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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 2022–23 fishing year

New Zealand Fisheries Assessment Report 2025/05

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ISSN 1179-5352 (online)
ISBN 978-1-991330-81-9 (online)

January 2025

Te Kāwanatanga o Aotearoa
New Zealand Government

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Devine, J.A.; Sutton, C.; Hart, A.; Spong, K. (2025). Catch-at-age for barracouta (*Thyrsites atun*) in BAR 5 and gemfish (*Rexea solandri*) in SKI 3 and SKI 7 for the 2022–23 fishing year. *New Zealand Fisheries Assessment Report 2025/05.* 12 p.

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PLAIN LANGUAGE SUMMARY

Catch-at-age data are important for stock assessment because they provide information on the strength and progression of age classes in the stock. These data include information on the length and age, from otoliths (the ear bones of fish), collected at sea by observers from the commercial catch.

This report provides estimation 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 2022–23 fishing year. These results are the third of a three-year catch-at-age series for these two species.

Most of the barracouta were aged 2–5 years and strong and weak cohorts could be tracked across years.

Gemfish from SKI 3 in the 2022–23 fishing year indicated that a large number of age 2 fish were present, but that the age 3 cohort was missing. Ageing error was not thought to explain this discrepancy.

Female gemfish from SKI 7 were generally larger (and older) than males in the bottom trawl catch, and a large number of fish under the age of 3 were present. Augmenting the 2020–21 data with information on smaller (younger) fish from the 2021 West Coast South Island trawl survey added information for fish aged 0–2.

EXECUTIVE SUMMARY

Devine, J.A.[1]; Sutton, C.; Hart, A.; Spong, K. (2025). Catch-at-age for barracouta (*Thyrsites atun*) in BAR 5 and gemfish (*Rexea solandri*) in SKI 3 and SKI 7 for the 2022–23 fishing year.

***New Zealand Fisheries Assessment Report 2025/05.* 12 p.**

Catch-at-age distributions were estimated using commercial catch and length frequency data and otoliths collected at sea by observers and then aged for barracouta (*Thrysites atun*, BAR) in BAR 5 and for gemfish (*Rexea solandri*, SKI) in SKI 3 and SKI 7 for the 2022–23 fishing year. Of the otoliths collected from commercial bottom trawl catches, 450 were proposed to be aged for barracouta in BAR 5 (452 read); and 300 were proposed for gemfish in each of SKI 3 (228 read) and SKI 7 (307 read). An additional 34 otoliths from gemfish under 60 cm from the WCSI survey were aged to augment the 2020–21 data and the age-length key was re-estimated.

As in 2021–22, the BAR 5 length frequencies used to inform the age-length key (ALK) in the 2022–23 fishing year were unimodal, whereas the length frequencies in the 2019–20 and 2020–21 fishing years had been bimodal. Both the 2021–22 and 2022–23 seasons included few fish under 60 cm indicating either fishing selectivity on smaller (and younger) barracouta had decreased or that low recruitment should be expected. Most of the barracouta were aged 2–5 years, cohorts could be tracked, and the CVs of age frequency estimates were low. Despite few fish of age 2 in 2021–22, age 3 fish were appearing in 2022–23.

For SKI 3, as was observed in the 2021–22 fishing season, the peak of the trawl fishery was shifted slightly earlier (December–April) compared with 2020–21 (February–April). Cohort progression was clearly present in the length frequencies for the smaller fish, but in the age frequencies in 2022–23, the 55–62 cm fish were not appearing as age 3. Gemfish otoliths were not considered difficult to age for the younger ages, and the cohort progression was visible in the older ages for the 2022–23 fishing year. Selecting only lengths, catch, and ages determined from otoliths from the February–April period had no impact on the age composition for the younger fish, but the age composition for the older fish changed, with fewer age 6–9 male fish present.

Cohort progression was clearly visible for SKI 7 in both the length and age distributions, where 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 respectively in 2021–22. Augmenting the 2020–21 data with information on smaller (younger) fish from the WCSI survey added information for fish aged 0–2 (which was previously lacking).

The amount of data collected by observers of the bottom trawl fisheries for BAR 5, SKI 3, and SKI 7 has reduced. The number of fish measured in the BAR 5 fishery has declined by approximately 50% since 2019–20. All otoliths were used for the SKI 3 fishery in 2022–23 and the number collected were below the target number needed to generate the age composition. The age composition of SKI 7 was improved by including otoliths from smaller fish, collected during the 2021 West Coast South Island trawl survey.

[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 relative year-class strength of recruited cohorts and enable calculation of selectivity ogives for the trawl surveys and commercial fisheries. This report provides estimation and 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 2022–23 fishing year (New Zealand fishing years start 1 October). These results are the third 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, otoliths 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.

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. This was because of a lack of observer data from fish less than 60 cm (or under 5 years of age) for the 2020–21 fishing year; there was concern that it may be an ongoing issue when sampling from the commercial fishery. The DWWG (November 2023) requested that additional otoliths from the 2021 west coast South Island deepwater survey be included and the 2020–21 age-length key be re-estimated for this final year of the ageing contract.

2. METHODS

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 commercial fisheries by Scientific Observers. For barracouta (BAR 5), it was proposed that 450 otoliths be aged from the peak season of the bottom trawl fishery (between February and April). For gemfish (SKI 3 and SKI 7), it was proposed that 300 otoliths be aged from the peak season of each of the bottom trawl fisheries. For SKI 3 this was between December and April in 2021–22 (noting that the peak had shifted slightly earlier than the previous year when the peak was February to April). For SKI 7 this was between June and September. Additional gemfish otoliths from gemfish less than 60 cm caught in the 2021 West Coast South Island trawl survey were also aged, to augment the 2021 commercial data, as smaller fish were missing from the commercial fishery.

Otoliths were selected for each sex separately from 1-cm length classes approximately proportionally to their occurrence in the scaled length frequency distribution, 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. Otoliths were included only from bottom trawl tows that had at least five fish measured.

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 50–60 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) coefficient of variation (CV) and average percentage error (APE) profiles. If agreement was poor between the reader and the reference set, another subset of otoliths was read; the reader was allowed to proceed to production ageing only when there was good agreement between their assessed ages and the reference set.

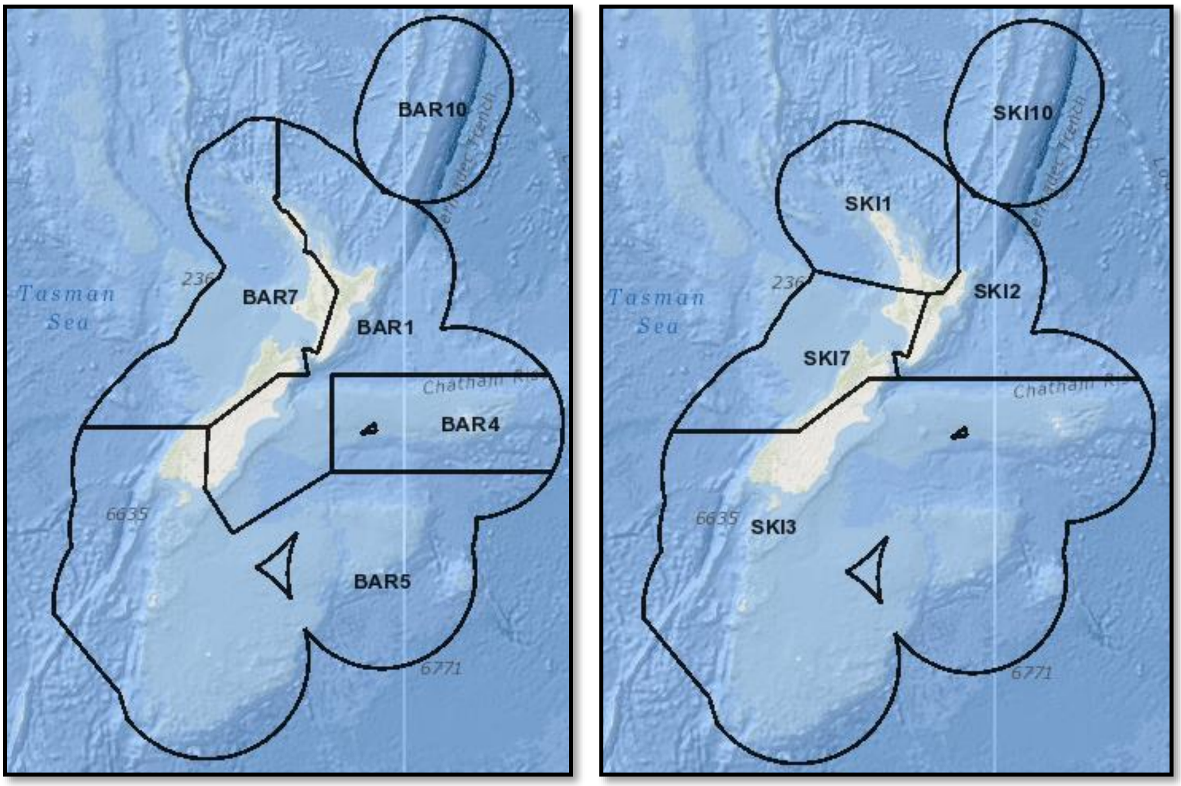

Figure 1: Barracouta (left) and gemfish (right) quota management areas (QMAs).

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 CV (Chang 1982), where a CV of 5% served as a reference point for many fishes of moderate longevity and reading complexity (Campana 2001).

The age data were used to construct age-length keys by sex which in turn were used to scale the 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 4.0% and 2.8%, respectively. No large systematic differences in interpretation of barracouta otoliths existed between reader 1 and the reference set (Figure 2).

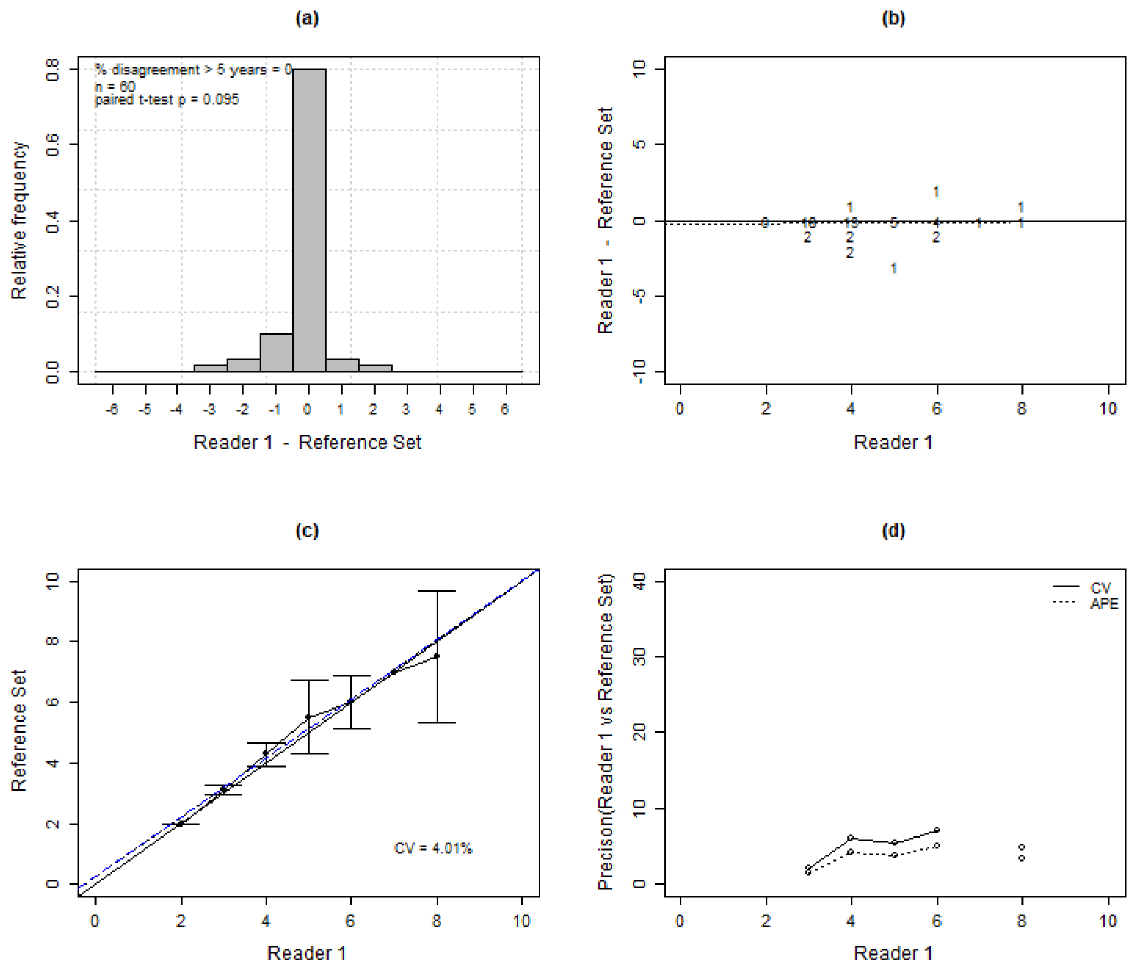

Figure 2: Results of the reference set comparison for barracouta. (a) Histograms of differences between reference set and reader; (b) differences between the reference set and reader for a given otolith; (c) bias plots; and (d) CV and APE profiles relative to the ages assigned during the first set of 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

Four hundred and fifty-two otoliths were read from the peak of the bottom trawl fishery between 1 February and 30 April for the 2022–23 fishing season, of which 53% 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 2022–23 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 2022–23 fishing seasons. Numbers in parentheses indicate the number of otoliths read for a previous analysis, before augmentation with additional otoliths (Devine et al. 2024). – indicates no unsexed otoliths were selected for ageing.

	2019–20	2020–21	2021–22	2022–23
Number of tows observed	453	320	336	230
Proportion catch observed	49	42	43	54
Number of female fish measured	9 315	6 491	7 294	4 338
Number of male fish measured	7 580	6 563	7 152	3 881
Number of female otoliths collected	1 306	851	641	629
Number of male otoliths collected	986	710	559	495
Number of female otoliths read	185 (154)	163 (133)	242	240
Number of male otoliths read	137 (108)	147 (122)	219	212
Number of unsexed otoliths read	– (55)	– (15)	–	–

The catch-scaled length frequencies in the 2022–23 fishing year were unimodal, whereas the length frequencies in the 2019–20 and 2020–21 fishing years had been bimodal (Figure 3). Both the 2021–22 and 2022–23 seasons included fewer fish under 60 cm indicating either fishing selectivity on smaller (and younger) barracouta had decreased or that one or more poor year classes might be expected. Most of the barracouta were aged 2–5 years, a cohort could be tracked (e.g., age 2 in 2020 to age 5 in 2023), and the CVs were low (Table 2, Figure 3). Despite there being few fish of age 2 in 2021–22, age 3 fish were appearing in large numbers in 2022–23 indicating that it was likely that fishing selectivity was greater on age 3 fish.

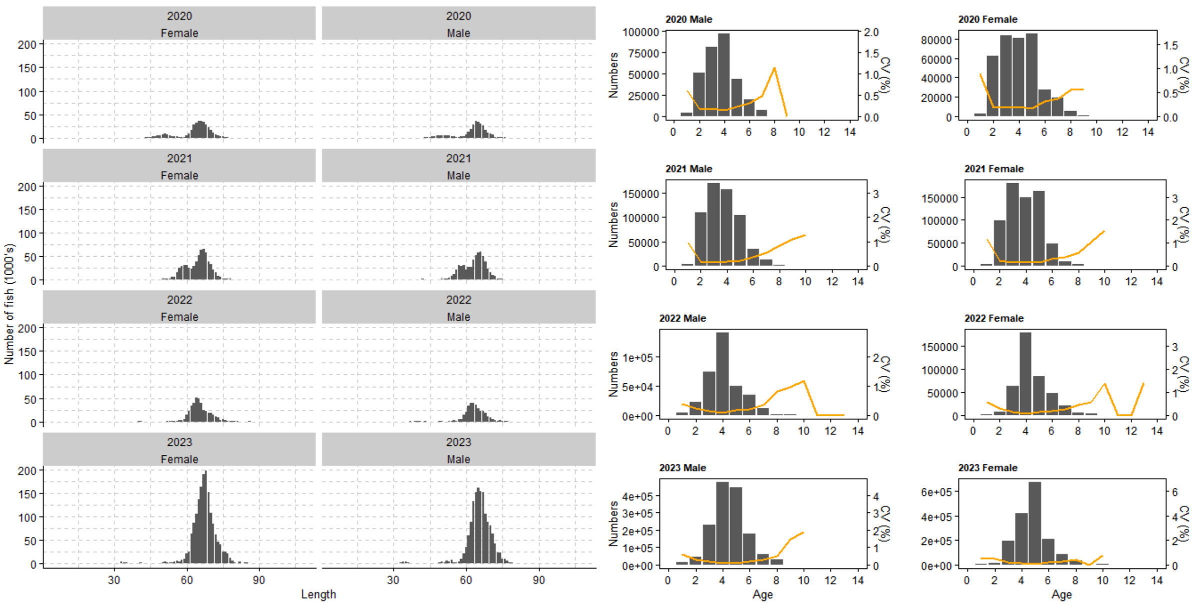

Figure 3: Scaled length frequency distributions (by sex) developed from the peak of the trawl fishery (Feb–Apr) (left) and (right) proportions-at-age (bars) and CV (lines) by sex for fishing years between 2019–20 (labelled 2020) and 2022–23 (2023) for the BAR 5 bottom trawl fishery.

Table 2: Calculated numbers-at-age and CVs by sex for barracouta (BAR 5) from the commercial trawl fishery for the 2019–20 to 2022–23 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				2021–22				2022–23			
Age	Male	CV	Female	CV	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	15 860	0.63	7 185	0.52
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	44 857	0.31	15 431	0.48
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	230 214	0.17	196 085	0.18
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	473 146	0.10	422 149	0.13
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	443 239	0.11	671 790	0.09
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	177 926	0.18	206 299	0.17
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	61 644	0.32	82 066	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	27 661	0.51	33 678	0.41
9	–	–	661	0.58	357	1.08	211	1.02	1 193	0.98	2 674	0.56	738	1.49	–	–
10	846	1.24	164	0.99	412	1.29	341	1.56	309	1.18	176	1.38	180	1.90	3 879	0.81
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 4.2% and 2.9%, respectively. There was a slight tendency for the reader to estimate older ages for the older fish, but no large systematic differences in interpretation of gemfish otoliths existed between reader 1 and the reference set (Figure 4).

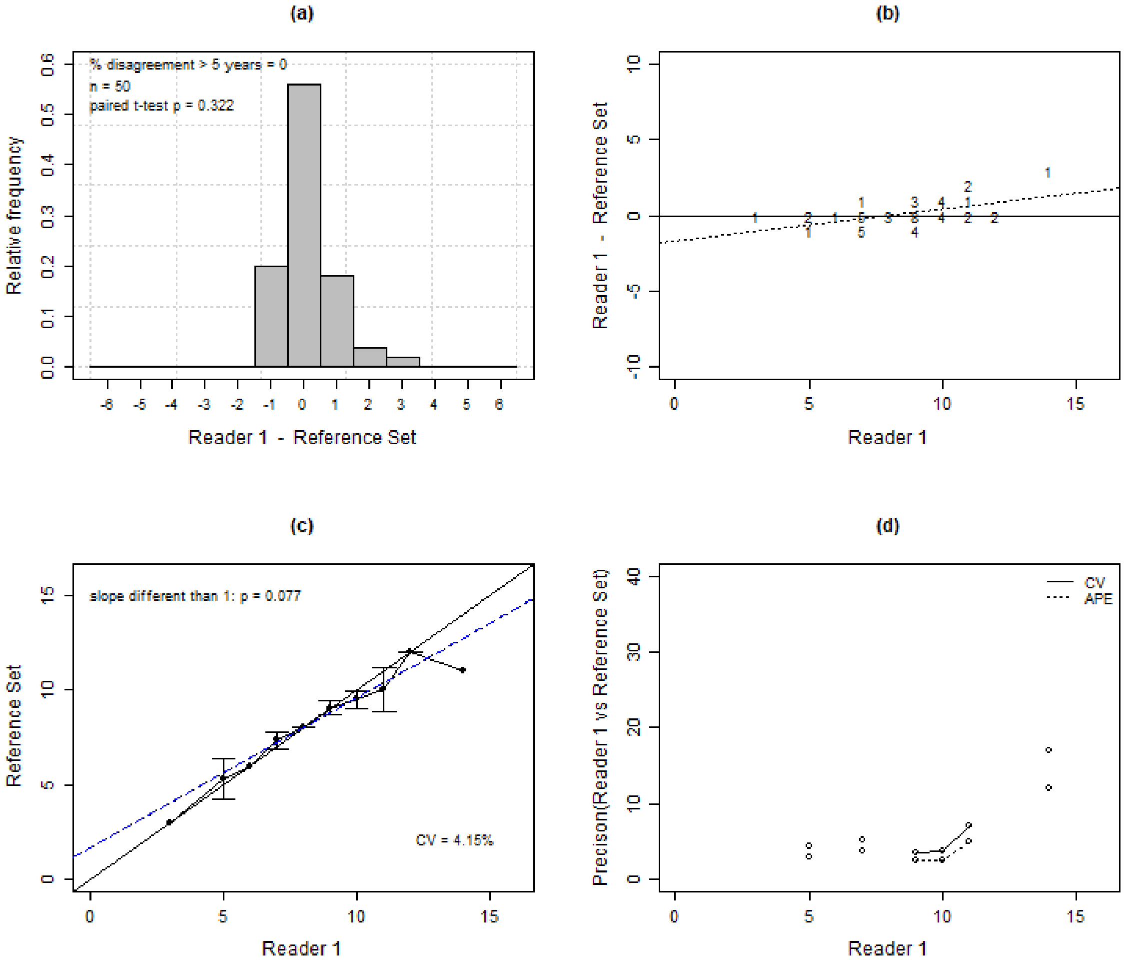

Figure 4: Results of the reference set comparison for gemfish. (a) Histograms of differences between reference set and reader; (b) differences between the reference set and reader for a given otolith; (c) bias plots; and (d) CV and APE profiles relative to the ages assigned during the first set of readings. 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

Of the otoliths collected by observers from the bottom trawl fishery between 1 December and 30 April, all but 9 were selected. This resulted in 228 otoliths selected and read from the 2022–23 fishing season, of which 57% were female. The peak of the trawl fishery was again shifted slightly earlier (December–April). The length frequencies were assessed to determine whether the inclusion of data from a different temporal period would have had an impact on the age compositions (Figure 5). If only the February–April period had been used, the frequency of fish in the 50–75 cm range would have been slightly greater, particularly for females, than when data from the whole December–April period were used.

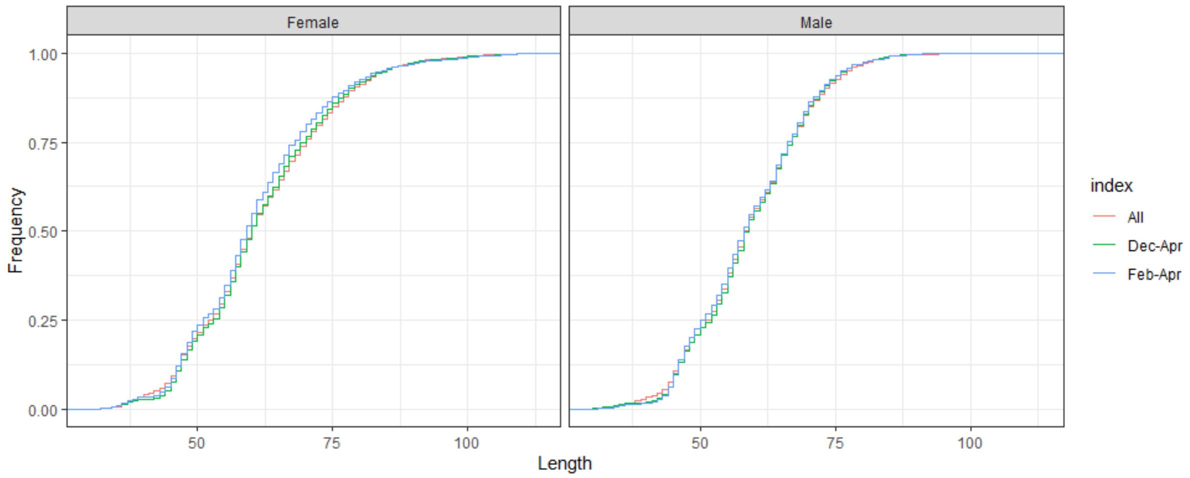

Figure 5: Cumulative proportion by length and sex from the SKI 3 bottom trawl fishery in 2022–23 for (red) all data, (blue) February–April only, and (green) December–April.

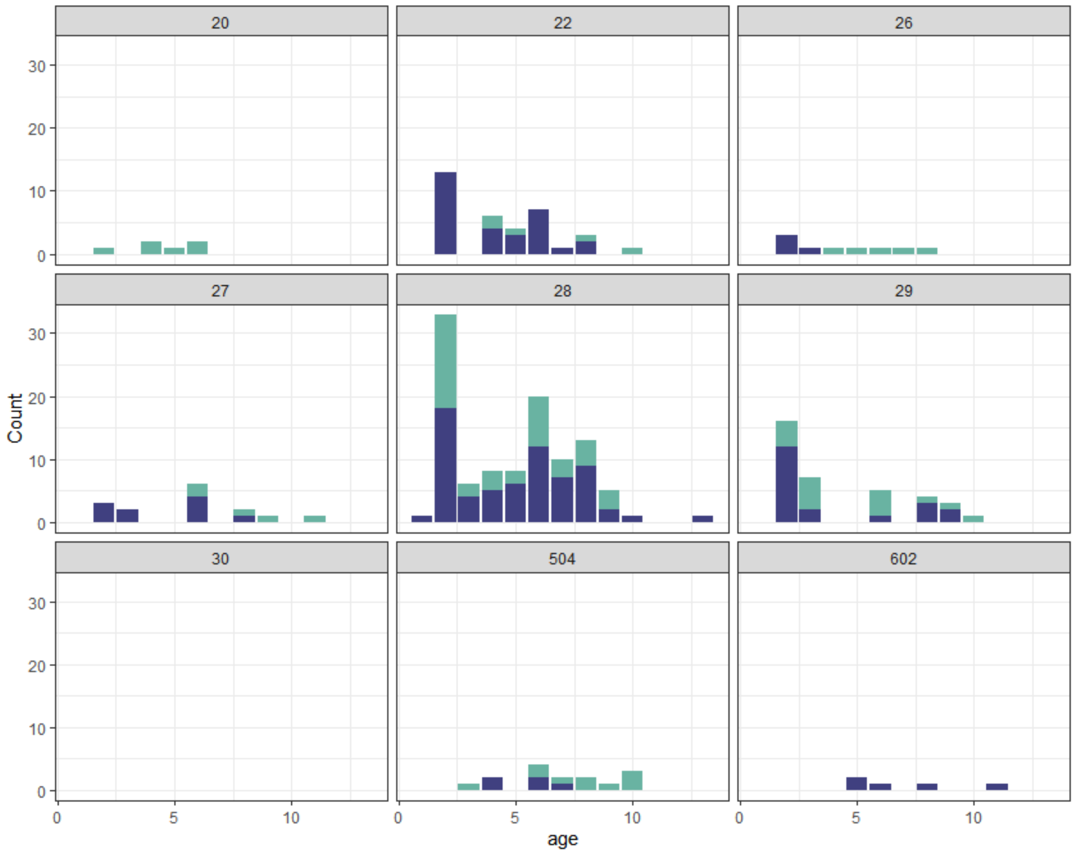

Figure 6: Number of otoliths by age for each of the statistical areas where otoliths were collected in SKI 3 from the bottom trawl fishery in 2022–23, colour-coded to indicate if available for the February–April period (dark blue) or included the December–January period. (light green).

The location of otolith collection was assessed to determine whether including fish from outside the main squid fishery area (Stewart-Snares shelf area) may have had an impact on the age composition (Figure 6). Otoliths from the Stewart-Snares shelf area (Statistical Areas 028 and 029), which were included in the data used for generating the age composition, had more gemfish of ages 2, 3, and 6 than the area around Banks Peninsula.

The length frequency distribution from the 2022–23 fishing year had multiple modes and included a strong mode between 55 and 62 cm, which corresponded to age 2 fish, with a second strong mode corresponding to ages 6–8 (Figure 7). Cohort progression was clearly present in the length frequencies from 2020–21 to 2022–23 for the smallest sized fish. However, in 2022–23, the 55–62 cm fish should have appeared as age 3, but were missing from the age distribution. The reference set checks indicated no systematic differences between the reader and the reference set collection for younger fish (although few otoliths under the age of 5 had been read). Further, gemfish otoliths were not considered difficult to age for the younger ages, and the cohort progression was visible in the older ages for the 2022–23 fishing year.

The Deepwater Working Group expressed concern about the large number of 2-year olds and lack of 3-year olds, and noted that including the December–January period resulted in the inclusion of a large number of small fish from the Stewart-Snares area (Figure 6), which was thought to play a role in the dominance of the age 2 fish. The DWWG therefore requested that the age composition be determined using data for only the February–April period. Selecting only lengths, catch, and ages determined from otoliths from the February–April period had no impact on the age composition and age 2 fish still dominated the age frequency (Table 3). However, the age composition for the older fish changed, with fewer age 6–9 male fish present.

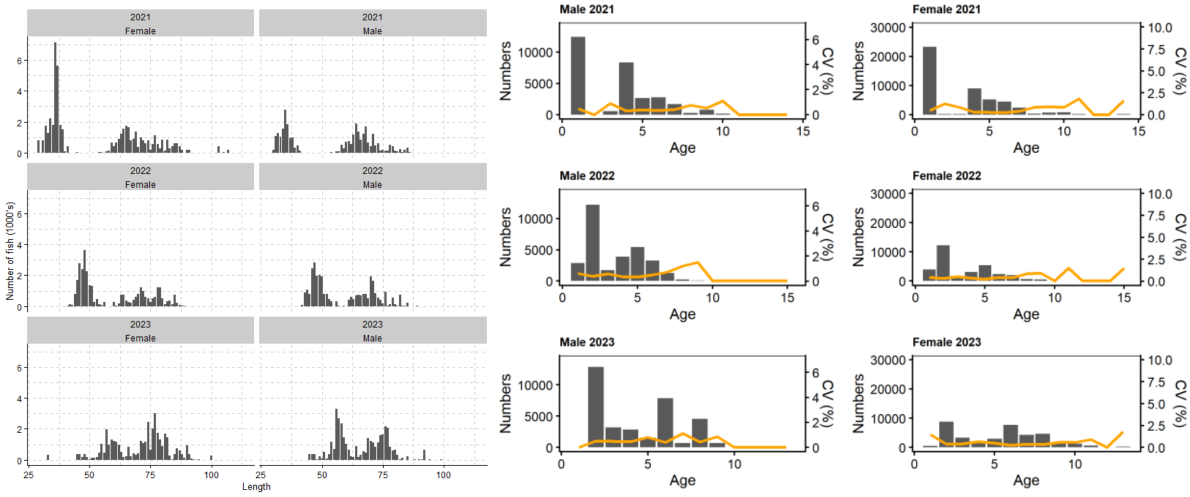

Figure 7: SKI 3 scaled length frequency distribution (by sex) developed from the peak of the bottom trawl fishery (December–April) (left). Proportions-at-age (bars) and CV (lines) by sex for fishing years between 2020–21 (labelled 2021) and 2022–23 (2023).

Table 3: Gemfish calculated numbers-at-age, separately by sex, with CVs, for SKI 3 and SKI 7 sampled by observers during commercial trawl operations for the 2022–23 fishing year. Age is in years. – indicates no fish of that age.

	SKI 3 Dec–Apr period					SKI 3 Feb–Apr period					SKI 7 Jun–Sept period			
Age	Male	CV	Female	CV	Age	Male	CV	Female	CV	Age	Male	CV	Female	CV
0	–	–	–	–	0	–	–	–	–	0	0	8.64	45	1.69
1	–	–	511	1.45	1	–	–	655	1.38	1	17 613	0.45	7 252	0.31
2	12 863	0.51	8 830	0.35	2	12 207	0.60	9 212	0.39	2	13 442	0.39	5 343	0.37
3	3 209	0.50	3 368	0.39	3	3 067	0.79	3 994	0.51	3	11 530	0.34	3 133	0.41
4	2 876	0.46	1 604	0.65	4	1 153	0.81	1 007	0.81	4	2 742	0.39	1 754	0.46
5	1 536	0.81	2 893	0.48	5	756	0.90	2 843	0.50	5	1 630	0.41	2 906	0.21
6	7 877	0.41	7 740	0.23	6	2 128	0.61	8 702	0.25	6	2 089	0.51	4 504	0.19
7	708	1.11	4 308	0.36	7	284	1.29	3 962	0.48	7	1 206	0.49	4 327	0.16
8	4 560	0.43	4 704	0.34	8	7 761	0.43	4 703	0.45	8	183	1.11	2 236	0.26
9	719	0.87	1 565	0.58	9	–	–	1 705	0.79	9	230	1.08	684	0.44
10	–	–	1 274	0.56	10	–	–	303	1.28	10	104	1.27	765	0.45
11	–	–	666	0.88	11	–	–	687	1.29	11	208	1.17	389	0.57
12	–	–	–	–	12	–	–	–	–	12	–	–	93	1.00
13+	–	–	280	1.80	13+	–	–	359	1.83	13+	293	1.29	420	0.72

3.2.3 SKI 7 age composition

An additional 34 otoliths from fish under 60 cm from the 2021 WCSI trawl survey were aged to augment the 2020–21 age composition (re-estimated here). Augmenting the 2020–21 data with information on smaller (younger) fish from the WCSI survey added information for fish aged 0–2 (previously lacking; Devine et al. 2024).

Three hundred and seven gemfish otoliths were aged from the peak of the SKI 7 bottom trawl fishery in 2022–23, of which 64% were from females. The length frequencies for the bottom trawl fishery between 1 June and 30 September 2022–23 had several modes, three of which were under 65 cm, which corresponded to ages 1–3 (Figure 8). 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 8). Cohort progression was visible in both the length and age distributions, where 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 8).

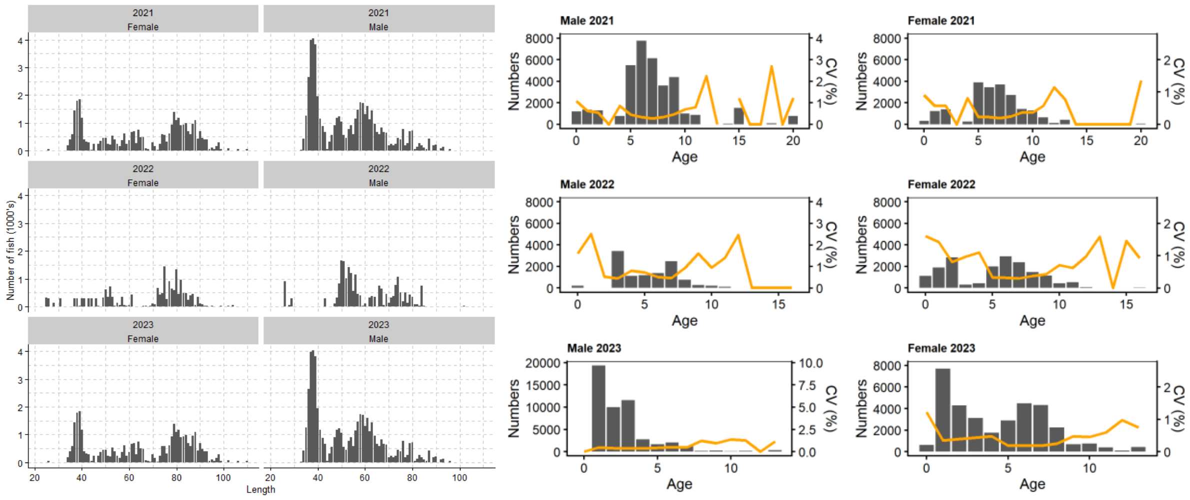

Figure 8: SKI 7 scaled length frequency distribution (by sex) developed from the peak of the bottom trawl fishery (June–September) (left). Proportions-at-age (bars) and CVs (lines) by sex fishing years between 2020–21 (labelled 2021) and 2022–23 (2023). Information from the 2021 WCSI survey were used to augment the length and age distribution for fish under 60 cm length in the 2020–21 fishing year.

4. DISCUSSION

The coverage by observers of the bottom trawl fisheries for BAR 5, SKI 3, and SKI 7 has become marginal for achieving target numbers of otoliths. The number of fish measured in the BAR 5 fishery has declined by approximately 50% since 2019–20. All otoliths collected in the SKI 3 fishery in 2022–23 were aged and the number of otoliths was still below the target required to generate the age composition. While no gaps were apparent in the age-length key, the coverage may not have been fully representative of the fishery, which might explain the large number of 2-year old fish in the collection. However investigating representativeness of the sampling is not part of this contract. The 2021 age composition of SKI 7 was improved by including otoliths from smaller fish, collected during the 2021 WCSI trawl survey.

Otoliths for determining the catch-at-age of the fishery should be collected during the peak of the fishery, which has changed for SKI 3. Changing the period of the peak of the fishery for SKI 3 from February–April to December–April did not appear to affect the age composition. Both length frequencies and the spatial distribution of the ages (at the scale of statistical areas) indicated that there was no effect. Nevertheless, the age composition for this fishery should be treated with caution for 2022–23, particularly because the progression of cohorts was not visible. The age reading was inspected and there did not appear to be an error with ageing the younger fish, which indicates that the sampling may not have been representative of the fishery in the last season.

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 gemfish should allow time to examine the otoliths and sample collection more closely, to determine if there could be a selectivity pattern or a potential ageing bias to explain the ageing discrepancies observed for SKI 3 and SKI 7.

5. ACKNOWLEDGEMENTS

This work was funded by Fisheries New Zealand under Project MID2021–01. The project was managed by Keren Spong. We thank the DWWG for their constructive comments and Matt Dunn (NIWA) and Gretchen Skea (Fisheries New Zealand) for reviewing a draft of the manuscript.

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