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Trawl survey of middle depth fish abundance on the west coast South Island, August 2016 (TAN1609)

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A trawl survey of the west coast South Island (WCSI) was carried out from 2 to 20 August 2016. This was the fourth in a time-series of trawl estimates for middle depth species from the WCSI, with previous surveys in 2000, 2012, and 2013. Species monitored by the trawl survey include important commercial species such as hake and ling, as well as a wide range of non-commercial fish and invertebrate species. Hoki was not a target species for the 2016 survey. The trawl survey was extended deeper in 2016 (from 800 to 1000 m) to improve coverage of deepwater bycatch species.

A total of 58 successful random trawl survey tows were completed in 11 strata north of Hokitika Canyon. Trawl abundance estimates and sampling CVs (in parentheses as a percentage) were estimated for three different areas: 'core' (2000 survey area from 300–650 m); 'all' (2012–13 survey area from 200–800 m); and 'deep' (2016 survey area from 200–1000 m). Estimates for 'all' in 2016 were 1661 t (13 %) for ling and 355 t (16 %) for hake. The trawl estimate of hake abundance in 2016 was less than half of that from 2013 (747 t), and the ling estimate was also 17% lower than that in 2013. Hake were also caught in the new deeper strata, and the 2016 estimate for 'deep' was 502 t (13%). Estimates for spiny dogfish, dark ghost shark, and hoki from the 2016 trawl survey were also lower than those from 2013, but estimates for silver warehou and lookdown dory were similar to those in 2013, and estimates for some other species (e.g., sea perch, giant stargazer) were higher. A notable observation was the reappearance of gemfish in the survey area. Very few gemfish were caught in surveys from 2000–13, but small gemfish were widespread from 200–430 m depth in 2016. These were mainly small gemfish from 20–45 cm which may indicate recent recruitment.

Ling catch rates were highest at 300–430 m depth in the north of the survey area. The length and age frequencies for ling were relatively broad and similar to those in previous WCSI surveys. Hake mainly occurred deeper than 500 m, with highest catch rates between 650 and 900 m. Hake catches in 2016 included a high proportion of smaller fish from the 2014 year-class.

As well as supporting the stock assessments for hake and ling, the trawl survey provides information on a number of bycatch species. A total of 181 species or species groups were caught, and 25 645 fish or squid of 109 different species were measured during the 2016 survey. Otoliths were collected from ling, hake, silver warehou, sea perch, lookdown dory, alfonsino, gemfish, and ribaldo. Reproductive measurements were made on 130 female sharks from 9 deepwater species.

1. INTRODUCTION

The west coast South Island (WCSI) is known as the main fishery for spawning hoki, but it is also a key fishery for a number of other middle depth species including hake and ling (Ministry for Primary Industries 2016).

A series of acoustic surveys targeting hoki were carried out on the WCSI from 1988–2000 (reviewed by O'Driscoll 2002). However, there was much uncertainty over the abundance indices from the 1997 and 2000 surveys because of the species mix in the northern strata. Following a review of results from the 2000 survey, Francis & O'Driscoll (2004) proposed a combined trawl and acoustic survey as a practical approach to measuring hoki abundance more consistently. The trawl component of a combined survey would also provide relative abundance estimates for other species in the northern area, including ling, hake, silver warehou, and lookdown dory (O'Driscoll et al. 2004).

Two WCSI surveys using the new combined trawl and acoustic design were carried out in 2012 (O'Driscoll et al. 2014) and 2013 (O'Driscoll et al. 2015a). These surveys were designed so that trawl surveys results were comparable to the random trawl component from the 2000 WCSI survey.

O'Driscoll et al. (2015b) reviewed the trawl and acoustic components of the WCSI survey to inform future survey design. That report concluded that trawl estimates from the northern area did not appear to be providing reliable indices of hoki abundance. Hoki trawl indices were highly variable from 2000–13 and were not consistent with changes in WCSI acoustic indices over the same period, estimated hoki abundance from trawl surveys in the Sub-Antarctic, or western spawning stock biomass estimated from the hoki stock assessment model. However, the trawl survey component provided fisheries-independent abundance estimates for hake, ling, and associated middle depth species. Trawl abundance estimates of hake and ling appeared to be consistent and of high quality, with relatively good precision (CVs less than 20%). The surveys also provided length and age frequencies for these species, and covered an appropriate spatial and depth distribution.

New Zealand's hake fisheries are certified as sustainable by the Marine Stewardship Council. Hake on the WCSI (HAK 7) is the largest hake fishery in New Zealand, with an estimated annual value of $3.5 million. The stock assessment for hake on the west coast South Island (HAK 7) was accepted for the first time in 2013 after incorporation of the 2000 and 2012 trawl survey series provided a 'reliable' abundance index (Horn 2013). Additional points in the trawl survey abundance time series should provide a better stock assessment in future.

The majority of New Zealand's ling fisheries are certified as sustainable by the Marine Stewardship Council. Ling on the WCSI (LIN 7) is one of the largest ling fisheries in New Zealand, with an estimated annual value of around NZ $11.4 million. The stock assessment for ling on the west coast South Island (LIN 7) was accepted in 2012 but 'with reservations' (Dunn et al. 2013). There is little contrast in the abundance index to allow for estimation of the magnitude of the biomass. However, the trawl survey is a valuable monitoring tool to measure any changes in abundance over time.

In addition to supporting the stock assessments for these two Tier 1 deepwater fisheries, the trawl survey provides information on a number of Tier 2 species including lookdown dory, sea perch, javelinfish, dark ghost shark, and ribaldo. For most of these species, the trawl survey provides the only fisheries-independent estimate of abundance on the WCSI, as well as providing biological data (length, sex, reproductive condition, age, etc.). Trawl estimates also provide data that could be used in the future to develop species-based, size-based, and trophodynamic ecosystem indicators (e.g. Tuck et al. 2009).

1.1 Project objectives

This report is the final reporting requirement for Ministry for Primary Industries Research Project DEE2016/03. The overall objective of this project is to estimate relative abundance indices for hake (*Merluccius australis*) and ling (*Genypterus blacodes*) off the west coast South Island. The specific objectives were as follows:

1. To continue the time series of relative abundance indices of hake and ling on the west coast South Island with a target coefficient of variation (CV) of the estimate of 30%.

2. To collect data for determining the age and size structure of hake, ling and other middle depth species.

3. To collect and preserve specimens of unidentified organisms taken during the trawl survey.

2. METHODS

2.1 Survey design

A key aspect of the survey design was to ensure consistency with trawl surveys in 2000, 2012, and 2013. This required the survey to be carried out from *Tangaroa* using the same trawl gear used for previous surveys. The 2016 survey was carried out from 2–20 August, which was over approximately the same time period as random trawling in previous surveys in 2000 (25 July to 31 August), 2012 (22 July to 14 August), and 2013 (1–18 August).

The trawl estimate was based on a stratified random trawl survey design (after Francis 1984). The trawl survey area in 2016 was based on the same strata used in 2012 and 2013, retaining the sub-stratification of Strata 1&2, and 4 used in the 2000 survey (Cordue 2002). There were four changes to the survey area in 2012 to improve coverage of other key species, particularly hake and ling (O'Driscoll et al. 2014). These were:

- Stratum 1&2 was extended further north from 40.8°S to 40.6°S to better cover the distribution of hoki and ling catches;
- Stratum 4D (650–800 m) was added to fully sample the offshore distribution of hoki, hake, and ribaldo in that area;
- Stratum 1&2S and 4S (200–300 m) were added to improve trawl indices for silver warehou, barracouta, frostfish, and gemfish.

The 2016 survey area (Figure 1, Table 1) was the same as that in 2012 and 2013, but with addition of two deeper strata (4E and 4F).Trawling in the new deeper strata had lower priority than that in the core strata, and was carried out at the end of the survey.

A total of 52 phase 1 stations was planned, based on a statistical analysis of catch rate data from the 2012 and 2013 surveys using the *allocate* programme (Francis 2006). A minimum of 3 and a maximum of 15 stations per stratum was used, with target sampling CVs of 20% for hake and ling, 25% for hoki, giant stargazer, sea perch, lookdown dory, and dark ghost shark, and 30% for silver warehou and spiny dogfish (Table 2). The allocation was run with a target CV of 20% for hake and ling because we believed that the MPI stated target of 30% would not provide sufficient certainty for ongoing monitoring and assessment (Alistair Dunn, Fisheries New Zealand, pers. comm.). Three phase 1 stations were arbitrarily allocated to each of the two new deeper strata 4E and 4F. This allocation gave a lower number of stations than were carried out on surveys in 2013 (65 valid tows) and in 2012 (63 tows), and a similar number of tows to 2000 (when there were 47 tows in only six strata: 1&2A, 1&2B, 1&2C, 4A, 4B, 4C). The reduced number of phase 1 stations for 2016 was because surveys in 2012 and 2013 were designed to achieve a CV of 20% for hoki, which is no longer one of the key target species.

In previous surveys there was no allowance for phase 2 stations. In 2016 we allowed 1–2 days for phase 2, if required, to reduce CVs for hake and ling. As phase 2 was not required, 6 additional stations were carried out in the new deeper strata (4E and 4F) (Table 1).

2.2 Vessel and equipment

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

2.3 Trawling procedure and biological sampling

Random trawling followed the standardised procedures described by Hurst et al. (1992). Station positions were selected randomly before the voyage using the Random Stations Generation Program (Version 1.6) developed by NIWA. A minimum distance between tows of 3 n. miles was used. If a station was found to be on foul ground, a search was made for suitable ground within 3 n. miles of the station position. If no suitable ground could be found, the station was abandoned and another random position was substituted. Random bottom tows were only carried out during daylight hours, with all random tows carried out between 0755 h and 1759 h NZST. At each station the trawl was towed for 3 n. miles at a speed over the ground of 3.5 knots. If foul ground was encountered, or the trawl hauled early due to reducing daylight or strong marks on the net monitor, the tow was included as valid only if at least 2 n. miles was covered.

Measurements of doorspread (from a SCANMAR ScanBas system), headline height (from a Furuno CN22 net monitor), and vessel speed (GPS speed over the ground, cross checked against distance travelled during the tow) were recorded every 5 min during each tow and average values calculated. Towing speed and gear configuration for random tows were maintained as constant as possible during the survey, following the guidelines given by Hurst et al. (1992). Acoustic recordings were made for all tows using the multi-frequency hull-mounted transducers.

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

An approximately random sample of up to 200 individuals of each commercial, and some common non-commercial, species from every successful tow was measured and sex determined. More detailed biological data were also collected on a subset of species and included fish weight, sex, gonad stage, gonad weight, and occasional observations on stomach fullness, contents, and prey condition. Otoliths were taken from hake and ling for age determination. Otoliths were also taken from silver warehou, sea perch, lookdown dory, alfonsino, gemfish, and ribaldo for future ageing work. A description of the macroscopic gonad stages used for teleosts and elasmobranchs is given in Appendix 2. Liver and gutted weights were recorded from up to 20 hoki per tow to determine condition indices. Opportunistic measurements were made on the reproductive condition of female deepwater sharks.

2.4 Other data collection

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

Acoustic data were collected during trawling and while steaming between trawl stations (both day and night) with the *Tangaroa* multi-frequency (18, 38, 70, 120, and 200 kHz) Simrad EK60 echosounders with hull-mounted transducers. All frequencies are regularly calibrated following standard procedures (Demer et al. 2015), with a calibration immediately following this voyage on 27 August 2016 in the Marlborough Sounds.

2.5 Trawl data analysis

Doorspread biomass was estimated by the swept area method of Francis (1981, 1989) as implemented in the analysis programme *SurvCalc* (Francis 2009). Total survey abundance was estimated for all species in the catch. The catchability coefficient (an estimate of the proportion of fish in the path of the net which is caught) is the product of vulnerability, vertical availability, and areal availability. These factors were set at 1 for the analysis, the assumptions being that fish were randomly distributed over the bottom, that no fish were present above the height of the headline, and that all fish within the path of the trawl doors were caught. Only data from random trawl tows where the gear performance was satisfactory (codes 1 or 2) were included for estimating abundance. Scaled length frequencies were calculated for the key species with *SurvCalc*, using length-weight data from this survey (Table 3).

Hake and ling otoliths were prepared and aged using validated ageing methods (hake, Horn (1997); ling, Horn (1993)). All available hake and ling otoliths were aged. 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).

3. RESULTS

3.1 Data collection

All survey objectives were completed. Weather conditions were generally very good, with wind speeds less than 20 knots. No survey time was lost due to bad weather. About 5 hours was lost on 8 August due to an electrical fault with the port trawl winch controls. This was fixed by the ship’s engineers.

A total of 58 successful trawl survey tows were completed in 11 strata (Figure 1, Table 1). Individual station details from all tows, including the catch of hoki, hake and ling are listed in Appendix 1. All tows were considered suitable for abundance estimation. No phase 2 tows were required as CVs for hake (16.1%) and ling (12.5%) were both less than 20% after phase 1. The four days allocated to phase 2 and/or bad weather were used for carrying out 6 extra random trawls in the deeper strata (4E and 4F) at the end of the survey.

3.2 Gear performance

Gear parameters by depth for valid trawl survey tows are summarised in Table 4. Headline height and doorspread were obtained for all successful tows. Measured gear parameters in 2016 were generally within the range of those obtained on the valid tows from the 2000 and 2012 surveys where the same gear was used (Table 5), although headline height was slightly higher on average and doorspread slightly lower; possibly because of the very good weather and sea conditions in 2016. Mean doorspread distances and headline heights for the 2000–16 WCSI surveys were also consistent with those from the *Tangaroa* hoki and middle depths time series surveys on the Chatham Rise (e.g., Stevens et al. 2014) and Sub-Antarctic (Bagley et al. 2014).

3.3 Catch

A total catch of 56.7 t was recorded from all tows. From the 180 species or species groups caught, 105 were teleosts, 29 elasmobranchs, 8 squids or octopuses, 12 crustaceans, and 14 echinoderms, the remainder comprising assorted benthic and pelagic animals (Appendix 3). The green weight of the top 50 species is given in Table 6, with hoki accounting for 50.7%, ling 11.5%, frostfish 6.2%, barracouta 4.9%, giant stargazer 3.4%, and hake 2.1% of the total catch from all tows.

3.4 Trawl abundance estimates

Abundance estimates and the trawl survey catch for core, all, and deep strata are given in Table 7. Abundance estimates and CVs (in parentheses) for 'all' strata were 1661 t (13 %) for ling and 355 t (16%) for hake. The core strata abundance estimate of 1635 t for ling was similar to the total estimate, and no ling were caught in the new deep (800–1000 m) strata. The estimate for hake from the core strata was 221 t, and the estimate including the deep strata of 502 t (13%) was 41% higher than that the 'all' estimate (Table 7). Target CVs were met for ling and hake (both target 20%), giant stargazer, sea perch, lookdown dory, and dark ghost shark (all target 25%), but exceeded for hoki (target 25%), silver warehou, and spiny dogfish (both target 30%).

Abundance estimates by stratum are given in Table 8. Very few hake or ling were caught in the 200–300 m shallow strata 4S and 1&2S (Table 8, Figure 2). Stratum 1&2A accounted for 60% of the ling abundance in 2016, similar to the contribution from this stratum in 2013 (64%), and slightly lower than the 70% contribution in 2012 (Figure 2). In strata deeper than 300 m, ling abundance decreased with increasing depth. Hake were most abundant in strata deeper than 500 m (1&2C, 4C, 4D, and 4E) (Figure 2). The shallow strata between 200–300 m accounted for most of the abundance of giant stargazer, barracouta, northern spiny dogfish and tarakihi, and were also important for school shark (Table 8, Figure 3). The new deep strata 4E and 4F (800–1000 m) had higher abundance estimates for smooth skin dogfish, Plunket's shark, and longnose velvet dogfish (Table 8, Figure 3). Abundance estimates for ribaldo and shovelnose dogfish were highest in stratum 4C, but both species were also found deeper, with the new deep strata accounting for 20% of the total (deep) abundance for both species (Table 8).

Trawl estimates from 2016 were compared to previous surveys in the WCSI time series (Table 9 and Figure 4). The 'all' area trawl estimate of hake abundance in 2016 (355 t) was less than half of that from 2013 (747 t), and the ling estimate (1661 t) was also 17% lower than that in 2013 (2194 t). Estimates for spiny dogfish, dark ghost shark, and hoki from the 2016 trawl survey were also lower than those from 2013, but estimates for silver warehou and lookdown dory were similar to those in 2013, and estimates for some other species (e.g., sea perch, giant stargazer) were higher. A notable observation was the reappearance of gemfish in the survey area. Very few gemfish were caught in surveys from 2000–13, but small gemfish were widespread from 200–430 m depth in 2016, and the all area abundance estimate was an order of magnitude higher than in 2013 (Table 9, Figure 4).

3.5 Species distribution

Catch rates of key species are plotted in Figure 5. As noted in Section 3.4, hake mainly occurred deeper than 500 m, with highest catch rates between 650 and 900 m in stratum 4D and 4E (Figure 5). Ling catch rates were highest between 300–430 m in the northern part of stratum 1&2A (Figure 5). Hoki catch rates were highest in 300–500 m, with one very large catch (13.1 t) in stratum 1&2A. The highest catch rates of giant stargazer, barracouta, northern spiny dogfish, tarakihi, school shark, and silver dory were in shallow strata less than 300 m (Figure 5). Ribaldo and shovelnose dogfish had the highest catch rates deeper than 650 m. Gemfish were widespread from 200–430 m depth (Figure 5).

3.6 Biological data

A total of 25 645 fish and squid of 109 different species were measured (Table 10). Of these, 8485 fish were also individually weighed (Table 10). Additional data on fish condition (liver and gutted weight) were recorded from 543 hoki. Pairs of otoliths were removed from 453 ling, 543 hake, 186 silver warehou, 664 sea perch, 364 lookdown dory, 193 alfonsino, 306 gemfish, and 131 ribaldo.

Population scaled length frequencies, calculated using length-weight data in Table 3, are presented for key species in Figure 6 and compared to previous surveys in 2000, 2012, and 2013. The length frequency distribution for ling was broad, and similar to the three previous surveys, with fish between 40 and 140 cm (Figure 6). Most ling were ages 3 to 20 years (Figure 7). Hake catches in 2016 included a mode of small fish from 35–45 cm (Figure 6). These were hake of age 2 from the 2014 year-class (Figure 8). Hake larger than 70 cm were far less abundant than in the three previous surveys (Figure 6). Most large hake in 2016 were females aged 5–12 years (Figure 8). Several modes were present in the hoki scaled length frequency (Figure 6), including small hoki at 27–38 cm (age 1 year from the 2015 year-class) and relatively high numbers at 40–58 cm (age 2 years from the 2014 year-class). The main length mode of larger hoki was between 60 and 100 cm. The modal length of silver warehou in 2016 of about 50 cm was similar to that in previous surveys, but few of the small (less than 30 cm) silver warehou, observed in 2012, were taken in 2016 (Figure 6). The increase in gemfish abundance in 2016 (see Figure 4) was mainly of small gemfish from 20–45 cm (Figure 6), likely ages 1–2 years, which may indicate good recent recruitment. Most other key species had similar length frequencies to previous surveys (Figure 6). The length distribution for barracouta was relatively narrow in 2016, with a mode at about 65 cm, which may indicate a dominant year-class (Figure 6).

Gonad staging of fish and elasmobranchs showed that many species were in spawning condition during the survey (Table 11). Fish in active spawning stages (gonad stages 4–6) accounted for 40% of ling females, and 7% of hake females. Most female hake were immature (stage 1) or maturing (gonad stage 3) (Table 11). Hoki were also actively spawning throughout the survey period, with 38% of female hoki maturing (stage 3), 16% spawning (stages 4–6) and 18% spent (stage 7) in research catches. A high proportion of hoki caught in deeper strata (greater than 500 m) were spent females. Other species of teleosts with more than 200 observations and over 50% of fish in maturing and spawning condition (gonad stages 3–6) included giant stargazer, silver dory, barracouta, Bollon's rattail and Oliver's rattail. Many female lookdown dory and tarakihi were spent (stage 7) or resting (stage 2). For elasmobranchs, 69% of the spiny dogfish females had pups (stage 5).

Measurements on the reproductive organs of 130 female sharks from nine deepwater species were also collected. Most measurements were collected on Owston's dogfish, (48), leafscale gulper shark (30), and shovelnose dogfish (20). About 80% of the female leafscale gulper sharks were mature, with a rarely observed pregnant female caught, as well as a large hermaphrodite (135 cm), with both male and female gonads.

3.7 Acoustic data

Although not a specific objective, over 50 GB of acoustic data were collected using the *Tangaroa* suite of multi-frequency echosounders (18, 38, 70, 120, and 200 kHz) throughout the voyage. No acoustic analysis was carried out for this project, but acoustic data may provide 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 help in interpretation of trawl survey results. In the future, acoustic estimates of mesopelagic fish may also be important when developing a trophic ecosystem model (e.g., O'Driscoll et al. 2011).

3.8 Hydrological data

The water column was weakly stratified with surface temperatures of 13.0–13.9° C (Figure 9) and bottom temperatures of 5.8–13.1° C (Figure 10). Highest surface temperatures were in the north of the survey area (Figure 9). Bottom temperature decreased with depth, with the lowest bottom temperatures in stratum 4F (Figure 10). There was no evidence from the survey for particularly unusual environmental conditions in 2016, with temperatures being in the range of those from previous surveys in 2012 (O'Driscoll et al. 2014) and 2013 (O'Driscoll et al. 2015a).

4. DISCUSSION

The WCSI survey has evolved: from a hoki acoustic survey in 1988–2007, with limited target trawling for mark identification (e.g., Cordue & Ballara 1998); to a design incorporating random bottom trawling to inform species mix in 2000 (Cordue 2002); to a combined acoustic and trawl survey design in 2012 and 2013 (O'Driscoll et al. 2014, 2015a); and now (in 2016), to a random trawl survey only, where hoki are no longer a target. The 2016 survey was successfully completed and was the fourth in a time-series of trawl estimates for ling and hake from the WCSI. In addition to supporting the stock assessments for these two Tier 1 deepwater fisheries, the trawl survey provides information on a number of bycatch species.

The timing of WCSI trawl surveys in 2000 and 2012–13 was driven by the need to obtain a concurrent acoustic index of spawning hoki. To allow comparability with results from the 2000–13 surveys, the 2016 trawl survey was carried out from 2–20 August. O'Driscoll et al. (2015b) explored the timing of the trawl survey component with respect to hoki, hake and ling based on an analysis of commercial fishing catch and effort in FMA7 over the period June-September in all years from 2000 to 2011. They concluded that there are strong reasons why the survey needs to be in July-August for hoki and no clear reasons to indicate more appropriate timing for hake and ling. Commercial catches of hake and ling are mainly taken from June to September, at the same time as the hoki fishery. Date does not enter CPUE models for hake as an explanatory variable (Ballara 2013). Trawl CPUE for ling declined from July to August, but was uncertain, while longline CPUE for ling was highest in September (Dunn et al. 2013). Gonad stage data from observed catches from 2000–13 showed some evidence of hake and ling spawning on the WCSI in late August to September (O'Driscoll et al. 2015b). Research trawl catches in 2016 showed that a relatively high proportion of ling (40% of females) were actively spawning during the survey, but most hake were pre-spawning. Estimated CVs for hake and ling were less than 20% for all four WCSI surveys (see Table 9), which does not suggest that there are particular issues with these species being aggregated at the time of the survey. An earlier (June) timing may also be appropriate for these species, but any later would lead to increased overlap with observed spawning in September. Carrying out the trawl survey outside the June-September period would be risky, as the distribution and abundance of hake and ling on the WCSI outside the main period of commercial fishing is poorly known. If an alternate timing is adopted for the trawl component, then this would represent the start of a new time-series.

The survey area (see Figure 1) was based on the same six strata used in all previous WCSI acoustic surveys, retaining the sub-stratification of Strata 1&2, and 4 used in the 2000 survey (Cordue 2002). There were four changes to the survey area in 2012 to improve coverage of other key species, particularly hake and ling (see Section 2.1). Data from commercial fisheries and the 2012 and 2013 trawl surveys suggested that the 2012 survey area (referred to as 'all' in this report) appeared to have an appropriate spatial and depth distribution in the northern area for hake and ling, as well as for silver warehou, silver dory, alfonsino, smooth skate, sea perch, javelinfish, lookdown dory, and dark ghost shark (O'Driscoll et al. 2015b). Coverage of species with a more inshore distribution (giant stargazer, spiny dogfish, barracouta, school shark, northern spiny dogfish, jack mackerel, frostfish, arrow squid, and tarakihi) was improved by the inclusion of shallower strata (1&2S and 4S) from 2012, but densities of these nine species are still likely to be considerable inshore of 200 m. O'Driscoll et al. (2015b) concluded that the survey did not extend deep enough for shovelnose dogfish, and possibly ribaldo. The addition of deeper strata 4E and 4F from 800–1000 m in 2016 improved the survey coverage for shovelnose dogfish, ribaldo, and other deepwater species (notably deepwater sharks) (see Figure 3), and also revealed that there was a significant amount of hake deeper than 800 m, with 29% of the estimated total ('deep') hake biomass in 2016 coming from the new deep strata (see Figure 2).

The trawl survey is restricted to the region north of Hokitika Canyon, but commercial catches show that the distribution of hake and ling extends into the Hokitika Canyon and along the shelf to the south (O'Driscoll et al. 2015b). The southern region is characterised by canyons with a steeply sloping shelf. The rough bottom topography means that much of the area is unsuitable for bottom trawling and therefore cannot be easily incorporated in a random trawl survey. As a consequence, use of trawl survey estimates from the northern area only as indices for the entire WCSI (or FMA7) relies on the assumption that a constant proportion of the stock resides within the northern trawlable area.

The estimate of hake biomass ('all' area) was less than half of the estimate from 2013, and only a third of the estimate from 2012 (see Table 9). Similarly 'core' area estimates of hake declined since 2000 (see Figure 4). The most recent assessment for HAK 7 was carried out in 2013 using fisheries data up to the end of the 2010–11 fishing year (Horn 2013). The assessment used catch-at-age from the commercial fishery since 1989–90, *Tangaroa* research surveys in 2000 and 2012, a CPUE series from 2001 to 2011, and estimates of biological parameters. The prior for the trawl survey catchability (q) was informed based on the Sub-Antarctic hake survey priors. The assessment was indicative of a stock that had been steadily fished down throughout the 1990s, but is very likely to be currently above the management target of 40% B_0 set by Fisheries New Zealand. Horn (2013) noted that improved confidence in the assessment of this hake stock will probably be achieved if the winter research survey series is continued, and an updated HAK 7 assessment incorporating 2013 and 2016 trawl survey results is scheduled for 2017. There was some evidence from the 2016 survey of recent hake recruitment, with a mode of fish from the 2014 year-class at age 2 years (see Figure 8).

Estimated ling biomass in 2016 was 17% lower than that in 2013 (see Table 9). The stock assessment for LIN 7WC (west coast South Island) was last updated in 2013 (Dunn et al. 2013). Model input data include catch histories, trawl fishery CPUE, extensive catch-at-age data from the trawl fishery, sparse catch-at-age data from the line fishery, biomass estimates and proportion-at-age from *Tangaroa* trawl surveys in 2000 and 2012, and estimates of biological parameters. A line fishery CPUE series was available, but was rejected as unlikely to be indexing stock abundance. Both biomass indices (trawl survey and CPUE) provided information on the minimum biomass of the stock, but little information on the upper limit. As for hake, the prior for the survey q was important in the model and was estimated using the Sub-Antarctic trawl survey priors as a starting point because the survey series in both areas used the same vessel and fishing gear. The ling assessment was accepted, with reservations. The status of the LIN 7WC stock in 2013 was highly uncertain, although the absolute virgin biomass was highly likely to have been greater than 50 000 t, and the exploitation rate was not high (Dunn et al. 2013). The data were not very informative about biomass, with the priors contributing as much as the data to the biomass estimates. An updated LIN 7WC assessment incorporating 2013 and 2016 trawl survey results is scheduled for 2017.

O'Driscoll et al. (2015b) concluded that trawl estimates from the northern area did not appear to be providing reliable indices of hoki abundance. Hoki estimates were highly variable between the 2000, 2012, 2013, and 2016 trawl surveys (see Table 9). There was a six-fold increase in estimated hoki abundance in the core trawl strata between 2000 and 2012, a halving in 2013, and a further large reduction (by 45%) in 2016. O'Driscoll et al. (2015a) suggested that the most likely explanation for variability in trawl indices for hoki was that there were changes in vertical availability. Regardless of the explanation, the amount of variability in northern trawl estimates on the WCSI is not consistent with changes in WCSI acoustic indices over the same period (O'Driscoll et al. 2015a), estimated hoki abundance from trawl surveys in the Sub-Antarctic (Bagley et al. 2014), or western spawning stock biomass estimated from the hoki stock assessment model (McKenzie 2015).

A notable observation was the reappearance of gemfish in the survey area in 2016. Very few gemfish were caught in surveys from 2000–13, but small gemfish were widespread from 200–430 m depth in

2016, and the abundance estimate was an order of magnitude higher than in 2013 (see Figure 4). Commercial landings of gemfish on the WCSI (SKI 7) were over 1000 t annually from 1983–84 to 1988–89, but then declined. The TACC was reduced to 300 t in 1997–98 and gemfish catches in the past 10 years were 144–301 t (Ministry for Primary Industries 2016). The assessment of the southern gemfish stock (SKI 3&7) has not been updated since 1997.

Other middle depth species were also monitored by this survey. None of the other stocks of species potentially monitored by the WCSI surveys are currently formally assessed (Ministry for Primary Industries 2016). However, for most Tier 2 species, the trawl survey provides the only fisheries-independent estimate of abundance on the WCSI, as well as providing biological data (length, sex, reproductive condition, age, etc.). It is difficult to assess the "quality" of trawl estimates for many of these species based on surveys in 2000–16, as there are often no alternative indices of abundance (either from stock assessment or reliable CPUE indices). However, the relatively good precision (CVs) of survey estimates, consistency of abundance estimates and length frequency distributions between surveys, and appropriate spatial and depth distribution, suggest that the WCSI survey provides potential for monitoring species including lookdown dory, sea perch, silver warehou, javelinfish, dark ghost shark, and ribaldo.

Understanding change in the marine ecosystem is becoming increasingly important to provide context for fisheries management and decision making about sustainable fishing. Indicators are important for monitoring different types of change, and more than one type of indicator is required, particularly within the context of climate change. The level of biological sampling on the 2016 WCSI survey was among the most comprehensive of any New Zealand survey. As noted in Section 2.3, all items in the catch are sorted and weighed, and large numbers of individuals were measured and weighed (see Table 10). In the future this high level of sampling will allow development of ecosystem indicators. Ecosystem indicators derived from trawl survey data have been developed elsewhere, and used successfully to identify the effects of fishing on fish communities (review by Tuck et al. 2009). The most commonly used indicators were based on measures of diversity or fish size (mean size or size spectra), but indicators incorporating trophic level were also considered. Routine data collection of catch weight by species by tow means that species-based indicators could be estimated for the core survey area in 2000–16, but size-based indicators could only be calculated for 2012–16, when a much wider range of species was measured.

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7. TABLES

Table 1: Stratum depth boundaries, areas, and numbers of planned and completed stations for the 2016 WCSI survey. Trawl station locations are shown in Figure 1 with station details in Appendix 1.

				Number of trawls	
Stratum name	Stratum code	Depth (m)	Area (km^2)	Planned	Completed
1&2S	12S	200–300	1 450	3	3
1&2A	12A	300–430	1 214	8	8
1&2B	12B	430–500	1 028	6	6
1&2C	12C	500–650	3 148	5	5
4S	4S	200–300	1 600	4	4
4A	4A	300–430	786	7	7
4B	4B	430–500	592	3	3
4C	4C	500–650	1 455	3	3
4D	4D	650–800	1 655	7	7
4E	4E	800–900	1 192	3	6
4F	4F	900–1 000	2 097	3	6
Total			16 217	52	58

Table 2: Numbers of stations required to achieve a target CV of 20% for hake (HAK) and ling (LIN), 25% for hoki (HOK), giant stargazer (GIZ), sea perch (SPE), lookdown dory (LDO), and dark ghost shark (GSH), and 30% for silver warehou (SWA) and spiny dogfish (SPD) are given by species. Three phase 1 stations were arbitrarily allocated to each of the two new deeper strata 4E and 4F. –, not applicable.

	Number of tows									
Stratum	HAK	LIN	HOK	SWA	GIZ	SPD	SPE	LDO	GSH	ALL
12A	3	8	3	3	3	3	3	3	4	8
12B	3	3	6	3	3	3	3	3	3	6
12C	3	3	5	5	3	3	3	3	3	5
12S	3	3	3	3	3	3	3	3	3	3
4A	3	3	6	3	3	7	3	3	4	7
4B	3	3	3	3	3	3	3	3	3	3
4C	3	3	3	3	3	3	3	3	3	3
4D	7	3	3	3	3	3	3	3	3	7
4S	3	3	3	3	4	3	3	3	3	4
4E	–	–	–	–	–	–	–	–	–	3
4F	–	–	–	–	–	–	–	–	–	3
Total	31	32	35	29	28	31	27	27	29	52

Table 3: Length-weight regression parameters* used to scale length frequencies for the top key species. Where data source is given as '4 WCSI surveys' length-weight parameters were estimated from combined data from TAN0007, TAN1210, TAN1308, and TAN1609.

			Regression parameters					
Common name	Code	Trip	*a*	*b*	r^2	n	Length range (cm)	Data source
Alfonsino	BYS	TAN0007	0.011277	3.185276	96.97	151	19.2–42.8	TAN0007
		TAN1210	0.010840	3.204823	93.60	717	18.8–42.8	4 WCSI surveys
		TAN1308	0.015798	3.090934	94.43	261	19.2–29.7	TAN1308
		TAN1609	0.010840	3.204823	93.60	717	18.8–42.8	4 WCSI surveys
Arrow squid	SQU	TAN0007	0.086161	2.654726	98.17	1 301	7.8–44.1	4 WCSI surveys
		TAN1210	0.089458	2.637327	97.90	690	9.3–44.1	TAN1210
		TAN1308	0.059867	2.778227	98.66	222	8.8–40.8	TAN1308
		TAN1609	0.109663	2.590245	97.97	390	7.8–39.7	TAN1609
Gemfish	RSO	TAN1210	0.003593	3.162704	99.33	497	21.7–106.7	4 WCSI surveys
		TAN1308	0.003593	3.162704	99.33	497	21.7–106.7	4 WCSI surveys
		TAN1609	0.003564	3.164520	99.09	459	21.7–92.0	TAN1609
Ghost shark	GSH	TAN0007	0.001871	3.284060	96.59	241	29.2–69.1	TAN0007
		TAN1210	0.001853	3.303338	97.78	422	24.6–68.3	TAN1210
		TAN1308	0.001184	3.410688	97.92	327	24.0–67.7	TAN1308
		TAN1609	0.001785	3.303987	98.11	210	28.9–67.6	TAN1609
Giant stargazer	GIZ	TAN1210	0.002395	3.494211	97.36	307	28.9–80.5	TAN1210
		TAN1308	0.003157	3.421391	97.54	288	29.1–77.2	TAN1308
		TAN1609	0.003758	3.382807	96.68	262	29.7–77.1	TAN1609
Hake	HAK	TAN0007	0.001426	3.369869	97.09	675	34.0–118.4	TAN0007
		TAN1210	0.002325	3.265825	97.86	828	30.8–126.4	TAN1210
		TAN1308	0.003819	3.150099	99.11	510	27.1–115.6	TAN1308
		TAN1609	0.001703	3.340023	99.10	540	34.4–127.0	TAN1609
Hoki	HOK	TAN0007	0.004512	2.906815	97.38	2 040	30.1–114.3	TAN0007
		TAN1210	0.004903	2.899645	98.75	1 423	27.3–116.8	TAN1210
		TAN1308	0.005337	2.869960	98.48	1 212	27.9–117.0	TAN1308
		TAN1609	0.005455	2.862549	98.67	615	27.9–120.5	TAN1609
Javelin fish	JAV	TAN0007	0.000385	3.484062	96.92	202	22.8–56.8	TAN0007
		TAN1210	0.000624	3.362976	98.06	313	13.3–64.4	TAN1210
		TAN1308	0.000840	3.277005	96.64	522	23.9–59.4	TAN1308
		TAN1609	0.000880	3.273912	97.75	257	18.3–60.9	TAN1609
Ling	LIN	TAN0007	0.000941	3.363432	98.94	1 079	29.6–172.2	TAN0007
		TAN1210	0.001025	3.354215	99.06	988	30.4–157.2	TAN1210
		TAN1308	0.000877	3.383045	99.23	764	31.6–161.2	TAN1308
		TAN1609	0.000891	3.381136	99.09	485	34.8–158.5	TAN1609
Lookdown dory	LDO	TAN0007	0.019595	3.019400	99.26	704	10.2–55.7	TAN0007
		TAN1210	0.028280	2.930620	99.24	570	10.0–56.1	TAN1210
		TAN1308	0.020686	3.010893	99.52	1 081	10.5–54.6	TAN1308
		TAN1609	0.023299	2.976418	99.20	369	11.7–52.9	TAN1609
Northern spiny dogfish	NSD	TAN0007	0.004080	3.033824	94.12	101	43.8–84.6	TAN0007
		TAN1210	0.003783	3.035716	96.57	263	32.9–87.4	TAN1210
		TAN1308	0.002325	3.141246	96.81	159	45.1–84.3	TAN1308
		TAN1609	0.005201	2.978715	94.78	185	44.2–81.0	TAN1609
Ribaldo	RIB	TAN0007	0.005874	3.167227	98.96	191	22.5–70.7	TAN0007
		TAN1210	0.006275	3.136584	99.30	256	17.4–75.3	TAN1210
		TAN1308	0.004781	3.203968	99.22	102	21.3–71.3	TAN1308
		TAN1609	0.009409	3.021075	98.46	128	20.4–67.9	TAN1609
School shark	SCH	TAN0007	0.007221	2.910860	95.71	394	68.5–154.4	4 WCSI surveys
		TAN1210	0.004699	3.001079	96.29	201	72.0–146.9	TAN1210
		TAN1308	0.015924	2.740432	93.35	104	77.3–143.5	TAN1308
		TAN1609	0.005940	2.963645	97.01	80	68.5–154.4	TAN1609
Sea perch	SPE	TAN0007	0.008536	3.162526	98.68	751	14.8–50.9	TAN0007
		TAN1210	0.009558	3.145208	98.57	485	11.9–48.4	TAN1210
		TAN1308	0.012088	3.066984	98.76	580	12.1–45.5	TAN1308
		TAN1609	0.009139	3.153859	98.18	667	12.4–42.8	TAN1609
Shovelnose dogfish	SND	TAN0007	0.000115	3.770184	91.14	76	78.0–114.0	TAN0007
		TAN1210	0.000367	3.519409	95.28	146	62.3–119.4	TAN1210
		TAN1308	0.000622	3.39870	97.40	72	44.9–110.3	TAN1308
		TAN1609	0.000858	3.332101	95.98	177	59.5–110.4	TAN1609

Table 3: continued.

Common name	Code	Trip	Regression parameters *a*	*b*	r^2	n	Length range (cm)	Data source
Silver dory	SDO	TAN0007	0.009927	3.185577	96.24	458	13.5–26.1	4 WCSI surveys
		TAN1210	0.009648	3.211215	96.49	161	14.6–25.7	TAN1210
		TAN1308	0.005810	3.368684	92.56	198	13.5–23.5	TAN1308
		TAN1609	0.025387	2.870553	96.20	84	14.9–25.9	TAN1609
Silver warehou	SWA	TAN0007	0.005190	3.329651	98.03	2 196	21.6–58.8	4 WCSI surveys
		TAN1210	0.003868	3.417534	99.27	712	21.6–57.2	TAN1210
		TAN1308	0.007890	3.215652	95.97	451	22.1–57.1	TAN1308
		TAN1609	0.005729	3.322149	94.80	222	30.0–58.7	TAN1609
Smooth skate	SSK	TAN0007	0.019817	2.988786	99.35	214	39.4–150.7	4 WCSI surveys
		TAN1210	0.020379	2.981812	99.54	73	39.7–140.0	TAN1210
		TAN1308	0.017887	3.007875	99.42	76	46.5–150.7	TAN1308
		TAN1609	0.019817	2.988786	99.35	214	39.4–150.7	4 WCSI surveys
Spiny dogfish	SPD	TAN0007	0.001137	3.323700	93.03	128	43.0–96.1	TAN0007
		TAN1210	0.000554	3.482981	88.28	1 249	43.0–96.5	4 WCSI surveys
		TAN1308	0.000554	3.482981	88.28	1 249	43.0–96.5	4 WCSI surveys
		TAN1609	0.000554	3.482981	88.28	1 249	43.0–96.5	4 WCSI surveys
Tarakihi	NMP	TAN1210	0.030711	2.848042	95.79	351	27.4–49.1	TAN1210
		TAN1308	0.013212	3.070905	95.47	392	28.5–47.8	TAN1308
		TAN1609	0.015634	3.026599	93.71	221	28.6–47.1	TAN1609

*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.

Table 4: Survey tow and gear parameters (recorded values only) for valid tows on the 2016 trawl survey. Values are number of tows (*n*), and the mean, standard deviation (s.d.), and range of observations for each parameter.

	n	Mean	s.d	Range
Tow parameters				
Tow length (n. miles)	58	2.8	0.33	2.06–3.07
Tow speed (knots)	58	3.5	0.10	3.0–3.7
Gear parameters (m)				
200–300 m				
Headline height	7	7.3	0.51	6.7–8.0
Doorspread	7	108.6	5.23	99.5–115.0
300–650 m				
Headline height	32	7.1	0.39	6.3–7.9
Doorspread	32	119.9	6.83	106.0–130.0
650–800 m				
Headline height	7	7.1	0.34	6.7–7.5
Doorspread	7	117.5	2.91	114.6–122.0
800–1000 m				
Headline height	12	6.8	0.23	6.5–7.2
Doorspread	12	127.3	3.26	122.6–133.0
All tows 200–1000 m				
Headline height	58	7.1	0.40	6.3–8.0
Doorspread	58	119.8	7.69	99.5–133.0

Table 5: Comparison of doorspread and headline measurements from valid trawl survey tows from the *Tangaroa* WCSI time-series. Values are the mean and standard deviation (s.d.). The number of tows with measurements (*n*) and range of observations is also given for doorspread.

	Doorspread (m)					Headline height (m)	
Survey	*n*	Mean	s.d.	min	max	mean	s.d.
2000	42	123.9	6.91	106.4	138.0	6.7	0.28
2012	60	119.2	8.04	101.3	135.1	7.0	0.32
2013	64	123.9	8.50	108.5	138.3	7.0	0.23
2016	58	119.8	7.69	99.5	133.0	7.1	0.40

Table 6: Total catch of the top 50 species from all tows during the 2016 WCSI survey.

Code	Common name	Scientific name	Catch (kg)
HOK	Hoki	*Macruronus novaezelandiae*	28 726.3
LIN	Ling	*Genypterus blacodes*	6 518.1
FRO	Frostfish	*Lepidopus caudatus*	3 497.5
BAR	Barracouta	*Thyrsites atun*	2 800.8
GIZ	Giant stargazer	*Kathetostoma giganteum*	1 939.3
HAK	Hake	*Merluccius australis*	1 203.1
SWA	Silver warehou	*Seriolella punctata*	1 046.6
SPD	Spiny dogfish	*Squalus acanthias*	1 025.3
SDO	Silver dory	*Cyttus novaezealandiae*	790.7
CYO	Smooth skin dogfish	*Centroscymnus owstoni*	709.1
SSK	Smooth skate	*Dipturus innominatus*	536.1
CSQ	Leafscale gulper shark	*Centrophorus squamosus*	502.1
SCH	School shark	*Galeorhinus galeus*	474.4
WHX	White rattail	*Trachyrincus aphyodes*	458.3
SND	Shovelnose dogfish	*Deania calcea*	419.3
LDO	Lookdown dory	*Cyttus traversi*	417.9
NMP	Tarakihi	*Nemadactylus macropterus*	392.5
RSO	Gemfish	*Rexea solandri*	390.0
WAR	Common warehou	*Seriolella brama*	383.2
SPE	Sea perch	*Helicolenus spp.*	353.1
SQU	Arrow squid	*Nototodarus sloanii & N. gouldi*	306.9
JAV	Javelin fish	*Lepidorhynchus denticulatus*	305.3
CBO	Bollons' rattail	*Coelorinchus bollonsi*	278.8
NSD	Northern spiny dogfish	*Squalus griffini*	270.7
CYL	Portugese dogfish	*Centroscymnus coelolepis*	247.8
GSH	Ghost shark	*Hydrolagus novaezealandiae*	184.8
SRH	Silver roughy	*Hoplostethus mediterraneus*	183.8
RIB	Ribaldo	*Mora moro*	174.5
ORH	Orange roughy	*Hoplostethus atlanticus*	137.7
BYS	Alfonsino	*Beryx splendens*	123.5
RCO	Red cod	*Pseudophycis bachus*	117.7
SOR	Spiky oreo	*Neocyttus rhomboidalis*	102.7
RBT	Redbait	*Emmelichthys nitidus*	102.5
PLS	Plunket's shark	*Proscymnodon plunketi*	96.9
CYP	Longnose velvet dogfish	*Centroscymnus crepidater*	70.9
YBO	Yellow boarfish	*Pentaceros decacanthus*	69.2
EUC	Eucla cod	*Euclichthys polynemus*	66.3
SCO	Swollenhead conger	*Bassanago bulbiceps*	66.0
HAP	Hapuku	*Polyprion oxygeneios*	63.0
CUC	Cucumber fish	*Paraulopus nigripinnis*	56.3
BSL	Black slickhead	*Xenodermichthys spp.*	53.7
CAR	Carpet shark	*Cephaloscyllium isabellum*	51.9
BEE	Basketwork eel	*Diastobranchus capensis*	50.6
JDO	John dory	*Zeus faber*	47.3
SSH	Slender smooth-hound	*Gollum attenuatus*	47.2
GSP	Pale ghost shark	*Hydrolagus bemisi*	43.9
SUN	Sunfish	*Mola mola*	40.0
RCH	Widenosed chimaera	*Rhinochimaera pacifica*	38.1
SRB	Southern rays bream	*Brama australis*	34.1
SBI	Bigscaled brown slickhead	*Alepocephalus australis*	30.5
Total			56 660.4

Table 7: Catch and total abundance estimates with coefficient of variation (CV in parentheses) of species ranked by abundance, for valid trawl tows in core strata (300–650 m), all strata (200–800 m), and deep strata (200–1000 m) in 2016. Species arranged in descending order of abundance.

		Catch (kg)			Biomass (t)		
Common name	Code	Core	All	Deep	Core	All	Deep
Hoki	HOK	28 461	28 636	28 726	7 734 (35.7)	7 797 (35.4)	7 830 (35.3)
Barracouta	BAR	45	2 801	2 801	9 (33.9)	2 328 (30.1)	2 328 (30.1)
Ling	LIN	6 480	6 518	6 518	1 635 (12.7)	1 661 (12.5)	1 661 (12.5)
Giant stargazer	GIZ	454	1 939	1 939	107 (19.9)	1 327 (19.2)	1 327 (19.2)
Frostfish	FRO	3 353	3 498	3 498	602 (96.0)	729 (80.7)	729 (80.7)
Hake	HAK	376	742	1 203	221 (23.9)	355 (16.1)	502 (12.6)
Silver dory	SDO	406	791	791	85 (43.1)	398 (62.1)	398 (62.1)
Spiny dogfish	SPD	815	1 025	1 025	173 (16.8)	358 (43.3)	358 (43.3)
Common warehou	WAR	10	383	383	2 (100.0)	335 (96.0)	335 (96.0)
Silver warehou	SWA	994	1 044	1 047	271 (36.5)	306 (33.4)	306 (33.3)
Smooth skin dogfish	CYO	0	305	709	0	110 (32.3)	244 (18.1)
Tarakihi	NMP	117	392	392	24 (36.9)	241 (23.8)	241 (23.8)
Smooth skate	SSK	458	536	536	190 (54.0)	238 (45.5)	238 (45.5)
Lookdown dory	LDO	363	416	418	210 (12.2)	230 (11.4)	230 (11.3)
School shark	SCH	317	474	474	68 (18.7)	193 (12.7)	193 (12.7)
Shovelnose dogfish	SND	82	310	419	68 (71.4)	151 (32.8)	189 (26.5)
Leafscale gulper shark	CSQ	0	390	502	0	142 (26.5)	180 (23.0)
Sea perch	SPE	312	353	353	158 (18.6)	179 (17.2)	179 (17.2)
White rattail	WHX	0	105	458	0	38 (40.4)	164 (13.0)
Bollons’ rattail	CBO	270	279	279	157 (14.6)	161 (14.4)	161 (14.4)
Northern spiny dogfish	NSD	142	271	271	33 (20.4)	132 (25.6)	132 (25.6)
Arrow squid	SQU	214	307	307	55 (17.1)	131 (22.8)	131 (22.8)
Gemfish	RSO	319	390	390	71 (15.6)	127 (22.5)	127 (22.5)
Javelin fish	JAV	272	304	305	112 (22.9)	124 (20.7)	124 (20.7)
Silver roughy	SRH	181	184	184	92 (22.8)	93 (22.6)	93 (22.6)
Portugese dogfish	CYL	0	0	248	0	0	79 (36.4)
Ribaldo	RIB	18	131	174	15 (44.3)	55 (17.2)	69 (14.3)
Redbait	RBT	98	102	102	55 (19.6)	58 (18.8)	58 (18.8)
Ghost shark	GSH	175	185	185	39 (16.6)	48 (15.3)	48 (15.3)
Orange roughy	ORH	0	5	138	0	2 (47.7)	46 (13.5)
Swollenhead conger	SCO	47	64	66	39 (41.6)	46 (37.0)	46 (36.6)
John dory	JDO	0	47	47	0	38 (34.0)	38 (34.0)
Spiky oreo	SOR	1	70	103	1 (100.0)	25 (28.2)	38 (20.7)
Plunket's shark	PLS	0	69	97	0	25 (33.5)	35 (31.4)
Cucumber fish	CUC	14	56	56	3 (26.7)	33 (46.7)	33 (46.7)
Alfonsino	BYS	124	124	124	31 (38.4)	31 (38.4)	31 (38.4)

Table 7: continued.

		Catch (kg)			Biomass (t)		
Common name	Code	Core	All	Deep	Core total	All total	Deep total
Red cod	RCO	115	118	118	29 (18.5)	31 (18.4)	31 (18.4)
Pale ghost shark	GSP	19	33	44	16 (47.1)	21 (37.9)	26 (31.7)
Longnose velvet dogfish	CYP	0	24	71	0 (100.0)	9 (33.5)	25 (16.3)
Carpet shark	CAR	33	52	52	7 (28.6)	23 (52.0)	23 (52.0)
Basketwork eel	BEE	0	2	51	0	1 (100.0)	22 (35.1)
Yellow boarfish	YBO	69	69	69	22 (29.4)	22 (29.4)	22 (29.4)
Sharpnose sevengill shark	HEP	23	23	23	21 (62.9)	21 (62.9)	21 (62.9)
Black slickhead	BSL	0	39	54	0	14 (21.8)	20 (17.9)
Hairy conger	HCO	22	27	30	17 (49.3)	19 (44.5)	20 (42.6)
White warehou	WWA	23	28	28	18 (40.7)	20 (38.2)	20 (38.2)
Eucla cod	EUC	66	66	66	18 (12.7)	18 (12.7)	18 (12.7)
Hapuku	HAP	55	63	63	12 (81.2)	17 (58.8)	17 (58.8)
Widenosed chimaera	RCH	0	0	38	0	0	16 (29.3)
Bigscaled brown slickhead	SBI	0	0	30	0	0	15 (27.7)
Slender smooth-hound	SSH	47	47	47	15 (46.0)	15 (46.0)	15 (46.0)
Rudderfish	RUD	19	19	24	12 (85.4)	12 (85.4)	14 (74.5)
Oliver's rattail	COL	7	28	28	5 (40.4)	12 (29.5)	12 (29.5)
Gurnard	GUR	0	13	13	0	11 (51.7)	11 (51.7)
Greenback jack mackerel	JMD	4	15	15	1 (78.1)	10 (56.1)	10 (56.1)
Southern rays bream	SRB	34	34	34	10 (44.9)	10 (44.9)	10 (44.9)
Mahia rattail	CMA	0	17	26	0	6 (22.3)	9 (18.7)
Four-rayed rattail	CSU	0	0	26	0	0 (100.0)	8 (18.3)
Spotted gurnard	JGU	12	17	17	3 (67.6)	7 (66.7)	7 (66.7)
Cape scorpionfish	TRS	0	0	17	0	0 (100.0)	7 (22.9)
Serrulate rattail	CSE	0	0	12	0	0 (100.0)	5 (10.6)
Baxter's lantern dogfish	ETB	0	2	18	0	1 (100.0)	5 (45.4)
Deepsea flathead	FHD	15	15	15	4 (31.7)	4 (31.7)	4 (31.7)
Rough skate	RSK	4	8	8	1 (78.7)	4 (48.2)	4 (48.2)
Bigeye cardinalfish	EPL	4	6	6	4 (48.0)	4 (42.4)	4 (41.5)
Lucifer dogfish	ETL	4	6	6	3 (17.5)	4 (16.2)	4 (16.2)
Slender jack mackerel	JMM	3	6	6	0 (100.0)	3 (61.5)	3 (61.5)
Spotted dogfish	SPO	3	7	7	1 (100.0)	3 (80.1)	3 (80.1)
Two saddle rattail	CBI	16	16	16	3 (26.8)	3 (26.8)	3 (26.8)
Orange perch	OPE	10	11	11	2 (40.5)	3 (37.8)	3 (37.8)
Bluenose	BNS	6	6	6	2 (100.0)	2 (100.0)	2 (100.0)
Deepsea cardinalfish	EPT	0	6	6	0	2 (66.1)	2 (66.1)
Seal shark	BSH	1	3	7	1 (51.7)	1 (33.0)	2 (34.4)

Table 8: Estimated trawl abundance (t) and coefficient of variation (% CV) of species by stratum arranged in descending order of total abundance. See Table 1 for stratum codes and Table 7 for species common names.

														Stratum
Species	012A	012B	012C	004A	004B	004C	Core (total)	012C	004S	004D	All (total)	004E	004F	Total
HOK	4 536 (57.8)	1 413 (54.2)	549 (20.1)	247 (35.1)	415 (38.4)	573 (60.0)	7 734 (35.7)	0	1 (100.0)	63 (14.3)	7 797 (35.4)	16 (21.5)	16 (74.4)	7 830 (35.3)
BAR	2 (72.8)	0	0	6 (37.7)	0	0	9 (33.9)	909 (61.7)	1 411 (29.7)	0	2 328 (30.1)	0	0	2 328 (30.1)
LIN	996 (17.6)	77 (46.2)	102 (33.5)	297 (25.4)	107 (56.6)	56 (31.3)	1 635 (12.7)	0 (100.0)	19 (100.0)	6 (80.5)	1 661 (12.5)	0	0	1 661 (12.5)
GIZ	74 (23.4)	3 (63.5)	0	28 (42.6)	2 (100.0)	0	107 (19.9)	218 (36.6)	1 002 (24.1)	0	1 327 (19.2)	0	0	1 327 (19.2)
FRO	6 (42.4)	4 (64.8)	0	586 (98.4)	5 (78.5)	0	602 (96.0)	15 (63.6)	113 (98.9)	0	729 (80.7)	0	0	729 (80.7)
HAK	0	18 (30.4)	63 (58.8)	2 (92.8)	24 (80.0)	114 (27.8)	221 (23.9)	0	1 (100.0)	133 (16.1)	355 (16.1)	107 (13.1)	41 (58.2)	502 (12.6)
SDO	36 (49.6)	0	0	49 (65.1)	0 (100.0)	0	85 (43.1)	236 (98.7)	77 (95.3)	0	398 (62.1)	0	0	398 (62.1)
SPD	5 (100.0)	15 (100.0)	0	121 (19.5)	32 (19.6)	0	173 (16.8)	0	185 (82.2)	0	358 (43.3)	0	0	358 (43.3)
WAR	0	0	0	2 (100.0)	0	0	2 (100.0)	0	333 (96.5)	0	335 (96.0)	0	0	335 (96.0)
SWA	164 (58.2)	27 (19.4)	27 (31.6)	13 (19.1)	17 (74.8)	24 (85.4)	271 (36.5)	26 (94.5)	4 (93.8)	5 (51.3)	306 (33.4)	1 (100.0)	0	306 (33.3)
CYO	0	0	0	0	0	0	0	0	0	110 (32.3)	110 (32.3)	89 (25.3)	45 (29.6)	244 (18.1)
NMP	6 (83.2)	0	0	18 (40.8)	0	0	24 (36.9)	72 (27.9)	145 (36.6)	0	241 (23.8)	0	0	241 (23.8)
SSK	20 (84.7)	17 (48.4)	105 (94.5)	27 (52.2)	21 (71.0)	0	190 (54.0)	2 (100.0)	31 (100.0)	15 (100.0)	238 (45.5)	0	0	238 (45.5)
LDO	4 (66.2)	37 (27.8)	117 (16.0)	0 (66.3)	14 (76.3)	38 (23.5)	210 (12.2)	0	0 (100.0)	19 (26.4)	230 (11.4)	0 (100.0)	0	230 (11.3)
SCH	38 (21.4)	0	0	27 (34.6)	3 (100.0)	0	68 (18.7)	65 (26.3)	59 (20.1)	0	193 (12.7)	0	0	193 (12.7)
SND	0	0	39 (100.0)	0	0	29 (100.0)	68 (71.4)	0	0	82 (10.9)	151 (32.8)	21 (27.2)	17 (34.8)	189 (26.5)
CSQ	0	0	0	0	0	0	0	0	0	142 (26.5)	142 (26.5)	25 (56.7)	13 (73.6)	180 (23.0)
SPE	19 (29.3)	20 (22.5)	90 (29.7)	4 (43.2)	5 (19.6)	19 (48.4)	158 (18.6)	1 (89.8)	10 (90.6)	10 (21.8)	179 (17.2)	0 (100.0)	0	179 (17.2)
WHX	0	0	0	0	0	0	0	0	0	38 (40.4)	38 (40.4)	65 (11.3)	61 (21.2)	164 (13.0)
CBO	3 (70.3)	28 (23.1)	94 (22.4)	0	9 (37.7)	24 (23.6)	157 (14.6)	0	0	3 (66.8)	161 (14.4)	0	0	161 (14.4)
NSD	17 (33.4)	5 (49.1)	0	10 (22.8)	1 (100.0)	0	33 (20.4)	67 (26.1)	32 (87.9)	0	132 (25.6)	0	0	132 (25.6)
SQU	18 (16.2)	8 (48.3)	2 (100.0)	17 (18.5)	4 (15.3)	7 (100.0)	55 (17.1)	63 (44.9)	13 (19.4)	0	131 (22.8)	0	0	131 (22.8)
RSO	20 (16.4)	3 (38.5)	3 (100.0)	36 (26.6)	8 (34.3)	0	71 (15.6)	24 (44.0)	33 (74.2)	0	127 (22.5)	0	0	127 (22.5)
JAV	13 (34.8)	25 (68.0)	23 (29.7)	3 (83.9)	18 (67.1)	30 (41.5)	112 (22.9)	0 (100.0)	0 (58.9)	11 (7.0)	124 (20.7)	0 (67.5)	0	124 (20.7)
SRH	2 (45.8)	25 (35.6)	36 (31.3)	0 (64.6)	4 (49.3)	24 (62.4)	92 (22.8)	0 (100.0)	0	1 (25.2)	93 (22.6)	0	0 (100.0)	93 (22.6)
CYL	0	0	0	0	0	0	0	0	0	0	0	58 (43.8)	22 (64.6)	79 (36.4)
RIB	0	0 (100.0)	9 (67.5)	0	0	6 (50.2)	15 (44.3)	0	0	41 (17.0)	55 (17.2)	10 (11.7)	4 (69.3)	69 (14.3)
RBT	3 (33.4)	3 (54.3)	26 (22.2)	1 (55.0)	7 (38.1)	14 (58.6)	55 (19.6)	1 (59.9)	2 (100.0)	1 (100.0)	58 (18.8)	0	0	58 (18.8)
GSH	23 (24.6)	0	0	16 (19.9)	0 (100.0)	0	39 (16.6)	4 (21.3)	4 (73.6)	0	48 (15.3)	0	0	48 (15.3)
ORH	0	0	0	0	0	0	0	0	0	2 (47.7)	2 (47.7)	29 (18.0)	15 (21.2)	46 (13.5)
SCO	0	0	23 (32.8)	0	0	16 (89.2)	39 (41.6)	0	0	6 (66.3)	46 (37.0)	0 (63.5)	0 (100.0)	46 (36.6)
JDO	0	0	0	0	0	0	0	14 (81.8)	24 (22.7)	0	38 (34.0)	0	0	38 (34.0)
SOR	0	0	0	0	0	1 (100.0)	1 (100.0)	0	0	25 (28.8)	25 (28.2)	6 (29.9)	7 (38.9)	38 (20.7)
PLS	0	0	0	0	0	0	0	0	0	25 (33.5)	25 (33.5)	5 (100.0)	5 (100.0)	35 (31.4)
CUC	1 (41.1)	0 (100.0)	0	2 (35.4)	0	0	3 (26.7)	3 (80.8)	27 (56.6)	0	33 (46.7)	0	0	33 (46.7)
BYS	2 (43.7)	1 (51.3)	2 (43.7)	18 (56.8)	2 (27.9)	6 (100.0)	31 (38.4)	0	0	0	31 (38.4)	0	0	31 (38.4)
RCO	24 (21.6)	0 (76.1)	0	5 (33.0)	0	0	29 (18.5)	0 (100.0)	2 (100.0)	0	31 (18.4)	0	0	31 (18.4)

Table 8: continued.

													Stratum
Species	012A	012B	012C	004A	004B	004C	Core (total)	012C	004S	004D	All (total)	004E	004F	Total
GSP	0	0	10 (70.7)	0	0	6 (51.0)	16 (47.1)	0	0	5 (52.1)	21 (37.9)	1 (49.7)	3 (35.1)	26 (31.7)
CYP	0	0	0	0	0	0 (100.0)	0 (100.0)	0	0	9 (34.1)	9 (33.5)	9 (20.0)	7 (30.7)	25 (16.3)
CAR	4 (40.8)	0	0	3 (39.6)	0	0	7 (28.6)	2 (100.0)	14 (83.8)	0	23 (52.0)	0	0	23 (52.0)
BEE	0	0	0	0	0	0	0	0	0	1 (100.0)	1 (100.0)	3 (32.4)	19 (41.6)	22 (35.1)
YBO	2 (53.7)	9 (36.0)	6 (75.3)	3 (91.4)	1 (38.0)	0	22 (29.4)	0	0	0	22 (29.4)	0	0	22 (29.4)
HEP	0	0	21 (62.9)	0	0	0	21 (62.9)	0	0	0	21 (62.9)	0	0	21 (62.9)
BSL	0	0	0	0	0	0	0	0	0	14 (21.8)	14 (21.8)	2 (38.4)	5 (39.0)	20 (17.9)
HCO	0	0 (100.0)	7 (36.2)	0	0	10 (80.9)	17 (49.3)	0	0	2 (41.8)	19 (44.5)	1 (47.8)	0 (100.0)	20 (42.6)
WWA	0	0 (100.0)	8 (61.3)	0	0	10 (56.0)	18 (40.7)	0	0	2 (100.0)	20 (38.2)	0	0	20 (38.2)
EUC	11 (14.6)	3 (24.5)	3 (49.1)	1 (58.2)	0	0	18 (12.7)	0	0	0	18 (12.7)	0	0	18 (12.7)
HAP	9 (100.0)	0	0	2 (71.0)	0	0	12 (81.2)	0	5 (57.9)	0	17 (58.8)	0	0	17 (58.8)
RCH	0	0	0	0	0	0	0	0	0	0	0	3 (64.9)	13 (32.8)	16 (29.3)
SBI	0	0	0	0	0	0	0	0	0	0	0	0	15 (27.7)	15 (27.7)
SSH	8 (78.0)	5 (34.3)	2 (100.0)	0 (100.0)	0	0	15 (46.0)	0	0	0	15 (46.0)	0	0	15 (46.0)
RUD	0	2 (100.0)	10 (100.0)	0	0	0	12 (85.4)	0	0	0	12 (85.4)	0	2 (100.0)	14 (74.5)
COL	0	0 (29.7)	3 (52.4)	0 (100.0)	0	2 (75.7)	5 (40.4)	0	0	8 (40.6)	12 (29.5)	0	0	12 (29.5)
GUR	0	0	0	0	0	0	0	10 (53.5)	0 (100.0)	0	11 (51.7)	0	0	11 (51.7)
JMD	1 (100.0)	0	0	0 (100.0)	0	0	1 (78.1)	4 (51.2)	5 (100.0)	0	10 (56.1)	0	0	10 (56.1)
SRB	3 (41.5)	2 (63.9)	1 (100.0)	0	4 (100.0)	0	10 (44.9)	0	0	0	10 (44.9)	0	0	10 (44.9)
CMA	0	0	0	0	0	0	0	0	0	6 (22.3)	6 (22.3)	2 (48.0)	1 (48.8)	9 (18.7)
CSU	0	0	0	0	0	0	0	0	0	0 (100.0)	0 (100.0)	6 (25.5)	3 (15.4)	8 (18.3)
JGU	2 (71.7)	0	0	0 (75.6)	0	0	3 (67.6)	4 (100.0)	0	0	7 (66.7)	0	0	7 (66.7)
TRS	0	0	0	0	0	0	0	0	0	0 (100.0)	0 (100.0)	2 (63.4)	5 (23.3)	7 (22.9)
CSE	0	0	0	0	0	0	0	0	0	0 (100.0)	0 (100.0)	1 (19.9)	4 (12.3)	5 (10.6)
ETB	0	0	0	0	0	0	0	0	0	1 (100.0)	1 (100.0)	4 (55.7)	1 (100.0)	5 (45.4)
FHD	1 (42.4)	0	1 (67.4)	0 (80.9)	1 (100.0)	0 (100.0)	4 (31.7)	0	0	0	4 (31.7)	0	0	4 (31.7)
RSK	0	1 (100.0)	0	0 (100.0)	0	0	1 (78.7)	0	3 (57.7)	0	4 (48.2)	0	0	4 (48.2)
EPL	0	0	2 (67.2)	0	0	1 (57.4)	4 (48.0)	0	0	1 (75.4)	4 (42.4)	0	0 (100.0)	4 (41.5)
ETL	0	0 (91.6)	2 (16.2)	0	0	1 (53.5)	3 (17.5)	0	0	0 (38.9)	4 (16.2)	0	0	4 (16.2)
JMM	0	0	0	0 (100.0)	0	0	0 (100.0)	1 (100.0)	1 (100.0)	0	3 (61.5)	0	0	3 (61.5)
SPO	1 (100.0)	0	0	0	0	0	1 (100.0)	3 (100.0)	0	0	3 (80.1)	0	0	3 (80.1)
CBI	2 (48.1)	0	0	2 (29.4)	0 (100.0)	0	3 (26.8)	0	0	0	3 (26.8)	0	0	3 (26.8)
OPE	2 (42.1)	0	0	0 (67.1)	0	0	2 (40.5)	0	1 (100.0)	0	3 (37.8)	0	0	3 (37.8)
BNS	0	0	0	0	2 (100.0)	0	2 (100.0)	0	0	0	2 (100.0)	0	0	2 (100.0)
EPT	0	0	0	0	0	0	0	0	0	2 (66.1)	2 (66.1)	0	0	2 (66.1)
BSH	0	0	0	0	0	1 (51.7)	1 (51.7)	0	0	1 (42.6)	1 (33.0)	1 (66.0)	0	2 (34.4)

Table 9: Trawl abundance estimates, coefficients of variation comparisons for the core strata (300–650 m), all strata (200–800 m), and deep strata (200–1000 m) from the 2000, 2012, 2013, and 2016 WCSI trawl surveys. The 2000 survey abundance estimates were re-calculated using 2012–13 stratum areas. Giant stargazer was coded as STA, gemfish as SKI, and tarakihi was TAR in 2000. Species arranged in descending order of abundance in 2016 survey.

		Core area abundance (t)				All area abundance (t)			Deep area abundance (t)
Common name	Code	2000	2012	2013	2016	2012	2013	2016	2016
Hoki	HOK	5 385 (20.6)	32 495 (24.2)	14 184 (26.9)	7 734 (35.7)	32 602 (24.1)	14 356 (26.5)	7 797 (35.4)	7 830 (35.3)
Barracouta	BAR	4 (72.7)	12 (42.8)	5 (52.1)	9 (33.9)	417 (34.8)	1 617 (36.8)	2 328 (30.1)	2 328 (30.1)
Ling	LIN	1 861 (17.3)	2 169 (14.8)	2 000 (18.4)	1 635 (12.7)	2 194 (14.7)	2 009 (18.3)	1 661 (12.5)	1 661 (12.5)
Giant stargazer	GIZ	74 (27.3)	97 (22.6)	92 (21.8)	107 (19.9)	608 (24.8)	592 (21.4)	1 327 (19.2)	1 327 (19.2)
Frostfish	FRO	31 (27.3)	30 (51.9)	9 (30.5)	602 (96.0)	38 (46.1)	26 (35.3)	729 (80.7)	729 (80.7)
Hake	HAK	803 (13.4)	583 (12.8)	331 (17.4)	221 (23.9)	1 103 (13.0)	747 (21.3)	355 (16.1)	502 (12.6)
Silver dory	SDO	113 (62.0)	259 (46.5)	304 (77.9)	85 (43.1)	677 (44.2)	602 (45.9)	398 (62.1)	398 (62.1)
Spiny dogfish	SPD	233 (53.6)	1 095 (24.7)	867 (29.0)	173 (16.8)	1 453 (22.6)	928 (27.2)	358 (43.3)	358 (43.3)
Common warehou	WAR	0	0	0	2 (100.0)	33 (88.7)	0	335 (96.0)	335 (96.0)
Silver warehou	SWA	1 507 (24.6)	617 (32.2)	313 (22.7)	271 (36.5)	877 (26.5)	317 (22.4)	306 (33.4)	306 (33.3)
Smooth skin dogfish	CYO	0	0	0	0	19 (73.4)	20 (100.0)	110 (32.3)	244 (18.1)
Tarakihi	NMP	22 (32.2)	21 (41.7)	24 (48.5)	24 (36.9)	267 (23.0)	311 (22.8)	241 (23.8)	241 (23.8)
Smooth skate	SSK	186 (28.0)	167 (29.5)	228 (19.6)	190 (54.0)	239 (30.4)	272 (23.1)	238 (45.5)	238 (45.5)
Lookdown dory	LDO	169 (14.4)	155 (11.9)	205 (11.1)	210 (12.2)	181 (10.6)	236 (11.6)	230 (11.4)	230 (11.3)
School shark	SCH	98 (69.8)	186 (24.8)	159 (24.8)	68 (18.7)	323 (15.8)	252 (18.3)	193 (12.7)	193 (12.7)
Shovelnose dogfish	SND	153 (29.5)	68 (70.6)	49 (24.8)	68 (71.4)	146 (44.4)	95 (28.0)	151 (32.8)	189 (26.5)
Leafscale gulper shark	CSQ	83 (46.2)	67 (45.6)	31 (52.0)	0	125 (35.0)	67 (43.2)	142 (26.5)	180 (23.0)
Sea perch	SPE	123 (6.7)	136 (15.9)	126 (9.2)	158 (18.6)	205 (26.9)	142 (9.8)	179 (17.2)	179 (17.2)
White rattail	WHX	0	0	3 (100.0)	0	17 (100.0)	19 (71.3)	38 (40.4)	164 (13.0)
Bollons' rattail	CBO	192 (11.3)	93 (10.8)	118 (8.9)	157 (14.6)	105 (11.1)	126 (9.3)	161 (14.4)	161 (14.4)
Northern spiny dogfish	NSD	96 (23.1)	49 (20.4)	48 (29.5)	33 (20.4)	269 (28.7)	131 (22.7)	132 (25.6)	132 (25.6)
Arrow squid	SQU	18 (22.6)	95 (18.3)	28 (9.9)	55 (17.1)	137 (14.9)	52 (17.6)	131 (22.8)	131 (22.8)
Gemfish	RSO	29 (39.4)	14 (32.2)	10 (46.8)	71 (15.6)	14 (32.2)	11 (43.0)	127 (22.5)	127 (22.5)
Javelin fish	JAV	198 (17.4)	166 (11.3)	122 (13.1)	112 (22.9)	195 (10.9)	141 (11.5)	124 (20.7)	124 (20.7)
Silver roughy	SRH	23 (18.0)	101 (23.3)	123 (14.8)	92 (22.8)	101 (23.3)	127 (14.3)	93 (22.6)	93 (22.6)
Portugese dogfish	CYL	0	0	0	0	0	0	0	79 (36.4)
Ribaldo	RIB	104 (26.3)	43 (25.3)	16 (29.9)	15 (44.3)	140 (21.6)	57 (25.7)	55 (17.2)	69 (14.3)
Redbait	RBT	3 (29.2)	13 (32.2)	13 (17.3)	55 (19.6)	16 (27.3)	14 (16.9)	58 (18.8)	58 (18.8)
Dark ghost shark	GSH	77 (32.5)	106 (16.9)	75 (21.4)	39 (16.6)	146 (15.1)	101 (20.2)	48 (15.3)	48 (15.3)
Orange roughy	ORH	0	0	0	0	0	0	2 (47.7)	46 (13.5)
Swollenhead conger	SCO	57 (19.2)	51 (31.6)	14 (30.9)	39 (41.6)	56 (29.1)	17 (27.9)	46 (37.0)	46 (36.6)
John dory	JDO	0	0	0	0	43 (41.2)	46 (46.9)	38 (34.0)	38 (34.0)
Spiky oreo	SOR	0	0	0	1 (100.0)	12 (72.1)	9 (74.8)	25 (28.2)	38 (20.7)
Plunket's shark	PLS	6 (70.6)	3 (71.3)	0	0	23 (54.4)	13 (100.0)	25 (33.5)	35 (31.4)
Cucumber fish	CUC	0 (100.0)	2 (30.1)	2 (33.8)	3 (26.7)	19 (64.9)	80 (36.0)	33 (46.7)	33 (46.7)

Table 9: continued.

		Core area abundance (t)				All area abundance (t)			Deep area abundance (t)
Common name	Code	2000	2012	2013	2016	2012	2013	2016	2016
Alfonsino	BYS	14 (41.0)	262 (58.8)	120 (26.2)	31 (38.4)	262 (58.8)	120 (26.2)	31 (38.4)	31 (38.4)
Red cod	RCO	12 (31.8)	22 (17.5)	62 (34.9)	29 (18.5)	22 (17.5)	62 (34.9)	31 (18.4)	31 (18.4)
Pale ghost shark	GSP	23 (28.2)	32 (28.2)	20 (18.5)	16 (47.1)	40 (25.4)	29 (18.4)	21 (37.9)	26 (31.7)
Longnose velvet dogfish	CYP	0	0	0 (100.0)	0 (100.0)	5 (56.9)	10 (65.1)	9 (33.5)	25 (16.3)
Carpet shark	CAR	11 (46.0)	28 (22.4)	16 (38.2)	7 (28.6)	87 (40.2)	31 (38.1)	23 (52.0)	23 (52.0)
Basketwork eel	BEE	0	0	0	0	0 (100.0)	0	1 (100.0)	22 (35.1)
Yellow boarfish	YBO	4 (47.3)	15 (39.7)	17 (22.1)	22 (29.4)	15 (39.6)	17 (21.9)	22 (29.4)	22 (29.4)
Sharpnose sevengill shark	HEP	0	1 (68.3)	9 (36.5)	21 (62.9)	1 (68.3)	9 (36.5)	21 (62.9)	21 (62.9)
Black slickhead	BSL	1 (70.1)	6 (70.5)	0 (100.0)	0	28 (32.6)	13 (51.6)	14 (21.8)	20 (17.9)
Hairy conger	HCO	24 (24.3)	4 (40.1)	16 (22.3)	17 (49.3)	4 (40.1)	16 (22.3)	19 (44.5)	20 (42.6)
White warehou	WWA	12 (50.9)	26 (60.4)	23 (27.9)	18 (40.7)	65 (34.2)	26 (26.9)	20 (38.2)	20 (38.2)
Eucla cod	EUC	0 (73.0)	7 (27.7)	6 (28.0)	18 (12.7)	7 (27.7)	6 (28.0)	18 (12.7)	18 (12.7)
Hapuku	HAP	36 (46.6)	35 (39.3)	16 (56.0)	12 (81.2)	99 (29.0)	61 (49.8)	17 (58.8)	17 (58.8)
Widenosed chimaera	RCH	0	0	0	0	0	0	0	16 (29.3)
Bigscaled brown slickhead	SBI	0	0	0	0	0	0	0	15 (27.7)
Slender smooth-hound	SSH	34 (21.1)	40 (34.2)	36 (26.3)	15 (46.0)	40 (34.2)	36 (26.3)	15 (46.0)	15 (46.0)
Rudderfish	RUD	8 (67.9)	6 (49.6)	15 (59.2)	12 (85.4)	6 (49.6)	15 (59.2)	12 (85.4)	14 (74.5)
Oliver's rattail	COL	13 (29.1)	12 (35.3)	7 (35.2)	5 (40.4)	41 (35.0)	21 (35.8)	12 (29.5)	12 (29.5)
Gurnard	GUR	0	0	0	0	1 (100.0)	5 (74.2)	11 (51.7)	11 (51.7)
Greenback jack mackerel	JMD	0	0	0	1 (78.1)	3 (73.4)	9 (100.0)	10 (56.1)	10 (56.1)
Southern rays bream	SRB	0	15 (41.1)	9 (41.0)	10 (44.9)	16 (37.9)	9 (38.7)	10 (44.9)	10 (44.9)
Mahia rattail	CMA	0	0	0	0	1 (33.9)	1 (63.0)	6 (22.3)	9 (18.7)
Four-rayed rattail	CSU	0	0	0	0	0	0	0 (100.0)	8 (18.3)
Spotted gurnard	JGU	0	1 (79.2)	0 (69.0)	3 (67.6)	1 (79.2)	0 (69.0)	7 (66.7)	7 (66.7)
Cape scorpionfish	TRS	0	0	0	0	0	1 (100.0)	0 (100.0)	7 (22.9)
Serrulate rattail	CSE	0	0	0	0	0	0 (100.0)	0 (100.0)	5 (10.6)
Baxter's lantern dogfish	ETB	0	0	0	0	0	0	1 (100.0)	5 (45.4)
Deepsea flathead	FHD	5 (17.7)	7 (18.5)	5 (21.7)	4 (31.7)	7 (18.5)	6 (21.4)	4 (31.7)	4 (31.7)
Rough skate	RSK	2 (70.5)	8 (31.9)	4 (42.9)	1 (78.7)	12 (39.1)	8 (39.8)	4 (48.2)	4 (48.2)
Bigeye cardinalfish	EPL	8 (32.8)	4 (29.7)	5 (27.0)	4 (48.0)	4 (29.7)	7 (26.0)	4 (42.4)	4 (41.5)
Lucifer dogfish	ETL	7 (16.3)	5 (15.3)	5 (36.0)	3 (17.5)	6 (13.9)	6 (29.1)	4 (16.2)	4 (16.2)
Slender jack mackerel	JMM	7 (60.6)	3 (43.8)	0	0 (100.0)	6 (50.2)	1 (100.0)	3 (61.5)	3 (61.5)
Spotted dogfish	SPO	0	0 (100.0)	1 (100.0)	1 (100.0)	3 (90.6)	6 (45.9)	3 (80.1)	3 (80.1)
Two saddle rattail	CBI	1 (68.4)	14 (20.5)	7 (29.0)	3 (26.8)	14 (20.5)	7 (28.3)	3 (26.8)	3 (26.8)
Orange perch	OPE	17 (99.4)	15 (66.1)	5 (100.0)	2 (40.5)	49 (45.2)	81 (93.1)	3 (37.8)	3 (37.8)
Bluenose	BNS	7 (61.6)	4 (50.8)	0 (100.0)	2 (100.0)	4 (50.8)	0 (100.0)	2 (100.0)	2 (100.0)
Deepsea cardinalfish	EPT	0	0 (100.0)	0	0	2 (88.2)	0	2 (66.1)	2 (66.1)
Seal shark	BSH	10 (68.9)	3 (36.1)	3 (34.3)	1 (51.7)	4 (32.2)	3 (28.2)	1 (33.0)	2 (34.4)

Table 10: Numbers of fish for which length, sex, and biological data were collected. Species arranged in alphabetical order of common name.

	Length frequency data				Length-weight data	
	No. of fish measured			No. of	No. of	No. of
Species	Total †	Male	Female	samples	fish	samples
Alfonsino	451	189	260	22	207	22
Arrow squid	623	238	310	33	437	32
Banded bellowsfish	5	1	0	1	5	1
Banded rattail	2	2	0	1	0	0
Barracouta	1 051	563	488	13	169	13
Basketwork eel	47	27	20	13	13	2
Baxters lantern dogfish	11	3	8	6	11	6
Bigeye cardinalfish	61	37	24	7	46	5
Bigscaled brown slickhead	38	32	6	6	10	1
Black slickhead	150	77	73	17	9	1
Blackspot rattail	3	2	1	2	0	0
Bluenose	1	1	0	1	1	1
Bollons' rattail	518	147	367	20	244	12
Bulbous rattail	1	1	0	1	0	0
Cape scorpionfish	15	7	8	9	13	7
Capro dory	10	0	0	1	0	0
Carpet shark	17	4	13	10	17	10
Catshark	1	1	0	1	1	1
Common warehou	108	58	50	4	28	4
Cubehead	6	4	2	1	6	1
Cucumber fish	313	131	126	8	40	3
Dealfish	1	1	0	1	1	1
Deepsea cardinalfish	2	1	1	2	2	2
Deepsea flathead	5	5	0	2	3	1
Eucla cod	337	258	13	11	99	5
Four-rayed rattail	487	222	261	13	25	1
Frill shark	1	0	1	1	1	1
Frostfish	386	226	157	23	168	23
Gemfish	1 132	525	607	31	460	31
Ghost shark	226	106	120	21	212	20
Giant stargazer	614	164	447	24	273	24
Greenback jack mackerel	12	5	7	5	12	5
Gurnard	16	13	3	3	16	3
Hairy conger	23	18	5	13	12	6
Hake	544	273	270	35	544	35
Hapuku	7	3	4	5	7	5
Hoki	5 751	2802	2945	50	620	41
Humpback rattail (slender rattail)	3	3	0	3	1	1
Javelin fish	1 582	830	691	34	266	15
John dory	24	21	3	6	24	6
Johnson's cod	14	9	5	8	0	0
Kingfish	1	1	0	1	1	1
Leafscale gulper shark	38	31	7	11	38	11
Ling	1 130	431	699	35	500	35
Long-nosed chimaera	1	1	0	1	1	1
Longnose velvet dogfish	65	35	30	19	65	19
Lookdown dory	911	486	407	33	382	33
Lucifer dogfish	27	13	14	12	27	12
Lyconus sp	1	1	0	1	0	0
Mahia rattail	56	25	30	15	8	2
Melanonus zugmayeri	4	3	1	1	4	1
Mirror dory	1	1	0	1	1	1
Nemichthys curvirostris	1	0	0	1	0	0
Northern spiny dogfish	219	82	137	23	186	23

Table 10 continued:

	Length frequency data				Length-weight data	
	No. of fish measured			No. of	No. of	No. of
Species	Total †	Female	Male	samples	fish	samples
Notable rattail	11	7	3	6	3	1
Oliver's rattail	427	89	213	8	11	1
Orange perch	23	11	12	6	23	6
Orange roughy	152	88	63	15	152	15
Pale ghost shark	31	21	10	16	31	16
Plunket's shark	15	10	5	7	15	7
Portugese dogfish	39	5	34	7	39	7
Prickly deepsea skate	2	1	1	2	2	2
Red cod	138	26	112	17	133	17
Redbait	171	99	71	29	171	29
Ribaldo	131	89	42	22	131	22
Rig	2	0	2	2	2	2
Rough skate	4	2	2	4	4	4
Rudderfish	4	3	1	3	4	3
Scabbardfish	1	0	1	1	1	1
Scaly gurnard	7	7	0	1	7	1
Scampi	10	5	5	8	10	8
School shark	80	36	44	21	80	21
Sea perch	2 589	1 281	1 286	43	721	43
Seal shark	10	7	3	8	10	8
Serrulate rattail	56	40	16	13	15	3
Sharpnose sevengill shark	2	2	0	2	2	2
Shovelnose dogfish	177	76	101	20	177	20
Silver dory	989	500	387	14	84	4
Silver roughy	976	555	405	20	139	7
Silver warehou	415	218	197	37	222	36
Silverside	10	0	10	1	0	0
Slender jack mackerel	4	0	4	3	4	3
Slender smooth-hound	28	18	10	8	28	8
Small-headed cod	1	0	1	1	0	0
Small banded rattail	11	6	5	2	11	2
Smallscaled brown slickhead	16	15	1	9	4	1
Smooth deepsea skate	1	1	0	1	1	1
Smooth skate	27	15	12	17	23	15
Smooth skin dogfish	161	61	100	17	161	17
Softnose skate (longtail skate)	2	2	0	2	1	1
Southern bastard cod	1	1	0	1	1	1
Southern rays bream	27	11	16	8	27	8
Spiky oreo	332	141	188	19	131	11
Spineback	6	5	1	6	0	0
Spiny dogfish	511	417	94	15	236	14
Spinyfin	3	2	1	3	1	1
Spotted gurnard	31	22	9	4	31	4
Swollenhead conger	48	12	36	13	37	7
Tarakihi	376	127	249	15	221	15
Two saddle rattail	29	16	13	8	29	8
Velvet dogfish	1	1	0	1	1	1
Velvet rattail	7	3	4	2	0	0
Warty squid	2	2	0	2	2	2
White rattail	168	108	60	18	20	2
White warehou	7	1	6	6	7	6
Widenosed chimaera	11	6	5	6	11	6
Witch	3	2	1	1	3	1
Yellow boarfish	304	65	72	11	88	6

Table 10 continued:

	Length frequency data				Length-weight data	
	No. of fish measured			No. of	No. of	No. of
Species	Total †	Female	Male	samples	fish	samples
Yellowtail jack mackerel	1	1	0	1	1	1
Total	25 645	12 359	12 535	58	8 485	58

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

Table 11: Species gonad stage observations* by each reproductive stage. Species selected are those with more than 200 observations from the 2016 WCSI trawl survey. Gonad stages are defined in Appendix 2. –, indicates no relevant stage. Species arranged by descending order of number of observations.

Species	Sex	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	Stage 7
Hoki	Female	491	283	1 060	286	35	135	506
	Male	309	97	115	1 122	770	433	92
Ling	Female	67	78	85	167	2	4	27
	Male	61	76	95	266	135	46	20
Barracouta	Female	0	1	483	45	18	7	1
	Male	0	3	3	358	121	0	2
Sea perch	Female	292	156	30	8	4	4	7
	Male	230	154	11	5	0	16	55
Gemfish	Female	252	156	2	0	0	0	0
	Male	310	94	9	16	0	10	57
Lookdown dory	Female	213	82	1	0	0	5	102
	Male	201	117	21	3	1	2	16
Giant stargazer	Female	8	12	98	10	17	2	17
	Male	4	7	0	233	169	27	6
Hake	Female	125	4	108	8	7	3	17
	Male	187	21	0	5	46	10	1
Silver dory	Female	0	0	178	82	0	0	0
	Male	0	7	117	106	1	0	0
Spiny dogfish	Female	4	17	14	68	274	16	–
	Male	0	1	91	–	–	–	–
Javelinfish	Female	168	125	0	0	0	0	0
	Male	89	39	4	0	0	0	0
Silver warehou	Female	1	1	195	16	5	0	0
	Male	0	0	4	152	40	1	0
Frostfish	Female	41	100	65	3	1	1	12
	Male	20	28	28	48	29	2	1
Tarakihi	Female	3	82	0	0	0	0	42
	Male	9	108	0	0	0	0	131
Bollons' rattail	Female	26	20	43	34	7	1	3
	Male	17	171	39	0	0	1	0
Alfonsino	Female	141	2	0	0	0	0	0
	Male	204	3	0	0	0	0	0
Spiky oreo	Female	105	29	7	0	0	0	0
	Male	161	21	3	1	0	2	0
Silver roughy	Female	115	71	1	0	0	0	0
	Male	64	35	15	0	0	0	0
Oliver's rattail	Female	6	7	38	22	8	1	1
	Male	7	49	86	2	1	0	0
Northern spiny dogfish	Female	73	9	0	0	0	0	–
	Male	80	8	49	–	–	–	–

8. FIGURES

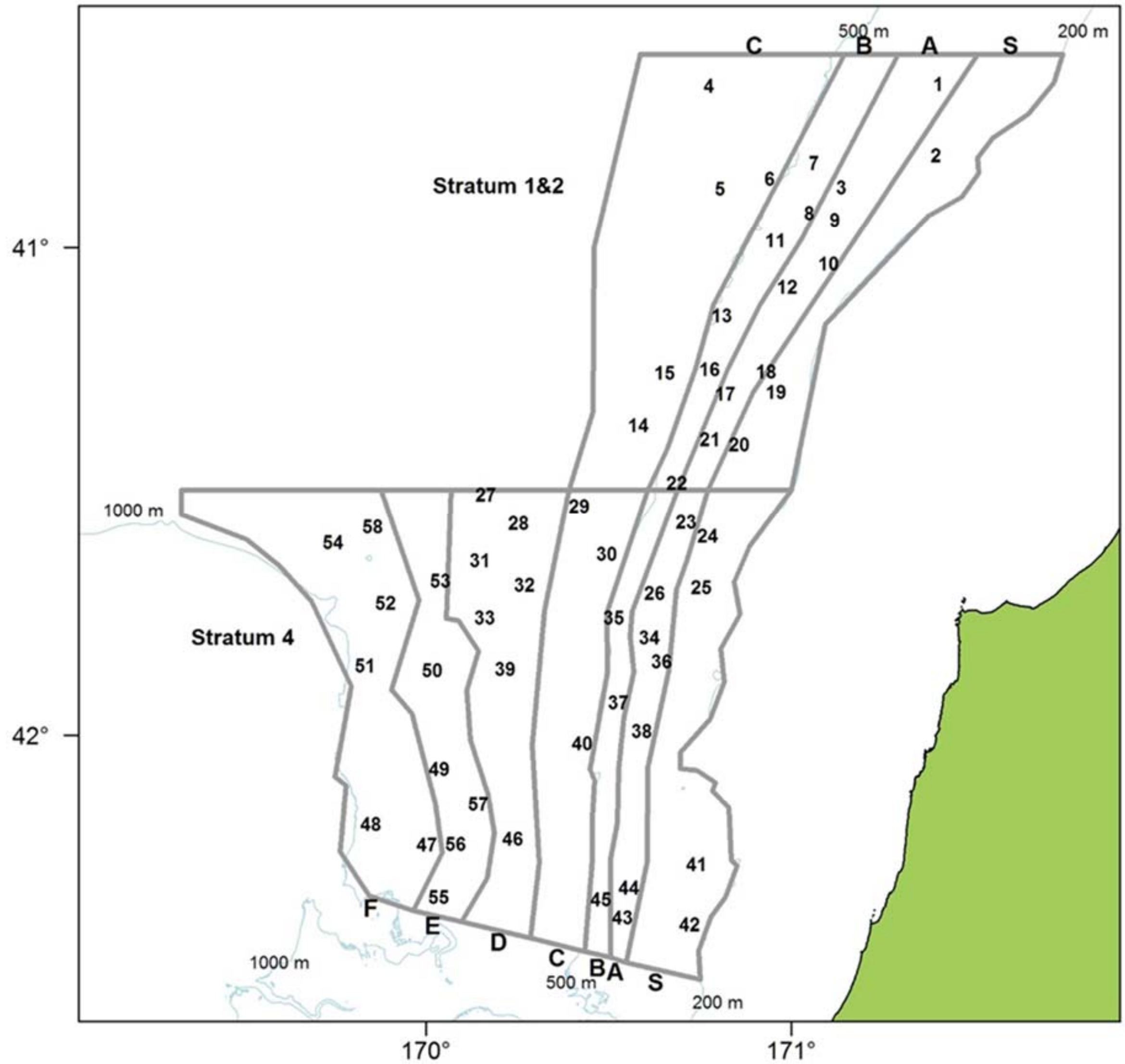


Figure 1: Trawl tow positions for the 2016 WCSI random trawl survey. Labels show station numbers. Stratum areas are given in Table 1. Station details are given in Appendix 1.

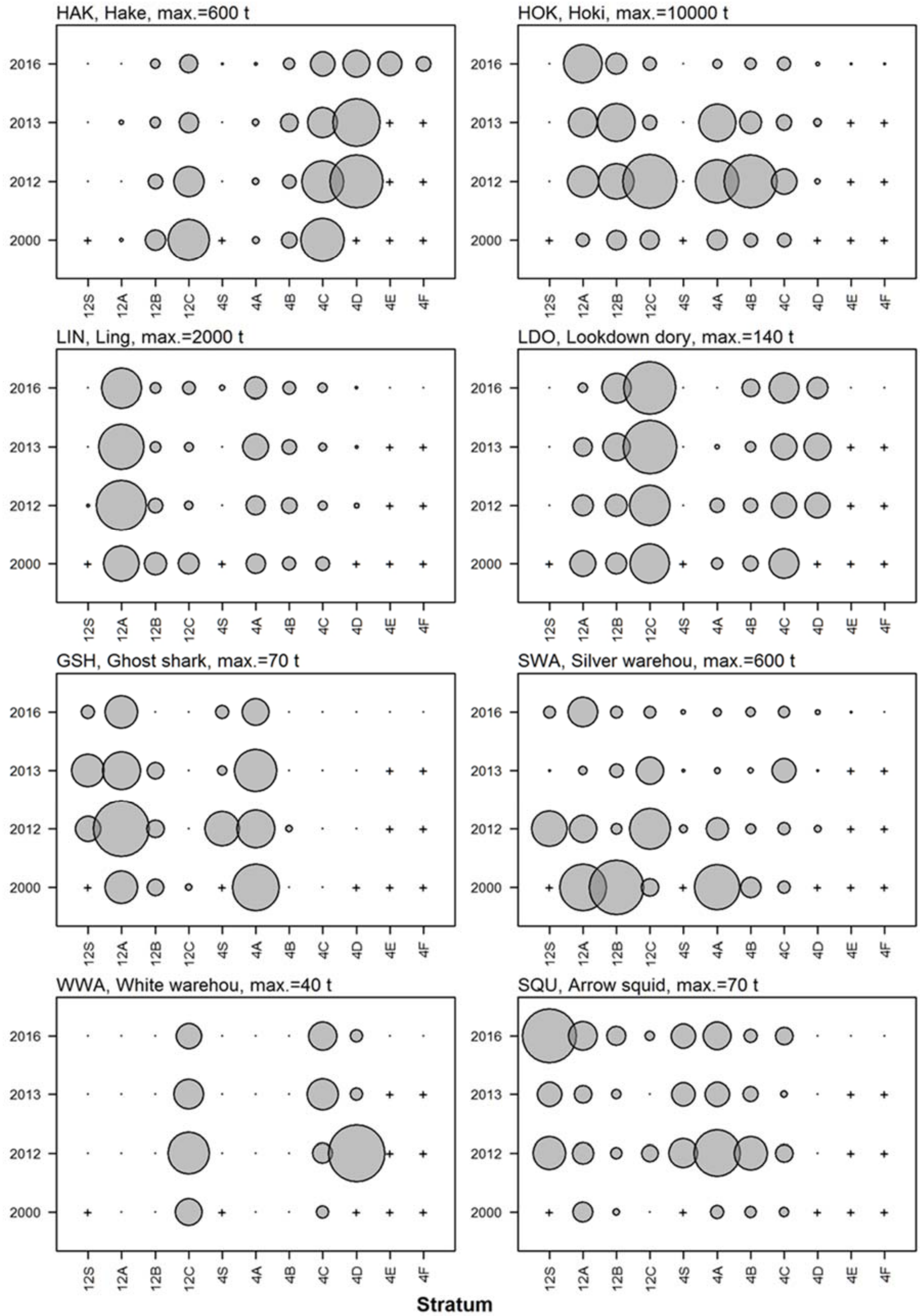


Figure 2: Relative biomass estimates by strata for 8 commercially important middle depth species sampled by annual trawl surveys of the WCSI, in 2010, 2012, 2013 and 2016. + indicates stratum not surveyed in that year.

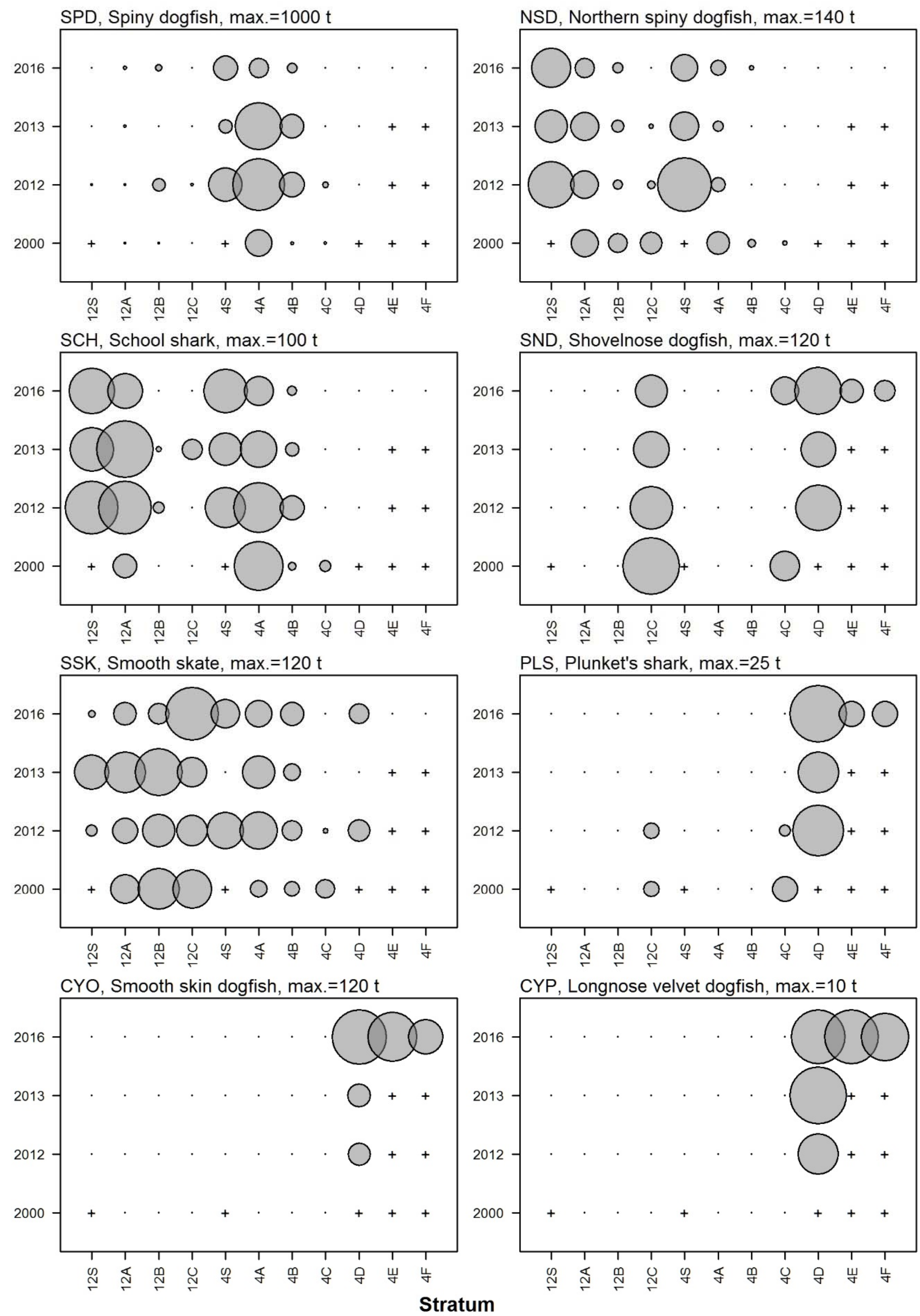


Figure 3: Relative biomass estimates by strata for 8 elasmobranch bycatch species sampled by annual trawl surveys of the WCSI, in 2010, 2012, 2013 and 2016. + indicates stratum not surveyed in that year.

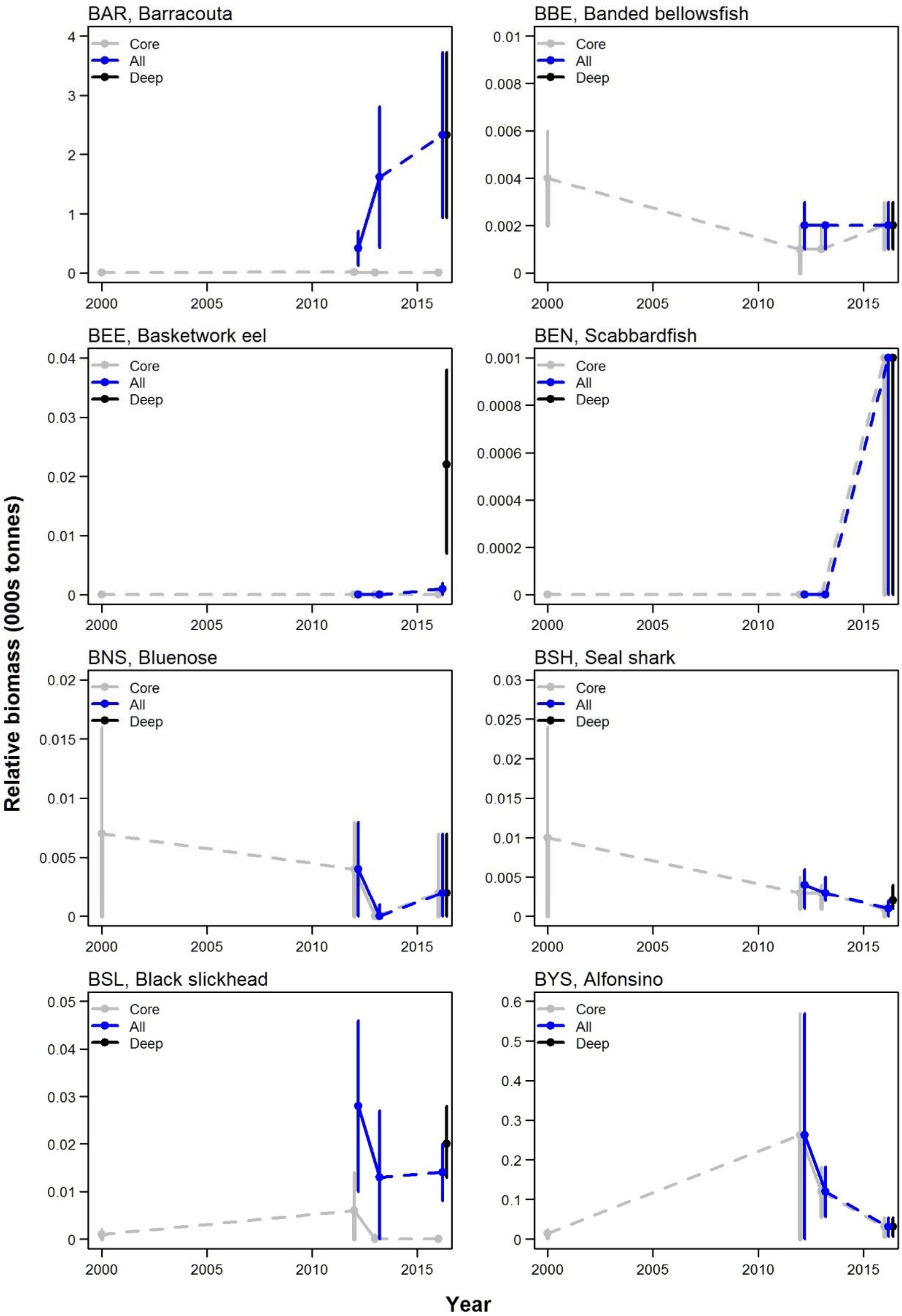
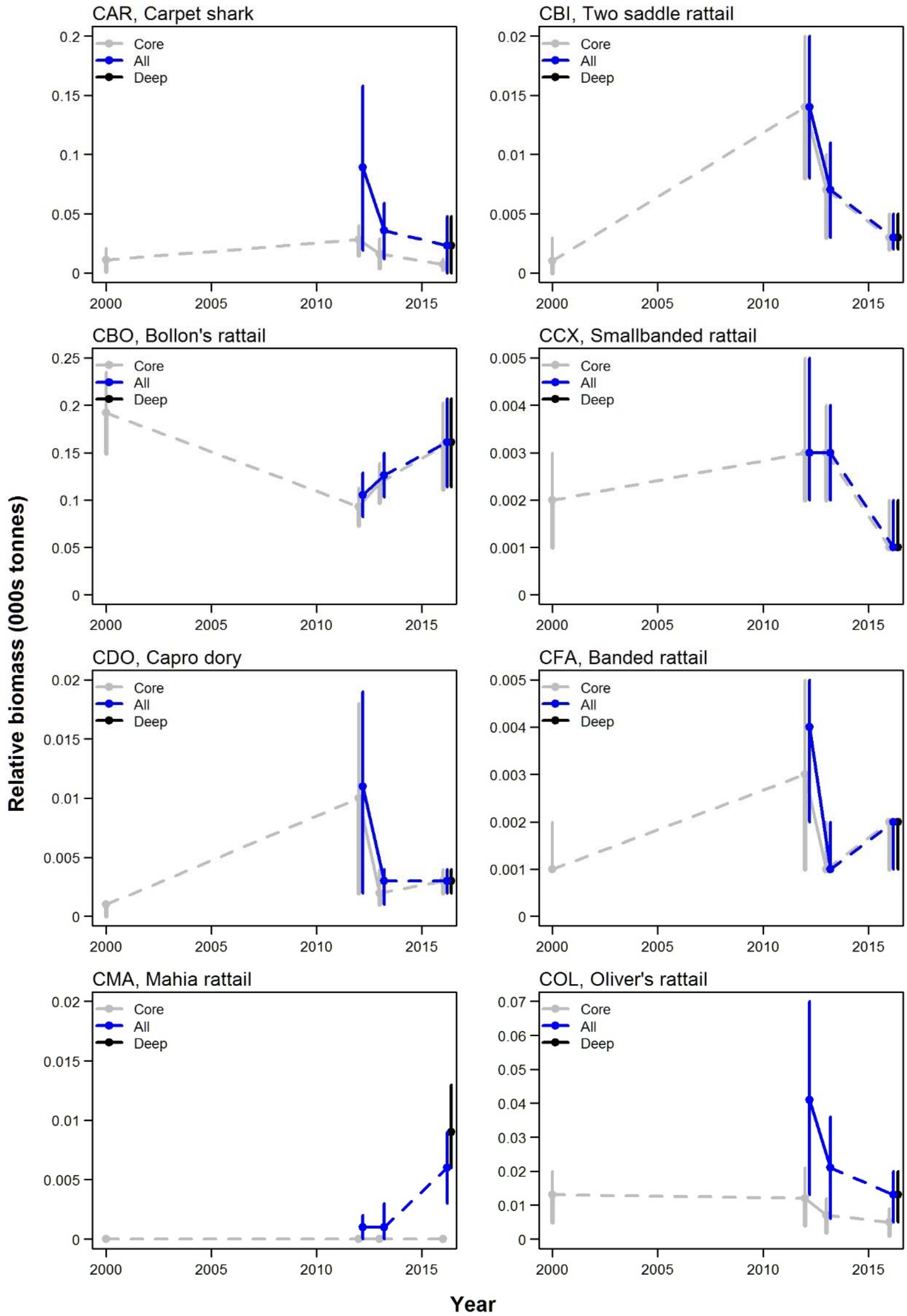


Figure 4: Relative biomass estimates (thousands of tonnes) of selected species sorted alphabetically by research code sampled by trawl surveys of the WCSI, 2000, 2012, 2013, and 2016. Grey lines show fish from core (300–650 m) strata, blue lines show fish from all strata (200–800 m), and black solid lines show fish from deep (200–1000 m) strata. Error bars show ± 2 standard errors.



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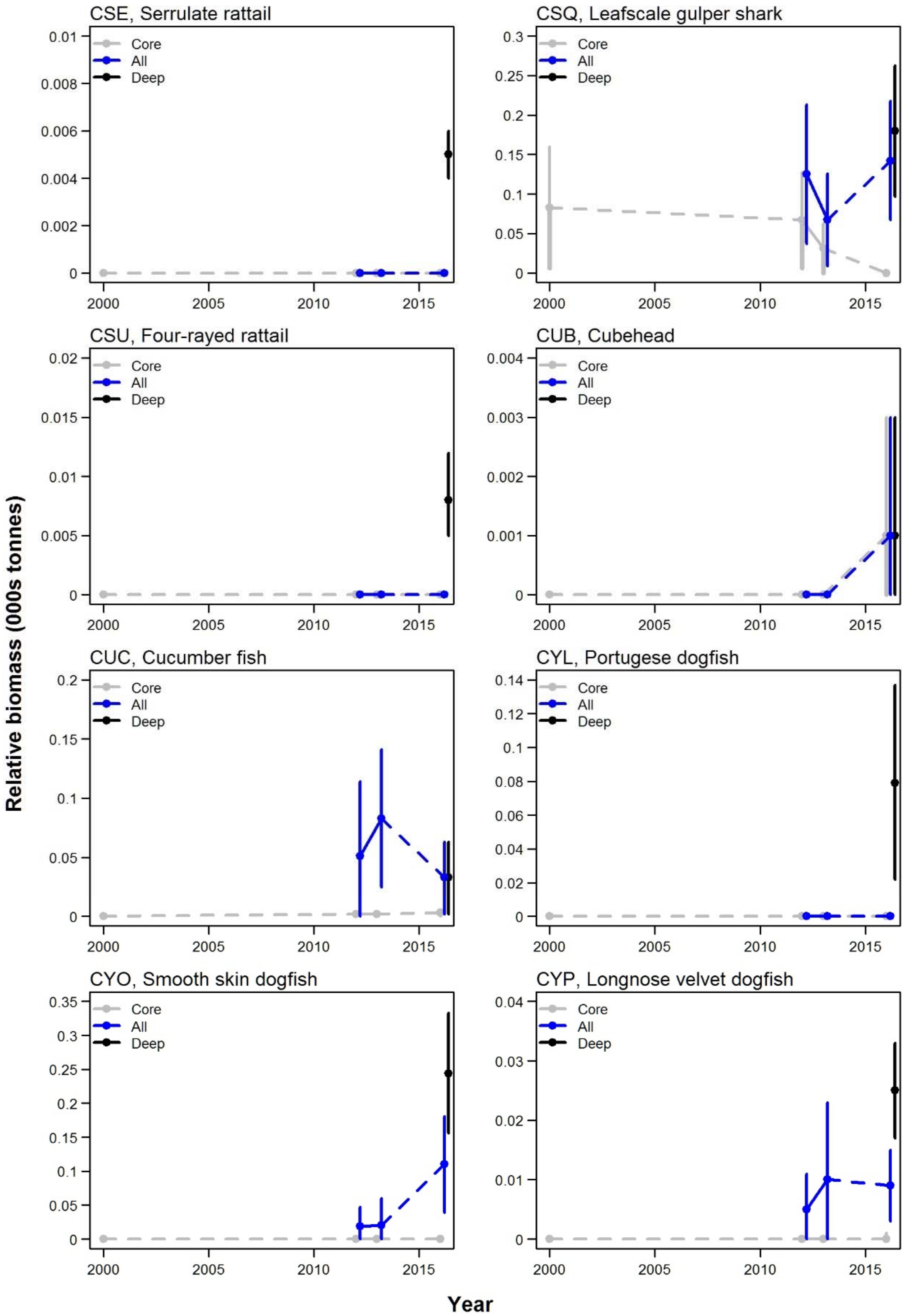

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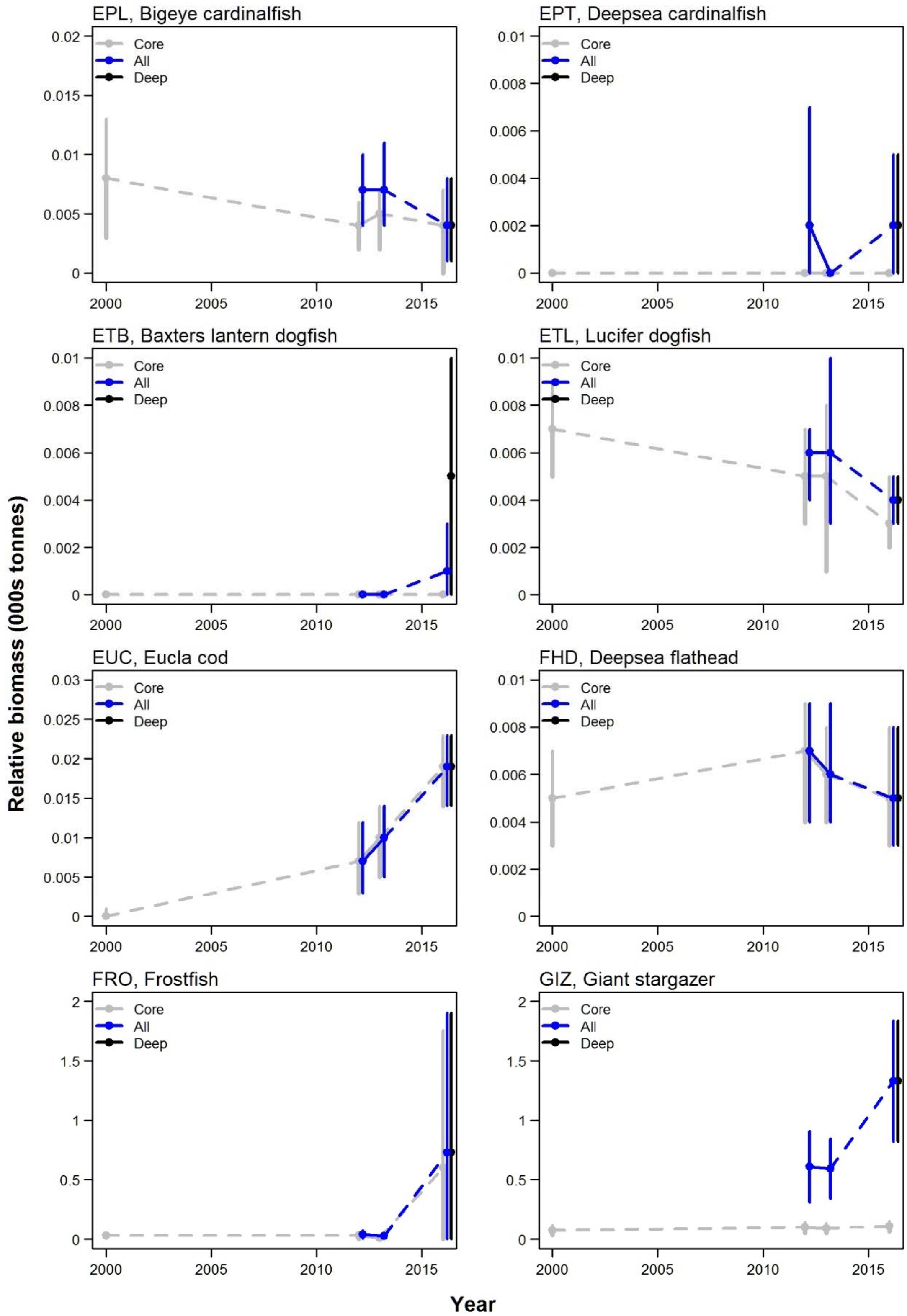

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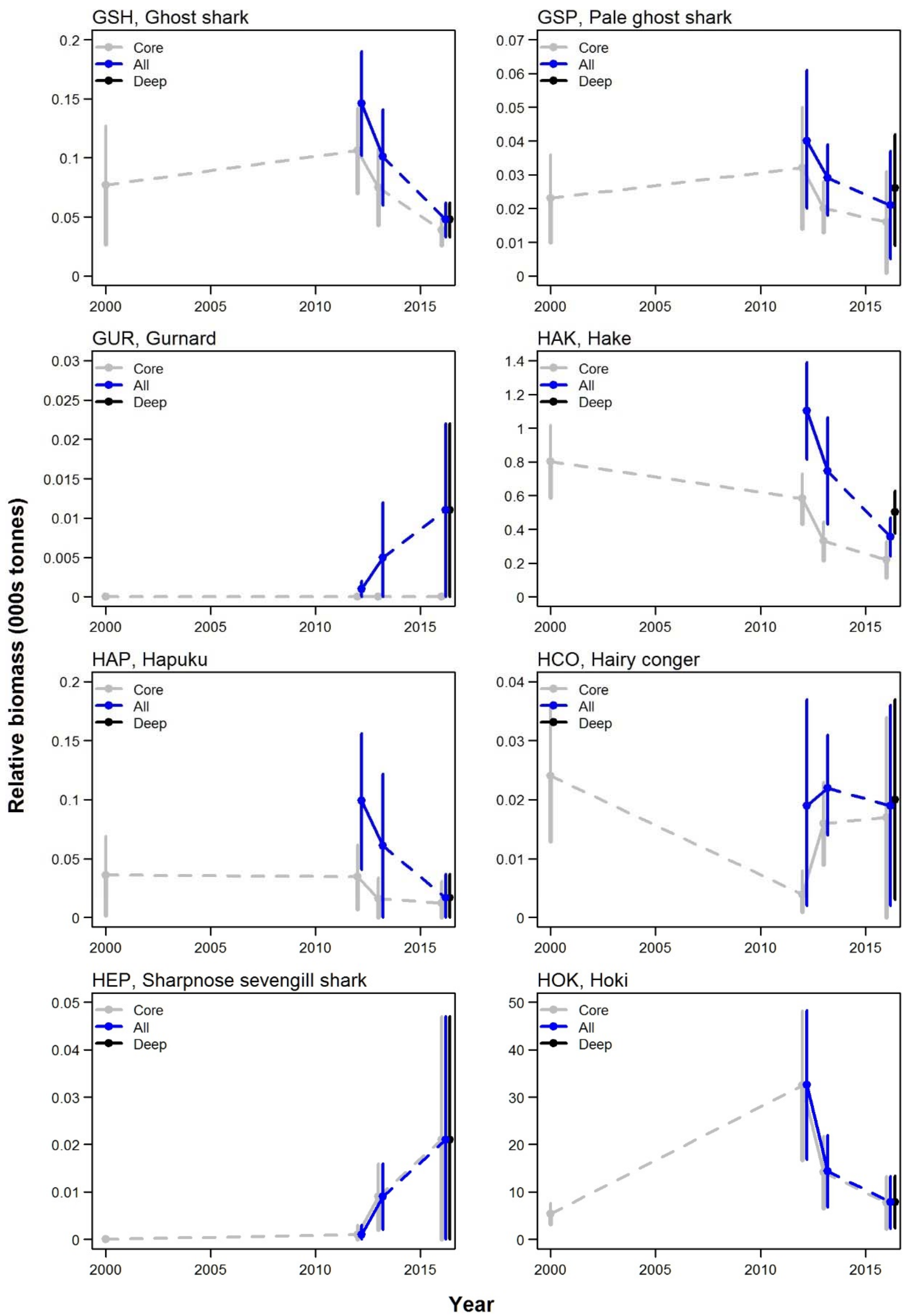

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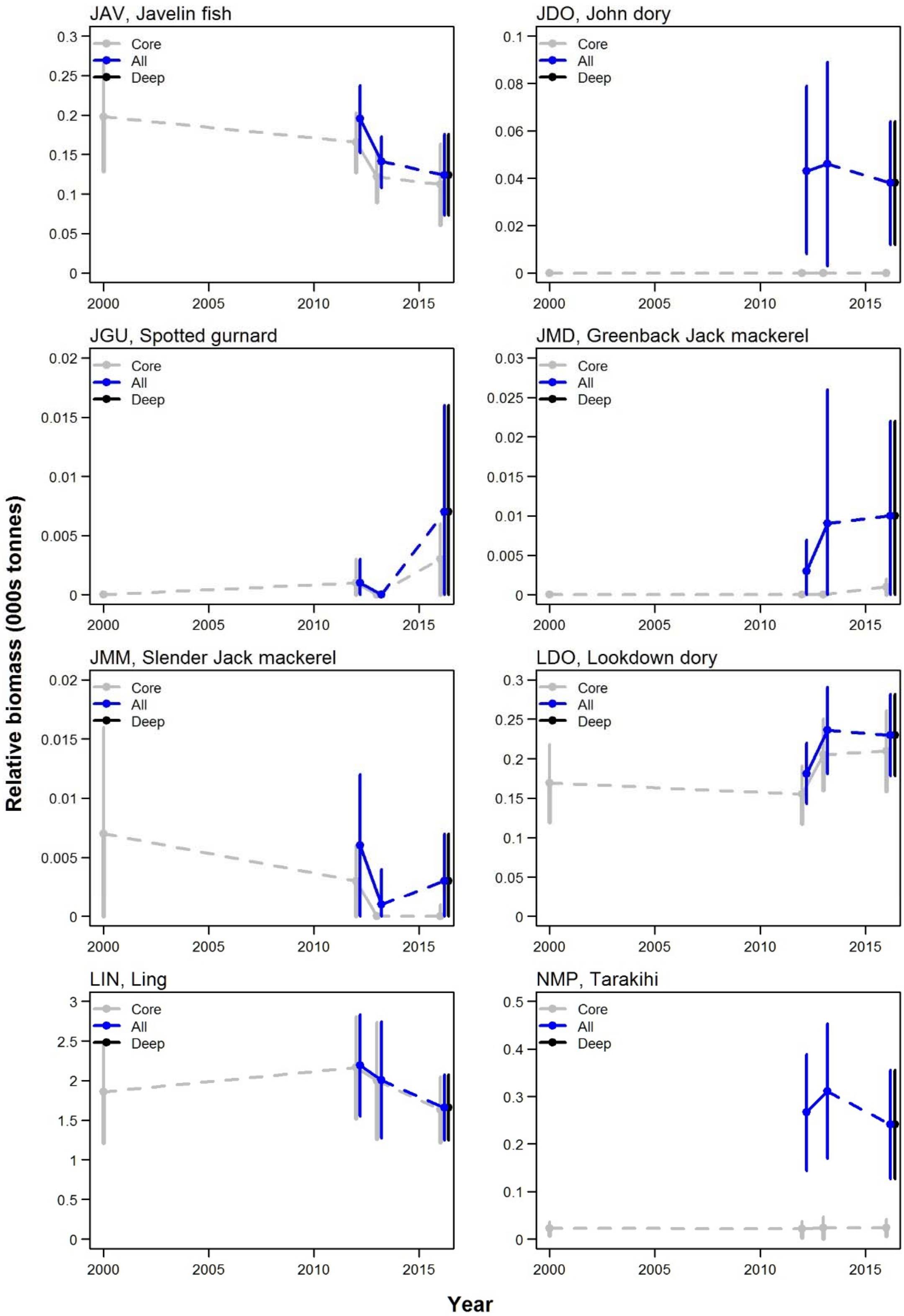

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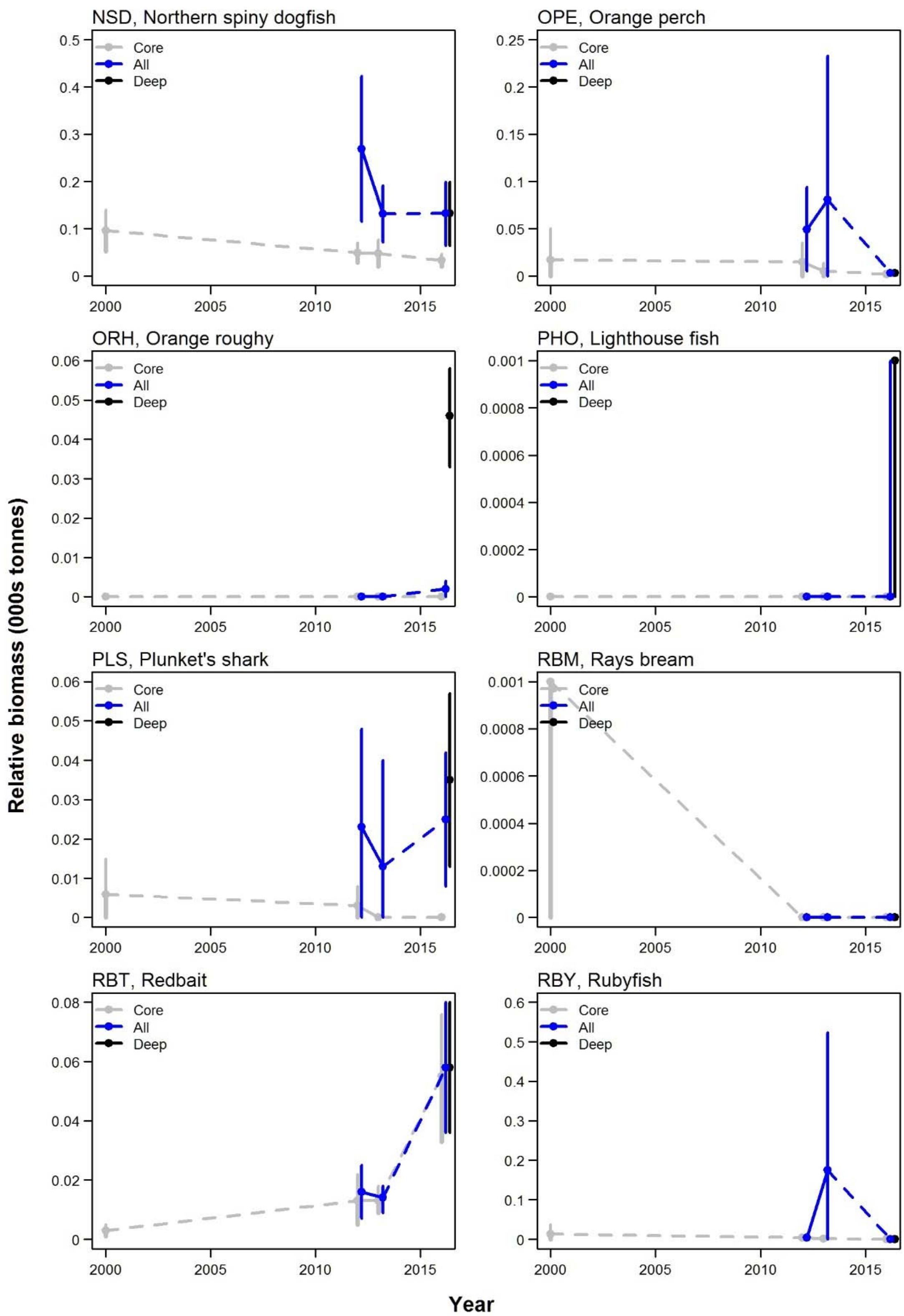

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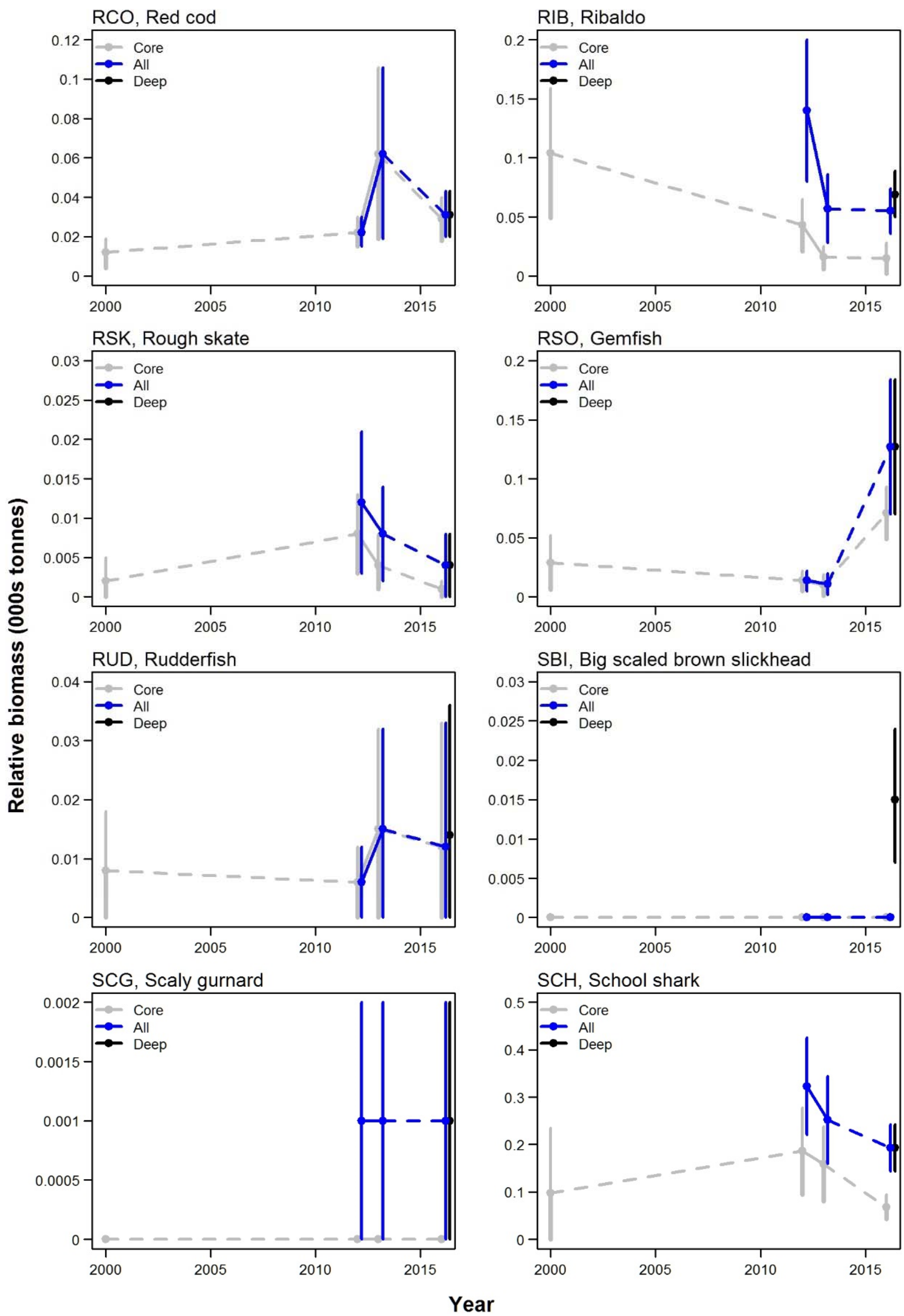

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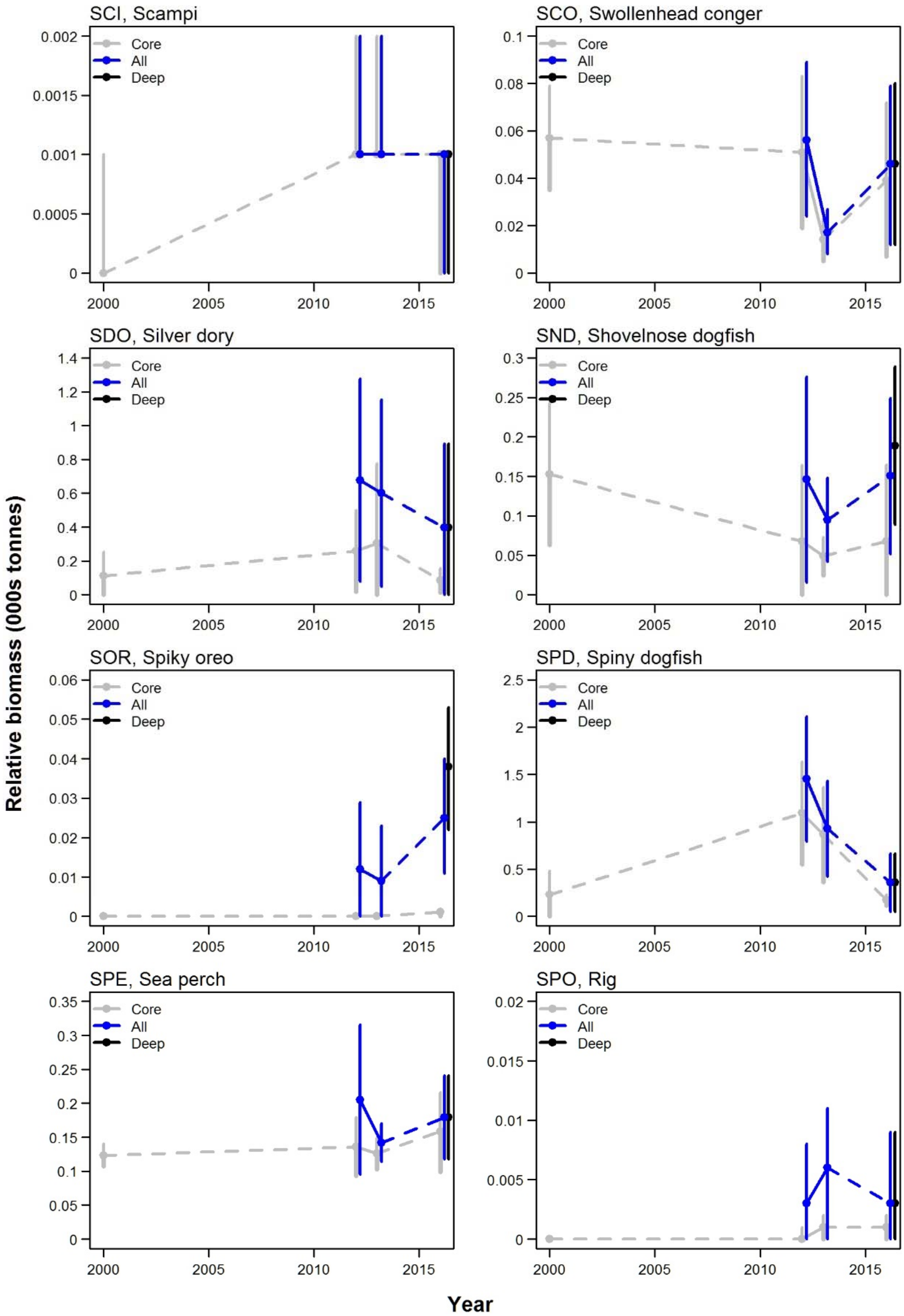

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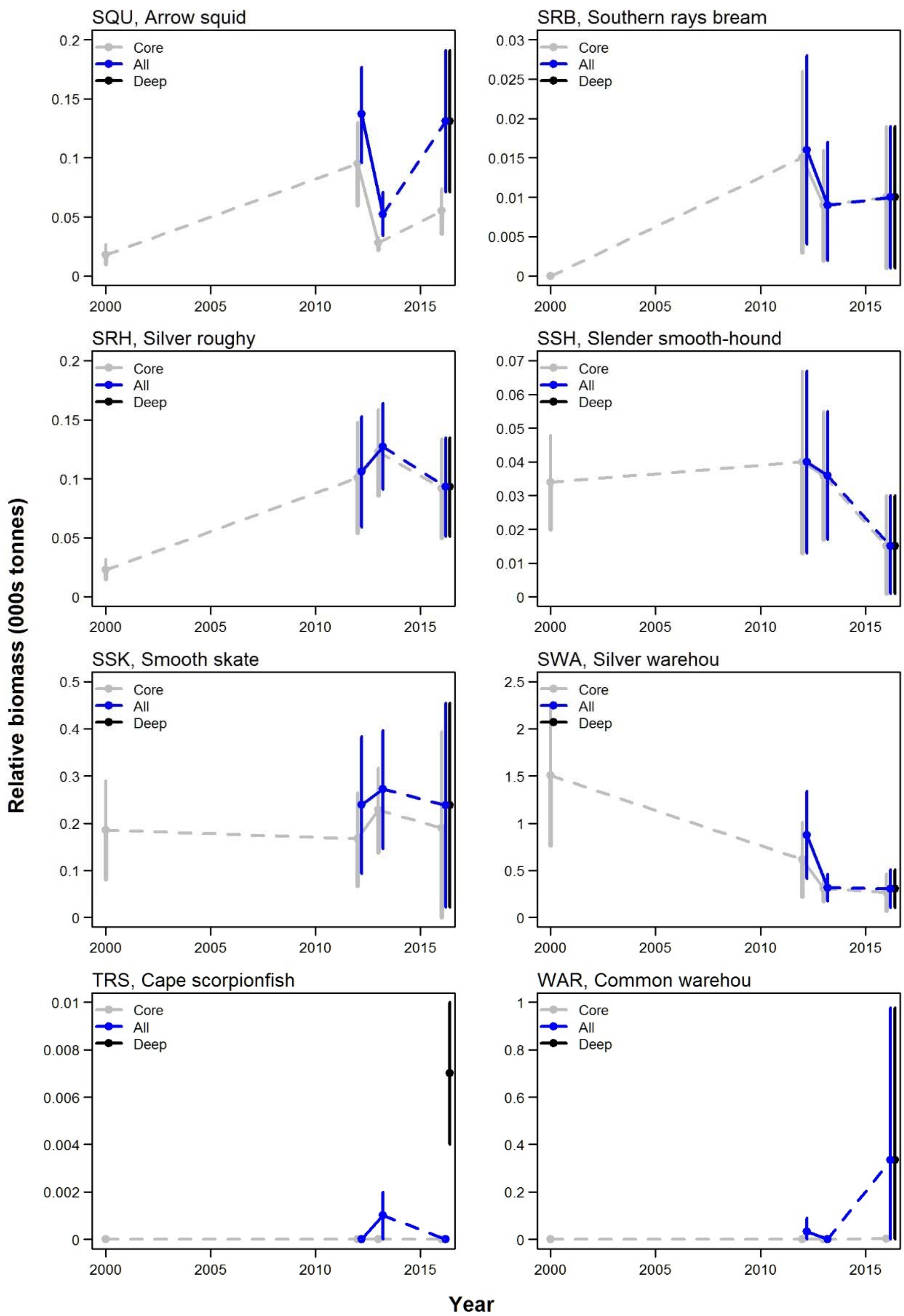

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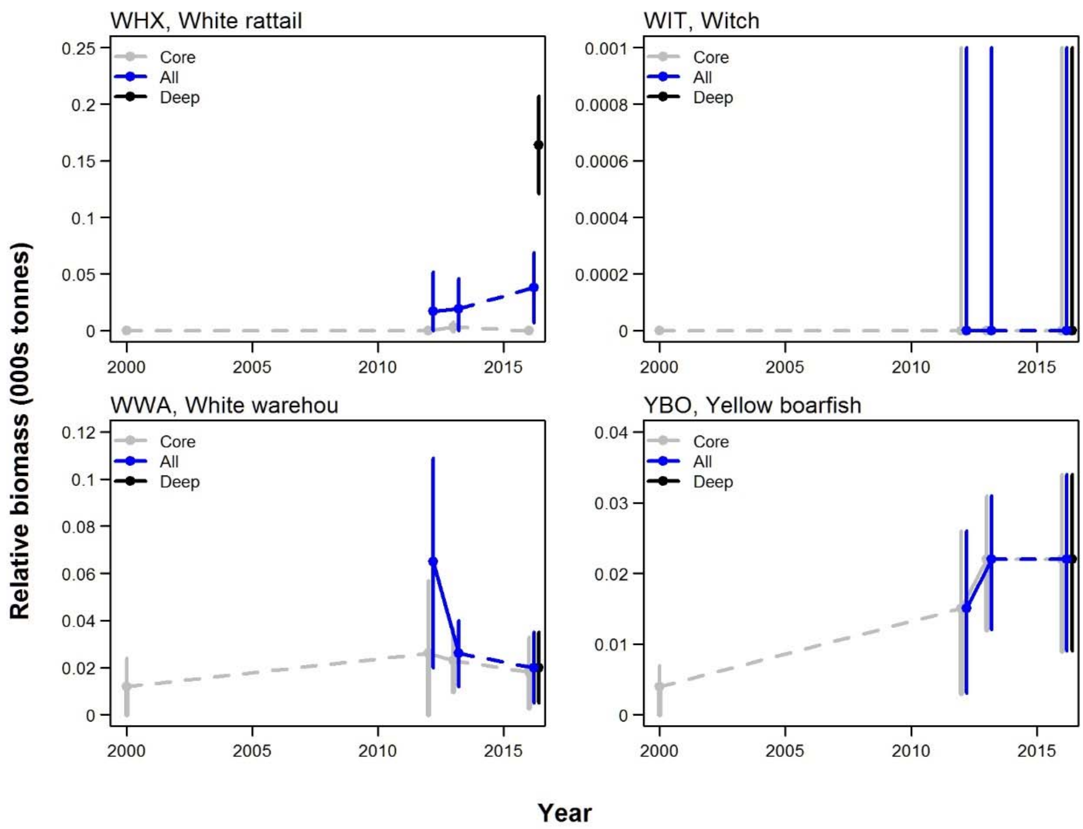

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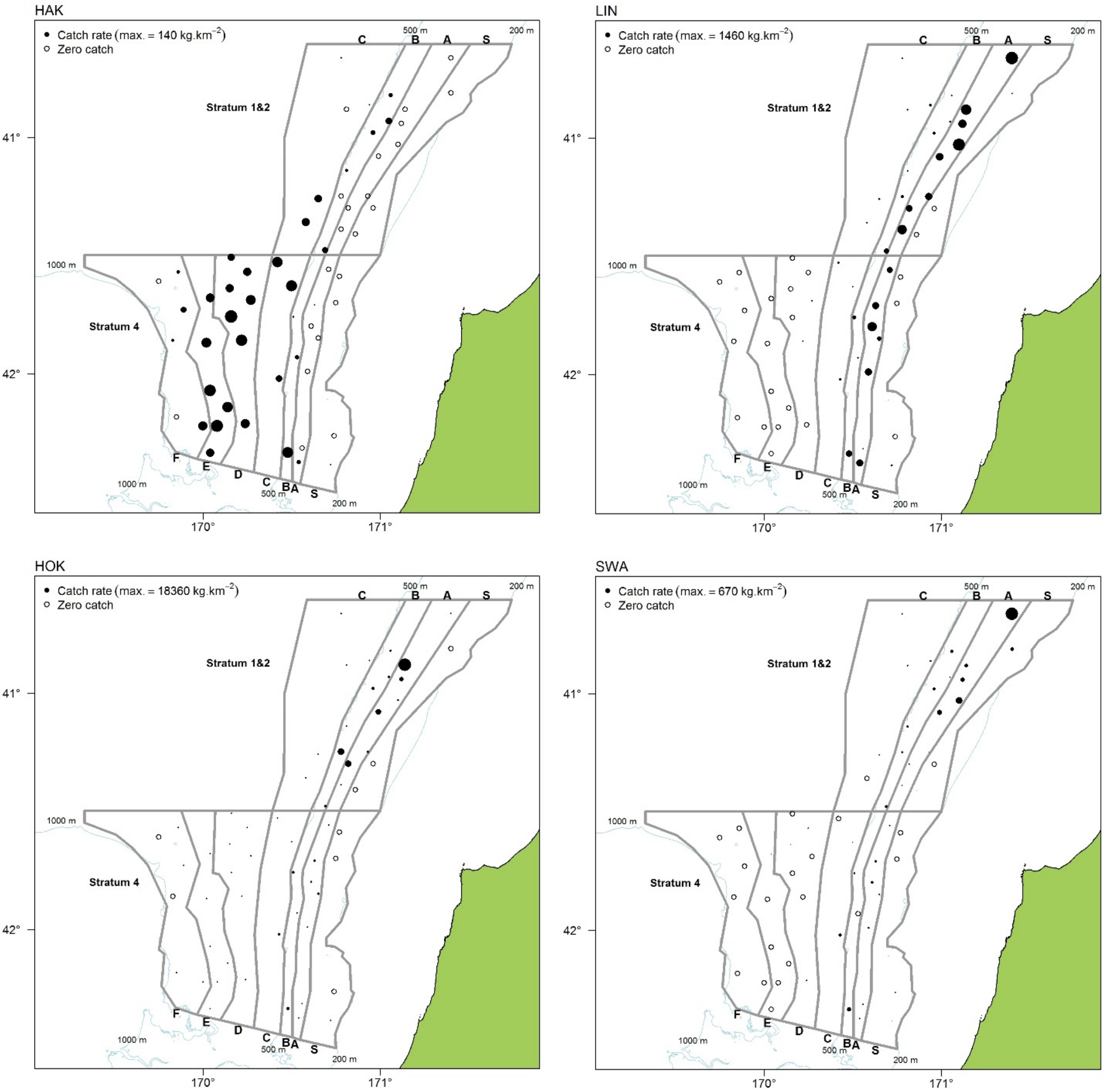


Figure 5: Distribution and catch rates of ling (LIN), hoki (HOK), hake (HAK), and silver warehou (SWA) on the WCSI 2016 trawl survey. Circle area is proportional to catch rate. Open circles indicate zero catches.

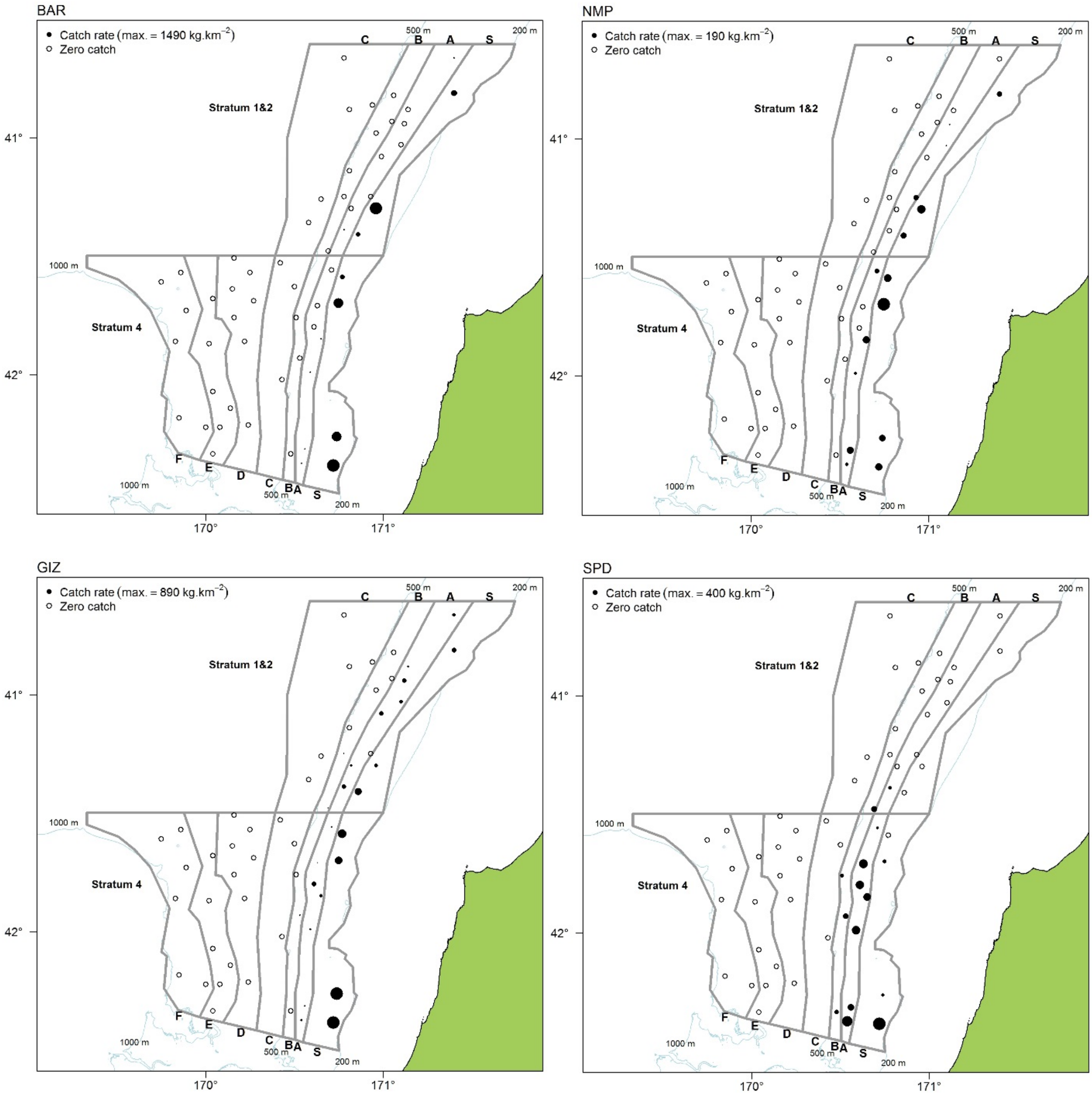


Figure 5 continued: Distribution and catch rates of barracouta (BAR), spiny dogfish (SPD), giant stargazer (GIZ), and tarakihi (NMP) on the WCSI 2016 trawl survey. Circle area is proportional to catch rate. Open circles indicate zero catches.

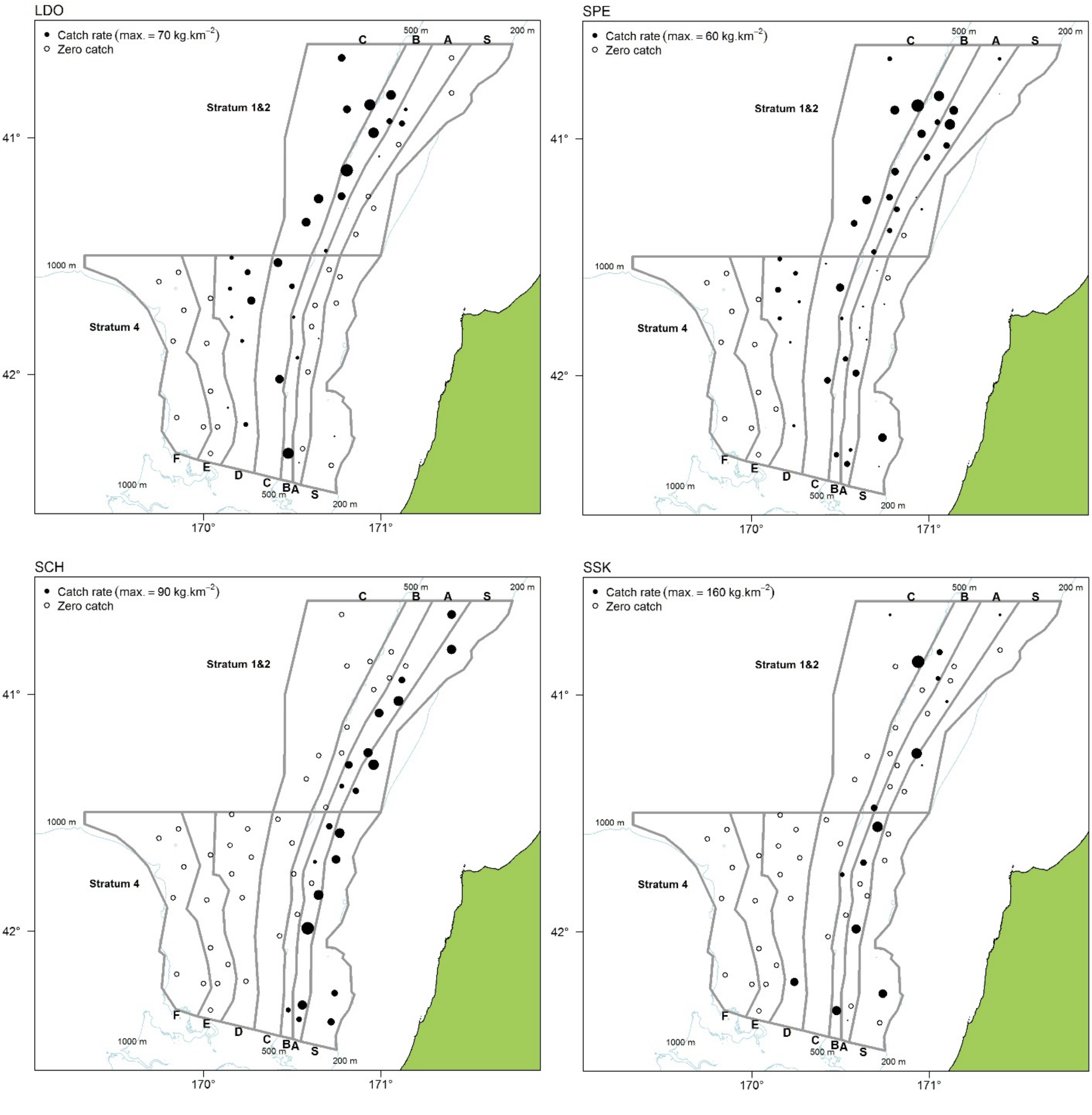


Figure 5 continued: Distribution and catch rates of smooth skate (SSK), school shark (SCH), lookdown dory (LDO) and sea perch (SPE) on the WCSI 2016 trawl survey. Circle area is proportional to catch rate. Open circles indicate zero catches.

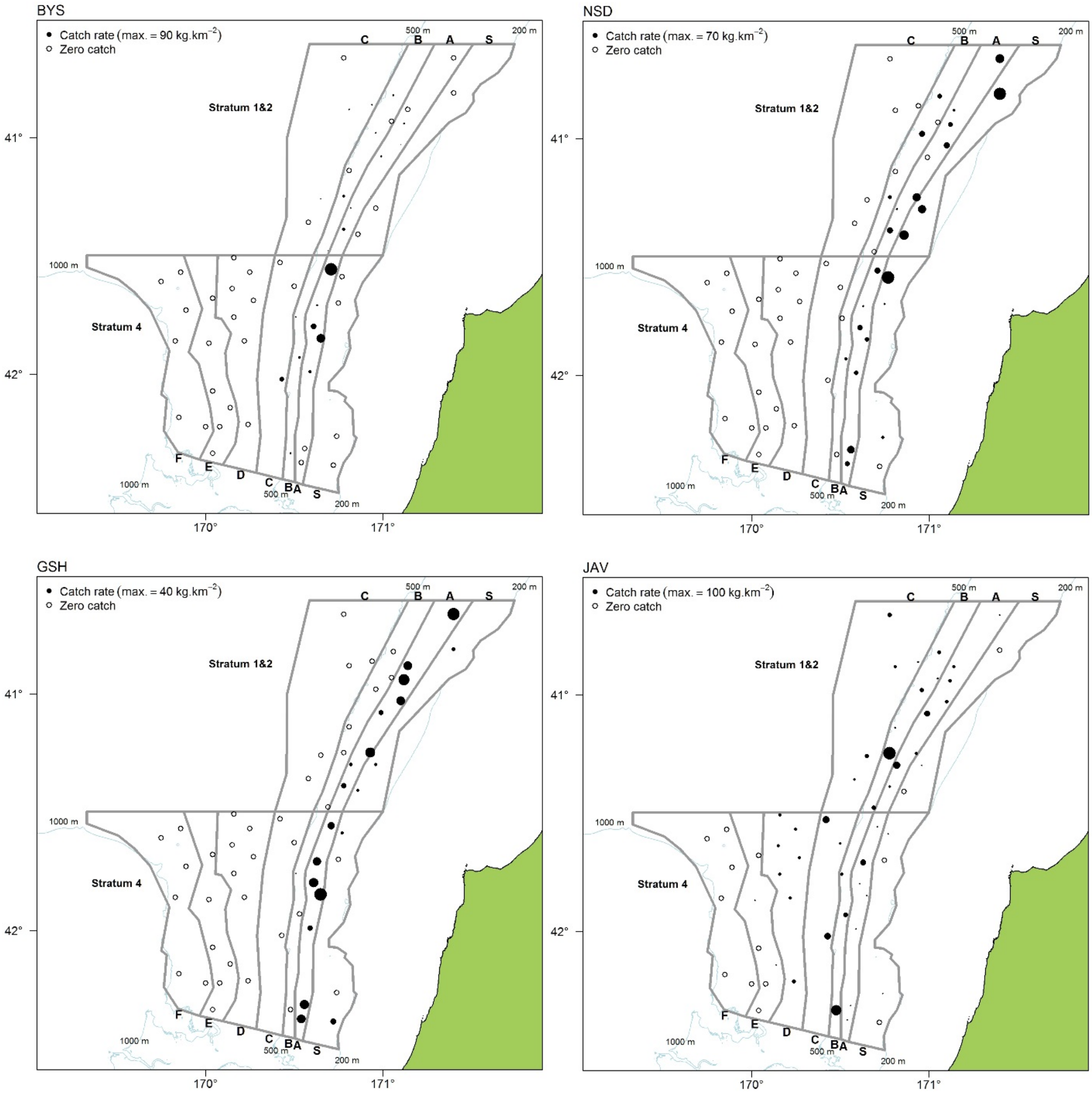


Figure 5 continued: Distribution and catch rates of javelinfish (JAV), northern spiny dogfish (NSD), alfonsino (BYS), and dark ghost shark (GSH) on the WCSI 2016 trawl survey. Circle area is proportional to catch rate. Open circles indicate zero catches.

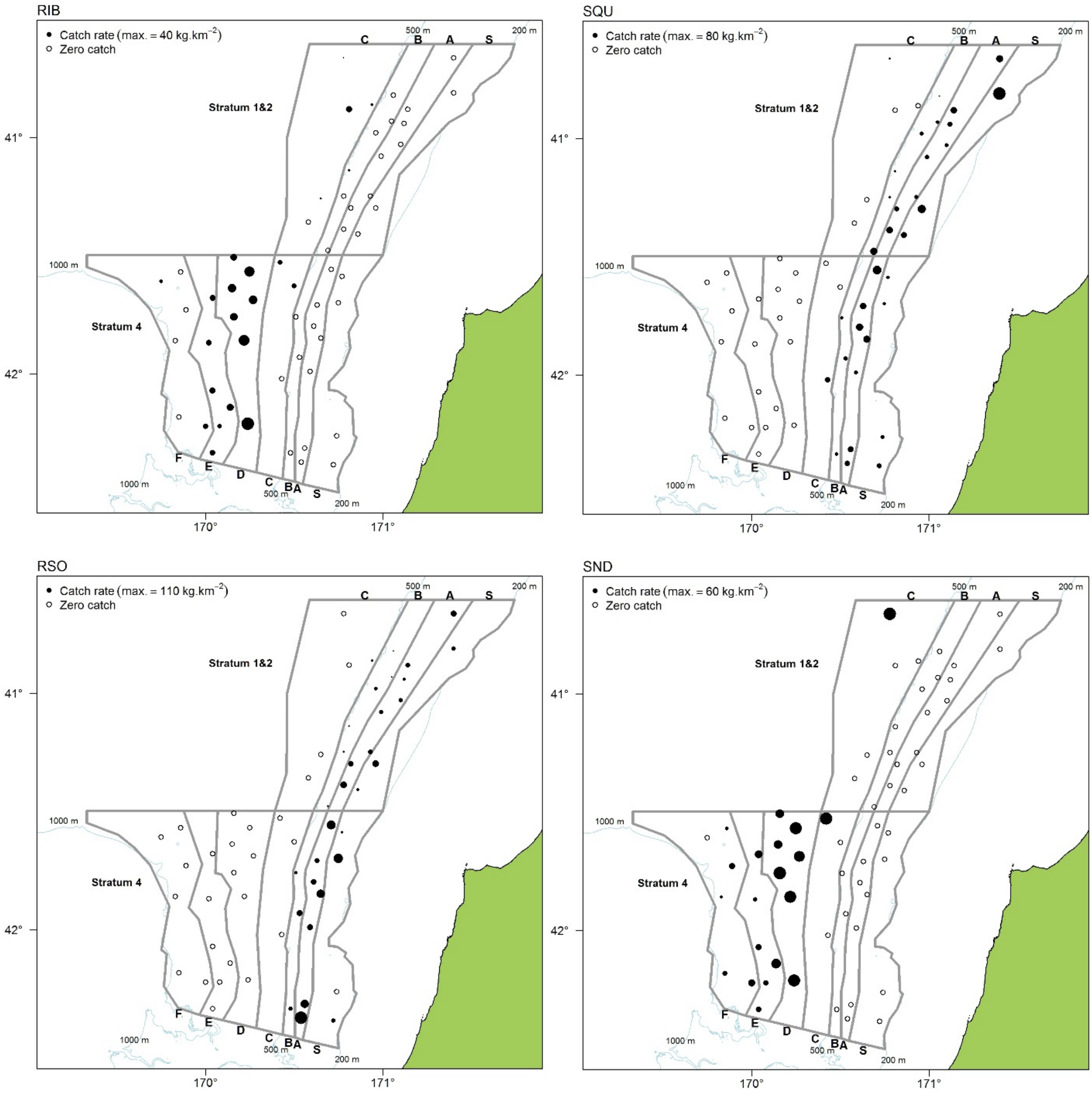


Figure 5 continued: Distribution and catch rates of shovelnose dogfish (SND), arrow squid (SQU), ribaldo (RIB), and gemfish (RSO) on the WCSI 2016 trawl survey. Circle area is proportional to catch rate. Open circles indicate zero catches.

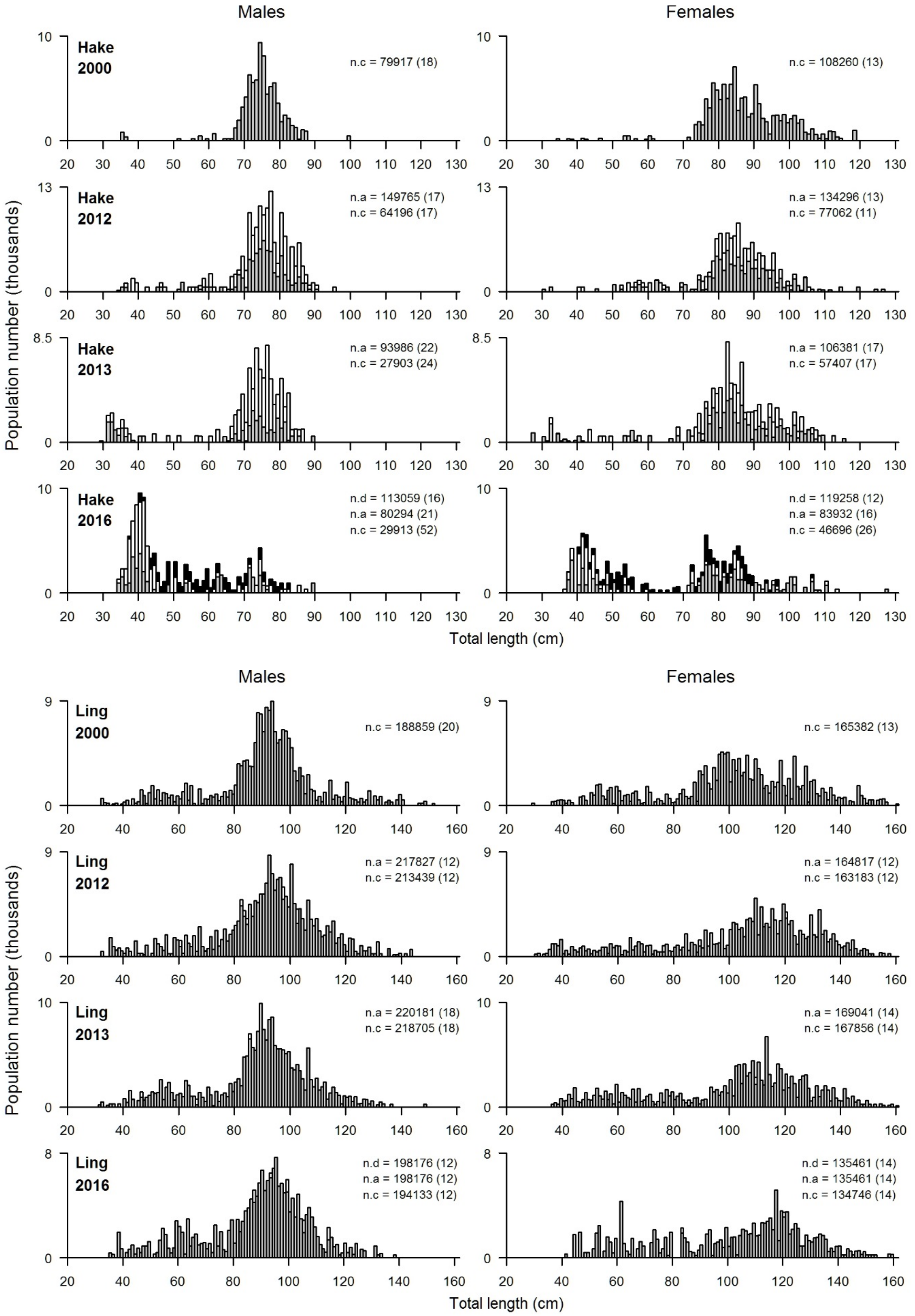


Figure 6: Length frequency distributions by sex of hake (HAK) and ling (LIN) for core (grey), all (white), and deep (black) strata from the 2000, 2012, 2013, and 2016 WCSI trawl surveys. n.d, estimated scaled total number of fish for deep strata; n.a, estimated scaled total number of fish for all strata; n.c, estimated scaled total number of fish for core strata; and CV, the coefficient of variation (in parentheses).

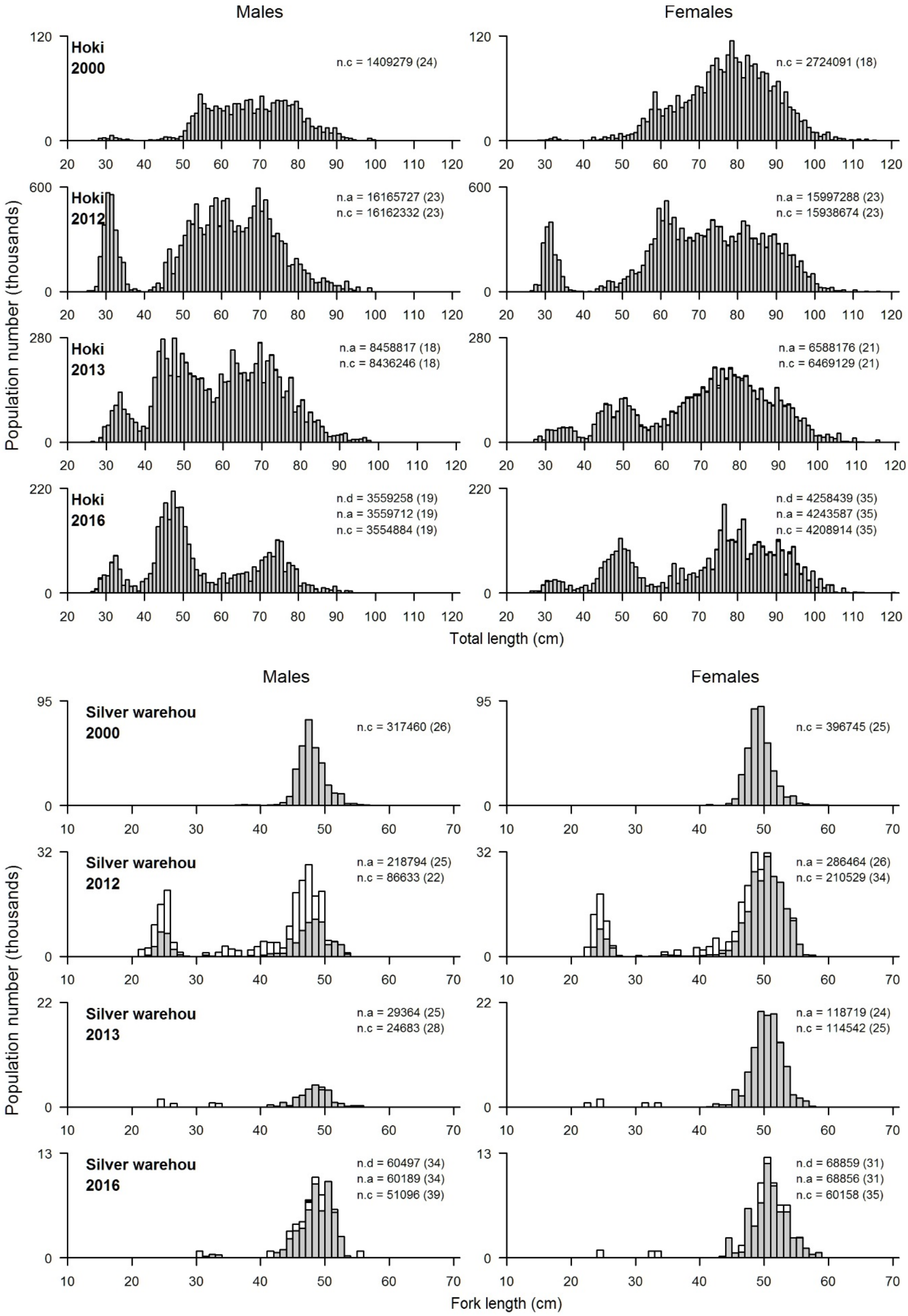


Figure 6: continued. Length frequency distributions by sex of hoki (HOK) and silver warehou (SWA) for core (grey), all (white), and deep (black) strata from the 2000, 2012, 2013, and 2016 WCSI trawl surveys. n.d, estimated scaled total number of fish for deep strata; n.a, estimated scaled total number of fish for all strata; n.c, estimated scaled total number of fish for core strata; and CV, the coefficient of variation (in parentheses).

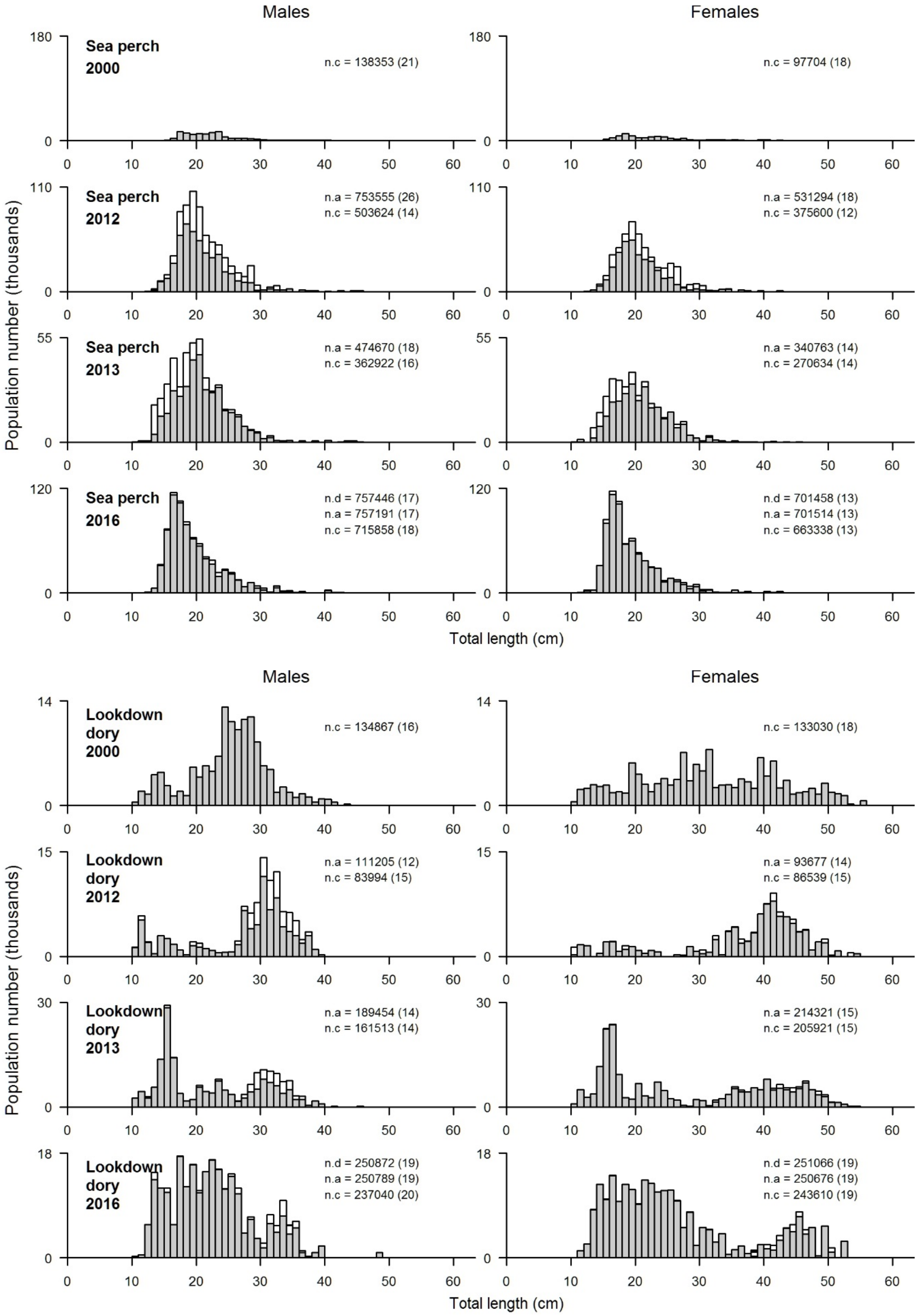
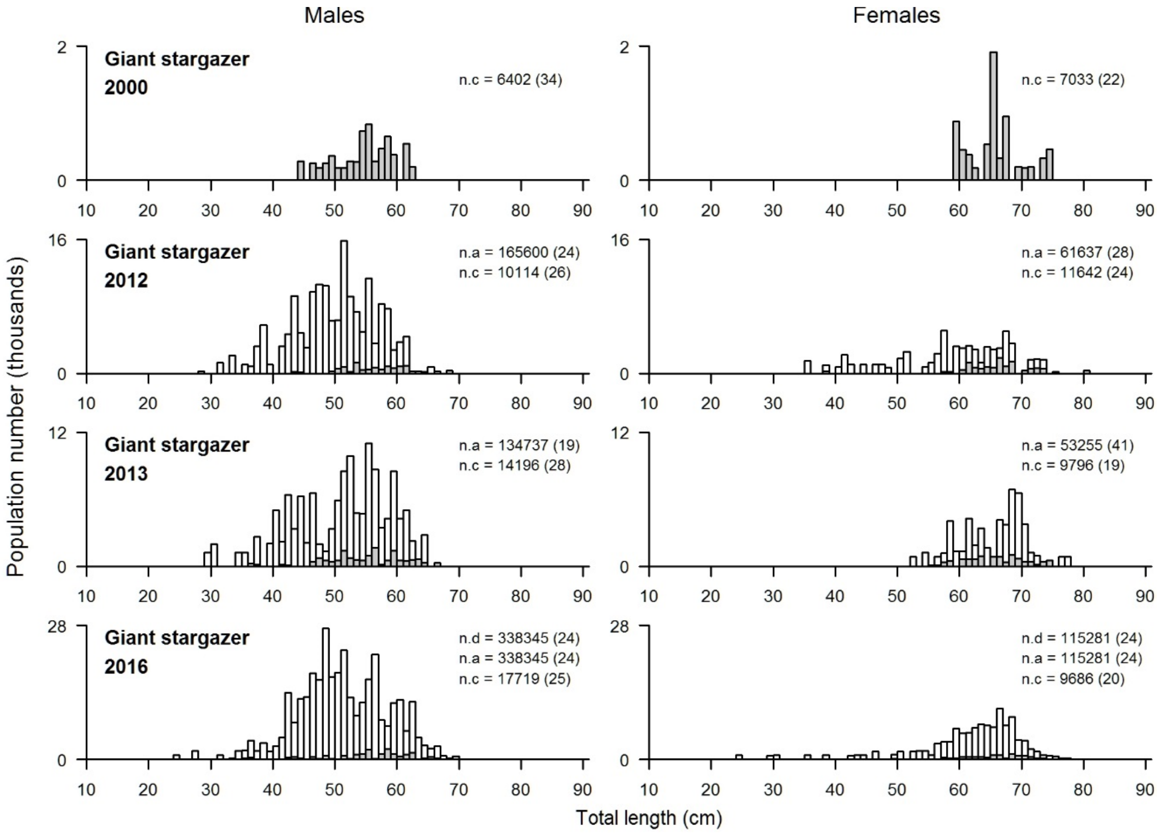


Figure 6: continued. Length frequency distributions by sex of sea perch (SPE) and lookdown dory (LDO) for core (grey), all (white), and deep (black) strata from the 2000, 2012, 2013, and 2016 WCSI trawl surveys. n.d, estimated scaled total number of fish for deep strata; n.a, estimated scaled total number of fish for all strata; n.c, estimated scaled total number of fish for core strata; and CV, the coefficient of variation (in parentheses).



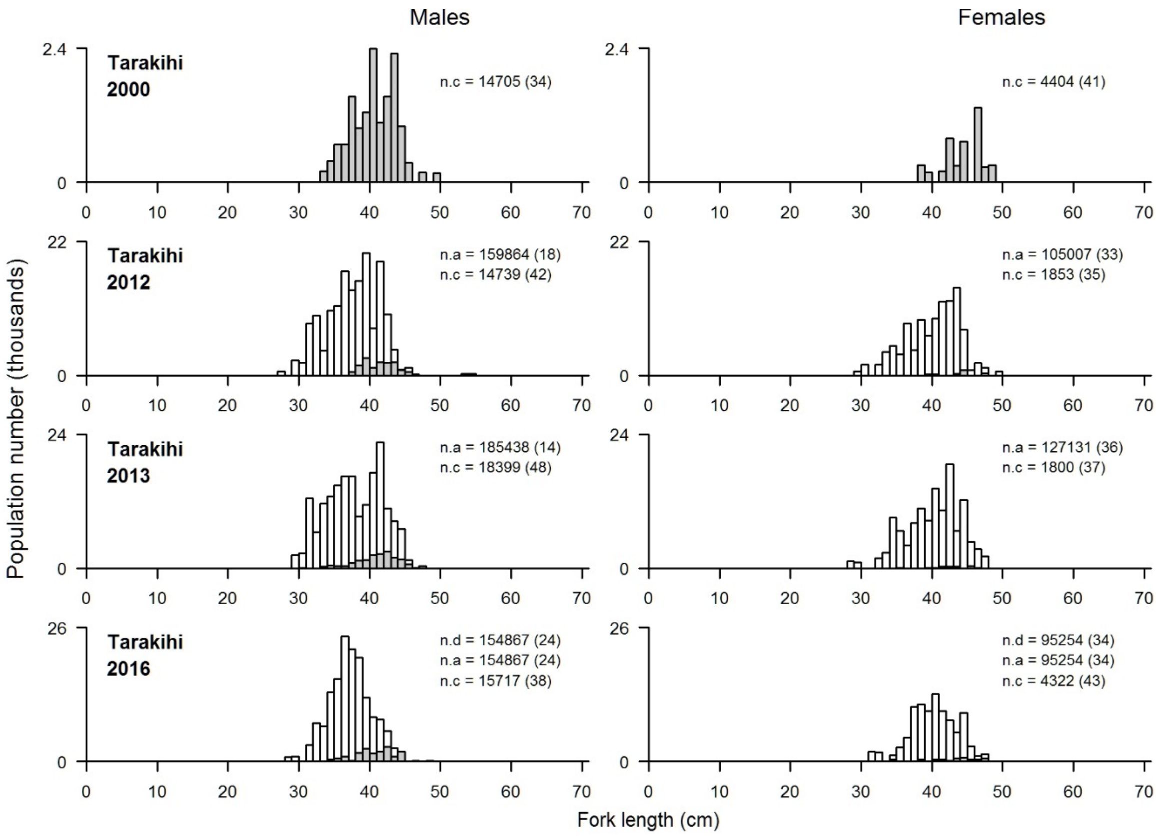


Figure 6: continued. Length frequency distributions by sex of giant stargazer (GIZ) and tarakihi (NMP) for core (grey), all (white), and deep (black) strata from the 2000, 2012, 2013, and 2016 WCSI trawl surveys. n.d, estimated scaled total number of fish for deep strata; n.a, estimated scaled total 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).

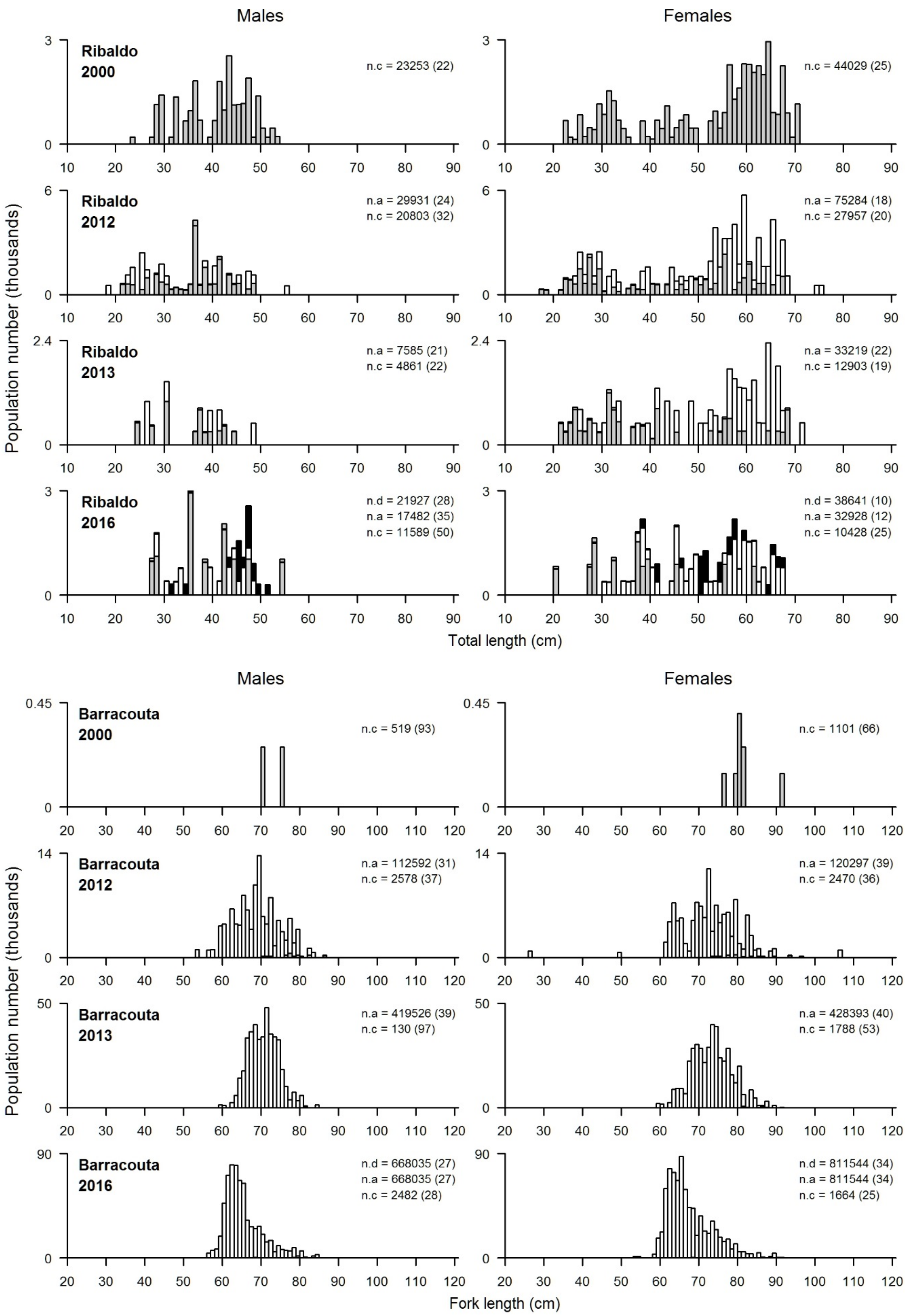


Figure 6: continued. Length frequency distributions by sex of ribaldo (RIB) and barracouta (BAR) for core (grey), all (white), and deep (black) strata from the 2000, 2012, 2013, and 2016 WCSI trawl surveys. n.d, estimated scaled total number of fish for deep strata; n.a, estimated scaled total number of fish for all strata; n.c, estimated scaled total number of fish for core strata; and CV, the coefficient of variation (in parentheses).

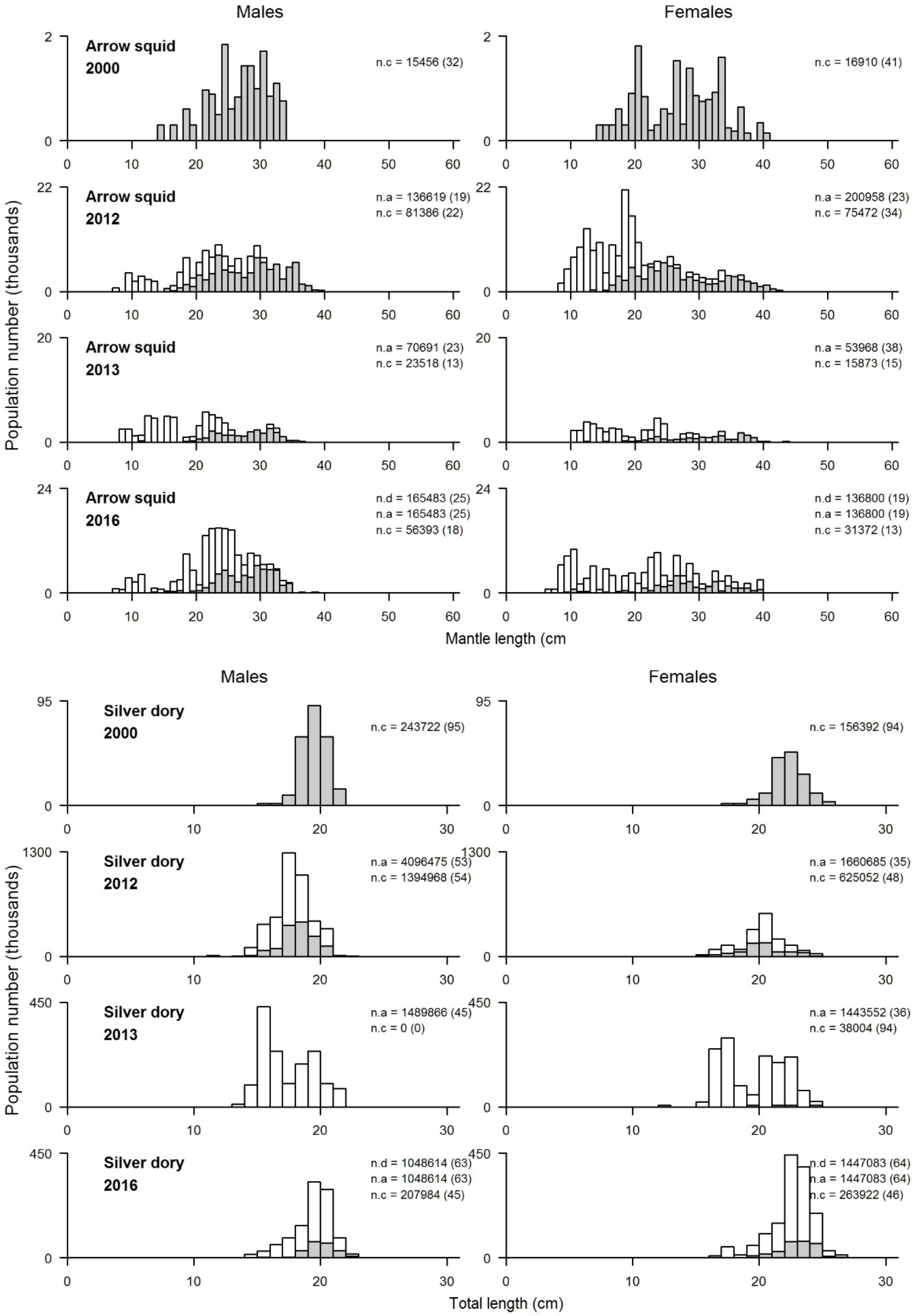


Figure 6: continued. Length frequency distributions by sex of arrow squid (SQU) and silver dory (SDO) for core (grey), all (white), and deep (black) strata from the 2000, 2012, 2013, and 2016 WCSI trawl surveys. n.d, estimated scaled total number of fish for deep strata; n.a, estimated scaled total number of fish for all strata; n.c, estimated scaled total number of fish for core strata; and CV, the coefficient of variation (in parentheses).

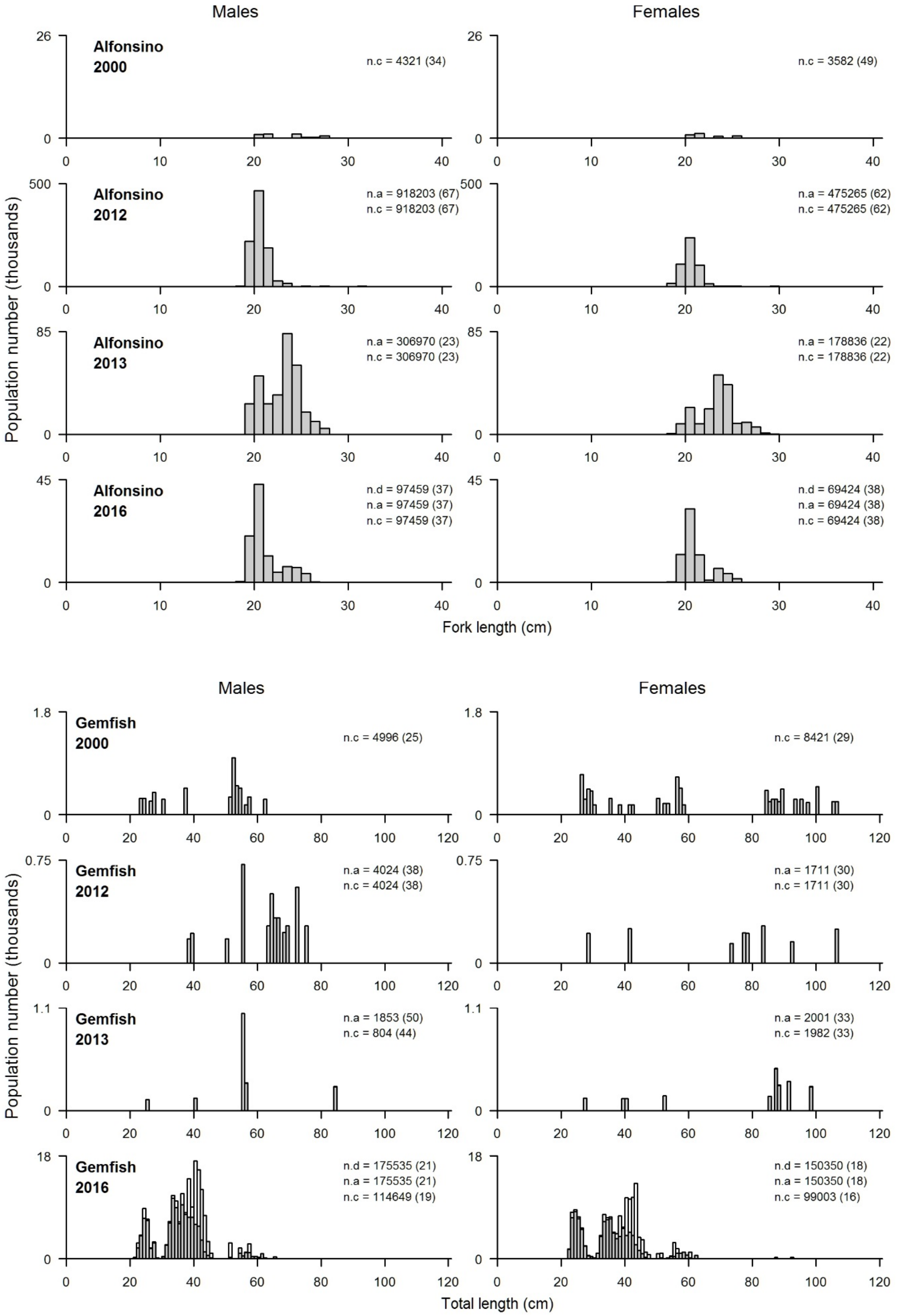


Figure 6: continued. Length frequency distributions by sex of alfonsino (BYS) and gemfish (RSO) for core (grey), all (white), and deep (black) strata from the 2000, 2012, 2013, and 2016 WCSI trawl surveys. n.d, estimated scaled total number of fish for deep strata; n.a, estimated scaled total number of fish for all strata; n.c, estimated scaled total number of fish for core strata; and CV, the coefficient of variation (in parentheses).

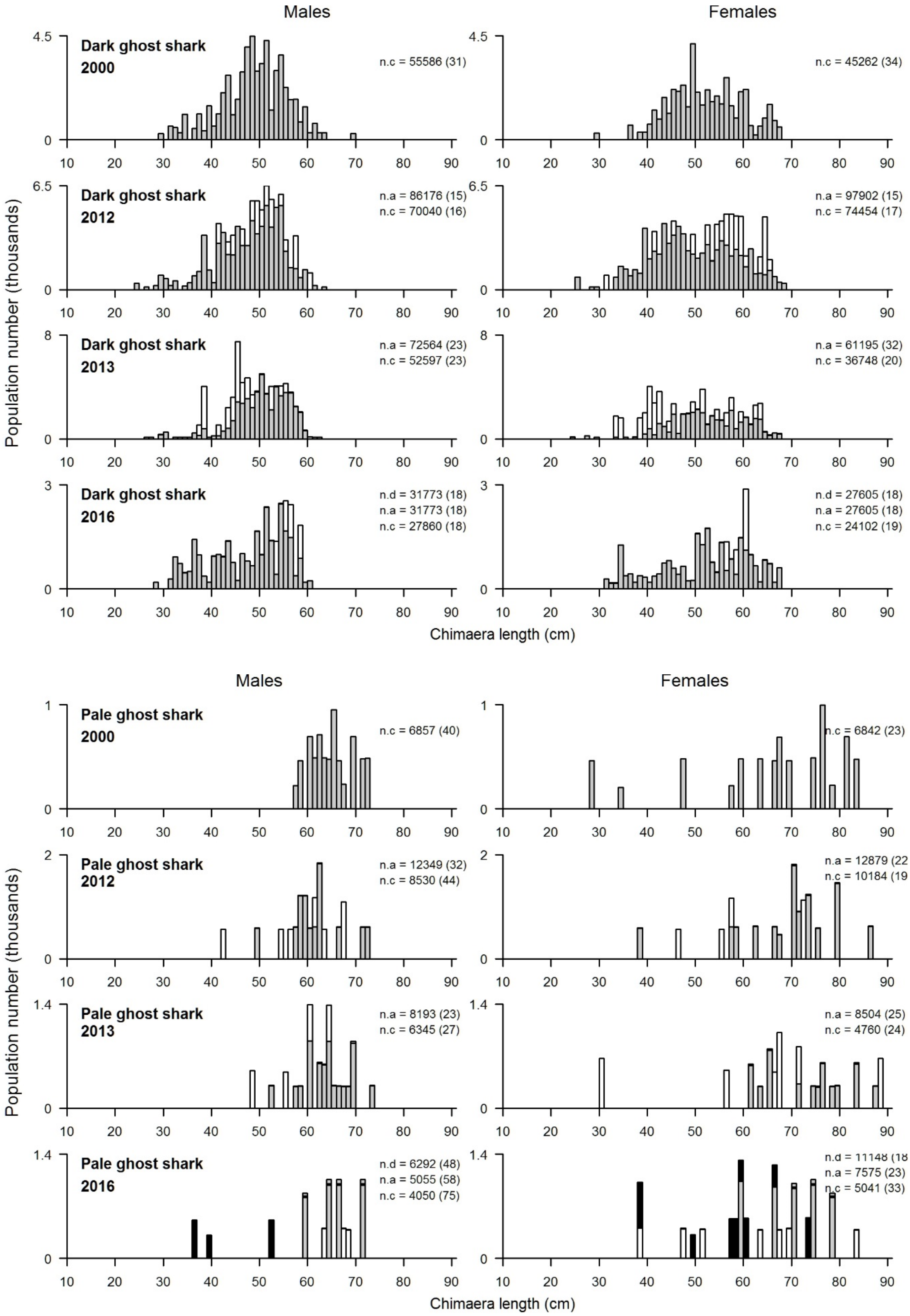


Figure 6: continued. Length frequency distributions by sex of dark ghost shark (GSH) and pale ghost shark (GSP) for core (grey), all (white), and deep (black) strata from the 2000, 2012, 2013, and 2016 WCSI trawl surveys. n.d, estimated scaled total number of fish for deep strata; n.a, estimated scaled 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).

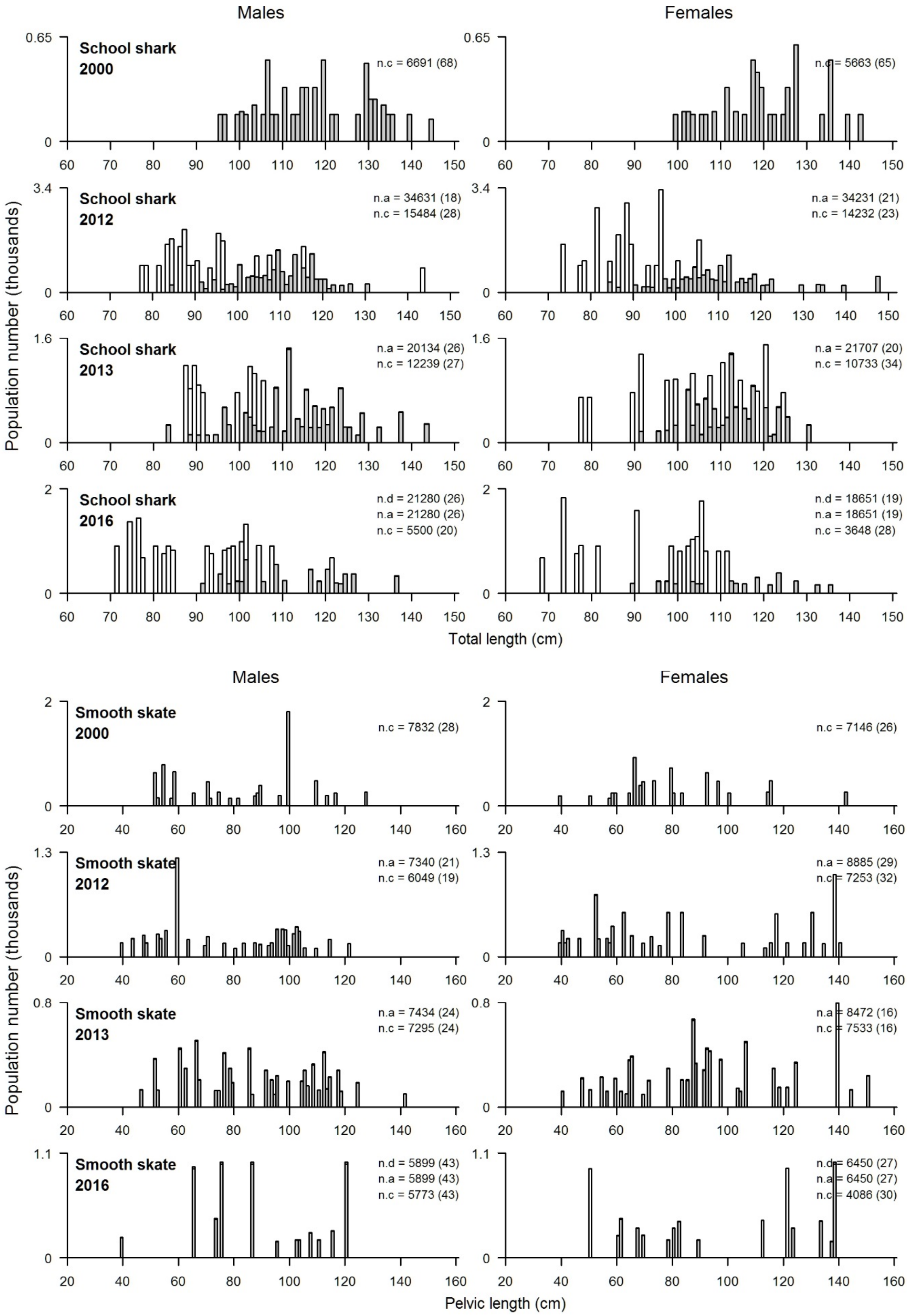


Figure 6: continued. Length frequency distributions by sex of school shark (SCH) and smooth skate (SSK) for core (grey), all (white), and deep (black) strata from the 2000, 2012, 2013, and 2016 WCSI trawl surveys. n.d, estimated scaled total number of fish for deep strata; n.a, estimated scaled total 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).

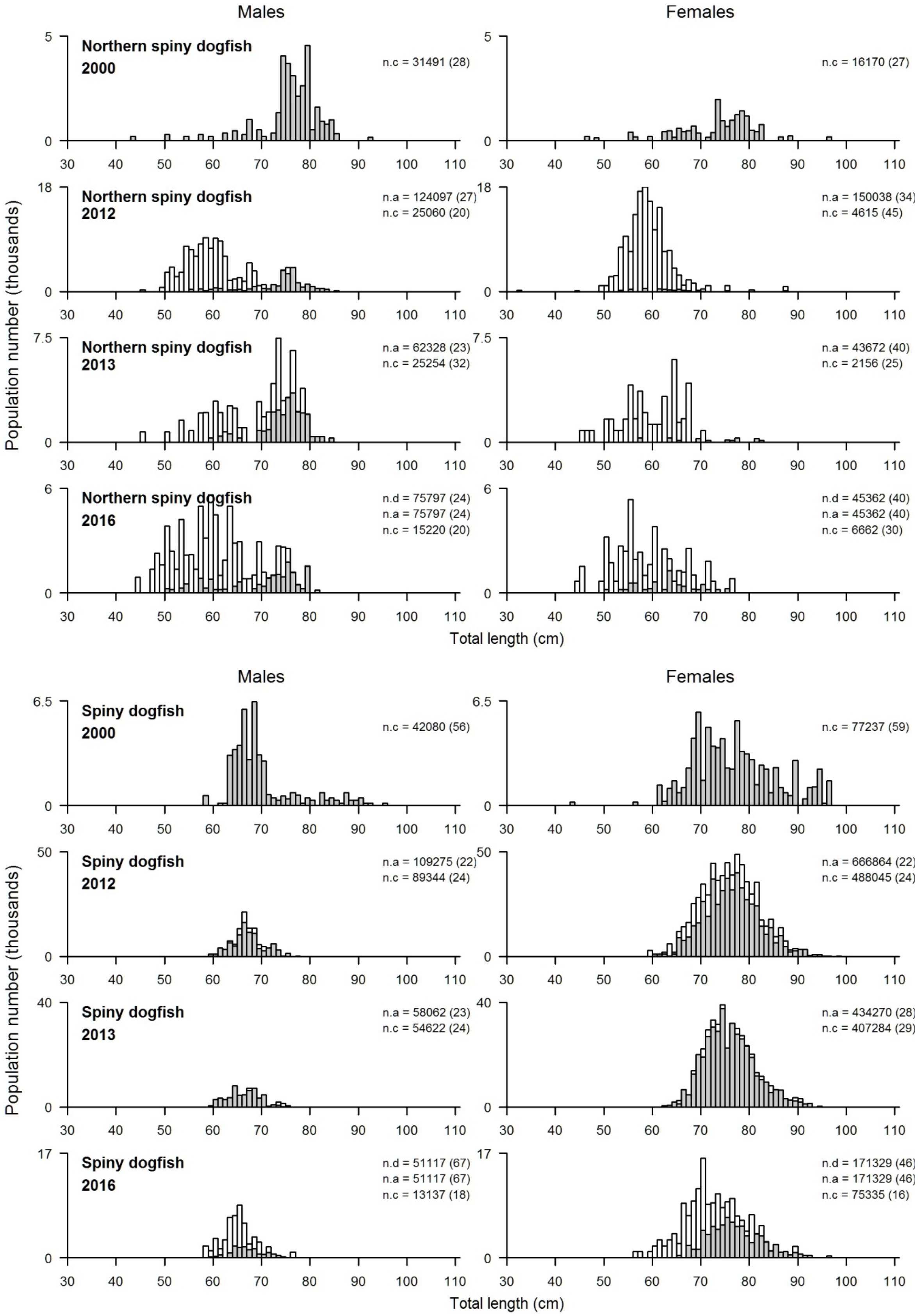


Figure 6: continued. Length frequency distributions by sex of northern spiny dogfish (NSD) and spiny dogfish (SPD) for core (grey), all (white), and deep (black) strata from the 2000, 2012, 2013, and 2016 WCSI trawl surveys. n.d, estimated scaled total number of fish for deep strata; n.a, estimated scaled 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).

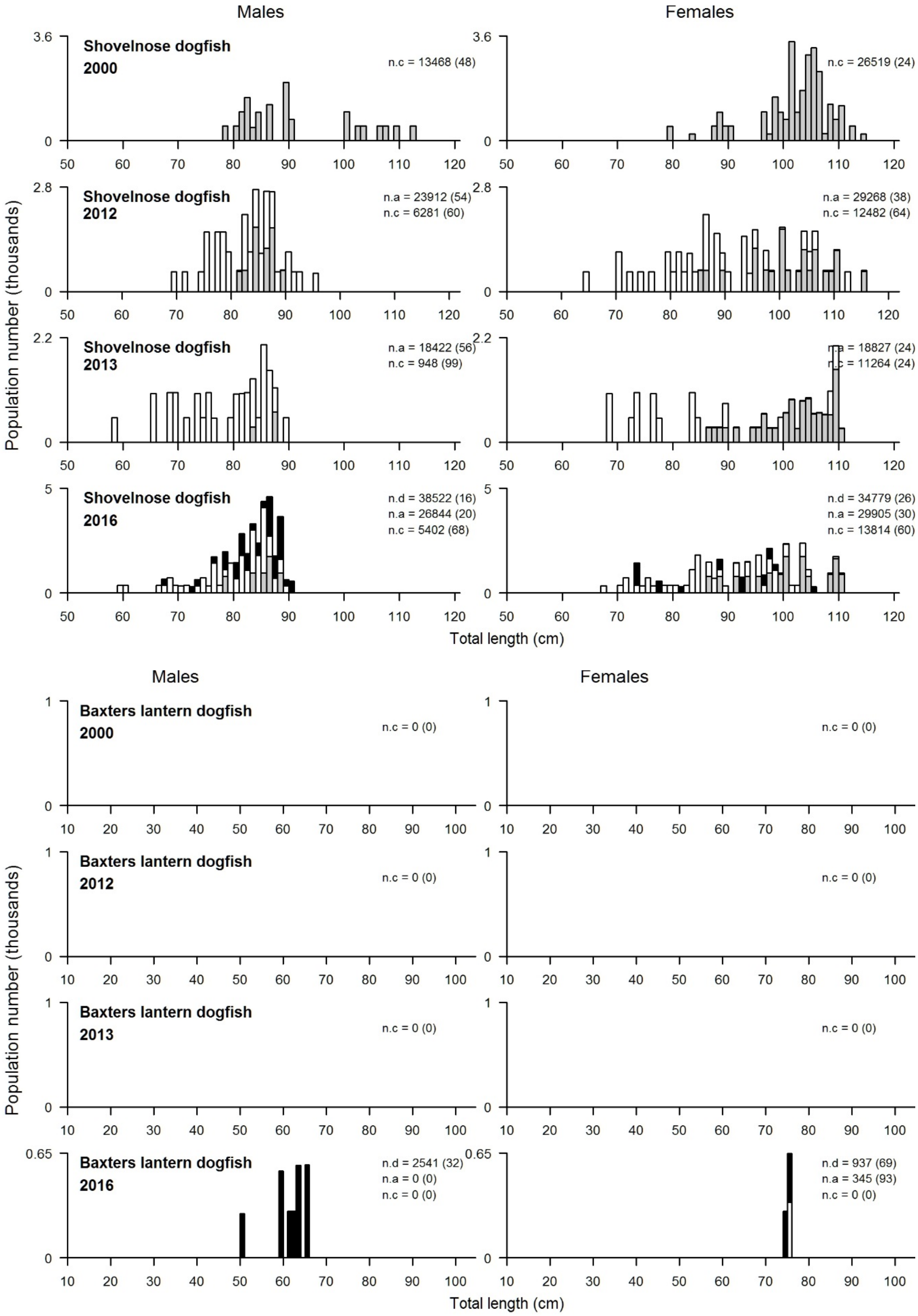
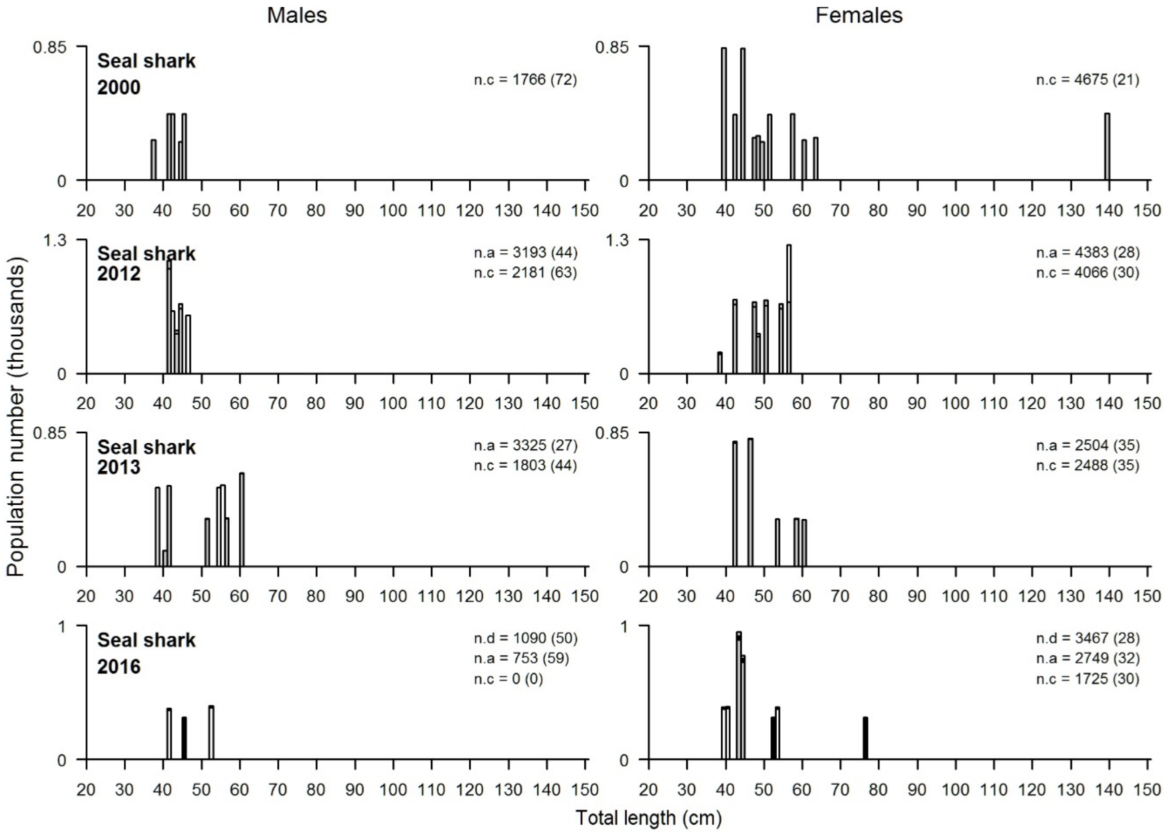


Figure 6: continued. Length frequency distributions by sex of shovelnose dogfish (SND) and Baxter's lantern dogfish (ETB) for core (grey), all (white), and deep (black) strata from the 2000, 2012, 2013, and 2016 WCSI trawl surveys. Baxter's lantern dogfish was not measured in the 2000, 2012, and 2013 surveys. n.d, estimated scaled total number of fish for deep strata; 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).



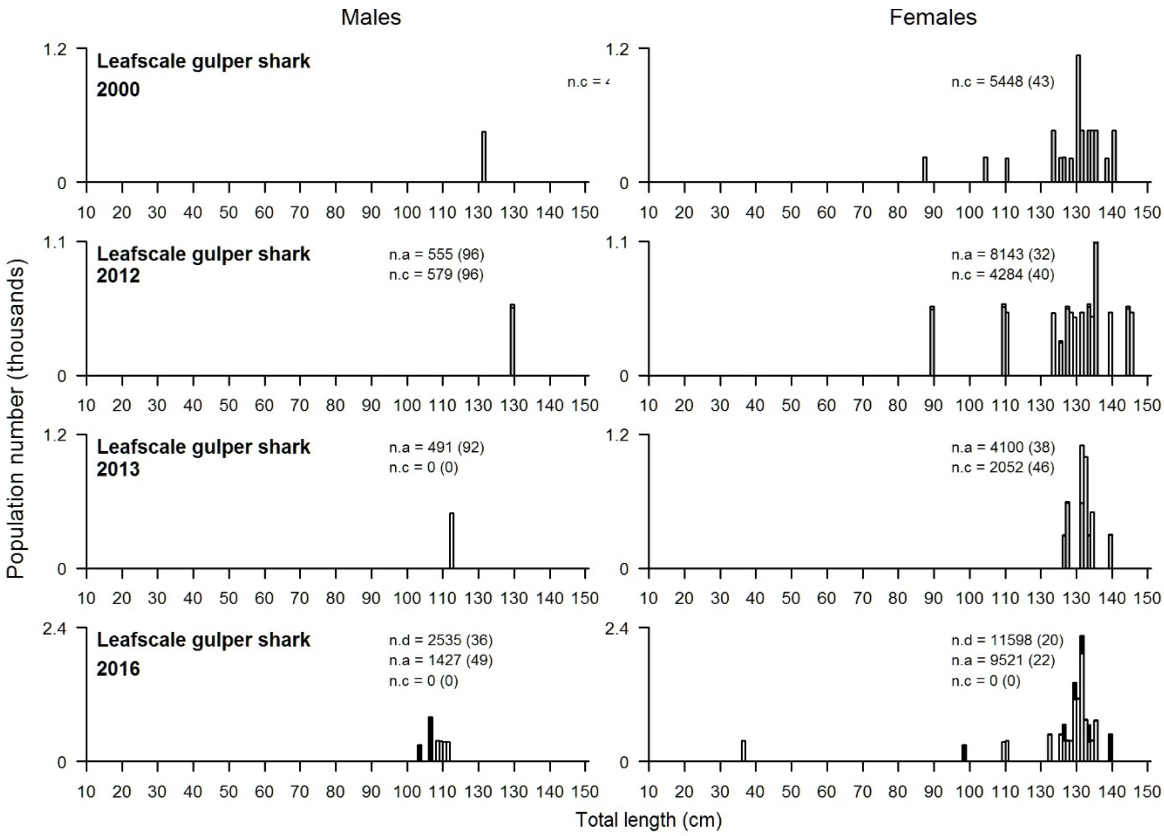


Figure 6: continued. Length frequency distributions by sex of seal shark (BSH) and leafscale gulper shark (CSQ) for core (grey), all (white), and deep (black) strata from the 2000, 2012, 2013, and 2016 WCSI trawl surveys. n.d, estimated scaled total number of fish for deep strata; n.a, estimated scaled 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).

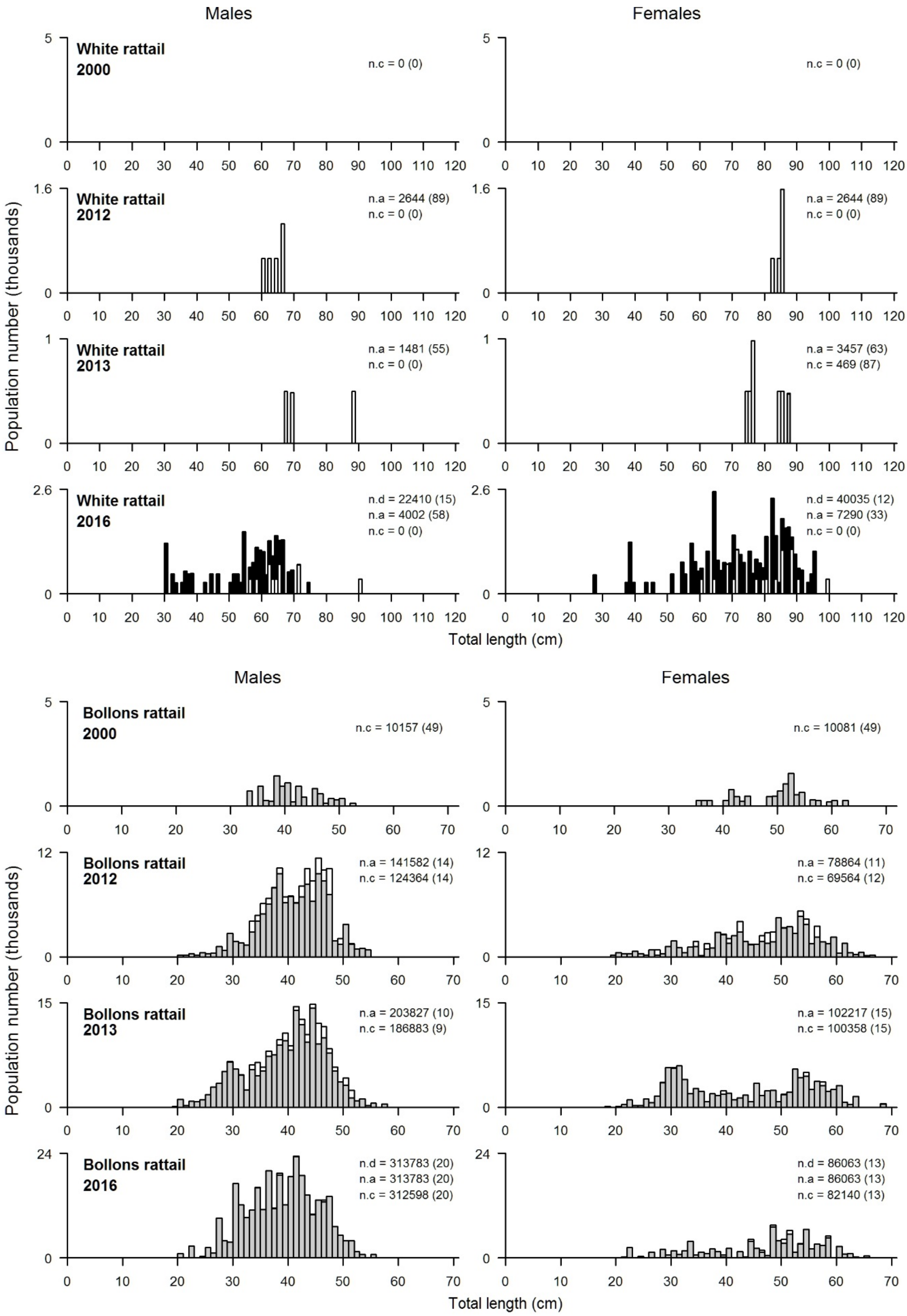


Figure 6: continued. Length frequency distributions by sex of white rattail (WHX) and Bollons' rattail (CBO) for core (grey), all (white), and deep (black) strata from the 2000, 2012, 2013, and 2016 WCSI trawl surveys. White rattail was not measured in the 2000 survey. n.d, estimated scaled total number of fish for deep strata; 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).

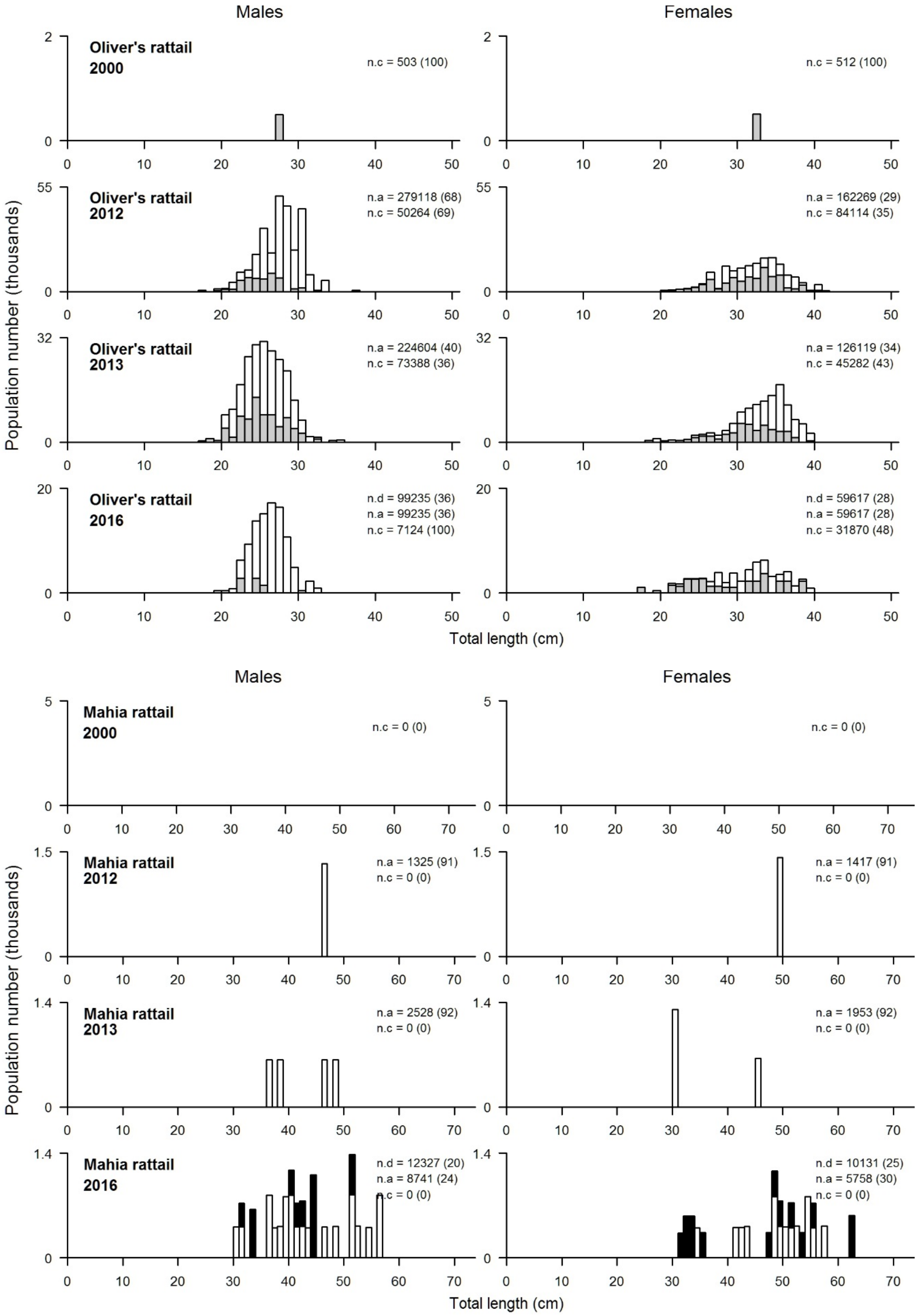


Figure 6: continued. Length frequency distributions by sex of Oliver's rattail (COL) and Mahia rattail (CMA) for core (grey), all (white), and deep (black) strata from the 2000, 2012, 2013, and 2016 WCSI trawl surveys. n.d, estimated scaled total number of fish for deep strata; n.a, estimated scaled 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).

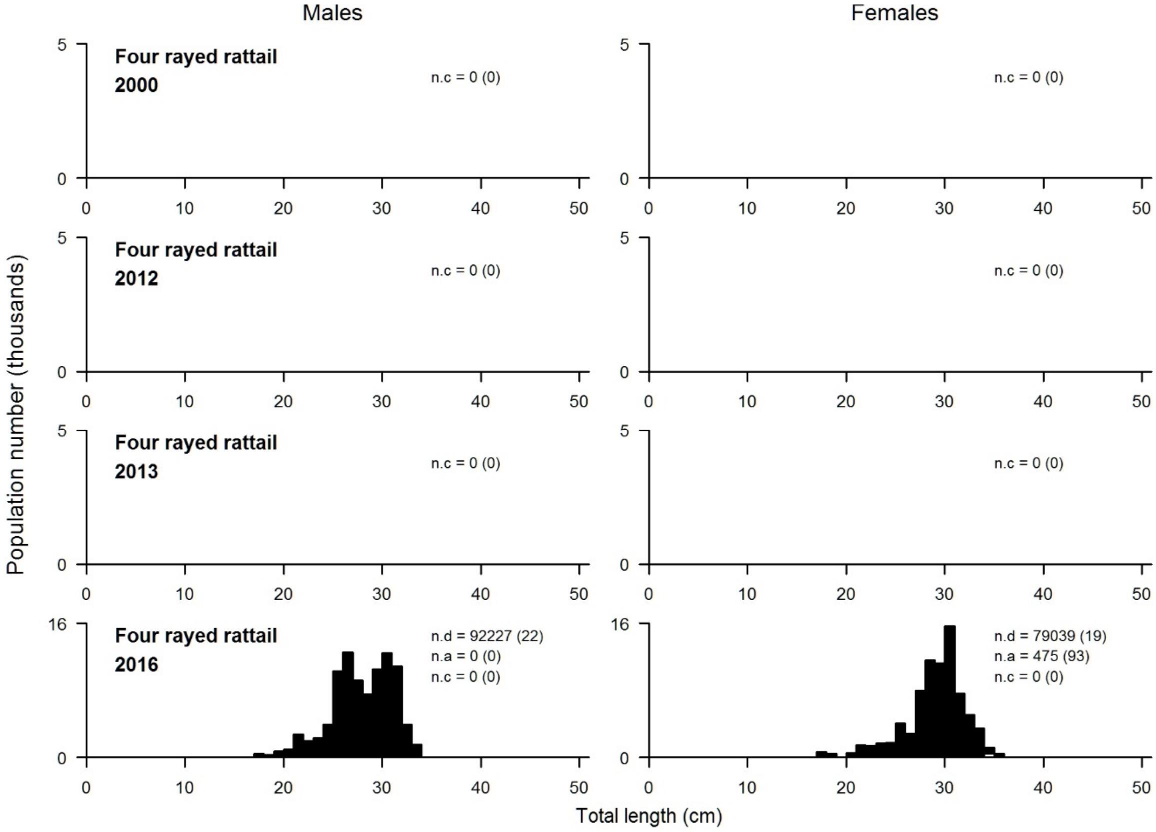


Figure 6: continued. Length frequency distributions by sex of four rayed rattail (CSU) for core (grey), all (white), and deep (black) strata from the 2000, 2012, 2013, and 2016 WCSI trawl surveys. Four rayed rattail were not measured in the 2000, 2012, and 2013 surveys. n.d, estimated scaled total number of fish for deep strata; n.a, estimated scaled total number of fish for all strata; n.c, estimated scaled total number of fish for core strata; and CV, the coefficient of variation (in parentheses).

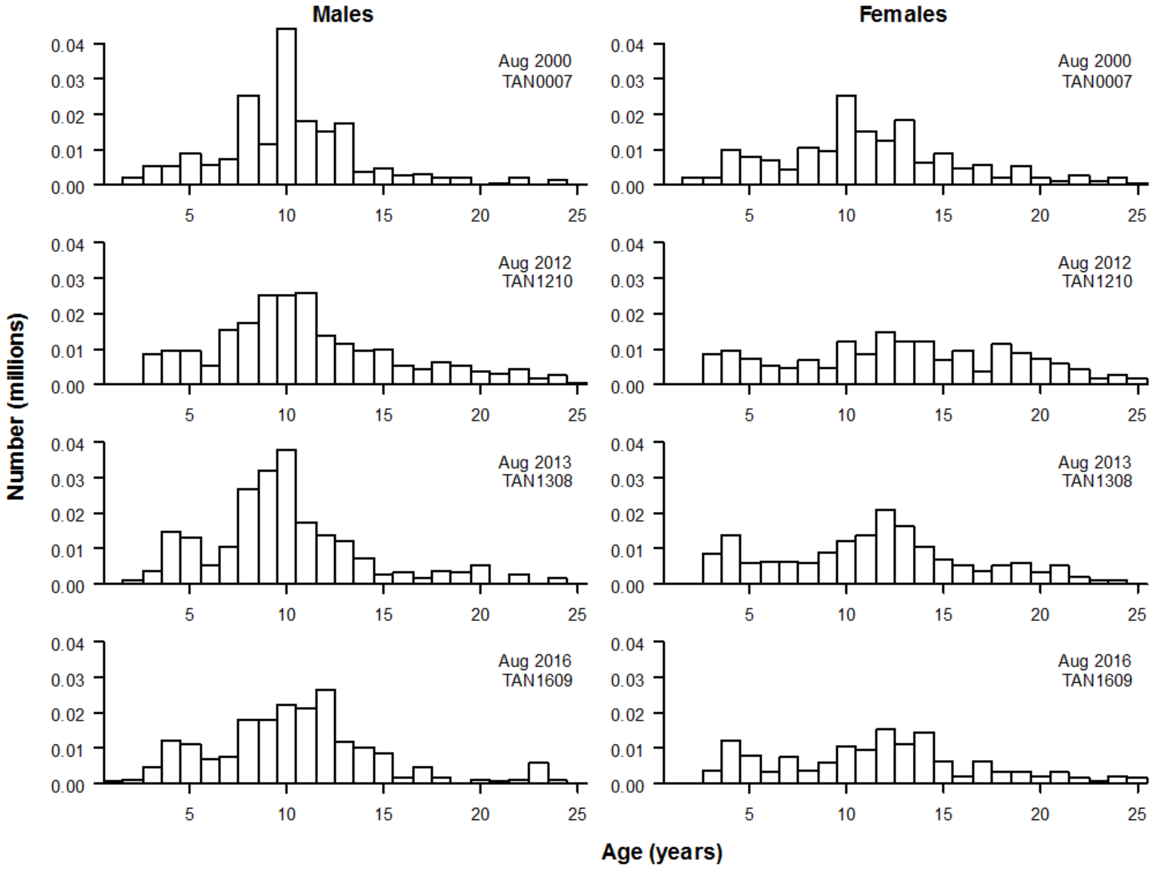


Figure 7: Scaled age frequency for ling in core strata from the WCSI trawl surveys in 2000 (TAN0007), 2012 (TAN1210), 2013 (TAN1308), and 2016 (TAN1609).

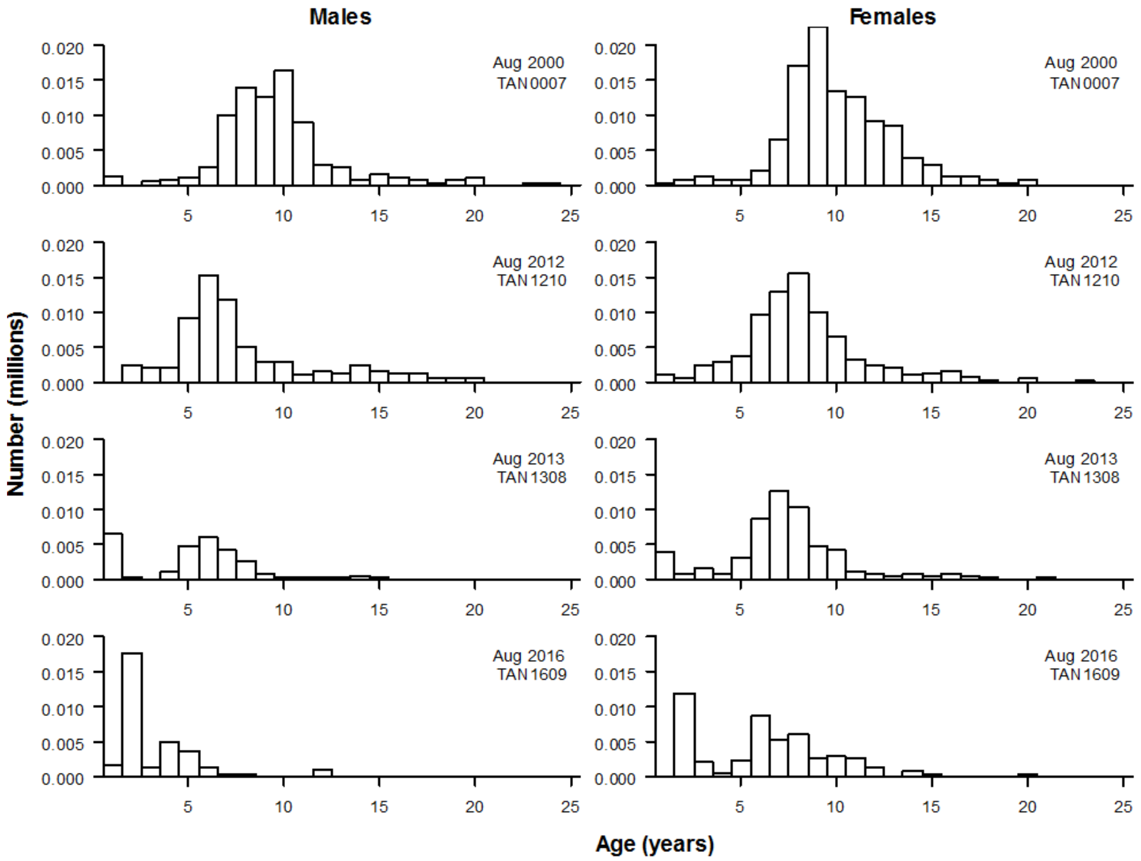


Figure 8: Scaled age frequency for hake in core strata from the WCSI trawl surveys in 2000 (TAN0007), 2012 (TAN1210), 2013 (TAN1308), and 2016 (TAN1609).

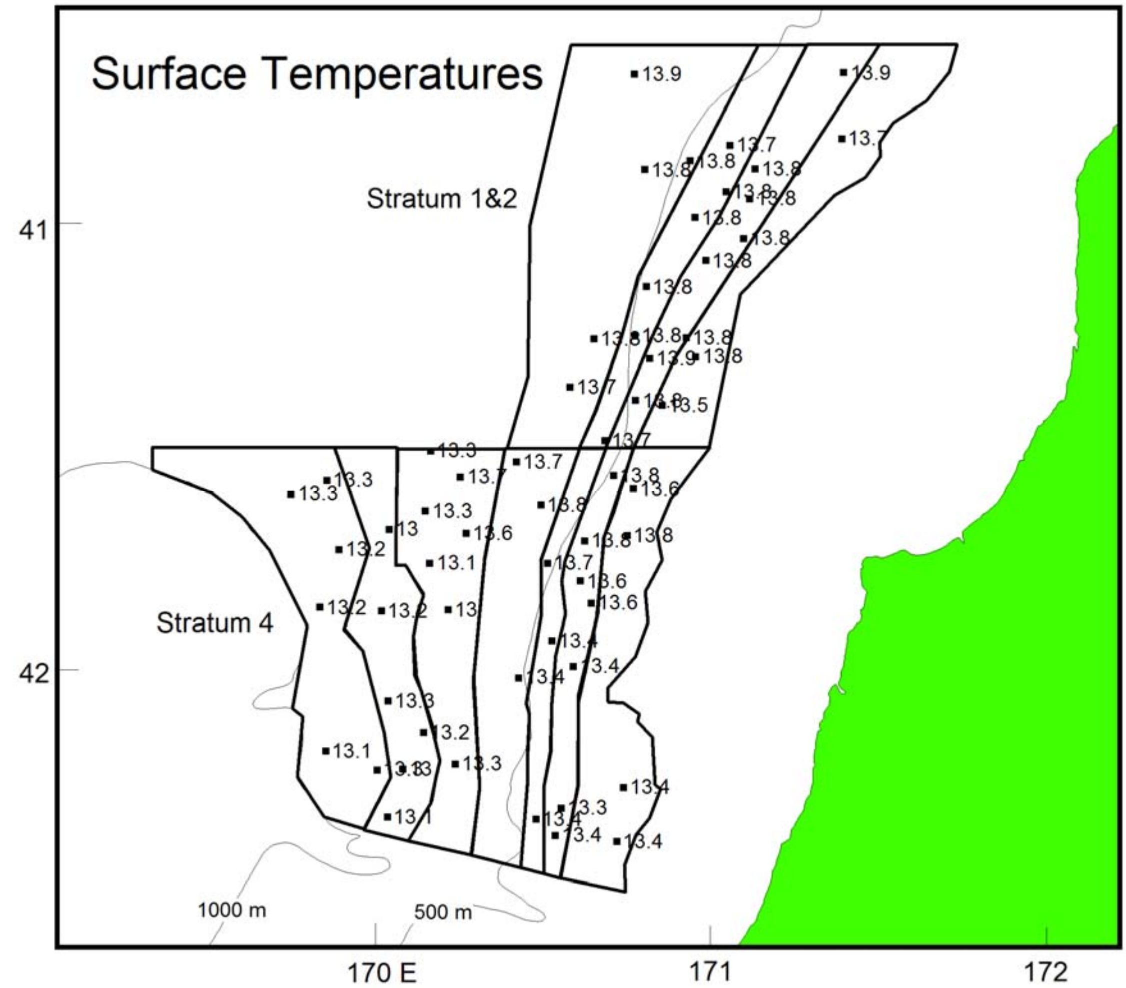


Figure 9: Surface water temperatures (°C) during the 2016 WCSI survey. Squares indicate bottom trawl tow positions.

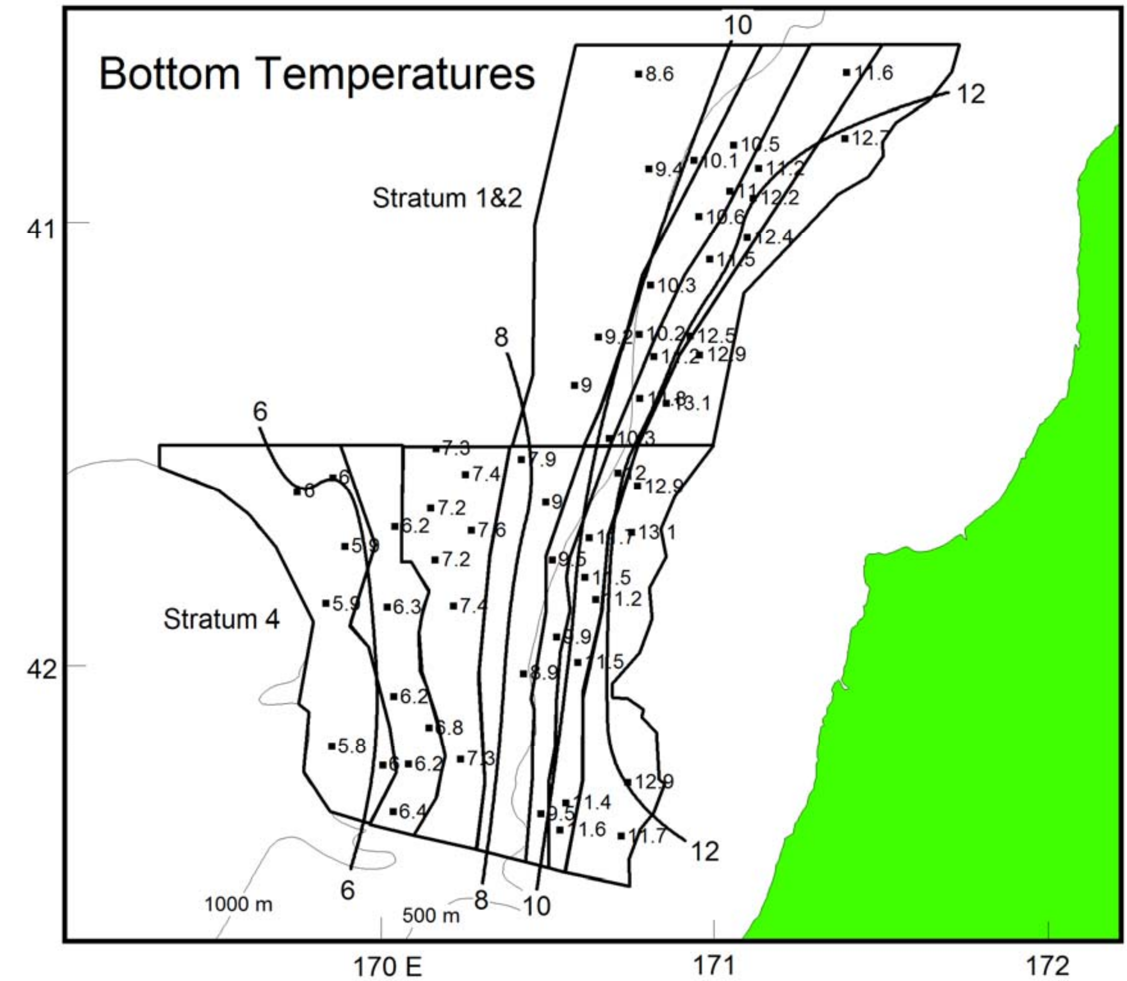


Figure 10: Bottom water temperatures (°C) during the 2016 WCSI survey. Squares indicate bottom trawl tow positions. Contours show isotherms estimated by eye.

APPENDIX 1: Station details and catch of hoki, ling, and hake.

Station	Date	Stratum code	Start latitude (° ‘ S)	Start longitude (° ‘ E)	Max. depth (m)	Distance towed (n. mile)	Catch hoki (kg)	Catch ling (kg)	Catch hake (kg)
1	4-Aug-16	012A	40 39.63	171 24.12	343	3.01	242.3	1 006.4	0.0
2	4-Aug-16	012S	40 48.48	171 23.75	259	2.94	0.0	0.5	0.0
3	4-Aug-16	012A	40 52.50	171 08.21	404	2.99	13 108.1	729.0	0.0
4	5-Aug-16	012C	40 39.84	170 46.50	603	2.97	124.6	8.6	0.5
5	5-Aug-16	012C	40 52.62	170 48.36	551	3.02	84.4	16.7	0.0
6	5-Aug-16	012C	40 51.41	170 56.48	515	2.98	102.7	47.8	1.2
7	5-Aug-16	012B	40 49.40	171 03.70	477	3.06	339.0	16.9	9.3
8	5-Aug-16	012B	40 55.63	171 02.95	442	2.12	333.3	15.3	16.9
9	6-Aug-16	012A	40 56.53	171 07.21	379	2.06	965.7	285.4	0.0
10	6-Aug-16	012A	41 01.93	171 06.11	330	3.03	259.1	878.3	0.0
11	6-Aug-16	012B	40 59.06	170 57.39	470	2.97	731.4	44.5	14.4
12	6-Aug-16	012A	41 04.87	170 59.31	406	3.00	2 238.4	330.6	0.0
13	6-Aug-16	012B	41 08.40	170 48.61	496	2.10	122.8	2.8	4.0
14	7-Aug-16	012C	41 21.89	170 34.94	568	2.94	80.1	10.9	35.5
15	7-Aug-16	012C	41 15.43	170 39.25	546	2.94	208.3	26.5	31.6
16	7-Aug-16	012B	41 15.04	170 46.59	479	2.20	2 448.9	42.0	0.0
17	7-Aug-16	012A	41 18.06	170 49.20	412	3.04	2 879.7	254.4	0.0
18	7-Aug-16	012A	41 15.30	170 55.85	318	2.11	292.3	190.4	0.0
19	8-Aug-16	012S	41 17.82	170 57.53	213	2.76	0.0	0.0	0.0
20	8-Aug-16	012S	41 24.32	170 51.48	251	3.07	0.0	0.0	0.0
21	8-Aug-16	012A	41 23.66	170 46.73	397	3.05	199.4	522.2	0.0
22	9-Aug-16	012B	41 29.05	170 41.20	448	3.03	447.5	153.8	19.1
23	9-Aug-16	004A	41 33.81	170 42.79	354	3.02	11.3	196.8	0.0
24	9-Aug-16	004S	41 35.57	170 46.29	248	3.00	0.0	0.0	0.0
25	9-Aug-16	004S	41 41.84	170 45.21	221	2.92	0.0	0.0	0.0
26	9-Aug-16	004A	41 42.56	170 37.61	374	3.05	400.3	276.9	0.6
27	10-Aug-16	004D	41 30.49	170 09.86	785	3.02	10.2	0.0	28.5
28	10-Aug-16	004D	41 33.98	170 15.24	740	3.03	16.1	0.0	35.4
29	10-Aug-16	004C	41 31.93	170 25.28	639	3.01	130.6	27.0	62.4
30	10-Aug-16	004C	41 37.76	170 29.70	552	3.00	80.6	11.3	72.2
31	11-Aug-16	004D	41 38.54	170 08.95	793	3.00	25.3	0.0	35.9
32	11-Aug-16	004D	41 41.54	170 16.26	704	3.00	34.9	2.9	56.0
33	11-Aug-16	004D	41 45.60	170 09.73	782	2.99	24.5	0.0	87.3
34	12-Aug-16	004A	41 47.98	170 36.76	368	2.08	172.2	342.8	0.0
35	12-Aug-16	004B	41 45.58	170 30.89	480	2.11	456.2	73.0	1.4
36	12-Aug-16	004A	41 50.94	170 38.72	362	3.04	475.7	107.8	0.0
37	12-Aug-16	004B	41 55.92	170 31.69	468	3.04	121.5	18.1	9.8
38	12-Aug-16	004A	41 59.39	170 35.53	352	2.97	78.0	311.9	0.0
39	13-Aug-16	004D	41 51.83	170 13.04	743	2.96	36.0	13.4	76.4
40	13-Aug-16	004C	42 00.93	170 25.73	537	2.50	487.5	32.6	19.8
41	13-Aug-16	004S	42 15.66	170 44.49	221	2.17	0.0	0.0	0.0
42	13-Aug-16	004S	42 22.98	170 43.37	218	2.10	0.8	21.6	0.7
43	14-Aug-16	004A	42 22.16	170 32.31	359	2.77	113.0	240.1	8.0
44	14-Aug-16	004A	42 18.51	170 33.39	335	3.01	38.8	11.3	0.0
45	14-Aug-16	004B	42 19.96	170 28.81	475	2.98	687.6	247.6	69.0
46	14-Aug-16	004D	42 12.54	170 14.33	750	3.01	26.8	0.0	46.5
47	15-Aug-16	004F	42 13.31	170 00.25	915	2.98	26.2	0.0	51.8
48	15-Aug-16	004F	42 10.80	169 51.04	979	2.99	2.3	0.0	0.0
49	15-Aug-16	004E	42 04.01	170 02.26	908	2.99	5.9	0.0	83.0
50	15-Aug-16	004E	41 51.97	170 01.06	882	3.07	10.9	0.0	62.3
51	16-Aug-16	004F	41 51.46	169 50.04	965	3.02	0.0	0.0	5.1
52	16-Aug-16	004F	41 43.77	169 53.44	935	3.02	2.4	0.0	19.2
53	16-Aug-16	004E	41 41.06	170 02.46	871	2.99	18.5	0.0	42.9
54	16-Aug-16	004F	41 36.32	169 44.83	961	2.71	0.0	0.0	0.0
55	17-Aug-16	004E	42 19.63	170 02.12	872	3.04	8.1	0.0	37.1

56	17-Aug-16	004E	42 13.17	170 04.95	876	2.99	5.1	0.0	87.5
57	17-Aug-16	004E	42 08.30	170 08.63	830	3.01	8.5	0.0	64.5
58	18-Aug-16	004F	41 34.43	169 51.30	922	3.01	2.5	0.0	7.3

APPENDIX 2: Description of gonad staging for teleosts and elasmobranchs

Teleosts (Middle Depths method, MD)

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

Elasmobranchs (Generalised shark and skate stage method, SS)

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

APPENDIX 3: Species list

Scientific and common names, species codes and occurrence (Occ.) of fish, squid, and other organisms from all trawl tows. Note species codes, particularly invertebrates are continually updated on the database following identification ashore.

Scientific name	Common name	Species code	Occ.
Porifera	unspecified sponges	ONG	2
Hexactinellida			
Euplectellidae			
Euplectella regalis	basket-weave horn sponge	ERE	3
Rossellidae			
Hyalascus sp.	Floppy tubular sponge	HYA	2
Cnidaria			
Scyphozoa	unspecified jellyfish	JFI	3
Anthozoa			
Pennatulacea	unspecified seapen	PTU	1
Hexacorallia			
Zoanthidea			
Epizoanthus sp.	zoanthid anenome	EPZ	2
Alcyonacea			
Isididae	bamboo coral	ISI	2
Lepidisis spp.	Bamboo coral	LLE	1
Scleractinia			
Caryophyliidae			
Stephanocyatus platypus	solitary bowl coral	STP	4
Annelida			
Eunicida			
Hyalinoecia tubicola	quill worm	HTU	1
Thaliacea			
Salpidae			
Pyrosoma atlanticum		PYR	4
Mollusca			
Gastropoda			
Buccinidae			
Austrofucus glans	knobbed whelk	KWH	1
Cephalopoda			
Teuthoidea: squids			
Cranchiidae	cranchid squid	CHQ	1
Histioteuthidae			
Histioteuthis spp.	violet squid	VSQ	4
Ommastrephidae			
Nototodarus sloanii & N.gouldi	arrow squid	SQU	33
Todarodes fillippovae	todarodes squid	TSQ	4
Onychoteuthidae			
Onykia robsoni	warty squid	MRQ	7
Pholidoteuthidae			
Pholidoteuthis massyae	large red scaly squid	PSQ	2
Octopodidae	unspecified octopus	OCP	2
Opisthoteuthididae			
Opisthoteuthis spp.	umbrella octopus	OPI	2
Arthropoda			
Crustacea			
Malacostraca			
Nematocarcinidae			

Lipkius holthuisi	omega prawn	LHO	17
Oplophoridae			
Acanthephyra spp.	Subantarctic ruby prawn	ACA	1
Oplophorus spp.	deepwater prawn	OPP	2
Pasiphaeidae			
Pasiphaea aff. tarda	deepwater prawn	PTA	6
Penaeidae			
Funchalia sp.	funchalia prawn	FUN	8
Sergestidae			
Sergestes spp.	sergestid prawn	SER	12
Solenoceridae			
Haliporoides sibogae	jack-knife prawn	HSI	6
Brachyura			
Majidae			
Teratomaia richardsoni	spiny masking crab	SMK	1
Jacquinotia edwardsii	giant spider crab	GSC	1
Nephropidae			
Metanephrops challengeri	scampi	SCI	9
Scyllaridae			
Ibacus alticrenatus	prawn killer	PRK	14
Thoracica			
Scapellidae	stalked barnacle	SBN	10
Echinodermata			
Asteroidea Sea stars			
Astropectinidae			
Dipsacaster magnificus	magnificent sea-star	DMG	3
Plutonaster knoxi	abyssal star	PKN	1
Psilaster acuminatus	geometric star	PSI	9
Pterasteridae			
Diplopteraster sp.		DPP	1
Brisingidae	armless stars	BRG	8
Goniasteridae			
Lithosoma novaezelandiae	rock star	LNV	3
Solasteridae			
Crossaster multispinus	sun star	CJA	1
Solaster torulatus	chubby sun-star	SOT	2
Zoroasteridae			
Zoroaster spp.	rat-tail star	ZOR	2
Ophiuroidea			
Ophiacanthidae			
Ophiophthalmus relictus	deepsea brittle star	ORE	1
Echinoidea			
Echinothuriidae, Phormosomatidae	unspecified Tam O’Shanter urchin	TAM	4
Echinothuriidae,		ECT	1
Holothuroidea			
Synallactidae			
Bathyplotes spp.	sea cucumber	BAM	1
Laetmogonidae			
Laetmogone spp.	sea cucumber	LAG	1
Chondrichthyes			
Triakidae: smoothhounds			
Galeorhinus galeus	school shark	SCH	21
Mustelus lenticilatus	rig	SPO	2
Chlamydoselachidae: frill sharks			
Chlamydoselachus anguineus	frill shark	FRS	1
Hexanchidae: cow sharks			
Heptranchias perlo	sharpnose sevengill shark	HEP	2

Centrophoridae: gulper sharks			
Centrophorus squamosus	deepwater spiny dogfish	CSQ	11
Deania calcea	shovelnose dogfish	SND	20
Somniosidae: sleeper sharks			
Centroscymnus crepidater	longnose velvet dogfish	CYP	19
C. owstoni	smooth skin dogfish	CYO	17
C. coelolepis	Portugese dogfish	CYL	7
Proscymnodon plunketi	Plunket's shark	PLS	7
Zameus squamulosus	velvet dogfish	ZAS	1
Etmopteridae: lanternsharks			
Etmopterus lucifer	lucifer dogfish	ETL	13
E. baxteri	Baxter’s lantern dogfish	ETB	6
Dalatiidae: kitefin sharks			
Scymnorhinus licha	seal shark	BSH	8
Squalidae: dogfishes			
Squalus acanthias	spiny dogfish	SPD	15
Squalus griffini	northern spiny dogfish	NSD	24
Proscylliidae: finback cat sharks			
Gollum attenuatus	slender smoothhound	SSH	8
Scyliorhinidae: cat sharks			
Apristurus spp.	catshark	APR	1
Cephaloscyllium isabellum	carpet shark	CAR	11
Torpedinidae: torpedo electric rays			
Torpedo fairchildi	electric ray	ERA	2
Rajidae: skates			
Brochiraja asperula	smooth deepsea skate	BTA	1
B. spinifera	prickly deepsea skate	BTS	3
Arhynchobatis asperrimus	softnose skate	LSK	2
Dipturus innominata	smooth skate	SSK	17
Zearaja nasuta	rough skate	RSK	4
Chimaeridae: chimaeras, ghost sharks			
Hydrolagus bemisi	pale ghost shark	GSP	16
H. novaezelandiae	dark ghost shark	GSH	21
Rhinochimaeridae: longnosed chimaeras			
Harriotta raleighana	longnose chimaera	LCH	1
Rhinochimaera pacifica	widenose chimaera	RCH	6
Osteichthyes			
Notacanthidae: spiny eels			
Notocanthus sexspinis	spineback	SBK	10
Synaphobranchidae: cutthroat eels			
Diastobranchus capensis	basketwork eel	BEE	13
Nemichthyidae: snipe eels			
Nemichthys curvirostris	snipe eel	NCU	5
Congridae: conger eels			
Bassanago bulbiceps	swollenheaded conger	SCO	14
B. hirsutus	hairy conger	HCO	15
Argentinidae: silversides			
Argentina elongata	silverside	SSI	12
Alepocephalidae: slickheads			
Alepocephalus antipodianus	smallscaled brown slickhead	SSM	9
A. australis	bigscaled brown slickhead	SBI	6
Xenodermichthys copei	black slickhead	BSL	17
Gonostomatidae: bristlemouths			
Gonostoma bathyphilum	deepsea lightfish	GBT	3
Bathylagidae: deepsea smelts		BLG	1
Platytroctidae: tubeshoulders			
Persparsia kopua	tubeshoulder	PER	1
Stomiidae: dragonfishes			
Chauliodontidae: viperfishes			

Chauliodus sloani	viperfish	CHA	11
Stomiinae: scaly dragonfishes			
Stomias spp.	scaly dragonfish	STO	9
Astronesthidae: snaggletooths			
Astronesthes spp.	snaggletooth	ASE	1
Malacosteinae: loosejaws			
Malacosteus australis.	southern loosejaw	MAU	3
Melanostomiidae: scaleless black dragonfishes		MST	5
Idiacanthinae: black dragonfishes			
Idiacanthus sp.	black dragonfish	IDI	2
Paraulopidae: cucumber fishes			
Paraulopus nigripinnis	cucumber fish	CUC	19
Sternoptychidae: hatchetfishes			
Argyropelecus gigas	giant hatchetfish	AGI	1
Photichthyidae: lighthouse fishes			
Phosichthys argenteus	lighthouse fish	PHO	10
Evermannellidae: sabretooth fishes			
Evermannella indica	sabretooth	SAB	1
Neoscopelidae: blackchins			
Neoscopelus macrolepidotus	large scaled blackchin	NML	1
Myctophidae: lanternfishes		LAN	1
Lampanyctus spp.	lanternfish	LPA	6
Trachipteridae: dealfishes			
Trachipterus trachypterus	dealfish	DEA	1
Moridae: morid cods			
Halargyreus johnsonii	Johnson’s cod	HJO	10
Lepidion microcephalus	small-headed cod	SMC	1
Mora moro	ribaldo	RIB	22
Notophycis marginata	dwarf cod	DCO	1
Pseudophycis bachus	red cod	RCO	18
Pseudophycis barbata	southern bastard cod	SBR	1
Melanonidae: pelagic cods			
Melanonus zugmayeri		MEZ	3
Euclichthyidae: eucla cods			
Euclichthys polynemus	eucla cod	EUC	23
Merlucciidae: hakes			
Lyconus sp.		LYC	2
Macruronus novaezelandiae	hoki	HOK	50
Merluccius australis	hake	HAK	35
Melanocetidae: humpback anglerfishes			
Melanocetus johnsonii	humpback anglerfish	MEJ	2
Himantolophidae: prickly anglerfishes			
Himantolophus sp.	prickly anglerfish	HIM	1
Macrouridae: rattails, grenadiers			
Coelorinchus biclinozonalis	two saddle rattail	CBI	12
C. bollonsi	Bollons’ rattail	CBO	25
C. fasciatus	banded rattail	CFA	6
C. innotabilis	notable rattail	CIN	11
C. matamua	Mahia rattail	CMA	16
C. maurofasciatus	dark banded rattail	CDX	1
C. oliverianus	Oliver's rattail	COL	21
C. parvifasciatus	small-banded rattail	CCX	14
Coryphaenoides dossenus	humpback rattail	CBA	4
C. serrulatus	serrulate rattail	CSE	13
C. subserrulatus	four rayed rattail	CSU	13
Gadomus aoteanus	filamentous rattail	GAO	1
Kuronezumia bubonis	bulbous rattail	NBU	1
Lepidorhynchus denticulatus	javelinfish	JAV	44
Lucigadus nigromaculatus	blackspot rattail	VNI	2
Trachonurus gagates	velvet rattail	TRX	3

Trachyrincus aphyodes	white rattail	WHX	18
Ophidiidae: cusk eels			
Genypterus blacodes	ling	LIN	36
Trachichthyidae: roughies			
Hoplostethus atlanticus	orange roughy	ORH	15
H. mediterraneus	silver roughy	SRH	34
Paratrachichthys trailli	common roughy	RHY	1
Diretmidae: discfishes			
Diretmus argentus	discfish	DIS	1
Diretmichthys parini	spinyfin	SFN	4
Berycidae: alfonsinos			
Beryx splendens	alfonsino	BYS	22
Macrorhamphosidae: snipefishes			
Centriscops humerosus	banded bellowsfish	BBE	8
Scorpaenidae: scorpionfishes			
Helicolenus spp.	sea perch	SPE	45
Trachyscorpia eschmeyeri	cape scorpionfish	TRS	9
Oreosomatidae: oreos			
Neocyttus rhomboidalis	spiky oreo	SOR	20
Zeidae: dories			
Capromimus abbreviatus	capro dory	CDO	33
Cyttus novaezealandiae	silver dory	SDO	18
C. traversi	lookdown dory	LDO	33
Zenopsis nebulosa	mirror dory	MDO	1
Zeus faber	john dory	JDO	6
Triglidae: searobins gurnards			
Chelidonichthys kumu	red gurnard	GUR	3
Lepidotrigla brachyoptera	scaly gurnard	SCG	3
Pterygotrigla picta	spotted gurnard	JGU	7
Hoplichthyidae: ghostflatheads			
Hoplichthys haswelli	deepsea flathead	FHD	17
Psychrolutidae: toadfishes			
Ambophthalmos angustus	pale toadfish	TOP	3
Psychrolutes microporos		PSY	1
Percichthyidae: temperate basses			
Polyprion oxygeneios	hapuku	HAP	5
Serranidae: sea basses			
Lepidoperca aurantia	orange perch	OPE	7
Apogonidae: cardinalfishes			
Epigonus lenimen	bigeye cardinalfish	EPL	9
E. telescopus	black cardinalfish	EPT	2
Emmelichthyidae: rovers			
Emmelichthys nitidus	redbait	RBT	29
Carangidae: jacks, pompanos			
Seriola lalandi	kingfish	KIN	1
Trachurus declivis	greenback jack mackerel	JMD	5
T. murphyi	slender jack mackerel	JMM	3
T. novaezelandiae	yellowtail jack mackerel	JMN	1
Bramidae: pomfrets			
Brama australis	southern Ray's bream	SRB	8
Caristiidae: manefishes			
Caristius meridionalis	southern manefish	PLA	1
Pentacerotidae: armorheads			
Pentaceros decacanthus	yellow boarfish	YBO	21
Cheilodactylidae: morwongs			
Nemadactylus macropterus	tarakihi	NMP	15
Uranoscopidae: armourhead stargazers			
Kathetostoma giganteum	giant stargazer	GIZ	24
Gempylidae: snake mackerels			
Rexea solandri	gemfish	RSO	31

Thyrsites atun	barracouta	BAR	13
Trichiuridae: cutlassfishes			
Benthodesmus spp.	scabbard fish	BEN	9
Lepidopus caudatus	frostfish	FRO	23
Centrolophidae: raftfishes, medusafishes			
Centrolophus niger	rudderfish	RUD	3
Hyperoglyphe antarctica	bluenose	BNS	1
Seriolella caerulea	white warehou	WWA	6
S. punctata	silver warehou	SWA	37
S. brama	common warehou	WAR	4
Nomeidae: eyebrowfishes, driftfishes			
Cubiceps spp.	cubehead	CUB	2
Bothidae: lefteyed flounders			
Arnoglossus scapha	witch	WIT	3
Diodontidae: porcupinefishes			
Allomycterus pilatus	porcupine fish	POP	2
Molidae: sunfishes			
Mola mola	sunfish	SUN	1