Final Research Report

Report Title	Length and age composition for the Northern Gemfish fisheries (SKI 1 & 2)
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1.5 Project Leader	N.L. Phillips
1.6 Duration of Project	
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1.7 Executive summary

This report is a Final Research Report for Objectives 4 and 5 of the gemfish stock assessment project investigating age, length and gonad condition of gemfish from FMAs SKI 1 and SKI 2.

Age distributions from 2001/02 continue to show similarities between the three northern gemfish fisheries (SKI 1E (east), SKI 1W (west) and SKI 2) with similar growth and recruitment patterns. There is slightly more variability in the SKI 2 age frequency time series probably due to the relatively low numbers sampled over a more extended time period (9 months) than for SKI 1 (6 weeks).

1.8 Overall Objective

The overall objective for project SKI2002/01 was:

1. To carry out stock assessments for gemfish (SKI 1 and 2), including estimating biomass and sustainable yields.

1.9 Specific Objectives:

The specific objectives covered by this report:

Objective 4: To determine the proportion at age of gemfish catch taken in SKI 2 from otolith samples collected in 2001/02 (under project INS2001/01).

Objective 5: To carry out sampling and determine the length and age composition and gonad condition of gemfish taken in SKI 1 target trawl fisheries during 2001–02 from samples collected in fish sheds. Catch at age data will have a target coefficient of variation (c.v.) of 20% (mean weighted c.v. across all age classes).

1.10 Introduction

Gemfish are caught in coastal waters around mainland New Zealand in depths ranging from 50 to 550 m. SKI 1 and SKI 2 (Figure 1) have supported important trawl fisheries with TACCs over 1000 t each, but these were reduced in 1997/98 and again in 2000/01 to 210 t for SKI 1 and 240 t for SKI 2 as the stock assessment indicated declining abundance.

The SKI 1 fishery occurs primarily on pre–spawning fish in May–June. Gemfish catches are low in July, when they are assumed to spawn, and post–spawning catches in August–September have been minimal. Preliminary analysis of the age structure of SKI 1E and SKI 1W fisheries suggests that they are from the same stock (Horn & Hurst 1999). However, given that there is some uncertainty about stock structure, length and age data from these two areas have been kept separate since 1996.

Catch at age data are an important input into the stock assessment process, providing information on the relative year class strength of recruited cohorts.

This report presents and updates the length and age structure of gemfish caught commercially during the 2001/02 fishing year in SKI 1 and 2. Length frequency and catch at age data are presented, and are compared with previous years. These results form part of the input to the 2002 gemfish stock assessment.

1.11 Methods

Objective 4: SKI 2 catch sampling.

Length frequency data and otoliths from SKI 2 for 2001/02 were collected under Objective 1 of MFish project INS2000/01. A summary of the sampling programme is reported in Blackwell et al (2002) and is briefly described here.

The sampling effort required to achieve a target c.v. of 30% was estimated as follows (D. Gilbert, NIWA, pers. com):

$$\sqrt{\frac{n}{n^*}} = \frac{C^*}{C}$$

$$\therefore n = \frac{n^* C^{*2}}{C^2}$$

Where C is the target mean weighted coefficient of variation (c.v.); C^* is the estimated mean weighted coefficient of variation for sample of size n^*.

Data from 7 years of sampling SKI 1E and 2 years of sampling both SKI 1W and SKI 2 were used to estimate the sampling effort required. The estimated mean sampling effort required was 11 samples (range 8–15) and 437 otoliths (range 281–680, males and females combined).

The catch sampling programme aimed to collect 15 samples and 500 otoliths from the SKI 2 fishery. The number of samples and otoliths was chosen from the upper end the estimates for two reasons: a) the mean sample size of 11 samples would only achieve the 30% c.v. on average and cannot be guaranteed to achieve the 30% c.v. in any one individual year; and b) the taking of a few more samples and otoliths (particularly of larger fish) ensures that more year classes will be estimated with acceptable precision for inclusion in the model to estimate year class strengths.

Within each sample, up to 50 fish were randomly selected, measured to the nearest centimetre below the fork length, sexed, and otoliths taken. Gonad development was recorded using the 5 stage scale used previously: 1, immature/resting (gonads small and ribbon or thread like, no eggs/milt visible); 2, maturing/developing (small eggs/milt visible); 3, mature (some hyaline eggs present, milt extrudable); 4, running ripe (milt/eggs flow freely); 5, spent (gonads reduced in size, ovaries red and flaccid, testis may be red or blackish with little or no milt present).

Sampling strata were based on vessels. A set of ten trawlers that accounted for around two thirds of the SKI 2 catch were identified and allocated as a single stratum ("BT1" stratum). All other vessels catching gemfish by any method were collectively grouped as a single stratum ("OTH" stratum).

Aging

Ageing was carried out using the methods of Horn & Hurst (1999). Prior to reading, otoliths were soaked in water for up to 2 hours as this clarifies the banding pattern. Otoliths immersed in water against a dark background are illuminated by reflected light and examined under a binocular microscope at x10 magnification. The number of hyaline zones (which appear dark using this examination technique) were counted wherever the pattern was clearest on the posterior end of the distal otolith surface. Gemfish probably spawn off Northland in about July, and a "birthday" of 1 August was used. The number of complete hyaline zones, plus a correction for the time elapsed between 1 August and the date of sampling is taken as the age of the fish.

Catch-at-age and catch-at-length estimates were produced using the 'catch-at-age' software developed by NIWA (Bull & Dunn 2002). The software scaled the length frequency of fish from each landing up to the landing weight, summed over landings in each stratum, scaled up to the total stratum catch, to yield length frequencies by stratum and overall. An age-length key was constructed from otolith data and applied to the length frequencies to produce age frequencies. The precision of each length or age frequency was measured by the mean weighted c.v. This was calculated as the average of the c.v.s for the individual length or age classes weighted by the proportion of fish in each class. The c.v.s were calculated by bootstrapping: fish were resampled within each landing, landings were resampled within each stratum, and otoliths were randomly resampled. Catch-at-age for previous years were also recalculated using the 'catch at age' software to ensure consistency between years.

Objective 5: SKI 1 catch sampling.

The sampling effort required to achieve a c.v. of 20% for SKI 1 was the same method used for SKI 2.

The required number of samples was estimated using data from 9 years of sampling SKI 1E and 4 years of sampling both SKI 1W and SKI 2. The estimated mean sampling effort

required, per fishery, was 12 samples (range 8–17) and 477 otoliths (range 281–680, males and females combined), to achieve the mean weighted c.v. of 20%.

The catch sampling programme aimed to collect 15 samples and 600 otoliths per season from each of the fisheries. Each fishery was treated as a single stratum. The number of samples and otoliths were chosen from the upper-end of the estimates for the same reasons mentioned above for Objective 4.

Since the 1996/97 fishing season, Sanford Ltd has carried out shed sampling from their own catch, and NIWA has sampled other companies. Resulting length frequency distributions from NIWA and Sanford were similar. Sanford Ltd currently holds about 55% of the gemfish quota and catches about 60% of the SKI catch. Sampling by Sanford Ltd was proportional to their catch. This resulted in Sanford Ltd aiming to collect 9 samples, and NIWA aiming to collect 6 samples from other fish processors, for each SKI 1 fishery.

Each sample comprised 200 fish, selected randomly, measured to the nearest centimetre below fork length, and sexed. Gonad development was recorded (where possible) using the 5-stage scale as in SKI 2. Otoliths were from at least 40 fish selected randomly in each sample. This method of sampling differed from SKI 2, as the SKI 1 fishery operates for a short time period (approximately 6 weeks) and the derived ages from the length frequencies using the age/length key would not be biased as very little growth occurs in that time period. In contrast, the SKI 2 fishery operates for approximately nine months and if extra fish were measured, the derived ages from the length frequencies using the age/length key would be biased as growth would occur in the time period and would not have been taken into account. For example, length frequencies from the start of the period would have ages applied to them that were obtained in part from fish aged from the end of the period. These ages would tend to be biased downwards. The reverse would apply to length frequencies from the end of the period. These biases would not necessarily cancel.

Calculation of scaled length frequencies and proportions at age was carried out, as for SKI 2 samples using the methods of Horn & Hurst (1999) and Bull & Dunn (2002) (see above).

1.12 Results

SKI 2 catch sampling

Details of the numbers of samples taken in 2001–02 from SKI 2 are given in Table 1. Eleven landings were sampled out of the planned 15. The target number could not be achieved, as the "OTH" vessels did not land sufficient quantities of gemfish. This resulted in a total of 598 fish measured and 549 aged (Table 1).

The gonad stages are summarised in Table 2. Two hundred and thirty five males and 363 females were staged. Sixty eight percent of males and 58% of females sampled were in the immature/resting stage (stage 1), with the remainder in the maturing/developing (stage 2) and mature stages (stage 3).

Length frequencies from SKI 2 for 2001/02 are shown in Figure 2. The distribution ranges from 35–110 cm with the main mode at around 65 cm for both males and females.

Numbers at age, by sex, for 2001–02 are listed in Table 3. Ages 3–6 dominated for both males and females, with 4-year-old fish being the most dominant age class. The mean weighted c.v. across all age classes was 25.8% , close to the target c.v. of 20%.

Plots of the age frequencies for the 2001–02 fishing year and previous years are presented in Figure 3. Most captured fish appear to be less than 7 years, which can be explained by the nature of the fishery. The SKI 2 fishery targets non-spawning gemfish and includes young fish that are immature.

SKI 1 catch sampling

Details of the numbers of samples taken from shed sampling in May/June are given in Table 1. The target number of 15 samples for each of SKI 1E and SKI 1W was not able to be achieved. Fishing was limited due to bad weather in late May and June, (especially in SKI 1W). A total of 18 samples were collected, 13 from SKI 1E and 5 from SKI 1W.

A total of 630 male and 578 female fish were staged (Table 2). The gonad stages are summarised in Table 2. Ninety percent of males and females sampled were in the mature stage (stage 3), with the remainder in the resting or developing stages (stages 1 and 2).

Length frequencies from SKI 1 (east and west combined) for 2001–02 are presented in Figure 2. The distribution ranges from 30–115 cm with the main mode at 85 cm for males and 95 cm for females.

Length frequencies from SKI 1 by fishery (SKI 1E & SKI 1W) are presented in Figure 4. The distributions and modes are very similar to each other, supporting the hypothesis that the fish from both strata are from the same population.

Numbers at age, by sex, for 2001–02 are listed in Table 3. Dominant ages vary from 6 to 13 years of age and are related to strong year classes moving through the fishery. The mean weighted c.v. across all age classes was 19.7%.

Plots of the age frequencies for the 2001–02 fishing year and previous years are presented in Figure 5. The 2002 age frequency shows a strong 1991-year class as in previous years, but only the 1984-year class is still discernible from the earlier group of strong year classes (1980, 1982, 1984).

1.13 Conclusions

- Age frequencies from 2001–02 continue to show similarities between the three northern gemfish fisheries (SKI 1E, SKI 1W and SKI 2)
- The 2001–02 SKI 1 fishery still has a wide range of ages present, 3–18, with no one year class being clearly dominant.
- The 2001–02 SKI 2 fishery has a similar range of ages preset to SKI 1 but ages 4–7 dominate the catch.

1.14 Publications

Nil.

1.15 Data storage

All catch sampling data up to 30 September 2002 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.

1.16 References cited:

Blackwell, R.G.; Horn, P.L.; McMillan, P.J. (2002) Commercial catch sampling of alfonsino, bluenose, gemfish and rubyfish in QMA 2 in 2000–01. Final Research Report for Ministry of Fisheries Research Project INS2000/01, Objective 1–3. 21 p. (Unpublished report held in NIWA library, Wellington.)

Bull, B.; Dunn, A. (2002). Catch-at-age: User manual v1.06.2002/09/12. *NIWA Technical Report 114*. 23 p. (Unpublished report held in NIWA library, Wellington.)

Horn, P.L.; Hurst, R.J. (1999). Age and stock structure of gemfish (*Rexea solandri*) in New Zealand waters. *Marine and Freshwater Research 50*: 103–115.

Table 1: Summary of catch sampling for SKI 1 & 2 for the 2001–02 fishing year.

Area	Strata	Period	Planned	Achieved	Total no. fish measured	No fish otolithed
SKI 1	East	May–Jun	15	13	3 159	604
	West	May–Jun	15	5	1 239	258
SKI 2	BT1	Nov–May	8	10	550	506
	OTH	Nov–May	7	1	48	43

Table 2: Gonad stage (%) of male and female gemfish from SKI 1 & 2. *n*, is the number of fish staged.

	SKI 1			SKI 2	
Stage	Male	Female	Stage	Male	Female
1	2	4	1	68	58
2	9	6	2	29	41
3	90	90	3	4	0
4	0	0	4	0	0
5	0	0	5	0	0
n	630	578		235	363

Table 3: Scaled numbers-at-age and calculated c.v.s (%) from catch sampling in SKI 1 and SKI 2 in 2001–02. The numbers of fish measured and aged and, the estimated c.v. (mean weighted c.v. across all age classes for both sexes) are also presented.

	SKI 1				SKI 2			
	Male		Female		Male		Female	
Age (years)	Number	c.v.	Number	c.v.	Number	c.v.	Number	c.v.
2	140	64	120	66	1	526	0	303
3	992	24	196	34	679	44	977	32
4	929	21	227	34	2343	24	3281	25
5	903	22	180	35	978	29	1759	23
6	1667	15	603	24	525	33	1376	21
7	923	19	300	32	238	51	475	32
8	470	27	269	42	133	82	189	49
9	1311	18	636	25	221	52	591	34
10	1758	16	1178	16	159	58	658	30
11	716	23	339	33	111	82	81	104
12	1365	18	1667	15	121	60	438	37
13	664	23	1480	15	31	120	103	64
14	181	39	236	43	50	123	116	65
15	637	26	557	23	46	102	77	76
16	79	61	149	42	29	156	95	79
17	302	36	369	29	33	130	39	107
18	89	77	145	47	27	158	20	146
19	61	85	90	63	0	0	5	204
20	41	78	34	93	0	0	0	0
21	0	0	19	116	0	0	0	0
Total measured	2 564		1 834		235		363	
Total aged	499		363		213		336	
Mean weighted c.v.		17				26		

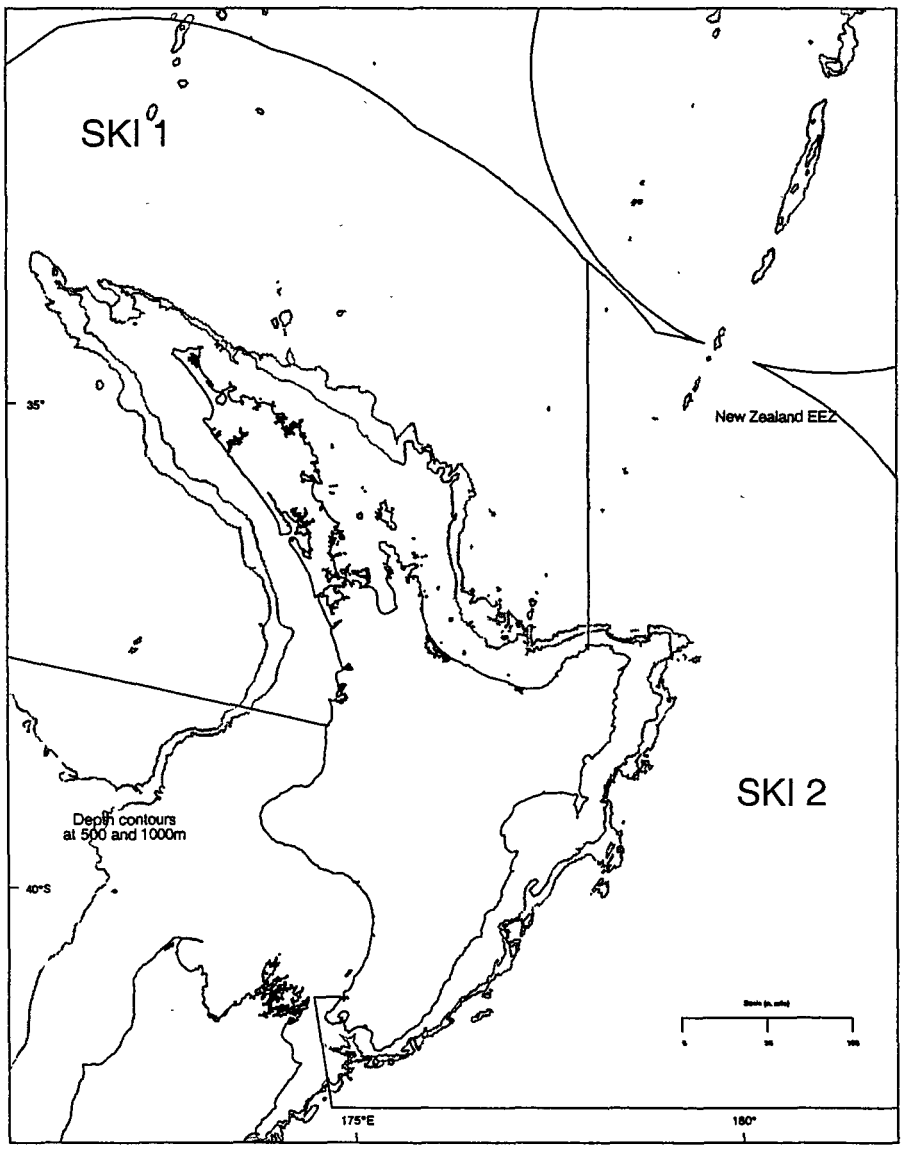

Figure 1: Definitions for the northern gemfish fisheries used in this report.

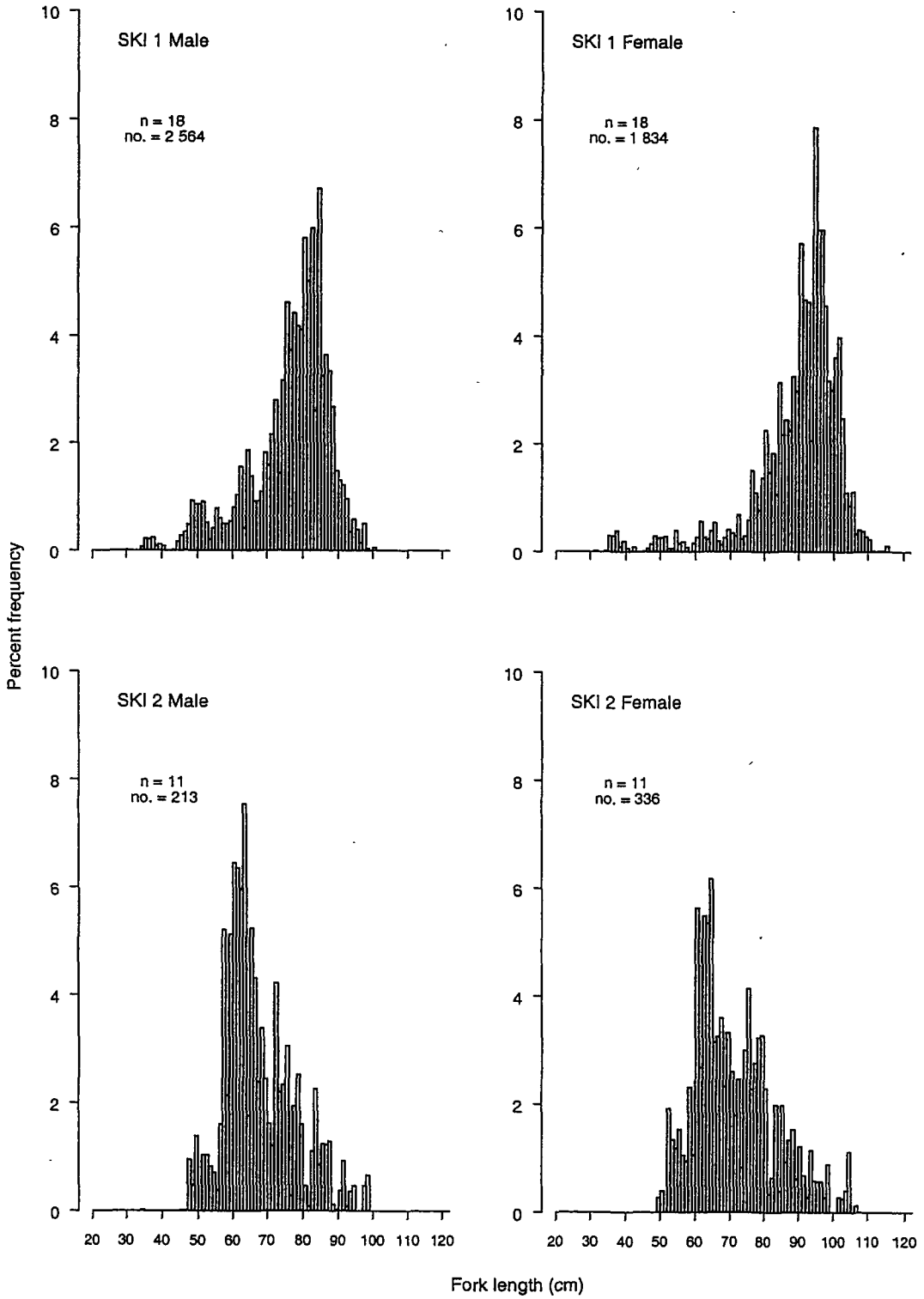

Figure 2: Length frequencies of male and female gemfish from SKI 1 & 2, 2001–02. (*n*= number of landings sampled, *no*= number of fish measured).

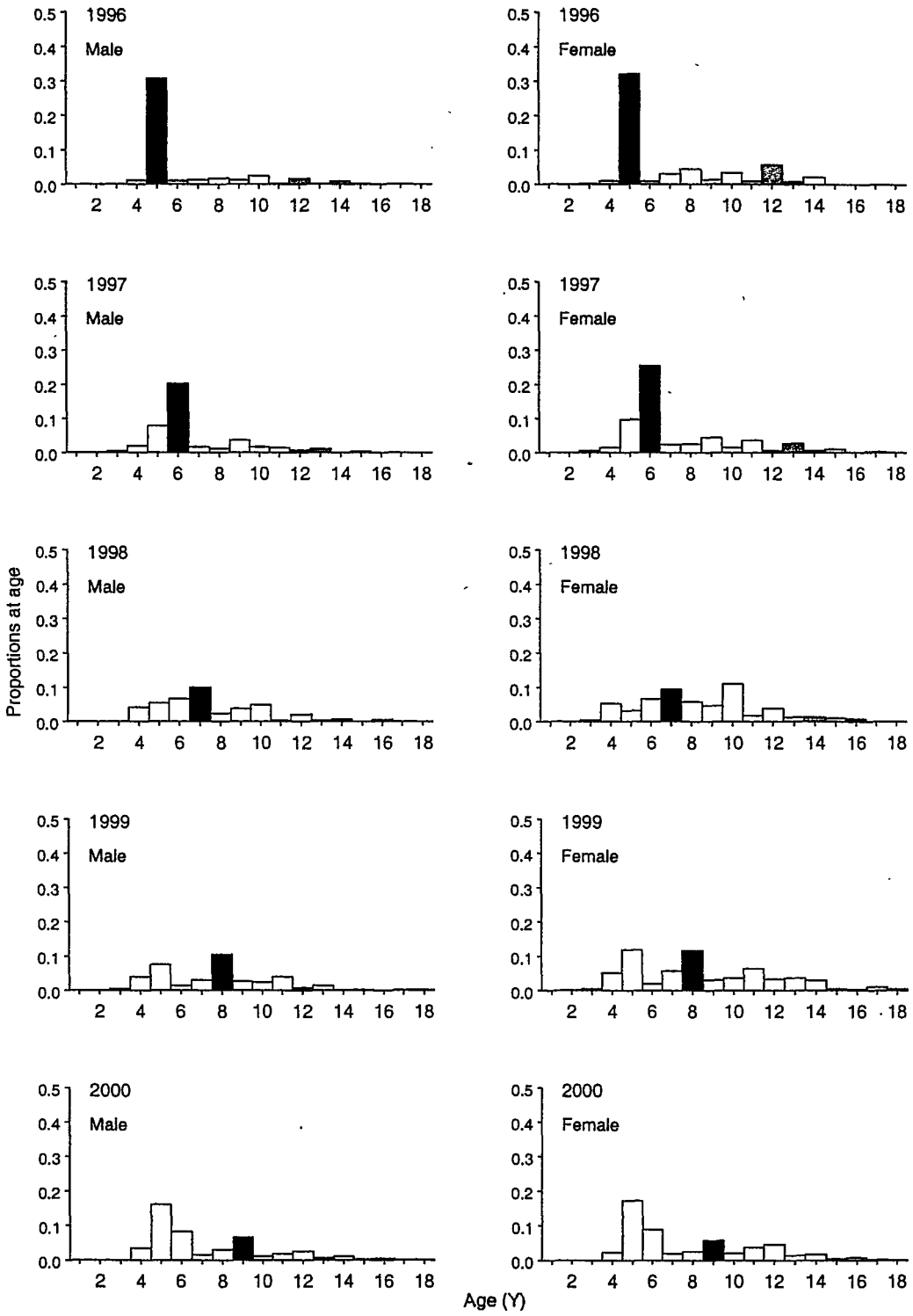

Figure 3: Age frequencies of gemfish from shed sampling catch at age data in SKI 2. Shaded bars show the 1984 (black) and 1991 (grey) year classes. Note: the age frequencies were recalculated using NIWA's "catch-at-age" software (Bull & Dunn 2002).

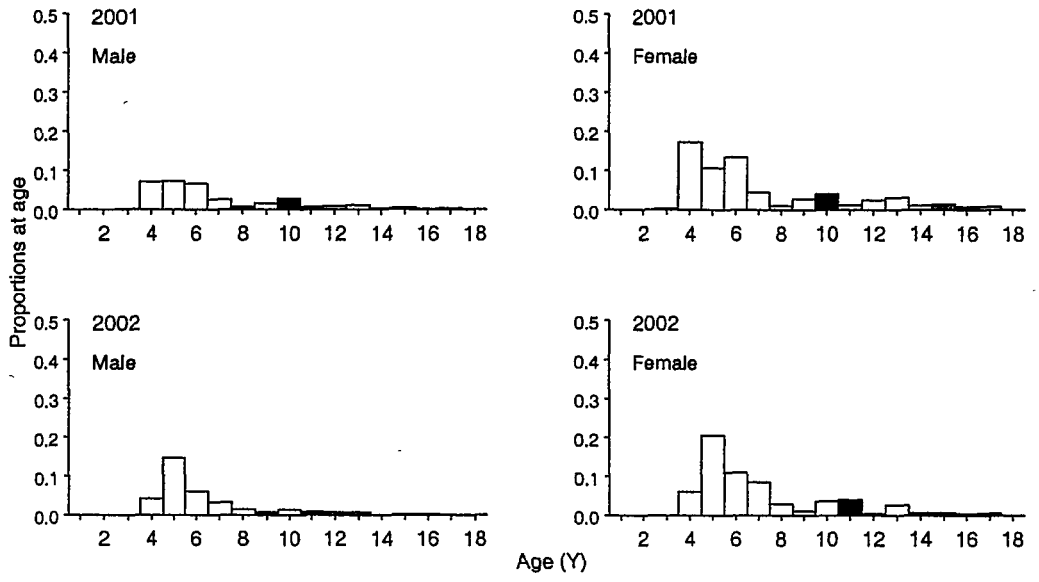

Figure 3: ***Continued.***

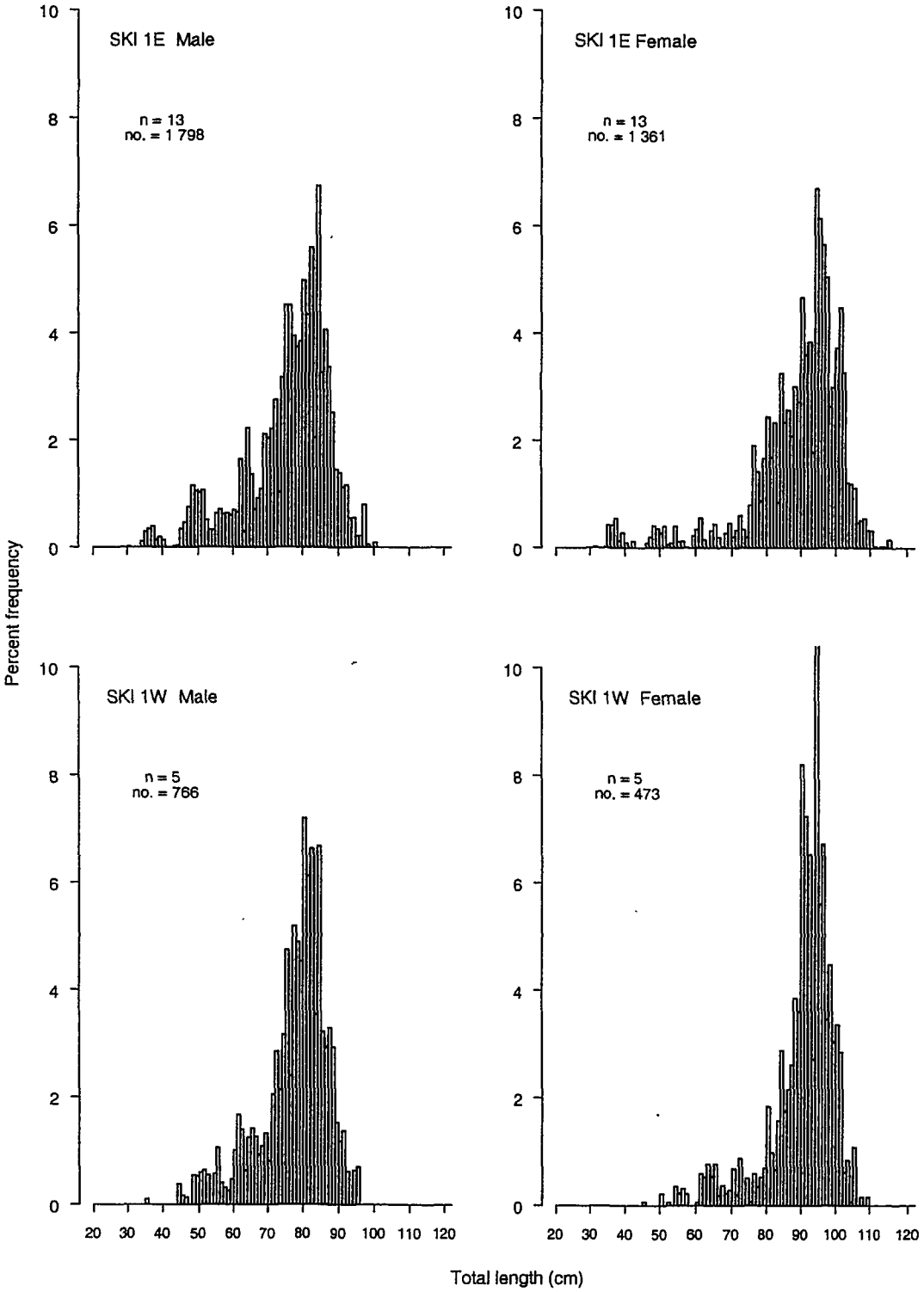

Figure 4: Length frequencies of male and female gemfish from SKI 1E and SKI 1W, 2001–02. (*n*= number of landings sampled, *no*= number of fish measured).

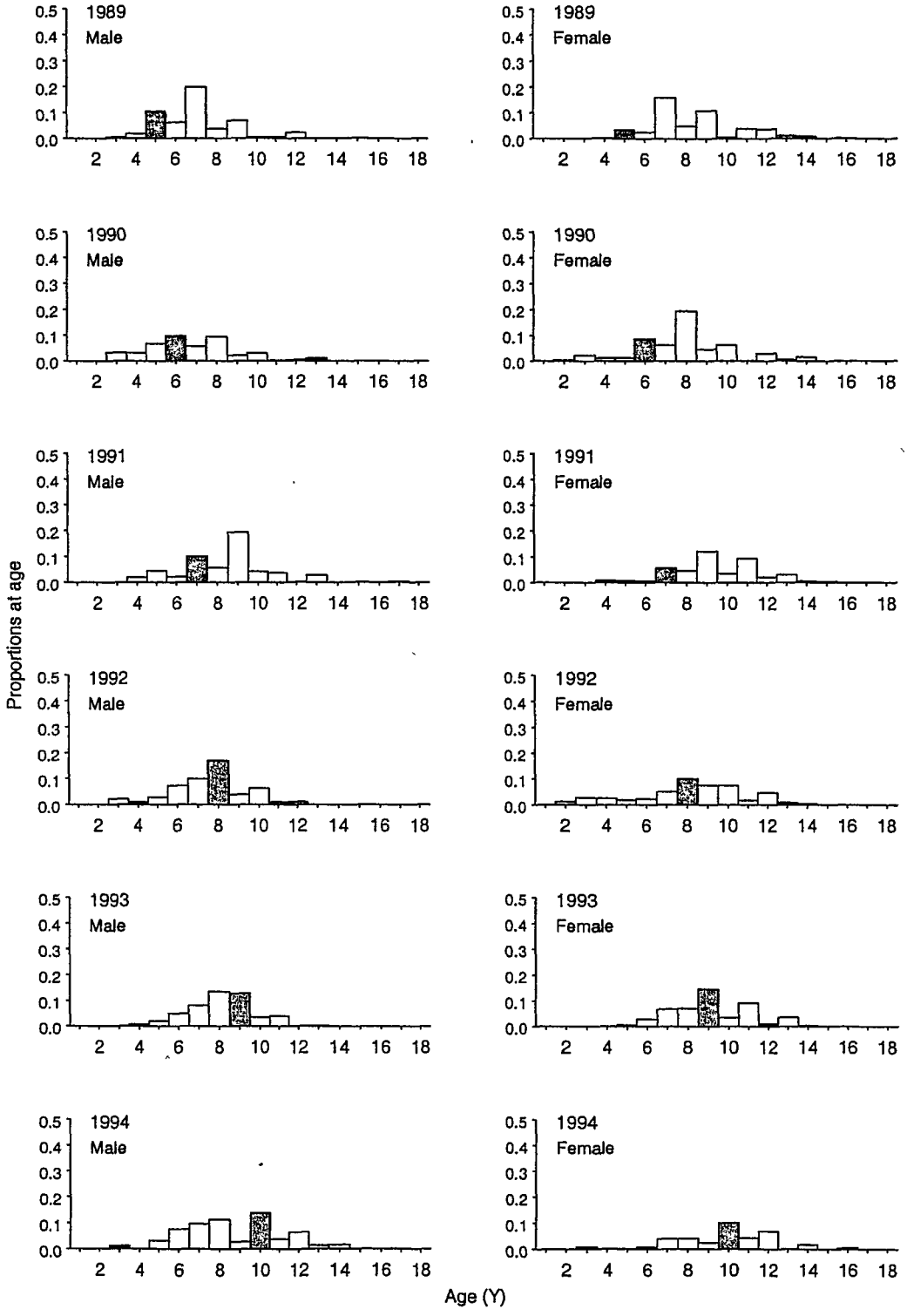

Figure 5: Age frequencies of gemfish from shed sampling catch at age data in SKI 1. Shaded bars show the 1984 (black) and 1991 (grey) year classes. Note: the age frequencies were recalculated using NIWA's "catch-at-age" software (Bull & Dunn 2002)

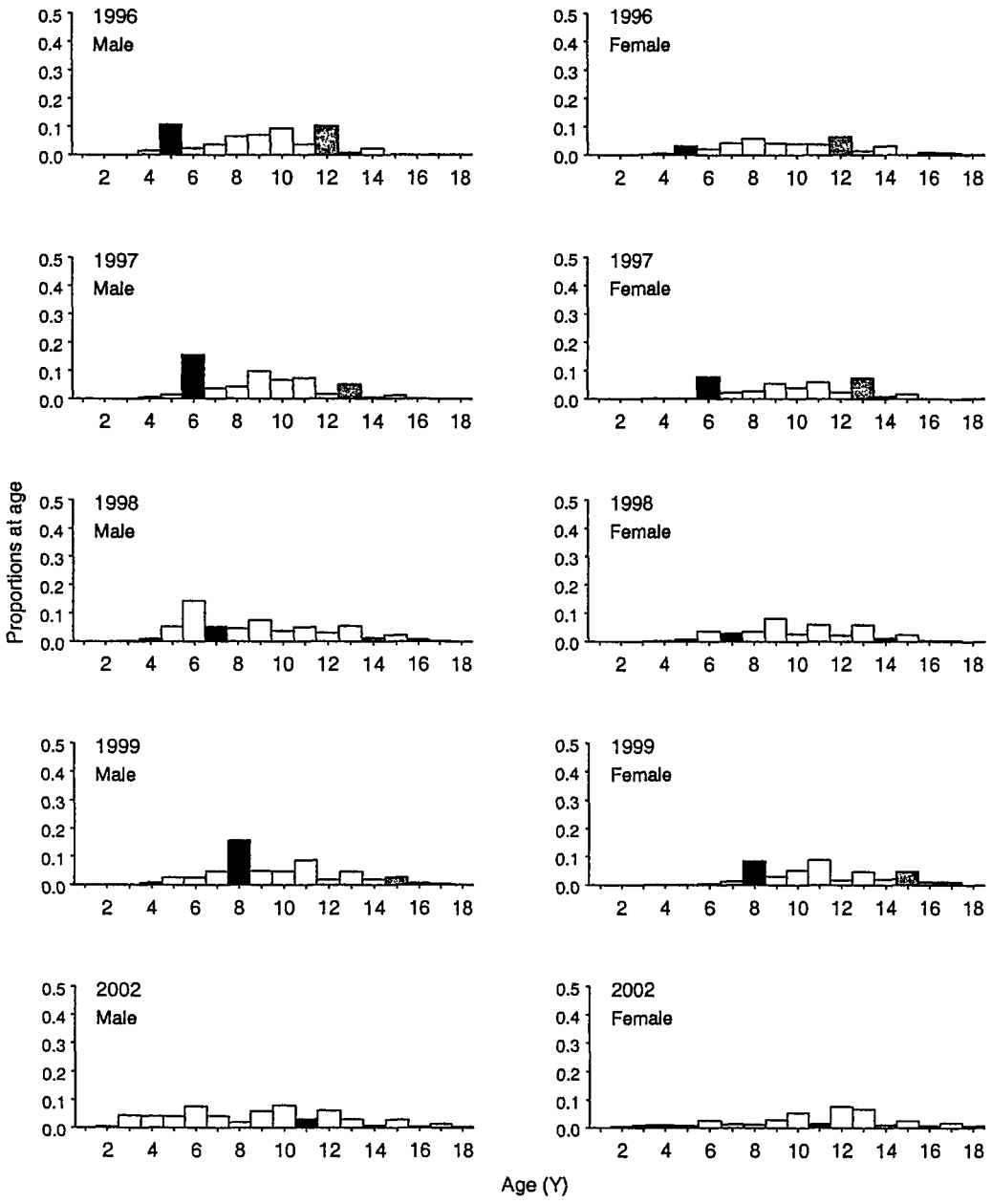

Figure 5: *Continued.*