NIWA

Taihoro Nukurangi

Comparison of estimated age distributions of WCSI hoki catches, derived using old and new ageing protocols, and catch-at-age data for ling.

N.L. Phillips, P.L. Horn, N.K. Davey

Final Research Report for
Ministry of Fisheries Research Project MID2003/02
Objectives 4 and 6

National Institute of Water and Atmospheric Research

July 2004

Final Research Report

Report Title	Comparison of estimated age distributions of WCSI hoki catches, derived using old and new ageing protocols, and catch-at-age data for ling
Authors	N.L. Phillips, P.L. Horn, N.K. Davey
1. Date	29 July 2004
2. Contractor	National Institute of Water and Atmospheric Research Limited (NIWA)
3. Project Title	Determination of catch at age in hoki, hake and ling fisheries
4. Project Code	MID2003/02
5. Project Leader	P.L. Horn
6. Duration of Project	
Start Date	1 October 2003
Expected completion date	31 May 2005

7. Executive summary

Samples of hoki otoliths collected since 1999 have been read using the protocols of Cordue et al. (2000) and Francis (2001). The Hoki Fishery Assessment Working Group agreed to the rereading of otolith samples from previous years in accord with the new protocols. Samples from the west coast South Island spawning fishery from 1993 to 1998 were reread and the resulting age frequencies were compared to the original age frequencies derived from the same otoliths read using the original protocols.

Most of the age frequencies were similar for the two different reading methods. However, there were obvious differences in some years, in age classes from 2 to 8 years for both males and females. The resulting year class strengths derived from the new readings appear to be more consistent with the year class strengths derived from length frequencies for the same fishery.

Ideally the age frequencies from each reading protocol should be compared in stock assessment models to assess which data set is more consistent with other information. If the age frequencies from reread hoki otoliths prove to be more consistent with other information it may be advisable to reread hoki otoliths from other years and areas using the new protocols.

Catch-at-age distributions estimated for ling from two trawl surveys and several commercial fisheries are presented. All samples met the target coefficient of variation (30%).

8. Overall Objective

The overall objective for project MID2003/02 was:

> To determine the catch at age from the main hoki, hake and ling fisheries as input data to the stock assessment of these species

9. Specific Objectives:

The specific objectives covered by this report:

> Objective 4: To determine the catch at age from ling fisheries in LIN 3 & 4, 5 & 6 and 7 in 2002/03 from samples collected at sea by the Observer Programme and from other sources, with a target coefficient of variation (c.v.) of 30 % for each fishstock (mean weighted c.v. across all age classes).
>
> Objective 6: To re-read samples of hoki otoliths from a number of years from the west coast, South Island commercial fishery.

10. Introduction

Hoki is the most abundant commercial fish species in New Zealand waters. TACC levels from the last few years have been in the region of 200 000–250 000 t, with a TACC of 200 000 t in 2002–03 (Annala et al. 2003). There are four main fisheries for hoki in New Zealand: west coast South Island (WCSI), Cook Strait, the Chatham Rise, and the Sub-Antarctic. The WCSI and Cook Strait are predominantly spawning fisheries during winter (June to September), while fishing in the other two areas is normally outside of the spawning season (O'Driscoll et al. 2002). Small catches of spawning hoki are also taken from other spawning grounds off the east coast South Island (ECSI) and late in the season at Puysegur Bank. Other out-of-season catches are taken from areas around the North and South Islands, but these are small by comparison to the Chatham Rise and Sub-Antarctic.

Stock assessment of hoki has been in a constant state of development, with improved methods being used and large increases in available data for stock assessment (Cordue et al. 2000). Catch-at-age data from the four major fisheries are an important input into the stock assessment process providing valuable information on the strength of recruited cohorts for these fisheries.

A validated aging method for hoki was determined by Horn and Sullivan (1996) which involved counting translucent zones in otolith transverse-sections. The reading protocol was refined in 2000 to include measurements of otolith ring radii for the first three rings (Cordue et al. 2000), and a method to estimate hoki age distributions with additional ring measurements was developed (Francis 2001). Hoki otoliths and age data collected since 1999 have been read and analysed using the protocols developed by Francis (2001). Hoki otoliths collected prior to 1999 were read using the methods of Horn and Sullivan (1996).

This report compares the WCSI hoki age distributions derived from otoliths collected prior to 1999 and read using the protocols of Horn and Sullivan (1996) to age distributions derived

using the same otoliths interpreted using the protocols Francis (2001). This report does not include any graphical or statistical tests of consistency within age interpretations as the requirement of the study was only to compare catch-at-age distributions from the two otolith reading methods.

Catch-at-age distributions estimated for ling from two trawl surveys and several commercial fisheries are also presented.

11. Methods

Samples of prepared hoki otoliths in resin blocks are available from the winter spawning fishery off west coast South Island from 1994 to 2002. Prepared otolith samples from 1988 to 1993 are set in plasticine strips on cardboard trays. The six samples from 1993 to 1998 were re-read using the new protocols of Francis (2001). The reread ages were used to generate an age-length key and the proportions-at-age were re-calculated using purpose built software (Bull & Dunn 2002), and were compared to previous age distributions derived from otoliths read using the original method.

Ling otoliths from all the commercial fishery samples were collected by Observers, with the Cook Strait sample being augmented by some shed sampling. Otoliths from each sample were selected, prepared, and read as follows. Otoliths (for each sex separately) from each 1 cm length class were selected proportionally to their occurrence in the scaled length frequency, with the constraint that the number of otoliths in each length class (where available) was at least one. In addition, all otoliths from fish in the extreme right hand tail of the scaled length frequency (i.e., large fish constituting 2% of that length frequency) were fully sampled. This provides a sample with a mean weighted c.v. similar to that from proportional sampling, but will do better than uniform sampling for the older age classes. Otoliths were prepared and read using the validated ageing method of Horn (1993). Catch-at-age and catch-at-length estimates scaled to the commercial catch by stratum were produced using the 'catch.at.age' software developed by NIWA (Bull & Dunn 2002). The software scales the length frequency of fish from each landing up to the landing weight, sums over landings in each stratum, and scales up to the total stratum catch, to yield length frequencies by stratum and overall. An age-length key is constructed from otolith data and applied to the length frequencies to yield age frequencies. The precision of each length or age frequency is measured by the mean weighted c.v., which is 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. Coefficients of variation are calculated by bootstrapping: fish are resampled within each landing, landings are resampled within each stratum, and otoliths are simply randomly resampled.

12. Results

Most of the hoki age frequencies derived from reading otoliths read using the new protocols were similar to the ages derived from reading otoliths using the old protocols (Figures 1 and 2). However, there are obvious differences in some years. The 1992 and 1994 year classes were stronger from reread otoliths for both males and females in most years. The 1985 year class appeared weaker from reread otoliths for both males and females. Also, the male 1993 year class was weaker from reread otoliths from 1996 to 1998, but only in 1998 for females.

New catch-at-age distributions for ling from the following samples are presented in Appendix A. The mean weighted c.v.s for these samples ranged from 19 to 29%, all lower than the target of 30%.

LIN 3&4: Trawl survey, January 2004
LIN 3&4: Commercial longline, Jul–Oct 2003
LIN 5&6: Trawl survey, December 2003
LIN 5&6: Commercial longline (spawning fishery), Oct–Dec 2002
LIN 5&6: Commercial longline (non-spawning fishery), Feb–Jul 2003
LIN 5&6: Commercial trawl, Jan–Jul 2003
LIN 7 (WCSI): Commercial trawl, Jun–Sep 2003
Cook Strait: Commercial trawl, Jun–Sep 2003

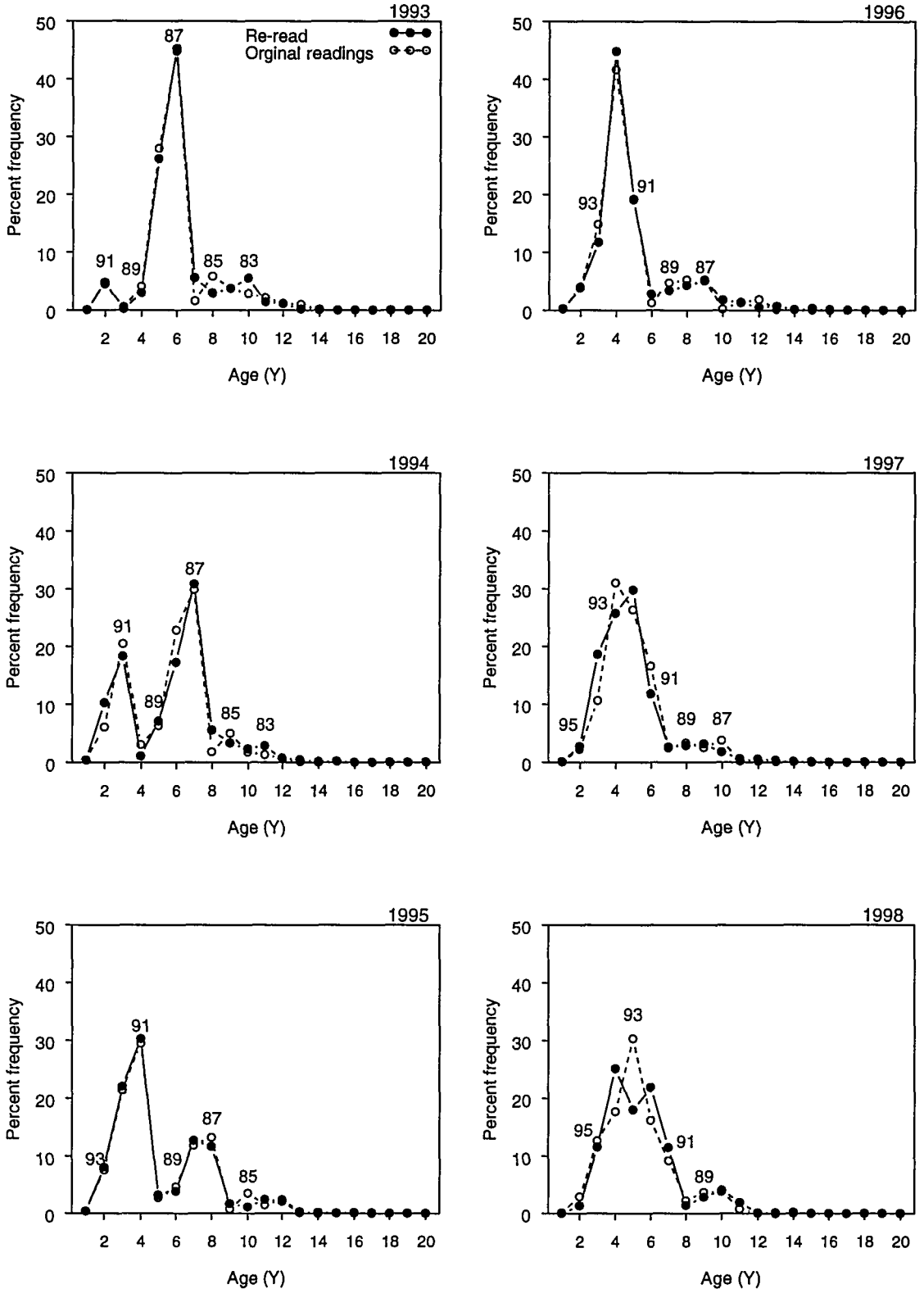

Figure 1: Comparison of the male hoki age distributions derived from otoliths read using the new protocols of Francis (2001) to the age distributions derived from otoliths read using the protocols of Horn & Sullivan (1996). Year classes are also plotted (e.g., "89" indicates the 1989 year class).

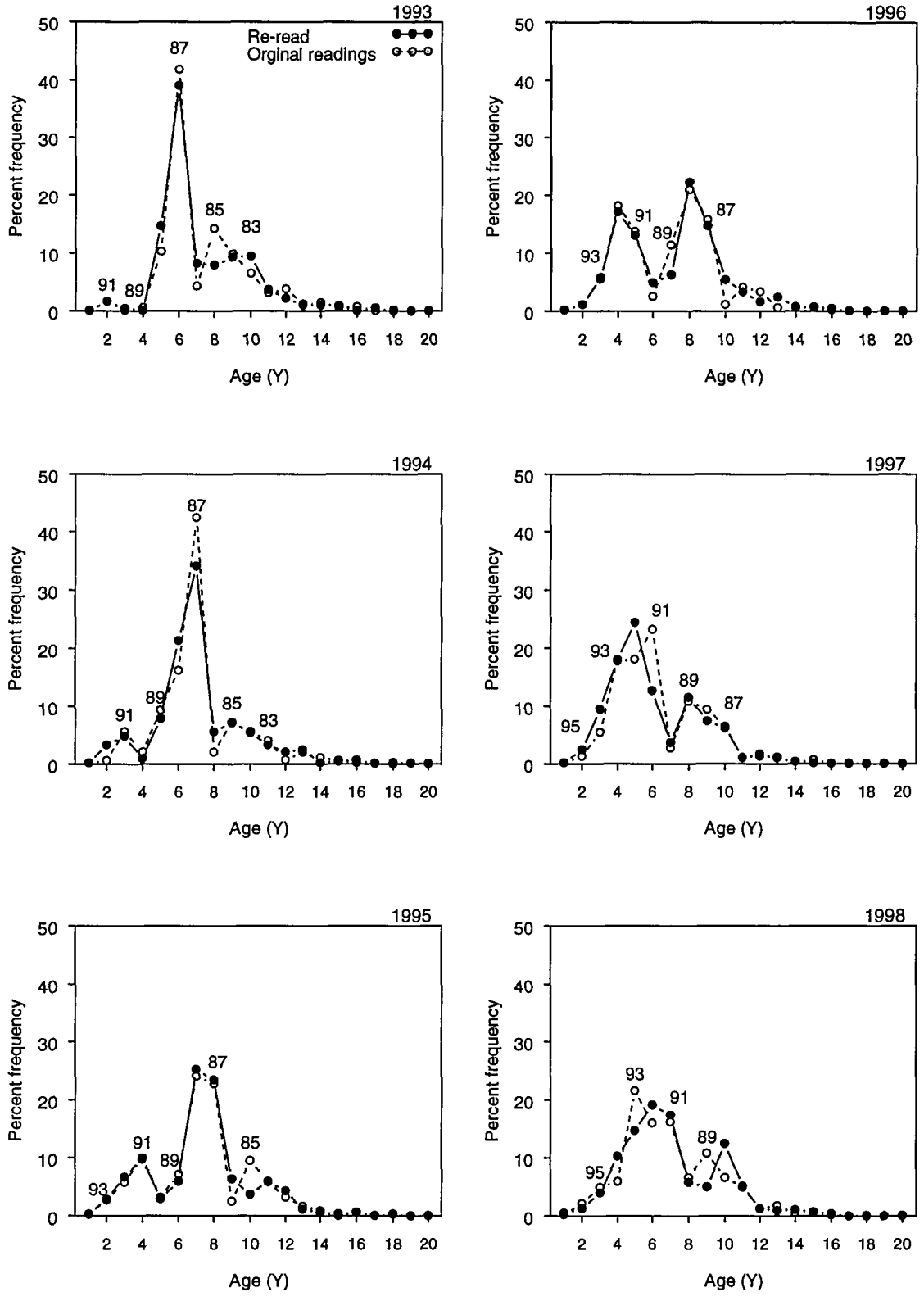

Figure 2: Comparison of the female hoki age distributions derived from otoliths read using the new protocols of Francis (2001) to the age distributions derived from otoliths read using the protocols of Horn & Sullivan (1996). Year classes are also plotted (e.g., "89" indicates the 1989 year class).

13. Discussion

Most of the age frequencies are similar between the two different reading methods. However, it is apparent that differences have occurred, and that they can occur in any of the relatively abundant age classes in the commercial catch (i.e., from ages 2 to 10), for both males and females.

The resulting year class strengths from the new readings appear to be more consistent with the length frequencies from the same hoki fishery published by O'Driscoll et al. (2002). For example, in 1998 the male 1993 year class appears stronger than the 1992 and 1994 year classes using the old readings. However, the male 1993 year class appears weaker than the 1992 and 1994 year classes for both the length frequencies and the new readings.

Whether or not these new readings have solved the perceived problems associated with the age frequencies detected in earlier hoki stock assessments is not clear (Cordue et al. 2000, Francis 2001). Ideally the age frequencies from both readings should be used in a stock assessment model to assess which of the two data sets are more consistent with other information, and whether the new data causes significant differences in the model outputs. If the age frequencies from reread hoki otoliths prove to be more consistent with other information it may be desirable to reread hoki otoliths from other years and/or areas using the new ageing protocols.

14. References

Annala, H.; Sullivan, K.J.; O'Brien, C.J.; Smith, N.M.W.M.; Grayling, S.M. (comp.) (2003). Report from the Fishery Assessment Plenary, May 2003: stock assessments and yield estimates 616 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.

Cordue, P.; 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 (Hoki ageing), Objective 1. 11 p. (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 2001/12.* 18 p.

Horn, P.L. (1993). Growth, age structure, and productivity of ling, *Genypterus blacodes* (Ophidiidae), in New Zealand waters. *New Zealand Journal of Marine and Freshwater Research 27*: 385–397.

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.

O'Driscoll, R.L.; Phillips, N.L.; Livingston, M.E.; Hicks, A.C.; Ballara, S.L. (2002). Catches, size, and age structure of the 2000–01 hoki fishery, and a summary of biological research for the 2002 stock assessment. *New Zealand Fisheries Assessment Report 2002/39.* 70 p.

Appendix A: New calculated catch-at-age distributions for ling

Table A1: Calculated numbers at age, separately by sex, with c.v.s, for ling caught during trawl surveys of the Campbell Plateau in December 2003 (survey TAN0317) and the Chatham Rise in January 2004 (survey TAN0401). Final line for each sample represents a plus group. Summary statistics for the samples are also presented.

	TAN0317					TAN0401			
Age	Male	c.v.	Female	c.v.	Age	Male	c.v.	Female	c.v.
1	0	–	0	–	1	0	–	0	–
2	0	–	0	–	2	3 555	1.5888	15 425	1.0775
3	61 841	0.5781	24 747	0.8633	3	68 450	0.4014	60 524	0.4020
4	235 168	0.3136	215 841	0.3205	4	369 973	0.1602	254 487	0.2002
5	256 047	0.3481	576 927	0.2398	5	258 158	0.2015	154 890	0.2374
6	1 015 360	0.1785	569 728	0.2642	6	169 717	0.2198	197 126	0.1938
7	645 081	0.2401	802 046	0.2199	7	216 467	0.1924	191 688	0.2200
8	439 807	0.2409	930 250	0.1972	8	243 609	0.1890	158 389	0.2101
9	321 541	0.2753	698 429	0.1781	9	161 483	0.2493	139 871	0.2309
10	398 879	0.2528	350 540	0.2588	10	88 946	0.2947	118 026	0.2776
11	209 501	0.3552	238 667	0.2887	11	49 225	0.4073	75 384	0.2991
12	101 858	0.4055	272 528	0.2735	12	80 825	0.3054	43 427	0.4076
13	144 317	0.3880	191 787	0.3005	13	59 353	0.3410	34 822	0.4274
14	111 714	0.4272	198 090	0.3138	14	40 470	0.4053	45 660	0.3412
15	105 728	0.4419	177 936	0.3423	15	33 972	0.4176	26 067	0.4849
16	69 475	0.5046	96 338	0.3869	16	26 802	0.4615	13 289	0.5517
17	68 109	0.5438	48 679	0.6196	17	17 768	0.5119	10 375	0.6799
18	35 168	0.5870	49 267	0.5650	18	6 824	1.0485	9 827	0.6889
19	48 379	0.6953	57 683	0.5641	19	0	–	6 476	0.8367
20	18 031	1.0115	32 243	0.6635	20	12 507	0.7153	3 384	1.0470
21+	68 017	0.5186	125 283	0.3710	21+	50 295	0.3375	23 040	0.4005
Measured males			1 270						865
Measured females			1 156						752
Aged males			242						300
Aged females			332						300
No. of tows			70						101
Meanweighted c.v. (sexes poled)			21.9						20.4

Table A2: Calculated numbers at age, separately by sex, with c.v.s, for ling caught during commercial longline operations on the Puysegur Bank in November–December 2002, and on the Campbell Plateau in February–July 2003. Final line for each sample represents a plus group. Summary statistics for the samples are also presented.

	Puysegur Bank					Campbell Plateau			
Age	Male	c.v.	Female	c.v.	Age	Male	c.v.	Female	c.v.
1	0	–	0	–	1	0	–	0	–
2	0	–	0	–	2	0	–	0	–
3	0	–	0	–	3	0	–	0	–
4	0	–	0	–	3	0	–	0	–
5	0	–	98	1.4012	5	0	–	254	1.4931
6	1 026	0.5172	478	0.6405	6	3 318	0.4683	2 107	0.4982
7	4 641	0.2330	3 578	0.3106	7	5 340	0.4216	6 156	0.3569
8	8 296	0.1904	10 301	0.1783	8	8 465	0.2959	10 148	0.2375
9	5 296	0.2613	12 623	0.1563	9	4 507	0.3813	9 361	0.2495
10	4 363	0.2837	7 703	0.2067	10	2 942	0.5218	7 924	0.2927
11	4 405	0.2797	4 534	0.2711	11	761	0.8857	4 841	0.3568
12	2 838	0.3710	4 828	0.2603	12	1 820	0.5975	7 696	0.2609
13	3 702	0.2745	6 306	0.2071	13	1 649	0.6353	8 507	0.2395
14	2 336	0.4105	5 948	0.2189	14	1 140	0.7508	7 375	0.2612
15	1 652	0.4548	3 176	0.2615	15	2 146	0.6923	5 608	0.3316
16	1 856	0.4094	2 086	0.3455	16	931	0.9675	3 478	0.3687
17	1 029	0.5956	5 223	0.2182	17	1 686	0.5055	7 224	0.2701
18	2 427	0.3750	1 377	0.3878	18	911	1.1160	1 905	0.5287
19	2 572	0.3460	2 150	0.3092	19	1 286	0.6989	3 180	0.3591
20	2 615	0.3140	1 211	0.5281	20	389	1.9623	1 789	0.5915
21	2 882	0.3258	1 159	0.4625	21+	8 113	0.2880	5 837	0.2788
22+	2 706	0.2937	2 047	0.3081					

Measured males	1 250	304
Measured females	1 687	611
Aged males	209	121
Aged females	306	269
No. of sets	214	43
Meanweighted c.v. (sexes poled)	19.8	29.4

Table A3: Calculated numbers at age, separately by sex, with c.v.s, for ling caught during commercial longline operations on the Chatham Rise in July–October 2003, and during commercial trawl operations on the Campbell Plateau in January–July 2003. Final line for each sample represents a plus group. Summary statistics for the samples are also presented.

	Chatham Rise longline					Campbell Plateau trawl			
Age	Male	c.v.	Female	c.v.	Age	Male	c.v.	Female	c.v.
1	0	–	0	–	1	0	–	0	–
2	0	–	0	–	2	1 991	1.5752	1 330	1.3387
3	0	–	0	–	3	15 114	0.7459	11 318	0.5496
4	0	–	7	1.6813	4	14 119	0.6606	19 812	0.3480
5	192	0.8036	40	0.9841	5	82 286	0.3865	82 905	0.3148
6	944	0.4682	557	0.4141	6	147 841	0.3060	98 712	0.3183
7	2 926	0.2228	511	0.5009	7	146 198	0.2910	172 679	0.2450
8	5 303	0.1960	2 540	0.2467	8	160 652	0.2699	292 506	0.1697
9	7 267	0.1695	2 779	0.2747	9	196 692	0.2187	232 303	0.1789
10	5 325	0.2204	2 822	0.2319	10	85 902	0.3829	133 102	0.2566
11	3 769	0.2430	2 592	0.2341	11	55 927	0.4750	80 161	0.3052
12	3 527	0.2500	3 762	0.1945	12	33 990	0.5059	66 544	0.3443
13	5 436	0.1832	4 438	0.1877	13	42 144	0.4312	48 614	0.4299
14	3 837	0.2185	5 248	0.1867	14	48 171	0.4275	51 803	0.4007
15	4 479	0.1986	3 520	0.2008	15	38 172	0.4476	42 035	0.4646
16	2 113	0.2918	1 651	0.3308	16	18 186	0.6282	28 612	0.5288
17	1 974	0.3045	1 689	0.3023	17	22 559	0.7129	25 851	0.5582
18	1 546	0.3542	1 851	0.3065	18	6 031	0.8486	4 995	1.3012
19	871	0.4212	902	0.3848	19	26 474	0.6160	29 995	0.6401
20	1 183	0.4039	439	0.6312	20+	133 446	0.2525	48 197	0.4514
21	1 783	0.3085	331	0.6233					
22	133	1.0975	349	0.6179					
23+	3 784	0.1813	1 461	0.2101					

Measured males	3 038	745
Measured females	2 071	872
Aged males	334	210
Aged females	282	274
No. of sets/tows	429	130
Meanweighted c.v. (sexes poled)	19.1	25.7

Table A4: Calculated numbers at age, separately by sex, with c.v.s, for ling caught during commercial trawl operations off the west coast of the South Island (WCSI) and in Cook Strait, during June–September 2003. Final line for each sample represents a plus group. Summary statistics for the samples are also presented.

	WCSI				Cook Strait				
Age	Male	c.v.	Female	c.v.	Age	Male	c.v.	Female	c.v.
1	0	–	0	–	1	0	–	0	–
2	55	1.8238	1 019	2.1551	2	29	2.0678	0	–
3	74	1.8053	1 163	1.8271	3	58	1.5065	175	0.9667
4	6 052	0.5616	7 024	0.4328	4	306	0.6638	128	0.7102
5	13 538	0.3793	18 674	0.3257	5	617	0.7131	653	0.4532
6	18 218	0.3115	13 568	0.3271	6	657	0.4308	701	0.3997
7	14 862	0.2843	11 101	0.3159	7	1 622	0.2916	1 679	0.3467
8	25 762	0.2163	7 807	0.3449	8	1 858	0.2456	2 352	0.2324
9	20 230	0.2419	8 914	0.3273	9	2 051	0.2443	3 770	0.2038
10	23 176	0.2098	13 491	0.2615	10	2 603	0.2121	2 906	0.2138
11	20 409	0.2100	21 043	0.2142	11	2 263	0.2563	2 210	0.2688
12	27 492	0.2014	17 637	0.2244	12	1 265	0.3006	1 606	0.2981
13	11 282	0.3170	25 376	0.1723	13	1 098	0.4023	2 008	0.2538
14	9 471	0.3069	14 424	0.2392	14	365	0.6180	505	0.4380
15	6 353	0.4000	8 887	0.3085	15	952	0.4187	512	0.4443
16	2 885	0.5148	6 188	0.3688	16	146	0.9865	65	1.5288
17	2 552	0.6772	4 038	0.4279	17+	751	0.4667	583	0.3969
18	0	0.0000	4 950	0.4483					
19	2 545	0.5700	3 891	0.4147					
20	1 578	0.8888	703	0.7591					
21+	4 113	0.4217	3 560	0.3616					

Measured males	1 191	430
Measured females	1 330	437
Aged males	285	277
Aged females	296	301
No. of tows/samples	347	56
Meanweighted c.v. (sexes poled)	22.8	24.5