



Catch-at-age for hake (*Merluccius australis*) and ling (*Genypterus blacodes*) in the 2011–12 fishing year and from trawl surveys in 2012–13, with a summary of all available data sets

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EXECUTIVE SUMMARY

Horn, P.L.; Sutton, C.P. (2014). Catch-at-age for hake (*Merluccius australis*) and ling (*Genypterus blacodes*) in the 2011–12 fishing year and from trawl surveys in 2012–13, with a summary of all available data sets.

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This report describes catch-at-age distributions for hake (*Merluccius australis*) and ling (*Genypterus blacodes*) estimated from commercial fisheries for these species in the 2011–12 fishing year (using data and otoliths collected at sea by observers), and from trawl surveys of hoki and middle depth species off west coast South Island in August 2012 (TAN1210), in the Sub-Antarctic in December 2012 (TAN1215) and on the Chatham Rise in January 2013 (TAN1301). For each estimated catch at age distribution there was a target coefficient of variation (CV) of 30% (mean weighted CV across all age classes).

For hake, the mean weighted CV targets were met for two of the three commercial fishery samples (WCSI, and Sub-Antarctic) and for the WCSI trawl survey, but not met for the Chatham Rise trawl fishery or the Sub-Antarctic and Chatham Rise trawl surveys. It appears likely that three relatively strong year classes were spawned on the Chatham Rise in 1990, and also 2001, 2002, and 2003.

For ling, the mean weighted CV targets were met for the commercial trawl survey samples from Chatham Rise and the Sub-Antarctic, and all three trawl surveys. The target was almost met for the WCSI trawl fishery. There were insufficient data collected to estimate catch-at-age for the 2012 Cook Strait trawl fishery. Catch-at-age was also produced for one of the two Sub-Antarctic ling longline fisheries in 2011–12 (the non-spawning fishery) and the WCSI line fishery; target CVs were met for both these samples.

In all age distributions for both species where the target CV was not met it was not possible to improve the precision by increasing the sample size as all available data and otoliths had been used in the analyses. It is anticipated that as observer coverage of the deepwater fleet increases, catch-at-age will be available from all fisheries each year. In addition, it would be desirable to ensure that, for all fisheries where catch-at-age is produced, observed trips occur in the areas and months that have been used to produce the time series reported here. The areas and months for each fishery are listed in this document.

This report also provides summaries of all catch-at-age distributions available for hake and ling from the various trawl survey and fisheries series.

1. INTRODUCTION

The work presented here aimed to determine catch-at-age from the main fisheries for hake and ling in the 2011–12 fishing year, and for hake and ling from trawl surveys conducted during 2012–13. Catch-at-age data are a vital input into the stock assessment process as they provide important information on the year class strength of recruited cohorts, and enable calculation of selectivity ogives for the trawl surveys and commercial fisheries for these species. This report describes the resulting catch-at-age distributions for hake and ling; the new data extend existing series of catch-at-age data in all cases. It fulfils the reporting requirements for Objectives 3, 4, and 7 (part) of Project MID201001C “Routine age determination of hoki and middle depth species from commercial fisheries and trawl surveys”, funded by the Ministry for Primary Industries. Those objectives are:

3. To determine the catch-at-age from hake fisheries in HAK 1, 4 and 7 from samples collected at sea by the Observer Programme.
4. To determine the catch-at-age from ling fisheries in LIN 3 & 4, 5 & 6 and 7 from samples collected at sea by the Observer Programme, and from other sources.
7. To determine the age and size structure of hoki, hake, ling and jack mackerel from the trawl surveys.

The report also summarises all historic catch at age data sets for hake and ling from trawl surveys and commercial fisheries, and describes the strata used in the analyses of data from the commercial trawl fisheries. The derivation of the strata was presented by Horn & Sutton (2008), although the Chatham Rise hake strata have been recently modified (Horn & Francis 2010).

2. METHODS

For hake, it was proposed to age the following samples within this project (with the number of aged otoliths in square brackets):

HAK 1 — commercial trawl fishery, Sep 2011–May 2012 [600].
HAK 1 — trawl survey, Dec 2012 (project MDT2010–01) [750].
HAK 4 — trawl survey, Jan 2013 (project HOK2010–02) [700].
HAK 4 — commercial trawl fishery, Oct 2011–April 2012 [500].
HAK 7 — trawl survey, Aug 2012 (project HOK2010–04) [750].

Only 26 hake were sampled by observers on the Chatham Rise (HAK 4), so a catch-at-age distribution was not able to be produced for that trawl fishery.

The following additional commercial fishery catch-at-age distribution for hake was estimated using the age-length key derived previously from the August 2012 west coast South Island trawl survey (HAK 7).

HAK 7 — commercial trawl fishery, Jun–Sep 2012.

For ling, it was proposed to age the following samples within this project (with the number of aged otoliths in square brackets):

LIN 3&4 — trawl survey, Jan 2013 (project HOK2010-02) [640].
LIN 3&4 — commercial longline fishery, Jun–Oct 2012 [580].
LIN 5&6 — trawl survey, Dec 2012 (project MDT2010-01) [640].
LIN 5&6 — commercial longline fishery, spawning, Puysegur, Oct–Dec 2011 [500].
LIN 5&6 — commercial longline fishery, non-spawning, Campbell, Feb–Jul 2012 [500].
LIN 6B — commercial longline fishery, Nov 2011–March 2012 [500].

LIN 7 — commercial trawl fishery, west coast South Island, Jun–Sep 2012 [600].

LIN 7&2 — commercial trawl fishery, Cook Strait, Jun–Sep 2012 [500].

No observer otoliths were available from the ling longline fisheries on the Chatham Rise (LIN 3&4), Puysegur spawning (LIN 5&6), or Bounty Plateau (LIN 6B). Also, only 5 ling otoliths were collected by observers from the winter 2012 Cook Strait trawl fishery (LIN 7&2), so a catch-at-age distribution was not able to be produced for that fishery.

The following additional commercial fishery catch-at-age distributions for ling were estimated using age-length keys derived previously from the December 2011 Sub-Antarctic trawl survey (LIN 5&6) and the January 2012 Chatham Rise trawl survey (LIN 3&4).

LIN 5&6 — commercial trawl fishery, Sep 2011–Apr 2012.

LIN 3&4 — commercial trawl fishery, Oct 2011–May 2012.

A catch-at-age model describing the age structure of each of the commercial fisheries and surveyed areas was developed as in previous years for both species. For each of the samples, otoliths (for each sex separately) from each 1 cm length class were selected in proportion 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 (constituting about 2% of that length frequency) were fully sampled. This provides a sample with a mean weighted CV similar to that from proportional sampling, but smaller than from uniform sampling for the older age classes (A. Dunn, NIWA, pers. comm.). Otoliths were prepared and read using the validated ageing technique for hake (Horn 1997) or ling (Horn 1993). Catch-at-age was calculated by constructing age-length keys separately for each sex and applying them to the scaled length frequency data derived from each fishery or survey separately using software developed specifically for this task by NIWA (Bull & Dunn 2002).

Fishery catch-at-age distributions are scaled to the total estimated catch from each fishery in the time period sampled. For fisheries with multiple strata, length frequency data from each stratum are first scaled to the estimated catch from that stratum, and then the length frequencies from all strata are summed, and the resulting total length frequency is applied to the age-length key. Survey catch-at-age distributions are scaled to total estimated biomass available to the trawl in the survey area.

Observer sampling of the HAK 1 and HAK 4 commercial trawl fisheries have sometimes provided only small numbers of otoliths. Consequently, catch-at-age distributions for these fisheries have been estimated using age-length keys combining commercial fishery and trawl survey age data. For example, the age-length key for the 2008–09 HAK 1 fishery includes otoliths from observer sampling from September 2008 to May 2009 plus age data from the TAN0813 trawl survey in December 2008.

The mean weighted CV targets for hake from trawl surveys have often not been met. To maximise the chances of meeting the target, all hake from the trawl shots used in the survey biomass and scaled length-frequency calculations were measured and had their otoliths collected. Also, any additional hake caught in survey tows not used for biomass calculations (i.e., foul shots, midwater tows, or night tows) were measured, sexed, and had their otoliths removed. These extra fish were aged, and the data incorporated into the age-length key. Consequently, in the data summaries shown below, the number of aged hake from the trawl surveys is often greater than the number of measured fish (i.e., the fish used to calculate the catch-at-length and catch-at-age).

3. RESULTS

3.1 Observer catch at age data from hake trawl fisheries

3.1.1 Chatham Rise

Data from the Chatham Rise has previously been analysed as four separate fisheries (e.g., Horn & Sutton 2009) as shown in Figure 1, and defined as follows:

1. West shallow (longitude $\leq 178.1^\circ$ E, and bottom depth ≤ 530 m).
2. West deep (longitude $\leq 178.1^\circ$ E, and bottom depth > 530 m).
3. East excl. area 404 (longitude $> 178.1^\circ$ E, and excluding Statistical Area 404).
4. Area 404 (178° W \leq longitude $\leq 179.5^\circ$ W, 42° S \leq latitude $\leq 43.75^\circ$ S).

However, following the recent assessment of the Chatham Rise hake stock (Horn & Francis 2010) it was concluded that splitting the data into two fisheries (i.e., west and east) was satisfactory. Consequently, two commercial age frequencies are developed for each year (whenever sufficient data are available) using a single age-length key and two strata separated at longitude 178.1° E. The raw data are still stratified as shown in Figure 1, so each fishery comprises two strata. A single age-length key for each year is considered to be acceptable as Horn & Dunn (2007) showed that mean age at length did not differ between fisheries.

A tow was included in the catch at age analysis if it occurred between 1 October and 30 April, and if at least five hake had been measured from it.

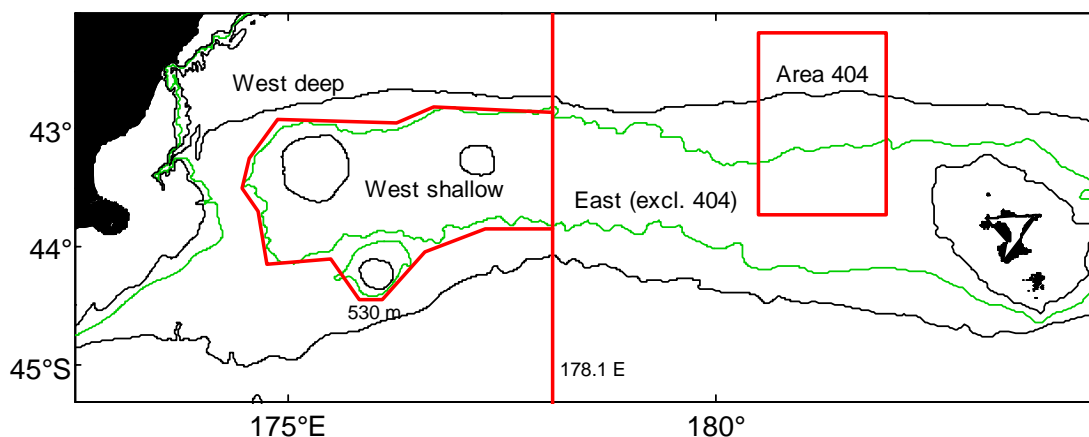


Figure 1: Fishery strata defined for the Chatham Rise hake fishery. The stratum boundary defined by depth (530 m) is shown only approximately. Isobaths at 1000, 500, and 250 m are also shown.

Observer data from each fishery were converted into catch-at-age distributions if there were at least 400 length measurements (west fishery) or 300 length measurements (east fishery). Table 1 summarises the quantities of useful data. In the 2011–12 fishing year, insufficient length data ($n = 26$ fish) and otoliths were available to calculate a catch-at-age distribution for either of the fisheries.

All estimated proportion at age distributions from the two Chatham Rise trawl fisheries are presented in Appendix A (Figures A1 and A2).

Table 1: Numbers of measured (by fishery) and aged (fisheries combined) male (Mal) and female (Fem) hake contributing to samples of proportion at age from the two commercial trawl fisheries on the Chatham Rise. The number of tows sampled by observers and the estimated mean weighted CV (%) by age are also listed.

Fishing year	Measured								Aged	
	West				East				Mal	Fem
	Mal	Fem	Tows	CV	Mal	Fem	Tows	CV		
1991–92	2 112	2 636	163	21.9	170	247	25	43.2	233	230
1992–93									–	–
1993–94	355	452	90	36.7					181	217
1994–95	318	603	69	32.8	234	88	14	43.1	170	191
1995–96	802	917	103	28.2					113	165
1996–97	354	233	28	39.6	335	75	28	48.6	145	149
1997–98	3 161	3 046	390	14.9	224	140	44	41.0	393	393
1998–99	712	1 279	171	19.4					290	440
1999–2000	807	901	168	19.0					442	499
2000–01	830	1 135	185	17.6	1 017	283	47	24.7	317	426
2001–02	386	492	89	20.6					455	419
2002–03	176	272	61	25.4					256	345
2003–04	597	438	101	26.8	378	92	38	26.6	364	304
2004–05	896	437	82	24.2					391	343
2005–06	234	330	69	39.1					189	255
2006–07					409	278	47	27.6	368	388
2007–08	286	270	53	20.6					350	335
2008–09	257	162	43	24.3					237	185
2009–10	147	259	38	25.6					228	244
2010–11	202	249	46	34.3					199	251
2011–12									–	–

3.1.2 Sub-Antarctic

There is one major and three very minor hake fisheries in the Sub-Antarctic area, so a single fishery ogive is considered suitable for this stock. Consequently, a commercial age frequency is developed using a single age-length key and the four fishery strata shown in Figure 2, and defined as follows:

1. Puysegur Bank ($165^{\circ} \text{ E} \leq \text{longitude} \leq 168^{\circ} \text{ E}$, $46^{\circ} \text{ S} \leq \text{latitude} \leq 48^{\circ} \text{ S}$).
2. Snares-Pukaki ($165^{\circ} \text{ E} \leq \text{longitude} \leq 175^{\circ} \text{ E}$, $46^{\circ} \text{ S} \leq \text{latitude} \leq 50.25^{\circ} \text{ S}$, but excluding the Puysegur Bank stratum and the area north of 48° S and east of 171.6°).
3. Auckland Island ($165^{\circ} \text{ E} \leq \text{longitude} \leq 169^{\circ} \text{ E}$, $50.25^{\circ} \text{ S} < \text{latitude} \leq 54^{\circ} \text{ S}$).
4. Campbell Island ($169^{\circ} \text{ E} < \text{longitude} \leq 174^{\circ} \text{ E}$, $50.25^{\circ} \text{ S} < \text{latitude} \leq 54^{\circ} \text{ S}$).

A tow was included in the catch at age analysis if it occurred between 1 September and 31 May, and if at least five hake had been measured from it. The start of the fishing year was not used as the start of the time stratum because a descriptive analysis of this fishery indicated a landings peak from September to February (Devine 2008), so it is logical to include the September catch with landings from the five months immediately following it, rather than with catches taken about seven months previously.

Table 2 summarises the quantities of data used each year to produce the catch at age distributions, and also lists the resulting mean weighted CVs. The details of the estimated catch at age distribution for trawl-caught hake in the 2011–12 fishing year are given in Table 3. The mean weighted CV of 15% was well within the target of 30%.

All estimated proportion at age distributions from the Sub-Antarctic trawl fishery are presented in Appendix A (Figure A3).

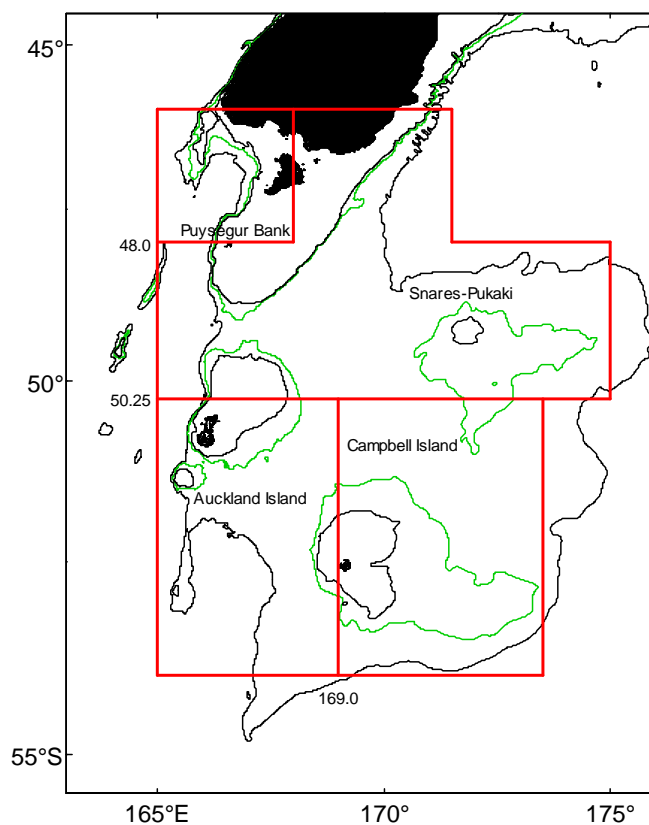


Figure 2: Fishery strata defined for the Sub-Antarctic hake fishery. Numbers show latitudes/longitudes of fishery boundaries. Isobaths at 1000, 500, and 250 m are also shown.

Table 2: Numbers of measured male and female hake, age data used in the age-length key, and tows sampled, and estimated mean weighted CV (%) by age, for the Sub-Antarctic trawl fishery.

Year	Males		Females		Tows	Mean CV
	Measured	Aged	Measured	Aged		
1989–90	269	47	548	71	74	42.0
1990–91	175	–	588	–	64	–
1991–92	557	215	1 363	409	151	24.9
1992–93	833	183	1 218	518	171	27.6
1993–94	512	87	609	173	119	47.8
1994–95	167	–	597	–	92	–
1995–96	289	65	435	110	75	50.0
1996–97	84	–	219	–	54	–
1997–98	390	82	1 018	193	154	37.7
1998–99	463	174	1 077	322	199	27.4
1999–2000	3 007	259	2 526	421	307	22.5
2000–01	527	388	1 648	698	216	29.6
2001–02	921	333	2 026	874	320	23.4
2002–03	271	258	908	739	197	40.4
2003–04	1 309	350	969	518	165	24.7
2004–05	179	185	424	305	82	40.1
2005–06	1 906	218	1 094	506	153	23.2
2006–07	547	224	666	351	73	38.5
2007–08	891	325	592	682	89	23.2
2008–09	1 221	311	893	498	109	23.9
2009–10	1 879	418	1 029	611	91	18.2
2010–11	3 738	296	1 212	282	117	20.2
2011–12	4 098	581	1 597	605	109	15.0

Table 3: Calculated numbers at age, separately by sex, with CVs, for hake sampled by observers during commercial trawl operations in the Sub-Antarctic during September 2011–May 2012. Summary statistics for the samples are also presented.

Age	Male	CV	Female	CV
3	0	0	11	2.325
4	1 416	0.480	362	0.489
5	5 916	0.252	761	0.426
6	9 229	0.201	1 144	0.320
7	27 737	0.130	3 017	0.244
8	46 956	0.099	8 989	0.163
9	39 407	0.112	13 783	0.133
10	18 924	0.161	14 987	0.130
11	11 308	0.213	6 536	0.206
12	11 495	0.208	4 626	0.223
13	12 478	0.210	3 833	0.265
14	11 782	0.199	3 065	0.266
15	10 752	0.216	3 971	0.253
16	8 448	0.277	1 569	0.369
17	7 834	0.255	1 958	0.406
18	7 159	0.294	2 432	0.320
19	4 652	0.347	2 430	0.369
20	2 153	0.520	1 320	0.420
21	1 982	0.544	753	0.548
22	2 061	0.511	292	0.826
23	0	0	0	0
24	1 069	0.738	132	1.231
25	0	0	0	0
26	0	0	0	0
27	0	0	0	0
28	524	1.105	0	0
29	0	0	0	0
30	0	0	0	0
31	524	1.003	0	0
Measured males				4 098
Measured females				1 597
Aged males				581
Aged females				605
No. of tows sampled				109
Mean weighted CV (sexes pooled)				15.0

3.1.3 West coast South Island (WCSI)

The fishery off WCSI was stratified as follows:

1. Deep (bottom depth ≥ 629 m).
2. North shallow (bottom depth < 629 m, latitude $< 42.55^\circ$ S).
3. South shallow (bottom depth < 629 m, latitude $\geq 42.55^\circ$ S).

A tow was included in the catch at age analysis if it occurred between 1 June and 30 September, and if at least five hake had been measured from it.

Table 4 summarises the quantities of data used each year to produce the catch at age distributions, and also lists the resulting mean weighted CVs. The details of the estimated catch at age distribution for trawl-caught hake in the 2011–12 fishing year are given in Table 5. The measured sample size was large, and the mean weighted CV of 14.4% was well within the target of 30%. The age-length key used to derive the 2011–12 fishery age distribution included all the age data obtained from the

research survey in July–August 2012, plus 85 additional otoliths from generally large fish taken by the commercial fishery. The additional otoliths were chosen to provide age data for hake length classes that did not occur in the survey samples, or were under-represented relative to their abundance in the trawl fishery sample.

All estimated proportion at age distributions from the WCSI trawl fishery are presented in Appendix A (Figure A4). The three year classes that showed up relatively strongly as 2-year-olds in catches from 2005, 2006, and 2007 appear to comprise a high proportion of the catch from 2010 to 2012, particularly for females.

Table 4: Numbers of measured male and female hake, age data used in the age-length key, and tows sampled, and estimated mean weighted CV (%) by age, for the WCSI trawl fishery.

Year	Males		Females		Tows	Mean CV
	Measured	Aged	Measured	Aged		
1989–90	578	210	567	261	57	23.1
1990–91	2 288	286	1 653	358	146	18.4
1991–92	2 592	196	1 193	261	121	22.5
1992–93	2 129	188	979	163	93	29.1
1993–94	1 598	151	1 643	272	174	32.5
1994–95	2 528	271	2 769	342	152	29.2
1995–96	2 862	287	1 753	326	193	28.9
1996–97	3 286	262	1 720	198	234	21.3
1997–98	2 339	257	1 497	253	237	21.4
1998–99	4 186	270	3 744	240	307	18.3
1999–2000	2 705	258	2 330	269	285	18.9
2000–01	1 529	176	1 723	280	192	23.9
2001–02	2 281	93	2 434	385	380	33.8
2002–03	1 917	227	2 063	234	296	20.0
2003–04	2 702	303	2 181	193	353	16.5
2004–05	2 305	238	2 324	280	217	23.8
2005–06	5 502	276	4 231	298	395	16.3
2006–07	3 385	248	3 258	257	132	16.7
2007–08	4 682	321	2 416	266	147	17.7
2008–09	5 773	301	3 610	301	178	18.8
2009–10	2 454	130	1 877	134	76	25.4
2010–11	2 489	260	2 489	353	104	16.8
2011–12	2 535	357	2 061	381	140	14.4

Table 5: Calculated numbers at age, separately by sex, with CVs, for hake sampled by observers during commercial trawl operations off the WCSI during June–September 2012. Summary statistics for the samples are also presented.

Age	Male	CV	Female	CV
2	250	1.977	448	1.222
3	198	1.417	791	0.698
4	10 063	0.347	1 160	0.568
5	110 199	0.119	14 043	0.253
6	146 010	0.117	59 534	0.133
7	112 797	0.135	68 189	0.127
8	51 297	0.185	71 885	0.119
9	34 815	0.244	44 199	0.156
10	26 381	0.287	28 775	0.201
11	13 868	0.361	14 779	0.267
12	16 338	0.330	10 684	0.328
13	16 268	0.333	7 228	0.376
14	24 563	0.238	4 000	0.520
15	15 619	0.349	4 798	0.477
16	13 252	0.381	6 551	0.429
17	13 821	0.341	3 686	0.542
18	7 950	0.505	595	1.087
19	4 281	0.623	1 391	1.173
20	4 139	0.769	988	1.027
23	0	0	40	2.130
Measured males				2 535
Measured females				2 061
Aged males				357
Aged females				381
No. of tows sampled				140
Mean weighted CV (sexes pooled)				14.4

3.2 Trawl survey catch at age data for hake

3.2.1 Chatham Rise

Trawl survey catch at age distributions are estimates of the numbers of hake, by sex and age, available to the trawl in the survey area between 200 and 800 m. In some years an additional deeper stratum (800–1000 m) on the north Rise is surveyed. However, to ensure comparability, the distributions presented here are for the ‘core’ strata only, i.e., 200–800 m.

Table 6 summarises the quantities of data used each year to produce the catch at age distributions, and also lists the resulting mean weighted CVs. The details of the estimated catch at age distribution for hake caught in the January 2013 trawl survey are given in Table 7. The mean weighted CV of 48.4% did not meet the target of 30%. However, this value cannot be improved as all available length data and otoliths were used in the analysis. The 30% target has been met in only one of the 20 surveys (TAN9106, see Table 6).

All estimated proportion at age distributions from the Chatham Rise trawl surveys are presented in Appendix A (Figure A5). It appears likely that a strong year class was produced in 2002 (i.e., spawned at the start of the 2001–02 fishing year, and aged 2 in January 2004), and that it was followed by two further relatively strong year classes in 2003 and 2004. The progression of these year classes is apparent in the survey size distributions since TAN0401. A relatively strong year class spawned at the start of the 1990–91 fishing year (age 3 in January 1994) is also apparent.

Table 6: Numbers of measured male and female hake, age data used in the age-length key, and tows sampled, and estimated mean weighted CV (%) by age, for the Chatham Rise resource surveys.

Source	Males		Females		Tows	Mean CV
	Measured	Aged	Measured	Aged		
AEX8903	220	154	212	179	63	39.5
TAN9106	322	233	305	230	122	30.0
TAN9212	243	200	275	225	121	32.7
TAN9401	293	181	355	217	123	33.1
TAN9501	201	170	229	191	87	38.7
TAN9601	149	113	200	165	56	36.4
TAN9701	149	145	159	149	77	36.1
TAN9801	137	135	142	139	55	39.0
TAN9901	94	103	142	157	62	44.1
TAN0001	177	177	178	177	72	35.9
TAN0101	104	112	148	150	66	37.3
TAN0201	104	177	121	172	61	36.4
TAN0301	33	34	69	71	46	61.4
TAN0401	94	82	110	105	53	49.4
TAN0501	115	134	107	113	55	45.3
TAN0601	109	123	126	138	56	33.8
TAN0701	133	158	136	142	61	32.6
TAN0801	55	65	87	99	60	38.0
TAN0901	259	238	201	191	70	32.5
TAN1001	122	142	97	107	56	39.7
TAN1101	49	74	63	65	45	44.5
TAN1201	48	78	83	98	54	49.5
TAN1301	51	73	109	112	47	48.4

Table 7: Calculated numbers at age in the survey area, separately by sex, with CVs, for hake caught during a trawl survey of the Chatham Rise in January 2013 (survey TAN1301). Summary statistics for the samples are also presented.

Age	Male	CV	Female	CV
2	6 690	0.987	3 670	0.950
3	1 614	1.442	3 331	1.155
4	15 182	0.578	19 614	0.494
5	15 545	0.484	5 430	0.774
6	11 174	0.572	23 008	0.366
7	3 416	1.059	7 939	0.814
8	9 124	0.658	14 540	0.447
9	7 458	0.688	21 091	0.542
10	7 663	0.691	20 434	0.442
11	4 592	0.963	16 816	0.444
12	1 926	1.556	11 113	0.526
13	0	–	16 667	0.432
14	0	–	9 469	0.780
15	0	–	1 423	1.647
16	454	1.831	8 591	0.614
17	2 851	1.082	9 164	0.671
18	0	–	6 630	0.727
19	557	1.279	0	–
20	0	–	2 801	1.376
23	0	–	3 056	1.133
Measured males			51	
Measured females			109	
Aged males			73	
Aged females			112	
No. of tows sampled			47	
Mean weighted CV (sexes pooled)			48.4	

3.2.2 Sub-Antarctic

Trawl survey catch at age distributions are estimates of the numbers of hake, by sex and age, available to the trawl in the survey. The main survey series has been conducted in summer. Those surveys have sampled depths from 300 to 800 m, plus an 800–1000 m stratum at Puysegur, and, in some years, other 800–1000 m strata off the Campbell Plateau. However, to ensure comparability, the distributions presented here are for the core 300–800 m strata plus the deep Puysegur stratum only. The catch at age distributions from the spring and autumn surveys are derived from the core 300–800 m strata only.

Table 8 summarises the quantities of data used each year to produce the catch at age distributions, and also lists the resulting mean weighted CVs. The details of the estimated catch at age distribution for hake caught in the November–December 2012 trawl survey are given in Table 9. The mean weighted CV of 39% did not meet the target of 30%. However, this value cannot be improved as all available length data and otoliths were used in the analysis. The 30% target has never been met in any of the Sub-Antarctic surveys (see Table 8).

All estimated proportion at age distributions from the Sub-Antarctic trawl surveys are presented in Appendix A; Figure A6 shows the summer survey distributions and Figure A7 shows the spring and autumn survey distributions.

Table 8: Numbers of measured male and female hake, age data used in the age-length key, and tows sampled, and estimated mean weighted CV (%) by age for the Sub-Antarctic resource surveys.

Survey	Males		Females		Tows	Mean CV
	Measured	Aged	Measured	Aged		
Summer surveys						
AEX8902	45	43	76	66	34	52.7
TAN9105	337	117	332	217	61	65.1
TAN9211	14	46	133	168	48	48.6
TAN9310	57	93	181	182	59	47.2
TAN0012	348	239	392	352	56	37.3
TAN0118	219	212	351	349	44	35.6
TAN0219	331	191	490	377	38	36.1
TAN0317	126	186	175	220	30	41.0
TAN0414	178	245	225	283	39	42.8
TAN0515	88	146	265	274	39	39.9
TAN0617	188	190	487	460	39	33.6
TAN0714	166	217	352	423	47	35.4
TAN0813	289	188	808	412	39	30.9
TAN0911	152	164	382	436	37	36.3
TAN1117	405	238	423	357	37	37.3
TAN1215	155	222	359	537	36	39.1
Autumn surveys						
TAN9204	60	58	113	107	48	46.8
TAN9304	36	36	124	122	54	49.5
TAN9605	32	86	93	137	45	61.9
TAN9805	49	94	146	189	31	52.0
Spring surveys						
TAN9209	76	68	141	113	44	43.8

Table 9: Calculated numbers at age in the survey area, separately by sex, with CVs, for hake caught during a trawl survey of the Sub-Antarctic in November–December 2012 (survey TAN1215). Summary statistics for the samples are also presented.

Age	Male	CV	Female	CV
3	8 165	0.517	11 839	0.509
4	33 531	0.414	92 230	0.454
5	30 630	0.355	72 195	0.430
6	10 342	0.440	47 256	0.325
7	11 668	0.382	37 700	0.344
8	7 324	0.634	37 436	0.320
9	8 956	0.577	29 051	0.344
10	7 926	0.517	29 914	0.384
11	3 138	0.768	21 777	0.358
12	1 407	0.994	8 973	0.491
13	834	1.329	9 351	0.562
14	0	–	11 686	0.523
15	3 979	0.656	6 019	0.581
16	564	1.879	2 489	0.685
17	0	–	2 430	0.866
18	1 691	0.878	8 651	0.818
19	3 409	0.742	2 063	1.045
20	1 635	0.906	5 785	0.729
21	747	1.740	687	1.308
22	0	–	0	–
23	875	1.332	974	1.774
24	906	1.451	0	–
25	0	–	487	1.220
Measured males				155
Measured females				359
Aged males				222
Aged females				537
No. of tows sampled				36
Mean weighted CV (sexes pooled)				39.1

3.2.3 West coast South Island

Trawl survey catch at age distributions are estimates of the numbers of hake, by sex and age, available to the trawl in the survey. A combined trawl and acoustic survey by *Tangaroa* in 2000 (O’Driscoll et al. 2004) was replicated (with some modifications) in winter 2012 (O’Driscoll et al. 2014), so a two survey comparable time series is available. The biomass estimates from the two surveys were standardised using random day-time bottom trawl stations in strata 1&2A, B, and C, and 4A, B, and C (depth 300–650 m), with stratum areas from the 2012 survey (O’Driscoll et al. 2014).

Table 10 summarises the quantities of data used each year to produce the catch at age distributions, and also lists the resulting mean weighted CVs. Because no otoliths from the 2000 survey were aged, the scaled length-frequency distribution from that survey was applied to the WCSI commercial fishery age-length key for 2000. The age-length key for the 2012 survey was derived using otoliths collected during the survey. The details of the estimated catch at age distributions for hake caught in both the 2000 and 2012 trawl surveys are given in Table 11. The mean weighted CVs of 26% met the target of 30%.

All estimated proportion at age distributions from the WCSI trawl surveys are presented in Appendix A (Figure A8).

Table 10: Numbers of measured male and female hake, age data used in the age-length key, and tows sampled, and estimated mean weighted CV (%) by age for the west coast South Island resource surveys.

Survey	Males		Females		Tows	Mean CV
	Measured	Aged	Measured	Aged		
TAN0007	331	230	407	255	36	26.4
TAN1210	211	330	228	332	36	26.6

Table 11: Calculated numbers at age in the survey area, separately by sex, with CVs, for hake caught during trawl surveys of the west coast South Island in August 2000 (TAN0007) and August 2012 (survey TAN1210). Summary statistics for the samples are also presented.

Age	TAN0007				TAN1210				
	Male	CV	Female	CV	Age	Male	CV	Female	CV
1	1 124	1.400	188	1.779	1	0	–	860	1.523
2	0	–	674	0.728	2	2 383	0.947	355	1.599
3	309	1.095	1 329	0.708	3	2 120	0.873	2 289	0.616
4	796	0.859	606	1.154	4	2 128	0.638	2 796	0.610
5	829	0.888	586	1.067	5	9 211	0.232	3 683	0.513
6	2 500	0.473	1 954	0.580	6	15 293	0.193	9 762	0.236
7	9 866	0.291	6 543	0.330	7	11 854	0.229	12 782	0.224
8	13 970	0.242	17 167	0.230	8	4 931	0.304	15 532	0.197
9	12 492	0.261	22 636	0.197	9	2 784	0.376	9 894	0.239
10	16 335	0.262	13 424	0.263	10	2 705	0.388	6 469	0.273
11	8 891	0.303	12 638	0.267	11	972	0.511	3 088	0.392
12	2 885	0.478	9 164	0.285	12	1 458	0.468	2 309	0.351
13	2 471	0.452	8 276	0.314	13	1 215	0.632	2 149	0.567
14	678	0.729	3 751	0.456	14	2 259	0.401	1 034	0.773
15	1 426	0.574	2 699	0.513	15	1 409	0.562	1 369	0.794
16	1 030	0.722	1 140	0.850	16	1 263	0.581	1 592	0.501
17	594	0.983	1 326	0.667	17	1 364	0.488	718	0.760
18	280	1.113	588	0.845	18	472	0.702	210	1.121
19	648	0.896	256	1.171	19	473	0.890	0	–
20	943	0.863	763	0.715	20	378	1.121	467	1.150
21	20	1.926	0	–	21	0	–	0	–
22	20	1.991	0	–	22	0	–	0	–
23	131	1.673	0	–	23	0	–	232	1.743
24	212	1.150	0	–					
28	20	1.964	0	–					
Measured males				331					211
Measured females				407					228
Aged males				230					330
Aged females				255					332
No. of tows sampled				36					36
Mean weighted CV (sexes pooled)				26.4					26.6

3.3 Observer catch at age data from ling longline fisheries

3.3.1 Chatham Rise

The line fishery data from the Chatham Rise are analysed using a single area stratum (i.e., FMAs 3 and 4 between 42° and 46° S), and a time stratum of 1 June to 31 October.

Table 12 summarises the quantities of data used each year to produce the catch at age distributions, and also lists the resulting mean weighted CVs. There were no data collected from the Chatham Rise ling longline fishery in 2012 or in the two previous years.

Table 12: Numbers of measured male and female ling, age data used in the age-length key, and sets sampled, and estimated mean weighted CV (%) by age, for the Chatham Rise longline fishery.

Year	Males		Females		Sets	Mean CV
	Measured	Aged	Measured	Aged		
2002	4 966	284	2 998	309	538	20.4
2003	3 038	337	2 071	289	429	19.1
2004	1 066	302	747	293	139	21.8
2005	889	356	479	234	137	21.6
2006	266	95	294	141	48	36.6
2007	351	174	268	139	62	31.1
2008	574	216	570	262	84	25.9
2009	619	283	798	413	147	21.5

All estimated proportion at age distributions from the Chatham Rise longline fishery are presented in Appendix B (Figure B1).

3.3.2 Sub-Antarctic

The line fishery data from the Sub-Antarctic stock are analysed as two separate fisheries, one spawning and one non-spawning. The spawning fishery was defined as a single stratum comprising the Puysegur Bank and Solander Corridor (i.e., Statistical Area 030), with a time stratum of 1 October to 31 December. The non-spawning fishery was defined as a single stratum comprising all of FMAs 5 and 6, excluding Statistical Area 030 and the Bounty Plateau, with a time stratum of 1 February to 31 July. Ling on the Bounty Plateau are analysed separately from Sub-Antarctic ling because they are believed to comprise a distinct biological stock (Horn 2005).

Table 13 summarises the quantities of data used each year to produce the catch at age distributions for the two Sub-Antarctic longline fisheries, and also lists the resulting mean weighted CVs. The details of the estimated catch at age distribution for non-spawning Sub-Antarctic line-caught ling in the 2011–12 fishing year are given in Table 14. The sample size was relatively small, but the mean weighted CV of 23.7% was below the target value of 30%. There was no observer sampling of spawning Sub-Antarctic line-caught ling in the 2011–12 fishing year.

All estimated proportion at age distributions from the spawning and non-spawning Sub-Antarctic longline fisheries are presented in Appendix B (Figures B2 and B3).

Table 13: Numbers of measured male and female ling, age data used in the age-length key, and sets sampled, and estimated mean weighted CV (%) by age, for the Sub-Antarctic spawning and non-spawning longline fisheries.

Fishery and year	Males		Females		Sets	Mean CV
	Measured	Aged	Measured	Aged		
Spawning line fishery						
2000	4 044	242	4 231	278	83	20.6
2001	2 084	131	1 962	143	55	28.7
2002	670	197	898	284	157	22.6
2003	1 250	211	1 687	307	214	20.0
2004	887	208	1 129	289	168	22.5
2005	193	88	362	179	54	28.6
2006	233	108	707	345	94	23.3
2007	412	191	418	217	82	25.1
2008	227	68	198	62	24	44.3
2010	89	51	361	177	45	34.0
Non-spawning line fishery						
1998	608	73	2 763	395	34	23.1
1999	3 316	214	7 535	428	136	18.3
2001	674	103	2 040	235	58	25.3
2003	304	128	611	273	43	29.3
2005	413	114	716	307	113	25.9
2009	165	61	454	196	49	28.0
2010	151	78	424	214	49	29.0
2011	180	60	823	267	64	27.3
2012	316	109	979	320	91	23.7

Table 14: Calculated numbers at age, separately by sex, with CVs, for ling sampled by observers during commercial longline operations in the Sub-Antarctic non-spawning fishery (LIN 5&6) in February–July 2012. Summary statistics for the samples are also presented.

Age	Male	CV	Female	CV
4	39	1.672	169	1.306
5	259	0.842	570	0.701
6	1 809	0.422	1 109	0.446
7	1 987	0.382	3 402	0.277
8	1 526	0.385	3 134	0.273
9	987	0.605	4 610	0.233
10	2 239	0.386	4 449	0.232
11	388	0.641	5 656	0.206
12	861	0.592	9 286	0.162
13	1 236	0.393	3 925	0.250
14	1 345	0.413	5 778	0.219
15	1 323	0.369	8 432	0.190
16	1 117	0.515	4 645	0.202
17	619	0.578	3 222	0.271
18	1 631	0.401	3 340	0.285
19	1 197	0.512	1 890	0.374
20	469	0.814	427	0.603
21	461	0.733	221	0.770
22	341	0.887	411	0.868
23	186	1.044	888	0.670
24	382	0.677	696	0.591
Measured males			316	
Measured females			979	
Aged males			109	
Aged females			320	
No. of sets sampled			91	
Mean weighted CV (sexes pooled)			23.7	

3.3.3 West coast South Island

The line fishery data from west coast South Island are analysed using a single area stratum and a time stratum of 1 May to 31 August.

Table 15 summarises the quantities of data used each year to produce the catch at age distributions, and also lists the resulting mean weighted CVs. Note that the 2003, 2006 and 2007 age-length keys were developed using age data from the trawl fisheries in the same years, as no otoliths were sampled from line trips. The 2012 age-length key was developed using 129 otoliths sampled from a longline trip, plus additional age data from the July 2012 research trawl survey off WCSI. The details of the estimated catch at age distribution for WCSI line-caught ling in the 2011–12 fishing year are given in Table 16. The sample size was relatively small, but the mean weighted CV of 29.3% was below the target value of 30%. All estimated proportion at age distributions from the WCSI longline fishery are presented in Appendix B (Figure B4).

Table 15: Numbers of measured male and female ling, age data used in the age-length key, and sets sampled, and estimated mean weighted CV (%) by age, for the west coast South Island longline fishery.

Year	Males		Females		Sets	Mean CV
	Measured	Aged	Measured	Aged		
2003	123	215	148	246	24	37.9
2006	104	191	301	329	24	35.0
2007	109	119	192	169	28	42.2
2012	190	246	379	311	31	29.3

Table 16: Calculated numbers at age, separately by sex, with CVs, for ling sampled by observers during commercial longline operations off west coast South Island (LIN 7) in May–August 2012. Summary statistics for the samples are also presented.

Age	Male	CV	Female	CV
7	573	0.760	117	1.455
8	1 794	0.464	807	0.631
9	3 568	0.373	690	0.624
10	2 871	0.331	3 384	0.351
11	3 590	0.315	4 329	0.292
12	2 490	0.367	6 049	0.296
13	3 158	0.368	4 654	0.295
14	3 046	0.323	5 301	0.306
15	3 015	0.370	4 926	0.337
16	2 006	0.463	8 197	0.267
17	1 078	0.602	4 983	0.315
18	1 009	0.564	6 570	0.294
19	1 141	0.660	7 601	0.274
20	450	0.841	4 958	0.319
21	595	0.692	5 343	0.325
22	723	0.821	2 545	0.459
23	425	1.084	864	0.756
24	1 154	0.572	3 744	0.443
Measured males			190	
Measured females			379	
Aged males			246	
Aged females			311	
No. of sets sampled			31	
Mean weighted CV (sexes pooled)			29.3	

3.3.4 Cook Strait

The line fishery data from Cook Strait are analysed using a single area stratum (i.e., those parts of FMAs 2, 7, and 8 between 41° and 42° S and 174° and 175.4° E, equating approximately to Statistical Areas 016 and 017), and a time stratum of 1 June to 30 September.

Table 17 summarises the quantities of data used each year to produce the catch at age distributions, and also lists the resulting mean weighted CVs. Note that the 2001 age-length key used 57 otoliths collected from the line fishery (i.e., all that had been collected), plus 316 otoliths collected from the trawl fishery in the same area and year. There was no observer sampling of Cook Strait line-caught ling in the 2011–12 fishing year. All estimated proportion at age distributions from the Cook Strait longline fishery are presented in Appendix B (Figure B5).

Table 17: Numbers of measured male and female ling, age data used in the age-length key, and sets sampled, and estimated mean weighted CV (%) by age, for the Cook Strait longline fishery.

Year	Males		Females		Sets	Mean CV
	Measured	Aged	Measured	Aged		
2001	315	179	356	194	17	29.8
2003	165	164	145	142	31	33.1
2006	607	319	538	275	116	19.3
2007	238	125	180	92	43	33.8

3.3.5 Bounty Plateau

The line fishery data from the Bounty Plateau are analysed using a single area stratum (i.e., that part of FMA 6 east of 176° E), and a time stratum of 1 November to 31 March.

Table 18 summarises the quantities of data used each year to produce the catch at age distributions, and also lists the resulting mean weighted CVs. There were no data collected from the Bounty Plateau ling longline fishery in the 2011–12 fishing year. All estimated proportion at age distributions from the Bounty Plateau longline fishery are presented in Appendix B (Figure B6).

Table 18: Numbers of measured male and female ling, age data used in the age-length key, and sets sampled, and estimated mean weighted CV (%) by age, for the Bounty Plateau longline fishery.

Year	Males		Females		Sets	Mean CV
	Measured	Aged	Measured	Aged		
1992–93	201	52	237	69	24	50.4
1999–2000	1 102	106	2 184	185	41	26.9
2000–01	405	50	713	66	20	43.6
2003–04	1 155	200	1 628	300	272	20.0
2007–08	308	156	562	271	86	25.3
2008–09	262	116	213	88	42	37.3

3.4 Observer catch at age data from ling trawl fisheries

3.4.1 Chatham Rise

Trawl fishery data from the Chatham Rise were used if they were collected between 1 October and 31 May in each fishing year, and were stratified using the following four strata:

1. Coast (longitude $\leq 174^\circ$ E, target not scampi).
2. Scampi (all tows targeting scampi).
3. North Rise (latitude $< 43.55^\circ$ S, longitude $> 174^\circ$ E, target not scampi).
4. South Rise (latitude $\geq 43.55^\circ$ S, longitude $> 174^\circ$ E, target not scampi).

Scampi target tows comprise a separate stratum because the gear used in this fishery usually retains ling of a smaller average size than the trawls used to target teleosts.

Table 19 summarises the quantities of data used each year to produce the catch at age distributions, and also lists the resulting mean weighted CVs. The details of the estimated catch at age distribution for trawl-caught ling in the 2011–12 fishing year are given in Table 20. The mean weighted CV of 26% was within the target value of 30%.

All estimated proportion at age distributions from the Chatham Rise trawl fishery are presented in Appendix B (Figure B7).

Table 19: Numbers of measured male and female ling, age data used in the age-length key, and tows sampled, and estimated mean weighted CV (%) by age, for the Chatham Rise trawl fishery.

Source	Males		Females		Tows	Mean CV
	Measured	Aged	Measured	Aged		
1991–92	2 151	252	2 653	281	143	27.0
1993–94	1 127	302	768	302	126	32.9
1994–95	359	236	302	201	59	45.1
1995–96	453	306	399	284	87	30.0
1996–97	162	317	240	242	31	41.1
1997–98	3 463	348	3 117	280	497	18.7
1998–99	3 306	336	2 469	318	312	20.0
1999–2000	887	322	1 013	326	161	24.8
2000–01	1 000	312	988	341	188	21.0
2001–02	642	294	708	334	129	23.8
2002–03	694	317	764	347	114	24.3
2003–04	356	303	600	302	99	30.1
2004–05	869	310	666	326	194	27.9
2005–06	251	328	291	330	54	34.5
2006–07	699	310	687	330	135	22.9
2007–08	2 755	317	2 070	325	276	20.9
2008–09	1 034	323	1 120	298	141	32.4
2009–10	526	318	571	309	87	28.9
2010–11	492	308	521	293	74	27.3
2011–12	739	257	767	297	82	26.4

Table 20: Calculated numbers at age, separately by sex, with CVs, for ling sampled by observers during commercial trawl operations on the Chatham Rise during October 2011–May 2012. Summary statistics for the samples are also presented.

Age	Male	CV	Female	CV
3	1 635	0.750	1 954	0.917
4	8 867	0.374	5 837	0.440
5	10 426	0.334	18 294	0.228
6	18 762	0.243	17 138	0.279
7	14 231	0.248	16 179	0.253
8	6 540	0.319	16 157	0.256
9	7 232	0.297	7 692	0.357
10	5 170	0.307	9 910	0.295
11	4 430	0.330	6 104	0.408
12	4 325	0.381	10 010	0.314
13	1 040	0.710	8 019	0.343
14	1 876	0.468	7 340	0.410
15	3 597	0.441	4 344	0.559
16	1 904	0.531	1 151	0.795
17	1 753	0.548	4 204	0.546
18	2 302	0.496	3 079	0.609
19	533	0.754	298	1.092
20	731	0.699	845	0.993
21	67	1.553	70	1.541
22	462	0.961	222	1.317
23	203	1.096	518	1.276
24	590	1.380	0	–
25	0	–	0	–
26	0	–	0	–
27	0	–	65	1.738
28	291	1.452	0	–
29	0	–	0	–
30	0	–	0	–
31	161	1.711	0	–
32	18	2.124	0	–
33	0	5.394	0	–
34	0	–	0	–
35	0	–	0	–
36	0	–	0	–
37	0	–	0	–
38	175	1.927	0	–
Measured males				739
Measured females				767
Aged males				257
Aged females				297
No. of tows sampled				82
Mean weighted CV (sexes pooled)				26.4

3.4.2 Sub-Antarctic

Trawl fishery data from the Sub-Antarctic were used if they were collected between 1 September and 30 April in each fishing year, and were stratified using the following three strata:

1. Scampi (all tows targeting scampi).
2. Shallow (bottom depth \leq 450 m, and target not scampi).
3. Deep (bottom depth $>$ 450 m, and target not scampi).

Table 21 summarises the quantities of data used each year to produce the catch at age distributions, and also lists the resulting mean weighted CVs. The details of the estimated catch at age distribution for trawl-caught ling in the 2011–12 fishing year are given in Table 22. The mean weighted CV of 22% was below the target value of 30%.

All estimated proportion at age distributions from the Sub-Antarctic trawl fishery are presented in Appendix B (Figure B8).

Table 21: Numbers of measured male and female ling, age data used in the age-length key, and tows sampled, and estimated mean weighted CV (%) by age, for the Sub-Antarctic trawl fishery.

Source	Males		Females		Tows	Mean CV
	Measured	Aged	Measured	Aged		
1991–92	1 466	437	1 652	667	141	22.0
1992–93	1 337	235	1 615	363	164	28.3
1993–94	686	256	1 059	357	129	29.2
1995–96	881	366	779	297	83	24.5
1997–98	1 408	274	1 717	302	218	29.0
2000–01	2 192	247	1 947	351	267	28.1
2001–02	1 887	264	2 579	327	424	24.8
2002–03	1 164	434	1 828	625	263	20.9
2003–04	853	246	1 397	337	202	22.9
2004–05	2 324	254	2 415	339	218	21.5
2005–06	2 739	288	2 618	305	252	20.4
2006–07	1 644	225	1 446	382	191	24.3
2007–08	4 104	229	3 258	353	183	23.3
2008–09	2 877	245	3 803	324	184	19.4
2009–10	2 899	226	3 266	336	121	21.7
2010–11	2 212	236	2 630	279	215	21.4
2011–12	2 826	260	2 398	316	131	21.9

Table 22: Calculated numbers at age, separately by sex, with CVs, for ling sampled by observers during commercial trawl operations in the Sub-Antarctic during September 2011–April 2012. Summary statistics for the samples are also presented.

Age	Male	CV	Female	CV
3	1 107	1.575	1 139	1.317
4	6 140	0.650	5 565	0.653
5	19 433	0.421	15 281	0.528
6	136 638	0.175	66 500	0.247
7	116 245	0.207	75 904	0.222
8	81 094	0.246	96 455	0.190
9	47 577	0.337	60 372	0.248
10	43 334	0.339	37 601	0.328
11	57 439	0.311	42 723	0.272
12	57 024	0.291	26 904	0.376
13	21 053	0.412	39 888	0.286
14	24 325	0.441	33 496	0.296
15	45 252	0.375	39 102	0.244
16	52 321	0.291	13 570	0.442
17	43 822	0.326	10 701	0.504
18	10 295	0.644	6 706	0.437
19	10 306	0.564	1 718	0.887
20	1 125	1.173	1 386	0.765
21	0	–	1 448	0.787
22	0	–	2 667	0.586
23	4 877	1.126	2 313	0.855
24	1 729	0.853	470	1.505
25	0	–	0	–
26	1 711	1.042	0	–
27	1 662	0.977	0	–
28	961	1.352	621	1.532
29	0	–	0	–
30	0	–	484	1.193
31	0	–	0	–
32	1 300	1.182	0	–
Measured males				2 826
Measured females				2 398
Aged males				260
Aged females				316
No. of tows sampled				131
Mean weighted CV (sexes pooled)				21.9

3.4.3 West coast South Island

Trawl fishery data off WCSI were used if they were collected between 1 June and 30 September each year, and were stratified using the following three strata:

1. Deep (bottom depth \geq 498 m).
2. North shallow (bottom depth < 498 m, latitude < 42.42° S).
3. South shallow (bottom depth < 498 m, latitude \geq 42.42° S).

Table 23 summarises the quantities of data used each year to produce the catch at age distributions, and also lists the resulting mean weighted CVs. There were insufficient data (particularly otoliths) collected to estimate the catch at age distribution for trawl-caught ling from 2008–09 to 2010–11. In the 2011–12 fishing year, the trawl fishery age-length key was derived using all the age data from the winter 2012 research trawl survey, plus 87 additional age data points derived from otoliths sampled from the commercial trawl fishery. The additional otoliths were chosen to provide age data for ling length classes that did not occur in the survey samples, or were under-represented relative to their abundance in the trawl fishery sample. The details of the estimated catch at age distribution for trawl-caught ling in the 2011–12 fishing year are given in Table 24. The mean weighted CV of 32% was just higher than the target value of 30%.

All estimated proportion at age distributions from the WCSI trawl fishery are presented in Appendix B (Figure B9).

Table 23: Numbers of measured male and female ling, age data used in the age-length key, and tows sampled, and estimated mean weighted CV (%) by age, for the WCSI trawl fishery.

Year	Males		Females		Tows	Mean CV
	Measured	Aged	Measured	Aged		
1991	563	176	440	220	65	34.8
1994	873	172	1 096	221	141	27.9
1995	1 051	238	794	268	111	24.3
1996	485	247	448	201	83	28.0
1997	1 532	442	901	399	173	19.5
1998	1 063	349	700	279	155	23.6
1999	1 862	285	1 126	263	221	23.7
2000	829	269	783	264	168	26.8
2001	1 106	256	924	307	178	29.6
2002	1 401	283	1 405	321	332	21.4
2003	1 157	293	1 290	302	286	23.3
2004	1 003	243	1 540	352	334	21.4
2005	908	282	899	355	184	24.9
2006	763	276	844	361	154	29.0
2007	228	148	258	158	65	38.7
2008	805	209	824	251	98	24.1
2012	686	321	576	345	83	31.8

Table 24: Calculated numbers at age, separately by sex, with CVs, for ling sampled by observers during commercial trawl operations off WCSI during June–September 2012. Summary statistics for the samples are also presented.

Age	Male	CV	Female	CV
3	838	1.036	551	1.216
4	11 017	0.813	4 524	0.561
5	11 054	0.596	5 066	0.414
6	14 473	0.827	7 326	0.515
7	31 324	0.493	9 926	0.640
8	39 378	0.355	29 881	0.459
9	64 832	0.238	28 618	0.401
10	62 649	0.232	37 239	0.402
11	78 091	0.238	17 785	0.441
12	30 524	0.341	31 121	0.340
13	22 655	0.424	20 236	0.389
14	19 045	0.493	16 931	0.403
15	17 304	0.561	13 196	0.455
16	6 673	0.779	15 187	0.404
17	7 239	0.705	6 715	0.879
18	7 864	0.834	13 421	0.477
19	5 064	0.945	10 820	0.532
20	2 719	1.018	13 171	0.466
21	2 070	0.956	8 285	0.674
22	1 118	0.790	7 778	0.784
23	235	1.019	1 853	1.113
24	596	1.027	8 408	1.398
25	85	2.196	585	0.975
26	703	1.223	0	–
27	0	–	306	2.015
28	24	1.771	0	–
29	0	–	95	2.214
Measured males				686
Measured females				576
Aged males				321
Aged females				345
No. of tows sampled				83
Mean weighted CV (sexes pooled)				31.8

3.4.4 Cook Strait

The trawl fishery in Cook Strait is analysed using a single area stratum (i.e., those parts of FMAs 2, 7, and 8 between 41° and 42° S and 174° and 175.4° E, equating approximately to Statistical Areas 016 and 017), and a time stratum of 1 June to 30 September.

Table 25 summarises the quantities of data used each year to produce the catch at age distributions, and also lists the resulting mean weighted CVs. There were insufficient data collected to estimate the catch at age distribution for trawl-caught ling in 2012 (i.e., 310 length measurements but only 5 otoliths).

All estimated proportion at age distributions from the Cook Strait trawl fishery are presented in Appendix B (Figure B10).

Table 25: Numbers of measured male and female ling, age data used in the age-length key, and tows sampled, and estimated mean weighted CV (%) by age, for the Cook Strait trawl fishery.

Year	Males		Females		Tows	Mean CV
	Measured	Aged	Measured	Aged		
1999	226	75	189	54	59	47.9
2000	197	95	191	93	62	40.9
2001	610	205	550	208	72	24.5
2002	583	219	644	241	58	27.9
2003	430	282	437	308	56	24.2
2004	609	269	645	241	48	27.2
2005	617	272	561	264	75	26.4
2006	729	248	539	226	26	26.4
2007	327	143	300	137	19	42.0
2008	569	280	470	226	44	27.0
2009	241	180	219	164	62	33.4
2010	274	195	250	196	41	36.2

3.5 Trawl survey catch at age data for ling

3.5.1 Chatham Rise

Trawl survey catch at age distributions are estimates of the numbers of ling, by sex and age, available to the trawl in the survey area between 200 and 800 m. In some years an additional deeper stratum (800–1000 m) on the north Rise is surveyed. However, to ensure comparability, the distributions presented here are for the core strata only, i.e., 200–800 m.

Table 26: Numbers of measured male and female ling, age data used in the age-length key, and tows sampled, and estimated mean weighted CV (%) by age, for the Chatham Rise trawl surveys.

Survey	Males		Females		Tows	Mean CV
	Measured	Aged	Measured	Aged		
AEX8903	743	303	613	296	130	26.0
TAN9106	1 208	252	1 189	281	174	22.4
TAN9212	1 229	286	1 108	313	177	21.7
TAN9401	1 541	302	1 349	302	157	21.5
TAN9501	583	236	578	201	114	28.1
TAN9601	556	306	509	284	79	27.7
TAN9701	837	317	601	242	98	24.3
TAN9801	665	348	492	280	88	24.5
TAN9901	1 071	336	848	318	111	23.8
TAN0001	1 080	322	969	326	113	22.0
TAN0101	1 145	312	1 084	341	108	20.5
TAN0201	1 053	294	1 170	334	102	19.7
TAN0301	813	317	808	347	98	20.6
TAN0401	865	303	752	302	101	20.2
TAN0501	845	310	801	326	98	22.5
TAN0601	1 007	328	880	330	90	21.0
TAN0701	733	310	732	330	94	21.0
TAN0801	610	317	623	325	92	22.3
TAN0901	946	338	880	312	103	24.3
TAN1001	608	322	882	339	70	25.0
TAN1101	523	334	508	313	80	30.6
TAN1201	656	273	697	313	93	23.0
TAN1301	646	287	652	324	83	24.9

Table 26 summarises the quantities of data used each year to produce the catch at age distributions, and also lists the resulting mean weighted CVs. The details of the estimated catch at age distribution for ling caught in the January 2013 trawl survey are given in Table 27. The mean weighted CV of 25% was below the target of 30%.

All estimated proportion at age distributions from the Chatham Rise trawl surveys are presented in Appendix B (Figure B11).

Table 27: Calculated numbers at age in the survey area, separately by sex, with CVs, for ling caught during trawl surveys of the Chatham Rise in January 2013 (survey TAN1301). Summary statistics for the samples are also presented.

Age	Male	CV	Female	CV
2	2 283	1.718	1 979	1.639
3	137 544	0.279	89 146	0.291
4	126 667	0.293	179 207	0.217
5	278 281	0.219	246 461	0.218
6	148 423	0.289	105 796	0.304
7	140 224	0.280	118 841	0.268
8	184 360	0.268	161 896	0.252
9	72 949	0.341	130 215	0.237
10	123 087	0.314	42 268	0.400
11	86 046	0.292	83 541	0.284
12	68 397	0.411	46 644	0.411
13	57 805	0.392	38 717	0.437
14	77 791	0.311	49 152	0.350
15	42 754	0.463	41 598	0.440
16	13 721	0.678	48 537	0.396
17	40 738	0.446	37 019	0.476
18	23 424	0.527	32 517	0.416
19	21 383	0.564	31 168	0.464
20	8 046	0.747	4 545	0.836
21	20 593	0.575	11 859	0.724
22	13 818	0.858	11 602	0.635
23	2 034	1.417	3 487	1.053
24	17 616	0.691	4 936	0.743
25	6 411	0.956	8 003	0.769
26	1 215	1.627	7 124	0.993
27	0	–	4 182	1.348
28	4 084	1.187	0	–
29	774	1.629	1 069	1.979
30	0	–	1 772	1.346
31	0	–	0	–
32	774	1.693	0	–
33	0	–	0	–
34	0	–	0	–
35	0	–	0	–
36	0	–	0	–
37	0	–	0	–
38	3 187	1.627	0	–
Measured males				646
Measured females				652
Aged males				287
Aged females				324
No. of tows sampled				83
Mean weighted CV (sexes pooled)				24.9

3.5.2 Sub-Antarctic

Trawl survey catch at age distributions are estimates of the numbers of ling, by sex and age, available to the trawl in the survey. The main survey series has been conducted in summer. Those surveys have sampled depths from 300 to 800 m, plus an 800–1000 m stratum at Puysegur, and, in some years, other 800–1000 m strata off the Campbell Plateau. However, to ensure comparability, the distributions presented here are for the core 300–800 m strata plus the deep Puysegur stratum only. The catch at age distributions from the autumn surveys are derived from the core 300–800 m strata only.

Table 28 summarises the quantities of data used each year to produce the catch at age distributions, and also lists the resulting mean weighted CVs. The details of the estimated catch at age distribution for ling caught in the November–December 2011 trawl survey are given in Table 29. The mean weighted CV of 26% was within the target of 30%, as it has been in all surveys in this series.

All estimated proportion at age distributions from the Sub-Antarctic trawl surveys are presented in Appendix B; Figure B12 shows the summer survey distributions and Figure B13 shows the autumn survey distributions.

Table 28: Numbers of measured male and female ling, age data used in the age-length key, and tows sampled, and estimated mean weighted CV (%) by age, for the Sub-Antarctic trawl surveys.

Survey	Males		Females		Tows	Mean CV
	Measured	Aged	Measured	Aged		
Summer surveys						
AEX8902	760	160	1 067	234	133	28.8
TAN9105	1 563	213	2 079	348	151	19.8
TAN9211	1 249	227	1 668	354	146	20.7
TAN9310	1 520	254	1 894	351	127	22.2
TAN0012	1 761	244	1 696	351	85	19.2
TAN0118	1 316	268	1 290	326	95	19.8
TAN0219	1 661	224	1 606	350	88	20.8
TAN0317	1 270	243	1 156	333	70	22.1
TAN0414	1 433	256	1 146	339	79	26.7
TAN0515	1 095	279	988	300	82	22.4
TAN0617	969	250	1 011	355	80	22.6
TAN0714	1 014	229	1 288	353	79	21.4
TAN0813	1 162	250	994	327	80	26.6
TAN0911	830	232	882	339	70	22.8
TAN1117	1 264	266	1 321	322	80	23.6
TAN1215	1 391	289	1 555	316	80	25.9
Autumn surveys						
TAN9204	1 570	221	1 498	310	90	21.5
TAN9304	1 353	261	1 344	373	97	21.1
TAN9605	1 129	325	902	303	88	21.9
TAN9805	809	271	765	296	64	22.9

Table 29: Calculated numbers at age in the survey area, separately by sex, with CVs, for ling caught during trawl surveys of the Sub-Antarctic in November–December 2012 (survey TAN1215). Summary statistics for the samples are also presented.

Age	Male	CV	Female	CV
2	4 485	1.580	0	–
3	220 107	0.378	178 711	0.443
4	289 404	0.502	379 520	0.316
5	955 070	0.330	1 006 494	0.301
6	1 247 707	0.244	960 558	0.273
7	770 180	0.219	1 078 986	0.244
8	575 667	0.222	1 000 769	0.223
9	396 439	0.246	700 054	0.234
10	330 724	0.282	383 915	0.318
11	198 100	0.334	365 860	0.313
12	138 734	0.428	224 166	0.399
13	96 598	0.490	116 722	0.532
14	94 368	0.478	250 334	0.331
15	32 775	0.720	194 794	0.397
16	67 588	0.546	264 394	0.347
17	82 826	0.486	204 295	0.383
18	49 552	0.641	211 786	0.375
19	51 893	0.699	125 557	0.435
20	41 546	0.578	68 670	0.586
21	28 328	0.612	57 875	0.594
22	14 569	0.833	33 442	0.747
23	30 587	0.819	20 037	0.840
24	26 838	0.722	4 837	1.678
25	0	–	61 573	0.640
26	0	–	3 390	1.431
27	14 024	1.131	1 051	2.070
28	0	–	690	1.766
29	0	–	7 922	1.245
30	0	–	20 432	1.269
31	0	–	0	–
32	0	–	1 285	2.279
Measured males				1 391
Measured females				1 555
Aged males				289
Aged females				316
No. of tows sampled				80
Mean weighted CV (sexes pooled)				25.9

3.5.3 West coast South Island

Trawl survey catch at age distributions are estimates of the numbers of ling, by sex and age, available to the trawl in the survey. A combined trawl and acoustic survey by *Tangaroa* in 2000 (O’Driscoll et al. 2004) was replicated (with some modifications) in winter 2012 (O’Driscoll et al. 2014), so a two year comparable time series is available. The biomass estimates from the two surveys were standardised using random daytime bottom trawl stations in strata 1&2A, B, and C, and 4A, B, and C (depth 300–650 m), with stratum areas from the 2012 survey (O’Driscoll et al. 2014).

Table 30 summarises the quantities of data used each year to produce the catch at age distributions, and also lists the resulting mean weighted CVs. Because no otoliths from the 2000 survey were aged, the scaled length-frequency distribution from that survey was applied to the WCSI commercial fishery age-length key for 2000. The age-length key for the 2012 survey was derived using otoliths collected during the survey. The details of the estimated catch at age distributions for ling caught in both the

2000 and 2012 trawl surveys are given in Table 31. The mean weighted CVs of 30% and 27% both met the target of 30%.

All estimated proportion at age distributions from the west coast South Island trawl surveys are presented in Appendix B (Figure B14).

Table 30: Numbers of measured male and female ling, age data used in the age-length key, and tows sampled, and estimated mean weighted CV (%) by age for the west coast South Island resource surveys.

Survey	Males		Females		Tows	Mean CV
	Measured	Aged	Measured	Aged		
TAN0007	784	284	637	276	45	29.5
TAN1210	962	305	722	308	48	26.7

Table 31: Calculated numbers at age in the survey area, separately by sex, with CVs, for ling caught during trawl surveys of the west coast South Island in August 2000 (TAN0007) and August 2012 (survey TAN1210). Summary statistics for the samples are also presented.

Age	TAN0007				TAN1210				
	Male	CV	Female	CV	Age	Male	CV	Female	CV
2	1 907	0.666	1 797	1.033	2	0	–	0	–
3	5 249	0.386	2 047	1.034	3	8 447	0.519	8 570	0.519
4	5 304	0.420	9 718	0.299	4	9 160	0.357	9 455	0.304
5	8 679	0.334	7 851	0.324	5	9 406	0.336	7 434	0.362
6	5 713	0.403	6 631	0.415	6	5 378	0.454	5 379	0.498
7	7 224	0.429	3 780	0.407	7	15 097	0.254	4 424	0.427
8	25 341	0.288	10 266	0.348	8	17 131	0.268	6 562	0.361
9	11 645	0.379	9 457	0.395	9	25 106	0.228	4 611	0.439
10	44 521	0.265	24 984	0.250	10	25 408	0.227	12 176	0.256
11	17 784	0.336	15 003	0.308	11	25 627	0.249	8 183	0.303
12	15 208	0.387	12 351	0.337	12	13 585	0.280	14 475	0.259
13	17 169	0.313	18 574	0.271	13	11 377	0.345	12 086	0.317
14	3 402	0.625	6 410	0.427	14	9 160	0.375	12 093	0.318
15	4 791	0.451	8 738	0.370	15	9 652	0.320	6 666	0.357
16	2 188	0.637	4 536	0.474	16	5 109	0.503	9 433	0.379
17	2 761	0.673	5 824	0.450	17	3 982	0.509	3 311	0.555
18	1 975	0.838	2 017	0.822	18	6 038	0.380	11 541	0.328
19	1 741	0.838	5 056	0.489	19	5 060	0.448	8 875	0.316
20	0	–	2 148	0.696	20	3 375	0.566	7 033	0.347
21	544	1.157	987	0.714	21	3 096	0.609	5 735	0.420
22	1 765	0.910	2 587	0.724	22	3 822	0.553	4 110	0.449
23	0	–	621	1.088	23	1 655	0.661	1 223	0.716
24	1 196	0.897	1 666	0.690	24	2 503	0.562	2 249	0.684
25	0	–	389	1.336	25	433	1.311	1 609	0.649
26	0	–	452	1.201	26	927	1.139	0	–
27	0	–	311	1.175	27	0	–	1 025	0.711
28	113	1.806	75	2.230	28	797	1.207	0	–
29	355	1.126	0	–	29	0	–	229	1.435
30	0	–	0	–	30	719	1.070	0	–
31	0	–	124	1.862	31	112	1.596	0	–
34	0	2.345	0	–					
35	0	2.299	0	–					
Measured males				784					962
Measured females				637					722
Aged males				284					305
Aged females				276					308
No. of tows sampled				45					48
Mean weighted CV (sexes pooled)				29.5					26.7

4. DISCUSSION

4.1 Hake

For hake, sufficient otoliths and length-frequency data to produce catch at age distributions that met the target mean weighted CVs. were available from the HAK 7 fishery off WCSI, and the HAK 1 fishery in the Sub-Antarctic. The target has almost always been met for samples in the WCSI fishery (see Table 4). The sampling intensity in the HAK 1 (Sub-Antarctic) commercial trawl fishery was very high in 2011–12. Sampling intensity in the Sub-Antarctic has varied considerably between years, with consequent wide variation in the mean weighted CVs (see Table 3). Hake on Chatham Rise are analysed as two separate fisheries (see Table 1), but sampling intensity in 2011–12 was too low to enable estimation of catch at age distribution for either fishery.

The Sub-Antarctic trawl survey in December 2012 caught fewer hake than in each of the previous five surveys in the summer series. Although all available length and otolith data were included in the estimation of catch-at-age, the CV target was not met. However, the target of 30% has never been met in any of the Sub-Antarctic surveys. The Chatham Rise survey in January 2013 produced low numbers of hake (160 measured fish), and consequently the catch-at-age distribution for the trawl survey had a mean weighted CV much higher than the target of 30% (48%). No improvements in the precision can be achieved, however, as all available data were included in the analysis. The target of 30% has been met in only one of the surveys in this series.

On the Chatham Rise, younger hake tend to be concentrated in the west, with the population dominated by fish aged 2–10 years (see Appendix A, Figure A1). Middle-aged and older hake (i.e., 5–15 years old) tend to dominate catches in the eastern Rise (see Figure A2). It has been shown previously that males and females appear to be about evenly abundant in all areas except Statistical Area 404, where males clearly dominate the catch (Horn & Sutton 2009). Some year class progressions are apparent. The year class spawned at the start of the 1990–91 fishing year (age 3 in January 1994) appears relatively strong, and can be tracked in some subsequent distributions through to about 2003. There is a clear year class progression apparent in the Chatham Rise survey distributions from 2004 to 2011 (Figure A5). The 2001 year class (aged 2+ in January 2004) clearly progresses through to age 9+ in 2011, for both males and females. It also appears likely that the two following year classes (2002 and 2003) are moderately strong.

In the Sub-Antarctic, there are some clear year class progressions, particularly in the male distributions. Figure A3 shows the progressions of hake aged 10 in 1990 through to age 16 in 1996, and aged 6 in 1998 through to age 12 in 2004.

The WCSI trawl catch is dominated by hake aged 5–12 years, with no clearly apparent year class progressions (see Figure A4). In some years, large numbers of 1- or 2-year-old fish are taken by the fishery, but these do not always manifest as strong cohorts in later years. However, it does appear that the relatively abundant 2-year-old fish in catches from 2005, 2006, and 2007 have progressed to comprise a high proportion of the catch from 2010 to 2012. A characteristic of most of the WCSI distributions is that numbers of fish aged 3 and 4 are generally very low. It seems likely that fish of this age are much less vulnerable or available to the trawl during the winter months of the fishery than younger or older hake.

4.2 Ling

Catch at age distributions were produced for two commercial longline fisheries in 2011–12 (Sub-Antarctic non-spawning and WCSI), and the target CV was met. Catch at age distributions were scheduled to be produced for the Chatham Rise and Bounty Plateau fisheries, but they were not sampled by observers in 2011–12. The WCSI sample was not scheduled to be prepared; this fishery has seldom been sampled by observers in the past as it is primarily conducted by small vessels completing short trips. The observer coverage of the ling longline fleet may increase in the near future. It would be desirable to ensure that trips

that are observed in the various areas occur during the months chosen for analysis of the particular fisheries (see Section 2).

Catch at age distributions were produced for trawl fisheries catching ling in three areas. The Chatham Rise distribution used observer length data applied to age-length keys obtained from a trawl survey, i.e., Chatham Rise length data collected from October 2011 to May 2012 were applied to the age-length key from the January 2012 (TAN1201) trawl survey of the Chatham Rise. The Sub-Antarctic distribution used observer length data applied to age-length keys obtained from a trawl survey, i.e., Sub-Antarctic length data collected from September 2011 to April 2012 were applied to the age-length key from the December 2011 (TAN1117) trawl survey of the Sub-Antarctic. The estimated catch-at-age distributions had mean weighted CVs well within the target of 30%. Most distributions calculated for both these fisheries in previous years had been within the target. Sampling of ling from the WCSI commercial fishery was relatively light (see Table 23). A catch at age distribution was able to be produced, however, although it had a mean weighted CV just higher than the target of 30%. Sampling of WCSI ling in the three previous years had been inadequate for estimation of the fishery age structure. An estimate of catch-at-age for the ling bycatch from the Cook Strait hoki spawning fisheries was not able to be produced for 2012 as insufficient fish were sampled. Sampling of the Cook Strait fishery was also inadequate in 2011.

Sufficient ling otoliths and length-frequency data were available from trawl surveys of the Sub-Antarctic (December 2012) and Chatham Rise (January 2013) to easily meet the mean weighted CV target. The target had been met in all previous surveys of these areas, except for Chatham Rise in 2011 (see Tables 26 and 28).

The ling longline fisheries catch few fish younger than 7 years, and much of the catch is older than 12 years. Sex ratios of the longline catch are about 1:1 on the Chatham Rise and in Cook Strait, but tend to be biased towards females in the other fisheries. This is particularly apparent in the Sub-Antarctic non-spawning fishery (see Figure B3). No clear year class progressions are apparent in any of the longline series.

Recruitment to the trawl fisheries is generally about two years earlier than to the line fisheries (i.e., at about 5 years), and most of the catch is 13 years or younger. No clear year class progressions are apparent in any of the trawl series. The ling trawl catch at age distributions from the WCSI fishery often exhibit a trough at about age 6 or 7. This is consistent with an inflexion point in the length-frequency distributions at lengths of about 72 cm for males and 77 cm for females (see figure 3 of Horn 2008). It seems likely that fish of this size are less vulnerable or available to the trawl during the winter months of the fishery.

5. ACKNOWLEDGMENTS

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Appendix A: Summaries of the proportions-at-age data for hake

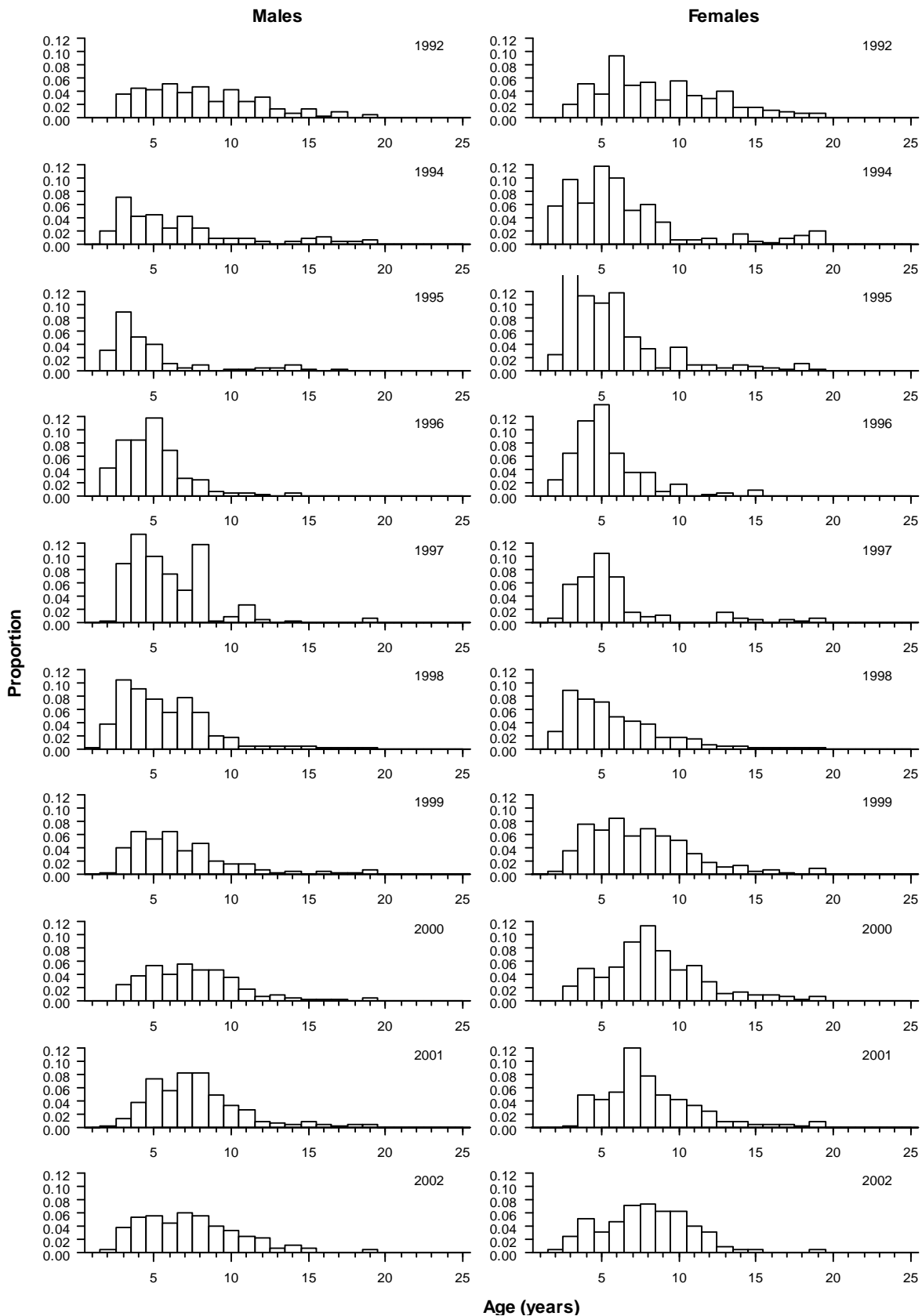


Figure A1: Available age frequencies of hake from commercial catch-at-age data in the Chatham Rise (west) trawl fishery, 1992 to 2012. Year labels relate to the latter year when sampling occurs over two calendar years, e.g., “2002” denotes the October 2001–April 2002 sample.

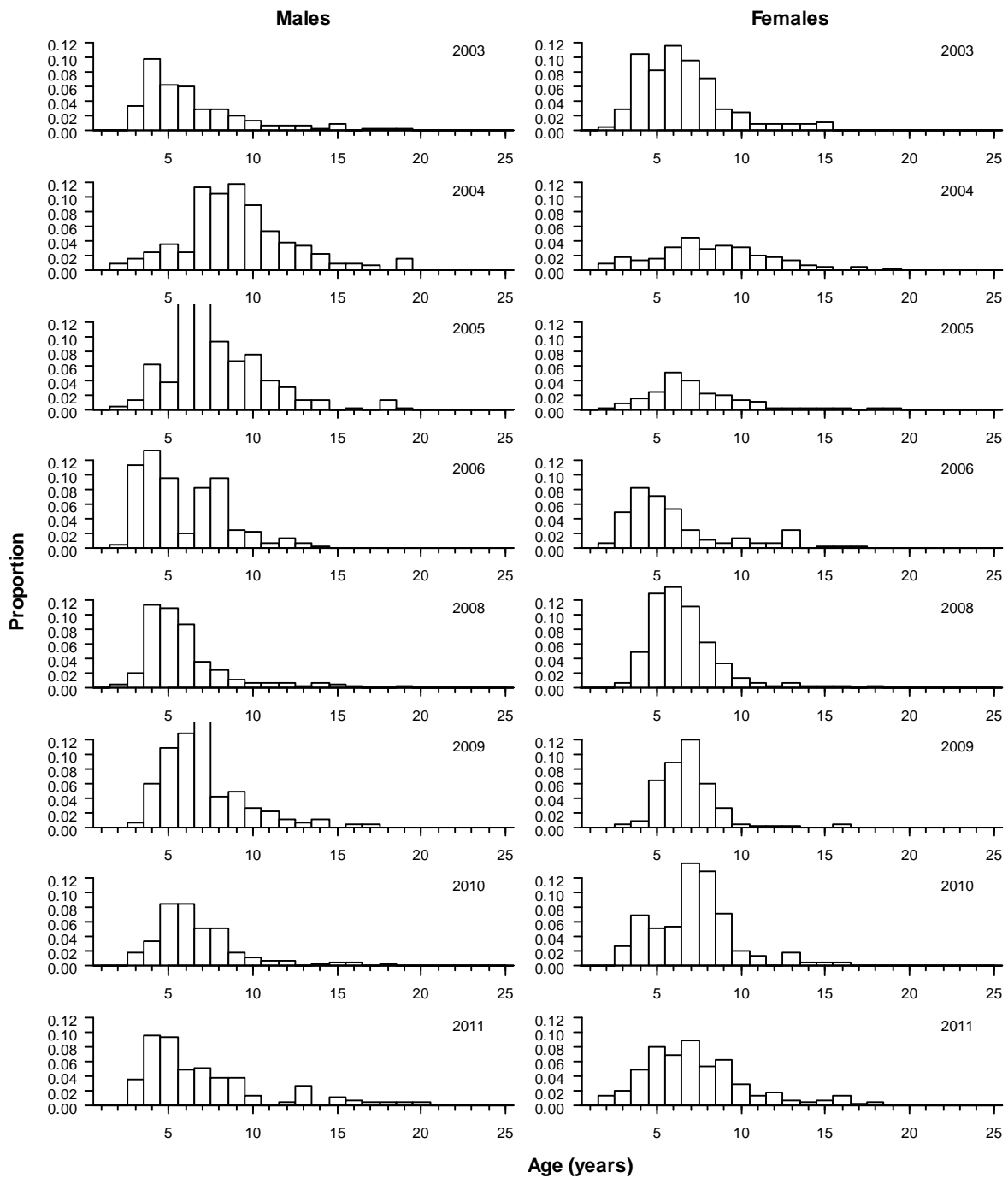


Figure A1 ctd.

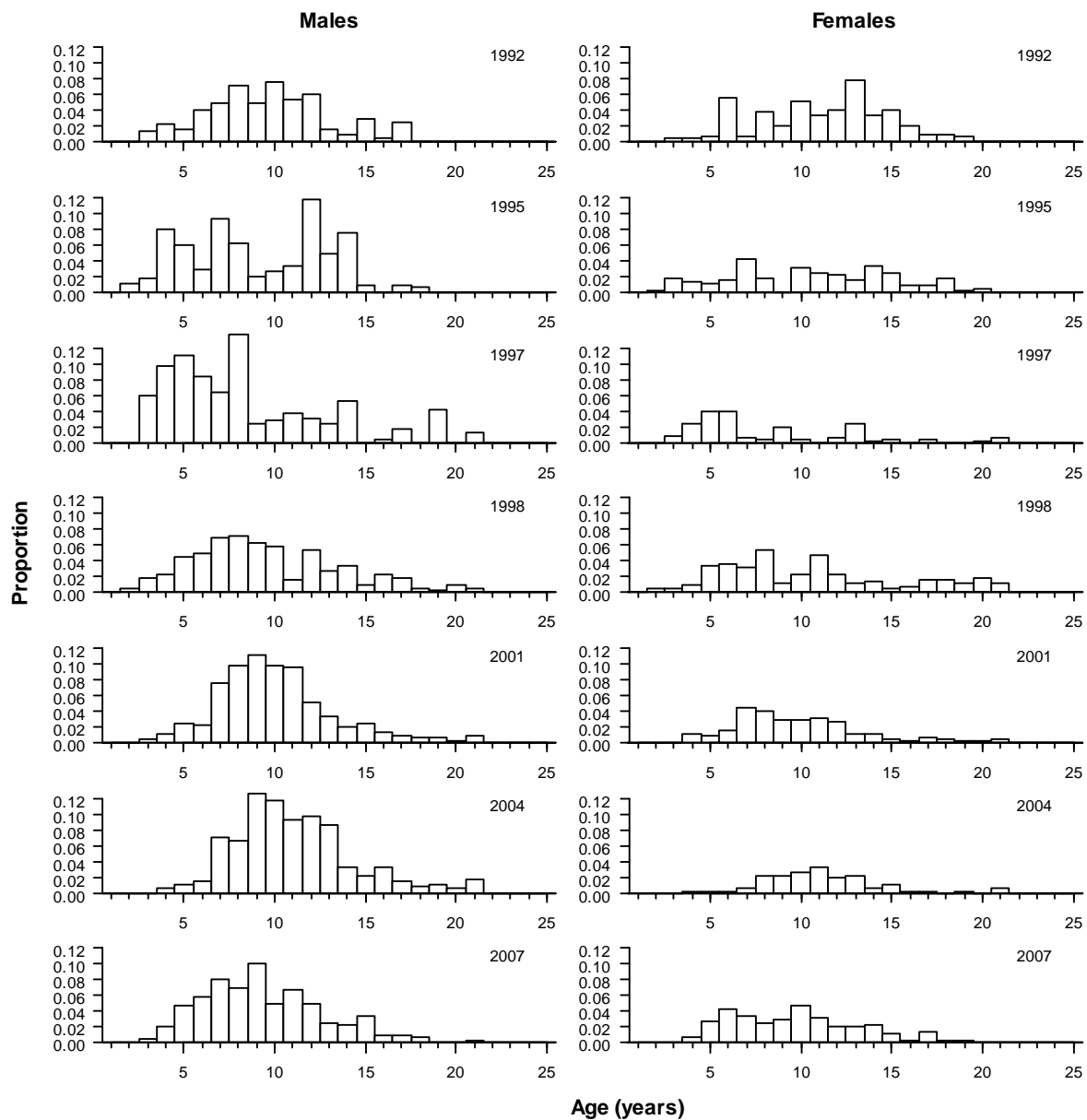


Figure A2: Available age frequencies of hake from commercial catch-at-age data in the Chatham Rise (east) trawl fishery, 1992 to 2012. Year labels relate to the latter year when sampling occurs over two calendar years, e.g., “1992” denotes the October 1991–April 1992 sample.

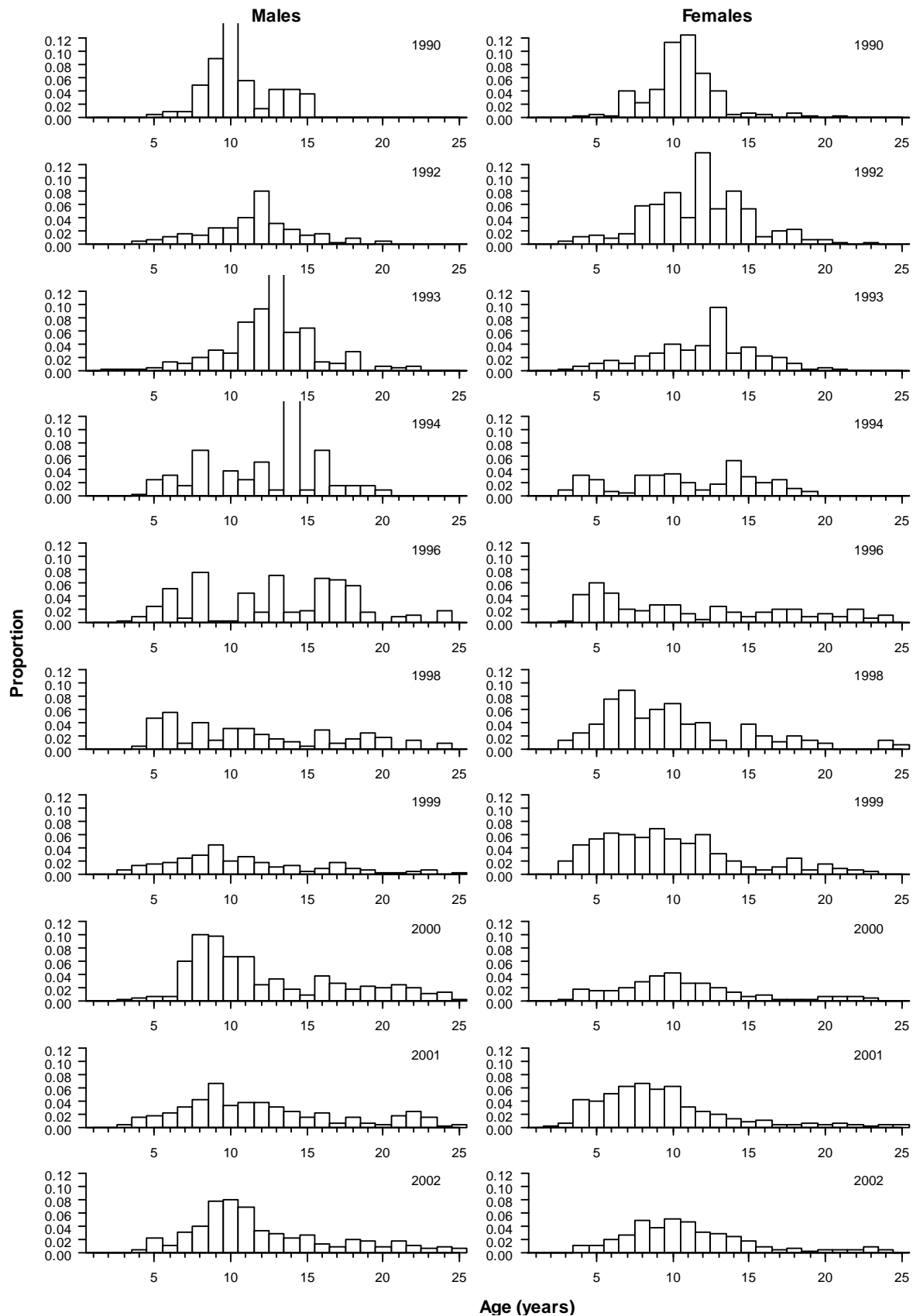


Figure A3: Available age frequencies of hake from commercial catch-at-age data in the Sub-Antarctic trawl fishery, 1990 to 2012. Year labels relate to the latter year when sampling occurs over two calendar years, e.g., “2002” denotes the September 2001–May 2002 sample.

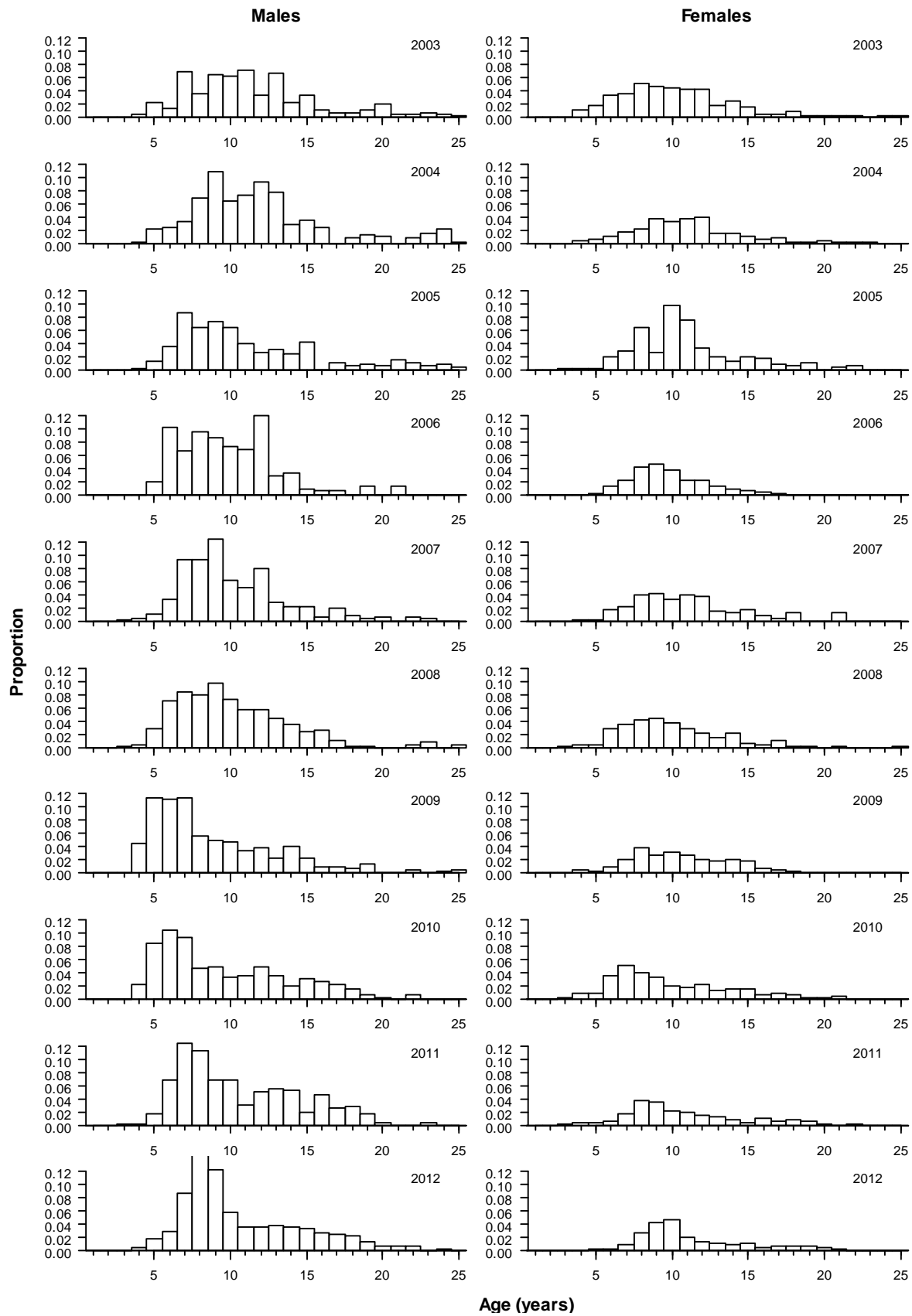


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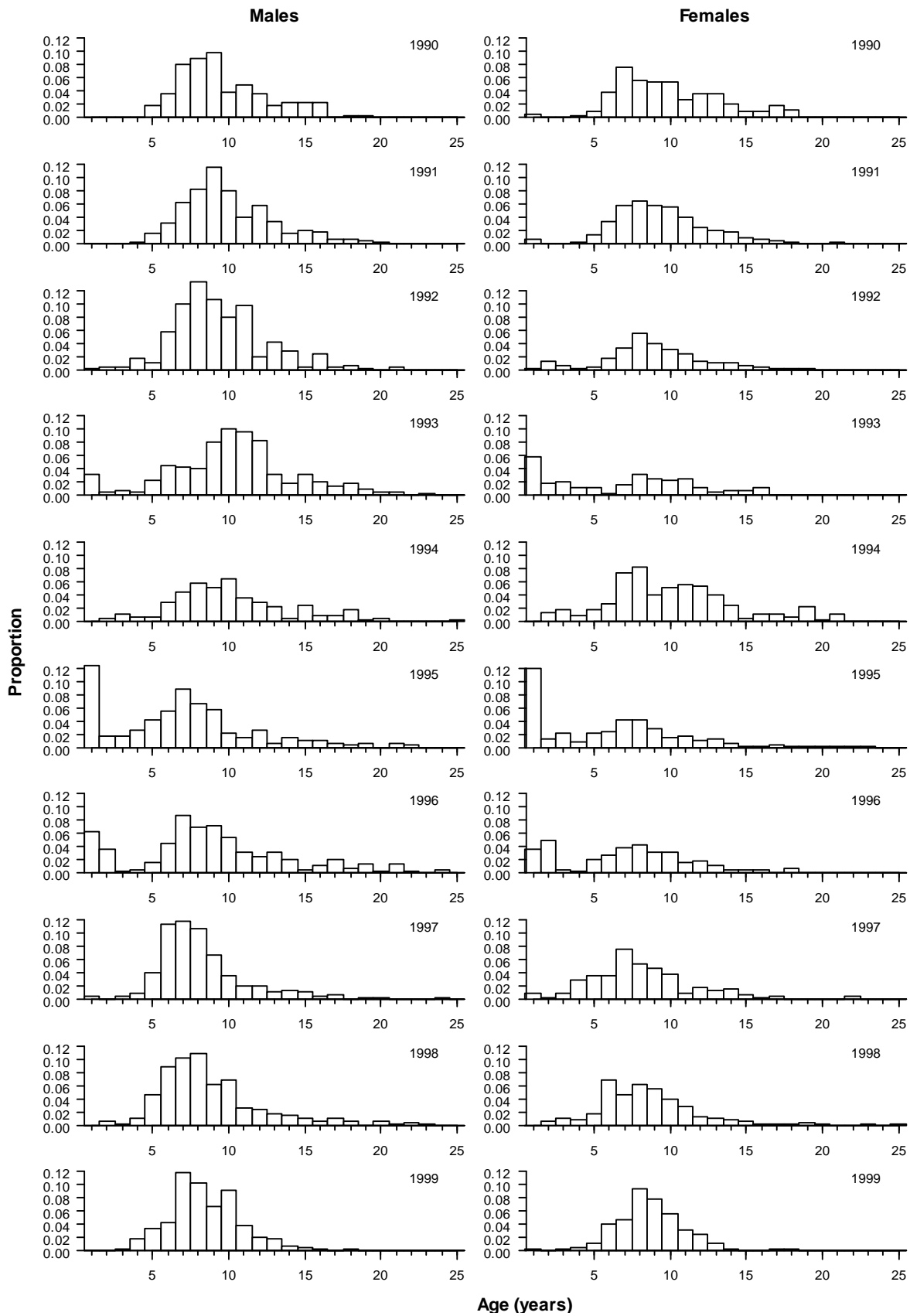


Figure A4: Available age frequencies of hake from commercial catch-at-age data in the WCSI trawl fishery, 1990 to 2012.

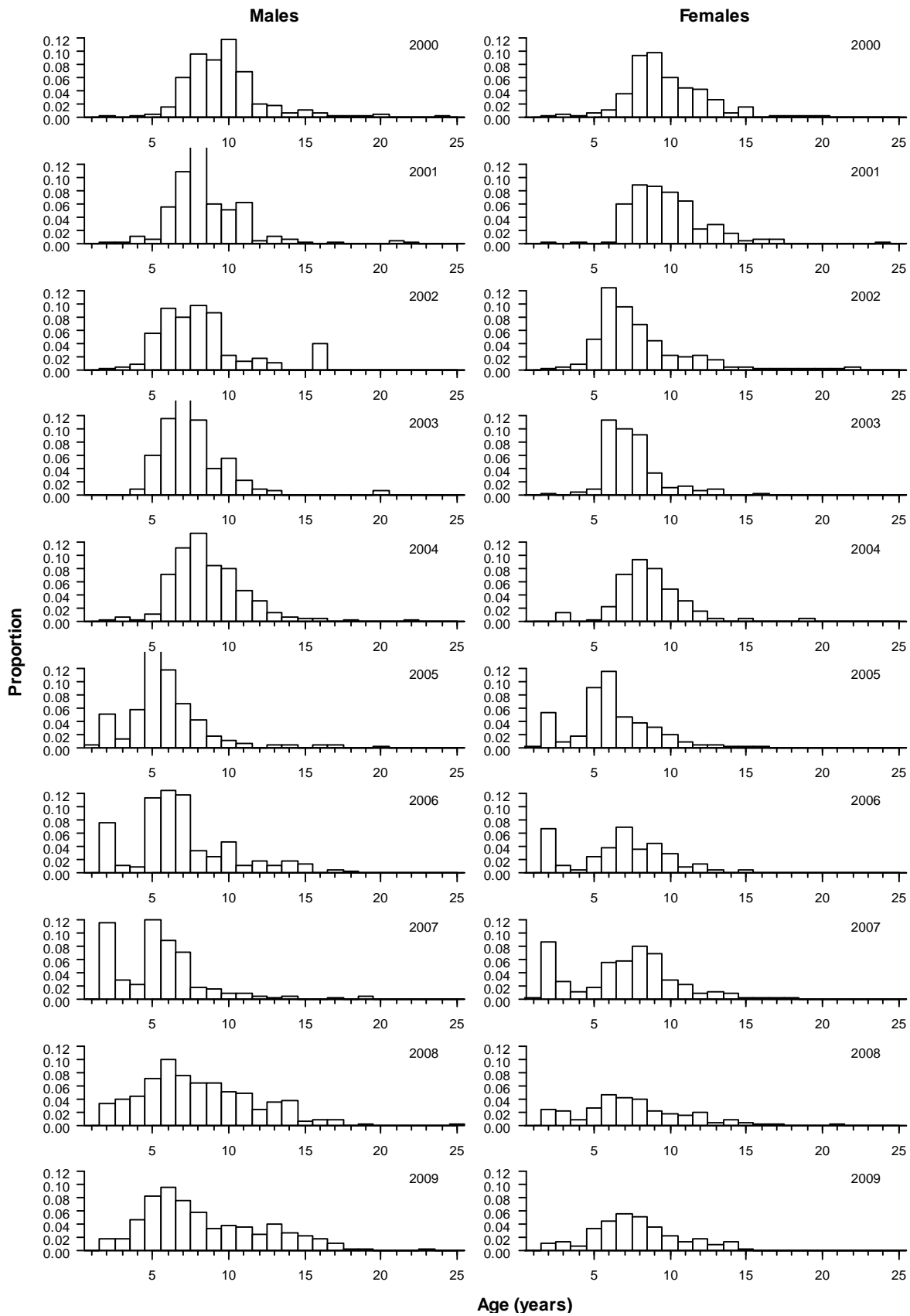


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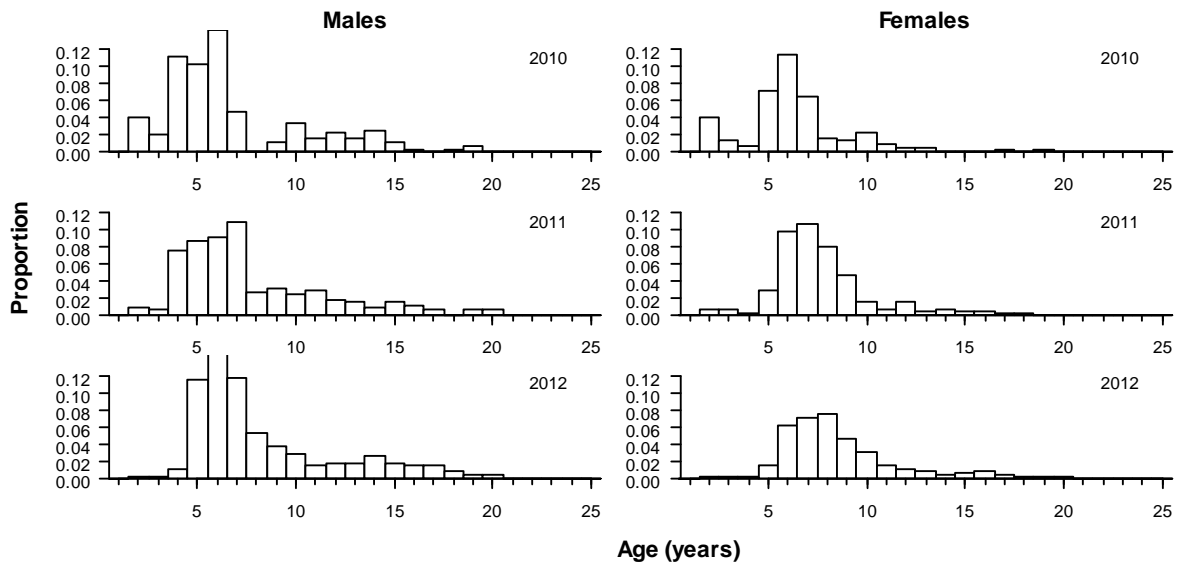


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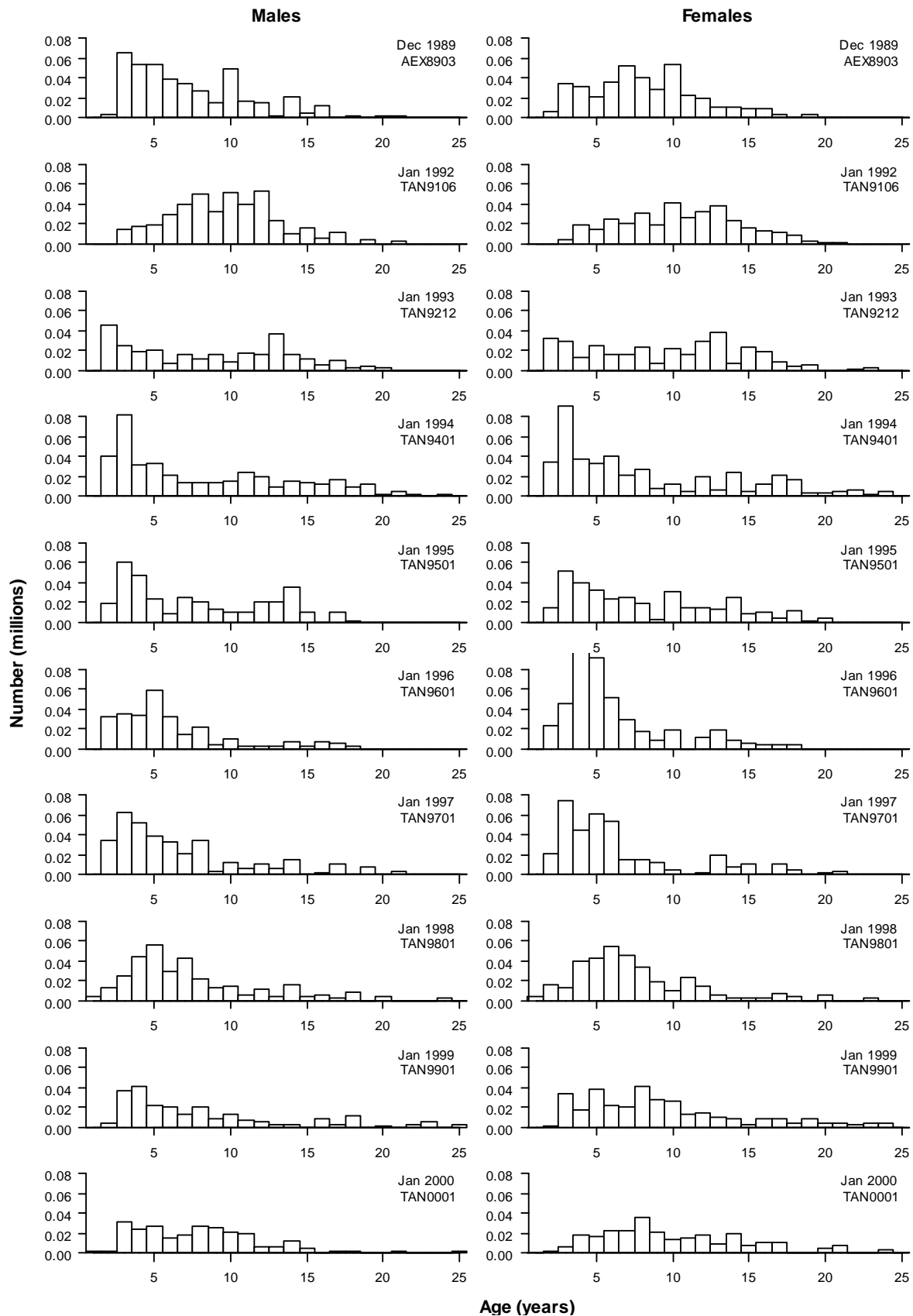


Figure A5: Available age frequencies of hake (ages 1 to 25) from resource surveys in the Chatham Rise, 1989–90 to 2012–13.

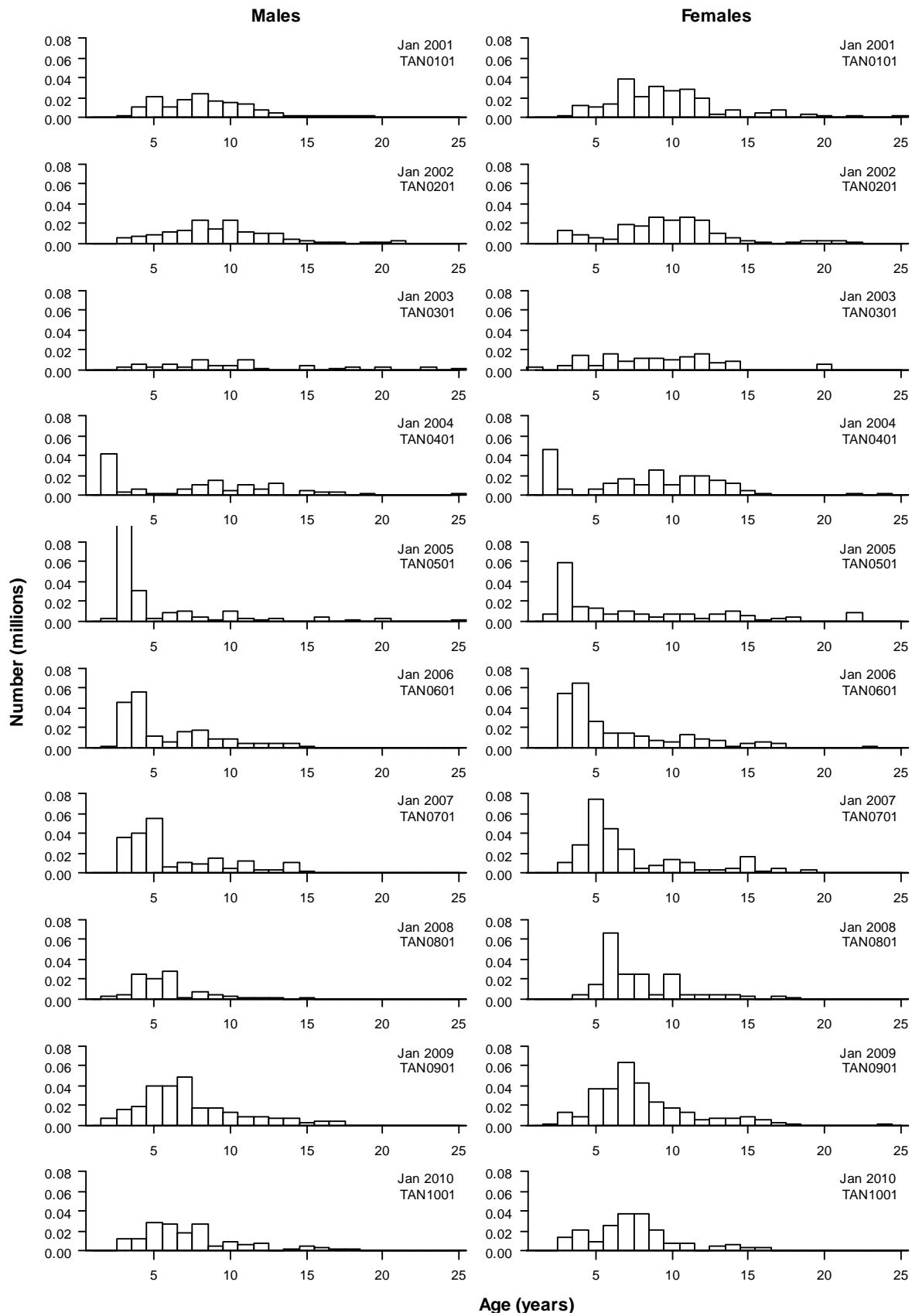


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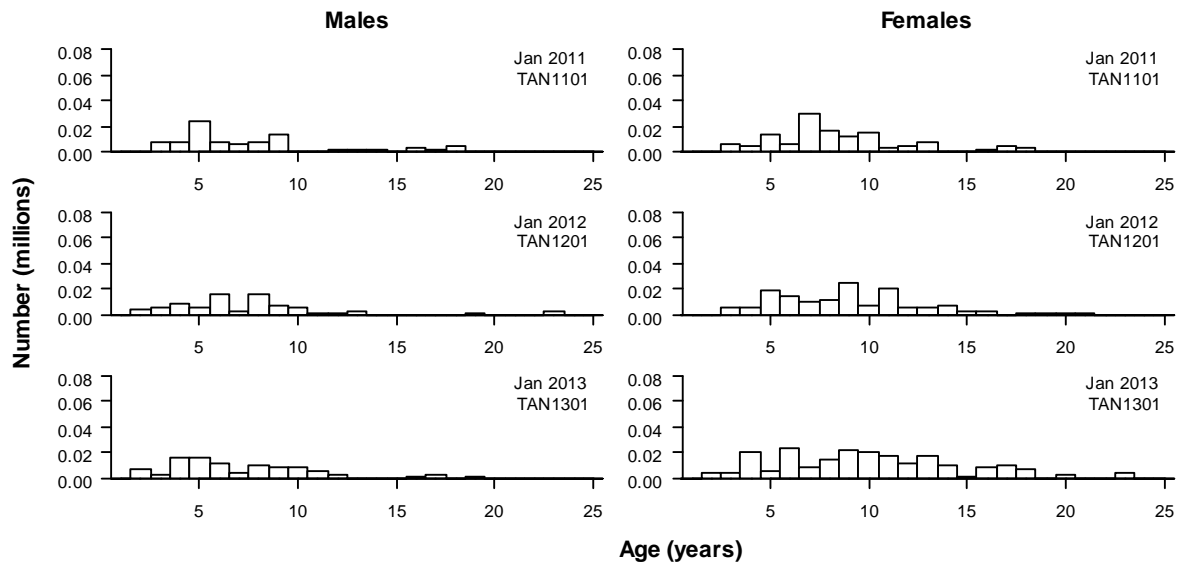


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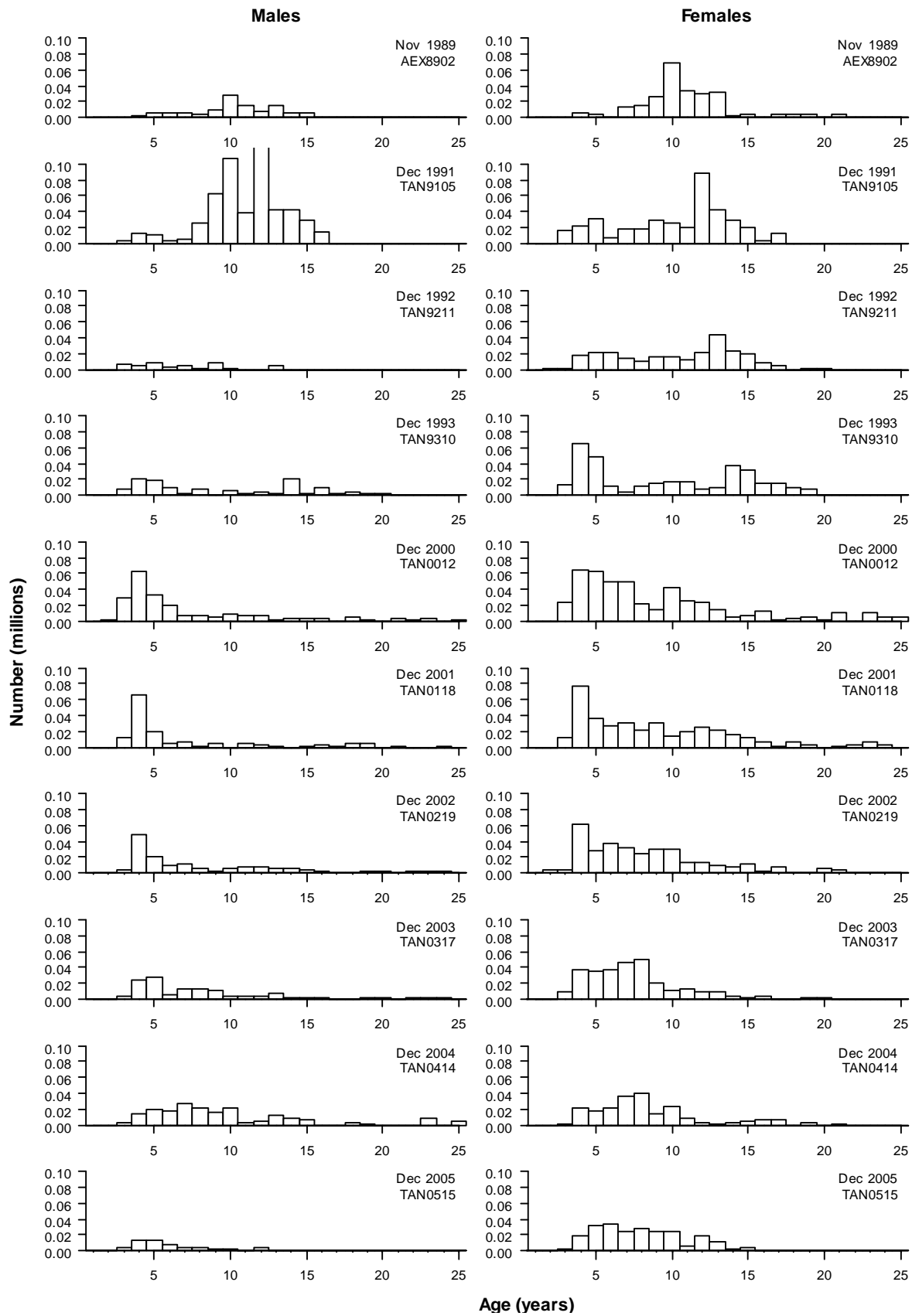


Figure A6: Available age frequencies of hake (ages 1 to 25) from summer resource surveys in the Sub-Antarctic, 1989 to 2012.

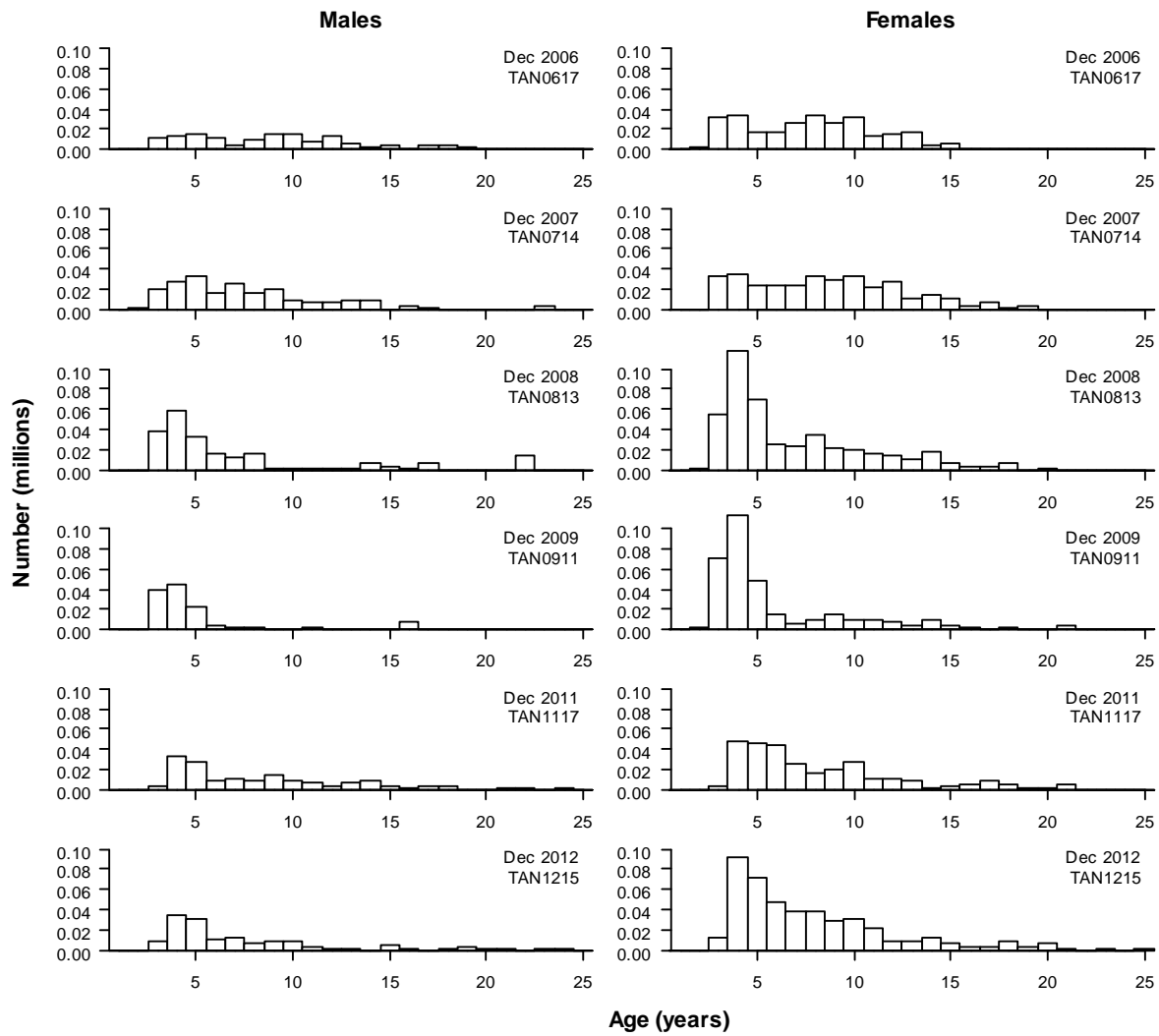


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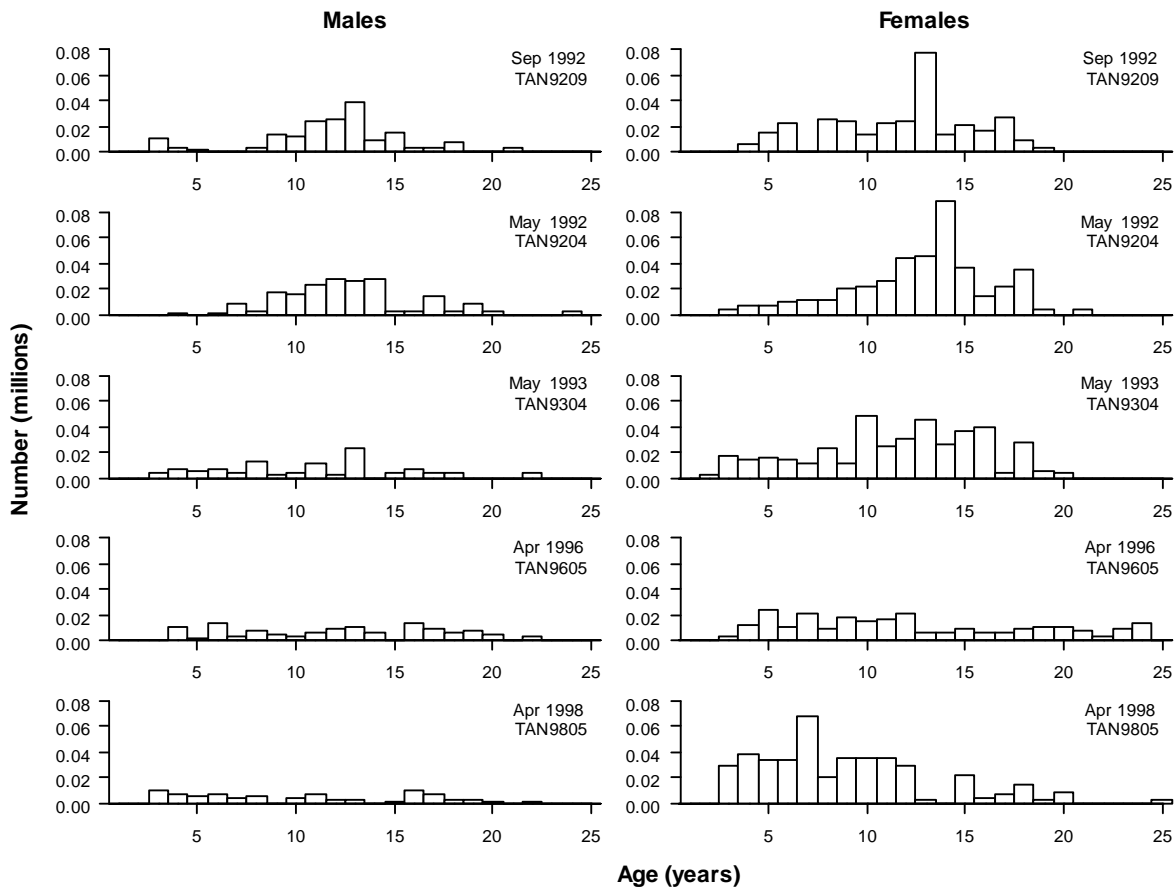


Figure A7: Available age frequencies of hake (ages 1 to 25) from spring and autumn resource surveys in the Sub-Antarctic, 1992 to 1998.

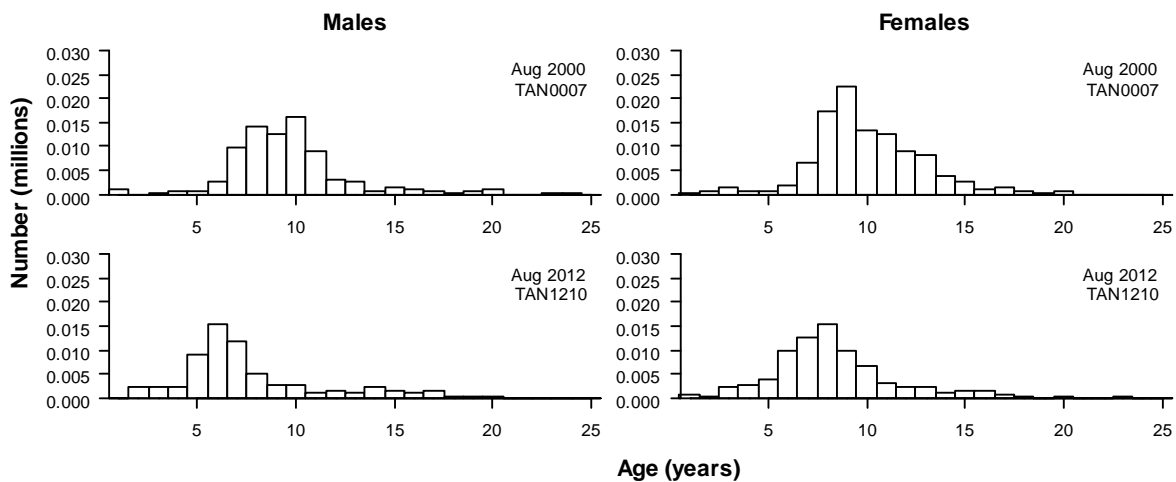


Figure A8: Available age frequencies of hake (ages 1 to 25) from resource surveys off WCSI, in 2000 and 2012.

Appendix B: Summaries of the proportions-at-age data for ling

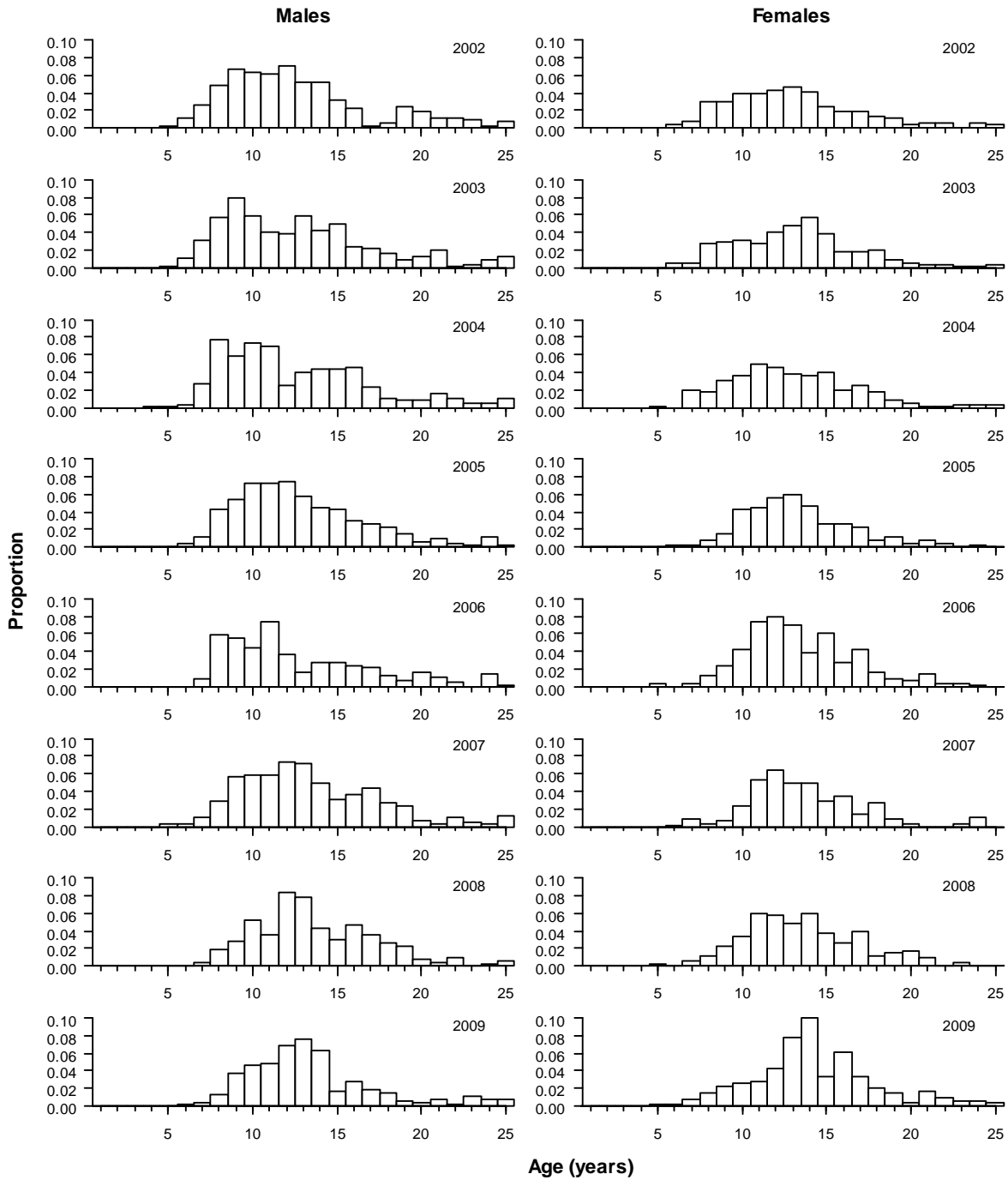


Figure B1: Available age frequencies of ling from commercial catch-at-age data in the Chatham Rise longline fishery, 2002 to 2012.

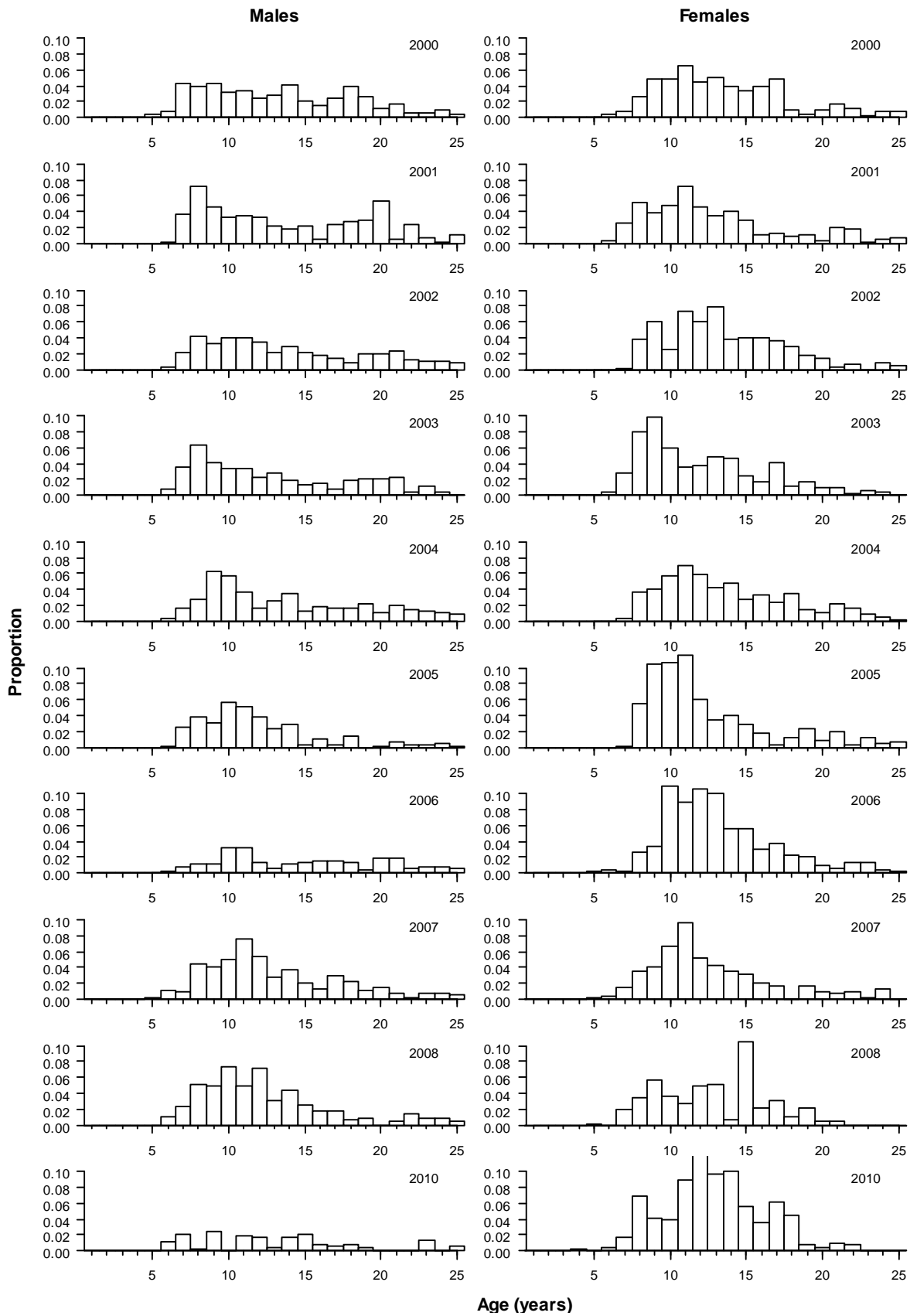


Figure B2: Available age frequencies of ling from commercial catch-at-age data in the Sub-Antarctic (spawning season) longline fishery, 2000 to 2012.

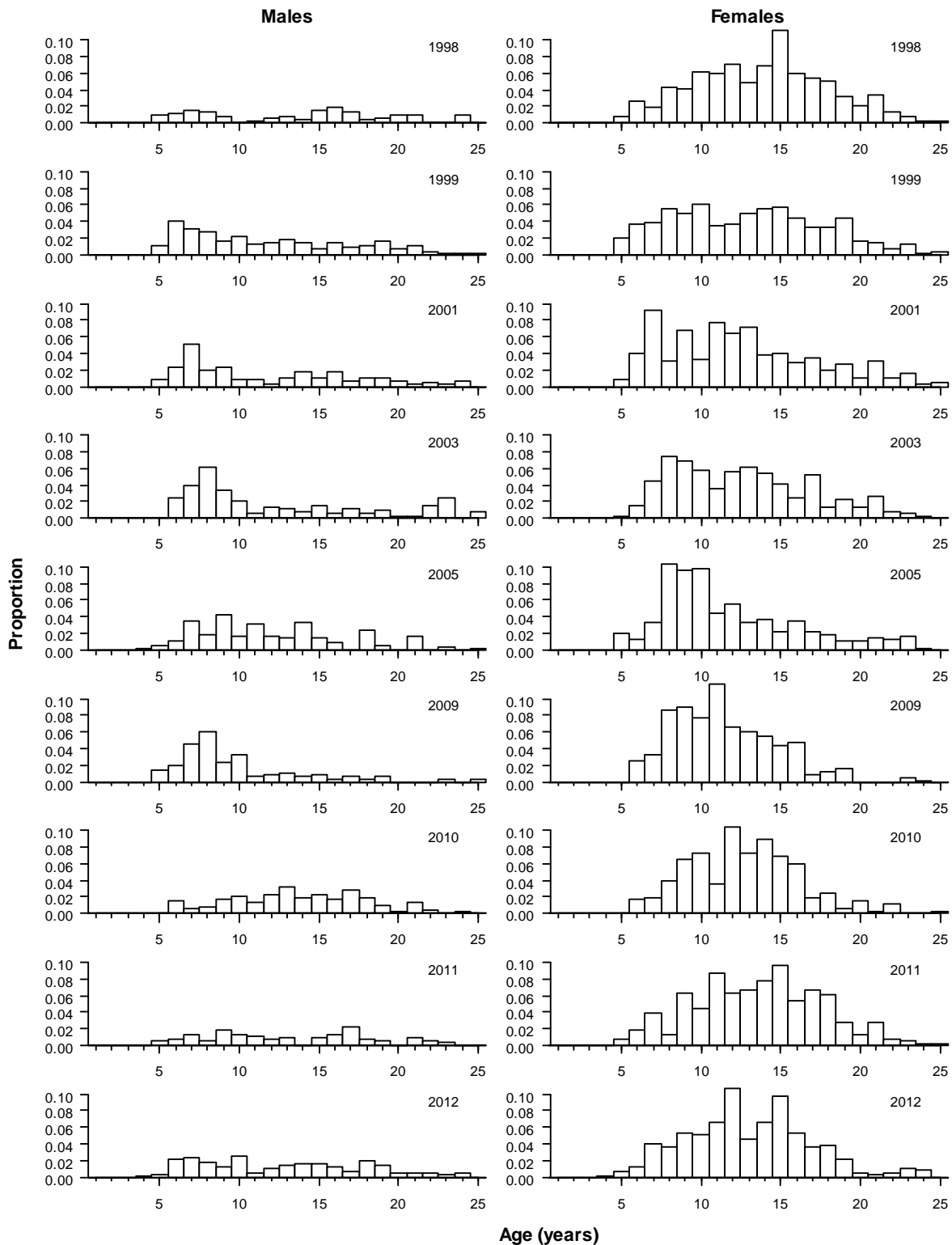


Figure B3: Available age frequencies of ling from commercial catch-at-age data in the Sub-Antarctic (non-spawning season) longline fishery, 1998 to 2012.

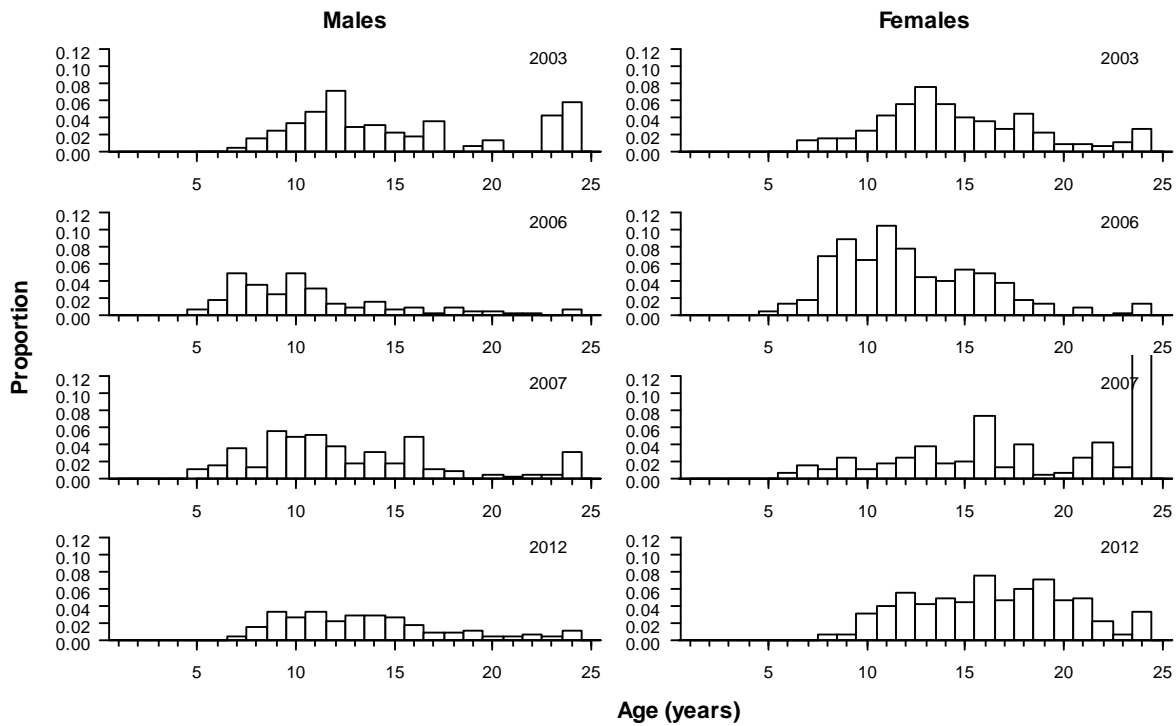


Figure B4: Available age frequencies of ling from commercial catch-at-age data in the west coast South Island line fishery, 2003 to 2012.

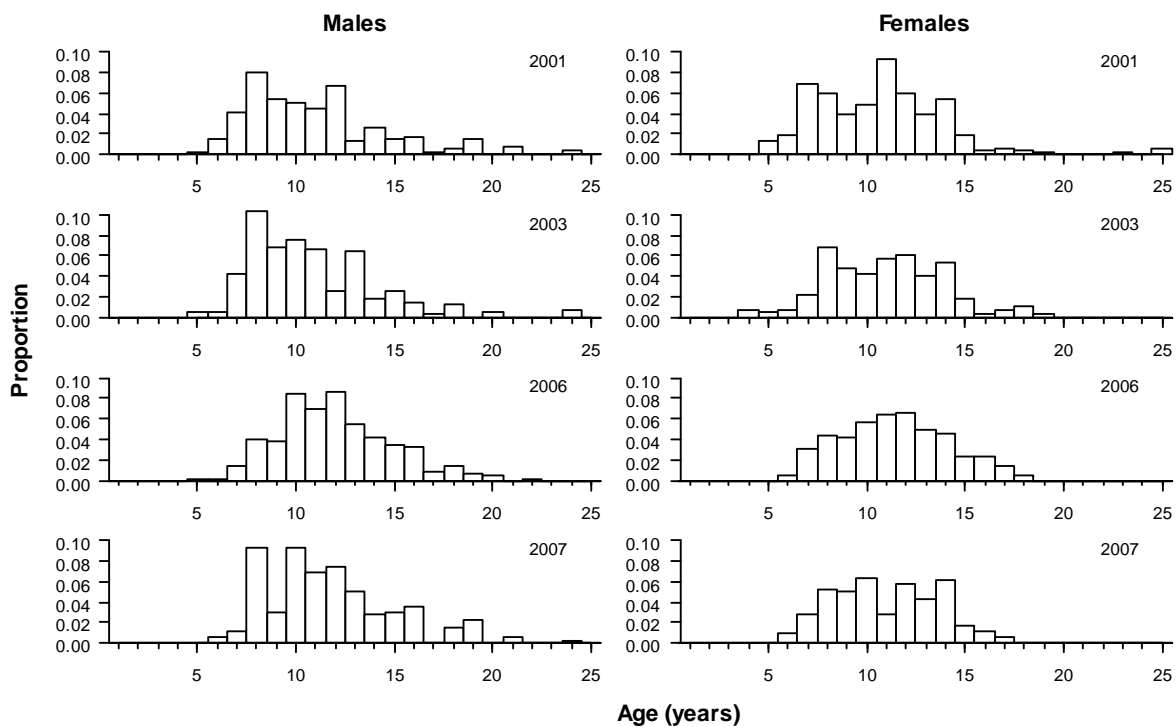


Figure B5: Available age frequencies of ling from commercial catch-at-age data in the Cook Strait longline fishery, 2001 to 2012.

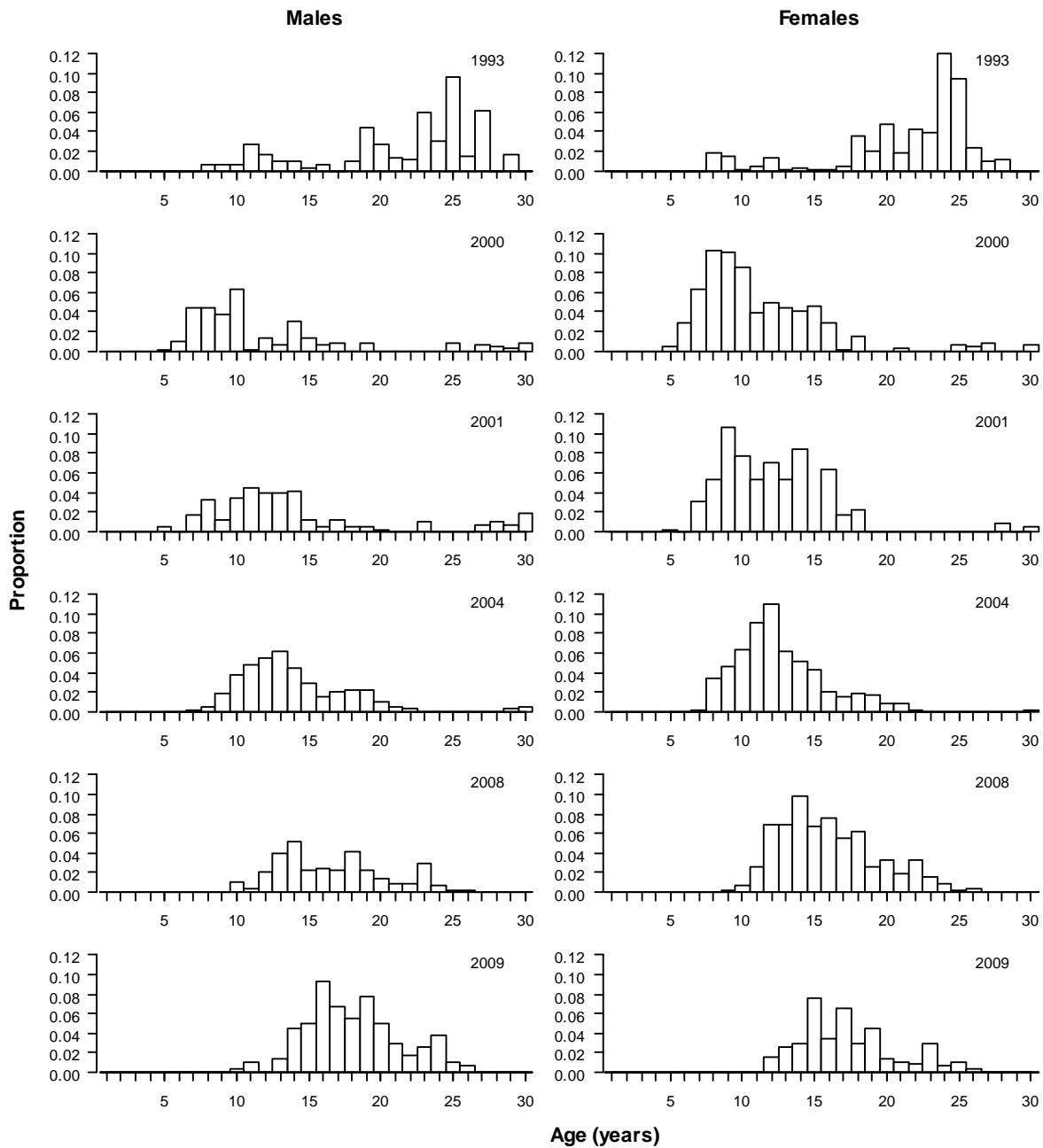


Figure B6: Available age frequencies of ling from commercial catch-at-age data in the Bounty Plateau longline fishery, 1993 to 2012.

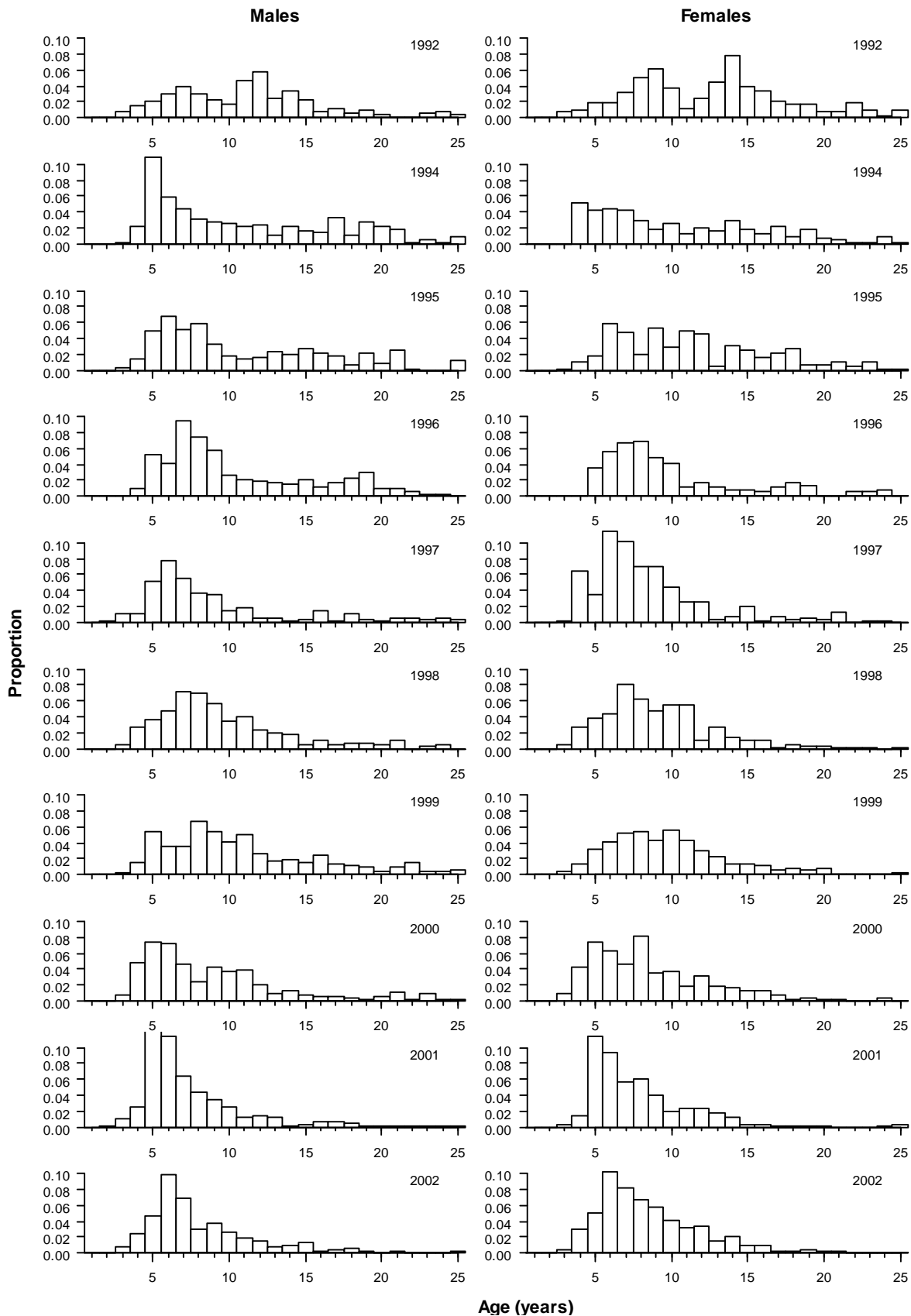


Figure B7: Available age frequencies of ling from commercial catch-at-age data in the Chatham Rise trawl fishery, 1992 to 2012. Year labels relate to the latter year when sampling occurs over two calendar years, e.g., “2002” denotes the October 2001–May 2002 sample.

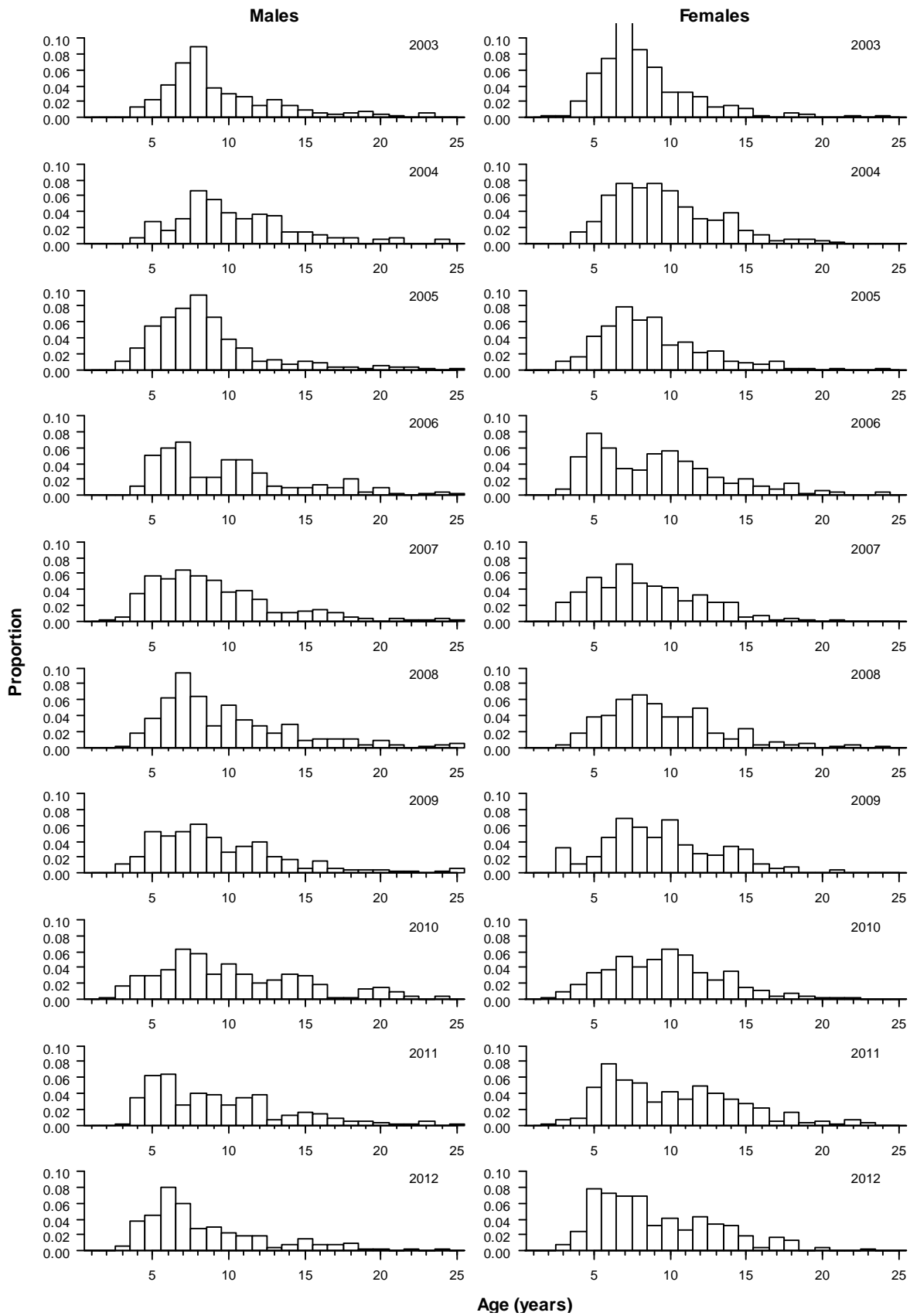


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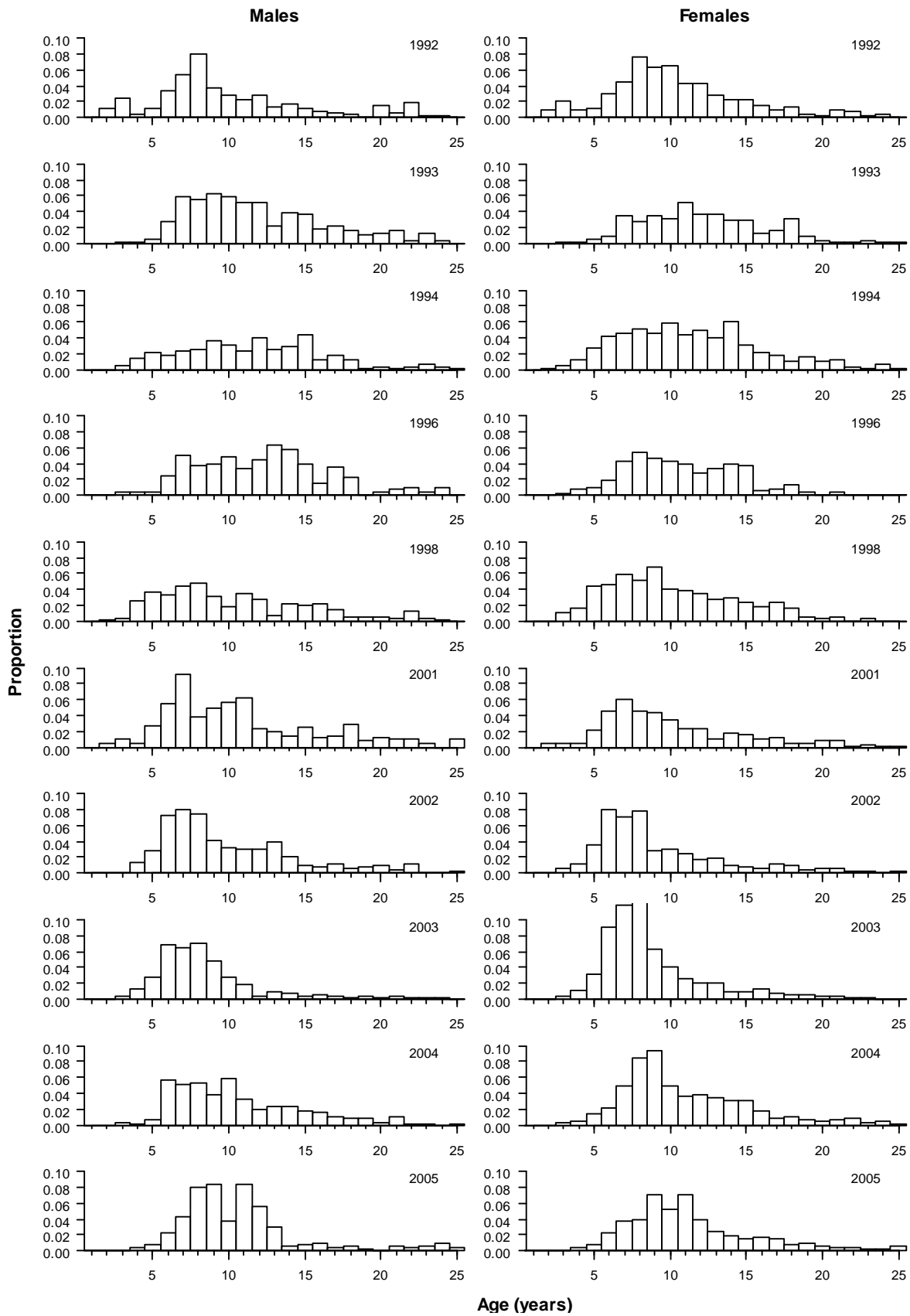


Figure B8: Available age frequencies of ling from commercial catch-at-age data in the Sub-Antarctic trawl fishery, 1992 to 2012. Year labels relate to the latter year when sampling occurs over two calendar years, e.g., “2005” denotes the September 2004–April 2005 sample.

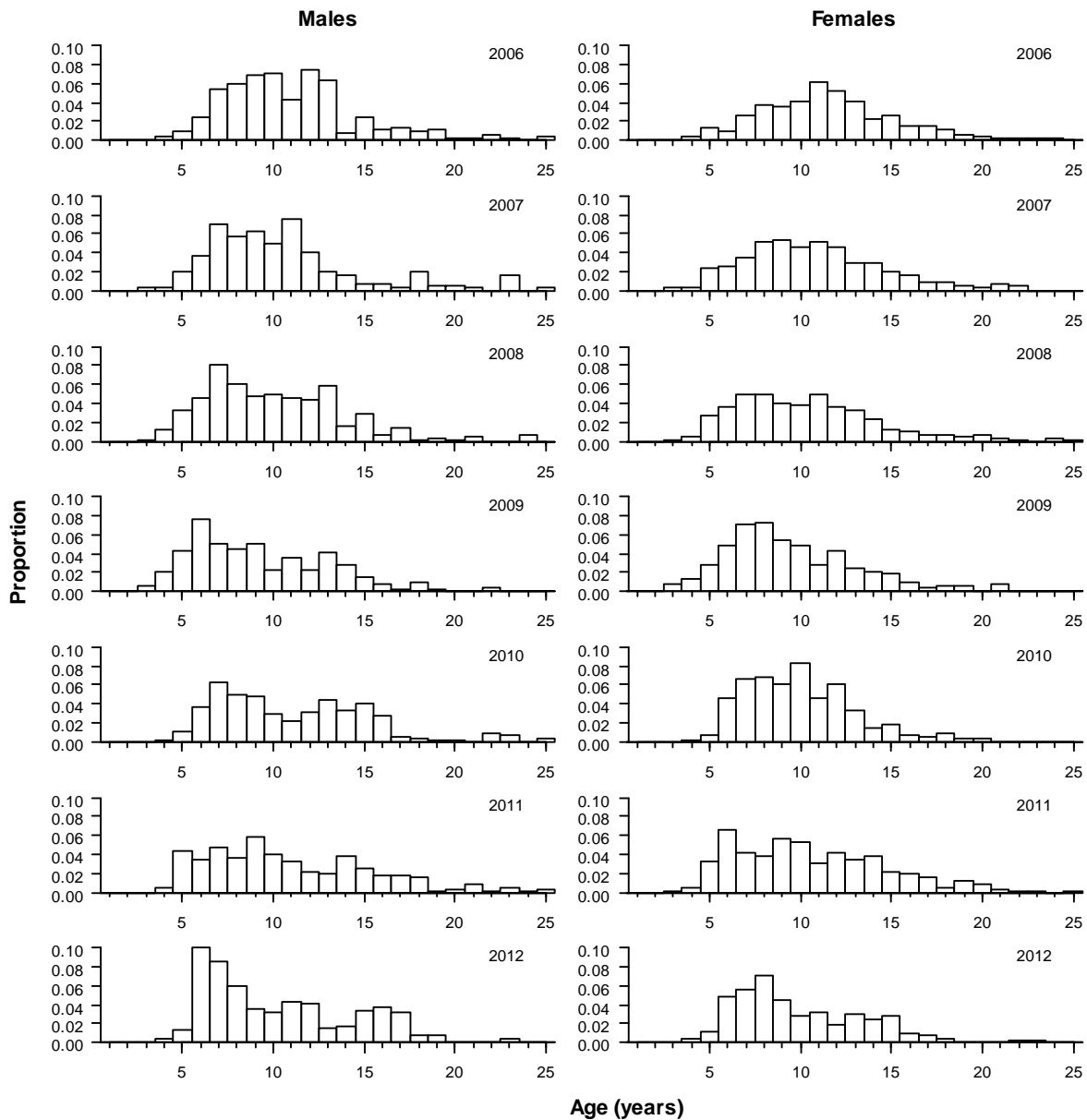


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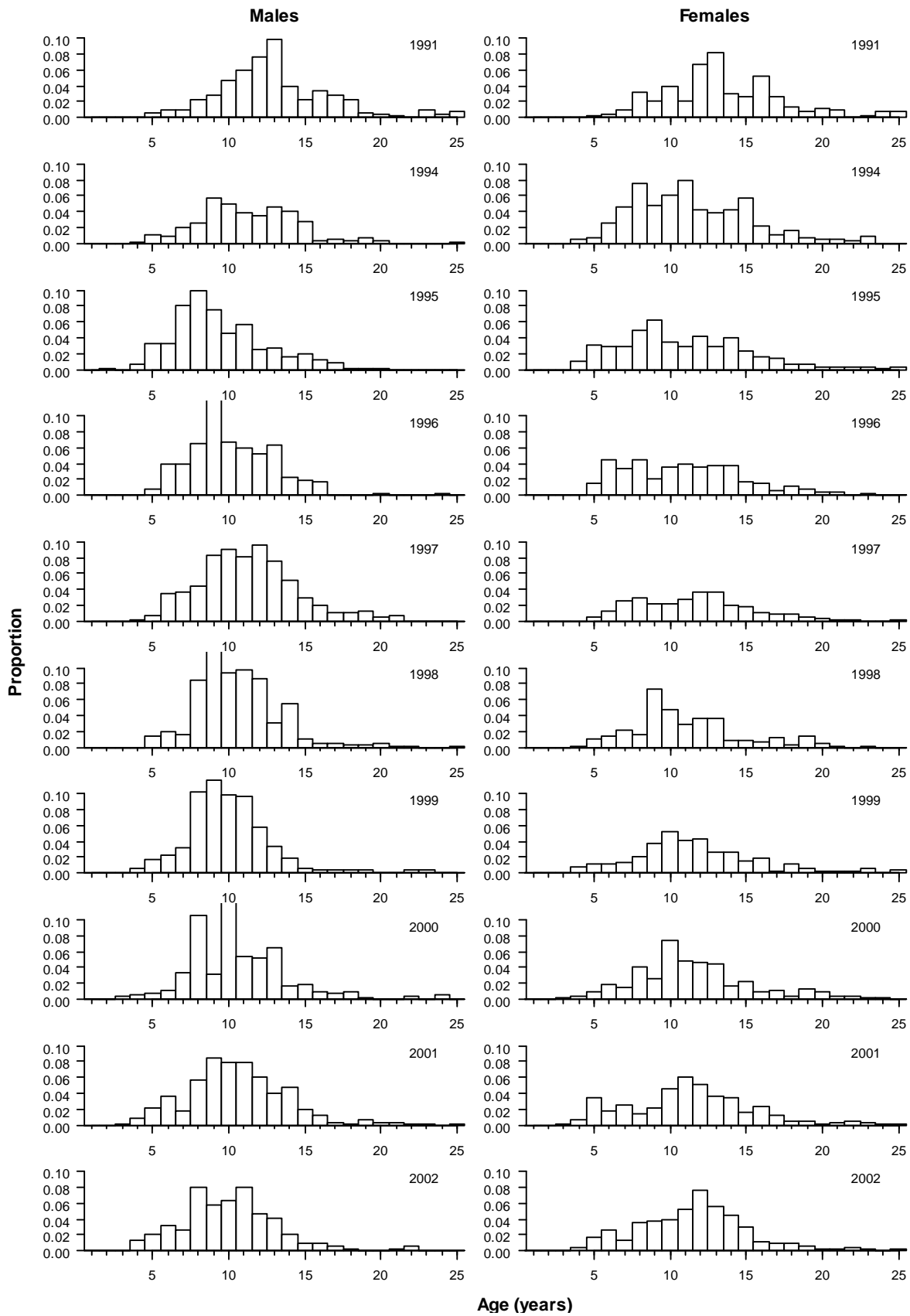


Figure B9: Available age frequencies of ling from commercial catch-at-age data in the WCSI trawl fishery, 1991 to 2012.

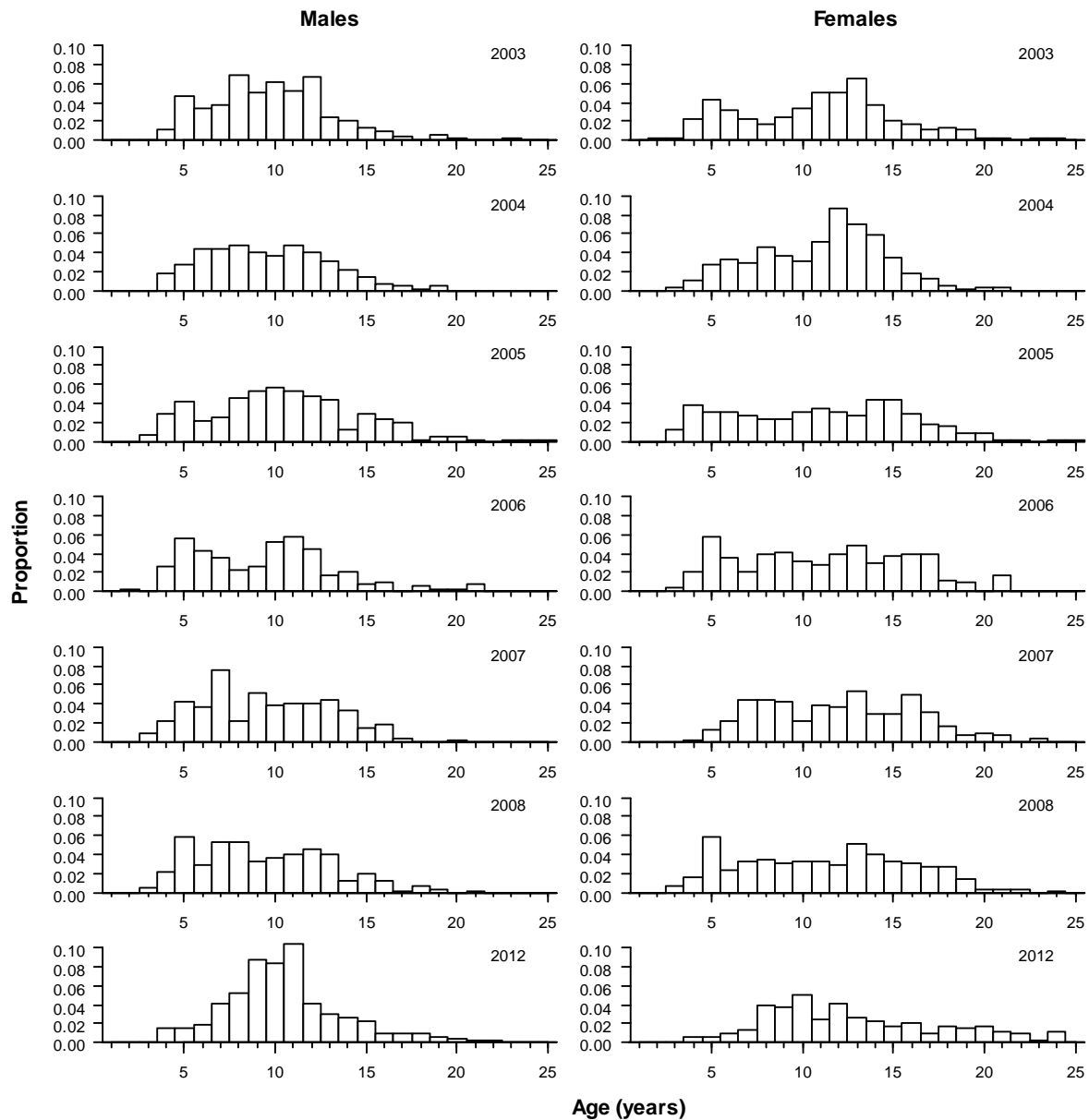


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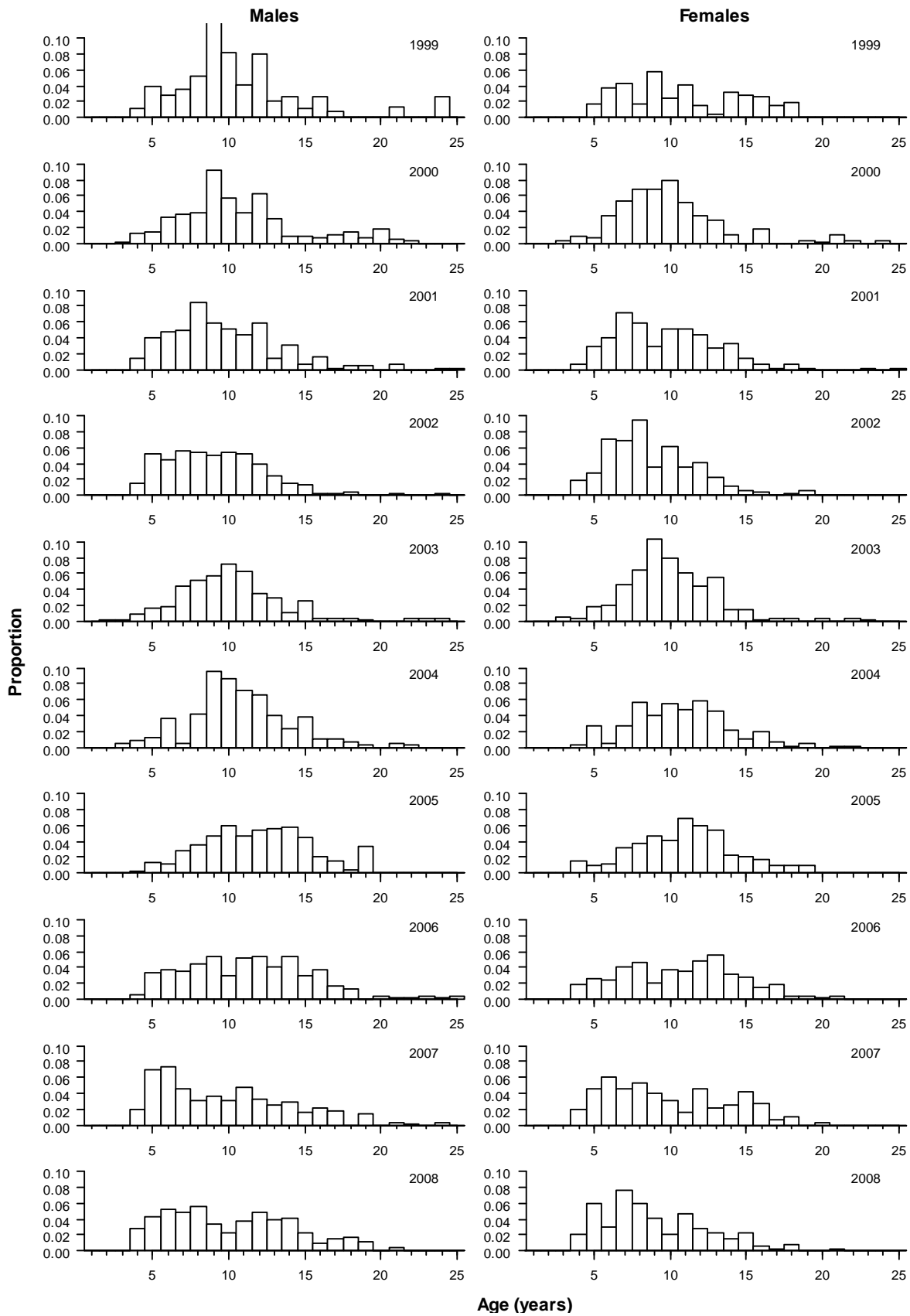


Figure B10: Available age frequencies of ling from commercial catch-at-age data in the Cook Strait trawl fishery, 1999 to 2012.

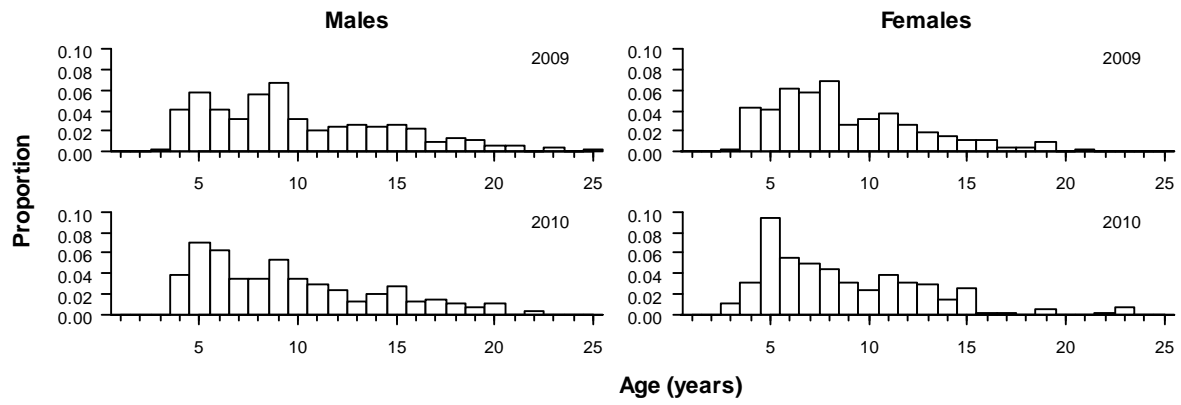


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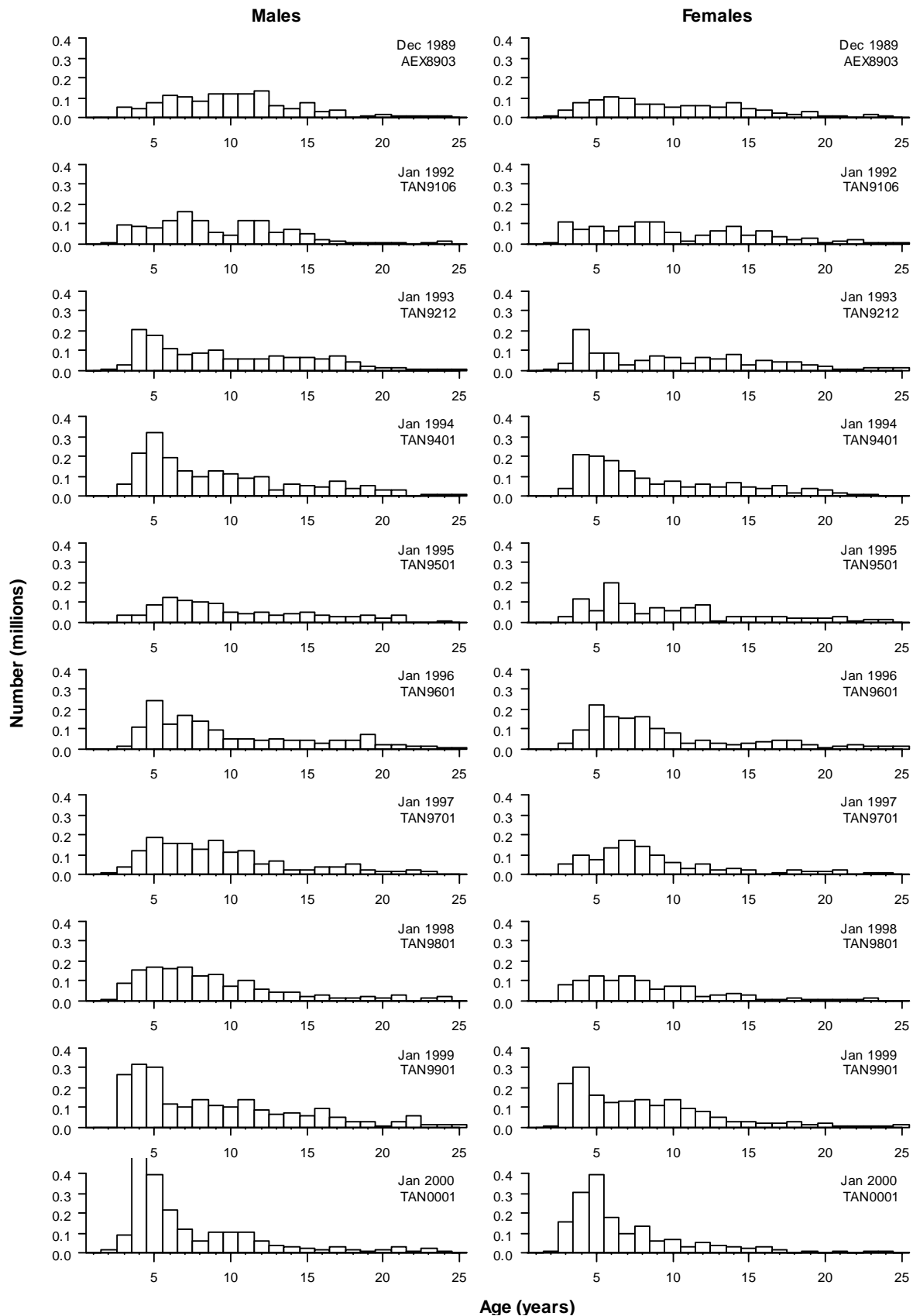


Figure B11: Available age frequencies of ling (ages 1 to 25) from resource surveys in the Chatham Rise, 1989–90 to 2012–13.

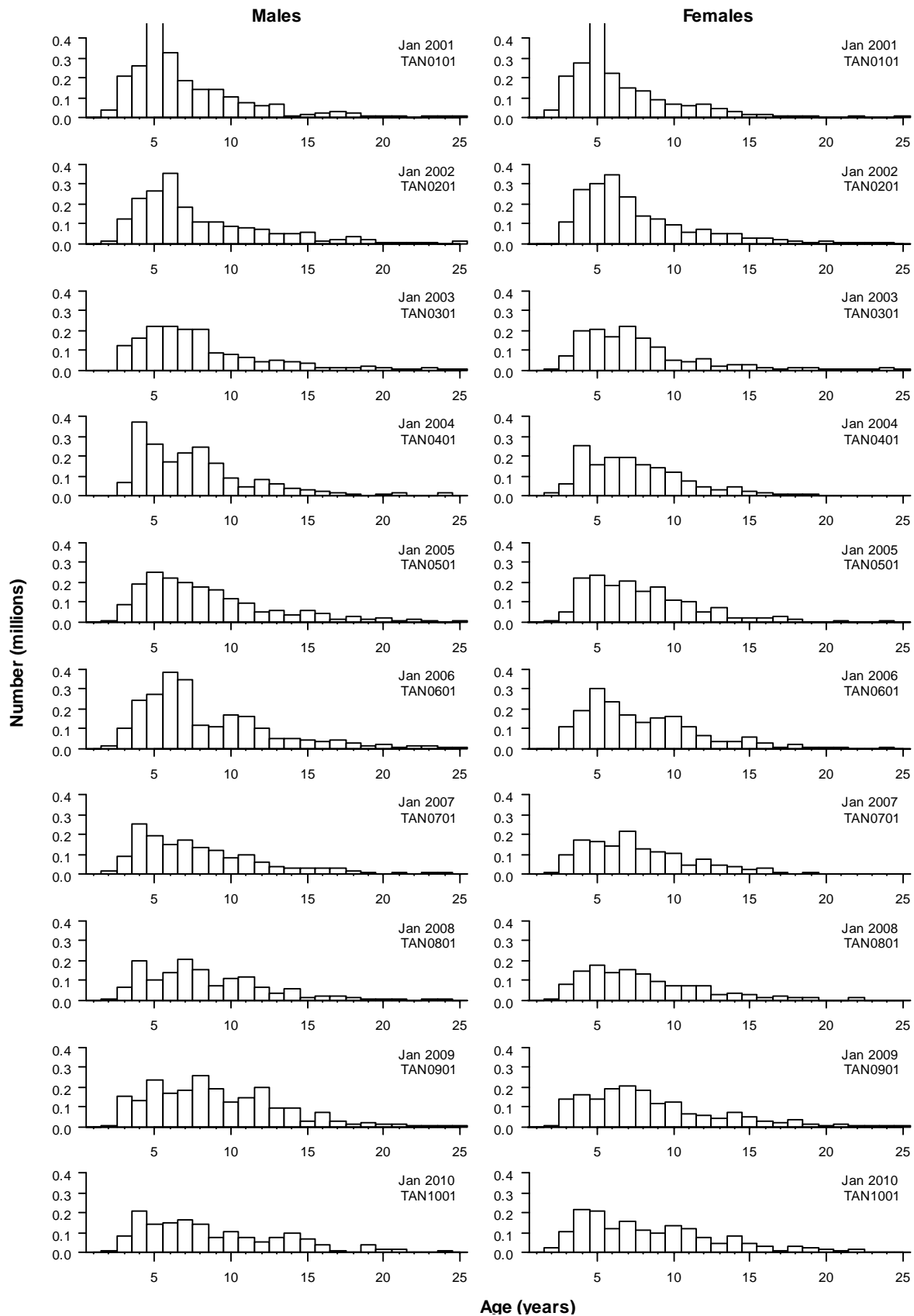


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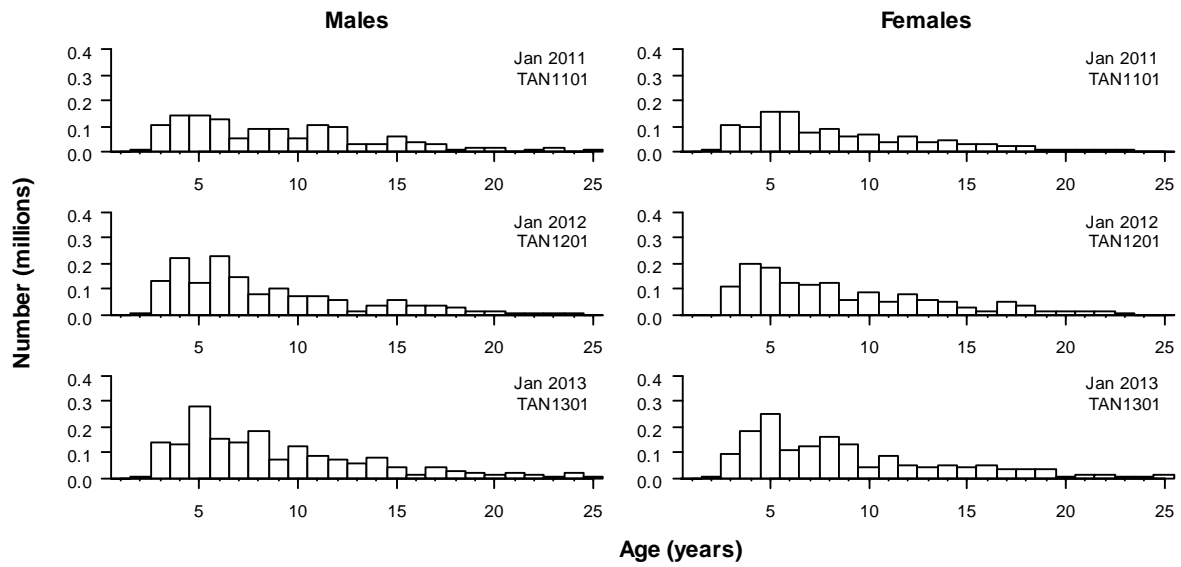


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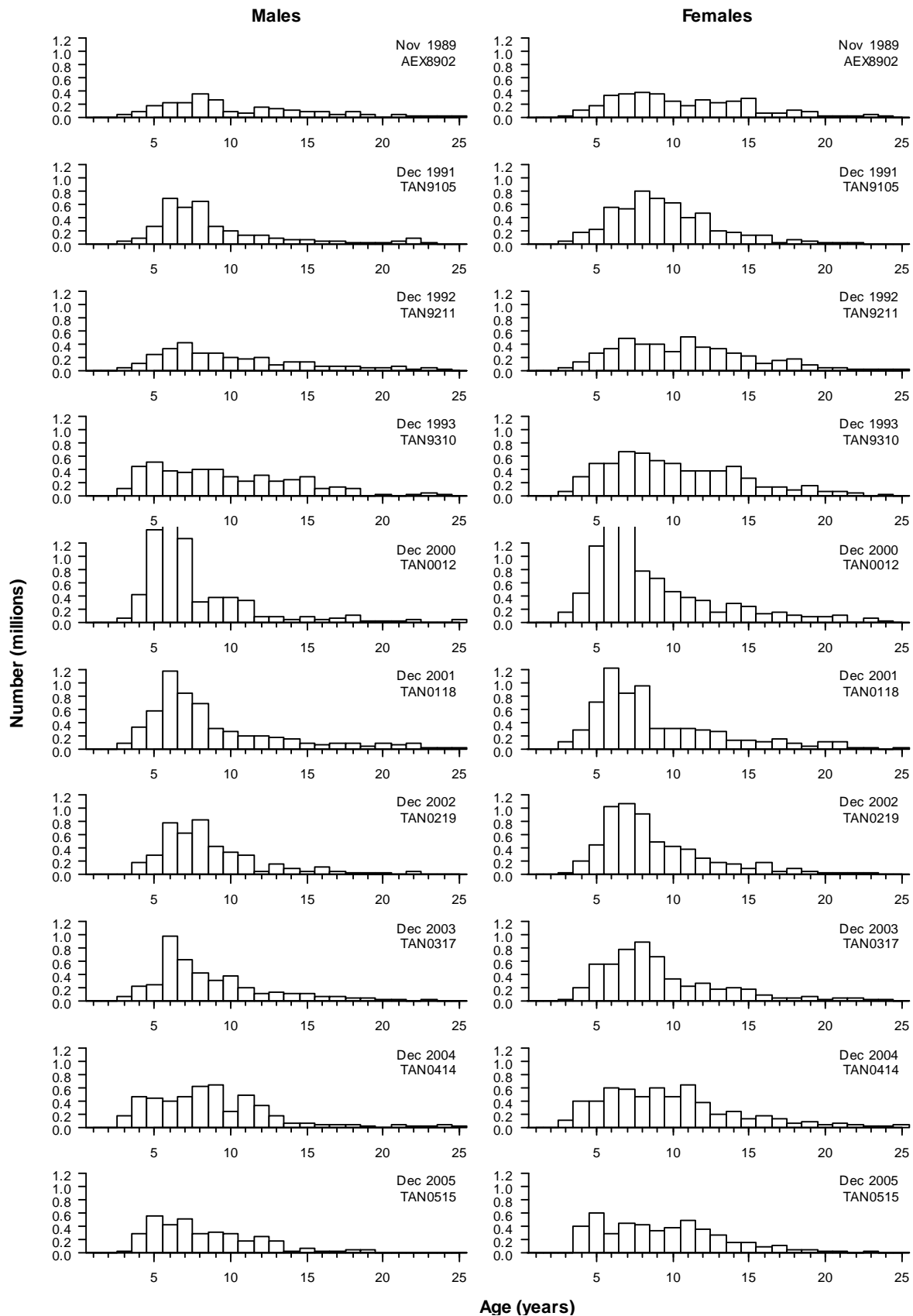


Figure B12: Available age frequencies of ling (ages 1 to 25) from summer resource surveys in the Sub-Antarctic, 1989 to 2012.

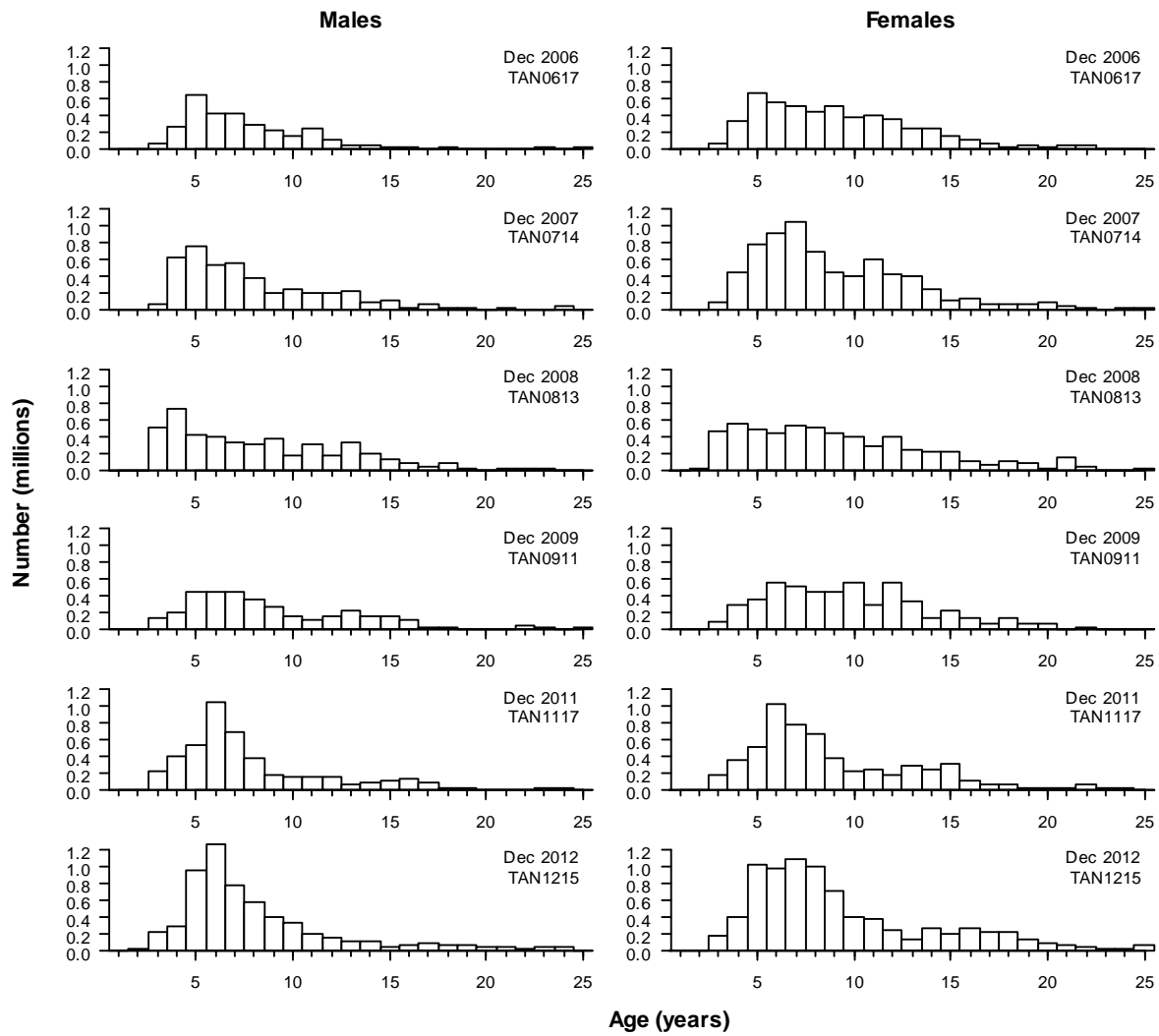


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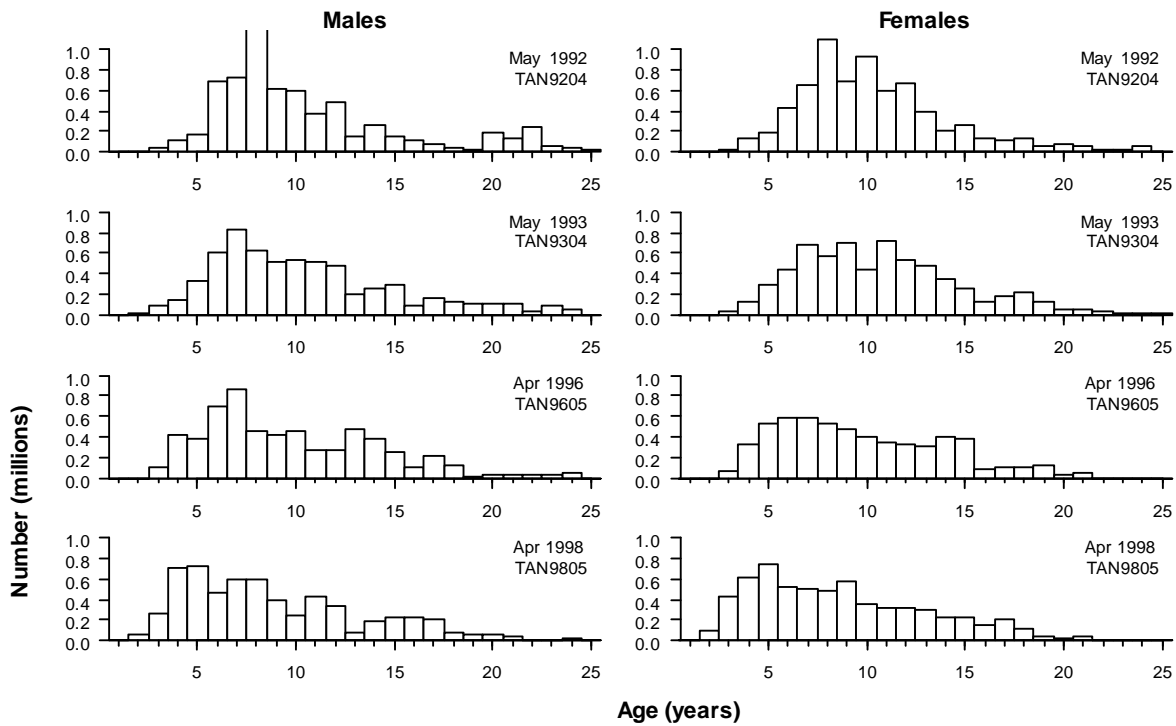


Figure B13: Available age frequencies of ling (ages 1 to 25) from autumn resource surveys in the Sub-Antarctic, 1992 to 1998.

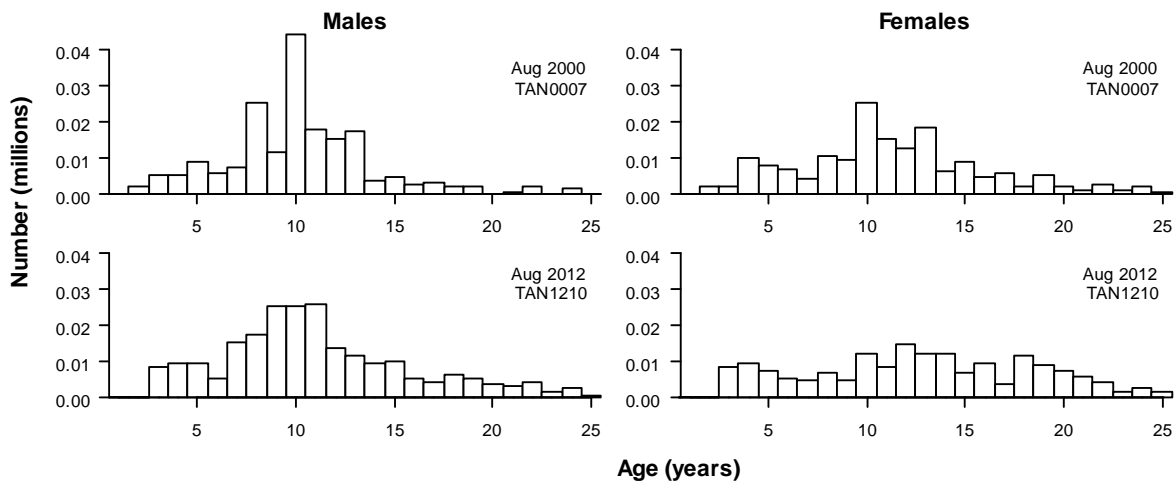


Figure B14: Available age frequencies of ling (ages 1 to 25) from winter resource surveys off WCSI, 2000 and 2012.