Ministry for Primary Industries
Manatū Ahu Matua

Trawl survey of hoki and middle-depth species on the Chatham Rise, January 2012 (TAN1201)

New Zealand Fisheries Assessment Report 2013/34

D. W. Stevens
R. L. O'Driscoll
M. R. Dunn
S. L. Ballara
P. L. Horn

ISSN 1179-5352 (online)
ISBN 978-0-478-41415-8 (online)

May 2013

New Zealand Government

Growing and Protecting New Zealand

Requests for further copies should be directed to:

Publications Logistics Officer
Ministry for Primary Industries
PO Box 2526
WELLINGTON 6140

Email: brand@mpi.govt.nz
Telephone: 0800 00 83 33
Facsimile: 04-894 0300

This publication is also available on the Ministry for Primary Industries websites at:
http://www.mpi.govt.nz/news-resources/publications.aspx
http://fs.fish.govt.nz go to Document library/Research reports

EXECUTIVE SUMMARY

Stevens, D.W.; O'Driscoll, R.L.; Dunn, M.R.; Ballara, S.L.; Horn, P.L. (2013). Trawl survey of hoki and middle depth species on the Chatham Rise, January 2012 (TAN1201).

***New Zealand Fisheries Assessment Report 2013/34.* 103 p.**

The twenty-first trawl survey in a time series to estimate the relative biomass of hoki and other middle depth species on the Chatham Rise was carried out from 2 to 28 January 2012. A random stratified sampling design was used, and 134 bottom trawl stations were successfully completed comprising 90 core (200–800 m) phase one biomass stations, 10 core phase two stations, and 34 deep (800–1300 m) stations.

The estimate of relative core biomass of all hoki was 87 505 t (c.v. 9.8%), a decrease of 6.8% from January 2011. This decrease was largely driven by a low biomass estimate for 1+ hoki of 2558 t. The relative biomass of recruited hoki (ages 3+ and older) was the highest since 1999. The relative biomass of hake in core strata increased by 15% to 1292 t (c.v. 14.7%) in 2012, but remains at low levels compared to the early 1990s. The relative biomass of ling was 8098 t (c.v. 13.8%), 13% higher than in January 2011, but the time-series for ling shows no overall trend.

The 2010 hoki year-class at age 1+ appears to be poor while the 2009 year-class at age 2+ was average in the trawl time series. The age frequency distribution for hake was broad, with most fish aged between 3 and 11 years. The age distribution for ling was also broad, with most fish aged between 3 and 18 years.

The estimated relative biomass of orange roughy in core strata and northern and eastern deep strata was 5202 t (c.v. 26.7%), a 31% decrease from 2011. The high 2011 estimate was largely due to a single large catch of orange roughy and precision of this estimate was poor (c.v. 60.0%). Additional surveys are required before biomass trends of orange roughy can be investigated.

Acoustic data were also collected during the trawl survey. Acoustic indices of mesopelagic fish abundance on the Chatham Rise in 2012 had increased from 2011 and were the highest since 2009. As in previous surveys, there was a weak positive correlation between acoustic density from bottom marks and trawl catch rates.

1. INTRODUCTION

In January 2012, the twenty-first in a time series of annual random trawl 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), 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 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 has been greatly reduced since 2000–01, hoki is still New Zealand's largest finfish fishery, with a catch limit from 1 October 2011 of 130 000 t. Hoki is assessed as two stocks, western and eastern. The current hypothesis is that juveniles from both stocks mix on the Chatham Rise and recruit to their respective stocks as they approach sexual maturity. The Chatham Rise is also 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 six years. The catch from the Chatham Rise in 2010–11 was 38 400 t, making this the second largest hoki fishery in the EEZ (behind the west coast South Island), contributing about 32% of the total New Zealand hoki catch (Ballara & O'Driscoll, 2012).

The hoki fishery is now strongly recruitment driven and therefore subject to 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 to deeper waters (to 1300 m) to provide fishery independent relative abundance indices for pre-recruit (20–30 cm) and dispersed adult orange roughy, as well as providing improved information for species like ribaldo and pale ghostshark, which are known to occur deeper than the current survey depth boundary (800 m).

Acoustic data have been recorded during trawls and while steaming between stations on all trawl surveys on the Chatham Rise since 1995, except 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), 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). 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 next ten years.

1.1 Project objectives

The trawl survey was carried out under contract to the Ministry for Primary Industries (project HOK2010/05A).
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 c.v. 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). This year stratum 7 was divided into strata 7A and 7B at 175° 30'E to more precisely assess the biomass of hake which appear 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 (1992–2011), 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 c.v. of 20% for 2+ hoki, and c.v.s of 15% for total hoki and 20% for hake. The initial allocation of 90 core stations in phase 1 (Table 1) was similar to that used in the 2011 survey, when the c.v. for 2+ hoki was 14.1% (Stevens et al. 2012). Phase 2 stations for core strata were allocated at sea, largely to improve the c.v. for 2+ hoki and total hoki biomass.

As in 2010 and 2011, the survey area included deep strata from 800–1300 m on the northern and eastern Chatham Rise. Deeper areas on the southwest Chatham Rise, surveyed in 2010 (Stevens et al. 2011), were not included in 2011 or 2012 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 2010–11 surveys, using the 'allocate' programme (Francis 2006) to estimate the optimal number of stations per stratum to achieve a target c.v. of 15% for both total orange roughy and orange roughy less than 30 cm. 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, Wellington. To maximise the amount of time spent trawling in the deep strata (800–1300 m) at night, the time spent searching for suitable core (200–800 m) tows at night was reduced significantly by using the nearest known successful tow position to the random station. Care had to be taken to ensure that the survey tows were at least 3 n. miles apart. For deep strata, there was often insufficient bathymetric data and few known tow positions, so these tows followed the standard survey methodology described by Hurst et al. (1992). If a station was found to be on foul ground, a search was made for suitable ground within 3 n. miles of the station position. If no suitable ground could be found, the station was abandoned and another random position was substituted. Core biomass tows were carried out during daylight hours (as defined by Hurst et al. (1992)), with all trawling between 0500 h and 1838 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 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 30 August 2011 in the Marlborough Sounds. The system and calibration parameters are given in Appendix 1 of O'Driscoll et al. (2012).

2.5 Hydrology

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

2.6 Catch and biological sampling

At each station all items in the catch were sorted into species and weighed on Seaway motion-compensating electronic scales accurate to about 0.2 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.

2.7 Estimation of relative biomass and length frequencies

Doorspread biomass was estimated by the swept area method of Francis (1981, 1989) using the formulae in Vignaux (1994) as implemented in NIWA custom software SurvCalc (Francis 2009). Biomass and coefficient of variation (c.v.) 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 ghostshark, pale ghostshark, 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 c.v.s 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, smooth, and spiky oreos, 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.

2.8 Estimation of numbers at age

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

Subsamples of 669 hoki otoliths and 582 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 the tails of the length distributions were represented. The numbers aged approximated the sample size necessary to produce mean weighted c.v.s of less than 20% for hoki and 30% for ling across all age classes. All 176 hake otoliths collected were prepared.

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

2.9 Acoustic data analysis

Acoustic analysis 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) 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. A more extensive analysis of these and other acoustic data from the Chatham Rise is being carried out as part of the Coasts and Oceans outcome-based-investment programme for the former Ministry of Science and Innovation.

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. Brief 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 may be found 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.

2.9.1 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 square kilometre 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).

2.9.2 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 2012. The methods were the same as those used by O'Driscoll et al. (2011a) and Stevens et al. (2012). 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 from 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 2012 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 location of deepwater strata required some long steams between trawls and reduced time available to survey the ground before trawling. Therefore successful known tow positions from all previous surveys were used to randomly select core biomass stations.

The weather during the survey was generally very good and fishing operations were only suspended once at the end of the survey (for 4 h on the morning of the 27 January). About 5 h were lost on the 13 January due to a faulty net monitor paravane, and about 7 h were lost on 15 January for net repairs.

In total 134 successful biomass tows were completed, comprising 90 core (200–800 m) phase 1 tows, 10 core phase 2 stations, and 34 deep (800–1300 m) phase 1 tows (Tables 1 and 2, Figure 2, Appendix 1). Seven core bottom trawls were excluded from relative biomass calculations: 6 tows came fast, and another tow was tangled on shooting. Thirty-four of 35 planned deep tows were completed. One deep tow was not completed due to rough weather at the end of the survey, and a further deep tow came fast. 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). Deep station density ranged from 1:416 km^2 in stratum 21a (800–1000 m, NE Chatham Rise) to 1:1940 km^2 in stratum 21b (800–1000 m, NE Chatham Rise). Mean station density was 1:1 356 km^2 (see Table 1).

3.2 Gear performance

Gear parameters are summarised in Table 3. A headline height value was obtained for all 134 successful tows, but doorspread readings were not available for 10 tows. Mean headline heights ranged from 6.1 to 7.4 m, averaged 6.9 m, and were consistent with previous surveys and within the optimal range (Hurst et al. 1992) (Table 3). Mean doorspread measurements by 200 m depth intervals ranged from 104.8 to 133.5 m, and averaged 121.7 m.

3.3 Hydrology

Surface and bottom temperatures were recorded throughout the survey from the Seabird CTD. The surface temperatures (Figure 3, top panel) ranged from 13.2 to 17.2 ^{o}C. Bottom temperatures ranged from 3.1 to 10.5 ^{o}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 134 valid biomass stations was 125.6 t, of which 44.8 t (35.7%) was hoki, 3.8 t (3.0%) was ling, and 0.9 t (0.7%) was hake (Table 4). Of the 289 species or species groups identified at sea, 138 were teleosts, 33 were elasmobranches, 1 was an agnathan, 23 were crustaceans, and 14 were cephalopods. The remainder consisted of assorted benthic and pelagic invertebrates. A full list of species caught, and the number of stations at which they occurred, is given in Appendix 2. Eleven benthic invertebrates were formally identified after the voyage (Appendix 3).

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 c.v.s achieved for hoki, hake, and ling from core strata were 9.8%, 14.7%, and 7.4% respectively. The c.v. for 2+ hoki (2009 year class) was 16.6%, below the target c.v. of 20%. High c.v.s (over 30%) generally occurred when species were not well sampled by the gear. For example, barracouta, silver warehou and slender mackerel are not strictly demersal and exhibit strong schooling behaviour. Others, such as hapuku, bluenose, and red cod, have high c.v.s as they are mainly distributed outside the core survey depth range (O'Driscoll et al. 2011b).

The combined relative biomass for the top 31 species in the core strata that are tracked annually (Livingston et al. 2002) was lower than in 2009–11, and average for the time series (Figure 4, top panel). As in previous years, hoki was the most abundant species caught (Table 4, Figure 4, lower panel), with a similar relative biomass to 2010 and 2011. The next most abundant QMS species were black oreo, silver warehou, dark ghostshark, ling, lookdown dory, spiny dogfish, sea perch, pale ghostshark, and smooth oreo, each with an estimated relative biomass of over 2000 t (Table 4). The most abundant non-QMS species were big-eye rattail, javelinfish, common roughy, Baxter's dogfish, oblique banded rattail, and Oliver's rattail (Table 4).

The estimate of relative biomass of hoki in the core strata was 87 505 t, a 6.8% decease from January 2011 (Table 5, Figure 5). This was largely driven by a small relative biomass estimate of 1+ hoki of 2558 t (Table

6). However, the relative biomass of 3++ (recuited) hoki was 27% higher than in 2011. The biomass of 2+ hoki (2009 year-class) was similar to the estimate of the 2007 year-class at 2+ in 2010 and the 2008 year-class at 2+ in 2011 (Table 6).

The relative biomass of hake in core strata increased by 14.9% in 2012 to 1292 t, but remains at low levels compared to the early 1990s (see Table 5, Figure 5). Catches were low in the newly 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 8098 t, 13.2% higher than in January 2011. The time series for ling shows no overall trend (Figure 5).

The relative biomass of dark ghostshark, lookdown dory, pale ghostshark, and sea perch, increased from 2011, while the relative biomass of giant stargazer, spiny dogfish, and silver warehou decreased (Figure 5). The relative biomass estimate for white warehou was about the same as in 2010 (Figure 5).

3.5.2 Deep strata (800–1300 m)

Relative biomass and c.v.s in deep strata were estimated for 22 of 45 core strata species (Table 4). The deep strata were included primarily to estimate the relative biomass of juvenile and recruited orange roughy. The estimated relative biomass of orange roughy in deep strata was 5202 t (c.v. 26.7%), which was 23.9% of the total biomass for core strata species in deep strata (Table 4). The relative biomass of orange roughy in all strata in 2012 was 31% lower than the estimated biomass of 7537 t in 2011. However, the high biomass in 2011 was driven by a single large catch (3 t) taken in stratum 22, and the c.v. was high (59.7%).

The estimated relative biomass of smooth oreo in deep strata was 5699 t (but precision was poor with a c.v. of 78.5%), which was 26.2% of the total biomass for core strata species in deep strata (Table 4). Only 10.7% of the relative biomass of spiky oreo in all strata and 1.8% 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 was not fished during 2011 and 2012. Deepwater sharks were abundant in deep strata, with 47%, 26%, and 74% of the total survey biomass of shovelnose dogfish, Baxter’s dogfish, and longnose velvet dogfish occurring in deep strata.

The deep strata contained 13.5% of total survey hake biomass, 2.5% of total survey hoki biomass, and 0.1% of total survey ling biomass. This indicates that the core survey strata is likely to have encompassed the majority of the population of hoki and ling, but excluded some hake (Table 4).

3.6 Catch distribution

Hoki

In the 2012 survey, hoki were caught at 98 of 100 core biomass stations, with the highest catch rates mainly in 400–600 m depths (Table 7, Figure 6). The highest individual catch rates of hoki in 2012 occurred on the southwest Chatham Rise in stratum 16, and comprised mainly recruited hoki (3+ and older) (Figure 6). As in previous surveys, 1+ hoki were largely confined to the Mernoo, Veryan, and Reserve Banks (Figure 6a), while 2+ hoki were found throughout much of the Rise, in particular in 200–600 m depth (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 14 on the southwest Chatham Rise, and on the northen Chatham Rise in strata 7a, 11a, and 2b (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 on the southern Chatham Rise in 400–600 m (strata 13–16) and the northeast of the Mernoo Bank (stratum 7B). Ling distribution was reasonably consistent, and catch rates were relatively stable over the time series (Figure 8).

Other species

As with previous surveys, spiny dogfish were widely distributed throughout the survey area at 200–600 m depths (Figure 9). Lookdown dory and sea perch were also widespread but were most abundant in the east, and on Reserve Bank (strata 19 and 20) respectively. Dark ghostshark were mainly caught in 200–400 m depths, and were particularly abundant on the Veryan Bank; while pale ghostshark were mostly caught in deeper water at 400–800 m depth, with higher catch rates to the west. Giant stargazer were mainly caught in shallower strata of the survey area, with the largest catches taken around the Mernoo (stratum 18) and Veryan Banks (strata 15 and 16). 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 were widespread on the northern and eastern Rise at 800–1300 m depths, with the largest catch of 872 kg taken on the northwest Rise in stratum 22 (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 7), while smooth oreo were mainly caught in the same area (stratum 6) and on the southeastern Rise at 800–1300 m depths (strata 25 and 28). The distribution of the two oreo species was incompletely sampled because deeper waters on the southwest Rise were not sampled in 2011 (Figure 9). Spiky oreo were more widespread and most abundant on the northern rise in 500–800 m (strata 2b, 1, 11c, 10b, and 22) (Table 7, 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

The hoki length and age frequencies were dominated by 2+ (49–60 cm) fish (Figures 10 and 11). There were very few 1+ (less than 49 cm) fish and few hoki longer than 80 cm (Figure 10) or older than age 6 (Figure 11). Female hoki were as abundant as males (ratio of 1.03 female : 1 male).

Hake

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 14 years. Since 2004 a cohort of hake from the 2002 year-class have been tracked by the survey. This cohort would be 10+ in 2012, but was not abundant: possibly indicating a reduction in the proportion of this yearclass, ageing error, or that these fish were not well sampled in 2012. Female hake were more abundant than males (1.68 female: 1 male).

Ling

Ling scaled length frequencies and calculated numbers at age (Figures 14 and 15) were broad, with most fish aged between 3 and 18. There was a period of good recruitment during the 1999–2006 period (Figure 15). Female ling were slightly less abundant than males (0.95 female: 1 male).

Other species

Length frequency distributions for key core and deepwater commercial species are shown in Figure 16a and b. 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 ghostsharks indicate that females grow larger than males. Length frequencies of sea perch, orange roughy, black oreo, smooth oreo, and spiky oreo indicate that males and females grow to a broadly similar size. The length frequency for orange roughy was broad, with a mode at 31–33 cm, but included fish as small as 7 cm (Figure 16). Length frequency modes appear to be visible for smooth oreo, but it is not known whether these represent distinct year classes. In contrast, the length frequency distribution of black oreo was largely unimodal. As with previous years, the catch of spiny dogfish was dominated by females (2.3 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, with a small number of female fish being classed as having spent gonads. About 23% of male ling were maturing or ripe, but few females were showing signs of reproductive activity. Similarly 60% of male hake were ripe, running ripe, or partially spent, but most females were immature or resting (49%) or maturing (47%) (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 results

Over 81 GB of acoustic data were collected with the multi-frequency (18, 38, 70, 120, and 200 kHz) hull-mounted EK60 systems during the trawl survey. Good weather and sea conditions during the survey meant that the quality of acoustic recordings was good and 84% of files were suitable for quantitative analysis. Only 18 of the 115 daytime trawl files were considered too poor to be analysed quantitatively.

Expanding symbol plots of the distribution of total acoustic backscatter from good and adequate quality recordings observed during daytime trawls and night transects are shown in Figure 17. As noted by O'Driscoll et al. (2011a), there is a consistent spatial pattern in total backscatter on the Chatham Rise, with higher backscatter in the west.

3.8.1 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 percent occurrence of acoustic mark types on the Chatham Rise in 2012 was generally similar to that observed in previous surveys, but higher percentages of daytime bottom and surface layers were observed than during 2011 (Table 11).

Pelagic and surface layers were the most common daytime mark types in 2012 (Table 11). Midwater trawling on previous Chatham Rise surveys suggests that pelagic layers contain 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. Surface layers were observed in almost all (99%) night recordings and most (88%) day echograms and may contain mesopelagic fish, euphausiids, and gelatinous zooplankton. Pelagic schools were observed in 38% of day steam files, 31% of day trawl files, and 5% of night files (Table 11). Trawling on voyages carried out for the Coasts and Oceans programme in May–June 2008 and November 2011 found that small pelagic schools were often dominated by the myctophids *Lampanyctodes hectoris* and *Symbolophorus* sp., or by *Maurolicus australis* (NIWA, unpublished data)

Bottom layers were observed in 86% of day steam files, 82% of day trawl files, and 39% of night files (Table 11). Like pelagic layers, bottom layers tended to disperse at night, to form bottom clouds. Bottom layers and clouds were usually associated with a mix of demersal fish species, but probably also contain mesopelagic species when these occur close to the bottom (O'Driscoll 2003). There was often mixing of bottom layers and pelagic layers. Bottom-referenced schools were present in only 5% of daytime trawl echograms and 14% of daytime steam recordings in 2012, and were most abundant in 200–400 m water depth. Bottom schools and layers 10–70 m off the bottom are 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).

3.8.2 Comparison of acoustics with bottom trawl catches

Acoustic data from 85 trawl files were integrated and compared with trawl catch rates (Table 12). Data from the other 30 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 (8 files), or not considered suitable for biomass estimation (4 files). Average acoustic backscatter values from bottom-referenced marks and from the entire water column in 2012 had increased from a low in 2011, and were at similar levels to those observed in 2009 (Table 12).

There was a weak positive correlation (Spearman's rank correlation, rho = 0.24) between acoustic backscatter in the bottom 100 m during the day and trawl catch rates (Figure 18). In previous 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 weak correlation between acoustic backscatter and trawl catch rates (Figure 18) arises because large catches are sometimes made when there are only weak marks observed acoustically, and conversely, relatively little is caught in some trawls where dense marks are present. O'Driscoll (2003) suggested that bottom-referenced layers on the Chatham Rise may also contain a high proportion of mesopelagic "feed" species, which contribute to the acoustic backscatter, but which are 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 migrates more than 50 m away from the bottom at night, suggesting that this component is not demersal fish (O'Driscoll et al. 2009). This combined with the diverse composition of demersal species present, means that it is unlikely that acoustics will provide an alternative biomass estimate for hoki on the Chatham Rise.

3.8.3 Time-series of relative mesopelagic fish abundance

In 2012, most acoustic backscatter was between 300 and 500 m depth during the day, and migrated into the surface 200 m at night (Figure 19). This was a similar vertical distribution pattern to that observed in 2001–10 (O'Driscoll et al. 2011a). In 2011, there was a different daytime distribution of backscatter, with a concentration of backscatter between 150 and 350 m, no obvious peak at 350–400 m, and smaller peaks centred at around 550 and 750 m (Stevens et al. 2012).

The vertically migrating component of acoustic backscatter is assumed to be dominated by mesopelagic fish (see McClatchie & Dunford, 2003 for rationale and caveats). In 2012, between 40 and 79% 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 percentages were similar to those observed in 2010 and 2011, but lower than in previous years, when up to 88% of the backscatter in some areas was estimated to be from mesopelagic fish (Table 13).

Day estimates of total acoustic backscatter over the Chatham Rise are consistently higher than night estimates (Figure 20) 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 20). Stevens et al. (2012) noted that there was relatively little good quality acoustic data available from the southeast Chatham Rise in 2011 due to poor weather conditions. Therefore it was uncertain whether the apparent decline in daytime backscatter in 2011 was related to sample availability (i.e., station locations), or to changes in the abundance, distribution, or behaviour of key mesopelagic species. Backscatter within 50 m of the bottom during the day has generally decreased since the start of the time series, but the estimate from 2012 increased from 2010, and was similar to that from 2009 (Figure 20). Backscatter close to the bottom at night has remained at consistently low levels throughout the time-series (Figure 20).

The 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 that was observed in the upper 200 m corrected for the estimated proportion in the surface deadzone. This effectively subtracts backscatter which remains 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 21 for the entire Chatham Rise and for the four sub-areas. Mesopelagic estimates from 2012 had increased from 2011 and were the highest since 2009 for the overall Chatham Rise and for the two western subareas (Table 14, Figure 21).

Hoki liver condition (defined as liver weight divided by gutted weight) on the Chatham Rise also increased from 2011 to 2012, and the condition of hoki in 2012 was similar to that observed in 2009 (Figure 22). However, O'Driscoll et al. (2011a) found no evidence for a link between hoki condition and mesopelagic indices between 2004 and 2010.

4. CONCLUSIONS

The 2012 survey successfully extended the January Chatham Rise time series into its twenty-first year and provided abundance indices for hoki, hake, and ling. The survey c.v. of 16.6% achieved for 2+ hoki was below the target level of 20%. The estimated relative biomass of hoki in all strata was 6.8% lower than in 2012, largely due to a low relative biomass estimate of 1+ hoki. However, the relative biomass of recuited hoki (3+ and older) was 27% higher than in 2011, and the highest since 1999.

The relative biomass of hake in core strata increased by 15% in 2012 to 1292 t, but remains at historically low levels compared to the early 1990s. The relative biomass of ling in core strata increased by 13% in 2012, but the time series for ling shows no overall trend.

The deep strata were successfully completed providing abundance indices for pre-recruit and recruited orange roughy. The estimated relative biomass of orange roughy in all strata (5205 t) decreased by 31% from 2011 to 2012, but was similar to the estimate from 2010 (4386 t). The high 2011 biomass estimate was due to a single large catch of orange roughy in stratum 22 on the northwest Chatham Rise, and precision was poor (c.v. 60.0%). Additional estimates are required before biomass trends can be determined.

5. ACKNOWLEDGMENTS

We thank the scientific staff and the master, officers, and crew of *Tangaroa* who contributed to the success of this voyage. Thanks to the scientific staff involved with the preparation, reading, and calculation of catch at age data for hoki, hake, and ling otoliths from this survey, and NIWA NIC staff for identification of invertebrates. A draft of this report was reviewed by Neil Bagley. This work was carried out by NIWA under contract to the Ministry for Primary Industries (Project HOK2010/05A).

6. REFERENCES

Bagley, N.W.; Hurst, R.J. (1998). Trawl survey of hoki and middle depth species on the Chatham Rise, January 1998 (TAN9801). *NIWA Technical Report 44*. 54 p.

Bagley, N.W.; Livingston, M.E. (2000). Trawl survey of hoki and middle depth species on the Chatham Rise, January 1999 (TAN9901). *NIWA Technical Report 81*. 52 p.

Ballara, S.L.; O'Driscoll, R.L. (2012). Catches, size, and age structure of the 2010–11 hoki fishery, and a summary of input data used for the 2012 stock assessment. *New Zealand Fisheries Assessment Report 2012/23*. 117 p.

Bull, B. (2000). An acoustic study of the vertical distribution of hoki on the Chatham Rise. *New Zealand Fisheries Assessment Report 2000/5*. 59 p.

Bull, B.; Bagley, N.W.; Hurst, R.J. (2000). Proposed survey design for the Southern Plateau trawl survey of hoki, hake and ling in November-December 2000. Final Research Report to the Ministry of Fisheries for Project MDT1999/01 Objective 1. 31 p. (Unpublished report held by Ministry for Primary Industries, Wellington.)

Bull, B.; Dunn, A. (2002). Catch-at-age user manual v1.06.2002/09/12. NIWA Internal Report 114. 23 p. (Unpublished report held in NIWA library, Wellington.)

Coombs, R.F.; Macaulay, G.J.; Knol, W.; Porritt, G. (2003). Configurations and calibrations of 38 kHz fishery acoustic survey systems, 1991–2000. *New Zealand Fisheries Assessment Report 2003/49.* 24 p.

Cordue, P.L.; Ballara, S.L.; Horn, P.L. (2000). Hoki ageing: recommendation of which data to routinely record for hoki otoliths. Final Research Report to the Ministry of Fisheries for Project MOF1999/01 (Hoki ageing). 24 p. (Unpublished report held by Ministry for Primary Industries, Wellington.)

Cordue, P.L.; Macaulay, G.J.; Ballara, S.L. (1998). The potential of acoustics for estimating juvenile hoki abundance by age on the Chatham Rise. Final Research Report for Ministry of Fisheries Research Project HOK9702 Objective 3. 35 p. (Unpublished report held by Ministry for Primary Industries, Wellington.)

Foote, K.G.; Knudsen, H.P.; Vestnes, G.; MacLennan, D.N.; Simmonds, E.J. (1987). Calibration of acoustic instruments for fish density estimation: a practical guide. *ICES Cooperative Research Report 144*. 68 p.

Francis, R.I.C.C. (1981) Stratified random trawl surveys of deep-water demersal fish stocks around New Zealand. *Fisheries Research Division Occasional Publication 32.* 28 p.

Francis, R.I.C.C. (1984) An adaptive strategy for stratified random trawl surveys. *New Zealand Journal of Marine and Freshwater Research 18:* 59–71.

Francis, R.I.C.C. (1989). A standard approach to biomass estimation from bottom trawl surveys. New Zealand Fisheries Assessment Research Document 89/3. 3 p. (Unpublished report held in NIWA library, Wellington.)

Francis, R.I.C.C. (2001). Improving the consistency of hoki age estimation. *New Zealand Fisheries Assessment Report 2001/12.* 18 p.

Francis, R.I.C.C. (2006). Optimum allocation of stations to strata in trawl surveys. *New Zealand Fisheries Assessment Report 2006/23*. 50 p.

Francis, R.I.C.C. (2009). SurvCalc User Manual. 39 p. (Unpublished report held at NIWA, Wellington.)

Horn, P.L. (1993). Growth, age structure, and productivity of ling, *Genypterus blacodes* (Ophidiidae), in New Zealand waters. *New Zealand Journal of Marine and Freshwater Research 27:* 385–397.

Horn, P.L. (1994a). Trawl survey of hoki and middle depth species on the Chatham Rise, December 1991-January 1992 (TAN9106). *New Zealand Fisheries Data Report No. 43*. 38 p.

Horn, P.L. (1994b). Trawl survey of hoki and middle depth species on the Chatham Rise, December 1992-January 1993 (TAN9212). *New Zealand Fisheries Data Report No. 44*. 43 p.

Horn, P.L. (1997). An ageing methodology, growth parameters and estimates of mortality for hake (*Merluccius australis*) from around the South Island, New Zealand. *Marine and Freshwater Research 48:* 201–209.

Horn, P.L.; Sullivan, K.J. (1996). Validated aging methodology using otoliths, and growth parameters for hoki (*Macruronus novaezeelandiae*) in New Zealand waters. *New Zealand Journal of Marine and Freshwater Research 30:* 161–174.

Hurst, R.J.; Bagley, N.W. (1994). Trawl survey of middle depth and inshore bottom species off Southland, February-March 1993 (TAN9301). *New Zealand Fisheries Data Report No. 52*. 58 p.

Hurst, R.J.; Bagley, N.; Chatterton, T.; Hanchet, S.; Schofield, K.; Vignaux, M. (1992). Standardisation of hoki/middle depth time series trawl surveys. MAF Fisheries Greta Point Internal Report No. 194. 89 p. (Unpublished report held in NIWA library, Wellington.)

Livingston, M.E.; Bull, B.; Stevens, D.W.; Bagley, N.W. (2002). A review of hoki and middle depth trawl surveys of the Chatham Rise, January 1992–2001. *NIWA Technical Report 113*. 146 p.

Livingston, M.E.; Stevens, D.W. (2005). Trawl survey of hoki and middle depth species on the Chatham Rise, January 2004 (TAN0401). *New Zealand Fisheries Assessment Report 2005/21*. 62 p.

Livingston, M.E.; Stevens, D.; O'Driscoll, R.L.; Francis, R.I.C.C. (2004). Trawl survey of hoki and middle depth species on the Chatham Rise, January 2003 (TAN0301). *New Zealand Fisheries Assessment Report 2004/16*. 71 p.

McClatchie, S.; Dunford, A. (2003). Estimated biomass of vertically migrating mesopelagic fish off New Zealand. *Deep-Sea Research Part I 50*: 1263–1281.

McClatchie, S.; Pinkerton, M.; Livingston, M.E. (2005). Relating the distribution of a semi-demersal fish, *Macruronus novaezelandiae*, to their pelagic food supply. *Deep-Sea Research Part I 52*: 1489–1501.

McNeill, E. (2001). ESP2 phase 4 user documentation. NIWA Internal Report 105. 31 p. (Unpublished report held in NIWA library, Wellington.)

O'Driscoll, R.L. (2001a). Analysis of acoustic data collected on the Chatham Rise trawl survey, January 2001 (TAN0101). Final Research Report for Ministry of Fisheries Research Project HOK2000/02 Objective 3. 26 p. (Unpublished report held by Ministry for Primary Industries, Wellington.)

O'Driscoll, R.L. (2001b). Classification of acoustic mark types observed during the 2000 Sub-Antarctic trawl survey (TAN0012). Final Research Report for Ministry of Fisheries Research Project MDT2000/01 Objective 3. 28 p. (Unpublished report held by Ministry for Primary Industries, Wellington.)

O'Driscoll, R.L. (2002). Estimates of acoustic:trawl vulnerability ratios from the Chatham Rise and Sub-Antarctic. Final Research Report for Ministry of Fisheries Research Projects HOK 2001/02 Objective 3 and MDT2001/01 Objective 4. 46 p. (Unpublished report held by Ministry for Primary Industries, Wellington.)

O'Driscoll, R.L. (2003). Determining species composition in mixed species marks: an example from the New Zealand hoki (*Macruronus novaezelandiae*) fishery. *ICES Journal of Marine Science 60*: 609–616.

O'Driscoll, R.L.; Bagley, N.W. (2004). Trawl survey of middle depth species in the Southland and Sub-Antarctic areas, November–December 2003 (TAN0317). *New Zealand Fisheries Assessment Report 2004/49*. 58 p.

O'Driscoll, R.L.; Dunford, A.J.; Fu, D. (2012). Acoustic estimates of southern blue whiting from the Campbell Island Rise, August–September 2011 (TAN1112). *New Zealand Fisheries Assessment Report 2012/18*. 52 p.

O'Driscoll, R. L.; Gauthier, S.; Devine, J. (2009). Acoustic surveys of mesopelagic fish: as clear as day and night? *ICES Journal of Marine Science 66*: 1310–1317.

O'Driscoll, R.L.; Hurst, R.J.; Dunn, M.R.; Gauthier, S.; Ballara, S.L. (2011a). Trends in relative biomass using time series of acoustic backscatter data from trawl surveys. *New Zealand Aquatic Environment and Biodiversity Report* 76. 99 p.

O'Driscoll, R.L.; MacGibbon, D.; Fu, D.; Lyon, W.; Stevens, D.W. (2011b). A review of hoki and middle depth trawl surveys of the Chatham Rise, January 1992–2010. *New Zealand Fisheries Assessment Report 2011/47*. 72 p. + CD.

Schofield, K.A.; Horn, P.L. (1994). Trawl survey of hoki and middle depth species on the Chatham Rise, January 1994 (TAN9401). *New Zealand Fisheries Data Report No. 53*. 54 p.

Schofield, K.A.; Livingston, M.E. (1995). Trawl survey of hoki and middle depth species on the Chatham Rise, January 1995 (TAN9501). *New Zealand Fisheries Data Report No. 59*. 53 p.

Schofield, K.A.; Livingston, M.E. (1996). Trawl survey of hoki and middle depth species on the Chatham Rise, January 1996 (TAN9601). *New Zealand Fisheries Data Report No. 71*. 50 p.

Schofield, K.A.; Livingston, M.E. (1997). Trawl survey of hoki and middle depth species on the Chatham Rise, January 1997 (TAN9701). *NIWA Technical Report 6*. 51 p.

Stevens, D.W.; Livingston, M.E.; Bagley, N.W. (2001). Trawl survey of hoki and middle depth species on the Chatham Rise, January 2000 (TAN0001). *NIWA Technical Report 104*. 55 p.

Stevens, D.W.; Livingston, M.E.; Bagley, N.W. (2002). Trawl survey of hoki and middle depth species on the Chatham Rise, January 2001 (TAN0101). *NIWA Technical Report 116*. 61 p.

Stevens, D.W.; Livingston, M.E. (2003). Trawl survey of hoki and middle depth species on the Chatham Rise, January 2002 (TAN0201). *New Zealand Fisheries Assessment Report 2003/19*. 57 p.

Stevens, D.W.; O'Driscoll, R.L. (2006): Trawl survey of hoki and middle depth species on the Chatham Rise, January 2005 (TAN0501) *New Zealand Fisheries Assessment Report 2006/13*. 73 p.

Stevens, D.W.; O'Driscoll, R.L. (2007): Trawl survey of hoki and middle depth species on the Chatham Rise, January 2006 (TAN0601) *New Zealand Fisheries Assessment Report 2007/5*. 73 p.

Stevens, D.W.; O'Driscoll, R.L.; Dunn, M.R.; Ballara, S.L.; Horn, P.L. (2012). Trawl survey of hoki and middle depth species on the Chatham Rise, January 2011 (TAN1101). *New Zealand Fisheries Assessment Report 2012/10*. 98 p.

Stevens, D.W.; O'Driscoll, R.L.; Dunn, M.R.; MacGibbon, D.; Horn, P.L.; Gauthier, S. (2011). Trawl survey of hoki and middle depth species on the Chatham Rise, January 2010 (TAN1001). *New Zealand Fisheries Assessment Report 2011/10*. 112 p.

Stevens, D.W.; O'Driscoll, R.L.; Gauthier, S (2008): Trawl survey of hoki and middle depth species on the Chatham Rise, January 2007 (TAN0701) *New Zealand Fisheries Assessment Report 2008/52*. 81 p.

Stevens, D.W.; O'Driscoll, R.L.; Horn, P.L. (2009a). Trawl survey of hoki and middle depth species on the Chatham Rise, January 2008 (TAN0801). *New Zealand Fisheries Assessment Report 2009/18*. 86 p.

Stevens, D.W.; O'Driscoll, R.L.; Horn, P.L. (2009b). Trawl survey of hoki and middle depth species on the Chatham Rise, January 2009 (TAN0901). *New Zealand Fisheries Assessment Report 2009/55*. 91 p.

Tuck, I., Cole, R., Devine, J. (2009). Ecosystem indicators for New Zealand fisheries. *New Zealand Aquatic Environment and Biodiversity Report 42*. 188 p.

Vignaux, M. (1994). Documentation of Trawlsurvey Analysis Program. MAF Fisheries Greta Point Internal Report No. 225. 44 p. (Unpublished report held in NIWA library, Wellington.)

Table 1: The number of completed valid biomass stations (200–1300m) by stratum during the 2012 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	6	6		6	1: 1 417
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	1	4	1: 1 461
16	400–600	SW Chatham Rise	11 522	3	3	7	10	1: 1 152
17	200–400	Veryan Bank	865	3	3		3	1: 288
18	200–400	Mernoo Bank	4 687	3	3	2	5	1: 937
19	200–400	Reserve Bank	9 012	5	5		5	1: 1 802
20	200–400	Reserve Bank	9 584	5	5		5	1: 1 917
Core	200–800		139 492	90	90	10	100	1: 1 395
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	10	10		10	1: 736
23	1000–1300	NW Chatham Rise	7 014	6	5		5	1: 1 403
24	1000–1300	NE Chatham Rise	5 672	4	4		4	1: 1 418
25	800–1000	SE Chatham Rise	5 596	5	5		5	1: 1 119
28	1000–1300	SE Chatham Rise	9 494	4	4		4	1: 2 374
Deep	800–1300		42 201	35	34	0	34	1: 1 241
Total	200–1300		181 693	125	124	10	134	1: 1 356

Table 2: Survey dates and number of valid 200–800 m depth biomass stations in surveys of the Chatham Rise, January 1992–2012.

Trip code	Start date	End date	No. of valid core biomass stations
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

Table 3: Tow and gear parameters by depth range for valid biomass stations (TAN1201). 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)	100	2.8	0.35	2.0–3.1
Tow speed (knots)	100	3.5	0.03	3.4−3.6
All tow parameters				
Tow length (n. miles)	134	2.9	0.32	2.0–3.1
Tow speed (knots)	134	3.5	0.03	3.4−3.6
Gear parameters				
200–400 m				
Headline height	27	7.0	0.22	6.6−7.4
Doorspread	27	118.3	7.06	106.2–128.0
400–600 m				
Headline height	55	6.8	0.28	6.1−7.2
Doorspread	54	123.4	4.79	104.8–133.5
600–800 m				
Headline height	18	6.9	0.23	6.5−7.3
Doorspread	17	120.5	4.42	112.4–127.4
800–1000 m				
Headline height	21	7.0	0.11	6.7−7.2
Doorspread	17	122.9	4.65	114.0–132.4
1000–1300 m				
Headline height	13	7.1	0.21	6.8−7.4
Doorspread	9	120.9	3.75	114.6–125.6
Core stations 200–800 m				
Headline height	100	6.9	0.26	6.1−7.4
Doorspread	98	121.5	5.85	104.8–133.5
All stations 200–1300 m				
Headline height	134	6.9	0.25	6.1−7.4
Doorspread	124	121.7	5.56	104.8–133.5

Table 4: Catch (kg) and total biomass (t) estimates (also by sex) with coefficient of variation (c.v.) of QMS species, other commercial species, and major non-commercial species for valid biomass stations in core strata (200–800 m depths); and biomass estimates for deep strata (800–1300 m depths). Total biomass includes unsexed fish. (-, no data.).

			Core strata 200–800m						800–1300 m	
Common name	Code	Catch	Biomass males		Biomass females		Total biomass		Deep biomass	
		kg	t	% c.v.	t	% c.v.	t	% c.v.	t	% c.v.
QMS species										
Hoki	HOK	42 938	38 282	11.0	48 251	9.2	87 505	9.8	2 248	19.0
Black oreo	BOE	4 795	11 317	20.1	11 377	24.4	22 983	22.4	430	75.7
Silver warehou	SWA	5 721	7 629	52.9	8 411	50.4	16 055	51.5	-	
Dark ghostshark	GSH	8 670	5 279	17.8	7 864	23.2	13 162	20.6	-	
Ling	LIN	3 761	3 244	10.0	4 854	8.7	8 098	7.4	11	84.0
Lookdown dory	LDO	2 764	2 307	21.7	3 599	9.4	5 913	13.2	30	87.0
Spiny dogfish	SPD	2 442	1 339	18.9	4 093	13.1	5 438	13.6	-	
Sea perch	SPE	1 995	2 230	7.7	1 894	8.4	4 827	9.9	3	58.1
Pale ghostshark	GSP	1 805	2 196	12.9	2 131	8.5	4 327	8.5	188	29.3
Smooth oreo	SSO	505	1 158	96.6	928	97.8	2 150	96.5	5 699	78.5
White warehou	WWA	886	930	34.8	993	32.0	1 925	32.0	-	
Spiky oreo	SOR	1 080	970	41.2	904	38.2	1 879	39.2	226	58.6
Giant stargazer	GIZ	875	446	15.0	1 298	15.8	1 751	13.3	5	100
Alfonsino	BYS	712	875	33.4	630	32.7	1 507	32.2	-	
Hake	HAK	794	314	25.5	978	15.8	1 292	14.7	201	26.9
Smooth skate	SSK	422	320	34.5	493	27.0	813	21.9	17	100
Red cod	RCO	277	422	53.7	194	45.2	616	49.1	-	
Barracouta	BAR	267	355	51.5	255	74.6	610	59.2	-	
Banded stargazer	BGZ	140	106	100	445	100	551	100	-	
Ribaldo	RIB	252	178	22.2	283	16.6	469	14.6	115	24.3
Southern Ray's bream	SRB	147	164	24.3	174	24.0	348	22.6	-	
Hapuku	HAP	109	164	35.8	160	37.6	324	33.7	-	
Arrow squid	NOS	112	121	35.5	153	28.5	294	27.8	1	100
School shark	SCH	73	130	59.1	46	100	176	64.6	-	
Deepsea cardinalfish	EPT	97	78	53.9	55	43.6	136	47.8	2	100
Tarakihi	NMP	40	100	34.3	20	90.7	120	25.4	-	
Slender mackerel	JMM	44	58	96.1	43	92.3	102	94.4	-	
Bluenose	BNS	58	23	68.0	69	45.7	92	46.7	-	
Lemon sole	LSO	26	26	45.4	29	39.7	55	38.2	-	
Jack mackerel	JMD	17	29	100	11	100	40	100	-	
Ray's Bream	RBM	13	28	100	5	100	33	100	-	
Frostfish	FRO	8	0		29	100	29	100	-	
Scampi	SCI	7	6	37.4	8	27.7	15	22.0	-	
Bass groper	BAS	6	9	100	0		9	100	-	
Orange roughy	ORH	2	0	100	3	100	3	100	5 202	26.7
Commercial non-QMS species (where biomass > 30 t)										
Shovelnose dogfish	SND	2 131	1 503	16.2	2 469	18.5	3 997	15.3	3 507	28.7
Non-commercial species (where biomass > 800 t)										
Big-eye rattail	CBO	6 235	-	-	-	-	13 514	8.5	9	69.7
Javelinfish	JAV	4 881	-	-	-	-	10 547	16.5	255	65.5
Common roughy	RHY	1 761	-	-	-	-	6 649	92.7	-	
Baxter's dogfish	ETB	557	-	-	-	-	2 294	37.0	812	35.5
Oblique banded rattail	CAS	859	-	-	-	-	1 770	11.0	-	
Oliver's rattail	COL	705	-	-	-	-	1 411	18.0	28	91.0
Orange perch	OPE	348	-	-	-	-	1 173	67.3	-	
Long-nosed chimaera	LCH	460	-	-	-	-	1 119	15.2	159	21.8
Longnose velvet dogfish	CYP	494	-	-	-	-	916	44.7	2 612	31.1
Total (above)		100 291								
Grand total (all species)		105 652								

Table 5: Estimated biomass (t) with coefficient of variation below (%) of hoki, hake, and ling sampled by annual trawl surveys of the Chatham Rise, January 1992–2012. stns, stations (-, no data; c.v., coefficient of variation.).

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

Table 6: Relative biomass estimates (t in thousands) of hoki, 200–800 m depths, Chatham Rise trawl surveys January 1992–2012 (c.v. coefficient of variation; 3++ all hoki aged 3 years and older; (see Appendix 4 for length ranges of age classes.).

		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)

Table 7: Estimated biomass (t) and coefficient of variation (% c.v.) of hoki, hake, ling, orange roughy, and 15 other key species by stratum (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); -, not calculated.).

												Species code
		HOK		SWA		SPD		LIN		GSH		SPE
Stratum	t	c.v.	t	c.v.	t	c.v.	t	c.v.	t	c.v.	t	c.v.
1	570	35	0	0	0	0	107	10	0	0	27	50
2a	1 276	33	0	0	0	0	58	77	0	0	18	50
2b	3 561	27	0	0	0	0	219	24	0	0	47	52
3	2 644	34	0	0	118	31	294	21	646	29	130	38
4	2 863	11	0	0	0	0	467	33	0	0	89	30
5	3 495	45	719	95	323	67	334	12	1 038	29	109	63
6	2 824	12	8	100	0	0	324	69	0	0	18	100
7a	5 445	41	26	85	247	64	339	23	23	77	90	45
7b	253	9	1	100	4	100	99	29	7	100	25	17
8a	805	28	0	0	123	82	122	28	6	100	69	24
8b	1 759	26	0	0	65	100	418	35	48	100	167	57
9	344	48	3 703	59	168	42	111	30	977	24	32	93
10a	1 711	78	3	100	159	98	130	39	130	100	50	36
10b	1 575	19	20	100	0	0	61	77	5	100	32	11
11a	1 360	21	23	100	127	88	128	15	199	60	33	19
11b	820	13	0	0	0	0	102	68	1	100	8	12
11c	2 335	42	0	0	243	87	135	22	131	92	28	7
11d	4 342	31	62	100	130	95	125	6	270	100	61	15
12	3 356	14	7	100	113	27	617	7	68	69	3	100
13	2 162	3	0	0	412	7	546	50	195	94	94	8
14	3 640	24	28	67	1 072	26	687	21	28	76	190	55
15	4 707	36	741	39	108	39	482	42	81	100	89	8
16	19 042	32	1 058	54	436	32	1 068	16	138	94	245	30
17	516	70	10	32	39	17	46	82	2 846	82	40	65
18	6 024	67	388	20	853	58	233	60	1 422	50	154	66
19	1 527	59	9 059	87	341	29	122	100	1 514	43	1 091	13
20	8 549	14	199	40	359	22	722	22	3 392	24	1 887	21
Core	87 505	10	16 055	52	5 438	14	8 098	7	13 162	21	4 827	10
21a	243	43	0	0	0	0	2	100	0	0	1	100
21b	483	23	0	0	0	0	0	0	0	0	0	0
22	1 088	35	0	0	0	0	9	100	0	0	1	100
23	145	43	0	0	0	0	0	0	0	0	1	100
24	16	85	0	0	0	0	0	0	0	0	0	0
25	261	32	0	0	0	0	0	0	0	0	0	0
28	12	100	0	0	0	0	0	0	0	0	0	0
Deep	2 248	19	0	0	0	0	11	84	0	0	3	58
Total	89 753	10	16 055	52	5 438	14	8 109	7	13 162	21	4 830	10

Table 7 (continued)

	Species code									
	LDO		GIZ		GSP		WWA		HAK	
Stratum	t	c.v.	t	c.v.	t	c.v.	t	c.v.	t	c.v.
1	39	28	0	0	319	34	91	100	35	31
2a	36	38	39	19	72	37	0	0	11	100
2b	129	23	14	100	152	21	0	0	119	32
3	355	54	9	100	0	0	30	100	52	52
4	186	48	0	0	479	16	0	0	51	50
5	361	29	70	21	0	0	67	50	26	22
6	0	0	0	0	930	26	38	53	21	100
7a	144	25	48	38	262	37	18	77	120	29
7b	19	15	20	35	23	19	2	100	53	77
8a	72	1	6	67	70	54	0	0	48	54
8b	210	53	0	0	71	32	4	100	87	57
9	22	100	295	11	0	0	0	0	0	0
10a	121	59	9	54	39	21	0	0	31	55
10b	54	23	0	0	32	85	0	0	52	100
11a	130	27	11	64	18	100	54	100	120	72
11b	25	10	17	50	6	71	0	0	39	39
11c	145	11	33	51	19	65	11	10	70	49
11d	749	87	31	100	7	100	138	100	53	65
12	440	13	75	57	151	23	0	0	0	0
13	249	25	24	100	290	33	0	0	0	0
14	859	31	104	100	375	23	12	100	160	65
15	188	6	176	14	372	34	33	71	10	100
16	617	18	242	31	639	17	775	55	67	42
17	32	62	52	30	0	0	5	57	0	0
18	129	50	204	45	0	0	5	58	37	100
19	88	64	104	58	0	0	393	100	11	100
20	513	22	166	83	0	0	248	37	20	100
Core	5 913	13	1 751	13	4 327	9	1 925	32	1 292	15
21a	0	0	0	0	2	61	0	0	31	50
21b	26	100	0	0	37	88	0	0	61	64
22	4	77	5	100	97	40	0	0	60	36
23	0	0	0	0	32	61	0	0	38	61
24	0	0	0	0	4	100	0	0	0	0
25	0	100	0	0	9	43	0	0	12	100
28	0	0	0	0	7	100	0	0	0	0
Deep	30	87	5	100	188	29	0	0	201	27
Total	5 943	13	1 756	13	4 515	8	1 925	32	1 493	13

Table 7 (continued)

	Species code									
	<20 cm ORH		<30 cm ORH		total ORH		BOE		SOR	
Stratum	t	c.v.	t	c.v.	t	c.v.	t	c.v.	t	c.v.
1	0	0	0	0	0	0	1	100	365	71
2a	1	100	0	0	3	100	0	0	30	28
2b	0	0	0	0	0	0	1	100	835	68
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	11 697	31	36	69
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	11 213	32	0	0
7a	0	0	0	0	0	0	0	0	0	0
7b	0	0	0	0	0	0	0	0	1	100
8a	0	0	0	0	0	0	0	0	0	0
8b	0	0	0	0	0	0	0	0	15	77
9	0	0	0	0	0	0	0	0	0	0
10a	0	0	0	0	0	0	0	0	0	0
10b	0	0	0	0	0	0	0	0	265	85
11a	0	0	0	0	0	0	0	0	0	0
11b	0	0	0	0	0	0	0	0	4	100
11c	0	0	0	0	0	0	0	0	319	99
11d	0	0	0	0	0	0	0	0	4	100
12	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	5	100
14	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	40	100	0	0
16	0	0	0	0	0	0	12	100	0	0
17	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	20	95	0	0
Core	1	100	0	100	3	100	22 983	22	1 879	39
21a	6	49	48	52	79	60	0	0	0	52
21b	20	50	139	93	246	79	1	100	40	53
22	4	55	2 047	45	2 150	43	2	100	168	78
23	12	91	609	58	690	51	1	100	0	0
24	0	100	573	19	665	18	0	0	9	70
25	6	73	603	89	1 004	89	409	80	9	79
28	12	79	257	73	368	75	17	59	0	0
Deep	60	31	925	41	5 202	27	430	76	226	59
Total	61	30	4 277	27	5 206	27	23 413	22	2 105	36

Table 7 (continued)

	Species code									
	SND		SSO		ETB		CYP		RIB	
Stratum	t	c.v.	t	c.v.	t	c.v.	t	c.v.	t	c.v.
1	752	32	1	100	12	100	76	100	75	58
2a	410	27	6	100	29	100	445	74	80	26
2b	2 433	22	13	88	7	82	281	72	57	31
3	0	0	0	0	0	0	0	0	0	0
4	37	50	0	0	250	30	0	0	33	51
5	0	0	0	0	0	0	0	0	0	0
6	10	100	2 130	97	1 940	44	109	100	30	54
7a	45	45	0	0	8	98	0	0	37	41
7b	2	100	0	0	0	0	0	0	2	100
8a	5	100	0	0	0	0	1	100	11	100
8b	49	100	0	0	0	0	2	100	16	100
9	0	0	0	0	0	0	0	0	0	0
10a	0	0	0	0	0	0	0	0	0	0
10b	123	72	0	0	2	100	0	0	3	100
11a	0	0	0	0	0	0	0	0	0	0
11b	11	56	0	0	0	0	0	0	5	54
11c	50	54	0	0	0	0	0	0	0	0
11d	20	100	0	0	0	0	0	0	16	60
12	0	0	0	0	0	0	0	0	42	33
13	0	0	0	0	13	100	0	0	2	100
14	0	0	0	0	0	0	0	0	6	100
15	21	59	0	0	9	100	0	0	15	62
16	27	89	0	0	25	50	1	100	37	59
17	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0
Core	3 997	15	2 150	97	2 294	37	916	45	469	15
21a	21	53	38	63	14	83	171	30	1	100
21b	1 120	36	4	31	22	100	523	21	85	27
22	249	28	132	68	31	39	286	24	13	81
23	51	48	72	61	53	20	38	63	0	0
24	782	87	193	88	49	30	282	83	0	0
25	808	49	623	97	249	72	1 207	63	16	76
28	476	100	4 638	96	395	57	105	91	0	0
Deep	3 507	29	5 699	79	812	36	2 612	31	115	24
Total	7 503	16	7 849	63	3 106	29	3 528	26	583	13

Table 8: Total numbers of fish, squid and scampi measured for length frequency distributions and biological samples from all stations (TAN1201). 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	565	376	942	703
Banded bellowsfish	BBE	713	459	1 734	425
Banded rattail	CFA	60	127	608	169
Banded stargazer	BGZ	7	22	29	29
Barracouta	BAR	103	69	172	104
Basketwork eel	BEE	150	430	673	380
Bass groper	BAS	1	0	1	1
Baxters lantern dogfish	ETB	408	336	746	447
Bigeye cardinalfish	EPL	1	3	58	4
Big-scale pomfret	BSP	1	0	1	1
Bigscaled brown slickhead	SBI	585	1 063	1 657	712
Black oreo	BOE	666	619	1 306	440
Black slickhead	BSL	106	242	678	148
Blackspot rattail	VNI	0	0	27	23
Bluenose	BNS	3	8	11	11
Bollons's rattail	CBO	1 908	1 489	3 560	1 288
Brown chimaera	CHP	0	1	1	1
Cape scorpionfish	TRS	4	5	9	9
Capro dory	CDO	0	0	115	50
Carpet shark	CAR	0	1	1	1
Catshark	APR	26	25	51	51
Common roughy	RHY	211	213	424	215
Crested bellowsfish	CBE	69	61	130	0
Dawson's catshark	DCS	8	1	9	9
Deepsea cardinalfish	EPT	178	86	265	209
Deepsea flathead	FHD	1	6	7	5
Deepwater spiny skate (Arctic skate)	DSK	1	0	1	1
Finless flounder	MAN	1	0	1	0
Four-rayed rattail	CSU	329	499	3 172	558
Frostfish	FRO	0	2	2	2
Ghost shark	GSH	1 480	1 676	3 157	994
Giant chimaera	CHG	1	2	3	3
Giant lepidion	LPS	1	0	1	1
Giant spineback	NOC	0	0	2	0
Giant stargazer	GIZ	112	143	256	256
Greenback jack mackerel	JMD	15	6	21	21
Hairy conger	HCO	3	7	10	8
Hake	HAK	79	98	177	177
Hapuku	HAP	9	8	17	17
Hoki	HOK	8 474	10 551	19 166	2 438
Humpback rattail (slender rattail)	CBA	0	20	21	20
Javelin fish	JAV	1 281	4 986	6 935	1 496
Johnson's cod	HJO	553	358	965	615

Table 8 (continued)

	Species code	Number measured Males	Number measured Females	Number measured Total	Number of biological samples
Kaiyomaru rattail	CKA	7	3	24	24
Largemouth manefish	PLA	0	1	1	1
Leafscale gulper shark	CSQ	8	26	34	31
Lemon sole	LSO	24	29	53	52
Ling	LIN	658	697	1 355	1 323
Longnose velvet dogfish	CYP	400	576	988	697
Long-nosed chimaera	LCH	224	242	466	321
Longnosed deepsea skate	PSK	4	1	5	5
Lookdown dory	LDO	1 703	1 619	3 345	1 788
Lucifer dogfish	ETL	323	245	621	444
Lyconus sp.	LYC	0	1	1	1
Mahia rattail	CMA	62	80	149	143
McMillan's rattail	CMX	0	3	3	3
Mirror dory	MDO	1	4	5	3
Murray's rattail	CMU	0	1	3	1
Nezumia namatahi	NNA	1	6	7	7
Northern spiny dogfish	NSD	6	0	6	6
Notable rattail	CIN	57	94	661	188
NZ southern arrow squid	NOS	124	137	262	172
Oblique banded rattail	CAS	265	1 247	1 874	651
Oliver's rattail	COL	577	717	2 489	545
Orange perch	OPE	153	148	301	161
Orange roughy	ORH	988	1 176	2 180	638
Owston's dogfish	CYO	76	45	121	121
Pale ghost shark	GSP	575	604	1 181	970
Plunkets shark	PLS	10	6	16	14
Prickly deepsea skate	BTS	3	1	4	4
Prickly dogfish	PDG	7	2	9	9
Rays bream	RBM	7	1	8	8
Red cod	RCO	278	124	402	338
Redbait	RBT	8	7	15	15
Ribaldo	RIB	99	74	175	174
Ridge scaled rattail	MCA	84	100	198	198
Robust cardinalfish	EPR	44	91	218	4
Roughhead rattail	CHY	17	10	27	18
Ruby fish	RBY	1	0	1	1
Rudderfish	RUD	53	19	75	72
Sandfish	GON	1	1	2	2
Scaly gurnard	SCG	24	34	58	0
Scampi	SCI	22	33	62	62
School shark	SCH	4	1	5	5
Sea perch	SPE	1 277	1 229	2 835	1 525
Seal shark	BSH	50	32	82	81
Serrulate rattail	CSE	214	128	495	344
Shortsnouted lancetfish	ABR	0	1	1	1
Shovelnose spiny dogfish	SND	684	792	1 478	906
Silver dory	SDO	144	110	254	44
Silver roughy	SRH	53	64	147	21
Silver warehou	SWA	603	677	1 284	761
Silverside	SSI	289	182	791	335

Table 8 (continued)

	Species code	Number measured Males	Number measured Females	Number measured Total	Number of biological samples
Sixgill shark	HEX	1	2	3	3
Slender jack mackerel	JMM	18	14	32	32
Slender ragfish	SUH	0	1	1	1
Small banded rattail	CCX	1	2	10	4
Small-headed cod	SMC	13	3	17	12
Smallscaled brown slickhead	SSM	465	382	849	404
Smooth deepsea skate	BTA	1	0	1	1
Smooth oreo	SSO	638	559	1 209	393
Smooth skate	SSK	19	18	37	37
Southern blue whiting	SBW	1	0	2	2
Southern rays bream	SRB	46	48	98	92
Spiky oreo	SOR	477	440	921	614
Spineback	SBK	26	287	456	237
Spiny dogfish	SPD	455	1 059	1 516	918
Spotty faced rattail	CTH	25	11	36	26
Striate rattail	CTR	0	3	3	3
Swollenhead conger	SCO	2	4	6	4
Tarakihi	NMP	26	5	31	31
Tasmanian ruffe	TUB	0	1	1	1
Todarodes squid	TSQ	4	3	8	8
Two saddle rattail	CBI	249	185	434	434
Unicorn rattail	WHR	2	5	16	8
Violet cod	VCO	18	17	35	35
Warty oreo	WOE	28	20	58	58
Warty squid (*Onykia ingens*)	MIQ	29	28	58	58
Warty squid (*O. robsoni*)	MRQ	0	1	1	1
White rattail	WHX	148	189	353	341
White warehou	WWA	250	239	490	463
Widenosed chimaera	RCH	95	72	167	162
Witch	WIT	1	2	3	3
Yellow cod	YCO	1	0	1	1
Total		31 362	39 015	78 738	

Table 9: Length-weight regression parameters* used to scale length frequencies (all data from TAN1201).

Species	*a* (intercept)	*b* (slope)	r^2	*n*	Length range (cm)
Baxter's dogfish	0.003747	3.075186	0.99	406	19–86
Black oreo	0.047827	2.742504	0.88	168	24–39
Dark ghostshark	0.003143	3.155096	0.96	728	34–75
Giant stargazer	0.008621	3.152636	0.98	255	20–81
Hake	0.003416	3.167097	0.98	177	41–130
Hoki	0.003022	2.996119	0.98	2 411	35–122
Ling	0.001466	3.259052	0.99	1 300	30–167
Longnose velvet dogfish	0.002246	3.163106	0.98	629	31–95
Lookdown dory	0.024006	2.968296	0.98	1 582	11–57
Orange roughy	0.054900	2.862727	0.98	609	8–41
Pale ghostshark	0.008403	2.909208	0.97	853	18–84
Ribaldo	0.006412	3.131120	0.97	173	31–77
Sea perch	0.009297	3.151456	0.98	1 158	14–49
Silver warehou	0.009894	3.166910	0.96	557	26–56
Smooth oreo	0.017475	3.057585	0.98	384	17–48
Spiny dogfish	0.001066	3.328378	0.95	797	52–98
Spiky oreo	0.026005	2.960420	0.98	487	14–44
White warehou	0.022701	2.996581	0.99	368	21–59

* $W = aL^b$ 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).

Common name	Sex	Staging method	Reproductive stage 1	2	3	4	5	6	7	Total
Alfonsino	Male	MD	8	7	-	-	-	-	-	15
	Female		10	6	-	-	-	-	-	16
Banded bellowsfish	Male	MD	1	7	-	-	-	-	-	8
	Female		2	10	-	-	-	-	-	12
Banded rattail	Male	MD	9	-	-	-	-	-	-	9
	Female		5	4	1	-	-	-	-	10
Banded stargazer	Male	MD	-	7	-	-	-	-	-	7
	Female		-	9	13	-	-	-	-	22
Basketwork eel	Male	MD	8	10	5	1	-	-	-	24
	Female		3	32	11	-	-	-	-	46
Baxter's dogfish	Male	SS	70	49	71	-	-	-	-	190
	Female		96	55	24	23	2	3	-	203
Bigeye rattail	Male	MD	26	69	-	-	-	-	-	95
	Female		16	50	-	-	-	-	-	66
Bigscaled brown	Male	MD	10	20	21	7	-	-	-	58
slickhead	Female		38	37	55	9	-	1	-	140
Black oreo	Male	MD	127	50	6	2	-	-	-	185
	Female		115	40	54	2	-	2	1	214
Black slickhead	Male	MD	-	23	7	-	-	-	-	30
	Female		4	-	11	-	-	-	-	15
Bluenose	Male	MD	-	-	-	-	-	-	-	-
	Female		-	1	1	-	-	-	-	2
Brown chimaera	Male	SS	-	-	-	-	-	-	-	-
	Female		1	-	-	-	-	-	-	1
Catshark	Male	SS	9	5	12	-	-	-	-	26
(*Apristurus* spp.)	Female		14	4	2	4	-	-	-	24
Common roughy	Male	MD	-	30	46	-	-	-	-	76
	Female		-	-	2	72	-	-	-	74
Dark ghostshark	Male	SS	101	150	104	-	-	-	-	355
	Female		173	158	46	38	-	-	-	415
Dawson's catshark	Male	SS	-	1	7	-	-	-	-	8
	Female		-	-	-	-	-	-	-	-
Deepsea cardinalfish	Male	MD	39	-	-	-	-	-	-	39
	Female		14	-	-	-	-	-	-	14
Deepwater spiny skate	Male	SS	-	-	1	-	-	-	-	1
(Arctic skate)	Female		-	-	-	-	-	-	-	-
Four-rayed rattail	Male	MD	1	11	2	-	-	-	-	14
	Female		2	29	40	-	-	-	-	71
Giant chimaera	Male	SS	1	-	-	-	-	-	-	1
	Female		-	2	-	-	-	-	-	2
Giant stargazer	Male	MD	-	1	-	-	-	-	-	1
	Female		1	2	4	-	-	-	-	7
Hake	Male	MD	11	13	8	15	25	7	-	79
	Female		23	25	46	-	2	2	-	98
Hairy conger	Male	MD	-	-	-	-	-	-	-	-
	Female		-	-	1	-	-	-	-	1
Hapuku	Male	MD	-	-	-	-	-	-	-	-
	Female		-	1	-	-	-	-	-	1
Hoki	Male	MD	579	338	-	-	-	-	-	917
	Female		709	787	2	-	-	-	19	1517
Humpback (slender)	Male	MD	-	-	-	-	-	-	-	-
rattail	Female		-	6	6	-	-	-	-	12
Javelinfish	Male	MD	-	3	2	-	-	-	-	5
	Female		20	65	1	-	-	-	-	86

Table 10 (continued)

Common name	Sex	Staging method	Reproductive stage 1	2	3	4	5	6	7	Total
Johnson's cod	Male	MD	77	79	1	-	-	-	-	157
	Female		61	61	52	-	-	-	-	174
Kaiyomaru rattail	Male	MD	-	6	-	-	-	-	-	6
	Female		-	-	2	-	-	-	-	2
	Male	MD	-	-	-	-	-	-	-	-
Largemouth manefish	Female		-	1	-	-	-	-	-	1
	Male	SS	7	-	1	-	-	-	-	8
Leafscale gulper shark	Female		12	2	6	1	-	1	-	22
Ling	Male	MD	263	229	92	56	-	-	-	640
	Female		282	372	10	1	-	-	-	665
Long-nosed chimaera	Male	SS	45	24	58	-	-	-	-	127
	Female		58	32	41	5	7	-	-	144
Longnosed deepsea	Male	SS	-	-	4	-	-	-	-	4
skate	Female		-	-	-	-	-	-	-	-
Longnose velvet	Male	SS	101	31	117	-	1	-	-	249
dogfish	Female		198	111	56	73	8	-	-	446
Lookdown dory	Male	MD	17	23	-	-	-	-	-	40
	Female		23	26	28	-	-	-	-	77
Lucifer dogfish	Male	SS	7	61	37	-	-	-	-	105
	Female		15	23	20	11	1	-	-	70
Mahia rattail	Male	MD	2	33	-	-	-	-	-	35
	Female		7	24	-	-	-	-	1	32
Murray's rattail	Male	MD	-	-	-	-	-	-	-	-
	Female		-	1	-	-	-	-	-	1
Nezumia namatahi	Male	MD	-	-	-	-	-	-	-	-
	Female		-	2	-	-	-	-	-	2
	Male	SS	-	-	3	-	-	-	-	3
Northern spiny dogfish	Female		-	-	-	-	-	-	-	-
Notable rattail	Male	MD	1	6	-	-	-	-	-	7
	Female		-	8	11	-	-	-	-	19
	Male	MD	8	13	-	-	-	-	-	21
Oblique banded rattail	Female		14	67	18	-	-	-	-	99
Oliver's rattail	Male	MD	6	7	-	-	-	-	-	13
	Female		2	43	-	-	-	-	-	45
Orange Roughy	Male	MD	108	80	109	-	1	-	-	298
	Female		65	43	227	-	-	2	-	337
Pale ghostshark	Male	SS	142	35	208	-	-	-	-	385
	Female		166	128	98	26	-	-	-	418
Plunket's shark	Male	SS	2	2	4	-	-	-	-	8
	Female		4	2	-	-	-	-	-	6
Prickly dogfish	Male	SS	1	4	2	-	-	-	-	7
	Female		-	-	-	-	-	-	-	-
Red cod	Male	MD	12	11	14	1	6	-	-	44
	Female		4	5	2	-	-	-	-	11
Ribaldo	Male	MD	-	8	4	-	-	-	-	12
	Female		-	12	-	-	-	-	-	12
Ridge scaled rattail	Male	MD	5	2	-	-	-	-	-	7
	Female		3	8	2	-	-	-	-	13
Robust cardinalfish	Male	MD	-	7	13	-	-	-	-	20
	Female		-	-	11	3	-	-	-	14
Roughhead rattail	Male	MD	-	4	-	-	-	-	-	4
(*C. trachycarus*)	Female		-	-	6	-	-	-	-	6
Rudderfish	Male	MD	11	3	3	2	-	-	-	19
	Female		5	4	-	-	-	-	-	9

Table 10 (continued)

Common name	Sex	Staging method	Reproductive stage 1	2	3	4	5	6	7	Total
School shark	Male	SS	-	1	2	-	-	-	-	3
	Female		-	-	-	-	-	-	-	-
Sea perch	Male	MD	7	13	1	-	-	-	-	21
	Female		8	20	-	-	-	-	-	28
Seal Shark	Male	SS	43	3	2	-	-	-	-	48
	Female		25	-	1	-	-	-	-	26
Serrulate rattail	Male	MD	2	59	1	-	-	-	-	62
	Female		1	30	11	-	-	-	-	42
Shovelnose dogfish	Male	SS	72	67	258	-	-	-	-	397
	Female		191	239	27	13	1	5	-	476
Silver dory	Male	MD	11	7	1	-	-	-	-	19
	Female		1	11	8	2	2	-	1	25
Silverside	Male	MD	-	1	1	-	-	-	-	2
	Female		-	7	2	-	-	-	-	9
Silver warehou	Male	MD	-	51	-	-	-	-	8	59
	Female		1	58	3	-	-	-	-	62
Sixgill shark	Male	SS	1	-	-	-	-	-	-	1
	Female		1	-	-	-	-	-	-	1
Smallscaled brown	Male	MD	24	15	6	1	-	-	-	46
slickhead	Female		35	20	3	-	-	-	1	59
	Male	SS	-	-	1	-	-	-	-	1
Smooth deepsea skate	Female		-	-	-	-	-	-	-	-
Smooth oreo	Male	MD	112	49	26	25	3	3	1	219
	Female		77	38	47	1	-	-	-	163
Smooth skate	Male	SS	15	2	1	-	-	-	-	18
	Female		8	1	1	-	-	-	-	10
Smooth skin dogfish	Male	SS	18	3	48	1	-	-	-	69
	Female		27	8	4	4	-	-	-	43
	Male	MD	-	6	-	-	-	-	-	6
Southern Ray's bream	Female		-	4	2	-	-	-	-	6
Spiky oreo	Male	MD	64	64	46	26	-	-	-	200
	Female		51	8	117	3	-	1	-	180
Spineback	Male	MD	-	-	-	-	2	1	1	4
	Female		-	-	19	4	5	4	4	36
Spiny dogfish	Male	SS	5	67	152	-	-	-	-	224
	Female		137	177	39	157	150	2	-	662
Tarakihi	Male	MD	-	-	4	-	-	-	-	4
	Female		-	-	-	-	-	-	-	-
Two saddle rattail	Male	MD	-	-	-	-	-	-	-	-
	Female		-	2	-	-	-	-	4	6
Violet cod	Male	MD	3	-	-	-	-	-	-	3
	Female		-	-	-	-	-	-	-	-
Warty oreo	Male	MD	1	-	-	-	-	-	-	1
	Female		1	-	-	-	-	-	-	1
White warehou	Male	MD	7	8	-	-	-	-	-	15
	Female		14	2	10	-	-	-	-	26
White rattail	Male	MD	17	12	-	-	-	-	-	29
	Female		7	7	6	-	-	-	-	20
Widenosed chimaera	Male	SS	23	15	11	-	-	-	-	49
	Female		24	6	4	4	-	-	-	38

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 2012 Chatham Rise trawl survey compared to results from previous surveys (from Stevens et al. 2012).

				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
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
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

Table 12: Average trawl catch (excluding benthic organisms) and acoustic backscatter from daytime core tows where acoustic data quality was suitable for echo integration on the Chatham Rise in 2001–12.

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

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 (updated from Stevens et al. 2012).

				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

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)											
		Unstratified		Northeast		Northwest		Southeast		Southwest		Stratified	
Survey	Year	Mean	c.v.	Mean	c.v.	Mean	c.v.	Mean	c.v.	Mean	c.v.	Mean	c.v.
TAN0101	2001	47.1	8	21.8	11	61.1	13	36.8	12	92.6	16	44.9	8
TAN0201	2002	35.8	6	25.1	11	40.3	11	29.6	13	54.7	13	34.0	7
TAN0301	2003	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

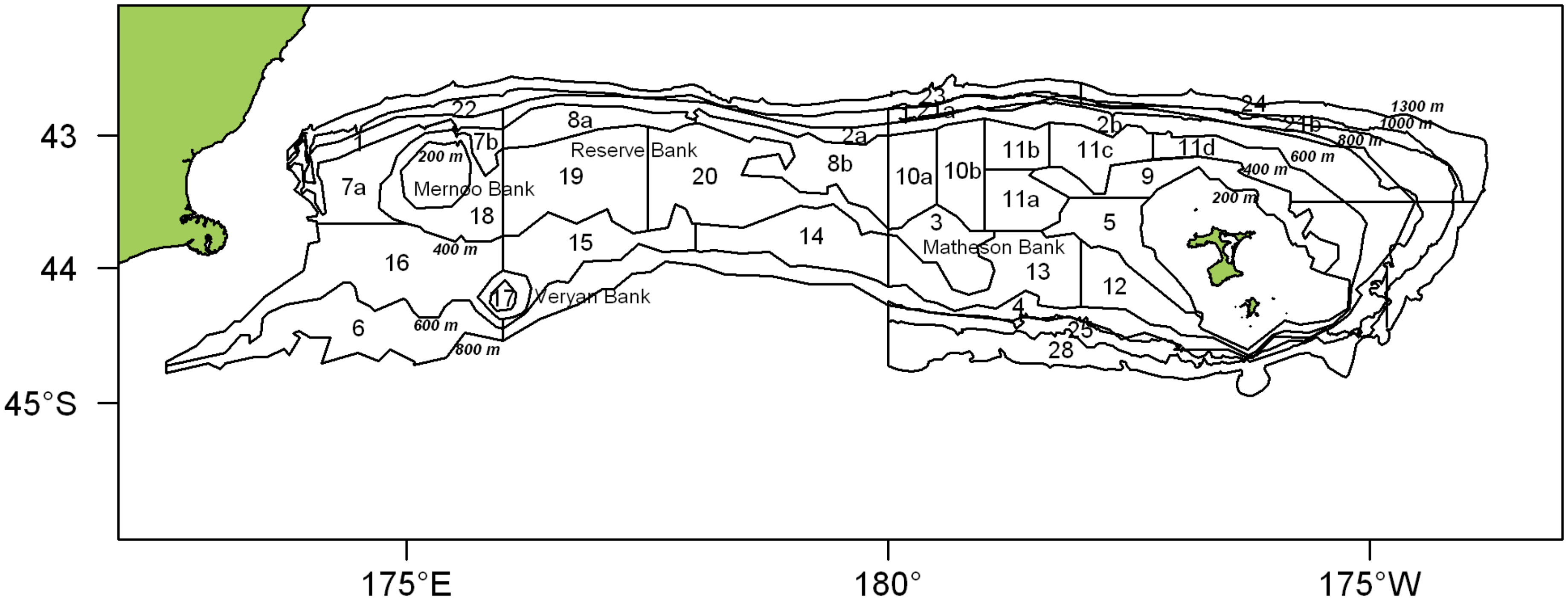

Figure 1: Trawl survey area showing stratum boundaries.

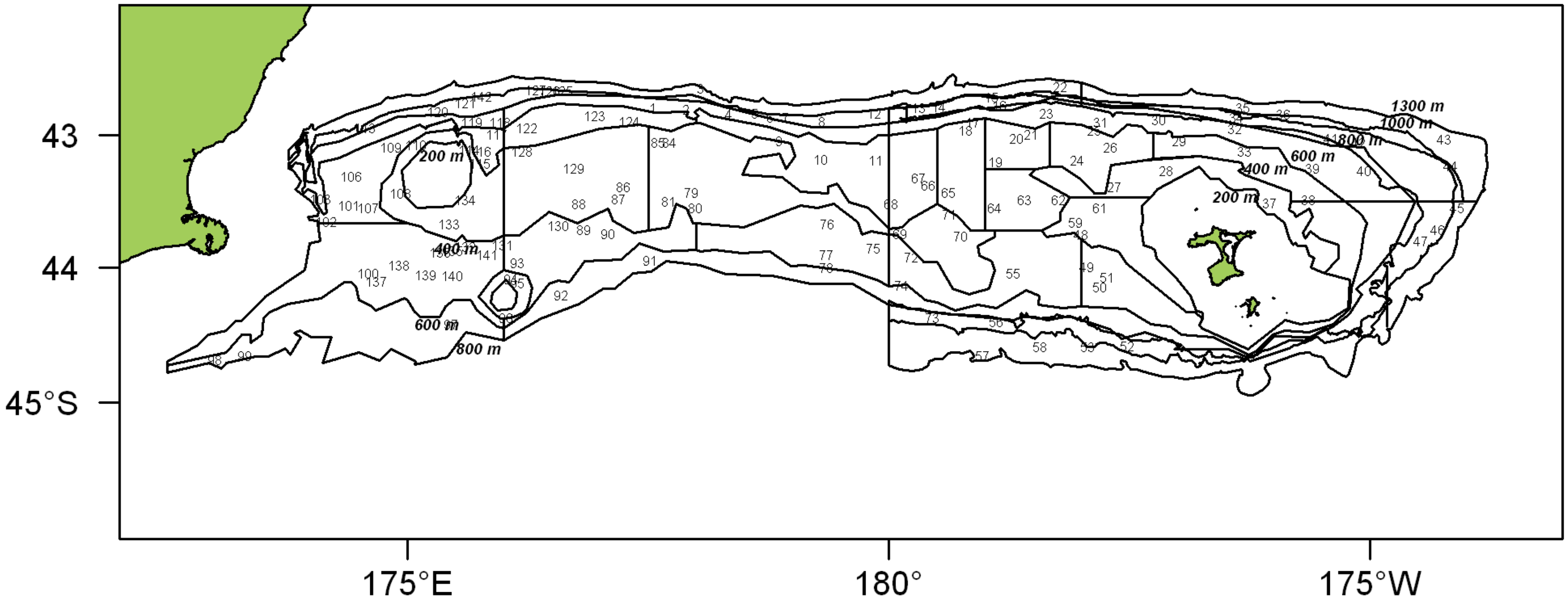

Figure 2: Trawl survey area showing positions of valid biomass stations (n = 134 stations) for TAN1201. In this and subsequent figures actual stratum boundaries are drawn for the new deepwater strata. These boundaries sometimes overlap with existing core survey stratum boundaries.

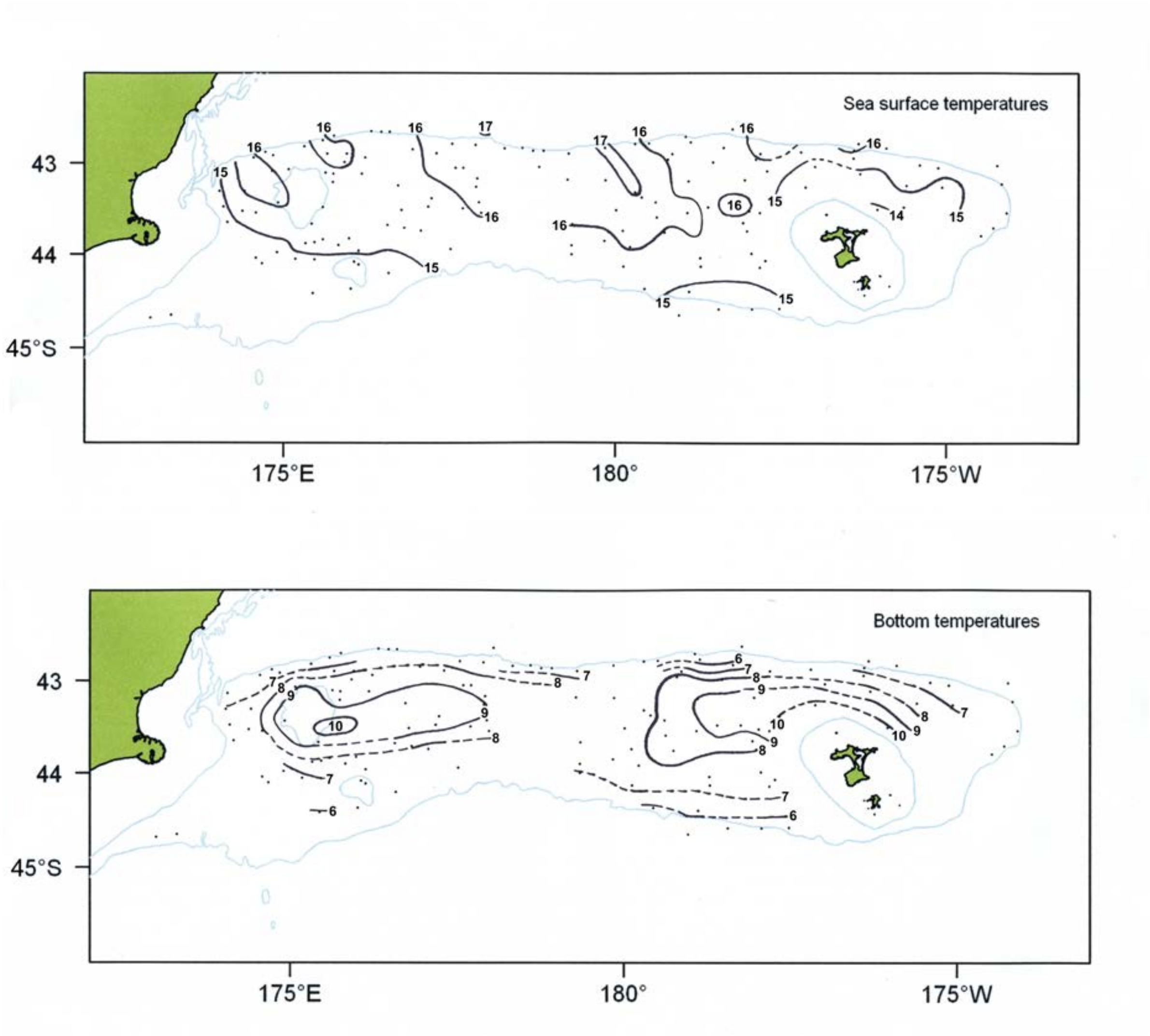

Figure 3: Positions of sea surface and bottom temperature recordings and approximate location of isotherms (^{o}C) interpolated by eye for TAN1201. The temperatures shown are from the calibrated Seabird CTD recordings made during each tow.

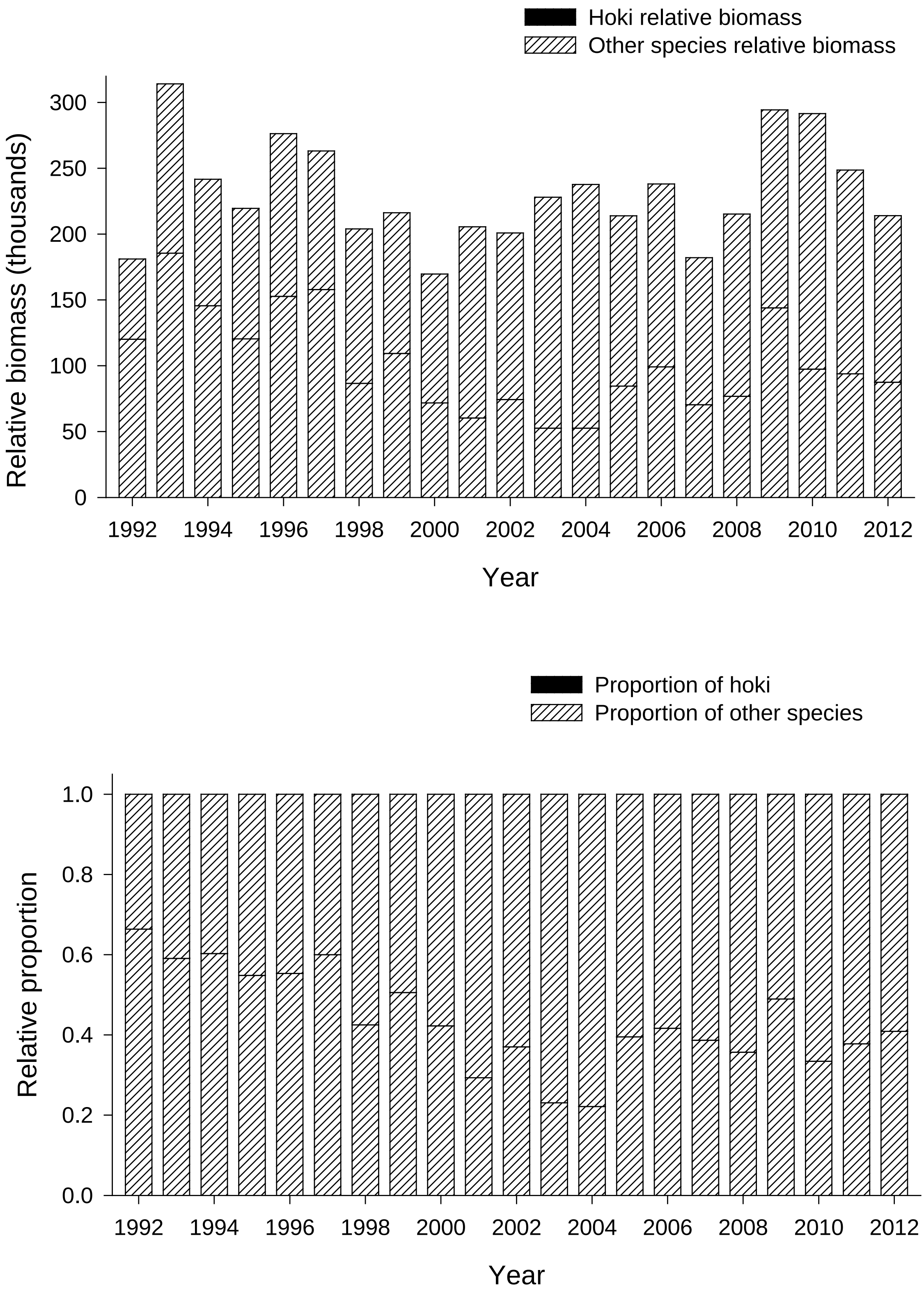

Figure 4: Relative biomass (top panel) and relative proportions of hoki and 30 other key species (lower panel) from trawl surveys of the Chatham Rise, January 1992–2012 (core strata only).

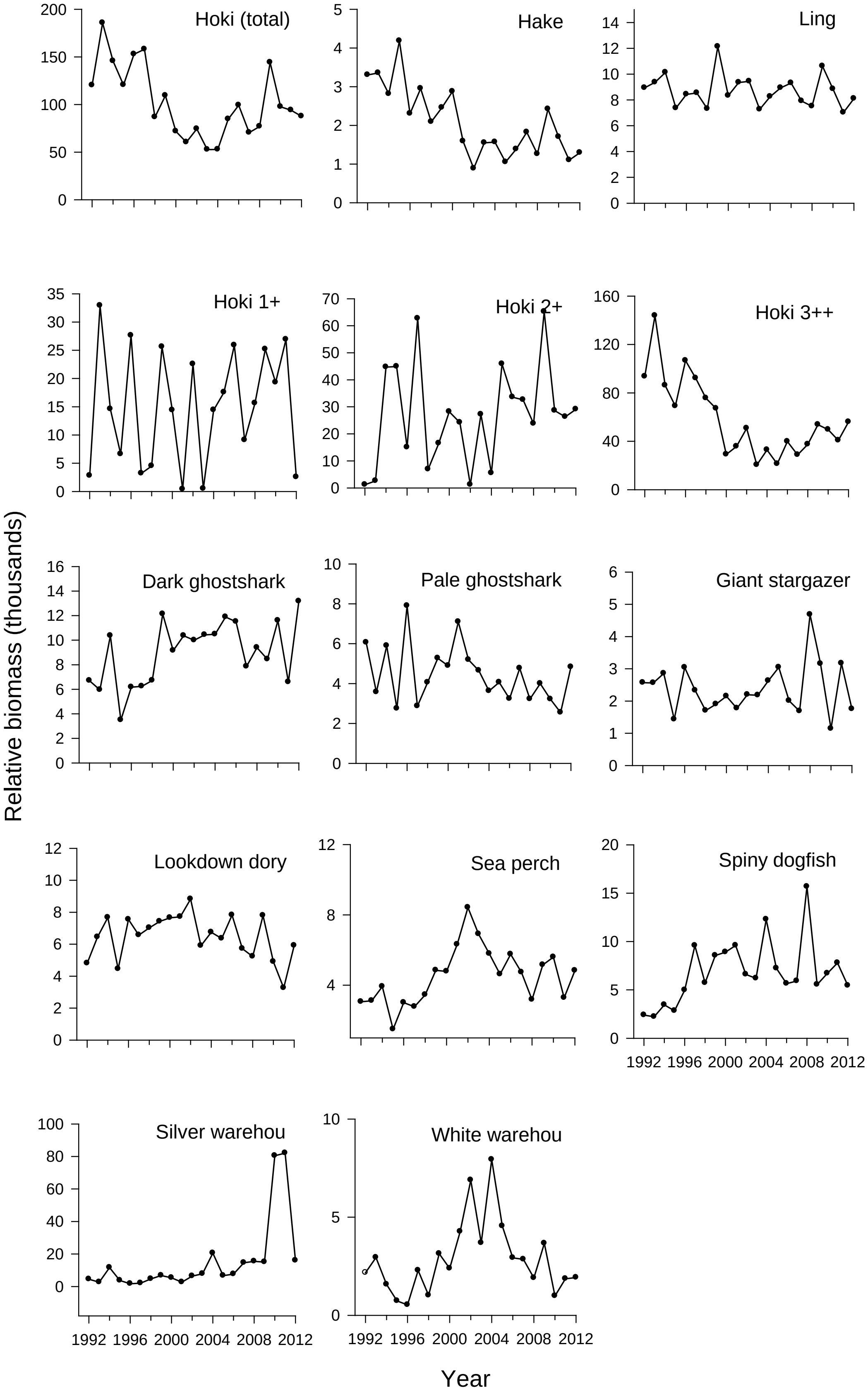

Figure 5: Relative biomass estimates (thousands of tonnes) of important species sampled by annual trawl surveys of the Chatham Rise, January 1992–2012 (core strata only).

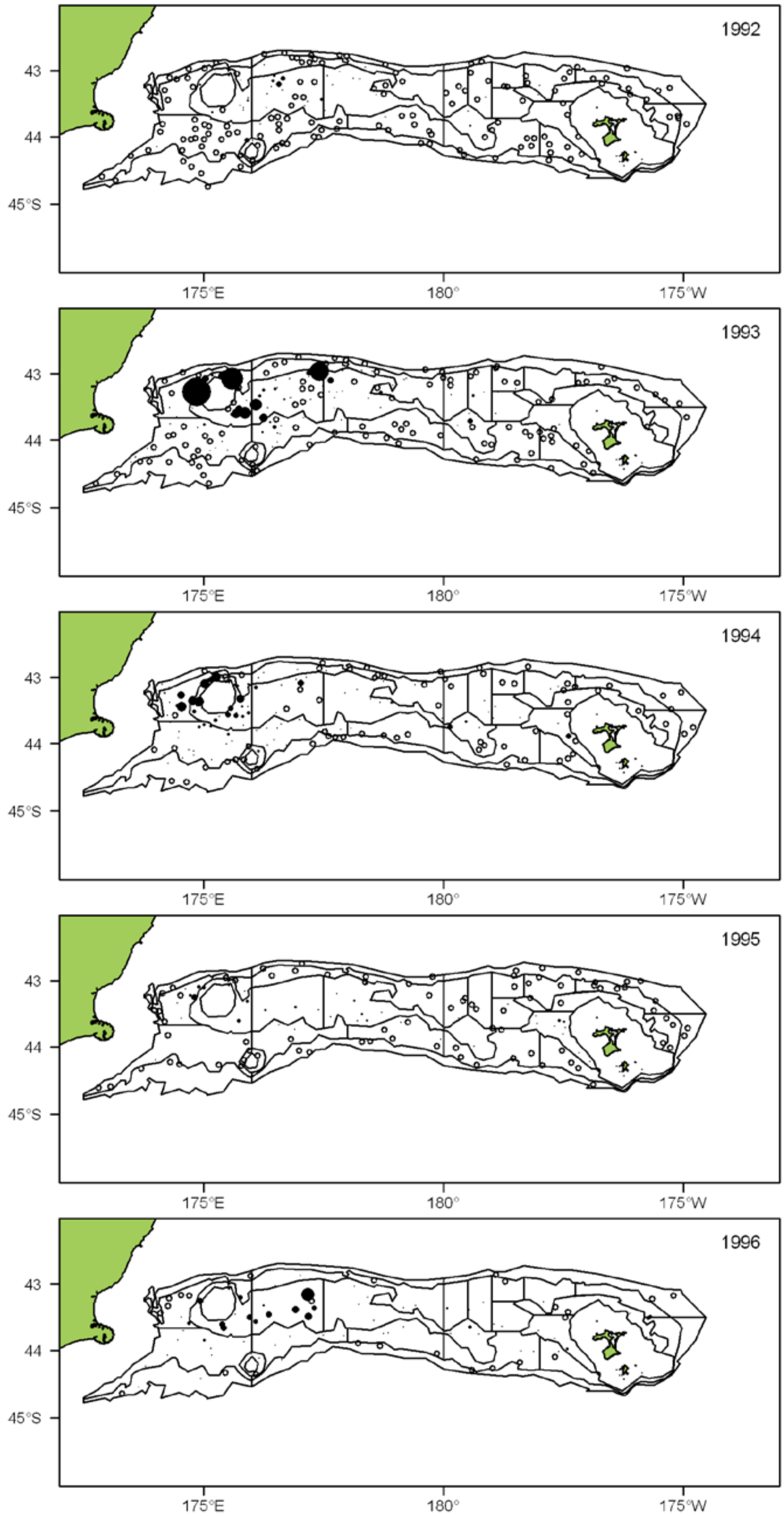

Figure 6a: Hoki 1+ catch distribution 1992–2012. Filled circle area is proportional to catch rate (kg km^{-2}). Open circles are zero catch. Maximum catch rate in series is 30 850 kg km^{-2}.

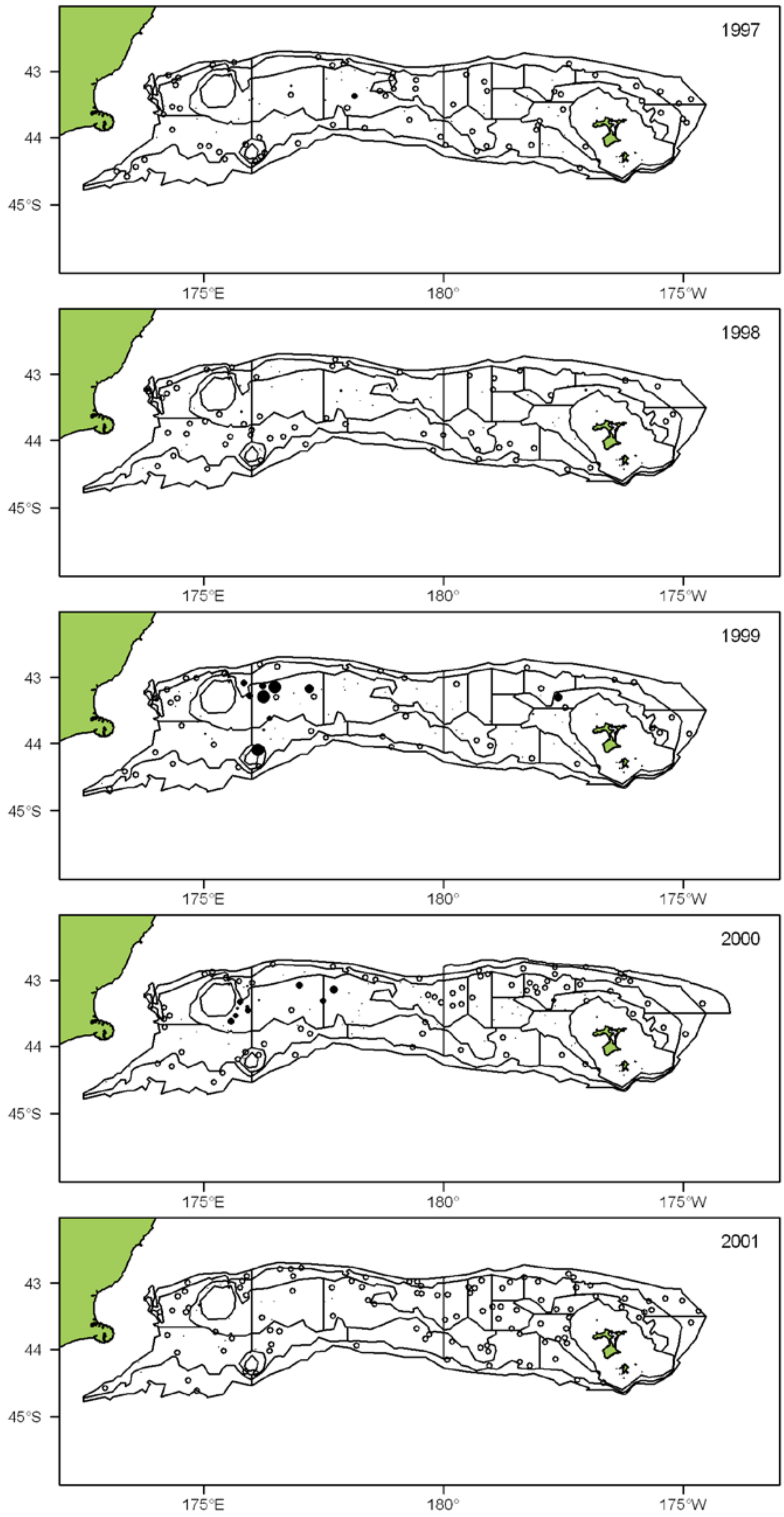

Figure 6a (continued)

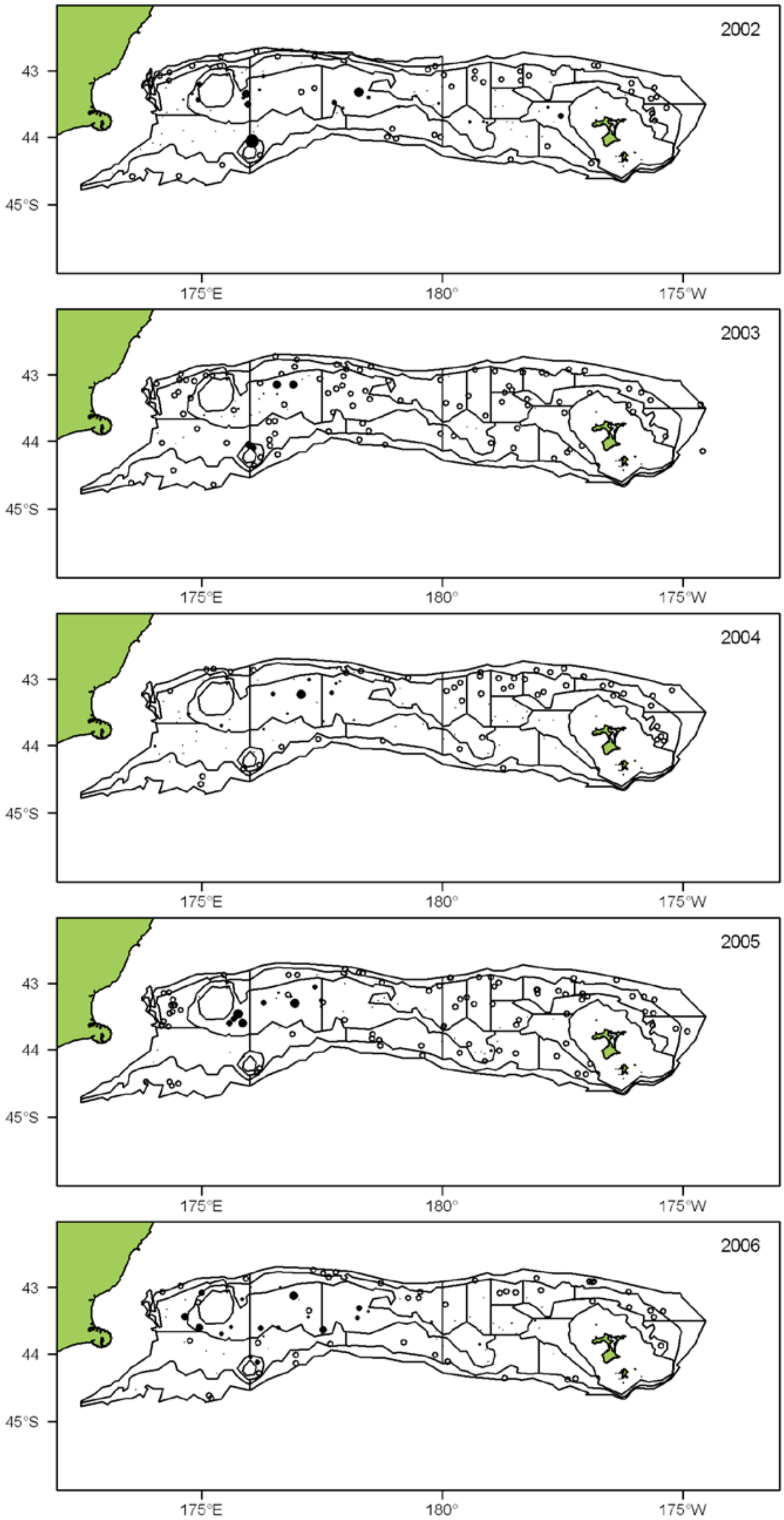

Figure 6a (continued)

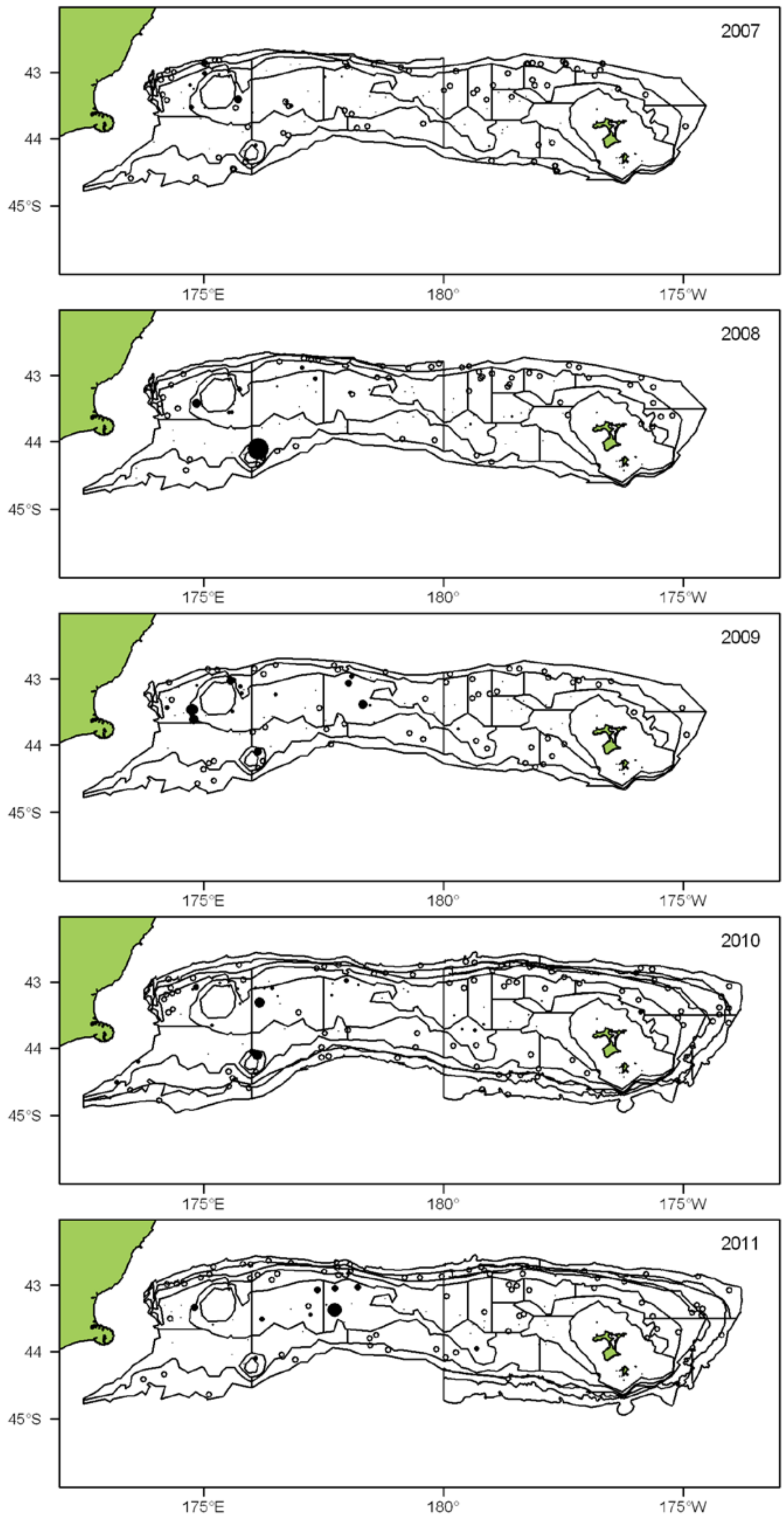

Figure 6a (continued)

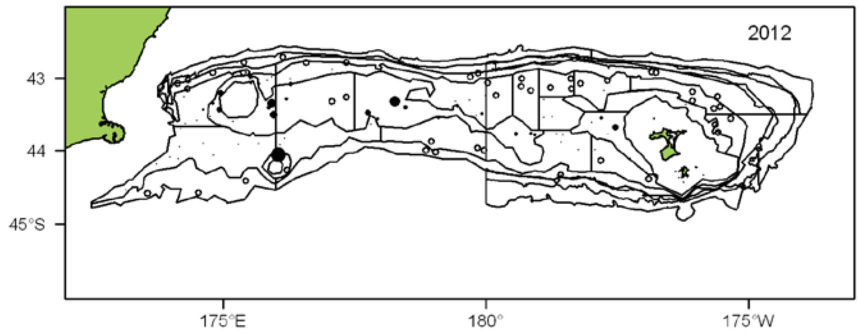

Figure 6a (continued)

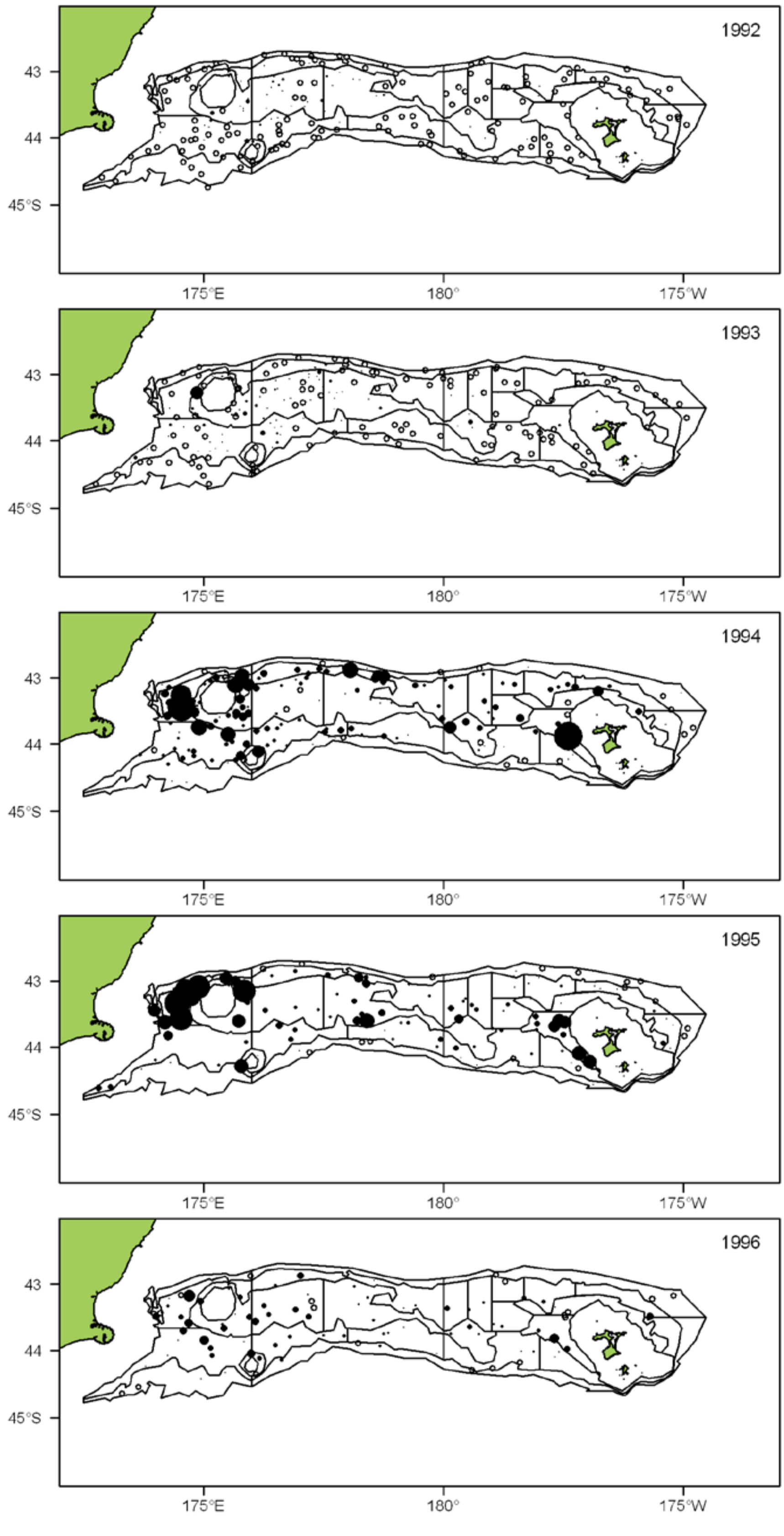

Figure 6b: Hoki 2+ catch distribution 1992–2012. Filled circle area is proportional to catch rate (kg km^{-2}). Open circles are zero catch. Maximum catch rate in series is 6791 kg km^{-2}.

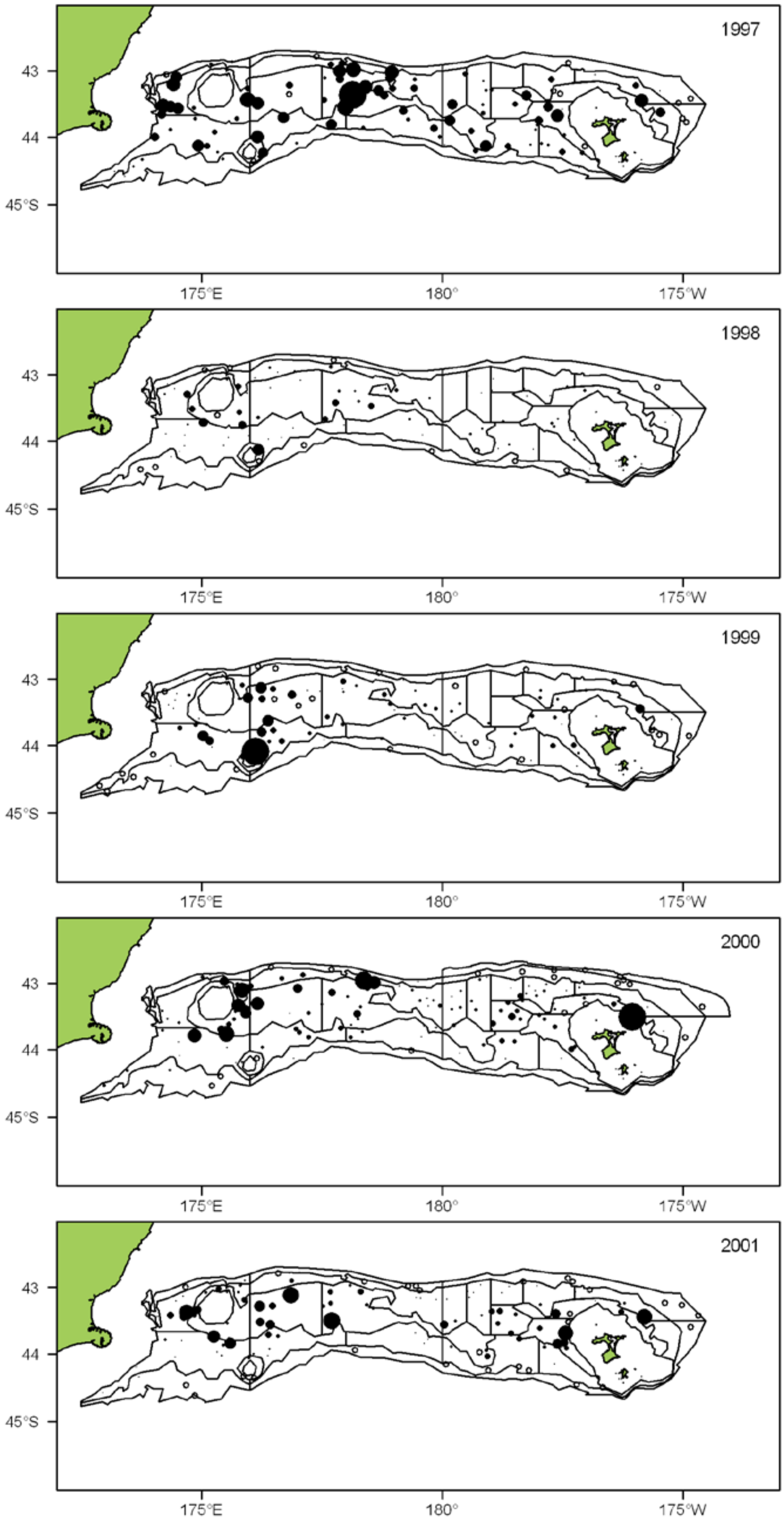

Figure 6b (continued)

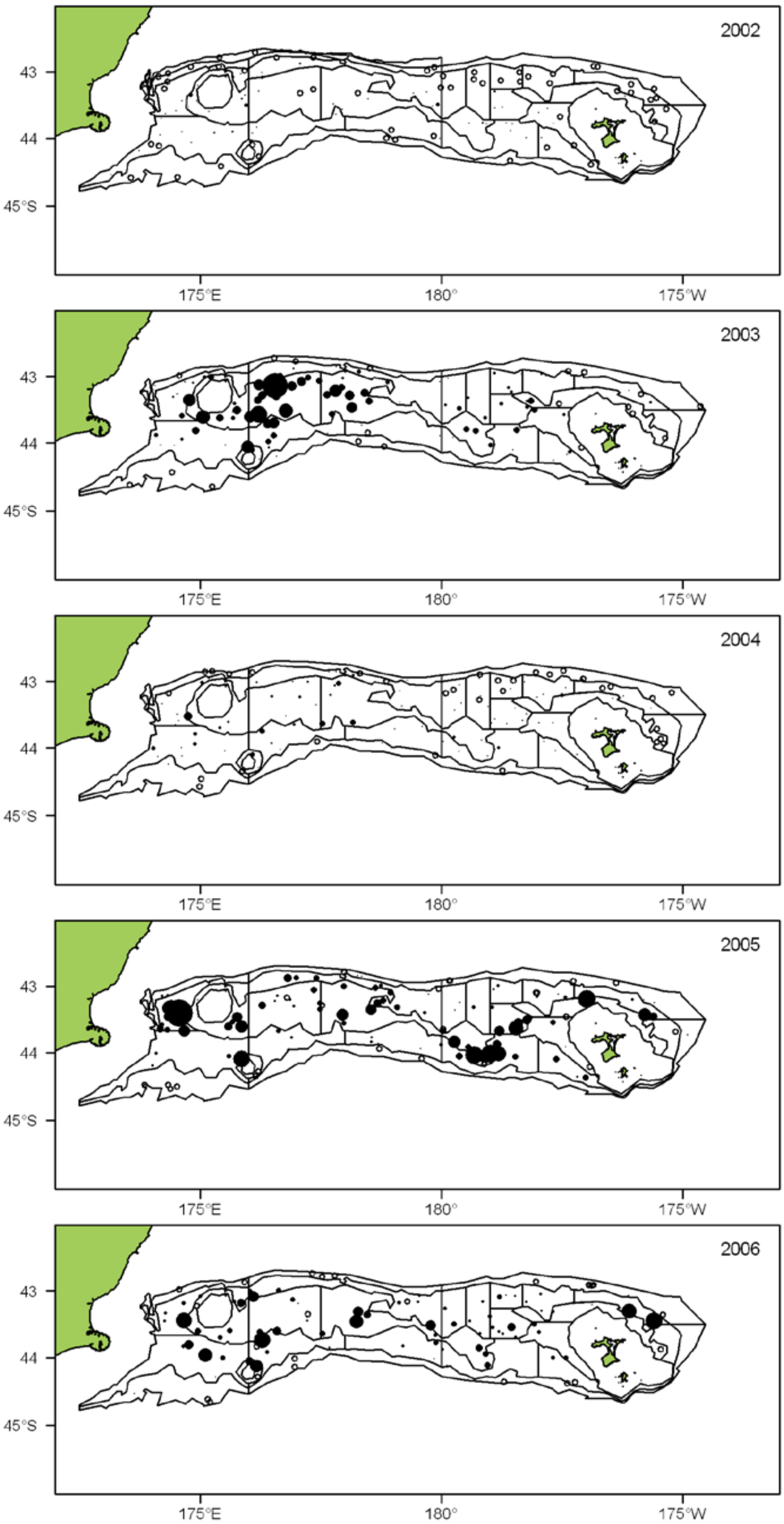

Figure 6b (continued)

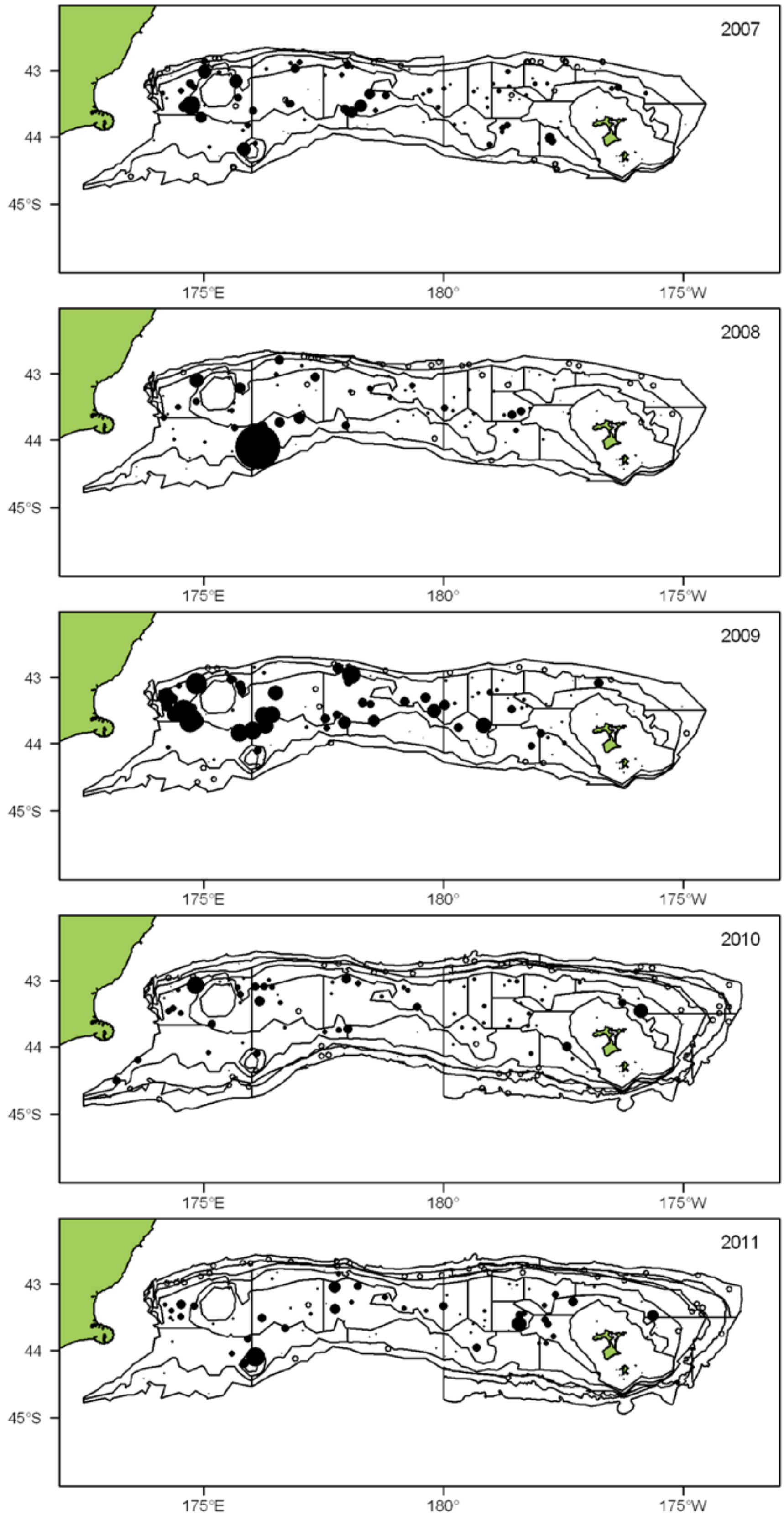

Figure 6b (continued)

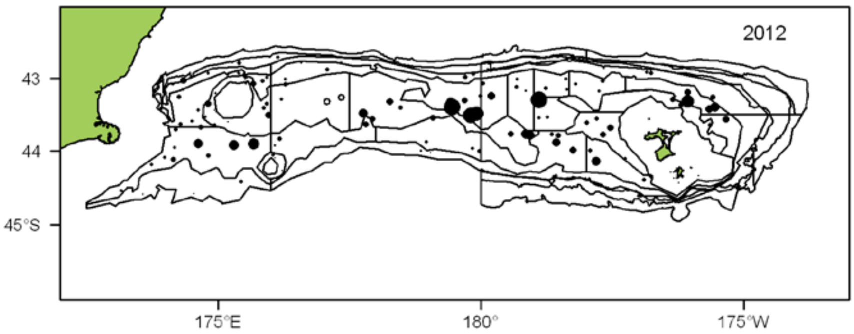

Figure 6b (continued)

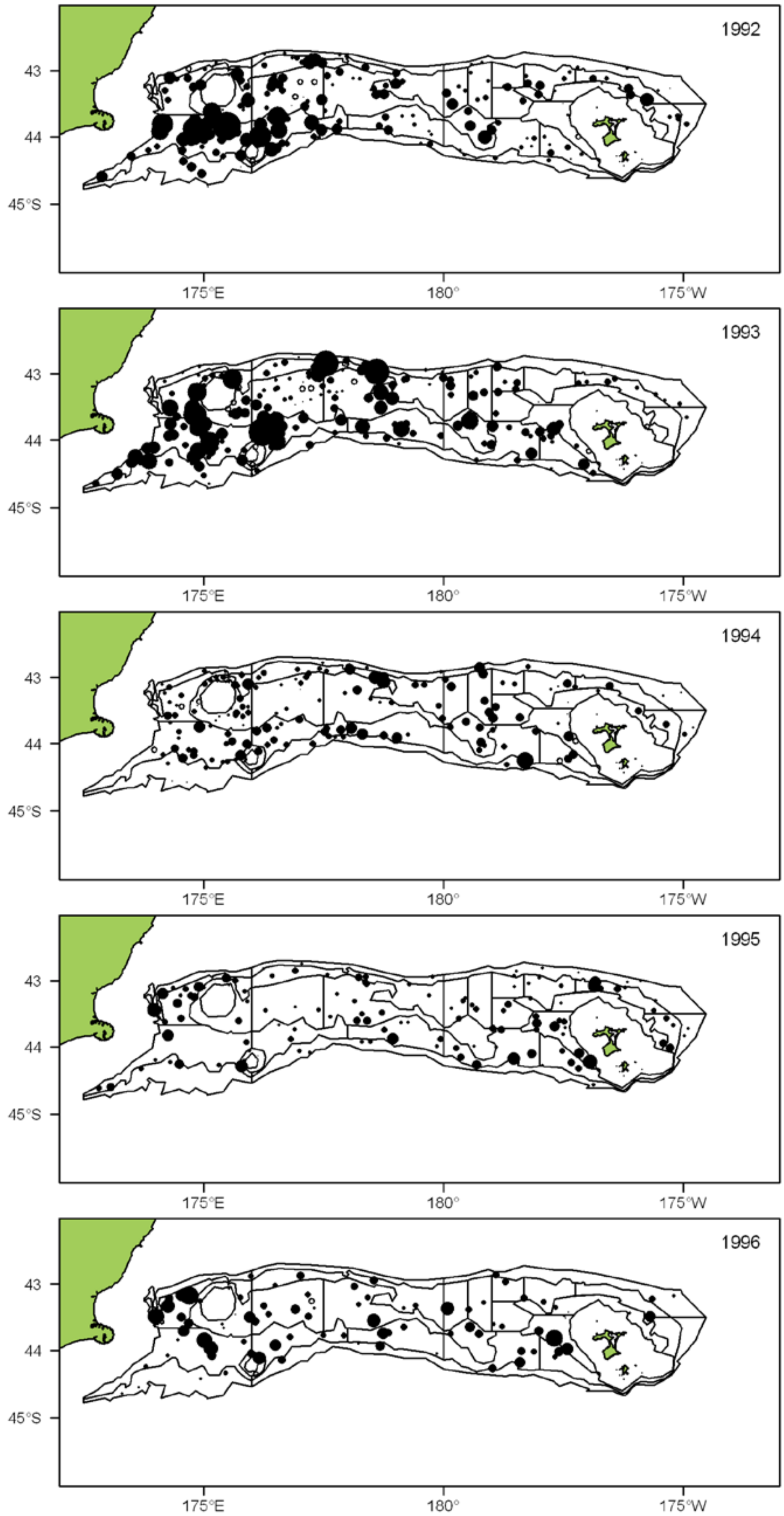

Figure 6c: Hoki 3++ catch distribution. 1992–2012. Filled circle area is proportional to catch rate (kg km^{-2}). Open circles are zero catch. Maximum catch rate in series is 11 177 kg km^{-2}.

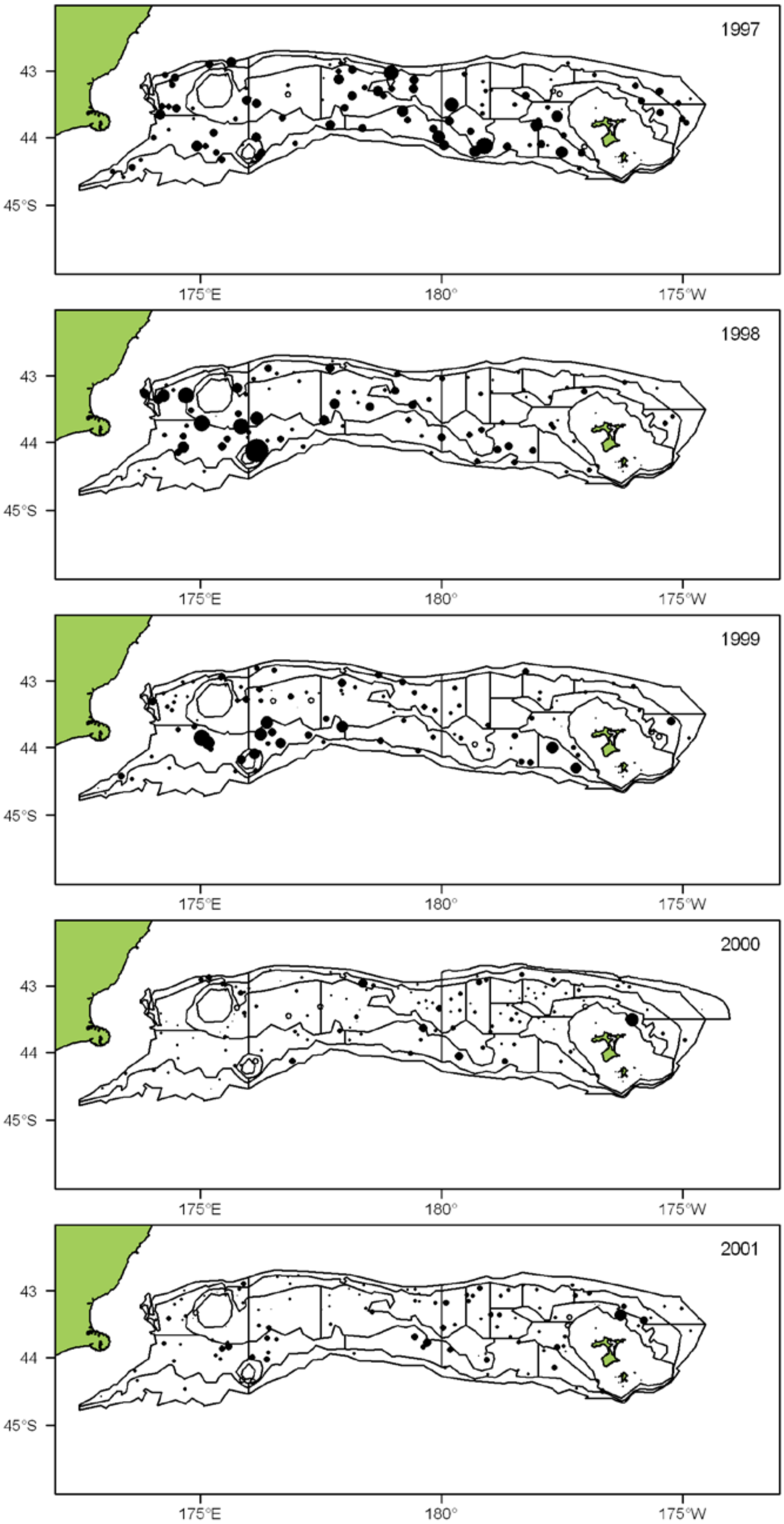

Figure 6c (continued)

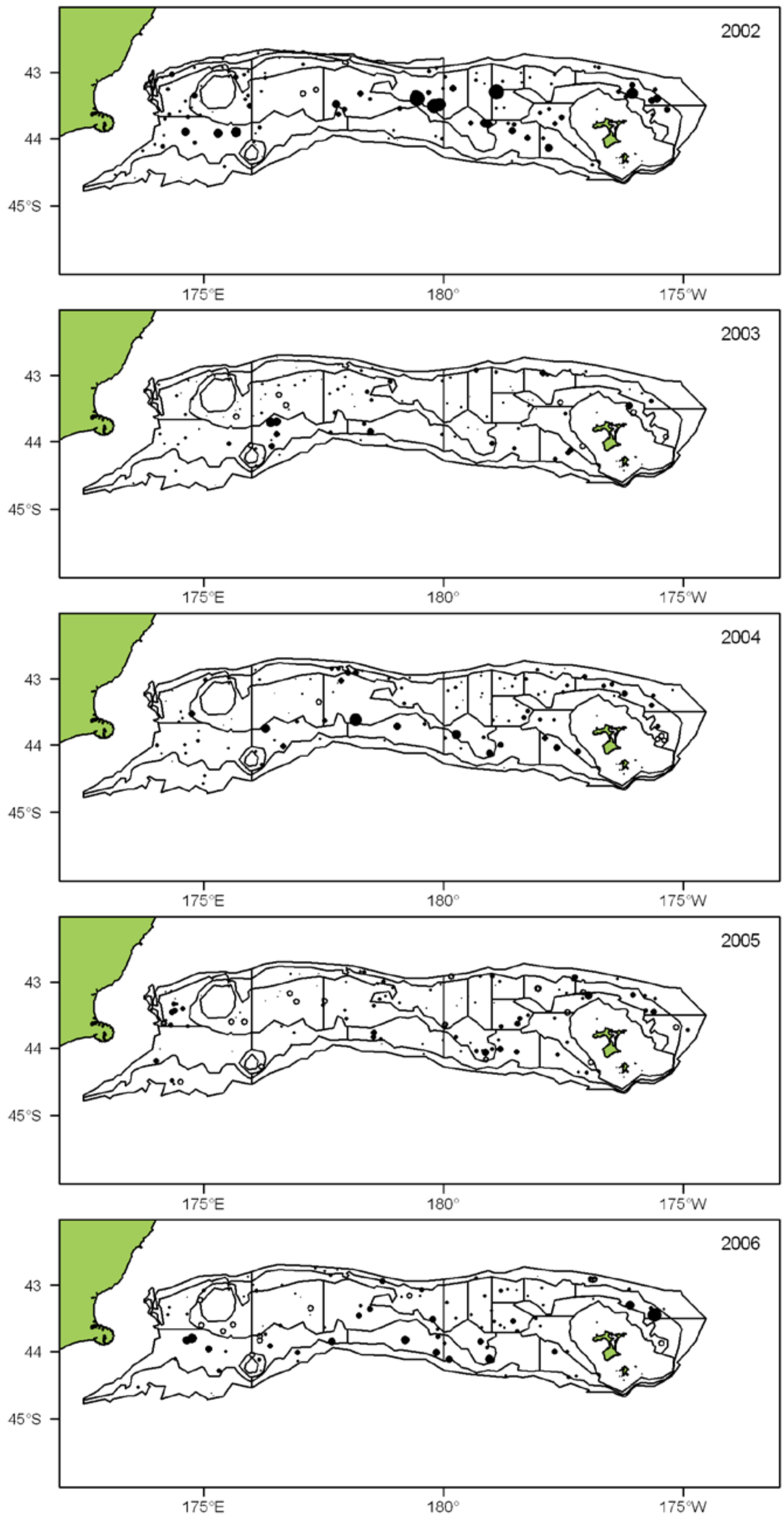

Figure 6c (continued)

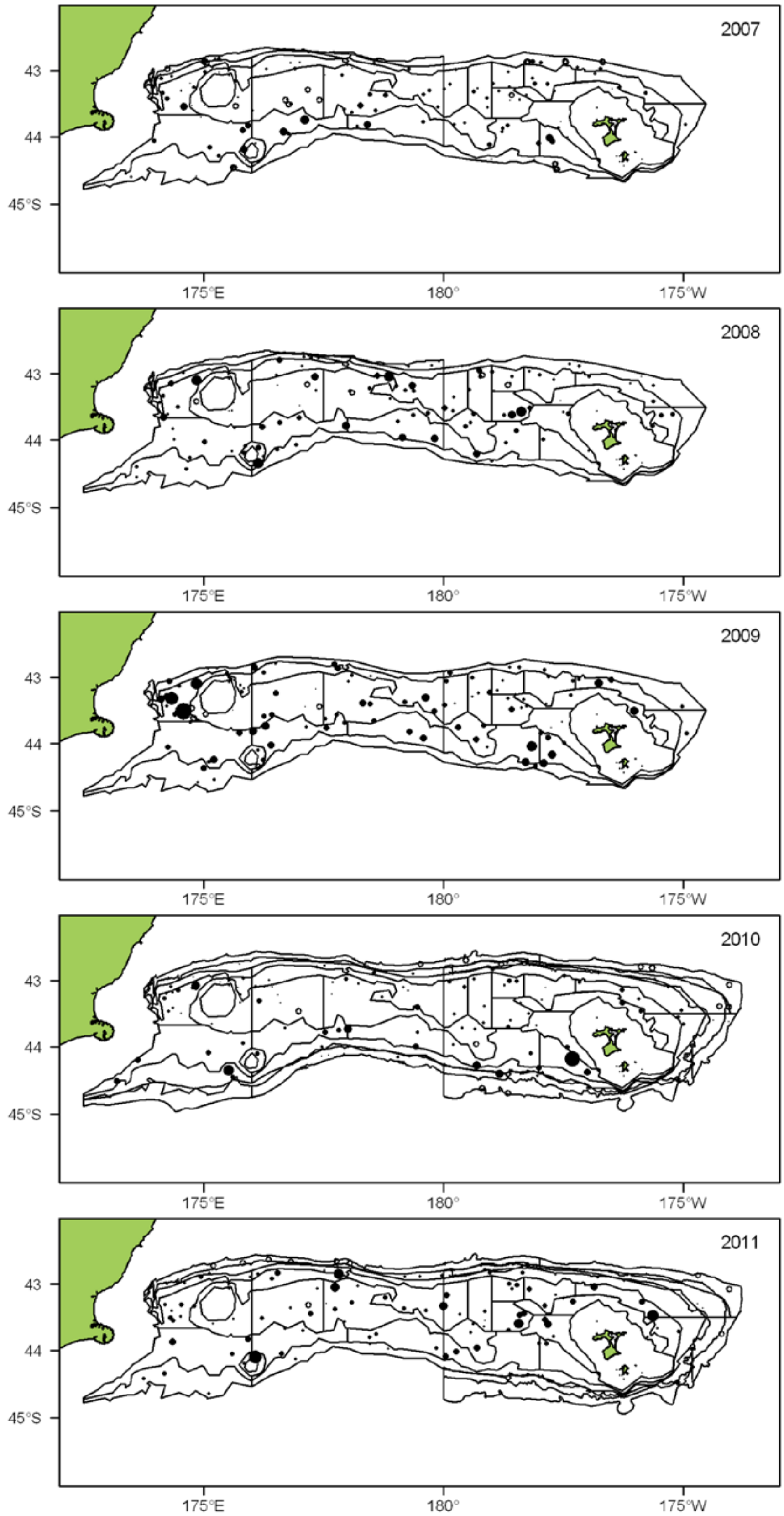

Figure 6c (continued)

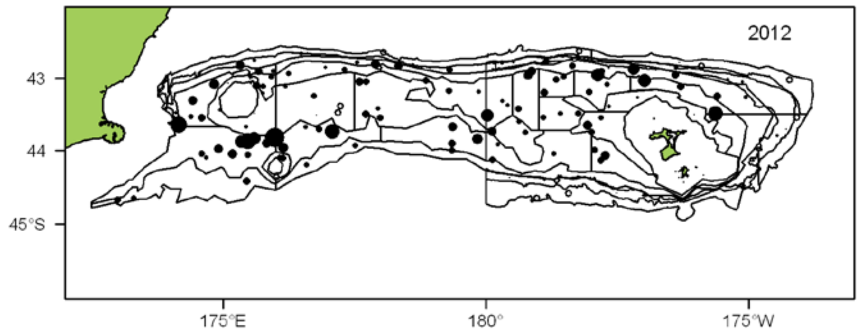

Figure 6c (continued)

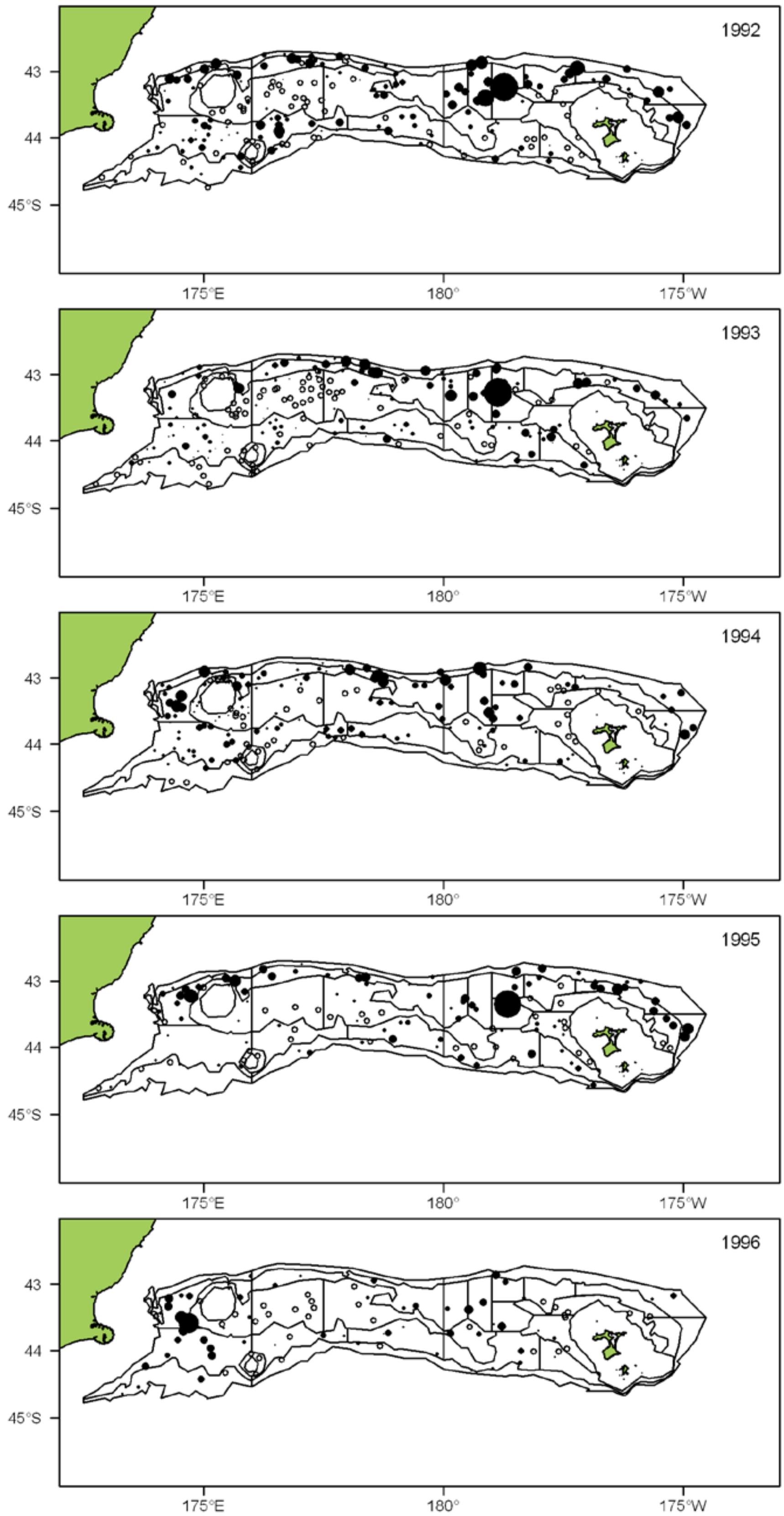

Figure 7: Hake catch distribution 1992–2012. Filled circle area is proportional to catch rate (kg km^{-2}). Open circles are zero catch. Maximum catch rate in series is 620 kg km^{-2}.

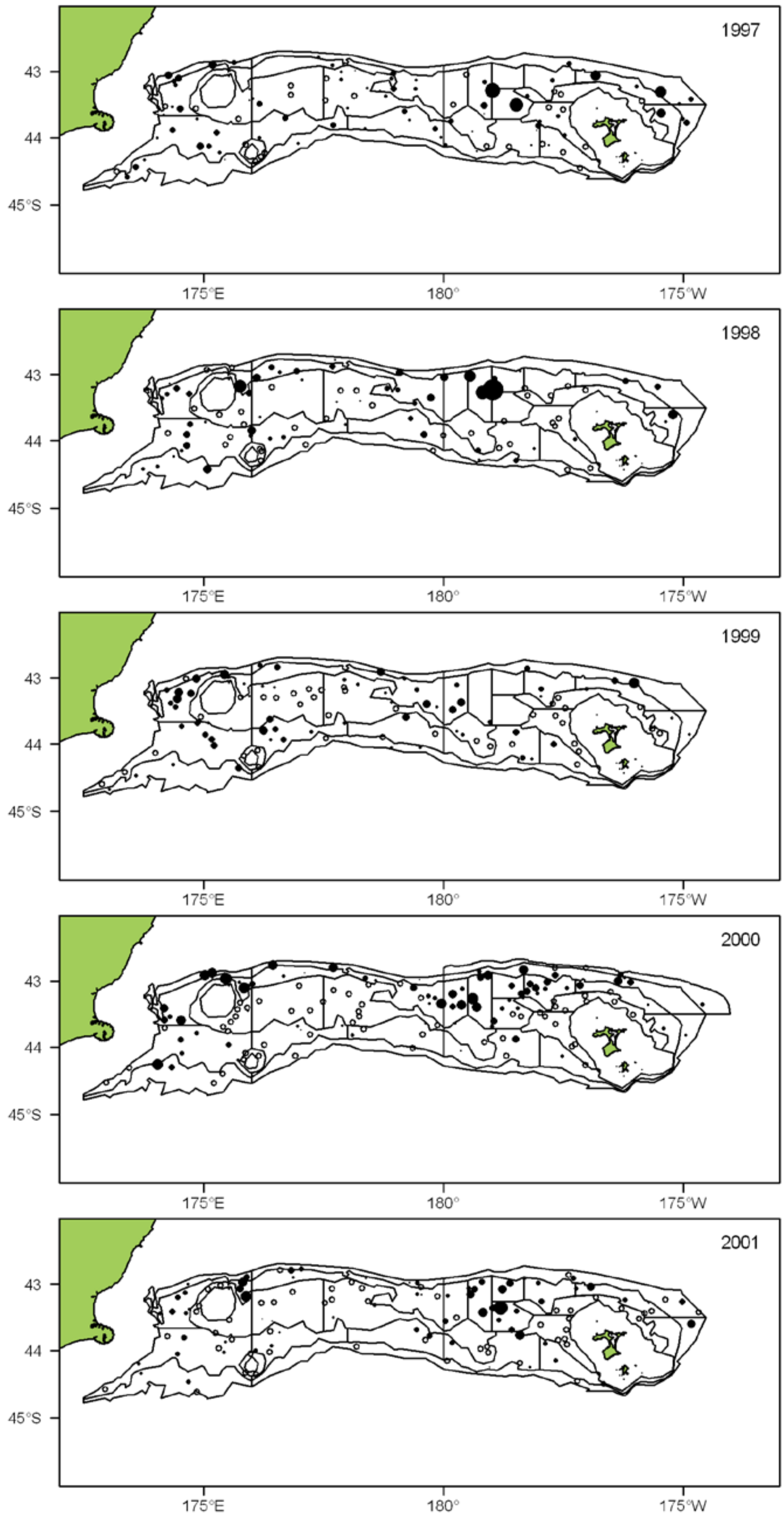

Figure 7 (continued)

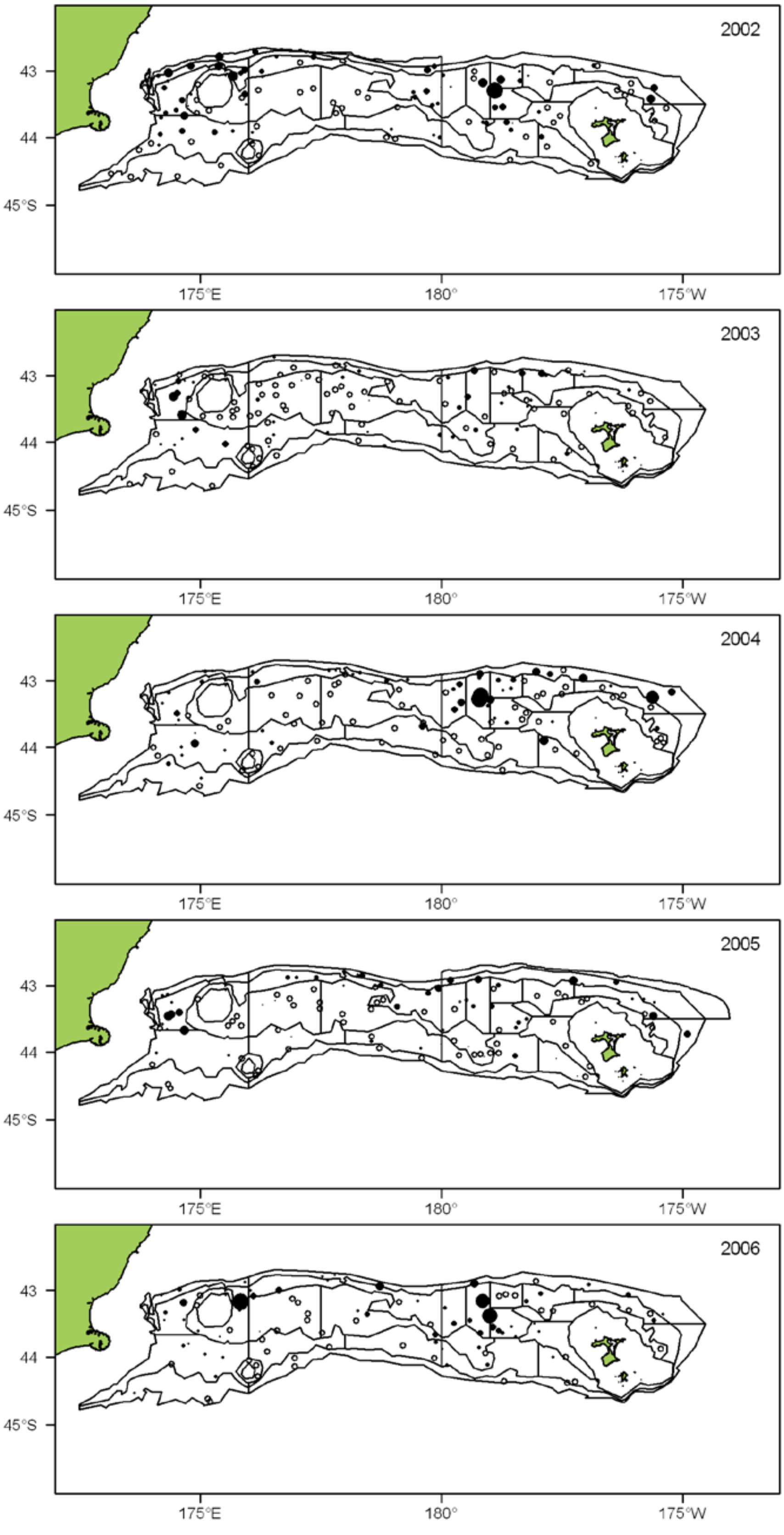

Figure 7 (continued)

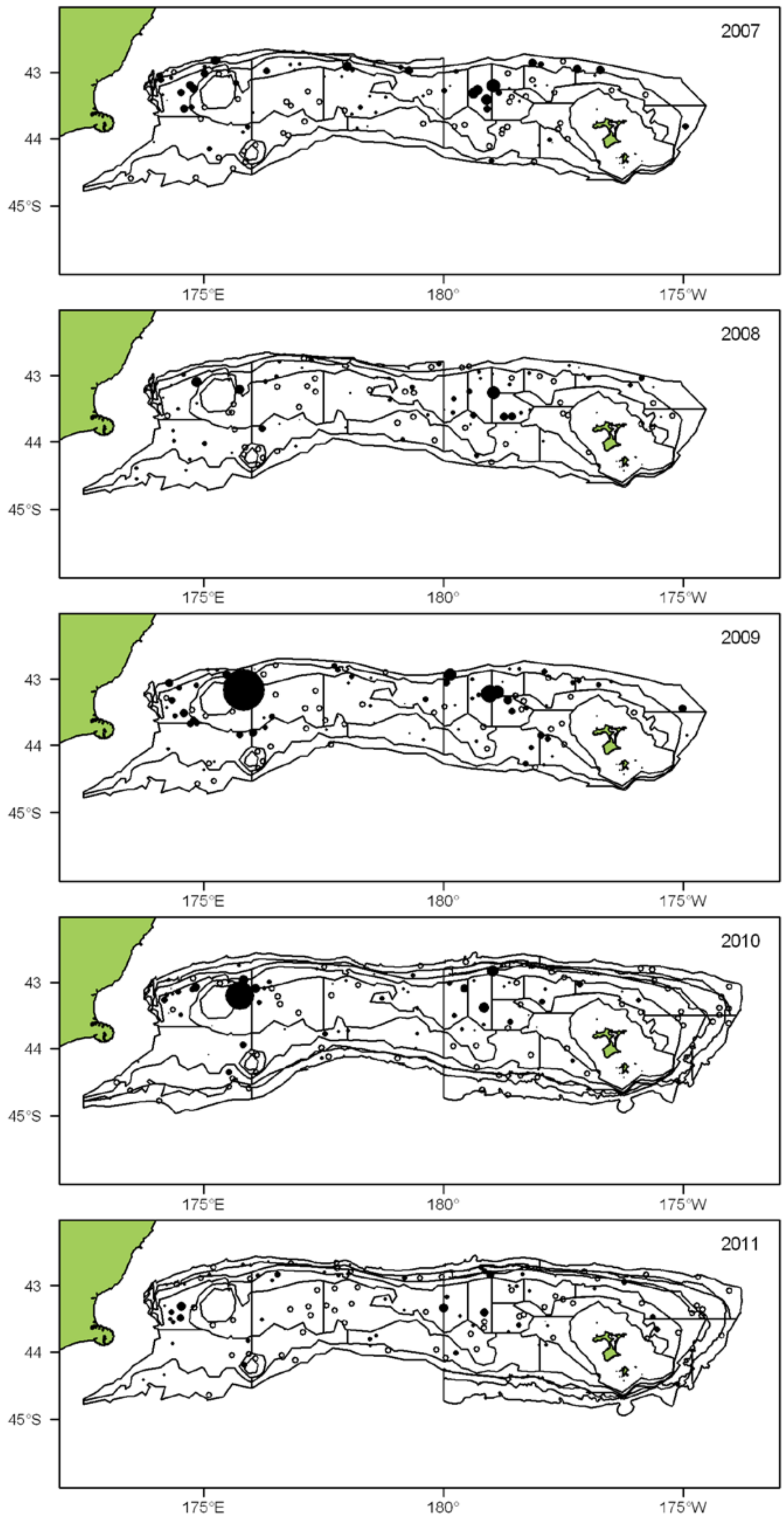

Figure 7 (continued)

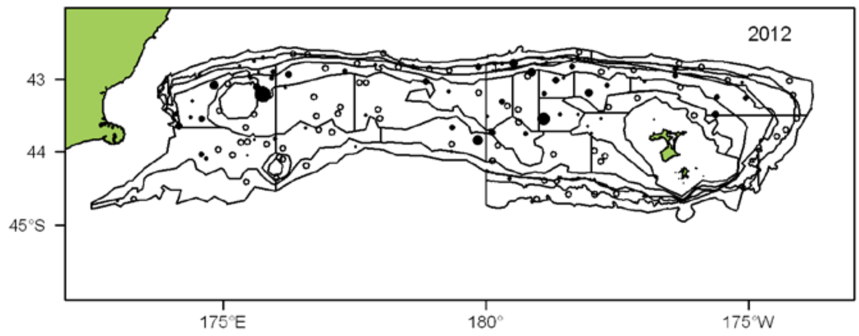

Figure 7 (continued)

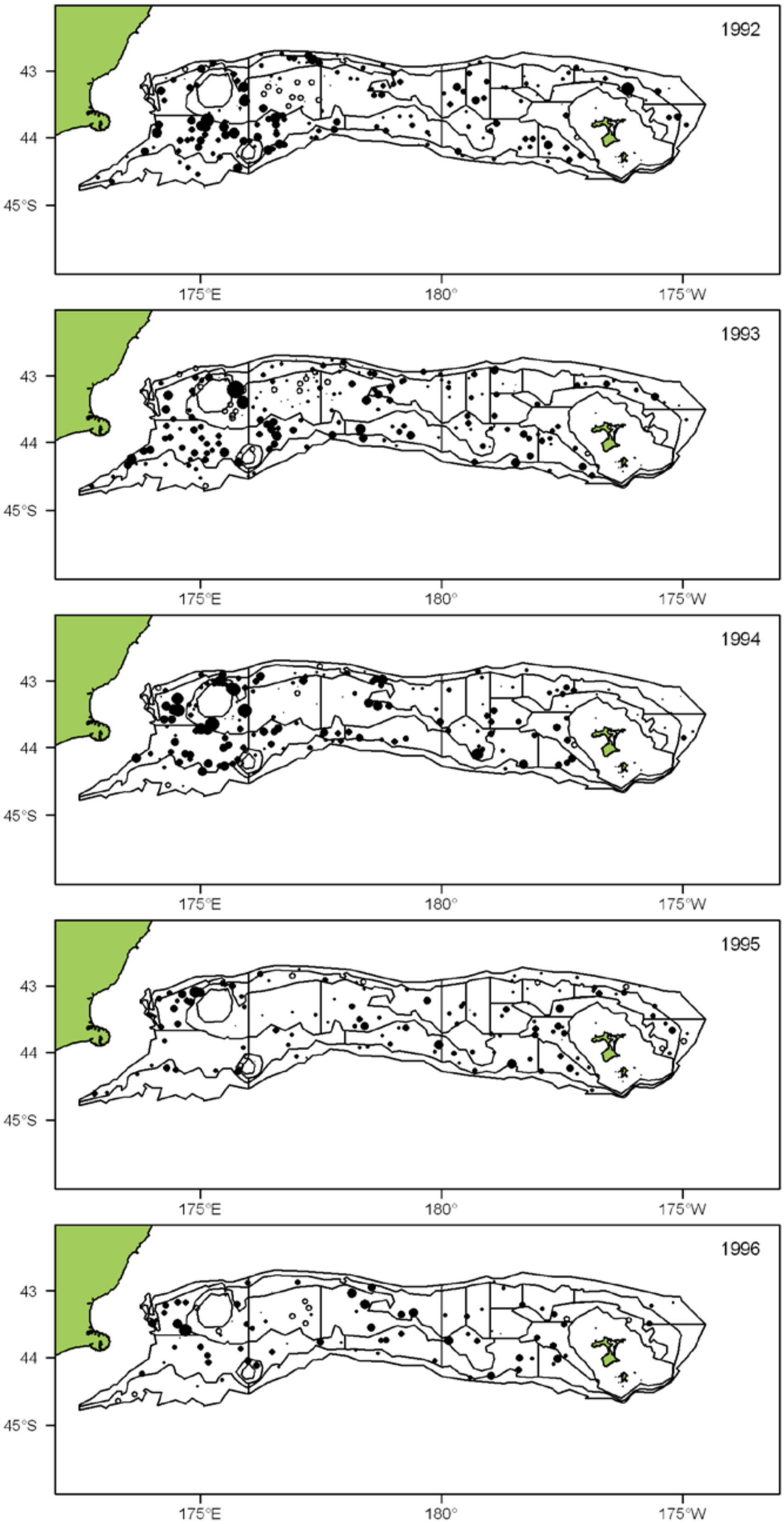

Figure 8: Ling catch distribution 1992–2012. Filled circle area is proportional to catch rate (kg km^{-2}). Open circles are zero catch. Maximum catch rate in series is 1786 kg km^{-2}.

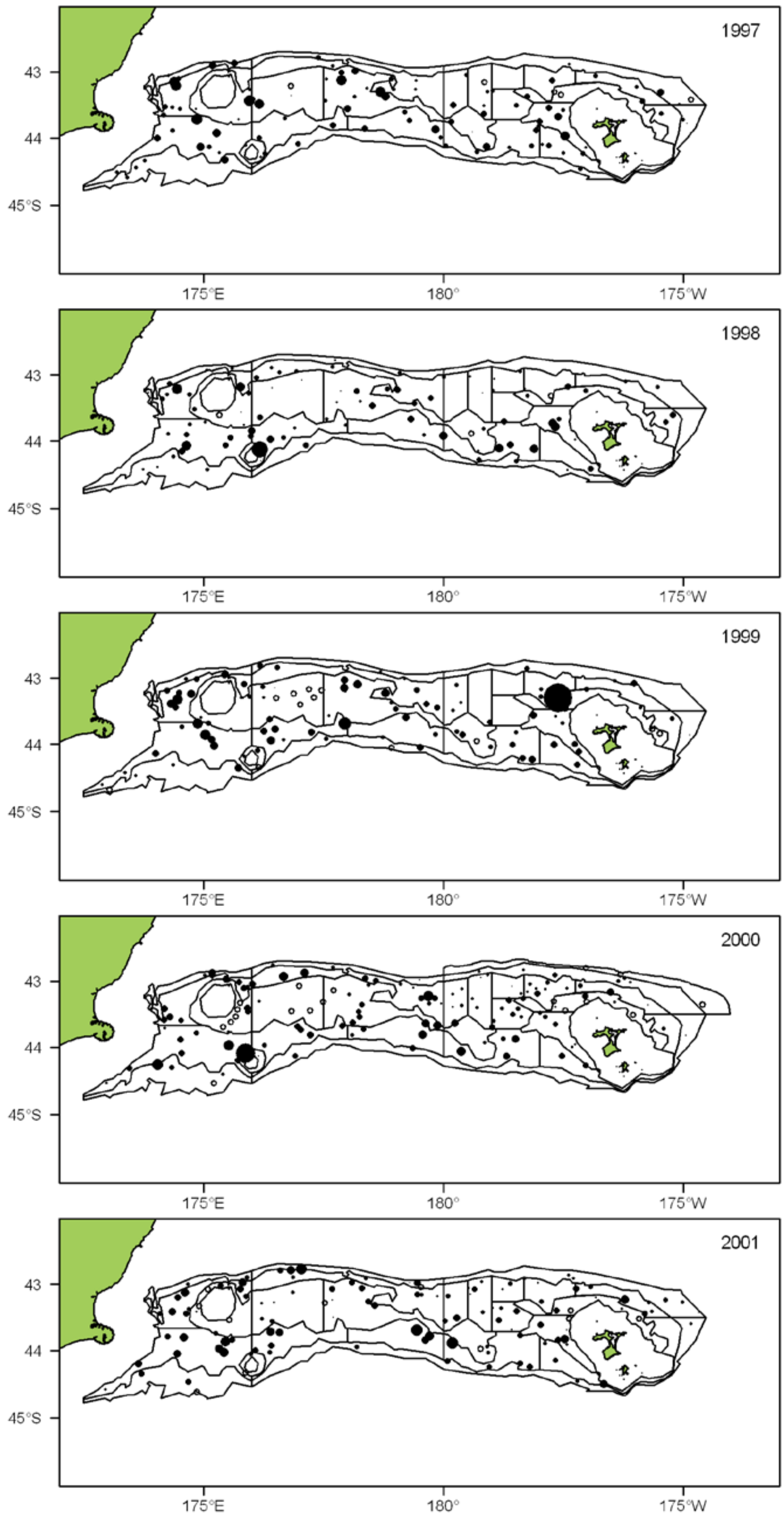

Figure 8 (continued)

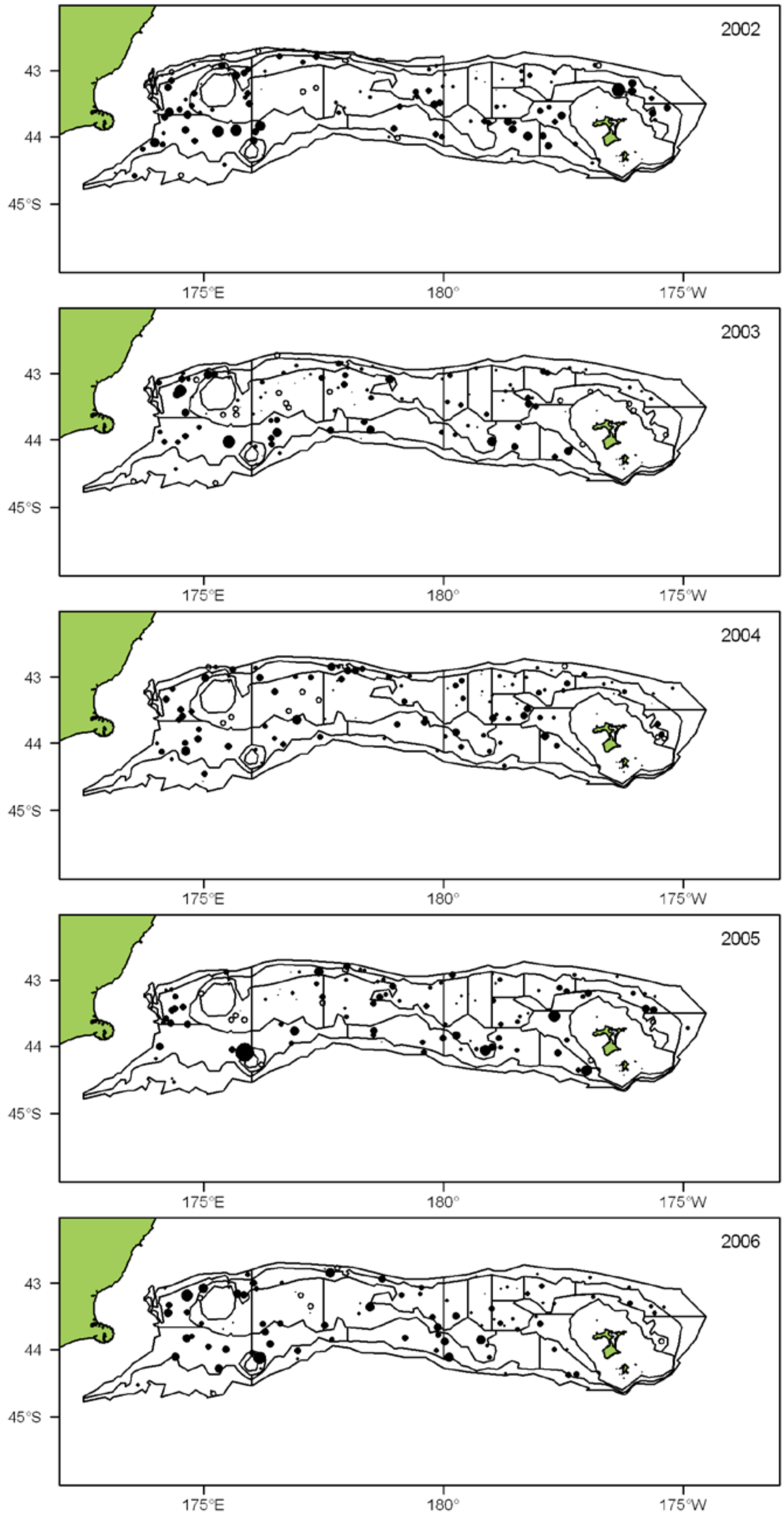

Figure 8 (continued)

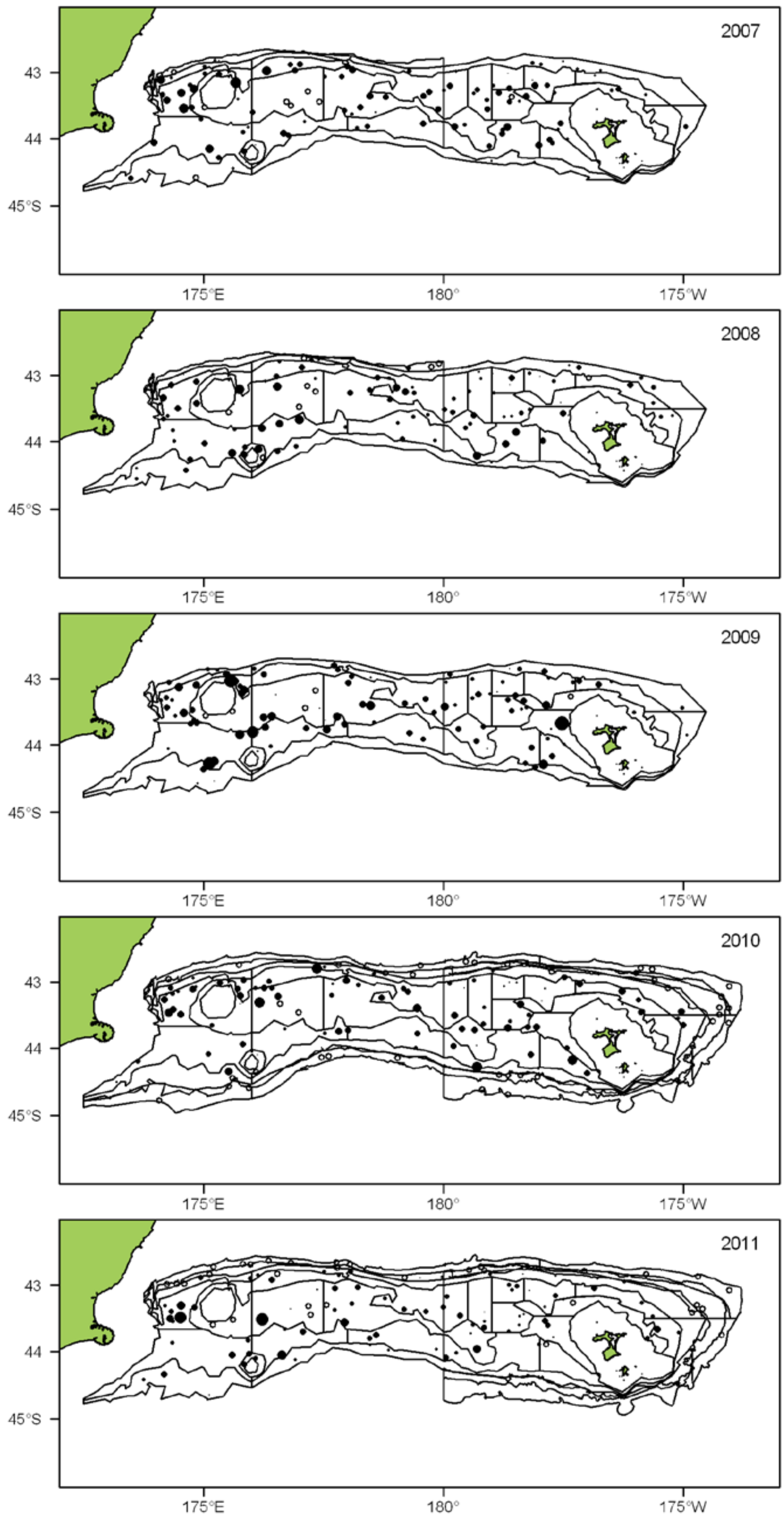

Figure 8 (continued)

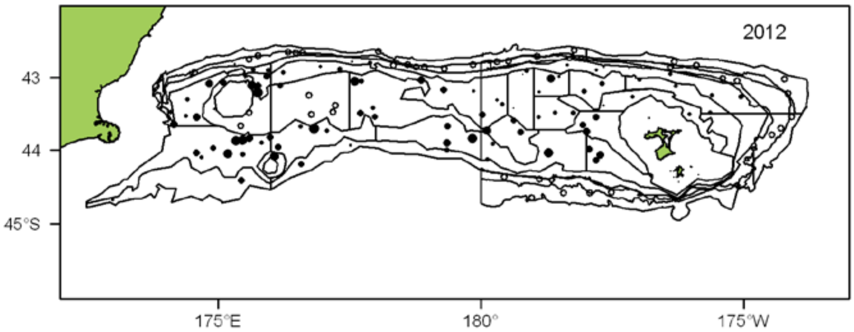

Figure 8 (continued)

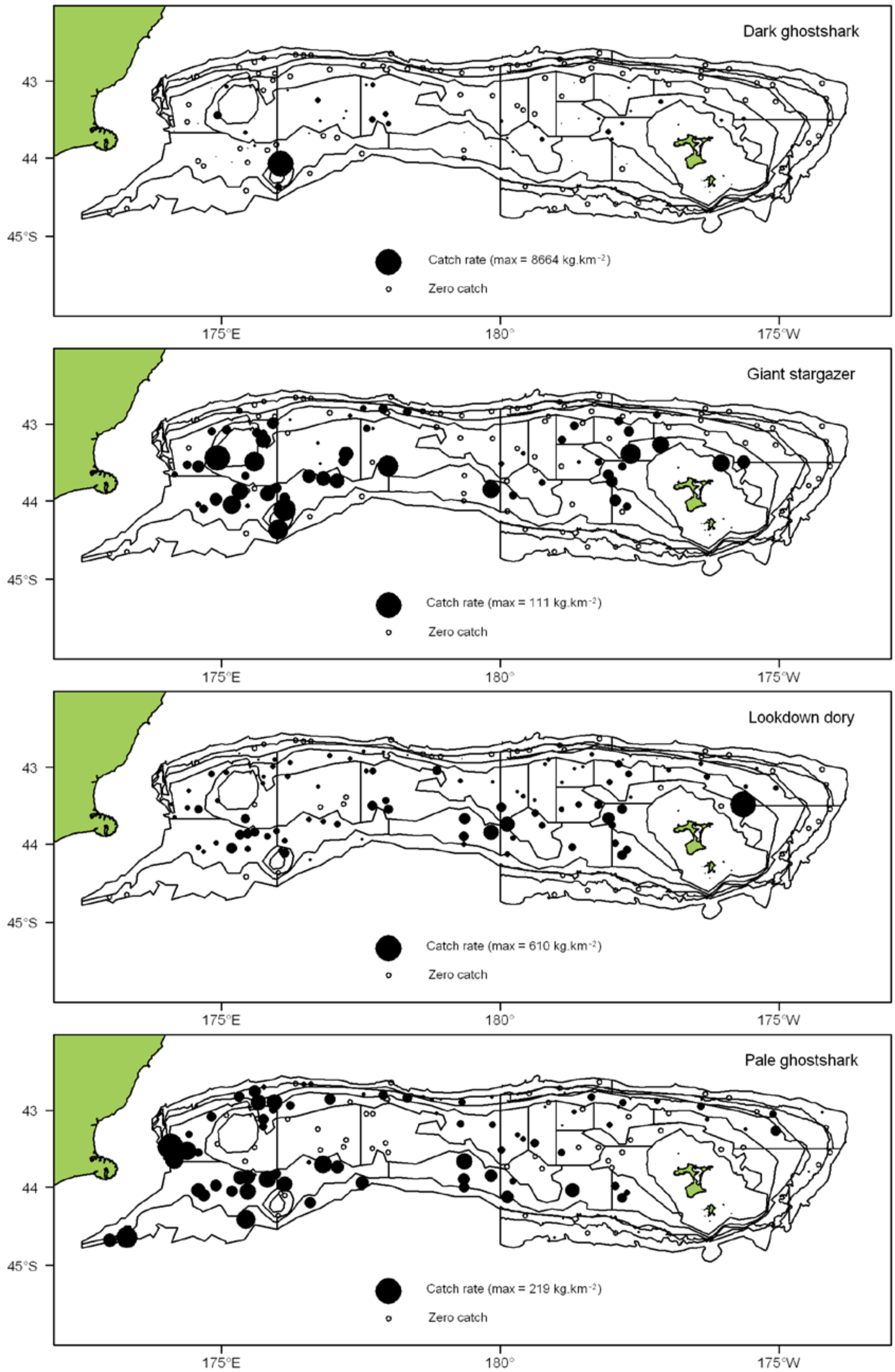

Figure 9: Catch rates (kg km^{-2}) of selected commercial species in 2012. Filled circle area is proportional to catch rate. Open circles are zero catch. (max., maximum catch rate).

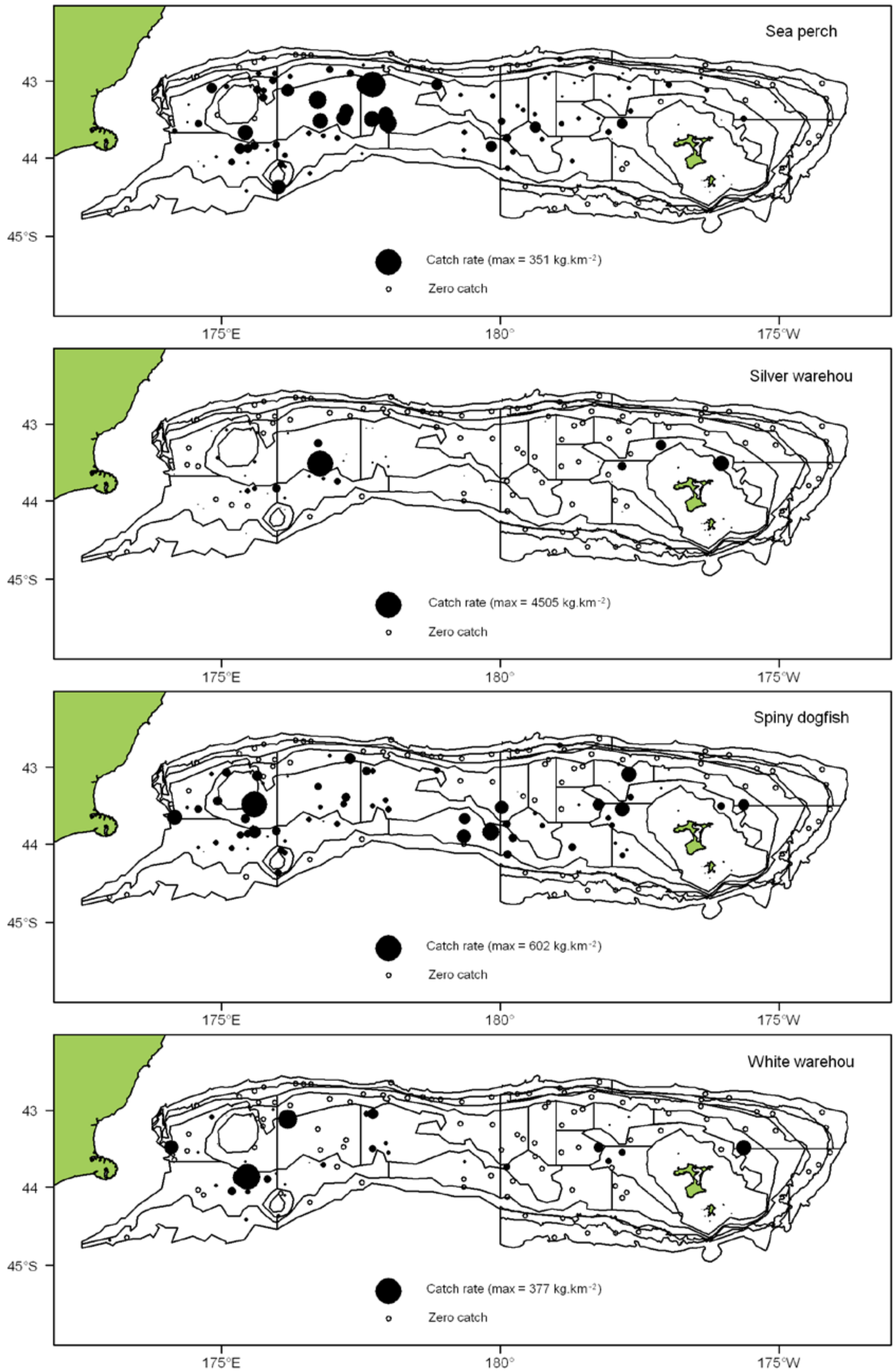

Figure 9 (continued)

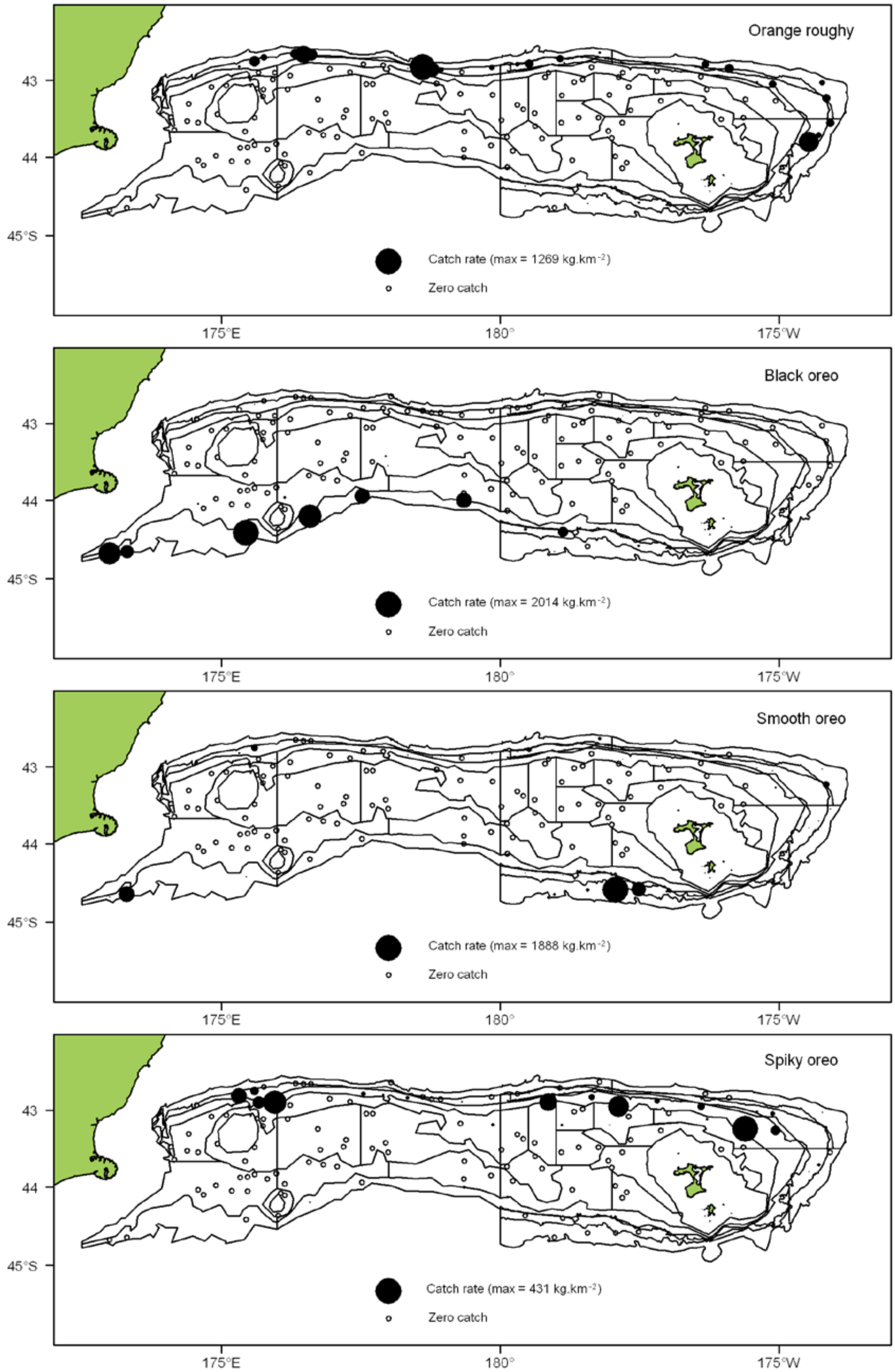

Figure 9 (continued)

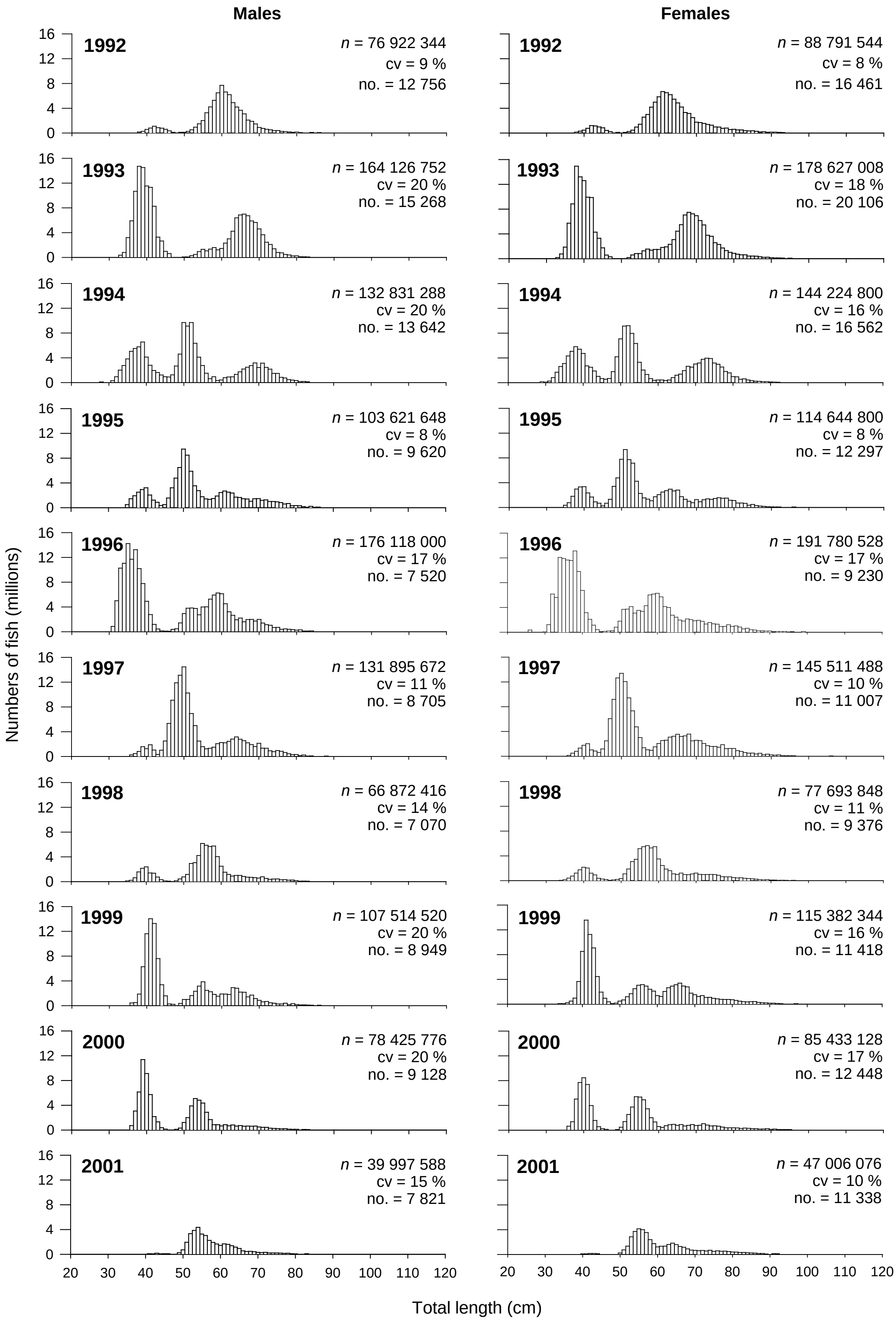

Figure 10: Estimated length frequency distributions of the male and female hoki population from *Tangaroa* surveys of the Chatham Rise, January 1992–2012. (c.v., coefficient of variation; *n*, estimated population number of male hoki (left panel) and female hoki (right panel); no., numbers of fish measured.).

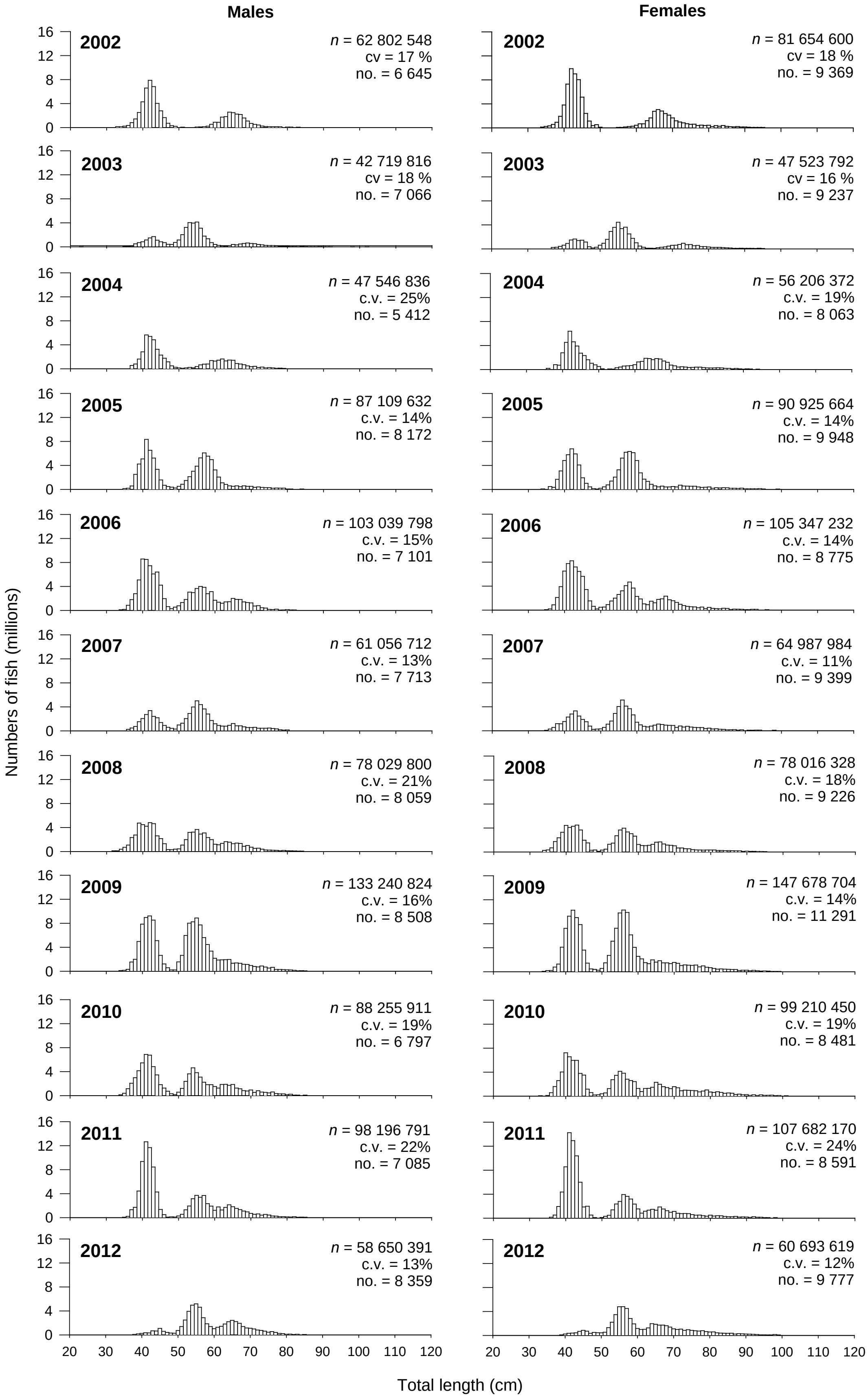

Figure 10 (continued)

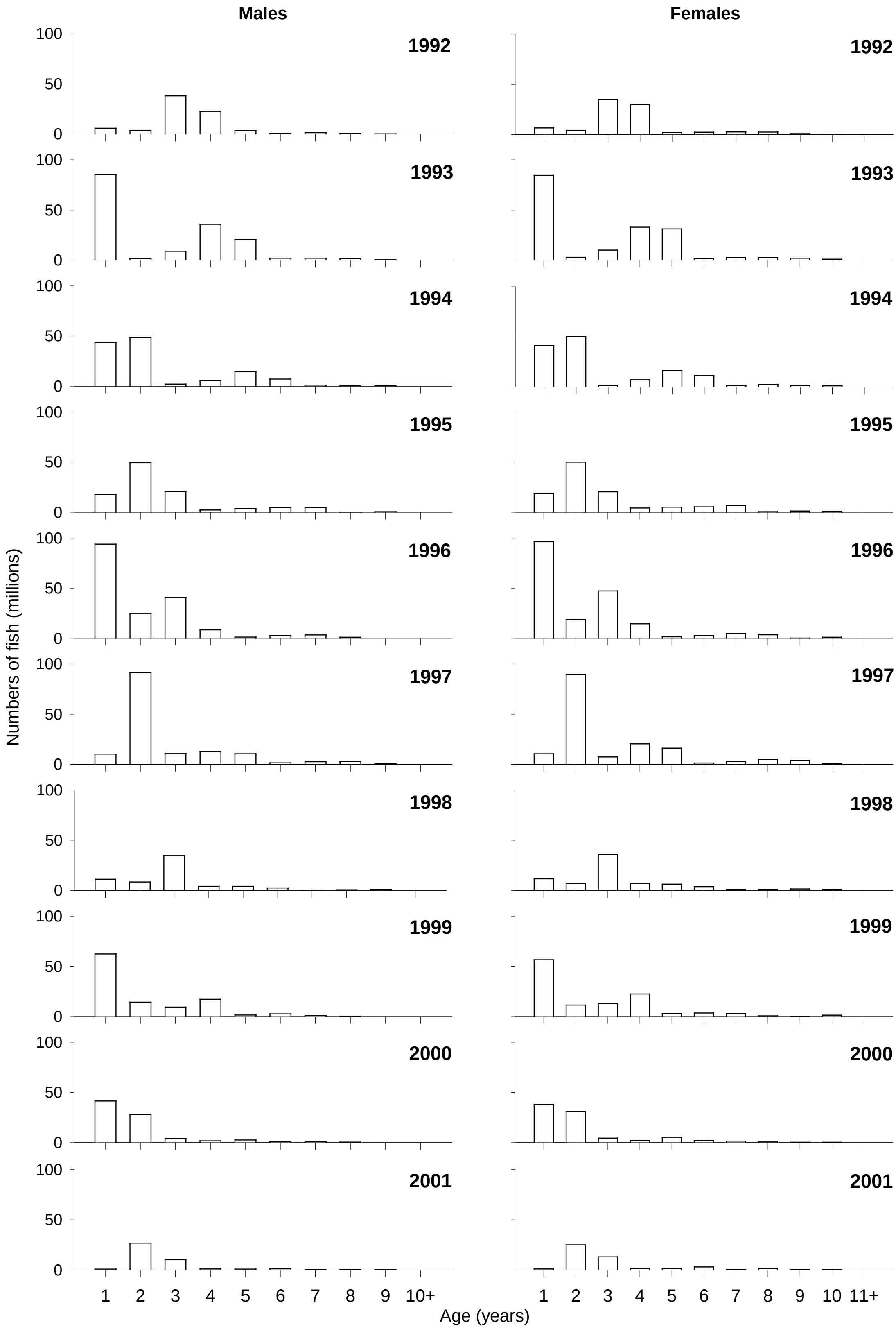

Figure 11: Estimated population numbers at age of hoki from *Tangaroa* surveys of the Chatham Rise, January, 1992–2012. (+, indicates plus group of combined ages.).

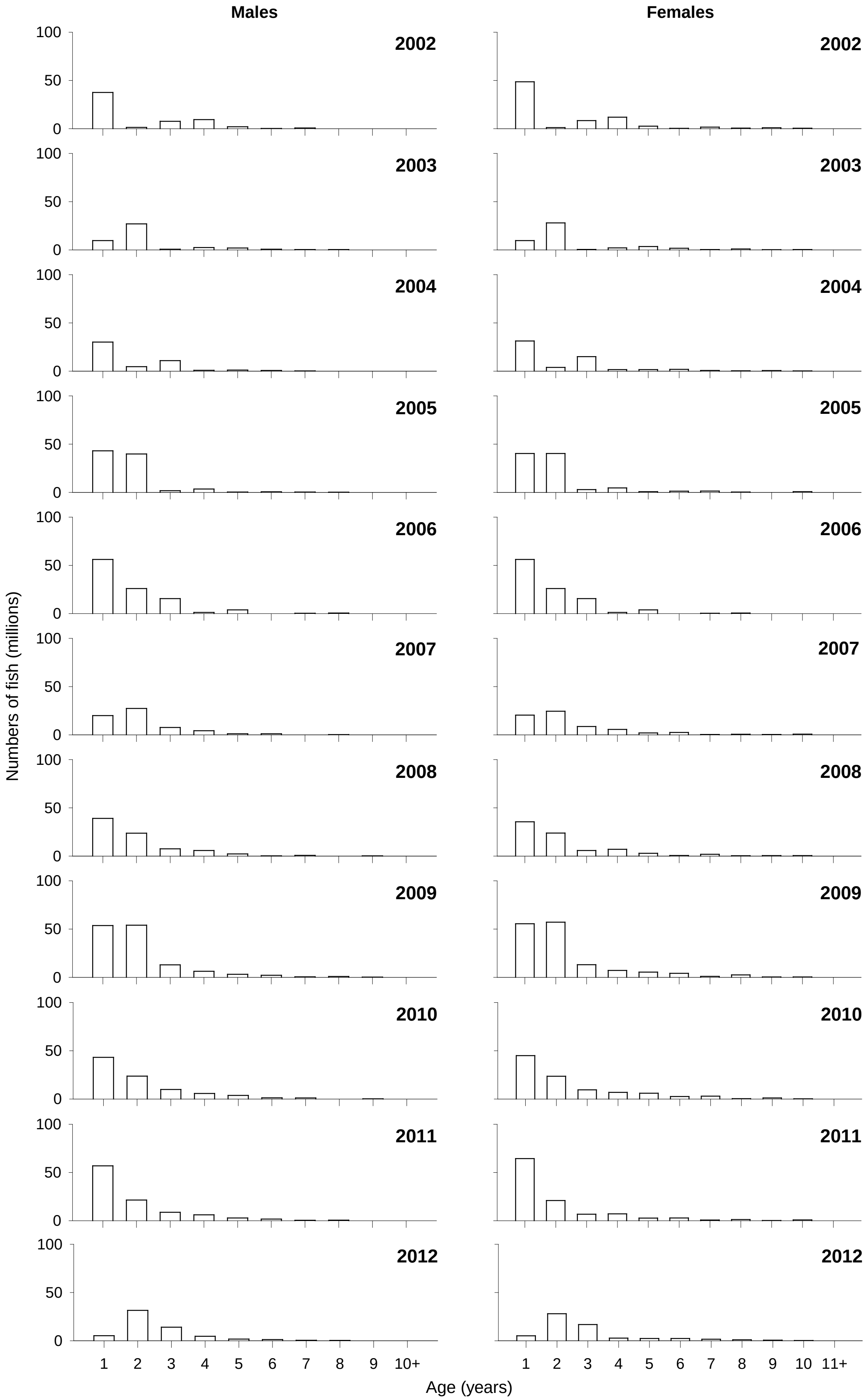

Figure 11 (continued)

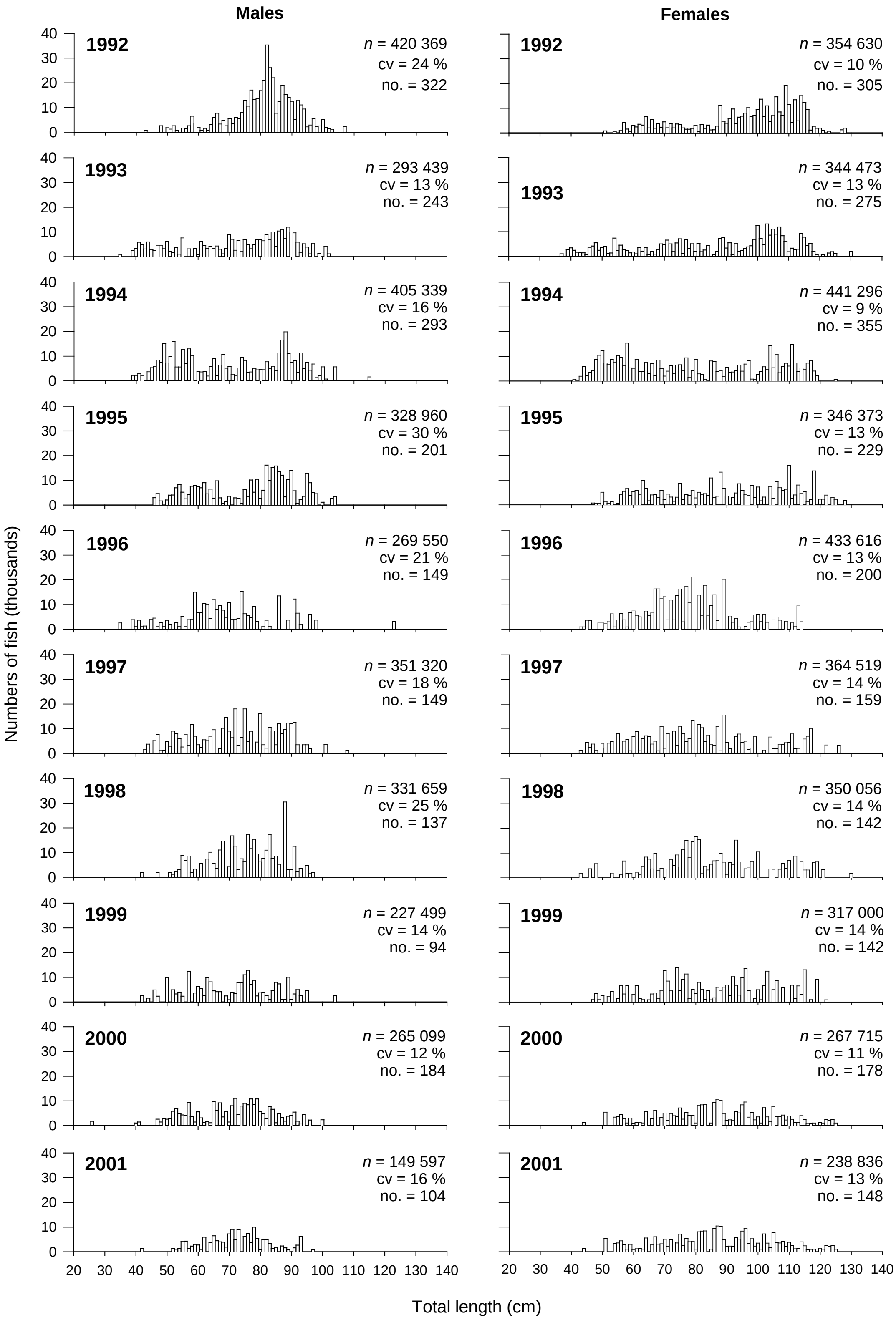

Figure 12: Estimated length frequency distributions of the male and female hake population from *Tangaroa* surveys of the Chatham Rise, January 1992–2012. (c.v., coefficient of variation; *n*, estimated population number of hake; no., numbers of fish measured.).

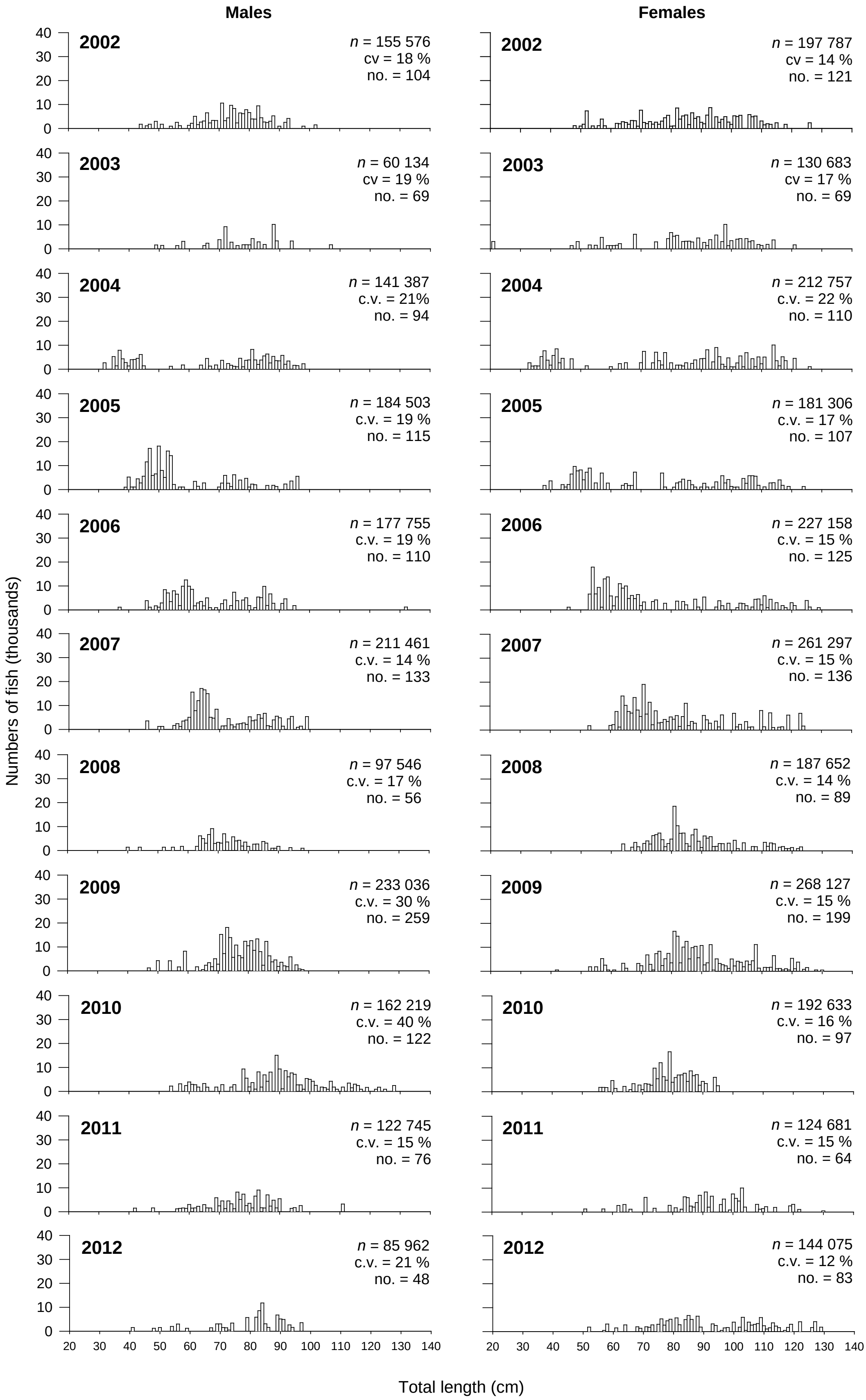

Figure 12 (continued)

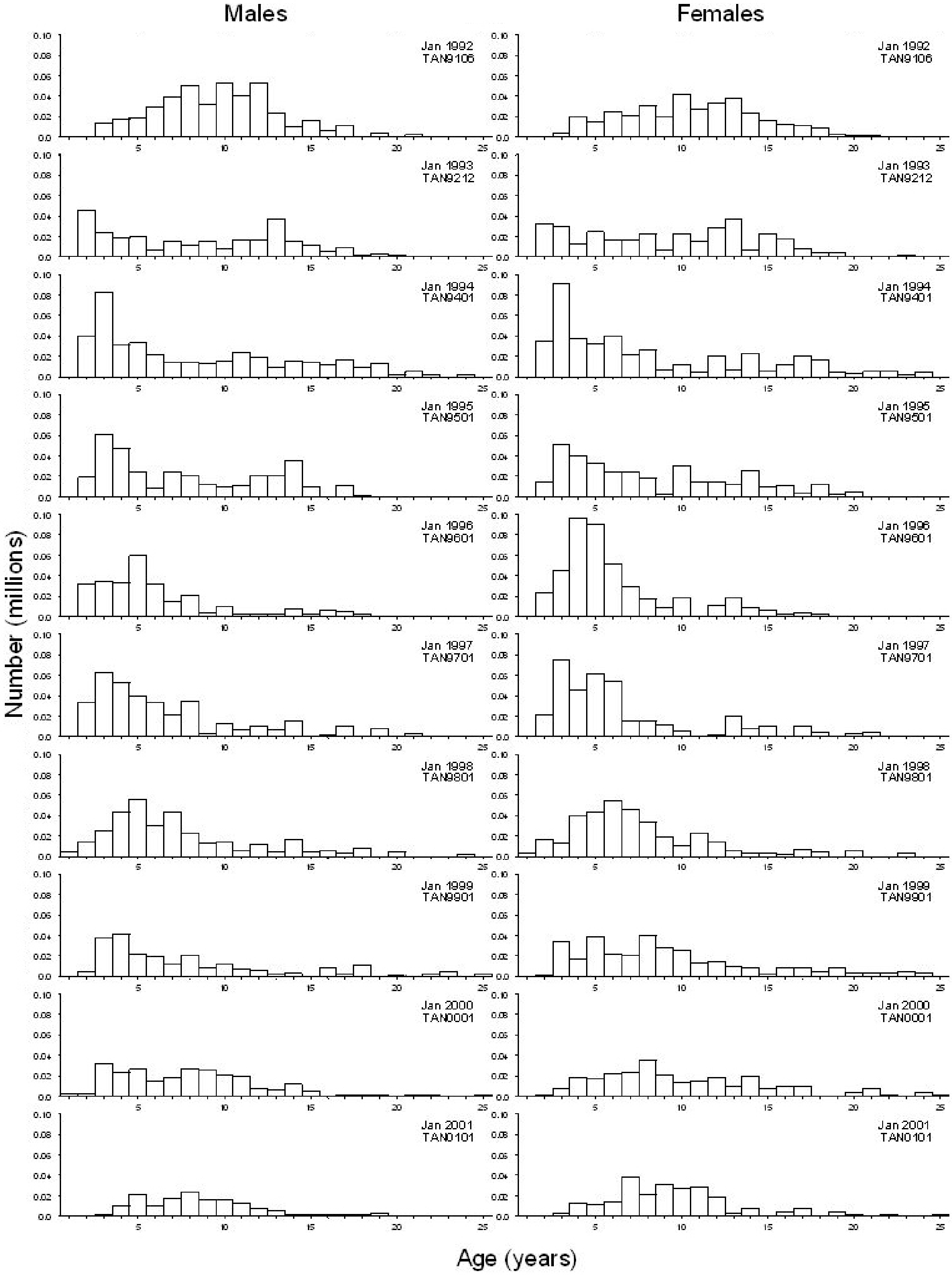

Figure 13: Estimated proportion at age of male and female hake from *Tangaroa* surveys of the Chatham Rise, January, 1992–2012.

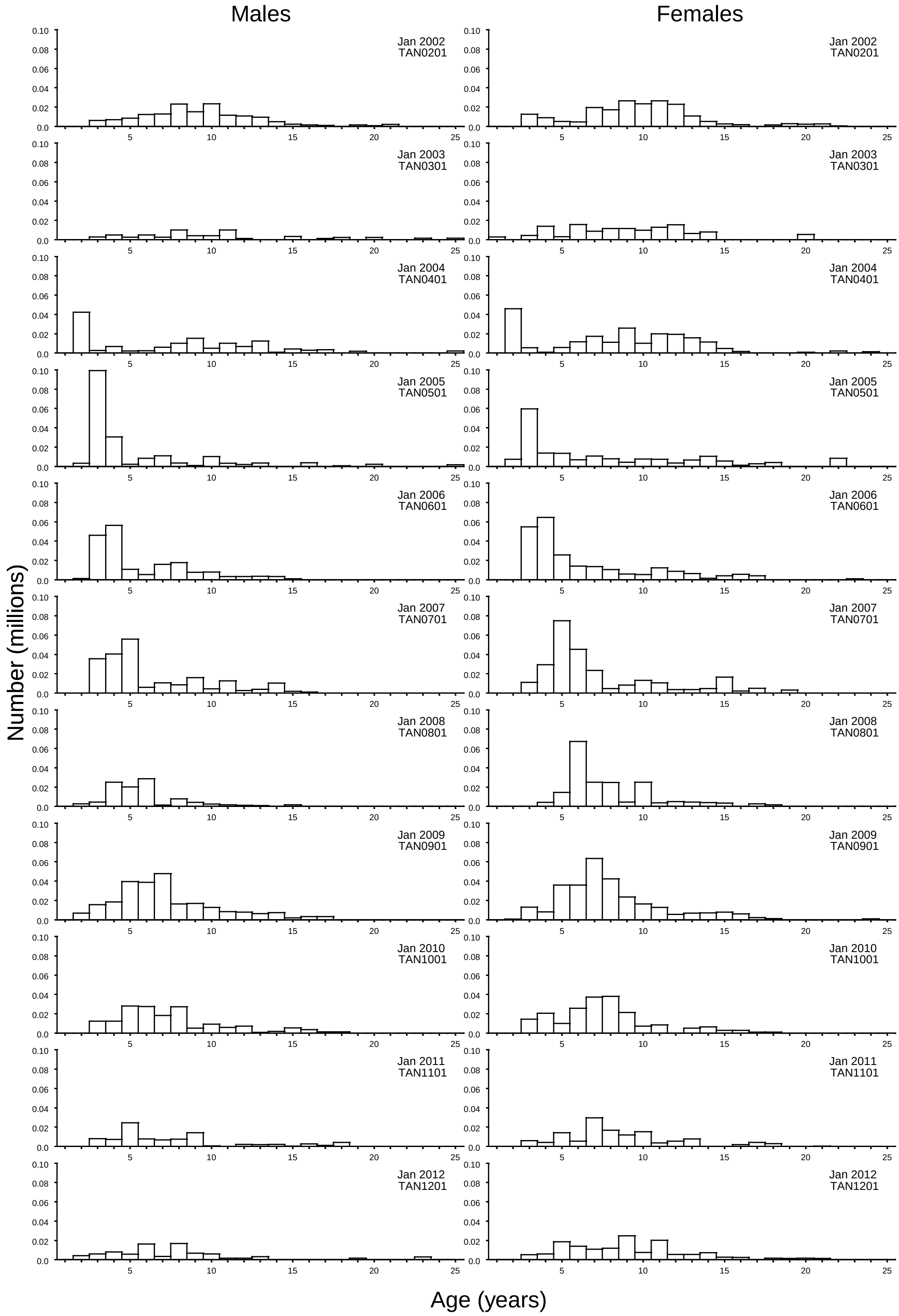

Figure 13 (continued)

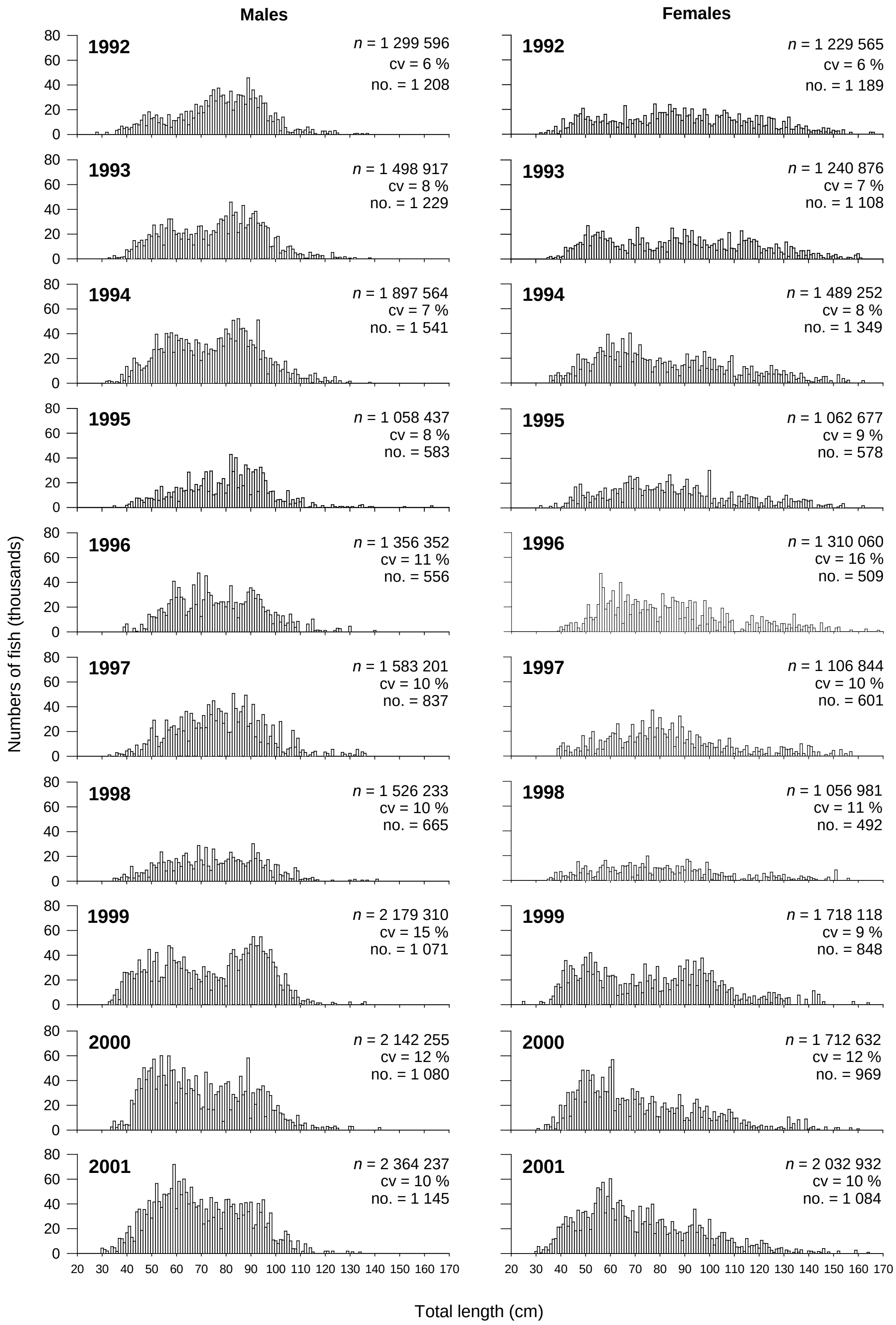

Figure 14: Estimated length frequency distributions of the ling population from *Tangaroa* surveys of the Chatham Rise, January 1992–2012. (c.v., coefficient of variation; *n*, estimated population number of ling; no., numbers of fish measured.).

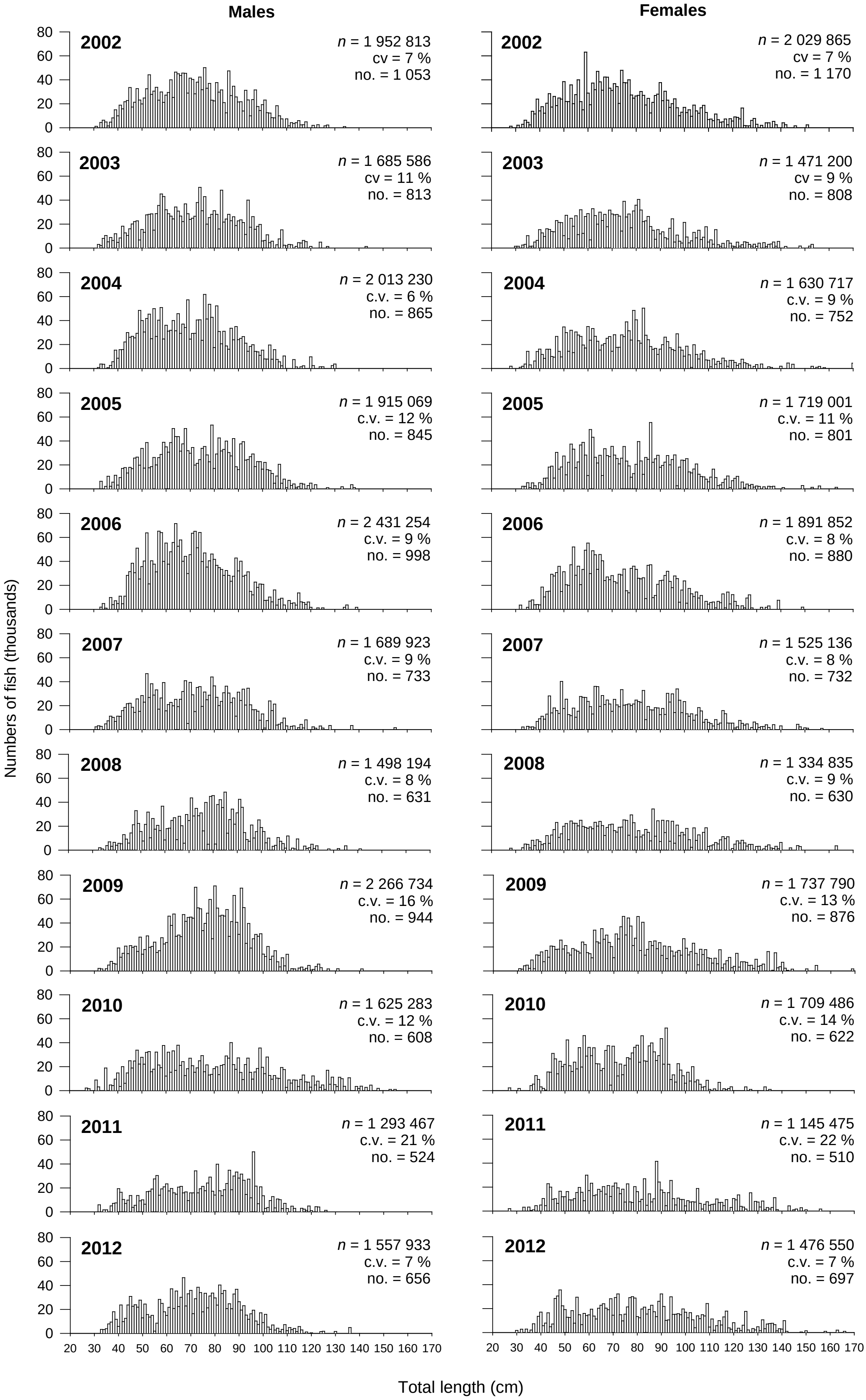

Figure 14 (continued)

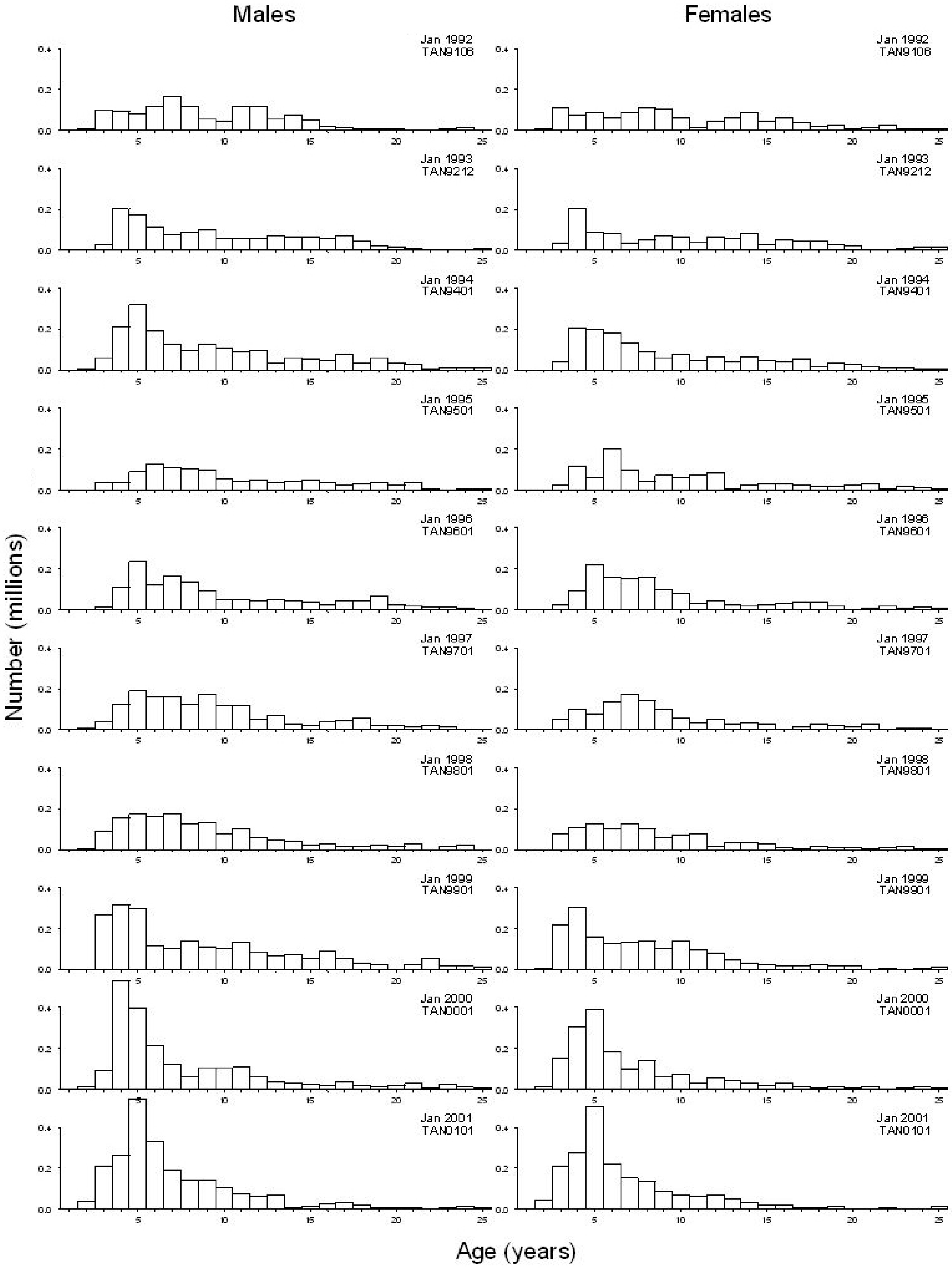

Figure 15: Estimated population numbers at age of male and female ling from *Tangaroa* surveys of the Chatham Rise, January, 1992–2012.

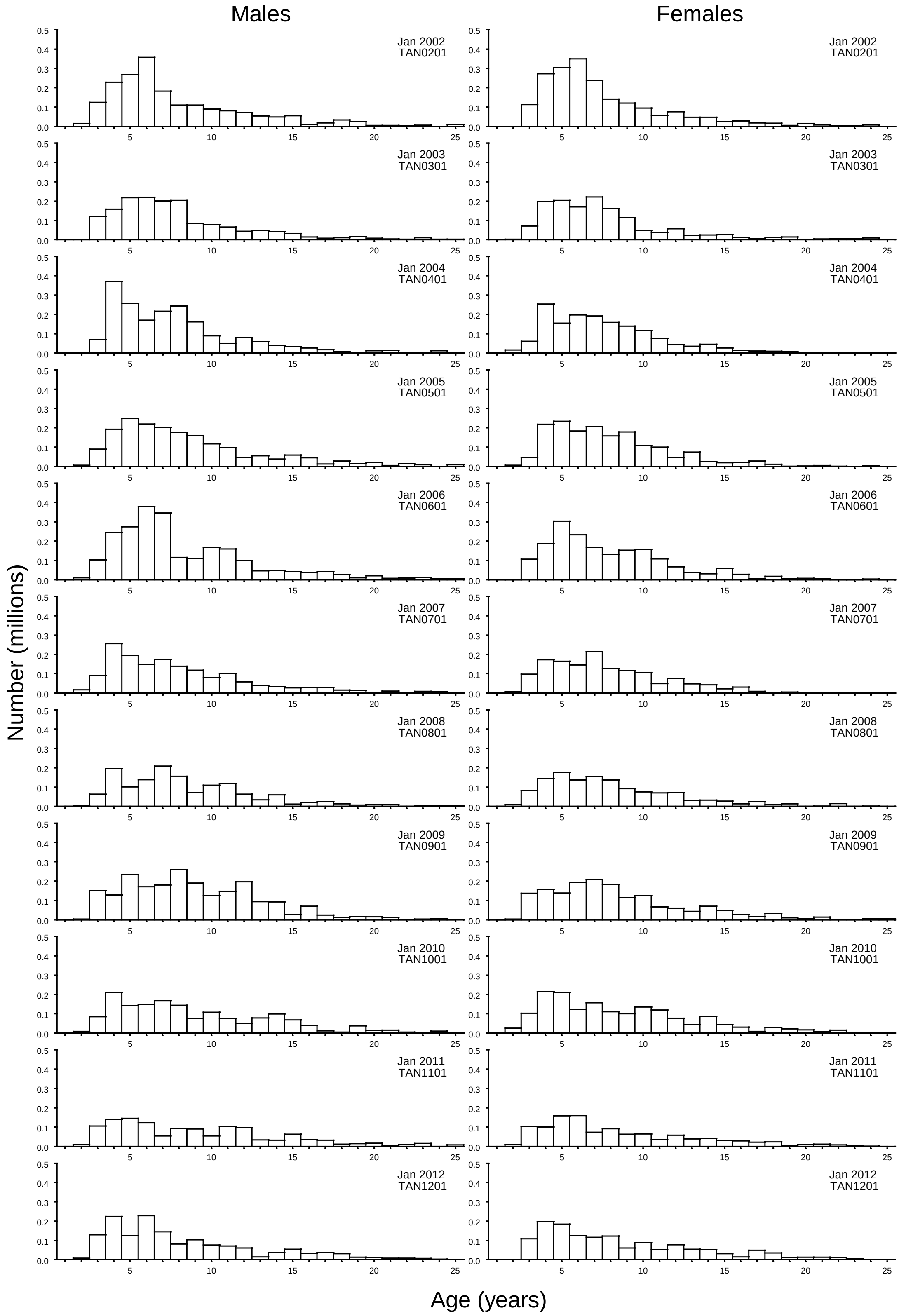

Figure 15 (continued)

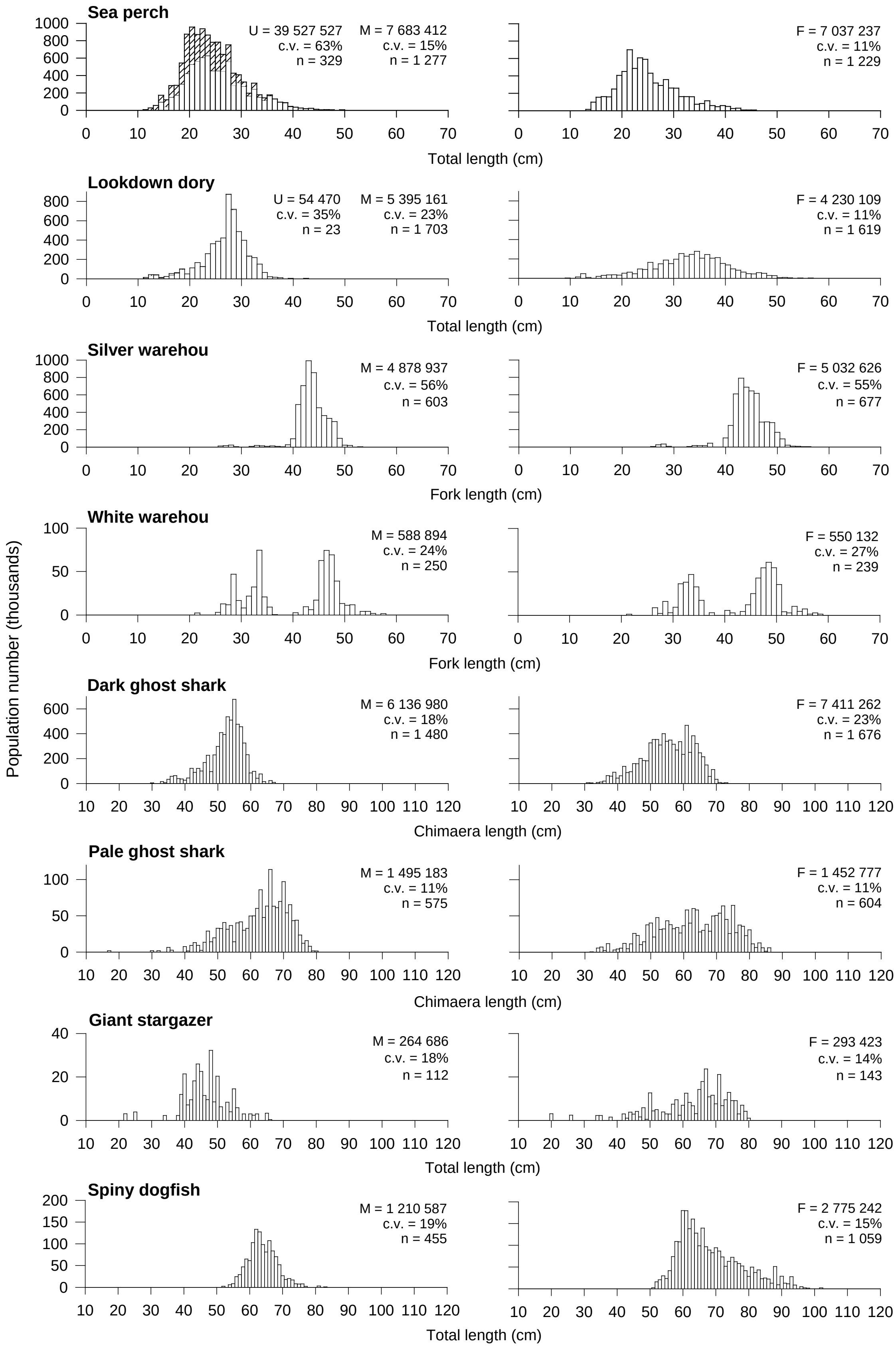

Figure 16a: Length frequencies of selected commercial species on the Chatham Rise 2012, scaled to population size by sex (M, estimated male population; F, estimated female population; U, estimated unsexed population (hatched bars); c.v. coefficient of variation of the estimated numbers of fish; n, number of fish measured).

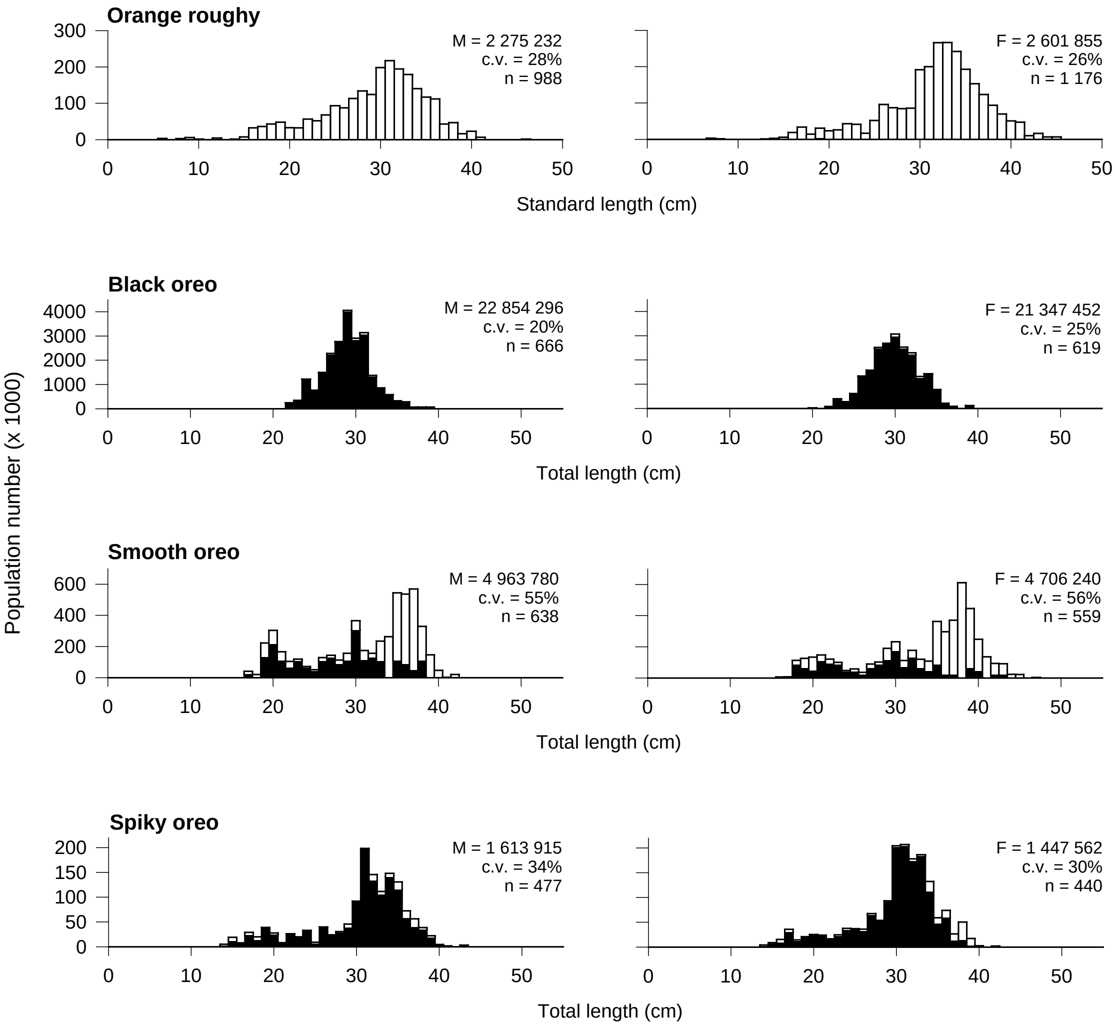

Figure 16b: Length frequencies of orange roughy and oreo species on the Chatham Rise 2012, scaled to population size by sex (M, estimated male population; F, estimated female population; U, estimated unsexed population (hatched bars); c.v. coefficient of variation of the estimated numbers of fish; n, number of fish measured). White bars show fish from all (200–1300 m) strata. Black bars show fish from core (200–800 m) strata only. Very few orange roughy were caught shallower than 800 m.

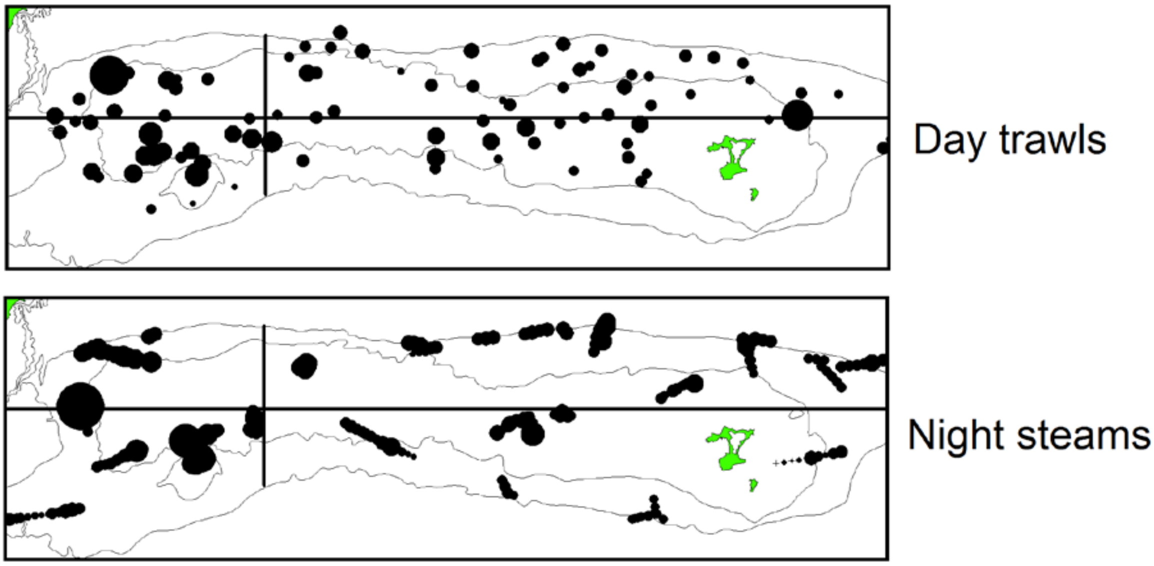

Figure 17: Distribution of total acoustic backscatter observed on the Chatham Rise during daytime trawls and night-time steams in January 2012. Circle area is proportional to the acoustic backscatter (maximum symbol size = 500 m^2 km^{-2}). Lines separate the four acoustic strata.

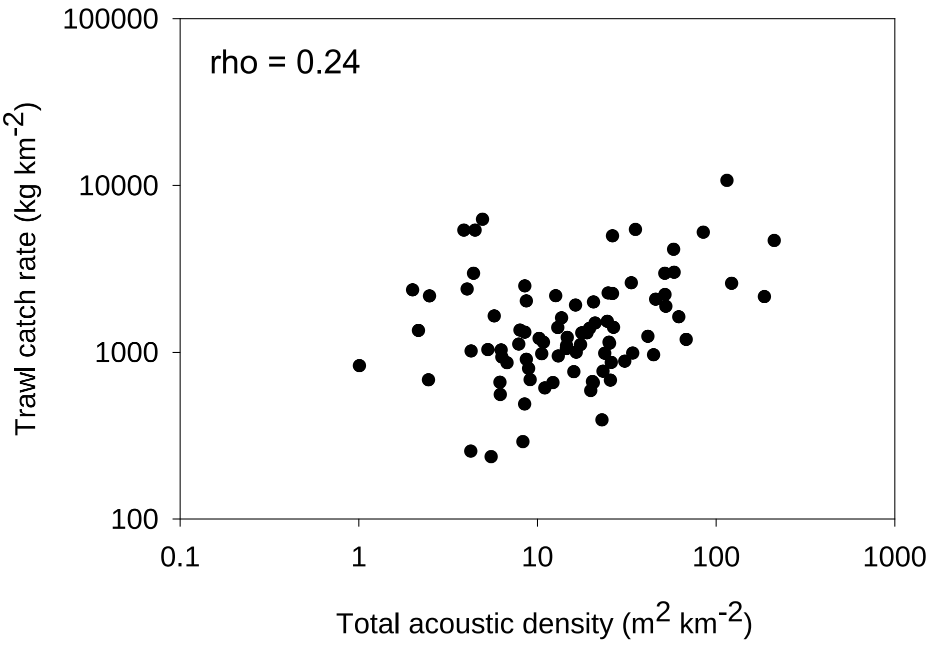

Figure 18: Relationship between total trawl catch rate (all species combined) and bottom-referenced acoustic backscatter recorded during the trawl on the Chatham Rise in 2012. Rho value is Spearman's rank correlation coefficients.

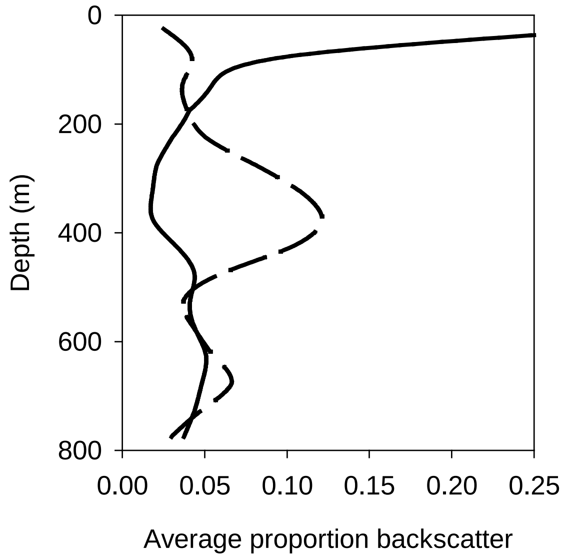

Figure 19: Vertical distribution of total acoustic backscatter integrated in 50 m depth bins on the Chatham Rise during the day (dashed lines) and at night (solid lines) in 2012.

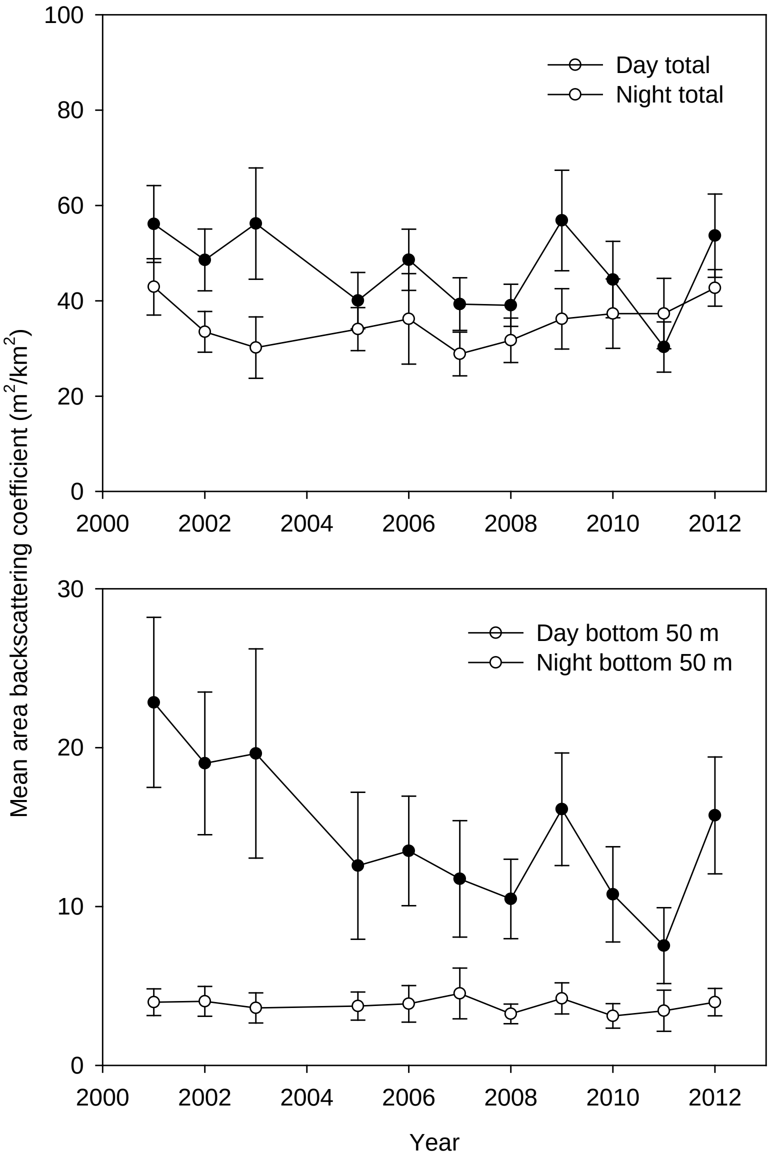

Figure 20: Comparison of relative acoustic abundance indices for the Chatham Rise based on (strata-averaged) mean areal backscatter (s_a). Error bars are plus or minus two standard errors.

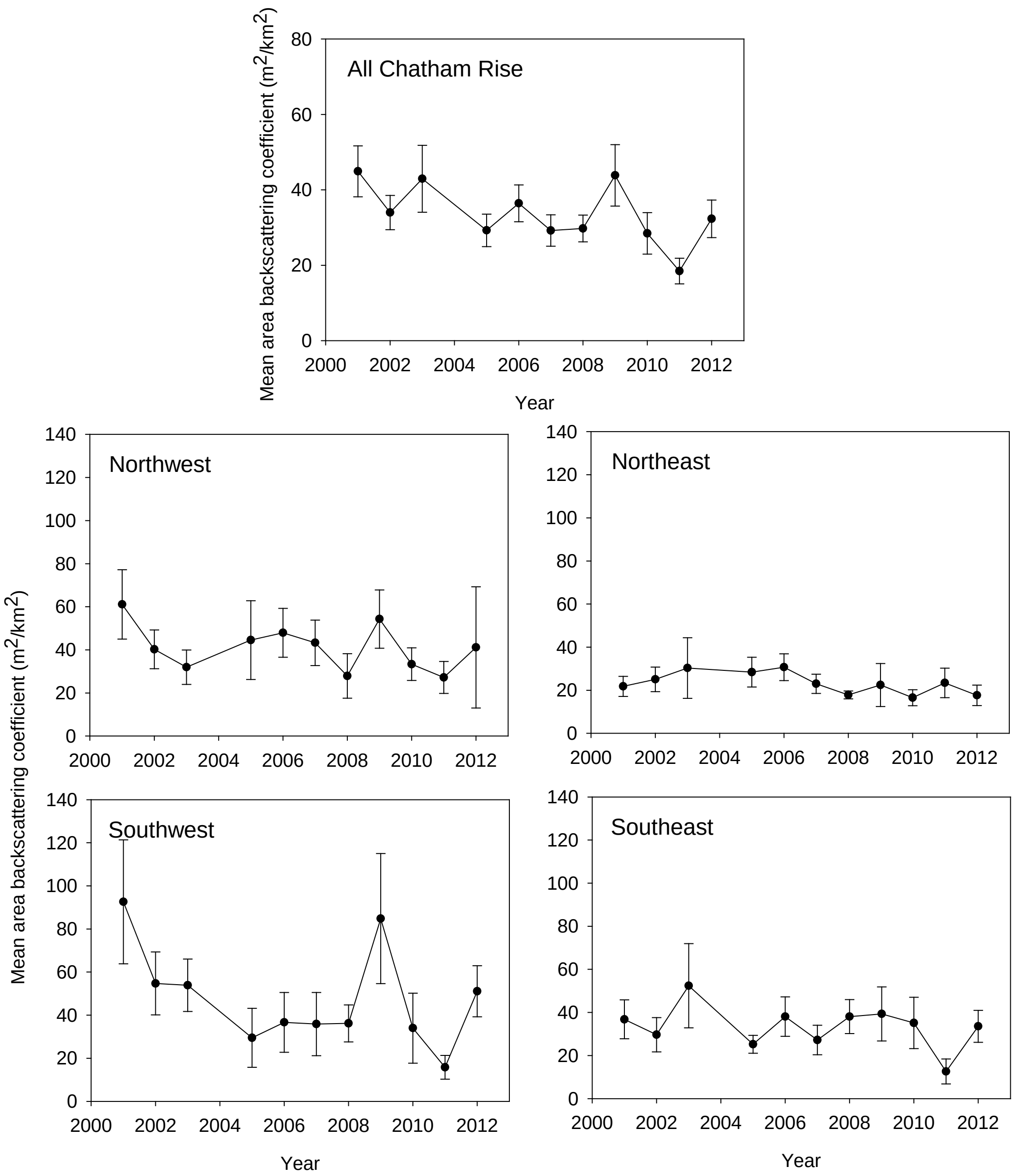

Figure 21: Relative acoustic abundance indices for mesopelagic fish on the Chatham Rise. Indices were derived by multiplying the total backscatter observed at each daytime trawl station by the estimated proportion of night-time backscatter in the same sub-area observed in the upper 200 m corrected for the estimated proportion in the surface deadzone (see Table 14). Panels show indices for the entire Chatham Rise and for four sub-areas. Error bars are approximate 95% confidence intervals from bootstrapping.

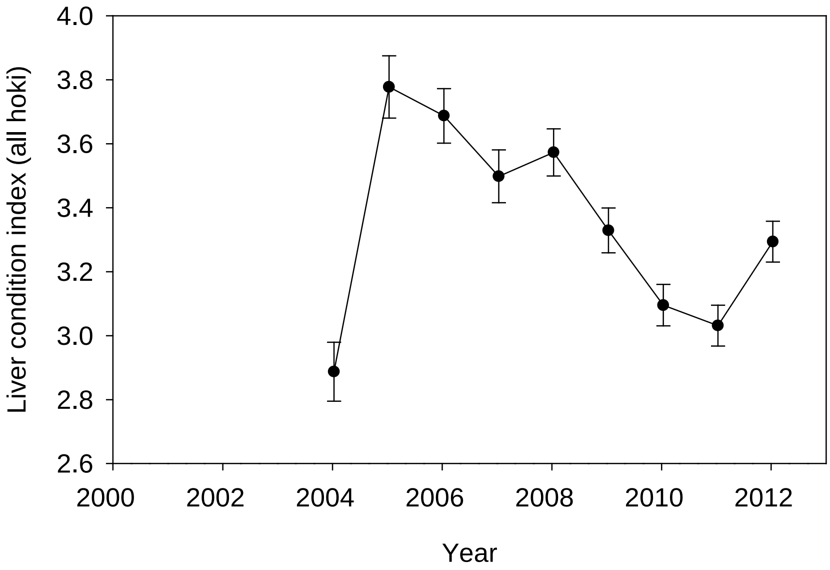

Figure 22: Hoki liver condition (liver weight divided by gutted weight) for all hoki sampled on the Chatham Rise surveys from 2004 to 2012 (updated from O'Driscoll et al. 2011).

Appendix 1: Individual station data for all stations conducted during the survey (TAN1201). P1, phase one trawl survey biomass station; P2, phase two trawl survey biomass stations; Strat., Stratum number; –, catch not recorded; *, foul trawl stations.

			Start tow					Gear depth		Dist.	Catch		
Stn.	Type	Strat.	Date	Time	Latitude	Longitude			m	Towed			Kg
				NZST	° ' S	° '	E/W	min.	max.	n. mile	Hoki	Hake	Ling
1	P1	2A	2-Jan-12	0748	42 47.40	177 32.81	E	681	715	3.02	94.8	0	6.0
2	P1	2A	2-Jan-12	1045	42 47.85	177 54.21	E	619	628	3.01	394.9	7.2	31.6
3	P1	23	2-Jan-12	1352	42 38.64	178 03.29	E	1219	1285	2.26	0	0	0
4	P1	2A	2-Jan-12	1715	42 50.62	178 20.36	E	767	789	3.02	337.3	0	0
5	P1	22	2-Jan-12	1952	42 49.51	178 36.78	E	991	1000	2.95	107.0	11.8	0
6	P1	22	2-Jan-12	2234	42 51.59	178 46.31	E	920	954	3.03	49.1	1.5	0
7	P1	22	3-Jan-12	0040	42 51.37	178 55.90	E	948	955	3.00	18.5	0	0
8	P1	22	3-Jan-12	0339	42 53.45	179 18.55	E	815	845	3.02	213.1	0	0
9	P1	8B	3-Jan-12	0814	43 02.35	178 51.64	E	412	415	3.00	263.3	20.5	76.7
10	P1	8B	3-Jan-12	1126	43 10.76	179 17.26	E	435	440	3.01	275.7	11.1	58.9
11	P1	8B	3-Jan-12	1448	43 11.41	179 51.73	E	500	504	3.00	98.0	0	15.8
12	P1	22	3-Jan-12	1839	42 49.72	179 50.85	E	947	955	3.01	5.8	19.5	0
13	P1	21A	3-Jan-12	2200	42 47.37	179 41.27	W	962	977	3.01	100.0	9.6	0
14	P1	21A	4-Jan-12	0010	42 46.54	179 29.10	W	938	954	3.00	51.7	32.2	0
15	P1	23	4-Jan-12	0347	42 42.37	178 56.09	W	1030	1035	3.01	18.4	9.1	0
16	P1	21A	4-Jan-12	0603	42 46.16	178 51.21	W	837	844	3.02	242.3	7.4	3.2
17	P1	10B	4-Jan-12	0845	42 53.83	179 07.72	W	580	583	3.01	373.2	33.2	33.6
18	P1	10B	4-Jan-12	1056	42 57.65	179 11.79	W	545	549	3.00	418.5	0	2.7
19	P1	11B	4-Jan-12	1414	43 12.16	178 53.27	W	485	490	3.01	344.6	12.4	10.6
20	P1	11B	4-Jan-12	1655	43 01.34	178 40.07	W	522	534	3.01	278.9	23.5	83.8
21	P1	11B	4-Jan-12	1837	42 59.16	178 31.42	W	509	539	3.01	228.8	4.9	11.9
22	P1	23	5-Jan-12	0002	42 37.87	178 13.17	W	1160	1204	3.03	0	0	0
23	P1	2B	5-Jan-12	0502	42 49.91	178 21.36	W	645	646	3.04	201.2	13.0	10.9
24	P1	11C	5-Jan-12	0850	43 11.48	178 02.61	W	462	464	2.99	318.1	27.1	33.5
25	P1	11C	5-Jan-12	1157	42 57.66	177 51.99	W	510	542	2.99	838.9	3.3	14.8
26	P1	11C	5-Jan-12	1404	43 05.49	177 42.29	W	454	459	3.02	216.6	11.0	31.0
27	P1	9	5-Jan-12	1715	43 23.16	177 39.66	W	333	338	2.95	75.5	0	5.2
28	P1	9	6-Jan-12	0500	43 16.15	177 06.96	W	301	308	2.16	27.9	0	12.5
29	P1	11D	6-Jan-12	0743	43 02.33	176 58.56	W	541	550	3.07	1 050.6	8.9	29.3
30	P1	2B	6-Jan-12	1037	42 52.93	177 11.33	W	726	746	3.00	610.1	0	2.9
31	P1	2B	6-Jan-12	1322	42 54.15	177 47.94	W	752	758	3.01	190.9	0	13.3
32	P1	2B	6-Jan-12	1613	42 57.27	176 24.03	W	716	719	2.99	280.7	12.4	19.3
33	P1	11D	6-Jan-12	1833	43 07.32	176 18.02	W	517	526	3.01	360.3	0	21.8
34	P1	21B	6-Jan-12	2250	42 51.63	176 23.27	W	902	907	3.00	78.6	15.5	0
35	P1	24	7-Jan-12	0134	42 47.63	176 19.50	W	1112	1124	3.01	7.0	0	0
36	P1	24	7-Jan-12	0436	42 50.28	175 54.07	W	1026	1037	2.98	0	0	0
37	P1	9	7-Jan-12	0950	43 30.72	176 02.34	W	276	291	2.17	5.9	0	12.5
38	P1	11D	7-Jan-12	1222	43 29.52	175 38.68	W	447	479	3.02	1 265.8	23.7	26.0
39	P1	2B	7-Jan-12	1520	43 15.17	175 35.71	W	647	659	3.01	274.2	15.5	25.1
40	P1	2B	7-Jan-12	1838	43 16.06	175 03.62	W	726	740	1.95	64.9	10.2	20.8
41	P1	21B	7-Jan-12	2213	43 01.04	175 23.81	W	818	820	3.04	56.3	0	0
42	P1	21B	8-Jan-12	0118	43 03.22	175 07.46	W	895	900	2.99	31.6	5.3	0
43	P1	24	8-Jan-12	0624	43 01.99	174 14.05	W	1172	1175	3.01	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
44	P1	24	8-Jan-12	0905	43 13.84	174 09.46	W	1006	1018	2.98	0.9	0	0
45	P1	28	8-Jan-12	1216	43 33.07	174 05.50	W	1042	1047	3.00	0	0	0
46	P1	25	8-Jan-12	1451	43 42.74	174 17.59	W	905	913	3.00	13.4	0	0
47	P1	25	8-Jan-12	1713	43 48.19	174 28.39	W	859	894	3.03	37.6	0	0
48	P1	5	9-Jan-12	0934	43 45.26	178 00.12	W	371	376	3.04	371.0	3.9	71.5
49	P1	12	9-Jan-12	1206	43 59.27	177 56.49	W	458	461	3.01	297.0	0	67.8
50	P1	12	9-Jan-12	1424	44 08.25	177 48.76	W	486	488	3.01	324.2	0	56.9
51	P1	12	9-Jan-12	1627	44 04.21	177 44.00	W	454	466	3.02	455.7	0	73.4
52	P1	25	9-Jan-12	2125	44 34.67	177 31.02	W	881	888	3.00	20.6	0	0
53	P1	28	10-Jan-12	0250	44 35.64	177 55.58	W	1006	1020	2.97	3.3	0	0
*54	P1	13	10-Jan-12	0845	44 07.91	178 41.86	W	465	475	1.87	-	-	-
55	P1	13	10-Jan-12	1107	44 02.37	178 42.84	W	437	449	2.09	147.7	0	78.0
56	P1	25	10-Jan-12	1441	44 24.04	178 52.68	W	857	867	3.01	69.3	0	0
57	P1	28	10-Jan-12	1839	44 39.14	179 01.90	W	1273	1284	3.01	0	0	0
58	P1	28	10-Jan-12	2312	44 35.46	178 25.58	W	1130	1140	2.99	0	0	0
59	P1	5	11-Jan-12	0716	43 39.39	178 03.31	W	370	380	3.01	1 159.7	6.4	50.1
*60	P1	5	11-Jan-12	0942	43 31.78	177 58.12	W	364	365	1.00	-	-	-
61	P1	5	11-Jan-12	1156	43 33.26	177 48.31	W	368	392	3.01	293.6	3.1	51.8
62	P1	11A	11-Jan-12	1516	43 29.14	178 14.26	W	414	417	3.04	419.0	5.0	38.8
63	P1	11A	11-Jan-12	1800	43 29.39	178 35.10	W	417	425	3.01	353.6	10.9	28.7
64	P1	11A	12-Jan-12	0503	43 33.20	178 53.93	W	447	455	3.00	190.0	67.6	22.8
65	P1	10B	12-Jan-12	0817	43 25.97	179 22.52	W	442	454	3.00	206.6	0	3.1
66	P1	10A	12-Jan-12	1034	43 22.51	179 35.25	W	464	472	3.01	82.0	0	25.6
67	P1	10A	12-Jan-12	1304	43 19.18	179 41.68	W	486	487	3.02	101.2	13.8	13.3
68	P1	10A	12-Jan-12	1545	43 31.32	179 58.74	W	403	404	3.02	1 004.8	8.0	52.4
69	P1	3	12-Jan-12	1836	43 44.24	179 52.71	W	370	372	2.13	591.7	12.2	56.5
70	P1	3	13-Jan-12	0502	43 45.74	179 14.89	W	377	383	3.02	443.1	13.2	50.1
71	P1	3	13-Jan-12	1446	43 35.88	179 22.12	W	380	398	3.03	266.5	0	42.3
72	P1	13	13-Jan-12	1824	43 55.34	179 45.92	W	406	419	3.00	222.7	0	27.9
73	P1	25	13-Jan-12	2339	44 22.33	179 32.83	W	870	879	3.00	18.1	7.1	0
74	P1	13	14-Jan-12	0508	44 07.56	179 52.01	W	502	537	3.03	247.1	0	30.2
75	P1	14	14-Jan-12	0907	43 50.80	179 50.58	E	433	445	3.00	601.2	40.6	108.8
76	P1	14	14-Jan-12	1314	43 40.20	179 21.75	E	460	476	3.00	357.9	13.6	50.3
77	P1	14	14-Jan-12	1610	43 54.19	179 21.01	E	510	511	3.01	266.1	0	72.2
78	P1	4	14-Jan-12	1814	44 00.08	179 20.92	E	597	627	3.01	194.6	4.7	31.6
79	P1	20	15-Jan-12	0521	43 25.74	177 57.25	E	310	331	3.02	414.1	0	25.9
80	P1	20	15-Jan-12	0720	43 33.05	177 59.55	E	349	356	3.00	385.1	0	40.9
81	P1	20	15-Jan-12	1027	43 30.01	177 42.42	E	346	357	2.02	448.0	4.8	43.2
*82	P1	20	15-Jan-12	1312	43 15.60	177 54.71	E	300	309	0.59	-	-	-
*83	P1	20	15-Jan-12	1438	43 10.02	177 55.86	E	349	369	2.24	-	-	-
84	P1	20	16-Jan-12	0518	43 02.86	177 43.48	E	319	320	2.66	694.9	0	32.4
85	P1	20	16-Jan-12	0714	43 02.79	177 35.71	E	339	355	3.03	832.4	0	94.2
86	P1	19	16-Jan-12	1058	43 23.41	177 14.11	E	240	248	2.40	0	0	0
87	P1	19	16-Jan-12	1250	43 29.03	177 11.33	E	246	269	3.01	1.5	0	0
88	P1	19	16-Jan-12	1644	43 31.39	176 46.64	E	248	262	3.03	14.9	0	0
89	P1	15	17-Jan-12	0517	43 42.85	176 49.53	E	466	468	3.01	266.1	0	127.9

Appendix 1: (continued)

Stn.	Type	Strat.	Date	Time NZST	Start tow Latitude ° ' S	Longitude ° '	E/W	Gear depth m min.	max.	Dist. towed n. mile	Hoki	Hake	Catch kg Ling
90	P1	15	17-Jan-12	0720	43 44.61	177 04.68	E	478	485	2.98	1 027.3	0	23.8
91	P1	4	17-Jan-12	1118	43 56.49	177 31.14	E	675	701	3.01	185.3	4.5	10.4
92	P1	4	17-Jan-12	1636	44 11.76	176 35.56	E	650	652	3.01	137.2	0	42.2
93	P1	15	18-Jan-12	0523	43 57.55	176 08.12	E	474	502	3.02	702.6	0	49.9
94	P1	17	18-Jan-12	0720	44 04.86	176 04.07	E	342	359	2.18	616.3	0	61.7
95	P1	17	18-Jan-12	0921	44 06.50	176 08.19	E	342	346	2.01	176.5	0	5.5
96	P1	17	18-Jan-12	1200	44 22.10	176 01.46	E	245	276	3.03	0	0	4.2
97	P1	6	18-Jan-12	1526	44 25.07	175 26.79	E	675	682	3.02	270.8	0	62.1
98	P1	6	19-Jan-12	0543	44 40.93	173 00.22	E	728	745	3.01	223.8	4.7	11.0
99	P1	6	19-Jan-12	0815	44 38.86	173 18.85	E	775	792	2.99	168.0	0	4.5
100	P1	16	19-Jan-12	1545	44 02.30	174 35.15	E	529	546	3.01	234.5	14.1	59.0
101	P1	7A	20-Jan-12	0534	43 31.86	174 23.36	E	555	557	3.02	303.4	10.7	19.6
102	P1	7A	20-Jan-12	0812	43 39.12	174 09.78	E	464	474	2.02	1 270.5	14.0	43.9
103	P1	1	20-Jan-12	1023	43 29.10	174 05.89	E	668	704	2.70	66.3	9.7	21.4
*104	P1	1	20-Jan-12	1236	43 18.78	174 02.23	E	629	645	0.87	-	-	-
*105	P1	1	20-Jan-12	1421	43 08.58	174 04.36	E	664	674	3.01	-	-	-
106	P1	7A	20-Jan-12	1736	43 18.66	174 25.23	E	525	561	3.01	460.4	4.7	26.2
107	P1	7A	21-Jan-12	0541	43 33.30	174 35.46	E	494	496	3.04	404.3	17.8	64.5
108	P1	18	21-Jan-12	0856	43 26.56	174 55.65	E	252	294	2.00	71.8	0	3.5
109	P1	7A	21-Jan-12	1200	43 05.13	174 50.04	E	477	478	3.01	861.6	35.6	76.3
110	P1	18	21-Jan-12	1413	43 04.04	175 05.68	E	302	329	3.03	79.9	0	58.2
*111	P1	1	21-Jan-12	1703	42 55.35	174 51.27	E	734	739	2.89	-	-	-
*112	P1	22	21-Jan-12	2107	42 52.73	174 43.92	E	932	932	0.00	-	-	-
113	P1	22	21-Jan-12	2354	42 56.14	174 33.61	E	914	928	3.00	63.2	4.3	0
114	P1	18	22-Jan-12	0536	43 06.78	175 38.59	E	374	375	3.01	3 093.5	26.6	99.6
115	P1	7B	22-Jan-12	0748	43 12.58	175 44.87	E	400	438	3.02	223.2	106.2	123.5
116	P1	7B	22-Jan-12	1120	43 07.29	175 45.80	E	453	466	3.01	215.7	7.0	57.5
117	P1	7B	22-Jan-12	1334	42 59.31	175 55.53	E	520	532	3.01	164.8	12.2	55.6
118	P1	1	22-Jan-12	1540	42 53.96	175 57.41	E	603	611	3.02	141.9	14.9	37.1
119	P1	1	22-Jan-12	1802	42 53.91	175 40.21	E	609	611	2.15	189.2	2.9	20.9
120	P1	22	22-Jan-12	2113	42 49.24	175 19.12	E	815	823	2.98	377.2	5.2	8.3
121	P1	22	23-Jan-12	0000	42 44.73	175 36.28	E	917	922	3.01	76.2	10.2	0
122	P1	8A	23-Jan-12	0843	42 56.23	176 14.20	E	524	534	3.01	158.9	20.0	28.3
123	P1	8A	23-Jan-12	1402	42 51.14	176 57.09	E	444	449	3.01	98.7	0	13.0
124	P1	8A	23-Jan-12	1716	42 53.65	177 18.81	E	405	415	3.02	266.0	12.1	38.5
125	P1	23	23-Jan-12	2314	42 39.53	176 36.62	E	1027	1028	3.01	22.8	0	0
126	P1	22	24-Jan-12	0159	42 39.70	176 28.54	E	955	960	3.01	79.5	3.5	0
127	P1	22	24-Jan-12	0418	42 39.08	176 19.72	E	965	979	3.02	30.6	0	0
128	P1	19	24-Jan-12	1023	43 07.03	176 11.54	E	379	399	3.01	246.5	4.4	48.3
129	P1	19	24-Jan-12	1405	43 15.04	176 43.91	E	280	282	3.01	328.0	0	0
130	P2	15	24-Jan-12	1819	43 40.55	176 33.96	E	402	416	2.06	134.2	3.3	17.9
131	P1	16	25-Jan-12	0542	43 49.96	175 59.22	E	454	460	2.15	2 523.1	6.4	43.3
132	P1	16	25-Jan-12	0808	43 50.39	175 36.14	E	416	428	3.01	2 218.3	3.2	70.6
133	P2	18	25-Jan-12	1050	43 39.95	175 25.51	E	305	311	2.00	671.6	0	0
134	P2	18	25-Jan-12	1303	43 29.52	175 36.24	E	233	237	2.01	13.2	0	0
135	P2	16	25-Jan-12	1632	43 52.18	175 28.09	E	436	452	2.15	1 580.8	0	79.5

Appendix 1: (continued)

Stn.	Type	Strat.	Date	Time NZST	Start tow Latitude ° ' S	Longitude ° '	E/W	Gear depth m min.	max.	Dist. towed n. mile	Hoki	Hake	Catch kg Ling
136	P2	16	25-Jan-12	1808	43 52.58	175 20.56	E	447	453	2.18	697.1	0	73.8
137	P2	16	26-Jan-12	0533	44 06.02	174 40.82	E	518	538	3.01	141.2	10.1	21.5
138	P2	16	26-Jan-12	0754	43 59.08	174 54.75	E	467	472	2.99	446.3	0	44.6
139	P2	16	26-Jan-12	1049	44 03.27	175 11.49	E	495	501	3.00	453.3	0	97.3
140	P2	16	26-Jan-12	1335	44 03.33	175 28.17	E	500	512	3.01	392.5	3.0	35.0
141	P2	16	26-Jan-12	1614	43 54.27	175 49.69	E	489	497	3.00	735.9	0	28.5
142	P2	23	27-Jan-12	0458	42 41.93	175 46.29	E	1015	1025	3.02	29.2	9.3	0

Appendix 2: Scientific and common names of species caught from all valid biomass tows (TAN1201). The occurrence (Occ.) of each species (number of tows caught) in the 134 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	6
Porifera	unspecified sponges	ONG	1
Demospongiae (siliceous sponges)			
Astrophorida (sandpaper sponges)			
Ancorinidae			
Ecionemia novaezelandiae	knobbly sandpaper sponge	ANZ	2
Pachastrellidae			
Thenea novaezelandiae	yoyo sponge	THN	1
Dictyoceratida (rubber sponges)			
Irciniidae			
Psammocinia cf. *hawere*	rubber sponge	PHW	1
Hadromerida (woody sponges)			
Suberitidae			
Suberites affinis	fleshy club sponge	SUA	7
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	1
Rossellidae			
Hyalascus sp.	floppy tubular sponge	HYA	29
Cnidaria			
Coral (Hydrozoan + Anthozoan corals)	unspecified coral	COU	1
Scyphozoa	unspecified jellyfish	JFI	22
Anthozoa			
Corallimorpharia (coral-like anemones)			
Corallimorphidae	coral-like anemones	CLM	1
Octocorallia			
Alcyonacea (soft corals)	unspecified soft coral	SOC	2
Primnoidae			
Thouarella spp.	bottle brush coral	THO	2
Pennatulacea (sea pens)	unspecified sea pens	PTU	12
Pennatulidae			
Pennatula spp.	purple sea pens	PNN	1
Pteroeididae			
Gyrophyllum sibogae	siboga sea pen	GYS	1
Hexacorallia			
Zoanthidea (zoanthids)			
Epizoanthidae			
Epizoanthus sp.		EPZ	4
Actinaria (anemones)			
Actinostolidae (smooth deepsea anemones)		ACS	30
Hormathiidae (warty deepsea anemones)		HMT	15
Scleractinia (stony corals)			

Appendix 2 (continued)

Scientific name	Common name	Species	Occ.
Caryophyllidae			
Desmophyllum dianthus	crested cup coral	DDI	4
Goniocorella dumosa	bushy hard coral	GDU	6
Flabellidae			
Flabellum spp.	flabellum coral	COF	8
Ascidiacea	unspecified sea squirt	ASC	1
Tunicata			
Thaliacea (salps)	unspecified salps	SAL	7
Salpidae			
Pyrosoma atlanticum		PYR	15
Mollusca			
Gastropoda (gastropods)			
Nudibranchia (sea slugs)		NUD	1
Buccinidae (whelks)			
Penion chathamensis		PCH	4
Ranellidae (tritons)			
Fusitriton magellanicus		FMA	34
Turridae (turrids)			
Comitas onokeana vivens		COV	1
Volutidae (volutes)			
Alcithoe wilsonae		AWI	1
Provocator mirabilis	golden volute	GVO	7
Cephalopoda			
Teuthoidea (squids)	unspecified squid	SQX	1
Onychoteuthidae			
Onykia ingens	warty squid	MIQ	64
O. robsoni	warty squid	MRQ	1
Histioteuthidae (violet squids)			
Histioteuthis atlantica	violet squid	HAA	1
Histioteuthis spp.	violet squid	VSQ	2
Ommastrephidae			
Nototodarus sloanii	Sloan's arrow squid	NOS	46
Todarodes filippovae	Todarodes squid	TSQ	16
Chiroteuthidae			
Chiroteuthis veryani		CVE	1
Mastigoteuthidae			
Mastigoteuthis sp.	squid	MSQ	1
Cranchiidae	unspecified cranchiid	CHQ	6
Teuthowenia pellucida		TPE	4
Cirrata (cirrate octopus)			
Opisthoteuthididae			
Opisthoteuthis spp.	umbrella octopus	OPI	4
Incirrata (incirrate octopus)			
Octopodidae	unspecified octopod	OCP	3
Enteroctopus zealandicus	yellow octopus	EZE	2
Graneledone spp.	deepwater octopus	DWO	1
Octopus mernoo	octopus	OME	1

Appendix 2 (continued)

Scientific name	Common name	Species	Occ.
Polychaeta			
Eunicida			
Onuphidae			
Hyalinoecia tubicola	quill worm	HTU	1
Phyllodocida			
Aphroditidae			
Aphrodita spp.	sea mouse	ADT	2
Crustacea			
Malacostraca			
Dendrobranchiata/Pleocyemata (prawns)			
Dendrobranchiata			
Aristeidae			
Aristaeopsis edwardsiana	scarlet prawn	PED	1
Pleocyemata			
Caridea			
Oplophoridae			
Oplophorus spp.	deepwater prawn	OPP	4
Pasiphaeidae			
Pasiphaea aff. *tarda*	deepwater prawn	PTA	7
Nematocarcinidae			
Lipkius holthuisi	omega prawn	LHO	25
Nematocarcinus spp.	spider prawn	NEC	1
Astacidea			
Nephropidae (clawed lobsters)			
Metanephrops challengeri	scampi	SCI	23
Palinura			
Polychelidae			
Polycheles spp.	deepsea blind lobster	PLY	6
Anomura			
Galatheoidea			
Chirostylidae (chirostylid squat lobsters)			
Uroptychus spp.	squat lobster	URP	1
Inachidae			
Vitjazmaia latidactyla	deepsea spider crab	VIT	1
Lithodidae (king crabs)			
Lithodes aotearoa	New Zealand king crab	LAO	1
L. robertsoni	Robertson's king crab	LRO	4
Neolithodes brodiei	Brodie's king crab	NEB	3
Paralomis zealandica	prickly king crab	PZE	3
Paguroidea (unspecified pagurid & parapagurid hermit crabs)		PAG	10
Paguridae (Pagurid hermit crabs)			
Propagurus deprofundis	hermit crab	PDE	1
Parapaguridae (Parapagurid hermit crabs)			
Parapagurus latimanus	hermit crab	PRL	1
Sympagurus dimorphus	hermit crab	SDM	15
Brachyura (true crabs)			
Atelecyclidae			
Trichopeltarion fantasticum	frilled crab	TFA	14
Goneplacidae			
Pycnoplax victoriensis	two-spined crab	CVI	1

Appendix 2 (continued)

Scientific name	Common name	Species	Occ.
Homolidae			
Dagnaudus petterdi	antlered crab	DAP	3
Majidae (spider crabs)			
Leptomithrax garricki	Garrick's masking crab	GMC	2
Teratomaia richardsoni	spiny masking crab	SMK	9
Portunidae (swimming crabs)			
Ovalipes molleri	Swimming crab	OVM	1
Lophogastrida (lophogastrids)			
Gnathophausiidae			
Gnathophausia ingens	giant red mysid	NEI	2
Echinodermata			
Asteroidea (starfish)	unspecified starfish	ASR	3
Asteriidae			
Allostichaster spp.	three-and-three stars	ALH	1
Cosmasterias dyscrita	cat's-foot star	CDY	3
Pseudechinaster rubens	starfish	PRU	15
Astropectinidae			
Dipsacaster magnificus	magnificent sea-star	DMG	15
Plutonaster knoxi	abyssal star	PKN	18
Proserpinaster neozelanicus	starfish	PNE	8
Psilaster acuminatus	geometric star	PSI	33
Sclerasterias mollis	cross-fish	SMO	1
Benthopectinidae			
Benthopecten spp.	starfish	BES	2
Cheiraster monopedicellaris	starfish	CMP	1
Brisingida		BRG	18
Goniasteridae			
Ceramaster patagonicus	pentagon star	CPA	1
Hippasteria phrygiana	trojan starfish	HTR	11
Lithosoma novaezelandiae	rock star	LNV	5
Mediaster sladeni	starfish	MSL	5
Pillsburiaster aoteanus	starfish	PAO	5
Odontasteridae			
Odontaster spp.	pentagonal tooth-star	ODT	1
Solasteridae			
Crossaster multispinus	sun star	CJA	22
Solaster torulatus	chubby sun-star	SOT	9
Zoroasteridae			
Zoroaster spp.	rat-tail star	ZOR	41
Comatulida (feather stars)	unspecified feather star	CMT	1
Ophiuroidea (basket and brittle stars)	unspecified brittle star	OPH	1
Euryalina (basket stars)			
Gorgonocephalidae			
Gorgonocephalus spp.	Gorgon's head basket stars	GOR	2
Ophiurida			
Ophiodermatidae			
Bathypectinura heros	deepsea brittle star	BHE	2

Appendix 2 (continued)

Scientific name	Common name	Species	Occ.
Echinoidea (sea urchins)			
Regularia			
Cidaridae (cidarid urchins)			
Goniocidaris parasol	parasol urchin	GPA	3
G. umbraculum	umbrella urchin	GOU	1
Echinothuriidae/Phormosomatidae	unspecified Tam O'Shanter urchin	TAM	7
Echinidae			
Gracilechinus multidentatus	deepsea kina	GRM	9
Dermechinus horridus	deepsea urchin	DHO	7
Spatangoida (heart urchins)			
Spatangidae			
Paramaretia peloria	Microsoft mouse	PMU	5
Spatangus multispinus	purple-heart urchin	SPT	15
Temnopleuroida			
Temnopleuridae			
Pseudechinus flemingi	Fleming's urchin	PFL	2
Holothuroidea	unspecified sea cucumber	HTH	3
Aspidochirotida			
Synallactidae			
Bathyplotes sp.	sea cucumber	BAM	10
Pseudostichopus mollis	sea cucumber	PMO	28
Elasipodida			
Laetmogonidae			
Laetmogone sp.	sea cucumber	LAG	9
Pannychia moseleyi	sea cucumber	PAM	8
Pelagothuridae			
Enypniastes exima	sea cucumber	EEX	2
Psychropotidae			
Benthodytes sp.	sea cucumber	BTD	1
Bryozoan	unspecified bryozoan	COZ	1
Agnatha (jawless fishes)			
Eptatretus cirrhatus	hagfish	HAG	3
Chondrichthyes (cartilagenous fishes)			
Hexanchidae: cow sharks			
Hexanchus griseus	sixgill shark	HEX	3
Squalidae: dogfishes			
Centrophorus squamosus	leafscale gulper shark	CSQ	16
Centroscymnus crepidater	longnose velvet dogfish	CYP	40
C. owstoni	smooth skin dogfish	CYO	31
Deania calcea	shovelnose dogfish	SND	62
Etmopterus baxteri	Baxter's dogfish	ETB	47
E. lucifer	lucifer dogfish	ETL	68
E. viator		ETM	1
Proscymnodon plunketi	Plunket's shark	PLS	11
Scymnorhinus licha	seal shark	BSH	38
Squalus acanthias	spiny dogfish	SPD	67
S. griffini	northern spiny dogfish	NSD	3

Appendix 2 (continued)

Scientific name	Common name	Species	Occ.
Oxynotidae: rough sharks			
Oxynotus bruniensis	prickly dogfish	PDG	11
Scyliorhinidae: cat sharks			
Apristurus spp.	catshark	APR	30
Cephaloscyllium isabellum	carpet shark	CAR	2
Halaelurus dawsoni	Dawson's catshark	DCS	6
Triakidae: smoothhounds			
Galeorhinus galeus	school shark	SCH	3
Torpedinidae: electric rays			
Torpedo fairchildi	electric ray	ERA	4
Narkidae: blind electric rays			
Typhlonarke aysoni	blind electric ray	TAY	2
T. tarakea	oval electric ray	TTA	2
T. spp.	numbfish	BER	1
Rajidae: skates			
Amblyraja hyperborea	deepwater spiny (Arctic) skate	DSK	1
Bathraja shuntovi	longnosed deepsea skate	PSK	9
Brochiraja asperula	smooth deepsea skate	BTA	16
B. spinifera	prickly deepsea skate	BTS	15
Dipturus innominatus	smooth skate	SSK	26
Chimaeridae: chimaeras, ghostsharks			
Chimaera lignaria	giant chimaera	CHG	1
C. sp. C	brown chimaera	CHP	2
Hydrolagus bemisi	pale ghostshark	GSP	85
H. novaezealandiae	dark ghostshark	GSH	55
H. sp. A	black ghost shark	HYB	2
Rhinochimaeridae: longnosed chimaeras			
Harriotta raleighana	long-nosed chimaera	LCH	68
Rhinochimaera pacifica	widenosed chimaera	RCH	30
Osteichthyes (bony fishes)			
Halosauridae: halosaurs			
Halosauropsis macrochir	abyssal halosaur	HAL	1
Halosaurus pectoralis	common halosaur	HPE	3
Notocanthidae: spiny eels			
Lipogenys gillii		FIS	1
Notacanthus chemnitzi	giant spineback	NOC	1
N. sexspinis	spineback	SBK	78
Synaphobranchidae: cutthroat eels			
Diastobranchus capensis	basketwork eel	BEE	30
Congridae: conger eels			
Bassanago bulbiceps	swollenhead conger	SCO	33
B. hirsutus	hairy conger	HCO	40
Nemichthyidae: snipe eels			
Avocettina sp.	black snipe eel	AVO	1
Gonorynchidae: sandfish			
Gonorynchus forsteri & *G. greyi*	sandfishes	GON	3
Argentinidae: silversides			
Argentina elongata	silverside	SSI	57
Bathylagidae: deepsea smelts			
Bathylagichthys sp.	deepsea smelt	DSS	5
Melanolagus bericoides	bigscale blacksmelt	MEB	2

Appendix 2 (continued)

Scientific name	Common name	Species	Occ.
Alepocephalidae: slickheads			
Alepocephalus antipodianus	smallscaled brown slickhead	SSM	26
A. australis	bigscaled brown slickhead	SBI	22
Rouleina guentheri	slickhead	RGN	1
Xenodermichthys sp.	black slickhead	BSL	15
Platytroctidae: tubeshoulders			
Persparsia kopua		PER	4
Sagamichthys schnakenbecki		SID	1
Sternoptychidae: hatchetfishes	unspecified hatchetfish	HAT	5
Argyropelecus gigas	giant hatchetfish	AGI	3
Photichthyidae: lighthouse fishes			
Photichthys argenteus	lighthouse fish	PHO	31
Chauliodontidae: viperfishes			
Chauliodus sloani	viperfish	CHA	9
Stomiidae: scaly dragonfishes			
Stomias spp.		STO	1
Melanostomiidae: scaleless black dragonfishes	unspecified melanostomiid	MST	1
Malacosteidae: loosejaws			
Malacosteus australis	southern loosejaw	MAU	3
M. spp.	loosejaw	MAL	1
Idiacanthidae: black dragonfishes			
Idiacanthus spp.	black dragonfish	IDI	1
Scopelarchidae: pearleyes			
Scopelarchoides kreffti	Krefft's pearleye	SKR	1
Notosudidae: waryfishes			
Scopelosaurus spp.		SPL	4
Paralepididae: barracudinas			
Magnisudis prionosa	barracudina	BCA	1
Alepisauridae: lancetfishes			
Alepisaurus brevirostris	shortsnouted lancetfish	ABR	1
Myctophidae: lanternfishes	unspecified lanternfish	LAN	4
Diaphus danae		DIA	6
Gymnoscopelus spp.		GYM	1
Lampadena speculigera		LPD	1
Lampadena spp.		LPD	2
Lampanyctus spp.		LPA	7
Moridae: morid cods			
Antimora rostrata	violet cod	VCO	2
Halargyreus johnsonii	Johnson's cod	HJO	39
Lepidion microcephalus	small-headed cod	SMC	25
L. schmidti	giant lepidion	LPS	1
Mora moro	ribaldo	RIB	46
Notophycis marginata	dwarf cod	DCO	2
Pseudophycis bachus	red cod	RCO	18
Tripterophycis gilchristi	grenadier cod	GRC	3
Gadidae: true cods			
Micromesistius australis	southern blue whiting	SBW	2
Merlucciidae: hakes			
Lyconus sp.		LYC	1
Macruronus novaezelandiae	hoki	HOK	125
Merluccius australis	hake	HAK	68

Appendix 2 (continued)

Scientific name	Common name	Species	Occ.
Macrouridae: rattails, grenadiers			
Coelorinchus acanthiger	spotty faced rattail	CTH	3
C. aspercephalus	oblique banded rattail	CAS	63
C. biclinozonalis	two saddle rattail	CBI	11
C. bollonsi	bigeye rattail	CBO	91
C. fasciatus	banded rattail	CFA	34
C. innotabilis	notable rattail	CIN	39
C. kaiyomaru	Kaiyomaru rattail	CKA	9
C. matamua	Mahia rattail	CMA	24
C. oliverianus	Oliver's rattail	COL	84
C. parvifasciatus	small banded rattail	CCX	13
C. trachycarus	roughhead rattail	CHY	9
Coryphaenoides dossenus	humpback (slender) rattail	CBA	14
C. murrayi	Murray’s rattail	CMU	3
C. serrulatus	serrulate rattail	CSE	35
C. striaturus	striate rattail	CTR	3
C. subserrulatus	four-rayed rattail	CSU	39
Kuronezumia leonis		NPU	1
Lepidorhynchus denticulatus	javelinfish	JAV	110
Lucigadus nigromaculatus	blackspot rattail	VNI	21
Macrourus carinatus	ridge scaled rattail	MCA	14
Mesobius antipodum	black javelinfish	BJA	8
Nezumia namatahi	squashed face rattail	NNA	3
Odontomacrurus murrayi		OMU	1
Trachyrincus aphyodes	white rattail	WHX	32
T. longirostris	unicorn rattail	WHR	4
Ophidiidae: cuskeels			
Genypterus blacodes	ling	LIN	95
Carapidae: pearlfishes			
Echiodon cryomargarites	messmate fish	ECR	4
Chaunacidae: seatoads			
Chaunax sp. C	pink frogmouth	CHX	1
Ceratiidae: seadevils			
Ceratias spp.		CER	2
Cryptopsaras couesi	seadevil	SDE	3
Regalecidae: oarfishes			
Agrostichthys parkeri	ribbonfish	AGR	1
Trachichthyidae: roughies, slimeheads			
Hoplostethus atlanticus	orange roughy	ORH	33
H. mediterraneus	silver roughy	SRH	51
Paratrachichthys trailli	common roughy	RHY	6
Diretmidae: discfishes			
Diretmus argenteus	discfish	DIS	3
Berycidae: alfonsinos			
Beryx decadactylus	longfinned beryx	BYD	1
Beryx splendens	alfonsino	BYS	39
Melamphaidae: bigscalefishes	unspecified bigscalefish	MPH	1
Zeidae: dories			
Capromimus abbreviatus	capro dory	CDO	11
Cyttus novaezealandiae	silver dory	SDO	13
C. traversi	lookdown dory	LDO	94
Zenopsis nebulosus	mirror dory	MDO	3

Appendix 2 (continued)

Scientific name	Common name	Species	Occ.
Oreosomatidae: oreos			
Allocyttus niger	black oreo	BOE	20
A. verrucosus	warty oreo	WOE	6
Neocyttus rhomboidalis	spiky oreo	SOR	35
Pseudocyttus maculatus	smooth oreo	SSO	37
Macrorhamphosidae: snipefishes			
Centriscops humerosus	banded bellowsfish	BBE	82
Notopogon lilliei	crested bellowsfish	CBE	3
Scorpaenidae: scorpionfishes			
Helicolenus spp.	sea perch	SPE	92
Trachyscorpia eschmeyeri	cape scorpionfish	TRS	6
Congiopodidae: pigfishes			
Alertichthys blacki	alert pigfish	API	1
Congiopodus leucopaecilus	pigfish	PIG	3
Triglidae: gurnards			
Lepidotrigla brachyoptera	scaly gurnard	SCG	9
Hoplichthyidae: ghostflatheads			
Hoplichthys haswelli	deepsea flathead	FHD	41
Psychrolutidae: toadfishes			
Ambophthalmos angustus	pale toadfish	TOP	11
Cottunculus nudus	bonyskull toadfish	COT	3
Psychrolutes microporos	blobfish	PSY	2
Percichthyidae: temperate basses			
Polyprion americanus	bass groper	BAS	1
P. oxygeneios	hapuku	HAP	10
Serranidae: sea perches, gropers			
Lepidoperca aurantia	orange perch	OPE	16
Apogonidae: cardinalfishes			
Epigonus denticulatus	white cardinalfish	EPD	5
E. lenimen	bigeye cardinalfish	EPL	13
E. robustus	robust cardinalfish	EPR	26
E. telescopus	deepsea cardinalfish	EPT	22
Rosenblattia robusta	rotund cardinalfish	ROS	3
Carangidae: trevallies, kingfishes			
Trachurus declivis	greenback jack mackerel	JMD	1
T. symmetricus murphyi	slender jack mackerel	JMM	3
Bramidae: pomfrets			
Brama australis	southern Ray's bream	SRB	33
B. brama	Ray’s bream	RBM	1
Taractichthys longipinnis	big-scale pomfret	BSP	1
Caristiidae: manefishes			
Caristius sp.	Largemouth manefish	PLA	1
Emmelichthyidae: bonnetmouths, rovers			
Emmelichthys nitidus	redbait	RBT	4
Plagiogeneion rubiginosum	rubyfish	RBY	1
Cheilodactylidae: tarakihi, morwongs			
Nemadactylus macropterus	tarakihi	NMP	6
Uranoscopidae: armourhead stargazers			
Kathetostoma binigrasella	banded stargazer	BGZ	1
K. giganteum	giant stargazer	STA	62

Appendix 2 (continued)

Scientific name	Common name	Species	Occ.
Pinguipedidae: sandperches, weevers			
Parapercis gilliesi	yellow cod	YCO	2
Gempylidae: snake mackerels			
Thyrsites atun	barracouta	BAR	4
Trichiuridae: cutlassfishes			
Lepidopus caudatus	frostfish	FRO	1
Centrolophidae: raftfishes, medusafishes			
Centrolophus niger	rudderfish	RUD	30
Hyperoglyphe antarctica	bluenose	BNS	6
Schedophilus huttoni	slender ragfish	SUH	1
Seriolella caerulea	white warehou	WWA	38
S. punctata	silver warehou	SWA	44
Tubbia tasmanica	Tasmanian ruffe	TUB	1
Achiropsettidae: southern flounders			
Neoachiropsetta milfordi	finless flounder	MAN	9
Bothidae: lefteyed flounders			
Arnoglossus scapha	witch	WIT	6
Pleuronectidae: righteyed flounders			
Pelotretis flavilatus	lemon sole	LSO	14

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

NIWA No.	Cruise/Station no.	Phylum	Class	Order	Family	Genus	Species
80798	TAN1201/67	Arthropoda	Malacostraca	Decapoda			
80803	TAN1201/88	Arthropoda	Malacostraca	Decapoda			
80818	TAN1201/55	Arthropoda	Malacostraca	Decapoda	Galatheidae	*Phylladiorhynchus*	n. sp.
80800	TAN1201/27	Arthropoda	Malacostraca	Decapoda	Goneplacidae	*Neommatocarcinus*	*huttoni*
80793	TAN1201/27	Arthropoda	Malacostraca	Decapoda	Homolidae	*Dagnaudus*	*petterdi*
80794	TAN1201/108	Arthropoda	Malacostraca	Decapoda	Homolidae	*Dagnaudus*	*petterdi*
80801	TAN1201/55	Arthropoda	Malacostraca	Isopoda	Arcturidae		
80795	TAN1201/3	Cnidaria	Anthozoa	Corallimorpharia			
80802	TAN1201/11	Cnidaria	Anthozoa	Pennatulacea			
80799	TAN1201/55	Echinodermata	Crinoidea				
80797	TAN1201/93	Echinodermata	Holothuroidea	Elasipodida	Laetmogonidae	*Pannychia*	*moseleyi*

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

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