



Trawl survey of hoki and middle-depth species on the Chatham Rise, January 2016 (TAN1601)

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| | |
|-----------------------------------------------------------------|----|
| EXECUTIVE SUMMARY | 1 |
| 1. INTRODUCTION | 2 |
| 1.1 Project objectives | 3 |
| 2. METHODS | 3 |
| 2.1 Survey area and design | 3 |
| 2.2 Vessel and gear specifications | 4 |
| 2.3 Trawling procedure | 4 |
| 2.4 Acoustic data collection | 5 |
| 2.5 Hydrology | 5 |
| 2.6 Catch and biological sampling | 5 |
| 2.7 Estimation of relative biomass and length frequencies | 5 |
| 2.8 Estimation of numbers at age | 6 |
| 2.9 Acoustic data analysis | 6 |
| 3. RESULTS | 7 |
| 3.1 2016 survey coverage | 7 |
| 3.2 Gear performance | 7 |
| 3.3 Hydrology | 7 |
| 3.4 Catch composition | 8 |
| 3.5 Relative biomass estimates | 8 |
| 3.5.1 Core strata (200–800 m) | 8 |
| 3.5.2 Deep strata (800–1300 m) | 9 |
| 3.6 Catch distribution | 9 |
| 3.7 Biological data | 10 |
| 3.7.1 Species sampled | 10 |
| 3.7.2 Length frequencies and age distributions | 10 |
| 3.7.3 Reproductive status | 11 |
| 3.8 Acoustic data quality | 11 |
| 3.8.1 Comparison of acoustics with bottom trawl catches | 11 |
| 3.8.2 Time-series of relative mesopelagic fish abundance | 12 |
| 3.9 Hoki condition | 12 |
| 4. CONCLUSIONS | 12 |
| 5. ACKNOWLEDGMENTS | 13 |
| 6. REFERENCES | 13 |

EXECUTIVE SUMMARY

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The twenty-fourth trawl survey in a time series to estimate the relative biomass of hoki and other middle depth species on the Chatham Rise was carried out from 3 January to 2 February 2016. A random stratified sampling design was used, and 139 bottom trawls were successfully completed. These comprised 84 core (200–800 m) phase 1 biomass tows, 9 core phase 2 tows, and 46 deep (800–1300 m) tows.

Estimated relative biomass of all hoki in core strata was 114 514 t (CV 14.2%), an increase of 12% from January 2014. This increase was largely driven by the biomass estimate for 1+ year old hoki of 47 566 t, the second highest in the time series for this age class of fish. The biomass estimate for 2+ hoki (2013 year class) was 12 902 t; one of the lower estimates in the time series. The relative biomass of recruited hoki (ages 3+ years and older) of 54 046 t was similar to that in 2014, and about average for the time series. The relative biomass of hake in core strata decreased by 6% to 1299 t (CV 18.5%) between 2014 and 2016. The relative biomass of ling was 10 201 t (CV 7.2%), 36% higher than that in January 2014, but the time-series for ling shows no overall trend.

The age frequency distribution for hoki was dominated by 1+ hoki (2014 year class) and there were relatively few 2+ hoki (2013 year class). The age frequency distribution for hake was broad, with most fish aged between 2 and 10 years. The age distribution for ling was also broad, with most fish aged between 2 and 20 years.

In 2016 the survey area was successfully extended to cover 800–1300 m depths around the entire Rise. The deep strata provide relative biomass indices for a range of deepwater sharks and other species associated with orange roughy and oreo fisheries.

Acoustic data were also collected during the trawl survey. As in previous surveys, there was a positive correlation between acoustic density from bottom marks and trawl catch rates. The acoustic index of mesopelagic fish abundance in 2016 was 30% higher than that in 2014, and the highest since 2009. The mesopelagic index increased in all four sub-areas, with the highest percentage increase (54%) in the southwest. Hoki liver condition was also higher in 2016 than that in 2014. There was a moderately strong positive correlation between hoki liver condition and indices of mesopelagic fish scaled by hoki abundance (“food per fish”).

1. INTRODUCTION

In January 2016, the twenty-fourth in a time series of random trawl surveys on the Chatham Rise was completed. This and all previous surveys in the series were carried out from RV *Tangaroa* and form the most comprehensive time series of relative species abundance at water depths of 200 to 800 m in New Zealand's 200-mile Exclusive Economic Zone. Previous surveys in this time series were documented by Horn (1994a, 1994b), Schofield & Horn (1994), Schofield & Livingston (1995, 1996, 1997), Bagley & Hurst (1998), Bagley & Livingston (2000), Stevens et al. (2001, 2002, 2008, 2009a, 2009b, 2011, 2012, 2013, 2014, 2015), Stevens & Livingston (2003), Livingston et al. (2004), Livingston & Stevens (2005), and Stevens & O'Driscoll (2006, 2007). Trends in relative biomass, and the spatial and depth distributions of 142 species or species groups, were reviewed for the surveys from 1992–2010 by O'Driscoll et al. (2011b).

The main aim of the Chatham Rise surveys is to provide relative biomass estimates of adult and juvenile hoki. Hoki is New Zealand's largest finfish fishery, with an annual total allowable commercial catch (TACC) of 150 000 t from 1 October 2015, down from 160 000 t in 2014–15. Hoki is assessed as two stocks, western and eastern. The current hypothesis is that juveniles from both stocks mix on the Chatham Rise and recruit to their respective stocks as they approach sexual maturity. The Chatham Rise is also thought to be the principal residence area for the hoki that spawn in Cook Strait and off the east coast South Island in winter (eastern stock). Annual commercial catches of hoki on the Chatham Rise peaked at about 75 000 t in 1997–98 and 1998–99, then decreased to a low of 30 700 t in 2004–05, before increasing again from 2008–09 to 2011–12 (Ballara & O'Driscoll 2014). The catch from the Chatham Rise in 2014–15 was 40 100 t, making this the second largest fishery in the EEZ (behind the west coast South island), and contributing about 25% of the total New Zealand hoki catch.

The hoki fishery is dominated by young fish and therefore is strongly influenced by recruitment. To manage the fishery and minimise potential risks, it is important to have some predictive ability concerning recruitment into the fishery. Extensive sampling throughout the EEZ has shown that the Chatham Rise is the main nursery ground for hoki aged 2 to 4 years. Abundance estimation of 2+ hoki on the Chatham Rise provides the best index of recruitment to the adult stocks. The continuation of the time series of trawl surveys on the Chatham Rise is therefore a high priority to provide information required to update the assessment of hoki.

Other middle depth species are also monitored by this survey time series (O'Driscoll et al. 2011b). These include important commercial species such as hake and ling, as well as a wide range of non-commercial fish and invertebrate species. For most of these species, the trawl survey is the only fisheries-independent estimate of abundance on the Chatham Rise, and the survey time-series fulfils an important "ecosystem monitoring" role (e.g., Tuck et al. 2009), as well as providing inputs into single-species stock assessment.

In 2010, the Chatham Rise survey was extended to deeper waters (to 1300 m) on the north and southeast Rise, to provide fishery independent relative abundance indices for a wider range of species, including pre-recruit (20–30 cm) and dispersed adult orange roughy, black oreo and smooth oreo, and some common bycatch such as deepwater sharks as well as providing improved information for species like ribaldo and pale ghost shark, which are known to occur deeper than the core survey maximum depth of 800 m. The deeper waters of the southwestern Rise are an important fishing area for oreos and during the 2010 pilot deepwater survey three additional deepwater strata (strata 27–29) were proposed in this area. However, due to time constraints within the 'normal' survey duration only two of these strata were completed (strata 26 and 27) and given that the primary focus of the deepwater survey was to provide data on pre-recruit and recruited orange roughy these southwest strata have not been surveyed since. The survey duration was extended by 6 days (i.e. from 25 to 31 days) in 2016, to provide fishery independent abundance indices for a range of common deepwater bycatch species in the orange roughy and oreo fisheries. The 2016 survey covered depths of 800–1300 m around the whole Chatham Rise, and included strata 27–29 and an additional stratum 30 (1000–1300 m on the southwest Chatham Rise).

Acoustic data have been recorded during trawls and while steaming between stations on all trawl surveys on the Chatham Rise since 1995, except for in 2004. Data from previous surveys were analysed to

describe mark types (Cordue et al. 1998, Bull 2000, O’Driscoll 2001, Livingston et al. 2004, Stevens & O’Driscoll 2006, 2007, Stevens et al. 2008, 2009a, 2009b, 2011, 2012, 2013, 2014), to provide estimates of the ratio of acoustic vulnerability to trawl catchability for hoki and other species (O’Driscoll 2002, 2003), and to estimate abundance of mesopelagic fish (McClatchie & Dunford 2003, McClatchie et al. 2005, O’Driscoll et al. 2009, 2011, Stevens et al. 2009b, 2011, 2012, 2013, 2014, 2015). Acoustic data also provide qualitative information on the amount of backscatter that is not available to the bottom trawl, either through fish being off the bottom or over areas of foul ground.

1.1 Project objectives

The trawl survey was carried out under contract to the Ministry for Primary Industries (project HOK2015/01). The specific objectives for the project were as follows:

1. To continue the time series of relative abundance indices of recruited hoki (eastern stock) and other middle depth and deepwater species on the Chatham Rise using trawl surveys and to determine the relative year class strengths of juvenile hoki (1, 2 and 3 year olds), with target coefficient of variation (CV) of 20 % for the number of 2 year olds.
2. To collect required data to support determination of the population age, size structure, and reproductive biology of hoki, hake, ling, jack mackerel, and other main species on the Chatham Rise.
3. To collect acoustic and related data during the trawl survey.
4. To sample deeper strata for orange roughy using a random trawl survey design.
5. To collect and preserve specimens of unidentified organisms taken during the trawl survey, and identify them later ashore.

2. METHODS

2.1 Survey area and design

As in previous years, the survey followed a two-phase random design (after Francis 1984). The main survey area of 200–800 m depth (Figure 1) was divided into 23 strata. Nineteen of these strata are the same as those used in 2003–11 (Livingston et al. 2004, Livingston & Stevens 2005, Stevens & O’Driscoll 2006, 2007, Stevens et al. 2008, 2009a, 2009b, 2011, 2012). In 2012, stratum 7 was divided into strata 7A and 7B at 175° 30'E to more precisely assess the biomass of hake which appeared to be spawning northeast of Mernoo Bank (in Stratum 7B). In 2013, the survey duration was reduced from 27 to 25 days, removing the contingency for bad weather and reducing the available time for phase 2 stations. To increase the time available for phase 2 stations in 2014, strata 10A and 10B were re-combined into a single stratum 10 and stratum 11A, 11B, 11C, 11D into a single stratum 11. These strata are in the 400–600 m depth range on the northeast Chatham Rise (Figure 1) and were originally split to reduce hake CVs. However, few hake have been caught in these strata since 2000 and the 18 phase 1 tows (3 in each sub-strata) assigned to this area in recent surveys are not justified by catches.

Station allocation for phase 1 was determined from simulations based on catch rates from all previous Chatham Rise trawl surveys (1992–2014), using the ‘allocate’ procedure of Bull et al. (2000) as modified by Francis (2006). This procedure estimates the optimal number of stations to be allocated in each stratum to achieve the Ministry for Primary Industries target CV of 20% for 2+ hoki, and CVs of 15% for total hoki and 20% for hake. The initial allocation of 84 core stations in phase 1 is given in Table 1. Phase 2 stations for core strata were allocated at sea, largely to improve the CV for 2+ hoki and total hoki biomass.

As in the 2010–14 surveys, the 2016 survey area included the deep strata from 800–1300 m on the north and east Chatham Rise, along with equivalent strata on the south west Chatham Rise (strata 26, 27, 29, (Stevens et al. 2011), and an additional stratum 30 (1000–1300 m on the southwest Chatham Rise)).

The station allocation for the deep strata was determined based on catch rates of eight deepwater bycatch species (basketwork eel, four-rayed rattail, longnose velvet dogfish, Baxter’s dogfish, ribaldo, bigscaled brown slickhead, shovelnose dogfish, and smallscaled brown slickhead) in the 2010–14 surveys. Orange roughy and oreos were no longer considered target species in 2016. The ‘allocate’ programme (Francis 2006) was used to estimate the optimal number of stations to be allocated in each of strata 21–28 to achieve a target CV of 25% for these eight bycatch species. A minimum of three stations per stratum was used. Five tows were arbitrarily allocated to each of the two new southwest Chatham Rise strata (strata 29 and 30) based on their survey area. This gave a total of 47 phase 1 deepwater stations (Table 1). There was no allowance for phase 2 trawling in deeper strata.

2.2 Vessel and gear specifications

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 bottom trawl was the same as that used on previous surveys of middle depth species by *Tangaroa*. The net is an eight-seam hoki bottom trawl with 100 m sweeps, 50 m bridles, 12 m backstrops, 58.8 m groundrope, 45 m headline, and 60 mm codend mesh (see Hurst & Bagley (1994) for net plan and rigging details). The trawl doors were Super Vee type with an area of 6.1 m². Measurements of doorspread (from a Scanmar 400 system) and headline height (from a Furuno net monitor) were recorded every five minutes during each tow and average values calculated.

2.3 Trawling procedure

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. To maximise the amount of time spent trawling in the deep strata (800–1300 m) at night, the time spent searching for suitable core (200–800 m) tows at night was reduced significantly by using the nearest known successful tow position to the random station. Care had to be taken to ensure that the survey tows were at least 3 n. miles apart. For deep strata, there was often insufficient bathymetric data and few known tow positions, so these tows followed the standard survey methodology described by Hurst et al. (1992). 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. Core biomass tows were carried out during daylight hours (as defined by Hurst et al. (1992)), with all trawling between 0457 h and 1903 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 tow hauled early due to reducing daylight, the tow was included as valid only if at least 2 n. miles was covered. If time ran short at the end of the day and it was not possible to reach the last station, the vessel headed towards the next station and the trawl gear was shot in time to ensure completion of the tow by sunset, as long as at least 50% of the steaming distance to the next station was covered.

Towing speed and gear configuration were maintained as constant as possible during the survey, following the guidelines given by Hurst et al. (1992). The average speed over the ground was calculated from readings taken every five minutes during the tow.

2.4 Acoustic data collection

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 after this voyage on 17 February 2016 at the Auckland Islands (O’Driscoll & Roberts 2016).

2.5 Hydrology

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).

2.6 Catch and biological sampling

At each station all items in the catch were sorted into species and weighed on Marel motion-compensating electronic scales accurate to about 0.04 kg. Where possible, fish, squid, and crustaceans were identified to species and other benthic fauna to species or family. Unidentified organisms were collected and frozen at sea and returned to NIWA for later identification.

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 the sex determined. More detailed biological data were also collected on a subset of species and included fish weight, gonad stage, and gonad weight. Otoliths were taken from hake, hoki, and ling for age determination. Additional data on liver condition were also collected from a subsample of 20 hoki by recording gutted and liver weights.

2.7 Estimation of relative biomass and length frequencies

Doorspread biomass was estimated by the swept area method of Francis (1981, 1989) using the formulae in Vignaux (1994) as implemented in NIWA custom software SurvCalc (Francis 2009). Biomass and coefficient of variation (CV) were calculated by stratum for 1+, 2+, and 3++ (a plus group of hoki aged 3 years or more) age classes of hoki, and for 12 other key species: hake, ling, dark ghost shark, pale ghost shark, giant stargazer, lookdown dory, sea perch, silver warehou, spiny dogfish, white warehou, Bollon’s rattail, and javelinfish. These species were selected because they are commercially important, or abundant bycatch species, and the trawl survey samples the main part of their depth distribution (O’Driscoll et al. 2011b). Doorspread swept-area biomass and CVs were also calculated by stratum for a subset of 13 deepwater species: orange roughy (fish less than 20 cm SL, fish less than 30 cm SL, and all fish), black oreo, smooth oreo, spiky oreo, ribaldo, shovel-nosed dogfish, Baxter’s dogfish, long-nosed velvet dogfish, bigscaled brown slickhead, smallscaled brown slickhead, basketwork eel, four-rayed rattails, and Johnson’s cod.

The catchability coefficient (an estimate of the proportion of fish in the path of the net which are caught) is the product of vulnerability, vertical availability, and areal availability. These factors were set at 1 for the analysis.

Scaled length frequencies were calculated for the major species with SurvCalc, using length-weight data from this survey.

2.8 Estimation of numbers at age

Hoki, hake, and ling otoliths were prepared and aged using validated ageing methods (hoki, Horn & Sullivan (1996) as modified by Cordue et al. (2000); hake, Horn (1997); ling, Horn (1993)).

Subsamples of 689 hoki otoliths and 642 ling otoliths were selected from those collected during the trawl survey. Subsamples were obtained by randomly selecting otoliths from 1 cm length bins covering the bulk of the catch and then systematically selecting additional otoliths to ensure that the tails of the length distributions were represented. The numbers aged approximated the sample size necessary to produce mean weighted CVs of less than 20% for hoki and 30% for ling across all age classes. All 221 hake otoliths collected were prepared.

Numbers-at-age were calculated from observed length frequencies and age-length keys using customised NIWA catch-at-age software (Bull & Dunn 2002). For hoki, this software also applied the “consistency scoring” method of Francis (2001), which uses otolith ring radii measurements to improve the consistency of age estimation.

2.9 Acoustic data analysis

Acoustic analysis followed the methods applied to recent Chatham Rise trawl surveys (e.g., Stevens et al. 2015), and generalised by O’Driscoll et al. (2011a). This report does not include discussion of mark classification or descriptive statistics on the frequency of occurrence of different mark types, as these were based on subjective classification, and were found not to vary much between surveys (e.g., Stevens et al. 2014).

Quantitative analysis was based on 38 kHz acoustic data from daytime trawl and night steam recordings. The 38 kHz data were used as this frequency was the only one available (other than uncalibrated 12 kHz data) for surveys before 2008 that used the old CREST acoustic system (Coombs et al. 2003). Analysis was carried out using the custom analysis software EchoAnalysis which replaces the Echo Sounder Package (ESP2) software (McNeill 2001) used previously. A new algorithm was developed in 2014 that allowed us to quantify the number of ‘bad pings’ in each acoustic recording. Bad pings were defined as those where values were significantly different from surrounding pings due to bubble aeration or noise spikes. Only acoustic data files where the proportion of bad pings was less than 30% were considered suitable for quantitative analysis.

Estimates of the mean acoustic backscatter per km² from bottom-referenced marks were calculated for each recording based on integration heights of 10 m, 50 m, and 100 m above the detected acoustic bottom. Total acoustic backscatter was also integrated throughout the water column in 50 m depth bins. Acoustic density estimates (backscatter per km²) from bottom-referenced marks were compared with trawl catch rates (kg per km²). No attempt was made to scale acoustic estimates by target strength, correct for differences in catchability, or carry out species decomposition (O’Driscoll 2002, 2003).

O’Driscoll et al. (2009, 2011a) developed a time series of relative abundance estimates for mesopelagic fish on the Chatham Rise based on that component of the acoustic backscatter that migrates into the upper 200 m of the water column at night (nyctoepipelagic backscatter). We updated the mesopelagic time series to include data from 2016. Day estimates of total backscatter were calculated using total mean area backscattering coefficients estimated from each trawl recording. Night estimates of demersal backscatter were based on data recorded while steaming between 2000 h and 0500 h NZST. Acoustic data were stratified into four broad sub-areas (O’Driscoll et al. 2011a). Stratum boundaries were:

Northwest – north of 43° 30’S and west of 177° 00’E;
Northeast – north of 43° 30’S and east of 177° 00’E;
Southwest – south of 43° 30’S and west of 177° 00’E;
Southeast – south of 43° 30’S and east of 177° 00’E.

The amount of mesopelagic backscatter at each day trawl station was estimated by multiplying the total backscatter observed at the station by the estimated proportion of night-time backscatter in the same sub-area that was observed in the upper 200 m corrected for the estimated proportion in the surface deadzone:

$$sa(meso)_i = p(meso)_s \times sa(all)_i$$

where $sa(meso)_i$ is the estimated mesopelagic backscatter at station i , $sa(all)_i$ is the observed total backscatter at station i , and $p(meso)_s$ is the estimated proportion of mesopelagic backscatter in the same stratum s as station i . $p(meso)_s$ was calculated from the observed proportion of night-time backscatter observed in the upper 200 m in stratum s ($p(200)_s$) and the estimated proportion of the total backscatter in the surface deadzone, p_{sz} . p_{sz} was estimated as 0.2 by O'Driscoll et al. (2009) and was assumed to be the same for all years and strata:

$$p(meso)_s = p_{sz} + p(200)_s \times (1 - p_{sz})$$

3. RESULTS

3.1 2016 survey coverage

The trawl survey was successfully completed. The deepwater trawling objective meant that trawling was carried out both day (core and some deep tows) and night (deep tows only). The weather during the survey was generally favourable. A total of 24 hours were lost due to rough weather, and a further 8 hours were lost due to the vessel responding to a marine emergency (an EPIRB activation).

In total, 139 successful biomass tows were completed, comprising 84 core (200–800 m) phase 1 tows, 9 core phase 2 tows, and 46 deep (800–1300 m) phase 1 tows (Tables 1 and 2, Figure 2, Appendix 1). Six tows were excluded from relative biomass calculations. These included two tows which came fast (stations 37, 62), two tows with gear parameters outside the acceptable range (stations 69, 71), one tow was abandoned due to rough bottom (station 26), and another tow was hauled early due to a large catch of sponge affecting gear performance (station 140). Station details for all tows are given in Appendix 1.

Core station density ranged from 1 per 288 km² in stratum 17 (200–400 m, Veryan Bank) to 1 per 3772 km² in stratum 4 (600–800 m, south Chatham Rise). Deepwater station density ranged from 1 per 416 km² in stratum 21a (800–1000 m, NE Chatham Rise) to 1 per 3165 km² in stratum 28 (1000–1300 m, SE Chatham Rise). Mean station density was 1 per 1554 km² (see Table 1).

3.2 Gear performance

Gear parameters are summarised in Table 3. A headline height value was obtained for all 139 successful tows, but doorspread readings were not available for 11 tows. Mean headline heights by 200 m depth intervals ranged from 6.7 to 7.1 m, averaged 6.8 m, and were consistent with previous surveys and within the optimal range (Hurst et al. 1992) (Table 3). Mean doorspread measurements by 200 m depth intervals ranged from 120.9 to 125.5 m, and averaged 123.4 m, and were also consistent with previous surveys.

3.3 Hydrology

The surface temperatures (Figure 3, top panel) ranged from 12.1 to 17.4°C. Bottom temperatures ranged from 3.0 to 10.3°C (Figure 3, bottom panel).

As in previous years, higher surface temperatures were most likely associated with subtropical water to the north. Lower temperatures were associated with Sub-Antarctic water to the south. Higher bottom

temperatures were generally associated with shallower depths to the north and west of the Chatham Islands and on and to the east of Mernoo Bank.

3.4 Catch composition

The total catch from all 139 valid biomass stations was 142.4 t, of which 56.6 t (39.7%) was hoki, 4.6 t (3.2%) was ling, and 0.9 t (0.7%) was hake (Table 4).

Of the 321 species or species groups identified from valid biomass tows, 156 were teleosts, 35 were elasmobranchs, 1 was an agnathan, 25 were crustaceans, and 28 were cephalopods. The remainder consisted of assorted benthic and pelagic invertebrates. A full list of species caught in valid biomass tows, and the number of stations at which they occurred, is given in Appendix 2. Of interest was the capture of two pointynose toadfish, *Ebinania* sp. A (from a non-valid tow), a rarely sampled and undescribed species previously known from only 4 specimens.

Fifty six invertebrate taxa (all cephalopods) were later identified (Appendix 3).

3.5 Relative biomass estimates

3.5.1 Core strata (200–800 m)

Relative biomass in core strata was estimated for 47 species (Table 4). The CVs achieved for hoki, hake, and ling from core strata were 14.2%, 18.5%, and 7.2% respectively. The CV for 2+ hoki (2013 year class) was 18.6%, below the target CV of 20%. High CVs (over 30%) generally occurred when species were not well sampled by the gear. For example, alfonsino, barracouta, southern Ray's bream, and slender mackerel are not strictly demersal and exhibit strong schooling behaviour and consequently catch rates of these are highly variable. Others, such as bluenose, hapuku, red cod, rough skate, and tarakihi, have high CVs as they are mainly distributed outside the core survey depth range (O'Driscoll et al. 2011b).

The combined relative biomass for the top 31 species in the core strata that are tracked annually (Livingston et al. 2002) was higher than in 2012 and 2014, lower than in 2013, and similar to that in 2011, and above average for the time series (Figure 4, top panel). As in previous years, hoki was the most abundant species caught (Table 4, Figure 4, lower panel). The relative proportion of hoki in 2016 was similar to 2009 and 2014, and higher than that in 2010–13. The next most abundant QMS species were black oreo, silver warehou, ling, dark ghost shark, lookdown dory, spiny dogfish, spiky oreo, sea perch, pale ghost shark, white warehou, alfonsino, and giant stargazer, each with an estimated relative biomass of over 2000 t (Table 4). The most abundant non-QMS species were Bollons's rattail, javelinfish, and shovelnose dogfish (Table 4).

Estimated relative biomass of hoki in the core strata in 2016 was 114 514 t, 12% higher than the hoki biomass in January 2014 (Table 5, Figures 5a, 6a, 6b). This was largely driven by a high biomass estimate for 1+ hoki (2014 year-class) of 47 566 t, the second highest in the time series. The biomass of 2+ hoki (2013 year-class) was 12 902 t, one of the lowest in the time series (Table 6). The relative biomass of 3++ (recruited) hoki was 54 046 t, similar estimate to the 2014 survey, and about average for the time series.

The relative biomass of hake in core strata was 1299 t, 6% lower than 2014, and about the same as the 2012 estimate, and still low compared to the early 1990s (see Table 5, Figures 5a, 6a, 6b).

The relative biomass of ling was 10 201 t, 36% higher than in January 2014, and one of the higher estimates in the time series. The time series for ling shows no overall trend (Figures 5a, 6a, 6b).

The relative biomass estimates for most other key core species (dark ghost shark, giant stargazer, lookdown dory, silver warehou, and white warehou) were higher than 2014 estimates, pale ghost shark and spiny dogfish were about the same, and sea perch was lower than the 2014 estimate (Figures 5a, 6a, 6a).

3.5.2 Deep strata (800–1300 m)

Relative biomass and CVs in deep strata were estimated for 21 of 45 core strata species (Table 4). The relative biomass of orange roughy in all strata in 2016 was 5037 t, compared to 6916 t in 2014 (Figures 5b, 6c). However, the precision was poor with a CV of 53.3%; the deepwater survey was not optimised for orange roughy in 2016.

The 2016 survey completed all strata in 800–1300 m depths on the southwest Rise for the first time, an area where black oreo are abundant. As a result, 32% of the relative biomass of black oreo in all strata (25 051 t) was estimated to occur in the deep strata (Table 4, Figures 5b, 6c) compared with 0.6% in the 2014 survey. The estimated relative biomass of smooth oreo in deep strata was 9180 t, but precision was poor with a CV of 45.3%.

Deepwater sharks were relatively abundant in deep strata, with 38%, 71%, and 83% of the total survey biomass of shovelnose dogfish, longnose velvet dogfish, and Baxter's dogfish occurring in deep strata (Figures 5b, 6c). Bigscaled brown slickheads, smallscaled brown slickheads, basketwork eels, and four-rayed rattails were largely restricted to deeper strata, while spiky oreo were largely restricted to core strata (Figures 5b, 6c).

The deep strata contained 14% of total survey hake biomass, 1.9% of the total survey hoki biomass, and 0.5% of total survey ling biomass. This indicates that the core survey strata is likely to have sampled most of the hoki and ling biomass available to the trawl survey method on the Chatham Rise, but missed some hake (Table 4).

3.6 Catch distribution

Spatial distribution maps of catches (Figures 7–11) were generally similar to that from previous surveys.

Hoki

In the 2016 survey, hoki were caught in all 93 core biomass stations, with the highest catch rates on the Reserve Bank in 200–400 m depths (strata 19 and 20) and west and south of Mernoo Bank in 400–600 m depths (strata 7a and 16) (Table 7a, Figure 7). The highest individual catch of hoki in 2016 was 4591 kg and it occurred west of Mernoo Bank in stratum 7a, and comprised mainly 1+ hoki (Figure 7a). Other high individual hoki catches of over 3 t were south of Mernoo Bank in stratum 16 and on Reserve Bank in strata 19 and 20). The strong year class of hoki aged 1+ (2014 year-class) was widely distributed but were more abundant close to Mernoo Bank and on Reserve Bank (Figure 7a). Hoki of age 2+ (2013 year-class) were found over much of the Rise at 200–600 m depths but were more abundant in the western strata (Figure 7b). Recruited hoki (3+ and older) were widespread but the highest catch rates were on the southwestern Rise (Figure 7c).

Hake

Catches of hake were consistently low throughout much of the survey area. The highest catch rates were in stratum 7b, northeast of Mernoo Bank, where high catches of hake were observed in 2009 and 2010, and in stratum 7a northwest of Mernoo Bank (Figure 8).

Ling

As in previous years, catches of ling were evenly distributed throughout most strata in the survey area (Figure 9). The highest catch rates were mainly on the south Chatham Rise in 400–600 m (strata 12 to 16). Ling distribution was consistent, and catch rates relatively stable, over the time series (Figure 9).

Other species

As with previous surveys, lookdown dory, sea perch and spiny dogfish were widely distributed throughout the survey area at 200–600 m depths. The largest catch rates for sea perch were taken on the west Rise while the largest catch rates of lookdown dory and spiny dogfish were taken on the east Rise (Figure 10). Dark ghost shark was mainly caught at 200–400 m depths, and was particularly abundant on the Veryan Bank; while pale ghost shark was mostly caught in deeper water at 400–800 m depth, with higher catch rates to the west. Giant stargazer was mainly caught in shallower strata, with the largest catch taken west of the Chatham Islands in stratum 12. Silver warehou and white warehou were patchily distributed at depths of 200–600 m, with the largest catches in the west (Figure 10).

Orange roughy was widespread on the north and east Rise at 800–1300 m depths, with the largest catch of 1068 kg taken on mid-north Rise in 1198 m in stratum 23 (Table 7b, Figure 10), a strata in which large catches have been taken on previous surveys in 2010–2015 (Figure 11). As with previous surveys, black oreo were mostly caught in stratum 6 on the southwest Rise at 600–800 m depths. A number of black oreo were also caught in stratum 27 (800–1000 m), but few fish were caught in the deeper stratum 30 (1000–1300 m), first surveyed in 2016 (Table 7a, Figures 10, 11). Smooth oreo were also mainly caught on the southwest Rise, with the largest catch rate taken in stratum 27 (800–1000 m). Large catches of smooth oreo have generally been taken in this area or on the northwest Rise on previous surveys (Figure 11). Spiky oreo were widespread and abundant on the northeast rise at 500–800 m, with the largest catch-rates taken in stratum 2b (Table 7b, Figure 10). Ribaldo, shovelnose dogfish, longnose velvet dogfish, and four-rayed rattail were more abundant on the north Rise, basketwork eel and bigscaled brown slickhead were abundant on the north Rise and south Rise, and Baxter’s dogfish and smallscaled brown slickhead were more abundant on the south Rise (Table 7b, Figure 10).

3.7 Biological data

3.7.1 Species sampled

The number of species and the number of samples for which length and length-weight data were collected are given in Table 8.

3.7.2 Length frequencies and age distributions

Length-weight relationships used in the SurvCalc program to scale length frequencies and calculate relative biomass and catch rates are given in Table 9.

Hoki

Length and age frequency distributions were dominated by 1+ year (less than 49 cm) fish (Figures 12 and 13). There were relatively few 2+ (49–62 cm) fish, and few longer than 80 cm (Figure 12) or older than 6 years (Figure 13). Females were slightly more abundant than males (ratio of 1.12 female: 1 male).

Hake

Length frequency and calculated number at age distributions (Figures 14 and 15) were relatively broad, with most male fish aged between 2 and 10 years and female fish between 2 and 14 years. Females were more abundant than males (1.35 female: 1 male).

Ling

Length frequency and calculated number at age distributions (Figures 16 and 17) indicated a wide range of ages, with most fish aged between 2 and 20. There is evidence of a period of good recruitment from 1999–2006 (Figure 17). The sex ratio was about even.

Other species

Length frequency distributions for key core and deepwater species are shown in Figures 18a, 18b. Clear modes are apparent in the size distribution of white warehou, which may correspond to individual cohorts.

Length frequencies of giant stargazer, lookdown dory, dark and pale ghost sharks, and several shark species (spiny dogfish, Baxter's dogfish, longnose velvet dogfish, and shovelnose dogfish) indicate that females grow larger than males (Figures 18a, 18b).

The deep strata contain a high proportion of large shovelnose dogfish, longnose velvet dogfish, and Baxter's dogfish (Figure 18). Bigscaled brown slickheads, smallscaled brown slickheads, basketwork eels, and four-rayed rattail were largely restricted to the deep strata (Figure 18b).

Length frequency distributions were similar for males and females of sea perch, silver warehou, orange roughy, black oreo, smooth oreo, and spiky oreo. The length frequency distribution for orange roughy was broad, with a mode at 30–37 cm, but included fish as small as 7 cm (Figures 18a, 18b).

The catch of spiny dogfish, bigscaled brown slickhead, basketwork eels, and four-rayed rattails were dominated by females (greater than 1.5 female: 1 male) while the catch of ribaldo was dominated by males (1.8 male: 1 female) (Figures 18a, 18b).

3.7.3 Reproductive status

Gonad stages of hake, hoki, ling, and a number of other species are summarised in Table 10. Almost all hoki were recorded as either resting or immature. About 31% of male ling were maturing or ripe, with few females showing signs of spawning. About 58% of male hake were ripe, running ripe, partially spent, or spent, but most females were immature or resting (65%) or maturing (29%) (Table 10). Most other species for which reproductive state was recorded did not appear to be reproductively active, except spiny dogfish and some deepwater sharks (Table 10).

3.8 Acoustic data quality

Over 91 GB of acoustic data were collected with the multi-frequency (18, 38, 70, 120, and 200 kHz) hull-mounted EK60 systems on each trawl station and while steaming between stations. Weather and sea conditions during the survey were generally very good meaning that acoustic data quality was high. Only 4% of acoustic files from the 2016 survey exceeded the threshold of 30% bad pings, and so were not suitable for quantitative analysis (Figure 19).

Expanding symbol plots of the distribution of total acoustic backscatter from daytime trawls and night transects in the core survey area are shown in Figure 20. As noted by O'Driscoll et al. (2011a), there is a consistent spatial pattern in total backscatter on the Chatham Rise, with higher backscatter in the west.

3.8.1 Comparison of acoustics with bottom trawl catches

Acoustic data from 90 trawl files were integrated and compared with trawl catch rates (Table 11). Data from the other three recordings during core daytime tows were not included in the analysis because the acoustic data were too noisy. Average acoustic backscatter values from the entire water column in 2016 was the highest in the time series (Table 11). Average acoustic backscatter in the bottom 10 m and 50 m were also relatively high (Table 11).

There was a positive correlation (Spearman's rank correlation, $\rho = 0.35$, $p < 0.01$) between acoustic backscatter in the bottom 100 m during the day and trawl catch rates (Figure 21). In previous Chatham Rise surveys from 2001–14, rank correlations between trawl catch rates and acoustic density estimates ranged from 0.15 (in 2006) to 0.50 (in 2013). The correlation between acoustic backscatter and trawl catch rates (Figure 21) is not perfect ($\rho = 1$) because the daytime bottom-referenced layers on the Chatham Rise may also contain a high proportion of mesopelagic species, which contribute to the acoustic backscatter, but which are not sampled by the bottom trawl (O'Driscoll 2003, O'Driscoll et al.

2009), and conversely some fish caught by the trawl may not be measured acoustically (e.g., close to bottom in acoustic deadzone). This, combined with the diverse composition of demersal species present, means that it is unlikely that acoustics will provide an alternative biomass estimate for hoki on the Chatham Rise.

3.8.2 Time-series of relative mesopelagic fish abundance

In 2016, most acoustic backscatter was between 200 and 500 m depth during the day, and migrated into the surface 200 m at night (Figure 22). The vertical distribution was similar to the pattern observed in all previous years except 2011 (O’Driscoll et al. 2011a, Stevens et al. 2013, 2014, 2015). In 2011, there was a different daytime distribution of backscatter, with a concentration of backscatter between 150 and 350 m, no obvious peak at 350–400 m, and smaller peaks centred at around 550 and 750 m (Stevens et al. 2012).

The vertically migrating component of acoustic backscatter is assumed to be dominated by mesopelagic fish (see McClatchie & Dunford, 2003 for rationale and caveats). In 2016, between 57 and 84% of the total backscatter in each of the four sub-areas was in the upper 200 m at night and was estimated to be from vertically migrating mesopelagic fish (Table 12). The proportion of backscatter attributed to mesopelagic fish in 2016 was similar to other surveys in the time-series, and lowest in the northwest where there were higher densities of demersal fish (Table 12).

Day estimates of total acoustic backscatter over the Chatham Rise were consistently higher than night estimates (Figure 23) because of the movement of fish into the surface deadzone (shallower than 14 m) at night (O’Driscoll et al. 2009). The only exception to this was in 2011, when night estimates were higher than day estimates (Figure 23). However, there was relatively little good quality acoustic data available from the southeast Chatham Rise in 2011 due to poor weather conditions (Stevens et al. 2012). Total daytime backscatter in 2016 was 24% higher than that observed in 2014. Backscatter within 50 m of the bottom during the day generally decreased from 2001 to 2011, but has subsequently increased (Figure 23). Backscatter close to the bottom at night has been relatively low throughout the time-series, but shows an increasing trend over the past seven years (Figure 23).

Acoustic indices of mesopelagic fish abundance are summarised in Table 13 and plotted in Figure 24 for the entire Chatham Rise and for the four sub-areas. The overall mesopelagic estimate for the Chatham Rise increased by 30% from 2014 and was the highest since 2009. The mesopelagic index increased in all four sub-areas, with the highest percentage increase (54%) in the southwest (Table 13, Figure 24).

3.9 Hoki condition

Liver condition (defined as liver weight divided by gutted weight) for all hoki on the Chatham Rise increased from 2014 to 2016 (Figure 25). This increase in overall condition occurred across all length classes (Figure 25). Stevens et al. (2014) suggested that hoki condition may be related to both food availability and hoki density, and estimated an index of “food per fish” from the ratio of the acoustic estimate of mesopelagic fish abundance divided by the trawl estimate of hoki abundance. The significant positive correlation between liver condition and the food per fish index reported in 2013 (Stevens et al. 2014) and 2014 (Stevens et al. 2015) was maintained with the addition of the 2016 data (Figure 26, Pearson’s correlation coefficient, $r = 0.72$, $n = 11$, $p < 0.02$).

4. CONCLUSIONS

The 2016 survey successfully extended the January Chatham Rise time series to 24 points (annual from 1992–2014, then 2016), and provided abundance indices for hoki, hake, ling, and a range of associated middle-depth species.

The estimated relative biomass of hoki in core strata was 12% higher than that in 2014, largely due to a high relative biomass estimate of 1+ hoki, the second highest in the time series. The relative biomass of 2+ hoki (2013 year class) was one of the lowest estimates in the time series. The estimated biomass of 3++ (recruited) hoki was similar to the 2014 survey and about average for the time series.

The relative biomass of hake in core strata was 6% lower than in 2014, and remains at historically low levels compared to the early 1990s. The relative biomass of ling in core strata was 36% higher than in 2014, but the time series for ling shows no overall trend.

In 2016 the survey area was successfully extended to cover 800–1300 m depths around the entire Rise. The deep strata provide relative biomass indices for a range of deepwater species associated with orange roughy and oreo fisheries. A high proportion of the estimated biomass of deepwater sharks (shovelnose dogfish, longnose velvet dogfish, and Baxter's dogfish) occurred in deep strata, and bigscaled brown slickheads, smallscaled brown slickheads, basketwork eels, and four-rayed rattails were largely restricted to deeper strata.

The deep strata contained only a small proportion of the total survey relative biomass for hake, hoki, and ling, confirming that the core survey area is appropriate for these species.

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Table 1: The number of completed valid biomass tows (200–1300 m) by stratum during the 2016 Chatham Rise trawl survey.

| Stratum number | Depth range (m) | Location | Area (km ²) | Phase 1 allocation | Phase 1 stations | Phase 2 stations | Total stations | Station density (1: km ²) |
|----------------|-----------------|-----------------|-------------------------|--------------------|------------------|------------------|----------------|---------------------------------------|
| 1 | 600–800 | NW Chatham Rise | 2 439 | 3 | 3 | | 3 | 1: 813 |
| 2A | 600–800 | NW Chatham Rise | 3 253 | 3 | 3 | | 3 | 1: 1 084 |
| 2B | 600–800 | NE Chatham Rise | 8 503 | 4 | 4 | | 4 | 1: 2 126 |
| 3 | 200–400 | Matheson Bank | 3 499 | 3 | 3 | | 3 | 1: 1 166 |
| 4 | 600–800 | SE Chatham Rise | 11 315 | 3 | 3 | | 3 | 1: 3 772 |
| 5 | 200–400 | SE Chatham Rise | 4 078 | 3 | 3 | | 3 | 1: 1 359 |
| 6 | 600–800 | SW Chatham Rise | 8 266 | 3 | 3 | | 3 | 1: 2 755 |
| 7A | 400–600 | NW Chatham Rise | 4 364 | 4 | 4 | 1 | 5 | 1: 1 091 |
| 7B | 400–600 | NW Chatham Rise | 869 | 3 | 3 | | 3 | 1: 290 |
| 8A | 400–600 | NW Chatham Rise | 3 286 | 3 | 3 | | 3 | 1: 1 095 |
| 8B | 400–600 | NW Chatham Rise | 5 722 | 3 | 3 | | 3 | 1: 1 907 |
| 9 | 200–400 | NE Chatham Rise | 5 136 | 3 | 3 | | 3 | 1: 1 712 |
| 10 | 400–600 | NE Chatham Rise | 6 321 | 4 | 4 | | 4 | 1: 1 580 |
| 11 | 400–600 | NE Chatham Rise | 11 748 | 7 | 7 | | 7 | 1: 1 678 |
| 12 | 400–600 | SE Chatham Rise | 6 578 | 3 | 3 | | 3 | 1: 2 193 |
| 13 | 400–600 | SE Chatham Rise | 6 681 | 3 | 3 | | 3 | 1: 2 227 |
| 14 | 400–600 | SW Chatham Rise | 5 928 | 3 | 3 | | 3 | 1: 1 976 |
| 15 | 400–600 | SW Chatham Rise | 5 842 | 3 | 3 | | 5 | 1: 1 168 |
| 16 | 400–600 | SW Chatham Rise | 11 522 | 3 | 3 | 8 | 11 | 1: 1 047 |
| 17 | 200–400 | Veryan Bank | 865 | 3 | 3 | | 3 | 1: 288 |
| 18 | 200–400 | Mernoo Bank | 4 687 | 4 | 4 | | 4 | 1: 1 172 |
| 19 | 200–400 | Reserve Bank | 9 012 | 7 | 7 | | 7 | 1: 1 287 |
| 20 | 200–400 | Reserve Bank | 9 584 | 6 | 6 | | 6 | 1: 1 597 |
| Core | 200–800 | | 139 492 | 84 | 84 | 9 | 93 | 1: 1 500 |
| 21A | 800–1000 | NE Chatham Rise | 1 249 | 3 | 3 | | 3 | 1: 416 |
| 21B | 800–1000 | NE Chatham Rise | 5 819 | 3 | 3 | | 3 | 1: 1 940 |
| 22 | 800–1000 | NW Chatham Rise | 7 357 | 11 | 11 | | 11 | 1: 669 |
| 23 | 1000–1300 | NW Chatham Rise | 7 014 | 4 | 4 | | 4 | 1: 1 754 |
| 24 | 1000–1300 | NE Chatham Rise | 5 672 | 3 | 3 | | 3 | 1: 1 891 |
| 25 | 800–1000 | SE Chatham Rise | 5 596 | 4 | 4 | | 4 | 1: 1 399 |
| 26 | 800–1000 | SW Chatham Rise | 5 158 | 4 | 3 | | 3 | 1: 1 719 |
| 27 | 800–1000 | SW Chatham Rise | 7 185 | 4 | 4 | | 4 | 1: 1 796 |
| 28 | 1000–1300 | SE Chatham Rise | 9 494 | 3 | 3 | | 3 | 1: 3 165 |
| 29 | 1000–1300 | SW Chatham Rise | 10 965 | 4 | 4 | | 4 | 1: 2 741 |
| 30 | 1000–1300 | SW Chatham Rise | 10 960 | 4 | 4 | | 4 | 1: 2 740 |
| Deep | 800–1300 | | 76 469 | 47 | 46 | 0 | 46 | 1: 1 662 |
| Total | 200–1300 | | 215 967 | 131 | 130 | 9 | 139 | 1: 1 554 |

Table 2: Survey dates and number of valid core (200–800 m depth) biomass tows in surveys of the Chatham Rise, January 1992–2014, and 2016. †, years where the deep component of the survey was carried out. Note: TAN1401 included an additional two days for ratcatcher bottom trawls.

| Trip code | Start date | End date | No. of valid core biomass tows |
|-----------|-------------|-------------|--------------------------------|
| TAN9106 | 28 Dec 1991 | 1 Feb 1992 | 184 |
| TAN9212 | 30 Dec 1992 | 6 Feb 1993 | 194 |
| TAN9401 | 2 Jan 1994 | 31 Jan 1994 | 165 |
| TAN9501 | 4 Jan 1995 | 27 Jan 1995 | 122 |
| TAN9601 | 27 Dec 1995 | 14 Jan 1996 | 89 |
| TAN9701 | 2 Jan 1997 | 24 Jan 1997 | 103 |
| TAN9801 | 3 Jan 1998 | 21 Jan 1998 | 91 |
| TAN9901 | 3 Jan 1999 | 26 Jan 1999 | 100 |
| TAN0001 | 27 Dec 1999 | 22 Jan 2000 | 128 |
| TAN0101 | 28 Dec 2000 | 25 Jan 2001 | 119 |
| TAN0201 | 5 Jan 2002 | 25 Jan 2002 | 107 |
| TAN0301 | 29 Dec 2002 | 21 Jan 2003 | 115 |
| TAN0401 | 27 Dec 2003 | 23 Jan 2004 | 110 |
| TAN0501 | 27 Dec 2004 | 23 Jan 2005 | 106 |
| TAN0601 | 27 Dec 2005 | 23 Jan 2006 | 96 |
| TAN0701 | 27 Dec 2006 | 23 Jan 2007 | 101 |
| TAN0801 | 27 Dec 2007 | 23 Jan 2008 | 101 |
| TAN0901 | 27 Dec 2008 | 23 Jan 2009 | 108 |
| TAN1001† | 2 Jan 2010 | 28 Jan 2010 | 91 |
| TAN1101† | 2 Jan 2011 | 28 Jan 2011 | 90 |
| TAN1201† | 2 Jan 2012 | 28 Jan 2012 | 100 |
| TAN1301† | 2 Jan 2013 | 26 Jan 2013 | 91 |
| TAN1401† | 2 Jan 2014 | 28 Jan 2014 | 87 |
| TAN1601† | 3 Jan 2016 | 2 Feb 2016 | 93 |

Table 3: Tow and gear parameters by depth range for valid biomass tows (TAN1601). Values shown are sample size (*n*), and for each parameter the mean, standard deviation (s.d.), and range.

| | <i>n</i> | Mean | s.d. | Range |
|----------------------------|----------|-------|------|-------------|
| Core tow parameters | | | | |
| Tow length (n. miles) | 93 | 2.9 | 0.28 | 2.1–3.1 |
| Tow speed (knots) | 93 | 3.5 | 0.03 | 3.4–3.5 |
| All tow parameters | | | | |
| Tow length (n. miles) | 139 | 2.9 | 0.23 | 2.1–3.1 |
| Tow speed (knots) | 19 | 3.5 | 0.02 | 3.4–3.5 |
| Gear parameters | | | | |
| 200–400 m | | | | |
| Headline height (m) | 29 | 6.8 | 0.25 | 6.3–7.6 |
| Doorspread (m) | 28 | 120.9 | 5.13 | 110.0–128.5 |
| 400–600 m | | | | |
| Headline height (m) | 48 | 6.7 | 0.23 | 6.2–7.2 |
| Doorspread (m) | 47 | 124.5 | 4.41 | 115.8–134.6 |
| 600–800 m | | | | |
| Headline height (m) | 16 | 6.7 | 0.21 | 6.4–7.0 |
| Doorspread (m) | 16 | 125.5 | 4.54 | 118.8–133.4 |
| 800–1000 m | | | | |
| Headline height (m) | 28 | 6.8 | 0.15 | 6.5–7.2 |
| Doorspread (m) | 26 | 123.1 | 4.59 | 112.8–133.3 |
| 1000–1300 m | | | | |
| Headline height (m) | 18 | 7.1 | 0.26 | 6.7–7.7 |
| Doorspread (m) | 11 | 122.8 | 5.65 | 113.2–129.5 |
| Core stations 200–800 m | | | | |
| Headline height (m) | 93 | 6.7 | 0.23 | 6.2–7.6 |
| Doorspread (m) | 91 | 123.6 | 4.96 | 110.0–134.6 |
| All stations 200–1300 m | | | | |
| Headline height (m) | 139 | 6.8 | 0.26 | 6.2–7.7 |
| Doorspread (m) | 128 | 123.4 | 4.91 | 110.0–134.6 |

Table 4: Catch (kg) and total relative biomass (t) estimates (also by sex) with coefficient of variation (CV) for QMS species, other commercial species, and key non-commercial species for valid biomass tows in the 2016 survey core strata (200–800 m); and biomass estimates (not catch) for deep strata (800–1300 m). Total biomass includes unsexed fish. (–, no data.). Arranged in descending relative biomass estimates for the core strata. –, no data.

| Common name | Code | Core strata 200–800m | | | | | | | 800–1300 m | |
|-----------------------------------|------|----------------------|---------------|---------|-----------------|---------|---------------|---------|--------------|---------|
| | | Catch kg | Biomass males | | Biomass females | | Total biomass | | Deep biomass | |
| | | | t | % CV | t | % CV | t | % CV | t | % CV |
| QMS species | | | | | | | | | | |
| Hoki | HOK | 55 190 | 53 388 | 16.1 | 60 825 | 12.8 | 114 514 | 14.2 | 2 218 | 14.8 |
| Black oreo | BOE | 4 186 | 8 340 | 12.2 | 8 603 | 14.4 | 16 981 | 13.1 | 8 070 | 33.5 |
| Silver warehou | SWA | 6 850 | 8 494 | 26.6 | 6 479 | 26.3 | 14 983 | 25.3 | – | – |
| Ling | LIN | 4 543 | 4 719 | 11.6 | 5 475 | 7.5 | 10 201 | 7.2 | 53 | 47.1 |
| Dark ghost shark | GSH | 8 212 | 5 450 | 12.1 | 6 449 | 12.8 | 11 925 | 11.7 | – | – |
| Lookdown dory | LDO | 2 851 | 2 188 | 9.8 | 4 281 | 9.5 | 6 494 | 8.8 | 30 | 43.2 |
| Spiny dogfish | SPD | 2 677 | 1 112 | 22.2 | 4 782 | 11.6 | 5 908 | 12.1 | – | – |
| Spiky oreo | SOR | 1 326 | 2 298 | 29.2 | 2 038 | 28.1 | 4 339 | 28.3 | 402 | 39.6 |
| Sea perch | SPE | 1 834 | 2 159 | 10.8 | 1 800 | 10.7 | 3 989 | 10.4 | 8 | 93.5 |
| Pale ghost shark | GSP | 1 811 | 1 532 | 9.7 | 1 516 | 10.4 | 3 259 | 10.4 | 618 | 17.1 |
| White warehou | WWA | 1 284 | 1 503 | 27.6 | 1 251 | 20.0 | 2 760 | 23.5 | – | – |
| Alfonsino | BYS | 1 166 | 1 343 | 43.6 | 1 188 | 40.3 | 2 565 | 41.4 | – | – |
| Giant stargazer | GIZ | 1 026 | 471 | 15.4 | 1 757 | 20.7 | 2 228 | 17.2 | 11 | 100 |
| Smooth skate | SSK | 734 | 581 | 26.9 | 1 081 | 27.6 | 1 662 | 22.3 | – | – |
| Hake | HAK | 739 | 380 | 23.5 | 919 | 20.3 | 1 299 | 18.5 | 213 | 28.6 |
| Southern Ray's bream | SRB | 305 | 279 | 29.4 | 284 | 29.2 | 566 | 28.6 | – | – |
| Smooth oreo | SSO | 145 | 257 | 93.8 | 298 | 95.6 | 555 | 94.7 | 9 180 | 45.3 |
| School shark | SCH | 231 | 285 | 41.4 | 244 | 40.8 | 529 | 31.3 | – | – |
| Arrow squid | NOS | 224 | 211 | 23.3 | 267 | 32.2 | 483 | 27.0 | – | – |
| Red cod | RCO | 400 | 256 | 30.7 | 165 | 33.1 | 422 | 29.4 | – | – |
| Ribaldo | RIB | 192 | 136 | 14.2 | 271 | 27.5 | 407 | 19.7 | 150 | 16.5 |
| Barracouta | BAR | 124 | 240 | 53.9 | 141 | 62.7 | 381 | 56.9 | – | – |
| Bluenose | BNS | 120 | 77 | 50.7 | 140 | 52.9 | 217 | 50.0 | – | – |
| Slender mackerel | JMM | 70 | 104 | 59.8 | 86 | 52.6 | 190 | 55.9 | – | – |
| Deepsea cardinalfish | EPT | 103 | 97 | 46.7 | 64 | 45.9 | 166 | 43.2 | – | – |
| Hapuku | HAP | 60 | 70 | 45.2 | 77 | 52.2 | 147 | 38.9 | – | – |
| Tarakihi | NMP | 30 | 43 | 21.4 | 50 | 77.7 | 93 | 49.7 | – | – |
| Lemon sole | LSO | 41 | 38 | 28.4 | 50 | 35.3 | 89 | 28.8 | – | – |
| Banded stargazer | BGZ | 20 | 19 | 100 | 30 | 100 | 49 | 100 | – | – |
| Rough skate | RSK | 30 | 15 | 85.6 | 32 | 66.5 | 47 | 64.7 | – | – |
| Scampi | SCI | 8 | 9 | 25.9 | 7 | 17.6 | 16 | 19.2 | – | – |
| Orange roughy | ORH | 8 | 3 | 50.4 | 11 | 64.2 | 14 | 54.6 | 5 023 | 53.5 |
| Redbait | RBT | 4 | 7 | 56.7 | 3 | 100 | 10 | 50.3 | – | – |
| Frostfish | FRO | 3 | 8 | 100 | – | – | 8 | 100 | – | – |
| Rubyfish | RBV | 2 | 5 | 100 | 2 | 100 | 6 | 79.1 | – | – |
| Ray's bream | RBM | 2 | 5 | 100 | – | – | 5 | 100 | – | – |
| Jack mackerel | JMD | 1 | 2 | 100 | – | – | 2 | 100 | – | – |
| Commercial non-QMS species | | | | | | | | | | |
| Shovelnose dogfish | SND | 2 746 | 1 836 | 22.8 | 3 943 | 24.5 | 5 962 | 21.2 | 3 605 | 22.2 |
| Southern blue whiting | SBW | 35 | 43 | 33.4 | 26 | 31.0 | 69 | 29.7 | – | – |

Table 4 (continued)

| Common name | Code | Catch kg | Core strata 200–800m | | | | | | 800–1300 m | |
|--------------------------------|------|-------------|----------------------|---------|-----------------|---------|---------------|---------|--------------|---------|
| | | | Biomass males | | Biomass females | | Total biomass | | Deep biomass | |
| | | | t | % CV | t | % CV | t | % CV | t | % CV |
| Non-commercial species | | | | | | | | | | |
| Bollons's rattail | CBO | 5 222 | 3 700 | 14.8 | 5 744 | 18.3 | 11 924 | 12.4 | 24 | 38.4 |
| Javelinfinch | JAV | 5 488 | 1 652 | 27.1 | 9 615 | 12.8 | 11 340 | 13.3 | 675 | 17.1 |
| Longnose velvet dogfish | CYP | 580 | 454 | 10.0 | 426 | 38.1 | 886 | 20.6 | 2 154 | 17.7 |
| Baxters lantern dogfish | ETB | 136 | 197 | 28.2 | 118 | 32.3 | 420 | 26.9 | 2 107 | 20.1 |
| Smallscaled brown slickhead | SSM | 24 | 28 | 100 | 5 | 100 | 36 | 92.9 | 2 681 | 25.5 |
| Basketwork eel | BEE | 6 | 3 | 100 | 20 | 100 | 22 | 27.1 | 2 220 | 10.2 |
| Four-rayed rattail | CSU | 14 | – | – | 5 | 81.9 | 22 | 27.1 | 1 995 | 45.7 |
| Bigscaled brown slickhead | SBI | – | – | – | – | – | – | – | 3 121 | 20.3 |
| Total (above) | | 110 803 | | | | | | | | |
| Grand total (all species) | | 118 638 | | | | | | | | |

Table 5: Estimated core 200–800 m relative biomass (t) with coefficient of variation below (%) for hoki, hake, and ling sampled by annual trawl surveys of the Chatham Rise, January 1992–2014, and 2016. No. Stns, number of valid stations; CV, coefficient of variation. See also Figure 5.

| Year | Survey | No. stns | Hoki | | Hake | | Ling | |
|------|---------|----------|---------|------|---------|------|---------|------|
| | | | Biomass | CV | Biomass | CV | Biomass | CV |
| 1992 | TAN9106 | 184 | 120 190 | 7.7 | 4 180 | 14.9 | 8 930 | 5.8 |
| 1993 | TAN9212 | 194 | 185 570 | 10.3 | 2 950 | 17.2 | 9 360 | 7.9 |
| 1994 | TAN9401 | 165 | 145 633 | 9.8 | 3 353 | 9.6 | 10 129 | 6.5 |
| 1995 | TAN9501 | 122 | 120 441 | 7.6 | 3 303 | 22.7 | 7 363 | 7.9 |
| 1996 | TAN9601 | 89 | 152 813 | 9.8 | 2 457 | 13.3 | 8 424 | 8.2 |
| 1997 | TAN9701 | 103 | 157 974 | 8.4 | 2 811 | 16.7 | 8 543 | 9.8 |
| 1998 | TAN9801 | 91 | 86 678 | 10.9 | 2 873 | 18.4 | 7 313 | 8.3 |
| 1999 | TAN9901 | 100 | 109 336 | 11.6 | 2 302 | 11.8 | 10 309 | 16.1 |
| 2000 | TAN0001 | 128 | 72 151 | 12.3 | 2 152 | 9.2 | 8 348 | 7.8 |
| 2001 | TAN0101 | 119 | 60 330 | 9.7 | 1 589 | 12.7 | 9 352 | 7.5 |
| 2002 | TAN0201 | 107 | 74 351 | 11.4 | 1 567 | 15.3 | 9 442 | 7.8 |
| 2003 | TAN0301 | 115 | 52 531 | 11.6 | 888 | 15.5 | 7 261 | 9.9 |
| 2004 | TAN0401 | 110 | 52 687 | 12.6 | 1 547 | 17.1 | 8 248 | 7.0 |
| 2005 | TAN0501 | 106 | 84 594 | 11.5 | 1 048 | 18.0 | 8 929 | 9.4 |
| 2006 | TAN0601 | 96 | 99 208 | 10.6 | 1 384 | 19.3 | 9 301 | 7.4 |
| 2007 | TAN0701 | 101 | 70 479 | 8.4 | 1 824 | 12.2 | 7 907 | 7.2 |
| 2008 | TAN0801 | 101 | 76 859 | 11.4 | 1 257 | 12.9 | 7 504 | 6.7 |
| 2009 | TAN0901 | 108 | 144 088 | 10.6 | 2 419 | 20.7 | 10 615 | 11.5 |
| 2010 | TAN1001 | 91 | 97 503 | 14.6 | 1 701 | 25.1 | 8 846 | 10.0 |
| 2011 | TAN1101 | 90 | 93 904 | 14.0 | 1 099 | 14.9 | 7 027 | 13.8 |
| 2012 | TAN1201 | 100 | 87 505 | 9.8 | 1 292 | 14.7 | 8 098 | 7.4 |
| 2013 | TAN1301 | 91 | 124 112 | 15.3 | 1 793 | 15.3 | 8 714 | 10.1 |
| 2014 | TAN1401 | 87 | 101 944 | 9.8 | 1 377 | 15.2 | 7 489 | 7.2 |
| 2016 | TAN1601 | 93 | 114 514 | 14.2 | 1 299 | 18.5 | 10 201 | 7.2 |

Table 6: Relative biomass estimates (t in thousands) for hoki, 200–800 m depths, Chatham Rise trawl surveys January 1992–2014, and 2016 (CV, coefficient of variation; 3++, all hoki aged 3 years and older; (see Appendix 4 for length ranges used to define age classes.). See also Figure 5.

| Survey | 1+ year class | 1+ hoki | | 2+ year class | 2+ hoki | | 3 ++ hoki | | Total hoki | |
|--------|---------------|---------|--------|---------------|---------|--------|-----------|--------|------------|--------|
| | | t | % CV | | t | % CV | t | % CV | t | % CV |
| 1992 | 1990 | 2.8 | (27.9) | 1989 | 1.2 | (18.1) | 116.1 | (7.8) | 120.2 | (9.7) |
| 1993 | 1991 | 32.9 | (33.4) | 1990 | 2.6 | (25.1) | 150.1 | (8.9) | 185.6 | (10.3) |
| 1994 | 1992 | 14.6 | (20.0) | 1991 | 44.7 | (18.0) | 86.2 | (9.0) | 145.6 | (9.8) |
| 1995 | 1993 | 6.6 | (13.0) | 1992 | 44.9 | (11.0) | 69.0 | (9.0) | 120.4 | (7.6) |
| 1996 | 1994 | 27.6 | (24.0) | 1993 | 15.0 | (13.0) | 106.6 | (10.0) | 152.8 | (9.8) |
| 1997 | 1995 | 3.2 | (40.0) | 1994 | 62.7 | (12.0) | 92.1 | (8.0) | 158.0 | (8.4) |
| 1998 | 1996 | 4.5 | (33.0) | 1995 | 6.9 | (18.0) | 75.6 | (11.0) | 86.7 | (10.9) |
| 1999 | 1997 | 25.6 | (30.4) | 1996 | 16.5 | (18.9) | 67.0 | (9.9) | 109.3 | (11.6) |
| 2000 | 1998 | 14.4 | (32.4) | 1997 | 28.2 | (20.7) | 29.5 | (9.3) | 71.7 | (12.3) |
| 2001 | 1999 | 0.4 | (74.6) | 1998 | 24.2 | (17.8) | 35.7 | (9.2) | 60.3 | (9.7) |
| 2002 | 2000 | 22.4 | (25.9) | 1999 | 1.2 | (21.2) | 50.7 | (12.3) | 74.4 | (11.4) |
| 2003 | 2001 | 5.0 | (46.0) | 2000 | 27.2 | (15.1) | 20.4 | (9.3) | 52.6 | (8.7) |
| 2004 | 2002 | 14.4 | (32.5) | 2001 | 5.5 | (20.4) | 32.8 | (12.9) | 52.7 | (12.6) |
| 2005 | 2003 | 17.5 | (23.4) | 2002 | 45.8 | (16.3) | 21.2 | (11.4) | 84.6 | (11.5) |
| 2006 | 2004 | 25.9 | (21.5) | 2003 | 33.6 | (18.8) | 39.7 | (10.3) | 99.2 | (10.6) |
| 2007 | 2005 | 9.1 | (27.5) | 2004 | 32.6 | (12.8) | 28.8 | (8.9) | 70.5 | (8.4) |
| 2008 | 2006 | 15.6 | (31.6) | 2005 | 23.8 | (15.5) | 37.5 | (7.8) | 76.9 | (11.4) |
| 2009 | 2007 | 25.2 | (28.8) | 2006 | 65.2 | (17.2) | 53.7 | (7.8) | 144.1 | (10.6) |
| 2010 | 2008 | 19.3 | (30.7) | 2007 | 28.6 | (15.4) | 49.6 | (16.3) | 97.5 | (14.6) |
| 2011 | 2009 | 26.9 | (36.9) | 2008 | 26.3 | (14.1) | 40.7 | (7.8) | 93.9 | (14.0) |
| 2012 | 2010 | 2.6 | (30.1) | 2009 | 29.1 | (16.6) | 55.9 | (8.0) | 87.5 | (9.8) |
| 2013 | 2011 | 50.9 | (24.5) | 2010 | 1.0 | (43.6) | 72.1 | (12.8) | 124.1 | (15.3) |
| 2014 | 2012 | 5.7 | (36.6) | 2011 | 43.3 | (14.2) | 53.0 | (10.9) | 101.9 | (9.8) |
| 2016 | 2014 | 47.6 | (27.6) | 2013 | 12.9 | (18.6) | 54.0 | (12.8) | 114.5 | (14.2) |

Table 7a: Estimated relative biomass (t) and coefficient of variation (% CV) for hoki, hake, ling, other key core strata species, and key deepwater species by stratum for the 2016 survey. See Table 4 for species code definitions. Core, total biomass from valid core tows (200–800 m); Deep, total biomass from valid deep tows (800–1300 m); Total, total biomass from all valid tows (200–1300 m); –, no data.

| Stratum | Species code | | | | | |
|---------|----------------|--------------|--------------|---------------|-------------|-------------|
| | HOK | HAK | LIN | GSH | GSP | LDO |
| 1 | 608 (46.1) | 22 (100.0) | 112 (20.6) | - | 124 (48.3) | 23 (75.9) |
| 2A | 660 (17.1) | 27 (66.7) | 162 (65.1) | - | 80 (17.6) | 29 (23.7) |
| 2B | 2 451 (19.4) | 234 (41.9) | 300 (24.1) | - | 82 (17.5) | 143 (22.2) |
| 3 | 790 (26.4) | 15 (100.0) | 141 (30.5) | 804 (9.8) | 6 (100.0) | 314 (22.1) |
| 4 | 3 408 (6.9) | 90 (100.0) | 880 (34.5) | - | 293 (34.0) | 279 (38.6) |
| 5 | 2 863 (62.4) | 10 (52.5) | 371 (21.3) | 1 287 (9.8) | 9 (51.4) | 414 (25.1) |
| 6 | 5 067 (70.3) | 38 (100.0) | 506 (59.4) | - | 433 (17.2) | 90 (62.4) |
| 7A | 12 280 (55.8) | 158 (81.6) | 437 (23.7) | 128 (86.9) | 180 (48.6) | 63 (21.2) |
| 7B | 589 (60.9) | 67 (87.7) | 91 (3.7) | 4 (38.5) | 18 (47.6) | 15 (8.7) |
| 8A | 1 038 (22.9) | 90 (41.4) | 165 (26.7) | - | 42 (66.8) | 62 (20.9) |
| 8B | 2 728 (34.3) | 96 (55.0) | 671 (4.7) | 70 (100.0) | 151 (32.1) | 388 (29.4) |
| 9 | 558 (53.6) | - | 62 (22.0) | 312 (84.1) | - | 42 (69.2) |
| 10 | 3 337 (52.2) | 50 (60.2) | 502 (39.0) | 210 (100.0) | 64 (18.1) | 346 (33.5) |
| 11 | 6 827 (32.0) | 31 (51.6) | 753 (21.8) | 1 775 (37.0) | 10 (100.0) | 653 (33.6) |
| 12 | 2 707 (12.9) | 9 (100.0) | 635 (31.8) | 602 (92.7) | 115 (79.8) | 635 (33.3) |
| 13 | 1 853 (41.0) | 56 (100.0) | 828 (35.8) | 355 (83.8) | 276 (41.0) | 652 (54.7) |
| 14 | 2 487 (49.9) | 40 (100.0) | 431 (5.9) | 105 (91.9) | 167 (3.8) | 289 (18.0) |
| 15 | 4 862 (48.0) | 90 (76.7) | 708 (17.5) | 162 (50.3) | 287 (21.0) | 444 (20.1) |
| 16 | 16 574 (27.4) | 124 (33.3) | 1 264 (12.3) | 2 (100.0) | 593 (18.4) | 597 (18.7) |
| 17 | 714 (71.1) | - | 14 (56.5) | 1 933 (48.0) | - | 72 (48.7) |
| 18 | 9 387 (26.7) | - | 32 (60.0) | 997 (17.6) | - | 170 (38.3) |
| 19 | 12 153 (61.6) | 29 (67.5) | 426 (49.9) | 1 521 (29.7) | - | 101 (39.2) |
| 20 | 20 575 (48.5) | 24 (100.0) | 712 (29.2) | 1 863 (16.8) | 128 (54.2) | 670 (19.6) |
| Core | 114 514 (14.2) | 1 299 (18.5) | 10 201 (7.2) | 12 129 (12.2) | 3 055 (8.8) | 6 494 (8.8) |
| 21A | 92 (17.7) | 34 (93.9) | 1 (100.0) | - | 4 (52.3) | - (100.0) |
| 21B | 141 (38.6) | 23 (62.5) | - | - | 19 (55.3) | 3 (100.0) |
| 22 | 597 (24.4) | 136 (35.1) | 23 (57.1) | - | 113 (22.3) | 18 (62.8) |
| 23 | 15 (100.0) | 8 (100.0) | - | - | - | - |
| 24 | 29 (50.1) | - | - | - | - | - |
| 25 | 574 (47.8) | 13 (100.0) | 10 (100.0) | - | 48 (48.3) | 10 (66.1) |
| 26 | 324 (20.6) | - | 19 (100.0) | - | 101 (44.3) | - |
| 27 | 397 (12.0) | - | - | - | 306 (28.8) | - |
| 28 | 35 (70.5) | - | - | - | 9 (100.0) | - |
| 29 | - | - | - | - | 6 (100.0) | - |
| 30 | 15 (100.0) | - | - | - | 12 (57.8) | - |
| Deep | 2 218 (13.9) | 213 (16.4) | 53 (7.2) | - (12.2) | 618 (7.9) | 30 (8.8) |
| Total | 116 732 (13.9) | 1 512 (16.4) | 10 254 (7.2) | 12 129 (12.2) | 3 673 (7.9) | 6 524 (8.8) |

Table 7a (continued)

| Stratum | Species code | | | | | |
|---------|--------------|--------------|---------------|--------------|--------------|------------|
| | SPE | SPD | SWA | WWA | GIZ | RIB |
| 1 | 1 (100.0) | 4 (100.0) | - | - | 8 (100.0) | 50 (29.1) |
| 2A | 18 (58.4) | - | - | - | - | 75 (4.6) |
| 2B | 58 (11.4) | - | - | - | - | 21 (23.8) |
| 3 | 129 (34.0) | 312 (35.3) | 79 (19.3) | 18 (80.8) | 32 (100.0) | - |
| 4 | 8 (100.0) | - | - | - | 19 (100.0) | 117 (58.4) |
| 5 | 86 (31.6) | 1 072 (18.1) | 865 (42.6) | 197 (29.1) | 58 (91.0) | - |
| 6 | 47 (61.1) | - | 9 (100.0) | - | 12 (100.0) | 29 (51.0) |
| 7A | 139 (47.0) | 158 (70.9) | 9 (55.7) | 7 (50.1) | 19 (43.5) | 28 (45.4) |
| 7B | 20 (36.0) | 14 (53.3) | - | 1 (100.0) | 19 (81.7) | 1 (100.0) |
| 8A | 116 (30.7) | 82 (51.7) | - | 5 (87.5) | 1 (100.0) | - |
| 8B | 182 (64.0) | 135 (71.7) | - | - | 7 (100.0) | - |
| 9 | 202 (47.1) | 152 (82.3) | 764 (68.0) | 89 (51.6) | 293 (34.8) | - |
| 10 | 158 (65.2) | 146 (100.0) | 7 (100.0) | 7 (100.0) | 12 (100.0) | 25 (71.9) |
| 11 | 286 (32.0) | 663 (52.4) | 836 (67.2) | 120 (49.2) | 277 (33.7) | 3 (100.0) |
| 12 | 116 (80.4) | 548 (51.3) | 232 (20.3) | 62 (75.5) | 394 (74.5) | - |
| 13 | 71 (32.7) | 497 (70.5) | 80 (85.4) | 18 (100.0) | 45 (100.0) | 9 (100.0) |
| 14 | 126 (20.0) | 393 (54.4) | 56 (100.0) | - (100.0) | 50 (52.7) | 23 (100.0) |
| 15 | 247 (58.6) | 228 (25.8) | 971 (80.8) | 876 (56.8) | 146 (36.5) | - |
| 16 | 136 (29.8) | 153 (25.5) | 1 180 (28.4) | 941 (41.0) | 221 (20.6) | 25 (52.0) |
| 17 | 16 (21.5) | 42 (30.9) | 29 (74.0) | 3 (83.8) | 45 (11.3) | - |
| 18 | 336 (23.4) | 332 (23.7) | 6 239 (42.2) | 68 (51.3) | 182 (46.9) | - |
| 19 | 897 (28.0) | 402 (13.5) | 833 (60.3) | 27 (43.8) | 194 (33.9) | - |
| 20 | 593 (23.4) | 575 (23.2) | 2 795 (85.3) | 321 (33.0) | 194 (68.0) | - |
| Core | 3 989 (10.4) | 5 908 (12.1) | 14 983 (25.3) | 2 760 (23.5) | 2 228 (17.2) | 407 (19.7) |
| 21A | 1 (100.0) | - | - | - | - | 5 (34.1) |
| 21B | - | - | - | - | - | 57 (18.7) |
| 22 | 8 (100.0) | - | - | - | 11 (100.0) | 49 (31.4) |
| 23 | - | - | - | - | - | - |
| 24 | - | - | - | - | - | - |
| 25 | - | - | - | - | - | 39 (41.1) |
| 26 | - | - | - | - | - | - |
| 27 | - | - | - | - | - | - |
| 28 | - | - | - | - | - | - |
| 29 | - | - | - | - | - | - |
| 30 | - | - | - | - | - | - |
| Deep | 8 (10.4) | - (12.1) | - (25.3) | - (23.5) | 11 (17.1) | 150 (15.1) |
| Total | 3 997 (10.4) | 5 908 (12.1) | 14 983 (25.3) | 2 760 (23.5) | 2 240 (17.1) | 557 (15.1) |

Table 7a (continued)

| Stratum | Species code | | | | | |
|---------|---------------|--------------|--------------|--------------|--------------|--------------|
| | BOE | SSO | SOR | SND | CYP | ETB |
| 1 | - | - | 29 (51.7) | 633 (61.9) | 106 (50.2) | 4 (82.2) |
| 2A | - | 2 (100.0) | 84 (16.4) | 1 652 (59.4) | 706 (24.0) | - |
| 2B | - | 9 (100.0) | 2 925 (38.8) | 2 113 (30.6) | 67 (58.2) | - |
| 3 | - | - | - | - | - | - |
| 4 | 1 391 (93.2) | 4 (100.0) | 1 236 (37.9) | 1 128 (17.0) | - | 4 (62.1) |
| 5 | - | - | - | - | - | - |
| 6 | 15 587 (11.6) | 539 (97.5) | - | - | - | 258 (31.6) |
| 7A | - | - | 1 (100.0) | 177 (81.6) | 6 (90.8) | 1 (100.0) |
| 7B | - | - | - | 2 (100.0) | - | - |
| 8A | - | - | - | 36 (100.0) | - | - |
| 8B | - | - | - | 21 (100.0) | - | - |
| 9 | - | - | - | - | - | - |
| 10 | - | - | 62 (100.0) | 110 (68.5) | - | - |
| 11 | - | - | 2 (100.0) | 7 (100.0) | - | - |
| 12 | - | - | - | 15 (100.0) | - | - |
| 13 | - | - | - | - | - | 45 (100.0) |
| 14 | - | - | - | - | - | 3 (74.9) |
| 15 | - | - | - | 32 (100.0) | - | 56 (100.0) |
| 16 | 3 (57.6) | - | - | 36 (51.9) | - | 49 (63.6) |
| 17 | - | - | - | - | - | - |
| 18 | - | - | - | - | - | - |
| 19 | - | - | - | - | - | - |
| 20 | - | - | - | - | - | - |
| Core | 16 981 (13.1) | 555 (94.7) | 4 339 (28.3) | 5 962 (21.2) | 886 (20.6) | 420 (26.9) |
| 21A | - | 3 (71.5) | 8 (16.1) | 116 (31.7) | 36 (14.7) | 8 (100.0) |
| 21B | - | 20 (36.1) | 275 (56.6) | 1 414 (36.3) | 1 103 (27.1) | 6 (100.0) |
| 22 | 1 (67.1) | 28 (47.5) | 87 (36.9) | 230 (23.0) | 247 (13.0) | 6 (40.6) |
| 23 | 2 (100.0) | 31 (40.0) | 2 (100.0) | 26 (68.7) | 14 (62.5) | 79 (33.3) |
| 24 | - | 2 (28.7) | 4 (100.0) | 134 (40.2) | 48 (57.7) | 48 (35.1) |
| 25 | 2 040 (100.0) | 40 (67.7) | 25 (45.2) | 1 612 (37.6) | 634 (36.7) | 371 (100.0) |
| 26 | 1 109 (37.3) | 1 329 (44.7) | - | 18 (69.7) | 47 (14.2) | 292 (31.2) |
| 27 | 4 574 (37.6) | 6 538 (60.6) | - | - | 20 (60.3) | 335 (45.4) |
| 28 | 136 (100.0) | 42 (50.1) | 1 (100.0) | 55 (100.0) | 6 (100.0) | 358 (10.0) |
| 29 | 40 (60.0) | 1 131 (97.3) | - | - | - | 238 (21.4) |
| 30 | 170 (60.5) | 17 (33.8) | - | - | - | 365 (19.2) |
| Deep | 8 070 (14.0) | 9 180 (43.0) | 402 (26.2) | 3 605 (15.7) | 2 154 (13.9) | 2 107 (17.3) |
| Total | 25 052 (14.0) | 9 735 (43.0) | 4 742 (26.2) | 9 568 (15.7) | 3 040 (13.9) | 2 527 (17.3) |

Table 7a (continued)

| Stratum | Species code | | | | | |
|---------|--------------|--------------|--------------|--------------|---------------|---------------|
| | SBI | SSM | BEE | CSU | CBO | JAV |
| 1 | - | 33 (100.0) | - | 4 (96.2) | 147 (42.4) | 129 (48.6) |
| 2A | - | 3 (100.0) | - | - | - | 811 (50.7) |
| 2B | - | - | - | 1 (100.0) | 122 (42.2) | 960 (44.2) |
| 3 | - | - | - | - | 571 (40.0) | 493 (40.5) |
| 4 | - | - | - | - | 597 (25.7) | 555 (16.0) |
| 5 | - | - | - | - | 288 (16.8) | 496 (39.7) |
| 6 | - | - | 22 (100.0) | - | 634 (68.0) | 1 056 (64.2) |
| 7A | - | - | - | - | 412 (20.9) | 390 (24.8) |
| 7B | - | - | - | - | 49 (12.4) | 37 (64.1) |
| 8A | - | - | - | - | 46 (22.3) | 245 (45.7) |
| 8B | - | - | - | - | 342 (45.4) | 300 (26.3) |
| 9 | - | - | - | - | - | 39 (96.2) |
| 10 | - | - | - | - | 278 (67.5) | 1 019 (79.8) |
| 11 | - | - | - | - | 1 033 (28.1) | 754 (34.1) |
| 12 | - | - | - | - | 1 478 (66.7) | 712 (43.3) |
| 13 | - | - | - | - | 1 068 (74.0) | 712 (84.8) |
| 14 | - | - | - | - | 495 (15.4) | 503 (32.9) |
| 15 | - | - | - | - | 1 165 (20.5) | 330 (48.4) |
| 16 | - | - | - | - | 2 159 (8.5) | 1 040 (29.9) |
| 17 | - | - | - | - | 8 (95.9) | 88 (62.7) |
| 18 | - | - | - | - | 46 (58.6) | 106 (36.5) |
| 19 | - | - | - | - | 340 (54.2) | 127 (38.5) |
| 20 | - | - | - | - | 631 (29.1) | 439 (28.7) |
| Core | - | 36 (92.9) | 22 (100.0) | 5 (82.3) | 11 909 (12.4) | 11 340 (13.3) |
| 21A | 6 (100.0) | - | 15 (83.5) | 85 (96.0) | - | 12 (70.3) |
| 21B | 40 (100.0) | 19 (100.0) | - | 362 (38.9) | - | 57 (61.7) |
| 22 | 15 (60.0) | 99 (84.7) | 49 (51.7) | 164 (54.0) | 17 (48.8) | 37 (59.1) |
| 23 | 931 (15.0) | 262 (17.8) | 484 (12.4) | 1 261 (70.6) | - | 1 (100.0) |
| 24 | 258 (39.0) | 2 (100.0) | 187 (33.7) | 67 (36.1) | - | - |
| 25 | - | - | 10 (100.0) | 9 (37.2) | 2 (100.0) | 298 (19.4) |
| 26 | - | 101 (43.1) | 24 (74.8) | 7 (85.2) | - | 224 (39.1) |
| 27 | 4 (100.0) | 155 (48.6) | 123 (59.5) | 1 (60.8) | - | 43 (50.1) |
| 28 | 841 (71.5) | 1 029 (52.5) | 505 (35.6) | 26 (94.7) | 3 (100.0) | 2 (100.0) |
| 29 | 770 (4.7) | 200 (33.3) | 406 (6.1) | 7 (100.0) | - | - |
| 30 | 257 (33.6) | 814 (48.1) | 406 (15.6) | - | 2 (100.0) | - (100.0) |
| Deep | 3 121 (20.3) | 2 681 (25.2) | 2 220 (10.2) | 1 995 (45.7) | 24 (12.4) | 675 (12.6) |
| Total | 3 121 (20.3) | 2 716 (25.2) | 2 231 (10.2) | 1 994 (45.7) | 11 933 (12.4) | 12 014 (12.6) |

Table 7b: Estimated relative biomass (t) and coefficient of variation (% CV) for pre-recruit (nominally < 20 cm SL), 20–30 cm, recruited (nominally > 30 cm SL), and total orange roughy. Core, total biomass from valid core tows (200–800 m; Deep, total biomass from valid deep tows (800–1300 m); Total, total biomass from all valid tows (200–1300 m); –, no data.

| Stratum | < 20 cm | 20–30 cm | ≥30 cm | Total |
|---------|------------|------------|--------------|--------------|
| 1 | - | - | - | - |
| 2A | 2 (100.0) | 4 (100.0) | 3 (100.0) | 9 (65.0) |
| 2B | - | - | - | - |
| 3 | - | - | - | - |
| 4 | - | - | - | - |
| 5 | - | - | - | - |
| 6 | - | - | - | - |
| 7A | - | - | - | - |
| 7B | - | - | - | - |
| 8A | - | - | - | - |
| 8B | - | - | 5 (100.0) | 5 (100.0) |
| 9 | - | - | - | - |
| 10 | - | - | - | - |
| 11 | - | - | - | - |
| 12 | - | - | - | - |
| 13 | - | - | - | - |
| 14 | - | - | - | - |
| 15 | - | - | - | - |
| 16 | - | - | - | - |
| 17 | - | - | - | - |
| 18 | - | - | - | - |
| 19 | - | - | - | - |
| 20 | - | - | - | - |
| Core | 2 (100.0) | 4 (100.0) | 8 (72.7) | 14 (54.6) |
| 21A | 1 (100.0) | 34 (97.3) | 29 (100.0) | 64 (98.6) |
| 21B | 3 (74.4) | 78 (18.2) | 203 (7.6) | 285 (7.6) |
| 22 | 2 (64.6) | 48 (38.9) | 403 (39.5) | 453 (37.5) |
| 23 | 56 (100.0) | 169 (91.3) | 3 123 (78.8) | 3 348 (79.7) |
| 24 | 1 (100.0) | 53 (57.6) | 636 (31.1) | 689 (31.7) |
| 25 | 9 (51.9) | 74 (61.5) | 84 (49.7) | 168 (54.3) |
| 26 | - | - | - | - |
| 27 | - | - | - | - |
| 28 | - | 8 (59.8) | 8 (100.0) | 16 (58.1) |
| 29 | - | - | - | - |
| 30 | - | - | - | - |
| Deep | 71 (78.3) | 464 (36.4) | 4 487 (55.1) | 5 023 (53.5) |
| Total | 74 (75.7) | 468 (36.0) | 4 495 (55.0) | 5 037 (53.3) |

Table 8: Total numbers of fish, squid and scampi measured for length frequency distributions and biological samples from all tows. The total number of fish measured is sometimes greater than the sum of males and females because some fish were unsexed.

| | Species code | Number measured Males | Number measured Females | Number measured Total | Number of biological samples |
|------------------------------------|--------------|-----------------------|-------------------------|-----------------------|------------------------------|
| Alfonsino | BYS | 458 | 402 | 886 | 411 |
| Banded bellowsfish | BBE | 1 | 21 | 2 195 | 405 |
| Banded rattail | CFA | 333 | 936 | 1 295 | 516 |
| Banded stargazer | BGZ | 1 | 1 | 2 | 2 |
| Barracouta | BAR | 50 | 28 | 78 | 53 |
| Basketwork eel | BEE | 194 | 486 | 823 | 348 |
| Baxter's lantern dogfish | ETB | 340 | 337 | 679 | 546 |
| Bigeye cardinalfish | EPL | 32 | 15 | 61 | 27 |
| Big-scale pomfret | BSP | 0 | 2 | 2 | 2 |
| Bigscaled brown slickhead | SBI | 423 | 797 | 1 222 | 754 |
| Black ghost shark | HYB | 2 | 0 | 2 | 2 |
| Black oreo | BOE | 1 133 | 1 199 | 2 335 | 396 |
| Black javelinfish | BJA | 56 | 51 | 111 | 40 |
| Black slickhead | BSL | 189 | 235 | 441 | 232 |
| Blackspot rattail | VNI | 0 | 0 | 6 | 6 |
| Blue mackerel | EMA | 0 | 1 | 1 | 1 |
| Bluenose | BNS | 9 | 14 | 23 | 23 |
| Bollons's rattail | CBO | 1 760 | 1 803 | 3 781 | 1 903 |
| Brown chimaera | CHP | 1 | 2 | 3 | 3 |
| Cape scorpionfish | TRS | 6 | 16 | 22 | 22 |
| Capro dory | CDO | 0 | 0 | 139 | 43 |
| Catshark (<i>Apristurus</i> spp.) | APR | 47 | 17 | 64 | 64 |
| Common roughy | RHY | 117 | 158 | 275 | 123 |
| Deepsea cardinalfish | EPT | 132 | 57 | 199 | 135 |
| Deepsea spiny (Arctic) skate | DSK | 0 | 1 | 1 | 1 |
| Four-rayed rattail | CSU | 423 | 761 | 1 989 | 608 |
| Frill shark | FRS | 0 | 2 | 2 | 2 |
| Frostfish | FRO | 2 | 0 | 2 | 2 |
| Gemfish | RSO | 0 | 1 | 1 | 1 |
| Ghost shark | GSH | 1 820 | 1 658 | 3 483 | 1 171 |
| Giant stargazer | GIZ | 150 | 178 | 329 | 307 |
| Greenback jack mackerel | JMD | 1 | 0 | 1 | 1 |
| Hairy conger | HCO | 2 | 2 | 17 | 4 |
| Hake | HAK | 115 | 106 | 221 | 221 |
| Hapuku | HAP | 5 | 6 | 11 | 11 |
| Hoki | HOK | 8 289 | 9 901 | 18 358 | 2 536 |
| Humpback rattail (slender rattail) | CBA | 0 | 8 | 8 | 8 |
| Javelin fish | JAV | 1 373 | 5 773 | 7 305 | 2 476 |
| Johnson's cod | HJO | 763 | 771 | 1 537 | 816 |
| Kaiyomaru rattail | CKA | 47 | 28 | 127 | 98 |
| Leafscale gulper shark | CSQ | 11 | 35 | 46 | 44 |
| Lemon sole | LSO | 39 | 49 | 89 | 89 |
| Ling | LIN | 893 | 884 | 1 779 | 1 469 |
| Longfinned beryx | BYD | 4 | 1 | 5 | 5 |
| Longnose velvet dogfish | CYP | 605 | 559 | 1 164 | 804 |
| Long-nosed chimaera | LCH | 273 | 234 | 508 | 428 |
| Longnosed deepsea skate | PSK | 1 | 0 | 1 | 1 |
| Lookdown dory | LDO | 1 766 | 2 232 | 4 117 | 2 121 |

Table 8 (continued)

| | Species code | Number measured Males | Number measured Females | Number measured Total | Number of biological samples |
|-----------------------------|--------------|-----------------------|-------------------------|-----------------------|------------------------------|
| Lucifer dogfish | ETL | 222 | 270 | 503 | 359 |
| Mahia rattail | CMA | 13 | 18 | 31 | 31 |
| Mirror dory | MDO | 1 | 7 | 8 | 8 |
| Murray's rattail | CMU | 0 | 5 | 5 | 5 |
| <i>Nezumia namatahi</i> | NNA | 1 | 3 | 4 | 4 |
| Northern spiny dogfish | NSD | 13 | 3 | 16 | 16 |
| Notable rattail | CIN | 132 | 245 | 697 | 296 |
| NZ southern arrow squid | NOS | 268 | 307 | 583 | 366 |
| Oblique banded rattail | CAS | 304 | 1 220 | 1 600 | 573 |
| Oliver's rattail | COL | 637 | 983 | 2 104 | 1 036 |
| Orange perch | OPE | 111 | 229 | 340 | 86 |
| Orange roughy | ORH | 672 | 727 | 1 423 | 873 |
| Owston's dogfish | CYO | 92 | 44 | 136 | 136 |
| Pale ghost shark | GSP | 552 | 559 | 1 114 | 842 |
| Plunket's shark | PLS | 4 | 5 | 9 | 9 |
| Pointynose blue ghost shark | HYP | 3 | 0 | 3 | 3 |
| Prickly dogfish | PDG | 7 | 4 | 11 | 10 |
| Ray's bream | RBM | 1 | 0 | 1 | 1 |
| Red cod | RCO | 307 | 156 | 465 | 264 |
| Redbait | RBT | 3 | 2 | 5 | 5 |
| Ribaldo | RIB | 115 | 66 | 181 | 169 |
| Ridge scaled rattail | MCA | 493 | 277 | 785 | 584 |
| Roughhead rattail | CHY | 9 | 30 | 40 | 40 |
| Rough skate | RSK | 2 | 3 | 5 | 5 |
| Ruby fish | RBY | 1 | 1 | 2 | 2 |
| Rudderfish | RUD | 26 | 12 | 38 | 38 |
| Scampi | SCI | 53 | 41 | 95 | 95 |
| School shark | SCH | 10 | 8 | 18 | 18 |
| Sea perch | SPE | 1 801 | 1 654 | 3 537 | 1 467 |
| Seal shark | BSH | 26 | 31 | 57 | 57 |
| Serrulate rattail | CSE | 141 | 114 | 277 | 234 |
| Shovelnose spiny dogfish | SND | 815 | 787 | 1 605 | 766 |
| Silver dory | SDO | 158 | 88 | 248 | 61 |
| Silver roughy | SRH | 30 | 31 | 211 | 89 |
| Silver warehou | SWA | 1 150 | 915 | 2 068 | 731 |
| Silverside | SSI | 104 | 61 | 1 020 | 181 |
| Sixgill shark | HEX | 1 | 1 | 2 | 2 |
| Slender jack mackerel | JMM | 32 | 27 | 59 | 59 |
| Small banded rattail | CCX | 41 | 25 | 173 | 94 |
| Small-headed cod | SMC | 18 | 14 | 32 | 32 |
| Smallscaled brown slickhead | SSM | 377 | 506 | 886 | 623 |
| Smooth deepsea skate | BTA | 1 | 0 | 1 | 1 |
| Smooth oreo | SSO | 836 | 643 | 1 481 | 429 |
| Smooth skate | SSK | 24 | 30 | 54 | 48 |
| Southern blue whiting | SBW | 57 | 34 | 91 | 75 |
| Southern rays bream | SRB | 105 | 101 | 207 | 177 |
| Spiky oreo | SOR | 625 | 639 | 1 272 | 534 |
| Spineback | SBK | 41 | 592 | 661 | 479 |
| Spiny dogfish | SPD | 381 | 1 117 | 1 499 | 944 |
| Spotty faced rattail | CTH | 3 | 12 | 15 | 15 |

Table 8 (continued)

| | Species code | Number measured Males | Number measured Females | Number measured Total | Number of biological samples |
|------------------------------|--------------|-----------------------|-------------------------|-----------------------|------------------------------|
| Striate rattail | CTR | 1 | 3 | 4 | 4 |
| Swollenhead conger | SCO | 1 | 4 | 14 | 8 |
| <i>Taningia</i> spp. (squid) | TDQ | 0 | 0 | 2 | 2 |
| Tarakihi | NMP | 11 | 10 | 21 | 21 |
| Thin tongue cardinalfish | EPM | 24 | 7 | 61 | 61 |
| Two saddle rattail | CBI | 207 | 146 | 354 | 211 |
| Unicorn rattail | WHR | 6 | 15 | 22 | 22 |
| Velvet rattail | TRX | 0 | 1 | 1 | 1 |
| Violet cod | VCO | 144 | 104 | 248 | 163 |
| Warty oreo | WOE | 33 | 29 | 62 | 62 |
| White rattail | WHX | 220 | 188 | 408 | 361 |
| White warehou | WWA | 429 | 349 | 798 | 449 |
| Widenosed chimaera | RCH | 80 | 84 | 165 | 142 |
| Total | | 33 839 | 43 354 | 83 584 | 33 760 |

Table 9: Length-weight regression parameters* used to scale length frequencies (all data from TAN1601). Length measurement method: TL, total length; FL, fork length, CL, chimaera length; SL, standard length.

| Species | a (intercept) | b (slope) | r^2 | n | Length range (cm) | Length measurement |
|-----------------------------|-----------------|-------------|-------|-------|-------------------|--------------------|
| Baxter's dogfish | 0.003310 | 3.109395 | 0.99 | 508 | 20–78 | TL |
| Basketwork eel | 0.000651 | 3.120626 | 0.92 | 255 | 59–126 | TL |
| Bigscaled brown slickhead | 0.004124 | 3.213271 | 0.96 | 361 | 26–58 | FL |
| Black oreo | 0.029557 | 2.895911 | 0.89 | 395 | 23–39 | TL |
| Bollons's rattail | 0.001570 | 3.325815 | 0.95 | 1 275 | 23–61 | TL |
| Dark ghost shark | 0.003607 | 3.126585 | 0.95 | 825 | 28–73 | CL |
| Four-rayed rattail | 0.024715 | 2.283233 | 0.67 | 311 | 23–39 | TL |
| Giant stargazer | 0.006519 | 3.232007 | 0.99 | 303 | 15–82 | TL |
| Hake | 0.002120 | 3.273983 | 0.98 | 218 | 38–128 | TL |
| Hoki | 0.004294 | 2.915508 | 0.99 | 2 241 | 36–111 | TL |
| Javelinfish | 0.001068 | 3.211086 | 0.97 | 1 402 | 19–65 | TL |
| Ling | 0.001596 | 3.242461 | 0.99 | 1 356 | 26–154 | TL |
| Longnose velvet dogfish | 0.002322 | 3.149649 | 0.98 | 553 | 30–97 | TL |
| Lookdown dory | 0.029584 | 2.911942 | 0.98 | 1 479 | 12–55 | TL |
| Orange roughy | 0.045577 | 2.912915 | 0.99 | 509 | 8–41 | SL |
| Pale ghost shark | 0.008473 | 2.907834 | 0.96 | 779 | 34–90 | CL |
| Ribaldo | 0.004551 | 3.219431 | 0.97 | 147 | 25–71 | TL |
| Sea perch | 0.009084 | 3.167219 | 0.99 | 1 199 | 14–50 | TL |
| Silver warehou | 0.015135 | 3.066795 | 0.97 | 674 | 16–56 | FL |
| Shovelnose dogfish | 0.001848 | 3.154963 | 0.97 | 737 | 31–114 | TL |
| Smallscaled brown slickhead | 0.008002 | 3.028016 | 0.98 | 438 | 22–69 | FL |
| Smooth oreo | 0.018479 | 3.067592 | 0.98 | 361 | 17–51 | TL |
| Spiny dogfish | 0.000848 | 3.392260 | 0.94 | 768 | 50–102 | TL |
| Spiky oreo | 0.025901 | 2.962600 | 0.99 | 478 | 10–43 | TL |
| White warehou | 0.012580 | 3.165014 | 0.99 | 433 | 14–60 | FL |

* $W = aL^b$ where W is weight (g) and L is length (cm); r^2 is the correlation coefficient, n is the sample size.

Table 10: Numbers of fish measured at each reproductive stage. MD, middle depths staging method; SS, Cartilaginous fish gonad stages — see footnote below table for staging details. —, no data.

| Common name | Sex | Staging method | Reproductive stage | | | | | | | Total |
|---------------------------|--------|----------------|--------------------|------|-----|----|----|---|----|-------|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| Alfonsino | Male | MD | 106 | 46 | 12 | — | — | — | — | 164 |
| | Female | | 79 | 49 | 1 | — | — | — | — | 129 |
| Banded rattail | Male | MD | 9 | 16 | 1 | — | — | — | — | 26 |
| | Female | | 12 | 35 | — | — | — | — | — | 47 |
| Banded stargazer | Male | MD | — | 1 | — | — | — | — | — | 1 |
| | Female | | — | 1 | — | — | — | — | — | 1 |
| Barracouta | Male | MD | — | 7 | 1 | 7 | 14 | 2 | 1 | 38 |
| | Female | | — | 5 | 16 | — | — | — | — | 21 |
| Basketwork eel | Male | MD | 11 | 12 | 1 | — | — | — | — | 24 |
| | Female | | 3 | 37 | 10 | — | — | — | — | 50 |
| Baxter's dogfish | Male | SS | 71 | 86 | 96 | — | — | — | — | 253 |
| | Female | | 139 | 99 | 42 | 2 | 6 | 1 | — | 289 |
| Bigscaled brown slickhead | Male | MD | 13 | 16 | 13 | 1 | — | — | 3 | 46 |
| | Female | | 18 | 20 | 53 | 8 | 2 | 1 | 3 | 105 |
| Black javelinfish | Male | MD | 4 | 13 | — | 1 | — | — | — | 18 |
| | Female | | 1 | 14 | — | — | — | — | — | 15 |
| Black slickhead | Male | MD | — | — | 10 | 5 | — | — | 2 | 17 |
| | Female | | — | — | 16 | 8 | — | — | — | 24 |
| Black oreo | Male | MD | 107 | 81 | 12 | 10 | — | — | 2 | 212 |
| | Female | | 67 | 50 | 63 | 1 | — | — | — | 181 |
| Blue mackerel | Male | MD | — | — | — | — | — | — | — | — |
| | Female | | — | — | 1 | — | — | — | — | 1 |
| Bluenose | Male | MD | 4 | 5 | — | — | — | — | — | 9 |
| | Female | | 9 | 3 | 2 | — | — | — | — | 14 |
| Bollons's rattail | Male | MD | 13 | 119 | 16 | — | — | — | — | 148 |
| | Female | | 21 | 110 | 11 | — | — | — | 2 | 142 |
| Cape scorpionfish | Male | MD | 2 | 2 | — | — | — | — | — | 4 |
| | Female | | 5 | 8 | — | — | — | — | — | 13 |
| Catshark | Male | SS | 2 | 9 | 5 | — | — | — | — | 16 |
| (<i>Apristurus</i> spp.) | Female | | 1 | — | 2 | — | — | — | — | 3 |
| Common roughy | Male | SS | — | 9 | 11 | 1 | — | — | — | 21 |
| | Female | | 1 | — | 1 | 17 | — | — | — | 19 |
| Dark ghost shark | Male | SS | 99 | 97 | 262 | — | — | — | — | 458 |
| | Female | | 184 | 188 | 46 | 6 | — | — | — | 424 |
| Deepsea cardinalfish | Male | MD | 24 | — | — | — | — | — | — | 24 |
| | Female | | 14 | 4 | — | — | — | — | — | 18 |
| Four-rayed rattail | Male | MD | 4 | 7 | — | — | — | — | — | 11 |
| | Female | | 1 | 13 | 9 | — | — | — | — | 23 |
| Frostfish | Male | MD | — | 1 | — | 1 | — | — | — | 2 |
| | Female | | — | — | — | — | — | — | — | — |
| Gemfish | Male | MD | — | — | — | — | — | — | — | — |
| | Female | | — | 1 | — | — | — | — | — | 1 |
| Giant stargazer | Male | MD | 45 | 100 | — | — | — | — | 1 | 146 |
| | Female | | 37 | 55 | 61 | — | — | 1 | 3 | 157 |
| Greenback jack mackerel | Male | MD | — | — | 1 | — | — | — | — | 1 |
| | Female | | — | — | — | — | — | — | — | — |
| Hake | Male | MD | 18 | 24 | 6 | 15 | 31 | 8 | 13 | 115 |
| | Female | | 31 | 37 | 30 | 1 | 1 | — | 4 | 104 |
| Hapuku | Male | MD | 2 | 3 | — | — | — | — | — | 5 |
| | Female | | 3 | 3 | — | — | — | — | — | 6 |
| Hoki | Male | MD | 456 | 319 | — | — | — | 2 | 1 | 778 |
| | Female | | 610 | 1113 | 5 | — | 1 | — | 9 | 1 738 |
| Humpback rattail | Male | MD | — | — | — | — | — | — | — | — |
| | Female | | — | 1 | — | — | — | — | — | 1 |
| Javelinfish | Male | MD | 30 | 57 | — | — | — | 2 | — | 89 |
| | Female | | 63 | 319 | 58 | — | — | — | 14 | 454 |

Table 10 (continued)

| Common name | Sex | Staging method | Reproductive stage | | | | | | | Total |
|---------------------------------------------|--------|----------------|--------------------|-----|-----|-----|---|-----|---|-------|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| Johnson's cod (<i>Halargyreus</i> spp.) | Male | MD | 34 | 43 | 42 | 18 | – | 1 | – | 138 |
| | Female | | 29 | 80 | 172 | – | – | – | – | 281 |
| Kaiyomaru rattail | Male | MD | – | 2 | – | – | – | – | – | 2 |
| | Female | | – | 2 | 2 | – | – | – | – | 4 |
| Leafscale gulper shark | Male | SS | 7 | – | 4 | – | – | – | – | 11 |
| | Female | | 5 | 8 | 15 | 3 | – | – | – | 31 |
| Lemon sole | Male | MD | 2 | 1 | – | – | – | – | – | 3 |
| | Female | | – | 2 | – | – | – | – | – | 2 |
| Ling | Male | MD | 306 | 180 | 100 | 124 | 7 | – | – | 717 |
| | Female | | 396 | 332 | 10 | 2 | – | – | – | 740 |
| Longfinned beryx | Male | MD | 3 | – | 1 | – | – | – | – | 4 |
| | Female | | – | 1 | – | – | – | – | – | 1 |
| Longnose spookfish | Male | SS | 52 | 29 | 130 | – | – | – | – | 211 |
| | Female | | 76 | 51 | 52 | – | – | – | – | 179 |
| Longnose velvet dogfish | Male | SS | 152 | 51 | 157 | – | – | – | – | 360 |
| | Female | | 146 | 84 | 41 | 21 | 9 | 1 | – | 302 |
| Longnosed deepsea skate | Male | MD | 1 | – | – | – | – | – | – | 1 |
| | Female | | – | – | – | – | – | – | – | – |
| Lookdown dory | Male | MD | 204 | 317 | 80 | 26 | 1 | – | – | 628 |
| | Female | | 247 | 209 | 270 | 1 | – | 215 | – | 744 |
| Lucifer dogfish | Male | SS | 13 | 28 | 70 | – | – | – | – | 111 |
| | Female | | 31 | 50 | 21 | 4 | 2 | 3 | – | 111 |
| Mirror dory | Male | MD | – | – | – | 1 | – | – | – | 1 |
| | Female | | – | – | 7 | – | – | – | – | 7 |
| <i>Nezumia namatahi</i> | Male | MD | – | 1 | – | – | – | – | – | 1 |
| | Female | | – | – | – | – | – | – | – | – |
| Northern spiny dogfish | Male | SS | – | 3 | 10 | – | – | – | – | 13 |
| | Female | | 2 | 1 | – | – | – | – | – | 3 |
| Notable rattail | Male | MD | – | 5 | 4 | – | – | – | – | 9 |
| | Female | | 5 | 8 | 14 | – | – | – | – | 27 |
| Oblique banded rattail | Male | MD | 3 | 7 | 1 | – | – | – | – | 11 |
| | Female | | 5 | 79 | – | – | – | – | – | 84 |
| Oliver's rattail | Male | MD | 1 | 29 | 5 | – | – | – | – | 35 |
| | Female | | 13 | 67 | 2 | – | – | – | – | 82 |
| Orange perch | Male | MD | – | 4 | 13 | 1 | 1 | – | – | 19 |
| | Female | | 2 | 10 | 12 | 5 | – | – | – | 29 |
| Orange roughy | Male | MD | 104 | 110 | 140 | – | – | – | – | 354 |
| | Female | | 78 | 25 | 268 | 2 | – | 2 | – | 375 |
| Pacific spookfish | Male | SS | 23 | 15 | 21 | – | – | – | – | 59 |
| | Female | | 28 | – | 5 | – | – | – | – | 33 |
| Pale ghost shark | Male | SS | 131 | 37 | 194 | – | – | – | – | 362 |
| | Female | | 173 | 163 | 70 | 3 | 2 | – | – | 406 |
| Plunket's shark | Male | SS | – | 2 | 1 | – | – | – | – | 3 |
| | Female | | 2 | 2 | 1 | – | – | – | – | 5 |
| Ray's bream | Male | MD | – | 1 | – | – | – | – | – | 1 |
| | Female | | – | – | – | – | – | – | – | – |
| Redbait | Male | MD | – | – | 1 | – | – | – | – | 1 |
| | Female | | – | – | 2 | – | – | – | – | 2 |
| Red cod | Male | MD | 49 | 20 | 18 | 32 | 6 | 5 | 6 | 136 |
| | Female | | 34 | 43 | 5 | 2 | – | – | – | 84 |
| Ribaldo | Male | MD | 6 | 61 | 36 | – | – | – | – | 103 |
| | Female | | 7 | 35 | – | – | – | – | 4 | 46 |
| Ridge scaled rattail | Male | MD | 134 | 74 | 13 | 1 | – | – | – | 222 |
| | Female | | 55 | 88 | 16 | – | – | – | – | 159 |
| Roughhead rattail | Male | MD | – | 1 | 4 | – | – | – | – | 5 |
| | Female | | 2 | – | 6 | 2 | – | – | – | 10 |

Table 10 (continued)

| Common name | Sex | Staging method | Reproductive stage | | | | | | | Total |
|-----------------------------|--------|----------------|--------------------|-----|-----|----|-----|---|----|-------|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| Rough skate | Male | SS | – | – | 1 | – | – | – | – | 1 |
| | Female | | – | 1 | – | – | 1 | – | – | 2 |
| Rubyfish | Male | MD | – | – | – | 1 | – | – | – | 1 |
| | Female | | – | – | 1 | – | – | – | – | 1 |
| Rudderfish | Male | MD | – | 4 | 4 | 5 | – | – | – | 13 |
| | Female | | – | 2 | 3 | – | 1 | – | – | 6 |
| School shark | Male | SS | – | 2 | 4 | – | – | – | – | 6 |
| | Female | | 2 | – | – | – | – | – | – | 2 |
| Sea perch | Male | MD | 91 | 353 | 64 | 1 | – | – | – | 509 |
| | Female | | 129 | 291 | 11 | 1 | 6 | 2 | 2 | 442 |
| Seal Shark | Male | SS | 25 | – | 1 | – | – | – | – | 26 |
| | Female | | 25 | 2 | 2 | – | – | – | – | 29 |
| Serrulate rattail | Male | MD | 3 | 11 | 8 | – | – | – | – | 22 |
| | Female | | 3 | 30 | 12 | – | – | – | – | 45 |
| Shovelnose dogfish | Male | SS | 27 | 46 | 346 | – | – | – | – | 419 |
| | Female | | 132 | 161 | 39 | 7 | 1 | 1 | – | 341 |
| Silver dory | Male | MD | 7 | 5 | 4 | – | – | – | – | 16 |
| | Female | | 12 | 5 | 2 | 3 | 1 | – | – | 23 |
| Silver warehou | Male | MD | 56 | 299 | 7 | – | – | 1 | – | 363 |
| | Female | | 35 | 253 | 17 | – | – | 1 | – | 306 |
| Sixgill shark | Male | SS | 1 | – | – | – | – | – | – | 1 |
| | Female | | – | – | – | – | – | – | – | – |
| Slender jack mackerel | Male | MD | 1 | 5 | 9 | 4 | 9 | – | – | 28 |
| | Female | | – | 2 | 17 | 2 | – | – | – | 21 |
| Sloan's arrow squid | Male | SQ | 1 | 23 | – | 11 | 21 | – | – | 56 |
| | Female | | 1 | 18 | 2 | 2 | 16 | – | – | 39 |
| Small-headed cod | Male | MD | – | 1 | – | – | – | – | – | 1 |
| | Female | | – | 2 | – | – | – | – | – | 2 |
| Smallscaled brown slickhead | Male | MD | 27 | 62 | 29 | 2 | – | – | – | 120 |
| | Female | | 18 | 102 | 13 | – | – | – | – | 133 |
| Smooth deepsea skate | Male | SS | – | – | 1 | – | – | – | – | 1 |
| | Female | | – | – | – | – | – | – | – | – |
| Smooth oreo | Male | MD | 76 | 33 | 36 | 21 | 21 | 6 | – | 196 |
| | Female | | 81 | 30 | 65 | 1 | – | – | – | 177 |
| Smooth skate | Male | SS | 12 | 10 | 1 | – | – | – | – | 33 |
| | Female | | 12 | 6 | 2 | – | – | – | – | 20 |
| Smooth skin dogfish | Male | SS | 12 | 6 | 71 | – | – | – | – | 99 |
| | Female | | 22 | 15 | 7 | – | – | – | – | 44 |
| Southern blue whiting | Male | MD | 6 | 40 | – | – | – | – | – | 46 |
| | Female | | 1 | 26 | – | – | – | – | – | 27 |
| Southern Ray's bream | Male | MD | 4 | 48 | 4 | – | – | – | – | 56 |
| | Female | | 1 | 29 | 15 | – | – | – | – | 45 |
| Spiky oreo | Male | MD | 95 | 90 | 28 | 4 | – | 2 | 16 | 235 |
| | Female | | 86 | 26 | 132 | 4 | 1 | 1 | 29 | 279 |
| Spineback | Male | SS | – | 3 | – | – | 2 | – | – | 5 |
| | Female | | 2 | 8 | 57 | 9 | 18 | – | 2 | 96 |
| Spiny dogfish | Male | SS | 5 | 29 | 134 | – | – | – | – | 168 |
| | Female | | 77 | 116 | 65 | 73 | 317 | 4 | – | 652 |
| Spotty faced rattail | Male | MD | – | – | – | – | – | – | – | – |
| | Female | | 1 | 1 | – | 1 | – | – | – | 3 |
| Striate rattail | Male | MD | 1 | – | – | – | – | – | – | 1 |
| | Female | | 2 | 1 | – | – | – | – | – | 3 |
| Swollenhead conger | Male | MD | – | 1 | – | – | – | – | – | 1 |
| | Female | | – | 1 | 1 | – | – | – | – | 2 |
| Tarakihi | Male | MD | – | 6 | 3 | – | – | – | 2 | 11 |
| | Female | | – | 9 | 1 | – | – | – | – | 10 |

Table 10 (continued)

| Common name | Sex | Staging method | Reproductive stage | | | | | | | Total |
|--------------------|--------|----------------|--------------------|-----|----|---|---|---|---|-------|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| Two saddle rattail | Male | MD | 1 | 3 | 15 | 1 | – | – | – | 20 |
| | Female | | 3 | 10 | 6 | 1 | – | – | 2 | 22 |
| Unicorn rattail | Male | MD | 3 | – | – | – | – | – | – | 3 |
| | Female | | 4 | 5 | – | – | – | – | – | 9 |
| Velvet rattail | Male | MD | – | – | – | – | – | – | – | – |
| | Female | | – | – | 1 | – | – | – | – | 1 |
| Violet rattail | Male | MD | 44 | 9 | 1 | – | 1 | – | – | 55 |
| | Female | | 27 | 27 | – | – | – | – | – | 54 |
| Warty oreo | Male | MD | 28 | 4 | – | – | – | – | – | 32 |
| | Female | | 21 | 7 | 1 | – | – | – | – | 29 |
| White rattail | Male | MD | 31 | 43 | 10 | – | – | – | 2 | 86 |
| | Female | | 10 | 58 | 14 | – | – | – | – | 82 |
| White warehou | Male | MD | 109 | 104 | 2 | – | – | – | – | 215 |
| | Female | | 97 | 56 | 20 | – | – | – | – | 173 |

Middle depths (MD) gonad stages: 1, immature; 2, resting; 3, ripening; 4, ripe; 5, running ripe; 6, partially spent; 7, spent (after Hurst et al. 1992).

Arrow squid (SQ) gonad stages: 1, immature unsexed; 2, immature sexed; 3, developing; 4, maturing; 5, mature; 6, spent.

Cartilaginous fish (SS) gonad stages: male – 1, immature; 2, maturing; 3, mature; female – 1, immature; 2, maturing; 3, mature; 4, gravid I; 5, gravid II; 6, post-partum.

Table 11: Average trawl catch (excluding benthic organisms) and acoustic backscatter from daytime core tows where acoustic data quality was suitable for echo integration on the Chatham Rise in 2001–16.

| Year | No. of recordings | Average trawl catch (kg km ⁻²) | Average acoustic backscatter (m ² km ⁻²) | | | |
|------|-------------------|--------------------------------------------|-----------------------------------------------------------------|-------------|-----------------------------|-----------------|
| | | | Bottom 10 m | Bottom 50 m | All bottom marks (to 100 m) | Entire echogram |
| 2001 | 117 | 1 858 | 3.63 | 22.39 | 31.80 | 57.60 |
| 2002 | 102 | 1 849 | 4.50 | 18.39 | 22.60 | 49.32 |
| 2003 | 117 | 1 508 | 3.43 | 19.56 | 29.41 | 53.22 |
| 2005 | 86 | 1 783 | 2.78 | 12.69 | 15.64 | 40.24 |
| 2006 | 88 | 1 782 | 3.24 | 13.19 | 19.46 | 48.86 |
| 2007 | 100 | 1 510 | 2.00 | 10.83 | 15.40 | 41.07 |
| 2008 | 103 | 2 012 | 2.03 | 9.65 | 13.23 | 37.98 |
| 2009 | 105 | 2 480 | 2.98 | 15.89 | 25.01 | 58.88 |
| 2010 | 90 | 2 205 | 1.87 | 10.80 | 17.68 | 44.49 |
| 2011 | 73 | 1 997 | 1.79 | 8.72 | 12.94 | 34.79 |
| 2012 | 85 | 1 793 | 2.60 | 15.96 | 26.36 | 54.77 |
| 2013 | 76 | 2 323 | 3.74 | 15.87 | 27.07 | 56.89 |
| 2014 | 48 | 1 790 | 3.15 | 14.96 | 24.42 | 48.45 |
| 2016 | 90 | 1 890 | 3.49 | 20.79 | 31.81 | 61.34 |

Table 12: Estimates of the proportion of total day backscatter in each stratum and year on the Chatham Rise which is assumed to be mesopelagic fish (*p(meso)s*). Estimates were derived from the observed proportion of night backscatter in the upper 200 m corrected for the proportion of backscatter estimated to be in the surface acoustic deadzone.

| Year | Stratum | | | |
|------|-----------|-----------|-----------|-----------|
| | Northeast | Northwest | Southeast | Southwest |
| 2001 | 0.64 | 0.83 | 0.81 | 0.88 |
| 2002 | 0.58 | 0.78 | 0.66 | 0.86 |
| 2003 | 0.67 | 0.82 | 0.81 | 0.77 |
| 2005 | 0.72 | 0.83 | 0.73 | 0.69 |
| 2006 | 0.69 | 0.77 | 0.76 | 0.80 |
| 2007 | 0.67 | 0.85 | 0.73 | 0.80 |
| 2008 | 0.61 | 0.64 | 0.84 | 0.85 |
| 2009 | 0.58 | 0.75 | 0.83 | 0.86 |
| 2010 | 0.48 | 0.64 | 0.76 | 0.63 |
| 2011 | 0.63 | 0.49 | 0.76 | 0.54 |
| 2012 | 0.40 | 0.52 | 0.68 | 0.79 |
| 2013 | 0.34 | 0.50 | 0.54 | 0.66 |
| 2014 | 0.54 | 0.62 | 0.74 | 0.78 |
| 2016 | 0.69 | 0.57 | 0.71 | 0.84 |

Table 13: Mesopelagic indices for the Chatham Rise. Indices were derived by multiplying the total backscatter observed at each daytime trawl station by the estimated proportion of night-time backscatter in the same sub-area observed in the upper 200 m (see Table 12) corrected for the estimated proportion in the surface deadzone (from O’Driscoll et al. 2009). Unstratified indices for the Chatham Rise were calculated as the unweighted average over all available acoustic data. Stratified indices were obtained as the weighted average of stratum estimates, where weighting was the proportional area of the stratum (northwest 11.3% of total area, southwest 18.7%, northeast 33.6%, southeast 36.4%).

| Survey | Year | Acoustic index (m ² km ⁻²) | | | | | | | | | | | | | |
|---------|------|---------------------------------------------------|----|-----------|----|-----------|----|-----------|----|-----------|----|------------|----|--|--|
| | | Unstratified | | Northeast | | Northwest | | Southeast | | Southwest | | Stratified | | | |
| | | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | | |
| tan0101 | 2002 | 47.1 | 8 | 21.8 | 11 | 61.1 | 13 | 36.8 | 12 | 92.6 | 16 | 44.9 | 8 | | |
| tan0201 | 2003 | 35.8 | 6 | 25.1 | 11 | 40.3 | 11 | 29.6 | 13 | 54.7 | 13 | 34.0 | 7 | | |
| tan0301 | 2004 | 40.6 | 10 | 30.3 | 23 | 32.0 | 12 | 52.4 | 19 | 53.9 | 11 | 42.9 | 10 | | |
| tan0501 | 2005 | 30.4 | 7 | 28.4 | 12 | 44.5 | 21 | 25.2 | 8 | 29.5 | 23 | 29.3 | 7 | | |
| tan0601 | 2006 | 37.0 | 6 | 30.7 | 10 | 47.9 | 12 | 38.1 | 12 | 36.7 | 19 | 36.4 | 7 | | |
| tan0701 | 2007 | 32.4 | 7 | 23.0 | 10 | 43.3 | 12 | 27.2 | 13 | 35.9 | 20 | 29.2 | 7 | | |
| tan0801 | 2008 | 29.1 | 6 | 17.8 | 5 | 27.9 | 19 | 38.1 | 10 | 36.2 | 12 | 29.8 | 6 | | |
| tan0901 | 2009 | 44.7 | 10 | 22.4 | 22 | 54.3 | 12 | 39.3 | 16 | 84.8 | 18 | 43.8 | 9 | | |
| tan1001 | 2010 | 27.0 | 8 | 16.5 | 11 | 33.4 | 11 | 35.1 | 17 | 34.0 | 24 | 28.5 | 10 | | |
| tan1101 | 2011 | 21.4 | 9 | 23.4 | 15 | 27.2 | 14 | 12.6 | 23 | 15.8 | 17 | 18.5 | 9 | | |
| tan1201 | 2012 | 30.8 | 8 | 17.6 | 13 | 41.1 | 34 | 33.5 | 11 | 51.1 | 12 | 32.3 | 8 | | |
| tan1301 | 2013 | 28.8 | 7 | 15.5 | 15 | 45.9 | 12 | 27.3 | 13 | 31.7 | 13 | 26.3 | 7 | | |
| tan1401 | 2014 | 31.7 | 9 | 19.4 | 8 | 37.6 | 12 | 35.8 | 18 | 44.6 | 24 | 32.1 | 10 | | |
| tan1601 | 2016 | 41.7 | 8 | 27.8 | 14 | 40.1 | 13 | 41.6 | 15 | 68.7 | 16 | 41.8 | 8 | | |

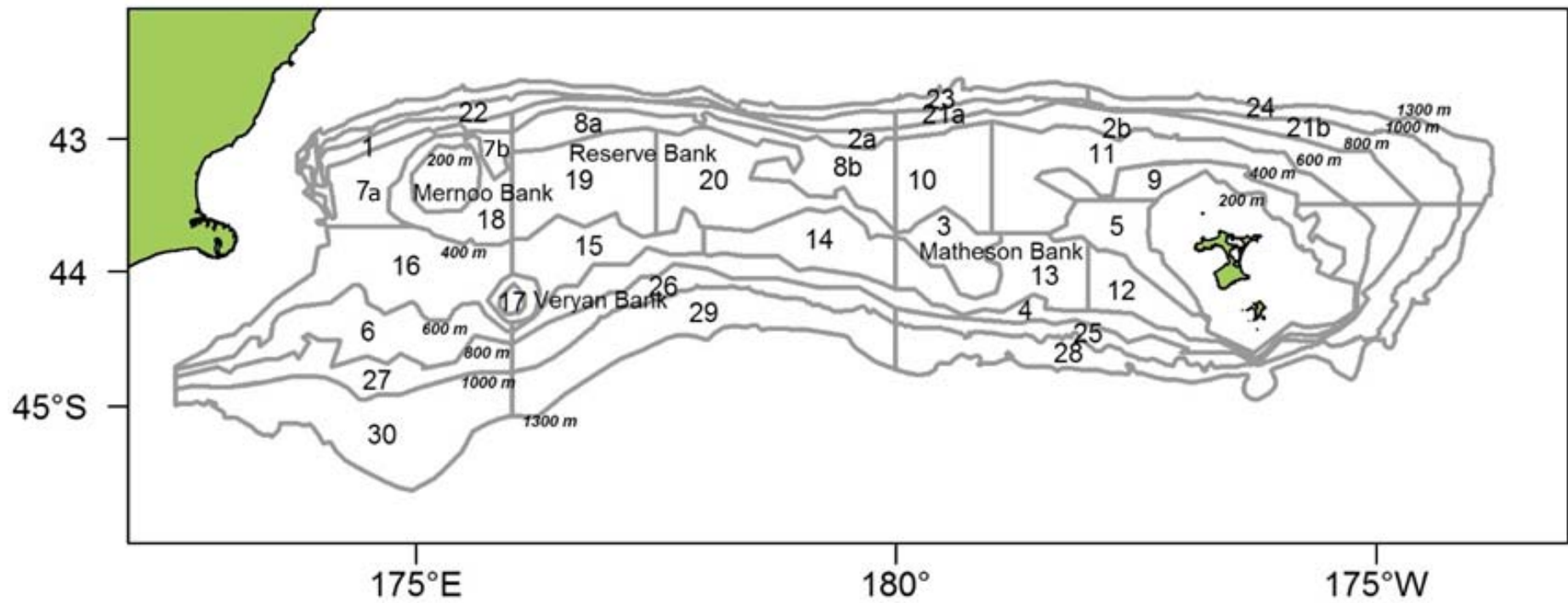


Figure 1: Chatham Rise trawl survey area showing stratum boundaries.

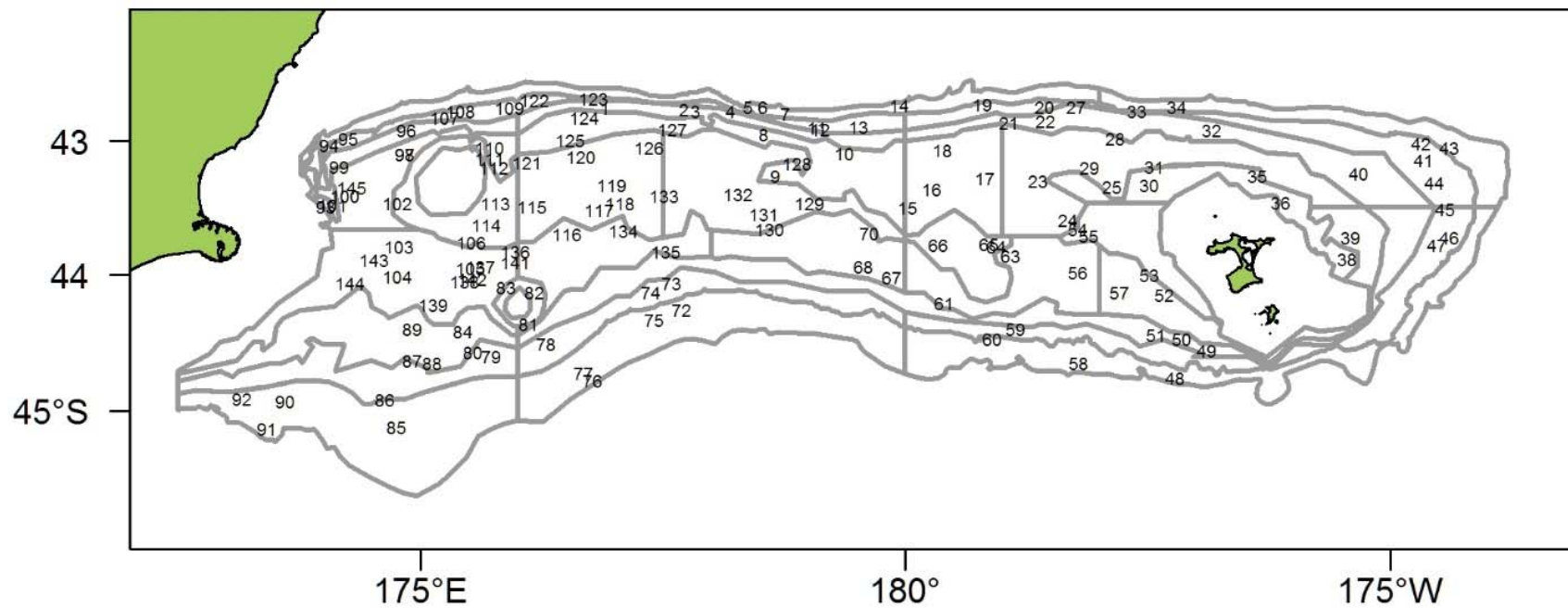


Figure 2: Trawl survey area showing positions of valid biomass stations (n = 139 stations) for TAN1601. In this and subsequent figures actual stratum boundaries are drawn for the deepwater strata. These boundaries sometimes overlap with existing core survey stratum boundaries.

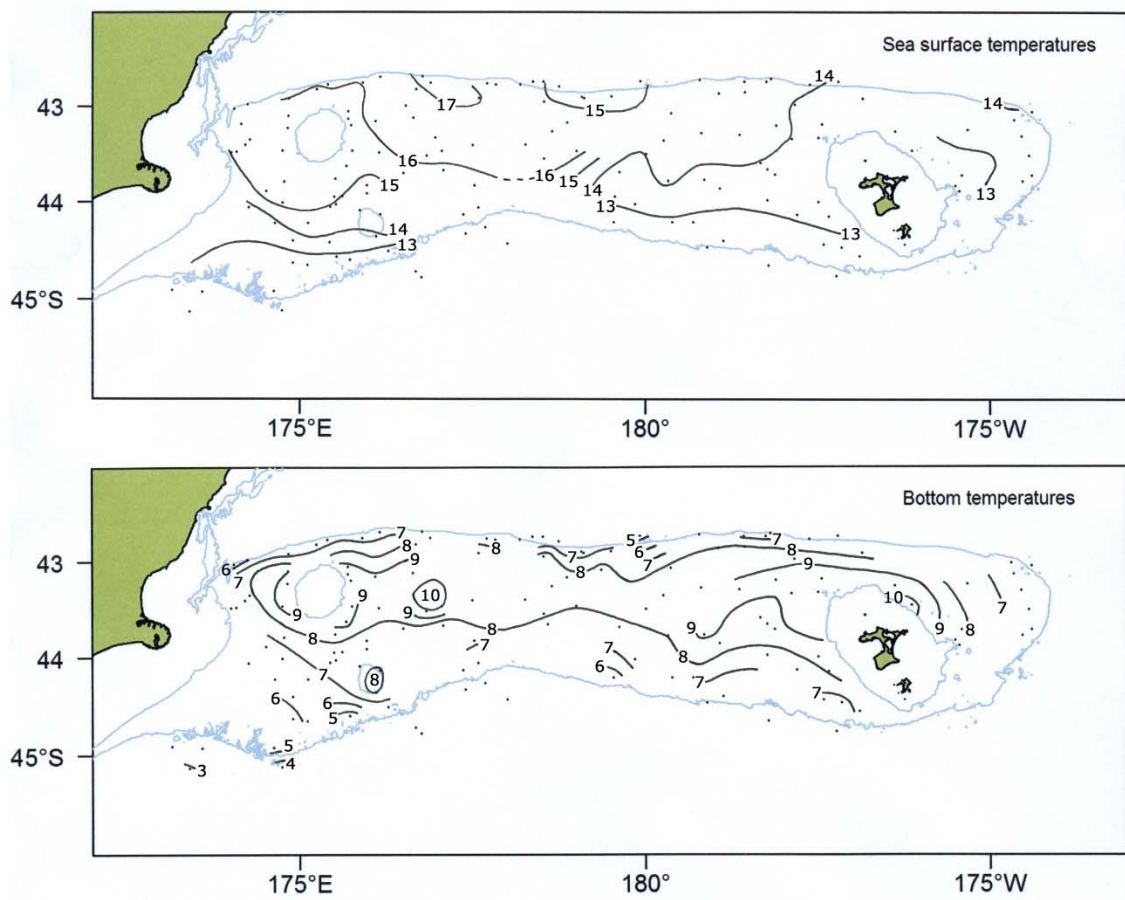


Figure 3: Positions of sea surface and bottom temperature recordings and approximate location of isotherms (°C) interpolated by eye for TAN1601. The temperatures shown are from the calibrated Seabird CTD recordings made during each tow.

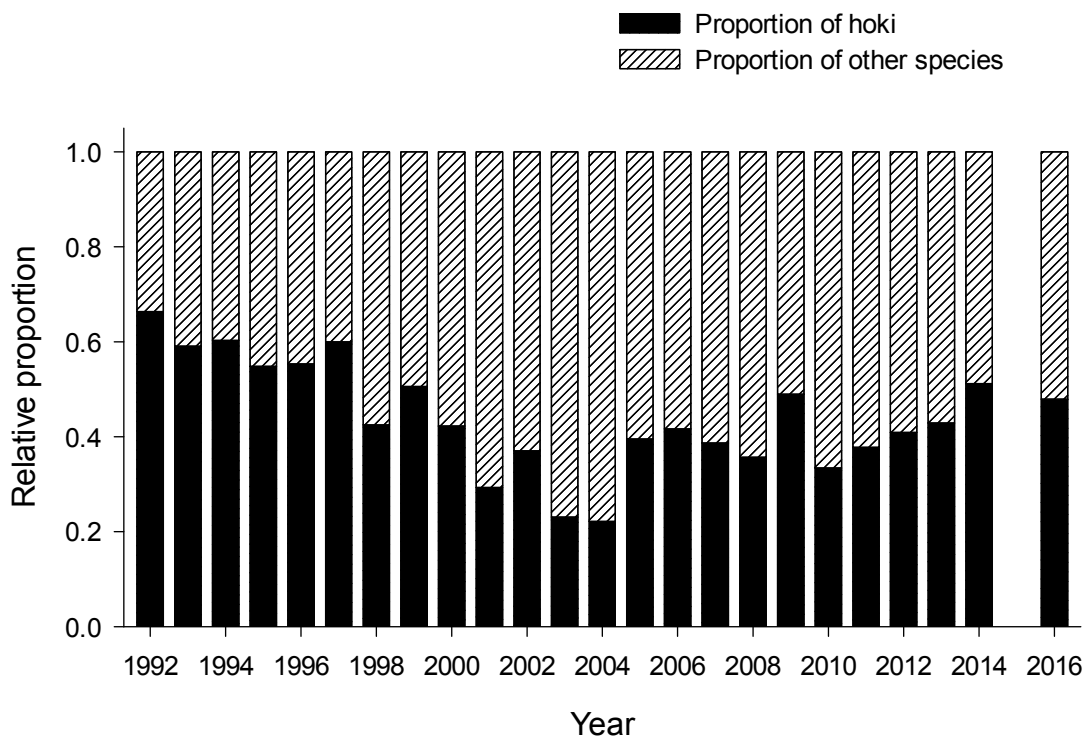
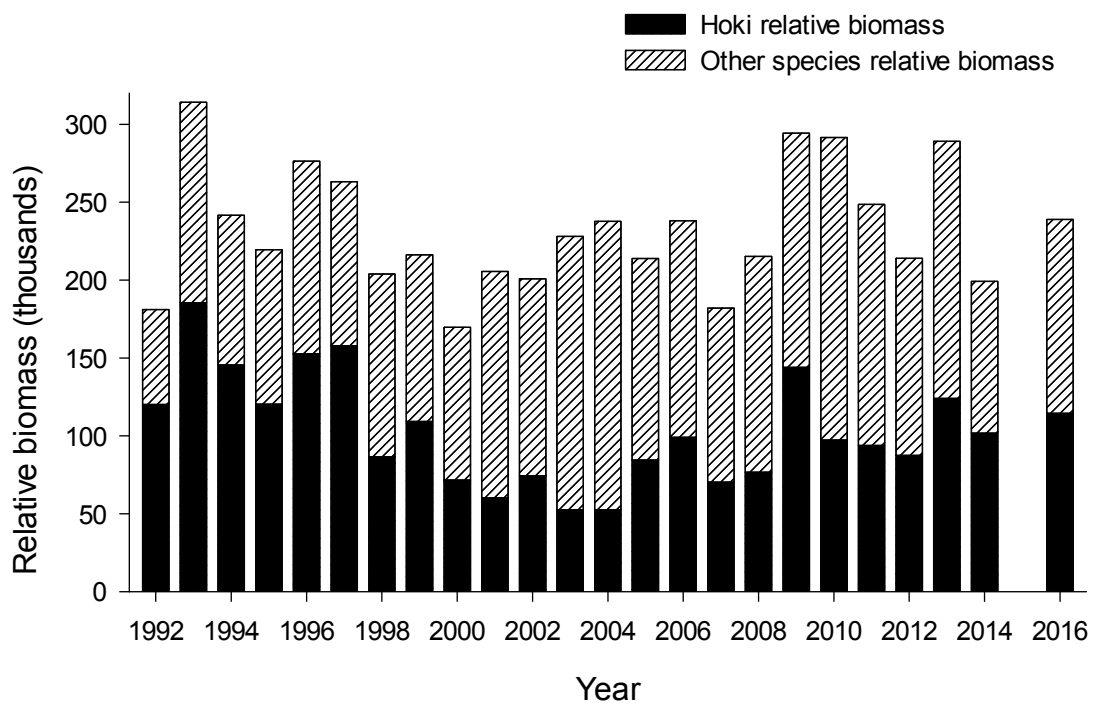


Figure 4: Relative biomass (top panel) and relative proportions of hoki and 30 other key species (lower panel) from trawl surveys of the Chatham Rise, January 1992–2016 (core strata only).

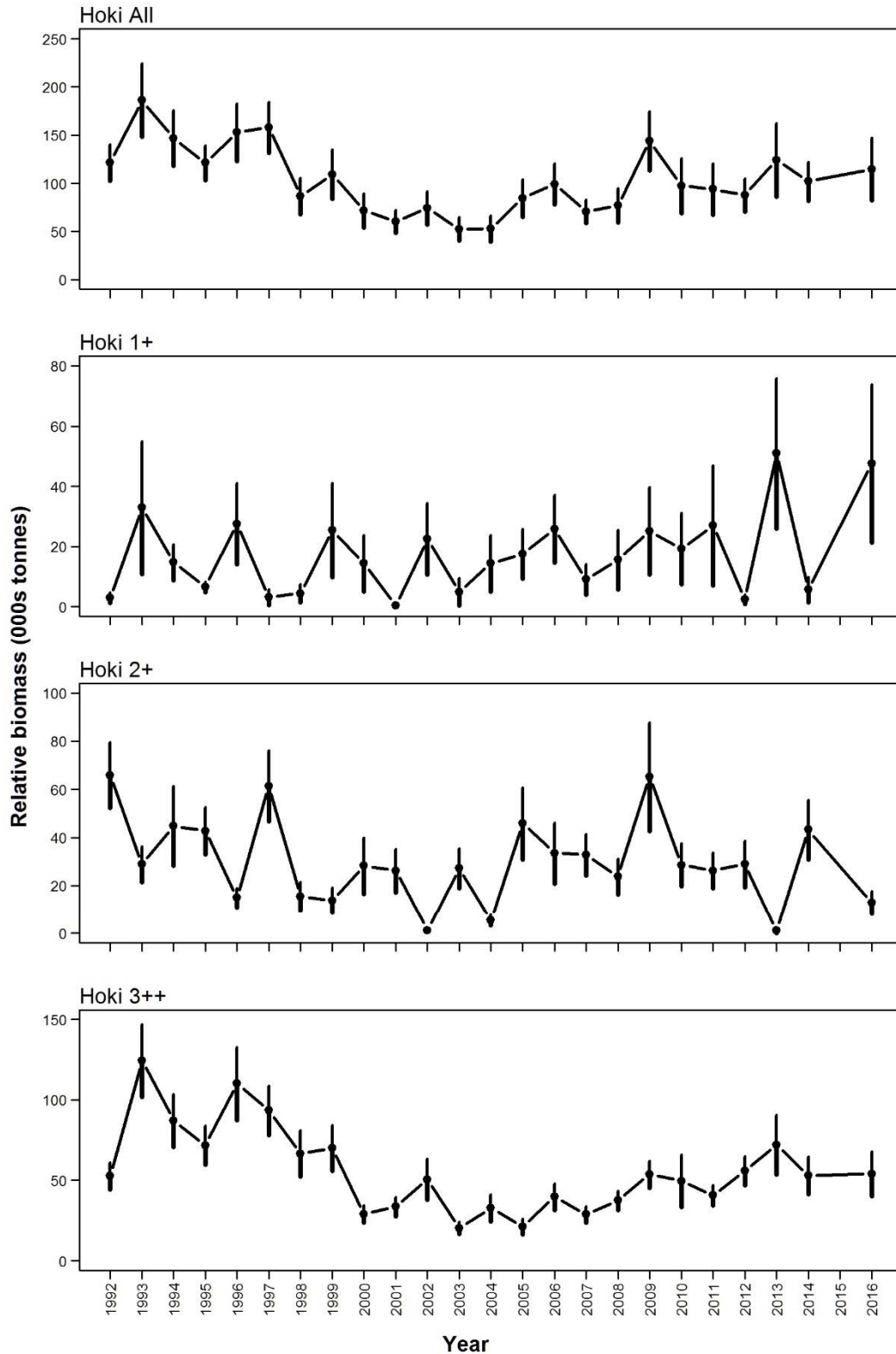


Figure 5a: Relative biomass estimates (thousands of tonnes) of hoki, hake, ling, and other selected commercial species sampled by annual trawl surveys of the Chatham Rise, January 1992–2014, and 2016 (core strata only). Error bars show ± 2 standard errors.

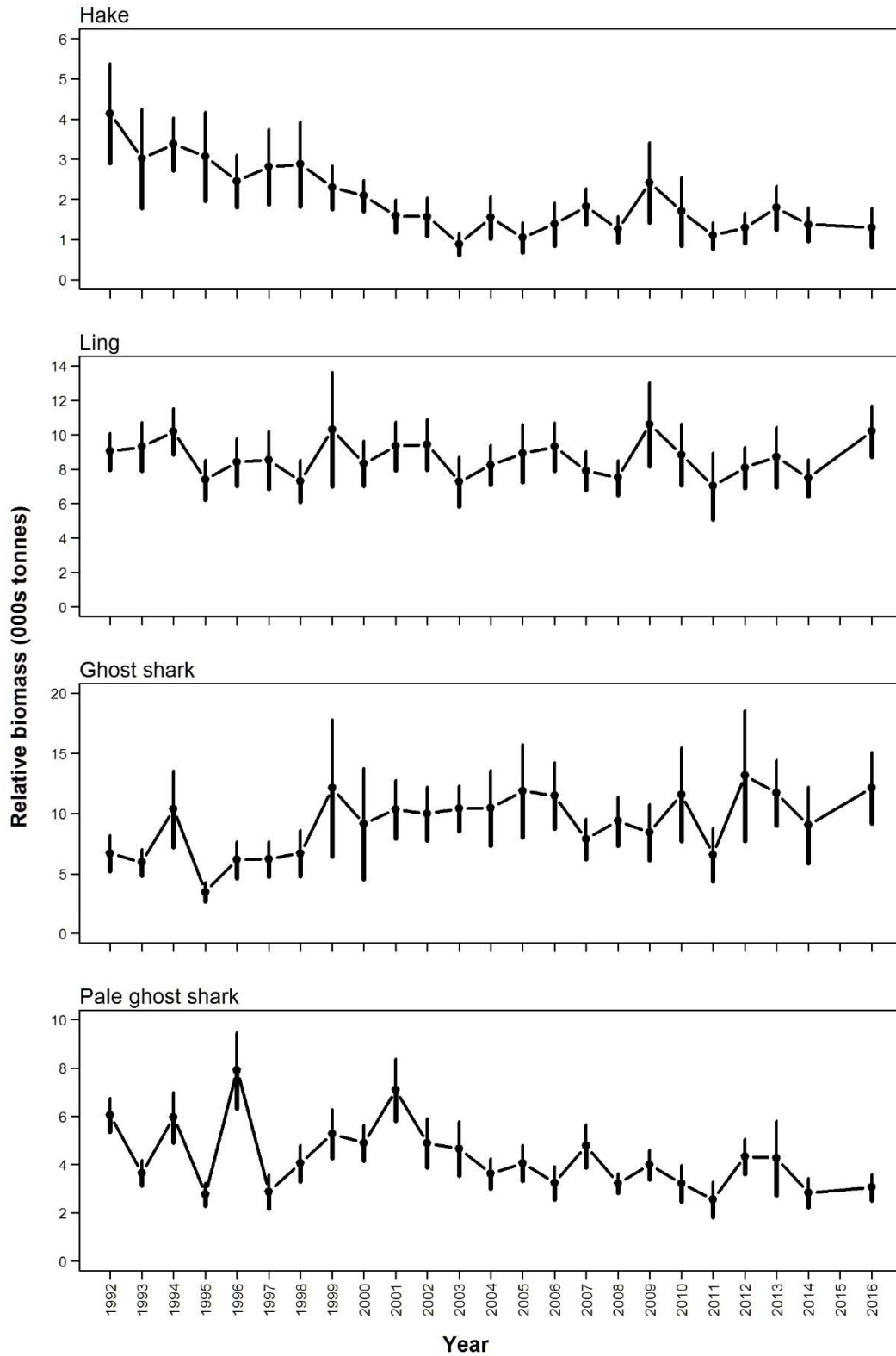


Figure 5a (continued)

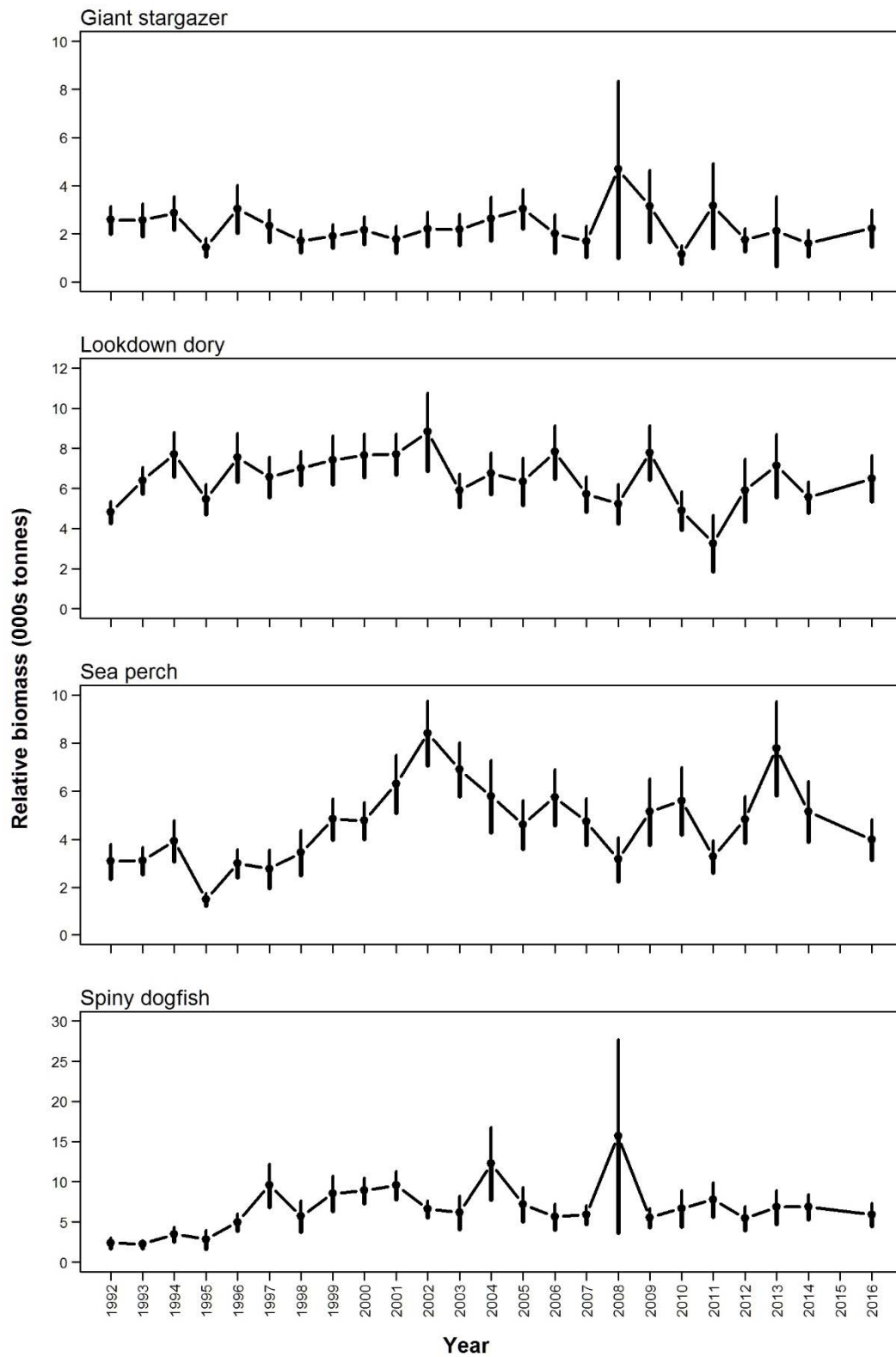


Figure 5a (continued)

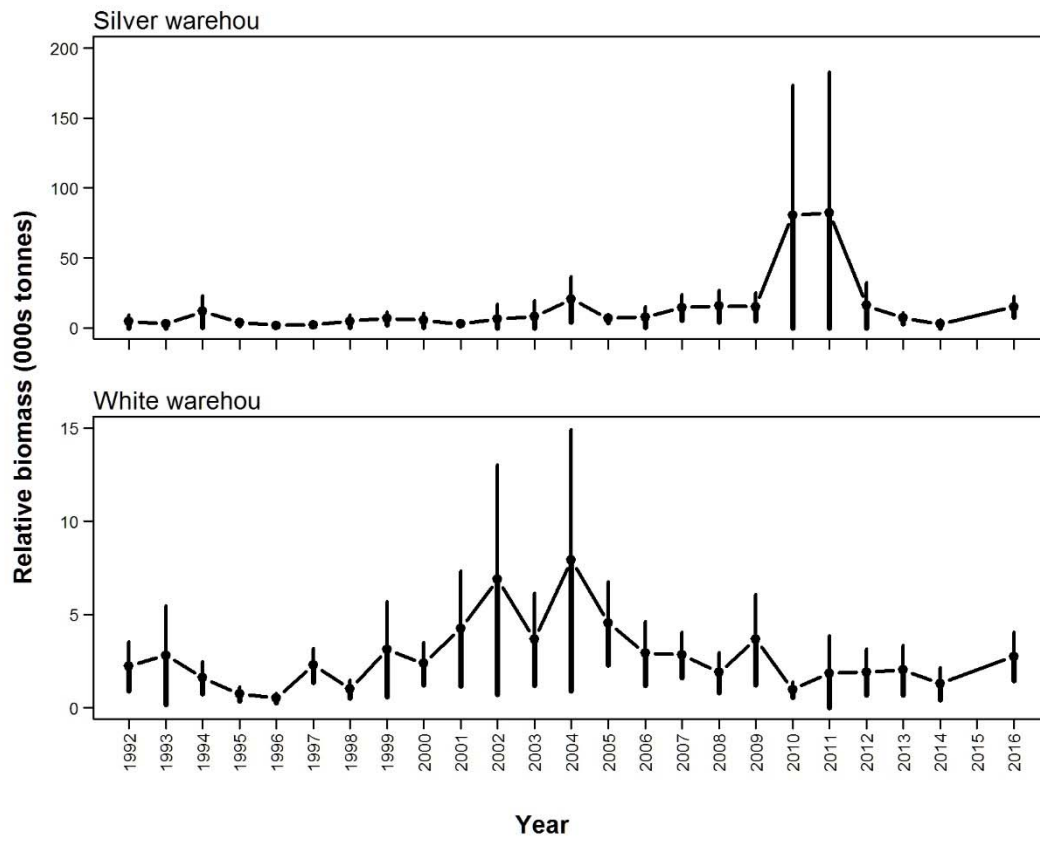


Figure 5a (continued)

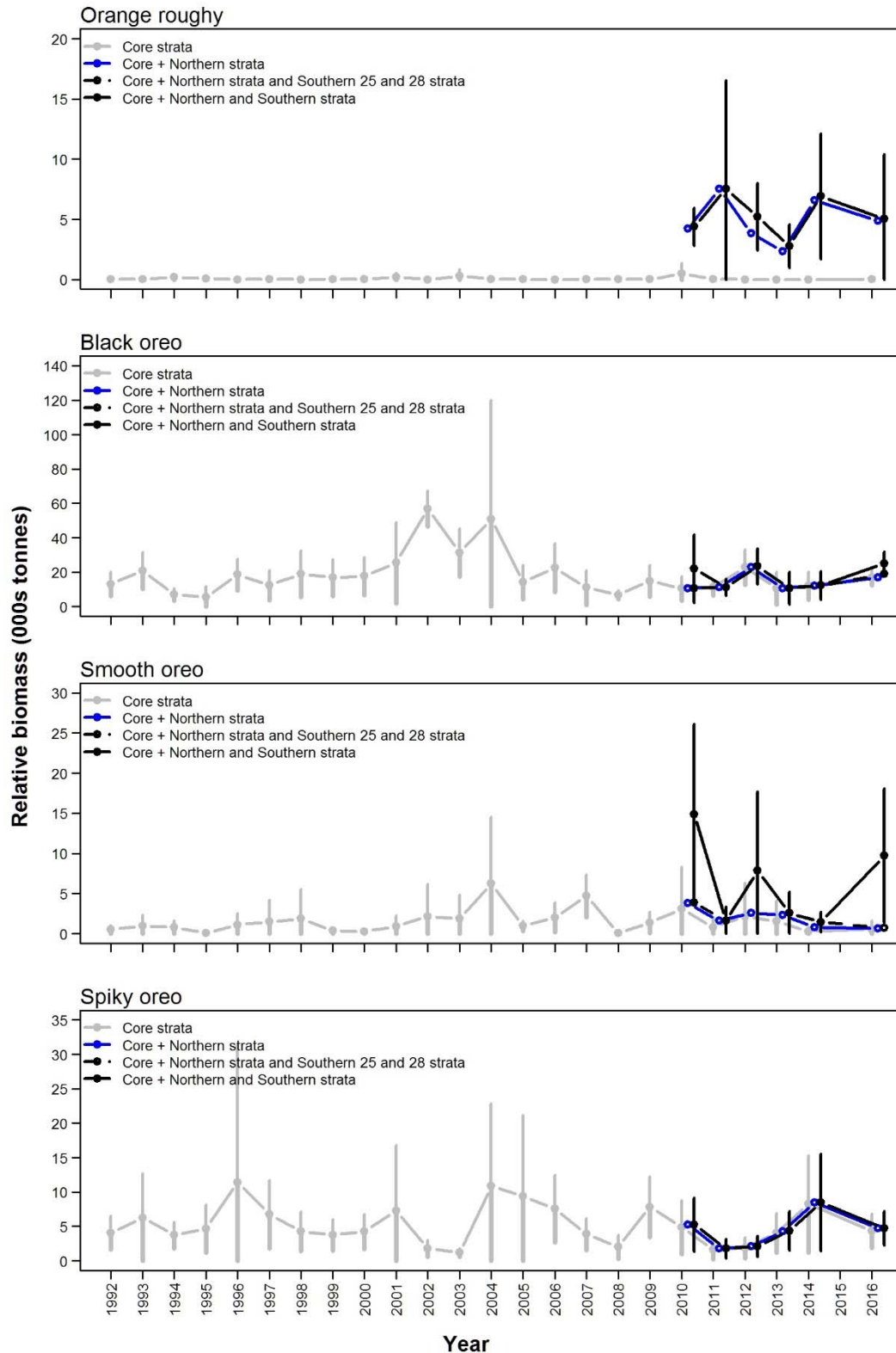


Figure 5b: Relative biomass estimates (thousands of tonnes) of orange roughy, oreo species, and other selected deepwater species sampled by annual trawl surveys of the Chatham Rise, January 1992–2014, and 2016. Grey lines show fish from core (200–800 m) strata. Blue lines show fish from core strata plus the northern deep (800–1300 m) strata. Black solid lines show fish from core strata plus the northern and southern deep (800–1300 m) strata, and black dotted lines show fish from core strata plus the northern and southern 25 and 28 deep strata (800–1300 m). Error bars show ± 2 standard errors.

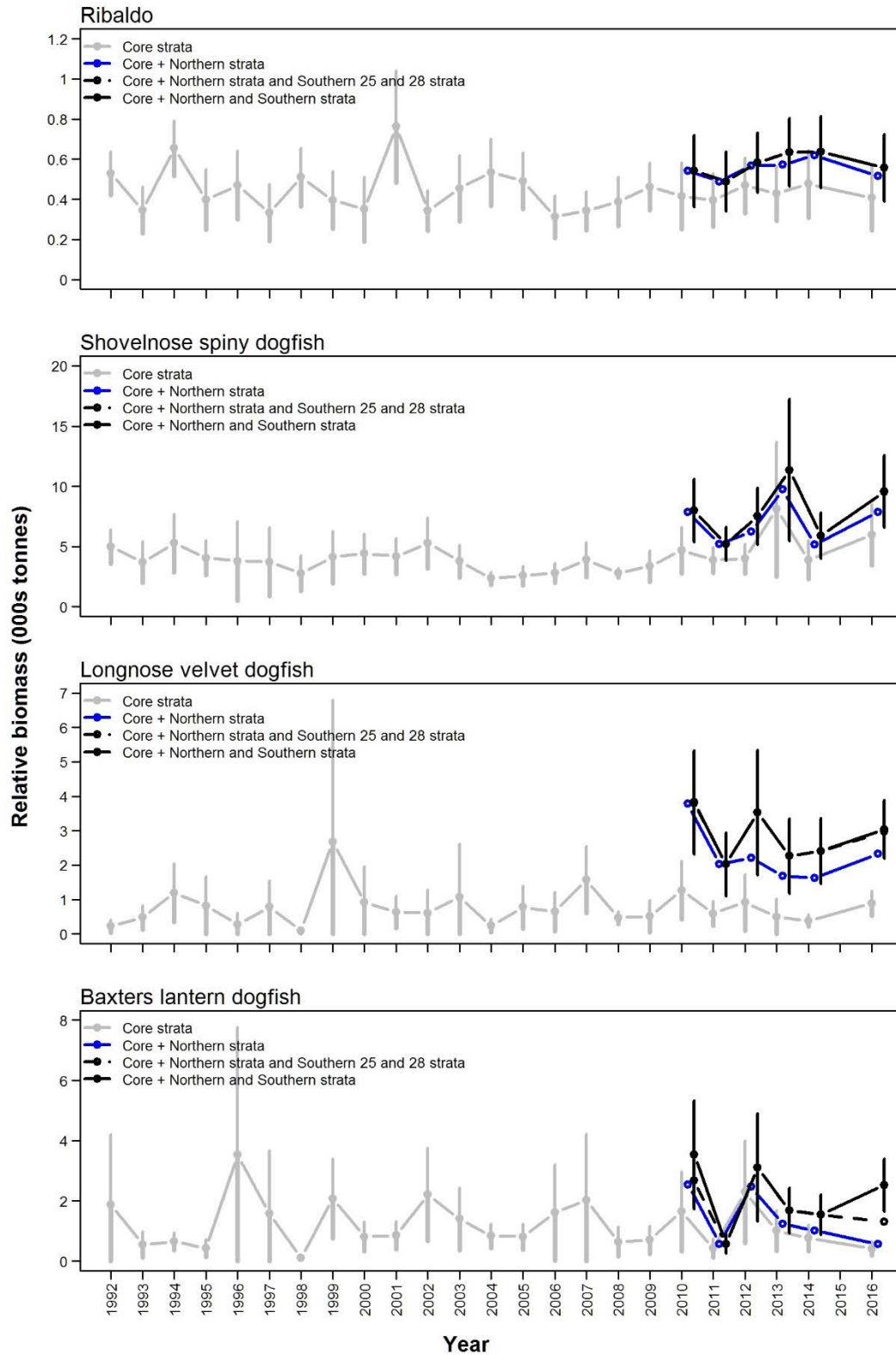


Figure 5b (continued)

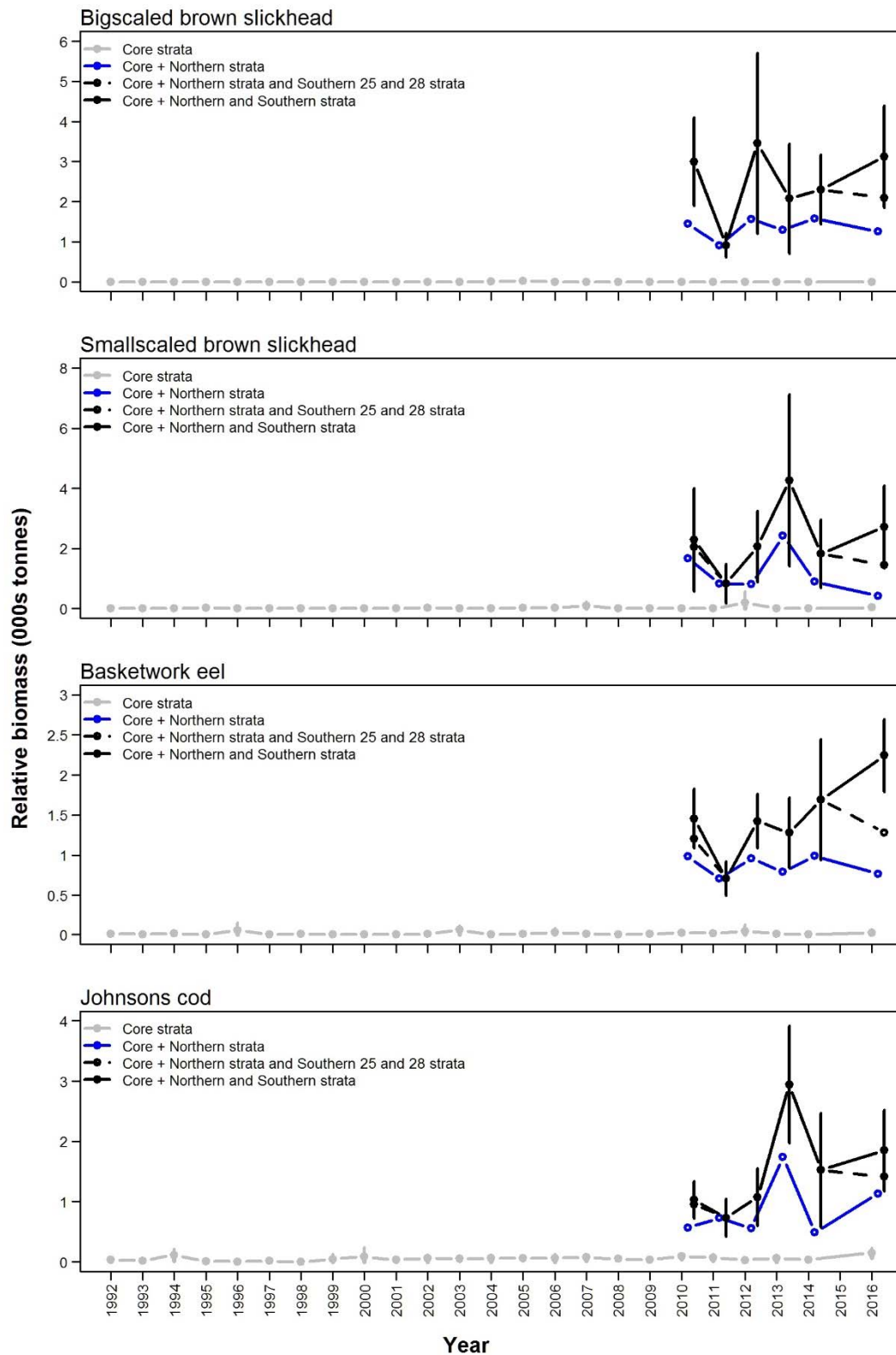


Figure 5b (continued)

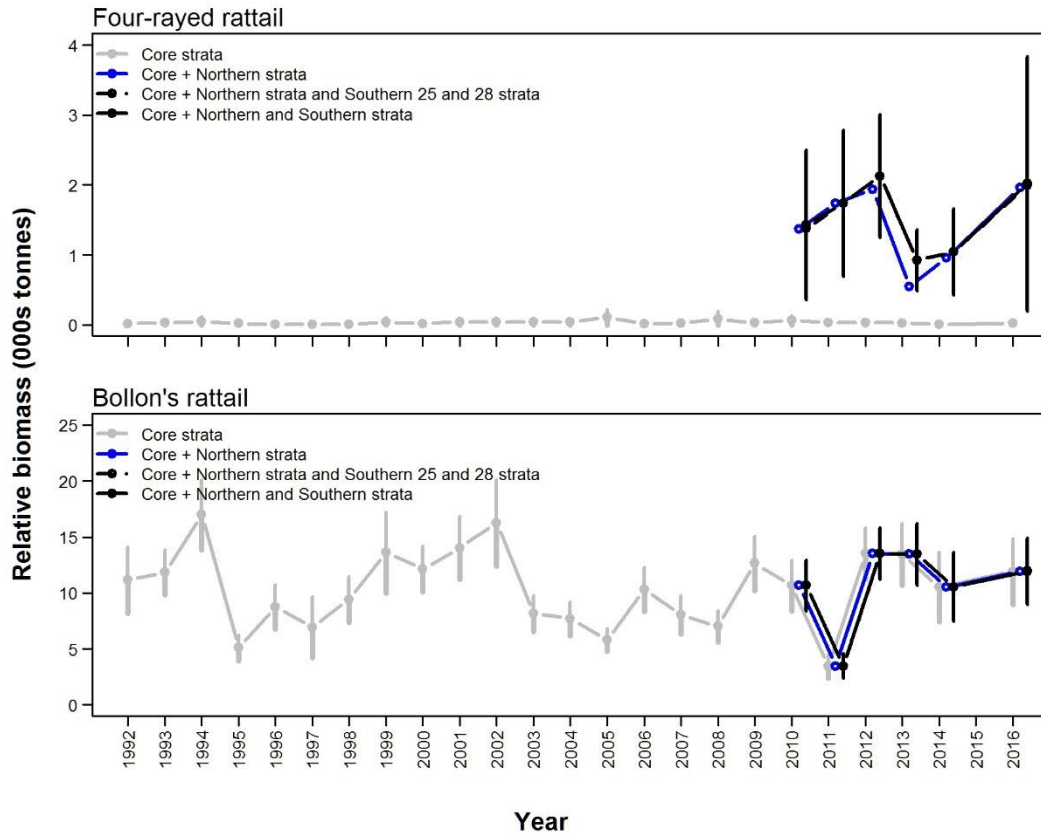


Figure 5b (continued)

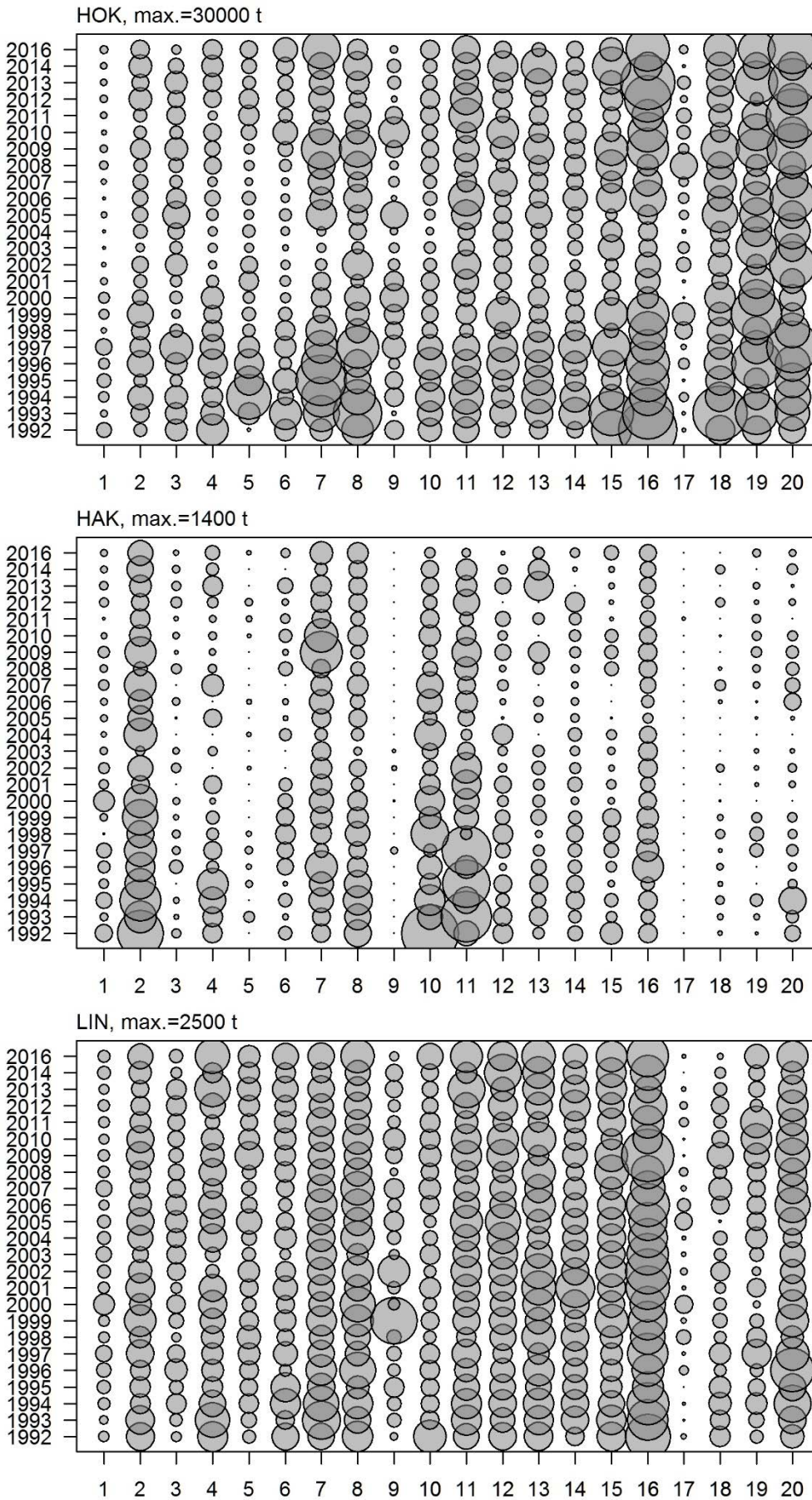


Figure 6a: Relative core (200–800 m) biomass estimates by strata for hoki, and other selected midwater species sampled by annual trawl surveys of the Chatham Rise, January 1992–2014, and 2016.

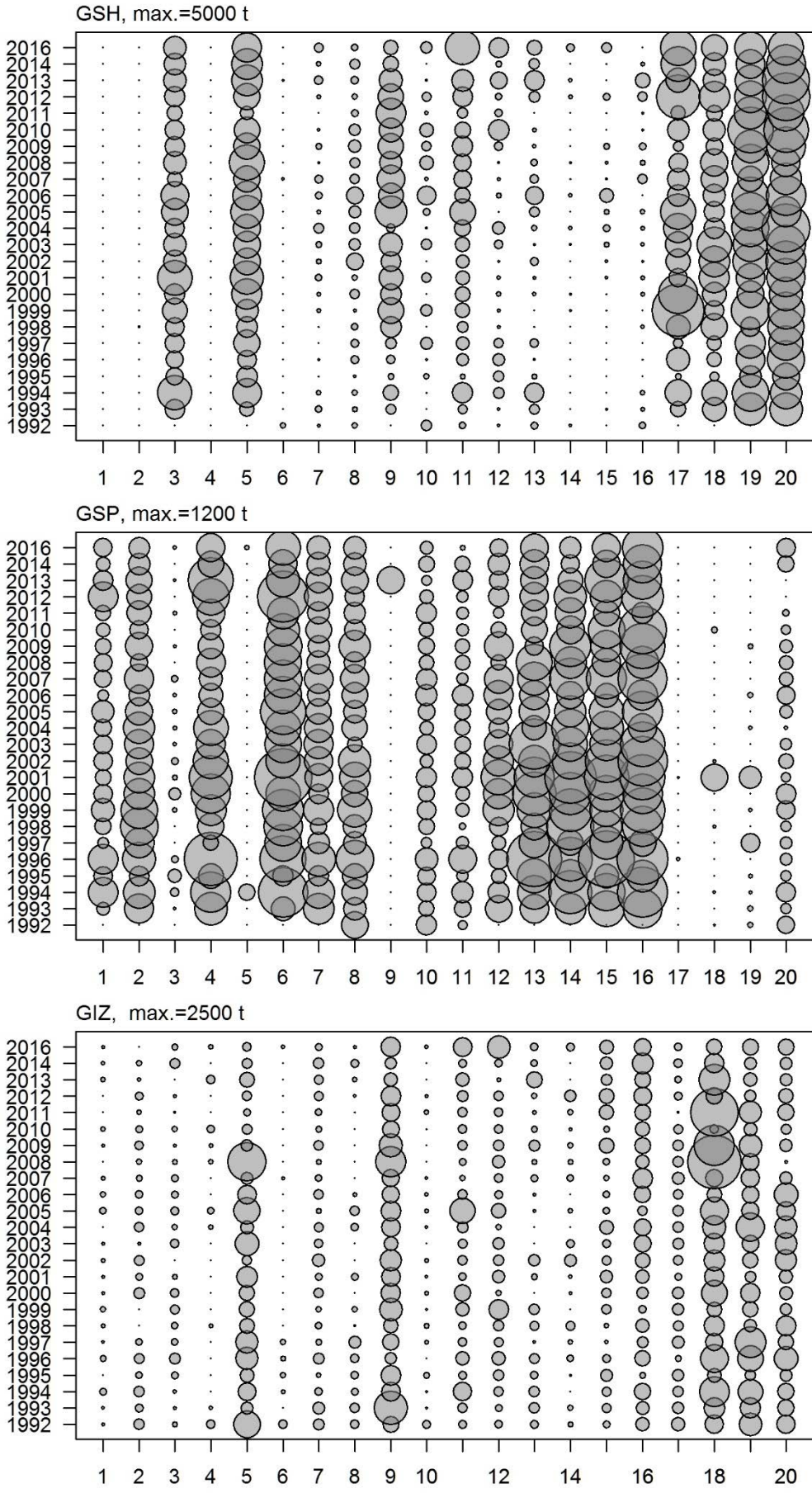


Figure 6a (continued)

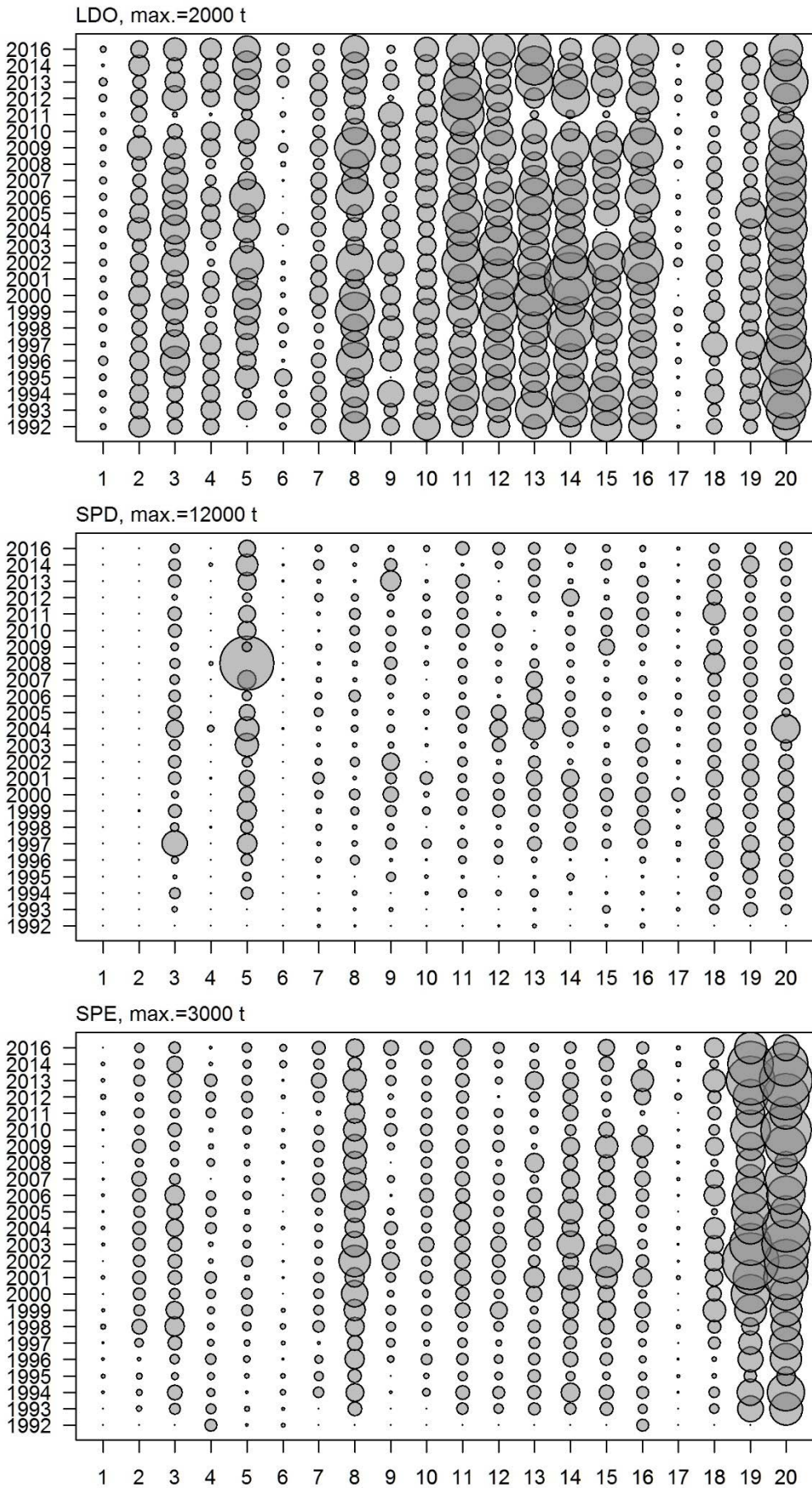


Figure 6a (continued)

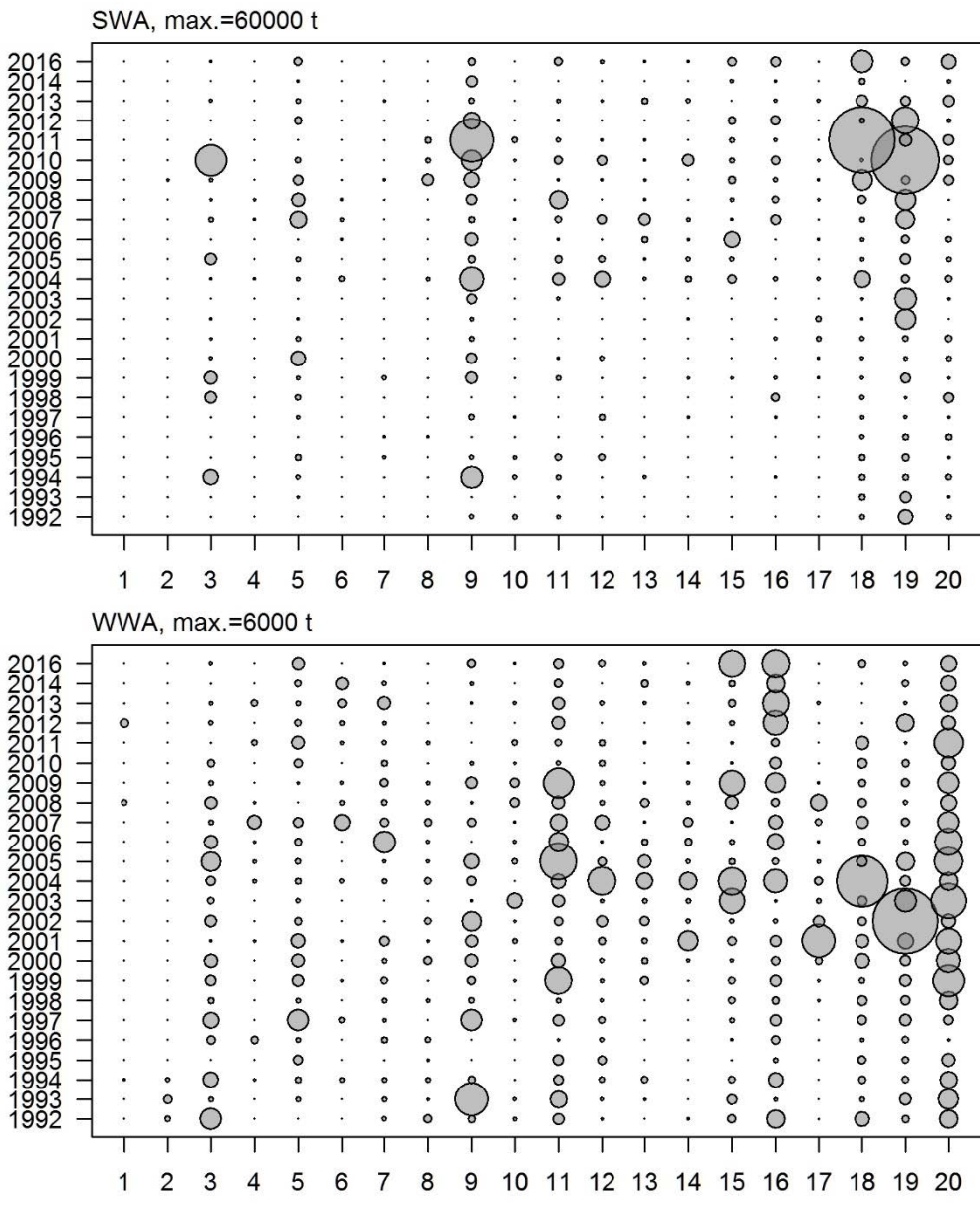


Figure 6a (continued)

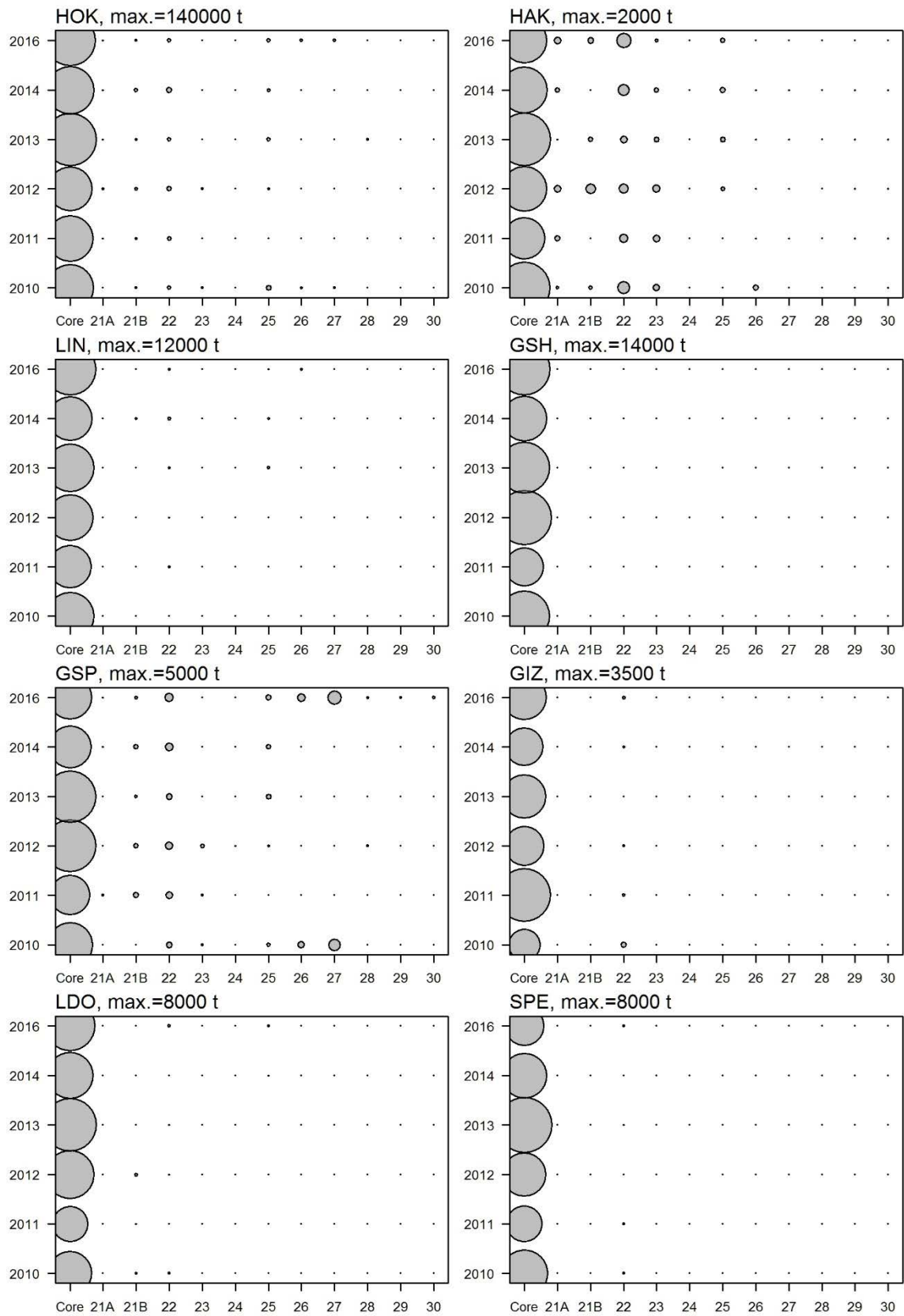


Figure 6b: Relative deep (800–1300 m) biomass estimates by strata for hoki and other selected middle depth species sampled by annual trawl surveys of the Chatham Rise, January 2010–2014, and 2016.

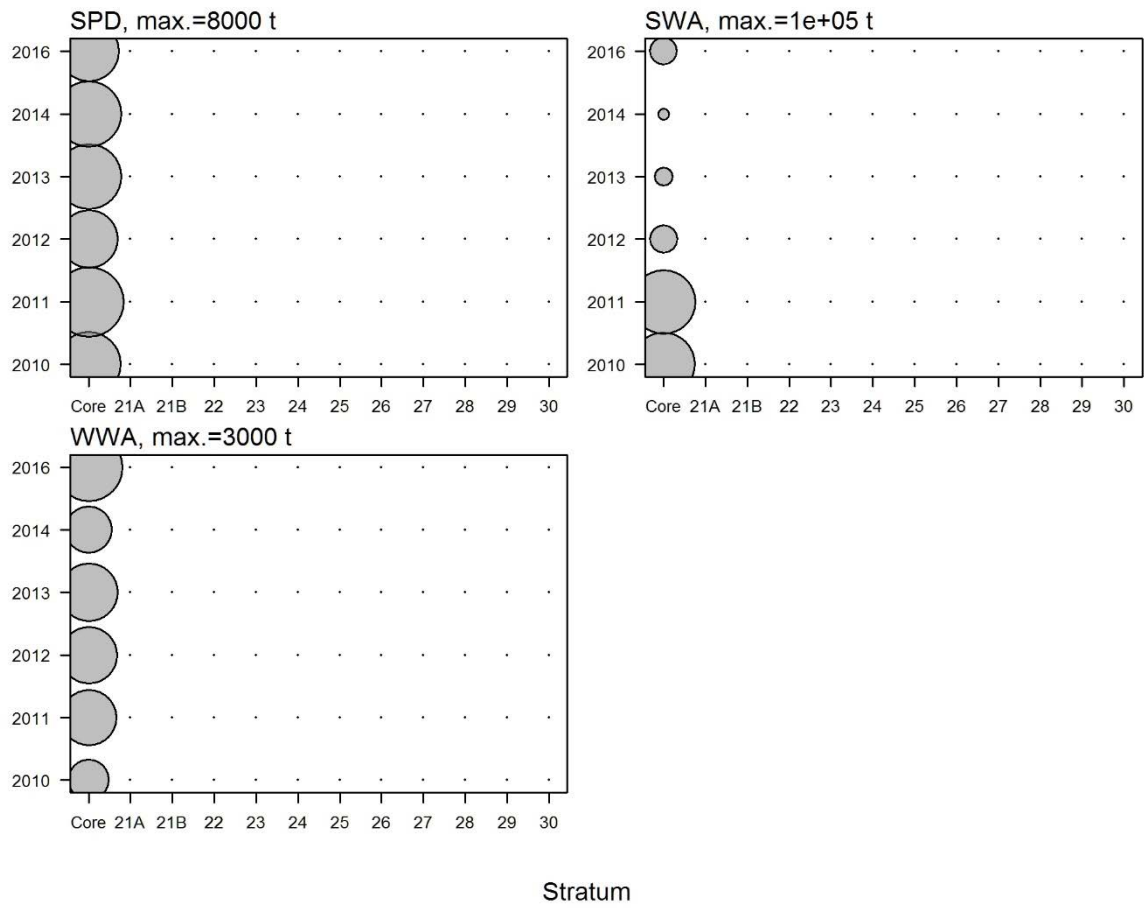


Figure 6b (continued)

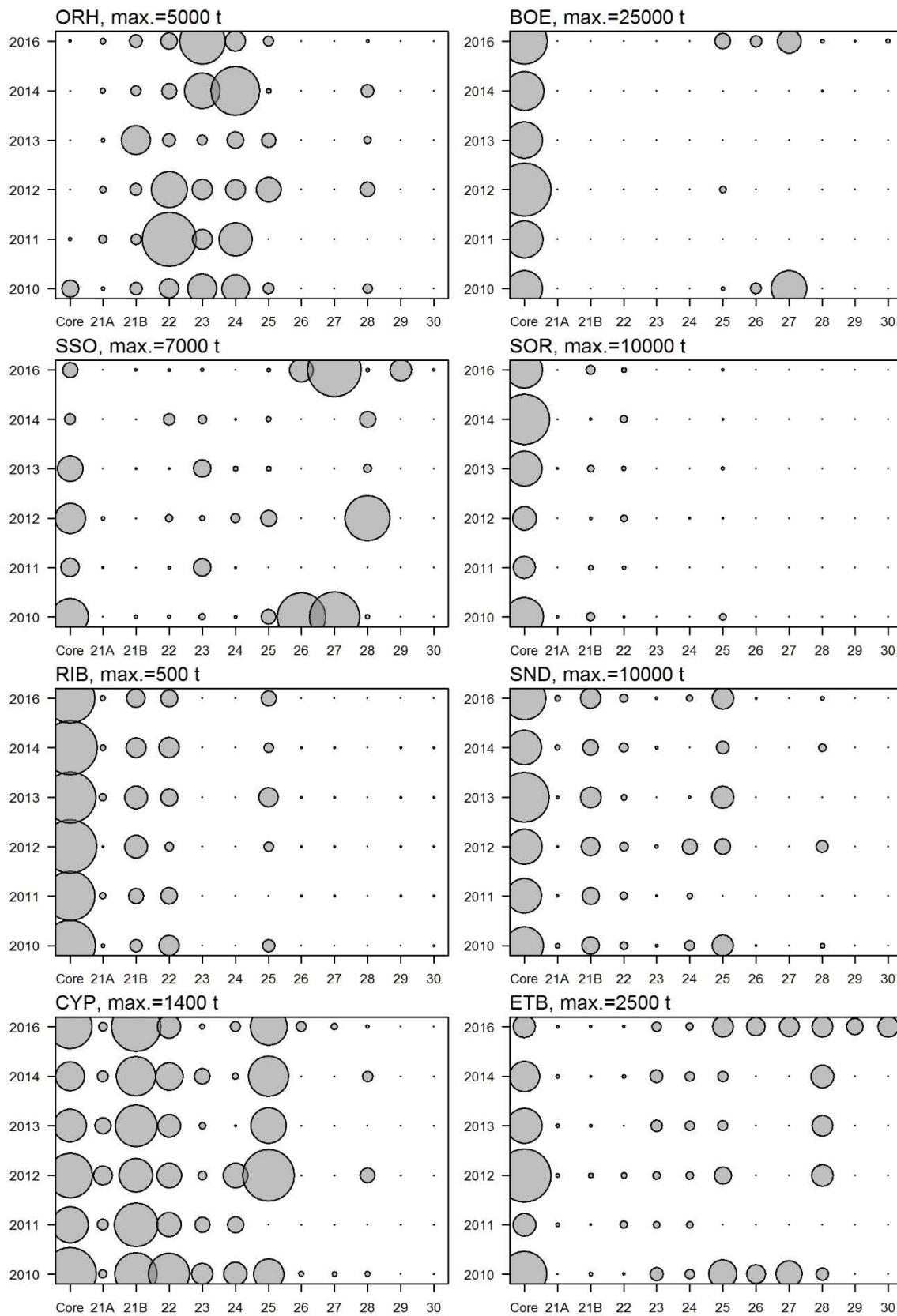


Figure 6c: Relative deep (800–1300 m) biomass estimates by strata for orange roughy, oreo species, and other selected deepwater species sampled by annual trawl surveys of the Chatham Rise, January 2010–2014, and 2016.

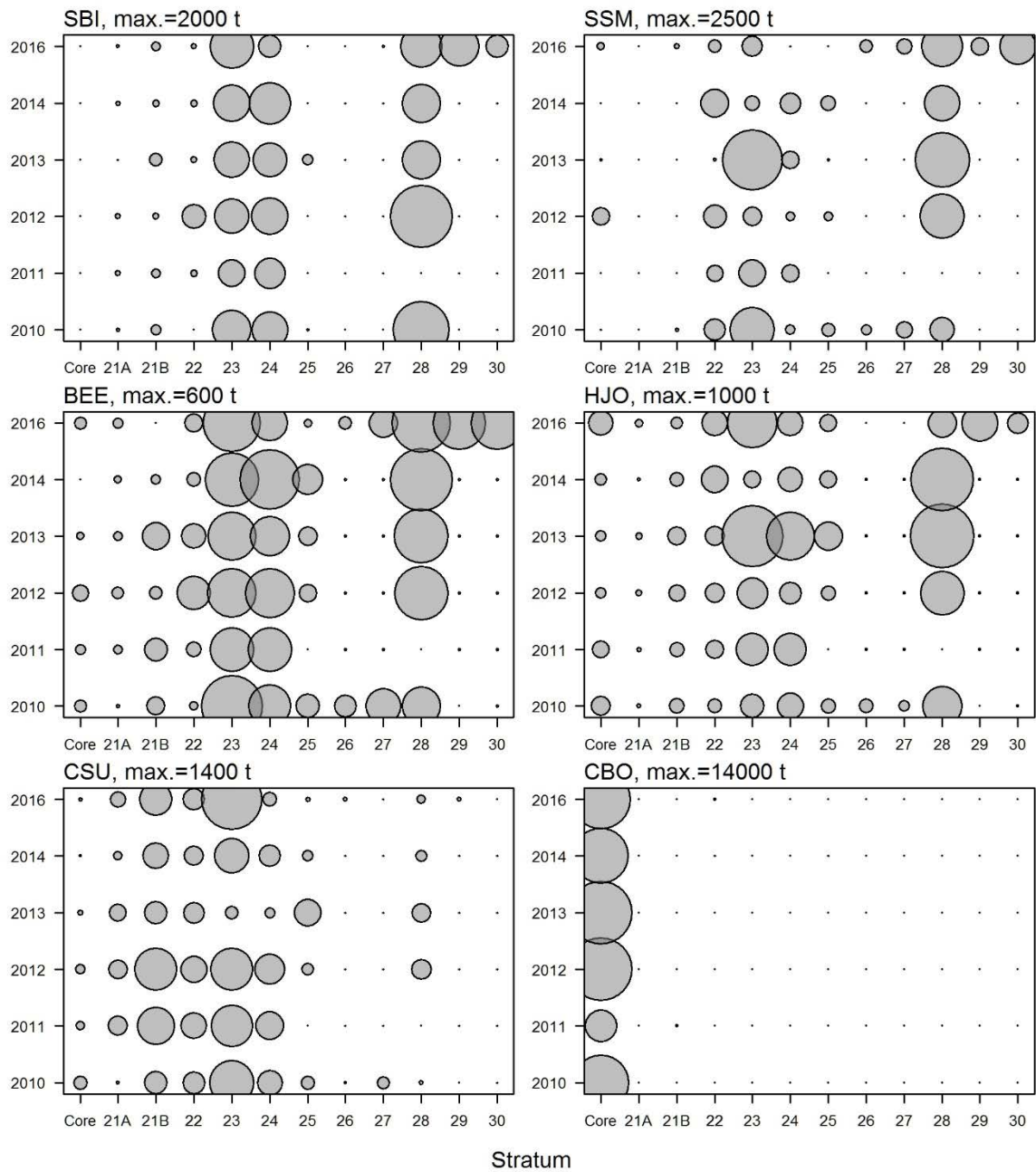


Figure 6c (continued)

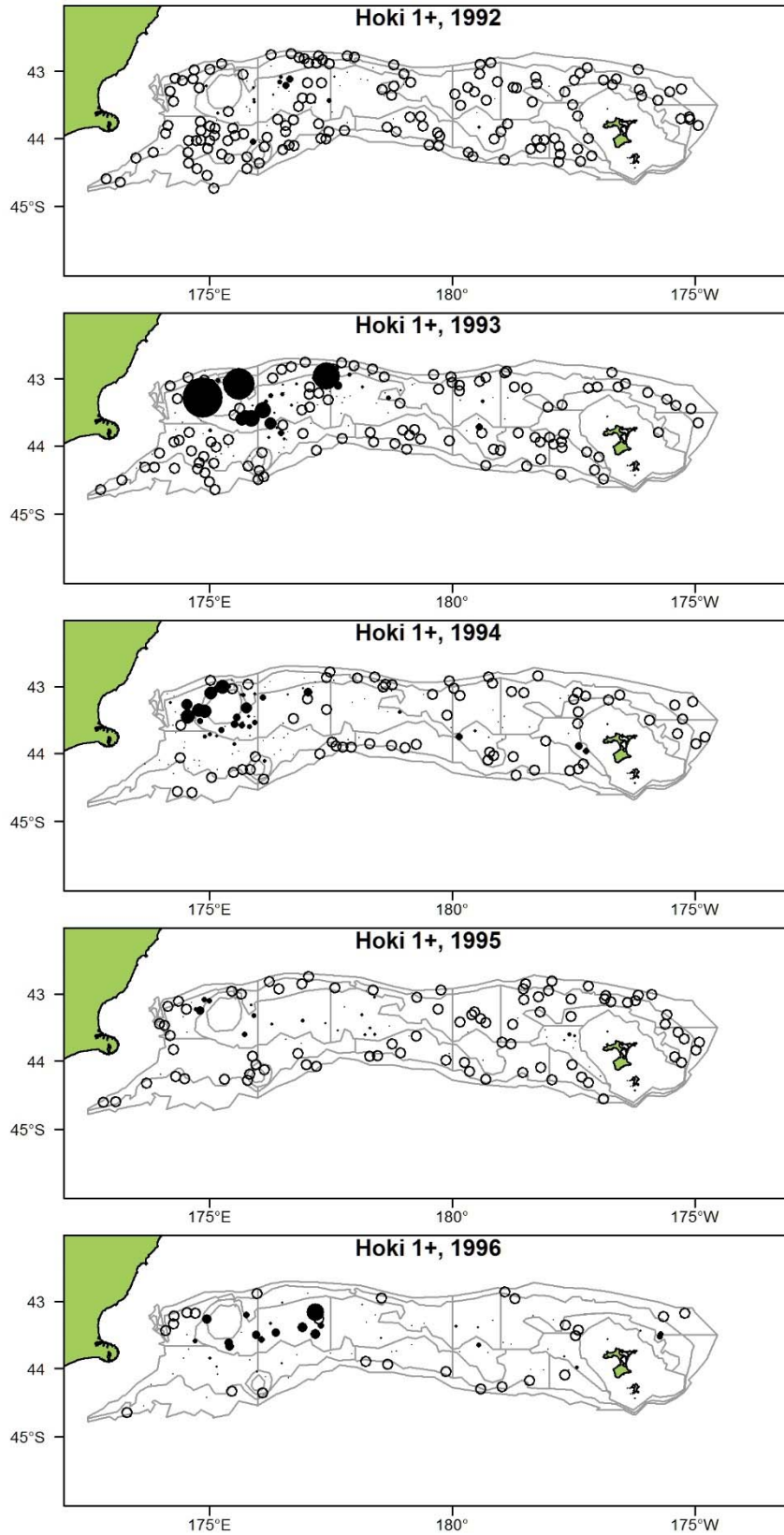


Figure 7a: Hoki 1+ catch distribution 1992–2014, and 2016. Filled circle area is proportional to catch rate (kg km⁻²). Open circles are zero catch. Maximum catch rate in series is 30 850 kg km⁻².

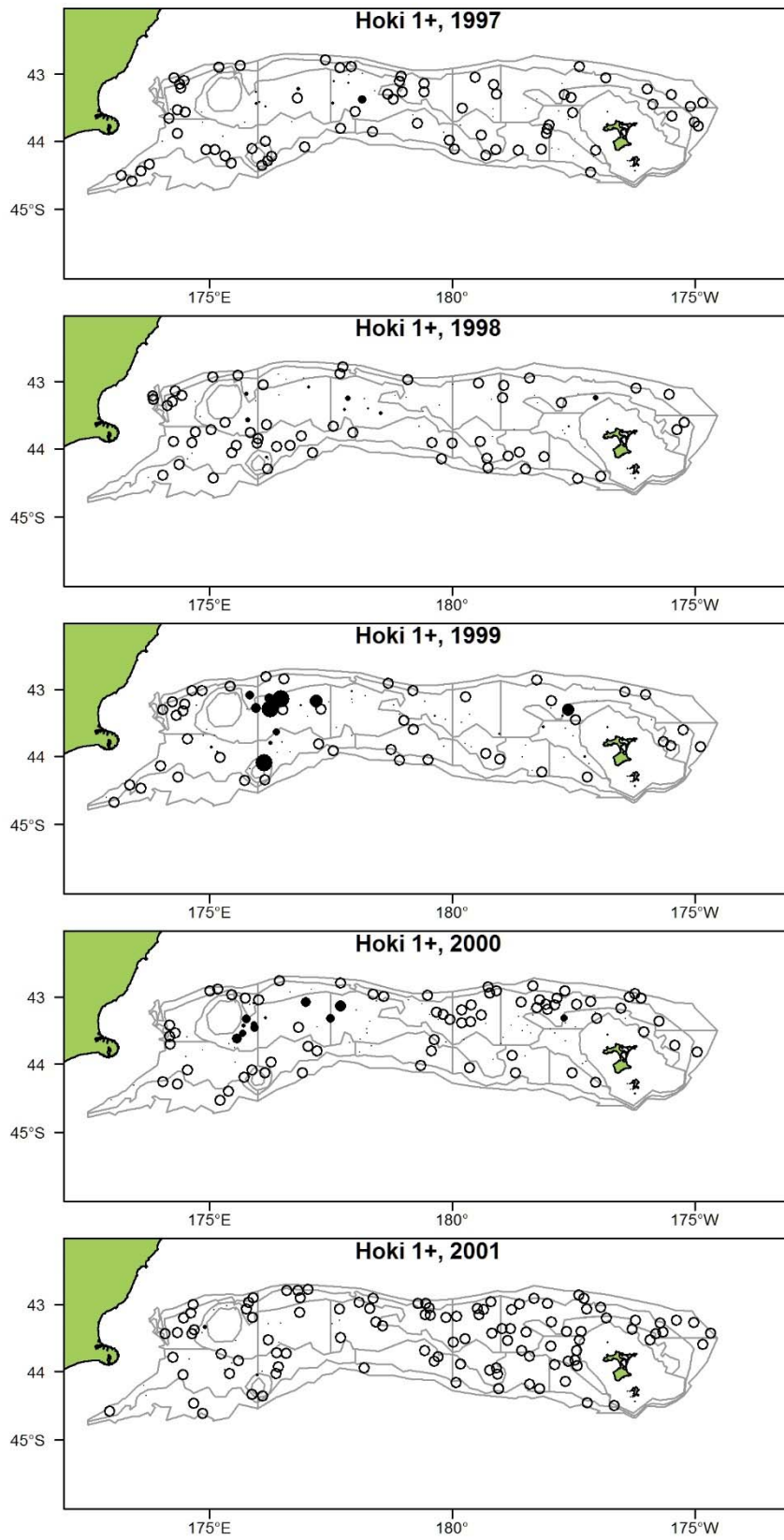


Figure 7a (continued)

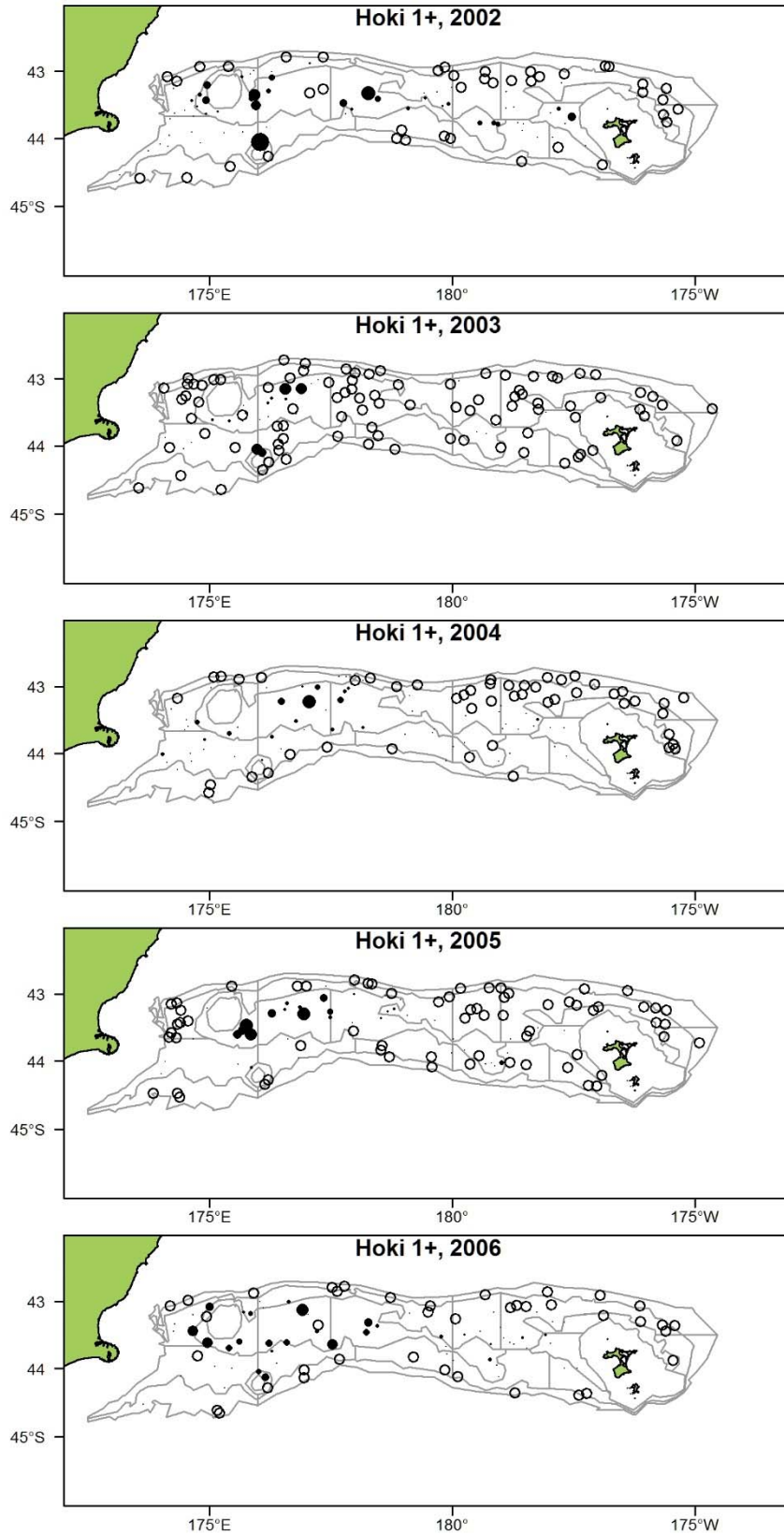


Figure 7a (continued)

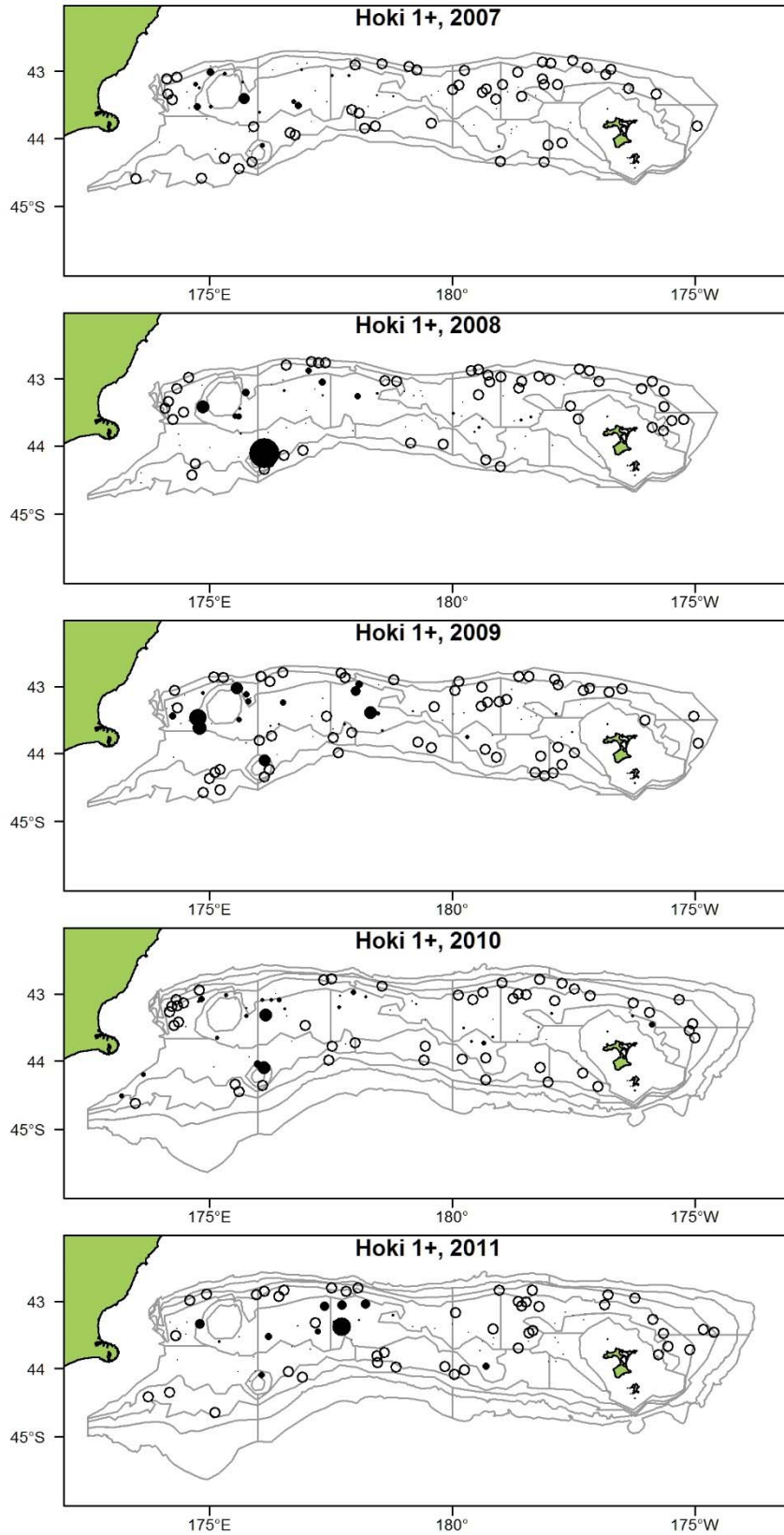


Figure 7a (continued)

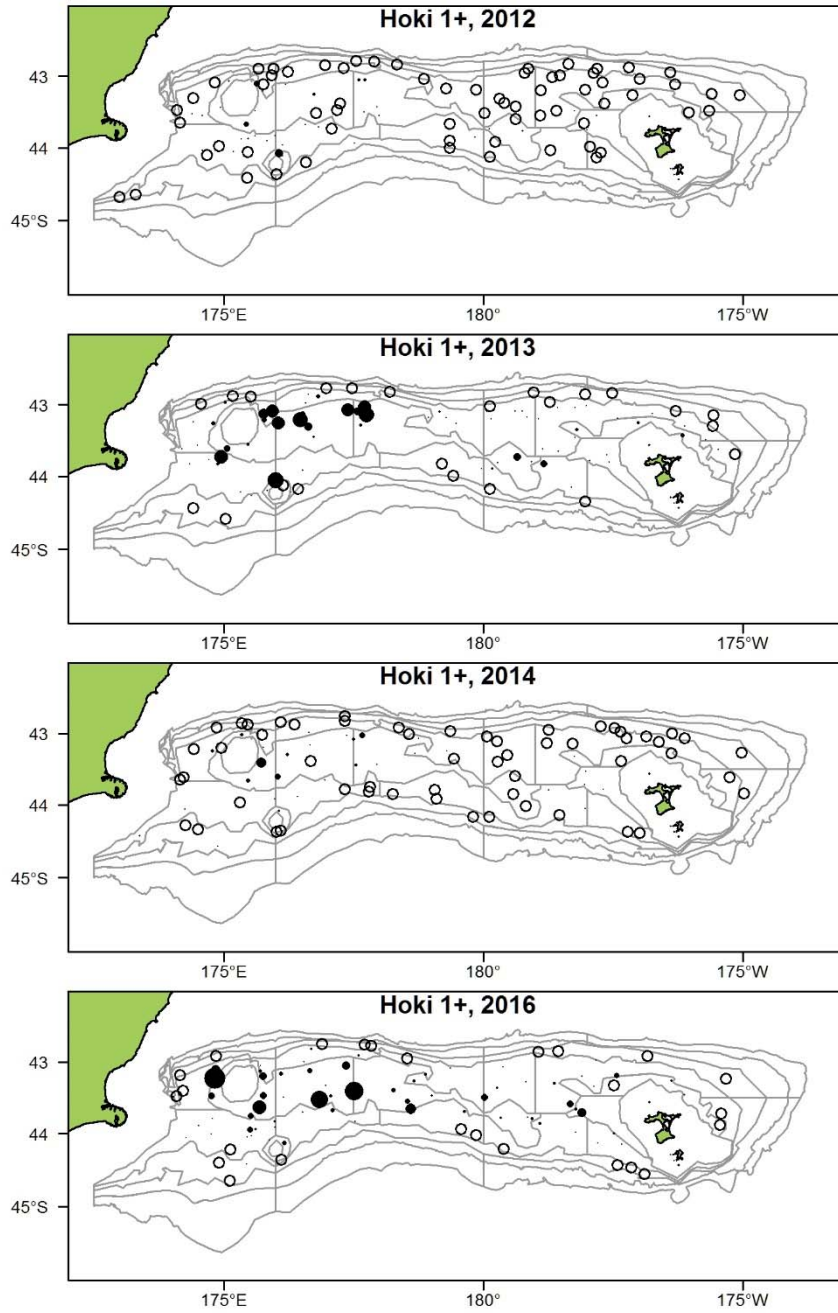


Figure 7a (continued)

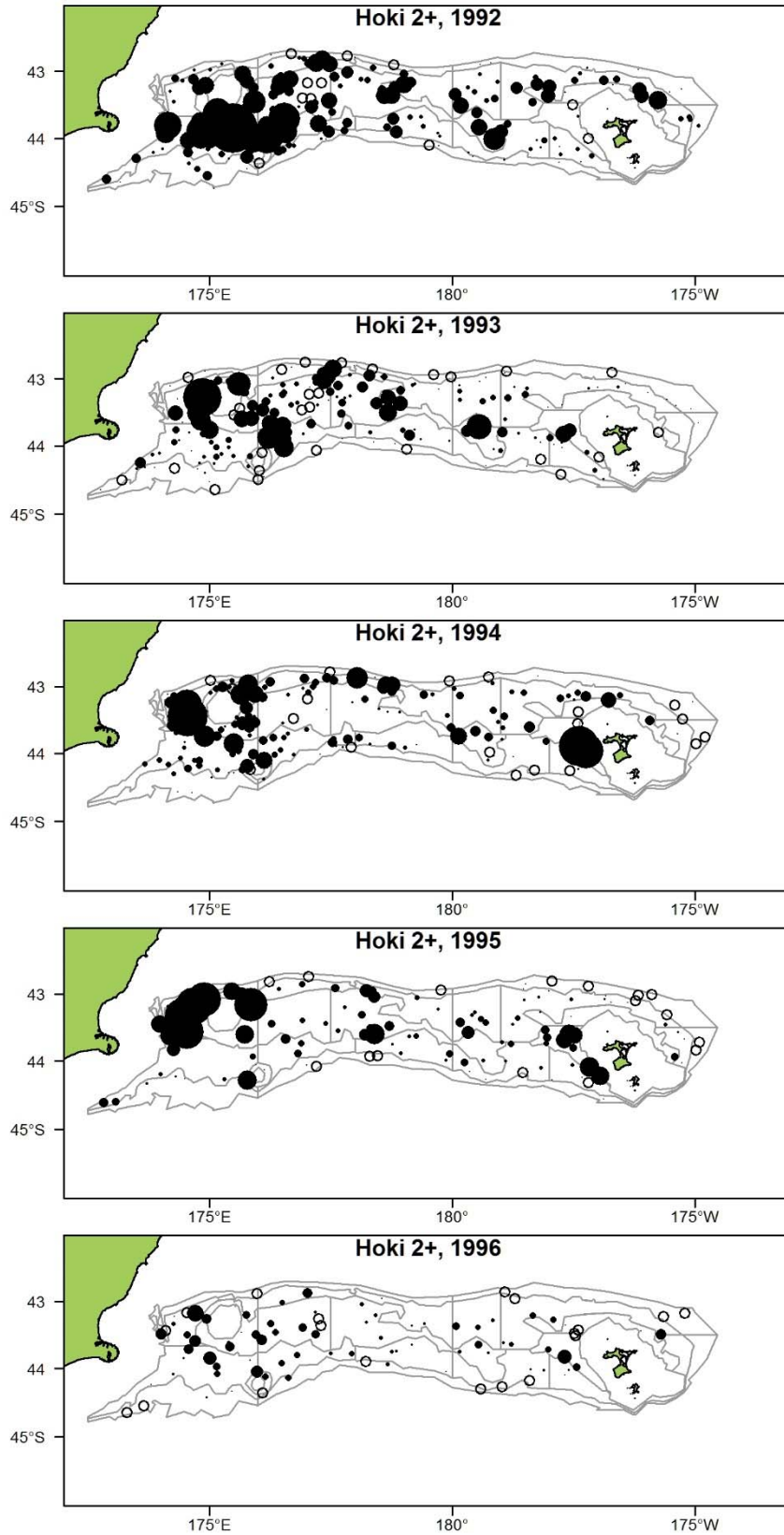


Figure 7b: Hoki 2+ catch distribution 1992–2014, and 2016. Filled circle area is proportional to catch rate (kg km⁻²). Open circles are zero catch. Maximum catch rate in series is 6791 kg km⁻².

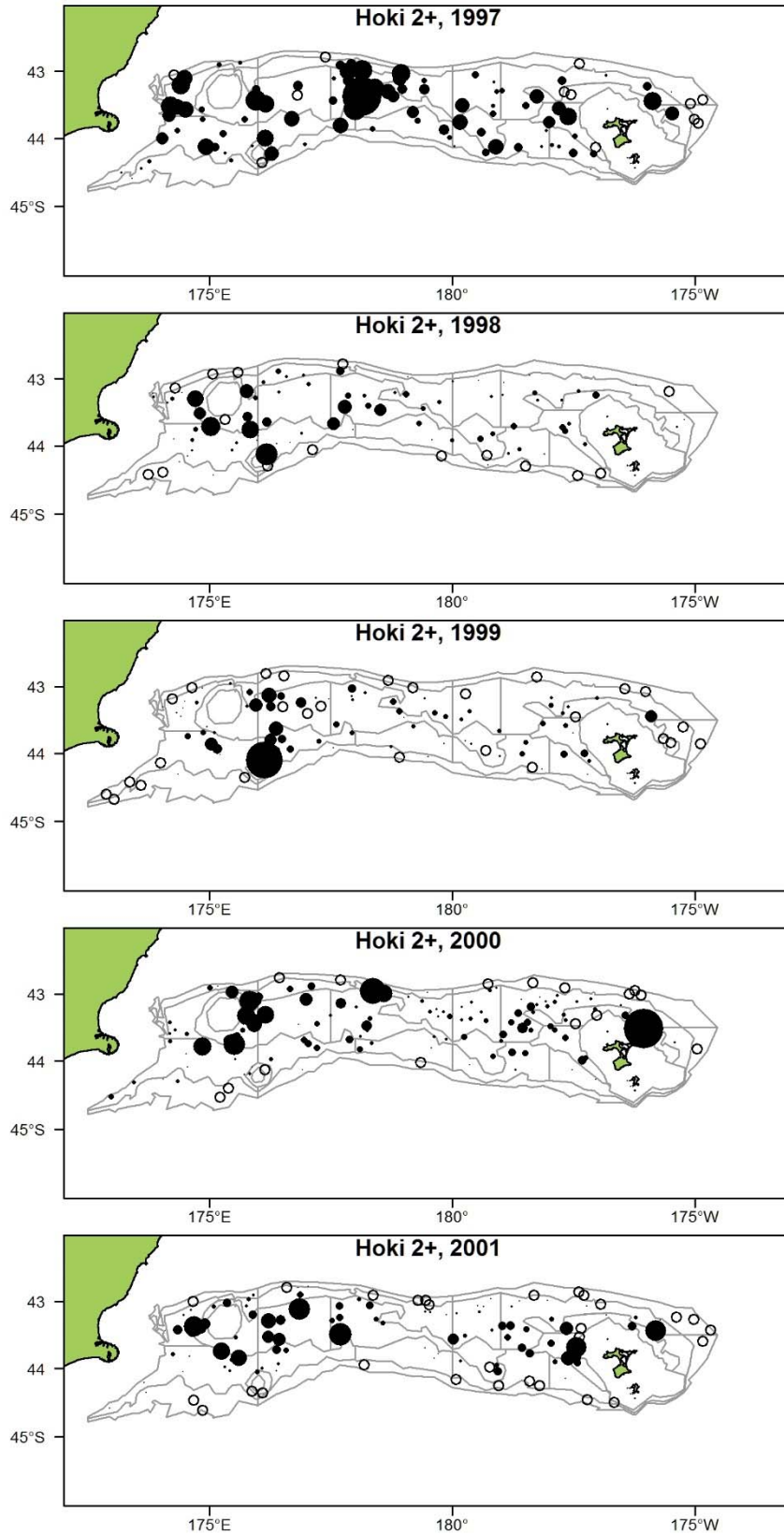


Figure 7b (continued)

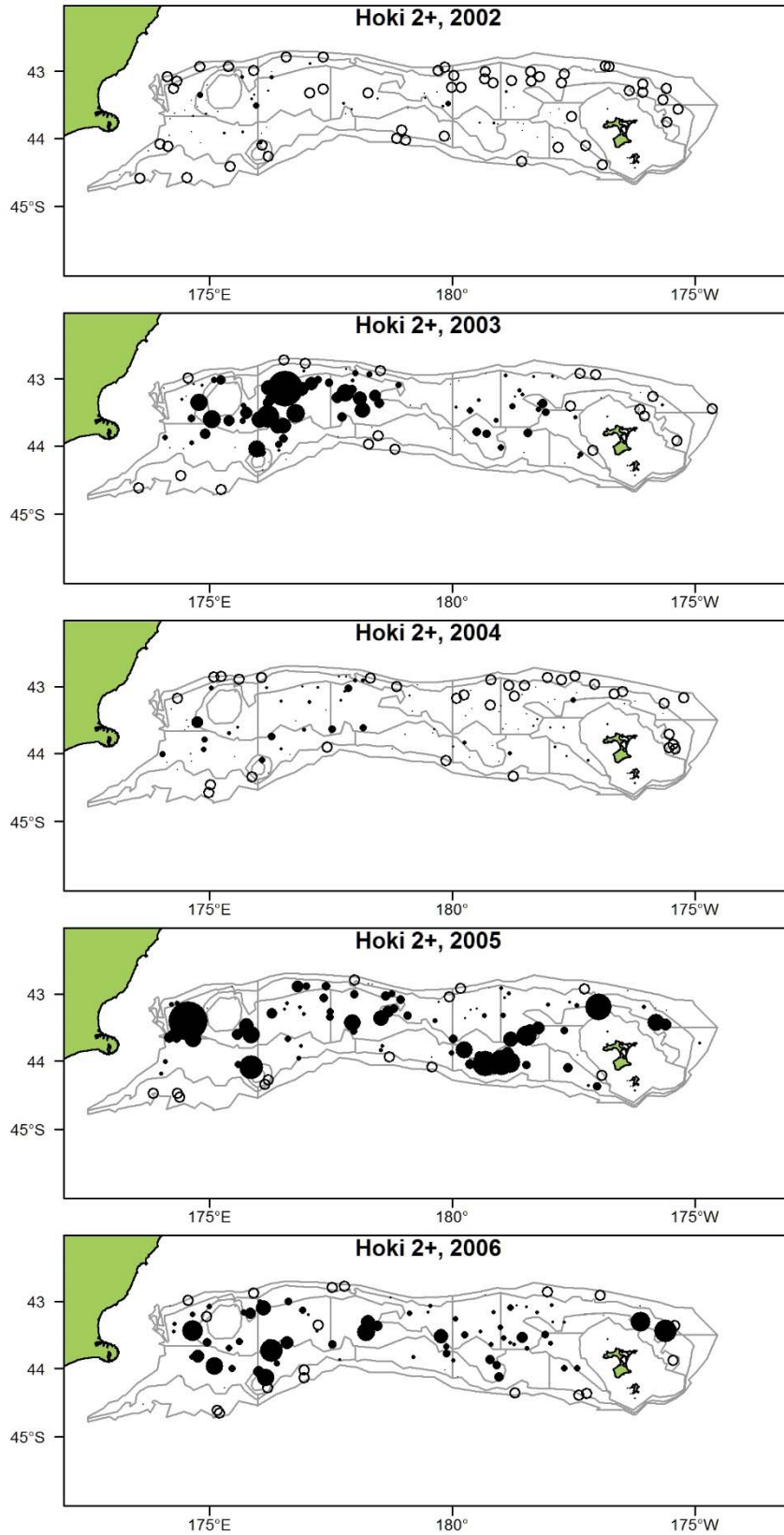


Figure 7b (continued)

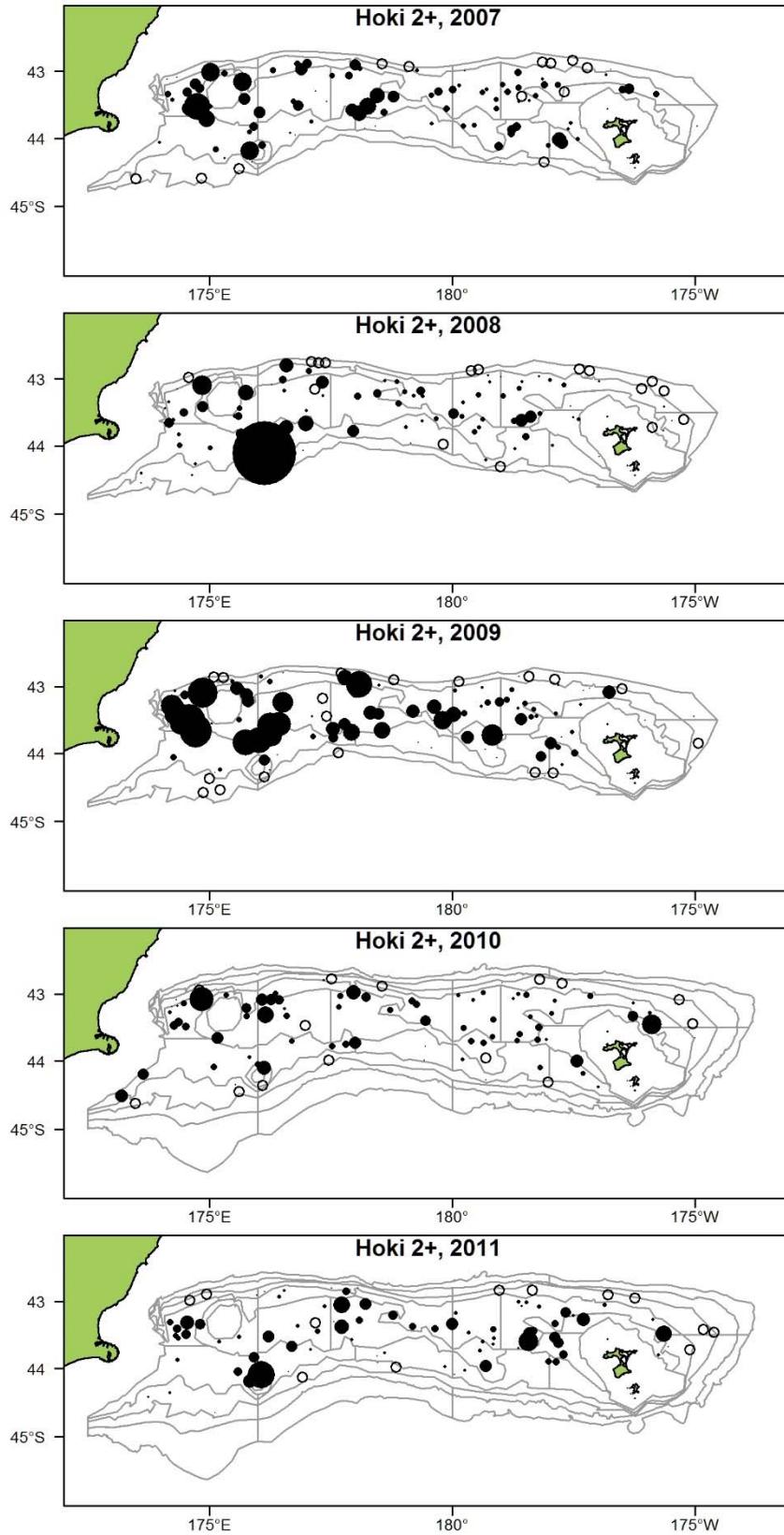


Figure 7b (continued)

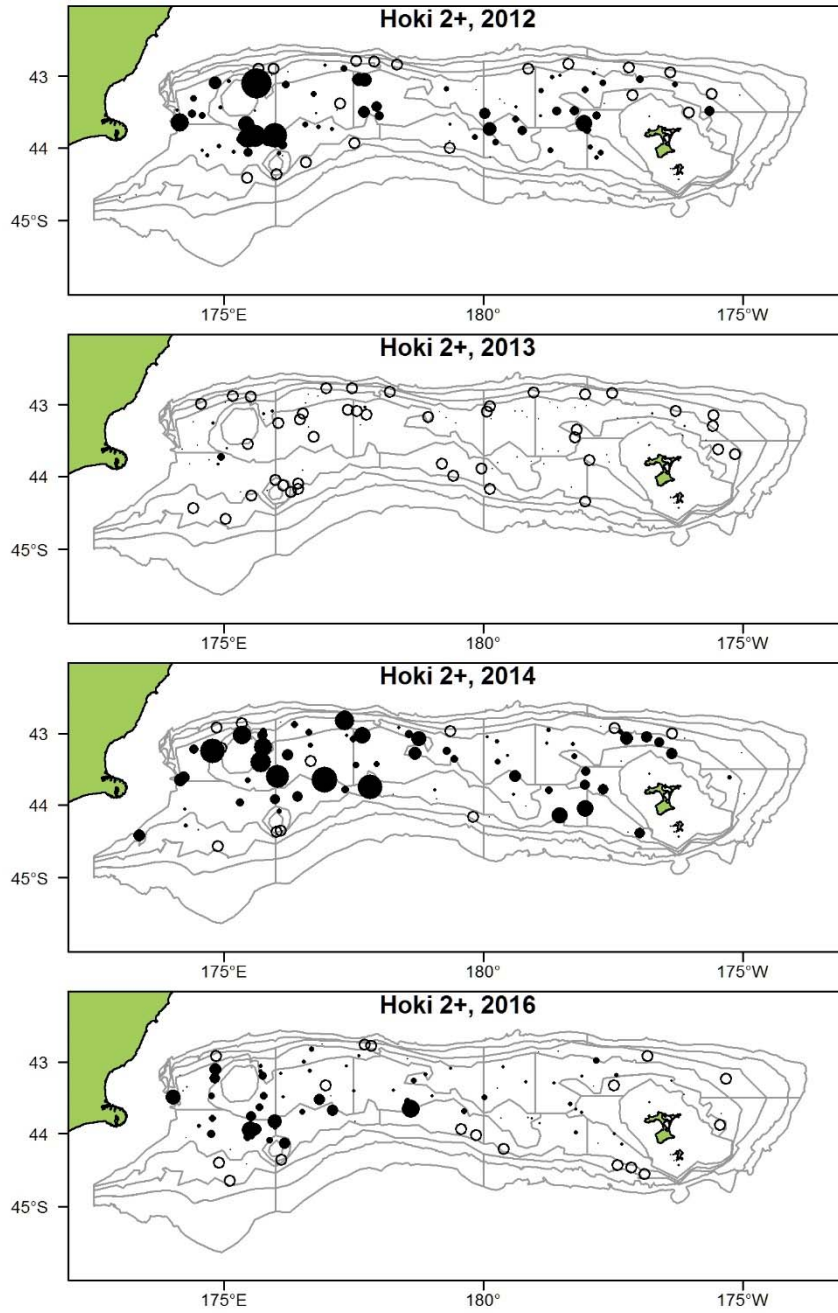


Figure 7b (continued)

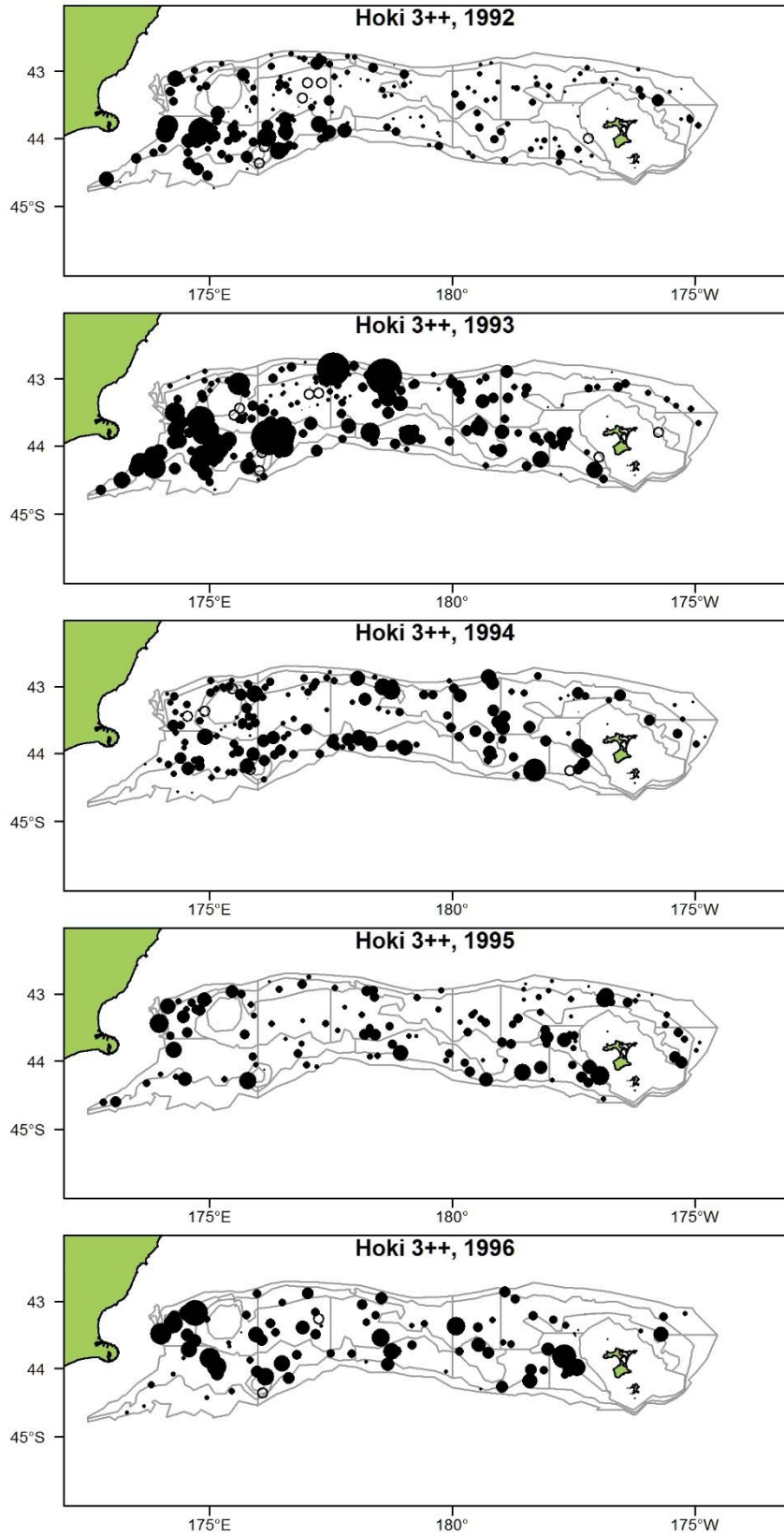


Figure 7c: Hoki 3++ catch distribution. 1992–2014, and 2016. Filled circle area is proportional to catch rate (kg km^{-2}). Open circles are zero catch. Maximum catch rate in series is $11\,177 \text{ kg km}^{-2}$.

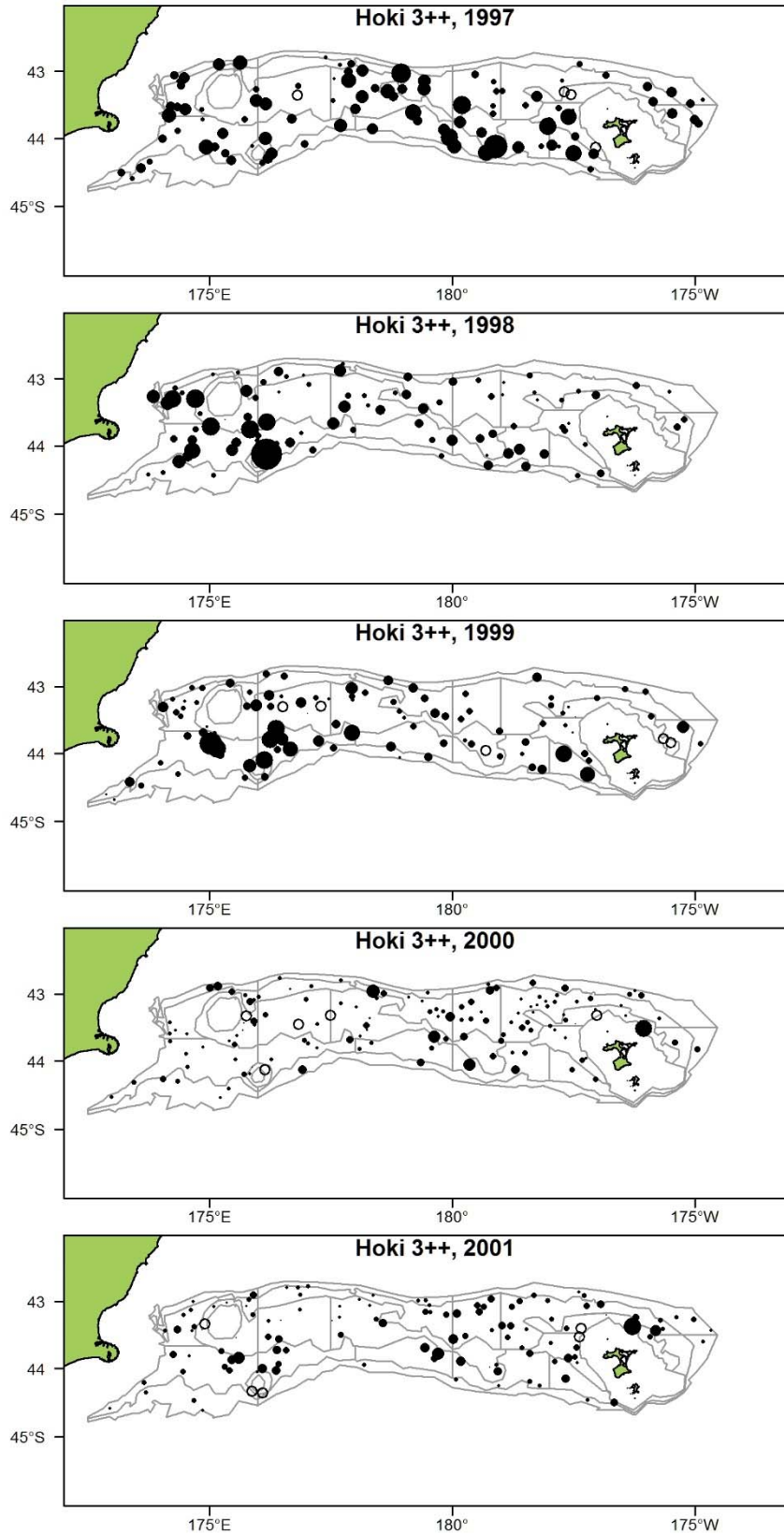


Figure 7c (continued)

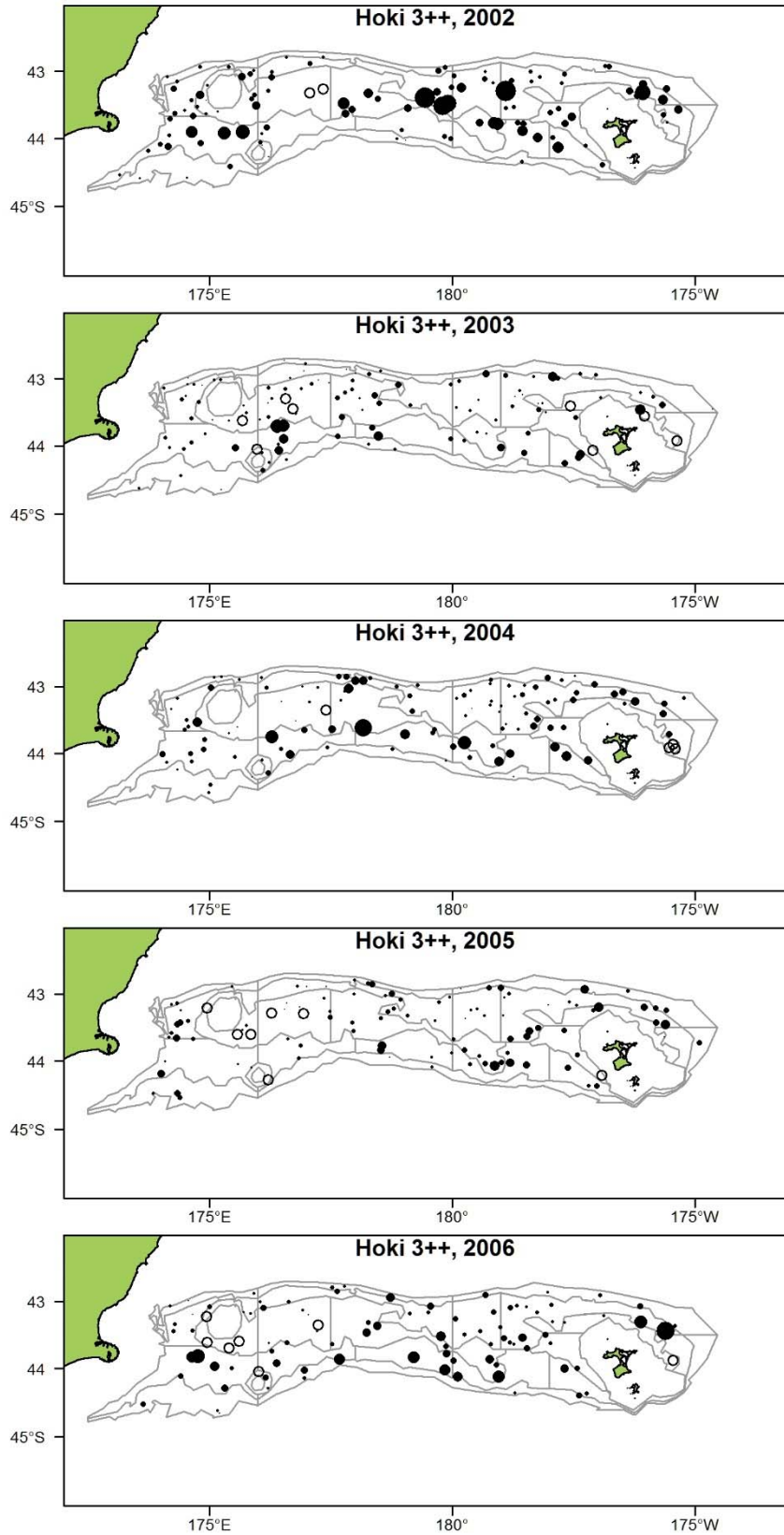


Figure 7c (continued)

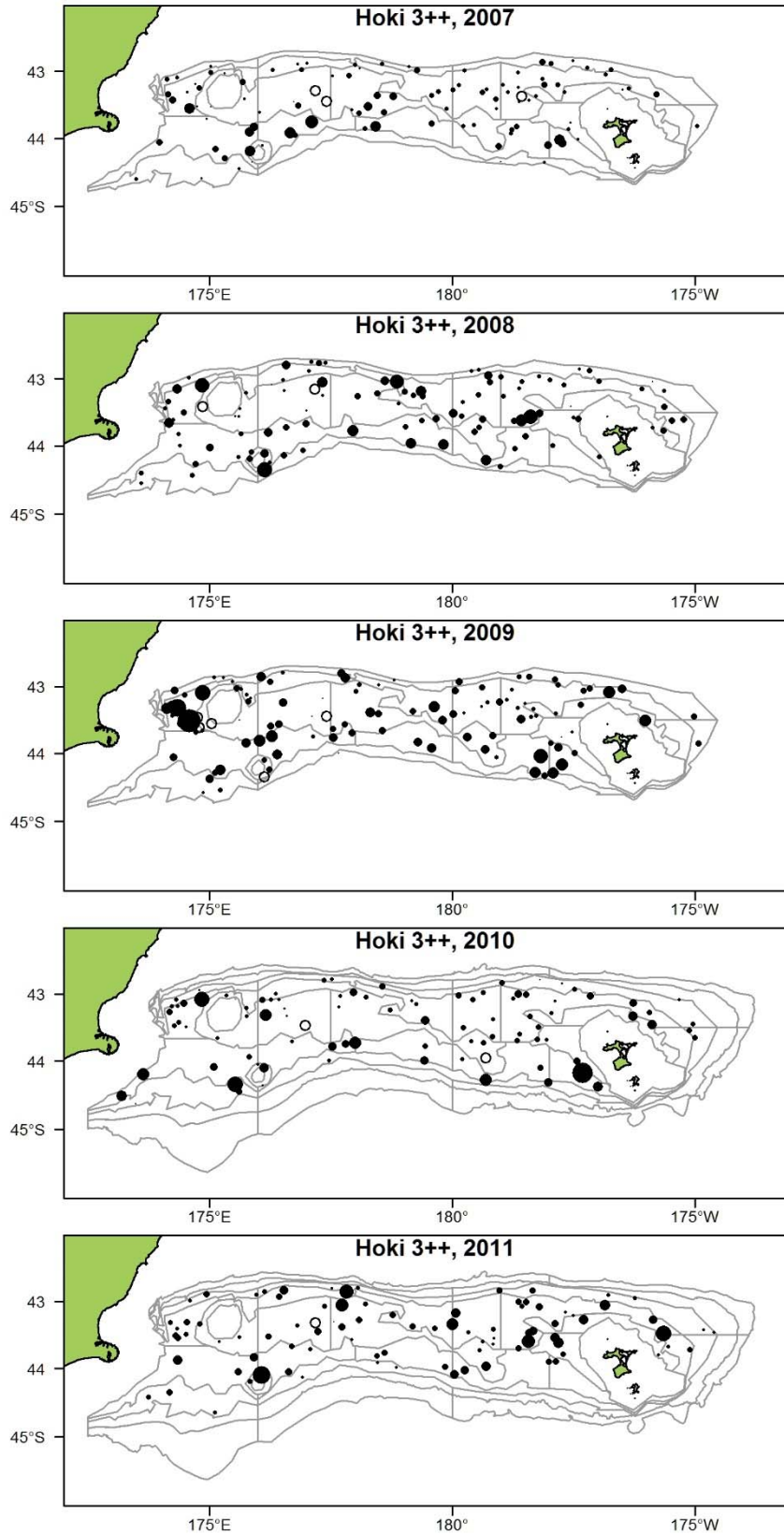


Figure 7c (continued)

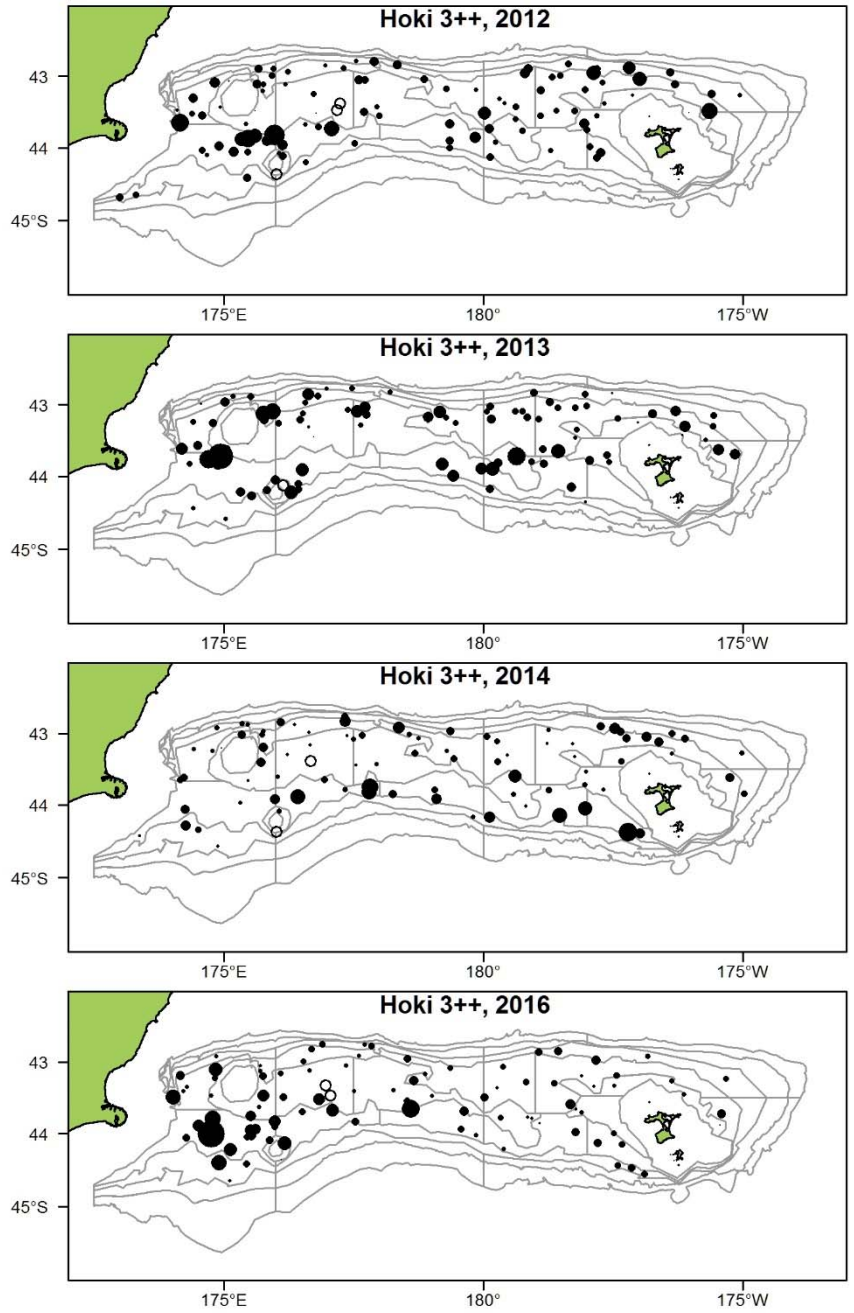


Figure 7c (continued)

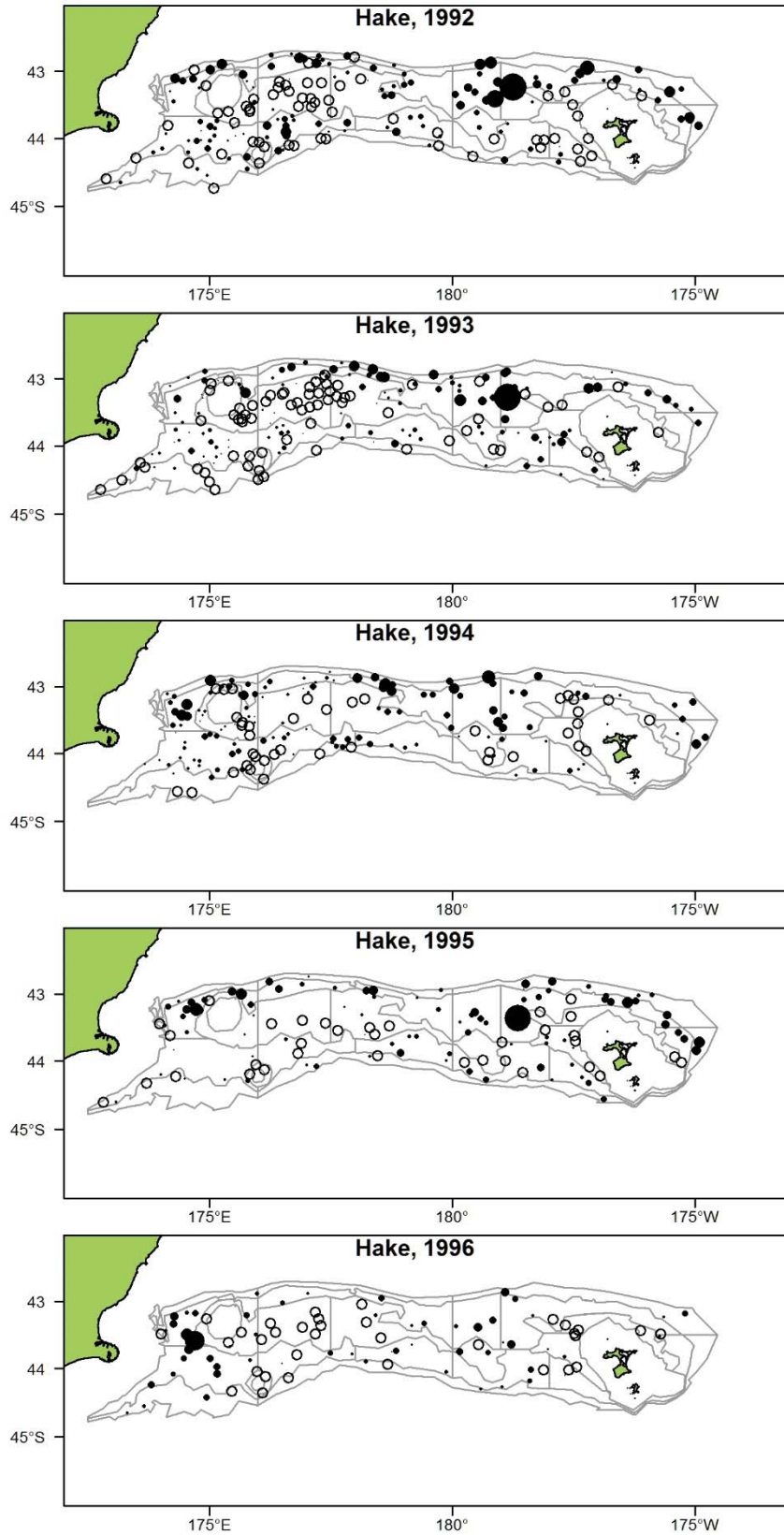


Figure 8: Hake catch distribution 1992–2014, and 2016. Filled circle area is proportional to catch rate (kg km⁻²). Open circles are zero catch. Maximum catch rate in series is 1320 kg km⁻².

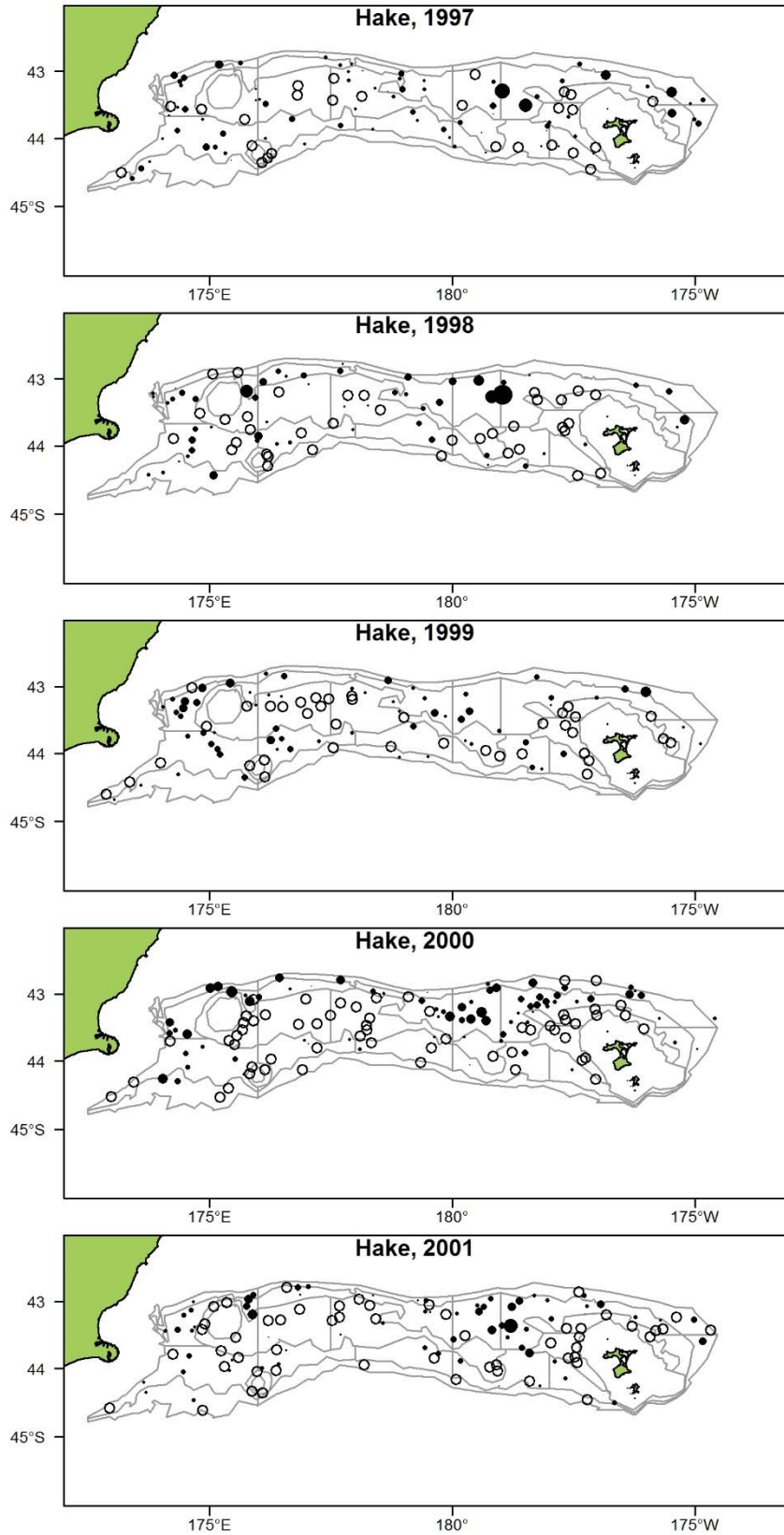


Figure 8 (continued)

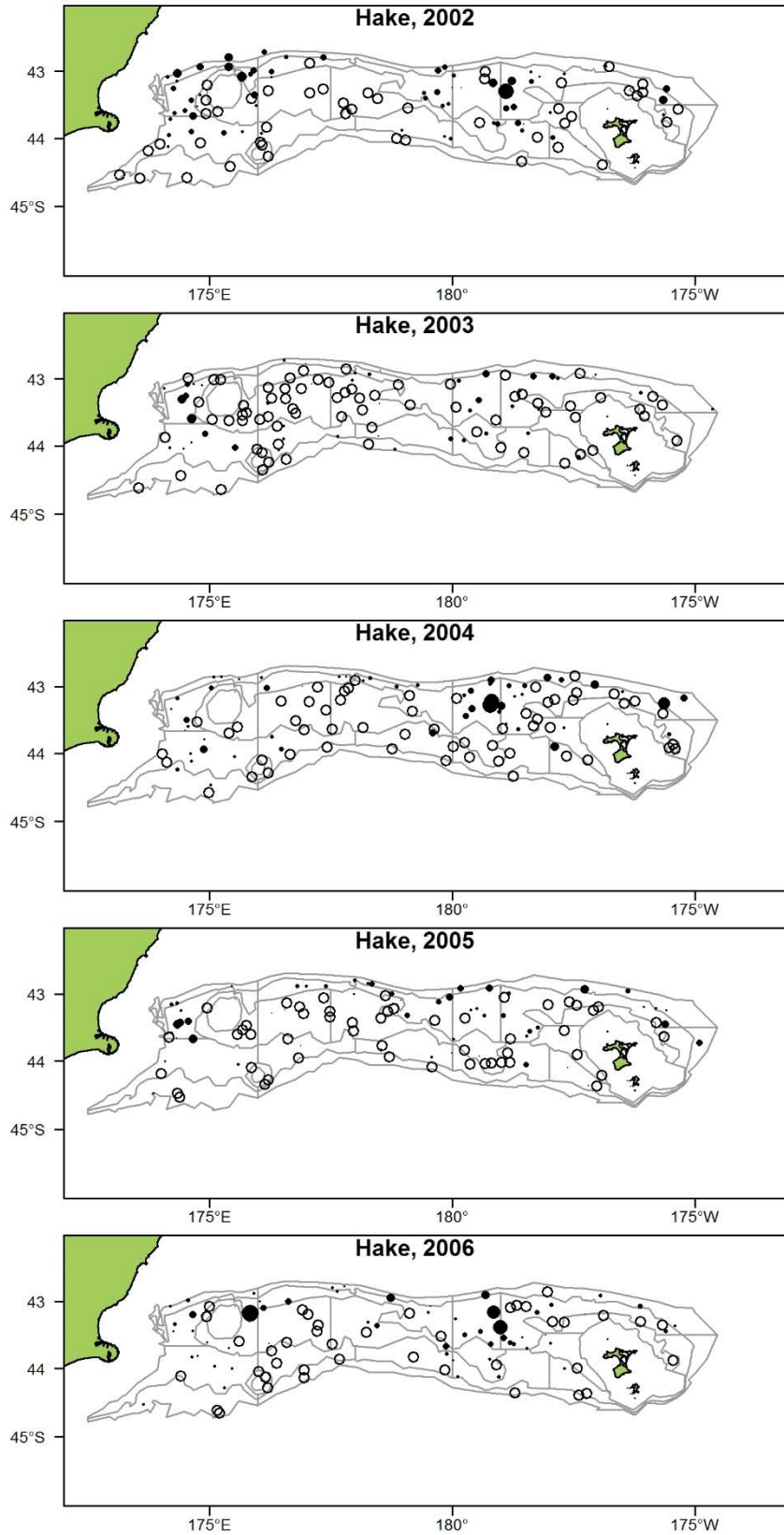


Figure 8 (continued)

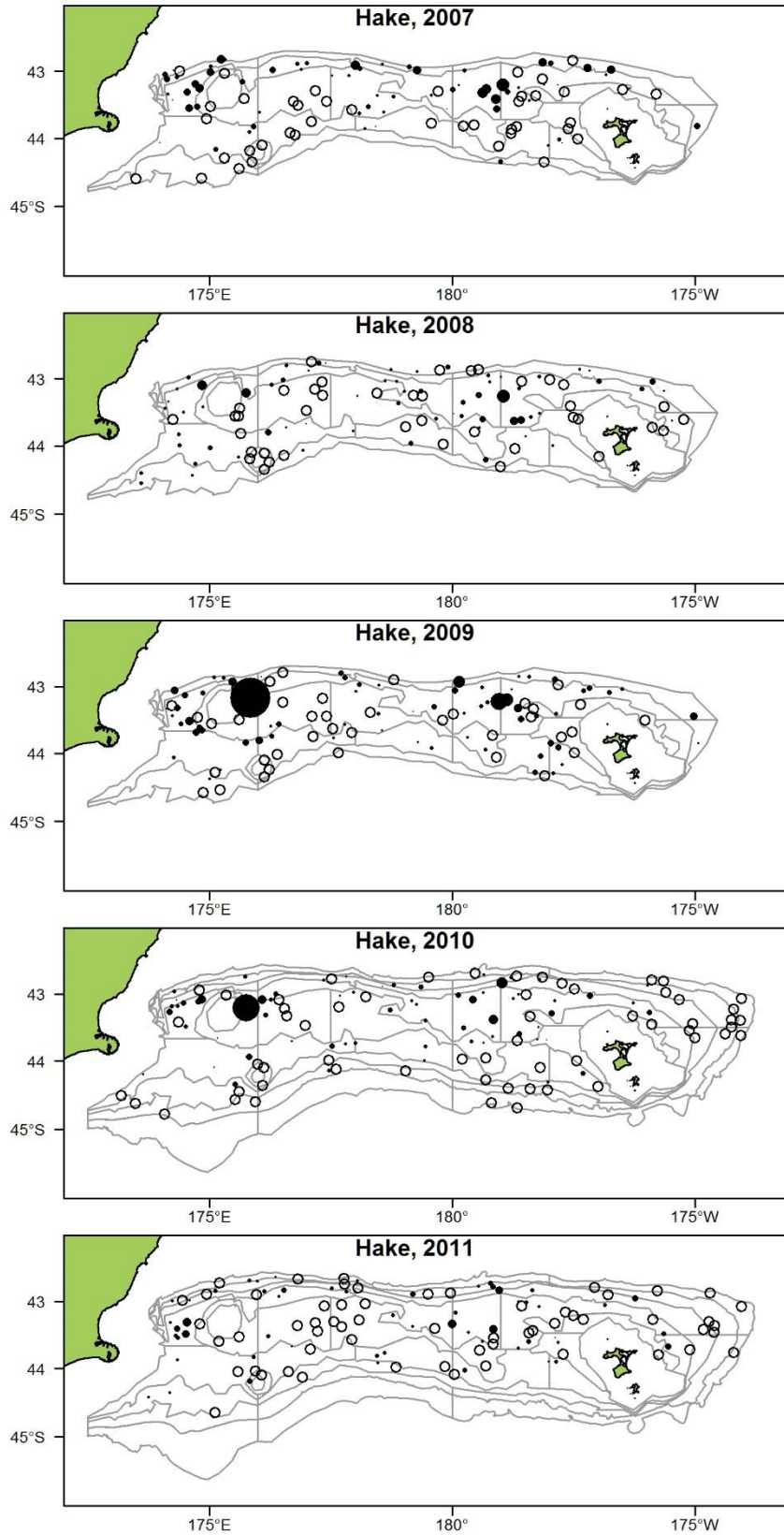


Figure 8 (continued)

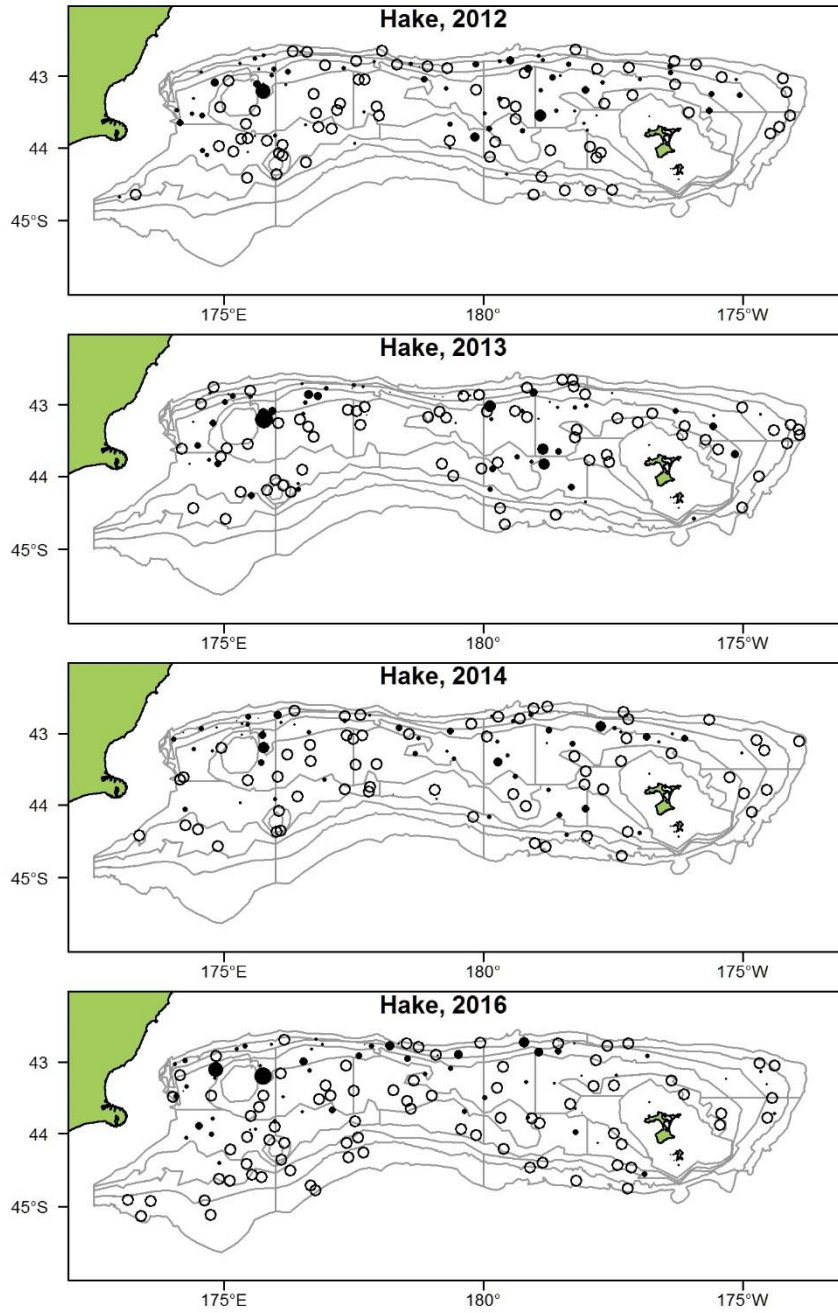


Figure 8 (continued)

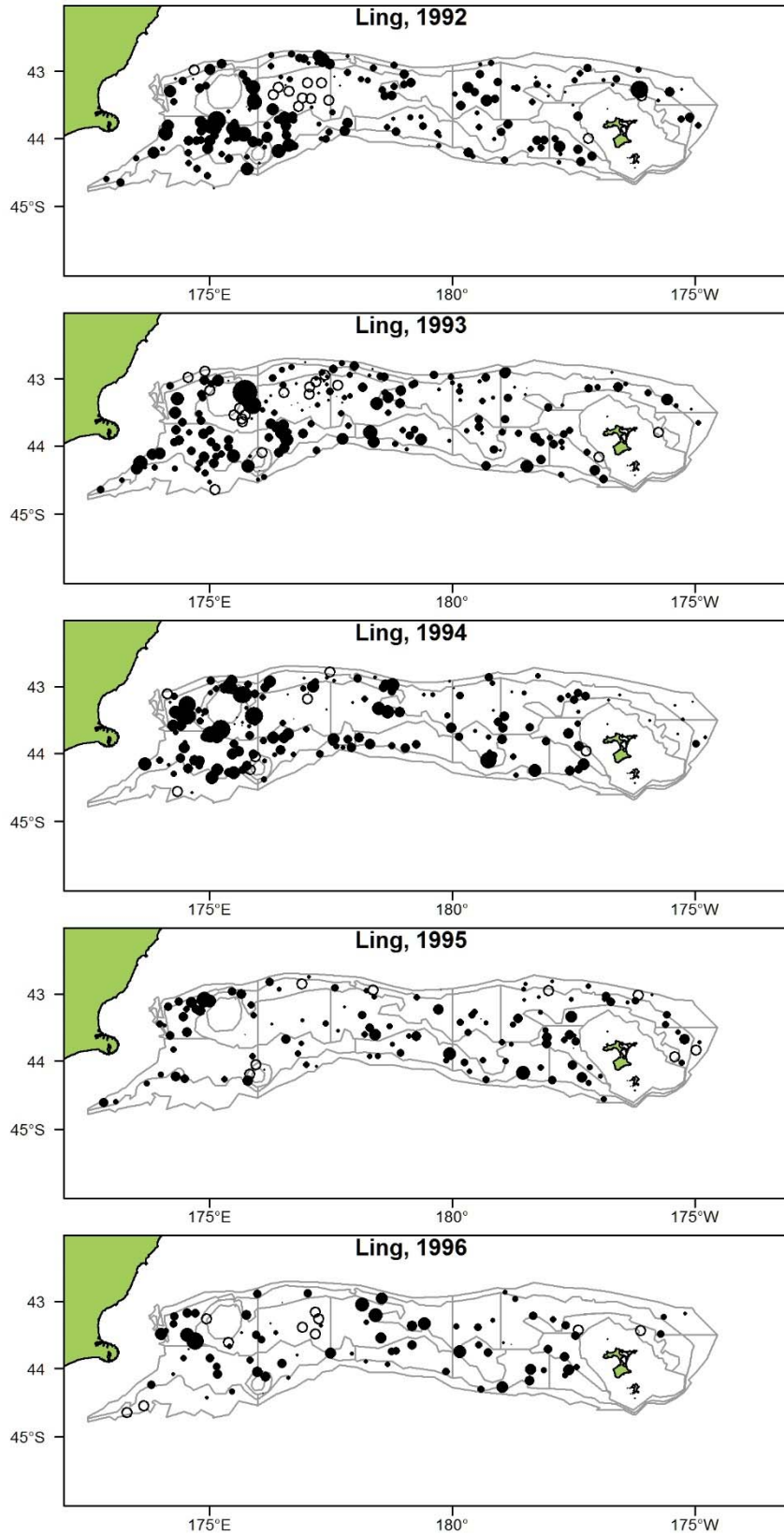


Figure 9: Ling catch distribution 1992–2014, and 2016. Filled circle area is proportional to catch rate (kg km⁻²). Open circles are zero catch. Maximum catch rate in series is 1786 kg km⁻².

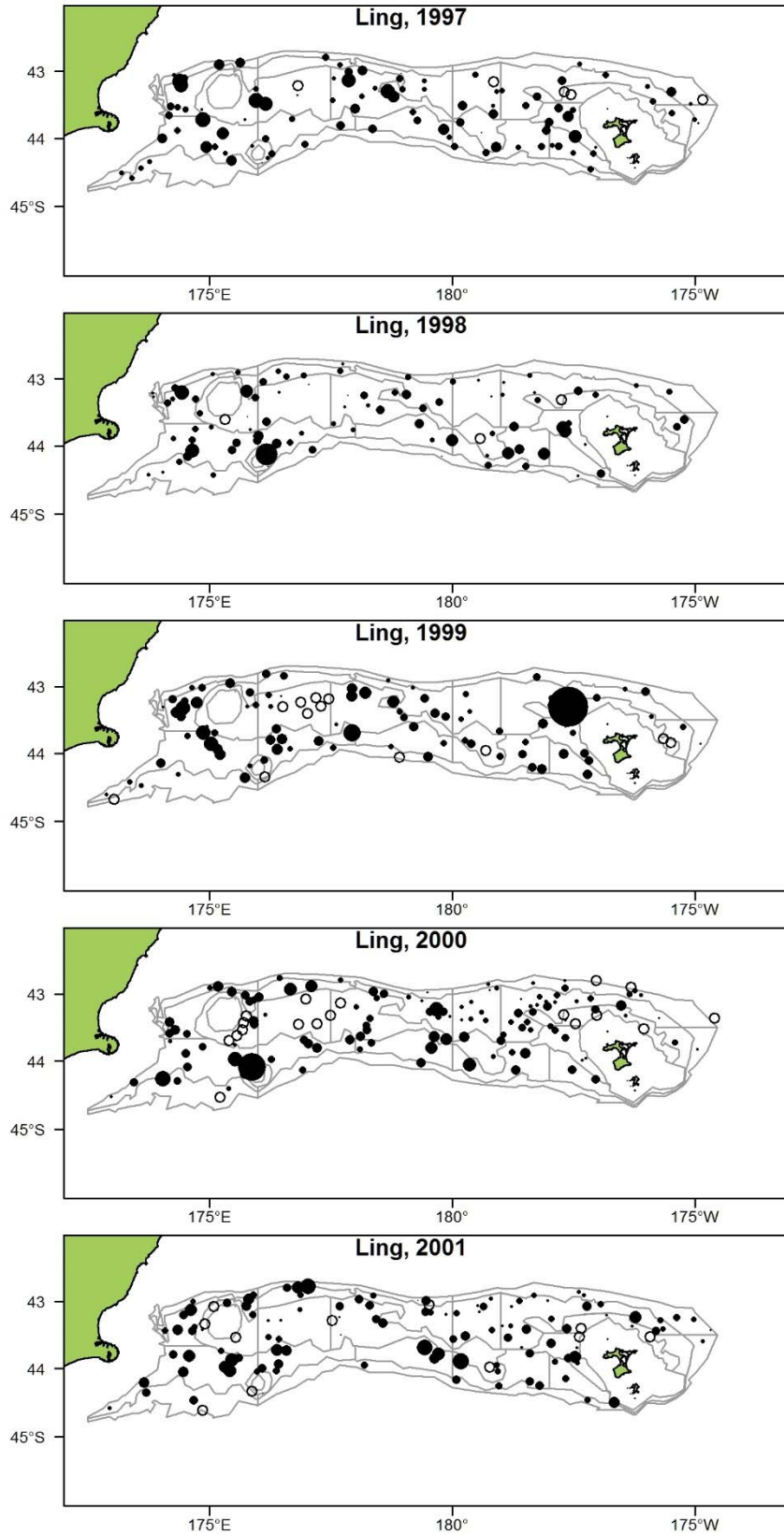


Figure 9 (continued)

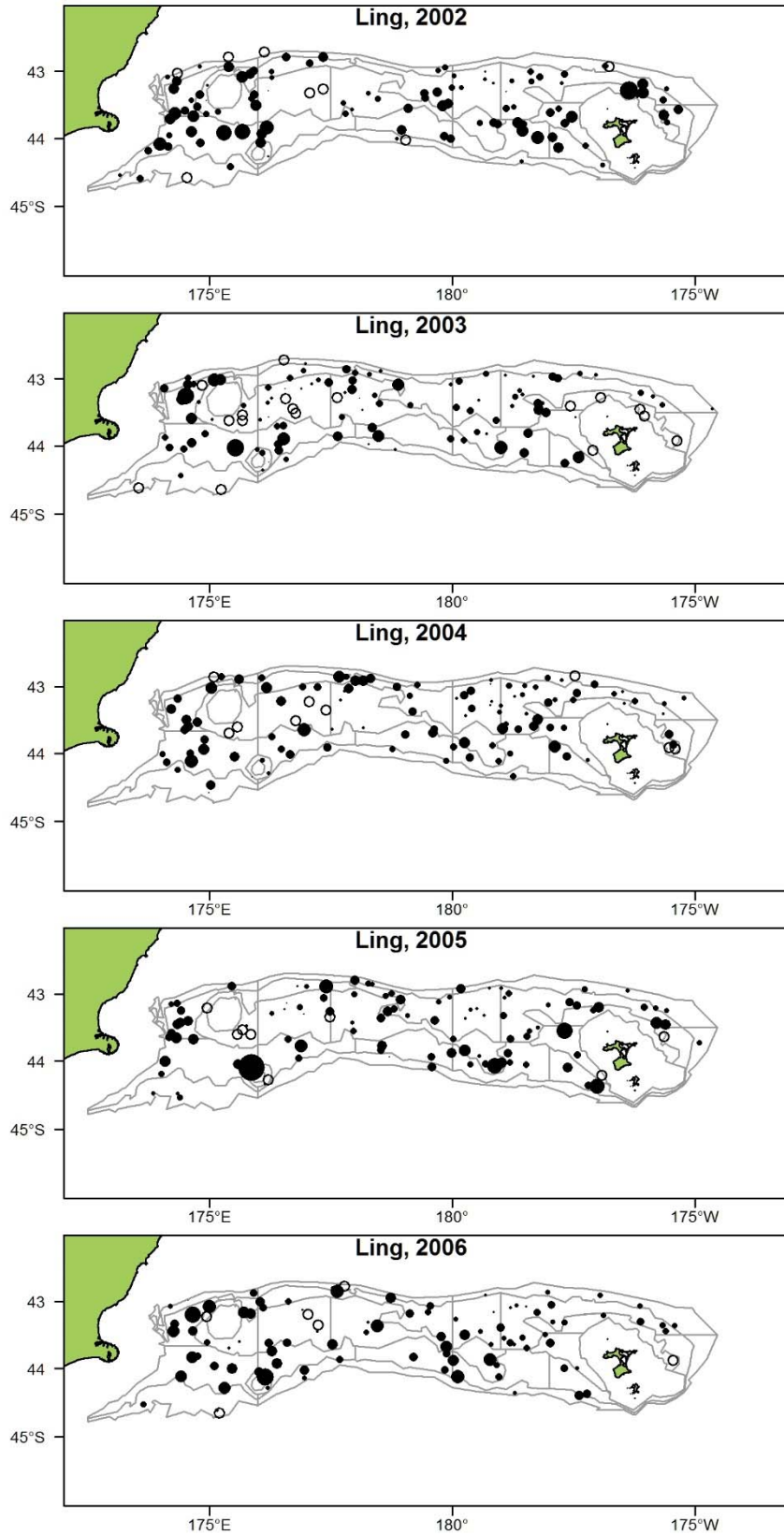


Figure 9 (continued)

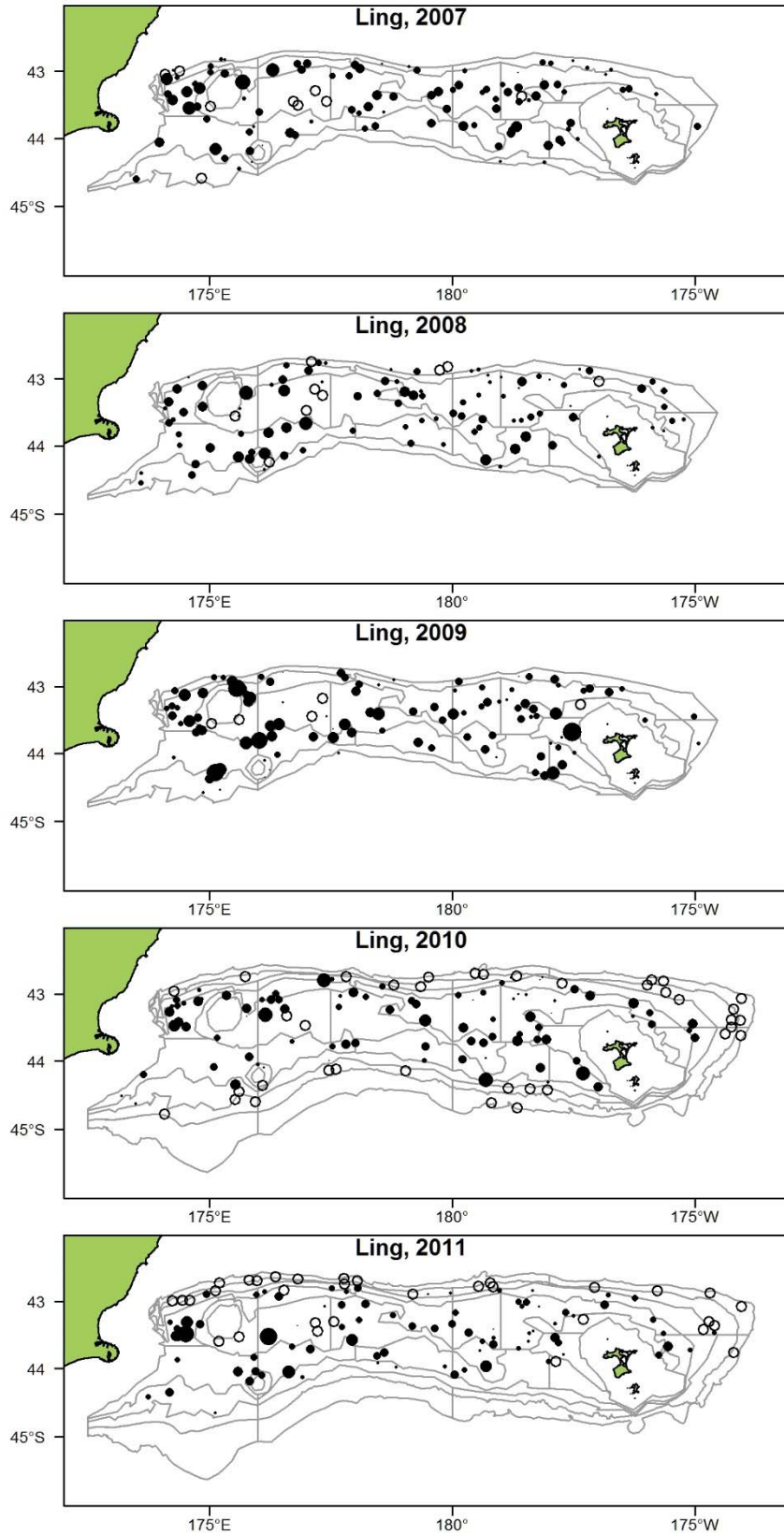


Figure 9 (continued)

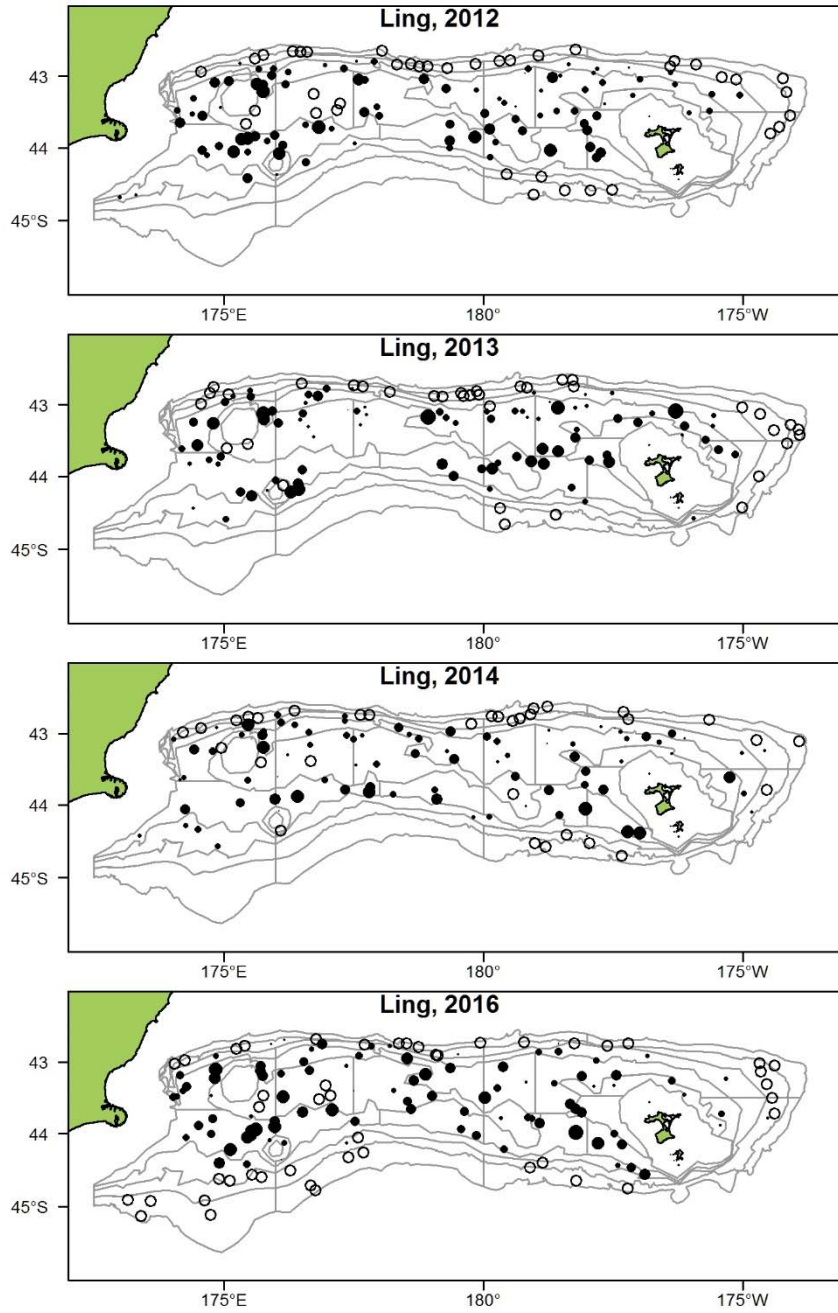


Figure 9 (continued)

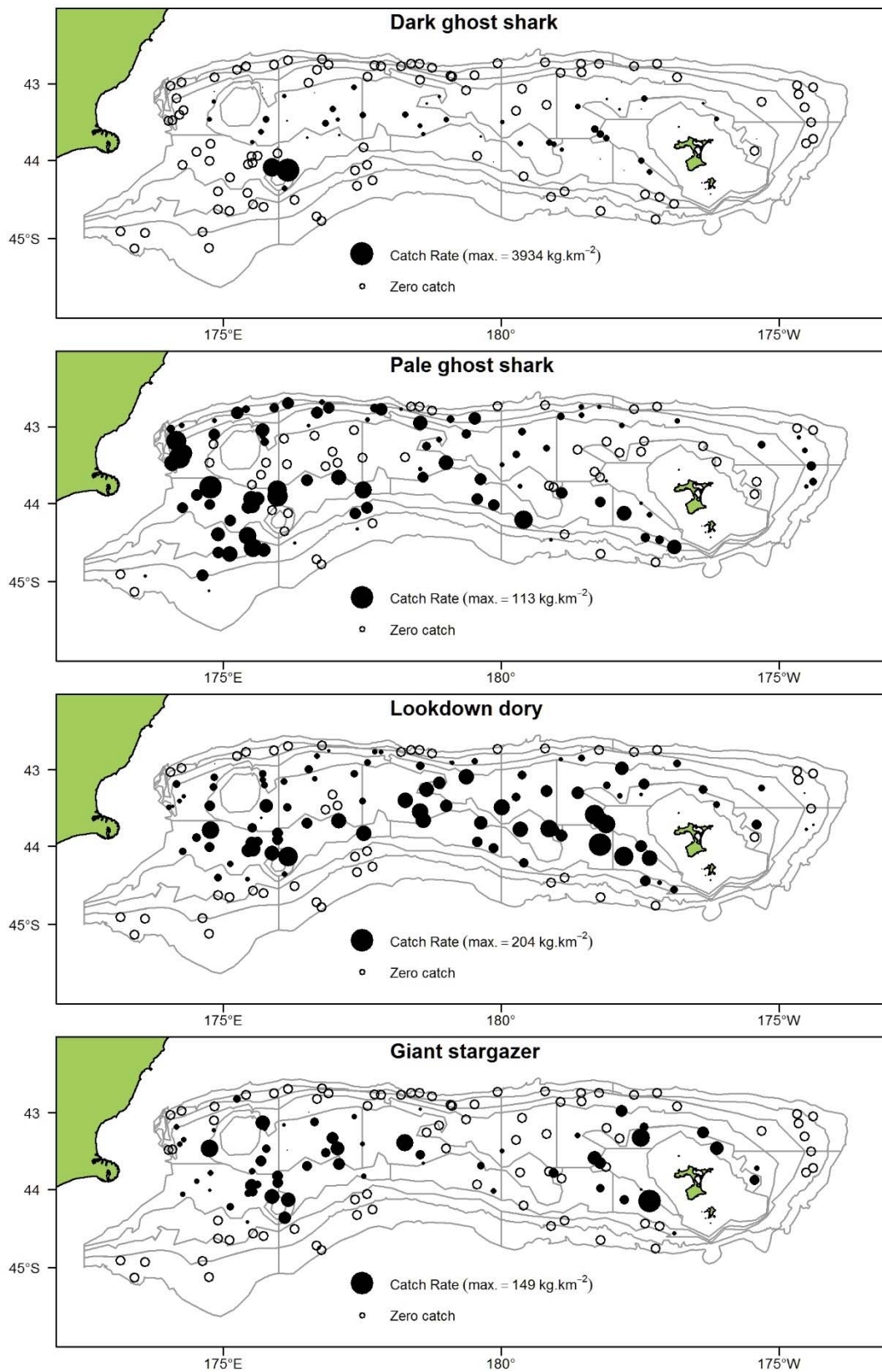


Figure 10: Catch rates (kg km⁻²) of selected core and deepwater commercial and bycatch species in 2016. Filled circle area is proportional to catch rate. Open circles are zero catch. (max., maximum catch rate).

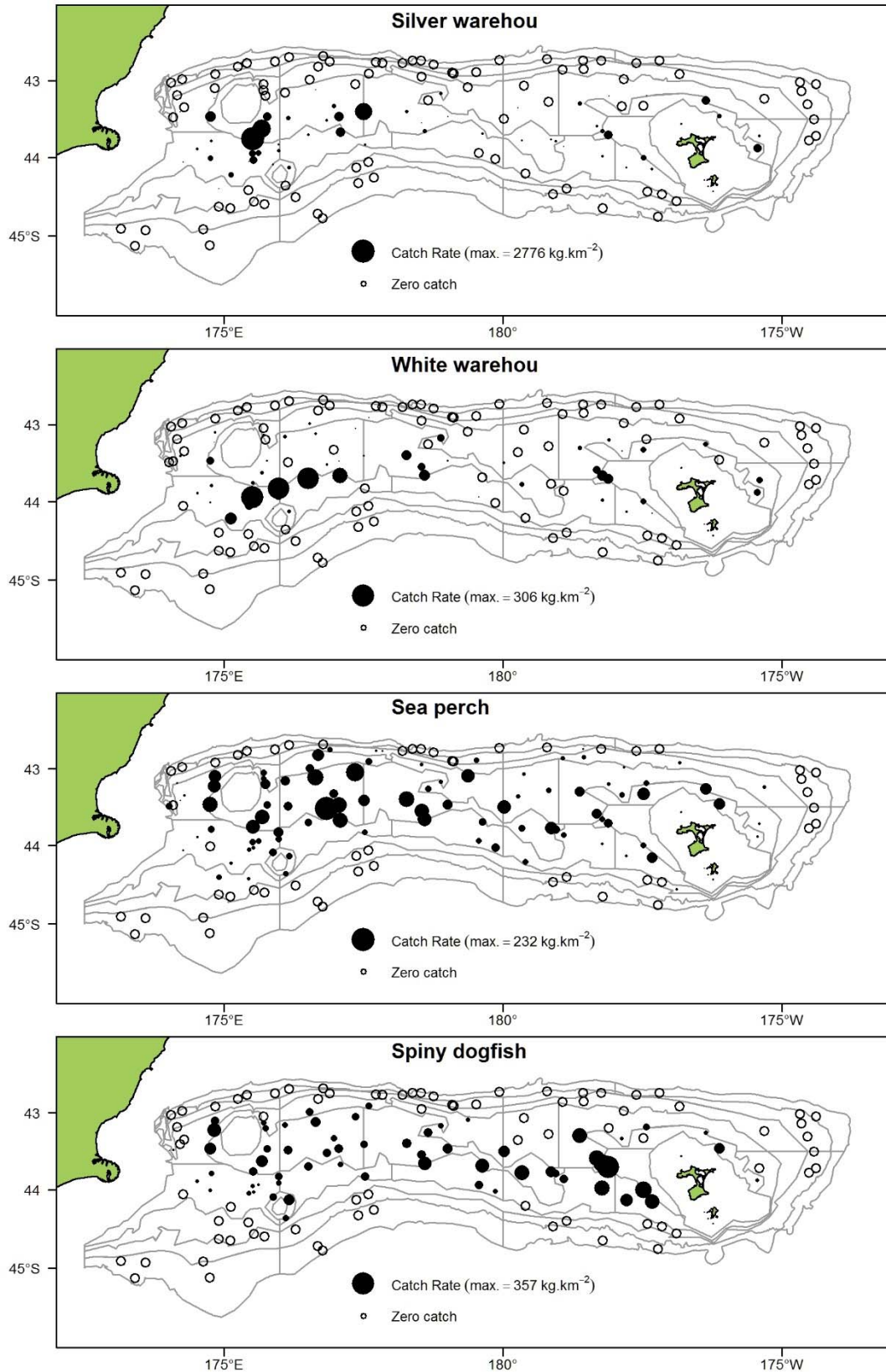


Figure 10 (continued)

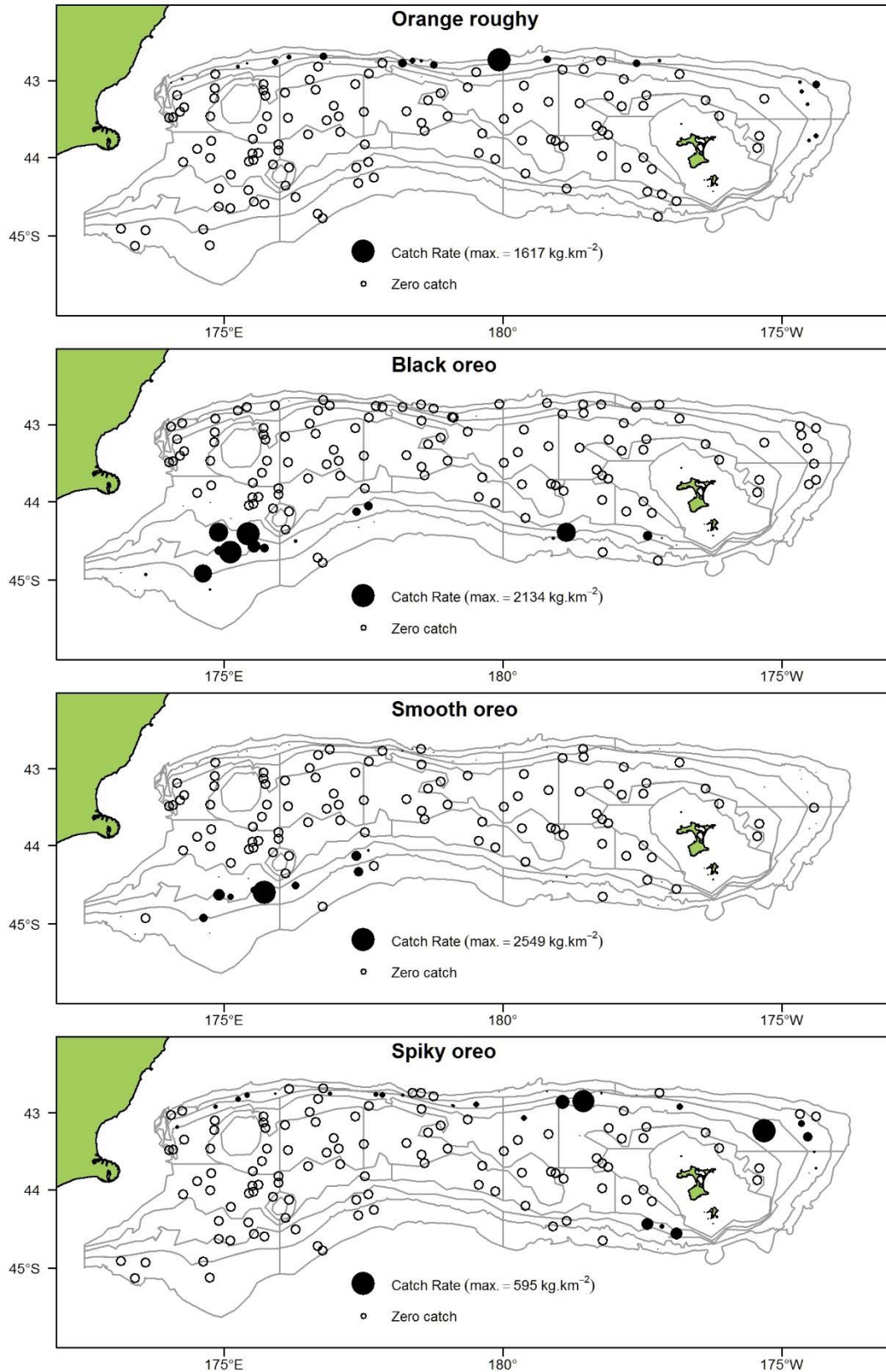


Figure 10 (continued)

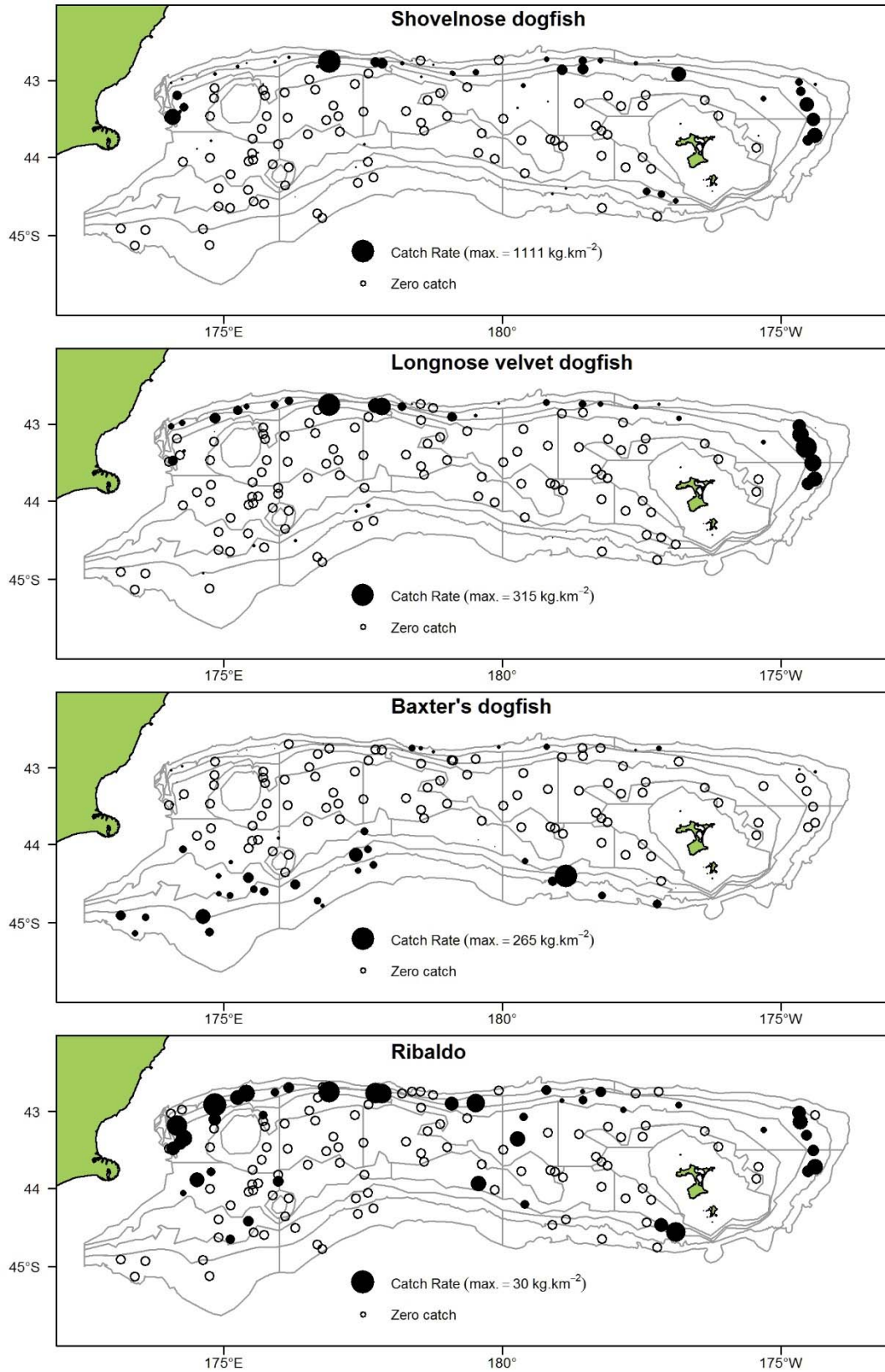


Figure 10 (continued)

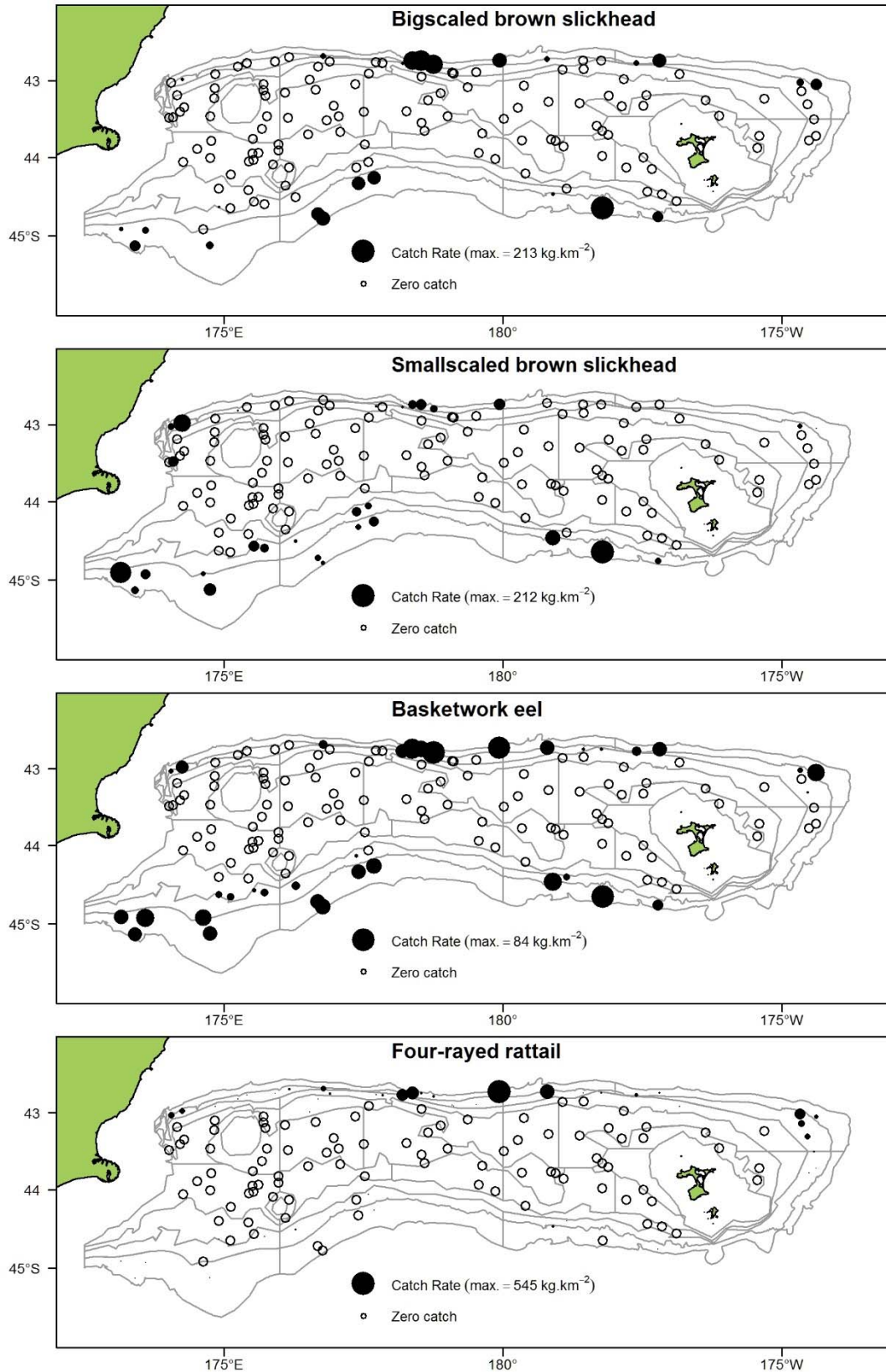


Figure 10 (continued)

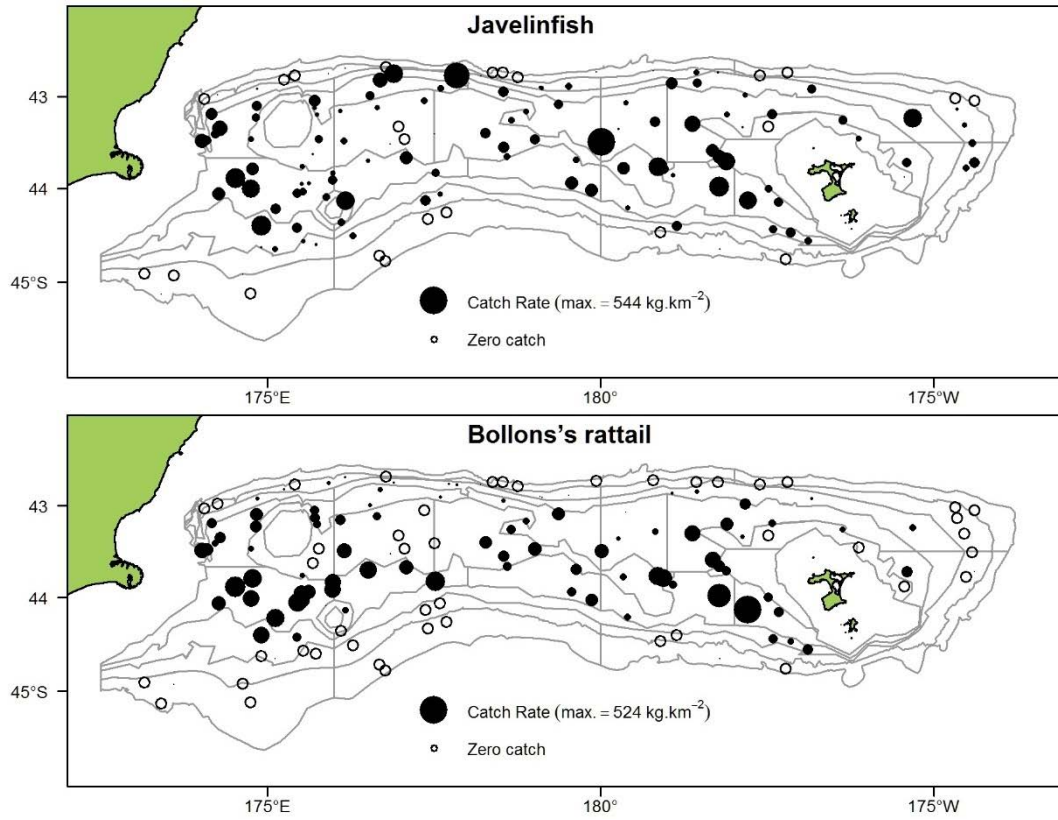


Figure 10 (continued)

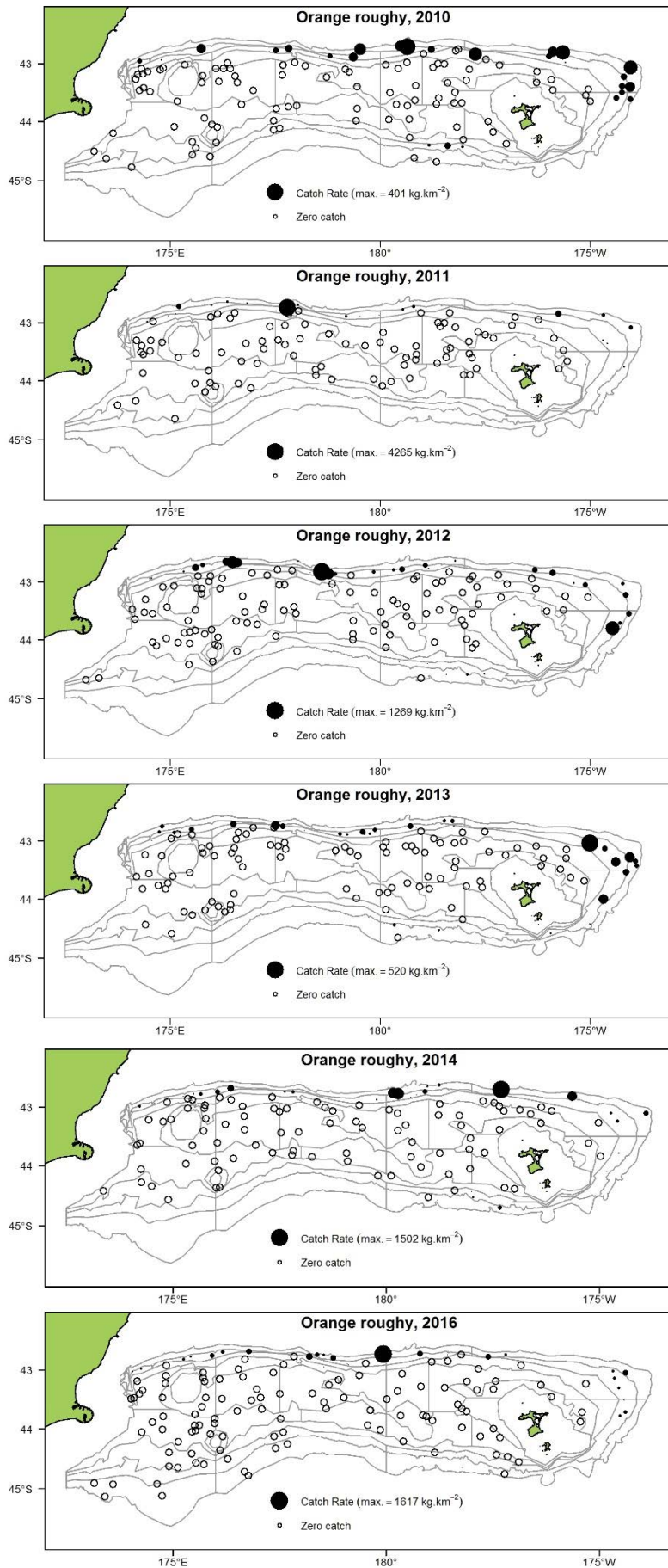


Figure 11: Orange roughy, black oreo, and smooth oreo catch distribution 1992-2014, and 2016. Filled circle area is proportional to catch rate (kg km²). Open circles are zero catch.

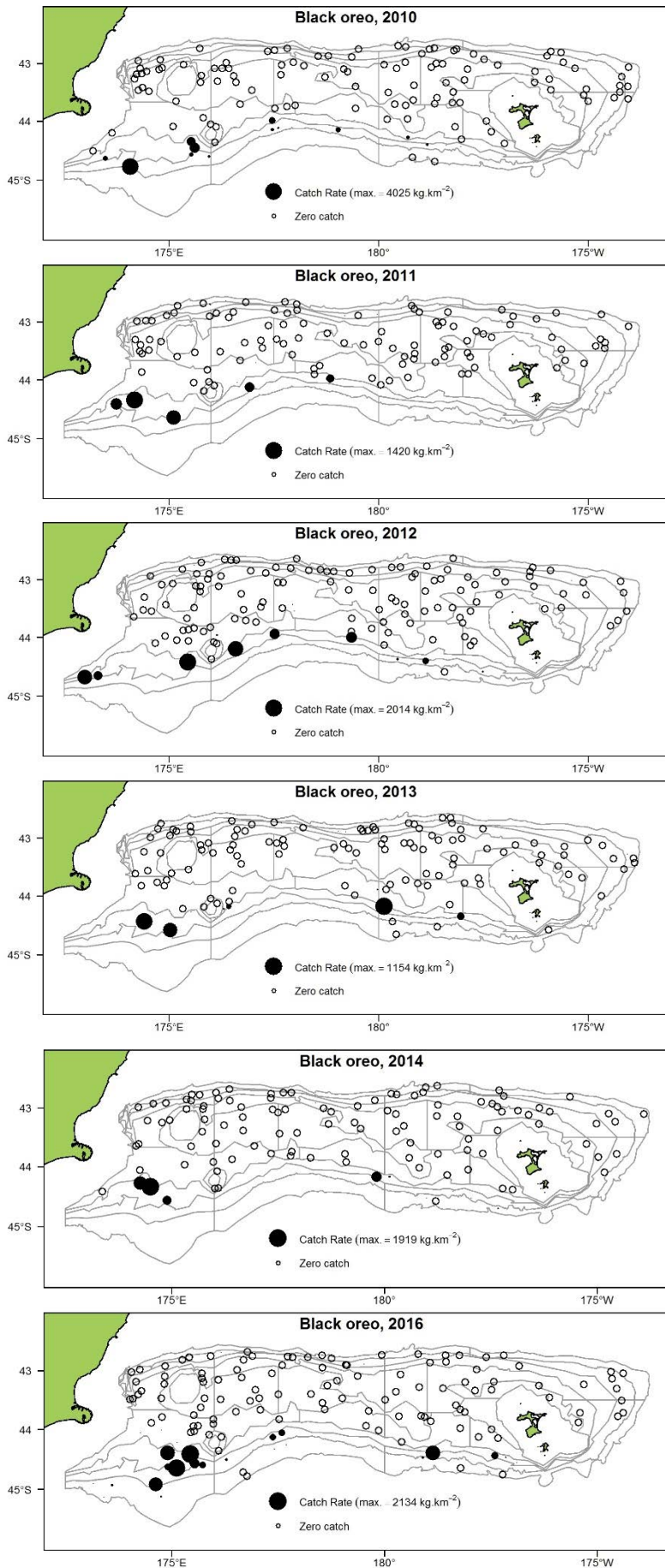


Figure 11 (continued)

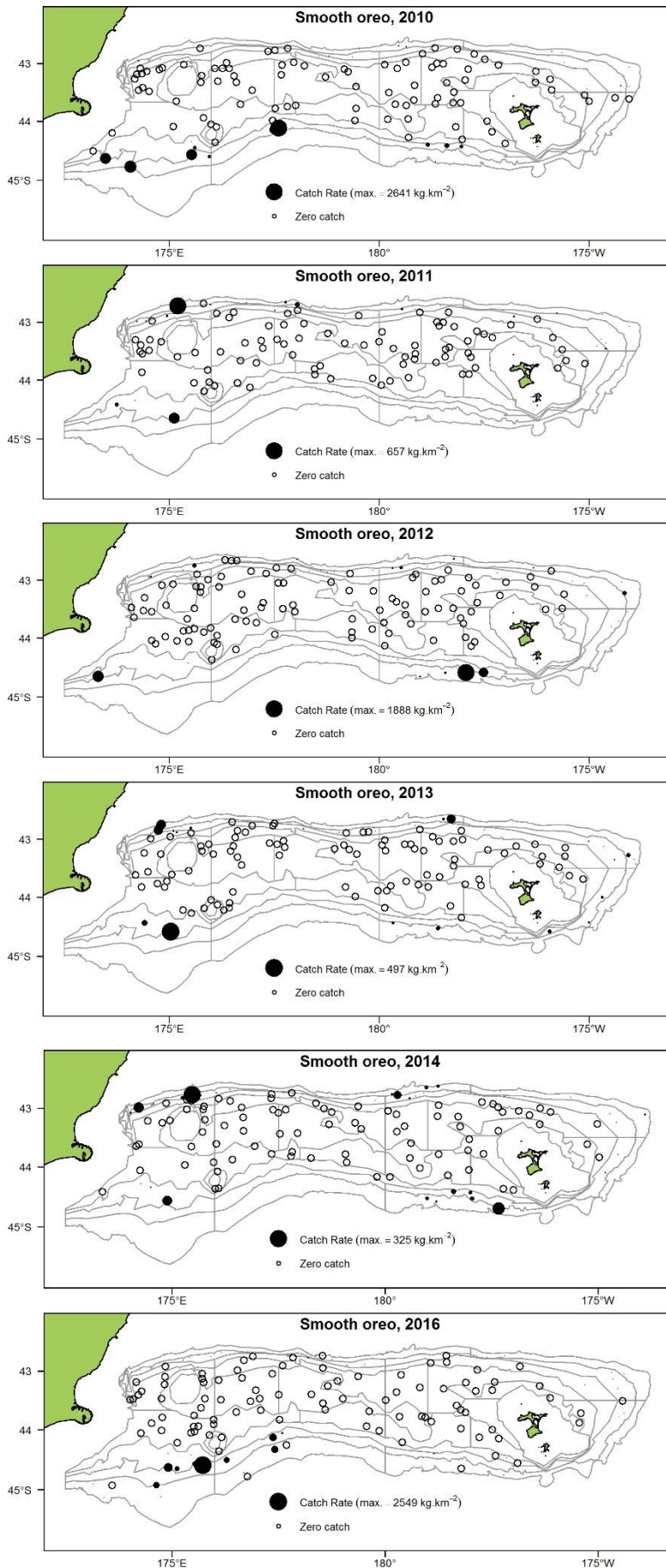


Figure 11 (continued)

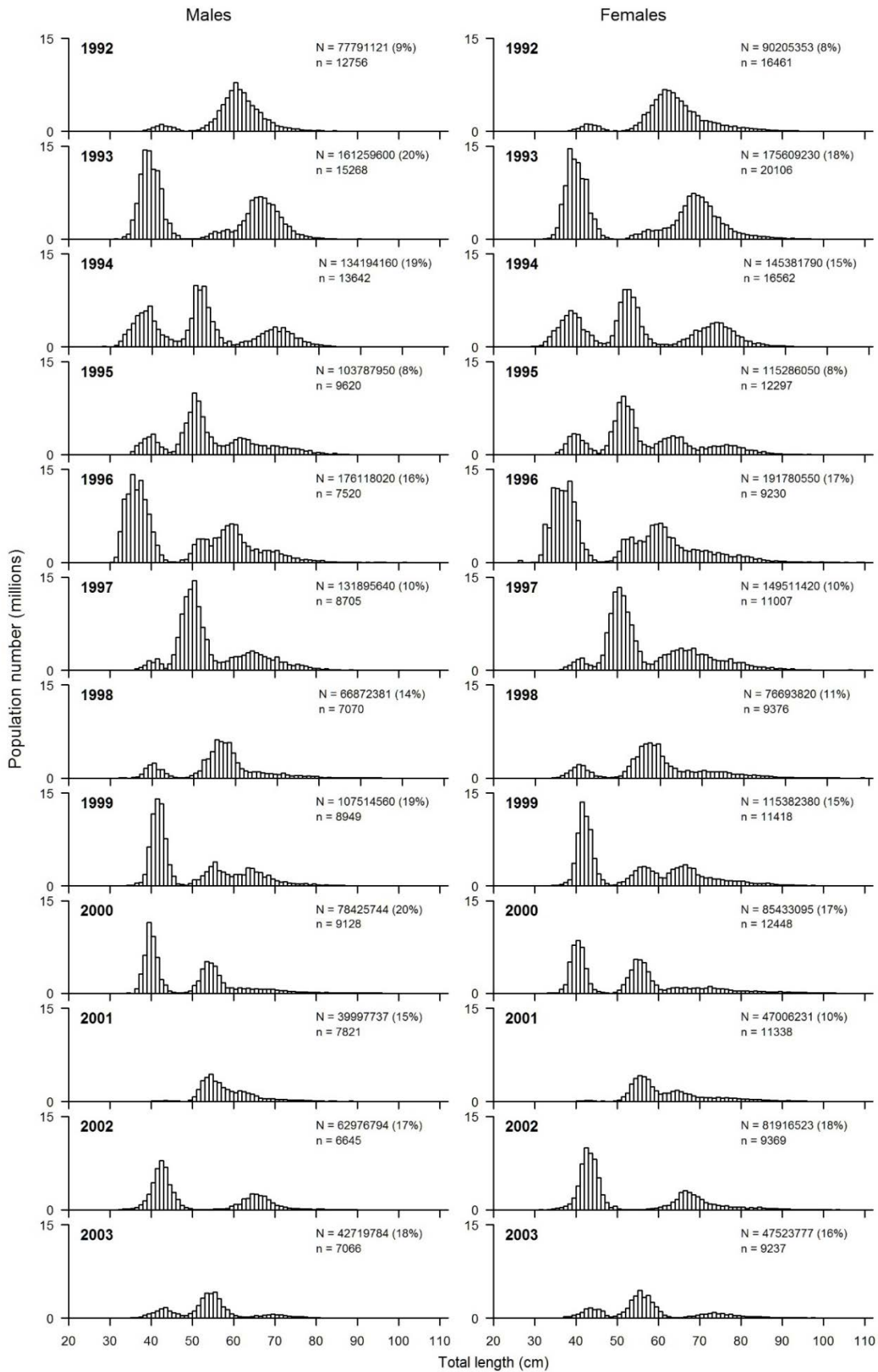


Figure 12: Estimated length frequency distributions of the male and female hoki population from *Tangaroa* surveys of the Chatham Rise, January 1992–2014, and 2016 for core strata. CV, coefficient of variation; n, estimated population number of male hoki (left panel) and female hoki (right panel); no., numbers of fish measured.

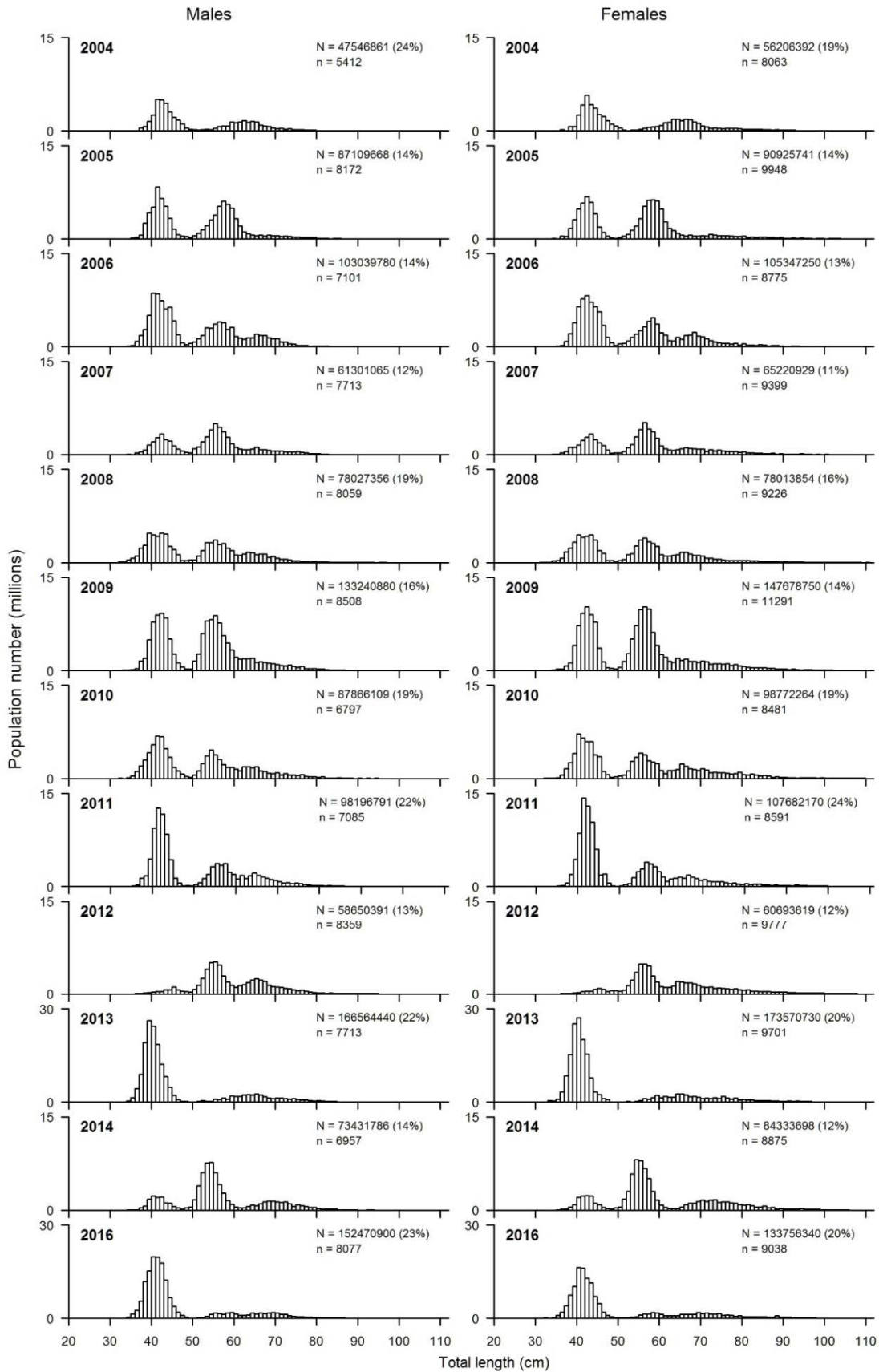


Figure 12 (continued). Note scale change for 2013 and 2016.

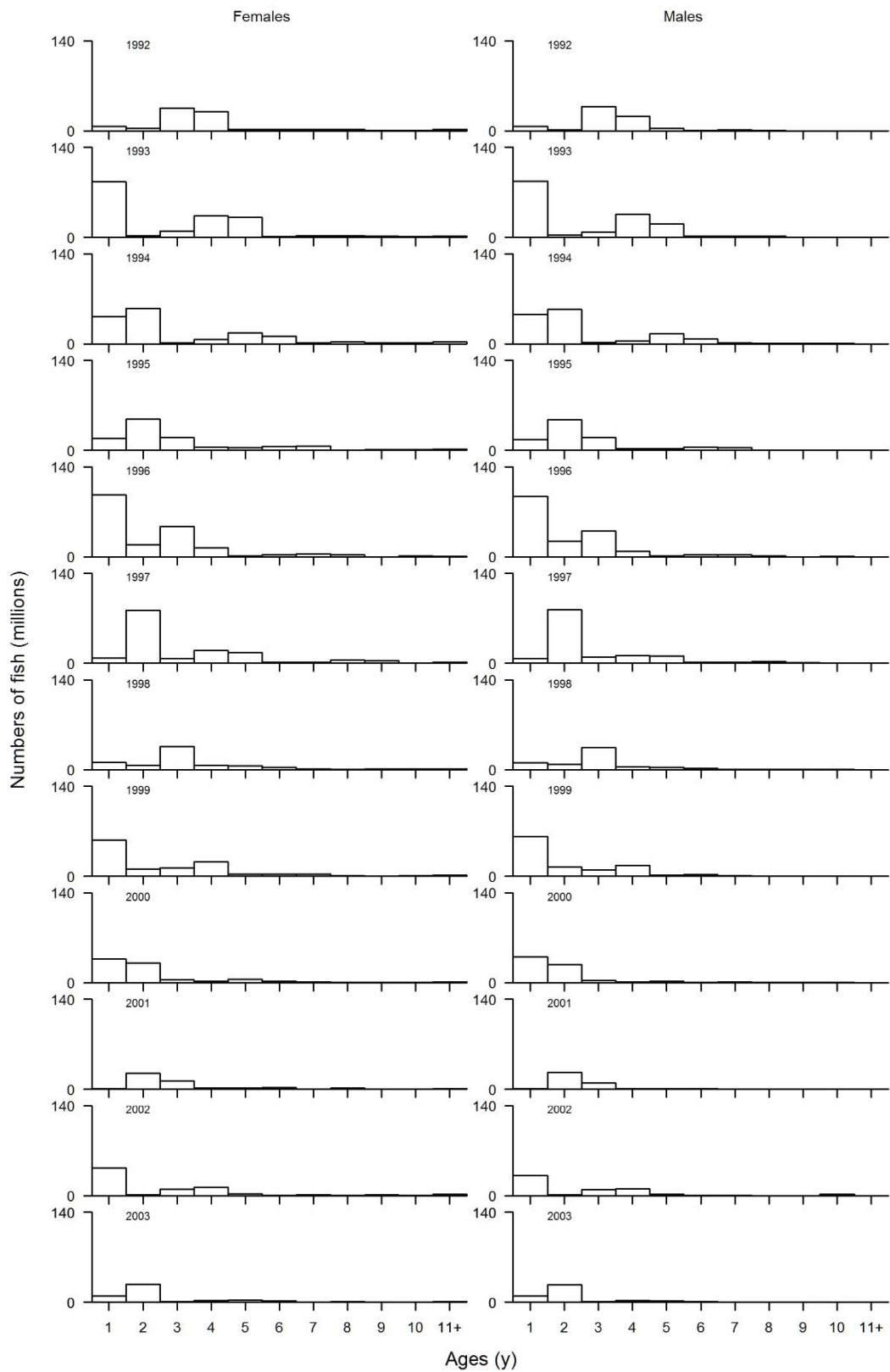


Figure 13: Estimated population numbers at age for hoki from *Tangaroa* surveys of the Chatham Rise, January, 1992–2014, and 2016. +, indicates plus group of combined ages.

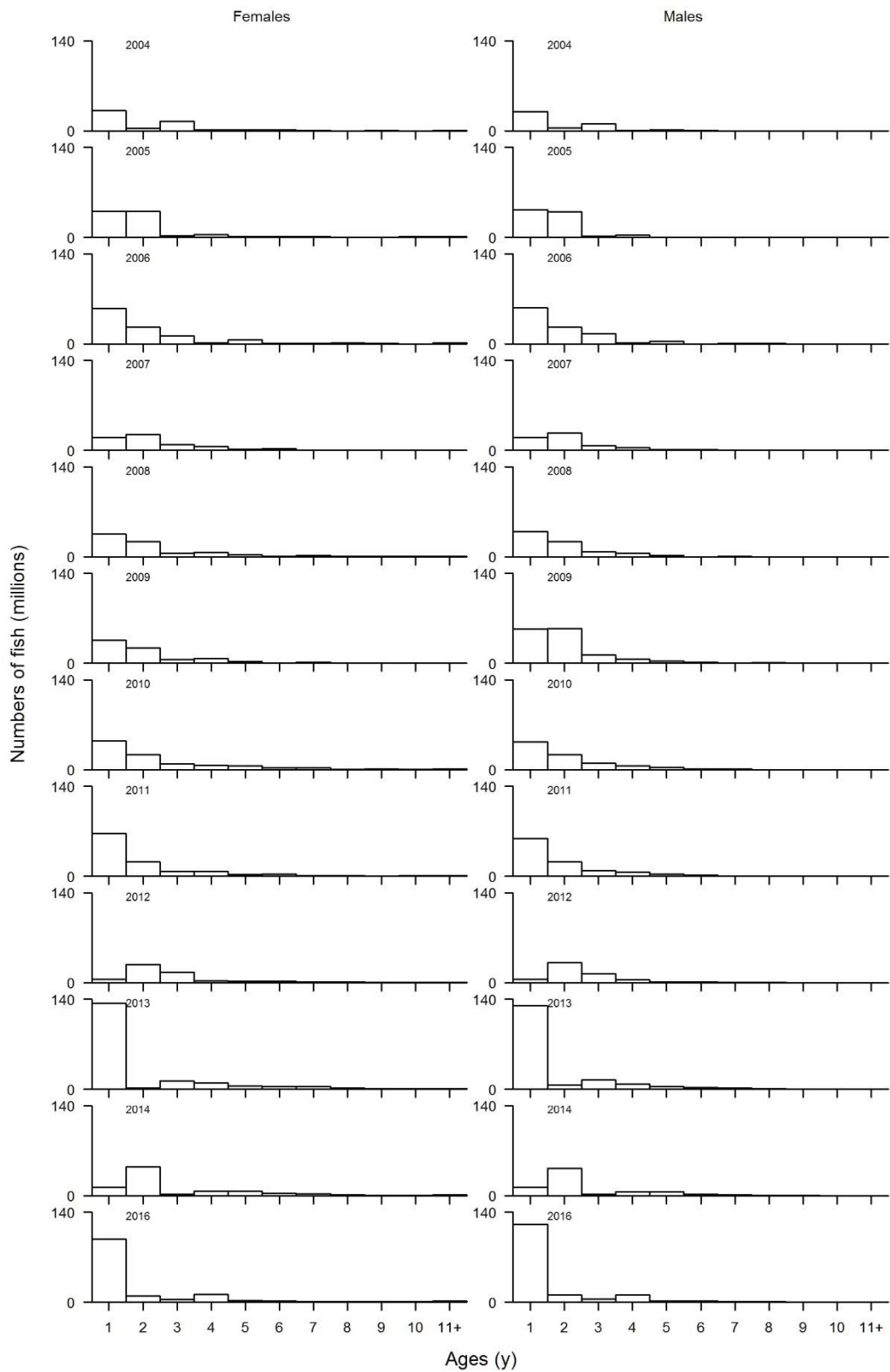


Figure 13 (continued)

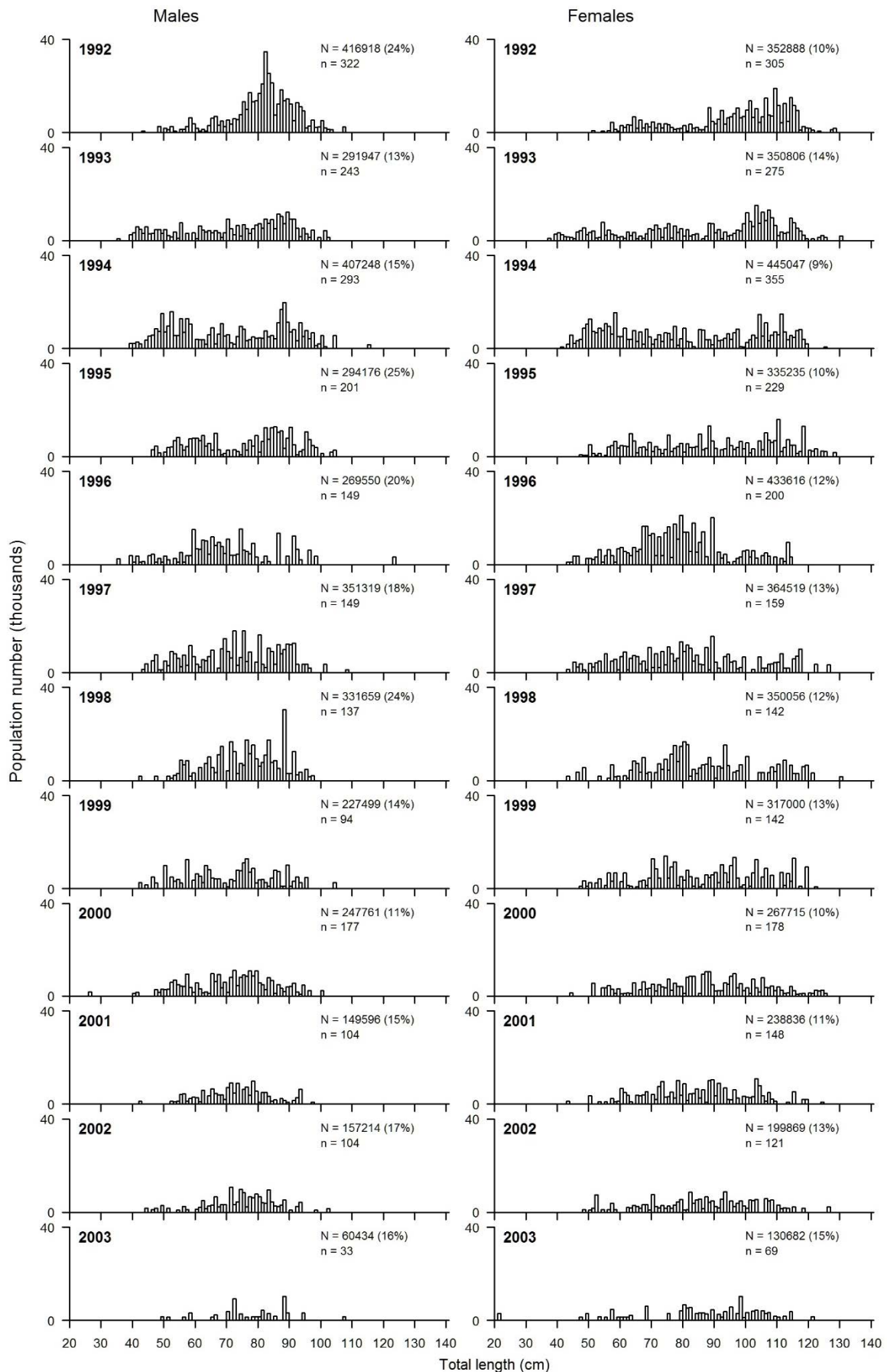


Figure 14: Estimated length frequency distributions of the male and female hake population from *Tangaroa* surveys of the Chatham Rise, January 1992–2014, and 2016 for core strata. CV, coefficient of variation; n, estimated population number of hake; no., numbers of fish measured.

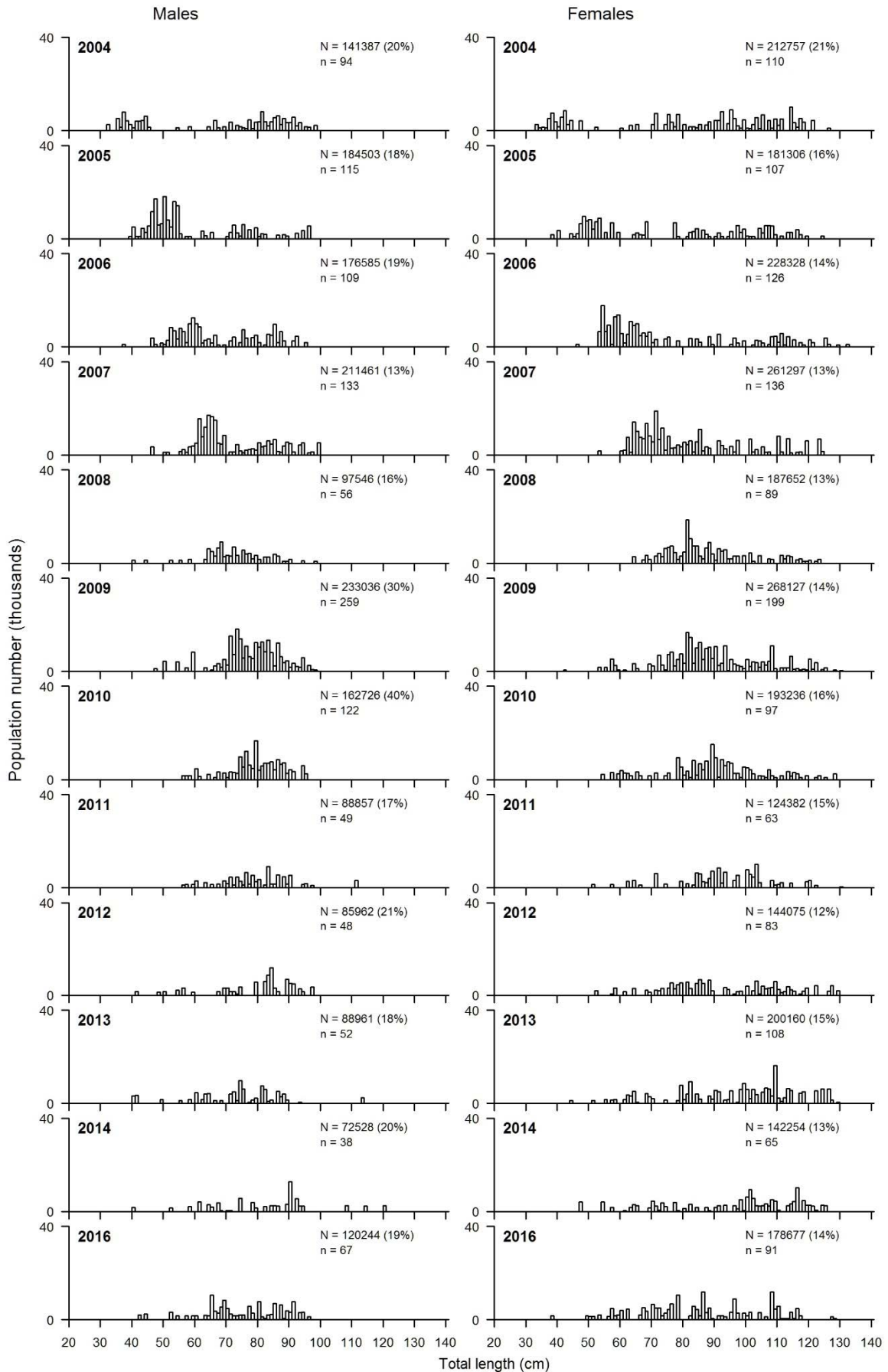


Figure 14 (continued)

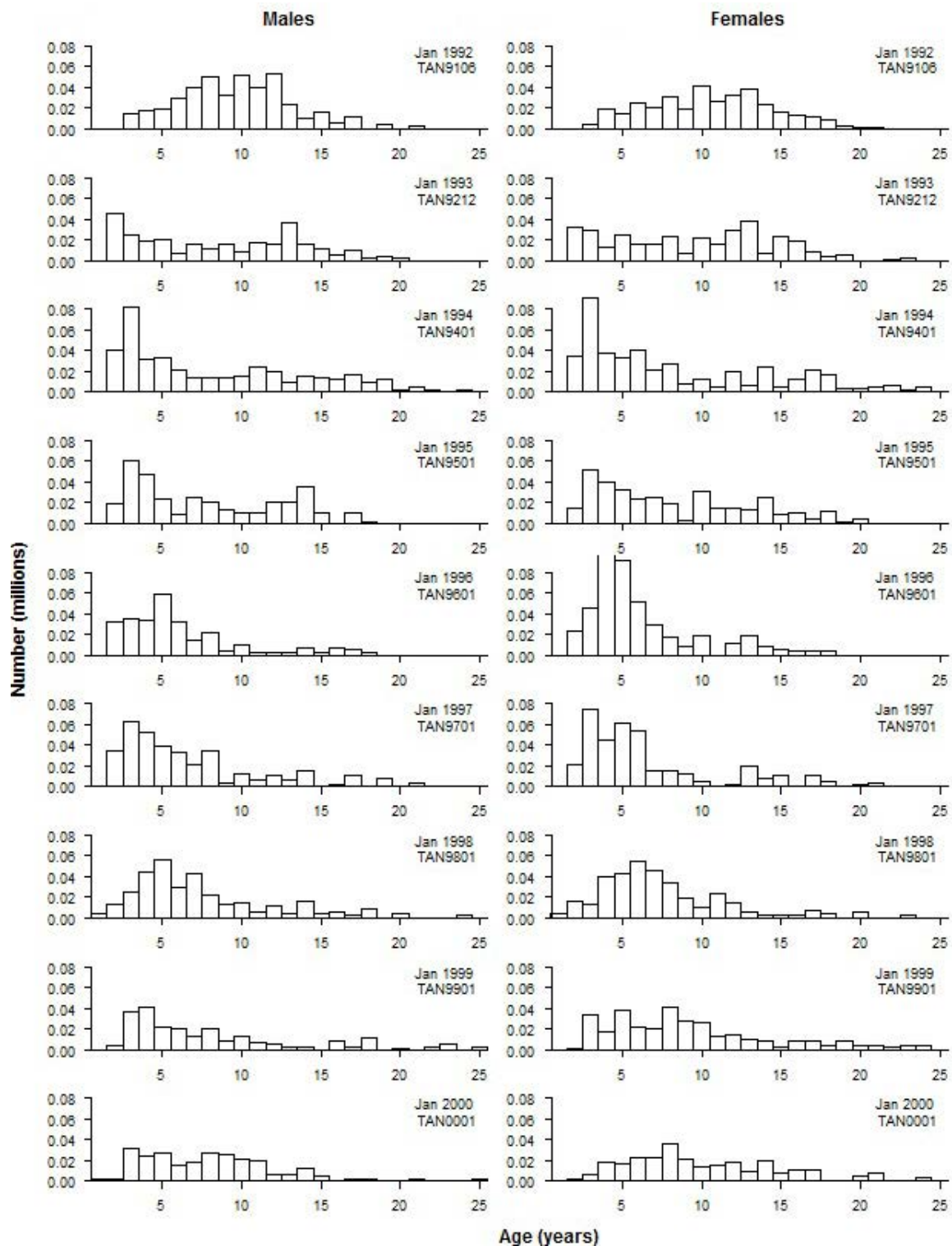


Figure 15: Estimated proportion at age for male and female hake from *Tangaroa* surveys of the Chatham Rise, January, 1992–2014, and 2016.

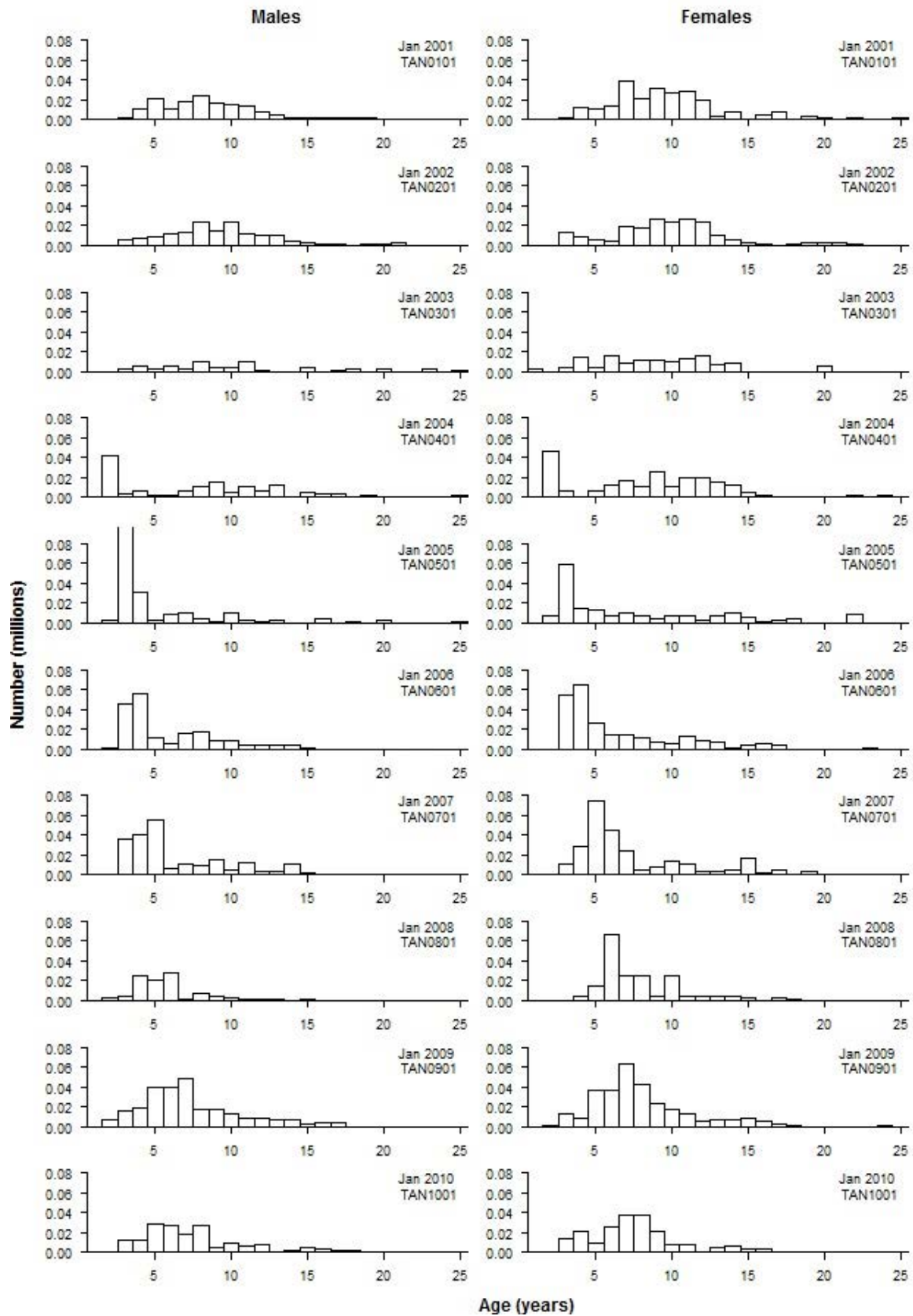


Figure 15 (continued)

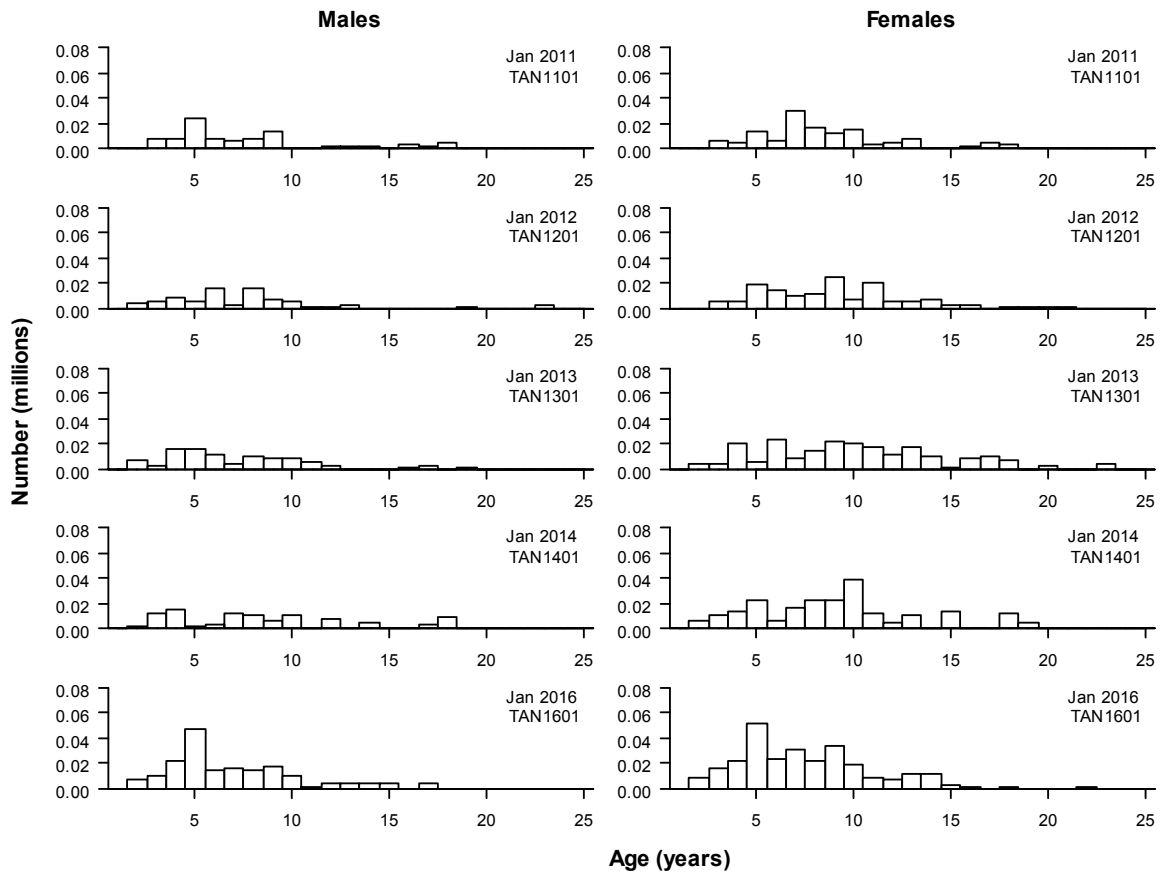


Figure 15 (continued)

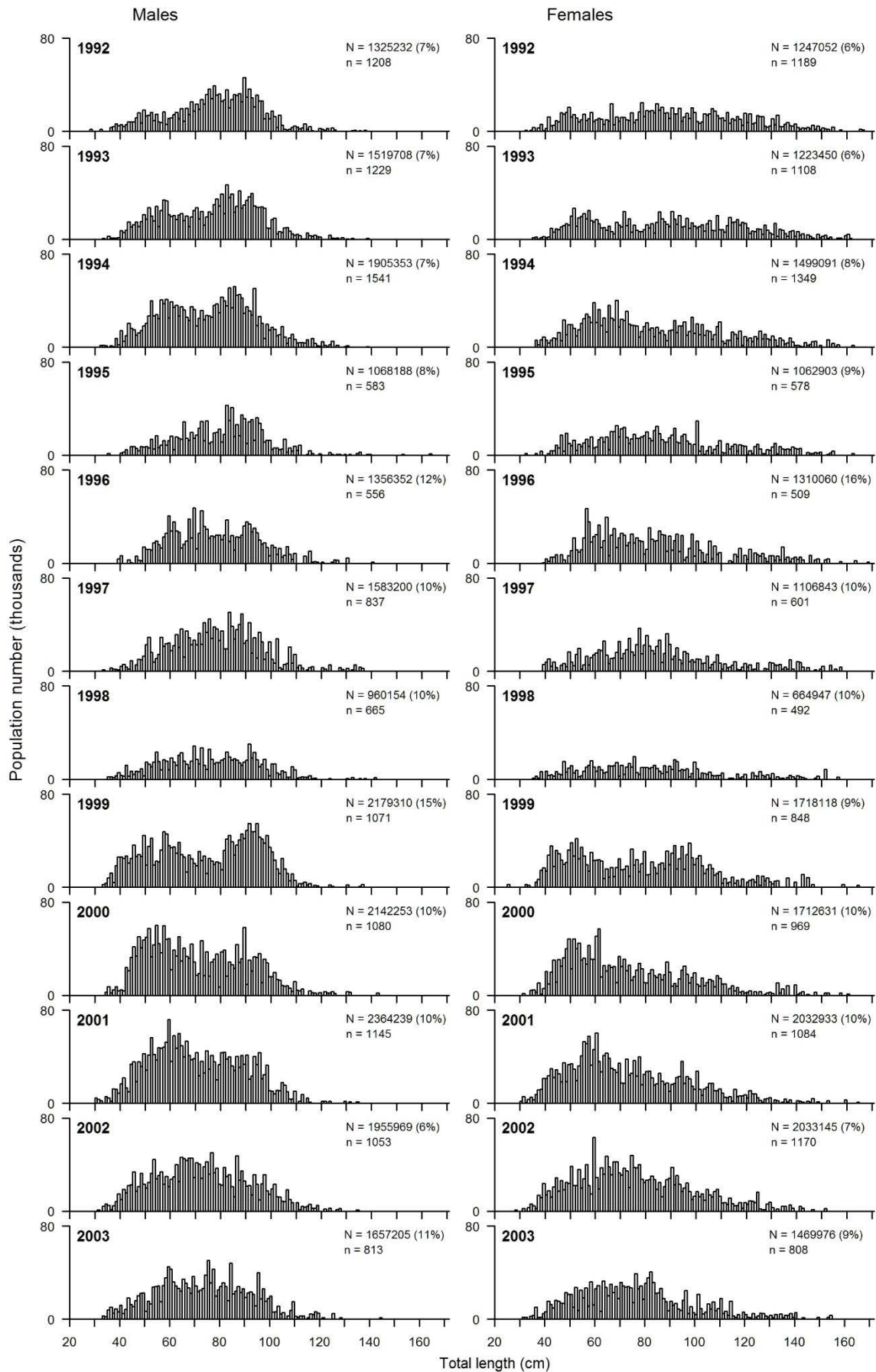


Figure 16: Estimated length frequency distributions of the ling population from *Tangaroa* surveys of the Chatham Rise, January 1992–2014, and 2016 for core strata. CV, coefficient of variation; n, estimated population number of ling; no., numbers of fish measured.

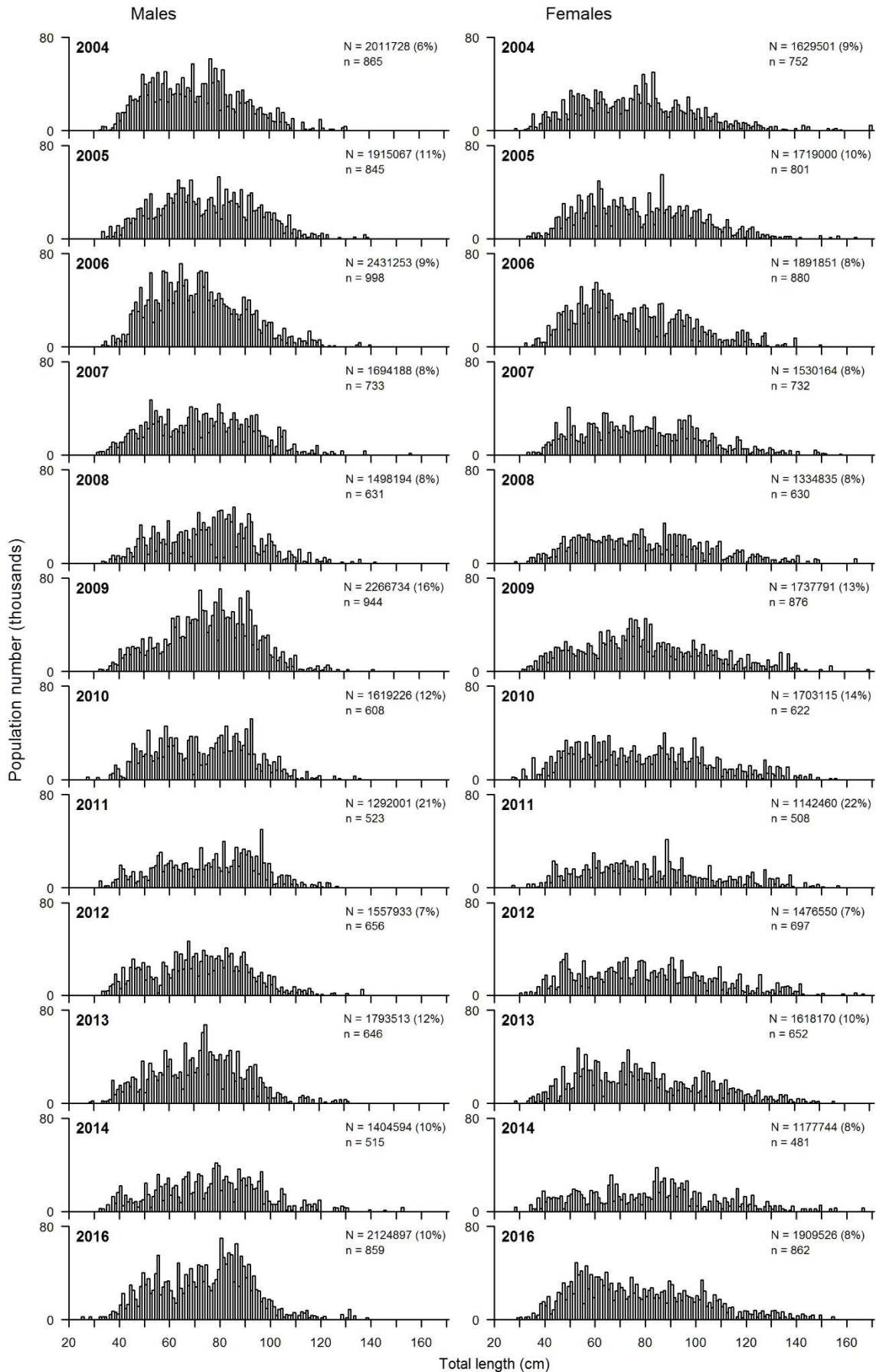


Figure 16 (continued)

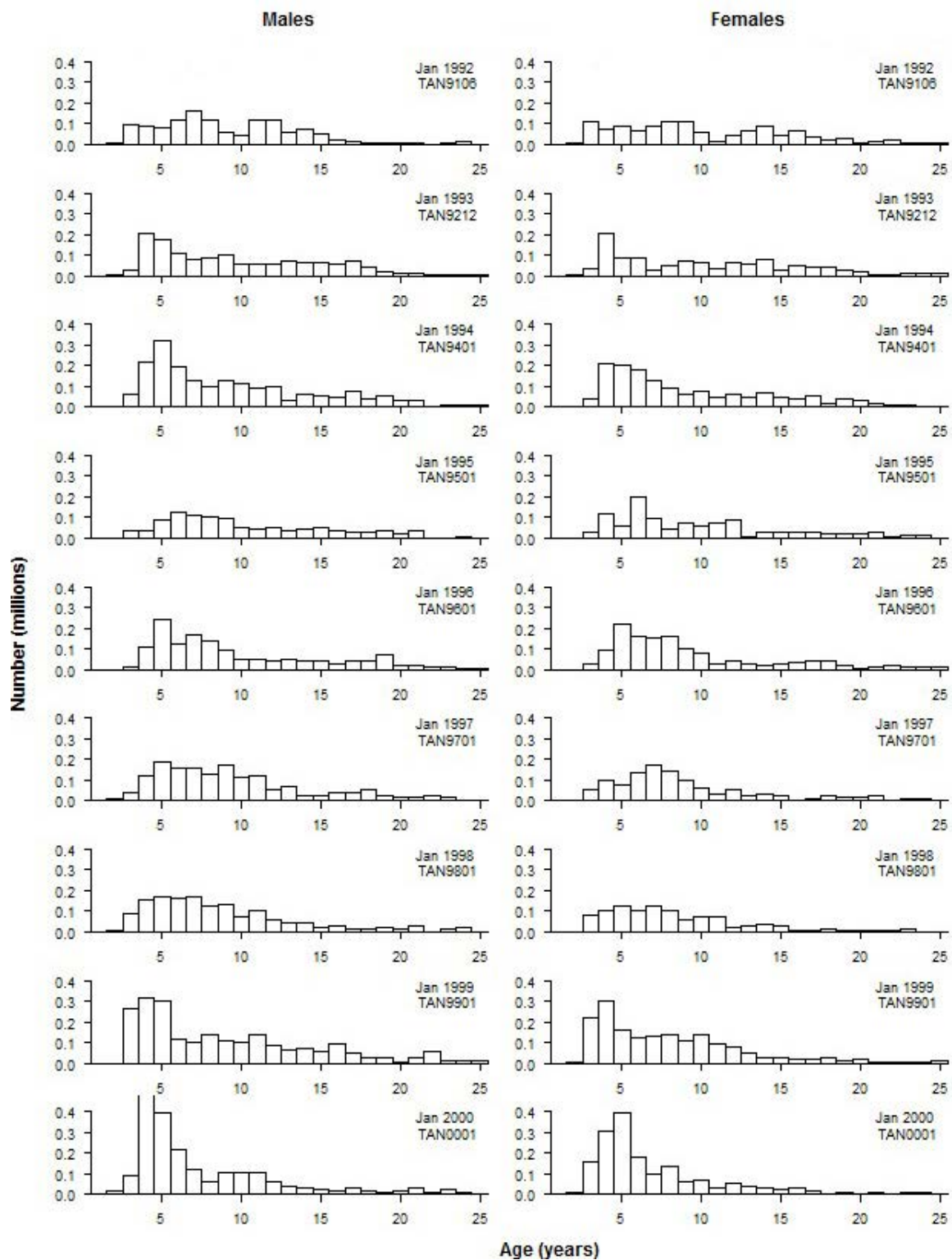


Figure 17: Estimated population numbers at age for male and female ling from *Tangaroa* surveys of the Chatham Rise, January, 1992–2014, and 2016.

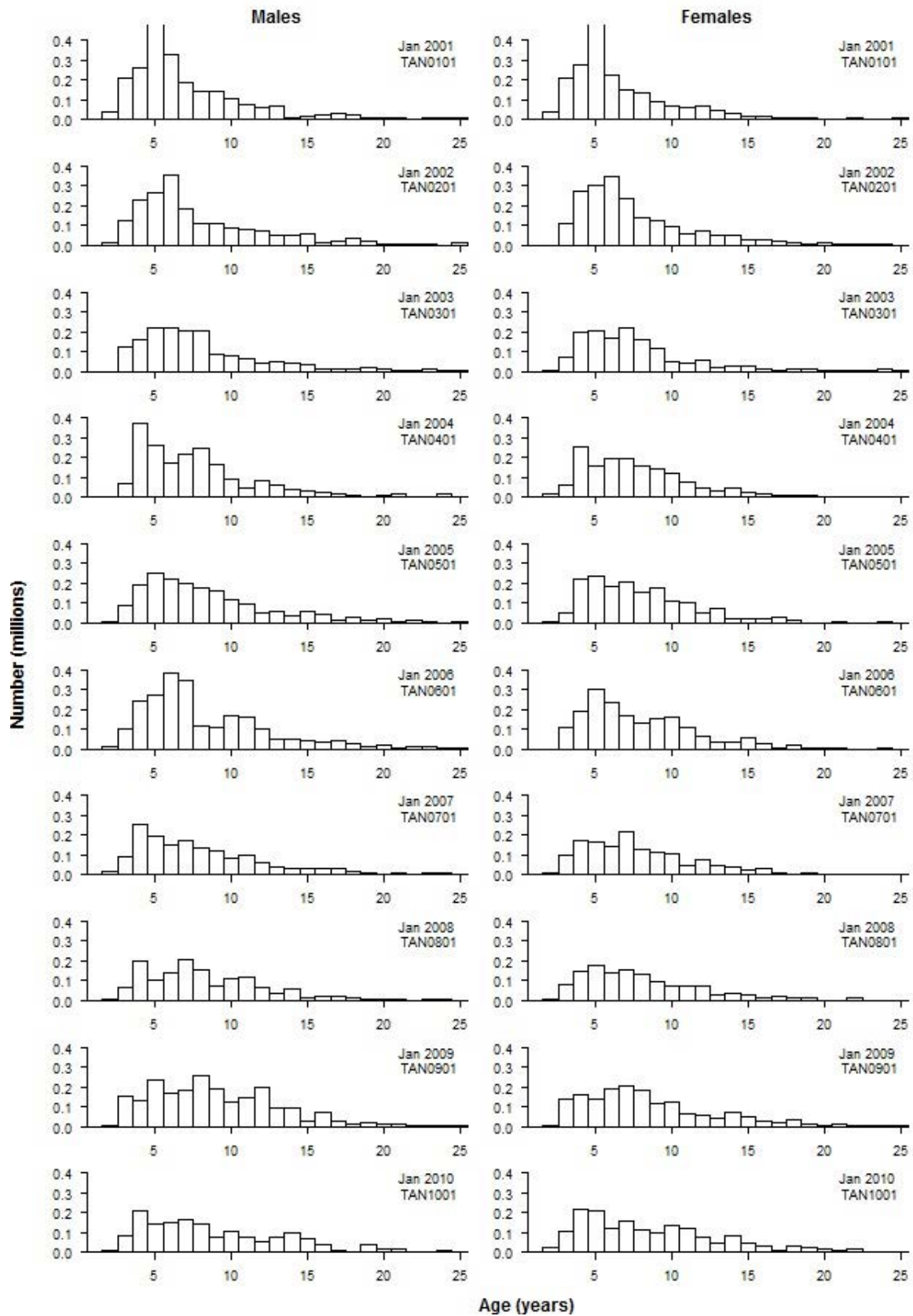


Figure 17 (continued)

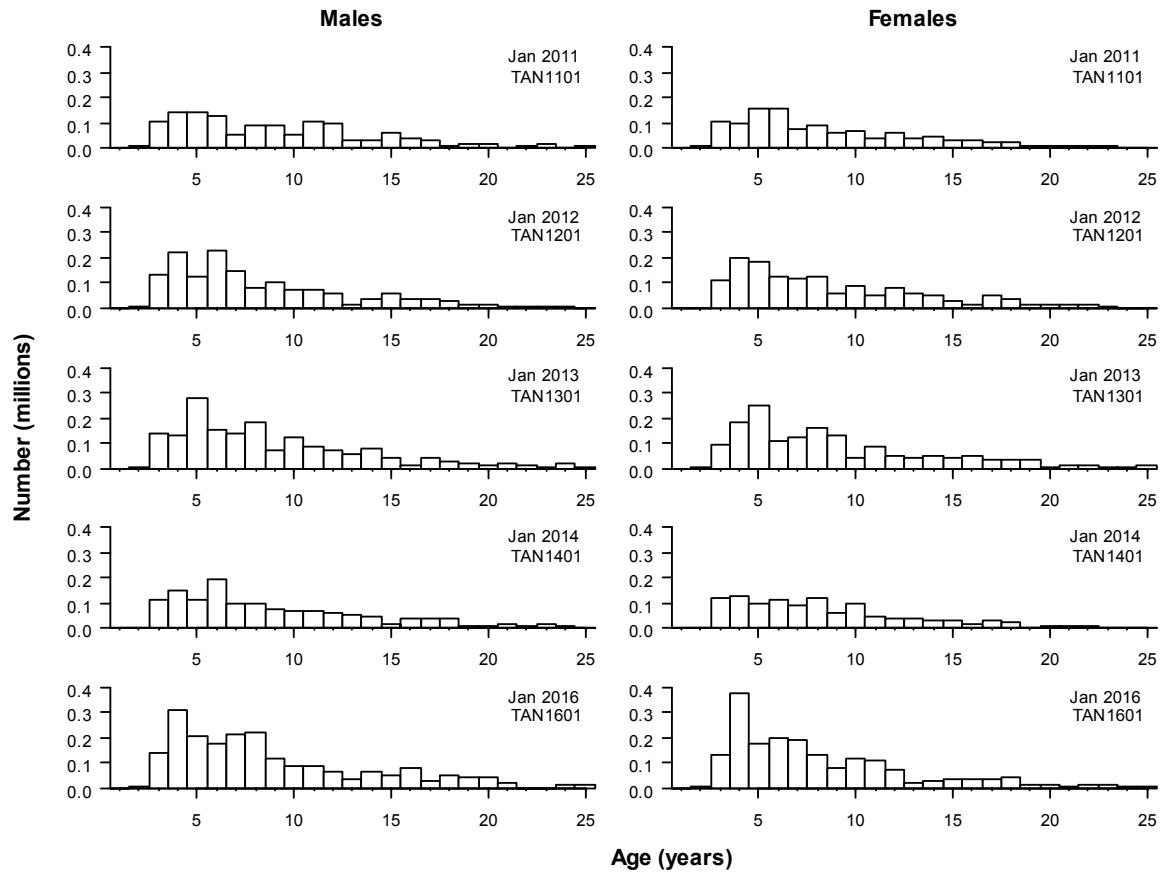


Figure 17 (continued)

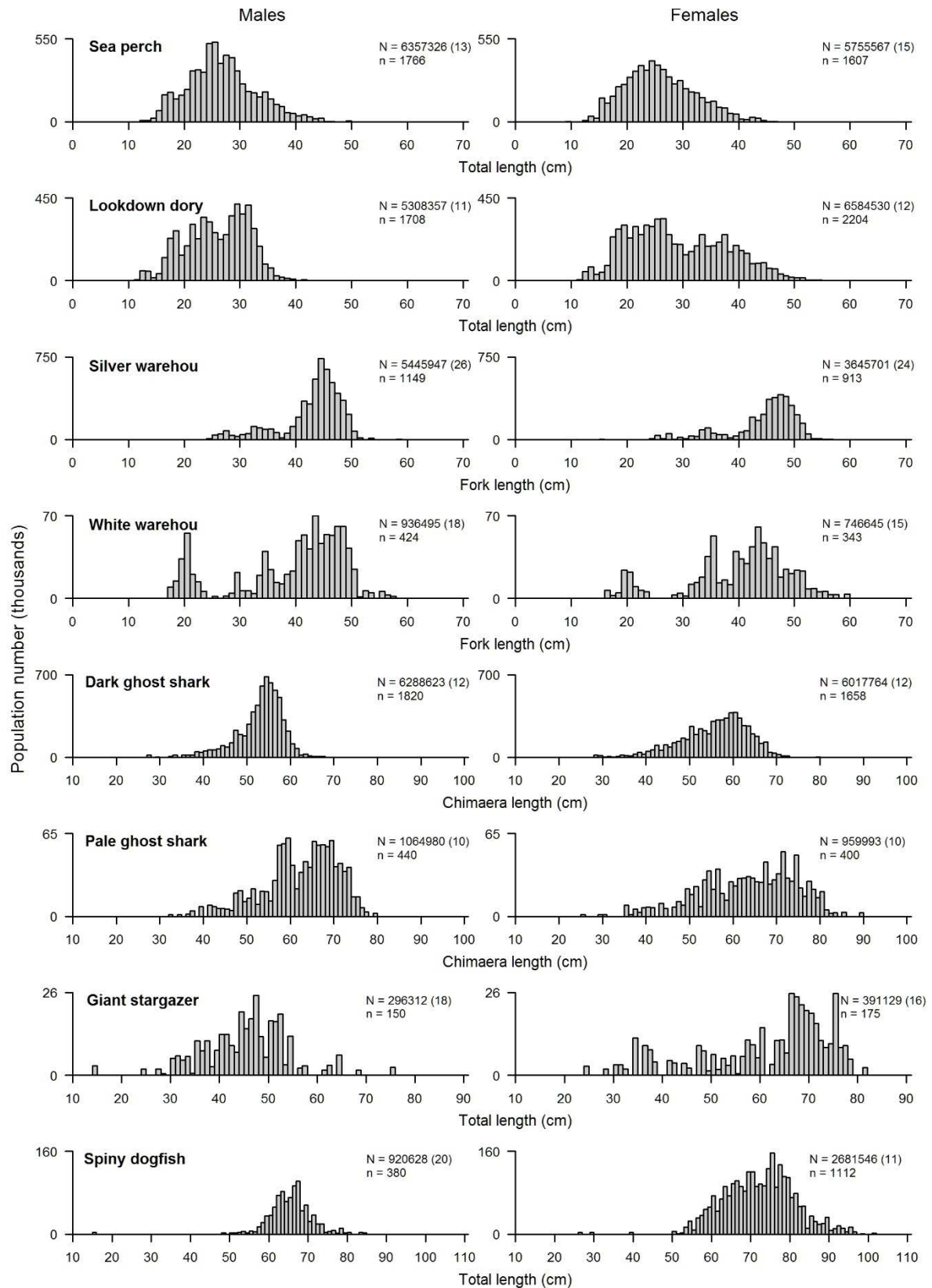


Figure 18a: Length frequency distributions of selected commercial species on the Chatham Rise 2016, scaled to population size by sex. M, estimated male population; F, estimated female population; U, estimated unsexed population (hatched bars); CV, coefficient of variation for the estimated numbers of fish; n, number of fish measured.

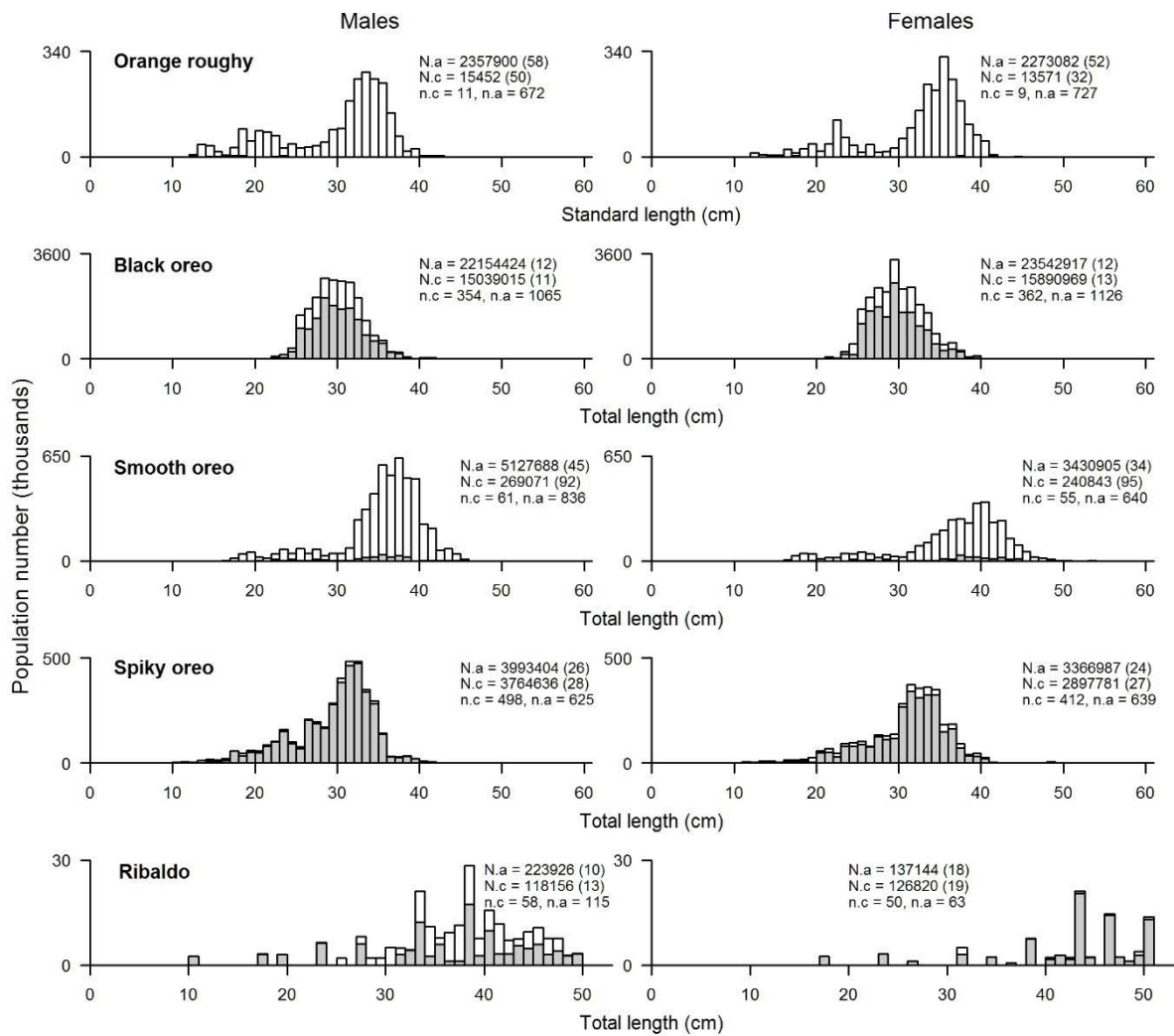


Figure 18b: Length frequencies of orange roughy, oreo species, and other selected deepwater species on the Chatham Rise 2016, scaled to population size by sex. M, estimated male population; F, estimated female population; CV, coefficient of variation of the estimated numbers of fish; n, number of fish measured. White bars show fish from all (200–1300 m) strata. Black bars show fish from core (200–800 m) strata.

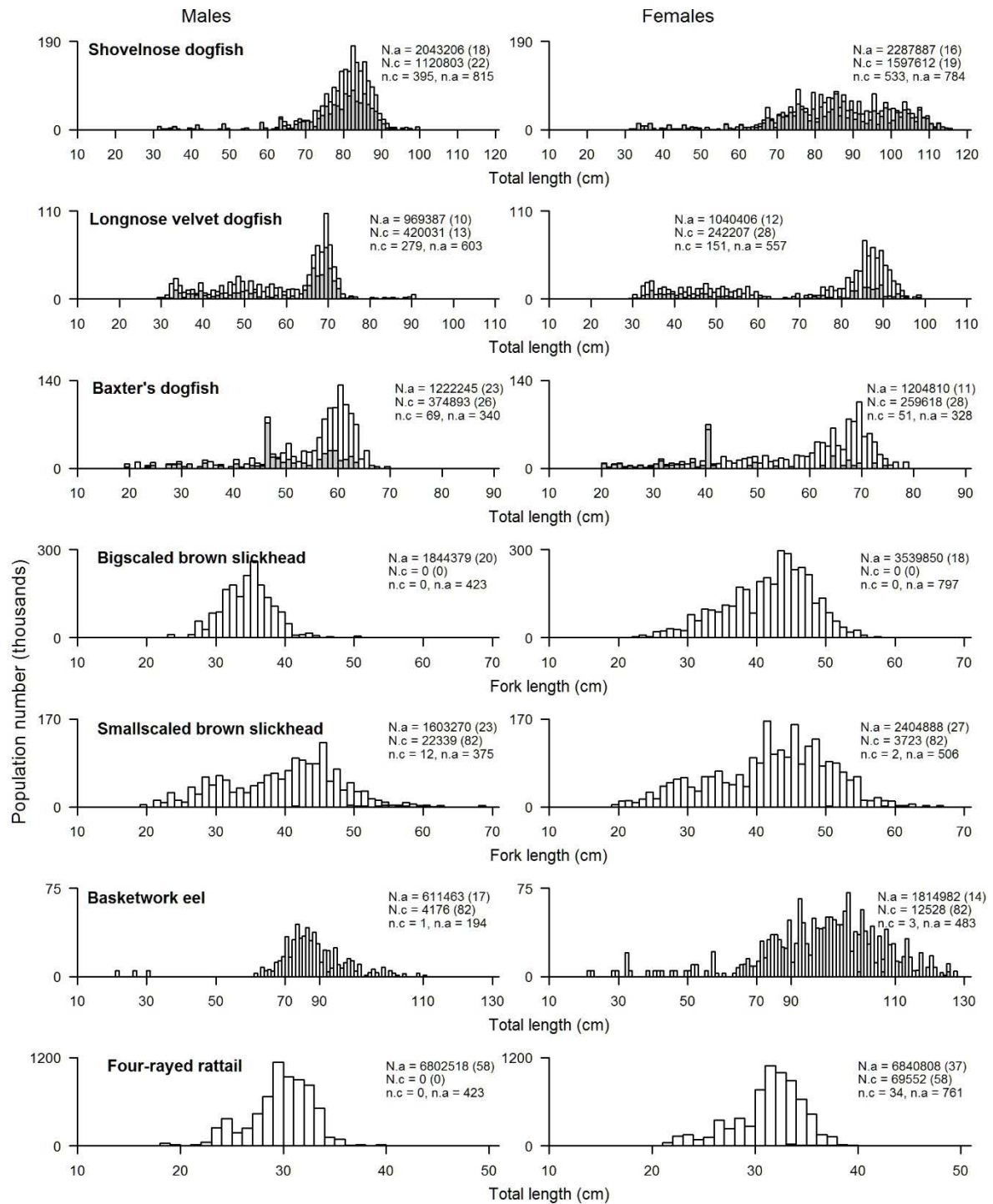


Figure 18b (continued)

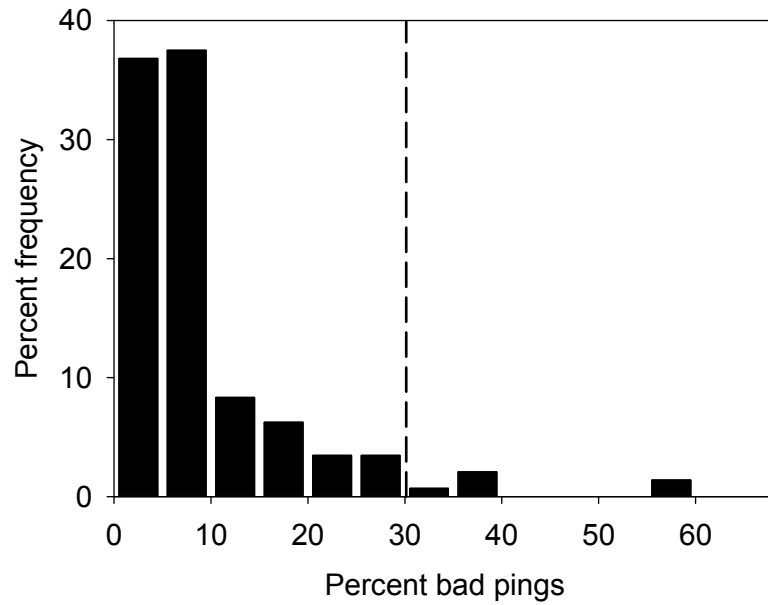


Figure 19: Percentage of bad pings in acoustic data from 2016 trawl survey. Only data with fewer than 30% bad pings (vertical dashed line) were analysed quantitatively.

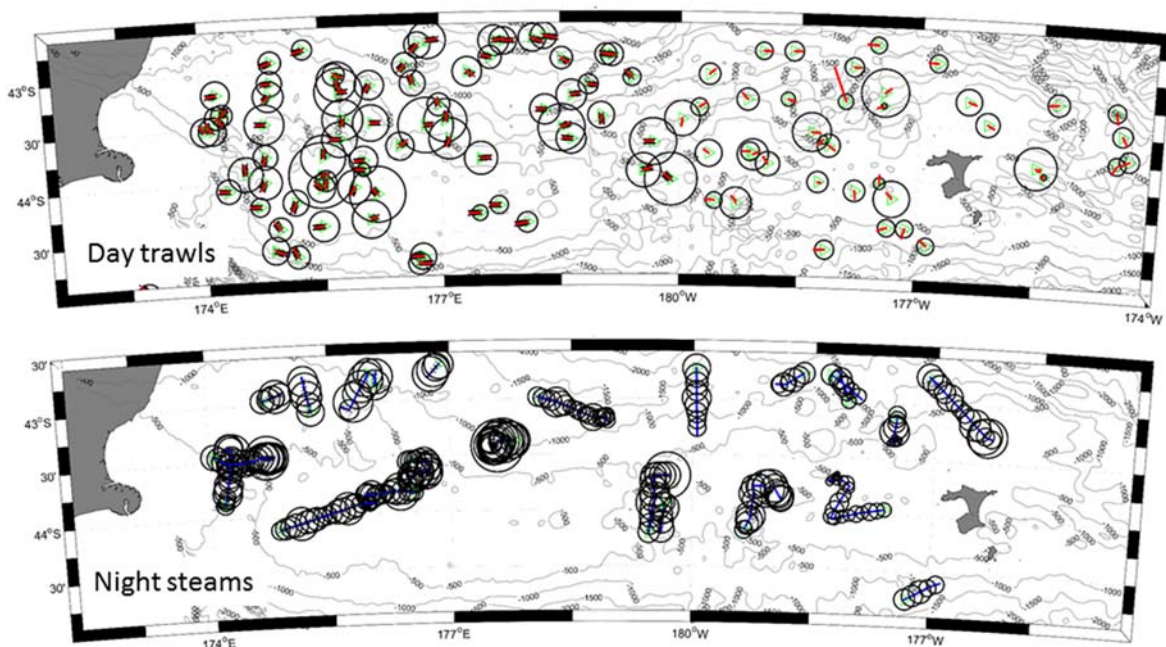


Figure 20: Distribution of total acoustic backscatter (open circles) observed on the Chatham Rise during daytime trawls (upper panel) and night-time steams (lower panel) throughout the entire survey area in January 2016. Circle area is proportional to the acoustic backscatter.

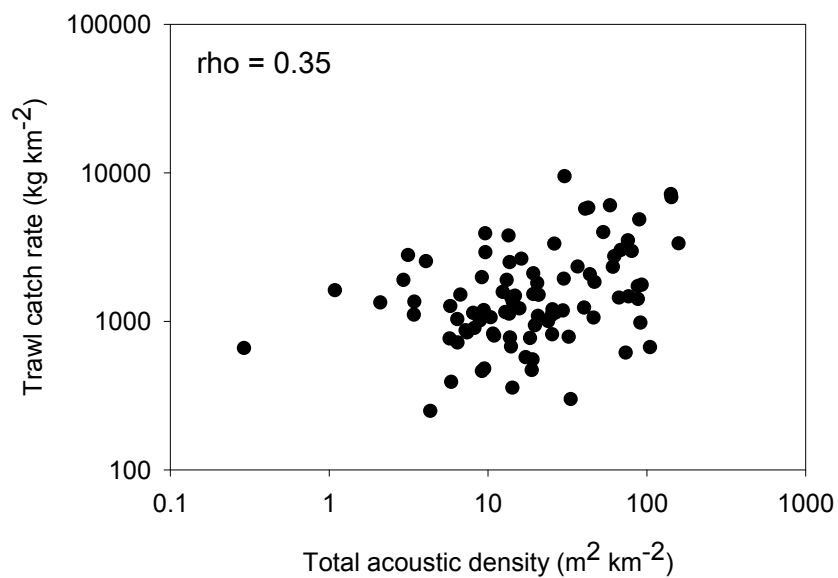


Figure 21: Relationship between total trawl catch rate (all species combined) and bottom-referenced acoustic backscatter recorded during the trawl on the Chatham Rise in 2016. Rho value is Spearman’s rank correlation coefficient.

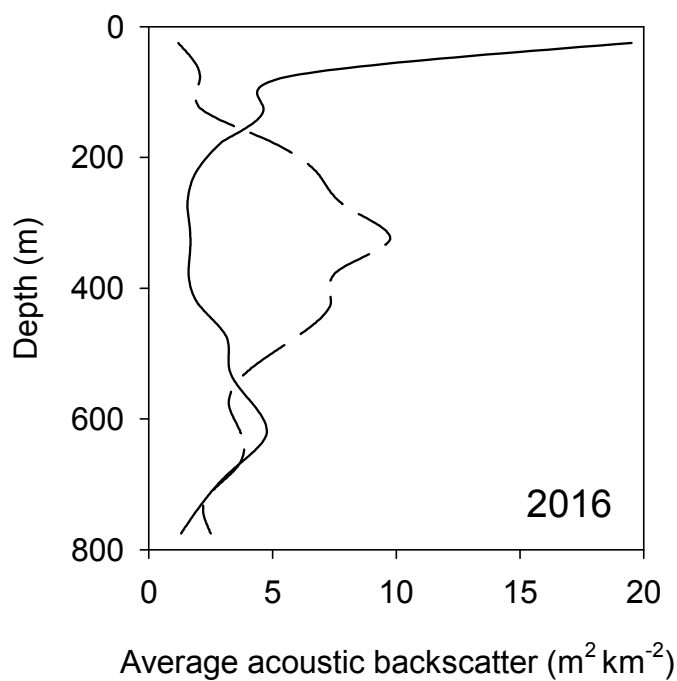


Figure 22: Vertical distribution of the average acoustic backscatter for the day (dashed lines) and at night (solid lines) for the Chatham Rise survey in 2016.

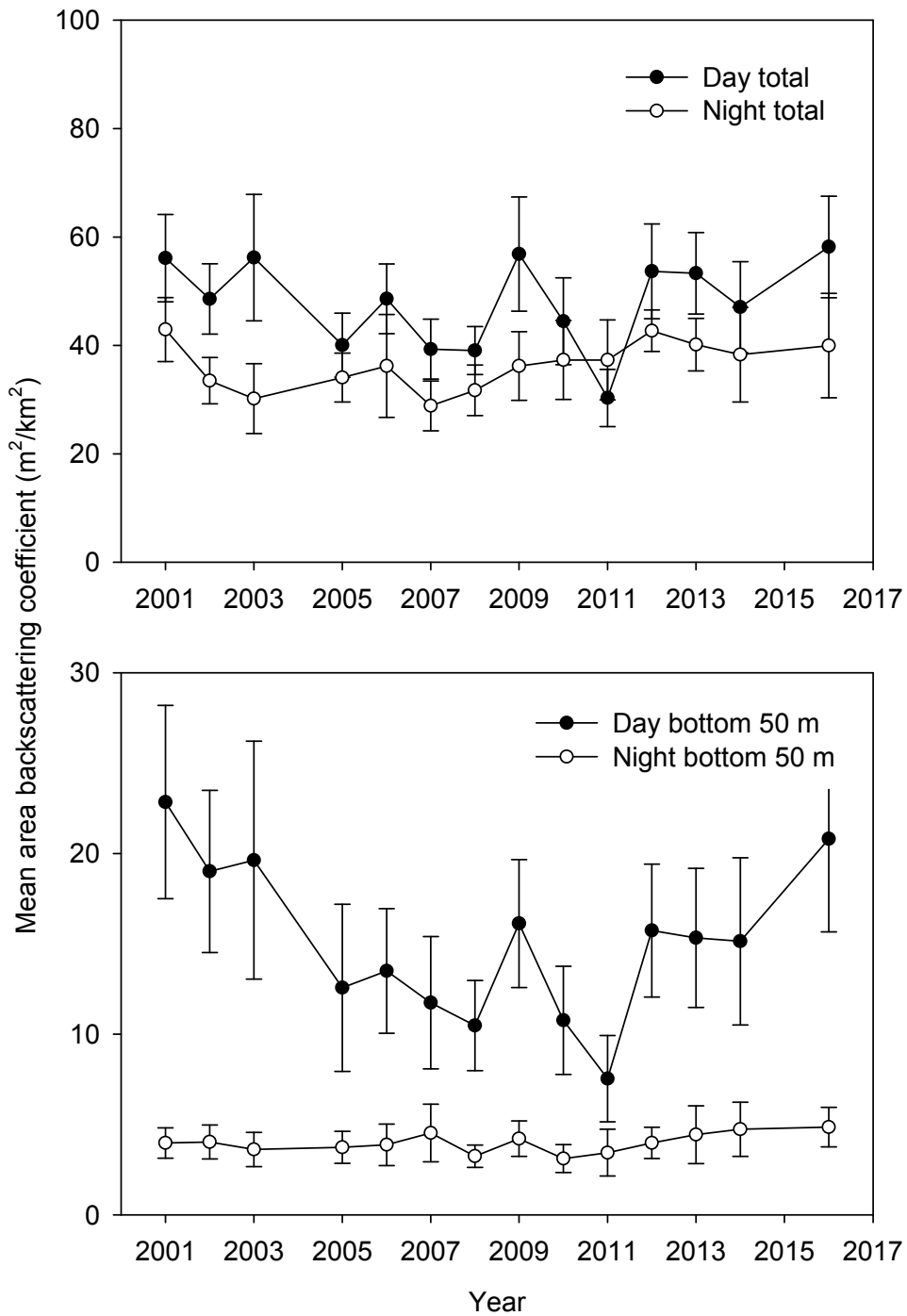


Figure 23: Comparison of relative acoustic abundance indices for the core Chatham Rise area based on (strata-averaged) mean areal backscatter. Error bars are ± 2 standard errors.

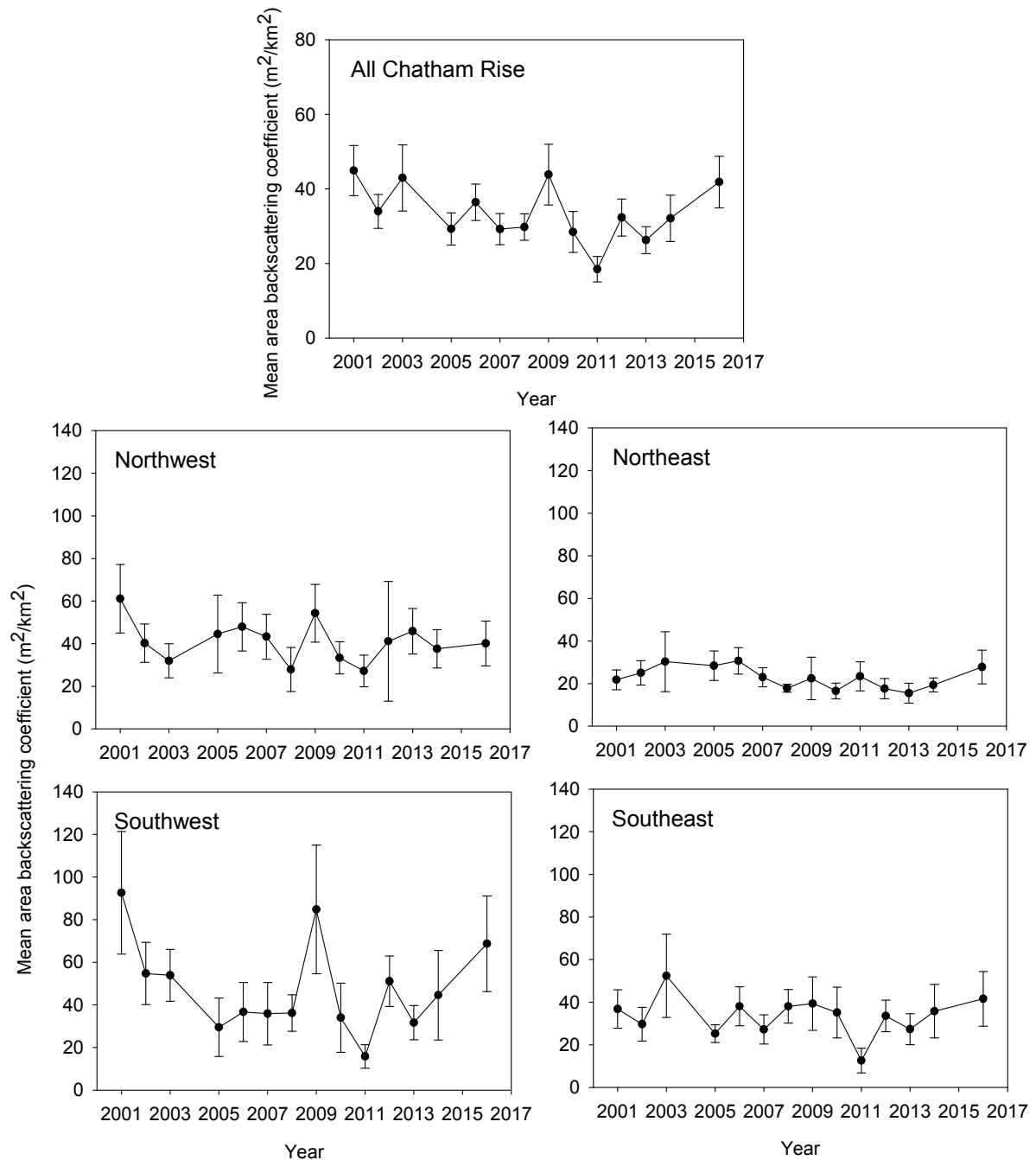


Figure 24: Relative acoustic abundance indices for mesopelagic fish on the Chatham Rise. Indices were derived by multiplying the total backscatter observed at each daytime trawl station by the estimated proportion of night-time backscatter in the same sub-area observed in the upper 200 m corrected for the estimated proportion in the surface deadzone. Panels show indices for the entire Chatham Rise and for four sub-areas. Error bars are ± 2 standard errors.

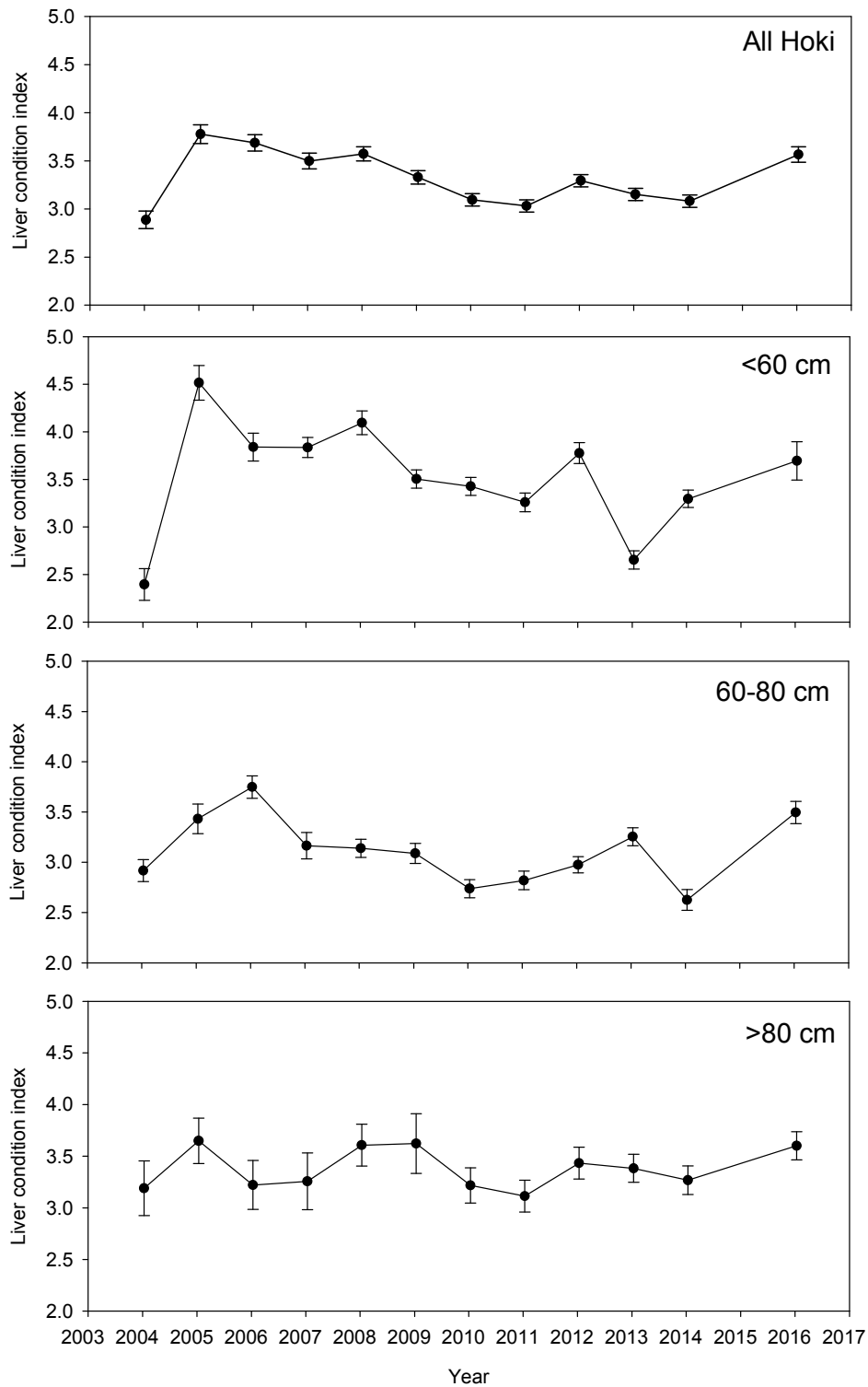


Figure 25: Time-series of hoki liver condition indices on the Chatham Rise from 2004–16. Data are plotted for all hoki, then three different size classes (<60 cm, 60–80 cm, and >80 cm). Error bars show ± 2 standard errors.

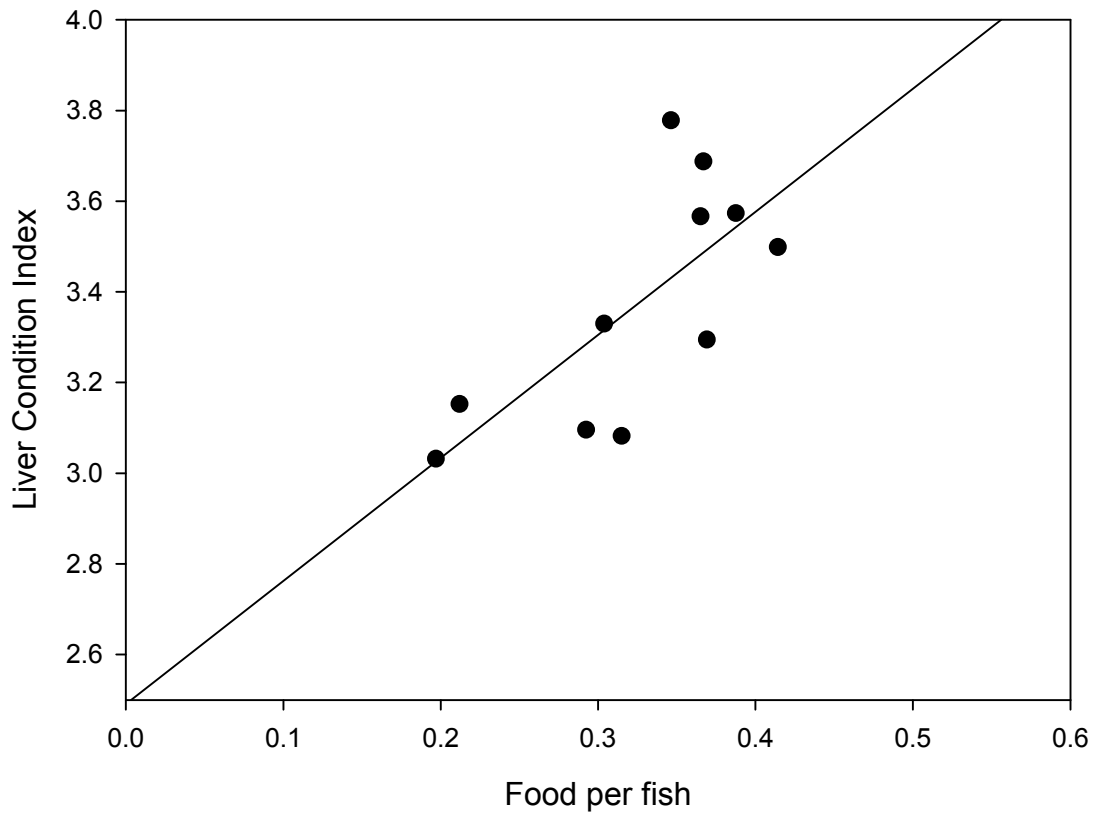


Figure 26: Correlation between hoki liver condition and the ratio between the acoustic estimate of mesopelagic fish abundance divided by the trawl estimate of hoki abundance (food per fish) for Chatham Rise surveys 2004–2016.

Appendix 1: Individual station data for all stations conducted during the survey (TAN1601). Stn., station number; P1, phase 1 trawl survey biomass tow; P2, phase 2 trawl survey biomass tow; Strat., Stratum number; *, foul trawl stations.

| Stn. | Type | Strat. | Date | Time | Start tow | | | Gear | depth | | Dist. Towed | Catch | | |
|------|------|--------|-----------|------|-----------|-----------|-----------|------|-------|------|-------------|---------|-------|------|
| | | | | | NZST | Latitude | Longitude | | min. | max. | | n. mile | hoki | hake |
| | | | | | ° ' S | ° ' E/W | | | m | | | | | |
| 1 | P1 | 2A | 4-Jan-16 | 638 | 42 45.19 | 176 54.01 | E | 685 | 715 | 3.01 | 236.9 | 5.4 | 110.4 | |
| 2 | P1 | 2A | 4-Jan-16 | 1206 | 42 45.84 | 177 43.48 | E | 766 | 791 | 3.03 | 133.5 | 0.4 | 0 | |
| 3 | P1 | 2A | 4-Jan-16 | 1430 | 42 46.26 | 177 50.50 | E | 722 | 735 | 2.99 | 238.2 | 18.6 | 38.7 | |
| 4 | P1 | 22 | 4-Jan-16 | 1733 | 42 45.92 | 178 12.09 | E | 965 | 973 | 3.00 | 45.4 | 61.8 | 19.7 | |
| 5 | P1 | 23 | 4-Jan-16 | 2014 | 42 44.51 | 178 23.05 | E | 1169 | 1172 | 3.03 | 0 | 4.4 | 0 | |
| 6 | P1 | 23 | 4-Jan-16 | 2236 | 42 44.64 | 178 31.92 | E | 1240 | 1243 | 3.00 | 0 | 0 | 0 | |
| 7 | P1 | 23 | 5-Jan-16 | 128 | 42 47.31 | 178 45.80 | E | 1165 | 1173 | 3.03 | 0 | 0 | 0 | |
| 8 | P1 | 8B | 5-Jan-16 | 506 | 42 56.97 | 178 32.68 | E | 489 | 530 | 3.02 | 375.1 | 32 | 128.4 | |
| 9 | P1 | 8B | 5-Jan-16 | 827 | 43 15.87 | 178 39.82 | E | 413 | 414 | 3.01 | 796.3 | 0 | 111.3 | |
| 10 | P1 | 8B | 5-Jan-16 | 1240 | 43 05.67 | 179 22.49 | E | 449 | 459 | 3.05 | 258.6 | 18.5 | 112.4 | |
| 11 | P1 | 22 | 5-Jan-16 | 1533 | 42 53.83 | 179 05.35 | E | 838 | 844 | 3.01 | 26.5 | 0 | 0 | |
| 12 | P1 | 22 | 5-Jan-16 | 1740 | 42 54.37 | 179 07.01 | E | 814 | 814 | 3.01 | 31.3 | 3.3 | 0 | |
| 13 | P1 | 22 | 5-Jan-16 | 2032 | 42 53.37 | 179 31.24 | E | 812 | 817 | 3.00 | 225.0 | 57.4 | 4.1 | |
| 14 | P1 | 23 | 5-Jan-16 | 2348 | 42 43.88 | 179 56.53 | E | 1197 | 1198 | 2.99 | 8.5 | 0 | 0 | |
| 15 | P1 | 10 | 6-Jan-16 | 620 | 43 30.02 | 179 58.52 | W | 400 | 405 | 3.01 | 1 350.8 | 19.0 | 152.2 | |
| 16 | P1 | 10 | 6-Jan-16 | 916 | 43 21.69 | 179 43.94 | W | 480 | 480 | 3.01 | 179.7 | 0 | 54.3 | |
| 17 | P1 | 10 | 6-Jan-16 | 1311 | 43 16.79 | 179 10.68 | W | 485 | 505 | 3.01 | 307.0 | 12.4 | 8.6 | |
| 18 | P1 | 10 | 6-Jan-16 | 1639 | 43 03.91 | 179 37.42 | W | 527 | 534 | 3.04 | 274.3 | 0 | 102.7 | |
| 19 | P1 | 21A | 6-Jan-16 | 2028 | 42 43.29 | 179 12.74 | W | 954 | 964 | 3.00 | 53.6 | 78.1 | 0 | |
| 20 | P1 | 21A | 7-Jan-16 | 55 | 42 44.67 | 178 33.40 | W | 836 | 846 | 3.08 | 97.7 | 0 | 3.1 | |
| 21 | P1 | 2B | 7-Jan-16 | 509 | 42 51.46 | 178 55.65 | W | 627 | 644 | 3.02 | 348.2 | 56.1 | 37.2 | |
| 22 | P1 | 2B | 7-Jan-16 | 748 | 42 51.23 | 178 33.29 | W | 605 | 606 | 3.01 | 415.7 | 35.4 | 58.7 | |
| 23 | P1 | 11 | 7-Jan-16 | 1158 | 43 17.70 | 178 37.76 | W | 344 | 436 | 3.03 | 467.5 | 5.8 | 38.3 | |
| 24 | P1 | 11 | 7-Jan-16 | 1509 | 43 35.14 | 178 19.14 | W | 400 | 405 | 3.01 | 1 503.8 | 0 | 103.7 | |
| 25 | P1 | 11 | 7-Jan-16 | 1839 | 43 20.42 | 177 52.41 | W | 433 | 438 | 3.00 | 99.4 | 0 | 7.8 | |
| *26 | P1 | 21A | 8-Jan-16 | 16 | 42 42.36 | 178 10.03 | W | 932 | 962 | 1.13 | - | - | - | |
| 27 | P1 | 21A | 8-Jan-16 | 257 | 42 44.29 | 178 14.36 | W | 853 | 859 | 3.00 | 68.6 | 3.3 | 0 | |
| 28 | P1 | 11 | 8-Jan-16 | 655 | 42 58.95 | 177 49.51 | W | 520 | 522 | 2.96 | 678.2 | 0 | 43.1 | |
| 29 | P1 | 11 | 8-Jan-16 | 1028 | 43 12.22 | 178 05.78 | W | 445 | 450 | 3.00 | 150.3 | 3.9 | 93.3 | |
| 30 | P1 | 9 | 9-Jan-16 | 500 | 43 19.94 | 177 29.02 | W | 319 | 326 | 2.13 | 112.6 | 0 | 12.1 | |
| 31 | P1 | 11 | 9-Jan-16 | 710 | 43 11.70 | 177 25.70 | W | 400 | 425 | 3.01 | 871.5 | 9.0 | 102.6 | |
| 32 | P1 | 2B | 9-Jan-16 | 1143 | 42 54.97 | 176 50.35 | W | 706 | 708 | 3.02 | 184.1 | 14.2 | 21.8 | |
| 33 | P1 | 24 | 9-Jan-16 | 1704 | 42 46.41 | 177 36.34 | W | 1011 | 1015 | 3.03 | 7.9 | 0 | 0 | |
| 34 | P1 | 24 | 9-Jan-16 | 2054 | 42 44.51 | 177 11.80 | W | 1102 | 1108 | 3.01 | 7.2 | 0 | 0 | |
| 35 | P1 | 11 | 10-Jan-16 | 457 | 43 15.72 | 176 22.05 | W | 408 | 410 | 3.01 | 297.2 | 0 | 59.9 | |
| 36 | P1 | 9 | 10-Jan-16 | 727 | 43 27.65 | 176 07.76 | W | 302 | 311 | 3.00 | 207.3 | 0 | 16.6 | |
| *37 | P1 | 9 | 10-Jan-16 | 1139 | 43 50.09 | 175 29.87 | W | 313 | 319 | 0.50 | - | - | - | |
| 38 | P1 | 9 | 10-Jan-16 | 1642 | 43 52.83 | 175 26.53 | W | 226 | 291 | 3.02 | 5.8 | 0 | 7.4 | |
| 39 | P1 | 12 | 11-Jan-16 | 1029 | 43 43.29 | 175 24.59 | W | 487 | 527 | 3.01 | 482.1 | 0 | 42.2 | |
| 40 | P1 | 2B | 11-Jan-16 | 1527 | 43 14.27 | 175 19.09 | W | 682 | 694 | 3.03 | 204.9 | 4.3 | 23.6 | |
| 41 | P1 | 21B | 11-Jan-16 | 2033 | 43 08.15 | 174 38.90 | W | 870 | 875 | 3.01 | 36.0 | 8.4 | 0 | |
| 42 | P1 | 21B | 11-Jan-16 | 2259 | 43 01.50 | 174 40.67 | W | 924 | 933 | 3.03 | 5.7 | 0 | 0 | |
| 43 | P1 | 24 | 12-Jan-16 | 135 | 43 02.89 | 174 23.11 | W | 1054 | 1090 | 3.01 | 0 | 0 | 0 | |
| 44 | P1 | 21B | 12-Jan-16 | 525 | 43 18.84 | 174 32.22 | W | 844 | 848 | 3.02 | 31.2 | 3.3 | 0 | |

Appendix 1: (continued)

| Stn. | Type | Strat. | Date | Start tow | | | E/W | Gear | | Dist. towed | Catch | | |
|------|------|--------|-----------|-----------|----------|-----------|-----|------|------|----------------|---------|------|-------|
| | | | | Time | Latitude | Longitude | | min. | max. | | n. mile | hoki | hake |
| | | | | NZST | ° ' S | ° ' S | | | m | | | | |
| 45 | P1 | 25 | 12-Jan-16 | 756 | 43 30.81 | 174 25.56 | W | 830 | 834 | 3.00 | 58.5 | 0 | 0 |
| 46 | P1 | 25 | 12-Jan-16 | 1034 | 43 43.13 | 174 23.59 | W | 828 | 843 | 3.05 | 57.1 | 8.9 | 0 |
| 47 | P1 | 25 | 12-Jan-16 | 1238 | 43 46.72 | 174 31.47 | W | 823 | 831 | 3.05 | 45.5 | 0 | 7.3 |
| 48 | P1 | 28 | 13-Jan-16 | 251 | 44 45.31 | 177 13.45 | W | 1199 | 1217 | 3.03 | 0 | 0 | 0 |
| 49 | P1 | 4 | 13-Jan-16 | 650 | 44 33.62 | 176 53.20 | W | 648 | 682 | 3.01 | 315.5 | 23.8 | 117.3 |
| 50 | P1 | 4 | 13-Jan-16 | 935 | 44 27.95 | 177 09.11 | W | 673 | 733 | 3.01 | 327.5 | 0 | 89.2 |
| 51 | P1 | 4 | 13-Jan-16 | 1227 | 44 26.28 | 177 24.62 | W | 664 | 6979 | 3.07 | 260.4 | 0 | 26.6 |
| 52 | P1 | 12 | 13-Jan-16 | 1558 | 44 08.82 | 177 19.84 | W | 408 | 414 | 3.02 | 307.6 | 0 | 98.7 |
| 53 | P1 | 5 | 13-Jan-16 | 1810 | 44 00.24 | 177 28.91 | W | 363 | 377 | 3.01 | 318.7 | 0 | 52.4 |
| 54 | P1 | 5 | 14-Jan-16 | 500 | 43 39.80 | 178 13.16 | W | 370 | 373 | 2.99 | 211.2 | 4.2 | 112.5 |
| 55 | P1 | 5 | 14-Jan-16 | 704 | 43 42.64 | 178 06.61 | W | 374 | 378 | 3.02 | 1 576.2 | 2.9 | 108.1 |
| 56 | P1 | 13 | 14-Jan-16 | 1007 | 43 59.08 | 178 13.48 | W | 443 | 460 | 3.03 | 500.2 | 25.4 | 208.9 |
| 57 | P1 | 12 | 14-Jan-16 | 1333 | 44 07.58 | 177 47.12 | W | 483 | 493 | 3.00 | 444.8 | 3.9 | 148.5 |
| 58 | P1 | 28 | 14-Jan-16 | 1924 | 44 38.87 | 178 12.37 | W | 1211 | 1214 | 3.01 | 2.3 | 0 | 0 |
| 59 | P1 | 25 | 15-Jan-16 | 37 | 44 24.20 | 178 51.34 | W | 856 | 873 | 3.02 | 249.3 | 0 | 0 |
| 60 | P1 | 28 | 15-Jan-16 | 448 | 44 28.05 | 179 05.86 | W | 1017 | 1028 | 3.04 | 8.6 | 0 | 0 |
| 61 | P1 | 13 | 15-Jan-16 | 1544 | 44 12.87 | 179 36.24 | W | 551 | 598 | 2.97 | 126.6 | 0 | 59.2 |
| *62 | P1 | 13 | 15-Jan-16 | 1903 | 44 12.61 | 179 18.27 | W | 416 | 443 | 2.30 | - | - | - |
| 63 | P1 | 13 | 16-Jan-16 | 502 | 43 51.68 | 178 54.76 | W | 405 | 413 | 3.02 | 205.0 | 0 | 103.7 |
| 64 | P1 | 3 | 16-Jan-16 | 706 | 43 47.55 | 179 03.80 | W | 391 | 395 | 2.06 | 267.1 | 0 | 46.6 |
| 65 | P1 | 3 | 16-Jan-16 | 901 | 43 46.32 | 179 08.41 | W | 369 | 385 | 3.00 | 108.1 | 13.2 | 57.8 |
| 66 | P1 | 3 | 16-Jan-16 | 1208 | 43 46.92 | 179 39.55 | W | 356 | 362 | 2.13 | 302.0 | 0 | 16.6 |
| 67 | P1 | 14 | 16-Jan-16 | 1541 | 44 01.12 | 179 51.31 | E | 492 | 507 | 3.02 | 135.4 | 0 | 78.1 |
| 68 | P1 | 14 | 16-Jan-16 | 1823 | 43 56.65 | 179 34.44 | E | 509 | 516 | 3.00 | 294.9 | 0 | 64.2 |
| *69 | P1 | 26 | 16-Jan-16 | 2312 | 44 12.47 | 179 32.84 | E | 873 | 893 | 3.05 | - | - | - |
| 70 | P1 | 14 | 17-Jan-16 | 502 | 43 41.44 | 179 38.10 | E | 413 | 418 | 3.02 | 828.5 | 20.3 | 75.7 |
| *71 | P1 | 29 | 17-Jan-16 | 1455 | 44 25.95 | 178 00.75 | E | 1198 | 1207 | 3.02 | - | - | - |
| 72 | P1 | 29 | 17-Jan-16 | 1833 | 44 15.72 | 177 41.27 | E | 1055 | 1057 | 3.01 | 0 | 0 | 0 |
| 73 | P1 | 26 | 17-Jan-16 | 2222 | 44 03.31 | 177 35.69 | E | 800 | 840 | 3.04 | 52.6 | 0 | 0 |
| 74 | P1 | 26 | 18-Jan-16 | 222 | 44 08.00 | 177 22.41 | E | 841 | 884 | 3.03 | 88.5 | 0 | 10.9 |
| 75 | P1 | 29 | 18-Jan-16 | 604 | 44 19.93 | 177 24.85 | E | 1155 | 1156 | 3.03 | 0 | 0 | 0 |
| 76 | P1 | 29 | 18-Jan-16 | 1213 | 44 46.76 | 176 45.96 | E | 1261 | 1274 | 3.00 | 0 | 0 | 0 |
| 77 | P1 | 29 | 18-Jan-16 | 1526 | 44 42.96 | 176 40.79 | E | 1200 | 1208 | 3.04 | 0 | 0 | 0 |
| 78 | P1 | 26 | 18-Jan-16 | 2045 | 44 30.58 | 176 17.62 | E | 845 | 875 | 3.01 | 47.2 | 0 | 0 |
| 79 | P1 | 27 | 19-Jan-16 | 210 | 44 35.92 | 175 43.82 | E | 809 | 833 | 3.02 | 44.1 | 0 | 0 |
| 80 | P1 | 27 | 19-Jan-16 | 440 | 44 33.97 | 175 32.36 | E | 809 | 812 | 3.02 | 43.9 | 0 | 0 |
| 81 | P1 | 17 | 19-Jan-16 | 827 | 44 21.55 | 176 06.78 | E | 317 | 347 | 2.22 | 5.6 | 0 | 1 |
| 82 | P1 | 17 | 19-Jan-16 | 1102 | 44 07.82 | 176 09.99 | E | 341 | 350 | 3.02 | 1 962.1 | 0 | 31.5 |
| 83 | P1 | 17 | 19-Jan-16 | 1326 | 44 05.24 | 175 52.71 | E | 324 | 334 | 2.99 | 507.0 | 0 | 14.3 |
| 84 | P1 | 6 | 19-Jan-16 | 1708 | 44 25.07 | 175 26.67 | E | 672 | 683 | 3.02 | 310.7 | 0 | 57.8 |
| 85 | P1 | 30 | 19-Jan-16 | 2357 | 45 07.25 | 174 44.95 | E | 1038 | 1070 | 3.02 | 0 | 0 | 0 |
| 86 | P1 | 27 | 20-Jan-16 | 305 | 44 55.36 | 174 38.03 | E | 873 | 873 | 3.03 | 69.3 | 0 | 0 |
| 87 | P1 | 27 | 20-Jan-16 | 902 | 44 38.04 | 174 54.56 | E | 800 | 834 | 3.00 | 64.0 | 0 | 0 |
| 88 | P1 | 6 | 20-Jan-16 | 1141 | 44 39.24 | 175 07.36 | E | 759 | 785 | 3.00 | 64.7 | 0 | 0 |
| 89 | P1 | 6 | 20-Jan-16 | 1445 | 44 24.28 | 174 54.79 | E | 612 | 642 | 3.05 | 1 463.6 | 13.8 | 125.9 |
| 90 | P1 | 30 | 20-Jan-16 | 2326 | 44 55.93 | 173 36.09 | E | 1159 | 1170 | 2.99 | 5.6 | 0 | 0 |
| 91 | P1 | 30 | 21-Jan-16 | 328 | 45 07.97 | 173 24.43 | E | 1272 | 1279 | 3.02 | 0 | 0 | 0 |

Appendix 1: (continued)

| Stn. | Type | Strat. | Date | Time | Start tow | | | Gear | depth | | Dist. towed | Catch | | |
|------|------|--------|-----------|------|-----------|-----------|-----|------|-------|------|-------------|---------|-------|------|
| | | | | | Latitude | Longitude | E/W | | min. | max. | | n. mile | hoki | hake |
| | | | | NZST | ° ' S | ° ' E | | | m | | | | | |
| 92 | P1 | 30 | 21-Jan-16 | 654 | 44 54.37 | 173 09.48 | E | 1123 | 1153 | 2.52 | | 0 | 0 | 0 |
| 93 | P1 | 7A | 21-Jan-16 | 1640 | 43 29.54 | 174 01.25 | E | 415 | 427 | 2.22 | 2 209.9 | 0 | 56.0 | |
| 94 | P1 | 22 | 21-Jan-16 | 2036 | 43 02.06 | 174 03.85 | E | 908 | 969 | 3.02 | 37.9 | 12.0 | 0 | |
| 95 | P1 | 22 | 21-Jan-16 | 2254 | 42 58.95 | 174 15.07 | E | 977 | 984 | 2.99 | 76.7 | 19.9 | 0 | |
| 96 | P1 | 1 | 22-Jan-16 | 509 | 42 55.37 | 174 50.98 | E | 733 | 743 | 3.03 | 112.6 | 0 | 33.0 | |
| 97 | P1 | 7A | 22-Jan-16 | 743 | 43 06.16 | 174 50.67 | E | 447 | 480 | 3.01 | 2 925.1 | 153.7 | 177.1 | |
| 98 | P1 | 7A | 22-Jan-16 | 743 | 43 06.16 | 174 50.67 | E | 447 | 480 | 3.01 | 6 243.9 | 5.6 | 92.1 | |
| 99 | P1 | 1 | 22-Jan-16 | 1349 | 43 11.30 | 174 09.36 | E | 606 | 612 | 3.01 | 478.2 | 0 | 64.3 | |
| 100 | P1 | 7A | 22-Jan-16 | 1628 | 43 24.71 | 174 13.10 | E | 558 | 566 | 3.01 | 118.8 | 2.6 | 50.9 | |
| 101 | P1 | 1 | 22-Jan-16 | 1857 | 43 28.68 | 174 05.46 | E | 690 | 701 | 2.36 | 157.6 | 26.7 | 40.4 | |
| 102 | P1 | 18 | 23-Jan-16 | 503 | 43 28.15 | 174 45.38 | E | 349 | 372 | 3.02 | 960.0 | 0 | 10.9 | |
| 103 | P1 | 16 | 23-Jan-16 | 803 | 43 47.16 | 174 46.60 | E | 477 | 482 | 3.01 | 1 672.2 | 13.0 | 73.5 | |
| 104 | P1 | 16 | 23-Jan-16 | 1024 | 44 00.79 | 174 45.40 | E | 493 | 510 | 3.01 | 4 947.5 | 21.9 | 66.0 | |
| 105 | P1 | 16 | 23-Jan-16 | 1515 | 43 57.06 | 175 30.49 | E | 472 | 480 | 2.49 | 2 280.5 | 4.7 | 84.1 | |
| 106 | P1 | 18 | 23-Jan-16 | 1734 | 43 45.89 | 175 30.92 | E | 353 | 377 | 2.24 | 1 658.2 | 0 | 16.3 | |
| 107 | P1 | 22 | 24-Jan-16 | 1842 | 42 49.32 | 175 15.14 | E | 835 | 840 | 3.01 | 118.4 | 12.4 | 0 | |
| 108 | P1 | 22 | 24-Jan-16 | 2128 | 42 46.47 | 175 24.67 | E | 895 | 903 | 3.01 | 49.4 | 21.2 | 0 | |
| 109 | P1 | 22 | 25-Jan-16 | 43 | 42 45.00 | 175 55.13 | E | 830 | 835 | 3.01 | 150.9 | 6.1 | 4.3 | |
| 110 | P1 | 7B | 25-Jan-16 | 502 | 43 03.08 | 175 42.55 | E | 477 | 479 | 3.02 | 146.8 | 8.6 | 96.6 | |
| 111 | P1 | 7B | 25-Jan-16 | 656 | 43 07.71 | 175 42.54 | E | 442 | 450 | 3.02 | 395.6 | 10.3 | 106.5 | |
| 112 | P1 | 7B | 25-Jan-16 | 845 | 43 12.06 | 175 45.02 | E | 425 | 445 | 3.02 | 1 489.7 | 212.0 | 109.5 | |
| 113 | P1 | 18 | 25-Jan-16 | 1138 | 43 28.33 | 175 46.07 | E | 280 | 307 | 2.20 | 1 902.6 | 0 | 0 | |
| 114 | P1 | 18 | 25-Jan-16 | 1342 | 43 38.00 | 175 41.02 | E | 280 | 295 | 3.01 | 3 490.1 | 0 | 0 | |
| 115 | P1 | 19 | 25-Jan-16 | 1721 | 43 29.55 | 176 09.02 | E | 369 | 381 | 3.04 | 440.6 | 8.5 | 165.1 | |
| 116 | P1 | 15 | 26-Jan-16 | 502 | 43 41.78 | 176 30.57 | E | 405 | 406 | 2.66 | 511.8 | 7.6 | 114.6 | |
| 117 | P1 | 19 | 26-Jan-16 | 734 | 43 31.45 | 176 50.19 | E | 265 | 276 | 2.26 | 6 240.0 | 0 | 0 | |
| 118 | P1 | 19 | 26-Jan-16 | 930 | 43 28.20 | 177 03.79 | E | 243 | 255 | 3.00 | 179.2 | 0 | 0 | |
| 119 | P1 | 19 | 26-Jan-16 | 1133 | 43 19.65 | 176 58.07 | E | 245 | 247 | 2.06 | 5.0 | 0 | 0 | |
| 120 | P1 | 19 | 26-Jan-16 | 1407 | 43 07.45 | 176 38.80 | E | 319 | 357 | 3.00 | 698.9 | 14.4 | 90.1 | |
| 121 | P1 | 19 | 26-Jan-16 | 1737 | 43 09.85 | 176 05.87 | E | 379 | 392 | 3.00 | 563.8 | 0 | 57.9 | |
| 122 | P1 | 22 | 26-Jan-16 | 2205 | 42 41.49 | 176 10.26 | E | 872 | 884 | 3.02 | 120.2 | 0 | 6.7 | |
| 123 | P1 | 22 | 27-Jan-16 | 148 | 42 41.03 | 176 47.01 | E | 954 | 956 | 3.03 | 10.2 | 9.2 | 0 | |
| 124 | P1 | 8A | 27-Jan-16 | 517 | 42 49.00 | 176 41.40 | E | 467 | 514 | 3.05 | 453.2 | 6.6 | 25.7 | |
| 125 | P1 | 8A | 27-Jan-16 | 732 | 42 59.25 | 176 32.70 | E | 428 | 438 | 3.01 | 286.7 | 45.7 | 71.8 | |
| 126 | P1 | 19 | 27-Jan-16 | 1235 | 43 03.20 | 177 21.50 | E | 299 | 306 | 3.00 | 1 312.4 | 0 | 17.8 | |
| 127 | P1 | 8A | 27-Jan-16 | 1522 | 42 54.81 | 177 35.92 | E | 405 | 423 | 3.04 | 207.6 | 30.1 | 52.7 | |
| 128 | P1 | 20 | 28-Jan-16 | 501 | 43 10.50 | 178 52.71 | E | 372 | 392 | 3.04 | 336.7 | 15.3 | 151.2 | |
| 129 | P1 | 20 | 28-Jan-16 | 756 | 43 28.34 | 179 00.79 | E | 365 | 375 | 3.01 | 214.7 | 0 | 100.1 | |
| 130 | P1 | 20 | 28-Jan-16 | 1110 | 43 39.90 | 178 36.17 | E | 388 | 396 | 3.03 | 4 906.1 | 0 | 92.4 | |
| 131 | P1 | 20 | 28-Jan-16 | 1313 | 43 33.22 | 178 32.44 | E | 348 | 362 | 3.00 | 946.8 | 0 | 70.4 | |
| 132 | P1 | 20 | 28-Jan-16 | 1614 | 43 23.88 | 178 16.03 | E | 335 | 344 | 2.47 | 588.3 | 0 | 30.0 | |
| 133 | P1 | 20 | 29-Jan-16 | 502 | 43 24.40 | 177 30.51 | E | 283 | 303 | 2.56 | 5 888.2 | 0 | 1.9 | |
| 134 | P1 | 15 | 29-Jan-16 | 859 | 43 40.23 | 177 05.69 | E | 411 | 475 | 3.02 | 1 626.9 | 38.5 | 160.7 | |
| 135 | P1 | 15 | 29-Jan-16 | 1226 | 43 50.08 | 177 31.99 | E | 557 | 563 | 3.00 | 357.8 | 0 | 88.3 | |
| 136 | P2 | 16 | 30-Jan-16 | 505 | 43 49.81 | 175 59.07 | E | 454 | 462 | 3.01 | 1 670.7 | 14.7 | 112.5 | |
| 137 | P2 | 16 | 30-Jan-16 | 757 | 43 56.48 | 175 37.44 | E | 486 | 493 | 3.02 | 1 315.0 | 9.8 | 175.8 | |

Appendix 1: (continued)

| Stn. | Type | Strat. | Date | Time | Start tow | | | Gear | depth | | Dist. Towed | Catch | | |
|------|------|--------|-----------|------|-----------|-----------|-----|------|-------|------|----------------|---------|-------|------|
| | | | | | Latitude | Longitude | E/W | | min. | max. | | n. mile | hoki | hake |
| | | | | NZST | ° ' S | ° ' E/W | m | | | | | | | |
| 138 | P2 | 16 | 30-Jan-16 | 1015 | 44 03.18 | 175 27.11 | E | 495 | 512 | 3.04 | 545.2 | 0 | 150.5 | |
| 139 | P2 | 16 | 30-Jan-16 | 1324 | 44 13.00 | 175 07.70 | E | 534 | 559 | 2.99 | 987.4 | 0 | 155.8 | |
| *140 | P2 | 16 | 30-Jan-16 | 1646 | 44 12.94 | 174 38.80 | E | 569 | 578 | 2.92 | - | - | - | |
| 141 | P2 | 16 | 31-Jan-16 | 503 | 43 54.89 | 175 59.03 | E | 514 | 546 | 3.04 | 465.2 | 0 | 163.5 | |
| 142 | P2 | 16 | 31-Jan-16 | 814 | 44 01.62 | 175 31.85 | E | 502 | 524 | 2.74 | 694.6 | 3.6 | 94.4 | |
| 143 | P2 | 16 | 31-Jan-16 | 1342 | 43 53.19 | 174 31.40 | E | 546 | 548 | 3.04 | 890.1 | 39.4 | 86.4 | |
| 144 | P2 | 16 | 31-Jan-16 | 1649 | 44 03.71 | 174 16.06 | E | 552 | 566 | 3.01 | 355.0 | 10.9 | 44.1 | |
| 145 | P2 | 7A | 1-Feb-16 | 516 | 43 20.87 | 174 17.24 | E | 576 | 584 | 3.02 | 130.5 | 16.9 | 88.0 | |

Appendix 2: Scientific and common names of species caught from all valid biomass tows (TAN1601). The occurrence (Occ.) of each species (number of tows caught) in the 139 valid biomass tows is also shown. Note that species codes are continually updated on the database following this and other surveys.

| Scientific name | Common name | Species | Occ. |
|------------------------------------------|--------------------------------|---------|------|
| Algae | unspecified seaweed | SEO | 5 |
| Porifera | unspecified sponges | ONG | 1 |
| Demospongiae (siliceous sponges) | | | |
| Astrophorida (sandpaper sponges) | | | |
| Ancorinidae | | | |
| <i>Ecionemia novaezealandiae</i> | knobbly sandpaper sponge | ANZ | 1 |
| Pachastrellidae | | | |
| <i>Poecillastra laminaris</i> | chipped fibreglass matt sponge | PLN | |
| Hadromerida (woody sponges) | | | |
| Suberitidae | | | |
| <i>Suberites affinis</i> | fleshy club sponge | SUA | 8 |
| Haplosclerida (air sponges) | | | |
| Callyspongiidae | | | |
| <i>Callyspongia</i> cf. <i>ramosa</i> | airy finger sponge | CRM | 1 |
| Spirophorida (spiral sponges) | | | |
| Tetillidae | | | |
| <i>Tetilla australe</i> | bristle ball sponge | TTL | 5 |
| <i>T. leptoderma</i> | furry oval sponge | TLD | 1 |
| Hexactinellida (glass sponges) | unspecified glass sponge | GLS | 1 |
| Lyssacinosa (tubular sponges) | | | |
| Euplectellidae | | | |
| <i>Euplectella regalis</i> | Basket-weave horn sponge | ERE | 6 |
| Rossellidae | | | |
| <i>Hyalascus</i> sp. | floppy tubular sponge | HYA | 32 |
| Poecilosclerida (bright sponges) | | | |
| Coelosphaeridae | | | |
| <i>Lissodendoryx bifacialis</i> | floppy chocolate plate sponge | LBI | 1 |
| Cnidaria | | | |
| Scyphozoa | unspecified jellyfish | JFI | 40 |
| Anthozoa | | | |
| Octocorallia | | | |
| Alcyonacea (soft corals) | unspecified soft coral | SOC | 5 |
| Isididae | | | |
| <i>Keratoisis</i> spp. | branching bamboo coral | BOO | 1 |
| <i>Lepidisis</i> spp. | bamboo coral | LLE | 2 |
| Pennatulacea (sea pens) | unspecified sea pens | PTU | 5 |
| Umbellulidae | | | |
| <i>Umbellula</i> spp. | sea pens | UMB | 1 |
| Hexacorallia | | | |
| Zoanthidea (zoanthids) | | | |
| Epizoanthidae | | | |
| <i>Epizoanthus</i> sp. | | EPZ | 6 |
| Corallimorpharia (coral-like anemones) | | | |
| Corallimorphidae | | | |
| <i>Corallimorphus</i> spp. | coral-like anemone | CLM | 1 |
| Actinaria (anemones) | unspecified anemone | ANT | 8 |
| Actiniidae | | | |
| <i>Bolocera</i> spp. | deepsea anemone | BOC | 3 |
| Actinostolidae (smooth deepsea anemones) | | ACS | 28 |
| Hormathiidae (warty deepsea anemones) | | HMT | 20 |
| Liponematidae | | | |
| <i>Liponema</i> spp. | deepsea anemone | LIP | 1 |

Appendix 2 (continued)

| Scientific name | Common name | Species | Occ. |
|----------------------------------------|--------------------------|---------|------|
| Scleractinia (stony corals) | | | |
| Caryophyllidae | | | |
| <i>Goniocorella dumosa</i> | bushy hard coral | GDU | 2 |
| <i>Stephanocyathus platypus</i> | solitary bowl coral | STP | 1 |
| Flabellidae | | | |
| <i>Flabellum</i> spp. | flabellum coral | COF | 12 |
| Hydrozoa | | | |
| Anthoathecata (hydroids) | unspecified hydroids | HDR | 1 |
| Stylasteridae | | | |
| <i>Lepidotheca</i> spp. | | LPT | 1 |
| Ascidiacea | unspecified sea squirt | ASC | 1 |
| Tunicata | | | |
| Thaliacea (salps) | | | |
| | unspecified salps | SAL | 2 |
| Salpidae | | | |
| <i>Pyrosoma atlanticum</i> | | PYR | 43 |
| <i>Soestia zonaria</i> | | ZZO | 1 |
| Mollusca | | | |
| Gastropoda (gastropods) | unspecified gastropods | GAS | 3 |
| Ranellidae (tritons) | | | |
| <i>Fusitriton magellanicus</i> | | FMA | 27 |
| Volutidae (volutes) | | | |
| <i>Provocator mirabilis</i> | golden volute | GVO | 7 |
| Cephalopoda | | | |
| Sepiolida (bobtail squids) | | | |
| Sepiadariidae | | | |
| <i>Sepioloidea</i> spp. | bobtail squid | SSQ | 3 |
| Teuthoidea (squids) | | | |
| Octopoteuthidae | | | |
| <i>Octopoteuthis</i> sp. 1 NZ | | OPO | 2 |
| <i>Taningia</i> spp. | | TDQ | 1 |
| Onychoteuthidae | | | |
| <i>Onykia ingens</i> | warty squid | MIQ | 69 |
| <i>O. robsoni</i> | warty squid | MRQ | 8 |
| Pholidoteuthidae | | | |
| <i>Pholidoteuthis</i> sp. 1 NZ | large red scaly squid | PSQ | 1 |
| Histioteuthidae (violet squids) | | | |
| <i>Histioteuthis atlantica</i> | violet squid | HAA | 4 |
| <i>Histioteuthis</i> spp. | violet squid | VSQ | 8 |
| Ommastrephidae | | | |
| | unspecified ommastrephid | OMQ | 1 |
| <i>Nototodarus sloanii</i> | Sloan's arrow squid | NOS | 56 |
| <i>Todarodes filippovae</i> | Todarodes squid | TSQ | 60 |
| Chiroteuthidae | | | |
| <i>Chiroteuthis veryani</i> | squid | CVE | 2 |
| Mastigoteuthidae | | | |
| <i>Idioteuthis cordiformis</i> | whip-lash squid | ICQ | 1 |
| <i>Mastigoteuthis agassizzi</i> | whip-lash squid | MAG | 1 |
| <i>Mastigoteuthis</i> spp. | whip-lash squid | MSQ | 1 |
| Cranchiidae | | | |
| | unspecified cranchiid | CHQ | 1 |
| <i>Galiteuthis suhmi</i> | squid | GAI | 2 |
| <i>Galiteuthis</i> spp. | squid | GAI | 6 |
| <i>Teuthowenia pellucida</i> | squid | TPE | 10 |

Appendix 2 (continued)

| Scientific name | Common name | Species | Occ. |
|------------------------------------------------------|-------------------------|---------|------|
| Incirrata (incirrate octopus) | | | |
| Amphitretidae | | | |
| <i>Amphitretis</i> spp. | deepwater octopus | AMP | 1 |
| <i>Vitreledonella richardi</i> | glass octopus | VRI | 1 |
| Octopodidae | | | |
| <i>Benthooctopus tangaroa</i> | octopus | BNO | 1 |
| <i>Enterooctopus zealandicus</i> | yellow octopus | EZE | 1 |
| <i>Graneledone taniwha taniwha</i> | deepwater octopus | GTA | 4 |
| <i>Octopus mernoo</i> | octopus | OME | 1 |
| <i>Thaumeledone zeiss</i> | deepwater octopus | TZE | 2 |
| Polychaeta | | | |
| Eunicida | | | |
| Eunicidae | | | |
| <i>Eunice</i> spp. | Eunice sea worm | EUN | 1 |
| Phyllodocida | | | |
| Aphroditidae | | | |
| <i>Aphrodita</i> spp. | sea mouse | ADT | 1 |
| Pycnogonida | | | |
| | unspecified sea spider | PYC | 1 |
| Crustacea | | | |
| Malacostraca | | | |
| Dendrobranchiata | | | |
| Aristeidae | | | |
| <i>Aristaeomorpha foliacea</i> | royal red prawn | AFO | 1 |
| <i>Aristeus</i> sp. | deepwater prawn | ARI | 2 |
| Sergestidae | | | |
| <i>Sergia potens</i> | deepwater prawn | SEP | 2 |
| Pleocyemata | | | |
| Caridea | | | |
| Oplophoridae | | | |
| <i>AcanthePHYra</i> spp. | SubAntarctic ruby prawn | ACA | 8 |
| <i>Oplophorus novaezeelandiae</i> | deepwater prawn | ONO | 1 |
| Pasiphaeidae | | | |
| <i>Pasiphaea barnardi</i> | deepwater prawn | PBA | 19 |
| Nematocarcinidae | | | |
| <i>Lipkius holthuisi</i> | omega prawn | LHO | 33 |
| Achelata | | | |
| Astacidea | | | |
| Nephropidae (clawed lobsters) | | | |
| <i>Metanephrops challengeri</i> | scampi | SCI | 32 |
| Palinura | | | |
| Polychelidae | | | |
| <i>Polycheles</i> spp. | deepsea blind lobster | PLY | 3 |
| Crab (unspecified anomuran + brachyuran crab) | | | |
| Anomura | | | |
| Galatheoidea | | | |
| Galatheidae (galatheid squat lobsters) | | | |
| <i>Munida gracilis</i> | squat lobster | MGA | 1 |
| Lithodidae (king crabs) | | | |
| <i>Lithodes aotearoa</i> | New Zealand king crab | LAO | 2 |
| <i>L. robertsoni</i> | Robertson's king crab | LRO | 2 |
| <i>Neolithodes brodiei</i> | Brodie's king crab | NEB | 2 |
| <i>Paralomis zealandica</i> | Prickly king crab | PZE | 2 |

Appendix 2 (continued)

| Scientific name | Common name | Species | Occ. |
|------------------------------------------|----------------------------|---------|------|
| Paguroidea (unspecified hermit crabs) | | PAG | 6 |
| Paguridae (Pagurid hermit crabs) | | | |
| <i>Diacanthurus rubricatus</i> | hermit crab | DIR | 6 |
| Parapaguridae (Parapagurid hermit crabs) | | | |
| <i>Sympagurus dimorphus</i> | hermit crab | SDM | 9 |
| Brachyura (true crabs) | | | |
| Atelecyclidae | | | |
| <i>Trichopeltarion fantasticum</i> | frilled crab | TFA | 14 |
| Homolidae | | | |
| <i>Dagnaudus petterdi</i> | antlered crab | DAP | 4 |
| Inachidae | | | |
| <i>Vitjazmaia latidactyla</i> | deepsea spider crab | VIT | 4 |
| Majidae (spider crabs) | | | |
| <i>Leptomithrax garricki</i> | Garrick's masking crab | GMC | 1 |
| <i>Teratomaia richardsoni</i> | spiny masking crab | SMK | 8 |
| Portunidae (swimming crabs) | | | |
| <i>Nectocarcinus bennetti</i> | smooth red swimming crab | NCB | 1 |
| <i>Ovalipes molleri</i> | swimming crab | OVM | 1 |
| Echinodermata | | | |
| Asteroidea (starfish) | unspecified starfish | ASR | 2 |
| Asteriidae | | | |
| <i>Cosmasterias dyscrita</i> | cat's-foot star | CDY | 1 |
| <i>Pseudechinaster rubens</i> | starfish | PRU | 2 |
| <i>Sclasterias mollis</i> | cross-fish | SMO | 4 |
| Astropectinidae | | | |
| <i>Dipsacaster magnificus</i> | magnificent sea-star | DMG | 13 |
| <i>Plutonaster knoxi</i> | abyssal star | PKN | 23 |
| <i>Proserpinaster neozelanicus</i> | starfish | PNE | 10 |
| <i>Psilaster acuminatus</i> | geometric star | PSI | 33 |
| Benthopectinidae | | | |
| <i>Benthopecten</i> spp. | starfish | BES | 3 |
| Brisingida | unspecified Brisingid | BRG | 14 |
| Echinasteridae | | | |
| <i>Henricia compacta</i> | starfish | HEC | 3 |
| Goniasteridae | | | |
| <i>Ceramaster patagonicus</i> | pentagon star | CPA | 4 |
| <i>Hippasteria phrygiana</i> | trojan starfish | HTR | 8 |
| <i>Lithosoma novaezelandiae</i> | rock star | LNV | 8 |
| <i>Mediaster sladeni</i> | starfish | MSL | 10 |
| <i>Pillsburiaster aoteanus</i> | starfish | PAO | 4 |
| Solasteridae | | | |
| <i>Crossaster multispinus</i> | sun star | CJA | 12 |
| <i>Solaster torulatus</i> | chubby sun-star | SOT | 5 |
| Pterasteridae | | | |
| <i>Diplopteraster</i> sp. | starfish | DPP | 2 |
| <i>Hymenaster carnosus</i> | starfish | HYC | 1 |
| Zoroasteridae | | | |
| <i>Zoroaster</i> spp. | rat-tail star | ZOR | 43 |
| Ophiuroidea (basket and brittle stars) | unspecified brittle star | OPH | 3 |
| Ophiodermatiae | | | |
| <i>Bathypectinura heros</i> | deepsea brittle star | BHE | 1 |
| Ophiuridae | | | |
| <i>Ophiomusium lymani</i> | brittle star | OLY | 4 |
| Euryalina (basket stars) | | | |
| Gorgonocephalidae | | | |
| <i>Gorgonocephalus</i> spp. | Gorgon's head basket stars | GOR | 2 |

Appendix 2 (continued)

| Scientific name | Common name | Species | Occ. |
|----------------------------------------------|----------------------------------|---------|------|
| Echinoidea (sea urchins) | | | |
| Regularia | | | |
| Cidaridae (cidarid urchins) | | | |
| <i>Goniocidaris parasol</i> | parasol urchin | GPA | 8 |
| Echinothuriidae/Phormosomatidae | unspecified Tam O'Shanter urchin | TAM | 49 |
| Phormosomatidae | | | |
| <i>Phormosoma</i> spp. | | PHM | 8 |
| Echinidae | | | |
| <i>Gracilechinus multidentatus</i> | deepsea kina | GRM | 16 |
| Spatangoida (heart urchins) | | | |
| Spatangidae | | | |
| <i>Paramaretia peloria</i> | Microsoft mouse | PMU | 5 |
| <i>Spatangus multispinus</i> | purple-heart urchin | SPT | 13 |
| Holothuroidea | unspecified holothurian | HTH | 4 |
| Aspidochirotida | | | |
| Synallactidae | | | |
| <i>Bathyploetes</i> sp. | sea cucumber | BAM | 5 |
| <i>Pseudostichopus mollis</i> | sea cucumber | PMO | 30 |
| Elasipodida | | | |
| Laetmogonidae | | | |
| <i>Laetmogone</i> sp. | sea cucumber | LAG | 9 |
| <i>Pannychia moseleyi</i> | sea cucumber | PAM | 7 |
| Pelagothuridae | | | |
| <i>Eynpniastes exima</i> | sea cucumber | EEX | 8 |
| Psychropotidae | | | |
| <i>Benthoodytes</i> sp. | sea cucumber | BTD | 5 |
| Brachiopoda (lamp shells) | unspecified lamp shell | BPD | 1 |
| Agnatha (jawless fishes) | | | |
| Myxinidae: hagfishes | | | |
| <i>Eptatretus cirrhatus</i> | hagfish | HAG | 4 |
| Chondrichthyes (cartilaginous fishes) | | | |
| Chlamydoselachidae: frilled sharks | | | |
| <i>Chlamydoselachus anguineus</i> | frill shark | FRS | 2 |
| Hexanchidae: cow sharks | | | |
| <i>Hexanchus griseus</i> | sixgill shark | HEX | 2 |
| Squalidae: dogfishes | | | |
| <i>Squalus acanthias</i> | spiny dogfish | SPD | 63 |
| <i>S. griffini</i> | northern spiny dogfish | NSD | 7 |
| Centrophoridae: gulper sharks | | | |
| <i>Centrophorus squamosus</i> | leafscale gulper shark | CSQ | 27 |
| <i>Deania calcea</i> | shovelnose spiny dogfish | SND | 57 |
| Etmopteridae: lantern sharks | | | |
| <i>Etmopterus baxteri</i> | Baxter's dogfish | ETB | 52 |
| <i>E. lucifer</i> | lucifer dogfish | ETL | 61 |
| Somniosidae: sleeper sharks | | | |
| <i>Centroscymnus crepidater</i> | longnose velvet dogfish | CYP | 41 |
| <i>C. owstoni</i> | smooth skin dogfish | CYO | 28 |
| <i>Proscymnodon plunketi</i> | Plunket's shark | PLS | 8 |
| Oxynotidae: rough sharks | | | |
| <i>Oxynotus bruniensis</i> | prickly dogfish | PDG | 15 |
| Dalatiidae: kitefin sharks | | | |
| <i>Dalatias licha</i> | seal shark | BSH | 30 |

Appendix 2 (continued)

| Scientific name | Common name | Species | Occ. |
|-----------------------------------------------|--------------------------------|---------|------|
| Scyliorhinidae: cat sharks | | | |
| <i>Apristurus</i> spp. | catshark | APR | 32 |
| <i>Bythaelurus dawsoni</i> | Dawson's catshark | DCS | 1 |
| <i>Cephaloscyllium isabellum</i> | carpet shark | CAR | 2 |
| Triakidae: smoothhounds | | | |
| <i>Galeorhinus galeus</i> | school shark | SCH | 11 |
| Torpedinidae: electric rays | | | |
| <i>Torpedo fairchildi</i> | electric ray | ERA | 2 |
| Narkidae: blind electric rays | | | |
| <i>Typhlonarke aysoni</i> | blind electric ray | TAY | 1 |
| <i>T. tarakea</i> | oval electric ray | TTA | 1 |
| <i>T. spp.</i> | numbfish | BER | 6 |
| Rajidae: skates | | | |
| <i>Amblyraja hyperborea</i> | deepwater spiny (Arctic) skate | DSK | 3 |
| <i>Bathraja shuntovi</i> | longnosed deepsea skate | PSK | 8 |
| <i>Brochiraja asperula</i> | smooth deepsea skate | BTA | 18 |
| <i>B. spinifera</i> | prickly deepsea skate | BTS | 3 |
| <i>Dipturus innominatus</i> | smooth skate | SSK | 38 |
| <i>Zearaja nasuta</i> | rough skate | RSK | 4 |
| Chimaeridae: chimaeras, ghost sharks | | | |
| <i>Chimaera carophila</i> | brown chimaera | CHP | 8 |
| <i>Hydrolagus bemisi</i> | pale ghost shark | GSP | 93 |
| <i>H. homonycteris</i> | black ghost shark | HYB | 1 |
| <i>H. novaezealandiae</i> | dark ghost shark | GSH | 52 |
| <i>H. trolli</i> | pointynose blue ghost shark | HYP | 1 |
| Rhinochimaeridae: longnosed chimaeras | | | |
| <i>Harriotta raleighana</i> | longnose spookfish | LCH | 66 |
| <i>Rhinochimaera pacifica</i> | Pacific spookfish | RCH | 27 |
| Osteichthyes (bony fishes) | | | |
| Halosauridae: halosaurs | | | |
| <i>Halosaurus pectoralis</i> | common halosaur | HPE | 3 |
| Notacanthidae: spiny eels | | | |
| <i>Notacanthus chemnitzii</i> | giant spineback | NOC | 2 |
| <i>N. sexspinis</i> | spineback | SBK | 74 |
| Synphobranchidae: cutthroat eels | | | |
| <i>Diastobranchius capensis</i> | basketwork eel | BEE | 35 |
| <i>Simenchelys parasitica</i> | snubnosed eel | SNE | 1 |
| <i>Synphobranchius affinis</i> | grey cutthroat eel | SAF | 1 |
| Nemichthyidae: snipe eels | | | |
| <i>Avocettina</i> spp. | black snipe eel | AVO | 1 |
| Congridae: conger eels | | | |
| <i>Bassanago bulbiceps</i> | swollenhead conger | SCO | 48 |
| <i>B. hirsutus</i> | hairy conger | HCO | 44 |
| Serrivomeridae: sawtooth eels | | | |
| <i>Serrivomer</i> spp. | sawtooth eel | SAW | 2 |
| Gonorynchidae: sandfish | | | |
| <i>Gonorynchus forsteri</i> & <i>G. greyi</i> | sandfishes | GON | 3 |
| Argentinidae: silversides | | | |
| <i>Argentina elongata</i> | silverside | SSI | 61 |
| Bathylagidae: deepsea smelts | | | |
| <i>Bathylagichthys</i> spp. | grey pencilsmelts | BAH | 3 |
| <i>Melanolagus bericoides</i> | bigscale blacksmelt | MEB | 6 |
| Platytroutidae: tubeshoulders | | | |
| <i>Persarsia kopua</i> | tubeshoulder | PER | 3 |

Appendix 2 (continued)

| Scientific name | Common name | Species | Occ. |
|-------------------------------------------------|-------------------------------|---------|------|
| Alepocephalidae: slickheads | | | |
| <i>Alepocephalus antipodanus</i> | smallscaled brown slickhead | SSM | 29 |
| <i>A. australis</i> | bigscaled brown slickhead | SBI | 24 |
| <i>Talismania longifilis</i> | slickhead | TAL | 1 |
| <i>Xenodermichthys</i> spp. | black slickhead | BSL | 18 |
| Sternoptychidae: hatchetfishes | | | |
| <i>Argyropelecus gigas</i> | giant hatchetfish | AGI | 4 |
| Photichthyidae: lighthouse fishes | | | |
| <i>Phosichthys argenteus</i> | lighthouse fish | PHO | 25 |
| Stomiidae: barbeled dragonfishes | | | |
| <i>Chauliodus sloani</i> | viperfish | CHA | 15 |
| <i>Idiacanthus</i> spp. | black dragonfish | IDI | 5 |
| <i>Malacosteus australis</i> | southern loosejaw | MAU | 3 |
| <i>Melanostomias</i> spp. | scaleless black dragonfishes | MEN | 3 |
| <i>Opostomias micripnus</i> | giant black dragonfish | OMI | 3 |
| <i>Stomias</i> spp. | | STO | 5 |
| Astronesthidae: snaggletooths | | | |
| <i>Astronesthes</i> spp. | unspecified snaggletooth | AST | 2 |
| <i>Borostomias antarcticus</i> | | ASE | 1 |
| <i>B. mononema</i> | | BAN | 5 |
| <i>Neonesthes microcephalus</i> | | BMO | 1 |
| <i>Neonesthes microcephalus</i> | | NMI | 1 |
| Chlorophthalmidae: cucumberfishes, tripodfishes | | | |
| <i>Paraulopus nigripinnis</i> | cucumber fish | CUC | 1 |
| Scopelarchidae: pearleyes | | | |
| <i>Scopelarchoides kreffti</i> | Kreffft's pearleye | SKR | 1 |
| Notosudidae: waryfishes | | | |
| <i>Scopelosaurus</i> spp. | | SPL | 3 |
| Paralepididae: barracudinas | | | |
| <i>Macroparalepis macrugeneion</i> | | MMA | 1 |
| <i>Magnisudis prionosa</i> | giant barracudina | BCA | 1 |
| Myctophidae: lanternfishes | | | |
| <i>Diaphus danae</i> | unspecified lanternfish | LAN | 9 |
| <i>Electrona paucirastra</i> | dana lanternfish | DDA | 5 |
| <i>Electrona paucirastra</i> | belted lanternfish | EPA | 1 |
| <i>Gymnoscopelus hintonoides</i> | false-midas lanternfish | GYH | 1 |
| <i>G. piabilis</i> | southern blacktip lanternfish | GYP | 3 |
| <i>Lampadena notialis</i> | notal lanternfish | LNT | 1 |
| <i>L. speculigera</i> | mirror lanternfish | LSP | 1 |
| <i>Lampanyctus australis</i> | austral lanternfish | LAU | 4 |
| <i>L. intricarius</i> | intricate lanternfish | LIT | 16 |
| <i>Nannobranchium achirus</i> | cripplefin lanternfish | LAC | 3 |
| <i>Symbolophorus boops</i> | bogue lanternfish | SBP | 3 |
| Moridae: morid cods | | | |
| <i>Antimora rostrata</i> | violet cod | VCO | 11 |
| <i>Halargyreus</i> spp. | 'Johnson's' cod | HJO | 49 |
| <i>Lepidion microcephalus</i> | small-headed cod | SMC | 31 |
| <i>Mora moro</i> | ribaldo | RIB | 43 |
| <i>Notophycis marginata</i> | dwarf cod | DCO | 8 |
| <i>Pseudophycis bachus</i> | red cod | RCO | 28 |
| <i>P. barbata</i> | southern bastard cod | SBR | 1 |
| Moridae: morid cods (cont) | | | |
| <i>Tripterophycis gilchristi</i> | grenadier cod | GRC | 2 |
| Gadidae: true cods | | | |
| <i>Micromesistius australis</i> | southern blue whiting | SBW | 19 |
| Merlucciidae: hakes | | | |
| <i>Lyconus</i> spp. | lyconus | LYC | 2 |
| <i>Macruronus novaezelandiae</i> | hoki | HOK | 127 |
| <i>Merluccius australis</i> | hake | HAK | 61 |

Appendix 2 (continued)

| Scientific name | Common name | Species | Occ. |
|---------------------------------------|--------------------------|---------|------|
| Macrouridae: rattails, grenadiers | | | |
| <i>Coelorinchus acanthiger</i> | spotty faced rattail | CTH | 4 |
| <i>C. aspercephalus</i> | oblique banded rattail | CAS | 46 |
| <i>C. biclinozonalis</i> | two saddle rattail | CBI | 10 |
| <i>C. bollonsi</i> | Bollons's rattail | CBO | 93 |
| <i>C. fasciatus</i> | banded rattail | CFA | 45 |
| <i>C. innotabilis</i> | notable rattail | CIN | 52 |
| <i>C. kaiyomaru</i> | Kaiyomaru rattail | CKA | 13 |
| <i>C. matamua</i> | Mahia rattail | CMA | 19 |
| <i>C. oliverianus</i> | Oliver's rattail | COL | 64 |
| <i>C. parvifasciatus</i> | small banded rattail | CCX | 17 |
| <i>C. trachycarus</i> | roughhead rattail | CHY | 11 |
| <i>Coryphaenoides dossenus</i> | humpback rattail | CBA | 8 |
| <i>C. murrayi</i> | Murray's rattail | CMU | 6 |
| <i>C. serrulatus</i> | serrulate rattail | CSE | 37 |
| <i>C. striaturus</i> | striate rattail | CTR | 2 |
| <i>C. subserrulatus</i> | four-rayed rattail | CSU | 47 |
| <i>Gadomus aoteanus</i> | filamentous rattail | GAO | 3 |
| <i>Lepidorhynchus denticulatus</i> | javelinfinch | JAV | 116 |
| <i>Lucigadus nigromaculatus</i> | blackspot rattail | VNI | 32 |
| <i>Macrourus carinatus</i> | ridge scaled rattail | MCA | 28 |
| <i>Mesobius antipodum</i> | black javelinfinch | BJA | 15 |
| <i>Nezumia namatahi</i> | | NNA | 5 |
| <i>Trachonurus gagates</i> | velvet rattail | TRX | 2 |
| <i>Trachonurus villosus</i> | | TVI | 1 |
| <i>Trachyrincus aphyodes</i> | white rattail | WHX | 36 |
| <i>T. longirostris</i> | unicorn rattail | WHR | 4 |
| Ophidiidae: cuskeels | | | |
| <i>Genypterus blacodes</i> | ling | LIN | 93 |
| Carapidae: pearlfishes | | | |
| <i>Echiodon cryomargarites</i> | messmate fish | ECR | 7 |
| Regalecidae: oarfishes | | | |
| <i>Agrostichthys parkeri</i> | ribbonfish | AGR | 2 |
| Trachichthyidae: roughies, slimeheads | | | |
| <i>Hoplostethus atlanticus</i> | orange roughy | ORH | 30 |
| <i>H. mediterraneus</i> | silver roughy | SRH | 43 |
| <i>Paratrachichthys trailli</i> | common roughy | RHY | 9 |
| Diretmidae: discfishes | | | |
| <i>Diretmus argenteus</i> | discfish | DIS | 4 |
| <i>Diretmichthys parini</i> | spinyfin | SFN | 1 |
| Anoplogastridae: fangtooth | | | |
| <i>Anoplogaster cornuta</i> | fangtooth | ANO | 3 |
| Berycidae: alfonsinos | | | |
| <i>Beryx decadactylus</i> | longfinned beryx | BYD | 2 |
| <i>B. splendens</i> | alfonsino | BYS | 34 |
| Melamphaidae: bigscalefishes | | | |
| | unspecified bigscalefish | MPH | 8 |
| Zeidae: dories | | | |
| <i>Capromimus abbreviatus</i> | capro dory | CDO | 16 |
| <i>Cyttus novaezealandiae</i> | silver dory | SDO | 13 |
| <i>C. traversi</i> | lookdown dory | LDO | 95 |
| <i>Zenopsis nebulosa</i> | mirror dory | MDO | 2 |
| Oreosomatidae: oreos | | | |
| <i>Allocyttus niger</i> | black oreo | BOE | 27 |
| <i>A. verrucosus</i> | warty oreo | WOE | 6 |
| <i>Neocyttus rhomboidalis</i> | spiky oreo | SOR | 33 |
| <i>Pseudocyttus maculatus</i> | smooth oreo | SSO | 45 |

Appendix 2 (continued)

| Scientific name | Common name | Species | Occ. |
|---------------------------------------|--------------------------|---------|------|
| Macrorhamphosidae: snipefishes | | | |
| <i>Centriscopus humerosus</i> | banded bellowsfish | BBE | 66 |
| <i>Notopogon lilliei</i> | crested bellowsfish | CBE | 2 |
| Scorpaenidae: scorpionfishes | | | |
| <i>Helicolenus</i> spp. | sea perch | SPE | 89 |
| <i>Trachyscorpia eschmeyeri</i> | Cape scorpionfish | TRS | 6 |
| Congiopodidae: pigfishes | | | |
| <i>Alertichthys blacki</i> | alert pigfish | API | 3 |
| <i>Congiopodus leucopaecilus</i> | pigfish | PIG | 2 |
| Triglidae: gurnards | | | |
| <i>Lepidotrigla brachyoptera</i> | scaly gurnard | SCG | 10 |
| Hoplichthyidae: ghostflatheads | | | |
| <i>Hoplichthys haswelli</i> | deepsea flathead | FHD | 44 |
| Psychrolutidae: toadfishes | | | |
| <i>Ambopthalmos angustus</i> | pale toadfish | TOP | 23 |
| <i>Cottunculus nudus</i> | bonyskull toadfish | COT | 1 |
| <i>Neophrynichthys latus</i> | dark toadfish | TOD | 1 |
| <i>Psychrolutes microporos</i> | blobfish | PSY | 5 |
| Percichthyidae: temperate basses | | | |
| <i>Polyprion oxygeneios</i> | hapuku | HAP | 7 |
| Serranidae: sea perches, gropers | | | |
| <i>Lepidoperca aurantia</i> | orange perch | OPE | 13 |
| Epigonidae: deepwater cardinalfishes | unspecified cardinalfish | CDL | 1 |
| <i>Epigonus denticulatus</i> | white cardinalfish | EPD | 12 |
| <i>E. lenimen</i> | bigeye cardinalfish | EPL | 7 |
| <i>E. machaera</i> | thin tongue cardinalfish | EPM | 22 |
| <i>E. robustus</i> | robust cardinalfish | EPR | 4 |
| <i>E. telescopus</i> | deepsea cardinalfish | EPT | 20 |
| <i>Rosenblattia robusta</i> | rotund cardinalfish | ROS | 1 |
| Carangidae: trevallies, kingfishes | | | |
| <i>Trachurus declivis</i> | greenback jack mackerel | JMD | 1 |
| <i>T. murphyi</i> | slender jack mackerel | JMM | 8 |
| Bramidae: pomfrets | | | |
| <i>Brama australis</i> | southern Ray's bream | SRB | 35 |
| <i>B. brama</i> | Ray's bream | RBM | 1 |
| <i>Taractichthys longipinnis</i> | big-scale pomfret | BSP | 1 |
| Emmelichthyidae: bonnetmouths, rovers | | | |
| <i>Emmelichthys nitidus</i> | redbait | RBT | 4 |
| <i>Plagiogeneion rubiginosum</i> | rubyfish | RBY | 2 |
| Cheilodactylidae: tarakihi, morwongs | | | |
| <i>Nemadactylus macropterus</i> | tarakihi | NMP | 6 |
| Zoarcidae: eelpouts | | | |
| <i>Melanostigma gelatinosum</i> | limp eel pout | EPO | 1 |
| Uranoscopidae: armourhead stargazers | | | |
| <i>Kathetostoma binigrasella</i> | banded stargazer | BGZ | 1 |
| <i>K. giganteum</i> | giant stargazer | GIZ | 62 |
| Pinguipedidae: sandperches, weevers | | | |
| <i>Parapercis gilliesi</i> | yellow cod | YCO | 2 |
| Percophidae: opalfishes | | | |
| <i>Hemerocoetes</i> spp. | opalfish | OPA | 2 |
| Gempylidae: snake mackerels | | | |
| <i>Paradiplospinus gracilis</i> | false frostfish | PDS | 1 |
| <i>Rexea solandri</i> | gemfish | RSO | 1 |
| <i>Thyrsites atun</i> | barracouta | BAR | 8 |
| Trichiuridae: cutlassfishes | | | |
| <i>Benthodesmus</i> spp. | scabbardfish | BEN | 1 |
| <i>Lepidopus caudatus</i> | frostfish | FRO | 1 |

Appendix 2 (continued)

| Scientific name | Common name | Species | Occ. |
|------------------------------------------|------------------|---------|------|
| Scombridae: mackerels, tunas | | | |
| <i>Scomber australasicus</i> | blue mackerel | EMA | 1 |
| Centrolophidae: raftfishes, medusafishes | | | |
| <i>Centrolophus niger</i> | rudderfish | RUD | 13 |
| <i>Hyperoglyphe antarctica</i> | bluenose | BNS | 6 |
| <i>Seriolella caerulea</i> | white warehou | WWA | 53 |
| <i>S. punctata</i> | silver warehou | SWA | 55 |
| Nomeidae: eyebrowfishes, driftfishes | | | |
| <i>Cubiceps</i> spp. | cubehead | CUB | 2 |
| Tetragonuridae: squaretails | | | |
| <i>Tetragonurus cuvieri</i> | squaretail | TET | 1 |
| Achiropsettidae: southern flounders | | | |
| <i>Neoachirosetta milfordi</i> | finless flounder | MAN | 10 |
| Bothidae: lefteyed flounders | | | |
| <i>Arnoglossus scapha</i> | witch | WIT | 17 |
| Pleuronectidae: righteyed flounders | | | |
| <i>Azygopus pinnifasciatus</i> | spotted flounder | SDF | 1 |
| <i>Pelotretis flavilatus</i> | lemon sole | LSO | 13 |

Appendix 3: Scientific and common names of mesopelagic and benthic invertebrates identified following the voyage.

| NIWA No. | Cruise/station_no. | Class | Order | Family | Genus | Species |
|----------|--------------------|-------------|-----------|-------------------|-------------------------|------------------------|
| 105444 | TAN1601/128 | Cephalopoda | Octopoda | | | |
| 105440 | TAN1601/88 | Cephalopoda | Octopoda | Amphitretidae | <i>Amphitretus</i> | <i>pelagicus</i> |
| 105582 | TAN1601/140 | Cephalopoda | Octopoda | Octopodidae | <i>Benthoctopus</i> | cf. <i>tangaroa</i> |
| 105583 | TAN1601/94 | Cephalopoda | Octopoda | Octopodidae | <i>Graneledone</i> | <i>taniwha</i> |
| 105584 | TAN1601/75 | Cephalopoda | Octopoda | Octopodidae | <i>Graneledone</i> | <i>taniwha</i> |
| 105581 | TAN1601/87 | Cephalopoda | Octopoda | Octopodidae | <i>Graneledone</i> | <i>taniwha</i> |
| 105197 | TAN1601/79 | Cephalopoda | Octopoda | Octopodidae | <i>Graneledone</i> | <i>taniwha</i> |
| 105436 | TAN1601/69 | Cephalopoda | Octopoda | Octopodidae | <i>Graneledone</i> | <i>taniwha</i> |
| 105438 | TAN1601/64 | Cephalopoda | Octopoda | Octopodidae | <i>Octopus</i> | <i>mernoo</i> |
| 105439 | TAN1601/132 | Cephalopoda | Octopoda | Octopodidae | <i>Octopus</i> | <i>mernoo</i> |
| 105443 | TAN1601/115 | Cephalopoda | Octopoda | Octopodidae | <i>Octopus</i> | ? <i>mernoo</i> |
| 105434 | TAN1601/92 | Cephalopoda | Octopoda | Octopodidae | <i>Thaumeledone</i> | cf. <i>zeiss</i> |
| 105435 | TAN1601/77 | Cephalopoda | Octopoda | Octopodidae | <i>Thaumeledone</i> | <i>zeiss</i> |
| 105441 | TAN1601/59 | Cephalopoda | Octopoda | Vitreledonellidae | <i>Vitreledonella</i> | <i>richardi</i> |
| 105548 | TAN1601/97 | Cephalopoda | Oegopsida | Chiroteuthidae | cf. <i>Chiroteuthis</i> | |
| 105589 | TAN1601/40 | Cephalopoda | Oegopsida | Chiroteuthidae | <i>Chiroteuthis</i> | <i>veranyi</i> |
| 105586 | TAN1601/19 | Cephalopoda | Oegopsida | Chiroteuthidae | <i>Chiroteuthis</i> | <i>veranyi</i> |
| 105564 | TAN1601/46 | Cephalopoda | Oegopsida | Chiroteuthidae | <i>Chiroteuthis</i> | <i>veranyi</i> |
| 105543 | TAN1601/125 | Cephalopoda | Oegopsida | Cranchiidae | cf. <i>Teuthowenia</i> | |
| 105576 | TAN1601/71 | Cephalopoda | Oegopsida | Cranchiidae | <i>Galiteuthis</i> | |
| 105572 | TAN1601/80 | Cephalopoda | Oegopsida | Cranchiidae | <i>Galiteuthis</i> | |
| 105558 | TAN1601/76 | Cephalopoda | Oegopsida | Cranchiidae | <i>Galiteuthis</i> | <i>suhmi</i> |
| 105550 | TAN1601/92 | Cephalopoda | Oegopsida | Cranchiidae | <i>Galiteuthis</i> | <i>suhmi</i> |
| 105559 | TAN1601/74 | Cephalopoda | Oegopsida | Cranchiidae | <i>Teuthowenia</i> | <i>pellucida</i> |
| 105551 | TAN1601/95 | Cephalopoda | Oegopsida | Cranchiidae | <i>Teuthowenia</i> | <i>pellucida</i> |
| 105549 | TAN1601/97 | Cephalopoda | Oegopsida | Cranchiidae | <i>Teuthowenia</i> | <i>pellucida</i> |
| 105555 | TAN1601/95 | Cephalopoda | Oegopsida | Cranchiidae | <i>Teuthowenia</i> | <i>pellucida</i> |
| 105569 | TAN1601/45 | Cephalopoda | Oegopsida | Histioteuthidae | <i>Histioteuthis</i> | |
| 105542 | TAN1601/92 | Cephalopoda | Oegopsida | Histioteuthidae | <i>Histioteuthis</i> | |
| 105560 | TAN1601/69 | Cephalopoda | Oegopsida | Histioteuthidae | <i>Histioteuthis</i> | |
| 105580 | TAN1601/88 | Cephalopoda | Oegopsida | Histioteuthidae | <i>Histioteuthis</i> | <i>atlantica</i> |
| 105591 | TAN1601/27 | Cephalopoda | Oegopsida | Histioteuthidae | <i>Histioteuthis</i> | <i>atlantica</i> |
| 105590 | TAN1601/7 | Cephalopoda | Oegopsida | Histioteuthidae | <i>Histioteuthis</i> | <i>atlantica</i> |
| 105575 | TAN1601/40 | Cephalopoda | Oegopsida | Histioteuthidae | <i>Histioteuthis</i> | <i>atlantica</i> |
| 105552 | TAN1601/90 | Cephalopoda | Oegopsida | Histioteuthidae | <i>Histioteuthis</i> | <i>atlantica</i> |
| 105553 | TAN1601/107 | Cephalopoda | Oegopsida | Histioteuthidae | <i>Histioteuthis</i> | <i>atlantica</i> |
| 105579 | TAN1601/86 | Cephalopoda | Oegopsida | Histioteuthidae | <i>Histioteuthis</i> | cf. <i>atlantica</i> |
| 105577 | TAN1601/87 | Cephalopoda | Oegopsida | Histioteuthidae | <i>Histioteuthis</i> | cf. <i>atlantica</i> |
| 105546 | TAN1601/129 | Cephalopoda | Oegopsida | Mastigoteuthidae | <i>Idioteuthis</i> | cf. <i>cordiformis</i> |
| 105578 | TAN1601/19 | Cephalopoda | Oegopsida | Mastigoteuthidae | <i>Idioteuthis</i> | <i>cordiformis</i> |
| 105566 | TAN1601/71 | Cephalopoda | Oegopsida | Mastigoteuthidae | <i>Mastigoteuthis</i> | |
| 105573 | TAN1601/76 | Cephalopoda | Oegopsida | Mastigoteuthidae | <i>Mastigoteuthis</i> | |
| 105587 | TAN1601/76 | Cephalopoda | Oegopsida | Mastigoteuthidae | <i>Mastigoteuthis</i> | <i>agassizii</i> |
| 105574 | TAN1601/6 | Cephalopoda | Oegopsida | Octopoteuthidae | <i>Octopoteuthis</i> | sp. I NZ |
| 105556 | TAN1601/91 | Cephalopoda | Oegopsida | Octopoteuthidae | <i>Octopoteuthis</i> | sp. I NZ |
| 105561 | TAN1601/69 | Cephalopoda | Oegopsida | Onychoteuthidae | <i>Onykia</i> | |
| 105571 | TAN1601/47 | Cephalopoda | Oegopsida | Onychoteuthidae | <i>Onykia</i> | |
| 105568 | TAN1601/88 | Cephalopoda | Oegopsida | Onychoteuthidae | <i>Onykia</i> | cf. <i>ingens</i> |
| 105585 | TAN1601/43 | Cephalopoda | Oegopsida | Pholidoteuthidae | <i>Pholidoteuthis</i> | sp. I NZ |
| 105544 | TAN1601/112 | Cephalopoda | Sepiida | Sepiadariidae | <i>Sepioloidea</i> | spp. |
| 105547 | TAN1601/98 | Cephalopoda | Sepiida | Sepiadariidae | <i>Sepioloidea</i> | spp. |
| 105545 | TAN1601/102 | Cephalopoda | Sepiida | Sepiadariidae | <i>Sepioloidea</i> | spp. |

Appendix 3 (continued)

| NIWA No. | Cruise/station_no. | Class | Order | Family | Genus | Species |
|-----------------|---------------------------|--------------|--------------|---------------|--------------|----------------|
| 105437 | TAN1601/88 | Cephalopoda | Teuthida | | | |
| 105567 | TAN1601/87 | Cephalopoda | Teuthida | | | |
| 105563 | TAN1601/87 | Cephalopoda | Teuthida | | | |
| 105565 | TAN1601/48 | Cephalopoda | Teuthida | | | |

Appendix 4: Length ranges (cm) used to identify 1+, 2+ and 3++ hoki age classes to estimate relative biomass values given in Figure 7a.

| Survey | Age group | | |
|----------|-----------|---------|------|
| | 1+ | 2+ | 3++ |
| Jan 1992 | < 50 | 50 – 64 | ≥ 65 |
| Jan 1993 | < 50 | 50 – 64 | ≥ 65 |
| Jan 1994 | < 46 | 46 – 58 | ≥ 59 |
| Jan 1995 | < 46 | 46 – 58 | ≥ 59 |
| Jan 1996 | < 46 | 46 – 54 | ≥ 55 |
| Jan 1997 | < 44 | 44 – 55 | ≥ 56 |
| Jan 1998 | < 47 | 47 – 55 | ≥ 53 |
| Jan 1999 | < 47 | 47 – 56 | ≥ 57 |
| Jan 2000 | < 47 | 47 – 60 | ≥ 61 |
| Jan 2001 | < 49 | 49 – 59 | ≥ 60 |
| Jan 2002 | < 52 | 52 – 59 | ≥ 60 |
| Jan 2003 | < 49 | 49 – 61 | ≥ 62 |
| Jan 2004 | < 51 | 51 – 60 | ≥ 61 |
| Jan 2005 | < 48 | 48 – 64 | ≥ 65 |
| Jan 2006 | < 49 | 49 – 62 | ≥ 63 |
| Jan 2007 | < 48 | 48 – 62 | ≥ 63 |
| Jan 2008 | < 49 | 49 – 59 | ≥ 60 |
| Jan 2009 | < 48 | 48 – 61 | ≥ 62 |
| Jan 2010 | < 48 | 48 – 61 | ≥ 62 |
| Jan 2011 | < 48 | 48 – 61 | ≥ 62 |
| Jan 2012 | < 49 | 49 – 59 | ≥ 60 |
| Jan 2013 | < 47 | 47 – 54 | ≥ 55 |
| Jan 2014 | < 48 | 48 – 60 | ≥ 61 |
| Jan 2016 | < 49 | 49 – 62 | ≥ 62 |