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Trawl survey of hoki and middle-depth species on the Chatham Rise, January 2014 (TAN1401)

New Zealand Fisheries Assessment Report 2015/19

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EXECUTIVE SUMMARY

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The twenty-third 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 2 to 28 January 2014. A random stratified sampling design was used, and 119 bottom trawls were successfully completed. These comprised 85 core (200–800 m) phase 1 biomass tows, 2 core phase 2 tows, and 32 deep (800–1300 m) tows.

Estimated relative biomass of all hoki in core strata was 101 944 t (CV 9.8%), a decrease of 18% from January 2013. This decrease was largely driven by the biomass estimate for 1+ year old hoki of 5709 t, one of the lowest in the time series for this age class of fish. The biomass estimate for 2+ hoki (2011 year class) was lower than that expected based on the 2013 survey at age 1+, but is one of the higher estimates in the time series. The relative biomass of recruited hoki (ages 3+ years and older) was lower than that in 2013 but about average for the time series. The relative biomass of hake in core strata decreased by 23% to 1377 t (CV 15.2%) in 2014. The relative biomass of ling was 7489 t (CV 7.2%), 14% lower than that in January 2013, but the time-series for ling shows no overall trend.

The age frequency distribution for hoki was dominated by 2+ hoki (2011 year class) and there were few 1+ hoki (2012 year class). The age frequency distribution for hake was broad, with most fish aged between 3 and 11 years. The age distribution for ling was also broad, with most fish aged between 3 and 18 years.

Acoustic data were also collected during the trawl survey. The total acoustic backscatter in 2014 was lower than that recorded in 2013, but the proportion of backscatter attributed to mesopelagic fish was higher, and the index of mesopelagic fish abundance on the Chatham Rise increased by 22%. As in previous surveys, there was a positive correlation between acoustic density from bottom marks and trawl catch rates in 2014. Hoki liver condition in 2014 was lower than that in 2013 for hoki greater than 60 cm, but increased for smaller fish. There was a positive correlation between hoki liver condition and indices of mesopelagic fish scaled by hoki abundance ("food per fish").

1. INTRODUCTION

In January 2014, the twenty-third in a time series of annual 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), 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 a total allowable commercial catch (TACC) of 160 000 t from 1 October 2014. Hoki is assessed as two stocks, western and eastern. The 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 to 39 000 t from 2008–09 to 2011–12, decreasing slightly to 36 500 t in 2012–13 (Ballara & O'Driscoll 2014). The Chatham Rise was the largest hoki fishery from 2006–07 to 2009–10, but catches are now lower than those from the WCSI, contributing about 28% of the total hoki catch in 2012–13 (Ballara & O'Driscoll 2014).

The hoki fishery is strongly recruitment driven and therefore affected by large fluctuations in stock size. 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 potential recruitment to the adult fisheries.

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 assessments.

Since 2010, the Chatham Rise survey has been extended into deeper waters (to 1300 m) to provide fishery independent relative biomass indices for pre-recruit (20–30 cm) and dispersed adult orange roughy, as well as providing improved information for a range of deepwater bycatch species, and species like ribaldo and pale ghost shark, which are known to occur deeper than the core survey depth boundary (800 m).

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, 2011a, Stevens et al. 2009b, 2011, 2012, 2013, 2014). Acoustic data also provide qualitative information on the amount of backscatter produced by fish that are not available to the bottom trawl, either through being off the bottom, or over areas of foul ground.

Other work carried out concurrently with the trawl survey included sampling and preservation of unidentified and rare organisms caught in the trawl.

The continuation of the time series of trawl surveys on the Chatham Rise is a high priority to provide information required to update the assessment of hoki and other middle depth species. In the 10-year

Deepwater Research Programme, the survey is scheduled to be carried out in eight of the ten years from 2011–2020.

1.1 Project objectives

The trawl survey was carried out under contract to the Ministry for Primary Industries (project HOK2010/05C). 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 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 CV of 20 % for the number of 2 year olds.

2. To collect data for determining the population age and size structure and reproductive biology of hoki, hake and ling.

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.

The survey duration was extended by two days, from 25 to 27 days, for an additional objective under NIWA core-funded project COBR1405. The overall objective of this work was:

1. To investigate the feasibility of using the 'ratcatcher' bottom trawl to sample small demersal species on the western Chatham Rise for a proposed NIWA funded survey in 2014–15.

Results from this core-funded objective are not included in this report.

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 (1992–2013), 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 85 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 2010–13 surveys, the survey area included deep strata from 800–1300 m on the north and east Chatham Rise. Deeper areas on the southwest Chatham Rise, surveyed in 2010 (Stevens et al. 2011), were not included in the 2011–14 surveys due to limited time and large steaming distances. The station allocation for the deep strata was determined based on catch rates of orange roughy from the 2010–13 surveys, using the 'allocate' programme (Francis 2006) to estimate the optimal number of stations per stratum to achieve a target CV of 15% for both total orange roughy and orange roughy less than 30 cm standard length (SL). 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 m^2. 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 0500 h and 1844 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 Fine-mesh midwater trawling

Where time permitted at night, we also aimed to conduct additional fine-meshed midwater trawls to obtain mesopelagic specimens for trophic and taxonomic studies. The midwater mesopelagic trawl had a 10 mm cod-end mesh and a headline height of 12–15 m, with a door spread of approximately 140–160 m. The trawl was towed obliquely from within 50 m of the seabed to the surface at an ascent rate of about 20 m per minute and vessel speed of 3.0 knots.

2.5 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 (Foote et al. 1987), with the most recent calibration on 28 July 2013 in Tasman Bay. The system and calibration parameters are given in appendix 1 of O'Driscoll et al. (2015).

2.6 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).

2.7 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. Specimens were stored at 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.

2.8 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 10 other key species: hake, ling, dark ghost shark, pale ghost shark, giant stargazer, lookdown dory, sea perch, silver warehou, spiny dogfish, and white warehou. These species were selected because they are commercially important, 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 8 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, shovelnosed dogfish, Baxter's dogfish, and longnosed velvet dogfish.

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, the assumptions being that fish were randomly distributed over the bottom, that no fish were present above the height of the headline, and that all fish within the path of the trawl doors were caught.

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

2.9 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 643 hoki otoliths and 597 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 179 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.

2.10 Acoustic data analysis

All acoustic recordings made during the trawl survey were visually examined. The quality of acoustic data recordings was subjectively classified as 'good', 'marginal', or 'poor' (see appendix 2 of O'Driscoll & Bagley (2004) for examples). Only good or marginal quality recordings were considered suitable for quantitative analysis.

Acoustic analysis generally followed the methods applied to recent Chatham Rise trawl surveys (e.g., Stevens et al. 2012, 2013, 2014), 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 custom Echo Sounder Package (ESP2) software (McNeill 2001).

Estimates of the mean acoustic backscatter per km^2 from bottom-referenced marks were calculated for each recording based on integration heights of 10 m, 50 m, and 100 m above the detected acoustic bottom. Total acoustic backscatter was also integrated throughout the water column in 50 m depth bins. Acoustic density estimates (backscatter per km^2) from bottom-referenced marks were compared with trawl catch rates (kg per km^2). No attempt was made to scale acoustic estimates by target strength, correct for differences in catchability, or carry out species decomposition (O'Driscoll 2002, 2003).

O'Driscoll et al. (2009, 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). Because some of the mesopelagic fish migrate very close to the surface at night, they move into the surface 'deadzone' (shallower than 14 m) where they are not detectable by the vessel's downward looking hull-mounted transducer. Consequently, there is a substantial negative bias in night-time acoustic estimates. To correct for this bias, O'Driscoll et al. (2009) used night estimates of demersal backscatter (which remains deeper than 200 m at night) to correct daytime estimates of total backscatter.

We updated the mesopelagic time series to include data from 2014. The methods were the same as those used by O'Driscoll et al. (2011a) and Stevens et al. (2013, 2014). 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:

$$sa(meso)_i = p(meso)_s * sa(all)_i$$

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 stratum s where station i occurred. $p(meso)_s$ 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:

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

3. RESULTS

3.1 2014 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 often poor and this slowed progress between stations. A total of 36 hours were lost due to rough weather, and a further 4 hours were lost due to the vessel responding to a marine emergency, namely an activated personal locator beacon. After consultation with Ministry for Primary Industries (MPI), three scampi moorings were also recovered from near the Mernoo Bank on 25 January for MPI Research Project SCI2010/05.

In total, 119 successful biomass tows were completed, comprising 85 core (200–800 m) phase 1 tows, 2 core phase 2 tows, and 32 deep (800–1300 m) phase 1 tows (Tables 1 and 2, Figure 2, Appendix 1). Four tows were excluded from relative biomass calculations. These included two tows due to net monitor failure and two tows with gear parameters outside the acceptable range. An additional four fine-meshed mesopelagic tows were carried out at night. Station details for all tows are given in Appendix 1.

Core station density ranged from 1:288 km^2 in stratum 17 (200–400 m, Veryan Bank) to 1:3772 km^2 in stratum 4 (600–800 m, south Chatham Rise). Deepwater station density ranged from 1:416 km^2 in stratum 21a (800–1000 m, NE Chatham Rise) to 1:3165 km^2 in stratum 28 (1000–1300 m, SE Chatham Rise). Mean station density was 1:1527 km^2 (see Table 1).

3.2 Gear performance

Gear parameters are summarised in Table 3. A headline height value was obtained for all 119 successful tows, but doorspread readings were not available for 5 tows. Mean headline heights by 200 m depth intervals ranged from 6.4 to 7.2 m, averaged 6.9 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 120.1 to 128.2 m, and averaged 125.0 m.

3.3 Hydrology

The surface temperatures (Figure 3, top panel) ranged from 12.7 to 18.5 °C. Bottom temperatures ranged from 3.5 to 11.8 °C (Figure 3, bottom panel).

As in previous years, higher surface temperatures were 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 of the Chatham Islands and on and to the east of the Mernoo Bank.

3.4 Catch composition

The total catch from all 119 valid biomass stations was 106.2 t, of which 44.8 t (42.2%) was hoki, 3.1 t (2.9%) was ling, and 0.7 t (0.7%) was hake (Table 4).

Of the 289 species or species groups identified from valid biomass tows, 140 were teleosts, 29 were elasmobranchs, 28 were crustaceans, and 18 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 a juvenile *Asperoteuthis lui*, a rarely sampled and poorly known squid species.

Fifty four species or species groups were identified from four fine-meshed midwater tows. A list of these species and the number of stations at which they occurred, is given in Appendix 3.

Ninety two invertebrate taxa (mainly cephalopods) were later identified, but many were from the same taxon (Appendix 4).

3.5 Relative biomass estimates

3.5.1 Core strata (200–800 m)

Relative biomass in core strata was estimated for 45 species (Table 4). The CVs achieved for hoki, hake, and ling from core strata were 9.8%, 15.2%, and 7.2% respectively. The CV for 2+ hoki (2011 year class) was 14.2%, 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, silver warehou, 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 lower than in 2012–13, similar to 2011–2012, and 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 2014 was higher than that in the previous four years but similar to the proportion of hoki in 2009. The next most abundant QMS species were black oreo, dark ghost shark, spiky oreo, ling, spiny dogfish, lookdown dory, sea perch, barracouta, pale ghost shark, and silver warehou, each with an estimated relative biomass of over 2000 t (Table 4). The most abundant non-QMS species were Bollons’s rattail, javelinfish, shovelnose dogfish, oblique banded rattail, and Oliver’s rattail (Table 4).

Estimated relative biomass of hoki in the core strata in 2014 was 101 944 t, 18% lower than the hoki biomass in January 2013 (Table 5, Figure 5a). This was largely driven by a low biomass estimate for 1+ hoki of 5709 t, one of the lowest in the time series. The biomass of 2+ hoki (2011 year-class) was 43 272 t, and although lower than expected based on the 2013 survey at age 1+, it is one of the higher estimates in the time series (Table 6). The relative biomass of 3++ (recruited) hoki was 52 963 t, 27% lower than in 2013, but about average for the time series.

The relative biomass of hake in core strata was 1377 t, 23% lower than 2013, but 7% higher than the 2012 estimate, and still low compared to the early 1990s (see Table 5, Figure 5a). Catches were higher than average in the recently created stratum 7b to the northeast of Mernoo Bank, where high catches of hake were observed in 2009 and 2010.

The relative biomass of ling was 7489 t, 14% lower than in January 2013. The time series for ling shows no overall trend (Figure 5a).

The relative biomass estimates for most other key core species (dark ghost shark, giant stargazer, lookdown dory, pale ghost shark, sea perch, silver warehou, and white warehou) were lower than 2013 estimates, while spiny dogfish was about the same (Figure 5a).

3.5.2 Deep strata (800–1300 m)

Relative biomass and CVs in deep strata were estimated for 19 of 45 core strata species (Table 4). The relative biomass of orange roughy in all strata in 2014 was 6916 t, compared to 2779 t in 2013 (Figure 5b). The higher estimate was largely due to the single larger catch of orange roughy (1.5 t) taken in stratum 24 and precision was poor with a CV of 37.7%.

The estimated relative biomass of smooth oreo in deep strata was 1182 t, but precision was poor with a CV of 47.9%. Only 0.6% of the relative biomass of black oreo in all strata were estimated to occur in the deep strata (Table 4, Figure 5b). However, the deep strata in 2014 did not cover the area of highest black oreo abundance. In the 2010 survey, 47% of the relative biomass of black oreo was from stratum 27 on the southeast Rise (Stevens et al. 2011), an area which has not been included in the survey since then.

Deepwater sharks were abundant in deep strata, with 34%, 50%, and 84% of the total survey biomass of shovelnose dogfish, Baxter’s dogfish, and longnose velvet dogfish occurring in deep strata (Figure 5b). 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 (Figure 5b).

The deep strata contained 8.8% of total survey hake biomass, 2.6% of the total survey hoki biomass, and 1.1% 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

Hoki

In the 2014 survey, hoki were caught at 85 of 87 core biomass stations, with the highest catch rates mainly at 400–600 m depths (Table 7a, Figure 6). The highest individual catch rate of hoki in 2014 occurred on the south Chatham Rise in stratum 15 northeast of the Veryan Bank, and comprised mainly 2+ and recruited hoki (3+ and older) (Figure 6). Other high individual catch rates of hoki were around the Mernoo Bank (strata 18, 7a and 7b), Reserve Bank (strata 19 and 20), and west of the Chatham Islands (strata 12 and 13). Although relatively uncommon in 2014, as with previous surveys 1+ hoki were largely confined to the Mernoo, Veryan, and Reserve Banks (Figure 6a). Hoki of age 2+ were found over much of the Rise at 200–600 m depths but were more abundant in the western strata (Figure 6b). Recruited hoki (3+ and older) were widespread but the highest catch rates were on the southern rise (Figure 6c).

Hake

Catches of hake were consistently low throughout much of the survey area. The highest catch rates were in stratum 7b on the southwest Chatham Rise, where high catches of hake were observed in 2009 and 2010, and on the northeast Chatham Rise in strata 10, and 11 (Figure 7).

Ling

As in previous years, catches of ling were evenly distributed throughout most strata in the survey area (Figure 8). 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 8).

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 and spiny dogfish were taken on the west Rise while the largest catch rates of lookdown dory were taken on the east Rise (Figure 9). 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 around the Mernoo Bank (stratum 18). Silver warehou and white warehou were patchily distributed at depths of 200–600 m, with the largest catches in the west (Figure 9).

Orange roughy was widespread on the north and east Rise at 800–1300 m depths, with the largest catch rates taken on the northeast Rise in 1000–1300 m in strata 23 and 24 (Table 7b, Figure 9). The largest catch was 1.5 t taken in 1265–1284 m in stratum 24 (Figure 9). Black oreo, predominantly juveniles, were almost entirely caught on the southwest Rise at 600–800 m depths, in strata 4 and 6 (Table 7b, Figure 9), while smooth oreo were more widespread, with the largest catch rates taken on the northeast Rise in 800–1000 m (stratum 22) and on the southeast Rise at 1000–1300 m depths (strata 28). Spiky oreo were widespread and abundant on the northeast rise at 500–800 m (strata 2b, 10, and 12), although the largest catch of 1.7 t was taken on the southeast Rise in stratum 12 (Table 7b, Figure 9). Shovelnose dogfish, ribaldo, bigscaled brown slickhead, smallscaled brown slickhead, and four-rayed rattail were more abundant on the north Rise, longnose velvet dogfish and basketwork eel were more abundant on the eastern Rise, and Baxter's dogfish were more abundant on the south Rise (Table 7b, Figure 9).

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 frequencies were dominated by 2+ year (48–60 cm) fish (Figures 10 and 11). There were very few 1+ (less than 48 cm) fish and few longer than 80 cm (Figure 10) or older than 7 years (Figure 11). Females were slightly more abundant than males (ratio of 1.15 female: 1 male).

Hake

Scaled length frequencies and calculated numbers at age (Figures 12 and 13) were relatively broad, with most male fish aged between 3 and 10 years and female fish between 2 and 11 years. Females were more abundant than males (1.39 female: 1 male).

Ling

Scaled length frequencies and calculated numbers at age (Figures 14 and 15) indicated a wide range of ages, with most fish aged between 3 and 18. There is evidence of a period of good recruitment from 1999–2006 (Figure 15). Females were slightly less abundant than males (0.86 female: 1 male).

Other species

Length frequency distributions for key core and deepwater species are shown in Figure 16. Clear modes are apparent in the size distribution of silver and white warehou, which may correspond to 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, shovelnose dogfish) indicate that females grow larger than males (Figure 16).

The deep strata contain a high proportion of large shovelnose dogfish, longnose velvet dogfish, and Baxter's dogfish (Figure 16). Bigscaled brown slickheads, small scaled brown slickheads, basketwork eels, and four-rayed rattail are largely restricted to the deep strata (Figure 16).

Length frequency distributions of males and females of sea perch, silver warehou, orange roughy, black oreo, smooth oreo, and spiky oreo are similar. The length frequency distribution for orange roughy was broad, with a mode at 30–37 cm, but included fish as small as 9 cm (Figure 16).

The catch of giant stargazer, spiny dogfish, bigscaled brown slickhead, and basketwork eels were dominated by females (greater than 1.5 female: 1 male) while the catch of ribaldo was dominated by males (1.9 male: 1 female) (Figure 16).

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 44% of male ling were maturing or ripe, but few females were showing signs of spawning. About 43% of male hake were ripe, running ripe, or partially spent, but most females were immature or resting (57%) or maturing (29%) (Table 10). Most other species for which reproductive state was recorded did not appear to be reproductively active, except some deepwater sharks (Table 10).

3.8 Acoustic data

Over 55 GB of acoustic data were collected with the multi-frequency (18, 38, 70, 120, and 200 kHz) hull-mounted EK60 systems during the trawl survey. Because of unfavourable weather and sea conditions during the survey, the quality of acoustic recordings was often poor. 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. Recordings subjectively classified as 'good' in 2014 had an average of only 3% bad pings, 'marginal' recordings had an average of 12% bad pings, and poor recordings had an average of 42% bad pings (Figure 17). About 36% of acoustic files from the 2014 survey were classified as poor, and so were not suitable for quantitative analysis.

Expanding symbol plots of the distribution of total acoustic backscatter from good and marginal quality recordings observed during daytime trawls and night transects are shown in Figure 18. 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 48 trawl files were integrated and compared with trawl catch rates (Table 11). Data from the other 39 recordings during core daytime tows were not included in the analysis because the acoustic data were too noisy. Average acoustic backscatter values from bottom-referenced marks and from the entire water column in 2014 were lower than those observed in 2012 and 2013, but within the range of previous surveys in the time-series (Table 12).

There was a moderate positive correlation (Spearman's rank correlation, rho = 0.35, $p < 0.02$) between acoustic backscatter in the bottom 100 m during the day and trawl catch rates (Figure 19). In previous Chatham Rise surveys from 2001–13, 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 19) 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 the bottom in the 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 2014, most acoustic backscatter was between 200 and 500 m depth during the day, and migrated into the surface 200 m at night (Figure 20). The vertical distribution was similar to the pattern observed in 2001–10 (O'Driscoll et al. 2011a) and 2012–13 (Stevens et al. 2013, 2014). 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 2014, between 54 and 78% 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 11). The proportion of backscatter attributed to mesopelagic fish in 2014 was higher than that in 2013, but similar to other surveys in the time-series (Table 11). The lower proportion of backscatter in the upper 200 m at night in 2013 was due to the occurrence of a higher proportion of the night-time backscatter occurring in deep scattering layers from 450–700 m (Stevens et al. 2014).

Day estimates of total acoustic backscatter over the Chatham Rise were consistently higher than night estimates (Figure 21) 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 21). 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 2014 was 12% lower than that observed in 2013. Backscatter within 50 m of the bottom during the day generally decreased from 2001 to 2011, but increased in 2012 (Figure 21). Backscatter close to the bottom at night has been relatively low throughout the time-series, but shows an increasing trend over the past five years (Figure 21).

Acoustic indices of mesopelagic fish abundance are summarised in Table 13 and plotted in Figure 22 for the entire Chatham Rise and for the four sub-areas. The overall mesopelagic estimate for the Chatham Rise increased by 22% from 2013 and was at a similar level to that observed in 2012. The mesopelagic index decreased on the northwest Chatham Rise, but increased in the other three sub-areas (Table 13, Figure 22).

3.9 Hoki condition

Liver condition (defined as liver weight divided by gutted weight) for all hoki on the Chatham Rise decreased from 2013 to 2014 (Figure 23). This decrease in overall condition was driven by fish larger than 60 cm, as the liver condition of small hoki (those less than 60 cm) increased (Figure 23). 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) was maintained with the addition of the 2014 data (Pearson's correlation coefficient, $r = 0.71$, $n = 10$, $p < 0.02$).

4. CONCLUSIONS

The 2014 survey successfully extended the January Chatham Rise time series into its twenty-third year 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 18% lower than that in 2013, largely due to a low relative biomass estimate of 1+ hoki, one of the lowest in the time series. The relative biomass of 2+ hoki (2011 year class) was lower than that expected based on the 2013 survey at age 1+, but is one of the higher estimates in the time series. The estimated biomass of 3++ (recruited) hoki was 27% lower than that in 2013 but is about average for the time series.

The relative biomass of hake in core strata was 23% lower in 2014 than that in 2013, and remains at historically low levels compared to the early 1990s. The relative biomass of ling in core strata was 14% lower in 2014 than in 2013, but the time series for ling shows no overall trend.

The deep strata were successfully surveyed providing relative biomass indices for pre-recruit and recruited orange roughy and a range of the commercial and bycatch species. The estimated relative biomass of orange roughy in all strata was 6916 t in 2014 compared to 2779 t in 2013. There was no trend in the time-series of orange roughy relative biomass in deep strata over the past five surveys. 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.

5. ACKNOWLEDGMENTS

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Table 1: The number of completed valid biomass tows (200–1300 m) by stratum during the 2014 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	5	5		5	1: 1 701
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		4	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	2	5	1: 1 168
16	400–600	SW Chatham Rise	11 522	4	4		4	1: 2 881
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	6	6		6	1: 1 502
20	200–400	Reserve Bank	9 584	6	6		6	1: 1 597
Core	200–800		139 492	85	85	2	87	1: 1603
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	5	5		5	1 :1 119
28	1000–1300	SE Chatham Rise	9 494	3	3		3	1: 3 165
Deep	800–1300		42 201	32	32	0	32	1: 1 319
Total	200–1300		181 699	117	117	2	119	1: 1 527

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

Table 3: Tow and gear parameters by depth range for valid biomass tows (TAN1401). Values shown are sample size (*n*), and for each parameter the mean, standard deviation (s.d.), and range.

	n	Mean	s.d.	Range
Core tow parameters				
Tow length (n. miles)	87	2.9	0.31	2.1–3.1
Tow speed (knots)	87	3.5	0.05	3.3–3.7
All tow parameters				
Tow length (n. miles)	119	2.9	0.30	2.1–3.1
Tow speed (knots)	119	3.5	0.05	3.3–3.7
Gear parameters				
200–400 m				
Headline height	28	6.9	0.28	6.2–7.6
Doorspread	28	120.1	6.44	109.6–130.8
400–600 m				
Headline height	42	6.7	0.27	6.1–7.2
Doorspread	42	126.3	4.90	110.0–135.9
600–800 m				
Headline height	17	6.4	0.22	6.4–7.2
Doorspread	16	128.2	5.88	115.4–137.0
800–1000 m				
Headline height	22	6.9	0.22	6.4–7.3
Doorspread	22	127.0	6.37	111.4–139.4
1000–1300 m				
Headline height	10	7.2	0.24	6.7–7.4
Doorspread	6	122.7	4.67	116.6–129.9
Core stations 200–800 m				
Headline height	87	6.8	0.27	6.1–7.6
Doorspread	86	124.7	6.43	109.6–137.0
All stations 200–1300 m				
Headline height	119	6.9	0.28	6.1–7.6
Doorspread	114	125.0	6.38	109.6–139.4

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 major non-commercial species for valid biomass tows in the 2014 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 order of relative biomass estimates for the core strata. –, no data.

		Core strata 200–800m								800–1300 m	
Common name	Code	Catch kg	Biomass males t	% CV	Biomass females t	% CV	Total biomass t	% CV		Deep biomass t	% CV
QMS species											
Hoki	HOK	42 580	42 075	10.8	59 842	9.5	101 944	9.8		2 775	22.9
Black oreo	BOE	3 040	5 969	30.6	6 178	36.1	12 214	33.3		74	68.8
Dark ghost shark	GSH	6 920	3 985	16.0	5 061	20.2	9 050	17.5		–	
Spiky oreo	SOR	2 950	4 582	42.7	3 603	42.1	8 255	42.8		220	64.3
Ling	LIN	3 038	3 497	10.0	3 980	8.5	7 489	7.2		86	47.4
Spiny dogfish	SPD	3 162	738	25.9	6 139	10.4	6 886	11.0		–	
Lookdown dory	LDO	2 144	1 829	7.6	3 716	7.8	5 560	6.9		13	54.9
Sea perch	SPE	2 280	2 634	12.3	2 507	12.8	5 158	12.1		3	58.8
Barracouta	BAR	856	2 118	98.4	1 098	96.0	3 223	97.4		–	
Pale ghost shark	GSP	1 113	1 558	12.8	1 263	11.5	2 824	10.5		178	20.4
Silver warehou	SWA	1 096	1 206	63.2	1 452	60.0	2 658	61.3		–	
Giant stargazer	GIZ	814	288	21.5	1 306	18.0	1 601	17.1		6	100
Hake	HAK	617	294	23.3	1 083	18.4	1 377	15.2		133	30.3
Alfonsino	BYS	591	717	41.0	636	48.2	1 357	43.8		–	
Smooth skate	SSK	605	541	35.4	768	30.3	1 309	22.0		179	100
White warehou	WWA	455	698	31.0	600	41.2	1 299	33.7		–	
Red cod	RCO	292	191	56.4	527	69.0	719	65.2		–	
Banded stargazer	BGZ	157	263	100	338	100	601	100		–	
Arrow squid	NOS	208	213	49.1	264	47.3	491	46.7		–	
Ribaldo	RIB	233	221	26.9	257	21.0	477	17.7		158	19.7
Southern Ray's bream	SRB	195	196	45.0	242	40.3	452	41.6		1	100
Smooth oreo	SSO	76	136	91.4	142	96.9	281	94.2		1 180	47.9
Tarakihi	NMP	72	55	95.0	220	100	275	99		–	
School shark	SCH	91	74	83.5	162	47.6	236	38.6		–	
Deepsea cardinalfish	EPT	92	80	44.6	85	37.1	166	39.4		0	100
Hapuku	HAP	58	42	50.5	113	43.6	155	34.3		–	
Slender mackerel	JMM	50	58	59.2	65	41.4	123	48.3		–	
Redbait	RBT	42	60	79.9	49	82.0	109	80.7		–	
Bluenose	BNS	45	40	70.8	56	45.6	96	51.1		–	
Jack mackerel	JMD	27	14	64.0	51	63.8	65	57.5		–	
Trumpeter	TRU	14	14	100	30	100	45	75.0		–	
Ray's bream	RBM	15	22	67.2	16	79.3	43	63.2		–	
Rough skate	RSK	14	–		37	69.1	37	69.1		–	
Lemon sole	LSO	17	24	39.3	9	20.9	35	31.0		–	
Scampi	SCI	5	7	44.8	3	44.8	11	32.7		–	
Red gurnard	GUR	3	–		10	100	10	100		–	
Frostfish	FRO	4	–		9	100	10	94.0		–	
Orange roughy	ORH	3	4	100	–		4	100		6 912	37.7
Rubyfish	RBY	1	–		–		2	100		–	
Commercial non-QMS species (where core biomass > 30 t)											
Shovelnose dogfish	SND	1 982	1 407	24.9	2 460	20.7	3 887	20.8		2 018	25.6
Southern blue whiting	SBW	100	129	73.7	96	87.3	227	79.0		–	
Non-commercial species (where core biomass > 800 t)											
Bollons's rattail	CBO	4 097	4 514	16.2	5 784	16.4	10 521	14.7		21	47.9
Javelinfish	JAV	3 570	1 076	33.8	6 978	16.9	8 407	16.6		209	32.6
Oblique banded rattail	CAS	969	50	27.5	949	26.6	1 272	20.8		–	
Oliver's rattail	COL	394	336	47.2	291	25.3	1 010	20.4		27	52.8
Total (above)		85 087									
Grand total (all species)		90 219									

Table 5: Estimated core 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. stns, stations; CV, coefficient of variation.). See also Figure 5.

		Core strata 200–800 m			
Year	Survey	No. stns	Hoki	Hake	Ling
1992	TAN9106	184	120 190	4 180	8 930
	CV		7.7	14.9	5.8
1993	TAN9212	194	185 570	2 950	9 360
	CV		10.3	17.2	7.9
1994	TAN9401	165	145 633	3 353	10 129
	CV		9.8	9.6	6.5
1995	TAN9501	122	120 441	3 303	7 363
	CV		7.6	22.7	7.9
1996	TAN9601	89	152 813	2 457	8 424
	CV		9.8	13.3	8.2
1997	TAN9701	103	157 974	2 811	8 543
	CV		8.4	16.7	9.8
1998	TAN9801	91	86 678	2 873	7 313
	CV		10.9	18.4	8.3
1999	TAN9901	100	109 336	2 302	10 309
	CV		11.6	11.8	16.1
2000	TAN0001	128	72 151	2 152	8 348
	CV		12.3	9.2	7.8
2001	TAN0101	119	60 330	1 589	9 352
	CV		9.7	12.7	7.5
2002	TAN0201	107	74 351	1 567	9 442
	CV		11.4	15.3	7.8
2003	TAN0301	115	52 531	888	7 261
	CV		11.6	15.5	9.9
2004	TAN0401	110	52 687	1 547	8 248
	CV		12.6	17.1	7.0
2005	TAN0501	106	84 594	1 048	8 929
	CV		11.5	18.0	9.4
2006	TAN0601	96	99 208	1 384	9 301
	CV		10.6	19.3	7.4
2007	TAN0701	101	70 479	1 824	7 907
	CV		8.4	12.2	7.2
2008	TAN0801	101	76 859	1 257	7 504
	CV		11.4	12.9	6.7
2009	TAN0901	108	144 088	2 419	10 615
	CV		10.6	20.7	11.5
2010	TAN1001	91	97 503	1 701	8 846
	CV		14.6	25.1	10.0
2011	TAN1101	90	93 904	1 099	7 027
	CV		14.0	14.9	13.8
2012	TAN1201	100	87 505	1 292	8 098
	CV		9.8	14.7	7.4
2013	TAN1301	91	124 112	1 793	8 714
	CV		15.3	15.3	10.1
2014	TAN1401	87	101 944	1 377	7 489
	CV		9.8	15.2	7.2

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

		1+ hoki			2+ hoki		3 ++ hoki		Total hoki	
Survey	1+ year class	t	% CV	2+ year class	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)

Table 7a: Estimated relative biomass (t) and coefficient of variation (% CV) for hoki, hake, ling, and nine other key core strata species by stratum for the 2014 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. 0, less than 0.5 t.

	Species code											
	HOK		GSH		LIN		SPD		LDO		SPE	
Stratum	t	CV	t	CV	t	CV	t	CV	t	CV	t	CV
1	393	8	–	–	132	80	–	–	6	64	13	67
2a	1 233	9	–	–	208	27	–	–	39	43	30	18
2b	3 495	25	–	–	172	62	–	–	209	17	54	22
3	2 137	77	728	47	94	90	516	20	149	23	231	56
4	4 186	50	–	–	307	21	61	100	128	41	14	100
5	2 010	8	1 438	30	334	15	1 768	30	489	22	63	2
6	2 774	51	–	–	303	17	23	100	105	54	47	81
7a	5 382	41	37	100	211	37	331	48	47	13	74	51
7b	791	52	2	100	87	34	49	94	37	9	19	24
8a	3 025	72	29	100	135	14	15	100	63	33	114	29
8b	4 232	24	135	100	337	36	39	100	366	51	49	38
9	1 675	35	359	86	214	70	566	28	78	50	79	52
10	1 805	24	–	–	237	31	–	–	272	33	75	14
11	6 560	29	1	100	337	33	35	75	363	16	106	18
12	8 069	36	57	92	998	7	192	72	395	16	58	25
13	10 956	35	171	100	732	32	476	38	884	11	78	19
14	2 888	18	2	100	411	34	92	79	378	22	74	30
15	12 597	29	4	100	645	20	417	44	331	24	198	58
16	7 073	22	27	87	895	29	99	26	303	30	66	47
17	111	95	1 794	65	1	63	25	28	5	100	26	64
18	7 078	55	794	37	98	60	465	20	105	43	70	82
19	6 518	59	1 236	40	200	40	1 116	29	214	42	1 858	14
20	6 956	33	2 235	27	402	31	600	26	594	31	1 760	30
Core	101 944	10	9 050	18	7 489	7	6 886	11	5 560	7	5 158	12
21a	112	20	–	–	–	–	–	–	3	100	1	100
21b	662	69	–	–	18	100	–	–	–	–	–	–
22	1 463	28	–	–	48	70	–	–	2	77	3	68
23	43	85	–	–	–	–	–	–	–	–	–	–
24	19	100	–	–	–	–	–	–	–	–	–	–
25	461	33	–	–	20	74	–	–	7	84	–	–
28	16	100	–	–	–	–	–	–	–	–	–	–
Deep	2 775	23	–	–	86	47	–	–	13	55	3	59
Total	104 719	10	9 050	18	7 576	7	6 886	11	5 573	7	5 161	12

Table 7a (continued)

	Species Code											
	GSP		SWA		GIZ		HAK		WWA		SOR	
Stratum	t	CV	t	CV	t	CV	t	CV	t	CV	t	CV
1	71	56	–	–	11	66	23	45	–	–	128	32
2a	121	24	–	–	21	51	45	78	–	–	261	70
2b	56	29	–	–	7	100	244	50	–	–	2 383	38
3	–	–	23	45	81	85	25	100	4	100	–	–
4	241	30	–	–	–	–	66	100	–	–	502	98
5	–	–	61	43	80	94	–	–	60	13	–	–
6	288	11	–	–	–	–	–	–	183	81	–	–
7a	162	42	6	100	53	31	28	61	23	100	–	–
7b	35	50	1	100	32	51	39	53	6	50	2	100
8a	37	14	–	–	38	99	37	36	–	–	9	100
8b	156	36	–	–	14	51	101	37	–	–	15	100
9	–	–	1 594	97	99	66	–	–	24	50	–	–
10	91	35	–	–	–	–	131	63	–	–	447	89
11	89	27	25	100	53	68	186	37	90	44	44	97
12	171	41	7	100	44	51	38	100	–	–	4 465	75
13	298	1	–	–	36	100	188	29	68	59	–	–
14	123	49	–	–	–	–	11	51	18	60	–	–
15	268	19	135	57	121	43	18	100	52	100	–	–
16	520	46	74	55	338	29	107	45	413	87	–	–
17	–	–	–	–	59	37	–	–	–	–	–	–
18	–	–	496	95	291	66	38	82	4	100	–	–
19	–	–	26	66	111	34	–	–	63	42	–	–
20	97	46	210	63	113	51	50	63	289	64	–	–
Core	2 824	11	2 658	61	1 601	17	1 377	15	1 299	34	8 255	43
21a	3	33	–	–	–	–	13	54	–	–	6	98
21b	34	44	–	–	–	–	–	–	–	–	22	73
22	107	24	–	–	6	100	85	40	–	–	174	80
23	–	–	–	–	–	–	14	100	–	–	–	–
24	–	–	–	–	–	–	–	–	–	–	–	–
25	33	62	–	–	–	–	22	74	–	–	18	63
28	–	–	–	–	–	–	–	–	–	–	–	–
Deep	178	20	–	–	6	100	133	30	–	–	220	64
Total	3 002	10	2 658	61	1 607	17	1 510	14	1 299	34	8 475	42

Table 7b: Estimated relative biomass (t) and coefficient of variation (% CV) for pre-recruit (nominally < 20 cm SL), recruited (nominally > 30 cm SL), and total orange roughy and six other key deep strata species by stratum for the 2014 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. 0, less than 0.5 t.

	Species code									
	<20 cm ORH		<30 cm ORH		total ORH		BOE		SND	
Stratum	t	CV	t	CV	t	CV	t	CV	t	CV
1	–	–	–	–	–	–	–	–	142	20
2a	0	100	3	100	4	100	–	–	1 236	45
2b	–	–	–	–	–	–	–	–	1 311	28
3	–	–	–	–	–	–	–	–	–	–
4	–	–	–	–	–	–	2 363	96	221	59
5	–	–	–	–	–	–	–	–	–	–
6	–	–	–	–	–	–	9 849	34	59	100
7a	–	–	–	–	–	–	–	–	369	100
7b	–	–	–	–	–	–	–	–	3	100
8a	–	–	–	–	–	–	–	–	11	58
8b	–	–	–	–	–	–	2	100	14	100
9	–	–	–	–	–	–	–	–	–	–
10	–	–	–	–	–	–	–	–	99	95
11	–	–	–	–	–	–	–	–	67	65
12	–	–	–	–	–	–	–	–	336	65
13	–	–	–	–	–	–	–	–	–	–
14	–	–	–	–	–	–	–	–	–	–
15	–	–	–	–	–	–	–	–	–	–
16	–	–	–	–	–	–	–	–	20	100
17	–	–	–	–	–	–	–	–	–	–
18	–	–	–	–	–	–	–	–	–	–
19	–	–	–	–	–	–	–	–	–	–
20	–	–	–	–	–	–	–	–	–	–
Core	0	100	3	100	4	100	12 214	33	3 887	21
21a	5	26	24	68	53	85	0	100	97	47
21b	11	49	77	51	181	48	–	–	844	54
22	16	67	114	35	379	39	1	73	273	24
23	10	41	106	50	2 077	51	–	–	40	43
24	1	100	131	51	3 891	61	–	–	–	–
25	2	57	19	35	41	54	20	50	564	20
28	0	100	40	100	291	96	53	95	198	100
Deep	44	29	510	22	6 912	38	74	69	2 018	26
Total	45	29	513	22	6 916	38	12 288	33	5 905	16

Table 7b (continued)

							Species code	
		SSO		ETB		CYP		RIB
Stratum	t	CV	t	CV	t	CV	t	CV
1	–	–	1	58	210	4	51	37
2a	–	–	–	–	48	50	76	66
2b	–	–	–	–	79	100	67	35
3	–	–	–	–	–	–	–	–
4	–	–	186	53	25	50	14	100
5	–	–	–	–	–	–	–	–
6	281	94	195	43	2	100	93	37
7a	–	–	2	39	15	100	37	100
7b	–	–	–	–	–	–	3	87
8a	–	–	–	–	–	–	10	100
8b	–	–	–	–	–	–	7	100
9	–	–	–	–	–	–	–	–
10	–	–	–	–	–	–	20	43
11	–	–	–	–	3	68	32	48
12	–	–	–	–	–	–	29	30
13	–	–	–	–	–	–	15	100
14	–	–	79	51	–	–	11	100
15	–	–	44	51	–	–	–	–
16	–	–	256	66	–	–	12	100
17	–	–	–	–	–	–	–	–
18	–	–	–	–	–	–	–	–
19	–	–	–	–	–	–	–	–
20	–	–	–	–	–	–	–	–
Core	281	94	764	29	381	22	477	18
21a	3	54	16	18	58	37	6	54
21b	4	49	4	100	704	39	67	34
22	310	71	13	61	345	29	70	26
23	175	53	139	15	115	63	–	–
24	12	45	80	25	19	76	–	–
25	73	39	96	50	735	48	16	68
28	603	85	430	57	53	100	–	–
Deep	1 180	48	778	33	2 029	23	158	20
Total	1 461	43	1 542	22	2 410	20	636	14

Table 8: Total numbers of fish, squid and scampi measured for length frequency distributions and biological samples from all tows (TAN1401). 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
Abyssal halosaur	HAL	2	5	8	0
Alfonsino	BYS	439	327	773	229
Banded bellowsfish	BBE	60	125	1 887	124
Banded rattail	CFA	92	114	425	32
Banded stargazer	BGZ	18	19	37	37
Barracouta	BAR	80	44	125	10
Basketwork eel	BEE	176	270	481	171
Baxter’s lantern dogfish	ETB	268	278	546	499
Bigeye cardinalfish	EPL	42	50	93	16
Bigscale blacksmelt	MEB	5	13	35	28
Big-scale pomfret	BSP	1	1	2	2
Bigscaled brown slickhead	SBI	267	422	689	172
Black ghost shark	HYB	8	1	9	5
Black oreo	BOE	359	342	703	185
Black javelinfish	BJA	29	63	92	92
Black slickhead	BSL	147	148	295	60
Blackspot rattail	VNI	0	1	36	7
Blobfish	PSY	0	1	1	1
Bluecod	BCO	0	1	1	0
Bluenose	BNS	7	7	14	14
Bollons's rattail	CBO	1 924	1 534	3 599	324
Brown chimaera	CHP	4	5	9	8
Cape scorpionfish	TRS	5	3	8	6
Carpet shark	CAR	0	2	2	2
Catshark (*Apristurus* spp.)	APR	3	2	5	5
Common halosaur	HPE	1	3	4	0
Common roughy	RHY	71	66	137	53
Crested bellowsfish	CBE	0	1	28	0
Dawson's catshark	DCS	1	0	1	1
Deepsea cardinalfish	EPT	161	132	310	186
Deepsea flathead	FHD	11	14	51	51
Deepsea smelts	BLG	0	0	3	3
Discfish	DIS	0	0	1	1
Dwarf cod	DCO	0	0	15	15
Four-rayed rattail	CSU	111	209	1 758	64
Frostfish	FRO	0	1	1	1
Ghost shark	GSH	1 363	1 239	2 604	623
Giant lepidion	LPS	2	1	3	0
Giant stargazer	GIZ	91	150	245	226
Greenback jack mackerel	JMD	6	20	26	25
Grey cutthroat eel	SAF	0	0	38	38
Hairy conger	HCO	8	24	71	49
Hake	HAK	88	92	180	179
Hapuku	HAP	3	5	8	7
Hoki	HOK	7 430	10 101	17 542	2 443
Humpback rattail (slender rattail)	CBA	0	16	16	16
Javelin fish	JAV	911	4 952	6 562	344
Johnson's cod	HJO	378	365	1 013	106

Table 8 (continued)

	Species code	Number measured Males	Number measured Females	Number measured Total	Number of biological samples
Kaiyomaru rattail	CKA	1	0	9	0
Kuronezumia leonis	NPU	0	0	2	0
Leafscale gulper shark	CSQ	27	32	59	59
Lemon sole	LSO	24	10	36	36
Lighthouse fish	PHO	0	0	1	1
Ling	LIN	538	522	1 061	968
Longfinned beryx	BYD	2	0	2	2
Longnose velvet dogfish	CYP	491	560	1 052	684
Long-nosed chimaera	LCH	176	227	404	228
Longnosed deepsea skate	PSK	1	3	4	4
Lookdown dory	LDO	1 352	1 443	2 855	1 236
Lucifer dogfish	ETL	358	209	571	330
Lyconus sp.	LYC	0	2	2	2
Mahia rattail	CMA	29	46	77	0
Murray's rattail	CMU	0	0	15	0
Nezumia namatahi	NNA	0	0	4	3
Northern spiny dogfish	NSD	3	0	3	2
Notable rattail	CIN	66	56	909	127
NZ southern arrow squid	NOS	197	211	436	298
Oblique banded rattail	CAS	194	1 061	1 653	177
Oliver's rattail	COL	676	804	2 681	223
Orange perch	OPE	55	53	110	55
Orange roughy	ORH	897	947	1 871	525
Owston's dogfish	CYO	105	44	149	126
Pale ghost shark	GSP	454	406	863	501
Pale toadfish	TOP	1	1	3	3
Plunket’s shark	PLS	12	6	18	17
Prickly deepsea skate	BTS	6	3	9	7
Prickly dogfish	PDG	7	2	9	8
Ray’s bream	RBM	8	5	13	9
Red cod	RCO	142	224	370	188
Red gurnard	GUR	0	2	2	0
Redbait	RBT	45	31	76	43
Ribaldo	RIB	145	83	228	150
Ridge scaled rattail	MCA	29	45	85	84
Robust cardinalfish	EPR	1	1	2	0
Rotund cardinalfish	ROS	0	0	1	1
Roughhead rattail	CHY	4	4	26	9
Rough skate	RSK	0	3	3	3
Ruby fish	RBY	0	0	1	0
Rudderfish	RUD	14	8	22	18
Scaly gurnard	SCG	1	5	109	6
Scampi	SCI	45	23	73	73
School shark	SCH	2	3	5	5
Sea perch	SPE	1 328	1 398	2 764	893
Seal shark	BSH	30	50	80	76
Serrulate rattail	CSE	92	38	476	76
Shovelnose spiny dogfish	SND	661	767	1 429	951
Silver dory	SDO	91	82	207	47
Silver roughy	SRH	86	75	237	62

Table 8 (continued)

	Species code	Number measured Males	Number measured Females	Number measured Total	Number of biological samples
Silver warehou	SWA	156	166	322	237
Silverside	SSI	29	12	438	13
Skate (*Brochiraja leviveneta*)	SKA	7	0	7	7
Slender jack mackerel	JMM	19	23	42	32
Small banded rattail	CCX	25	74	133	0
Small-headed cod	SMC	12	8	27	17
Smallscaled brown slickhead	SSM	325	242	571	142
Smooth deepsea skate	BTA	5	3	8	8
Smooth oreo	SSO	408	317	729	321
Smooth skate	SSK	18	23	41	41
Snubnosed eel	SNE	1	1	31	31
Southern blue whiting	SBW	131	79	211	93
Southern rays bream	SRB	70	79	151	95
Spiky oreo	SOR	917	725	1 656	588
Spineback	SBK	48	491	607	180
Spiny dogfish	SPD	248	1 137	1 388	676
Spotty faced rattail	CTH	0	1	6	0
Swollenhead conger	SCO	22	35	76	35
Tarakihi	NMP	11	40	51	51
Thin tongue cardinalfish	EPM	71	71	280	90
Todarodes sp.	TSQ	0	0	6	6
Two saddle rattail	CBI	48	54	113	40
Trumpeter	TRU	1	1	2	2
Upturned snout rattail	CJX	5	2	13	13
Venefica sp.	VEN	0	0	7	7
Violet cod	VCO	1	0	1	0
Warty oreo	WOE	1	1	2	0
Warty squid (*Onykia ingens*)	MIQ	23	32	56	56
White cardinalfish	EPD	0	0	68	0
White rattail	WHX	196	145	347	316
White warehou	WWA	183	127	311	258
Widenosed chimaera	RCH	69	18	87	45
Total		26 018	34 571	69 357	18 176

Table 9: Length-weight regression parameters* used to scale length frequencies (all data from TAN1401).

Species	*a* (intercept)	*b* (slope)	r^2	*n*	Length range (cm)
Baxter's dogfish	0.002790	3.149581	0.99	492	20–78
Black oreo	0.058817	2.691750	0.88	184	23–40
Dark ghost shark	0.004185	3.085331	0.94	621	35–72
Giant stargazer	0.007466	3.198411	0.98	221	19–79
Hake	0.002451	3.239739	0.98	178	30–126
Hoki	0.003431	2.966965	0.99	2 432	37–117
Ling	0.001419	3.264991	0.99	968	28–167
Longnose velvet dogfish	0.002232	3.157791	0.99	671	30–100
Lookdown dory	0.023009	2.988073	0.99	1 195	11–54
Orange roughy	0.060085	2.828839	0.99	521	7–41
Pale ghost shark	0.007852	2.923799	0.97	480	23–84
Ribaldo	0.003545	3.293072	0.98	150	25–71
Sea perch	0.014647	3.024648	0.98	888	11–49
Silver warehou	0.010782	3.144758	0.99	237	27–53
Shovelnose dogfish	0.001823	3.160841	0.97	943	32–115
Smooth oreo	0.030456	2.912595	0.99	318	16–50
Spiny dogfish	0.000833	3.393251	0.94	670	54–97
Spiky oreo	0.036708	2.862895	0.98	586	10–44
White warehou	0.017838	3.054782	0.99	257	20–57

* $W = aL^b$ 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	4	1	1	–	–	–	–	6
	Female		6	3	–	–	–	–	–	9
Barracouta	Male	MD	–	–	7	56	15	–	–	78
	Female		–	4	34	1	–	–	–	39
Baxter’s dogfish	Male	SS	89	24	99	–	–	–	–	212
	Female		91	72	36	12	14	1	–	226
Bigscaled brown slickhead	Male	MD	–	2	1	–	–	–	–	3
	Female		11	10	19	1	–	–	–	41
Big-scale pomfret	Male	MD	–	1	–	–	–	–	–	1
	Female		–	1	–	–	–	–	–	1
Black javelinfish	Male	MD	1	–	–	0	–	–	–	1
	Female		–	–	–	–	–	–	–	–
Black ghost shark	Male	SS	–	–	3	–	–	–	–	3
	Female		–	–	1	–	–	–	–	1
Black oreo	Male	MD	39	37	7	2	–	–	3	88
	Female		37	32	31	–	–	–	–	100
Bluenose	Male	MD	6	–	–	–	–	–	–	6
	Female		5	–	–	–	–	–	–	5
Blue skate (*B. leviveneta*)	Male	SS	1	–	3	–	–	–	–	4
	Female		–	–	–	–	–	–	–	–
Bollons’s rattail	Male	MD	–	3	–	–	–	–	–	3
	Female		5	12	–	–	–	–	–	17
Brown chimaera	Male	SS	1	–	2	–	–	–	–	3
	Female		–	2	1	–	–	–	–	3
Carpet shark	Male	SS	–	–	–	–	–	–	–	–
	Female		–	–	2	–	–	–	–	2
Dark ghost shark	Male	SS	129	200	286	–	–	–	–	615
	Female		209	199	48	2	–	–	–	458
Deepsea cardinalfish	Male	MD	5	–	–	–	–	–	–	5
	Female		4	–	–	–	–	–	–	4
Giant stargazer	Male	MD	2	8	–	–	–	–	–	10
	Female		4	49	6	–	–	–	1	60
Greenback jack mackerel	Male	MD	–	3	1	2	–	–	–	6
	Female		–	1	3	15	–	–	–	19
Hake	Male	MD	20	21	7	15	18	5	2	88
	Female		24	28	26	–	1	7	5	91
Hapuku	Male	MD	–	–	1	–	–	–	–	1
	Female		–	1	–	–	–	–	–	1
Hoki	Male	MD	4525	2513	41	–	–	1	–	7080
	Female		4815	4954	27	1	–	1	4	9802
Humpback rattail	Male	MD	–	–	–	–	–	–	–	–
	Female		1	6	3	–	–	–	–	10
Leafscale gulper shark	Male	SS	16	4	4	–	–	–	–	24
	Female		16	8	6	1	–	1	–	32
Ling	Male	MD	154	112	88	124	1	–	–	479
	Female		205	262	2	1	–	–	–	470
Longfinned beryx	Male	MD	1	–	–	–	–	–	–	1
	Female		–	–	–	–	–	–	–	–
Longnose spookfish	Male	SS	3	15	29	–	–	–	–	47
	Female		9	20	11	1	–	–	–	41
Longnose velvet dogfish	Male	SS	233	36	190	–	–	–	–	459
	Female		191	149	101	16	5	1	–	463
Lookdown dory	Male	MD	97	114	82	28	–	–	1	322
	Female		110	69	176	–	–	10	1	470

Table 10 (continued)

Common name	Sex	Staging method	Reproductive stage							Total
			1	2	3	4	5	6	7	
Lucifer dogfish	Male	SS	15	32	102	–	–	–	–	149
	Female		22	50	16	4	4	–	–	96
Northern spiny dogfish	Male	SS	–	2	–	–	–	–	–	2
	Female		–	–	–	–	–	–	–	–
Oblique banded rattail	Male	MD	–	–	–	–	–	–	–	–
	Female		11	20	–	–	–	–	–	31
Orange perch	Male	MD	1	–	8	8	4	1	–	22
	Female		–	–	11	9	1	–	–	21
Orange roughy	Male	MD	221	199	373	–	–	–	–	793
	Female		136	125	476	–	–	–	–	737
Pacific spookfish	Male	SS	7	1	21	–	–	–	–	29
	Female		3	2	2	–	–	–	–	7
Pale ghost shark	Male	SS	92	39	161	–	–	–	–	292
	Female		93	64	55	3	1	–	–	216
Plunket’s shark	Male	SS	6	3	2	–	–	–	–	11
	Female		5	–	–	–	–	–	–	5
Prickly deepsea skate	Male	SS	–	2	1	–	–	–	–	3
	Female		–	–	–	–	–	–	–	–
Prickly dogfish	Male	SS	1	3	1	–	–	–	–	5
	Female		–	–	–	–	–	–	–	–
Ray’s bream	Male	MD	1	–	–	–	–	–	–	1
	Female		–	–	–	–	–	–	–	–
Redbait	Male	MD	–	–	5	17	19	–	–	41
	Female		–	–	2	21	7	–	–	30
Red cod	Male	MD	3	3	4	7	–	–	2	19
	Female		7	5	3	–	–	–	–	15
Red gurnard	Male	MD	–	–	–	–	–	–	–	–
	Female		–	–	–	2	–	–	–	2
Ribaldo	Male	MD	1	41	19	1	–	–	–	62
	Female		–	14	–	–	–	–	–	14
Ridge scaled rattail	Male	MD	10	4	–	2	–	–	–	16
	Female		10	8	–	–	–	–	–	18
Rough skate	Male	SS	–	–	–	–	–	–	–	–
	Female		1	1	1	–	–	–	–	3
Rudderfish	Male	MD	–	–	2	–	–	–	–	2
	Female		–	–	2	–	–	–	–	2
School shark	Male	SS	–	–	–	–	–	–	–	–
	Female		–	–	1	–	–	–	–	1
Seal Shark	Male	SS	23	1	2	–	–	–	–	26
	Female		33	3	2	–	–	2	–	38
Shovelnose dogfish	Male	SS	63	132	290	–	–	–	–	485
	Female		158	319	36	1	–	2	–	516
Silver warehou	Male	MD	16	60	1	–	–	–	–	77
	Female		9	64	–	–	–	–	–	73
Slender jack mackerel	Male	MD	1	1	–	1	–	–	–	3
	Female		–	5	2	1	1	–	–	9
Smallscaled brown slickhead	Male	MD	1	5	4	–	–	–	–	10
	Female		1	5	4	–	–	–	–	10
Smooth deepsea skate	Male	SS	–	1	–	–	–	–	–	1
	Female		1	–	–	–	–	–	–	1
Smooth oreo	Male	MD	91	48	23	27	16	3	4	212
	Female		72	29	55	–	–	–	–	156
Smooth skate	Male	SS	6	7	3	–	–	–	–	16
	Female		7	8	–	–	–	–	–	15
Smooth skin dogfish	Male	SS	1	12	80	–	–	–	–	93
	Female		10	18	7	2	1	4	–	42

Table 10 (continued)

Common name	Sex	Staging method	Reproductive stage 1	2	3	4	5	6	7	Total
Southern blue	Male	MD	59	5	–	–	–	–	–	64
whiting	Female		46	2	–	–	–	–	–	48
Spiky oreo	Male	MD	118	333	77	34	–	–	–	562
	Female		66	83	301	1	1	1	1	454
Spiny dogfish	Male	SS	–	43	150	–	–	–	–	193
	Female		28	144	124	96	398	4	–	794
Tarakihi	Male	MD	–	1	3	6	–	–	–	10
	Female		1	8	29	2	–	–	–	40
Trumpeter	Male	MD	–	1	–	–	–	–	–	1
	Female		–	–	–	–	–	–	–	–
White rattail	Male	MD	8	28	–	–	–	–	–	36
	Female		11	10	7	–	–	–	–	28
White warehou	Male	MD	34	28	–	–	–	–	–	62
	Female		23	16	19	–	–	–	–	58

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).
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: 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.

	Stratum			
Year	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

Table 12: 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 2001–14.

			Average acoustic backscatter (m^2 km^{-2})			
Year	No. of recordings	Average trawl catch (kg 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

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 11) 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%).

Acoustic index (m^2 km^{-2})

Year	Unstratified		Northeast		Northwest		Southeast		Southwest		Stratified	
	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
2002	47.1	8	21.8	11	61.1	13	36.8	12	92.6	16	44.9	8
2003	35.8	6	25.1	11	40.3	11	29.6	13	54.7	13	34.0	7
2004	40.6	10	30.3	23	32.0	12	52.4	19	53.9	11	42.9	10
2005	30.4	7	28.4	12	44.5	21	25.2	8	29.5	23	29.3	7
2006	37.0	6	30.7	10	47.9	12	38.1	12	36.7	19	36.4	7
2007	32.4	7	23.0	10	43.3	12	27.2	13	35.9	20	29.2	7
2008	29.1	6	17.8	5	27.9	19	38.1	10	36.2	12	29.8	6
2009	44.7	10	22.4	22	54.3	12	39.3	16	84.8	18	43.8	9
2010	27.0	8	16.5	11	33.4	11	35.1	17	34.0	24	28.5	10
2011	21.4	9	23.4	15	27.2	14	12.6	23	15.8	17	18.5	9
2012	30.8	8	17.6	13	41.1	34	33.5	11	51.1	12	32.3	8
2013	28.8	7	15.5	15	45.9	12	27.3	13	31.7	13	26.3	7
2014	31.7	9	19.4	8	37.6	12	35.8	18	44.6	24	32.1	10

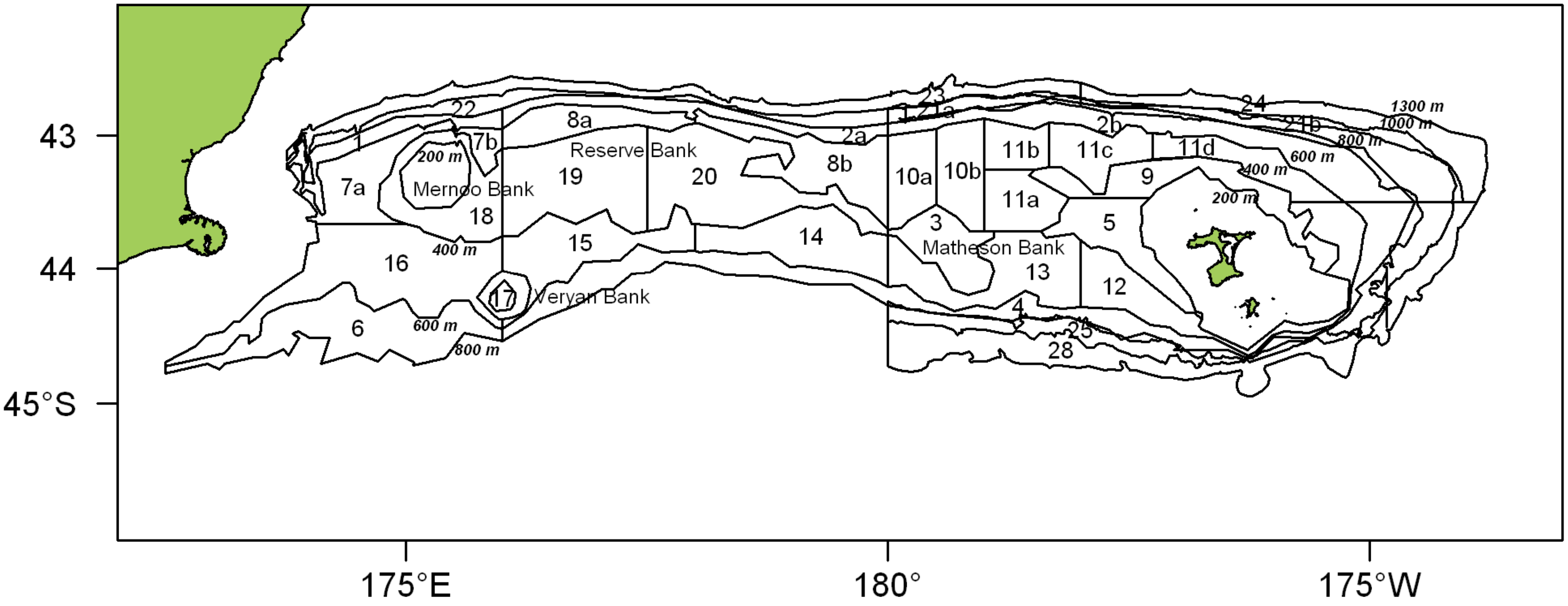


Figure 1: Chatham Rise trawl survey area showing stratum boundaries.

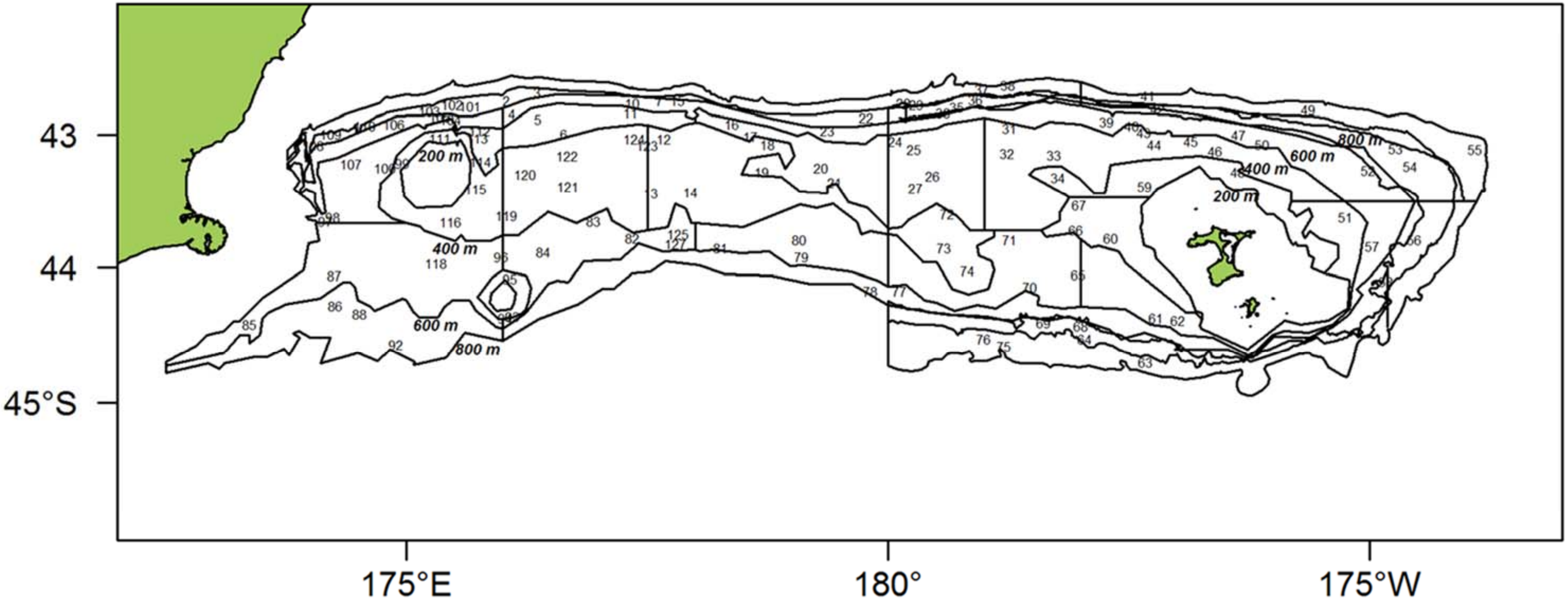


Figure 2: Trawl survey area showing positions of valid biomass stations (n = 119 stations) for TAN1401. In this and subsequent figures actual stratum boundaries are drawn for the deepwater strata. These boundaries sometimes overlap with existing core survey stratum boundaries.

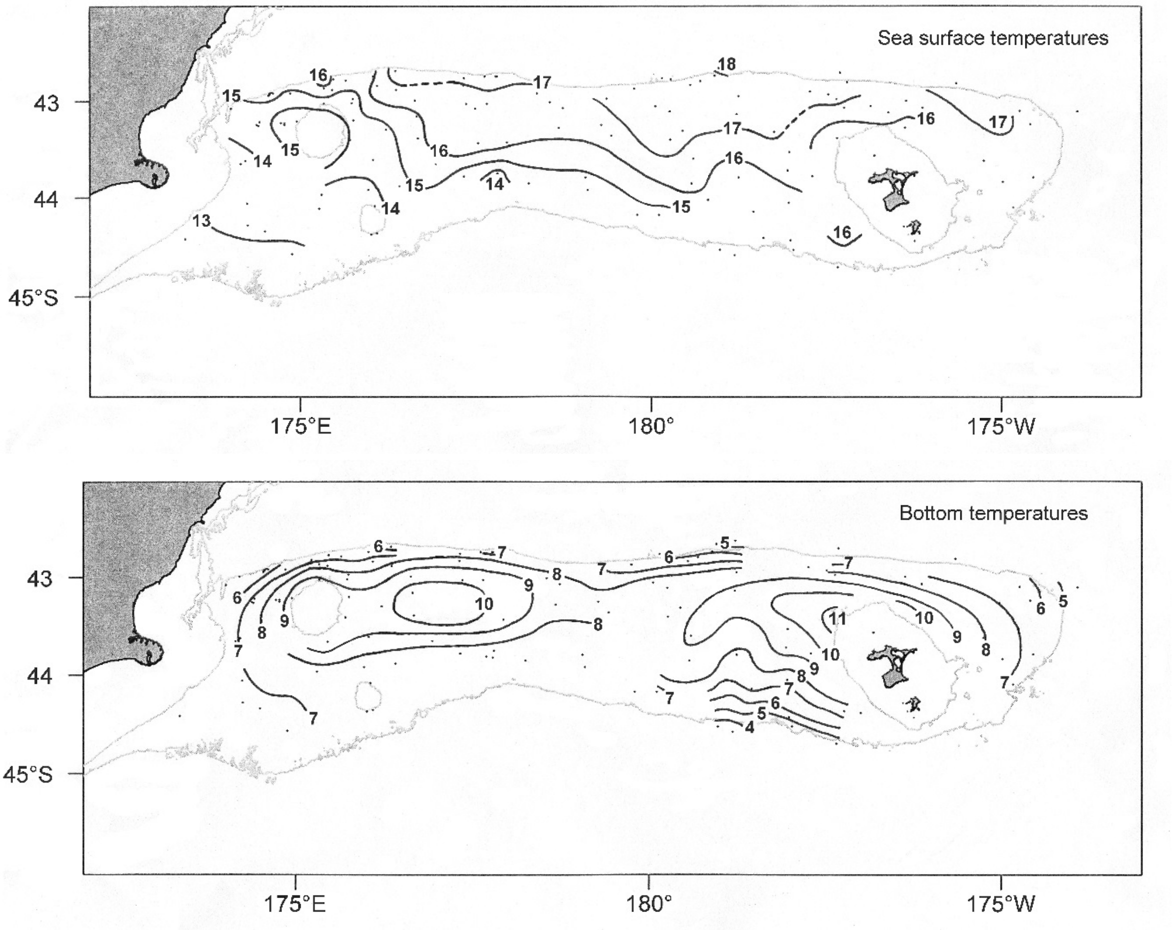


Figure 3: Positions of sea surface and bottom temperature recordings and approximate location of isotherms (ºC) interpolated by eye for TAN1401. The temperatures shown are from the calibrated Seabird CTD recordings made during each tow.

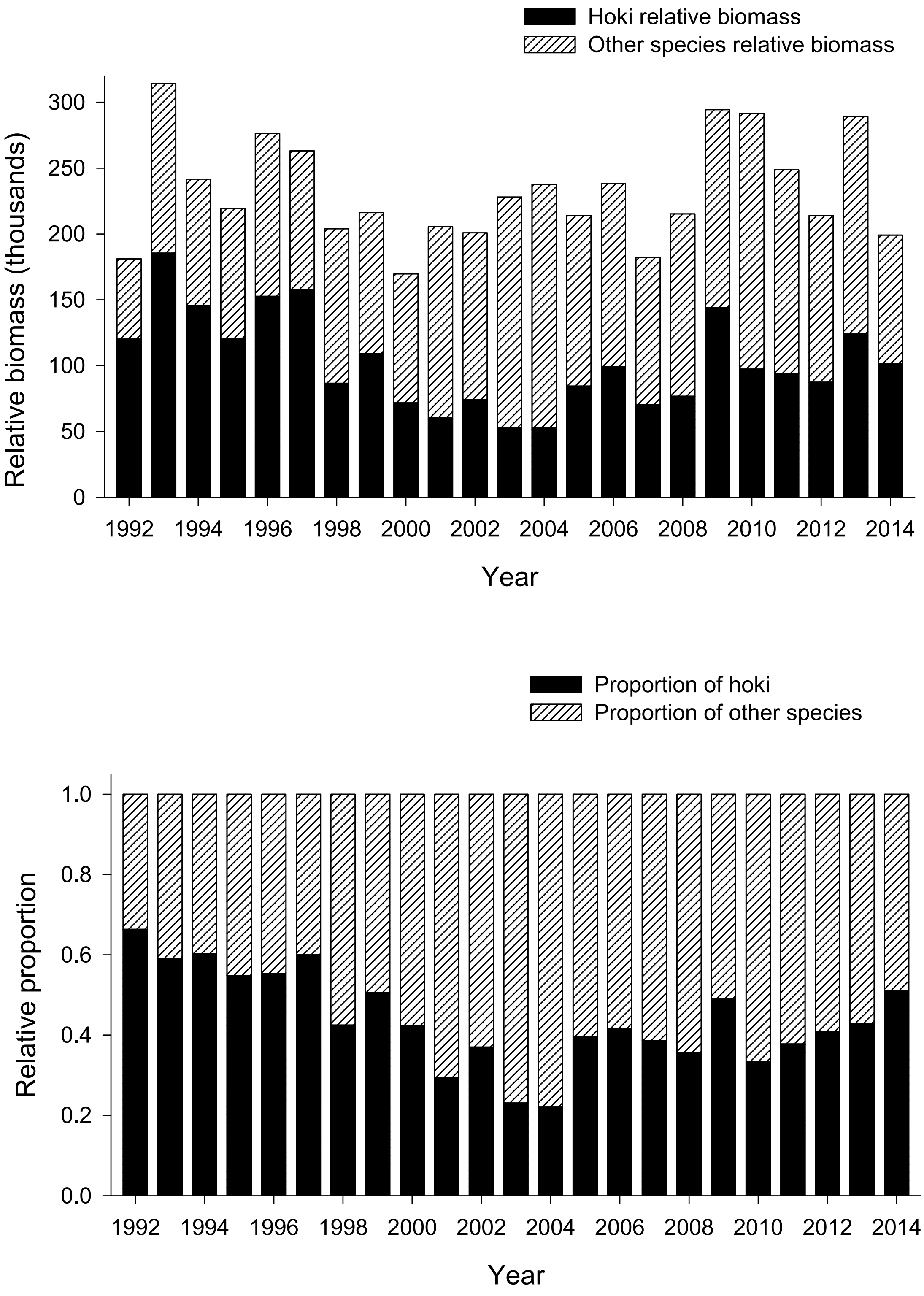


Figure 4: Relative biomass (top panel) and relative proportions of hoki and 30 other key species (lower panel) from trawl surveys of the Chatham Rise, January 1992–2014 (core strata only).

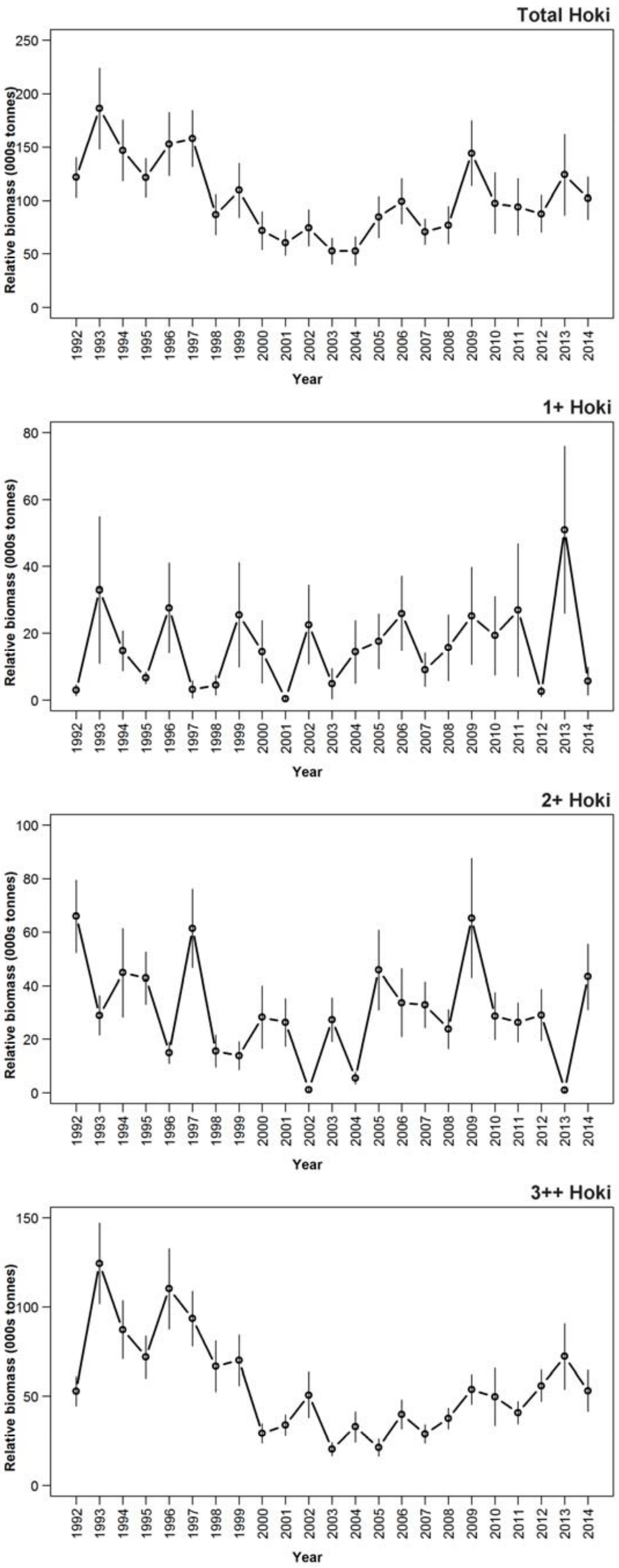


Figure 5a: Relative biomass estimates (thousands of tonnes) of hoki, hake, ling, and other selected commercial species sampled by annual trawl surveys of the Chatham Rise, January 1992–2014 (core strata only). Error bars show ± 2 standard errors.

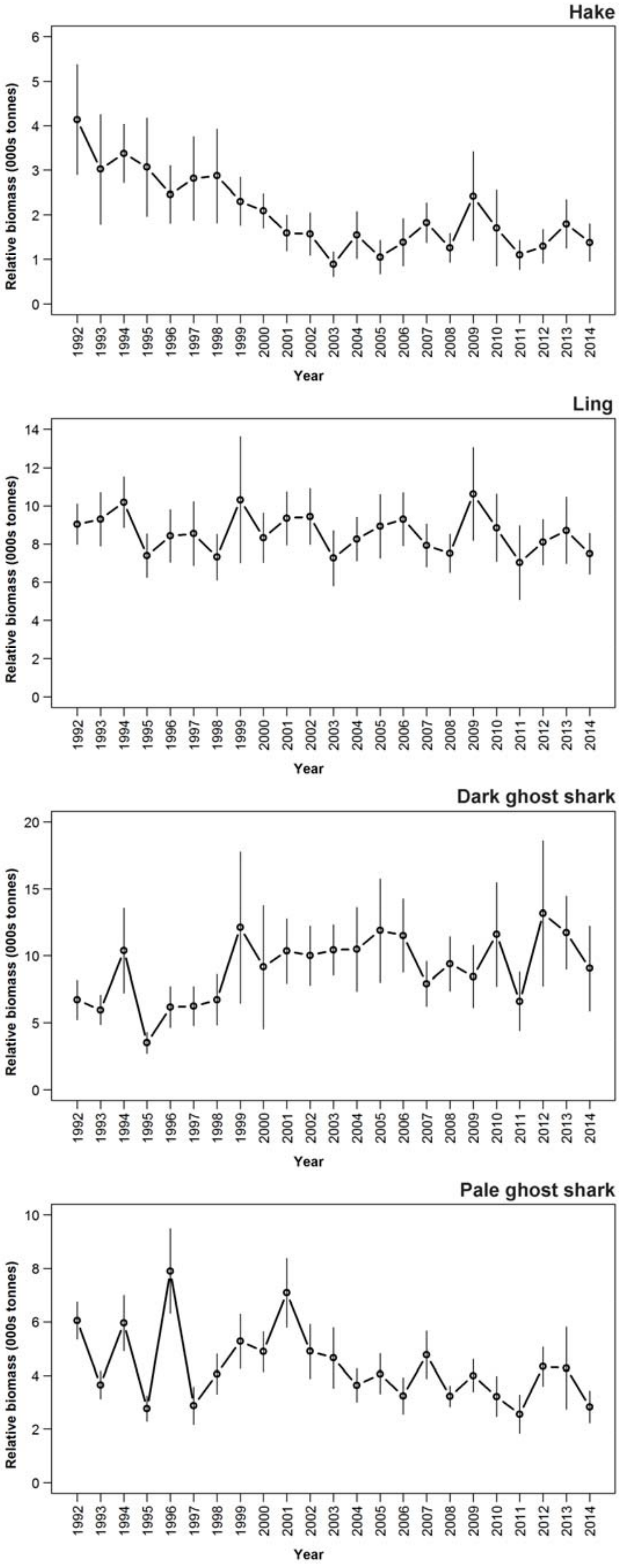
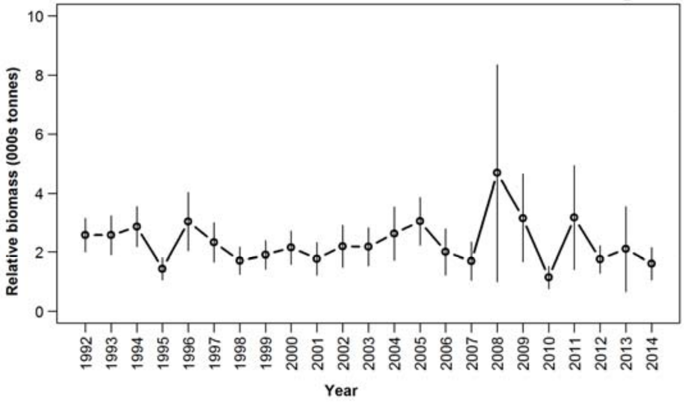
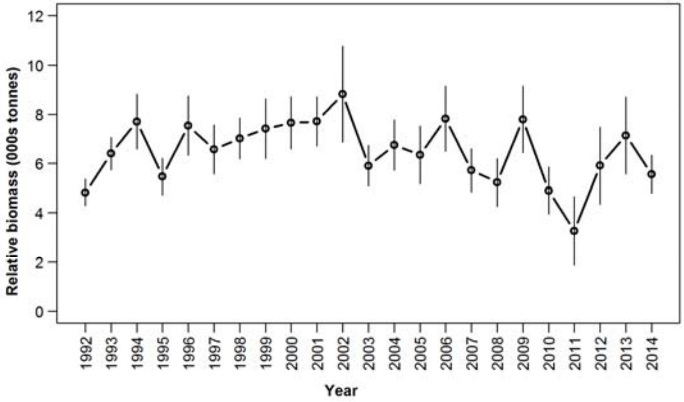
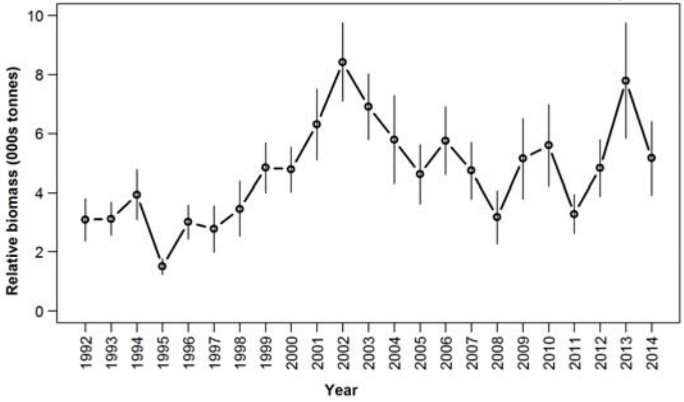


Figure 5a (continued)


Giant stargazer


Lookdown dory


Sea perch

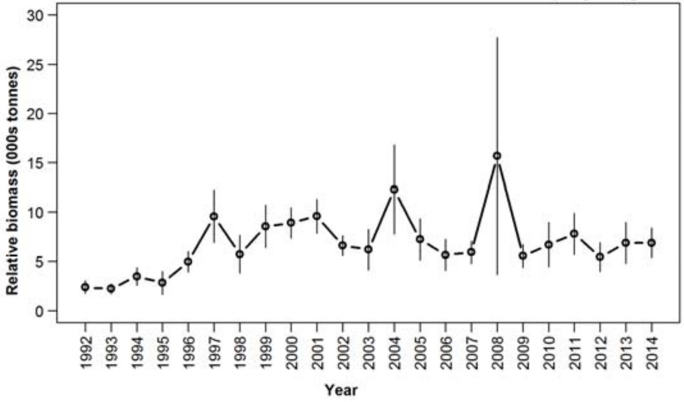

Spiny dogfish

Figure 5a (continued)

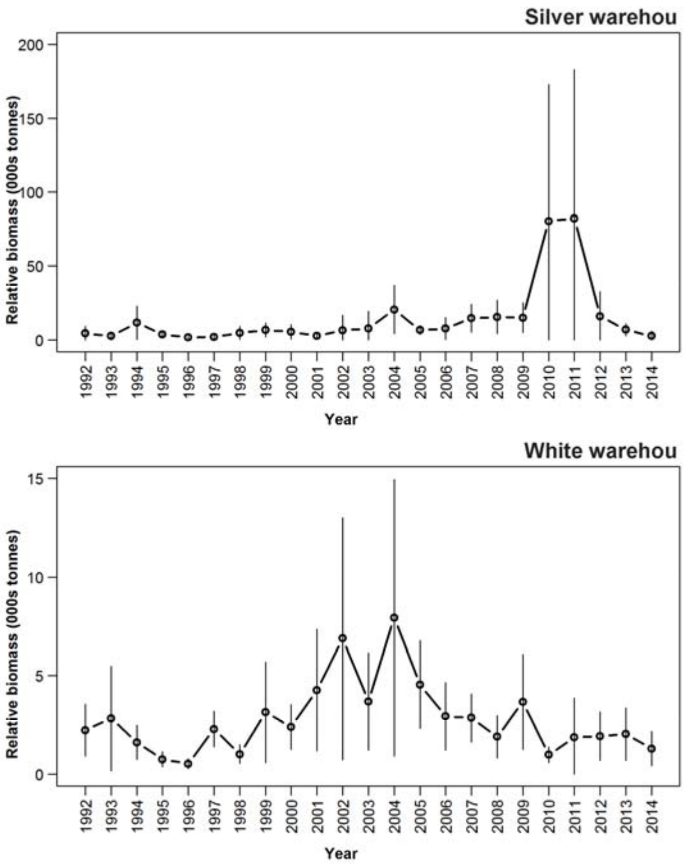


Figure 5a (continued)

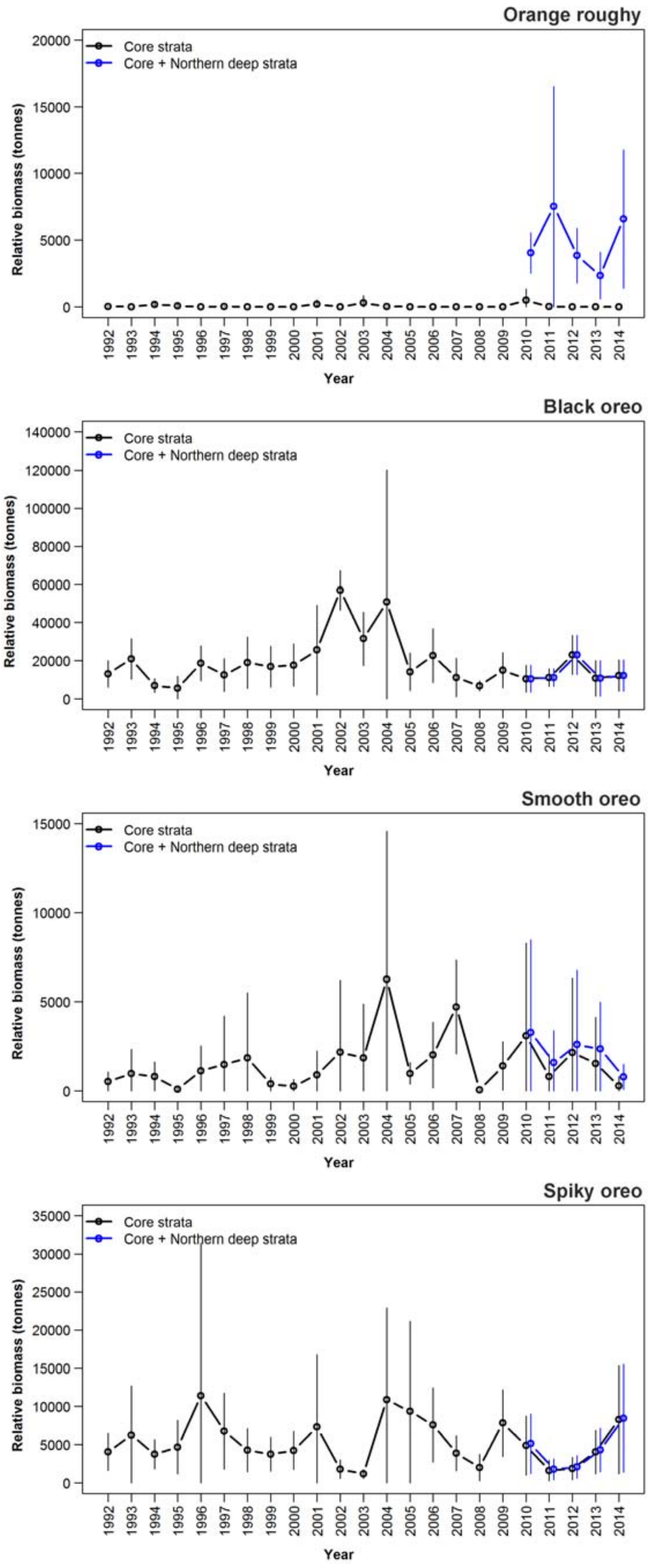


Figure 5b: Relative biomass estimates (thousands of tonnes) of orange roughy, oreo species, and other selected deepwater species sampled by annual trawl surveys of the Chatham Rise, January 1992–2014. Black lines show fish from core (200–800 m) strata. Blue lines show fish from core strata plus the northern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

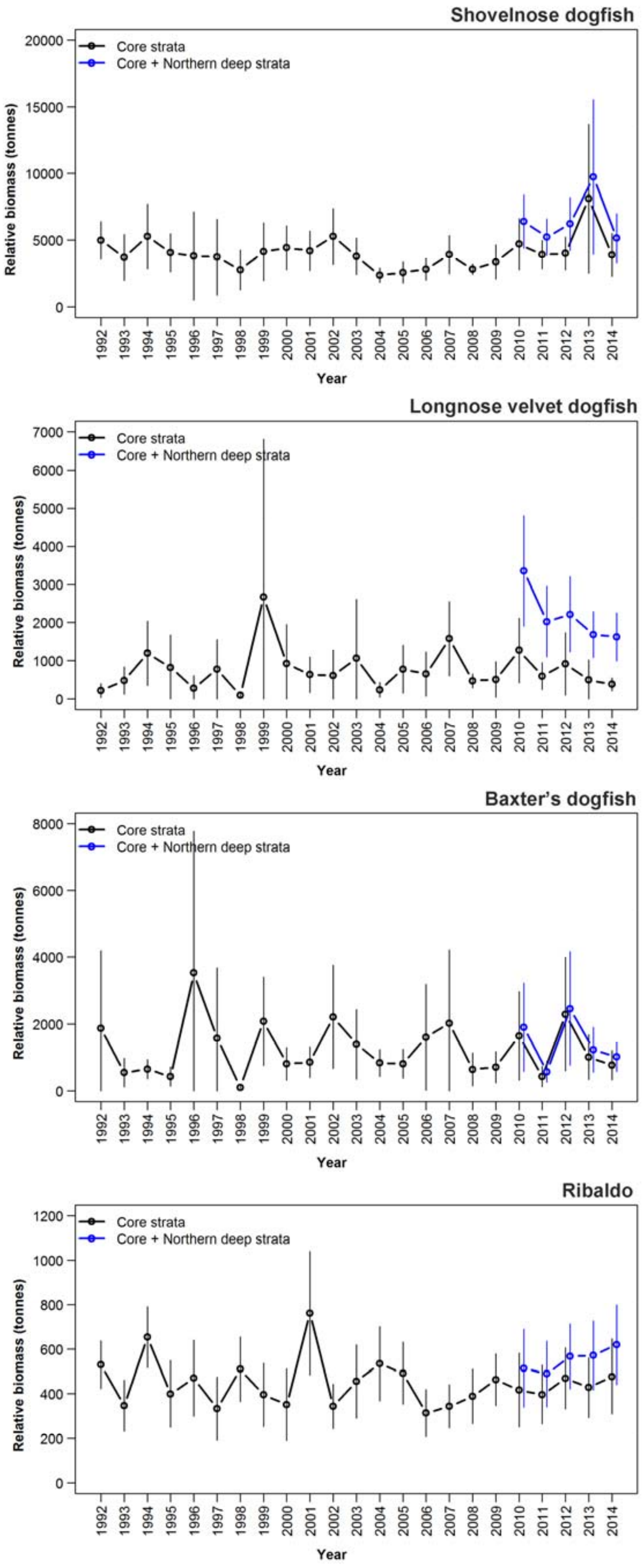


Figure 5b (continued)

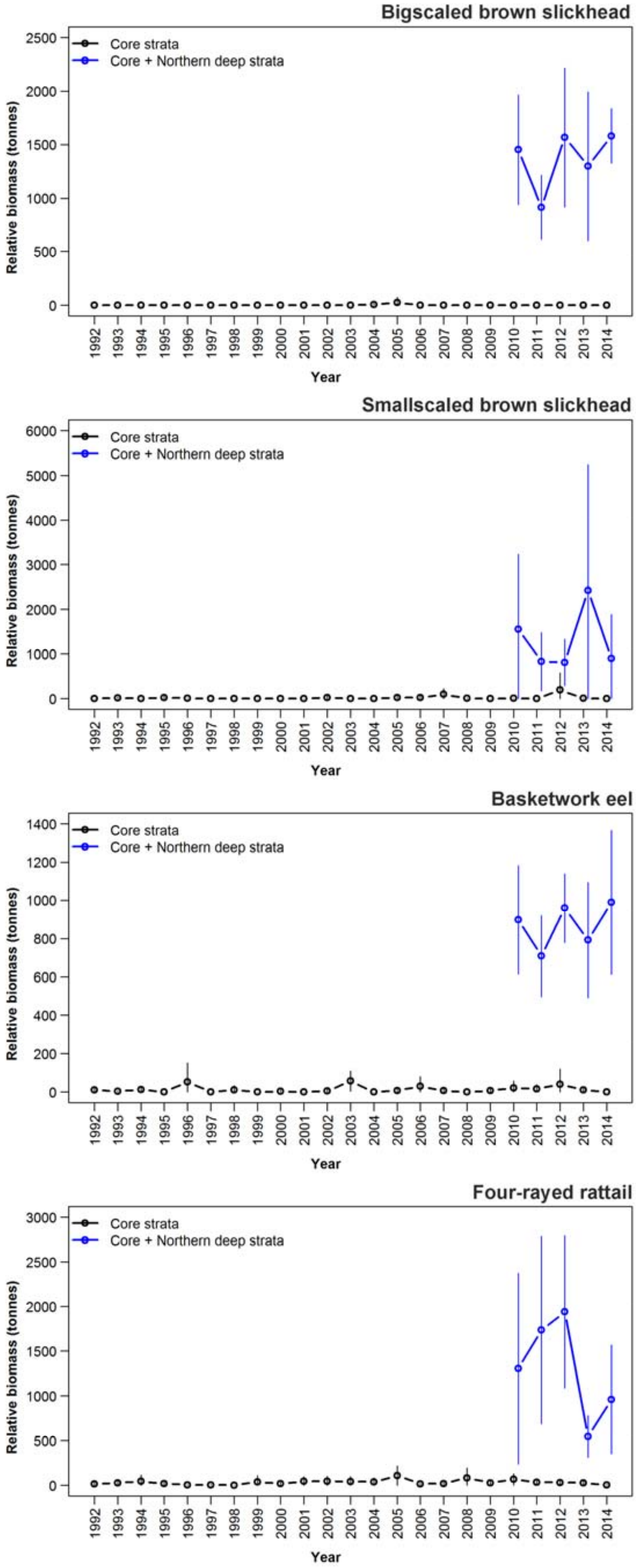


Figure 5b (continued)

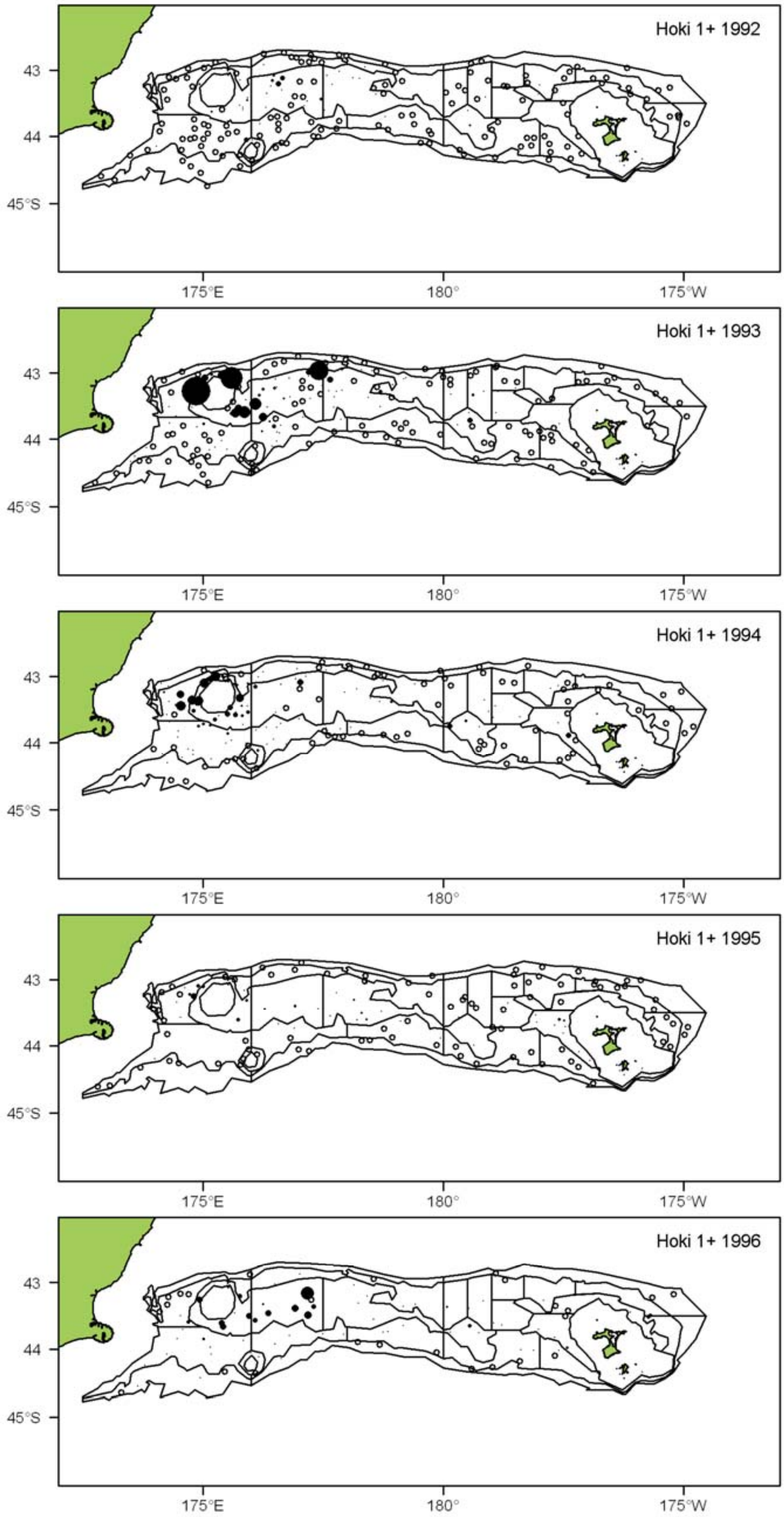


Figure 6a: Hoki 1+ catch distribution 1992–2014. Filled circle area is proportional to catch rate (kg km^{-2}). Open circles are zero catch. Maximum catch rate in series is 30 850 kg km^{-2}.

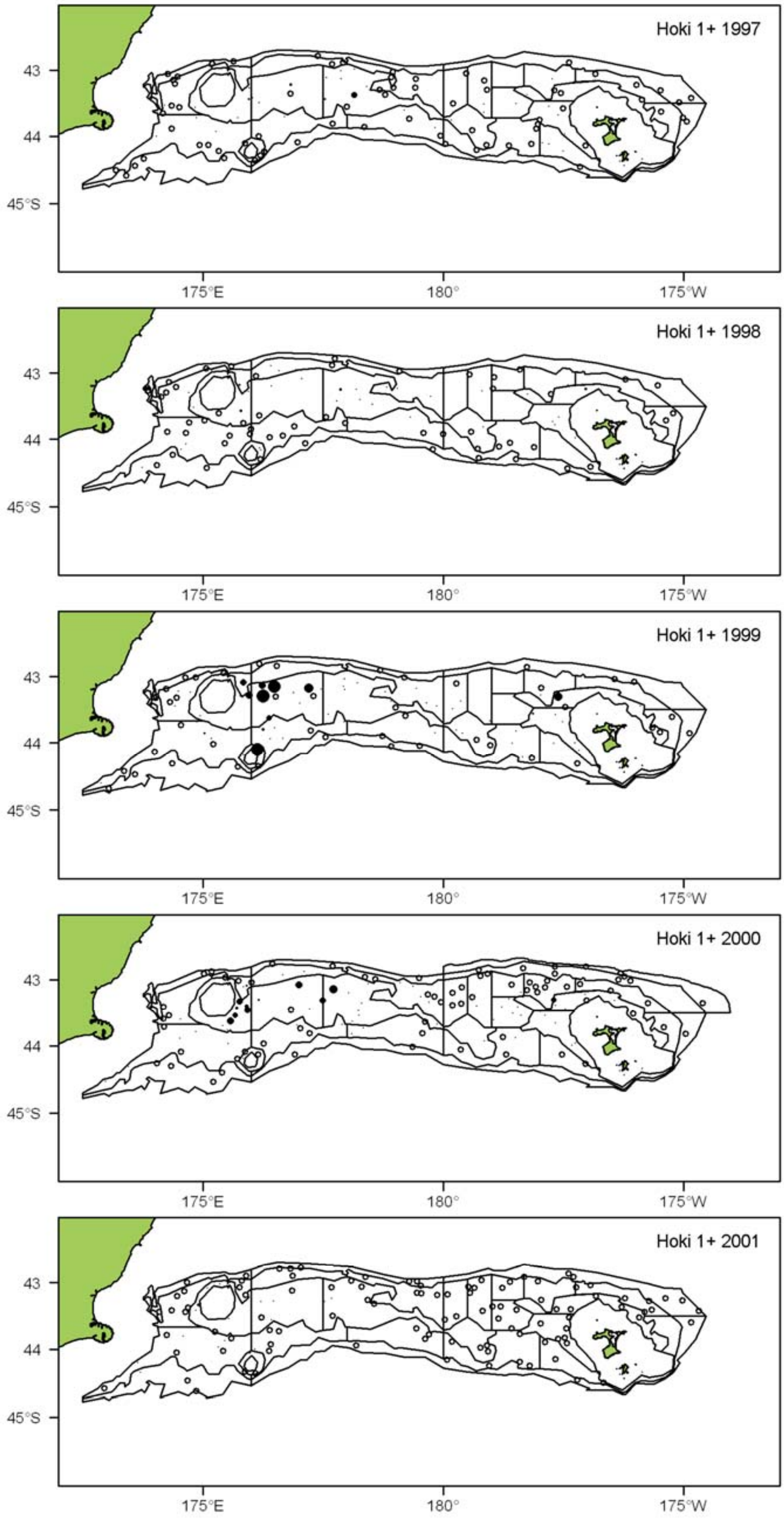


Figure 6a (continued)

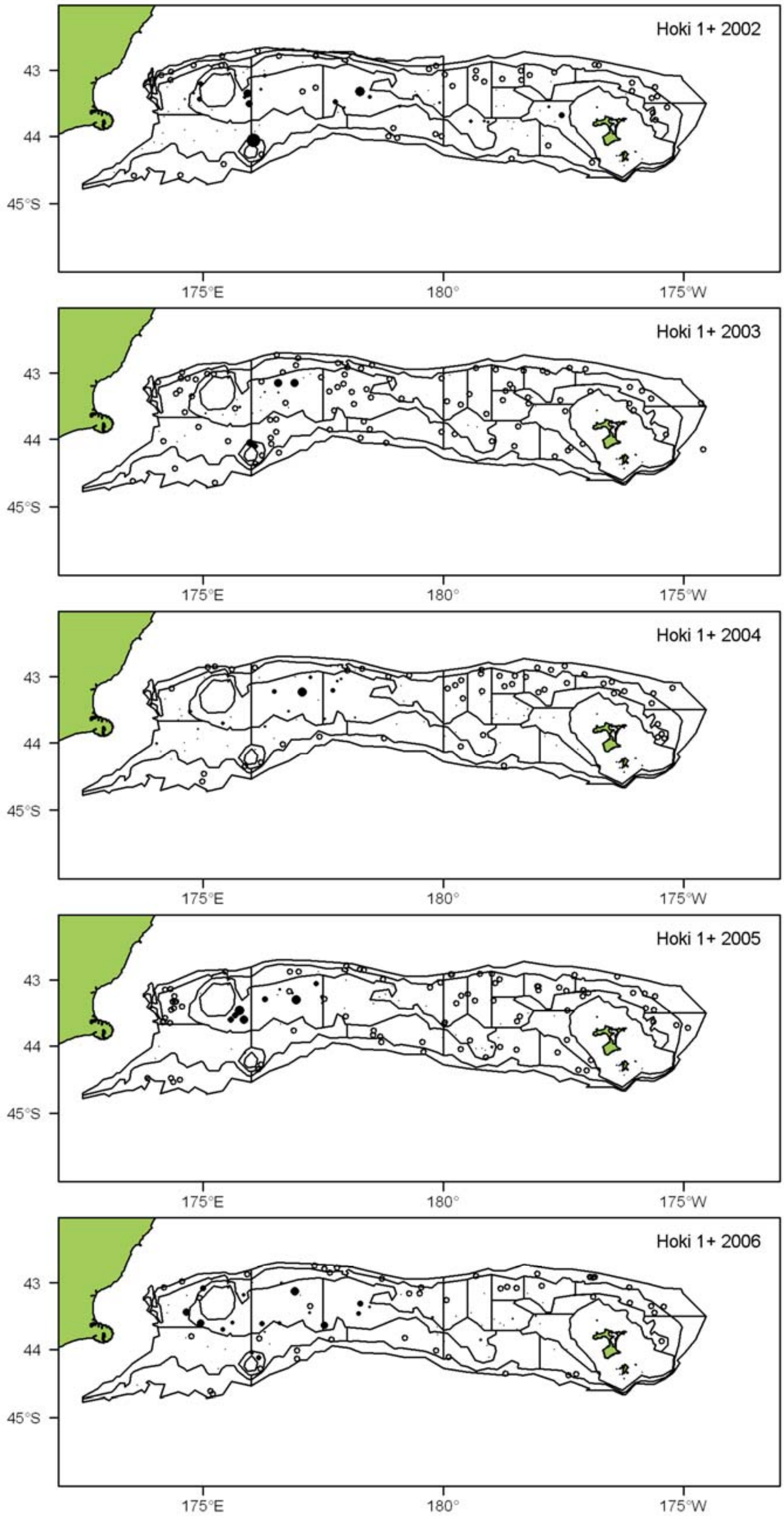


Figure 6a (continued)

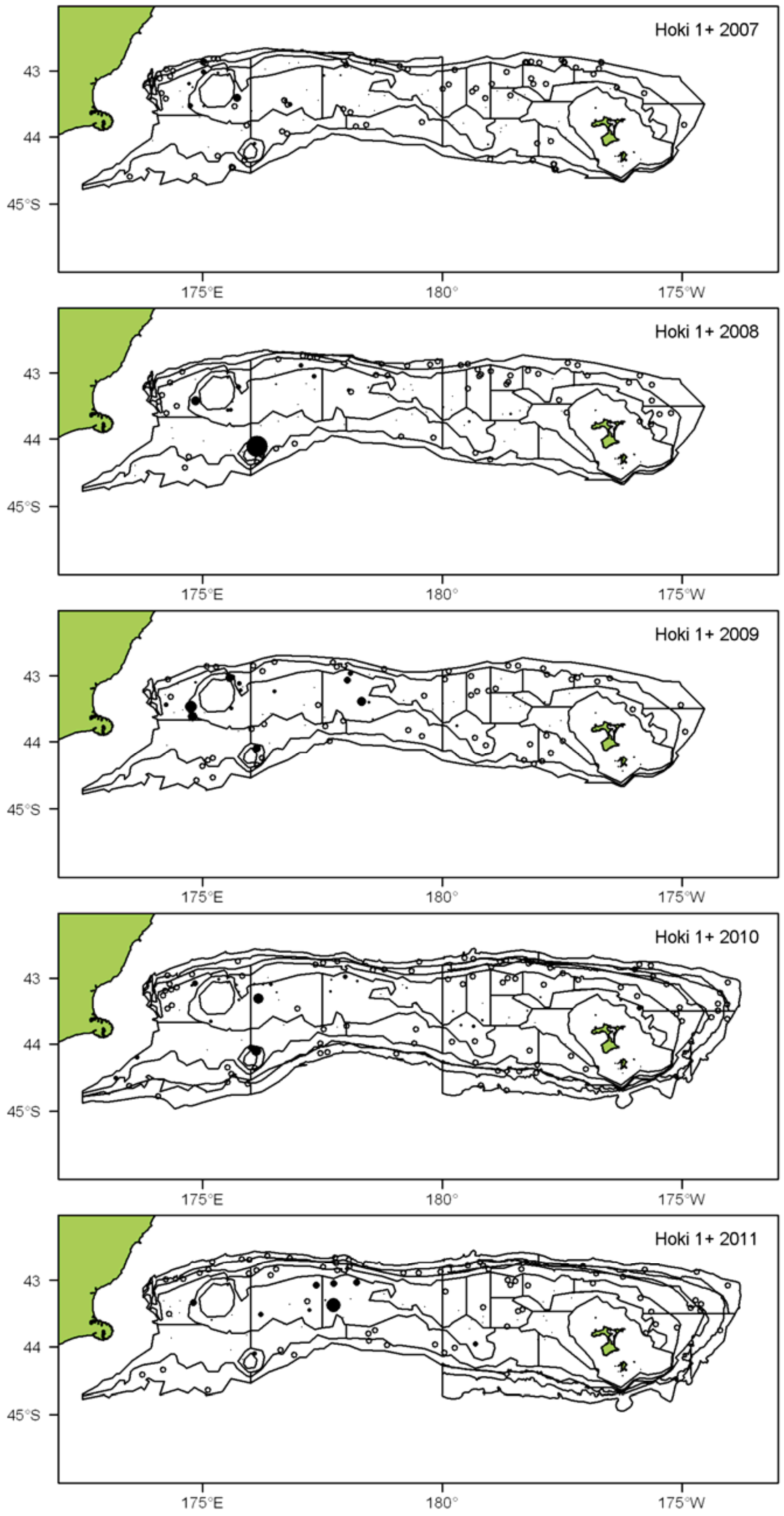


Figure 6a (continued)

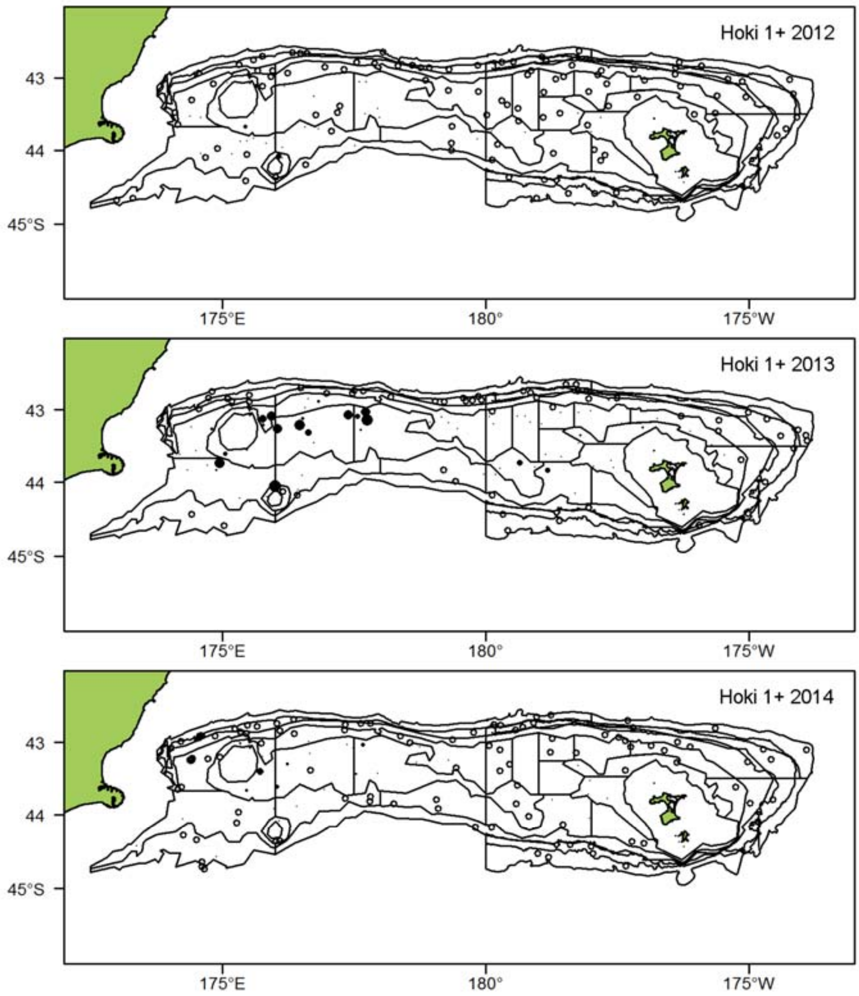


Figure 6a (continued)

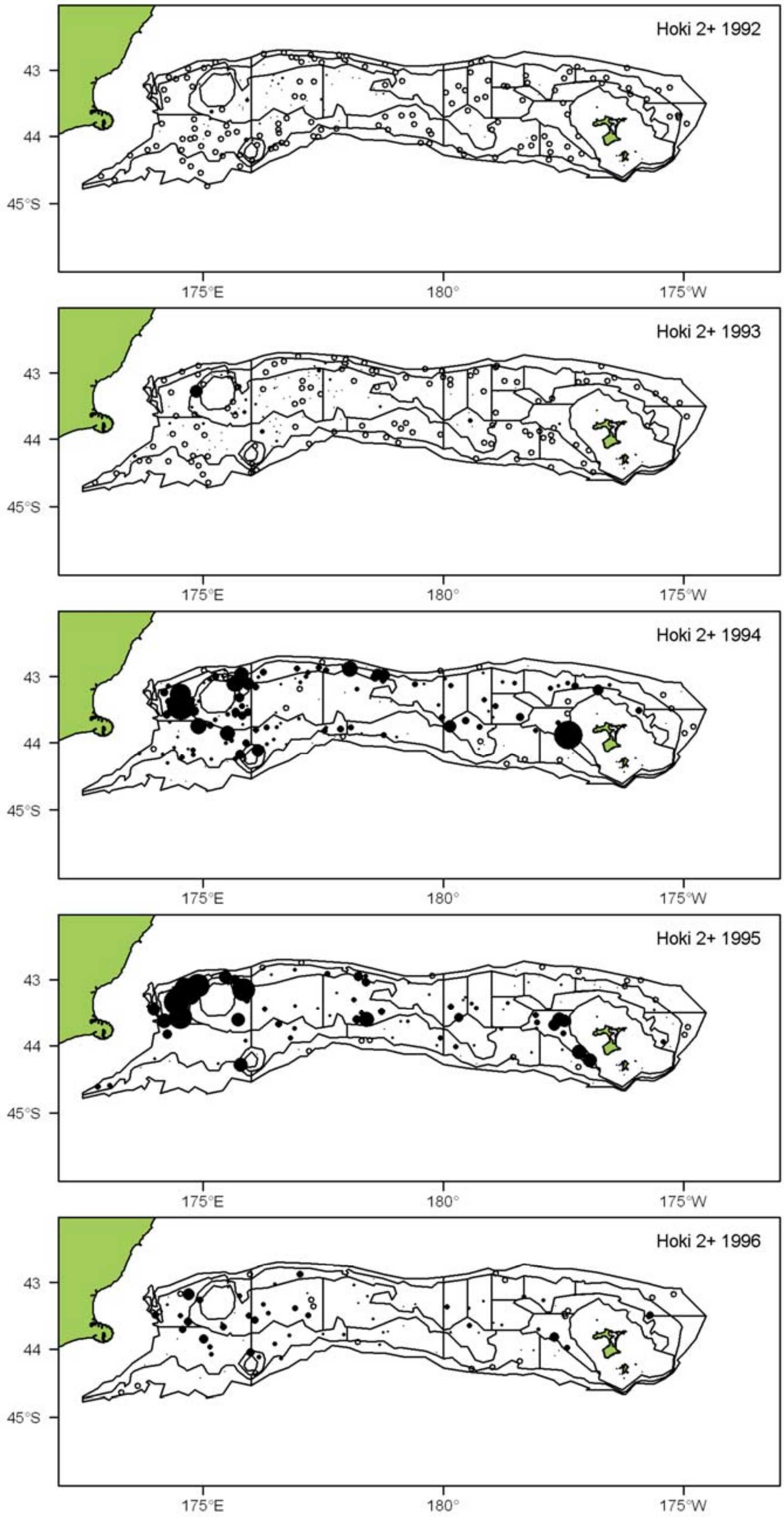


Figure 6b: Hoki 2+ catch distribution 1992–2014. Filled circle area is proportional to catch rate (kg km^{-2}). Open circles are zero catch. Maximum catch rate in series is 6791 kg km^{-2}.

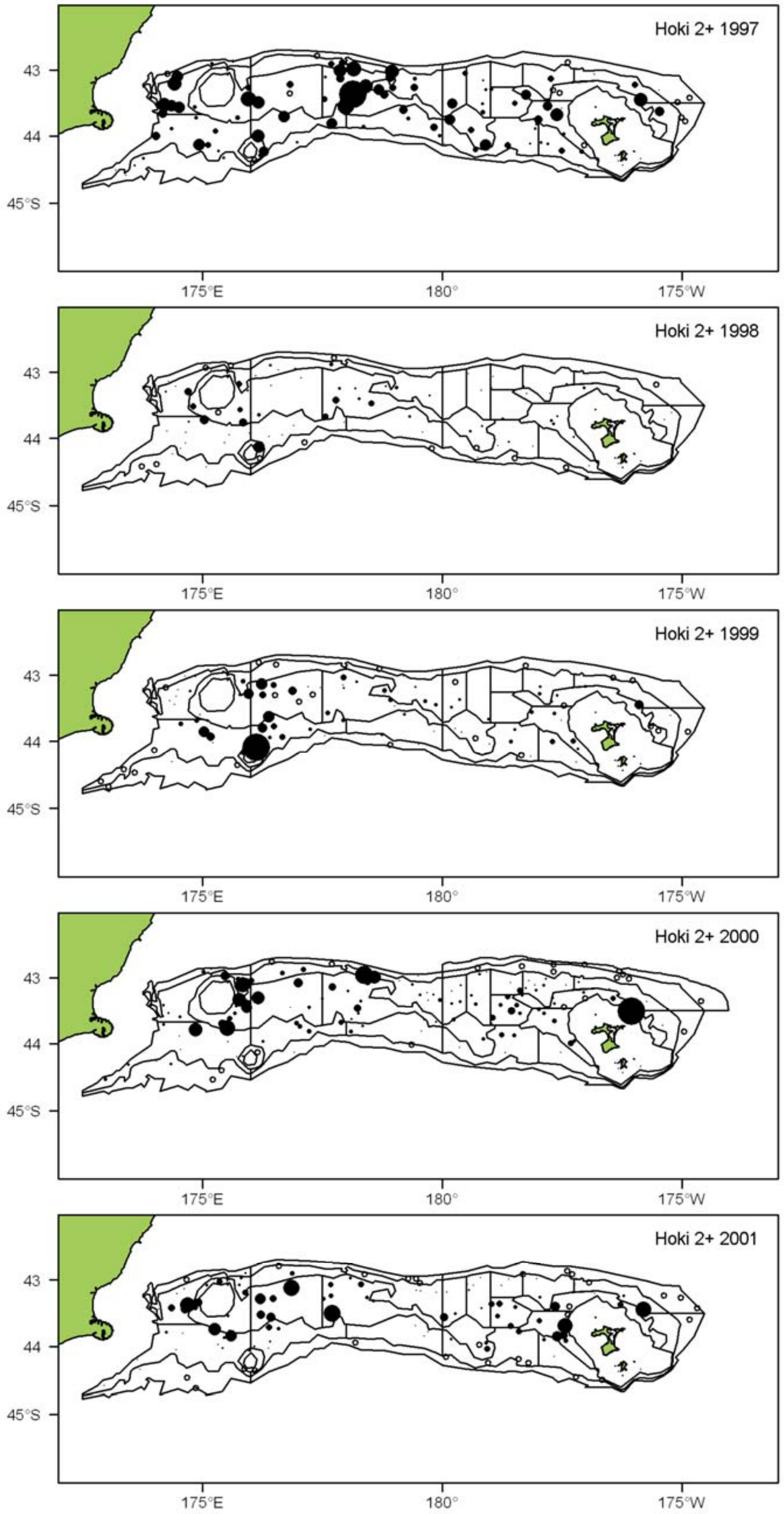


Figure 6b (continued)

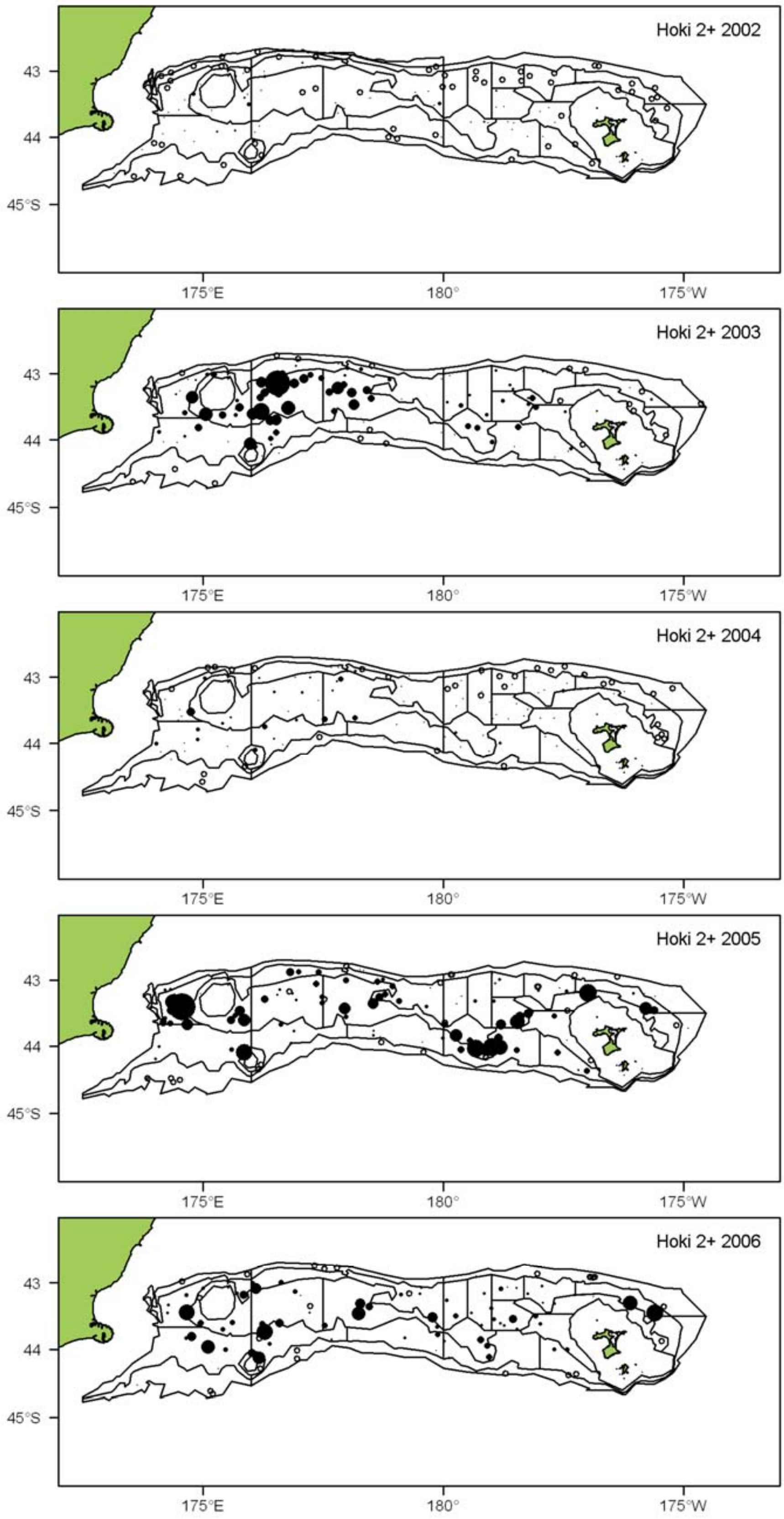


Figure 6b (continued)

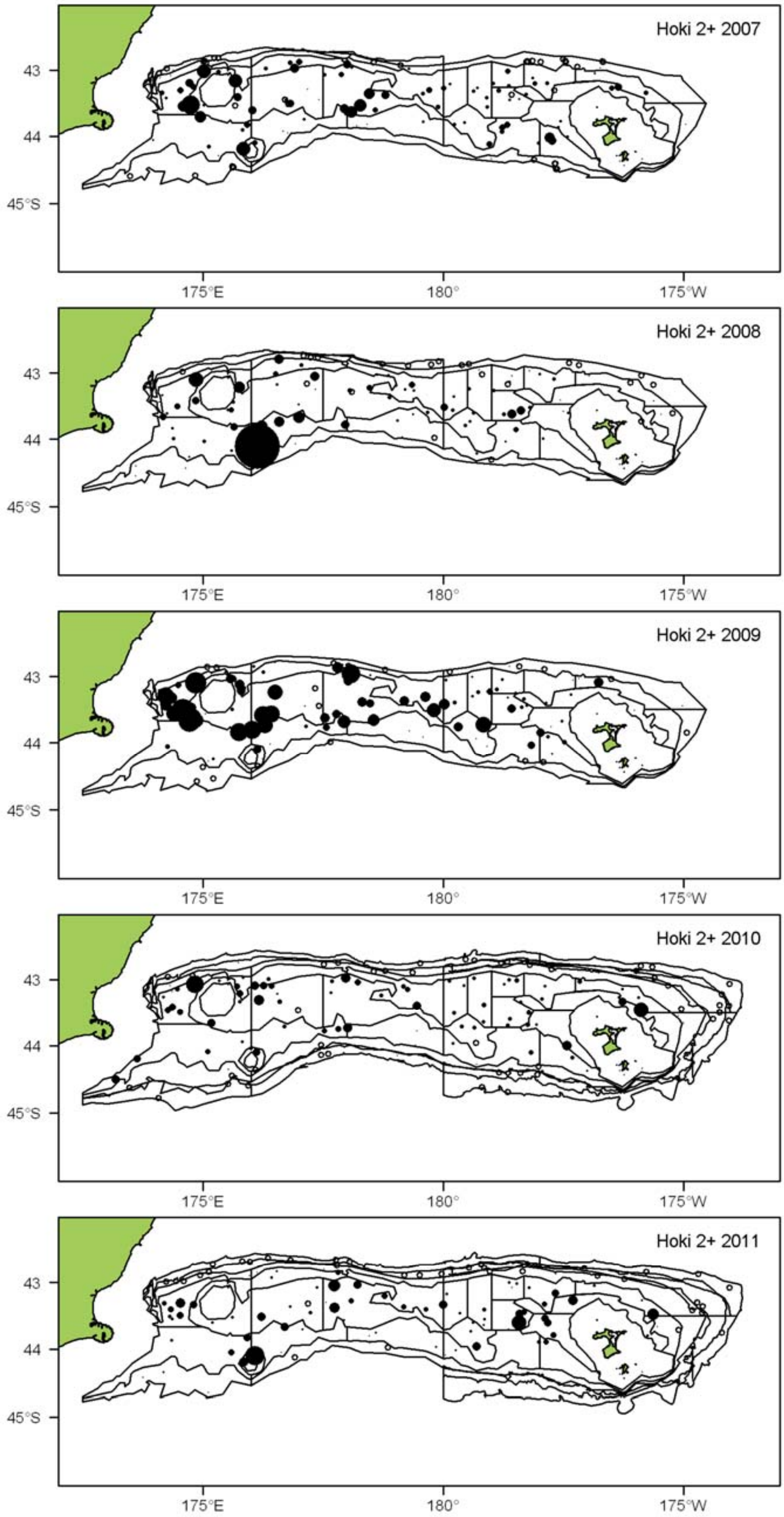


Figure 6b (continued)

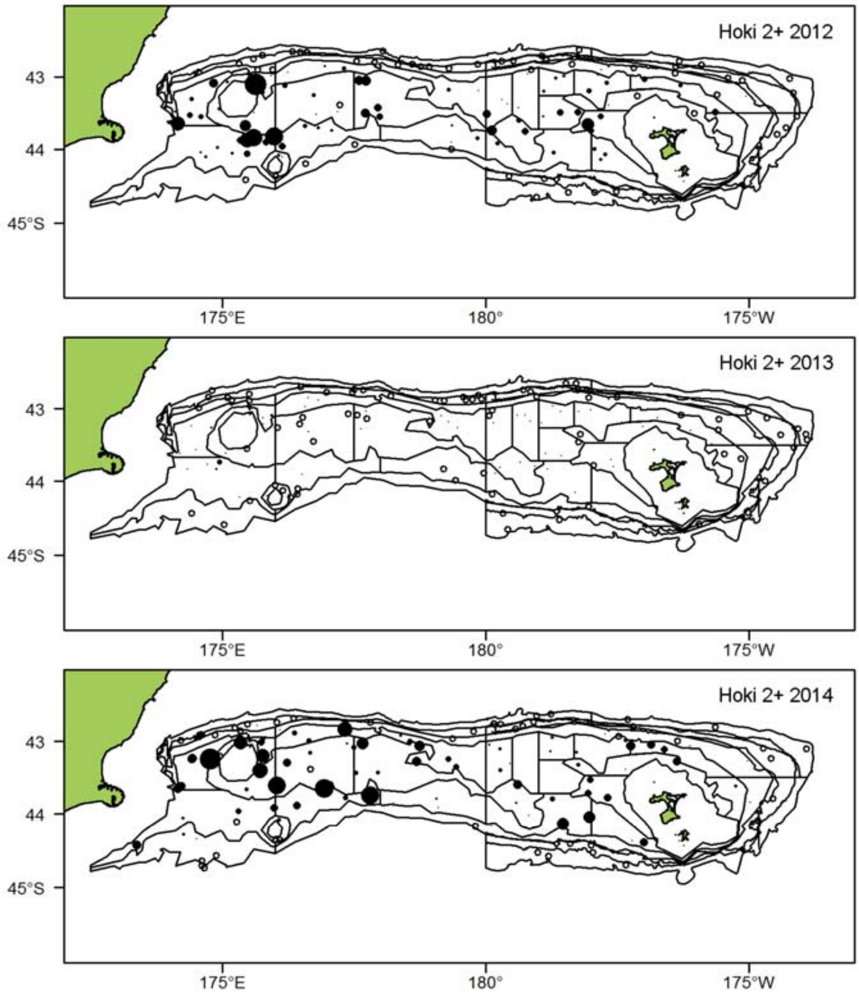


Figure 6b (continued)

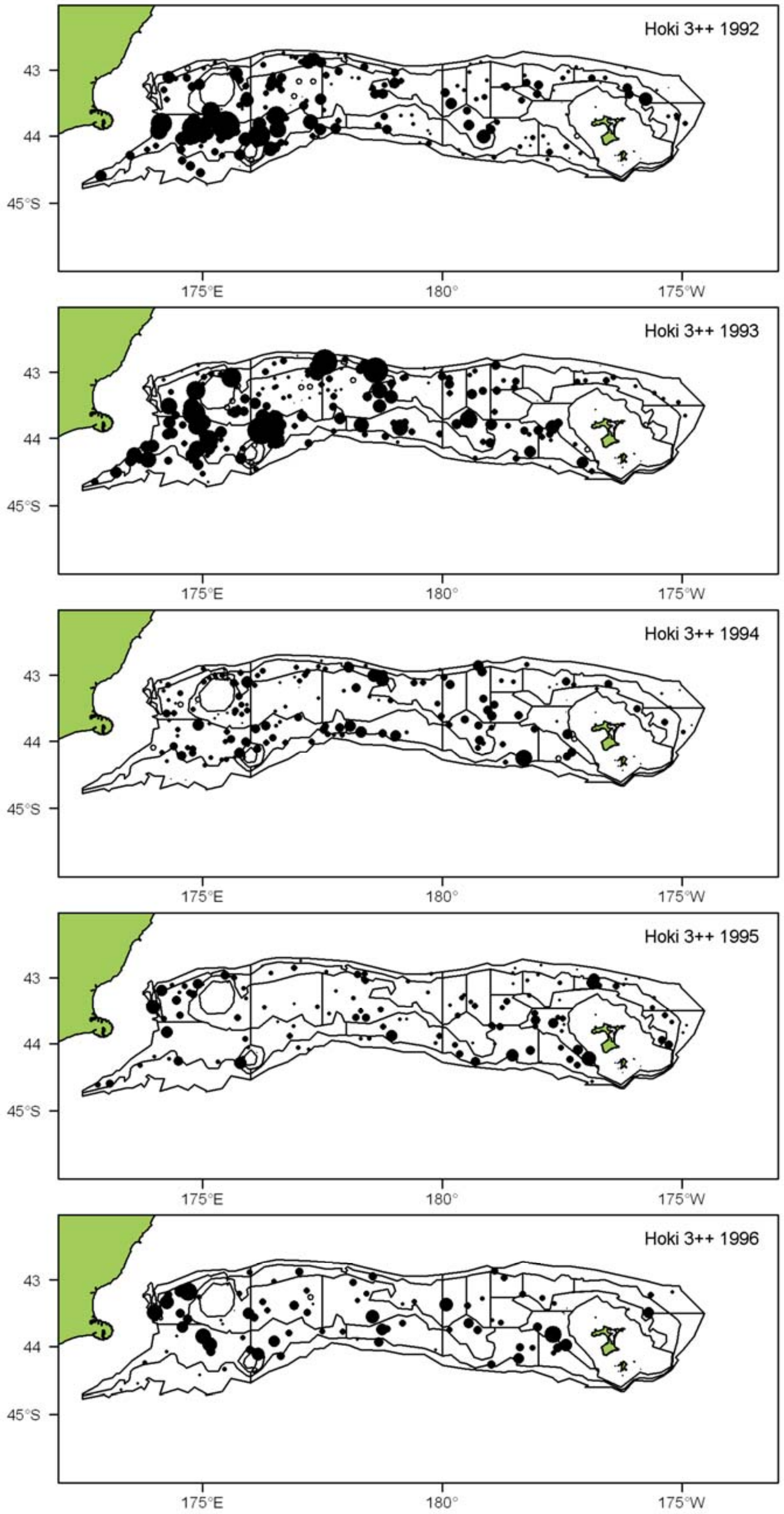
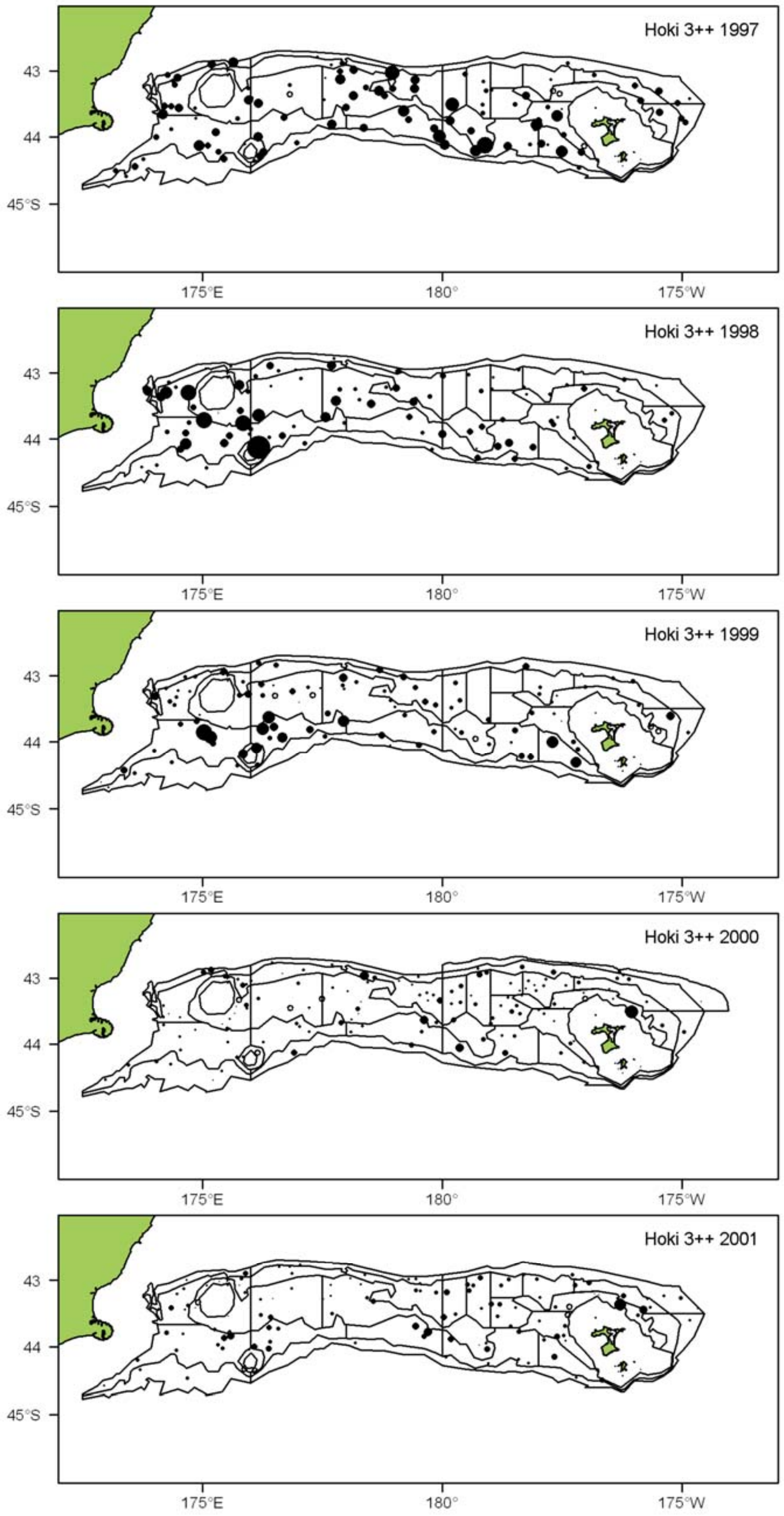


Figure 6c: Hoki 3++ catch distribution. 1992–2014. Filled circle area is proportional to catch rate (kg km^{-2}). Open circles are zero catch. Maximum catch rate in series is 11 177 kg km^{-2}.



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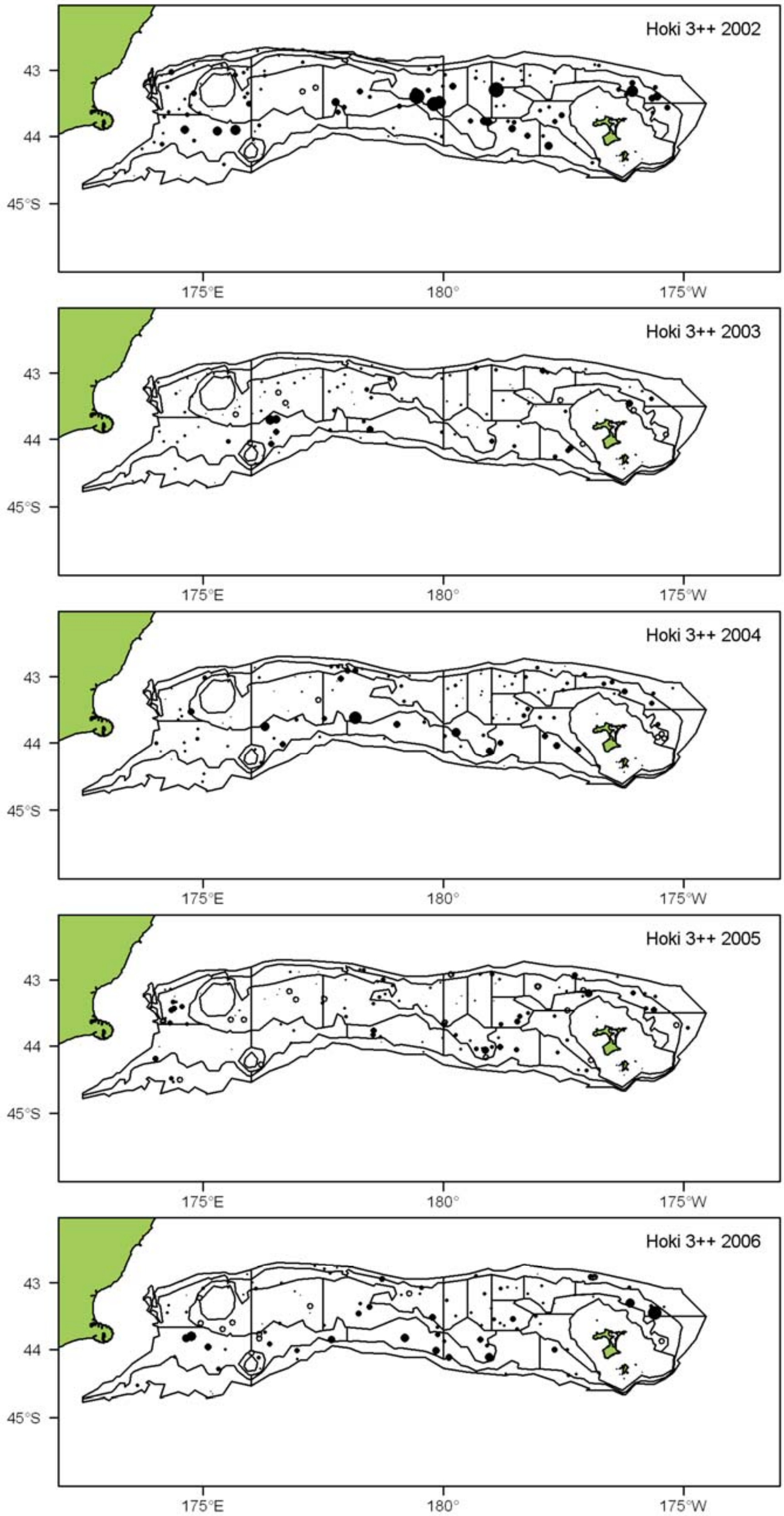

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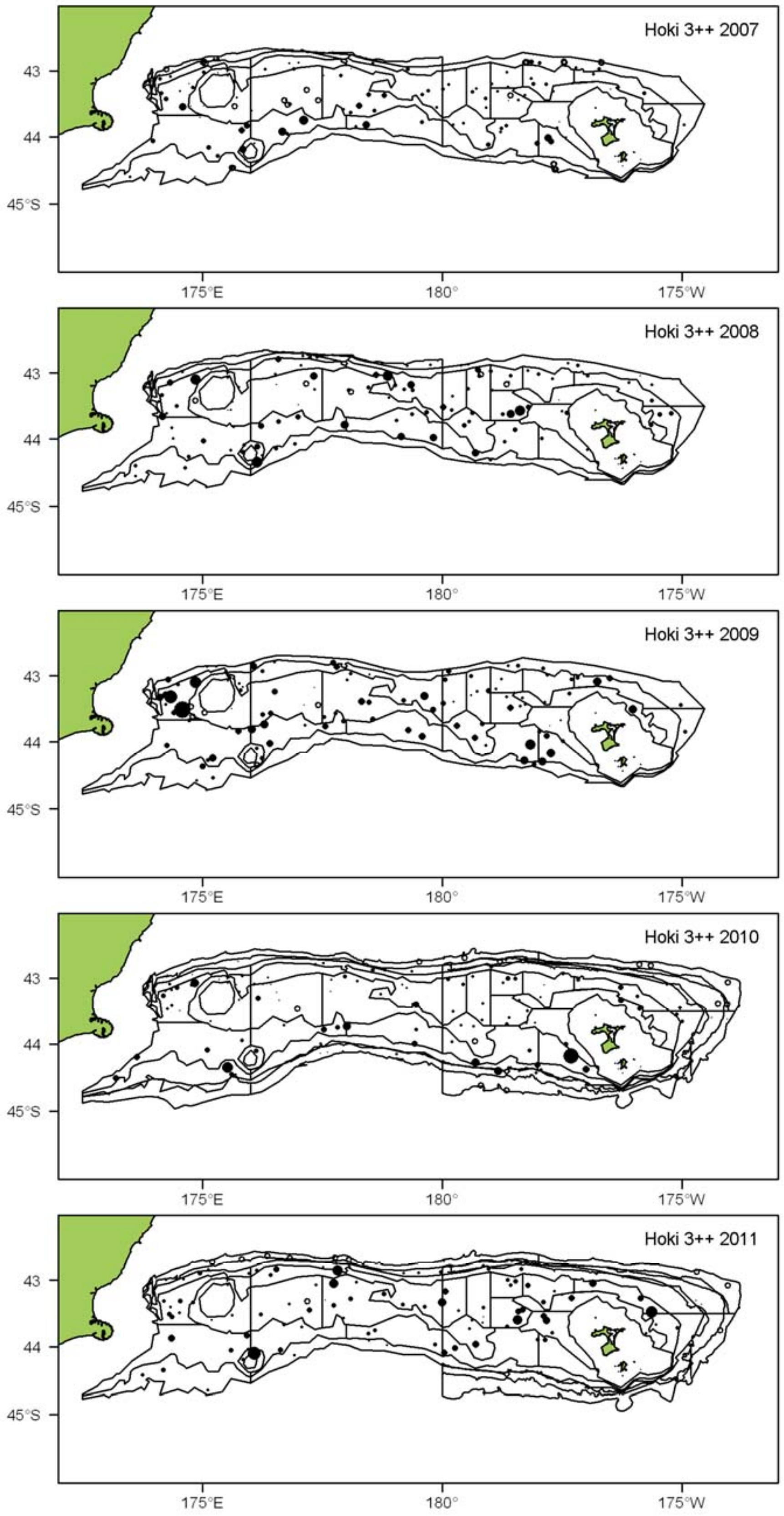

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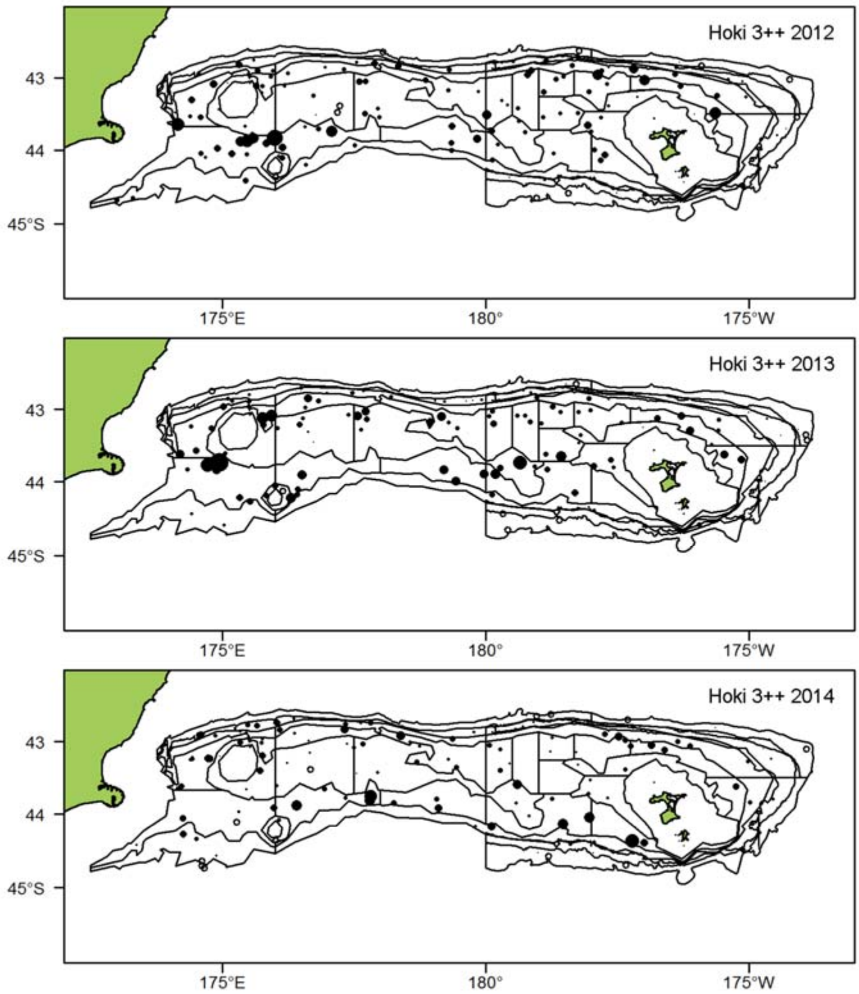


Figure 6c (continued)

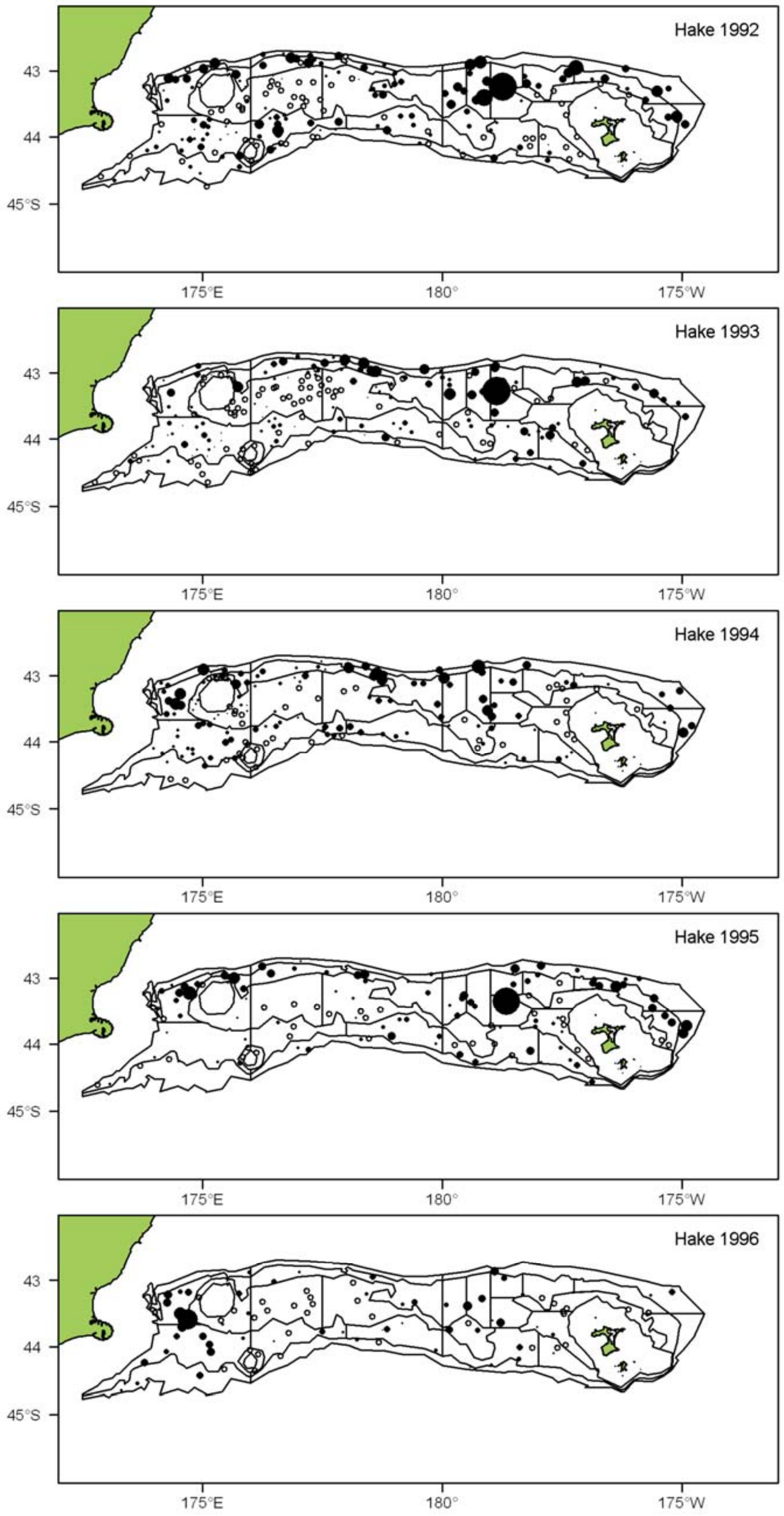
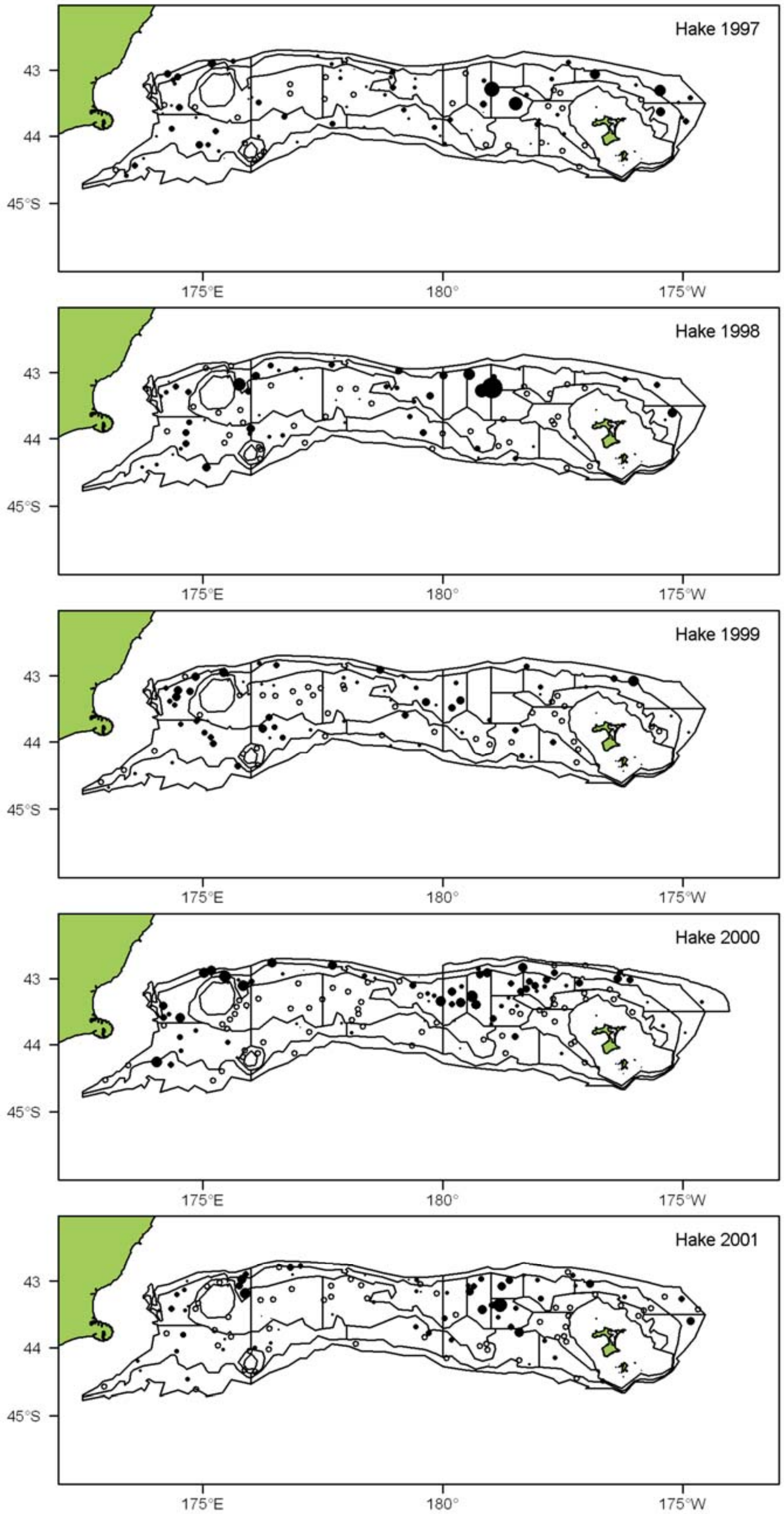


Figure 7: Hake catch distribution 1992–2014. Filled circle area is proportional to catch rate (kg km^{-2}). Open circles are zero catch. Maximum catch rate in series is 620 kg km^{-2}.



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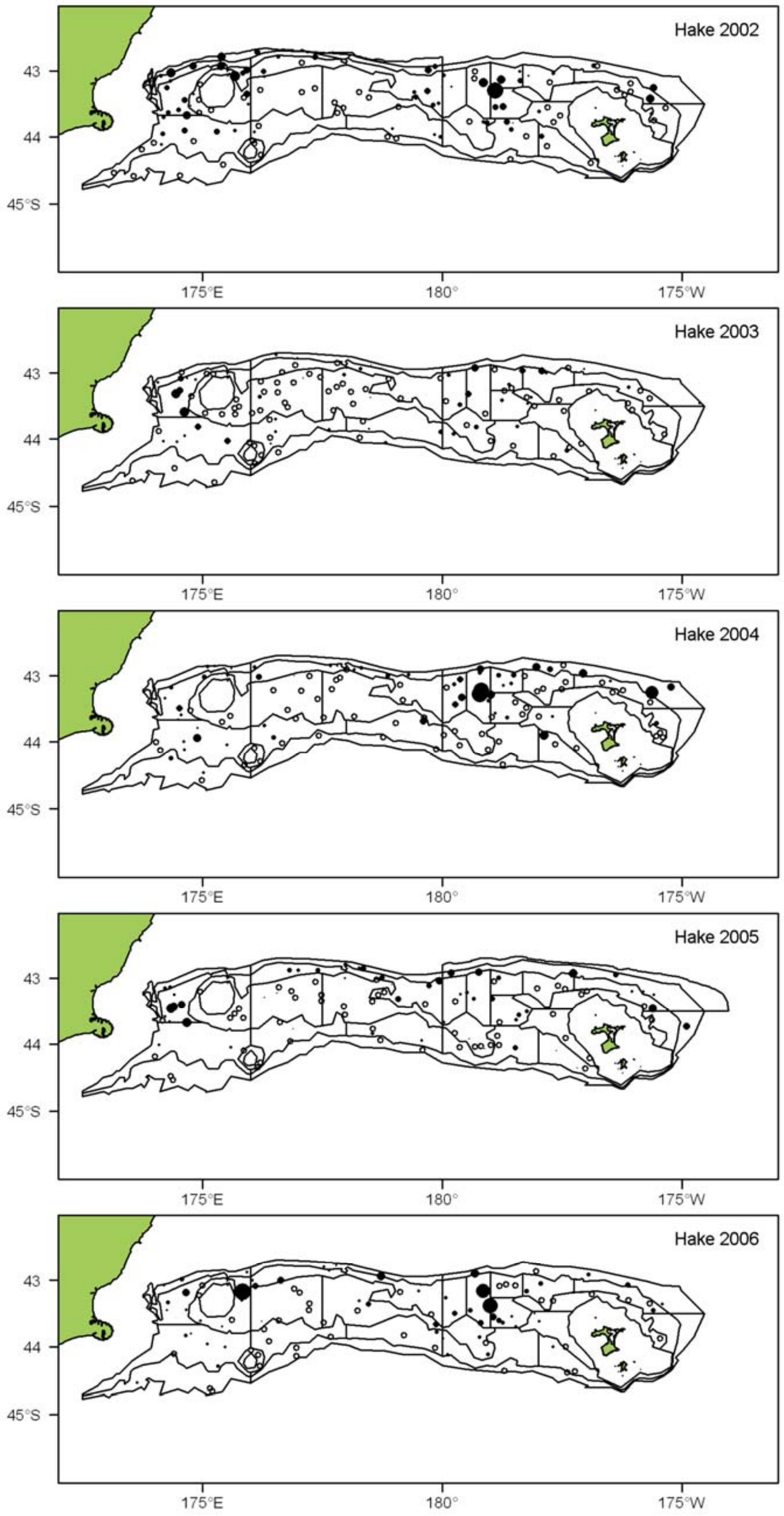

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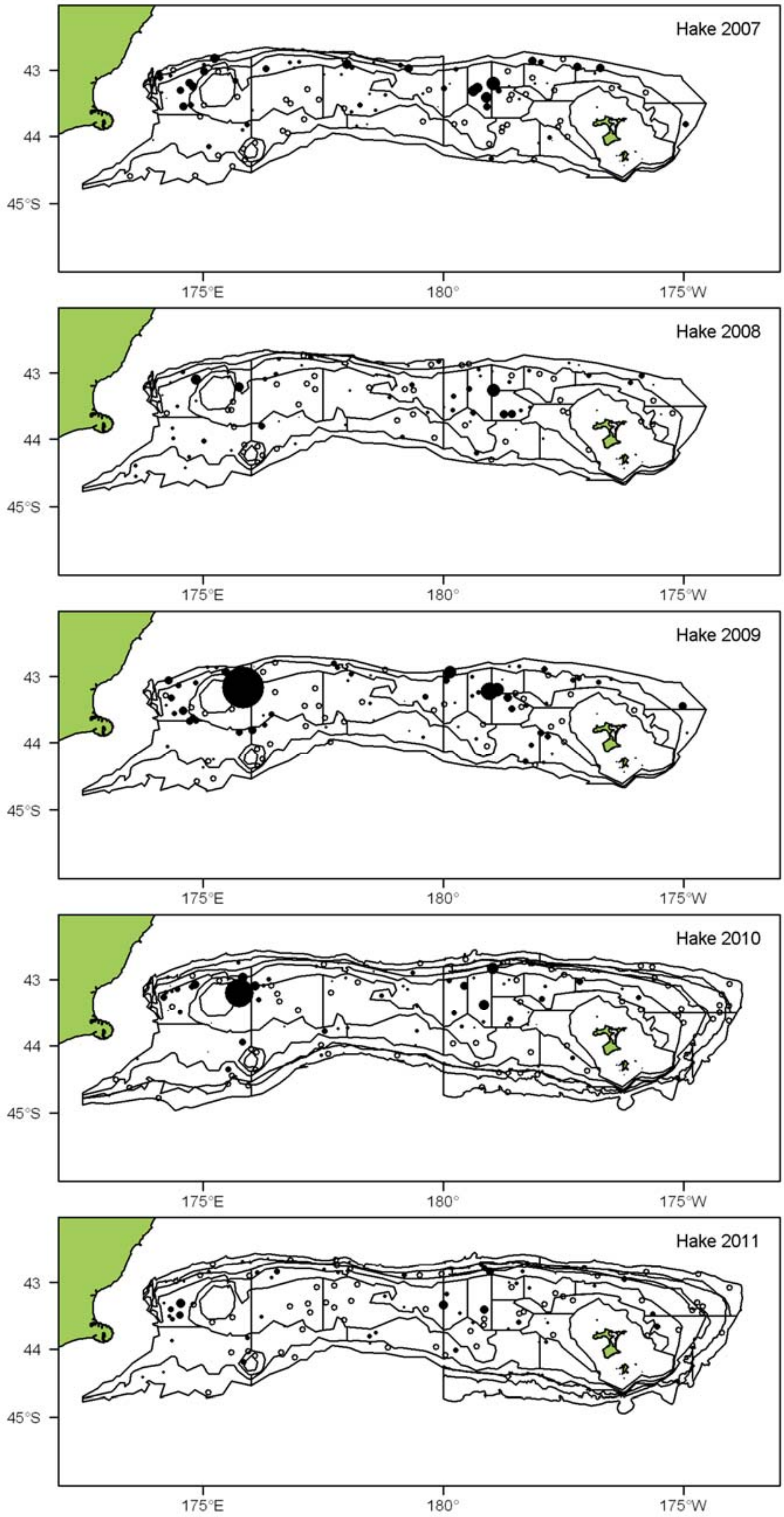

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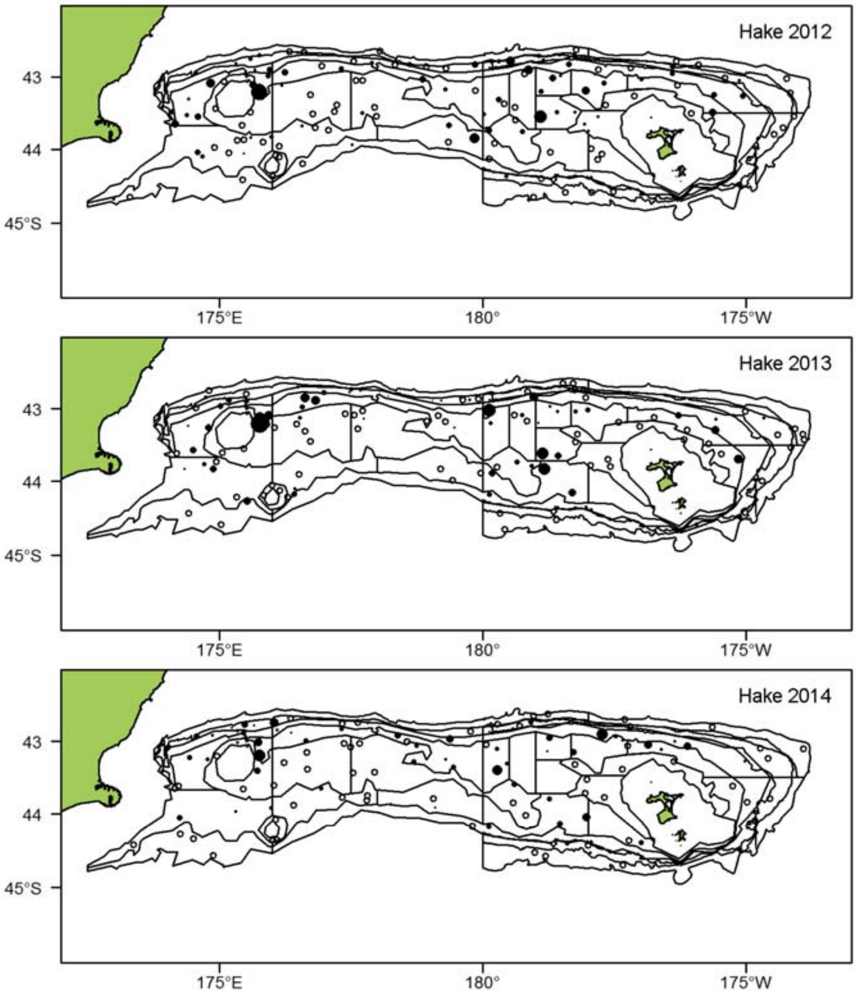

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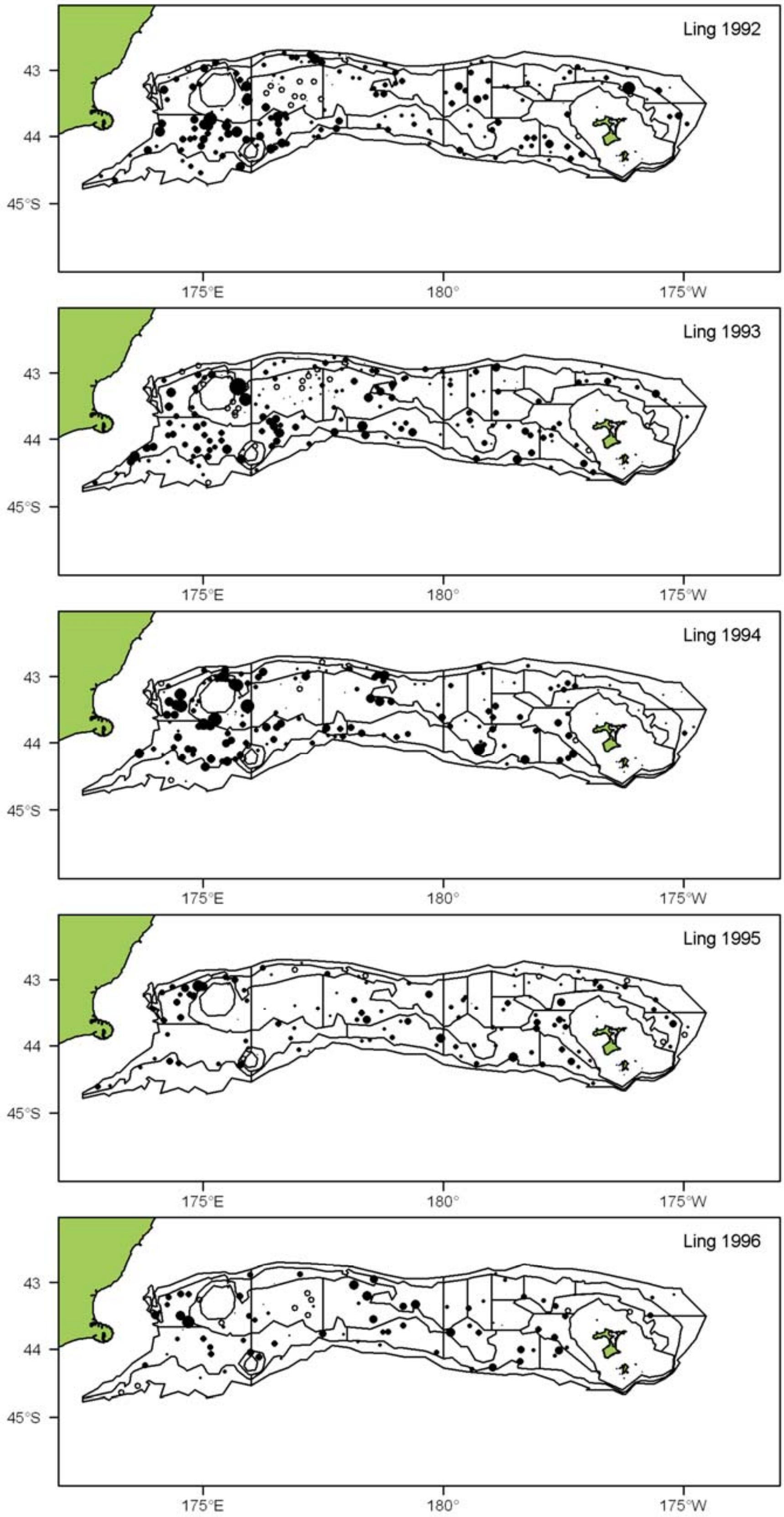
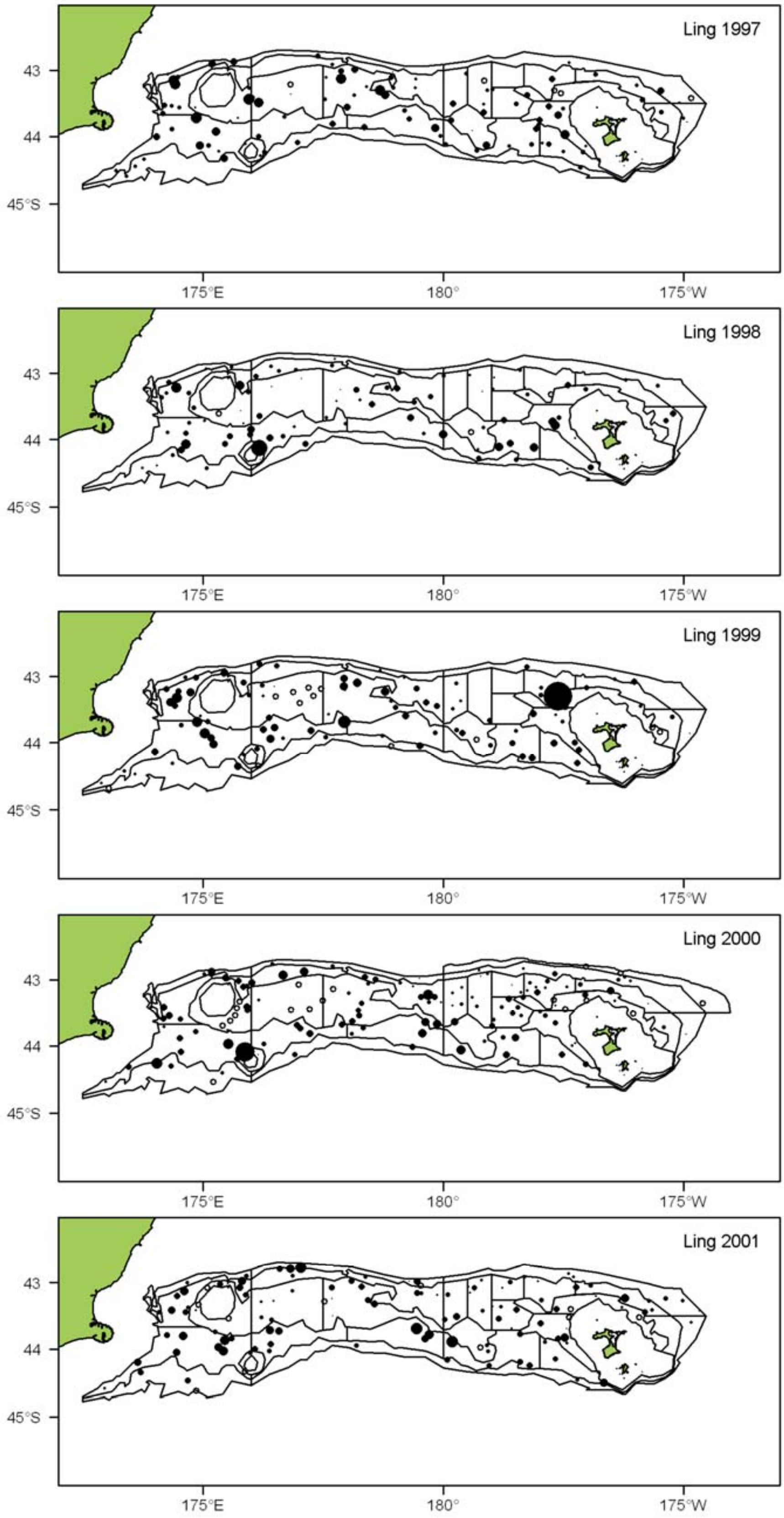


Figure 8: Ling catch distribution 1992–2014. Filled circle area is proportional to catch rate (kg km^{-2}). Open circles are zero catch. Maximum catch rate in series is 1786 kg km^{-2}.



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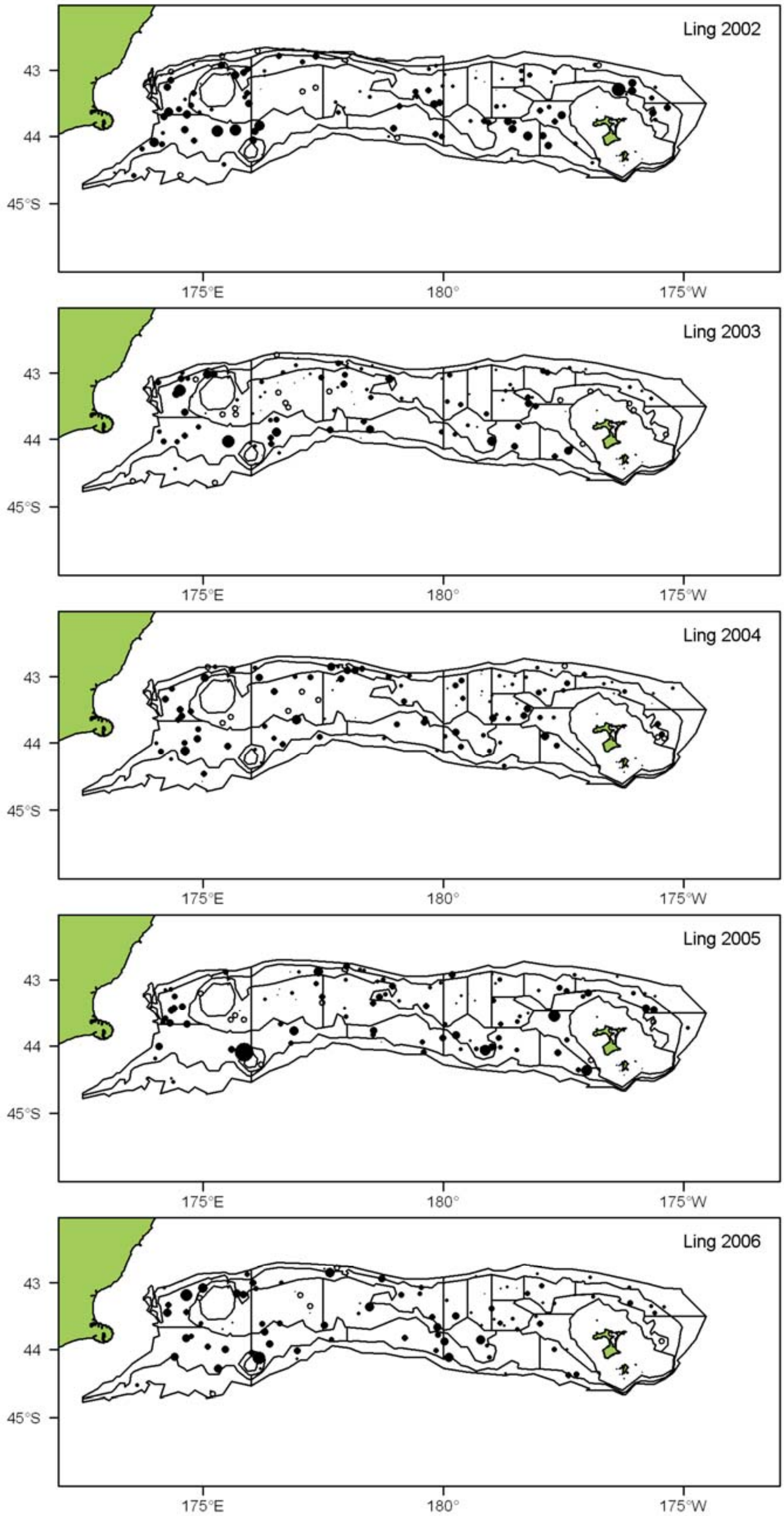

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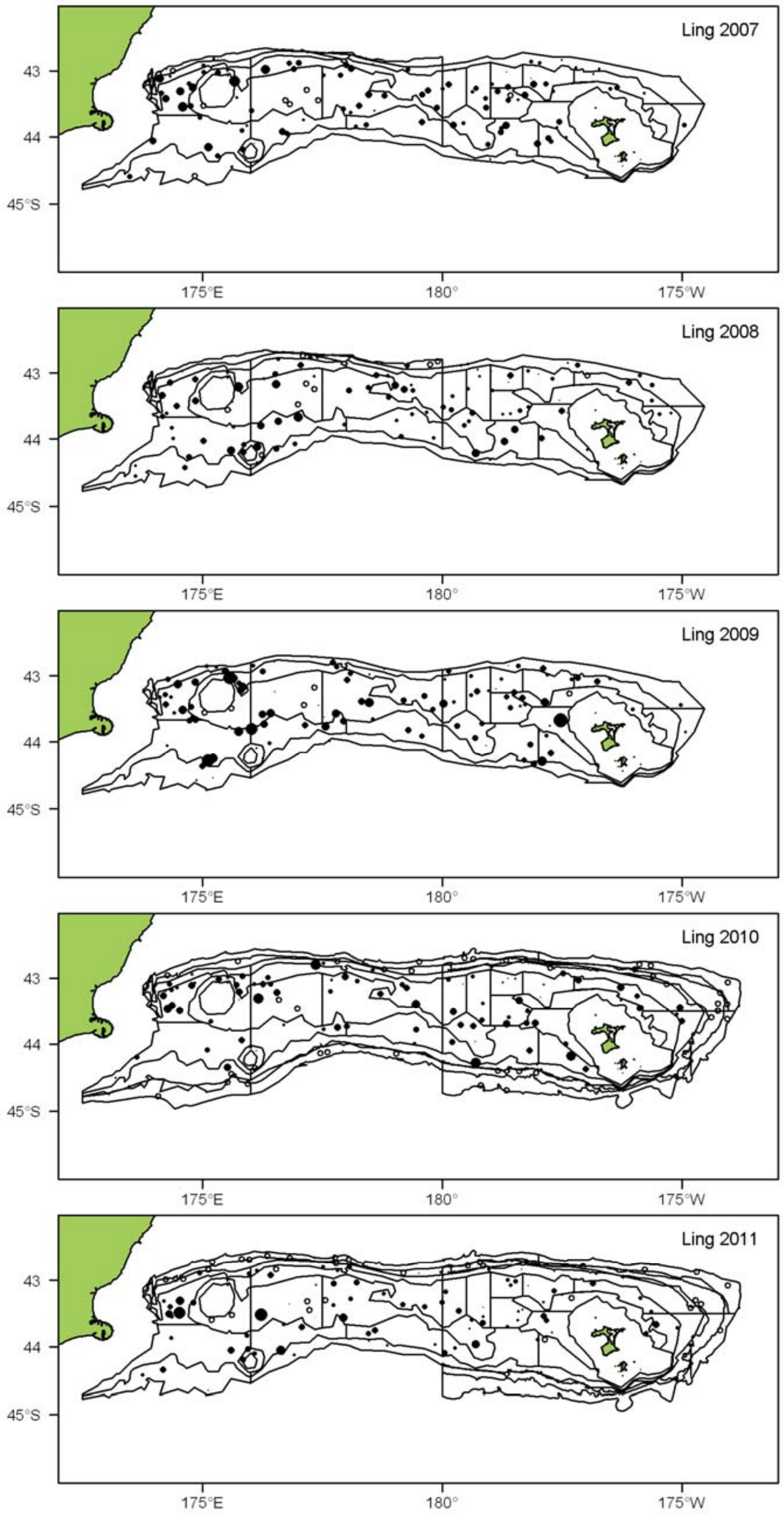

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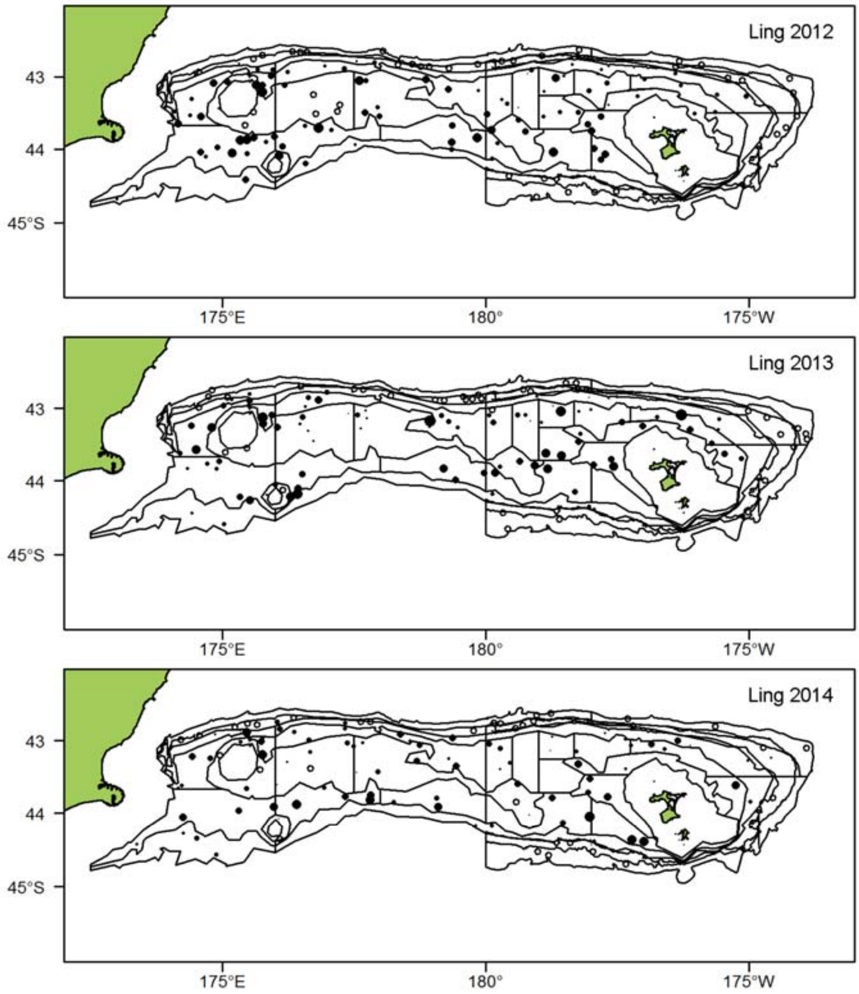

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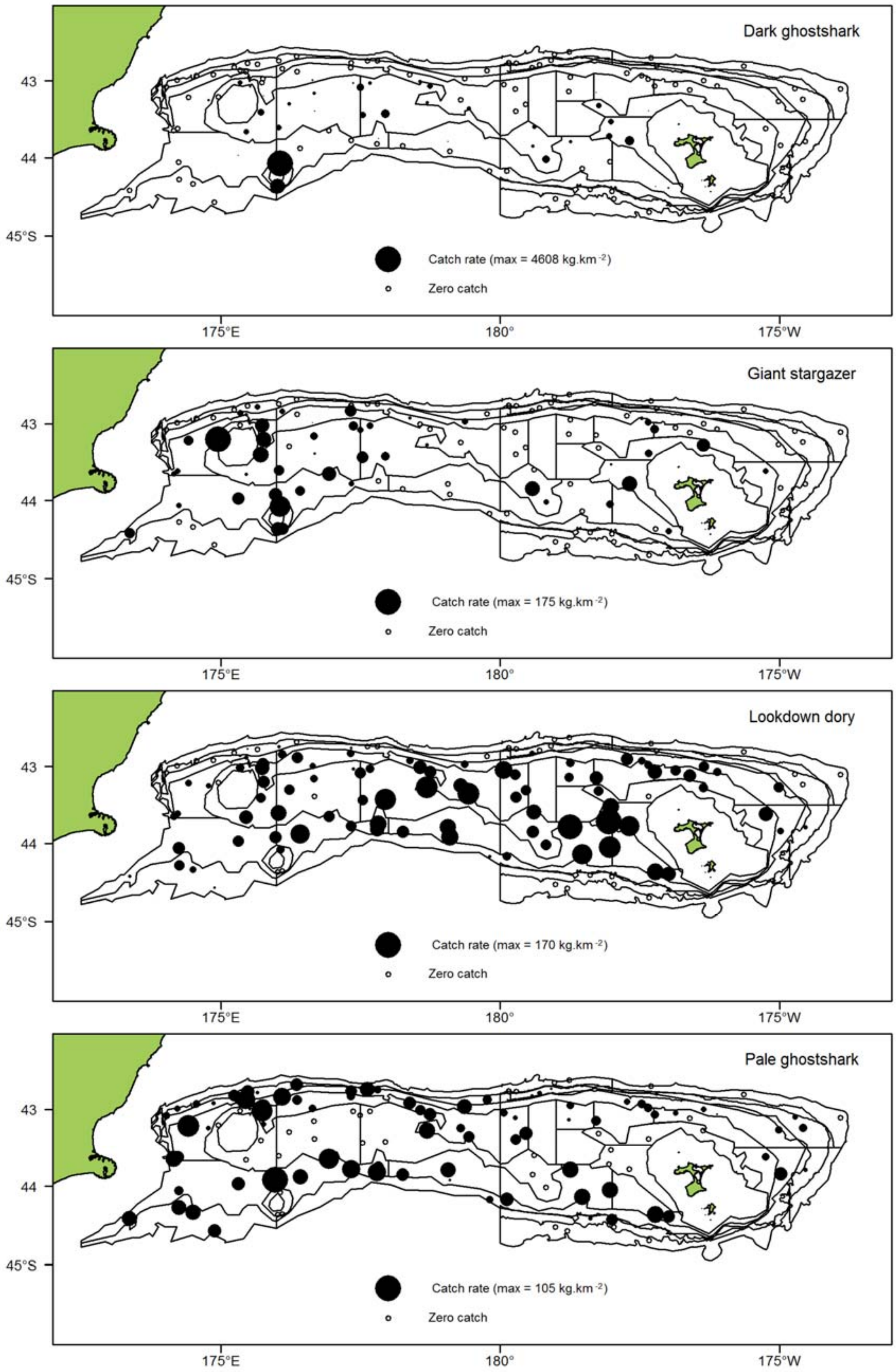
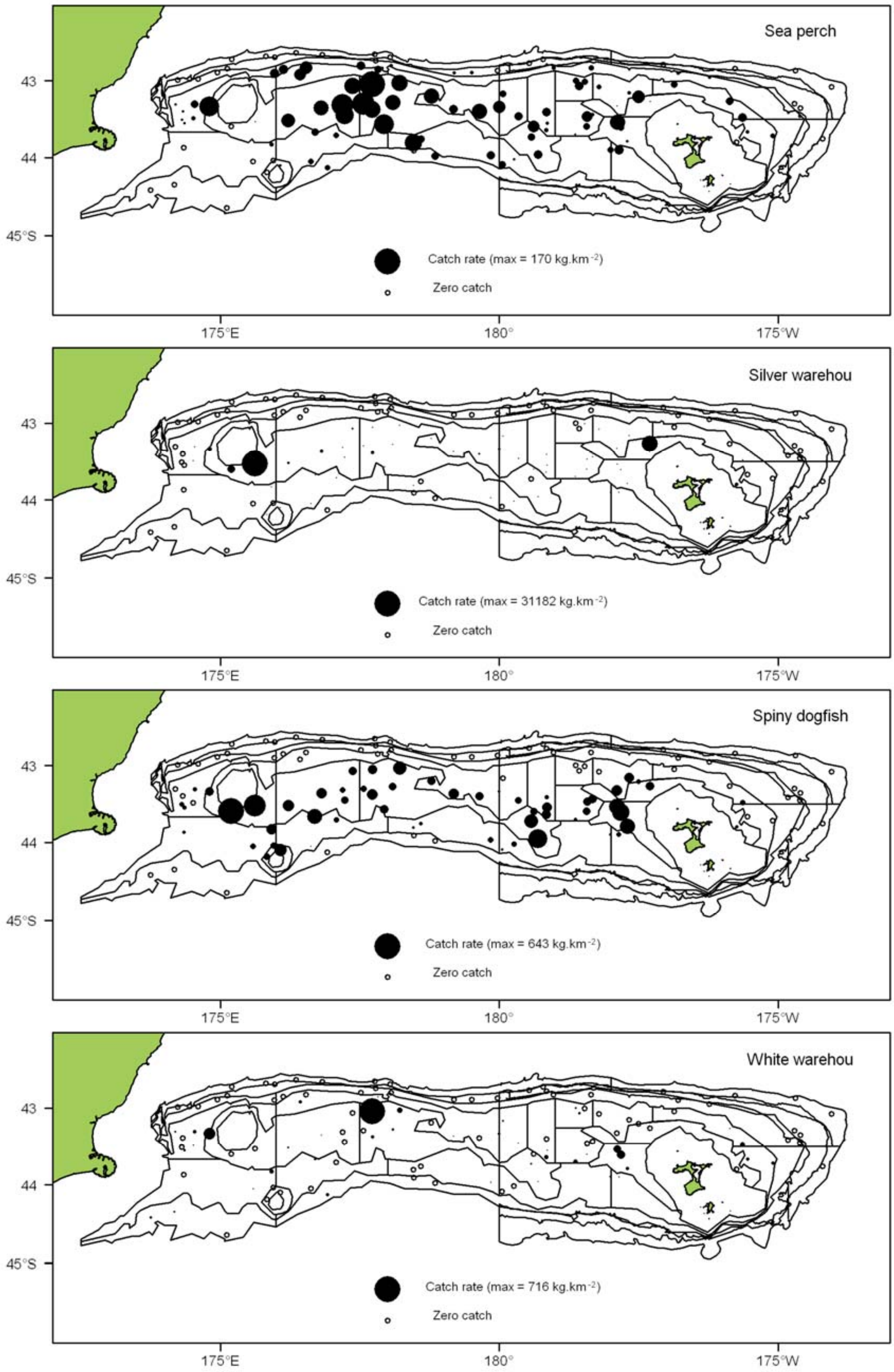


Figure 9: Catch rates (kg km^{-2}) of selected core and deepwater commercial species in 2014. Filled circle area is proportional to catch rate. Open circles are zero catch. (max., maximum catch rate).



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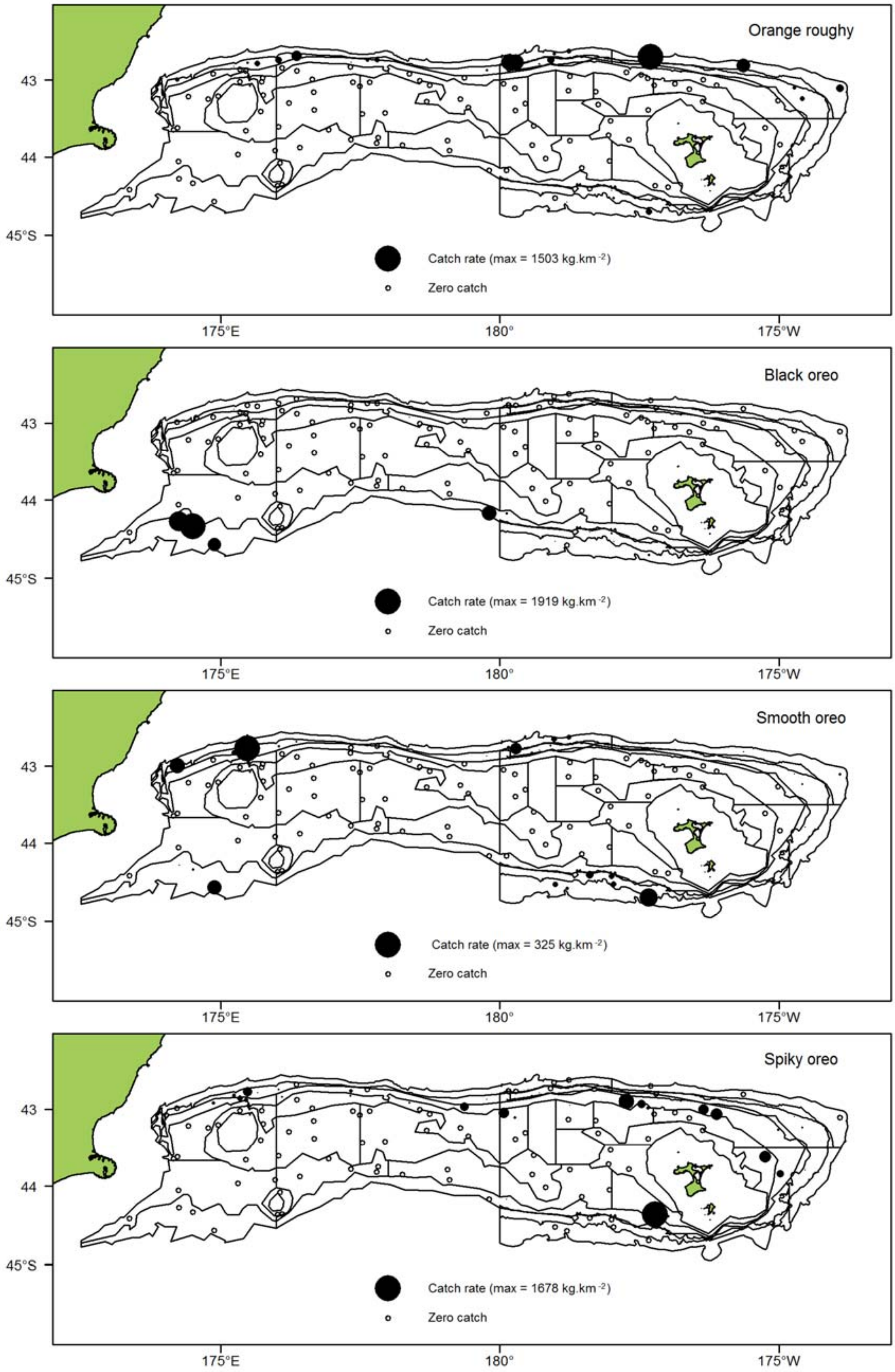

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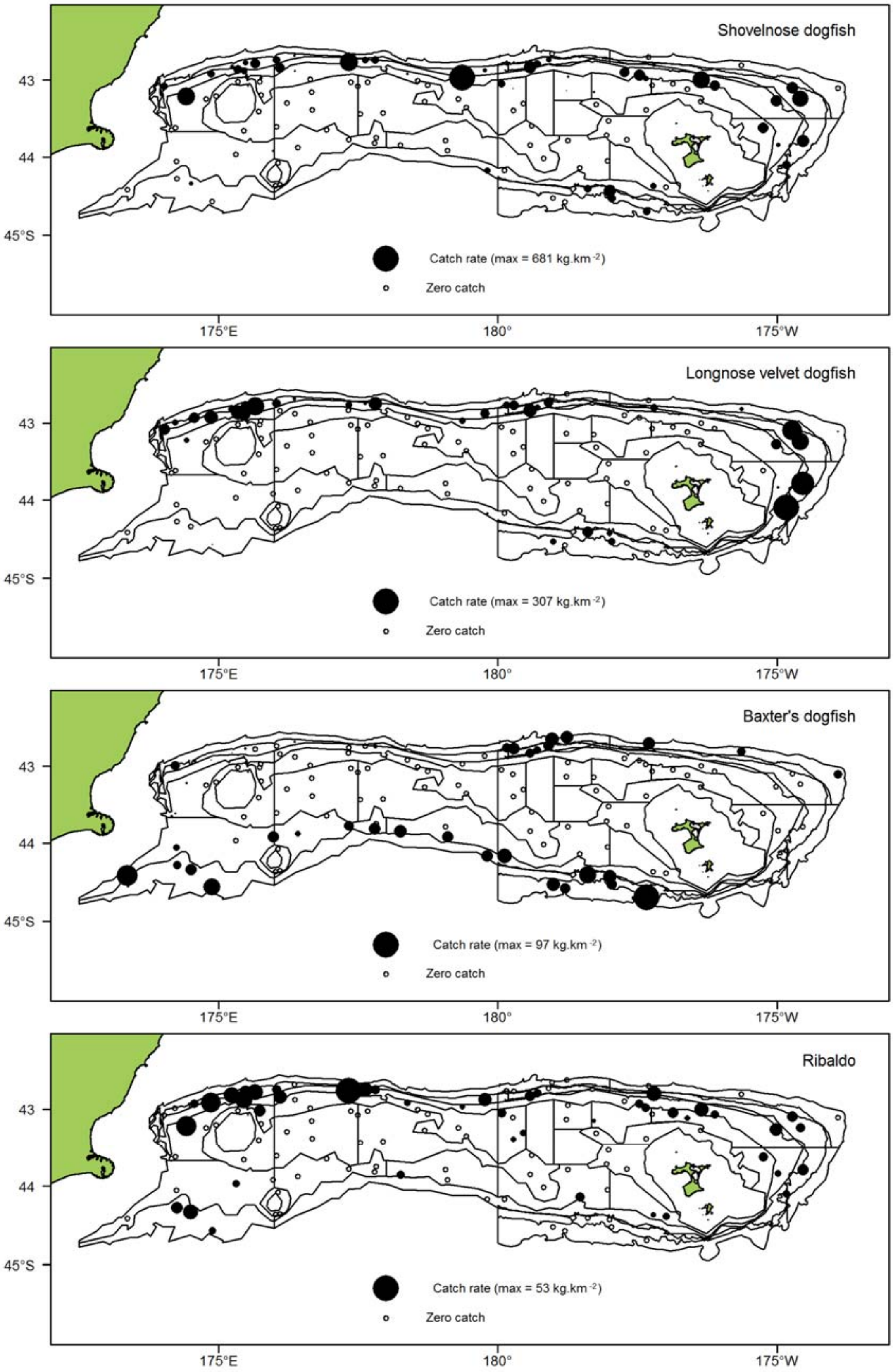

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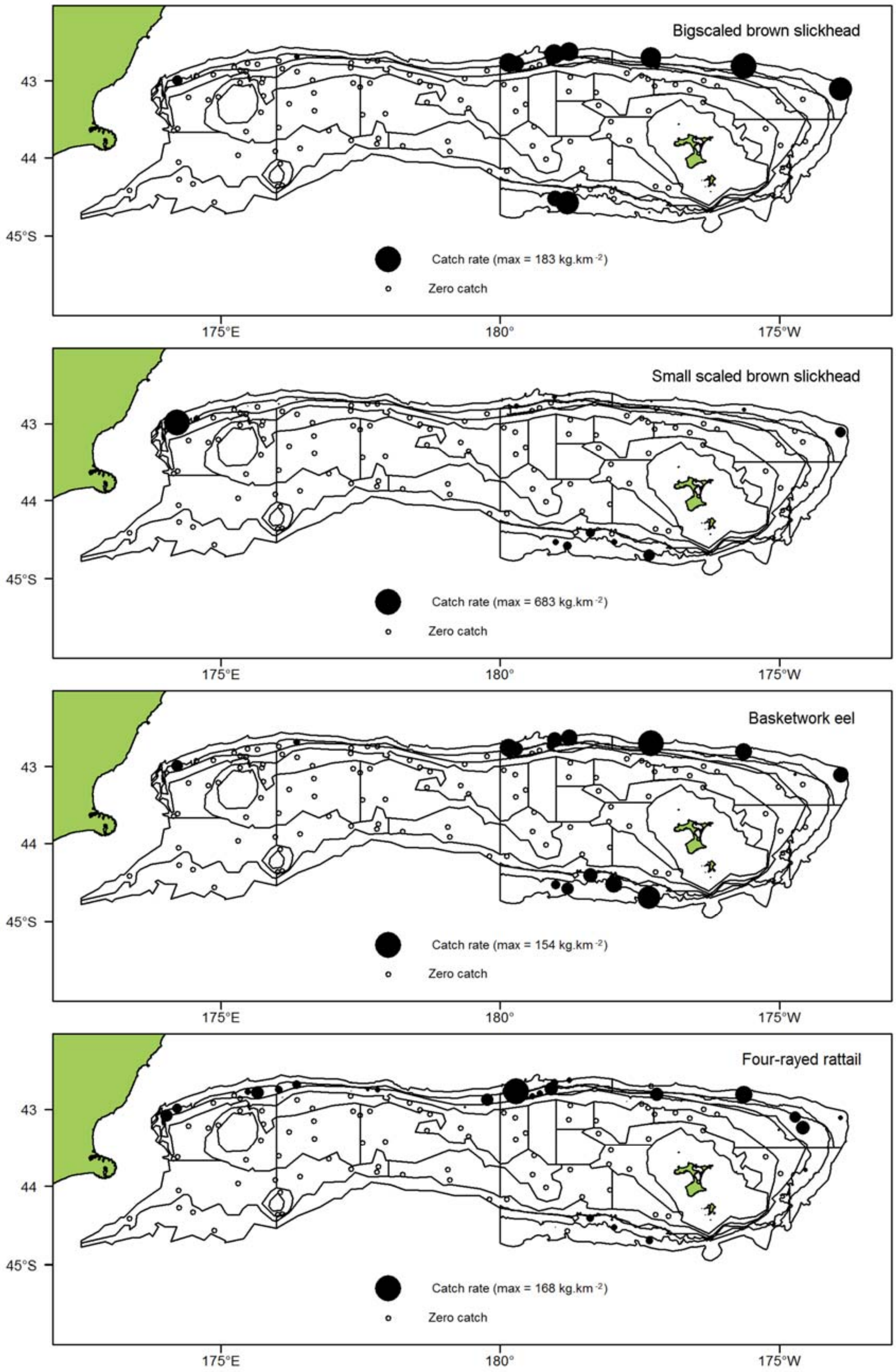

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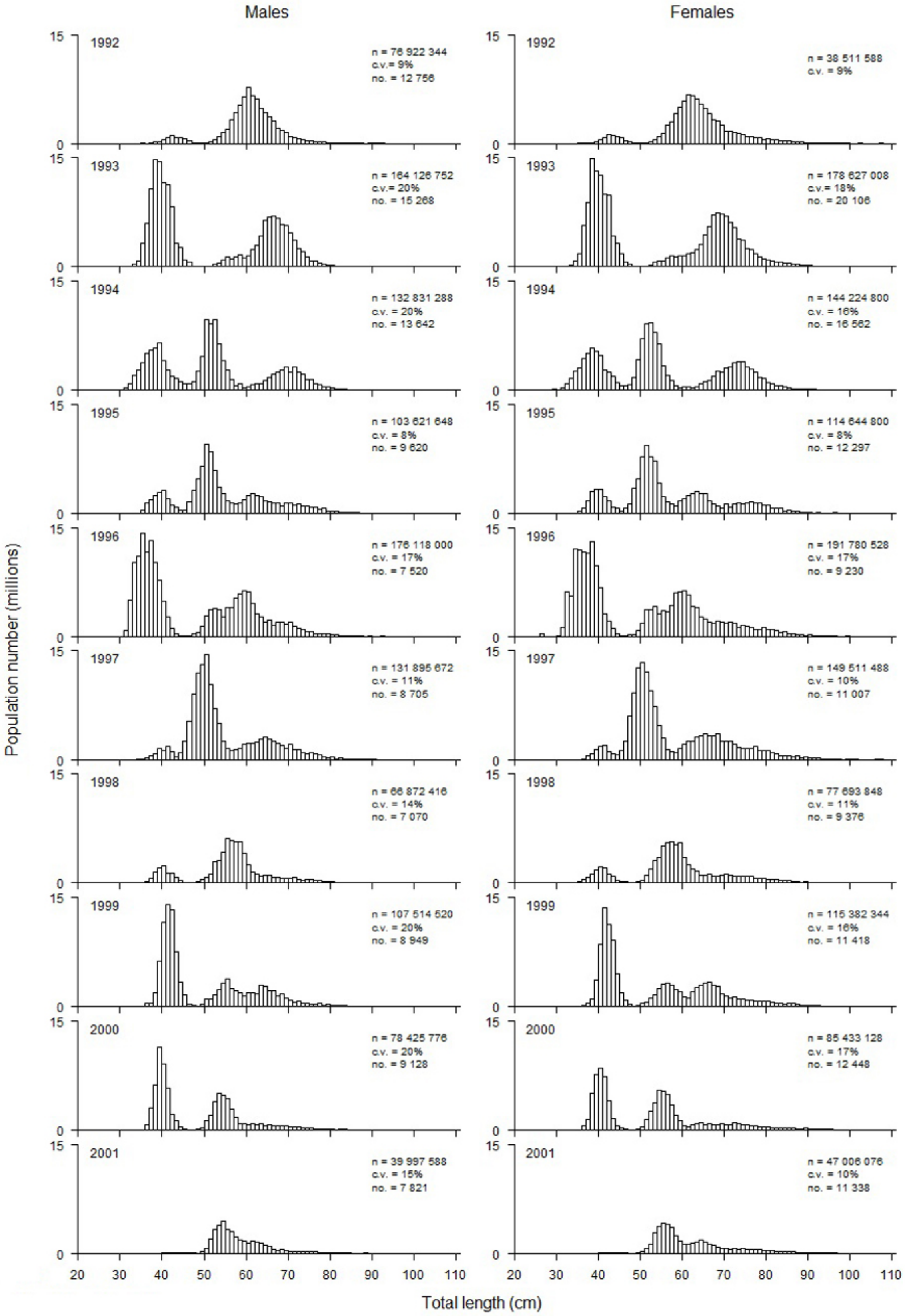

Figure 10: Estimated length frequency distributions of the male and female hoki population from *Tangaroa* surveys of the Chatham Rise, January 1992–2014. CV, coefficient of variation; n, estimated population number of male hoki (left panel) and female hoki (right panel); no., numbers of fish measured.

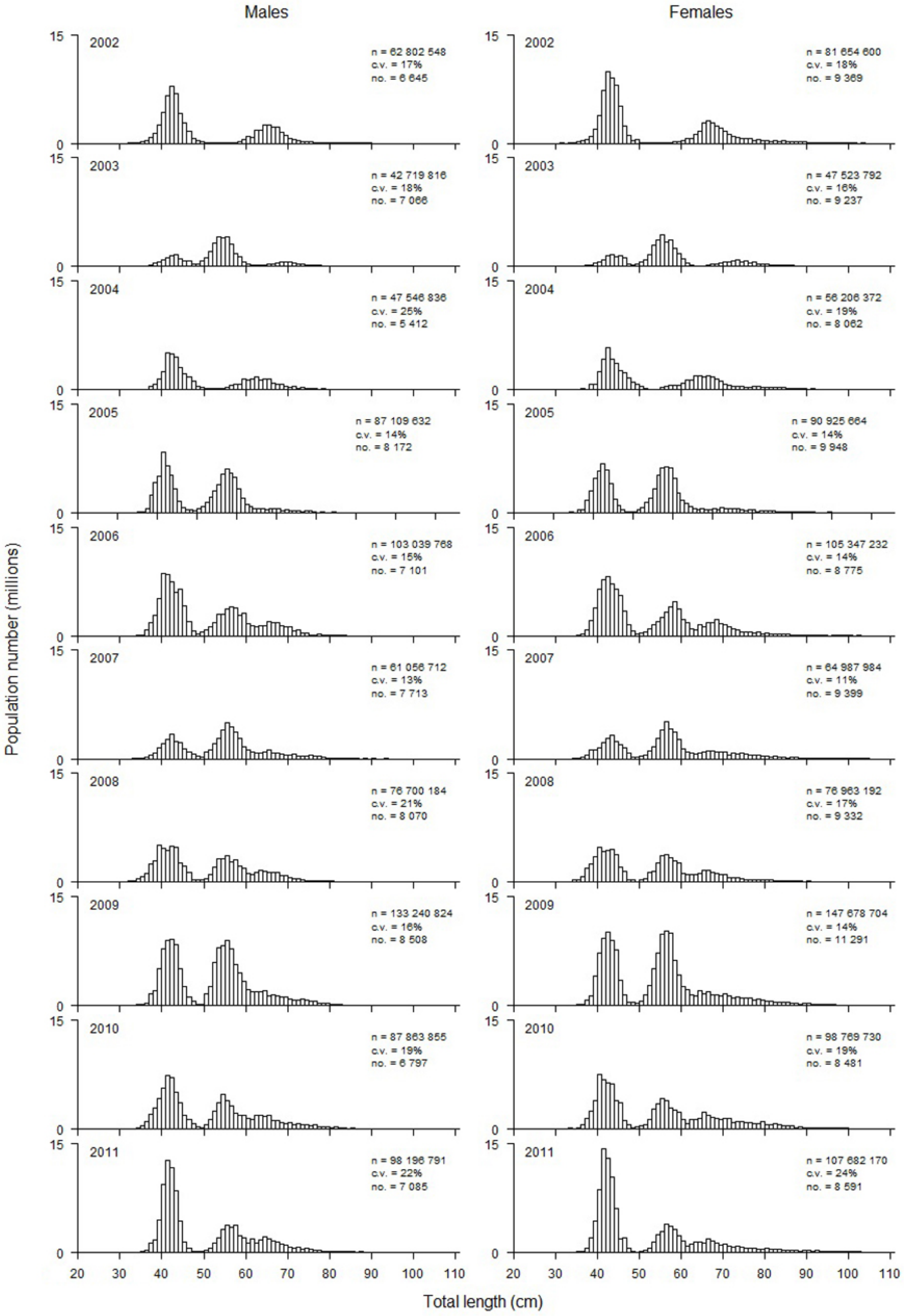

Figure 10 (continued)

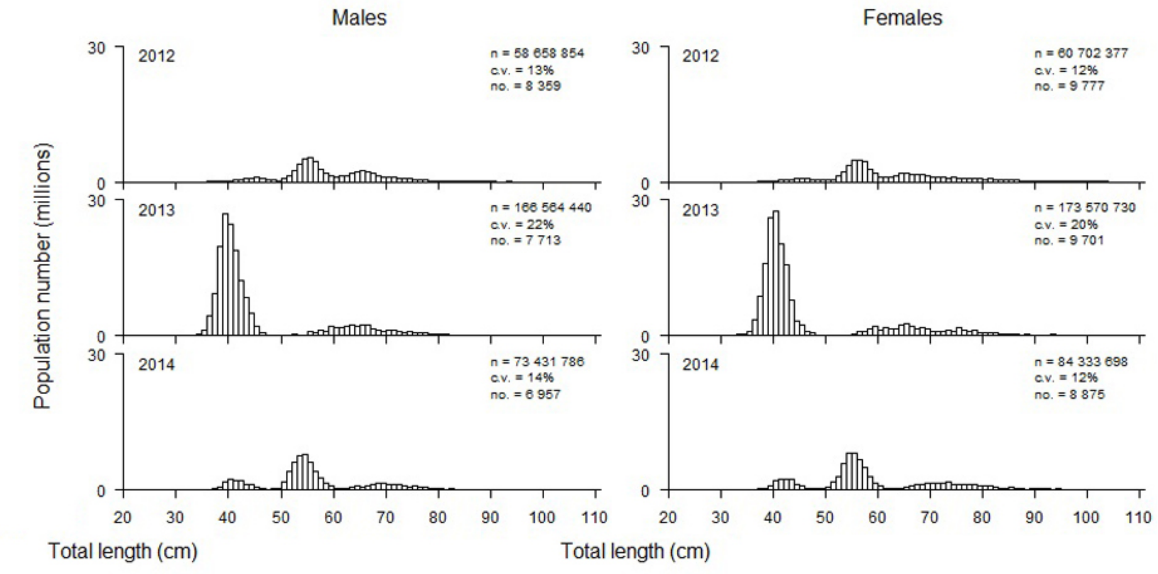

Figure 10 (continued)

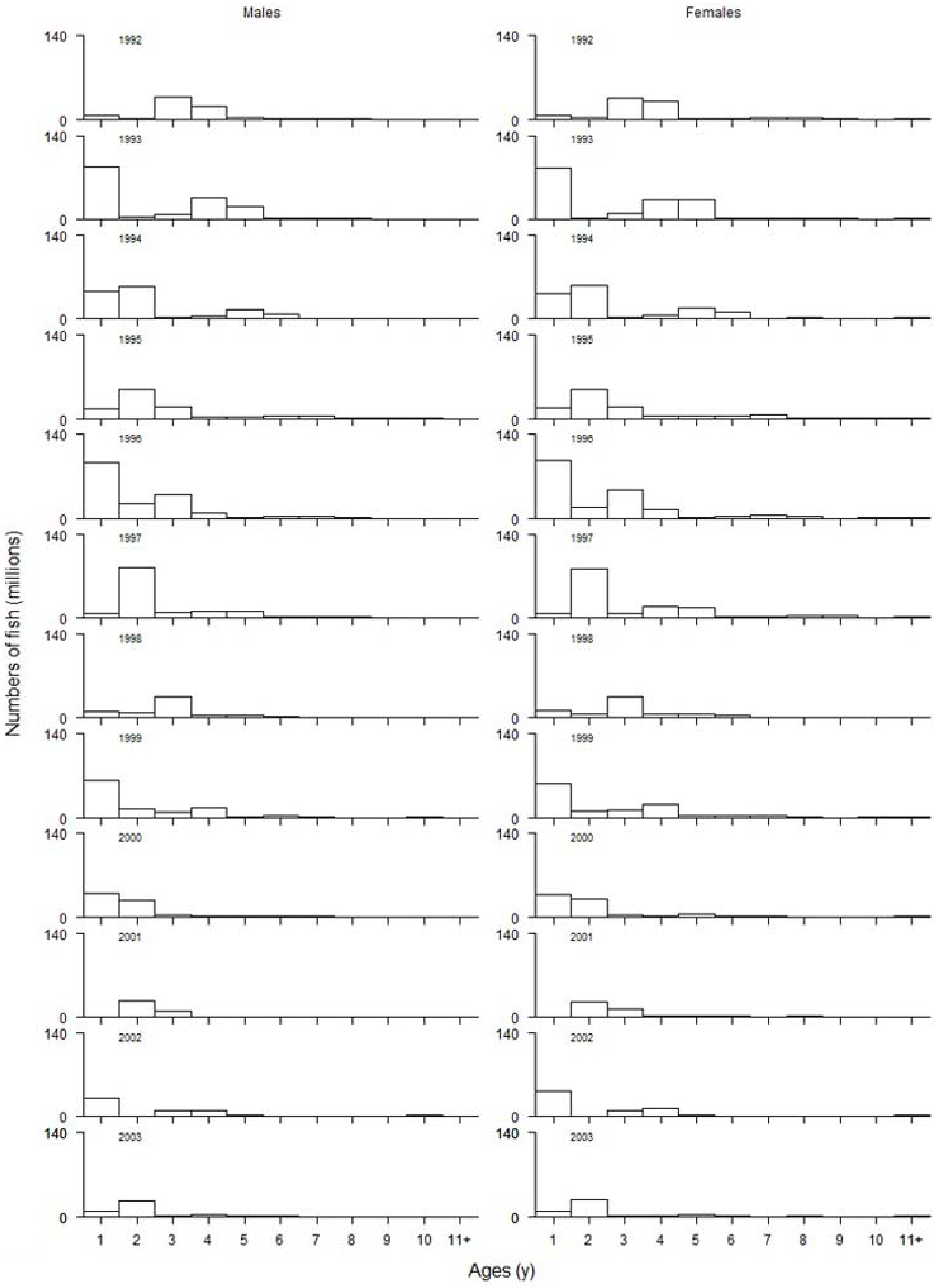

Figure 11: **Estimated population numbers at age for hoki from *Tangaroa* surveys of the Chatham Rise, January, 1992–2014. +, indicates plus group of combined ages.**

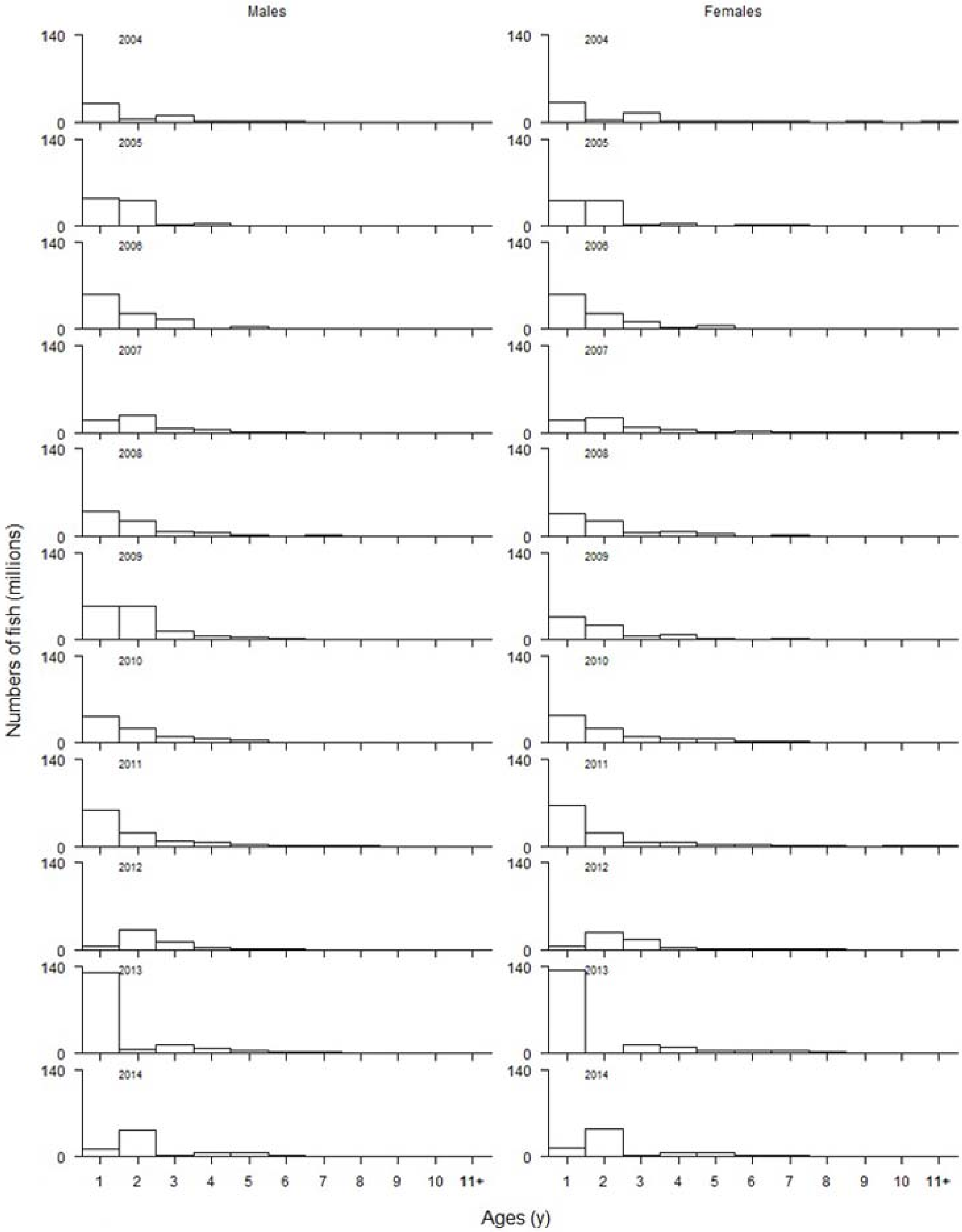

Figure 11 (continued)

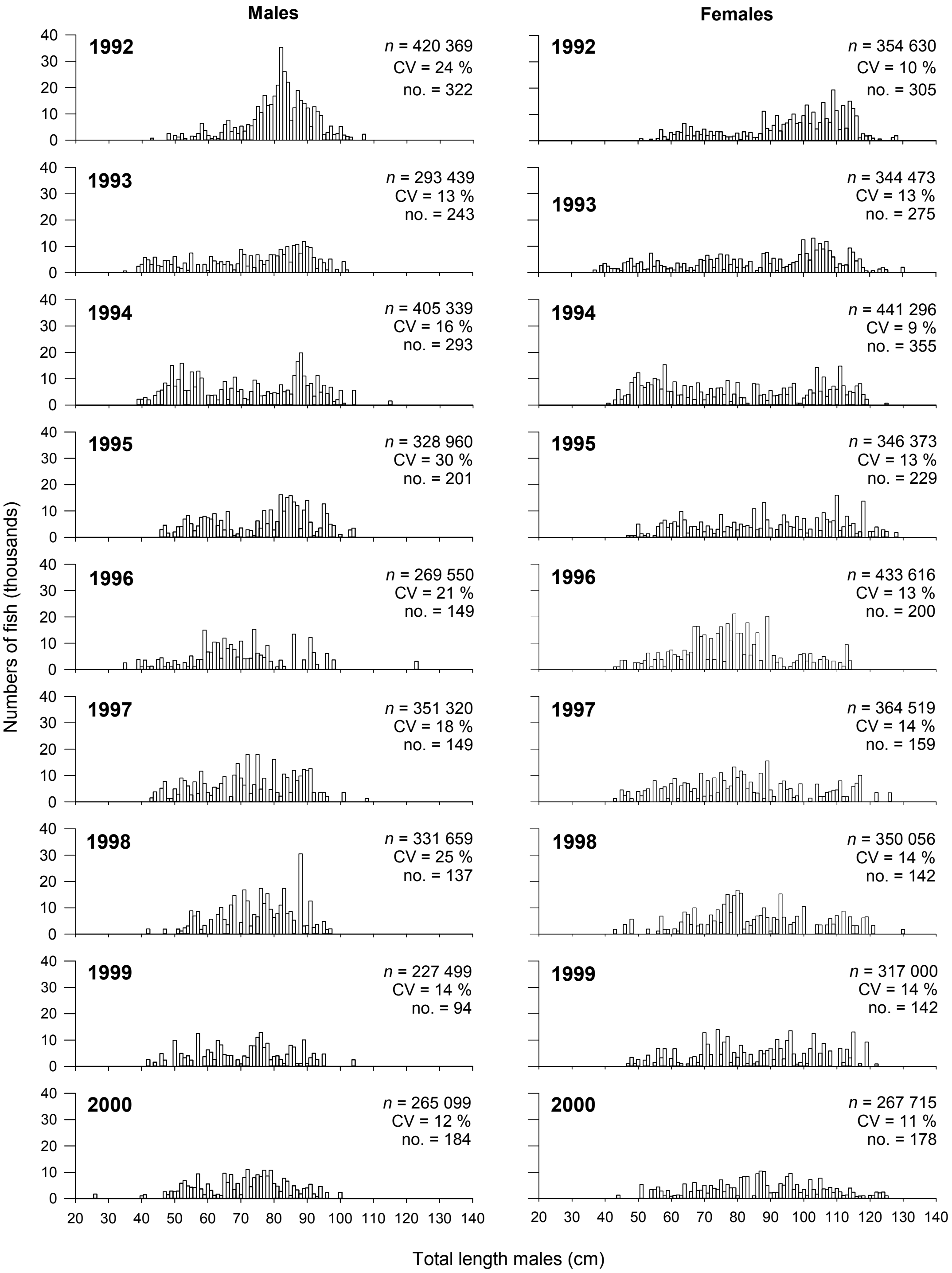

Figure 12: Estimated length frequency distributions of the male and female hake population from *Tangaroa* surveys of the Chatham Rise, January 1992–2014. CV, coefficient of variation; *n*, estimated population number of hake; no., numbers of fish measured.

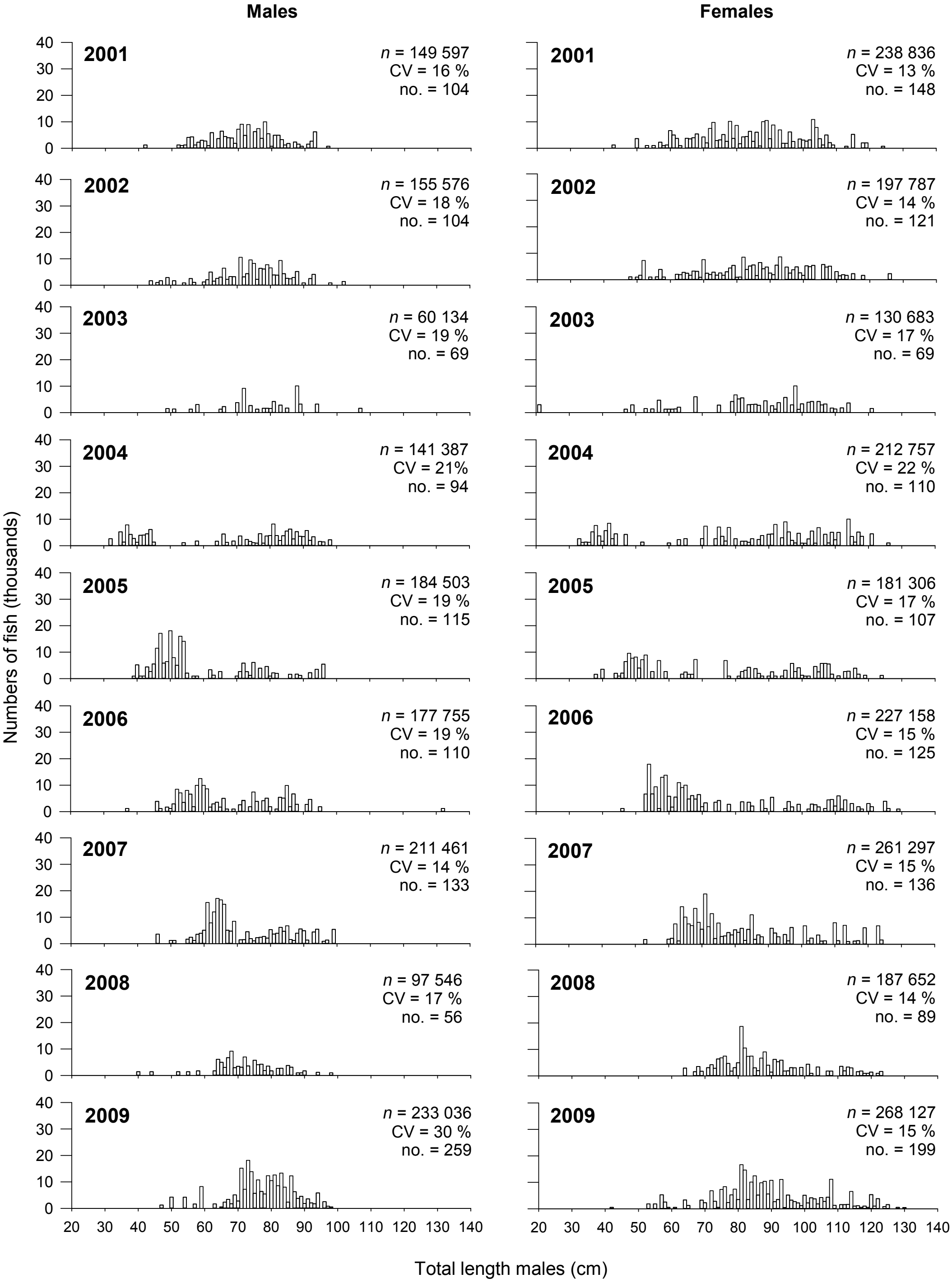

Figure 12 (continued)

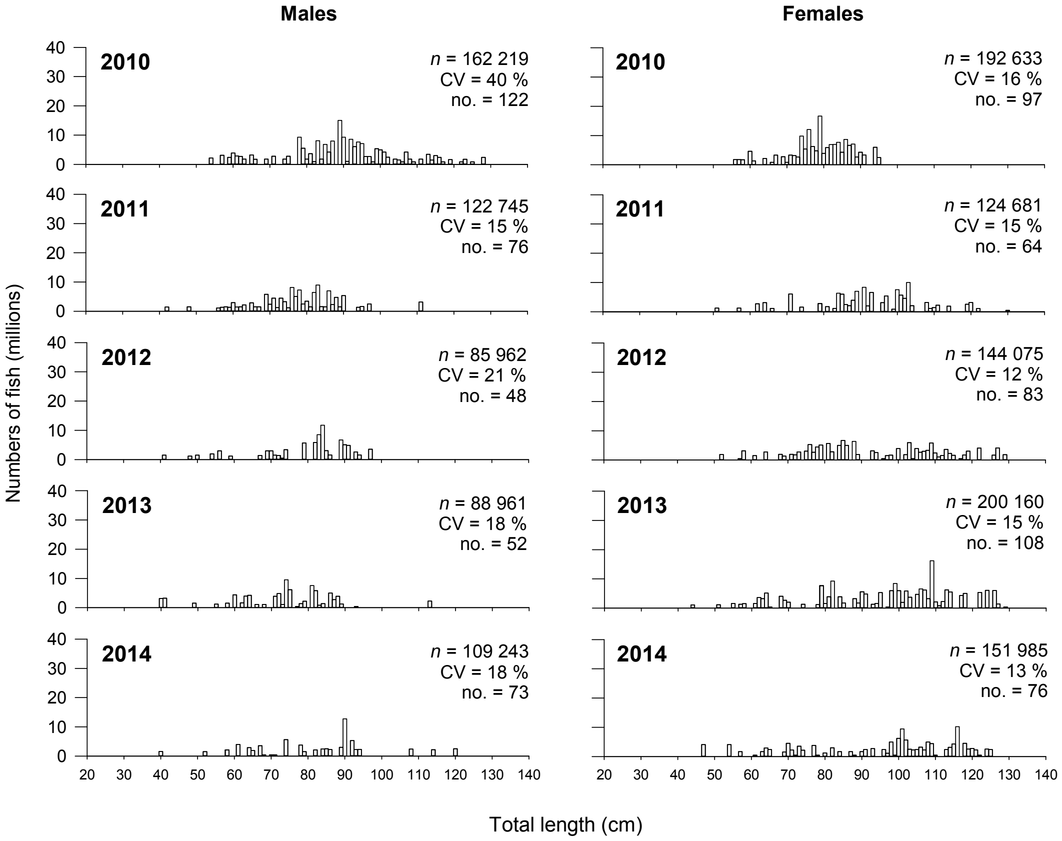

Figure 12 (continued)

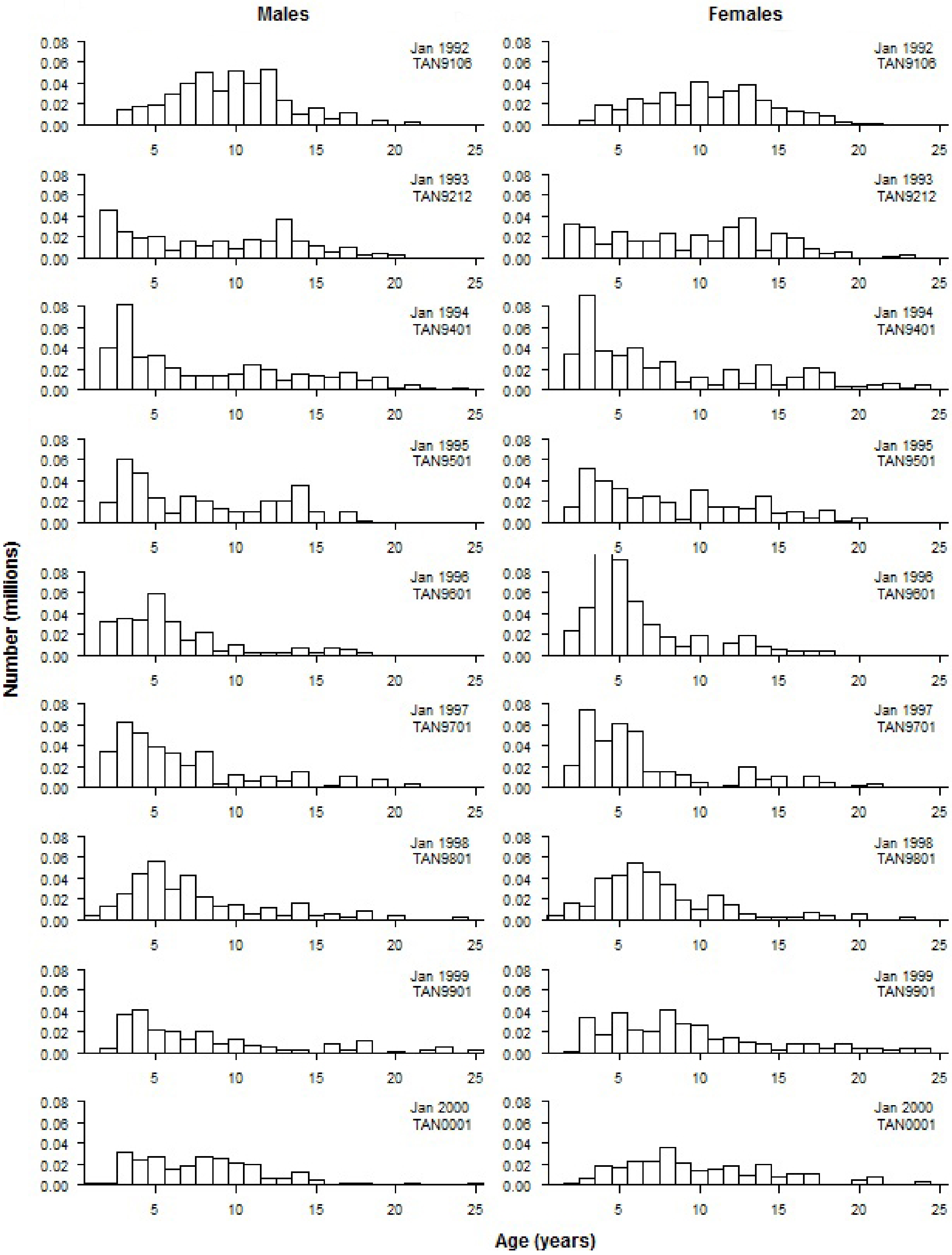

Figure 13: Estimated proportion at age for male and female hake from *Tangaroa* surveys of the Chatham Rise, January, 1992–2014.

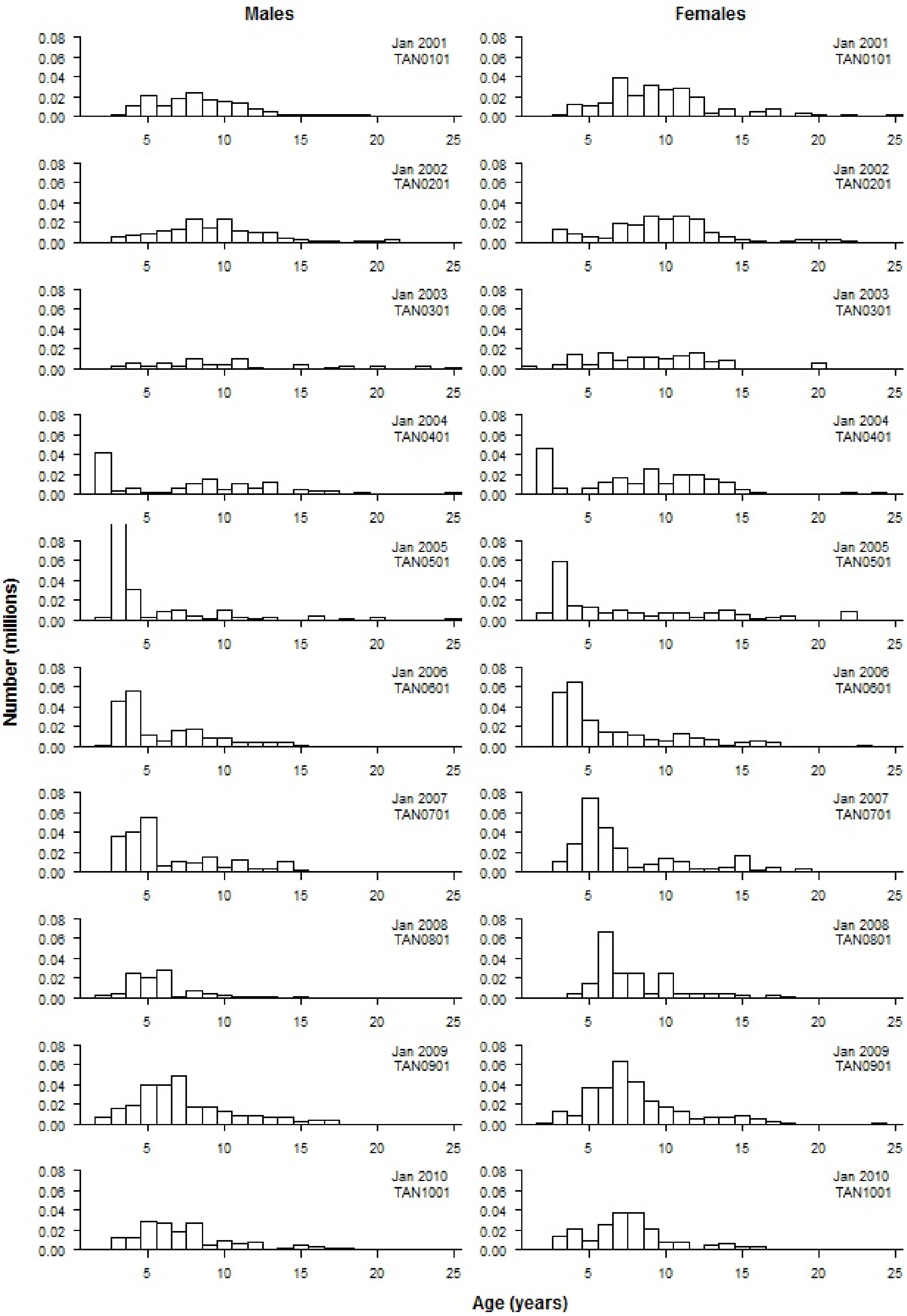

Figure 13 (continued)

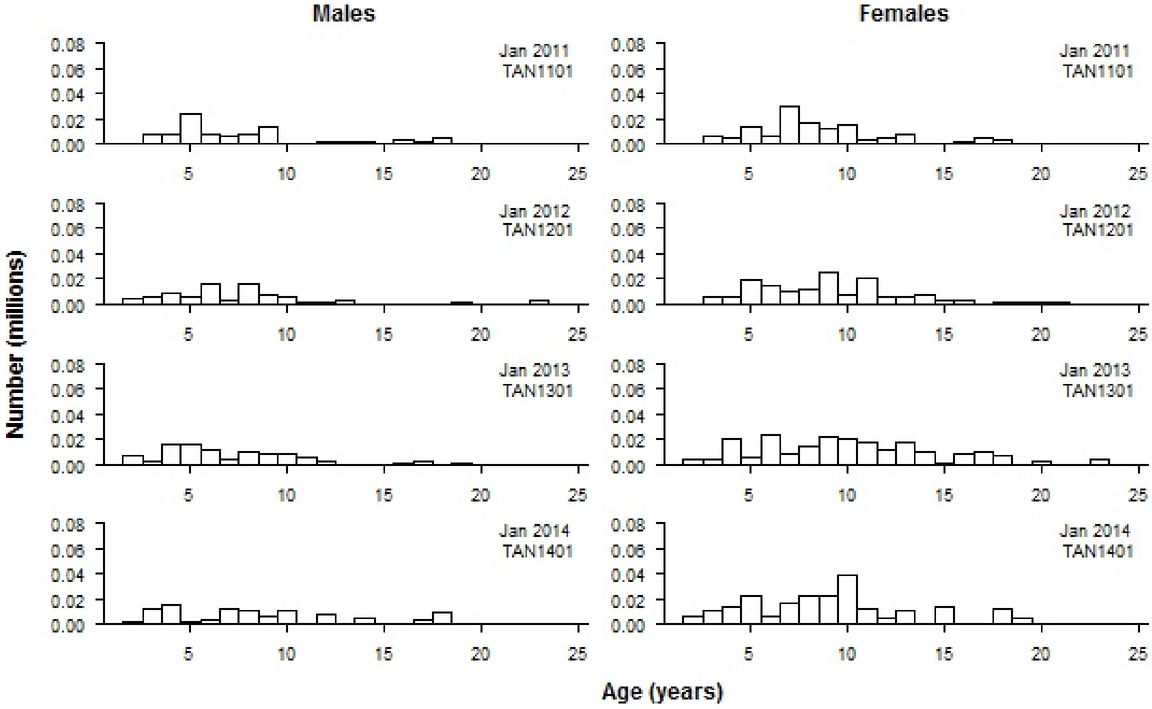

Figure 13 (continued)

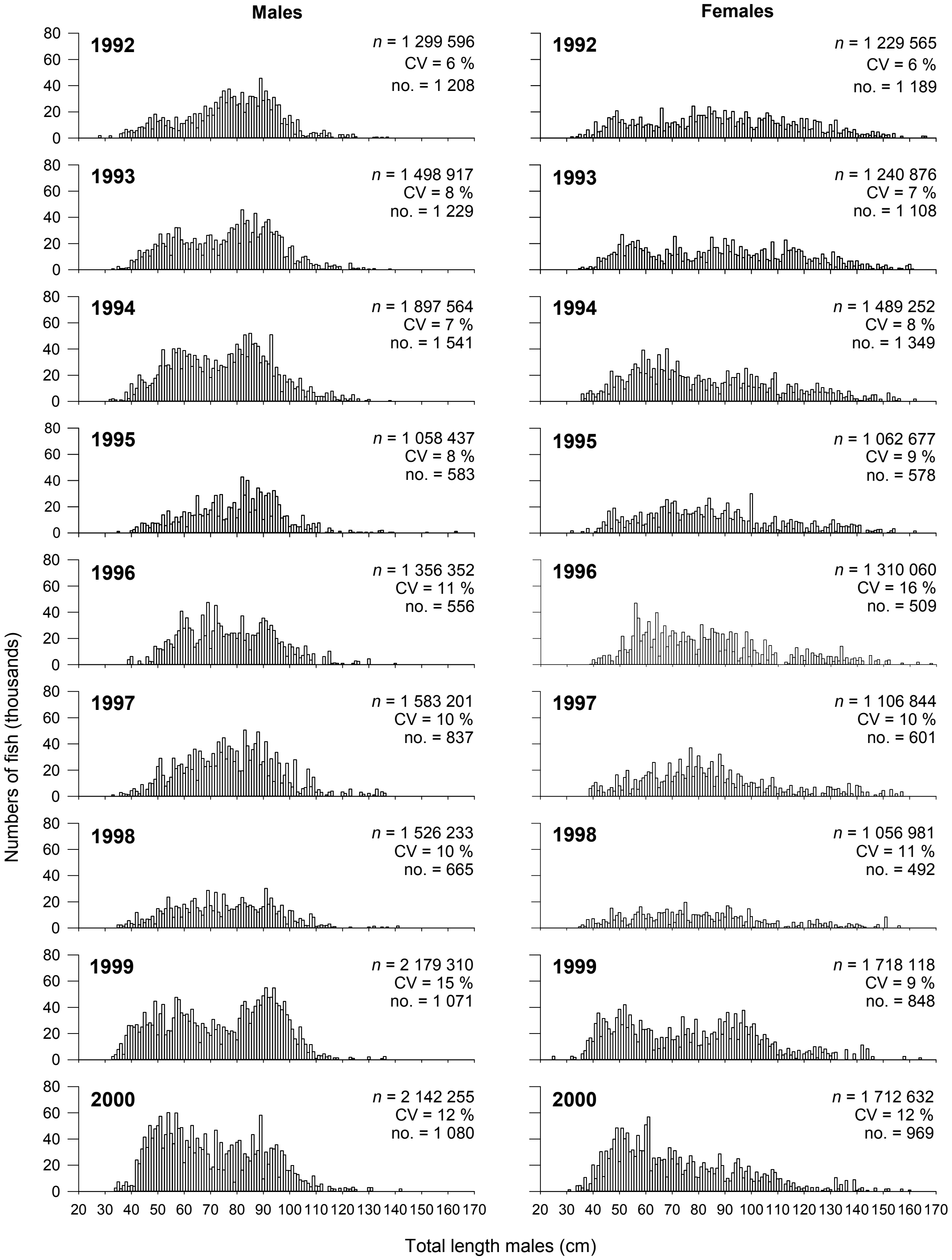

Figure 14: Estimated length frequency distributions of the ling population from *Tangaroa* surveys of the Chatham Rise, January 1992–2014. CV, coefficient of variation; *n,* estimated population number of ling; no., numbers of fish measured.

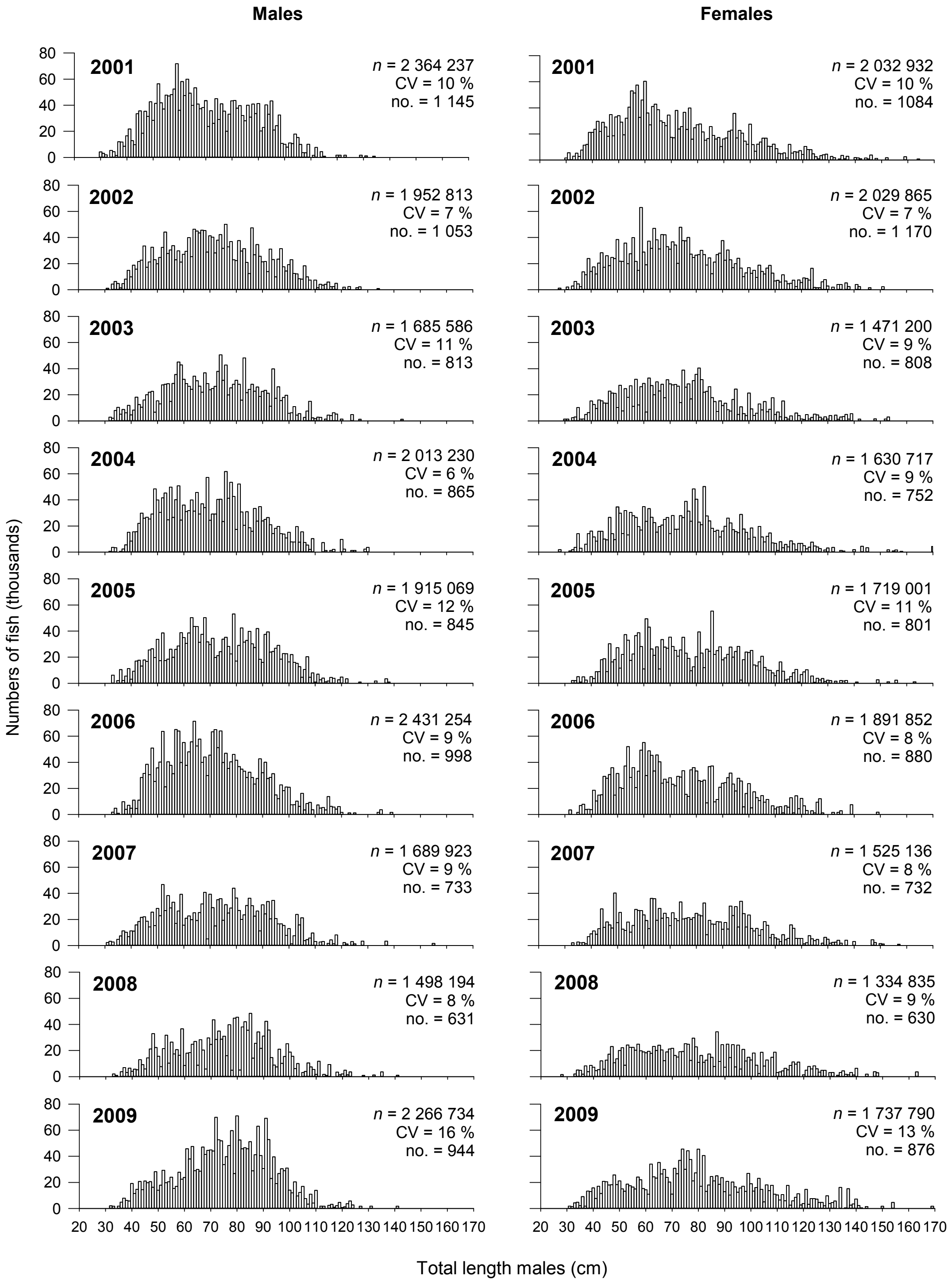

Figure 14 (continued)

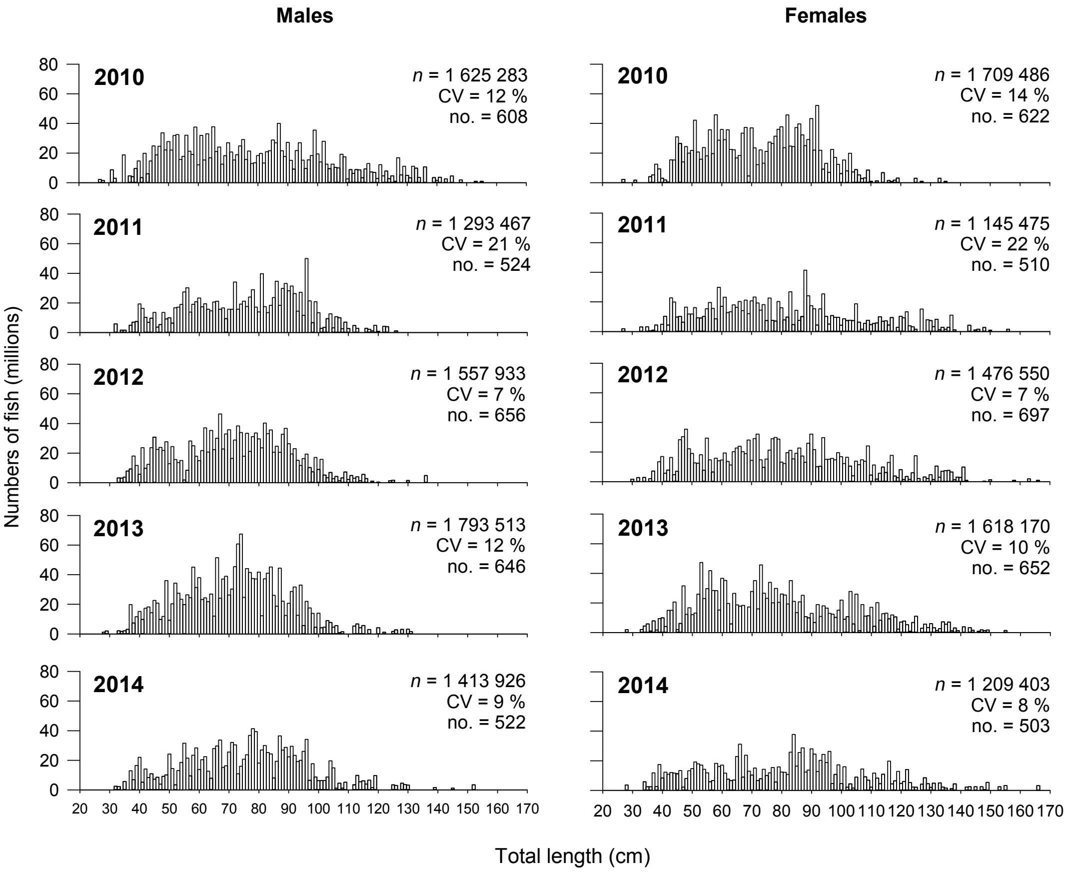

Figure 14 (continued)

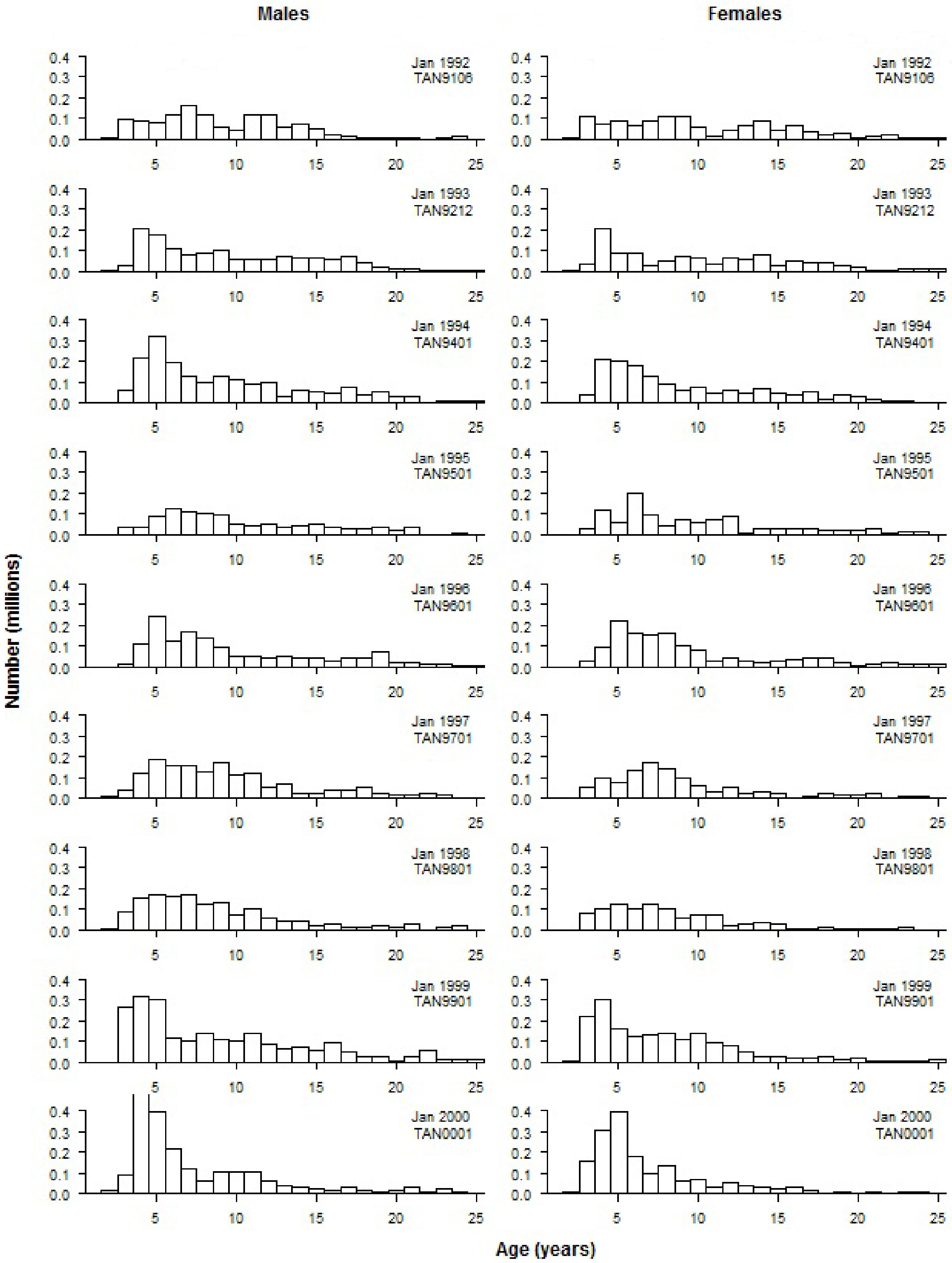

Figure 15: Estimated population numbers at age for male and female ling from *Tangaroa* surveys of the Chatham Rise, January, 1992–2014.

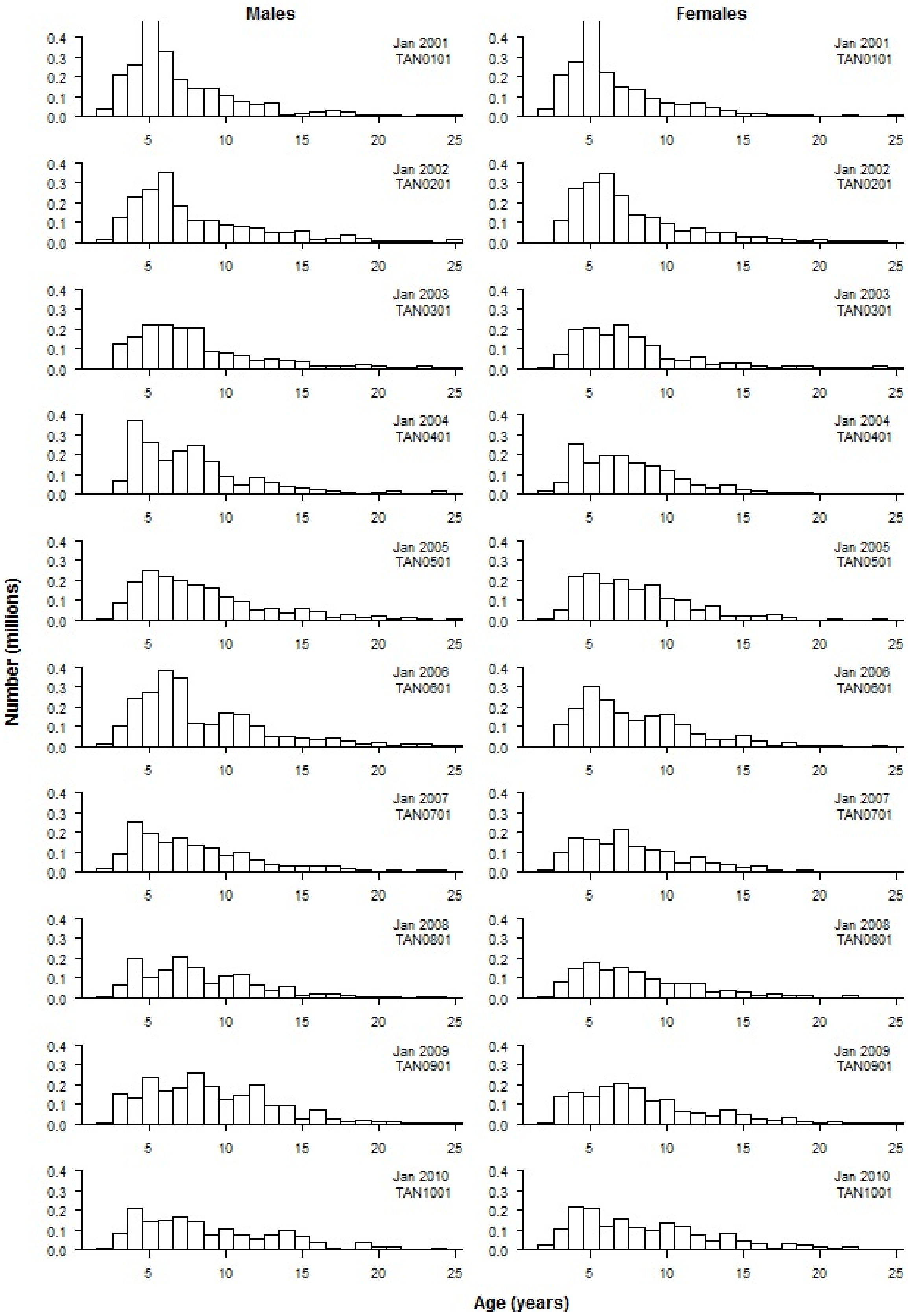

Figure 15 (continued)

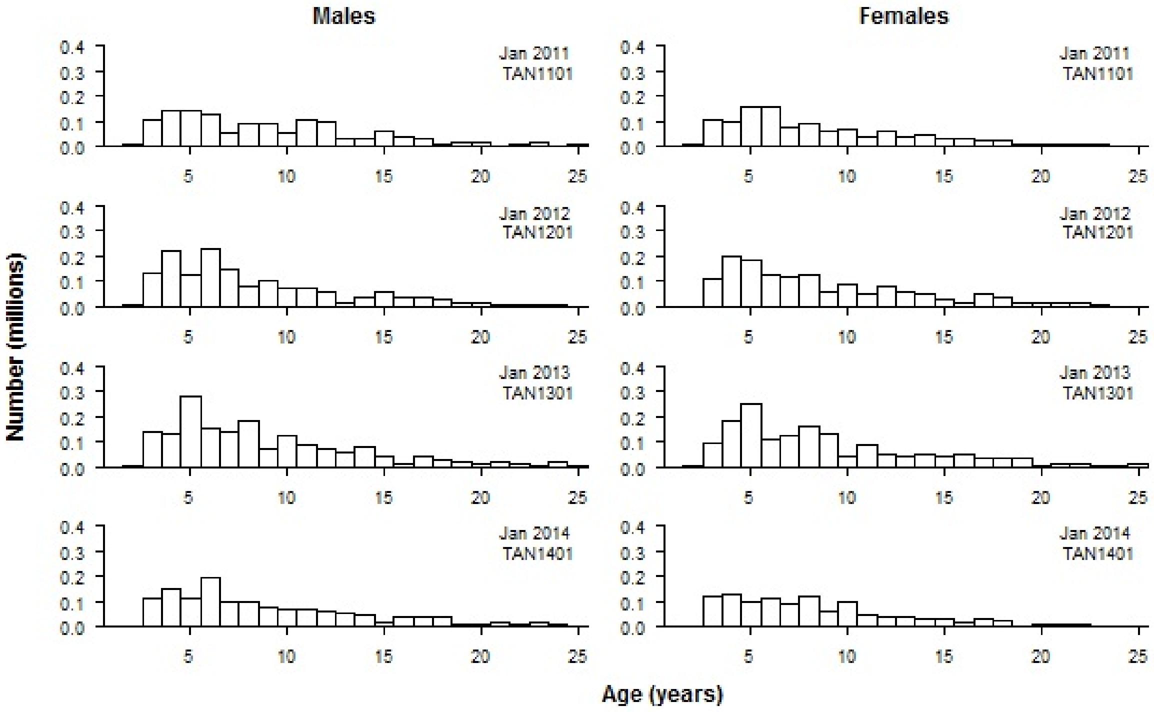

Figure 15 (continued)

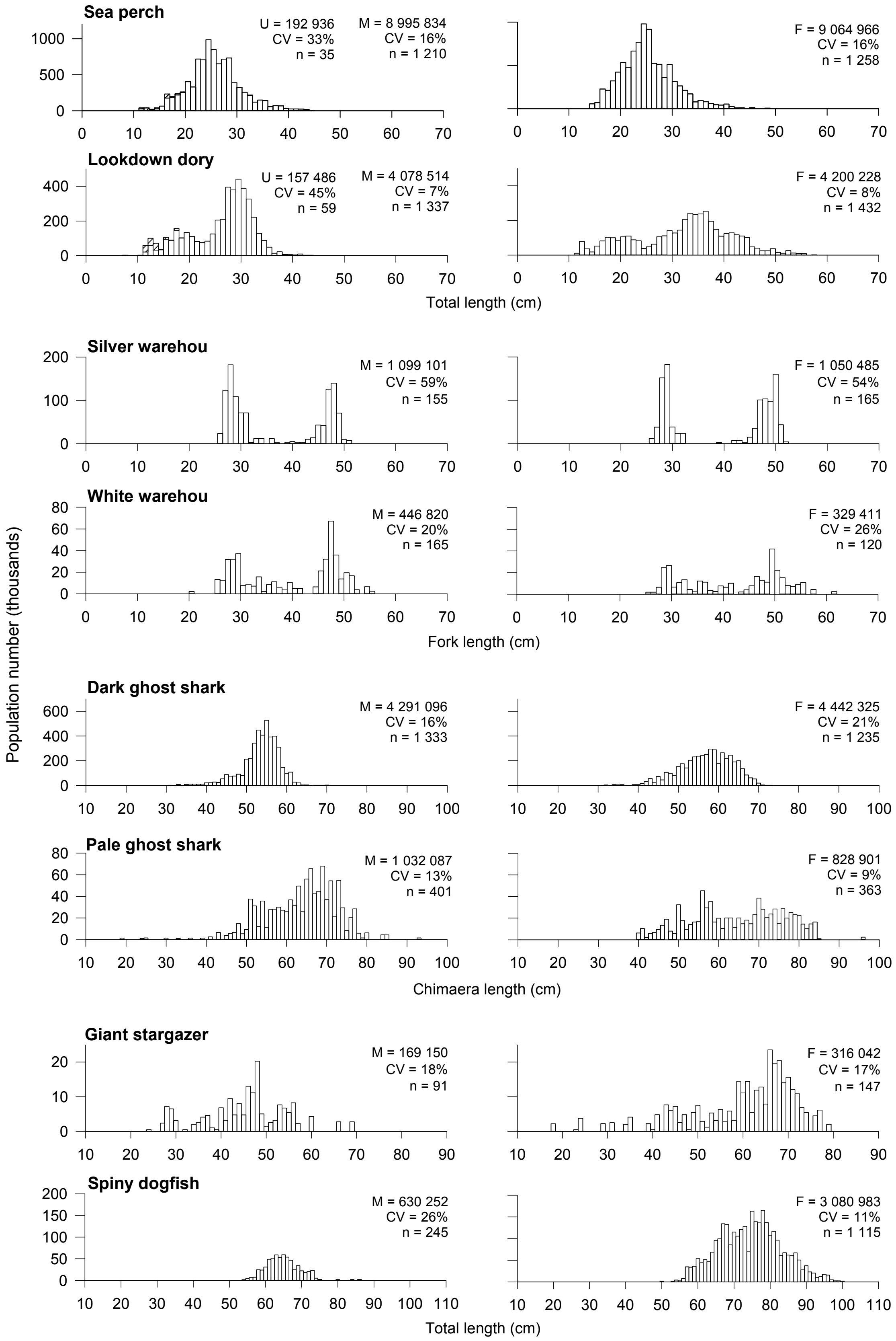

Figure 16a: Length frequencies of selected commercial species on the Chatham Rise 2014, scaled to population size by sex. M, estimated male population; F, estimated female population; U, estimated unsexed population (hatched bars); CV, coefficient of variation for the estimated numbers of fish; n, number of fish measured.

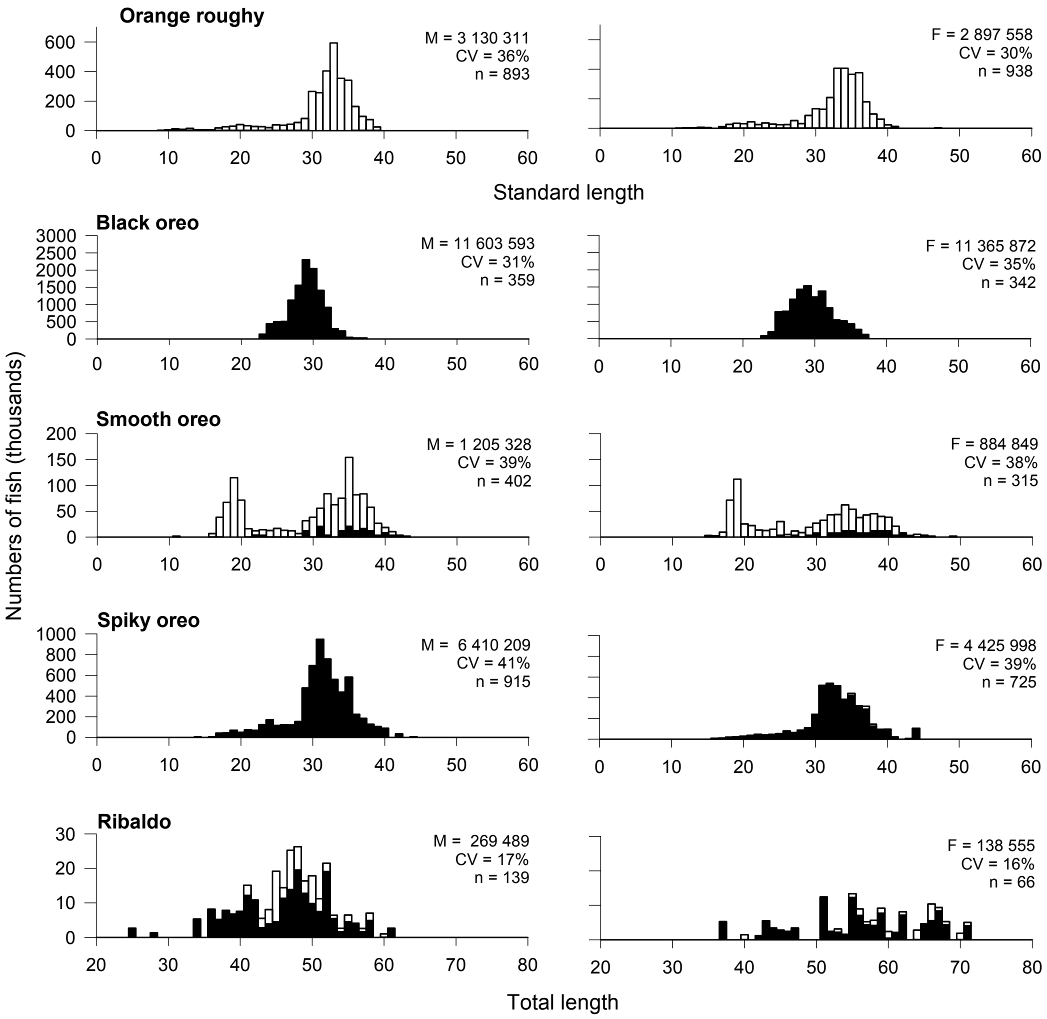

Figure 16b: Length frequencies of orange roughy, oreo species, and other selected deepwater species on the Chatham Rise 2014, scaled to population size by sex. M, estimated male population; F, estimated female population; CV, coefficient of variation of the estimated numbers of fish; n, number of fish measured. White bars show fish from all (200–1300 m) strata. Black bars show fish from core (200–800 m) strata.

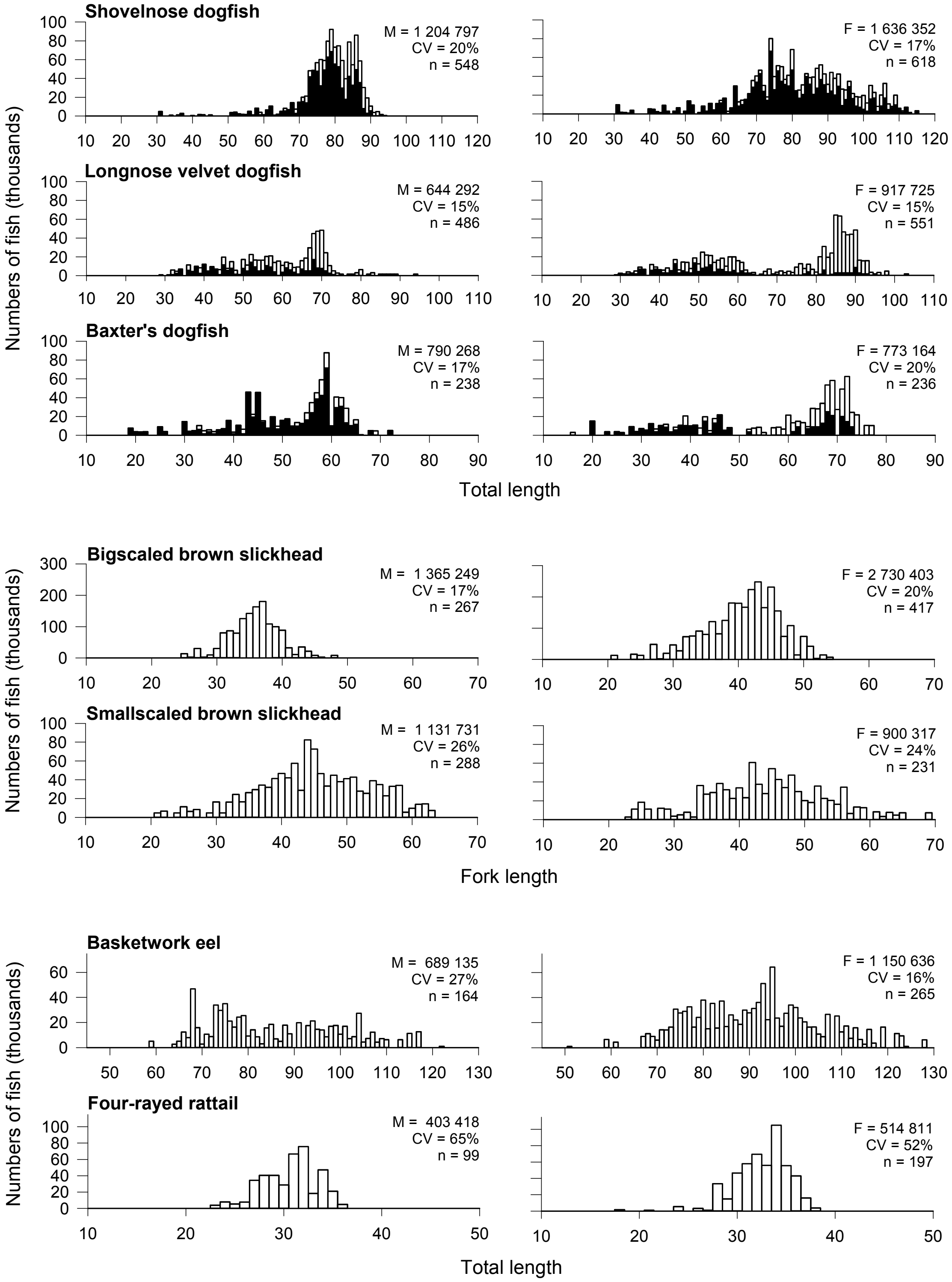

Figure 16b (continued)

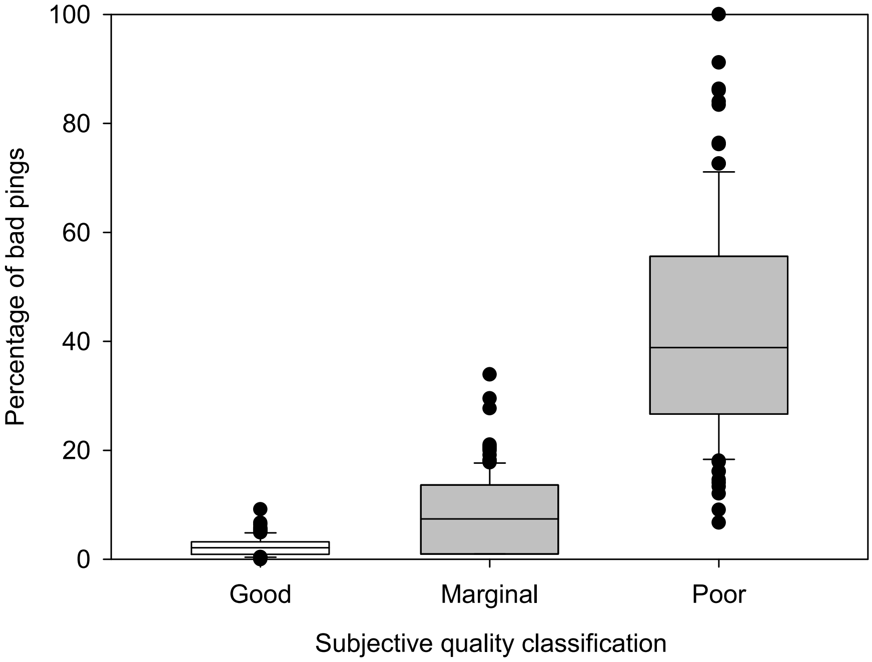

Figure 17: Percentage of bad pings in acoustic data from 2014 trawl survey subjectively classified as good, marginal, and poor. Only good and marginal data were analysed quantitatively.

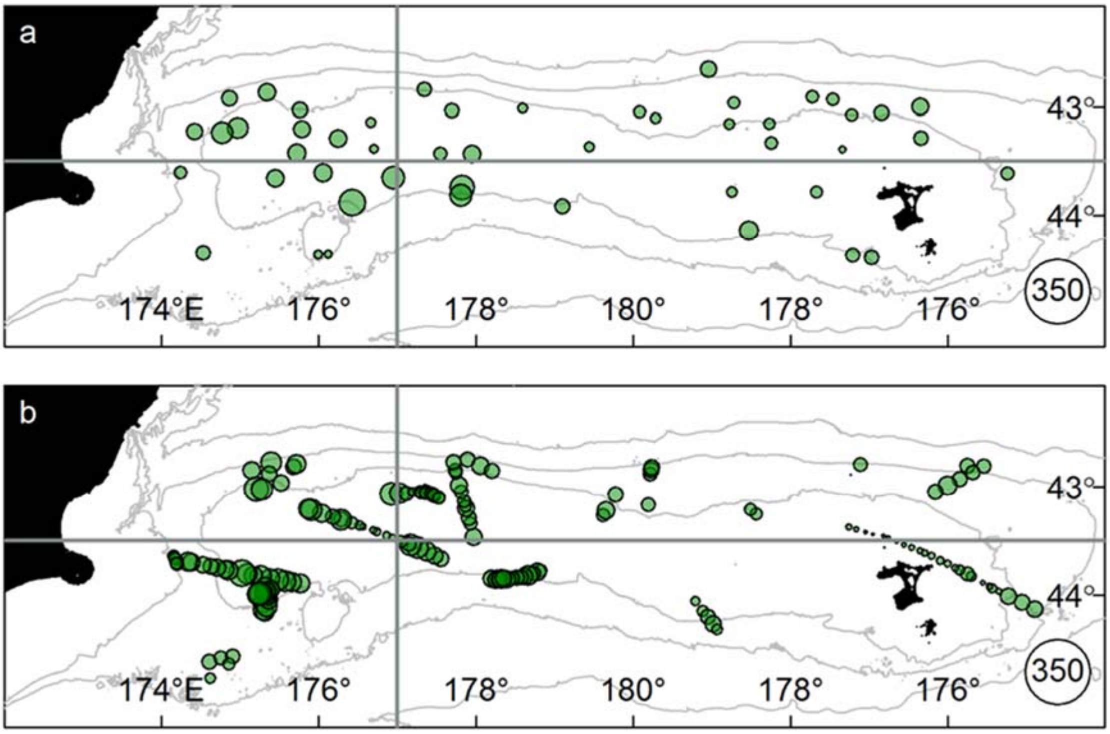

Figure 18: Distribution of total acoustic backscatter (green circles) observed on the Chatham Rise during daytime (a) trawls and night-time (b) steams in January 2014. Circle area is proportional to the acoustic backscatter (white circle on bottom right represents maximum symbol size in m^2 km^{-2} in the acoustic time series). Grey lines separate the four acoustic sub-area strata. Depth contours are at 500, 1000, and 1500 metres.

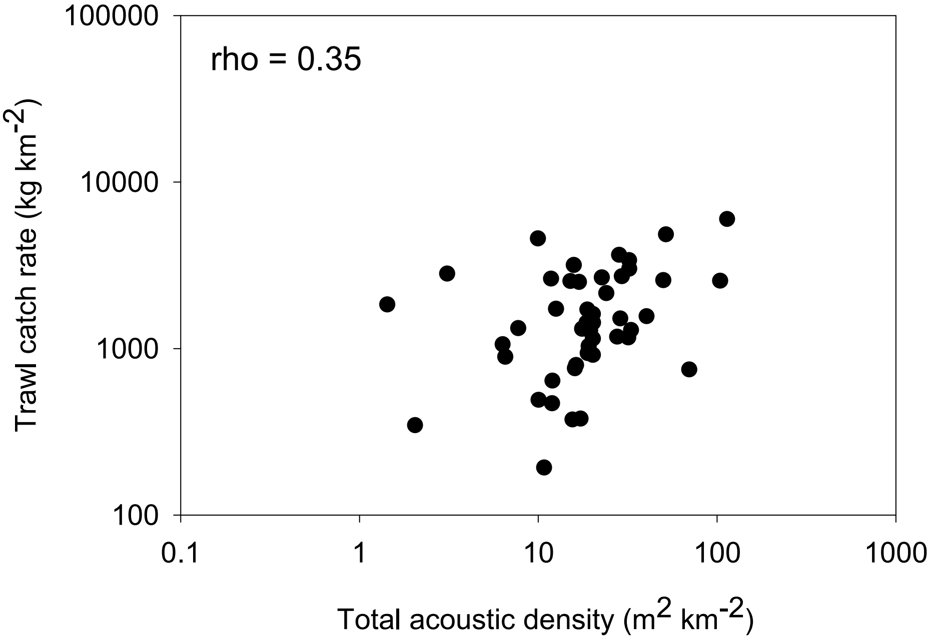

Figure 19: Relationship between total trawl catch rate (all species combined) and bottom-referenced acoustic backscatter recorded during the trawl on the Chatham Rise in 2014. Rho value is Spearman's rank correlation coefficient.

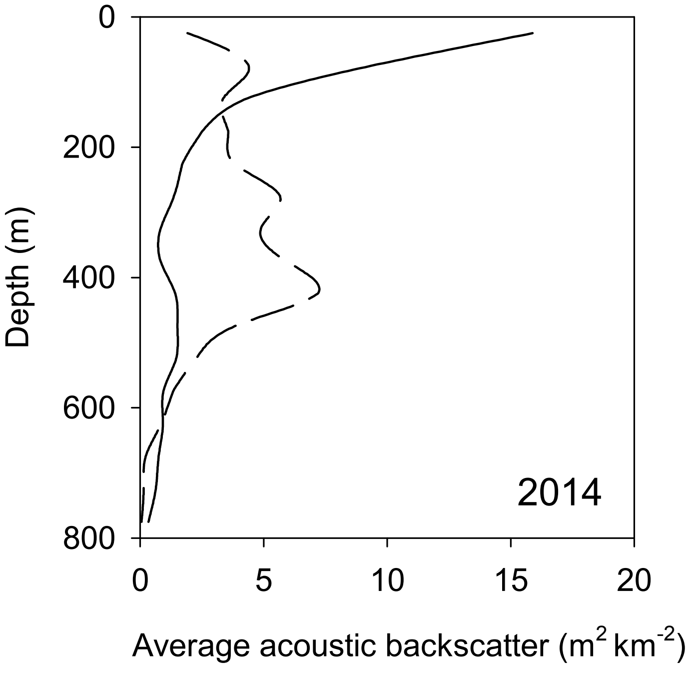

Figure 20: Vertical distribution of the average acoustic backscatter during the day (dashed lines) and at night (solid lines) for the Chatham Rise survey in 2014.

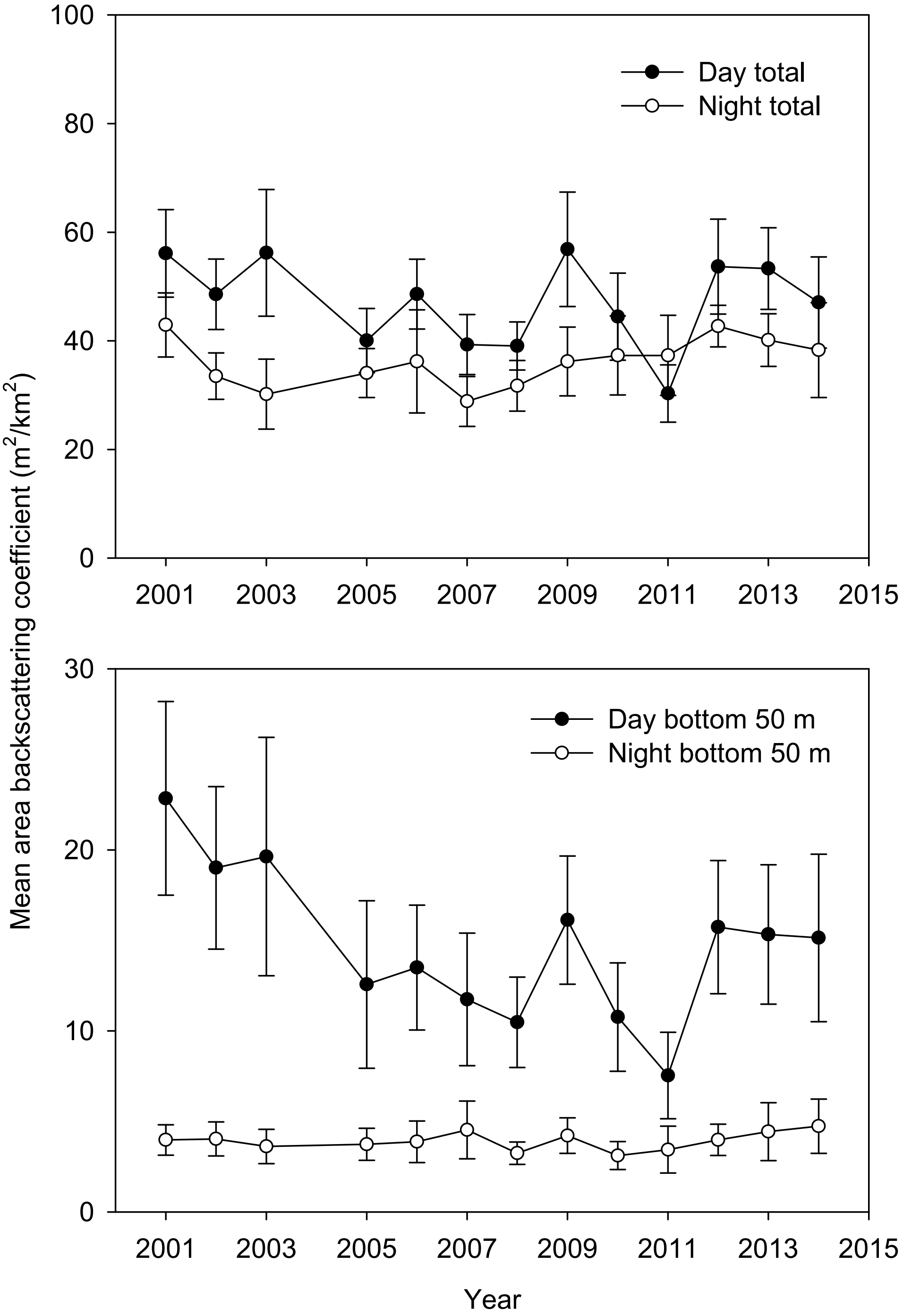

Figure 21: Comparison of relative acoustic abundance indices for the Chatham Rise based on (strata-averaged) mean areal backscatter. Error bars are ± 2 standard errors.

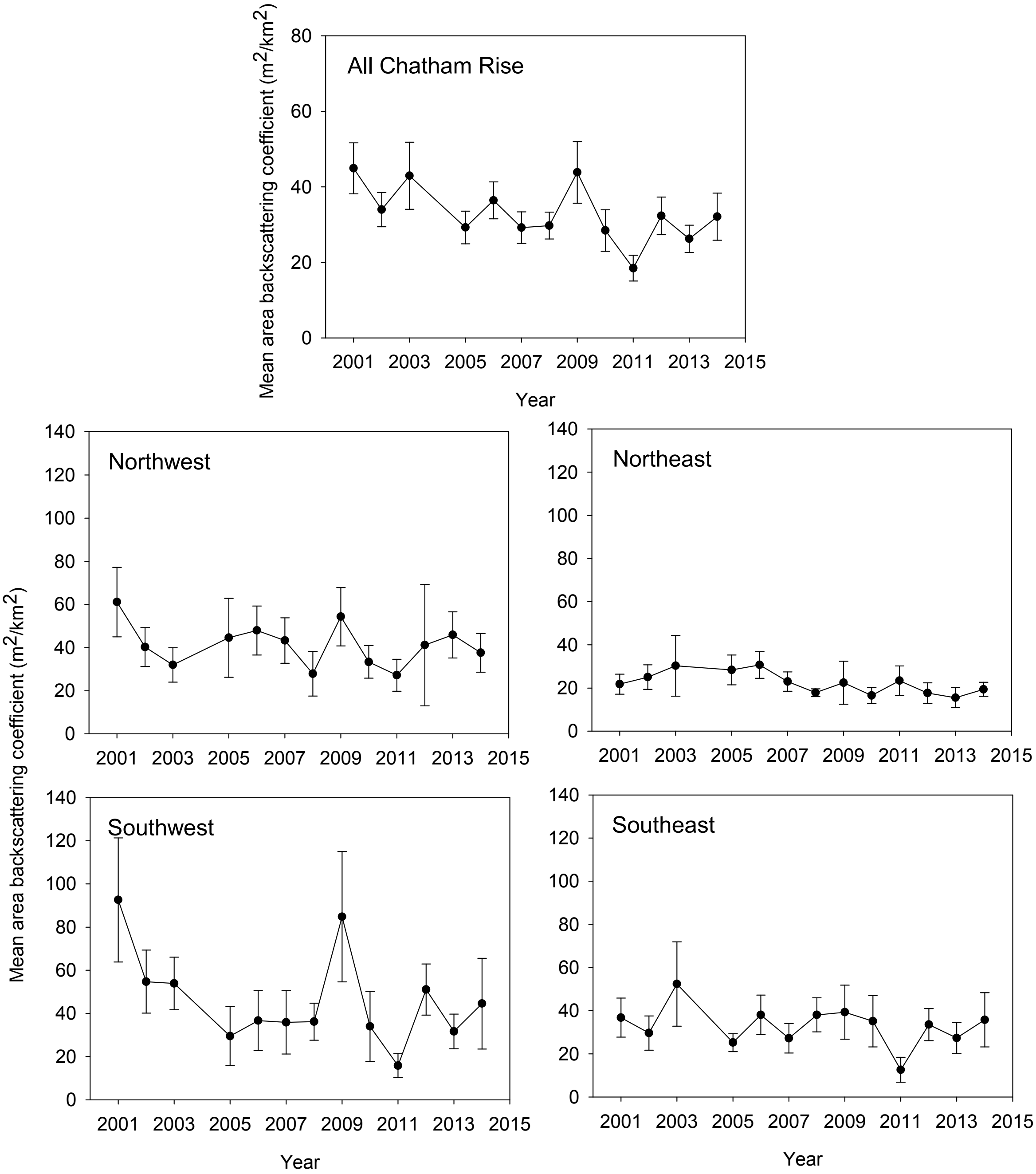

Figure 22: Relative acoustic abundance indices for mesopelagic fish on the Chatham Rise. Indices were derived by multiplying the total backscatter observed at each daytime trawl station by the estimated proportion of night-time backscatter in the same sub-area observed in the upper 200 m corrected for the estimated proportion in the surface deadzone. Panels show indices for the entire Chatham Rise and for four sub-areas (see Figure 18 for sub-area boundaries). Error bars are ± 2 standard errors.

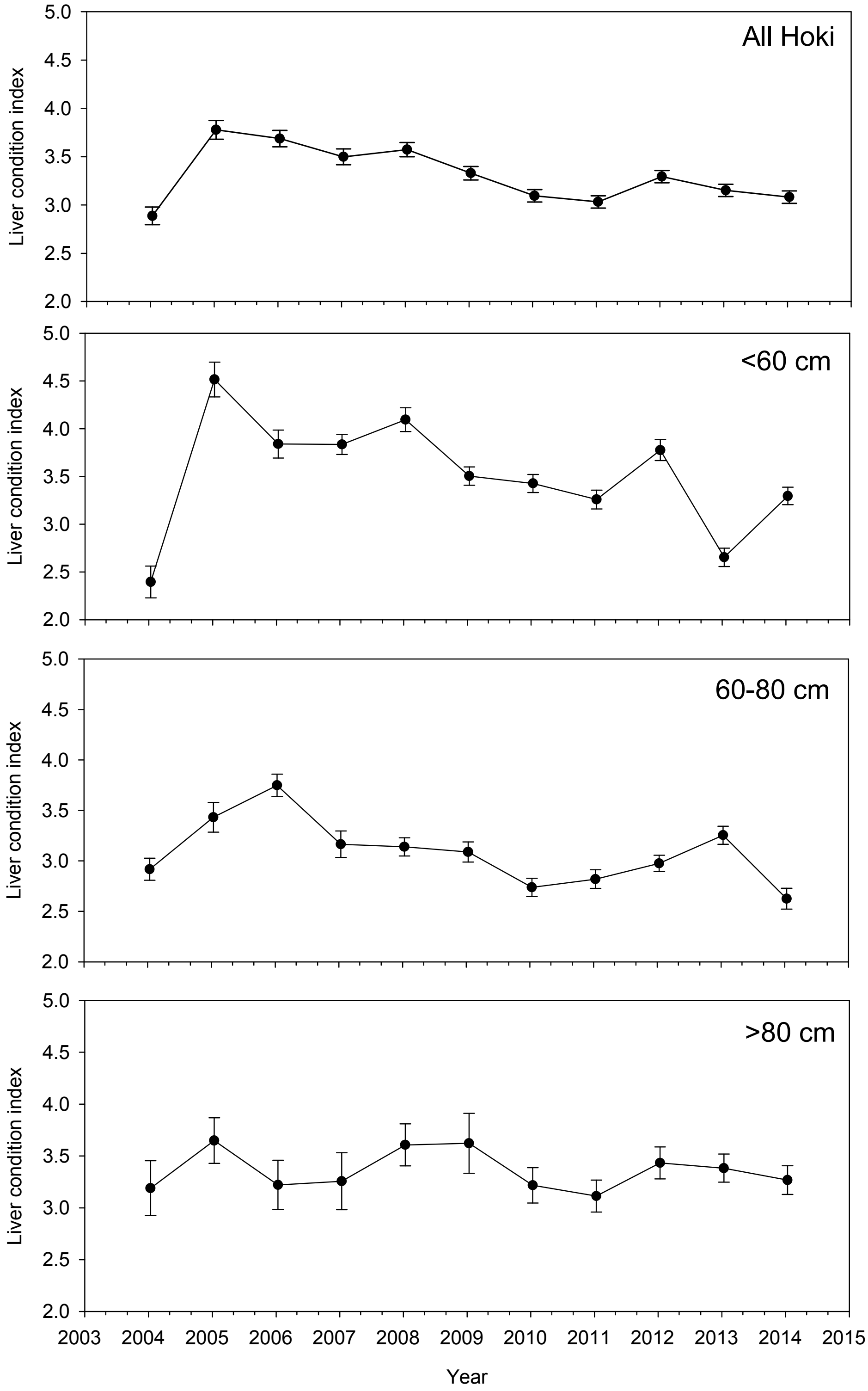

Figure 23: Time-series of hoki liver condition indices on the Chatham Rise from 2004–14. Data are plotted for all hoki, and for three different size classes (<60 cm, 60–80 cm, and >80 cm). Error bars show ± 2 standard errors.

Appendix 1: Individual station data for all stations conducted during the survey (TAN1401). Stn., station number; P1, phase 1 trawl survey biomass tow; P2, phase 2 trawl survey biomass tow; RN, fine-meshed midwater tow; MP, NIWA core-funded ratcatcher tow; Strat., Stratum number; *, foul trawl stations.

						Start tow		Gear	depth	Dist.			Catch
Stn.	Type	Strat.	Date	Time	Latitude	Longitude			m	Towed			kg
				NZST	° ' S	° '	E/W	min.	max.	n. mile	hoki	hake	ling
*1	P1	22	2-Jan-14	1910	42 44.88	175 37.49	E	892	927	3.01	253.3	14.5	0
2	P1	22	2-Jan-14	2227	42 44.14	176 02.69	E	805	820	3.10	446.4	35.2	33.7
3	P1	22	3-Jan-14	0142	42 40.91	176 21.43	E	880	887	2.98	64.5	0	0
4	P1	2A	3-Jan-14	0519	42 50.43	176 06.14	E	626	636	2.98	303.1	4.6	44.1
5	P1	8A	3-Jan-14	0905	42 52.84	176 21.98	E	498	524	2.25	135.7	1.7	21.1
6	P1	8A	3-Jan-14	1630	42 59.21	176 38.18	E	406	417	2.97	184.9	11.7	35.6
7	P1	22	3-Jan-14	2156	42 44.27	177 37.83	E	896	902	2.97	87.4	0	0
*8	P1	22	3-Jan-14	2356	42 44.41	177 47.67	E	850	855	0.18	0	0	0
*9	P1	22	4-Jan-14	0209	42 44.46	177 47.87	E	855	860	0.37	0	0	0
10	P1	2A	4-Jan-14	0558	42 45.81	177 20.13	E	736	756	3.00	224.4	0	25.9
11	P1	8A	4-Jan-14	0807	42 49.81	177 19.61	E	494	528	2.99	1 465.1	9.3	20.8
12	P1	20	4-Jan-14	1103	43 01.95	177 40.08	E	309	323	3.01	1 255.0	0	14.0
13	P1	20	4-Jan-14	1534	43 26.17	177 32.45	E	296	311	3.01	230.3	0	4.6
14	P1	20	4-Jan-14	1828	43 25.68	177 57.21	E	310	329	2.08	138.6	0	22.0
15	P1	22	5-Jan-14	0018	42 44.46	177 48.40	E	837	853	2.98	205.8	4.4	0
16	P1	8B	5-Jan-14	0501	42 54.98	178 23.04	E	532	539	2.99	594.7	18.1	52.8
17	P1	20	5-Jan-14	0701	43 00.55	178 34.42	E	384	396	3.01	284.3	0	16.7
18	P1	20	5-Jan-14	0855	43 04.19	178 44.97	E	382	393	3.01	655.4	10.7	40.8
19	P1	8B	5-Jan-14	1155	43 17.02	178 41.27	E	401	405	2.99	643.0	13.6	54.8
20	P1	8B	5-Jan-14	1617	43 15.29	179 18.01	E	428	438	2.25	206.8	3.0	9.2
21	P1	20	5-Jan-14	1810	43 21.53	179 26.19	E	387	398	3.03	359.6	11.2	63.8
22	P1	22	5-Jan-14	2354	42 52.31	179 46.45	E	860	867	3.01	81.6	0	0
23	P1	2A	6-Jan-14	0516	42 58.32	179 22.17	E	607	617	3.02	299.1	26.0	69.9
24	P1	10	6-Jan-14	0947	43 02.75	179 55.96	W	555	560	3.02	245.5	0	45.7
25	P1	10	6-Jan-14	1210	43 06.47	179 43.77	W	519	520	3.09	205.5	9.6	36.0
26	P1	10	6-Jan-14	1526	43 18.73	179 32.64	W	477	490	3.02	76.3	8.1	21.4
27	P1	10	6-Jan-14	1813	43 23.70	179 43.30	W	466	471	3.01	302.2	41.9	7.3
28	P1	23	6-Jan-14	2345	42 45.33	179 50.59	W	1064	1070	3.00	14.9	5.4	0
29	P1	23	7-Jan-14	0239	42 46.42	179 42.39	W	1016	1019	2.99	1.9	0	0
30	P1	21A	7-Jan-14	0523	42 49.55	179 25.68	W	813	815	3.01	86.8	8.0	0
31	P1	11	7-Jan-14	0927	42 57.27	178 44.13	W	525	529	3.00	140.0	19.8	6.5
32	P1	11	7-Jan-14	1158	43 08.25	178 46.18	W	487	497	3.04	81.2	3.0	2.8
33	P1	11	7-Jan-14	1542	43 09.03	178 16.88	W	474	491	3.00	99.4	17.0	20.3
34	P1	9	7-Jan-14	1749	43 19.10	178 14.18	W	375	384	3.02	126.9	0	66.5
35	P1	21A	8-Jan-14	0204	42 47.27	179 17.44	W	838	851	2.99	48.4	0	0
36	P1	21A	8-Jan-14	0419	42 44.03	179 05.57	W	919	923	2.99	50.6	12.9	0
37	P1	23	8-Jan-14	0716	42 39.07	179 01.89	W	1162	1169	2.22	0	0	0
38	P1	23	8-Jan-14	1021	42 37.32	178 45.70	W	1090	1271	3.03	0	0	0
39	P1	2B	8-Jan-14	1619	42 54.25	177 43.76	W	610	616	2.98	275.9	55.3	5.7
40	P1	2B	8-Jan-14	1828	42 55.89	177 28.44	W	618	621	3.00	499.2	9.6	1.4
41	P1	24	8-Jan-14	2150	42 42.00	177 18.06	W	1265	1284	3.01	0	0	0
42	P1	21B	9-Jan-14	0125	42 47.98	177 12.03	W	922	932	3.08	182.6	0	0
43	P1	11	9-Jan-14	0507	42 59.00	177 21.05	W	533	573	3.00	357.9	3.6	16.7
44	P1	11	9-Jan-14	0708	43 04.09	177 14.39	W	485	496	3.01	687.8	0	18.0

Appendix 1: ***continued***

						Start tow		Gear	depth	Dist.			Catch
Stn.	Type	Strat.	Date	Time	Latitude	Longitude			m	towed			kg
				NZST	° ' S	° '	E/W	min.	max.	n. mile	hoki	hake	ling
45	P1	11	9-Jan-14	0950	43 02.98	176 51.33	W	502	534	3.01	764.8	29.8	57.1
46	P1	11	9-Jan-14	1226	43 07.06	176 36.64	W	449	493	3.05	636.9	6.0	21.2
47	P1	2B	9-Jan-14	1503	42 59.88	176 21.52	W	653	655	3.00	222.8	4.2	49.1
48	P1	9	9-Jan-14	1826	43 16.94	176 22.04	W	385	389	3.09	399.7	0	7.0
49	P1	24	10-Jan-14	0001	42 48.39	175 38.56	W	1120	1125	3.00	6.9	0	0
50	P1	2B	10-Jan-14	0506	43 04.28	176 07.29	W	608	612	3.01	260.9	23.4	4.0
51	P1	12	10-Jan-14	1111	43 37.12	175 14.83	W	557	569	3.00	402.0	0	91.2
52	P1	2B	10-Jan-14	1459	43 16.47	175 01.09	W	746	754	3.03	123.1	4.7	10.5
53	P1	21B	10-Jan-14	1943	43 06.08	174 43.96	W	871	872	3.01	10.6	0	0
54	P1	21B	10-Jan-14	2309	43 14.22	174 35.08	W	838	853	3.06	40.6	0	6.7
55	P1	24	11-Jan-14	0418	43 06.83	173 54.38	W	1195	1205	3.03	0	0	0
56	P1	25	11-Jan-14	1110	43 47.54	174 32.14	W	810	811	2.99	75.4	0	0
57	P1	4	11-Jan-14	1451	43 50.61	174 58.72	W	655	698	2.97	180.3	0	25.5
58	P1	25	11-Jan-14	1802	44 06.03	174 49.70	W	836	840	3.00	24.5	0	10.3
59	P1	9	12-Jan-14	0554	43 23.22	177 20.17	W	231	238	2.16	105.5	0	6.9
60	P1	5	12-Jan-14	0924	43 46.86	177 41.56	W	383	386	3.01	375.4	0	70.8
61	P1	12	12-Jan-14	1411	44 22.04	177 13.42	W	525	527	3.02	1 377.7	0	109.6
62	P1	12	12-Jan-14	1613	44 23.17	176 59.21	W	446	479	3.01	732.5	12.1	112.7
63	P1	28	12-Jan-14	2034	44 42.10	177 20.01	W	1114	1140	3.01	0	0	0
64	P1	25	13-Jan-14	0231	44 31.63	177 57.47	W	925	949	3.06	24.3	3.4	0
65	P1	13	13-Jan-14	0713	44 03.21	178 01.56	W	462	469	2.12	1 091.7	22.1	88.4
66	P1	5	13-Jan-14	1039	43 42.98	178 02.75	W	368	371	3.03	384.0	0	41.5
67	P1	5	13-Jan-14	1439	43 31.55	178 01.47	W	354	362	3.04	294.4	0	62.4
68	P1	25	13-Jan-14	2315	44 26.09	178 00.16	W	842	846	3.02	52.4	0	3.4
69	P1	25	14-Jan-14	0246	44 24.58	178 23.67	W	882	921	2.12	94.2	7.9	0
70	P1	13	14-Jan-14	0559	44 08.65	178 31.68	W	455	473	2.20	1 179.6	12.0	32.1
71	P1	13	14-Jan-14	0911	43 47.30	178 44.46	W	414	434	2.05	240.2	8.4	44.0
72	P1	3	14-Jan-14	1315	43 35.94	179 23.29	W	378	380	2.27	847.4	11.6	41.2
73	P1	3	14-Jan-14	1618	43 51.29	179 25.35	W	284	298	2.56	107.3	0	0
74	P1	3	14-Jan-14	1844	44 01.15	179 10.57	W	268	283	2.25	45.7	0	2.6
75	P1	28	15-Jan-14	0019	44 34.99	178 47.89	W	1211	1222	2.20	0	0	0
76	P1	28	15-Jan-14	0329	44 31.55	179 00.81	W	1108	1129	3.01	3.5	0	0
77	P1	4	15-Jan-14	0905	44 10.37	179 53.00	W	625	630	3.04	560.5	13.4	24.1
78	P1	4	15-Jan-14	1200	44 10.10	179 48.82	E	714	716	3.00	103.5	0	11.9
79	P1	14	15-Jan-14	1648	43 55.15	179 06.25	E	519	529	2.29	371.9	1.8	65.7
80	P1	14	15-Jan-14	1835	43 47.49	179 04.45	E	448	454	2.21	188.3	0	26.1
81	P1	14	16-Jan-14	0502	43 51.02	178 15.79	E	533	539	3.02	299.7	1.8	28.0
82	P1	15	16-Jan-14	0958	43 46.99	177 20.27	E	500	510	3.01	289.2	0	72.3
83	P1	15	16-Jan-14	1310	43 39.09	176 56.63	E	422	433	3.01	2 049.4	10.7	30.5
84	P1	15	16-Jan-14	1644	43 52.50	176 25.47	E	490	507	2.53	1 009.8	0	98.1
85	P1	16	18-Jan-14	0503	44 25.21	173 22.11	E	473	537	3.04	436.2	0	12.3
86	P1	6	18-Jan-14	1002	44 17.09	174 15.67	E	624	651	2.99	481.7	0	19.1
87	P1	16	18-Jan-14	1324	44 03.64	174 15.03	E	540	556	3.00	389.3	14.5	73.0
88	P1	6	18-Jan-14	1713	44 20.67	174 30.82	E	645	650	3.01	201.9	0	33.3
89	RN		18-Jan-14	2121	44 44.65	174 39.56	E	100	807	1.81	0	0	0
90	RN		18-Jan-14	2304	44 42.58	174 36.95	E	80	827	1.81	1.0	0	0

Appendix 1: ***continued***

			Start tow					Gear depth		Dist.	Catch		
Stn.	Type	Strat.	Date	Time	Latitude	Longitude			m	towed			kg
				NZST	º ' S	º '	E/W	min.	max.	n. mile	hoki	hake	ling
91	RN		19-Jan-14	0058	44 38.39	174 36.60	E	77	792	1.76	0	0	0
92	P1	6	19-Jan-14	0509	44 34.47	174 53.28	E	726	769	3.01	47.9	0	27.1
93	P1	17	19-Jan-14	1045	44 21.74	176 05.92	E	318	331	3.03	7.8	0	0
94	P1	17	19-Jan-14	1256	44 22.06	176 00.94	E	274	278	3.03	0	0	1.3
95	P1	17	19-Jan-14	1607	44 04.83	176 04.11	E	339	358	2.82	227.9	0	0.5
96	P1	16	19-Jan-14	1820	43 54.99	175 59.09	E	516	546	3.00	670.5	7.9	81.5
97	P1	7A	20-Jan-14	0500	43 39.23	174 09.87	E	464	487	3.00	567.0	0	8.5
98	P1	7A	20-Jan-14	0657	43 36.96	174 13.75	E	509	532	3.00	617.0	0	18.8
99	P1	18	20-Jan-14	1136	43 12.54	174 57.58	E	207	217	2.20	0.9	0	0
100	P1	7A	20-Jan-14	1351	43 14.81	174 47.07	E	420	441	3.08	1 974.9	7.1	43.8
101	P1	22	20-Jan-14	2129	42 46.77	175 39.83	E	826	830	3.02	257.0	1.7	0
102	P1	22	20-Jan-14	2337	42 45.93	175 29.05	E	886	889	3.01	228.0	17.2	0
103	P1	22	21-Jan-14	0204	42 49.50	175 14.30	E	823	832	3.05	54.5	2.0	0
104	P1	1	21-Jan-14	0509	42 52.89	175 27.82	E	625	637	3.04	102.7	13.1	104.2
105	P1	1	21-Jan-14	0726	42 51.72	175 21.28	E	674	687	3.01	105.7	3.8	6.1
106	P1	1	21-Jan-14	1040	42 55.00	174 52.24	E	728	744	3.04	134	3.3	8.9
107	P1	7A	21-Jan-14	1421	43 13.36	174 25.85	E	556	572	3.01	327.9	11.3	65.0
108	P1	22	21-Jan-14	1751	43 04.97	174 01.96	E	806	857	3.02	55.9	13.8	18.2
109	P1	22	21-Jan-14	2030	42 59.27	174 13.36	E	976	979	3.02	16.8	1.2	0
110	P1	22	21-Jan-14	2338	42 56.05	174 34.14	E	902	918	3.02	24.7	15.3	0
111	P1	18	22-Jan-14	0506	43 01.41	175 20.82	E	334	354	3.02	1 228.5	3.2	22.9
112	P1	7B	22-Jan-14	0750	42 57.90	175 45.60	E	550	554	3.02	212.4	3.1	29.4
113	P1	7B	22-Jan-14	1010	43 01.12	175 44.57	E	492	503	3.02	411.1	30.4	67.7
114	P1	7B	22-Jan-14	1250	43 12.00	175 46.10	E	434	440	3.06	1 305.3	61.9	113.8
115	P1	18	22-Jan-14	1525	43 24.86	175 43.44	E	278	288	2.27	1 742.3	13.1	0
116	P1	18	22-Jan-14	1804	43 39.73	175 27.76	E	304	306	2.16	235.3	0	23.6
117	RN	2	22-Jan-14	2150	44 06.81	175 17.02	E	79	500	1.05	6.7	0	0
118	P1	16	23-Jan-14	0503	43 58.32	175 18.50	E	462	466	3.00	248.8	4.3	53.9
119	P1	19	23-Jan-14	0937	43 36.34	176 02.35	E	343	353	3.01	1 874.2	0	0.7
120	P1	19	23-Jan-14	1251	43 17.86	176 13.81	E	311	332	3.01	522.1	0	6.7
121	P1	19	23-Jan-14	1541	43 23.36	176 40.99	E	247	259	2.57	0	0	0
122	P1	19	23-Jan-14	1811	43 09.64	176 40.19	E	299	327	3.02	126.7	0	21.9
123	P1	19	24-Jan-14	0506	43 04.97	177 29.71	E	309	325	2.76	304.9	0	25.6
124	P1	19	24-Jan-14	0641	43 01.55	177 22.07	E	298	311	3.01	88.5	0	36.4
125	P2	15	24-Jan-14	1407	43 44.82	177 49.02	E	465	469	2.50	2 066.7	0	50.8
*126	P2	15	24-Jan-14	1645	43 48.78	177 42.83	E	503	535	2.68	187.1	0	33.9
127	P2	15	24-Jan-14	1827	43 49.48	177 47.90	E	494	528	3.00	1 198.3	0	102.5
128	MP		25-Jan-14	1159	43 15.05	174 46.01	E	429	436	1.05	672.1	17.9	17.9
129	MP		25-Jan-14	1437	43 13.90	174 43.78	E	446	456	1.02	340.1	22.0	22.5
130	MP		25-Jan-14	1818	42 56.52	174 33.83	E	893	898	0.77	2.6	9.0	0
131	MP		25-Jan-14	2140	42 55.24	174 36.95	E	908	911	0.99	15.7	13.1	0
132	MP		26-Jan-14	0744	43 15.71	174 24.48	E	563	575	0.97	89.3	0	59.2
133	MP		26-Jan-14	1010	43 14.21	174 25.85	E	559	568	0.99	126.8	3.9	17.2
134	MP		26-Jan-14	2008	43 15.21	174 23.33	E	568	576	0.94	21.9	0	53.7
135	MP		26-Jan-14	2321	43 13.76	174 46.55	E	430	437	0.91	152.2	6.4	19.9
136	MP		27-Jan-14	0531	42 55.48	174 34.02	E	935	939	0.96	0	6.3	0
137	MP		27-Jan-14	0817	42 54.62	174 35.83	E	948	953	0.92	0	16.5	0

Appendix 2: Scientific and common names of species caught from all valid biomass tows (TAN1401). The occurrence (Occ.) of each species (number of tows caught) in the 119 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	1
Phaeophyceae (brown seaweed)	unspecified brown sea weed	PHA	4
Laminariaceae			
Macrocystis pyrifera	bladder kelp	KBB	3
Porifera	unspecified sponges	ONG	3
Demospongiae (siliceous sponges)			
Astrophorida (sandpaper sponges)			
Ancorinidae			
Ecionemia novaezelandiae	knobbly sandpaper sponge	ANZ	6
Geodiidae			
Pachymatisma sp.	rocky dumpling sponge	PAZ	1
Hadromerida (woody sponges)			
Suberitidae			
Suberites affinis	fleshy club sponge	SUA	6
Haplosclerida (air sponges)			
Callyspongiidae			
Callyspongia sp.	airy finger sponge	CRM	1
Hexactinellida (glass sponges)			
Lyssacinosida (tubular sponges)			
Rossellidae			
Hyalascus sp.	floppy tubular sponge	HYA	23
Poecilosclerida (bright sponges)			
Coelosphaeridae			
Lissodendoryx bifacialis	floppy chocolate plate sponge	LBI	1
Crellidae			
Crella incrustans	orange frond sponge	CIC	1
Cnidaria			
Coral (Hydrozoan + Anthozoan corals)	unspecified coral	COU	2
Scyphozoa	unspecified jellyfish	JFI	16
Anthozoa			
Octocorallia			
Alcyonacea (soft corals)			
Isididae			
Keratoisis spp.	branching bamboo coral	BOO	2
Primnoidae			
Thouarella spp.	bottle brush coral	THO	3
Pennatulacea (sea pens)	unspecified sea pens	PTU	8
Halipteridae			
Halipteris willemoesi	two-toothed sea pen	HWL	1
Pennatulidae			
Pennatula spp.	purple sea pens	PNN	1
Primnoidae	primnoid sea fans	PRI	3
Hexacorallia			
Zoanthidea (zoanthids)			
Epizoanthidae			
Epizoanthus sp.		EPZ	2
Actinaria (anemones)	unspecified anemome	ANT	6
Actiniidae			
Bolocera spp.	deepsea anemone	BOC	1
Actinostolidae (smooth deepsea anemones)		ACS	19
Hormathiidae (warty deepsea anemones)		HMT	5

Appendix 2 (continued)

Scientific name	Common name	Species	Occ.
Scleractinia (stony corals)			
Caryophyllidae			
Caryophyllia spp.	carnation cup coral	CAY	4
Desmophyllum dianthus	crested cup coral	DDI	1
Goniocorella dumosa	bushy hard coral	GDU	3
Stephanocyathus platypus	solitary bowl coral	STP	1
Flabellidae			
Flabellum spp.	flabellum coral	COF	3
Hydrozoa			
Anthomedusae			
Solanderiidae			
Solanderia spp.		HDR	1
Ascidiacea	unspecified sea squirt	ASC	1
Tunicata			
Thaliacea (salps)	unspecified salps	SAL	49
Salpidae			
Pyrosoma atlanticum		PYR	25
Thetys vagina		ZVA	1
Mollusca			
Bivalvia (bivalves)			
Anomiidae			
Pododesmus spp.	bivalve	BIV	1
Gastropoda (gastropods)			
Buccinidae (whelks)			
Penion chathamensis		PCH	2
Ranellidae (tritons)			
Fusitriton magellanicus		FMA	11
Volutidae (volutes)			
Provocator mirabilis	golden volute	GVO	1
Cephalopoda			
Sepiolida (bobtail squids)			
Sepiadariidae			
Sepioloidea spp.	bobtail squid	SSQ	1
Teuthoidea (squids)			
Architeuthidae			
Architeuthis dux	giant squid tentacle	GSQ	1
Octopoteuthidae			
Octopoteuthis spp.		OPO	2
Onychoteuthidae			
Onykia ingens	warty squid	MIQ	53
O. robsoni	warty squid	MRQ	8
Pholidoteuthidae			
Pholidoteuthis massyae	large red scaly squid	PSQ	3
Histioteuthidae (violet squids)			
Histioteuthis atlantica	violet squid	HAA	2
Histioteuthis spp.	violet squid	VSQ	10
Ommastrephidae			
Nototodarus sloanii	Sloan's arrow squid	NOS	31
Todarodes filippovae	Todarodes squid	TSQ	22
Chiroteuthidae			
Asperoteuthis lui	squid	ALU	1
Chiroteuthis veryani	squid	CVE	2
Cranchiidae	unspecified cranchiid	CHQ	10
Galiteuthis spp.	squid	GAI	1
Teuthowenia pellucida	squid	TPE	4

Appendix 2 (continued)

Scientific name	Common name	Species	Occ.
Cirrata (cirrate octopus)			
Opisthoteuthididae			
Opisthoteuthis spp.	umbrella octopus	OPI	2
Incirrata (incirrate octopus)			
Octopodidae			
Enteroctopus zealandicus	yellow octopus	EZE	2
Vampyromorpha (vampire squids)			
Vampyroteuthidae			
Vampyroteuthis infernalis	vampire squid	VAM	2
Polychaeta	unspecified polychaete	POL	1
Eunicida			
Eunicidae			
Eunice spp.	Eunice sea worm	EUN	1
Crustacea			
Malacostraca			
Dendrobranchiata/Pleocyemata (prawns)	unspecified prawn	NAT	1
Dendrobranchiata			
Aristeidae			
Aristeus sp.	deepwater prawn	ARI	2
Sergestidae			
Sergia potens	deepwater prawn	SEP	1
Pleocyemata			
Caridea			
Campylonotidae			
Campylonotus rathbunae	sabre prawn	CAM	2
Oplophoridae			
Acanthephyra pelagica		APE	5
Acanthephyra spp.	SubAntarctic ruby prawn	ACA	2
Notostomus auriculatus	scarlet prawn	NAU	1
Oplophorus spp.	deepwater prawn	OPP	4
Pasiphaeidae			
Pasiphaea aff. *tarda*	deepwater prawn	PTA	16
Pasiphaea spp.	deepwater prawn	PAS	2
Nematocarcinidae			
Lipkius holthuisi	omega prawn	LHO	24
Achelata			
Astacidea			
Nephropidae (clawed lobsters)			
Metanephrops challengeri	scampi	SCI	20
Palinura			
Polychelidae			
Polycheles spp.	deepsea blind lobster	PLY	6
Anomura			
Galatheoidea			
Chirostylidae (chirostylid squat lobsters)			
Uroptychus spp.	squat lobster	URP	1
Galatheidae (galatheid squat lobsters)			
Munida gracilis	squat lobster	MGA	1
Lithodidae (king crabs)			
Lithodes aotearoa	New Zealand king crab	LAO	3
Neolithodes brodiei	Brodie’s king crab	NEB	1
Parapaguridae (Parapagurid hermit crabs)			
Sympagurus dimorphus	hermit crab	SDM	6

Appendix 2 (continued)

Scientific name	Common name	Species	Occ.
Brachyura (true crabs)			
Atelecyclidae			
Trichopeltarion fantasticum	frilled crab	TFA	8
Goneplacidae			
Neommatocarcinus huttoni	policeman crab	NHU	1
Pycnoplax victoriensis	two-spined crab	CVI	3
Homolidae			
Dagnaudus petterdi	antlered crab	DAP	2
Inachidae			
Platymaia maoria	Dell’s spider crab	PTM	1
Vitjazmaia latidactyla	deepsea spider crab	VIT	2
Majidae (spider crabs)			
Leptomithrax garricki	Garrick’s masking crab	GMC	1
Teratomaia richardsoni	spiny masking crab	SMK	11
Lophogastrida (lophogastrids)			
Gnathophausiidae			
Gnathophausia sp.		GNA	1
Isopoda	unspecified isopod	ISO	1
Echinodermata			
Asteroidea (starfish)	unspecified starfish	ASR	2
Asteriidae			
Cosmasterias dyscrita	cat’s-foot star	CDY	1
Astropectinidae			
Dipsacaster magnificus	magnificent sea-star	DMG	17
Plutonaster knoxi	abyssal star	PKN	20
Proserpinaster neozelanicus	starfish	PNE	10
Psilaster acuminatus	geometric star	PSI	20
Sclerasterias mollis	cross-fish	SMO	3
Benthopectinidae			
Benthopecten spp.	starfish	BES	1
Brisingida	unspecified Brisingid	BRG	10
Goniasteridae			
Ceramaster patagonicus	pentagon star	CPA	3
Hippasteria phrygiana	trojan starfish	HTR	7
Mediaster arcuatus	starfish	MAT	1
Mediaster sladeni	starfish	MSL	2
Pillsburiaster aoteanus	starfish	PAO	7
Solasteridae			
Crossaster multispinus	sun star	CJA	4
Solaster torulatus	chubby sun-star	SOT	12
Pterasteridae			
Diplopteraster sp.	starfish	DPP	1
Zoroasteridae			
Zoroaster spp.	rat-tail star	ZOR	25
Ophiuroidea (basket and brittle stars)	unspecified brittle star	OPH	1
Ophiomyxidae			
Ophiomyxa brevirima	brittle star	OPH	1
Euryalina (basket stars)			
Gorgonocephalidae			
Astrothrombus rugosus		GOR	2
Gorgonocephalus spp.	Gorgon's head basket stars	GOR	2
Echinoidea (sea urchins)			
Regularia			
Cidaridae (cidarid urchins)			
Goniocidaris parasol	parasol urchin	GPA	1

Appendix 2 (continued)

Scientific name	Common name	Species	Occ.
Histiocidaridae (cidarid urchins)			
Histiocidaris spp.		HIS	1
Echinothuriidae/Phormosomatidae	unspecified Tam O'Shanter urchin	TAM	36
Echinidae			
Gracilechinus multidentatus	deepsea kina	GRM	11
Spatangoida (heart urchins)			
Spatangidae			
Paramaretia peloria	Microsoft mouse	PMU	2
Spatangus multispinus	purple-heart urchin	SPT	6
Holothuroidea	unspecified holothurian	HTH	2
Aspidochirotida			
Synallactidae			
Bathyplotes sp.	sea cucumber	BAM	7
Pseudostichopus mollis	sea cucumber	PMO	18
Elasipodida			
Laetmogonidae			
Laetmogone sp.	sea cucumber	LAG	9
Pelagothuridae			
Enypniastes exima	sea cucumber	EEX	4
Psychropotidae			
Benthodytes sp.	sea cucumber	BTD	2
Chondrichthyes (cartilaginous fishes)			
Squalidae: dogfishes			
Squalus acanthias	spiny dogfish	SPD	56
S. griffini	northern spiny dogfish	NSD	3
Centrophoridae: gulper sharks			
Centrophorus squamosus	leafscale gulper shark	CSQ	23
Deania calcea	shovelnose dogfish	SND	54
Etmopteridae: lantern sharks			
Etmopterus baxteri	Baxter's dogfish	ETB	43
E. lucifer	lucifer dogfish	ETL	62
Somniosidae: sleeper sharks			
Centroscymnus crepidater	longnose velvet dogfish	CYP	39
C. owstoni	smooth skin dogfish	CYO	28
Proscymnodon plunketi	Plunket's shark	PLS	12
Oxynotidae: rough sharks			
Oxynotus bruniensis	prickly dogfish	PDG	9
Dalatiidae: kitefin sharks			
Dalatias licha	seal shark	BSH	40
Scyliorhinidae: cat sharks			
Apristurus spp.	catshark	APR	16
Bythaelurus dawsoni	Dawson's catshark	DCS	2
Cephaloscyllium isabellum	carpet shark	CAR	2
Triakidae: smoothhounds			
Galeorhinus galeus	school shark	SCH	6
Torpedinidae: electric rays			
Torpedo fairchildi	electric ray	ERA	1
Narkidae: blind electric rays			
Typhlonarke spp.	blind electric ray	BER	1
Rajidae: skates			
Amblyraja hyperborea	deepwater spiny (Arctic) skate	DSK	2
Bathraja shuntovi	longnosed deepsea skate	PSK	4
Brochiraja asperula	smooth deepsea skate	BTA	21
B. spinifera	prickly deepsea skate	BTS	7

Appendix 2 (continued)

Scientific name	Common name	Species	Occ.
Dipturus innominatus	smooth skate	SSK	25
Zearaja nasuta	rough skate	RSK	3
Chimaeridae: chimaeras, ghost sharks			
Chimaera sp.	brown chimaera	CHP	5
Hydrolagus bemisi	pale ghost shark	GSP	82
H. novaezealandiae	dark ghost shark	GSH	39
H. homonycteris	black ghost shark	HYB	3
Rhinochimaeridae: longnosed chimaeras			
Harriotta raleighana	longnose spookfish	LCH	54
Rhinochimaera pacifica	Pacific spookfish	RCH	24
Osteichthyes (bony fishes)			
Halosauridae: halosaurs			
Halosaurus pectoralis	common halosaur	HPE	6
Halosauropsis macrochir	abyssal halosaur	HPE	1
Notocanthidae: spiny eels			
Notacanthus chemnitzi	giant spineback	NOC	2
N. sexspinis	spineback	SBK	52
Synaphobranchidae: cutthroat eels			
Diastobranchus capensis	basketwork eel	BEE	18
Nemichthyidae: snipe eels			
Avocettina spp.	black snipe eel	AVO	1
Congridae: conger eels			
Bassanago bulbiceps	swollenhead conger	SCO	34
B. hirsutus	hairy conger	HCO	31
Serrivomeridae: sawtooth eels			
Serrivomer sp.	sawtooth eel	SAW	3
Gonorynchidae: sandfish			
Gonorynchus forsteri & *G. greyi*	sandfishes	GON	5
Argentinidae: silversides			
Argentina elongata	silverside	SSI	49
Bathylagidae: deepsea smelts	unspecified deepsea smelts	BLG	1
Melanolagus bericoides	bigscale blacksmelt	MEB	6
Platytroctidae: tubeshoulders			
Normichthys yahganorum	tubeshoulder	NOR	3
Persparsia kopua	tubeshoulder	PER	3
Alepocephalidae: slickheads			
Alepocephalus antipodianus	smallscaled brown slickhead	SSM	17
A. australis	bigscaled brown slickhead	SBI	16
Rouleina spp.	slickhead	BAT	1
Xenodermichthys copei	black slickhead	BSL	8
Gonostomatidae: lightfishes			
Diplophos spp.	twin light dragonfishes	DIP	2
Sternoptychidae: hatchetfishes	unspecified hatchetfish	HAT	1
Argyropelecus gigas	giant hatchetfish	AGI	4
Photichthyidae: lighthouse fishes			
Phosichthys argenteus	lighthouse fish	PHO	25
Stomiidae: barbeled dragonfishes			
Chauliodus sloani	viperfish	CHA	5
Idiacanthus spp.	black dragonfish	IDI	4
Malacosteus australis	southern loosejaw	MAU	5
Melanostomias spp.	scaleless black dragonfishes	MEN	2
Opostomias micripnus	giant black dragonfish	OMI	2
Stomias spp.		STO	2
Notosudidae: waryfishes			
Scopelosaurus spp.		SPL	2
Alepisauridae: lancetfishes			
Alepisaurus brevirostris	shortsnouted lancetfish	ABR	2

Appendix 2 (continued)

Scientific name	Common name	Species	Occ.
Paralepididae: barracudinas			
Macroparalepis macrugeneion		MMA	1
Magnisudis prionosa	giant barracudina	BCA	1
Myctophidae: lanternfishes	unspecified lanternfish	LAN	18
Diaphus spp.		DIA	1
Gymnoscopelus spp.		GYM	2
Lampanyctodes hectoris	Hector’s lanternfish	LHE	1
Lampanyctus spp.		LPA	3
Moridae: morid cods			
Antimora rostrata	violet cod	VCO	3
Halargyreus johnsonii	Johnson's cod	HJO	40
Lepidion microcephalus	small-headed cod	SMC	22
L. schmidti	giant lepidion	LPS	2
Mora moro	ribaldo	RIB	47
Notophycis marginata	dwarf cod	DCO	5
Pseudophycis bachus	red cod	RCO	24
Moridae: morid cods (cont)			
Tripterophycis gilchristi	grenadier cod	GRC	1
Gadidae: true cods			
Micromesistius australis	southern blue whiting	SBW	10
Merlucciidae: hakes			
Lyconus spp.	lyconus	LYC	1
Macruronus novaezelandiae	hoki	HOK	111
Merluccius australis	hake	HAK	59
Macrouridae: rattails, grenadiers			
Coelorinchus acanthiger	spotty faced rattail	CTH	5
C. aspercephalus	oblique banded rattail	CAS	47
C. biclinozonalis	two saddle rattail	CBI	10
C. bollonsi	Bollons’s rattail	CBO	87
C. fasciatus	banded rattail	CFA	36
C. innotabilis	notable rattail	CIN	35
C. kaiyomaru	Kaiyomaru rattail	CKA	2
C. matamua	Mahia rattail	CMA	15
C. oliverianus	Oliver's rattail	COL	69
C. parvifasciatus	small banded rattail	CCX	14
C. trachycarus	roughhead rattail	CHY	4
Coryphaenoides dossenus	humpback rattail	CBA	10
C. murrayi	Murray’s rattail	CMU	3
C. serrulatus	serrulate rattail	CSE	34
C. striaturus	striate rattail	CTR	1
C. subserrulatus	four-rayed rattail	CSU	36
Gadomus aoteanus	filamentous rattail	GAO	3
Kuronezumia leonis		NPU	1
Lepidorhynchus denticulatus	javelinfish	JAV	95
Lucigadus nigromaculatus	blackspot rattail	VNI	29
Macrourus carinatus	ridge scaled rattail	MCA	15
Mesobius antipodum	black javelinfish	BJA	9
Nezumia coheni	Cohen’s rattail	NZC	1
N. namatahi		NNA	2
Odontomacrurus murrayi		OMU	1
Trachonurus gagates	velvet rattail	TRX	1
Trachyrincus aphyodes	white rattail	WHX	31
T. longirostris	unicorn rattail	WHR	1
Ophidiidae: cuskeels			
Genypterus blacodes	ling	LIN	87
Carapidae: pearlfishes			
Echiodon cryomargarites	messmate fish	ECR	2

Appendix 2 (continued)

Scientific name	Common name	Species	Occ.
Trachichthyidae: roughies, slimeheads			
Hoplostethus atlanticus	orange roughy	ORH	31
H. mediterraneus	silver roughy	SRH	37
Paratrachichthys trailli	common roughy	RHY	3
Diretmidae: discfishes			
Diretmus argenteus	discfish	DIS	3
Diretmichthys parini	spinyfin	SFN	1
Anoplogastridae: fangtooth			
Anoplogaster cornuta	fangtooth	ANO	1
Berycidae: alfonsinos			
Beryx decadactylus	longfinned beryx	BYD	2
B. splendens	alfonsino	BYS	35
Melamphaidae: bigscalefishes	unspecified bigscalefish	MPH	2
Zeidae: dories			
Capromimus abbreviatus	capro dory	CDO	9
Cyttus novaezealandiae	silver dory	SDO	12
C. traversi	lookdown dory	LDO	86
Oreosomatidae: oreos			
Allocyttus niger	black oreo	BOE	14
A. verrucosus	warty oreo	WOE	5
Neocyttus rhomboidalis	spiky oreo	SOR	36
Pseudocyttus maculatus	smooth oreo	SSO	34
Macrorhamphosidae: snipefishes			
Centriscops humerosus	banded bellowsfish	BBE	61
Notopogon lilliei	crested bellowsfish	CBE	1
Scorpaenidae: scorpionfishes			
Helicolenus spp.	sea perch	SPE	85
Trachyscorpia eschmeyeri	Cape scorpionfish	TRS	4
Triglidae: gurnards			
Chelidonichthys kumu	red gurnard	GUR	1
Lepidotrigla brachyoptera	scaly gurnard	SCG	7
Hoplichthyidae: ghostflatheads			
Hoplichthys haswelli	deepsea flathead	FHD	32
Psychrolutidae: toadfishes			
Ambophthalmos angustus	pale toadfish	TOP	20
Psychrolutes microporos	blobfish	PSY	3
Percichthyidae: temperate basses			
Polyprion oxygeneios	hapuku	HAP	7
Serranidae: sea perches, gropers			
Lepidoperca aurantia	orange perch	OPE	13
Epigonidae: deepwater cardinalfishes			
Epigonus denticulatus	white cardinalfish	EPD	8
E. lenimen	bigeye cardinalfish	EPL	15
E. machaera	thin tongue cardinalfish	EPM	18
E. robustus	robust cardinalfish	EPR	6
E. telescopus	deepsea cardinalfish	EPT	19
Rosenblattia robusta	rotund cardinalfish	ROS	2
Carangidae: trevallies, kingfishes			
Trachurus declivis	greenback jack mackerel	JMD	6
T. murphyi	slender jack mackerel	JMM	10
Bramidae: pomfrets			
Brama australis	southern Ray's bream	SRB	26
B. brama	Ray’s bream	RBM	5
Taractichthys longipinnis	big-scale pomfret	BSP	1
Emmelichthyidae: bonnetmouths, rovers			
Emmelichthys nitidus	redbait	RBT	5
Plagiogeneion rubiginosum	rubyfish	RBY	1

Appendix 2 (continued)

Scientific name	Common name	Species	Occ.
Pentacerotidae: boarfishes, armourheads			
Pentaceros decacanthus	yellow boarfish	YBO	1
Cheilodactylidae: tarakihi, morwongs			
Nemadactylus macropterus	tarakihi	NMP	2
Latridae: trumpeters			
Latris lineata	trumpeter	TRU	2
Uranoscopidae: armourhead stargazers			
Kathetostoma binigrasella	banded stargazer	BGZ	1
K. giganteum	giant stargazer	GIZ	51
Pinguipedidae: sandperches, weevers			
Parapercis colias	blue cod	BCO	1
P. gilliesi	yellow cod	YCO	1
Percophidae: opalfishes			
Hemerocoetes spp.	opalfish	OPA	1
Gempylidae: snake mackerels			
Thyrsites atun	barracouta	BAR	6
Trichiuridae: cutlassfishes			
Lepidopus caudatus	frostfish	FRO	2
Centrolophidae: raftfishes, medusafishes			
Centrolophus niger	rudderfish	RUD	20
Hyperoglyphe antarctica	bluenose	BNS	6
Seriolella caerulea	white warehou	WWA	33
S. punctata	silver warehou	SWA	27
Tubbia tasmanica	Tasmanian ruffe	TUB	3
Nomeidae: eyebrowfishes, driftfishes			
Cubiceps spp.	cubehead	CUB	2
Tetragonuridae: squaretails			
Tetragonurus cuvieri	squaretail	TET	2
Achiropsettidae: southern flounders			
Neoachiropsetta milfordi	finless flounder	MAN	1
Bothidae: lefteyed flounders			
Arnoglossus scapha	witch	WIT	11
Pleuronectidae: righteyed flounders			
Pelotretis flavilatus	lemon sole	LSO	7

Appendix 3: Scientific and common names of species caught from fine-meshed midwater tows (TAN1401). The occurrence (Occ.) of each species (number of tows caught) in the four midwater 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.
Cnidaria			
Scyphozoa	unspecified jellyfish	JFI	3
Hydrozoa			
Siphonophora	siphonophores	ZSP	3
Tunicata			
Thaliacea (salps)	unspecified salps	SAL	4
Pyrosomatidae			
Pyrosoma atlanticum		PYR	3
Mollusca			
Cephalopoda			
Teuthoidea (squids)			
Brachioteuthidae			
Brachioteuthis spp.		SQB	1
Histioteuthidae (violet squids)			
Histioteuthis spp.	violet squid	VSQ	2
Ommastrephidae			
Todarodes filippovae	Todarodes squid	TSQ	1
Onychoteuthidae			
Notonykia nesisi		NON	1
Notonykia spp.		NON	1
Cranchiidae	unspecified cranchiid	CHQ	2
Galiteuthis spp.		GAI	1
Teuthowenia pellucida		TPE	2
Crustacea	unspecified crustacean	CRU	3
Euphausiacea	unspecified euphausid	EUP	4
Malacostraca			
Dendrobranchiata			
Sergestidae			
Eusergestes arcticus	prawn	SAC	4
Sergestes spp.	prawn	SER	1
Pleocyemata			
Caridea			
Oplophoridae			
Oplophorus spp.	deepwater prawn	OPP	3
Pasiphaeidae			
Pasiphaea spp.	deepwater prawn	PAS	1
Galatheoidea	unspecified galatheid	GAL	2
Amphipoda	unspecified amphipod	APH	1
Hyperiidea			
Phronima sedentaria	barrel shrimp	APH	3
Chondrichthyes (cartilagenous fishes)			
Etmopteridae: lantern sharks			
Etmopterus baxteri	Baxter's dogfish	ETB	3
Osteichthyes (bony fishes)	unspecified bony fish	FIS	1
Notacanthidae: spiny eels			
Notocanthus sexspinis	spineback	SBK	1
Argentinidae: silversides			
Argentina elongata	silverside	SSI	1

Appendix 3 (continued)

Scientific name	Common name	Species	Occ.
Bathylagidae: deepsea smelts	unspecified deepsea smelt	BLG	3
Diplophidae: diplophids			
Diplophos spp.	twin light dragonfishes	DIP	1
Sternoptychidae: hatchetfishes			
Argyropelecus hemigymnus	common hatchetfish	AHE	1
Maurolicus australis	pearlside	MMU	4
Sternoptyx pseudodiaphana	false oblique hatchetfish	SPU	1
Phosichthyidae: lighthouse fishes			
Woodsia meyerwaardeni	austral lightfish	WMY	1
Stomiidae: scaly dragonfishes			
Chauliodus sloani	viperfish	CHA	1
Melanostomias spp.	scaleless black dragonfishes	MEN	1
Stomias spp.		STO	2
Myctophidae: lanternfishes	unspecified lanternfish	LAN	1
Diaphus danae	Dana lanternfish	DDA	4
D. hudsoni	Hudson’s lanternfish	DHU	1
Electrona carlsbergi	Carlsberg’s lanternfish	ELC	3
Gymnoscopelus spp.		GYM	1
Lampadena notialis	notal lanternfish	LNT	1
Lampanyctodes hectoris	Hector’s lanternfish	LHE	4
Lampanyctus spp.		LPA	2
Metelectrona ventralis	flaccid lanternfish	MVE	3
Protomyctophum spp.		PRO	3
Symbolophorus boops	bogue lanternfish	SBP	2
Merlucciidae: hakes			
Macruronus novaezelandiae	hoki	HOK	2
Macrouridae: rattails, grenadiers			
Coelorinchus bollonsi	Bollons’s rattail	CBO	1
C. oliverianus	Oliver’s rattail	COL	1
Diretmidae: discfishes			
Diretmus argenteus	discfish	DIS	1
Zeidae: dories			
Cyttus traversi	lookdown dory	LDO	1
Oreosomatidae: oreos			
Allocyttus niger	black oreo	BOE	2
Epigonidae: deepwater cardinalfishes		APG	1
Bramidae: pomfrets			
Brama australis	southern Ray's bream	SRB	1
Centrolophidae: raftfishes, medusafishes			
Seriolella punctata	silver warehou	SWA	1

Appendix 4: Scientific and common names of mesopelagic and benthic invertebrates identified following the voyage. List includes species caught in NIWA core-funded ratcatcher trawls (tows 128–137).

NIWA No.	Cruise/Station_no.	Class	Order	Family	Genus	Species
91988	TAN1401/124	Asteroidea	Valvatida	Goniasteridae	*Mediaster*	*arcuatus*
91989	TAN1401/94	Ophiuroidea	Ophiurida	Ophiomyxidae	*Ophiomyxa*	*brevirima*
91990	TAN1401/5	Ophiuroidea	Euryalinida	Gorgonocephalidae	*Astrothrombus*	*rugosus*
91991	TAN1401/5	Anthozoa	Gorgonacea	Primnoidae		
91993	TAN1401/104	Bivalvia	Pterioida	Anomiidae	*Pododesmus*	sp.
91994	TAN1401/60	Hydrozoa	Anthoathecata	Solanderiidae	Solanderia	
91995	TAN1401/5	Anthozoa	Pennatulacea	Halipteridae	*Halipteris*	*willemoesi*
91997	TAN1401/106	Anthozoa	Gorgonacea	Primnoidae		
92058	TAN1401/91	Malacostraca	Decapoda	Munididae	*Munida*	*gregaria*
92059	TAN1401/124	Malacostraca	Decapoda	Chirostylidae	*Uroptychus*	sp.
92075	TAN1401/124	Anthozoa	Scleractinia	Caryophylliidae	*Goniocorella*	*dumosa*
92469	TAN1401/131	Cephalopoda	Oegopsida	Cranchiidae	*Teuthowenia*	*pellucida*
92470	TAN1401/101	Cephalopoda	Oegopsida	Cranchiidae	*Teuthowenia*	*pellucida*
92471	TAN1401/101	Cephalopoda	Oegopsida	Cranchiidae	*Teuthowenia*	*pellucida*
92472	TAN1401/101	Cephalopoda	Oegopsida	Cranchiidae	*Teuthowenia*	*pellucida*
92473	TAN1401/101	Cephalopoda	Oegopsida	Cranchiidae	*Teuthowenia*	*pellucida*
92474	TAN1401/101	Cephalopoda	Oegopsida	Cranchiidae	*Teuthowenia*	*pellucida*
92475	TAN1401/52	Cephalopoda	Oegopsida	Cranchiidae	*Teuthowenia*	*pellucida*
92476	TAN1401/110	Cephalopoda	Oegopsida	Cranchiidae	*Teuthowenia*	*pellucida*
92477	TAN1401/109	Cephalopoda	Oegopsida	Cranchiidae	*Teuthowenia*	*pellucida*
92478	TAN1401/101	Cephalopoda	Oegopsida	Cranchiidae	*Teuthowenia*	*pellucida*
92479	TAN1401/131	Cephalopoda	Oegopsida	Cranchiidae	*Teuthowenia*	*pellucida*
92480	TAN1401/137	Cephalopoda	Oegopsida	Cranchiidae	*Teuthowenia*	*pellucida*
92481	TAN1401/101	Cephalopoda	Oegopsida	Cranchiidae	*Teuthowenia*	*pellucida*
92483	TAN1401/91	Cephalopoda	Oegopsida	Cranchiidae	*Teuthowenia*	*pellucida*
92486	TAN1401/137	Cephalopoda	Oegopsida	Cranchiidae	*Teuthowenia*	*pellucida*
92487	TAN1401/90	Cephalopoda	Oegopsida	Cranchiidae	*Teuthowenia*	*pellucida*
92488	TAN1401/56	Cephalopoda	Oegopsida	Cranchiidae	*Teuthowenia*	*pellucida*
92489	TAN1401/53	Cephalopoda	Oegopsida	Cranchiidae		
92490	TAN1401/91	Cephalopoda	Oegopsida	Cranchiidae	*Galiteuthis*	spp.
92491	TAN1401/76	Cephalopoda	Oegopsida	Cranchiidae	*Galiteuthis*	spp.
92492	TAN1401/106	Cephalopoda	Oegopsida	Cranchiidae		
92493	TAN1401/89	Cephalopoda	Oegopsida	Cranchiidae		
92494	TAN1401/89	Cephalopoda	Oegopsida	Cranchiidae		
92495	TAN1401/91	Cephalopoda	Oegopsida	Cranchiidae		
92496	TAN1401/89	Cephalopoda	Oegopsida	Cranchiidae		
92497	TAN1401/91	Cephalopoda	Oegopsida	Cranchiidae		
92498	TAN1401/57	Cephalopoda	Oegopsida	Chiroteuthidae	*Chiroteuthis*	*veranyi*
92499	TAN1401/52	Cephalopoda	Oegopsida	Chiroteuthidae	*Chiroteuthis*	*veranyi*
92500	TAN1401/78	Cephalopoda	Octopoda	Opisthoteuthididae	*Opisthoteuthis*	*robsoni*
92501	TAN1401/68	Cephalopoda	Octopoda	Opisthoteuthididae	*Opisthoteuthis*	*robsoni*
92502	TAN1401/131	Cephalopoda	Oegopsida	Onychoteuthidae	*Notonykia*	*africanae*
92503	TAN1401/91	Cephalopoda	Oegopsida	Brachioteuthidae	*Brachioteuthis*	spp.
92504	TAN1401/49	Cephalopoda	Oegopsida	Onychoteuthidae	*Onykia*	*ingens*
92505	TAN1401/131	Cephalopoda	Oegopsida	Onychoteuthidae	*Notonykia*	*africanae*
92506	TAN1401/129	Cephalopoda	Sepiolida	Sepiolidae	*Iridoteuthis*	spp.
92507	TAN1401/90	Cephalopoda	Oegopsida	Onychoteuthidae	*Notonykia*	spp.
92508	TAN1401/91	Cephalopoda	Oegopsida	Brachioteuthidae	*Brachioteuthis*	spp.
92509	TAN1401/91	Cephalopoda	Oegopsida	Brachioteuthidae	*Brachioteuthis*	spp.
92510	TAN1401/91	Cephalopoda	Oegopsida	Brachioteuthidae	*Brachioteuthis*	spp.
92511	TAN1401/91	Cephalopoda	Oegopsida	Brachioteuthidae	*Brachioteuthis*	spp.
92512	TAN1401/128	Cephalopoda	Sepiolida	Sepiolidae		
92513	TAN1401/116	Cephalopoda	Sepiolida	Sepiolidae		
92514	TAN1401/131	Cephalopoda	Sepiolida	Sepiolidae		
92515	TAN1401/129	Cephalopoda	Octopoda	Octopodidae	*Octopus*	spp.
92516	TAN1401/116	Thaliacea [Salps]	Salpida	Salpidae	*Thetys*	*vagina*

Appendix 4 (continued)

NIWA No.	Cruise/Station_no.	Class	Order	Family	Genus	Species
92517	TAN1401/55	Cephalopoda	Oegopsida	Histioteuthidae	*Histioteuthis*	spp.
92518	TAN1401/102	Cephalopoda	Oegopsida	Histioteuthidae	*Histioteuthis*	spp.
92519	TAN1401/102	Cephalopoda	Oegopsida	Histioteuthidae	*Histioteuthis*	spp.
92520	TAN1401/102	Cephalopoda	Oegopsida	Histioteuthidae	*Histioteuthis*	spp.
92521	TAN1401/102	Cephalopoda	Oegopsida	Histioteuthidae	*Histioteuthis*	spp.
92522	TAN1401/102	Cephalopoda	Oegopsida	Histioteuthidae	*Histioteuthis*	spp.
92523	TAN1401/102	Cephalopoda	Oegopsida	Histioteuthidae	*Histioteuthis*	spp.
92524	TAN1401/105	Cephalopoda	Oegopsida	Histioteuthidae	*Histioteuthis*	spp.
92525	TAN1401/52	Cephalopoda	Oegopsida	Histioteuthidae	*Histioteuthis*	spp.
92526	TAN1401/102	Cephalopoda	Oegopsida	Histioteuthidae	*Histioteuthis*	spp.
92527	TAN1401/29	Cephalopoda	Oegopsida	Histioteuthidae	*Histioteuthis*	spp.
92559	TAN1401/90	Cephalopoda	Oegopsida	Histioteuthidae	*Histioteuthis*	spp.
92560	TAN1401/137	Cephalopoda	Oegopsida	Histioteuthidae	*Histioteuthis*	spp.
92561	TAN1401/108	Cephalopoda	Oegopsida	Histioteuthidae	*Histioteuthis*	spp.
92562	TAN1401/106	Cephalopoda	Oegopsida	Histioteuthidae	*Histioteuthis*	spp.
92563	TAN1401/132	Cephalopoda	Octopoda	Opisthoteuthididae	*Opisthoteuthis*	spp.
92564	TAN1401/103	Cephalopoda	Oegopsida	Histioteuthidae	*Histioteuthis*	spp.
92565	TAN1401/91	Cephalopoda	Oegopsida	Histioteuthidae	*Histioteuthis*	spp.
92566	TAN1401/108	Cephalopoda	Oegopsida	Histioteuthidae	*Histioteuthis*	spp.
92567	TAN1401/133	Cephalopoda	Oegopsida	Histioteuthidae	*Histioteuthis*	spp.
92568	TAN1401/106	Cephalopoda	Oegopsida	Histioteuthidae	*Histioteuthis*	spp.
92569	TAN1401/86	Cephalopoda	Oegopsida	Histioteuthidae	*Histioteuthis*	spp.
92570	TAN1401/68	Cephalopoda	Oegopsida	Histioteuthidae	*Histioteuthis*	spp.
92571	TAN1401/86	Cephalopoda	Oegopsida	Histioteuthidae	*Histioteuthis*	spp.
92572	TAN1401/86	Cephalopoda	Oegopsida	Histioteuthidae	*Histioteuthis*	*atlantica*
92573	TAN1401/107	Cephalopoda	Oegopsida	Histioteuthidae	*Histioteuthis*	*atlantica*
92574	TAN1401/109	Cephalopoda	Oegopsida	Histioteuthidae	*Histioteuthis*	spp.
92575	TAN1401/91	Cephalopoda	Oegopsida	Onychoteuthidae	*Notonykia*	*nesisi*
93264	TAN1401/136	Cephalopoda	Vampyromorphida	Vampyroteuthidae	*Vampyroteuthis*	*infernalis*
93265	TAN1401/55	Cephalopoda	Vampyromorphida	Vampyroteuthidae	*Vampyroteuthis*	*infernalis*
93266	TAN1401/137	Cephalopoda	Vampyromorphida	Vampyroteuthidae	*Vampyroteuthis*	*infernalis*
93267	TAN1401/137	Cephalopoda	Vampyromorphida	Vampyroteuthidae	*Vampyroteuthis*	*infernalis*
93268	TAN1401/56	Cephalopoda	Oegopsida	Chiroteuthidae	*Asperoteuthis*	*lui*
93271	TAN1401/137	Cephalopoda	Vampyromorphida	Vampyroteuthidae	*Vampyroteuthis*	*infernalis*
94740	TAN1401/28	Cephalopoda	Vampyromorphida	Vampyroteuthidae	*Vampyroteuthis*	*infernalis*
94885	TAN1401/95	Cephalopoda	Octopoda	Octopodidae	*Enteroctopus*	*zealandicus*

Appendix 5: Length ranges (cm) used to identify 1+, 2+ and 3++ hoki age classes to estimate relative biomass values given in Table 6.

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