

**Trawl survey of hoki and middle-depth species on the Chatham Rise,  
January 2011 (TAN1101)**

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

NIWA  
PO Box 14 901  
Wellington

**Published by Ministry of Agriculture and Forestry  
Wellington  
2012**

**ISSN 1175-1584 (print)  
ISSN 1179-5352 (online)  
ISBN 978-0-478-38814-5 (online)**

**© Crown Copyright - Ministry of Agriculture and Forestry**

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.

This series continues the informal  
New Zealand Fisheries Assessment Research Document series  
which ceased at the end of 1999.

Requests for further copies should be directed to:

Publications Logistics Officer  
Ministry of Agriculture and Forestry  
P O Box 2526  
WELLINGTON

Telephone: 0800 00 83 33  
Facsimile: 04-894 0300

This publication is also available on the Ministry of Fisheries website at  
<http://fs.fish.govt.nz> go to Document library/Research reports  
or the MAF website at:  
<http://www.maf.govt.nz/news-resources/publications.aspx>

## EXECUTIVE SUMMARY

**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.*

The twentieth 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 2011. A random stratified sampling design was used, and 114 bottom trawl stations were successfully completed comprising of 88 core (200–800 m) phase one biomass stations, 2 core phase two stations, 23 deep (800–1300 m) stations, and 1 deep phase two station.

The estimate of relative core biomass of all hoki was 93 904 t (c.v. 14.0%), a decrease of 3.7% from January 2010. This was largely driven by a decrease in recruited hoki (3+ and older) from 49 585 t in 2010 to 40 697 t in 2011. The relative biomass of hake decreased by 35.4% to 1099 t (c.v. 14.9%) in 2011. The relative biomass of ling was 7027 t (c.v. 13.8%), 21% lower than in January 2010, but the time-series for ling shows no overall trend.

The 2009 hoki year-class at age 1+ appears to be above average in biomass while the 2008 year-class at age 2+ looks to be average in the trawl time series. The age frequency distribution for hake was broad, with a peak of younger fish from ages 5–8 years, suggesting a pulse of recent recruitment. The age distribution for ling was broad, with most fish aged between 3 and 16 years.

Due to loss of time early in the survey, the southern deep strata (strata 25 and 28) were dropped. The estimated relative biomass of orange roughy in core strata and northern deep strata was 7537 t, a 72% increase from 2010. However, precision was poor (c.v. 60.0%), and the increase was largely due to a 3 t catch on the northwest Chatham Rise.

Acoustic data were also collected during the trawl survey. Acoustic indices of mesopelagic fish abundance on the Chatham Rise in 2011 were the lowest in the time-series going back to 2001. The low acoustic estimate in 2011 was due to the absence of strong daytime mesopelagic marks between 300 and 500 m, particularly on the south Chatham Rise. Total acoustic backscatter observed at night did not show the same decline. Comparison with results from earlier surveys is confounded because there was relatively little good quality acoustic data available from the southeast Chatham Rise in 2011 due to poor weather conditions. Therefore it is uncertain whether the apparent decline in mesopelagic indices in 2011 was related to sample availability (i.e., station locations), or to changes in the species composition, distribution, or abundance of key mesopelagic species. As in previous surveys, there was a weak positive correlation between acoustic density from bottom marks and trawl catch rates in 2011.

## 1. INTRODUCTION

In January 2011, the twentieth in a time series of annual random trawl surveys to estimate relative abundance indices for hoki and a range of other middle depth species 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. The surveys follow a random stratified design, with stratification by depth, longitude, and latitude across the Chatham Rise to ensure full coverage of the area.

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), Stevens & Livingston (2003), Livingston et al. (2004), Livingston & Stevens (2005), and Stevens & O'Driscoll (2006, 2007). Trends in relative biomass and changes in catch and age distribution of 31 species from surveys 1992–2001 were reviewed by Livingston et al. (2002). Relative biomass trends and spatial and depth distributions of 142 species or groups from surveys 2002–2010 were reviewed by O'Driscoll et al. (2011b). Of the priority species, the relative biomass of hoki decreased in the middle part of the time series but subsequently increased, hake showed a significant decrease over the time series, and ling showed no clear trend over the time series.

The 2011 survey results presented here continue the Chatham Rise trawl survey series as part of a long-term research programme to estimate the relative abundance of hoki and other middle depth species for stock assessment. The survey covers the principal juvenile stocks of hoki, believed to derive from both western and eastern spawning stocks. It also surveys older hoki that form part of the eastern stock spawning in Cook Strait and off the east coast South Island. Although older hoki also occur over deepwater and in association with hills, such as the Andes complex east of the Chatham Rise (Livingston et al. 2004), the survey is treated as representative of the eastern adult stock. As well as relative abundance, the survey provided fishery-independent data on the population size structure of middle depth species and their catch distribution across the Chatham Rise. Otoliths from a range of Quota Management System (QMS) species were collected for ageing and use in stock assessments.

Since 2010, the Chatham Rise survey has been extended to deeper waters (to 1300 metres) to provide fishery independent relative abundance indices for a wider range of species, including pre-recruit (20–30 cm) and dispersed adult orange roughy, and black and smooth oreos, as well as providing improved information for species like ribaldo and pale ghostshark, which are known to occur deeper than the historic survey depth boundary (800 m).

Acoustic data were recorded during trawls and while steaming between stations on all trawl surveys on the Chatham Rise since 1995, except for 2004. Data from previous surveys were analysed to describe mark types (Cordue et al. 1998, Bull 2000, O'Driscoll 2001, Livingston et al. 2004, Stevens & O'Driscoll 2006, 2007, Stevens et al. 2008, 2009a, 2009b, 2011), 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, Stevens et al. 2009b, 2011). Acoustic data also provide qualitative information on the amount of backscatter that is not available to the bottom trawl, either 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.

## 1.1 Project objectives

The trawl survey was carried out under contract to the Ministry of Fisheries (project HOK2007/02C). 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 determine the population proportions at age for hoki on the Chatham Rise.
3. To collect acoustic and related data during the trawl survey.
4. To sample deeper strata for orange roughy using a random trawl survey design.
5. To collect and preserve specimens of unidentified organisms taken during the trawl survey, and identify them later ashore.

## 2. METHODS

### 2.1 Survey area and design

As in previous years, the survey followed a two-phase random design (after Francis 1984). The main survey area of 200–800 m depth (Figure 1) was divided into the same 26 strata used in 2003–10 (Livingston et al. 2004, Livingston & Stevens 2005, Stevens & O’Driscoll 2006, 2007, Stevens et al. 2008, 2009a, b, 2011). Station allocation for phase 1 was determined from simulations based on catch rates from all previous Chatham Rise trawl surveys (1992–2010), 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 of Fisheries 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 88 stations in phase 1 (Table 1) was the same as that used in the 2010 survey, when the c.v. for 2+ hoki was 15.4% (Stevens et al. 2011). Phase 2 stations were allocated at sea, largely to improve the c.v. for 1+ hoki.

As in 2010, the survey area was extended to 1300 m. Strata on the southwest Chatham Rise (strata 26, 27, and 29), were excluded 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 pilot survey, 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. Nine of the planned 32 deep tows were not completed because strata 25 and 28 were dropped due to lack of time.

### 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<sup>2</sup>. Measurements of doorspread (from a Scanmar 400 system) and headline height (from a Furuno net monitor) were recorded every 5 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 0512 h and 1833 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 5 min 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 27 January 2010 in Palliser Bay. The system and calibration parameters are given in table 2 of Stevens et al. (2011).

## 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 second 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. Doorspread swept-area biomass and c.v.s were also calculated by stratum for a subset of 8 abundant deepwater species: orange roughy (fish less than 20 cm, fish less than 30 cm, and all fish), black, smooth, and spiky oreos, ribaldo, shovel-nosed dogfish, Baxter's dogfish, and long-nosed 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 647 hoki otoliths and 647 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 139 hake otoliths collected were read.

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) 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 at 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 a FRST programme (CO1X0501).

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 mark 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, 2011a).

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 km<sup>2</sup> 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<sup>2</sup>) from bottom-referenced marks were compared with trawl catch rates (kg per km<sup>2</sup>). 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. (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. 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 2011. The methods were the same as those used by O'Driscoll et al. (2011a) and Stevens et al. (2011). Day estimates of total backscatter were calculated using total mean area backscattering coefficients estimated from each trawl recording. Night estimates of demersal backscatter were based on data recorded while steaming between 2000 h and 0500 h NZST. Acoustic data were stratified into four broad sub-areas (O'Driscoll et al. 2011a). Stratum boundaries were:

Northwest – north of 43° 30'S and west of 177° 00'E;

Northeast – north of 43° 30'S and east of 177° 00'E;

Southwest – south of 43° 30'S and west of 177° 00'E;

Southeast – south of 43° 30'S and east of 177° 00'E.

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



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

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

$$p(meso)_s = psz + p(200)_s * (1 - psz)$$

### 3. RESULTS

#### 3.1 2011 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 known successful tow positions were used for all core biomass tows.

This was the first *Tangaroa* voyage after an extensive re-fit in Singapore from July–Nov 2010 and considerable effort was put into making sure ship's systems and equipment (especially winches and trawl gear) were consistent with those used for previous surveys. Time was lost early in the voyage due to operational problems with ship electrical systems (a breaker was tripping during trawling). There was also loss of time on 9 January due to broken winding-on gear on the port trawl winch. The net monitor paravane flooded on 11 January and was replaced. The replacement unit was faulty and was not suitable for trawling in deep water, so two new units were picked up south of Cape Palliser from RV *Ikateri* on the night 17 January with no significant loss of survey time. Fishing operations only had to be suspended once (for 6 hours on the night of 18 January), by rough conditions (20–35 knot winds and 2–4 m swells) and for much of the survey poor weather reduced vessel speed between trawl survey stations.

Because of the cumulative loss of time during the first two weeks of the voyage there was concern that core survey objectives might not be met. After discussions with MFish, the two deep strata on the southeast Chatham Rise (strata 25 and 28) were dropped. This decision ensured that all phase 1 tows within the core (200–800 m) survey area were completed. Strata 25 and 28 have been less important for orange roughy, with only 8% of the estimated relative orange biomass in these two strata in 2010.

In total 114 successful biomass tows were completed, comprising 88 core (200–800 m) phase 1 tows, 2 core phase 2 stations, 23 deep (800–1300 m) phase 1 tows, and one deep phase 2 tow (Tables 1 and 2, Figure 2, Appendix 1). All 88 of the planned core phase 1 stations were completed. Eight core bottom trawls were excluded from relative biomass calculations: 4 tows came fast, another tow was hauled early due to very high headline height and doorspread readings, and 3 tows were excluded due to equipment failure (the net monitor and the starboard winch cable feeder failed). All deep tows were successful, however, nine of the planned 32 deep tows were not completed, as a result of strata 25 and 28 being dropped due to lack of time.

Core station density ranged from 1:288 km<sup>2</sup> in stratum 17 (200–400 m, Veryan Bank) to 1:3722 km<sup>2</sup> in stratum 4 (600–800 m, south Chatham Rise). Deep station density ranged from 1:416 km<sup>2</sup> in stratum 21a (800–1000 m, NE Chatham Rise) to 1:1940 km<sup>2</sup> in stratum 21b (800–1000 m, NE Chatham Rise). Mean station density was 1:1594 km<sup>2</sup> (see Table 1).

### 3.2 Gear performance

Gear parameters are summarised in Table 3. A headline height value was obtained for all 114 successful tows, but doorspread readings were not available for 19 tows, due to a combination of the Scanmar door sensors not working and the net monitor not being used on tows greater than 1000 m depth. Mean headline heights ranged from 6.0 to 7.9 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 104.5 to 139.8 m, and averaged 125.9 m. This is the highest average doorspread in the time series by 4 m (O'Driscoll et al. 2011b), and reflects the higher overall doorspreads on this survey including 33 over 130 metres (Table 3), and outside the optimal range (Hurst et al. 1992). The reason for these higher doorspread readings is unknown.

### 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 13.1 to 17.9 °C. Bottom temperatures ranged from 3.2 to 11.3 °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 114 valid biomass stations was 130 t, of which 48.3 t (37.3%) was hoki, 3.2 t (2.5%) was ling, and 0.7 t (0.5%) was hake (Table 4). Silver warehou were caught in good numbers with 28.2 t (21.8%), including an 18 t catch. Of the 274 species or species groups identified at sea, 128 were teleosts, 35 were elasmobranchs, 1 was an agnathan, 26 were crustaceans, and 15 were cephalopods. The remainder consisted of assorted benthic and pelagic invertebrates. A full list of species caught, and the number of core stations at which they occurred, is given in Appendix 2. Eighteen benthic invertebrates were formally identified after the voyage (Appendix 3).

### 3.5 Relative biomass estimates

#### Core strata (200–800 m)

Relative core biomass was estimated for 41 species (Table 4). The c.v.s achieved for hoki, hake, and ling from core strata were 14.0%, 14.9%, and 13.8% respectively. The c.v. for 2+ hoki (2008 year class) was 14.1%, 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, alfonsino, silver warehou, slender mackerel, and arrow squid are not strictly demersal and exhibit strong schooling behaviour. Others, such as hapuku, tarakihi, and red cod, have high c.v.s because they are mainly distributed outside the core survey depth range.

The combined relative biomass for the top 31 species in the core strata that are tracked from year to year was lower than in 2009 and 2010, but still relatively high (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. The relative biomass for the 30 other key species was 20% lower than in 2010. Silver warehou was a notable exception with a second successive record relative biomass estimate, largely due to an 18 t catch in stratum 18, southeast of the Mernoo Bank (Figure 5). The next most abundant QMS species were black oreo, spiny dogfish, ling, dark ghost shark, sea perch, lookdown dory, giant stargazer, and pale ghost shark each with an estimated relative biomass of over

2000 t (Table 4). The most abundant non-QMS species were common roughy, javelinfish, big-eye rattail, banded bellowsfish, orange perch, and two saddle rattail (Table 4).

The estimate of relative biomass of hoki in the core strata was 93 904 t, a 3.7% decrease from January 2010 (Table 5, Figure 5). This was largely driven by a 17.9% decrease in recruited hoki (3+ and older) from 49 585 t in 2010 to 40 697 t in 2011 (Table 6). However, the relative biomass of 1+ hoki (2009 year-class) was higher than in 2010 and appears to be one of the stronger year classes in the time series. The number of 2+ hoki (2008 year-class) was similar to last year (Table 6).

The relative biomass of hake in core strata decreased by 35.4% in 2011 to 1099 t, one of the lowest estimates in the time series (see Table 5, Figure 5). There were no core tows to the northeast of Mernoo Bank (stratum 18), where good catches of hake were observed on the previous two surveys.

The relative biomass of ling was 7 027 t, 20.6% lower than in January 2010. The time series for ling shows no overall trend (Figure 5).

The relative biomass of giant stargazer, spiny dogfish, and white warehou increased from 2010, while the relative biomass of dark ghost shark, lookdown dory, pale ghost shark, sea perch, and white warehou decreased (Figure 5). The relative biomass estimate for silver warehou is high but precision is low (c.v. 61.5%) due to one large catch of 18.3 t in stratum 18 (Figure 5).

### **Deep strata (800–1300 m)**

Relative biomass and c.v.s were estimated for 19 of 41 core strata species that were also captured in deep survey strata on the northern Chatham Rise (Table 4). The deep strata were included into the survey design primarily to estimate the relative biomass of juvenile and recruited orange roughy. The estimated relative biomass of orange roughy was 7 513 t (c.v. 59.9%), which was 65.0% of the total biomass for core species in deep strata (Table 4). The c.v. for the relative biomass of orange roughy in all strata in 2011 was large compared to 2010, when the c.v. was 16.6%, because of a single large catch (3 t) taken in stratum 22. There was only enough time to complete a single phase 2 tow in stratum 22, and this was insufficient to reduce the c.v. to target levels.

The estimated relative biomass of smooth oreo in deep strata was 783 t (but precision was poor with a c.v. of 82.8%). Only 8% of the relative biomass of spiky oreo in all strata and 0.1% 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, an area which was not fished during this year's survey. Shovelnose dogfish were abundant in the deep strata, with 25% of their total survey relative biomass found in these strata (Table 4).

The deep strata contained 8.6% of total survey hake biomass, 1.3% of total survey hoki biomass, and 0.3% of total survey ling biomass indicating that the core survey strata are likely to encompass the majority of the population (Table 4).

## **3.6 Catch distribution**

### **Hoki**

In the 2011 survey, hoki were caught at 89 of 90 core biomass stations, with the highest catch rates mainly in shallow strata (200–400 m) on the western Chatham Rise (Table 7, Figure 6). The highest individual catch rates of hoki in 2009 occurred on the Reserve Bank in stratum 20, and comprised mainly 1+ (2009 year class) hoki (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 the northern strata in 200–600 m depth (Figure 6b). The distribution of 3++ hoki was similar to that of 2+ fish (Figure 6c).

## Hake

Catches of hake were consistently low throughout much of the survey area. The highest catch rates were west of the Mernoo Bank in stratum 7, and in the known hake spawning area in strata 10A and 10B. Unlike 2009 and 2010, no random stations fell east of the Mernoo Bank in stratum 7 (Table 7, Figure 7) where hake appear to spawn.

## Ling

As in previous years, catches of ling were evenly distributed throughout most strata in the survey area (Table 7, Figure 8). The highest catch rates were on the Reserve Bank (stratum 19) and NW Chatham Rise (stratum 7). Ling distribution was reasonably consistent, and catch rates have been 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 (Table 7, Figure 9). Lookdown dory and sea perch were also widespread but were most abundant in the east of the survey area, and Reserve Bank (strata 19 and 20) respectively. Dark ghost shark were mainly caught in 200–400 m depths, while pale ghost shark were mostly caught in deeper water at 400–800 m depth. Giant stargazer were abundant in the shallower strata of the survey area, with the largest catches taken in stratum 18 (Mernoo Bank) (Table 7). Silver warehou and white warehou were patchily distributed at depths of 200–600 m. In 2011, there was a large catch of 18 t of silver warehou in stratum 18 (Mernoo Bank) (Figure 9).

Orange roughy were widespread on the northern Rise at 800–1300 m depths, with the largest catch of 3 t taken in on the north-western Rise in stratum 22 (Figure 9). The 3 t catch consisted of both juvenile and adult orange roughy (Table 7). The spatial distribution of black and smooth oreos was relatively patchy compared to orange roughy, although the distribution of the former two species was incompletely sampled because strata 25 and 28 were dropped (Figure 9). Black oreo, predominantly juveniles, were almost entirely caught on the south-western 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 north-western rise at 800–1300 m depths (stratum 23). Spiky oreo were more widespread and most abundant on the northern rise in 600–800 m depths (strata 2 and 12) (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 frequency (Figure 10) was dominated by 1+ (less than 48 cm) and 2+ (48–62 cm) fish (Figure 11). There were few hoki longer than 80 cm (Figure 10) or older than age 6 (Figure 11). Female hoki were slightly more abundant than males (ratio of 1.10 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 9 years and female fish between 3 and 13 years. Since 2004 a cohort of small fish have moved through, which would be 9+ (2001 year-class) in 2011. This year-class was not abundant in 2011. It is uncertain whether this is due to a real decline in the abundance of this cohort, ageing error, or the population not being well sampled in 2011. Female hake were as abundant as males (1.02 female: male).

## Ling

Ling scaled length frequencies and calculated numbers at age (Figures 14 and 15) were broad, with most fish aged between 3 and 17. There was a period of good recruitment during the 1990s (Figure 15). Female ling were slightly less abundant than males (0.9 female: male).

## Other species

Length frequency distributions for key core and deepwater commercial species are shown in Figure 16. Clear modes are apparent in the size distribution of silver warehou and white warehou, which may correspond to yearly cohorts. Length frequencies of lookdown dory, giant stargazer, spiny dogfish, and dark and pale ghost sharks 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 similar size. Because larger orange roughy are more abundant in deeper water, the inclusion of the deep-water strata allowed the main depth distribution of orange roughy to be sampled. Length frequency modes were apparent in the length distribution for orange roughy, and possibly also smooth oreo, but are unlikely to represent distinct year classes given the high longevity of these species. In contrast, the length frequency distribution of black oreo was unimodal. As with previous years, the catch of spiny dogfish was dominated by females (3.8 female: 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. All hoki were recorded as either resting or immature. About 35% of male ling were maturing or ripe, but few females were showing signs of reproductive activity. Similarly 39% of male hake were ripe or running ripe, but most females were resting (51%) or maturing (35%) (Table 10). The majority of the other species for which reproductive state was recorded showed no sign of reproductive activity, the exceptions being two saddle rattails and the occasional deepwater shark (Table 10).

## 3.8 Acoustic results

Over 78 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. Moderate to rough weather and sea conditions for much of the survey meant that the quality of acoustic recordings was not as good as in some previous surveys, but 77% of the 327 files collected were still suitable for quantitative analysis. Twenty three of the 102 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. (2011b), there is a consistent spatial pattern in total backscatter, with higher backscatter in the west. There were relatively few trawl stations with acoustic data from the southeast Chatham Rise in 2011 (see Figure 17 – only 13 acoustic data-points in this stratum in 2011 compared to 22–30 points from each of the surveys from 2001–10) because of poor weather conditions while the survey was in this region.

### 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 2011 was generally similar to that observed in previous surveys, but a lower percentage of bottom schools and layers and a higher percentage of bottom clouds were observed during the day in 2011 (Table 11). Bottom clouds are more diffuse and dispersed than bottom layers and the increase in this mark type, along with a concurrent reduction in occurrence of bottom layers, may have been due to the reduced acoustic density in bottom-referenced layers (see Section 3.8.2 below).

Pelagic layers were the most common daytime mark type, occurring in 79% of day steam files and 71% of day trawl files in 2011 (Table 11). Midwater trawling on previous Chatham Rise surveys suggests that pelagic layers contain mesopelagic fish species, such as pearlsheds (*Maurolicus australis*) and lanternfishes (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 surface layers. Surface layers were observed in almost all (97%) night recordings and most (70%) day echograms. Pelagic schools were observed in 32% of day steam files, 37% of day trawl files, and 6% of night files (Table 11). Cordue et al. (1998) suggested that pelagic schools or “bullets” were associated with Ray’s bream, but it is likely that the schools are aggregations of mesopelagic fish, on which Ray’s bream feed. Trawling on a voyage carried out by the FRST programme in May–June 2008 found that small pelagic schools were often dominated by the myctophid *Symbolophorus* spp. (Stéphane Gauthier, NIWA, pers. comm.)

Bottom layers were observed in 59% of day steam files, 50% of day trawl files, and 26% 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 and steam) recordings in 2011, 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 73 trawl files were integrated and compared with trawl catch rates (Table 12). Data from the other 29 daytime trawl recordings were not included in the analysis because the acoustic data were too noisy (23 files) or because the trawl was outside the 200–800 m core survey area (6 files). Average acoustic backscatter values from bottom-referenced marks and from the entire water column in 2011 were the lowest in the time-series stretching back to 2001 (Table 12). Average trawl catch from the comparable tows in 2011 was also lower than that in 2007–10, but higher than the average catch rates in 2001–06 (Table 12). However the trawl catch in 2011 was driven up by two large catches of silver warehou (tows 53 and 112), and the median trawl catch in 2011 was the second lowest (after 2008) in the time-series.

There was a weak positive correlation (Spearman’s rank correlation,  $\rho = 0.32$ ) between acoustic backscatter in the bottom 100 m during the day and trawl catch rates (Figure 18). In previous Chatham Rise surveys from 2001–10, 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 relative biomass estimate for hoki on the Chatham Rise.

### 3.8.3 Time-series of relative mesopelagic fish abundance

In surveys from 2001–10, most acoustic backscatter was between 300 and 500 m depth during the day, and migrated into the surface 200 m at night (e.g., pattern for 2010 in Figure 19). In 2011, there was no strong daytime peak centred around 350 m, but there was a concentration of backscatter between 150 and 350 m, and smaller peaks centred at around 550 and 750 m (Figure 19). The distribution of backscatter at night in 2011 was similar to the pattern observed in previous surveys, with most backscatter in the upper 200 m (Figure 19).

The vertically migrating component of acoustic backscatter is assumed to be dominated by mesopelagic fish (see McClatchie & Dunford, 2003 for rationale and caveats). In 2011, between 49 and 76% 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, 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).

From 2001 to 2010, day estimates of total acoustic backscatter over the Chatham Rise were 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). In 2011, for the first time, night estimates were higher than day estimates (Figure 20). Day estimates of total backscatter have declined since 2009, but night estimates have been relatively consistent over the same period (Figure 20). O’Driscoll et al. (2011b) concluded that changes in total backscatter are probably related to patterns in mesopelagic fish abundance, rather than demersal fish abundance, but it is difficult to explain why day estimates have declined in the last two years and night estimates have not unless there has been a change in species composition and/or diel behaviour. Similarly, backscatter within 50 m of the bottom during the day has decreased since the start of the time series, but backscatter close to the bottom at night was about the same throughout (Figure 20).

The ‘best’ estimate of mesopelagic fish abundance was calculated by multiplying estimates of the total daytime backscatter by the estimated proportion of night-time backscatter in the same sub-area 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. 2011b). 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 2011 were the lowest in the time-series for the overall Chatham Rise and for three of the four subareas (Table 14). There were particularly large declines in daytime backscatter observed in the two southern strata in 2011 (Table 14, Figure 21).

Decreases in total acoustic backscatter during the day (see Table 12) and the derived mesopelagic estimates (Figure 21) in 2011 were due to the absence of strong daytime mesopelagic marks between 300 and 500 m (see Figure 19), particularly on the southern Chatham Rise. When combined with the relative lack of both daytime bottom layers and pelagic schools in 2011 (see Table 11), this suggests a change in mesopelagic species composition on the south Chatham Rise compared to previous surveys. However, comparison with results from earlier surveys is confounded because there was relatively little good quality acoustic data available from the southeast Chatham Rise in 2011 due to poor weather (see Figure 17). Therefore it is uncertain whether the apparent change in mesopelagic indices

in 2011 was related to sample availability (i.e., station locations), or to environmental conditions, a change in seasonal patterns of distribution, or an actual change in abundance of key mesopelagic species.

#### 4. CONCLUSIONS

The 2011 survey successfully extended the January Chatham Rise time series into its twentieth year and provided abundance indices for hoki, hake, and ling. The survey c.v. of 14.1% achieved for 2+ hoki was well below the target level of 20%. The estimated relative biomass of hoki in all strata was 3.7% lower than in 2010, largely due to a decrease in the relative biomass of recruited hoki. However, the 1+ year-class (2009 year-class) was higher than in 2010 and appears to be one of the stronger cohorts in the time series. The 2+ year-class (2008 year-class) is similar to last year and about average in the time series.

The relative biomass of hake in core strata decreased by 35% in 2011 to 1099 t, which is one of the lowest estimates in the time series. However there were no core tows to the northeast of Mernoo Bank (stratum 18), where good catches of hake have been observed on the previous two surveys. The relative biomass of ling in core strata also decreased in 2011, but the time series for ling shows no overall trend.

Due to loss of time early in the survey, the southern deep strata (strata 25 and 28) were dropped. However, the northern 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 increased by 72% in 2011 to 7537 t, but precision was poor (c.v. 60.0%), and the increase was largely due to a 3 t catch of orange roughy in stratum 22 on the northwest Chatham Rise. The 2010 and 2011 orange roughy relative biomass estimates are the first in a time series. Additional estimates are required before biomass trends can be investigated.

#### 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. This work was carried out by NIWA under contract to the Ministry of Fisheries (Project HOK2010/02). A draft of this report was reviewed by Peter McMillan.



## 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.
- 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 of Fisheries, 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 of Fisheries, 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 of Fisheries, 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 of Fisheries, 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 of Fisheries, 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 of Fisheries, 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.; 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* 72p. + 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. (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.; 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.; 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.; 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.
- 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 2011 Chatham Rise trawl survey.**

| Stratum number | Depth range (m) | Location        | Area (km <sup>2</sup> ) | Phase 1 allocation | Phase 1 stations | Phase 2 stations | Total stations | Station density (1: km <sup>2</sup> ) |
|----------------|-----------------|-----------------|-------------------------|--------------------|------------------|------------------|----------------|---------------------------------------|
| 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                              |
| 7              | 400–600         | NW Chatham Rise | 5 233                   | 6                  | 6                |                  | 6              | 1: 872                                |
| 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                   | 4                  | 4                |                  | 4              | 1: 742                                |
| 11B            | 400–600         | NE Chatham Rise | 2 072                   | 3                  | 3                |                  | 3              | 1: 691                                |
| 11C            | 400–600         | NE Chatham Rise | 3 342                   | 3                  | 3                |                  | 3              | 1: 1 114                              |
| 11D            | 400–600         | NE Chatham Rise | 3 368                   | 3                  | 3                |                  | 3              | 1: 1 123                              |
| 12             | 400–600         | SE Chatham Rise | 6 578                   | 3                  | 3                |                  | 3              | 1: 2 193                              |
| 13             | 400–600         | SE Chatham Rise | 6 681                   | 3                  | 3                |                  | 3              | 1: 2 227                              |
| 14             | 400–600         | SW Chatham Rise | 5 928                   | 3                  | 3                |                  | 3              | 1: 1 976                              |
| 15             | 400–600         | SW Chatham Rise | 5 842                   | 3                  | 3                |                  | 3              | 1: 1 947                              |
| 16             | 400–600         | SW Chatham Rise | 11 522                  | 3                  | 3                |                  | 3              | 1: 3 841                              |
| 17             | 200–400         | Veryan Bank     | 865                     | 3                  | 3                |                  | 3              | 1: 288                                |
| 18             | 200–400         | Mernoo Bank     | 4 687                   | 3                  | 3                |                  | 3              | 1: 1 562                              |
| 19             | 200–400         | Reserve Bank    | 9 012                   | 4                  | 4                |                  | 4              | 1: 2 253                              |
| 20             | 200–400         | Reserve Bank    | 9 584                   | 5                  | 5                | 2                | 7              | 1: 1 369                              |
| 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                   | 6                  | 6                | 1                | 7              | 1: 1 051                              |
| 23             | 1000–1300       | NW Chatham Rise | 7 014                   | 7                  | 7                |                  | 7              | 1: 1 002                              |
| 24             | 1000–1300       | NE Chatham Rise | 5 672                   | 4                  | 3                |                  | 3              | 1: 1 891                              |
| 25             | 800–1000        | SE Chatham Rise | 5 596                   | 5                  | 0                |                  | 0              |                                       |
| 28             | 1000–1300       | SE Chatham Rise | 9 494                   | 4                  | 1                |                  | 1              |                                       |
| Total          |                 |                 | 181 699                 | 120                | 111              | 3                | 114            | 1: 1 594                              |

**Table 2: Survey dates and number of valid 200–800 m depth biomass stations in surveys of the Chatham Rise, January 1992–2011.**

| 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                                 |

**Table 3: Tow and gear parameters by depth range for valid biomass stations (TAN1101). Values shown are sample size (n), and for each parameter the mean, standard deviation (s.d.), and range.**

|                            | n   | Mean (m) | s.d. | Range       |
|----------------------------|-----|----------|------|-------------|
| <b>Core tow parameters</b> |     |          |      |             |
| Tow length (n. miles)      | 90  | 2.9      | 0.25 | 2.0–3.2     |
| Tow speed (knots)          | 90  | 3.5      | 0.06 | 3.3–3.7     |
| <b>All tow parameters</b>  |     |          |      |             |
| Tow length (n. miles)      | 114 | 2.9      | 0.24 | 2.0–3.2     |
| Tow speed (knots)          | 114 | 3.5      | 0.06 | 3.3–3.7     |
| <b>Gear parameters</b>     |     |          |      |             |
| 200–400 m                  |     |          |      |             |
| Headline height            | 26  | 7.0      | 0.34 | 6.2–7.6     |
| Doorspread                 | 25  | 119.6    | 7.80 | 104.5–132.6 |
| 400–600 m                  |     |          |      |             |
| Headline height            | 46  | 6.7      | 0.32 | 6.0–7.7     |
| Doorspread                 | 39  | 129.1    | 4.48 | 118.8–139.8 |
| 600–800 m                  |     |          |      |             |
| Headline height            | 18  | 6.8      | 0.23 | 6.5–7.2     |
| Doorspread                 | 18  | 127.3    | 6.62 | 113.0–136.3 |
| 800–1000 m                 |     |          |      |             |
| Headline height            | 13  | 7.0      | 0.30 | 6.6–7.6     |
| Doorspread                 | 11  | 126.0    | 4.75 | 119.9–133.0 |
| 1000–1300 m                |     |          |      |             |
| Headline height            | 11  | 7.3      | 0.33 | 6.9–7.9     |
| Doorspread                 | 2   | 127.3    | 8.84 | 121.0–133.5 |
| Core stations 200–800 m    |     |          |      |             |
| Headline height            | 90  | 6.8      | 0.33 | 6.0–7.7     |
| Doorspread                 | 82  | 125.8    | 7.36 | 104.5–139.8 |
| All stations 200–1300 m    |     |          |      |             |
| Headline height            | 114 | 6.9      | 0.36 | 6.0–7.9     |
| Doorspread                 | 95  | 125.9    | 7.07 | 104.5–139.8 |

**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.).**

| Common name   | Code | Core strata 200–800m |               |           |                 |           |               | 800–1300 m |              |           |
|---|------|----------------------|---------------|-----------|-----------------|-----------|---------------|------------|--------------|-----------|
|   |      | Catch<br>kg          | Biomass males |           | Biomass females |           | Total biomass |            | Deep biomass |           |
|   |      |                      | t             | %<br>c.v. | t               | %<br>c.v. | t             | %<br>c.v.  | t            | %<br>c.v. |
| <b>QMS species</b>  |      |                      |               |           |                 |           |               |            |              |           |
| Hoki  | HOK  | 47 339               | 42 016        | 14.4      | 51 796          | 14.0      | 93 904        | 14.0       | 1 223        | 11.2      |
| Silver warehou  | SWA  | 28 221               | 46 181        | 63.1      | 35 894          | 59.5      | 82 075        | 61.5       | -            | -         |
| Black oreo  | BOE  | 2 764                | 5 478         | 21.3      | 5 676           | 21.1      | 11 195        | 21.0       | 16           | 60        |
| Spiny dogfish   | SPD  | 3 290                | 1 384         | 27.4      | 6 410           | 12.1      | 7 794         | 13.6       | -            | -         |
| Ling  | LIN  | 3 210                | 3 169         | 17.2      | 3 858           | 12.5      | 7 027         | 13.8       | 19           | 73.1      |
| Dark ghostshark   | GSH  | 3 195                | 2 546         | 16.5      | 4 041           | 18.0      | 6 588         | 16.6       | -            | -         |
| Sea perch   | SPE  | 1 379                | 1 660         | 10.7      | 1 614           | 10.6      | 3 278         | 10.2       | 8            | 61.2      |
| Lookdown dory   | LDO  | 1 670                | 1 294         | 34.7      | 1 960           | 16.2      | 3 257         | 21.4       | 8            | 44.6      |
| Giant stargazer   | STA  | 1 074                | 1 047         | 31.2      | 2 121           | 26.7      | 3 169         | 27.7       | 8            | 100       |
| Pale ghostshark   | GSP  | 1 053                | 1 250         | 14.9      | 1 300           | 14.1      | 2 550         | 14.2       | 145          | 21.2      |
| White warehou   | WWA  | 918                  | 1 032         | 55.5      | 828             | 52.2      | 1 861         | 53.9       | -            | -         |
| Spiky oreo  | SOR  | 741                  | 798           | 47.3      | 812             | 37.9      | 1 619         | 41.9       | 154          | 42.3      |
| Arrow squid   | NOS  | 449                  | 615           | 63.9      | 894             | 66.7      | 1 511         | 65.3       | 1            | 100       |
| Hake  | HAK  | 581                  | 321           | 22.9      | 778             | 16.9      | 1 099         | 14.9       | 103          | 28.8      |
| Alfonsino   | BYS  | 552                  | 571           | 56.4      | 465             | 44.1      | 1 038         | 50.4       | 4            | 100       |
| Smooth skate  | SSK  | 498                  | 314           | 38.3      | 600             | 40.0      | 1 009         | 32.0       | 8            | 100       |
| Smooth oreo   | SSO  | 233                  | 413           | 79.2      | 390             | 73.3      | 808           | 76.4       | 783          | 82.8      |
| Hapuku  | HAP  | 138                  | 258           | 48.2      | 181             | 33.0      | 438           | 38.1       | -            | -         |
| Ribaldo   | RIB  | 229                  | 204           | 15.9      | 192             | 25.6      | 396           | 16.7       | 93           | 34.7      |
| Red cod   | RCO  | 166                  | 192           | 64.6      | 161             | 57.9      | 357           | 61.6       | -            | -         |
| Southern Ray's bream  | SRB  | 100                  | 185           | 78.8      | 171             | 52.1      | 355           | 65.8       | -            | -         |
| School shark  | SCH  | 113                  | 275           | 72.9      | 51              | 100       | 325           | 62.8       | -            | -         |
| Barracouta  | BAR  | 48                   | 77            | 56.6      | 92              | 62.5      | 169           | 58.2       | -            | -         |
| Rough skate   | RSK  | 94                   | 28            | 60.9      | 126             | 65.5      | 154           | 54.9       | -            | -         |
| Tarakihi  | TAR  | 43                   | 103           | 59.4      | 47              | 39.8      | 150           | 49.6       | -            | -         |
| Slender mackerel  | JMM  | 48                   | 91            | 82.3      | 46              | 72.1      | 137           | 78.5       | -            | -         |
| Deepsea cardinalfish  | EPT  | 42                   | 33            | 42.6      | 28              | 44.1      | 62            | 41.9       | -            | -         |
| Bluenose  | BNS  | 33                   | 23            | 70.9      | 28              | 63.1      | 51            | 48.0       | -            | -         |
| Orange roughy   | ORH  | 13                   | 14            | 52.2      | 11              | 56.6      | 24            | 53.5       | 7 513        | 59.9      |
| Lemon sole  | LSO  | 10                   | 11            | 41.2      | 10              | 44.0      | 21            | 40.5       | -            | -         |
| Rubyfish  | RBY  | 6                    | 5             | 75.9      | 4               | 100       | 12            | 87.7       | -            | -         |
| Scampi  | SCI  | 4                    | 3             | 25.5      | 5               | 26.3      | 9             | 18.8       | -            | -         |
| Frostfish   | FRO  | 2                    | 8             | 100       | 0               | -         | 8             | 100        | -            | -         |
| Jack mackerel   | JMD  | 3                    | 1             | 100       | 6               | 100       | 7             | 82.8       | -            | -         |
| <b>Commercial non-QMS species (where biomass &gt; 30 t)</b> |      |                      |               |           |                 |           |               |            |              |           |
| Shovelnose dogfish  | SND  | 2 198                | 2 140         | 16.2      | 1 756           | 14.4      | 3 897         | 13.7       | 1 329        | 32.6      |
| <b>Non-commercial species (where biomass &gt; 800 t)</b>    |      |                      |               |           |                 |           |               |            |              |           |
| Common roughy   | RHY  | 3 028                | -             | -         | -               | -         | 11 604        | 98.0       | -            | -         |
| Javelinfinh   | JAV  | 3 349                | -             | -         | -               | -         | 7 849         | 12.3       | 109          | 46.2      |
| Big-eye rattail   | CBO  | 1 556                | -             | -         | -               | -         | 3 455         | 15.7       | 19           | 39.6      |
| Banded bellowsfish  | BBE  | 776                  | -             | -         | -               | -         | 1 314         | 11.9       | 10           | 100       |
| Orange perch  | OPE  | 372                  | -             | -         | -               | -         | 1 164         | 42.6       | -            | -         |
| Two saddle rattail  | CBI  | 247                  | -             | -         | -               | -         | 853           | 29.2       | -            | -         |
| Total (above)   |      | 109 785              |               |           |                 |           |               |            |              |           |
| Grand total (all species)                                   |      | 115 434              |               |           |                 |           |               |            |              |           |

**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 1992–2011. stns, stations (-, no data; c.v., coefficient of variation.).**

| Year | Survey  | Core strata 200–800 m |         |       |        |
|------|---------|-----------------------|---------|-------|--------|
|      |         | 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   |

**Table 6: Relative biomass estimates (t in thousands) of hoki, 200–800 m depths, Chatham Rise trawl surveys January 1992–2011 (c.v. coefficient of variation; 3++ all hoki aged 3 years and older; (see Appendix 4 for length ranges of age classes).**

| Survey | 1+ year class | 1+ hoki |        | 2+ year class | 2+ hoki |        | 3 ++ hoki |        | Total hoki |        |
|--------|---------------|---------|--------|---------------|---------|--------|-----------|--------|------------|--------|
|        |               | t       | % c.v  |               | 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) |



**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); Total, total biomass from all valid tows (200–1300 m); -, not calculated.)**

| Stratum | Species code |      |        |      |       |      |       |      |       |      |       |      |
|---------|--------------|------|--------|------|-------|------|-------|------|-------|------|-------|------|
|         | HOK          |      | SWA    |      | SPD   |      | LIN   |      | GSH   |      | SPE   |      |
|         | t            | c.v. | t      | c.v. | t     | c.v. | t     | c.v. | t     | c.v. | t     | c.v. |
| 1       | 435          | 33   | 0      | 0    | 0     | 0    | 92    | 51   | 0     | 0    | 18    | 100  |
| 2a      | 440          | 30   | 0      | 0    | 0     | 0    | 137   | 25   | 0     | 0    | 49    | 37   |
| 2b      | 1 210        | 24   | 0      | 0    | 0     | 0    | 187   | 30   | 0     | 0    | 33    | 22   |
| 3       | 3 137        | 78   | 15     | 53   | 686   | 47   | 221   | 66   | 372   | 90   | 77    | 29   |
| 4       | 815          | 11   | 0      | 0    | 0     | 0    | 160   | 23   | 0     | 0    | 83    | 61   |
| 5       | 3 803        | 24   | 22     | 34   | 1 066 | 10   | 220   | 45   | 284   | 42   | 91    | 75   |
| 6       | 1 786        | 27   | 0      | 0    | 0     | 0    | 347   | 57   | 0     | 0    | 0     | 0    |
| 7       | 2 818        | 22   | 36     | 93   | 51    | 46   | 612   | 35   | 1     | 100  | 22    | 49   |
| 8a      | 2 700        | 49   | 0      | 0    | 0     | 0    | 128   | 68   | 0     | 0    | 97    | 28   |
| 8b      | 3 397        | 18   | 533    | 61   | 448   | 16   | 317   | 16   | 77    | 50   | 260   | 28   |
| 9       | 2 808        | 76   | 22 753 | 91   | 178   | 52   | 120   | 71   | 1 336 | 33   | 69    | 98   |
| 10a     | 2 430        | 50   | 366    | 47   | 53    | 82   | 184   | 13   | 6     | 53   | 64    | 35   |
| 10b     | 672          | 37   | 31     | 34   | 205   | 35   | 113   | 63   | 19    | 100  | 29    | 60   |
| 11a     | 3 709        | 48   | 145    | 15   | 150   | 28   | 51    | 26   | 54    | 58   | 33    | 53   |
| 11b     | 622          | 17   | 5      | 100  | 0     | 0    | 83    | 20   | 0     | 0    | 27    | 21   |
| 11c     | 1 763        | 6    | 19     | 26   | 229   | 51   | 89    | 61   | 37    | 55   | 12    | 42   |
| 11d     | 4 492        | 52   | 82     | 100  | 32    | 100  | 181   | 29   | 79    | 100  | 50    | 17   |
| 12      | 1 831        | 46   | 60     | 100  | 49    | 100  | 290   | 69   | 97    | 93   | 69    | 56   |
| 13      | 3 327        | 9    | 74     | 89   | 94    | 53   | 311   | 29   | 0     | 0    | 57    | 44   |
| 14      | 1 600        | 7    | 11     | 54   | 108   | 35   | 348   | 32   | 0     | 0    | 224   | 60   |
| 15      | 2 594        | 40   | 355    | 50   | 501   | 84   | 590   | 39   | 3     | 100  | 58    | 15   |
| 16      | 8 927        | 12   | 148    | 100  | 537   | 57   | 778   | 35   | 8     | 100  | 20    | 100  |
| 17      | 2 108        | 79   | 9      | 55   | 64    | 46   | 62    | 13   | 325   | 37   | 1     | 100  |
| 18      | 4 730        | 76   | 54 228 | 85   | 1 857 | 43   | 124   | 100  | 388   | 47   | 162   | 99   |
| 19      | 7 338        | 52   | 1 853  | 60   | 688   | 26   | 745   | 100  | 1 561 | 29   | 729   | 21   |
| 20      | 24 410       | 44   | 1 330  | 48   | 798   | 20   | 536   | 34   | 1 940 | 41   | 942   | 16   |
| 21a     | 118          | 61   | 0      | 0    | 0     | 0    | 0     | 0    | 0     | 0    | 1     | 100  |
| 21b     | 262          | 1    | 0      | 0    | 0     | 0    | 0     | 0    | 0     | 0    | 0     | 0    |
| 22      | 836          | 14   | 0      | 0    | 0     | 0    | 19    | 73   | 0     | 0    | 8     | 65   |
| 23      | 3            | 100  | 0      | 0    | 0     | 0    | 0     | 0    | 0     | 0    | 0     | 0    |
| 24      | 4            | 100  | 0      | 0    | 0     | 0    | 0     | 0    | 0     | 0    | 0     | 0    |
| 25      | 0            | 0    | 0      | 0    | 0     | 0    | 0     | 0    | 0     | 0    | 0     | 0    |
| 28      | 0            | 0    | 0      | 0    | 0     | 0    | 0     | 0    | 0     | 0    | 0     | 0    |
| Core    | 93 904       | 14   | 82 075 | 62   | 7 794 | 14   | 7 027 | 14   | 6 588 | 17   | 3 278 | 10   |
| Total   | 95 127       | 14   | 82 075 | 62   | 7 794 | 14   | 7 046 | 14   | 6 588 | 17   | 3 286 | 10   |

**Table 7 (continued)**

| Stratum | Species code |      |       |      |       |      |       |      |       |      |
|---------|--------------|------|-------|------|-------|------|-------|------|-------|------|
|         | LDO          |      | STA   |      | GSP   |      | WWA   |      | HAK   |      |
|         | t            | c.v. | t     | c.v. | t     | c.v. | t     | c.v. | t     | c.v. |
| 1       | 14           | 64   | 0     | 0    | 87    | 71   | 0     | 0    | 4     | 100  |
| 2a      | 62           | 11   | 17    | 100  | 116   | 17   | 0     | 0    | 31    | 54   |
| 2b      | 88           | 21   | 0     | 0    | 101   | 20   | 0     | 0    | 132   | 52   |
| 3       | 16           | 52   | 3     | 90   | 7     | 100  | 5     | 65   | 11    | 100  |
| 4       | 5            | 100  | 0     | 0    | 282   | 34   | 40    | 100  | 24    | 100  |
| 5       | 71           | 40   | 41    | 55   | 0     | 0    | 203   | 38   | 16    | 71   |
| 6       | 21           | 84   | 0     | 0    | 369   | 10   | 24    | 55   | 41    | 50   |
| 7       | 82           | 15   | 35    | 57   | 180   | 34   | 27    | 53   | 155   | 30   |
| 8a      | 86           | 15   | 2     | 100  | 50    | 79   | 17    | 75   | 54    | 29   |
| 8b      | 135          | 29   | 0     | 0    | 120   | 75   | 2     | 100  | 33    | 55   |
| 9       | 362          | 52   | 251   | 46   | 0     | 0    | 0     | 0    | 0     | 0    |
| 10a     | 245          | 53   | 5     | 100  | 146   | 52   | 16    | 46   | 89    | 56   |
| 10b     | 20           | 29   | 12    | 58   | 7     | 100  | 24    | 89   | 59    | 100  |
| 11a     | 254          | 44   | 27    | 51   | 0     | 0    | 16    | 85   | 22    | 68   |
| 11b     | 37           | 51   | 0     | 0    | 9     | 57   | 7     | 59   | 14    | 60   |
| 11c     | 35           | 24   | 42    | 47   | 25    | 100  | 0     | 0    | 11    | 100  |
| 11d     | 761          | 80   | 0     | 0    | 19    | 25   | 34    | 85   | 38    | 56   |
| 12      | 337          | 15   | 57    | 52   | 42    | 52   | 53    | 38   | 95    | 62   |
| 13      | 40           | 75   | 16    | 81   | 230   | 78   | 8     | 100  | 57    | 80   |
| 14      | 48           | 30   | 25    | 61   | 334   | 35   | 5     | 100  | 61    | 51   |
| 15      | 29           | 30   | 159   | 89   | 238   | 88   | 13    | 100  | 8     | 100  |
| 16      | 136          | 54   | 190   | 46   | 170   | 45   | 82    | 80   | 105   | 55   |
| 17      | 3            | 61   | 3     | 50   | 0     | 0    | 0     | 0    | 7     | 100  |
| 18      | 25           | 100  | 1699  | 48   | 0     | 0    | 226   | 100  | 0     | 0    |
| 19      | 188          | 100  | 381   | 51   | 0     | 0    | 9     | 95   | 33    | 100  |
| 20      | 157          | 47   | 203   | 61   | 18    | 100  | 1050  | 92   | 0     | 0    |
| 21a     | 1            | 100  | 0     | 0    | 5     | 37   | 0     | 0    | 22    | 29   |
| 21b     | 5            | 50   | 0     | 0    | 51    | 40   | 0     | 0    | 0     | 0    |
| 22      | 3            | 100  | 8     | 100  | 81    | 28   | 0     | 0    | 49    | 53   |
| 23      | 0            | 0    | 0     | 0    | 7     | 53   | 0     | 0    | 31    | 39   |
| 24      | 0            | 0    | 0     | 0    | 0     | 0    | 0     | 0    | 0     | 0    |
| 25      | 0            | 0    | 0     | 0    | 0     | 0    | 0     | 0    | 0     | 0    |
| 28      | 0            | 0    | 0     | 0    | 0     | 0    | 0     | 0    | 0     | 0    |
| Core    | 3 257        | 21   | 3 169 | 28   | 2 550 | 14   | 1 861 | 54   | 1 099 | 15   |
| Total   | 3 266        | 21   | 3 177 | 28   | 2 695 | 14   | 1 861 | 54   | 1 201 | 14   |

**Table 7 (continued)**

| Stratum | Species code |      |            |      |           |      |        |      |       |      |
|---------|--------------|------|------------|------|-----------|------|--------|------|-------|------|
|         | <20 cm ORH   |      | <30 cm ORH |      | total ORH |      | BOE    |      | SOR   |      |
|         | t            | c.v. | t          | c.v. | t         | c.v. | t      | c.v. | t     | c.v. |
| 1       | 0            | 0    | 0          | 0    | 1         | 100  | 0      | 0    | 80    | 58   |
| 2a      | 1            | 100  | 2          | 100  | 5         | 100  | 0      | 0    | 229   | 44   |
| 2b      | 2            | 65   | 10         | 72   | 17        | 70   | 0      | 0    | 623   | 30   |
| 3       | 0            | 0    | 0          | 0    | 0         | 0    | 0      | 0    | 0     | 0    |
| 4       | 0            | 0    | 0          | 0    | 0         | 0    | 2 740  | 52   | 38    | 44   |
| 5       | 0            | 0    | 0          | 0    | 0         | 0    | 0      | 0    | 0     | 0    |
| 6       | 0            | 0    | 0          | 0    | 0         | 0    | 8 452  | 22   | 2     | 100  |
| 7       | 0            | 0    | 0          | 0    | 0         | 0    | 0      | 0    | 0     | 0    |
| 8a      | 0            | 0    | 0          | 0    | 0         | 0    | 0      | 0    | 2     | 100  |
| 8b      | 0            | 0    | 0          | 0    | 0         | 0    | 0      | 0    | 0     | 0    |
| 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    | 0     | 0    |
| 11a     | 0            | 0    | 0          | 0    | 0         | 0    | 0      | 0    | 0     | 0    |
| 11b     | 0            | 0    | 0          | 0    | 0         | 0    | 0      | 0    | 2     | 100  |
| 11c     | 0            | 0    | 0          | 0    | 0         | 0    | 0      | 0    | 0     | 0    |
| 11d     | 0            | 0    | 0          | 0    | 0         | 0    | 0      | 0    | 0     | 0    |
| 12      | 1            | 100  | 1          | 100  | 1         | 100  | 0      | 0    | 643   | 100  |
| 13      | 0            | 0    | 0          | 0    | 0         | 0    | 0      | 0    | 0     | 0    |
| 14      | 0            | 0    | 0          | 0    | 0         | 0    | 0      | 0    | 0     | 0    |
| 15      | 0            | 0    | 0          | 0    | 0         | 0    | 3      | 62   | 0     | 0    |
| 16      | 0            | 0    | 0          | 0    | 0         | 0    | 0      | 0    | 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    | 0      | 0    | 0     | 100  |
| 21a     | 2            | 52   | 28         | 42   | 111       | 49   | 0      | 100  | 1     | 100  |
| 21b     | 3            | 83   | 80         | 25   | 190       | 29   | 0      | 0    | 87    | 39   |
| 22      | 344          | 97   | 1 834      | 94   | 4 726     | 94   | 6      | 75   | 62    | 89   |
| 23      | 7            | 51   | 54         | 37   | 666       | 48   | 10     | 86   | 3     | 100  |
| 24      | 2            | 100  | 199        | 46   | 1 819     | 34   | 0      | 0    | 0     | 0    |
| 25      | 0            | 0    | 0          | 0    | 0         | 0    | 0      | 0    | 0     | 0    |
| 28      | 0            | 0    | 0          | 0    | 0         | 0    | 0      | 0    | 0     | 0    |
| Core    | 4            | 48   | 13         | 57   | 24        | 54   | 11 195 | 21   | 1619  | 42   |
| Total   | 362          | 92   | 2 208      | 79   | 7 537     | 60   | 11 211 | 21   | 1 772 | 39   |

**Table 7 (continued)**

| Stratum | Species code |      |       |      |     |      |       |      |     |      |
|---------|--------------|------|-------|------|-----|------|-------|------|-----|------|
|         | SND          |      | SSO   |      | ETB |      | CYP   |      | RIB |      |
|         | t            | c.v. | t     | c.v. | t   | c.v. | t     | c.v. | t   | c.v. |
| 1       | 308          | 39   | 11    | 92   | 0   | 100  | 183   | 51   | 27  | 29   |
| 2a      | 1 028        | 14   | 4     | 100  | 4   | 100  | 88    | 100  | 95  | 33   |
| 2b      | 2 279        | 22   | 27    | 62   | 47  | 100  | 317   | 38   | 69  | 32   |
| 3       | 0            | 0    | 0     | 0    | 0   | 0    | 0     | 0    | 0   | 0    |
| 4       | 0            | 0    | 0     | 0    | 132 | 91   | 2     | 100  | 5   | 100  |
| 5       | 0            | 0    | 0     | 0    | 0   | 0    | 0     | 0    | 0   | 0    |
| 6       | 68           | 89   | 766   | 81   | 237 | 34   | 0     | 0    | 35  | 52   |
| 7       | 81           | 46   | 0     | 0    | 3   | 60   | 6     | 89   | 48  | 36   |
| 8a      | 6            | 100  | 0     | 0    | 0   | 0    | 0     | 0    | 22  | 80   |
| 8b      | 0            | 0    | 0     | 0    | 0   | 0    | 0     | 0    | 0   | 0    |
| 9       | 0            | 0    | 0     | 0    | 0   | 0    | 0     | 0    | 0   | 0    |
| 10a     | 17           | 100  | 0     | 0    | 0   | 0    | 0     | 0    | 3   | 100  |
| 10b     | 0            | 0    | 0     | 0    | 0   | 0    | 0     | 0    | 3   | 100  |
| 11a     | 0            | 0    | 0     | 0    | 0   | 0    | 0     | 0    | 0   | 0    |
| 11b     | 37           | 24   | 0     | 0    | 3   | 100  | 0     | 100  | 17  | 70   |
| 11c     | 0            | 0    | 0     | 0    | 0   | 0    | 0     | 0    | 4   | 100  |
| 11d     | 0            | 0    | 0     | 0    | 0   | 0    | 0     | 0    | 4   | 100  |
| 12      | 65           | 100  | 0     | 0    | 0   | 0    | 0     | 0    | 9   | 100  |
| 13      | 0            | 0    | 0     | 0    | 0   | 0    | 0     | 0    | 0   | 0    |
| 14      | 0            | 0    | 0     | 0    | 0   | 0    | 0     | 0    | 39  | 100  |
| 15      | 0            | 0    | 0     | 0    | 0   | 0    | 0     | 0    | 17  | 60   |
| 16      | 7            | 100  | 0     | 0    | 3   | 100  | 0     | 0    | 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    | 0     | 0    | 0   | 0    |
| 21a     | 24           | 33   | 7     | 67   | 13  | 85   | 58    | 8    | 7   | 18   |
| 21b     | 994          | 42   | 6     | 78   | 3   | 100  | 871   | 47   | 39  | 64   |
| 22      | 186          | 23   | 28    | 40   | 44  | 49   | 270   | 9    | 47  | 43   |
| 23      | 11           | 72   | 728   | 89   | 41  | 46   | 108   | 29   | 0   | 0    |
| 24      | 114          | 78   | 15    | 52   | 43  | 55   | 121   | 100  | 0   | 0    |
| 25      | 0            | 0    | 0     | 0    | 0   | 0    | 0     | 0    | 0   | 0    |
| 28      | 0            | 0    | 0     | 0    | 0   | 0    | 0     | 0    | 0   | 0    |
| Core    | 3 897        | 14   | 808   | 76   | 430 | 36   | 596   | 29   | 396 | 17   |
| Total   | 5 226        | 13   | 1 592 | 56   | 573 | 27   | 2 024 | 23   | 489 | 15   |

**Table 8: Total numbers of fish, squid and scampi measured for length frequency distributions and biological samples (TAN1101). The total number of fish measured is sometimes greater than the sum of males and females because some fish were unsexed.**

| Species                       | Species code | Number measured<br>Males | Number measured<br>Females | Number measured<br>Total |
|-------------------------------|--------------|--------------------------|----------------------------|--------------------------|
| Abyssal rattail               | CTR          | 0                        | 2                          | 2                        |
| Alfonsino                     | BYS          | 381                      | 325                        | 710                      |
| Banded bellowsfish            | BBE          | 306                      | 253                        | 2 894                    |
| Banded rattail                | CFA          | 38                       | 18                         | 258                      |
| Barracouta                    | BAR          | 12                       | 16                         | 28                       |
| Basketwork eel                | BEE          | 159                      | 292                        | 461                      |
| Baxter's dogfish              | ETB          | 116                      | 111                        | 227                      |
| Bigeye cardinalfish           | EPL          | 187                      | 145                        | 334                      |
| Bigscaled brown slickhead     | SBI          | 416                      | 630                        | 1 049                    |
| Black javelinfish             | BJA          | 1                        | 5                          | 6                        |
| Black oreo                    | BOE          | 536                      | 522                        | 1 062                    |
| Black slickhead               | BSL          | 171                      | 102                        | 273                      |
| Blackspot rattail             | VNI          | 15                       | 19                         | 37                       |
| Bluenose                      | BNS          | 6                        | 3                          | 9                        |
| Bollons rattail               | CBO          | 1 454                    | 912                        | 2 376                    |
| Brown chimaera                | CHP          | 5                        | 3                          | 8                        |
| Carpet shark                  | CAR          | 1                        | 0                          | 1                        |
| Catshark                      | APR          | 10                       | 5                          | 15                       |
| Common roughy                 | RHY          | 193                      | 207                        | 401                      |
| Crested bellowsfish           | CBE          | 1                        | 5                          | 142                      |
| Dark ghostshark               | GSH          | 956                      | 1 002                      | 1 958                    |
| Dawson's catshark             | DCS          | 1                        | 2                          | 3                        |
| Deepsea cardinalfish          | EPT          | 68                       | 45                         | 115                      |
| Deepsea flathead              | FHD          | 6                        | 12                         | 18                       |
| Deepwater spiny skate         | DSK          | 1                        | 0                          | 1                        |
| Finless flounder              | MAN          | 2                        | 1                          | 3                        |
| Four-rayed rattail            | CSU          | 975                      | 795                        | 2 313                    |
| Frill shark                   | FRS          | 0                        | 2                          | 2                        |
| Frostfish                     | FRO          | 1                        | 0                          | 1                        |
| Giant stargazer               | STA          | 186                      | 193                        | 381                      |
| Greenback jack mackerel       | JMD          | 1                        | 2                          | 3                        |
| Hairy conger                  | HCO          | 1                        | 6                          | 7                        |
| Hake                          | HAK          | 76                       | 65                         | 141                      |
| Hapuku                        | HAP          | 18                       | 10                         | 28                       |
| Hoki                          | HOK          | 7 236                    | 9 087                      | 16 340                   |
| Humpback rattail              | CBA          | 1                        | 19                         | 20                       |
| Javelin fish                  | JAV          | 1 103                    | 5 387                      | 6 579                    |
| Johnson's cod                 | HJO          | 322                      | 534                        | 873                      |
| Leafscale gulper shark        | CSQ          | 24                       | 45                         | 69                       |
| Lemon sole                    | LSO          | 14                       | 11                         | 25                       |
| Ling                          | LIN          | 524                      | 514                        | 1 039                    |
| Longnose velvet dogfish       | CYP          | 312                      | 430                        | 742                      |
| Long-nosed chimaera           | LCH          | 155                      | 127                        | 282                      |
| Longnosed deepsea skate       | PSK          | 5                        | 2                          | 7                        |
| Lookdown dory                 | LDO          | 1 041                    | 848                        | 1 902                    |
| Lucifer dogfish               | ETL          | 192                      | 215                        | 408                      |
| Mahia rattail                 | CMA          | 59                       | 72                         | 131                      |
| <i>Nezumia namatahi</i>       | NNA          | 0                        | 1                          | 1                        |
| Northern spiny dogfish        | NSD          | 3                        | 1                          | 4                        |
| Notable rattail               | CIN          | 231                      | 291                        | 596                      |
| <i>Notocanthus chemnitzii</i> | NOC          | 1                        | 0                          | 1                        |

**Table 8 (continued)**

| Species                       | Species code | Number measured<br>Males | Number measured<br>Females | Number measured<br>Total |
|-------------------------------|--------------|--------------------------|----------------------------|--------------------------|
| NZ southern arrow squid       | NOS          | 278                      | 327                        | 608                      |
| Oblique banded rattail        | CAS          | 168                      | 931                        | 1 178                    |
| Oliver's rattail              | COL          | 751                      | 1 046                      | 1 967                    |
| Orange perch                  | OPE          | 185                      | 247                        | 433                      |
| Orange roughy                 | ORH          | 771                      | 906                        | 1 688                    |
| Pale ghostshark               | GSP          | 354                      | 358                        | 712                      |
| Plunket's shark               | PLS          | 7                        | 6                          | 13                       |
| Prickly deepsea skate         | BTS          | 0                        | 2                          | 2                        |
| Prickly dogfish               | PDG          | 3                        | 8                          | 11                       |
| Red cod                       | RCO          | 98                       | 74                         | 188                      |
| Redbait                       | RBT          | 12                       | 7                          | 19                       |
| Ribaldo                       | RIB          | 125                      | 55                         | 180                      |
| Ridge scaled rattail          | MCA          | 11                       | 30                         | 41                       |
| Robust cardinalfish           | EPR          | 68                       | 71                         | 140                      |
| Rough skate                   | RSK          | 6                        | 9                          | 15                       |
| Roughhead rattail             | CHY          | 11                       | 5                          | 16                       |
| Roughhead rattail             | CTH          | 2                        | 4                          | 6                        |
| Ruby fish                     | RBY          | 7                        | 5                          | 20                       |
| Rudderfish                    | RUD          | 11                       | 3                          | 14                       |
| Sandfish                      | GON          | 0                        | 2                          | 2                        |
| Scampi                        | SCI          | 16                       | 22                         | 40                       |
| School shark                  | SCH          | 7                        | 1                          | 8                        |
| Sea perch                     | SPE          | 1 287                    | 1 387                      | 2 687                    |
| Seal shark                    | BSH          | 26                       | 41                         | 67                       |
| Serrulate rattail             | CSE          | 265                      | 126                        | 394                      |
| Shovelnose dogfish            | SND          | 778                      | 553                        | 1 337                    |
| Silver dory                   | SDO          | 133                      | 100                        | 234                      |
| Silver roughy                 | SRH          | 131                      | 110                        | 251                      |
| Silver warehou                | SWA          | 1 160                    | 975                        | 2 136                    |
| Silverside                    | SSI          | 480                      | 328                        | 974                      |
| Sixgill shark                 | HEX          | 1                        | 1                          | 2                        |
| Slender mackerel              | JMM          | 25                       | 13                         | 38                       |
| Small banded rattail          | CCX          | 0                        | 4                          | 4                        |
| Small-headed cod              | SMC          | 2                        | 4                          | 6                        |
| Smallscaled brown slickhead   | SSM          | 257                      | 163                        | 420                      |
| Smooth oreo                   | SSO          | 326                      | 300                        | 628                      |
| Smooth skate                  | SSK          | 19                       | 21                         | 40                       |
| Smoothskin dogfish            | CYO          | 98                       | 54                         | 152                      |
| Southern blue whiting         | SBW          | 5                        | 3                          | 8                        |
| Southern Ray's bream          | SRB          | 40                       | 42                         | 82                       |
| Spiky oreo                    | SOR          | 593                      | 588                        | 1 232                    |
| Spineback                     | SBK          | 13                       | 90                         | 104                      |
| Spiny dogfish                 | SPD          | 395                      | 1 470                      | 1 865                    |
| Swollenhead conger            | SCO          | 8                        | 6                          | 14                       |
| Tarakihi                      | TAR          | 23                       | 10                         | 33                       |
| <i>Trachyscorpia capensis</i> | TRS          | 0                        | 4                          | 4                        |
| <i>Tubbia tasmanica</i>       | TUB          | 0                        | 3                          | 3                        |
| Two saddle rattail            | CBI          | 29                       | 113                        | 142                      |
| Unicorn rattail               | WHR          | 1                        | 1                          | 2                        |
| Velvet rattail                | TRX          | 0                        | 1                          | 1                        |
| Viperfish                     | CHA          | 0                        | 1                          | 1                        |
| Warty oreo                    | WOE          | 22                       | 16                         | 38                       |

**Table 8 (continued)**

| Species                           | Species code | Number measured Males | Number measured Females | Number measured Total |
|-----------------------------------|--------------|-----------------------|-------------------------|-----------------------|
| Warty squid ( <i>O. robsoni</i> ) | MRQ          | 4                     | 1                       | 5                     |
| White cardinalfish                | EPD          | 0                     | 2                       | 116                   |
| White rattail                     | WHX          | 150                   | 107                     | 257                   |
| White warehou                     | WWA          | 292                   | 228                     | 521                   |
| Wide-nosed chimaera               | RCH          | 62                    | 58                      | 120                   |
| Witch                             | WIT          | 16                    | 15                      | 31                    |
| Total                             |              | 27 055                | 34 352                  | 65 536                |

**Table 9: Length-weight regression parameters\* used to scale length frequencies (all data from TAN1101).**

| Species         | <i>a</i> (intercept) | <i>b</i> (slope) | <i>r</i> <sup>2</sup> | <i>n</i> | Length range (cm) |
|-----------------|----------------------|------------------|-----------------------|----------|-------------------|
| Black oreo      | 0.016020             | 3.070446         | 0.86                  | 168      | 24–39             |
| Dark ghostshark | 0.002705             | 3.197002         | 0.96                  | 699      | 34–75             |
| Giant stargazer | 0.008261             | 3.161064         | 0.98                  | 377      | 27–81             |
| Hake            | 0.002783             | 3.210539         | 0.98                  | 137      | 42–131            |
| Hoki            | 0.003737             | 2.948525         | 0.99                  | 2 071    | 37–109            |
| Ling            | 0.001272             | 3.295430         | 0.99                  | 886      | 28–156            |
| Lookdown dory   | 0.025799             | 2.950263         | 0.99                  | 1 124    | 11–56             |
| Orange roughy   | 0.039710             | 2.944295         | 0.99                  | 496      | 7–41              |
| Pale ghostshark | 0.006639             | 2.968266         | 0.97                  | 620      | 23–87             |
| Sea perch       | 0.012641             | 3.063978         | 0.99                  | 1 133    | 12–49             |
| Silver warehou  | 0.009822             | 3.151097         | 0.98                  | 755      | 15–55             |
| Smooth oreo     | 0.022146             | 2.997321         | 0.99                  | 270      | 17–51             |
| Spiny dogfish   | 0.001138             | 3.321544         | 0.94                  | 995      | 52–106            |
| White warehou   | 0.019184             | 3.025823         | 0.99                  | 261      | 16–60             |

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

**Table 10: Numbers of fish measured at each reproductive stage (Bony and cartilaginous fish were staged using different methods – see footnote below table).**

| Common name                | Sex                                 | Reproductive stage |     |     |    |    |   |   |   | Total |
|----------------------------|-------------------------------------|--------------------|-----|-----|----|----|---|---|---|-------|
|                            |                                     | 1                  | 2   | 3   | 4  | 5  | 6 | 7 | 8 |       |
| Alfonsino                  | Male                                | 1                  | -   | -   | -  | -  | - | - | - | 1     |
|                            | Female                              | 2                  | -   | -   | -  | -  | - | - | - | 2     |
| Banded rattail             | Male                                | -                  | 1   | -   | -  | -  | - | - | - | 1     |
|                            | Female                              | -                  | 4   | -   | -  | -  | - | - | - | 4     |
| Baxter's dogfish           | Male                                | 42                 | 8   | 61  | -  | -  | - | - | - | 111   |
|                            | Female                              | 51                 | 23  | 7   | 9  | 13 | 2 | - | - | 105   |
| Bigeye rattail             | Male                                | -                  | 48  | -   | -  | -  | - | - | - | 48    |
|                            | Female                              | 2                  | 26  | -   | -  | -  | - | - | - | 28    |
| Blackjavelinfinh           | Male                                | 1                  | -   | -   | -  | -  | - | - | - | 1     |
|                            | Female                              | 2                  | 1   | 1   | -  | 1  | - | - | - | 5     |
| Black oreo                 | Male                                | 85                 | 74  | 5   | -  | -  | - | - | - | 164   |
|                            | Female                              | 56                 | 108 | 12  | -  | -  | - | - | - | 176   |
| Black slickhead            | Male                                | 15                 | 62  | -   | -  | -  | - | - | - | 77    |
|                            | Female                              | 6                  | -   | 19  | -  | -  | - | - | - | 25    |
| Carpet shark               | Male                                | 1                  | -   | -   | -  | -  | - | - | - | 1     |
|                            | Female                              | -                  | -   | -   | -  | -  | - | - | - | -     |
| Catshark                   | Male                                | 3                  | 2   | 5   | -  | -  | - | - | - | 10    |
|                            | ( <i>Apristurus</i> spp.)<br>Female | 3                  | -   | -   | -  | 1  | - | - | - | 4     |
| Dark ghostshark            | Male                                | 40                 | 43  | 172 | -  | -  | - | - | - | 255   |
|                            | Female                              | 74                 | 105 | 43  | -  | -  | - | - | - | 222   |
| Dawson's catshark          | Male                                | -                  | -   | 1   | -  | -  | - | - | - | 1     |
|                            | Female                              | -                  | 1   | 1   | -  | -  | - | - | - | 2     |
| Deepsea cardinalfish       | Male                                | 15                 | -   | -   | -  | -  | - | - | - | 15    |
|                            | Female                              | 7                  | -   | -   | -  | -  | - | - | - | 7     |
| Frill shark                | Male                                | -                  | -   | -   | -  | -  | - | - | - | -     |
|                            | Female                              | -                  | 1   | -   | -  | -  | - | - | - | 1     |
| Giant stargazer            | Male                                | 1                  | -   | -   | -  | -  | - | - | - | 1     |
|                            | Female                              | -                  | -   | -   | -  | -  | - | - | - | -     |
| Hake                       | Male                                | 16                 | 13  | 10  | 14 | 15 | 6 | 1 | - | 75    |
|                            | Female                              | 7                  | 32  | 22  | -  | -  | - | 2 | - | 63    |
| Hoki                       | Male                                | 481                | 319 | -   | -  | -  | - | - | - | 800   |
|                            | Female                              | 678                | 662 | -   | -  | -  | - | - | - | 1340  |
| Humpback (slender) rattail | Male                                | -                  | -   | -   | -  | -  | - | - | - | -     |
|                            | Female                              | 1                  | 8   | 2   | -  | -  | - | - | - | 11    |
| Javelinfinh                | Male                                | 3                  | 16  | 11  | -  | -  | - | - | - | 30    |
|                            | Female                              | 23                 | 8   | 4   | -  | -  | - | - | - | 35    |
| Leafscale gulper shark     | Male                                | 19                 | -   | 2   | -  | -  | - | - | - | 21    |
|                            | Female                              | 31                 | 3   | 7   | 1  | -  | 1 | - | - | 43    |
| Ling                       | Male                                | 186                | 108 | 118 | 40 | -  | - | - | - | 452   |
|                            | Female                              | 171                | 270 | 2   | 2  | -  | - | - | - | 445   |
| Long-nosed chimaera        | Male                                | 28                 | 3   | 51  | -  | -  | - | - | - | 82    |
|                            | Female                              | 34                 | 14  | 20  | 3  | -  | - | - | - | 71    |
| Longnosed deepsea skate    | Male                                | 1                  | 2   | -   | -  | -  | - | - | - | 3     |
|                            | Female                              | -                  | 1   | -   | -  | -  | - | - | - | 1     |
| Longnose velvet dogfish    | Male                                | 140                | 13  | 82  | -  | -  | - | - | - | 235   |
|                            | Female                              | 177                | 87  | 41  | 31 | 1  | 1 | - | - | 338   |
| Lookdown dory              | Male                                | 4                  | 3   | -   | -  | -  | - | - | - | 7     |
|                            | Female                              | 2                  | -   | -   | -  | -  | - | - | - | 2     |
| Lucifer dogfish            | Male                                | 4                  | 12  | 51  | -  | -  | - | - | - | 67    |
|                            | Female                              | 24                 | 30  | 10  | 7  | -  | 1 | - | - | 72    |
| Mahia rattail              | Male                                | 6                  | 19  | -   | -  | -  | - | - | - | 25    |
|                            | Female                              | 2                  | 20  | -   | -  | -  | - | - | - | 22    |



**Table 10 (continued)**

| Common name                                      | Sex    | Reproductive stage |     |     |     |     |   |   |   | Total |
|--|--------|--------------------|-----|-----|-----|-----|---|---|---|-------|
|  |        | 1                  | 2   | 3   | 4   | 5   | 6 | 7 | 8 |       |
| Northern spiny dogfish                           | Male   | 1                  | -   | 2   | -   | -   | - | - | - | 3     |
|  | Female | -                  | -   | 1   | -   | -   | - | - | - | 1     |
| Oblique banded rattail                           | Male   | 3                  | 9   | 1   | -   | -   | - | - | - | 13    |
|  | Female | 8                  | 52  | -   | -   | -   | - | - | - | 60    |
| Oliver's rattail                                 | Male   | -                  | 3   | -   | -   | -   | - | - | - | 3     |
|  | Female | -                  | 2   | -   | -   | -   | - | - | - | 2     |
| Orange Roughy                                    | Male   | 126                | 108 | 2   | -   | -   | - | - | - | 236   |
|  | Female | 107                | 96  | 108 | -   | -   | - | - | 1 | 312   |
| Pale ghostshark                                  | Male   | 81                 | 12  | 135 | -   | -   | - | - | - | 228   |
|  | Female | 98                 | 51  | 46  | 6   | 1   | - | - | - | 202   |
| Plunket's shark                                  | Male   | 3                  | 2   | -   | -   | -   | - | - | - | 5     |
|  | Female | 1                  | 3   | -   | -   | -   | - | - | - | 4     |
| Prickly deepsea skate                            | Male   | -                  | -   | -   | -   | -   | - | - | - | -     |
|  | Female | 2                  | -   | -   | -   | -   | - | - | - | 2     |
| Prickly dogfish                                  | Male   | -                  | 1   | 2   | -   | -   | - | - | - | 3     |
|  | Female | 1                  | 2   | 2   | -   | -   | 1 | - | - | 6     |
| Ribaldo  | Male   | -                  | 21  | -   | -   | -   | - | - | - | 21    |
|  | Female | -                  | 6   | -   | -   | -   | - | - | - | 6     |
| Ridge scaled rattail                             | Male   | -                  | -   | -   | -   | -   | - | - | - | -     |
|  | Female | 1                  | -   | -   | -   | -   | - | - | - | 1     |
| Roughhead rattail<br>( <i>C. trachycarus</i> )   | Male   | -                  | 7   | 4   | -   | -   | - | - | - | 11    |
|  | Female | -                  | -   | 4   | 1   | -   | - | - | - | 5     |
| Rough skate                                      | Male   | -                  | -   | 5   | -   | -   | - | - | - | 5     |
|  | Female | 3                  | 1   | 1   | -   | -   | 1 | - | - | 6     |
| Rudderfish                                       | Male   | -                  | -   | -   | -   | -   | - | - | - | -     |
|  | Female | -                  | -   | 1   | -   | -   | - | - | - | 1     |
| School shark                                     | Male   | -                  | 1   | 5   | -   | -   | - | - | - | 6     |
|  | Female | -                  | -   | -   | -   | -   | - | - | - | -     |
| Sea Perch  | Male   | 1                  | 7   | -   | -   | -   | - | - | - | 8     |
|  | Female | 9                  | 6   | -   | -   | 2   | - | - | - | 17    |
| Seal Shark                                       | Male   | 24                 | -   | 1   | -   | -   | - | - | - | 25    |
|  | Female | 31                 | 3   | 1   | 1   | -   | - | - | - | 36    |
| Shovelnose dogfish                               | Male   | 73                 | 66  | 236 | -   | -   | - | - | - | 375   |
|  | Female | 161                | 103 | 18  | 7   | 1   | 2 | - | - | 292   |
| Silver warehou                                   | Male   | -                  | 33  | -   | -   | -   | - | - | - | 33    |
|  | Female | -                  | 19  | -   | -   | -   | - | - | - | 19    |
| Small banded rattail                             | Male   | -                  | -   | -   | -   | -   | - | - | - | -     |
|  | Female | -                  | -   | -   | 1   | -   | - | - | - | 1     |
| Smooth oreo                                      | Male   | 115                | 35  | 23  | 5   | -   | - | - | - | 178   |
|  | Female | 88                 | 34  | 14  | -   | 2   | - | - | - | 138   |
| Smooth skate                                     | Male   | 10                 | 1   | 1   | -   | -   | - | - | - | 12    |
|  | Female | 11                 | 6   | -   | -   | -   | - | - | - | 17    |
| Smooth skin dogfish                              | Male   | 12                 | 2   | 73  | -   | -   | - | - | - | 87    |
|  | Female | 17                 | 20  | 6   | 3   | -   | - | - | - | 46    |
| Southern Ray's bream                             | Male   | 1                  | -   | -   | -   | -   | - | - | - | 1     |
|  | Female | -                  | -   | -   | -   | -   | - | - | - | -     |
| Spiky oreo                                       | Male   | 101                | 85  | 16  | -   | -   | - | - | - | 202   |
|  | Female | 89                 | 91  | 27  | 1   | 2   | 1 | - | - | 211   |
| Spiny dogfish                                    | Male   | 6                  | 23  | 234 | -   | -   | - | - | - | 263   |
|  | Female | 223                | 281 | 85  | 121 | 277 | 7 | - | - | 994   |
| Spotty faced rattail<br>( <i>C. acanthiger</i> ) | Male   | -                  | 1   | 1   | -   | -   | - | - | - | 2     |
|  | Female | -                  | 4   | -   | -   | -   | - | - | - | 4     |
| Squashed face rattail                            | Male   | -                  | -   | -   | -   | -   | - | - | - | -     |
|  | Female | -                  | -   | 1   | -   | -   | - | - | - | 1     |

**Table 10 (continued)**

| Common name                   | Sex    | Reproductive stage |    |    |   |   |   |    |   | Total |
|-------------------------------|--------|--------------------|----|----|---|---|---|----|---|-------|
|                               |        | 1                  | 2  | 3  | 4 | 5 | 6 | 7  | 8 |       |
| Striate rattail               | Male   | -                  | -  | -  | - | - | - | -  | - | -     |
|                               | Female | -                  | 2  | -  | - | - | - | -  | - | 2     |
| Tarakihi                      | Male   | 1                  | 12 | 2  | - | - | - | -  | - | 15    |
|                               | Female | -                  | 4  | -  | - | - | - | -  | - | 4     |
| <i>Trachyscorpia capensis</i> | Male   | -                  | -  | -  | - | - | - | -  | - | -     |
|                               | Female | -                  | 1  | -  | - | - | - | -  | - | 1     |
| Two saddle rattail            | Male   | -                  | 25 | 3  | - | - | 1 | -  | - | 29    |
|                               | Female | 14                 | 64 | 14 | 4 | - | 5 | 11 | - | 112   |
| Unicorn rattail               | Male   | -                  | 1  | -  | - | - | - | -  | - | 1     |
|                               | Female | -                  | 1  | -  | - | - | - | -  | - | 1     |
| Velvet rattail                | Male   | -                  | -  | -  | - | - | - | -  | - | -     |
|                               | Female | -                  | -  | -  | 1 | - | - | -  | - | 1     |
| Warty oreo                    | Male   | -                  | 5  | -  | - | - | - | -  | - | 5     |
|                               | Female | -                  | -  | 1  | - | - | - | -  | - | 1     |
| White warehou                 | Male   | 5                  | 1  | -  | - | - | - | -  | - | 6     |
|                               | Female | 3                  | 1  | -  | - | - | - | -  | - | 4     |
| White rattail                 | Male   | 9                  | 7  | -  | - | - | - | -  | - | 16    |
|                               | Female | 5                  | 16 | -  | - | - | - | -  | - | 21    |
| Widenosed chimaera            | Male   | -                  | -  | 14 | - | - | - | -  | - | 14    |
|                               | Female | 4                  | 6  | 4  | - | - | - | -  | - | 14    |

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)

Deepwater gonad stages (excluding oreos): male: 1, immature/resting; 2, early maturation; 3, mature; 4, ripe; 5, spent; 8, partially spent: female: 1, immature/resting; 2, early maturation; 3, mature; 4, ripe; 5, running ripe; 6, spent; 7, atretic; 8, partially spent

Oreo gonad stages: male: 1, immature; 2, resting/early maturation; 3, mature; 4, ripe; 5, spent; 8, partially spent: female: 1, immature; 2, resting/early maturation; 3, mature; 4, ripe; 5, running ripe; 6, spent; 7, atretic; 8, partially spent

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 2011 Chatham Rise trawl survey compared to results from previous surveys (from Stevens et al. 2011).**

| Acoustic file         | Survey | <i>n</i> | Surface Layer | Pelagic marks |       |       | Bottom marks |       |        |
|-----------------------|--------|----------|---------------|---------------|-------|-------|--------------|-------|--------|
|                       |        |          |               | School        | Layer | Cloud | Layer        | Cloud | School |
| Day trawl             | 2011   | 102      | 61            | 37            | 71    | 61    | 50           | 50    | 6      |
|                       | 2010   | 111      | 59            | 32            | 73    | 59    | 73           | 41    | 6      |
|                       | 2009   | 110      | 63            | 40            | 78    | 53    | 75           | 33    | 13     |
|                       | 2008   | 110      | 63            | 39            | 83    | 56    | 58           | 41    | 9      |
|                       | 2007   | 112      | 71            | 42            | 77    | 45    | 46           | 46    | 8      |
|                       | 2006   | 102      | 59            | 40            | 88    | 44    | 67           | 36    | 16     |
|                       | 2005   | 111      | 57            | 37            | 93    | 31    | 60           | 42    | 23     |
|                       | 2003   | 123      | 64            | 41            | 85    | 55    | 47           | 47    | 22     |
| Day steam             | 2011   | 100      | 80            | 32            | 79    | 76    | 59           | 60    | 4      |
|                       | 2010   | 109      | 71            | 50            | 79    | 63    | 82           | 37    | 8      |
|                       | 2009   | 99       | 63            | 56            | 80    | 45    | 81           | 42    | 21     |
|                       | 2008   | 82       | 67            | 46            | 91    | 48    | 77           | 28    | 20     |
|                       | 2007   | 81       | 78            | 44            | 91    | 40    | 69           | 43    | 15     |
|                       | 2006   | 79       | 76            | 47            | 95    | 42    | 87           | 37    | 16     |
|                       | 2005   | 78       | 71            | 45            | 95    | 37    | 76           | 45    | 35     |
|                       | 2003   | 66       | 80            | 55            | 97    | 49    | 83           | 35    | 24     |
| Night steam and trawl | 2011   | 125      | 97            | 6             | 26    | 90    | 26           | 74    | 2      |
|                       | 2010   | 117      | 97            | 6             | 19    | 86    | 43           | 77    | 5      |
|                       | 2009   | 93       | 96            | 11            | 18    | 78    | 40           | 68    | 4      |
|                       | 2008   | 46       | 100           | 2             | 20    | 83    | 24           | 87    | 2      |
|                       | 2007   | 51       | 100           | 10            | 25    | 92    | 20           | 80    | 4      |
|                       | 2006   | 33       | 94            | 15            | 48    | 88    | 45           | 85    | 6      |
|                       | 2005   | 30       | 100           | 33            | 53    | 77    | 57           | 83    | 7      |
|                       | 2003   | 44       | 100           | 14            | 18    | 93    | 30           | 96    | 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 2001–11.**

| Year (Survey)  | No. of recordings | Average trawl catch (kg km <sup>-2</sup> ) | Average acoustic backscatter (m <sup>2</sup> km <sup>-2</sup> ) |             |                             |                 |
|----------------|-------------------|--|---|-------------|-----------------------------|-----------------|
|                |                   |  | Bottom 10 m   | Bottom 50 m | All bottom marks (to 100 m) | Entire echogram |
| 2001 (TAN0101) | 117               | 1 858                                      | 3.63  | 22.39       | 31.80                       | 57.60           |
| 2002 (TAN0201) | 102               | 1 849                                      | 4.50  | 18.39       | 22.60                       | 49.32           |
| 2003 (TAN0301) | 117               | 1 508                                      | 3.43  | 19.56       | 29.41                       | 53.22           |
| 2005 (TAN0501) | 86                | 1 783                                      | 2.78  | 12.69       | 15.64                       | 40.24           |
| 2006 (TAN0601) | 88                | 1 782                                      | 3.24  | 13.19       | 19.46                       | 48.86           |
| 2007 (TAN0701) | 100               | 1 510                                      | 2.00  | 10.83       | 15.40                       | 41.07           |
| 2008 (TAN0801) | 103               | 2 012                                      | 2.03  | 9.65        | 13.23                       | 37.98           |
| 2009 (TAN0901) | 105               | 2 480                                      | 2.98  | 15.89       | 25.01                       | 58.88           |
| 2010 (TAN1001) | 90                | 2 205                                      | 1.87  | 10.80       | 17.68                       | 44.49           |
| 2011 (TAN1101) | 73                | 1 997                                      | 1.79  | 8.72        | 12.94                       | 34.79           |

**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)<sub>s</sub>*). 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. 2011).**

| Year | Stratum   |           |           |           |
|------|-----------|-----------|-----------|-----------|
|      | Northeast | Northwest | Southeast | Southwest |
| 2001 | 0.64      | 0.83      | 0.81      | 0.88      |
| 2002 | 0.58      | 0.78      | 0.66      | 0.86      |
| 2003 | 0.67      | 0.82      | 0.81      | 0.77      |
| 2005 | 0.72      | 0.83      | 0.73      | 0.69      |
| 2006 | 0.69      | 0.77      | 0.76      | 0.80      |
| 2007 | 0.67      | 0.85      | 0.73      | 0.80      |
| 2008 | 0.61      | 0.64      | 0.84      | 0.85      |
| 2009 | 0.58      | 0.75      | 0.83      | 0.86      |
| 2010 | 0.48      | 0.64      | 0.76      | 0.63      |
| 2011 | 0.63      | 0.49      | 0.76      | 0.54      |

**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%).**

| Survey  | Year | Acoustic index (m <sup>2</sup> /km <sup>2</sup> ) |      |           |      |           |      |           |      |           |      |            |      |
|---------|------|---|------|-----------|------|-----------|------|-----------|------|-----------|------|------------|------|
|         |      | Unstratified                                      |      | Northeast |      | Northwest |      | Southeast |      | Southwest |      | Stratified |      |
|         |      | 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    |

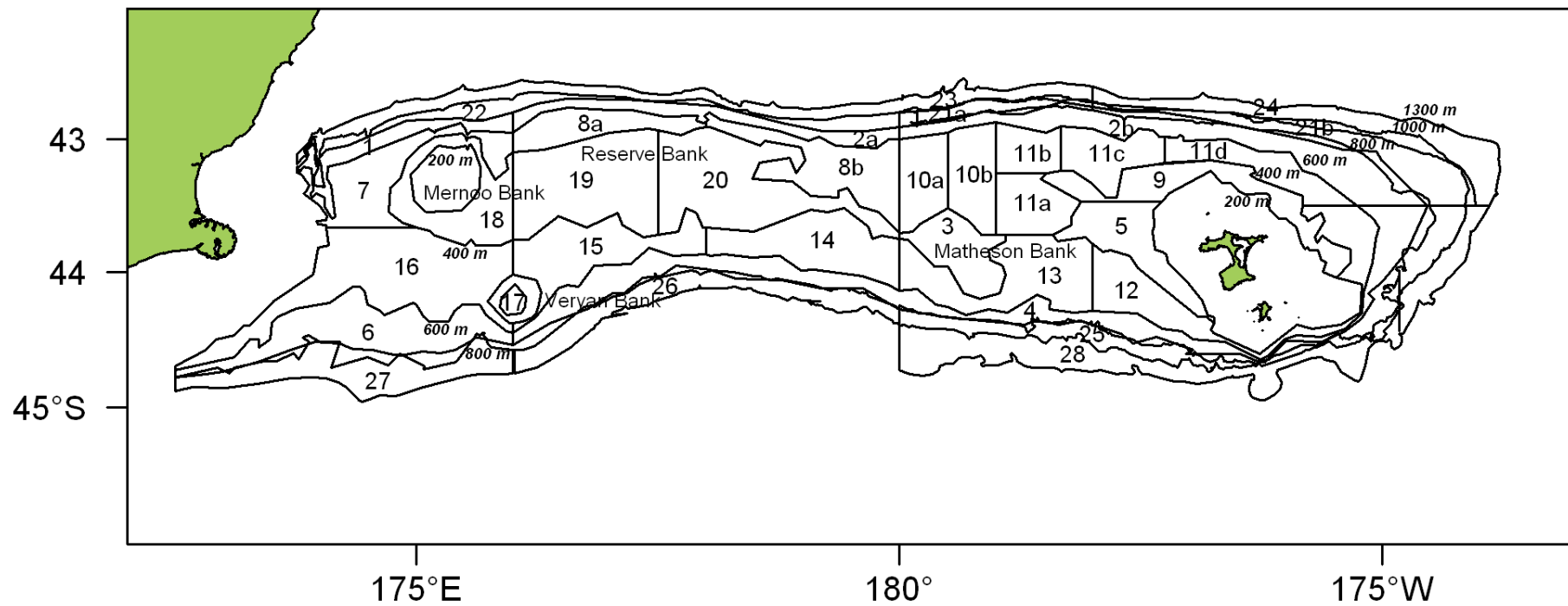
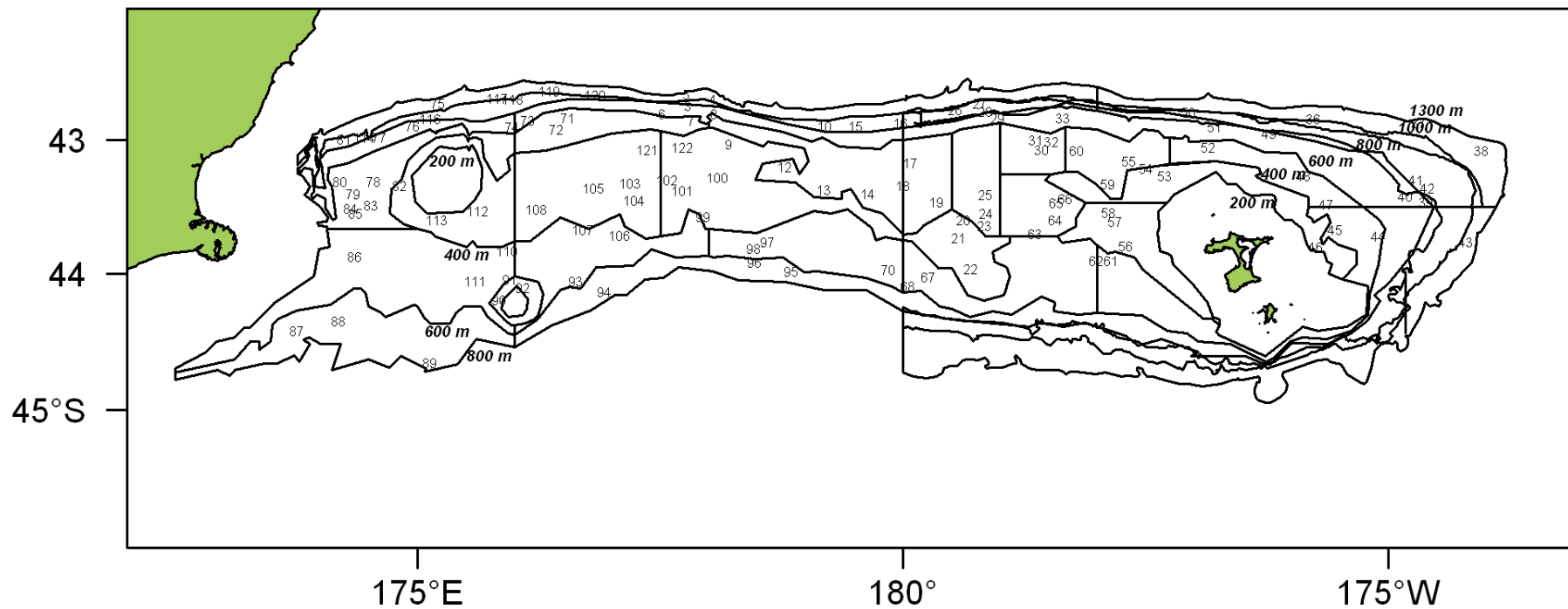
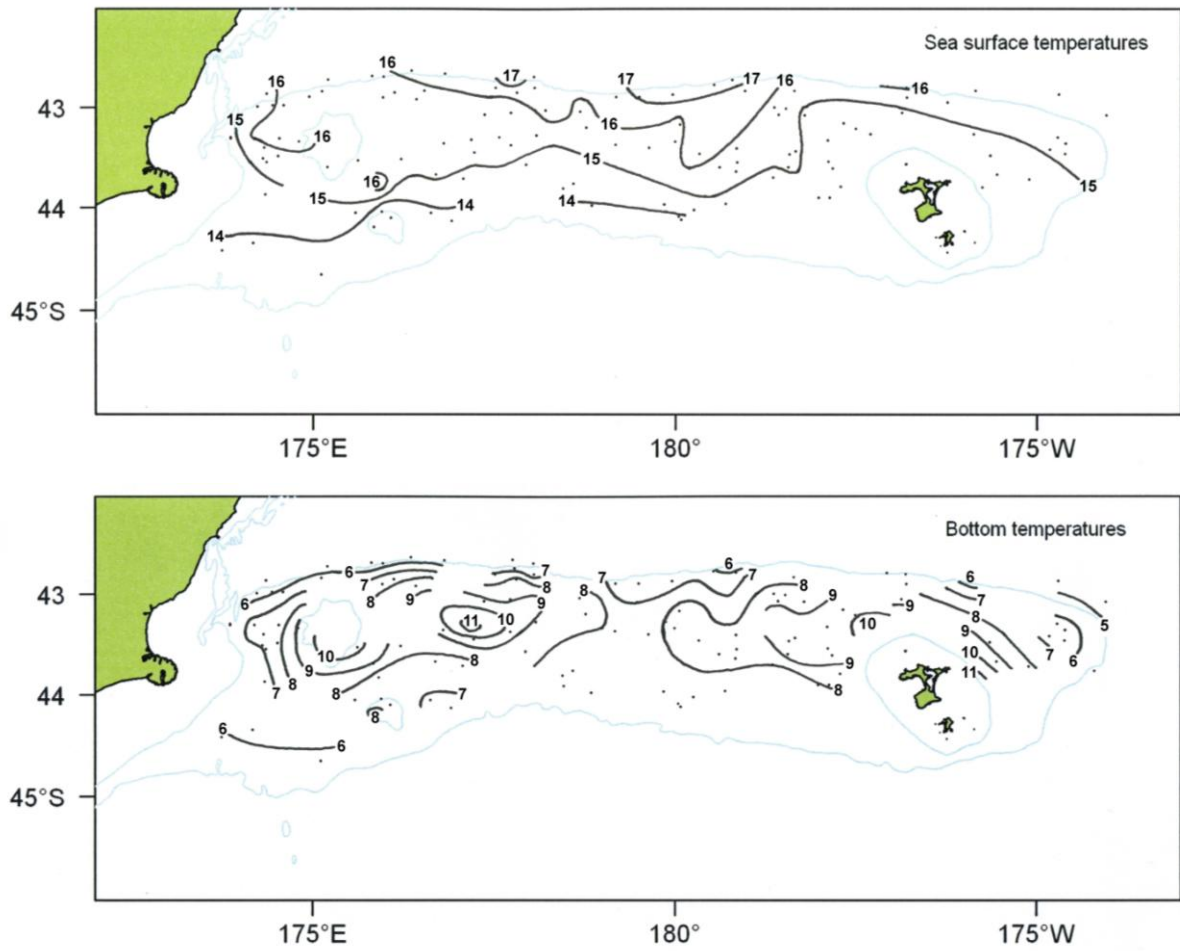


Figure 1: Trawl survey area showing stratum boundaries. Strata 25–28 were not surveyed in 2011.

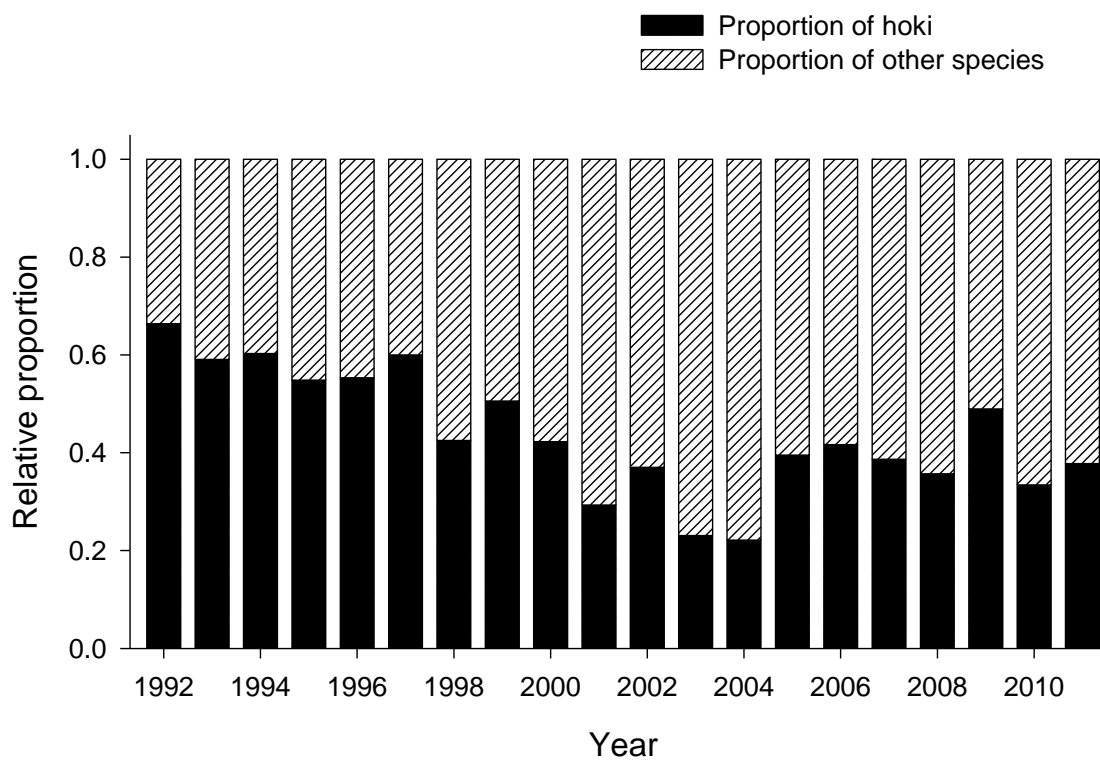
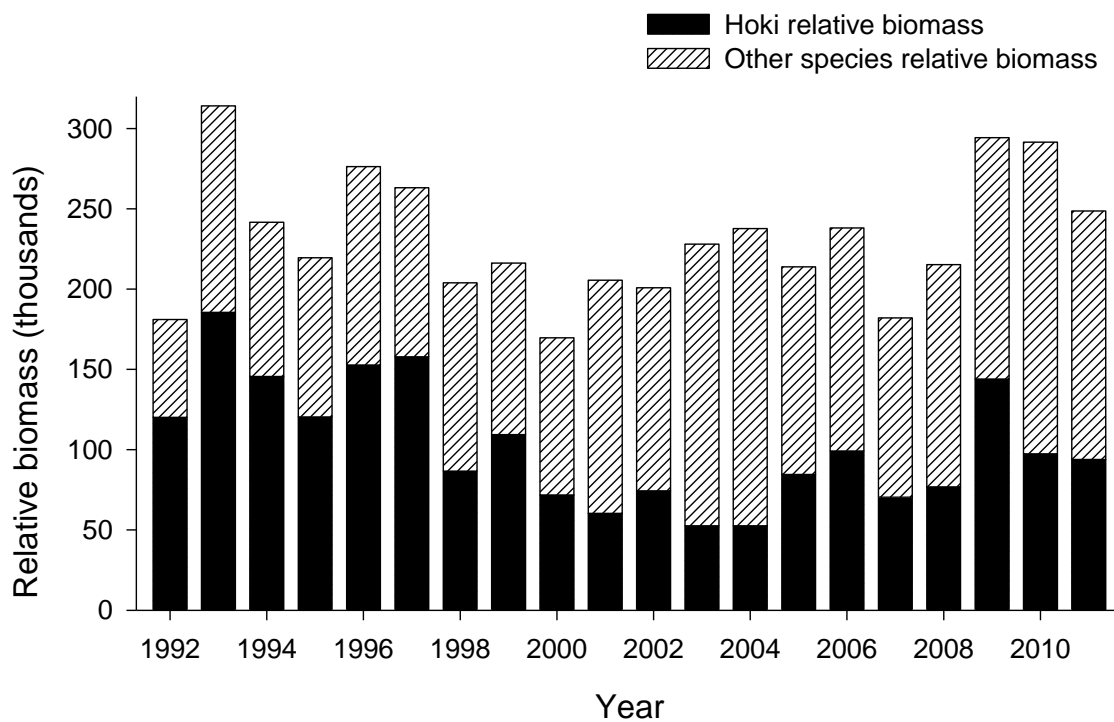


**Figure 2: Trawl survey area showing positions of valid biomass stations (n = 114 stations) for TAN1101. In this and subsequent figures actual stratum boundaries are drawn for the new deepwater strata. These boundaries sometimes overlap with existing core survey stratum boundaries.**

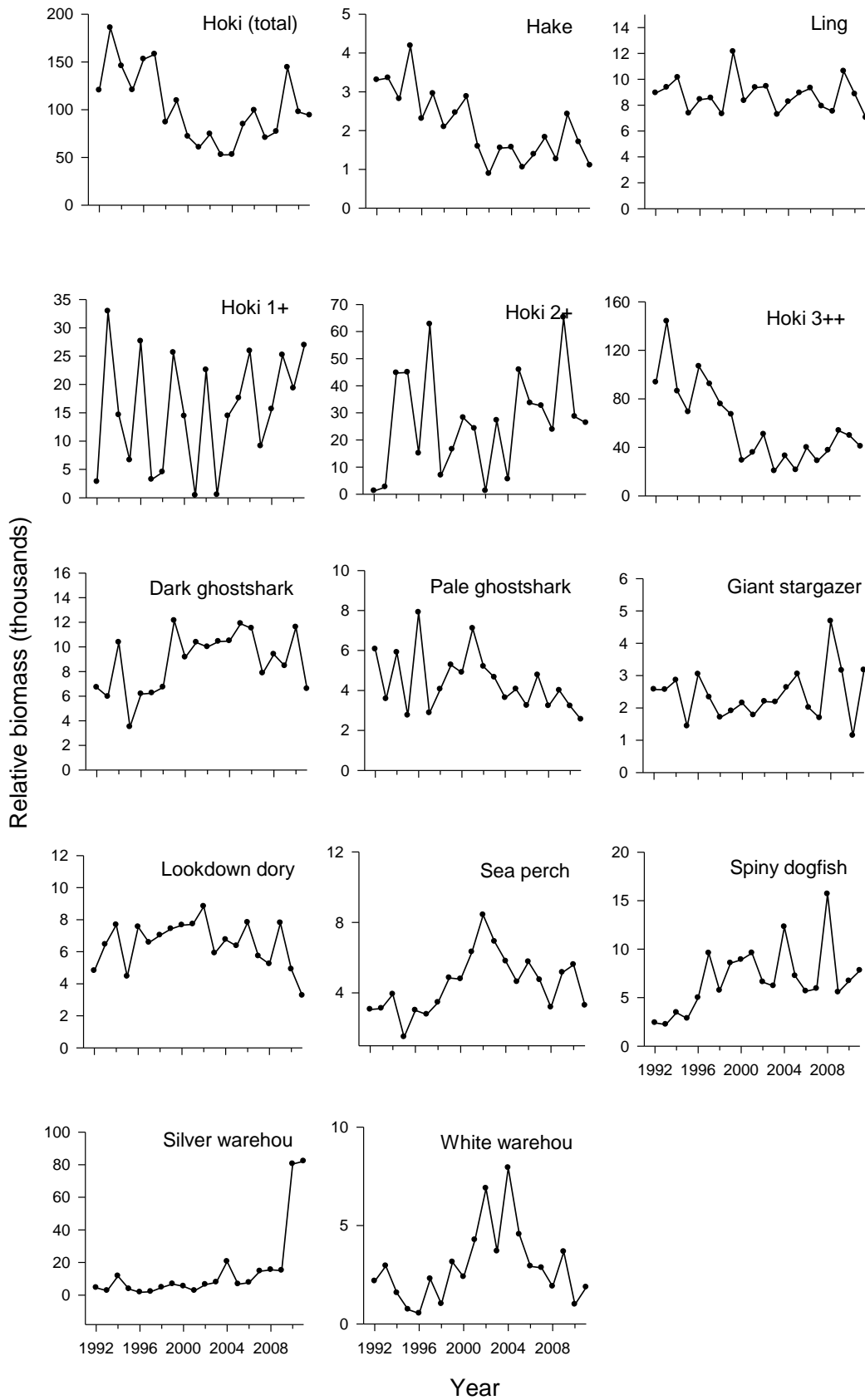


**Figure 3: Positions of sea surface and bottom temperature recordings and approximate location of isotherms (°C) interpolated by eye. The temperatures shown are from the calibrated Seabird CTD recordings made during each tow.**

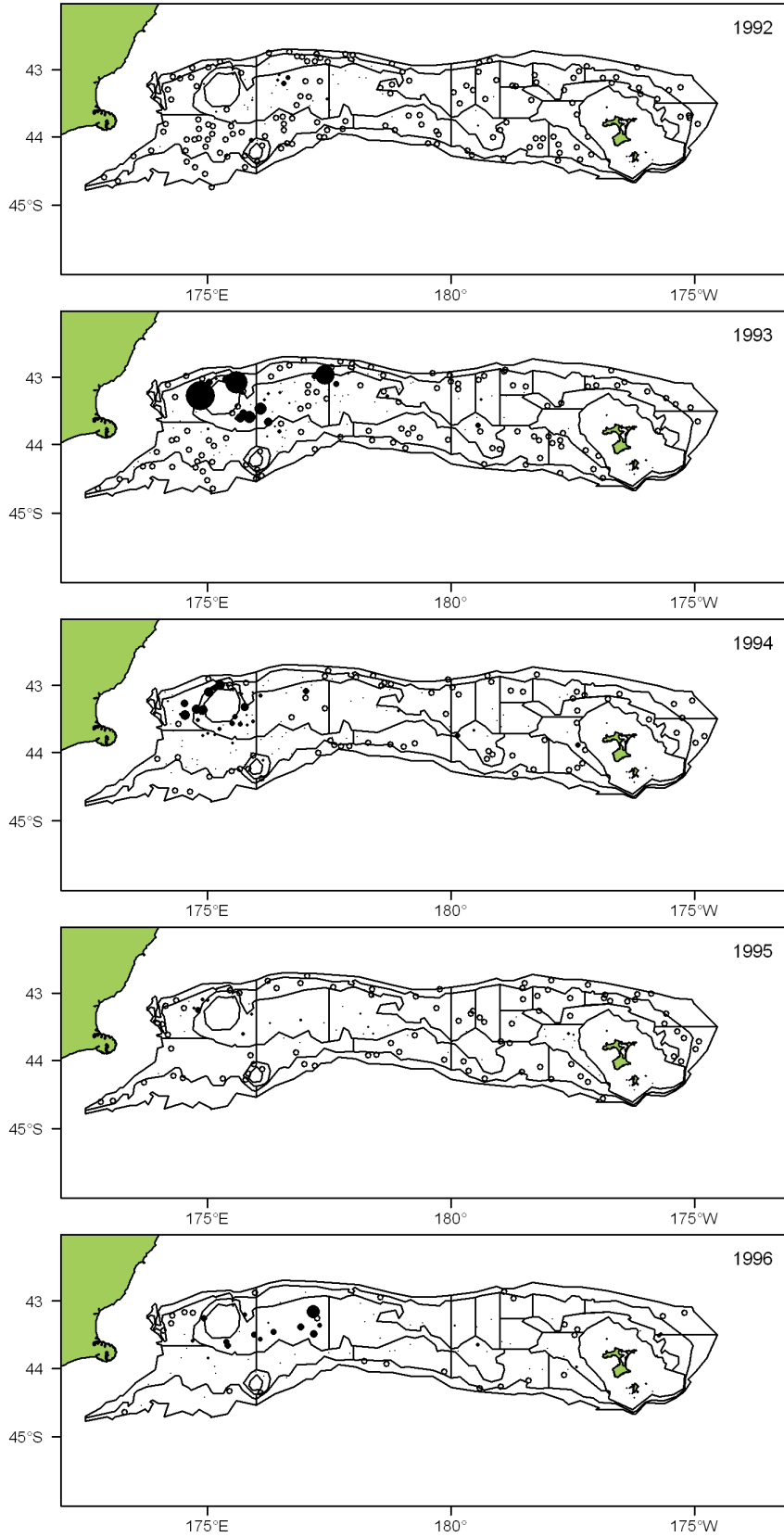




**Figure 4: Relative biomass (top panel) and relative proportions of hoki and 30 other key species (lower panel) from trawl surveys of the Chatham Rise, January 1992–2011.**



**Figure 5: Relative biomass estimates (thousands) of important species sampled by annual trawl surveys of the Chatham Rise, January 1992–2011.**



**Figure 6a: Hoki 1+ catch distribution 1992–2011. Filled circle area is proportional to catch rate (kg.km<sup>-2</sup>). Open circles are zero catch. Maximum catch rate in series is 30 850 kg.km<sup>-2</sup>.**

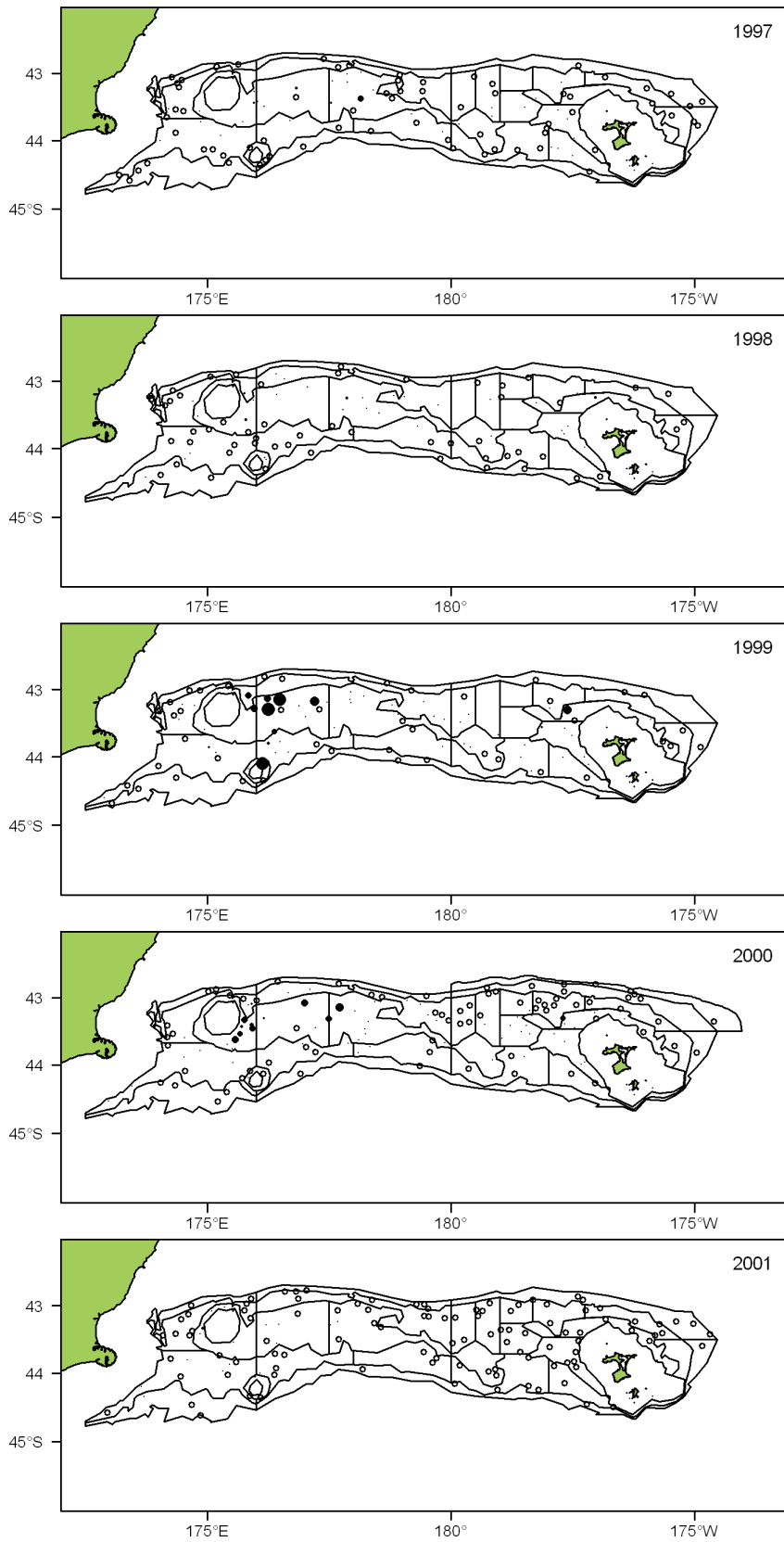


Figure 6a (continued)

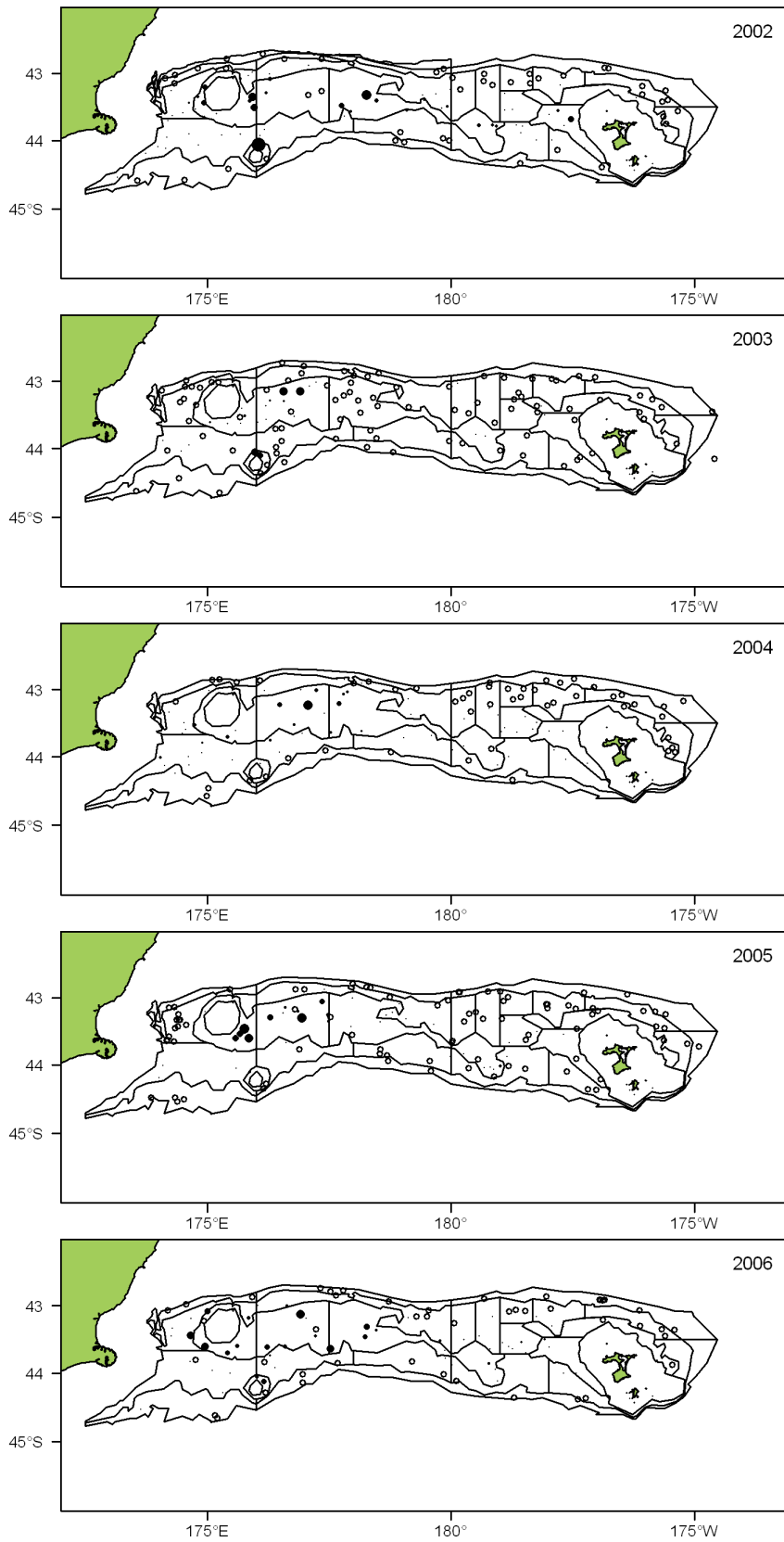
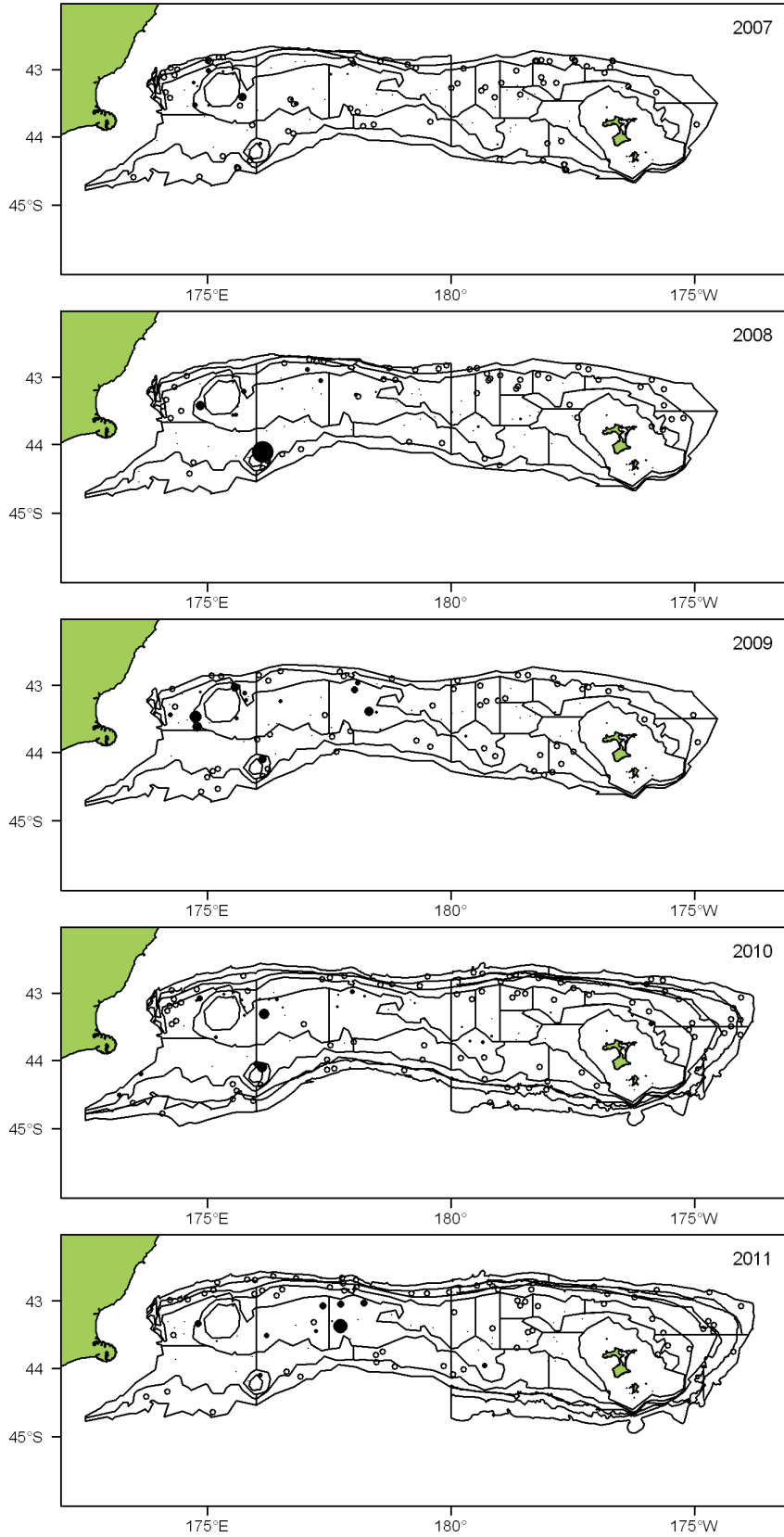
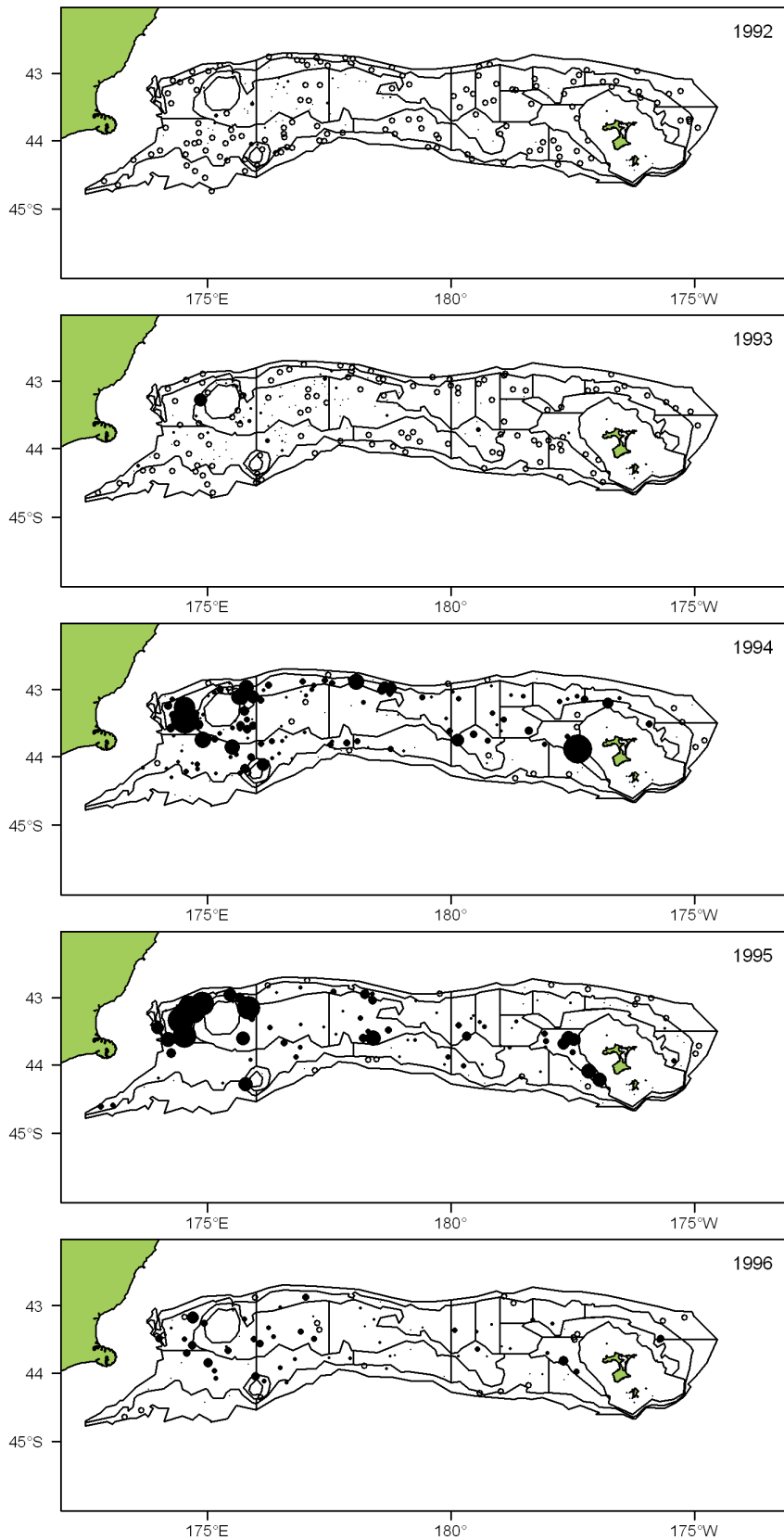


Figure 6a (continued)



**Figure 6a (continued)**



**Figure 6b: Hoki 2+ catch distribution 1992–2011. Filled circle area is proportional to catch rate ( $\text{kg.km}^{-2}$ ). Open circles are zero catch. Maximum catch rate in series is  $6791 \text{ kg.km}^{-2}$ .**

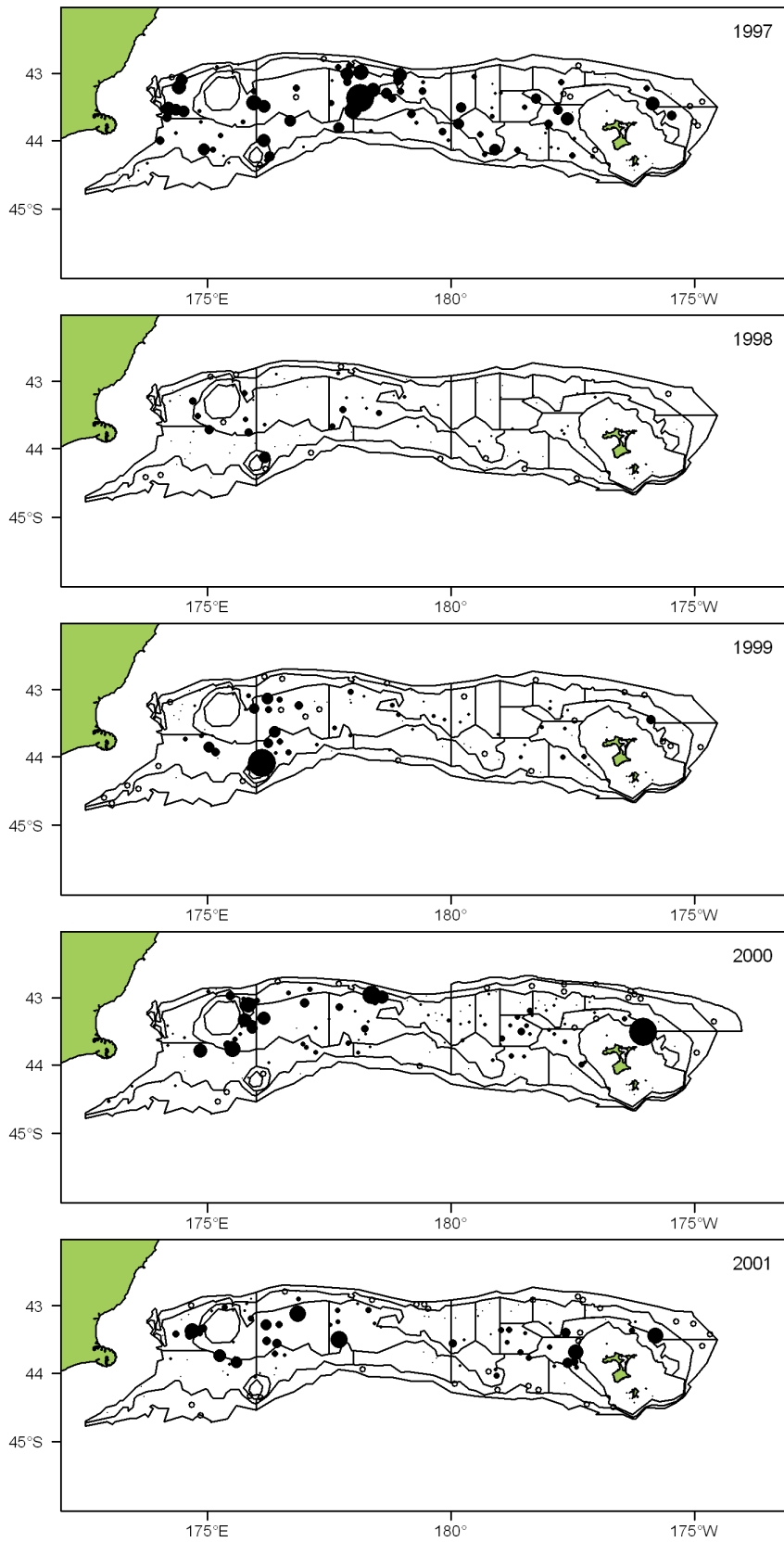


Figure 6b (continued)



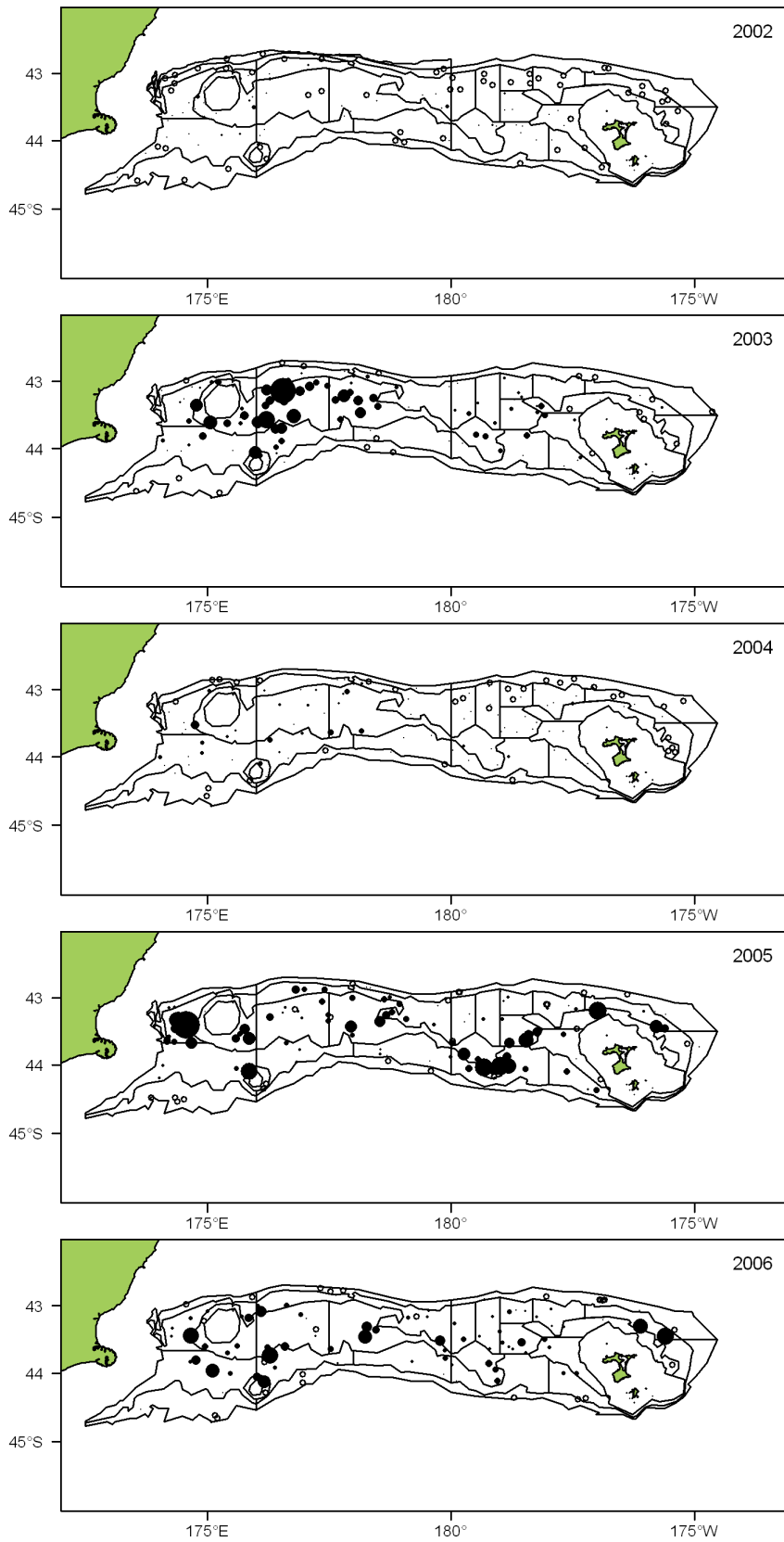


Figure 6b (continued)

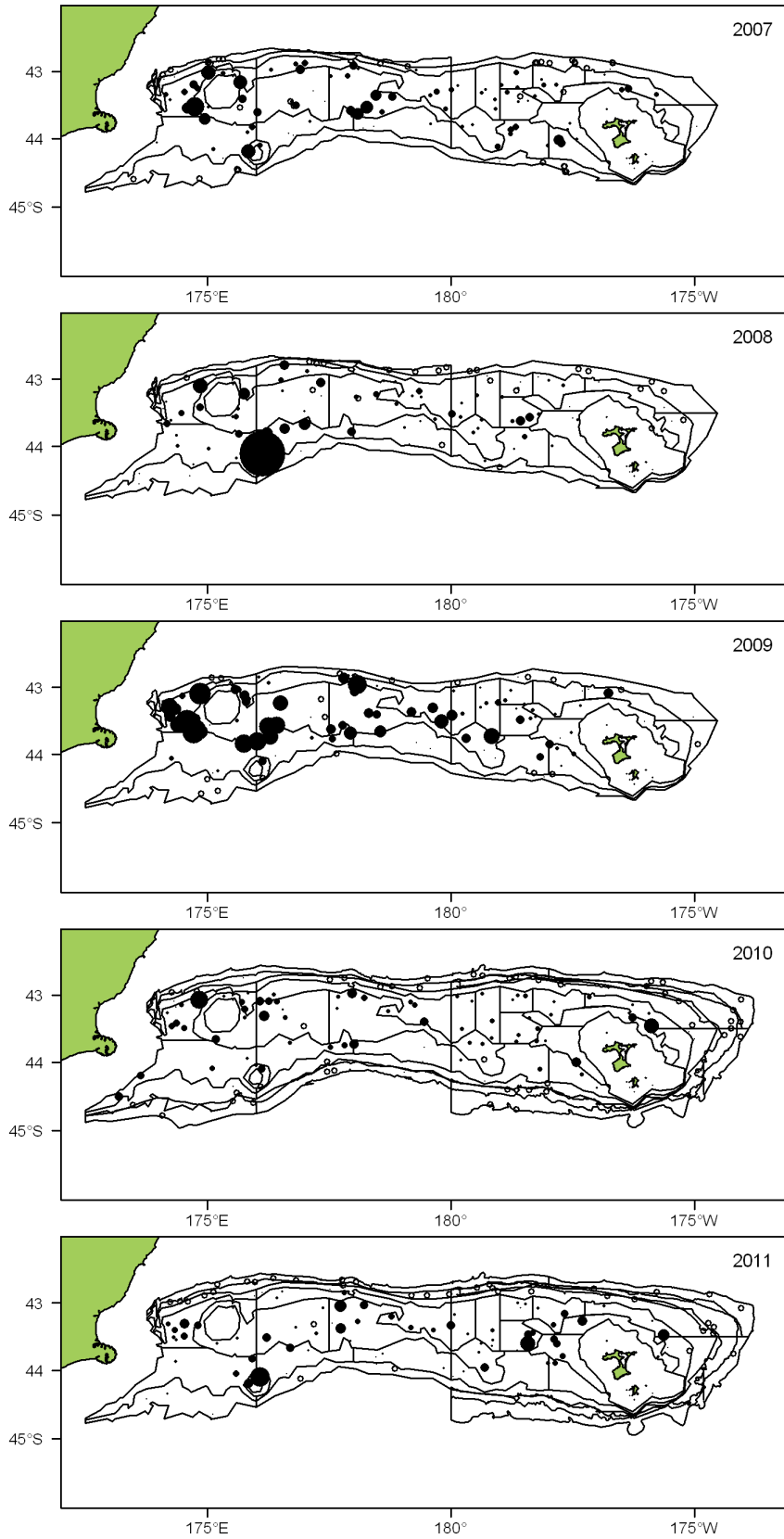
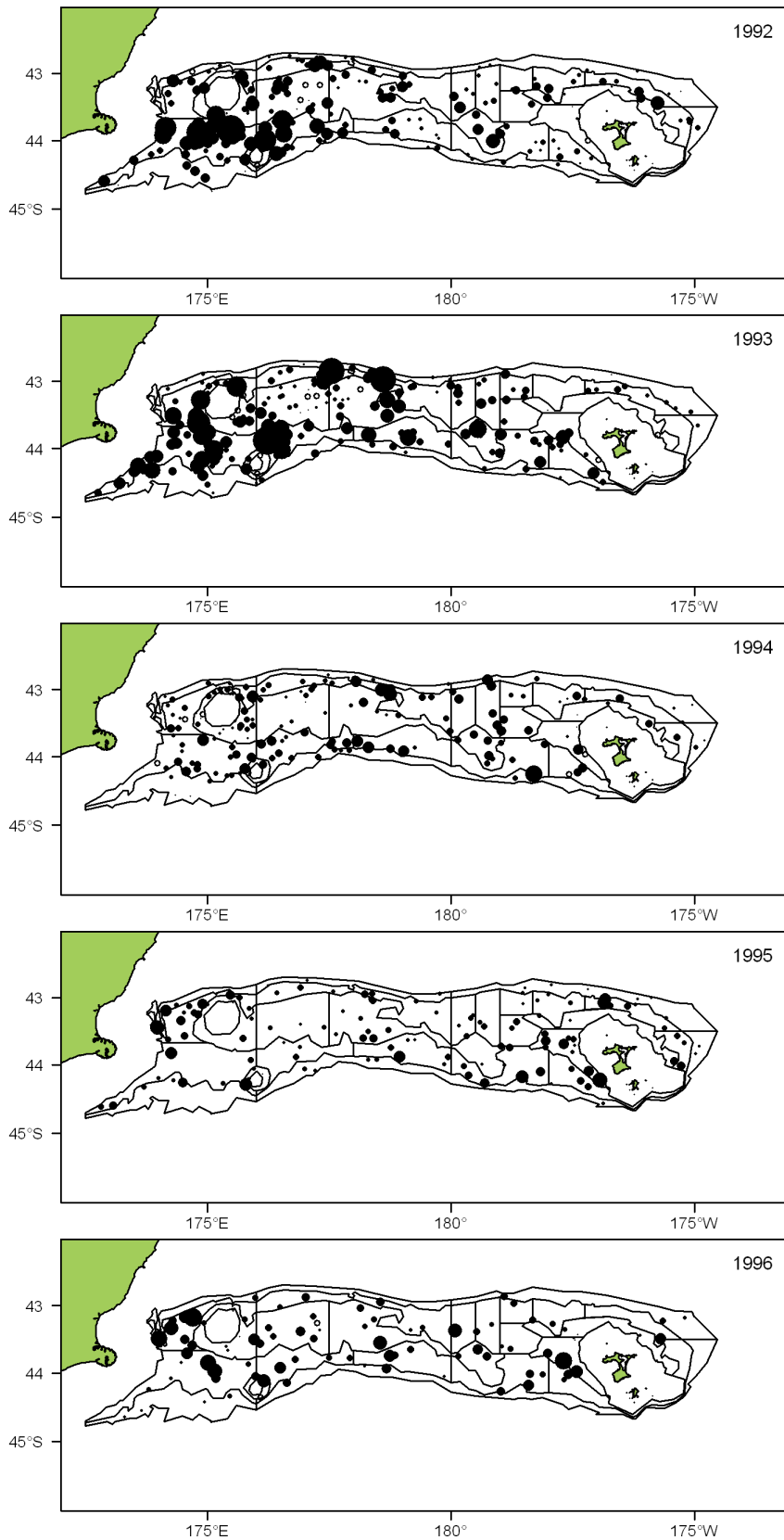


Figure 6b (continued)



**Figure 6c: Hoki 3++ catch distribution. 1992–2011. Filled circle area is proportional to catch rate ( $\text{kg.km}^{-2}$ ). Open circles are zero catch. Maximum catch rate in series is  $11\,177 \text{ kg.km}^{-2}$ .**

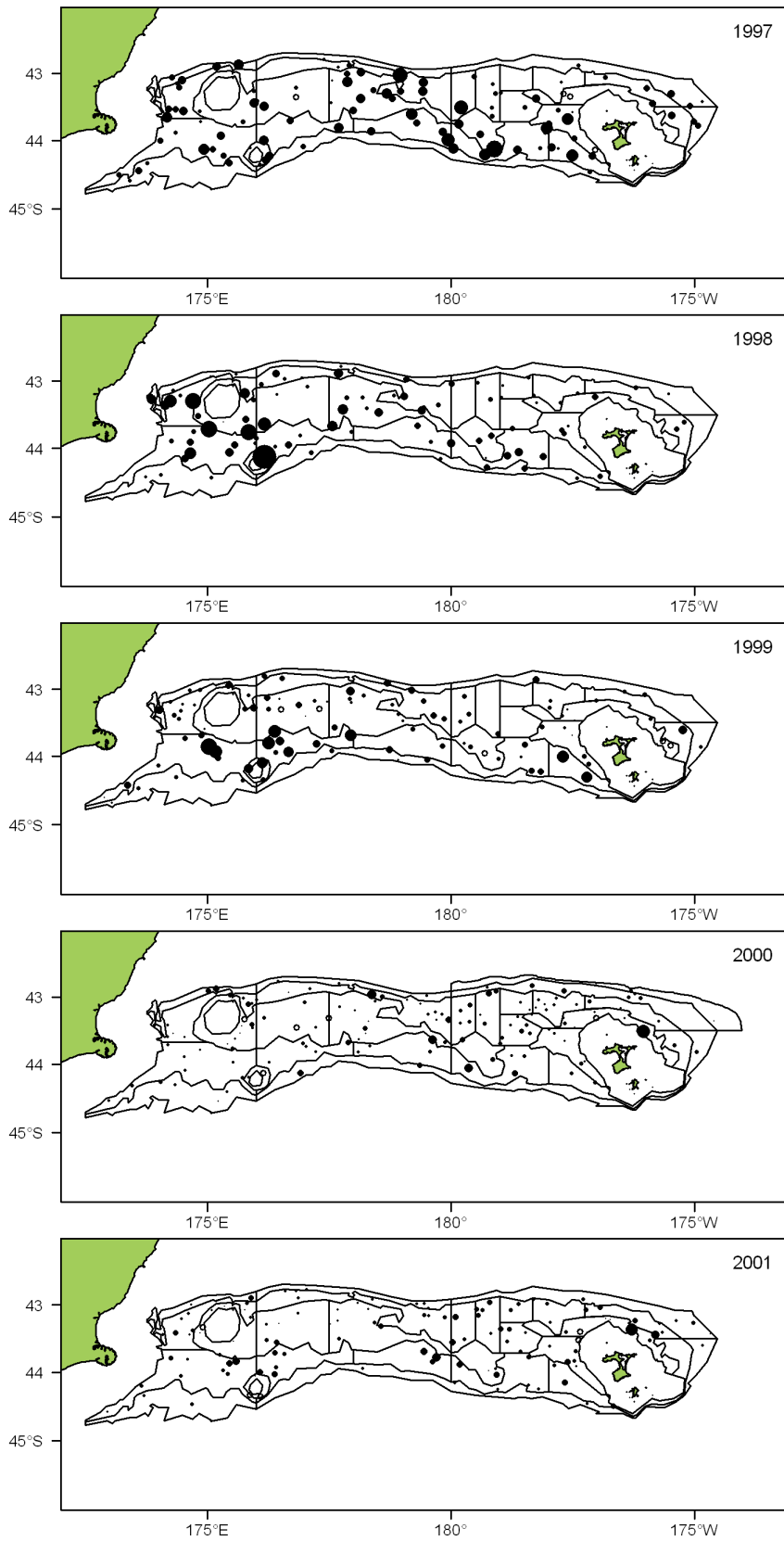


Figure 6c (continued)

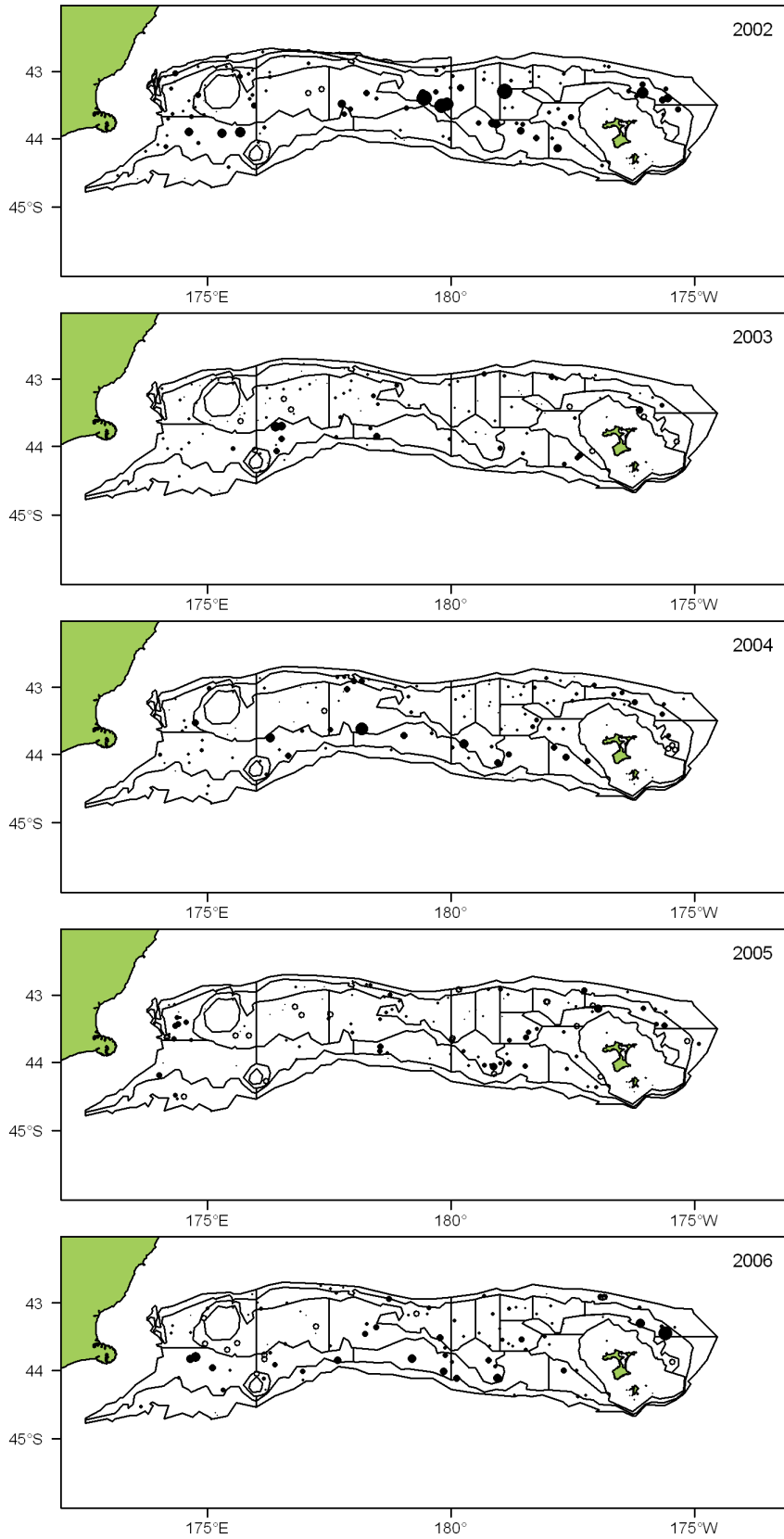
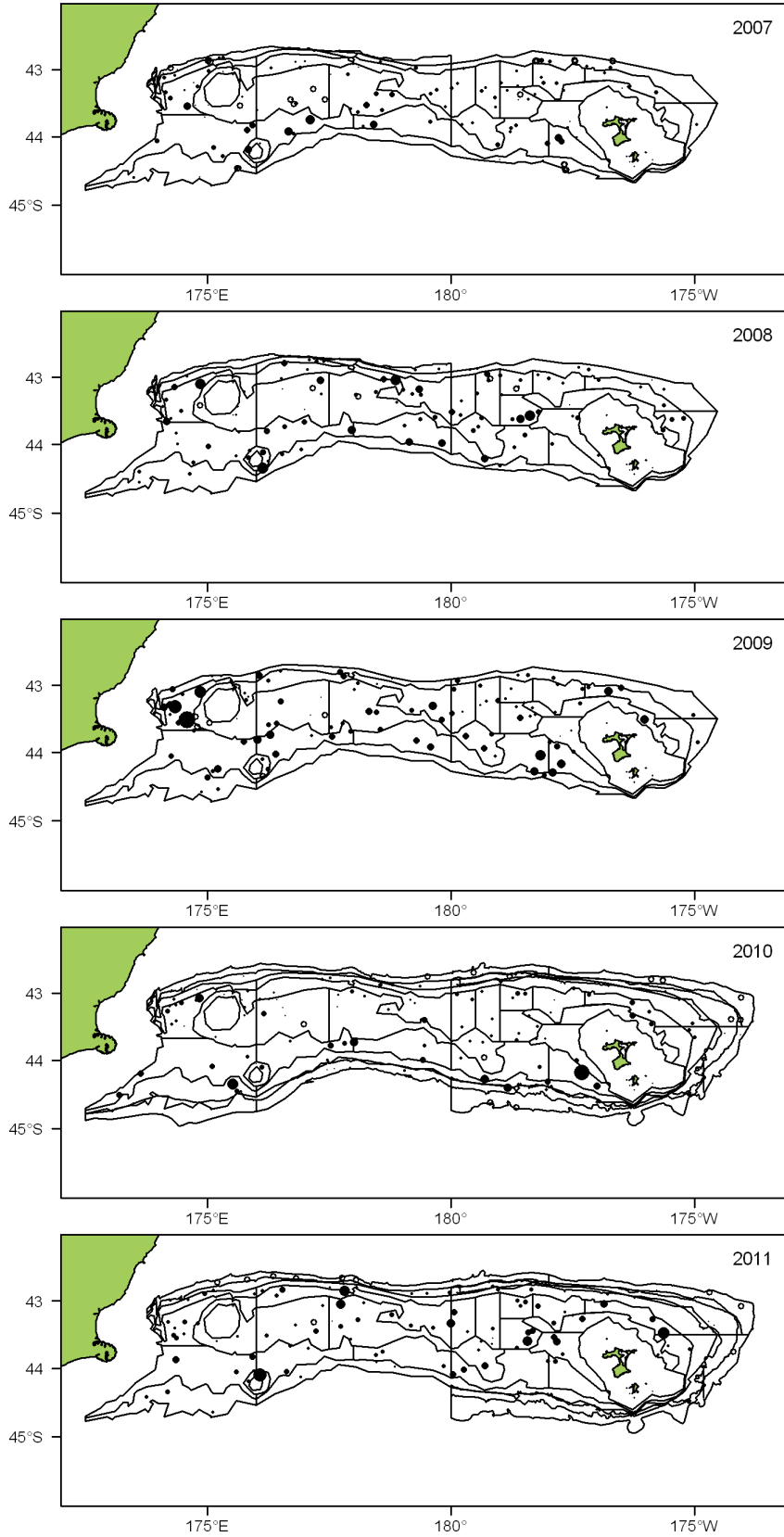
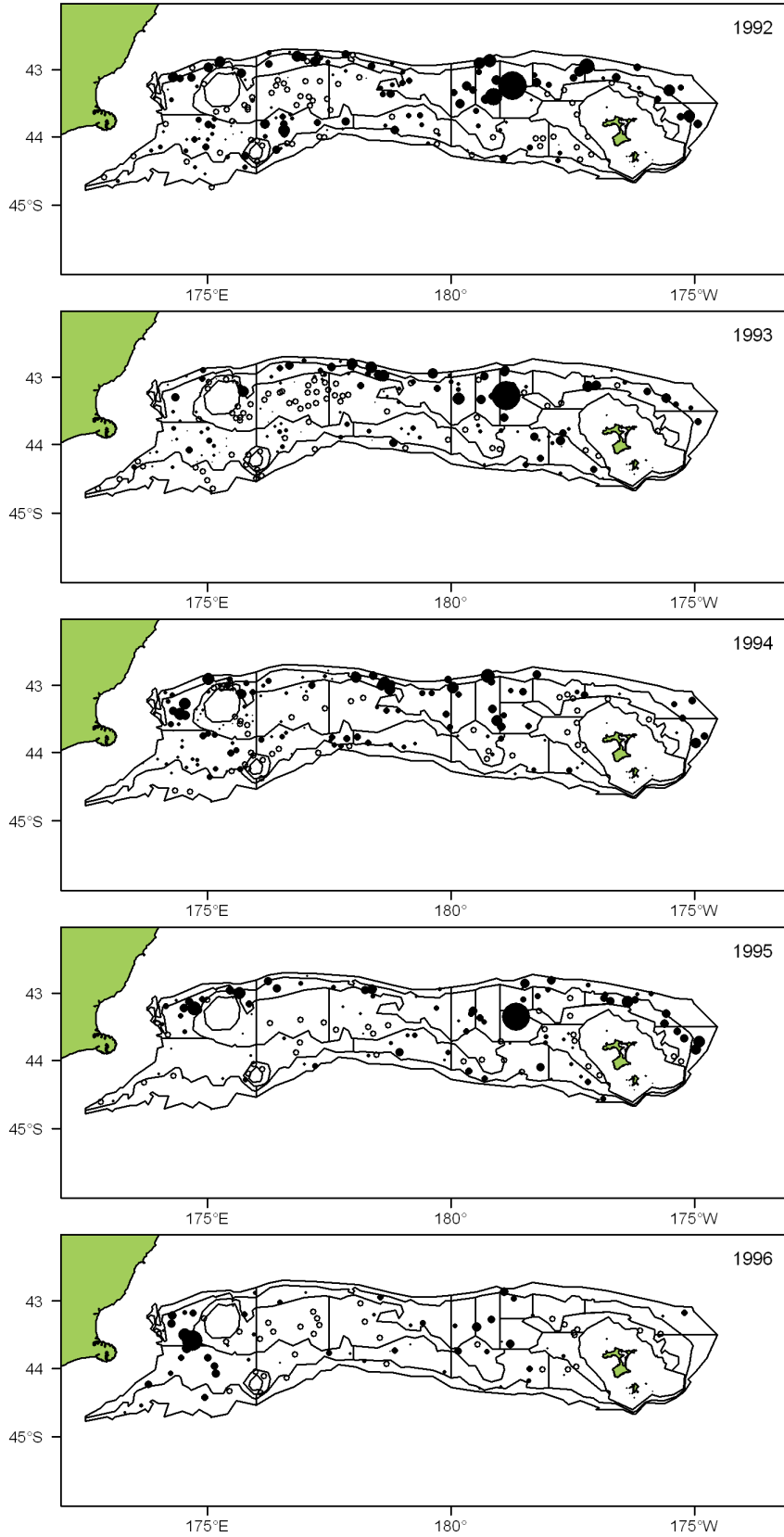


Figure 6c (continued)



**Figure 6c (continued)**



**Figure 7: Hake catch distribution 1992–2011. Filled circle area is proportional to catch rate ( $\text{kg}\cdot\text{km}^{-2}$ ). Open circles are zero catch. Maximum catch rate in series is  $620 \text{ kg}\cdot\text{km}^{-2}$ .**

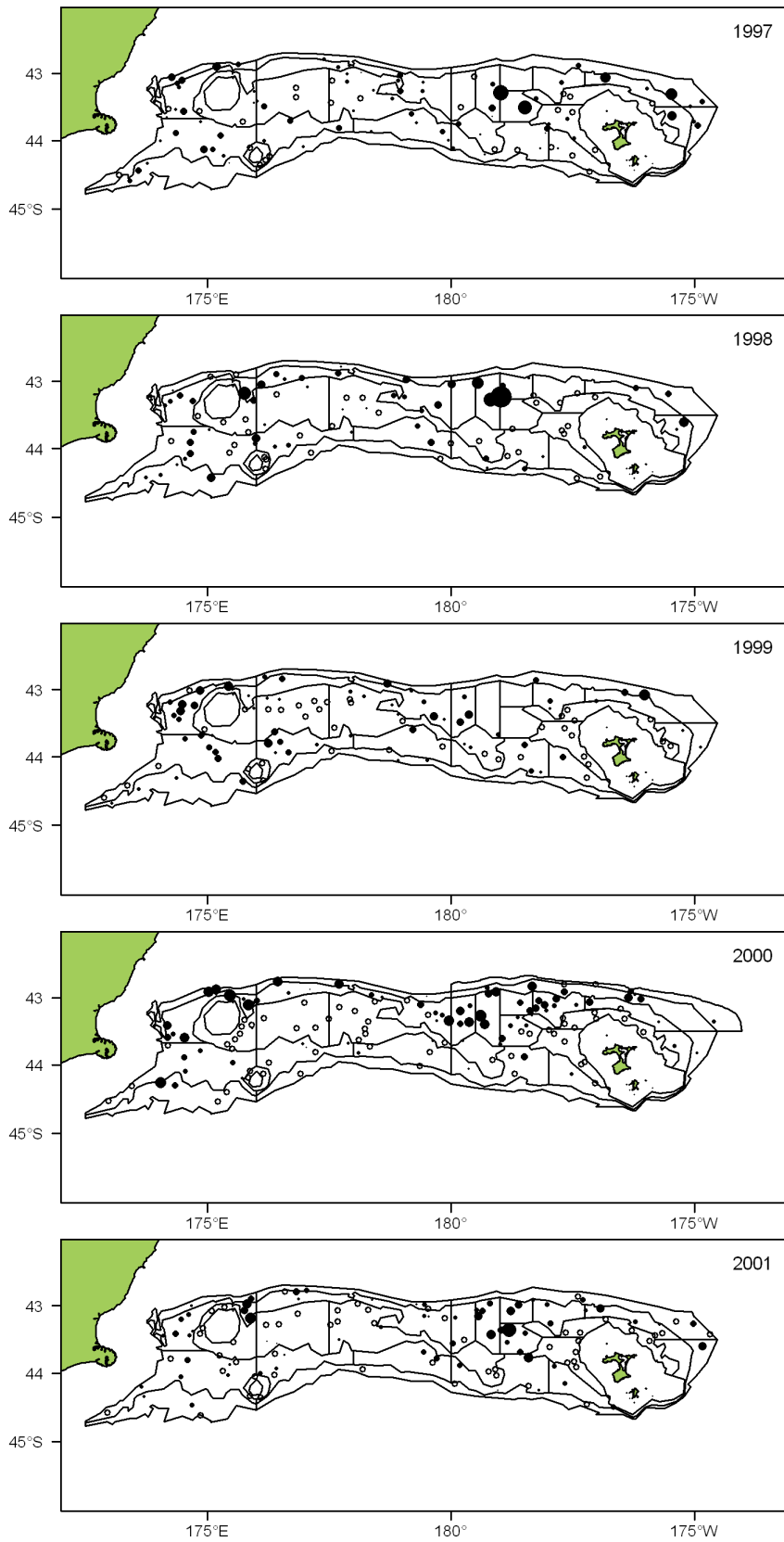


Figure 7 (continued)



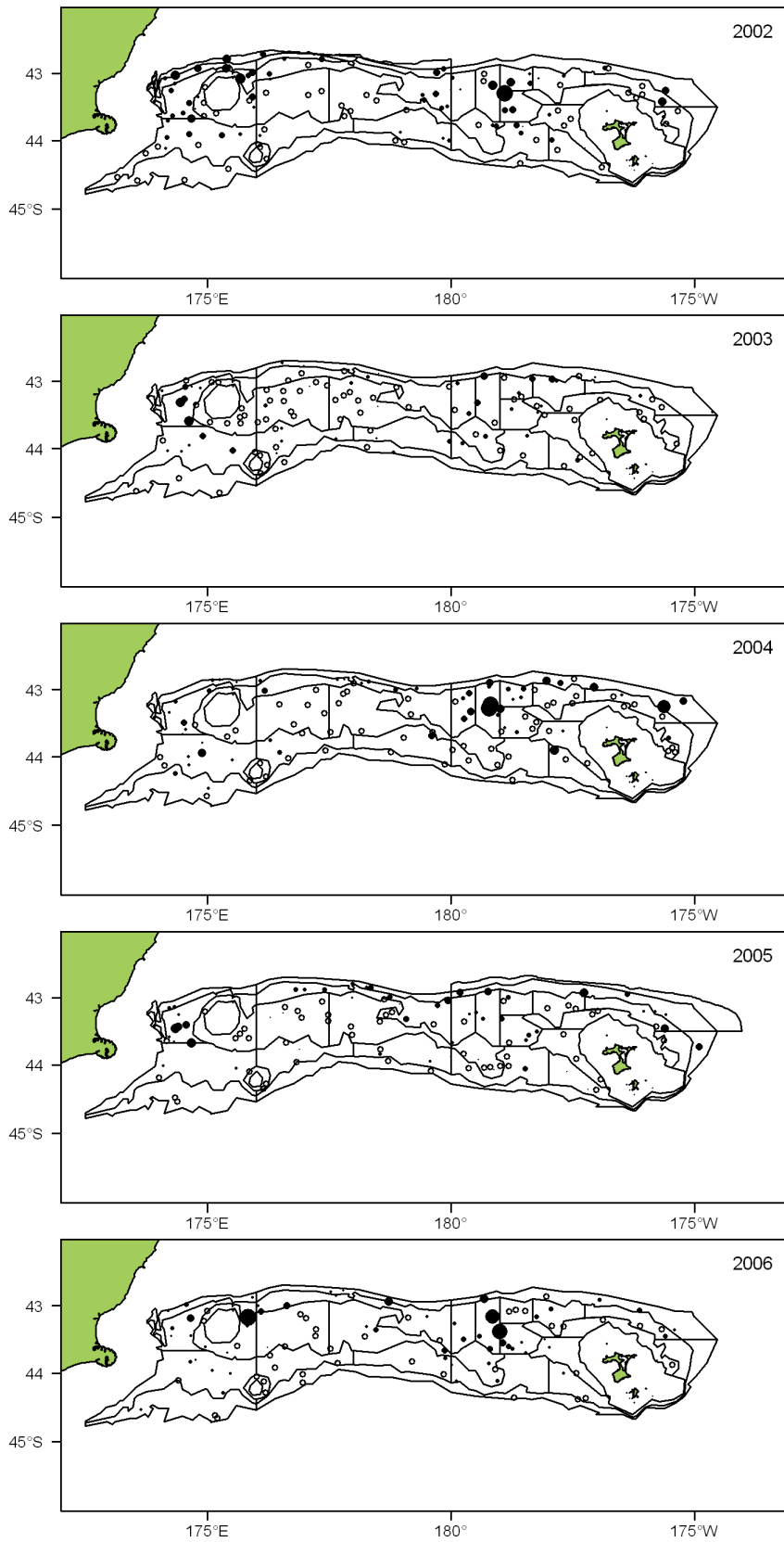


Figure 7 (continued)

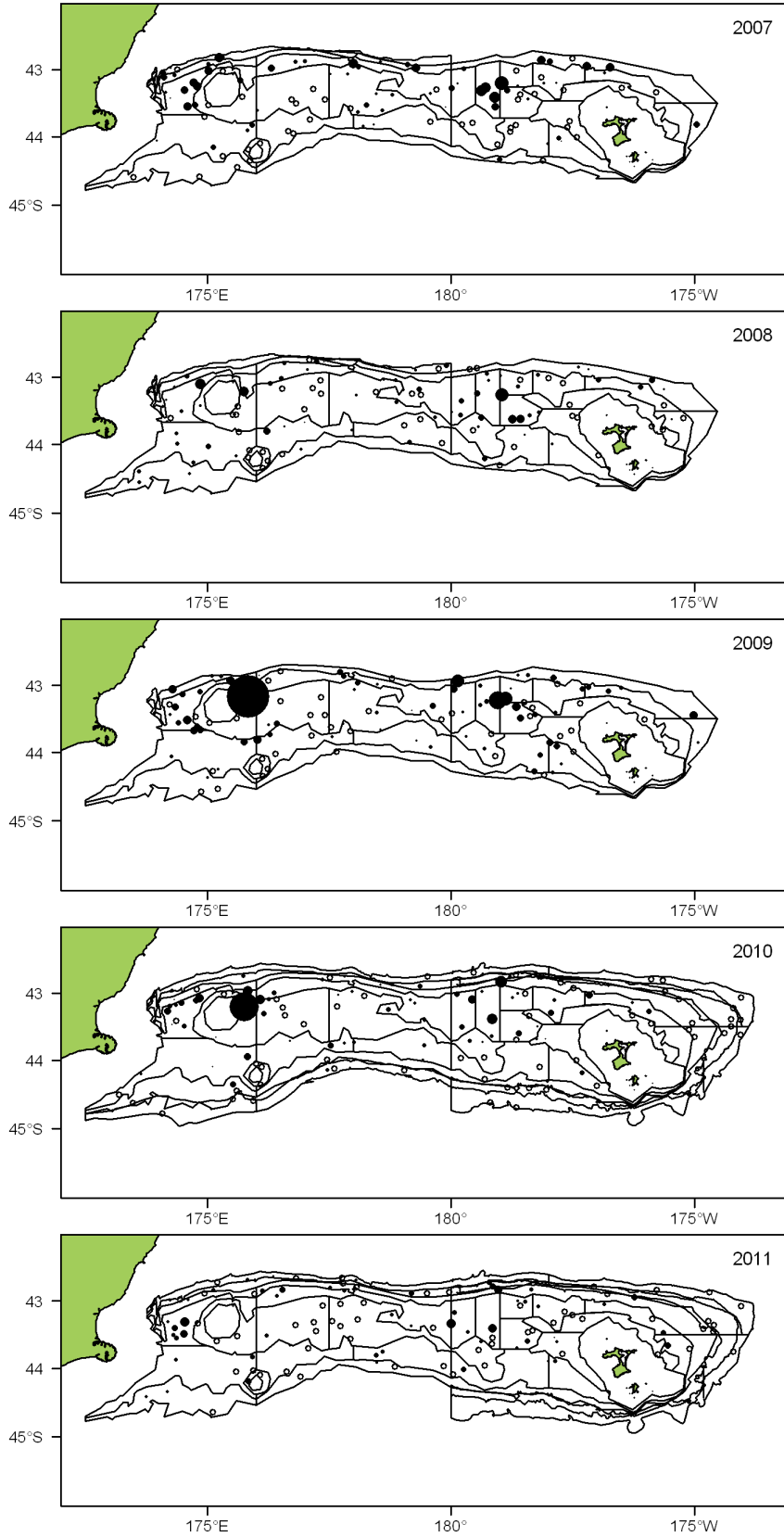
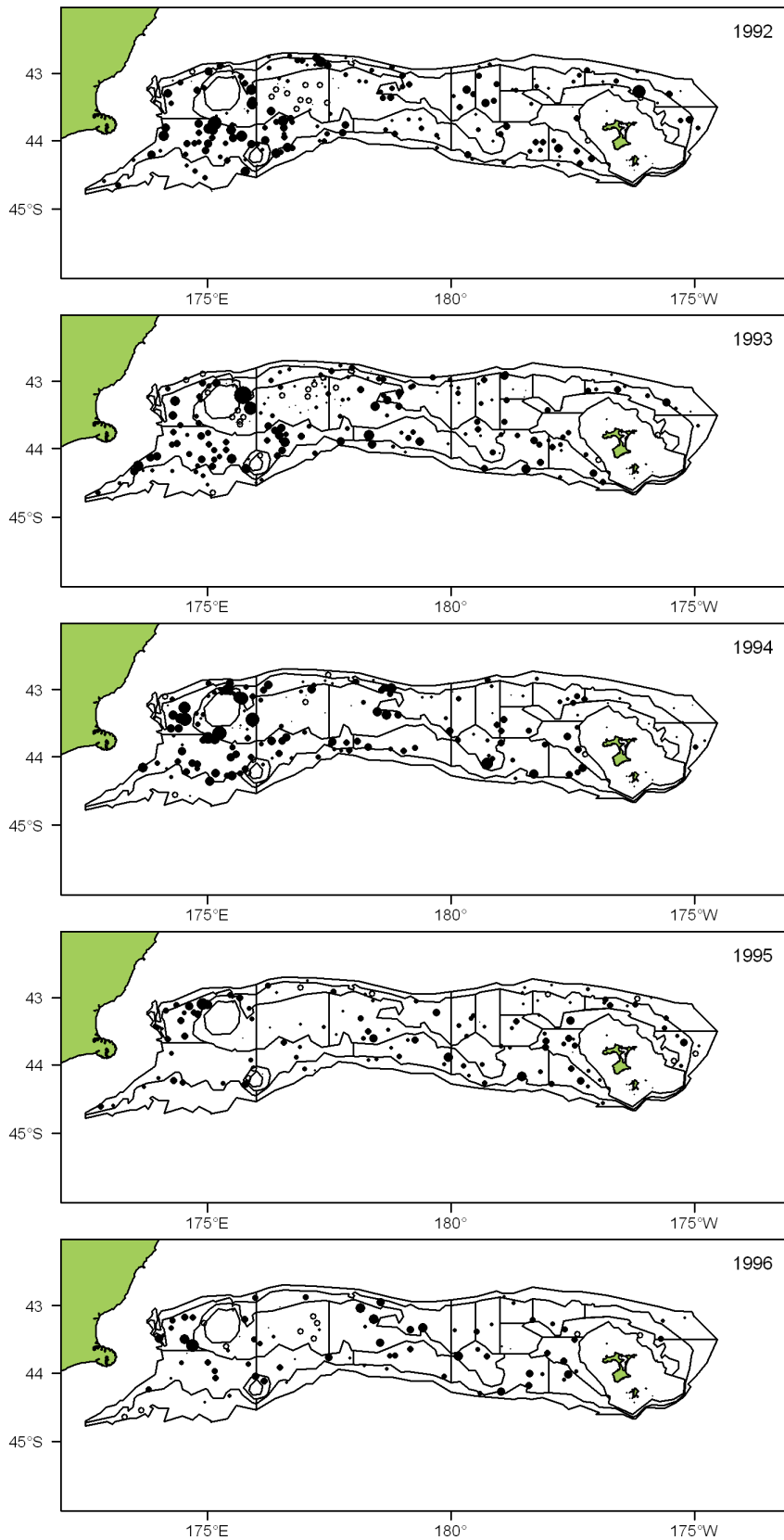
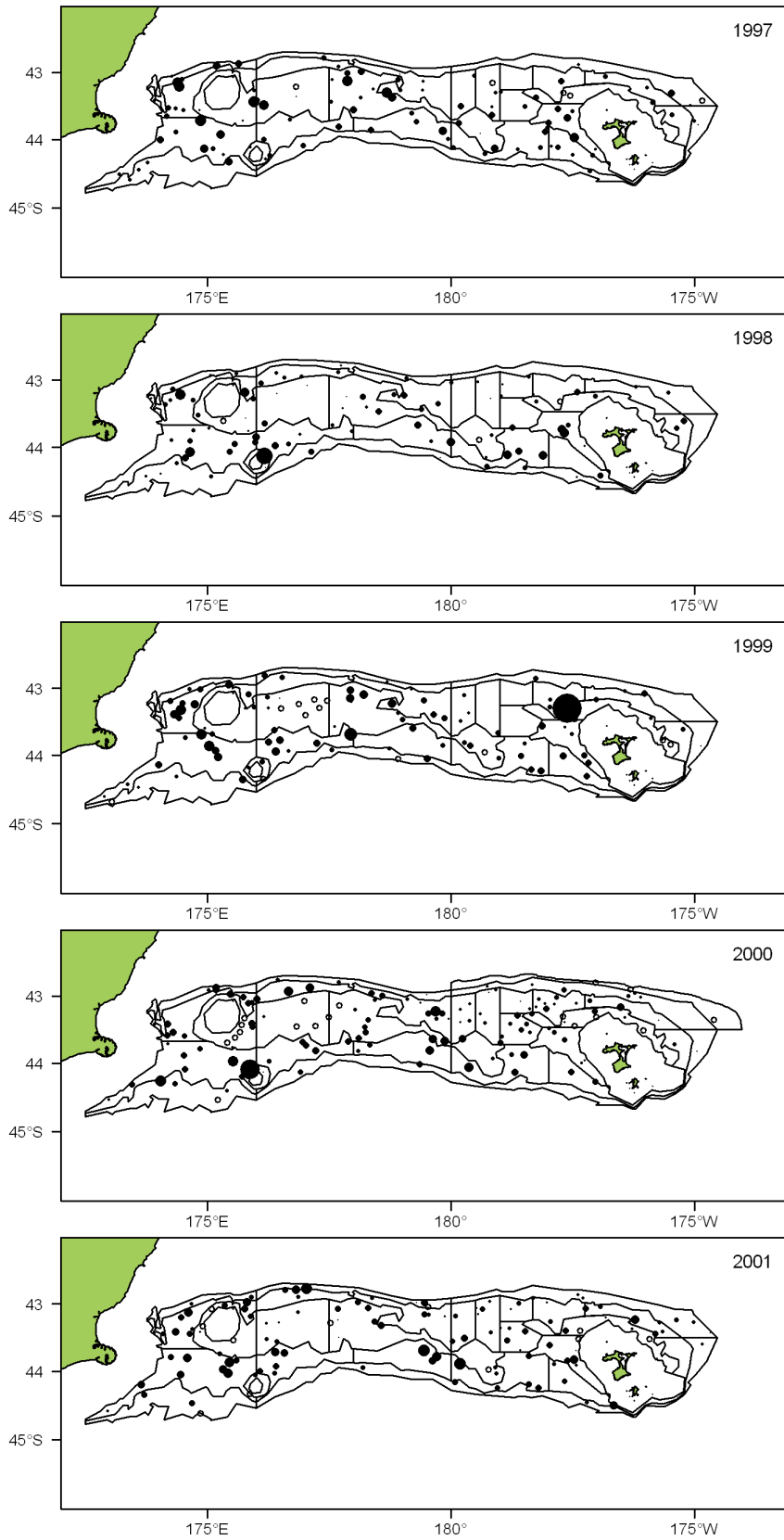


Figure 7 (continued)



**Figure 8: Ling catch distribution 1992–2011. Filled circle area is proportional to catch rate ( $\text{kg.km}^{-2}$ ). Open circles are zero catch. Maximum catch rate in series is  $1786 \text{ kg.km}^{-2}$ .**



**Figure 8 (continued)**



Figure 8 (continued)

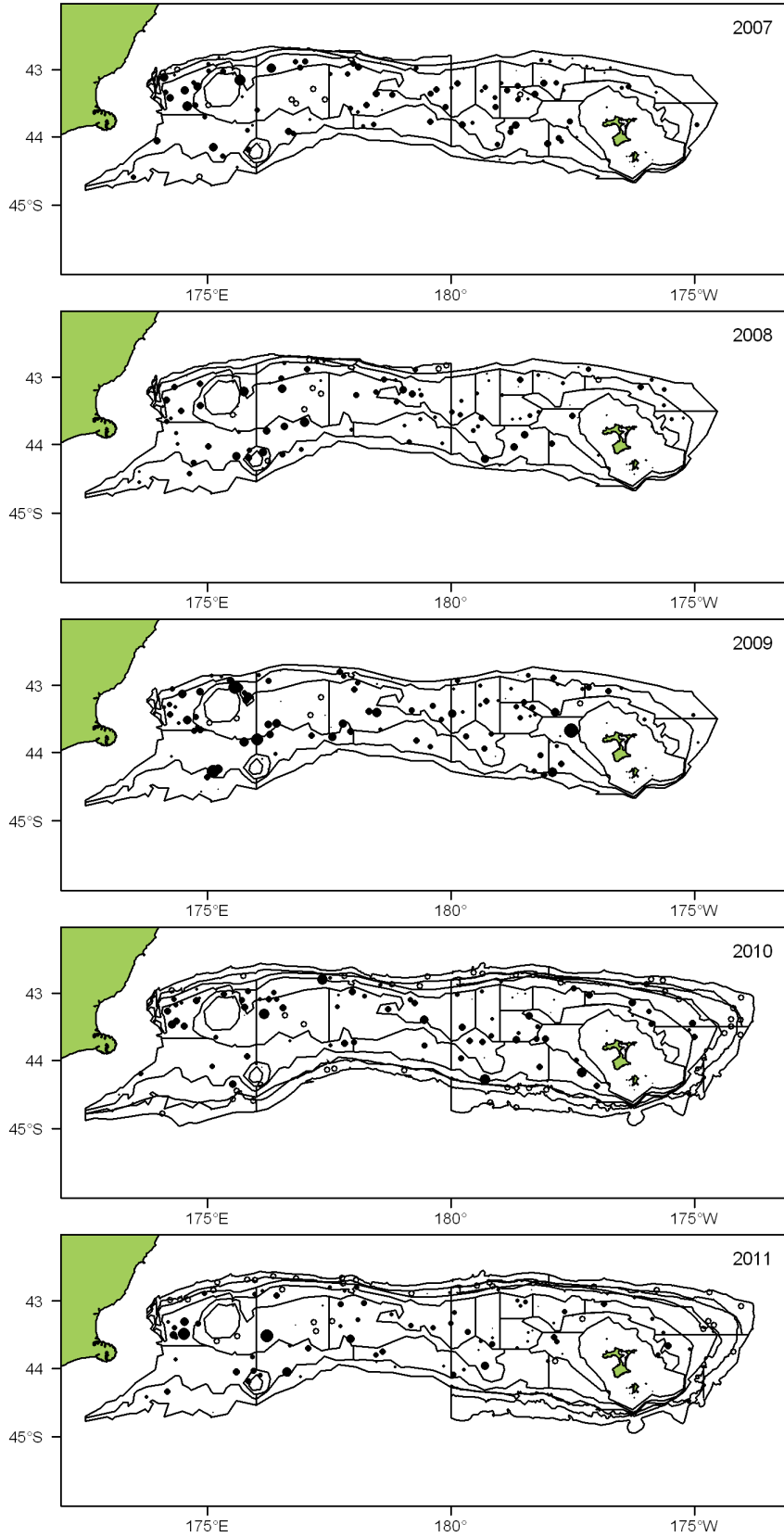
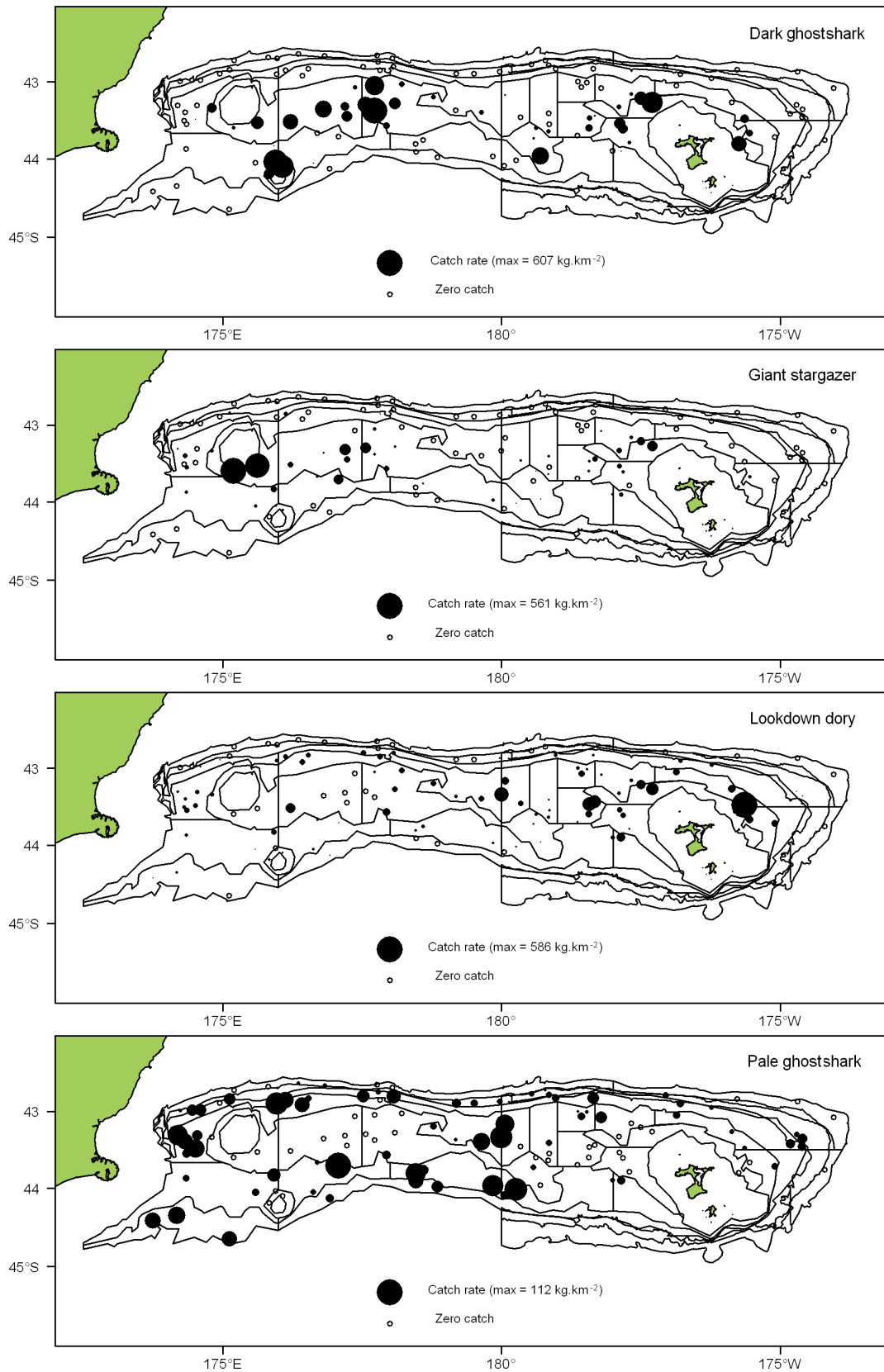


Figure 8 (continued)



**Figure 9: Catch rates (kg.km<sup>-2</sup>) of selected commercial species in 2011. Filled circle area is proportional to catch rate. Open circles are zero catch. (max., maximum catch rate).**

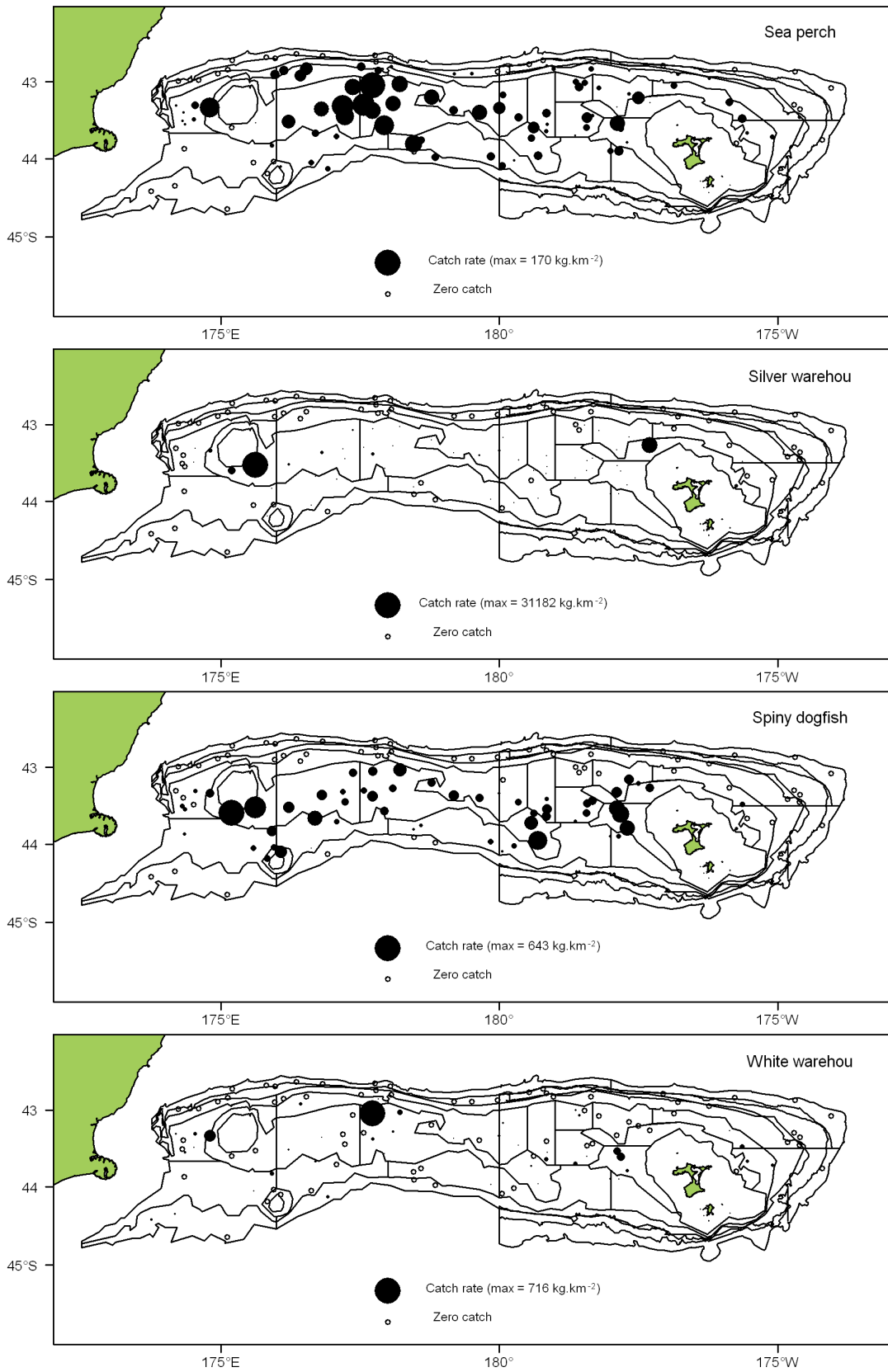


Figure 9 (continued)



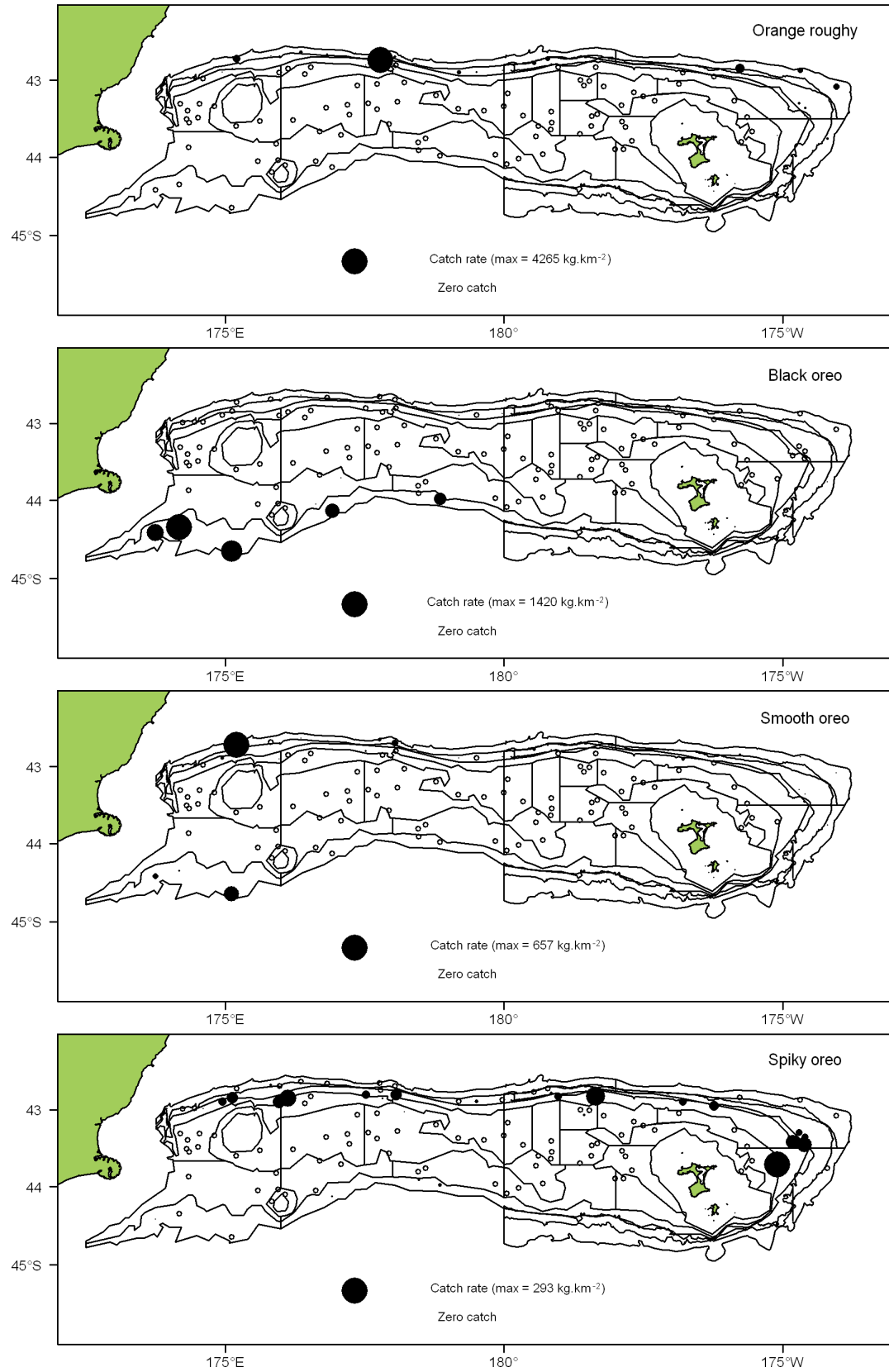
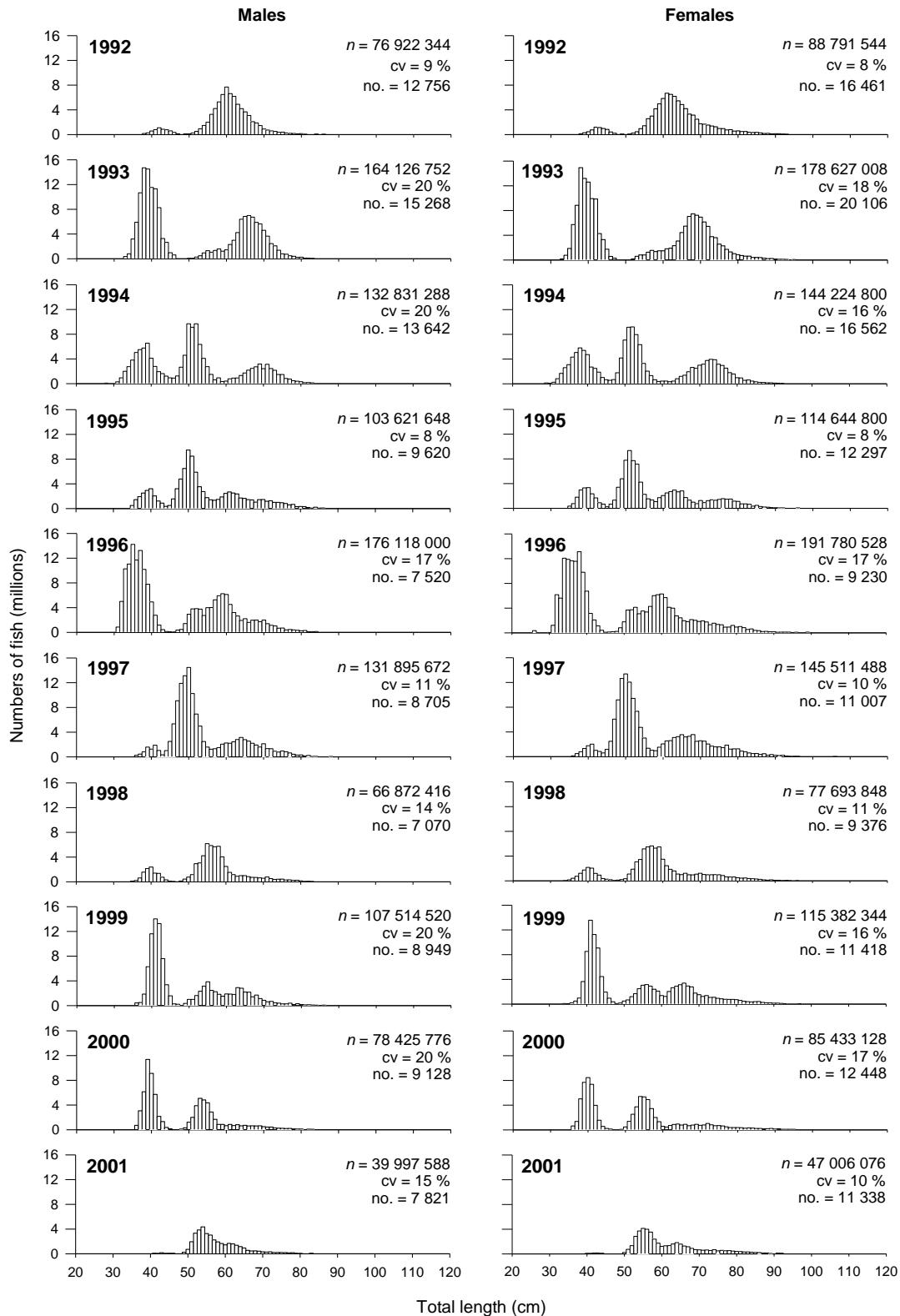


Figure 9 (continued)



**Figure 10: Estimated length frequency distributions of the male and female hoki population from *Tangaroa* surveys of the Chatham Rise, January 1992–2011. (c.v., coefficient of variation; *n*, estimated population number of male hoki (left panel) and female hoki (right panel); no., numbers of fish measured.).**

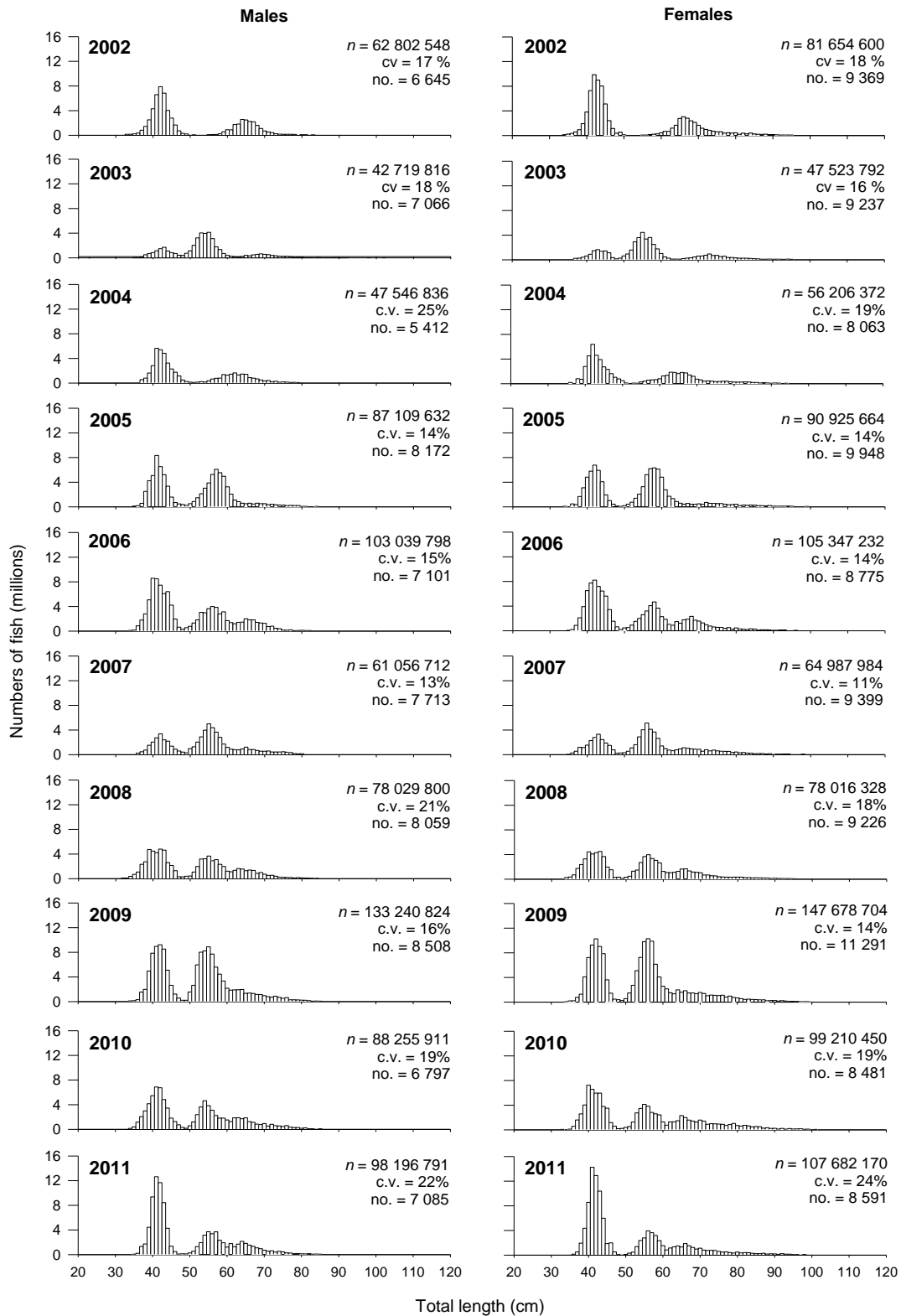
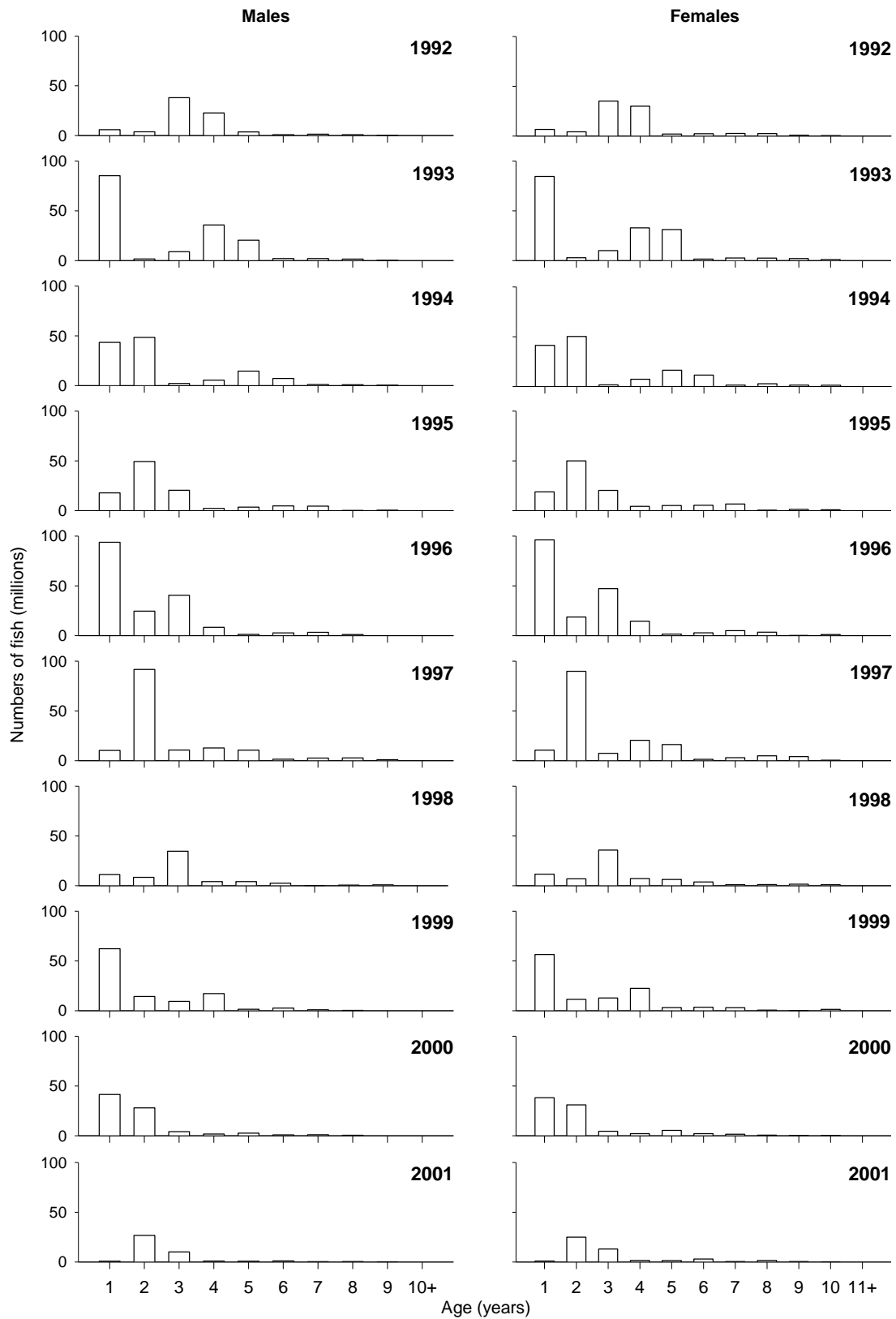
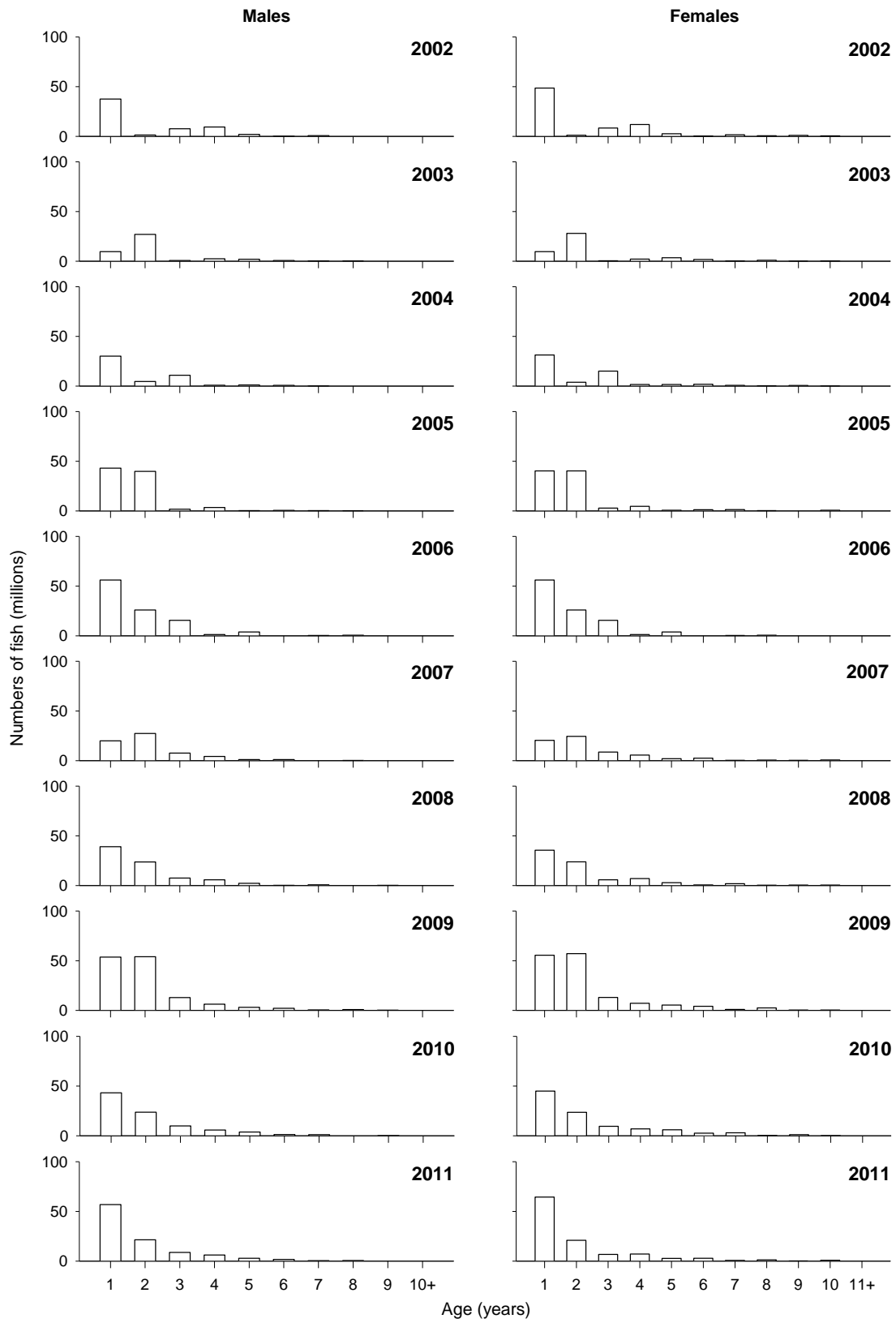


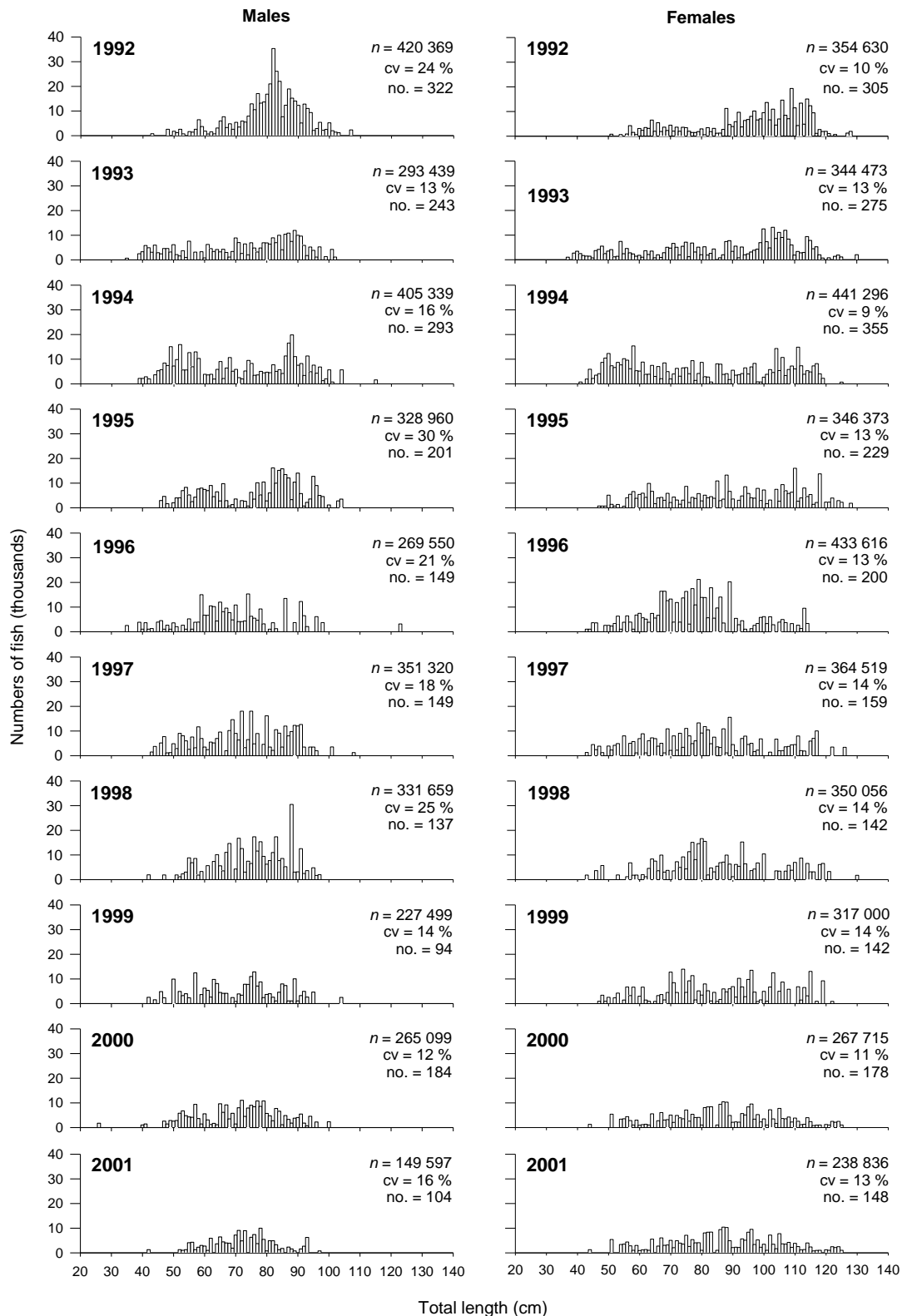
Figure 10 (continued)



**Figure 11: Estimated population numbers at age of hoki from *Tangaroa* surveys of the Chatham Rise, January, 1992–2011. (+, 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 1992–2011. (c.v., coefficient of variation; *n*, estimated population number of hake; no., numbers of fish measured.).**

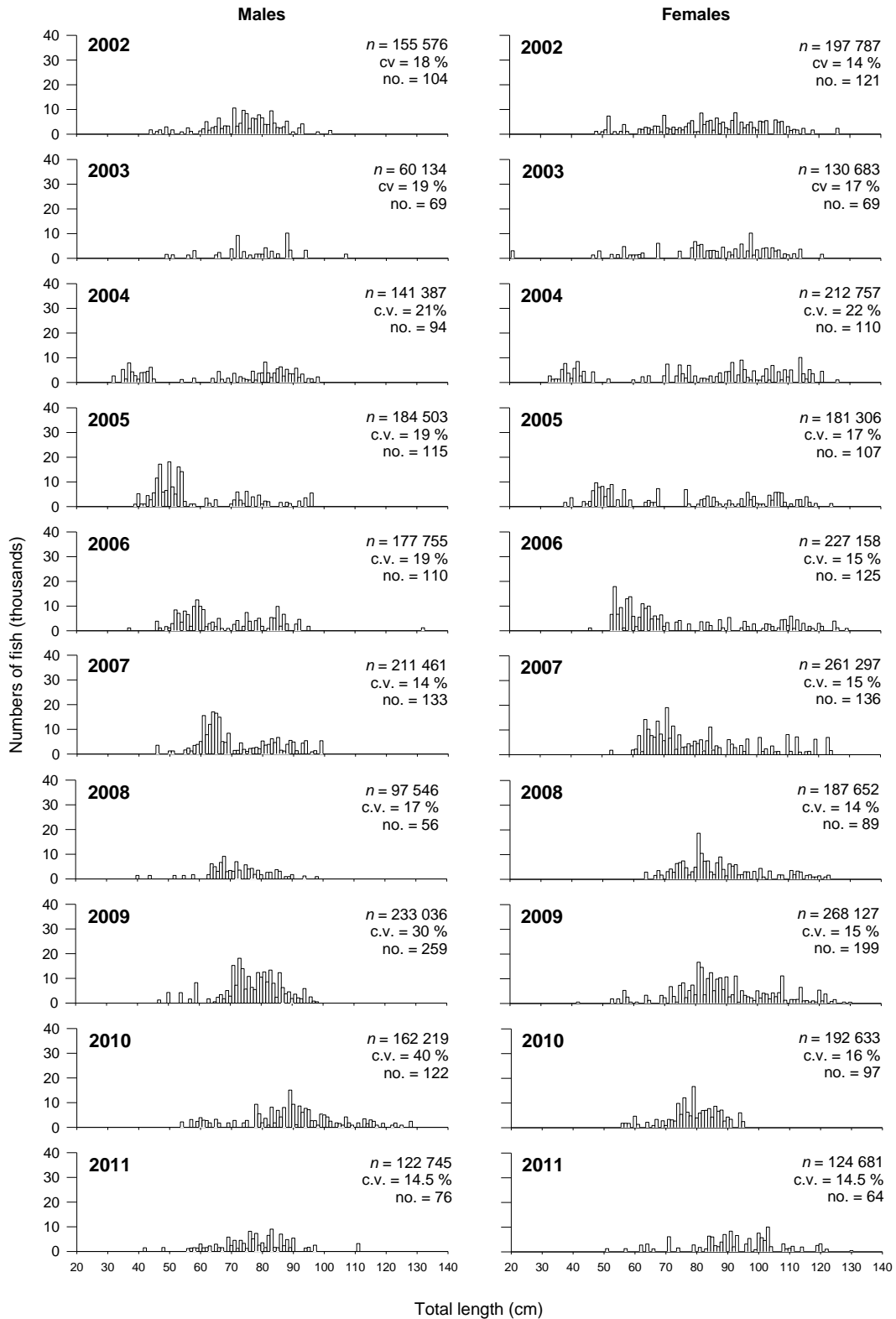
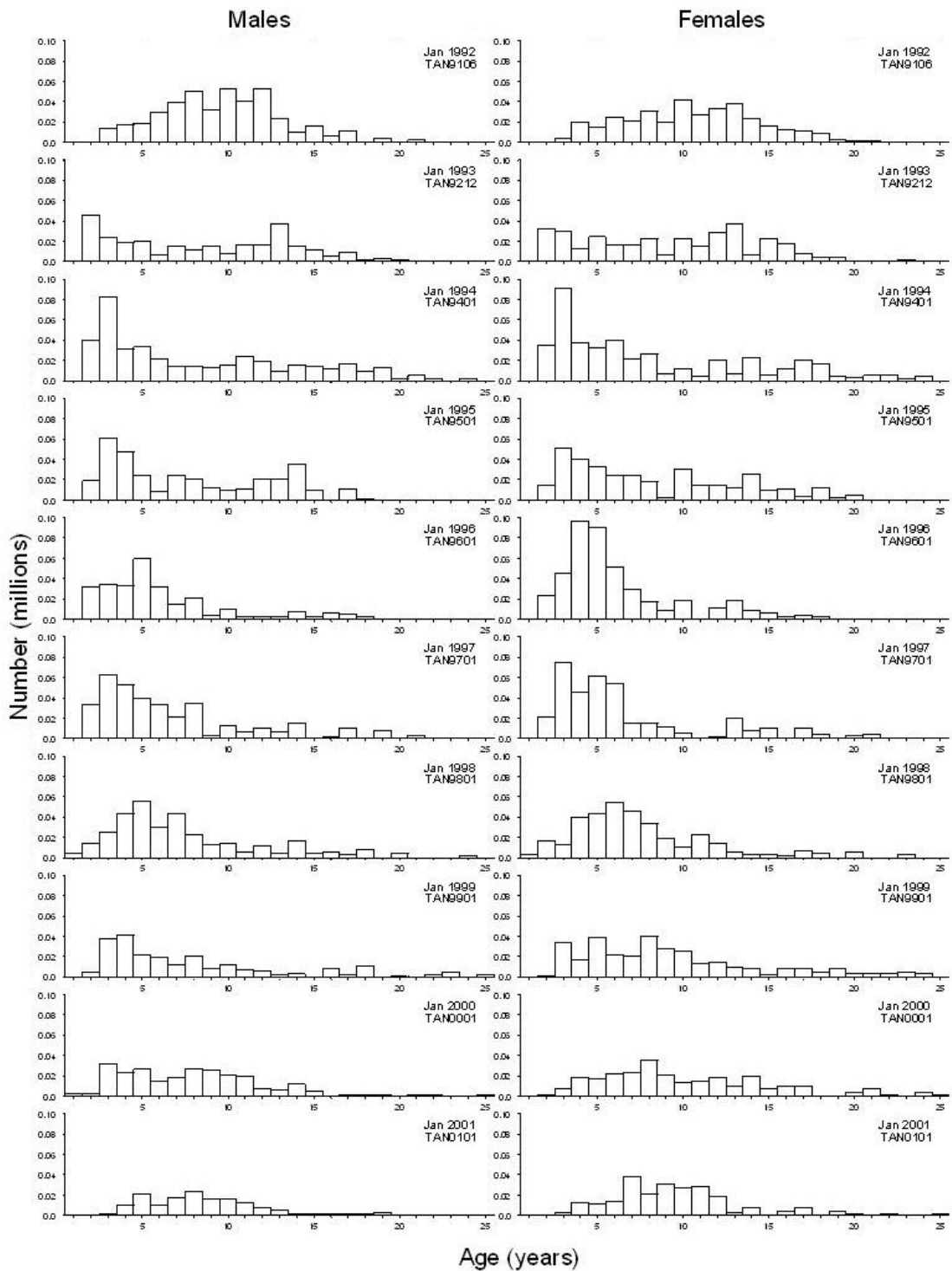


Figure 12 (continued)



**Figure 13: Estimated proportion at age of male and female hake from *Tangaroa* surveys of the Chatham Rise, January, 1992–2011.**



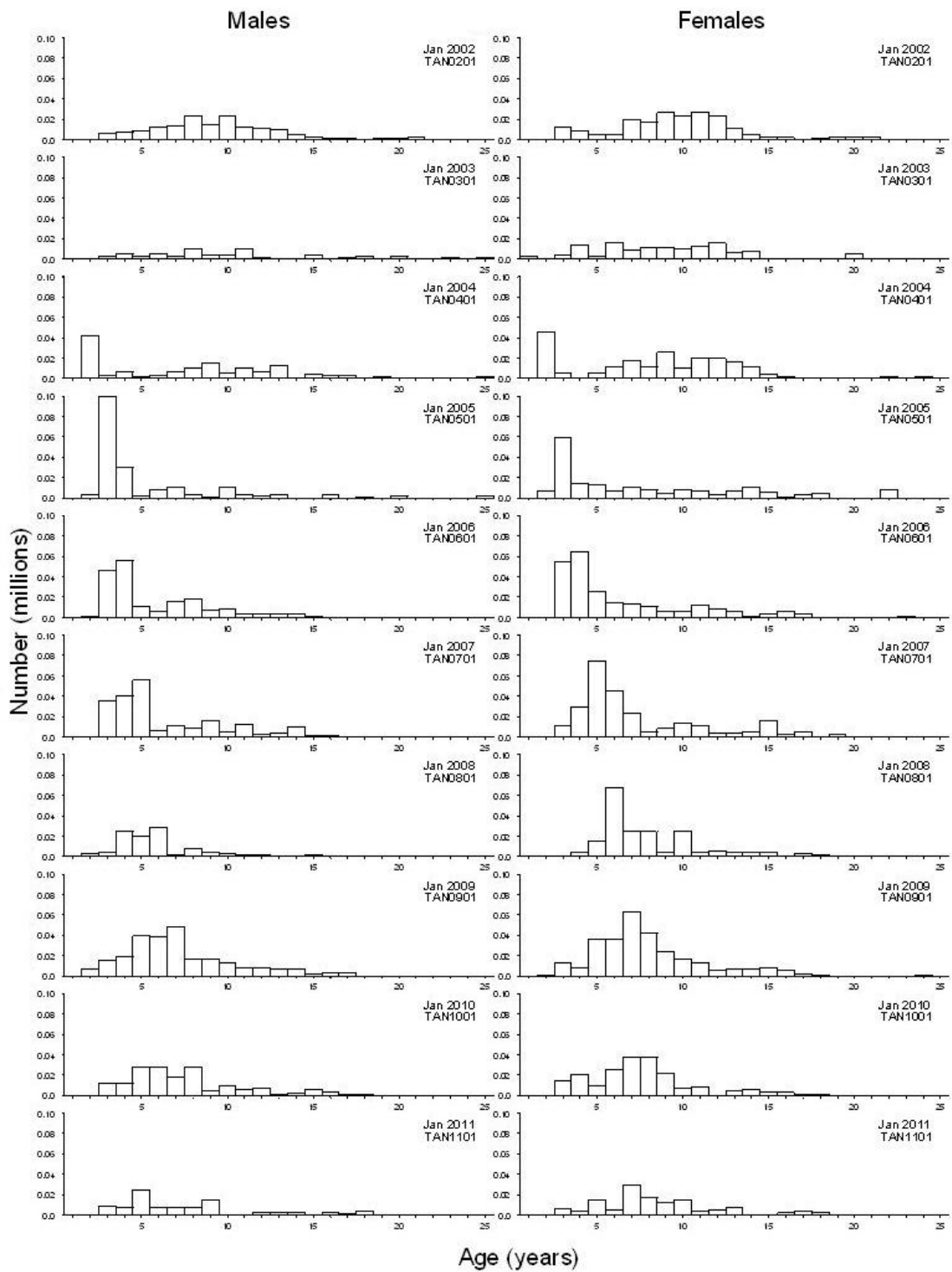
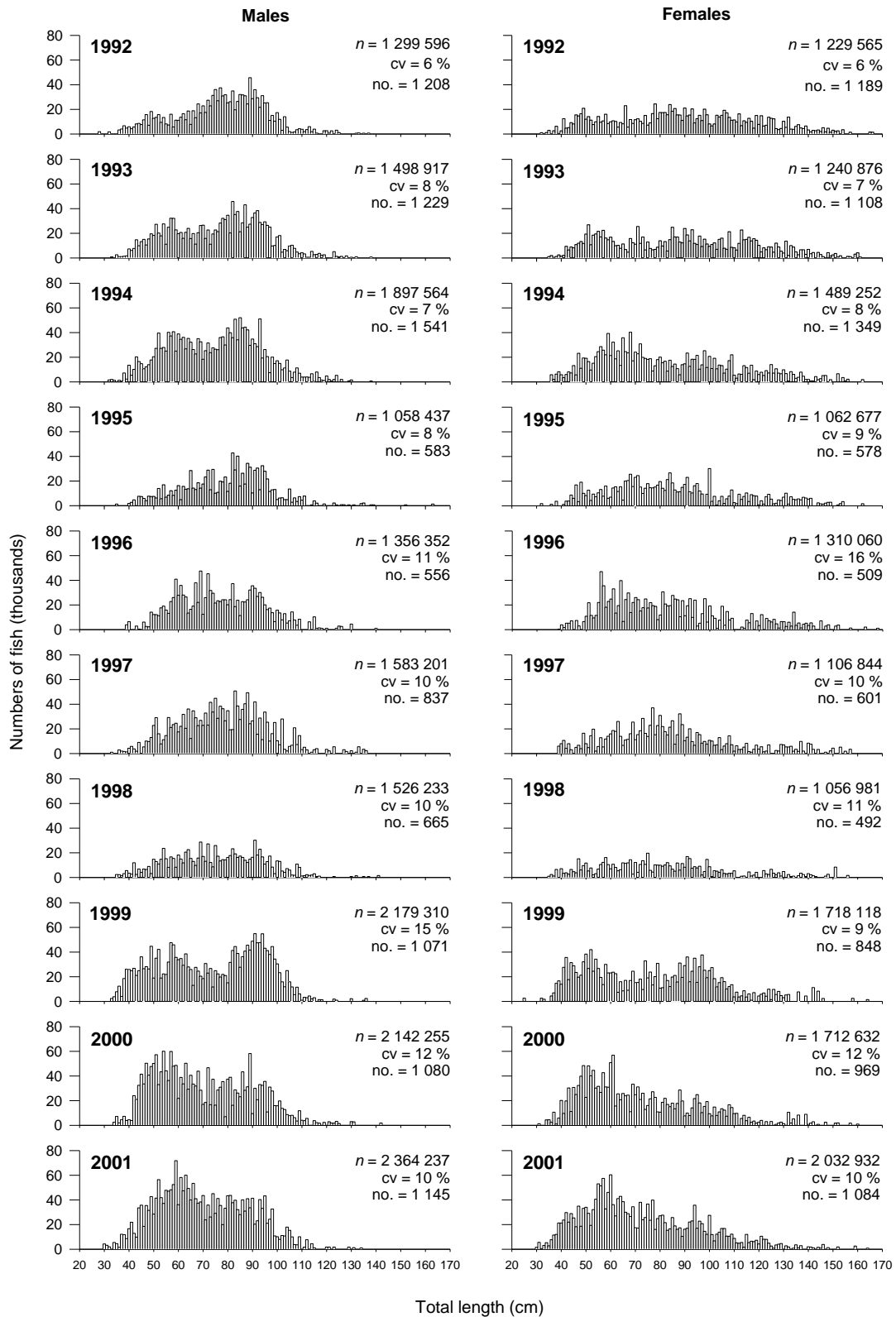


Figure 13 (continued)



**Figure 14: Estimated length frequency distributions of the ling population from *Tangaroa* surveys of the Chatham Rise, January 1992–2011. (c.v., coefficient of variation; *n*, estimated population number of ling; no., numbers of fish measured.).**

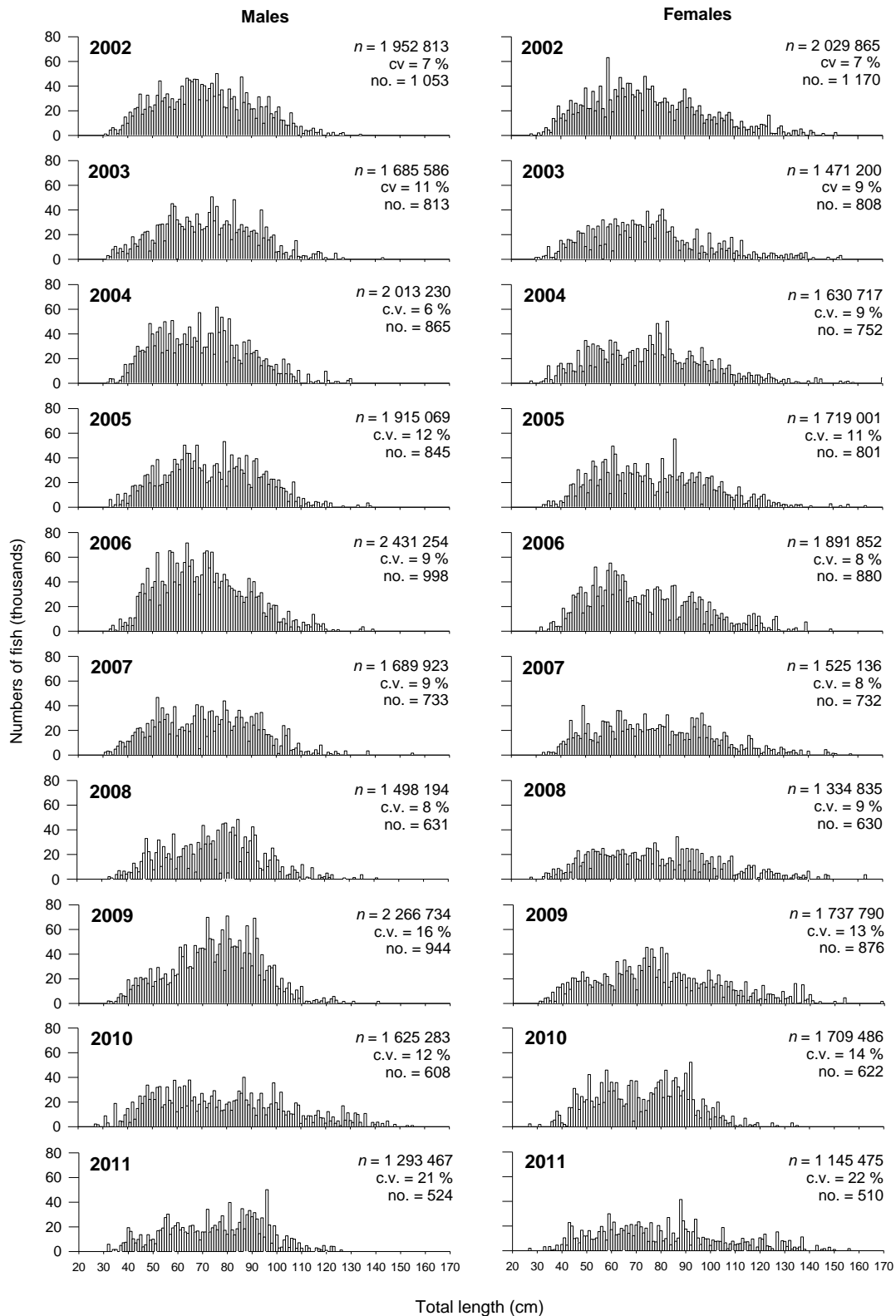
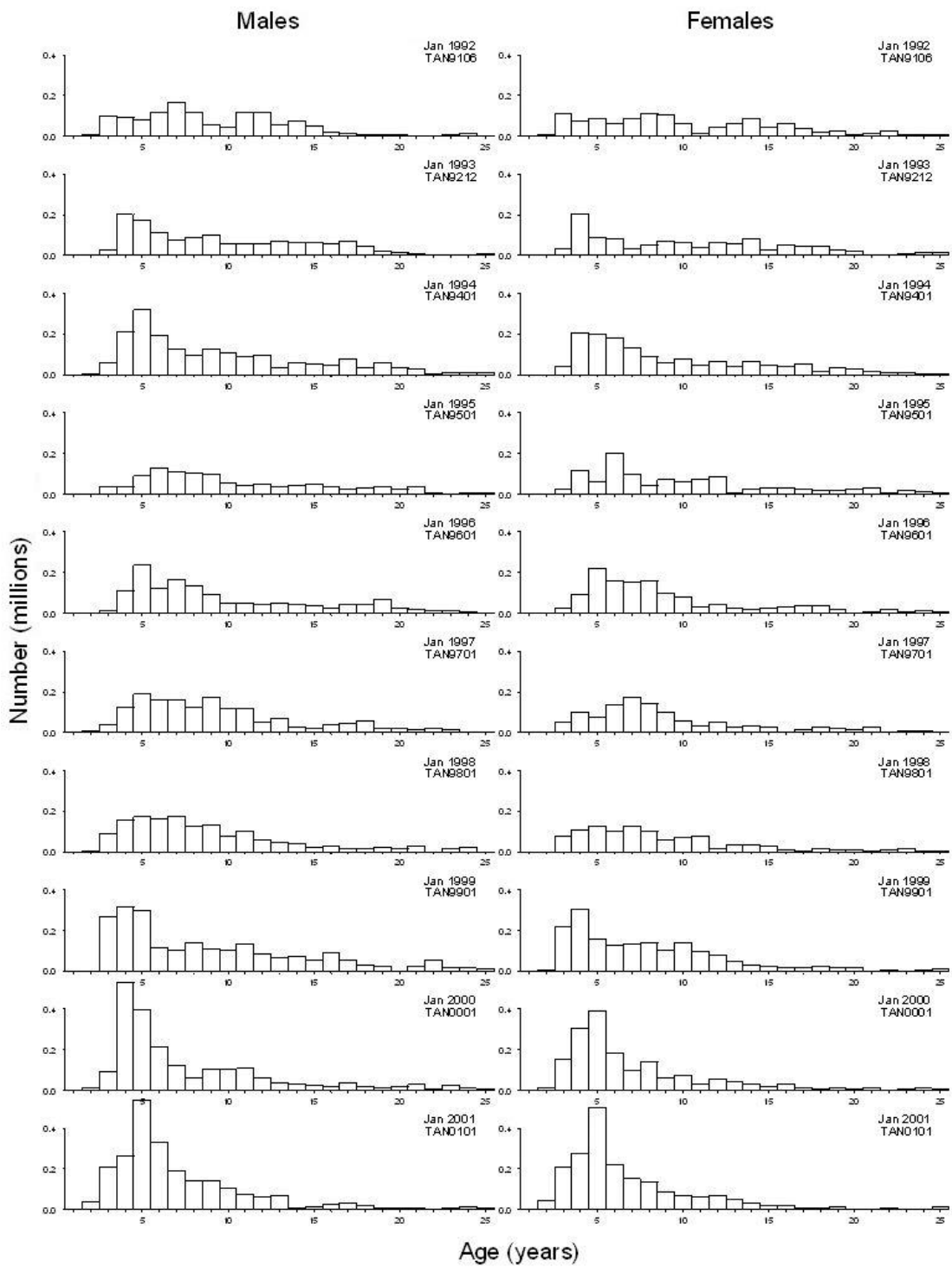


Figure 14 (continued)



**Figure 15: Estimated population numbers at age of male and female ling from *Tangaroa* surveys of the Chatham Rise, January, 1992–2011.**

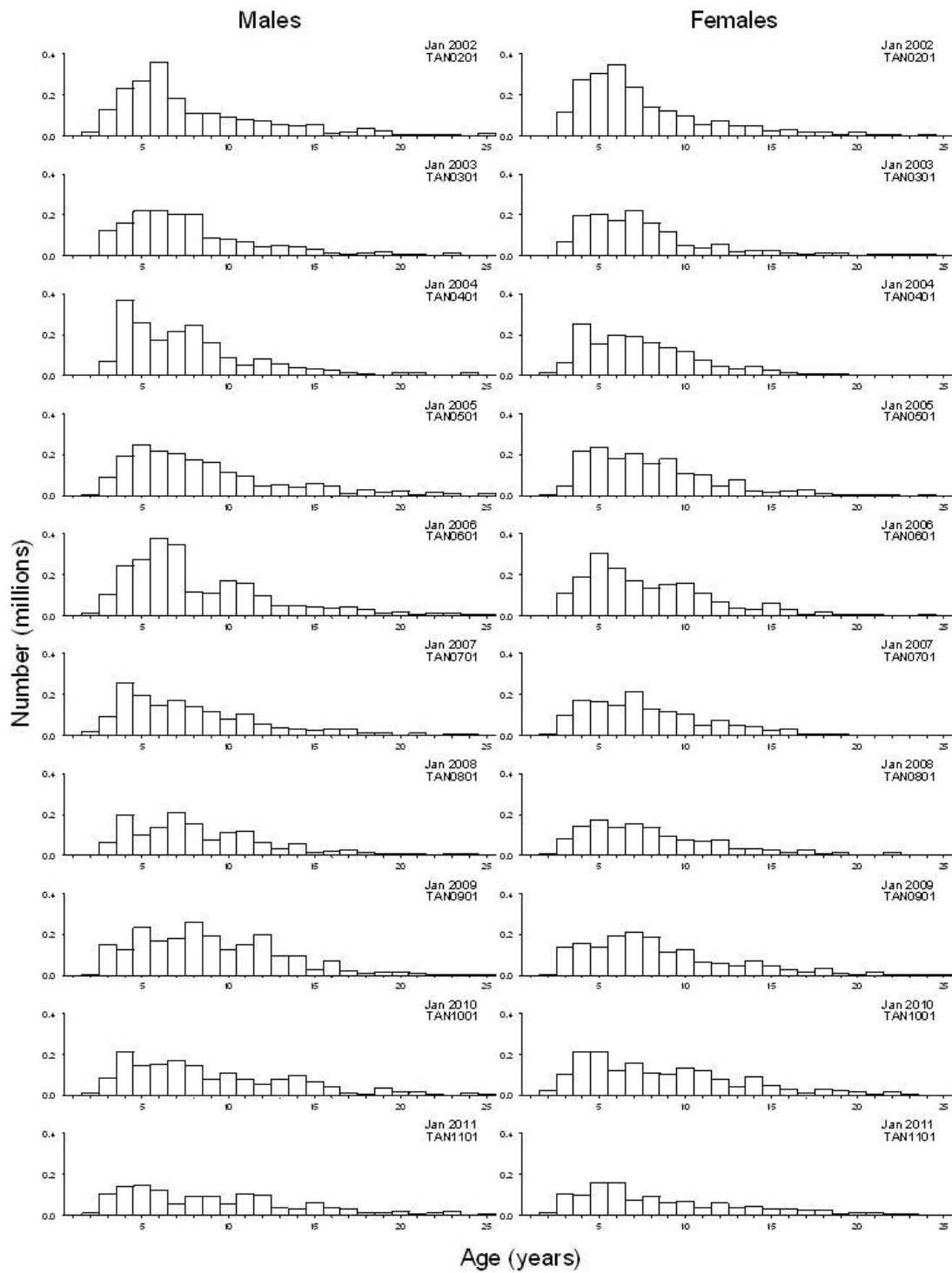
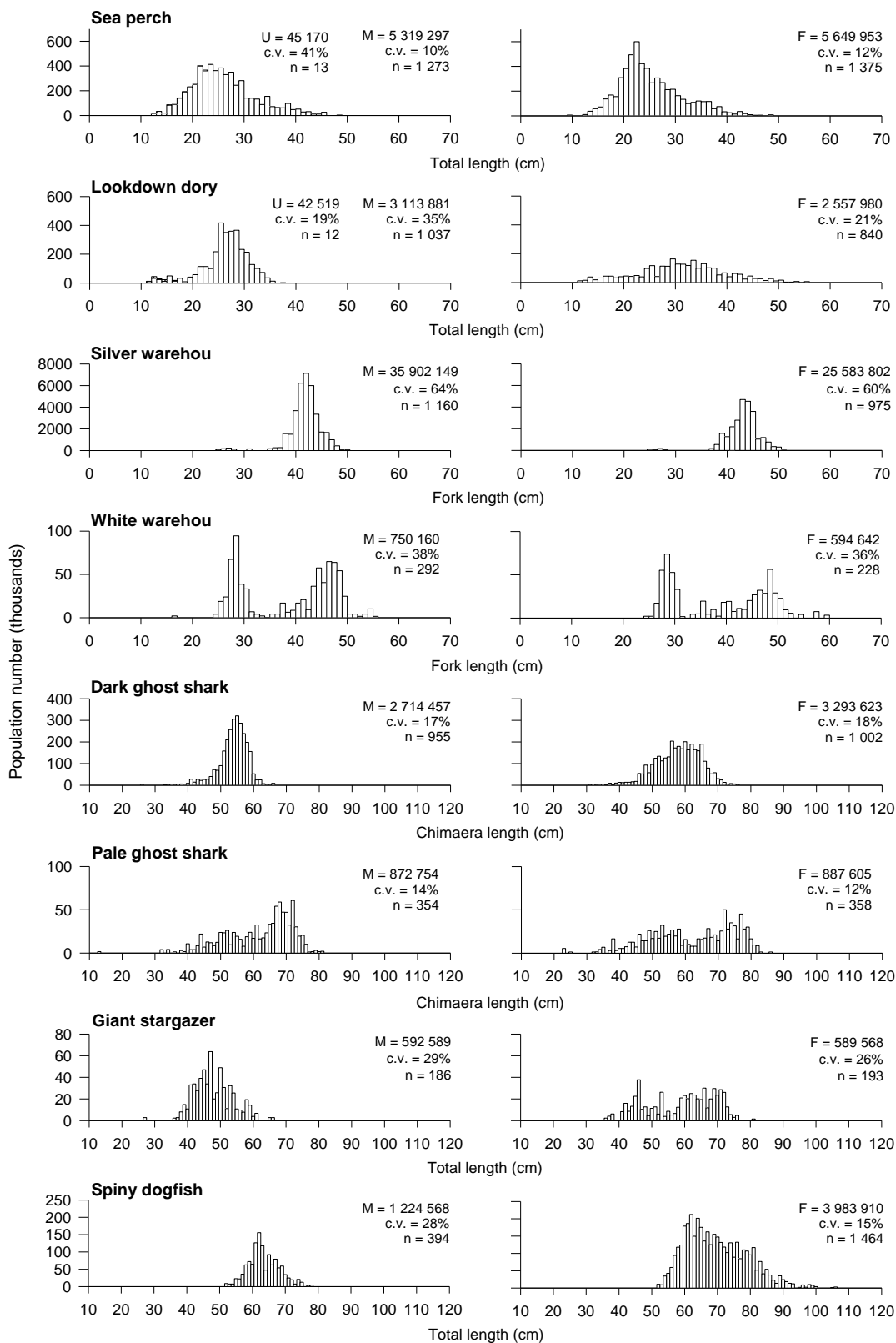
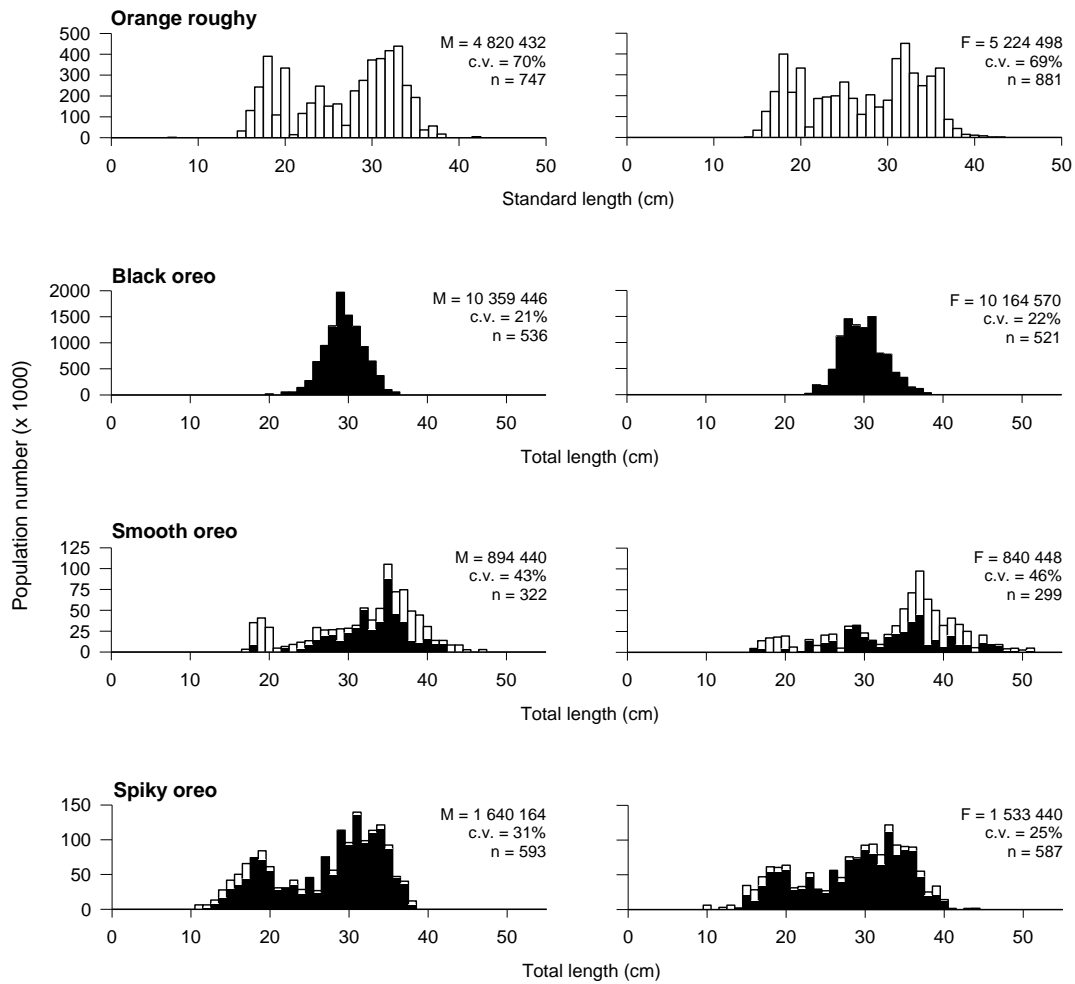


Figure 15 (continued)



**Figure 16a: Length frequencies of selected commercial species on the Chatham Rise 2011, 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 2011, 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.**

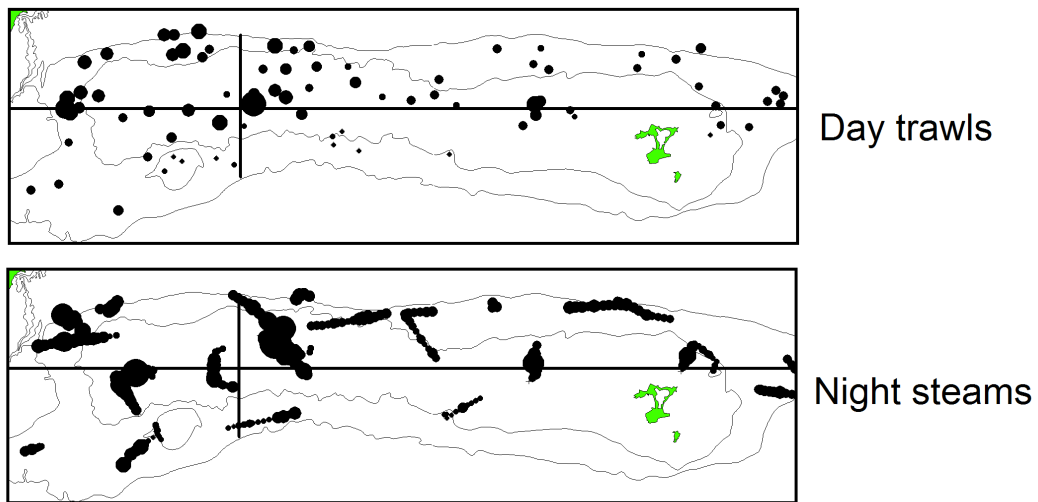


Figure 17: Distribution of total acoustic backscatter observed on the Chatham Rise during daytime trawls and night-time steams in January 2011. Circle area is proportional to the acoustic backscatter (maximum symbol size =  $500 \text{ m}^2 \text{ km}^{-2}$ ). Lines separate the four acoustic strata.

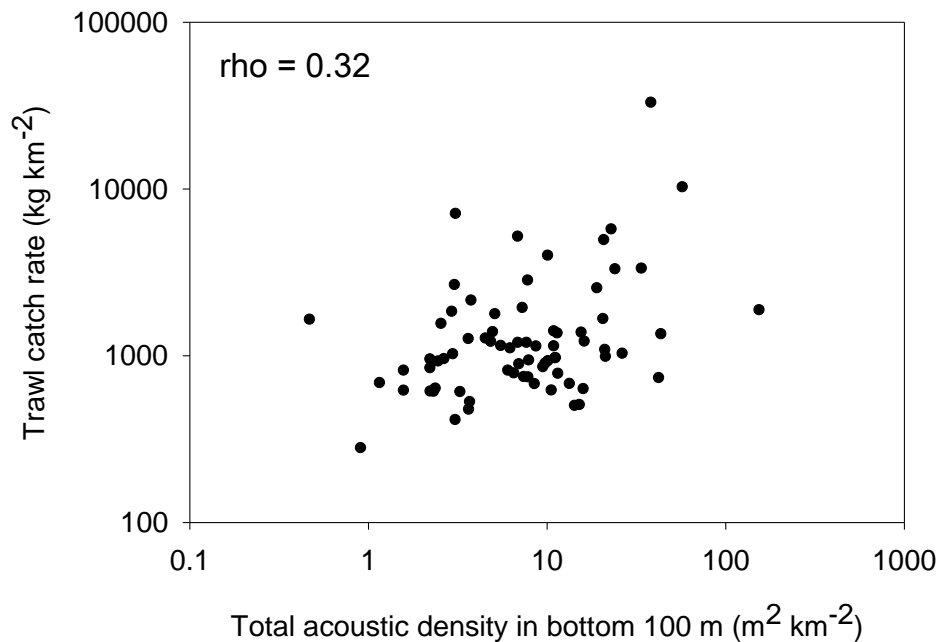
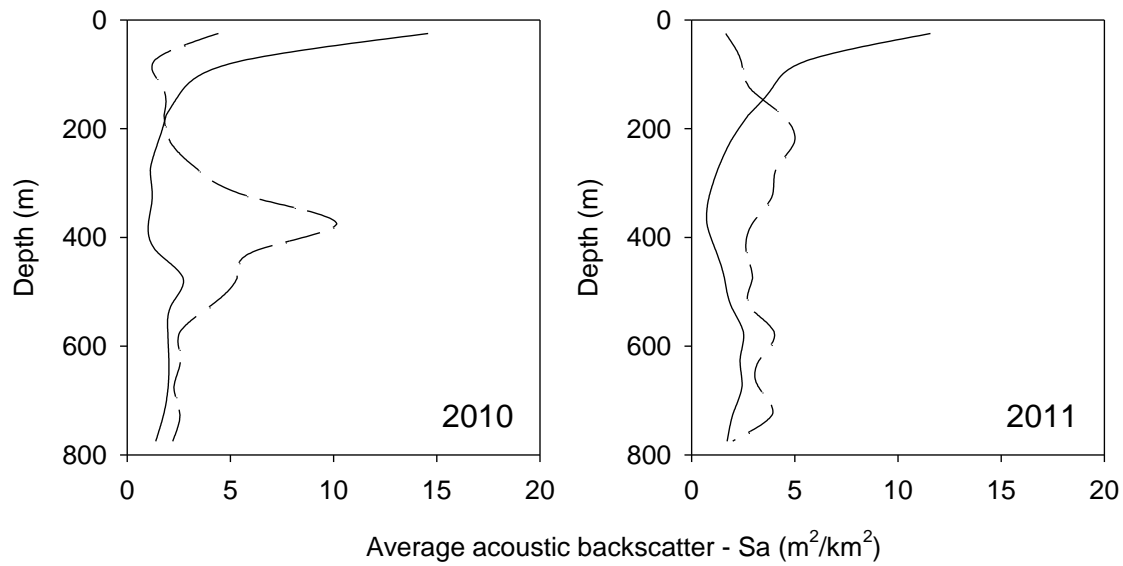
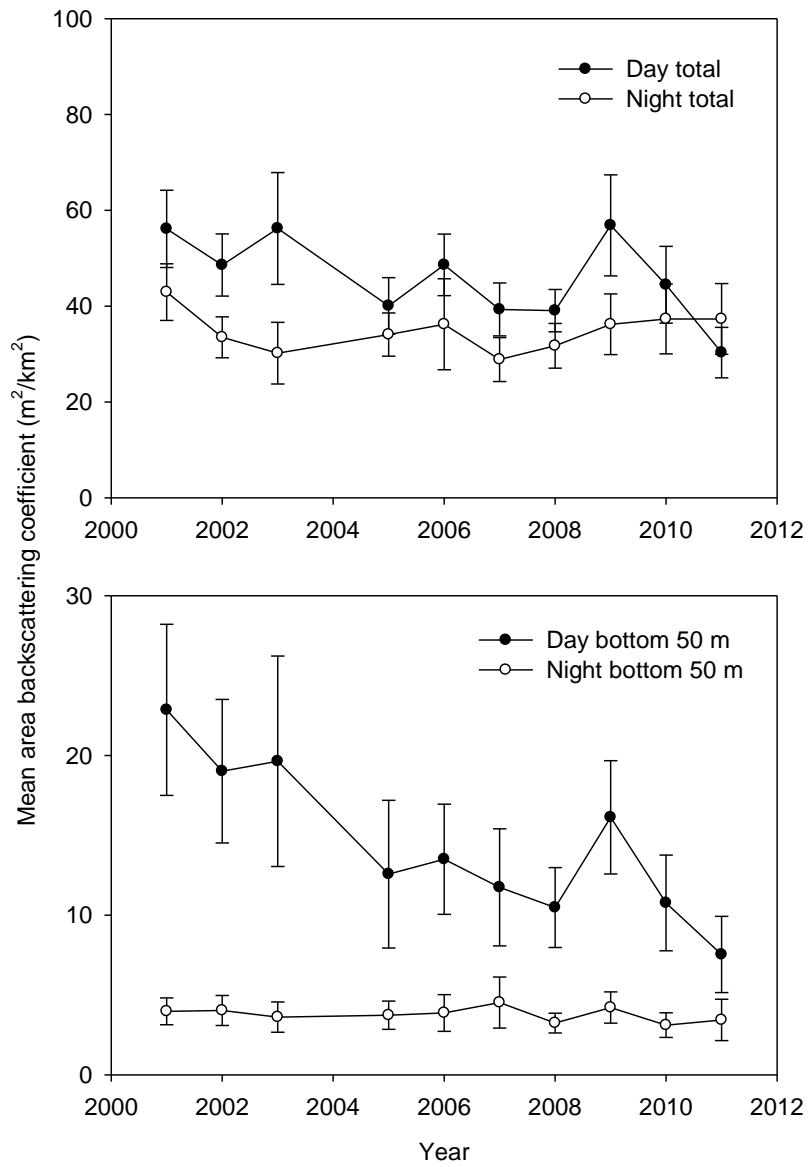


Figure 18: Relationship between total trawl catch rate (all species combined) and bottom-referenced acoustic backscatter recorded during the trawl on the Chatham Rise in 2011. Rho value is Spearman's rank correlation coefficients.

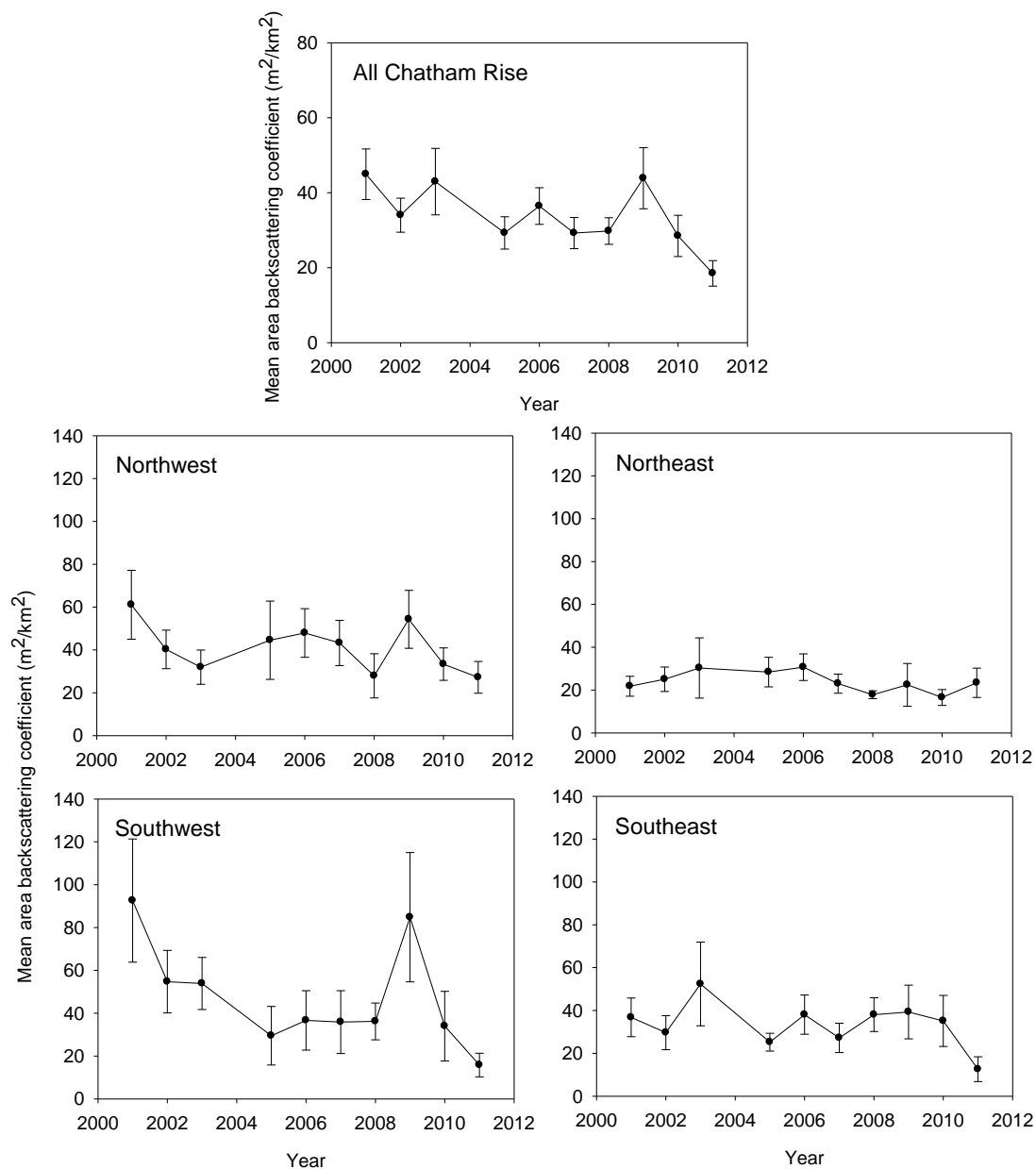




**Figure 19. Comparison of distribution of total acoustic backscatter integrated in 50 m depth bins on the Chatham Rise observed during the day (dashed lines) and at night (solid lines) in 2010 and 2011.**



**Figure 20: Comparison of relative acoustic abundance indices for the Chatham Rise based on (strata-averaged) mean areal backscatter ( $s_a$ ). Error bars are  $\pm 2$  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 20). Panels show indices for the entire Chatham Rise and for four sub-areas. Error bars are approximate 95% confidence intervals from bootstrapping.**

**Appendix 1: Individual station data for all stations conducted during the survey (TAN1101). RD, daytime research trawl survey biomass station; P2, phase 2 trawl survey biomass stations; RN, night-time research trawl survey station; Strat., Stratum number; -, catch not recorded; \*, foul trawl stations.**

| Stn. | Type | Strat. | Start tow |      |          |       |           |       | Gear depth |      | Dist. | Catch |         |      |      |
|------|------|--------|-----------|------|----------|-------|-----------|-------|------------|------|-------|-------|---------|------|------|
|      |      |        | Date      | Time | Latitude |       | Longitude |       | m          |      | Towed | kg    |         |      |      |
|      |      |        |           | NZST | °        | '     | S         | °     | '          | E/W  | min.  | max.  | n. mile | hoki | hake |
| *1   | P1   | 7      | 2-Jan-11  | 1508 | 43       | 18.52 | 173       | 52.33 | E          | 456  | 459   | 0.48  | -       | -    | -    |
| *2   | P1   | 7      | 2-Jan-11  | 1541 | 43       | 18.27 | 173       | 52.31 | E          | 454  | 462   | 0.61  | -       | -    | -    |
| 3    | P1   | 22     | 3-Jan-11  | 2113 | 42       | 44.44 | 177       | 47.50 | E          | 846  | 858   | 3.01  | 69      | 0    | 0    |
| 4    | P1   | 23     | 4-Jan-11  | 0102 | 42       | 41.20 | 178       | 03.23 | E          | 1068 | 1080  | 2.95  | 0       | 6    | 0    |
| 5    | P1   | 23     | 4-Jan-11  | 0442 | 42       | 39.05 | 177       | 46.03 | E          | 1176 | 1246  | 3.00  | 0       | 0    | 0    |
| 6    | P1   | 2A     | 4-Jan-11  | 0942 | 42       | 47.78 | 177       | 31.36 | E          | 654  | 6702  | 3.00  | 36      | 7    | 24   |
| 7    | P1   | 8A     | 4-Jan-11  | 1221 | 42       | 50.84 | 177       | 49.09 | E          | 487  | 496   | 3.04  | 1 187   | 10   | 20   |
| 8    | P1   | 2A     | 4-Jan-11  | 1449 | 42       | 48.15 | 178       | 03.62 | E          | 679  | 685   | 3.03  | 107     | 0    | 43   |
| 9    | P1   | 20     | 4-Jan-11  | 1810 | 43       | 01.94 | 178       | 12.65 | E          | 345  | 354   | 3.03  | 1 645   | 0    | 49   |
| 10   | P1   | 22     | 5-Jan-11  | 0054 | 42       | 53.52 | 179       | 11.61 | E          | 851  | 855   | 3.02  | 76      | 16   | 0    |
| *11  | P1   | 20     | 5-Jan-11  | 0543 | 43       | 02.26 | 178       | 41.30 | E          | 383  | 390   | 2.46  | 175     | 7    | 10   |
| 12   | P1   | 8B     | 5-Jan-11  | 0833 | 43       | 12.10 | 178       | 46.62 | E          | 410  | 414   | 2.87  | 548     | 8    | 26   |
| 13   | P1   | 8B     | 5-Jan-11  | 1157 | 43       | 22.29 | 179       | 11.03 | E          | 410  | 412   | 2.64  | 337     | 4    | 39   |
| 14   | P1   | 8B     | 5-Jan-11  | 1513 | 43       | 24.03 | 179       | 38.52 | E          | 418  | 436   | 2.75  | 273     | 0    | 40   |
| 15   | P1   | 22     | 6-Jan-11  | 0023 | 42       | 53.28 | 179       | 30.52 | E          | 819  | 825   | 3.01  | 99      | 0    | 4    |
| 16   | P1   | 22     | 6-Jan-11  | 0418 | 42       | 52.47 | 179       | 58.36 | E          | 826  | 840   | 3.01  | 133     | 0    | 10   |
| 17   | P1   | 10A    | 6-Jan-11  | 0759 | 43       | 10.32 | 179       | 55.95 | W          | 513  | 517   | 3.02  | 467     | 13   | 33   |
| 18   | P1   | 10A    | 6-Jan-11  | 1037 | 43       | 20.37 | 179       | 59.84 | W          | 426  | 444   | 3.02  | 1 161   | 46   | 49   |
| 19   | P1   | 10A    | 6-Jan-11  | 1327 | 43       | 27.57 | 179       | 39.57 | W          | 438  | 447   | 2.54  | 127     | 6    | 44   |
| 20   | P1   | 3      | 6-Jan-11  | 1615 | 43       | 35.90 | 179       | 22.69 | W          | 386  | 396   | 2.83  | 105     | 6    | 22   |
| 21   | P1   | 3      | 6-Jan-11  | 1833 | 43       | 43.88 | 179       | 25.54 | W          | 363  | 375   | 2.36  | 128     | 0    | 5    |
| 22   | P1   | 3      | 7-Jan-11  | 0514 | 43       | 57.47 | 179       | 18.14 | W          | 203  | 224   | 3.00  | 1 358   | 0    | 86   |
| 23   | P1   | 10B    | 7-Jan-11  | 0918 | 43       | 38.13 | 179       | 09.68 | W          | 40   | 413   | 3.01  | 88      | 0    | 54   |
| 24   | P1   | 10B    | 7-Jan-11  | 1133 | 43       | 32.95 | 179       | 08.34 | W          | 449  | 450   | 3.04  | 97      | 0    | 17   |
| 25   | P1   | 10B    | 7-Jan-11  | 1407 | 43       | 24.50 | 179       | 09.21 | W          | 450  | 458   | 3.02  | 253     | 38   | 3    |
| 26   | P1   | 21A    | 7-Jan-11  | 2036 | 42       | 46.26 | 179       | 27.54 | W          | 927  | 959   | 3.01  | 16      | 5    | 0    |
| 27   | P1   | 21A    | 7-Jan-11  | 2314 | 42       | 43.28 | 179       | 12.57 | W          | 951  | 954   | 3.00  | 37      | 16   | 0    |
| 28   | P1   | 21A    | 8-Jan-11  | 0212 | 42       | 46.80 | 179       | 08.93 | W          | 816  | 820   | 2.06  | 103     | 12   | 0    |
| 29   | P1   | 2B     | 8-Jan-11  | 0516 | 42       | 49.93 | 179       | 01.58 | W          | 689  | 702   | 3.00  | 167     | 33   | 20   |
| 30   | P1   | 11B    | 8-Jan-11  | 0937 | 43       | 04.12 | 178       | 34.44 | W          | 510  | 524   | 2.93  | 141     | 0    | 19   |
| 31   | P1   | 11B    | 8-Jan-11  | 1215 | 43       | 00.12 | 178       | 37.73 | W          | 528  | 531   | 3.03  | 238     | 4    | 29   |
| 32   | P1   | 11B    | 8-Jan-11  | 1409 | 43       | 00.46 | 178       | 28.49 | W          | 533  | 537   | 3.01  | 274     | 10   | 40   |
| 33   | P1   | 2B     | 8-Jan-11  | 1706 | 42       | 49.95 | 178       | 20.93 | W          | 644  | 652   | 2.99  | 188     | 11   | 5    |
| *34  | P1   | 21B    | 9-Jan-11  | 0151 | 42       | 47.86 | 176       | 48.21 | W          | 975  | 977   | 3.04  | -       | -    | -    |
| *35  | P1   | 24     | 9-Jan-11  | 1528 | 42       | 49.63 | 175       | 50.10 | W          | 1050 | 1063  | 0.41  | -       | -    | -    |
| 36   | P1   | 24     | 9-Jan-11  | 1717 | 42       | 50.31 | 175       | 46.26 | W          | 1010 | 1033  | 2.97  | 2       | 0    | 0    |
| 37   | P1   | 24     | 10-Jan-11 | 0005 | 42       | 52.40 | 174       | 41.56 | W          | 1182 | 1197  | 2.98  | 0       | 0    | 0    |
| 38   | P1   | 24     | 10-Jan-11 | 0510 | 43       | 04.72 | 174       | 02.23 | W          | 1157 | 1203  | 2.98  | 0       | 0    | 0    |
| 39   | P1   | 2B     | 10-Jan-11 | 1021 | 43       | 27.32 | 174       | 36.63 | W          | 775  | 777   | 3.02  | 48      | 0    | 18   |
| 40   | P1   | 2B     | 10-Jan-11 | 1235 | 43       | 25.03 | 174       | 48.98 | W          | 765  | 792   | 3.01  | 38      | 0    | 0    |
| 41   | P1   | 21B    | 10-Jan-11 | 1541 | 43       | 18.02 | 174       | 42.77 | W          | 827  | 831   | 3.01  | 31      | 0    | 0    |
| 42   | P1   | 21B    | 10-Jan-11 | 1753 | 43       | 21.75 | 174       | 35.72 | W          | 820  | 835   | 3.00  | 29      | 0    | 0    |
| 43   | P1   | 28     | 10-Jan-11 | 2232 | 43       | 45.78 | 174       | 11.84 | W          | 1126 | 1150  | 2.99  | 0       | 0    | 0    |
| 44   | P1   | 12     | 11-Jan-11 | 0512 | 43       | 43.11 | 175       | 06.16 | W          | 572  | 587   | 3.00  | 146     | 0    | 21   |

Appendix 1: *continued*

| Stn. | Type | Strat. |           |      | Start tow |           |      | Gear depth |         | Dist.<br>towed | Catch |      |      |
|------|------|--------|-----------|------|-----------|-----------|------|------------|---------|----------------|-------|------|------|
|      |      |        | Date      | Time | Latitude  | Longitude |      | m          | n. mile |                | hoki  | hake | ling |
|      |      |        |           | NZST | ° ' S     | ° ' E/W   | min. | max.       |         |                |       |      |      |
| 45   | P1   | 12     | 11-Jan-11 | 1337 | 43 40.26  | 175 33.19 | W    | 408        | 427     | 3.01           | 71    | 22   | 73   |
| 46   | P1   | 9      | 11-Jan-11 | 1619 | 43 48.15  | 175 44.85 | W    | 224        | 272     | 2.99           | 81    | 0    | 33   |
| 47   | P1   | 11D    | 12-Jan-11 | 1020 | 43 29.04  | 175 38.24 | W    | 450        | 496     | 3.00           | 1 785 | 15   | 23   |
| 48   | P1   | 11D    | 12-Jan-11 | 1332 | 43 16.24  | 175 52.26 | W    | 532        | 542     | 3.02           | 355   | 0    | 30   |
| 49   | P1   | 2B     | 12-Jan-11 | 1718 | 42 56.94  | 176 13.86 | W    | 749        | 756     | 2.99           | 90    | 20   | 29   |
| 50   | PI   | 21B    | 12-Jan-11 | 2249 | 42 47.29  | 177 03.66 | W    | 977        | 990     | 3.00           | 31    | 0    | 0    |
| 51   | P1   | 2B     | 13-Jan-11 | 0522 | 42 53.81  | 176 47.39 | W    | 757        | 778     | 3.00           | 84    | 0    | 19   |
| 52   | P1   | 11D    | 13-Jan-11 | 0846 | 43 02.75  | 176 51.72 | W    | 508        | 531     | 2.98           | 574   | 9    | 60   |
| 53   | P1   | 9      | 13-Jan-11 | 1333 | 43 16.19  | 177 18.17 | W    | 308        | 339     | 2.02           | 615   | 0    | 0    |
| 54   | P1   | 9      | 13-Jan-11 | 1535 | 43 12.77  | 177 29.89 | W    | 365        | 374     | 2.16           | 64    | 0    | 8    |
| 55   | P1   | 11C    | 13-Jan-11 | 1743 | 43 09.60  | 177 40.32 | W    | 408        | 410     | 2.99           | 395   | 0    | 43   |
| 56   | P1   | 5      | 14-Jan-11 | 0518 | 43 47.18  | 177 42.55 | W    | 375        | 390     | 3.01           | 340   | 0    | 7    |
| 57   | P1   | 5      | 14-Jan-11 | 0833 | 43 36.45  | 177 49.21 | W    | 367        | 379     | 3.02           | 832   | 6    | 41   |
| 58   | P1   | 5      | 14-Jan-11 | 1118 | 43 32.42  | 177 52.89 | W    | 360        | 366     | 3.02           | 783   | 2    | 66   |
| 59   | P1   | 11C    | 14-Jan-11 | 1339 | 43 19.68  | 177 53.36 | W    | 433        | 439     | 3.01           | 424   | 0    | 13   |
| 60   | P1   | 11C    | 14-Jan-11 | 1704 | 43 04.61  | 178 12.33 | W    | 519        | 528     | 2.99           | 352   | 7    | 4    |
| 61   | P1   | 12     | 15-Jan-11 | 0522 | 43 53.76  | 177 51.56 | W    | 407        | 432     | 2.99           | 369   | 9    | 0    |
| 62   | PI   | 13     | 15-Jan-11 | 0711 | 43 53.95  | 178 00.80 | W    | 440        | 440     | 3.04           | 304   | 3    | 26   |
| 63   | P1   | 11A    | 15-Jan-11 | 1137 | 43 41.87  | 178 38.14 | W    | 436        | 448     | 3.01           | 203   | 6    | 21   |
| 64   | P1   | 11A    | 15-Jan-11 | 1343 | 43 35.76  | 178 25.66 | W    | 412        | 417     | 3.01           | 2 119 | 16   | 10   |
| 65   | P1   | 11A    | 15-Jan-11 | 1547 | 43 28.08  | 178 25.27 | W    | 427        | 430     | 3.00           | 701   | 0    | 12   |
| 66   | P1   | 11A    | 15-Jan-11 | 1802 | 43 26.18  | 178 19.80 | W    | 424        | 424     | 2.52           | 444   | 0    | 6    |
| 67   | PI   | 13     | 16-Jan-11 | 0522 | 44 01.24  | 179 44.21 | W    | 440        | 451     | 3.01           | 371   | 16   | 22   |
| 68   | P1   | 13     | 16-Jan-11 | 0750 | 44 05.14  | 179 57.14 | W    | 500        | 575     | 3.02           | 418   | 0    | 54   |
| *69  | PI   | 4      | 16-Jan-11 | 1120 | 44 07.26  | 179 54.72 | W    | 618        | 624     | 0.87           | -     | -    | -    |
| 70   | P1   | 14     | 16-Jan-11 | 1307 | 43 58.12  | 179 50.85 | E    | 464        | 485     | 3.05           | 233   | 0    | 19   |
| 71   | P1   | 8A     | 17-Jan-11 | 0805 | 42 50.00  | 176 32.55 | E    | 497        | 511     | 3.01           | 399   | 19   | 0    |
| 72   | P1   | 8A     | 17-Jan-11 | 1005 | 42 55.46  | 176 26.06 | E    | 482        | 493     | 3.04           | 216   | 7    | 64   |
| 73   | P1   | 2A     | 17-Jan-11 | 1245 | 42 50.98  | 176 07.80 | E    | 607        | 612     | 3.01           | 136   | 12   | 19   |
| 74   | P1   | 1      | 17-Jan-11 | 1443 | 42 53.95  | 175 58.29 | E    | 602        | 609     | 3.02           | 92    | 0    | 31   |
| 75   | P1   | 23     | 18-Jan-11 | 0149 | 42 42.94  | 175 12.81 | E    | 1179       | 1187    | 3.02           | 0     | 0    | 0    |
| 76   | P1   | 1      | 18-Jan-11 | 0538 | 42 53.21  | 174 56.86 | E    | 766        | 780     | 2.92           | 207   | 0    | 46   |
| 77   | P1   | 1      | 18-Jan-11 | 0830 | 42 58.90  | 174 35.72 | E    | 752        | 782     | 3.03           | 74    | 4    | 0    |
| 78   | P1   | 7      | 18-Jan-11 | 1155 | 43 18.64  | 174 32.45 | E    | 496        | 498     | 3.15           | 853   | 50   | 122  |
| 79   | P1   | 7      | 18-Jan-11 | 1423 | 43 24.07  | 174 19.61 | E    | 575        | 579     | 3.02           | 274   | 21   | 44   |
| 80   | P1   | 7      | 18-Jan-11 | 1626 | 43 18.55  | 174 11.81 | E    | 575        | 577     | 2.61           | 222   | 5    | 20   |
| 81   | P1   | 22     | 18-Jan-11 | 2026 | 42 59.11  | 174 14.37 | E    | 978        | 984     | 2.94           | 57    | 6    | 0    |
| 82   | P1   | 18     | 19-Jan-11 | 0541 | 43 20.68  | 174 48.71 | E    | 353        | 384     | 2.99           | 1 780 | 0    | 56   |
| 83   | P1   | 7      | 19-Jan-11 | 0846 | 43 29.68  | 174 31.25 | E    | 513        | 535     | 2.82           | 386   | 32   | 203  |
| 84   | P1   | 7      | 19-Jan-11 | 1105 | 43 30.88  | 174 18.68 | E    | 543        | 558     | 3.01           | 317   | 11   | 86   |
| 85   | P1   | 7      | 19-Jan-11 | 1317 | 43 32.83  | 174 21.47 | E    | 556        | 560     | 2.75           | 264   | 11   | 25   |
| 86   | P1   | 16     | 19-Jan-11 | 1658 | 43 52.32  | 174 20.78 | E    | 534        | 545     | 2.99           | 525   | 7    | 26   |
| 87   | P1   | 6      | 20-Jan-11 | 0544 | 44 25.16  | 173 45.16 | E    | 703        | 708     | 3.00           | 143   | 5    | 23   |
| 88   | P1   | 6      | 20-Jan-11 | 0907 | 44 21.18  | 174 10.54 | E    | 674        | 676     | 2.99           | 233   | 5    | 63   |
| 89   | P1   | 6      | 20-Jan-11 | 1534 | 44 39.26  | 175 07.47 | E    | 761        | 787     | 3.02           | 95    | 0    | 5    |
| 90   | P1   | 17     | 21-Jan-11 | 0537 | 44 11.43  | 175 50.11 | E    | 275        | 323     | 2.99           | 549   | 15   | 50   |

**Appendix 1: continued**

| Stn. | Type | Strat. | Start tow |      |          |           |     |      | Gear depth |         | Dist.<br>towed | Catch |      |      |
|------|------|--------|-----------|------|----------|-----------|-----|------|------------|---------|----------------|-------|------|------|
|      |      |        | Date      | Time | Latitude | Longitude | E/W | m    |            | n. mile |                | hoki  | hake | Ling |
|      |      |        |           | NZST | ° ' S    | ° ' E/W   |     | min. | max.       |         |                |       |      |      |
| 91   | P1   | 17     | 21-Jan-11 | 0831 | 44 02.69 | 175 57.08 | E   | 348  | 366        | 2.99    | 104            | 0     | 50   |      |
| 92   | P1   | 17     | 21-Jan-11 | 1022 | 44 05.81 | 176 04.81 | E   | 266  | 342        | 2.99    | 4 046          | 0     | 34   |      |
| 93   | P1   | 15     | 21-Jan-11 | 1418 | 44 02.95 | 176 38.00 | E   | 546  | 584        | 3.01    | 269            | 0     | 132  |      |
| 94   | P1   | 4      | 21-Jan-11 | 1749 | 44 07.75 | 176 55.15 | E   | 668  | 687        | 3.01    | 66             | 0     | 15   |      |
| 95   | P1   | 4      | 22-Jan-11 | 0548 | 43 59.10 | 178 51.21 | E   | 632  | 672        | 3.01    | 44             | 0     | 10   |      |
| 96   | P1   | 4      | 22-Jan-11 | 0845 | 43 54.82 | 178 27.92 | E   | 611  | 645        | 3.02    | 47             | 5     | 6    |      |
| 97   | P1   | 14     | 22-Jan-11 | 1202 | 43 45.38 | 178 36.03 | E   | 423  | 427        | 3.06    | 205            | 10    | 65   |      |
| 98   | P1   | 14     | 22-Jan-11 | 1354 | 43 48.77 | 178 27.56 | E   | 450  | 490        | 3.02    | 163            | 12    | 44   |      |
| 99   | P1   | 20     | 22-Jan-11 | 1745 | 43 34.42 | 177 56.43 | E   | 347  | 354        | 3.01    | 95             | 0     | 101  |      |
| 100  | P1   | 20     | 23-Jan-11 | 0537 | 43 16.93 | 178 05.13 | E   | 321  | 333        | 2.15    | 305            | 0     | 25   |      |
| 101  | P1   | 20     | 23-Jan-11 | 0820 | 43 22.93 | 177 43.86 | E   | 315  | 347        | 3.01    | 6 002          | 0     | 27   |      |
| 102  | P1   | 20     | 22-Jan-11 | 1028 | 43 17.89 | 177 34.05 | E   | 253  | 261        | 2.99    | 108            | 0     | 0    |      |
| 103  | P1   | 19     | 23-Jan-11 | 1307 | 43 19.47 | 177 11.70 | E   | 215  | 230        | 3.00    | 0              | 0     | 0    |      |
| 104  | P1   | 19     | 23-Jan-11 | 1457 | 43 27.18 | 177 13.59 | E   | 245  | 259        | 2.12    | 516            | 0     | 0    |      |
| 105  | P1   | 19     | 23-Jan-11 | 1747 | 43 21.47 | 176 48.76 | E   | 270  | 273        | 3.01    | 163            | 0     | 0    |      |
| 106  | P1   | 15     | 24-Jan-11 | 0539 | 43 42.60 | 177 04.86 | E   | 465  | 478        | 3.03    | 129            | 0     | 58   |      |
| 107  | P1   | 15     | 24-Jan-11 | 0836 | 43 40.43 | 176 41.96 | E   | 423  | 444        | 3.04    | 551            | 3     | 30   |      |
| 108  | P1   | 19     | 24-Jan-11 | 1156 | 43 31.48 | 176 13.45 | E   | 373  | 378        | 3.01    | 1 327          | 10    | 237  |      |
| *109 | P1   | 18     | 24-Jan-11 | 1514 | 43 41.44 | 175 50.12 | E   | 312  | 322        | 0.63    | -              | -     | -    |      |
| 110  | P1   | 16     | 24-Jan-11 | 1659 | 43 50.00 | 175 55.17 | E   | 457  | 460        | 3.01    | 703            | 13    | 40   |      |
| 111  | P1   | 16     | 25-Jan-11 | 0544 | 44 02.72 | 175 35.32 | E   | 514  | 536        | 3.01    | 441            | 0     | 76   |      |
| 112  | P1   | 18     | 25-Jan-11 | 1010 | 43 31.69 | 175 37.26 | E   | 242  | 254        | 3.04    | 123            | 0     | 0    |      |
| 113  | P1   | 18     | 25-Jan-11 | 1312 | 43 36.29 | 175 11.85 | E   | 244  | 281        | 2.01    | 117            | 0     | 0    |      |
| 114  | P1   | 22     | 25-Jan-11 | 2038 | 42 58.53 | 174 26.91 | E   | 878  | 898        | 2.89    | 37             | 0     | 0    |      |
| *115 | P1   | 23     | 25-Jan-11 | 2307 | 42 51.82 | 174 21.32 | E   | 1245 | 1250       | 1.36    | 0              | 0     | 0    |      |
| 116  | P2   | 22     | 26-Jan-11 | 0352 | 42 50.21 | 175 07.59 | E   | 839  | 866        | 2.99    | 93             | 10    | 0    |      |
| 117  | P1   | 23     | 26-Jan-11 | 0819 | 42 40.62 | 175 49.15 | E   | 1055 | 1074       | 3.00    | 0              | 8     | 0    |      |
| 118  | P1   | 23     | 26-Jan-11 | 1212 | 42 41.18 | 175 58.93 | E   | 1012 | 1169       | 3.01    | 2              | 5     | 0    |      |
| 119  | P1   | 23     | 26-Jan-11 | 1615 | 42 38.02 | 176 21.53 | E   | 1020 | 1040       | 3.01    | 0              | 3     | 0    |      |
| 120  | P1   | 23     | 26-Jan-11 | 1955 | 42 39.89 | 176 49.69 | E   | 1024 | 1045       | 2.99    | 0              | 0     | 0    |      |
| 121  | P2   | 20     | 27-Jan-11 | 0538 | 43 03.91 | 177 22.35 | E   | 292  | 300        | 2.15    | 1 028          | 0     | 5    |      |
| 122  | P2   | 20     | 27-Jan-11 | 0906 | 43 02.94 | 177 43.57 | E   | 317  | 323        | 2.96    | 2 864          | 0     | 49   |      |

**Appendix 2: Scientific and common names of species caught from all valid biomass tows (TAN1101). The occurrence (Occ.) of each species (number of tows caught) in the 114 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. |
|--|-----------------------------|---------|------|
| <b>Algae</b>                             | unspecified seaweed         | SEO     | 4    |
| <b>Porifera</b>                          | unspecified sponges         | ONG     | 8    |
| Demospongiae (siliceous sponges)         |                             |         |      |
| Astrophorida (sandpaper sponges)         |                             |         |      |
| Ancorinidae                              |                             |         |      |
| <i>Ancorina novaezelandiae</i>           | knobbly sandpaper sponge    | ANZ     | 3    |
| Geodiidae                                |                             |         |      |
| <i>Geodinela vestigifera</i>             | ostrich egg sponge          | GVE     | 4    |
| Hadromerida (woody sponges)              |                             |         |      |
| Suberitidae                              |                             |         |      |
| <i>Suberites affinis</i>                 | fleshy club sponge          | SUA     | 13   |
| Poecilosclerida (bright sponges)         |                             |         |      |
| Crellidae                                |                             |         |      |
| <i>Crella incrustans</i>                 | orange frond sponge         | CIC     | 1    |
| Hymedesmiidae                            |                             |         |      |
| <i>Phorbas</i> spp.                      | grey fibrous massive sponge | PHB     | 1    |
| Hexactinellida (glass sponges)           |                             |         |      |
| Lyssacinosida (tubular sponges)          |                             |         |      |
| Rossellidae                              |                             |         |      |
| <i>Hyalascus</i> sp.                     | floppy tubular sponge       | HYA     | 23   |
| <b>Cnidaria</b>                          |                             |         |      |
| Coral (Hydrozoan + Anthozoan corals)     | unspecified coral           | COU     | 1    |
| Anthoathecata (hydroids)                 |                             |         |      |
| Stylasteridae                            |                             |         |      |
| <i>Calyptopora reticulata</i>            | white hydrocoral            | CRE     | 1    |
| Scyphozoa                                | unspecified jellyfish       | JFI     | 16   |
| Anthozoa                                 |                             |         |      |
| Octocorallia                             |                             |         |      |
| Alcyonacea (soft corals)                 | unspecified soft coral      | SOC     | 1    |
| Gorgonacea (gorgonian corals)            |                             |         |      |
| Primnoidae                               |                             |         |      |
| <i>Primnoa</i> spp.                      |                             | PMN     | 1    |
| Pennatulacea (sea pens)                  | unspecified sea pens        | PTU     | 9    |
| Pennatulidae                             |                             |         |      |
| <i>Pennatula</i> spp.                    | purple sea pens             | PNN     | 1    |
| Hexacorallia                             |                             |         |      |
| Zoanthidea (zoanthids)                   |                             |         |      |
| Epizoanthidae                            |                             |         |      |
| <i>Epizoanthus</i> sp.                   |                             | EPZ     | 3    |
| Actinaria (anemones)                     | unspecified anemones        | ANT     | 5    |
| Actiniidae (deepsea anemones)            |                             | BOC     | 3    |
| Actinostolidae (smooth deepsea anemones) |                             | ACS     | 24   |
| Hormathiidae (warty deepsea anemones)    |                             | HMT     | 15   |
| Scleractinia (stony corals)              |                             |         |      |
| Caryophyllidae                           |                             |         |      |
| <i>Desmophyllum dianthus</i>             | crested cup coral           | DDI     | 4    |
| <i>Goniocorella dumosa</i>               | bushy hard coral            | GDU     | 10   |
| <i>Stephanocyathus platypus</i>          | solitary bowl coral         | STP     | 1    |

**Appendix 2 (continued)**

| Scientific name  | Common name            | Species | Occ. |
|--|------------------------|---------|------|
| Flabellidae<br><i>Flabellum</i> spp.                         | flabellum coral        | COF     | 8    |
| <b>Asciacea</b>  | unspecified sea squirt | ASC     | 1    |
| <b>Tunicata</b>  |                        |         |      |
| Thaliacea (salps)  | unspecified salps      | SAL     | 9    |
| Salpidae<br><i>Pyrosoma atlanticum</i>                       |                        | PYR     | 3    |
| <b>Mollusca</b>  |                        |         |      |
| Gastropoda (gastropods)                                      |                        |         |      |
| Nudibranchia (sea slugs)                                     |                        | NUD     | 1    |
| Buccinidae (whelks)<br><i>Penion chathamensis</i>            |                        | PCH     | 1    |
| Ranellidae (tritons)<br><i>Fusitriton magellanicus</i>       |                        | FMA     | 28   |
| Volutidae (volutes)<br><i>Provocator mirabilis</i>           | golden volute          | GVO     | 3    |
| Bivalvia (bivalves)  |                        |         |      |
| Limidae<br><i>Acesta maui</i>                                | giant file shell       | AMA     |      |
| Cephalopoda  |                        |         |      |
| Teuthoidea (squids)  | unspecified squid      | SQX     | 1    |
| Lycoteuthidae<br><i>Lycoteuthis lorigera</i>                 | crowned firefly squid  | LSQ     | 1    |
| Octopoteuthididae<br><i>Octopoteuthis megaptera</i>          |                        | OCM     | 1    |
| Onychoteuthidae<br><i>Onykia ingens</i>                      | warty squid            | MIQ     | 49   |
| <i>O. robsoni</i>  | warty squid            | MRQ     | 5    |
| <i>Pholidoteuthis boschmai</i>                               | scaly squid            | PSQ     | 1    |
| Histioteuthidae (violet squids)<br><i>Histioteuthis</i> spp. | violet squid           | VSQ     | 1    |
| Ommastrephidae<br><i>Nototodarus sloanii</i>                 | Sloan's arrow squid    | NOS     | 37   |
| <i>Todarodes filippovae</i>                                  | Todarodes squid        | TSQ     | 27   |
| Mastigoteuthidae<br><i>Mastigoteuthis</i> sp.                | squid                  | MSQ     | 1    |
| Cranchiidae<br><i>Teuthowenia pellucida</i>                  |                        | TPE     | 4    |
| Cirrata (cirrate octopus)                                    |                        |         |      |
| Opisthoteuthididae<br><i>Opisthoteuthis</i> spp.             | umbrella octopus       | OPI     | 6    |
| Incirrata (incirrate octopus)                                |                        |         |      |
| Octopodidae<br><i>Enteroctopus zealandicus</i>               | yellow octopus         | EZE     | 2    |
| <i>Graneledone taniwha taniwha</i>                           | deepwater octopus      | GTA     | 4    |
| <i>Octopus mernoo</i>  | octopus                | OME     | 6    |



## Appendix 2 (continued)

| Scientific name   | Common name            | Species | Occ. |
|---|------------------------|---------|------|
| <b>Polychaeta</b>   | unspecified polychaete | POL     | 1    |
| Phyllodocida  |                        |         |      |
| Aphroditidae  |                        |         |      |
| <i>Aphrodita</i> spp.                                       | sea mouse              | ADT     | 2    |
| Eunicidae   |                        |         |      |
| <i>Eunice</i> spp.  | Eunice sea worm        | EUN     | 1    |
| <b>Crustacea</b>  |                        |         |      |
| Malacostraca  |                        |         |      |
| Dendrobranchiata/Pleocyemata (prawns)                       |                        |         |      |
| Dendrobranchiata  |                        |         |      |
| Aristeidae  |                        |         |      |
| <i>Aristaeomorpha foliacea</i>                              | royal red prawn        | AFO     | 2    |
| <i>Austropenaeus nitidus</i>                                | prawn                  | NAT     | 1    |
| Solenoceridae   |                        |         |      |
| <i>Haliporoides sibogae</i>                                 | jack-knife prawn       | HSI     | 1    |
| Pleocyemata   |                        |         |      |
| Caridea   |                        |         |      |
| Oplophoridae  |                        |         |      |
| <i>AcanthePHYRA pelagica</i>                                |                        |         |      |
| <i>A. spp.</i>  | ruby prawn             | ACA     | 1    |
| <i>Notostomus auriculatus</i>                               | scarlet prawn          | NAU     | 1    |
| <i>Oplophorus novaezeelandiae</i>                           | deepwater prawn        | ONO     | 1    |
| <i>O. spp.</i>  | deepwater prawn        | OPP     | 1    |
| Pasiphaeidae  |                        |         |      |
| <i>Pasiphaea</i> aff. <i>tarda</i>                          | deepwater prawn        | PTA     | 14   |
| Nematocarcinidae  |                        |         |      |
| <i>Lipkius holthuisi</i>                                    | omega prawn            | LHO     | 20   |
| <i>Nematocarcinus</i> spp.                                  | spider prawn           | NEC     | 1    |
| Astacidea   |                        |         |      |
| Nephropidae (clawed lobsters)                               |                        |         |      |
| <i>Metanephrops challengeri</i>                             | scampi                 | SCI     | 21   |
| Palinura  |                        |         |      |
| Polychelidae  |                        |         |      |
| <i>Polycheles</i> spp.                                      | deepsea blind lobster  | PLY     | 10   |
| Anomura   |                        |         |      |
| Galatheidae (squat lobsters)                                |                        |         |      |
| Galatheoidea  |                        |         |      |
| <i>Munida gracilis</i>                                      | squat lobster          | MGA     | 2    |
| Inachidae   |                        |         |      |
| <i>Vitjazmaia latidactyla</i>                               | deepsea spider crab    | VIT     | 4    |
| Lithodidae (king crabs)                                     |                        |         |      |
| <i>Lithodes aotearoa</i>                                    | New Zealand king crab  | LMU     | 3    |
| <i>Neolithodes brodiei</i>                                  | Brodie's king crab     | NEB     | 2    |
| <i>Paralomis zealandica</i>                                 | prickly king crab      | PZE     | 1    |
| Paguroidea (unspecified pagurid & parapagurid hermit crabs) |                        | PAG     | 20   |
| Paguridae (Pagurid hermit crabs)                            |                        |         |      |
| <i>Diacanthurus rubricatus</i>                              | hermit crab            | DIR     | 1    |
| Parapaguridae (Parapagurid hermit crabs)                    |                        |         |      |
| <i>Sympagurus dimorphus</i>                                 | hermit crab            | SDM     | 8    |

## Appendix 2 (continued)

| Scientific name                               | Common name                      | Species | Occ. |
|---|----------------------------------|---------|------|
| <b>Brachyura (true crabs)</b>                 |                                  |         |      |
| <b>Atelecyclidae</b>                          |                                  |         |      |
| <i>Trichopeltarion fantasticum</i>            | frilled crab                     | TFA     | 21   |
| <b>Goneplacidae</b>                           |                                  |         |      |
| <i>Pycnoplax victoriensis</i>                 | two-spined crab                  | CVI     | 4    |
| <b>Homolidae</b>                              |                                  |         |      |
| <i>Dagnaudus petterdi</i>                     | antlered crab                    | DAP     | 5    |
| <b>Majidae (spider crabs)</b>                 |                                  |         |      |
| <i>Leptomithrax garricki</i>                  | Garrick's masking crab           | GMC     | 1    |
| <i>Teratomaia richardsoni</i>                 | spiny masking crab               | SMK     | 14   |
| <b>Portunidae (swimming crabs)</b>            |                                  |         |      |
| <i>Ovalipes mollerii</i>                      | Swimming crab                    | OVM     | 1    |
| <b>Echinodermata</b>                          |                                  |         |      |
| <b>Asteroidea (starfish)</b>                  |                                  |         |      |
| <b>Asteriidae</b>                             |                                  |         |      |
| <i>Pseudechinaster rubens</i>                 | starfish                         | PRU     | 9    |
| <b>Astropectinidae</b>                        |                                  |         |      |
| <i>Dipsacaster magnificus</i>                 | magnificent sea-star             | DMG     | 19   |
| <i>Plutonaster knoxi</i>                      | abyssal star                     | PKN     | 19   |
| <i>Proserpinaster neozelanicus</i>            | starfish                         | PNE     | 19   |
| <i>Psilaster acuminatus</i>                   | geometric star                   | PSI     | 35   |
| <i>Sclerasterias mollis</i>                   | cross-fish                       | SMO     | 16   |
| <b>Benthopectinidae</b>                       |                                  |         |      |
| <i>Benthopecten</i> spp.                      | starfish                         | BES     | 4    |
| <b>Brisingida</b>                             |                                  |         |      |
|   |                                  | BRG     | 16   |
| <b>Goniasteridae</b>                          |                                  |         |      |
| <i>Hippasteria phrygiana</i>                  | trojan starfish                  | HTR     | 8    |
| <i>Lithosoma novaezelandiae</i>               | rock star                        | LNV     | 1    |
| <i>Mediaster sladeni</i>                      | starfish                         | MSL     | 11   |
| <i>Pillsburiaster aoteanus</i>                | starfish                         | PAO     | 6    |
| <b>Odontasteridae</b>                         |                                  |         |      |
| <i>Odontaster</i> spp.                        | pentagonal tooth-star            | ODT     | 2    |
| <b>Solasteridae</b>                           |                                  |         |      |
| <i>Crossaster multispinus</i>                 | sun star                         | CJA     | 14   |
| <i>Solaster torulatus</i>                     | chubby sun-star                  | SOT     | 5    |
| <b>Zoroasteridae</b>                          |                                  |         |      |
| <i>Zoroaster</i> spp.                         | rat-tail star                    | ZOR     | 37   |
| <b>Ophiuroidea (basket and brittle stars)</b> |                                  |         |      |
|   | unspecified brittle star         | OPH     | 1    |
| <b>Euryalina (basket stars)</b>               |                                  |         |      |
| <b>Gorgonocephalidae</b>                      |                                  |         |      |
| <i>Gorgonocephalus</i> spp.                   | Gorgon's head basket stars       | GOR     | 5    |
| <b>Echinoidea (sea urchins)</b>               |                                  |         |      |
| <b>Regularia</b>                              |                                  |         |      |
| <b>Cidaridae (cidarid urchins)</b>            |                                  |         |      |
| <i>Goniocidaris parasol</i>                   | parasol urchin                   | GPA     | 5    |
| <b>Histiocidaridae (cidarid urchins)</b>      |                                  |         |      |
| <i>Poriocidaris purpurata</i>                 |                                  | PCD     | 1    |
| <b>Echinothuriidae/Phormosomatidae</b>        |                                  |         |      |
|   | unspecified Tam O'Shanter urchin | TAM     | 51   |
| <b>Echinidae</b>                              |                                  |         |      |
| <i>Gracilechinus multidentatus</i>            | deepsea kina                     | GRM     | 15   |
| <i>Dermechinus horridus</i>                   | deepsea urchin                   | DHO     | 1    |

## Appendix 2 (continued)

| Scientific name                              | Common name             | Species | Occ. |
|--|-------------------------|---------|------|
| <b>Pedinidae</b>                             |                         |         |      |
| <i>Caenopedina</i> sp.                       | giant purple pedinid    | CAL     | 1    |
| <b>Spatangidae (heart urchins)</b>           |                         |         |      |
| <i>Spatangus multispinus</i>                 | purple-heart urchin     | SPT     | 19   |
| <b>Holothuroidea</b>                         |                         |         |      |
| Aspidochirotida                              |                         |         |      |
| <b>Synallactidae</b>                         |                         |         |      |
| <i>Bathyplores moseleyi</i>                  | sea cucumber            | BAM     | 9    |
| <i>Pseudostichopus mollis</i>                | sea cucumber            | PMO     | 17   |
| <b>Elasipodida</b>                           |                         |         |      |
| <b>Laetmogonidae</b>                         |                         |         |      |
| <i>Laetmogone</i> sp.                        | sea cucumber            | LAG     | 9    |
| <i>Pannychia moseleyi</i>                    | sea cucumber            | PAM     | 6    |
| <b>Pelagothuridae</b>                        |                         |         |      |
| <i>Enypniastes exima</i>                     | sea cucumber            | EEX     | 6    |
| <b>Psychropotidae</b>                        |                         |         |      |
| <i>Benthodytes</i> sp.                       | sea cucumber            | BTD     | 2    |
| <b>Brachiopoda</b>                           |                         |         |      |
|  | unspecified lamp shell  | BPD     | 2    |
| <b>Agnatha (jawless fishes)</b>              |                         |         |      |
| <i>Eptatretus cirrhatus</i>                  | hagfish                 | HAG     | 1    |
| <b>Chondrichthyes (cartilaginous fishes)</b> |                         |         |      |
| <b>Chlamydoselachidae: frill shark</b>       |                         |         |      |
| <i>Chlamydoselachus anguineus</i>            | frill shark             | FRS     | 2    |
| <b>Hexanchidae: cow sharks</b>               |                         |         |      |
| <i>Hexanchus griseus</i>                     | sixgill shark           | HEX     | 2    |
| <b>Chlamydoselachidae: frill shark</b>       |                         |         |      |
| <i>Chlamydoselachus anguineus</i>            | frill shark             | FRS     | 2    |
| <b>Hexanchidae: cow sharks</b>               |                         |         |      |
| <i>Hexanchus griseus</i>                     | sixgill shark           | HEX     | 2    |
| <b>Squalidae: dogfishes</b>                  |                         |         |      |
| <i>Centrophorus squamosus</i>                | leafscale gulper shark  | CSQ     | 21   |
| <i>Centroscymnus crepidater</i>              | longnose velvet dogfish | CYP     | 34   |
| <i>C. owstoni</i>                            | smooth skin dogfish     | CYO     | 28   |
| <i>Deania calcea</i>                         | shovelnose dogfish      | SND     | 44   |
| <i>Etmopterus baxteri</i>                    | Baxter's dogfish        | ETB     | 30   |
| <i>E. lucifer</i>                            | Lucifer dogfish         | ETL     | 49   |
| <i>Proscymnodon plunketi</i>                 | Plunket's shark         | PLS     | 10   |
| <i>Scymnorhinus licha</i>                    | seal shark              | BSH     | 33   |
| <i>Squalus acanthias</i>                     | spiny dogfish           | SPD     | 57   |
| <i>S. griffini</i>                           | northern spiny dogfish  | NSD     | 4    |
| <b>Oxynotidae: rough sharks</b>              |                         |         |      |
| <i>Oxynotus bruniensis</i>                   | prickly dogfish         | PDG     | 9    |
| <b>Scyliorhinidae: cat sharks</b>            |                         |         |      |
| <i>Apristurus</i> spp.                       | catshark                | APR     | 18   |
| <i>Cephaloscyllium isabellum</i>             | carpet shark            | CAR     | 1    |
| <i>Halaelurus dawsoni</i>                    | Dawson's catshark       | DCS     | 9    |
| <b>Triakidae: smoothhounds</b>               |                         |         |      |
| <i>Galeorhinus galeus</i>                    | school shark            | SCH     | 4    |

## Appendix 2 (continued)

| Scientific name                               | Common name                    | Species | Occ. |
|---|--------------------------------|---------|------|
| Torpedinidae: electric rays                   |                                |         |      |
| <i>Torpedo fairchildi</i>                     | electric ray                   | ERA     | 1    |
| Narkidae: blind electric rays                 |                                |         |      |
| <i>Typhlonarke aysoni</i>                     | blind electric ray             | TAY     | 1    |
| <i>T. tarakea</i>                             | oval electric ray              | TTA     | 1    |
| <i>T. spp.</i>                                | numbfish                       | BER     | 3    |
| Rajidae: skates                               |                                |         |      |
| <i>Amblyraja hyperborea</i>                   | deepwater spiny (Arctic) skate | DSK     | 1    |
| <i>Bathraja shuntovi</i>                      | longnosed deepsea skate        | PSK     | 5    |
| <i>Brochiraja asperula</i>                    | smooth deepsea skate           | BTA     | 25   |
| <i>B. leviveneta</i>                          | blue skate                     | BTH     | 1    |
| <i>B. spinifera</i>                           | prickly deepsea skate          | BTS     | 6    |
| <i>Dipturus innominatus</i>                   | smooth skate                   | SSK     | 25   |
| <i>Zearaja nasuta</i>                         | rough skate                    | RSK     | 7    |
| Chimaeridae: chimaeras, ghostsharks           |                                |         |      |
| <i>Chimaera sp.</i>                           | brown chimaera                 | CHP     | 6    |
| <i>Hydrolagus bemisi</i>                      | pale ghostshark                | GSP     | 70   |
| <i>H. novaezealandiae</i>                     | dark ghostshark                | GSH     | 42   |
| Rhinochimaeridae: longnosed chimaeras         |                                |         |      |
| <i>Harriotta raleighana</i>                   | long-nosed chimaera            | LCH     | 51   |
| <i>Rhinochimaera pacifica</i>                 | widenosed chimaera             | RCH     | 20   |
| <b>Osteichthyes (bony fishes)</b>             |                                |         |      |
| Halosauridae: halosaurs                       |                                |         |      |
| <i>Halosaurus pectoralis</i>                  | common halosaur                | HPE     | 6    |
| Notocanthidae: spiny eels                     |                                |         |      |
| <i>Notacanthus chemnitzii</i>                 | giant spineback                | NOC     | 1    |
| <i>N. sexspinis</i>                           | spineback                      | SBK     | 50   |
| Synphobranchidae: cutthroat eels              |                                |         |      |
| <i>Diastobranchus capensis</i>                | basketwork eel                 | BEE     | 22   |
| Congridae: conger eels                        |                                |         |      |
| <i>Bassanago bulbiceps</i>                    | swollenhead conger             | SCO     | 27   |
| <i>B. hirsutus</i>                            | hairy conger                   | HCO     | 30   |
| Serrivomeridae: sawtooth eels                 |                                |         |      |
| <i>Serrivomer sp.</i>                         | sawtooth eel                   | SAW     |      |
| Gonorynchidae: sandfish                       |                                |         |      |
| <i>Gonorynchus forsteri</i> & <i>G. greyi</i> | sandfishes                     | GON     | 2    |
| Argentinidae: silversides                     |                                |         |      |
| <i>Argentina elongata</i>                     | silverside                     | SSI     | 51   |
| Bathylagidae: deepsea smelts                  |                                |         |      |
| <i>Melanolagus bericoides</i>                 | bigscale blacksmelt            | MEB     | 7    |
| <i>Nansenia sp.</i>                           | deepsea smelt                  | DSS     | 1    |
| Alepocephalidae: slickheads                   |                                |         |      |
| <i>Alepocephalus antipodanus</i>              | smallscaled brown slickhead    | SSM     | 14   |
| <i>A. australis</i>                           | bigscaled brown slickhead      | SBI     | 16   |
| <i>Xenodermichthys copei</i>                  | black slickhead                | BSL     | 14   |
| Platytroutidae: tubeshoulders                 |                                |         |      |
| <i>Perspasia kopua</i>                        |                                | PER     | 1    |
| Gonostomatidae: lightfishes                   |                                |         |      |
|   | unspecified lightfish          | GST     | 1    |
| Sternoptychidae: hatchetfishes                |                                |         |      |
| <i>Argyropelecus gigas</i>                    | giant hatchetfish              | AGI     | 4    |

## Appendix 2 (continued)

| Scientific name                                 | Common name                  | Species | Occ. |
|---|------------------------------|---------|------|
| Photichthyidae: lighthouse fishes               |                              |         |      |
| <i>Photichthys argenteus</i>                    | lighthouse fish              | PHO     | 23   |
| Chauliodontidae: viperfishes                    |                              |         |      |
| <i>Chauliodus sloani</i>                        | viperfish                    | CHA     | 10   |
| Astronesthidae: snaggletooths                   | unspecified snaggletooth     | AST     | 1    |
| Melanostomiidae: scaleless black dragonfishes   |                              |         |      |
| <i>Melanostomias</i> spp.                       | scaleless black dragonfishes | MEN     | 1    |
| Malacosteidae: loosejaws                        |                              |         |      |
| <i>Malacosteus</i> spp.                         | loosejaw                     | MAL     | 7    |
| Idiacanthidae: black dragonfishes               |                              |         |      |
| <i>Idiacanthus</i> spp.                         | black dragonfish             | IDI     | 2    |
| Chlorophthalmidae: cucumberfishes, tripodfishes |                              |         |      |
| <i>Chlorophthalmus nigripinnis</i>              | cucumberfish                 | CUC     | 1    |
| Scopelarchidae: pearleyes                       | unspecified pearleye         | PEY     | 1    |
| <i>Scopelarchoides kreffti</i>                  | Kreffft's pearleye           | SKR     | 1    |
| Notosudidae: waryfishes                         |                              |         |      |
| <i>Scopelosaurus</i> spp.                       |                              | SPL     | 2    |
| Paralepididae: barracudinas                     | unspecified barracudina      | PAL     | 1    |
| <i>Macroparalepis macrugeneion</i>              |                              | MMA     | 2    |
| Evermannellidae: sabretooth fishes              |                              |         |      |
| <i>Evermanella balbo</i>                        | brown sabretooth             | EVB     | 1    |
| Myctophidae: lanternfishes                      | unspecified lanternfish      | LAN     | 16   |
| <i>Gymnoscopelus</i> spp.                       |                              | GYM     | 1    |
| <i>Lampadena notialis</i>                       |                              | LPD     | 2    |
| <i>Lampanyctodes hectoris</i>                   | Hector's lanternfish         | LHE     | 2    |
| <i>Lampanyctus</i> spp.                         |                              | LPA     | 15   |
| <i>Symbolophorus</i> spp.                       |                              | SYM     | 1    |
| Moridae: morid cods                             |                              |         |      |
| <i>Halargyreus johnsonii</i>                    | Johnson's cod                | HJO     | 35   |
| <i>Lepidion microcephalus</i>                   | small-headed cod             | SMC     | 13   |
| <i>Mora moro</i>                                | ribaldo                      | RIB     | 40   |
| <i>Notophycis marginata</i>                     | dwarf cod                    | DCO     | 3    |
| <i>Pseudophycis bachus</i>                      | red cod                      | RCO     | 14   |
| <i>Tripteroptychys gilchristi</i>               | grenadier cod                | GRC     | 3    |
| Melanonidae: pelagic cods                       |                              |         |      |
| <i>Melanonus gracilis</i>                       | small toothed pelagic cod    | MEL     | 1    |
| <i>M. zugmayeri</i>                             | large toothed pelagic cod    | MEZ     | 3    |
| Euclichthyidae: eucla cods                      |                              |         |      |
| <i>Euclichthys polynemus</i>                    | eucla cod                    | EUC     | 1    |
| Gadidae: true cods                              |                              |         |      |
| <i>Micromesistius australis</i>                 | southern blue whiting        | SBW     | 3    |
| Merlucciidae: hakes                             |                              |         |      |
| <i>Macruronus novaezelandiae</i>                | hoki                         | HOK     | 104  |
| <i>Merluccius australis</i>                     | hake                         | HAK     | 55   |
| Macrouridae: rattails, grenadiers               |                              |         |      |
| <i>Coelorinchus acanthiger</i>                  | spotty faced rattail         | CTH     | 2    |
| <i>C. aspercephalus</i>                         | oblique banded rattail       | CAS     | 48   |
| <i>C. biclinozonalis</i>                        | two saddle rattail           | CBI     | 9    |
| <i>C. bollonsi</i>                              | bigeye rattail               | CBO     | 82   |
| <i>C. fasciatus</i>                             | banded rattail               | CFA     | 32   |
| <i>C. innotabilis</i>                           | notable rattail              | CIN     | 32   |
| <i>C. matamua</i>                               | Mahia rattail                | CMA     | 17   |

**Appendix 2 (continued)**

| Scientific name                       | Common name                | Species | Occ. |
|---------------------------------------|----------------------------|---------|------|
| <i>C. maurofasciatus</i>              | dark banded rattail        | CDX     | 1    |
| <i>C. oliverianus</i>                 | Oliver's rattail           | COL     | 69   |
| <i>C. parvifasciatus</i>              | small banded rattail       | CCX     | 10   |
| <i>C. trachycarus</i>                 | roughhead rattail          | CHY     | 8    |
| <i>Coryphaenoides dossenus</i>        | humpback (slender) rattail | CBA     | 16   |
| <i>C. serrulatus</i>                  | serrulate rattail          | CSE     | 29   |
| <i>C. striaturus</i>                  | striate rattail            | CTR     | 2    |
| <i>C. subserrulatus</i>               | four-rayed rattail         | CSU     | 37   |
| <i>Lepidorhynchus denticulatus</i>    | javelinfish                | JAV     | 94   |
| <i>Lucigadus nigromaculatus</i>       | blackspot rattail          | VNI     | 29   |
| <i>Macrourus carinatus</i>            | ridge scaled rattail       | MCA     | 11   |
| <i>Mesobius antipodum</i>             | black javelinfish          | BJA     | 4    |
| <i>Nezumia namatahi</i>               | squashed face rattail      | NNA     | 3    |
| <i>Trachonurus gagates</i>            | velvet rattail             | TRX     | 2    |
| <i>Trachyrincus aphyodes</i>          | white rattail              | WHX     | 26   |
| <i>T. longirostris</i>                | unicorn rattail            | WHR     | 3    |
| Ophidiidae: cuskeels                  |                            |         |      |
| <i>Genypterus blacodes</i>            | ling                       | LIN     | 82   |
| Carapidae: pearlfishes                |                            |         |      |
| <i>Echiodon cryomargarites</i>        | messmate fish              | ECR     | 3    |
| Ceratiidae: seadevils                 |                            |         |      |
| <i>Cryptosaras couesi</i>             | seadevil                   | SDE     | 2    |
| Himantolophidae: prickly anglerfishes |                            |         |      |
| <i>Himantolophus appellii</i>         | prickly anglerfish         | HIA     | 1    |
| Linophrynidae: linophrynids           |                            |         |      |
| <i>Haplophryne mollis</i>             | phantom angler             | LPH     | 1    |
| Trachichthyidae: roughies, slimeheads |                            |         |      |
| <i>Hoplostethus atlanticus</i>        | orange roughy              | ORH     | 29   |
| <i>H. mediterraneus</i>               | silver roughy              | SRH     | 48   |
| <i>Paratrachichthys trailli</i>       | common roughy              | RHY     | 8    |
| Diretmidae: discfishes                |                            |         |      |
| <i>Diretmus argenteus</i>             | discfish                   | DIS     | 2    |
| Anoplogastridae: fangtooth            |                            |         |      |
| <i>Anoplogaster cornuta</i>           | fangtooth                  | ANO     | 2    |
| Berycidae: alfonsinos                 |                            |         |      |
| <i>Beryx splendens</i>                | alfonsino                  | BYS     | 34   |
| Zeidae: dories                        |                            |         |      |
| <i>Capromimus abbreviatus</i>         | capro dory                 | CDO     | 13   |
| <i>Cyttus novaezealandiae</i>         | silver dory                | SDO     | 14   |
| <i>C. traversi</i>                    | lookdown dory              | LDO     | 81   |
| Oreosomatidae: oreos                  |                            |         |      |
| <i>Allocyttus niger</i>               | black oreo                 | BOE     | 14   |
| <i>A. verrucosus</i>                  | warty oreo                 | WOE     | 6    |
| <i>Neocyttus rhomboidalis</i>         | spiky oreo                 | SOR     | 27   |
| <i>Pseudocyttus maculatus</i>         | smooth oreo                | SSO     | 31   |
| Macrorhamphosidae: snipefishes        |                            |         |      |
| <i>Centriscops humerosus</i>          | banded bellowsfish         | BBE     | 68   |
| <i>Notopogon lilliei</i>              | crested bellowsfish        | CBE     | 6    |
| Scorpaenidae: scorpionfishes          |                            |         |      |
| <i>Helicolenus</i> spp.               | sea perch                  | SPE     | 81   |
| <i>Trachyscorpia capensis</i>         |                            | TRS     | 2    |

## Appendix 2 (continued)

| Scientific name                             | Common name                           | Species      | Occ. |
|---|---------------------------------------|--------------|------|
| Congiopodidae: pigfishes                    |                                       |              |      |
| <i>Alertichthys blacki</i>                  | alert pigfish                         | API          | 4    |
| <i>Congiopodus leucopaecilus</i>            | pigfish                               | PIG          | 2    |
| Triglidae: gurnards                         |                                       |              |      |
| <i>Lepidotrigla brachyoptera</i>            | scaly gurnard                         | SCG          | 8    |
| Hoplichthyidae: ghostflatheads              |                                       |              |      |
| <i>Hoplichthys haswelli</i>                 | deepsea flathead                      | FHD          | 34   |
| Psychrolutidae: toadfishes                  |                                       |              |      |
| <i>Ambopthalmos angustus</i>                | pale toadfish                         | TOP          | 11   |
| <i>Psychrolutes microporos</i>              | blobfish                              | PSY          | 3    |
| Percichthyidae: temperate basses            |                                       |              |      |
| <i>Polyprion oxygeneios</i>                 | hapuku                                | HAP          | 11   |
| Serranidae: sea perches, groper             |                                       |              |      |
| <i>Lepidoperca aurantia</i>                 | orange perch                          | OPE          | 11   |
| Apogonidae: cardinalfishes                  |                                       |              |      |
| <i>Epigonus denticulatus</i>                | white cardinalfish                    | EPD          | 10   |
| <i>E. lenimen</i>                           | bigeye cardinalfish                   | EPL          | 11   |
| <i>E. robustus</i>                          | robust cardinalfish                   | EPR          | 21   |
| <i>E. telescopus</i>                        | deepsea cardinalfish                  | EPT          | 14   |
| <i>Rosenblattia robusta</i>                 | rotund cardinalfish                   | ROS          | 5    |
| Carangidae: trevallies, kingfishes          |                                       |              |      |
| <i>Trachurus declivis</i>                   | greenback jack mackerel               | JMD          | 2    |
| <i>T. symmetricus murphyi</i>               | slender jack mackerel                 | JMM          | 5    |
| Bramidae: pomfrets                          |                                       |              |      |
| <i>Brama australis</i><br>& <i>B. brama</i> | southern Ray's bream<br>& Ray's bream | SRB &<br>RBM | 19   |
| Emmelichthyidae: bonnetmouths, rovers       |                                       |              |      |
| <i>Emmelichthys nitidus</i>                 | redbait                               | RBT          | 6    |
| <i>Plagiogeneion rubiginosum</i>            | rubyfish                              | RBV          | 3    |
| Cheilodactylidae: tarakihi, morwongs        |                                       |              |      |
| <i>Nemadactylus macropterus</i>             | tarakihi                              | TAR          | 6    |
| Uranoscopidae: armourhead stargazers        |                                       |              |      |
| <i>Kathetostoma giganteum</i>               | giant stargazer                       | STA          | 47   |
| Percophidae: opalfishes                     |                                       |              |      |
| <i>Hemerocoetes</i> spp.                    | opalfish                              | OPA          | 1    |
| Pinguipedidae: sandperches, weevers         |                                       |              |      |
| <i>Parapercis gilliesi</i>                  | yellow cod                            | YCO          | 1    |
| Gempylidae: snake mackerels                 |                                       |              |      |
| <i>Nesiarchus nasutus</i>                   | black baracouta                       | BBA          | 2    |
| <i>Thysites atun</i>                        | barracouta                            | BAR          | 6    |
| Trichiuridae: cutlassfishes                 |                                       |              |      |
| <i>Benthodesmus</i> spp.                    | scabbardfish                          | BEN          | 1    |
| <i>Lepidopus caudatus</i>                   | frostfish                             | FRO          | 1    |
| Centrolophidae: raftfishes, medusafishes    |                                       |              |      |
| <i>Centrolophus niger</i>                   | rudderfish                            | RUD          | 10   |
| <i>Hyperoglyphe antarctica</i>              | bluenose                              | BNS          | 5    |
| <i>Schedophilus huttoni</i>                 | slender ragfish                       | SUH          | 1    |
| <i>S. maculatus</i>                         | pelagic butterfish                    | SUM          | 1    |
| <i>Seriola caerulea</i>                     | white warehou                         | WWA          | 42   |
| <i>S. punctata</i>                          | silver warehou                        | SWA          | 53   |
| <i>Tubbia tasmanica</i>                     | Tasmanian ruffe                       | TUB          | 3    |

**Appendix 2 (continued)**

| Scientific name                     | Common name      | Species | Occ. |
|-------------------------------------|------------------|---------|------|
| Bothidae: lefteyed flounders        |                  |         |      |
| <i>Arnoglossus scapha</i>           | witch            | WIT     | 10   |
| <i>Neochirosetta milfordi</i>       | finless flounder | MAN     | 5    |
| Pleuronectidae: righteyed flounders |                  |         |      |
| <i>Pelotretis flavilatus</i>        | lemon sole       | LSO     | 9    |



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

| NIWA No. | Cruise/Station_no | Phylum        | Class                 | Subclass     | Order                             | Family            | Genus                 | Species                     |
|----------|-------------------|---------------|-----------------------|--------------|-----------------------------------|-------------------|-----------------------|-----------------------------|
| 70541    | TAN1101/54        | Arthropoda    | Malacostraca          |              | Decapoda                          | Homolidae         | <i>Dagnaudus</i>      | <i>petterdi</i>             |
| 70521    | TAN1101/74        | Cnidaria      | Anthozoa              | Hexacorallia | Actiniaria                        | Actiniidae        |                       |                             |
| 70529    | TAN1101/14        | Cnidaria      | Anthozoa              | Hexacorallia | Corallimorpharia                  |                   |                       |                             |
| 70523    | TAN1101/98        | Cnidaria      | Anthozoa              | Octocorallia | Gorgonacea                        | Primnoidae        |                       |                             |
| 70530    | TAN1101/98        | Cnidaria      | Anthozoa              | Hexacorallia | Scleractinia                      | Caryophylliidae   | <i>Desmophyllum</i>   | <i>dianthus</i>             |
| 70531    | TAN1101/20        | Cnidaria      | Anthozoa              | Hexacorallia | Scleractinia                      | Caryophylliidae   | <i>Goniocorella</i>   | <i>dumosa</i>               |
| 70527    | TAN1101/36        | Cnidaria      | Hydrozoa              | Siphonophora |                                   |                   |                       |                             |
| 70520    | TAN1101/47        | Echinodermata | Asteroidea            |              | Valvatida                         | Goniasteridae     | <i>Mediaster</i>      | <i>sladeni</i>              |
| 70524    | TAN1101/99        | Echinodermata | Asteroidea            |              | Velatida                          | Pterasteridae     | <i>Pteraster</i>      | <i>(Apterodon) bathamae</i> |
| 70526    | TAN1101/92        | Echinodermata | Asteroidea            |              | Velatida                          | Pterasteridae     | <i>Pteraster</i>      | <i>(Apterodon) bathamae</i> |
| 70528    | TAN1101/8         | Echinodermata | Holothuroidea (Class) |              | Molpadiida                        | Molpadiidae       | <i>Heteromolpadia</i> | <i>pikei</i>                |
| 70539    | TAN1101/9         | Echinodermata | Holothuroidea (Class) |              | Molpadiida                        | Molpadiidae       | <i>Heteromolpadia</i> | <i>pikei</i>                |
| 70525    | TAN1101/54        | Echinodermata | Ophiuroidea           |              | Euryalinida [aka Phyrynophiurida] | Gorgonocephalidae | <i>Astrothorax</i>    | <i>waitei</i>               |
| 70522    | TAN1101/18        | Mollusca      | Cephalopoda           | Coleoidea    | Octopoda                          | Octopodidae       | <i>Octopus</i>        | <i>mernoo</i>               |
| 70540    | TAN1101/9         | Mollusca      | Cephalopoda           | Coleoidea    | Octopoda                          | Octopodidae       | <i>Octopus</i>        | <i>mernoo</i>               |
| 70532    | TAN1101/54        | Porifera      | Demospongiae          |              | Astrophorida                      | Ancorinidae       | <i>Ecionemia</i>      | <i>novaezealandiae</i>      |
| 70533    | TAN1101/49        | Porifera      | Demospongiae          |              | Astrophorida                      | Ancorinidae       | <i>Tethyopsis</i>     | n. sp. 1                    |
| 62167    | TAN1101/54        | Porifera      | Demospongiae          |              | Astrophorida                      | Geodiidae         | <i>Geodia</i>         | <i>vestigifera</i>          |

**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 |