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EXECUTIVE SUMMARY

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The seventeenth 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 between 27 December 2007 and 23 January 2008. Using a random stratified sampling design, 101 bottom trawl stations (95 phase 1 and 6 phase 2 stations) were successfully completed in core depths of 200–800 m. In addition, 4 random bottom trawls were completed in 800–1000 m depths (stratum 22) to estimate the abundance of hake.

The estimate of relative biomass of all hoki was 76 859 t, an increase of 9% from January 2007. This increase was driven by an increase in recruitment of 1+ hoki from 9100 t in 2007 (2005 year-class) to 15 600 t in 2008 (2006 year-class), and an increase of recruited (3+ years and older) hoki from 28 800 t in 2007 to 37 500 t in 2008. The 2005 hoki year-class at 2+ was weaker than the 2002–04 year-classes at the same age but still about average in the time series. The biomass of hake in core strata decreased by 31% in 2008 to 1257 t, and remains at historically low levels. The biomass of ling was 7504 t, 5% lower than in January 2007, but the time-series for ling shows no overall trend.

Coefficients of variation (c.v.s) of biomass estimates were 11.4% for total hoki, 12.9% for hake, and 6.7% for ling. The c.v. for age 2+ hoki was 15.5%, which was well below the MFish target c.v. of 20%.

The age frequency distribution for hake was dominated by young fish from ages 4–8, suggesting a pulse of recent recruitment, particularly of the 2001 year-class (seen as age 6+ in 2008). The age distribution for ling was broad, with most fish aged between 3 and 12.

Acoustic data were also collected during the trawl survey. There was a weak positive correlation between acoustic density estimates close to the bottom and trawl catch rates. Mesopelagic fish biomass was estimated from acoustic data. Although values from 2007 and 2008 are the two lowest in the series, there has been no clear trend in mesopelagic fish biomass on the Chatham Rise over the last 8 years.

1. INTRODUCTION

In January 2008, the seventeenth 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 the RV *Tangaroa* and form the most comprehensive time series of species abundance in 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 have been documented by Horn (1994a, 1994b), Schofield & Horn (1994), Schofield & Livingston (1995, 1996, 1997), Bagley & Hurst (1998), Bagley & Livingston (2000), Stevens et al. (2001, 2002), Stevens & Livingston (2003), Livingston et al. (2004), Livingston & Stevens (2005), Stevens & O'Driscoll (2006, 2007), and Stevens et al. (2008). Trends in biomass and changes in catch and age distribution of 31 species from surveys 1992–2001 were reviewed by Livingston et al. (2002). Hoki dominated the catches in every survey, and formed 53 to 66% of the total biomass from 1992 to 1997. By 2001, however, the proportion of hoki decreased to 29% as the biomass estimate dropped steadily from about 160 000 t in 1997 to 60 300 t in 2001 (Livingston et al. 2002). Hake, another priority species in this research programme, also showed a decline in biomass within the time series, while ling biomass was relatively stable, showing no trend (Livingston et al. 2002).

The 2008 survey results presented here continue the Chatham Rise trawl survey series as part of a long-term research programme to estimate the 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 seamounts, 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 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.

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

Other work carried out concurrently with the trawl survey included sampling and preservation of unidentified organisms caught in the trawl and collection of mesopelagic prey species from midwater trawls at night.

1.1 Project objectives

The trawl survey was carried out under contract to the Ministry of Fisheries (project HOK2007/02). 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 using otolith samples from the trawl survey.

3. To collect acoustic and related data during the trawl survey.

4. To collect and preserve specimens of unidentified organisms taken during the trawl survey.

2. METHODS

2.1 Survey area and design

As in previous years, the survey followed a two-phase random design (after Francis 1984). The main survey area, 200–800 m depths (Figure 1), was divided into the same 26 strata used in 2003–07 (Livingston et al. 2004, Livingston & Stevens 2005, Stevens & O'Driscoll 2006, 2007, Stevens et al. 2008). Station allocation for phase 1 was determined from simulations based on catch rates from all previous Chatham Rise trawl surveys (1992–2007), 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 95 stations in phase 1 (Table 1) is similar to that used in the 2007 survey, when the c.v. for 2+ hoki was 12.8% (Stevens et al. 2008). Phase 2 stations were allocated at sea to improve c.v.s for hoki and hake, and to increase the number of hake sampled.

Because time permitted, an additional deep (800–1000 m) stratum on the northwest flank of the Chatham Rise (stratum 22 in Figure 1) was included in the 2008 survey. Stratum 22, which is sampled primarily for hake, was previously surveyed in 2002 and 2007 (Stevens & Livingston 2003, Stevens et al. 2008).

2.2 Vessel and gear specifications

Tangaroa is a purpose-built, research stern trawler of 70 m overall length, a beam of 14 m, 3000 kW (4000 hp) of power, and a gross tonnage of 2282 t.

The bottom trawl was the same as that used on previous surveys of middle depth species by *Tangaroa.* The net is an eight-seam hoki bottom trawl with 100 m sweeps, 50 m bridles, 12 m backstrops, 58.8 m groundrope, 45 m headline, and 60 mm codend mesh (see Hurst & Bagley (1994) for net plan and rigging details). The trawl doors were Super Vee type with an area of 6.1 m^2. Measurements of doorspread (from a Scanmar 400 system) and headline height (from a Furuno net monitor) were recorded every 5 minutes during each tow and average values calculated.

Some additional trawling was carried out using a midwater mesopelagic trawl outside the normal trawl survey hours (i.e., at night) to collect information on prey species. The mesopelagic trawl had a headline height of 18.5 m and a codend mesh size of 10 mm.

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. A minimum distance between stations of 3 n. miles was used. 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. Tows were carried out during daylight hours (as defined by Hurst et al. 1992), with all trawling between 0500 h and 1842 h NZST, except for the mesopelagic tows carried out at night to help interpretation of acoustic data. These night tows were not used for biomass estimation.

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 had been 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) using the *CREST* system (Coombs et al. 2003) with hull-mounted Simrad single-beam 12 kHz and 38 kHz transducers. The 38 kHz transducer has been regularly calibrated following standard procedures (Foote et al. 1987). The 12 kHz transducer was not calibrated. Data collected on 12 kHz were used only to make visual comparisons with 38 kHz data and were not analysed quantitatively.

Additional acoustic data were collected to address specific questions about diurnal vertical migration of mesopelagic fish arising from FRST programme CO1X0501. Where time permitted, after the final trawl shot of the day, the vessel steamed back over the trawl path at dusk to show the mesopelagic layers ascending, and then back over the trawl path again at night. This was done on 18 nights. On 5 of these nights, a mesopelagic trawl was carried out on surface layers (less than 200 m deep) after completion of the final (night) run over the trawl path to provide information on the species composition of the migrating layers.

2.5 Hydrology

Temperature and salinity data were collected using a calibrated Seabird SM-37 Microcat CTD datalogger mounted on the headline of the trawl. Data were collected at 5 s intervals throughout the trawl, providing vertical profiles. Surface values were read off the vertical profile at the beginning of each tow at a depth of about 5 m, which corresponded to the depth of the hull temperature sensor used in previous surveys. Bottom values were about 7.0 m above the sea-bed (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 0.3 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 are being stored at NIWA for subsequent 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 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 biomass and length frequencies

Doorspread biomass was estimated by the swept area method of Francis (1981, 1989) using the formulae in Vignaux (1994). 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 ghost shark, pale ghost shark, giant stargazer, lookdown dory, sea perch, silver warehou, spiny dogfish, and white warehou. These species were selected because they are commercially important, and the trawl survey samples the main part of their depth distribution. Other species such as black oreo are also commercial and relatively abundant on these surveys, but their depth distribution extends well beyond that sampled by the survey and the data are not representative of the full population.

The catchability coefficient (an estimate of the proportion of fish in the path of the net which is 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 the Trawlsurvey Analysis Program, version 3.2 (Vignaux 1994), using length-weight data from this survey.

Data from all biomass stations (categories P1 or P2) and where the gear performance was satisfactory (codes 1 or 2) were included for estimating biomass and calculating length frequencies.

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 650 hoki otoliths and 642 ling otoliths were selected from those collected during the trawl survey. Subsamples were obtained by randomly selecting otoliths from 1 cm length bins covering the bulk of the catch and then systematically selecting additional otoliths to ensure 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 165 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 measurents 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). All acoustic recordings made during the trawl survey were visually examined. Marks were classified into seven main categories based on the relative depth of the mark in the water column, mark orientation (surface- or bottom-referenced), mark structure (layers or schools) and the relative strength of the mark on 38 kHz and 12 kHz. Descriptive statistics were produced on the frequency of occurrence of different marks. Brief descriptions of the mark types are given below. Example echograms may be found in Cordue et al. (1998), Bull (2000), O'Driscoll (2001a, 2001b), and Stevens et al. (2008).

1. Surface layers

These occurred within the upper 100 m of the water column and tended to be stronger on 12 kHz than on 38 kHz.

2. Pelagic layers

Surface-referenced midwater layers which were typically continuous for more than 1 km and much stronger on 12 kHz than on 38 kHz. This category is equivalent to "Type A" marks of Bull (2000).

3. Pelagic schools

Well defined schools in midwater which are generally stronger on 38 kHz and appear as crescents on 12 kHz. Equivalent to "bullet" marks of Cordue et al. (1998) and Bull (2000). In 2007, pelagic schools were further subdivided into three categories (Stevens et al. 2008):

a) Type A schools: dense well defined schools with a clear nucleus which occur in the upper 250 m.
b) Type B schools: schools or shoals which are not as discrete or strong as type A schools, with little evidence of a nucleus. Often occur in patches, creating a semi-continuous layer. Usually at 100–400 m depth.
c) Type C schools: dense schools similar to type A, but occurring deeper than 250 m.

4. Pelagic clouds

Surface-referenced midwater marks which were more diffuse and dispersed than pelagic layers, typically over 100 m thick with no clear boundaries.

5. Bottom layers

Bottom-referenced layers which were continuous for more than 1 km and were generally stronger on 38 kHz than on 12 kHz. Equivalent to "Type B" marks of Bull (2000) and "Type 1" marks of Cordue et al. (1998).

6. Bottom clouds

Bottom-referenced marks which were more diffuse and dispersed than bottom layers with no clear upper boundary.

7. Bottom schools

Distinct schools close to the bottom. These appear as crescents on 12 kHz and are equivalent to "Type C" marks of Bull (2000).

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.

A quantitative analysis was carried out on daytime trawl and night steam recordings using custom Echo Sounder Package (ESP2) software (McNeill 2001). Estimates of the mean acoustic backscatter per square kilometre from bottom referenced marks (bottom layers, clouds, and schools) were calculated for each recording based on integration heights of 10 m, 50 m, and 100 m above the detected acoustic bottom. Total acoustic backscatter was also integrated throughout the water column in 50 m depth bins. Acoustic density estimates (backscatter per square kilometre) from bottom-referenced marks were compared with trawl catch rates (kilograms per square kilometre). No attempt was made to scale acoustic estimates by target strength, correct for differences in catchability, or carry out species decomposition (O'Driscoll 2002, 2003).

O'Driscoll et al. (in press) developed a time series of relative abundance estimates for mesopelagic fish on the Chatham Rise based on that component of the acoustic backscatter that migrates into the upper 200 m of the water column at night (nyctoepipelagic backscatter). Because some of the mesopelagic fish migrate very close to the surface at night, they move into the surface 'deadzone' (shallower than 14 m) where they are not detectable by the vessel's downward looking hull-mounted transducer. Consequently, there is a substantial negative bias in night-time acoustic estimates. To correct for this bias, O'Driscoll et al. (in press) used night estimates of demersal backscatter (which remains deeper than 200 m at night) to correct daytime estimates of total backscatter.

We updated the time series of O'Driscoll et al. (in press) to include data from 2008. (Day estimates of total backscatter were calculated using total mean area backscattering coefficients from each trawl recording.) These were treated as random point samples to estimate survey mean and variance. The Chatham Rise was divided into two strata (east and west of 177º E) based on consistent observations of higher acoustic backscatter in the west (McClatchie et al. 2005). Night estimates of demersal backscatter were based on data recorded while steaming between 2000 h and 0500 h NZST. To estimate abundance, we treated each night as a single random transect. The assumption of randomness was at least partly valid because the vessel was steaming between random trawl stations. Mean area backscattering coefficients were calculated for each 'transect', and then an overall survey estimate and variance was obtained using the formulae of Jolly & Hampton (1990). As for day recordings, the Chatham Rise was divided into east and west strata at 177º E.

3. RESULTS

3.1 2008 survey coverage

The trawl survey was successfully completed, with good progress throughout the survey area. Fifteen hours were lost to bad weather, and eight hours were required to fix a damaged trawl. A total of 101 successful biomass tows were completed in the core strata, comprising 95 phase 1 tows and 6 phase 2 stations (Tables 1 and 2, Figure 2, Appendix 1). Another 4 biomass tows were conducted in stratum 22. A further 5 random bottom trawl stations were excluded from the biomass calculations: 4 tows came fast, and another was too deep for the survey area. Five fine-meshed midwater tows were carried out at night to help interpretation of acoustic data.

Station density ranged from 1:173 km^2 in stratum 17 (200–400 m, Veryan Bank) to 1:3722 km^2 in stratum 4 (600–800 m, south Chatham Rise). Mean station density was 1:1399 km^2 (see Table 1).

3.2 Gear performance

Gear parameters are summarised in Table 3. The headline height and doorspread readings were obtained for all 105 successful tows. Gear configuration was relatively consistent over the depth range of the survey. Mean doorspread measurements by 200 m depth intervals ranged from 107.6 to 119.3 m and mean headline height ranged from 6.7 to 6.9 m (Table 3). Measured gear parameters in 2008 were similar to those obtained on other voyages of *Tangaroa* in this area when the same gear was used, and were all within the optimal range (Hurst et al. 1992).

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 13.0 to 19.7 °C. Bottom temperatures ranged from 6.0 to 11.7 °C (Figure 3, bottom panel).

As in previous years, higher surface temperatures were associated with subtropical water to the north. Lower temperatures were associated with Sub-Antarctic water to the south. Higher bottom temperatures were generally associated with shallower depths to the north of the Chatham Islands and on and to the east of the Mernoo Bank.

3.4 Catch composition

The total catch from the 101 valid biomass stations was 137.1 t, of which 56.3 t (41.1%) was hoki, 3.4 t (2.5%) was ling, and 0.7 t (0.5%) was hake (Table 4). Of the 242 species or species groups identified, there were 102 teleosts, 27 elasmobranches, 1 agnathan, 19 crustaceans, and 12 cephalopods, the remainder consisting 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. A few benthic invertebrates are still awaiting formal identification.

3.5 Biomass estimates

Relative biomass was estimated for 44 species (Table 4). The c.v.s achieved for hoki, hake, and ling were 11.4%, 12.9%, and 6.7% respectively. The c.v. for 2+ hoki (2005 year class) was 15.5%, well 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, slender mackerel, and silver warehou are not strictly demersal and exhibit strong schooling behaviour. Others, such as spiky oreo and red cod, have high c.v.s as they are mainly distributed outside the survey depth range.

The combined biomass for the top 31 species in the core strata that are tracked from year to year was 15% higher than in 2007 (Figure 4, top panel). As in previous years, hoki was the most abundant species caught (Table 4), and formed a similar proportion of the total biomass to 2005 to 2007 (Figure 4, lower panel). Alfonsino, spiny dogfish, silver warehou, dark ghost shark, barracouta, ling, black oreo, lookdown dory, giant stargazer, red cod, pale ghost shark, sea perch, and spiky oreo were the next most abundant QMS species, each with an estimated biomass over 2000 t (Table 4). The most abundant non-QMS species were javelinfish, big-eye rattail, and shovelnose dogfish (Table 4).

The estimate of relative biomass of all hoki was 70 479 t, an increase of 9% from January 2007 (Table 5, Figure 5). This was driven by increases in the biomass of 1+ hoki (2006 year-class) from 9100 t in 2007 to 15 600 t in 2008, and in recruited hoki (3+ years and older) from 28 800 t in 2007 to 37 500 t in 2008 (Table 6). The biomass estimate of 2+ hoki (2005 year-class) was 23 800 t, which although less than the previous 3 years (32 600 to 45 800 t), was still about average (Table 6). The biomass of hake in core strata decreased by 31% in 2008, to 1257 t, and remains at historically low levels compared to the early 1990s (see Table 5, Figure 5). The biomass of ling was 7504 t, which was 5% lower than in January 2007, but the timeseries for ling shows no overall trend (Figure 5).

The relative biomass of dark ghost shark, giant stargazer, and spiny dogfish increased from 2007, while the biomass of pale ghost shark, sea perch, and white warehou decreased (Figure 5). Biomass estimates for lookdown dory and silver warehou were similar in 2007 and 2008 (Figure 5).

3.6 Catch distribution

Hoki

In the 2008 survey, hoki were caught in all core biomass stations, but the highest catch rates were mainly in shallow strata (200–400 m) on the western Chatham Rise, reflecting good numbers of smaller hoki (1+, 2+ and 3+ hoki, Table 7, Figure 6). The highest individual catch rate of hoki in 2008 occurred in stratum 17, on the Veryan Bank, and comprised 20.7 t of mainly 1+ (2006 year class) and 2+ (2005 year class) hoki (Figure 6). This catch rate dominated both year classes. As in previous surveys, the remaining 1+ hoki were largely confined to the Mernoo and Reserve Banks (Figure 6a), while 2+ hoki were abundant throughout much of the Rise in 200-600 m depth (Figure 6b). The distribution of 3++ hoki was similar to that of 2+ fish (Figure 6c).

Hake

As in 2006 and 2007, the highest catch rates of hake were in the known hake spawning area in stratum 11A (Figure 7). There were also consistent catches west of the Mernoo Bank in stratum 7. Few hake were taken from the south side of the Rise. Hake catches in the four tows in stratum 22 were low (Table 7, Figure 7) and the estimated hake biomass from this deep stratum was about 20% of what it was in 2002 (see Table 5).

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 to the east of Mernoo Bank in stratum 15 and on the Matheson Bank (stratum 13). Ling distribution has been reasonably consistent, and catch rates have remained relatively stable over the time series (Figure 8).

Other species

As with previous surveys, lookdown dory and sea perch were widely distributed throughout the survey area in 200–600 m depths (Table 7, Figure 9). Spiny dogfish were also most abundant in these depths but catch rates were dominated by large catches (0.9 t and 3 t) in stratum 5 (west of the Chatham Islands). Dark ghost shark were mainly caught in 200–400 m depths with the largest catches taken in stratum 17 on the Veryan Bank. Giant stargazer were also most abundant in shallower strata with the largest catch taken in stratum 18 around the Mernoo Bank (Table 7). Pale ghost shark were mostly caught in deeper water at 400–800 m depth. Silver warehou and white warehou were patchily distributed at depths of 200–600 m. In 2008, there were large (over 1500 kg km^{-2}) catches of silver warehou in strata 11a (NE Chatham Rise) and 19 (Reserve Bank), and a large catch of white warehou in stratum 17 (Mernoo Bank) (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 Trawlsurvey Analysis Program to scale length frequencies and calculate biomass and catch rates are given in Table 9.

Hoki

The hoki length frequency (Figure 10) was dominated by 1+ (less than 49 cm) and 2+ (49–63 cm) fish (Figure 11). There were few hoki longer than 80 cm (Figure 10) or older than age 5 (Figure 11). The overall sex ratio for hoki was even.

Hake

Hake scaled length frequencies and calculated numbers at age (Figures 12 and 13) show a mode of small fish moving through since 2004, visible as a mode at age 6+ (2001 year-class). Female hake were almost twice as abundant as males (1.92 females : 1 male).

Ling

Ling scaled length frequencies and calculated numbers at age (Figures 14 and 15) were broad, with most fish aged between 3 and 12. There appears to have been a period of good recruitment during the 1990s (Figure 15). Male ling were slightly more abundant than females (0.89 females : 1 male).

Other species

Length frequency distributions for other 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. As with previous years, the catch of spiny dogfish was dominated by females (7.3 females to every 1 male). Sex ratios were about even for most other species (Figure 16).

3.7.3 Reproductive status

Gonad stages of hake, hoki, ling, and small numbers of other species are summarised in Table 10. Almost all hoki (98%) were either resting or immature. About 36% of male ling were ripe, but few females were showing signs of reproductive activity. Similarly 45% of male hake were ripe or running ripe, but most females were resting (36%) or maturing (42%) (Table 10).

3.8 Acoustic results

3.8.1 Description of acoustic mark types

A total of 257 acoustic data files (115 “trawl” files and 142 “steam” files) were recorded during the trawl survey. Good weather conditions for much of the voyage meant that the quality of acoustic recordings was generally good (87% of all echograms). Only 2% of the daytime trawl files were considered too poor to be analysed quantitatively. 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. Data were sub-divided into three depth ranges (200–400 m, 400–600 m, 600–1000 m) based on the maximum depth observed during the acoustic file.

Pelagic layers were the most common daytime mark type, occurring in 91% of day steam files and 83% of trawl files (Table 12). Midwater trawling on previous Chatham Rise surveys suggests that pelagic layers contain mesopelagic fish species, such as pearlsides (*Maurolicus australis*) and myctophids (McClatchie & Dunford 2003). 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 all dusk and night recordings and most day echograms. Pelagic schools were observed in 46% of day steam files, 39% of trawl files, and 2% of night files (Table 12). 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.

Bottom layers were observed in 77% of day steam files, 58% of day trawl files, and 24% of night files (Table 12). 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 14% of daytime (trawl and steam) recordings, and were most abundant in 200–400 m water depth (see Table 11). Bottom schools and layers 10–70 m off the bottom were sometimes associated with catches of 1+ and 2+ hoki, but also with other species such as barracouta and alfonsino (Stevens & O'Driscoll 2006, 2007).

The percent occurrence of acoustic mark types on the Chatham Rise in 2008 was generally similar to that observed in previous surveys (Table 12).

3.8.2 Fine-mesh midwater trawls

Five night trawls were carried out using a fine-mesh midwater trawl during the 2008 survey to provide information on vertically migrating mesopelagic fish for the FRST programme CO1X0501. All tows sampled surface layers from 50 to 65 m depth. Catches ranged from 1.7 to 12.6 kg total weight. Catches were not sorted at sea, but were frozen and preserved for later identification ashore. However, initial inspection showed catches were dominated by myctophids, with some squid, crustaceans, and other pelagic fish. This is consistent with the catch composition from tows on surface layers in previous years: in 2005, 10 trawls shallower than 200 m caught 59% myctophids, 26% salps, 7% crustaceans, and 3% squid (Stevens & O'Driscoll 2006); in 2006, 5 tows caught 83% myctophids, 3% squid, 3% crustaceans, 2% salps, and 6% other fish (Stevens & O'Driscoll 2007); in 2007, 3 tows caught mainly 47% myctophids and 37% other fish (Stevens et al. 2008).

3.8.3 Comparison of acoustics with bottom trawl catches

Acoustic data from 103 trawl files were integrated and compared with trawl catch rates. Data from the other 7 daytime trawl recordings were not included in the analysis because the acoustic data were too noisy (2 files) or because the associated trawl was not considered suitable for biomass estimation (5 files). Average acoustic backscatter from the bottom 10 m in 2008 was similar to that recorded in 2007, and lower than in the 5 previous years (Table 13). Although average acoustic backscatter close to the bottom was low, average trawl catch rates in 2008 were the highest in the series (Table 13), driven by the occurrence of several very large catches (4 tows with catch rates greater than 9000 kg km^{-2}). There was a very weak positive correlation between acoustic backscatter and trawl catch rates in 2008 (Figure 17). As in some previous years, trawl catch rates were more strongly correlated with total acoustic backscatter from the whole bottom-referenced layer (up to 100 m from the seabed) than with backscatter from the bottom 10 m only (Figure 17). This suggests that the trawl may be herding fish from more than 10 m above the bottom. In previous Chatham Rise surveys from 2001 to 2007, rank correlations between trawl catch rates and acoustic density estimates (from the entire bottom-referenced layer) ranged from 0.15 (in 2006) to 0.46 (in 2001).

The weak correlation between acoustic backscatter and trawl catch rates (Figure 17) 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. Ongoing research as part of the FRST project C01X0501 supports this hypothesis.

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. in press). This, combined with the diverse composition of demersal species present, means that it is unlikely that acoustics will provide an alternative biomass estimate for hoki on the Chatham Rise in the short term.

3.8.4 Timeseries of relative mesopelagic fish abundance

Most acoustic backscatter observed in 2008 was concentrated at 200–500 m depth during the day, and migrated into the surface 200 m at night (Figure 18). This was very similar to the pattern observed in 2001–07 (O'Driscoll et al. in press). This vertically migrating component was assumed to be dominated by mesopelagic fish (see McClatchie and Dunford (2003) for rationale and caveats). About 74% of the total night backscatter was in the top 14–200 m in 2008. The time series of mean acoustic backscatter in the surface 14–200 m at night showed a very similar pattern between surveys to total night backscatter (Figure 19). Day estimates of total acoustic backscatter over the Chatham Rise were consistently higher than night estimates (Figure 19) because of the movement of fish into the surface deadzone (shallower than 14 m) at night.

As noted above, mesopelagic schools and layers often occurred close to the bottom during the day. This meant that daytime estimates in the bottom 50 m were always higher than night estimates (Figure 19). The component of backscatter that remained within 50 m of the bottom at night was assumed to be from demersal fish and made up only 10% of the total night backscatter in 2008. There has been a declining trend in the amount of acoustic backscatter in the bottom 50 m during the day but not at night (Figure 19). One explanation for this observation may be that mesopelagic fish are not migrating as close to the bottom as they used to, but we can think of no biological reason for this.

The 'best' estimate of mesopelagic fish abundance was calculated by subtracting night estimates of the backscatter which remains deeper than 200 m (i.e., the bathypelagic and demersal components) from day estimates of total backscatter (Figure 20). This gives values which are an average of 40% higher than uncorrected night estimates of backscatter in the top 14–200 m (see Figure 19). Although values from 2007 and 2008 are the two lowest in the series, there has been no clear trend in mesopelagic fish biomass on the Chatham Rise over the last 8 years (Figure 20).

4. CONCLUSIONS

The 2008 survey successfully extended the January Chatham Rise time series into its seventeenth year and provided abundance indices for hoki, hake, and ling. The survey c.v. of 15.5% achieved for 2+ hoki was well within the target precision level of 20%. The estimated total biomass of hoki was 9% higher than in the previous survey, due to an increase in the biomass of 1+ hoki and recruited hoki (3+ years and older). The 2005 hoki year-class was average at age 2+. The biomass of hake in core strata decreased by 31% to 1257 t, and remains at historically low levels. The biomass of ling was similar to that in January 2007, and the trawl timeseries for ling shows no overall trend.

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Table 1: The number of completed valid biomass stations by stratum during the 2008 Chatham Rise trawl survey.

Stratum number	Depth range (m)	Location	Area (km^2)	Phase 1 stations	Phase 2 stations	Total stations	Station density (1: km^2)
1	600–800	NW Chatham Rise	2 439	3		3	1: 813
2A	600–800	NW Chatham Rise	3 253	3		3	1: 1 084
2B	600–800	NE Chatham Rise	8 503	6		6	1: 1 417
3	200–400	Matheson Bank	3 499	3		3	1: 1 166
4	600–800	SE Chatham Rise	11 315	3		3	1: 3 772
5	200–400	SE Chatham Rise	4 078	3		3	1: 1 359
6	600–800	SW Chatham Rise	8 266	3		3	1: 2 755
7	400–600	NW Chatham Rise	5 233	6		6	1: 872
8A	400–600	NW Chatham Rise	3 286	3		3	1: 1 095
8B	400–600	NW Chatham Rise	5 722	3	2	5	1: 1 144
9	200–400	NE Chatham Rise	5 136	3		3	1: 1 712
10A	400–600	NE Chatham Rise	2 958	3		3	1: 986
10B	400–600	NE Chatham Rise	3 363	3		3	1: 1121
11A	400–600	NE Chatham Rise	2 966	5		5	1: 593
11B	400–600	NE Chatham Rise	2 072	3		3	1: 691
11C	400–600	NE Chatham Rise	3 342	3		3	1: 1 114
11D	400–600	NE Chatham Rise	3 368	3		3	1: 1 123
12	400–600	SE Chatham Rise	6 578	3		3	1: 2 193
13	400–600	SE Chatham Rise	6 681	3		3	1:2 227
14	400–600	SW Chatham Rise	5 928	3	2	5	1: 1 186
15	400–600	SW Chatham Rise	5 842	3		3	1: 1 947
16	400–600	SW Chatham Rise	11 522	6		6	1: 1 920
17	200–400	Veryan Bank	865	3	2	5	1: 173
18	200–400	Mernoo Bank	4 687	4		4	1: 172
19	200–400	Reserve Bank	9 012	6		6	1: 1 502
20	200–400	Reserve Bank	9 584	5		5	1: 1 197
22	800–1000	NW Chatham Rise	7 357	4		4	1: 1 839
Total			146 855	99	6	105	1: 1 399

Table 2: Survey dates and number of valid 200–800 m depth biomass stations in surveys of the Chatham Rise, January 1992–2008

Trip_code	Start date	End date	No. of valid 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

Table 3: Tow and gear parameters by depth range for valid biomass stations (TAN0801). Values shown are sample size (n), and for each parameter the mean, standard deviation (s.d.), and range

	n	Mean (m)	s.d.	Range
Tow parameters				
Tow length (n. miles)	105	3.0	0.09	2.5–3.0
Tow speed (knots)	105	3.5	0.04	3.3–3.6
Gear parameters				
200–400 m				
Headline height	29	6.9	0.17	6.8–7.3
Doorspread	29	107.6	6.60	95.1–123.8
400–600 m				
Headline height	54	6.7	0.12	6.4–7.0
Doorspread	54	117.2	3.42	108.2–124.1
600–800 m				
Headline height	18	6.8	0.14	6.6–7.1
Doorspread	18	117.4	4.35	108.6–122.2
800–1000 m				
Headline height	4	6.9	0.08	6.8–7.0
Doorspread	4	119.3	1.65	117.1–120.9
All stations 200–1000 m				
Headline height	105	6.8	0.16	6.4–7.3
Doorspread	105	114.7	6.33	95.1–124.1

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 with c.v. s for stratum 22 (800–1000m depths). Total biomass includes unsexed fish. (-, no data.)**

			Core strata 200-800m						Stratum 22	
Common name	Code	Catch	Biomass males		Biomass females		Total biomass		Total biomass	
		kg	t	% c.v.	t	% c.v.	t	% c.v.	t	% c.v.
QMS species										
Hoki	HOK	56 349	34 980	13.1	41 828	10.3	76 859	11.4	663	32
Alfonsino	BYS	12 309	14 465	91.2	11 560	91.3	26 027	91.2	-	
Spiny dogfish	SPD	6 816	1 154	40.8	14 511	41.0	15 674	38.3	-	
Silver warehou	SWA	8 958	7 414	36.0	8 132	37.1	15 546	36.4	-	
Dark ghost shark	GSH	5 861	3 951	11.4	5 430	11.0	9 391	10.9	-	
Barracouta	BAR	3 434	4 664	24.8	3 796	26.4	8 470	22.1	-	
Ling	LIN	3 405	3 497	9.3	4 002	7.9	7 504	6.7	130	82
Black oreo	BOE	1 475	3 075	15.5	3 711	22.2	6 787	19.1	-	
Lookdown dory	LDO	2 582	1 774	11.3	3 447	10.0	5 225	9.3	6	64
Giant stargazer	STA	2 190	1 318	30.8	3 327	46.3	4 677	39.4	-	
Red cod	RCO	1 569	2 115	87.7	1 189	69.8	3 305	80.9	-	
Pale ghost shark	GSP	1 306	1 516	6.8	1 701	9.2	3 220	6.1	16	47
Sea perch	SPE	1 402	1 622	15.2	1 501	15.0	3 170	14.3	5	100
Spiky oreo	SOR	945	1 039	47.9	988	38.3	2 028	42.9	29	96
White warehou	WWA	1 950	945	30.4	921	28.0	1 899	28.3	-	
Arrow squid	NOS	1 592	641	41.9	766	41.1	1 444	40.6	-	
Smooth skate	SSK	620	350	40.0	1 026	31.4	1 376	26.2	-	
Hake	HAK	713	269	18.3	988	14.3	1 257	12.9	66	51
Slender mackerel	JMM	274	239	49.8	364	57.0	603	54.0	-	
Tarakihi	TAR	176	350	33.6	133	22.3	483	25.7	-	
Ribaldo	RIB	212	141	19.3	247	18.8	388	15.8	91	33
School shark	SCH	125	78	37.5	155	45.0	283	23.4	-	
Hapuku	HAP	92	143	29.0	88	22.1	231	20.9	-	
Southern Ray's bream /Ray's bream	SRB/ RBM	81	84	50.4	67	48.4	152	47.4	-	
Smooth oreo	SSO	21	39	46.6	17	29.8	56	32.5	20	52
Red gurnard	GUR	15	24	100	10	100	37	100	-	
Lemon sole	LSO	16	15	44.3	8	46.1	32	33.0	-	
Deepsea cardinalfish	EPT	14	11	39.1	17	54.4	29	38.6	-	
Trumpeter	TRU	8	0		23	100	23	100	-	
Bluenose	BNS	9	0		15	70.7	15	70.7	-	
Orange roughy	ORH	182	3	74.9	8	75.3	11	71.1	483	60
Jack mackerel	JMD	4	8	63.7	2	100	10	52.9	-	
Blue mackerel	EMA	4	3	100	6	100	9	100	-	
Scampi	SCI	3	4	34.4	3	45.8	7	28.4	-	
Frostfish	FRO	1	2	100	0		2	100	-	
Rubyfish	RBY	1	0		0		2	50.2	-	
Longfinned beryx	BYD	0.3	0		0		0.4	70.8	-	

(continued over)

Table 4 (continued)

Common name	Code	Catch	Core strata 200-800m						Stratum 22	
			Biomass males		Biomass females		Total biomass		Total biomass	
		kg	t	% c.v.	t	% c.v.	t	% c.v.	t	% c.v.
Commercial non-QMS species (where biomass > 30 t)										
Shovelnose dogfish	SND	1 783	1 462	12.9	1 353	12.1	2 816	6.9	831	62
Redbait	RBT	32	4	100	2	100	73	57.6	-	
Non-commercial species (where biomass > 800 t)										
Javelinfish	JAV	3 969	-	-	-	-	8 381	19.6	691	98
Big-eye rattail	CBO	3 196	-	-	-	-	7 020	10.2	2	64
Oliver's rattail	COL	550	-	-	-	-	1 520	18.0	56	99
Banded bellowsfish	BBE	649	-	-	-	-	1 107	14.1	-	-
Oblique-banded rattail	CAS	607	-	-	-	-	824	16.4	-	-
Total (above)		128 500								
Grand total (all species)		137 116								

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 1992–2008. stns, stations (-, no data; c.v., coefficient of variation.)

		Core strata 200–800 m				800–1000 m			
Year	Survey	No. stns	Hoki	Hake	Ling	No. stns	Hoki	Hake	Ling
1992	TAN9106	184	120 190	4 180	8 930	0	-	-	-
	c.v.		7.7	14.9	5.8				
1993	TAN9212	194	185 570	2 950	9 360	0	-	-	-
	c.v.		10.3	17.2	7.9				
1994	TAN9401	165	145 633	3 353	10 129	0	-	-	-
	c.v.		9.8	9.6	6.5				
1995	TAN9501	122	120 441	3 303	7 363	0	-	-	-
	c.v.		7.6	22.7	7.9				
1996	TAN9601	89	152 813	2 457	8 424	0	-	-	-
	c.v.		9.8	13.3	8.2				
1997	TAN9701	103	157 974	2 811	8 543	0	-	-	-
	c.v.		8.4	16.7	9.8				
1998	TAN9801	91	86 678	2 873	7 313	0	-	-	-
	c.v.		10.9	18.4	8.3				
1999	TAN9901	100	109 336	2 302	10 309	0	-	-	-
	c.v.		11.6	11.8	16.1				
2000	TAN0001	128	72 151	2 152	8 348	4	411	62	18
	c.v.		12.3	9.2	7.8		56	64	100
2001	TAN0101	119	60 330	1 589	9 352	0	-	-	-
	c.v.		9.7	12.7	7.5				
2002	TAN0201	107	74 351	1 567	9 442	3	1 955	338	0
	c.v.		11.4	15.3	7.8		39	23	
2003	TAN0301	115	52 531	888	7 261	0	-	-	-
	c.v.		11.6	15.5	9.9				
2004	TAN0401	110	52 687	1 547	8 248	0	-	-	-
	c.v.		12.6	17.1	7.0				
2005	TAN0501	106	84 594	1 048	8 929	0	-	-	-
	c.v.		11.5	18.0	9.4				
2006	TAN0601	96	99 208	1 384	9 301	0	-	-	-
	c.v.		10.6	19.3	7.4				
2007	TAN0701	101	70 479	1 824	7 907	5	542	152	49
	c.v.		8.4	12.2	7.2		52	56	53
2008	TAN0801	101	76 859	1 257	7 504	4	663	66	130
	c.v.		11.4	12.9	6.7		32	51	82

Table 6: Relative biomass estimates (t in thousands) of hoki, 200–800 m depths, Chatham Rise trawl surveys January 1992–2008 (c.v. coefficient of variation; 3++ all hoki aged 3 years and older; (see Appendix 3 for length ranges of age classes.)

		1+ hoki			2+ hoki		3 ++ hoki		Total hoki	
Survey	1+ year class	t	% c.v	2+ year class	t	% c.v	t	% c.v	t	% c.v
1992	1990	2.8	(27.9)	1989	1.2	(18.1)	116.1	(7.8)	120.2	(9.7)
1993	1991	32.9	(33.4)	1990	2.6	(25.1)	150.1	(8.9)	185.6	(10.3)
1994	1992	14.6	(20.0)	1991	44.7	(18.0)	86.2	(9.0)	145.6	(9.8)
1995	1993	6.6	(13.0)	1992	44.9	(11.0)	69.0	(9.0)	120.4	(7.6)
1996	1994	27.6	(24.0)	1993	15.0	(13.0)	106.6	(10.0)	152.8	(9.8)
1997	1995	3.2	(40.0)	1994	62.7	(12.0)	92.1	(8.0)	158.0	(8.4)
1998	1996	4.5	(33.0)	1995	6.9	(18.0)	75.6	(11.0)	86.7	(10.9)
1999	1997	25.6	(30.4)	1996	16.5	(18.9)	67.0	(9.9)	109.3	(11.6)
2000	1998	14.4	(32.4)	1997	28.2	(20.7)	29.5	(9.3)	71.7	(12.3)
2001	1999	0.4	(74.6)	1998	24.2	(17.8)	35.7	(9.2)	60.3	(9.7)
2002	2000	22.4	(25.9)	1999	1.2	(21.2)	50.7	(12.3)	74.4	(11.4)
2003	2001	0.5	(46.0)	2000	27.2	(15.1)	20.4	(9.3)	52.6	(8.7)
2004	2002	14.4	(32.5)	2001	5.5	(20.4)	32.8	(12.9)	52.7	(12.6)
2005	2003	17.5	(23.4)	2002	45.8	(16.3)	21.2	(11.4)	84.6	(11.5)
2006	2004	25.9	(21.5)	2003	33.6	(18.8)	39.7	(10.3)	99.2	(10.6)
2007	2005	9.1	(27.5)	2004	32.6	(12.8)	28.8	(8.9)	70.5	(8.4)
2008	2006	15.6	(31.6)	2005	23.8	(15.5)	37.5	(7.8)	76.9	(11.4)

Table 7: Estimated biomass (t) and coefficient of variation (% c.v.) of hoki, hake, ling, and 8 other key species by stratum (See Table 3 for species common names.) (-, not calculated.)

	Species code																					
	HOK		SPD		SWA		GSH		LIN		LDO		STA		GSP		SPE		WWA		HAK	
Stratum	t	c.v.	t	c.v.	t	c.v.	t	c.v.	t	c.v.	t	c.v.	t	c.v.	t	c.v.	t	c.v.	t	c.v.	t	c.v.
1	689	32	0	-	0	-	0		103	66	19	72	0		119	46	1	100	40	100	27	27
2a	575	38	0	-	0	-	0		66	67	26	9	9	100	50	30	15	19	0		25	88
2b	947	25	0	-	0	-	0		277	26	105	19	19	100	64	36	48	18	0		61	62
3	1 878	39	377	29	96	42	804	16	194	22	249	19	22	100	0		55	37	186	87	43	78
4	2 639	56	65	51	117	59	0		552	31	55	48	17	100	296	11	53	48	12	100	31	100
5	931	18	10 393	58	2 237	51	1 878	33	155	65	82	100	1 100	17	0		34	55	0		0	
6	1 370	29	0	-	57	100	0		316	36	16	73	0		498	9	7	100	33	68	87	19
7	6 555	31	40	42	50	69	10	94	510	25	74	29	22	56	195	26	68	42	45	93	145	53
8a	3 061	17	72	51	0	-	97	77	223	22	58	41	0		22	62	160	23	4	100	40	33
8b	4 018	17	27	50	0	-	61	44	365	33	418	19	0		144	37	323	34	24	100	45	52
9	685	28	595	40	1 472	88	762	28	47	36	225	58	680	30	0		0		13	100	0	
10a	1 612	32	82	56	36	58	294	57	169	15	257	62	0		57	42	69	44	57	100	39	41
10b	1 248	15	0	-	3	100	0		60	26	32	21	0		28	41	33	25	53	100	55	35
11a	3 080	43	269	46	4 214	41	400	52	102	19	365	58	7	81	46	49	27	43	131	65	149	42
11b	434	9	3	100	0	-	2	63	73	79	18	21	0		15	59	18	9	2	100	12	66
11c	713	24	67	90	0	-	45	100	86	39	125	56	23	52	10	51	28	34	44	73	15	100
11d	756	30	0	-	0	-	11	100	137	61	94	45	10	100	14	24	51	16	27	66	51	50
12	1 826	30	120	96	10	100	7	100	324	41	228	32	118	74	87	79	36	38	37	100	21	51
13	3 531	14	325	36	86	100	75	65	811	4	339	46	20	70	472	11	334	75	92	65	58	83
14	4 187	44	182	38	32	32	9	72	235	13	339	38	21	46	363	19	185	41	20	77	29	72
15	8 278	39	116	20	190	49	17	100	842	16	470	18	37	74	285	21	234	14	213	79	83	80
16	4 090	21	86	41	578	43	41	100	810	24	328	50	138	62	379	22	101	59	86	35	134	25
17	6 510	65	121	35	118	41	554	43	57	44	40	6	87	19	0		7	35	345	94	0	
18	6 539	36	1 623	22	886	38	1 132	10	139	85	126	86	2 121	86	0		47	90	100	100	7	100
19	4 415	37	570	15	5 339	95	1 996	20	275	79	141	76	216	28	0		756	36	25	70	25	100
20	6 291	21	540	46	27	50	1 194	44	578	14	997	16	10	42	74	64	481	41	311	98	74	33
22	663	32	0	-	0		0	-	130	82	6	64	0		16	47	5	100	0		66	51
Total	76 859	11	15 674	38	15 546	36	9 391	11	7 504	7	5 225	9	4 677	39	3 220	6	3 170	14	1 899	28	1 257	13

Table 8: Total numbers of fish, squid, and scampi measured for length frequency distributions and biological samples from all stations (TAN0801). The number of stomachs collected is also provided.

Species	Number measured Males	Number measured Females	Number measured Total	Number of biological samples
Alfonsino	588	456	1 044	298
Banded bellowsfish	1	7	1 868	351
Banded rattail	5	16	165	40
Barracouta	219	154	374	101
Baxter's dogfish	112	87	199	141
Bigeye rattail	1 265	859	2 466	920
Black oreo	418	447	865	190
Blue mackerel	1	2	3	0
Bluenose	0	2	2	2
Catshark	0	1	1	1
Dark ghost shark	1 286	1 405	2 697	1 284
Deepsea cardinalfish	18	13	32	32
Four-rayed rattail	91	93	411	39
Frill shark	0	0	1	1
Frostfish	1	0	1	1
Giant stargazer	248	269	520	387
Hake	66	99	165	165
Hapuku	15	10	25	21
Hoki	8 130	9 384	17 527	2 036
Jack mackerel (*T. declivis*)	4	1	5	4
Javelinfish	300	2 075	5 869	1 408
Johnson's cod	13	10	23	16
Leafscale gulper shark	13	32	45	45
Lemon sole	15	7	22	19
Ling	640	633	1 275	1 155
Long-finned Beryx	0	0	1	1
Longnose velvet dogfish	246	229	475	238
Long-nosed chimaera	111	106	217	207
Lookdown dory	1 551	1 525	3 080	1 896
Lucifer dogfish	120	110	237	215
Mahia rattail	24	22	46	45
Mirror dory	0	1	1	1
Northern spiny dogfish	2	0	2	2
Notable rattail	0	0	5	0
NZ southern arrow squid	421	515	952	8
Oblique banded rattail	55	283	878	155
Oliver's rattail	72	62	1 903	556
Orange perch	34	40	74	56
Orange roughy	103	120	237	69
Pale ghost shark	396	384	781	742
Plunket's shark	8	8	16	16
Prickly dogfish	2	1	3	3
Ray's bream	29	30	59	45
Red cod	221	152	374	207
Red gurnard	11	4	16	0
Red squid	0	0	1	0
Redbait	2	1	3	3
Ribaldo	67	58	125	122

Table 8 (continued)

Species	Number measured Males	Number measured Females	Number measured Total	Number of biological samples
Scampi	12	11	25	25
School shark	3	4	8	8
Sea perch	1 131	1 177	2 494	1 198
Seal shark	29	27	56	56
Serrulate rattail	0	0	13	0
Shovelnose dogfish	478	295	773	588
Silver warehou	883	960	1 843	796
Silverside	0	0	109	16
Sixgill shark	1	0	1	1
Slender mackerel (*T. s. murphyi*)	65	107	172	63
Smooth oreo	22	15	37	20
Smooth skate	15	25	40	40
Smoothskin dogfish	80	38	118	92
Southern blue whiting	17	8	25	1
Spiky oreo	451	435	897	451
Spiny dogfish	178	1 196	1 376	857
Tarakihi	108	36	144	98
Trumpeter	0	2	2	2
Two saddle rattail	52	113	213	84
White cardinalfish	0	0	20	0
White rattail	58	30	90	89
White warehou	302	236	558	416
Wide-nosed chimaera	13	7	20	20
Yellow cod	0	1	1	1
Total			54 126	18 166

Table 9: Length-weight regression parameters* used to scale length frequencies (all data from TAN0801).

Species	*a* (intercept)	*b* (slope)	r^2	*n*	Length range (cm)
Dark ghost shark	0.003375	3.135088	0.97	1 281	27–76
Giant stargazer	0.007364	3.188933	0.97	382	25–81
Hake	0.002003	3.286460	0.98	165	40–124
Hoki	0.003118	2.988453	0.99	2 034	35–112
Ling	0.001426	3.262332	0.99	1 142	28–163
Lookdown dory	0.026328	2.942791	0.98	1 857	11–54
Pale ghost shark	0.009859	2.870385	0.97	732	29–87
Sea perch	0.009542	3.130979	0.98	1 178	12–48
Silver warehou	0.014389	3.067159	0.98	794	25–55
Spiny dogfish	0.000986	3.341876	0.96	851	55–105
White warehou	0.035596	2.864950	0.98	416	24–60

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

Table 10: Numbers of fish measured at each reproductive stage*

		Reproductive stage							
Common name	Sex	1	2	3	4	5	6	7	Total
Barracouta	Male	0	0	3	11	1	0	0	15
	Female	0	0	5	2	0	1	0	8
Hake	Male	10	20	5	6	19	4	2	66
	Female	12	36	42	1	0	0	8	99
Hoki	Male	402	419	1	0	1	3	1	827
	Female	480	707	0	1	5	2	10	1 205
Ling	Male	135	182	79	103	5	3	1	508
	Female	152	343	6	2	0	0	0	503
Sea Perch	Male	0	0	5	0	0	0	0	5
	Female	0	0	0	8	0	0	0	8
White rattail	Male	1	3	0	0	0	0	0	4
	Female	2	3	1	0	0	0	0	6

*Stage: 1, immature; 2, resting; 3, ripening; 4, ripe; 5, running ripe; 6, partially spent; 7, spent. (after Hurst et al. 1992).

Table 11: Percent occurrence of seven major acoustic mark types (see text for definitions) by depth range during the 2008 Chatham Rise trawl survey. Several mark types were usually present in the same echogram. *n* is the number of acoustic files examined. Table does not include 19 acoustic recordings

				Pelagic marks			Bottom marks		
Acoustic file	Max. depth (m)	*n*	Surface Layer	School	Layer	Cloud	Layer	Cloud	School
Day trawl	200–400	29	76	21	90	31	41	28	31
	400–600	59	61	46	86	56	75	41	2
	600–1000	22	50	45	64	91	36	59	0
Day steam	200–400	19	68	11	84	37	58	5	58
	400–600	46	72	59	98	39	93	28	9
	600–1000	17	53	53	82	82	53	53	6
Dusk steam	200–400	6	100	0	17	67	0	50	17
	400–600	8	100	25	75	38	25	75	0
	600–1000	5	100	20	40	100	20	60	0
Night (steam & trawl)	200–400	10	100	10	30	80	0	80	10
	400–600	21	100	0	24	81	33	90	0
	600–1000	15	100	0	7	87	27	87	0

Table 12: Percent occurrence of mark types during the 2008 Chatham Rise trawl survey compared to results from previous surveys (Stevens et al. 2008).

				Pelagic marks			Bottom marks		
Acoustic file	Survey	*n*	Surface Layer	School	Layer	Cloud	Layer	Cloud	School
Day trawl	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	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 & trawl)	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 13. Average trawl catch (excluding benthic organisms) and acoustic backscatter from daytime tows where acoustic data quality was suitable for echo integration on the Chatham Rise in 2001–08.

			Average acoustic backscatter (m^2 km^{-2})			
	No. of recordings	Average trawl catch (kg km^{-2})	Bottom 10 m	Bottom 50 m	All bottom marks (to 100 m)	Entire echogram
2001 (TAN0101)	117	1 858	3.43	21.12	30.00	54.34
2002 (TAN0201)	105	1 844	4.25	17.35	21.32	46.53
2003 (TAN0301)	117	1 508	3.23	18.46	27.75	50.21
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

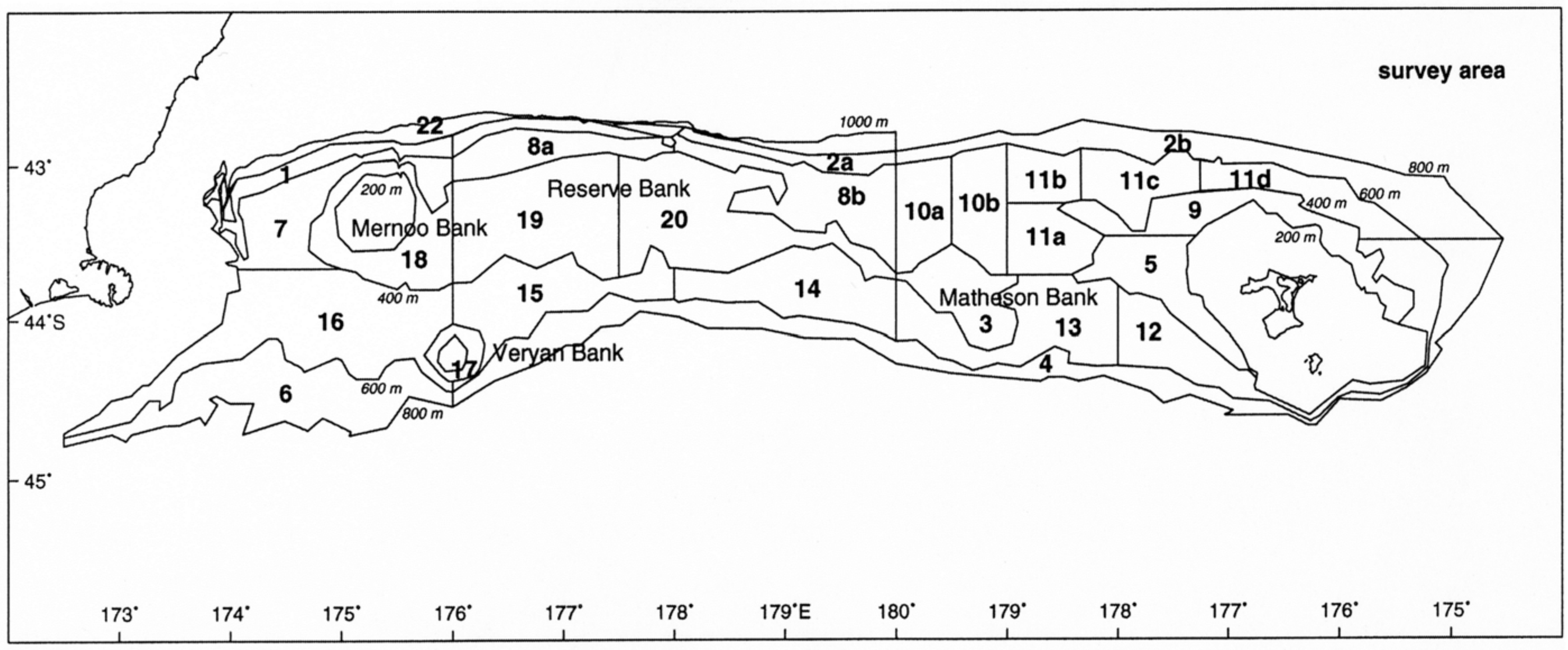


Figure 1: Trawl survey area showing stratum boundaries for TAN0801.

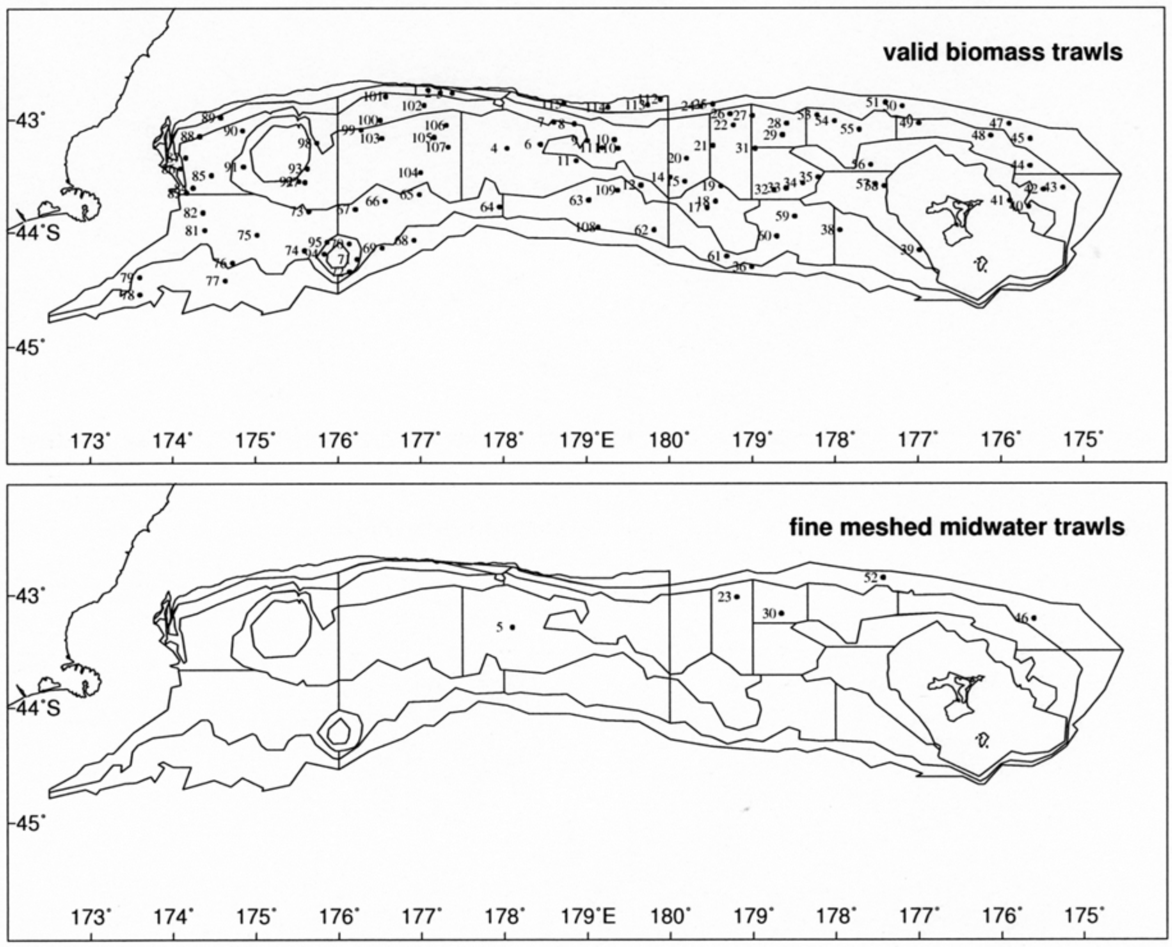


Figure 2: Trawl survey area showing positions of valid biomass stations (n = 105 – including 4 stations in stratum 22) and successful fine-meshed midwater trawls (n = 5) for TAN0801.

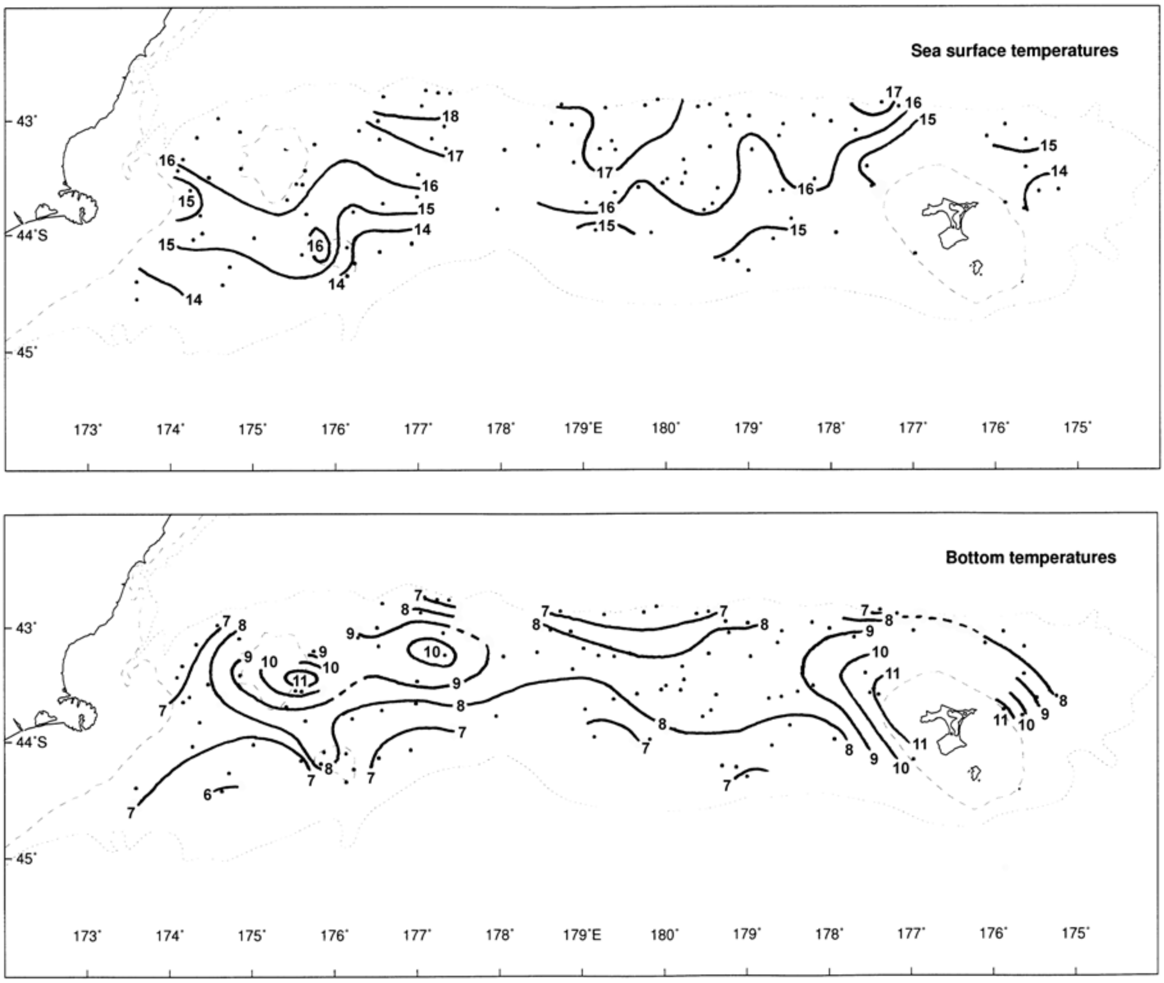
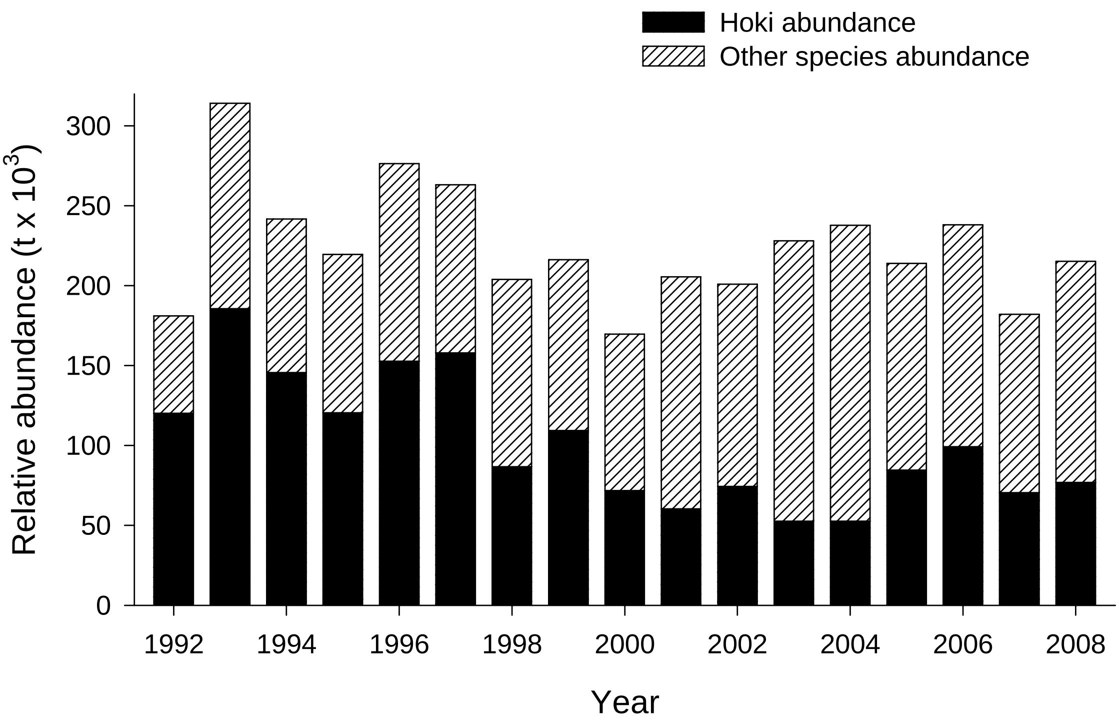


Figure 3: Positions of sea surface and bottom temperature recordings and approximate location of isotherms (°C) interpolated by eye. The temperatures shown are from the calibrated Seabird CTD recordings made during each tow



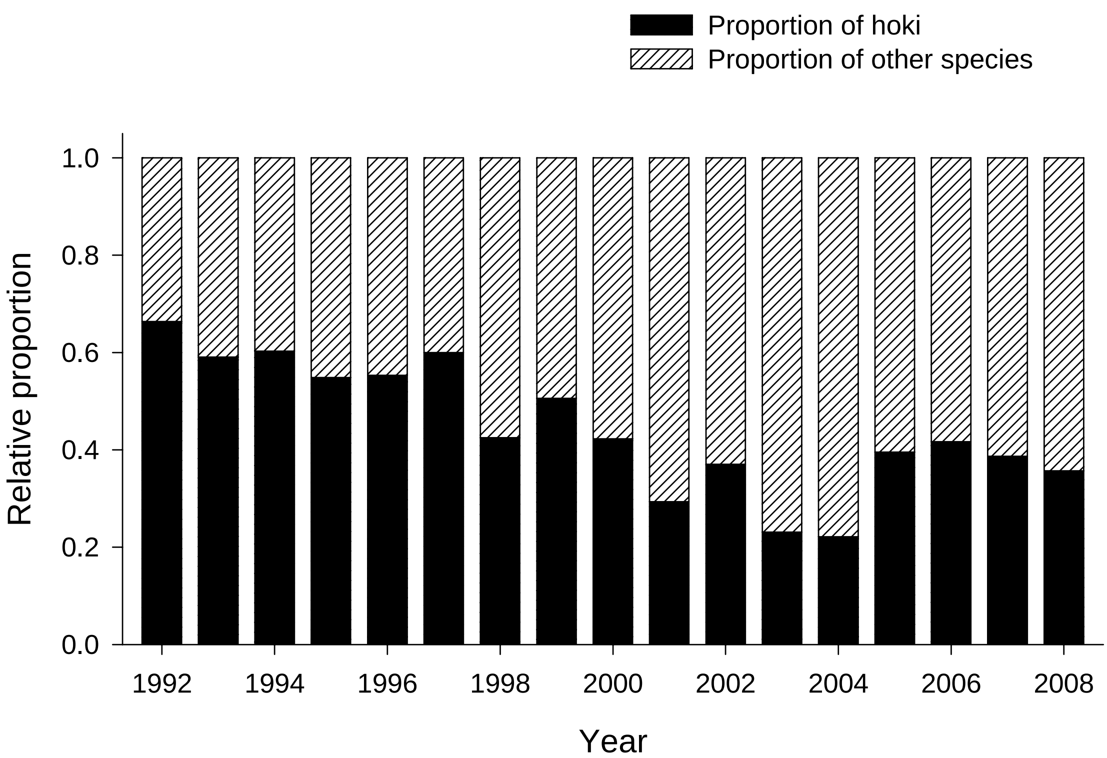


Figure 4: Relative biomass (top panel) and relative proportions of hoki and 30 other key species (lower panel) from trawl surveys of the Chatham Rise, January 1992–2008

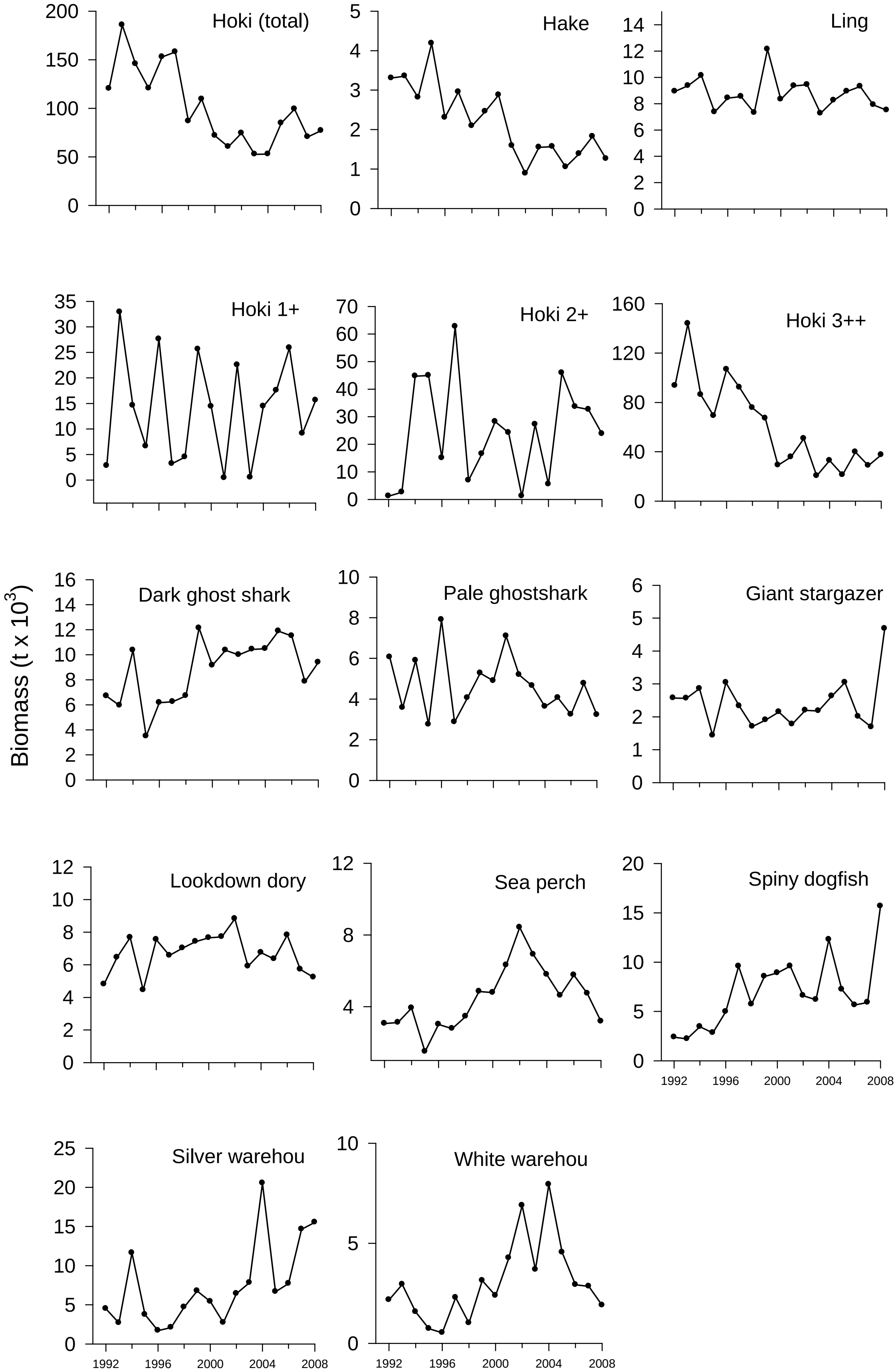


Figure 5: Relative biomass estimates (t x 10^3) of important species sampled by annual trawl surveys of the Chatham Rise, January 1992–2008

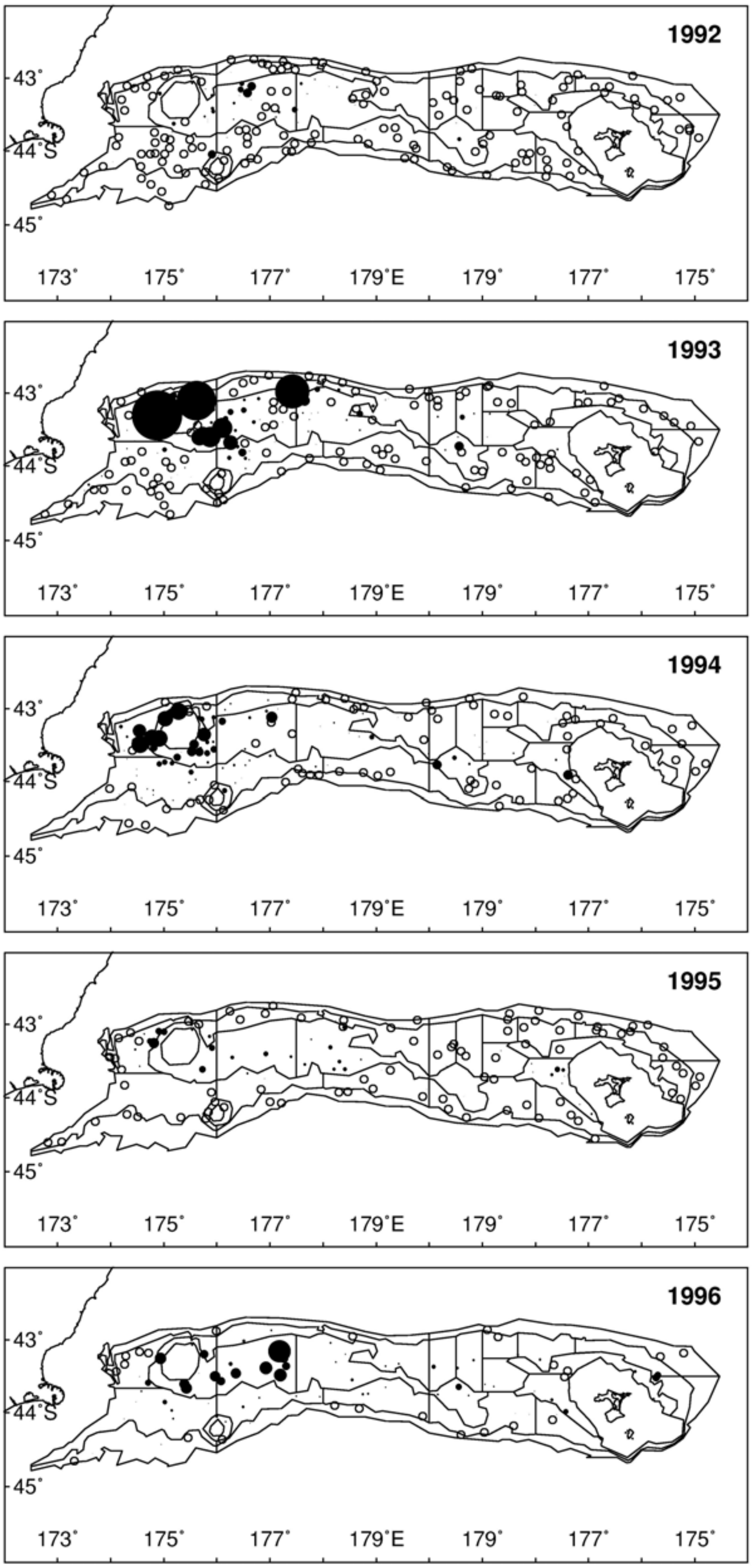


Figure 6a: Hoki 1+ catch distribution 1992–2008. Filled circle area is proportional to catch rate (kg.km^{-2}). Open circles are zero catch. Maximum catch rate in series is 30 850 kg.km^{-2}

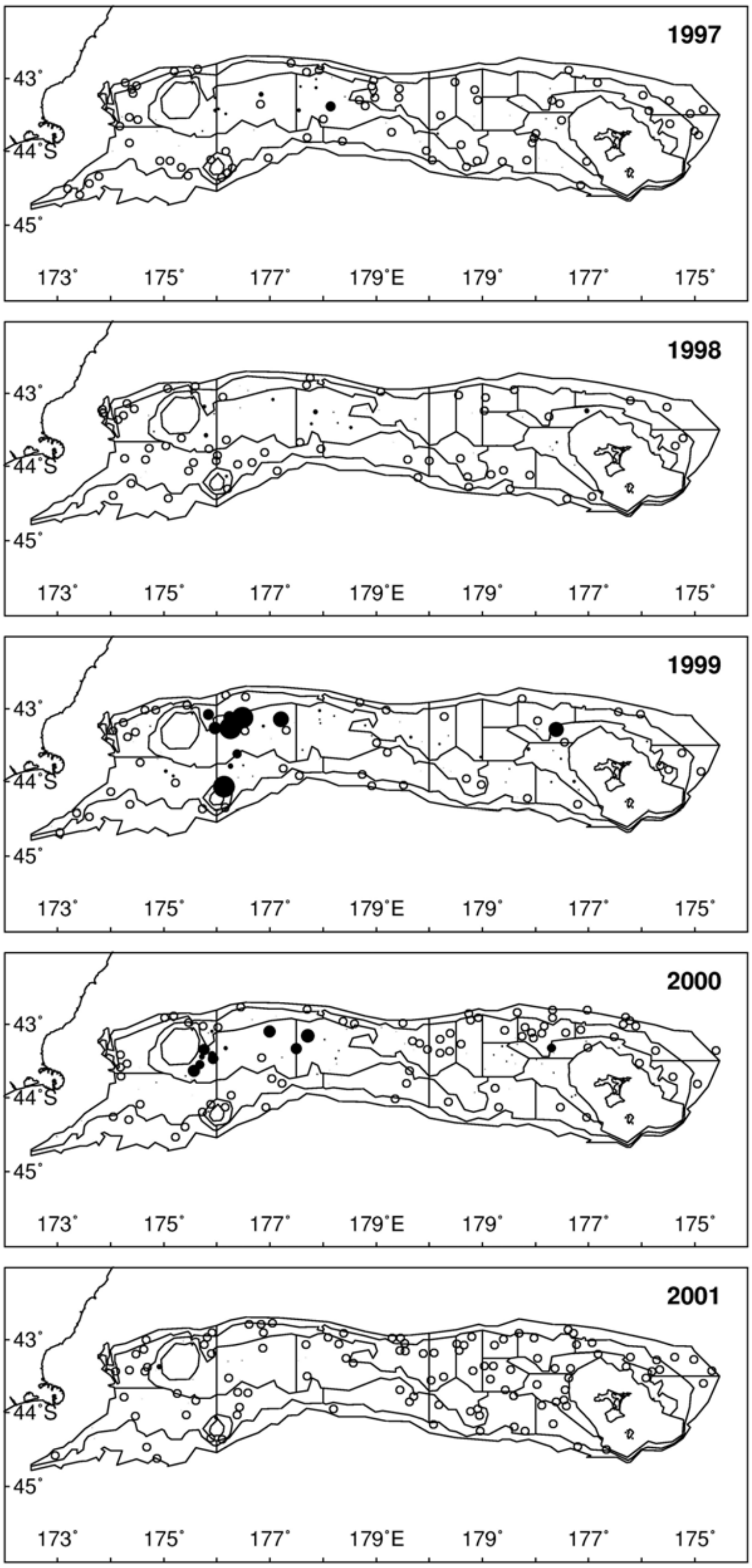


Figure 6a (continued)

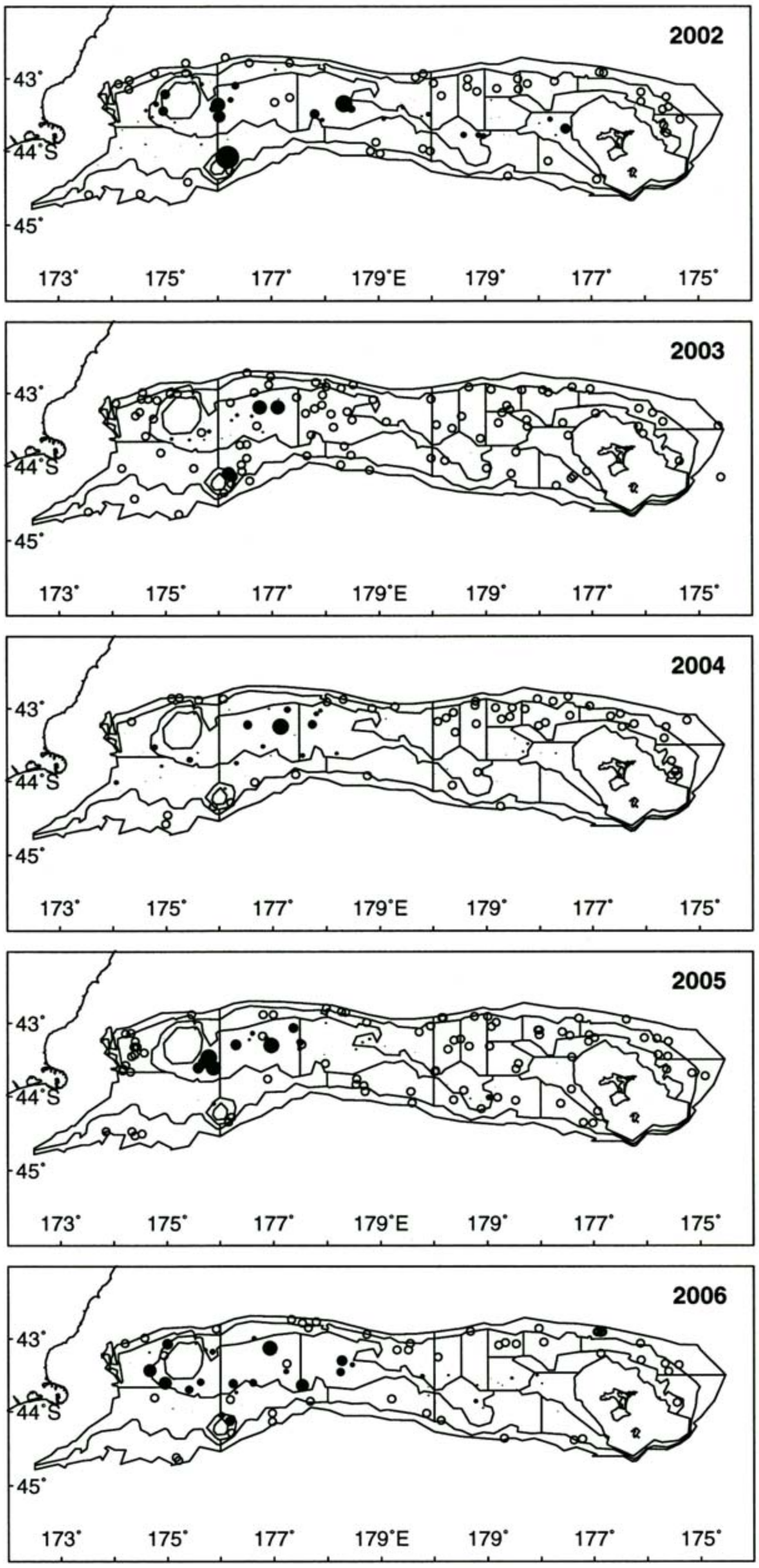


Figure 6a (continued)

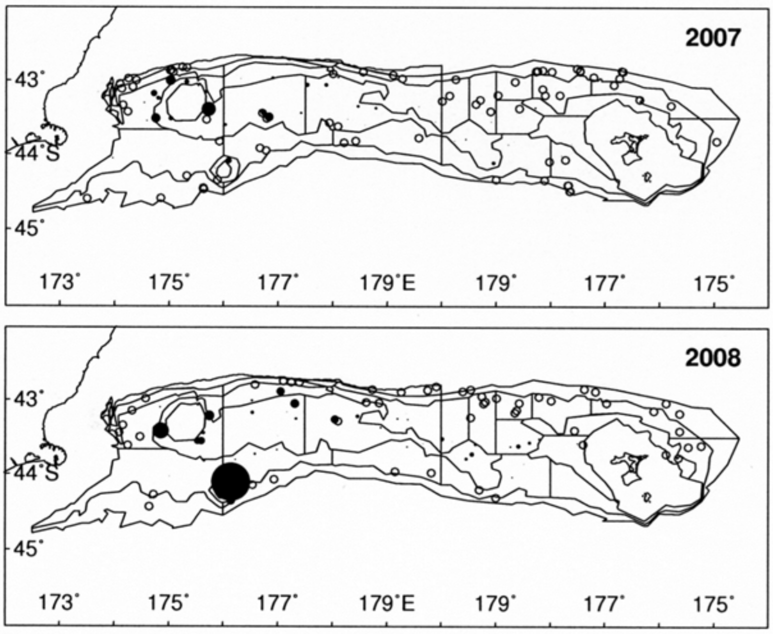


Figure 6a (continued)

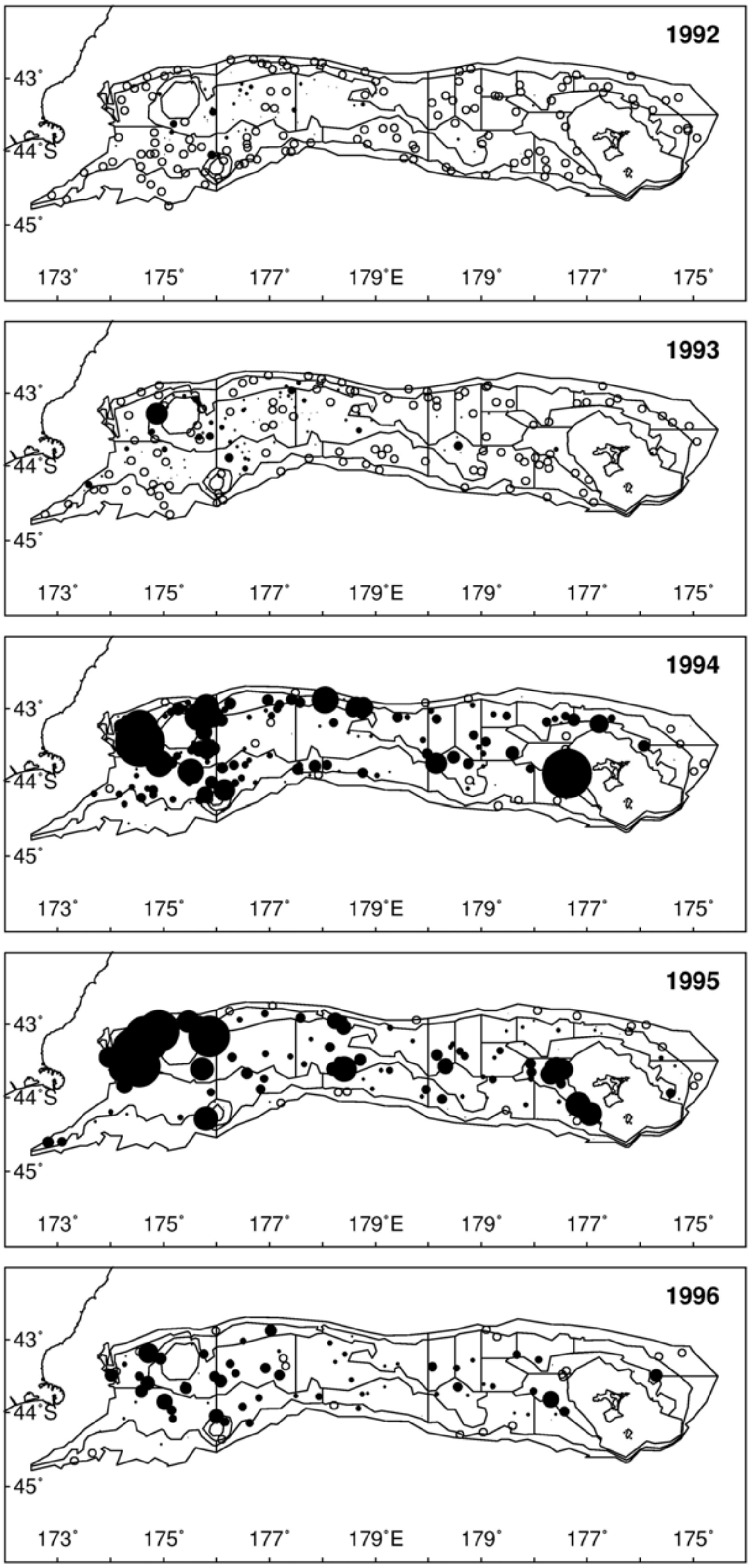


Figure 6b: Hoki 2+ catch distribution 1992–2008. Filled circle area is proportional to catch rate ($kg.km^{-2}$). Open circles are zero catch. Maximum catch rate in series is 6791 $kg.km^{-2}$

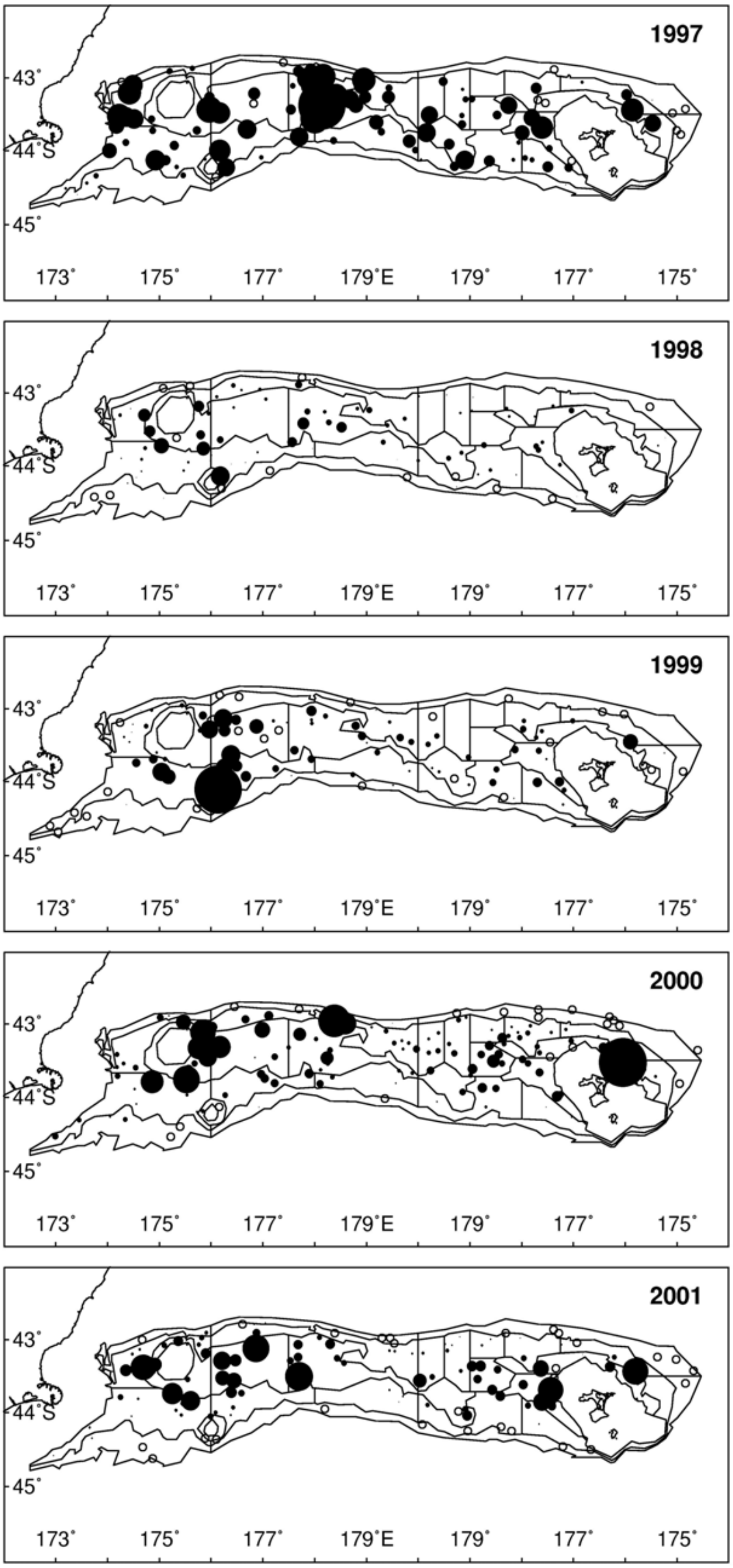


Figure 6b (continued)

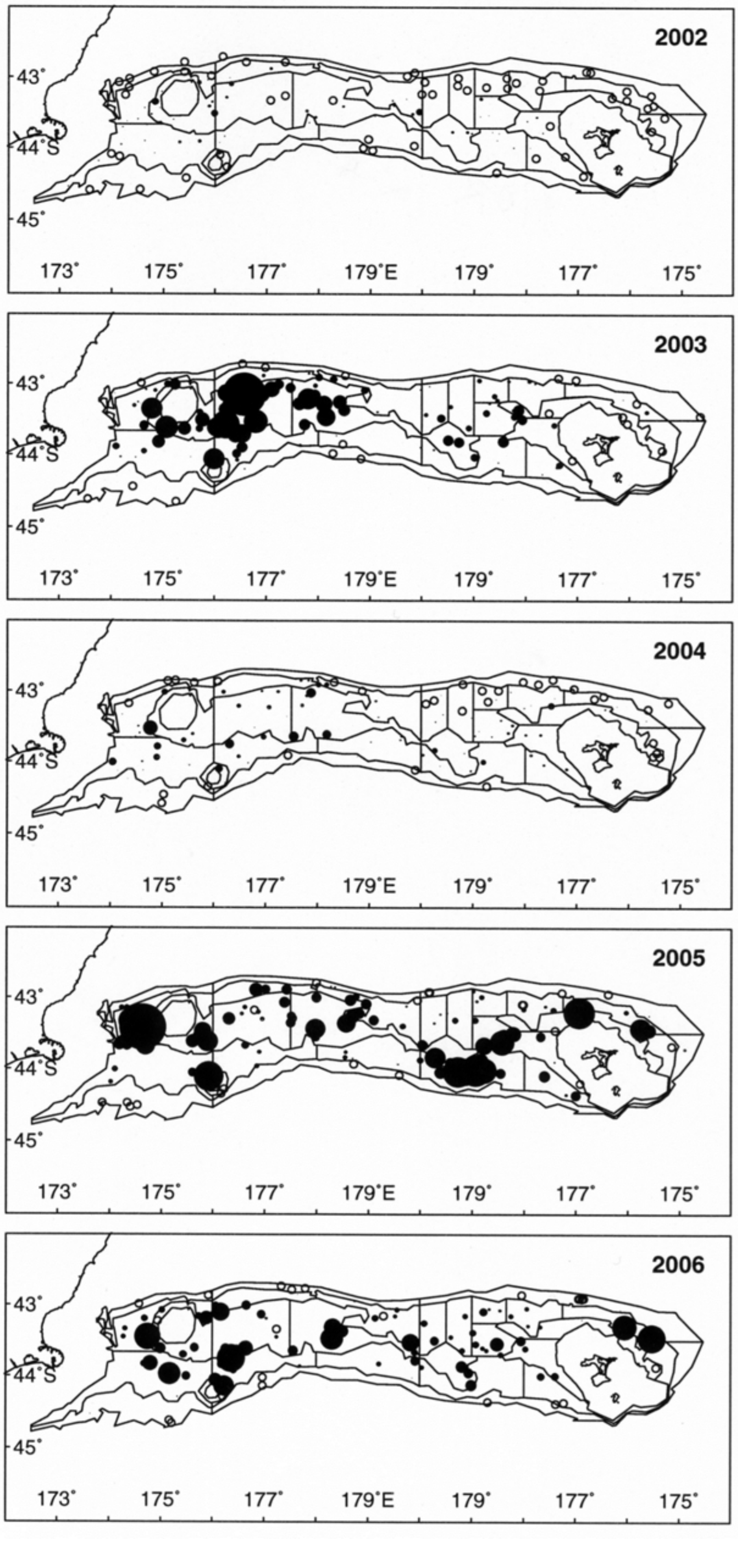


Figure 6b (continued)

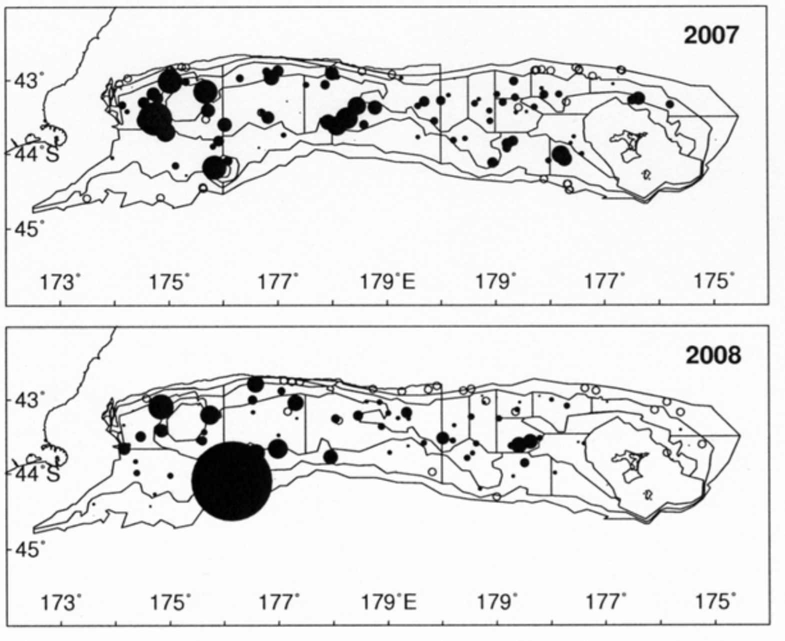


Figure 6b (continued)

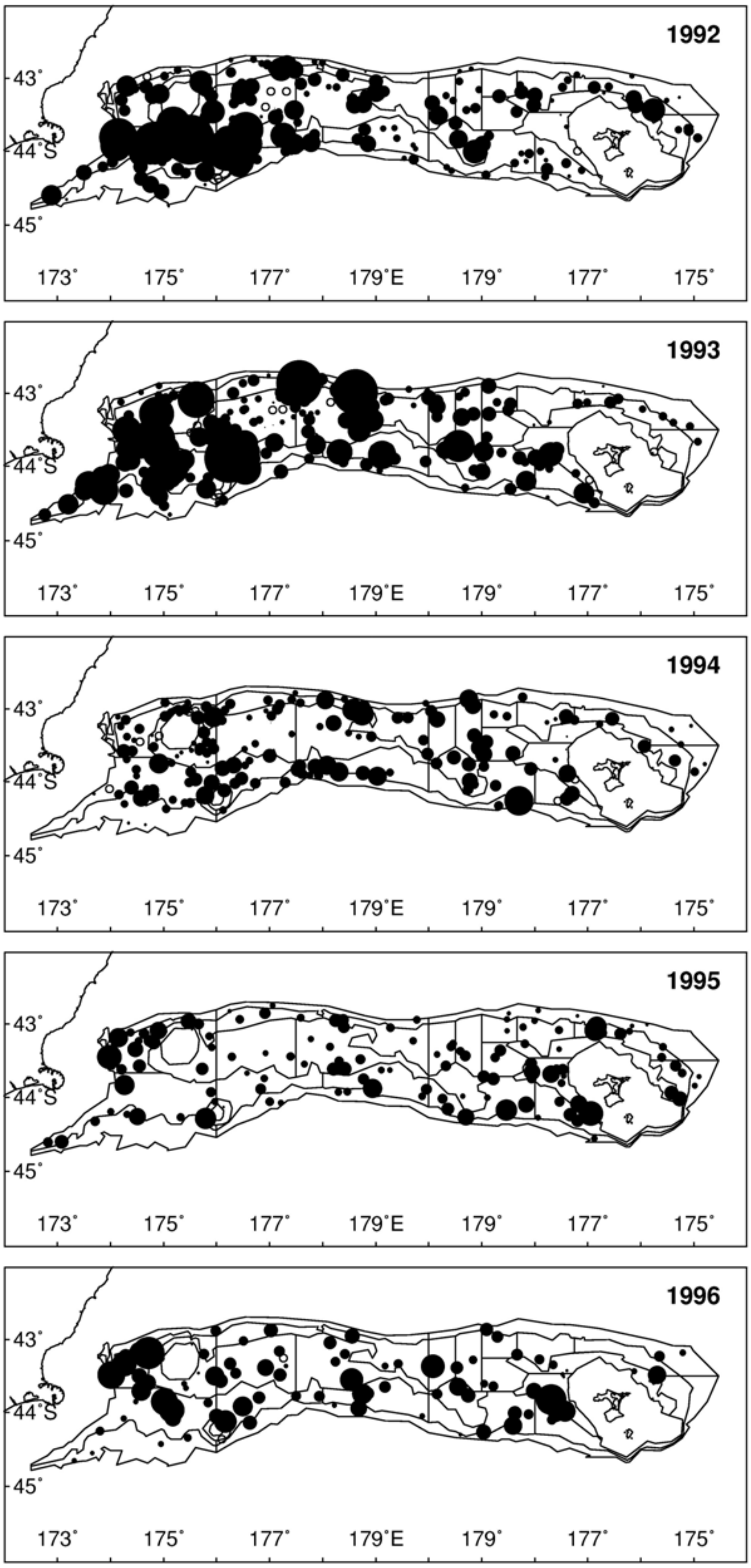


Figure 6c: Hoki 3++ catch distribution. 1992–2008. Filled circle area is proportional to catch rate (kg.km^{-2}). Open circles are zero catch. Maximum catch rate in series is 11 177 kg.km^{-2}

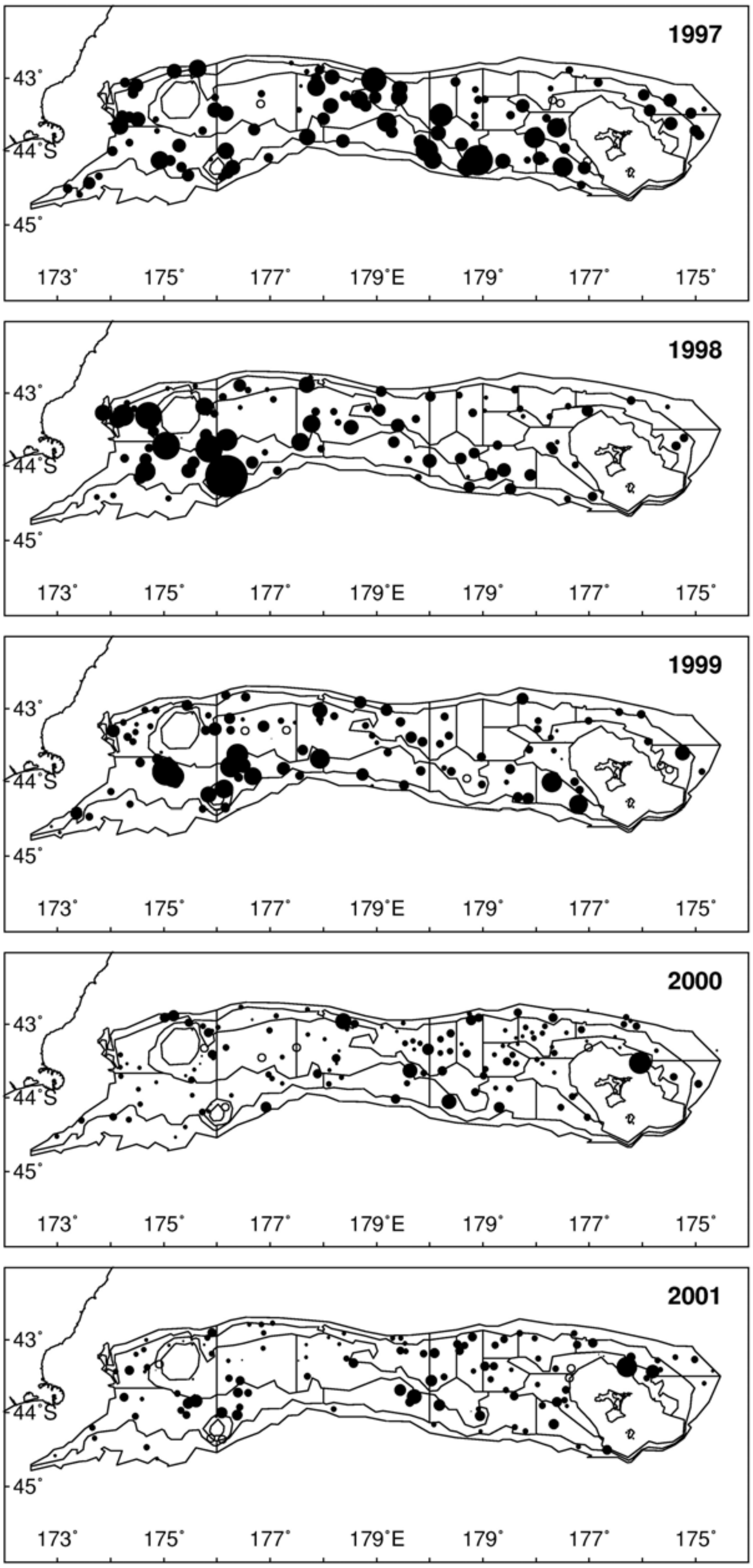


Figure 6c (continued)

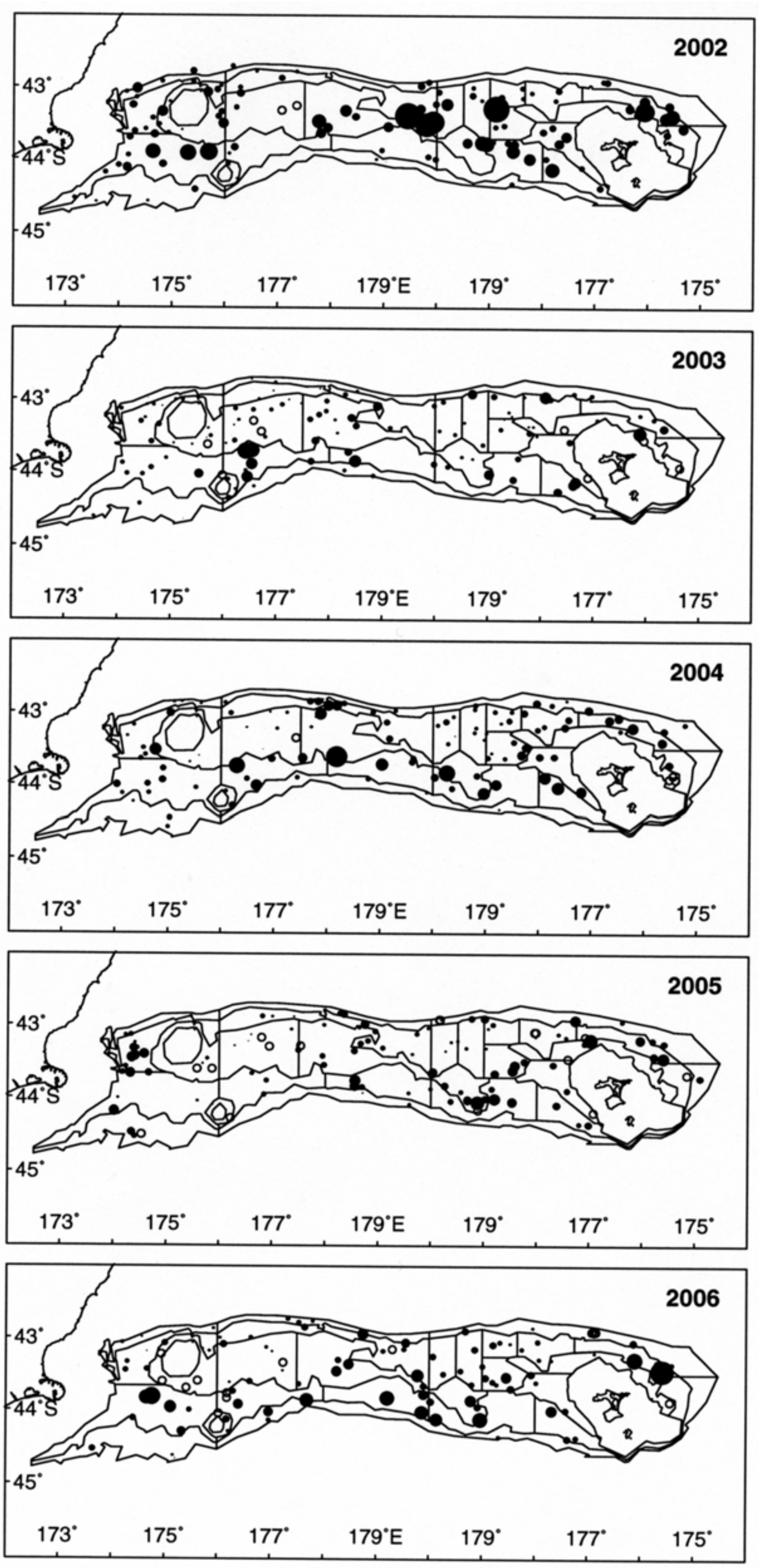


Figure 6c (continued)

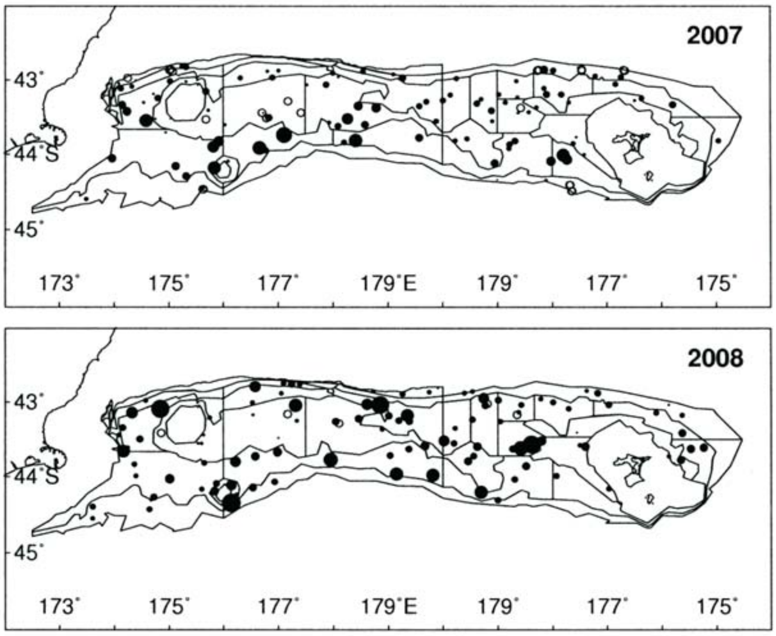


Figure 6c (continued)

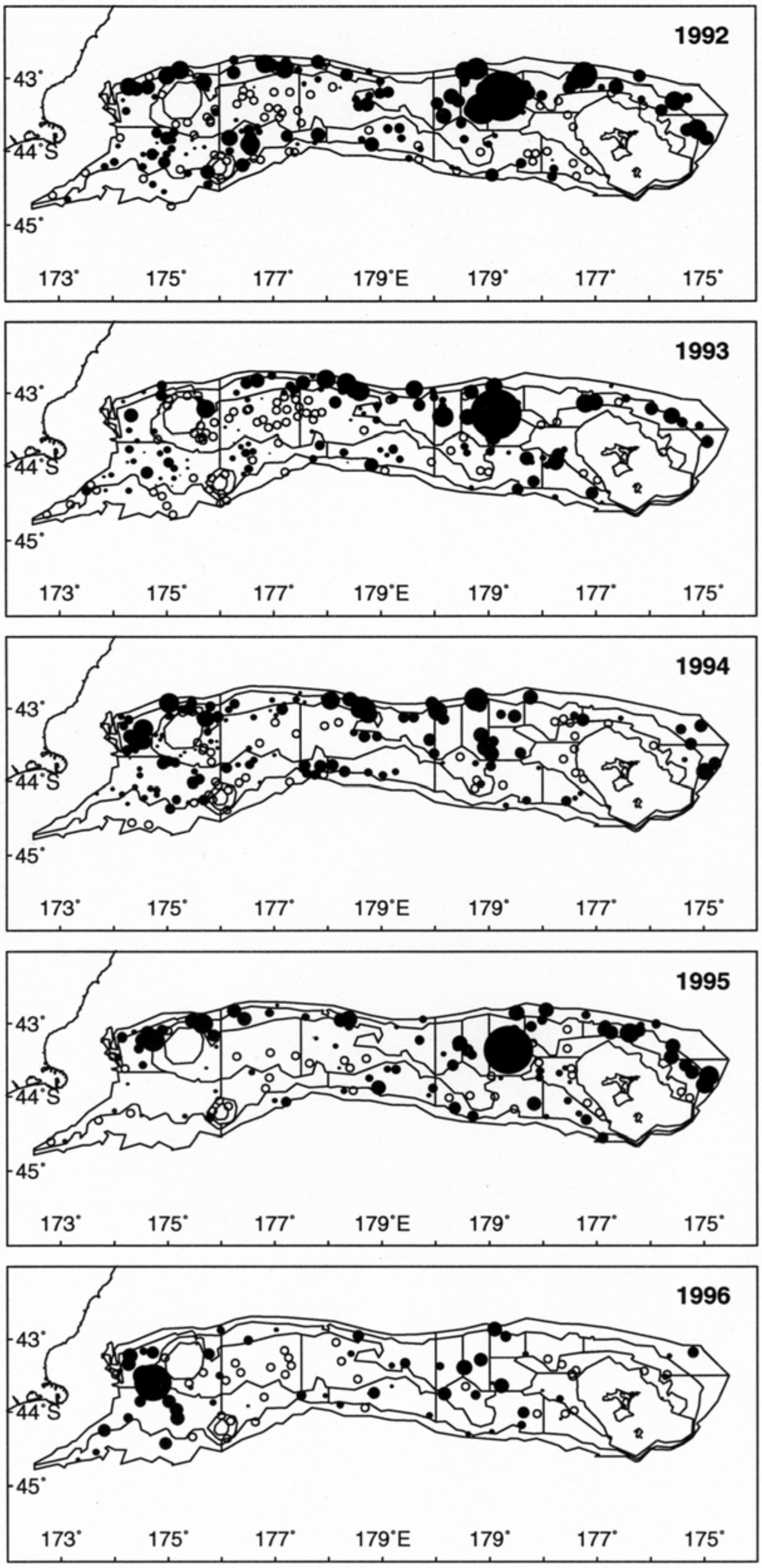


Figure 7: Hake catch distribution 1992–2008. Filled circle area is proportional to catch rate (kg.km^{-2}). Open circles are zero catch. Maximum catch rate in series is 620 kg.km^{-2}

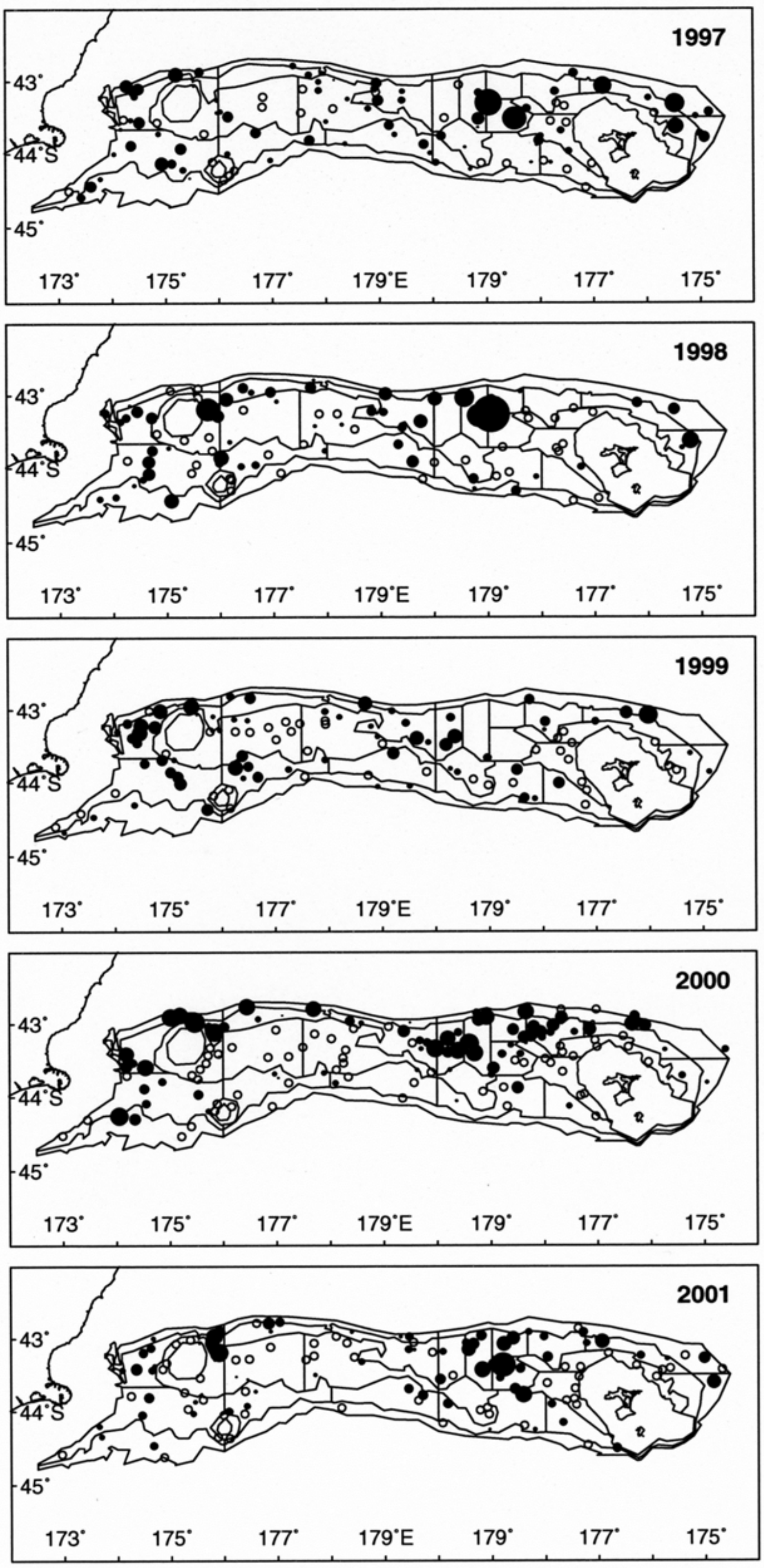


Figure 7 (continued)

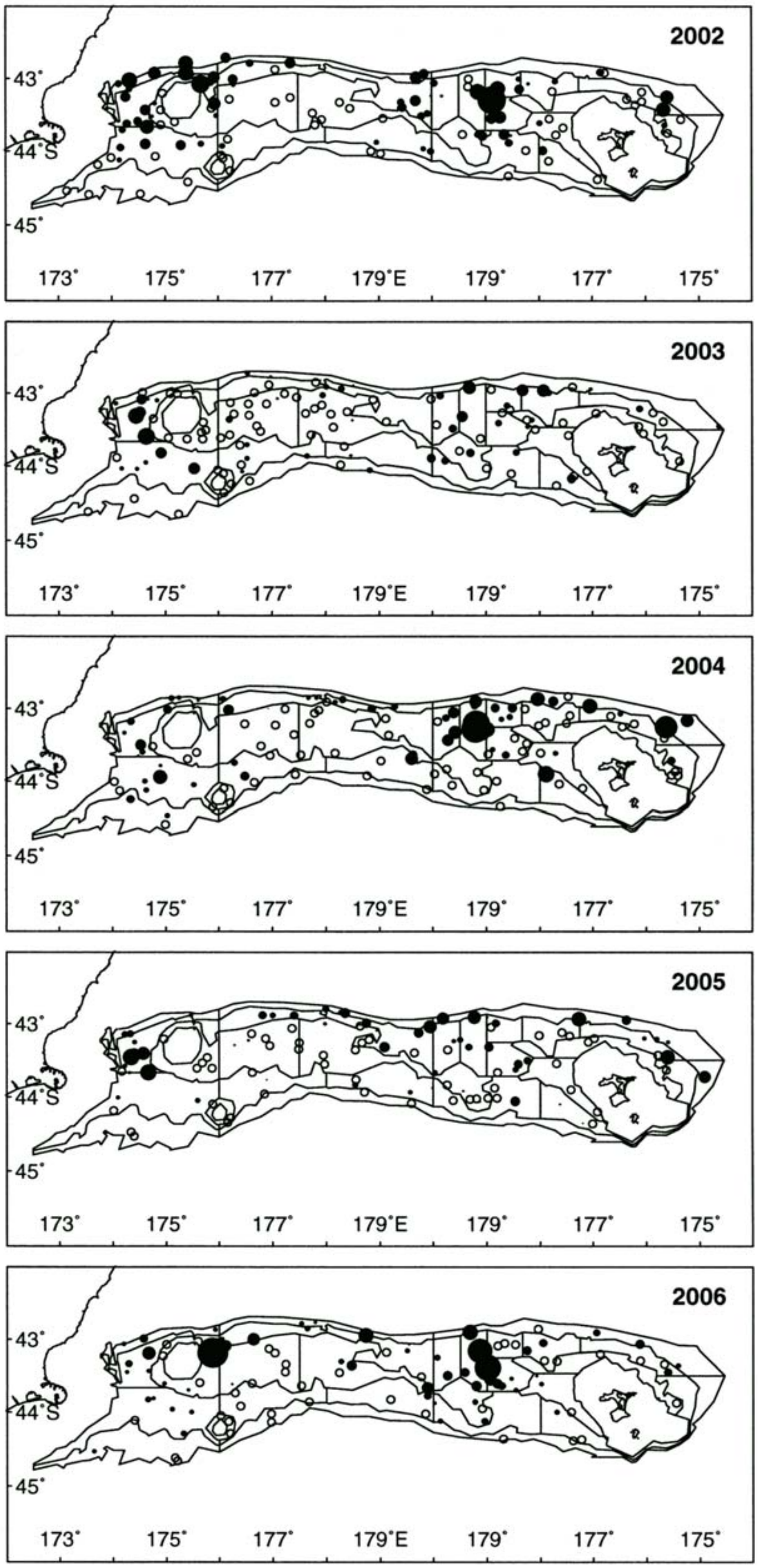
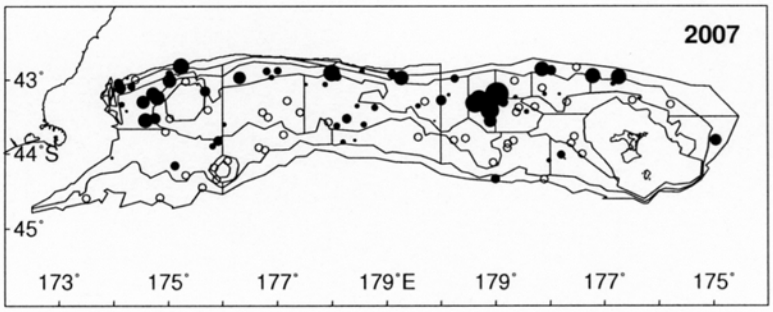


Figure 7 (continued)



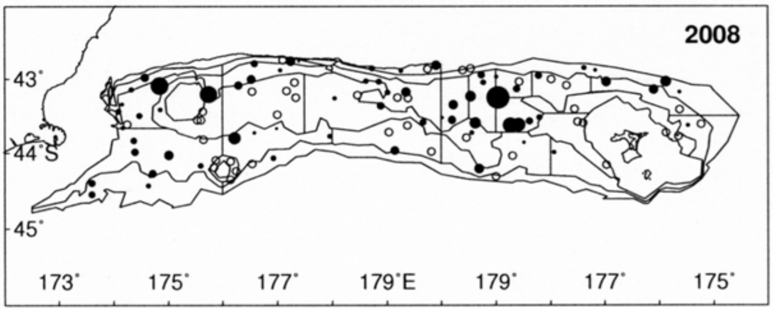


Figure 7 (continued)

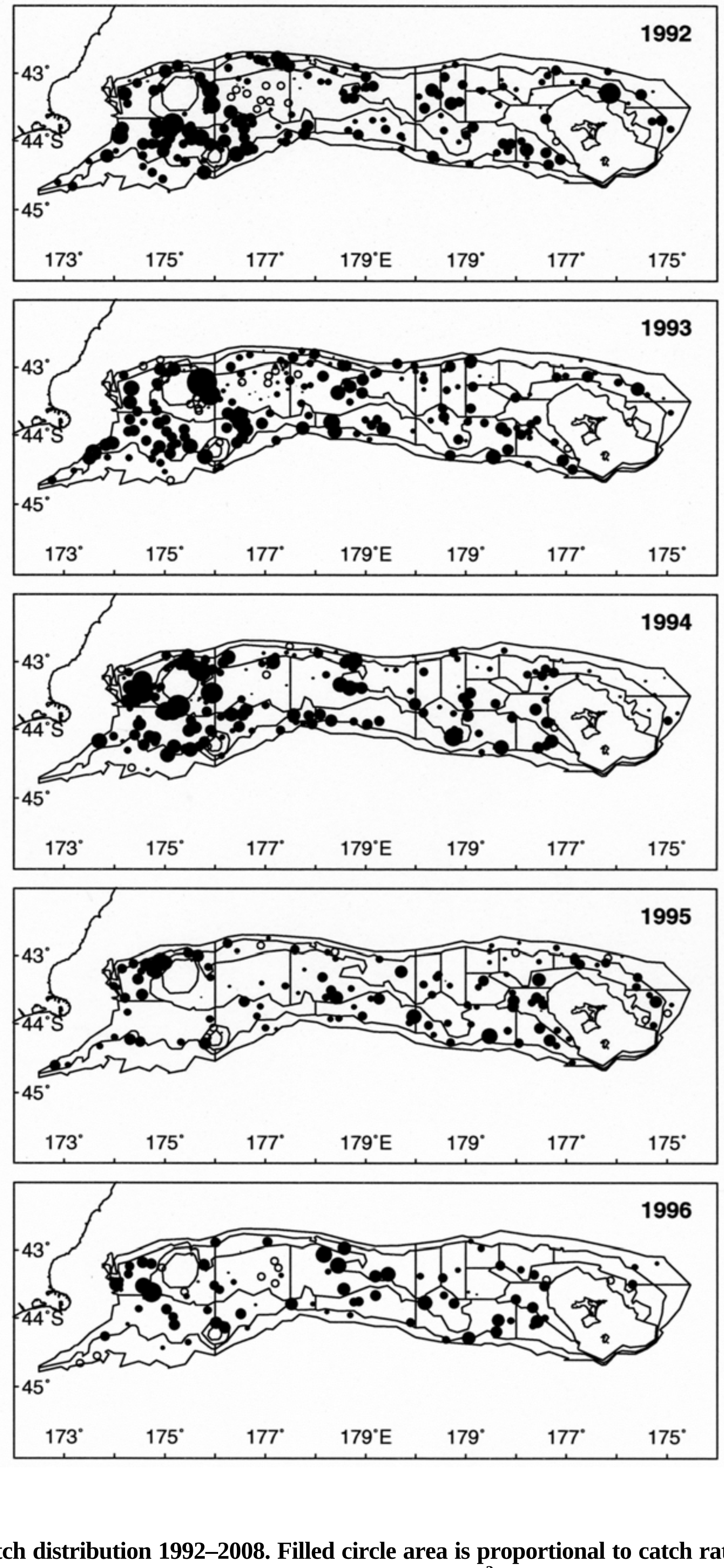


Figure 8: Ling catch distribution 1992–2008. Filled circle area is proportional to catch rate ($kg.km^{-2}$). Open circles are zero catch. Maximum catch rate in series is 1786 $kg.km^{-2}$

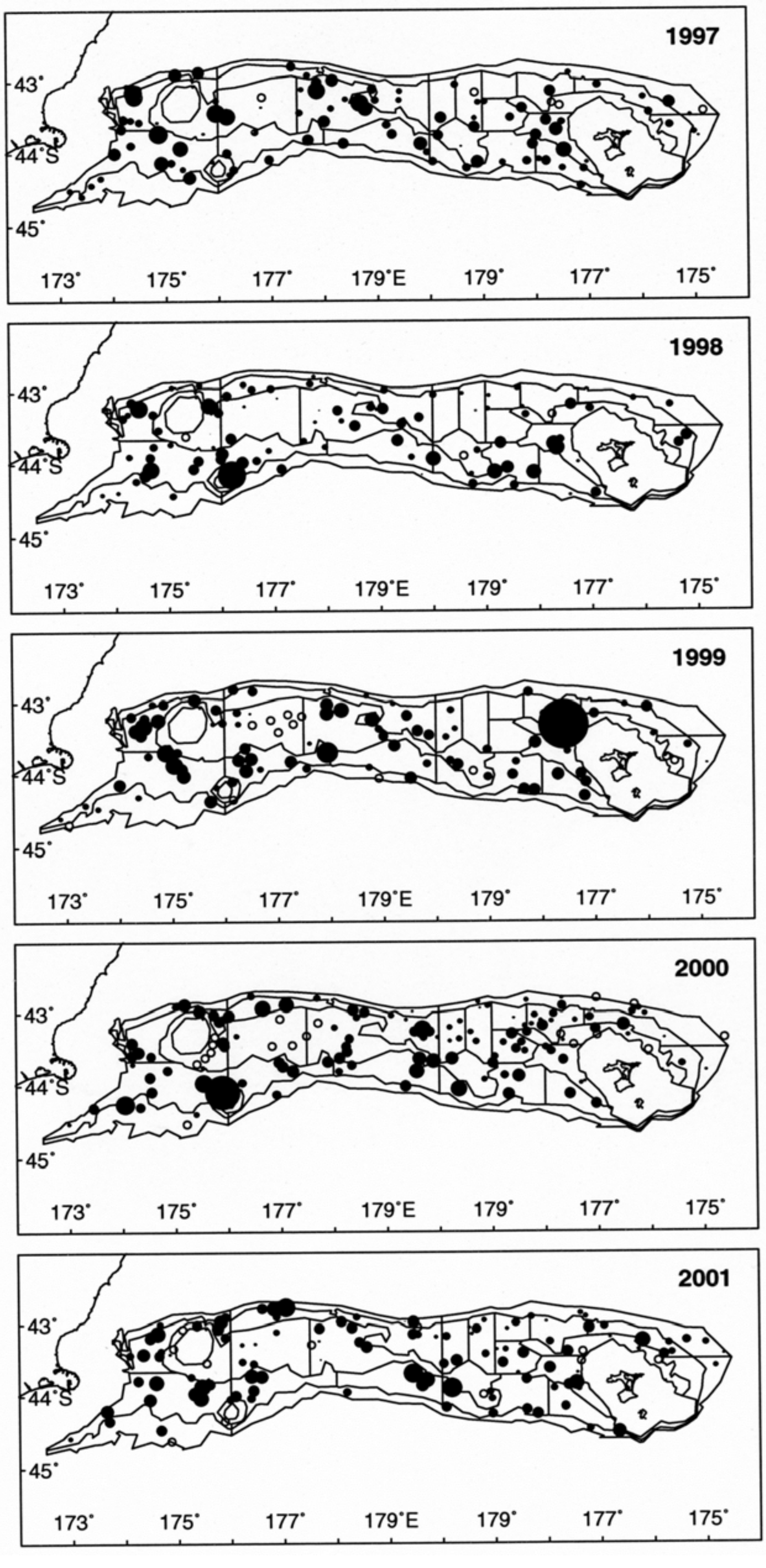


Figure 8 (continued)

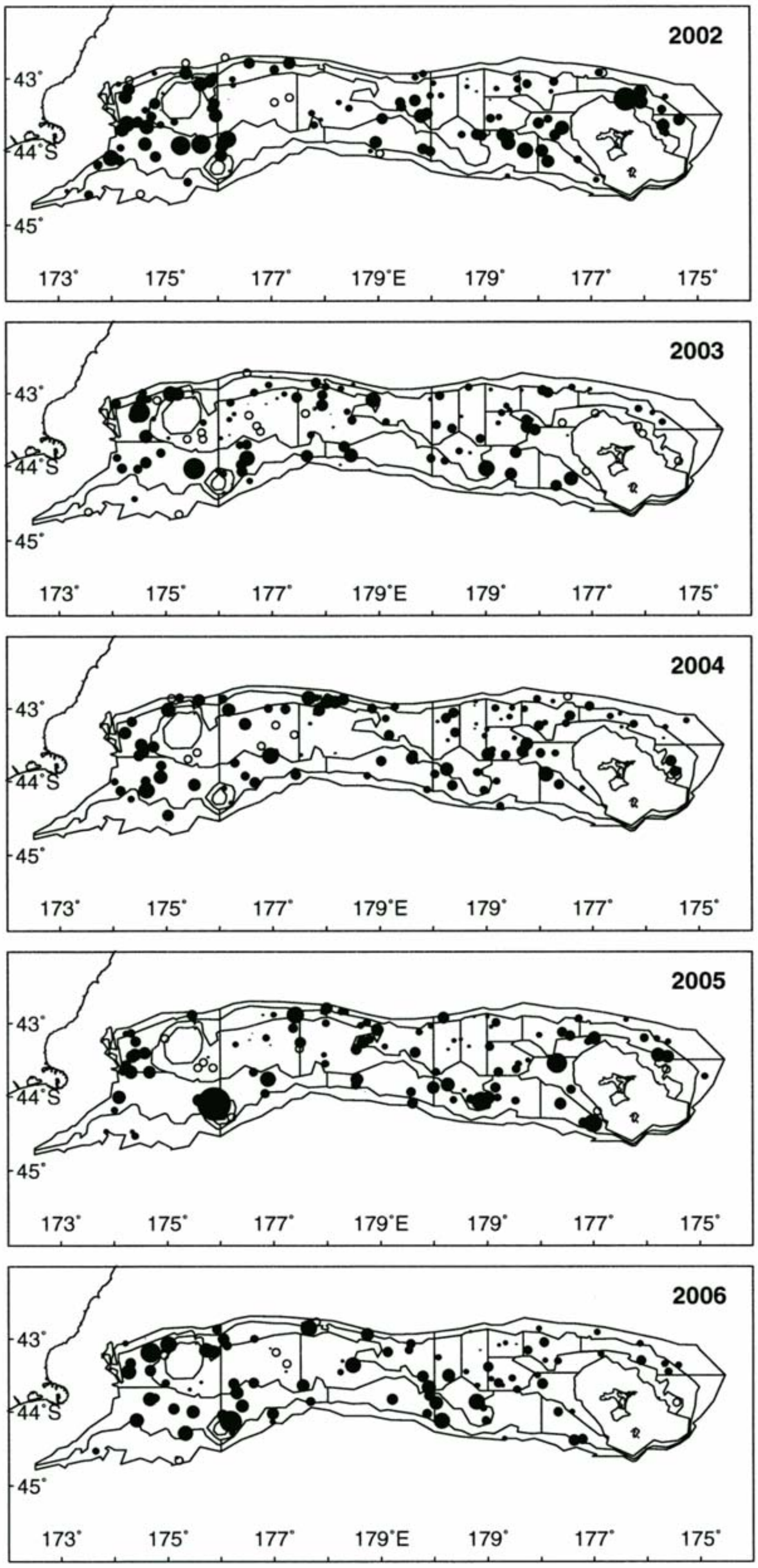
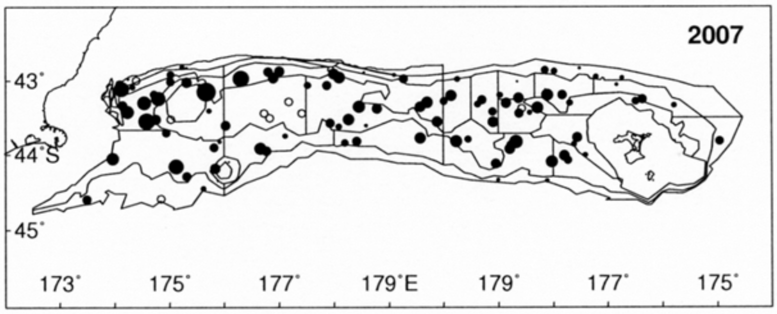


Figure 8 (continued)



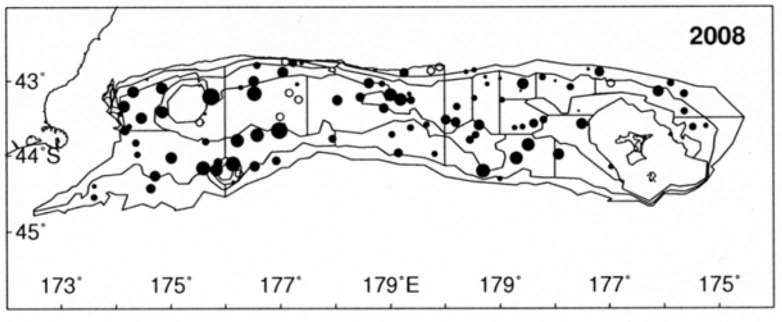


Figure 8 (continued)

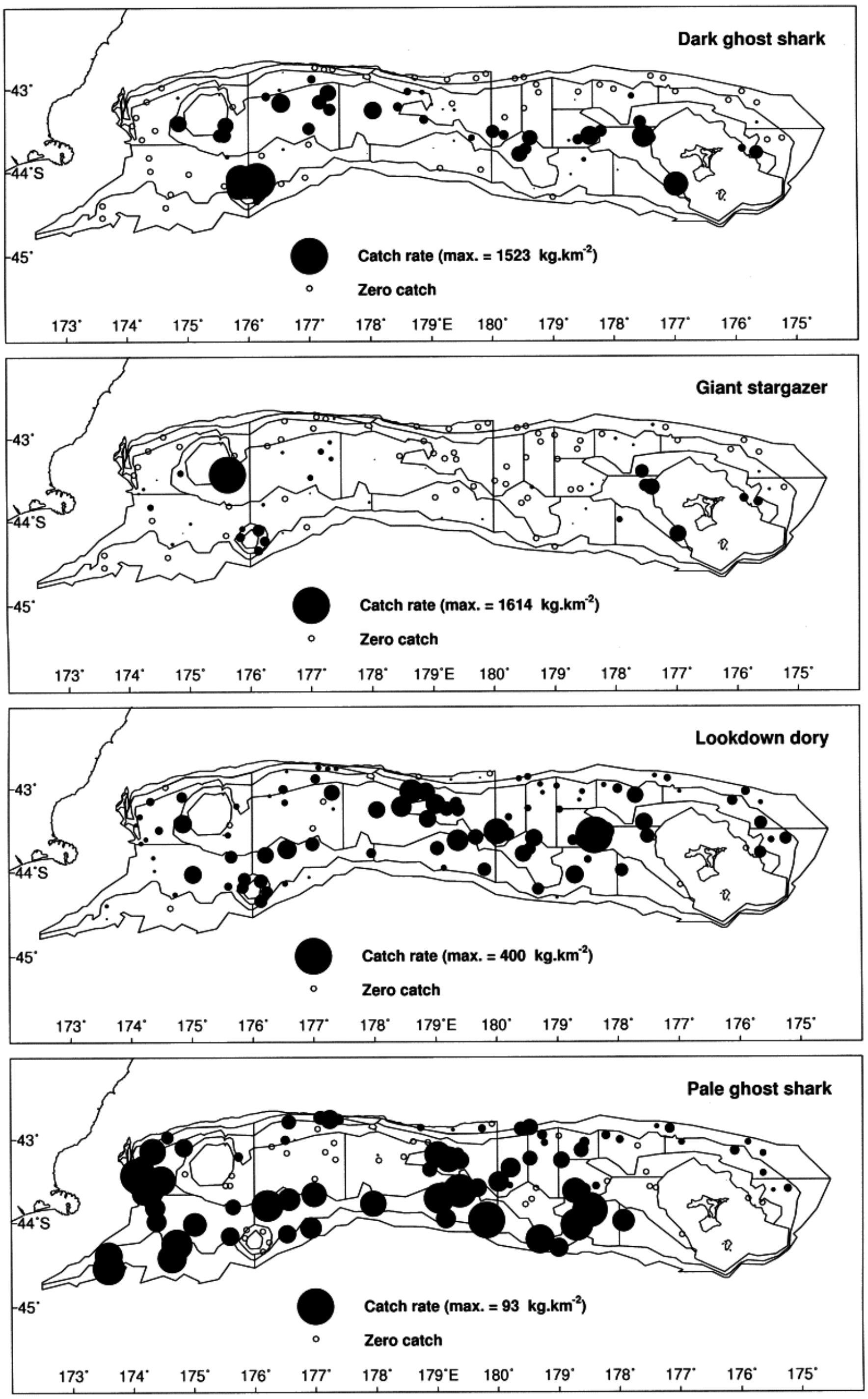


Figure 9: Catch rates (kg.km^{-2}) of selected commercial species in 2008. Filled circle area is proportional to catch rate. Open circles are zero catch. (max., maximum catch rate)

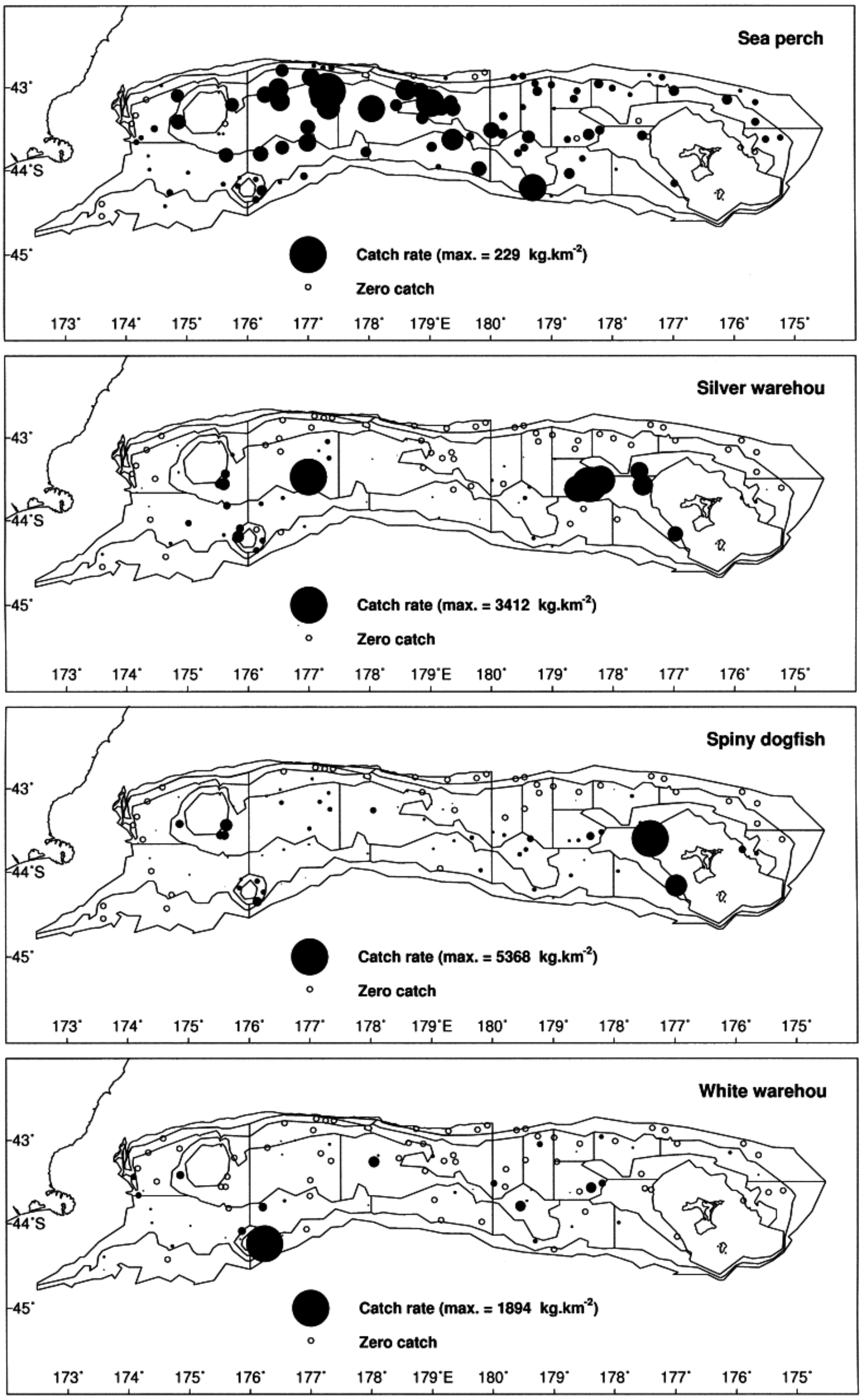


Figure 9 (continued)

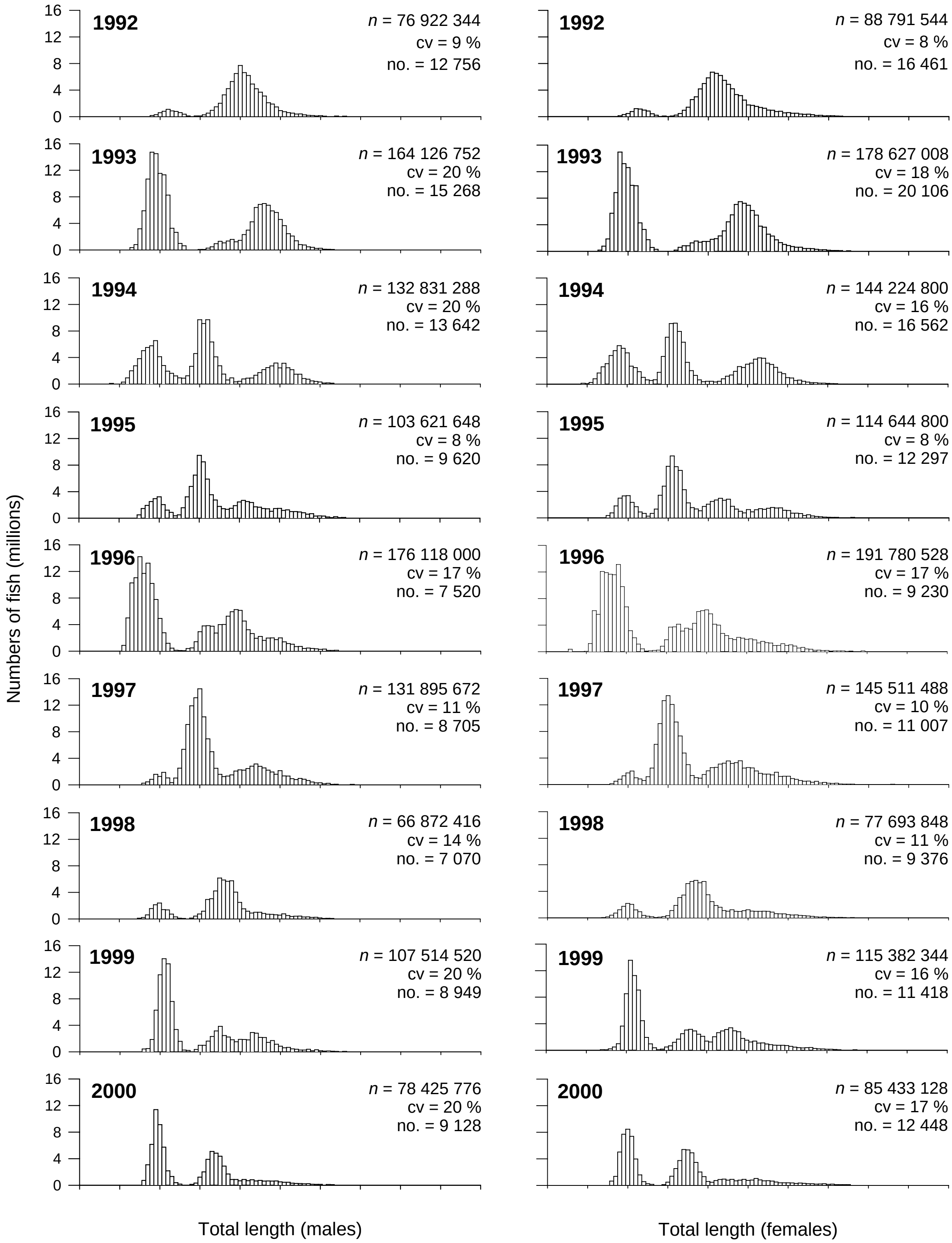


Figure 10: Estimated length frequency distributions of the male and female hoki population from *Tangaroa* surveys of the Chatham Rise, January 1992–2008. (c.v., coefficient of variation; *n*, estimated population number of male hoki (left panel) and female hoki (right panel); no., numbers of fish measured.)

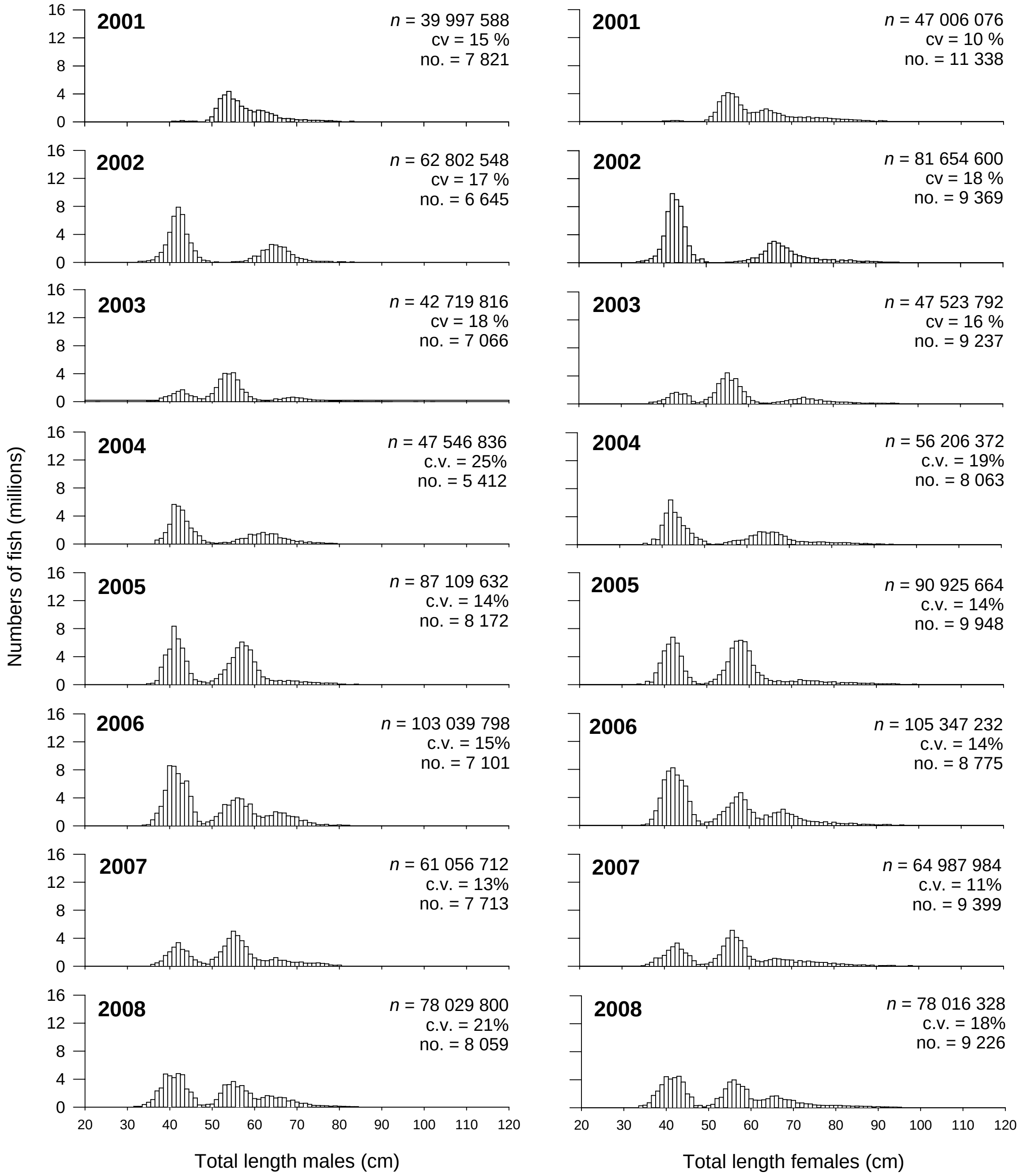


Figure 10 (continued)

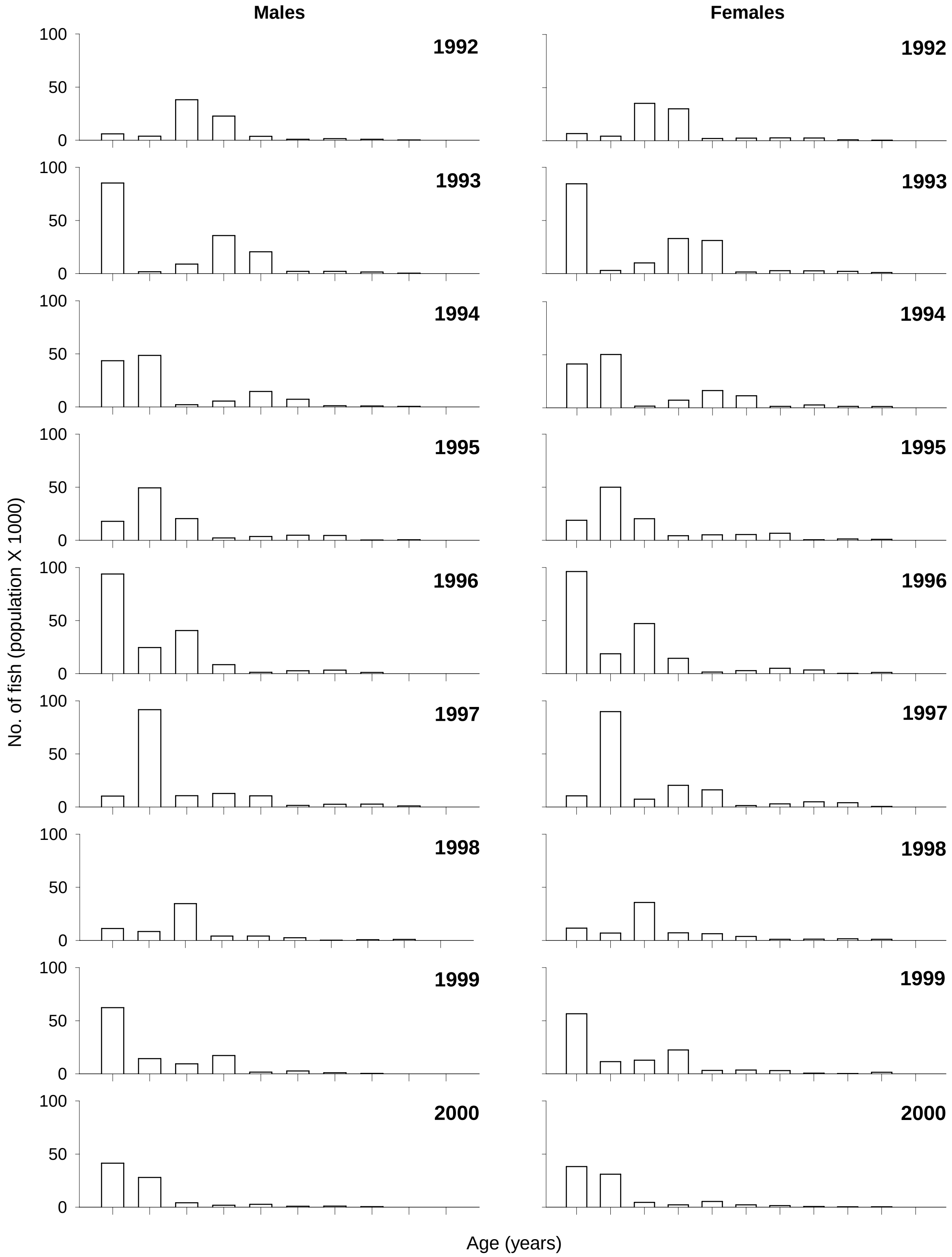


Figure 11: Estimated population numbers at age of hoki from *Tangaroa* surveys of the Chatham Rise, January, 1992–2008. (+, indicates plus group of combined ages.)

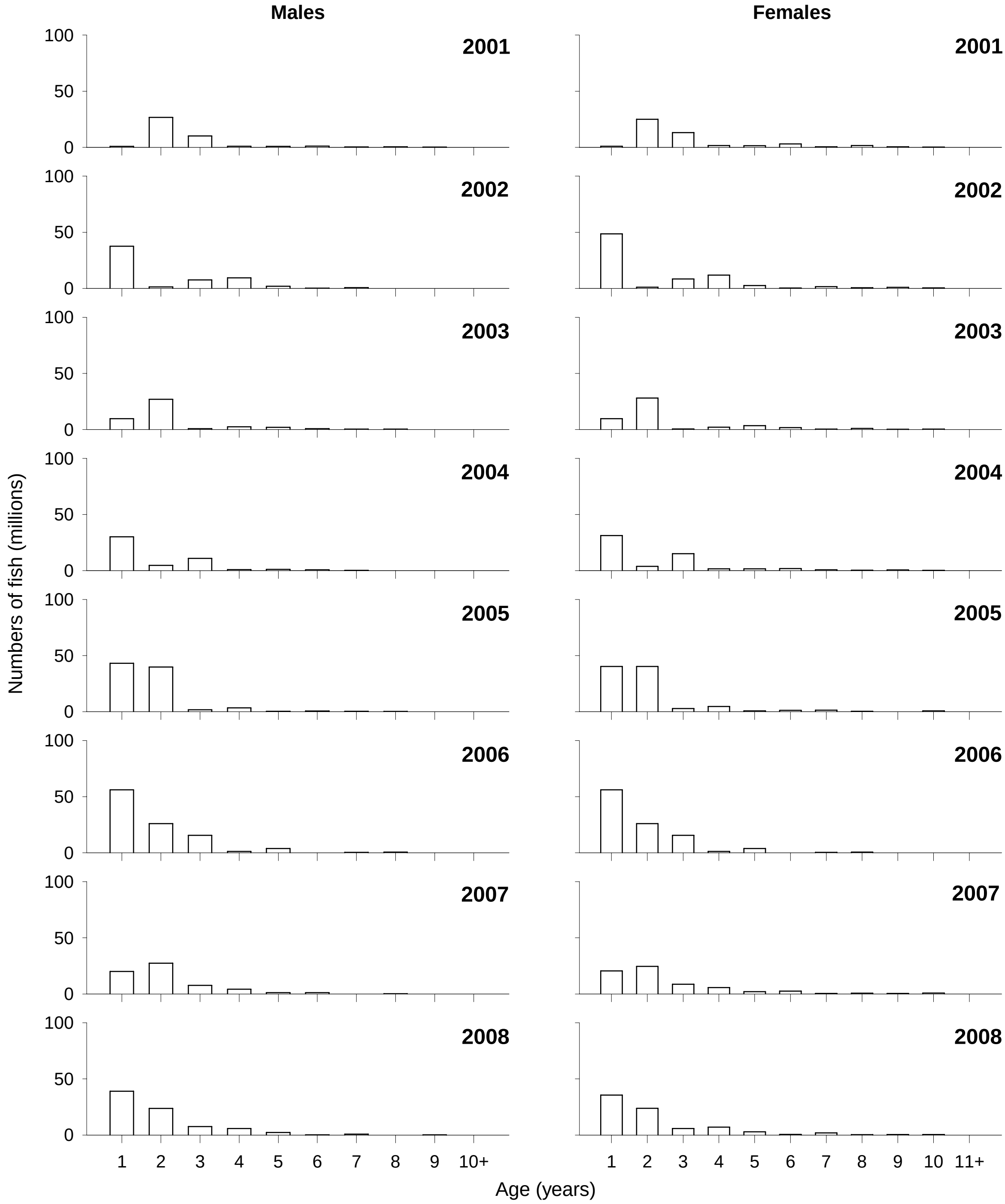


Figure 11 (continued)

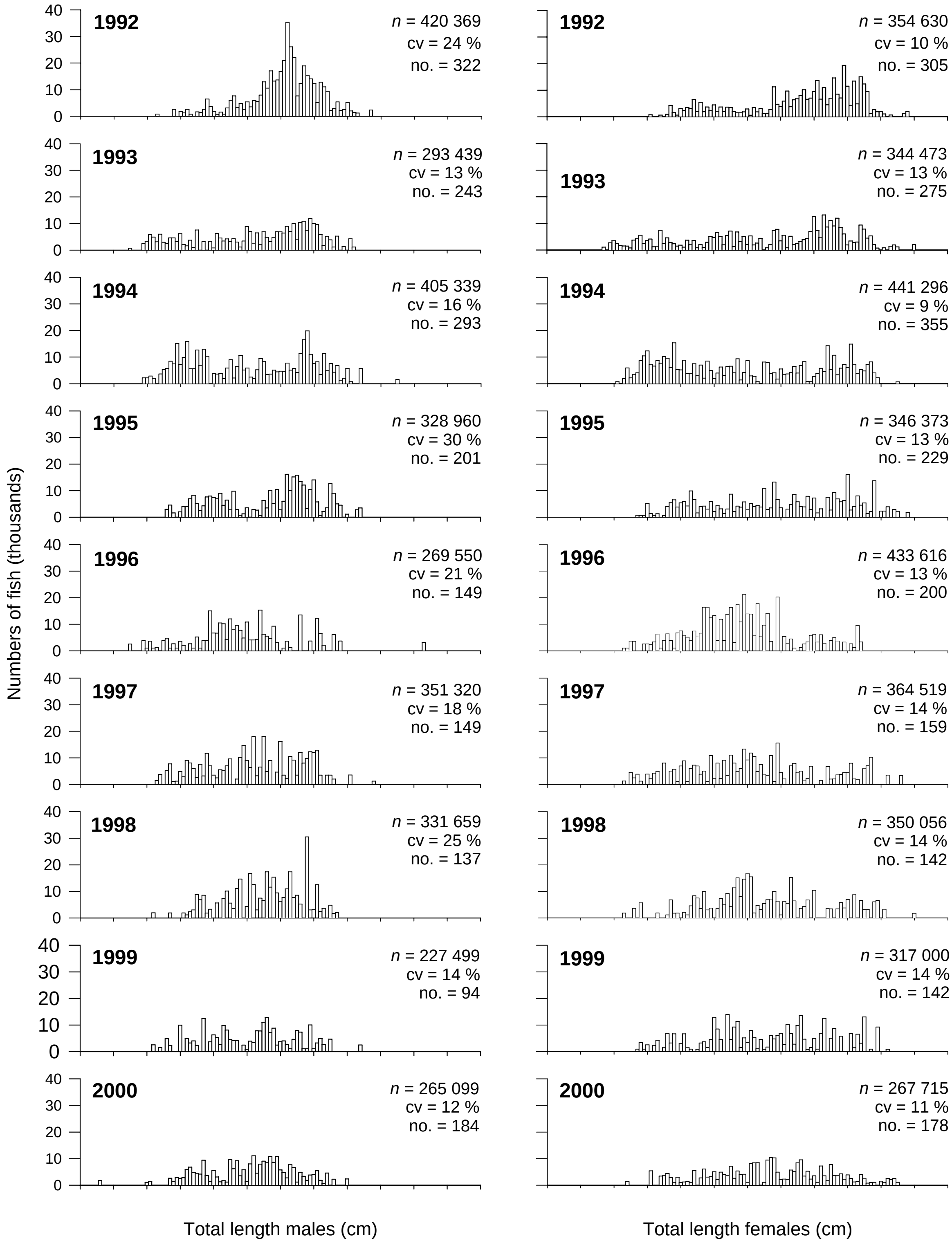


Figure 12: Estimated length frequency distributions of the male and female hake population from *Tangaroa* surveys of the Chatham Rise, January 1992–2008. (c.v., coefficient of variation; *n*, estimated population number of hake; no., numbers of fish measured.)

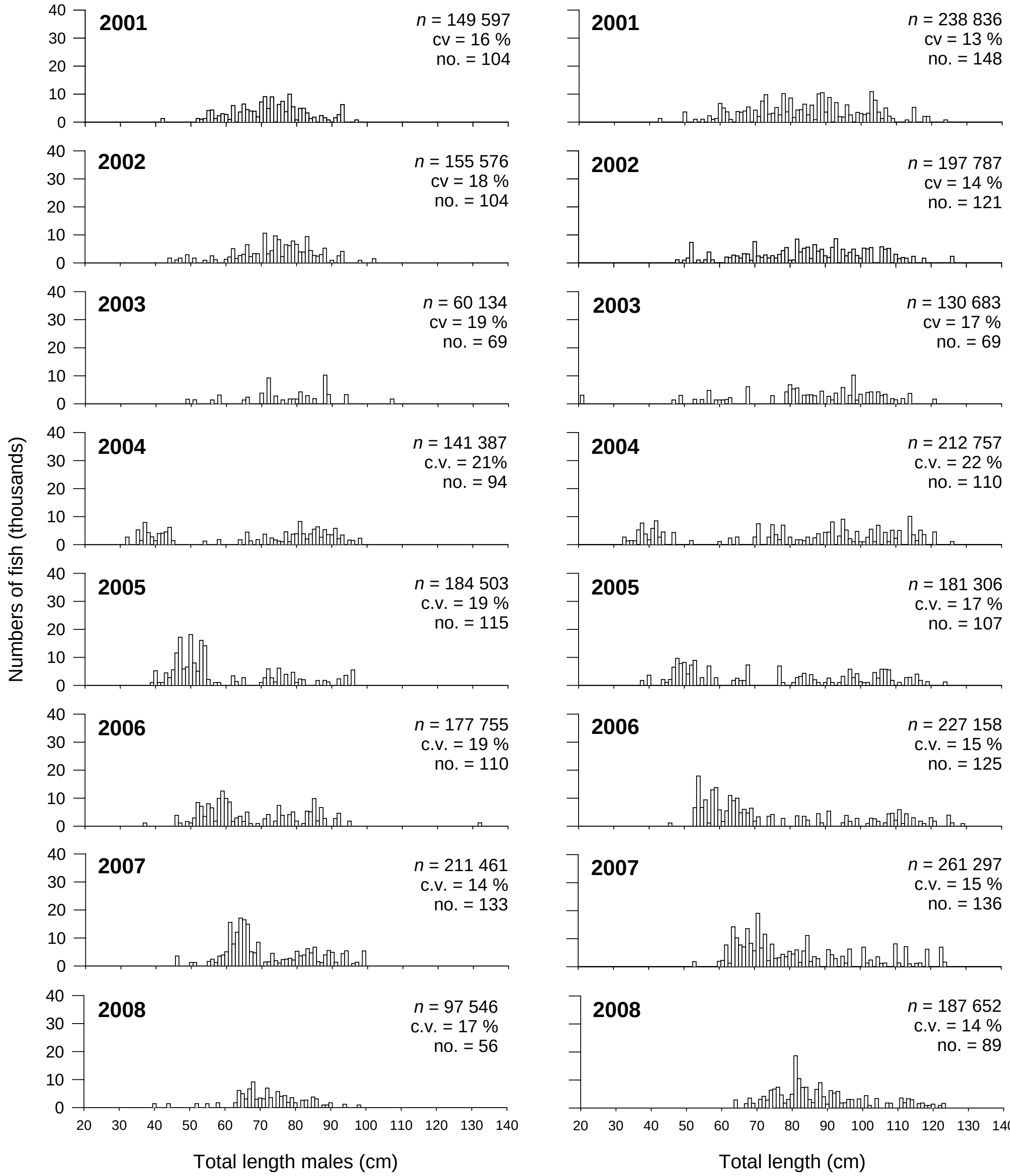


Figure 12 (continued)

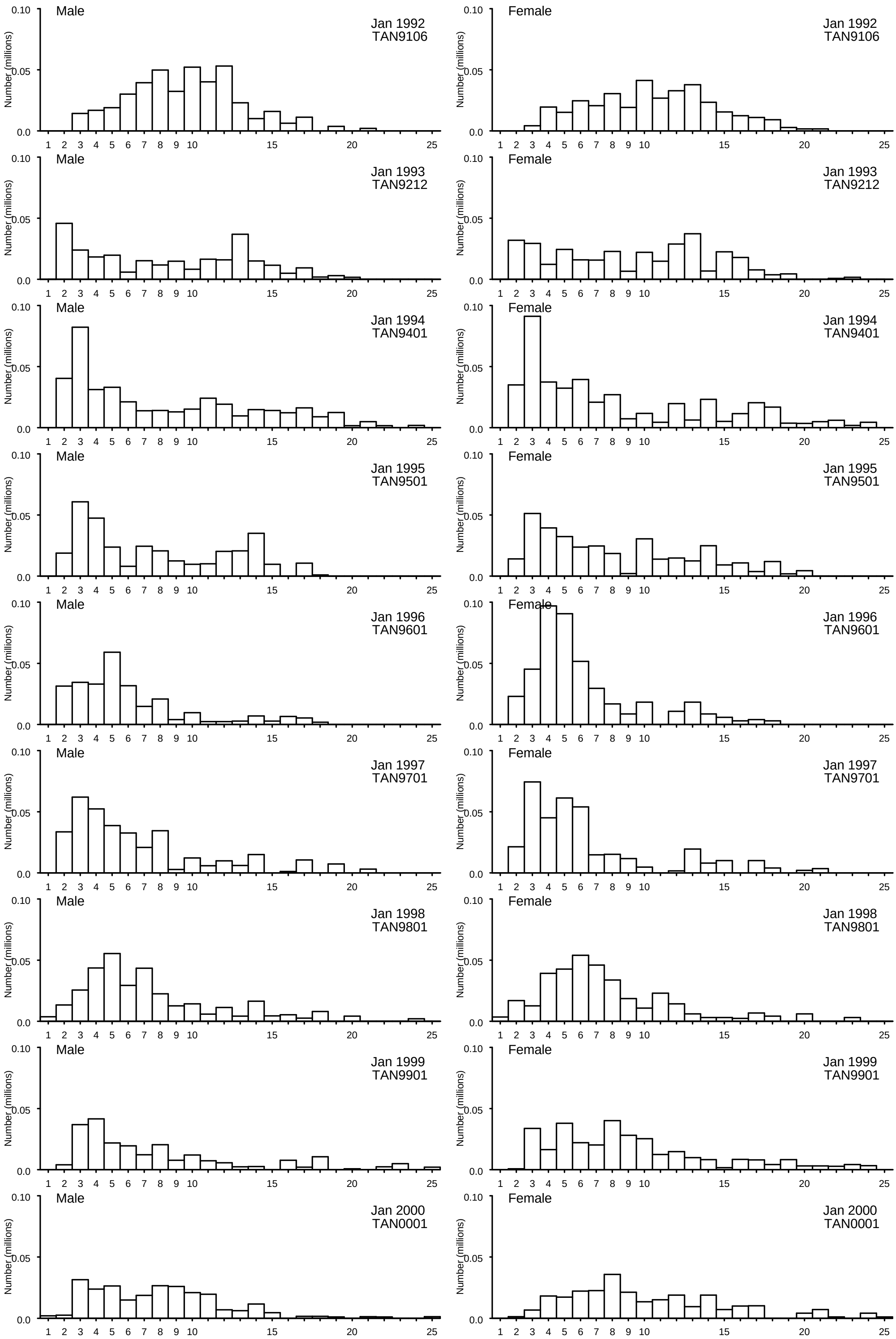


Figure 13: Estimated proportion at age of male and female hake from *Tangaroa* surveys of the Chatham Rise, January, 1992–2008

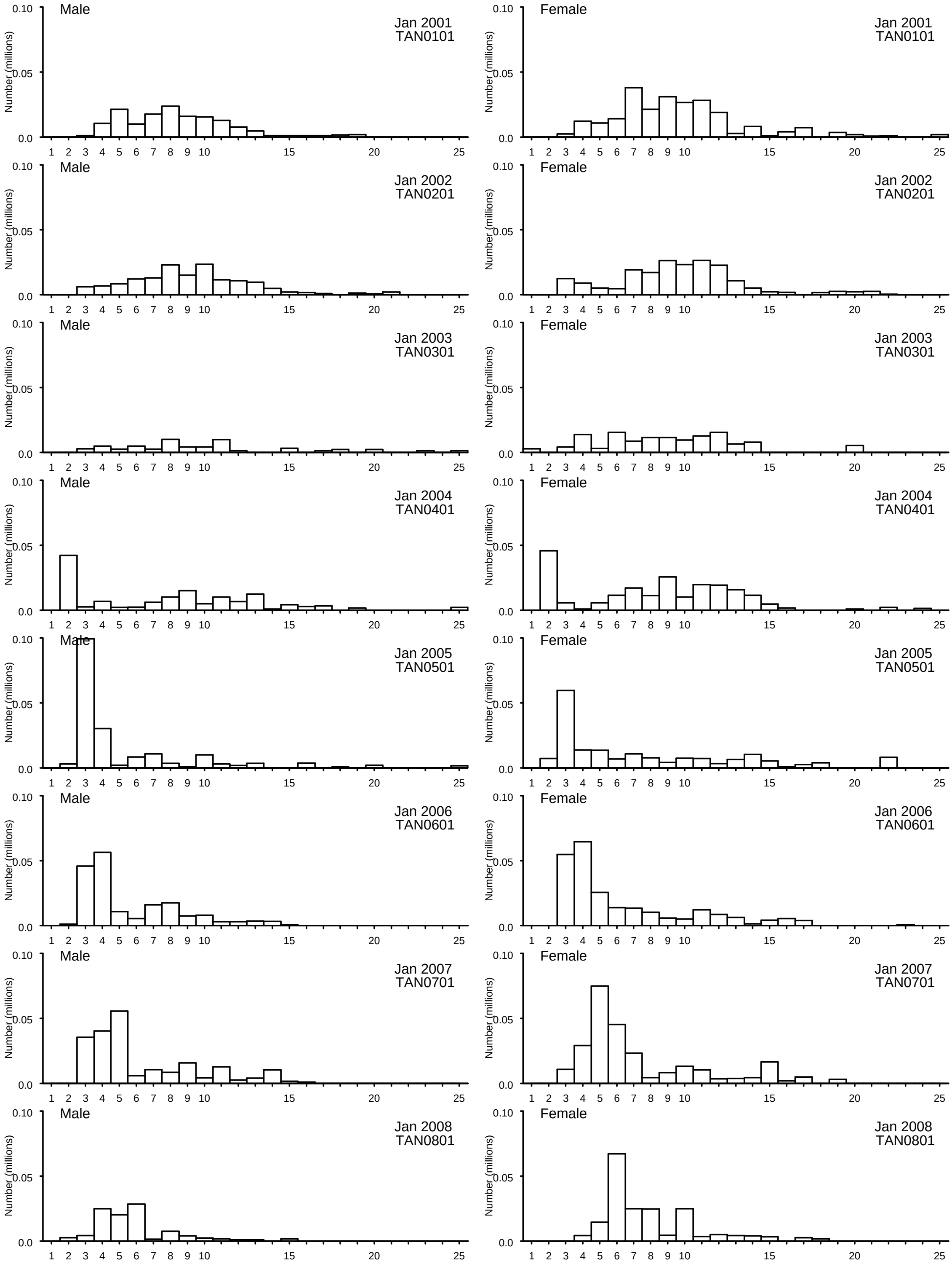


Figure 13 (continued)

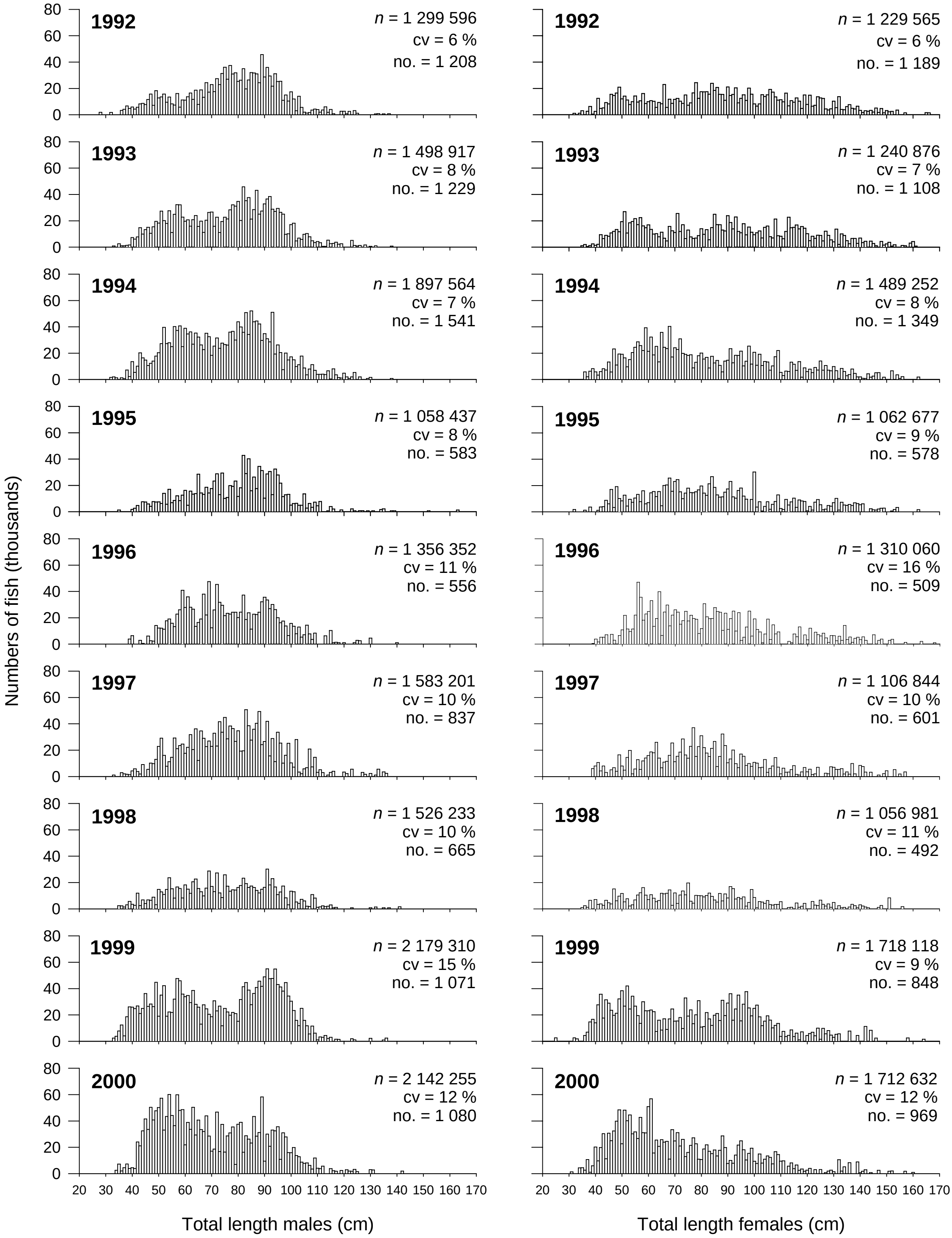


Figure 14: Estimated length frequency distributions of the ling population from *Tangaroa* surveys of the Chatham Rise, January 1992–2008. (c.v., coefficient of variation; *n*, estimated population number of ling; no., numbers of fish measured.)

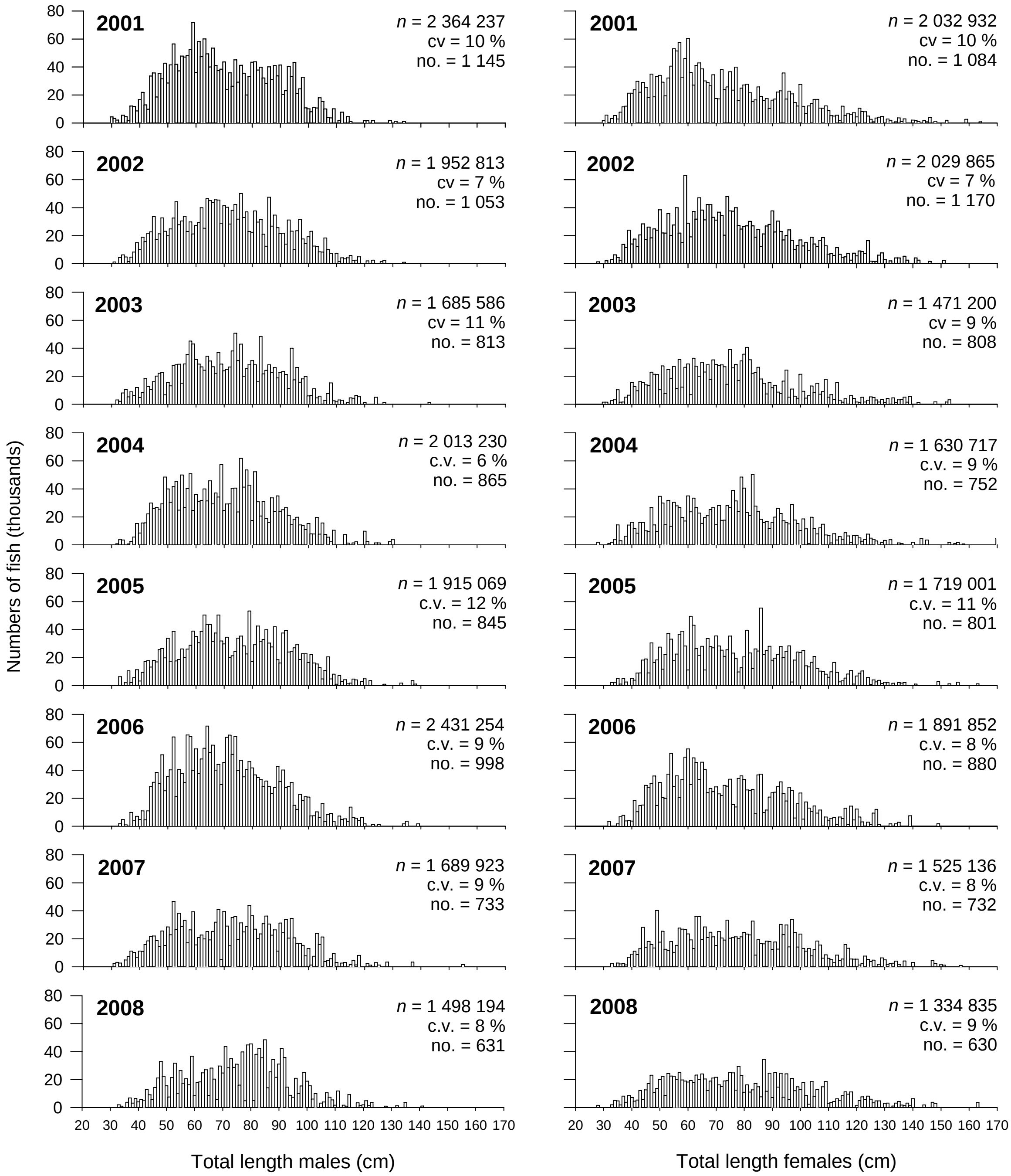


Figure 14 (continued)

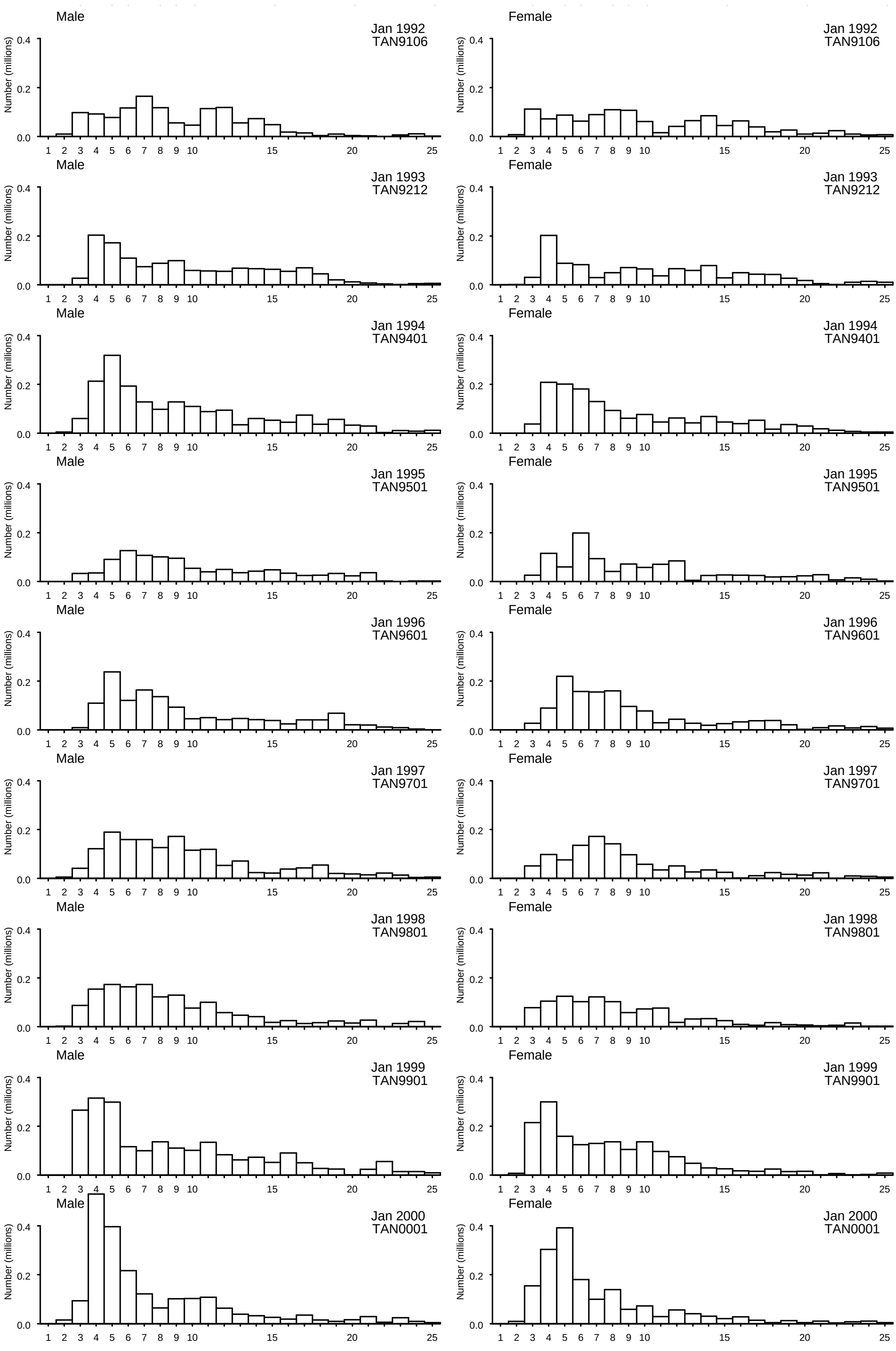


Figure 15: Estimated population numbers at age of male and female ling (age 1–15 years) from *Tangaroa* surveys of the Chatham Rise, January, 1992–2008. (Note: the age class of 15 years is not a plus group.)

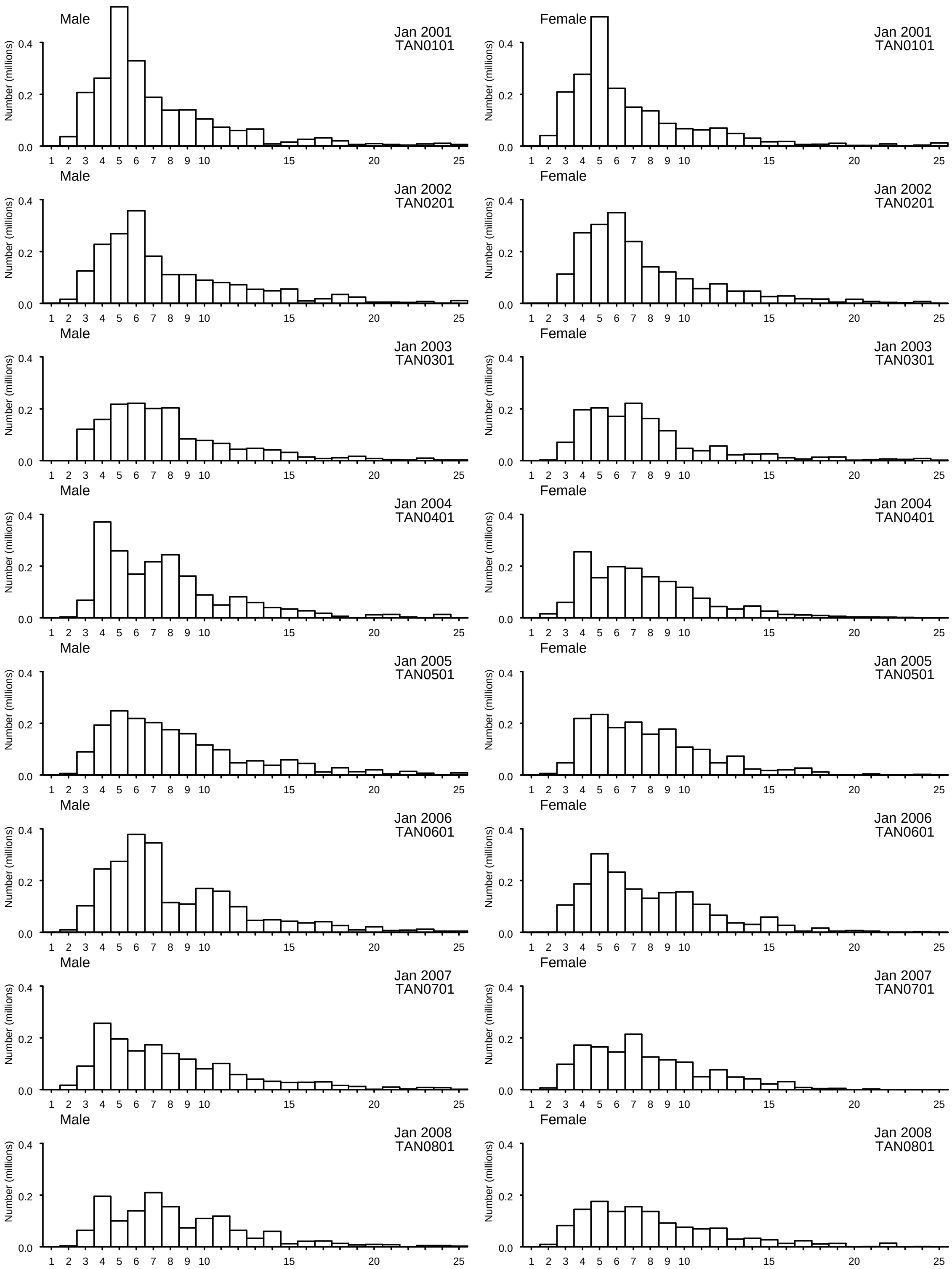


Figure 15 (continued)

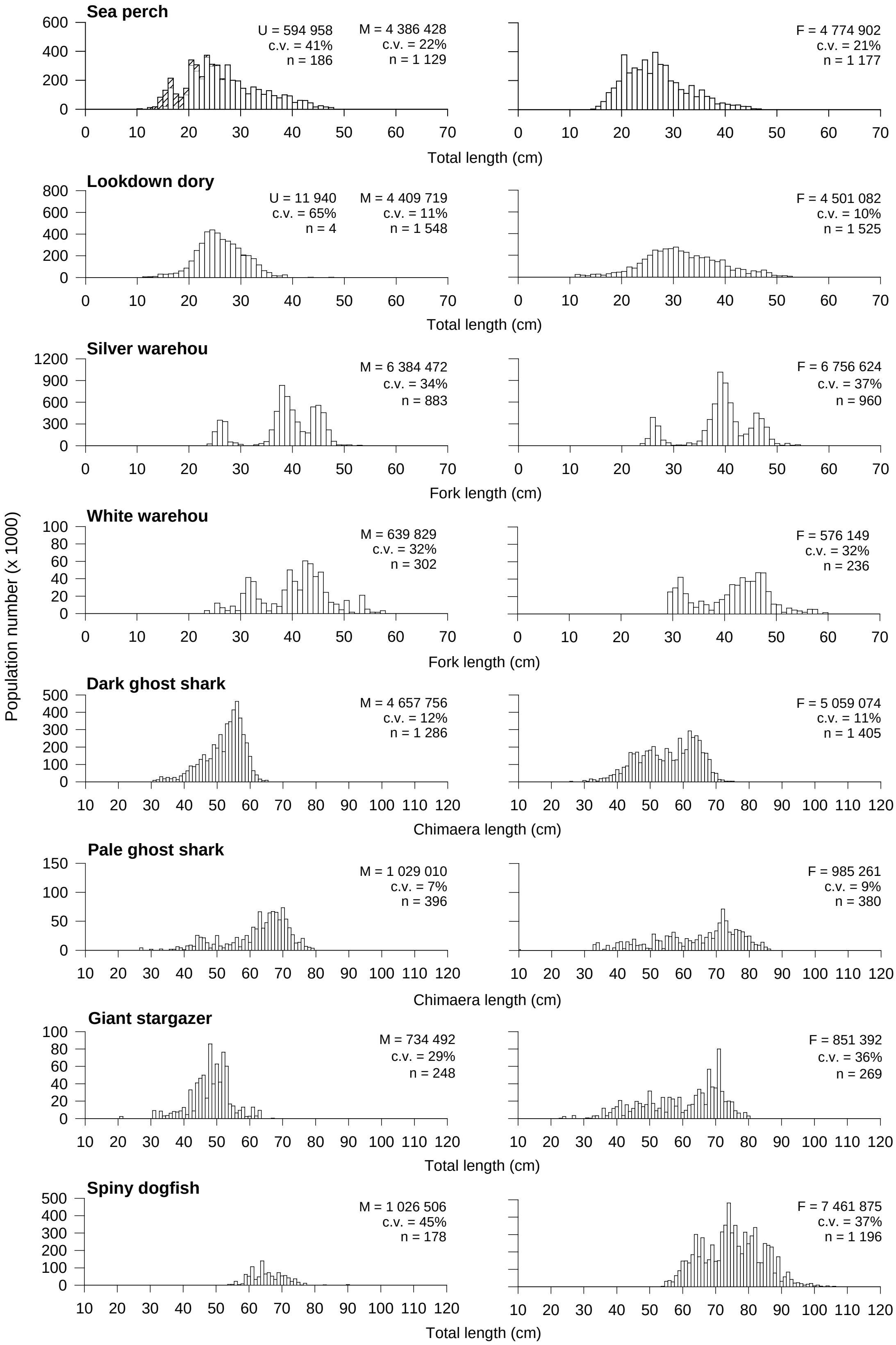


Figure 16: Length frequencies of selected commercial species on the Chatham Rise 2008, scaled to population size by sex (M, estimated male population; F, estimated female population; U, estimated unsexed population (hatched bars); c.v. coefficient of variation of the estimated numbers of fish; n, number of fish measured).

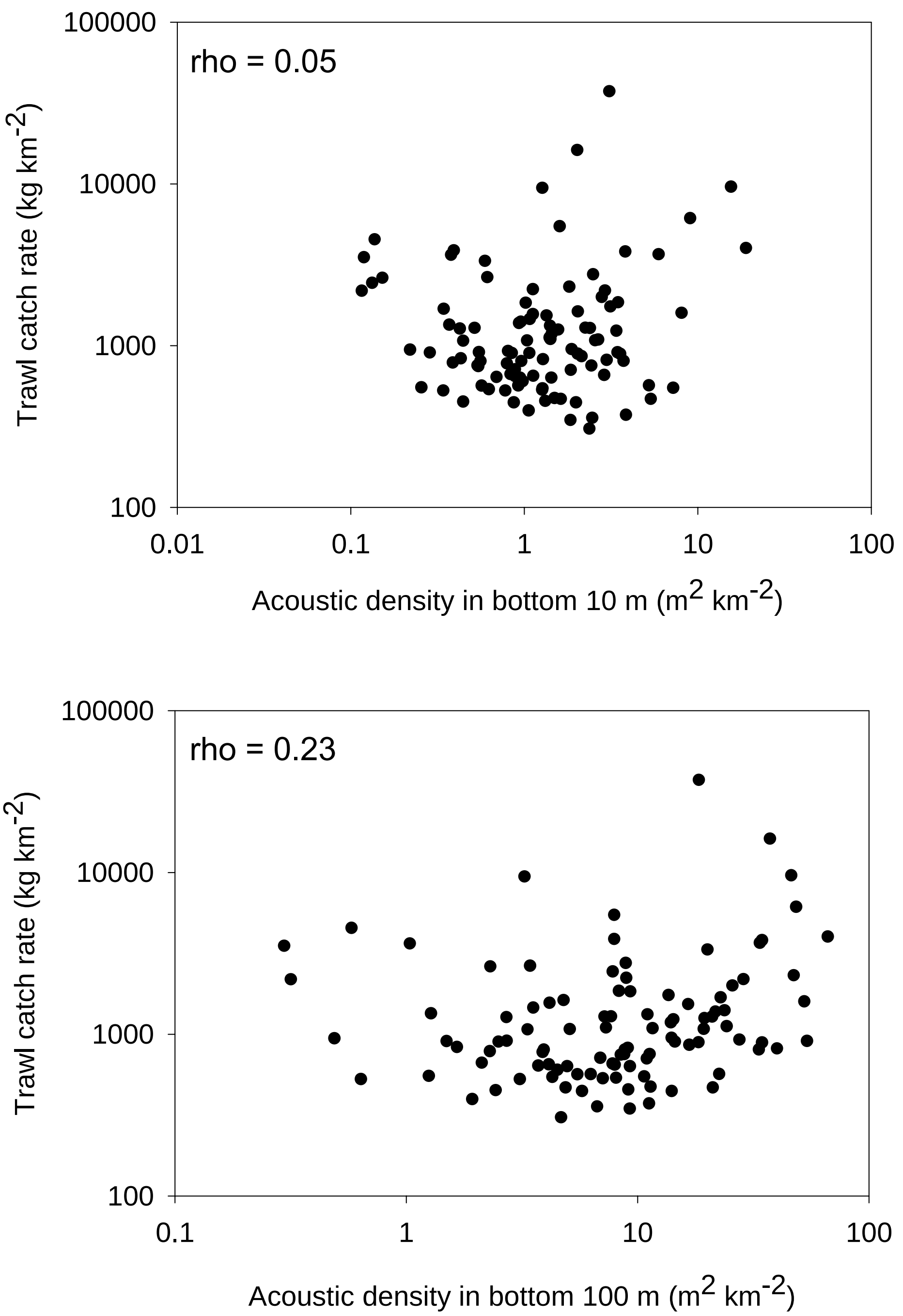


Figure 17. Relationship between total trawl catch rate (all species combined) and bottom-referenced acoustic backscatter recorded during the trawl on the Chatham Rise in 2008. Rho values are Spearman's rank correlation coefficients.

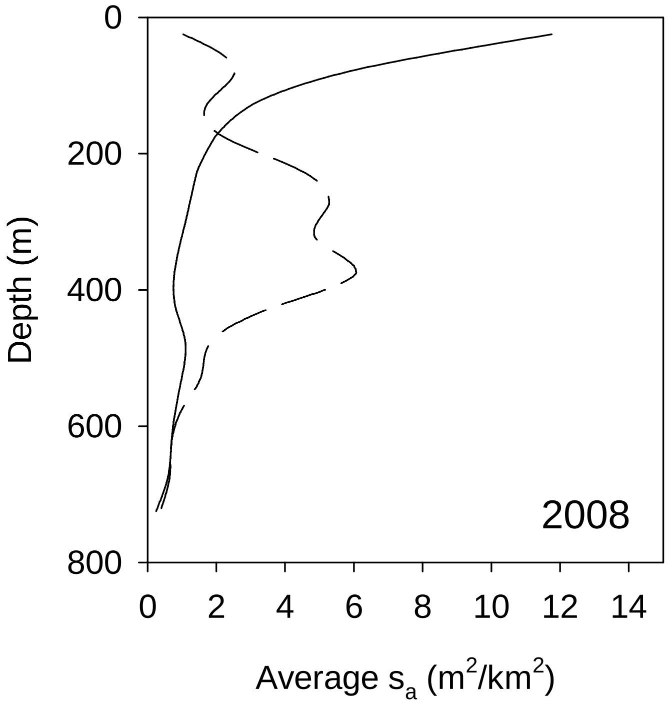


Figure 18. Average vertical distribution of total acoustic backscatter integrated in 50 m depth bins on the Chatham Rise observed during the day (dashed line) and at night (solid line) in 2008.

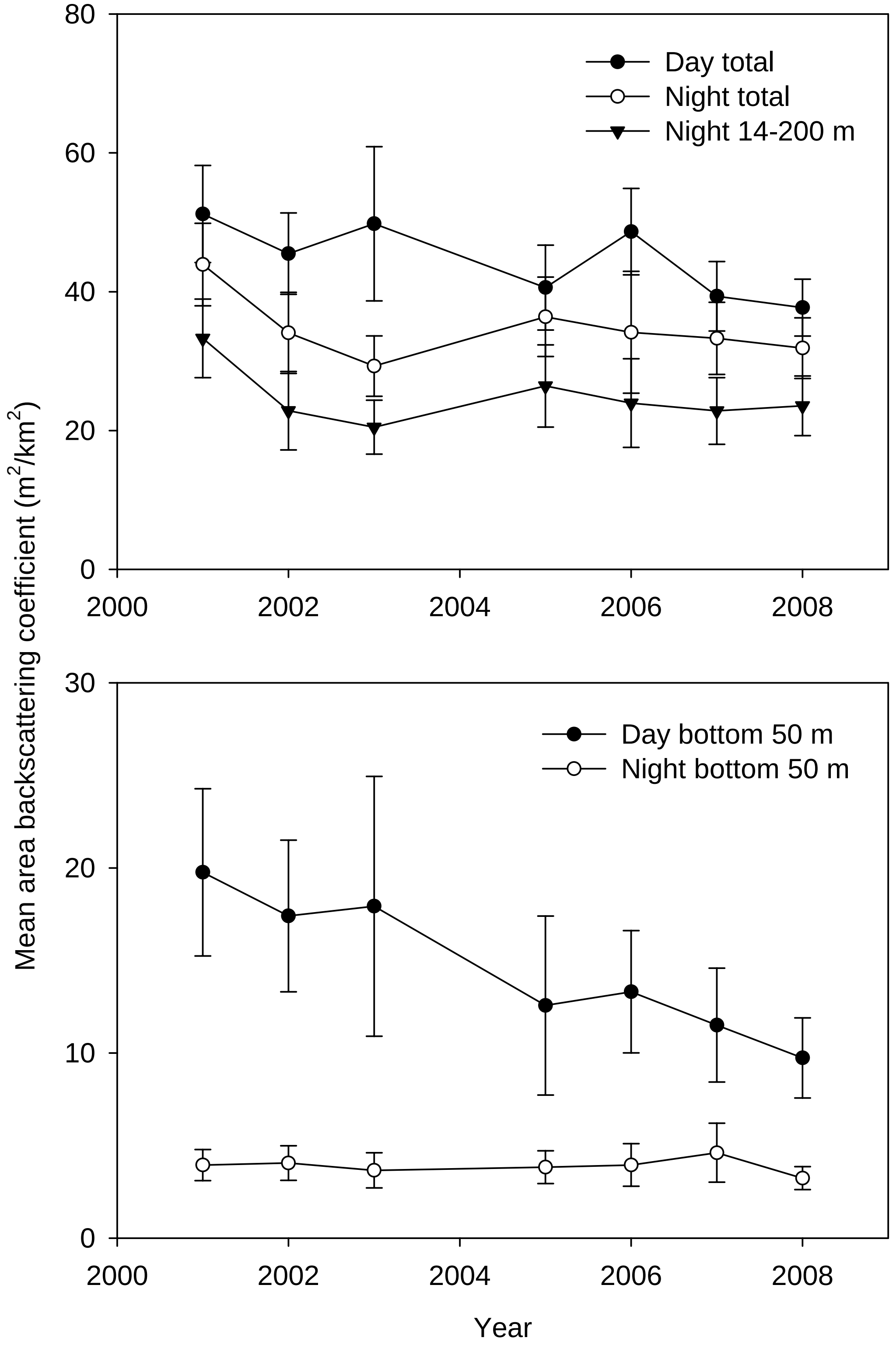


Figure 19. Comparison of relative acoustic abundance indices for the Chatham Rise based on (strata-averaged) mean areal backscatter (s_a). Error bars are ± 2 standard errors.

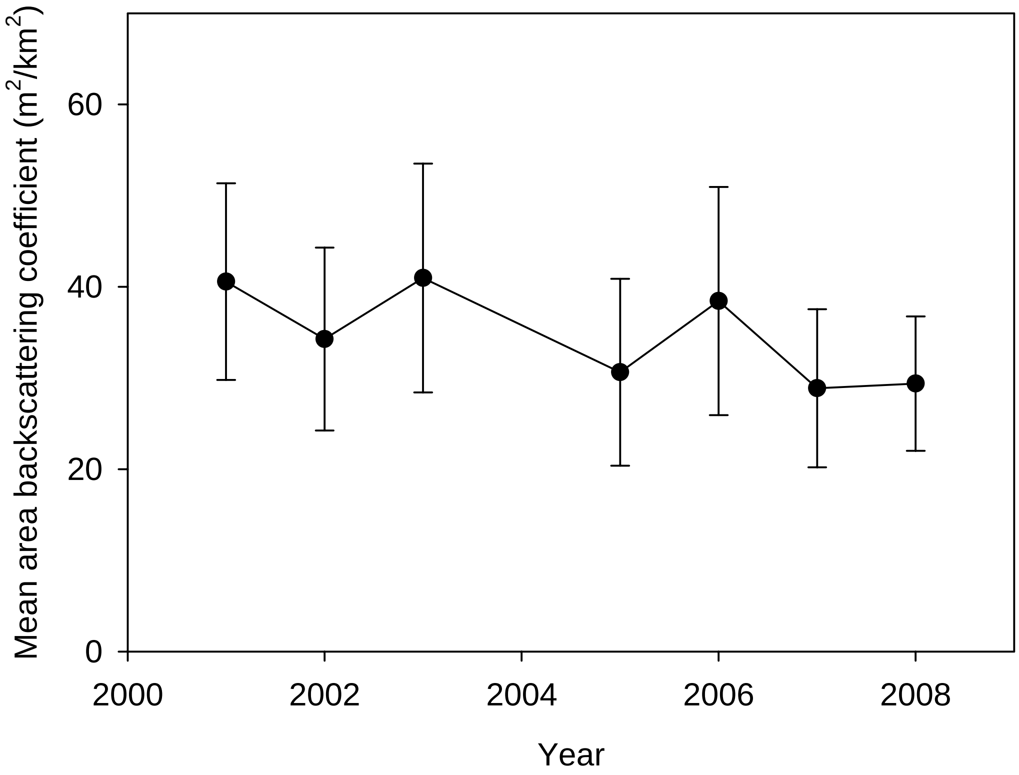


Figure 20. Relative acoustic abundance indices for mesopelagic fish on the Chatham Rise. Estimates were derived from day estimates of total backscatter with the night bathypelagic and demersal components (which remain deeper than 200 m at night) subtracted. Error bars are approximate 95% confidence intervals from bootstrapping.

Appendix 1: Individual station data for all stations conducted during the survey (TAN0801). P1, phase 1 trawl survey biomass stations; P2, phase 2 trawl survey biomass stations; RN, research night stations (fine meshed midwater trawls for the feeding study); RF, feeding tows for additional stomach samples; Strat., Stratum number.

						Start tow		Gear depth		Dist.			Catch
Stn.	Type	Strat.	Date	Time	Latitude	Longitude			m	Towed			kg
				NZST	° ' S	° '	E/W	min.	max.	n. mile	hoki	hake	ling
1	P1	2A	28-Dec-07	0705	42 44.28	177 05.87	E	772	783	3.00	98.7	0.0	0.0
2	P1	2A	28-Dec-07	1040	42 45.70	177 14.80	E	733	739	3.00	161.1	14.3	30.8
3	P1	2A	28-Dec-07	1245	42 45.83	177 23.47	E	767	770	3.00	94.0	1.2	9.6
4	P1	20	28-Dec-07	1802	43 15.66	178 03.03	E	320	339	3.00	729.8	3.0	44.9
5	RN	20	28-Dec-07	2141	43 17.40	178 06.09	E	50	64	1.60	0.1	0.0	0.0
6	P1	20	29-Dec-07	0515	43 13.47	178 27.35	E	381	390	3.00	445.1	0.0	36.3
7	P1	20	29-Dec-07	0750	43 01.52	178 37.06	E	380	386	3.00	383.6	4.7	46.9
8	P1	8B	29-Dec-07	0958	43 02.43	178 51.88	E	414	416	3.01	925.0	5.9	18.9
9	P1	8B	29-Dec-07	1312	43 11.43	179 01.28	E	421	424	3.01	207.6	4.7	70.2
10	P1	8B	29-Dec-07	1551	43 10.97	179 20.91	E	433	439	3.00	694.8	14.4	11.0
11	PI	20	30-Dec-07	0505	43 22.31	178 53.22	E	386	395	3.00	179.5	8.8	39.7
12	P1	20	30-Dec-07	0931	43 35.35	179 40.12	E	392	396	3.00	295.7	7.6	19.0
13	P1*	8B	30-Dec-07	1210	43 33.14	179 57.74	E	402	412	3.01	772.2	40.7	87.2
14	P1	10A	30-Dec-07	1448	43 31.04	179 58.74	W	401	403	3.00	767.8	1.8	44.7
15	P1	10A	30-Dec-07	1652	43 33.37	179 48.18	W	401	407	3.00	200.3	10.4	42.0
16	P1*	10A	30-Dec-07	1842	43 27.87	179 45.85	W	416	420	0.84	53.7	0.0	22.5
17	P1	3	31-Dec-07	0507	43 47.33	179 32.12	W	326	328	2.99	361.5	0.0	31.5
18	P1	3	31-Dec-07	0657	43 43.95	179 26.11	W	367	375	3.00	328.9	3.6	25.4
19	P1	3	31-Dec-07	0905	43 35.86	179 22.23	W	383	399	3.00	349.9	19.5	50.2
20	P1	10A	31-Dec-07	1216	43 20.93	179 46.89	W	483	492	3.01	116.5	13.8	25.6
21	P1	10B	31-Dec-07	1534	43 14.17	179 27.67	W	508	515	3.01	213.7	18.3	17.7
22	P1	10B	31-Dec-07	1810	43 03.12	179 13.05	W	530	531	3.00	187.7	5.5	10.8
23	RN	10B	31-Dec-07	2137	43 01.46	179 11.49	W	56	63	1.55	0.0	0.0	0.0
24	P1	2B	1-Jan-08	0507	42 52.94	179 36.46	W	728	733	2.98	74.4	0.0	11.6
25	P1	2B	1-Jan-08	0657	42 51.90	179 27.81	W	732	734	3.00	66.4	0.0	13.4
26	P1	10B	1-Jan-08	1014	42 57.07	179 15.32	W	549	559	3.00	339.4	8.9	7.0
27	P1	11B	1-Jan-08	1230	42 58.00	178 59.18	W	525	531	3.00	148.4	2.9	6.3
28	P1	11B	1-Jan-08	1531	43 02.28	178 34.39	W	527	597	2.98	130.6	0.0	59.8
29	P1	11B	1-Jan-08	1739	43 08.46	178 37.46	W	489	503	3.01	139.3	8.9	3.6
30	RN	11B	1-Jan-08	2138	43 10.18	178 39.24	W	50	58	1.57	0.0	0.0	0.0
31	P1	11A	2-Jan-08	0503	43 15.73	178 57.29	W	464	467	3.01	183.3	82.5	17.3
32	P1	11A	2-Jan-08	0822	43 37.85	178 43.86	W	445	452	3.00	266.5	36.9	14.4
33	P1	11A	2-Jan-08	1009	43 36.93	178 34.84	W	407	418	2.46	951.8	24.1	13.1
34	P1	11A	2-Jan-08	1218	43 34.32	178 22.87	W	414	422	3.01	1328.3	8.5	34.9
35	P1	11A	2-Jan-08	1600	43 31.17	178 11.72	W	402	419	2.99	345.4	5.7	26.0
36	P1	4	3-Jan-08	0503	44 18.51	178 59.86	W	640	648	3.01	133.5	0.0	14.8
37	P1*	13	3-Jan-08	0720	44 13.56	179 07.71	W	484	492	1.68	142.2	12.2	14.1
38	P1	12	3-Jan-08	1826	43 59.19	177 56.08	W	459	461	3.00	151.7	3.4	56.7
39	P1	5	4-Jan-08	0500	44 09.72	176 58.43	W	237	239	2.51	76.9	0.0	10.7
40	P1	9	4-Jan-08	1807	43 46.82	175 38.93	W	295	321	3.00	171.9	0.0	4.2
41	P1	9	5-Jan-08	0505	43 43.82	175 52.64	W	214	219	2.99	52.7	0.0	8.8
42	P1	12	5-Jan-08	0806	43 37.69	175 28.15	W	475	501	2.99	211.5	2.9	27.4
43	P1	12	5-Jan-08	1010	43 36.81	175 14.00	W	567	578	3.02	201.3	0.0	14.0

Appendix 1 (continued)

			Start tow					Gear depth		Dist.	Catch		
Stn.	Type	Strat.	Date	Time	Latitude	Longitude			m	towed			kg
				NZST	° ' S	° '	E/W	min.	max.	n. mile	hoki	hake	ling
44	P1	11D	5-Jan-08	1429	43 25.03	175 37.75	W	486	504	3.03	197.7	0.0	24.5
45	P1	2B	5-Jan-08	1757	43 10.66	175 37.62	W	666	684	3.00	89.3	2.5	30.9
46	RN	2B	5-Jan-08	2143	43 12.94	175 36.24	W	50	59	1.55	0.0	0.0	0.0
47	P1	2B	6-Jan-08	0502	43 02.63	175 52.78	W	707	713	3.01	16.7	19.2	25.5
48	P1	11D	6-Jan-08	0736	43 08.87	176 06.18	W	543	553	3.00	98.4	14.3	55.2
49	P1	11D	6-Jan-08	1230	43 02.17	176 58.48	W	546	555	3.00	148.5	15.4	0.0
50	P1	2B	6-Jan-08	1455	42 53.07	177 10.45	W	722	730	3.01	134.9	2.4	41.1
51	P1	2B	6-Jan-08	1720	42 50.94	177 22.72	W	775	780	3.02	51.6	4.2	5.4
52	RN	2B	6-Jan-08	2146	42 51.03	177 25.42	W	50	59	1.57	0.0	0.0	0.0
53	P1	11C	7-Jan-08	0506	42 57.76	178 12.39	W	548	550	2.98	86.4	8.5	21.0
54	P1	11C	7-Jan-08	0710	43 00.86	177 59.67	W	514	516	3.00	158.4	0.0	4.0
55	P1	11C	7-Jan-08	0937	43 05.53	177 41.73	W	456	457	3.00	165.4	0.0	24.2
56	P1	9	7-Jan-08	1256	43 24.54	177 33.50	W	314	326	3.01	12.7	0.0	3.0
57	P1	5	7-Jan-08	1531	43 34.94	177 30.13	W	301	315	2.99	85.8	0.0	50.2
58	P1	5	7-Jan-08	1746	43 35.86	177 23.90	W	222	237	2.99	208.3	0.0	3.2
59	PI	13	9-Jan-08	0502	43 51.88	178 28.70	W	448	457	3.00	339.5	2.0	74.6
60	P1	13	9-Jan-08	0753	44 02.40	178 41.72	W	431	450	3.00	167.7	0.0	72.5
61	P1	13	9-Jan-08	1200	44 12.89	179 18.03	W	414	452	3.01	510.5	14.9	84.9
62	P1	14	9-Jan-08	1657	43 59.03	179 49.40	E	490	492	3.01	473.2	0.0	17.7
63	P1	14	10-Jan-08	0505	43 43.29	179 02.25	E	437	443	3.01	184.0	0.0	22.4
64	P1	14	11-Jan-08	0502	43 46.86	177 57.66	E	473	490	3.01	951.9	4.2	29.5
65	P1	15	11-Jan-08	1136	43 40.27	176 59.31	E	452	456	2.99	944.1	1.6	125.0
66	P1	15	11-Jan-08	1512	43 43.70	176 34.62	E	430	439	2.99	828.5	2.1	81.3
67	P1	15	11-Jan-08	1755	43 48.19	176 12.97	E	441	464	2.99	1048.5	24.9	80.3
68	P1	4	12-Jan-08	0508	44 04.42	176 55.53	E	625	637	3.01	133.5	5.4	33.9
69	P1	4	12-Jan-08	0810	44 08.58	176 32.33	E	614	616	3.00	201.7	0.0	49.0
70	P1	17	12-Jan-08	1106	44 06.31	176 08.44	E	290	343	3.02	20668.4	0.0	88.0
71	P1	17	12-Jan-08	1418	44 14.45	176 14.11	E	262	373	3.01	59.6	0.0	0.0
72	P1	17	12-Jan-08	1618	44 20.99	176 08.66	E	310	345	2.52	745.8	0.0	5.2
73	P1	16	13-Jan-08	0507	43 49.21	175 38.94	E	416	423	3.03	477.1	0.0	26.7
74	P1	16	13-Jan-08	0833	44 09.95	175 35.71	E	555	570	3.04	123.1	5.5	90.8
75	P1	16	13-Jan-08	1225	44 01.63	175 01.21	E	476	480	3.01	323.2	13.9	60.8
76	P1	16	13-Jan-08	1552	44 16.34	174 43.39	E	578	583	3.01	171.5	9.5	49.7
77	P1	6	13-Jan-08	1838	44 25.63	174 38.22	E	679	681	3.01	118.3	4.3	40.7
78	P1	6	14-Jan-08	0512	44 32.93	173 35.96	E	701	723	3.02	69.8	7.4	21.0
79	P1	6	14-Jan-08	0723	44 23.89	173 35.72	E	658	662	3.00	133.9	8.9	11.7
80	P1*	16	14-Jan-08	1204	44 02.43	174 16.90	E	557	563	1.43	–	11.2	–
81	P1	16	14-Jan-08	1351	43 59.22	174 23.39	E	564	567	2.98	151.6	9.0	20.3
82	P1	16	14-Jan-08	1634	43 49.85	174 22.07	E	540	547	3.04	154.5	7.6	27.5
83	P1	7	15-Jan-08	0518	43 39.36	174 10.02	E	467	486	2.99	690.2	2.8	39.1
84	P1	7	15-Jan-08	0711	43 36.70	174 14.77	E	519	541	3.00	112.0	0.0	18.6
85	P1	7	15-Jan-08	0928	43 30.03	174 28.18	E	524	539	3.00	352.2	6.1	58.9
86	P1	1	15-Jan-08	1258	43 26.46	174 05.56	E	714	742	3.03	84.8	5.5	14.3
87	P1	7	15-Jan-08	1501	43 20.49	174 09.42	E	569	574	3.00	164.2	2.8	64.1
88	P1	1	15-Jan-08	1805	43 09.07	174 19.62	E	602	609	3.01	391.8	4.9	63.6
89	P1	1	16-Jan-08	0514	42 58.93	174 34.97	E	782	796	2.84	67.1	10.2	3.6

Appendix 1 (continued)

Stn.	Type	Strat.	Date	Start tow Time NZST	Latitude ° ' S	Longitude ° '	E/W	Gear depth m min.	max.	Dist. towed n. mile	Catch Kg hoki	hake	Ling
90	P1	7	16-Jan-08	0812	43 06.12	174 50.91	E	448	478	3.00	2030.3	48.9	62.0
91	P1	18	16-Jan-08	1126	43 25.42	174 51.43	E	278	320	3.00	2109.1	3.5	62.4
92	P1	18	16-Jan-08	1540	43 33.41	175 31.73	E	244	245	3.01	363.1	0.0	0.0
93	P1	18	16-Jan-08	1822	43 26.48	175 38.00	E	217	230	3.01	181.9	0.0	4.1
94	P2	17	17-Jan-08	0517	44 11.62	175 50.17	E	287	330	3.00	271.6	0.0	65.0
95	P2	17	17-Jan-08	0823	44 05.48	175 52.41	E	325	346	3.00	295.6	0.0	35.0
96	P1*	18	17-Jan-08	1413	43 41.80	175 25.11	E	330	342	1.17	–	–	–
97	P1	18	17-Jan-08	1713	43 33.80	175 36.21	E	255	267	2.99	549.5	0.0	3.0
98	P1	7	18-Jan-08	0517	43 12.68	175 44.96	E	402	436	2.99	1481.3	46.9	134.8
99	P1	19	18-Jan-08	0846	43 05.64	176 17.20	E	375	395	3.00	30.3	10.8	12.9
100	P1	8A	18-Jan-08	1120	43 00.45	176 31.09	E	430	440	3.02	275.5	12.5	53.9
101	P1	8A	18-Jan-08	1347	42 47.70	176 34.99	E	546	557	3.00	890.8	8.6	25.2
102	P1	8A	18-Jan-08	1801	42 52.51	177 02.83	E	407	411	2.99	683.7	3.1	55.2
103	P1	19	19-Jan-08	0513	43 10.22	176 32.17	E	307	314	2.99	160.6	0.0	93.1
104	P1	19	19-Jan-08	0915	43 28.59	177 00.22	E	248	254	3.00	40.6	0.0	0.0
105	P1	19	19-Jan-08	1250	43 09.75	177 10.12	E	240	252	3.01	6.8	0.0	0.0
106	P1	19	19-Jan-08	1520	43 03.28	177 19.13	E	289	298	3.00	1501.8	0.0	8.4
107	P1	19	19-Jan-08	1812	43 14.91	177 20.41	E	226	238	3.00	103.4	0.0	0.0
108	P2	14	20-Jan-08	0512	43 57.73	179 08.94	E	570	583	3.02	517.2	12.0	37.5
109	P2	14	20-Jan-08	0945	43 38.07	179 23.07	E	444	451	3.00	178.3	0.0	22.1
110	P2	8B	20-Jan-08	1345	43 15.59	179 23.50	E	434	435	3.00	228.8	0.0	30.4
111	P2	8B	20-Jan-08	1537	43 15.19	179 12.14	E	436	442	3.01	199.2	0.0	70.7
112	P1	22	21-Jan-08	0515	42 49.25	179 54.31	E	966	971	3.01	9.9	14.6	0.0
113	P1	22	21-Jan-08	0720	42 52.23	179 45.12	E	867	874	3.01	71.2	0.0	0.0
114	P1	22	21-Jan-08	1027	42 53.49	179 16.29	E	837	856	3.00	100.9	3.6	39.2
115	P1	22	21-Jan-08	1410	42 51.60	178 44.34	E	912	924	3.03	56.8	5.8	6.8

* Foul trawl stations

Appendix 2: Scientific and common names of species caught from valid biomass tows (TAN0801). The occurrence (Occ.) of each species (number of tows caught) in the 101 valid core biomass tows is also shown. Note that species codes are continually updated on the database following this and other surveys.

Scientific name	Common name	Species	Occ.
Algae			
Durvillea spp.	bull kelp	KBL	1
Porifera	unspecified sponges	ONG	3
Hexactinellida (glass sponges)			
Lyssacinosida (tubular sponges)			
Rossellidae			
Hyalascus sp.	floppy tubular sponge	HYA	22
Demospongiae (siliceous sponges)			
Astrophorida (sandpaper sponges)			
Ancorinidae			
Ancorina novaezelandiae	knobbly sandpaper sponge	ANZ	3
Jaspis sp.		ONG	1
Tethyopsis sp.		ONG	1
Geodiidae			
Geodia regina		ONG	1
Geodinella vestigifera	convoluted ostrich egg sponge	GVE	2
Pachymatisma sp.		ONG	2
Pachastrellidae			
Thenea novaezelandiae	yoyo sponge	THN	2
Dictyoceratida (rubber sponges)			
Dysideidae			
Dysidea sp.		ONG	1
Irciniidae			
Psammocinia sp.	rubber sponge	PHW	1
Hadromerida (woody sponges)			
Suberitidae			
Suberites affinis	fleshy club sponge	SUA	9
Haplosclerida (air sponges)			
Callyspongia cf. *ramosa*	airy finger sponge	CRM	1
Hymedesmiidae			
Phorbas sp.	grey fibrous massive sponge	PHB	1
Poecilosclerida (bright sponges)			
Coelosphaeridae			
Lissodendoryx bifacialis		ONG	1
Latrunculiidae			
Latrunculia sp.		ONG	1
Mycalidae			
Mycale incurvata		ONG	1
Myxillidae			
Biemna sp.		ONG	1
Cnidaria			
Hydrozoa	unspecified hydroid	HDR	2
Scyphozoa	unspecified jellyfish	JFI	6
Anthozoa			
Octocorallia			
Alcyonacea (soft corals)	unspecified soft coral	SOC	1
Gorgonacea (gorgonian corals)		GOC	
Acanthogorgiidae			
Acanthogorgia spp.		GOC	1

Appendix 2 (continued)

Scientific name	Common name	Specie s	Occ.
Anthothelidae			
Iciligorgia spp.		GOC	2
Chrysogorgiidae			
Radicipes spp.		GOC	5
Primnoidae			
Thouarella spp.	bottlebrush coral	THO	1
Pennatulacea (sea pens)	unspecified sea pens	SPN	8
Anthoptilidae			
Anthoptilum spp.		SPN	1
Pennatulidae			
Pennatula spp.	purple sea pens	PNN	4
Hexacorallia			
Zoanthidea (zoanthids)			
Epizoanthidae			
Epizoanthus sp.		EPZ	1
Actinaria (anemones)	unspecified anemones	ANT	2
Actinostolidae (smooth deepsea anemones)		ACS	15
Hormathiidae (warty deepsea anemones)		HMT	9
Scleractinia (stony corals)	unspecified stony coral	SIA	3
Caryophyllidae			
Caryophyllia spp.	carnation cup coral	CAY	1
Desmophyllum dianthus	crested cup coral	DDI	2
Goniocorella dumosa	bushy hard coral	GDU	7
Solenosmilia variabilis	deepwater branching coral	SVA	2
Flabellidae			
Flabellum spp.	flabellum coral	COF	6
Oculinidae			
Oculina virgosa	deepwater branching coral	OVI	1
Ascidiacea	unspecified sea squirt	ASC	1
Tunicata			
Thaliacea (salps)	unspecified salps	SAL	3
Mollusca			
Gastropoda (gastropods)			
Nudibranchia (sea slugs)	unspecified sea slug	NUD	2
Ranellidae (tritons)			
Fusitriton magellanicus		FMA	25
Bivalvia (bivalves)			
Limidae			
Acesta maui	giant file shell	AMA	1
Cephalopoda			
Teuthoidea (squids)	unspecified squid	SQX	1
Onychoteuthidae			
Moroteuthis ingens	warty squid	MIQ	29
M. robsoni	warty squid	MRQ	2
Histioteuthidae			
Histioteuthis spp.	violet squid	VSQ	1

Appendix 2 (continued)

Scientific name	Common name	Species	Occ.
Ommastrephidae			
Nototodarus sloanii	Sloan's arrow squid	NOS	53
Ommastrephes bartrami	Ommastrephid squid	RSQ	1
Todarodes filippovae and *T. angolensis*	*Todarodes* squid	TSQ	25
Pholidoteuthidae			
Pholidoteuthis massyae boschmai	large red scaly squid	PSQ	2
Cranchiidae	cranchiid squid	CHQ	7
Octopoda (octopods)	unspecified octopod	OCP	8
Octopodidae			
Benthoctopus spp.	deepwater octopus	BNO	1
Enteroctopus zealandicus	yellow octopus	EZE	3
Graneledone spp.	deepwater octopus	DWO	4
Crustacea			
Malacostraca			
Dendrobranchiata/Pleocyemata (prawns)			
Dendrobranchiata			
Solenoceridae			
Haliporoides sibogae	jack-knife prawn	HSI	1
Pleocyemata			
Caridea			
Pasiphaeidae			
Pasiphaea aff. *tarda*	deepwater prawn	PTA	2
Nematocarcinidae			
Lipkius holthuisi	omega prawn	LHO	14
Penaeidea			
Sergestidae			
Sergestes spp.	sergestid prawn	SER	2
Astacidea			
Nephropidae (clawed lobsters)			
Metanephrops challengeri	scampi	SCI	14
Palinura			
Polychelidae			
Polycheles spp.	deepsea blind lobster	PLY	4
Anomura			
Galatheoidea			
Galatheidae (squat lobsters)			
Munida gracilis		MGA	2
Uroptychus sp.		URP	3
Lithodidae (king crabs)			
Lithodes murrayi	Murray's king crab	LMU	1
Paralomis zealandica	prickly king crab	PZE	5
Paguroidea (unspecified pagurid & parapagurid hermit crabs)		PAG	2
Paguridae (Pagurid hermit crabs)			
Porcellanopagrus sp.	hermit crab	PAG	1
Brachyura			
Atelecyclidae			
Trichopeltarion fantasticum	frilled crab	TFA	8
Goneplacidae			
Neommatocarcinus huttoni	policeman crab	NHU	2
Homolidae			
Dagnaudus petterdi	antlered crab	DAP	7

Appendix 2 (continued)

Scientific name	Common name	Specie s	Occ.
Majidae (spider crabs)			
Leptomithrax garricki	Garrick's masking crab	GMC	5
Teratomaia richardsoni	spiny masking crab	SMK	5
Portunidae (swimming crabs)			
Liocarcinus corrugatus	dwarf swimming crab	LCO	1
Ovalipes molleri	swimming crab	OVM	1
Echinodermata			
Crinoidea (sea lilies and feather stars)			
Antedonidae	unspecified feather star	CMT	1
Asteroidea (starfish)			
Asteriidae			
Cosmasterias dyscrita	cat's-foot star	CDY	2
Pseudechinaster rubens	starfish	PRU	13
Astropectinidae			
Dipsacaster magnificus	magnificent sea-star	DMG	18
Plutonaster knoxi	abyssal star	PKN	21
Proserpinaster neozelanicus	starfish	PNE	4
Psilaster acuminatus	geometric star	PSI	34
Sclerasterias mollis	cross-fish	SMO	9
Benthopectinidae			
Benthopecten spp.	starfish	BES	4
Brisingida	armless stars	BRG	2
Novodiniidae			
Novodinia novaezelandiae		BRG	1
Echinasteridae			
Henricia compacta		HEC	1
Goniasteridae			
Hippasteria phrygiana	trojan starfish	HTR	8
Mediaster sladeni	starfish	MSL	15
Pillsburiaster aoteanus	starfish	PAO	2
Pterasteridae			
Diplopteraster sp.	starfish	DPP	1
Solasteridae			
Crossaster multispinus	sun star	CJA	8
Solaster torulatus	chubby sun-star	SOT	6
Zoroasteridae			
Zoroaster spp.	rat-tail star	ZOR	36
Ophiuroidea (basket and brittle stars)	unspecified brittle star	OPH	1
Euryalina (basket stars)			
Gorgonocephalidae			
Astrothorax waitei	Waites snake-star	AWA	1
Gorgonocephalus spp.	Gorgon's head basket stars	GOR	6
Echinoidea (sea urchins)			
Regularia			
Cidaridae (cidarid urchins)			
Goniocidaris parasol	parasol urchin	GPA	8
Echinothuriidae (Tam O'Shanter urchins)	unspecified Tam O'Shanter urchin	TAM	30
Echinidae			
Gracilechinus multidentatus	deepsea kina	GRM	5
Dermechinus horridus	deepsea urchin	DHO	1

Appendix 2 (continued)

Scientific name	Common name	Specie s	Occ.
Spatangidae (heart urchins)			
Spatangus multispinus	purple-heart urchin	SPT	10
Holothuroidea	unspecified sea cucumber	HTH	1
Aspidochirotida			
Synallactidae			
Bathyplotes moseleyi	sea cucumber	BAM	7
Pseudostichopus mollis	sea cucumber	PMO	10
Dendrochirotida			
Psolidae			
Psolus sp.	sea cucumber	HTH	2
Elasipodida			
Laetmogonidae			
Laetmogone sp.	sea cucumber	LAG	7
Pannychia moseleyi	sea cucumber	PAM	7
Brachiopoda	unspecified lamp shell	BPD	2
Agnatha (jawless fishes)			
Eptatretus cirrhatus	hagfish	HAG	1
Chondrichthyes (cartilagenous fishes)			
Chlamydoselachidae: frill shark			
Chlamydoselachus anguineus	frill shark	FRS	2
Hexanchidae: cow sharks			
Hexanchus griseus	sixgill shark	HEX	2
Squalidae: dogfishes			
Centrophorus squamosus	leafscale gulper shark	CSQ	22
Centroscymnus crepidater	longnose velvet dogfish	CYP	19
C. owstoni	smooth skin dogfish	CYO	15
C. plunketi	Plunket's shark	PLS	12
Deania calcea	shovelnose dogfish	SND	45
Etmopterus baxteri	Baxter's dogfish	ETB	21
E. lucifer	Lucifer dogfish	ETL	63
Scymnorhinus licha	seal shark	BSH	33
Squalus acanthias	spiny dogfish	SPD	67
S. griffini	northern spiny dogfish	NSD	3
Alopiidae: thresher sharks			
Alopius vulpinus	thresher shark	THR	1
Oxynotidae: rough sharks			
Oxynotus bruniensis	prickly dogfish	PDG	10
Scyliorhinidae: cat sharks			
Apristurus spp.	catshark	APR	1
Cephaloscyllium isabellum	carpet shark	CAR	2
Halaelurus dawsoni	Dawson's catshark	DCS	2
Triakidae: smoothhounds			
Galeorhinus galeus	school shark	SCH	6
Torpedinidae: electric rays			
Torpedo fairchildi	electric ray	ERA	1
Narkidae: blind electric rays			
Typhlonarke spp.	numbfish	BER	1

Appendix 2 (continued)

Scientific name	Common name	Species	Occ.
Rajidae: skates			
Dipturus innominatus	smooth skate	SSK	28
Notoraja spp.	bluntnose deepsea skates	BTH	37
Chimaeridae: chimaeras, ghostsharks			
Hydrolagus bemisi	pale ghost shark	GSP	72
H. novaezealandiae	dark ghost shark	GSH	58
Rhinochimaeridae: longnosed chimaeras			
Harriotta raleighana	long-nosed chimaera	LCH	44
Rhinochimaera pacifica	widenosed chimaera	RCH	6
Osteichthyes (bony fishes)			
Halosauridae: halosaurs			
Halosaurus pectoralis	common halosaur	HPE	3
Notocanthidae: spiny eels			
Notacanthus sexspinis	spineback	SBK	52
Synaphobranchidae: cutthroat eels			
Diastobranchus capensis	basketwork eel	BEE	3
Congridae: conger eels			
Bassanago bulbiceps	swollenhead conger	SCO	30
B. hirsutus	hairy conger	HCO	27
Gonorynchidae: sandfish			
Gonorynchus forsteri & *G. greyi*	sandfishes	GON	2
Argentinidae: silversides			
Argentina elongata	silverside	SSI	43
Bathylagidae: deepsea smelts			
Bathylagus spp.	deepsea smelt	DSS	1
Alepocephalidae: slickheads			
Alepocephalus australis	smallscaled brown slickhead	SSM	3
Xenodermichthys spp.	black slickhead	BSL	8
Gonostomatidae: lightfishes		GST	3
Sternoptychidae: hatchetfishes		HAT	1
Argyrinus iridescens	hatchetfish	AIR	1
Photichthyidae: lighthouse fishes			
Photichthys argenteus	lighthouse fish	PHO	11
Chauliodontidae: viperfishes			
Chauliodus sloani	viperfish	CHA	3
Malacosteidae: loosejaws	unspecified loosejaw	MAL	1
Idiacanthidae: black dragonfishes			
Idiacanthus spp.		IDI	3
Paralepididae: barracudinas	unspecified barracudina	PAL	1
Anotopteridae: daggertooth			
Anotopterus pharao	daggertooth	ANP	1
Myctophidae: lanternfishes	unspecified lantern fish	LAN	4
Diaphus spp.		DIA	1
Lampanyctus spp.		LPA	1
Moridae: morid cods			
Antimora rostrata	violet cod	VCO	4
Halargyreus johnsonii	Johnson's cod	HJO	16
Lepidion microcephalus	small-headed cod	SMC	3
Mora moro	ribaldo	RIB	37
Pseudophycis bachus	red cod	RCO	22
Tripterophycis gilchristi	grenadier cod	GRC	1

Appendix 2 (continued)

Scientific name	Common name	Specie s	Occ.
Gadidae: true cods			
Micromesistius australis	southern blue whiting	SBW	3
Merlucciidae: hakes			
Macruronus novaezelandiae	hoki	HOK	105
Merluccius australis	hake	HAK	65
Macrouridae: rattails, grenadiers			
Caelorinchus aspercephalus	oblique banded rattail	CAS	55
C. biclinozonalis	two saddle rattail	CBI	13
C. bollonsi	bigeye rattail	CBO	84
C. cookianus	Cook's rattail	CCO	1
C. fasciatus	banded rattail	CFA	38
C. innotabilis	notable rattail	CIN	14
C. matamua	Mahia rattail	CMA	12
C. parvifasciatus	small banded rattail	CCX	3
C. oliverianus	Oliver's rattail	COL	71
Coryphaenoides dossenus	humpback (slender) rattail	CBA	5
C. serrulatus	serrulate rattail	CSE	11
C. subserrulatus	four-rayed rattail	CSU	15
Lepidorhynchus denticulatus	javelinfish	JAV	99
Mesobius antipodum	black javelinfish	BJA	1
Nezumia namatahi	squashed face rattail		
Trachyrincus aphyodes	white rattail	WHX	12
Ventrifossa nigromaculata	blackspot rattail	VNI	31
Ophidiidae: cuskeels			
Genypterus blacodes	ling	LIN	96
Carapidae: pearlfishes			
Pyramodon ventralis	pearlfish	PVE	1
Ceratiidae: seadevils			
Ceratias spp.		CER	1
Cryptopsaras couesi	seadevil	SDE	1
Trachichthyidae: roughies, slimeheads			
Hoplostethus atlanticus	orange roughy	ORH	9
H. mediterraneus	silver roughy	SRH	43
Paratrachichthys trailli	common roughy	RHY	9
Diretmidae: discfishes			
Diretmus argenteus	discfish	DIS	1
Berycidae: alfonsinos			
Beryx decadactylus	longfinned beryx	BYD	2
B. splendens	alfonsino	BYS	28
Taratichthys longipinnis	big-scale pomfret	BSP	1
Zeidae: dories			
Capromimus abbreviatus	capro dory	CDO	11
Cyttus novaezealandiae	silver dory	SDO	21
C. traversi	lookdown dory	LDO	95
Zenopsis nebulosus	mirror dory	MDO	4
Oreosomatidae: oreos			
Allocyttus niger	black oreo	BOE	9
Neocyttus rhomboidalis	spiky oreo	SOR	23
Pseudocyttus maculatus	smooth oreo	SSO	11
Macrorhamphosidae: snipefishes			
Centriscops humerosus	banded bellowsfish	BBE	76

Appendix 2 (continued)

Scientific name	Common name	Specie s	Occ.
Scorpaenidae: scorpionfishes			
Helicolenus spp.	sea perch	SPE	91
Congiopodidae: pigfishes			
Alertichthys blacki	alert pigfish	API	1
Congiopodus coriaceus	deepsea pigfish	DSP	2
Congiopodus leucopaecilus	pigfish	PIG	2
Triglidae: gurnards			
Cheilidonichthys kumu	red gurnard	GUR	1
Lepidotrigla brachyoptera	scaly gurnard	SCG	14
Hoplichthyidae: ghostflatheads			
Hoplichthys haswelli	deepsea flathead	FHD	31
Psychrolutidae: toadfishes			
Ambophthalmos angustus	pale toadfish	TOP	13
Percichthyidae: temperate basses			
Polyprion oxygeneios	hapuku	HAP	11
Serranidae: sea perches, gropers			
Lepidoperca aurantia	orange perch	OPE	11
Apogonidae: cardinalfishes			
Epigonus denticulatus	white cardinalfish	EPD	3
E. lenimen	bigeye cardinalfish	EPL	13
E. robustus	robust cardinalfish	EPR	9
E. telescopus	deepsea cardinalfish	EPT	15
Carangidae: trevallies, kingfishes			
Trachurus declivis	jack mackerel	JMD	4
T. symmetricus murphyi	slender mackerel	JMM	8
Bramidae: pomfrets			
Brama brama	Ray's bream	RBM	19
Emmelichthyidae: bonnetmouths, rovers			
Emmelichthys nitidus	redbait	RBT	9
Plagiogeneion rubiginosum	rubyfish	RBY	2
Cheilodactylidae: tarakihi, morwongs			
Nemadactylus macropterus	tarakihi	TAR	8
Latridae: moki, trumpeters			
Latris lineata	trumpeter	TRU	1
Uranoscopidae: armourhead stargazers			
Kathetostoma giganteum	giant stargazer	STA	47
Percophidae: opalfishes			
Hemerocoetes spp.	opalfish	OPA	1
Pinguipedidae: sandperches, weevers			
Parapercis gilliesi	yellow cod	YCO	1
Gempylidae: snake mackerels			
Ruvettus pretiosus	oilfish	OFH	1
Thyrsites atun	barracouta	BAR	14
Trichiuridae: cutlassfishes			
Lepidopus caudatus	frostfish	FRO	1
Scombridae: mackerels, tunas			
Scomber australasicus	blue mackerel	EMA	1

Appendix 2 (continued)

Centrolophidae: raftfishes, medusafishes			
Centrolophus niger	rudderfish	RUD	15
Hyperoglyphe antarctica	bluenose	BNS	2
Schedophilus sp.		SUS	7
Seriolella caerulea	white warehou	WWA	43
S. punctata	silver warehou	SWA	53
Bothidae: lefteyed flounders			
Arnoglossus scapha	witch	WIT	13
Neoachiropsetta milfordi	finless flounder	MAN	1
Pleuronectidae: righteyed flounders			
Pelotretis flavilatus	lemon sole	LSO	13

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

	Age group			
Survey	0+	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