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NIWA

Taihoru Nukurangi

**Catch sampling from the commercial
Cook Strait hoki catch in winter 2000**

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**Final Research Report for
Ministry of Fisheries Research Project HOK1999/04
Objective 1**

**National Institute of Water and Atmospheric Research
April 2001**

Final Research Report

Report title: Catch sampling from the commercial Cook Strait hoki catch in winter 2000

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1. **Date:** 1 May 2001
2. **Contractor:** NIWA
3. **Project Title:** Stock monitoring of hoki fisheries for determination of catch at age data.
4. **Project Code:** HOK1999/04
5. **Project Leader:** Richard O'Driscoll
6. **Duration of Project:**
 - Start date: 1 October 1999
 - Expected completion date: 31 May 2001

7. Executive Summary

This report presents the results from market sampling of the Cook Strait hoki fishery in winter 2000. The sampling design and implementation are described, and the size and age structure of the commercial catch are estimated.

The sampling design in 2000 was similar to that used in 1999. Catches were stratified by time, island of landing (North or South), and vessel size (South Island samples only). Sampling within strata was in proportion to the catch taken in 1999, with a target of 51 samples.

Fifty-four samples were taken during the 2000 spawning season. Target numbers of samples by port, month and vessel size category were met. A total of 2399 otolith pairs were collected, from which a sub-sample of 755 otolith pairs was selected and read.

The Cook Strait commercial hoki catch in 2000 consisted primarily of the 1991–97 year classes. The 1995 and 1996 year classes were relatively weak, but the 1997 year class appears to be strong. There were differences in length and age distributions between sexes. The catch of males was mainly fish less than 90 cm, but larger female hoki from the 1987 and 1988 year classes were still an important part of the commercial catch in 2000.

8. Programme Objectives:

1. To determine the catch at age from the main hoki fisheries as input data to the stock assessment of hoki (*Macruronus novaezelandiae*).

9. Objectives for 1999/2000 covered by this report:

This report describes work arising from Objective 1 of Project HOK1999/04:

To collect otolith samples in the processing sheds and determine the age and size structure of the commercial catch of hoki from Cook Strait during winter 2000.

10. Introduction

Annual shed sampling of the Cook Strait spawning hoki catch has taken place since 1988. The shed samples of hoki length frequencies and otoliths from each year are analysed to provide estimates of catch-at-age by sex for input into the hoki stock assessment models (Cordue 2000, Ballara & Livingston 2001). This report extends the existing time series to cover the winter 2000 catch.

This report describes three activities: the work that was done to determine the sampling design for winter 2000; the implementation of the sampling programme over the 2000 season; and the estimation of the size and age structure of the commercial catch for the Cook Strait 2000 season.

11. Methods

1. Finalise sampling design.

A successful sampling methodology has been in place for several years. Sampling of Cook Strait landings is done mainly in Nelson where the large majority of Cook Strait caught hoki is processed (Picton landings are mainly processed in Nelson sheds). Some sampling of hoki in Wellington has been included since 1998, following a review by Cordue et al. (1999) which indicated an increasing proportion of the Cook Strait catch was landed in Wellington. Sampling is done from June to September when spawning fish are targeted by the Cook Strait fleet.

The sampling design has changed over time. The stratification was reviewed before the 1998 winter fishery by Cordue et al. (1999) and again prior to the 1999 season by Ballara & Cordue (2000). The distribution of previous sampling effort, the distribution of landings, and the variation in length frequencies between sheds, ports of landing and different sized vessels were considered. In 1999 samples were stratified by time, island of landing (North or South), and vessel size (< 30m, ≥ 30 to < 40 m, ≥ 40 m).

To finalise the sampling design for winter 2000, two activities were undertaken. First, length frequencies for the 1999 catch were compared between existing strata to see if there were visible differences. Second, the total number of samples was apportioned between strata using the estimated catches in 1999 (within each stratum).

2. Implement sampling design.

Samples from landings were collected in the prescribed manner, where possible by NIWA staff based closest to the port of landing. Data forms were checked, otoliths selected and prepared, and

data entered into the catch sampling database maintained by NIWA. Otoliths are stored by NIWA's ageing unit.

3. Estimate the length and age frequencies

The total length frequency is a weighted average of the individual length samples, stratified by time, island of landing (i.e., North or South Island), and vessel length category (Ballara & Cordue 2000). Strata were based on fortnightly or monthly time periods depending on the number of samples available in each month. Individual samples are weighted by landing weight, with the strata weights being the total monthly or fortnightly catches by island of landing and vessel length category.

Length frequencies were also examined by shed. As catches by shed were unavailable, each shed was allocated the same arbitrary catch and length frequencies were examined as percent frequencies.

Length frequencies from the market sampling programme were visually compared with length frequencies of hoki sampled in Cook Strait by the Ministry of Fisheries Scientific Observer Programme to check for differences between sampling methods.

An age-length key was constructed by reading a sub-sample of the collected otoliths. This age-length key was then applied to the total length frequency to produce an age frequency for the catch (for June to September inclusive). The ageing technique of Horn & Sullivan (1996) has been refined, resulting in a two-step process, the first of which applies the original method of Horn & Sullivan (Cordue et al. 2000). The numbers at age reported here have been derived from this first step and are therefore directly comparable to those from previous years. The second step gathers additional information from otoliths to improve the accuracy of the ageing (Cordue et al. 2000). The technique for deriving numbers at age incorporating this second step has been developed (Francis 2001), but has not been applied to any data presented in this report.

12. Results

1. Finalise sampling design.

The length composition of the 1999 commercial catch changed over the spawning season, with larger females being present during July and August (Figure 1). There were only five samples from Wellington, but it appears that a much smaller proportion of males were landed in the North Island compared to the South Island (Figure 2). Differences in length frequencies between vessel classes were also apparent, with the largest vessels tending to catch a greater proportion of smaller hoki than the other vessels (Figure 3). These results supported the existing stratification by time, island of landing, and vessel size.

Most of the 1999 catch was landed in Nelson/Picton, with about 8% of the catch landed in Wellington (Table 1). Catches were highest in August for all vessel size categories (Table 1). The largest vessel class (≥ 40 m) took about half the total catch overall, and caught over twice as much catch in September than the smaller vessels categories did (Table 2).

The proposed distribution of sampling effort each month in winter 2000 was based on the proportion of catches within each stratum in winter 1999 (Tables 1 and 2). At the request of the Ministry, about 50 samples were to be taken during the spawning season only (June to September). A total of 51 samples was proposed to adequately cover the 2000 sampling in the time, island of landing and vessel size strata (Tables 3 and 4).

2. Implement sampling design.

A total of 54 market samples were taken from Cook Strait during the 2000 spawning season (Tables 5 and 6). Target numbers of samples by island were met, with six Wellington samples (one extra in August) and 48 Nelson/Picton samples (two extra in July). Monthly target samples for Nelson/Picton were also met (Table 6). There were slight deviations between the actual and proposed distribution of samples across vessel size categories (three extra for < 30m, two fewer for the ≥ 30 & < 40 m, and one extra for the ≥ 40 m vessel categories). There was a spread of samples across different companies (Table 7), although nearly half the South Island samples were taken from the Nelson Sealords shed.

A sample of 2399 pairs of otoliths was collected from hoki caught in the Cook Strait spawning fishery in 2000. A sub-sample of 755 otolith pairs was selected, and the otoliths were prepared and read using the technique described by Horn & Sullivan (1996).

The otolith sub-sample was derived by randomly selecting a set number of otoliths from each of a series of 5 cm length bins covering the bulk of the catch and then systematically selecting additional otoliths to ensure the tails of the length distribution were represented. For males, a target of 350 otoliths was set. The resulting selection provided exactly 351 otoliths, made up of 12 from the left hand tail (<51 cm), 27 from the right hand tail (>91 cm), and 39 from each of the eight intervening 5-cm bins. For females the target number of otoliths was 400 (more than for the males as females generally have more age classes). A total of 404 otoliths were selected, 3 from the left hand tail (<54 cm), 21 from the right hand tail (>104 cm), and 38 from each of ten 5-cm bins. The chosen sample sizes approximated those necessary to produce mean weighted c.v.s of less than 20% across all age classes.

3. Estimate the length and age frequencies

The length frequency of female hoki from the 2000 Cook Strait catch was bimodal (Figure 4a), with the left hand mode comprising the 1997 year class (age 3). The main mode was made up of the 1991–96 year classes with older fish tailing out to the right. No clear year class modes were apparent, although the 1994 year class was probably at the peak of the distribution at about 74 cm. There were slightly fewer large female fish over 90 cm taken in the 2000 season than in the 1997–1999 seasons.

The length frequency distribution of male hoki was also bimodal (Figure 4b), again with the left hand mode the 1997 year class and the right hand mode made up of the 1991–96 year class fish. The peak of the right mode, at 71 cm, likely comprised the 1994 year class. There were fewer large male fish than females.

As in the West Coast South Island (WCSI) fishery, the 1995 year class has merged on the left shoulder of the 1994 year class in both males and females, suggesting that the 1995 year class is growing faster than the 1994 year class. The 1997 year class was strong compared to other year classes previously seen at age three in Cook Strait for both males and females.

Samples from the Scientific Observer programme in Cook Strait had a similar overall distribution to the market sampling data (Figure 5).

Both market sampling and Scientific Observer data showed that a greater proportion of larger fish, particularly females, were caught during July and August (Figures 6 and 7). In June there were few females over 80 cm, but in July and August there were many fish in the 80 to 100 cm range. The proportion of large females then dropped back again in the September samples. The change in size of female fish is also shown with the increase and then decrease of mean length per catch sample

(Figure 8) as the larger fish moved into, then out of, Cook Strait during the spawning season. Male hoki also showed an increase and decrease in mean length over the season (Figure 8), although the trend in length frequencies is not as apparent (Figures 6 and 7).

Length frequencies were compared across the island of landing (Nelson/Picton, and Wellington), vessel size, and main sheds/companies in 2000 (Figures 9–11). There was a similar range of lengths for each sex in both islands in 2000 (Figure 9), but, as in 1999 (Figure 2), it appears a lower proportion of males were landed in Wellington. There were differences in length frequencies between vessel classes, with the largest vessels tending to catch a higher proportion of smaller hoki, particularly males, than the other vessels (Figure 10). Different sheds showed similar length ranges, but there were some differences in the shape of the length frequency distributions (Figure 11). For example, samples from Sanfords had proportionally less of the 1997 year class. Differences between sheds were confounded because of sampling in sheds in different months (see Table 7).

Catch-at-age data showed that the Cook Strait commercial catch was dominated by females from the 1987–97 year classes and males from the 1992–97 year classes (Figure 12). The relative levels of the 1994 and 1995 year classes have changed from 1999. In 2000 the 1994 year class (age 6) increased for both males and females, while the 1995 year class (age 5) decreased. The 1995 year class now appears weak relative to 1994. This contrasts with 1999 when the 1995 year class was at the same level as the 1994 year class for females, and stronger than the 1994 year class for males. The 1997 year class appears to be strong for both males and females. For the females, the 1997 year class is the strongest in the series at age three. The 1987–89 year classes (ages 11–13) were still strongly represented in the catch of females in 2000, but there were few males older than age 10.

13. Conclusions

The length frequency of hoki in the Cook Strait commercial catch showed changes during the spawning season and there are differences in size and sex composition of hoki sampled from different vessel length categories and different ports. Hence, catch sampling of Cook Strait hoki should be stratified by time, island of landing, and vessel size. There may also be differences in hoki length distributions between sheds, so it is important to keep catch sampling spread between companies/sheds. Because of changing patterns in the fishery, data should be analysed each year to determine the best stratification to obtain representative sampling of the catch.

Length and age frequency data collected during the 2000 Cook Strait spawning season showed the adult mode of the catch was made up primarily of the 1991–96 year classes. The 1995 year class is present but is relatively weak, and its length distribution has almost merged with that of the 1994 year class. The 1996 year class is also relatively weak. The up-coming 1997 year class appears to be strong at age three. Large females from the 1987 and 1988 year classes are still an important part of the commercial catch, but there are few males greater than age 10.

13. Publications

None.

14. Data Storage

The catch sampling data are stored on the Ministry of Fisheries database *market*.

15. References

- Ballara, S.L.; Cordue, P.L. (2000). Catch sampling of Cook Strait hoki for the 1998–99 fishing year. Research Progress Report for Ministry of Fisheries Research Project HOK9801, Objective 3.
- Ballara, S.L.; Livingston, M.E. (2001). Catches, size and age structure of the 1998–99 hoki fishery. *New Zealand Fisheries Assessment Report 2001/6*. 63 p.
- Cordue, P.L. (2000). MIAEL estimation of biomass and fishery indicators for the 1999 assessment of hoki stocks. *New Zealand Fisheries Assessment Report 2000/10*. 69 p.
- Cordue, P.L., Ballara S.L.; Fisher, D.O. (1999). Catch sampling of Cook Strait hoki for the 1997–98 fishing year. Final Research Report for Ministry of Fisheries Research Project HOK9701, Objective 4.
- Cordue, P.L.; Ballara, S.L.; Horn P.L. (2000). Hoki ageing: recommendation of which data to routinely record for hoki otoliths. Final Research Report for Ministry of Fisheries Research Project MOF199901 (Unpublished report held by Ministry of Fisheries, Wellington.)
- Francis, R.I.C.C. (2001): Improving the consistency of hoki age estimation. *New Zealand Fisheries Assessment Report 2001/13*. 18 p.
- Horn, P.L.; Sullivan, K.J. (1996). Validated aging methodology using otoliths, and growth parameters for hoki (*Macruronus novaezelandiae*) in New Zealand waters. *New Zealand Journal of Marine and Freshwater Research* 30: 161–174.

Table 1: Cook Strait catches (t) for the 1998–99 fishing year by port of landing. Data source CLR and CELR landing data.

	Port of landing		
	Nelson/Picton	Wellington	Total+
Oct	674	1	676
Nov	1 188	3	1 191
Dec	929	12	947
Jan	1 397	2	1 427
Feb	1 022	6	1 028
Mar	1 436	2	1 437
Apr	818	2	820
May	1 241	1	1 243
Jun	2 269	*	2 307
Jul	8 571	652	11 067
Aug	14 385	2 510	17 925
Sep	6 557	514	7 205
Total	40 516	3 706	47 275

* less than 1 tonne

+ includes all other ports where Cook Strait caught hoki were landed

Table 2: Cook Strait catches (t) for the 1998–99 fishing year by month and vessel category. Data source TCELR and CELR estimated data.

	Vessel length (m)		
	<30	≥30 & <40	≥40
Oct	3	148	409
Nov	2	170	667
Dec	9	55	472
Jan	4	32	845
Feb	8	27	477
Mar	2	48	708
Apr	2	31	411
May	2	167	528
Jun	78	563	1 170
Jul	3 134	3 087	4 020
Aug	6 836	4 222	7 018
Sep	1 575	1 872	4 123
Total	11 652	10 421	20 848

Table 3: Target number of Cook Strait samples by month and Island of landing for the 2000 sampling season.

Island	Month				
	Jun	Jul	Aug	Sep	Total
South (Nelson/Picton)	3	13	21	9	46
North (Wellington)	0	1	3	1	5

Table 4: Target number of Nelson/Picton samples by vessel size class for the 2000 sampling season.

Vessel size	Month				Total
	Jun	Jul	Aug	Sep	
<30m	0	4	8	2	14
≥30 & <40	1	4	5	2	12
≥40m	2	5	8	5	20

Table 5: Number of Cook Strait samples by month and island of landing taken for the 2000 sampling season.

Island	Month				Total
	Jun	Jul	Aug	Sep	
South (Nelson/Picton)	3	15	21	9	48
North (Wellington)	0	1	4	1	6

Table 6: Number of Nelson/Picton samples by vessel size class for the 2000 sampling season.

Vessel size	Month				Total
	Jun	Jul	Aug	Sep	
<30m	0	5	10	2	17
≥30 & <40	1	5	3	1	10
≥40m	2	5	8	6	21

Table 7: Number of samples taken by shed, port and month during the 2000 sampling season.

Port	Shed	Month				Total
		Jun	Jul	Aug	Sep	
Nelson	Sealords Nelson	2	5	3	2	12
	Talleys Motueka	-	2	1	-	3
	Sanfords Nelson	-	4	3	2	9
	Amaltal Nelson	1	3	7	1	12
	Total	3	14	14	5	36
Picton	Talleys Motueka	-	1	1	-	2
	Sealords Nelson	-	-	5	4	9
	Total	-	1	6	4	11
Motueka	Talleys Motueka	-	-	1	-	1
	Total	-	-	1	-	1
Wgtn	Wgtn Trawling Co	-	1	1	1	3
	Cook Strait Seafoods	-	2	1	-	3
	Total	-	3	2	1	6

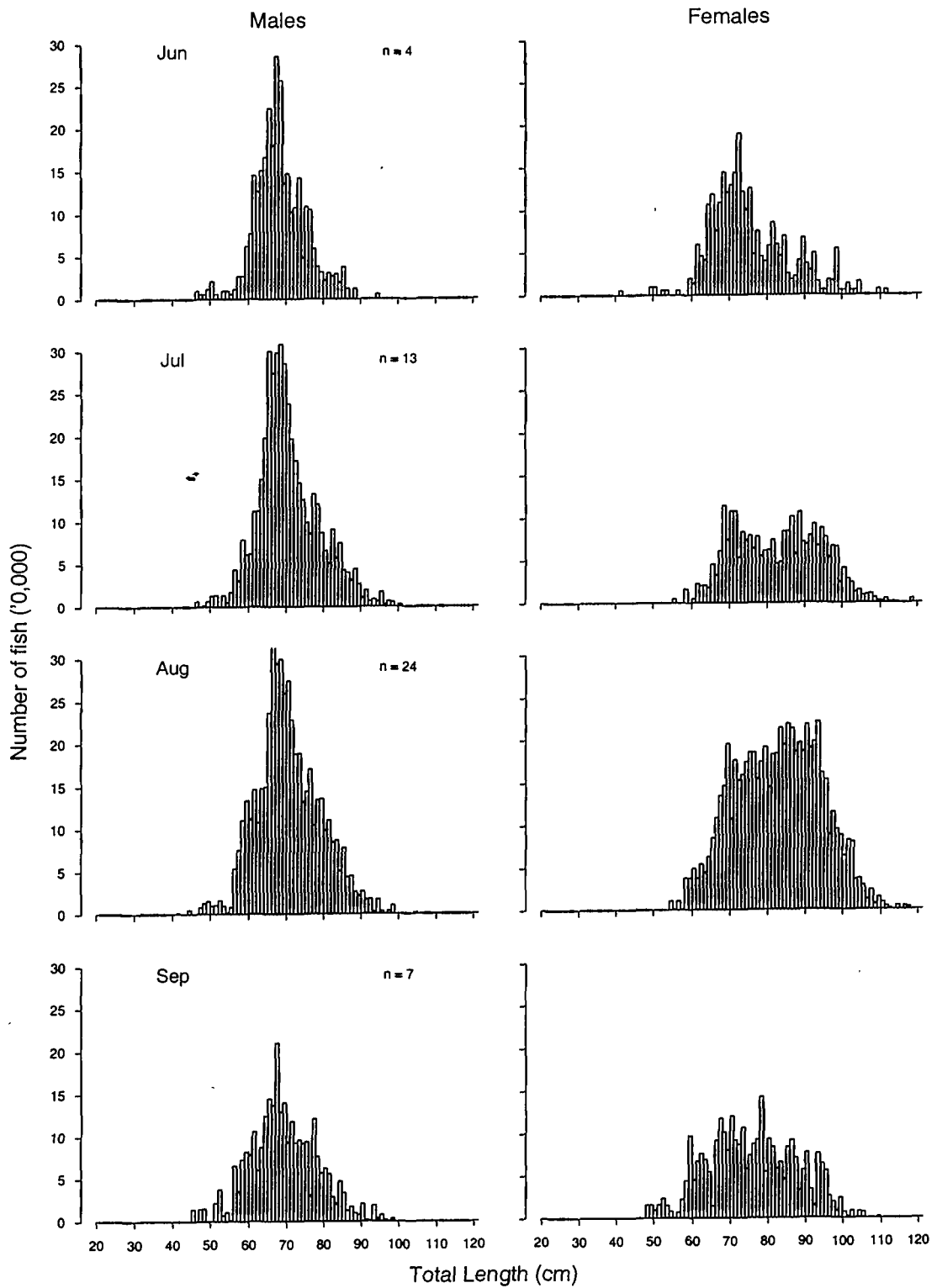


Figure 1: Estimated length frequencies by month for the Cook Strait hoki catches in winter 1999 (n is the number of landings sampled).

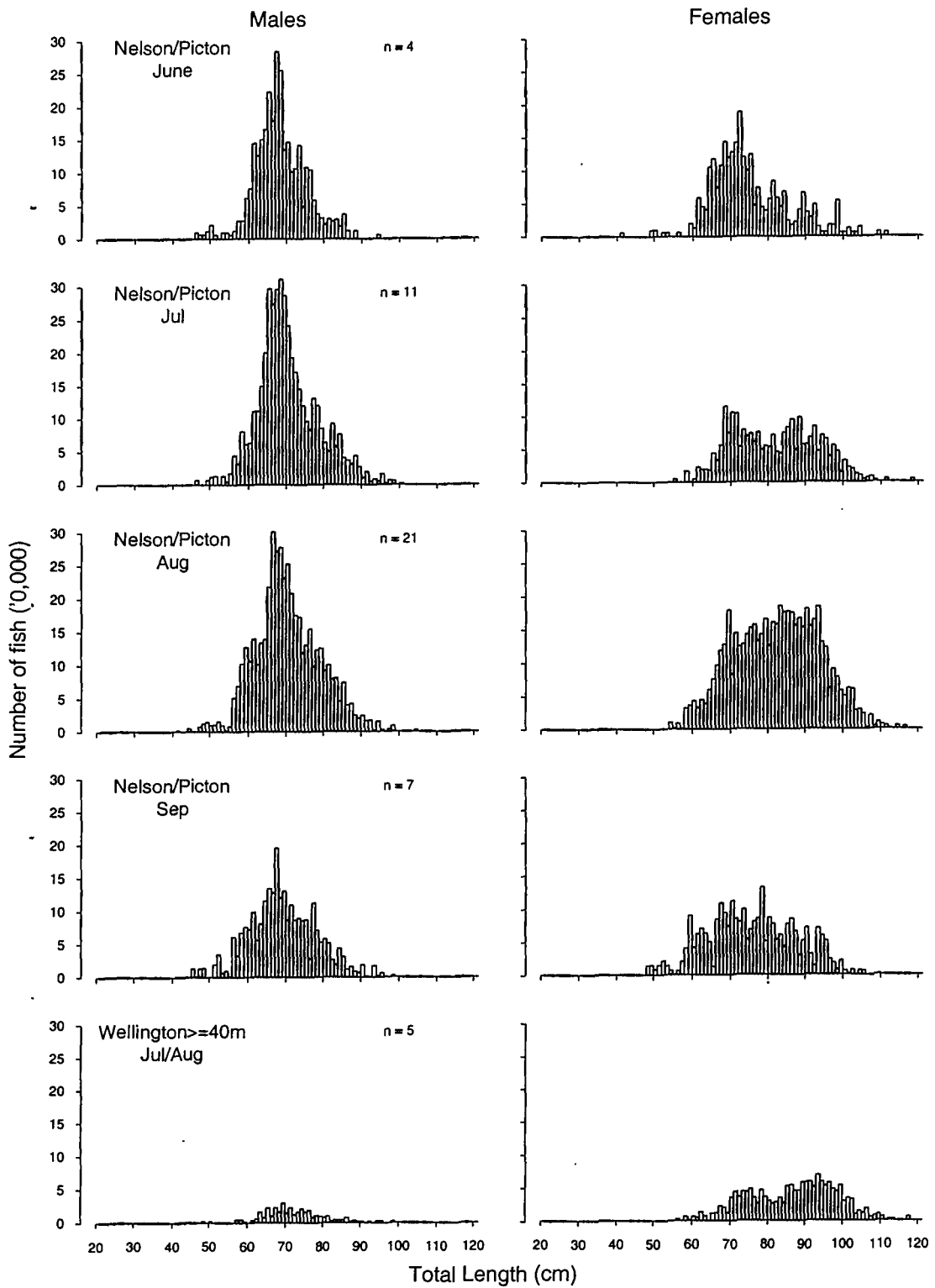


Figure 2: Estimated length frequencies for the Cook Strait hoki catches in winter 1999 for each "Island of landing" (North Island = Wellington, South Island = Nelson/Picton).

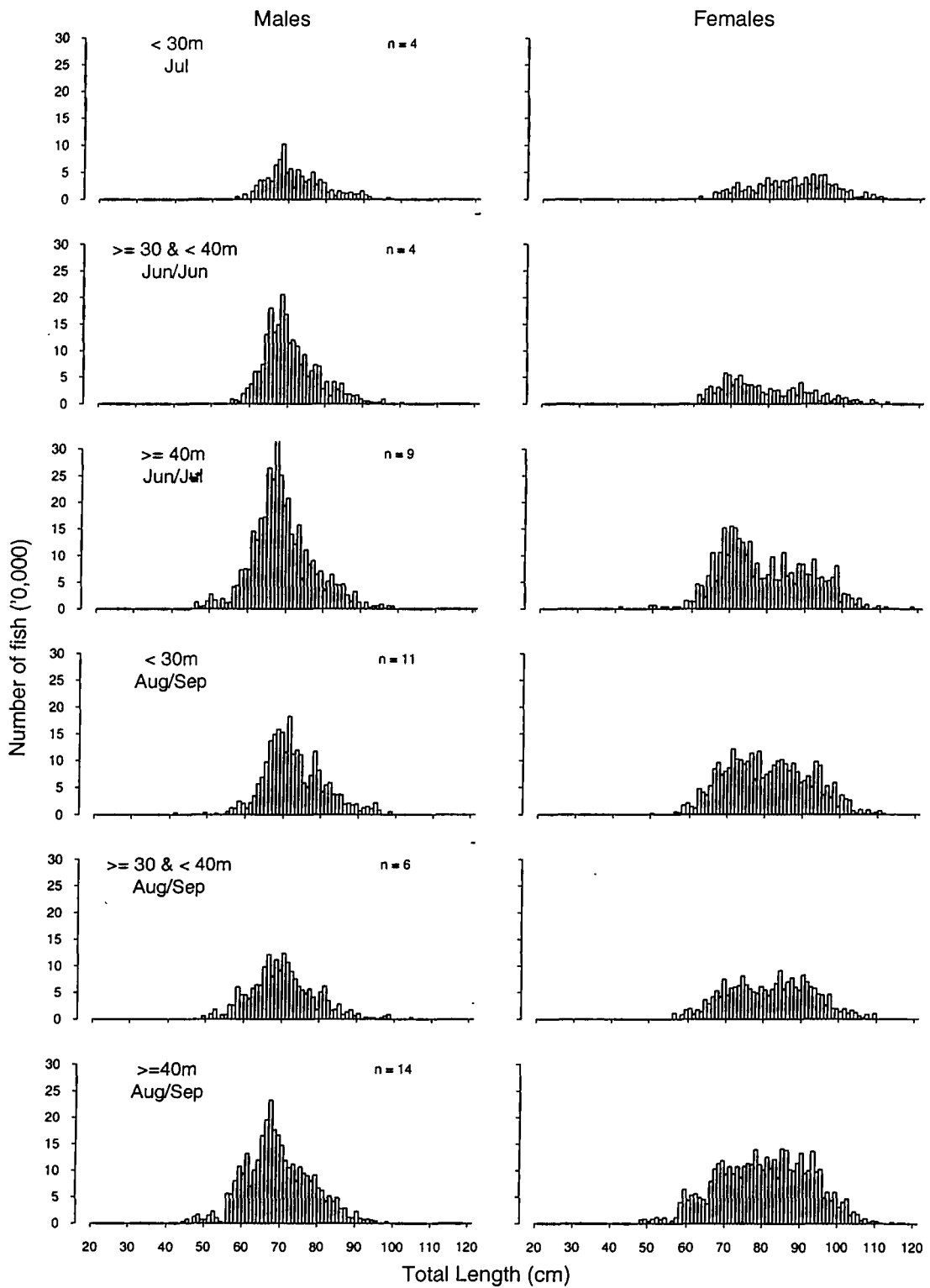


Figure 3: Estimated length frequencies for the Cook Strait hoki catches in winter 1999 for each vessel class (combined into 2-month intervals, note that there were no samples in June for vessels < 30 m).

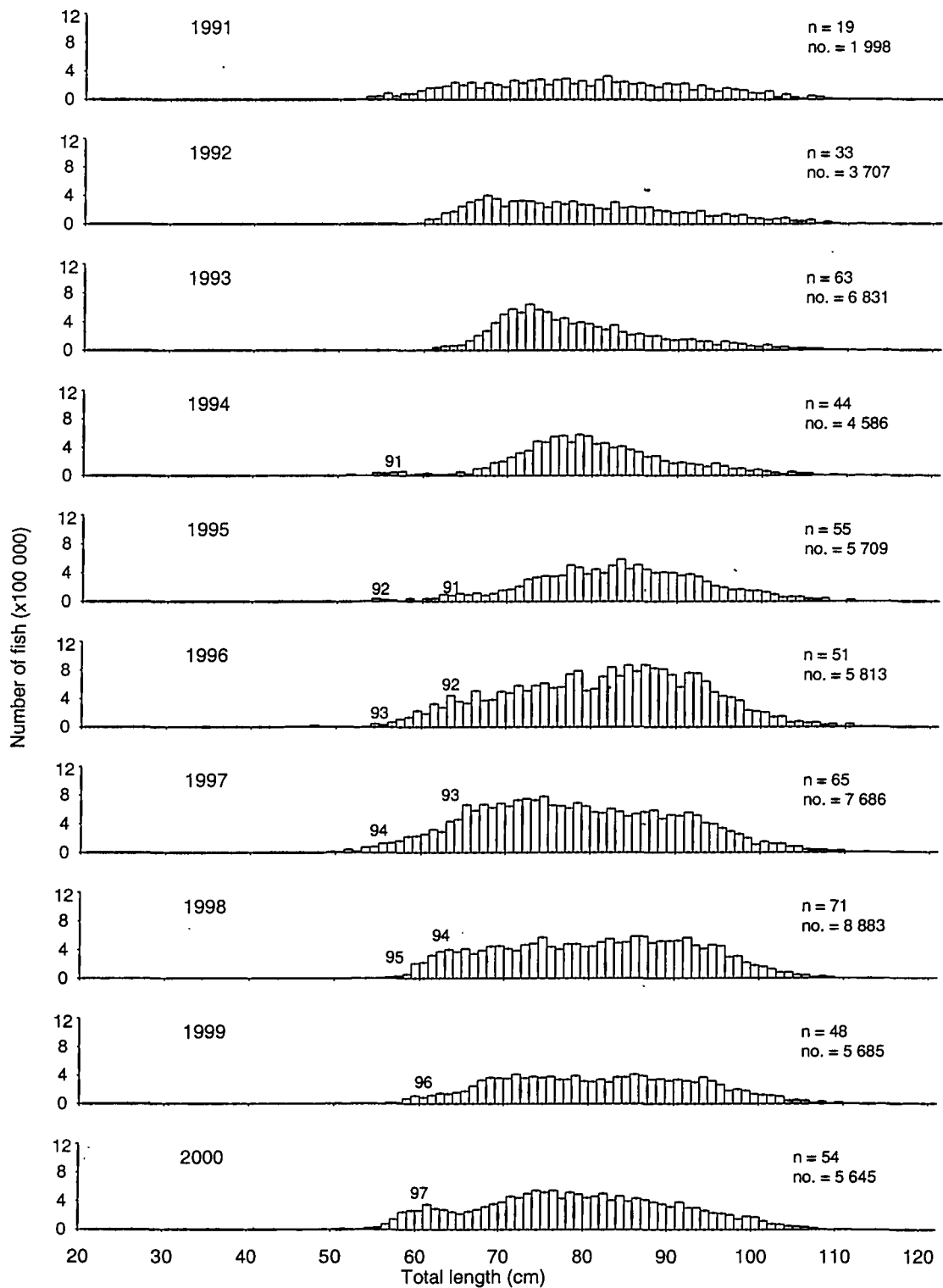


Figure 4a: Length frequency of female hoki taken in commercial catches from the Cook Strait spawning fishery from 1991 to 2000 (sampled in the sheds by the Stock Monitoring Programme; n, the number of landings sampled; no, the number of fish sampled; numbers above the histogram mark year class modes, e.g., 91 = 1991 year class).

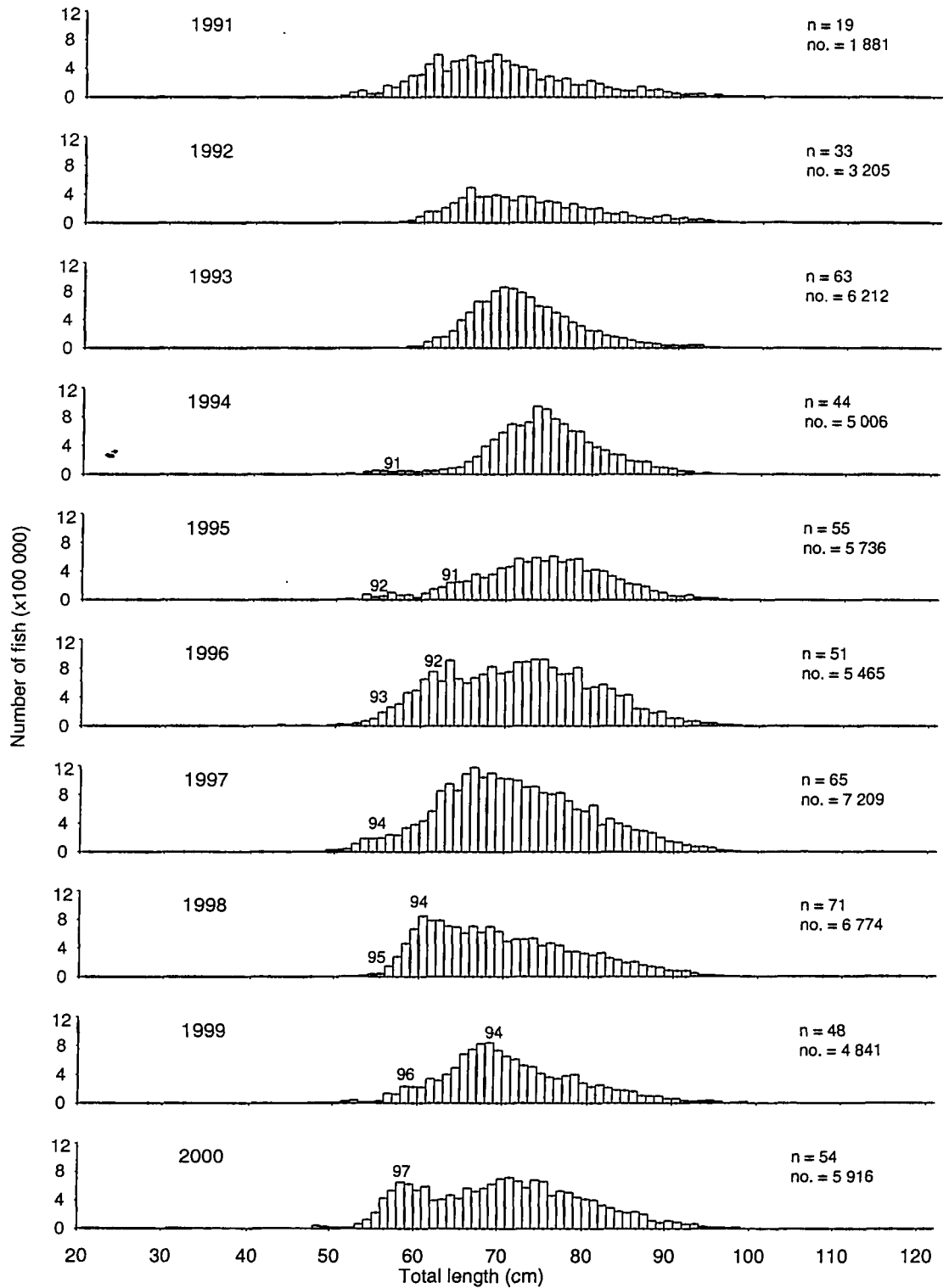


Figure 4b: Length frequency of male hoki taken in commercial catches from the Cook Strait spawning fishery from 1991 to 2000 (sampled in sheds by the Stock Monitoring Programme; n, the number of landings sampled; no, the number of fish sampled; numbers above the histogram mark year class modes, e.g., 91 = 1991 year class).

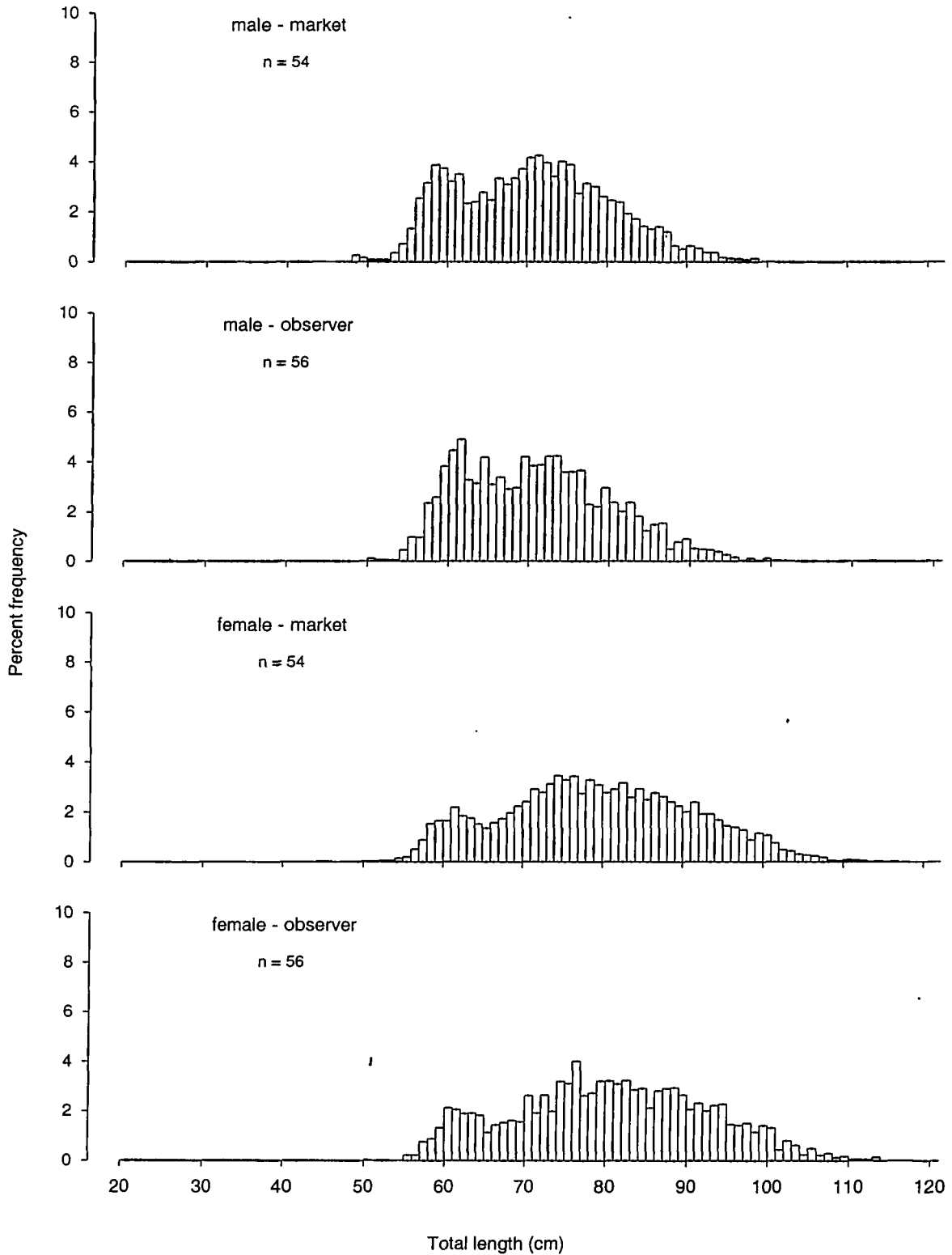


Figure 5: Comparison of Scientific Observer Programme, and the Stock Monitoring Programme length frequencies of hoki taken in commercial catches from Cook Strait during the 2000 spawning season (n, the number of tows or landings sampled per area; percent frequency refers to numbers of fish).

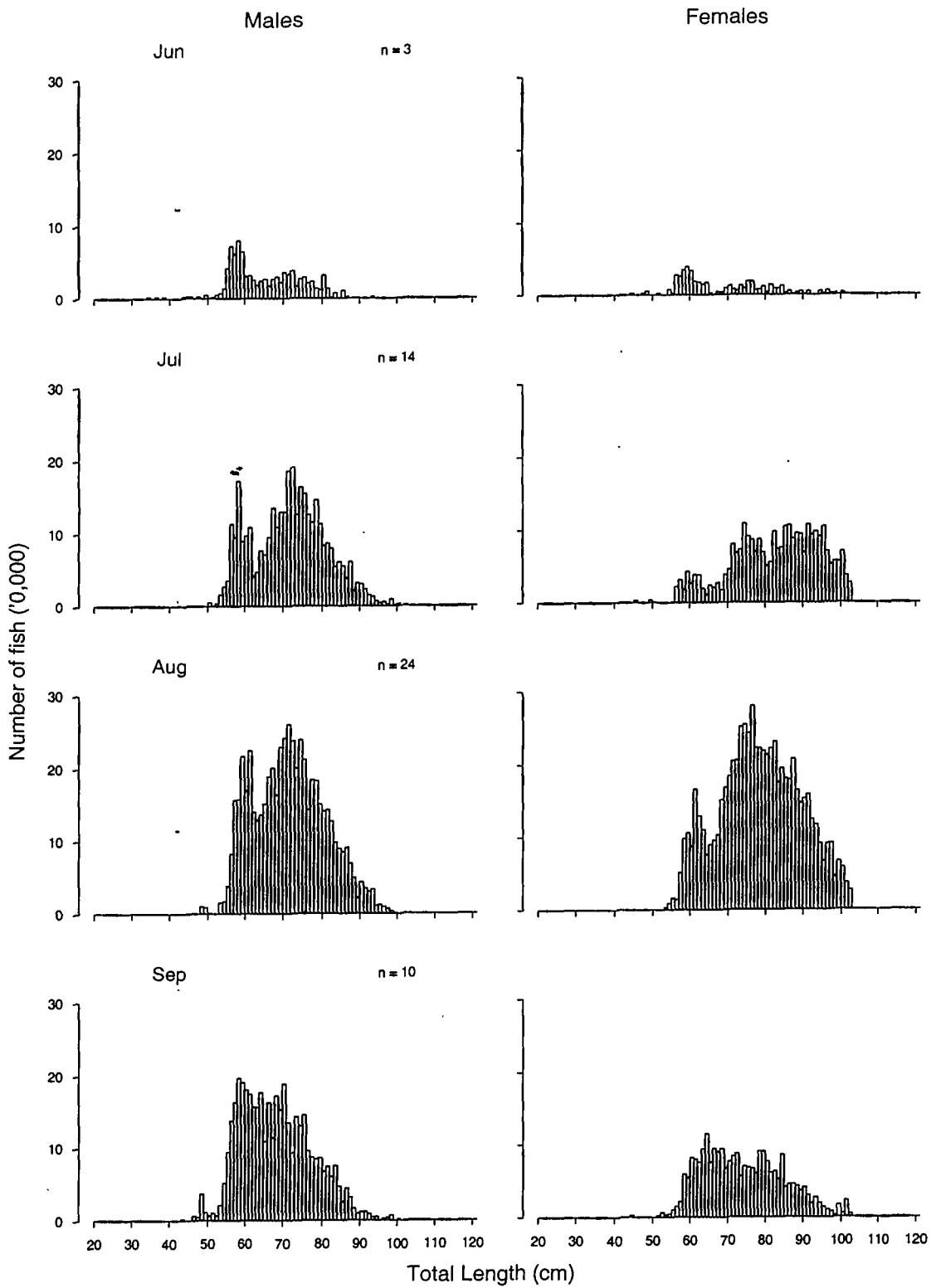


Figure 6: Monthly length frequencies of hoki taken in commercial catches from the Cook Strait fishery from June to September 2000 (sampled in sheds by the Stock Monitoring Programme; n, the number of landings sampled).

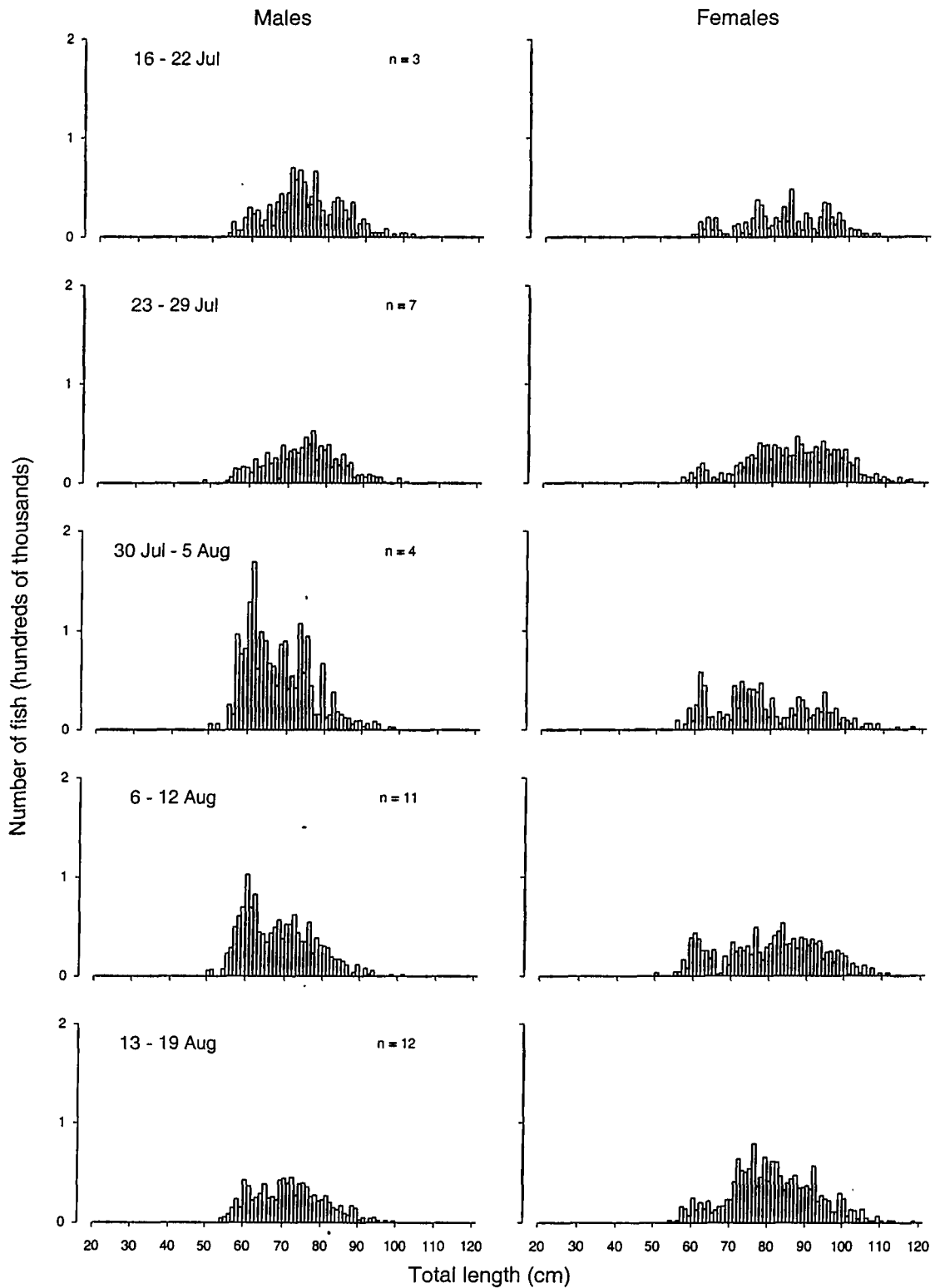


Figure 7: Weekly length frequencies of hoki taken in commercial catches from the Cook Strait fishery from July to September 2000 (sampled in sheds by the Stock Monitoring Programme; n is the number of landings sampled).

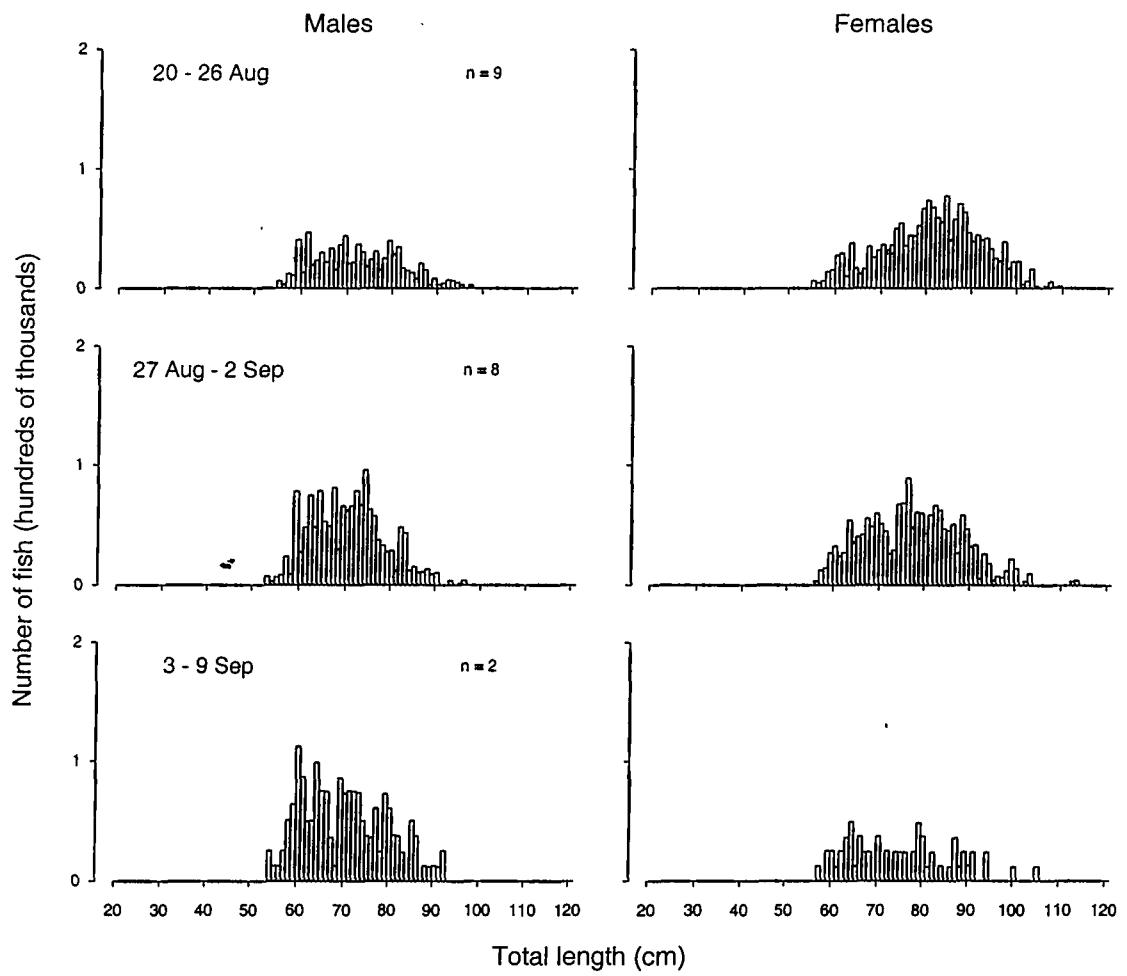


Figure 7: continued.

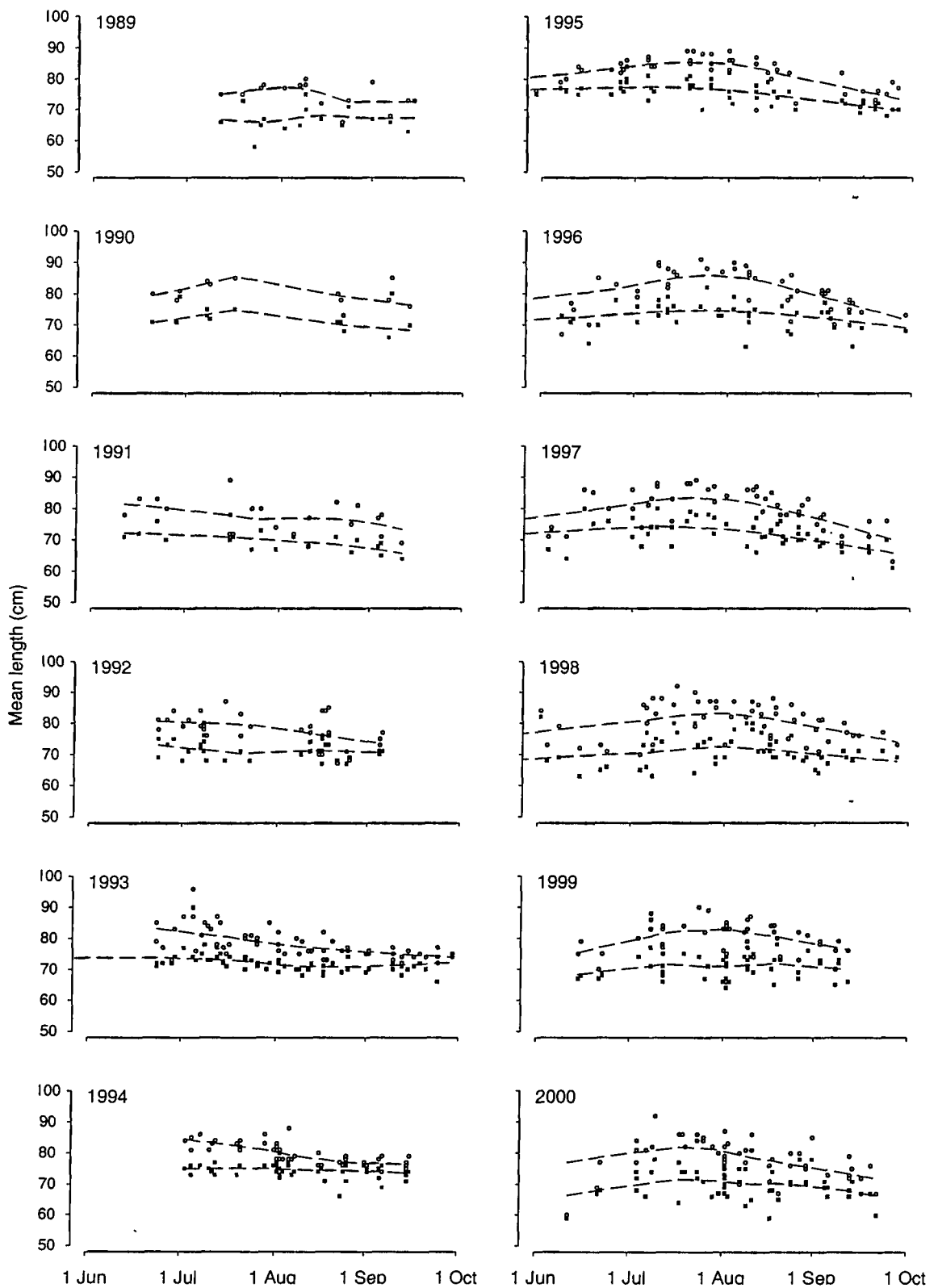


Figure 8: Mean length of female (circles) and male (squares) hoki per sample taken by the Stock Monitoring Program in commercial landed catches from the Cook Strait fishery 1989–2000. Lines are a loess fit.

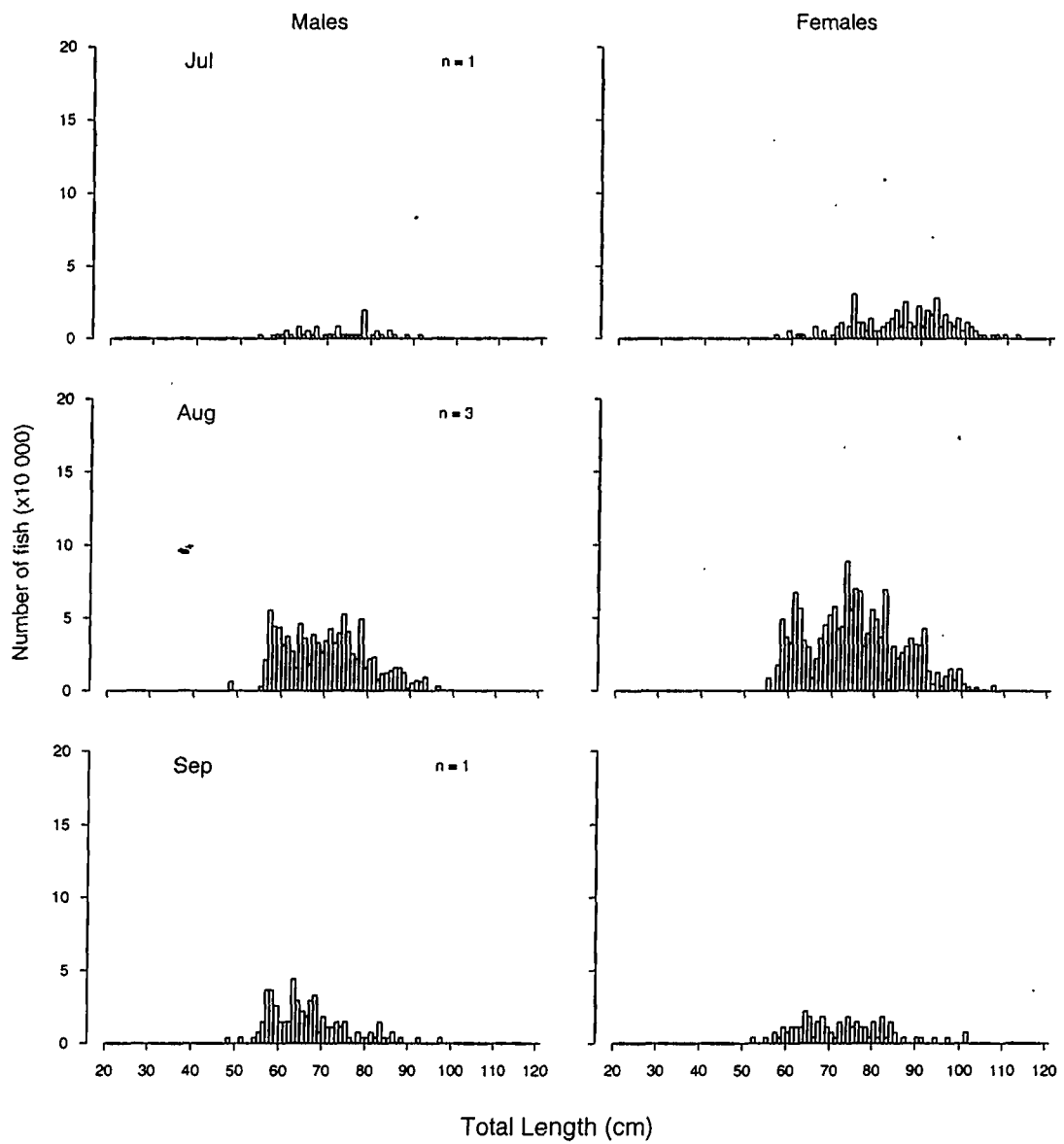


Figure 9a: Monthly North Island port (Wellington) length frequencies of hoki taken in commercial catches from the Cook Strait fishery from July to September 2000 (sampled in sheds by the Stock Monitoring Programme; n, the number of landings sampled).

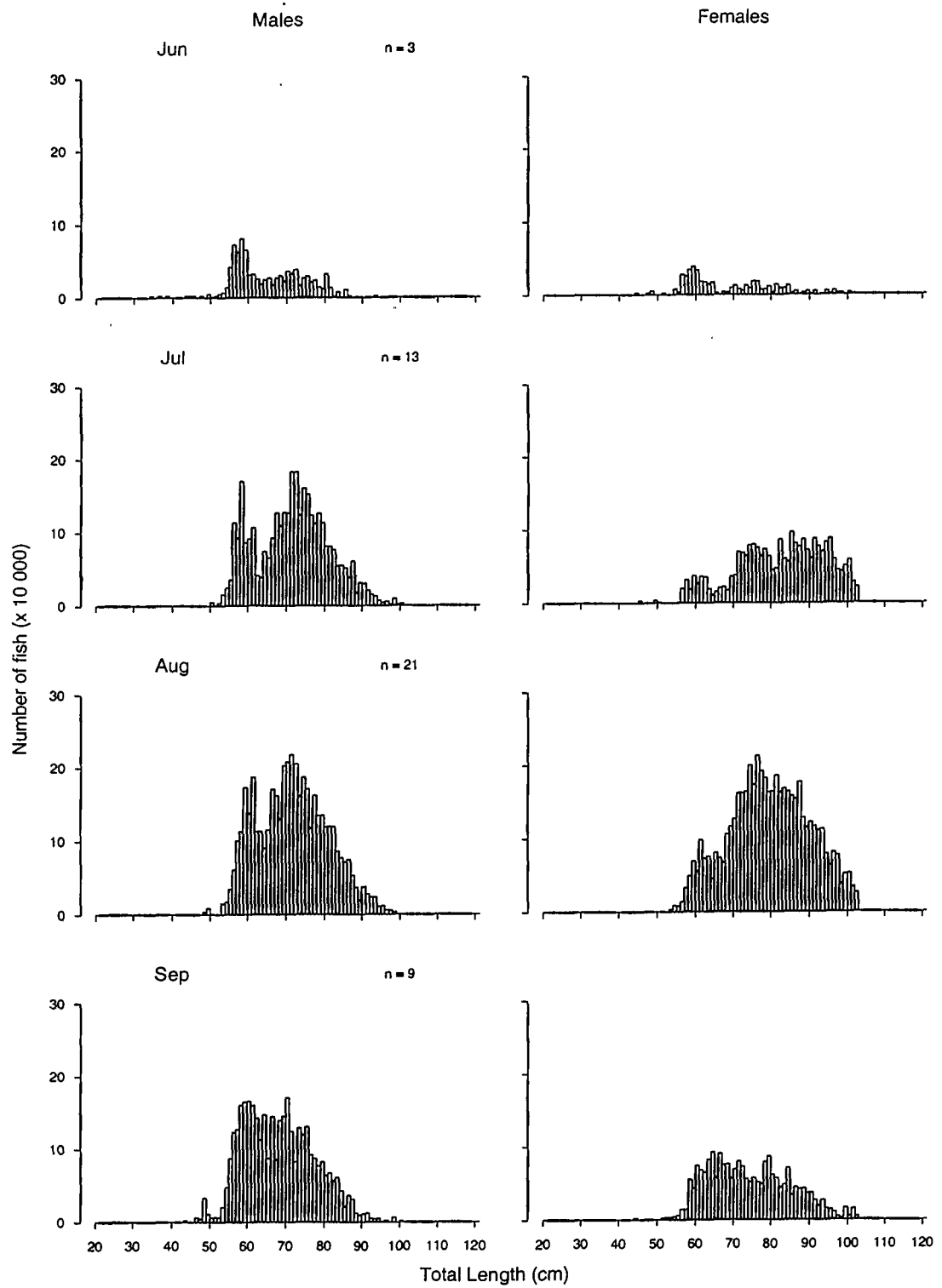


Figure 9b: Monthly South Island port (Nelson and Picton) length frequencies of hoki taken in commercial catches from the Cook Strait fishery from June to September 2000 (sampled in sheds by the Stock Monitoring Programme; n, the number of landings sampled).

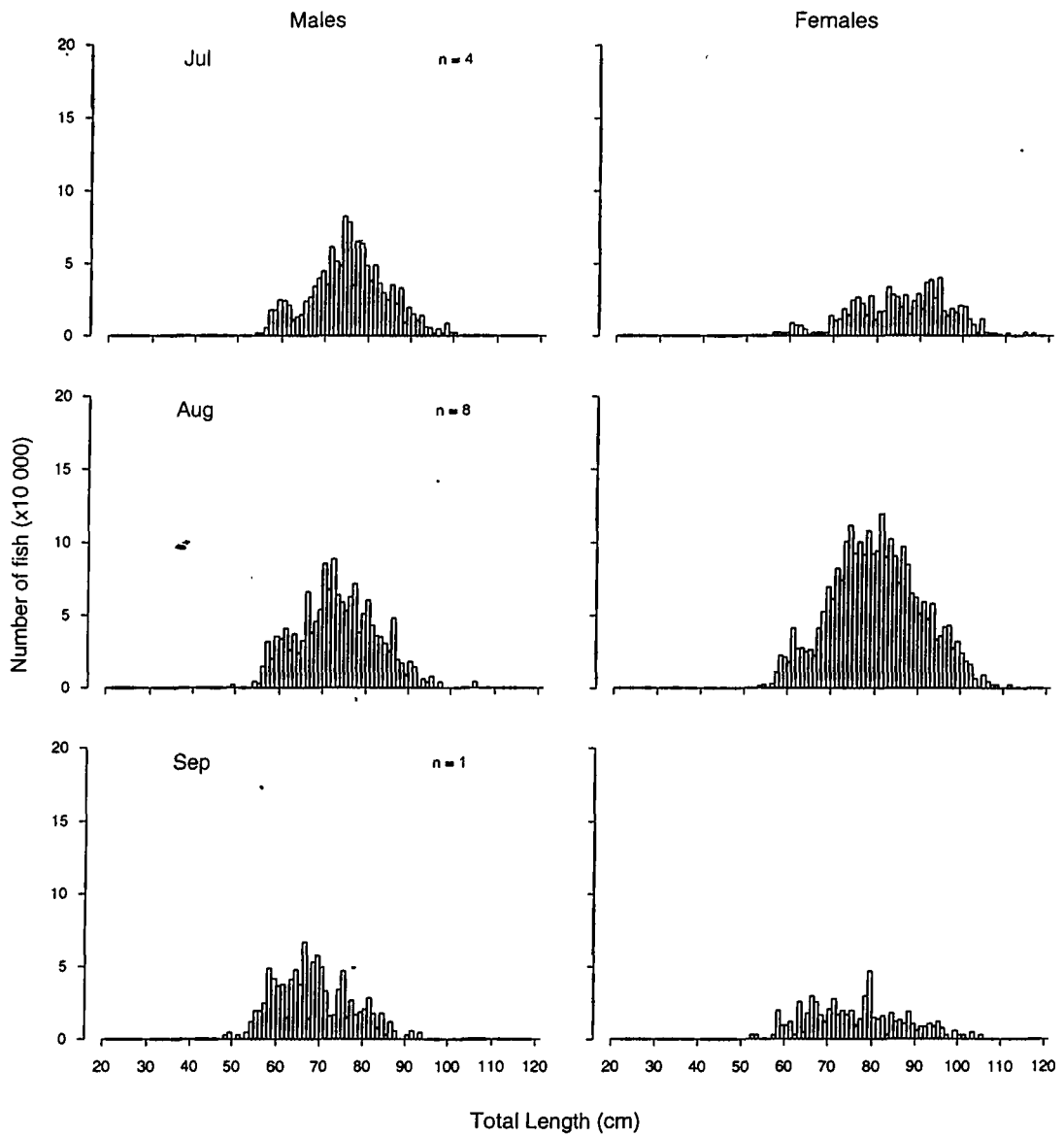


Figure 10a: <30 m vessel class South Island port monthly length frequencies of hoki taken in commercial catches from the Cook Strait fishery from July to September 2000 (sampled in sheds by the Stock Monitoring Programme; n, the number of landings sampled).

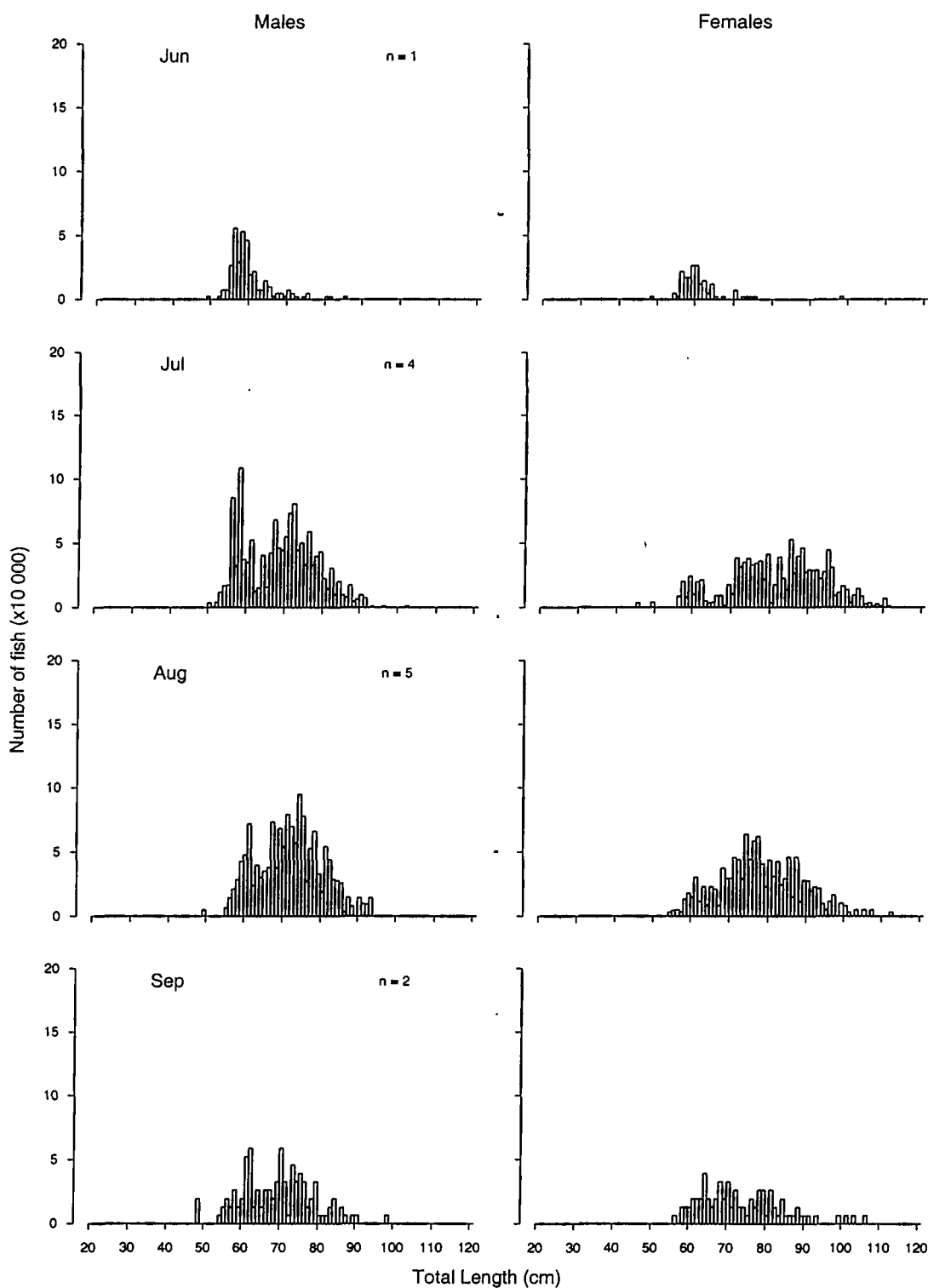


Figure 10b: ≥ 30 and < 40 m vessel class South Island port monthly length frequencies of hoki taken in commercial catches from the Cook Strait fishery from June to September 2000 (sampled in sheds by the Stock Monitoring Programme; n, the number of landings sampled).

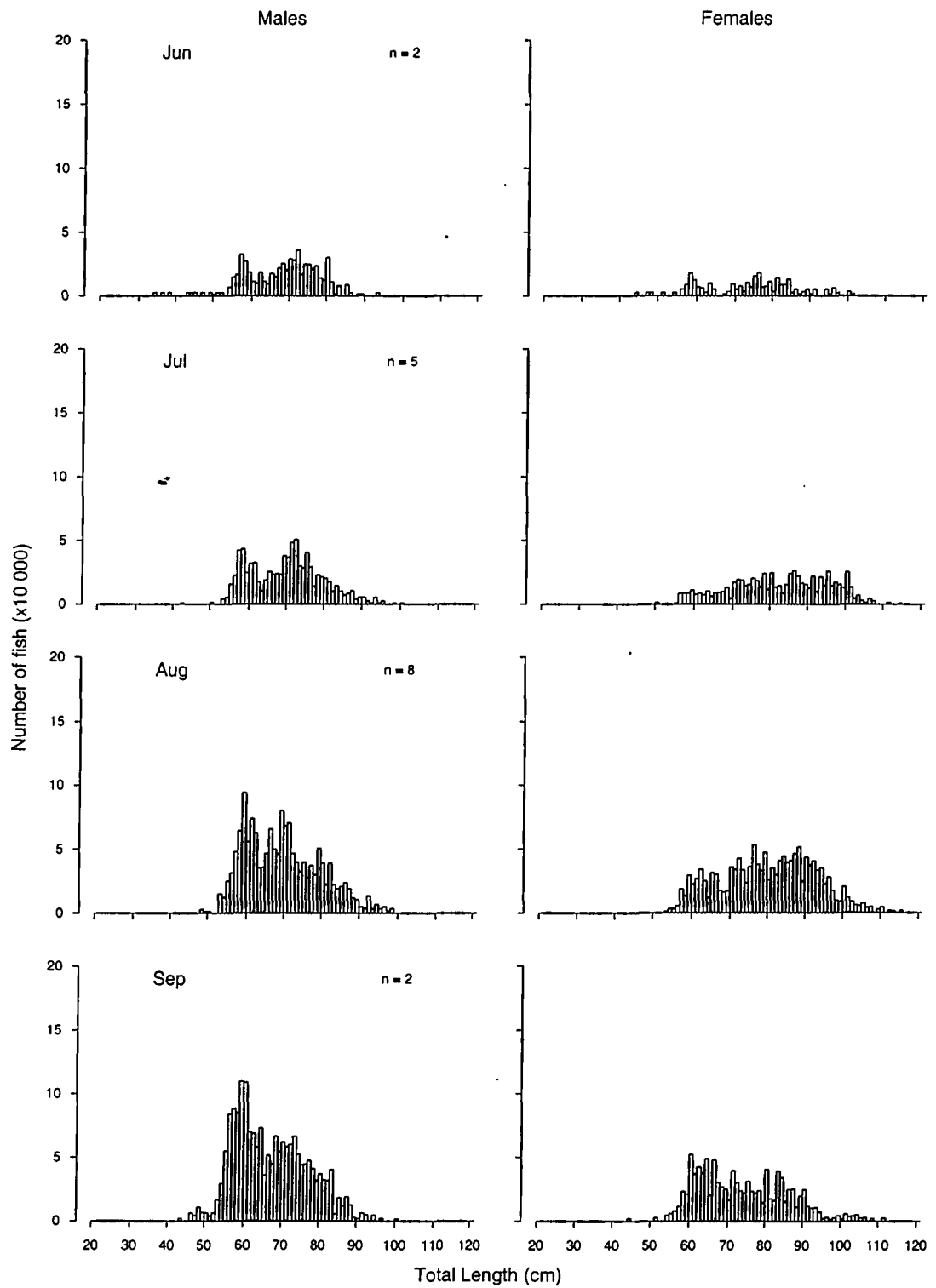


Figure 10c: ≥ 40 m vessel class South Island port monthly length frequencies of hoki taken in commercial catches from the Cook Strait fishery from June to September 2000 (sampled in sheds by the Stock Monitoring Programme; n, the number of landings sampled).

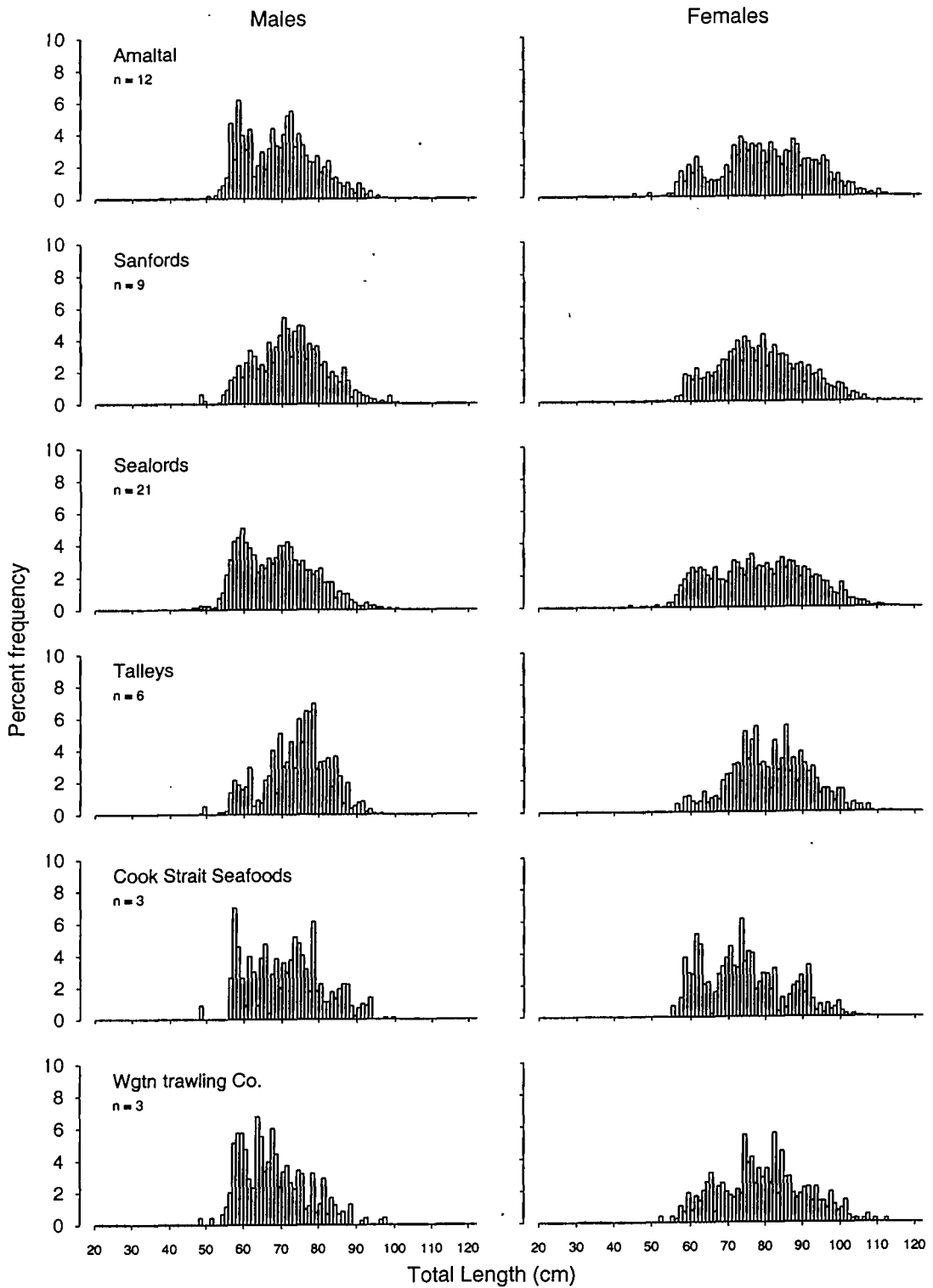


Figure 11: Length frequencies of hoki taken in commercial catches from the Cook Strait fishery sampled in different sheds by the Stock Monitoring Programme. (n, the number of landings sampled).

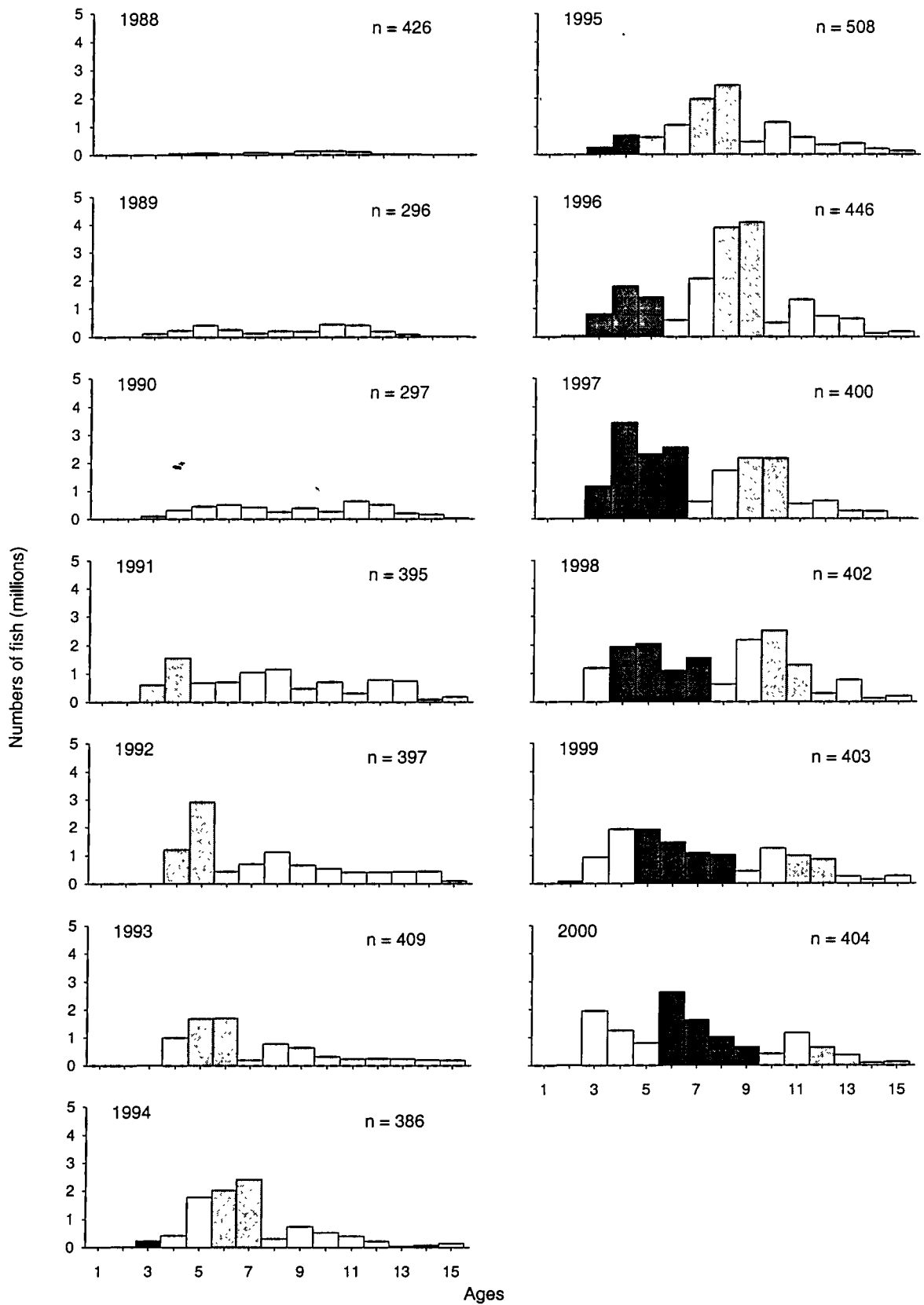


Figure 12a: Catch at age data for female hoki taken in commercial catches from the Cook Strait spawning fishery from 1988 to 2000 (sampled in sheds by the Stock Monitoring Programme; n is the number of fish aged). The 1987-88 (grey) and 1991-94 (black) year classes are shaded.

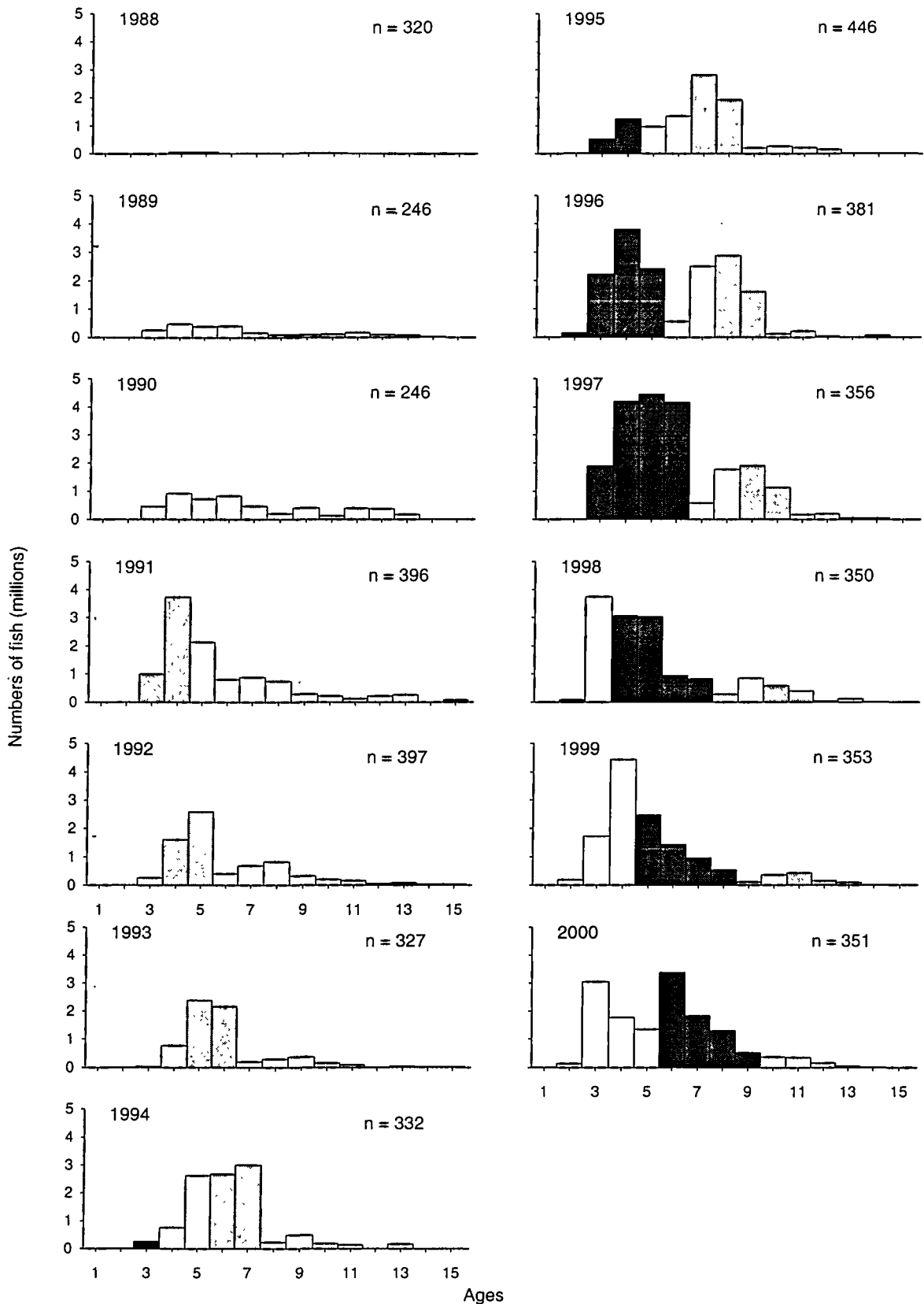


Figure 12b: Catch at age data for male hoki taken in commercial catches from the Cook Strait spawning fishery from 1988 to 2000 (sampled in sheds by the Stock Monitoring Programme; n is the number of fish aged). The 1987-88 (grey) and 1991-94 (black) year classes are shaded.