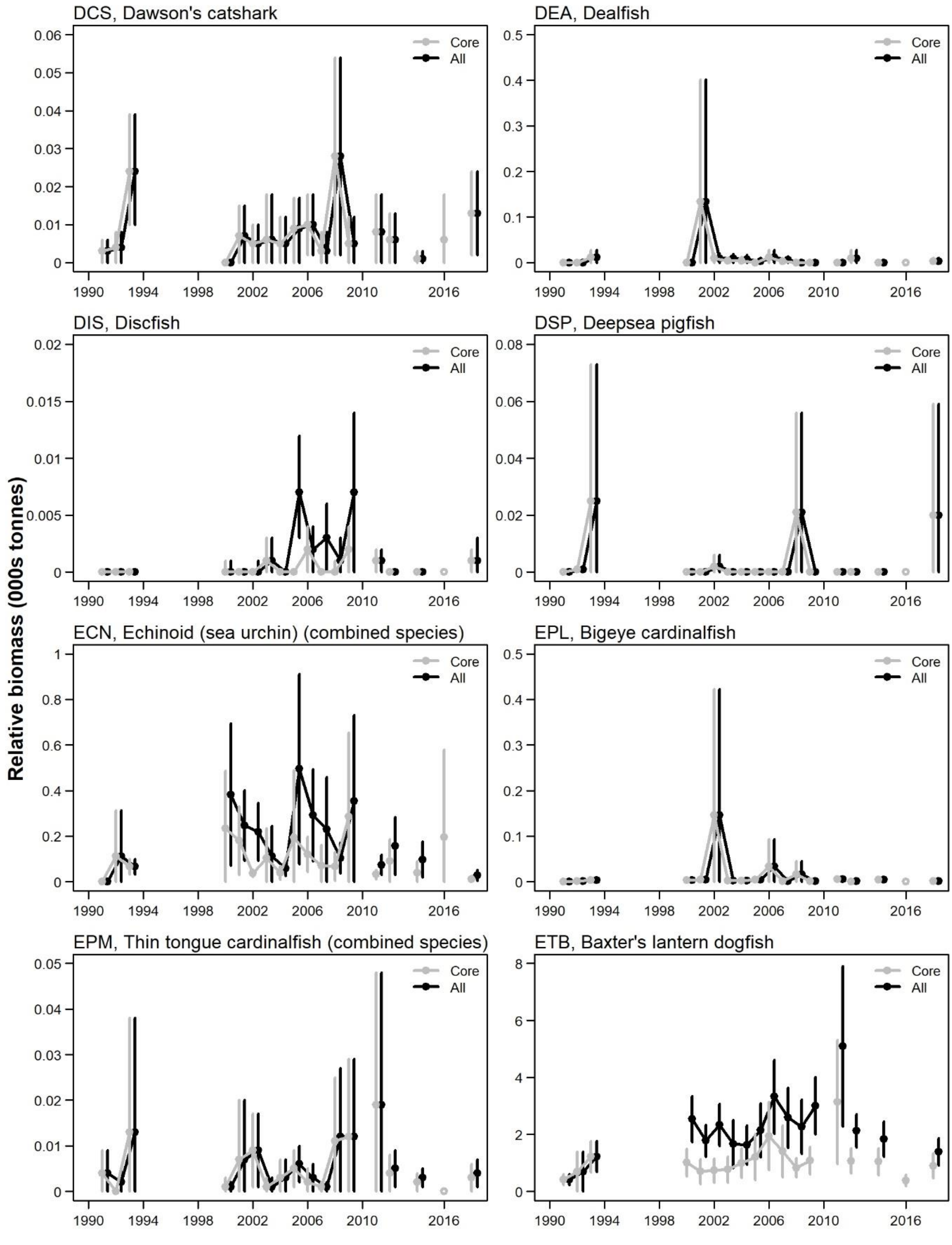

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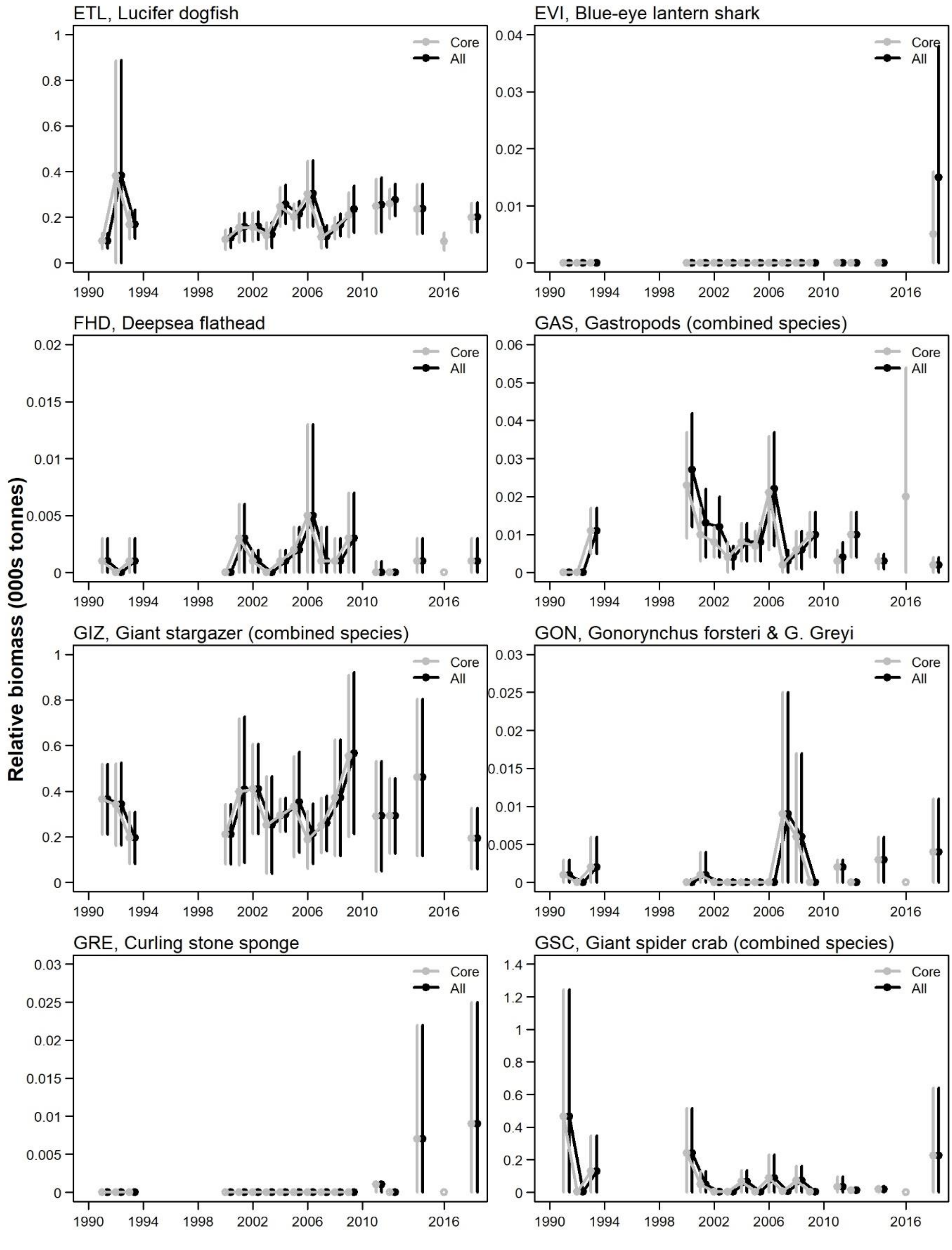

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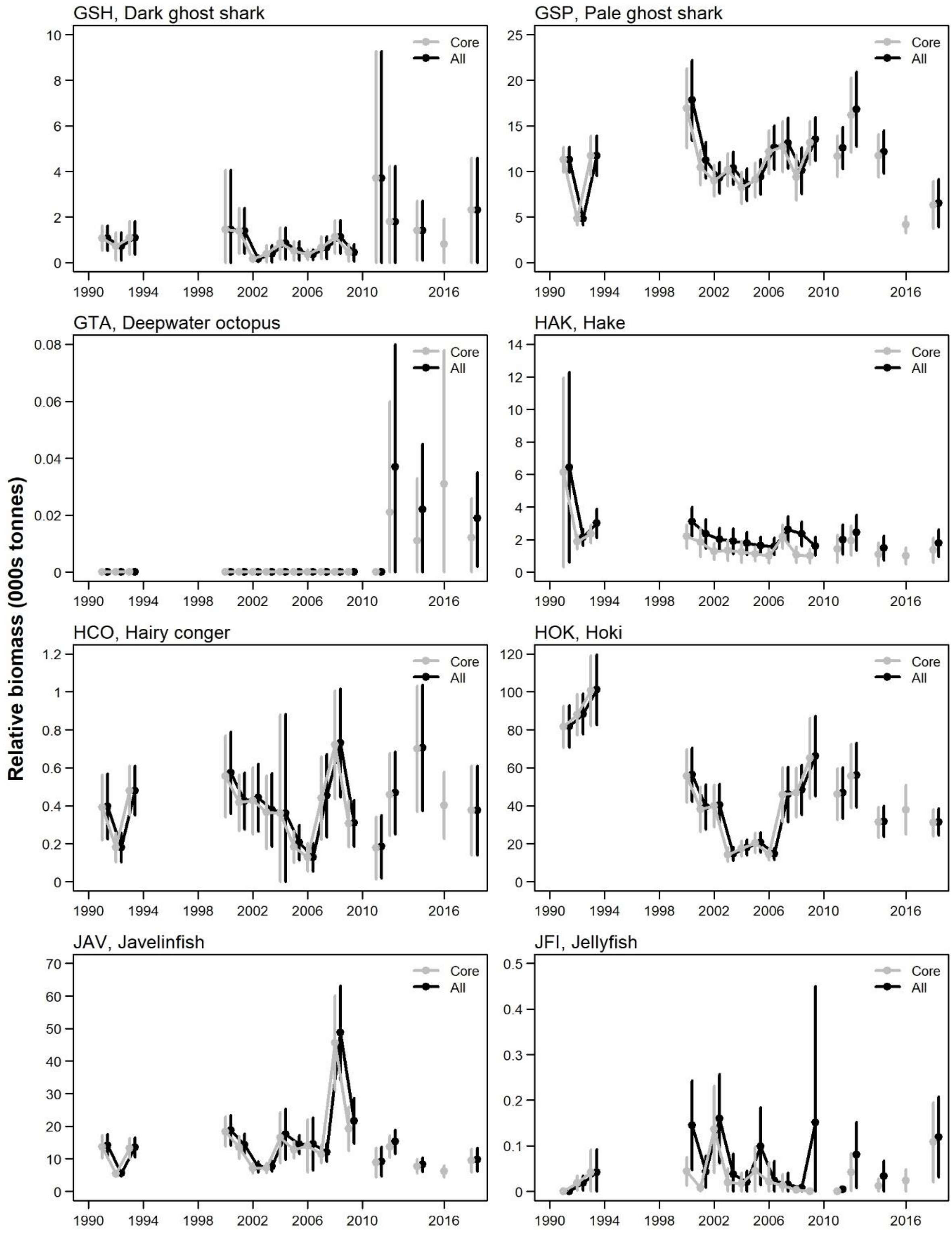

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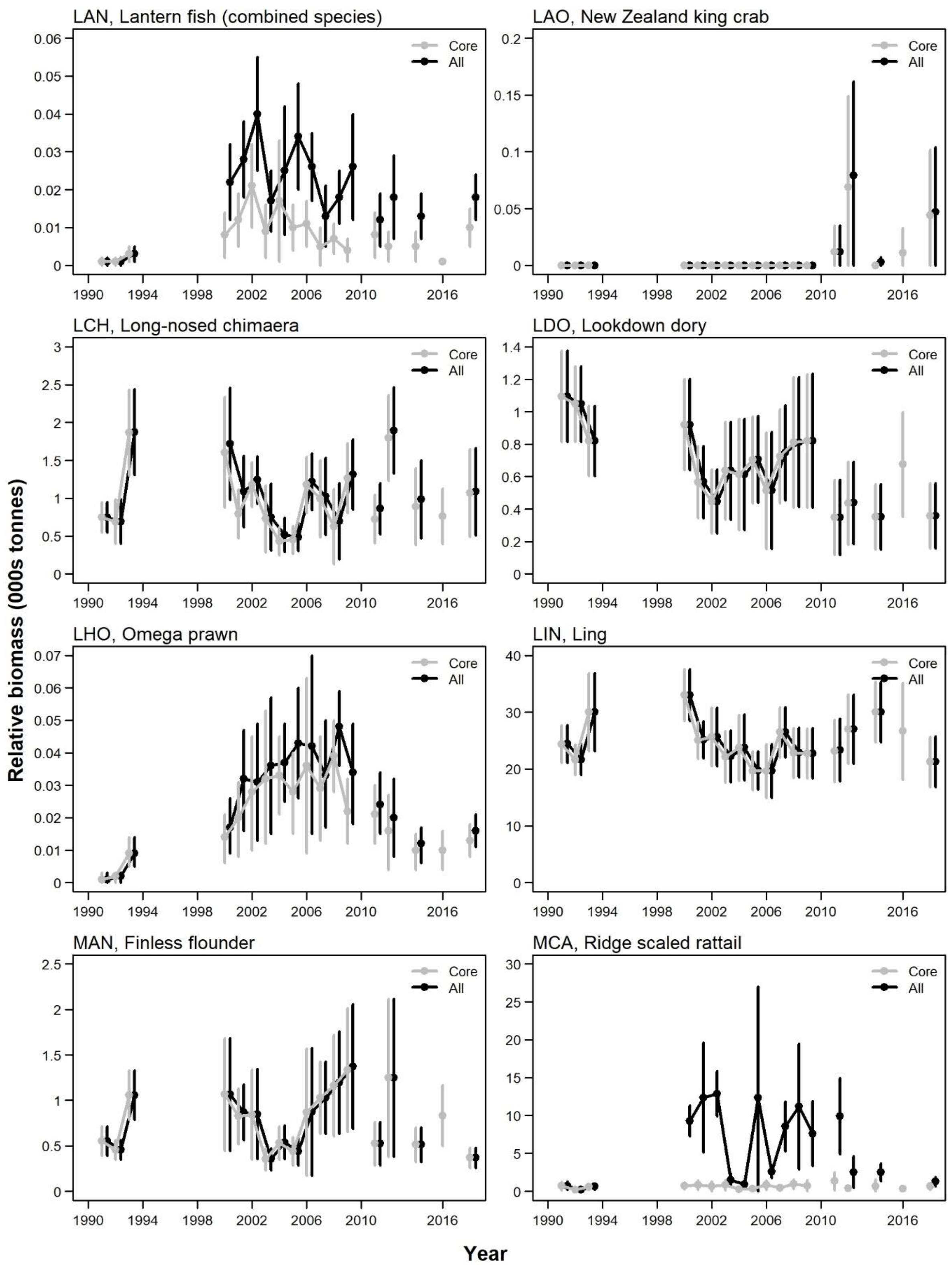

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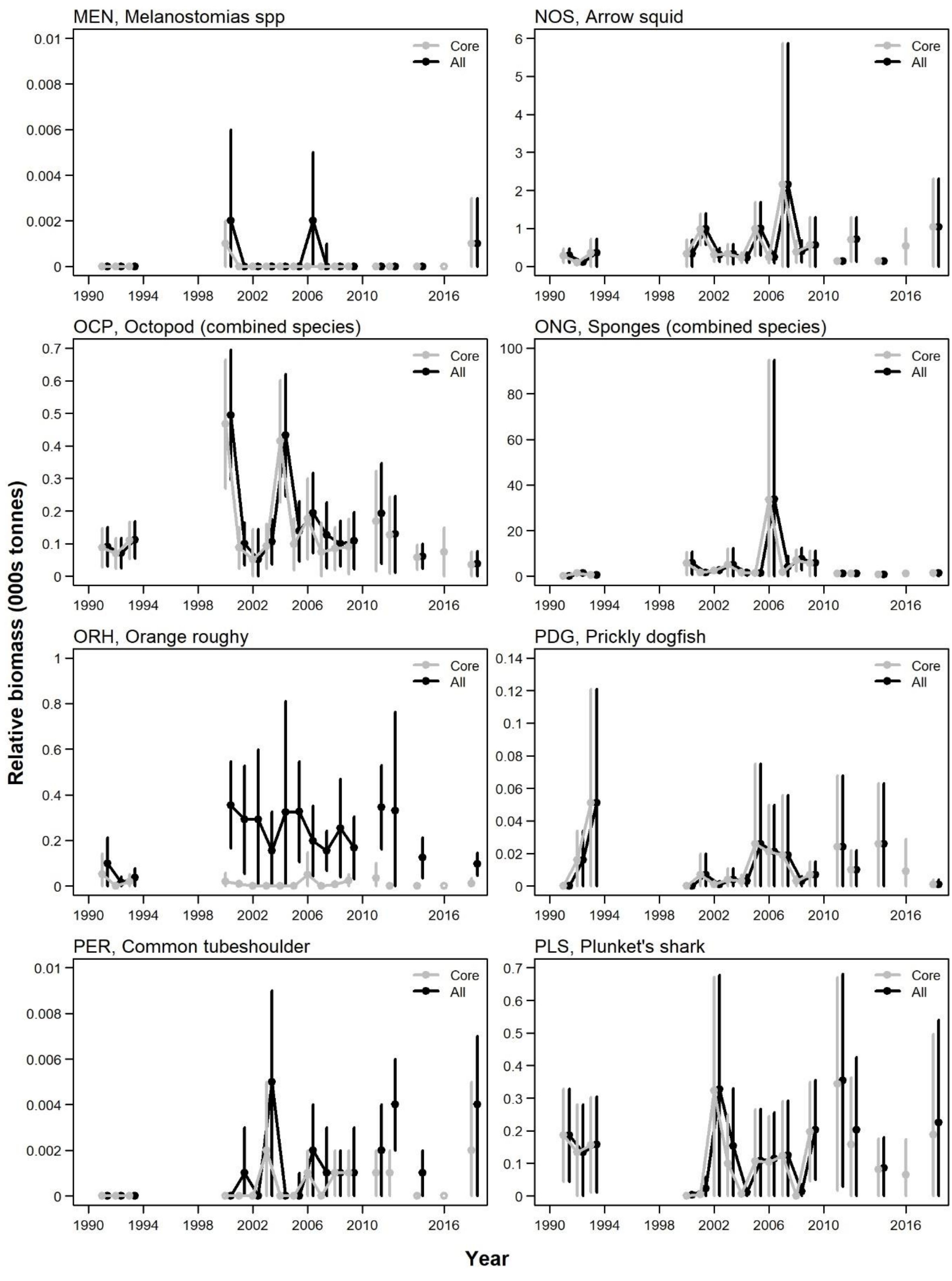

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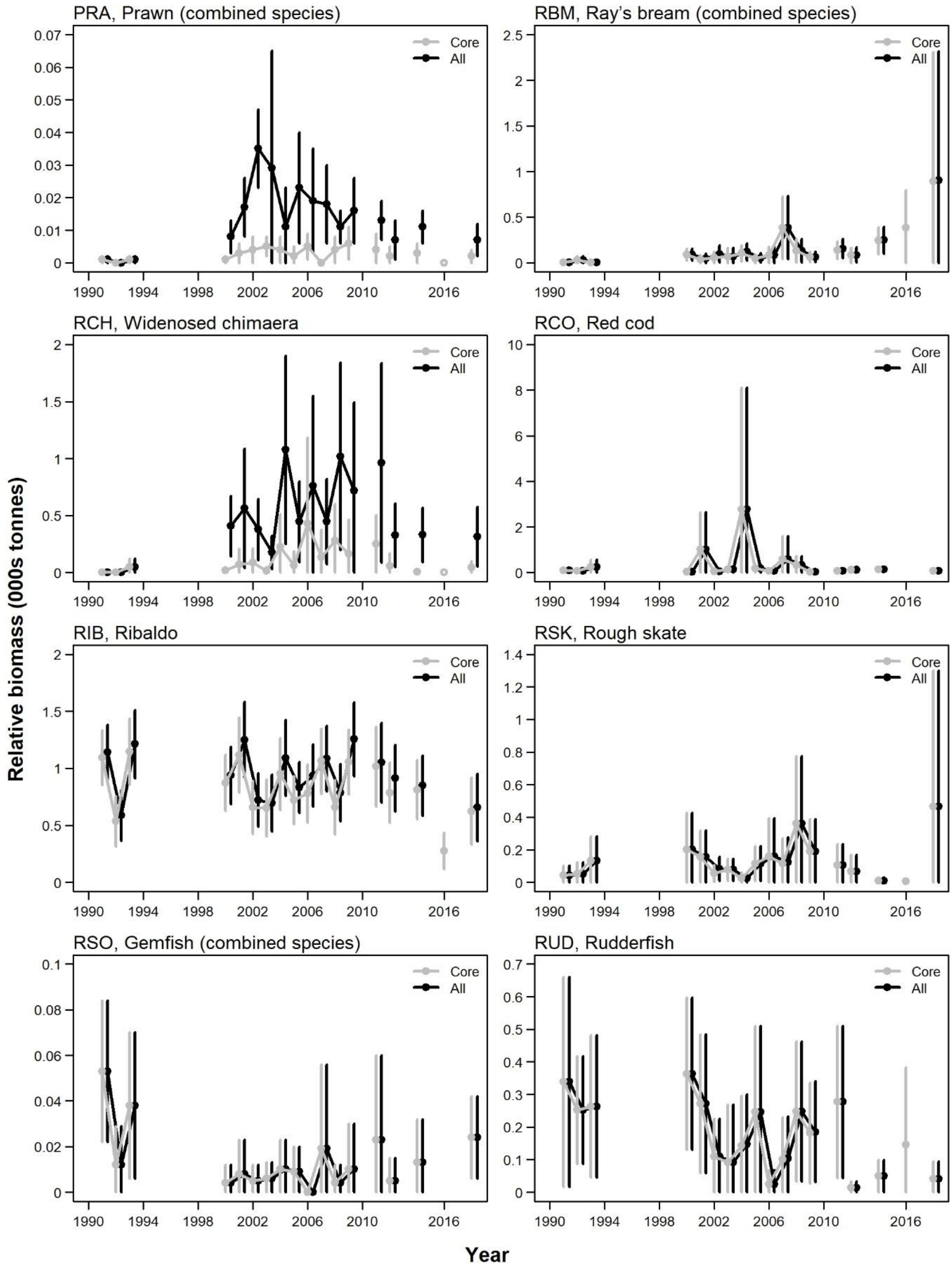

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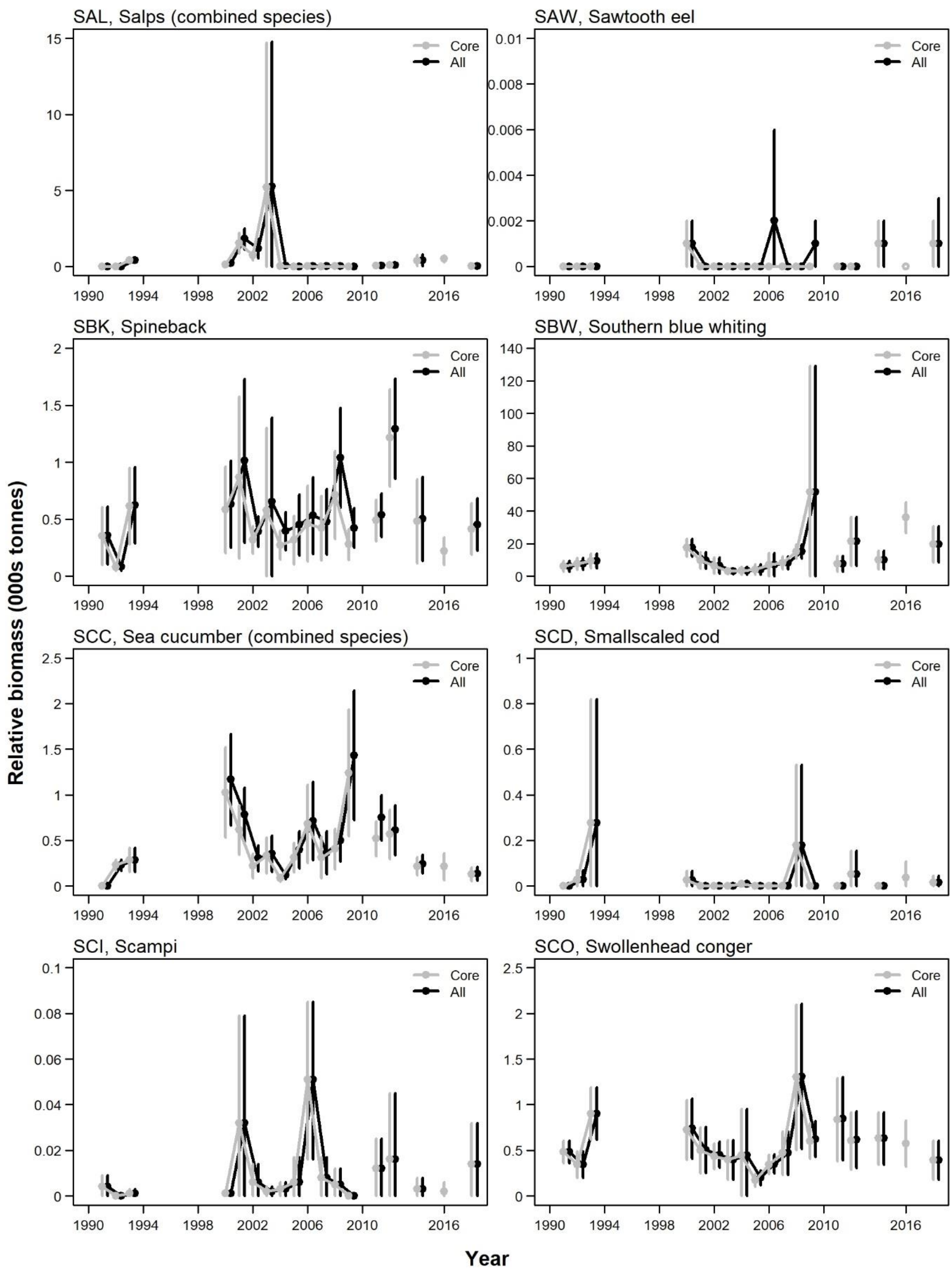

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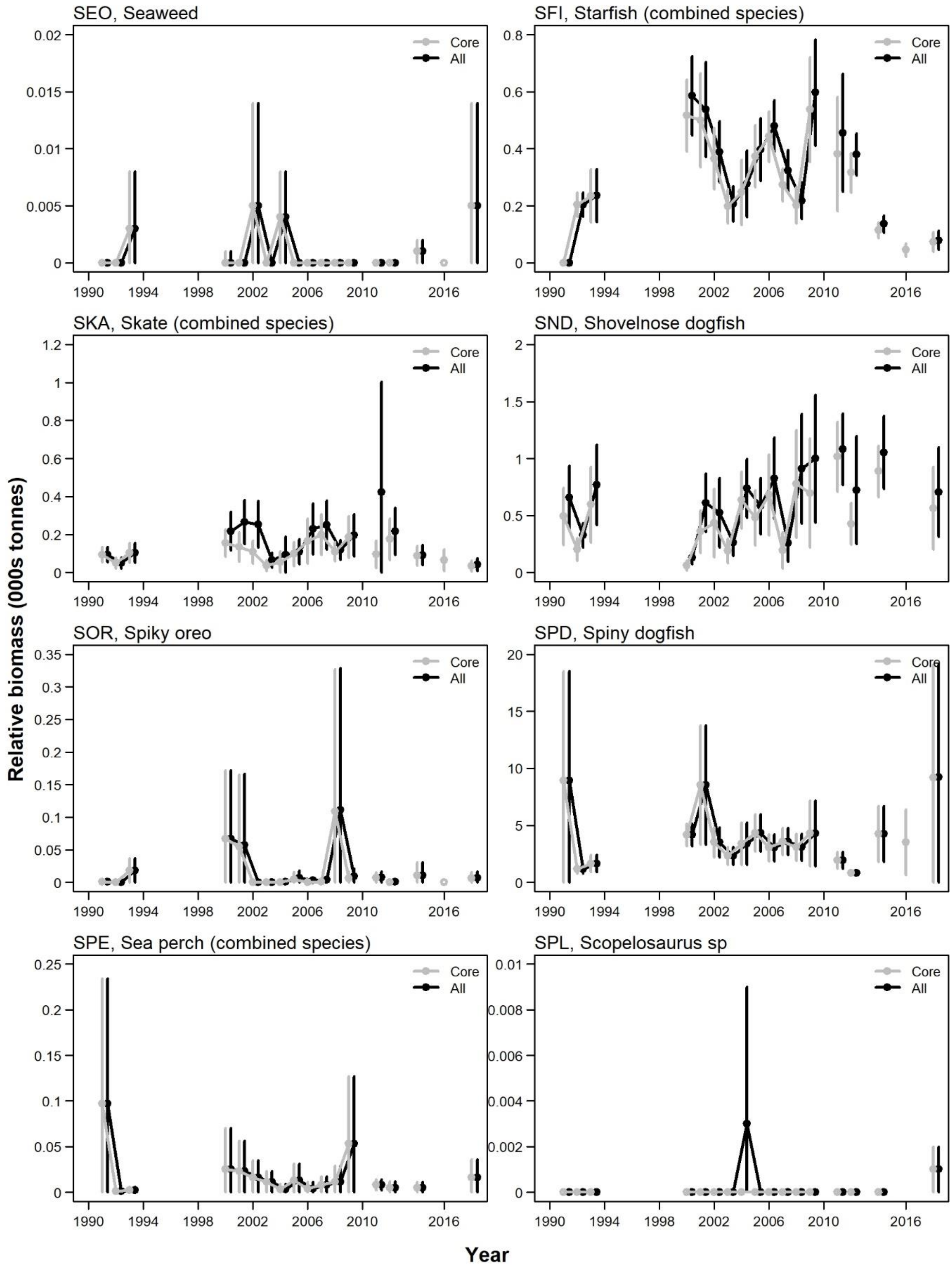

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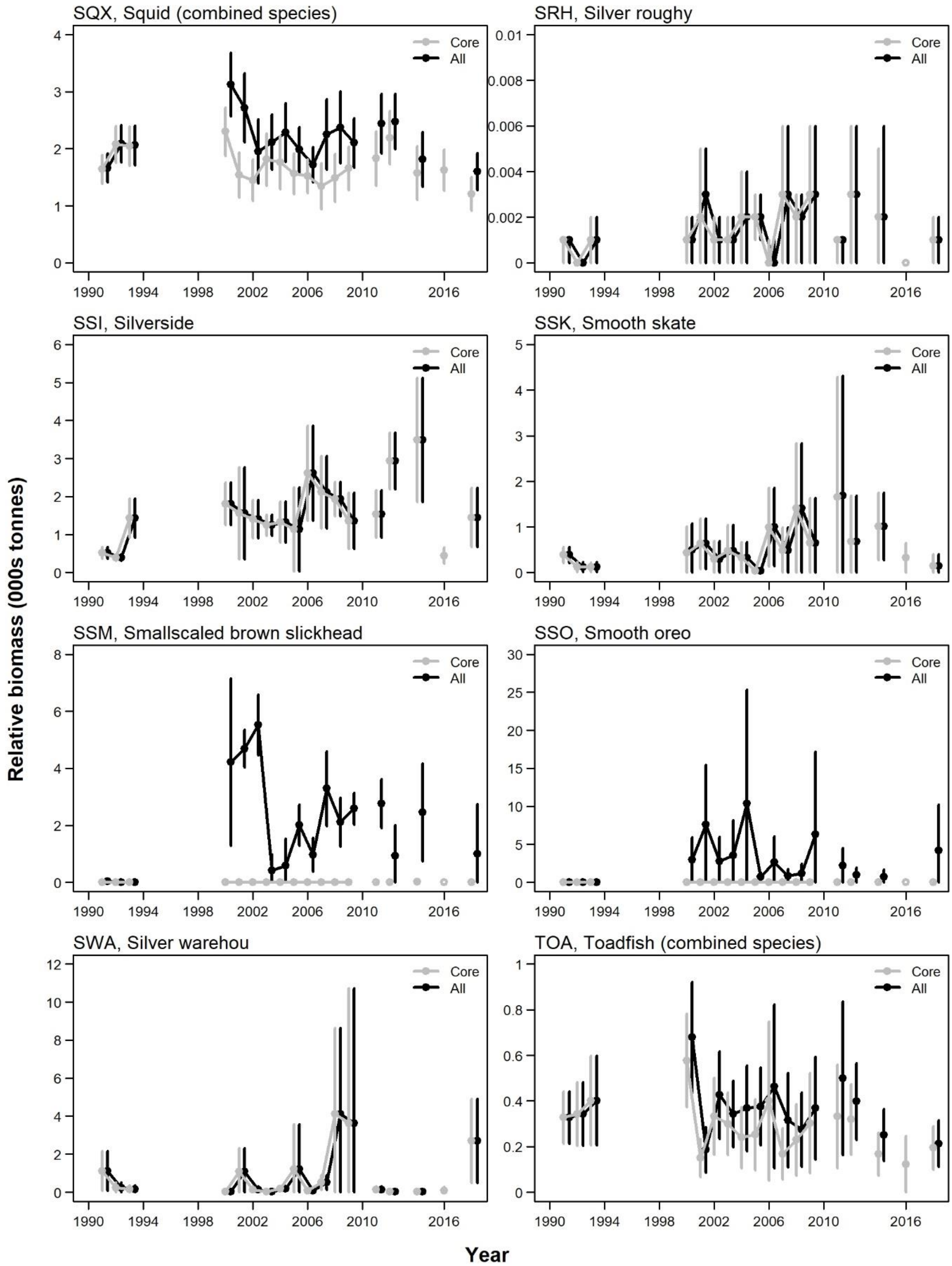

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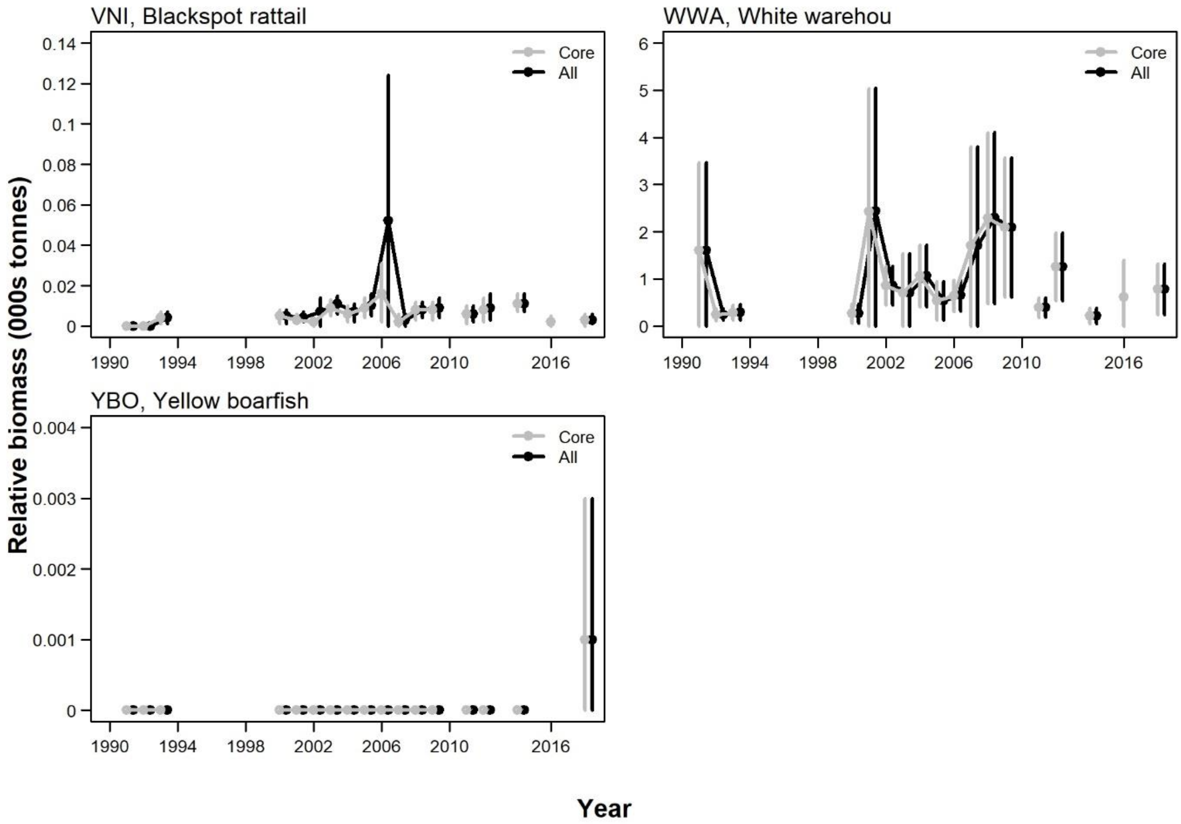

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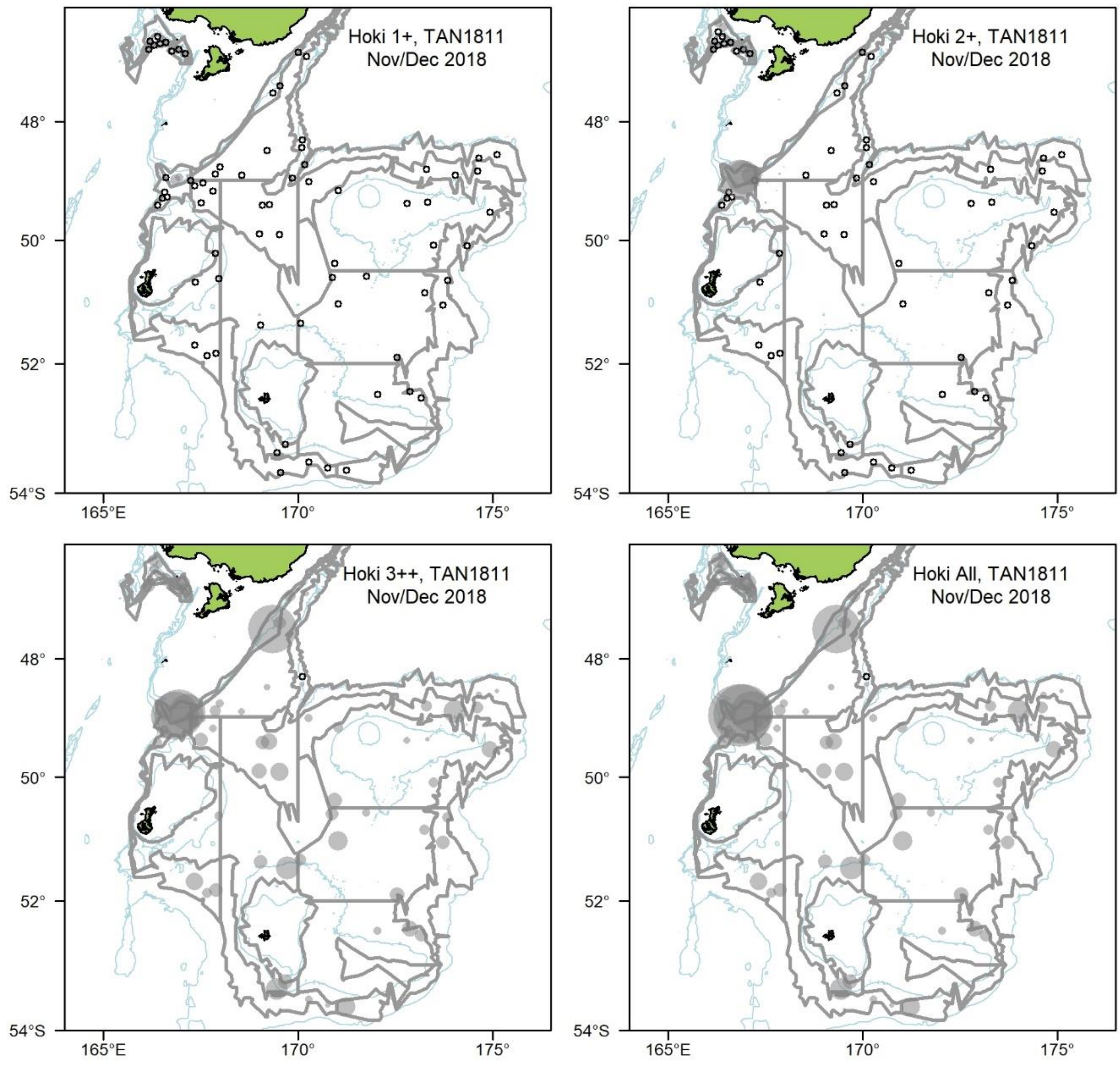


Figure 5: Distribution and catch rates in kg per km^2 of all, 1+ (less than 46 cm), 2+ (47 to less than 58 cm), and 3++ year old (more than 58 cm) hoki (HOK) from the November–December 2018 Southland and Sub-Antarctic trawl survey. Circle area is proportional to catch rate, maximum circle size is 500+ kg per km^2. Open circles indicate zero catches.

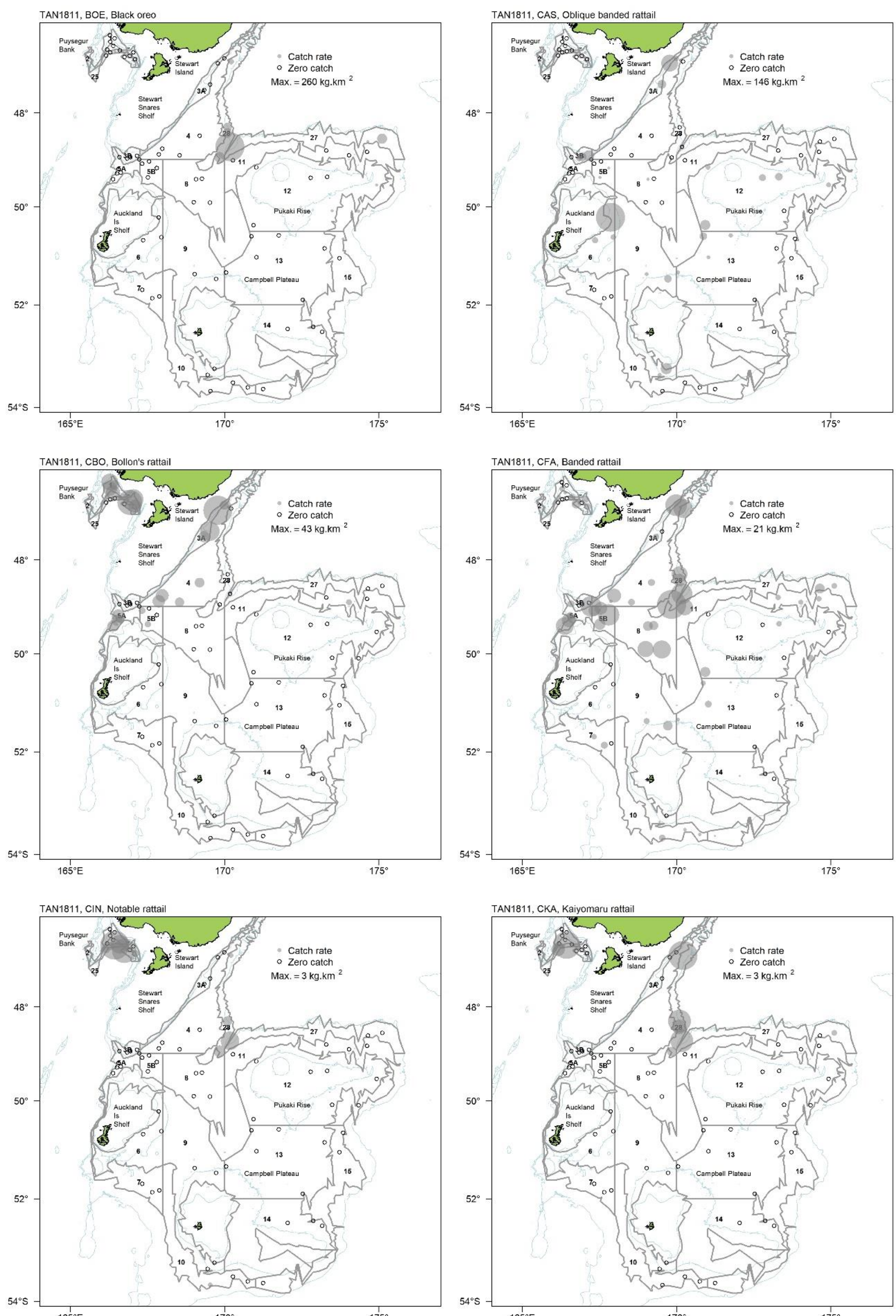
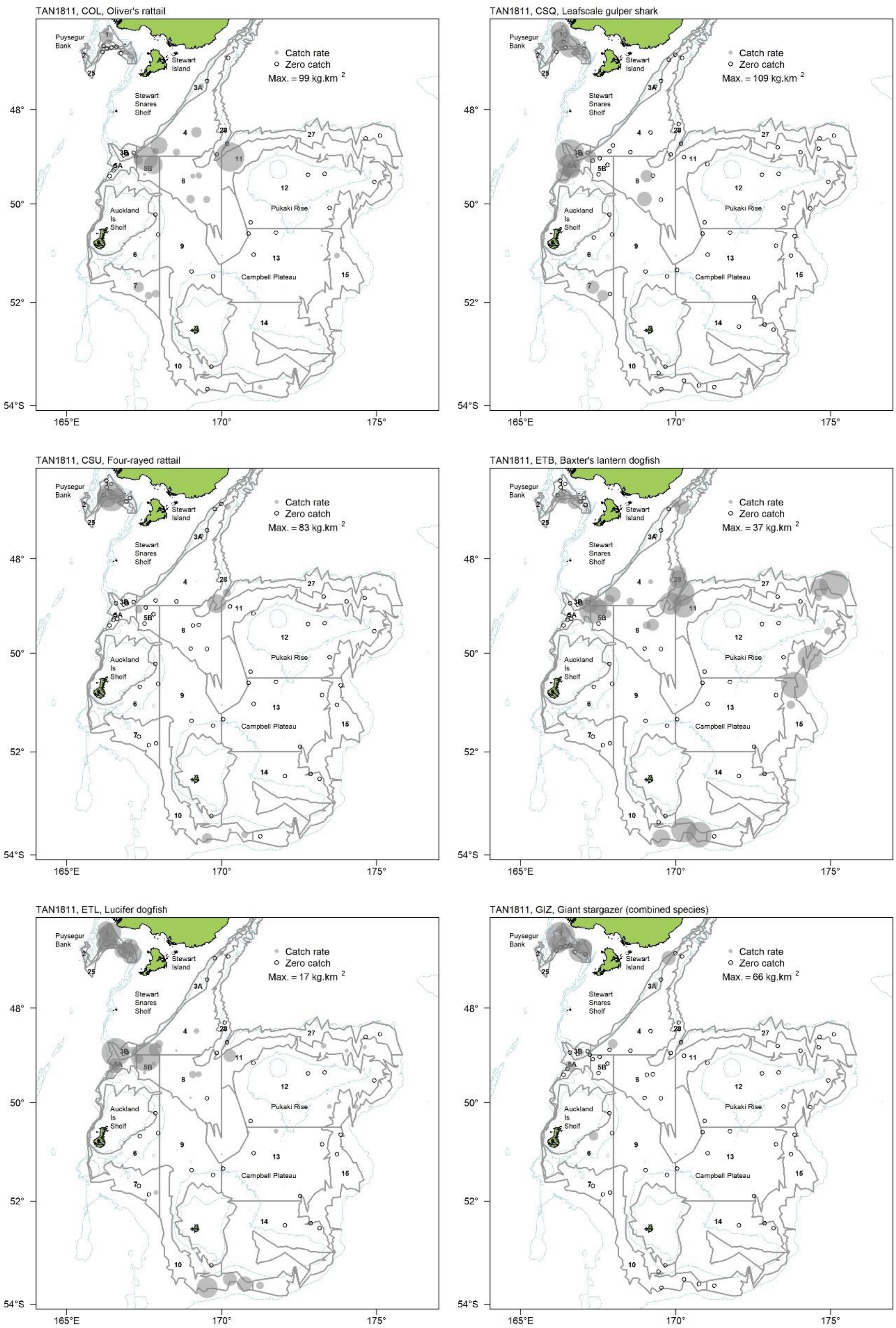


Figure 6: Distribution and catch rates of selected species sorted alphabetically by research code from the November–December 2018 Southland and Sub-Antarctic trawl survey. Circle area is proportional to catch rate. Open circles indicate zero catches.



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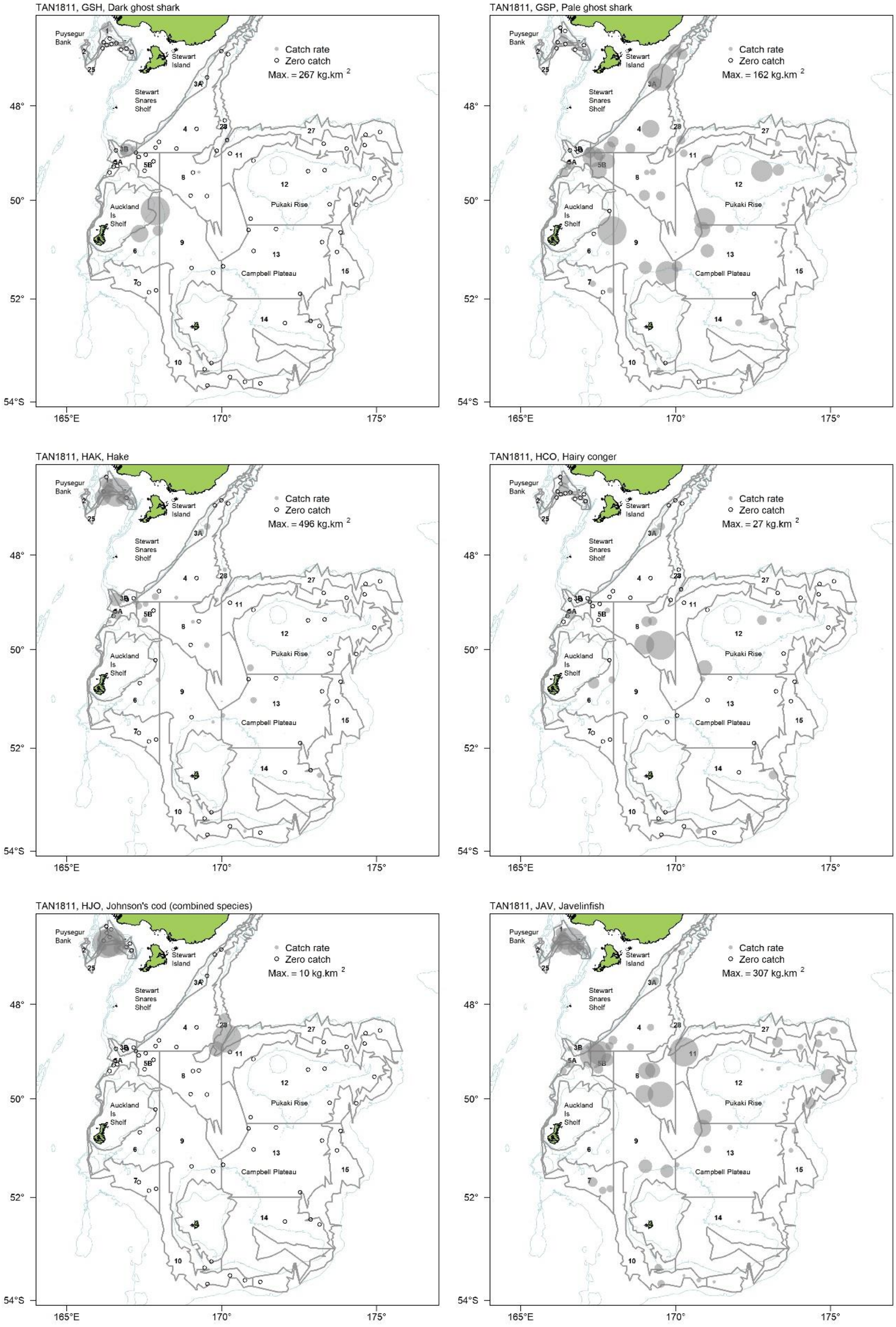

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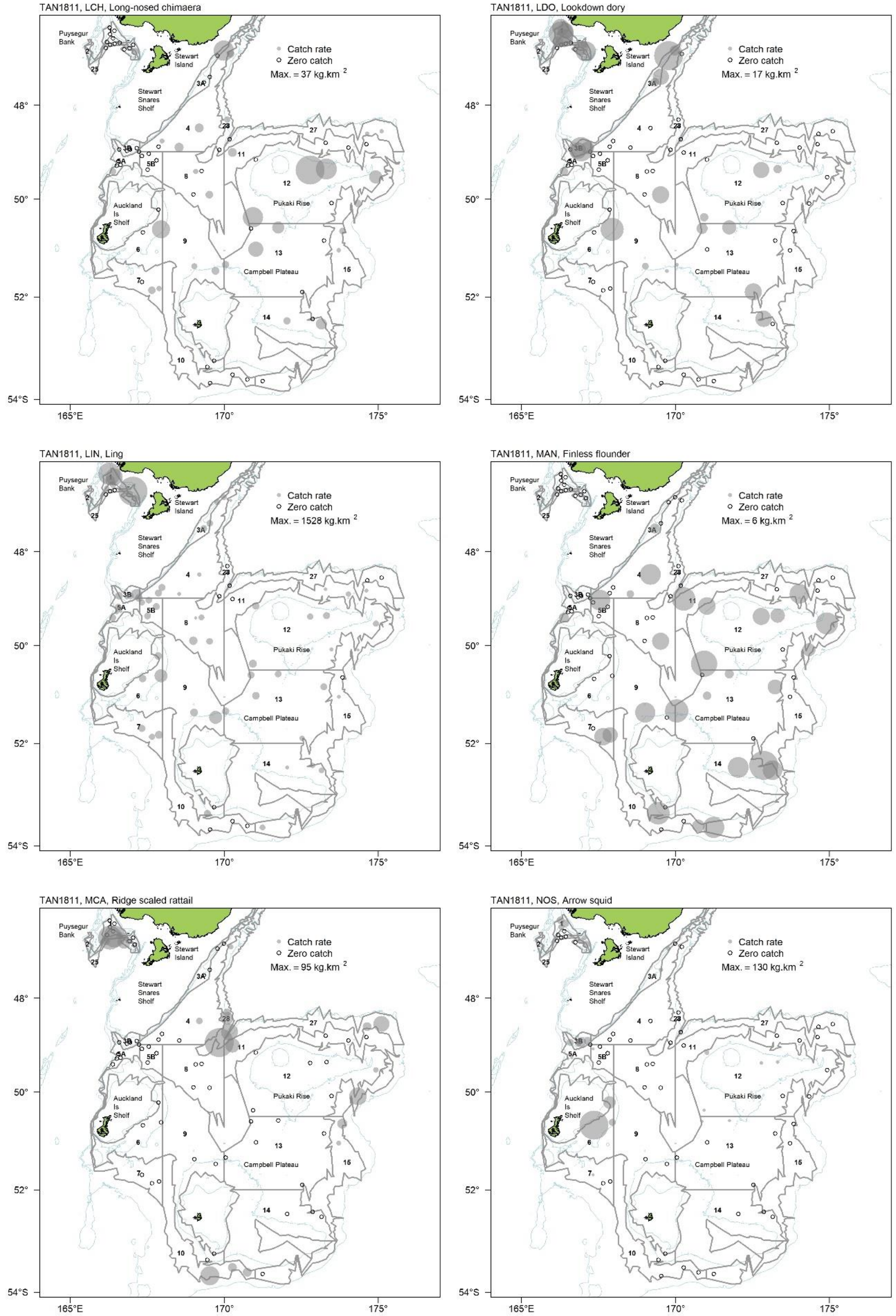

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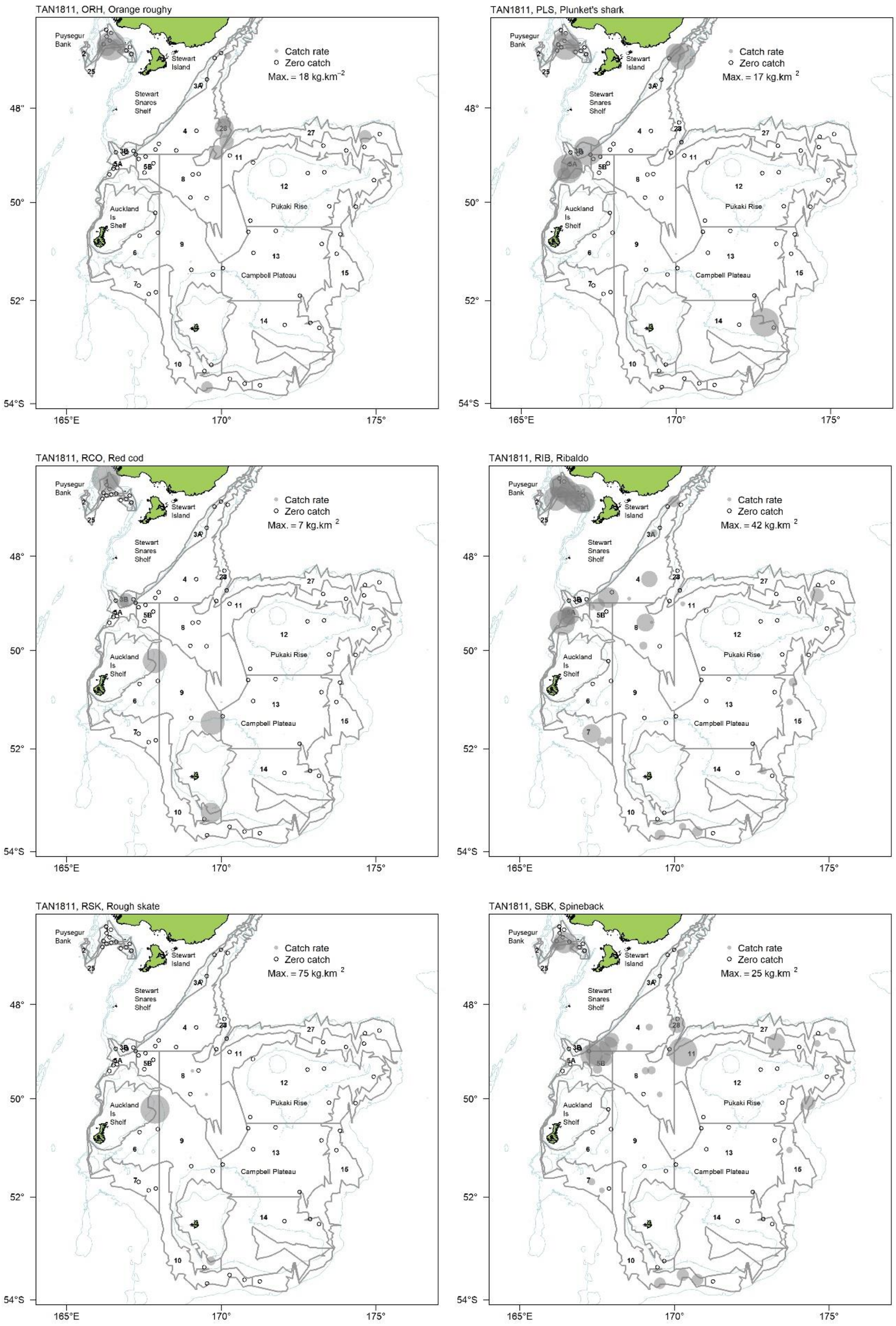

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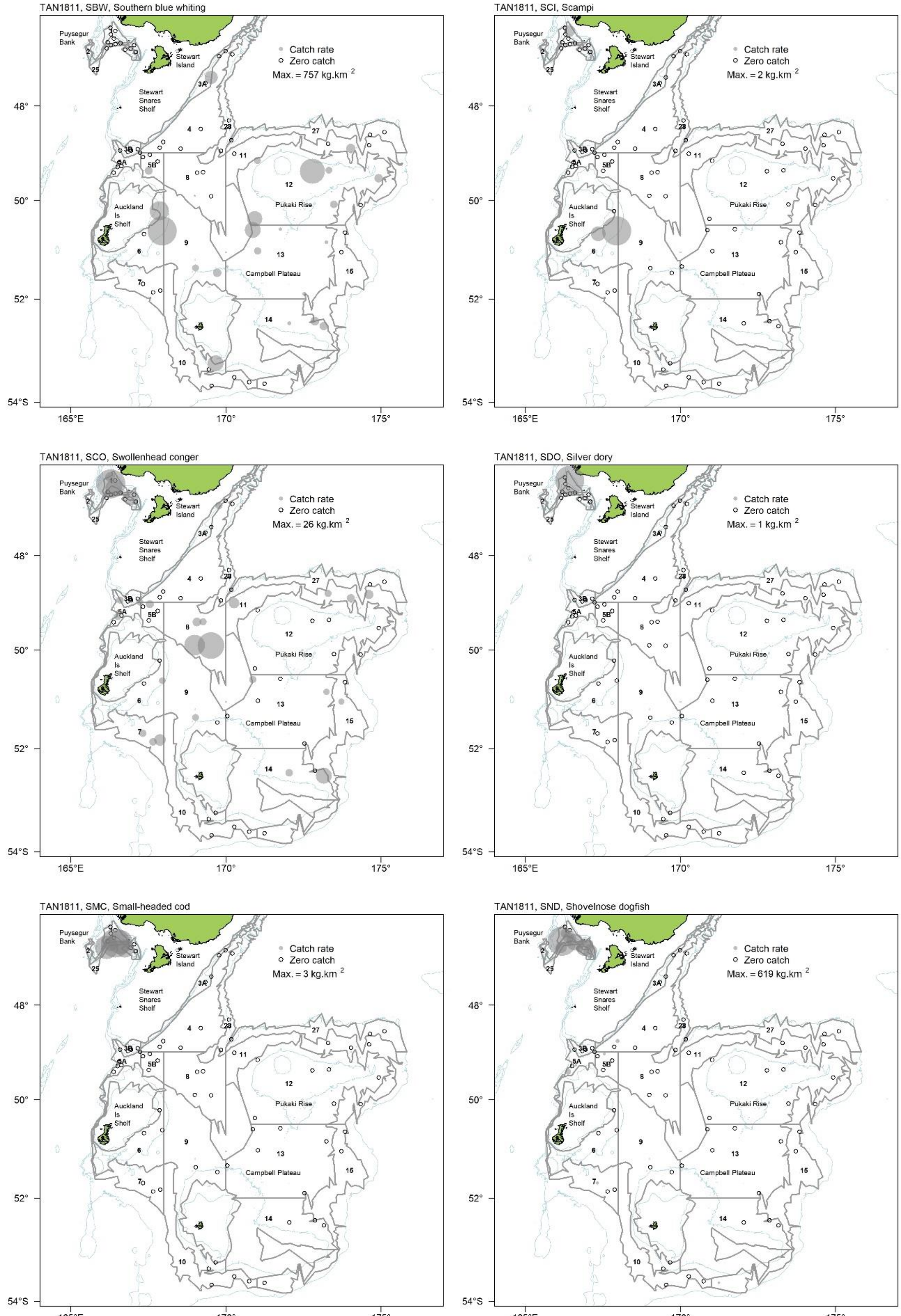

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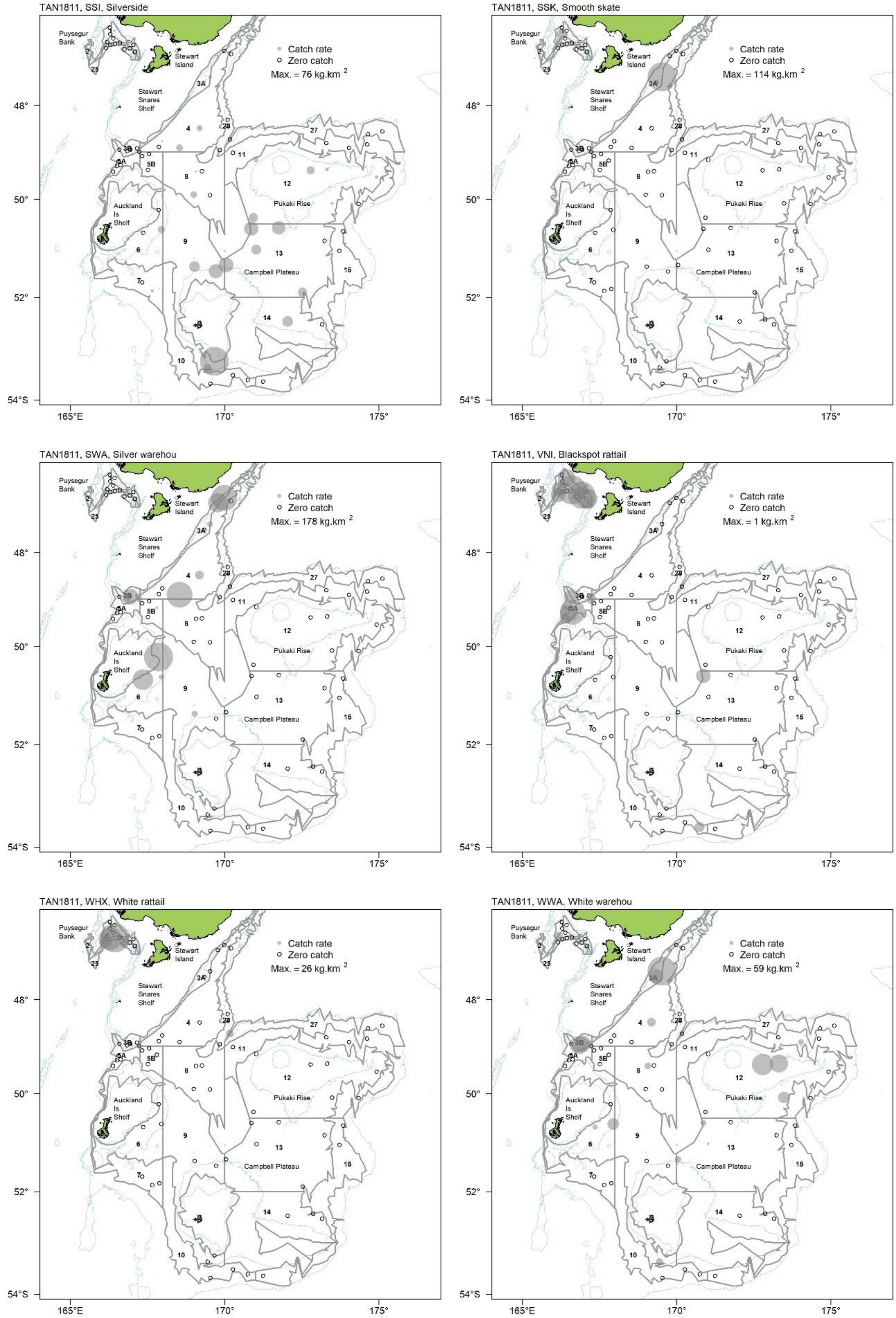

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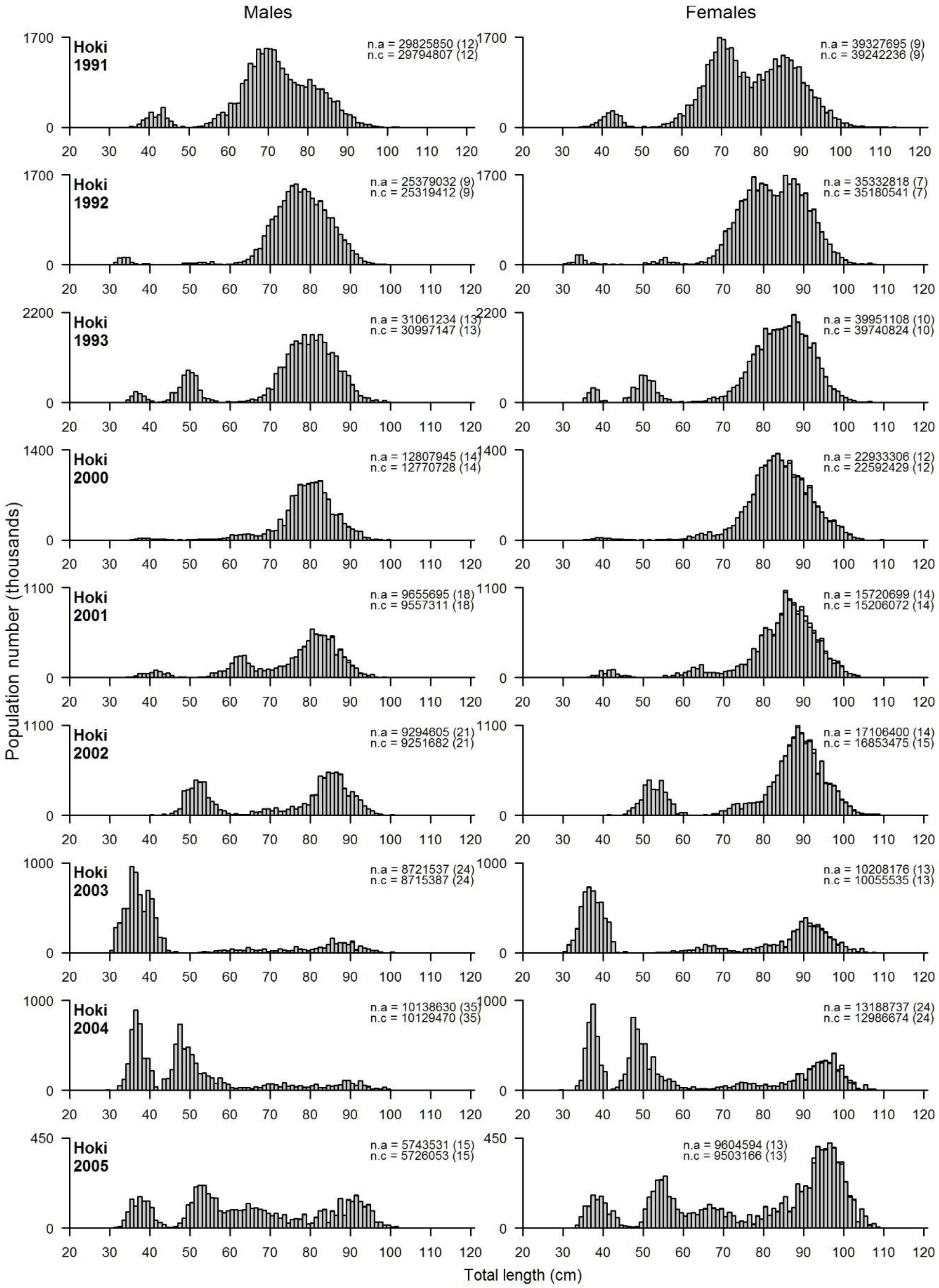
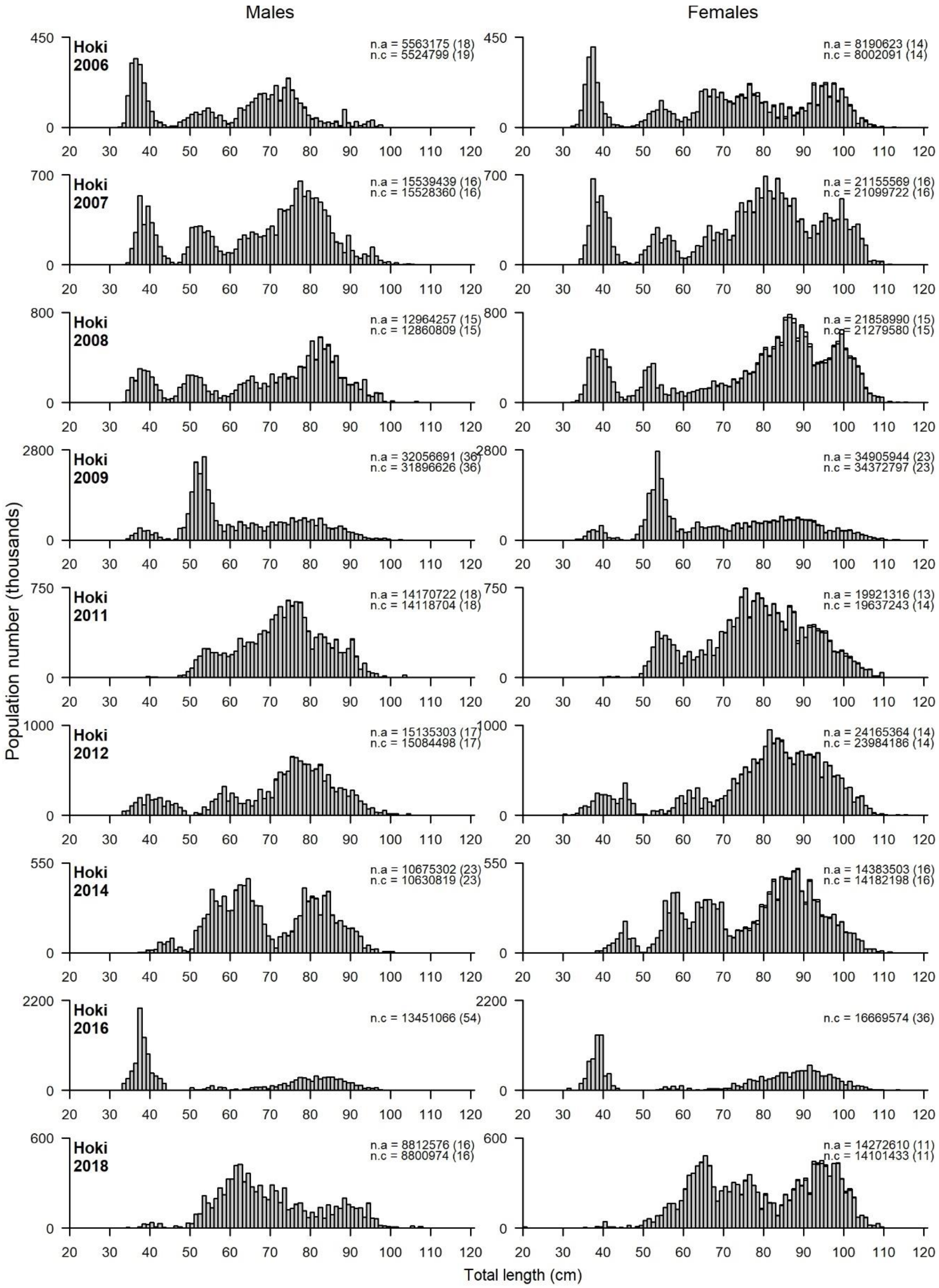


Figure 7a: Length frequency distributions by sex of hoki for core (grey), and all (white) strata from the Southland and Sub-Antarctic November–December *Tangaroa* surveys. n.a, estimated scaled total number of fish for all strata; n.c, estimated scaled total number of fish for core strata; and CV, the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



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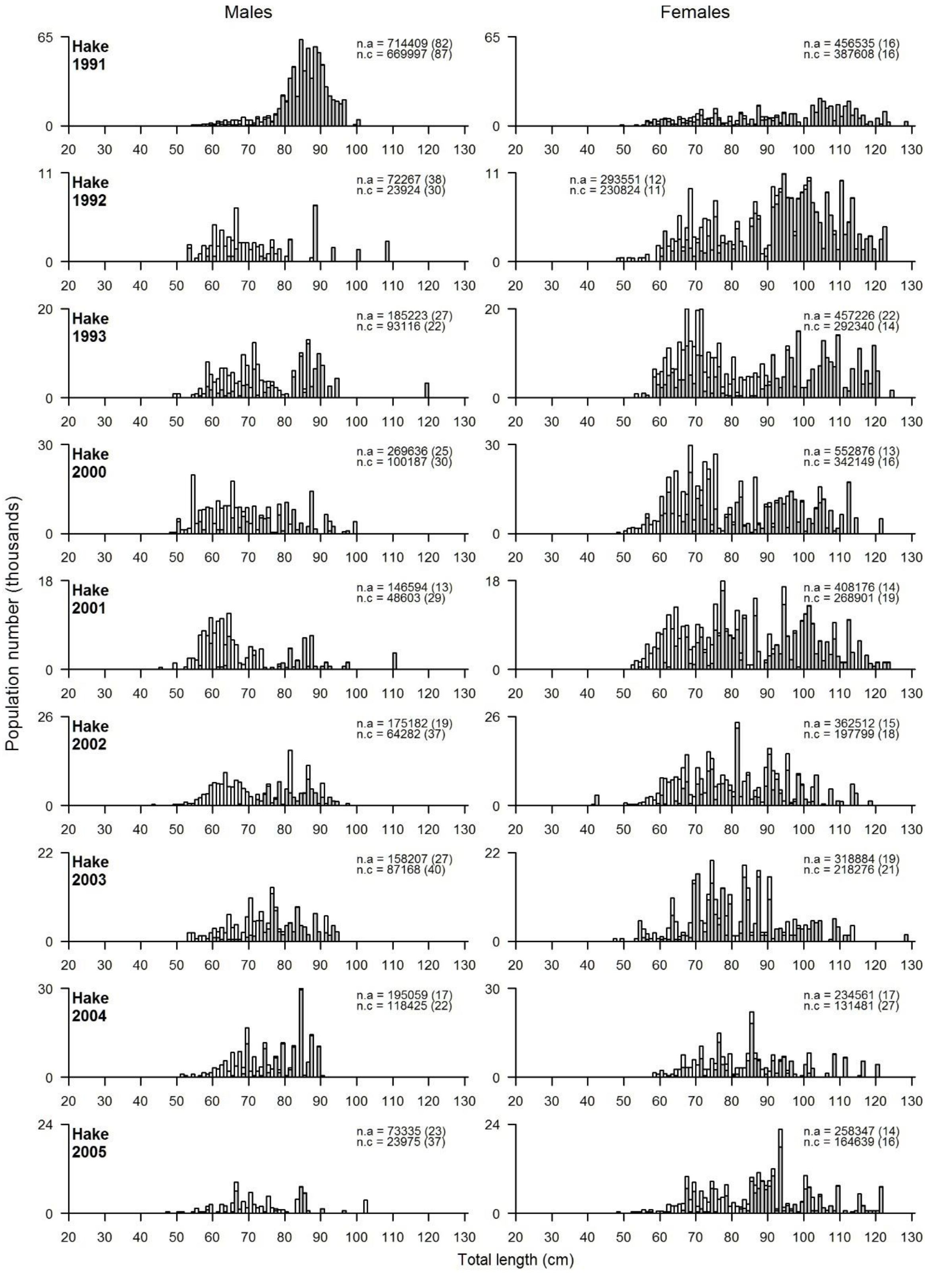
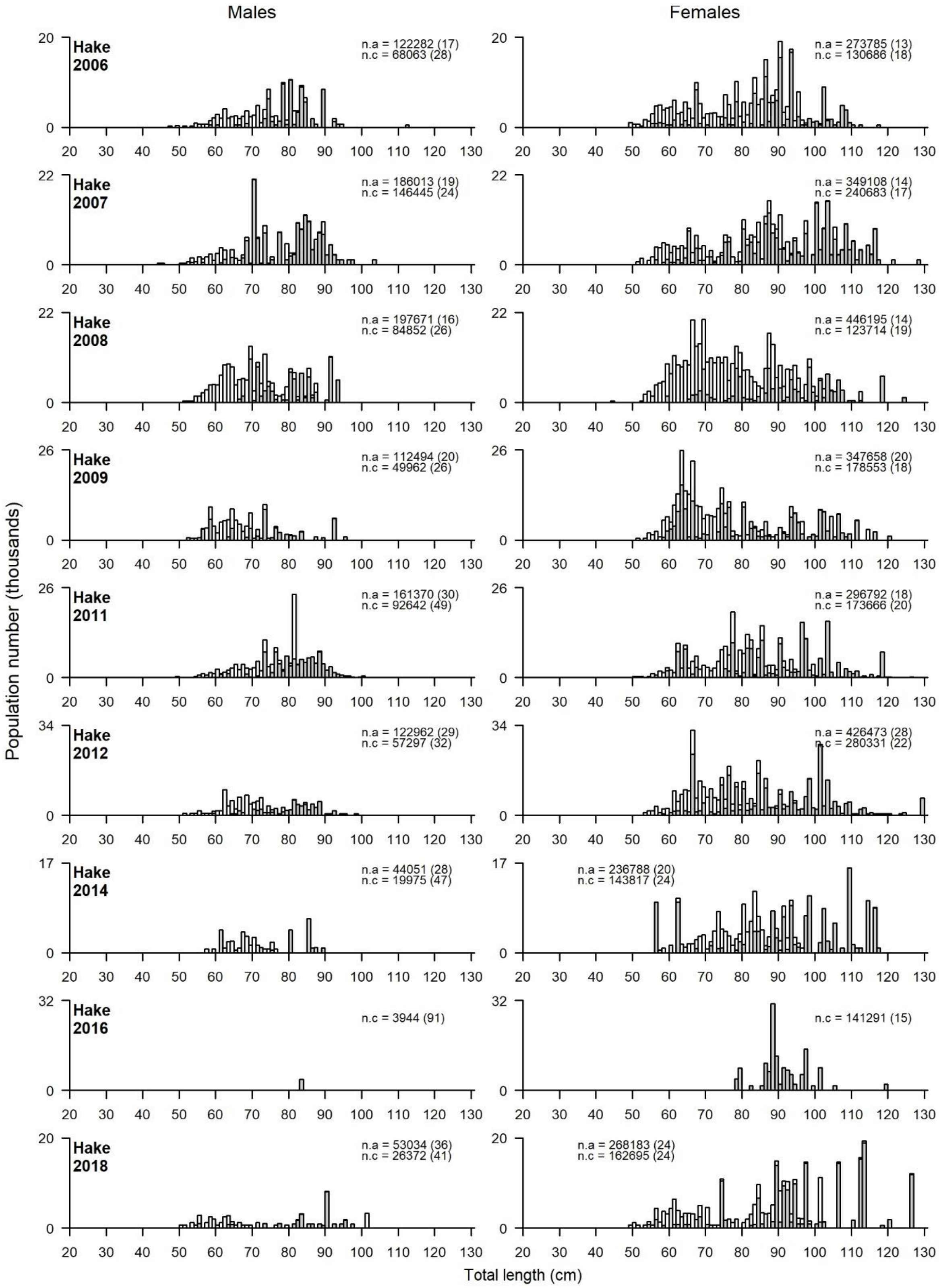


Figure 7b: Length frequency distributions by sex of hake for core (grey), and all (white) strata from the Southland and Sub-Antarctic November–December trawl surveys. n.a, estimated scaled total number of fish for all strata; n.c, estimated scaled total number of fish for core strata; and CV, the coefficient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



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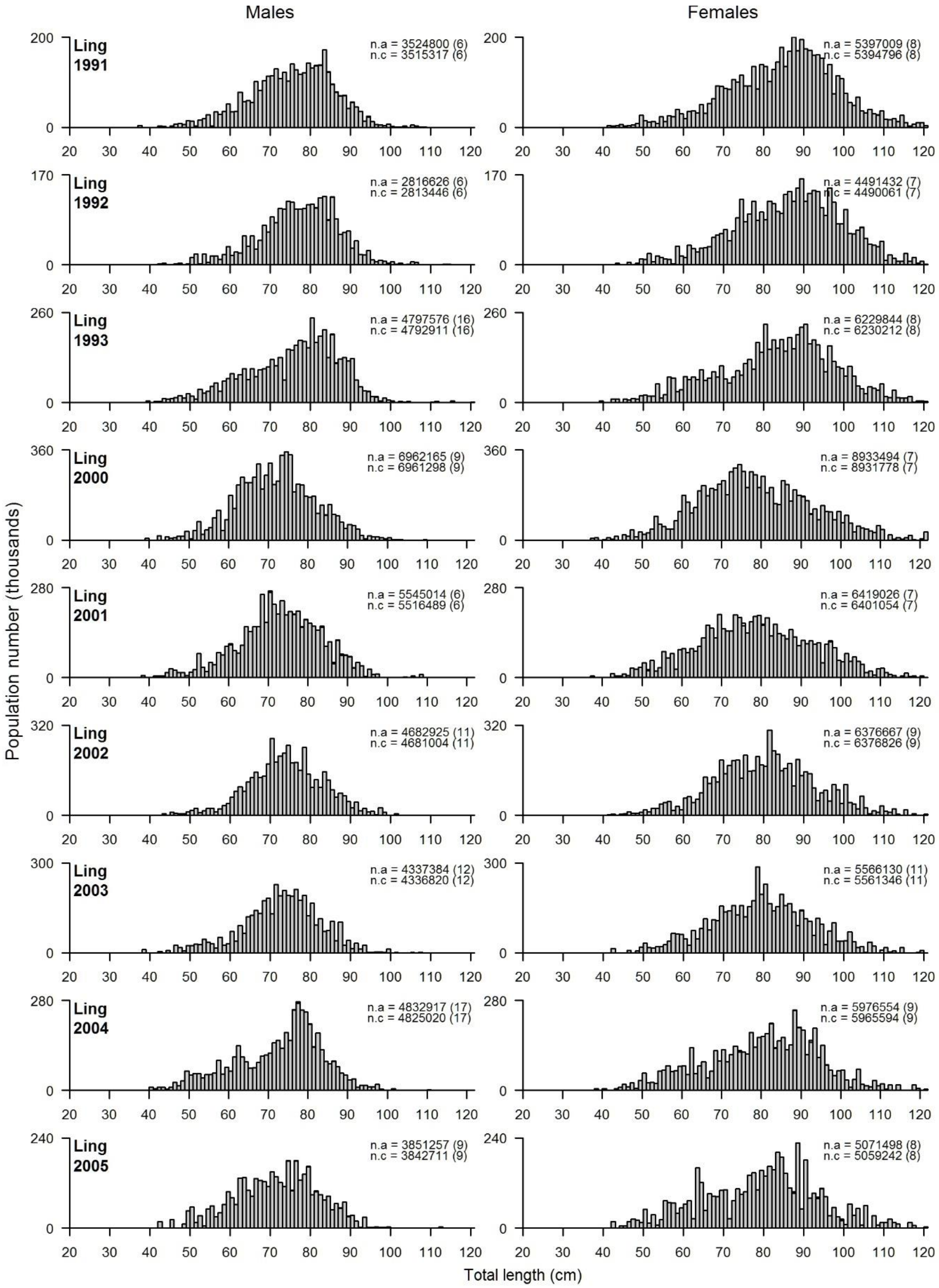


Figure 7c: Length frequency distributions by sex of ling for core (grey), and all (white) strata from the Southland and Sub-Antarctic November–December trawl surveys. n.a, estimated scaled total number of fish for all strata; n.c, estimated scaled total number of fish for core strata; and CV, the coefficient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

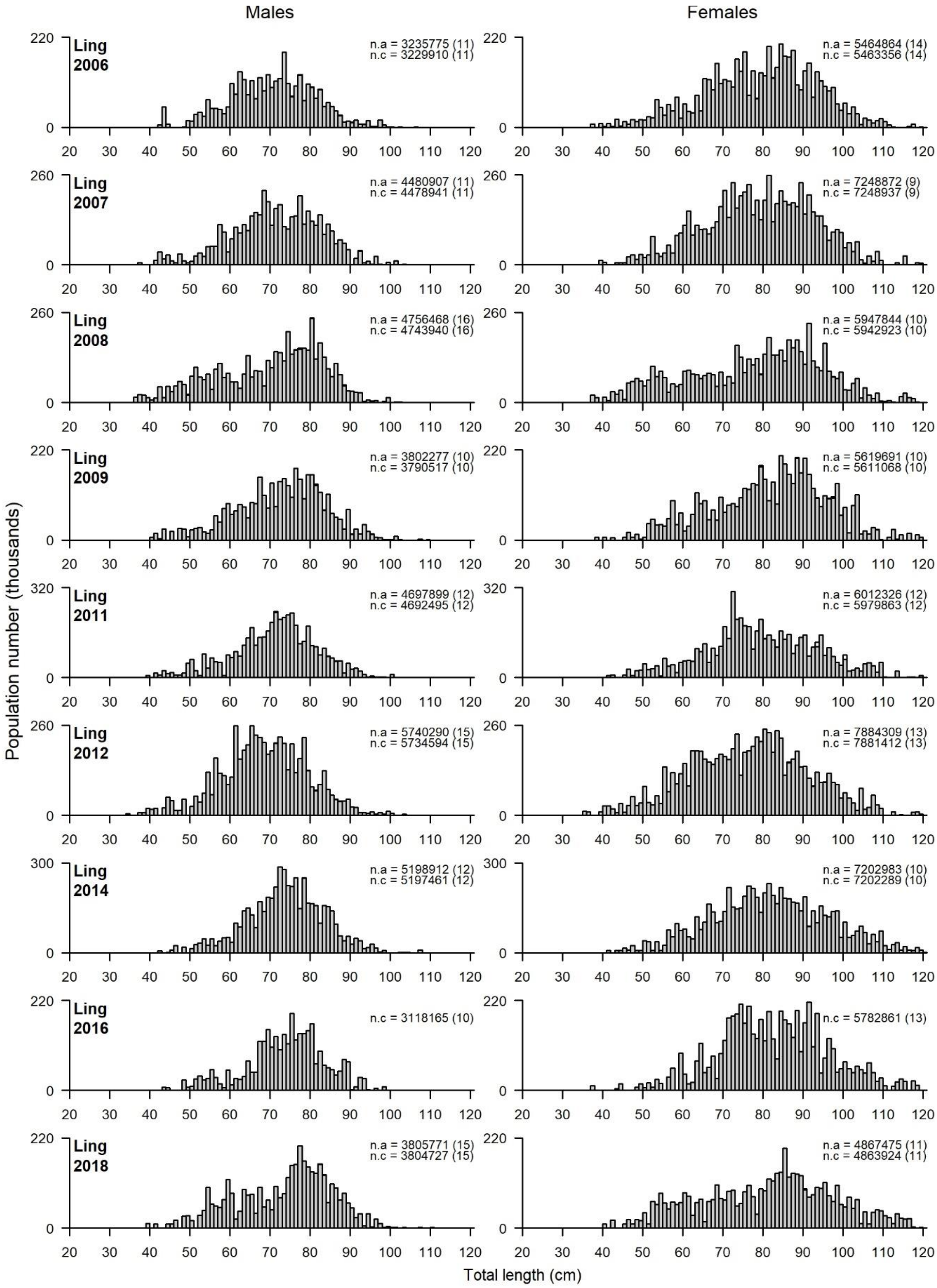


Figure 7c: continued.

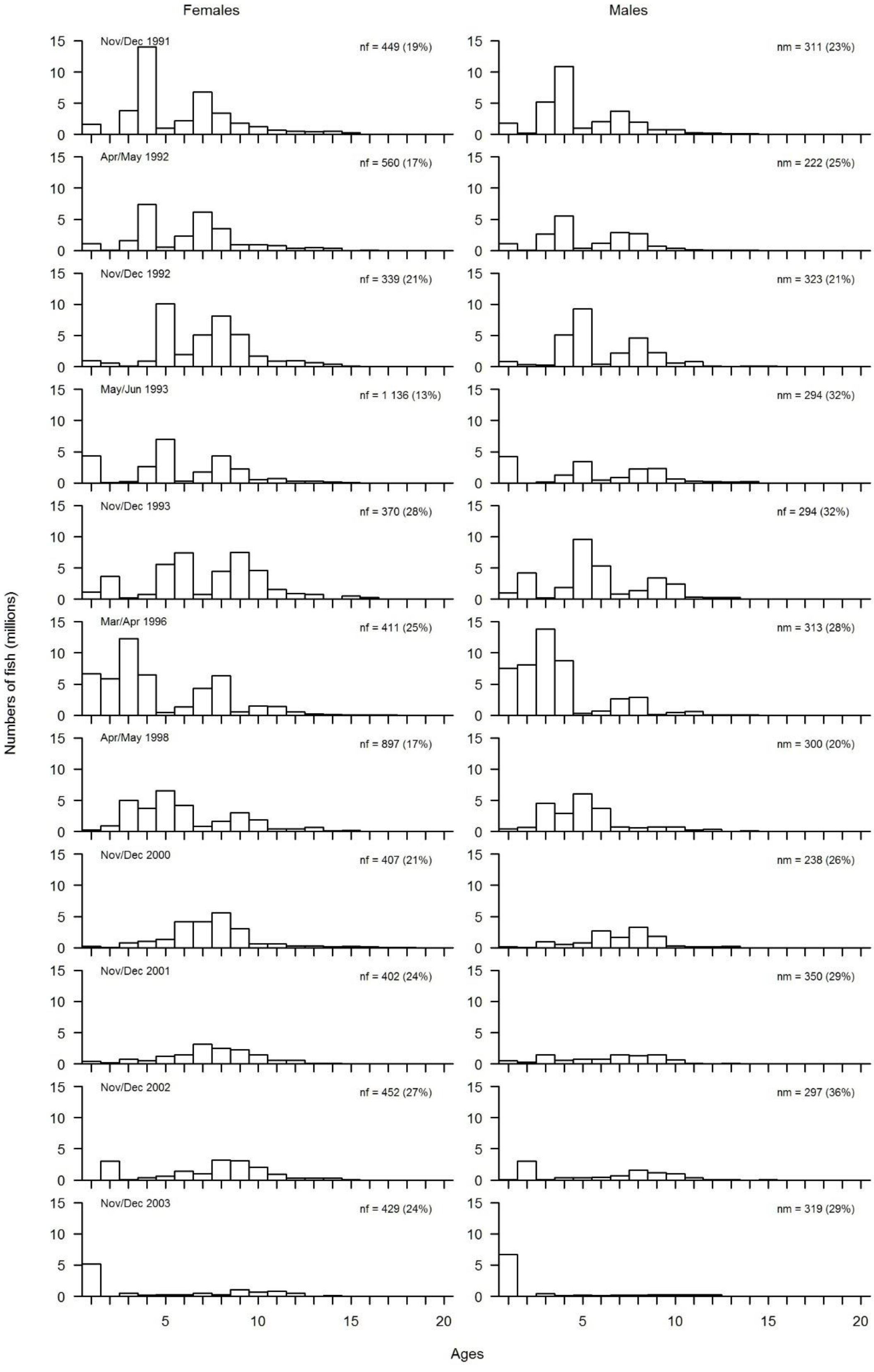


Figure 8a: Scaled age frequency for hoki in core strata from the Southland and Sub-Antarctic November–December *Tangaroa* surveys in 1991–1993, 2000–2009, 2011–2012, 2014, 2016, and 2018. Number of fish aged (nm, males; nf, females) are given with CVs in parentheses.

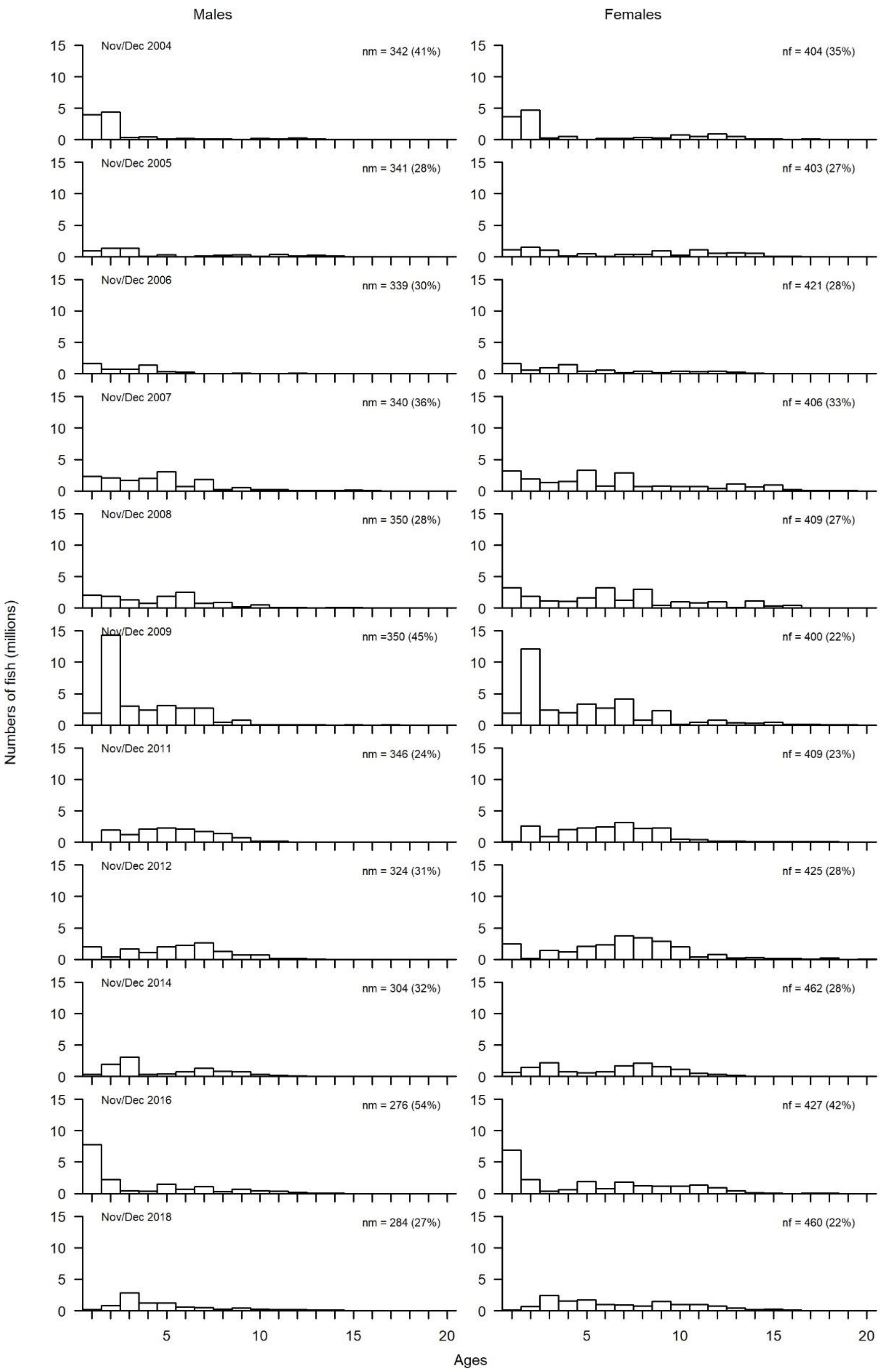


Figure 8a: Hoki continued.

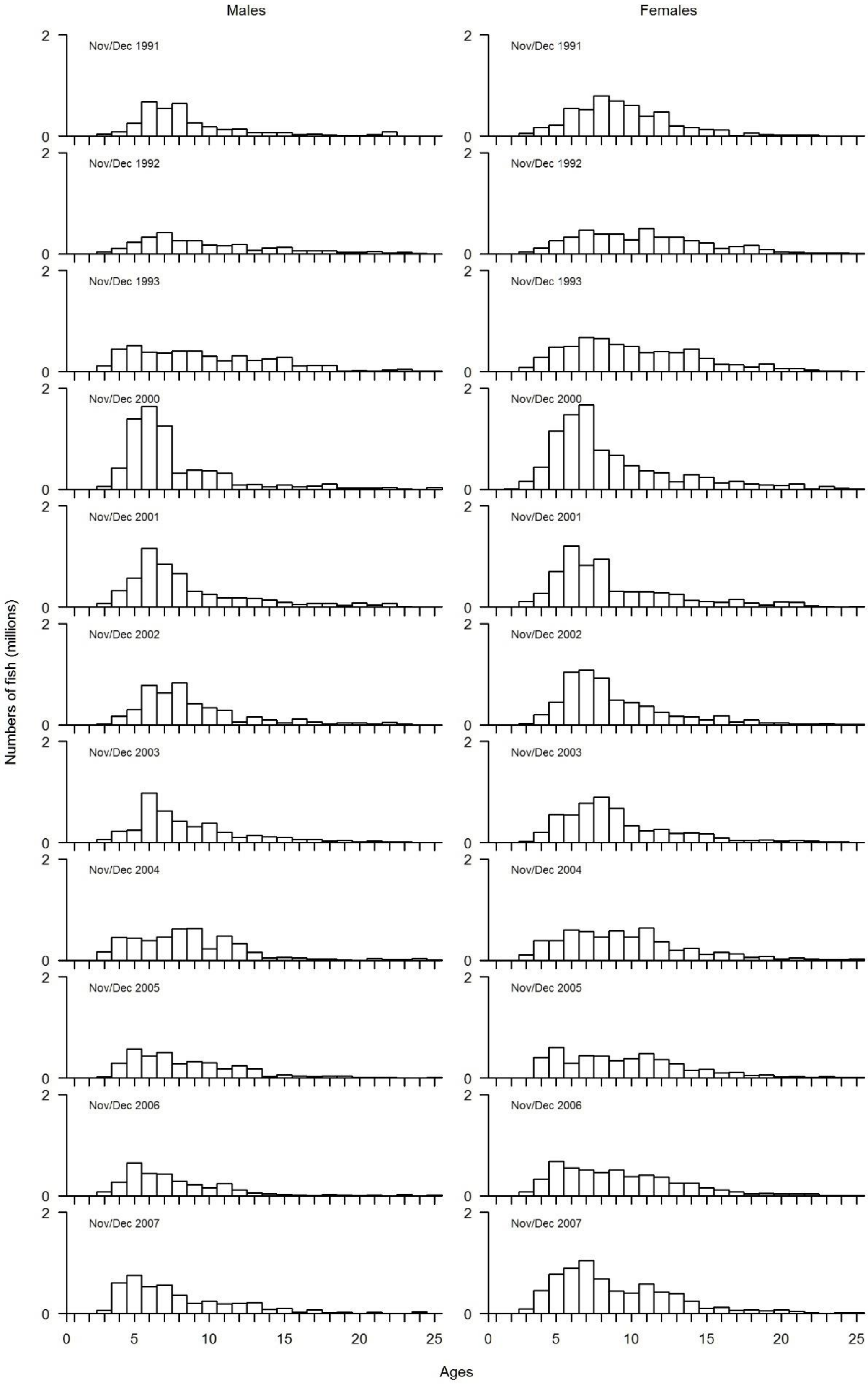


Figure 8b: Scaled age frequency for ling in core strata from the Southland and Sub-Antarctic November–December *Tangaroa* surveys in 1991–1993, 2000–2009, 2011–2012, 2014, 2016, and 2018.

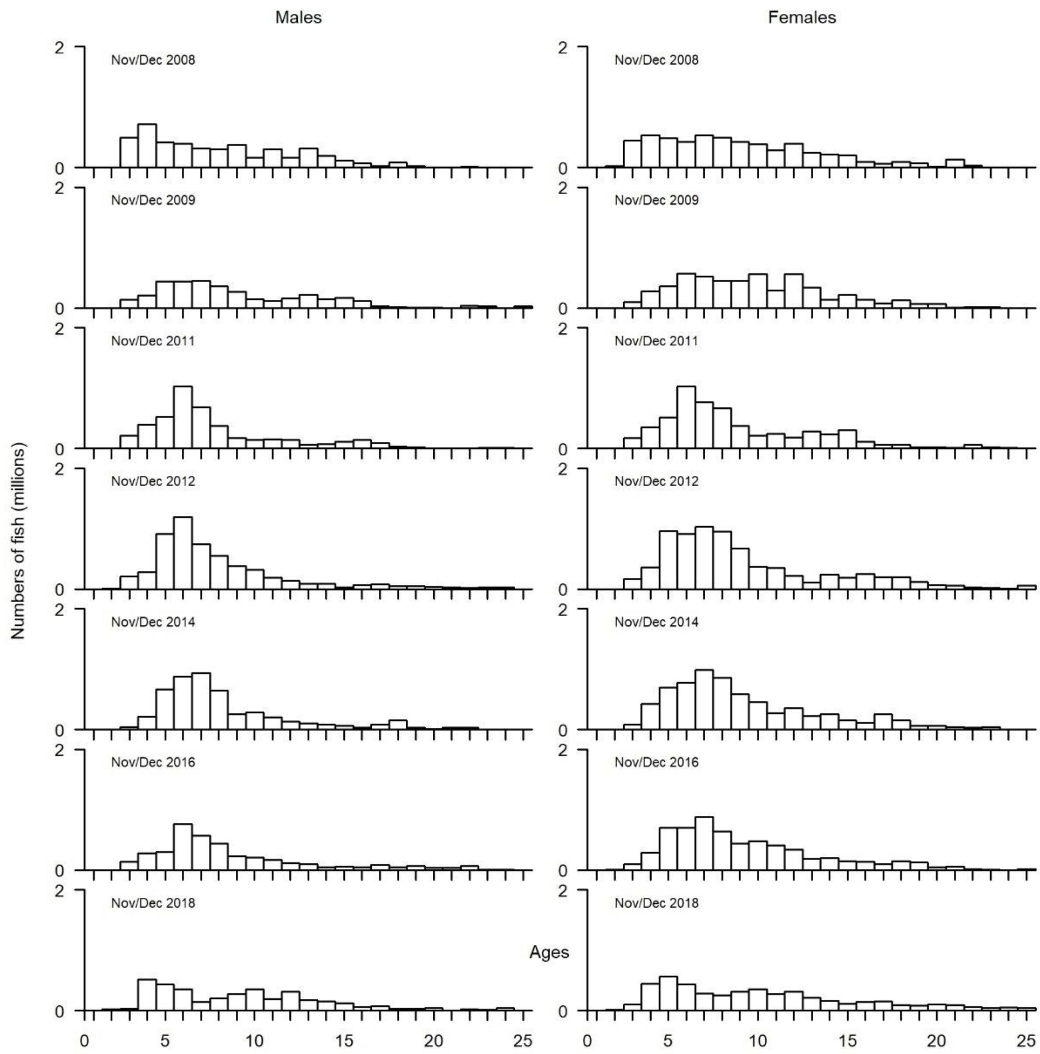


Figure 8b: Ling continued.

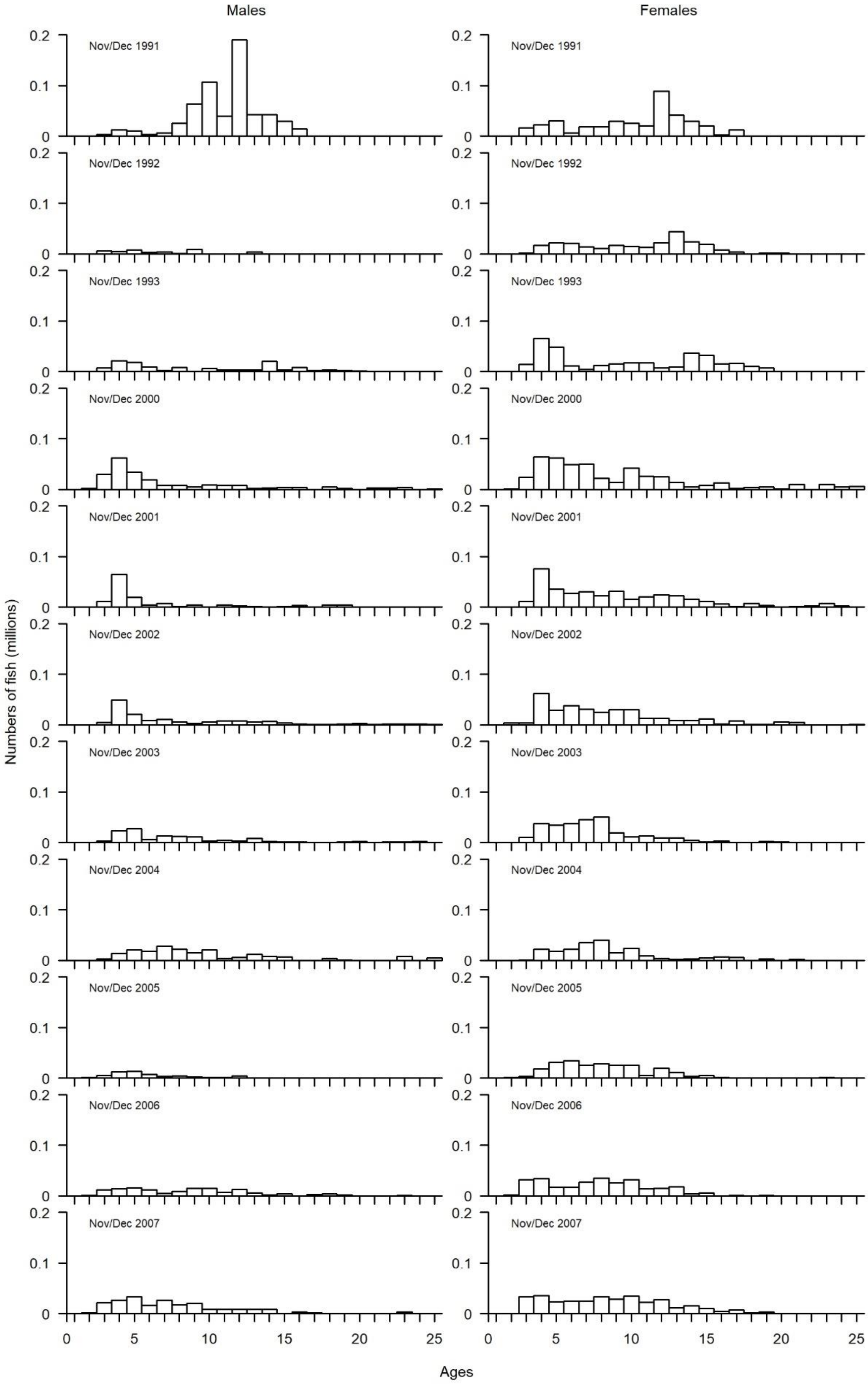


Figure 8c: Scaled age frequency for hake in core plus Puysegur strata from the Southland and Sub-Antarctic November–December *Tangaroa* surveys in 1991–1993, 2000–2009, 2011–2012, 2014, and 2018. No age data for the 2016 survey.

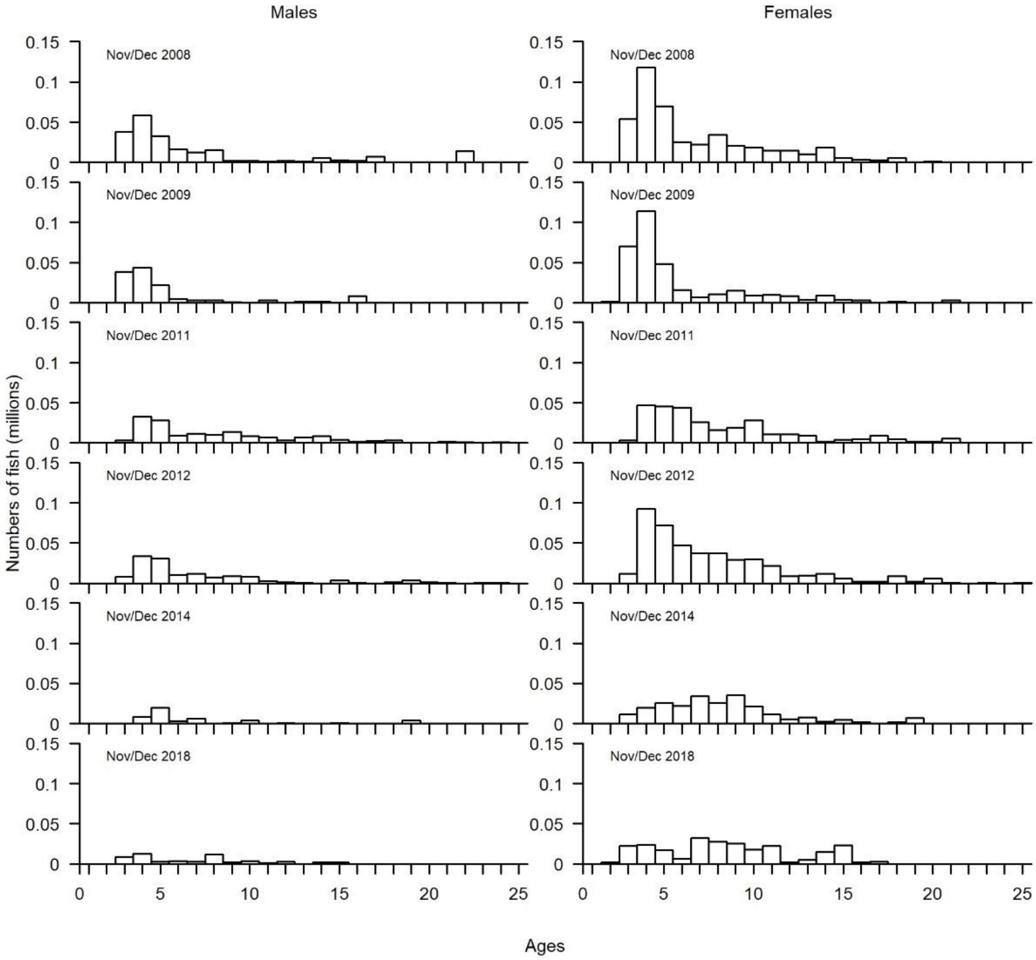


Figure 8c: Hake continued.

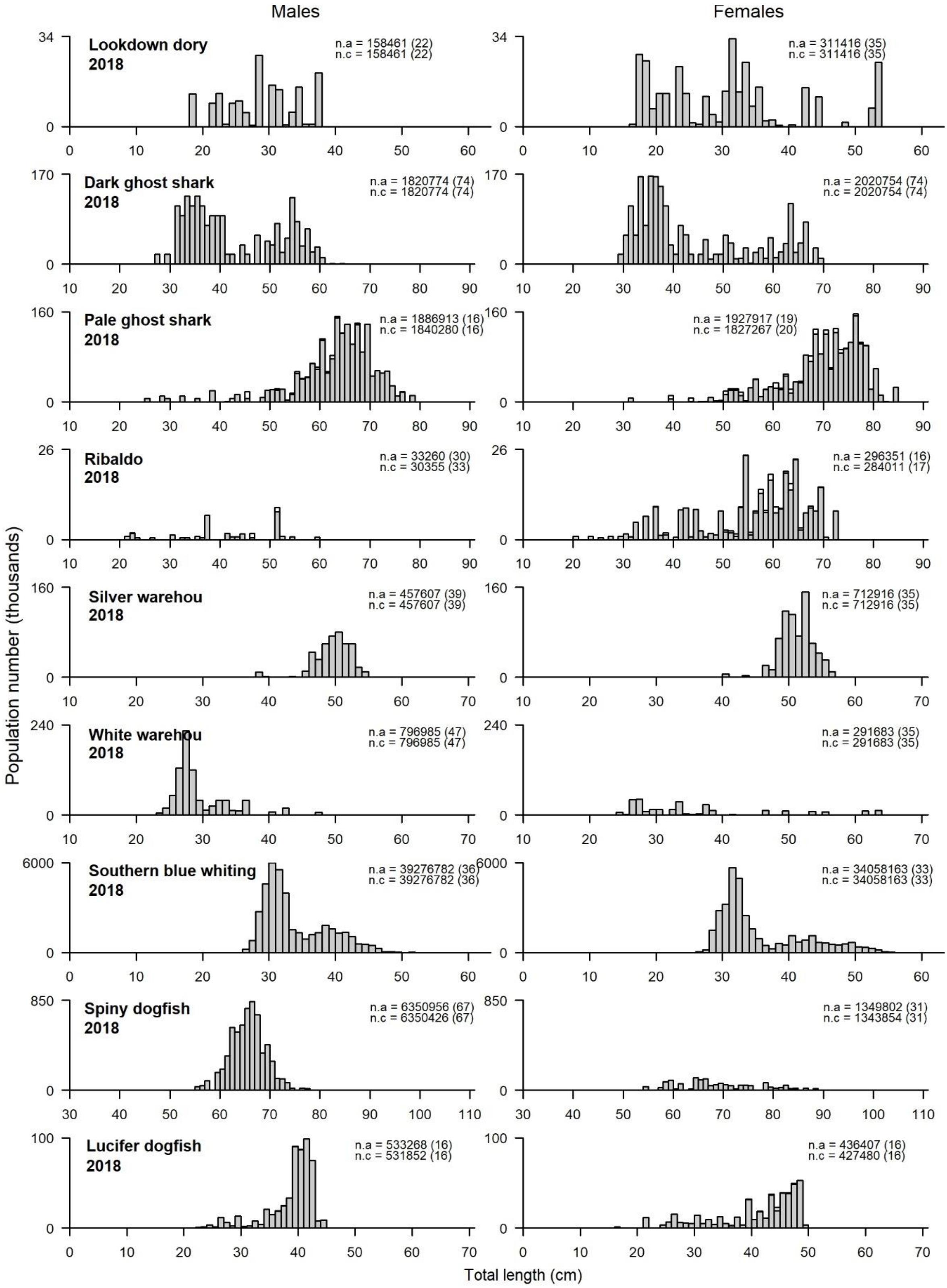


Figure 9: Length frequency distributions by sex of selected species for core (grey), and all (white) strata from the November–December 2018 Southland and Sub-Antarctic trawl survey. n.c, estimated scaled total number of fish for core strata; n.a, estimated scaled total number of fish for all strata; and CV, the coefficient of variation for core and all (in parentheses).

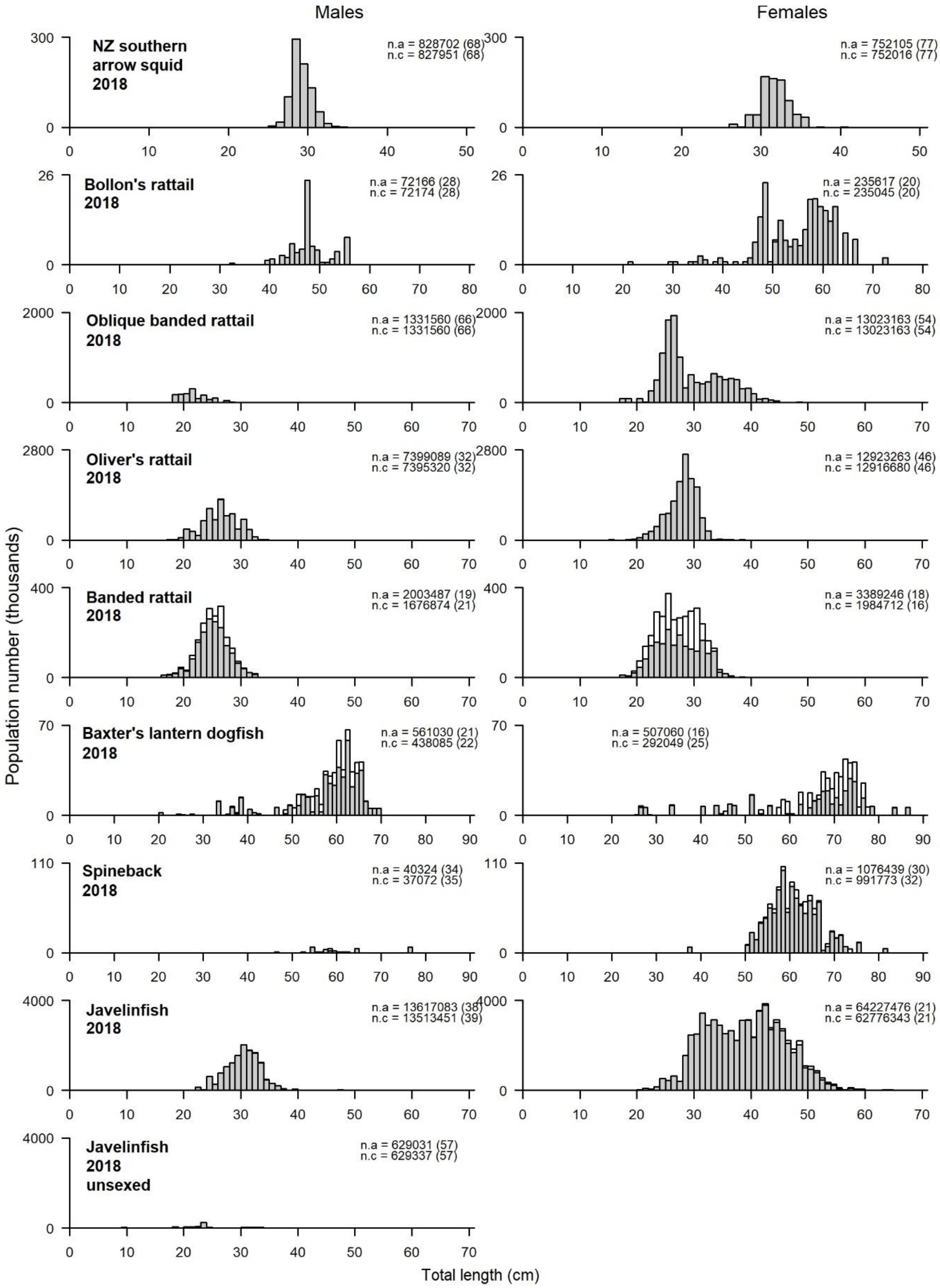
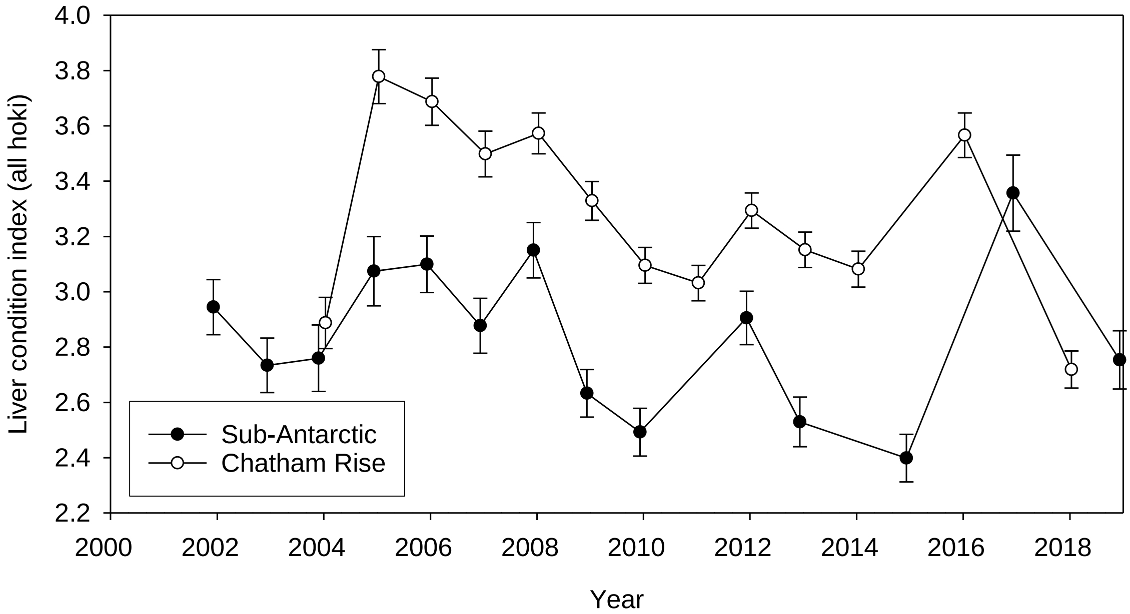


Figure 9: continued.



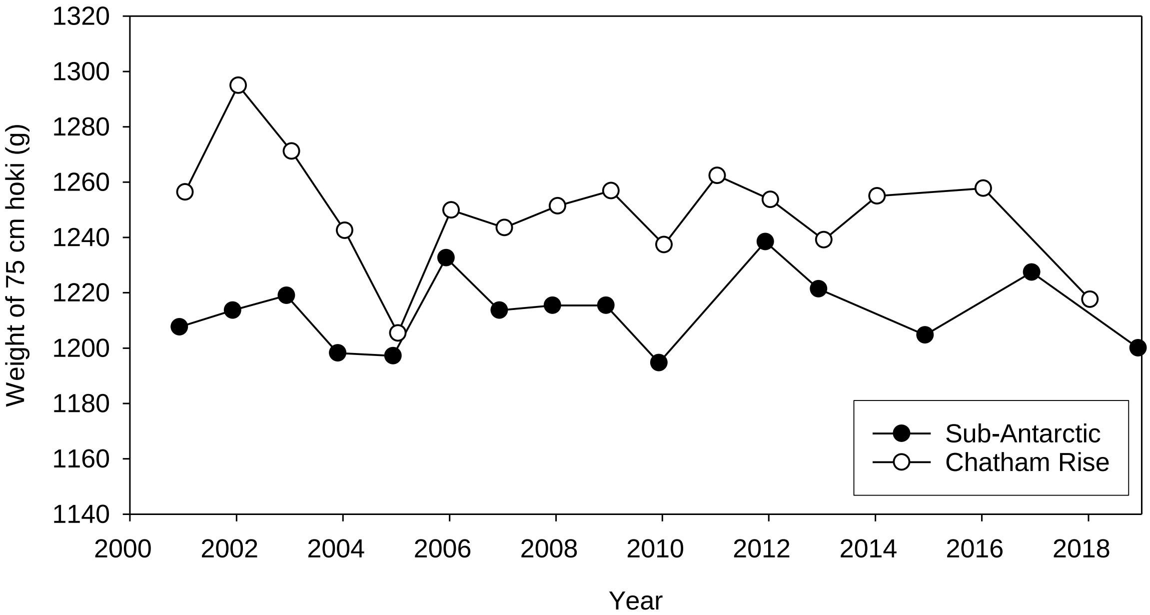


Figure 10: Liver (upper panel) and somatic (lower panel) condition indices of hoki sampled in the Sub-Antarctic summer trawl surveys since 2000. Condition indices are compared with those from the Chatham Rise survey (from Stevens et al. 2018).

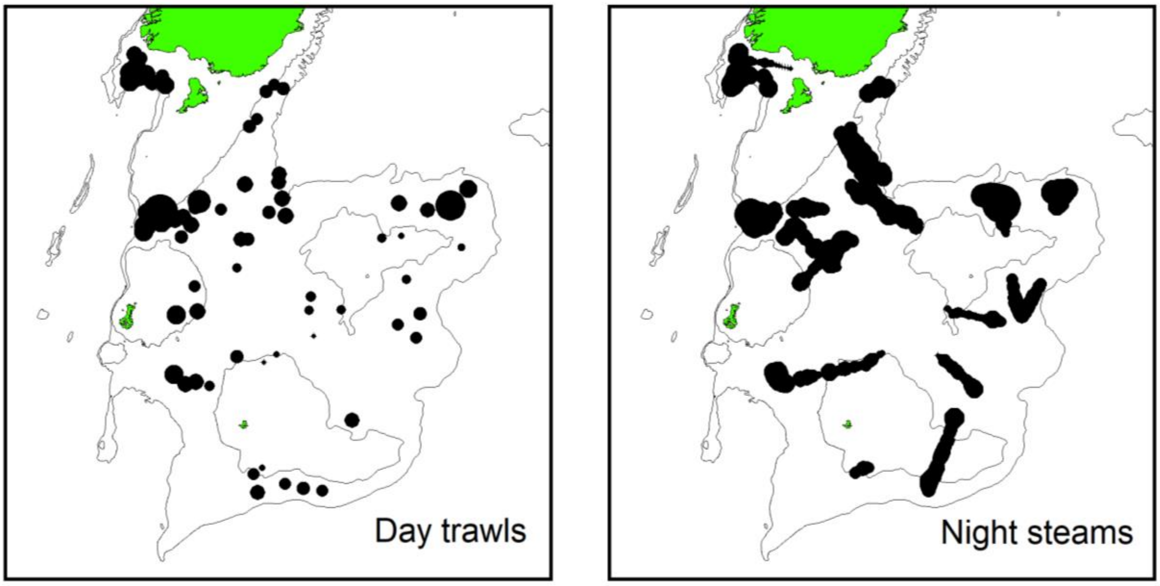


Figure 11: Spatial distribution of total acoustic backscatter (m^2 km^{-2}) in the Sub-Antarctic observed during day trawl stations (left panel) and night steams (right panel). Circle area is proportional to the acoustic backscatter. Maximum circle size is 150 m^2 km^{-2}.

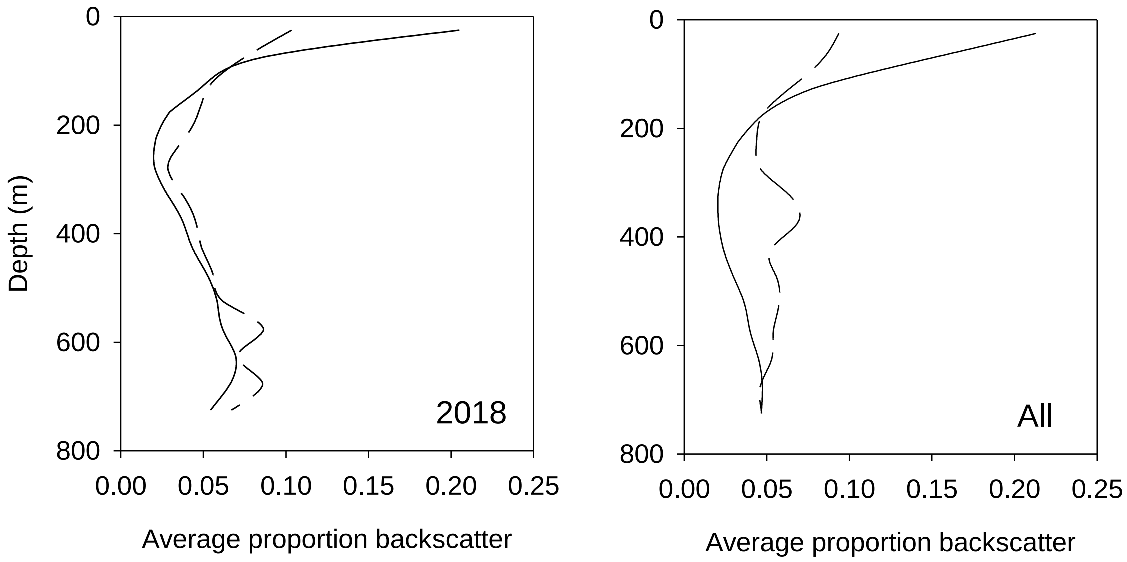


Figure 12: Distribution of total acoustic backscatter integrated in 50 m depth bins on the Sub-Antarctic observed during the day (dashed lines) and at night (solid lines) in 2018 (left panel) and average distribution from 2000–16 (right panel).

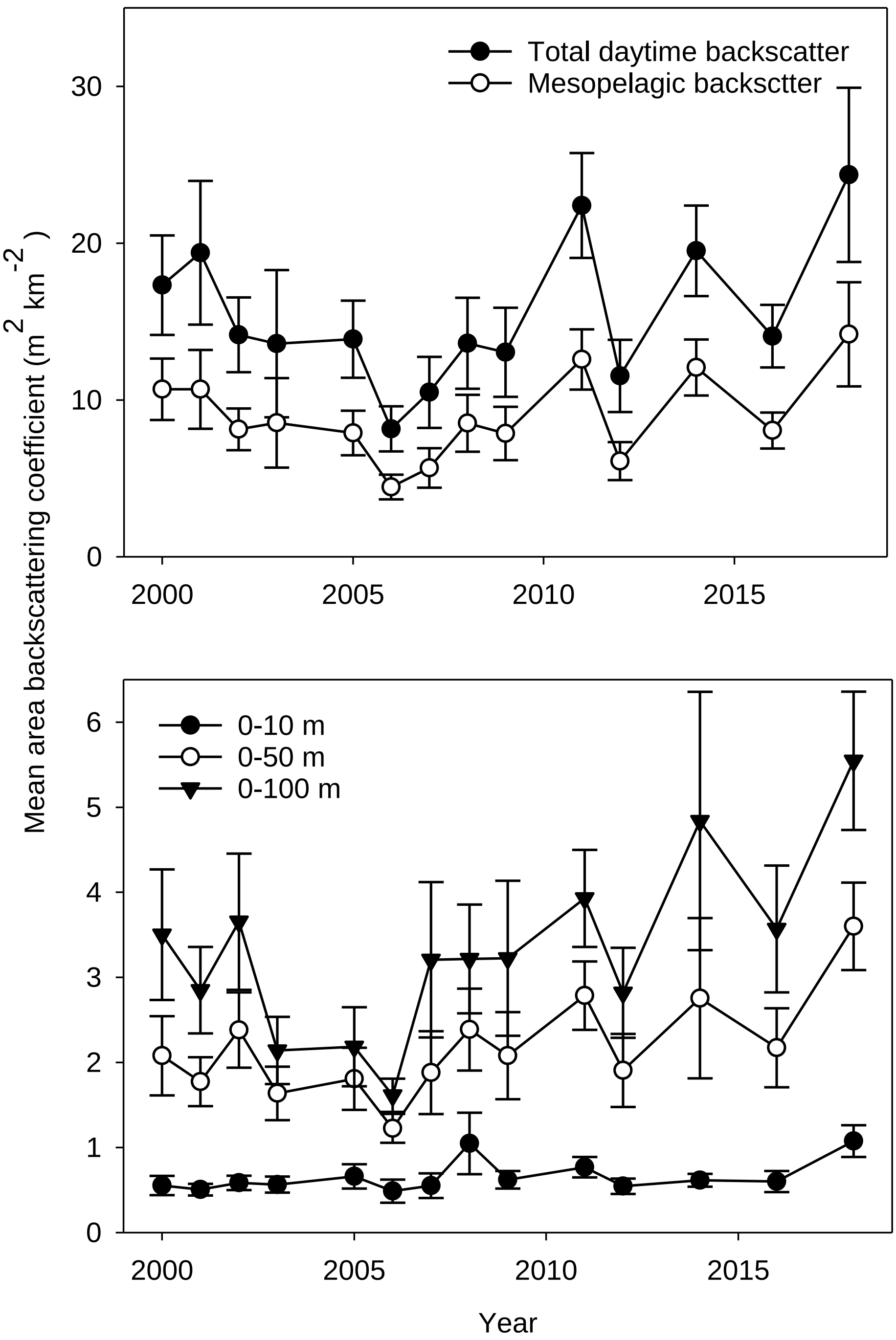


Figure 13: Estimates of total acoustic backscatter (upper panel), and backscatter in the bottom 10, 50, and 100 m (lower panel) from 38 kHz data collected during daytime trawls in 2000–18. Error bars are ± 2 standard errors.

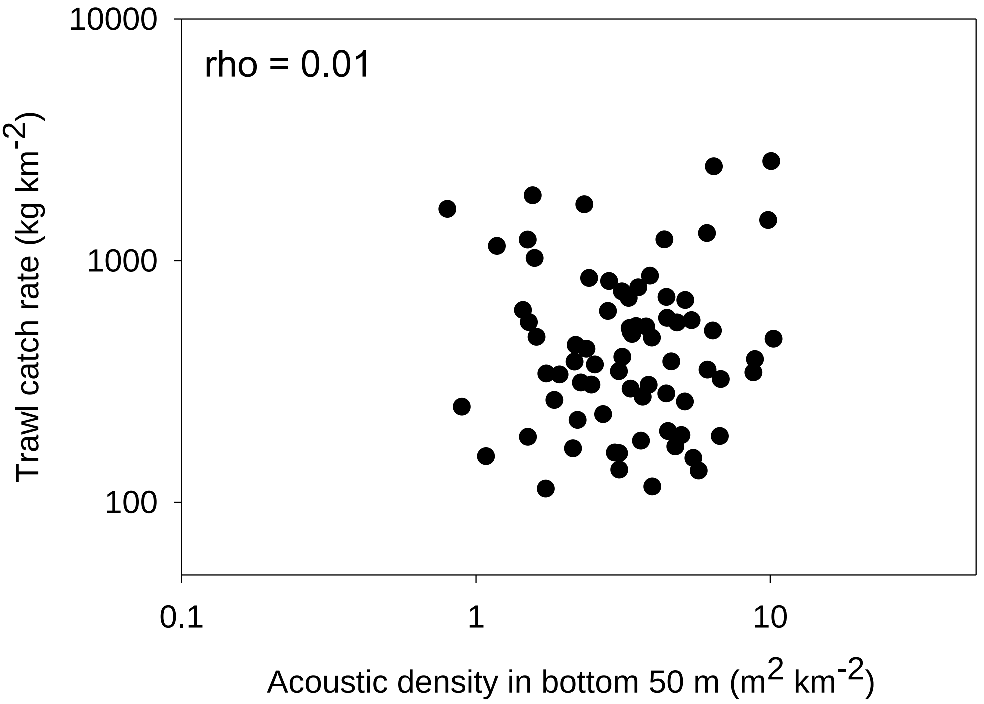


Figure 14: Relationship between total trawl catch rate (all species excluding benthic invertebrates) and acoustic backscatter recorded during the trawl in the Sub-Antarctic in 2018. Rho value is the Spearman's rank correlation coefficient.

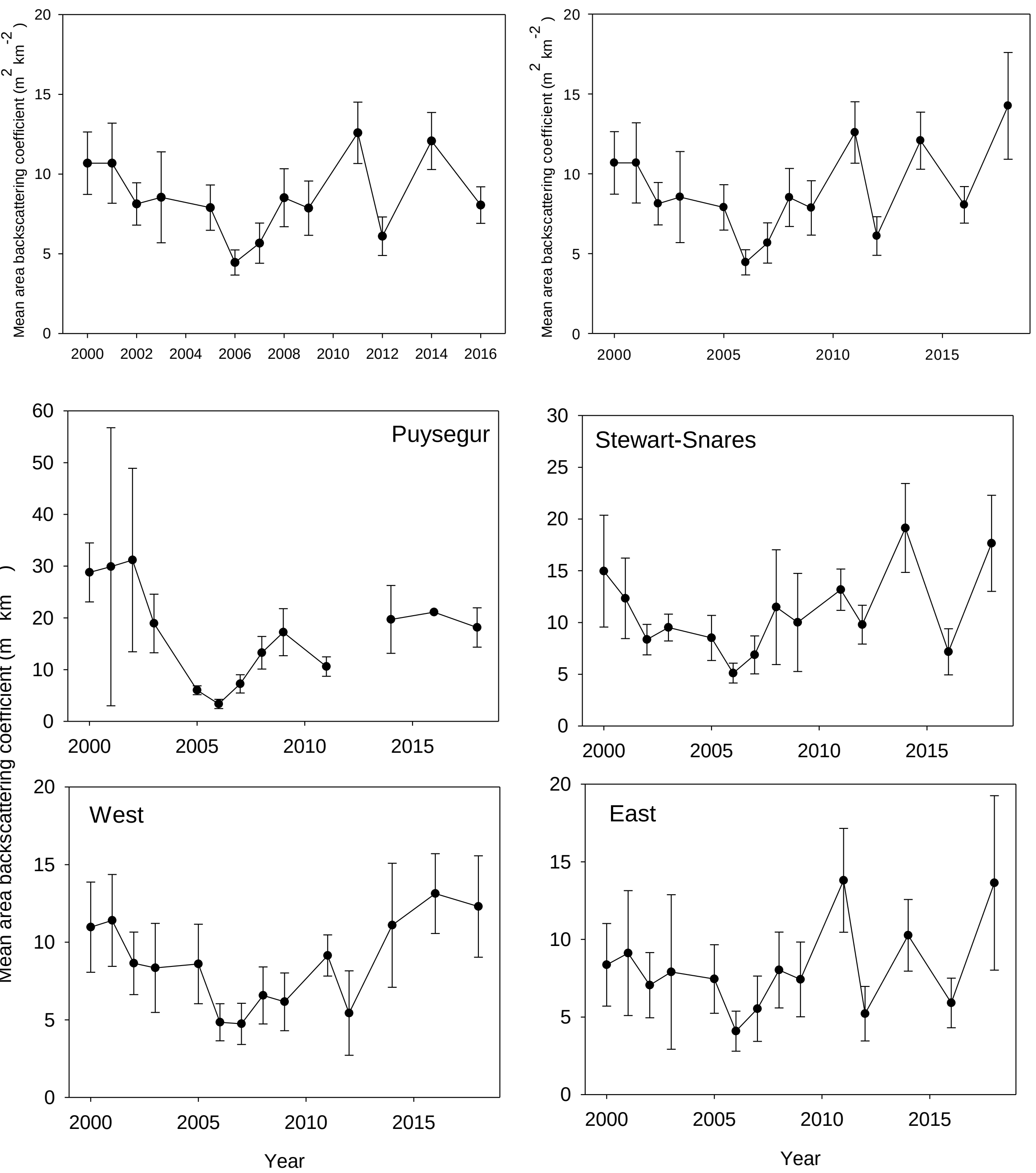


Figure 15: Time series of mesopelagic indices for the Sub-Antarctic (top panel) and by region (lower four panels). Error bars are ± 2 standard errors. Note that the 2012 survey did not produce any data suitable for acoustic analysis from Puysegur. There was only one data point for Puysegur in 2016.

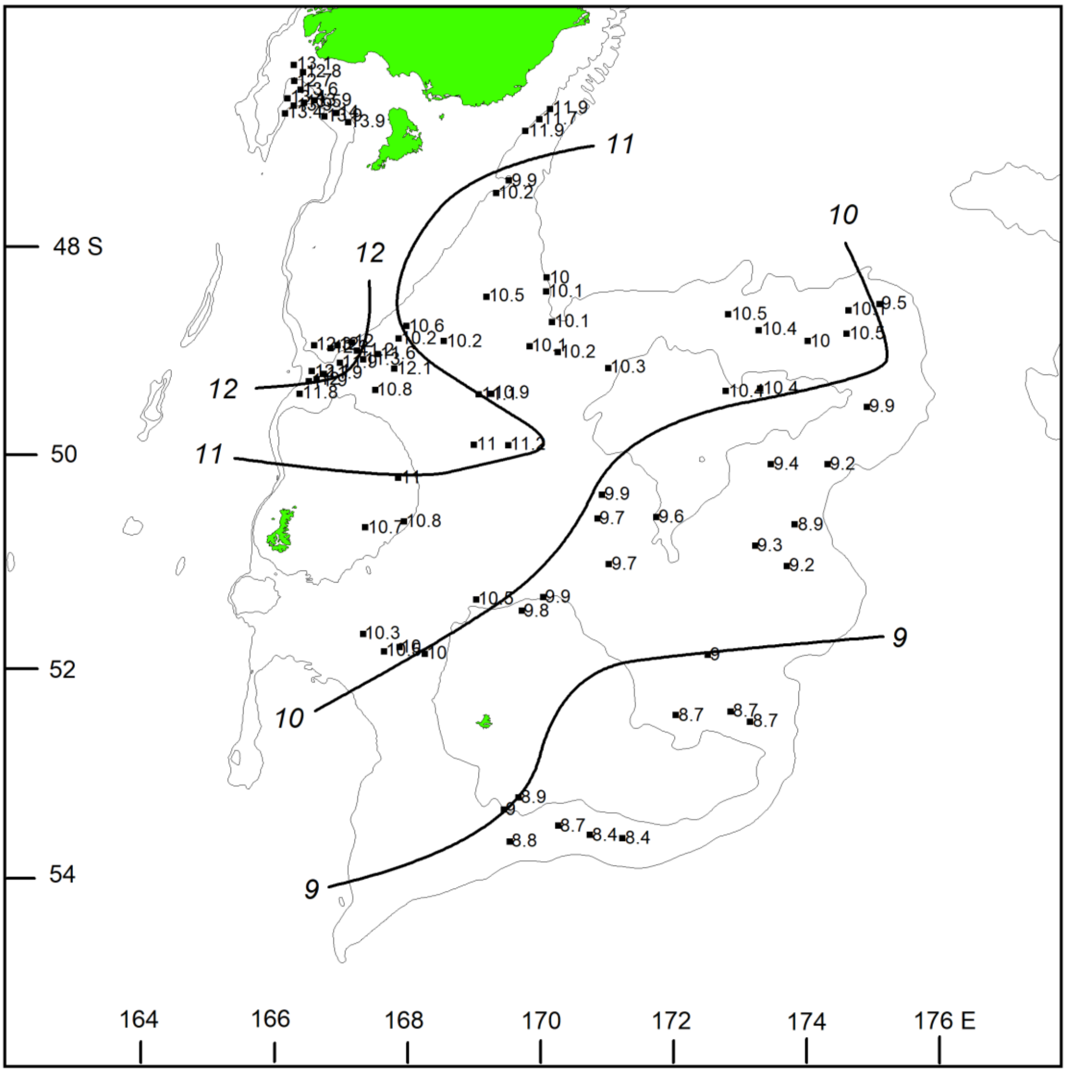


Figure 16: Surface water temperatures (°C). Squares indicate station positions. Contours show isotherms estimated by eye.

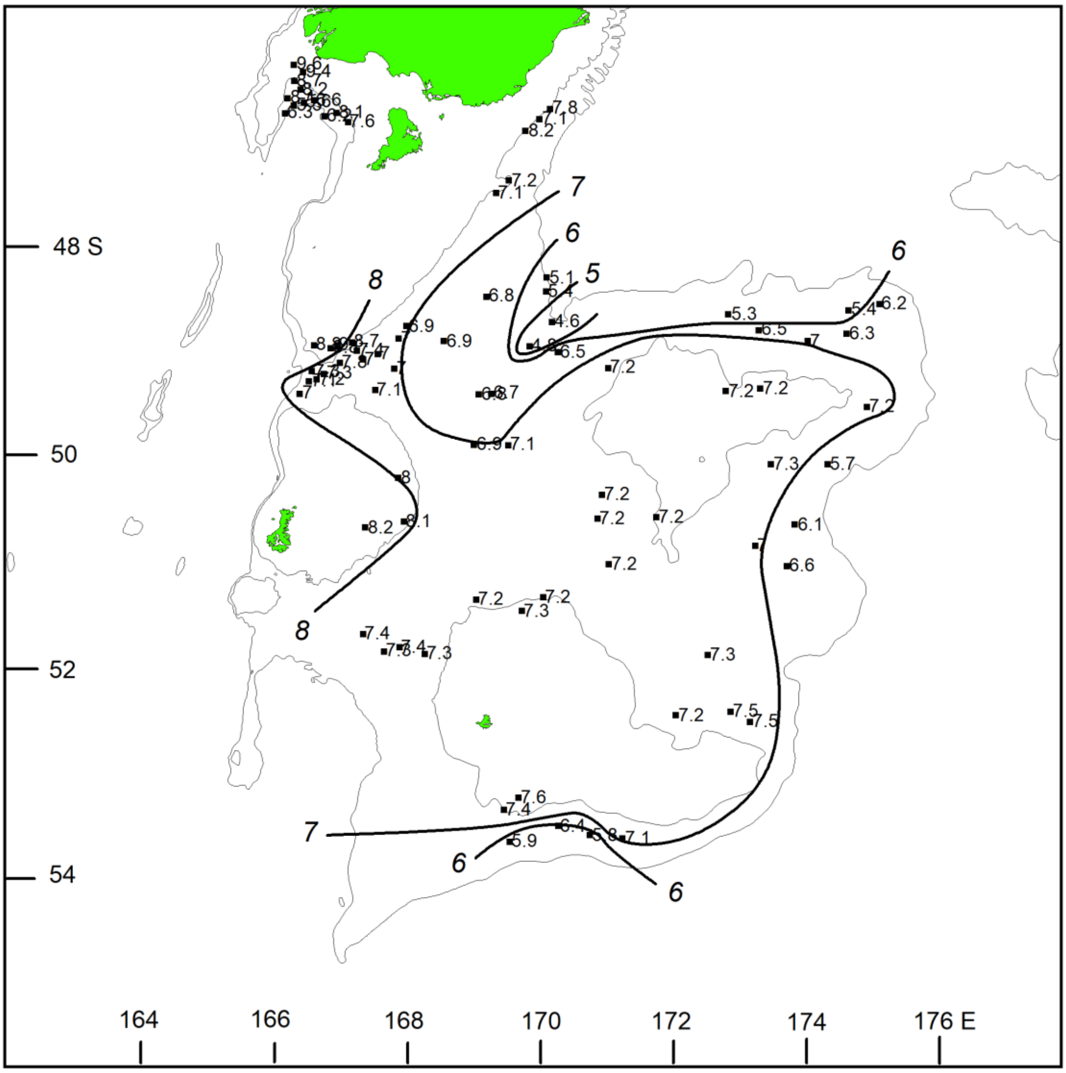


Figure 17: Bottom water temperatures (°C). Squares indicate station positions. Contours show isotherms estimated by eye.

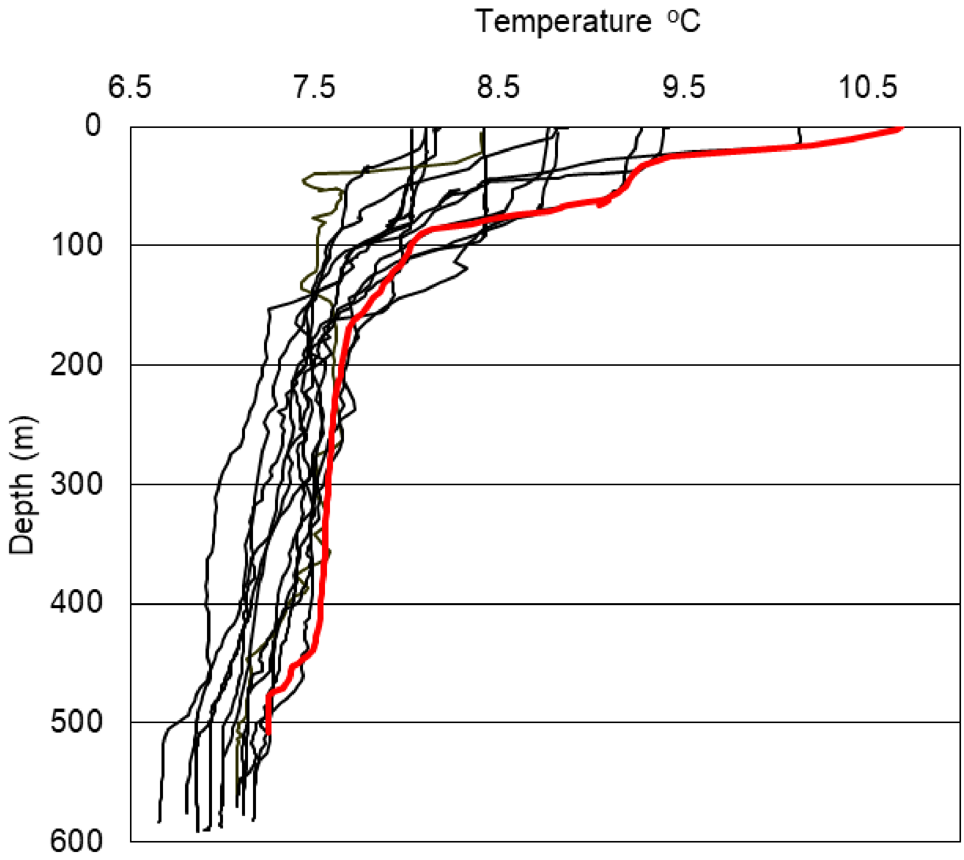


Figure 18: Comparison of vertical profiles of temperature from the net-mounted CTD on tows in stratum 9 at approximately 50° 45' S and 169° 00' E in 2002 (TAN0219 station 54, on 6 December), 2003 (TAN0317 station 45, on 29 November), 2004 (TAN0414 station 54, on 14 December), 2005 (TAN0515 station 42, on 6 December), 2006 (TAN0617 station 33, on 5 December), 2007 (TAN0714 station 40 on 7 December), 2008 (TAN0813 station 17, on 30 November), 2009 (TAN0911 station 46, on 9 December) 2011 (TAN1117 station 53, on 9 December) 2012 (TAN1215 station 69, on 13 December), 2014 (TAN1412 station 71, on 16 December), 2016 (TAN1614 station 42, on 11 December), and 2018 (TAN1811 station 66, on 13 December). 2018 is the red line.

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. GT gear trials.

Station	Date yyyy-mm-dd	Stratum	Start Latitude (S)	Start Longitude (E)	Distance (n. mile)	Hoki (kg)	Ling (kg)	Hake (kg)
1	2018-11-25	GT	44 21.26	174 15.16	1.41	-	-	-
2	2018-11-25	GT	44 21.22	174 10.44	1.50	-	-	-
3	2018-11-25	GT	44 21.13	174 10.99	1.24	-	-	-
4	2018-11-25	GT	44 28.84	173 49.60	0.81	-	-	-
5	2018-11-26	GT	46 42.03	170 08.84	3.01	128.8	31.8	4.9
6	2018-11-27	0028	46 52.06	170 12.61	3.02	15.5	3.2	-
7	2018-11-27	003A	46 47.89	169 59.10	2.98	8.9	37.6	-
8	2018-11-27	003A	46 54.69	169 46.53	2.99	58.3	38.4	-
9	2018-11-27	003A	47 22.97	169 31.54	3.01	66.5	50.8	17.4
10	2018-11-27	003A	47 30.12	169 20.41	3.02	1049.5	65.6	16.4
11	2018-11-28	0028	48 18.41	170 05.91	3.01	-	-	7.2
12	2018-11-28	0028	48 26.48	170 05.48	3.00	13.2	-	7.9
13	2018-11-28	0027	48 43.98	170 10.50	3.06	4.6	-	6.5
14	2018-11-28	0028	48 57.74	169 50.32	3.01	4.2	-	8.4
15	2018-11-28	0011	49 01.13	170 16.00	3.00	26.5	-	-
16	2018-11-30	0001	46 16.70	166 17.09	3.02	79.2	569.1	-
17	2018-11-30	0001	46 21.11	166 25.51	2.98	57.3	321.5	1.1
18	2018-11-30	0001	46 25.86	166 17.56	2.98	38.2	120.5	58.8
19	2018-11-30	0025	46 38.43	166 26.42	3.02	1.3	-	27.9
20	2018-11-30	0025	46 40.22	166 17.28	3.03	4.2	-	44.2
21	2018-11-30	0025	46 44.60	166 09.41	3.02	69.4	-	103.7
22	2018-12-01	0002	46 36.05	166 11.51	3.02	15.7	31.8	-
23	2018-12-01	0002	46 30.97	166 23.17	3.03	24.2	52.1	34.5
24	2018-12-01	0025	46 37.07	166 35.96	3.15	68.2	4.9	326.7
25	2018-12-01	0025	46 46.20	166 44.79	2.99	10.9	5.2	41.3
26	2018-12-01	0002	46 44.41	166 56.00	2.11	97.2	40.4	-
27	2018-12-01	0002	46 49.43	167 06.15	2.15	55.4	32.2	21.3
28	2018-12-02	0001	46 40.14	167 02.59	2.98	110.2	924.0	2.8
29	2018-12-02	0004	48 46.13	167 58.85	3.00	27.0	56.1	-
30	2018-12-03	0004	48 53.30	167 52.22	2.98	54.5	68.8	20.5
31	2018-12-03	0004	48 54.74	168 32.61	3.03	23.4	20.9	6.9
32	2018-12-03	0004	48 29.56	169 11.30	2.95	17.1	23.4	-
33	2018-12-04	0012	49 10.11	171 01.37	2.98	47.2	71.2	-
34	2018-12-04	0012	49 23.31	172 47.58	2.96	21.3	42.8	-
35	2018-12-04	0012	49 22.02	173 19.01	3.04	8.7	62.6	-
36	2018-12-05	0027	48 39.49	172 50.17	1.26	-	-	-
37	2018-12-05	0011	48 48.50	173 17.44	2.99	50.9	16.2	-
38	2018-12-05	0011	48 54.72	174 01.92	2.99	233.9	33.0	-
39	2018-12-05	0011	48 50.58	174 36.88	3.00	57.6	18.4	-
40	2018-12-06	0027	48 37.08	174 38.61	2.97	18.3	-	-
41	2018-12-07	0027	48 33.58	175 06.77	3.00	9.9	-	-
42	2018-12-07	0012	49 32.43	174 55.36	2.97	116.7	47.7	-
43	2018-12-07	0011	50 05.19	174 20.11	3.02	21.5	4.8	-
44	2018-12-08	0012	50 05.08	173 28.61	3.01	46.8	21.7	-
45	2018-12-08	0015	50 39.55	173 50.21	2.97	53.4	-	-
46	2018-12-08	0015	51 03.51	173 43.26	3.08	85.0	20.4	-
47	2018-12-08	0013	50 51.81	173 14.34	2.99	46.8	65.4	-
48	2018-12-09	0013	50 35.56	171 45.12	3.01	28.6	56.7	-
49	2018-12-09	0012	50 22.66	170 55.96	2.97	93.0	81.3	20.7

APPENDIX 2: continued.

Station	Date yyyy-mm-dd	Stratum	Start Latitude (S)	Start Longitude (E)	Distance (n. mile)	Hoki (kg)	Ling (kg)	Hake (kg)
50	2018-12-09	0013	50 36.33	170 52.14	3.04	66.6	56.9	-
51	2018-12-09	0013	51 02.33	171 02.01	3.00	165.0	75.2	14.8
52	2018-12-10	0013	51 54.23	172 31.58	3.03	99.0	39.5	-
53	2018-12-10	0014	52 26.62	172 51.96	2.98	112.3	33.7	-
54	2018-12-10	0014	52 32.46	173 09.70	2.99	65.4	40.9	11.2
55	2018-12-10	0014	52 28.70	172 02.51	3.03	30.8	20.1	-
56	2018-12-11	0015	53 39.13	171 14.50	3.05	170.4	45.1	-
57	2018-12-11	0010	53 37.05	170 44.92	3.04	13.0	-	4.8
57	2018-12-11	0010	53 31.98	170 16.38	2.89	24.3	-	-
58	2018-12-11	0010	53 41.16	169 32.48	3.01	4.8	-	-
59	2018-12-11	0009	53 22.81	169 27.28	3.03	226.3	62.5	-
60	2018-12-12	0009	53 15.88	169 40.38	3.01	87.6	-	-
61	2018-12-12	0009	51 53.72	168 15.84	2.46	128.3	76.4	-
62	2018-12-12	0007	51 49.79	167 52.72	2.99	72.1	84.9	-
63	2018-12-13	0009	51 21.08	170 02.74	3.99	74.5	79.0	11.0
64	2018-12-13	0009	51 28.97	169 43.47	3.06	238.8	218.5	4.5
65	2018-12-13	0009	51 22.53	169 02.08	2.94	78.0	78.3	-
66	2018-12-13	0007	51 52.15	167 38.80	3.02	43.2	43.6	-
67	2018-12-14	0007	51 42.21	167 19.88	3.02	127.1	58.6	-
68	2018-12-14	0006	50 41.23	167 21.53	2.78	6.9	64.8	-
69	2018-12-14	0006	50 37.86	167 56.73	2.33	27.1	167.1	6.0
70	2018-12-14	0006	50 12.97	167 51.63	3.01	7.0	69.8	-
71	2018-12-15	0008	49 25.22	169 04.33	2.99	70.5	8.8	5.7
72	2018-12-15	0008	49 24.89	169 15.81	3.00	114.8	41.8	-
73	2018-12-15	0008	49 54.32	169 31.26	3.01	136.0	50.5	11.3
74	2018-12-15	0008	49 54.21	168 59.98	3.02	96.2	93.3	-
75	2018-12-16	005B	49 22.66	167 30.78	2.99	81.8	52.3	13.9
76	2018-12-16	005B	49 10.64	167 47.89	3.00	26.4	65.1	-
77	2018-12-16	005B	49 05.15	167 19.88	3.01	43.9	44.7	20.3
78	2018-12-16	005B	49 02.20	167 32.94	3.00	12.7	52.5	11.9
79	2018-12-16	003B	48 55.43	167 09.83	3.00	697.2	134.8	-
80	2018-12-17	003B	48 57.14	166 35.66	2.18	48.1	53.6	52.6
81	2018-12-17	003B	48 59.00	166 50.40	3.01	1772.8	26.7	5.3
82	2018-12-17	003B	48 57.15	166 56.58	2.99	1479.6	52.0	-
83	2018-12-18	005A	49 13.61	166 44.38	1.26	18.2	17.2	105.6
84	2018-12-18	005A	49 24.96	166 22.62	2.91	30.7	55.2	6.0
85	2018-12-18	005A	49 16.60	166 37.84	3.03	44.3	14.7	35.8
86	2018-12-18	005A	49 12.03	166 33.57	3.00	28.5	75.5	-
87	2018-12-19	005A	49 07.26	166 59.10	1.61	12.7	59.7	35.0
88	2018-12-19	005A	49 17.76	166 30.85	3.03	12.5	21.5	-
89	2018-12-19	005A	49 00.16	167 14.09	3.01	26.3	74.4	15.4
90	2018-12-09	0013	50 36.33	170 52.14	3.04	66.6	56.9	-

APPENDIX 3: Species list

Species code, common name, family, scientific name, and number of stations where caught from all trawl tows for all organisms caught on TAN1811. Note species codes, particularly invertebrates are continually updated on the database following identification ashore.

Species	Common name	Family	Scientific name	No. of stations
ACA	Subantarctic ruby prawn	Oplophoridae	*Acanthephyra* spp.	2
ACS	Smooth deepsea anemones	Actinostolidae	*Actinostolidae*	6
AEX	New Zealand catshark	Scyliorhinidae	*Apristurus exsanguis*	2
ANO	Fangtooth	Anoplogastridae	*Anoplogaster cornuta*	1
API	Alert pigfish	Congiopodidae	*Alertichthys blacki*	1
ARI	*Aristeus* spp	Aristeidae	*Aristeus* spp.	2
BAH	Grey pencilsmelts	Microstomatidae	*Bathylagichthys* spp.	2
BAM	*Bathyplotes* spp.	Synallactidae	*Bathyplotes* spp.	1
BAN	Borostomias antarcticus	Stomiidae	*Borostomias antarcticus*	1
BBE	Banded bellowsfish	Macroramphosidae	*Centriscops humerosus*	2
BBR	Bronze bream	Bramidae	*Xenobrama microlepis*	1
BCA	Barracudina	Paralepididae	*Magnisudis prionosa*	1
BEE	Basketwork eel	Synaphobranchidae	*Diastobranchus capensis*	11
BEN	Scabbardfish	Trichiuridae	*Benthodesmus* spp.	1
BJA	Black javelinfish	Macrouridae	*Mesobius antipodum*	4
BNO	*Benthoctopus* spp.	Octopodidae	*Benthoctopus* spp.	4
BOC	Deepsea anemone	Actiniidae	*Bolocera* spp.	1
BOE	Black oreo	Oreosomatidae	*Allocyttus niger*	13
BSH	Seal shark	Dalatiidae	*Dalatias licha*	12
BSP	Big-scale pomfret	Bramidae	*Taractichthys longipinnis*	1
BTA	Smooth deepsea skate	Rajidae	*Brochiraja asperula*	6
BTS	Prickly deepsea skate	Rajidae	*Brochiraja spinifera*	4
CAM	Sabre prawn	-	*Camplyonotus rathbunae*	4
CAS	Oblique banded rattail	Macrouridae	*Coelorinchus aspercephalus*	32
CBA	Humpback rattail (slender rattail)	Macrouridae	*Coryphaenoides dossenus*	3
CBO	Bollons rattail	Macrouridae	*Coelorinchus bollonsi*	26
CCX	Small banded rattail	Macrouridae	*Coelorinchus parvifasciatus*	4
CDL	Cardinalfish	Epigonidae	Epigonidae	1
CDO	Capro dory	Zeidae	*Capromimus abbreviatus*	2
CFA	Banded rattail	Macrouridae	*Coelorinchus fasciatus*	61
CHA	Viper fish	Stomiidae	*Chauliodus sloani*	8
CHG	Giant chimaera	Chimaeridae	*Chimaera lignaria*	1
CIN	Notable rattail	Macrouridae	*Coelorinchus innotabilis*	11
CJA	Sun star	Solasteridae	*Crossaster multispinus*	4
CKA	Kaiyomaru rattail	Macrouridae	*Coelorinchus kaiyomaru*	9
CLM	Coral-like anemones	Corallimorphidae	*Corallimorphidae*	2
CMA	Mahia rattail	Macrouridae	*Coelorinchus matamua*	4
COF	Flabellum coral	Flabellidae	*Flabellum* spp.	2
COL	Olivers rattail	Macrouridae	*Coelorinchus oliverianus*	50
CPA	Pentagon star	Goniasteridae	*Ceramaster patagonicus*	6
CPH	Cephalopoda	-	Cephalopoda	2
CRM	Airy finger sponge	Callyspongiidae	*Callyspongia cf ramosa*	1
CSE	Serrulate rattail	Macrouridae	*Coryphaenoides serrulatus*	9
CSQ	Leafscale gulper shark	Centrophoridae	*Centrophorus squamosus*	19
CSU	Four-rayed rattail	Macrouridae	*Coryphaenoides subserrulatus*	22
CYO	Smooth skin dogfish	Squalidae	*Centroscymnus owstoni*	5
CYP	Longnose velvet dogfish	Squalidae	*Centroscymnus crepidater*	20

Appendix 3 continued:

Species	Common name	Family name	Scientific name	No. of stations
DCO	Dwarf cod	Moridae	*Notophycis marginata*	4
DCS	Dawson's catshark	Scyliorhinidae	*Bythaelurus dawsoni*	4
DDA	Dana lanternfish	Myctophidae	*Diaphus danae*	1
DEA	Dealfish	Trachipteridae	*Trachipterus trachypterus*	1
DHO	Sea urchin	Echinidae	*Dermechinus horridus*	2
DIP	Twin light dragonfishes	Diplophidae	*Diplophos* spp.	1
DIR	Pagurid	Paguridae	*Diacanthurus rubricatus*	3
DIS	Discfish	Diretmidae	*Diretmus argenteus*	5
DMG	*Dipsacaster magnificus*	Astropectinidae	*Dipsacaster magnificus*	6
DSP	Deepsea pigfish	Congiopodidae	*Congiopodus coriaceus*	1
DWO	Deepwater octopus	Octopodidae	*Graneledone* spp.	1
ELC	Carlsberg's lanternfish	Myctophidae	*Electrona carlsbergi*	1
EPL	Bigeye cardinalfish	Epigonidae	*Epigonus lenimen*	5
EPM	Thin tongue cardinalfish	Epigonidae	*Epigonus machaera*	2
EPT	Deepsea cardinalfish	Epigonidae	*Epigonus telescopus*	6
EPZ	*Epizoanthus* spp.	Epizoanthidae	*Epizoanthus* spp.	1
ERE	Basket-weave horn sponge	Euplectellidae	*Euplectella regalis*	1
ETB	Baxter’s lantern dogfish	Etmopteridae	*Etmopterus granulosus*	35
ETL	Lucifer dogfish	Etmopteridae	*Etmopterus lucifer*	49
EVB	Brown sabretooth	Evermannellidae	*Evermannella balbo*	2
EVI	Blue-eye lantern shark	Etmopteridae	*Etmopterus viator*	2
FHD	Deepsea flathead	Hoplichthyidae	*Hoplichthys haswelli*	2
FIS	Fish	-	-	1
FMA	*Fusitriton magellanicus*	Ranellidae	*Fusitriton magellanicus*	4
GAS	Gastropods	-	Gastropoda	1
GIZ	Giant stargazer	Uranoscopidae	*Kathetostoma giganteum*	15
GOC	Gorgonian coral	-	Gorgonacea	1
GON	*Gonorynchus forsteri* & *G. Greyi*	Gonorynchidae	*Gonorynchus forsteri* & *G. greyi*	1
GOR	*Gorgonocephalus* spp	Gorgonocephalidae	*Gorgonocephalus* spp.	1
GRE	Curling stone sponge	Geodiidae	*Geodia regina*	2
GRM	Sea urchin	Echinidae	*Gracilechinus multidentatus*	1
GSC	Giant spider crab	Majidae	*Jacquinotia edwardsii*	3
GSH	Ghost shark	Chimaeridae	*Hydrolagus novaezealandiae*	12
GSP	Pale ghost shark	Chimaeridae	*Hydrolagus bemisi*	68
GTA	Deepwater octopus	Octopodidae	*Graneledone taniwha*	6
GYB	Bolin's lanternfish	Myctophidae	*Gymnoscopelus bolini*	4
GYF	Fraser's lanternfish	Myctophidae	*Gymnoscopelus fraseri*	1
GYM	*Gymnoscopelus* spp	Myctophidae	*Gymnoscopelus* spp.	1
HAK	Hake	Merlucciidae	*Merluccius australis*	38
HAS	Australasian slender cod	Moridae	*Halargyreus* sp.	9
HBA	Bigeye sea perch	Sebastidae	*Helicolenus barathri*	1
HCO	Hairy conger	Congridae	*Bassanago hirsutus*	20
HIS	*Histocidaris* spp.	Histocidaridae	*Histocidaris* spp.	2
HMT	Deepsea anemone	Hormathiidae	Hormathiidae	7
HOK	Hoki	Merlucciidae	*Macruronus novaezelandiae*	84
HPC	Sea perch	Sebastidae	*Helicolenus percoides*	2
HTR	Trojan starfish	Goniasteridae	*Hippasteria phrygiana*	7
HYA	Floppy tubular sponge	Rossellidae	*Hyalascus* sp.	30
IDI	Black dragonfishes	Stomiidae	*Idiacanthus* spp.	2
JAV	Javelin fish	Macrouridae	*Lepidorhynchus denticulatus*	85

Appendix 3 continued:

Species	Common name	Family name	Scientific name	No. of stations
JFI	Jellyfish	-	-	18
KBB	Bladder kelp	Laminariaceae	*Macrocystis pyrifera*	1
LAC	Cripplefin lanternfish	Myctophidae	*Nannobrachium achirus*	1
LAG	*Laetmogone* spp.	Laetmogonidae	*Laetmogone* spp.	2
LAO	New Zealand king crab	Lithodidae	*Lithodes aotearoa*	6
LAU	Austral lanternfish	Myctophidae	*Lampanyctus australis*	3
LBI	*Lissodendoryx bifacialis*	Coelosphaeridae	*Lissodendoryx bifacialis*	1
LCH	Long-nosed chimaera	Rhinochimaeridae	*Harriotta raleighana*	30
LDO	Lookdown dory	Zeidae	*Cyttus traversi*	32
LHO	Omega prawn	-	*Lipkius holthuisi*	29
LIN	Ling	Ophidiidae	*Genypterus blacodes*	70
LIT	Intricate lanternfish	Myctophidae	*Lampanyctus intricarius*	9
LNT	Notal lanternfish	Myctophidae	*Lampadena notialis*	1
LNV	Rock star	Goniasteridae	*Lithosoma novaezelandiae*	6
LPI	Giant lepidion	Moridae	*Lepidion inosimae*	1
LSQ	*Lycoteuthis lorigera*	Lycoteuthidae	*Lycoteuthis lorigera*	1
LYC	*Lyconus* sp	Merlucciidae	*Lyconus* sp.	2
MAN	Finless flounder	Achiropsettidae	*Neoachiropsetta milfordi*	28
MCA	Ridge scaled rattail	Macrouridae	*Macrourus carinatus*	21
MEN	*Melanostomias* spp	Stomiidae	*Melanostomias* spp.	1
MIQ	Warty squid	Onychoteuthidae	*Onykia ingens*	62
MRQ	Warty squid	Onychoteuthidae	*Onykia robsoni*	6
NEB	Brodie's king crab	Lithodidae	*Neolithodes brodiei*	2
NML	Large scaled blackchin	Neoscopelidae	*Neoscopelus macrolepidotus*	1
NNA	*Nezumia namatahi*	Macrouridae	*Nezumia namatahi*	1
NOS	NZ southern arrow squid	Ommastrephidae	*Nototodarus sloanii*	30
OAR	Oarfish	Regalecidae	*Regalecus glesne*	1
ONG	Sponges	-	Porifera	2
ONO	*Oplophorus novaezeelandiae*	Oplophoridae	*Oplophorus novaezeelandiae*	2
OPI	Umbrella octopus	Opisthoteuthidae	*Opisthoteuthis* spp.	5
OPO	*Octopoteuthis* spp.	Octopoteuthiidae	*Octopoteuthis* spp.	1
ORH	Orange roughy	Trachichthyidae	*Hoplostethus atlanticus*	12
PAG	Pagurid	-	Paguroidea	2
PAO	*Pillsburiaster aoteanus*	Goniasteridae	*Pillsburiaster aoteanus*	8
PAS	*Pasiphaea* spp	-	*Pasiphaea* spp.	6
PDG	Prickly dogfish	Oxynotidae	*Oxynotus bruniensis*	1
PER	*Persparsia kopua*	Platytroctidae	*Persparsia kopua*	9
PGE	Gemmate lanternfish	Myctophidae	*Protomyctophum gemmatum*	1
PHO	Lighthouse fish	Phosichthyidae	*Phosichthys argenteus*	13
PLS	Plunket's shark	Somniosidae	*Centroscymnus plunketi*	10
PMO	*Pseudostichopus* mollis	Synallactidae	*Pseudostichopus mollis*	20
PRO	*Protomyctophum* spp	Myctophidae	*Protomyctophum* spp.	1
PSI	Geometric star	Astropectinidae	*Psilaster acuminatus*	1
PSK	Longnosed deepsea skate	Rajidae	*Bathyraja shuntovi*	1
PSY	Psychrolutes	Psychrolutidae	*Psychrolutes microporos*	1
PYC	Sea spiders	-	Pycnogonida	1
PYR	*Pyrosoma atlanticum*	Pyrosomatidae	*Pyrosoma atlanticum*	6
PZE	Prickly king crab	Lithodidae	*Paralomis zealandica*	1

Appendix 3 continued:

Species	Common name	Family name	Scientific name	No. of stations
RAG	Ragfish	Centrolophidae	*Pseudoicichthys australis*	1
RCH	Widenosed chimaera	Rhinochimaeridae	*Rhinochimaera pacifica*	9
RCO	Red cod	Moridae	*Pseudophycis bachus*	7
RIB	Ribaldo	Moridae	*Mora moro*	37
ROK	Rocks stones	-	Geological specimens	2
RSK	Rough skate	Rajidae	*Zearaja nasuta*	5
RSO	Gemfish	Gempylidae	*Rexea solandri*	8
RUD	Rudderfish	Centrolophidae	*Centrolophus niger*	3
SAL	Salps	-	-	4
SAW	Sawtooth eel	Serrivomeridae	*Serrivomer* spp.	2
SBK	Spineback	Notacanthidae	*Notacanthus sexspinis*	34
SBW	Southern blue whiting	Gadidae	*Micromesistius australis*	24
SCD	Smallscaled cod	Nototheniidae	*Notothenia microlepidota*	1
SCI	Scampi	Nephropidae	*Metanephrops challengeri*	3
SCO	Swollenhead conger	Congridae	*Bassanago bulbiceps*	29
SDO	Silver dory	Zeidae	*Cyttus novaezealandiae*	1
SEO	Seaweed	-	-	1
SEP	*Sergia potens*	Sergestidae	*Sergia potens*	3
SKA	Skate	-	Rajidae Arhynchobatidae (Families)	1
SMC	Small-headed cod	Moridae	*Lepidion microcephalus*	5
SMK	Spiny masking crab	Majidae	*Teratomaia richardsoni*	1
SMO	Cross-fish	Asteriidae	*Sclerasterias mollis*	1
SND	Shovelnose spiny dogfish	Centrophoridae	*Deania calcea*	20
SOR	Spiky oreo	Oreosomatidae	*Neocyttus rhomboidalis*	4
SOT	*Solaster torulatus*	Solasteridae	*Solaster torulatus*	1
SPD	Spiny dogfish	Squalidae	*Squalus acanthias*	39
SPL	*Scopelosaurus* sp	Notosudidae	*Scopelosaurus* sp.	1
SPU	False oblique hatchetfish	Sternoptychidae	*Sternoptyx pseudodiaphana*	1
SQB	*Brachioteuthis* sp	-	*Brachioteuthis* sp.	1
SQX	Squid	-	-	2
SRB	Southern rays bream	Bramidae	*Brama australis*	10
SRH	Silver roughy	Trachichthyidae	*Hoplostethus mediterraneus*	5
SSI	Silverside	Argentinidae	*Argentina elongata*	31
SSK	Smooth skate	Rajidae	*Dipturus innominatus*	4
SSM	Smallscaled brown slickhead	Alepocephalidae	*Alepocephalus antipodianus*	8
SSO	Smooth oreo	Oreosomatidae	*Pseudocyttus maculatus*	10
STO	Stomiatidae	Stomiidae	*Stomias* spp.	1
SUA	Fleshy club sponge	Suberitidae	*Suberites affinis*	13
SUM	Pelagic butterfish	Centrolophidae	*Schedophilus maculatus*	1
SWA	Silver warehou	Centrolophidae	*Seriolella punctata*	15
TAG	*Todarodes angolensis*	Ommastrephidae	*Todarodes angolensis*	22
TAM	Tam O shanter urchin	-	Echinothuriidae & Phormosomatidae	16
THO	Bottlebrush coral	Primnoidae	*Thouarella* spp.	1
TLD	Furry oval sponge	Tetillidae	*Tetilla leptoderma*	2
TOP	Pale toadfish	Psychrolutidae	*Ambophthalmos angustus*	14
TRS	Cape scorpionfish	Scorpaenidae	*Trachyscorpia eschmeyeri*	1
TTL	Bristle ball sponge	Tetillidae	*Tetilla australe*	2
VCO	Violet cod	Moridae	*Antimora rostrata*	5

Appendix 3 continued:

Species	Common name	Family name	Scientific name	No. of stations
VNI	Blackspot rattail	Macrouridae	*Lucigadus nigromaculatus*	13
VSQ	Violet squid	-	*Histioteuthis spp.*	12
VST	Variable spotted toadfish	Psychrolutidae	*Neophrynichthys heterospilos*	1
WHU	Whale bone (unspecified)	-	-	2
WHX	White rattail	Macrouridae	*Trachyrincus aphyodes*	5
WOD	Wood	-	Wood	1
WWA	White warehou	Centrolophidae	*Seriolella caerulea*	23
YBO	Yellow boarfish	Pentacerotidae	*Pentaceros decacanthus*	1
ZAS	Velvet dogfish	Somniosidae	*Zameus squamulosus*	2
ZOR	Rat-tail star	Zoroasteridae	*Zoroaster spp.*	15
ZVA	*Thetys vagina*	Salpidae	*Thetys vagina*	4

APPENDIX 4: Species code changes or combined species groupings

Combined species names or groups	Species code	Notes
Giant stargazer	GIZ	STA, GIZ
Gemfish	RSO	SKI, RSO
Tarakihi	NMP	TAR, NMP
Combined Catfish	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