

**Commercial catch sampling for length and age of
hoki and ling in Cook Strait
in the winter 2004 hoki spawning fishery**

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**Final Research Report for
Ministry of Fisheries Research Project MID2003-03
Objectives 1 & 2**

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- 5. Project Leader** P.L. Horn
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| Start Date | 1 January 2004 |
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- 7. Objectives**
1. To collect otolith samples in the fish processing sheds and determine the age and size structure of the commercial landings of hoki from Cook Strait during winter 2004.
 2. To collect the otoliths required for determining the catch at age from the Cook Strait ling fishery in winter 2004 and determine the length frequency distribution of this catch (LIN 2 & 7).
- 8. Executive summary**

This report describes the sampling programme carried out on commercial landings of hoki (*Macruronus novaezelandiae*) and ling (*Genypterus blacodes*) in Cook Strait, during the winter 2004 hoki spawning fishery, and the subsequent estimates of catch-at-age for these fisheries. This report fulfils the reporting requirements of Objectives 1 and 2 of project MID2003-03.

Hoki and ling were sampled for length, sex, and age from the Cook Strait trawl fishery. Sampling occurred in processing sheds from June to September 2004, and the target number of samples was achieved for both species. Data and otoliths collected at sea by Observers were incorporated into the ling analysis. Catch-at-length and catch-at-age distributions, scaled to total catch, are presented for both species.

For hoki, the mean weighted c.v.s over all age classes was 12.8%, below the target c.v. of 20%. For ling, the mean weighted c.v.s over all age classes was 26.5%, below the target c.v. of 30%.

9. Introduction

There are four main fisheries for hoki in New Zealand: west coast South Island (WCSI); Cook Strait; the Chatham Rise; and the Southern Plateau. The WCSI and Cook Strait are predominantly spawning fisheries during winter, while fishing in the other two areas is normally outside of the spawning season (O'Driscoll et al. 2004).

Annual shed sampling of the Cook Strait spawning hoki catch has been carried out since 1988. The shed samples of hoki length frequencies and otoliths from each year have been analysed to provide estimates of catch-at-age by sex for input into the stock assessment models (e.g., O'Driscoll et al. 2004). The first objective in this project is to extend the existing Cook Strait hoki time series to include the winter 2004 catch.

Ling is an important middle depth species taken mainly around the South Island. It supports a substantial bottom longline fishery, and is a major bycatch in middle depth trawl fisheries. In Cook Strait, ling is an important bycatch of the hoki trawl fishery, and is also targeted by line. Administratively, ling in Cook Strait derive either from the LIN 7 or LIN 2 stocks. In recent years, Cook Strait ling landings have made up about 7% of the LIN 7 catch and 15% of the LIN 2 catch.

In 2001, 2002, and 2003, shed sampling of the Cook Strait ling catch was carried out to supplement the small number of otoliths collected by Observers. The second objective in this project is to again collect supplementary otoliths and extend the existing Cook Strait ling time series to include the winter 2004 catch.

10. Methods

Objective 1: Sampling of hoki for length, sex, and age.

Sampling of Cook Strait landings is done primarily in Nelson where the majority of Cook Strait caught hoki is processed (landings in Picton are also processed in Nelson). A review of landings up to 1997 (Cordue et al. 1999) showed that an increasing proportion of the Cook Strait catch was being landed in Wellington, so in recent years extra sampling effort has been allocated for hoki landed in that port. Ballara & Cordue (2000) found there was significant variation in the length frequencies of Cook Strait hoki from different sized vessels. Because of this, an additional stratification by vessel size has been implemented for the South Island samples since 1999. Samples are also stratified by time in relation to the monthly distribution of catch. Recent practice has been to concentrate efforts in July and August, with some samples taken in late June and early September (O'Driscoll et al. 2004).

The sampling design for 2004 was based on the previous year's landings. The proportion of landings from 2003 were examined prior to the 2004 fishery to see if sampling effort needed to be redistributed between month, island of landing (North or

South), and vessel size (3 classes: 0 to < 30m, ≥ 30 to < 40 m, ≥ 40 m) strata. The proposed 50 samples for 2004 were divided between the strata in approximately the same proportion as the 2003 catch (Tables 1 and 2).

For each sample, about 200 fish were sexed and measured, and otoliths were taken from every fourth fish. The associated landing weight was recorded for each sample. Data forms were checked, and data entered into the *market* database maintained by NIWA. Otoliths are archived at NIWA Greta Point.

The total catch at age for the Cook Strait fishery was estimated from a total length frequency for the catch and an associated age-length key. The total length frequency was a weighted average of the individual length samples, stratified by month, island of landing, and vessel length category. Individual length samples were scaled up by landing weight. The data were aggregated by stratum, and then each stratum scaled up to the total fishery catch for that stratum.

As in recent years, about 750 otoliths were used to construct the age-length key (about 400 from females and about 350 from males; more female otoliths to allow for the extra age classes due to their lower natural mortality and later maturation). This number of otoliths is in line with previous instructions from the Ministry on the number to use, and also in agreement with calculations from previous year's samples on the number to use to achieve the target c.v. of 20%. Otoliths were prepared and read using the validated method of Horn & Sullivan (1996), as modified by Cordue et al. (2000), and age data were entered on to the *age* database maintained by NIWA. The age-length key was applied to the total length frequency using custom-built NIWA 'catch.at.age' software (Bull & Dunn 2002) to produce an age frequency for the catch. The NIWA software incorporates data from otolith ring measurements using the consistency scoring method of Francis (2001) in the age-length key, with c.v.s calculated by bootstrapping.

Objective 2: Sampling of ling for length, sex, and age.

Scientific Observers on vessels targeting hoki in Cook Strait do sample ling, but the number of observed trips in Cook Strait is relatively low and variable (owing to the flexible fishing strategies of most companies, and the relatively short stays of most hoki trawlers in this area). Consequently, additional on-shore sampling of the ling bycatch from the hoki fishery was conducted to ensure the availability of comprehensive length and otolith samples.

Eighteen ling samples were scheduled from trips where hoki were targeted in Cook Strait during June–September 2004. Each sample aimed to record length, sex and gonad stage of at least 40 ling. Otoliths were taken from approximately every third fish. The associated landing weight was recorded for each sample. Data forms were checked, and data entered into the *market* database maintained by NIWA. Otoliths are archived at NIWA Greta Point.

The scaled length-frequency distribution, by sex, was calculated using the 'catch.at.length' software developed by NIWA (Bull & Dunn 2002). Both the shed sample and Observer data were included in this analysis. The total length frequency is

a weighted average of the individual length samples. Individual length samples were scaled up by trip weight (for shed samples), or tow weight (for Observer samples).

All available otoliths (381 from shed samples and 112 from Observer samples) were prepared and read using the validated ageing technique for ling reported by Horn (1993). (500 otoliths were scheduled to be prepared.) Proportion-at-age was calculated by constructing age-length keys separately for each sex and applying them to the scaled length-frequency distribution, using the 'catch.at.age' software developed by NIWA (Bull & Dunn 2002).

11. Results

Objection 1: Sampling of hoki for length, sex, and age.

The landed catch of hoki from Cook Strait by stratum (week of landing, island of landing, vessel size) was determined from an extract provided by the Ministry of Fisheries. An estimated total of 38 017 t was landed in the 2004 winter fishery.

A total of 51 samples were collected, 43 from Nelson and 8 from Wellington (Table 2). The actual Nelson sampling schedule differed slightly from the proposed programme because of a reduction in fishing by vessels in the smaller size categories, relative to 2003.

The scaled length-frequency distributions for the 2004 fishery are presented for males (Figure 1a) and females (Figure 1b) separately, and can be compared with distributions from previous years. The relatively strong mode of the 2000 year class apparent in the 2003 fishery sample has grown to a modal length of about 69–72 cm and now dominates the 2004 distributions of both sexes.

Estimated catch-at-age, by sex, is listed in Table 3. The distributions are presented for males (Figure 2a) and females (Figure 2b) separately, and can be compared with those from previous years. Four-year-old fish (the 2000 year class) dominate the distributions, particularly for males. The mean weighted c.v. across all age classes was 12.8%, less than the target c.v. of 20%.

Objective 2: Sampling of ling for length, sex, and age.

The scheduled 18 samples were completed at Nelson. The number of ling examined ranged from 39 to 111 per sample, producing a total of 1087 measured and sexed fish, and 381 otoliths. The sampled landings comprised 36 t of ling. Sampling of Cook Strait ling at sea by Observers had occurred on five trips and 30 tows, producing 167 length measurements and 112 otoliths.

The length-frequency distributions, scaled to represent the sampled catch, are quite spiky, as might be expected from the relatively small samples sizes, i.e. 600–700 fish per sex (Figure 3).

Estimated catch-at-age, by sex, is listed in Table 4. The mean weighted c.v. across all age classes was 26.5%, less than the target c.v. of 30%. The age distributions are

presented for males and females separately (Figure 4), and can be compared with those from previous years.

12. Conclusions

Sampling of the Cook Strait spawning hoki fishery has been conducted annually since 1988. During that time, sampling methods have evolved to produce representative length and age distributions of the catch. The targeted number of samples was met in 2004, although the scheduled sampling regime was changed slightly owing to apparent changes in the composition of the fleet, relative to last year (i.e., fewer smaller vessels participated in the fishery in 2004). The mean weighted c.v. for the calculated hoki catch-at-age distribution was well within the target of 20%. The progression between 2003 and 2004 of the relatively strong year class spawned in 2000 was apparent in the length and age distributions. This year class dominated the 2004 male catch.

Shore-based sampling of the ling bycatch from the Cook Strait hoki spawning fishery has been conducted annually since 2001. Samples are available from 1999 and 2000, but they are based on relatively few fish sampled at sea by Observers (see Figure 4). The targeted number of samples was met in 2004, and the data were augmented by Observer samples. The mean weighted c.v. for the calculated ling catch-at-age distribution was within the target of 30%. No clear progressions of strong or weak year classes are apparent in the age distributions.

13. Publications

Nil.

14. Data storage

All catch sampling data collected during this project are stored on the *market* database, and all age data are stored on the *age* database. Both databases are administered by NIWA for the Ministry of Fisheries.

15. References

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Table 1: Target number of Cook Strait hoki samples by “Island”, month, and vessel size class, for the 2004 sampling season

“Island”	Vessel	Month				Total
		Jun	Jul	Aug	Sep	
South (Nelson)	<30 m (BT3)	0	5	6	2	13
	≥30 & <40 (BT2)	1	3	4	2	10
	≥40 m (BT1)	2	8	6	3	19
North (Wellington)	All	0	2	4	2	8

Table 2: Achieved number of Cook Strait hoki samples by “Island”, month, and vessel size class, for the 2004 sampling season

“Island”	Vessel	Month				Total
		Jun	Jul	Aug	Sep	
South (Nelson)	<30 m (BT3)	0	5	5	2	12
	≥30 & <40 (BT2)	0	3	4	2	9
	≥40 m (BT1)	3	9	7	3	22
North (Wellington)	All	0	2	4	2	8

Table 3: Scaled catch-at-age (numbers and percentage) and calculated c.v.s from catch sampling of hoki in the Cook Strait fishery in winter 2004. The numbers of fish successfully aged by sex, and the estimated mean weighted c.v. for both sexes, are also presented.

Age	Male			Female		
	Number	%	c.v.	Number	%	c.v.
2	225 150	0.89	0.315	82 399	0.33	0.492
3	1 503 018	5.94	0.171	545 848	2.16	0.256
4	4 774 646	18.85	0.111	3 348 542	13.22	0.123
5	919 598	3.63	0.198	1 433 579	5.66	0.170
6	1 239 327	4.89	0.158	1 690 863	6.68	0.163
7	801 824	3.17	0.189	1 508 694	5.96	0.158
8	417 688	1.65	0.234	1 846 516	7.29	0.160
9	164 909	0.65	0.308	860 941	3.40	0.197
10	188 895	0.75	0.327	1 147 483	4.53	0.174
11	84 152	0.33	0.412	669 439	2.64	0.220
12	70 292	0.28	0.396	803 067	3.17	0.200
13	32 494	0.13	0.574	476 081	1.88	0.282
14	8 921	0.04	1.086	76 865	0.30	0.491
15	0	0.00	—	144 229	0.57	0.454
16	1 971	0.01	1.987	197 620	0.78	0.440
17	0	0.00	—	25 736	0.10	0.688
18	0	0.00	—	26 701	0.11	0.940
21	3 275	0.01	0.991	3 744	0.01	0.940
Total measured			4 505			6 397
Total aged			312			411
Mean weighted c.v.			16.2			18.1
Mean weighted c.v. (both sexes)						12.8

Table 4: Scaled proportions-at-age (%) and calculated c.v.s from catch sampling of ling in the Cook Strait hoki spawning fishery in winter 2004. Age 17 represents a plus group. The numbers of fish successfully aged by sex, and the estimated mean weighted c.v. for both sexes, are also presented.

Age	<u>Male</u>		<u>Female</u>	
	%	c.v.	%	c.v.
3	0.51	1.427	0.00	—
4	0.76	0.799	0.26	0.747
5	1.20	0.659	2.63	0.439
6	3.54	0.412	0.49	0.690
7	0.53	0.835	2.64	0.365
8	4.17	0.348	5.62	0.310
9	9.57	0.276	3.95	0.329
10	8.67	0.265	5.49	0.260
11	7.10	0.260	4.79	0.273
12	6.51	0.264	5.87	0.256
13	4.02	0.366	4.60	0.284
14	2.31	0.423	2.18	0.428
15	3.78	0.309	1.10	0.665
16	1.11	0.528	1.97	0.516
17	3.01	0.303	1.60	0.583
Total measured		609		645
Total aged		260		233
Mean weighted c.v.		36.8		36.5
Mean weighted c.v. (both sexes)				26.5

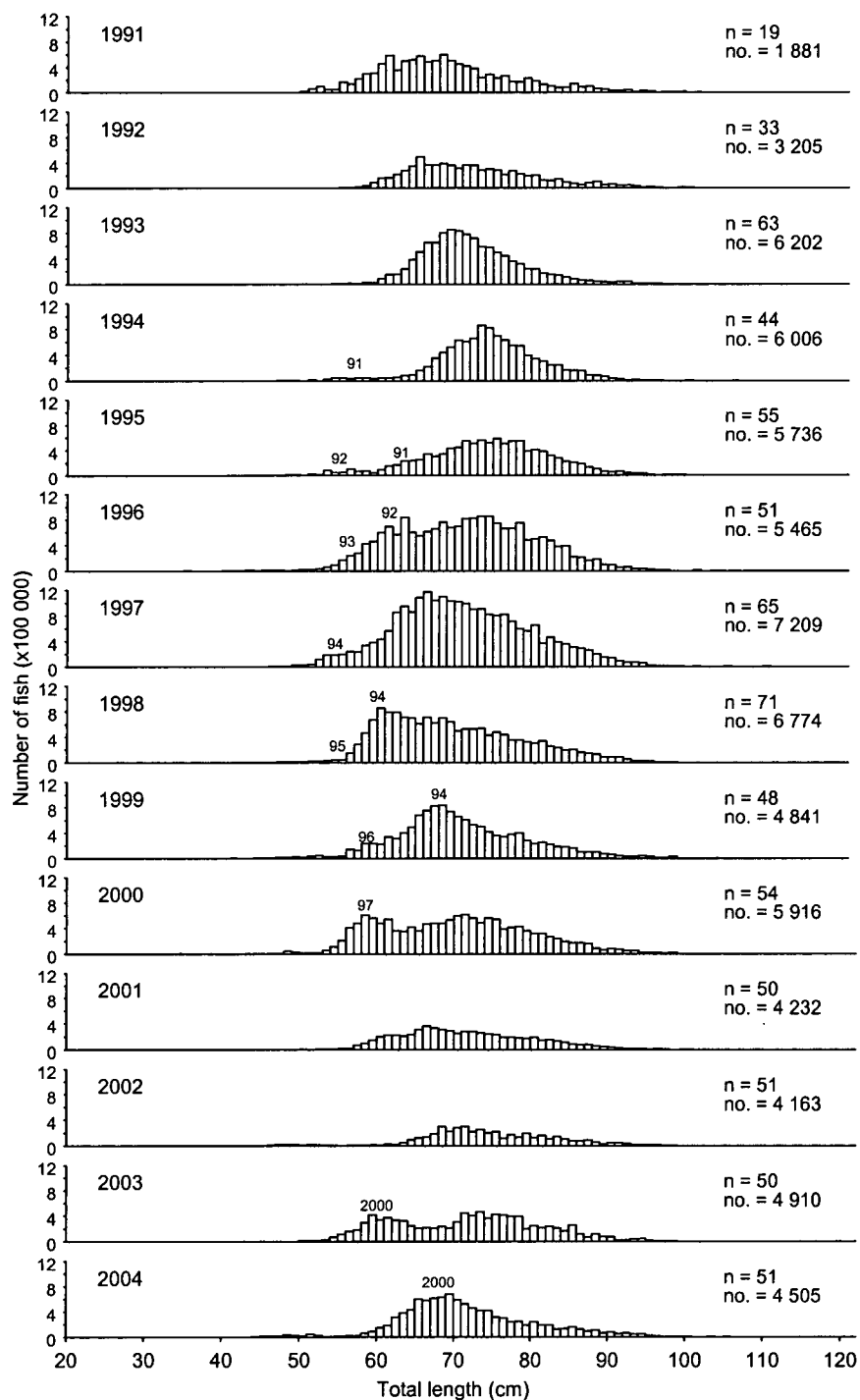


Figure 1a: Length frequency of male hoki in commercial catches from the Cook Strait spawning fishery from 1991 to 2004, sampled in processing sheds by the Stock Monitoring Programme. n, number of landings sampled; no., number of fish sampled. Numbers above the histograms mark year class modes, e.g., 91 = 1991 year class.

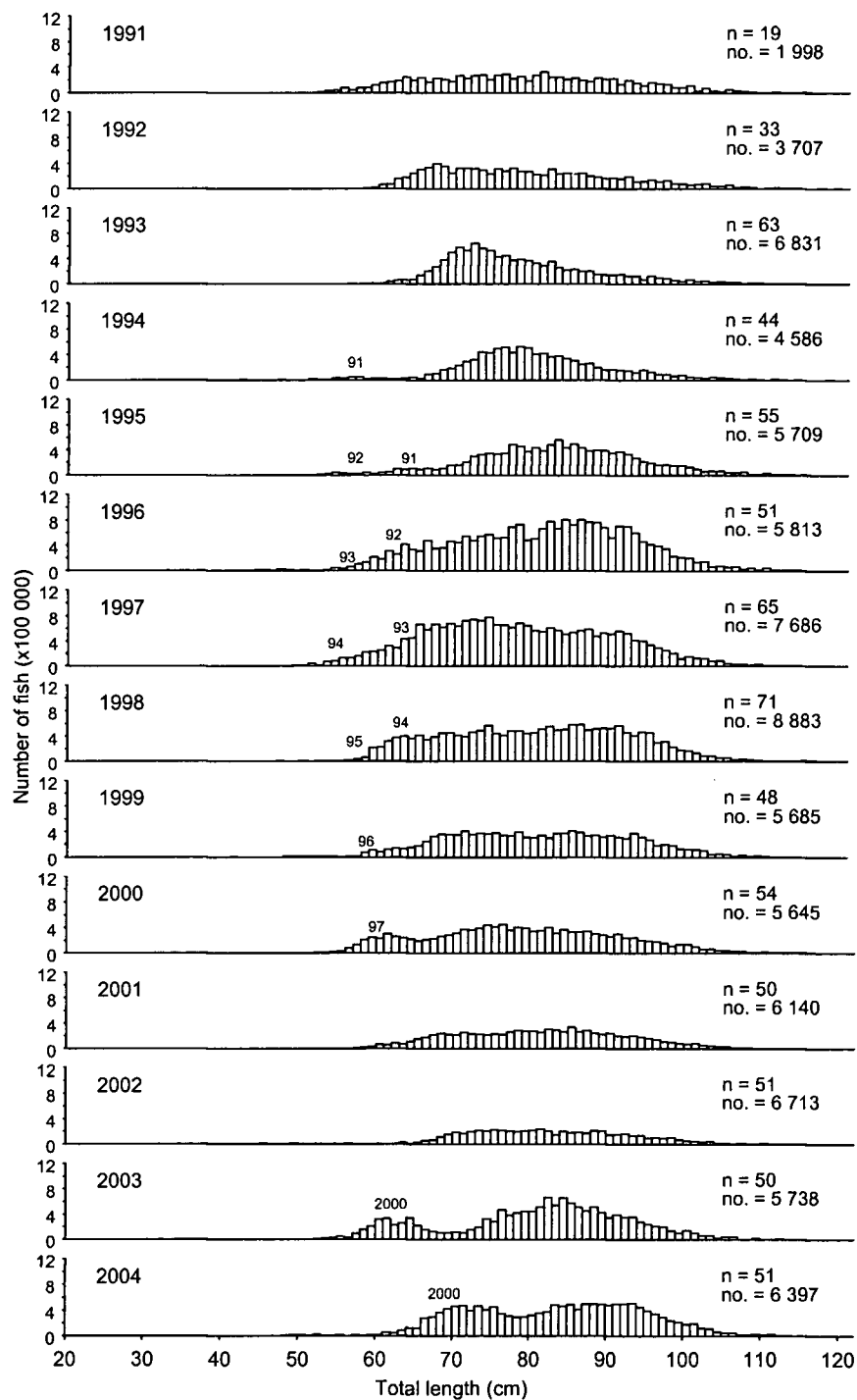


Figure 1b: Length frequency of female hoki in commercial catches from the Cook Strait spawning fishery from 1991 to 2004, sampled in processing sheds by the Stock Monitoring Programme. n, number of landings sampled; no., number of fish sampled. Numbers above the histograms mark year class modes, e.g., 91 = 1991 year class.

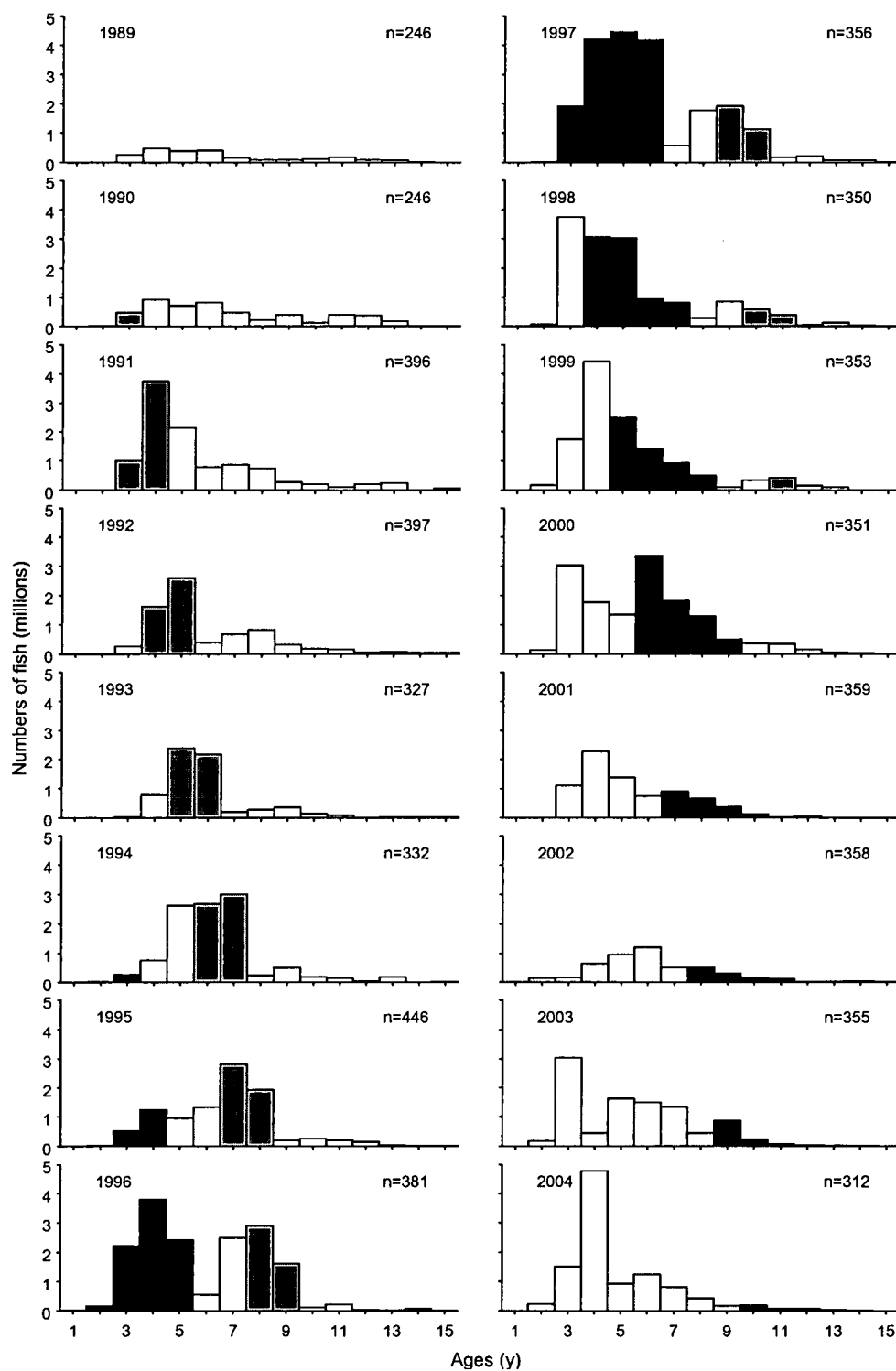


Figure 2a: Catch-at-age of male hoki in commercial catches from the Cook Strait spawning fishery from 1989 to 2004, sampled in processing sheds by the Stock Monitoring Programme. n, number of fish aged. Similar shaded bars denote year class groupings.

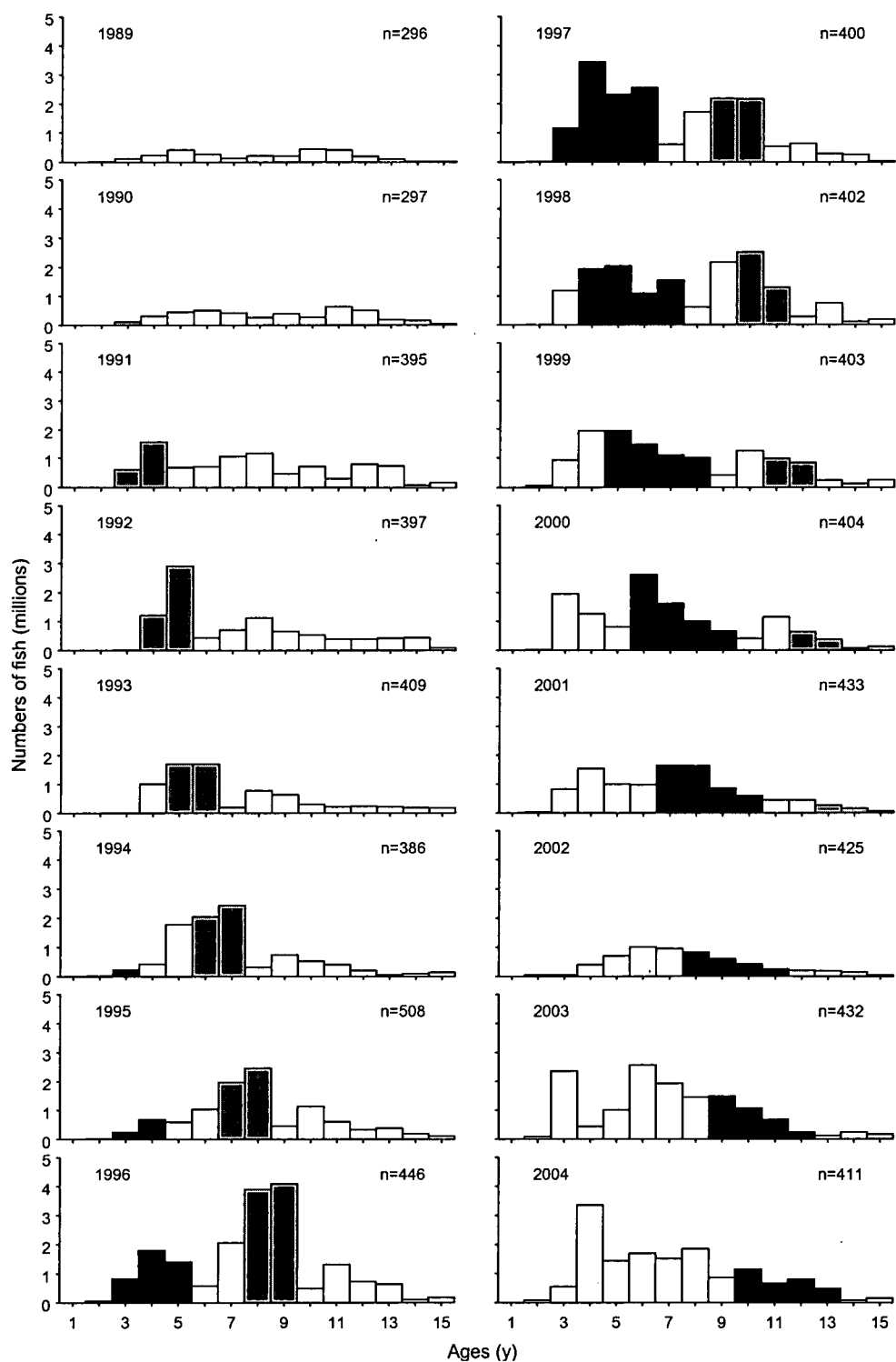


Figure 2b: Catch-at-age of female hoki in commercial catches from the Cook Strait spawning fishery from 1989 to 2004, sampled in processing sheds by the Stock Monitoring Programme. n, number of fish aged. Similar shaded bars denote year class groupings.

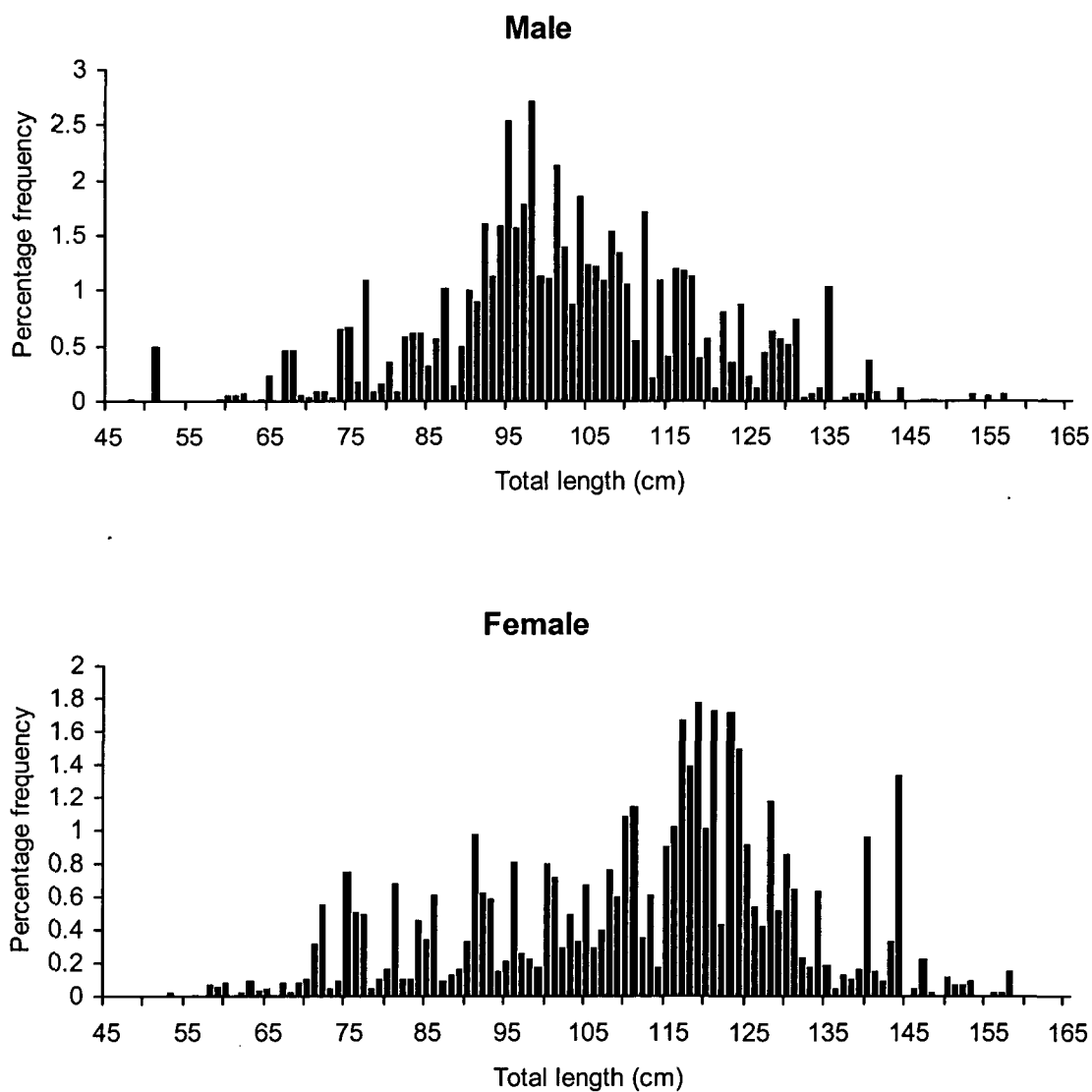


Figure 3: Catch-at-length of ling in commercial catches from the Cook Strait hoki spawning fishery in 2004, sampled in processing sheds by the Stock Monitoring Programme and at sea by Observers. N, number of fish measured.

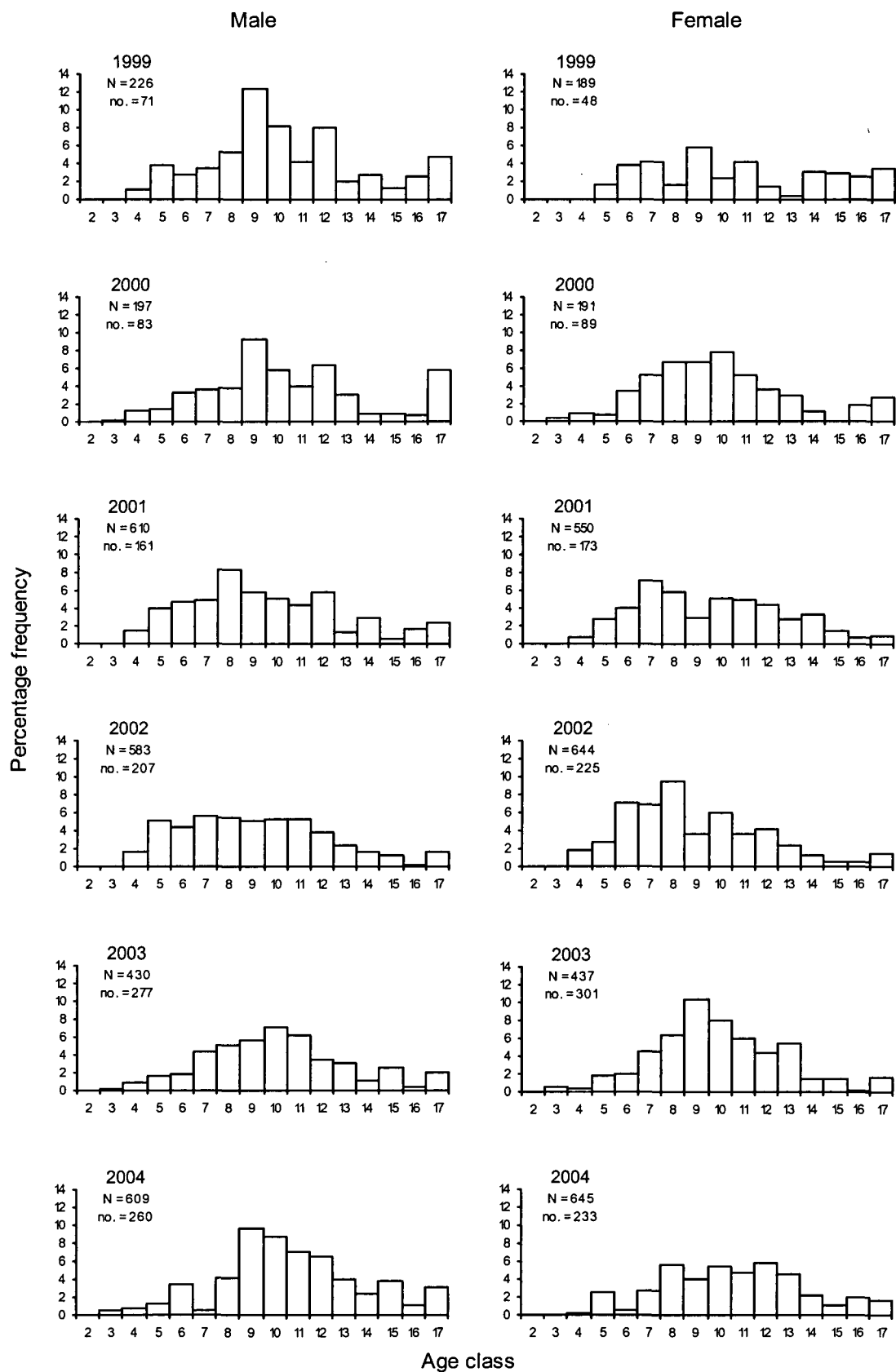


Figure 4: Catch-at-age of ling in commercial catches from the Cook Strait hoki spawning fishery from 1999 to 2004, sampled in processing sheds by the Stock Monitoring Programme and at sea by Observers. Age class 17 represents a plus group. N, number of fish measured; no., number of fish aged.