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Tini a Tangaroa

Trawl survey of hoki and middle-depth species in the Southland and Sub-Antarctic areas, November–December 2024 (TAN2413)

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PLAIN LANGUAGE SUMMARY

This report provides results from the 21st summer trawl survey of hoki, hake, and ling in the Sub-Antarctic carried out from 23 November to 23 December 2024. Seventy-three of the 78 planned stations were completed.

When compared with the previous survey in 2022, biomass estimates in the core survey area (200–800 m depths) were up by 62% for hoki, up by 1% for ling, and up by 23% for hake. The precision target for hoki was not met but targets were met for ling and hake.

The hoki length and age distributions were mainly adult fish, very few 2+ fish were present (2022 year class, 45–58 cm), but there was a small yet distinct cohort of 1+ fish. The strong cohort of 1+ hoki from 2020 are still present as 5+ fish. The hake and ling length and age distributions were broad, with few juvenile fish.

The acoustic estimate of midwater fish abundance in 2024 was lower than that in 2022 and below the average of the time series.

A total of 240 species or species groups were caught and 30 740 fish, chondrichthyans, or squid of 90 different species were measured. Weights were taken from 12 167 individuals. For all species caught on the survey, abundance estimates and other data are available online at the Trawl Survey Information Portal https://tsip-uat.niwa.co.nz/home.

EXECUTIVE SUMMARY

MacGibbon, D.J.[1]; Ballara, S.L.; Escobar-Flores, P.C.; Barnes, T.C. (2025). Trawl survey of hoki and middle-depth species in the Southland and Sub-Antarctic areas, November–December 2024 (TAN2413).

***New Zealand Fisheries Assessment Report 2025/43*. 63 p.**

The 21st RV *Tangaroa* trawl survey of the Sub-Antarctic summer series was conducted from 23 November to 23 December 2024. Previous summer surveys were in 1991–93, 2000–09, 2011, 2012, 2014, 2016, 2018, 2020, and 2022. Species monitored by the trawl survey include important commercial species such as hoki, hake, and ling, as well as a wide range of non-commercial fish and invertebrate species. A total of 73 of the 78 planned phase one stations were completed in 20 strata. There was insufficient time to complete all planned phase one stations, or any phase two stations, due to bad weather, but all strata were surveyed.

Biomass estimates and coefficients of variation (CVs) for all strata (300–1000 m) for hoki were 80 631 t (22.0%), for ling 24 946 t (8.1%), and for hake 1553 t (16.2%). For the core strata (300–800 m), the hoki biomass was 80 044 t (22.2%), the ling biomass was 24 936 t (8.1%), and the hake biomass was 1205 t (19.9%). Hoki biomass increased by 62% from 2022; the 2024 estimate was the fourth highest in the time series and the highest estimate since the early 1990s. The abundance estimates for ling and hake in core strata were 1% and 23% higher respectively than those in 2022.

The hoki length frequency in 2024 was dominated by adult fish with a weak mode of 1+ fish (2023 year class, fish under 45 cm) and few 2+ fish (2022 year class, 45–58 cm). Most male hoki were between 1 and 11 years old and most females between 1 and 15 years old. The strong 1+ hoki year class observed in 2020 were still dominant in 2024 as 5+ fish. The hake length distribution was broad, with few males over 90 cm and few females over 120 cm. Most male hake were between 3 and 6 years old and most females between 3 and 17 years old. The ling length distribution was also broad, with few males over 100 cm and few females over 120 cm. Most ling were between 4 and 20 years old.

Acoustic data were collected during the trawl survey. The overall acoustic index of mesopelagic fish abundance was lower than that in 2022, and below the average of the time series. There was a statistically significant positive correlation between acoustic density from demersal marks and trawl catch rates.

As well as supporting the stock assessments for hoki, hake, and ling, the trawl survey provides information on a number of bycatch species. Abundance estimates and other information from all species caught on the survey are available online on the Trawl Survey Information Portal https://tsip-uat.niwa.co.nz/home. In 2024, a total of 240 species or species groups were caught and 30 740 fish, chondrichthyans, or squid of 90 different species were measured. Individual weights from 12 167 fish were taken. The liver condition of 1076 hoki was recorded. Otoliths were collected from 1204 hoki, 337 hake, and 958 ling.

1. INTRODUCTION

Trawl surveys of the Southland and Sub-Antarctic region (often collectively referred to as the 'Southern Plateau' or 'Sub-Antarctic') provide fishery-independent abundance indices for hoki (*Macruronus novaezelandiae*), hake (*Merluccius australis*), and ling (*Genypterus blacodes*). Hoki is New Zealand's largest fishery, with a current annual commercial catch limit of 110 000 tonnes (t). The Southland and Sub-Antarctic region is thought to be the principal residence area for the hoki that spawn off the west coast of the South Island (WCSI) in winter ('western' stock). Annual catches of hoki from the Southern Plateau (including Puysegur) peaked at over 35 000 t in 1999–2000 to 2001–02, but have been variable since, ranging from around 6000 to 20 000 t over the past 20 years (Fisheries New Zealand 2025). Hoki are managed as a single stock throughout the Exclusive Economic Zone (EEZ), but there is an agreement to split the catch between western and eastern areas. The current agreed catch limit for hoki from western areas is 45 000 t, with the remaining 65 000 t allocated to the eastern fishery (Fisheries New Zealand 2025). Hake and ling are also important commercial species in Southland and the Sub-Antarctic. The catch of hake in the southern areas in 2023–24 was 945 t (HAK 1, includes the western Chatham Rise). Catches of ling in southern areas were 4763 t (LIN 5, Southland), and 4414 t (LIN 6, Sub-Antarctic) (Fisheries New Zealand 2025).

Two time series of trawl surveys have been carried out from RV *Tangaroa* in the Southland and Sub-Antarctic region (subsequently referred to as the Sub-Antarctic survey series): a summer series in November–December 1991–93, 2000–09, 2011, 2012, 2014, 2016, 2018, 2020, and 2022; and an autumn series in March–June 1992, 1993, 1996, and 1998 (see reviews by O'Driscoll & Bagley 2001, Bagley et al. 2013a). The main focus of the early surveys (1991–93) was to estimate the abundance of hoki. The surveys in 1996 and 1998 were developed primarily for hake and ling. The autumn season was chosen for these species because the biomass estimates were generally higher and more precise at that time of year. Autumn surveys also allowed the proportion of maturing hoki to be estimated (Livingston et al. 1997, Livingston & Bull 2000). However, interpretation of trends in the autumn trawl survey series was complicated by the possibility that different proportions of the hoki adult biomass may have already left the survey area to spawn. The timing of the trawl survey was moved back to November–December in 2000 to obtain an estimate of total adult hoki biomass at a time when abundance should be at a maximum in the Sub-Antarctic area.

Hoki biomass estimates from the four summer surveys in 2003 to 2006 were the lowest observed in either the summer or autumn Sub-Antarctic trawl time series. Hoki abundance estimates increased threefold between the 2006 and 2007 trawl surveys (Bagley et al. 2009). This biomass increase was sustained in 2008 (O'Driscoll & Bagley 2009), with further increases in 2009 (Bagley & O'Driscoll 2012) and 2012 (Bagley et al. 2014). The estimated hoki biomass from the 2014 survey decreased by 43% from 2012, the lowest since 2006 (Bagley et al. 2017), and this was interpreted by the 2016 hoki assessment model as observation error. There is some evidence for variable catchability in this survey series (O'Driscoll et al. 2015). Past hoki assessments had been unable to fit the observations well and this led to relatively high process error being estimated for the Sub-Antarctic trawl surveys by the assessment model (McKenzie 2019). However, the model has since been revised and the more recent assessment did not have difficulty fitting observations from the Southern Plateau surveys; inputs from the time series (proportions at age and abundance indices) were important for understanding the overall western stock (McGregor et al. 2022, McGregor & Langley 2025).

Other middle depth species are monitored by this survey time series, including commercial species such as hake, ling, lookdown dory (*Cyttus traversi*), and ribaldo (*Mora moro*), as well as a wide range of non-commercial fish and invertebrate species. For most of these species, the trawl survey is the only fisheries-independent estimate of abundance in the Sub-Antarctic, and the survey time series fulfils an important 'ecosystem monitoring' role (e.g., Tuck et al. 2009), as well as providing inputs into single-species stock assessments. A review of all the summer Sub-Antarctic *Tangaroa* trawl survey time series to 2009 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). Biomass estimates and catch rate distribution plots for all species are available on NIWA's Trawl Survey Information Portal https://tsip-uat.niwa.co.nz/home, as are length frequency distributions for those species that are measured.

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), to estimate abundance of mesopelagic fish (McClatchie & Dunford 2003, O'Driscoll et al. 2009, 2011, Bagley & O'Driscoll 2012, Bagley et al. 2013b, 2014, 2017, O'Driscoll et al. 2018, MacGibbon et al. 2019, Stevens et al. 2022, 2024 Escobar-Flores et al. 2022), and to support ecosystem studies in the Sub-Antarctic region (Roberts et al. 2022). 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 the Sub-Antarctic is a high priority for providing information required to update the assessment of hoki and other middle depth species. The survey is currently carried out biennially. The 2024 survey provided the twenty-first summer estimate of western hoki biomass, in time to be used in the 2025 hoki stock assessment (McGregor-Tiatia & Langley in prep.).

1.1 Project objectives

This report is the final reporting requirement for the 2024 Sub-Antarctic survey that comes under Fisheries New Zealand Research Project MID2021-02.

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 2022, 2024).

The specific objectives are as follows:

1. To carry out a trawl survey in December 2024 to continue the time series of relative abundance indices for hoki (HOK 1), hake (HAK 1), and ling (LIN 5 and 6) on the Southern Plateau.

2. To collect data for determining the population age, size structure, and reproductive biology of hoki, hake, and ling and other middle depth species on the Southern Plateau.

3. To collect acoustic and related data during the trawl survey.

4. To collect and preserve specimens of unidentified organisms taken during the trawl survey for later identification 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 RV *Tangaroa* using the same trawl gear and protocols used for previous surveys.

The 2024 survey was carried out from 23 November to 23 December 2024 and followed a two-phase stratified random design (after Francis 1984). The survey area was divided into 20 strata by area and depth (300–600, 600–800, and 800–1000 m) (Figure 1). There are 17 core strata ranging in depth from 300–800 m that have been surveyed in all previous summer and autumn surveys (Table 1). Strata 3 and 5 were subdivided in 2000 to increase the coverage in the region where hake and ling aggregations were thought to occur (Bull et al. 2000). Deeper 800–1000 m strata (strata 25–28) have been surveyed since 1996. Stratum 26, at 800–1000 m depth, south of Campbell Island, was dropped in 2012 due to a reduction in the number of survey days. There is also no 800–1000 m stratum along the eastern side of the survey area because catches of hoki, hake, and ling from the adjacent strata are small. Known areas of extensive foul ground were excluded from the survey. Three trawls were conducted in the Campbell East Deep Benthic Protection Area (BPA). Written approval to sample within this BPA was granted by Fisheries New Zealand (dated 16 October 2024).

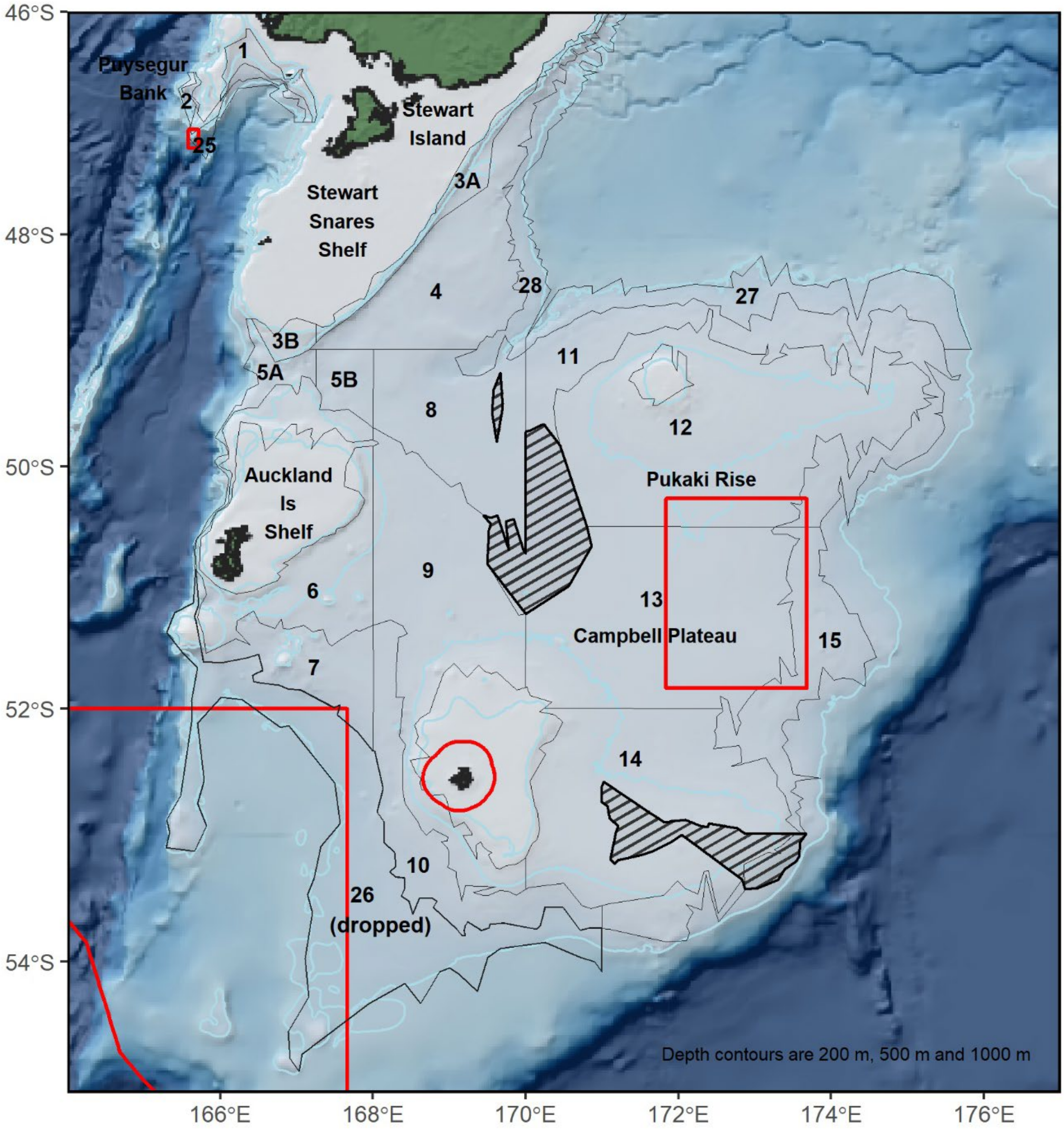

Figure 1: Stratum boundaries from the November–December 2024 Sub-Antarctic trawl survey. Stratum areas are given in Table 1. Red boxes are Benthic Protection Areas.

The allocation of stations in phase one 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 2007–2022 surveys because these better reflect recent changes in hoki distribution and abundance. Allocations of stations for hake and ling were based on all surveys from 2000–2022. A minimum of three stations per stratum was specified. As in previous years, conservative target coefficients of variation (CVs) of 17% for hake and 12% for hoki and ling were used in the statistical analysis to increase the chance that past Fisheries New Zealand target CVs of 20% for hake and 15% for both hoki and ling would be met (no formal CVs were specified by Fisheries New Zealand at the tendering stage of this project). This resulted in a total of 78 stations being planned for phase one (Table 1). Seventy-two stations were required to meet the target CVs and an additional six stations were added (one each in strata 3b, 4, 5a, 5b, 12, and 28) outside of the statistical framework because of the need to focus effort on covering the full distributional range of hake age classes.

Table 1: Stratum areas, depths, phase one allocations, and number of successful biomass stations from the November–December 2024 Sub-Antarctic trawl survey. Stratum boundaries are shown in Figure 1 and station positions are plotted in Figure 2.

Stratum	Name	Depth (m)	Area (km^2)	Phase 1 allocation	Total completed
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 Island	300–600	16 682	3	3
7	South Auckland	600–800	8 497	3	3
8	N.E. Auckland	600–800	17 294	4	3
9	N. Campbell Island	300–600	27 398	4	3
10	S. Campbell Island	600–800	11 288	3	3
11	N.E. Pukaki Rise	600–800	23 008	4	4
12	Pukaki	300–600	45 259	6	4
13	N.E. Camp. Plateau	300–600	36 051	4	4
14	E. Camp. Plateau	300–600	27 659	3	3
15	E. Camp. Plateau	600–800	15 179	3	2
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 Island	800–1 000	8 336	4	4
Total			288 417	78	73

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 long headline, and 60 mm codend mesh. The trawl doors were Super Vee type with an area of 6.1 m^2.

2.3 Trawling procedure and biological sampling

Random trawling followed the standardised procedures described by Hurst et al. (1992). Station positions were generated randomly before the voyage using NIWA's RandomStation program (Francis & Fu 2012). A minimum distance between tows of 3 nautical miles (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 the next most practical station was substituted. Random bottom tows were only carried out during daylight hours, with all random tows carried out between 0446 h and 2057 h New Zealand Standard Time (NZST). At each station, the trawl was towed for 3 n. miles at a speed over the ground of 3.5 knots. If foul ground was encountered, or the trawl was hauled early due to reducing daylight or strong marks on the net monitor potentially indicating a large catch, the tow was included as valid only if the tow distance was at least 2 n. miles. If time ran short at the end of the day and it was not possible to reach the last station, the vessel headed towards the next station and the trawl was shot on that course before 1900 h NZST, if at least 50% of the steaming distance to that station had been covered.

Measurements of doorspread and headline height (from a Simrad TV80 Trawl Eye net monitoring system) and vessel speed (GPS speed over the ground, cross checked against distance travelled during the tow) were recorded every five minutes during each tow and average values were calculated. Towing speed and gear configuration for tows were maintained as constant as possible during the survey, following the guidelines given by Hurst et al. (1992).

From each tow, all items in the catch were sorted and weighed on Marel motion-compensating electronic scales, accurate 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 hoki, hake, and ling and up to 100 individuals of other commercial and some common non-commercial species were measured and sex-determined where possible from every successful tow. More detailed biological data were also collected on a subset of species and included fish weight, length, sex, and on occasions gonad stage, and gonad weight on up to 20 individuals per tow. Stomach fullness stomach contents, and prey condition were also recorded for up to 20 hoki, hake, and ling per tow. Otoliths were taken from hake, hoki, and ling for age determination. A description of the macroscopic gonad stages used for teleosts 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 6-second intervals throughout the trawl, providing vertical profiles. Surface values were read off the vertical profile at the beginning of each tow at a depth of about 5 m, which corresponded to the depth of the hull temperature sensor used in surveys prior to CTDs being mounted on the trawl. Bottom values were from about 7 m above the seabed (i.e., the height of the trawl headline above the seabed).

Acoustic data were collected during trawling and while steaming between trawl stations (day and night) with the RV *Tangaroa* combination of EK60 and EK80 echosounders operating at five frequencies (18, 38, 70, 120, and 200 kHz) with hull-mounted transducers. The 70 kHz echosounder was an EK80 system operated in FW (frequency modulated) mode, whereas all other frequencies were EK60 systems operated in CW (continuous wave) mode. All frequencies were regularly calibrated following standard procedures (Demer et al. 2015), with the most recent calibration on 22 July 2024 in Tasman Bay west of Greville Harbour. The time-series of system and calibration parameters are given in Appendix 3 of Devine et al. (2025).

2.5 Trawl data analysis

Doorspread biomass was estimated by the swept area method of Francis (1981, 1989) using *R-SurvCalc*, an updated version of the C++ trawl survey analysis program *SurvCalc* (Francis 2009) implemented in the R-programming language. Total survey abundance was estimated for all species in the catch. Only data from random trawl tows where the gear performance was satisfactory were included for estimating abundance. Survey biomass and CV by stratum were estimated for all species caught and are available online on the Trawl Survey Information Portal https://tsip-uat.niwa.co.nz/home

Scaled length frequencies for hake, hoki, and ling were calculated with *R-SurvCalc* using length-weight parameters derived from data collected on this survey. The same was done for other species for the

Trawl Survey Information Portal, where possible. Where there were insufficient data (i.e., fewer than 50 fish weighed, the estimated r^2 of the length-weight regression less than 90%, or the length range of fish was too narrow), length-weight data from all Sub-Antarctic summer surveys combined were used. Length-weight parameters used to scale hake, hoki, and ling length frequencies are given in Table 2.

Table 2: Length-weight regression parameters* used to scale length frequencies for hake, hoki, and ling for the 2024 survey. $W = aL^b$ where W is weight (g) and L is length (cm); r^2 is the correlation coefficient, N is the number of samples.

Common name	a	b	r^2	N	Length range	Source
Hake	0.002851	3.210394	97.69	333	50.0–128.4	This survey
Hoki	0.004597	2.894428	96.58	1204	35.0–118.7	This survey
Ling	0.001309	3.290232	96.30	1106	34.3–139.3	This survey

Sub-samples of hoki and ling otoliths and all available hake otoliths were selected for ageing. Hoki, ling, and hake otoliths were prepared and aged using validated ageing methods (hoki, Horn & Sullivan (1996) as modified by Cordue et al. (2000); ling, Horn (1993); hake, Horn (1997)). Ageing was carried out under Fisheries New Zealand research project MID2021-01. Numbers-at-age were calculated from observed length frequencies from successful random tows and age-length keys using custom NIWA catch-at-age software (Bull & Dunn 2002). For hoki, this software also applied the ‘consistency scoring’ method of Francis (2001), which uses otolith ring radii measurements to improve the consistency of age estimation. Sub-samples for hoki and ling were derived by randomly selecting otoliths from each of a series of 1 cm length bins covering the bulk of the catch, and then systematically selecting additional otoliths to ensure the tails of the length distribution were represented. The chosen sample size approximates that necessary to produce a mean weighted CV of less than 20% across all age classes.

2.6 Acoustic data analysis

Quantitative analysis was based on 38 kHz acoustic data from daytime trawl and night steam recordings. The 38 kHz data were used as this frequency was the only one available (other than uncalibrated 12 kHz data) for surveys before 2008 that used the old CREST acoustic system (Coombs et al. 2003). Analysis was carried out using the custom analysis software ESP3 (Ladroit et al. 2020). The calibration parameters used for analysis of 38 kHz data were obtained from the July 2024 calibration, with transducer peak gain G_0 = 26.66 dB and corrective factor Sa_{corr} = -0.59 dB (Devine et al. 2025).

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 m^2 scaled by 10^6) 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) 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 2024. The methods were the same as those used by O’Driscoll et al. (2015, 2018), MacGibbon et al. 2019, and Stevens et al. (2022). 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 73 successful trawl survey stations were completed in 20 strata (Table 1, Figure 2). There was insufficient time for any phase two stations to be carried out, and time constraints due to bad weather meant that five of the planned phase one stations were not completed. However, all strata were surveyed.

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

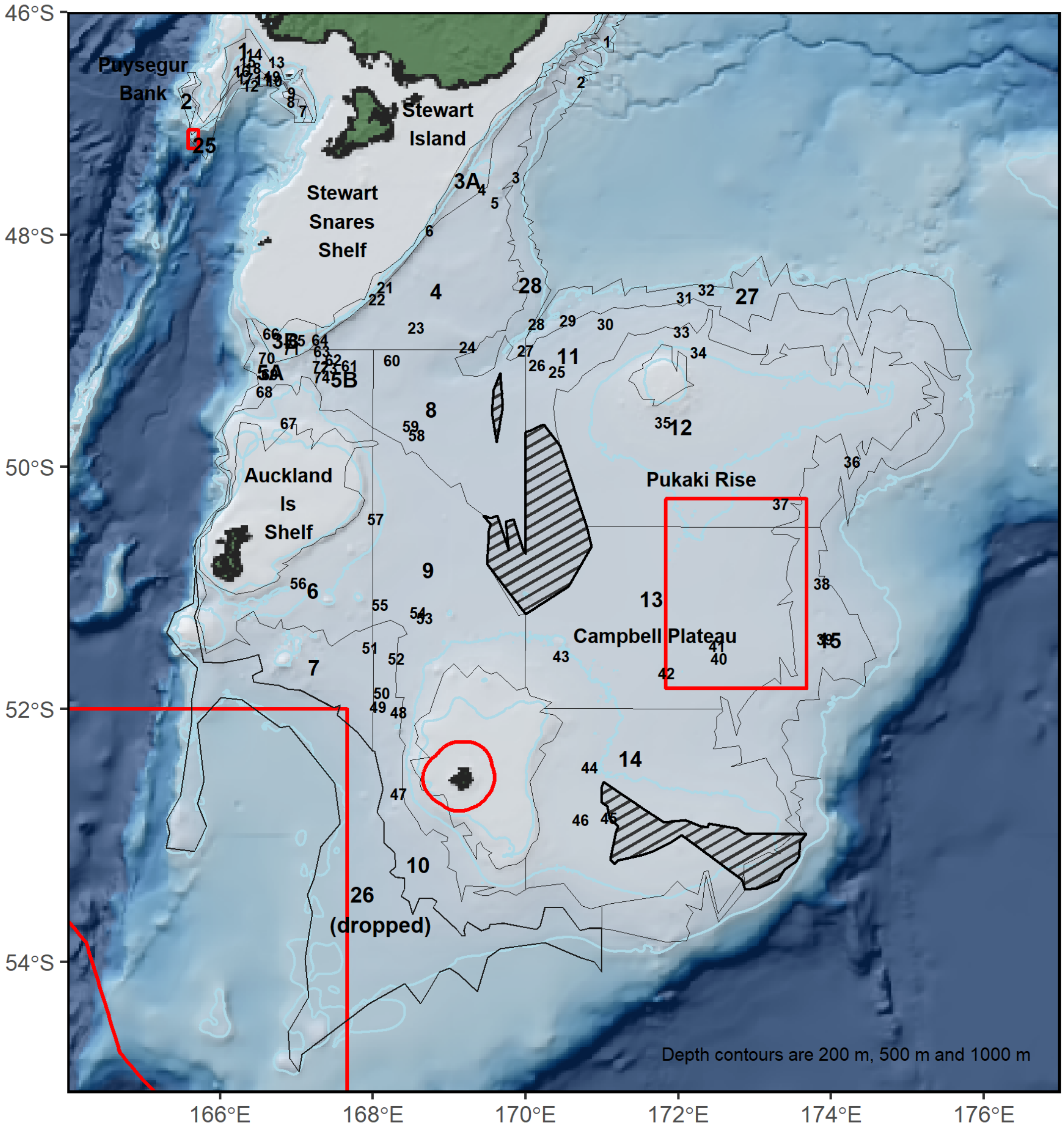

Figure 2: Valid trawl station start positions from the November–December 2024 Sub-Antarctic trawl survey. Labels show station numbers. Station details are given in Appendix 2.

3.2 Gear performance

Gear parameters by depth for valid trawl survey tows are summarised in Table 3. Doorspread and headline height were obtained for all successful tows using the Simrad TV80 Trawl Eye net monitoring system.

The mean headline height of 6.7 m was within the range of means (6.5–7.4 m) obtained on other voyages of *Tangaroa* in this area using the same gear (Table 4). Doorspread values were within values seen on past surveys (Table 4).

Table 3: Survey tow and gear parameters (recorded values only) from the November–December 2024 Sub-Antarctic trawl survey. Values are number of tows (n), and the mean, standard deviation (s.d.), and range of observations for each parameter.

	Depth of bottom (m)	n	Mean	s.d.	Range
Tow parameters					
Tow length (n. miles)		73	3	0.17	2.2–3.1
Tow speed (knots)		73	3.5	0.04	3.3–3.6
Gear parameters (m)					
Headline height	300–600	29	6.7	0.28	6.1–7.3
	600–800	32	6.7	0.18	6.2–7.0
	800–1 000	12	6.8	0.09	6.6–6.9
	All depths	73	6.7	0.21	6.1–7.3
Doorspread	300–600	29	121.7	7.27	104.3–130.6
	600–800	32	122.2	5.08	111.4–130.1
	800–1 000	12	123.9	3.02	120.2–131.7
	All depths	73	122.3	5.79	104.3–131.7

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

	Doorspread (m)					Headline height (m)	
Survey	*n*	Mean	S.D.	Min	Max	Mean	S.D.
1991	152	126.5	7.05	106.5	145.5	6.6	0.31
1992	127	121.4	6.03	105.0	138.4	7.4	0.38
1993	138	120.7	7.14	99.9	133.9	7.1	0.33
2000	68	121.4	5.22	106.0	132.4	7.0	0.20
2001	95	117.5	5.19	103.5	127.6	7.1	0.25
2002	97	120.3	5.92	107.0	134.5	6.8	0.14
2003	13	123.1	3.80	117.3	129.7	7.0	0.22
2004	85	120.0	6.11	105.0	131.8	7.1	0.28
2005	91	117.1	6.53	104.0	134.4	7.2	0.22
2006	85	120.5	4.82	104.0	129.7	7.0	0.24
2007	94	114.3	7.43	97.5	130.8	7.2	0.23
2008	92	115.5	5.05	103.8	128.3	6.9	0.22
2009	81	116.6	7.07	93.8	129.7	7.0	0.21
2011	95	120.0	6.39	101.2	133.2	6.9	0.26
2012	91	116.8	6.77	99.3	130.1	7.1	0.30
2014	86	122.6	6.62	106.5	133.9	7.0	0.20
2016	56	124.3	5.64	111.5	139.7	6.9	0.27
2018	82	122.3	5.89	109.6	134.2	6.5	0.28
2020	72	121.8	8.34	101.0	135.1	7.1	0.33
2022	74	121.3	4.71	112.1	129.8	6.9	0.33
2024	73	122.3	5.79	104.3	131.7	6.7	0.21

3.3 Catch

The top 50 species by catch weight and the total weight of all species caught (including those not in the top 50) is given in Table 5. A total of 49.0 t was caught, and the top 50 species by catch weight accounted for 98.6% of this. A total of 240 species or species groups were caught, of which 108 were teleosts, 26 were chondrichthyans, 23 were squids or octopuses, 24 were crustaceans, and the remainder comprised assorted benthic and pelagic animals (see Appendix 3 for a complete list of species or species groups caught and their frequency of occurrence). Of the total catch from all trawls, hoki accounted for 27.8%, ling 12.0%, and hake 2.0% (Table 5). Other abundant Quota Management System (QMS) species were spiny dogfish at 7.8%, dark ghost shark at 4.2%, gemfish at 3.7%, pale ghost shark at 3.2%, and black oreo at 3.1%. The most abundant non-QMS species were shovelnose dogfish at 8.1%, javelinfish at 6.0%, and leaf scale gulper shark at 1.5% (Table 5).

Table 5: Total catch of the top 50 species from all tows during the 2024 survey. NB: 'Total' is the total catch of all species caught on the survey.

Species	Common name	Scientific name	Catch (kg)
HOK	Hoki	*Macruronus novaezelandiae*	13 627.5
LIN	Ling	*Genypterus blacodes*	5893.3
SND	Shovelnose spiny dogfish	*Deania calceus*	3987.7
SPD	Spiny dogfish	*Squalus acanthias*	3816.6
JAV	Javelin fish	*Lepidorhynchus denticulatus*	2937.3
GSH	Dark ghost shark	*Hydrolagus novaezealandiae*	2075.5
RSO	Gemfish	*Rexea solandri*	1793.4
GSP	Pale ghost shark	*Hydrolagus bemisi*	1566.9
SSO	Smooth oreo	*Pseudocyttus maculatus*	1502.7
SBW	Southern blue whiting	*Micromesistius australis*	1045.8
HAK	Hake	*Merluccius australis*	989.4
BOE	Black oreo	*Allocyttus niger*	714.4
CSQ	Leafscale gulper shark	*Centrophorus squamosus*	711.1
CYP	Longnose velvet dogfish	*Centroscymnus crepidater*	659.6
ETB	Baxter's lantern dogfish	*Etmopterus granulosus*	529.8
MCA	Ridge scaled rattail	*Macrourus carinatus*	512.5
GIZ	Giant stargazer	*Kathetostoma giganteum*	498.1
SWA	Silver warehou	*Seriolella punctata*	486.1
RIB	Ribaldo	*Mora moro*	456.7
COL	Oliver's rattail	*Coelorinchus oliverianus*	423.1
HYA	Floppy tubular sponge	*Hyalascus* sp.	305.6
LDO	Lookdown dory	*Cyttus traversi*	299.7
CFA	Banded rattail	*Coelorinchus fasciatus*	271.3
CBO	Bollons' rattail	*Coelorinchus bollonsi*	267.5
WWA	White warehou	*Seriolella caerulea*	245.6
MIQ	Warty squid	*Moroteuthopsis ingens*	234.8
CSU	Four-rayed rattail	*Coryphaenoides subserrulatus*	224.3
SBK	Spineback	*Notacanthus sexspinis*	221.8
NOS	NZ southern arrow squid	*Nototodarus sloanii*	157.4
SSM	Smallscaled brown slickhead	*Alepocephalus antipodianus*	154.4
SSI	Silverside	*Argentina elongata*	139.8
RCH	Widenosed chimaera	*Rhinochimaera pacifica*	130.9
SCO	Swollenhead conger	*Bassanago bulbiceps*	120.6
CAS	Oblique banded rattail	*Coelorinchus aspercephalus*	115.8
LCH	Long-nosed chimaera	*Harriotta raleighana*	106.6
SSK	Smooth skate	*Dipturus innominatus*	106.6
BEE	Basketwork eel	*Diastobranchus capensis*	99.1
HCO	Hairy conger	*Bassanago hirsutus*	93.8
ETL	Lucifer dogfish	*Etmopterus lucifer*	88.3
WHX	White rattail	*Trachyrincus aphyodes*	87.0
MAN	Finless flounder	*Neoachiropsetta milfordi*	85.1
RUD	Rudderfish	*Centrolophus niger*	78.5
SRB	Southern Ray's bream	*Brama australis*	77.3
ORH	Orange roughy	*Hoplostethus atlanticus*	75.1
MRQ	Warty squid	*Onykia robsoni* & *O.* n. sp. 'splendens'	71.8
BJA	Black javelinfish	*Mesovagus antipodum*	66.6
TAG	*Todarodes angolensis*	*Todarodes angolensis*	61.9
HPC	Sea perch	*Helicolenus percoides*	55.6
SCH	School shark	*Galeorhinus galeus*	46.4
DEA	Dealfish	*Trachipterus trachypterus*	43.0
Total (of *all* species caught)			49 002.1

A total of 163.8 kg of specimens were collected for various projects, including:

- 237 sample lots of squids and fish heads for scanning (AUT)
- 68 sample lots of various grenadier species (whole or tissue sample) (PhD study)

- 12 sample lots of sharks for taxonomic resolution
- 12 sample lots of toadfish (diet study)
- 62 sample lots of mesopelagic fishes for population genetics and fish and otolith reference libraries
- 38 sample lots of octopus species for taxonomic resolution
- 9 sample lots of fish species for University of Victoria courses
- 4 sample lots of southern Ray's bream tissue for taxonomic resolution
- 6 sample lots of basketwork eel tissue for genetic studies (CSIRO)

Five leaf scale gulper sharks were also tagged with satellite tags and released to improve knowledge of distribution and movement.

An additional oblique tow using a fine-meshed mesopelagic trawl was carried out in the Solander Trough on 1 December. This was carried out after completing all strata at Puysegur Trench during the transit back to the main survey area. It did not cost any time to the contracted survey objectives as there would have been insufficient time to carry out any trawls in daylight hours after arriving back at the main survey ground. This trawl was done to increase our understanding of the trophic relationships of mesopelagic fish, obtain specimens for the New Zealand fish otolith atlas, collect rare specimens for Te Papa and the NIWA Invertebrate collection (NIC), and collect specimens for barcoding for work ground-truthing acoustic data using alternate techniques. A total of 8.6 kg was caught in the mesopelagic trawl. This is included in the total catch weight in Table 5 but is not included in abundance estimates for the trawl survey.

3.4 Trawl survey abundance estimates

Abundance estimates and catch for the core strata (300–800 m depth range) and for all strata (300–1000 m) are given in Table 6 for hoki, hake, and ling. Estimated abundance and coefficients of variation (CVs in parentheses) for core strata were 80 043.8 t (22.2%) for hoki, 1205.1 t (19.9%) for hake, and 24 935.6 t (8.1%) for ling. Target CVs of 15% were not met for hoki but were for ling. The target CV of 20% for hake was met. Estimated abundance and CVs (in parentheses) for all strata were 80 631.0 t (22.0%) for hoki, 1553.2 t (16.2%) for hake, and 24 946.2 t (8.1%) for ling. Abundance estimates and CVs of all other species caught on the survey are available on NIWA's Trawl Survey Information Portal https://tsip-uat.niwa.co.nz/home and summarised in Section 3.4.1 for some of the important non-target species.

Table 6: Catch (kg) and abundance estimates (t) of hoki, hake, and ling from core strata (300–800 m) and all strata (300–1000 m), with coefficient of variation (CV, in parentheses).

		Catch (kg)		Biomass (t)	
Common name	Code	Core	All	Core	All
Hoki	HOK	13 323.0	13 627.5	80 043.8 (22.2)	80 631.0 (22.0)
Hake	HAK	408.1	989.4	1 205.1 (19.9)	1 553.2 (16.2)
Ling	LIN	5 873.9	5 893.3	24 935.6 (8.1)	24 946.2 (8.1)

Abundance estimates by stratum are given in Table 7 and plotted in Figure 3 for hoki, hake, and ling. Hoki were spread over the core survey area but just over half came from strata 4 and 9 (Stewart-Snares Shelf, north Campbell Island) although a number of other strata also caught substantial amounts of hoki. Strata 3A, 3B, and 4 (Stewart Snares shelf) accounted for 31% of the hoki abundance in 2024, compared with just 8% in 2022, and 24% in 2020. The western Campbell Plateau (strata 9 and 10), Pukaki Rise (strata 11 and 12), and eastern Campbell Plateau (strata 13–15) contributed 32%, 7%, and 8% of the estimated hoki biomass in 2024, respectively, compared with 27%, 16%, and 14% in 2022. Hoki were also caught in all 800–1000 m strata but contributed less than 1% of the total biomass for all strata (Table 7).

Ling were caught in all core strata, although strata 6, 8, 9, and 12 accounted for just over half of the biomass in 2024. Other strata also contributed substantially, with another 25% coming from strata 3A, 4, 7, and 13. The 300–600 m strata accounted for 63% of the ling biomass. Only a further 11 t came from the 800–1000 metre stratum, all from stratum 25 at Puysegur.

In core depths, hake were mainly caught in stratum 4 (600–800 m) and stratum 6 (300–600 m). Stratum

9 (300–600 m) and stratum 11 (600–800 m) also contributed substantially but from one off catches so the associated stratum CVs are 100%. These four strata account for just over half of the total core hake biomass of 1205 t. No hake were caught in strata 12 or 13. A further 316 t were estimated from stratum 25 at Puysegur (800–1000 m), and 33 t from stratum 28 (800–1000 m, east of Stewart Island).

Table 7: Estimated biomass (t) and CVs (%, in parentheses) by stratum for hoki, hake, and ling for the 2024 survey. Subtotals include biomass calculated from survey for core strata (0001–0015), core including Puysegur (0001–0015, 0025), and total (0001–0015, 0025, 0027–0028).

			Species
Stratum	Hoki	Hake	Ling
0001	387 (68.9)	12 (100.0)	929 (26.3)
0002	129 (45.0)	46 (62.8)	227 (40.2)
003A	2 247 (67.9)	27 (79.6)	1 482 (29.2)
003B	155 (58.3)	3 (100.0)	70 (39.1)
0004	22 715 (61.9)	237 (38.3)	1 477 (66.8)
005A	1 276 (22.6)	95 (44.0)	623 (21.6)
005B	1 038 (26.4)	60 (26.2)	434 (35.2)
0006	4 707 (83.6)	195 (25.8)	2 091 (51.5)
0007	2 788 (11.1)	58 (60.6)	1 412 (0.9)
0008	6 657 (12.9)	87 (100.0)	3 027 (19.7)
0009	18 416 (49.4)	122 (100.0)	5 100 (13.2)
0010	7 129 (50.4)	74 (51.6)	745 (34.2)
0011	1 980 (30.5)	100 (100.0)	710 (30.3)
0012	3 941 (35.2)	-	2 549 (25.0)
0013	2 329 (25.8)	-	1 740 (22.5)
0014	2 738 (20.8)	89 (100.0)	1 632 (6.1)
0015	1 412 (19.3)	-	689 (56.9)
Subtotal (core)	80 044 (22.2)	1 205 (19.9)	24 936 (8.1)
0025	99 (37.0)	316 (22.9)	253 (45.6)
Subtotal (core plus Puys)	80 143 (22.1)	1 521 (16.4)	13 355 (12.8)
0027	187 (63.1)	-	161 (73.5)
0028	302 (53.8)	33 (64.7)	572 (65.9)
Total	80 631 (22.0)	1 553 (16.1)	14 089 (12.4)

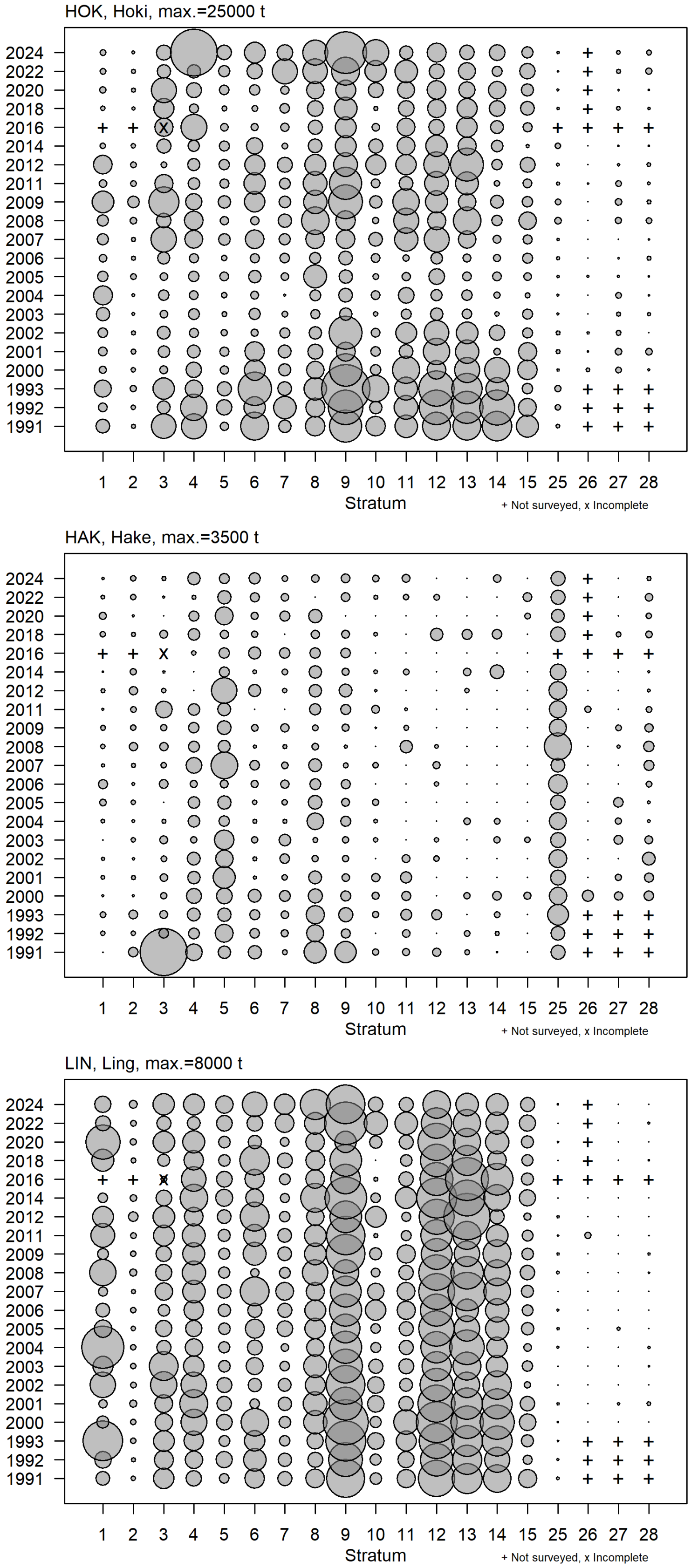

Figure 3: Relative biomass estimates by stratum for hoki, hake, and ling sampled from the Sub-Antarctic November–December *Tangaroa* summer time-series. +, stratum not surveyed in that year. Strata 3A and 3B were combined into stratum 3 and, in 2016, ×; stratum 3A was not sampled.

Core trawl estimates from 2024 were compared with those from previous surveys in the summer Sub-Antarctic time series in Table 8 and Figure 4. The core hoki biomass estimate was 62% higher than the 2022 estimate (which was 31% higher than the 2020 estimate). The 2024 core hoki abundance estimate was the fourth highest estimate in the time series and was similar to the first three estimates from 1991 to 1993, albeit with lower precision at 22.2% compared with 6.1–9.2% in the early 1990s (Figure 4, Table 8).

The core ling biomass estimate in 2024 was slightly higher (1%) than the 2022 estimate. The last four estimates were the among the lowest in the time series and similar to those from 2007 to 2011. The core estimate for hake in 2024 was 23% higher than the 2022 estimate (which was the lowest in the time-series) and is more similar to the 2020 and 2018 estimates. Hake abundance has fluctuated somewhat over the time series but has remained relatively stable and low since 2014.

Table 8: Time series of trawl abundance estimates (t) and coefficients of variation (% in parentheses) for hoki, hake, and ling for the core strata (300–800 m) and all strata (300–1000 m) from the summer *Tangaroa* time series. Biomass estimates from 2016 are scaled to account for missing strata. – indicates zero biomass or not calculated (all strata in 2016).

	Hoki		Hake		Ling	
Year	Core	All	Core	All	Core	All
1991	81 630.7 (6.82)	81 815.5 (6.81)	6 133.8 (47.45)	6 446.6 (45.19)	24 394.5 (6.76)	24 433.5 (6.75)
1992	88 053.2 (6.1)	88 383.6 (6.08)	1 859.5 (12)	2 146.4 (11.75)	21 633.1 (6.19)	21 651.9 (6.18)
1993	100 629.1 (9.19)	101 111.9 (9.15)	2 348.3 (12.31)	3 007.1 (14.69)	30 030.9 (11.44)	30 045.3 (11.44)
2000	55 662.5 (12.6)	56 407.3 (12.45)	2 193.9 (16.97)	3 102.5 (14.37)	33 023.1 (6.89)	33 032.6 (6.89)
2001	38 145.2 (15.49)	39 396.5 (15.02)	1 831.4 (24.03)	2 360.4 (19.06)	25 058.9 (6.52)	25 167.7 (6.49)
2002	39 889.9 (13.75)	40 502.5 (13.55)	1 282.7 (19.81)	2 037.2 (16.26)	25 628.0 (10.06)	25 634.6 (10.05)
2003	14 318.2 (12.85)	14 723.5 (12.55)	1 334.5 (24.13)	1 897.5 (20.62)	22 174.4 (10.24)	22 192.4 (10.23)
2004	17 592.7 (11.8)	18 114.0 (11.55)	1 250.2 (26.65)	1 774.2 (20.08)	23 743.9 (12.23)	23 794.4 (12.2)
2005	20 440.1 (12.81)	20 679.7 (12.66)	1 133.3 (19.9)	1 624.1 (17.35)	19 685.4 (8.55)	19 755.5 (8.52)
2006	14 336.1 (10.66)	14 747.3 (10.47)	998.3 (22.15)	1 588.2 (16.63)	19 637.4 (12)	19 660.5 (11.99)
2007	45 875.6 (15.78)	46 003.0 (15.73)	2 187.5 (17)	2 622.4 (15.27)	26 485.8 (8.31)	26 492.2 (8.31)
2008	46 980.8 (13.94)	48 341.1 (13.57)	1 074.3 (22.63)	2 354.3 (15.64)	22 831.8 (9.56)	22 879.6 (9.54)
2009	65 016.8 (16.24)	66 157.5 (15.97)	991.9 (22.02)	1 601.7 (18.16)	22 712.5 (9.65)	22 771.9 (9.63)
2011	46 069.5 (14.74)	46 757.2 (14.53)	1 434.4 (29.96)	2 003.6 (22.84)	23 178.4 (11.81)	23 336.4 (11.74)
2012	55 739.3 (15.17)	56 131.0 (15.06)	1 942.8 (23.39)	2 442.8 (22.42)	27 009.6 (11.26)	27 035.6 (11.25)
2014	31 329.0 (12.9)	31 727.3 (12.76)	1 101.1 (31.7)	1 485.4 (25.04)	30 004.6 (8.82)	30 010.5 (8.82)
2016	37 992.0 (17)	-	1 000.0 (25)	-	26 656.0 (16)	-
2018	31 097.6 (11.31)	31 476.0 (11.17)	1 354.3 (28.48)	1 785.2 (23.61)	21 270.0 (10.4)	21 285.6 (10.39)
2020	37 851.0 (12.34)	37 992.1 (12.3)	1 309.9 (23.22)	1 618.6 (18.93)	22 343.2 (12.38)	22 355.1 (12.37)
2022	49 557.2 (8.98)	50 272.6 (8.86)	983.1 (20.84)	1 379.1 (17.8)	24 659.8 (9.21)	24 689.0 (9.2)
2024	80 043.8 (22.17)	80 631.0 (22.01)	1 205.1 (19.86)	1 553.2 (16.15)	24 935.6 (8.09)	24 946.2 (8.09)

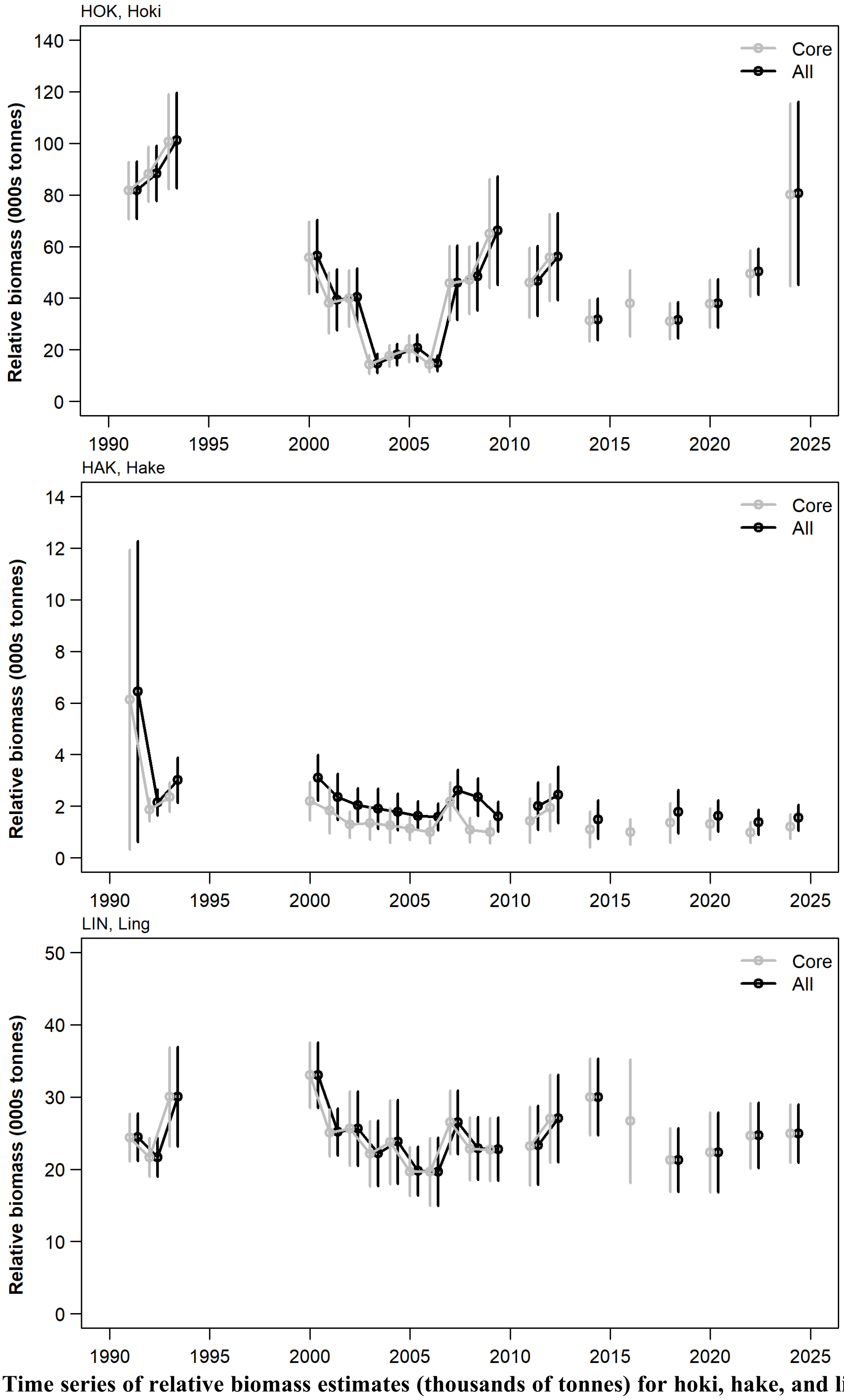

Figure 4: Time series of relative biomass estimates (thousands of tonnes) for hoki, hake, and ling for the Sub-Antarctic November–December *Tangaroa* surveys. Grey lines show fish from core (300–800 m) strata; black lines show fish from all strata (300–1000 m). Error bars show ± 2 standard errors. 2016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

3.4.1 Abundance estimates of other important species

Biomass estimates were higher in 2024 than in 2022 for spiny dogfish, dark ghost shark, ribaldo, and silver warehou but lower for southern blue whiting, pale ghost shark, white warehou, javelinfish, lookdown dory, oblique banded rattail, and black oreo dory.

The 2024 biomass estimates for spiny dogfish, dark ghost shark, lookdown dory, and silver warehou were well above the time series means and slightly above for ribaldo. Abundance estimates for oblique banded rattail and black oreo dory were well below the time series means and slightly below for white warehou, javelinfish, southern blue whiting, and pale ghost shark.

3.5 Species distribution

Hoki were widespread throughout the core survey area, occurring in 68 of the 73 valid biomass stations (Figure 5, Appendix 2). Hoki catch rates were generally higher in the west, with the largest catch coming from stratum 4 near the Stewart-Snares Shelf. Catches of 1+ hoki were relatively small and confined to the west, mostly around the Stewart Snares Shelf area. Catches of 2+ hoki were higher and more widespread than 1+ hoki but still mainly restricted to the western strata. 3++ fish were widespread across the core strata but like the 1+ and 2+ cohorts, catch rates were highest in the western strata.

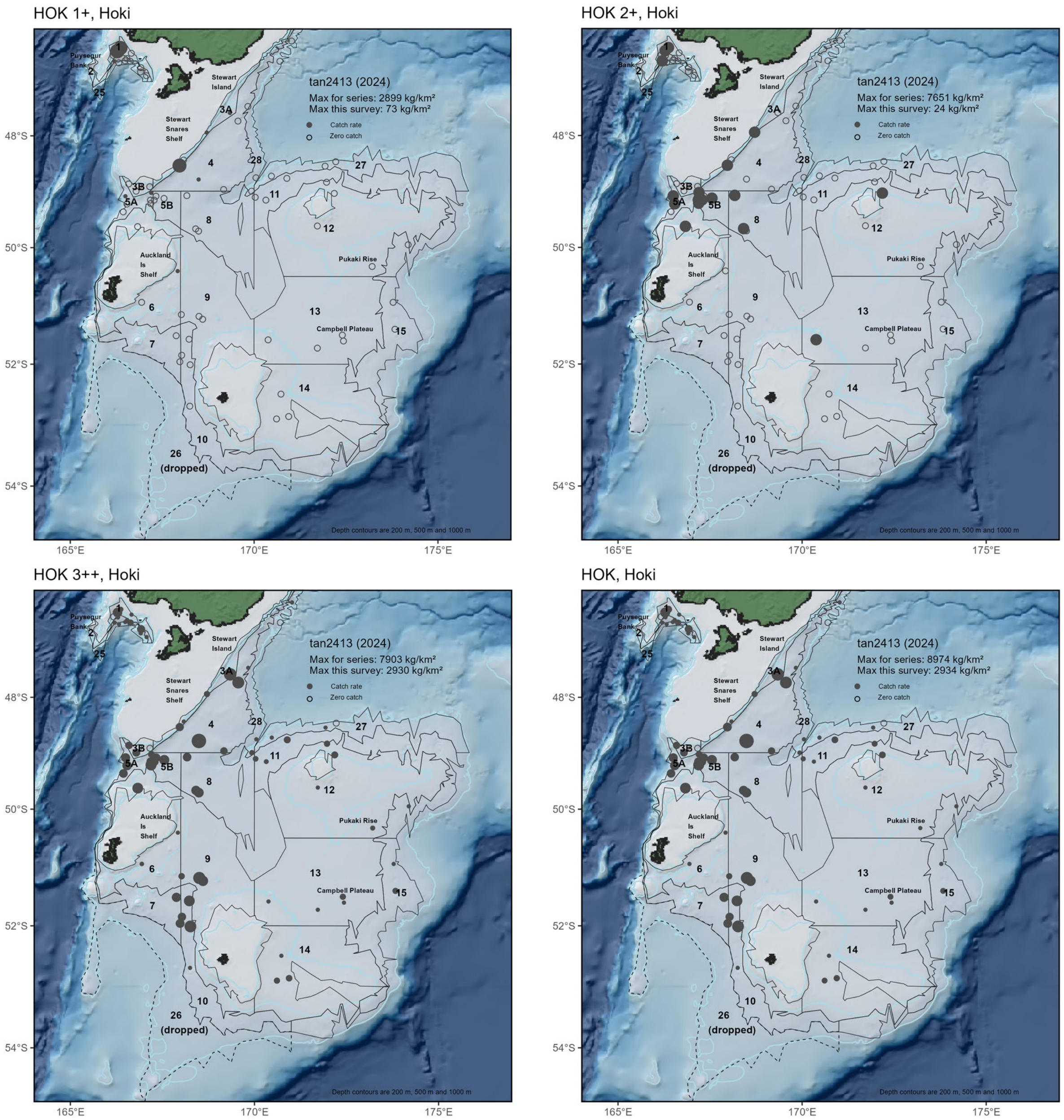

Figure 5: Distribution and catch rates in kg per km^2 of 1+ (less than 44 cm), 2+ (44 to less than 58 cm), 3++ year old (more than 58 cm), and all hoki from the November–December 2024 Sub-Antarctic trawl survey. Circle area is proportional to catch rate. Open circles indicate zero catches.

Catch rates of hake and ling are plotted in Figure 6. Hake were caught on 35 of the 73 valid biomass stations. The highest mean catch rates were at Puysegur Trench stratum 25 (800–1000 m) followed by stratum 2 (600–800 m). Reasonable catch rates were also seen at the Stewart-Snares Shelf in strata 4, 5A and 5B, and stratum 6 (Auckland Island Shelf). Catches overall were concentrated in the west.

Ling were caught on 62 of the 73 valid biomass stations, across the survey ground but catch rates were higher in the western strata (Figure 6). The highest mean catch rate was in stratum 1 at Puysegur, followed by strata 3A, 3B, 5A, and 5B at the Stewart Snares Shelf. Reasonable catch rates were also seen around the Auckland Islands and to the north-east of Campbell Island.

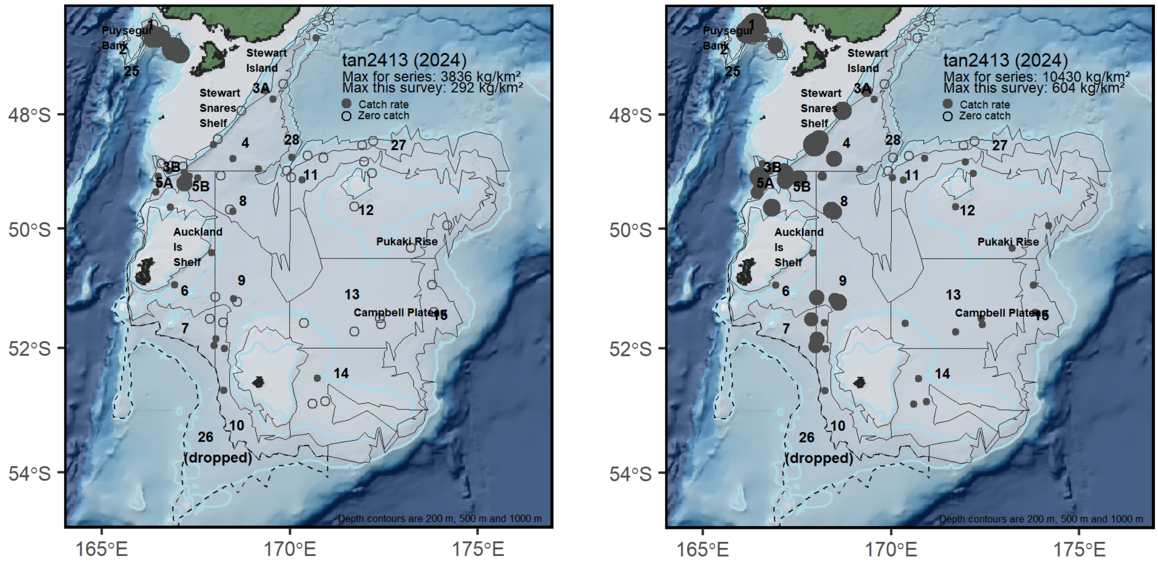

Figure 6: Distribution and catch rates of hake (left plot) and ling (right plot), from the November–December 2024 Sub-Antarctic trawl survey. Circle area is proportional to catch rate. Open circles indicate zero catches.

3.6 Biological data

A total of 30 740 fish and squid of 90 different species were measured and, of these, 12 010 fish were also individually weighed (Table 9). Additional data on fish condition (liver and gutted weight) were recorded from 1076 hoki. Pairs of otoliths were removed from 1204 hoki, 958 ling, and 337 hake. Sub-samples of 753 hoki and 578 ling otoliths were selected for ageing. All 337 hake otoliths were aged.

Table 9: Numbers of fish for which length, sex, and biological data were collected from the November–December 2024 Sub-Antarctic trawl survey. Total is sometimes greater than the sum of male and female fish because the sex of some fish was not recorded.

Common	Species	Number measured			Number of
name	code	Males	Females	Total	biological samples
Alfonsino	BYS	1	1	2	2
NZ southern arrow squid	NOS	73	17	92	53
Australasian narrow-nosed spookfish	LCH	47	33	80	79
Australasian slender cod	HAS	5	9	20	10
Banded bellowsfish	BBE	1	-	1	1
Banded rattail	CFA	938	1 325	2 271	798
Basketwork eel	BEE	56	69	126	105
Baxter's lantern dogfish	ETB	269	226	495	310
Bigeye cardinalfish	EPL	3	8	11	9
Bigeye sea perch	HBA	2	1	3	3
Black javelinfish	BJA	61	49	111	36
Black oreo	BOE	250	233	484	107
Blackspot rattail	VNI	12	21	33	31
Bollons' rattail	CBO	39	116	155	139

Common	Species	Number measured			Number of
Bronze bream	BBR	1	2	3	3
Cape scorpionfish	TRS	-	1	1	-
Carpet shark	CAR	-	1	1	1
Brown chimaera	CHP	1	1	2	2
Common roughy	RHY	1	1	2	2
Dark ghost shark	GSH	386	434	820	257
Dawson's catshark	DCS	1	1	2	2
Dealfish	DEA	-	1	1	-
Deepsea cardinalfish	EPT	32	21	54	53
Deepsea flathead	FHD	2	4	6	6
Finless flounder	MAN	16	4	27	27
Four-rayed rattail	CSU	197	365	564	178
Frostfish	FRO	-	-	1	1
Gemfish	RSO	191	267	458	195
Giant chimaera	CHG	-	1	1	1
Giant stargazer	GIZ	35	99	134	112
Gonorynchus forsteri & *G. greyi*	GON	-	1	1	1
Hairy conger	HCO	33	34	67	64
Hake	HAK	173	167	341	341
Hapuku	HAP	1	2	3	3
Hoki	HOK	2 162	3 644	5 809	1 225
Humpback rattail (slender rattail)	CBA	-	4	4	4
Javelinfish	JAV	749	3 589	4 343	1 136
Kaiyomaru rattail	CKA	10	5	17	17
Leafscale gulper shark	CSQ	50	48	99	98
Ling	LIN	1 098	1 007	2 105	1 118
Longnose velvet dogfish	CYP	143	192	336	191
Lookdown dory	LDO	81	168	249	245
Lucifer dogfish	ETL	243	196	439	295
Mahia rattail	CMA	3	3	6	2
New Zealand catshark	AEX	7	-	7	7
Notable rattail	CIN	11	13	35	4
Oblique banded rattail	CAS	56	447	507	235
Oliver's rattail	COL	828	1 546	2 389	688
Orange roughy	ORH	106	85	224	117
Pale ghost shark	GSP	528	518	1 046	751
Pale toadfish	TOP	1	-	6	6
Plunket's shark	PLS	3	4	7	7
Prickly deepsea skate	BTS	1	-	1	1
Prickly dogfish	PDG	2	1	3	3
Ragfish	RAG	1	1	2	2
Red cod	RCO	18	6	24	24
Ribaldo	RIB	41	222	263	212
Ridge scaled rattail	MCA	77	147	224	201
Rough-skinned clubhook squid	MIQ	16	18	37	14
Rough skate	RSK	3	7	10	10
Rudderfish	RUD	-	5	5	5

Common	Species	Number measured			Number of
Scampi	SCI	3	2	5	5
School shark	SCH	3	-	3	3
Sea perch	HPC	19	49	69	39
Seal shark	BSH	7	13	20	20
Shortspine lanternshark	ETU	18	10	28	28
Shovelnose dogfish	SND	262	452	714	206
Silver dory	SDO	12	14	26	26
Silver warehou	SWA	75	130	205	68
Silverside	SSI	252	334	628	198
Slender clubhook squid	MRQ	2	1	3	-
Small-headed cod	SMC	11	5	16	-
Small banded rattail	CCX	37	42	83	63
Small-scaled brown slickhead	SSM	72	69	141	103
Smooth deepsea skate	BTA	4	-	4	4
Smooth oreo	SSO	266	208	474	126
Smooth skate	SSK	2	5	7	7
Smooth skin dogfish	CYO	13	13	26	26
Southern blue whiting	SBW	700	675	1 375	358
Southern Ray's bream	SRB	12	30	42	42
Spiky oreo	SOR	45	32	77	43
Spineback	SBK	35	447	482	314
Spiny dogfish	SPD	1 132	325	1 457	538
Swollenhead conger	SCO	34	63	97	92
Todarodes angolensis	TAG	1	3	4	-
Violet cod	VCO	11	2	13	13
White rattail	WHX	26	4	30	3
White warehou	WWA	58	38	96	90
Widenosed chimaera	RCH	25	19	44	44
Witch	WIT	1	-	1	1
Total	-	12 203	18 376	30 740	12 010

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

The hoki length frequency distribution in 2024 was dominated by adult fish (Figure 7a). A weak mode of 1+ fish (2023 year class, under 45 cm) was seen, but few 2+ fish (2022 year class, ranging in length from about 45–58 cm) were caught. The rest of the distribution is indistinct and comprises a number of year classes of fish mainly aged 3–10 years old. As in previous years, the distribution of adult hoki was broad, up to about 105 cm for males and 110 cm for females. Few hoki were caught in the deeper strata but what were tended to be larger fish. Almost all male hoki were aged between 1 and 11 years of age (Figure 8a). For females, the age distribution was broader, with nearly all fish being between 1 and 15 years of age. Relatively strong 1+ cohorts have been observed in some previous surveys (e.g., 2003–08 and 2020). The strong year class of 1+ fish observed in the 2020 survey (2019 year class, both sexes) was present as the dominant cohort of 3+ fish in 2022 and were again dominant in 2024 as 5+ fish. For both sexes, fish aged 5 years and older were more prevalent before 2000, although fish aged 5 years and older are more prevalent in 2022 and 2024 compared with more recent years.

The hake length distribution in 2024 was broad, with adult fish up to 93 cm for males and 128 cm for females (Figure 7b). Throughout the time series, there are few fish of either sex less than 50 cm, few males larger than 90 cm, and while females up to 120 cm are relatively common fish larger than this are rare. Hake are often found in the deeper strata, but these are rarely fish greater than 100 cm, and mostly between 50–70 cm for males and 50–100 cm for females. Most male hake in 2024 were between 3 and 6 years old in 2024 (Figure 8b). There were a number of 19-year-old male hake in 2022. This year class is not obvious when tracking back through the age frequencies, although they were relatively strong at age 5 in 2008. This year class was still apparent (as 21-year-olds) in low numbers in 2024. Most female hake in 2024 were between 3 and 17 years old (Figure 8b).

The length frequency distribution of ling in 2024 was broad with few males over 100 cm or females over 120 cm (Figure 7c). The overall length frequency was similar to that in 2022 except that there were fewer fish of 50–70 cm in 2024, particularly for males (Figure 7c). Most ling of both sexes were between 4 and 20 years old (Figure 8c). There were fewer ling of both sexes aged over 20 years in 2024 compared with 2022.

Population scaled length frequency distributions for all other species that were measured on the 2024 survey are available on NIWA's Trawl Survey Information Portal https://tsip-uat.niwa.co.nz/home.

Gonad staging of hoki, ling, and hake is given in (Table 10). All male and female hoki were either resting or immature. The proportions at each stage were virtually identical between males and females with 10% of females and 11% of males immature (stage 1), and 90% of females and 88% of males resting (stage 2). Ripening, ripe, and running ripe hoki (stages 3–5) are not expected at this time of year and none were observed. Most years have seen small proportions (usually less than 10%) of partially spent and spent fish (stages 6 and 7) of both sexes. However, none were observed in 2024.

For female ling, 11% were immature, 70% were resting, 11% were ripening, and 7% ripe. None were running ripe, partially spent, or spent. For male ling, 7% were immature and about 30% resting. Ripening, ripe, and running ripe males accounted for 21%, 38%, and 4% respectively. None were partially spent or spent.

For female hake, 8% were immature, 72% were resting, 18% were ripening, and the remaining 2% spent. There were no ripe or running ripe female hake. All stages of gonad development were seen for male hake except for spent fish. Most were not in spawning condition with 14% immature and 68% resting. Ripening, ripe, and running ripe males accounted for 6%, 7%, and 4% respectively. The remaining 1% were partially spent.

Table 10: Proportion of fish by gonad stage (see Appendix 1 for gonad stage descriptions) for hoki, hake, and ling from the November–December 2024 Sub–Antarctic trawl survey. – indicates zero.

Species	Sex	Staging method	Reproductive stage 1	2	3	4	5	6	7	Total
Hoki	Female	MD	0.10	0.90	–	–	–	–	–	3 590
	Male		0.11	0.88	–	–	–	–	–	2 135
Ling	Female	MD	0.11	0.70	0.11	0.07	–	–	–	919
	Male		0.07	0.30	0.21	0.38	0.04	–	–	1 006
Hake	Female	MD	0.08	0.72	0.18	–	–	–	0.02	133
	Male		0.14	0.68	0.06	0.07	0.04	0.01	–	120

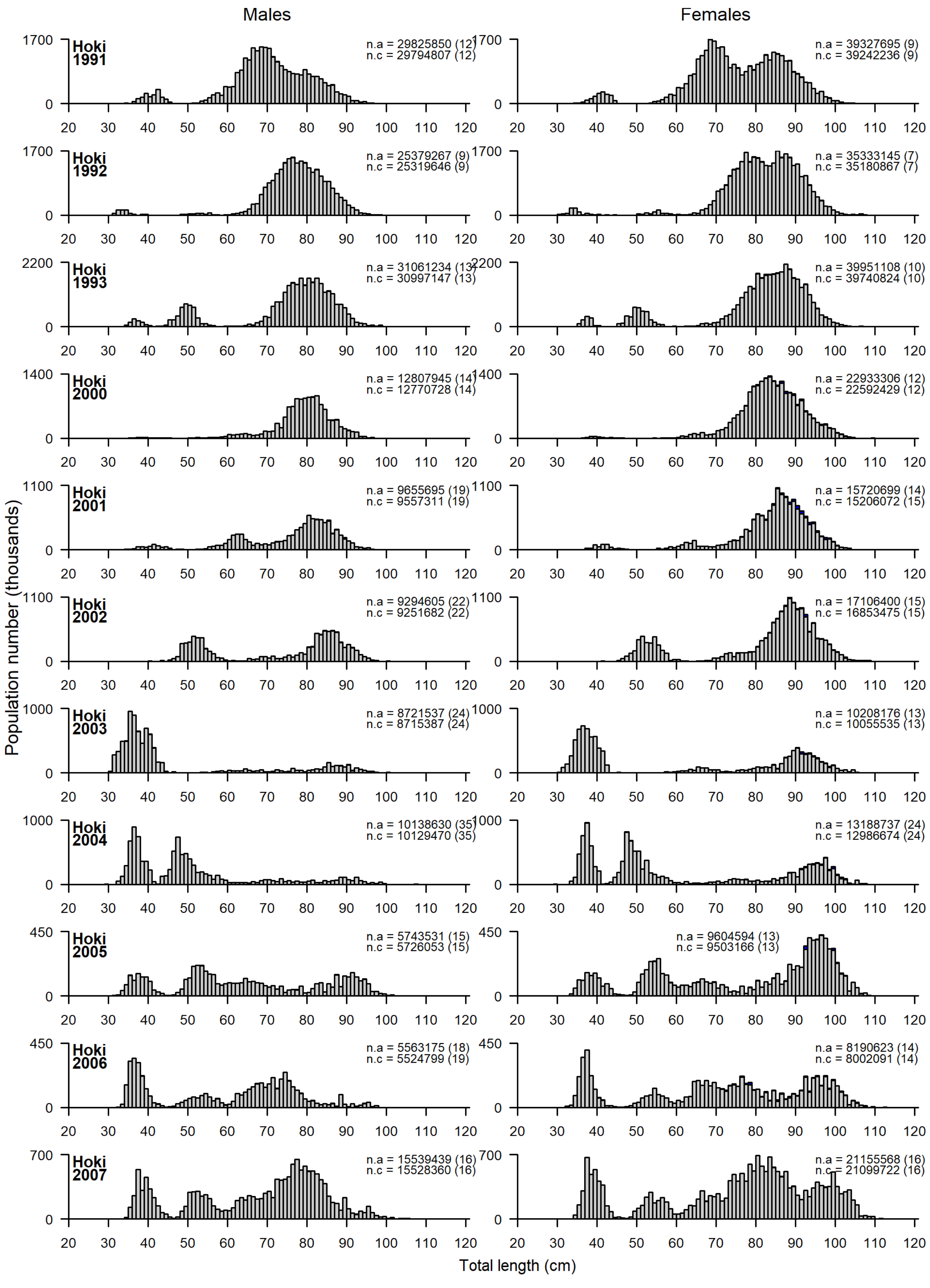

Figure 7a: Length frequency distributions by sex of hoki for core (grey) and all (blue) strata from all Sub-Antarctic November–December *Tangaroa* surveys. n.a, estimated scaled total number of fish for all strata; n.c, estimated scaled total number of fish for core strata; and CV, the coefficient of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

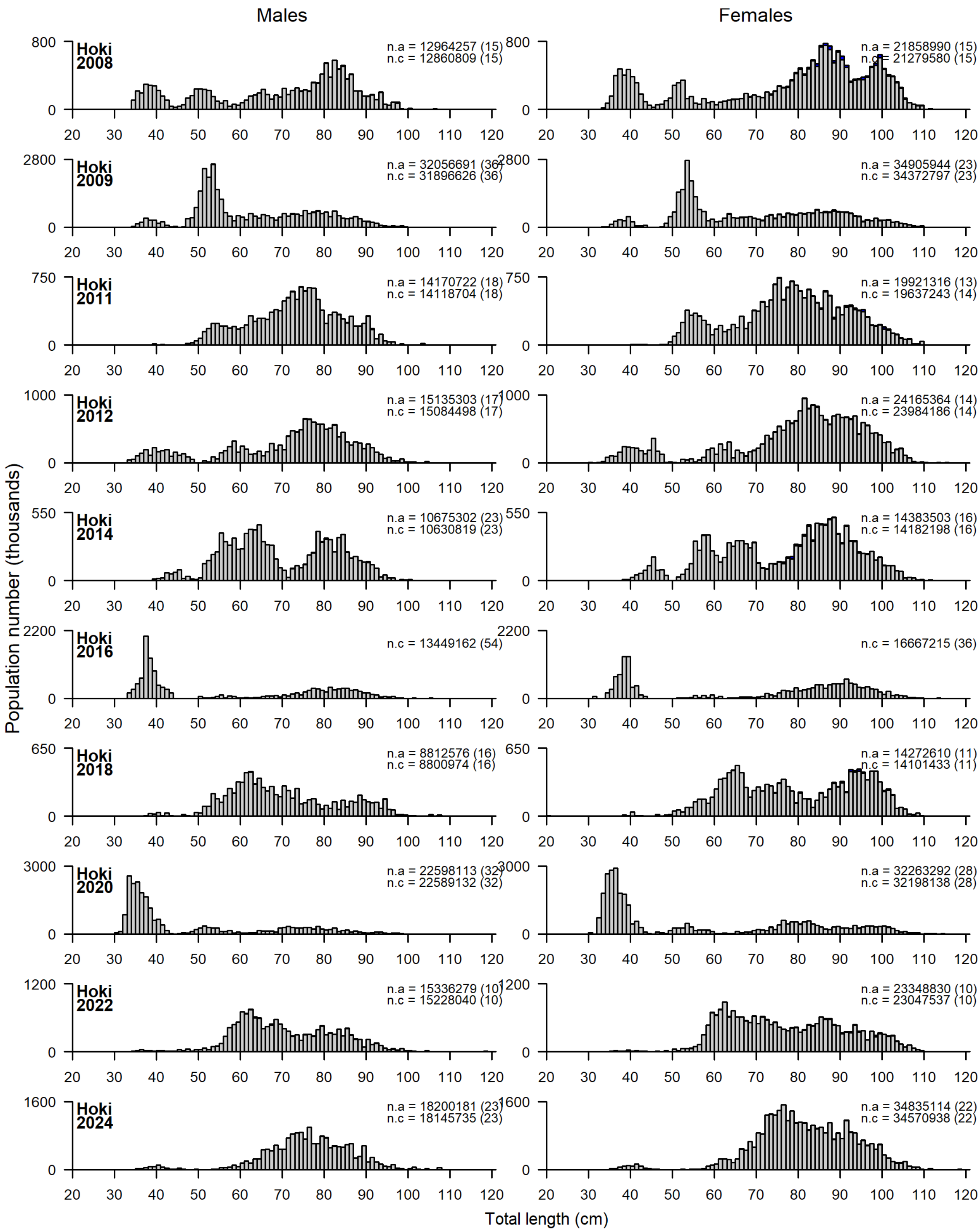

Figure 7a: continued.

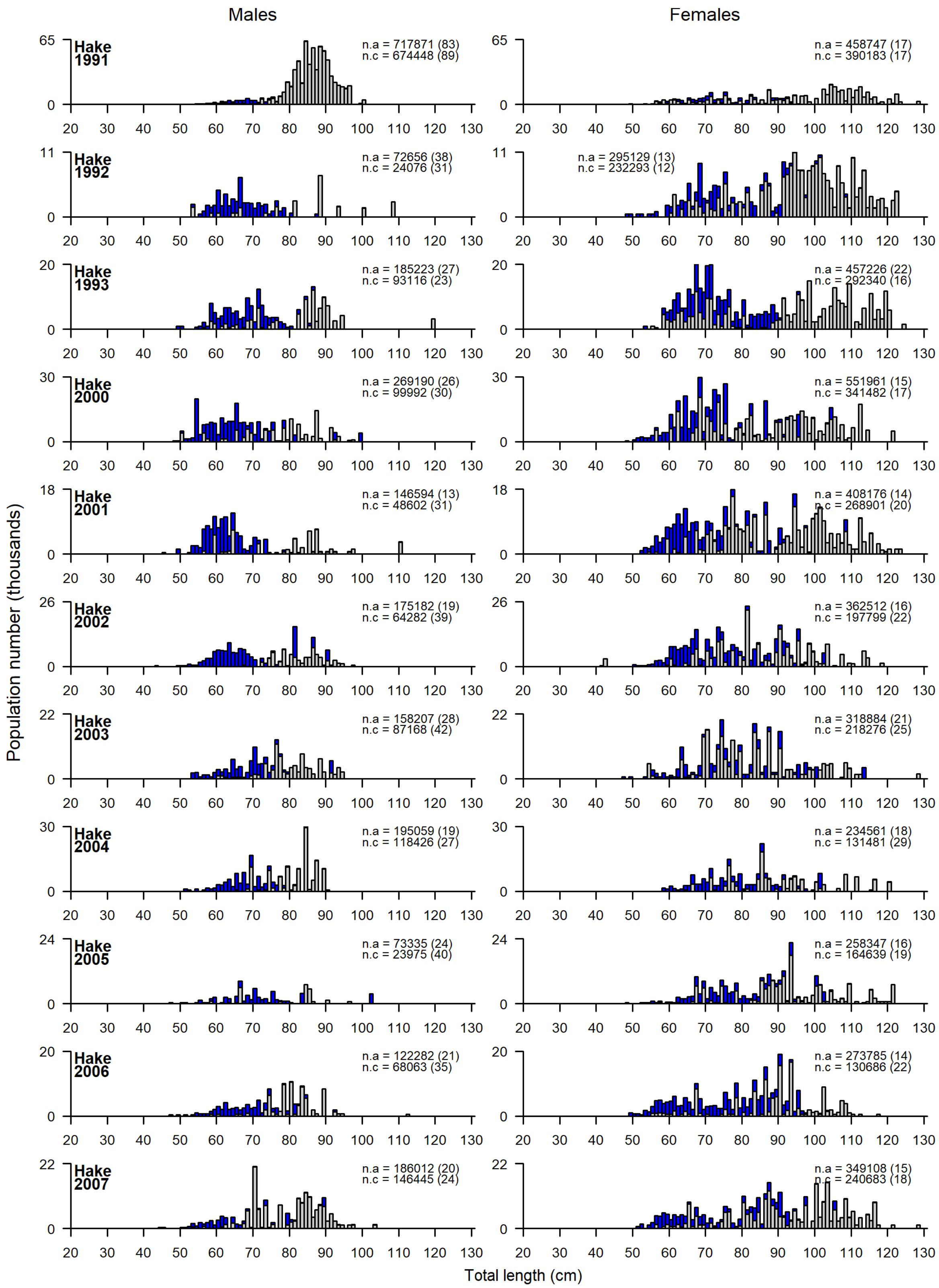

Figure 7b: Length frequency distributions by sex of hake for core (grey) and all (blue) strata from all - Antarctic November–December trawl surveys. n.a, estimated scaled total number of fish for all strata; n.c, estimated scaled total number of fish for core strata; and CV, the coefficient of variation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

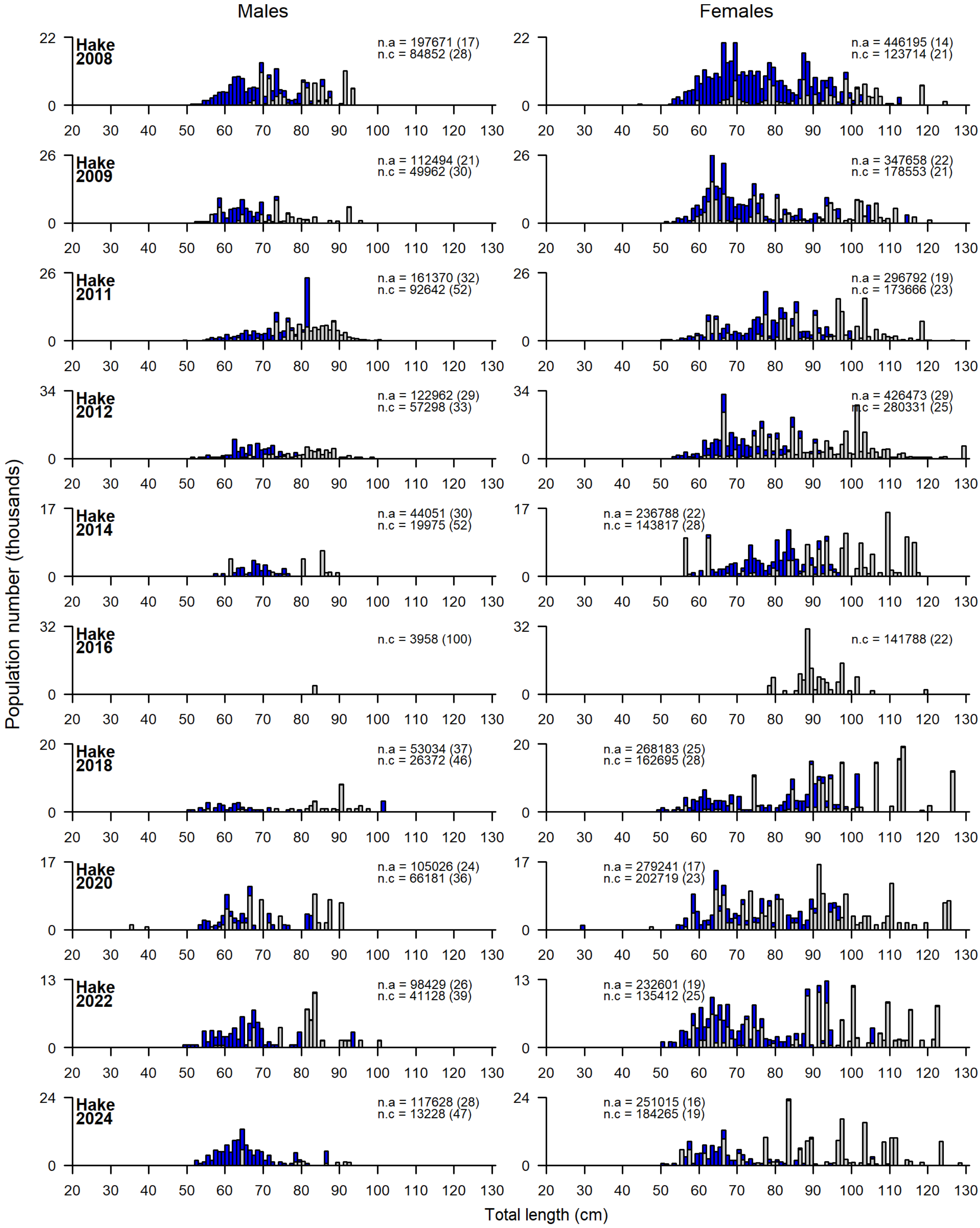

Figure 7b: Continued

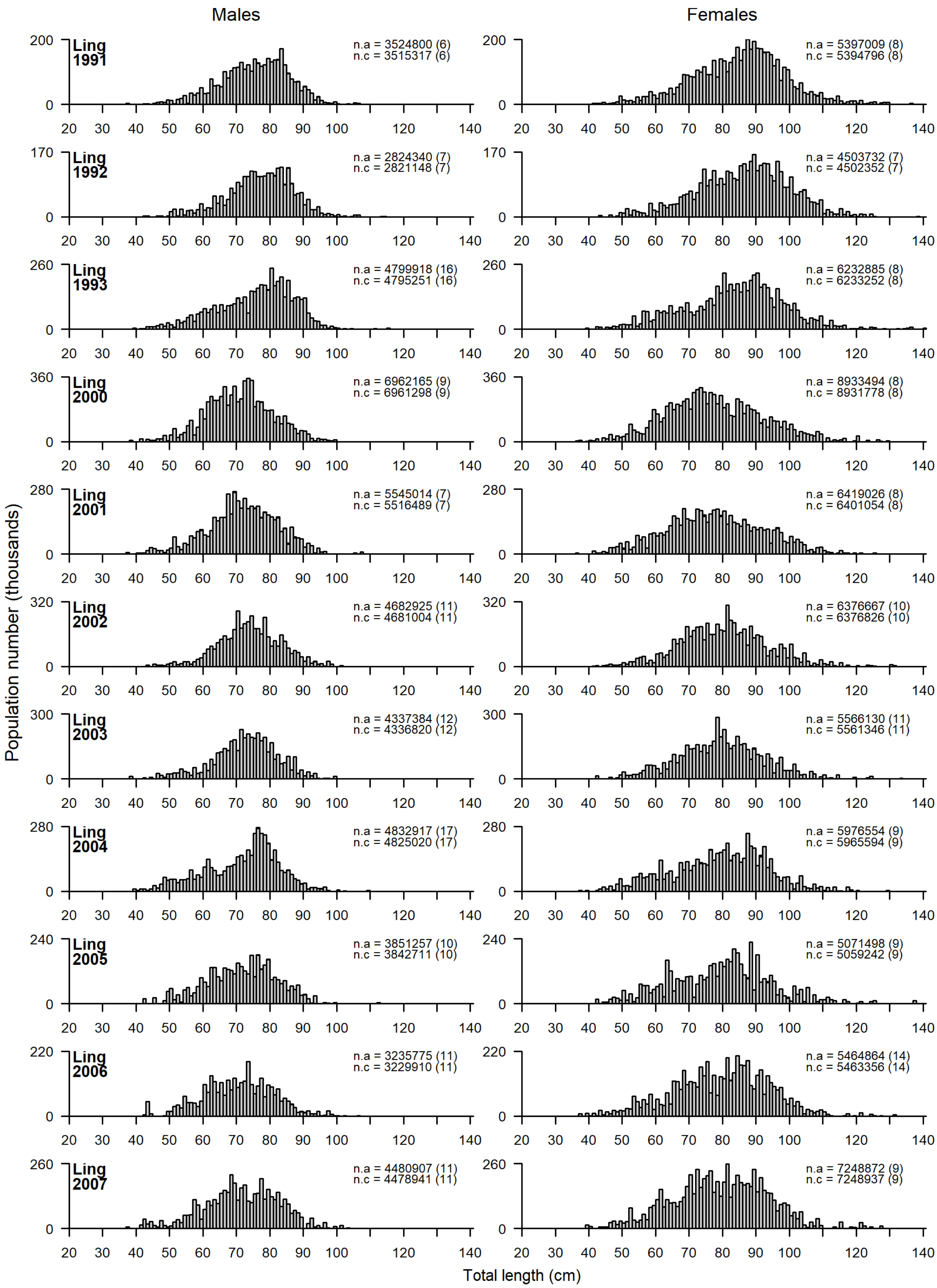

Figure 7c: Length frequency distributions by sex of ling for core (grey) and all (blue) strata from all Sub-Antarctic November–December trawl surveys. n.a, estimated scaled total number of fish for all strata; n.c, estimated scaled total number of fish for core strata; and CV, the coefficient of variation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

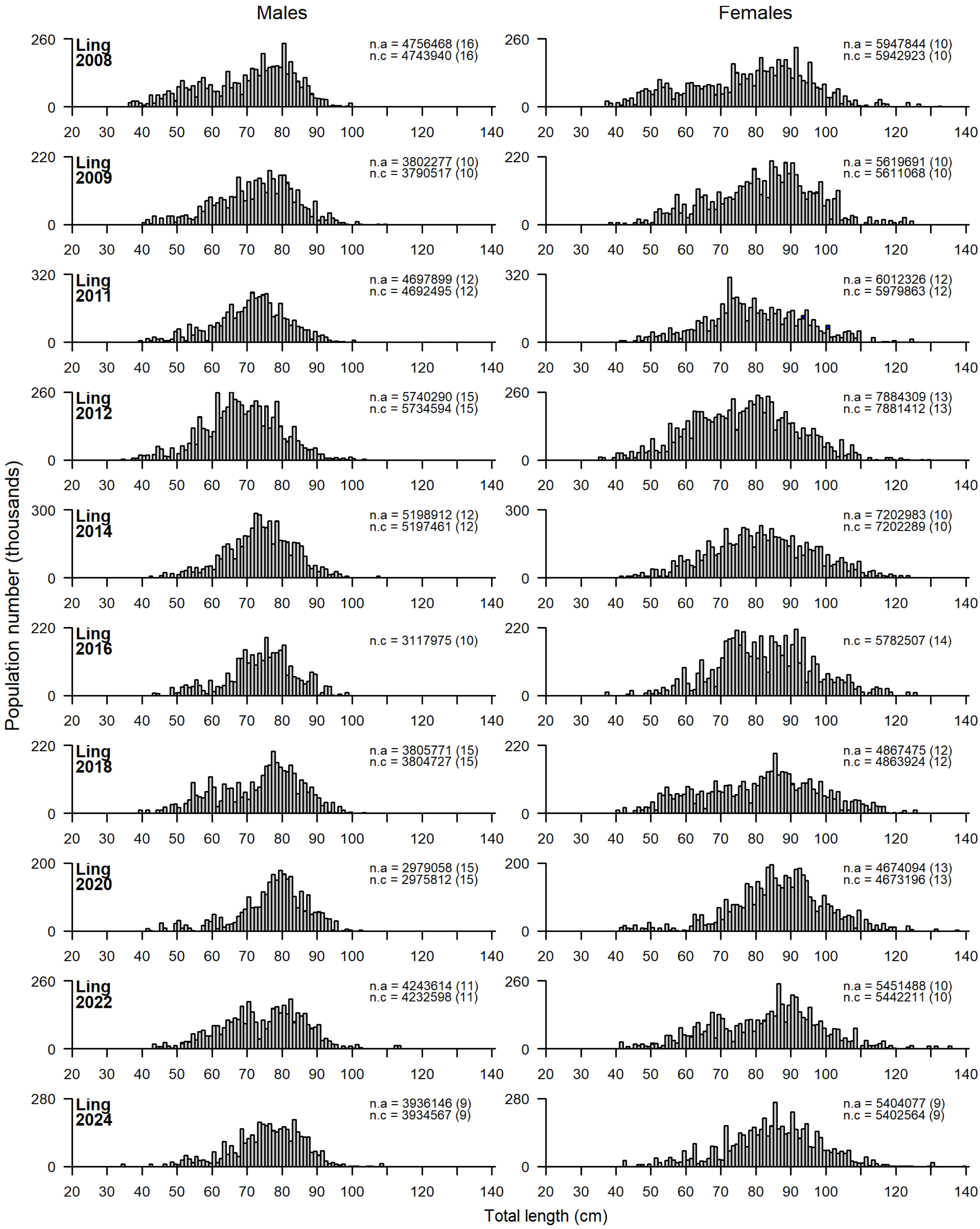

Figure 7c: Continued

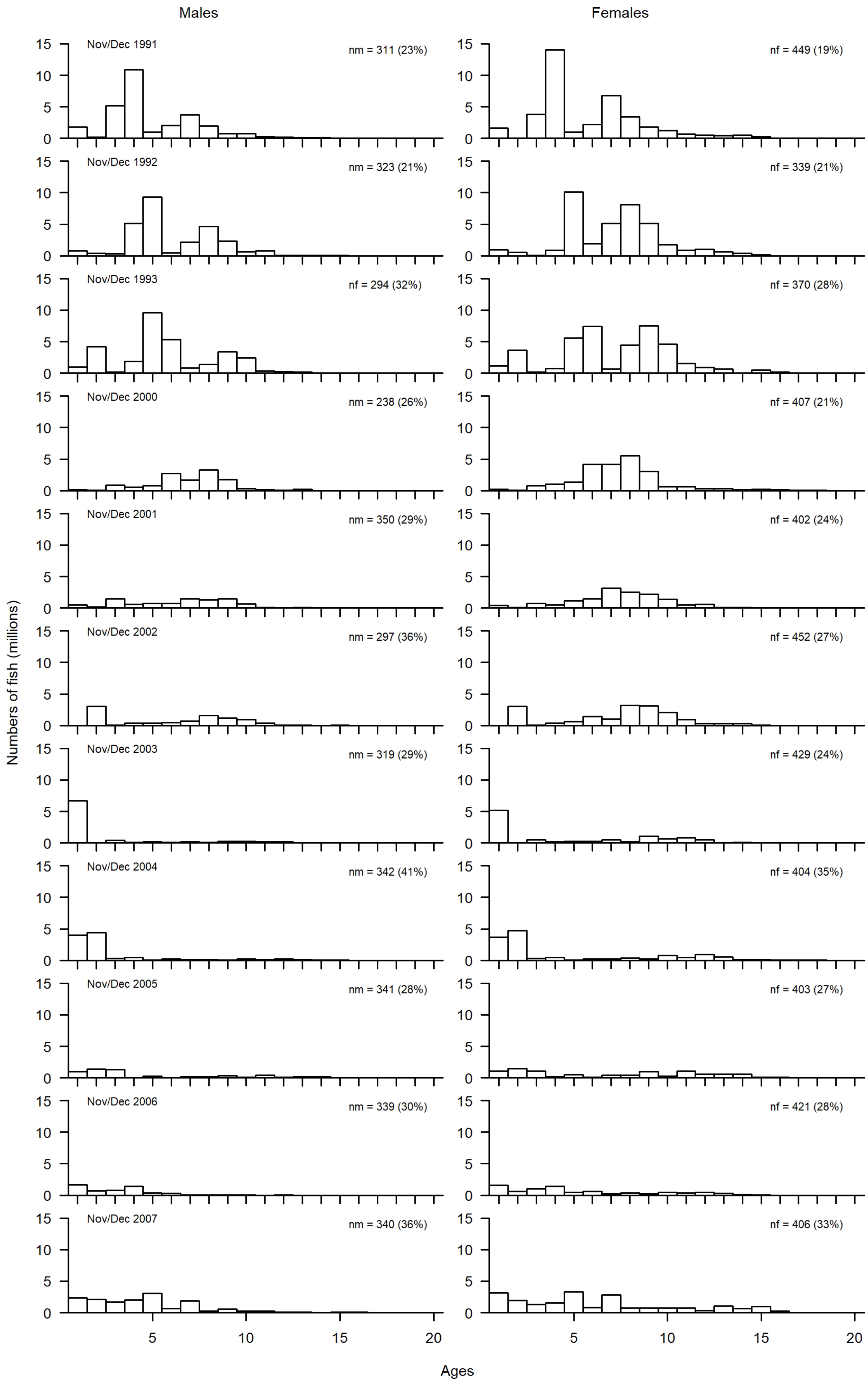

Figure 8a: Scaled age frequency distributions by sex for hoki in core strata from the Sub-Antarctic November–December *Tangaroa* surveys. Number of fish aged are indicated by nm (males) or nf (females). CV (%) in parentheses.

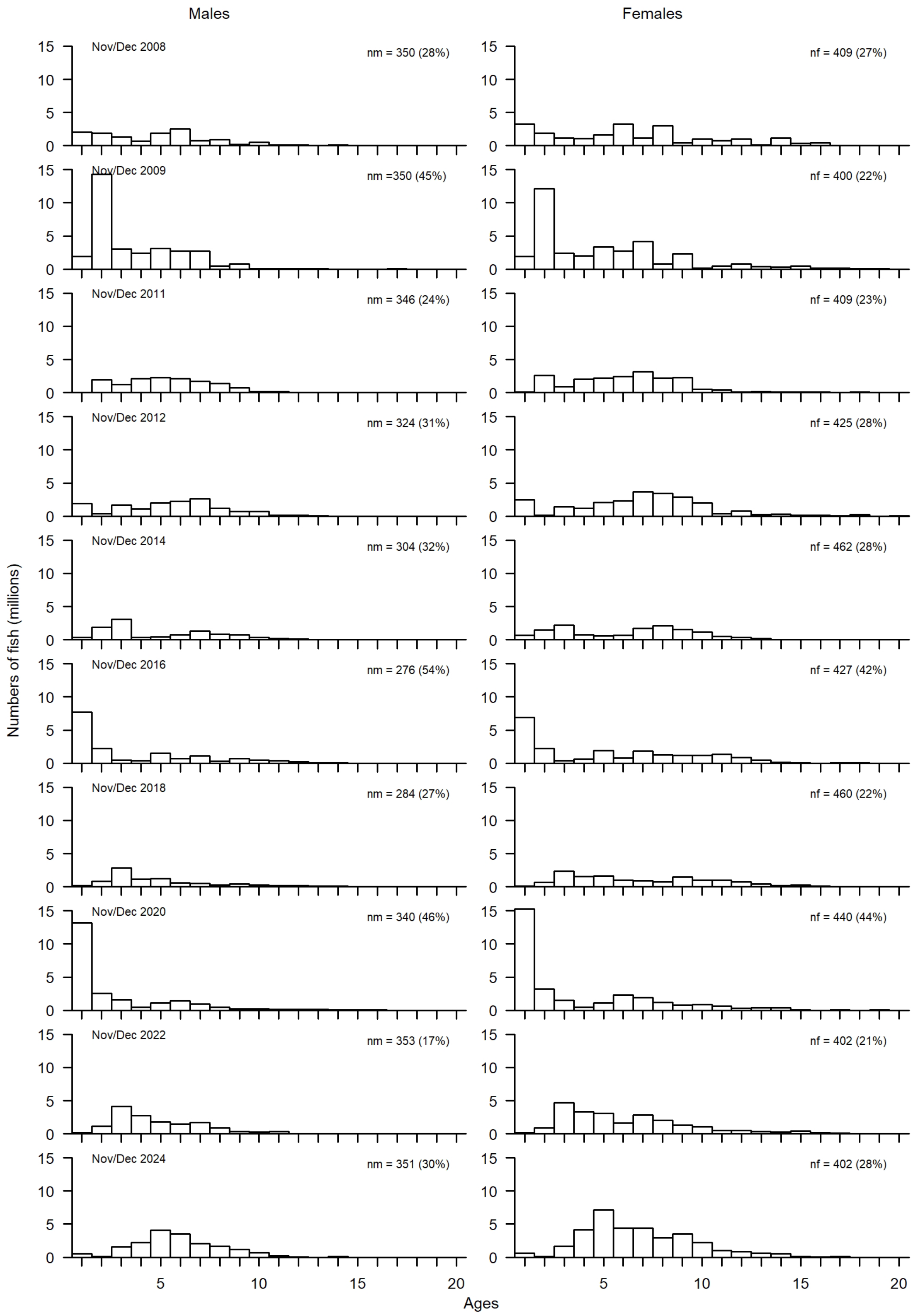

Figure 8a: continued.

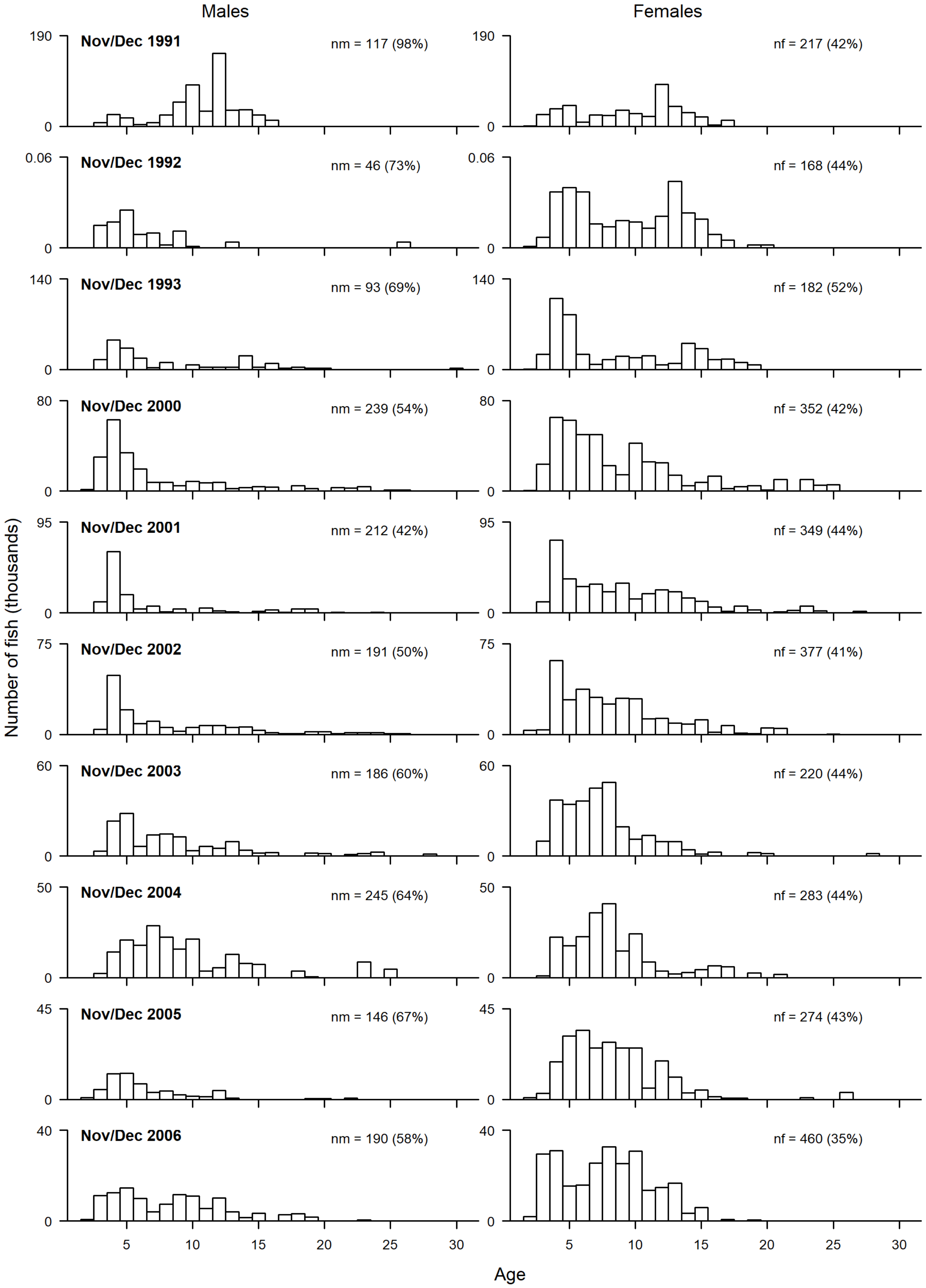

Figure 8b: Scaled age frequency distributions by sex for hake in core plus Puysegur strata from the Sub-Antarctic November–December *Tangaroa* surveys.

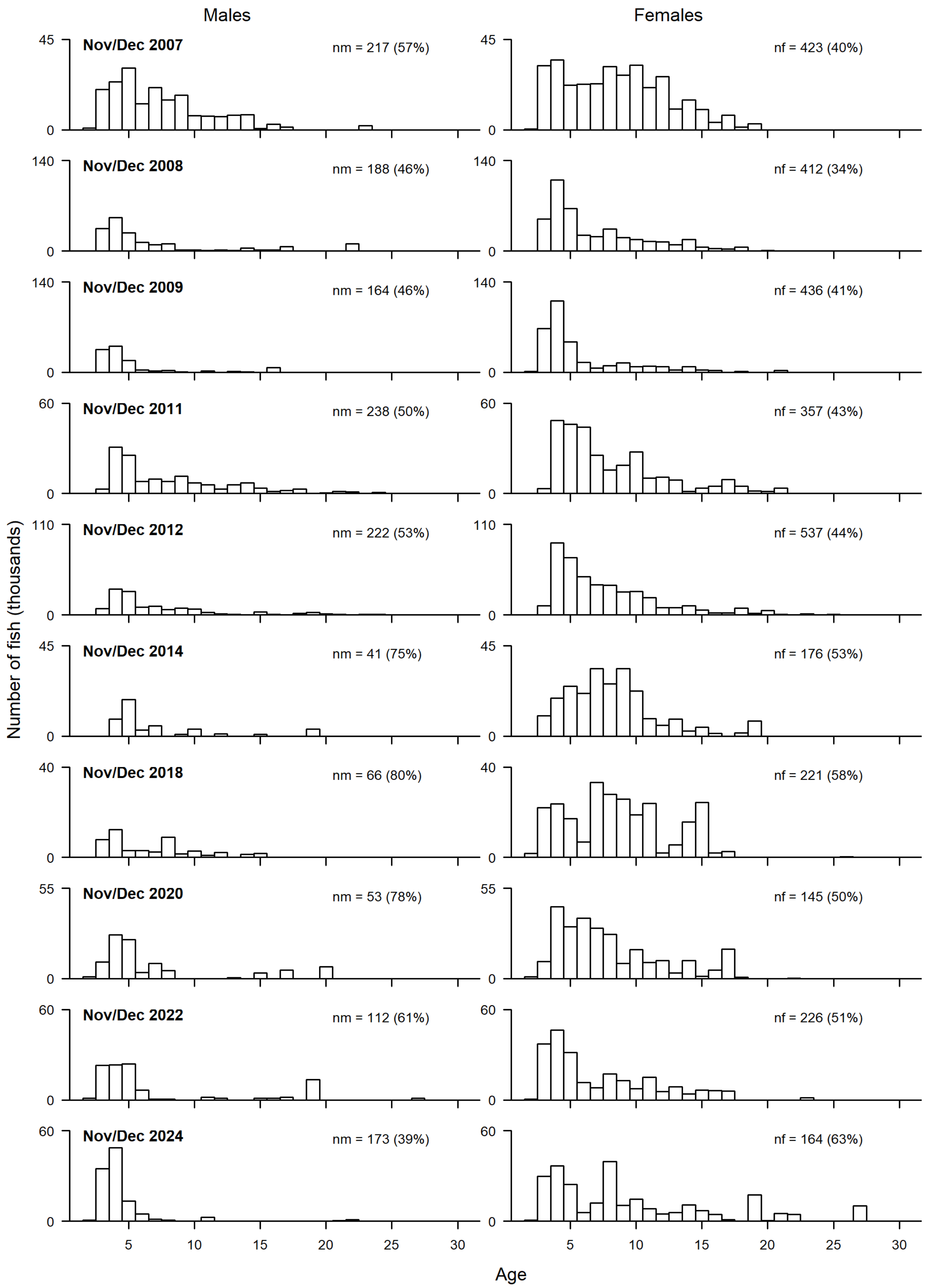

Figure 8b: continued. NB: No age data for hake exist for the 2016 survey.

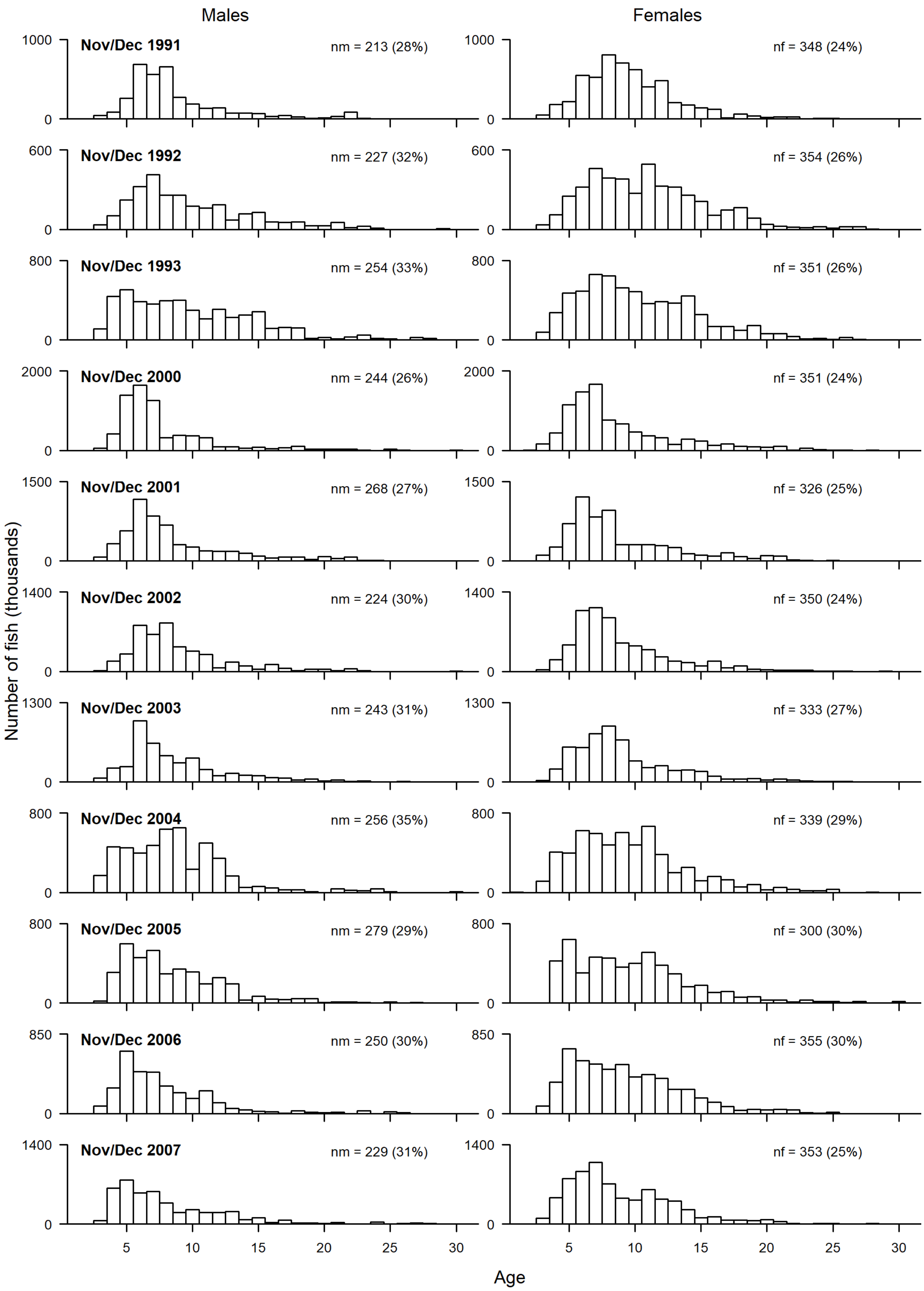

Figure 8c: Scaled age frequency distributions by sex for ling in core strata from the Sub-Antarctic November–December *Tangaroa* surveys.

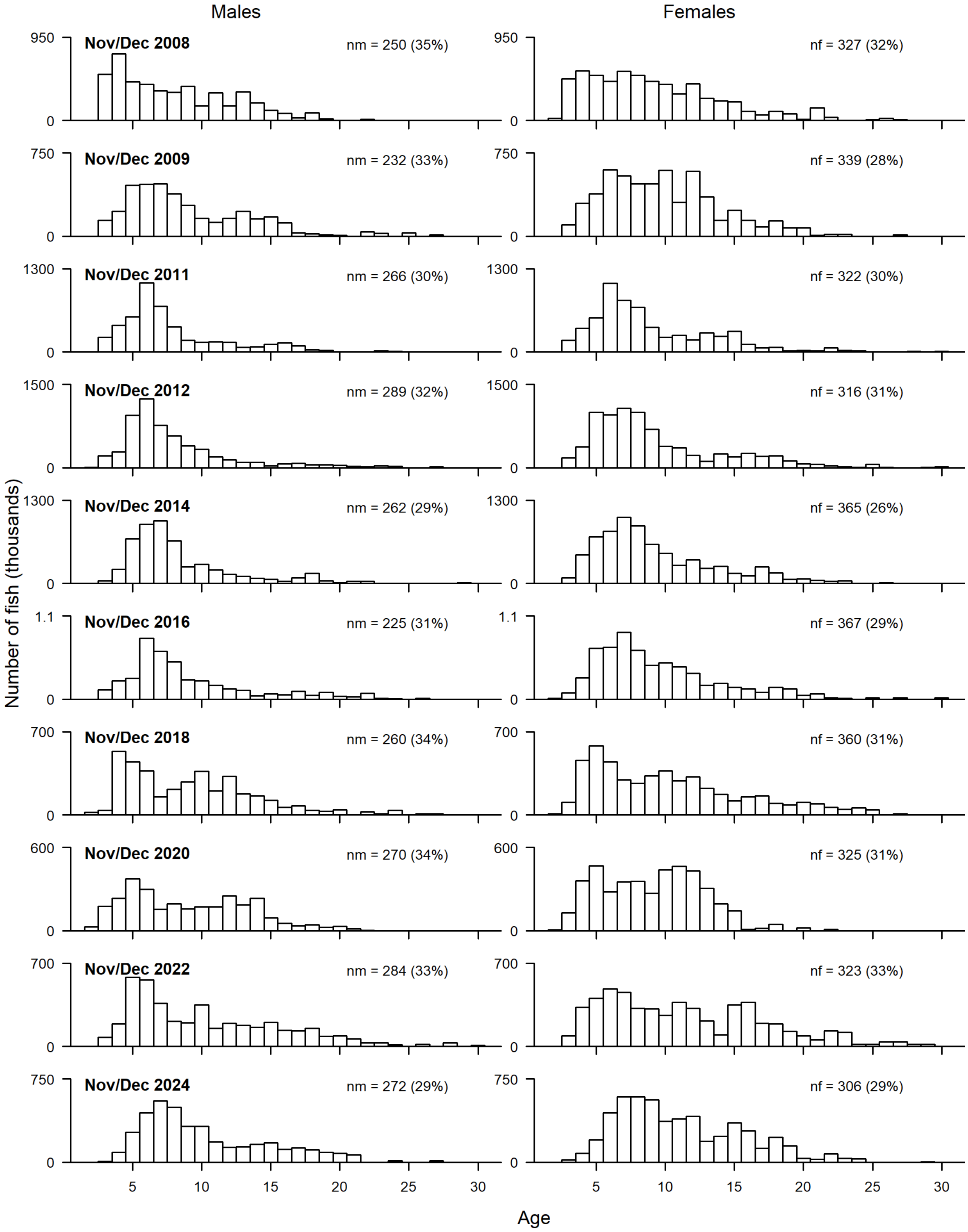

Figure 8c: continued.

3.7 Hoki condition indices

Liver and gutted weights were recorded from 1076 hoki in 2024. Both liver condition (Table 11) and somatic condition (measured as the estimated average weight of a 75 cm hoki) were higher in 2024 than in 2022 (Stevens et al. 2024), and slightly above the long-term mean for the time-series (Figure 9). Compared with 2022, liver condition increased in all sub-areas was above the long term mean in all sub-areas as well (Table 11). Hoki condition indices in the Sub-Antarctic were consistently lower than those from the Chatham Rise survey except for the most recent surveys, and this pattern is less apparent since the surveys became biennial in 2012 (Figure 9).

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	0.76	-	3.37	3.1
2018	2.75	1.9	3.04	2.6	1.95	4.4	2.64	3.2
2020	2.99	2.2	3.19	3.0	2.44	6.3	2.82	3.5
2022	2.44	2.0	2.75	2.6	2.00	4.6	2.04	3.2
2024	3.09	1.9	3.62	2.9	2.53	5.3	2.82	2.8
Mean	2.82	0.4	3.10	0.7	2.15	1.1	2.75	0.7

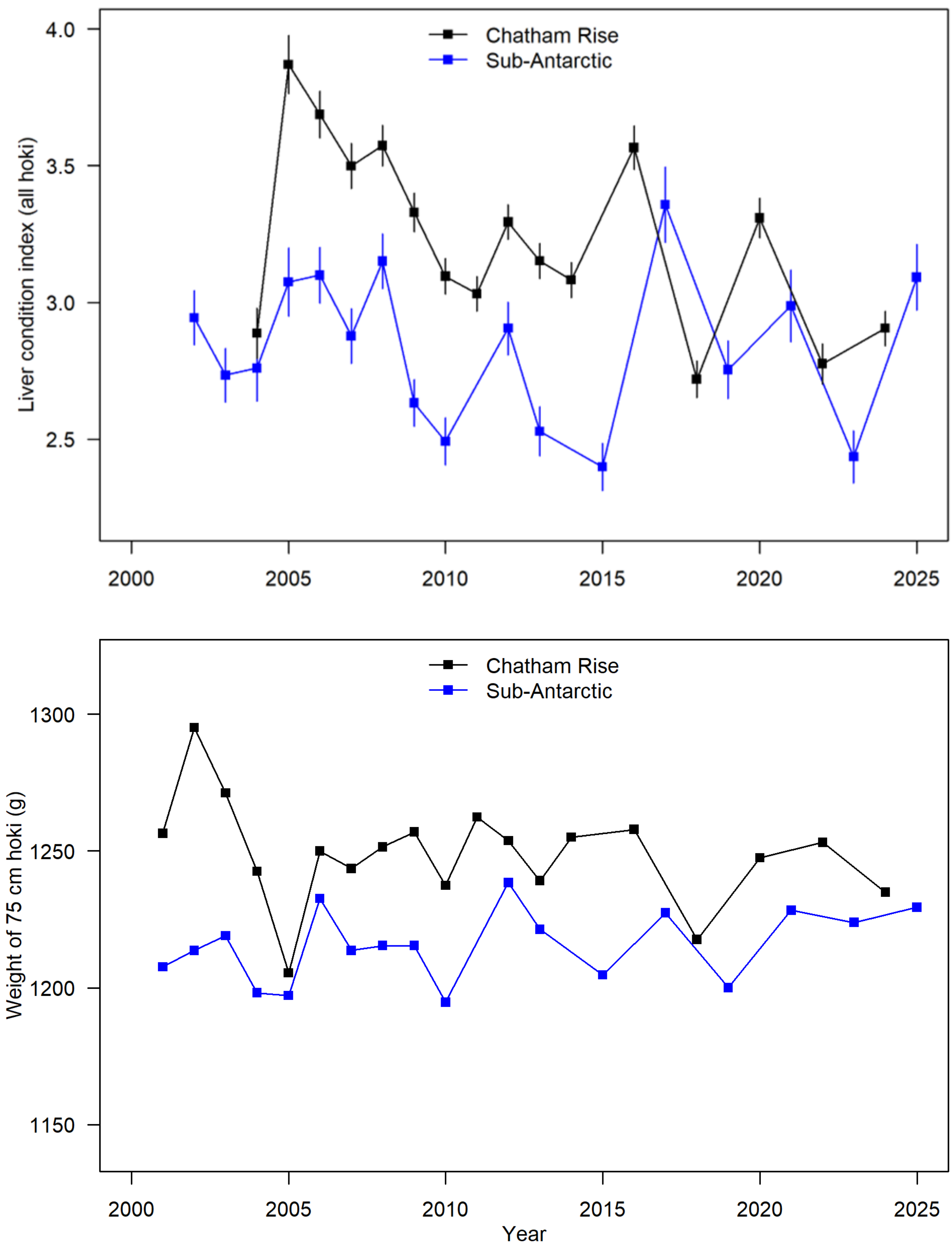

Figure 9: Liver (upper panel) and somatic (lower panel) condition indices of hoki sampled in the Sub-Antarctic summer trawl surveys since 2000. Condition indices are compared with those from the Chatham Rise survey (from Stevens et al. 2023).

3.9 Acoustic data

Over 255 GB of acoustic data was collected. Excluding data acquired for system testing, during transits to and from port and the survey areas, and daytime steam files (which are not used in the acoustics analysis), resulted in 130 files recorded. These 130 files were grouped into trawls and night-time steams referred to as ‘events’. A total of 92 events were recorded during the survey. Twenty-three percent of events were found to be unsuitable for quantitative analysis (i.e., exceeded the 30% bad transmits threshold criteria) (Table 12).

Spatial distribution of total backscatter from good and marginal quality recordings in the survey area was similar to that observed in previous years (Stevens et al. 2024), with highest acoustic densities at Puysegur and south of the Stewart/Snares shelf in stratum 3B (see Figure 10). Low backscatter density was widely distributed across the Sub-Antarctic region. In comparison with previous years, the vertical distribution of acoustic backscatter in 2024 decreased in the upper 200 m and increased below 400 m at night. The increase in backscatter at depth at night contrasted with the vertical distribution pattern observed in previous years (Figure 11). The vertical distribution pattern observed during daytime also showed a decrease of backscatter in the top 200 m and an increase from about 300 m. 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).

Total daytime backscatter in the water column (from 10 m below the transducer to the seabed) in 2024 was slightly higher than in the previous survey. Mesopelagic backscatter in 2024 was lower than in the previous three surveys and similar to that estimated in 2016 (Figure 12). Backscatter within 10 m, 50 m and 100 m from the seabed in 2024 increased, with backscatter within 50 m and 100 m being the highest in the time series.

There was a significant positive correlation between acoustic backscatter in the bottom 50 m during the day and trawl catch rates in 2024 (Spearman correlation coefficient, rho = 0.30, p-value < 0.05) (Figure 13).

The proportion of the backscatter assumed to be mesopelagic fish was lower in the Puysegur region than in the East or West regions (Table 13). Despite this, estimated indices in 2024 were higher at Puysegur than in the East and West regions (Table 14). Mesopelagic indices decreased by 25, 9, 28, and 29% relative to 2022 for the eastern Sub-Antarctic, Puysegur, Steward-Snares shelf, and the western Sub-Antarctic, respectively. This represents a continuation of the overall decreasing trend since 2018 for the eastern Sub-Antarctic and Stewart-Snares shelf, and since 2016 for the western Sub-Antarctic and Puysegur (Table 14, Figure 14). The overall estimate of mesopelagic backscatter in 2024 (8.1×10^{-6} $m^2\ m^{-2}$) was lower than in 2022 and lower than the average for the time-series ($9.2 \times 10^{-6}\ m^2\ m^{-2}$) (Figure 14).

Table 12: Quality of acoustic data collected during trawl surveys in the Sub-Antarctic between 2000 and 2024. In 2000–14, the quality of each recording was subjectively categorised as “good”, “marginal”, or “poor” based on the appearance of the 38 kHz echograms (see appendix 2 of O’Driscoll & Bagley (2004) for examples). In 2016, the subjective definition was replaced by an equivalent quantitative metric where “good” was defined as fewer than 10% bad pings, “marginal” was defined as 10–30% bad pings, and “poor” was defined as greater than 30% bad pings.

		% of recordings		
Year	Number of recordings	Good	Marginal	Poor
2000	234	57	21	22
2001	221	65	20	15
2002	202	78	12	10
2003	169	37	25	38
2004*	163	0	0	100
2005	197	75	16	9
2006	195	46	25	29
2007	194	63	16	20
2008	235	61	28	11
2009	319	46	33	20
2011	261	47	35	18
2012**	294	18	22	60
2014	258	30	31	39
2016	229	40	33	27
2018	261	75	18	7
2020***	242	43	23	34
2022****	5 659	71	17	12
2024	92	34	43	23

* There was a problem with synchronisation of scientific and ship’s echosounders on TAN0414 (O’Driscoll & Bagley 2006a), so data from this survey were not suitable for quantitative analysis due to the presence of acoustic interference.
** For 19% of all files in TAN1215, the scientific and ship’s echosounders were not synchronised, hence acoustic interference occurred. These files were treated as poor recording and were not suitable for quantitative analysis.
*** Multibeam echosounder was used without synchronisation and the interference from this system made data quality of four trawl files of poor quality.
**** From hereon, % of recordings only accounts for nighttime steams and daytime trawls. In 2022, larger amount of data are attributed to the switch from the EK60 to EK80 system. From trawl 66 onwards, data interference caused by the EA600 made the data unsuitable for analyses and were therefore not included.
***** From hereon, number of recordings accounts for number of nighttime steams and daytime trawls used for analysis (not number of individual recording or raw files).

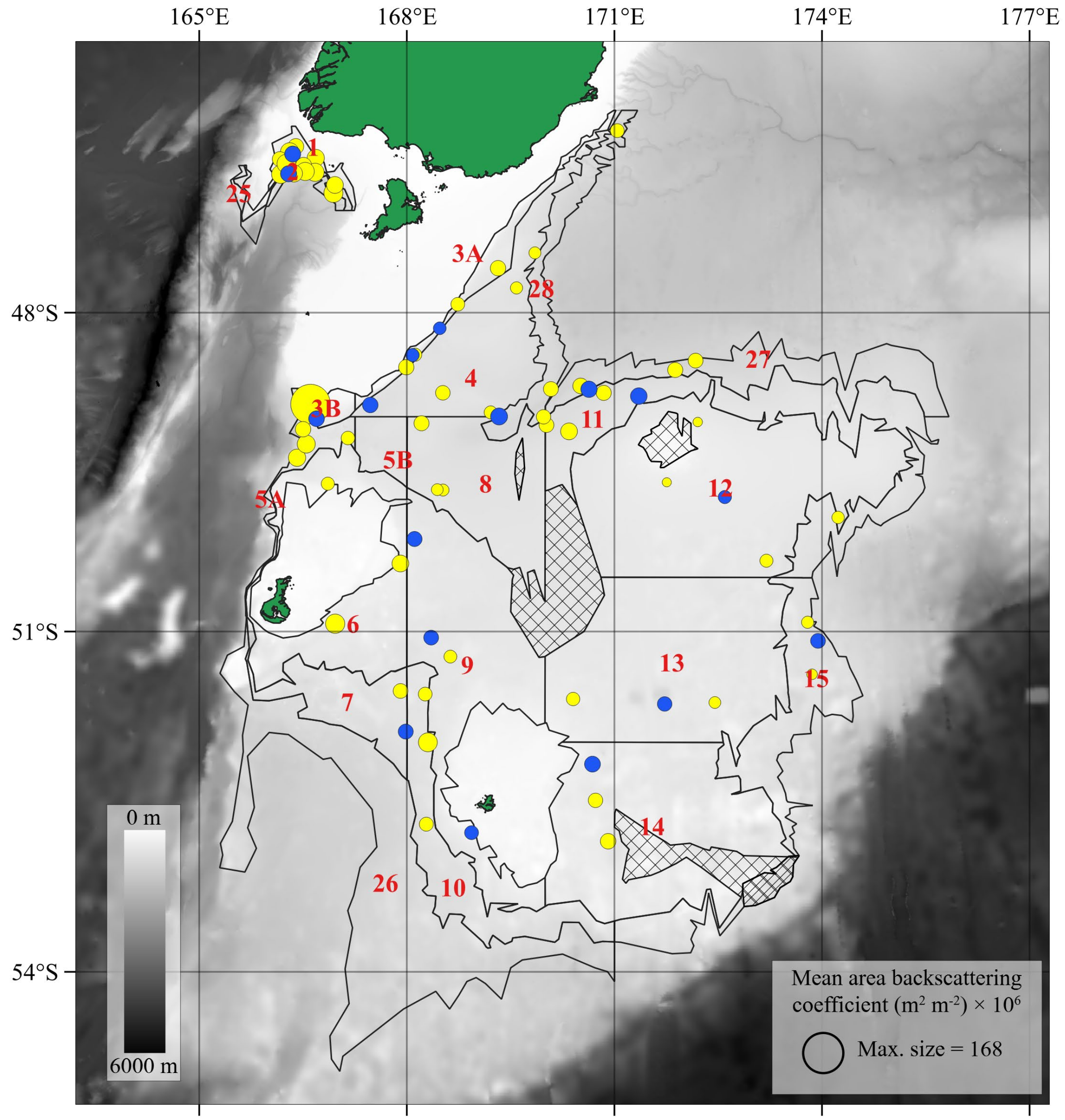

Figure 10: Spatial distribution of total acoustic backscatter ($m^2\ m^{-2}$) scaled by 10^6 in the Sub-Antarctic observed during day trawl stations (yellow bubbles) and night steams (blue bubbles) using mean latitude and longitude for each type of acoustic recording. Circle area is proportional to the acoustic backscatter. Trawl survey strata are indicated in red numbers.

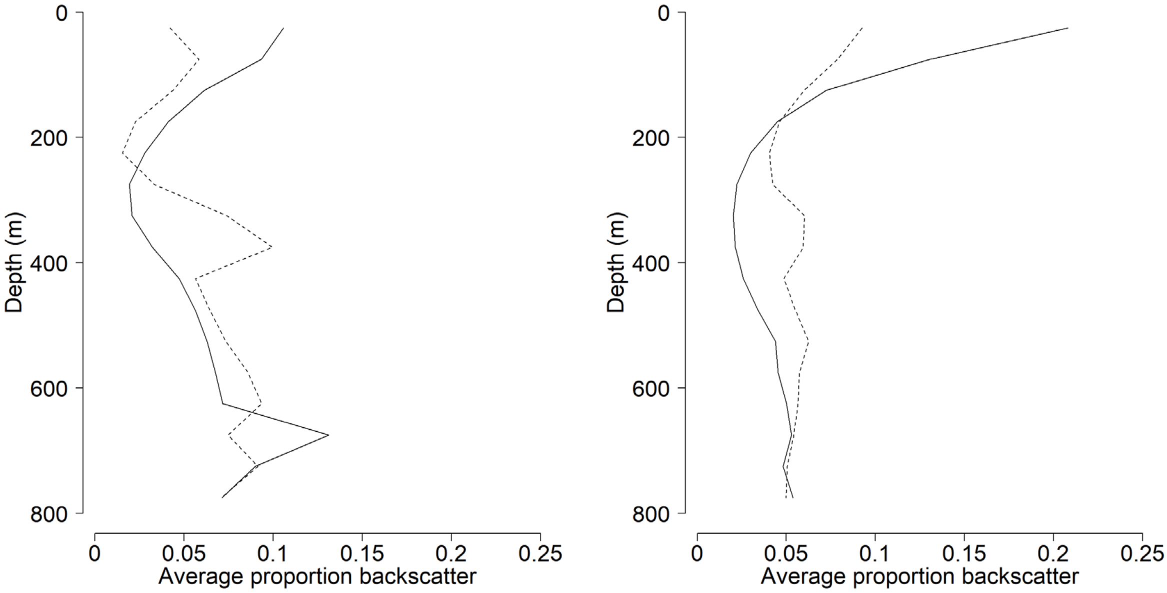

Figure 11: Distribution of total acoustic backscatter integrated in 50 m depth bins on the Sub-Antarctic observed during the day (dashed lines) and at night (solid lines) in 2024 (left panel) and average distribution from 2000–22 combined (right panel).

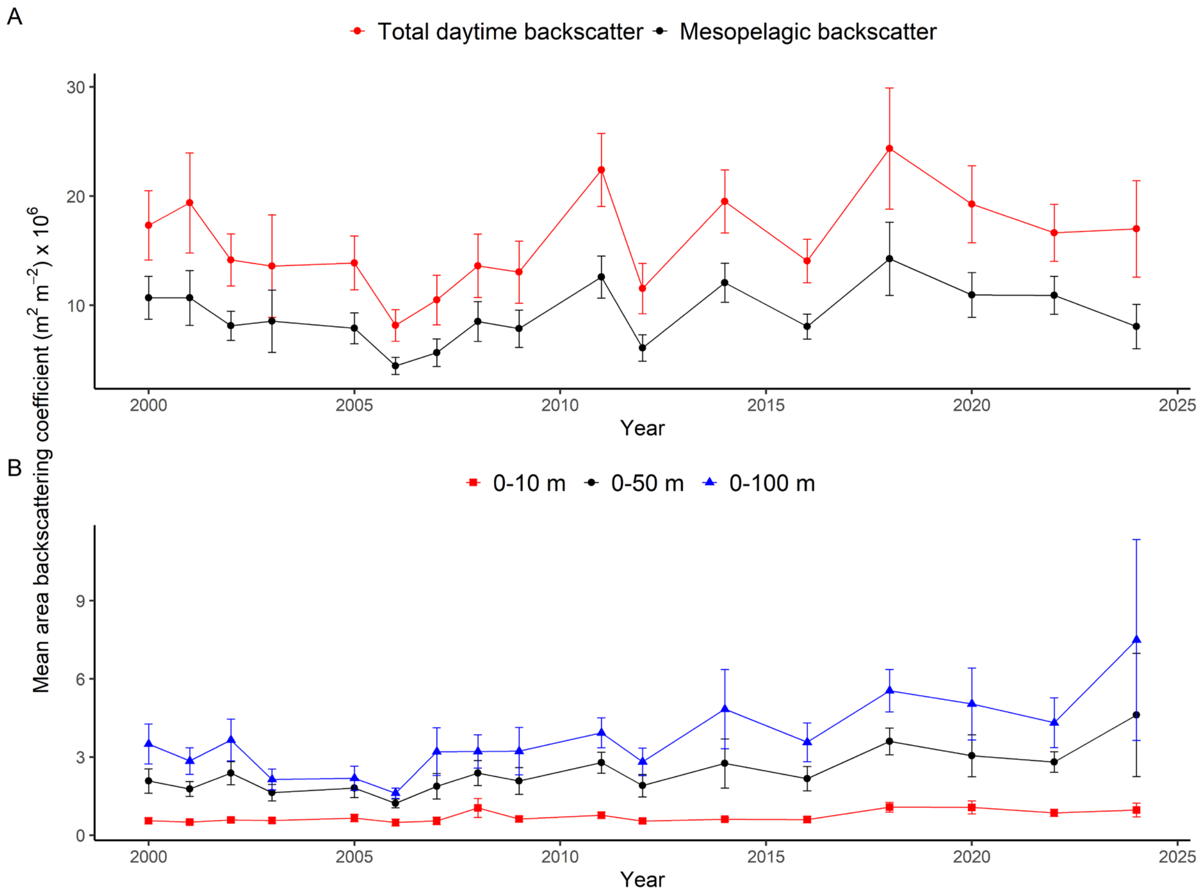

Figure 12: Estimates of total and mesopelagic acoustic backscatter (A), and backscatter in the bottom 10, 50, and 100 m (B) from 38 kHz data collected during daytime trawls from 2000–24. Error bars are ± 2 standard errors.

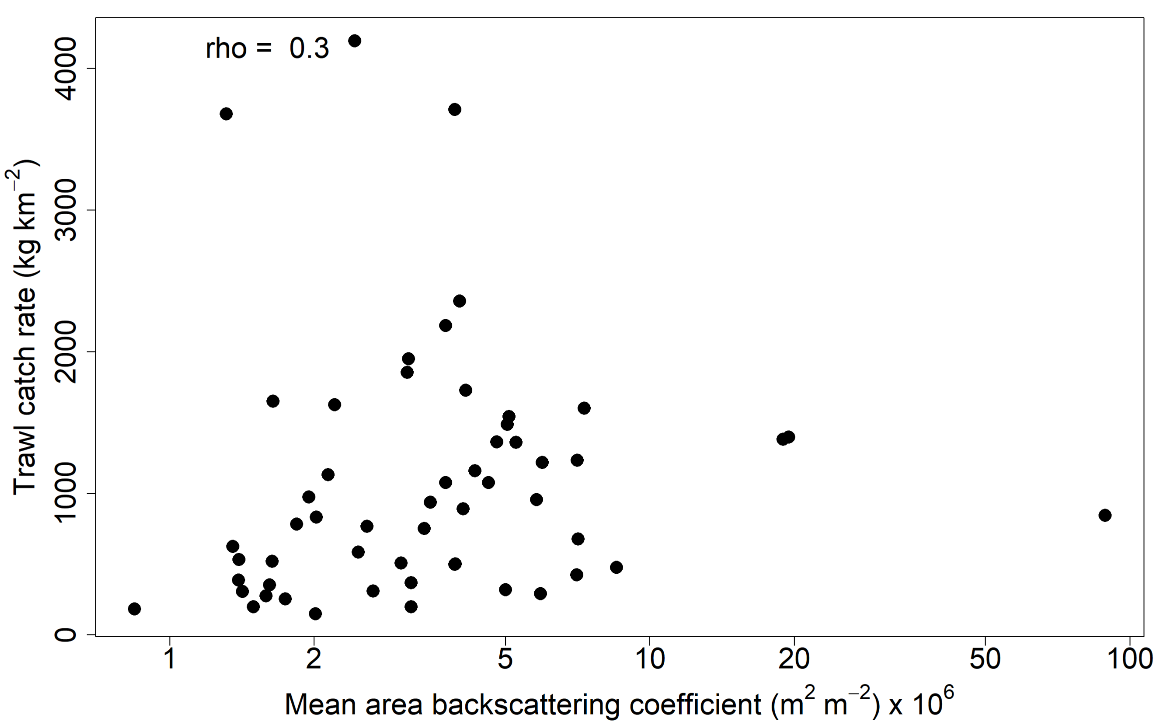

Figure 13: Relationship between total trawl catch rate (all species excluding benthic invertebrates) and acoustic backscatter recorded during the trawl in the Sub-Antarctic in 2024. Rho value is the Spearman's rank correlation coefficient.

Table 13: Proportion of total daytime backscatter in the Sub-Antarctic assumed to be mesopelagic fish. Estimates were derived from the observed proportion of nighttime backscatter in the upper 200 m in the three subareas without correcting 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
2020	0.58	0.54*	0.55
2022	0.66	0.46	0.67
2024	0.51	0.44	0.45

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

Table 14: Mesopelagic indices for the Sub-Antarctic. Indices were derived by multiplying daytime estimates of total backscatter by the estimated proportion of night backscatter in the upper 200 m, averaged for each region. Total indices were obtained as the weighted average of each region, 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; and * there was only one data point at Puysegur in 2016.

	Acoustic index (m^2/km^2)									
	East		Puysegur		Stewart-Snares		West		Total	
Year	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
2000	8.37	15.9	28.80	9.9	14.97	18.1	10.97	13.2	10.68	9.2
2001	9.12	22.0	29.90	44.9	12.34	15.8	11.41	13.0	10.68	11.8
2002	7.05	14.9	31.19	28.4	8.35	8.8	8.64	11.6	8.13	8.2
2003	7.90	31.5	18.92	14.9	9.52	6.8	8.35	17.2	8.54	16.7
2005	7.45	14.8	6.04	7.1	8.51	12.8	8.60	14.9	7.90	9.0
2006	4.09	15.7	3.38	13.3	5.12	9.4	4.84	12.4	4.45	8.8
2007	5.54	19.0	7.26	12.2	6.88	13.3	4.74	14.0	5.67	11.1
2008	8.03	15.2	13.26	11.9	11.49	24.1	6.57	14.0	8.52	10.7
2009	7.43	16.2	17.23	13.2	10.01	23.7	6.17	15.1	7.86	10.8
2011	13.81	12.1	10.61	8.8	13.18	7.6	9.15	7.2	12.59	7.6
2012	5.21	16.8	–	–	9.79	9.6	5.44	25.0	6.10	9.9
2014	10.27	11.2	19.70	16.6	19.14	11.2	11.10	18.0	12.08	7.4
2016	5.91	13.5	21.10	*	7.18	15.5	13.13	9.8	8.06	7.1
2018	13.64	20.6	18.14	10.5	17.66	13.1	12.30	13.3	14.25	11.7
2020	9.03	18.8	26.86	15.8	16.91	11.3	8.86	3.5	10.94	9.4
2022	8.93	11.2	12.75	14.4	15.91	10.7	11.12	23.1	10.92	7.9
2024	6.74	11.5	11.62	5.4	11.53	37.3	7.89	15.2	8.07	12.6

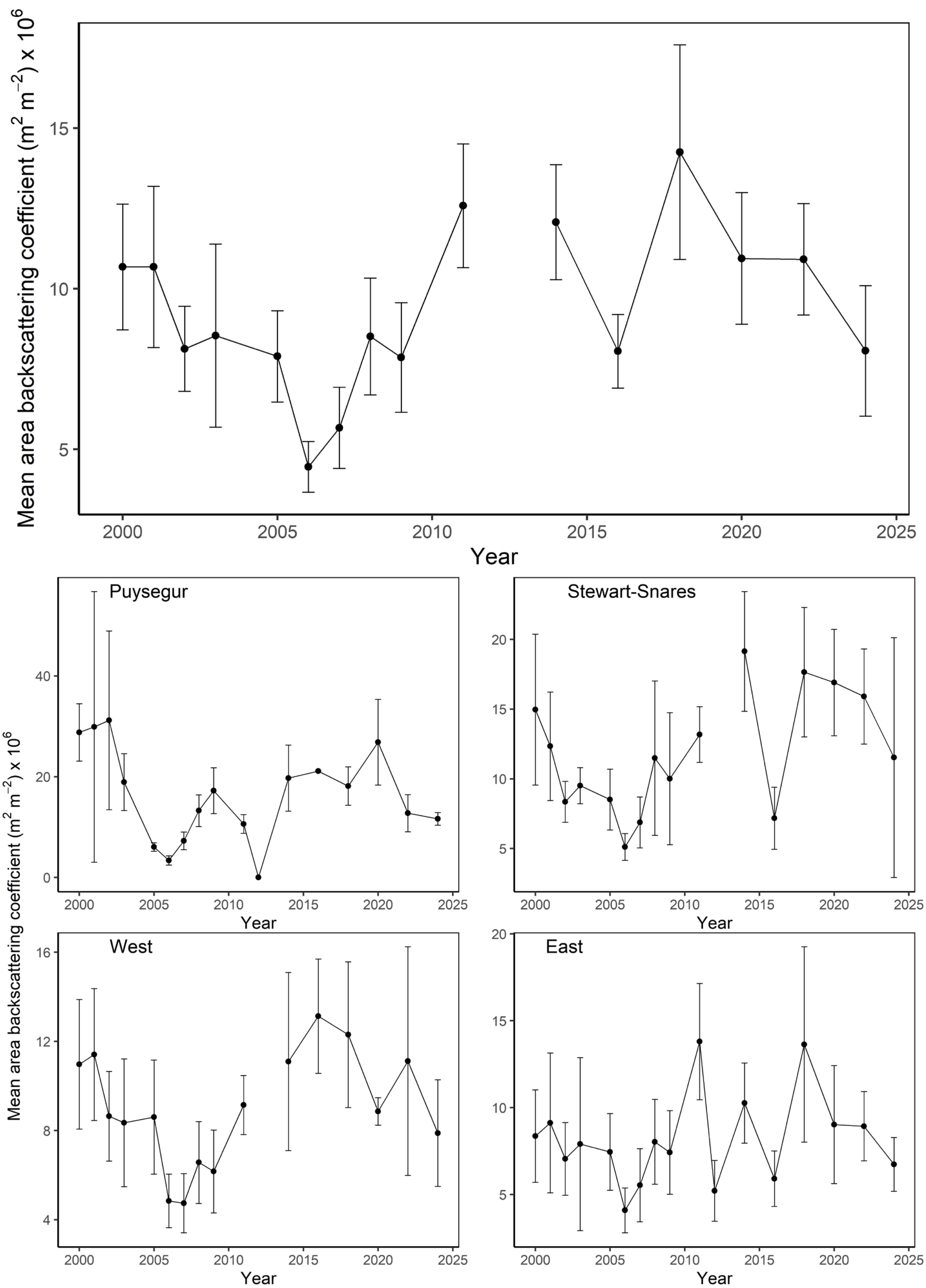

Figure 14: Time series of mesopelagic indices for the Sub-Antarctic (top panel) and by region (lower four panels). Mesopelagic indices for the Sub-Antarctic region (top panel) were obtained as the weighted average of region estimates, where weighting was the proportional area of the region (East 55.5% of total area, Puysegur 1.9%, Stewart-Snares 20.5%, West 22.1%). Error bars are ± 2 standard errors. Note that the 2012 survey did not produce any data suitable for acoustic analysis from Puysegur and there was only one data point for Puysegur in 2016.

3.10 Hydrological data

Temperature profiles were available from 71 CTD casts. Surface (5 m depth) temperatures in the survey area ranged between 7.2 and 12.8 °C and bottom temperatures were between 5.1 and 10.5°C. The warmest surface waters were at Puysegur and along the southern extent of the Stewart-Snares Shelf while the coldest surface temperatures were towards the southern and eastern extents of the survey ground (Figure 15). The warmest bottom temperatures were at the Puysegur Trench and Stewart-Snares Shelf, while the coldest bottom temperatures were in deep water on the northern Campbell Plateau (Figure 16). As in previous years, there was a general trend of increasing surface water temperatures towards the north and west (Figure 15).

The mean surface temperature of 10.0 °C in 2024 was 0.6 °C colder than that in 2022 but still above the long-term mean (9.9 °C) (Figure 17). The mean bottom temperature in 2024 (7.3 °C) was the highest in the time series, up slightly from 2022 which was the previous high, but only slightly higher than the mean temperatures observed since 2012. Overall, mean bottom temperature has been relatively steady, particularly since 2009. Mean bottom temperatures observed from 2002 to 2011 were 6.7–7.0 °C. Before 2002, temperature sensors were uncalibrated and cannot be compared.

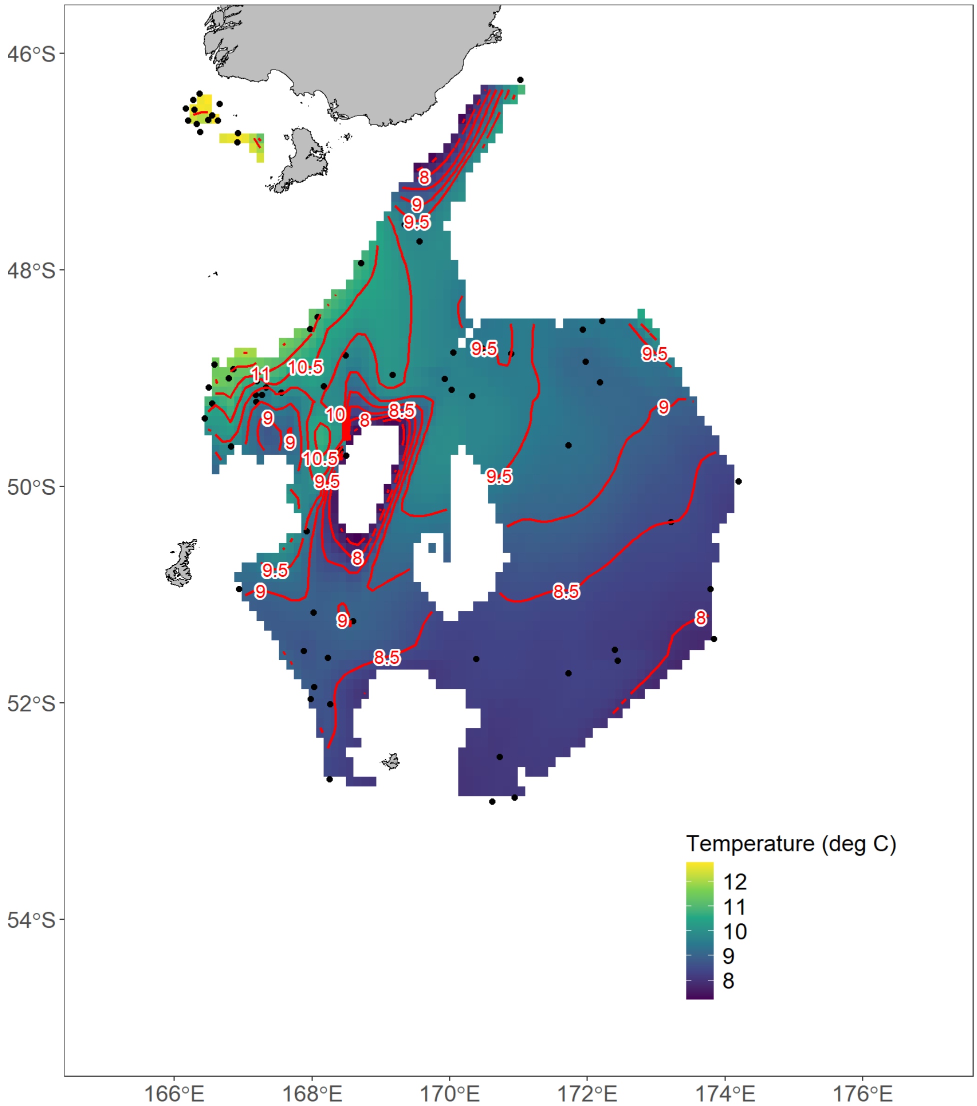

Figure 15: Surface water temperatures (°C). Points indicate station positions. Red contours show isotherms estimated using a cubic polynomial spline.

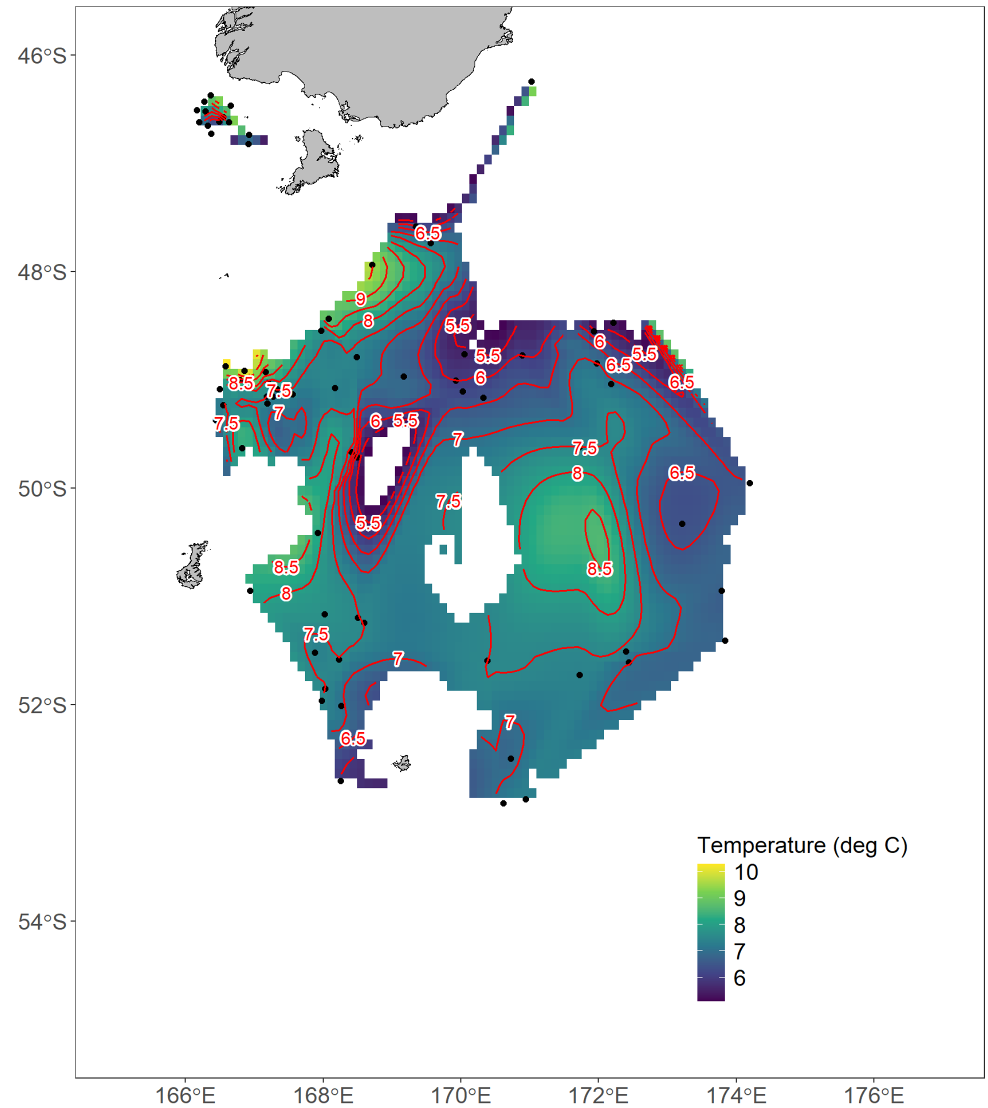

Figure 16: Bottom water temperatures (°C). Points indicate station positions. Red contours show isotherms estimated using a cubic polynomial spline.

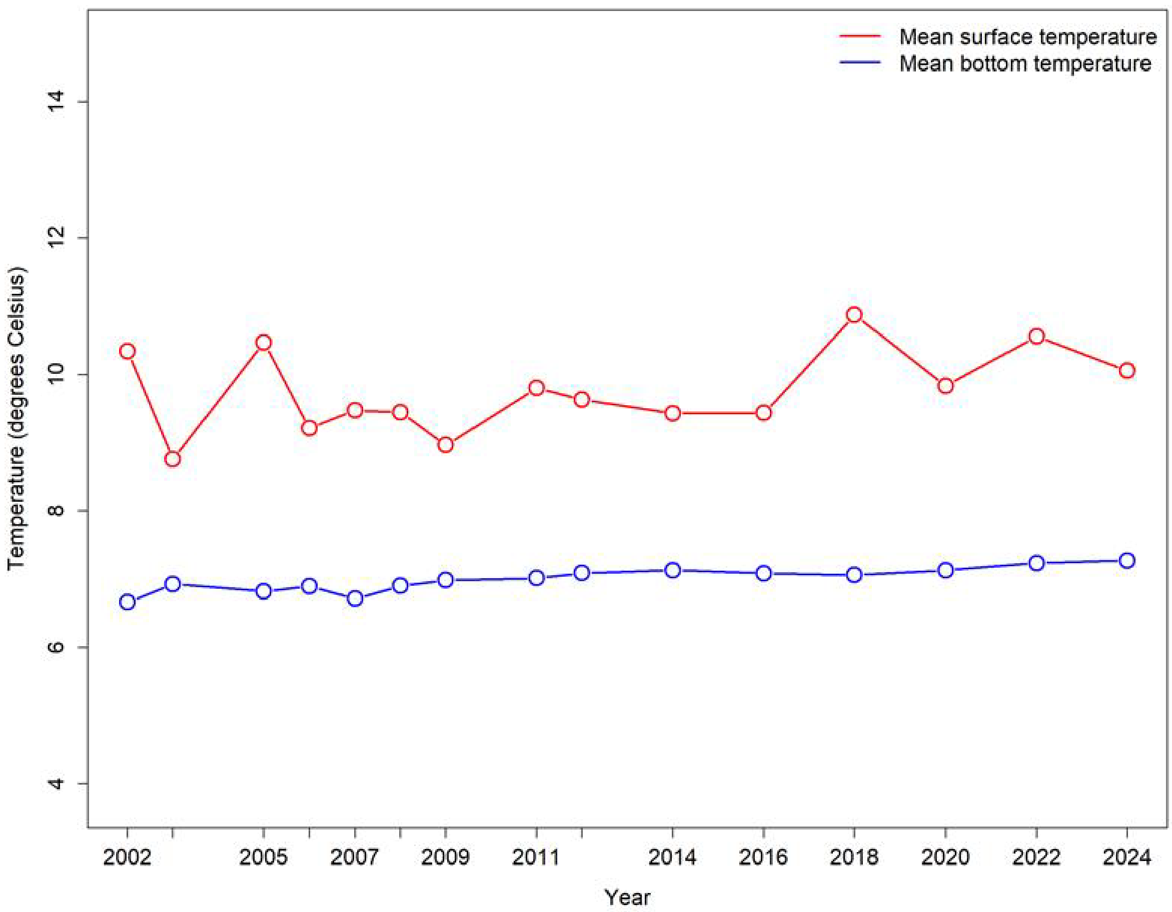

Figure 17: Mean surface and bottom CTD temperatures by year from surveys 2002–2024. Surveys prior to 2002 are not included as temperature sensors were not calibrated.

4. DISCUSSION AND CONCLUSIONS

The hoki biomass estimate for the core strata in 2024 was 62% higher than the 2022 estimate, which was 31% higher than the 2020 estimate, which in turn was 22% higher than the 2018 estimate. This follows a period of low estimates from 2014–2018, the second lowest period in the time series after the ‘four low years’ of 2003–2006. The utility of inputs from the Sub-Antarctic trawl survey into the stock assessment (proportions at age data, abundance indices) support the continuation of the time series. Other important commercial and non-commercial species are also monitored by the time series, which further supports its continuation.

Ling biomass estimates increased in 2020 and 2022, and the index was essentially unchanged in 2024, halting the decline from 2016. The three most recent estimates were similar to ling biomass from 2007 to 2011. Ling continued to show a broad length and age distribution, but fewer fish aged over 20 years were caught in 2024 compared with 2022. There were almost no ling aged over 25 years which is a notable difference with 2022, although 2024 is more similar to age frequencies in surveys earlier in the time series where ling older than 25 were rare.

The core estimate for hake was 23% higher than the 2022 estimate, and similar to the 2020 and 2018 estimates. The age distribution of hake in 2024 was similar to that in 2022 although there were fewer males and more females aged 3–5, more males but fewer females aged 6–10, and fewer fish of either sex aged 10–17.

For other important species the abundance estimates were higher for spiny dogfish, dark ghost shark, ribaldo, and silver warehou and lower for southern blue whiting, pale ghost shark, white warehou, javelinfish, lookdown dory, oblique banded rattail, and black oreo dory. For many Tier 2 species, this time series provides the only fisheries-independent estimates of abundance in the Sub-Antarctic area, as well as providing biological data (length, sex, reproductive condition, and age). It is difficult to assess the ‘quality’ of trawl estimates for many of these species because there are often no alternative indices of abundance to assist in validation, either from stock assessment or reliable catch-per-unit-effort (CPUE) indices. However, the relatively good precision (low 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 monitors a variety of species well, including lookdown dory, javelinfish, pale ghost shark, and ribaldo (Bagley et al. 2013a). Biomass estimates for all species, length frequencies for those that are measured, and other data such as geographic distributions are available on the Trawl Survey Information Portal https://tsip-uat.niwa.co.nz/home

Acoustic data collected on the survey showed a similar spatial distribution to that observed in previous years. Total daytime backscatter was slightly higher in 2024 than in 2022. The proportion of acoustic backscatter in 2024 decreased in the upper 200 m and increased below 400 m at night compared to previous surveys. There was a significant positive correlation between daytime acoustic backscatter in the bottom 50 m and trawl catches. Significant positive correlations between backscatter and catches ($p < 0.05$) have been observed in 2000, 2001, 2003, 2005, 2007, 2008, 2009, 2011 and 2020 (O’Driscoll 2002, O’Driscoll & Bagley 2003a, 2004, 2006b, 2009, Bagley et al. 2009, Bagley & O’Driscoll 2012, Bagley et al. 2013b, Stevens et al. 2022, Stevens et al. 2023), but not in 2002, 2004, 2006, 2012, 2014, 2016 or 2018 (O’Driscoll & Bagley 2003b, 2006a, 2008, Bagley et al. 2014, 2017, O’Driscoll et al. 2018, MacGibbon et al. 2019). Near-bottom layers may also contain mesopelagic species, which contribute to the acoustic backscatter, but which are not sampled by the bottom trawl due to being too small (e.g., O’Driscoll et al. 2009), and conversely some fish caught by the trawl may not be measured acoustically (e.g., species close to bottom in the acoustic deadzone). The overall acoustic index of mesopelagic fish abundance was lower than that in 2022, and below the average of the time series. The four sub-areas all showed decreases in the acoustic index.

Mean surface temperature decreased from 2022 but was still above the long term mean for the time series. Mean bottom temperature increased slightly from 2022 to a new time series high.

5. ACKNOWLEDGEMENTS

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APPENDIX 1: DESCRIPTION OF THE MIDDLE MEPTH GONAD STAGING GUIDE USED FOR TELEOSTS.

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.

APPENDIX 2: STATION DETAILS AND CATCH OF HOKI, HAKE, AND LING.

Station	Date	Stratum	Start Latitude (S)	Start Longitude (E)	Distance (n. mile)	Hoki (kg)	Hake (kg)	Ling (kg)
1	26/11/2024	0028	46 14.64	171 01.31	2.78	22.5	-	-
2	26/11/2024	0028	46 37.10	170 42.06	3.01	-	3.5	-
3	27/11/2024	0004	47 27.45	169 49.78	3.07	20.5	-	-
4	27/11/2024	003A	47 34.80	169 20.68	3.00	908.8	2.4	78.2
5	27/11/2024	0004	47 44.07	169 33.68	3.11	789.1	11.1	44.8
6	27/11/2024	003A	47 56.11	168 42.87	3.01	71.9	-	169.5
7	29/11/2024	0025	46 53.14	167 04.33	3.02	26.0	119.7	-
8	29/11/2024	0025	46 49.31	166 54.72	3.03	24.3	201.2	-
9	29/11/2024	0002	46 44.17	166 55.44	3.11	168.9	-	144.3
10	29/11/2024	0025	46 37.16	166 37.76	3.03	86.5	62.8	16.0
11	29/11/2024	0025	46 36.77	166 29.17	3.02	35.8	128.9	3.4
12	29/11/2024	0025	46 39.18	166 19.33	2.98	7.7	59.8	-
13	30/11/2024	0001	46 28.04	166 39.59	3.05	7.4	-	61.0
14	30/11/2024	0001	46 22.14	166 22.09	2.99	117.6	-	403.7
15	30/11/2024	0001	46 25.87	166 16.55	2.98	356.9	15.1	342.5
16	30/11/2024	0001	46 30.57	166 10.00	3.08	-	-	342.1
17	30/11/2024	0002	46 37.07	166 11.98	3.08	20.4	-	40.5
18	30/11/2024	0002	46 31.14	166 17.22	3.10	55.1	62.1	247.2
19	1/12/2024	0002	46 34.25	166 32.68	3.02	33.9	31.1	46.0
20*	1/12/2024	-	46 43.42	166 22.64	3.13	-	-	-
21	2/12/2024	003A	48 26.15	168 04.61	3.01	21.7	-	184.4
22	2/12/2024	003A	48 32.64	167 58.19	3.04	208.7	12.4	365.4
23	2/12/2024	0004	48 47.31	168 29.24	3.06	1972.0	6.2	137.1
24	2/12/2024	0004	48 58.05	169 10.07	3.07	120.7	13.1	6.8
25	3/12/2024	0011	49 09.75	170 19.34	3.14	57.7	12.2	34.8
26	3/12/2024	0011	49 06.41	170 01.66	3.00	62.6	-	3.3
27	3/12/2024	0028	49 00.19	169 55.62	3.07	62.2	-	-
28	3/12/2024	0028	48 45.59	170 03.15	2.18	9.3	5.4	-
29	4/12/2024	0027	48 43.53	170 28.44	3.13	22.0	-	-
30	4/12/2024	0011	48 46.42	170 53.40	2.98	97.6	-	24.0
31	4/12/2024	0027	48 32.87	171 55.80	3.03	8.2	-	-
32	4/12/2024	0027	48 28.18	172 13.03	3.01	-	-	-
33	6/12/2024	0012	48 50.66	171 58.47	3.06	84.1	-	33.8
34	6/12/2024	0012	49 02.16	172 10.76	2.98	105.6	-	70.7
35	6/12/2024	0012	49 37.17	171 43.43	3.04	2.6	-	31.5
36	7/12/2024	0011	49 57.28	174 11.58	2.24	10.1	-	17.0
37	7/12/2024	0012	50 19.82	173 12.79	3.00	57.4	-	25.6
38	7/12/2024	0015	50 56.87	173 46.90	3.04	54.8	-	14.3
39	8/12/2024	0015	51 24.61	173 49.92	3.08	80.0	-	51.3
40	8/12/2024	0013	51 36.55	172 26.02	2.34	23.7	-	32.1
41	8/12/2024	0013	51 30.41	172 24.02	3.02	78.2	-	14.7
42	8/12/2024	0013	51 43.57	171 43.19	2.99	27.8	-	28.8
43	10/12/2024	0013	51 35.70	170 22.88	3.06	43.9	-	50.1
44	11/12/2024	0014	52 29.74	170 43.56	3.05	41.4	6.8	37.4
45	11/12/2024	0014	52 52.42	170 56.28	2.99	86.1	-	44.6
46	11/12/2024	0014	52 54.49	170 36.82	2.59	69.6	-	36.4
47	14/12/2024	0010	52 42.20	168 14.99	3.07	23.9	6.2	15.5
48	14/12/2024	0010	52 00.79	168 15.57	3.07	822.1	8.3	67.2
49	14/12/2024	0007	51 57.76	167 58.90	3.00	235.4	10.1	117.7

*oblique mesopelagic trawl, not suitable for biomass estimation

Appendix 2 (continued).

Station	Date	Stratum	Start Latitude (S)	Start Longitude (E)	Distance (n. mile)	Hoki (kg)	Hake (kg)	Ling (kg)
50	14/12/2024	0007	51 51.22	168 01.84	3.03	185.9	4.4	119.2
51	15/12/2024	0007	51 31.24	167 52.88	3.03	282.2	-	118.7
52	15/12/2024	0010	51 34.83	168 13.84	2.99	516.6	-	59.5
53	15/12/2024	0009	51 14.61	168 35.89	3.10	463.4	-	168.6
54	15/12/2024	0009	51 11.66	168 30.07	3.02	922.0	9.7	103.7
55	16/12/2024	0009	51 09.81	168 01.30	3.06	88.5	-	136.7
56	16/12/2024	0006	50 56.97	166 56.47	3.11	58.9	4.7	61.0
57	16/12/2024	0006	50 24.77	167 55.31	2.76	9.1	10.8	26.5
58	17/12/2024	0008	49 42.89	168 29.69	2.93	313.3	10.3	131.4
59	17/12/2024	0008	49 40.14	168 24.53	3.03	255.5	-	141.7
60	17/12/2024	0008	49 04.56	168 10.33	3.01	194.6	-	72.4
61	17/12/2024	005B	49 07.82	167 33.14	3.05	376.8	7.3	150.9
62	18/12/2024	005B	49 05.20	167 19.84	3.01	194.4	19.4	53.8
63	18/12/2024	005B	49 01.61	167 11.87	3.01	96.6	16.1	132.1
64	18/12/2024	003B	48 55.50	167 09.82	3.04	-	-	62.9
65	18/12/2024	003B	48 54.88	166 51.60	3.04	-	-	5.5
66	18/12/2024	003B	48 52.39	166 35.12	3.05	118.9	-	33.9
67	19/12/2024	0006	49 37.91	166 49.58	3.03	506.7	8.0	169.8
68	19/12/2024	005A	49 22.19	166 26.60	3.00	206.4	11.5	101.2
69	19/12/2024	005A	49 13.94	166 32.70	3.05	295.1	17.1	124.9
70	19/12/2024	005A	49 05.16	166 30.09	3.05	252.0	25.2	263.8
71	19/12/2024	003B	48 59.92	166 47.30	3.03	151.5	5.0	19.9
72	20/12/2024	005A	49 09.33	167 10.86	2.97	179.6	-	151.6
73	20/12/2024	005B	49 09.37	167 16.52	2.94	185.6	6.3	18.8
74	20/12/2024	005A	49 13.18	167 11.15	3.05	531.2	55.2	81.1

APPENDIX 3: SPECIES CAUGHT DURING TAN2413

Scientific and common names of species caught from all tows (includes oblique mesopelagic tow carried out at Solander Trough). The occurrence (Occ.) of each species is the number of stations in which a species was caught. Note that species codes are continually updated on the database following this and other surveys.

Scientific name	Common name	Species	Occ.
Porifera	unspecified sponge	ONG	7
Demospongiae (siliceous sponges)			
Heteroscleromorpha			
Haplosclerida			
Callyspongiidae			
Dactylia palmata	sponge	DPA	1
Poecilosclerida (bright sponges)			
Crellidae			
Crella incrustans	orange frond sponge	CIC	1
Hymedesmiidae			
Phorbas sp.	grey fibrous massive sponge	PHB	1
Suberitida			
Suberitidae			
Suberites affinis	fleshy club sponge	SUA	7
Tetractinellida			
Astrophorida (sandpaper sponges)			
Ancorinidae			
Rhabdastrella sp.	pink ice egg sponge	RHA	1
Geodiidae			
Geodia vestigifera	ostrich egg sponge	GVE	1
Pachymatisma sp.	rocky dumpling sponge	PAZ	1
Spirophorina (spiral sponges)			
Tetillidae			
Antarctotetilla leptoderma	furry oval sponge	TLD	4
Tetilla australis	bristle ball sponge	TTL	1
Hexactinellida (glass sponges)			
Lyssacinosida (tubular sponges)			
Rossellidae			
Hyalascus sp.	floppy tubular sponge	HYA	20
Cnidaria			
Scyphozoa	unspecified jellyfish	JFI	11
Atollidae			
Atolla wyvillei	Atolla jellyfish	AWY	1
Rhopalonematidae	jellyfish	RHP	1
Anthozoa			
Octocorallia			
Malacalcyonacea/Scleralcyonacea	gorgonian octocoral	GOC	1
Hexacorallia			
Actinaria (anemones)			
Actiniidae			
Bolocera spp.	deepsea anemone	BOC	2
Liponematidae			
Liponema spp.	deepsea anemone	LIP	1
Actinostolidae (smooth deepsea anemones)		ACS	10
Hormathiidae (warty deepsea anemones)		HMT	14
Scleractinia (stony corals)			
Flabellidae			
Flabellum spp.	flabellum coral	COF	3

Appendix 3 (continued)

Scientific name	Common name	Species	Occ.
Zoantharia (zoanthids)			
Epizoanthidae			
Epizoanthus sp.		EPZ	3
Hydrozoa (hydroids)	unspecified hydroids	HDR	1
Leptothecata, Anthoathecata (excluding Stylasteridae)		HDF	1
Siphonophorae (siphonophores)	unspecified siphonophores	ZSP	1
Tunicata			
Thaliacea			
Salpida (salps)	unspecified salps	SAL	3
Salpidae			
Soestia zonaria	salp	ZZO	1
Thetys vagina	salp	ZVA	2
Mollusca			
Gastropoda (gastropods)			
Hipponidae			
Malluvium calcareum	cap limpet	MCC	1
Ranellidae (tritons)			
Fusitriton magellanicus		FMA	14
Turridae (turrids)			
Comitas onokeana vivens		COV	1
Volutidae (volutes)	unspecified volute	VOL	3
Cephalopoda			
Teuthoidea (squids)	unspecified squid	SQX	2
Oegopsida			
Cranchiidae	unspecified cranchiid	CHQ	1
Teuthowenia pellucida	squid	TPE	1
Brachioteuthidae			
Brachioteuthis spp.	squid	SQB	2
Histioteuthidae (violet squids)			
Histioteuthis spp.	violet squid	VSQ	4
Lycoteuthidae			
Lycoteuthis lorigera	crowned firefly squid	LSQ	3
Octopoteuthidae			
Octopoteuthis spp.		OPO	2
Ommastrephidae			
Nototodarus sloanii	Sloan's arrow squid	NOS	36
Todarodes angolensis		TAG	19
T. filippovae		TSQ	5
Onychoteuthidae			
Moroteuthopsis ingens	rough-skinned clubhook squid	MIQ	54
Onykia robsoni & O. n. sp. ‘splendens’	slender clubhook squid	MRQ	9
Octopodiformes			
Octopoda	unspecified octopus	OCP	1
Cirrata (cirrate octopus)			
Opisthoteuthidae			
Opisthoteuthis spp.	umbrella octopus	OPI	6
Incirrata (incirrate octopus)			
Octopodidae			
Graneledone kubodera + G. taniwha	deepwater octopus	DWO	7
Muusoctopus spp.	octopus	BNO	8
Octopus campbelli	octopus	OCA	1
O. mernoo	octopus	OME	1

Appendix 3 (continued)

Scientific name	Common name	Species	Occ.
Vampyromorpha			
Vampyroteuthidae			
Vampyroteuthis infernalis	vampire squid	VAM	1
Polychaeta			
Eunicidae		EUN	1
Pycnogonida	unspecified pycnogonid	PYC	2
Crustacea			
Cirripedia	unspecified barnacle	BRN	1
Euphausiacea	unspecified euphausiid	EUP	1
Malacostraca			
Decapoda			
Dendrobranchiata/Pleocyemata			
Dendrobranchiata			
Sergestidae			
Gennadas gilchristi	prawn	SAC	1
Sergestidae			
Eusergestes antarcticus	prawn	SAC	1
Pleocyemata			
Caridea			
Campylonotidae			
Campylonotus rathbunae	sabre prawn	CAM	3
Oplophoridae			
Acanthephyra spp.	sub-Antarctic ruby prawn	ACA	1
Notostomus auriculatus	scarlet prawn	NAU	2
Oplophorus spp.	deepwater prawn	OPP	2
Pasiphaeidae			
Pasiphaea barnardi	deepwater prawn	PBA	2
Nematocarcinidae			
Lipkius holthuisi	omega prawn	LHO	23
Achelata			
Astacidea			
Nephropidae (clawed lobsters)			
Metanephrops challengeri	scampi	SCI	2
Anomura			
Lithodoidea			
Lithodidae (king crabs)	unspecified king crab	KIC	1
Lithodes aotearoa	New Zealand king crab	LAO	2
L. robertsoni	Robertson’s king crab	LRO	2
Paralomis zealandica	prickly king crab	PZE	1
Paguroidea (Pagurid and parapagurid hermit crabs)		PAG	5
Parapaguridae (Parapagurid hermit crabs)			
Diacanthurus rubricatus	hermit crab	DIR	1
Sympagurus dimorphus	hermit crab	SDM	2
Lophogastrida			
Gnathophausiidae			
Gnathophausia sp.	giant red mysid	GNA	1
Chirostyloidea			
Chirostylidae			
Uroptychus spp.	squat lobster	URP	1
Brachyura (true crabs)			
Majidae (spider crabs)			
Jacquinotia edwardsii	giant spider crab	GSC	2
Teratomaia richardsoni	spiny masking crab	SMK	2

Appendix 3 (continued)

Scientific name	Common name	Species	Occ.
Amphipoda			
Hyperiidea			
Phrosinidae			
Primno macropa	barrel shrimp	ZBS	1
Isopoda	unspecified isopod	ISO	1
Echinodermata			
Asteroidea (starfish)			
Asteriidae			
Cosmasterias dyscrita	cat's-foot star	CDY	1
Sclerasterias mollis	cross-fish	SMO	1
Astropectinidae			
Dipsacaster magnificus	magnificent sea-star	DMG	9
Plutonaster knoxi	abyssal star	PKN	1
Psilaster acuminatus	geometric star	PSI	2
Goniasteridae			
Ceramaster patagonicus	pentagon star	CPA	3
Hippasteria phrygiana	trojan starfish	HTR	7
Lithosoma novaezelandiae	rock star	LNV	8
Pillsburiaster aoteanus	starfish	PAO	8
Solasteridae			
Crossaster multispinus	sun star	CJA	7
Pterasteridae			
Diplopteraster sp.	starfish	DPP	3
Zoroasteridae			
Zoroaster spp.	rat-tail star	ZOR	18
Ophiuroidea (basket & brittle stars)			
Euryalina (basket stars)			
Gorgonocephalidae			
Gorgonocephalus spp.	Gorgon's head basket stars	GOR	1
Ophiurida (brittle stars)			
Ophiodermatidae			
Bathypectinura heros	deepsea brittle star	BHE	1
Ophiuridae			
Ophiophthalmus relictus	deepsea brittle star	ORE	1
Echinozoa			
Echinoidea (sea urchins)			
Crinoidea			
Isocrinida (sea lilies)	unspecified sealilies	CRN	1
Cidaridae			
Goniocidaris parasol	parasol urchin	GPA	1
Echinothuriidae/Phormosomatidae	unspecified Tam O'Shanter urchin	TAM	6
Echinidae			
Dermechinus horridus	deepsea urchin	DHO	1
Holothuroidea	unspecified sea cucumber	HTH	1
Aspidochirotida			
Synallactidae			
Bathyplotes sp.	sea cucumber	BAM	3
Pseudostichopus mollis	sea cucumber	PMO	19
Elasipodida			
Laetmogonidae			
Laetmogone sp.	sea cucumber	LAG	1
Bryozoa	unspecified bryozoan	COZ	1

Appendix 3 (continued)

Scientific name	Common name	Species	Occ.
Chondrichthyes (cartilaginous fishes)			
Chimaeridae: chimaeras, ghost sharks			
Chimaera carophila	brown chimaera	CHP	1
C. lignaria	giant chimaera	CHG	1
Hydrolagus bemisi	pale ghost shark	GSP	62
H. novaezealandiae	dark ghost shark	GSH	18
Rhinochimaeridae: longnosed chimaeras			
Harriotta raleighana	longnose spookfish	LCH	34
Rhinochimaera pacifica	Pacific spookfish	RCH	11
Scyliorhinidae: cat sharks			
Apristurus exsanguis	New Zealand catshark	AEX	4
Bythaelurus dawsoni	Dawson's catshark	DCS	3
Cephaloscyllium isabella	carpet shark	CAR	1
Triakidae: smoothhounds			
Galeorhinus galeus	school shark	SCH	2
Squalidae: dogfishes			
Squalus acanthias	spiny dogfish	SPD	41
Centrophoridae: gulper sharks			
Centrophorus squamosus	leafscale gulper shark	CSQ	17
Deania spp.	shovelnose spiny dogfish	SND	14
Etmopteridae: lantern sharks			
Etmopterus granulosus	Baxter's dogfish	ETB	27
E. lucifer	lucifer dogfish	ETL	36
E. pusillus	smooth lanternshark	ETP	2
E. unicolor	shortspine dogfish	ETU	4
Somniosidae: sleeper sharks			
Centroselachus crepidater	longnose velvet dogfish	CYP	17
Centroscymnus owstoni	Owston’s dogfish	CYO	6
Proscymnodon plunketi	Plunket's shark	PLS	7
Dalatiidae: kitefin sharks			
Dalatias licha	seal shark	BSH	7
Oxynotidae: rough sharks			
Oxynotus bruniensis	prickly dogfish	PDG	3
Rajidae: skates			
Dipturus innominatus	smooth skate	SSK	7
Zearaja nasuta	rough skate	RSK	4
Arhynchobatidae: softnose skates			
Brochiraja asperula	smooth deepsea skate	BTA	7
B. spinifera	prickly deepsea skate	BTS	1
Osteichthyes (bony fishes)			
Notocanthidae: spiny eels			
Notacanthus sexspinis	spineback	SBK	36
Derichthyidae: longneck eels			
Derichthys serpentinus	serpent eel	DSE	1
Synaphobranchidae: cutthroat eels			
Diastobranchus capensis	basketwork eel	BEE	13
Congridae: conger eels			
Bassanago bulbiceps	swollenhead conger	SCO	26
B. hirsutus	hairy conger	HCO	22
Serrivomeridae: sawtooth eels			
Serrivomer samoensis	common sawtooth eel	SSA	1
Gonorynchidae: sandfishes			
Gonorynchus forsteri	sandfish	GFO	1

Appendix 3 (continued)

Scientific name	Common name	Species	Occ.
Argentinidae: silversides			
Argentina elongata	silverside	SSI	24
Bathylagidae: deepsea smelts			
Bathylagichthys parini	Parin's deepsea smelt	BPA	4
B. spp.	deepsea smelt	BAH	1
Melanolagus bericoides	bigscale blacksmelt	MEB	1
Platytroctidae: tubeshoulders			
Persparsia kopua	common tubeshoulder	PER	4
Alepocephalidae: slickheads			
Alepocephalus antipodianus	smallscaled brown slickhead	SSM	8
Diplophidae: portholefishes			
Diplophos rebainsi	Rebain's portholefish	DRB	1
Sternoptychidae: marine hatchetfishes			
Argyropelecus gigas	giant hatchetfish	AGI	2
Sternoptyx pseudodiaphana	false oblique hatchetfish	SPU	1
Phosichthyidae: lighthouse fishes			
Phosichthys argenteus	lighthouse fish	PHO	18
Woodsia meyerwaardeni	austral lightfish	WMY	1
Stomiinae: scaly dragonfishes			
Borostomias antarcticus	Southern snaggletooth	BAN	1
Chauliodontinae: viperfishes			
Chauliodus sloani	viperfish	CHA	2
Idiacanthinae: black dragonfishes			
Idiacanthus atlanticus	common black dragonfish	IAT	1
Stomiinae: scaly dragonfishes			
Melanostomias niger	black dragonfish	MNG	1
Stomiinae: scaly dragonfishes			
Stomias boa	scaly dragonfish	SBB	3
Notosudidae: waryfishes			
Scopelosaurus spp.	waryfishes	SPL	1
Paralepididae: barracudinas	unspecified barracudina	PAL	1
Magnisudis prionosa	giant barracudina	BCA	2
Neoscopelidae: blackchins			
Neoscopelus macrolepidotus	largescale blackchin	NML	1
Carapidae: pearlfishes			
Echiodon cryomargarites	messmate fish	ECR	1
Ophidiidae: cuskeels			
Genypterus blacodes	ling	LIN	62
Myctophidae: lanternfishes	unspecified lanternfish	LAN	1
Diaphus danae	Dana lanternfish	DDA	2
Electrona carlsbergi	Carlsberg's lanternfish	ELC	1
Gymnoscopelus bolini	Bolin's lanternfish	GYB	1
G. piabilis	southern blacktip lanternfish	GYP	1
Lampanyctus achirus	cripplefin lanternfish	LAC	1
L. australis	austral lanternfish	LAU	1
L. intricarius	intricate lanternfish	LIT	1
L. spp.	lanternfish	LPA	1
Lampanyctodes hectoris	Hector's lanternfish	LHE	2
Protomyctophum spp.	lanternfish	PRO	1
Trachipteridae: dealfishes			
Trachipterus trachypterus	dealfish	DEA	7
Euclichthyidae: eucla cods			
Euclichthys polynemus	eucla cod	EUC	1

Appendix 3 (continued)

Scientific name	Common name	Species	Occ.
Macrouridae: rattails			
Coelorinchus aspercephalus	oblique banded rattail	CAS	27
C. bollonsi	Bollons’ rattail	CBO	25
C. fasciatus	banded rattail	CFA	56
C. innotabilis	notable rattail	CIN	9
C. kaiyomaru	Kaiyomaru rattail	CKA	5
C. matamua	Mahia rattail	CMA	7
C. oliverianus	Oliver's rattail	COL	51
C. parvifasciatus	smallbanded rattail	CCX	6
Coryphaenoides dossenus	humpback rattail	CBA	6
C. serrulatus	serrulate rattail	CSE	4
C. subserrulatus	four-ray rattail	CSU	16
Lepidorhynchus denticulatus	javelinfish	JAV	71
Lucigadus nigromaculatus	blackspot rattail	VNI	20
Macrourus carinatus	ridge scaled rattail	MCA	21
Mesobius antipodum	black javelinfish	BJA	6
Trachyrincidae: rough rattails			
Trachyrincus aphyodes	white rattail	WHX	6
Moridae: morid cods			
Antimora rostrata	violet cod	VCO	4
Halargyreus sp.	Australasian slender cod	HAS	8
Lepidion microcephalus	small-headed cod	SMC	6
Mora moro	ribaldo	RIB	37
Notophycis marginata	dwarf cod	DCO	1
Pseudophycis bachus	red cod	RCO	9
Tripterophycis gilchristi	grenadier cod	GRC	1
Melanonidae: pelagic cods			
Melanonus gracilis	smalltooth pelagic cod	MEL	1
Merlucciidae: hakes			
Lyconus pinnatus	fangtooth hoki	LYC	2
Macruronus novaezelandiae	hoki	HOK	68
Merluccius australis	hake	HAK	35
Gadidae: true cods			
Micromesistius australis	southern blue whiting	SBW	23
Melamphaidae: bigscalefishes	unspecified bigscalefish	MPH	1
Poromitra atlantica	common bigscalefish	CBS	1
Diretmidae: discfishes			
Diretmus argenteus	discfish	DIS	2
Trachichthyidae: roughies, slimeheads			
Hoplostethus atlanticus	orange roughy	ORH	10
H. mediterraneus	silver roughy	SRH	5
Paratrachichthys trailli	common roughy	RHY	3
Berycidae: alfonsinsos			
Beryx splendens	alfonsino	BYS	2
Cyttidae: cyttid dories			
Cyttus novaezealandiae	silver dory	SDO	2
C. traversi	lookdown dory	LDO	35
Oreosomatidae: oreos			
Allocyttus niger	black oreo	BOE	8
Neocyttus rhomboidalis	spiky oreo	SOR	6
Pseudocyttus maculatus	smooth oreo	SSO	10
Zeniontidae: armoureye dories			
Capromimus abbreviatus	capro dory	CDO	2

Appendix 3 (continued)

Scientific name	Common name	Species	Occ.
Macroramphosidae: snipefishes, bellowsfishes			
Centriscops humerosus	banded bellowsfish	BBE	4
Sebastidae: sea perches			
Helicolenus barathri	bigeye sea perch	HBA	2
H. percoides	sea perch	HPC	2
Trachyscorpia eschmeyeri	Cape scorpionfish	TRS	1
Hoplichthyidae: ghostflatheads			
Hoplichthys cf. *haswelli*	deepsea flathead	FHD	8
Psychrolutidae: toadfishes			
Ambophthalmos angustus	pale toadfish	TOP	15
Psychrolutes microporos	blobfish	PSY	2
Polyprionidae: wreckfishes			
Polyprion oxygeneios	hāpuku	HAP	3
Epigonidae: deepwater cardinalfishes			
Epigonus lenimen	bigeye cardinalfish	EPL	6
E. telescopus	deepsea cardinalfish	EPT	5
Howellidae: pelagic basslets			
Rosenblattia robusta	robust pelagic basslet	ROS	1
Bramidae: pomfrets			
Brama australis	southern Ray's bream	SRB	9
Xenobrama microlepis	bronze bream	BBR	2
Uranoscopidae: armourhead stargazers			
Kathetostoma giganteum	giant stargazer	GIZ	24
Gempylidae: snake mackerels			
Rexea solandri	gemfish	RSO	17
Trichiuridae: cutlassfishes, scabbardfishes			
Lepidopus caudatus	frostfish	FRO	1
Centrolophidae: raftfishes, medusafishes			
Centrolophus niger	rudderfish	RUD	4
Pseudoicichthys australis	ragfish	RAG	2
Seriolella caerulea	white warehou	WWA	20
S. punctata	silver warehou	SWA	9
Bothidae: lefteye flounders			
Arnoglossus scapha	witch	WIT	2
Rhombosoleidae: southern righteye flounders			
Azygopus flemingi	spotted flounder	SDF	1
Achiropsettidae: finless flounders			
Neoachiropsetta milfordi	finless flounder	MAN	25

APPENDIX 4: SCIENTIFIC AND COMMON NAMES OF INVERTEBRATES IDENTIFIED FOLLOWING TAN2413

NIWA No.	Station No.	Class	Order	Family	Genus	Species
–	1	Cephalopoda	Oegopsida	Onychoteuthidae	*Onykia*	*robsoni*
–	1	Cephalopoda	Oegopsida	Ommastrephidae	*Todarodes*	*angolensis*
175768	2	Cephalopoda	Oegopsida	Brachioteuthidae	*Brachioteuthis*	cf. *linkovskyi*
–	2	Cephalopoda	Oegopsida	Ommastrephidae	*Todarodes*	*angolensis*
–	2	Cephalopoda	Oegopsida	Onychoteuthidae	*Onykia*	n. sp.
–	2	Cephalopoda	Oegopsida	Onychoteuthidae	*Onykia*	*robsoni*
–	3	Cephalopoda	Oegopsida	Onychoteuthidae	*Moroteuthopsis*	*ingens*
–	5	Cephalopoda	Oegopsida	Onychoteuthidae	*Onykia*	n. sp.
–	5	Cephalopoda	Oegopsida	Ommastrephidae	*Nototodarus*	*sloanii*
–	6	Cephalopoda	Oegopsida	Ommastrephidae	*Nototodarus*	*sloanii*
–	7	Cephalopoda	Oegopsida	Onychoteuthidae	*Moroteuthopsis*	
–	7	Cephalopoda	Vampyromorpha	Vampyroteuthidae	*Vampyroteuthis*	
–	7	Cephalopoda	Oegopsida	Ommastrephidae	*Todarodes*	*filippovae*
–	8	Cephalopoda	Oegopsida	Ommastrephidae	*Todarodes*	*filippovae*
–	8	Cephalopoda	Oegopsida	Ommastrephidae	*Nototodarus*	*sloanii*
–	9	Cephalopoda	Oegopsida	Ommastrephidae	*Nototodarus*	*sloanii*
–	11	Cephalopoda	Oegopsida	Ommastrephidae	*Nototodarus*	*sloanii*
–	11	Cephalopoda	Oegopsida	Octopoteuthidae	*Octopoteuthis*	
–	12	Cephalopoda	Oegopsida	Lycoteuthidae	*Lycoteuthis*	
–	13	Cephalopoda	Oegopsida	Ommastrephidae	*Nototodarus*	*sloanii*
–	14	Cephalopoda	Oegopsida	Ommastrephidae	*Nototodarus*	*sloanii*
–	15	Cephalopoda	Oegopsida	Ommastrephidae	*Nototodarus*	*sloanii*
–	15	Cephalopoda	Oegopsida	Ommastrephidae	*Nototodarus*	*sloanii*
175770	16	Cephalopoda	Oegopsida	Lycoteuthidae	*Lycoteuthis*	
–	16	Cephalopoda	Oegopsida	Ommastrephidae	*Nototodarus*	*sloanii*
–	16	Cephalopoda	Oegopsida	Ommastrephidae	*Nototodarus*	*sloanii*
–	16	Cephalopoda	Oegopsida	Ommastrephidae	*Nototodarus*	*sloanii*
–	16	Cephalopoda	Oegopsida	Ommastrephidae	*Nototodarus*	*sloanii*
175769	17	Cephalopoda	Oegopsida	Onychoteuthidae	*Moroteuthopsis*	
–	17	Cephalopoda	Oegopsida	Ommastrephidae	*Nototodarus*	*sloanii*
–	18	Cephalopoda	Oegopsida	Ommastrephidae	*Nototodarus*	*sloanii*
178669	20	Malacostraca	Euphausiacea	Euphausiidae	*Euphausia*	*lucens*
–	20	Cephalopoda	Oegopsida	Cranchiidae	*Teuthowenia*	*pellucida*
–	20	Cephalopoda	Oegopsida	Cranchiidae	*Teuthowenia*	*pellucida*
–	20	Cephalopoda	Oegopsida	Cranchiidae	*Teuthowenia*	*pellucida*
175763	20	Cephalopoda	Oegopsida	Cranchiidae	*Galiteuthis*	
–	20	Cephalopoda	Oegopsida	Octopoteuthidae	*Octopoteuthis*	*rugosa*
–	20	Cephalopoda	Vampyromorpha	Vampyroteuthidae	*Vampyroteuthis*	
175766	20	Cephalopoda	Oegopsida	Gonatidae	*Gonatus*	cf. *antarcticus*
175767	20	Cephalopoda	Oegopsida	Onychoteuthidae	*Moroteuthopsis*	
175765	20	Cephalopoda	Oegopsida	Onychoteuthidae	*Notonykia*	*nesisi*
175764	20	Cephalopoda	Oegopsida	Histioteuthidae	*Histioteuthis*	*macrohista*
–	20	Cephalopoda	Oegopsida	Histioteuthidae	*Histioteuthis*	*atlantica*
–	20	Cephalopoda	Oegopsida	Histioteuthidae	*Histioteuthis*	*atlantica*

Appendix 4 continued

–	20	Cephalopoda	Oegopsida	Ommastrephidae	*Todarodes*	*filippovae*
–	20	Cephalopoda	Oegopsida	Ommastrephidae	*Todarodes*	*filippovae*
–	20	Cephalopoda	Oegopsida	Histioteuthidae	*Histioteuthis*	*macrohista*
–	21	Cephalopoda	Oegopsida	Ommastrephidae	*Nototodarus*	*sloanii*
178538	22	Demospongiae	Haplosclerida	Phloeodictyidae	*Oceanapia*	sp. 04
178539	22	Demospongiae	Tetractinellida	Vulcanellidae	*Poecillastra*	*ducitriaena*
–	23	Cephalopoda	Oegopsida	Histioteuthidae	*Histioteuthis*	aff. *atlantica*
–	23	Cephalopoda	Oegopsida	Ommastrephidae	*Nototodarus*	*sloanii*
–	24	Cephalopoda	Oegopsida	Ommastrephidae	*Nototodarus*	*sloanii*
–	27	Cephalopoda	Oegopsida	Brachioteuthidae	*Brachioteuthis*	
178544	29	Thecostraca	Pollicipedomorpha	Pollicipedidae	*Anelasma*	*squalicola*
–	39	Cephalopoda	Sepiolida	Sepiolidae	*Stoloteuthis*	*maoria*
–	44	Cephalopoda	Oegopsida	Lycoteuthidae	*Lycoteuthis*	
–	46	Cephalopoda	Oegopsida	Lycoteuthidae	*Lycoteuthis*	
–	46	Cephalopoda	Oegopsida	Lycoteuthidae	*Lycoteuthis*	
–	46	Cephalopoda	Oegopsida	Lycoteuthidae	*Lycoteuthis*	
175762	47	Cephalopoda	Oegopsida	Cranchiidae	*Taonius*	
–	47	Cephalopoda	Oegopsida	Histioteuthidae	*Histioteuthis*	cf. *atlantica*
175761	47	Cephalopoda	Oegopsida	Onychoteuthidae	*Moroteuthopsis*	
178537	47	Asteroidea	Spinulosida	Echinasteridae	*Henricia*	
–	48	Cephalopoda	Sepiolida	Sepiolidae	*Stoloteuthis*	*maoria*
–	51	Cephalopoda	Oegopsida	Lycoteuthidae	*Lycoteuthis*	
–	54	Cephalopoda	Oegopsida	Ommastrephidae	*Nototodarus*	*sloanii*
–	56	Cephalopoda	Oegopsida	Ommastrephidae	*Nototodarus*	*sloanii*
–	56	Cephalopoda	Oegopsida	Ommastrephidae	*Nototodarus*	*sloanii*
–	56	Cephalopoda	Oegopsida	Ommastrephidae	*Nototodarus*	*sloanii*
–	56	Cephalopoda	Oegopsida	Ommastrephidae	*Nototodarus*	*sloanii*
–	61	Cephalopoda	Oegopsida	Ommastrephidae	*Nototodarus*	*sloanii*
178540	63	Demospongiae	Tetractinellida	Tetillidae	*Cinachyra*	sp. 01
–	65	Cephalopoda	Oegopsida	Ommastrephidae	*Nototodarus*	*sloanii*
–	68	Cephalopoda	Oegopsida	Octopoteuthidae	*Octopoteuthis*	
–	68	Cephalopoda	Oegopsida	Ommastrephidae	*Nototodarus*	*sloanii*