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Catch-at-age for barracouta (*Thyrsites atun*) in BAR 5 and gemfish (*Rexea solandri*) in SKI 3 and SKI 7 for the 2021–22 fishing year

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Plain language summary

Catch-at-age data are important for the stock assessment of fish species because they provide information on the strength and progression of age classes in the stock, including juveniles and fish that are large enough to be taken by commercial fishers. These data include information on fish length and age (from otoliths—the ear bones of fish) collected at sea by observers from the commercial catch.

This report provides analyses of catch-at-age from the bottom trawl fisheries for barracouta (*Thyrsites atun*, BAR) in BAR 5 (Southland) and for gemfish (*Rexea solandri*, SKI) in SKI 3 (southeast coast) and SKI 7 (Challenger) for the 2021–22 fishing year. These results are the second of a three-year catch-at-age series for these two species.

Data for the 2021–22 season included few barracouta under 60 cm, indicating either less fishing on smaller (and younger) barracouta, or a poor year class should be expected. Most of the barracouta were aged 2–5 years.

Gemfish from SKI 3 in the 2021–22 fishing year showed a range of fish sizes, with most between 45 and 52 cm, which corresponded to age 2 fish, and also at sizes that corresponded to ages 4–6.

Gemfish from SKI 7 were less variable in length and included some fish under 50 cm, mainly females, which corresponded to ages 0–1. Most of the gemfish in SKI 7 around 50 cm in length corresponded to age 2; this was a strong cohort, particularly for males. Females were generally larger (and older) than males in the bottom trawl catch, with a strong mode at ages 5–8 for the females.

EXECUTIVE SUMMARY

Devine, J.A.[1]; Sutton, C.; Hart, A. (2024). Catch-at-age for barracouta (*Thyrsites atun*) in BAR 5 and gemfish (*Rexea solandri*) in SKI 3 and SKI 7 for the 2021–22 fishing year.

***New Zealand Fisheries Assessment Report 2024/01.* 13 p.**

Catch-at-age distributions were estimated using commercial catch and length frequency data and otoliths collected at sea by observers for barracouta (*Thrysites atun*, BAR) in BAR 5 and for gemfish (*Rexea solandri*, SKI) in SKI 3 and SKI 7 for the 2021–22 fishing year. Length frequency data and otolith samples were collected from the commercial bottom trawl fisheries. Of the otoliths collected, 450 were proposed to be aged for barracouta in BAR 5 (461 read); and 300 were proposed for gemfish in each of SKI 3 (306 read) and SKI 7 (283 read).

The length frequencies for barracouta in BAR 5 were unimodal in 2021–22 but had been bimodal in the previous two years. The 2021–22 season included few fish under 60 cm, indicating either fishing selectivity on smaller (and younger) barracouta had decreased, or a poor year class should be expected. Most of the barracouta were aged 2–5, cohorts could be tracked, and the CVs were low; ageing of additional otoliths from larger fish for the 2019–20 and 2020–21 seasons reduced the CVs for the older ages.

The length frequencies used to generate the age-length key (ALK) for gemfish in SKI 3 in the 2021–22 fishing year had multiple modes and included a strong mode between 45 and 52 cm, which corresponded to age 2 fish, with a second strong mode corresponding to ages 4–6. The age frequencies were similar for both sexes, but slightly more older fish were female, and the CVs were very low. The large number of age 1 fish in 2020–21 were clearly visible at age 2 in 2021–22. The location of otolith collection was examined to determine if including fish from outside the main squid fishery area may have had an impact on the age composition; it did not. Changing the definition of the peak of the fishery for SKI 3 from February to April, as used for the 2020–21 ALK, to December to April for the 2021–22 analysis also did not affect the length or age compositions.

The length frequencies for gemfish in SKI 7 had several modes and included some fish under 50 cm, mainly females, which corresponded to ages 0–1. Most of the gemfish in SKI 7 around 50 cm in length corresponded to age 2; this was a strong cohort, particularly for males. Females were generally larger (and older) than males in the bottom trawl catch, with a strong mode at ages 5–8 for the females. The CVs were very low for both sexes. Tracking of cohorts was possible in the age frequencies from 2020–21 to 2021–22.

[1] All authors affiliated with National Institute of Water and Atmospheric Research Ltd (NIWA).

1. INTRODUCTION

Catch-at-age data are important for the stock assessment process as they provide information on the year-class strength of recruited cohorts and enable calculation of selectivity ogives for the trawl surveys and commercial fisheries. This report provides analyses of catch-at-age from the bottom trawl fisheries for barracouta (*Thyrsites atun*, BAR) in BAR 5 (Southland) and for gemfish (*Rexea solandri*, SKI) in SKI 3 (southeast coast) and SKI 7 (Challenger) for the 2021–22 fishing year. These results are the second of a three-year catch-at-age series for these two species.

This report fulfils the reporting requirements for barracouta and gemfish in Objective 1 of research project MID2021-01 "Routine age determination of middle depth and deepwater species from commercial fisheries and resource surveys", funded by Fisheries New Zealand. The overall objective was:

1. To determine the catch-at-age for commercial catch and resource surveys of specified middle depth and deepwater fishstocks.

This project was only concerned with availability of length frequency data and otolith samples from commercial fisheries. Where sufficient samples were available, they were aged, and age distributions were constructed. There was no formal evaluation of representativeness of observer sampling, nor of the appropriateness of using the resulting age distributions for stock assessment. We expect this evaluation to be carried out as part of subsequent characterisation or assessment projects.

The Deepwater Working Group (DWWG) requested at the 11 November 2022 meeting that data from the west coast South Island (WCSI) trawl surveys be investigated for augmenting the otolith selection for SKI 7 for the 2021–22 fishing year. This was because of a lack of data for the less than 60 cm size range (or under 5 years of age) for the 2020–21 fishing year and there was concern that it may be an ongoing issue when sampling from the commercial fishery. At that time, the DWWG did not request that data from the 2020–21 fishing year be augmented with additional otoliths for the surveys. Additional otoliths from larger fish were also agreed to be aged for the BAR 5 stock for the 2019–20 and 2020–21 fishing years at the 11 November 2022 DWWG (Devine et al. 2023).

2. METHODS

Both barracouta and gemfish are each managed as five separate fishstocks within the New Zealand Economic Exclusion Zone (EEZ) (Figure 1). Length frequency data and otolith samples were collected from the commercial fisheries by Scientific Observers. Four hundred and fifty otoliths were proposed to be aged for barracouta in BAR 5, from the peak season of the bottom trawl fishery; this was between February and April. An additional 60 otoliths were selected from barracouta 65 cm or greater for the 2019–20 and 2020–21 fishing years from the peak of the trawl fishery. For gemfish, 300 otoliths per fishstock were proposed to be aged for each of SKI 3 and SKI 7. Otoliths were taken from the peak season of bottom trawl fisheries, which was between December and April for SKI 3 in 2021–22, noting that the peak had shifted slightly earlier than the previous year (when peak was February to April), and between June and September for SKI 7.

Otoliths were selected for each sex separately from 1-cm length classes approximately proportionally to their occurrence in the scaled length frequency, where at least one otolith was selected per length class, if available. All otoliths from fish in the extreme right-hand tail of the scaled length frequency distribution were fully sampled (constituting about 2% of the length frequency). This provides a sample with a mean weighted CV similar to that from proportional sampling, but typically is better than uniform sampling for the older age classes. Only tows that had at least five fish measured were included, to ensure tows had representative length data.

Otoliths were interpreted whole after a brief period of soaking in water, as per Horn & Hurst (1999) and Horn (2002). Otoliths were read and interpreted by a single reader using standardised methodologies of Horn & Hurst (1999) for gemfish and Horn (2002) for barracouta. Prior to reading otoliths, readers sampled 50 otoliths from the reference sets and their performance relative to the agreed reference ages was determined using (a) histograms of differences between reference set and reader; (b) differences between the reference set and reader for a given otolith; (c) bias plots; and (d) CV and average percentage error (APE) profiles.

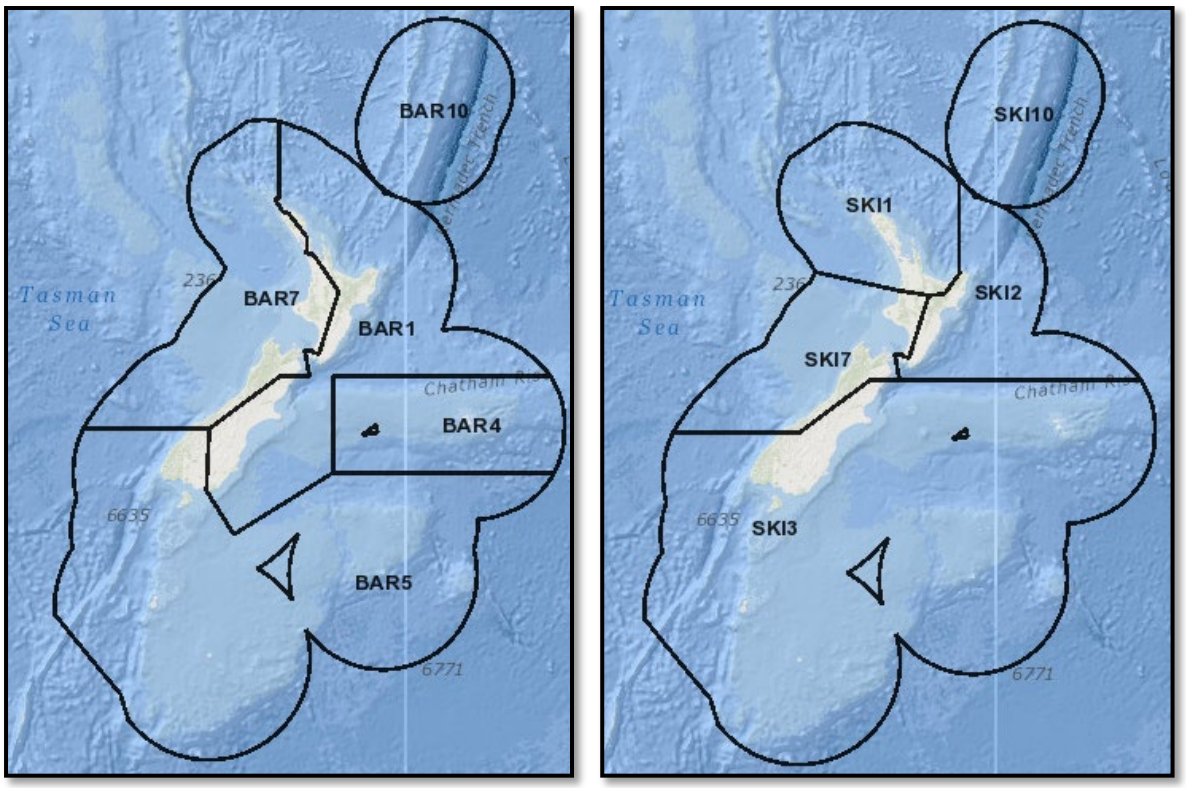

Figure 1: Barracouta (left) and gemfish (right) quota management areas (QMAs).

Otolith reading precision was quantified by carrying out within-reader comparison tests following Campana et al. (1995) for each species reference set, including the index of average percentage error (IAPE, Beamish & McFarlane 1983) and mean coefficient of variation (CV, Chang 1982), where a CV of 5% serves as a reference point for many fishes of moderate longevity and reading complexity (Campana 2001).

Commercial fishery catch-at-age distributions were derived by scaling the sample age-frequency estimates to the total estimated catch from each fishery in the time period sampled. The age data were used to construct age-length keys by sex which in turn were used to convert the weighted length composition of the catch to catch-at-age by sex (Bull & Dunn 2002). The length-weight relationships for barracouta were from Hurst & Bagley (1992) and for gemfish, from Hurst & Bagley (1998).

3. RESULTS

3.1 Barracouta

3.1.1 Reference set check

The CV and IAPE calculated for the within-reader comparison were 4.5% and 3.2%, respectively. No large systematic differences in interpretation of barracouta otoliths existed between reader 1 and the reference set (Figure 2).

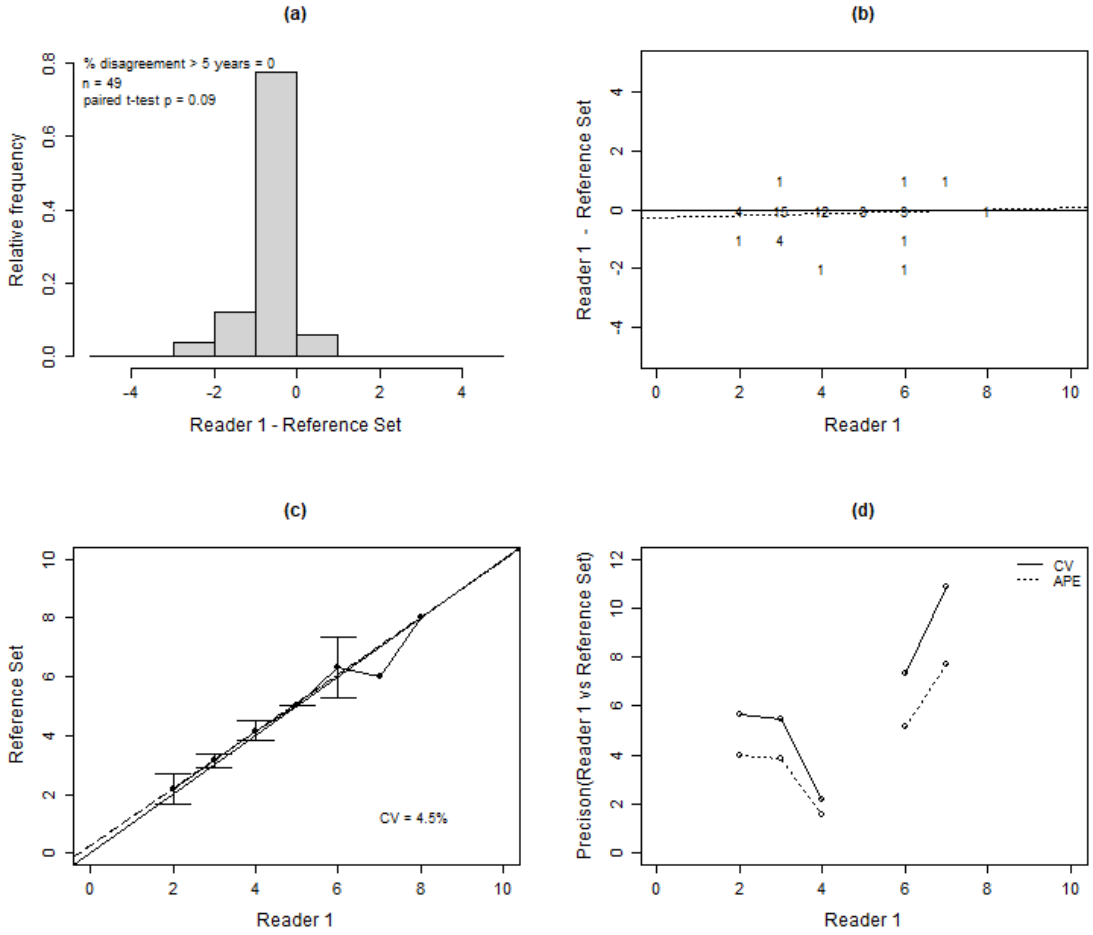

Figure 2: Results of the reference set comparison for barracouta. (a) Histograms of differences between reference set and reader; (b) differences between the reference set and reader for a given otolith; (c) bias plots; and (d) CV and APE profiles relative to the ages assigned during the first set of readings. The expected one-to-one (solid line) and actual relationship (dashed line) between the reference set and reader ages are overlaid on (b) and (c).

3.1.2 BAR 5 age composition

Population proportion-at-age was generated from observer data for the bottom trawl fishery, where data were included if a tow occurred between 1 February and 30 April and if at least five barracouta were measured to ensure that tows had representative length data. Four hundred and sixty-one otoliths were read from the 2021–22 fishing season, of which 52% were female (Table 1). The proportion of the observed catch sampled was similar to that in previous years, but fewer otoliths were collected from both sexes in the 2021–22 fishing season than previously.

Table 1: Amount of observer data and total number of read otoliths for barracouta (BAR 5) by sex for the 2019–20 to 2021–22 fishing seasons. Numbers in parentheses indicate the number of otoliths read for the previous analysis (Devine et al. 2023). – indicates no unsexed otoliths were selected for ageing.

	2019–20	2020–21	2021–22
Number of tows observed	455	320	339
Proportion catch observed	49	42	43
Number of female fish measured	9 315	6 491	7 294
Number of male fish measured	7 580	6 563	7 152
Number of female otoliths collected	1 306	851	641
Number of male otoliths collected	986	710	559
Number of female otoliths read	185 (154)	163 (133)	242
Number of male otoliths read	137 (108)	147 (122)	219
Number of unsexed otoliths read	– (55)	– (15)	–

The length frequencies used to generate the age-length key (ALK) in the 2021–22 fishing year were unimodal, whereas the length frequencies in the previous two years had been bimodal (Figure 3). The 2021–22 season included few fish under 60 cm indicating either fishing selectivity on smaller (and younger) barracouta had decreased or a poor year class should be expected. Most of the barracouta were aged 2–5 years, cohorts could be tracked, and the CVs were low; ageing additional otoliths for larger fish for the 2019–20 and 2020–21 seasons reduced the CVs for the older ages (Table 2, Figure 3).

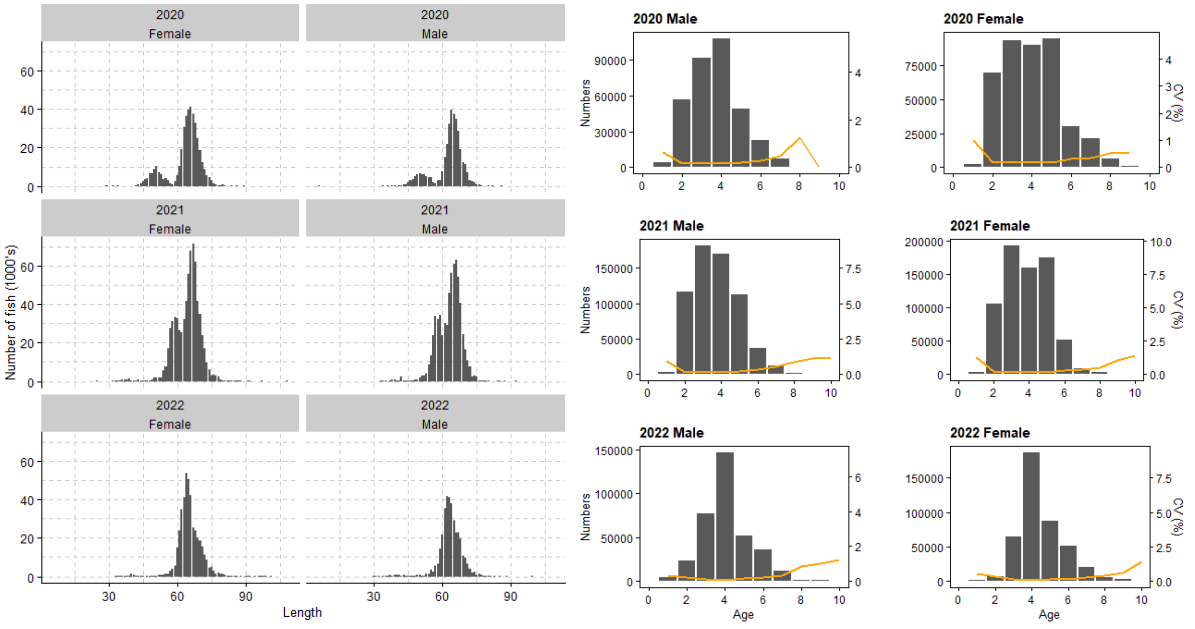

Figure 3: (left) Scaled length frequency distribution (by sex) developed from the peak of the trawl fishery (Feb–Apr) and (right) proportions-at-age (bars) and CV (lines) by sex for BAR 5 for fishing years between 2019–20 and 2021–22 for the bottom trawl fishery.

Table 2: Calculated numbers-at-age and CVs by sex for barracouta (BAR 5) from the commercial trawl fishery for the 2019–20 to 2021–22 fishing years. Age is in years. – indicates no fish of that age. Terminal age for a given year (no data or blank cells after this age) was a plus group.

	2019–20				2020–21				2022–22			
Age	Male	CV	Female	CV	Male	CV	Female	CV	Male	CV	Female	CV
1	3 908	0.60	2 125	0.89	3 102	0.93	3 544	1.16	4 552	0.39	1 950	0.59
2	50 943	0.16	62 682	0.18	109 029	0.18	98 768	0.22	22 475	0.25	6 865	0.32
3	81 796	0.18	83 603	0.19	169 854	0.15	179 871	0.15	74 581	0.14	62 698	0.16
4	96 848	0.14	80 769	0.19	158 462	0.17	149 074	0.17	141 106	0.09	179 129	0.08
5	43 784	0.22	85 264	0.17	104 602	0.21	162 715	0.16	50 069	0.16	84 200	0.13
6	20 159	0.30	27 255	0.31	34 831	0.37	48 165	0.31	34 388	0.20	48 633	0.18
7	6 667	0.49	19 334	0.36	11 852	0.53	8 697	0.39	11 190	0.35	19 958	0.27
8	162	1.14	5 609	0.55	1 953	0.85	2 487	0.58	1 183	0.80	6 000	0.44
9	–	–	661	0.58	357	1.08	211	1.02	1 193	0.98	2 674	0.56
10	846	1.24	164	0.99	412	1.29	341	1.56	309	1.18	176	1.38
11					1 044	1.07	706	1.31	–	–	–	–
12									–	–	–	–
13									–	–	142	1.43
14									–	–	1 216	0.54

3.2 Gemfish

3.2.1 Reference set check

The CV and IAPE calculated for the within-reader comparison were 3.4% and 2.4%, respectively. No large systematic differences in interpretation of gemfish otoliths existed between reader 1 and the reference set (Figure 4).

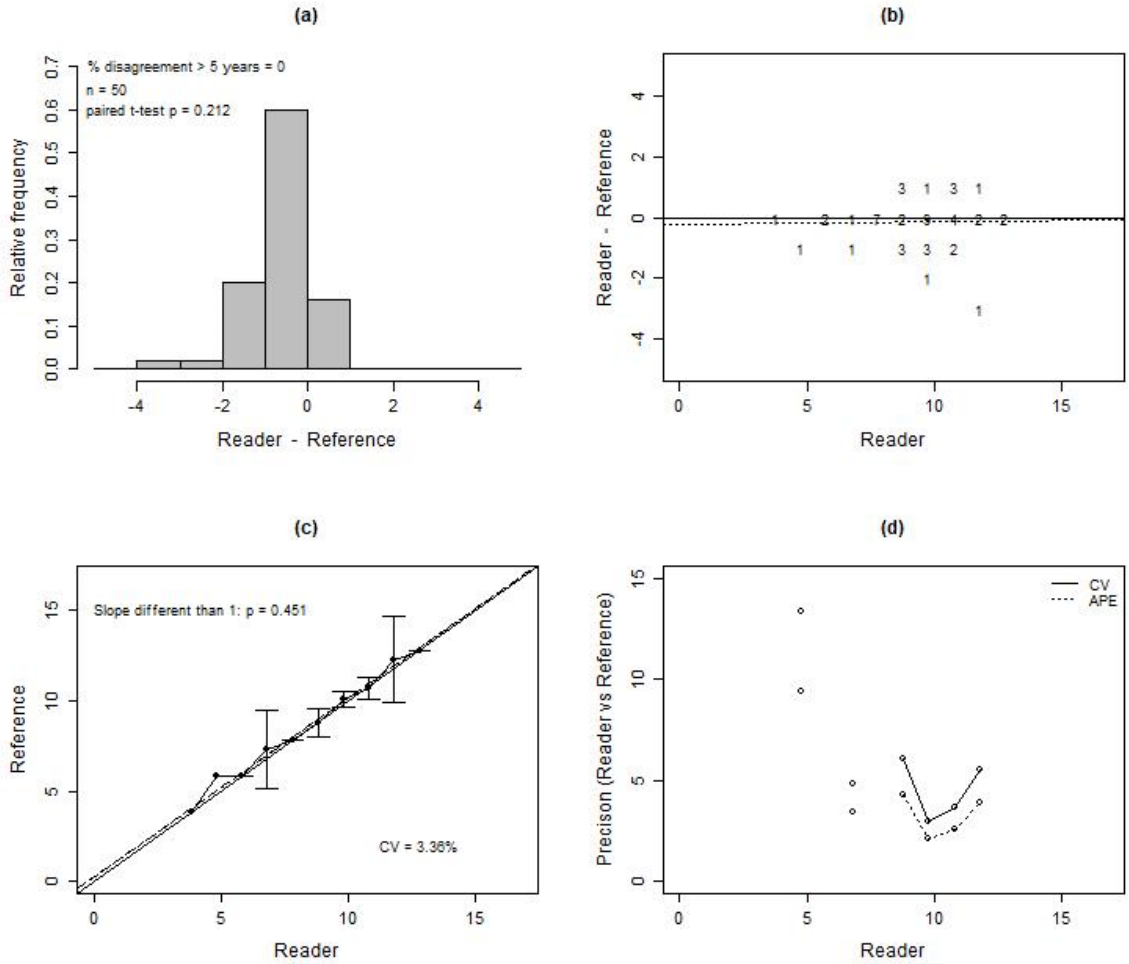

Figure 4: Results of the reference set comparison for gemfish. (a) Histograms of differences between reference set and reader; (b) differences between the reference set and reader for a given otolith; (c) bias plots; and (d) CV and APE profiles relative to the ages assigned during the first set of readings. The expected one-to-one (solid line) and actual relationship (dashed line) between the reference set and reader ages are overlaid on (b) and (c).

3.2.2 SKI 3 age composition

Proportion-at-age was generated from observer data for the bottom trawl fishery, where data were included if at least five gemfish were measured to ensure that tows had representative length data and a tow occurred between 1 December and 30 April. Three hundred and thirty-three otoliths were selected and 306 were read from the 2021–22 fishing season, of which 53% were female. The peak of the trawl fishery appeared to shift slightly earlier (December–April) compared with 2020–21 (February–April) and the length frequencies were assessed to determine if the inclusion of data from a different temporal period would have had an impact on the age compositions for both the 2020–21 and 2021–22 fishing years (Figures 5–6). No notable difference was apparent for either sex for the 2020–21 fishing year (Figure 5) and only slightly less fish under 45 cm would have been excluded in 2021–22 if the February–April period had been used (Figure 6).

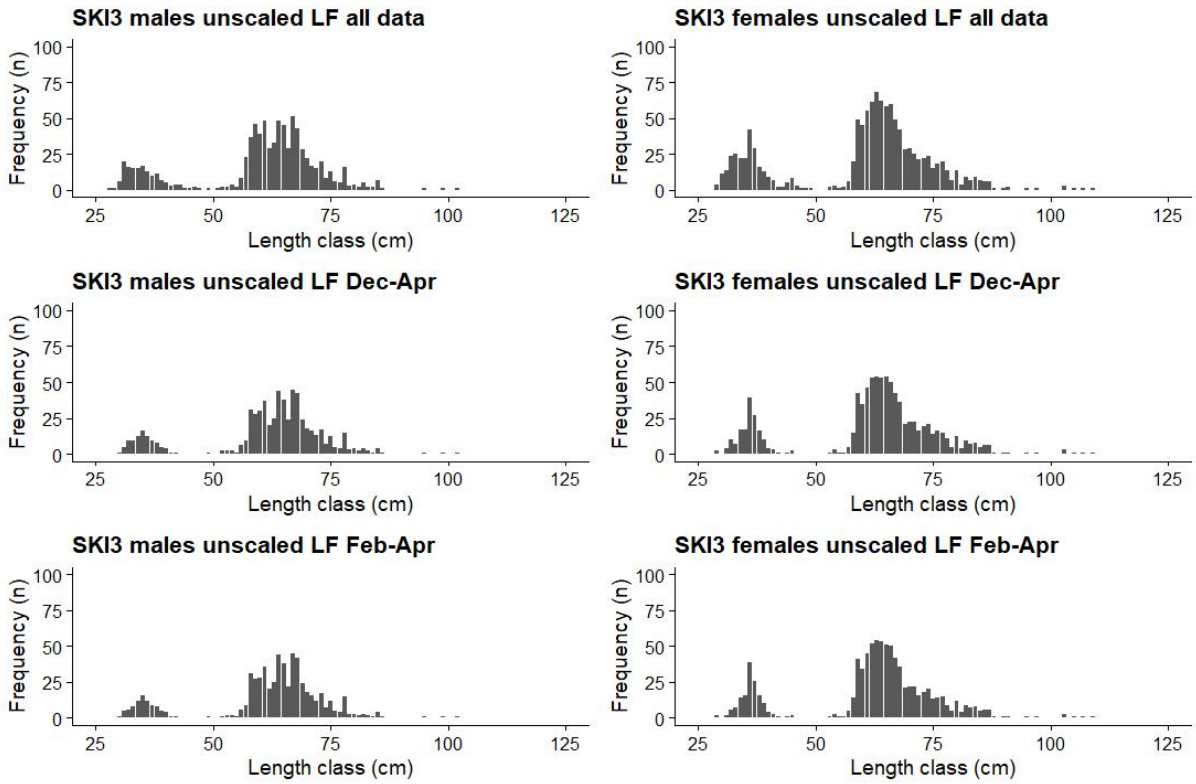

Figure 5: Comparison of the unscaled length frequencies by sex from the SKI 3 bottom trawl fishery in 2020–21 for (top) all data, (middle) December–April only, and (bottom) February–April only.

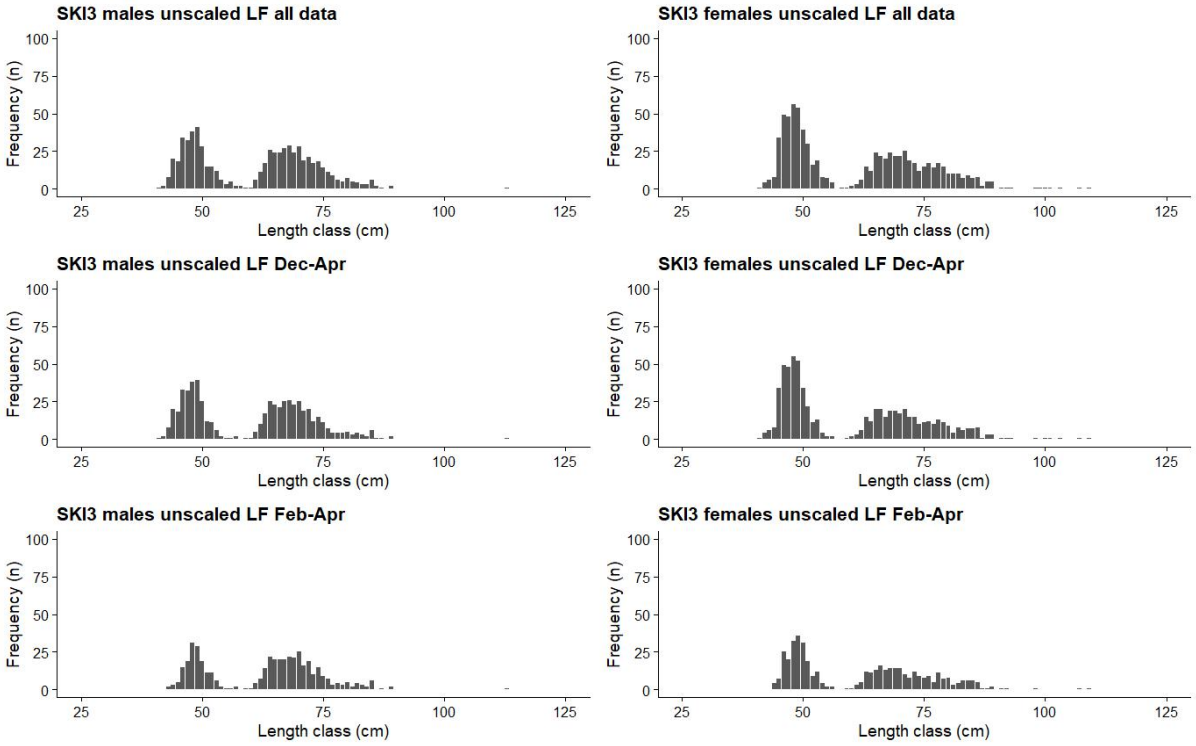

Figure 6: Comparison of the unscaled length frequencies by sex from the SKI 3 bottom trawl fishery in 2021–22 for (top) all data, (middle) December–April only, and (bottom) February–April only.

The location of where the otoliths were collected was assessed to determine if including fish from outside the main squid fishery area (Stewart-Snares shelf area) may have had an impact on the age composition (Figure 7). Otoliths from near Banks Peninsula (Statistical Areas 020 and 022) were included in the data used for generating the age composition and these areas had slightly more gemfish of age 4 and 5 than around the southern South Island in the Stewart-Snares shelf area (see Figure 7). This did not over-inflate the number of age 4 or 5 fish in the age compositions (Figure 8), likely because a large number of age 5 fish were also in the Statistical Areas 028 and 029 of the Stewart-Snares shelf (Figure 7).

The length frequencies used to generate the ALK in the 2021–22 fishing year had multiple modes and included a strong mode between 45 and 52 cm, which corresponded to age 2 fish, with a second strong mode corresponding to ages 4–6 (Figure 8). The age frequencies were similar for both sexes, but slightly more older fish were female. The large number of age 1 fish in 2020–21 were clearly visible at age 2 in 2021–22 (Figure 8). Details of the estimated catch-at-age distribution for trawl-caught gemfish in the 2021–22 fishing year are given in Table 3.

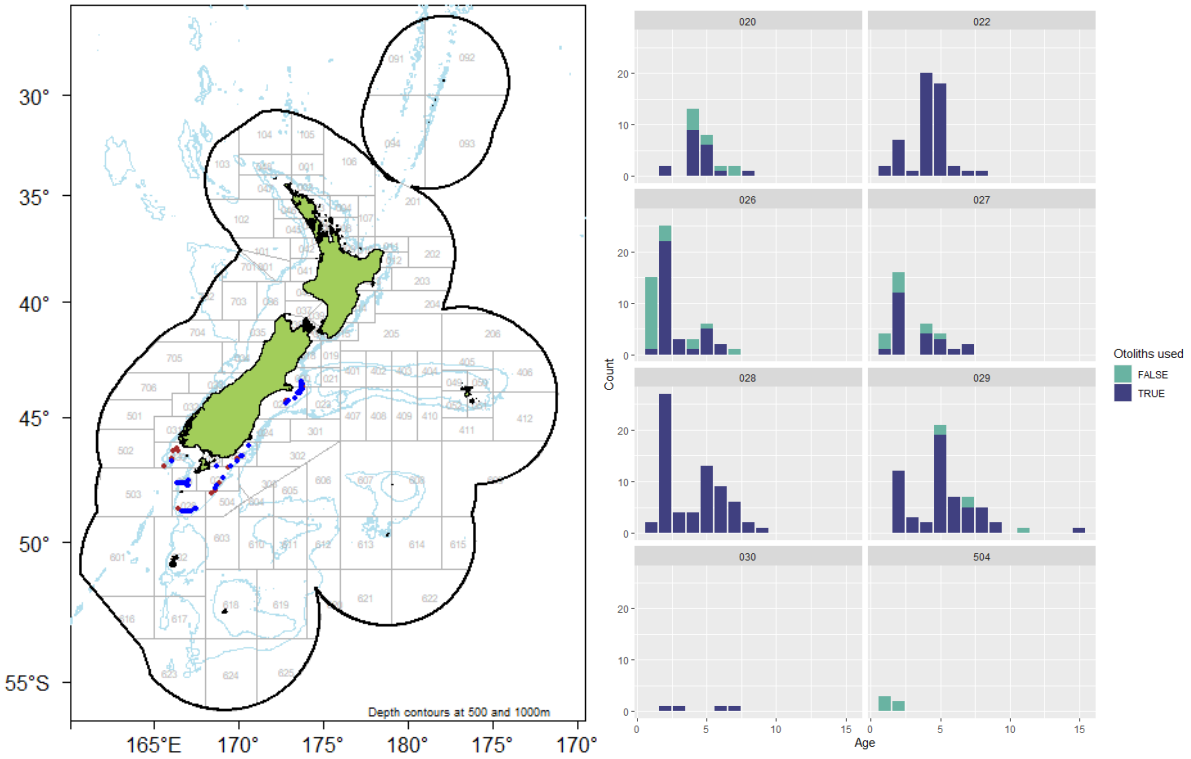

Figure 7: (left) Map showing statistical areas where otoliths were collected for gemfish in SKI 3 from the bottom trawl fishery in 2021–22 (all months, brown points; December–April only, blue points). (right) Number of otoliths by age for each of the statistical areas where otoliths were collected in SKI 3 from the bottom trawl fishery in 2021–22, colour-coded to indicate if used in the age composition (dark blue) or not (light blue).

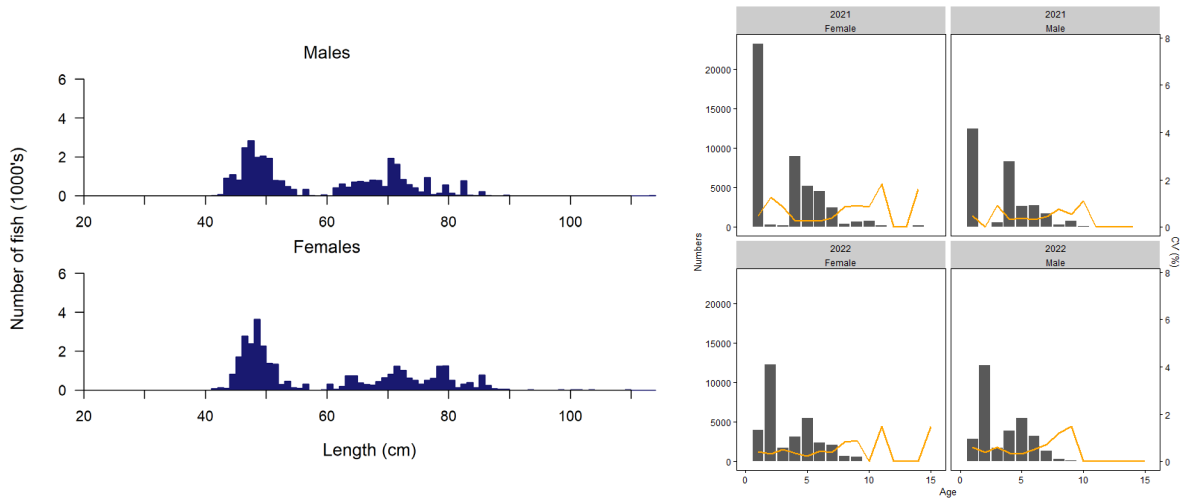

Figure 8: **(left) Scaled length frequency distribution (by sex) developed from the peak of the trawl fishery (December–April) in 2021–22 and (right) proportions-at-age (bars) and CV (lines) by sex for SKI 3 in the 2020–21 and 2021–22 fishing years for the bottom trawl fishery.**

Table 3: **Calculated numbers-at-age, separately by sex, with CVs, for gemfish (SKI 3 and SKI 7) sampled by observers during commercial trawl operations for the 2021–22 fishing year. Age is in years. – indicates no fish of that age.**

			SKI 3					SKI 7	
Age	Male	CV	Female	CV	Age	Male	CV	Female	CV
1	2 864	0.60	3 946	0.42	0	210	1.60	1 126	1.61
2	12 183	0.37	12 303	0.31	1	3	2.51	1 886	1.42
3	1 723	0.59	1 729	0.49	2	8 936	0.53	2 839	0.80
4	3 890	0.35	3 085	0.36	3	3 419	0.44	321	0.97
5	5 457	0.31	5 440	0.21	4	1 105	0.81	424	1.10
6	3 251	0.50	2 333	0.44	5	1 172	0.72	2 003	0.33
7	1 304	0.74	2 048	0.39	6	1 380	0.51	2 956	0.32
8	279	1.20	689	0.83	7	2 494	0.46	2 395	0.29
9	111	1.48	576	0.89	8	772	0.93	1 475	0.38
10	–	–	–	–	9	280	1.60	1 157	0.43
11	–	–	32	1.49	10	223	0.96	450	0.71
12	–	–	–	–	11	118	1.41	527	0.63
13	–	–	–	–	12	9	2.45	74	0.98
14	–	–	–	–	13	–	–	19	1.59
15	–	–	24	1.47	14	–	–	–	–
16+	16	1.77	61	1.59	15	–	–	18	1.46
					16	–	–	64	0.92
					17+	908	1.10	2	2.03

3.2.3 SKI 7 age composition

Proportion-at-age distributions were generated from observer data for the bottom trawl fishery, where data were included if a tow occurred between 1 June and 30 September and if at least five gemfish were measured to ensure that tows had representative length data. The length frequencies used to generate the ALK had several modes and included some fish under 50 cm, mainly for females, which corresponded to ages 0–1 (Figure 9). Most of the gemfish in SKI 7 around 50 cm in length corresponded to age 2; this was a strong cohort, particularly for males. Females were generally larger (and older) than males in the bottom trawl catch, with a strong mode of ages 5–8 for females. The CVs for both sexes were very low (Table 3, Figure 9). The large proportion of age 5 female fish and age 6 male fish observed in 2020–21 were present as age 6 and age 7 in 2021–22 (Figure 9).

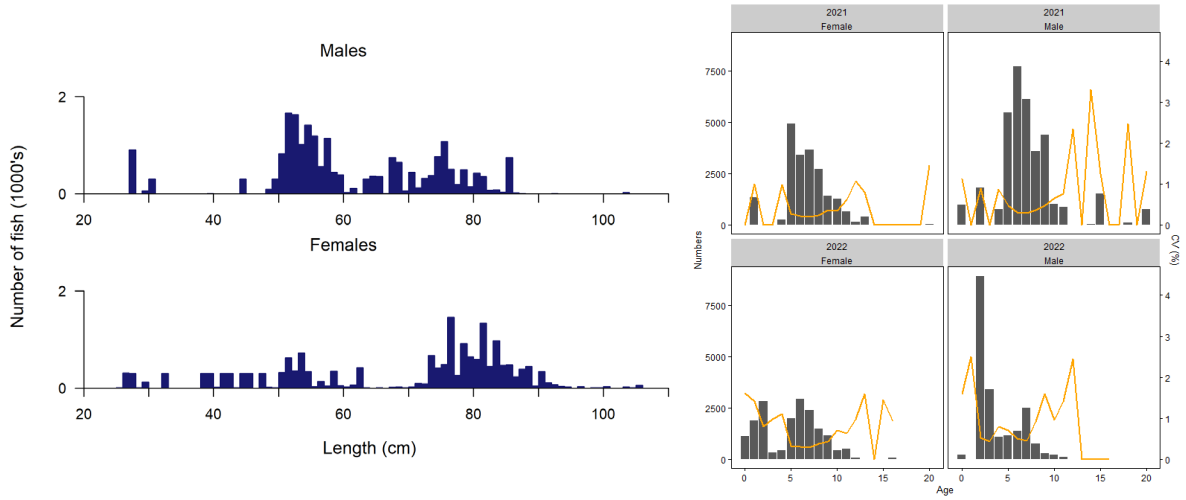

Figure 9: (left) Scaled length frequency distribution (by sex) developed from the peak of the trawl fishery (June–September) in 2021–22 and (right) proportions-at-age (bars) and CVs (lines) by sex for SKI 7 in the 2020–21 and 2021–22 fishing years for the bottom trawl fishery.

The DWWG (30 Aug 2023) requested a comparison of the length frequencies from the RV *Tangaroa* WCSI survey and the SKI 7 observer data. The unscaled length frequencies for gemfish from the 2021 survey were similar to the unscaled length frequencies from the observer data from the bottom trawl fishery (Figure 10). No gemfish have been aged yet from the WCSI survey.

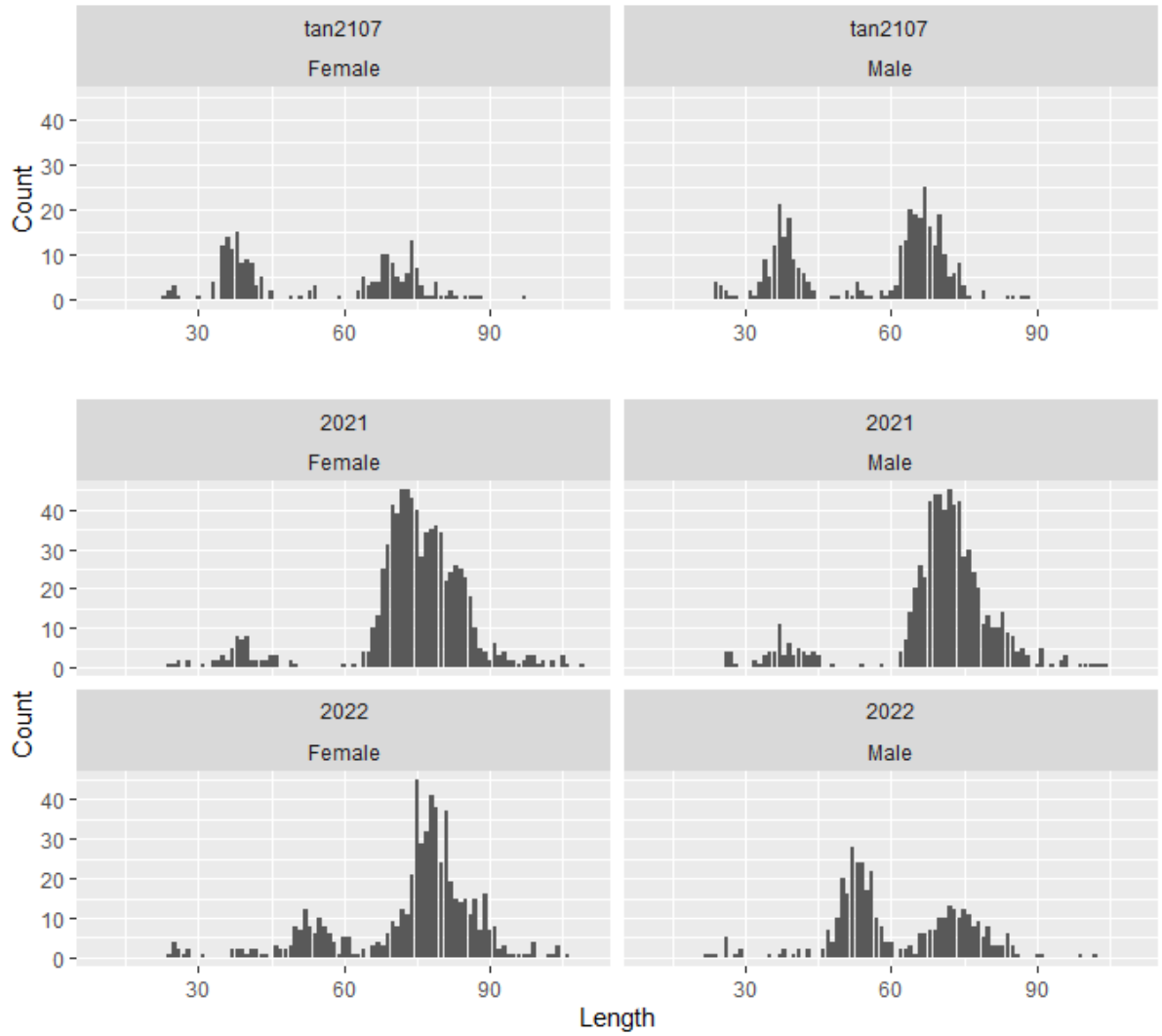

Figure 10: Unscaled length frequency distributions (by sex) of fish that had otoliths collected from the (top) 2021 WCSI (offshore) survey, (middle) peak of the bottom trawl fishery for SKI 7 in 2021, and (bottom) peak of the bottom trawl fishery for SKI 7 in 2022.

4. DISCUSSION

The bottom trawl fisheries for BAR 5, SKI 3, and SKI 7 were well covered by the observers and enough otoliths were selected from the peak of each fishery to generate an age-length key for the three stocks for these fisheries. The CVs were good for all ages for all three stocks and strong year classes could be tracked in subsequent years.

Changing the definition of the peak of the fishery for SKI 3 from February to April, as used for the 2020–21 ALK, to December to April for the 2021–22 analysis might affect the age composition. The data used, both length frequencies and spatial distribution of the ages (at the scale of the statistical area) indicated that there was no effect; the length distribution of the samples were similar and there was no effect of including slightly more age 4 and 5 fish from the east coast of the South Island.

The DWWG (7 September 2023) noted that should more age information be needed for SKI 7 for the 2020–21 fishing year, additional age information could be used from the WCSI offshore survey. At the time of writing, no decision has been made by the working group to do so.

The strong cohorts of females at age 5 and males at age 6 in SKI 7 in 2020–21 were seen again the following year (2021–22) when they were at ages 6 and 7. Why the strong cohorts did not originate from the same year in both sexes is not known. We suggest the next project to age this species and region should allow time to examine the otoliths and how they were collected more closely, to see if there could be a selectivity pattern, or a potential ageing bias, to explain this feature.

5. ACKNOWLEDGEMENTS

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