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The age composition of the commercial trawl catch of silver warehou (*Seriolella punctata*) in SWA 3 and SWA 4

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A stock assessment model for silver warehou (*Seriolella punctata*) in SWA 3 and SWA 4 is currently being developed and it is desirable to have sets of commercial catch-at-age data for input into the model to help inform fishery selectivity and year class strengths. This report provides estimates of the catch-at-age of silver warehou taken as both a target and bycatch in commercial trawl fisheries on the western Chatham Rise in three years (September–February 2006–07, 2010–11, and 2013–14) and off Southland in two years (January–April 2012 and 2014). These distributions add to series already available for both these areas. Consequently, comparable distribution of commercial catch-at-age are now available for eight years from the western Chatham Rise and six years from Southland. The series of western Chatham Rise distributions is indicative of a fishery that is driven by pulses of recruitment; a pair of adjacent year classes (spawned in 2005 and 2006) appear to have dominated catches from 2010 to 2016.

1. INTRODUCTION

Silver warehou (*Seriolella punctata*) are common around South Island, New Zealand, and on the Chatham Rise and Auckland Island shelf at depths of 100–500 m (Anderson et al. 1998). Most commercial catch is taken from the Chatham Rise, Canterbury Bight, south-east of Stewart Island, and off the west coast of South Island (McGregor 2018). The fishery dates back to the 1960s, but recorded landings only date back to 1974 and the fishery came under the Quota Management System (QMS) in 1986. Historically, most silver warehou catch was taken as bycatch in the hoki (*Macruronus novaezelandiae*), squid (*Nototodarus sloanii*, *N. gouldi*), barracouta (*Thyrsites atun*), and jack mackerel (*Trachurus* spp.) trawl fisheries, although some targeting occurred (Phillips 2001). From 1990, the southern fishery (south of latitude 45.5°S) was predominantly squid target followed by silver warehou target, and the western Chatham Rise fishery (east of longitude 180°) was predominantly hoki target until 2008 after which the catches from hoki and silver warehou target were similar (McGregor 2018).

The stock structure of silver warehou in New Zealand waters is unknown. Spawning occurs on the western Chatham Rise, west coast South Island, and Stewart-Snares shelf in late winter, and at the Chatham Islands in spring-summer (Horn et al. 2001). The fishery is currently managed as three separate fish stocks based on the Quota Management Areas (Figure 1). The current boundaries, however, bear little relation to known spawning areas and fish distribution. An administrative stock exists for the Kermadec area (SWA 10), but no catch of silver warehou has been recorded from this area.

In a descriptive analysis of the SWA 3 and SWA 4 fisheries, McGregor (2018) showed that the main areas of catch were: Southland (encompassing the Stewart-Snares shelf, Puysegur region, and the Auckland Islands shelf); the east coast of the South Island (focussed on an area from Banks Peninsula to Mernoo Bank); and, to a lesser extent, the eastern Chatham Rise (centred around the Chatham Islands). Catch in those areas was seasonal depending on the target fishery. The distribution of silver warehou catch roughly conformed to the 100–400 m slope area, with smaller fish caught predominantly in shallower waters and larger fish in deeper waters (McGregor 2018). Catches from the Southland region were taken mainly from January to April. On the western Chatham Rise, catches were more concentrated from September to February (McGregor 2018).

A stock assessment model for silver warehou in SWA 3 and 4 is being developed under MPI Project DEE2016-16 (McGregor submitted). It is desirable to have sets of commercial catch-at-age data for input into the model to help inform fishery selectivity and year class strengths. Several previous research projects have produced age-length data and estimates of catch-at-age for SWA 3 and 4. Under Project SWA1999-01, Horn et al. (2001) produced catch-at-age distributions for Southland commercial catches in each of the years 1992–93 to 1995–96, using otoliths collected both by observers and from trawl surveys on the Stewart-Snares shelf in February 1993–1996 (Hurst & Bagley 1997). Commercial catch distributions were also produced for the same set of four fishing years for the entire Chatham Rise, but the samples of aged otoliths were relatively small (167–191 per year) leading to the distributions being relatively imprecise (Horn et al. 2001). Two additional commercial age distributions were estimated for fishing years 2004–05 and 2009–10 for the entire Chatham Rise under Project MID2010-01 (Horn et al. 2012). Most recently, age distributions were estimated for commercial catches on the western Chatham Rise fishery in September–February 2000–01, 2012–13, and 2015–16 as part of Project DEE2016-20 (Horn & McGregor 2018).

This report presents new age distributions of the commercial catch of silver warehou sampled by observers in SWA 3 and 4. The sample periods and areas are: western Chatham Rise (September–February 2006–07, 2010–11, and 2013–14) and Southland (January–April 2012 and 2014). The target mean-weighted coefficient of variation (CV) for each catch-at-age sample was 30%. This document fulfils the reporting requirements relating to silver warehou in objective 2 of Project MID2017-01 "Routine age determination of middle depth and deepwater species from commercial fisheries and resource surveys", funded by the Ministry for Primary Industries (MPI). That objective is "To age other species as required for targeted studies to meet specific research requirements".

This report also produces comparable catch-at-age distributions from the relevant area-month combinations using the available age-length data developed under previous projects. These comparable age distributions used only lengths and otoliths sampled from the areas and months defined in the previous paragraph. Consequently, the report summarises eight distributions for silver warehou on the western Chatham Rise, and six distributions for Southland.

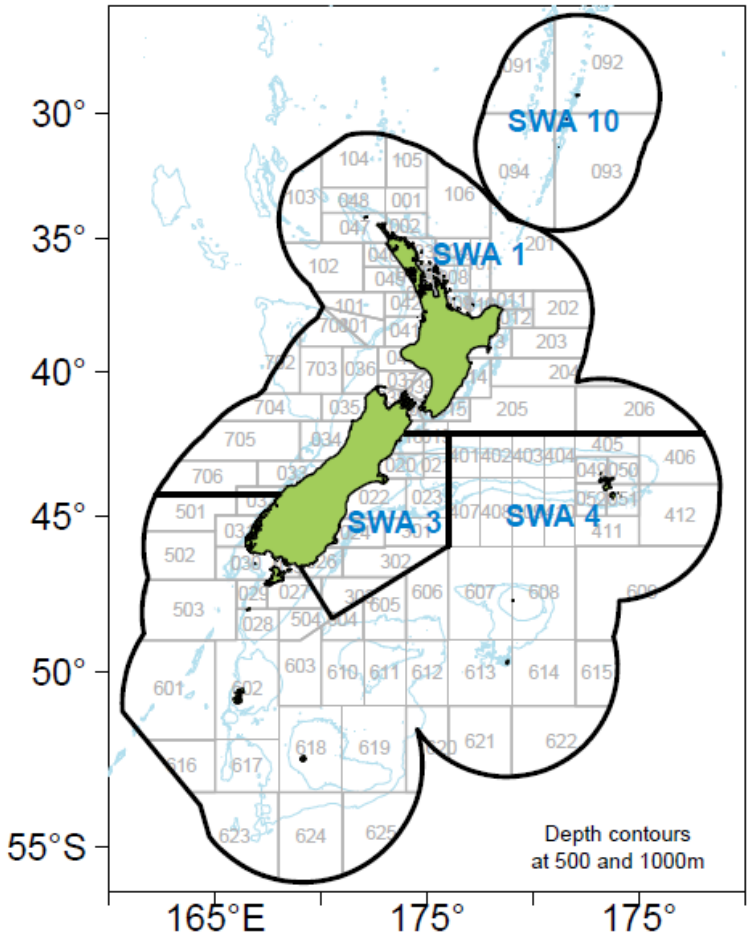

Figure 1: Quota Management Area (QMA) boundaries for silver warehou Fishstocks SWA 1, SWA 3, SWA 4, and SWA 10, as well as statistical areas (grey), and 500 m and 1000 m depth contours (blue lines).

2. METHODS

The recommended sampling scheme for silver warehou used by Ministry observers was described in full by Sutton (2002). Typically, about 100 fish were randomly sampled from the catch for length measurements every two to three days during each fishing trip. Samples were collected more frequently when larger catches of silver warehou were made. Fork length, to the nearest centimetre below actual length, and sex were collected from each fish in these samples. Sagittal otolith pairs were collected from subsamples of fish randomly sampled for length measurements. The sampling protocols used by Ministry observers for target and bycatch species are quite different. Generally, target species data are collected from every observed fishing event or trawl, whereas bycatch species data are collected at most from a single observed fishing event per observed day (Sutton 2002).

The project aim was to age samples of 300 otoliths from each of the chosen area-year combinations, i.e., western Chatham Rise (September–February 2006–07, 2010–11, and 2013–14) and Southland (January–April 2012 and 2014). The western Chatham Rise samples were selected from observed trawl tows in a box defined by latitudes 42.5°–45.0° S and longitudes 172.5° E–180.0°, from September to February. The Southland samples were from south of latitude 46° S, from January to April.

For each sample, otoliths (by 1 cm length classes) were selected roughly in proportion to the scaled length-frequency distribution, although with some weighting in favour of fish over 40 cm to better inform multiple year classes. Fish of lengths greater than 40 cm were likely to comprise multiple age classes from about ages 4 to 20, and fish from the shorter lengths likely to comprise only about three age classes (Horn et al. 2001). Silver warehou have previously been aged, with no statistically significant difference in growth rate between sexes (Horn et al. 2001), so sex was not considered as a factor in the otolith selection process.

Silver warehou were aged using counts of zones in otolith cross-sections, which were shown to form annually (Horn & Sutton 1996). Cross-sections were prepared by baking whole otoliths in an oven until amber coloured (275°C for 4 min), embedding them in clear epoxy resin, and cutting the otolith transversely through the nucleus with a diamond-edged saw. The cut surface of the resin block was coated in paraffin oil, illuminated by reflected light, and examined under a binocular microscope (×40). A pattern of dark brown and light brown zones was apparent. The dark brown zones on the cross-section corresponded with the translucent zones on the whole otolith. Counts of zones in the otolith section were generally made on the ventral side adjacent to the sulcus. The number of complete dark zones (i.e., dark zones with lighter material outside them) were counted. Fish length was unknown to the single otolith reader.

For each sampled year, catch-at-age was calculated by constructing an age-length key and applying it to the scaled length frequency data derived from the fishery using software developed specifically for this task by NIWA (Bull & Dunn 2002). For each year-fishery sample, an age-length key was constructed using the data for all successfully aged otoliths. Occasionally, additional 'estimated' data were included to describe the ages of fish in the distinct juvenile length-frequency modes if some lengths in these modes had not been sampled and aged. Where otoliths were not available for large lengths (greater than 50 cm) in some samples, a 'plus' category was estimated. Fishery catch-at-age distributions were scaled to the total estimated catch in the time period sampled. The western Chatham Rise and Southland fisheries each had two strata (see below), so for each fishery the length frequency data from each stratum were first scaled to the estimated catch from that stratum, and then the length frequencies from the two strata were summed, and the age-length key was applied to the total length frequency.

The stratification of trawl tows was developed based on the median length of silver warehou measured in each observed tow, using available effort and location variables. Following methods outlined by Breiman et al. (1984), a classification tree was developed with suitable splitting variables; data were presented as branches with similar proportions within each stratum and diverse proportions between strata. The tree was pruned based on the 1 standard error rule. A single tree was developed for each fishery.

3. RESULTS

3.1 Fishery stratification

For the western Chatham Rise fishery, three nodes were required (Figure 2). This gave three strata: Shallow (February), Shallow (Sep–Jan) and Deep, but the month effect was ignored as only 33 tows over all fishing years were sampled from less than 306 m in February. Hence, two strata were used: 1, Shallow (<306 m), and 2, Deep (≥306 m) (Figure 2). Silver warehou in shallower waters tended to be smaller than those in deeper waters.

For the Southland fishery, three nodes were required (Figure 3). This gave two strata based on target species: 1, Shallower predominantly midwater species (target species barracouta, jack mackerels, arrow squid, redbait, blue warehou), and 2, Deeper predominantly demersal species (target species hoki, hake, ling, scampi, silver warehou, white warehou). Stratum 1 also split by latitude; however, the latitude branch with 498 data points did not have data from every year, so only the target species split was kept. Silver warehou taken by the shallower, midwater target fisheries tended to be smaller than those taken by the deeper, bottom trawl fisheries.

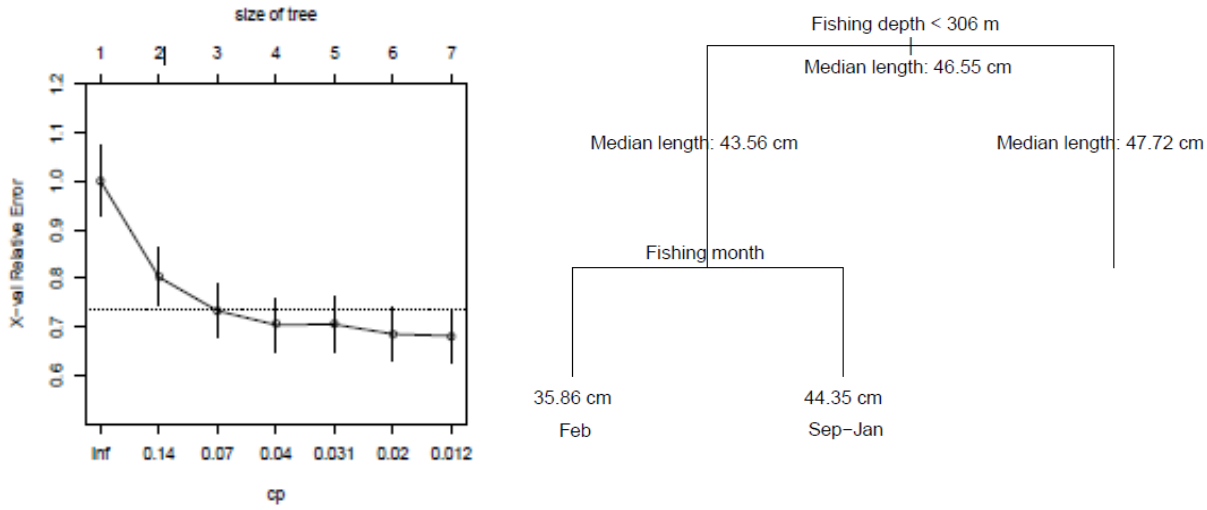

Figure 2: Regression tree relative error for the Western Chatham Rise fishery by number of nodes (left panel); regression tree with three nodes (right panel).

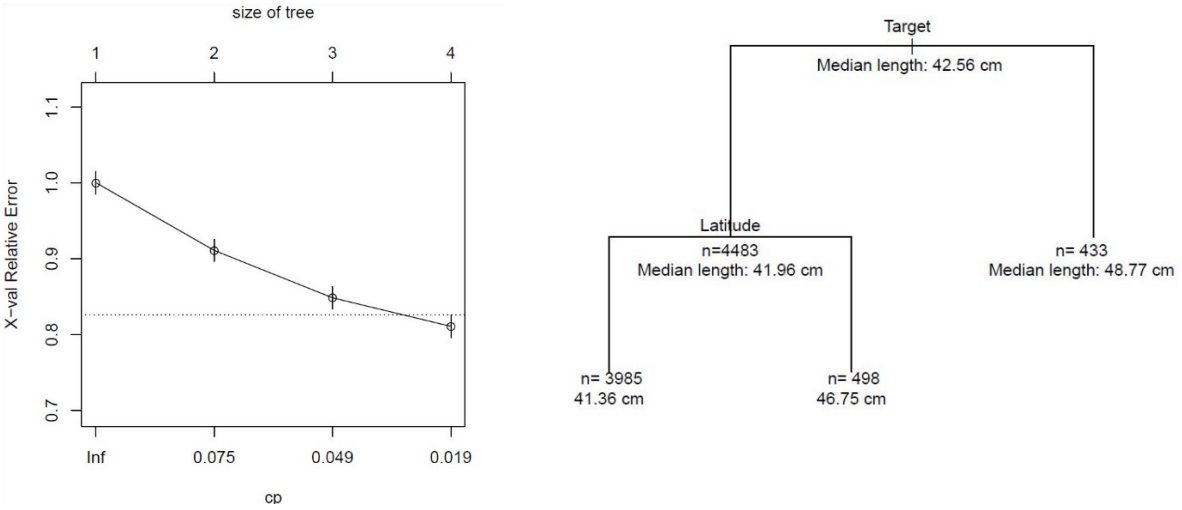

Figure 3: Regression tree relative error for the Southland fishery by number of nodes (left panel); regression tree with three nodes (right panel).

3.2 New catch-at-age distributions

The details of the estimated catch-at-age distribution for trawl-caught silver warehou from the western Chatham Rise in 2006–07, 2010–11, and 2013–14 are presented in Table 1. The mean weighted CVs of

24% or lower for the three samples bettered the target value of 30%. The estimated distributions were dominated by fish 2–10 years old, with none older than 19 years.

The details of the estimated catch-at-age distribution for trawl-caught silver warehou from Southland in 2012 and 2014 are presented in Table 2. The mean weighted CV of 27% for the 2014 sample bettered the target value of 30%, but the 2012 sample had a slightly higher CV of 33%. The estimated distributions were dominated by fish 1–14 years old, with none older than 19 years.

Table 1: Calculated numbers-at-age (sexes combined), with CVs, for silver warehou caught during commercial trawl operations on the western Chatham Rise in September–February 2006–07, 2010–11, and 2013–14. Summary statistics for the sample are also presented. The 'plus' category constitutes fish of large lengths for which no otoliths were available.

	2006–07		2010–11		2013–14	
Age (years)	Number	CV	Number	CV	Number	CV
0	0	–	362	1.533	0	–
1	8 892	1.400	6 339	0.405	19 212	0.563
2	37 243	0.589	19 002	0.452	45 894	0.356
3	74 928	0.302	70 351	0.286	37 537	0.223
4	94 518	0.195	128 354	0.212	27 972	0.280
5	145 453	0.149	281 632	0.123	26 203	0.263
6	226 382	0.115	550 553	0.079	27 241	0.267
7	104 169	0.169	136 966	0.174	61 763	0.170
8	44 501	0.275	99 608	0.229	83 818	0.136
9	29 115	0.349	69 809	0.274	140 710	0.100
10	15 050	0.473	106 627	0.217	16 413	0.338
11	17 698	0.390	5 716	1.046	14 983	0.323
12	18 443	0.422	0	–	24 854	0.249
13	12 661	0.502	3 786	1.068	11 721	0.361
14	6 727	0.688	5 897	1.047	5 050	0.604
15	2 725	0.809	0	–	0	–
16	522	1.390	0	–	0	–
17	3 473	1.085	0	–	0	–
18	0	–	0	–	0	–
19	529	1.496	0	–	0	–
20	0	–	0	–	0	–
21	0	–	0	–	0	–
plus	0	–	743	1.770	0	–
No. measured		903		4 622		4 632
No. aged		305		303		306
No. of trips sampled		9		14		25
No. of tows sampled		51		91		133
Mean weighted CV (%)		24.1		16.4		21.6

Table 2: Calculated numbers-at-age (sexes combined), with CVs, for silver warehou caught during commercial trawl operations off Southland in January–April 2012 and 2014. Summary statistics for the sample are also presented. The 'plus' category constitutes fish of large lengths for which no otoliths were available.

	2012		2014	
Age (years)	Number	CV	Number	CV
0	467	1.916	15	1.378
1	138 994	0.555	24 633	0.365
2	30 592	0.439	38 728	0.245
3	35 582	0.320	74 331	0.209
4	48 636	0.241	49 191	0.237
5	29 712	0.309	36 822	0.269
6	57 571	0.252	16 932	0.398
7	49 333	0.247	40 509	0.270
8	111 127	0.171	59 617	0.240
9	41 281	0.275	61 417	0.206
10	43 750	0.257	95 604	0.179
11	59 187	0.247	76 927	0.221
12	52 104	0.250	37 902	0.280
13	11 249	0.587	25 449	0.393
14	7 462	0.684	31 106	0.347
15	3 070	1.087	17 044	0.489
16	4 961	0.627	2 548	1.106
17	1 842	1.087	4 396	1.017
18	639	1.038	4 396	1.017
19	158	1.543	0	–
plus	84	2.247	246	2.603
No. measured		2 436		6 281
No. aged		299		305
No. of trips sampled		17		34
No. of tows sampled		84		182
Mean weighted CV (%)		33.1		26.7

3.3 Catch-at-age distributions from pre-existing data

A summary of sample details for all the estimated catch-at-age distributions (including those from Section 3.2 above) is provided in Table 3. Note that some of these data, and the resulting catch-at-age distributions, will differ slightly to those presented in previous reports (e.g., Horn et al. 2001, 2012) because of changes to the sampled area, the period of sampling, or the fishery stratification. However, now the samples described in Table 3 are all comparable within area (i.e., sampled from the same time periods using the same stratification).

Observer sampling of the western Chatham Rise fishery sampled both strata (i.e., Shallow and Deep) comprehensively in all analysed years, with the exception of 2004–05. In this year, no data were available from the shallow stratum, which accounted for a small proportion (14%) of the fishery catch. For the Southland area, observer sampling of both strata was comprehensive in 1993, 2012 and 2014. In 1994 and 1995, however, the deeper stratum was either not sampled at all (1994, 70% of the catch), or was very poorly sampled (1995, 62% of the catch, only 99 length measurements taken). Consequently, the numbers of older aged fish in the estimated age distributions for 1994 and 1995 are likely to be either under-estimated (1994) or very imprecisely estimated (1995). In 1996 the numbers of

sampled tows (n = 60) and aged otoliths (n = 251) were relatively small, resulting in a relatively high CV (41%).

Table 3: Summary of sample details for estimated catch-at-age distributions. mwCV, mean weighted CV (%) for catch-at-age distribution.

Sample period	No. of fish		No. of samples		mwCV
	Measured	Aged	Trips	Tows	
Western Chatham Rise					
2000–01	1 992	306	18	145	32.2
2004–05	620	314	7	75	27.2
2006–07	903	305	9	51	24.1
2009–10	2 486	343	11	84	19.0
2010–11	4 622	303	14	91	16.4
2012–13	6 506	303	27	122	19.1
2013–14	4 632	306	25	133	21.6
2015–16	4 111	318	18	90	20.2
Southland					
1993	2 601	382	11	151	26.7
1994	1 716	319	6	81	34.1
1995	1 477	303	7	94	47.2
1996	1 459	251	10	60	40.6
2012	2 436	299	17	84	33.1
2014	6 281	305	34	182	26.7

Total scaled age distributions for the available samples are presented by fishing year for the western Chatham Rise (Figure 4) and Southland (Figure 5). There are clear indications of year class progressions in both areas. On the western Chatham Rise, the year class spawned in 2000 (age 4 in 2004–05) was strong in four distributions (red bars, Figure 4). The 2005 and 2006 year classes were also relatively strong in all the distributions from 2009–10 onwards (orange bars, Figure 4). In the Southland fishery, the year classes spawned in 1991 and 1992 (ages 1 and 2 in early 1993) exhibited an apparent progression through the four early samples (red bars, Figure 5). The 2010 and 2003 year classes (apparent as age 1 and age 8 in the 2012 distribution) clearly progressed as strong cohorts through to 2014 (orange and green bars, respectively, Figure 5). Interestingly, there are no similarities between the two areas in the patterns of apparently strong year classes, although comparisons are limited to a relatively short period (2012–2014).

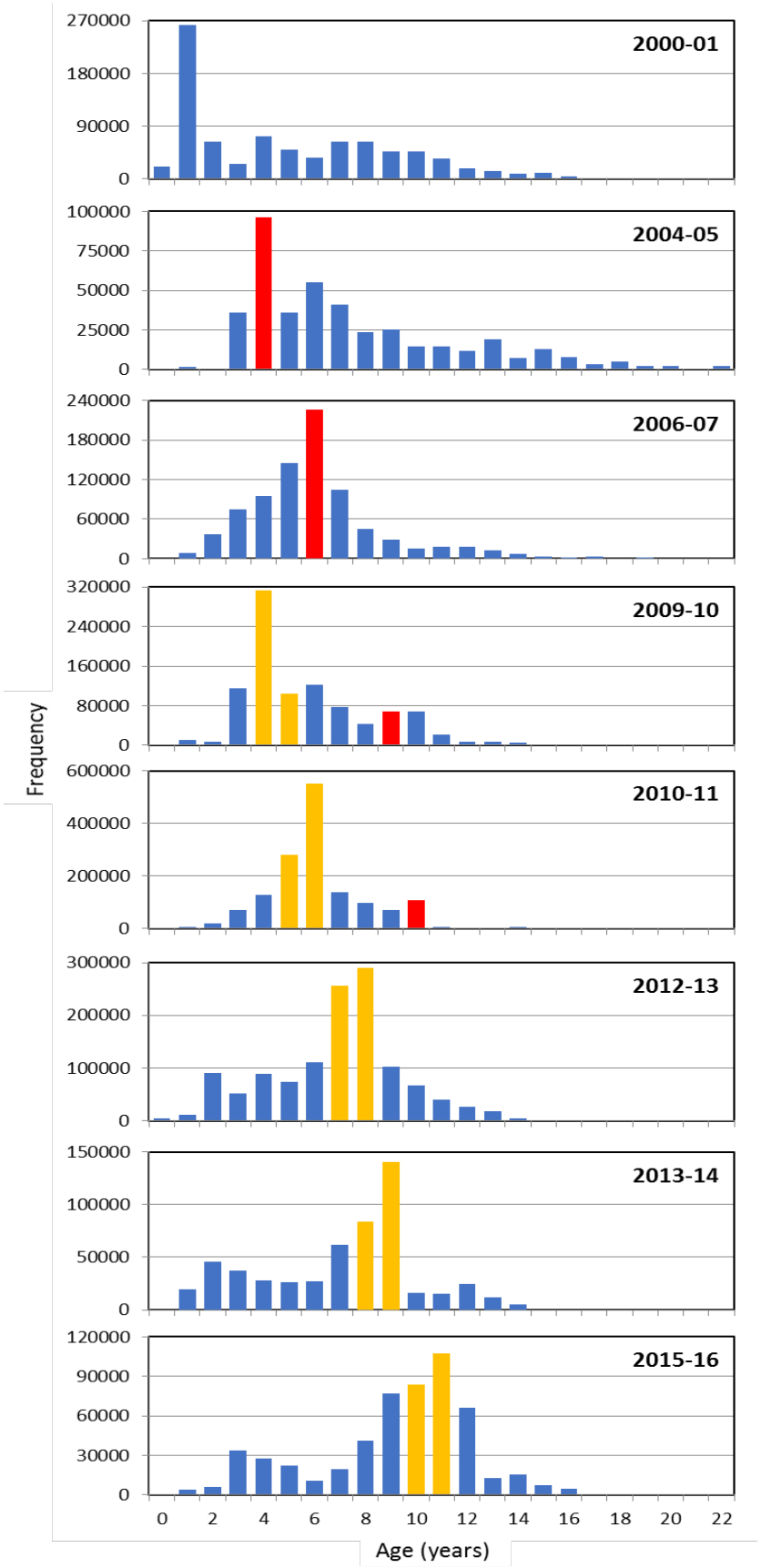

Figure 4: Scaled commercial catch-at-age distributions for the trawl catch of silver warehou sampled from the western Chatham Rise. The 2000 (red bars), and 2005 and 2006 (orange bars) year classes are indicated.

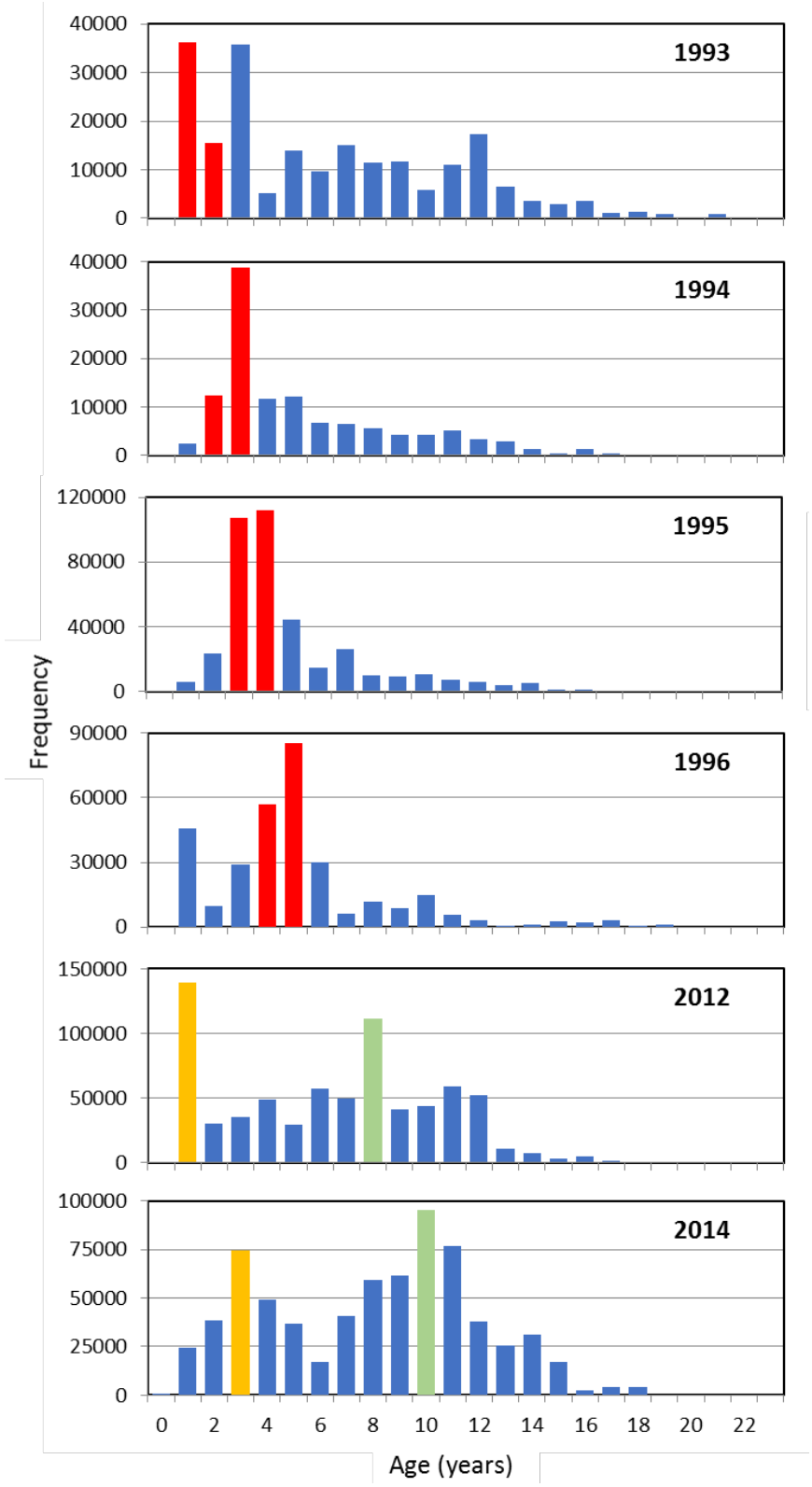

Figure 5: Scaled commercial catch-at-age distributions for the trawl catch of silver warehou sampled from off Southland. The 1991 and 1992 (red bars), 2003 (green bars), and 2010 (orange bars) year classes are indicated.

4. DISCUSSION

A stock assessment model for silver warehou in SWA 3 and 4 is currently being developed and it is desirable to have sets of commercial catch-at-age data for input into the model to help inform fishery selectivity and year class strengths. The stock structure of silver warehou in New Zealand waters is poorly understood. Spawning occurs on the western Chatham Rise, west coast South Island, and Stewart-Snares shelf in late winter, and at the Chatham Islands in spring-summer (Horn et al. 2001). The fishery is currently managed as three separate fish stocks based on the Quota Management Areas. However, the current boundaries bear little relation to known spawning areas and fish distribution. A descriptive analysis of the SWA 3 and SWA 4 fisheries showed that the main areas of catch were Southland (encompassing the Stewart-Snares shelf, Puysegur region, and the Auckland Islands shelf), the east coast of the South Island (focussed on an area from Banks Peninsula to Mernoo Bank), and, to a lesser extent, the eastern Chatham Rise (centred around the Chatham Islands) (McGregor 2018). Catch in those areas was seasonal depending on the target fishery. Catches from the Southland region were taken mainly from January to April. On the western Chatham Rise, catches were more concentrated from September to February (McGregor 2018). The stock assessment is likely to concentrate on the silver warehou from these two areas.

Several previous research projects produced age-length data and estimates of catch-at-age for SWA 3 and 4 (Horn et al. 2001, 2012, Horn & McGregor 2018). However, only Horn & McGregor (2018) produced catch-at-age distributions for the areas and months defined in the previous paragraph (i.e., the western Chatham Rise fishery in September–February 2000–01, 2012–13, and 2015–16). The current project has added three additional distributions for the western Chatham Rise in September–February (2006–07, 2010–11, and 2013–14), as well as two distributions for the Southland fishery (January–April 2012 and 2014). Previously reported data has also been reanalysed to develop additional comparable catch-at-age distributions for western Chatham Rise in 2004–05 and 2009–10, and Southland in 1993–1996. Consequently, comparable distributions of commercial catch-at-age are now available for eight years from the western Chatham Rise and six years from Southland. However, as noted, the 1994–96 Southland distributions may not be suitable for use in the assessment model as they are likely to be poorly representative of the entire Southland fishery. All other distributions should usefully inform trawl fishery selectivity ogives and year class strengths in stock assessment modelling.

The series of western Chatham Rise distributions are indicative of a fishery that is driven by pulses of recruitment; a pair of adjacent year classes (spawned in 2005 and 2006) appear to have dominated catches from 2010 to 2016. However, care must be taken when interpreting the likely future strength of year classes of young fish (i.e., fish aged 0–3 years). Based on length-frequency information from sampled trawl catches (author's unpublished data), it appears likely that silver warehou tend to school by size, so schools of smaller fish will often largely comprise a single year class. If samples are taken from relatively large catches of small fish, when scaled up, they can produce a year class that dominates a distribution numerically, as may be the case for 1-year-old fish in the western Chatham Rise distribution from 2000–01. That year class does not appear as strong in any subsequent distribution. By the time they are 4 years old, most silver warehou will be larger than 40 cm and will probably be in schools comprising multiple year classes. Samples from schools such as these are likely to provide a more accurate indication of the population age-frequency.

5. ACKNOWLEDGMENTS

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APPENDIX A. Silver warehou trawl catch-at-age data, by fishing year

This appendix lists the estimated proportions-at-age in the silver warehou trawl fisheries on the western Chatham Rise and off Southland, by fishing year. The columns in each table are headed so that, for example, the year 2007 refers to the 2006–07 fishing year. Data are presented with sexes combined, in a format that can easily be converted to a CASAL input file in a single-sex model.

Table A1: Proportions-at-age (male, female, and unsexed combined), with CVs, for the western Chatham Rise fishery, by fishing year. The 'plus' category constitutes fish of large lengths for which no otoliths were available.

	Proportion								CV							
Age	2001	2005	2007	2010	2011	2013	2014	2016	2001	2005	2007	2010	2011	2013	2014	2016
0	0.0249	0	0	0.0011	0.0002	0.0038	0	0.0007	0.755	0	0	1.611	1.533	0.536	0	1.093
1	0.3120	0.0035	0.0105	0.0107	0.0043	0.0092	0.0354	0.0072	0.254	1.215	1.400	0.640	0.405	0.535	0.563	0.435
2	0.0752	0.0004	0.0442	0.0077	0.0128	0.0729	0.0845	0.0113	0.702	1.353	0.589	0.630	0.452	0.232	0.356	0.413
3	0.0308	0.0861	0.0889	0.1184	0.0474	0.0420	0.0691	0.0618	0.517	0.356	0.302	0.211	0.286	0.323	0.223	0.265
4	0.0861	0.2311	0.1121	0.3236	0.0864	0.0714	0.0515	0.0512	0.305	0.215	0.195	0.111	0.212	0.231	0.280	0.237
5	0.0582	0.0858	0.1725	0.1075	0.1896	0.0596	0.0482	0.0417	0.262	0.287	0.149	0.183	0.123	0.260	0.263	0.274
6	0.0423	0.1326	0.2685	0.1266	0.3706	0.0904	0.0501	0.0204	0.294	0.188	0.115	0.170	0.079	0.190	0.267	0.402
7	0.0755	0.0988	0.1236	0.0794	0.0922	0.2068	0.1137	0.0361	0.189	0.169	0.169	0.171	0.174	0.120	0.170	0.300
8	0.0752	0.0568	0.0528	0.0435	0.0670	0.2341	0.1543	0.0757	0.190	0.276	0.275	0.266	0.229	0.095	0.136	0.204
9	0.0548	0.0600	0.0345	0.0697	0.0470	0.0823	0.2590	0.1417	0.257	0.225	0.349	0.226	0.274	0.195	0.100	0.154
10	0.0563	0.0347	0.0179	0.0700	0.0718	0.0539	0.0302	0.1552	0.224	0.293	0.473	0.180	0.217	0.233	0.338	0.140
11	0.0403	0.0344	0.0210	0.0225	0.0038	0.0322	0.0276	0.1983	0.259	0.291	0.390	0.387	1.046	0.314	0.323	0.122
12	0.0218	0.0280	0.0219	0.0061	0	0.0219	0.0457	0.1221	0.377	0.377	0.422	0.590	0.000	0.401	0.249	0.152
13	0.0156	0.0458	0.0150	0.0072	0.0025	0.0149	0.0216	0.0242	0.413	0.247	0.502	0.537	1.068	0.436	0.361	0.370
14	0.0100	0.0173	0.0080	0.0047	0.0040	0.0031	0.0093	0.0291	0.596	0.470	0.688	0.796	1.047	0.987	0.604	0.339
15	0.0114	0.0306	0.0032	0	0	0	0	0.0133	0.489	0.330	0.809	0	0	0	0	0.537
16	0.0053	0.0189	0.0006	0	0	0	0	0.0089	0.754	0.373	1.390	0	0	0	0	0.571
17	0.0019	0.0081	0.0041	0	0	0	0	0	1.585	0.636	1.085	0	0	0	0	0
18	0	0.0115	0	0.0010	0	0	0	0	0	0.540	0.000	1.094	0	0	0	0
19	0	0.0052	0.0006	0.0001	0	0	0	0	0	0.752	1.496	4.294	0	0	0	0
20	0.0019	0.0049	0	0	0	0	0	0	1.698	0.822	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0.0054	0	0	0	0	0	0	0	0.925	0	0	0	0	0	0
plus	0.0001	0.0001	0	0	0.0005	0.0013	0	0.0012	2.434	1.807	0	0	1.770	0.610	0	0.920

Table A2: Proportions-at-age (male, female, and unsexed combined), with CVs, for the Southland fishery, by fishing year. The 'plus' category constitutes fish of large lengths for which no otoliths were available.

	Proportion						CV					
Age	1993	1994	1995	1996	2012	2014	1993	1994	1995	1996	2012	2014
0	0	0	0	0	0.0006	0	0	0	0	0	1.916	0
1	0.1729	0.0200	0.0150	0.1431	0.1910	0.0353	0.275	0.520	0.681	0.981	0.555	0.365
2	0.0745	0.1042	0.0605	0.0308	0.0420	0.0555	0.264	0.475	0.757	0.712	0.439	0.245
3	0.1714	0.3233	0.2766	0.0903	0.0489	0.1065	0.219	0.251	0.539	0.269	0.320	0.209
4	0.0245	0.0974	0.2898	0.1782	0.0668	0.0705	0.417	0.273	0.386	0.217	0.241	0.237
5	0.0662	0.1008	0.1147	0.2673	0.0408	0.0528	0.265	0.274	0.208	0.162	0.309	0.269
6	0.0461	0.0560	0.0377	0.0945	0.0791	0.0243	0.256	0.355	0.481	0.271	0.252	0.398
7	0.0724	0.0540	0.0676	0.0196	0.0678	0.0581	0.189	0.354	0.350	0.558	0.247	0.270
8	0.0548	0.0475	0.0247	0.0370	0.1527	0.0854	0.234	0.385	0.582	0.413	0.171	0.240
9	0.0559	0.0349	0.0244	0.0267	0.0567	0.0880	0.234	0.542	0.636	0.534	0.275	0.206
10	0.0277	0.0356	0.0274	0.0466	0.0601	0.1370	0.338	0.357	0.595	0.439	0.257	0.179
11	0.0522	0.0425	0.0179	0.0177	0.0813	0.1102	0.234	0.327	0.663	0.627	0.247	0.221
12	0.0824	0.0275	0.0148	0.0102	0.0716	0.0543	0.198	0.401	0.636	0.533	0.250	0.280
13	0.0314	0.0241	0.0101	0.0012	0.0155	0.0365	0.311	0.372	0.731	0.871	0.587	0.393
14	0.0168	0.0113	0.0129	0.0035	0.0103	0.0446	0.390	0.481	0.695	1.025	0.684	0.347
15	0.0135	0.0030	0.0028	0.0084	0.0042	0.0244	0.437	0.840	0.907	0.687	1.087	0.489
16	0.0169	0.0115	0.0020	0.0070	0.0068	0.0037	0.412	0.687	1.016	0.619	0.627	1.106
17	0.0054	0.0034	0	0.0102	0.0025	0.0063	0.869	0.946	0	0.789	1.087	1.017
18	0.0063	0	0.0008	0.0000	0.0009	0.0063	0.677	0	1.452	2.367	1.038	1.017
19	0.0041	0.0008	0	0.0029	0.0002	0	0.818	1.408	0	1.361	1.543	0
20	0	0.0001	0	0	0	0	0	2.044	0	0	0	0
21	0.0044	0	0	0	0	0	0.823	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0.0021	0	0	0	0	0	1.094	0	0	0	0
plus	0	0	0	0.0049	0.0001	0.0004	0	0	0	1.580	2.247	2.603