New Zealand Fisheries
Assessment Report
2007/5
March 2007
ISSN 1175-1584

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New Zealand Fisheries Assessment Report 2007/5
March 2007

**Published by Ministry of Fisheries**
**Wellington**
**2007**

**ISSN 1175-1584**



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

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

## EXECUTIVE SUMMARY

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The fifteenth 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 2005 and 23 January 2006. Using a random stratified sampling design, 96 phase 1 bottom trawl stations were successfully completed in core depths of 200–800 m. No phase 2 bottom trawl stations were completed due to mechanical problems. The estimate of relative biomass of all hoki was 99 208 t, an increase of 15% from January 2005, and the highest estimate since 1999. This increase was driven by reasonable recruitment of 1+ year old (25 877 t), and 2+ year old (33 586 t) hoki. The biomass estimate for recruited hoki (3+ years and older) increased from 21 200 t in 2005 to 39 745 in 2006, due to inclusion of the above average 2002 year class.

The biomass of hake in core strata increased by 32% to 1384 t, but remains at historically low levels. The biomass of ling was 9301 t, which was slightly higher than in January 2005, but the timeseries for ling shows no overall trend.

Coefficients of variation (c.v.s) achieved were 10.6% for total hoki, 19.3% for hake, and 7.4% for ling. The c.v. for age 2+ hoki was 18.8%, which was below the target c.v. of 20%.

Age frequency distributions of hake showed relatively high numbers of 3 and 4 year olds, possibly indicating two years of reasonable recruitment. Ling age frequencies indicate moderate recruitment during the late 1990s.

Acoustic data were also collected during the trawl survey. There was a weak, but non-significant, correlation between acoustic density estimates and trawl catch rates.

## 1. INTRODUCTION

In January 2006, the fifteenth 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 research vessel *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), and Stevens & O'Driscoll (2006). 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 2006 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 principle 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 these 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), to provide estimates of the ratio of acoustic vulnerability to trawl catchability for hoki and other species (O'Driscoll 2002, 2003), and to estimate biomass of mesopelagic fish (McClatchie & Dunford 2003, McClatchie et al. 2005). 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 collection of unidentified organisms collected in the trawl, collection of stomach samples from a range of fish species, collection of prey species from beam and midwater trawls at night, and tagging of chemically marked giant stargazers (see Section 1.1).

### 1.1 Project objectives

The trawl survey was carried out under contract to the Ministry of Fisheries (project HOK2005/02). 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.

As with the 2005 survey, two additional objectives were added to the 2006 survey under Ministry of Fisheries projects ZBD2004/02 and STA2004/03.

The first of these projects aims to study trophic relationships between key species on the Chatham Rise (ZBD2004/02). The overall objective of this work is:

1. To characterise trophic relationships among abundant fish species of the Chatham Rise in a format that will inform ecosystem-based fisheries management and contribute directly to the creation of a trophic ecosystem model.

The second of these projects (STA2004/03) aims to validate presumed annual otolith growth zones of giant stargazer (*Kathetostoma giganteum*) by tagging and releasing chemically marked individuals. The overall objective of this work is:

1. To validate growth zones in stargazer (*Kathetostoma giganteum*) otoliths.

## 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, 2004, and 2005 (Livingston, et al. 2004, Livingston & Stevens 2005, Stevens & O'Driscoll 2006). Station allocation for phase 1 was determined from simulations based on catch rates from the last three Chatham Rise trawl surveys (2003–05), using the 'allocate' optimisation programme (after Bull et al. 2000) to achieve the Ministry of Fisheries target c.v. of 20% for 2 year old hoki. A total of 96 stations was originally planned for phase 1, with up to 21 phase 2 stations to be allocated at sea to improve c.v.s for hoki and hake, and to increase the number of hake sampled.

### 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 and a beam 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. The beam trawl had a headline height of 0.6 m and a codend liner 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 0449 h and 1902 h NZST, except for 8 mesopelagic tows and 7 beam trawl bottom tows which were carried out at night to provide key prey species for the trophic study. 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 a custom-built *CREST* system (Coombs et al. 2003) with hull-mounted Simrad single-beam 12 kHz and 38 kHz transducers. *CREST* is a computer-based ‘software echo-sounder’ which supports multiple channels. The transmitter was a switching type with a nominal power output of 2 kW rms. Transmitted pulse length was 1 ms with 3 s between transmits. The *CREST* receiver has a broadband, wide dynamic range pre-amplifier and serial analog-to-digital converters (ADCs), which feed a digital signal processor (DSP56002). Data from the ADCs were complex demodulated, filtered, and a 20 log $R$ time-varied gain was applied, with the complex data stored for later processing. The 38 kHz transducer has been 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.

## 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 and digital photographs 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.

Sampling of fish stomachs during the survey was based upon the protocol described by Livingston (2004). Stomach sampling targeted the 25 most abundant species caught on the survey. Biological data describing length, weight, sex, and on occasions, maturity status, were collected for each specimen, and then the stomachs were carefully removed, individually labelled, and frozen. Stomach contents will be analysed in the NIWA laboratory as part of project ZBD2004/02.

## 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 match phase 1, P1 - no phase 2 stations were conducted on this survey, see 3.1 below) 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 750 hoki otoliths and 640 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 hake otoliths 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

All acoustic recordings made during the trawl survey were visually examined. Marks were classified into eight categories based on the relative depth of the mark in the water column, mark orientation (surface- or bottom-referenced), mark structure (layers, schools, or single targets), 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 eight marks types are given below. Example echograms may be found in Cordue et al. (1998), Bull (2000), and O'Driscoll (2001a, 2001b).

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 appear as crescents on 12 kHz. Equivalent to 'bullet' marks of Cordue et al. (1998) and Bull (2000).

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).

8. Single targets

Inverted U-shaped single targets visible on 38 kHz close to the bottom.

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 also carried out to compare acoustic backscatter from bottom-referenced marks with daytime trawl catch rates. Acoustic data collected on 38-kHz during each tow were integrated using custom Echo Sounder Package (ESP2) software (McNeill 2001) to calculate the mean acoustic backscatter per km$^2$. Two values of acoustic backscatter were calculated for each trawl. The first estimate was based an integration height of 10 m above the acoustic bottom, which was similar to the measured headline height of the trawl (average 7.0 m). The second acoustic estimate integrated all backscatter from the bottom up to the maximum height of the bottom referenced mark or 100 m, but excluded all other mark types. Raw acoustic density estimates (backscatter per km$^2$) were then compared with trawl catch rates (kg per km$^2$). No attempt was made to scale acoustic estimates by target strength, corrected for differences in catchability, or carry out species decomposition (O'Driscoll 2002, 2003).

## 3. RESULTS

### 3.1 2005 survey coverage

The trawl survey was successfully completed. A total of 96 successful phase 1 biomass tows were carried out (Table 1, Figure 2). Due to winch problems, *Tangaroa* had to return to port for repairs slose to the end of the survey. Although *Tangaroa* later resumed trawling and completed the phase 1 stations, no phase 2 tows were completed. A further 6 random bottom trawl stations were excluded from the biomass calculations: 3 tows which came fast, one in which the net was ripped, one hauled early due to rough bottom, and one which was too deep for the survey area. An additional 8 fine meshed mesopelagic tows and 7 beam tows were carried out at night were time permitted to provide specimens of key prey species for the trophic study (ZBD2004/02).

Station density ranged from 1:288 km$^2$ in stratum 17 (200–400 m, Veryan Bank) to 1:3722 km$^2$ in stratum 4 (600–800 m, south Chatham Rise). Mean station density was 1:1530 km$^2$.

### 3.2 Gear performance

Gear configuration for valid biomass tows was relatively constant over the 200–800 m depth range. Mean doorspread measurements by 200 m depth intervals ranged from 112.5 to 119.1 m and mean headline height ranged from 6.8 to 7.0 m, and were all within the optimal range (Hurst et al. 1992) (Table 3).

The dates of the trawl survey were within the time frame covered in previous years (Table 2). Doorspread and headline readings were recorded for all 96 valid biomass stations (Table 3).

### 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 12.5 to 17.1 °C. Bottom temperatures, ranged from 5.8 to 10.7 °C (Figure 3, bottom panel).

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

### 3.4 Catch composition

Two hundred and five species or species groups were recorded from the 96 valid biomass tows. The total catch was 110 t, of which 45.1 t (41.0%) was hoki, 7.7 t (7.0%) was javelinfish, 6.3 t (5.7%) was dark ghost shark, 4.7 t (4.3%) was black oreo, 4.2 t (3.8%) was ling, and 4.1 t (3.7%) was big eye rattail (Table 4).

Of the 205 species or species groups identified, there were 95 teleosts, 25 elasmobranches, 1 agnathan (blind eel), 21 crustaceans, and 9 cephalopods, the remainder consisting of assorted benthic and pelagic invertebrates. A full list of species caught, and the number of stations at which they occurred, is given in Appendix 2. A number of benthic invertebrates are awaiting formal identification.

### 3.5 Biomass estimates

Relative biomass was estimated for 48 species (Table 4). The c.v.s achieved for hoki, hake, and ling were 10.6%, 19.3%, and 7.4% respectively. The c.v. for 2+ hoki (2003 year class) was 18.8%, 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 and silver warehou are not demersal and exhibit strong schooling behaviour. Others, such as smooth 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 higher than in 2005 but similar to that in 2004 (Figure 4, top panel). Although at historically low levels, hoki biomass was 17% higher than in 2005. As in previous years, hoki was still the most abundant species caught (Table 4), and formed a similar proportion of the total biomass to last year (Figure 4, lower panel). Black oreo, dark ghost shark, ling, lookdown dory, silver warehou, spiky oreo, alfonsino, sea perch, spiny dogfish, pale ghost shark, white warehou, arrow squid, smooth oreo, and giant stargazer were the next most abundant QMS species after hoki, each with an estimated biomass over 2000 t. The most abundant commercial non-QMS species was shovelnose dogfish with a biomass of 2815 t. A substantial biomass of non-commercial species, primarily javelinfish and bigeye rattails was also estimated (Table 4).

The relative hoki biomass, estimated at 99 208 t, was 15% higher than that of 2005 (Table 5). This increase was driven by average 1+ (2004 year class) and 2+ cohorts (2003 year class). The biomass of fish aged 3 years and over (3++) increased from 21 200 t in 2005 to 33 586, due to recruitment of the above average 2002 year class, but remains at historically low levels (Table 6). The hake biomass estimate was about 30% higher than that of 2005. Ling biomass was up slightly from 2005.

The relative biomass of lookdown dory and sea perch increased from 2005, while the biomass of dark ghost sharks and silver warehou was about the same, and the biomass of giant stargazer, silver warehou, spiny dogfish and pale ghost sharks decreased (Figure 5).

### 3.6 Catch distribution

#### Hoki

In the 2006 survey, hoki were caught at 93 of the 96 biomass stations, but the highest catch rates were mainly in shallow strata (200–400 m) along the crest of the Chatham Rise, reflecting the abundance of juvenile (1+ and 2+) hoki (Figures 6a and 6b). One year old hoki (2004 year class) were relatively abundant and largely confined to the Mernoo, Reserve, and Veryan Banks (strata 18, 19, 20, and 17) on the western side of the survey area. Two year old hoki (2003 year class) were abundant across much of the rise in 200-400 m depth, and sometimes to 600 m depth. The older 3++ fish were distributed throughout much of the survey area, but were often associated with juvenile hoki in the 200-600 m strata, probably reflecting the distribution of the above average 2002 year class (Figure 6c). The highest individual 2006 catch rate of hoki occurred in stratum 11D, to the northeast of the Chatham Islands and consisted mainly of 2+ and 3+ hoki.

### Hake

In 2006, catch rates of hake were higher than in 2005, and similar to those in 2004. The highest catch rates were in stratum 7, east of the Mernoo Bank, and in the hake spawning area in strata 10B and 11A (Figure 7). The highest individual catch rate of hake was in stratum 7 and appears to have been associated with juvenile hoki. Few hake were taken from the top of the rise at depths of 200–400 m and from the south side of the survey area. The decline in hake catch rates over the time series is seen in Figure 7.

### Ling

As in previous years, catches of ling were evenly distributed throughout most strata in the survey area (Figure 8). The largest catch was taken on the Veryan Bank (stratum 17). Ling distribution has been reasonably consistent, and catch rates have remained relatively stable over the time series.

### Other species

As with previous surveys, sea perch and lookdown dory were widely distributed throughout the survey area, but were more abundant in 200–600 m depths on the west and eastern halves of the survey area respectively. Spiny dogfish were also widely distributed, although larger catches were taken from the southern rise in 200–600 m depths. Dark ghost shark where mainly caught in 200–400 m depths with the largest catch again taken in stratum 17 on Veryan Bank. Pale ghost shark were mainly captured in deeper water at 400–800 m depth. Giant stargazer were more abundant around the Mernoo, Veryan, and Reserve banks, and to the west of the Chatham Islands in 200-400 m depths. Silver warehou and white warehou were patchily distributed and predominantly taken at depths of 200–600 m (Figure 9, Tables 7 and 8).

## 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 9.

### 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 of 1+, 2+ and 3++ hoki, are given in Table 10.

### Hoki

The 1+ (less than 49 cm), 2+ (49–63 cm), and 3+ (63-73 cm) age classes of hoki dominated scaled length frequencies and age frequencies in the 2006 survey (Figures 10 and 11), and confirm the observation of good 1+ and 2+ age classes in 2005. As with previous years, there were very few larger adults over 4 years of age present in the survey area in 2006.

### Hake

Hake scaled length frequencies and calculated numbers at age (Figures 12 and 13) show a pulse of small fish from 45 to about 65 cm of age 3+ and 4+. This confirms the observation of a good 3+ age-class in 2005, however, the reasonable numbers of 3+ in 2006 were not observed as 2+ fish in 2005. This may be due to reduced availability of 2+ hake in the survey area. Few hake longer than 70 cm and older than age 5 were caught in 2006.

### Ling

Ling scaled length frequencies and calculated numbers at age comprise mainly medium-sized individuals of 4–11 years old, which corresponds to a period of strong recruitment during the 1990s (Figures 14 and 15). The time series is a poor indicator of 1+ and 2+ age class strength for ling, perhaps because of reduced selectivity or availability in the survey area.

### Other species

Length frequency distributions for other species are shown in Figure 16. Clear modes are apparent in the size distributions of white and silver warehou, which probably correspond to yearly cohorts. Length frequencies of lookdown dory, giant stargazer, spiny dogfish, and dark ghost shark indicate that females grow larger than males. It is unclear if modal peaks correspond to individual year classes in the length frequencies of these species (Figure 16).

### 3.7.3 Reproductive status

Gonad stages of hake, hoki, ling, sea perch, and small numbers of other species are summarised in Table 11. Almost all hoki (97%) were either resting or immature. About 28% of male ling were ripe, but few females were showing signs of reproductive activity this year. Due to reasonable recruitment in 2001 and possibly 2002, about 40% of hake were immature. Another 27% of hake were resting, and about 20% of females had gonads that were ripening. A reasonable number (26%) of female lookdown dory were ripe (Table 11). Adults of most other species were resting.

### 3.7.4 Sex ratios

The overall sex ratio for hoki (1.02 females to every 1 male) were almost even (see Figure 10) Female hake were more abundant than males (1.27:1) (Figure 12), while male ling were more abundant than females (0.78 females: 1 male) (see Figure 14). As with previous years, the catch of spiny dogfish was dominated by females (3.63:1), and there were more female than male giant stargazers (1.80:1) caught. Sex ratios were about even for most other species (see Figure 16).

### 3.7.5 Additional objectives

### Trophic study (project ZBD2004/02)

The aims of the trophic study were successfully met, with 6961 fish stomachs collected from 25 key species and a few large trophic predators (see Table 9). Fifteen night tows were carried out: 8 fine meshed mesopelagic tows and 7 beam tows to provide specimens of key prey species for the trophic study.

### Giant stargazer age validation (project STA2004/03)

The aims of the giant stargazer age validation study were successfully met, with 165 giant stargazers tagged and released. No tagged stargazers were recaptured from those tagged on last years survey.

## 3.8 Acoustic results

### 3.8.1 Description of acoustic mark types

A total of 214 acoustic data files (110 'trawl' files and 104 'steam' files) were recorded during the trawl survey. Good weather conditions for much of the voyage meant that quality of acoustic recordings was generally good (72% of all echograms) or marginal (17%). Only 8% of the trawl files were considered too poor to be analysed quantitatively. The frequency of occurrence of each of the eight mark categories is given in Table 12. 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 95% of day steam files and 88% of trawl files (Table 13). 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 94% of night recordings and most day echograms. Pelagic schools were observed in 47% of day steam files, 40% of trawl files, and 15% of night files (Table 13). 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.

Eight night trawls were carried out using a fine-meshed midwater trawl during the 2006 survey to provide information on key prey species as part of the trophic feeding study (MFish project ZBD2004/02). Five of these trawls sampled surface layers from 0–160 m depth (tows 12, 45, 76, 77, 107). These tows caught mainly myctophids (83% of total catch), with small quantities of pearlsides (3%), squid (3%), crustaceans (3%), salps (2%), and other demersal and pelagic fish (6%). This was broadly similar to the catch composition from surface layers in 2005, when 10 trawls caught 59% myctophids, 26% salps, 7% crustaceans, and 3% squid (Stevens & O'Driscoll 2006). Three midwater trawls in 2006 sampled deeper pelagic clouds from 200–680 m depth (tows 43, 44, and 106). These deeper tows also caught myctophids (42% of total catch), but there was a higher proportion of demersal fish (30%), squid (20%), and crustaceans (6%) than in tows on shallower surface layers. Catch rates in all mesopelagic trawls in 2006 were low, with a maximum catch of 16.6 kg in tow 77.

Bottom layers were observed in 87% of day steam files, 67% of day trawl files, and 45% of night files (Table 13). 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, particularly when the seabed rose or fell. Bottom-referenced schools were present in 16% of daytime (trawl and steam) recordings, and were most abundant in 200–400 m water depth (see Table 12). Bottom schools and layers 10–70 m off the bottom were sometimes associated with large catches of 1+ and 2+ hoki (e.g., Figure 17a), but also with other species such as barracouta and alfonsino (Stevens & O'Driscoll 2006). Single target echoes close to the bottom were observed in most files, regardless of depth or time of day (see Table 12). Single targets usually occurred in the same echogram as other mark types, making identification of the species responsible for the single target echoes difficult, but probably consist of low densities of demersal fish.

Table 13 compares the percentage occurrence of marks on the Chatham Rise in 2006 with that from two previous surveys in 2003 and 2005. Daytime marks on the Chatham Rise in 2006 were generally similar to those observed in previous surveys, although there were a lower proportion of bottom schools in 2006. Daytime mark types such as pelagic schools, pelagic layers and bottom layers were more frequently recorded during night recordings in 2005 and 2006 than in 2003 (Table 13). This was probably because some night steams started relatively early in the evening during the last two surveys (before 18:00 NZST), before marks dispersed and ascended.

### 3.8.2 Comparison of acoustics with bottom trawl catches

Acoustic data from 88 trawl files were integrated and compared with trawl catch rates. Data from the other 22 trawl recordings were not included in the analysis because the acoustic data were too noisy (8 files), they were carried out at night (8 files), or because the trawl was not considered suitable for biomass estimation (6 files). Average acoustic backscatter from the bottom 10 m and trawl catch rates (for all species combined) in 2006 were similar to 2001–05 (Table 14). There was a very weak positive correlation between acoustic backscatter and trawl catch rates in 2006 (Figure 18), which was not statistically significant ($p = 0.14$). In previous Chatham Rise surveys from 2001–05, rank correlations between trawl catch rates and acoustic density estimates (from the entire bottom-referenced layer) ranged from 0.18 (in 2003) to 0.46 (in 2001).

The weak correlation between acoustic backscatter and trawl catch rates (Figure 18) arises because large catches are sometimes made when there are only weak marks observed acoustically, and conversely, relatively little is caught in some trawls where dense marks are present. The two echograms in Figure 17 correspond to trawls at similar depths in adjacent strata with very similar catches of small hoki and other species. However, there is 30 times more acoustic backscatter within 10 m of the bottom, and 70 times more backscatter in the bottom 100 m, in tow 81 (Figure 17b) compared to tow 79 (Figure 17a). O'Driscoll (2003) suggested that bottom-referenced layers on the Chatham Rise (such as those shown in Figure 17b) 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. 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.

## 4. CONCLUSIONS

The 2006 survey successfully extended the January Chatham Rise time series into its fifteenth year and provided abundance indices for hoki, hake, and ling. The survey c.v. of 18.8% achieved for 2+ hoki was well within the target precision level of 20%. The estimated total biomass of hoki was 15% higher than in the previous survey, due to reasonable recruitment of 1+ and 2+ year old hoki into the survey area. The estimated biomass of recruited hoki (3+ years and older) increased by 87% from 2005 (21 200 t to 39 745 t), due to inclusion of the reasonable 2002 year class, but continues to remain at low levels compared to the 1990s. The biomass of hake in core strata increased by 32% to 1384 t, due to a good showing of 3+ (2002 year class) and 4+ (2001 year class) year old hake, but the overall biomass estimate remains at historically low levels. The biomass of ling was similar to previous surveys and the trawl time-series has showed no overall trend.

## 5. ACKNOWLEDGMENTS

We thank the scientific staff and the Master, officers, and crew of *Tangaroa* who contributed to the success of this voyage. Thanks also to our internal reviewer, Neil Bagley, for providing constructive comments on this manuscript, and to the scientific staff involved with the preparation, reading, and calculation of catch at age data for hoki, hake, and ling otoliths from this survey. This work was carried out by NIWA under contract to the Ministry of Fisheries (Project HOK2005/02).

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**Table 1: The number of completed valid biomass stations by stratum during Phases 1 of the 2006 survey (Note: No Phase 2 stations were completed during the 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 | 5 | | 5 | 1: 1 701 |
| 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 | 7 | | 7 | 1: 748 |
| 8A | 400–600 | NW Chatham Rise | 3 286 | 3 | | 3 | 1: 1 095 |
| 8B | 400–600 | NW Chatham Rise | 5 722 | 3 | | 3 | 1: 1 907 |
| 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: 1 121 |
| 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 | | 3 | 1: 1 976 |
| 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 | | 3 | 1: 288 |
| 18 | 200–400 | Mernoo Bank | 4 687 | 5 | | 5 | 1: 937 |
| 19 | 200–400 | Reserve Bank | 9 012 | 6 | | 6 | 1: 1 502 |
| 20 | 200–400 | Reserve Bank | 9 584 | 5 | | 5 | 1: 1 917 |
| Total | | | 146 855 | 96 | 0 | 96 | 1: 1 530 |

**Table 2: Survey dates and number of valid 200-800 m depth biomass stations in surveys of the Chatham Rise, January 1992-2006**

| 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 |

**Table 3: Tow and gear parameters by depth range for valid biomass stations. 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) | 96 | 2.9 | 0.20 | 2.0–3.1 |
| Tow speed (knots) | 95 | 3.5 | 0.05 | 3.0–3.6 |
| **Gear parameters** | | | | |
| 200–400 m | | | | |
| Headline height | 28 | 7.0 | 0.22 | 6.6–7.4 |
| Doorspread | 28 | 112.5 | 6.9 | 95.3–124.2 |
| 400–600 m | | | | |
| Headline height | 51 | 6.8 | 0.12 | 6.6–7.1 |
| Doorspread | 51 | 119.1 | 4.35 | 105.8–128.8 |
| 600–800 m | | | | |
| Headline height | 17 | 6.9 | 0.12 | 6.6–7.0 |
| Doorspread | 17 | 117.1 | 3.29 | 110.3–122.1 |
| All stations 200–800 m | | | | |
| Headline height | 96 | 6.9 | 0.17 | 6.6–7.4 |
| Doorspread | 96 | 116.8 | 5.81 | 95.3–128.8 |

**Table 4: Catch (kg) and total biomass (t) estimates (also by sex) with coefficient of variation (c.v.), of QMS species, other commercial species, and major non-commercial species for valid biomass stations in 200–800 m depths. Total biomass includes unsexed fish. (-, no data.) Note: A number of giant stargazers were tagged and released and therefore were not sexed**

| Common name | Code | Catch | Biomass males | | Biomass females | | Total biomass | |
|---|---|---|---|---|---|---|---|---|
| | | kg | t | % c.v. | t | % c.v. | t | % c.v. |
| **QMS species** | | | | | | | | |
| Hoki | HOK | 45 068 | 45 137 | 11.8 | 53 950 | 9.9 | 99 208 | 10.6 |
| Black oreo | BOE | 4 720 | 12 409 | 35.1 | 10 200 | 27.6 | 22 625 | 31.3 |
| Dark ghost shark | GSH | 6 293 | 4 649 | 12.3 | 6 850 | 12.3 | 11 502 | 11.9 |
| Ling | LIN | 4 202 | 4 800 | 9.9 | 4 485 | 7.9 | 9 301 | 7.4 |
| Lookdown dory | LDO | 3 139 | 2 526 | 8.8 | 5 252 | 10.2 | 7 818 | 8.4 |
| Silver warehou | SWA | 2 850 | 3 827 | 53.3 | 3 877 | 46.6 | 7 704 | 48.1 |
| Spiky oreo | SOR | 2 784 | 4 058 | 33.8 | 3 517 | 30.5 | 7 576 | 32.1 |
| Alfonsino | BYS | 3 955 | 3 823 | 88.6 | 2 480 | 87.5 | 6 439 | 86.4 |
| Sea perch | SPE | 2 464 | 2 972 | 9.9 | 2 617 | 11.0 | 5 752 | 10.0 |
| Spiny dogfish | SPD | 2 613 | 969 | 15.6 | 4 667 | 14.4 | 5 650 | 14.1 |
| Pale ghost shark | GSP | 1 264 | 1 434 | 11.9 | 1 788 | 11.1 | 3 237 | 10.5 |
| White warehou | WWA | 1 523 | 1 464 | 34.4 | 1 462 | 25.4 | 2 929 | 29.4 |
| Arrow squid | NOS | 1 901 | 1 103 | 26.9 | 1 534 | 30.9 | 2 678 | 28.6 |
| Smooth oreo | SSO | 455 | 1 131 | 44.6 | 877 | 47.5 | 2 010 | 45.6 |
| Giant stargazer | STA | 960 | 152 | 25.3 | 639 | 26.8 | 2 007 | 19.5 |
| Smooth skate | SSK | 730 | 598 | 37.3 | 840 | 31.0 | 1 521 | 28.7 |
| Hake | HAK | 851 | 445 | 24.8 | 939 | 20.8 | 1 384 | 19.3 |
| Barracouta | BAR | 197 | 339 | 80.1 | 123 | 57.3 | 462 | 72.0 |
| Red cod | RCO | 194 | 202 | 57.2 | 127 | 34.3 | 337 | 46.0 |
| School shark | SCH | 144 | 242 | 47.9 | 45 | 71.2 | 304 | 40.8 |
| Ribaldo | RIB | 144 | 91 | 15.9 | 223 | 24.3 | 313 | 16.9 |
| Southern Ray's bream | SRB | 172 | 160 | 30.4 | 196 | 27.5 | 411 | 26.9 |
| Bluenose | BNS | 116 | 78 | 39.5 | 123 | 59.6 | 201 | 47.2 |
| Slender mackerel | JMM | 44 | 40 | 79.4 | 23 | 91.3 | 76 | 70.7 |
| Tarakihi | TAR | 24 | 43 | 53.9 | 29 | 69.0 | 72 | 55.5 |
| Lemon sole | LSO | 27 | 26 | 32.9 | 31 | 18.8 | 58 | 21.0 |
| Rough skate | RSK | 18 | 32 | 70.9 | 24 | 100 | 56 | 55.8 |
| Trumpeter | TRU | 17 | 31 | 77.1 | 12 | 100 | 43 | 82.1 |
| Scampi | SCI | 17 | 19 | 30.2 | 12 | 20.4 | 37 | 21.0 |
| Deepsea cardinalfish | EPT | 19 | 15 | 51.2 | 11 | 60.7 | 28 | 40.9 |
| Hapuku | HAP | 14 | - | | 24 | 41.1 | 24 | 41.1 |
| Frostfish | FRO | 5 | 8 | 66.5 | 5 | 100 | 13 | 65.1 |
| Rubyfish | RBY | 5 | 5 | 80.0 | 3 | 79.9 | 8 | 80.0 |
| Jack mackerel | JMD | 5 | 6 | 100 | 2 | 100 | 8 | 100 |
| Blue mackerel | EMA | 3 | 5 | 100 | 2 | 100 | 7 | 100 |

(continued on p. 21)

**Table 4 (continued)**

| Common name | Code | Catch | Biomass males | | Biomass females | | Total biomass | |
|---|---|---|---|---|---|---|---|---|
| | | kg | t | % c.v. | t | % c.v. | t | % c.v. |
| **Commercial non-QMS species (where biomass > 30 t)** | | | | | | | | |
| Shovelnose dogfish | SND | 1 329 | 1 268 | 16.5 | 1 543 | 18.7 | 2 815 | 14.4 |
| Redbait | RBT | 44 | 69 | 55.9 | 33 | 55.5 | 102 | 55.1 |
| Southern blue whiting | SBW | 164 | 43 | 99.1 | 32 | 87.3 | 75 | 94.0 |
| Northern spiny dogfish | NSD | 16 | 40 | 70.9 | 0 | | 44 | 64.1 |
| **Non-commercial species (where biomass > 800 t)** | | | | | | | | |
| Javelinfish | JAV | 7 702 | - | - | - | - | 20 380 | 19.6 |
| Big-eye rattail | CBO | 4 114 | - | - | - | - | 10 326 | 9.5 |
| Oliver's rattail | COL | 654 | - | - | - | - | 2 056 | 30.8 |
| Baxter's dogfish | ETB | 380 | - | - | - | - | 1 608 | 49.4 |
| Oblique-banded ratt. | CAS | 1237 | - | - | - | - | 1 489 | 13.0 |
| Orange perch | OPE | 618 | - | - | - | - | 1 425 | 56.6 |
| Banded bellowsfish | BBE | 636 | - | - | - | - | 1 264 | 13.4 |
| Silver dory | SDO | 413 | - | - | - | - | 1 104 | 51.7 |
| Longnose chimaera | LCH | 302 | - | - | - | - | 946 | 18.4 |
| Total (above) | | 104 546 | - | - | - | - | 245 433 | - |
| Grand total (all species) | | 109 977 | - | - | - | - | - | - |

**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 1992-2006. 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 | | | | |

**Table 6: Relative biomass estimates (t in thousands) of hoki, 200–800 m depths, Chatham Rise trawl surveys January 1992–2006 (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) |

**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 | | GSH | | LIN | | LDO | | SWA | | SPE | | SPD | | GSP | | WWA | | STA | | 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 | 116 | 34 | 0 | - | 77 | 58 | 31 | 63 | 0 | - | 8 | 100 | 0 | - | 44 | 30 | 0 | - | 28 | 61 | 24 | 40 |
| 2a | 777 | 61 | 0 | - | 137 | 90 | 57 | 29 | 0 | - | 46 | 44 | 0 | - | 77 | 24 | 0 | - | 44 | 12 | 70 | 78 |
| 2b | 1 367 | 24 | 0 | - | 236 | 18 | 104 | 13 | 0 | - | 108 | 16 | 0 | - | 84 | 18 | 0 | - | 0 | 0 | 167 | 52 |
| 3 | 3 604 | 23 | 1 161 | 48 | 318 | 51 | 338 | 39 | 49 | 39 | 340 | 44 | 487 | 58 | 5 | 100 | 229 | 50 | 41 | 60 | 25 | 52 |
| 4 | 2 138 | 49 | 0 | - | 557 | 51 | 235 | 83 | 0 | - | 77 | 75 | 8 | 100 | 205 | 58 | 11 | 100 | 0 | - | 0 | - |
| 5 | 1 725 | 26 | 1 239 | 13 | 193 | 41 | 732 | 50 | 39 | 82 | 63 | 40 | 346 | 20 | 0 | - | 73 | 84 | 270 | 70 | 12 | 60 |
| 6 | 679 | 68 | 0 | - | 137 | 71 | 0 | - | 67 | 100 | 0 | - | 0 | - | 503 | 40 | 0 | - | 0 | - | 16 | 100 |
| 7 | 4 700 | 61 | 83 | 86 | 738 | 19 | 139 | 22 | 24 | 83 | 171 | 56 | 163 | 52 | 181 | 41 | 575 | 99 | 75 | 78 | 237 | 67 |
| 8a | 2 266 | 41 | 87 | 47 | 336 | 45 | 87 | 28 | 6 | 100 | 180 | 42 | 109 | 64 | 39 | 66 | 0 | - | 13 | 100 | 84 | 34 |
| 8b | 4 790 | 60 | 348 | 86 | 432 | 11 | 743 | 23 | 4 | 100 | 507 | 24 | 403 | 86 | 204 | 41 | 15 | 100 | 2 | 100 | 4 | 100 |
| 9 | 294 | 61 | 942 | 50 | 131 | 50 | 77 | 76 | 2 115 | 97 | 6 | 100 | 126 | 46 | 0 | - | 0 | - | 236 | 56 | 0 | - |
| 10a | 924 | 27 | 170 | 100 | 197 | 41 | 126 | 26 | 8 | 62 | 110 | 47 | 57 | 89 | 65 | 37 | 13 | 100 | 0 | - | 38 | 36 |
| 10b | 942 | 13 | 374 | 81 | 61 | 36 | 165 | 39 | 11 | 53 | 70 | 39 | 71 | 64 | 103 | 34 | 4 | 100 | 11 | 100 | 217 | 65 |
| 11a | 1 336 | 41 | 285 | 54 | 127 | 26 | 218 | 18 | 4 | 63 | 53 | 33 | 152 | 26 | 76 | 53 | 79 | 81 | 10 | 62 | 146 | 61 |
| 11b | 435 | 48 | 0 | - | 26 | 38 | 32 | 19 | 0 | - | 26 | 37 | 0 | - | 25 | 48 | 0 | - | 1 | 100 | 0 | - |
| 11c | 528 | 12 | 56 | 97 | 168 | 27 | 62 | 23 | 0 | - | 25 | 38 | 20 | 17 | 46 | 30 | 0 | - | 34 | 54 | 40 | 50 |
| 11d | 8 777 | 49 | 34 | 82 | 175 | 18 | 158 | 49 | 57 | 100 | 81 | 18 | 0 | - | 15 | 59 | 394 | 97 | 24 | 100 | 19 | 100 |
| 12 | 2 353 | 48 | 40 | 92 | 500 | 12 | 540 | 36 | 52 | 51 | 92 | 70 | 39 | 75 | 308 | 6 | 7 | 100 | 52 | 50 | 16 | 100 |
| 13 | 3 208 | 24 | 486 | 100 | 812 | 33 | 833 | 24 | 494 | 59 | 213 | 22 | 838 | 65 | 309 | 50 | 54 | 63 | 10 | 68 | 39 | 23 |
| 14 | 5 065 | 11 | 25 | 100 | 438 | 10 | 717 | 10 | 126 | 94 | 224 | 9 | 358 | 67 | 273 | 11 | 73 | 78 | 0 | - | 27 | 100 |
| 15 | 7 687 | 47 | 300 | 100 | 579 | 20 | 389 | 41 | 3 054 | 99 | 313 | 73 | 246 | 56 | 210 | 27 | 34 | 50 | 33 | 74 | 0 | - |
| 16 | 11 494 | 35 | 0 | - | 1 372 | 13 | 696 | 16 | 34 | 65 | 145 | 47 | 205 | 34 | 334 | 22 | 343 | 77 | 213 | 30 | 69 | 24 |
| 17 | 1 069 | 59 | 741 | 53 | 131 | 64 | 14 | 33 | 82 | 40 | 6 | 62 | 156 | 21 | 0 | - | 6 | 52 | 70 | 32 | 0 | - |
| 18 | 5 590 | 33 | 763 | 30 | 250 | 69 | 141 | 33 | 205 | 30 | 392 | 50 | 435 | 17 | 0 | - | 74 | 67 | 177 | 58 | 8 | 64 |
| 19 | 9 613 | 43 | 2 034 | 27 | 259 | 57 | 235 | 46 | 882 | 53 | 1 185 | 28 | 558 | 5 | 13 | 67 | 38 | 65 | 225 | 17 | 3 | 100 |
| 20 | 17 731 | 25 | 2 334 | 21 | 916 | 34 | 949 | 26 | 390 | 66 | 1 311 | 18 | 872 | 15 | 117 | 78 | 908 | 46 | 438 | 63 | 125 | 50 |
| Total | 99 208 | 11 | 11 502 | 12 | 9 301 | 7 | 7 818 | 8 | 7 704 | 48 | 5 752 | 10 | 5 650 | 14 | 3 237 | 10 | 2 929 | 29 | 2 007 | 19 | 1 384 | 19 |

**Table 8: Catch rate (kg.km$^{-2}$) and standard deviations (s.d.) of hoki, hake, ling, and 8 other species by stratum (See Table 3 for species common names.) (-, not calculated.)**

| Stratum | HOK | | GSH | | LIN | | LDO | | SWA | | SPE | | SPD | | GSP | | WWA | | STA | | HAK | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | kg.km$^{-2}$ | s.d. | kg.km$^{-2}$ | s.d. | kg.km$^{-2}$ | s.d. | kg.km$^{-2}$ | s.d. | kg.km$^{2}$ | s.d. | kg.km$^{-2}$ | s.d. | kg.km$^{-2}$ | s.d. | kg.km$^{-2}$ | s.d. | kg.km$^{-2}$ | s.d. | kg.km$^{-2}$ | s.d. | kg.km$^{-2}$ | s.d. |
| 1 | 48 | 28 | 0 | - | 32 | 32 | 13 | 14 | 0 | - | 3 | 6 | 0 | - | 18 | 9 | 0 | - | 12 | 12 | 10 | 7 |
| 2a | 239 | 251 | 0 | - | 42 | 66 | 18 | 9 | 0 | - | 14 | 11 | 0 | - | 24 | 10 | 0 | - | 14 | 3 | 21 | 29 |
| 2b | 161 | 88 | 0 | - | 28 | 11 | 12 | 3 | 0 | - | 13 | 5 | 0 | - | 10 | 4 | 0 | - | 0 | - | 20 | 23 |
| 3 | 1 030 | 409 | 332 | 274 | 91 | 80 | 96 | 66 | 14 | 10 | 97 | 73 | 139 | 139 | 1 | 3 | 65 | 57 | 12 | 12 | 7 | 6 |
| 4 | 189 | 162 | 0 | - | 49 | 43 | 21 | 30 | 0 | - | 7 | 9 | 0.7 | 1 | 18 | 18 | 0.9 | 2 | 0 | - | 0 | - |
| 5 | 423 | 189 | 304 | 67 | 47 | 34 | 180 | 157 | 10 | 14 | 15 | 11 | 85 | 30 | 0 | - | 18 | 26 | 66 | 80 | 3 | 3 |
| 6 | 82 | 97 | 0 | - | 17 | 20 | 0 | - | 8 | 14 | 0 | - | 0 | - | 61 | 43 | 0 | - | 0 | - | 2 | 3 |
| 7 | 898 | 1443 | 16 | 36 | 141 | 71 | 27 | 16 | 5 | 10 | 33 | 48 | 31 | 43 | 35 | 37 | 110 | 287 | 14 | 30 | 45 | 81 |
| 8a | 689 | 491 | 27 | 22 | 102 | 80 | 26 | 13 | 2 | 3 | 55 | 40 | 33 | 37 | 12 | 13 | 0 | - | 4 | 7 | 26 | 15 |
| 8b | 837 | 871 | 61 | 91 | 75 | 15 | 130 | 52 | 0.7 | 1 | 89 | 38 | 70 | 104 | 36 | 25 | 3 | 4 | 0.4 | 0.7 | 0.7 | 1 |
| 9 | 57 | 60 | 183 | 160 | 25 | 22 | 15 | 20 | 412 | 691 | 1 | 2 | 25 | 20 | 0 | - | 0 | - | 46 | 45 | 0 | - |
| 10a | 312 | 148 | 57 | 99 | 66 | 47 | 43 | 19 | 3 | 3 | 37 | 30 | 19 | 30 | 22 | 14 | 4 | 8 | 0 | - | 13 | 8 |
| 10b | 280 | 65 | 111 | 155 | 18 | 11 | 49 | 33 | 3 | 3 | 21 | 14 | 21 | 23 | 31 | 18 | 1 | 2 | 3 | 5 | 65 | 72 |
| 11a | 451 | 411 | 96 | 117 | 43 | 25 | 74 | 30 | 1 | 2 | 18 | 13 | 51 | 30 | 26 | 30 | 27 | 48 | 3 | 4 | 49 | 67 |
| 11b | 210 | 175 | 0 | - | 12 | 8 | 15 | 5 | 0 | - | 13 | 8 | 0 | - | 12 | 10 | 0 | - | 0.6 | 1 | 0 | - |
| 11c | 158 | 32 | 17 | 28 | 50 | 23 | 18 | 7 | 0 | - | 8 | 5 | 6 | 2 | 14 | 7 | 0 | - | 10 | 10 | 12 | 10 |
| 11d | 2 606 | 2204 | 10 | 14 | 52 | 16 | 47 | 40 | 17 | 29 | 24 | 7 | 0 | - | 5 | 5 | 117 | 196 | 7 | 13 | 6 | 10 |
| 12 | 358 | 296 | 6 | 10 | 76 | 15 | 82 | 52 | 8 | 7 | 14 | 17 | 6 | 8 | 47 | 5 | 1 | 2 | 8 | 7 | 2 | 4 |
| 13 | 480 | 198 | 73 | 126 | 122 | 71 | 125 | 53 | 74 | 75 | 32 | 12 | 125 | 142 | 46 | 40 | 8 | 9 | 2 | 2 | 6 | 2 |
| 14 | 854 | 159 | 4 | 7 | 74 | 13 | 121 | 21 | 21 | 35 | 38 | 6 | 60 | 70 | 46 | 9 | 12 | 17 | 0 | - | 4 | 8 |
| 15 | 1 316 | 1067 | 51 | 89 | 99 | 35 | 67 | 48 | 523 | 895 | 54 | 68 | 42 | 41 | 36 | 17 | 6 | 5 | 6 | 7 | 0 | - |
| 16 | 998 | 860 | 0 | - | 119 | 39 | 60 | 24 | 3 | 5 | 13 | 14 | 18 | 15 | 29 | 15 | 30 | 56 | 19 | 14 | 6 | 4 |
| 17 | 1 236 | 1269 | 856 | 780 | 152 | 167 | 16 | 9 | 95 | 66 | 7 | 8 | 180 | 66 | 0 | - | 7 | 6 | 81 | 44 | 0 | - |
| 18 | 1 193 | 882 | 163 | 110 | 53 | 82 | 30 | 22 | 44 | 30 | 84 | 94 | 93 | 36 | 0 | - | 16 | 24 | 38 | 49 | 2 | 2 |
| 19 | 1 067 | 1134 | 226 | 151 | 29 | 40 | 26 | 29 | 98 | 126 | 132 | 90 | 62 | 8 | 1 | 2 | 4 | 7 | 25 | 11 | 0.3 | 0.7 |
| 20 | 1 850 | 1017 | 244 | 115 | 96 | 72 | 99 | 58 | 41 | 60 | 137 | 56 | 91 | 30 | 12 | 21 | 95 | 98 | 46 | 65 | 13 | 15 |

Species code

**Table 9: Total numbers of fish, squid, and scampi measured for length frequency distributions and biological samples from all stations. The number of stomachs collected is also provided**

| Species | Number measured Males | Number measured Females | Number measured Total* | Number of biological samples | Number of stomachs collected |
|---|---|---|---|---|---|
| Alfonsino | 276 | 176 | 552 | 324 | 90 |
| Arrow squid | 595 | 718 | 1 370 | 1 055 | 143 |
| Banded bellowsfish | 2 | 54 | 1 890 | 1 437 | 130 |
| Barracouta | 76 | 23 | 99 | 69 | 50 |
| Baxter's dogfish | 159 | 97 | 256 | | |
| Bigeye rattail | 1 046 | 946 | 2 604 | 2 481 | 434 |
| Black oreo | 419 | 321 | 741 | | |
| Bluenose | 14 | 16 | 30 | 3 | |
| Blue mackerel | 2 | 1 | 3 | 3 | |
| Dark ghost shark | 1 531 | 1 837 | 3 370 | 1525 | 367 |
| Deepsea cardinalfish | 50 | 7 | 68 | 30 | |
| Frill shark | 0 | 1 | 1 | 1 | |
| Frostfish | 3 | 1 | 4 | 4 | 4 |
| Giant stargazer | 57 | 86 | 322 | 322 | 97 |
| Hake | 127 | 136 | 265 | 265 | 234 |
| Hapuku | 0 | 3 | 3 | 3 | 1 |
| Hoki | 7 102 | 8 801 | 15 969 | 2 196 | 716 |
| Jack mackerel (*T. declivis*) | 5 | 2 | 7 | | |
| Javelin fish | 35 | 262 | 5 144 | 4 780 | 524 |
| Leafscale gulper shark | 4 | 15 | 19 | 16 | 16 |
| Lemon sole | 35 | 33 | 68 | | |
| Ling | 999 | 881 | 1 882 | 1 765 | 946 |
| Longnose velvet dogfish | 112 | 177 | 291 | 91 | 58 |
| Long-nosed chimaera | 135 | 114 | 251 | 249 | 180 |
| Lookdown dory | 1 502 | 1 619 | 3 158 | 2 634 | 219 |
| Lucifer dogfish | 38 | 34 | 80 | | |
| Northern spiny dogfish | 4 | 0 | 4 | | |
| Oblique banded rattail | 57 | 698 | 1 465 | 1 420 | 228 |
| Oilfish | 0 | 1 | 1 | 1 | |
| Oliver's rattail | 168 | 320 | 1 870 | 1 714 | 250 |
| Orange perch | 175 | 170 | 355 | 235 | 97 |
| Orange roughy | 38 | 23 | 84 | | |
| Pale ghost shark | 330 | 370 | 704 | 656 | 267 |
| Plunket's shark | 4 | 9 | 13 | 10 | 10 |
| Red cod | 135 | 78 | 214 | 152 | 70 |
| Redbait | 66 | 39 | 105 | | |
| Ribaldo | 44 | 47 | 91 | 63 | 1 |
| Rough skate | 2 | 1 | 3 | 1 | |
| Ruby fish | 3 | 2 | 5 | 5 | |
| Scampi | 70 | 57 | 135 | 135 | |
| School shark | 7 | 2 | 10 | 10 | 10 |
| Sea perch | 1 203 | 1 270 | 2 696 | 2 108 | 221 |
| Seal shark | 5 | 28 | 33 | 33 | 24 |
| Shovelnose dogfish | 437 | 381 | 822 | 485 | 398 |
| Silverside | 0 | 0 | 30 | | |
| Silver warehou | 588 | 523 | 1 111 | 770 | 267 |
| Slender mackerel (*T. s. murphyi*) | 21 | 12 | 33 | | |
| Smoothskin dogfish | 7 | 10 | 17 | 16 | 15 |
| Smooth oreo | 223 | 167 | 391 | 237 | |
| Smooth skate | 20 | 19 | 40 | 40 | 40 |

**Table 9 (continued)**

| | | | | | |
|---|---|---|---|---|---|
| Southern blue whiting | 34 | 28 | 62 | | |
| Southern Ray's bream (*B. australis*) | 52 | 59 | 114 | 111 | 104 |
| Spiky oreo | 642 | 556 | 1 202 | 68 | |
| Spiny dogfish | 327 | 1 140 | 1 469 | 1 187 | 636 |
| Tarakihi | 11 | 7 | 18 | 10 | |
| Trumpeter | 3 | 1 | 4 | 1 | |
| White warehou | 335 | 344 | 682 | 390 | 114 |
| Wide-nosed chimaera | 1 | 0 | 1 | | |
| | | | | | |
| Total | | | 52 233 | 29 131 | 6 961 |

* Total sometimes exceeds sum of male and female fish due to the presence of some fish that are recorded unsexed.

**Table 10: Length-weight regression parameters* used to scale length frequencies**

| Species | *a* (intercept) | *b* (slope) | $r^2$ | *n* | Length range (cm) | Data source |
|---|---|---|---|---|---|---|
| Alfonsino | 0.013557 | 3.154521 | 0.98 | 182 | 17–47 | TAN0601 |
| Dark ghost shark | 0.003144 | 3.156958 | 0.97 | 862 | 32–71 | TAN0601 |
| Giant stargazer | 0.008933 | 3.150787 | 0.98 | 285 | 8–80 | TAN0601 |
| Hake | 0.002212 | 3.265915 | 0.99 | 262 | 38–133 | TAN0601 |
| Hoki | 0.004478 | 2.904336 | 0.99 | 2 076 | 34–110 | TAN0601 |
| Ling | 0.001389 | 3.269408 | 0.99 | 1 751 | 33–150 | TAN0601 |
| Lookdown dory | 0.025097 | 2.951996 | 0.98 | 1 288 | 12–57 | TAN0601 |
| Orange perch | 0.010848 | 3.216931 | 0.95 | 162 | 16–37 | TAN0601 |
| Pale ghost shark | 0.006604 | 2.964592 | 0.97 | 549 | 30–89 | TAN0601 |
| Sea perch | 0.011792 | 3.089367 | 0.98 | 1 198 | 13–48 | TAN0601 |
| Shovelnose dogfish | 0.001964 | 3.134533 | 0.99 | 437 | 31–115 | TAN0601 |
| Silver warehou | 0.017241 | 3.018155 | 0.99 | 585 | 22–57 | TAN0601 |
| Spiny dogfish | 0.001269 | 3.277916 | 0.96 | 935 | 54–129 | TAN0601 |
| White warehou | 0.040664 | 2.832498 | 0.98 | 350 | 17–59 | TAN0601 |
| | | | | | | |
| Lemon sole | 0.006492 | 3.170475 | 0.92 | 125 | 24–39 | TAN9106-TAN0201 |
| Slender mackerel | 0.441049 | 2.022669 | 0.66 | 83 | 42–55 | TAN9106-TAN0201 |
| | | | | | | |
| Scampi | 0.819172 | 2.746626 | 0.88 | 1 032 | 2.7–7.2 | TAN9106-TAN0301 |
| | | | | | | |
| Black oreo | 0.011389 | 3.189330 | 0.86 | 1 215 | 18–37 | TAN9106-TAN0601 |
| Ray's bream and southern Ray's bream | 0.025761 | 2.900390 | 0.95 | 901 | 26–56 | TAN9106-TAN0601 |
| Ribaldo | 0.003294 | 3.312948 | 0.98 | 1 207 | 21–78 | TAN9106-TAN0601 |
| Smooth oreo | 0.037581 | 2.865858 | 0.94 | 604 | 16–57 | TAN9106-TAN0601 |
| Smooth skate | 0.022837 | 2.961627 | 0.99 | 525 | 29–158 | TAN9106-TAN0601 |
| | | | | | | |
| Arrow squid | 0.0290 | 3.00 | - | - | - | Sullivan et al. (2005) |
| Barracouta | 0.017103 | 2.676995 | 0.93 | 148 | 47–83 | TAN0501 |
| Blue mackerel | 0.000003 | 3.4058 | 0.99 | 1 410 | - | Manning et al. |
| Bluenose | 0.00963 | 3.173 | - | - | - | Horn (1988) |
| Deepsea cardinalfish | 0.0269 | 2.870105 | 0.96 | 213 | 33–75 | Tracey et al. (2000) |
| Frostfish | 0.000369 | 3.178669 | 1 | 1 203 | 11–176 | All records on database |
| Jack mackerel | 0.016500 | 2.93000 | - | 200 | 15–53 | Database, COR9001 |
| Hapuku | 0.014230 | 2.998 | - | 1 644 | 50–130 | Johnston (1983) |
| Northern spiny dogfish | 0.002275 | 3.165802 | 0.97 | 242 | 36–94 | All records on database |
| Redbait | 0.004212 | 3.320061 | 1 | 190 | 12–40 | All records on database |
| Red cod | 0.0092 | 3.003 | 0.98 | 923 | 13–72 | Beentjes (1992) |
| Rubyfish | 0.012656 | 3.091618 | 0.99 | 355 | 15–53 | All records on database |
| Rough skate | 0.033966 | 2.876666 | - | 336 | 14–70 | Stevenson & Beentjes (1999) |
| School shark | 0.00702 | 2.91 | - | 804 | 30–166 | Seabrook-Davison, unp. |
| Southern blue whiting | 0.003 | 3.2 | - | 444 | 19–55 | Hatanaka et al. (1989) |
| Spiky oreo | 0.025360 | 2.964571 | 0.97 | 420 | 18–43 | TAN0101 |
| Tarakihi | 0.02 | 2.98 | - | - | - | Annala et al. (1990) |
| Trumpeter | 0.012672 | 3.053848 | 0.97 | 21 | 31-77 | All records on database |

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

**Table 11: Numbers of fish measured at each reproductive stage***

| Common name | Sex | Reproductive stage 1 | 2 | 3 | 4 | 5 | 6 | 7 | Total |
|---|---|---|---|---|---|---|---|---|---|
| Alfonsino | Male | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Female | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 2 |
| Bigeye rattail | Male | 4 | 33 | 0 | 0 | 0 | 0 | 0 | 37 |
| | Female | 1 | 10 | 0 | 0 | 0 | 0 | 0 | 11 |
| Giant stargazer | Male | 1 | 24 | 0 | 0 | 0 | 0 | 0 | 25 |
| | Female | 2 | 16 | 7 | 0 | 0 | 0 | 0 | 25 |
| Hake | Male | 60 | 21 | 8 | 6 | 22 | 7 | 3 | 127 |
| | Female | 47 | 49 | 28 | 0 | 0 | 2 | 9 | 135 |
| Hapuku | Male | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Female | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Hoki | Male | 477 | 293 | 4 | 0 | 0 | 6 | 2 | 782 |
| | Female | 457 | 780 | 0 | 0 | 0 | 0 | 47 | 1284 |
| Javelinfish | Male | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Female | 0 | 7 | 3 | 0 | 0 | 0 | 0 | 10 |
| Ling | Male | 397 | 200 | 70 | 256 | 4 | 2 | 0 | 929 |
| | Female | 355 | 464 | 2 | 3 | 0 | 0 | 0 | 824 |
| Lookdown dory | Male | 3 | 5 | 16 | 11 | 0 | 0 | 0 | 35 |
| | Female | 5 | 43 | 17 | 0 | 0 | 0 | 0 | 65 |
| Orange perch | Male | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Female | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| Red cod | Male | 0 | 3 | 2 | 1 | 0 | 5 | 13 | 24 |
| | Female | 2 | 5 | 0 | 0 | 0 | 0 | 3 | 10 |
| Ribaldo | Male | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 2 |
| | Female | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 3 |
| Sea perch | Male | 2 | 1 | 5 | 0 | 0 | 0 | 0 | 8 |
| | Female | 2 | 12 | 0 | 0 | 0 | 0 | 0 | 14 |
| Silver warehou | Male | 2 | 5 | 0 | 0 | 0 | 0 | 1 | 8 |
| | Female | 0 | 5 | 2 | 0 | 0 | 0 | 1 | 8 |
| White warehou | Male | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| | Female | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |

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

**Table 12: Percentage occurrence of eight acoustic mark types (see text for definitions) by depth range during the 2006 Chatham Rise trawl survey. Several mark types were usually present in the same echogram. *n* is the number of acoustic files examined.**

| | | | | Pelagic marks | | | Bottom marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Acoustic file | Max. depth (m) | *n* | Surface Layer | School | Layer | Cloud | Layer | Cloud | School | Single target |
| Day trawl | 200–400 | 32 | 34 | 16 | 88 | 44 | 59 | 22 | 41 | 72 |
| | 400–600 | 52 | 69 | 52 | 96 | 35 | 71 | 40 | 6 | 50 |
| | 600–1000 | 18 | 72 | 50 | 67 | 72 | 67 | 50 | 0 | 61 |
| Day steam | 200–400 | 16 | 50 | 13 | 81 | 56 | 75 | 38 | 25 | 63 |
| | 400–600 | 42 | 81 | 50 | 100 | 26 | 86 | 31 | 12 | 62 |
| | 600–1000 | 21 | 86 | 67 | 95 | 62 | 100 | 48 | 19 | 67 |
| Night (steam & trawl) | 200–400 | 4 | 75 | 25 | 75 | 100 | 25 | 100 | 25 | 100 |
| | 400–600 | 15 | 100 | 13 | 47 | 80 | 27 | 73 | 7 | 93 |
| | 600–1000 | 14 | 93 | 14 | 43 | 93 | 71 | 93 | 0 | 79 |

**Table 13: Percentage occurrence of mark types during the 2006 Chatham Rise trawl survey compared to results from previous surveys of the Chatham Rise in 2003 (from Livingston et al. 2004) and 2005 (from Stevens & O'Driscoll 2006).**

| | | | | Pelagic marks | | | Bottom marks | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Acoustic file | Survey | *n* | Surface Layer | School | Layer | Cloud | Layer | Cloud | School | Single target |
| Day trawl | 2006 | 102 | 59 | 40 | 88 | 44 | 67 | 36 | 16 | 59 |
| | 2005 | 111 | 57 | 37 | 93 | 31 | 60 | 42 | 23 | 55 |
| | 2003 | 123 | 64 | 41 | 85 | 55 | 47 | 47 | 22 | 74 |
| Day steam | 2006 | 79 | 76 | 47 | 95 | 42 | 87 | 37 | 16 | 63 |
| | 2005 | 78 | 71 | 45 | 95 | 37 | 76 | 45 | 35 | 73 |
| | 2003 | 66 | 80 | 55 | 97 | 49 | 83 | 35 | 24 | 77 |
| Night (steam & trawl) | 2006 | 33 | 94 | 15 | 48 | 88 | 45 | 85 | 6 | 88 |
| | 2005 | 30 | 100 | 33 | 53 | 77 | 57 | 83 | 7 | 100 |
| | 2003 | 44 | 100 | 14 | 18 | 93 | 30 | 96 | 2 | 96 |

**Table 14: Average trawl catch (excluding benthic organisms) and acoustic backscatter from bottom-referenced marks during tows where acoustic data quality was suitable for echo integration on the Chatham Rise in 2001–06. All tows were conducted during daylight. Data for 2001–03 are from Livingston et al (2004) and for 2005 from Stevens & O'Driscoll (2006).**

| Survey | Number of recordings | Average trawl catch (kg $km^{-2}$) | Average acoustic backscatter ($m^2$ $km^{-2}$) | |
|---|---|---|---|---|
| | | | Bottom 10 m | Entire layer |
| 2001 (TAN0101) | 115 | 1 447 | 2.499 | 26.06 |
| 2002 (TAN0201) | 105 | 1 844 | 4.006 | 20.13 |
| 2003 (TAN0301) | 117 | 1 507 | 3.208 | 27.41 |
| 2005 (TAN0501) | 86 | 1 783 | 2.776 | 15.64 |
| 2006 (TAN0601) | 88 | 1 782 | 3.236 | 19.46 |

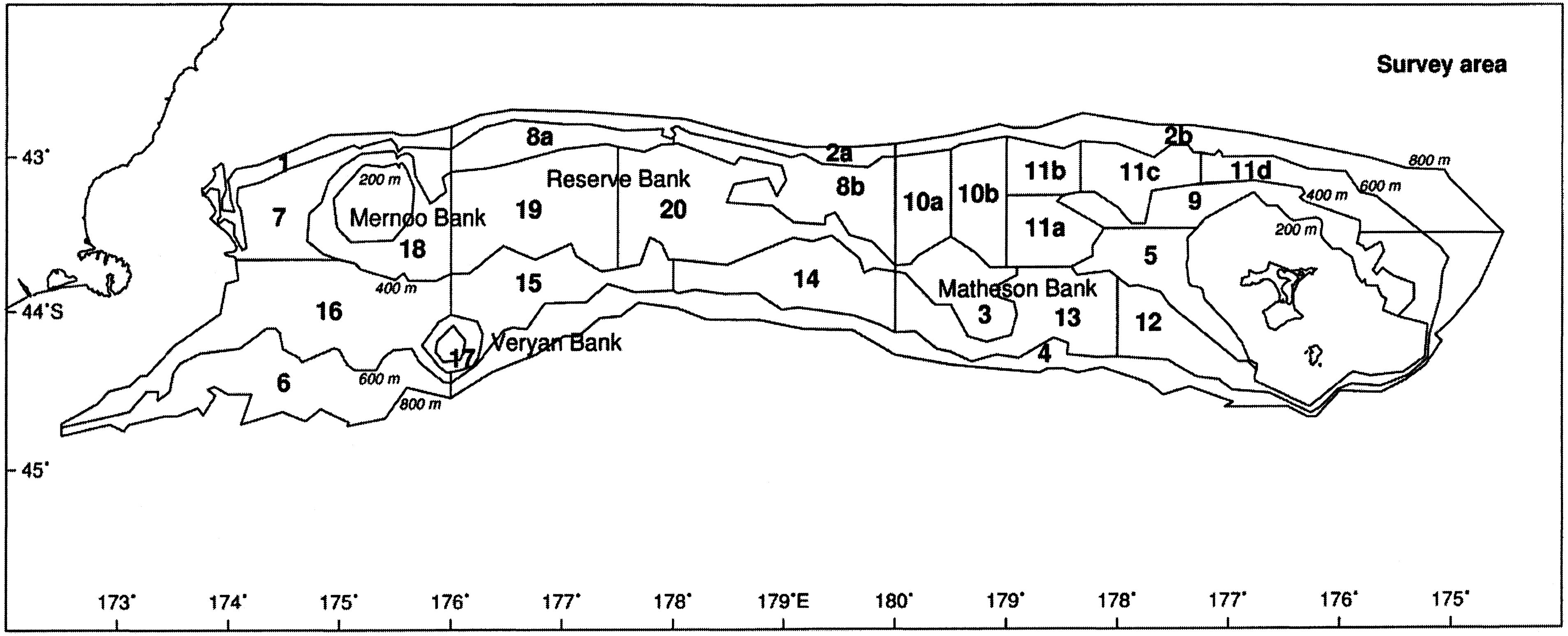


Figure 1: Trawl survey area showing stratum boundaries for TAN0601

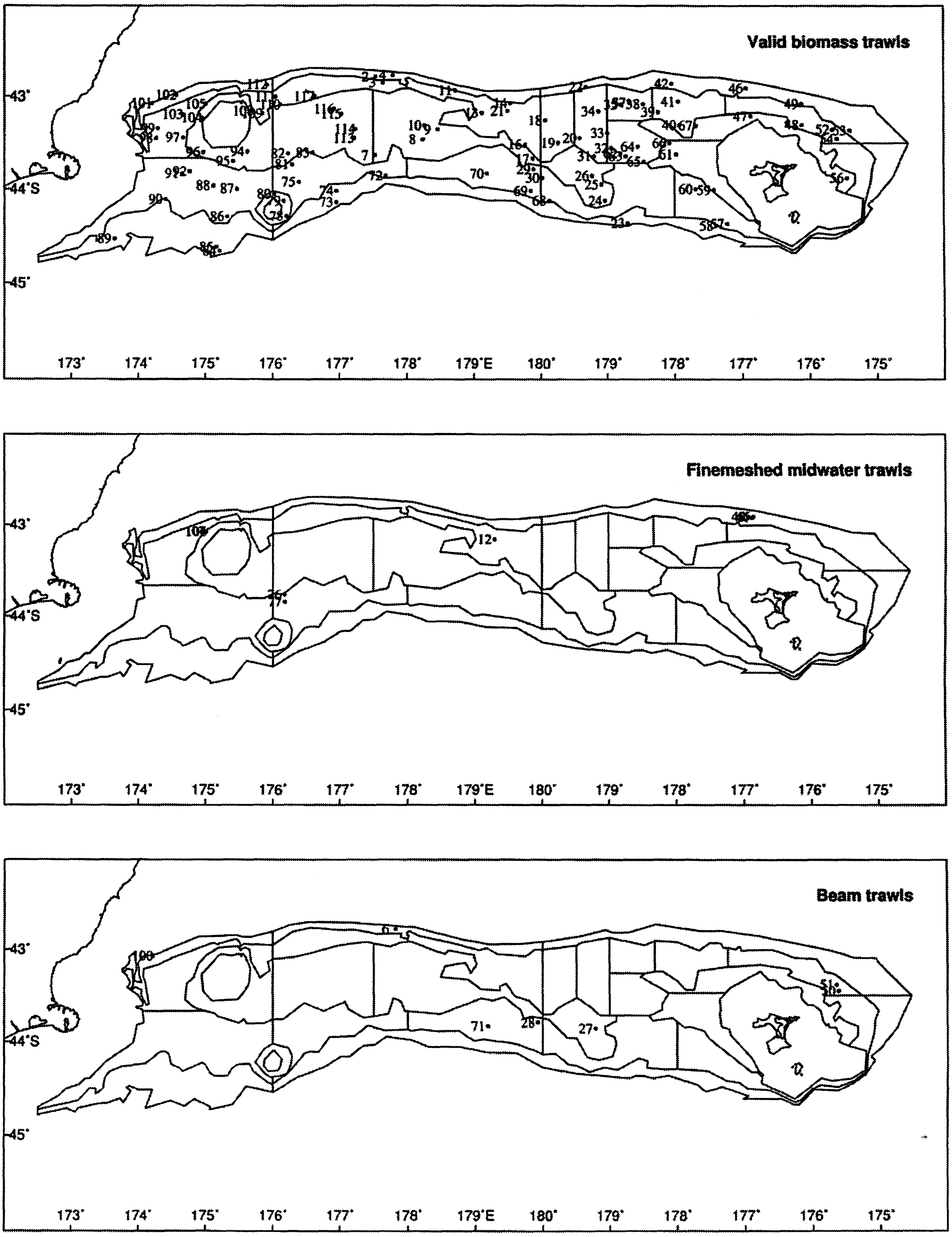


**Figure 2: Trawl survey area showing positions of valid biomass stations (n = 96), fine meshed midwater trawl stations (n = 7), and beam trawl stations (n = 8) for TAN0601**

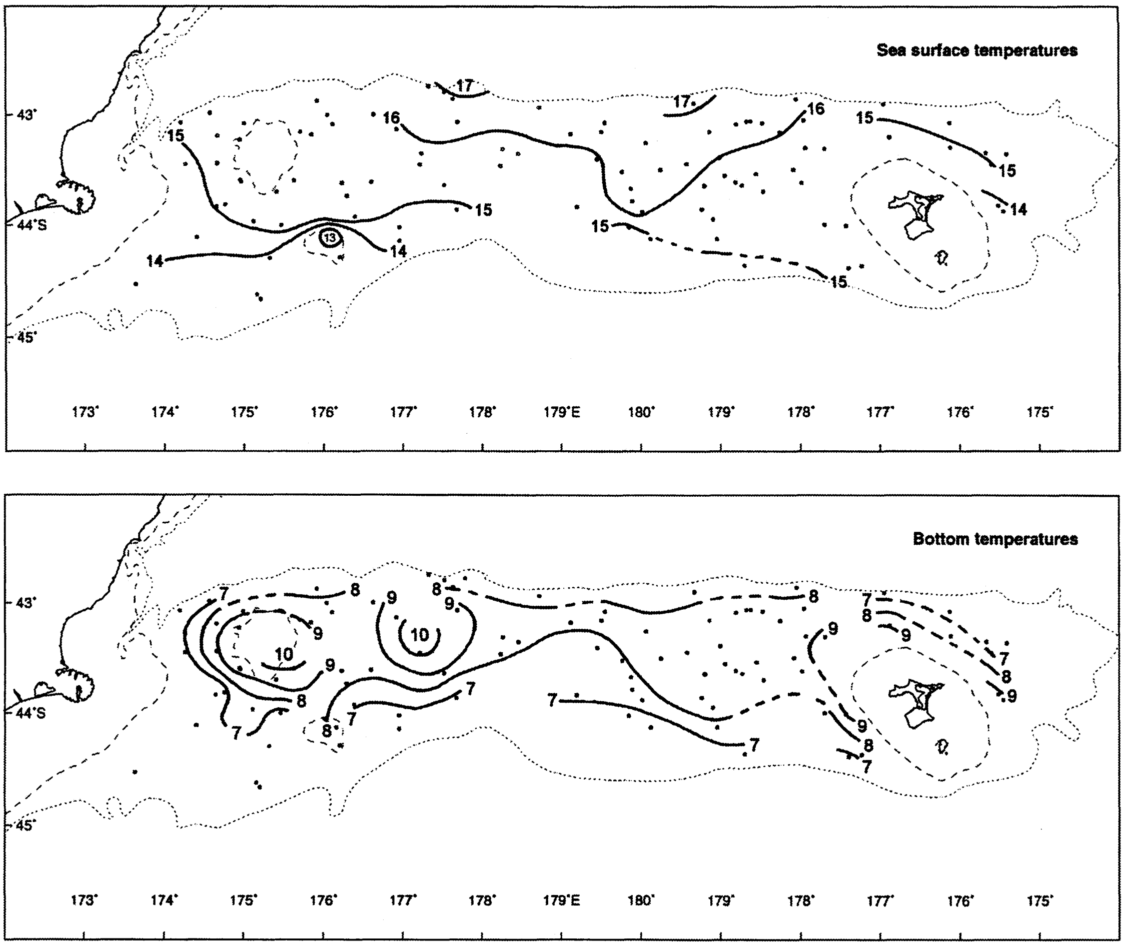


**Figure 3: Positions of sea surface and bottom temperature recordings and approximate location of isotherms (°C) interpolated by eye. The temperatures shown are from the calibrated Seabird CTD recordings made during each tow**

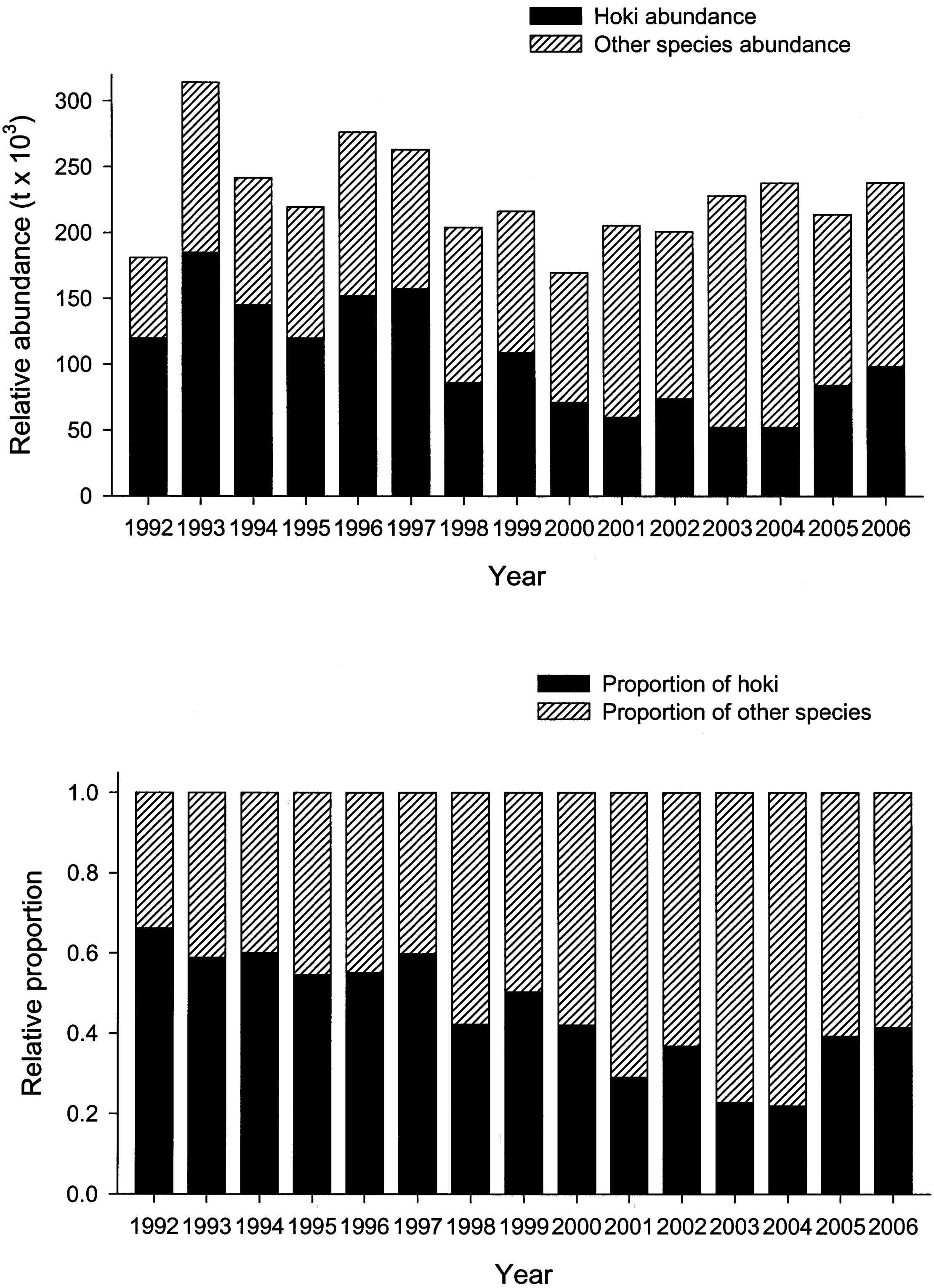


**Figure 4: Relative biomass (top panel) and relative proportions of hoki and 30 other key species (lower panel) from trawl surveys of the Chatham Rise, January 1992–2006**

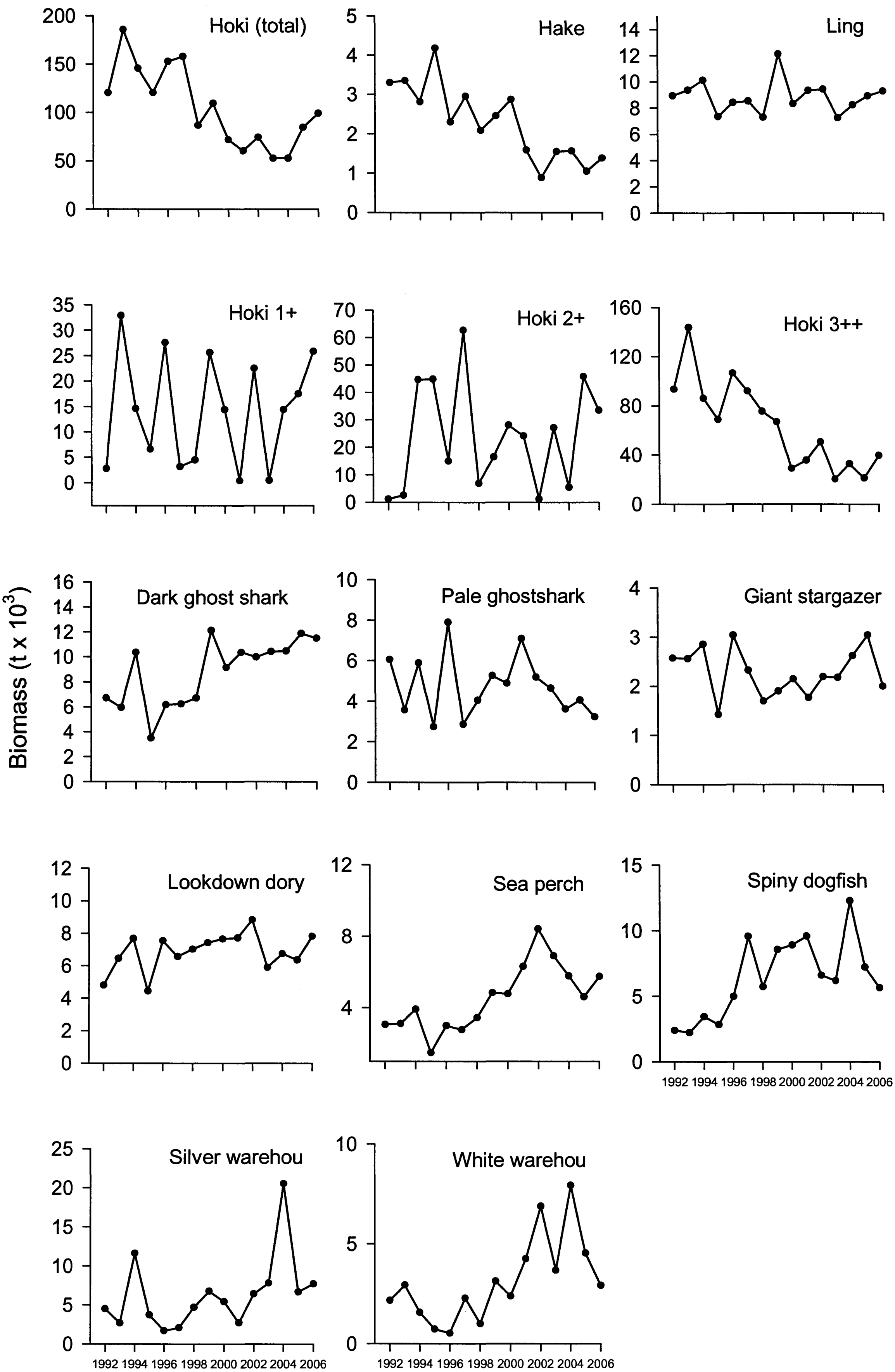


**Figure 5: Relative biomass estimates (t x $10^3$) of important species sampled by annual trawl surveys of the Chatham Rise, January 1992–2006**

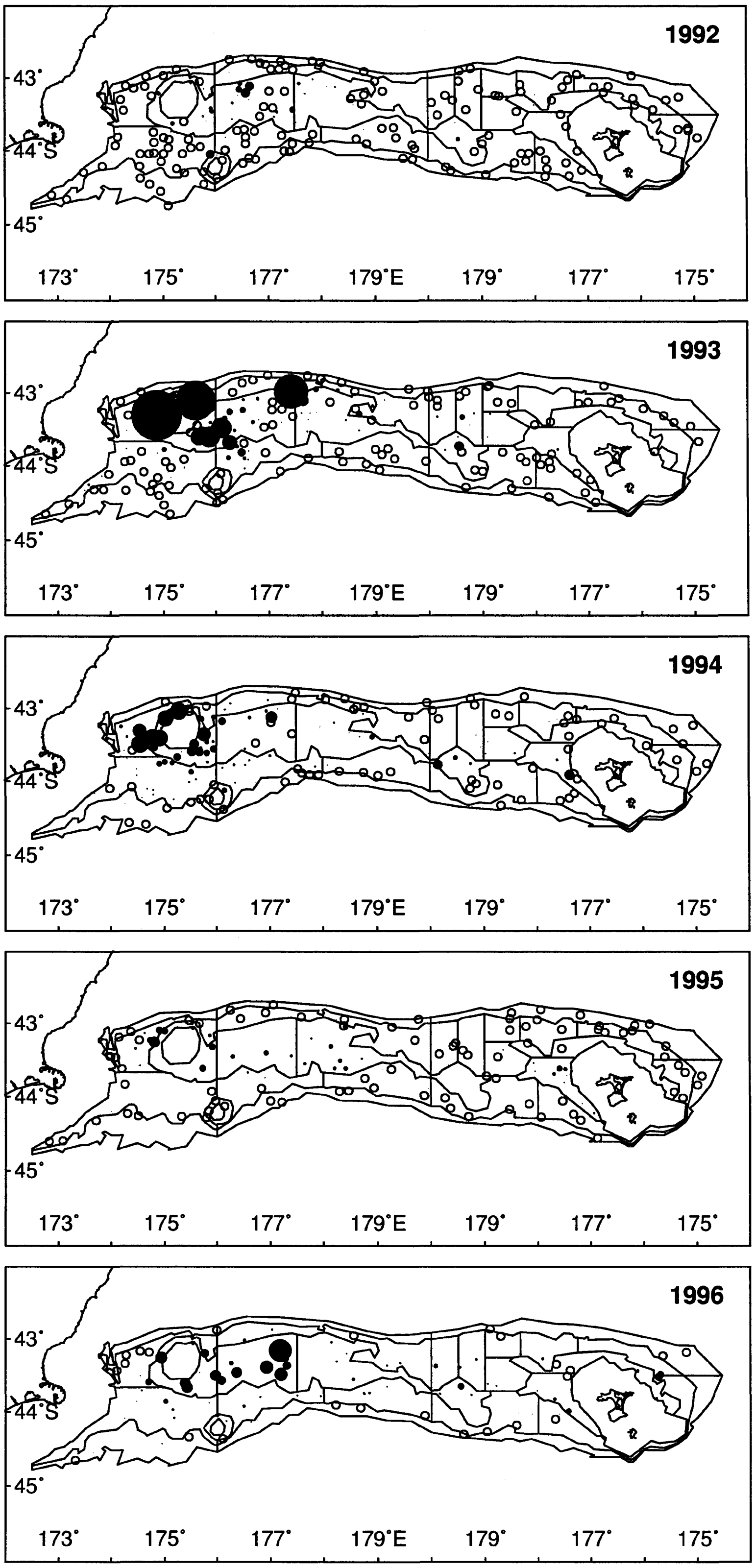


**Figure 6a: Hoki 1+ catch distribution 1992–2006. Filled circle area is proportional to catch rate (kg.km$^{-2}$). Open circles are zero catch. Maximum catch rate in series is 30 850 kg.km$^{-2}$**

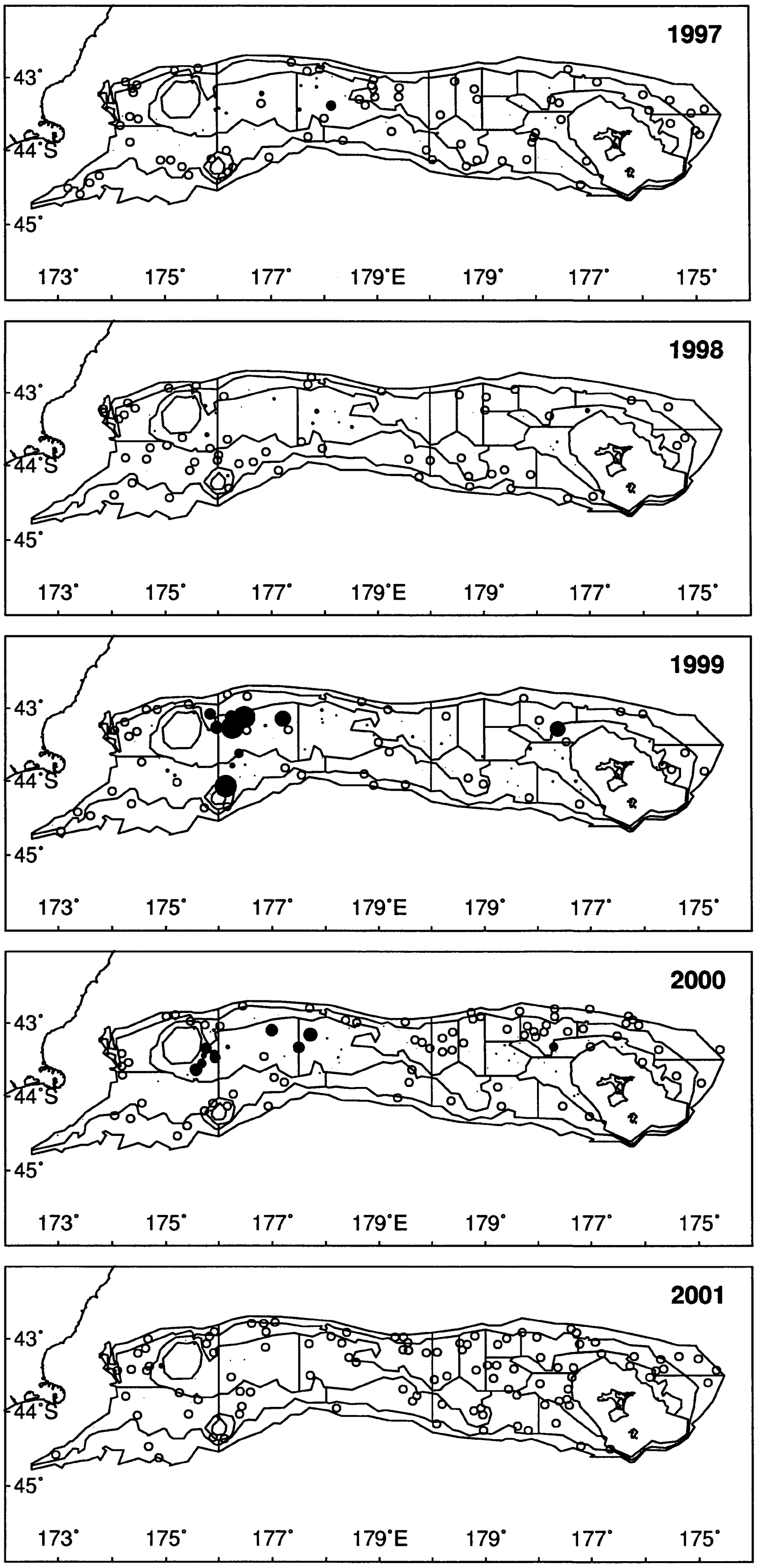


**Figure 6a (continued)**

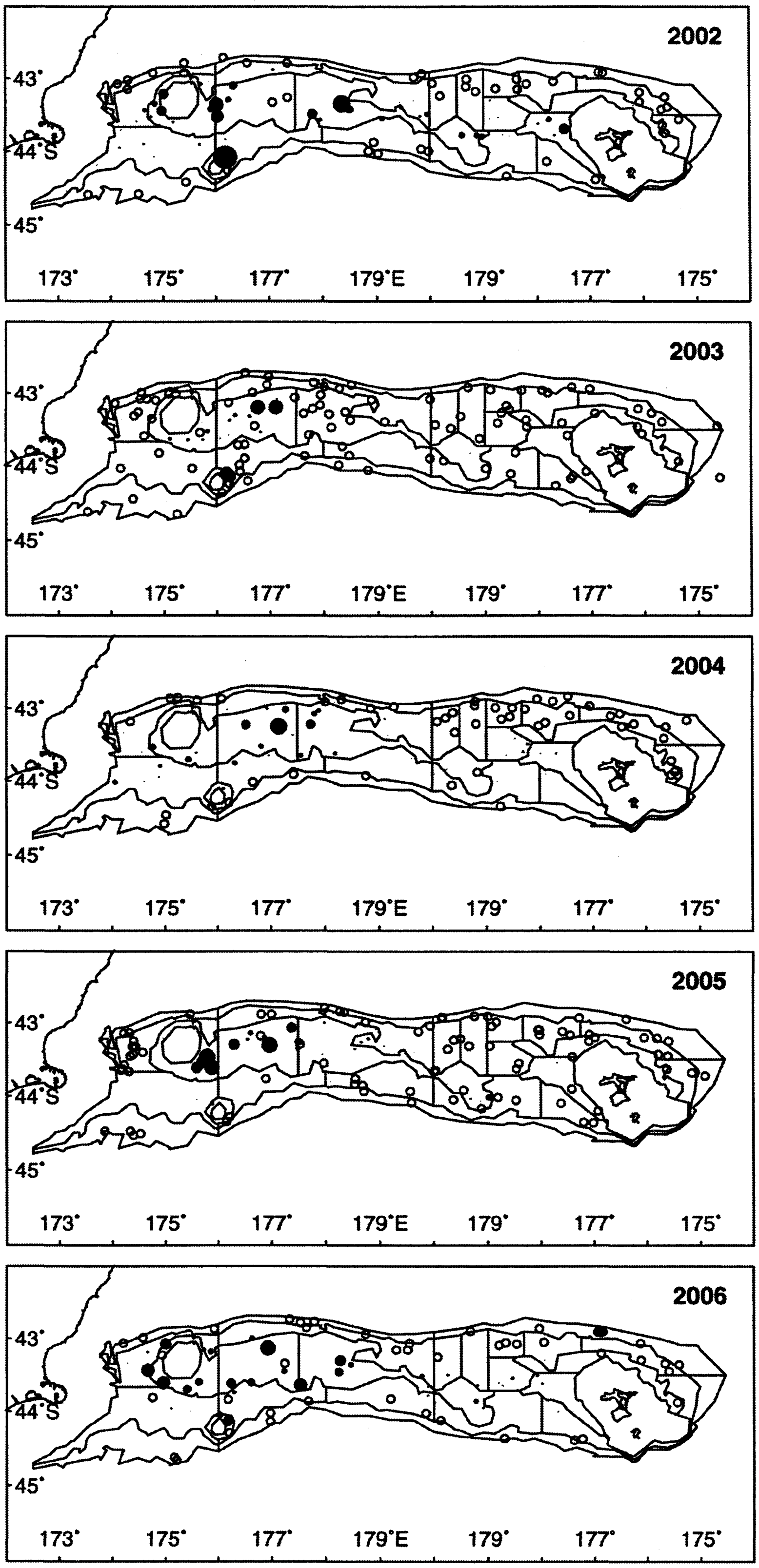


**Figure 6a (continued)**

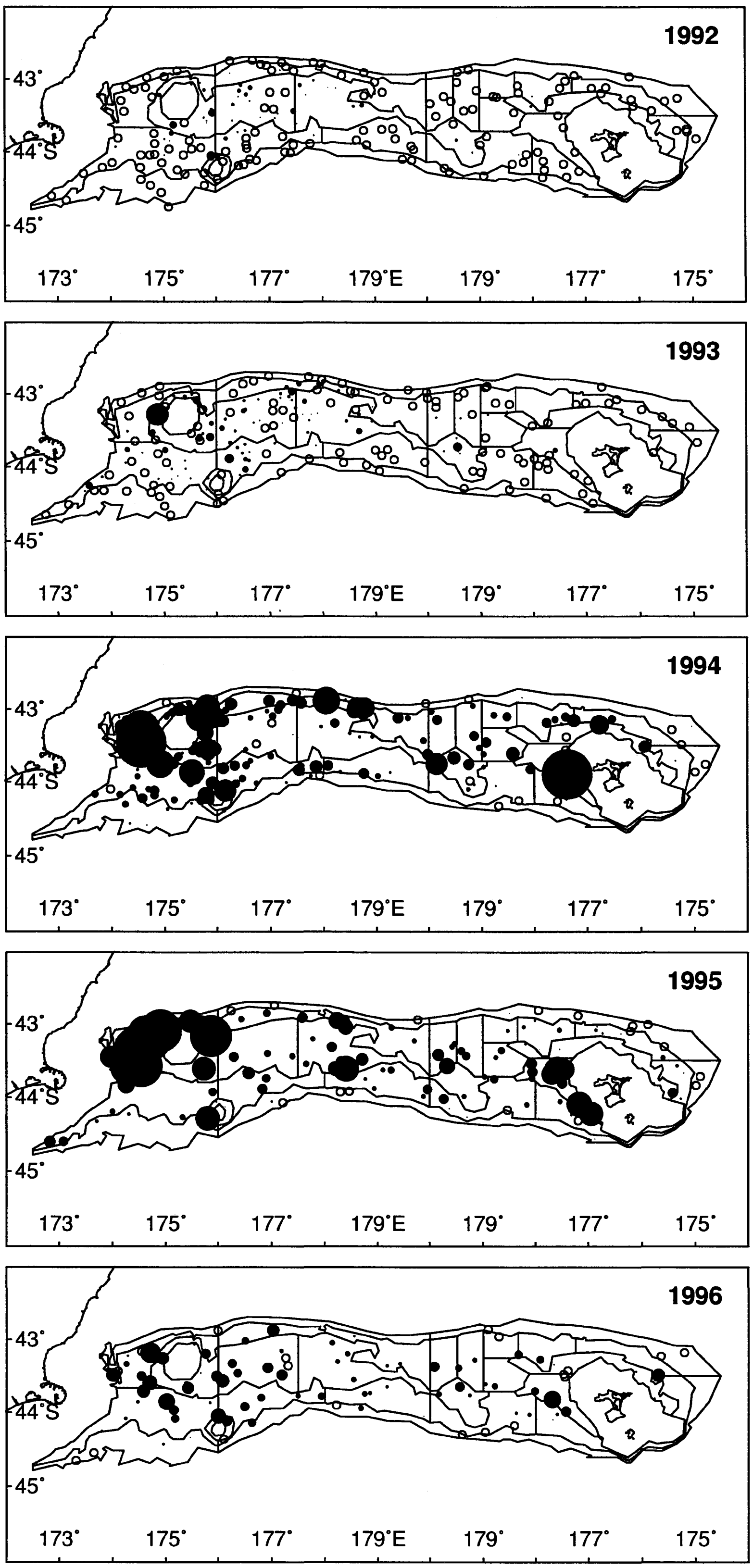


**Figure 6b: Hoki 2+ catch distribution 1992–2006. Filled circle area is proportional to catch rate (kg.km$^{-2}$). Open circles are zero catch. Maximum catch rate in series is 6 791 kg.km$^{-2}$**

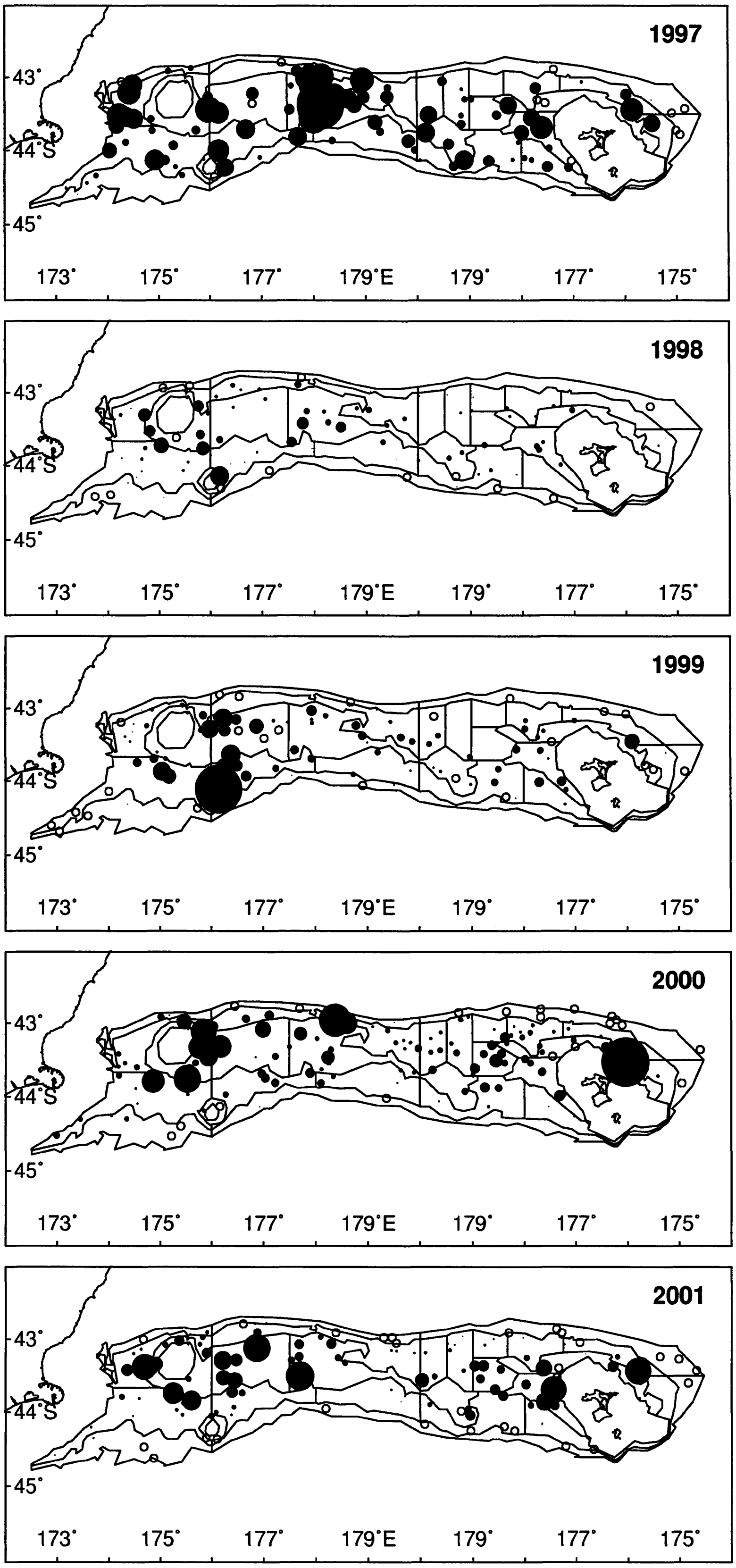


**Figure 6b (continued)**

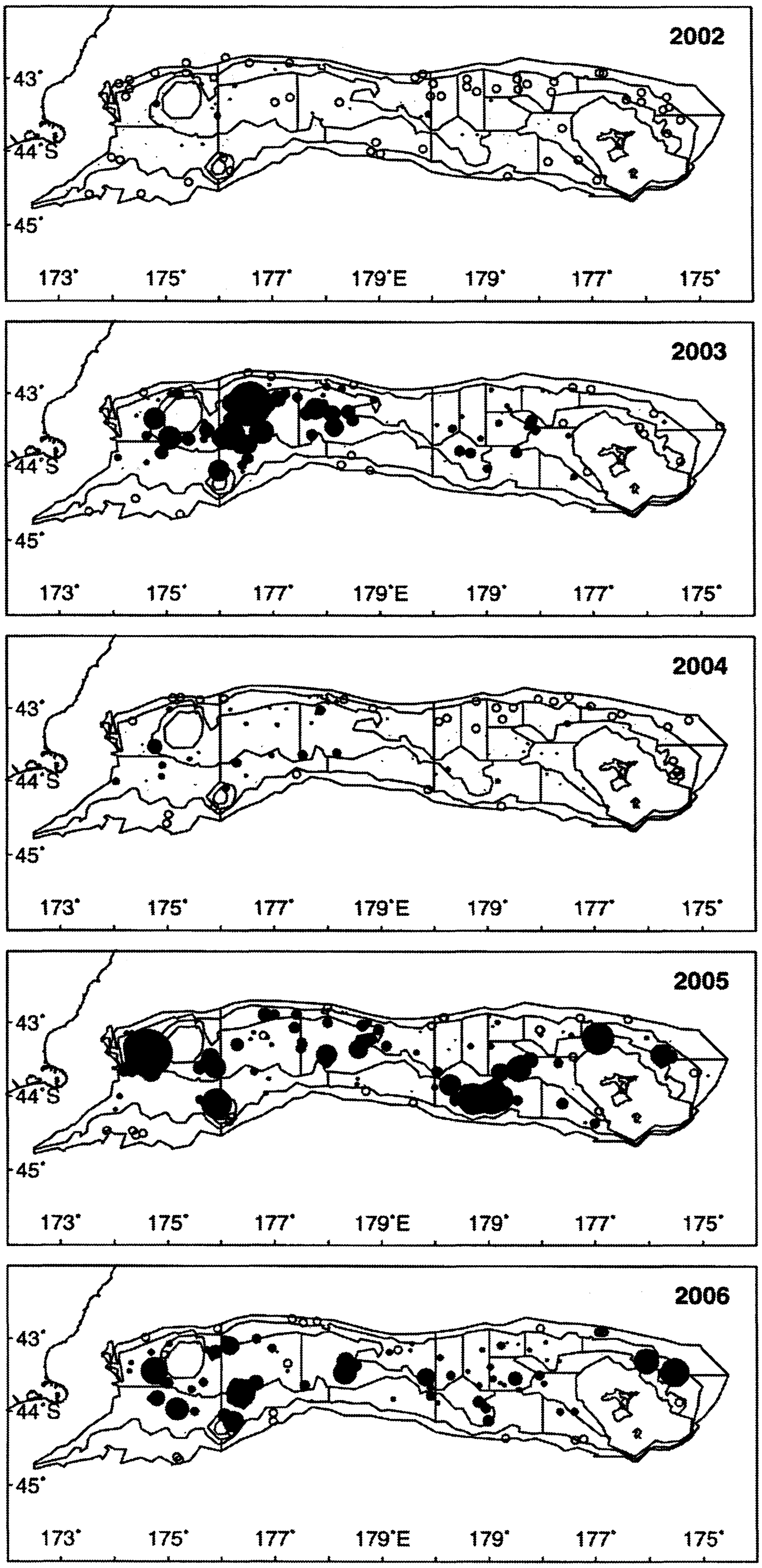


**Figure 6b (continued)**

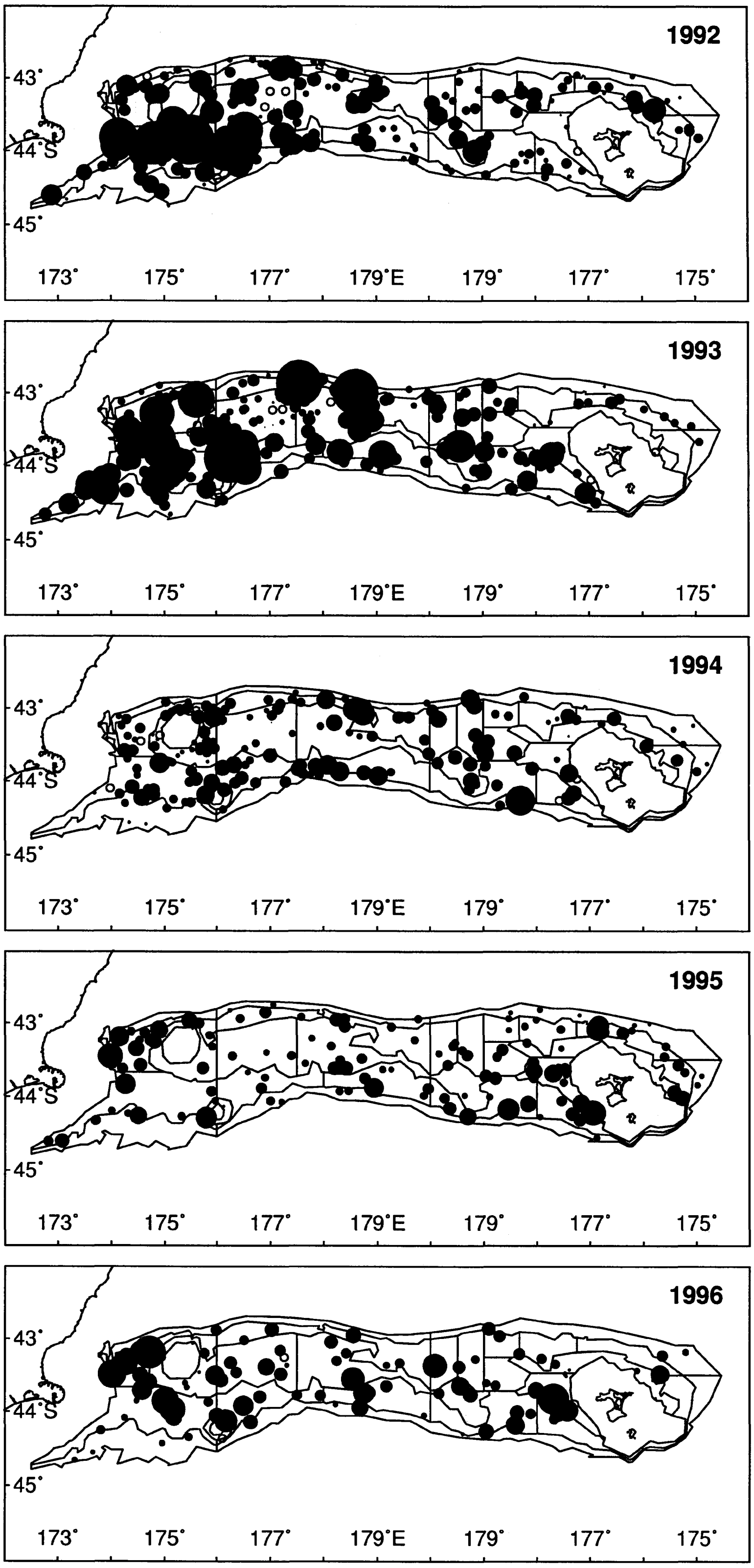


**Figure 6c: Hoki 3++ catch distribution. 1992–2006. Filled circle area is proportional to catch rate (kg.km$^{-2}$). Open circles are zero catch. Maximum catch rate in series is 11 177 kg.km$^{-2}$**

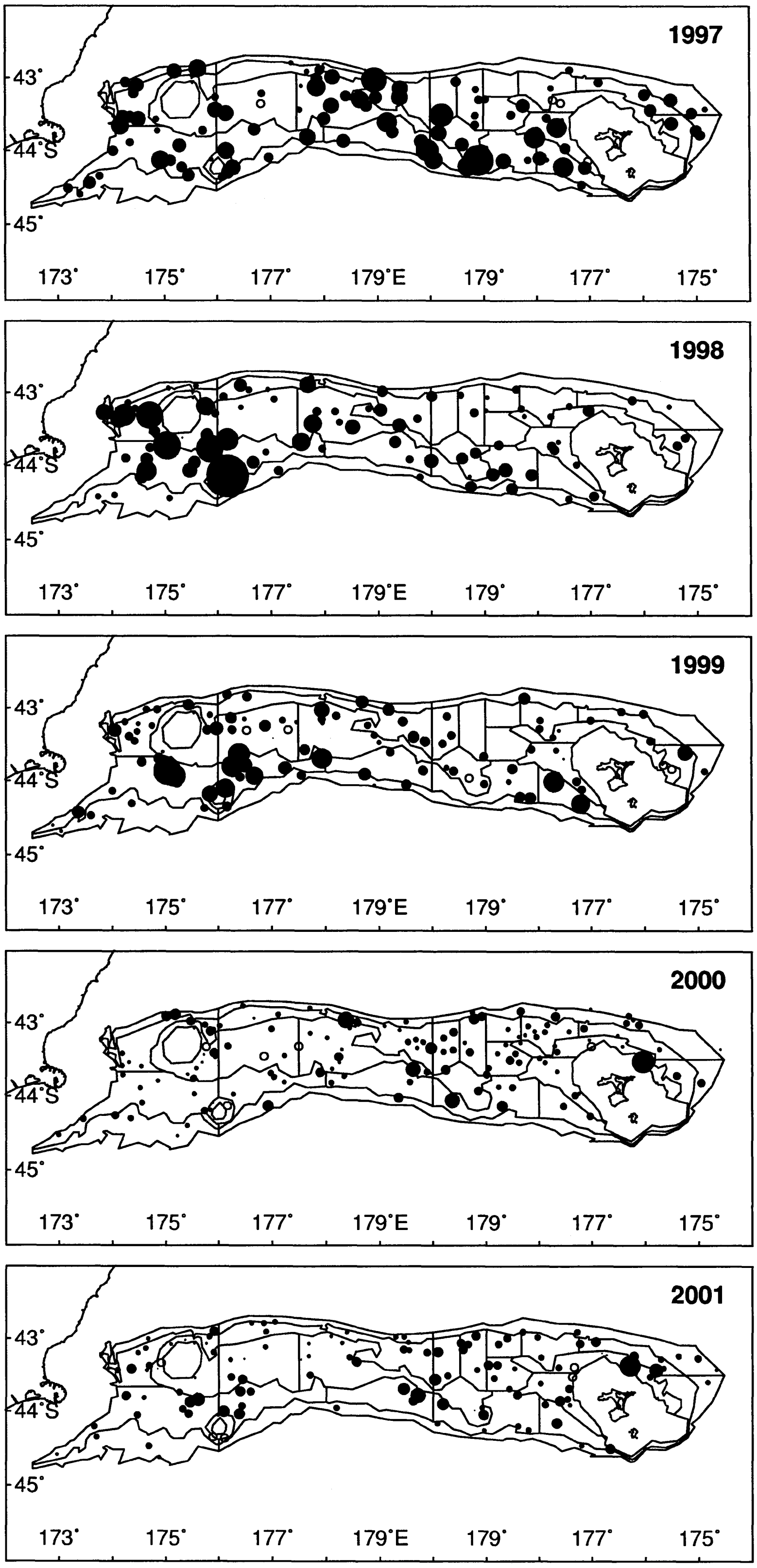


**Figure 6c (continued)**

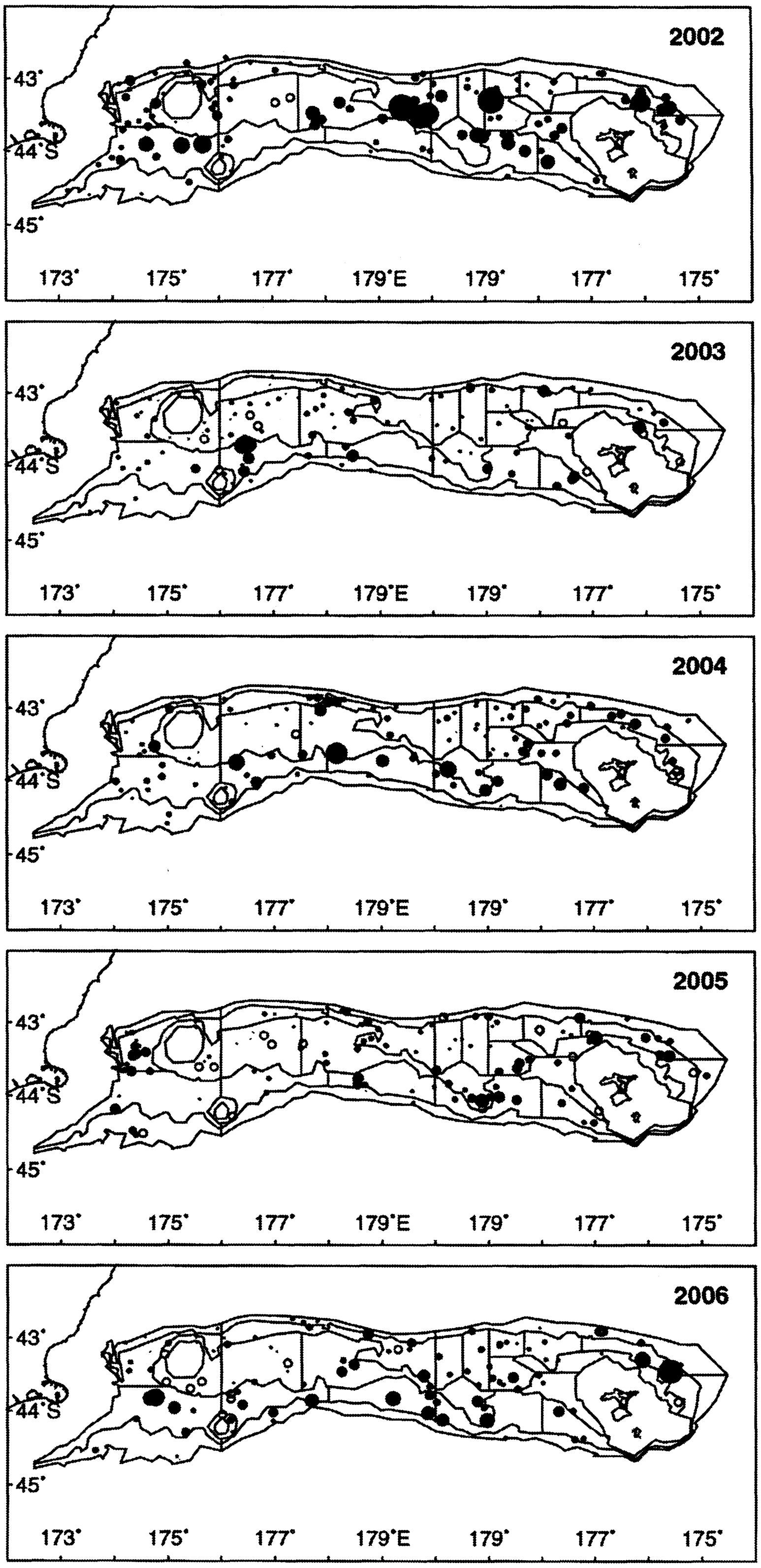


**Figure 6c (continued)**

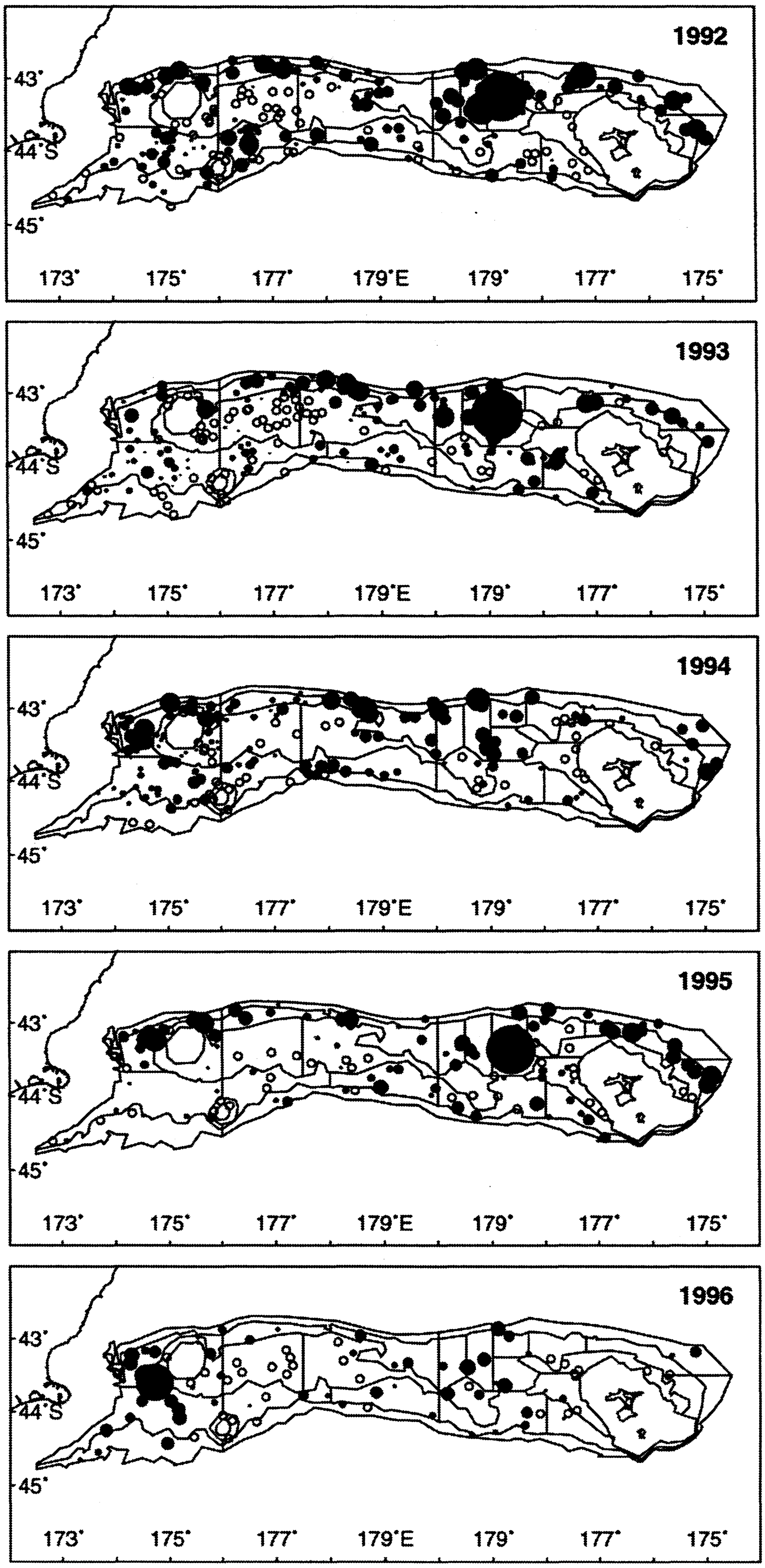


**Figure 7: Hake catch distribution 1992–2006. Filled circle area is proportional to catch rate (kg.km$^{-2}$). Open circles are zero catch. Maximum catch rate in series is 620 kg.km$^{-2}$**

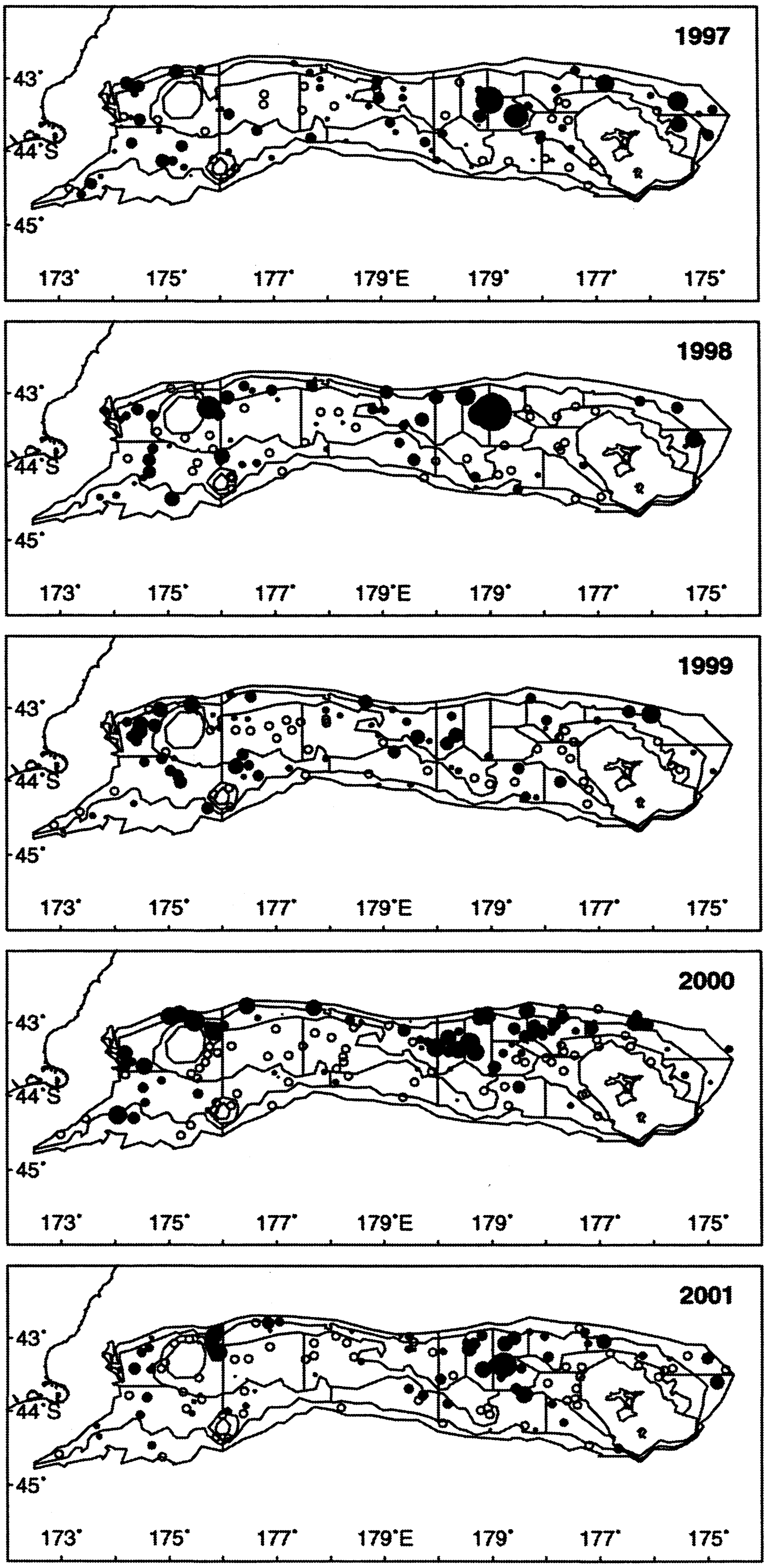


**Figure 7 (continued)**

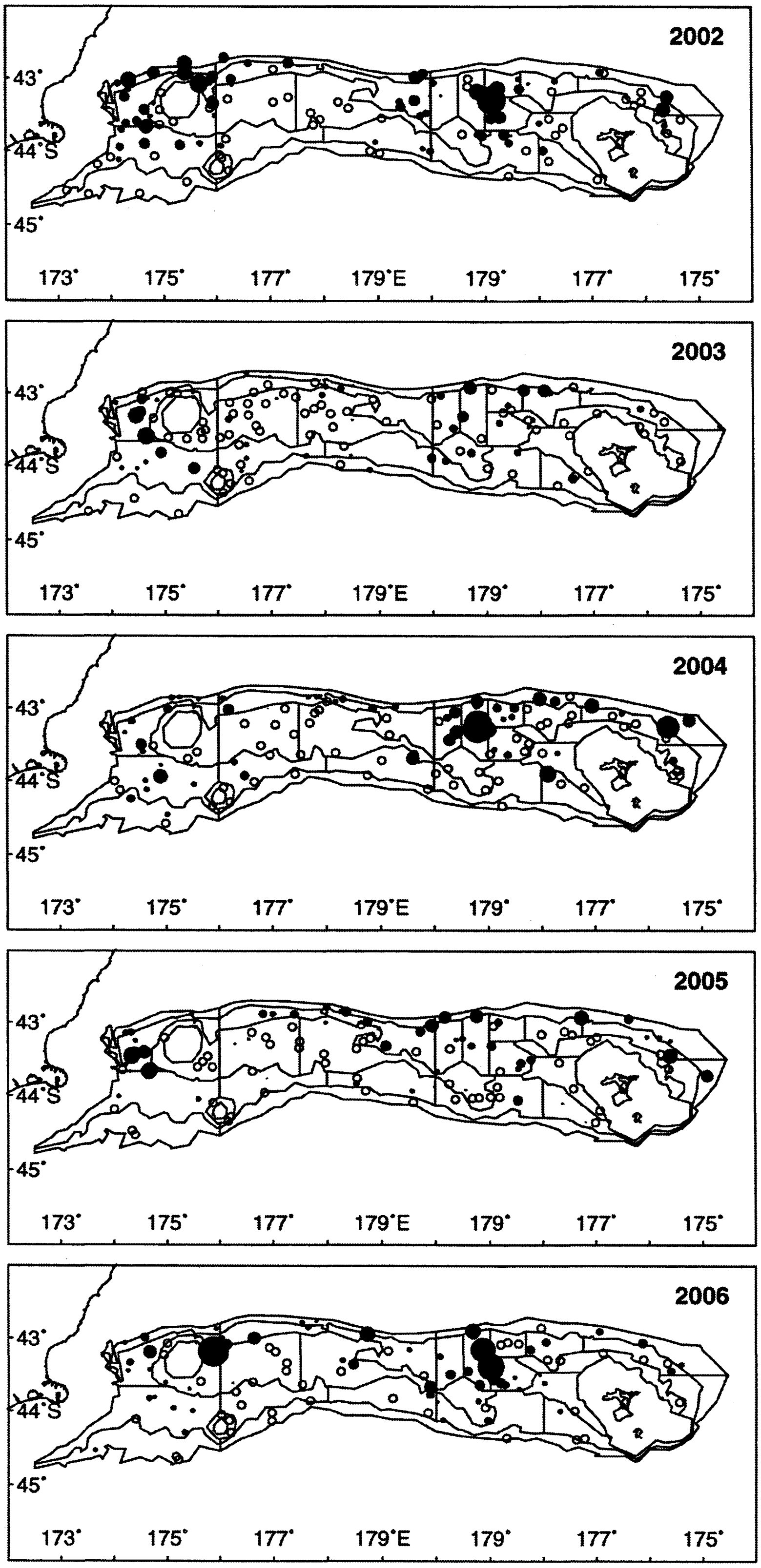


**Figure 7 (continued)**

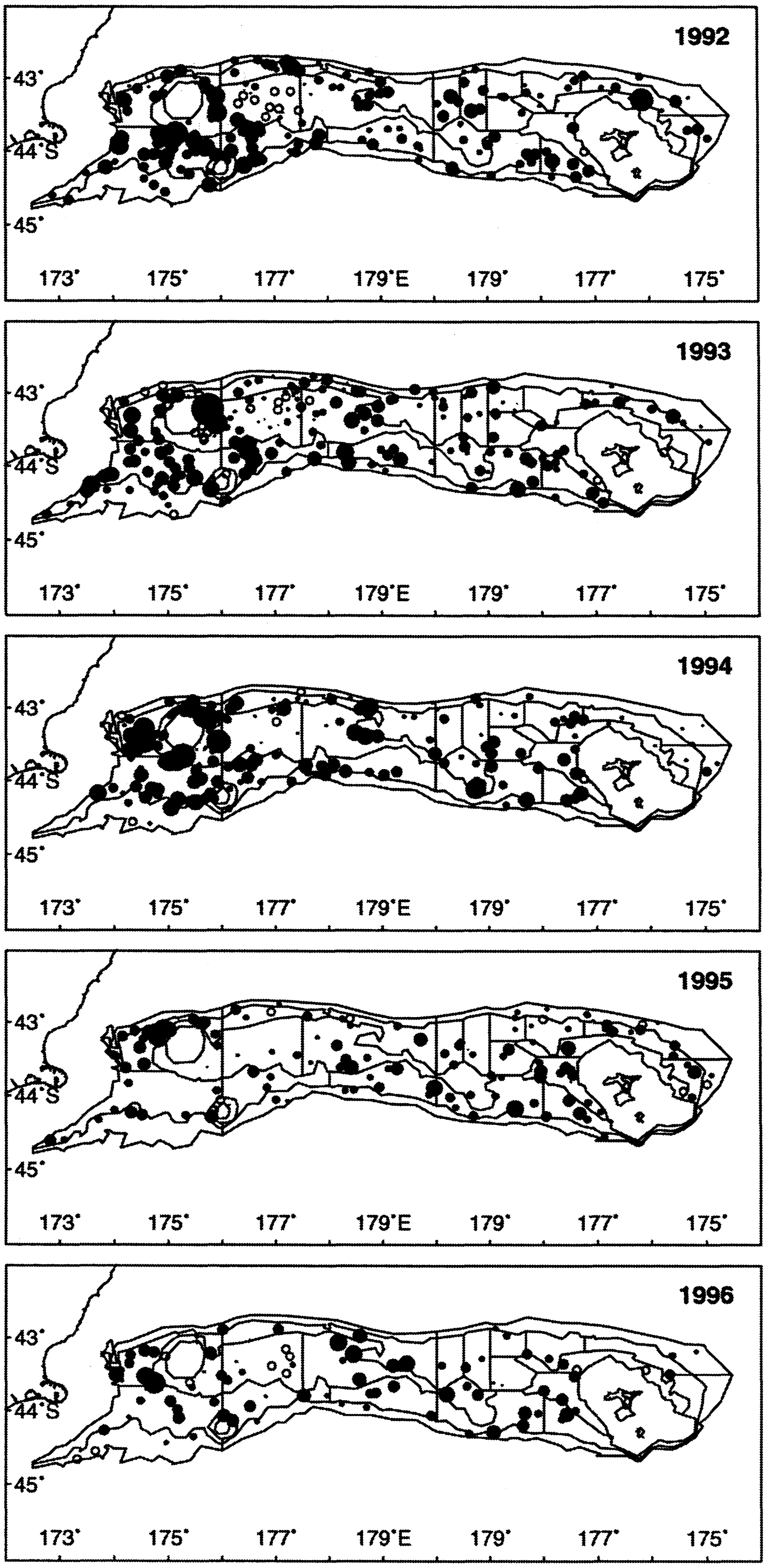


**Figure 8: Ling catch distribution 1992–2006. Filled circle area is proportional to catch rate (kg.km$^{-2}$). Open circles are zero catch. Maximum catch rate in series is 1786 kg.km$^{-2}$**

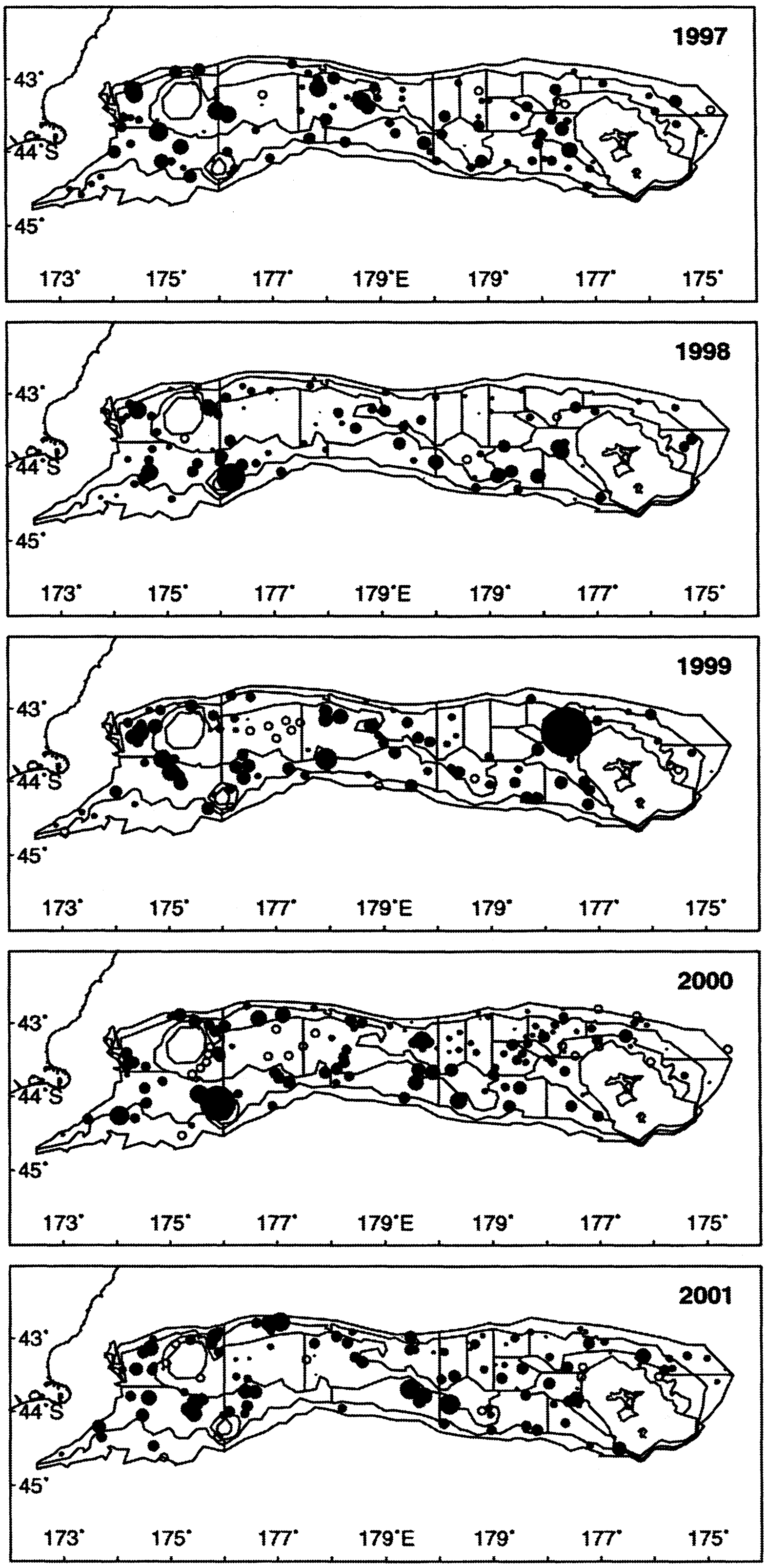


**Figure 8 (continued)**

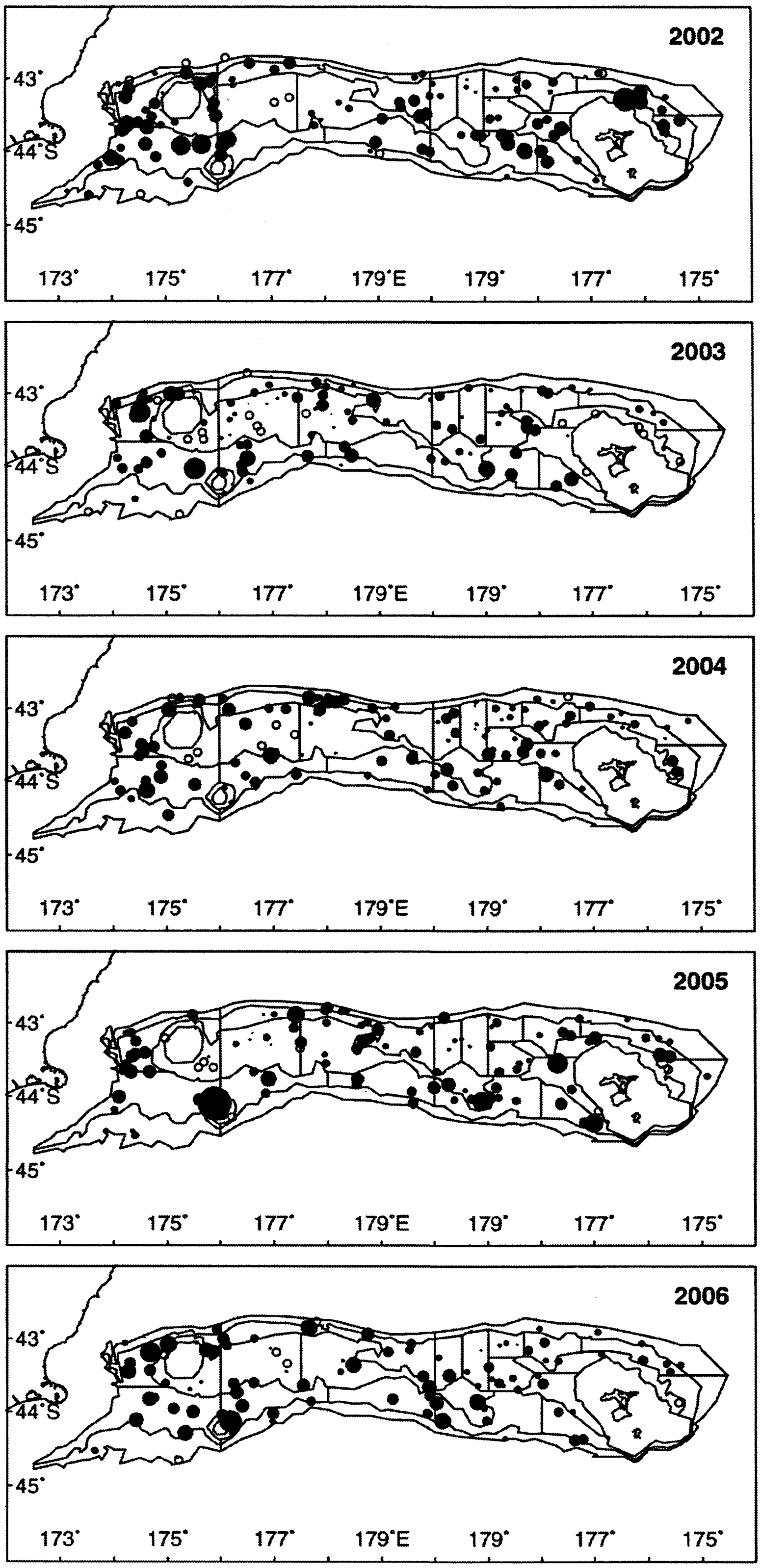


**Figure 8 (continued)**

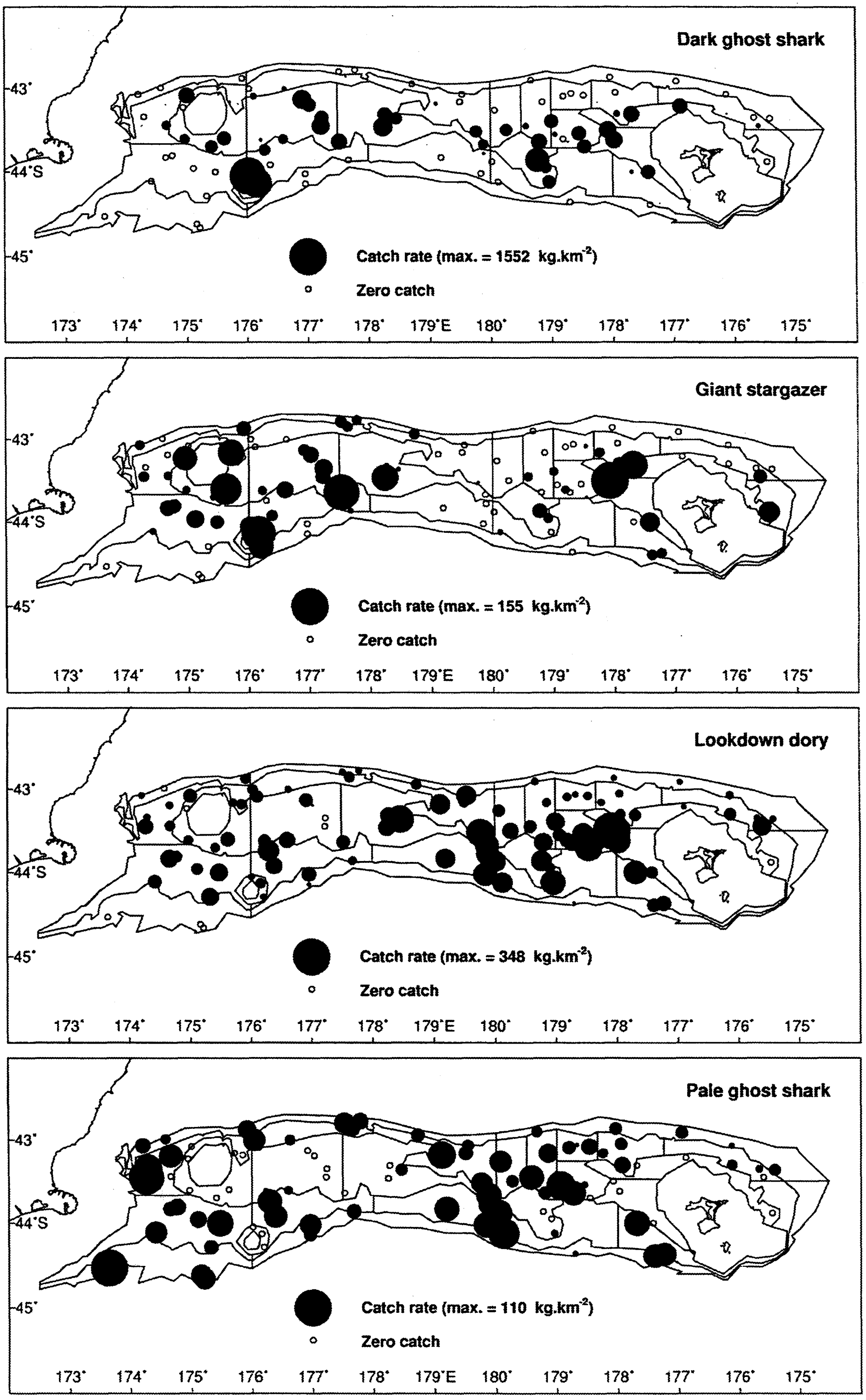


**Figure 9: Catch rates (kg.km$^{-2}$) of selected commercial species in 2006. Filled circle area is proportional to catch rate. Open circles are zero catch. (max., maximum catch rate)**

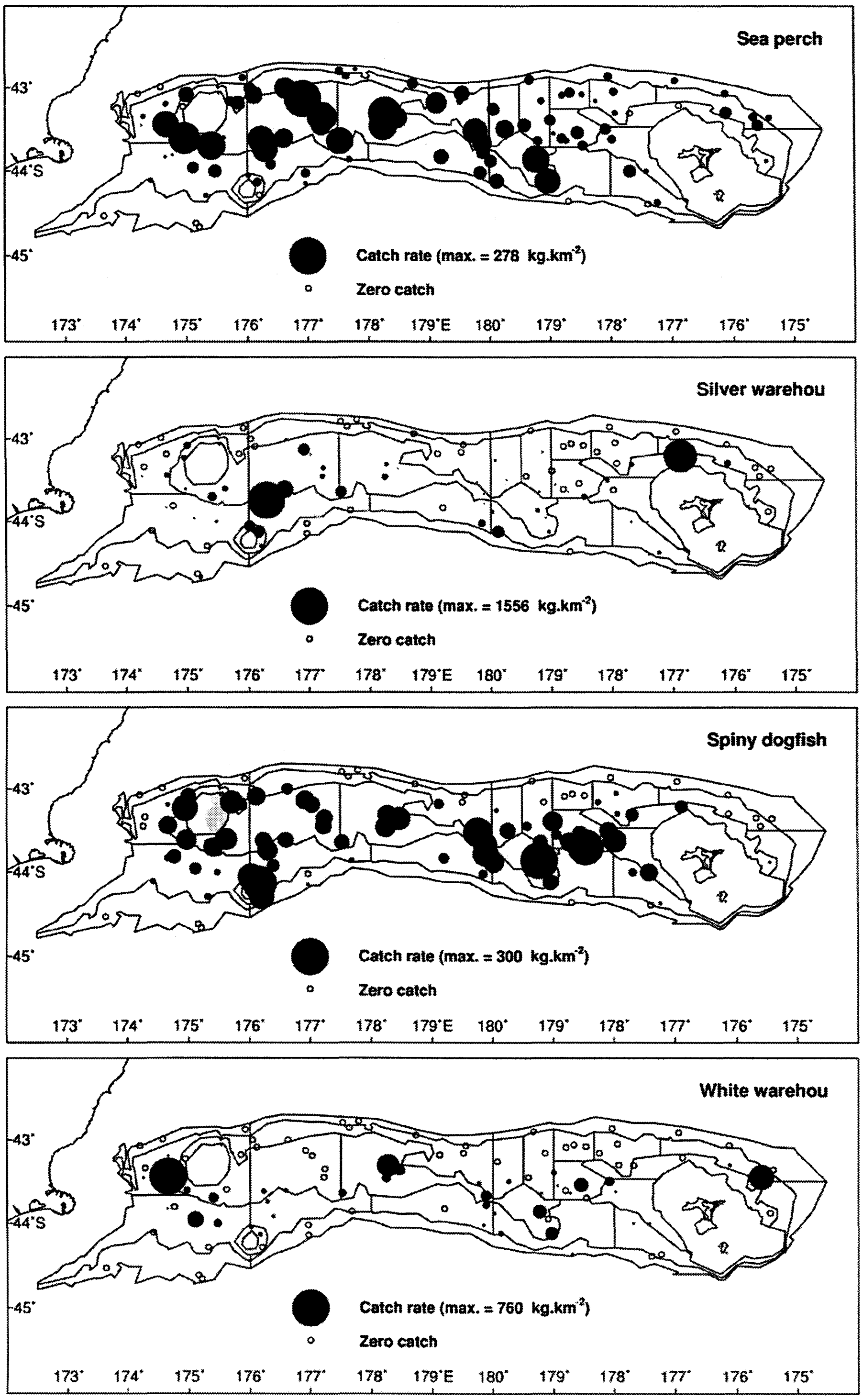


**Figure 9 (continued)**

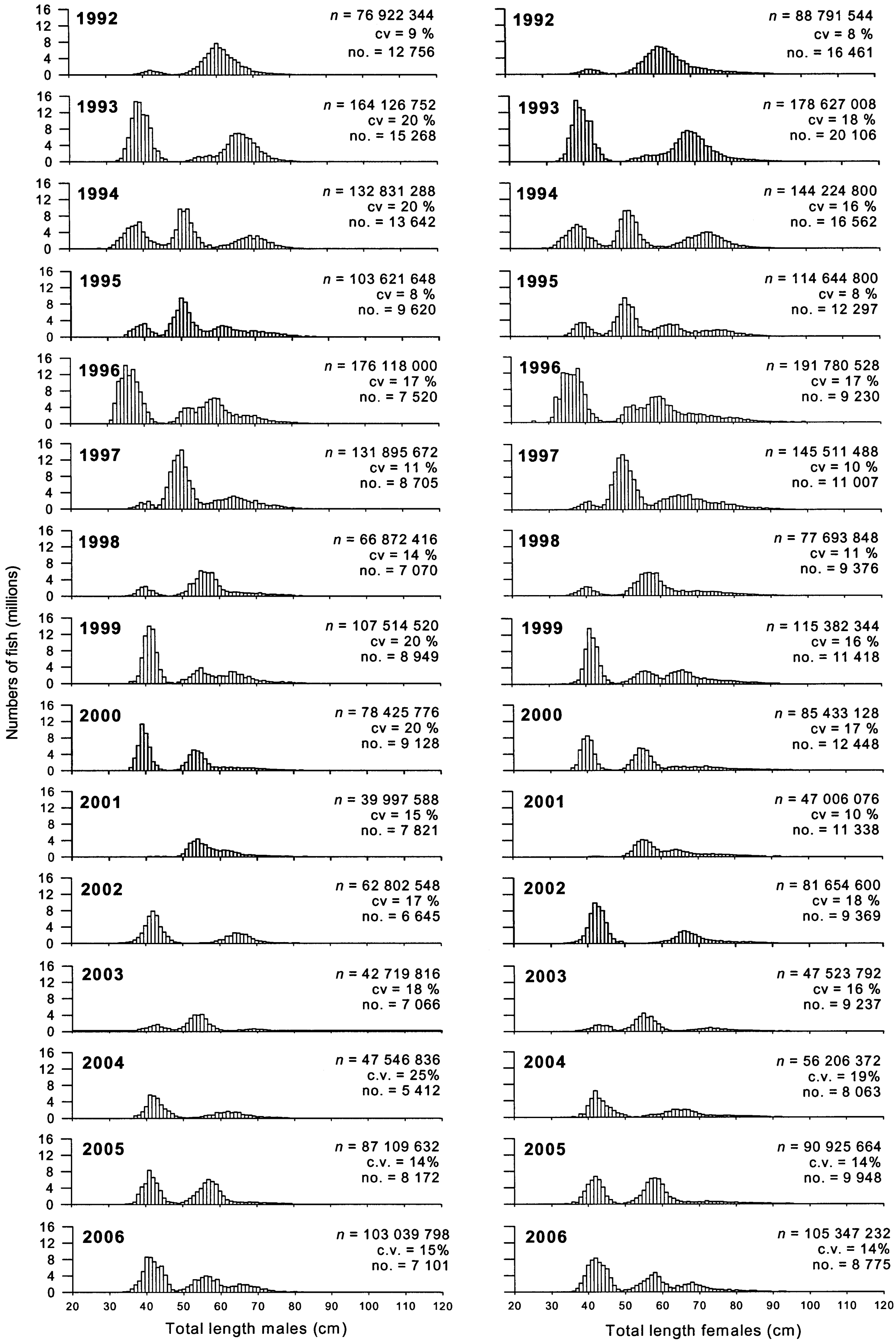


**Figure 10: Estimated length frequency distributions of the male and female hoki population from *Tangaroa* surveys of the Chatham Rise, January 1992–2006. (c.v., coefficient of variation; *n*, estimated population number of male hoki (left panel) and female hoki (right panel); no., numbers of fish measured.)**

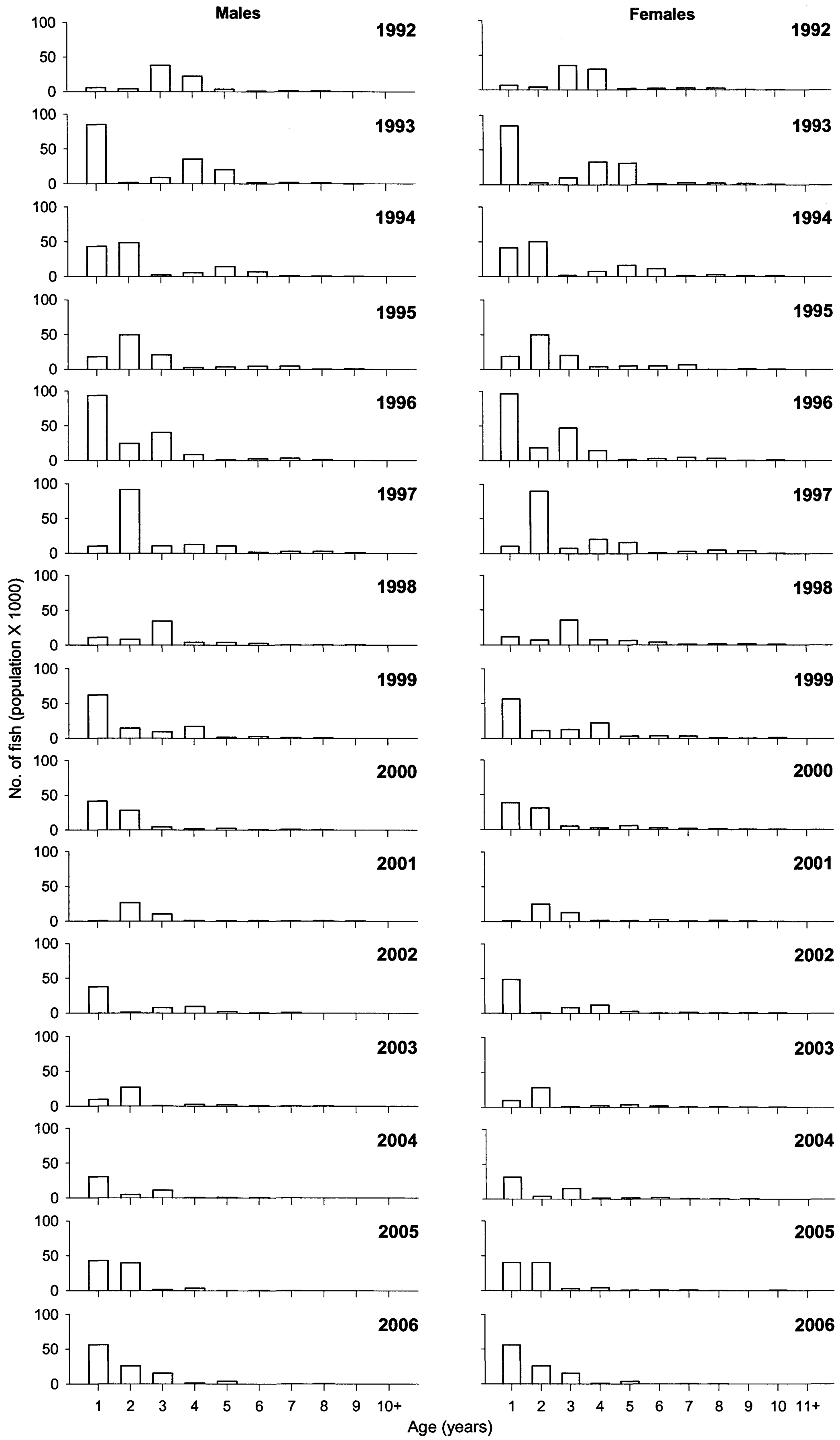


**Figure 11: Estimated population numbers at age of hoki from *Tangaroa* surveys of the Chatham Rise, January, 1992–2006. (+, indicates plus group of combined ages.)**

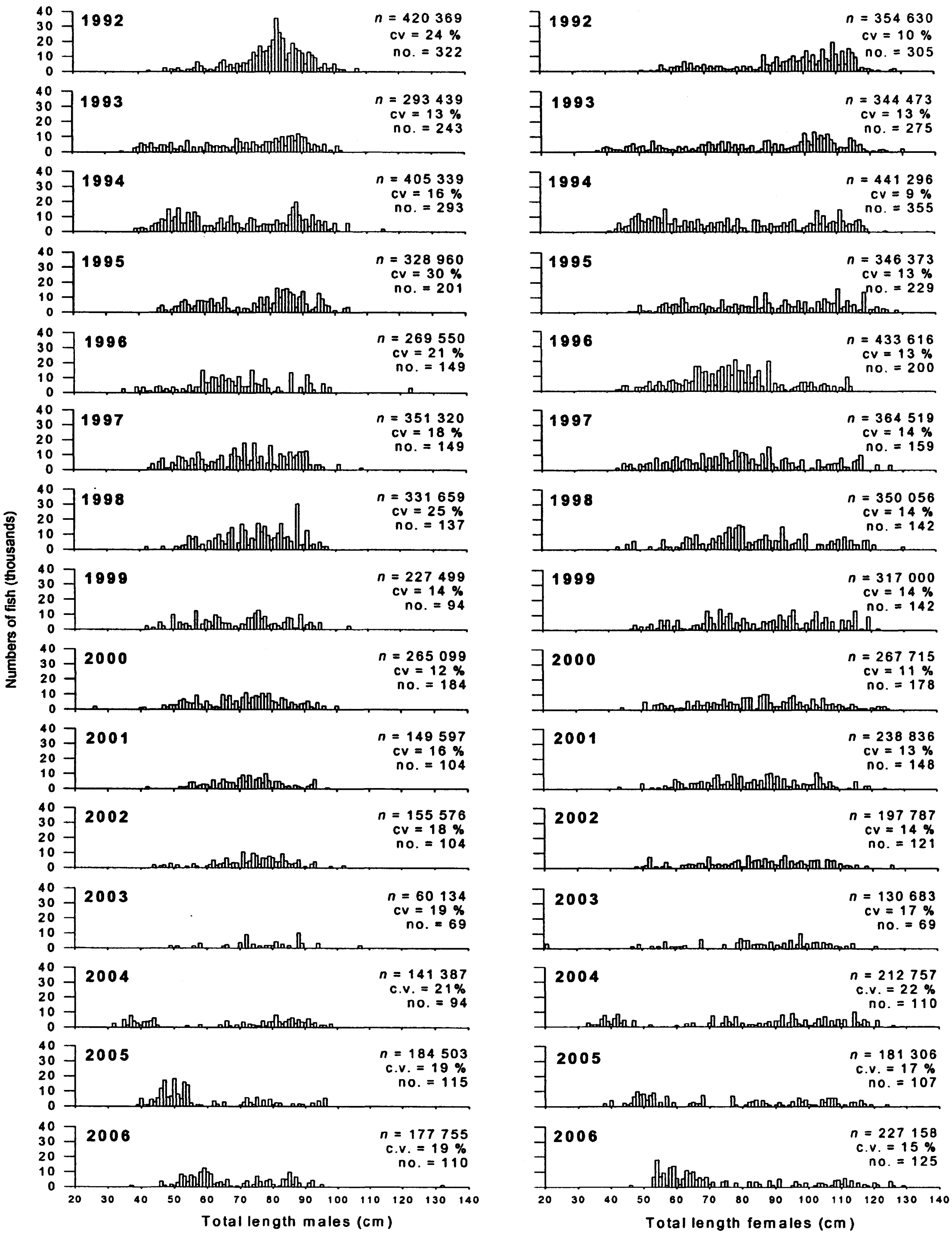


**Figure 12: Estimated length frequency distributions of the male and female hake population from *Tangaroa* surveys of the Chatham Rise, January 1992–2006. (c.v., coefficient of variation; *n*, estimated population number of hake; no., numbers of fish measured.)**

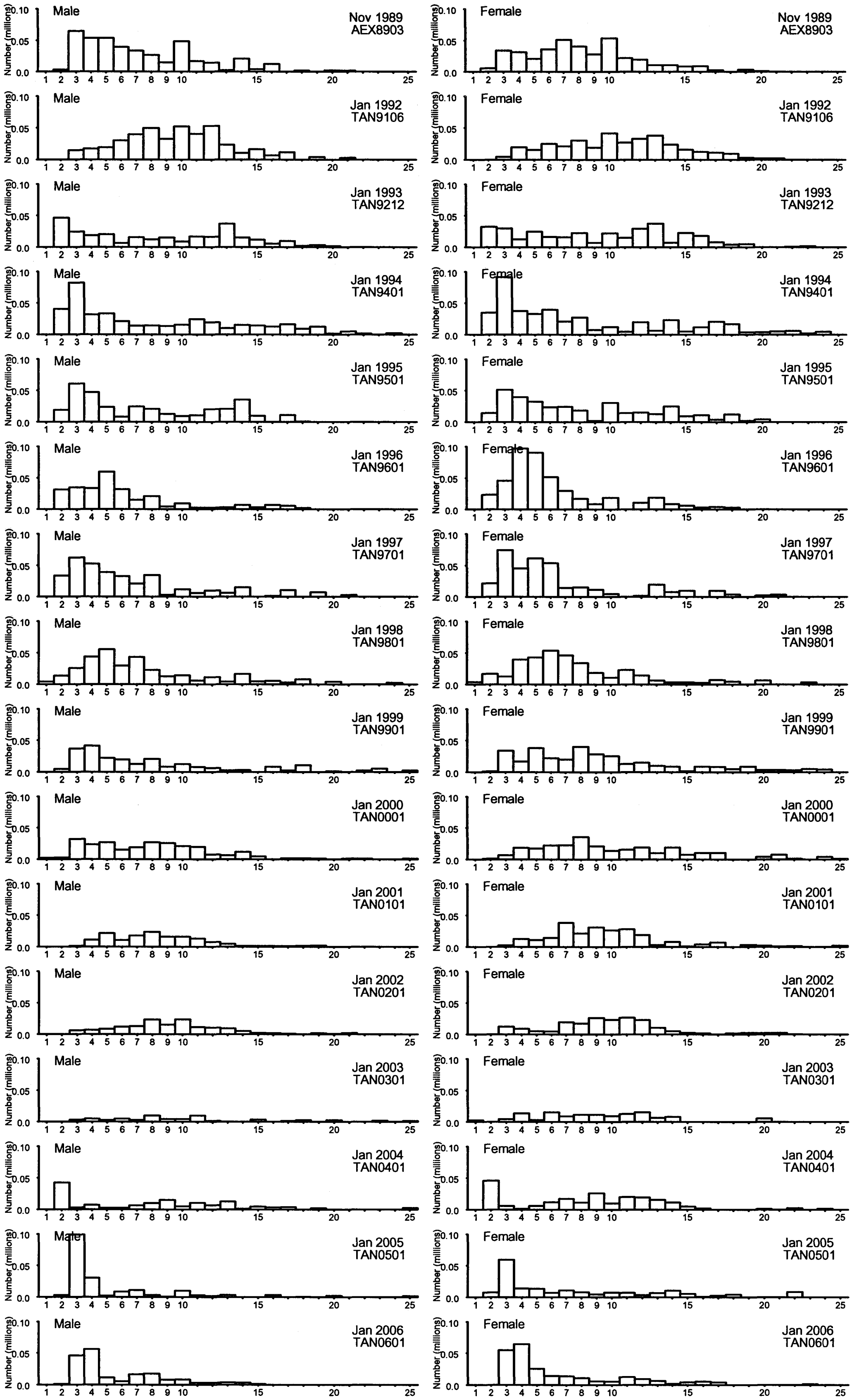


**Figure 13: Estimated proportion at age of male and female hake from *Tangaroa* surveys of the Chatham Rise, January, 1992–2006**

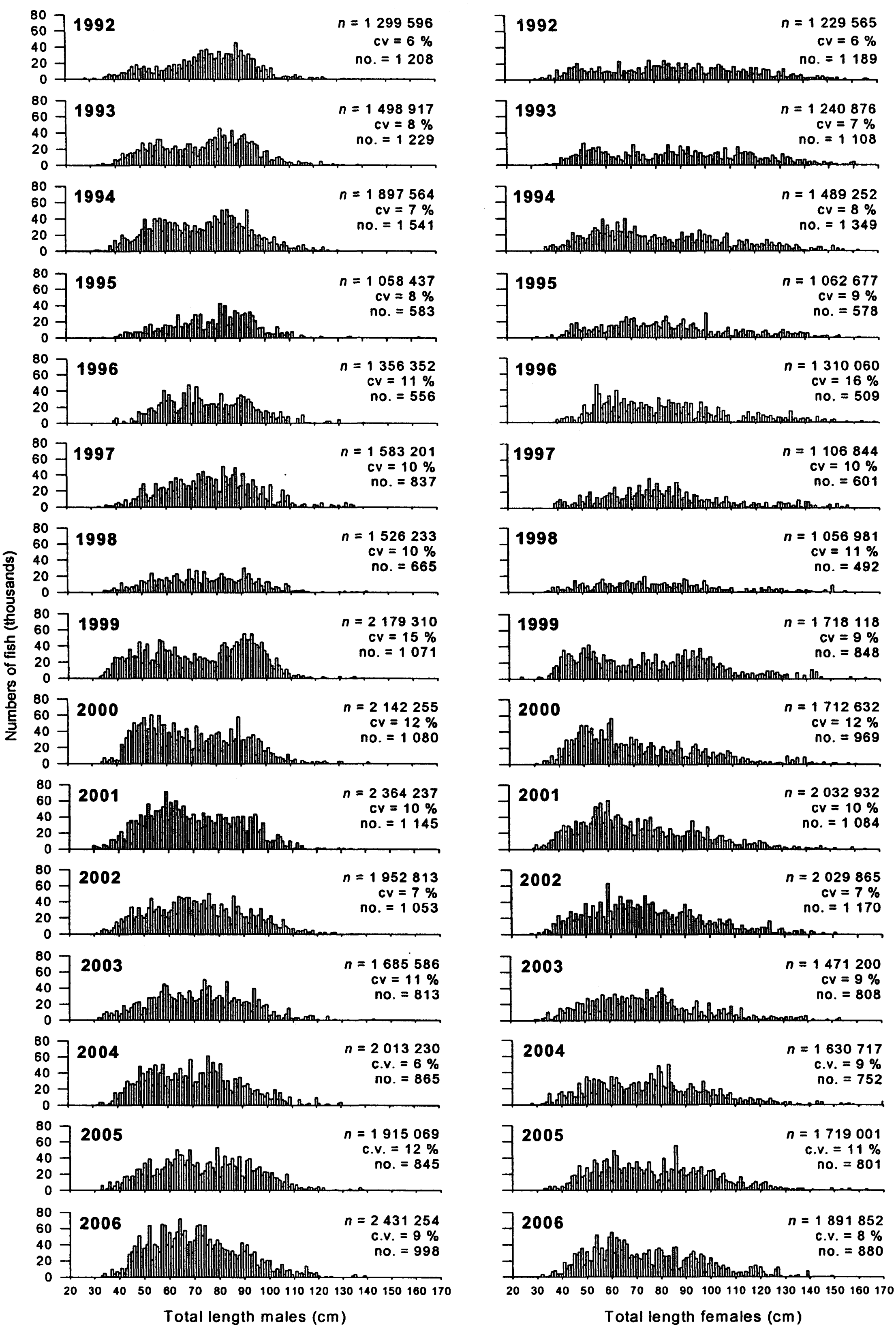


**Figure 14: Estimated length frequency distributions of the ling population from *Tangaroa* surveys of the Chatham Rise, January 1992–2006. (c.v., coefficient of variation; *n*, estimated population number of ling; no., numbers of fish measured.)**

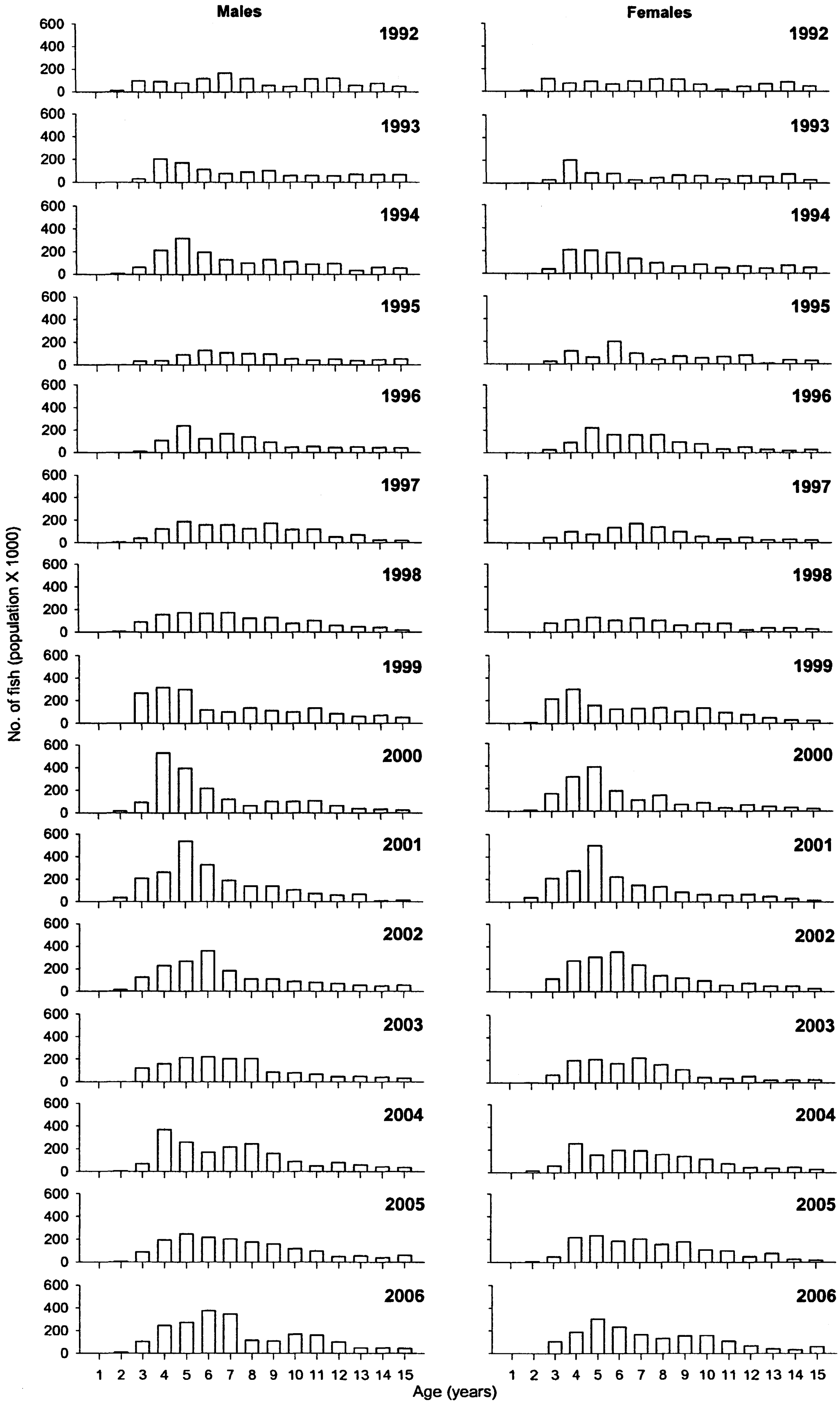


**Figure 15: Estimated population numbers at age of male and female ling (age 1–15 years) from *Tangaroa* surveys of the Chatham Rise, January, 1992–2006. (Note: the age class of 15 years is not a plus group.)**

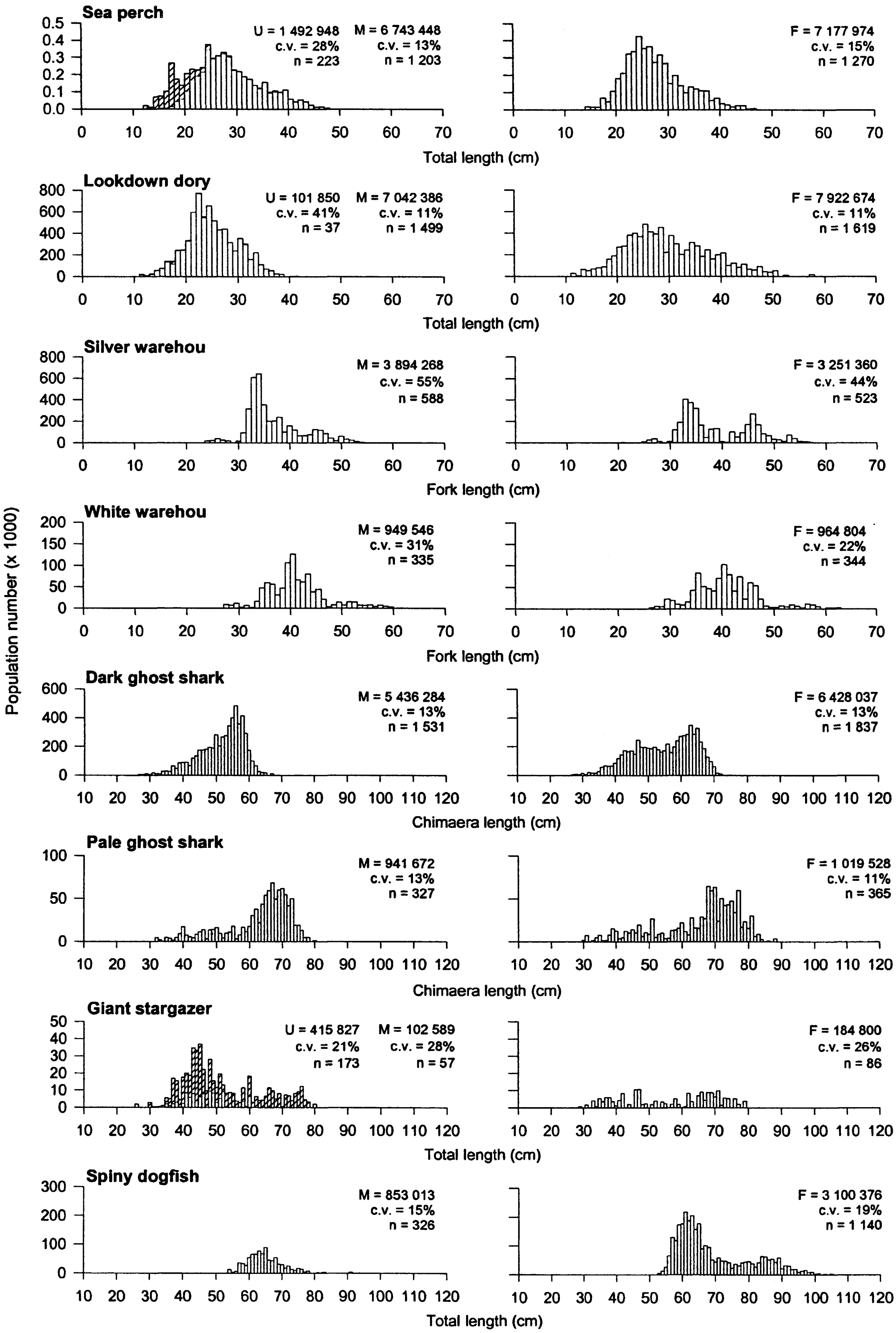


**Figure 16: Length frequencies of selected commercial species on the Chatham Rise 2006, scaled to population size by sex (M, estimated male population; F, estimated female population; U, estimated unsexed population (hatched bars); c.v. coefficient of variation of the estimated numbers of fish; n, number of fish measured.) Note: unsexed fish are not shown for most species.**

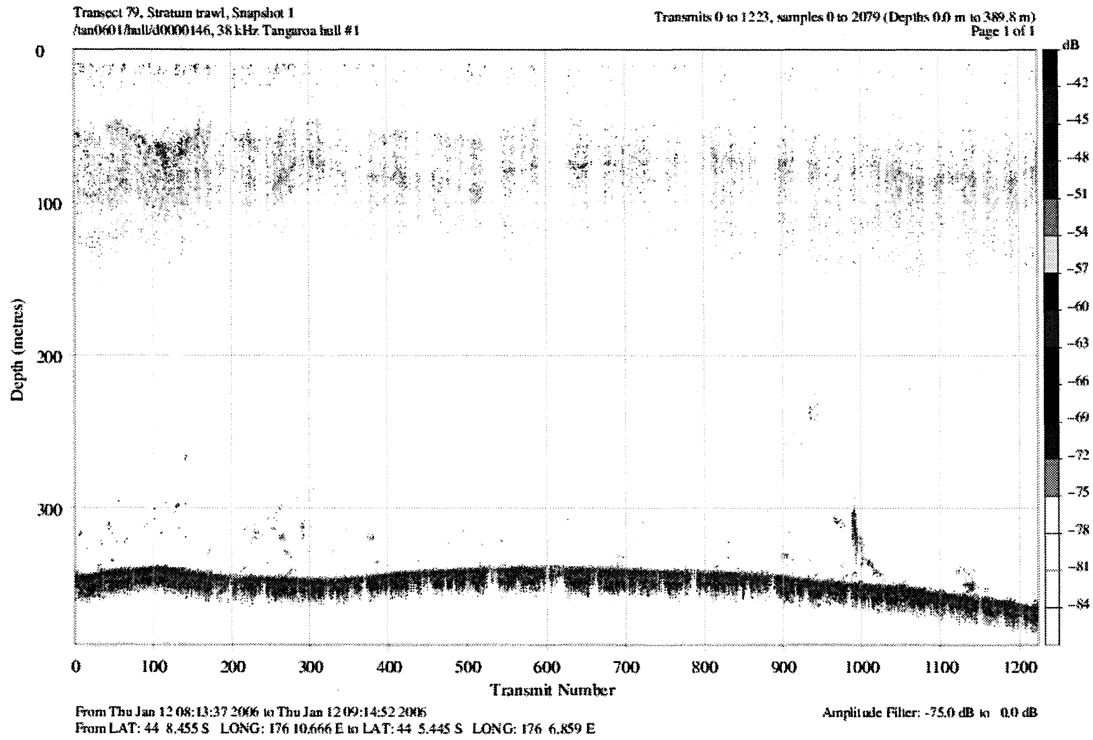


**Figure 17a: Acoustic echogram collected during tow 79 in stratum 17 showing weak bottom schools. The associated tow caught 1656 kg of small hoki. The horizontal scale (1230 pings) is equivalent to about 6.6 km at the tow speed of 3.5 knots.**

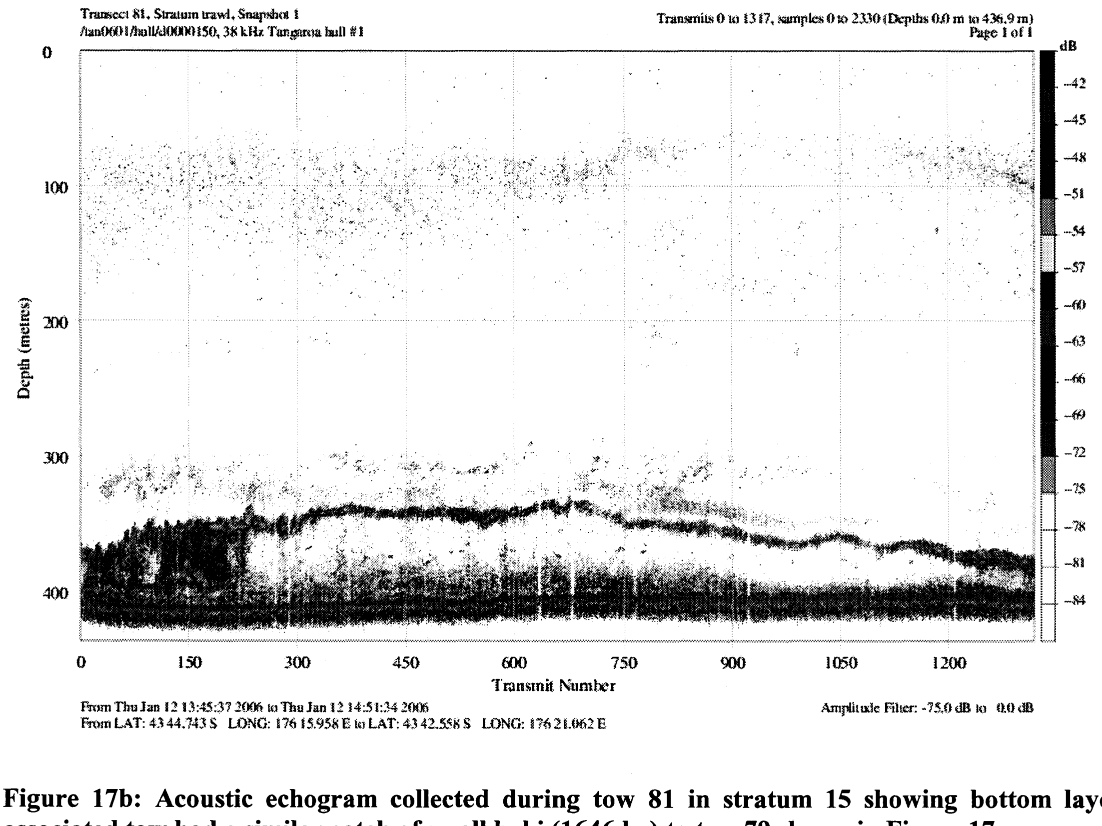


**Figure 17b: Acoustic echogram collected during tow 81 in stratum 15 showing bottom layers. The associated tow had a similar catch of small hoki (1646 kg) to tow 79 shown in Figure 17a.**

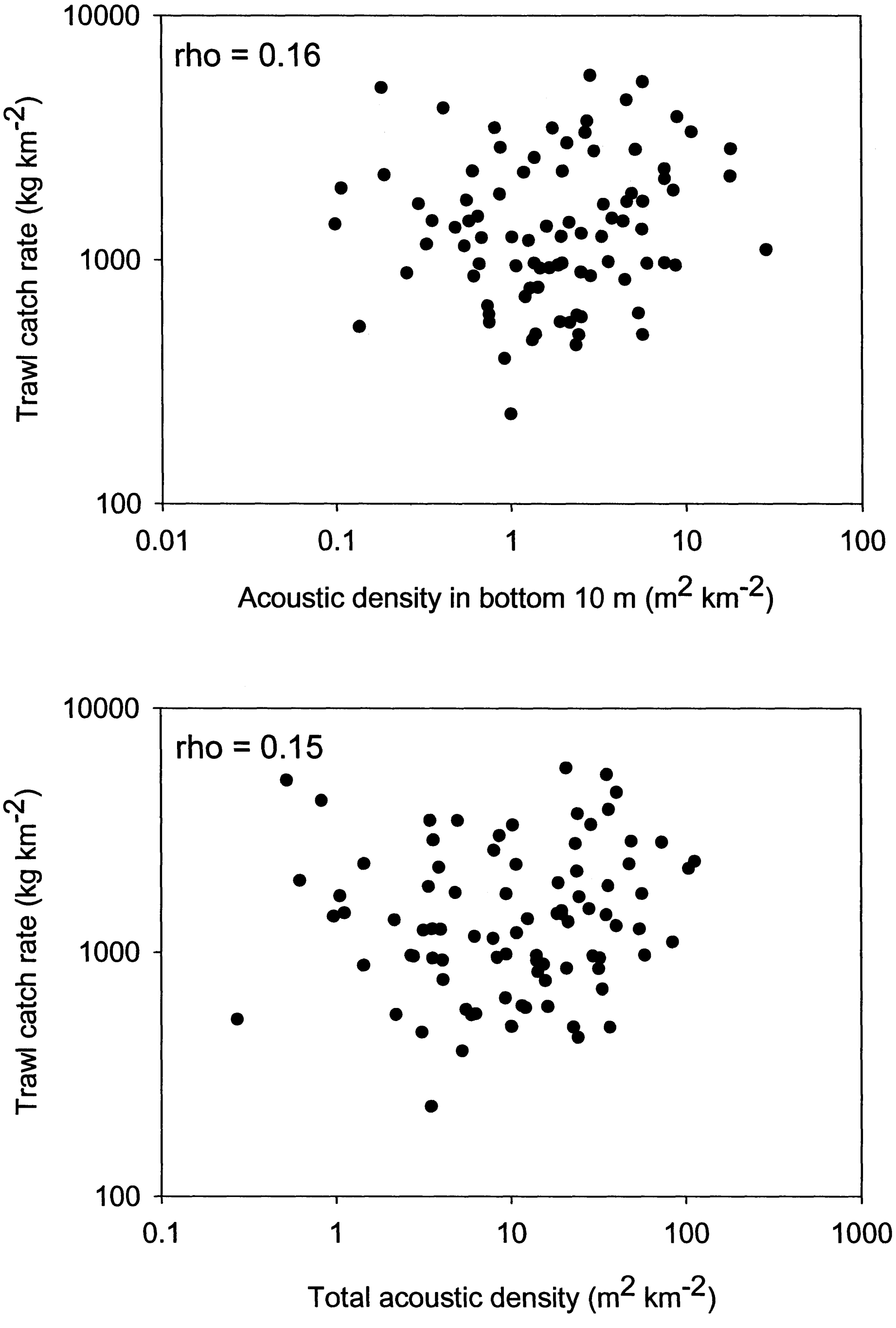


**Figure 18: Relationship between total trawl catch rate (all species combined) and acoustic backscatter recorded during the trawl on the Chatham Rise in 2006. Rho values are Spearman's rank correlation coefficients.**

**Appendix 1: Individual station data for all stations conducted during the survey (TAN0601). P1, phase 1 trawl survey biomass stations; Beam, research beam trawls; MWT, fine meshed midwater trawls; NV, non-valid biomass stations; Strat., Stratum number. Note: No P2, phase 2 trawl survey biomass stations were conducted.**

| | | | Start tow | | | | | 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 | NV | | 28-Dec-05 | 500 | 42 44.18 | 177 19.63 | E | 861 | 867 | 3 | | | |
| 2 | P1 | 2A | 28-Dec-05 | 740 | 42 47.30 | 177 31.97 | E | 681 | 707 | 3.01 | 126.0 | 6.3 | 8.2 |
| 3 | P1 | 8A | 28-Dec-05 | 957 | 42 51.18 | 177 38.48 | E | 500 | 506 | 2.99 | 220.4 | 8.4 | 194.6 |
| 4 | P1 | 2A | 28-Dec-05 | 1236 | 42 46.26 | 177 47.56 | E | 742 | 743 | 3.01 | 64.3 | 3.2 | 0.0 |
| 5* | P1 | 20 | 28-Dec-05 | 1619 | 43 03.96 | 177 41.82 | E | 317 | 324 | 1.72 | | | |
| 6 | Beam | | 28-Dec-05 | 2018 | 42 46.43 | 177 49.30 | E | 722 | 725 | 0.27 | | | |
| 7 | P1 | 20 | 29-Dec-05 | 456 | 43 38.20 | 177 31.63 | E | 309 | 322 | 2.4 | 2447.5 | 0.0 | 114.3 |
| 8 | P1 | 20 | 29-Dec-05 | 854 | 43 27.87 | 178 14.23 | E | 333 | 352 | 3 | 2800.2 | 0.0 | 31.5 |
| 9 | P1 | 20 | 29-Dec-05 | 1116 | 43 21.35 | 178 27.61 | E | 382 | 390 | 2.98 | 1219.5 | 23.7 | 179.6 |
| 10 | P1 | 20 | 29-Dec-05 | 1403 | 43 18.75 | 178 15.96 | E | 324 | 340 | 2.57 | 2407.3 | 8.6 | 10.5 |
| 11 | P1 | 2A | 29-Dec-05 | 1826 | 42 56.11 | 178 43.72 | E | 642 | 643 | 3 | 526.7 | 54.8 | 118.0 |
| 12 | MWT | | 30-Dec-05 | 2 | 43 09.62 | 179 17.96 | E | 98 | 160 | 0.81 | | | |
| 13 | P1 | 8B | 30-Dec-05 | 457 | 43 10.63 | 179 07.37 | E | 420 | 426 | 2.99 | 251.6 | 0.0 | 72.5 |
| 14 | P1 | 8B | 30-Dec-05 | 758 | 43 04.44 | 179 33.05 | E | 491 | 496 | 2.99 | 421.4 | 2.0 | 62.4 |
| 15* | P1 | 20 | 30-Dec-05 | 1139 | 43 24.35 | 179 27.17 | E | 385 | 396 | 2.92 | | | |
| 16 | P1 | 8B | 30-Dec-05 | 1456 | 43 31.14 | 179 46.04 | E | 402 | 412 | 2.55 | 1838.5 | 0.0 | 91.3 |
| 17 | P1 | 20 | 30-Dec-05 | 1806 | 43 40.25 | 179 52.78 | E | 397 | 400 | 2.33 | 376.0 | 32.8 | 142.1 |
| 18 | P1 | 10A | 31-Dec-05 | 506 | 43 15.37 | 179 55.95 | W | 497 | 499 | 3 | 323.5 | 9.7 | 29.4 |
| 19 | P1 | 10A | 31-Dec-05 | 748 | 43 30.06 | 179 44.68 | W | 422 | 427 | 3 | 454.7 | 21.7 | 119.2 |
| 20 | P1 | 10B | 31-Dec-05 | 1029 | 43 26.85 | 179 25.23 | W | 442 | 453 | 2.96 | 211.6 | 19.2 | 24.2 |
| 21 | P1 | 10A | 31-Dec-05 | 1358 | 43 09.36 | 179 30.61 | E | 519 | 525 | 3.01 | 158.7 | 6.7 | 50.8 |
| 22 | P1 | 2B | 31-Dec-05 | 1706 | 42 53.80 | 179 19.50 | W | 619 | 621 | 3 | 241.4 | 57.9 | 8.9 |
| 23 | P1 | 4 | 1-Jan-06 | 510 | 44 21.70 | 178 41.76 | W | 732 | 742 | 3.02 | 85.6 | 0.0 | 22.6 |
| 24 | P1 | 3 | 1-Jan-06 | 829 | 44 07.29 | 179 02.29 | W | 342 | 364 | 3 | 1337.9 | 12.6 | 52.3 |
| 25 | P1 | 3 | 1-Jan-06 | 1101 | 43 56.83 | 179 05.41 | W | 361 | 382 | 2.96 | 566.4 | 0.0 | 38.1 |
| 26 | P1 | 3 | 1-Jan-06 | 1732 | 43 51.38 | 179 14.07 | W | 287 | 311 | 3 | 1185.6 | 9.2 | 182.6 |
| 27 | Beam | | 1-Jan-06 | 1954 | 43 51.50 | 179 13.01 | W | 294 | 296 | 0.38 | | | |
| 28 | Beam | | 2-Jan-06 | 250 | 43 47.51 | 179 55.58 | E | 403 | 404 | 0.26 | | | |
| 29 | P1 | 14 | 2-Jan-06 | 458 | 43 47.02 | 179 53.52 | E | 405 | 407 | 2.99 | 718.0 | 13.5 | 70.2 |
| 30 | P1 | 13 | 2-Jan-06 | 659 | 43 52.69 | 179 58.75 | W | 421 | 437 | 3 | 348.8 | 3.2 | 133.1 |
| 31 | P1 | 10B | 2-Jan-06 | 1246 | 43 38.60 | 179 11.97 | W | 406 | 416 | 2.93 | 340.6 | 26.5 | 24.9 |
| 32 | P1 | 11A | 3-Jan-06 | 509 | 43 33.24 | 178 56.46 | W | 455 | 455 | 3.01 | 389.8 | 35.9 | 24.6 |
| 33 | P1 | 11A | 3-Jan-06 | 824 | 43 23.39 | 179 00.14 | W | 432 | 441 | 3 | 289.4 | 168.1 | 75.1 |
| 34 | P1 | 10B | 3-Jan-06 | 1206 | 43 09.43 | 179 08.16 | W | 514 | 519 | 2.93 | 288.3 | 148.0 | 5.1 |
| 35 | P1 | 11B | 3-Jan-06 | 1447 | 43 05.13 | 178 47.94 | W | 504 | 512 | 3 | 409.1 | 0.0 | 10.3 |
| 36* | P1 | 11B | 3-Jan-06 | 1705 | 43 03.66 | 178 36.83 | W | 526 | 549 | 1.25 | | | |
| 37 | P1 | 11B | 3-Jan-06 | 1858 | 43 03.73 | 178 40.21 | W | 517 | 548 | 3 | 137.0 | 0.0 | 21.4 |
| 38 | P1 | 11B | 4-Jan-06 | 521 | 43 04.64 | 178 28.13 | W | 522 | 524 | 2.99 | 83.5 | 0.0 | 5.3 |
| 39 | P1 | 11C | 4-Jan-06 | 730 | 43 09.72 | 178 14.90 | W | 470 | 488 | 3 | 161.2 | 18.8 | 57.8 |
| 40 | P1 | 11C | 4-Jan-06 | 1034 | 43 18.25 | 177 55.83 | W | 437 | 438 | 3.02 | 124.4 | 0.0 | 24.2 |
| 41 | P1 | 11C | 4-Jan-06 | 1415 | 43 03.13 | 177 57.01 | W | 501 | 518 | 3 | 188.2 | 16.8 | 68.5 |
| 42 | P1 | 2B | 4-Jan-06 | 1754 | 42 51.49 | 178 02.61 | W | 619 | 635 | 2.99 | 45.9 | 0.0 | 25.8 |
| 43 | MWT | | 5-Jan-06 | 7 | 42 54.45 | 176 55.62 | W | 644 | 680 | 0.55 | | | |

**Appendix 1 (continued)**

| Stn. | Type | Strat. | Date | Start tow Time NZST | Latitude ° ' S | Longitude ° ' | E/W | Depth m min. | max. | Dist. towed n. mile | Catch kg hoki | hake | ling |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 44 | MWT | | 5-Jan-06 | 214 | 42 55.25 | 176 52.55 | W | 230 | 245 | 1.17 | | | |
| 45 | MWT | | 5-Jan-06 | 326 | 42 54.47 | 176 51.26 | W | 75 | 83 | 0.98 | | | |
| 46 | P1 | 2B | 5-Jan-06 | 513 | 42 54.32 | 176 56.73 | W | 716 | 719 | 3.01 | 150.4 | 12.8 | 33.2 |
| 47 | P1 | 9 | 5-Jan-06 | 834 | 43 12.38 | 176 52.67 | W | 330 | 352 | 3 | 51.1 | 0.0 | 35.1 |
| 48 | P1 | 11D | 5-Jan-06 | 1255 | 43 17.92 | 176 07.00 | W | 447 | 449 | 3 | 2848.0 | 0.0 | 70.0 |
| 49 | P1 | 2B | 5-Jan-06 | 1705 | 43 04.48 | 176 07.58 | W | 607 | 607 | 3 | 253.8 | 20.6 | 36.4 |
| 50 | Beam | | 6-Jan-06 | 133 | 43 26.91 | 175 37.16 | W | 475 | 478 | 0.34 | | | |
| 51 | Beam | | 6-Jan-06 | 303 | 43 22.81 | 175 38.85 | W | 517 | 517 | 0.38 | | | |
| 52 | P1 | 11D | 6-Jan-06 | 452 | 43 20.98 | 175 39.94 | W | 536 | 545 | 3.01 | 290.8 | 0.0 | 39.2 |
| 53 | P1 | 2B | 6-Jan-06 | 734 | 43 21.69 | 175 24.56 | W | 649 | 659 | 3 | 112.6 | 6.8 | 34.4 |
| 54 | P1 | 11D | 6-Jan-06 | 1020 | 43 27.07 | 175 36.07 | W | 459 | 499 | 3.02 | 4679.3 | 17.2 | 46.6 |
| 55* | P1 | 9 | 6-Jan-06 | 1355 | 43 49.48 | 175 30.82 | W | 318 | 343 | 1.15 | | | |
| 56 | P1 | 9 | 6-Jan-06 | 1722 | 43 52.56 | 175 27.03 | W | 249 | 292 | 2.59 | 0.0 | 0.0 | 0.0 |
| 57 | P1 | 12 | 7-Jan-06 | 506 | 44 22.00 | 177 13.60 | W | 536 | 540 | 3 | 145.4 | 0.0 | 74.3 |
| 58 | P1 | 12 | 7-Jan-06 | 810 | 44 23.16 | 177 23.30 | W | 581 | 588 | 3 | 231.2 | 0.0 | 91.9 |
| 59 | P1 | 5 | 7-Jan-06 | 1152 | 44 00.28 | 177 25.43 | W | 358 | 365 | 2.99 | 380.1 | 0.0 | 23.5 |
| 60 | P1 | 12 | 7-Jan-06 | 1428 | 43 59.76 | 177 41.55 | W | 419 | 438 | 2.99 | 696.4 | 7.4 | 61.7 |
| 61 | P1 | 5 | 7-Jan-06 | 1902 | 43 37.16 | 177 58.65 | W | 373 | 377 | 1.99 | 258.9 | 5.9 | 86.1 |
| 62 | P1 | 11A | 8-Jan-06 | 449 | 43 36.83 | 178 48.34 | W | 449 | 452 | 3.01 | 231.4 | 22.2 | 60.2 |
| 63 | P1 | 11A | 8-Jan-06 | 639 | 43 38.56 | 178 43.66 | W | 448 | 452 | 3 | 171.1 | 15.5 | 14.7 |
| 64 | P1 | 11A | 8-Jan-06 | 857 | 43 32.40 | 178 32.84 | W | 410 | 430 | 3 | 1171.0 | 4.7 | 39.2 |
| 65 | P1 | 13 | 8-Jan-06 | 1128 | 43 41.93 | 178 27.41 | W | 403 | 410 | 2.98 | 384.3 | 6.6 | 46.0 |
| 66 | P1 | 5 | 8-Jan-06 | 1448 | 43 29.91 | 178 04.83 | W | 371 | 382 | 3 | 630.3 | 2.7 | 32.6 |
| 67 | P1 | 9 | 8-Jan-06 | 1816 | 43 18.60 | 177 41.35 | W | 342 | 346 | 3 | 120.5 | 0.0 | 41.2 |
| 68 | P1 | 13 | 10-Jan-06 | 827 | 44 07.32 | 179 52.55 | W | 502 | 536 | 3 | 707.6 | 7.7 | 185.5 |
| 69 | P1 | 14 | 10-Jan-06 | 1104 | 44 01.11 | 179 51.07 | E | 495 | 510 | 2.94 | 816.6 | 0.0 | 62.8 |
| 70 | P1 | 14 | 10-Jan-06 | 1508 | 43 50.01 | 179 11.85 | E | 471 | 489 | 3 | 1028.5 | 0.0 | 88.6 |
| 71 | Beam | | 10-Jan-06 | 1725 | 43 49.97 | 179 11.34 | E | 479 | 486 | 0.46 | | | |
| 72 | P1 | 15 | 11-Jan-06 | 506 | 43 51.61 | 177 40.98 | E | 588 | 597 | 3 | 849.1 | 0.0 | 59.1 |
| 73 | P1 | 4 | 11-Jan-06 | 940 | 44 08.37 | 176 57.33 | E | 690 | 698 | 3 | 105.9 | 0.0 | 26.1 |
| 74 | P1 | 4 | 11-Jan-06 | 1233 | 44 01.09 | 176 57.47 | E | 603 | 606 | 2.99 | 375.4 | 0.0 | 99.0 |
| 75 | P1 | 15 | 11-Jan-06 | 1652 | 43 55.35 | 176 23.28 | E | 513 | 515 | 3.02 | 561.5 | 0.0 | 119.7 |
| 76 | MWT | | 12-Jan-06 | 52 | 43 46.01 | 176 10.59 | E | 130 | 145 | 0.61 | | | |
| 77 | MWT | | 12-Jan-06 | 151 | 43 50.63 | 176 10.68 | E | 32 | 45 | 1.32 | | | |
| 78 | P1 | 17 | 12-Jan-06 | 521 | 44 17.20 | 176 12.26 | E | 231 | 348 | 2.98 | 58.9 | 0.0 | 20.6 |
| 79 | P1 | 17 | 12-Jan-06 | 723 | 44 07.65 | 176 09.73 | E | 341 | 354 | 2.99 | 2580.0 | 0.0 | 340.3 |
| 80 | P1 | 17 | 12-Jan-06 | 919 | 44 03.18 | 176 01.40 | E | 345 | 372 | 3 | 1070.3 | 0.0 | 94.8 |
| 81 | P1 | 15 | 12-Jan-06 | 1259 | 43 44.10 | 176 17.47 | E | 403 | 411 | 3.01 | 2537.0 | 0.0 | 118.7 |
| 82 | P1 | 19 | 12-Jan-06 | 1531 | 43 37.06 | 176 13.85 | E | 367 | 367 | 2.95 | 1338.6 | 1.8 | 81.9 |
| 83 | P1 | 19 | 12-Jan-06 | 1837 | 43 36.61 | 176 35.95 | E | 371 | 388 | 2 | 1592.1 | 0.0 | 78.2 |
| 84 | P1 | 6 | 13-Jan-06 | 520 | 44 39.54 | 175 12.34 | E | 782 | 796 | 3.01 | 10.7 | 0.0 | 0.0 |
| 85 | P1 | 6 | 13-Jan-06 | 731 | 44 37.07 | 175 09.54 | E | 749 | 756 | 3 | 43.2 | 0.0 | 10.5 |
| 86 | P1 | 16 | 13-Jan-06 | 1138 | 4417.54 | 175 19.32 | E | 571 | 590 | 3 | 352.6 | 9.4 | 163.1 |
| 87 | P1 | 16 | 13-Jan-06 | 1541 | 43 59.92 | 175 28.22 | E | 479 | 489 | 3.01 | 335.2 | 6.0 | 121.7 |
| 88 | P1 | 16 | 13-Jan-06 | 1825 | 43 57.85 | 175 06.85 | E | 460 | 461 | 3 | 2099.4 | 6.8 | 89.1 |
| 89 | P1 | 6 | 14-Jan-06 | 514 | 44 31.66 | 173 38.49 | E | 717 | 730 | 3 | 192.4 | 5.8 | 39.0 |

**Appendix 1 (continued)**

| Stn. | Type | Strat. | Start tow Date 2001 | Time NZST | Latitude ° ' S | Longitude ° ' | E/W | Depth m min. | max. | Dist. towed n. mile | hoki | hake | Catch kg ling |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 90 | P1 | 16 | 14-Jan-06 | 1042 | 44 06.52 | 174 24.32 | E | 576 | 578 | 3.03 | 211.1 | 0.0 | 142.2 |
| 91 | P1 | 16 | 14-Jan-06 | 1345 | 43 50.04 | 174 38.97 | E | 506 | 514 | 3.06 | 984.4 | 9.5 | 140.6 |
| 92 | P1 | 16 | 14-Jan-06 | 1535 | 43 48.74 | 174 45.73 | E | 480 | 485 | 3 | 2002.7 | 4.3 | 57.9 |
| 93* | P1 | 18 | 14-Jan-06 | 1816 | 43 35.57 | 174 57.09 | E | 351 | 356 | 0.94 | | | |
| 94 | P1 | 18 | 15-Jan-06 | 504 | 43 35.79 | 175 37.48 | E | 268 | 278 | 3 | 903.9 | 0.0 | 9.8 |
| 95 | P1 | 18 | 15-Jan-06 | 709 | 43 41.93 | 175 24.65 | E | 332 | 357 | 3 | 1031.8 | 3.2 | 12.3 |
| 96 | P1 | 18 | 15-Jan-06 | 1047 | 43 36.35 | 174 57.83 | E | 347 | 363 | 3 | 2354.5 | 5.0 | 48.6 |
| 97 | P1 | 7 | 15-Jan-06 | 1326 | 43 26.52 | 174 39.76 | E | 401 | 436 | 2.99 | 4097.1 | 5.4 | 91.6 |
| 98 | P1 | 7 | 15-Jan-06 | 1608 | 43 27.01 | 174 15.60 | E | 556 | 561 | 3.02 | 204.2 | 4.3 | 154.6 |
| 99 | P1 | 7 | 15-Jan-06 | 1820 | 43 20.69 | 174 17.39 | E | 582 | 587 | 3 | 186.8 | 13.1 | 82.4 |
| 100 | Beam | | 16-Jan-06 | 355 | 43 04.21 | 174 13.09 | E | 744 | 745 | 0.2 | | | |
| 101 | P1 | 1 | 16-Jan-06 | 538 | 43 04.32 | 174 11.95 | E | 741 | 747 | 3 | 74.9 | 5.9 | 27.7 |
| 102 | P1 | 1 | 16-Jan-06 | 827 | 42 59.10 | 174 34.14 | E | 784 | 799 | 3 | 19.0 | 17.4 | 1.9 |
| 103 | P1 | 7 | 16-Jan-06 | 1130 | 43 11.56 | 174 39.68 | E | 486 | 492 | 2.98 | 211.9 | 42.2 | 288.0 |
| 104 | P1 | 18 | 16-Jan-06 | 1424 | 43 13.73 | 174 56.67 | E | 216 | 256 | 2.11 | 0.0 | 0.0 | 0.0 |
| 105 | P1 | 18 | 16-Jan-06 | 1631 | 43 04.79 | 174 59.86 | E | 356 | 383 | 3.02 | 1673.0 | 0.0 | 195.6 |
| 106 | MWT | | 16-Jan-06 | 1932 | 43 04.84 | 175 00.62 | E | 205 | 267 | | | | |
| 107 | MWT | | 16-Jan-06 | 2050 | 43 04.40 | 174 59.82 | E | 45 | 53 | | | | |
| 108 | P1 | 7 | 17-Jan-06 | 516 | 43 09.42 | 175 42.44 | E | 426 | 431 | 3 | 398.5 | 22.1 | 151.3 |
| 109 | P1 | 7 | 17-Jan-06 | 701 | 43 10.82 | 175 50.78 | E | 417 | 453 | 3 | 1026.7 | 225.3 | 118.5 |
| 110 | P1 | 8A | 17-Jan-06 | 918 | 43 05.23 | 176 06.58 | E | 437 | 439 | 2.99 | 1200.4 | 30.7 | 63.0 |
| 111 | P1 | 7 | 17-Jan-06 | 1136 | 43 00.08 | 176 02.68 | E | 504 | 513 | 2.99 | 161.1 | 4.9 | 100.9 |
| 112 | P1 | 1 | 17-Jan-06 | 1357 | 42 52.23 | 175 55.07 | E | 637 | 647 | 2.98 | 48.7 | 5.7 | 65.3 |
| 113 | P1 | 19 | 22-Jan-06 | 535 | 43 27.03 | 177 12.94 | E | 246 | 256 | 3.01 | 450.9 | 0.0 | 7.1 |
| 114 | P1 | 19 | 22-Jan-06 | 734 | 43 21.17 | 177 14.22 | E | 219 | 234 | 3 | 0.0 | 0.0 | 0.0 |
| 115 | P1 | 19 | 22-Jan-06 | 951 | 43 11.30 | 177 01.78 | E | 247 | 273 | 3.03 | 65.2 | 0.0 | 0.0 |
| 116 | P1 | 19 | 22-Jan-06 | 1140 | 43 07.92 | 176 55.32 | E | 299 | 317 | 3.02 | 2953.3 | 0.0 | 5.4 |
| 117 | P1 | 8A | 22-Jan-06 | 1423 | 42 59.80 | 176 37.61 | E | 412 | 420 | 3.01 | 647.7 | 37.7 | 49.5 |

* Foul trawl stations

**Appendix 2: Scientific and common names of species caught from valid biomass tows (TAN0601). The occurrence (Occ.) of each species (number of tows caught) in the 96 valid biomass tows is also shown. (Note that codes are continually updated on the database following this and other surveys.)**

| Scientific name | common name | species | Occ. |
|---|---|---|---|
| **Porifera** | unspecified sponges | ONG | 18 |
| Callyspongiidae | | | |
| *Callyspongia cf. ramosa* | airy finger sponge | CRM | 1 |
| Geodiidae | | | |
| *Geodinella vestigifera* | ostrich egg sponge | GVE | 1 |
| Rossellidae | | | |
| *Acanthascus* (*Rhabdocalyptus*) sp. | floppy trumpet sponge | GLS | 15 |
| **Cnidaria** | | | |
| Coral (Hydrozoan + Anthozoan corals) | unspecified corals | COU | 3 |
| Hydrozoa | hydroid | HDR | 1 |
| Scyphozoa | jellyfish | JFI | 3 |
| **Anthozoa** | | | |
| Scleractinia (stony corals) | | | |
| Caryophyllidae | | | |
| *Desmophyllum dianthus* | crested cup coral | DDI | 4 |
| *Goniocorella dumosa* | bushy hard coral | GDU | 6 |
| Dendrophylliiae | | | |
| *Enallopsammia rostrata* | deepwater branching coral | ERO | 1 |
| Flabellidae | | | |
| *Flabellum* spp. | flabellum cup corals | COF | 2 |
| Stylasteridae | | | |
| *Errina* spp. | red hydrocorals | ERR | 1 |
| Pennatulacea (sea pens) | unspecified seapens | SPN | 5 |
| Actinaria (sea anemones) | unspecified sea anemones | ANT | 4 |
| Actiniidae (deepsea anemones) | | | |
| *Bolocera* spp. | | BOC | 4 |
| Actinostolidae (smooth deepsea anemones) | | ACS | 12 |
| Hormathiidae (warty deepsea anemones) | | HMT | 16 |
| Liponematidae (deepsea anemones) | | | |
| *Liponema* spp. | | LIP | 1 |
| **Tunicata** | | | |
| Thaliacea (salps) | unspecified salps | SAL | 10 |
| *Pyrosoma atlanticum* | | PYR | 1 |
| **Mollusca** | | | |
| Gastropoda (gastropods) | unspecified gastropods | GAS | 7 |
| Cymatiidae | | | |
| *Fusitriton magellanicus* | | FMA | 33 |
| Turbinellidae | | | |
| *Coluzea mariae* | | CMR | 1 |
| Volutidae | unspecified volutes | VOL | 1 |
| *Provocator mirabilis* | golden volute | GVO | 3 |
| Bivalvia (bivalves) | | | |
| Limidae | | | |
| *Acesta maui* | giant file shell | AMA | 1 |

**Appendix 2 (continued)**

| Scientific name | common name | species | Occ. |
|---|---|---|---|
| Cephalopoda | | | |
| Sepiodea (cuttlefishes) | | | |
| Sepiolidae | unspecified sepiolids | SEQ | 1 |
| Teuthoidea (squids) | | | |
| Onychoteuthidae | | | |
| *Moroteuthis ingens* | warty squid | MIQ | 31 |
| Histioteuthidae | | | |
| *Histioteuthis* spp. | violet squid | VSQ | 4 |
| Ommastrephidae | | | |
| *Nototodarus sloanii* | arrow squid | NOS | 66 |
| *Todarodes filippovae* | Antarctic flying squid | TSQ | 33 |
| Cranchiidae | unspecified cranchiid squids | CHQ | 1 |
| Octopoda (octopods) | unspecified octopod | OCP | 1 |
| *Enteroctopus zealandicus* | yellow octopus | EZE | 4 |
| *Graneledone* spp. | deepwater octopus | DWO | 4 |
| **Crustacea** | | | |
| Dendrobranchiata/Pleocyemata (prawns) | unspecified prawns | NAT | 3 |
| Dendrobranchiata | | | |
| Aristeidae | | | |
| *Aristaeopsis edwardsiana* | scarlet prawn | PED | 1 |
| Penaeidae | | | |
| *Funchalia* spp. | | FUN | 2 |
| Solenoceridae | | | |
| *Haliporoides sibogae* | jack-knife prawn | HSI | 2 |
| Pleocyemata | | | |
| Caridea | | | |
| Campylonotidae | | | |
| *Camplyonotus rathbonae* | sabre prawn | CAM | 5 |
| Pandalidae | | | |
| *Plesionika martia* | golden prawn | PLM | 1 |
| Pasiphaeidae | | | |
| *Pasiphaea* spp. | deepwater prawns | PAS | 3 |
| Nematocarcinidae | | | |
| *Lipkius holthuisi* | omega prawn | LHO | 10 |
| Astacidea | | | |
| Nephropidae (clawed lobsters) | | | |
| *Metanephrops challengeri* | scampi | SCI | 41 |
| Palinura | | | |
| Polychelidae | | | |
| *Polycheles suhmi* | deepsea blind lobster | PSU | 4 |
| Crab (Anomuran + Brachyuran crabs) | unspecified crabs | CRB | 8 |
| Anomura | | | |
| Galatheidae (squat lobsters) | | | |
| *Munida gracilis* | | MNI | 2 |
| Lithodidae (king crabs) | | | |
| *Lithodes murrayi* | Murray's king crab | LMU | 1 |
| *Paralomis zelandica* | prickly king crab | PZE | 2 |
| Paguroidea (unspecified pagurid & parapagurid hermit crabs) | | PAG | 9 |
| Paguridae | | | |
| *Diacanthurus rubricatus* | hermit crab | DIR | 1 |

**Appendix 2 (continued)**

| Scientific name | common name | species | Occ. |
|---|---|---|---|
| Parapaguridae | | | |
| *Sympagurus dimorphus* | hermit crab | SDM | 8 |
| Brachyura | | | |
| Atelecyclidae | | | |
| *Trichopeltarion fantasticum* | frilled crab | | 8 |
| Goneplacidae | | | |
| *Carcinoplax victoriensis* | two-spined crab | CVI | 6 |
| Homolidae | | | |
| *Dagnaudus petterdi* | antlered crab | DAP | 11 |
| Majidae (spider crabs) | | | |
| *Leptomithrax australis* | giant masking crab | SSC | 8 |
| *Teratomaia richardsoni* | spiny masking crab | SMK | 2 |
| | | | |
| **Echinodermata** | | | |
| Asteroidea (starfish) | unspecified asteroids | ASR | 7 |
| Asteriidae | | | |
| *Cosmasterias dyscrita* | cat's-foot star | CDY | 11 |
| Astropectinidae | | | |
| *Dipsachaster magnificus* | magnificent sea-star | DMG | 14 |
| *Plutonaster knoxi* | abyssal star | PLT | 25 |
| *Psilaster acuminatus* | geometric star | PSI | 49 |
| *Sclerasterias mollis* | cross fish | SMO | 3 |
| Benthopectinidae | | | |
| *Benthopecten pikei* | five-spined star | BPI | 3 |
| Brisingida | armless stars | BRG | 1 |
| Goniasteridae | | | |
| *Ceramaster patagonicus patagonicus* | pentagon star | CPA | 3 |
| *Hippasteria phrygiana* | trojan star | HTR | 3 |
| *Lithosoma novaezelandiae* | rock star | LNV | 4 |
| *Mediaster sladeni* | Sladen's star | MSL | 11 |
| Odontasteridae | | | |
| *Odontaster benhami* | pentagonal tooth-star | ODT | 2 |
| Solasteridae | | | |
| *Crossaster multispinus* | sun-star | CJA | 23 |
| *Solaster torulatus* | chubby sun-star | SOT | 3 |
| Zoroasteridae | | | |
| *Zoroaster* spp. | rat-tail star | ZOR | 30 |
| Holothuroidea (sea cucumbers) | unspecified holothurians | HTH | 32 |
| Ophiuroidea (basket and brittle stars) | | | |
| *Bathypectinura heros* | deepsea brittle star | BHE | 1 |
| Euryalina (basket stars) | | | |
| Gorgonocephalidae | | | |
| *Astrothorax waitei* | Waite's snake star | AWA | 2 |
| *Gorgonocephalus* sp. | Gorgon's head basket stars | GOR | 13 |
| Echinoidea (sea urchins) | | | |
| Regularia | | | |
| Cidaridae (cidarid urchins) | | | |
| *Goniocidaris parasol* | parasol urchin | GPA | 2 |
| *G. umbraculum* | umbrella urchin | GOU | 5 |
| Echinothuriidae (Tam-o-shanter urchins) | | TAM | 31 |

**Appendix 2 (continued)**

| Scientific name | common name | species | Occ. |
|---|---|---|---|
| Echinidae | | | |
| *Gracilechinus multidentatus* | deepsea kina | GRM | 9 |
| *Dermechinus horridus* | deepsea urchin | DHO | 2 |
| Spatangidae (heart urchins) | | | |
| *Paramaretia peloria* | Microsoft mouse | PMU | 2 |
| *Spatangus multispinus* | purple-heart urchin | SPT | 6 |
| Temnopleuridae | | | |
| *Pseudechinus flemingi* | Fleming's urchin | PFL | 1 |
| **Agnatha** (jawless fishes) | | | |
| *Eptatretus cirrhatus* | hagfish | HAG | 1 |
| **Chondrichthyes** (cartilagenous fishes) | | | |
| Chlamydoselachidae: frill shark | | | |
| *Chlamydoselachus anguineus* | frill shark | FRS | 1 |
| Squalidae: dogfishes | | | |
| *Centrophorus squamosus* | leafscale gulper shark | CSQ | 11 |
| *Centroscymnus crepidater* | longnose velvet dogfish | CYP | 11 |
| *C. owstoni* | smooth skin dogfish | CYO | 5 |
| *C. plunketi* | Plunket's shark | PLS | 9 |
| *Deania calcea* | shovelnose dogfish | SND | 40 |
| *Etmopterus baxteri* | Baxter's dogfish | ETB | 16 |
| *E. lucifer* | Lucifer dogfish | ETL | 49 |
| *Scymnorhinus licha* | seal shark | BSH | 19 |
| *Squalus acanthias* | spiny dogfish | SPD | 65 |
| *S. mitsukurii* | northern spiny dogfish | NSD | 3 |
| Oxynotidae: rough sharks | | | |
| *Oxynotus bruniensis* | prickly dogfish | PDG | 6 |
| Scyliorhinidae: cat sharks | | | |
| *Apristurus* spp. | catshark | APR | 6 |
| *Cephaloscyllium isabellum* | carpet shark | CAR | 1 |
| *Bythaelurus dawsoni* | New Zealand catshark | DCS | 1 |
| Triakidae: smoothhounds | | | |
| *Galeorhinus galeus* | school shark | SCH | 8 |
| Torpedinidae: electric rays | | | |
| *Torpedo fairchildi* | electric ray | ERA | 4 |
| Narkidae: blind electric rays | | | |
| *Typhlonarke tarakea* | oval electric ray | TTA | 3 |
| Rajidae: skates | | | |
| *Dipturus innominatus* | smooth skate | SSK | 29 |
| *D. nasutus* | rough skate | RSK | 3 |
| *Notoraja* spp. | bluntnose deepsea skates | BTH | 20 |
| Chimaeridae: chimaeras, ghostsharks | | | |
| *Hydrolagus novaezealandiae* | ghost shark | GSH | 52 |
| *H. bemisi* | pale ghost shark | GSP | 67 |
| Rhinochimaeridae: longnosed chimaeras | | | |
| *Harriotta raleighana* | long-nosed chimaera | LCH | 44 |
| *Rhinochimaera pacifica* | widenosed chimaera | RCH | 2 |

**Appendix 2 (continued)**

| Scientific name | common name | species | Occ. |
|---|---|---|---|
| **Osteichthyes (bony fishes)** | | | |
| Notocanthidae: spiny eels | | | |
| *Notacanthus sexspinis* | spineback | SBK | 32 |
| Synaphobranchidae: cutthroat eels | | | |
| *Diastobranchus capensis* | basketwork eel | BEE | 2 |
| Congridae: conger eels | | | |
| *Bassanago bulbiceps* | swollenhead conger | SCO | 35 |
| *B. hirsutus* | hairy conger | HCO | 18 |
| Argentinidae: silversides | | | |
| *Argentina elongata* | silverside | SSI | 55 |
| Alepocephalidae: slickheads | | | |
| *Alepocephalus australis* | smallscaled brown slickhead | SSM | 1 |
| *Xenodermichthys* spp. | black slickhead | BSL | 3 |
| Gonostomatidae: lightfishes | | | |
| *Diplophos* spp. | | DIP | 1 |
| Sternoptychidae: hatchetfishes | unspecified hatchetfish | HAT | 1 |
| *Argyropelecus gigas* | giant hatchetfish | AGI | 1 |
| Photichthyidae: lighthouse fishes | | | |
| *Photichthys argenteus* | lighthouse fish | PHO | 10 |
| Chauliodontidae: viperfishes | | | |
| *Chauliodus sloani* | viper fish | CHA | 1 |
| Malacosteidae: loosejaws | unspecified loosejaw | MAL | 2 |
| Paralepididae: barracudinas | unspecified barracudina | PAL | 1 |
| Myctophidae: lanternfishes | unspecified lanternfish | LAN | 7 |
| *Lampanyctus spp.* | | LPA | 1 |
| Moridae: morid cods | | | |
| *Antimora rostrata* | violet cod | VCO | 1 |
| *Halargyreus johnsonii* | Johnson's cod | HJO | 6 |
| *Lepidion microcephalus* | small-headed cod | SMC | 1 |
| *Mora moro* | ribaldo | RIB | 24 |
| *Notophycis marginata* | dwarf cod | DCO | 3 |
| *Pseudophycis bachus* | red cod | RCO | 25 |
| *Tripterophycis gilchristi* | grenadier cod | GRC | 2 |
| Gadidae: true cods | | | |
| *Micromesistius australis* | southern blue whiting | SBW | 3 |
| Merlucciidae: hakes | | | |
| *Macruronus novaezelandiae* | hoki | HOK | 93 |
| *Merluccius australis* | hake | HAK | 56 |
| Macrouridae: rattails, grenadiers | | | |
| *Caelorinchus aspercephalus* | oblique banded rattail | CAS | 59 |
| *C. biclinozonalis* | two saddle rattail | CBI | 10 |
| *C. bollonsi* | bigeye rattail | CBO | 82 |
| *C. fasciatus* | banded rattail | CFA | 26 |
| *C. innotabilis* | notable rattail | CIN | 10 |
| *C. matamua* | Mahia rattail | CMA | 5 |
| *C. oliverianus* | Oliver's rattail | COL | 59 |
| *C. parvifasciatus* | small banded rattail | CCX | 17 |
| *Coryphaenoides dossenus* | humpback rattail | CBA | 2 |
| *C. serrulatus* | serrulate rattail | CSE | 9 |
| *C. subserrulatus* | four-rayed rattail | CSU | 7 |

**Appendix 2 (continued)**

| Scientific name | common name | species | Occ. |
|---|---|---|---|
| *Lepidorhynchus denticulatus* | javelinfish | JAV | 89 |
| *Lucigadus nigromaculata* | blackspot rattail | VNI | 31 |
| *Macrourus carinatus* | ridge scaled rattail | MCA | 3 |
| *Trachyrincus aphyodes* | white rattail | WHX | 5 |
| Ophidiidae: cuskeels | | | |
| *Genypterus blacodes* | ling | LIN | 90 |
| Ceratiidae: seadevils | | | |
| *Cryptopsaras couesi* | seadevil | SDE | 2 |
| Trachipteridae: dealfishes | | | |
| *Trachipterus trachypterus* | dealfish | DEA | 1 |
| Regalecidae: oarfish | | | |
| *Agrostichthys parkeri* | ribbonfish | AGR | 1 |
| Trachichthyidae: roughies | | | |
| *Hoplostethus mediterraneus* | silver roughy | SRH | 33 |
| *Paratrachichthys trailli* | common roughy | RHY | 3 |
| Berycidae: alfonsinos | | | |
| *Beryx splendens* | alfonsino | BYS | 36 |
| Zeidae: dories | | | |
| *Capromimus abbreviatus* | capro dory | CDO | 17 |
| *Cyttus novaezealandiae* | silver dory | SDO | 19 |
| *C. traversi* | lookdown dory | LDO | 88 |
| *Zenopsis nebulosus* | mirror dory | MDO | 1 |
| Oreosomatidae: oreos | | | |
| *Allocyttus niger* | black oreo | BOE | 10 |
| *Neocyttus rhomboidalis* | spiky oreo | SOR | 18 |
| *Pseudocyttus maculatus* | smooth oreo | SSO | 8 |
| Macrorhamphosidae: snipefishes | | | |
| *Centriscops humerosus* | banded bellowsfish | BBE | 62 |
| *Notopogon lilliei* | crested bellowsfish | CBE | 4 |
| Scorpaenidae: scorpionfishes | | | |
| *Helicolenus* spp. | sea perch | SPE | 85 |
| Congiopodidae: pigfishes | | | |
| *Alertichthys blacki* | alert pigfish | API | 10 |
| *Congiopodus coriaceus* | deepsea pigfish | DSP | 1 |
| *Congiopodus leucopaecilus* | pigfish | PIG | 1 |
| Triglidae: gurnards | | | |
| *Lepidotrigla brachyoptera* | scaly gurnard | SCG | 6 |
| Hoplichthyidae: ghostflatheads | | | |
| *Hoplichthys haswelli* | deepsea flathead | FHD | 44 |
| Psychrolutidae: toadfishes | | | |
| *Ambophthalmos angustus* | pale toadfish | TOP | 24 |
| *Cottunculus nudus* | bonyskull toadfish | COT | 1 |
| *Neophrynichthys latus* | dark toadfish | TOD | 1 |
| *Psychrolutes microporos* | blobfish | PSY | 1 |
| Percichthyidae: temperate basses | | | |
| *Polyprion oxygeneios* | hapuku | HAP | 3 |
| Serranidae: sea perches | | | |
| *Lepidoperca aurantia* | orange perch | OPE | 12 |
| Apogonidae: cardinalfishes | | | |
| *Epigonus lenimen* | bigeye cardinalfish | EPL | 14 |
| *E. robustus* | robust cardinalfish | EPR | 5 |
| *E. telescopus* | deepsea cardinalfish | EPT | 12 |

**Appendix 2 (continued)**

| Scientific name | common name | species | Occ. |
| --- | --- | --- | --- |
| Carangidae: jacks, trevallies, kingfishes | | | |
| *Trachurus declivis* | jack mackerel | JMD | 1 |
| *T. symmetricus murphyi* | slender mackerel | JMM | 5 |
| Bramidae: pomfrets | | | |
| *Brama australis* | southern Ray's bream | SRB | 32 |
| *Xenobrama microlepis* | bronze bream | BBR | 3 |
| Emmelichthyidae: bonnetmouths, rovers | | | |
| *Emmelichthys nitidus* | redbait | RBT | 7 |
| *Plagiogeneion rubiginosum* | ruby fish | RBY | 2 |
| Cheilodactylidae: tarakihi, morwongs | | | |
| *Nemadactylus macropterus* | tarakihi | TAR | 4 |
| Latrididae: moki, trumpeters | | | |
| *Latris lineata* | trumpeter | TRU | 2 |
| Uranoscopidae: armourhead stargazers | | | |
| *Kathetostoma giganteum* | giant stargazer | STA | 41 |
| Gemplylidae: snake mackerels | | | |
| *Ruvettus pretiosus* | oilfish | OFH | 1 |
| *Thyrsites atun* | barracouta | BAR | 6 |
| Trichiuridae: cutlassfishes | | | |
| *Lepidopus caudatus* | frostfish | FRO | 2 |
| Scombridae: mackerels, tunas | | | |
| *Scomber australasicus* | blue mackerel | EMA | 1 |
| Centrolophidae: raftfishes, medusafishes | | | |
| *Centrolophus niger* | rudderfish | RUD | 17 |
| *Hyperoglyphe antarctica* | bluenose | BNS | 8 |
| *Schedophilus* sp. | | SUS | 2 |
| *Seriolella caerulea* | white warehou | WWA | 41 |
| *S. punctata* | silver warehou | SWA | 52 |
| *Tubbia tasmanica* | | TUB | 1 |
| Nomeidae: eyebrowfishes, driftfishes | | | |
| *Cubiceps* spp. | cubehead | CUB | 2 |
| Bothidae: lefteyed flounders | | | |
| *Arnoglossus scapha* | witch | WIT | 9 |
| *Neoachiropsetta milfordi* | finless flounder | MAN | 2 |
| Peluronectidae: righteyed flounders | | | |
| *Azygopus pinnifasciatus* | spotted flounder | SDF | 2 |
| *Pelotretis flavilatus* | lemon sole | LSO | 10 |

**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 |