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Trawl survey of hoki and middle-depth species on the Chatham Rise, January 2013 (TAN1301)

New Zealand Fisheries Assessment Report 2014/02

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The twenty-second 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 26 January 2013. A random stratified sampling design was used, and 123 bottom trawls were successfully completed. These comprised 89 core (200–800 m) phase one biomass tows, 2 core phase two tows, and 32 deep (800–1300 m) tows.

Estimated relative biomass of all hoki in core strata was 124 112 t (CV 15.3%), an increase of 42% from January 2012. This increase was largely driven by the biomass estimate for 1+ year old hoki of 50 943 t, the highest in the time series for this age class of fish. The relative biomass of recruited hoki (ages 3+ years and older) was the highest since 1998. The relative biomass of hake in core strata increased by 38% to 1793 t (CV 15.3%) in 2013, but this estimate was low compared to those from the early 1990s. The relative biomass of ling was 8714 t (CV 10.1%), 7.6% higher than in January 2012, but the time-series for ling shows no overall trend.

While the 2011 hoki year-class at age 1+ was estimated to be the strongest in the trawl time series, the 2010 year-class at age 2+ was estimated to be the weakest in the time series. The age frequency distribution for hake was broad, with most fish aged between 3 and 12 years. The age distribution for ling was also broad, with most fish aged between 3 and 19 years.

Acoustic data were also collected during the trawl survey. The total acoustic backscatter in 2013 was similar to that recorded in 2012, but the proportion of backscatter attributed to mesopelagic fish was lower and the index of mesopelagic fish abundance on the Chatham Rise decreased by 18%. Hoki liver condition was positively correlated with indices of mesopelagic fish scaled by hoki abundance ("food per fish") from 2004–13. As in previous surveys, there was a positive correlation between acoustic backscatter from bottom marks and trawl catch rates in 2013.

1. INTRODUCTION

In January 2013, the twenty-second 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), 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. Although the TACC for hoki (total of 130 000 t in 2011–12) was still lower than the high value in earlier years (250 000 t in 2000–01), hoki is still New Zealand's largest finfish fishery. 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 catches of hoki on the Chatham Rise peaked at over 75 000 t in 1997–98 and 1998–99 but decreased to 31 000 to 34 000 t from 2003–04 to 2005–06. The Chatham Rise catch has increased again over the past seven years. The catch from the Chatham Rise in 2011–12 was 39 200 t, making this the second largest hoki fishery in the EEZ (behind the west coast South Island), contributing about 30% of the total New Zealand hoki catch (Ballara & O'Driscoll in press).

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 assessment.

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 species like ribaldo and pale ghost shark, which are known to occur deeper than the core survey depth boundary (800 m).

Acoustic data were recorded during tows 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 2001a, Livingston et al. 2004, Stevens & O'Driscoll 2006, 2007, Stevens et al. 2008, 2009a, 2009b, 2011, 2012, 2013), 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). Acoustic data also provide qualitative information on the amount of backscatter that is not available to the bottom trawl, either through being off the bottom, or over areas of foul ground.

Other work carried out concurrently with the trawl survey included sampling and preservation of unidentified 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 HOK2010/05B).
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.

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 27 strata. Twenty five 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, 2013). 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). Station allocation for phase 1 was determined from simulations based on catch rates from all previous Chatham Rise trawl surveys (1992–2012), 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 89 core stations in phase 1 (Table 1) was similar to that used in the 2012 survey, when the CV for 2+ hoki was 16.6% (Stevens et al. 2013). 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 2010–12 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 2011–13 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 2010–12 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 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 at 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 0515 h and 1834 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 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 were regularly calibrated following standard procedures (Foote et al. 1987), with the most recent calibration on 21 July 2012 Tasman Bay. The system and calibration parameters are given in Appendix 1 of O'Driscoll et al. (in press).

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 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, sex, 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, fish less than 30 cm, 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 645 hoki otoliths and 611 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 185 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

Acoustic analysis generally followed the methods applied to recent Chatham Rise trawl surveys (e.g., Stevens & O’Driscoll 2007, Stevens et al. 2008, 2009a, 2009b, 2011, 2012, 2013) and generalised by O’Driscoll et al. (2011a).

All acoustic recordings made during the trawl survey were visually examined. Marks were classified into seven main categories based on the relative depth of the mark in the water column, mark orientation (surface- or bottom-referenced), mark structure (layers or schools) and the relative strength of the mark on the five frequencies. Most of the analyses in this report are based on the 38 kHz data as this frequency was the only one available (along with uncalibrated 12 kHz data) for all previous surveys that used the old CREST acoustic system (Coombs et al. 2003). We did not attempt to do a full multifrequency analysis of mark types for this report.

Descriptive statistics were produced on the frequency of occurrence of the seven different mark types: surface layers, pelagic layers, pelagic schools, pelagic clouds, bottom layers, bottom clouds, and bottom schools. Descriptions of the marks types are provided in previous reports (e.g., Stevens et al. 2008, 2009a, 2009b, 2011), and an example multifrequency echogram is shown in Stevens et al. (2009b). Other example (38 kHz) echograms are in Cordue et al. (1998), Bull (2000), O’Driscoll (2001a, 2001b), and Stevens et al. (2008, 2011).

As part of the qualitative description, 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.

2.10.1 Comparison of acoustics with bottom trawl catches

A quantitative analysis was carried out on daytime trawl and night steam recordings using custom Echo Sounder Package (ESP2) software (McNeill 2001). Estimates of the mean acoustic backscatter per km^2 from bottom referenced marks (bottom layers, clouds, and schools) 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).

2.10.2 Time-series of relative mesopelagic fish abundance

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 2013. The methods were the same as those used by O’Driscoll et al. (2011a) and Stevens et al. (2013). 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 same stratum s as station i. $p(meso)_s$ was calculated from the observed proportion of night-time backscatter observed in the upper 200 m in stratum s ($p(200)_s$) and the estimated proportion of the total backscatter in the surface deadzone, p_{sz}. p_{sz} was estimated as 0.2 by O'Driscoll et al (2009) and was assumed to be the same for all years and strata:

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

3. RESULTS

3.1 2013 survey coverage

The trawl survey was successfully completed. The deepwater trawling objective meant that trawling was carried out both day (core and some deep tows) and night (deep tows only). The weather during the survey was generally good, although 41.5 hours were lost due to rough weather, and a further 7 hours were lost for net repairs.

In total, 123 successful biomass tows were completed, comprising 89 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). Ten tows were excluded from relative biomass calculations. These included a single core tow in stratum 3 which came fast and nine deep tows: 4 came fast, 4 had excessive headline heights, and one tow was aborted due to rough bottom. Due to the number of unsuccessful deep tows and rough weather only 4 of 5 planned tows were completed in each of strata 23 and 25. An additional 7 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 1:3722 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 1:3155 km^2 in stratum 28 (1000–1300 m, SE Chatham Rise). Mean station density was 1:1 477 km^2 (see Table 1).

3.2 Gear performance

Gear parameters are summarised in Table 3. A headline height value was obtained for all 123 successful tows, but doorspread readings were not available for 7 tows. Mean headline heights by 200 m depth intervals ranged from 6.5 to 7.1 m, averaged 6.7 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 115.1 to 125.9 m, and averaged 121.8 m.

3.3 Hydrology

The surface temperatures (Figure 3, top panel) ranged from 13.9 to 17.9 °C. Bottom temperatures ranged from 3.1 to 10.7 °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 123 valid biomass stations was 135.2 t, of which 51.4 t (38.0%) was hoki, 3.7 t (2.7%) was ling, and 1.0 t (0.8%) was hake (Table 4). Of the 337 species or species groups identified at sea, 166 were teleosts, 34 were elasmobranchs, 2 were agnathans, 31 were crustaceans, and 19 were cephalopods. The remainder consisted of assorted benthic and pelagic invertebrates. A full list of species caught in biomass tows, and the number of stations at which they occurred, is given in Appendix 2. Of interest was the capture of the third known specimen of a new pointy nosed toadfish species (*Ebinania* sp.).

A full list of species caught in fine meshed midwater tows, and the number of stations at which they occurred, is given in Appendix 3.

Twenty benthic invertebrate taxa were formally identified after the voyage (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 15.3%, 15.3%, and 10.1% respectively. The CV for 2+ hoki (2010 year class) was 43.6%, well above the target CV of 20%, however there were very few 2+ hoki captured. High CVs (over 30%) generally occurred when species were not well sampled by the gear. For example, barracouta, and slender mackerel are not strictly demersal and exhibit strong schooling behaviour. Others, such as hapuku, bluenose, tarakihi, and rough skate have high CVs as they are mainly distributed outside the core survey depth range (O’Driscoll et al. 2011b).

The combined relative biomass for the top 31 species in the core strata that are tracked annually (Livingston et al. 2002) was higher than in 2011–12, similar to 2009–2010, and among the higher estimates 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), with a similar relative biomass to 2012. The next most abundant QMS species were alfonsino, dark ghost shark, black oreo, ling, sea perch, lookdown dory, silver warehou, spiny dogfish, pale ghost shark, spiky oreo, giant stargazer, and white warehou, each with an estimated relative biomass of over 2000 t (Table 4). The most abundant non-QMS species were javelinfish, big-eye rattail, shovelnose dogfish, oblique banded rattail, Oliver’s rattail, banded bellowsfish, Baxter’s dogfish, and longnose spookfish (Table 4).

Estimated relative biomass of hoki in the core strata was 124 112 t, 42% higher than January 2012 (Table 5, Figure 5). This was largely driven by a biomass estimate for 1+ hoki of 50 943 t, the highest in the time series. The relative biomass of 3++ (recuited) hoki was also 29% higher than in 2012, and the highest since 1998. The biomass of 2+ hoki (2010 year-class) was only 1034 t, the lowest in the time series (Table 6).

The relative biomass of hake in core strata was 1793 t, 38.8% higher than 2012, but was still low compared to the early 1990s (see Table 5, Figure 5). 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 8714 t, 7.6% higher than in January 2012. The time series for ling shows no overall trend (Figure 5).

The relative biomass estimates for giant stargazer, lookdown dory, sea perch, and spiny dogfish were higher than 2012 estimates, while the estimates for dark ghost shark, pale ghost shark, and silver warehou were lower (Figure 5). The relative biomass estimate for white warehou was about the same as those in 2011–12 (Figure 5).

3.5.2 Deep strata (800–1300 m)

Relative biomass and CVs in deep strata were estimated for 18 of 45 core strata species (Table 4). The estimated relative biomass of orange roughy in deep strata was 2776 t (CV 32.4%), which was 24.4% of the total biomass for core strata species in deep strata (Table 4). The relative biomass of orange roughy in all strata in 2013 was 2779 t, which was 46% lower than the estimate of 5205 t in 2012.

The estimated relative biomass of smooth oreo in deep strata was 1532 t, 9.1% of the total biomass for core strata species in deep strata (Table 4), but precision was poor with a CV of 84.9%. Only 6.8% of the relative biomass of spiky oreo in all strata and 0.05% of the relative biomass of black oreo in all strata were estimated to occur in the deep strata (Table 4). However, 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 29%, and 40% of the total survey biomass of shovelnose dogfish and Baxter’s dogfish occurring in deep strata.

The deep strata contained 4.3% of total survey hake biomass, 1.4% of the total survey hoki biomass, and 0.5% of total survey ling biomass. This indicates that the core survey strata is likely to have sampled most of the hoki and ling biomass available to the trawl survey method on the Chatham Rise, but missed some hake (Table 4).

3.6 Catch distribution

Hoki

In the 2013 survey, hoki were caught at 89 of 91 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 2013 occurred on the southwest Chatham Rise in stratum 16 close to the Mernoo Bank, and comprised 1+ and recruited hoki (3+ and older) (Figure 6). Other high individual catch rates of hoki were around the Mernoo (strata 18 and 7b), Reserve (strata 19 and 20), and Veryan Banks (stratum 17). As in previous surveys, 1+ hoki were largely confined to the Mernoo, Veryan, and Reserve Banks (Figure 6a). Although relatively uncommon in 2013, 2+ hoki were found over much of the Rise at 200–600 m depths (Figure 6b). The distribution of 3++ hoki was similar to that of 2+ fish but extended into deeper water (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 10a, 11a, and 13 (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 north Chatham Rise in 400–600 m (strata 7B, 11B, 11D), although the largest catch rate was on the Reserve Bank (stratum 20) in 370–390 m. 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, although the largest catch rates 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 of 325 kg taken on the northeast Rise in stratum 21b (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), while smooth oreo was mainly caught in stratum 6 and on the north Rise at 1000–1300 m depths (strata 23). Spiky oreo was more widespread and most abundant on the northeast rise at 500–800 m (strata 2b, 11d, 10a, and 12) (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 1+ year (less than 47 cm) fish (Figures 10 and 11). There were very few 2+ (47–55 cm) fish and few longer than 80 cm (Figure 10) or older than 7 years (Figure 11). The sex ratio was equal (ratio of 1.04 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 3 and 12 years. Since 2004 a cohort from the 2002 year-class has been tracked by the survey. This cohort was 11+ in 2013, but was not abundant: possibly indicating a reduction in the proportion of this year-class, ageing error, or that these fish were not well sampled in 2013. Females were more abundant than males (2.24 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 19. There is evidence of a period of good recruitment from 1999–2006 (Figure 15). Females were slightly less abundant than males (0.90 female: 1 male).

Other species

Length frequency distributions for key core and deepwater commercial species are shown in Figure 16. Clear modes are apparent in the size distribution of white warehou, which may correspond to cohorts. Length frequencies of lookdown dory, giant stargazer, spiny dogfish, and dark and pale ghost sharks indicate that females grow larger than males. Length frequency distributons 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 29–36 cm, but included fish as small as 7 cm (Figure 16). As with previous years, the catch of spiny dogfish was dominated by females (3.8 female: 1 male). Sex ratios were about even for most other species (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 21% of male ling were maturing or ripe, but few females were showing signs of reproductive activity. About 40% of male hake were ripe, running ripe, or partially spent, but most females were immature or resting (52%) or maturing (37%) (Table 10). Most other species for which reproductive state was recorded showed no sign of reproductive activity, except some deepwater sharks (Table 10).

3.8 Acoustic data quality

Over 71 GB of acoustic data were collected with the multi-frequency (18, 38, 70, 120, and 200 kHz) hull-mounted EK60 ecosounder systems during the trawl survey. Weather and sea conditions during the survey was good to average and 76% of files were suitable for quantitative analysis. Only 18 of the 107 daytime trawl files were considered too poor to be analysed quantitatively.

Acoustic data showed some electrical background noise in deeper water (Figure 17) which did not exist in previous years. A noise recording was performed in deep water (980–1200 m bottom depth) on 12 January 2013. The Simrad EK60 transducers were switched into ‘passive mode’ to measure the ambient background noise over the whole water column. Data from the entire echogram were integrated in 50 m vertical bins. Noise results were plotted against the average acoustic backscatter for the day and night to show the contribution to the overall acoustic backscatter (Figure 18). The contribution of the noise was only marginal, with the main affect at depths greater than 1000 m, so no noise correction was applied in our analyses. The source of the electrical noise was subsequently diagnosed as a fault with the shielding of the transducer cable and was rectified.

Expanding symbol plots for the distribution of total acoustic backscatter from good and adequate quality recordings observed during daytime trawls and night transects are shown in Figure 19. As noted by O’Driscoll et al. (2011a), there was a consistent spatial pattern in total backscatter on the Chatham Rise, with higher backscatter in the west.

3.8.1 Description of acoustic mark types

The frequency of occurrence of each of the seven mark categories is given in Table 11. Often several types of mark were present in the same echogram. The occurrence of acoustic mark types on the Chatham Rise in 2013 was different to that observed in previous surveys. Notably, the percentage of daytime surface layers halved whereas percentages of pelagic and bottom cloud increased by a third (Table 11). Some of these changes might be explained by differences in subjective classification between analysts (Johannes Oeffner in 2013 and Richard O’Driscoll previously), but cross-validation checks on a subset of echograms indicated that the decline in occurrence of daytime surface layers in 2013 was real. Mesopelagic trawling on voyages funded as part of the Coasts and Oceans outcome-based-investment programme for the former Ministry of Science and Innovation in May–June 2008 and November 2011 suggest that daytime surface layers often contain euphausiids, mesopelagic fish, and gelatinous zooplankton (NIWA, unpublished data). Surface layers were observed in almost all (96%) night files (Table 11).

Pelagic layers were the most common daytime mark types in 2013 (Table 11). Midwater trawling on previous Chatham Rise surveys suggested that pelagic layers contained mesopelagic fish species, such as pearlsides (*Maurolicus australis*) and myctophids (McClatchie & Dunford 2003, Stevens et al. 2009a). These mesopelagic species vertically migrate, rising in the water column and dispersing during the night, turning into pelagic clouds and merging with surface layers. Pelagic schools were observed in 34% of day trawl files, 20% of day steam files and 14% of night files (Table 11). Trawling on Coasts and Oceans voyages found that small pelagic schools were often dominated by the myctophids *Lampanyctodes hectoris* and *Symbolophorus* spp., or by pearlside *Maurolicus australis* (NIWA, unpublished data).

Bottom layers were observed in 76% of day steam files, 72% of day trawl files, and 51% of night files (Table 11). Like pelagic layers, bottom layers tended to be dispersed at night, to form bottom clouds. Bottom layers and clouds were usually associated with a mix of demersal fish species, but probably also contained mesopelagic species when they were close to the bottom (O'Driscoll 2003). There was often mixing of bottom layers and pelagic layers. Bottom-referenced schools were present in 13% of daytime trawl echograms but only in 8% of daytime steam recordings in 2013, and were most abundant at 250–450 m water depth. Bottom schools and layers 10–70 m off the bottom were sometimes associated with catches of 1+ and 2+ hoki, but also with other species such as alfonsino and silver warehou (Stevens et al. 2008, 2009a, 2009b, 2011). Strong bottom schools observed during trawl 72 in 2013 (Figure 20) were associated with a catch of 17.6 t of alfonsino.

3.8.2 Comparison of acoustics with bottom trawl catches

Acoustic data from 76 trawl files were integrated and compared with trawl catch rates (Table 12). Data from the other 31 daytime trawl recordings were not included in the analysis because the acoustic data were too noisy (18 files), or because the trawl was outside the 200–800 m core survey area (11 files) or were foul trawls (2 files). Average acoustic backscatter values from bottom-referenced marks and from the entire water column in 2013 were at similar levels to those observed in 2012 (Table 12).

There was a moderate positive correlation (Spearman's rank correlation, rho = 0.50, $p < 0.001$) between acoustic backscatter in the bottom 100 m during the day and trawl catch rates (Figure 21). This is the highest correlation since the start of the acoustic time series in 2001. In Chatham Rise surveys from 2001-11, rank correlations between trawl catch rates and acoustic density estimates ranged from 0.15 (in 2006) to 0.46 (in 2001). The correlation between acoustic backscatter and trawl catch rates (Figure 21) is not perfect (rho = 0.5) because large catches were sometimes made when there were only weak marks observed acoustically, and conversely, relatively little was caught in some trawls where dense marks were present. O'Driscoll (2003) suggested that bottom-referenced layers on the Chatham Rise may also have contained a high proportion of mesopelagic "feed" species, which contribute to the acoustic backscatter, but which were not sampled by the bottom trawl. Comparison of paired day and night acoustic recordings from the same location indicates that, on average, 35–50% of the bottom-referenced backscatter observed during the day migrated more than 50 m away from the bottom at night, suggesting that this component is not demersal fish (O'Driscoll et al. 2009). This result combined with the diverse composition of demersal species sampled by trawling, means that it is unlikely that acoustics will provide an alternative biomass estimate for hoki on the Chatham Rise.

3.8.3 Time-series of relative mesopelagic fish abundance

In 2013, most acoustic backscatter was between 200 and 600 m depth during the day, and migrated into the surface 200 m at night (see Figure 18). The vertical distribution was similar to the pattern observed in 2001–10 (O'Driscoll et al. 2011a) and 2012 (Stevens et al. 2013), except that a higher proportion of backscatter occurred between 450 and 700 m at night in 2013 compared to previous surveys. An example of this night-time deep scattering layer is given in Figure 22. 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 was assumed to be dominated by mesopelagic fish (see McClatchie and Dunford, 2003 for rationale and caveats). In 2013, between 34 and 66% 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 13). These values are the lowest since the start of the time series in 2001. 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 (see Figures 18 and 22).

Day estimates of total acoustic backscatter over the Chatham Rise were consistently higher than night estimates (Figure 23) because of the movement of fish into the surface deadzone (shallower than 14 m) at night (O'Driscoll et al. 2009). The only exception to this was in 2011, when night estimates were higher than day estimates (Figure 23). However, there was relatively little good quality acoustic data available from the southeast Chatham Rise in 2011 due to poor weather conditions (Stevens et al. 2012). Daytime backscatter in 2013 was similar to that observed in 2012. Backscatter within 50 m of the bottom during the day decreased since the start of the time series, but increased in 2012 and 2013 (Figure 23). Backscatter close to the bottom at night remained at consistently low levels throughout the time-series but increased slightly over the past four years (Figure 23).

The 'best' estimate of mesopelagic fish abundance was calculated by multiplying estimates of the total daytime backscatter 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. This effectively subtracts the backscatter which was deeper than 200 m at night (i.e., the bathypelagic and demersal components) from day estimates of total backscatter (O'Driscoll et al. 2011a). The estimated acoustic indices calculated using this method are summarised in Table 14 and plotted in Figure 24 for the entire Chatham Rise survey area and for the four sub-areas. The overall mesopelagic estimate for the Chatham Rise decreased by 18% from 2012 and the 2013 estimate was the second lowest of the time series (the lowest was in 2009). The 2013 mesopelagic index increased on the northwest Chatham Rise, but decreased in the other three sub-areas (Table 14, Figure 24).

Hoki condition

Liver condition (defined as liver weight divided by gutted weight) on the Chatham Rise decreased from 2012 to 2013, but the condition of fish in 2013 was higher than in 2010 and 2011 (Figure 25). O'Driscoll et al. (2011a) found no evidence for a link between hoki condition and mesopelagic fish indices between 2004 and 2010. However, in the 2013 analysis, we calculated a new index of "food per fish" from the ratio of the acoustic estimate of mesopelagic fish abundance (see Table 14) divided by the trawl estimate of hoki abundance (see Table 7a). This index takes account of density dependence of hoki on food availability. There was a significant positive correlation between liver condition and food per fish (Pearson's correlation coefficient, $r = 0.73$, $n = 12$, $p = 0.005$) (Figure 25).

4. CONCLUSIONS

The 2013 survey successfully extended the January Chatham Rise time series into its twenty-second year and provided abundance indices for hoki, hake, and ling.

The estimated relative biomass of hoki in core strata was 42% higher than in 2012, largely due to a high relative biomass estimate of 1+ hoki, the highest in the time series. The relative biomass of 3++ hoki (recuited) hoki was 29% higher than in 2012, and the highest since 1998. The estimated biomass of 2+ hoki (2010 year class) was the lowest in the time series.

The relative biomass of hake in core strata was 39% higher in 2013 than 2012, but remains at historically low levels compared to the early 1990s. The relative biomass of ling in core strata was 8% higher in 2013, but the time series for ling shows no overall trend.

The deep strata were successfully completed providing relative biomass indices for pre-recruit and recruited orange roughy. The estimated relative biomass of orange roughy in all strata was 46% lower in 2013 compared to 2012. There was no trend in the orange roughy relative biomass time series for the deep component (4 surveys) suggesting that additional surveys in the series are required. The deep strata contained only a small proportion of the total survey relative biomass for hake, hoki, and ling, confirming that the core survey area is appropriate for these species.

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Table 1: The number of completed valid biomass tows (200–1300 m) by stratum during the 2013 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	4 333	5	5		5	1: 866
7B	400–600	NW Chatham Rise	894	3	3		3	1: 298
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
10A	400–600	NE Chatham Rise	2 958	3	3		3	1: 986
10B	400–600	NE Chatham Rise	3 363	3	3		3	1: 1 121
11A	400–600	NE Chatham Rise	2 966	3	3		3	1: 989
11B	400–600	NE Chatham Rise	2 072	3	3		3	1: 691
11C	400–600	NE Chatham Rise	3 342	3	3		3	1: 1 114
11D	400–600	NE Chatham Rise	3 368	3	3		3	1: 1 123
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		3	1: 1 947
16	400–600	SW Chatham Rise	11 522	3	3	2	5	1: 2 304
17	200–400	Veryan Bank	865	3	3		3	1: 288
18	200–400	Mernoo Bank	4 687	3	3		3	1: 1 562
19	200–400	Reserve Bank	9 012	5	5		5	1: 1 802
20	200–400	Reserve Bank	9 584	5	5		5	1: 1 916
Core	200–800		139 492	89	89	2	91	1: 1 533
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	12	12		12	1: 613
23	1000–1300	NW Chatham Rise	7 014	5	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	4		4	1: 1 399
28	1000–1300	SE Chatham Rise	9 494	3	3		3	1: 3 155
Deep	800–1300		42 201	34	32	0	32	1: 1319
Total	200–1300		181 693	123	121	2	123	1: 1 477

Table 2: Survey dates and number of valid core (200–800 m depth) biomass tows in surveys of the Chatham Rise, January 1992–2013. †, years where the deep component of the survey was carried out.

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

Table 3: Tow and gear parameters by depth range for valid biomass tows (TAN1301). 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)	91	2.8	0.35	2.0–3.1
Tow speed (knots)	91	3.5	0.04	3.4−3.7
All tow parameters				
Tow length (n. miles)	123	2.8	0.33	2.0–3.1
Tow speed (knots)	123	3.5	0.05	3.4−3.7
Gear parameters				
200–400 m				
Headline height	25	6.7	0.33	6.2−7.3
Doorspread	25	122.1	7.45	109.4–122.1
400–600 m				
Headline height	49	6.5	0.20	6.1−6.9
Doorspread	48	125.9	5.48	113.5–135.5
600–800 m				
Headline height	17	6.7	0.28	6.3−7.4
Doorspread	16	117.8	6.69	108.4–117.8
800–1000 m				
Headline height	22	7.0	0.28	6.4−7.7
Doorspread	21	117.0	5.29	108.3–127.7
1000–1300 m				
Headline height	10	7.1	0.39	6.7−7.8
Doorspread	6	115.1	8.16	104.2–124.8
Core stations 200–800 m				
Headline height	91	6.6	0.28	6.1−7.4
Doorspread	89	123.4	6.96	108.4–135.5
All stations 200–1300 m				
Headline height	123	6.7	0.34	6.1−7.8
Doorspread	116	121.8	7.30	104.2–135.5

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 2013 survey core strata (200–800 m); and biomass estimates (not catch) for deep strata (800–1300 m). Total biomass includes unsexed fish. (–, no data.). Arranged in descending relative biomass estimates for the core strata. –, no data.

		Core strata 200–800m							800–1300 m	
Common name	Code	Catch	Biomass males		Biomass females		Total biomass		Deep biomass	
		kg	t	% CV	t	% CV	t	% CV	t	% CV
QMS species										
Hoki	HOK	50 185	55 695	17.5	68 316	13.9	124 112	15.3	1 794	29.0
Alfonsino	BYS	17 813	11 181	97.7	33 595	99.2	44 779	98.8	–	
Dark ghost shark	GSH	5 700	4 915	12.0	6 776	12.7	11 723	11.6	–	
Black oreo	BOE	2 081	5 879	43.0	4 883	43.7	10 779	43.3	5	63.4
Ling	LIN	3 674	3 629	12.7	5 085	10.5	8 714	10.1	48	72.1
Sea perch	SPE	3 031	3 055	19.6	3 296	21.5	7 785	12.5	6	67.8
Lookdown dory	LDO	2 961	2 391	15.9	4 734	9.6	7 141	11.0	6	66.3
Silver warehou	SWA	2 593	3 428	34.5	3 506	25.2	6 945	29.3	–	
Spiny dogfish	SPD	2 748	951	22.7	5 870	15.7	6 864	15.3	–	
Pale ghost shark	GSP	1 444	1 771	16.1	1 776	25.4	4 270	18.0	123	33.4
Spiky oreo	SOR	1 946	2 101	37.2	1 894	34.4	4 045	35.2	295	49.2
Giant stargazer	GIZ	824	471	61.6	1 610	28.6	2 108	34.3	–	
White warehou	WWA	1 091	1 054	36.3	953	29.3	2 030	32.7	–	
Hake	HAK	962	262	20.2	1 532	16.4	1 793	15.3	81	35.9
Smooth oreo	SSO	277	778	84.0	754	85.9	1 532	84.9	1 035	23.4
Smooth skate	SSK	682	749	25.5	744	28.4	1 494	19.6	19	74.7
Barracouta	BAR	265	281	63.3	699	90.3	980	82.2	–	
Southern Ray’s bream	SRB	285	439	37.7	472	40.4	922	38.4	–	
School shark	SCH	177	152	68.3	190	45.6	531	48.5	–	
Ribaldo	RIB	232	178	17.6	241	24.1	428	15.7	207	25.1
Red cod	RCO	246	221	31.5	185	18.7	406	23.7	–	
Arrow squid	NOS	152	127	14.7	174	18.3	308	14.1	–	
Hapuku	HAP	80	88	40.7	138	53.5	225	37.3	–	
Bluenose	BNS	48	28	67.9	52	50.5	80	47.6	–	
Deepsea cardinalfish	EPT	70	46	33.0	26	39.7	75	31.1	–	
Lemon sole	LSO	30	20	42.0	42	26.5	75	19.7	–	
Frostfish	FRO	20	–		36	60.5	72	39.6	–	
Bass	BAS	11	–		–		42	100	–	
Rough skate	RSK	15	9	76.1	29	100	38	78.5	–	
Slender mackerel	JMM	8	11	70.9	5	100	29	43.8	–	
Tarakihi	NMP	7	17	50.7	9	51.7	25	41.2	–	
Banded stargazer	BGZ	4	16	100	–		16	100	–	
Scampi	SCI	7	8	22.7	4	25.4	13	17.0	–	
Jack mackerel	JMD	2	–		–		5	73.8	–	
Orange roughy	ORH	2	1	100	2	100	3	75.1	2 776	32.4
Ray’s Bream	RBM	1	–		–		3	100	–	
Rubyfish	RBY	2	3	100	–		3	100	–	
Commercial non-QMS species (where core biomass > 30 t)										
Shovelnose dogfish	SND	3 710	2 333	32.1	5 757	37.1	8 100	34.4	3 254	29.6
Non-commercial species (where core biomass > 800 t)										
Javelinfish	JAV	6 352	–	–	–	–	15 418	13.9	752	78.8
Bollons’s rattail	CBO	5 731	–	–	–	–	13 447	10.3	11	59.8
Oblique banded rattail	CAS	1 284	–	–	–	–	2 110	14.6	–	
Oliver's rattail	COL	640	–	–	–	–	1 618	18.6	16	54.3
Banded bellowsfish	BBE	561	–	–	–	–	1 294	26.1	–	
Baxter’s dogfish	ETB	214	–	–	–	–	1 011	33.0	673	25.6
Longnose spookfish	LCH	326	–	–	–	–	832	20.1	265	31.9
Total (above)		118 494								
Grand total (all species)		122 292								

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 1992–2013. 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

Table 6: Relative biomass estimates (t in thousands) for hoki, 200–800 m depths, Chatham Rise trawl surveys January 1992–2013 (CV coefficient of variation; 3++ all hoki aged 3 years and older; (see Appendix 5 for length ranges of age classes.). See also Figure 5.

		1+ hoki			2+ hoki		3 ++ hoki		Total hoki	
Survey	1+ year class	t	% c.v	2+ year class	t	% c.v	t	% c.v	t	% c.v
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	0.5	(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)

Table 7a: Estimated relative biomass (t) and coefficient of variation (% CV) for hoki, hake, ling, and 8 other key species by stratum for the 2013 survey. See Table 4 for species common names. 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		SPE		LDO		SWA	
Stratum	t	CV	t	CV	t	CV	t	CV	t	CV	t	CV
1	394	45	–	–	77	63	15	94	43	48	–	–
2a	554	19	–	–	67	80	46	46	25	5	–	–
2b	2 098	22	–	–	165	17	65	22	83	30	–	–
3	4 574	68	788	24	298	29	164	35	238	33	168	42
4	3 126	41	–	–	941	61	146	75	237	73	–	–
5	1 555	19	1 425	31	409	19	82	18	385	23	328	51
6	2 127	43	8	100	483	56	3	100	85	100	20	100
7a	2 601	19	61	95	410	21	100	56	98	26	91	55
7b	2 539	35	51	42	118	23	105	40	89	73	17	51
8a	1 866	28	32	26	196	45	196	17	35	16	2	100
8b	2 914	52	56	50	249	16	308	39	319	32	12	51
9	1 549	22	821	39	227	50	99	86	155	54	410	61
10a	1 001	20	–	–	100	56	42	18	62	24	–	–
10b	958	11	6	100	96	45	34	11	93	13	3	100
11a	1 709	60	466	70	359	11	53	21	500	26	31	71
11b	657	16	–	–	136	81	19	38	45	5	6	100
11c	908	5	186	98	123	56	28	9	162	21	23	100
11d	2 174	11	61	55	379	49	69	44	123	52	131	53
12	3 536	35	439	87	436	11	51	13	365	10	88	63
13	6 745	24	601	73	723	24	292	49	823	29	484	80
14	5 189	4	23	100	558	14	233	38	702	16	251	100
15	4 880	28	–	–	690	20	86	8	571	54	6	100
16	25 989	57	335	82	541	23	446	77	417	19	172	69
17	1 542	87	890	53	18	81	5	86	23	72	173	41
18	6 570	64	787	64	134	100	477	57	175	52	1 792	64
19	16 039	42	1 414	38	190	53	2 105	21	162	78	1 244	58
20	20 318	36	3 273	14	590	68	2 517	28	1 125	50	1 492	94
Core	124 112	15	11 723	12	8 714	10	7 785	13	7 141	11	6 945	29
21a	100	19	–	–	–	–	–	–	0	100	–	–
21b	243	40	–	–	–	–	–	–	–	–	–	–
22	658	22	–	–	19	100	6	68	6	71	–	–
23	24	74	–	–	–	–	–	–	–	–	–	–
24	9	100	–	–	–	–	–	–	–	–	–	–
25	571	79	–	–	29	100	–	–	–	–	–	–
28	191	100	–	–	–	–	–	–	–	–	–	–
Deep	1 794	29	–	–	48	72	6	68	6	66	–	–
Total	125 906	15	11 723	12	8 763	10	7 7 91	13	7 148	11	6 945	29

Table 7a (continued)

										Species code
	SPD		GSP		GIZ		WWA		HAK	
Stratum	t	CV	t	CV	t	CV	t	CV	t	CV
1	–	–	143	40	17	50	4	100	32	52
2a	–	–	136	54	11	100	–	–	24	64
2b	–	–	115	24	–	–	–	–	175	51
3	589	33	3	100	–	–	21	21	38	52
4	–	–	721	33	60	100	64	100	172	31
5	1207	25	–	–	168	28	33	29	–	–
6	14	100	392	35	–	–	100	51	101	100
7a	64	77	211	39	26	41	16	84	76	38
7b	12	56	11	100	38	43	191	98	105	44
8a	32	51	27	53	19	100	–	–	128	28
8b	–	–	230	34	–	–	4	100	8	100
9	1482	56	269	100	138	60	8	86	–	–
10a	–	–	25	56	–	–	16	63	110	86
10b	40	24	14	51	–	–	–	–	16	100
11a	682	39	74	61	87	48	63	69	115	67
11b	20	59	45	7	7	100	3	100	11	18
11c	5	100	9	100	37	100	10	89	34	50
11d	–	–	15	44	8	100	105	92	29	100
12	8	100	128	68	15	100	28	54	107	100
13	493	22	266	26	201	96	15	65	351	35
14	111	84	226	14	–	–	1	100	–	–
15	78	56	682	86	98	43	73	41	16	100
16	452	66	527	47	190	24	873	68	119	61
17	31	12	1	100	37	21	14	61	–	–
18	652	26	–	–	705	96	–	–	–	–
19	546	38	–	–	136	32	18	100	20	100
20	346	35	–	–	110	44	369	47	5	100
Core	6 864	15	4 270	18	2 108	34	2 030	33	1 793	15
21a	–	–	2	74	–	–	–	–	1	100
21b	–	–	15	54	–	–	–	–	14	100
22	–	–	59	29	–	–	–	–	32	27
23	–	–	–	–	–	–	–	–	17	100
24	–	–	–	–	–	–	–	–	–	–
25	–	–	46	79	–	–	–	–	17	100
28	–	–	–	–	–	–	–	–	–	–
Deep	–	–	123	33	–	–	–	–	81	36
Total	6 864	15	4 393	18	2 108	34	2 030	33	1 874	15

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 7 other key deep strata species by stratum for the 2013 survey. See Table 4 for species common names. 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	–	–	–	–	2	100	–	–	924	38
2a	1	100	1	100	1	100	–	100	1 100	7
2b	–	–	–	–	–	–	–	–	4 768	56
3	–	–	–	–	–	–	–	–	–	–
4	–	–	–	–	–	–	5 479	70	748	96
5	–	–	–	–	–	–	–	–	–	–
6	–	–	–	–	–	–	5 258	51	24	100
7a	–	–	–	–	–	–	–	–	109	48
7b	–	–	–	–	–	–	–	–	–	–
8a	–	–	–	–	–	–	–	–	–	–
8b	–	–	–	–	–	–	–	–	–	–
9	–	–	–	–	–	–	–	–	–	–
10a	–	–	–	–	–	–	–	–	121	41
10b	–	–	–	–	–	–	–	–	72	51
11a	–	–	–	–	–	–	–	–	–	–
11b	–	–	–	–	–	–	–	–	75	45
11c	–	–	–	–	–	–	–	–	8	100
11d	–	–	–	–	–	–	–	–	76	100
12	–	–	–	–	–	–	–	–	65	100
13	–	–	–	–	–	–	–	–	–	–
14	–	–	–	–	–	–	16	100	10	100
15	–	–	–	–	–	–	25	100	–	–
16	–	–	–	–	–	–	–	–	–	–
17	–	–	–	–	–	–	–	–	–	–
18	–	–	–	–	–	–	–	–	–	–
19	–	–	–	–	–	–	–	–	–	–
20	–	–	–	–	–	–	–	–	–	–
Core	1	100	1	100	3	75	10 779	43	8 100	34
21a	3	71	16	82	26	88	–	–	32	24
21b	4	53	214	29	1 393	60	–	–	1 448	56
22	20	27	102	24	282	28	1	59	126	24
23	1	58	27	55	177	13	–	–	–	–
24	0	100	48	51	467	52	1	100	24	100
25	55	91	189	83	342	61	3	100	1 624	32
28	–	–	17	59	89	59	–	–	–	–
Deep	84	59	614	28	2 776	32	5	63	3 254	30
Total	85	59	615	28	2 778	32	10 784	43	11 353	26

Table 7b (continued)

	Species code									
	SOR		SSO		ETB		CYP		RIB	
Stratum	t	CV	t	CV	t	CV	t	CV	t	CV
1	159	50	5	100	0	100	173	45	86	22
2a	44	30	4	100	14	100	286	87	112	14
2b	2 328	52	4	100	6	100	34	100	31	35
3	–	–	–	–	–	–	–	–	–	–
4	50	64	–	–	389	44	–	–	58	85
5	–	–	–	–	–	–	–	–	–	–
6	2	100	1 519	86	309	65	3	100	8	100
7a	22	100	–	–	5	100	1	100	10	41
7b	–	–	–	–	–	–	–	–	5	100
8a	–	–	–	–	–	–	–	–	3	100
8b	–	–	–	–	–	–	–	–	–	–
9	–	–	–	–	–	–	–	–	–	–
10a	450	55	–	–	–	–	–	–	2	100
10b	–	–	–	–	–	–	–	–	18	52
11a	–	–	–	–	–	–	–	–	–	–
11b	–	–	–	–	–	–	–	–	13	33
11c	–	–	–	–	–	–	–	–	–	–
11d	690	92	–	–	–	–	–	–	1	100
12	297	100	–	–	–	–	–	–	20	59
13	–	–	–	–	–	–	–	–	–	–
14	3	100	–	–	7	100	–	–	14	100
15	–	–	–	–	255	79	–	–	–	–
16	–	–	–	–	25	58	–	–	45	62
17	–	–	–	–	–	–	–	–	–	–
18	–	–	–	–	–	–	–	–	–	–
19	–	–	–	–	–	–	–	–	–	–
20	–	–	–	–	–	–	–	–	–	–
Core	4 045	35	1 532	85	1 011	33	497	53	428	16
21a	9	99	2	27	14	65	124	20	9	54
21b	160	87	15	33	8	56	795	17	86	41
22	79	44	12	56	2	62	244	22	50	33
23	2	100	722	30	115	27	22	58	–	–
24	–	–	64	90	80	14	3	100	–	–
25	43	48	65	49	86	81	578	78	63	54
28	2	100	156	53	367	42	–	–	–	–
Deep	295	49	1 035	23	673	26	1 766	27	207	25
Total	4 340	33	2 567	52	1 684	22	2 263	24	635	13

Table 8: Total numbers of fish, squid and scampi measured for length frequency distributions and biological samples from all tows (TAN1301). The total number of fish measured is sometimes greater than the sum of males and females because some fish were unsexed.

	Species code	Number measured Males	Number measured Females	Number measured Total	Number of biological samples
Alfonsino	BYS	408	505	916	445
Banded bellowsfish	BBE	0	94	1 823	13
Banded rattail	CFA	128	160	359	61
Banded stargazer	BGZ	1	0	1	1
Barracouta	BAR	33	63	96	37
Basketwork eel	BEE	215	159	482	0
Baxters lantern dogfish	ETB	222	186	408	333
Bigeye cardinalfish	EPL	28	38	67	0
Big-scale pomfret	BSP	0	1	1	1
Bigscaled brown slickhead	SBI	332	541	873	116
Black ghost shark	HYB	1	0	1	0
Black oreo	BOE	514	416	932	142
Black javelinfish	BJA	80	63	150	143
Black slickhead	BSL	73	119	482	20
Blobfish	PSY	1	1	4	0
Bluenose	BNS	6	6	12	11
Bollons's rattail	CBO	1 557	1 430	3 203	965
Brown chimaera	CHP	23	22	45	0
Cape scorpionfish	TRS	2	3	5	0
Carpet shark	CAR	1	2	3	3
Common halosaur	HPE	0	2	2	0
Common roughy	RHY	12	6	18	0
Crested bellowsfish	CBE	11	3	14	0
Deepsea cardinalfish	EPT	112	47	192	179
Electric ray	ERA	0	1	1	1
Finless flounder	MAN	0	0	1	0
Four-rayed rattail	CSU	33	108	1 731	0
Frostfish	FRO	0	5	5	5
Ghost shark	GSH	1 438	1 551	2 997	867
Giant stargazer	GIZ	95	132	228	133
Hairy conger	HCO	6	12	23	0
Hake	HAK	73	112	185	185
Hapuku	HAP	6	6	12	11
Hoki	HOK	7 785	10 204	18 022	2 174
Humpback rattail	CBA	0	14	16	9
Javelin fish	JAV	1 019	4 607	6 308	1 467
Johnson's cod	HJO	664	674	1 372	45
Kaiyomaru rattail	CKA	7	4	11	11
Leafscale gulper shark	CSQ	8	25	33	31
Lemon sole	LSO	19	36	64	34
Ling	LIN	651	652	1 303	1 285
Longfinned beryx	BYD	2	1	3	3
Longnose velvet dogfish	CYP	391	444	836	706
Longnose spookfish	LCH	235	188	424	122
Longnose deepsea skate	PSK	0	2	2	0
Lookdown dory	LDO	1 584	1 604	3 209	1 516
Lucifer dogfish	ETL	117	140	270	83
Mahia rattail	CMA	59	66	131	53

Table 8 (continued)

	Species code	Number measured Males	Number measured Females	Number measured Total	Number of biological samples
McMillan's rattail	CMX	0	0	18	0
Murray's rattail	CMU	0	0	16	0
Nezumia namatahi	NNA	1	2	4	3
Northern spiny dogfish	NSD	21	0	21	21
Notable rattail	CIN	7	34	335	0
NZ southern arrow squid	NOS	143	143	307	35
Oblique banded rattail	CAS	124	1 384	1 979	1 349
Oliver's rattail	COL	157	256	1 151	66
Orange perch	OPE	113	99	212	23
Orange roughy	ORH	774	780	1 617	543
Owston's dogfish	CYO	73	45	118	96
Pale ghost shark	GSP	490	443	950	513
Pale toadfish	TOP	0	0	2	0
Plunkets shark	PLS	5	2	7	5
Prickly dogfish	PDG	1	6	7	7
Red cod	RCO	224	140	364	198
Redbait	RBT	1	0	1	1
Ribaldo	RIB	134	70	205	141
Ribbonfish	AGR	0	1	1	0
Ridge scaled rattail	MCA	57	79	138	59
Roughhead rattail	CHY	3	2	6	6
Rough skate	RSK	2	1	3	2
Ruby fish	RBY	1	0	1	1
Rudderfish	RUD	20	9	29	24
Scampi	SCI	41	23	64	0
School shark	SCH	4	6	10	10
Sea perch	SPE	1 275	1 305	3 238	1 308
Seal shark	BSH	33	35	68	56
Serrulate rattail	CSE	73	32	323	24
Shovelnose spiny dogfish	SND	560	838	1 398	963
Silver dory	SDO	37	27	95	0
Silver roughy	SRH	18	8	70	0
Silver warehou	SWA	496	597	1 094	517
Silverside	SSI	29	6	382	0
Slender jack mackerel	JMM	2	1	4	3
Small-headed cod	SMC	6	2	9	0
Smallscaled brown slickhead	SSM	256	234	490	26
Smooth oreo	SSO	353	367	720	297
Smooth skate	SSK	21	21	42	35
Southern blue whiting	SBW	58	48	227	130
Southern rays bream	SRB	113	111	227	161
Spiky oreo	SOR	733	672	1 433	314
Spineback	SBK	42	393	524	0
Spiny dogfish	SPD	250	1 001	1 259	554
Spotty faced rattail	CTH	22	39	61	61
Striate rattail	CTR	0	0	5	0
Swollenhead conger	SCO	3	9	27	0
Tarakihi	NMP	4	2	6	6
Thin tongue cardinalfish	EPM	9	10	102	0

Table 8 (continued)

	Species code	Number measured Males	Number measured Females	Number measured Total	Number of biological samples
Two saddle rattail	CBI	65	94	240	111
Unicorn rattail	WHR	28	44	72	72
Velvet dogfish	ZAS	1	0	1	1
Violet cod	VCO	0	0	4	0
Warty oreo	WOE	59	53	112	9
Warty squid (*Onykia ingens*)	MIQ	2	1	3	0
White cardinalfish	EPD	0	5	68	0
White rattail	WHX	247	233	488	78
White warehou	WWA	312	218	541	363
Pacific spookfish	RCH	42	19	61	14
Total		25 497	34 405	68 236	19 481

Table 9: Length-weight regression parameters* used to scale length frequencies (all data from TAN1301).

Species	*a* (intercept)	*b* (slope)	r^2	*n*	Length range (cm)
Baxter's dogfish	0.004123	3.059520	0.98	322	25–77
Black oreo	0.053393	2.706913	0.90	140	22–38
Dark ghost shark	0.003747	3.119359	0.95	699	29–69
Giant stargazer	0.014663	3.037573	0.99	127	10–81
Hake	0.001558	3.343141	0.99	180	39–129
Hoki	0.003099	2.987576	0.99	2 156	36–114
Ling	0.001105	3.323368	0.99	1 204	28–178
Longnose velvet dogfish	0.002363	3.148041	0.99	588	31–95
Lookdown dory	0.024052	2.968930	0.99	1 343	11–57
Orange roughy	0.055987	2.838198	0.99	541	9–41
Pale ghost shark	0.005420	3.014748	0.98	488	32–89
Ribaldo	0.012288	2.968697	0.93	140	35–73
Sea perch	0.012654	3.060484	0.99	1 052	11–48
Silver warehou	0.022491	2.955869	0.91	516	35–56
Smooth oreo	0.038374	2.836293	0.98	256	16–50
Spiny dogfish	0.000699	3.435752	0.95	526	55–97
Spiky oreo	0.022260	3.003344	0.98	308	11–42
White warehou	0.015363	3.096525	0.99	363	16–60

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

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

Common name	Sex	Staging	Reproductive stage							
		method	1	2	3	4	5	6	7	Total
Alfonsino	Male	MD	5	9	–	–	–	–	–	14
	Female		–	16	1	–	–	–	–	17
Barracouta	Male	MD	–	1	1	–	–	–	–	2
	Female		–	–	–	1	–	–	–	1
Baxter's dogfish	Male	SS	57	63	52	–	–	–	–	172
	Female		28	74	16	5	22	7	–	152
Black oreo	Male	MD	40	20	3	–	1	1	–	65
	Female		30	6	19	–	–	–	–	55
Carpet shark	Male	SS	–	–	1	–	–	–	–	1
	Female		2	–	–	–	–	–	–	2
Dark ghost shark	Male	SS	140	109	128	–	–	–	–	377
	Female		173	98	43	18	–	–	–	332
Giant stargazer	Male	MD	–	1	–	–	–	–	–	1
	Female		1	5	1	–	–	6	1	14
Hake	Male	MD	29	9	5	9	19	1	1	73
	Female		17	41	41	2	1	1	9	112
Hapuku	Male	MD	1	–	–	–	–	–	–	1
	Female		1	1	–	–	–	–	–	2
Hoki	Male	MD	366	376	1	1	–	1	–	745
	Female		515	899	–	–	–	–	1	1415
Humpback rattail	Male	MD	–	–	–	–	–	–	–	–
	Female		2	4	1	–	–	–	–	7
Kaiyomaru rattail	Male	MD	1	6	–	–	–	–	–	7
	Female		–	–	4	–	–	–	–	4
Leafscale gulper shark	Male	SS	3	1	3	–	–	–	–	7
	Female		3	11	7	–	1	–	–	22
Ling	Male	MD	258	234	56	71	–	–	–	619
	Female		273	345	6	3	–	–	–	627
Longnose spookfish	Male	SS	17	14	26	–	–	–	–	47
	Female		24	7	5	11	–	–	–	47
Longnose velvet dogfish	Male	SS	149	66	55	–	–	–	–	270
	Female		180	99	46	7	3	1	–	336
Lookdown dory	Male	MD	2	2	7	19	–	–	–	30
	Female		20	2	42	–	–	–	12	76
Lucifer dogfish	Male	SS	11	22	15	–	–	–	–	48
	Female		12	14	7	1	–	–	–	34
Mahia rattail	Male	MD	–	5	–	–	–	–	–	5
	Female		5	9	–	–	–	–	–	14
Nezumia namatahi	Male	MD	–	–	–	–	–	–	–	–
	Female		–	1	1	–	–	–	–	2
Northern spiny dogfish	Male	SS	–	21	–	–	–	–	–	21
	Female		–	–	–	–	–	–	–	–
Orange roughy	Male	MD	127	90	17	–	–	–	–	234
	Female		99	54	142	–	–	–	–	295
Pale ghost shark	Male	SS	126	25	137	–	–	–	–	288
	Female		101	50	30	29	1	–	–	211
Plunket's shark	Male	SS	3	–	–	–	–	–	–	3
	Female		1	–	–	1	–	–	–	2
Prickly dogfish	Male	SS	–	–	1	–	–	–	–	1
	Female		–	2	–	2	–	–	–	4
Red cod	Male	MD	1	8	1	–	–	–	–	10
	Female		1	6	–	–	–	1	3	11

Table 10 (continued)

Common name	Sex	Staging method	Reproductive stage 1	2	3	4	5	6	7	Total
Ribaldo	Male	MD	1	9	9	–	–	–	–	19
	Female		2	6	1	–	–	–	1	10
Roughhead rattail	Male	MD	–	8	2	–	–	–	–	10
(*C. acanthiger*)	Female		2	16	4	–	–	–	–	22
Rough skate	Male	SS	2	–	–	–	–	–	–	2
	Female		–	–	–	–	–	–	–	0
Rudderfish	Male	MD	1	–	1	1	–	–	–	3
	Female		–	1	–	–	–	–	–	1
School shark	Male	SS	–	1	1	–	–	–	–	2
	Female		–	–	–	–	–	3	–	3
Sea perch	Male	MD	–	6	2	–	–	–	–	8
	Female		1	5	–	–	–	–	–	6
Seal Shark	Male	SS	19	2	5	–	–	–	–	26
	Female		24	2	–	–	–	2	–	28
Serrulate rattail	Male	MD	–	8	–	–	–	–	–	8
	Female		–	2	1	–	–	–	–	3
Shovelnose dogfish	Male	SS	90	95	152	–	–	–	–	337
	Female		174	310	39	8	1	1	–	533
Silver warehou	Male	MD	–	31	–	–	–	–	–	31
	Female		–	37	14	–	–	–	–	51
Smooth oreo	Male	MD	81	15	18	12	15	7	3	151
	Female		81	18	32	2	–	–	8	141
Smooth skate	Male	SS	10	3	5	–	–	–	–	18
	Female		10	4	1	–	–	–	–	15
Smooth skin dogfish	Male	SS	3	14	42	–	–	–	–	59
	Female		11	17	6	2	1	–	–	37
Spiky oreo	Male	MD	7	13	1	2	–	–	6	29
	Female		6	2	26	1	–	–	15	50
Spiny dogfish	Male	SS	1	84	28	–	–	–	–	113
	Female		35	124	25	84	157	3	–	428
Tarakihi	Male	MD	–	–	–	–	–	–	–	–
	Female		1	–	–	–	–	–	–	1
Unicorn rattail	Male	MD	6	13	9	–	–	–	–	28
	Female		2	6	36	–	–	–	–	44
Velvet dogfish	Male	SS	–	–	1	–	–	–	–	1
	Female		–	–	–	–	–	–	–	–
Warty oreo	Male	MD	–	–	–	–	1	–	–	1
	Female		–	1	2	–	–	–	–	3
White warehou	Male	MD	1	13	–	–	–	–	–	14
	Female		–	2	3	–	–	–	–	5
Pacific spookfish	Male	SS	4	2	7	–	–	–	–	13
	Female		–	1	–	–	–	–	–	1

Middle depths 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 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: Percent occurrence of seven mark types during the 2013 Chatham Rise trawl survey compared to results from previous surveys.

				Pelagic marks			Bottom marks		
Acoustic file	Year	*n*	Surface Layer	School	Layer	Cloud	Layer	Cloud	School
Day trawl	2003	123	64	41	85	55	47	47	22
	2005	111	57	37	93	31	60	42	23
	2006	102	59	40	88	44	67	36	16
	2007	112	71	42	77	45	46	46	8
	2008	110	63	39	83	56	58	41	9
	2009	110	63	40	78	53	75	33	13
	2010	111	59	32	73	59	73	41	6
	2011	102	61	37	71	61	50	50	6
	2012	115	82	31	79	64	82	41	5
	2013	107	41	34	92	83	72	57	13
Day steam	2003	66	80	55	97	49	83	35	24
	2005	78	71	45	95	37	76	45	35
	2006	79	76	47	95	42	87	37	16
	2007	81	78	44	91	40	69	43	15
	2008	82	67	46	91	48	77	28	20
	2009	99	63	56	80	45	81	42	21
	2010	109	71	50	79	63	82	37	8
	2011	100	80	32	79	76	59	60	4
	2012	130	92	38	91	68	86	44	14
	2013	127	44	20	93	90	76	60	8
Night steam and trawl	2003	44	100	14	18	93	30	96	2
	2005	30	100	33	53	77	57	83	7
	2006	33	94	15	48	88	45	85	6
	2007	51	100	10	25	92	20	80	4
	2008	46	100	2	20	83	24	87	2
	2009	93	96	11	18	78	40	68	4
	2010	117	97	6	19	86	43	77	5
	2011	125	97	6	26	90	26	74	2
	2012	121	99	5	20	93	39	74	2
	2013	94	96	14	64	94	51	66	5

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, 2001–13.

			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

Table 13: 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

Table 14: 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 13) 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})
Survey	Year	Unstratified		Northeast		Northwest		Southeast		Southwest		Stratified	
		Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
TAN0101	2002	47.1	8	21.8	11	61.1	13	36.8	12	92.6	16	44.9	8
TAN0201	2003	35.8	6	25.1	11	40.3	11	29.6	13	54.7	13	34.0	7
TAN0301	2004	40.6	10	30.3	23	32.0	12	52.4	19	53.9	11	42.9	10
TAN0501	2005	30.4	7	28.4	12	44.5	21	25.2	8	29.5	23	29.3	7
TAN0601	2006	37.0	6	30.7	10	47.9	12	38.1	12	36.7	19	36.4	7
TAN0701	2007	32.4	7	23.0	10	43.3	12	27.2	13	35.9	20	29.2	7
TAN0801	2008	29.1	6	17.8	5	27.9	19	38.1	10	36.2	12	29.8	6
TAN0901	2009	44.7	10	22.4	22	54.3	12	39.3	16	84.8	18	43.8	9
TAN1001	2010	27.0	8	16.5	11	33.4	11	35.1	17	34.0	24	28.5	10
TAN1101	2011	21.4	9	23.4	15	27.2	14	12.6	23	15.8	17	18.5	9
TAN1201	2012	30.8	8	17.6	13	41.1	34	33.5	11	51.1	12	32.3	8
TAN1301	2013	28.8	7	15.5	15	45.9	12	27.3	13	31.7	13	26.3	7

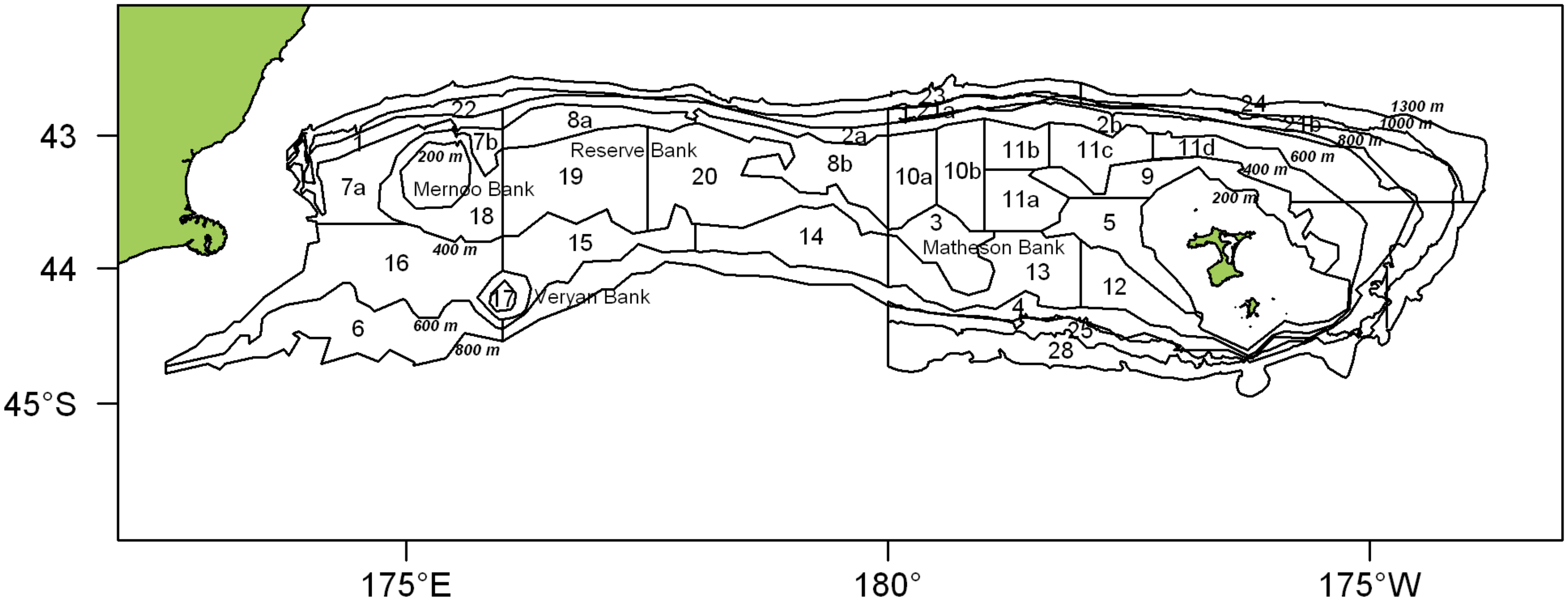


Figure 1: Chatham Rise trawl survey area showing stratum boundaries.

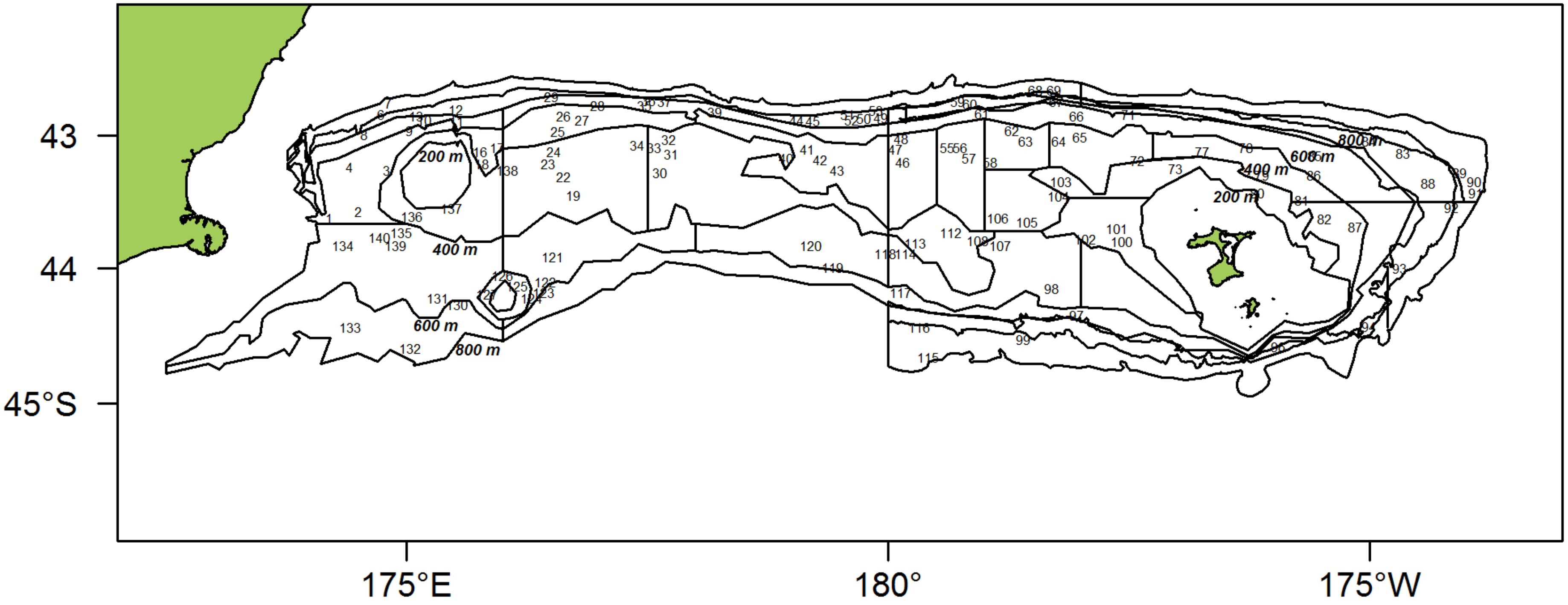


Figure 2: Trawl survey area showing positions of valid biomass stations (n = 123 stations) for TAN1301. In this and subsequent figures actual stratum boundaries are drawn for the deepwater strata. These boundaries sometimes overlap with existing core survey stratum boundaries.

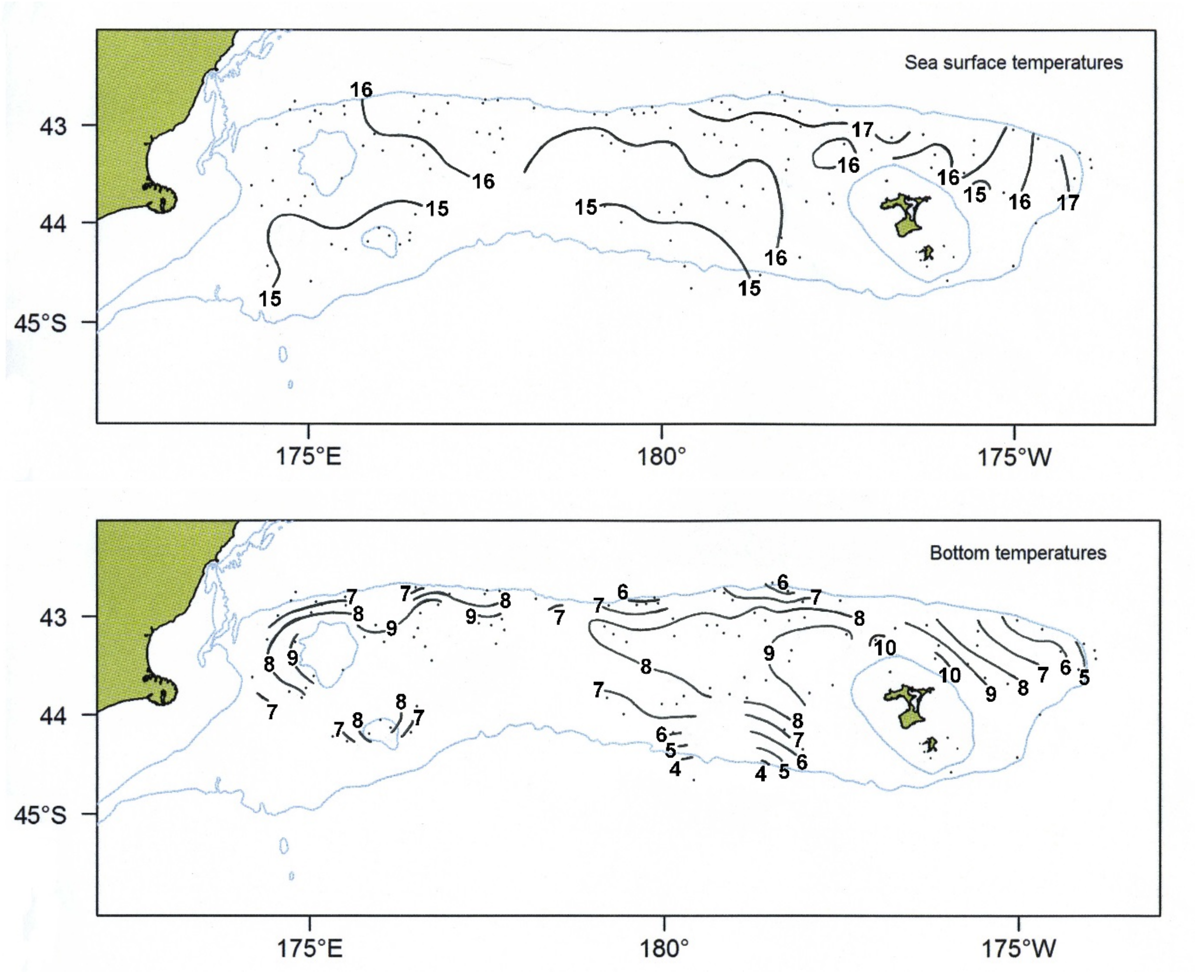


Figure 3: Positions of sea surface and bottom temperature recordings and approximate location of isotherms (^{o}C) interpolated by eye for TAN1301. The temperatures shown are from the calibrated Seabird CTD recordings made during each tow.

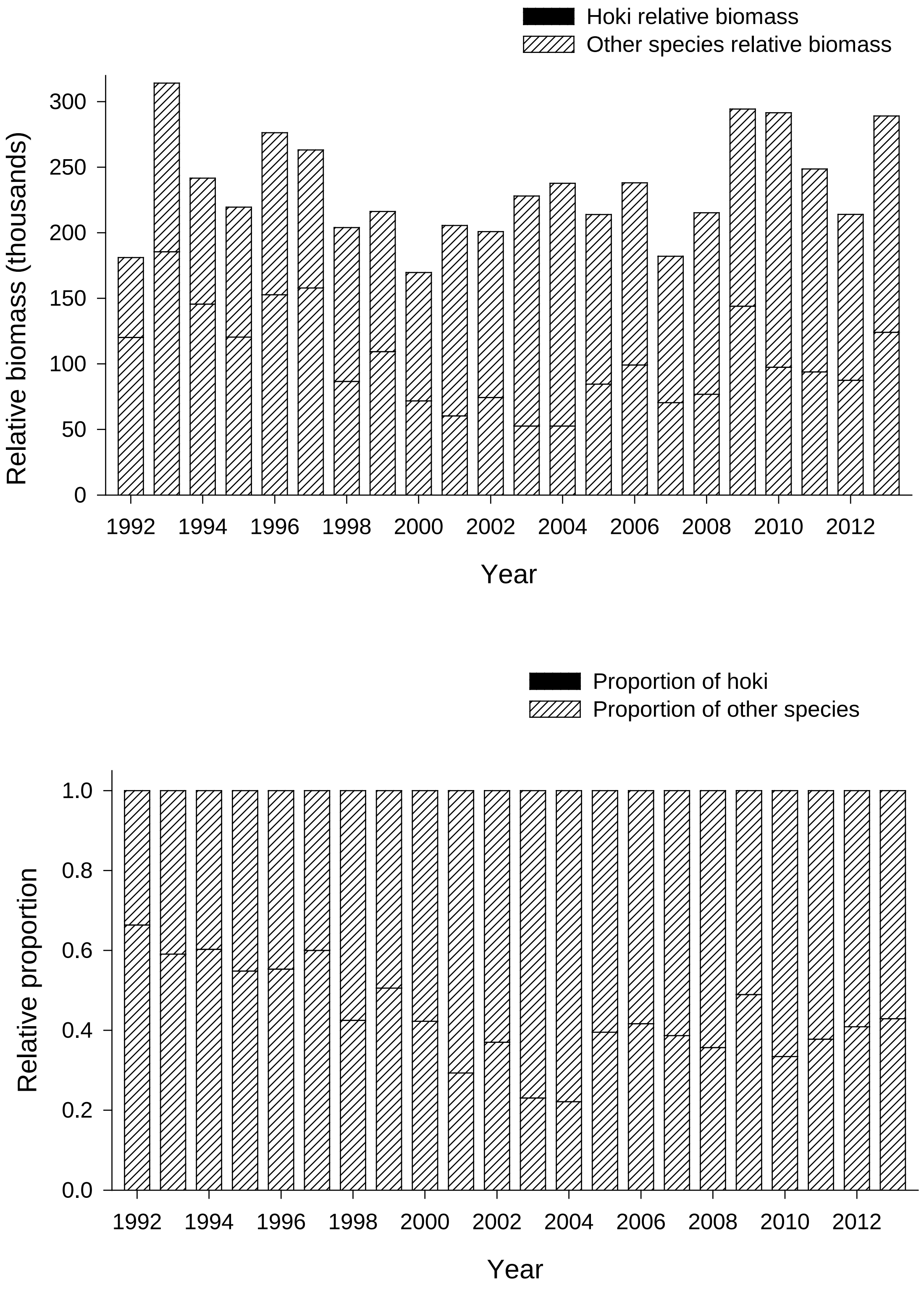


Figure 4: Relative biomass (top panel) and relative proportions of hoki and 30 other key species (lower panel) from trawl surveys of the Chatham Rise, January 1992–2013 (core strata only).

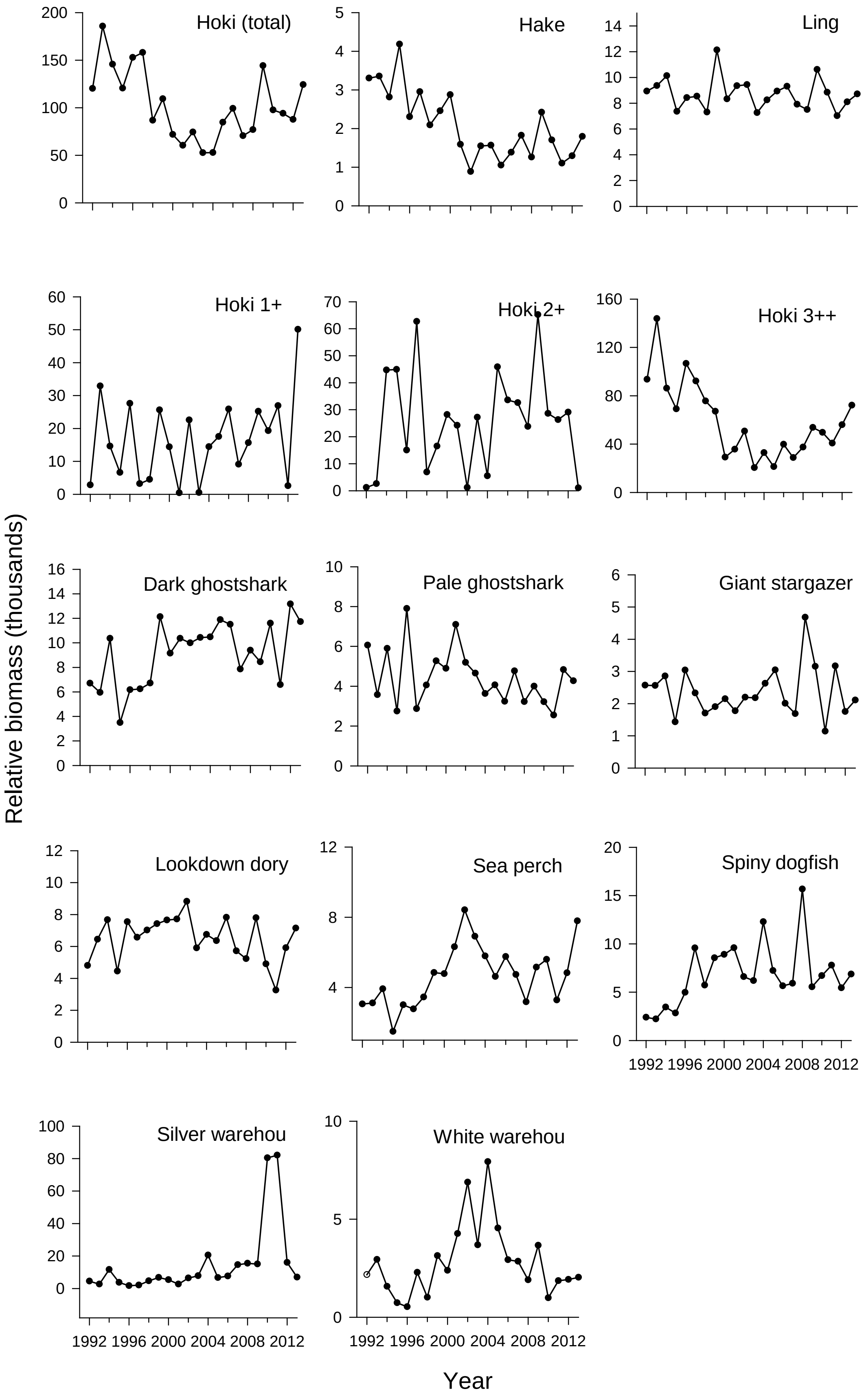


Figure 5: Relative biomass estimates (thousands of tonnes) of important species sampled by annual trawl surveys of the Chatham Rise, January 1992–2013 (core strata only).

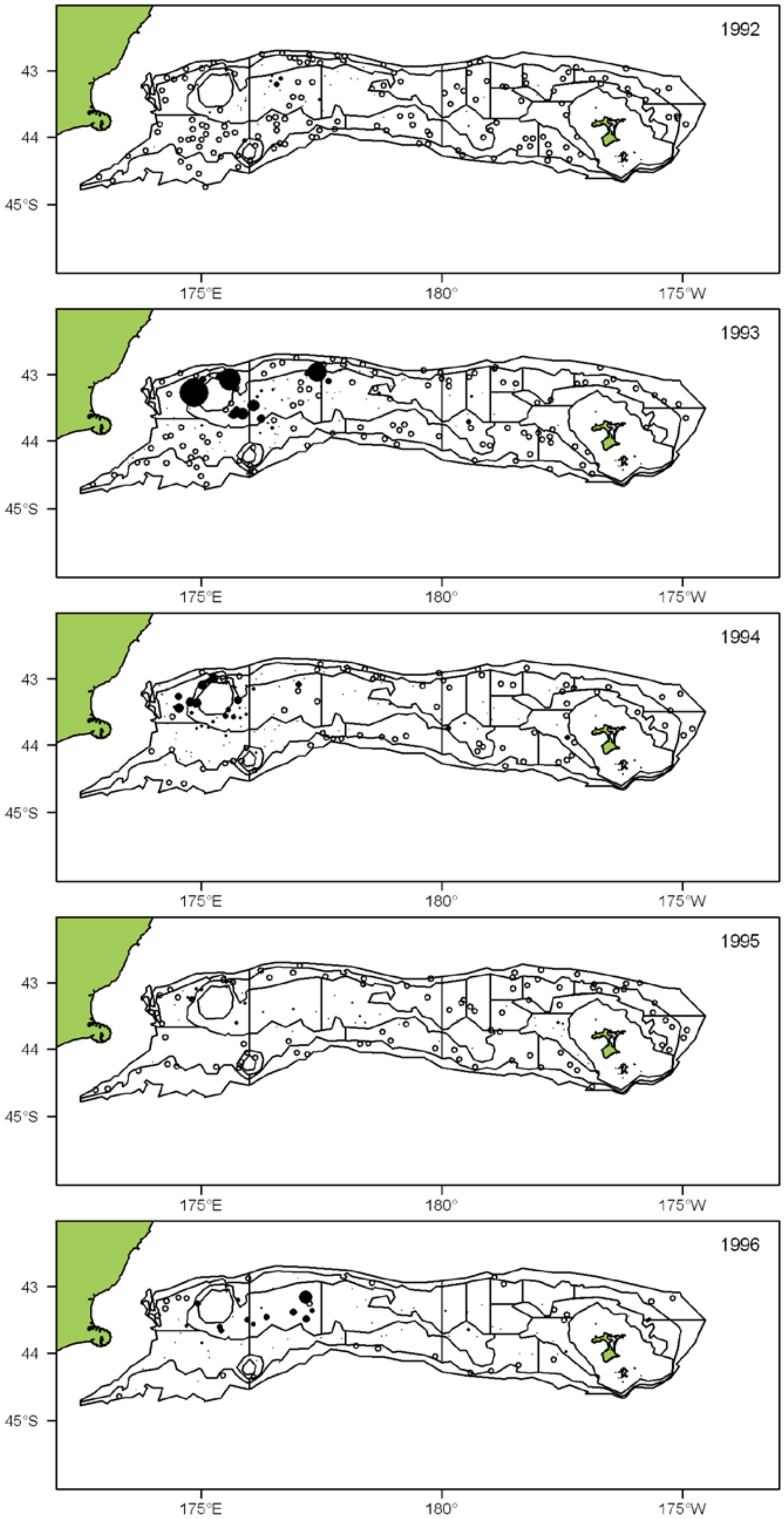


Figure 6a: Hoki 1+ catch distribution 1992–2013. Filled circle area is proportional to catch rate (kg.km^{-2}). Open circles are zero catch. Maximum catch rate in series is 30 850 kg.km^{-2}.

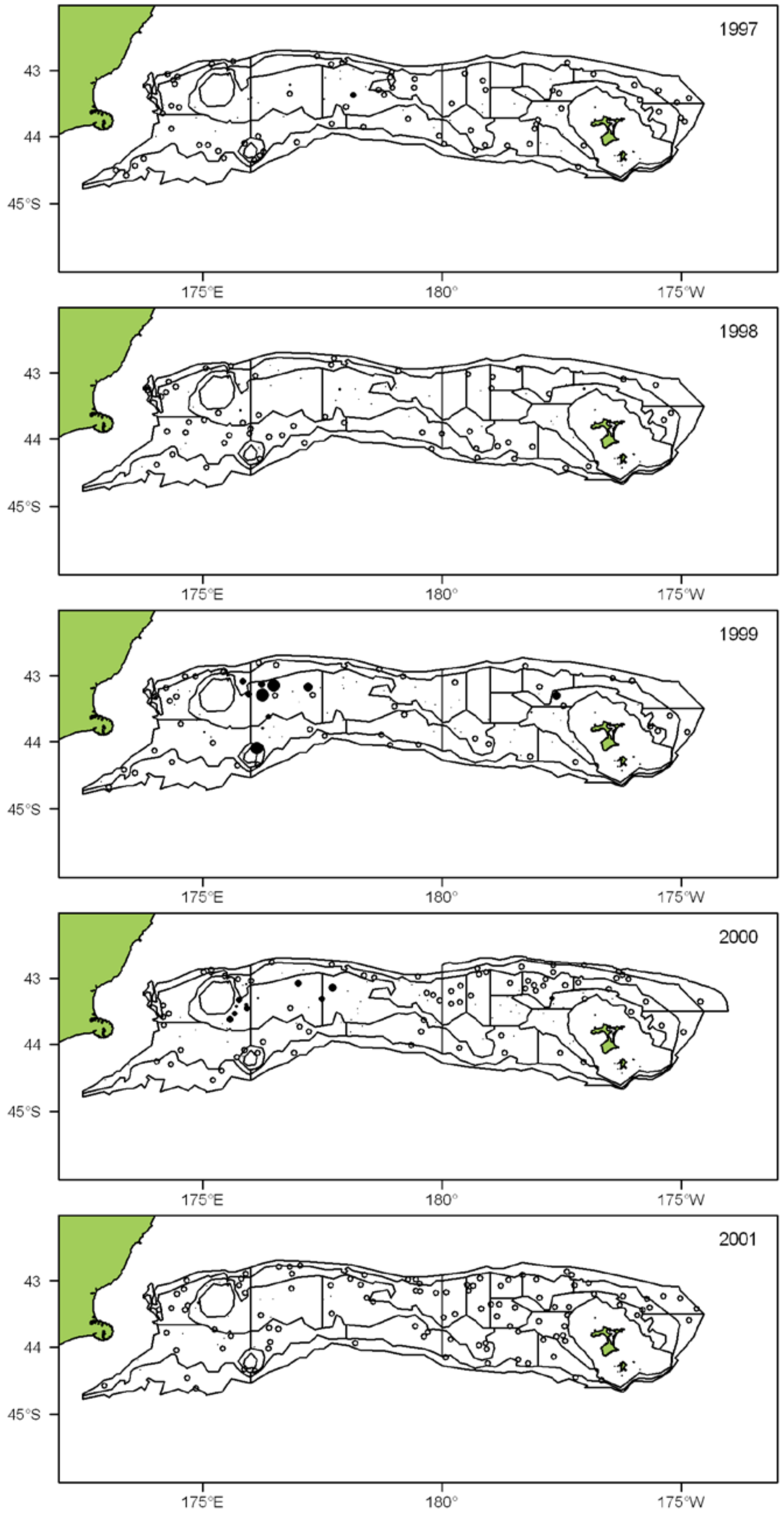


Figure 6a (continued)

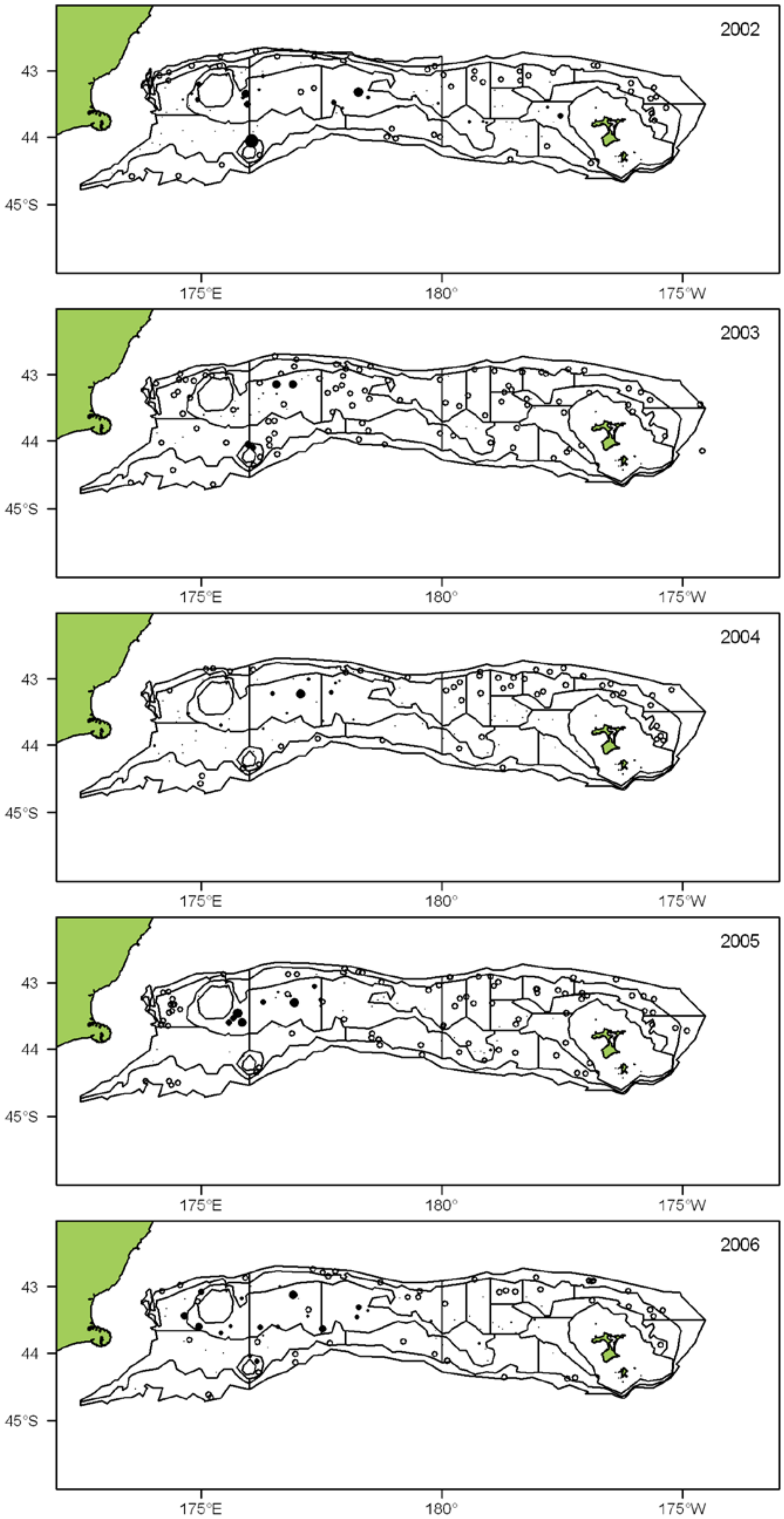


Figure 6a (continued)

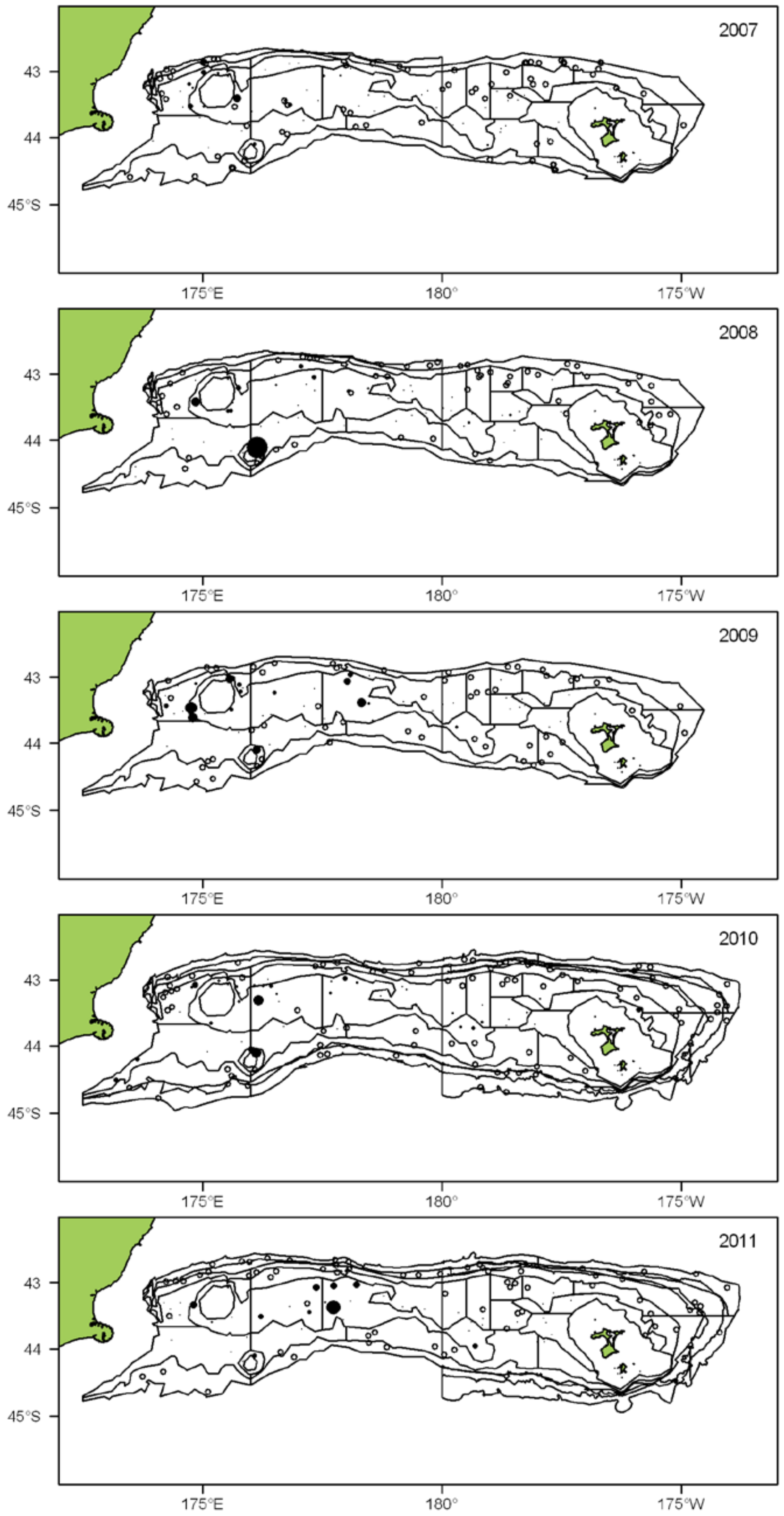


Figure 6a (continued)

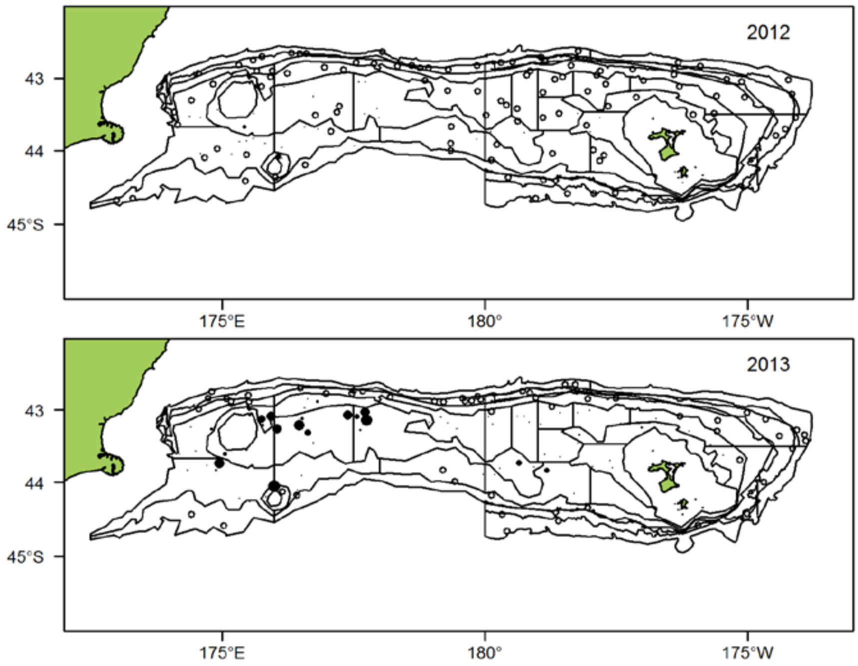


Figure 6a (continued)

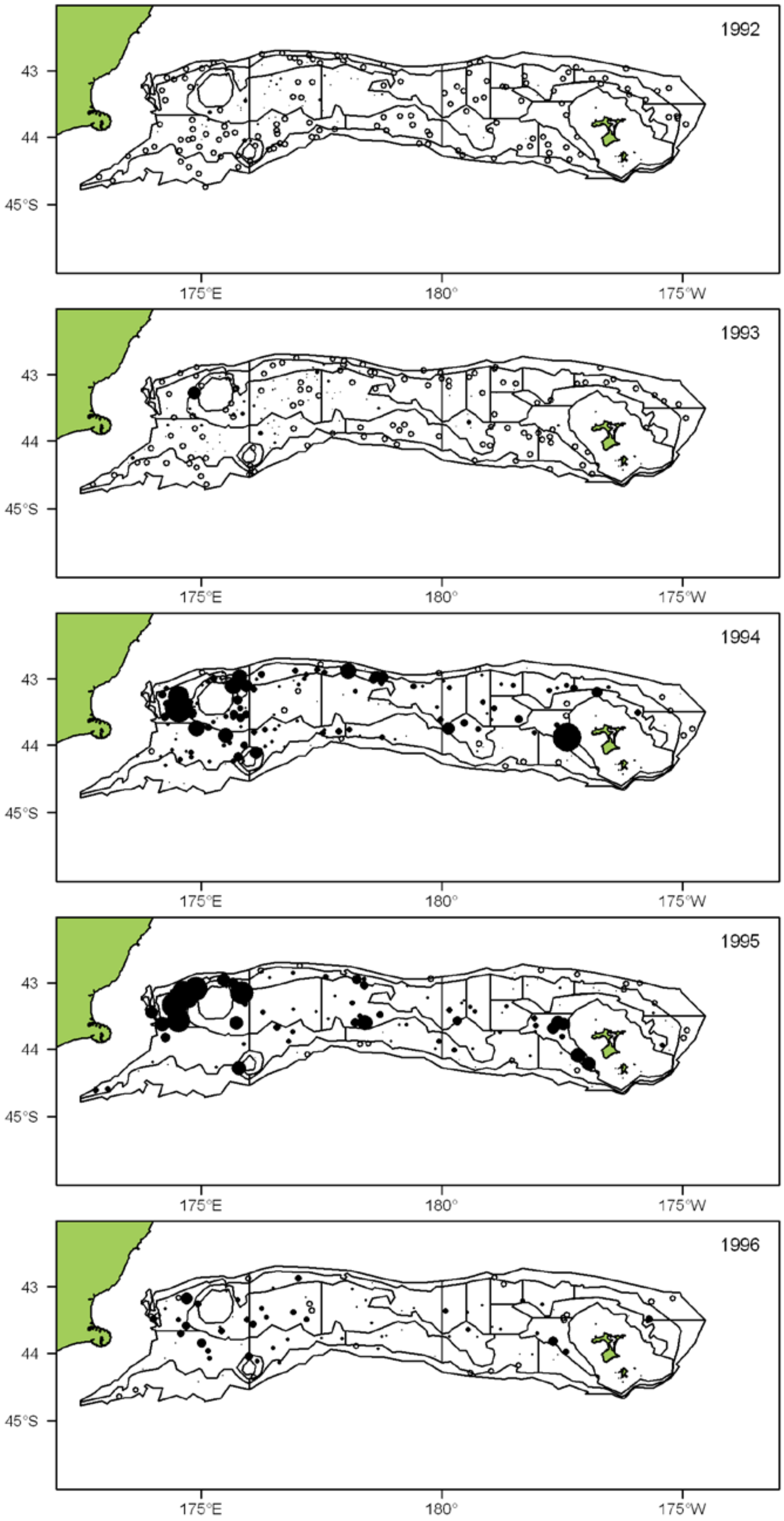


Figure 6b: Hoki 2+ catch distribution 1992–2013. Filled circle area is proportional to catch rate (kg.km^{-2}). Open circles are zero catch. Maximum catch rate in series is 6791 kg.km^{-2}.

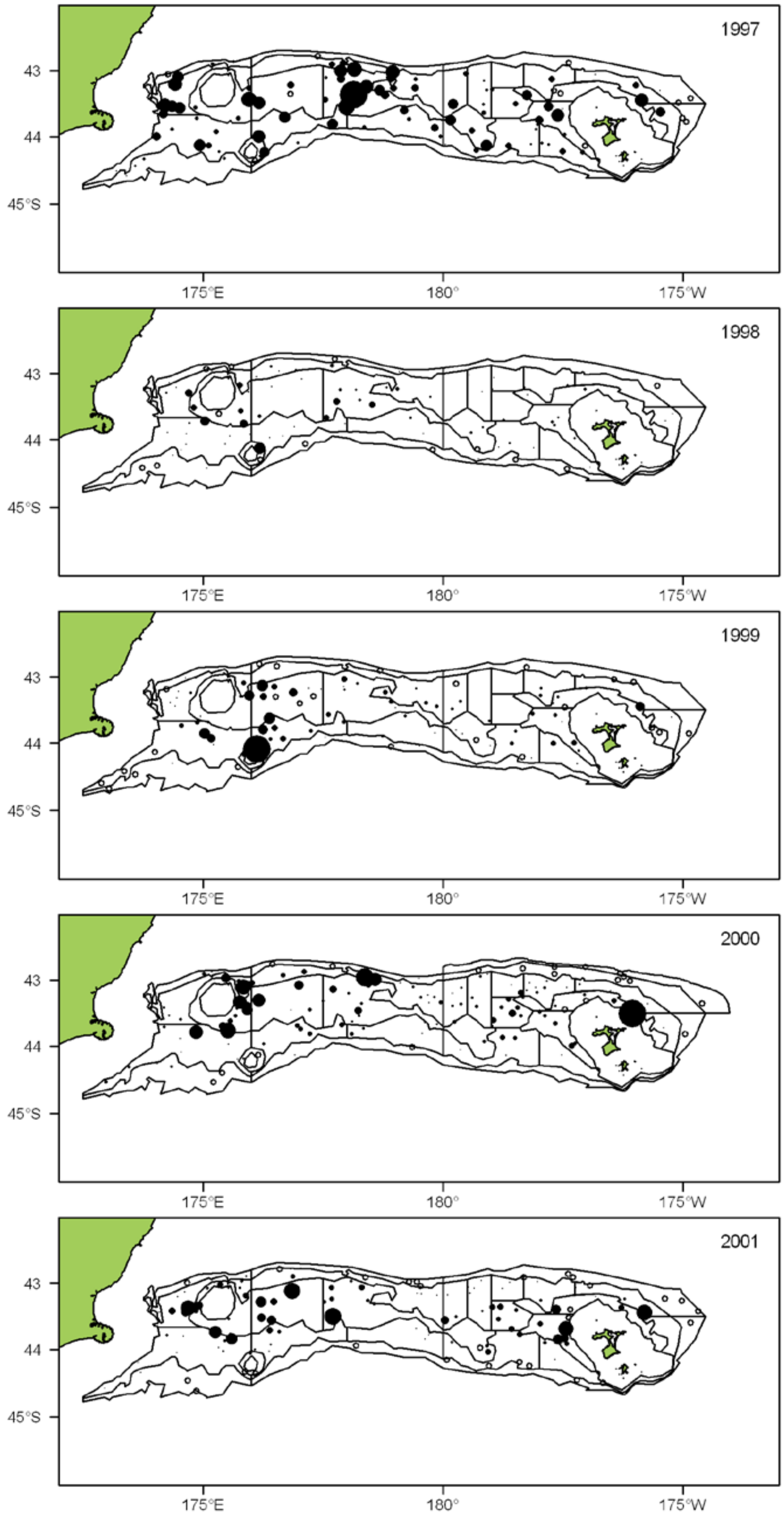


Figure 6b (continued)

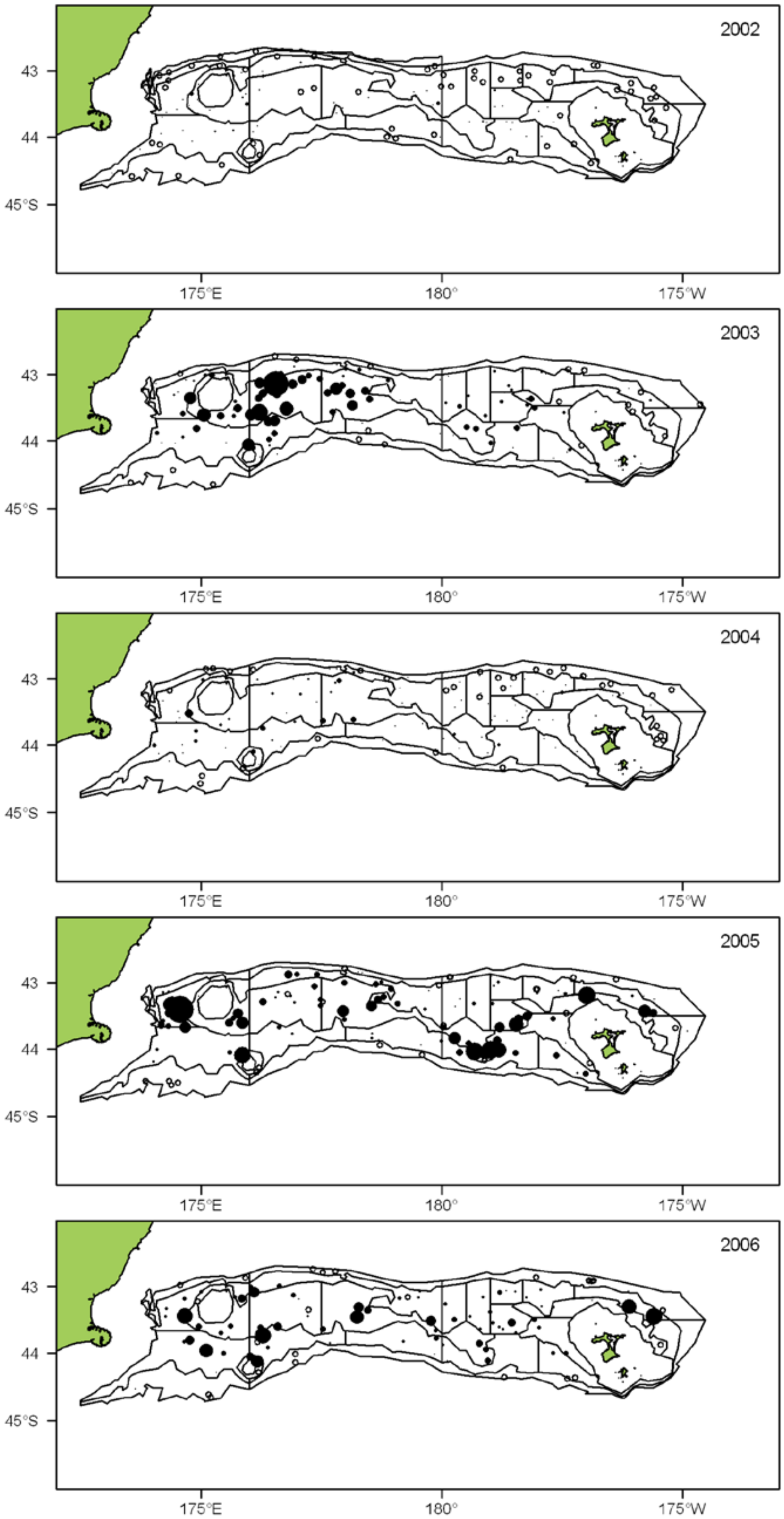


Figure 6b (continued)

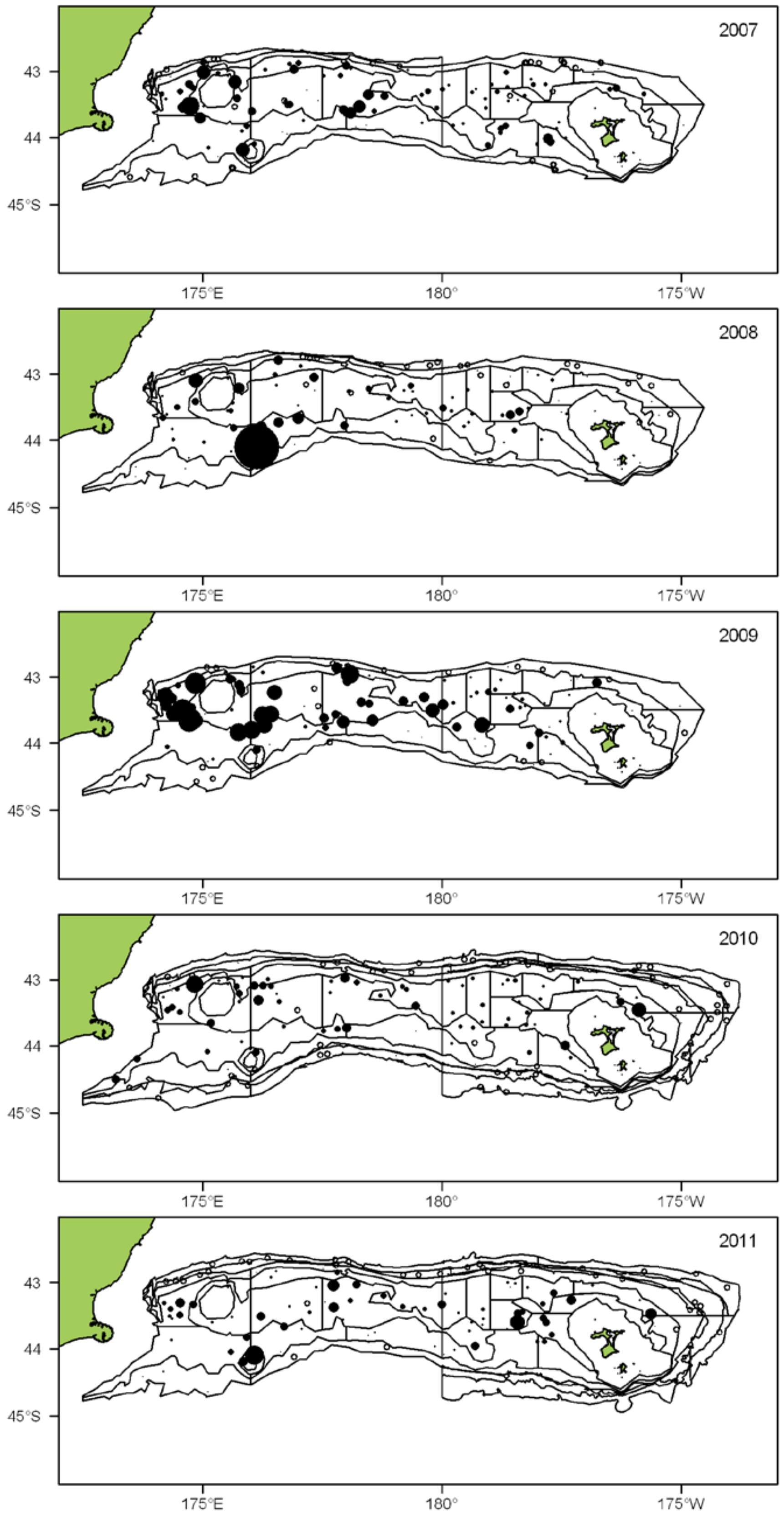


Figure 6b (continued)

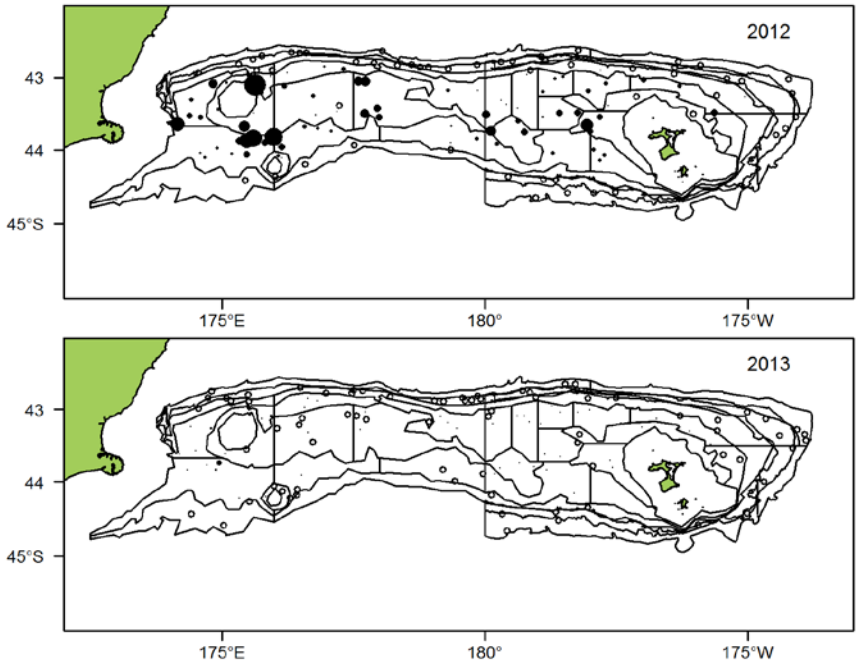


Figure 6b (continued)

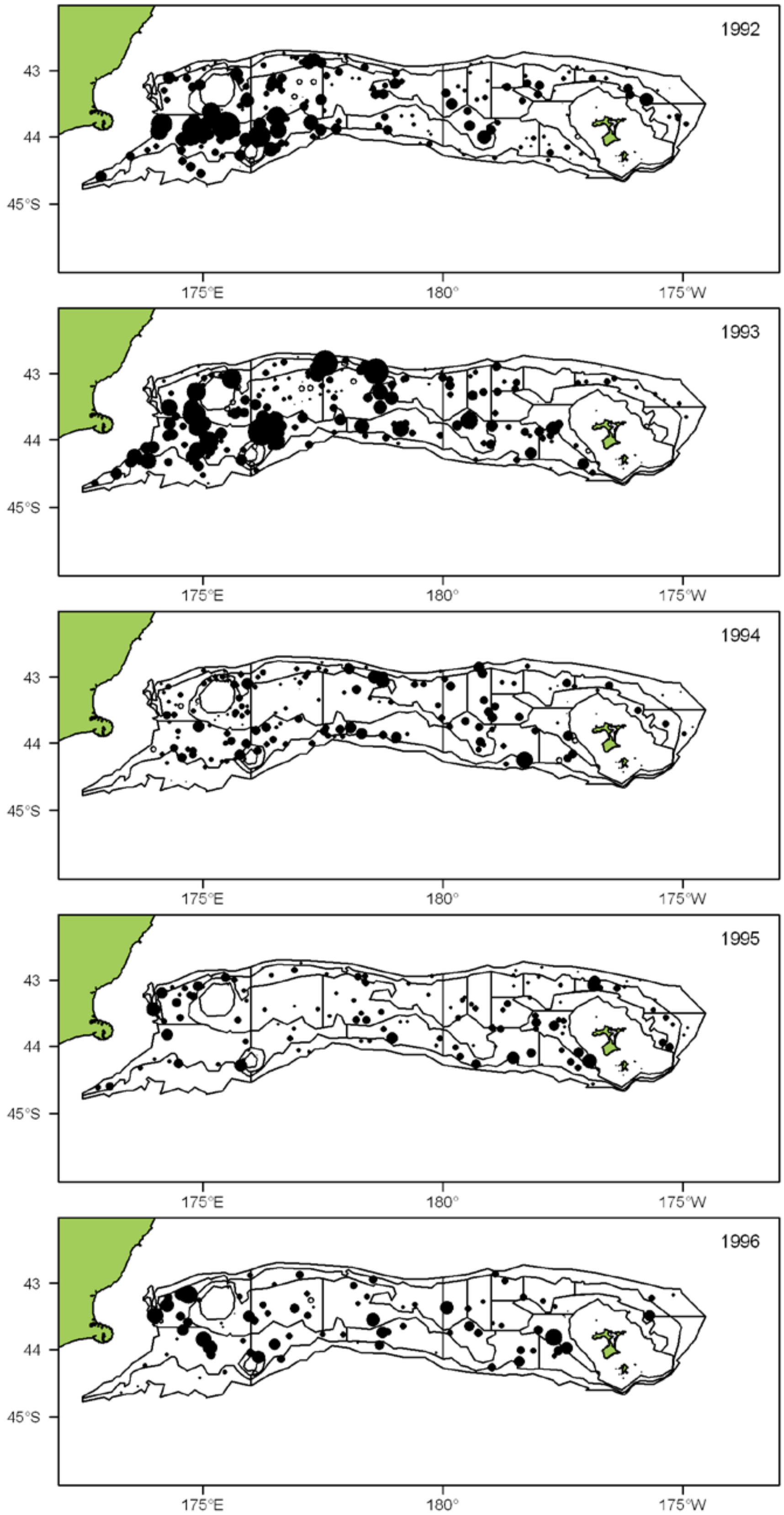


Figure 6c: Hoki 3++ catch distribution. 1992–2013. Filled circle area is proportional to catch rate (kg.km^{-2}). Open circles are zero catch. Maximum catch rate in series is 11 177 kg.km^{-2}.

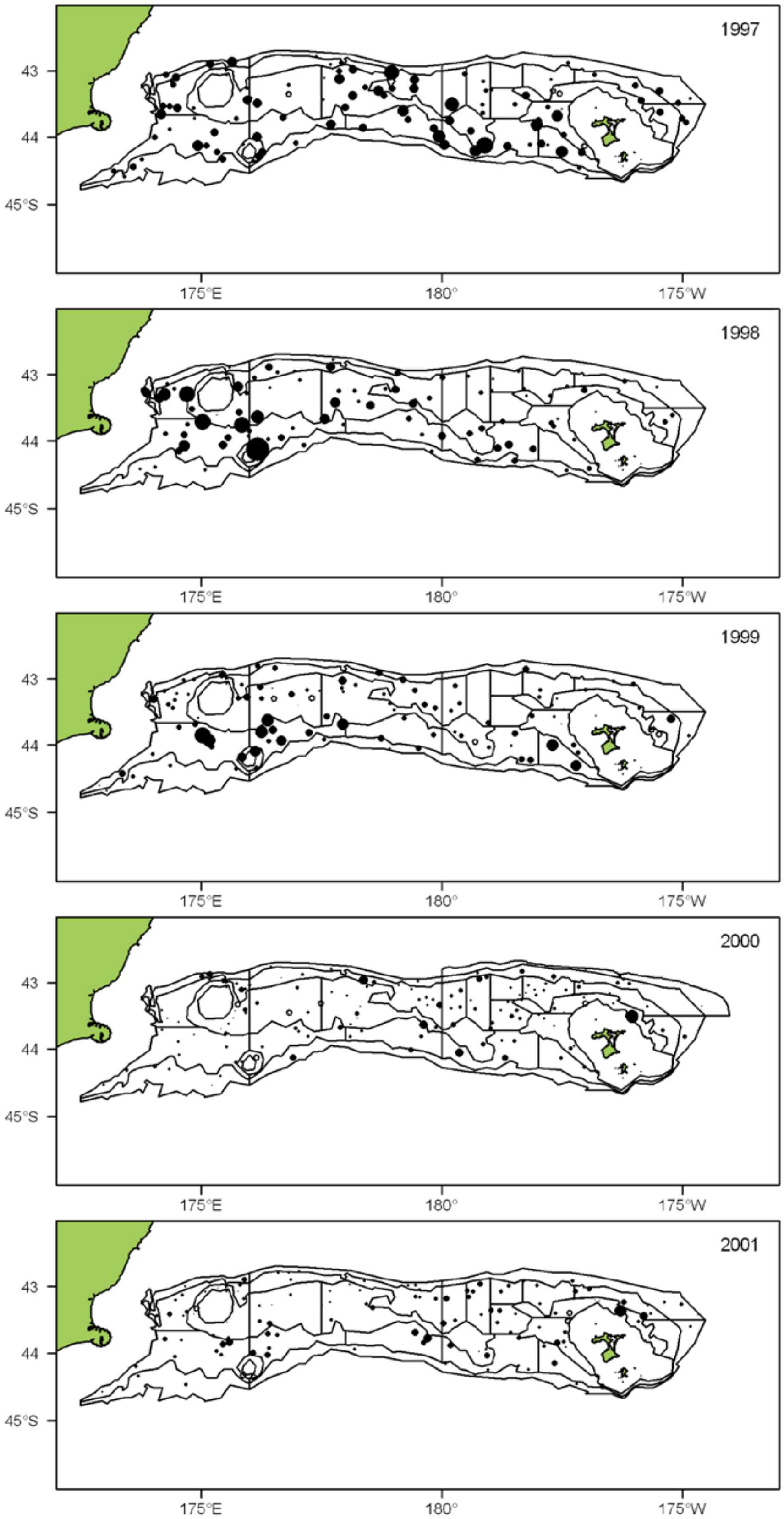
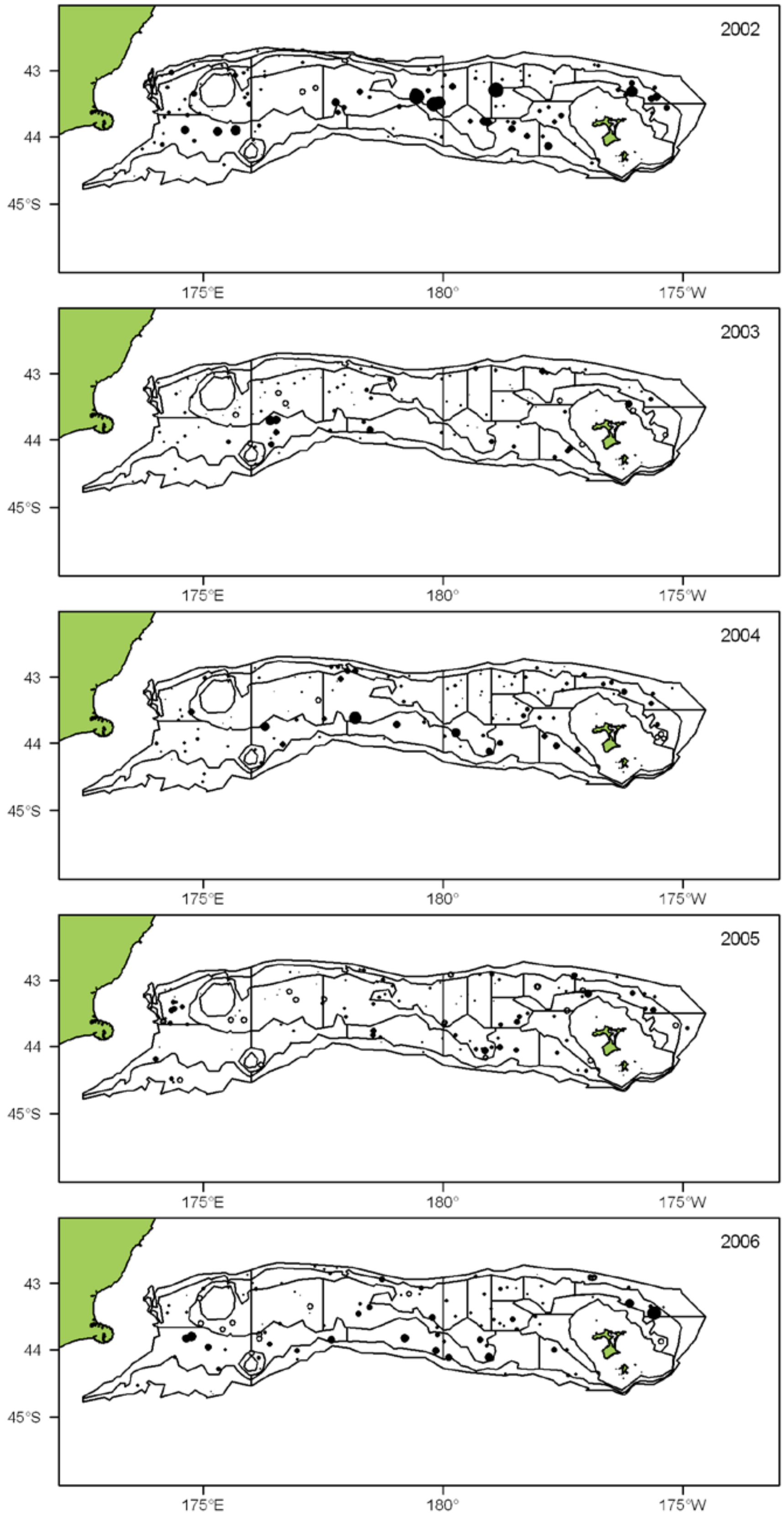


Figure 6c (continued)



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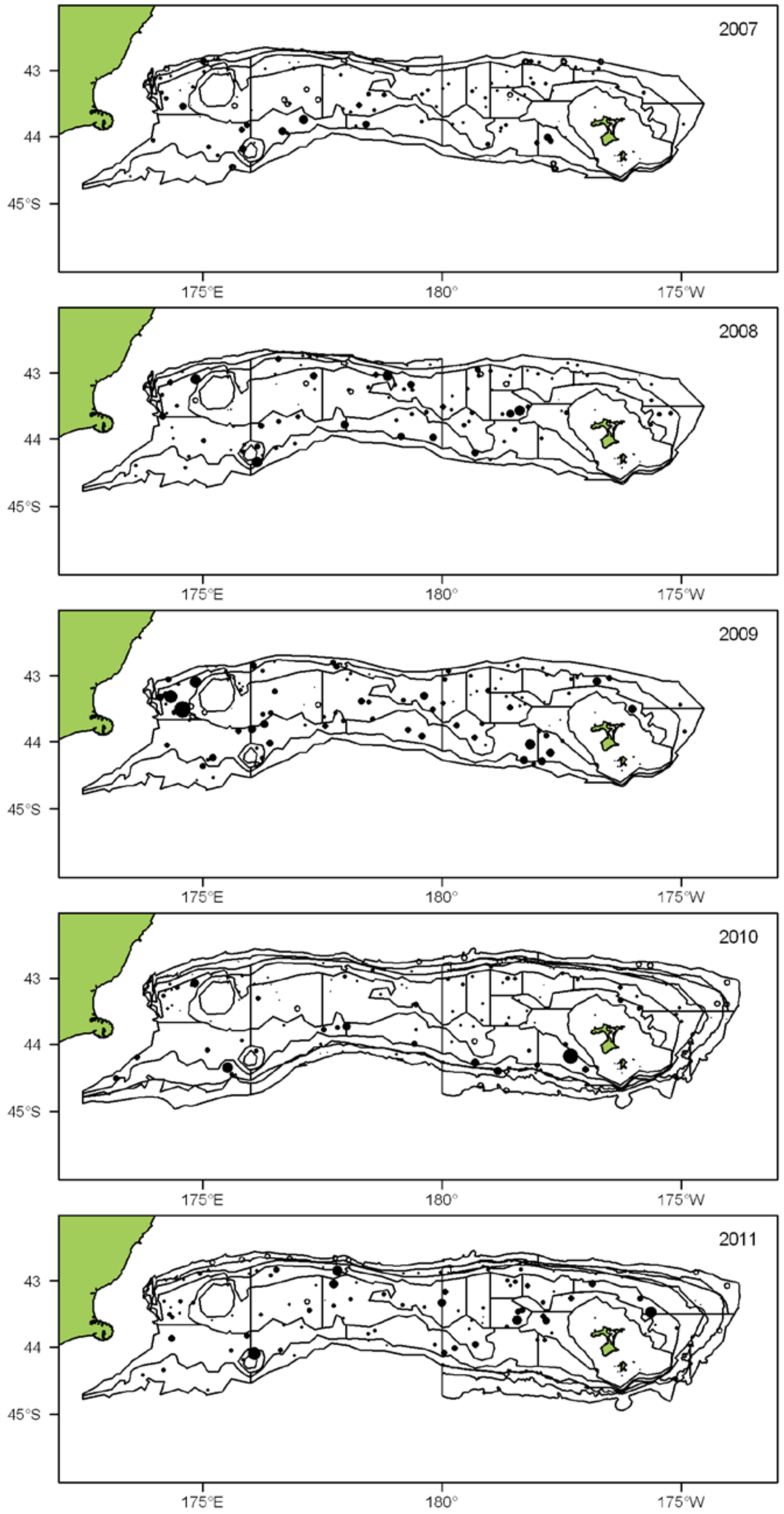

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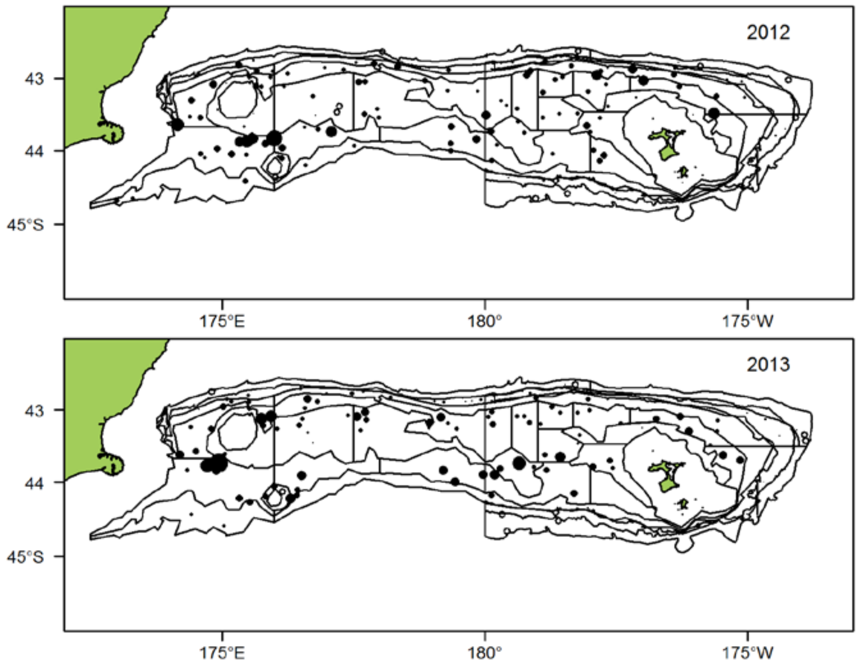


Figure 6c (continued)

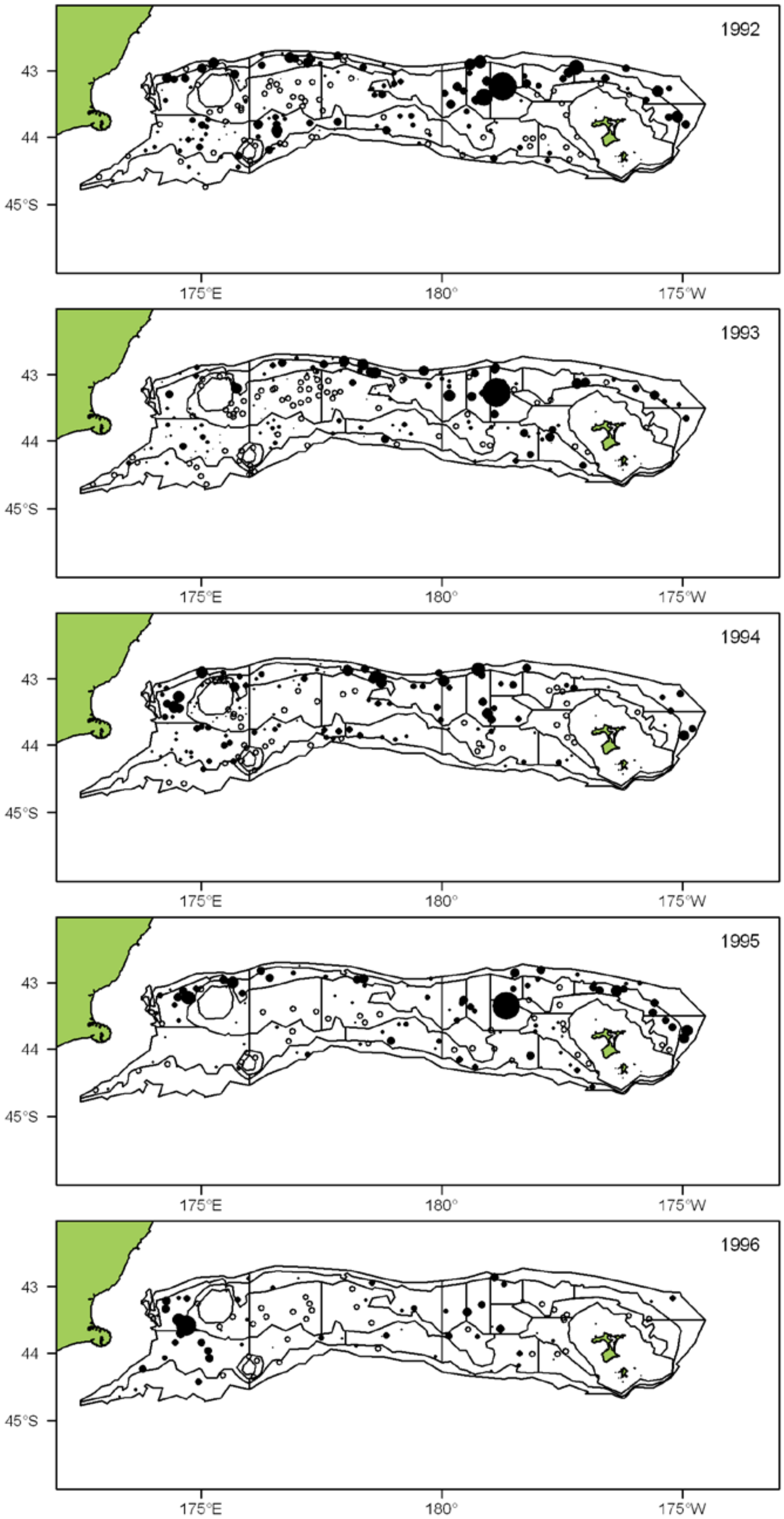


Figure 7: Hake catch distribution 1992–2013. Filled circle area is proportional to catch rate (kg.km^{-2}). Open circles are zero catch. Maximum catch rate in series is 620 kg.km^{-2}.

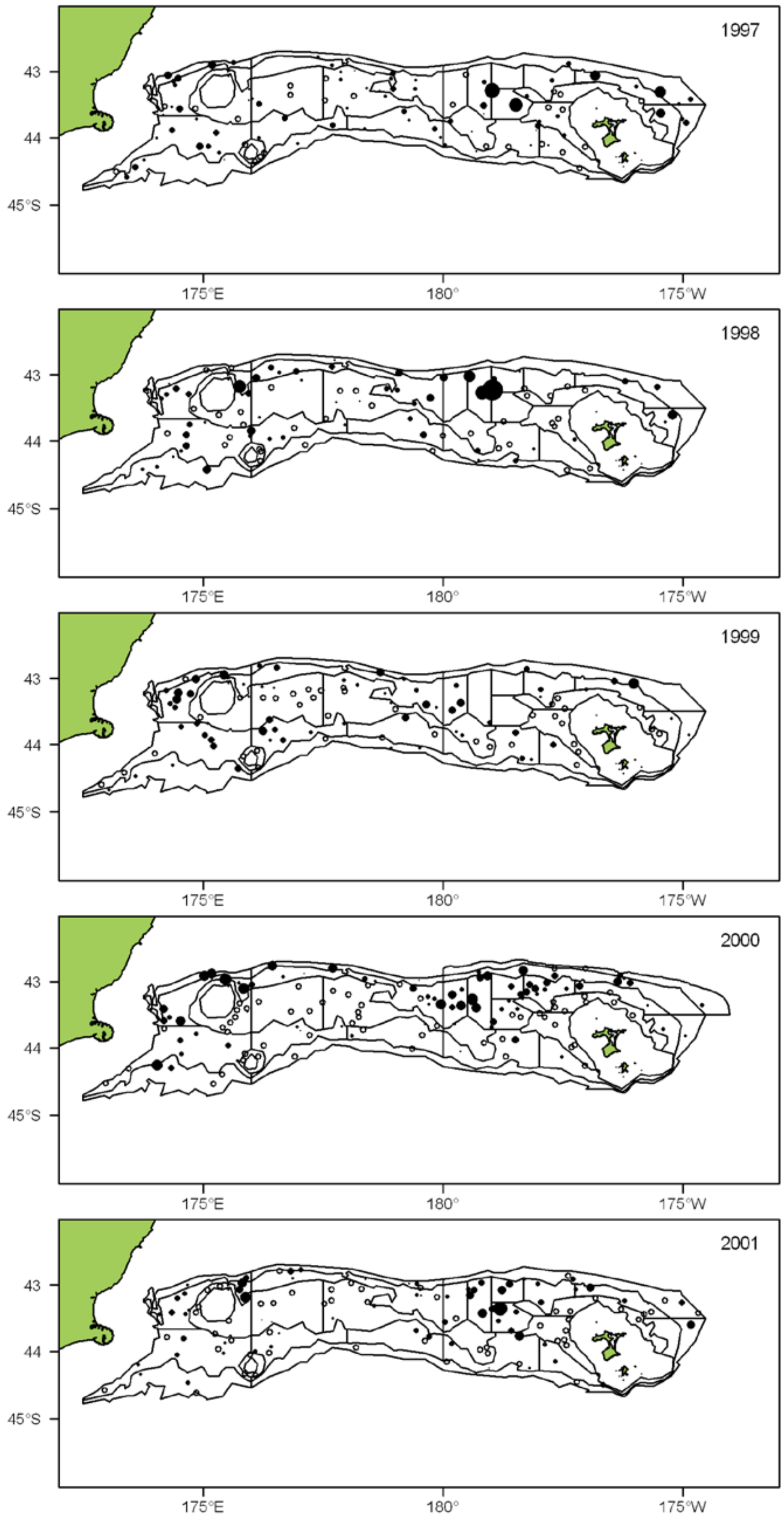
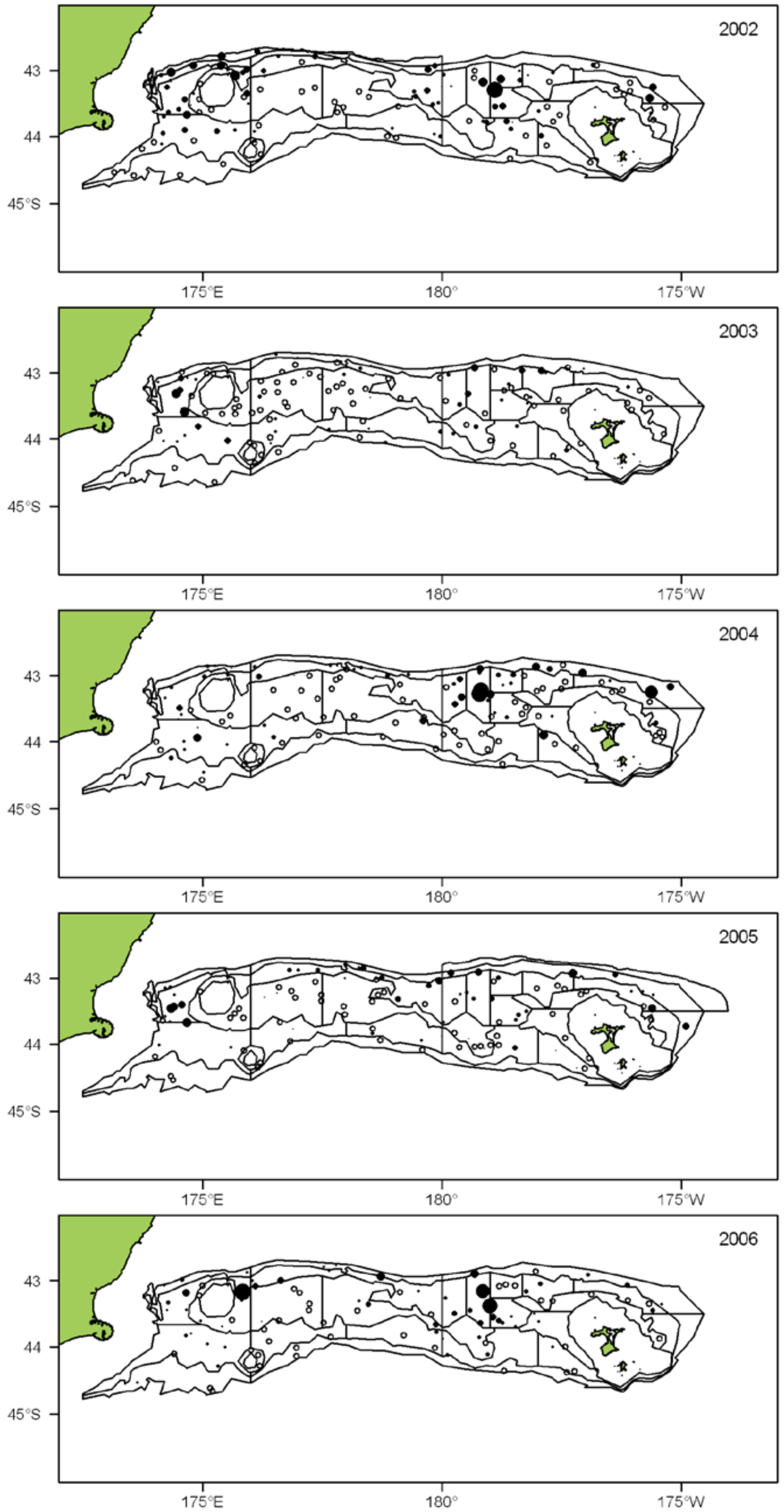


Figure 7 (continued)



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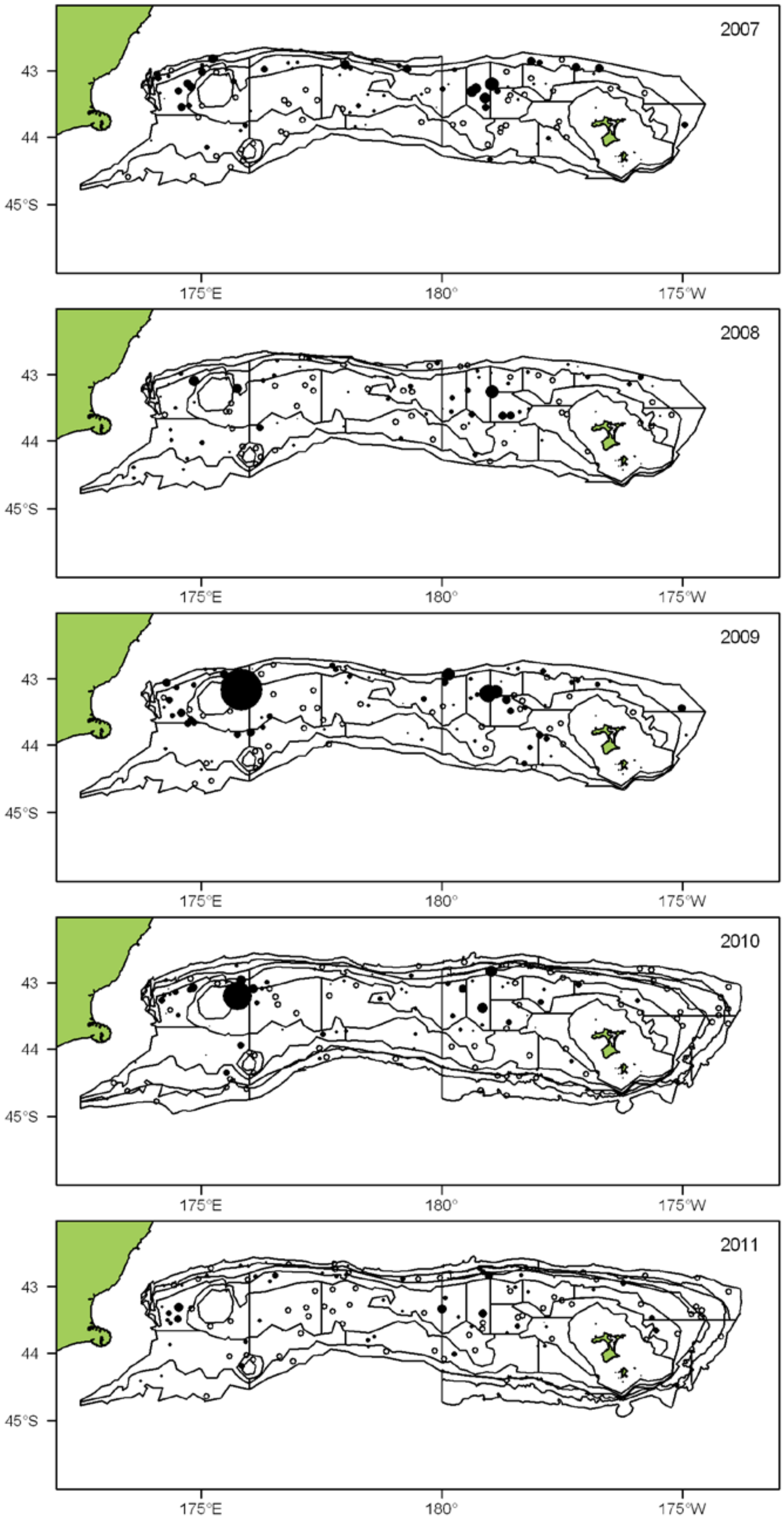

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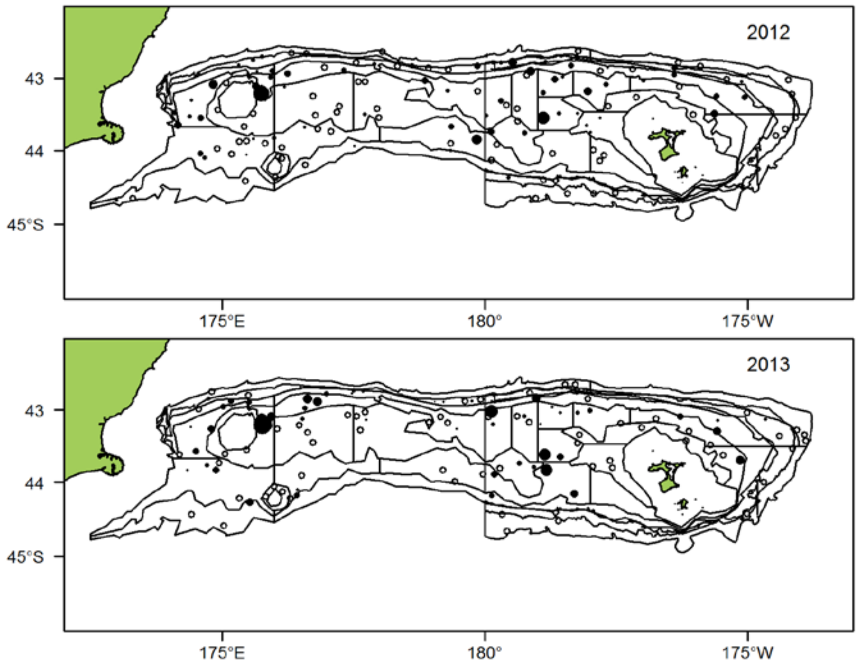


Figure 7 (continued)

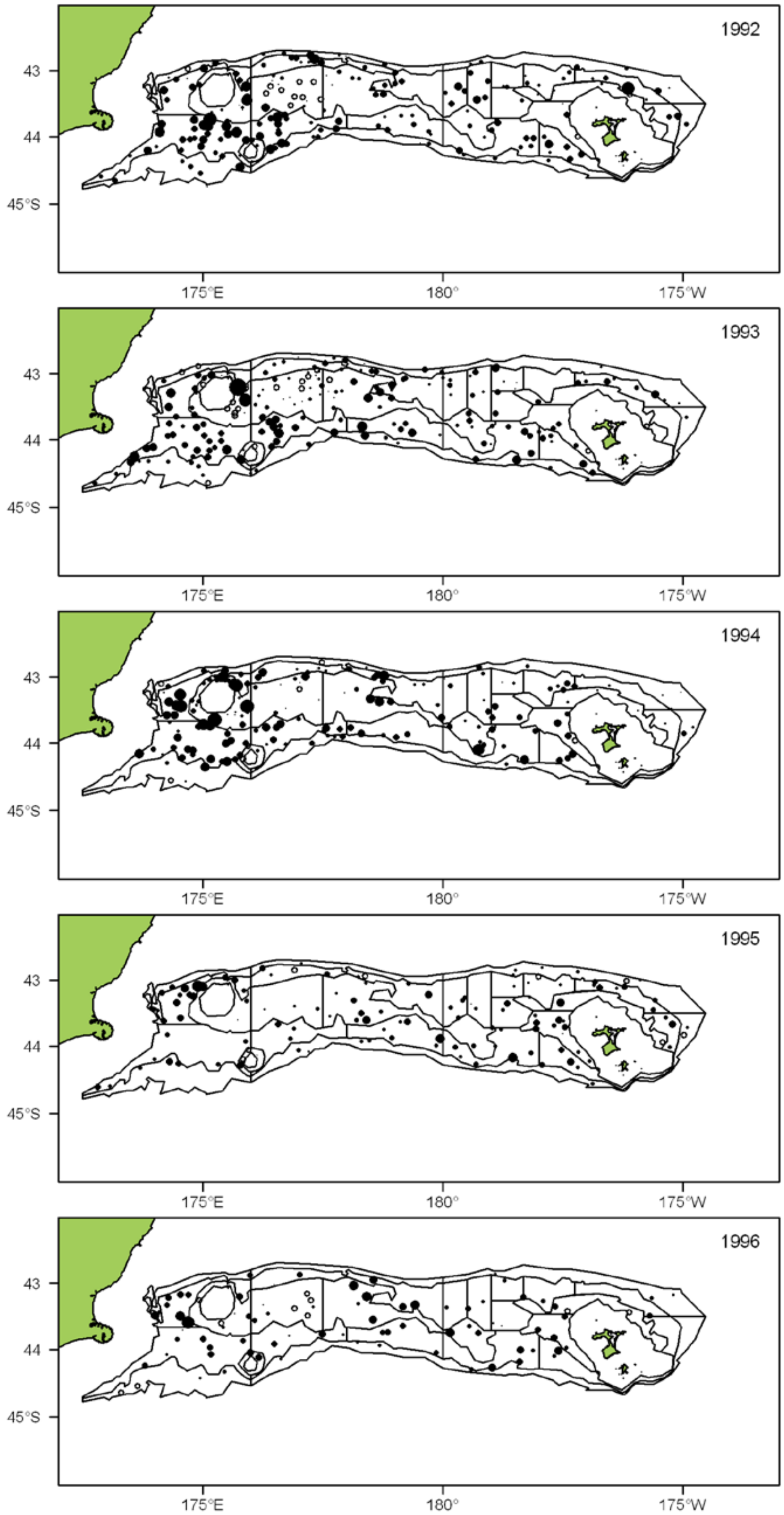
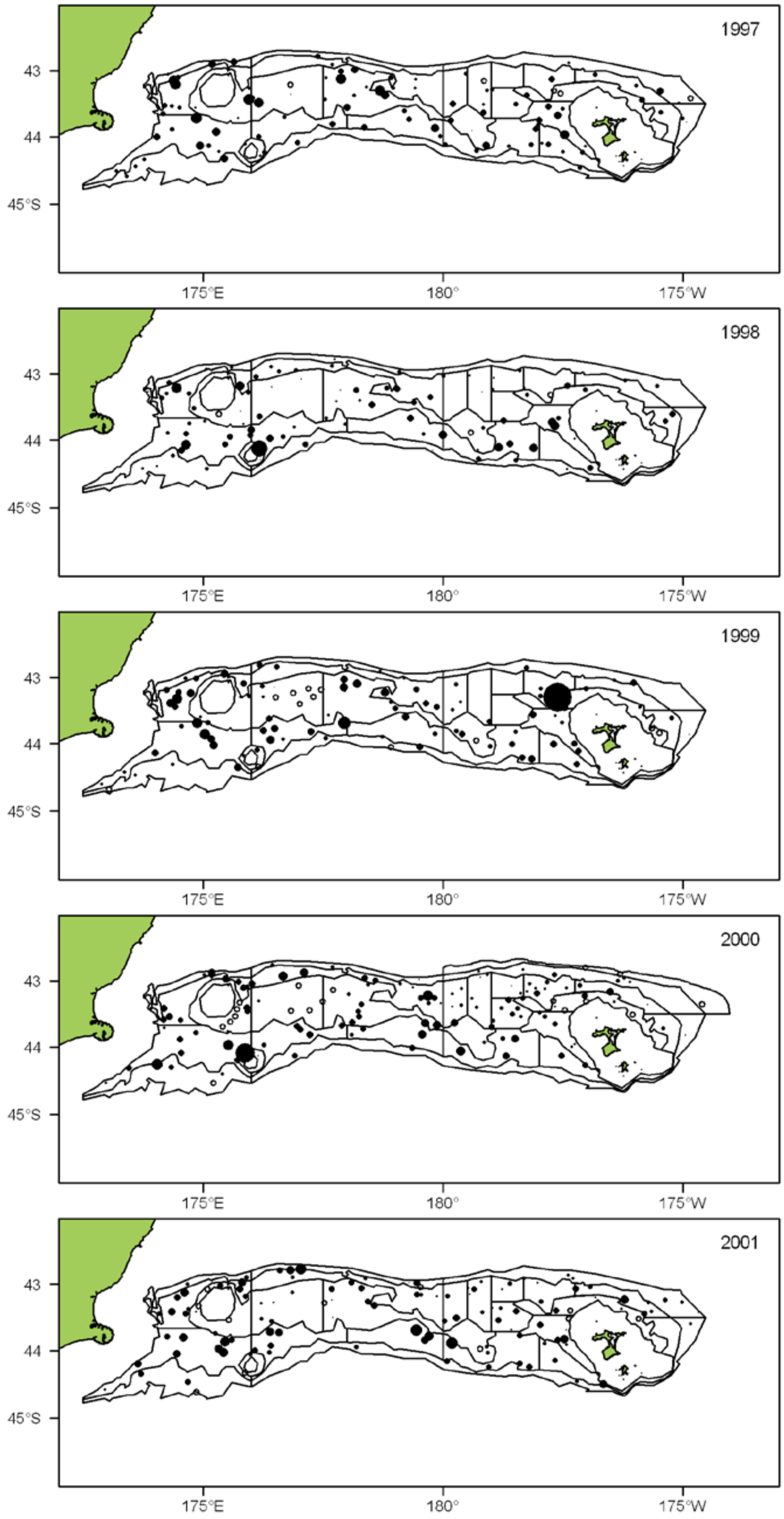


Figure 8: Ling catch distribution 1992–2013. Filled circle area is proportional to catch rate (kg.km^{-2}). Open circles are zero catch. Maximum catch rate in series is 1786 kg.km^{-2}.



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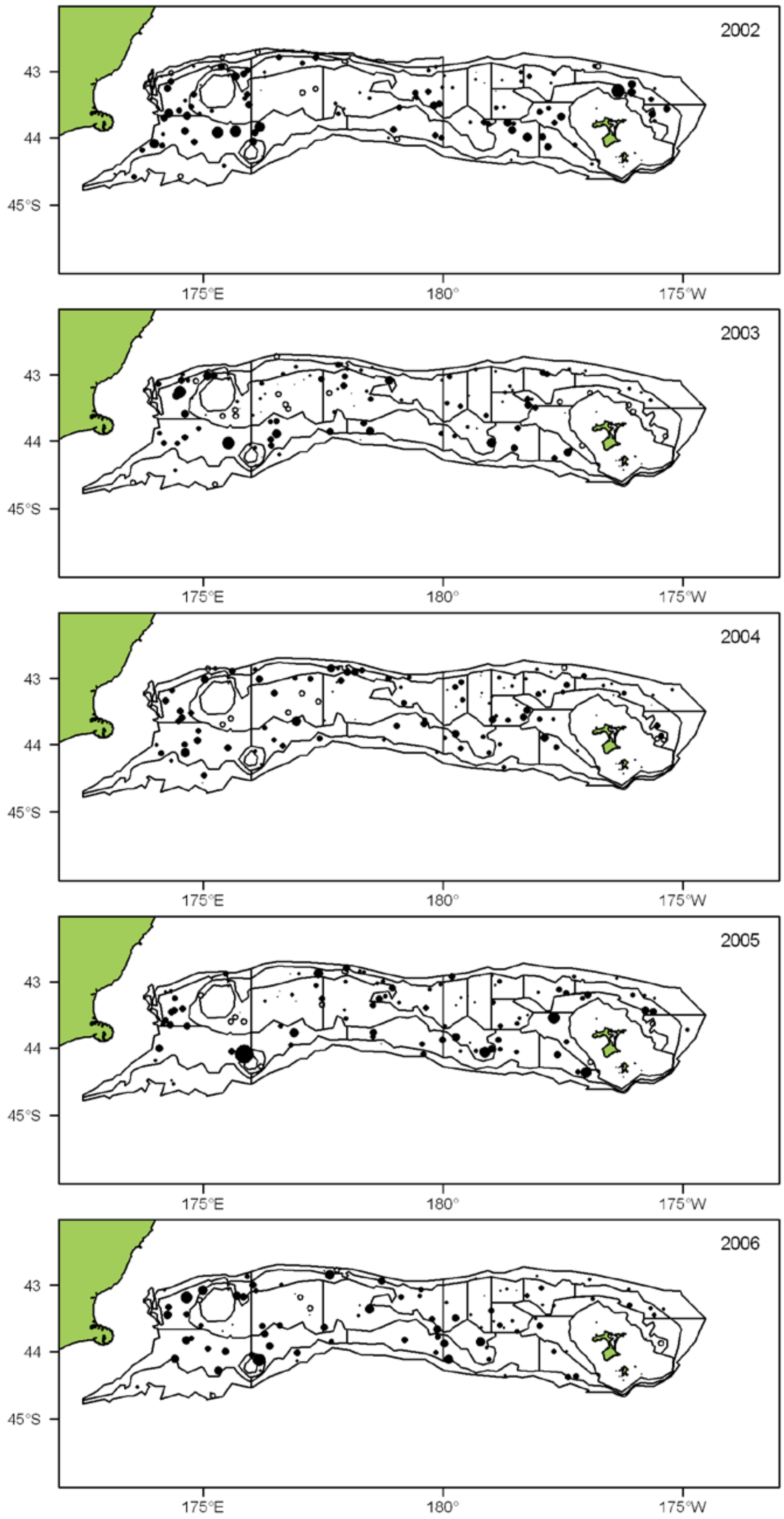

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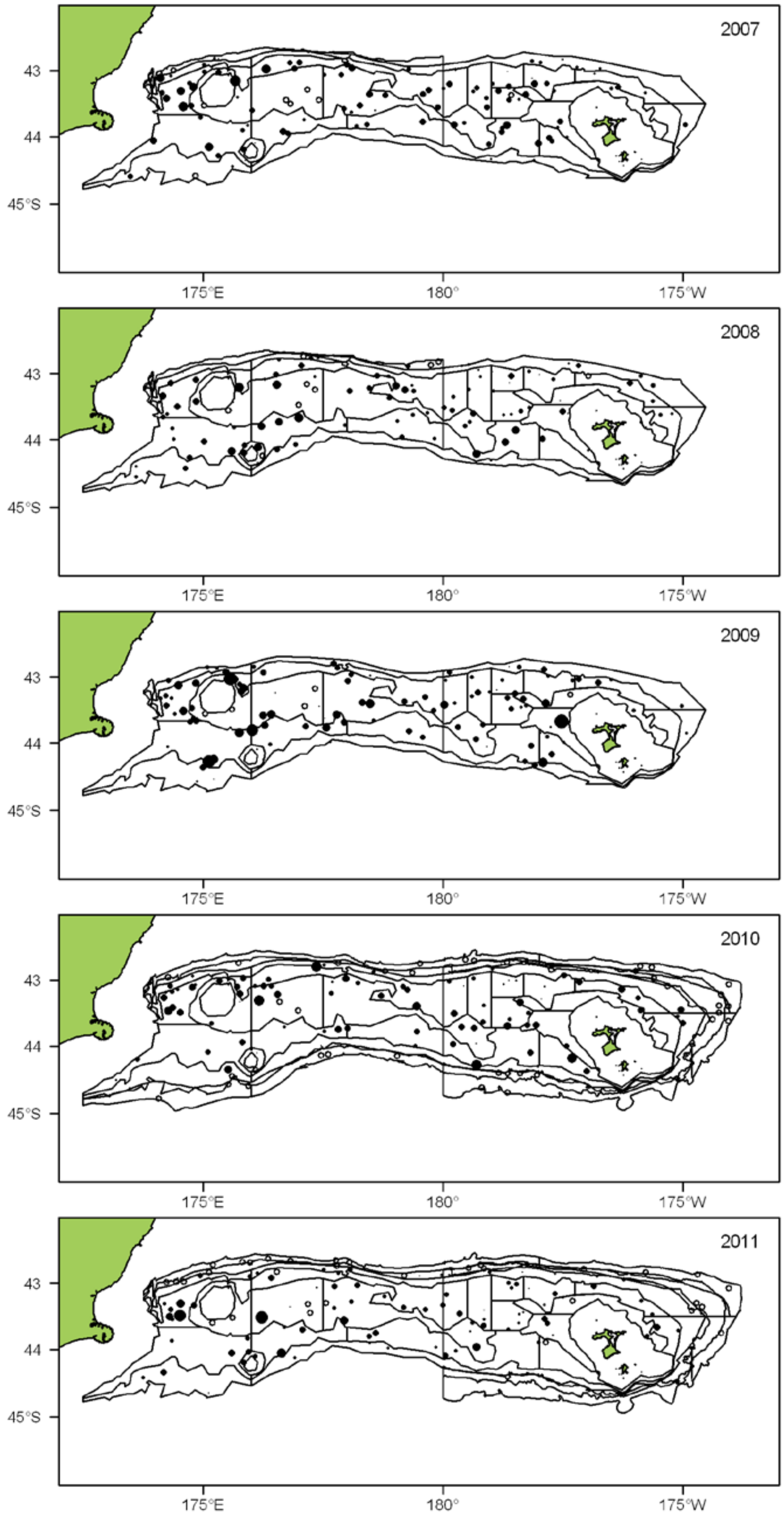

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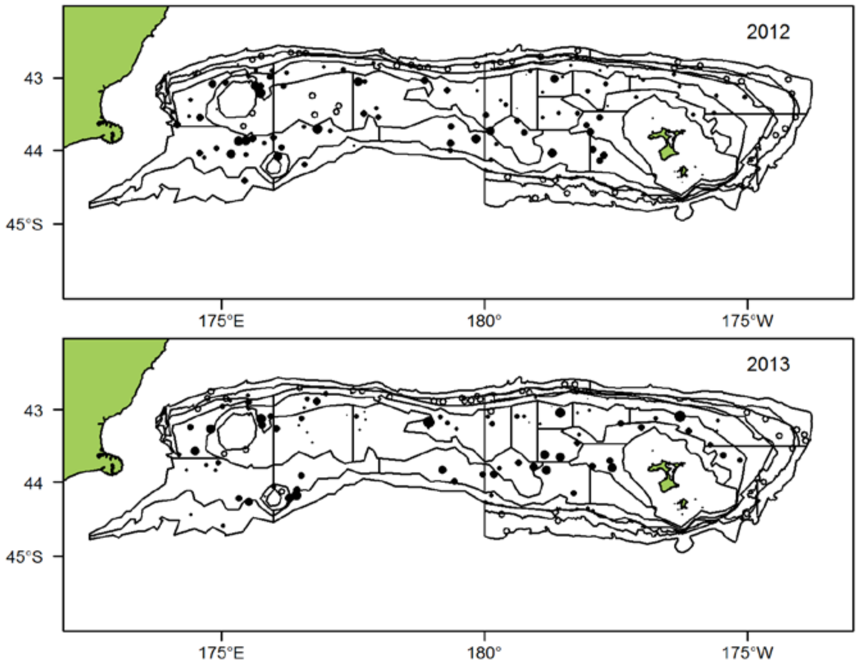

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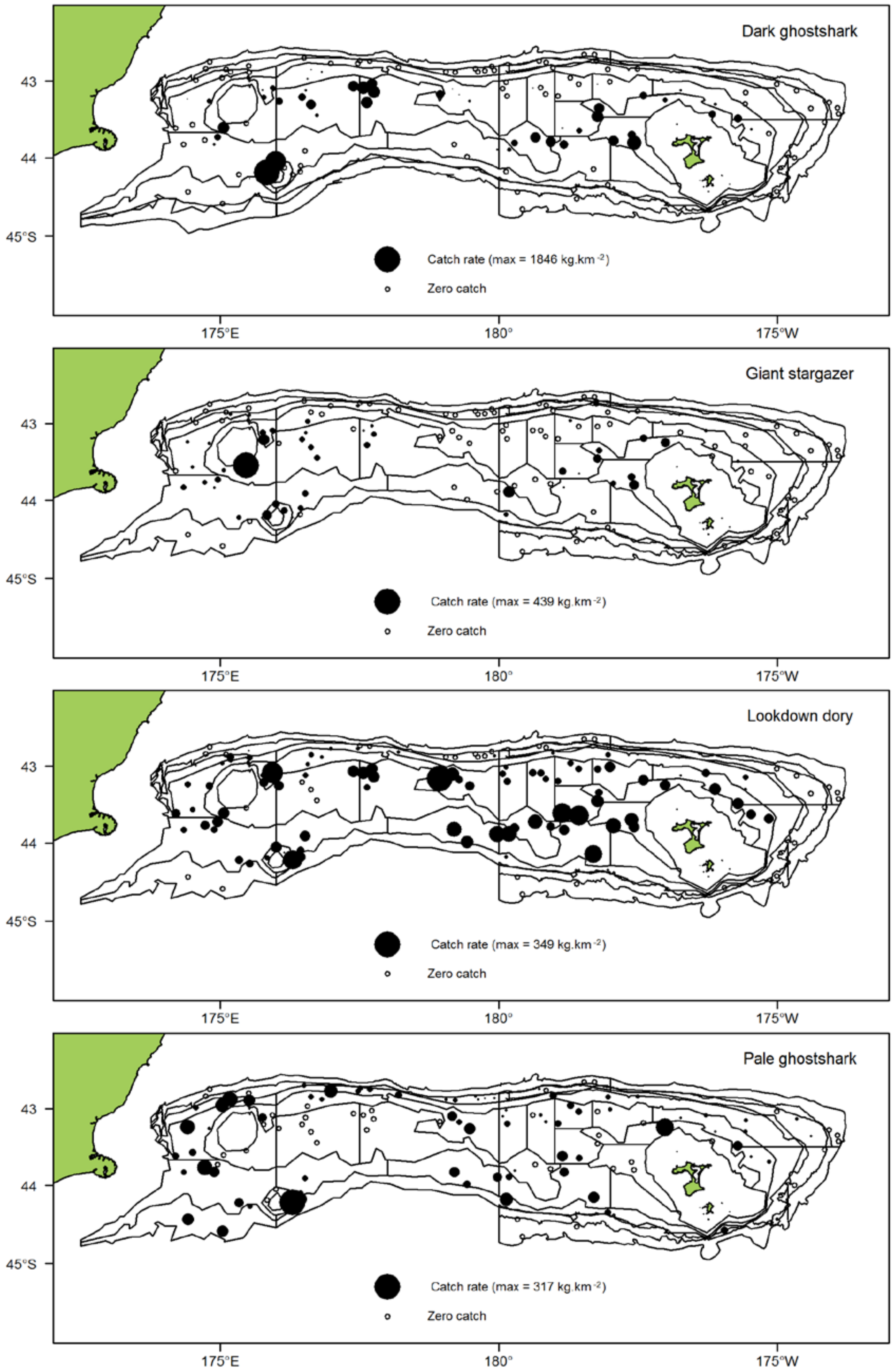
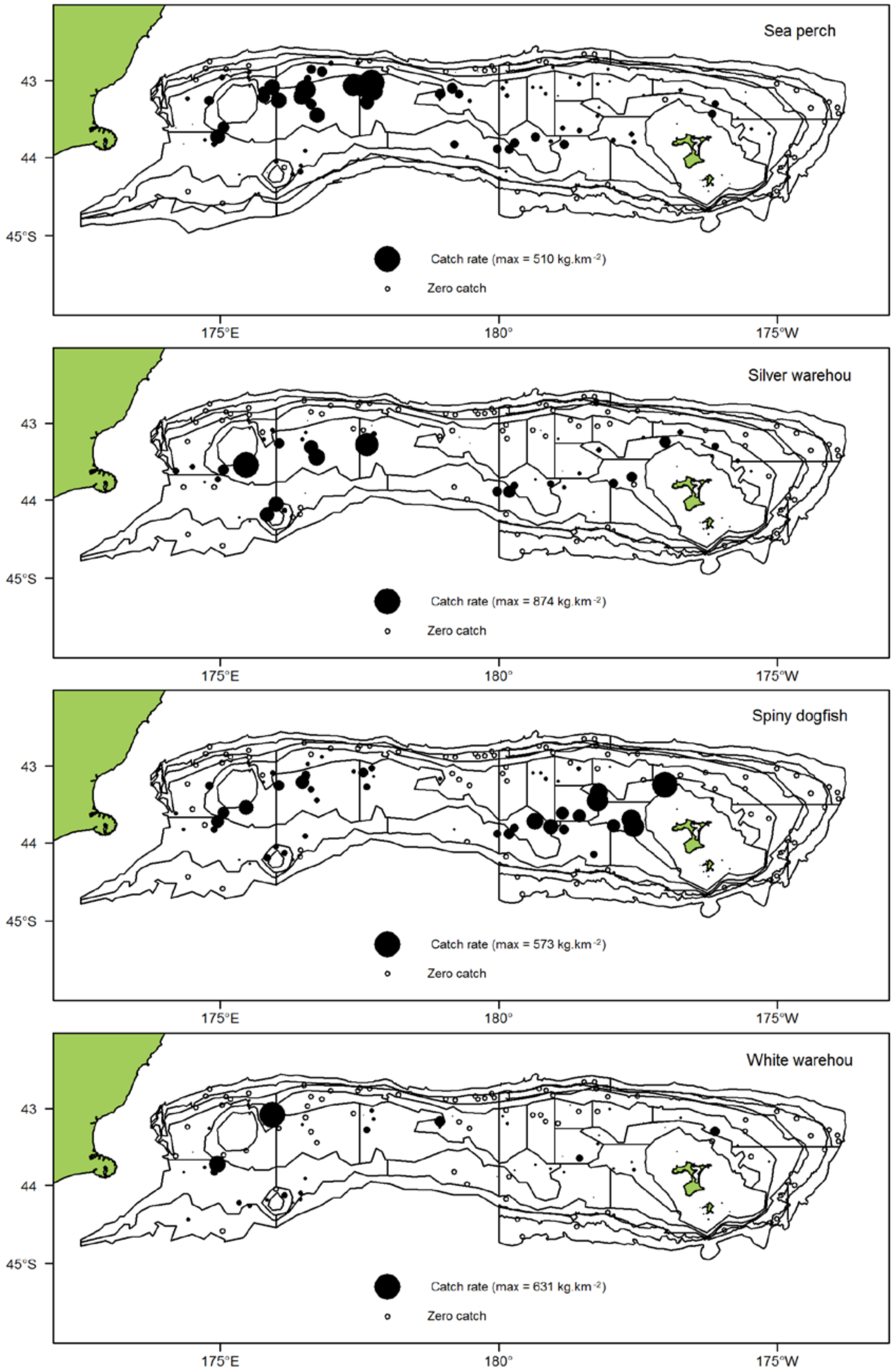


Figure 9: Catch rates (kg.km^{-2}) of selected core and deepwater commercial species in 2013. Filled circle area is proportional to catch rate. Open circles are zero catch. (max., maximum catch rate).



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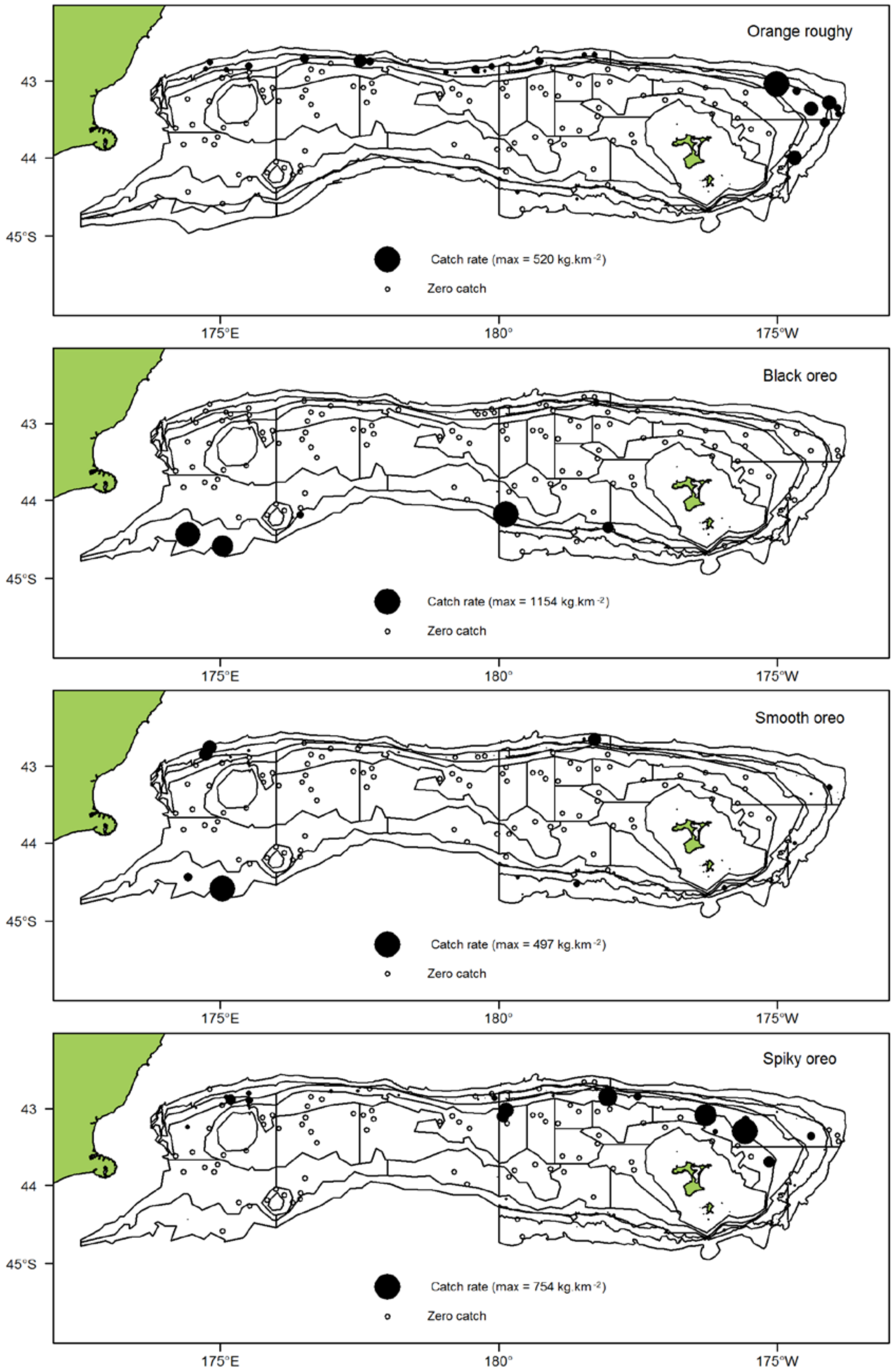

Figure 9 (continued)

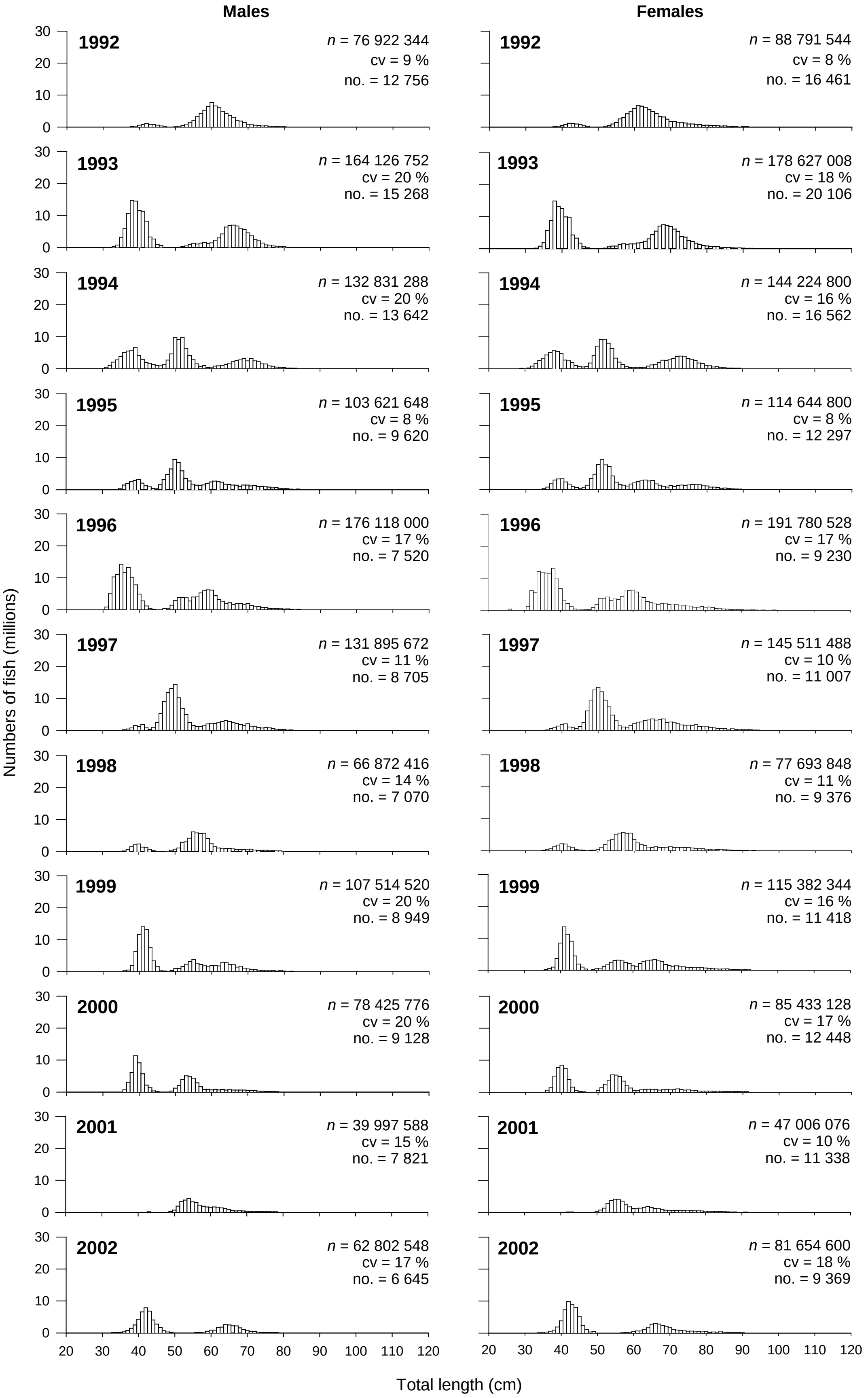

Figure 10: Estimated length frequency distributions of the male and female hoki population from *Tangaroa* surveys of the Chatham Rise, January 1992–2013. CV, coefficient of variation; *n*, estimated population number of male hoki (left panel) and female hoki (right panel); no., numbers of fish measured.

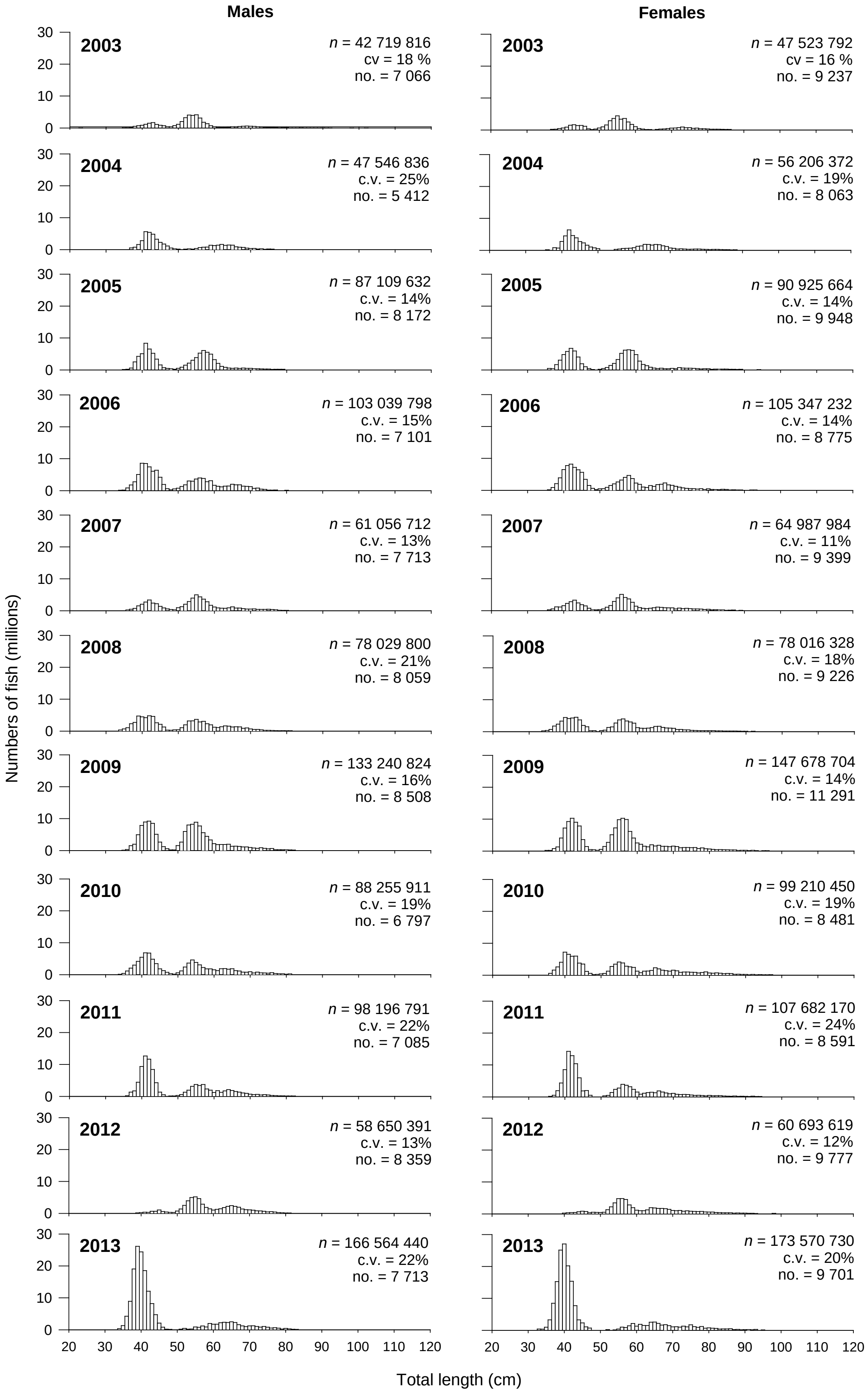

Figure 10 (continued)

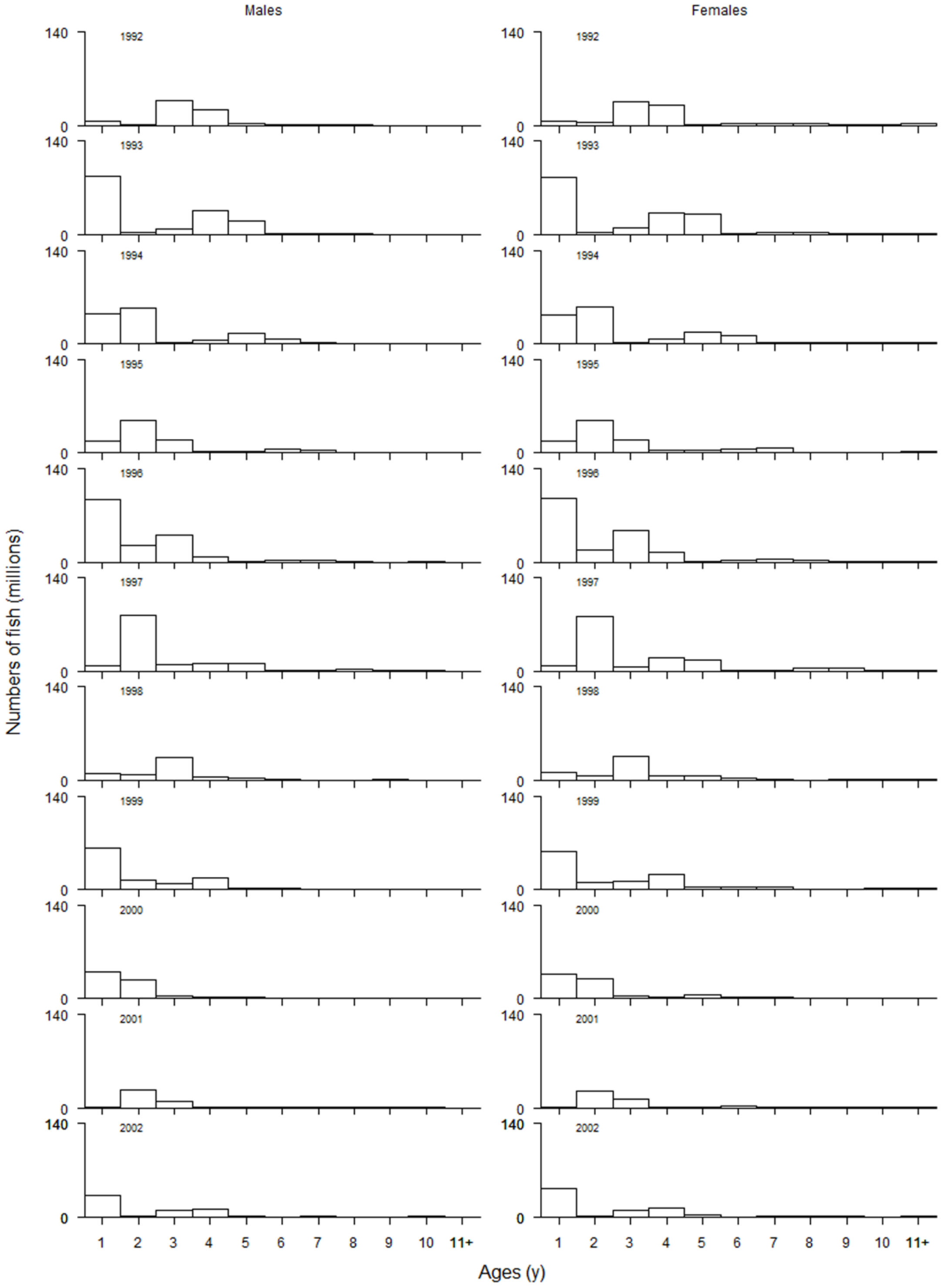

Figure 11: Estimated population numbers at age for hoki from *Tangaroa* surveys of the Chatham Rise, January, 1992–2013. +, indicates plus group of combined ages.

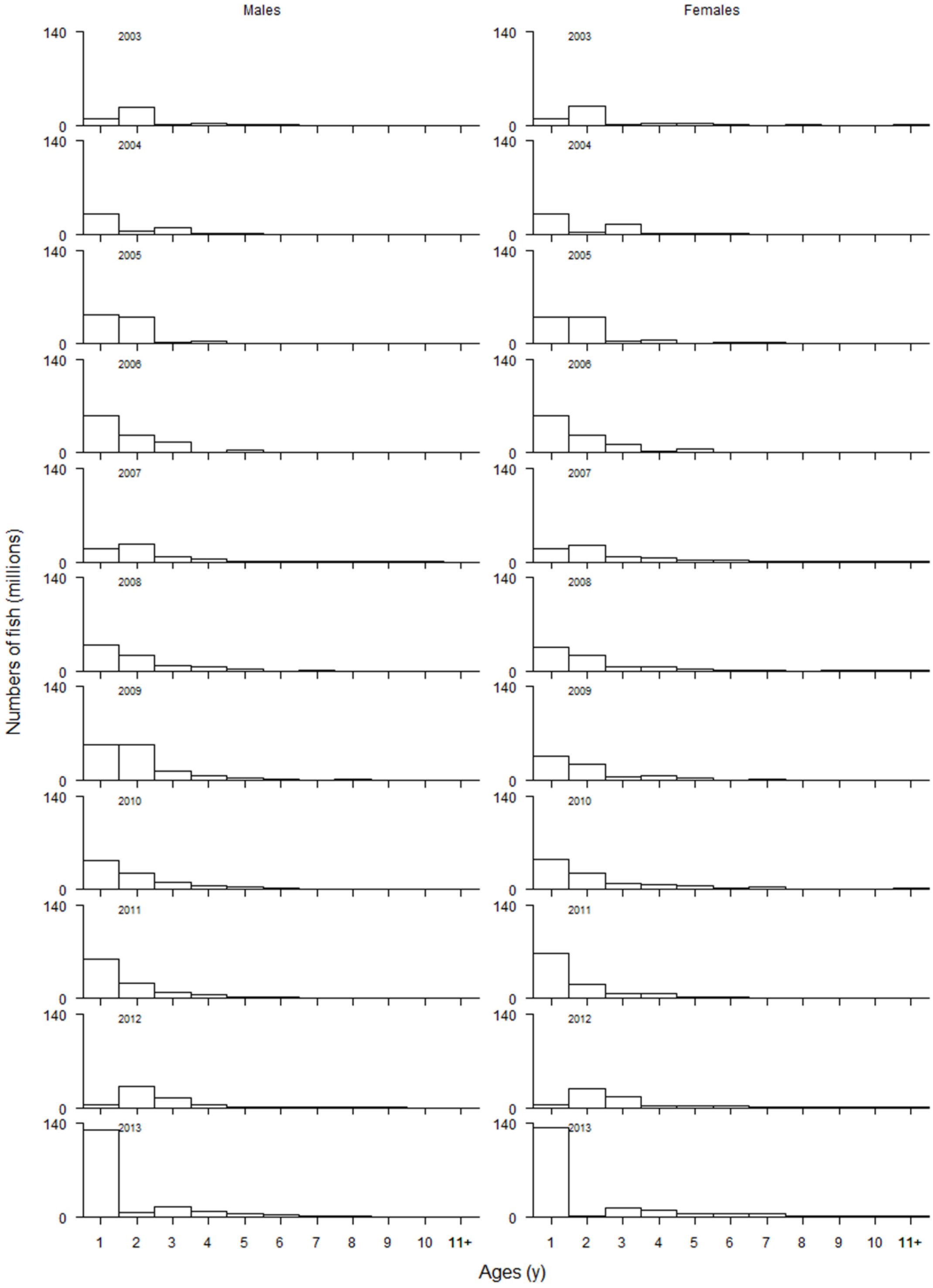

Figure 11 (continued)

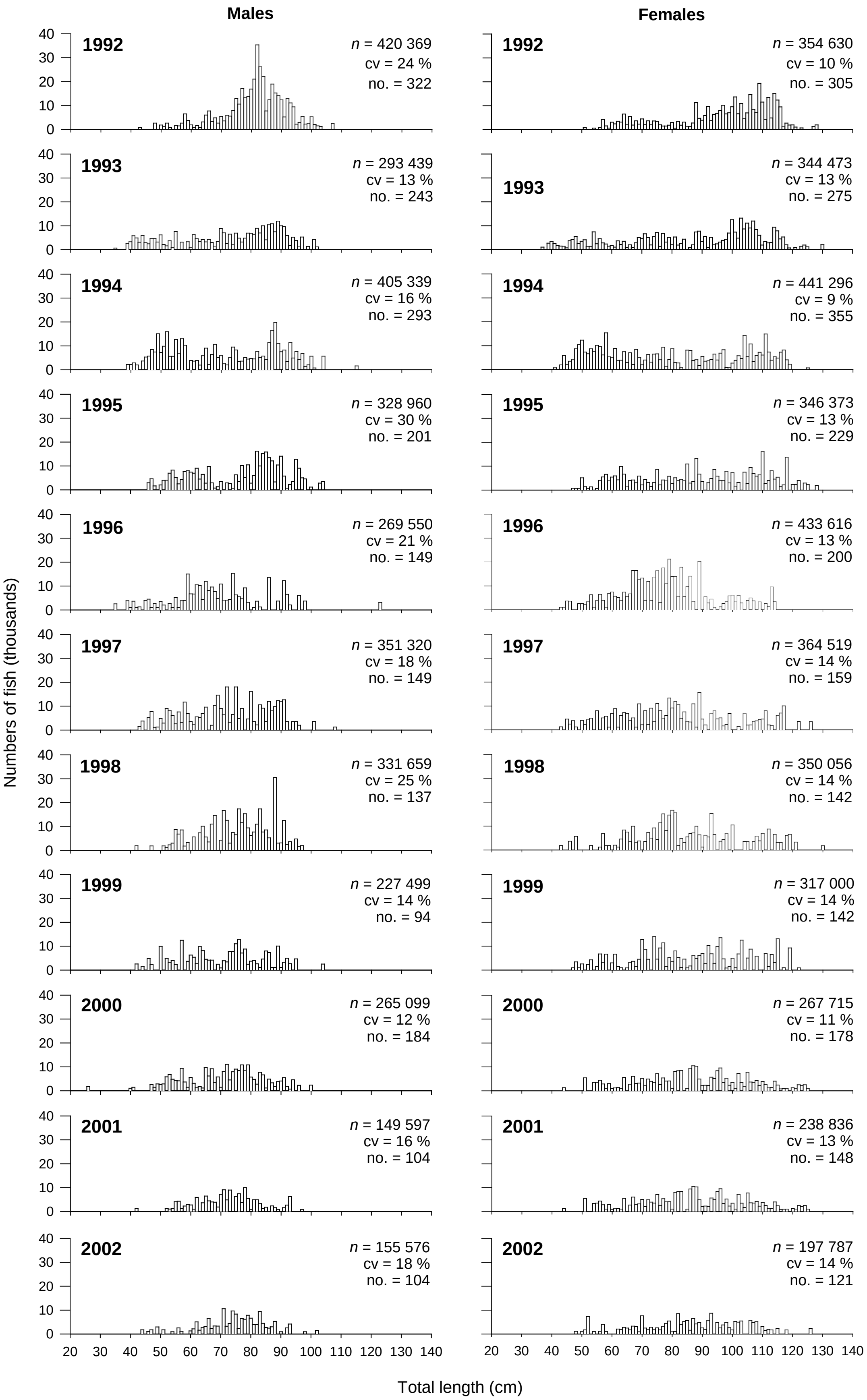

Figure 12: Estimated length frequency distributions of the male and female hake population from *Tangaroa* surveys of the Chatham Rise, January 1992–2013. CV, coefficient of variation; *n*, estimated population number of hake; no., numbers of fish measured.

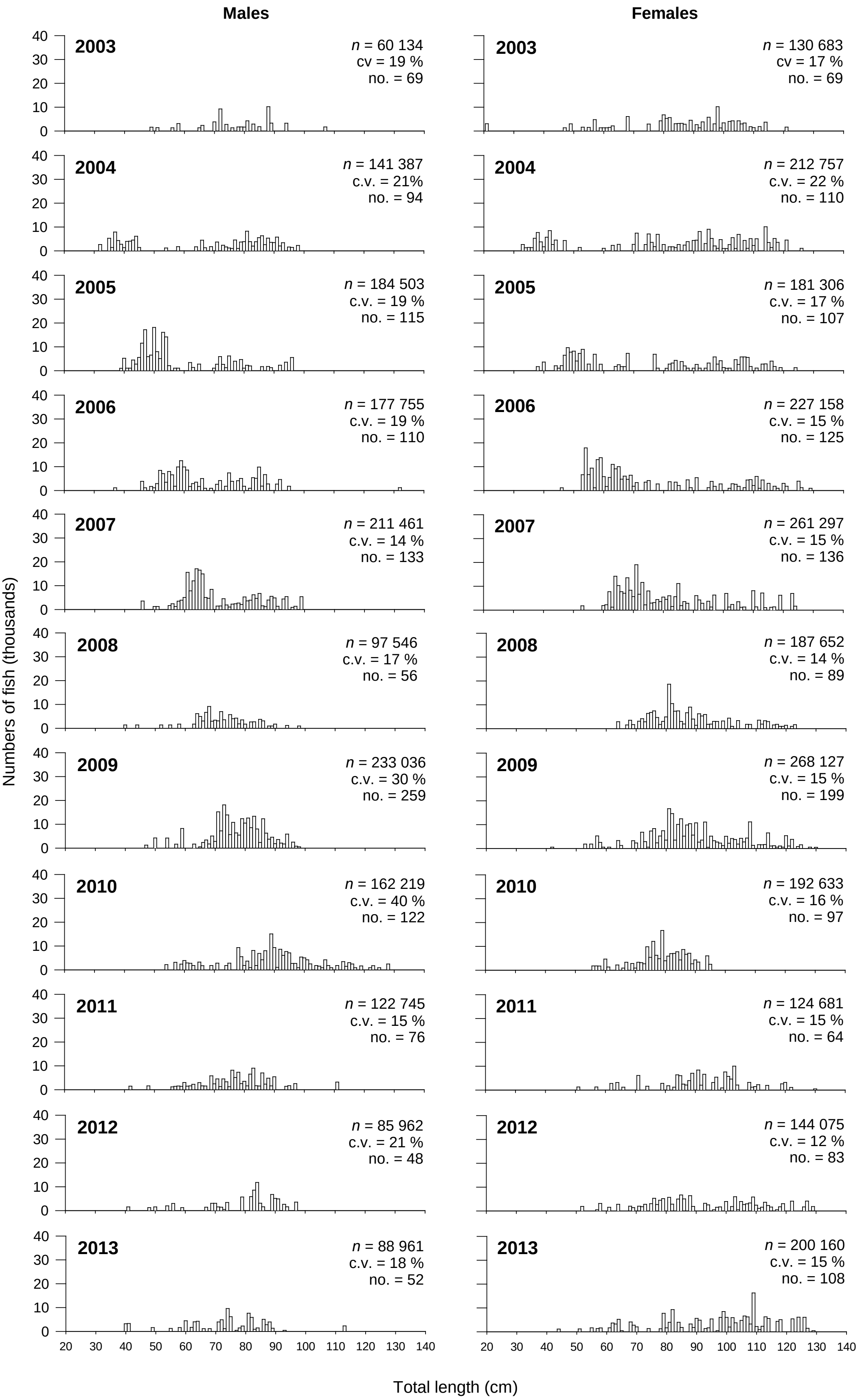

Figure 12 (continued)

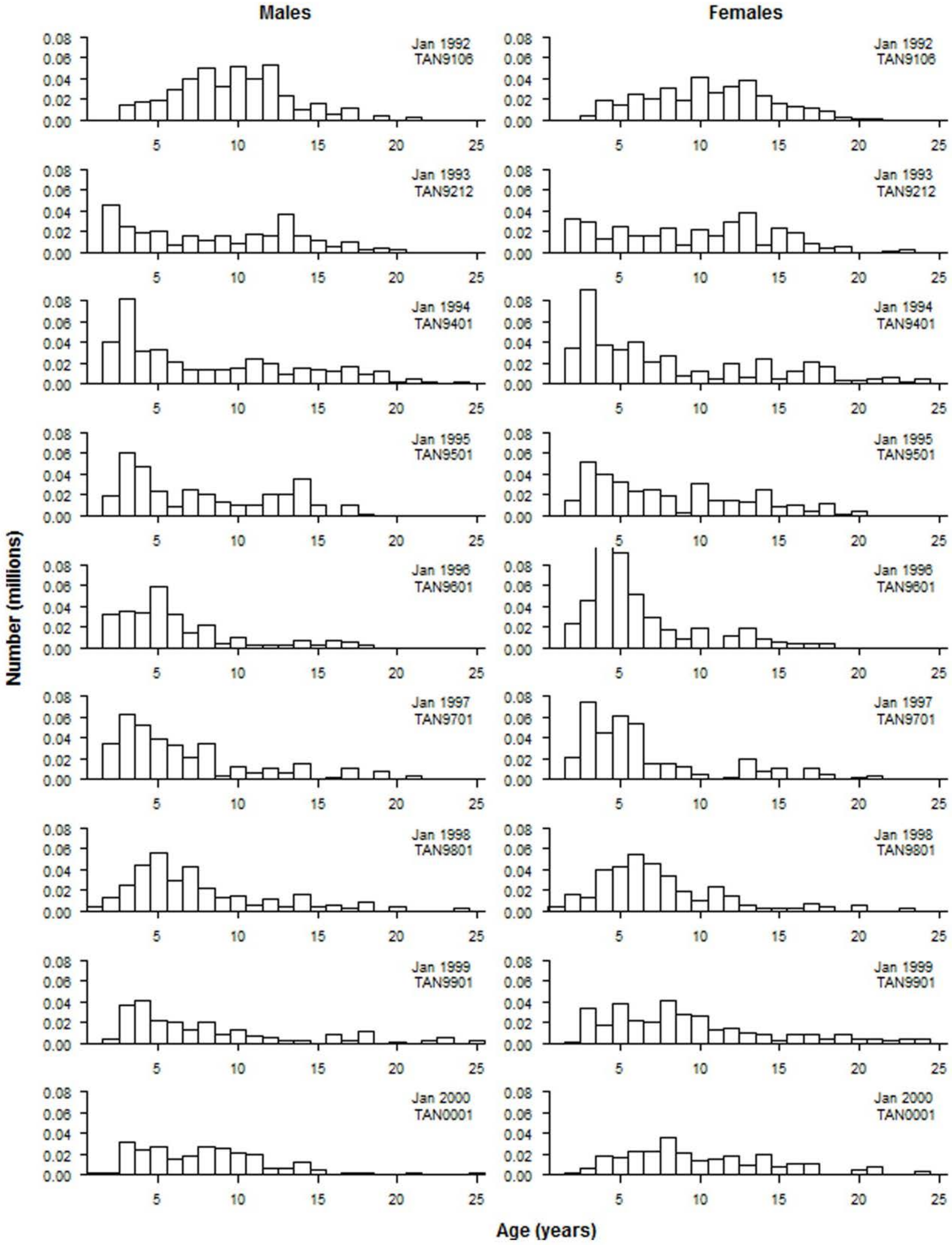

Figure 13: Estimated proportion at age for male and female hake from *Tangaroa* surveys of the Chatham Rise, January, 1992–2013.

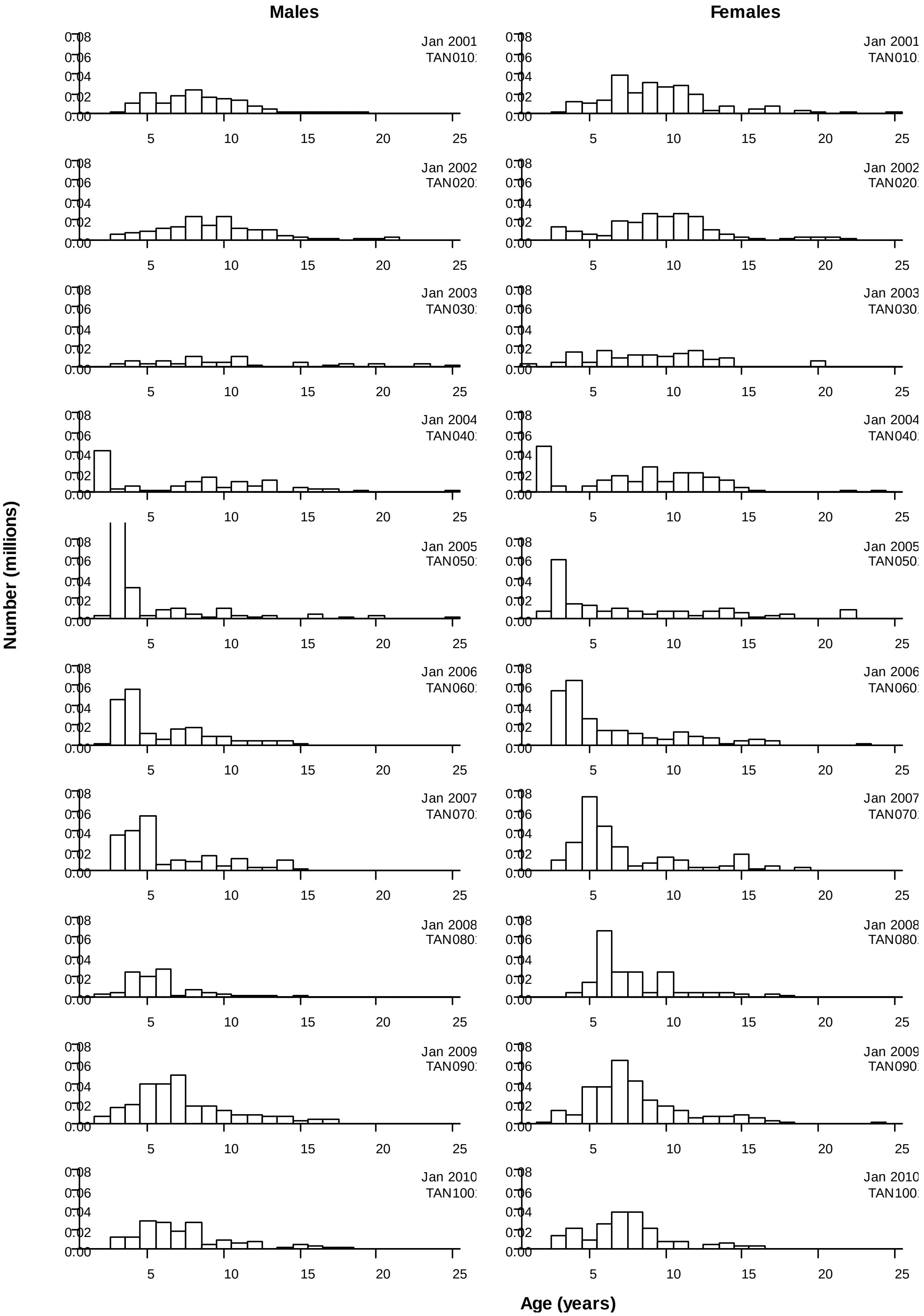

Figure 13 (continued)

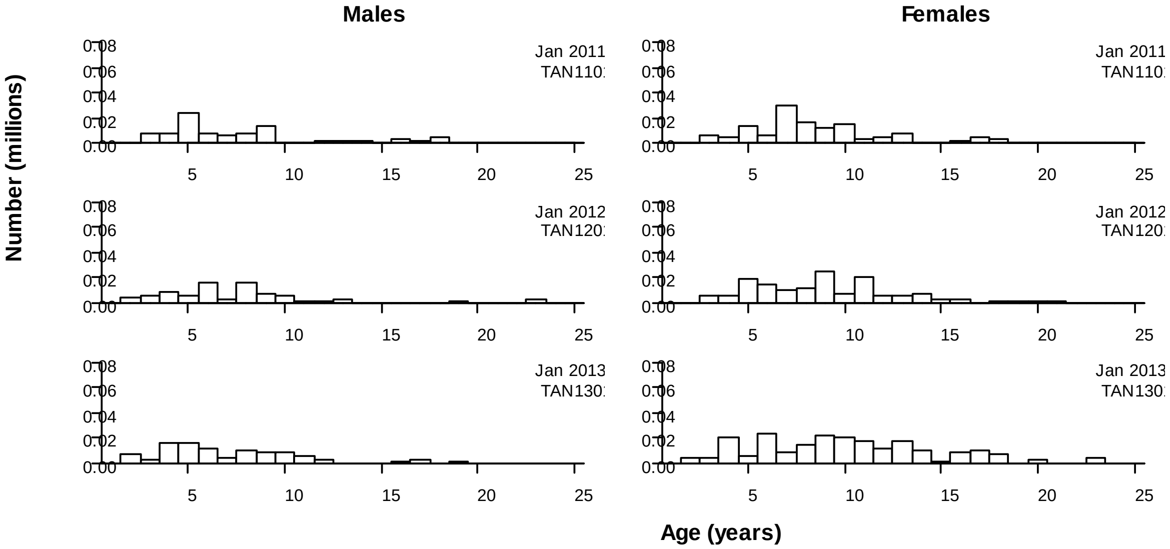

Figure 13 (continued)

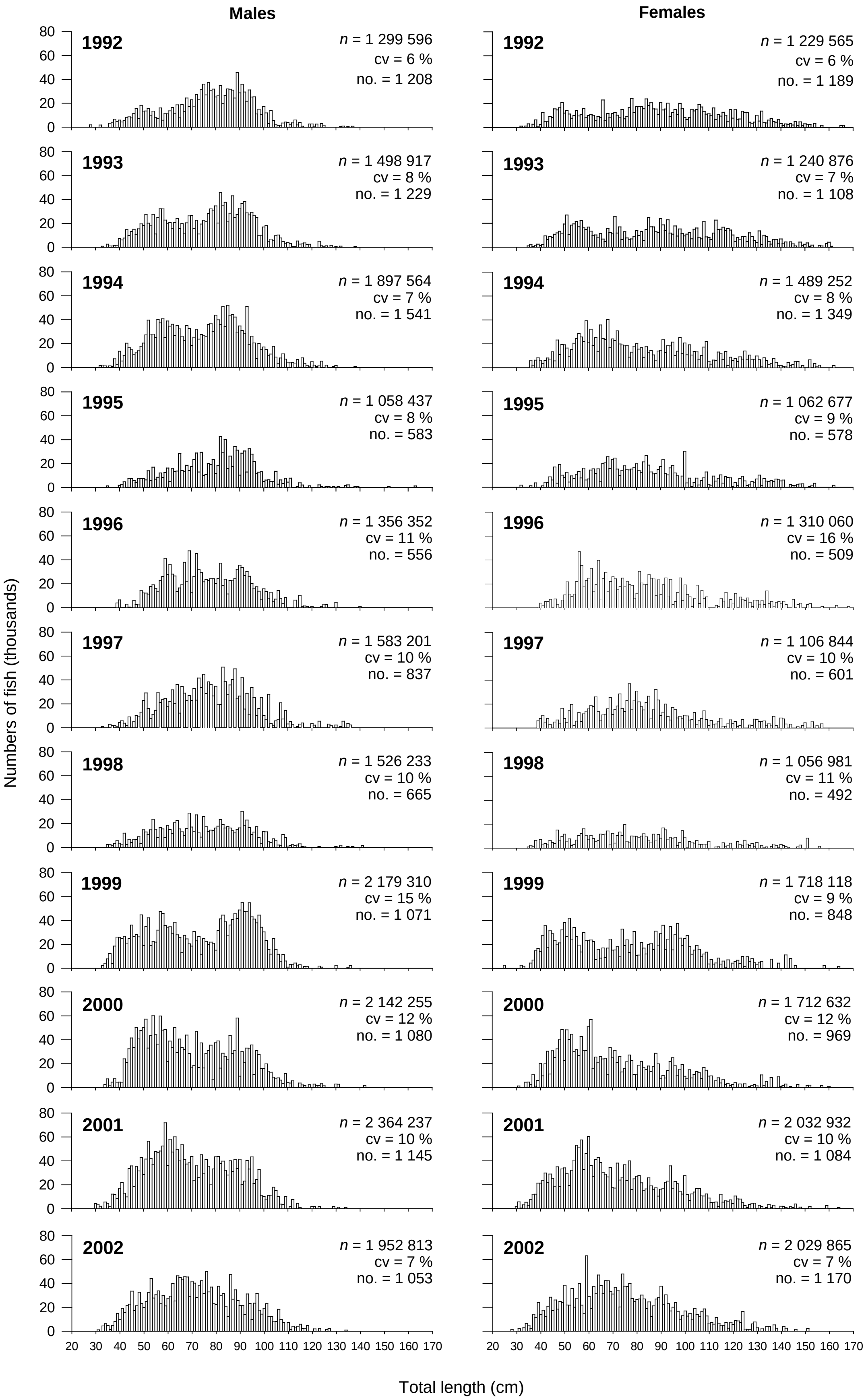

Figure 14: Estimated length frequency distributions of the ling population from *Tangaroa* surveys of the Chatham Rise, January 1992–2013. CV, coefficient of variation; *n*, estimated population number of ling; no., numbers of fish measured.

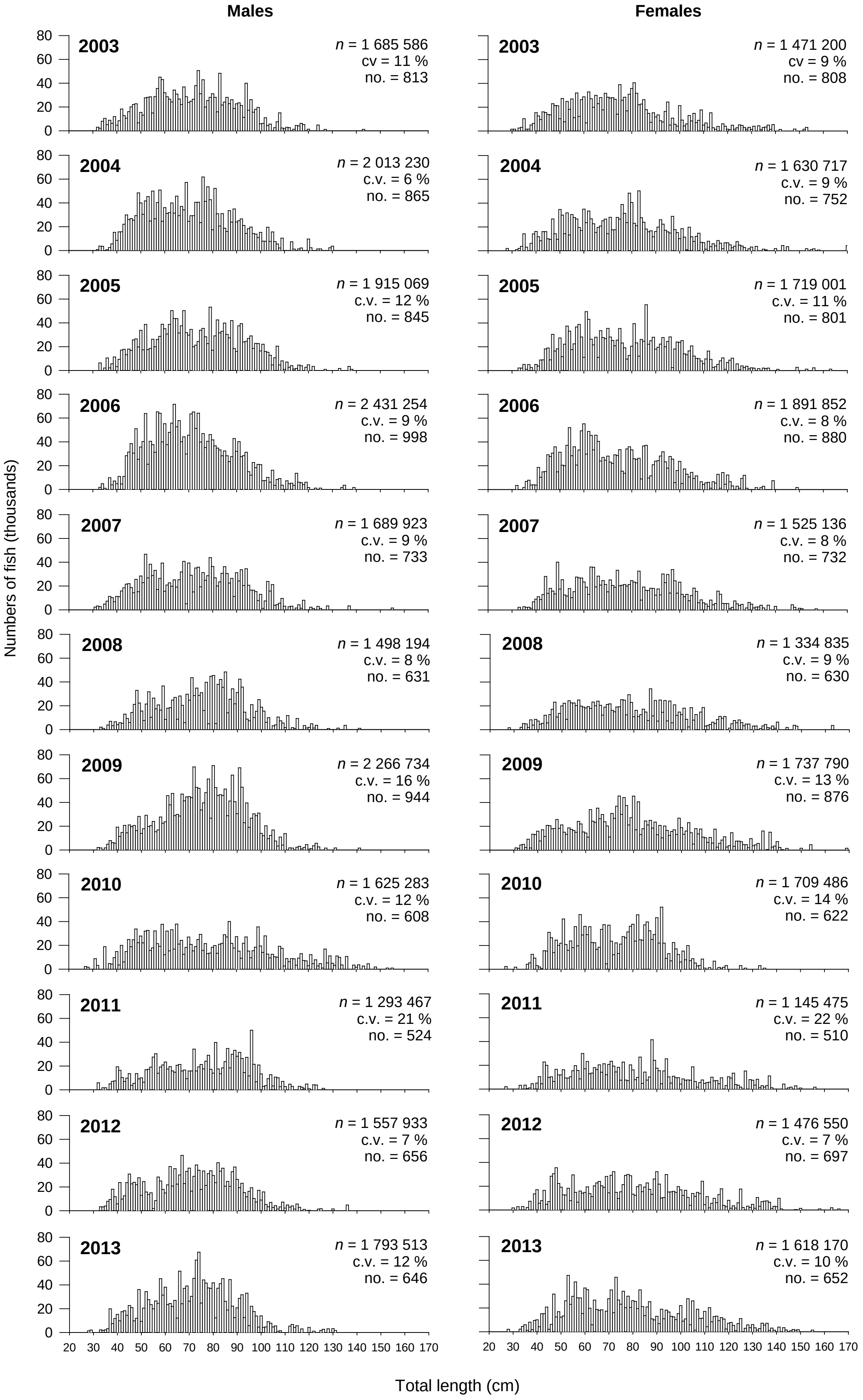

Figure 14 (continued)

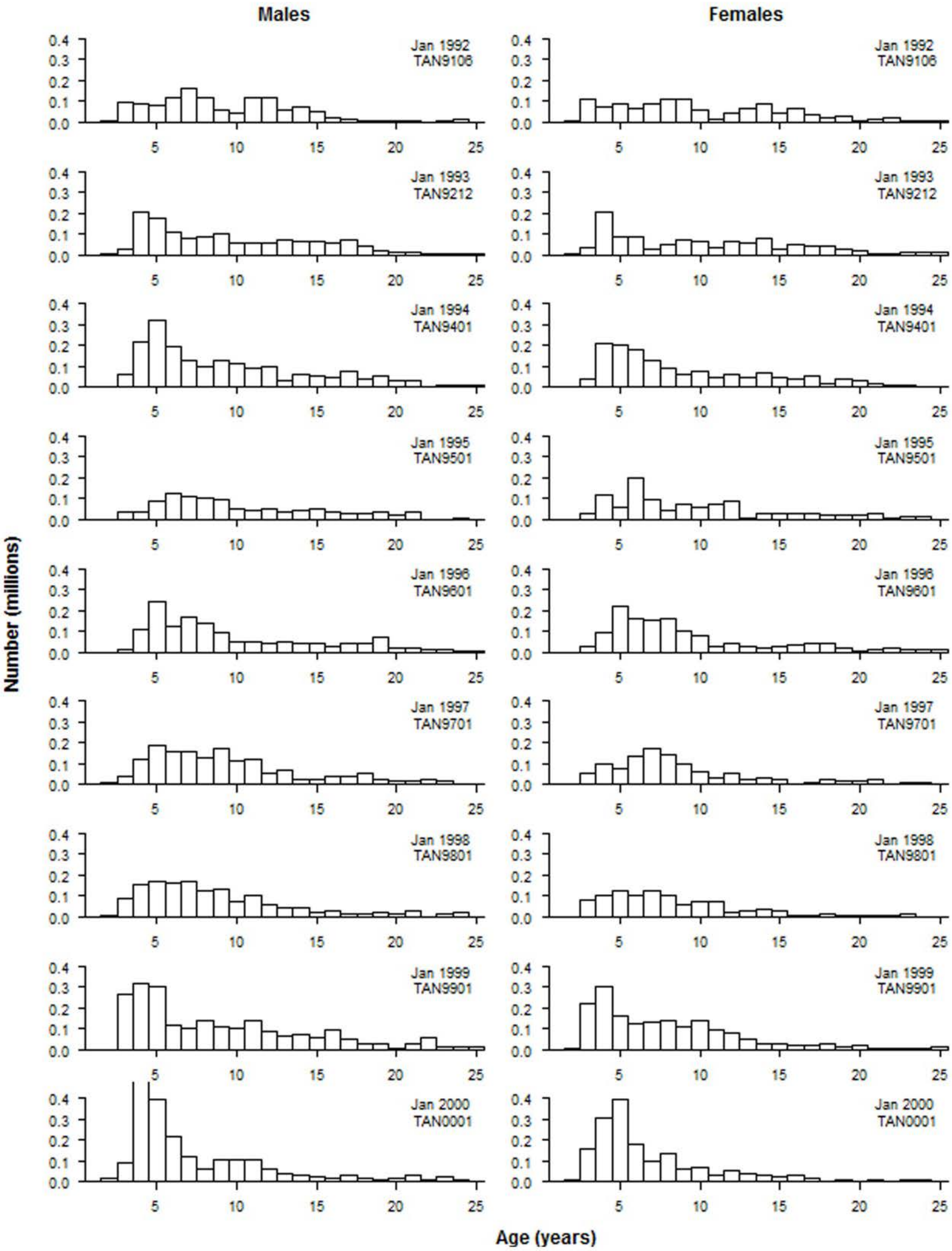

Figure 15: Estimated population numbers at age for male and female ling from *Tangaroa* surveys of the Chatham Rise, January, 1992–2013.

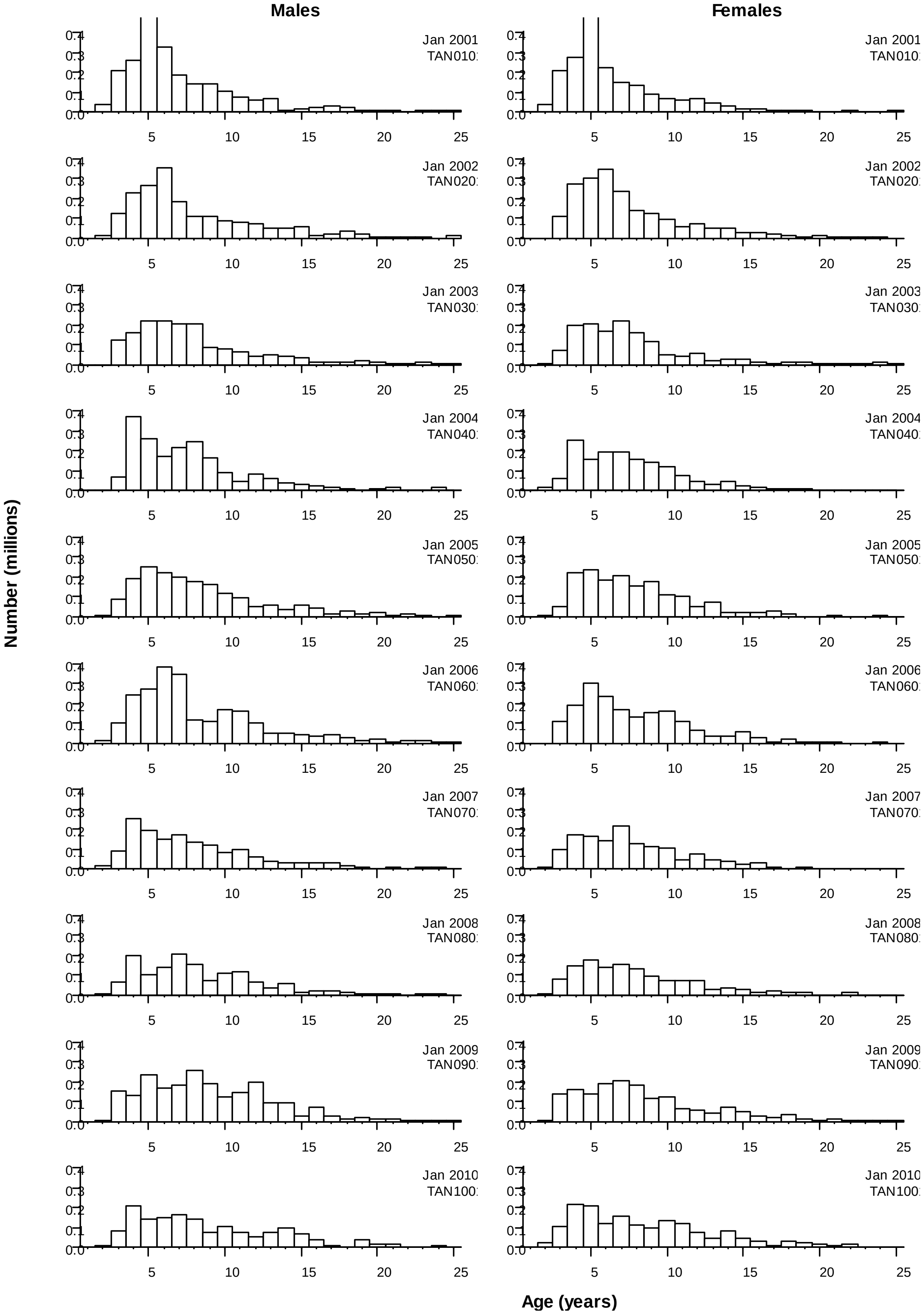

Figure 15 (continued)

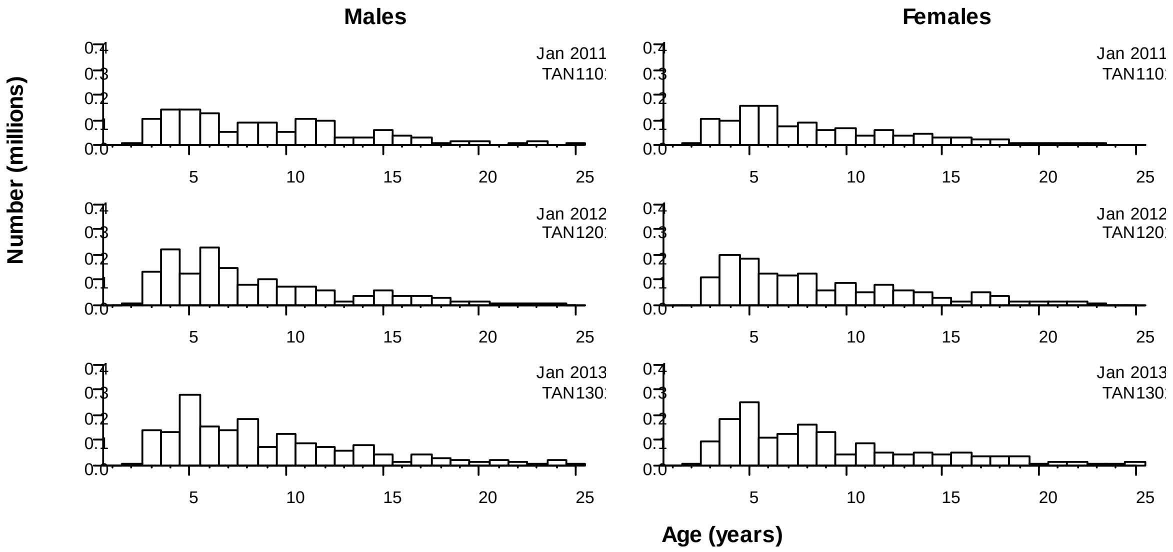

Figure 15 (continued)

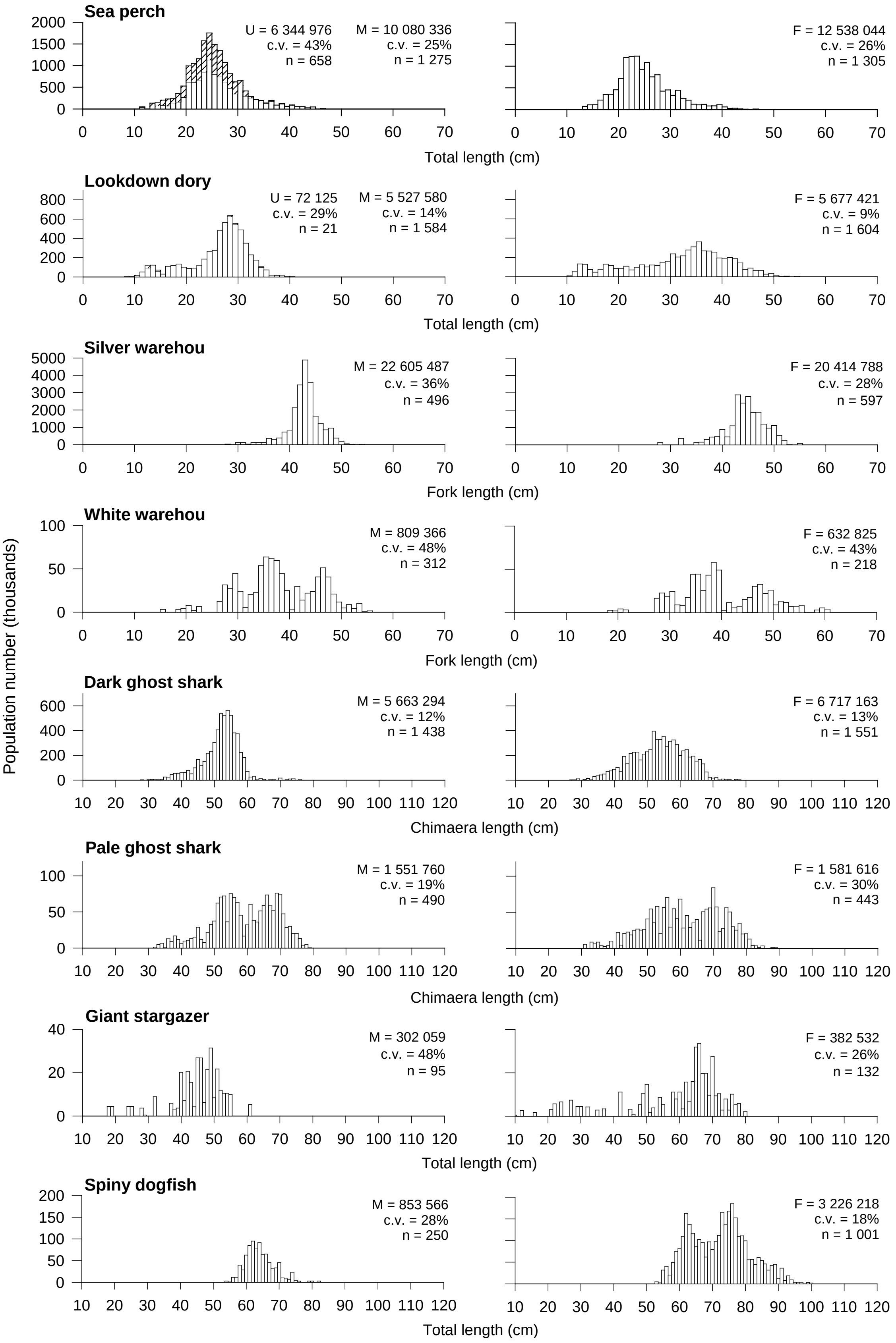

Figure 16a: Length frequencies of selected commercial species on the Chatham Rise 2013, scaled to population size by sex. M, estimated male population; F, estimated female population; U, estimated unsexed population (hatched bars); CV coefficient of variation for the estimated numbers of fish; n, number of fish measured.

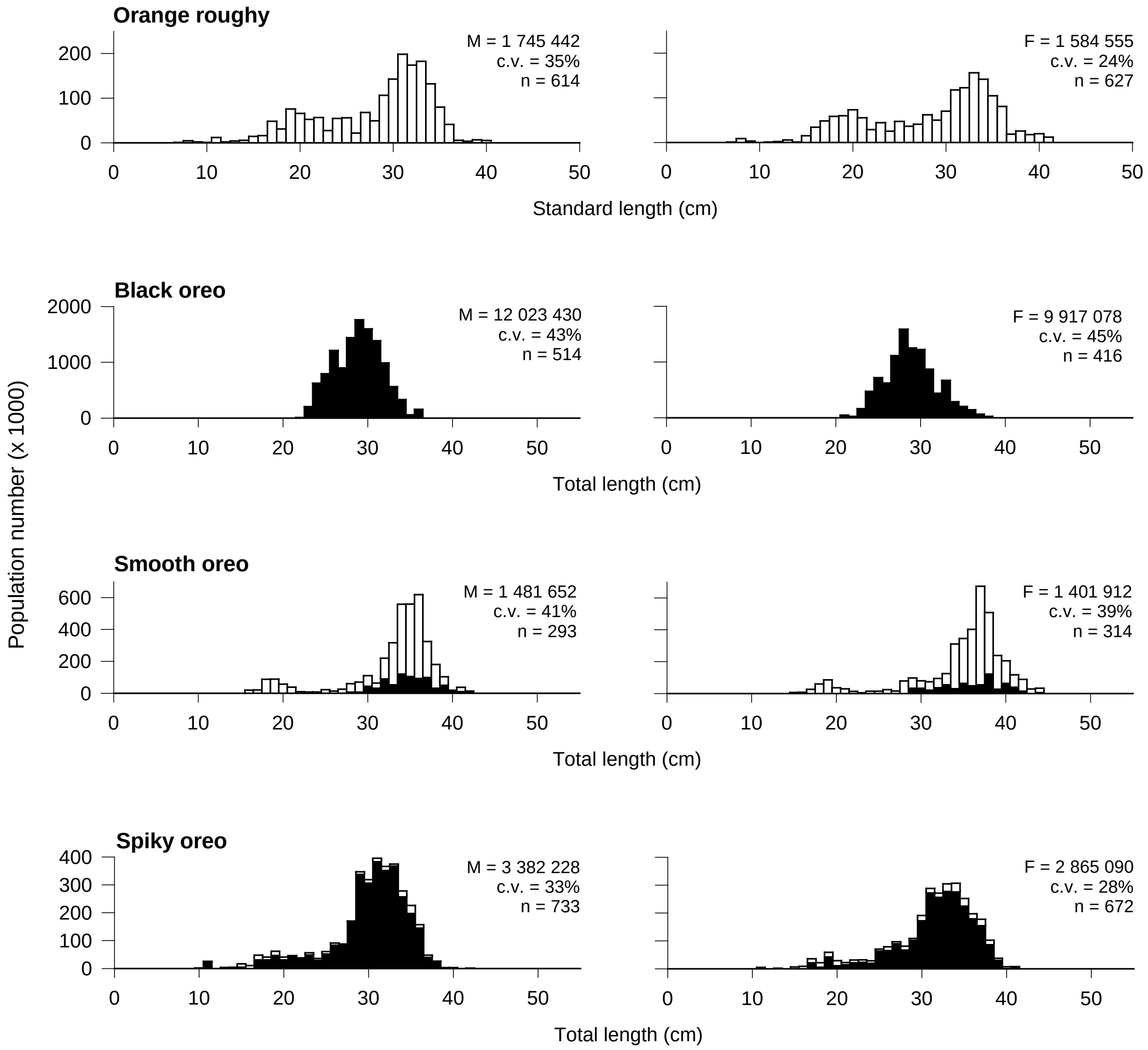

Figure 16b: Length frequencies of orange roughy and oreo species on the Chatham Rise 2013, scaled to population size by sex. M, estimated male population; F, estimated female population; CV coefficient of variation of the estimated numbers of fish; n, number of fish measured. White bars show fish from all (200–1300 m) strata. Black bars show fish from core (200–800 m) strata.

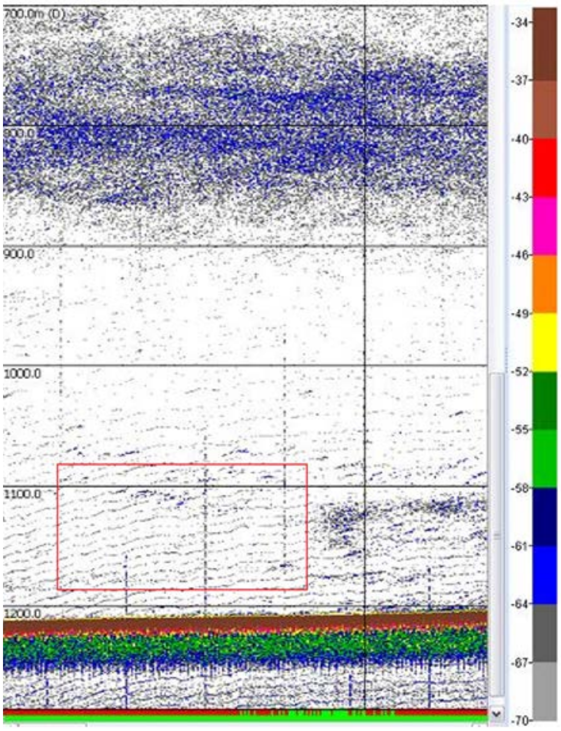

Figure 17: Screenshot of an echogram showing electrical noise interference. Red box highlights the typical appearance of the detected noise with repetitive wavy horizontal lines. Echogram depth range is from 700 to 1300 m only. Colour bar shows acoustic backscattering strength in dB.

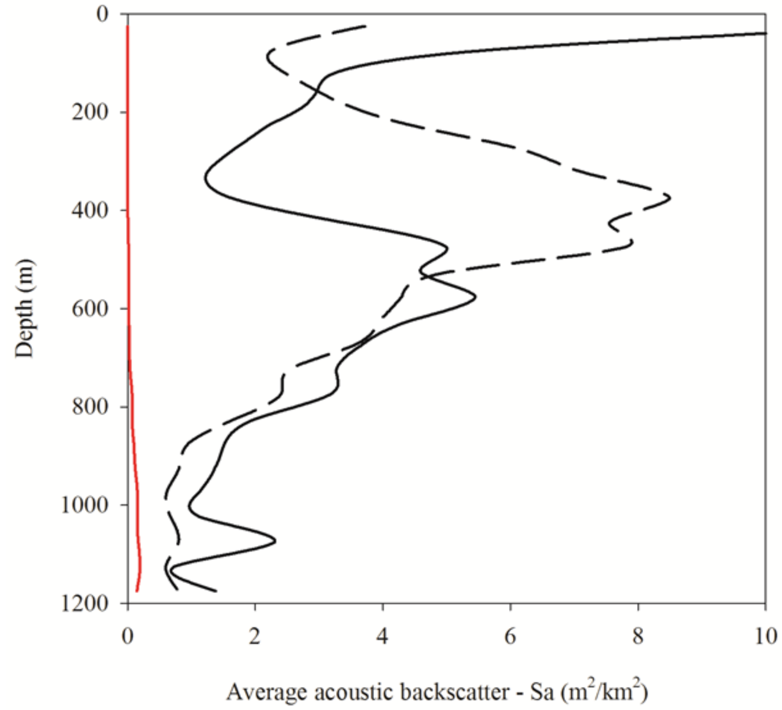

Figure 18: Vertical distribution of the average acoustic backscatter for the day (dashed lines) and at night (solid lines) and the contribution of the observed noise to the acoustic backscatter (red line) for the Chatham Rise survey in 2013.

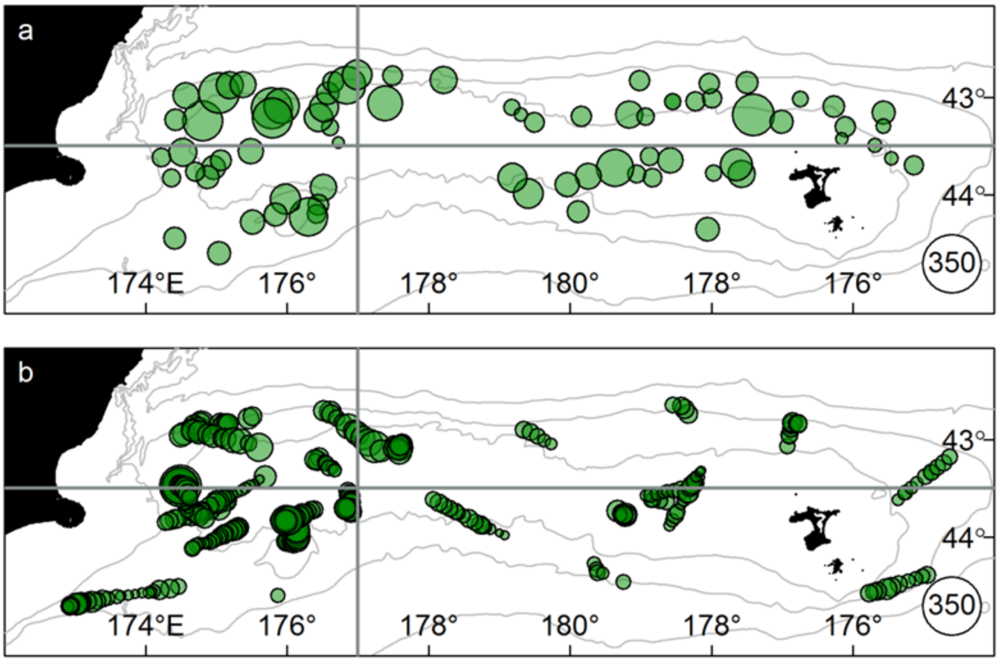

Figure 19: Distribution of total acoustic backscatter (green circles) observed on the Chatham Rise during daytime (a) tows and night-time (b) steams in January 2013. Circle area is proportional to the acoustic backscatter (white circle on bottom right represents maximum symbol size in $m^2.km^{-2}$). Grey lines separate the four acoustic strata.

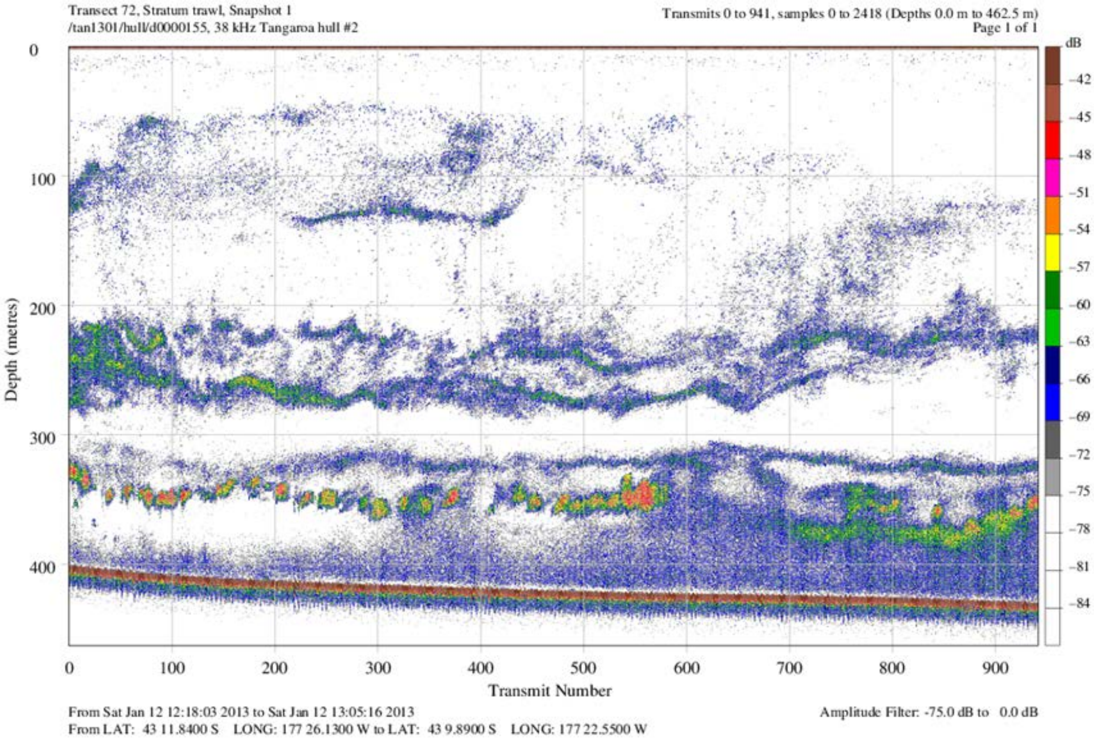

Figure 20: Acoustic echogram recorded during tow 72 on January 12, 2013 showing bottom schools about 70 m above the seabed. This tow caught 17.6 t of alfonsino.

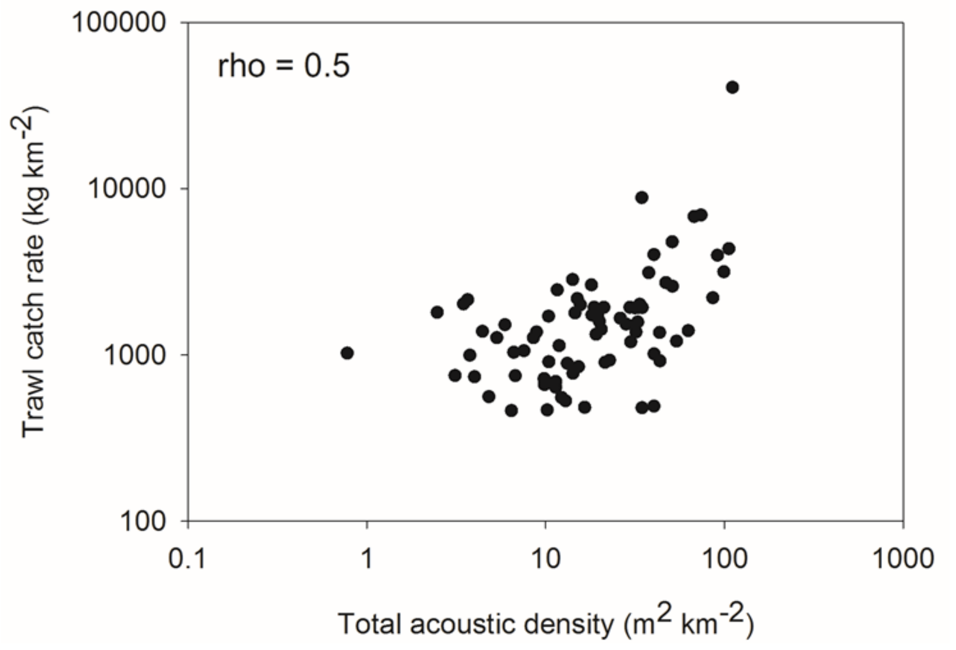

Figure 21: Relationship between total trawl catch rate (all species combined) and bottom-referenced acoustic backscatter recorded during the trawl survey on the Chatham Rise in 2013. Rho value is Spearman's rank correlation coefficient.

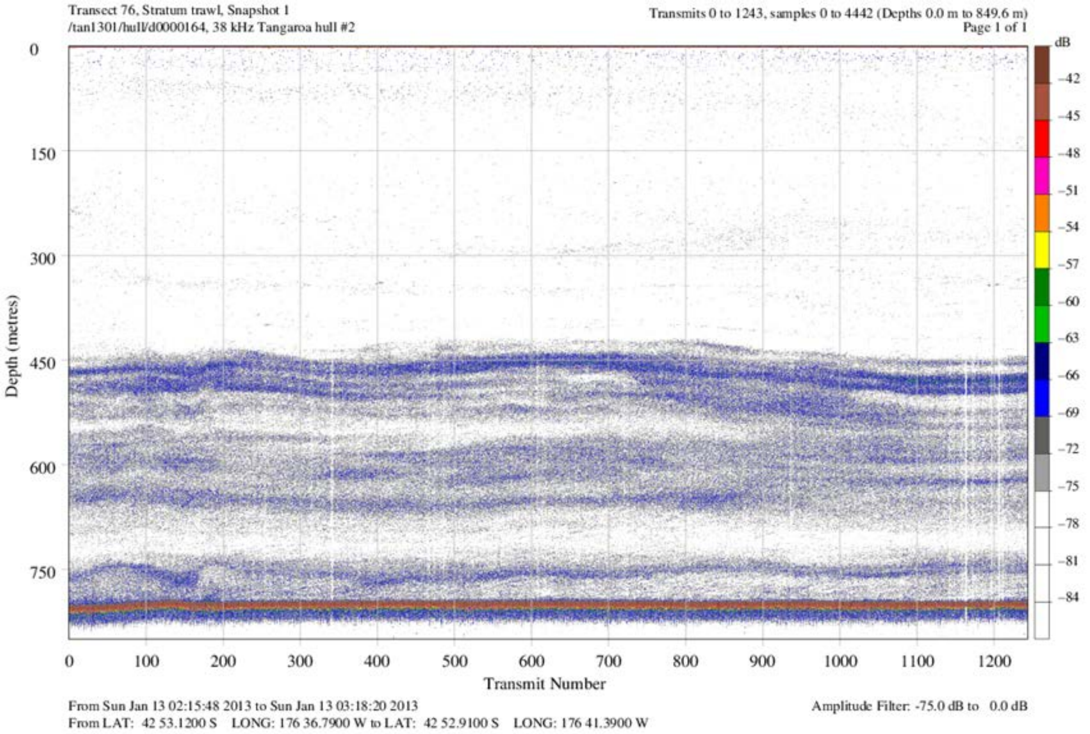

Figure 22: Acoustic echogram recorded at night (02:15 to 03:18 NZDT) on January 12, 2013 showing deep scattering layers at 450–700 m depth.

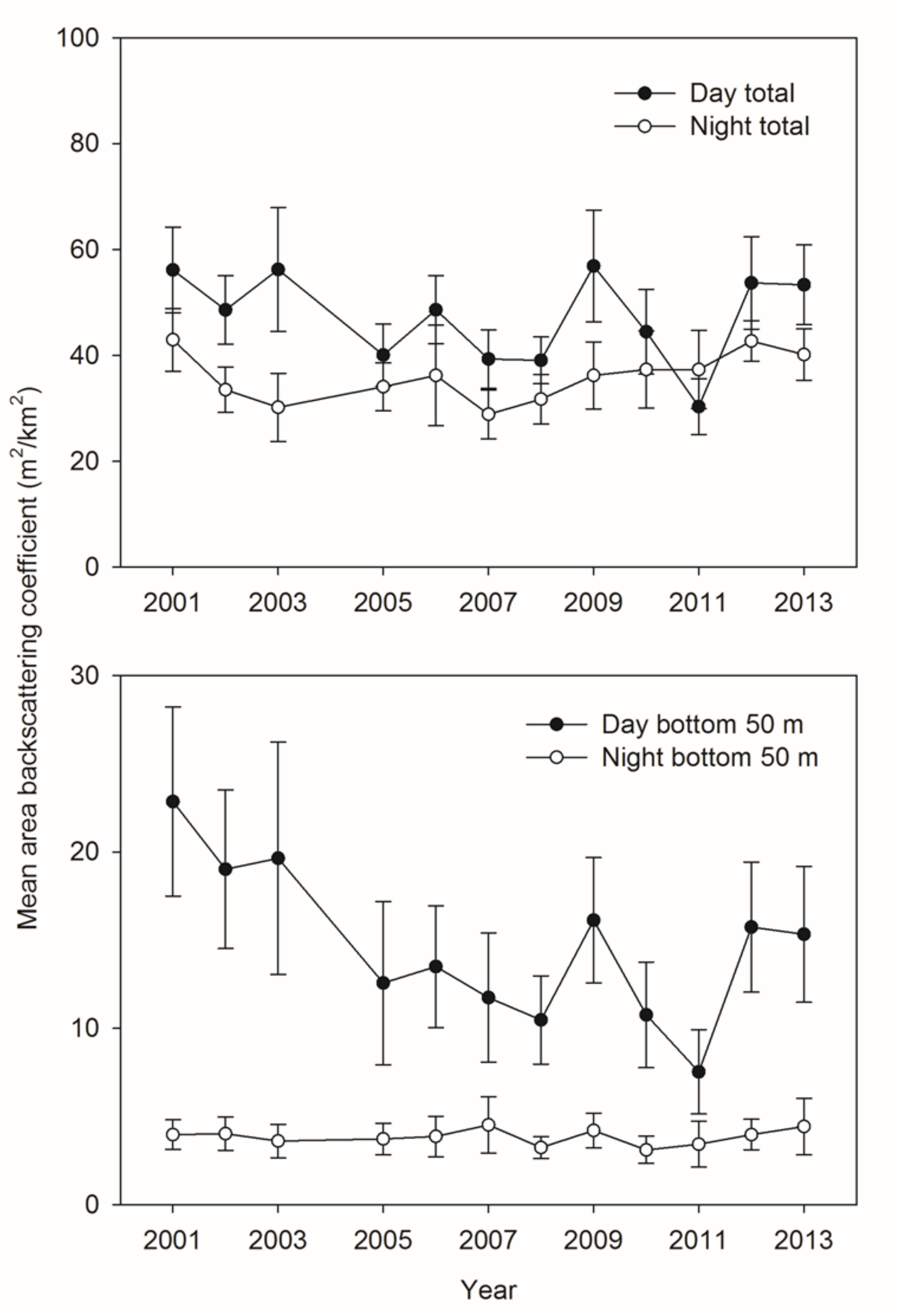

Figure 23: Comparison of relative acoustic abundance indices for the Chatham Rise based on (strata-averaged) mean areal backscatter. Error bars are ± 2 standard errors.

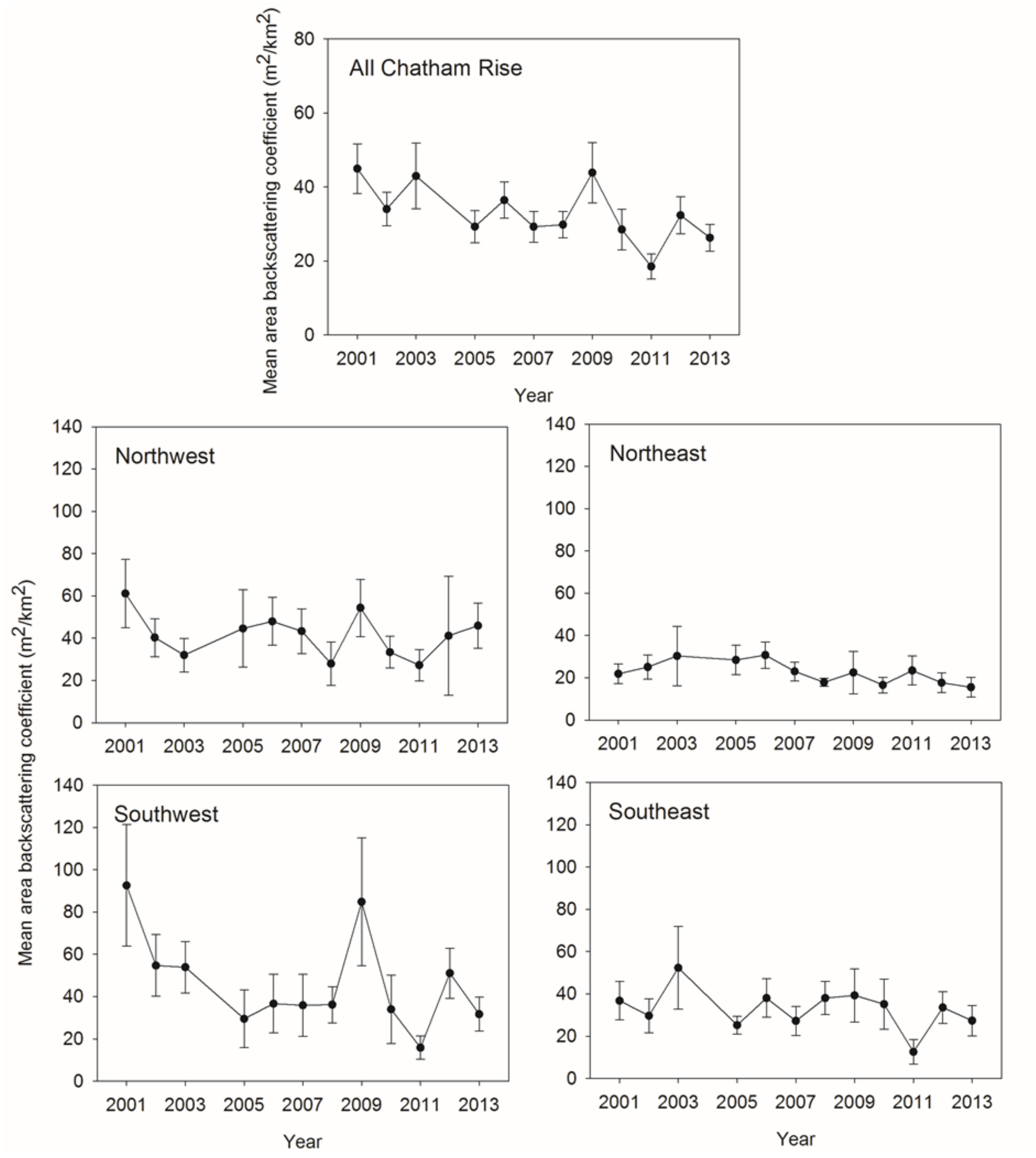

Figure 24: Relative acoustic abundance indices for mesopelagic fish on the Chatham Rise. Indices were derived by multiplying the total backscatter observed at each daytime trawl station by the estimated proportion of night-time backscatter in the same sub-area observed in the upper 200 m corrected for the estimated proportion in the surface deadzone. Panels show indices for the entire Chatham Rise and for four sub-areas. Error bars are approximate 95% confidence intervals from bootstrapping.

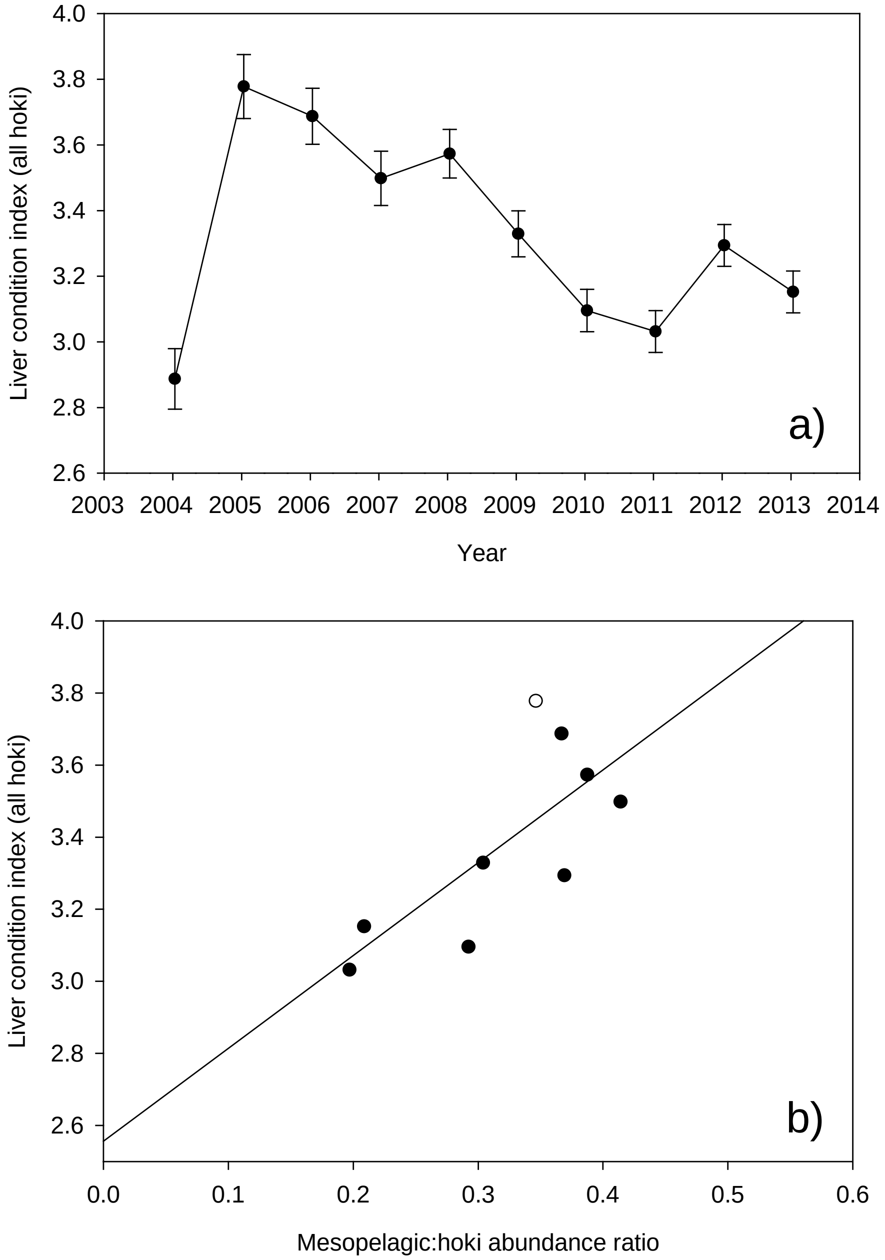

Figure 25: Hoki liver condition index for all hoki on the Chatham Rise from 2004–13 plotted as: a) a time-series, where error bars show ± 2 standard errors; and b) relationship with ratio of mesopelagic fish abundance estimated by acoustics to hoki abundance from the trawl survey (food per fish ratio).

Appendix 1: Individual station data for all stations conducted during the survey (TAN1301). Stn., station number; P1, phase one trawl survey biomass tow; P2, phase two trawl survey biomass tow; RN, fine-meshed midwater tow; Strat., Stratum number; *, foul tow.

			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	7A	3-Jan-13	0814	43 37.25	174 11.92	E	486	520	2.98	603.3	0	32.7
2	P1	7A	3-Jan-13	1046	43 34.33	174 30.17	E	517	541	3.02	363.9	21.2	102.0
3	P1	7A	3-Jan-13	1415	43 15.51	174 47.74	E	407	426	3.01	525.4	24.8	110.3
4	P1	7A	3-Jan-13	1751	43 14.58	174 24.89	E	562	569	2.92	147.6	2.6	51.1
*5	P1	22	3-Jan-13	2213	42 54.17	174 44.23	E	858	879	1.61	46.4	2.6	3.8
6	P1	23	4-Jan-13	0117	42 50.31	174 44.52	E	1030	1040	3.10	2.1	6.7	0
7	P1	23	4-Jan-13	0351	42 45.07	174 48.44	E	1206	1207	3.00	0	0	0
8	P1	1	4-Jan-13	0735	42 59.27	174 33.90	E	776	786	3.00	17.3	0	0
9	P1	7A	4-Jan-13	1130	42 57.71	175 01.56	E	551	583	3.01	486.9	15.7	44.6
10	P1	1	4-Jan-13	1328	42 52.63	175 10.58	E	688	706	3.01	108.7	14.2	15.9
11	P1	1	4-Jan-13	1602	42 53.23	175 30.99	E	610	622	3.01	180.2	10.5	44.6
12	P1	22	4-Jan-13	1823	42 48.06	175 30.72	E	805	807	3.03	90.7	0	19.3
13	P1	22	4-Jan-13	2145	42 50.79	175 05.97	E	824	830	3.02	128.7	2.5	0
*14	P1	22	5-Jan-13	0041	42 48.90	175 00.26	E	963	966	0.31	0	2.0	0
*15	P1	22	5-Jan-13	0224	42 51.32	174 59.48	E	848	870	2.89	192.6	9.8	0
16	P1	7B	5-Jan-13	0744	43 07.45	175 45.74	E	453	471	2.99	2169.3	54.6	123.9
17	P1	7B	5-Jan-13	1012	43 05.48	175 56.11	E	418	428	3.01	3129.9	37.1	59.2
18	P1	7B	5-Jan-13	1230	43 12.70	175 46.53	E	405	434	2.99	631.9	146.6	85.4
19	P1	19	5-Jan-13	1737	43 26.89	176 43.78	E	249	258	3.00	49.2	0	6.4
20	RN		6-Jan-13	0034	43 20.44	176 40.62	E	43	70	3.74	0	0	0
21	RN		6-Jan-13	0211	43 22.51	176 42.42	E	70	124	6.34	0	0	0
22	P1	19	6-Jan-13	0518	43 18.76	176 38.06	E	253	268	3.01	816.5	0	8
23	P1	19	6-Jan-13	0745	43 12.74	176 27.93	E	298	325	2.56	2267.1	0	10.5
24	P1	19	6-Jan-13	0959	43 07.29	176 31.59	E	327	371	3.03	398.5	7.9	46.8
25	P1	8A	6-Jan-13	1159	42 58.19	176 34.00	E	436	441	3.03	185.7	12.5	12.0
26	P1	8A	6-Jan-13	1344	42 51.06	176 37.82	E	457	496	2.99	565.4	37.5	37.0
27	P1	8A	6-Jan-13	1551	42 52.75	176 49.35	E	416	418	2.98	430.0	31.1	74.1
28	P1	2A	6-Jan-13	1808	42 46.00	176 58.61	E	645	650	3.00	74.1	11.3	35.5
29	P1	22	6-Jan-13	2225	42 42.17	176 30.17	E	826	830	2.96	127.6	4.5	0
30	P1	20	7-Jan-13	0517	43 16.77	177 38.01	E	272	278	3.01	213.6	0	7.9
31	P1	20	7-Jan-13	0749	43 08.49	177 44.76	E	313	319	3.03	2895.7	1.9	8.5
32	P1	20	7-Jan-13	1010	43 01.91	177 43.27	E	317	330	3.01	2568.7	0	6.9
33	P1	20	7-Jan-13	1202	43 05.24	177 34.10	E	330	352	2.58	1123.0	0	28.3
34	P1	19	7-Jan-13	1344	43 04.05	177 23.36	E	295	303	2.01	1527.1	0	0.2
35	P1	2A	7-Jan-13	1706	42 46.46	177 28.35	E	718	761	3.02	155.8	1.9	5.9
36	P1	22	7-Jan-13	1956	42 43.80	177 30.52	E	921	952	2.09	9.8	6.8	0
37	P1	22	7-Jan-13	2305	42 44.10	177 41.01	E	890	903	3.03	66.5	3.9	0
*38	P1	23	8-Jan-13	0325	42 38.38	178 00.42	E	1199	1207	2.01	0	0	0
39	P1	2A	8-Jan-13	0633	42 49.12	178 12.19	E	745	750	3.12	115.7	1.7	0
40	P1	20	8-Jan-13	1127	43 10.05	178 56.40	E	372	389	3.01	532.9	0	162.5
41	P1	8B	8-Jan-13	1402	43 06.11	179 09.66	E	422	426	2.52	609.1	0	31.8
42	P1	8B	8-Jan-13	1601	43 10.69	179 17.19	E	433	437	3.00	162.1	0	31.5
43	P1	8B	8-Jan-13	1813	43 15.81	179 28.38	E	430	430	3.01	186.6	3.0	22.4
44	P1	22	8-Jan-13	2312	42 53.06	179 03.05	E	873	880	3.02	39.6	1.5	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	22	9-Jan-13	0115	42 53.54	179 13.44	E	838	847	3.02	58.9	1.7	0
46	P1	10A	9-Jan-13	0626	43 11.89	179 51.23	W	513	515	3.00	320.7	7.8	46.2
47	P1	10A	9-Jan-13	0846	43 05.94	179 55.52	W	524	535	2.99	172.0	0	26.9
48	P1	10A	9-Jan-13	1048	43 01.03	179 52.40	W	568	572	3.01	242.2	74.4	0
49	P1	22	9-Jan-13	1414	42 51.64	179 55.15	E	866	879	3.01	80.0	0	0
50	P1	22	9-Jan-13	1836	42 52.23	179 45.23	E	863	872	2.98	26.5	3.3	0
51	P1	22	9-Jan-13	2250	42 50.16	179 34.83	E	943	969	3.02	12.8	4.7	0
52	P1	22	10-Jan-13	0103	42 52.99	179 36.96	E	810	835	2.99	29.3	0	0
53	P1	22	10-Jan-13	0419	42 48.66	179 52.05	E	993	996	3.01	15.8	2.6	0
*54	P1	23	10-Jan-13	0715	42 44.41	179 53.44	E	1183	1193	2.04	0	0	0
55	P1	10B	10-Jan-13	1154	43 05.49	179 23.33	W	527	532	3.00	181.9	0	37.6
56	P1	10B	10-Jan-13	1354	43 05.34	179 15.07	W	529	533	3.03	195.1	10.6	20.3
57	P1	10B	10-Jan-13	1601	43 10.08	179 09.38	W	511	518	3.01	257.5	0	5.2
58	P1	11B	10-Jan-13	1834	43 11.81	178 56.61	W	486	488	2.50	166.3	2.6	12.7
59	P1	21A	10-Jan-13	2358	42 44.59	179 16.81	W	938	950	3.03	45.3	1.8	0
60	P1	21A	11-Jan-13	0210	42 45.83	179 08.73	W	850	853	3.02	72.6	0	0
61	P1	2B	11-Jan-13	0524	42 49.87	179 01.59	W	694	705	2.99	219.0	32.2	11.5
62	P1	11B	11-Jan-13	0805	42 57.85	178 43.20	W	523	529	2.99	300.9	3.5	3.4
63	P1	11B	11-Jan-13	0959	43 02.37	178 34.07	W	524	592	3.00	185.5	5.3	121.1
64	P1	11C	11-Jan-13	1232	43 02.68	178 14.09	W	529	530	3.01	176.0	10.4	10.2
65	P1	11C	11-Jan-13	1433	43 00.84	178 00.56	W	514	515	3.04	192.7	11.3	12.8
66	P1	2B	11-Jan-13	1729	42 51.30	178 02.53	W	620	629	2.99	196.3	0	4.6
67	P1	21A	11-Jan-13	2024	42 44.21	178 14.77	W	857	864	3.00	42.6	0	0
68	P1	23	11-Jan-13	2344	42 38.80	178 28.00	W	1111	1118	3.04	6.3	0	0
69	P1	23	12-Jan-13	0204	42 38.97	178 16.54	W	1150	1184	3.03	0	0	0
*70	P1	23	12-Jan-13	0432	42 37.98	178 08.99	W	1215	1253	2.00	0	0	0
71	P1	2B	12-Jan-13	0844	42 50.69	177 30.46	W	779	784	2.99	25.0	2.4	14.4
72	P1	11C	12-Jan-13	1231	43 11.16	177 24.73	W	412	429	2.05	129.6	0	34.5
73	P1	9	12-Jan-13	1829	43 15.24	177 01.30	W	304	308	1.97	74.0	0	35.5
74	RN		12-Jan-13	2256	42 50.08	176 46.10	W	0	900	1.68	0	0	0
75	RN		13-Jan-13	0046	42 48.06	176 38.19	W	0	950	1.83	0	0	0
76	RN		13-Jan-13	0234	42 53.06	176 39.34	W	0	750	1.41	0	0	0
77	P1	11D	13-Jan-13	0515	43 07.42	176 44.15	W	448	451	2.98	381.8	0	25.8
78	P1	11D	13-Jan-13	0810	43 05.54	176 17.22	W	547	554	2.99	417.6	16.6	142.2
79	P1	11D	13-Jan-13	1045	43 17.86	176 07.35	W	442	448	3.01	574.8	0	62.5
80	P1	9	13-Jan-13	1259	43 25.64	176 10.32	W	321	333	2.37	172.2	0	5.9
81	P1	12	13-Jan-13	1540	43 29.38	175 42.55	W	434	444	3.01	121.1	0	45.8
82	P1	12	13-Jan-13	1800	43 37.70	175 28.19	W	464	500	2.65	471.7	0	47.7
83	P1	21B	13-Jan-13	2353	43 07.99	174 39.32	W	869	871	3.01	48.0	4.6	0
84	P1	21B	14-Jan-13	0306	43 02.17	175 00.31	W	946	956	3.05	16.6	0	0
85	P1	2B	14-Jan-13	0707	43 08.95	175 34.43	W	690	701	3.02	172.2	4.3	17.4
86	P1	2B	14-Jan-13	0929	43 17.79	175 35.07	W	620	640	2.99	197.9	31.6	16.5
87	P1	12	14-Jan-13	1329	43 41.67	175 08.81	W	572	582	3.02	441.3	33.1	36.5
88	P1	21B	14-Jan-13	1834	43 21.75	174 24.15	W	872	876	3.02	15.3	0	0
89	P1	24	14-Jan-13	2232	43 17.05	174 04.05	W	1037	1057	3.00	2.9	0	0
90	P1	24	15-Jan-13	0139	43 21.18	173 54.96	W	1157	1173	3.02	0	0	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
91	P1	24	15-Jan-13	0504	43 25.96	173 53.88	W	1229	1258	3.01	0	0	0
92	P1	25	15-Jan-13	0905	43 32.26	174 08.93	W	988	993	3.08	5.8	0	0
93	P1	25	15-Jan-13	1414	44 00.21	174 41.16	W	903	915	3.04	12.9	0	0
94	P1	25	15-Jan-13	1852	44 25.99	175 00.44	W	902	936	3.01	22.3	0	0
*95	P1	25	16-Jan-13	0028	44 34.97	175 53.28	W	901	901	0.33	24.6	0	0
96	P1	25	16-Jan-13	0242	44 34.79	175 56.83	W	810	826	2.49	177.3	6.2	10.7
97	P1	4	16-Jan-13	1307	44 21.09	178 02.60	W	736	745	3.01	34.3	3.8	20.0
98	P1	13	16-Jan-13	1616	44 08.95	178 18.17	W	486	488	3.01	382.0	25.7	40.9
99	P1	28	17-Jan-13	0206	44 32.05	178 35.71	W	1053	1074	3.01	41.9	0	0
100	P1	5	17-Jan-13	1143	43 48.30	177 34.19	W	368	370	2.94	167.4	0	91.8
101	P1	5	17-Jan-13	1329	43 41.83	177 37.34	W	385	390	3.02	261.1	0	54.4
102	P1	5	17-Jan-13	1612	43 47.08	177 57.28	W	370	377	3.00	352.3	0	57.0
103	P1	9	19-Jan-13	0517	43 21.09	178 12.04	W	367	385	2.32	222.1	0	19.5
104	P1	11A	19-Jan-13	0719	43 27.86	178 13.98	W	408	421	3.00	84.2	0	65.3
105	P1	11A	19-Jan-13	1011	43 39.07	178 33.90	W	410	430	3.01	882.9	20.2	94.9
106	P1	11A	19-Jan-13	1234	43 37.05	178 51.50	W	451	452	3.03	249.0	61.3	93.5
107	P1	13	19-Jan-13	1606	43 50.08	178 50.04	W	413	424	2.44	675.4	45.9	70.6
108	P1	3	19-Jan-13	1826	43 47.67	179 03.98	W	392	397	2.46	188.6	8.3	76.2
*109	P1	28	20-Jan-13	0005	44 29.25	179 20.21	W	1088	1088	0.88	0	0	0
*110	P1	28	20-Jan-13	0157	44 29.13	179 21.22	W	1076	1107	2.52	0.8	0	0
*111	P1	3	20-Jan-13	0947	43 35.92	179 22.76	W			0.28	20.7	0	0
112	P1	3	20-Jan-13	1127	43 43.51	179 21.16	W	373	385	2.00	1419.7	8.7	39.4
113	P1	3	20-Jan-13	1351	43 48.88	179 43.22	W	372	383	3.01	358.4	0	29.6
114	P1	13	20-Jan-13	1552	43 53.30	179 49.26	W	408	410	2.04	563.1	15.5	62.1
115	P1	28	20-Jan-13	2309	44 39.83	179 34.77	W	1229	1233	3.05	0	0	0
116	P1	28	21-Jan-13	0247	44 26.43	179 40.33	W	1051	1060	2.04	0	0	0
117	P1	4	21-Jan-13	0558	44 10.57	179 52.38	W	625	634	3.04	263.6	12.1	23.1
118	P1	14	21-Jan-13	0908	43 53.51	179 58.46	E	431	452	2.82	540.8	0	46.3
119	P1	14	21-Jan-13	1238	43 59.47	179 25.67	E	573	576	3.02	569.5	0	62.8
120	P1	14	21-Jan-13	1459	43 50.02	179 12.11	E	469	485	3.02	645.3	0	80.5
121	P1	15	22-Jan-13	0534	43 54.86	176 31.43	E	483	505	3.00	763.7	0	59.1
122	P1	15	22-Jan-13	0748	44 05.76	176 26.30	E	557	574	1.98	170.3	3.8	50.6
123	P1	4	22-Jan-13	1013	44 10.91	176 25.64	E	616	628	3.00	256.9	14.6	124.8
124	P1	15	22-Jan-13	1229	44 12.94	176 18.07	E	528	567	2.04	475.0	0	71.7
125	P1	17	22-Jan-13	1421	44 07.95	176 08.77	E	244	259	3.02	0	0	0
126	P1	17	22-Jan-13	1605	44 02.81	175 59.93	E	339	384	2.37	2364.2	0	26.7
127	P1	17	22-Jan-13	1806	44 11.29	175 50.26	E	289	323	2.33	237.4	0	4.2
128	RN		22-Jan-13	2202	44 39.70	175 48.37	E	0	875	1.52	0	0	0
129	RN		23-Jan-13	0003	44 46.37	175 40.94	E	0	935	2.63	0	0	0
130	P1	6	23-Jan-13	0537	44 16.32	175 31.53	E	604	611	3.01	336.0	25.7	85.4
131	P1	16	23-Jan-13	0748	44 13.26	175 19.94	E	530	556	3.01	383.5	0	57.5
132	P1	6	23-Jan-13	1326	44 35.57	175 02.34	E	755	756	2.16	69.7	0	18.8
133	P1	6	23-Jan-13	1708	44 26.31	174 25.49	E	710	717	3.00	95.6	0	8.8
134	P1	16	24-Jan-13	0533	43 50.10	174 20.50	E	523	549	3.00	159.9	3	16.1
135	P1	16	24-Jan-13	0913	43 43.72	174 56.99	E	422	440	2.09	3579.3	0	31.8
136	P1	18	24-Jan-13	1101	43 36.75	175 03.66	E	318	327	2.01	438.1	0	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
137	P1	18	24-Jan-13	1330	43 33.27	175 27.98	E	212	229	2.01	55.6	0	0
138	P1	18	24-Jan-13	1741	43 15.52	176 03.23	E	349	360	2.10	1591.8	0	43.9
139	P2	16	25-Jan-13	0533	43 49.51	174 53.13	E	455	465	3.02	740.4	22.4	19.5
140	P2	16	25-Jan-13	0747	43 46.40	174 42.91	E	489	512	3.01	1360.9	8.8	23.9

Appendix 2: Scientific and common names of species caught from all valid biomass tows (TAN1301). The occurrence (Occ.) of each species (number of tows caught) in the 123 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	3
Phaeophyta (brown seaweed)	unspecified brown sea weed	PHA	2
Lessoniaceae			
Ecklonia spp.		ECK	1
Porifera	unspecified sponges	ONG	7
Demospongiae (siliceous sponges)			
Astrophorida (sandpaper sponges)			
Ancorinidae			
Stellata sp.	orange fat finger sponge	SLT	1
Geodiidae			
Geodia regina	curling stone sponge	GRE	1
G. vestigifera	ostrich egg sponge	GVE	1
Pachastrellidae			
Poecillastra laminaris	fiberglass cup sponge	PLN	1
Thenea novaezelandiae	yoyo sponge	THN	1
Hadromerida (woody sponges)			
Suberitidae			
Suberites affinis	fleshy club sponge	SUA	8
Spirophorida (spiral sponges)			
Tetillidae			
Tetilla leptoderma	furry oval sponge	TLD	2
Hexactinellida (glass sponges)			
Lyssacinosida (tubular sponges)			
Euplectellidae			
Euplectella regalis	basket-weave horn sponge	ERE	2
Rossellidae			
Hyalascus sp.	floppy tubular sponge	HYA	17
Poecilosclerida (bright sponges)			
Coelosphaeridae			
Lissodendoryx bifacialis	floppy chocolate plate sponge	LBI	3
Crellidae			
Crella incrustans	orange frond sponge	CIC	2
Hymedesmiidae			
Phorbas sp.	grey fibrous massive sponge	PHB	1
Cnidaria			
Scyphozoa	unspecified jellyfish	JFI	16
Anthozoa			
Corallimorpharia (coral-like anemones)			
Corallimorphidae	coral-like anemones	CLM	3
Octocorallia			
Alcyonacea (soft corals)	unspecified soft coral	SOC	6
Isididae			
Keratoisis spp.	branching bamboo coral	BOO	1
Lepidisis spp.	bamboo coral	LLE	2
Primnoidae			
Thouarella spp.	bottle brush coral	THO	1
Pennatulacea (sea pens)	unspecified sea pens	PTU	16
Pennatulidae			
Pennatula spp.	purple sea pens	PNN	10

Appendix 2 (continued)

Scientific name	Common name	Species	Occ.
Hexacorallia			
Zoanthidea (zoanthids)			
Epizoanthidae			
Epizoanthus sp.		EPZ	16
Actinaria (anemones)	unspecified anemome	ANT	3
Actiniidae			
Bolocera spp.	deepsea anemone	BOC	1
Actinostolidae (smooth deepsea anemones)		ACS	33
Hormathiidae (warty deepsea anemones)		HMT	19
Scleractinia (stony corals)			
Caryophyllidae			
Goniocorella dumosa	bushy hard coral	GDU	6
Stephanocyathus platypus	solitary bowl coral	STP	5
Flabellidae			
Flabellum spp.	flabellum coral	COF	12
Tunicata			
Thaliacea (salps)	unspecified salps	SAL	8
Salpidae			
Pyrosoma atlanticum		PYR	50
Mollusca			
Gastropoda (gastropods)	unspecified gastropod	GAS	1
Nudibranchia (sea slugs)		NUD	2
Buccinidae (whelks)			
Penion chathamensis		PCH	3
Ranellidae (tritons)			
Fusitriton magellanicus		FMA	31
Volutidae (volutes)			
Alcithoe wilsonae		AWI	1
Provocator mirabilis	golden volute	GVO	3
Bivalvia (bivalves)			
Ostreoida			
Pectinidae (scallops)			
Zygochlamys delicatula	queen scallop	QSC	1
Cephalopoda			
Sepiolida (bobtail squids)			
Sepiadariidae			
Sepioloidea spp.	bobtail squid	SSQ	1
Teuthoidea (squids)			
Octopoteuthidae			
Octopoteuthis spp.		OPO	1
Taningia danae	Dana octopus squid	TDQ	1
Onychoteuthidae			
Onykia ingens	warty squid	MIQ	54
O. robsoni	warty squid	MRQ	3
Pholidoteuthidae			
Pholidoteuthis massyae	large red scaly squid	PSQ	2
Histioteuthidae (violet squids)			
Histioteuthis atlantica	violet squid	HAA	2
Histioteuthis miranda	violet squid	HMI	1
Histioteuthis spp.	violet squid	VSQ	4
Ommastrephidae			
Nototodarus sloanii	Sloan's arrow squid	NOS	42
Todarodes filippovae	Todarodes squid	TSQ	29

Appendix 2 (continued)

Scientific name	Common name	Species	Occ.
Chiroteuthidae			
Chiroteuthis veryani	squid	CVE	2
Mastigoteuthidae			
Mastigoteuthis sp.	squid	MSQ	1
Cranchiidae	unspecified cranchiid	CHQ	3
Teuthowenia pellucida	squid	TPE	3
Cirrata (cirrate octopus)			
Opisthoteuthididae			
Opisthoteuthis spp.	umbrella octopus	OPI	3
Incirrata (incirrate octopus)			
Octopodidae			
Enteroctopus zealandicus	yellow octopus	EZE	1
Graneledone spp.	deepwater octopus	DWO	2
Polychaeta	unspecified polychaete	POL	2
Eunicida			
Eunicidae			
Eunice spp.	Eunice sea worm	EUN	1
Onuphidae			
Hyalinoecia tubicola	quill worm	HTU	1
Phyllodocida			
Aphroditidae			
Aphrodita spp.	sea mouse	ADT	1
Crustacea			
Malacostraca			
Dendrobranchiata/Pleocyemata (prawns)	unspecified prawn	NAT	3
Dendrobranchiata			
Aristeidae			
Aristaeopsis edwardsiana	scarlet prawn	PED	2
Solenoceridae			
Haliporoides sibogae	jack-knife prawn	HSI	1
Pleocyemata			
Caridea			
Campylonotidae			
Campylonotus rathbunae	sabre prawn	CAM	1
Oplophoridae			
Acanthephyra spp.	SubAntarctic ruby prawn	ACA	3
Notostomus auriculatus	scarlet prawn	NAU	3
Oplophorus spp.	deepwater prawn	OPP	2
Pasiphaeidae			
Pasiphaea aff. *tarda*	deepwater prawn	PTA	13
Pasiphaea spp.	deepwater prawn	PAS	1
Nematocarcinidae			
Lipkius holthuisi	omega prawn	LHO	29
Achelata			
Astacidea			
Nephropidae (clawed lobsters)			
Metanephrops challengeri	scampi	SCI	33
Palinura			
Polychelidae			
Polycheles spp.	deepsea blind lobster	PLY	7
Anomura			
Galatheoidea			
Galatheidae (galatheid squat lobsters)			
Munida gracilis	squat lobster	MGA	1

Appendix 2 (continued)

Scientific name	Common name	Species	Occc.
Inachidae			
Vitjazmaia latidactyla	deepsea spider crab	VIT	4
Lithodidae (king crabs)			
Lithodes aotearoa	New Zealand king crab	LAO	1
L. robertsoni	Robertson’s king crab	LRO	1
Neolithodes brodiei	Brodie’s king crab	NEB	5
Paguroidea (unspecified pagurid & parapagurid hermit crabs)		PAG	11
Paguridae (Pagurid hermit crabs)			
Diacanthurus rubricatus	hermit crab	DIR	2
Bathypaguropsis yaldwyni	hermit crab	BYL	1
Propagurus deprofundis	hermit crab	PDE	2
Parapaguridae (Parapagurid hermit crabs)			
Sympagurus dimorphus	hermit crab	SDM	7
Brachyura (true crabs)			
Atelecyclidae			
Trichopeltarion fantasticum	frilled crab	TFA	10
Goneplacidae			
Pycnoplax victoriensis	two-spined crab	CVI	3
Majidae (spider crabs)			
Leptomithrax garricki	Garrick’s masking crab	GMC	2
Teratomaia richardsoni	spiny masking crab	SMK	14
Portunidae (swimming crabs)			
Ovalipes molleri	swimming crab	OVM	1
Lophogastrida (lophogastrids)			
Gnathophausiidae			
Gnathophausia ingens	giant red mysid	NEI	3
Echinodermata			
Asteroidea (starfish)	unspecified starfish	ASR	5
Asteriidae			
Cosmasterias dyscrita	cat’s-foot star	CDY	2
Pseudechinaster rubens	starfish	PRU	8
Astropectinidae			
Dipsacaster magnificus	magnificent sea-star	DMG	20
Plutonaster knoxi	abyssal star	PKN	32
Proserpinaster neozelanicus	starfish	PNE	13
Psilaster acuminatus	geometric star	PSI	30
Sclerasterias mollis	cross-fish	SMO	4
Benthopectinidae			
Cheiraster monopedicellaris	starfish	CMP	2
Brisingida	unspecified Brisingid	BRG	17
Echinasteridae			
Henricia compacta	starfish	HEC	1
Goniasteridae			
Hippasteria phrygiana	trojan starfish	HTR	14
Lithosoma novaezelandiae	rock star	LNV	2
Mediaster sladeni	starfish	MSL	13
Pillsburiaster aoteanus	starfish	PAO	4
Solasteridae			
Crossaster multispinus	sun star	CJA	21
Solaster torulatus	chubby sun-star	SOT	12
Pterasteridae			
Diplopteraster sp.	starfish	DPP	2
Zoroasteridae			
Zoroaster spp.	rat-tail star	ZOR	37

Appendix 2 (continued)

Scientific name	Common name	Species	Occ.
Ophiuroidea (basket and brittle stars)	unspecified brittle star	OPH	1
Ophiurida			
Ophiuridae			
Ophiomusium lymani	deepsea brittle star	OLY	1
Euryalina (basket stars)			
Gorgonocephalidae			
Gorgonocephalus spp.	Gorgon's head basket stars	GOR	3
Echinoidea (sea urchins)	unspecified sea urchin	URO	1
Regularia			
Cidaridae (cidarid urchins)			
Goniocidaris parasol	parasol urchin	GPA	5
G. umbraculum	umbrella urchin	GOU	5
Histiocidaridae (cidarid urchins)			
Histiocidaris spp.		HIS	6
Echinothuriidae/Phormosomatidae	unspecified Tam O'Shanter urchin	TAM	44
Echinothuriidae	echinothuriid Tam O'Shanter urchin	ECT	4
Echinidae			
Gracilechinus multidentatus	deepsea kina	GRM	17
Dermechinus horridus	deepsea urchin	DHO	1
Spatangoida (heart urchins)			
Spatangidae			
Paramaretia peloria	Microsoft mouse	PMU	4
Spatangus multispinus	purple-heart urchin	SPT	5
Holothuroidea			
Aspidochirotida			
Synallactidae			
Bathyplotes sp.	sea cucumber	BAM	23
Pseudostichopus mollis	sea cucumber	PMO	37
Elasipodida			
Laetmogonidae			
Laetmogone sp.	sea cucumber	LAG	13
Pannychia moseleyi	sea cucumber	PAM	5
Pelagothuridae			
Enypniastes exima	sea cucumber	EEX	4
Psychropotidae			
Benthodytes sp.	sea cucumber	BTD	1
Agnatha (jawless fishes)			
Myxinidae (hagfishes)			
Eptatretus cirrhatus	hagfish	HAG	2
Neomyxine biniplicata	slender hagfish	NBI	1
Chondrichthyes (cartilagenous fishes)			
Chlamydoselachidae: frill sharks			
Chlamydoselachus anguineus	frill shark	FRS	1
Squalidae: dogfishes			
Squalus acanthias	spiny dogfish	SPD	53
S. griffini	northern spiny dogfish	NSD	3
Centrophoridae: gulper sharks			
Centrophorus squamosus	leafscale gulper shark	CSQ	17
Deania calcea	shovelnose dogfish	SND	53
Etmopteridae: lantern sharks			
Etmopterus baxteri	Baxter's dogfish	ETB	38
E. lucifer	lucifer dogfish	ETL	61

Appendix 2 (continued)

Scientific name	Common name	Species	Occ.
Somniosidae: sleeper sharks			
Centroscymnus crepidater	longnose velvet dogfish	CYP	35
C. owstoni	smooth skin dogfish	CYO	28
Proscymnodon plunketi	Plunket's shark	PLS	8
Zameus squamulosus	velvet dogfish	ZAS	2
Oxynotidae: rough sharks			
Oxynotus bruniensis	prickly dogfish	PDG	5
Dalatiidae: kitefin sharks			
Dalatias licha	seal shark	BSH	33
Scyliorhinidae: cat sharks			
Apristurus spp.	catshark	APR	16
Bythaelurus dawsoni	Dawson's catshark	DCS	1
Cephaloscyllium isabellum	carpet shark	CAR	3
Triakidae: smoothhounds			
Galeorhinus galeus	school shark	SCH	7
Torpedinidae: electric rays			
Torpedo fairchildi	electric ray	ERA	1
Narkidae: blind electric rays			
Typhlonarke aysoni	blind electric ray	TAY	6
T. tarakea	oval electric ray	TTA	1
Rajidae: skates			
Amblyraja hyperborea	deepwater spiny (Arctic) skate	DSK	1
Bathraja shuntovi	longnosed deepsea skate	PSK	7
Brochiraja asperula	smooth deepsea skate	BTA	18
B. spinifera	prickly deepsea skate	BTS	9
Brochiraja spp.	deepsea skates	BTH	2
Dipturus innominatus	smooth skate	SSK	33
Zearaja nasuta	rough skate	RSK	3
Chimaeridae: chimaeras, ghost sharks			
Chimaera lignaria	giant chimaera	CHG	1
C. sp. C	brown chimaera	CHP	2
Hydrolagus bemisi	pale ghost shark	GSP	78
H. novaezealandiae	dark ghost shark	GSH	51
H. homonycteris	black ghost shark	HYB	2
Rhinochimaeridae: longnosed chimaeras			
Harriotta raleighana	longnose spookfish	LCH	58
Rhinochimaera pacifica	Pacific spookfish	RCH	22
Osteichthyes (bony fishes)			
Halosauridae: halosaurs			
Halosaurus pectoralis	common halosaur	HPE	2
Notocanthidae: spiny eels			
Notacanthus chemnitzi	giant spineback	NOC	1
N. sexspinis	spineback	SBK	67
Synaphobranchidae: cutthroat eels			
Diastobranchus capensis	basketwork eel	BEE	29
Synaphobranchus affinis	grey cutthroat eel	SAF	1
Nettastomatidae: duckbill eels			
Venefica sp.	periscope duckbill eel	VEN	1
Congridae: conger eels			
Bassanago bulbiceps	swollenhead conger	SCO	53
B. hirsutus	hairy conger	HCO	33
Serrivomeridae: sawtooth eels			
Serrivomer sp.	sawtooth eel	SAW	2
Gonorynchidae: sandfish			
Gonorynchus forsteri & *G. greyi*	sandfishes	GON	4

Appendix 2 (continued)

Scientific name	Common name	Species	Occ.
Argentinidae: silversides			
Argentina elongata	silverside	SSI	48
Bathylagidae: deepsea smelts			
Melanolagus bericoides	bigscale blacksmelt	MEB	6
Alepocephalidae: slickheads			
Alepocephalus antipodianus	smallscaled brown slickhead	SSM	15
A. australis	bigscaled brown slickhead	SBI	19
Rouleina guentheri	slickhead	RGN	2
Xenodermichthys copei	black slickhead	BSL	14
Platytroctidae: tubeshoulders			
Normichthys yahganorum	tubeshoulder	NOR	2
Persparsia kopua	tubeshoulder	PER	7
Gonostomatidae: lightfishes			
Diplophos spp.	twin light dragonfishes	DIP	1
Gonostoma bathyphilum	deepsea lightfish	GBT	1
Sternoptychidae: hatchetfishes	unspecified hatchetfish	HAT	1
Argyropelecus gigas	giant hatchetfish	AGI	3
Photichthyidae: lighthouse fishes			
Phosichthys argenteus	lighthouse fish	PHO	17
Chauliodontidae: viperfishes			
Chauliodus sloani	viperfish	CHA	6
Stomiidae: scaly dragonfishes			
Stomias spp.		STO	1
Melanostomiidae: scaleless black dragonfishes			
Melanostomias spp.	scaleless black dragonfishes	MEN	1
Malacosteidae: loosejaws			
Malacosteus australis	southern loosejaw	MAU	4
Idiacanthidae: black dragonfishes			
Idiacanthus spp.	black dragonfish	IDI	3
Chlorophthalmidae: cucumberfishes, tripodfishes			
Bathypterois spp.	tripod fish	TRI	1
Scopelarchidae: pearleyes			
Scopelarchoides kreffti	Krefft's pearleye	SKR	1
Notosudidae: waryfishes			
Scopelosaurus spp.		SPL	2
Paralepididae: barracudinas			
Macroparalepis macrugeneion		MMA	2
Myctophidae: lanternfishes	unspecified lanternfish	LAN	7
Diaphus danae	Dana lanternfish	DDA	9
D. hudsoni	Hudson’s lanternfish	DHU	1
D. ostenfeldi	Ostenfeld’s lanternfish	DOE	1
Gymnoscopelus spp.		GYM	2
Lampadena notialis	notal lanternfish	LNT	1
L. speculigera	mirror lanternfish	LSP	2
Lampadena spp.		LPD	1
Lampanyctus australis	austral lanternfish	LAU	1
L. intricarius	intricate lanternfish	LIT	4
Lampanyctus spp.		LPA	19
Metelectrona ventralis	flaccid lanternfish	MVE	1
Moridae: morid cods			
Antimora rostrata	violet cod	VCO	6
Halargyreus johnsonii	Johnson's cod	HJO	39
Lepidion microcephalus	small-headed cod	SMC	20
Mora moro	ribaldo	RIB	46
Notophycis marginata	dwarf cod	DCO	6
Pseudophycis bachus	red cod	RCO	27

Appendix 2 (continued)

Scientific name	Common name	Species	Occ.
Moridae: morid cods (cont)			
Physiculus luminosa	luminescent cod	PLU	1
Tripterophycis gilchristi	grenadier cod	GRC	4
T. svetovidovi	giant grenadier cod	GRG	2
Melanonidae: pelagic cods			
Melanonus gracilis	small toothed pelagic cod	MEL	1
M. zugmayeri	large toothed pelagic cod	MEZ	2
Gadidae: true cods			
Micromesistius australis	southern blue whiting	SBW	14
Merlucciidae: hakes			
Macruronus novaezelandiae	hoki	HOK	116
Merluccius australis	hake	HAK	60
Macrouridae: rattails, grenadiers			
Coelorinchus acanthiger	spotty faced rattail	CTH	8
C. aspercephalus	oblique banded rattail	CAS	55
C. biclinozonalis	two saddle rattail	CBI	14
C. bollonsi	Bollons’s rattail	CBO	84
C. fasciatus	banded rattail	CFA	43
C. innotabilis	notable rattail	CIN	42
C. kaiyomaru	Kaiyomaru rattail	CKA	7
C. matamua	Mahia rattail	CMA	28
C. oliverianus	Oliver's rattail	COL	71
C. parvifasciatus	small banded rattail	CCX	23
C. trachycarus	roughhead rattail	CHY	9
Coryphaenoides dossenus	humpback rattail	CBA	14
C. mcmillani	McMillan’s rattail	CMX	2
C. murrayi	Murray’s rattail	CMU	2
C. serrulatus	serrulate rattail	CSE	36
C. striaturus	striate rattail	CTR	5
C. subserrulatus	four-rayed rattail	CSU	34
Gadomus aoteanus	filamentous rattail	GAO	1
Lepidorhynchus denticulatus	javelinfish	JAV	103
Lucigadus nigromaculatus	blackspot rattail	VNI	33
Macrourus carinatus	ridge scaled rattail	MCA	15
Mesobius antipodum	black javelinfish	BJA	8
Nezumia namatahi	squashed face rattail	NNA	8
Odontomacrurus murrayi		OMU	1
Trachonurus gagates	velvet rattail	TRX	2
T. villosus		TVI	1
Trachyrincus aphyodes	white rattail	WHX	29
T. longirostris	unicorn rattail	WHR	3
Ophidiidae: cuskeels			
Genypterus blacodes	ling	LIN	87
Carapidae: pearlfishes			
Echiodon cryomargarites	messmate fish	ECR	3
Chaunacidae: seatoads			
Chaunax sp.	pink frogmouth	CHX	2
Ceratiidae: seadevils			
Cryptopsaras couesi	seadevil	SDE	3
Regalecidae: oarfishes			
Agrostichthys parkeri	ribbonfish	AGR	3
Trachichthyidae: roughies, slimeheads			
Hoplostethus atlanticus	orange roughy	ORH	33
H. mediterraneus	silver roughy	SRH	44
Paratrachichthys trailli	common roughy	RHY	12

Appendix 2 (continued)

Scientific name	Common name	Species	Occ.
Diretmidae: discfishes			
Diretmus argenteus	discfish	DIS	1
Anoplogastridae: fangtooth			
Anoplogaster cornuta	fangtooth	ANO	1
Berycidae: alfonsinos			
Beryx decadactylus	longfinned beryx	BYD	3
B. splendens	alfonsino	BYS	39
Melamphaidae: bigscalefishes	unspecified bigscalefish	MPH	3
Zeidae: dories			
Capromimus abbreviatus	capro dory	CDO	14
Cyttus novaezealandiae	silver dory	SDO	17
C. traversi	lookdown dory	LDO	89
Oreosomatidae: oreos			
Allocyttus niger	black oreo	BOE	14
A. verrucosus	warty oreo	WOE	3
Neocyttus rhomboidalis	spiky oreo	SOR	41
Pseudocyttus maculatus	smooth oreo	SSO	32
Macrorhamphosidae: snipefishes			
Centriscops humerosus	banded bellowsfish	BBE	66
Notopogon lilliei	crested bellowsfish	CBE	1
Scorpaenidae: scorpionfishes			
Helicolenus spp.	sea perch	SPE	88
Trachyscorpia eschmeyeri	cape scorpionfish	TRS	5
Congiopodidae: pigfishes			
Congiopodus leucopaecilus	pigfish	PIG	1
Triglidae: gurnards			
Lepidotrigla brachyoptera	scaly gurnard	SCG	8
Hoplichthyidae: ghostflatheads			
Hoplichthys haswelli	deepsea flathead	FHD	43
Psychrolutidae: toadfishes			
Ambophthalmos angustus	pale toadfish	TOP	23
Ebinania sp. A	pointynose toadfish	PNT	1
Psychrolutes microporos	blobfish	PSY	8
Percichthyidae: temperate basses			
Polyprion americanus	bass	BAS	1
P. oxygeneios	hapuku	HAP	9
Serranidae: sea perches, gropers			
Lepidoperca aurantia	orange perch	OPE	13
Apogonidae: cardinalfishes			
Epigonus denticulatus	white cardinalfish	EPD	10
E. lenimen	bigeye cardinalfish	EPL	9
E. machaera	thin tongue cardinalfish	EPM	17
E. robustus	robust cardinalfish	EPR	4
E. telescopus	deepsea cardinalfish	EPT	18
Carangidae: trevallies, kingfishes			
Trachurus declivis	greenback jack mackerel	JMD	2
T. murphyi	slender jack mackerel	JMM	6
Bramidae: pomfrets			
Brama australis	southern Ray's bream	SRB	38
B. brama	Ray’s bream	RBM	1
Pterycombus petersii	fanfish	FAN	1
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	4
Uranoscopidae: armourhead stargazers			
Kathetostoma binigrasella	banded stargazer	BGZ	1
K. giganteum	giant stargazer	GIZ	46
Pinguipedidae: sandperches, weevers			
Parapercis gilliesi	yellow cod	YCO	1
Percophidae: opalfishes			
Hemerocoetes spp.	opalfish	OPA	1
Gempylidae: snake mackerels			
Nesiarchus nasutus	black barracouta	BBA	1
Thyrsites atun	barracouta	BAR	9
Trichiuridae: cutlassfishes			
Lepidopus caudatus	frostfish	FRO	4
Centrolophidae: raftfishes, medusafishes			
Centrolophus niger	rudderfish	RUD	27
Hyperoglyphe antarctica	bluenose	BNS	6
Seriolella caerulea	white warehou	WWA	50
S. punctata	silver warehou	SWA	48
Tubbia tasmanica	Tasmanian ruffe	TUB	3
Nomeidae: eyebrowfishes, driftfishes			
Cubiceps spp.	cubehead	CUB	1
Tetragonuridae: squaretails			
Tetragonurus cuvieri	squaretail	TET	1
Achiropsettidae: southern flounders			
Neoachiropsetta milfordi	finless flounder	MAN	6
Bothidae: lefteyed flounders			
Arnoglossus scapha	witch	WIT	12
Pleuronectidae: righteyed flounders			
Pelotretis flavilatus	lemon sole	LSO	13

Appendix 3: Scientific and common names of species caught from fine-meshed midwater tows (TAN1301). The occurrence (Occ.) of each species (number of tows caught) in the 7 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	1
Tunicata			
Thaliacea (salps)	unspecified salps	SAL	4
Mollusca			
Cephalopoda			
Sepiolida (bobtail squids)			
Sepiolidae			
Heteroteuthis dagamensis	bobtail squid	HES	1
Teuthoidea (squids)	unspecified squid	SQX	2
Octopoteuthidae			
Octopoteuthis sp.		OCM	1
Onychoteuthidae			
Onychoteuthis sp.		OBA	1
Histioteuthidae (violet squids)			
Histioteuthis spp.	violet squid	VSQ	3
Brachioteuthidae			
Brachioteuthis spp.		SQB	2
Ommastrephidae			
Todarodes filippovae	Todarodes squid	TSQ	2
Chiroteuthididae			
Chiroteuthis sp.		CVE	1
Cranchiidae			
Liguriella podophthalma		SQX	1
Teuthowenia pellucida		TPE	2
Crustacea			
Malacostraca			
Dendrobranchiata/Pleocyemata (prawns)	unspecified prawn	NAT	1
Dendrobranchiata			
Penaeidae			
Funchalia spp.	Funchalia prawn	FUN	1
Sergestidae			
Eusergestes arcticus	prawn	SAC	3
Pleocyemata			
Caridea			
Oplophoridae			
Acanthephyra spp.	SubAntarctic ruby prawn	ACA	2
Oplophorus spp.	deepwater prawn	OPP	4
Pasiphaeidae			
Pasiphaea aff. *tarda*	deepwater prawn	PTA	1
Achelata			
Palinuridae (rock lobsters)	unspecified phyllosoma	PHY	1
Chondrichthyes (cartilagenous fishes)			
Etmopteridae: lantern sharks			
Etmopterus baxteri	Baxter's dogfish	ETB	2
Osteichthyes (bony fishes)			
Nemichthyidae: snipe eels			
Avocettina sp.	black snipe eel	AVO	1
Bathylagidae: deepsea smelts	unspecified deepsea smelt	BLG	3

Appendix 3 (continued)

Scientific name	Common name	Species	Occ.
Opisthoproctidae: spookfishes			
Opisthoproctus grimaldi	mirrorbelly	MBE	1
Platytroctidae: tubeshoulders			
Persparsia kopua		PER	3
Gonostomatidae: lightfishes			
Margrethia obtusirostra	blunthead bristlemouth	MOB	1
Sternoptychidae: hatchetfishes	unspecified hatchetfish	HAT	3
Argyropelecus gigas	giant hatchetfish	AGI	2
A. hemigymnus	hatchetfish	AHE	3
Maurolicus australis	pearlside	MMU	4
Polyipnus ruggeri	hatchetfish	PYP	1
Sternoptyx pseudodiaphana	hatchetfish	STE	3
Photichthyidae: lighthouse fishes			
Phosichthys argenteus	lighthouse fish	PHO	3
Chauliodontidae: viperfishes			
Chauliodus sloani	viperfish	CHA	4
Stomiidae: scaly dragonfishes			
Stomias spp.		STO	4
Melanostomiidae: scaleless black dragonfishes		MST	3
Malacosteidae: loosejaws			
Malacosteus australis	southern loosejaw	MAU	2
Idiacanthidae: black dragonfishes			
Idiacanthus spp.	black dragonfish	IDI	3
Scopelarchidae: pearleyes	unspecified pearleye	PEY	1
Notosudidae: waryfishes			
Scopelosaurus spp.		SPL	2
Myctophidae: lanternfishes	unspecified lanternfish	LAN	2
Bolinichthys supralateralis	stubby lanternfish	BOL	2
Diaphus danae	Dana lanternfish	DDA	5
D. hudsoni	Hudson’s lanternfish	DHU	4
D. ostenfeldi	Ostenfeld’s lanternfish	DOE	3
Diaphus spp.		DIA	1
Electrona spp.		ELT	5
Gymnoscopelus spp.		GYM	2
Lampadena notialis	notal lanternfish	LNT	2
L. speculigera	mirror lanternfish	LSP	2
Lampanyctodes hectoris	Hector’s lanternfish	LHE	3
Lampanyctus spp.		LPA	5
Lampichthys procerus		LPR	3
Metelectrona ventralis	flaccid lanternfish	MVE	4
Protomyctophum spp.		PRO	5
Symbolophorus boops	bogue lanternfish	SBP	3
Moridae: morid cods			
Notophycis marginata	dwarf cod	DCO	1
Macrouridae: rattails, grenadiers			
Mesobius antipodum	black javelinfish	BJA	1
Diretmidae: discfishes			
Diretmus argenteus	discfish	DIS	1
Melamphaidae: bigscalefishes			
Sio nordenskjoldii		SNO	2
Oreosomatidae: oreos			
Allocyttus niger	black oreo	BOE	1
Pseudocyttus maculatus	smooth oreo	SSO	1
Apogonidae: cardinalfishes			
Epigonus robustus	robust cardinalfish	EPR	1
Howella brodiei	pelagic cardinalfish	HOW	3

Appendix 3 (continued)

Scientific name	Common name	Species	Occ.
Bramidae: pomfrets			
Brama australis	southern Ray's bream	SRB	1
Emmelichthyidae: bonnetmouths, rovers			
Emmelichthys nitidus	redbait	RBT	1
Centrolophidae: raftfishes, medusafishes			
Seriolella caerulea	white warehou	WWA	1
S. punctata	silver warehou	SWA	2
Tetragonuridae			
Tetragonurus cuvieri	squaretail	TET	1

Appendix 4: Scientific and common names of mesopelagic and benthic invertebrates identified following the voyage

NIWA No.	Cruise/Station_no.	Phylum	Class	Order	Family	Genus	Species
86700	TAN1301/015	Cnidaria	Anthozoa	Gorgonacea	Isididae		
89388	TAN1301/050	Mollusca	Cephalopoda	Oegopsida	Octopoteuthidae	*Octopoteuthis*	sp.
89553	TAN1301/064	Echinodermata	Asteroidea	Valvatida	Goniasteridae	*Hippasteria*	sp.
89390	TAN1301/074	Mollusca	Cephalopoda	Oegopsida	Brachioteuthidae	*Brachioteuthis*	sp.
89392	TAN1301/074	Mollusca	Cephalopoda	Oegopsida	Histioteuthidae	*Histioteuthis*	sp.
89391	TAN1301/074	Mollusca	Cephalopoda	Oegopsida	Cranchiidae	*Liguriella*	*podophthalma*
89384	TAN1301/074	Mollusca	Cephalopoda	Oegopsida	Octopoteuthidae	*Octopoteuthis*	sp.
89389	TAN1301/074	Mollusca	Cephalopoda	Oegopsida	Onychoteuthidae	*Onychoteuthis*	sp.
89566	TAN1301/074	Arthropoda	Malacostraca	Amphipoda	Phronimidae	*Phronima*	sp.
89386	TAN1301/075	Mollusca	Cephalopoda	Oegopsida	Pyroteuthidae		
89385	TAN1301/075	Mollusca	Cephalopoda	Sepiolida	Sepiolidae	*Heteroteuthis*	*dagamensis*
89387	TAN1301/075	Mollusca	Cephalopoda	Oegopsida	Histioteuthidae	*Histioteuthis*	sp.
89395	TAN1301/076	Mollusca	Cephalopoda	Oegopsida	Cranchiidae		
89382	TAN1301/076	Mollusca	Cephalopoda	Oegopsida	Brachioteuthidae	*Brachioteuthis*	sp.
89393	TAN1301/076	Mollusca	Cephalopoda	Oegopsida	Chiroteuthidae	*Chiroteuthis*	sp.
89383	TAN1301/076	Mollusca	Cephalopoda	Oegopsida	Histioteuthidae	*Histioteuthis*	sp.
89394	TAN1301/076	Mollusca	Cephalopoda	Oegopsida	Cranchiidae	*Teuthowenia*	*pellucida*
89396	TAN1301/076	Mollusca	Cephalopoda	Oegopsida	Cranchiidae	*Teuthowenia*	*pellucida*
89548	TAN1301/115	Echinodermata	Echinoidea	Echinothurioida	Echinothuriidae	*Araeosoma*	sp.
89567	TAN1301/129	Arthropoda	Malacostraca	Amphipoda	Phronimidae	*Phronima*	sp.

Appendix 5: Length ranges (cm) used to identify 1+, 2+ and 3++ hoki age classes to estimate relative biomass values given in Table 7a.

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