SPRFMO
South Pacific Regional Fisheries Management Organisation

14th MEETING OF THE SCIENTIFIC COMMITTEE

7 to 12 September 2026, Tórshavn, Faroe Islands

SC14 - DW 14
History and Progress of New Zealand's Exploratory Fishing for Toothfish (*Dissostichus* spp.) in the SPRFMO Convention Area 2016–2025

New Zealand

South Pacific Regional Fisheries Management Organisation

14th Meeting of the Scientific Committee

Tórshavn, Faroe Islands, 5 September to 12 September 2026

History and Progress of New Zealand's Exploratory Fishing for Toothfish (*Dissostichus* spp.) in the SPRFMO Convention Area, 2016–2025

J.M. (Jack) Fenaughty
Silvifish Resources Ltd, Wellington, New Zealand

2026

Executive Summary

New Zealand has undertaken a staged exploratory bottom longline programme for toothfish in the SPRFMO Convention Area since 2016. The programme was designed as a precautionary, incremental research fishery to address a key knowledge gap on the distribution, biology and stock structure of *Dissostichus* spp. in waters immediately north of the CCAMLR Convention Area.

Exploratory fishing from 2016 to 2024 shows that Antarctic toothfish (*D. mawsoni*) are consistently present close to the eastern SPRFMO–CCAMLR boundary and, in some locations, at relatively high local densities. Catches from this area are overwhelmingly dominated by Antarctic toothfish, with Patagonian toothfish (*D. eleginoides*) occurring only occasionally.

In contrast, early results from the 2025 exploratory phase in the western New Zealand exploratory areas indicate a different pattern, with lower overall catch rates and a higher occurrence of Patagonian toothfish. These observations align with broader regional patterns, in which Patagonian toothfish are more prevalent further west, while Antarctic toothfish dominate at higher latitudes close to the eastern SPRFMO–CCAMLR boundary.

Across the eastern SPRFMO–CCAMLR boundary programme, biological samples indicate a population composed almost entirely of adult fish, with male-skewed sex ratios and persistently low body condition. Seasonal patterns in reproductive condition are consistent across multiple years, with fish sampled in late winter and spring generally in post-spawning or recovering condition, and those sampled in late summer developing towards spawning.

Taken together, the available evidence provides strong, internally consistent support for the interpretation that the eastern area is used by Antarctic toothfish for spawning or closely related reproductive activity. This indicates that spawning-related distribution extends north of 60°S and that the SPRFMO and CCAMLR Convention Areas cannot be considered independently for this species.

The exploratory programme has demonstrated that structured fishing under strict controls can yield critical scientific information in data-poor deepwater environments while maintaining low observed bycatch and few recorded interactions with protected species and benthic taxa.

1. Introduction and Purpose

New Zealand's exploratory toothfish fishing in the SPRFMO Convention Area was initiated to address the lack of fishery-dependent biological and ecological information on *Dissostichus* spp. in high-latitude waters immediately north of the CCAMLR Convention Area.

This region borders CCAMLR Subareas 88.1 and 88.2 to the north, where fisheries and research have identified important patterns in Antarctic toothfish biology, movement and reproductive behaviour. However, prior to 2016, there was little corresponding information from the SPRFMO area, limiting understanding of stock connectivity and the spatial extent of key life-history processes.

This paper summarises New Zealand's exploratory work from 2016 to 2025. It documents programme development, outlines biological and operational results, and evaluates their significance for Antarctic toothfish distribution, spawning dynamics and stock structure. The staged progression of the exploratory programme is shown in Figure 1.

2. Development of the Exploratory Programme

2.1 Initial proposal and design (2015)

The programme originated in a 2015 proposal to the Scientific Committee, presented as a precautionary exploratory fishery under Article 22. The proposal recognised that the area had effectively no prior fishing or survey data and required a staged, information-driven approach.

The initial approach was deliberately incremental. It began with bathymetric prospecting and the identification of fishable ground, followed by structured test fishing and adaptive expansion, with further work justified by results.

A catch limit of 30 t of *Dissostichus* spp. per year was adopted, supported by one scientific observer, an operational electronic monitoring system, and set-by-set reporting. Data collection and survey design were aligned with CCAMLR approaches to maximise comparability.

Wherever possible, the programme has also retained methods and procedures already used in the longer CCAMLR research and fishery time series. This included maintaining comparable approaches to set-level reporting, biological sampling, tagging, bycatch recording and benthic observations, so that data collected in the SPRFMO Convention Area could be interpreted alongside adjacent CCAMLR datasets rather than as an isolated series.

The main objectives were to map fishable habitat, determine species composition, describe size, maturity and condition, investigate movement and stock structure through tagging, and monitor bycatch and benthic interactions.

2.2 Initial implementation (2016–2017)

The first operational phase of New Zealand's exploratory toothfish programme was conducted by *San Aspiring* during the winter periods of 2016 and 2017. Fishing was carried out in two approved research boxes, Research Box A and Research Box B, close to the eastern SPRFMO–CCAMLR boundary, adjacent to the northern boundary of the CCAMLR Convention Area and south and east of New Zealand. These areas were selected because available bathymetric information suggested the possible presence of fishable seamount or ridge habitat, but there was little direct information on toothfish occurrence, species composition, catch rates, or benthic habitats.

The 2016–2017 phase was deliberately small and precautionary, and was designed less as a commercial fishing operation than as an initial test of toothfish occurrence, fishable habitat, and the feasibility of the research and sampling protocols.

In 2016, seven sets were completed between 1 and 9 August: four in Research Box A and three in Research Box B. Research fishing ended when the catch approached the annual limit, with a small margin deliberately left as a precaution against exceeding the allocation. In 2017, twelve sets were completed between 13 and 20 September: eight in Research Box A and four in Research Box B. As in 2016, fishing stopped once the annual allocation was almost fully used, but not completely taken, for the same precautionary reason.

The total retained toothfish catch was about 29 tonnes per year. The catch was almost entirely Antarctic toothfish, with only two small Patagonian toothfish recorded, both from Research Box A in 2017. This was an important early result because the original proposal recognised uncertainty about whether Antarctic or Patagonian toothfish would dominate in the proposed research boxes. The results clearly showed that the area sampled in 2016 and 2017 was dominated by Antarctic toothfish.

Catch rates differed markedly between the two research boxes. Research Box B recorded much higher catch rates than Research Box A in both years, although rates varied among sets. The high catch rates from Research Box B were comparable to those observed in recognised or inferred spawning areas in the northern Ross Sea and Amundsen Sea regions of the adjacent CCAMLR Convention Area. This provided the first strong indication that the SPRFMO area north of 60°S could be biologically relevant to Antarctic toothfish spawning dynamics.

Biological sampling also provided important early evidence. Antarctic toothfish sampled in 2016 and 2017 were almost entirely large adults, with very few individuals below 120 cm total length. The sex ratio was skewed towards males, particularly in 2016, when males comprised about 85% of the catch-weighted sample. Male dominance was still evident in 2017, though less pronounced, with males comprising about 60% of the sampled fish. This pattern was consistent with observations from spawning-associated areas in the northern Ross Sea.

Reproductive and condition data were central to interpreting these first two voyages. Gonad maturity observations and gonadosomatic indices indicated that many fish were either spent, recovering, or developing, with 2016 samples showing particularly low body condition. Sampling in 2017 occurred about five weeks later than in 2016, and body condition was slightly improved. This seasonal difference supported the interpretation that spawning had occurred before the fishing period, most likely during the austral winter.

The 2016–2017 programme also demonstrated that the research fishing could be conducted with minimal observed environmental impact. Fish bycatch was less than 1% of the total catch by weight in both years and consisted mainly of macrourids, blue antimora and other deepwater fish species. Invertebrate bycatch was very low, with only small quantities of gorgonians, sponges, crabs and other benthic taxa recorded. No seabird mortality, marine mammal interactions, turtle interactions, or capture of other species of concern was reported during the two voyages.

Tagging was implemented successfully from the outset. A total of 194 Antarctic toothfish were tagged and released over the two years: 104 in 2016 and approximately 90 in 2017. Two Antarctic toothfish tagged in 2016 were recaptured during the 2017 survey on the same seamount, with no significant movement observed over the year at liberty. Although limited, these early recaptures demonstrated that the tagging programme was technically feasible and could contribute to future movement and stock-connectivity analyses.

Overall, the 2016–2017 work achieved its objectives. It confirmed that substantial catches of Antarctic toothfish could be taken north of the CCAMLR boundary, that the catch was dominated by large adult fish, and that many fish were in post-spawning or recovering condition. It also showed that the work could be carried out with low observed bycatch and minimal evident environmental impact. Those results were sufficient to support expansion of the programme in 2019–2021.

2.3 Expansion of the eastern study area (2019–2021)

Following the initial 2016–2017 work, the 2019–2021 phase represented the first major eastward expansion of New Zealand's exploratory toothfish programme close to the eastern SPRFMO–CCAMLR boundary. Its purpose was to test whether the patterns identified in the original Research Boxes A and B persisted across adjacent seamount, ridge and slope features.

This phase was authorised under CMM-14a-2019 and expanded the research area into Blocks L–O. The design retained overlap with the original research areas so that previously tagged fish could potentially be recaptured, while extending coverage into adjacent seamount, ridge and slope features. This provided a stronger basis for examining spatial distribution, relative abundance, seasonal patterns, and stock-linkage questions.

A key feature of the 2019–2021 programme was its seasonal structure. Fishing in 2019 occurred in September–October, after the inferred winter spawning period, while fishing in 2020 and 2021 occurred in February–March, before the expected spawning period. This provided an important opportunity to compare post-spawning and pre-spawning gonad development and body condition within the same general research area.

Over the three years, the authorised vessel *San Aspiring* completed 100 research sets across Blocks L, N and O. No fishable ground was identified in Block M. The programme produced a total retained toothfish catch of 101.5 tonnes, overwhelmingly Antarctic toothfish. Catch was highly spatially structured, with most Antarctic toothfish taken in Block N, smaller catches in Block L, and no Antarctic toothfish recorded from Block O despite substantial effort. This pattern demonstrated that suitable habitat and fish concentrations were not distributed uniformly across the research area, as also shown in the catch–depth pattern in Figure 2.

The catch was overwhelmingly Antarctic toothfish. Six Patagonian toothfish were recorded over the three-year period: three in the north-eastern sector of Block O in 2019, one small fish in southern Block L in 2020, and two in Block N in 2021, one of which was tagged and released. This confirmed that Patagonian toothfish occur in the eastern study area but are a minor component of catches.

The biological information collected during this phase substantially strengthened the interpretation derived from the 2016–2017 results. Antarctic toothfish sampled during 2019–2021 were almost entirely adult, with only about 1.2% of the catch-weighted sample shorter than 120 cm total length. Sex ratios were again skewed towards males, with males comprising 60.3% of the catch-weighted sample in 2019, 64.2% in 2020 and 62.7% in 2021. These results were consistent with records from the northern Ross Sea region and supported the view that the area contains mature fish associated with spawning dynamics (Figure 3).

The seasonal biological signal was particularly important. Fish sampled in September–October 2019 were generally in post-spawning condition, whereas those sampled in February–March 2020 and 2021 were developing towards spawning. Gonadosomatic indices, maturity staging and body condition data together indicated that Antarctic toothfish in this eastern area follow a seasonal reproductive cycle consistent with winter spawning (Figure 4).

This phase also reinforced the role of body condition as an indicator of spawning-related use. Antarctic toothfish sampled in the SPRFMO area were in poorer condition than those from known feeding areas on the Ross Sea slope. This pattern was evident in both post-spawning and pre-spawning samples, suggesting that fish using this area may be associated with reproductive activity rather than active feeding (Figure 5).

Tagging remained a central component of the programme. The required tagging rate was met each year, and by the end of 2021, a total of 516 Antarctic toothfish had been tagged across the full 2016–2021 programme. Recaptures included short-term local recaptures and one long-term recapture of a fish originally tagged in the Ross Sea, underscoring the importance of continued tagging to evaluate movement and stock connectivity across the SPRFMO–CCAMLR boundary.

Bycatch increased relative to the 2016–2017 phase, comprising approximately 7.8% of total catch by weight in 2019, 4.2% in 2020 and 5.9% in 2021. This increase is best interpreted as a consequence of the broader exploratory design and the large number of sets made in areas where Antarctic toothfish were absent or sparse. Non-target catch was dominated by macrourids, blue antimora and lepidion codlings, consistent with expectations for deepwater longline fishing in the region.

The 2019–2021 phase moved the programme beyond the initial confirmation of toothfish presence. It provided a structured, multi-year dataset showing that Antarctic toothfish occurrence in the eastern study area was spatially patchy yet biologically consistent. The results also provided stronger support for the interpretation that mature Antarctic toothfish use the area to spawn.

2.4 Expansion and consolidation (2022–2024)

The 2022–2024 work extended and reinforced the eastern SPRFMO–CCAMLR boundary programme rather than initiating a new line of investigation. Its main value was to test whether the patterns observed in 2019–2021 — Antarctic toothfish dominance, localised high catch rates and adult-dominated catches — persisted when fishing was extended across the wider L–S research area.

The design retained comparability with the L–O work but spread effort more widely across Blocks L–S. This was important because earlier surveys had already shown that toothfish were patchily distributed. The question was whether areas of higher catch were persistent, whether additional fishable habitat could be identified, whether other localised areas were used for spawning or spawning-related activity, and whether the biological signal remained consistent with spawning-related use of the region.

In 2022, fishing was conducted in Research Blocks L, M, N and Q. A total of 31 sets and 89,198 hooks were recorded, yielding 38.7 tonnes of Antarctic toothfish. The catch was almost entirely Antarctic toothfish and remained concentrated in the established high-catch area centred on Block N, with moderate catches also taken from Block L. Tagging was maintained at a high level, with 155 Antarctic toothfish tagged and one recapture reported.

The 2023 fishing was cut short due to microbial contamination in the vessel’s fuel system, commonly known as diesel bug. As a result, only five sets and 15,515 hooks were completed, yielding 34.4 tonnes of Antarctic toothfish. Although the authorised research area extended across Blocks L, N, O, P and Q, the limited fishing was concentrated mainly in the established Block N area. The catch remained almost entirely Antarctic toothfish. A total of 135 Antarctic toothfish were tagged, with two recaptures reported. Although spatial coverage was constrained, the substantial catch from relatively limited effort was notable.

In 2024, fishing was conducted in Research Blocks L, N and O. Fourteen sets and 34,285 hooks were recorded, yielding 32.6 tonnes of Antarctic toothfish. The catch again consisted almost entirely of Antarctic toothfish. The main high-catch pattern remained associated with Block N, although some moderate catch was also taken from hilltop features in Block L. A total of 122 Antarctic toothfish were tagged, a tagging ratio of 3.74 fish per tonne.

Taken together, the 2022–2024 results reinforced key findings from earlier phases of the programme. Antarctic toothfish remained the dominant species in catches, and high catches continued to be associated mainly with the established Block N area, including the earlier Research Box B, with Block L contributing moderate catches in some years. Tagging targets were met or exceeded, thereby maintaining the programme's value for evaluating movement and stock connectivity.

The biological interpretation from this phase is consistent with earlier results. The persistence of adult-dominated catches, the dominance of Antarctic toothfish, and the repeated concentration of high catches around the Block N feature support the view that this area is not marginal habitat. Rather, it appears to include discrete habitat areas used by mature Antarctic toothfish, with Block L contributing additional, but generally less consistent, catches.

The 2022–2024 phase also demonstrated the value of keeping the work tightly linked to bathymetry and biological sampling. In these remote and still poorly mapped areas, useful information is obtained only when fishing effort is carefully directed and sampling remains consistent. That experience helped shape the broader exploratory work proposed from 2025 onwards.

2.5 New exploratory areas (2025 onwards)

The exploratory phase initiated in 2025 is a distinct component of the overall programme, both geographically and in the nature of the research question. Unlike the earlier work close to the eastern SPRFMO–CCAMLR boundary, which investigated areas adjacent to known Antarctic toothfish habitat, the 2025 activity targeted previously untested western New Zealand exploratory areas, where bathymetry and species composition were poorly understood.

This western focus is also relevant because there is a substantial Patagonian toothfish fishery around Macquarie Island, and research within the New Zealand EEZ has also produced catches of the same species. The 2025 work therefore lies in a broader regional context where Patagonian toothfish occurrence is already known, but where its distribution and relationship to the SPRFMO exploratory areas remain unresolved.

Initial fishing effort in 2025 was limited in scale and focused primarily on identifying fishable ground and improving bathymetric information. A total of nine exploratory sets were reported across the defined research areas (Table 1). Catch levels were lower than in the eastern study area, with a total retained catch of approximately 1 tonne. Effort was therefore directed more toward habitat identification than systematic biological sampling.

In contrast to earlier phases of the programme, the species composition of catches in these new areas differed. While Antarctic toothfish were still present, Patagonian toothfish were more frequently encountered and, in some locations, appeared to dominate the limited catches obtained. Although the sample size remains small, this represents a clear departure from the overwhelmingly Antarctic toothfish-dominated catches observed in the eastern study area.

Catch rates in the 2025 exploratory areas were generally low, with a high proportion of zero or near-zero catch sets. As in earlier exploratory work, this reflects both the lack of prior knowledge of fishable habitat and the likelihood that suitable ground is patchily distributed. However, the absence of consistently high catch rates in the limited sampling to date contrasts with the established high-catch pattern associated with Research Block N, including the earlier Research Box B, in the eastern study area.

Given the exploratory nature of this work, biological sampling is currently insufficient to provide a robust assessment of population structure, reproductive condition, or seasonal dynamics comparable to that developed for the eastern study area. Preliminary observations suggest a more mixed population structure, but further data collection is required before any conclusions can be drawn about maturity composition, sex ratios, or reproductive state.

The observed increase in the relative occurrence of Patagonian toothfish in these more westerly, lower-latitude areas aligns with broader regional patterns in the distribution of *Dissostichus* spp., in which Patagonian toothfish are more prevalent further west and Antarctic toothfish dominate higher-latitude areas closer to the SPRFMO–CCAMLR boundary. At this stage, however, the available 2025 data should be regarded as indicative rather than definitive.

To date, the main outcome of the 2025 programme has been improved information on seabed features, bathymetry and potentially fishable habitat in previously uncharacterised parts of the SPRFMO Convention Area west of New Zealand. Further work is needed to determine whether these areas support sufficient toothfish densities for structured research and whether biological patterns comparable to those observed in the eastern study area occur there.

The 2025 results should therefore be kept separate from the 2016–2024 time series from the eastern study area. They provide useful context for regional variation in species composition but do not yet directly contribute to the evidence for spawning-related use identified in that area.

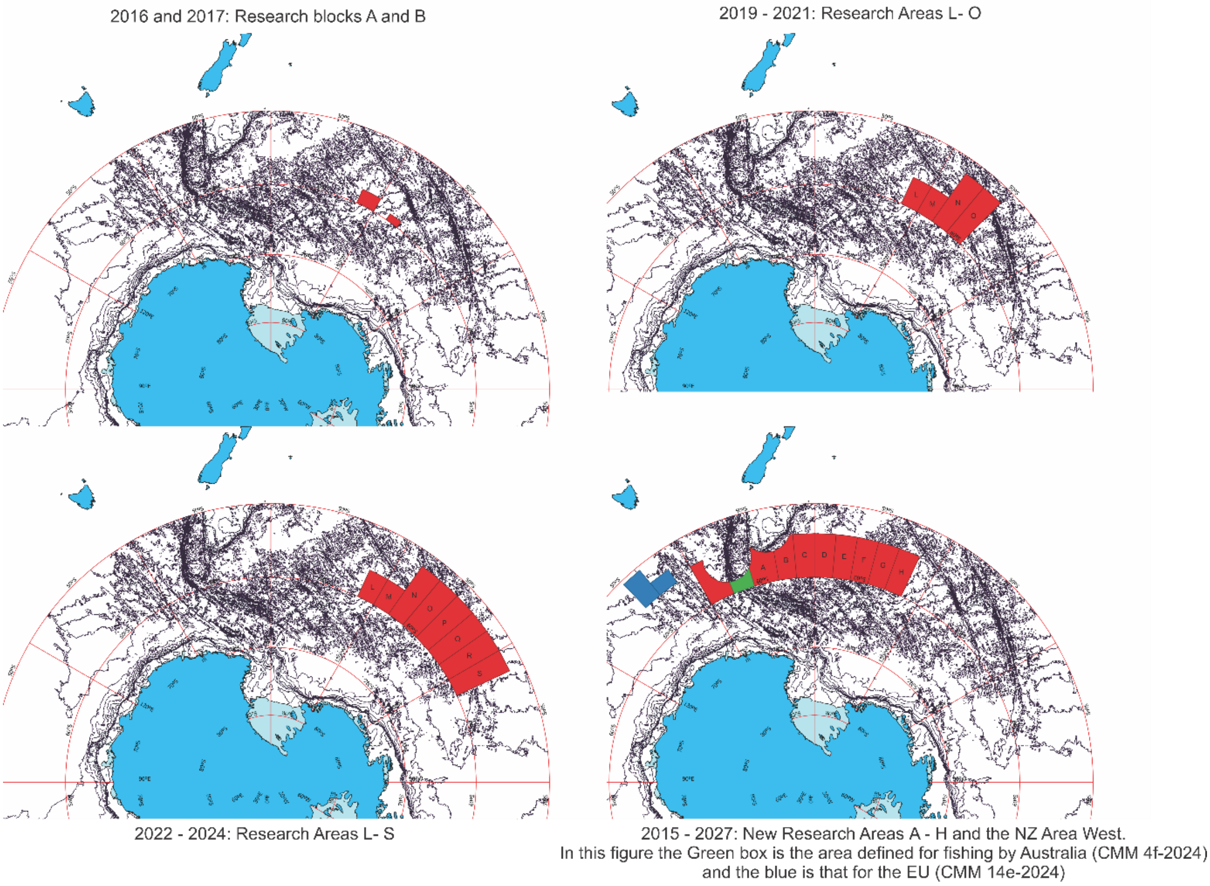

Figure 1. Progression of New Zealand exploratory toothfish research in the SPRFMO Convention Area, showing the staged development of approved research areas from 2016 through the 2025–2027 exploratory phase. Results summarised in this paper are reported to 2025.

NB: Some figures are reproduced or adapted from programme final reports and illustrate selected patterns rather than the complete 2016–2025 dataset.

3. Scientific Objectives and Data Collected

Throughout the programme, the scientific objectives have remained broadly consistent: to define distribution and habitat, determine species composition, characterise biological state and reproductive condition, estimate movement and connectivity through tagging, and monitor bycatch and environmental effects.

The collected data include set-level catch and effort information, biological measurements such as size, sex, maturity and gonad weight, otoliths and other biological samples, tagging and recapture records, and benthic and bycatch observations.

4. Summary of Results

Table 1. Summary of New Zealand SPRFMO exploratory toothfish fishing, 2016–2025. Reported recaptures to 2023 total 12, including short-term local recaptures and one long-distance recapture of a fish originally tagged in the CCAMLR Area after 15 years at liberty.

Year	Timing	Area	Effort	Catch	Composition	Tagging
2016	Aug	A–B	7 sets; ~25,700 hooks	28.96 t TOA	Almost entirely TOA	104 TOA tagged
2017	Sep	A–B	12 sets; ~41,200 hooks	~29 t TOA	Almost entirely TOA; 2 TOP	90 TOA tagged; 2 recaptures
2018	–	–	No fishing	No catch	–	–
2019	Sep–Oct	L–O	35 sets; ~124,000 hooks	36.5 t TOA	~92% TOA; 3 TOP	114 TOA tagged; 1 in-season recapture
2020	Feb–Mar	L–O	32 sets; ~98,000 hooks	40.9 t TOA	~96% TOA; 1 TOP	133 TOA tagged; 5 recaptures
2021	Feb–Mar	L–O	33 sets; ~106,000 hooks	24.1 t TOA	~94% TOA; 2 TOP	75 TOA tagged; 1 TOP tagged; 1 recapture
2022	Mar	L, M, N, Q	31 sets; 89,198 hooks	38.7 t TOA	Almost entirely TOA	155 TOA tagged; 1 recapture
2023	Mar–Apr	L, N, O, P, Q	5 sets; 15,515 hooks	34.4 t TOA	Almost entirely TOA	135 TOA tagged; 2 recaptures
2024	Oct	L, N, O	14 sets; 34,285 hooks	32.6 t TOA	Almost entirely TOA	122 TOA tagged

2025	Oct–Nov	NZSWRB1 and A	9 sets; 33,423 hooks	~1.0 t TOP/TOA, predominantly TOP	Mixed, mainly TOP	4 TOP tagged; 1 TOA tagged

4.1 Species composition and catch patterns

Species composition differed clearly between the 2016–2024 eastern study area and the newer western New Zealand exploratory areas.

Catches from the eastern study area were consistently dominated by Antarctic toothfish (*Dissostichus mawsoni*), a pattern established in the initial 2016–2017 surveys and sustained through the expanded 2019–2021 and 2022–2024 programmes. During the 2019–2021 phase, Antarctic toothfish accounted for approximately 94% of the total catch by weight, while Patagonian toothfish (*D. eleginoides*) were recorded only infrequently. In contrast, the 2025 western New Zealand exploratory areas produced a more mixed catch, with Patagonian toothfish dominant in the limited catch obtained. This contrast indicates that the eastern study area forms part of the normal distribution range of Antarctic toothfish, rather than representing marginal or occasional occurrence.

Catch rates of Antarctic toothfish were highly variable both within and between years, but this variability was clearly structured spatially rather than random. High catch rates were consistently concentrated in specific areas, particularly Research Block N, with lower but still meaningful catch in Block L, and little or no Antarctic toothfish recorded from Block O despite comparable fishing effort. No fishable ground was identified in Block M. This pattern is evident in the relationship between catch and depth (Figure 2), where many sets yielded little or no catch, while a smaller number of sets produced relatively high catches.

The presence of numerous zero or low-catch sets alongside localised high catches indicates that suitable habitat is patchily distributed and associated with specific seabed features rather than broad areas. Across the programme, the main high-catch area has been centred on Research Block N, including the earlier Research Box B, while Block L has contributed moderate catches in some years. Blocks M and O have been comparatively low-yielding and have not been significant sources of high catches. These results are consistent with observations from CCAMLR longline fisheries, where Antarctic toothfish are known to aggregate on seamounts, ridges and slope features.

Across the 2016–2024 eastern study-area time series, Antarctic toothfish consistently dominated catches, while Patagonian toothfish occurred only sporadically in small numbers. There is no evidence of a shift in species dominance over this period, reinforcing the interpretation that Antarctic toothfish are the primary occupants of these eastern high-latitude habitats.

The 2025 western New Zealand exploratory work provides an important contrast. Although effort remains limited, initial results show lower catch rates and a greater relative occurrence of Patagonian toothfish than in the eastern study area. Antarctic toothfish were still present, but the limited catches were more mixed and Patagonian toothfish dominated.

This contrast between the eastern study area and the 2025 western New Zealand exploratory areas aligns with broader regional patterns in the distribution of the two species. Antarctic toothfish are generally more abundant at higher latitudes and in areas adjacent to the Ross and Amundsen Sea systems, whereas Patagonian toothfish are more prevalent further west and at lower latitudes in the South Pacific. The exploratory results therefore suggest a spatial transition in species dominance across the SPRFMO Convention Area, with Antarctic toothfish dominating close to the eastern SPRFMO–CCAMLR boundary and Patagonian toothfish becoming more common in western and lower-latitude areas.

Catch rates in the 2025 exploratory areas were generally low, with a high proportion of zero or near-zero sets, similar to the early stages of the eastern study-area work. However, unlike the 2016–2017 and 2019–2021 work, there has been no evidence of consistent high-density aggregations comparable to those observed in the established Block N/Research Box B area. This may reflect true differences in habitat suitability, limited spatial coverage, or the early stage of exploration in these regions.

Taken together, species composition and catch patterns reveal a clear spatial structure in the distribution of *Dissostichus* spp. within the SPRFMO Convention Area. Antarctic toothfish dominate the eastern study area across all years examined, and their occurrence is not evenly distributed but is concentrated around particular seabed features, where catch rates can be locally high. Patagonian toothfish occur only occasionally in these high-latitude eastern areas but become more frequent in the newer western New Zealand exploratory areas. This contrast indicates that the SPRFMO Convention Area includes a transition zone in the relative distribution of Antarctic and Patagonian toothfish, rather than a single, uniform population domain.

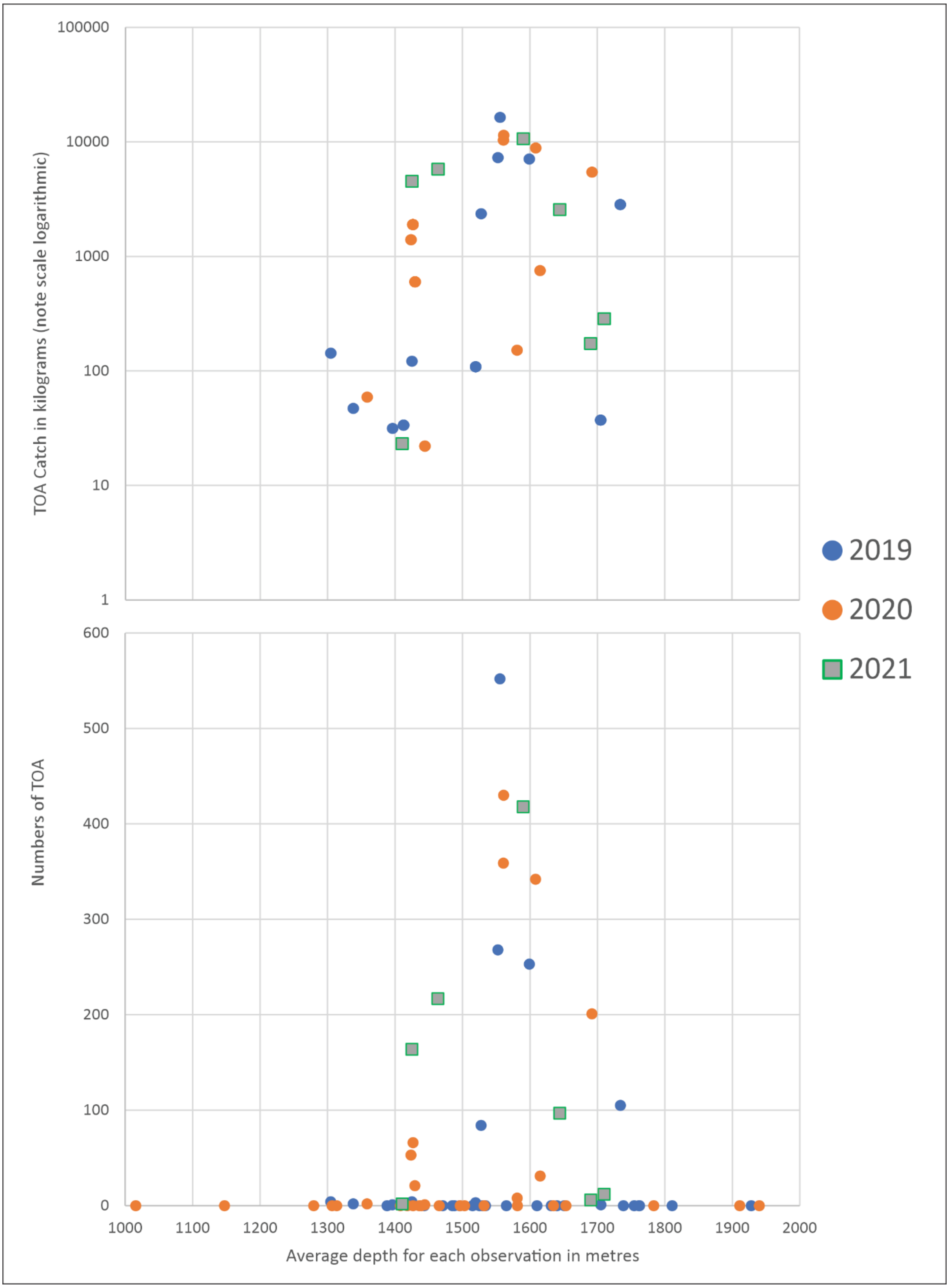

Figure 2. Catch versus depth for Antarctic toothfish (2019–2021). The figure illustrates high variability, including numerous zero catches, reflecting exploratory sampling and patchy habitat distribution.

4.2 Population structure

The 2016–2024 surveys show a consistent but spatially structured Antarctic toothfish population in the eastern SPRFMO study area. Patagonian toothfish occurred only in small numbers. Antarctic toothfish catch rates were highly heterogeneous but locally very high, particularly in Research Box B, where rates of approximately 2,300–2,500 kg per 1,000 hooks were observed, compared with much lower and more variable rates of around 70–100 kg per 1,000 hooks in Research Box A. These results indicate strong spatial structuring around discrete bathymetric features, consistent with the catch–depth pattern shown in Figure 2.

The sampled eastern Antarctic toothfish population was composed almost entirely of large, mature fish, with total lengths ranging from approximately 95 to 189 cm and only a small proportion of individuals below 120 cm, indicating a near absence of juveniles. This adult-dominated structure is consistent with the length-frequency distributions shown for the 2019–2021 surveys (Figure 3). Mean individual weight was consistently around 29–30 kg. Sex ratios were skewed towards males, with approximately 85% male in 2016 and about 60% male in 2017. Biological indicators showed that fish were typically in poor somatic condition, with high proportions of empty or bait-only stomachs: around 91% in 2016 and 84% in 2017. Gonadosomatic indices averaged about 4.7 for females and 2.9 for males in 2016, declining to approximately 3.3 and 1.7, respectively, in 2017, with most fish classified as spent or recovering. Together, these characteristics strongly support the interpretation that the area close to the eastern SPRFMO–CCAMLR boundary represents a spawning or immediate post-spawning component of a wider Antarctic toothfish stock linked to CCAMLR regions, consistent with the reproductive and body-condition patterns summarised in Figures 4 and 5.

In contrast, more recent work undertaken in 2025 in the western New Zealand exploratory areas indicates a markedly different species composition, with Patagonian toothfish predominating (Table 1). This shift in species dominance, from an eastern Antarctic toothfish-dominated stock component to a western area where Patagonian toothfish predominate, highlights clear longitudinal structuring of the *Dissostichus* complex within the SPRFMO area. The western observations suggest either a transition zone between species distributions or the presence of spatially distinct stock components associated with different water masses, bathymetric features, or reproductive behaviours.

Limited recaptures include fish recovered locally over annual timeframes, consistent with temporary site fidelity to seamount or ridge features during spawning or spawning-related activity, while the long-distance recapture confirms movement across the SPRFMO–CCAMLR boundary. However, the available recaptures are insufficient to define movement rates, stock boundaries or the degree of connectivity among areas.

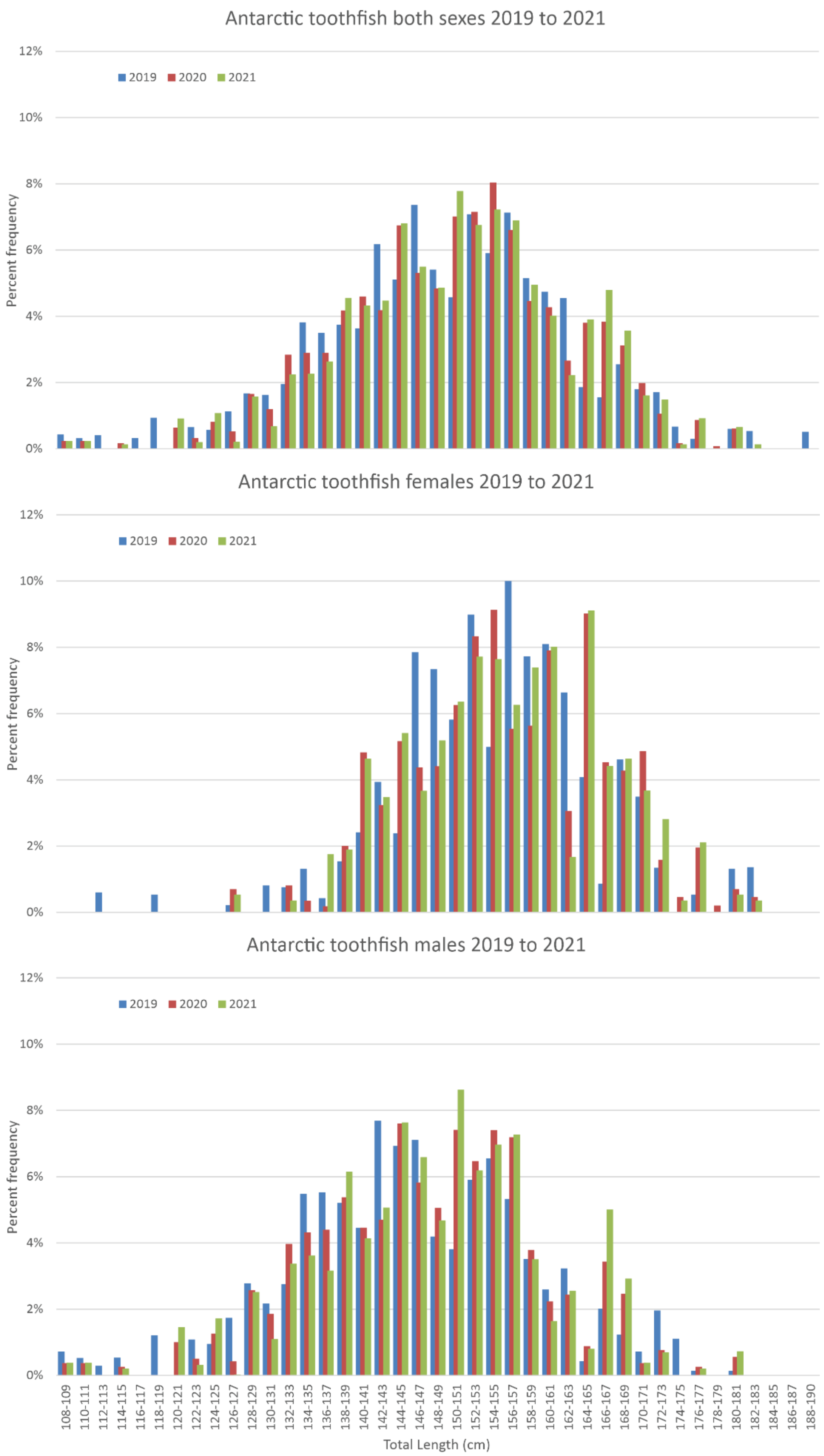

Figure 3. Length-frequency distributions across survey years 2019–2021.

4.3 Reproductive condition and timing

Reproductive data show a clear seasonal pattern. Fish sampled in spring, including in 2016 and 2019, were generally post-spawning or recovering, whereas fish sampled during February and March in 2020 and 2021 were developing towards spawning. Gonadosomatic indices and maturity staging are consistent with this progression and support the inference that spawning occurs during the austral winter, most likely between June and August (Figure 4).

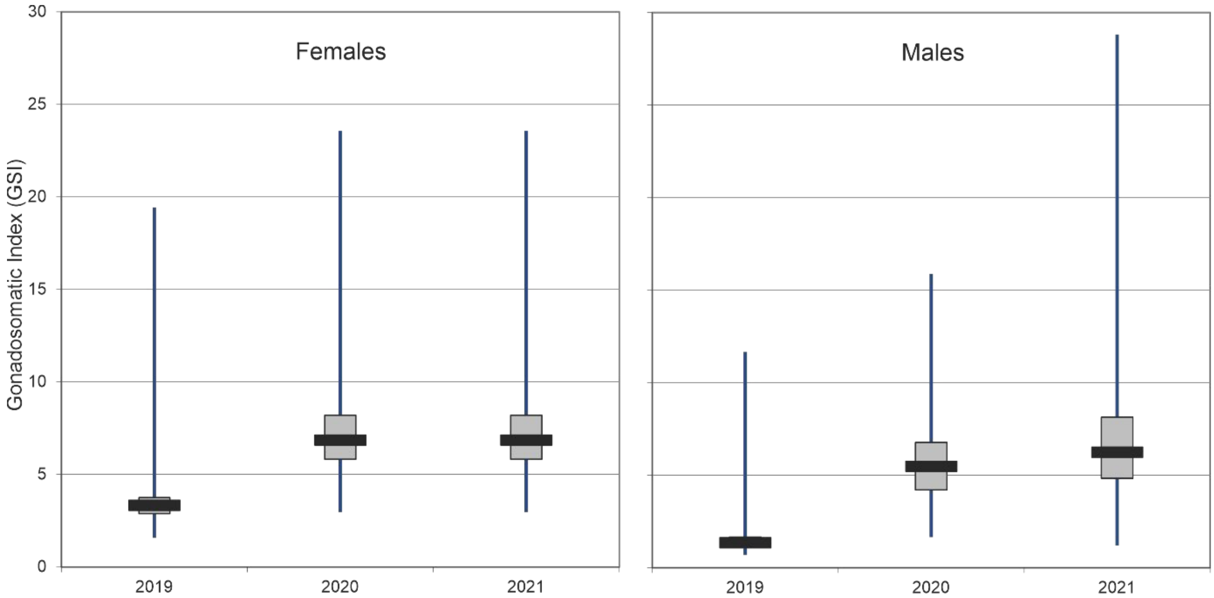

Figure 4. Seasonal reproductive condition (GSI). Demonstrates progression from post-spawning in 2019 to developing condition in 2020 and 2021. See the bottom frame in Figure 5 for context.

4.4 Body condition

Condition indices indicate that Antarctic toothfish sampled in the eastern study area were generally in poorer condition than fish from recognised feeding areas. Condition was lowest close to the inferred spawning period and improved slightly thereafter, which is consistent with energy depletion associated with reproduction rather than active feeding (Figure 5).

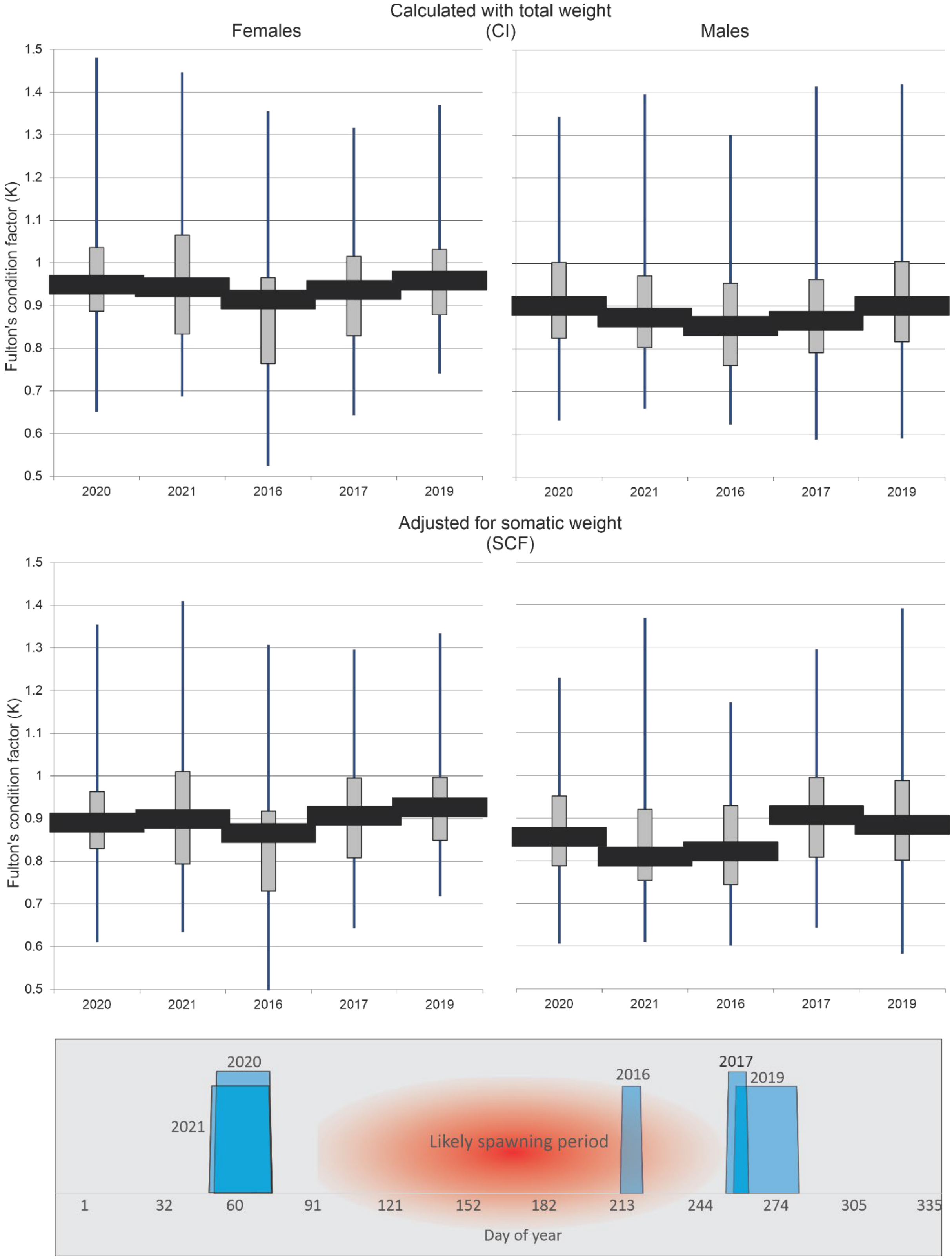

Figure 5. Body condition indices by season and sex, with lowest condition near spawning and subsequent recovery thereafter.

4.5 Tagging and movement

Tagging has been integral to the exploratory programme. Between 2016 and 2021, 516 Antarctic toothfish were tagged and released, and tagging targets were met in each phase of the work. The size distribution of tagged fish was broadly representative of the retained catch, supporting the usefulness of the tagging dataset for future movement and stock-structure analyses (Figure 6).

Recaptures include both short-term local recaptures and a long-distance recapture from the CCAMLR area after 15 years at liberty. These results do not yet define movement rates or stock boundaries, but they demonstrate that movement between the two management areas occurs and that continued tagging is essential to resolve connectivity.

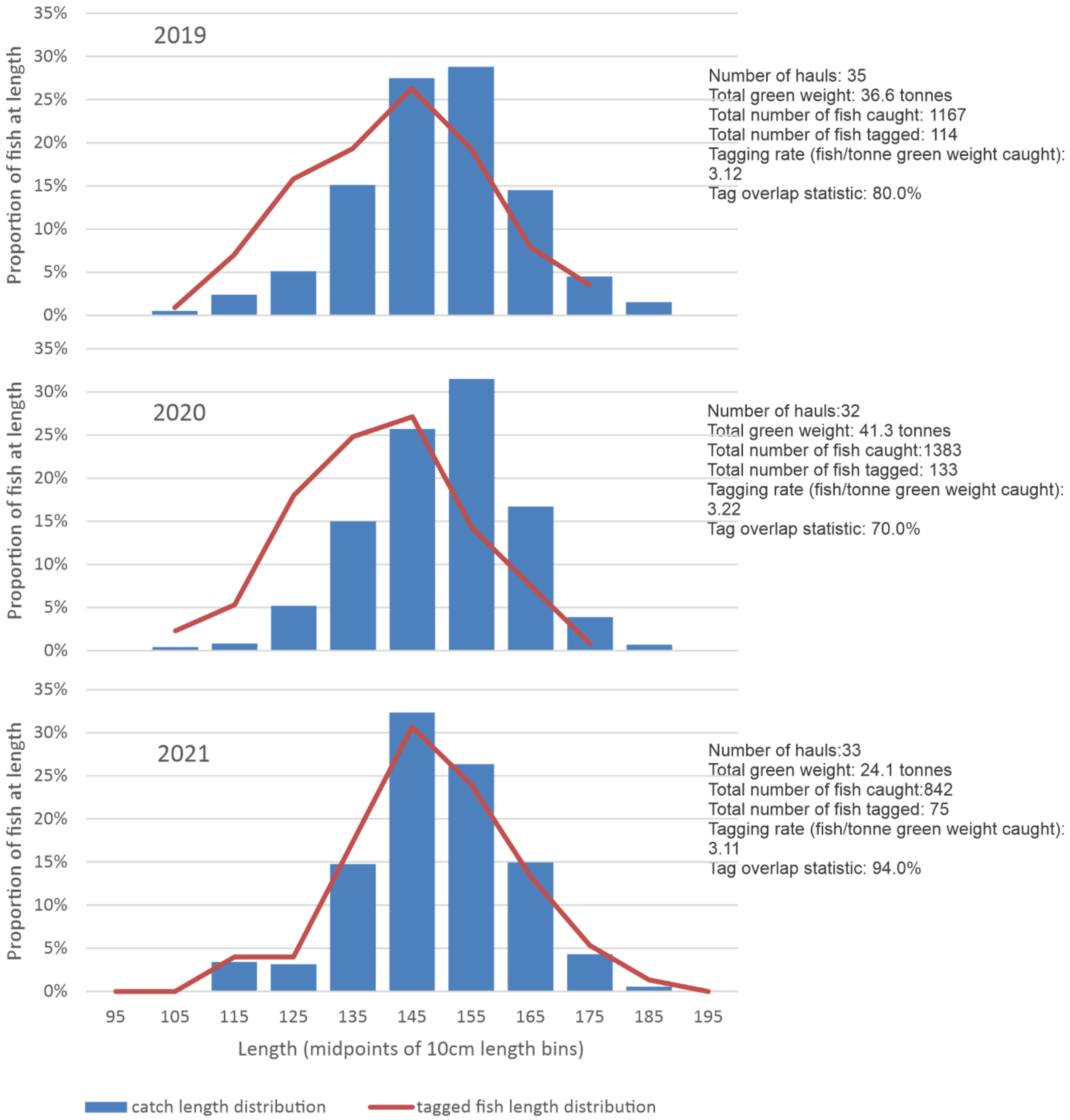

Figure 6. Length distributions of tagged and retained Antarctic toothfish in 2019–2021, showing that tagged fish were broadly representative of the sampled population.

4.6 Evidence for spawning-related use in the eastern study area

The spawning interpretation rests on several independent yet mutually consistent observations: dominance of Antarctic toothfish, near absence of juveniles, male-skewed sex ratios, clear seasonal progression in reproductive condition, low body condition, and localised high catch rates on specific seabed features. These patterns are reflected in the catch, length, reproductive-condition and body-condition summaries shown in Figures 2–5, and together provide strong evidence that the eastern study area is used by Antarctic toothfish for spawning.

4.7 New exploratory areas

The 2025 exploratory work should be considered separately from the 2016–2024 eastern study-area time series. The results remain preliminary and primarily reflect early-stage habitat identification in previously untested western New Zealand exploratory areas. Catch rates were low, and the species composition showed a higher relative occurrence of Patagonian toothfish. These data are useful for understanding regional variation, but they do not yet provide a biological basis comparable to that of the earlier eastern programme.

5. Discussion

New Zealand's exploratory toothfish programme has evolved from a small, precautionary test fishery into a sustained research programme for *Dissostichus* spp. in the SPRFMO Convention Area. It has generated fishery, biological, tagging, bycatch and habitat data from areas where little or no direct information was previously available. This is particularly important for deepwater toothfish habitats, where conventional fishery-independent surveys are difficult to conduct and structured exploratory fishing may be the only practical means of obtaining data at relevant depths, seasons and spatial scales.

The strongest and most consistent finding from the 2016–2024 eastern SPRFMO–CCAMLR boundary programme is that Antarctic toothfish occur regularly north of 60°S and can be locally abundant on discrete seabed features. Catch history, species composition and biological data indicate that these areas should not be considered marginal habitat. Rather, the eastern study area appears to include habitat used by large, mature Antarctic toothfish, consistent with spawning-related movement or aggregation. This interpretation is supported by the repeated dominance of Antarctic toothfish, the near absence of juveniles, male-skewed sex ratios, seasonal progression in reproductive state, poor body condition, and the concentration of high catch rates around specific bathymetric features (Figures 2–5).

These findings have significance beyond the SPRFMO exploratory fishery. The results indicate that Antarctic toothfish distribution and reproductive ecology extend across the SPRFMO–CCAMLR boundary, and that the two Convention Areas cannot be considered independently for this species. The biological signal from the eastern study area aligns with broader hypotheses for Antarctic toothfish in the Ross Sea and Amundsen Sea region, in which mature fish migrate to localised spawning areas before returning to other habitats. The limited tag recaptures do not yet define movement rates or stock boundaries, but they demonstrate that continued tagging is essential to evaluate connectivity between SPRFMO and CCAMLR areas quantitatively.

The contrast between the 2016–2024 eastern study-area time series and the 2025 western New Zealand exploratory work is also important. The 2025 data remain preliminary, but they indicate a different pattern: lower catches, less certain fishable habitat, and a higher relative occurrence of Patagonian toothfish. These results should not be merged uncritically with the eastern time series. Instead, they should be treated as evidence that the SPRFMO Convention Area contains spatially distinct toothfish habitats and may include a shift in the relative dominance of Antarctic and Patagonian toothfish. Further sampling will be required before the biological significance of the western and lower-latitude exploratory areas can be assessed with confidence.

The programme has also demonstrated the practical value of a staged, precautionary research design. Low initial catch limits, observer coverage, an operational electronic monitoring system, systematic biological sampling, tagging, and monitoring of non-target catch and VME indicator taxa have enabled exploratory fishing to proceed while generating information needed for future management advice. The results also show that interpretation depends heavily on accurate bathymetry and careful spatial design. Many sets in exploratory areas yield little or no catch, and high catch rates may be linked to very specific seabed features. Improving bathymetric resolution is therefore not merely an operational requirement but a scientific prerequisite for interpreting distribution and relative abundance.

Participation in exploratory research also carries real costs for the companies involved. Vessel time, fuel, crew and staff time, fishing gear, observer support, and the opportunity cost of foregone commercial fishing are all material. In practice, those costs must be offset either by a return from the catch taken during the trip or by a realistic prospect that the research will open future fishing opportunities. Without that balance, continued industry participation in remote, high-cost research fishing is unlikely to be sustainable.

There are also important benefits from this industry-supported work that are not easily quantified in catch or effort summaries. The voyages have returned large numbers of fish, invertebrate and other biological samples to research organisations and museum collections, providing material for species identification, taxonomy, ageing, reproductive studies, genetic work and broader biodiversity documentation. These ancillary collections add scientific value beyond the immediate objectives of the exploratory fishery, particularly in remote deepwater areas where independent sampling opportunities are rare.

From a management perspective, SPRFMO has accumulated a substantial evidence base from New Zealand's exploratory work, but the evidence remains uneven across areas. The eastern study-area work now provides a coherent biological interpretation of Antarctic toothfish, whereas the newer 2025 western New Zealand exploratory areas remain at an early prospecting stage. Future advice should distinguish between areas where continued research can refine an existing interpretation and those where the first priority remains defining fishable habitat, species composition, and whether sufficient toothfish densities exist to support structured sampling.

The programme's ongoing value will depend on maintaining the link between operational fishing activity and clearly defined scientific objectives. Continued tagging, biological sampling, recording of catch and effort at fine spatial scales, and monitoring of non-target and benthic interactions remain essential. Equally, effective implementation will require ongoing cooperation among industry, New Zealand agencies, SPRFMO and CCAMLR, so that data collected in the SPRFMO area can be interpreted alongside adjacent CCAMLR datasets and incorporated into broader stock-structure and assessment discussions where appropriate.

6. Conclusions

New Zealand's exploratory toothfish programme has provided the first sustained time series of fishing, biological and tagging information for *Dissostichus* spp. in the eastern study area. The work has confirmed that Antarctic toothfish occur regularly north of the CCAMLR boundary and that catches in these research areas are overwhelmingly dominated by large, mature Antarctic toothfish.

Combined evidence from species composition, size structure, reproductive condition, body condition, catch distribution and tagging supports the interpretation that the eastern study area is used by Antarctic toothfish for spawning. This finding is central to the programme's significance and indicates that Antarctic toothfish stock structure and movement should continue to be considered across the SPRFMO–CCAMLR boundary rather than within each Convention Area in isolation.

The 2025 exploratory work in the western New Zealand exploratory areas should be considered separately from the 2016–2024 eastern study-area time series. The data collected to date are preliminary and mainly provide information on bathymetry, fishable ground and initial species composition. The increased occurrence of Patagonian toothfish is an important observation, but further sampling is required before robust conclusions can be drawn about population structure, reproductive condition or long-term fishery potential in those areas.

Implementation should focus on maintaining a precautionary, information-based approach. Priority tasks include continuing tagging at scientifically useful rates, maintaining consistent biological sampling, improving bathymetric mapping of candidate fishing grounds, clearly distinguishing between Antarctic and Patagonian toothfish components in reporting, and continuing to monitor non-target catch, seabird and marine mammal interactions, and VME indicator taxa. Data should continue to be reported to SPRFMO and, where relevant, shared in formats that allow comparison with CCAMLR datasets.

For future Scientific Committee consideration, the programme supports three linked outcomes: continued evaluation of Antarctic toothfish spawning-related use of the eastern study area; assessment of movement and stock connectivity with adjacent CCAMLR areas; and cautious development of new exploratory areas, only where sufficient information is available to justify continued sampling.

7. Recommendations from this paper

It is recommended that the Scientific Committee:

- **Note** the sustained contribution of New Zealand to the exploratory toothfish programme since 2016 and acknowledge the substantial operational, biological, tagging, bycatch and habitat information obtained from previously data-poor areas.
- **Recognise** the evidence that the eastern study area is used by Antarctic toothfish for spawning or closely related reproductive activities, and that movement and stock structure should be considered across the SPRFMO–CCAMLR boundary.
- **Recommend** that precautionary research, including tagging, biological sampling, bathymetric mapping and monitoring of non-target catch and vulnerable marine ecosystems, be continued.

8. Acknowledgements

This programme has relied on the contributions and cooperation of many people and organisations. I thank Sanford Limited for providing the vessel, crew and operational support that made the research fishing possible, and for its continued commitment to working within the approved exploratory research framework. I also thank the Sanford Science staff, Dave Bilton, Kazuto Senga and Marianne Nyegaard, for their support with planning, coordination, participation at sea in tagging and biological sampling, data provision, and review throughout the programme.

I thank the officers, crew and vessel management teams involved in the voyages for their professionalism and practical support with tagging, biological sampling, catch recording and safe operations in remote fishing grounds. I am also grateful to the scientific observers, whose work provided much of the biological data, tagging records, bycatch information and seabird, marine mammal and benthic observations used in this programme.

The programme has also drawn on input from New Zealand government agencies, scientific advisers, data managers and analysts, as well as discussions through the SPRFMO and CCAMLR processes.

I am also grateful to all others who have contributed since 2016, including those involved in voyage planning, data processing, species identification, ageing,

reproductive analyses, tag administration, and preparation of material for successive SPRFMO Scientific Committee meetings.

9. Major References

The references listed below are provided to assist the Scientific Committee. They are based on papers, proposals and reports previously submitted to SPRFMO, together with supporting literature relevant to the programme. References have not been inserted throughout the text because this paper is intended as an overall summary of the project; more detailed source material is available in the original reports and submissions.

Allain, V.; Kerandel, J.A.; Andrefouët, S.; Magron, F.; Clark, M.; Kirby, D.S.; Muller-Karger, F.E. 2008. Enhanced seamount location database for the western and central Pacific Ocean: screening and cross-checking of 20 existing datasets. *Deep Sea Research Part I*, 55: 1035–1047.

Anderson, O.F.; Guinotte, J.M.; Rowden, A.A.; Clark, M.R.; Mormede, S.; Bowden, D.; Davies, A.J. submitted. Field validation of habitat suitability models for vulnerable marine ecosystems in the South Pacific Ocean: implications for the use of broad-scale models in fisheries management.

Anderson, O.F.; Small, C.J.; Croxall, J.P.; Dunn, E.K.; Sullivan, B.J.; Yates, O.; Black, A. 2011. Global seabird bycatch in longline fisheries. *Endangered Species Research*, 14: 91–106.

Baird, K.; Small, C.; Bell, E.; Walker, K.; Elliot, G.; Nicholls, D.; Alderman, R.; Scofield, P.; Deppe, L.; Thomas, B.; Dias, M.P. 2015. The overlap of threatened seabirds with reported bycatch areas between 25° and 30° South in the WCPFC area. WCPFC-SC11-2015/EB-WP-09.

CCAMLR Secretariat. 2012. Preliminary assessment of known and anticipated impacts of proposed bottom fishing activities on VMEs in 2012/13. CCAMLR-XXXI/14 Rev. 1.

Clark, M.R.; Althaus, F.; Schlacher, T.A.; Williams, A.; Bowden, D.A.; Rowden, A.A. 2016. The impacts of deep-sea fisheries on benthic communities: a review. *ICES Journal of Marine Science*, 73 (Suppl. 1): i51–i69.

Davies, A.J.; Guinotte, J.M. 2011. Global habitat suitability for framework-forming cold-water corals. *PLoS ONE*, 6: e18483.

Fenaughty, J.M. 2006. Geographical differences in condition, reproductive development, sex ratio, and length distribution in Antarctic toothfish (*Dissostichus mawsoni*) from the Ross Sea, Antarctica. *CCAMLR Science*, 13: 27–45.

Fenaughty, J.M.; Eastman, J.T.; Sidell, B.D. 2008. Biological implications of low condition factor "ax handle" specimens of the Antarctic toothfish, *Dissostichus mawsoni*, from the Ross Sea. *Antarctic Science*, 20(6): 537–551.

Fenaughty, J.M. 2008. The autoline system – an updated descriptive review. CCAMLR WG-FSA-08/60.

Fenaughty, J.M.; Cryer, M. 2016. *Report on the first year's fishing under New Zealand's exploratory fishery for toothfish within the SPRFMO Convention Area*. SC-04-DW-02. 4th Meeting of the SPRFMO Scientific Committee, The Hague, Kingdom of the Netherlands, 10–15 October 2016. South Pacific Regional Fisheries Management Organisation.

Fenaughty, J.M.; Cryer, M.; Dunn, A. 2018. Research results from the SPRFMO exploratory fishing program for Antarctic toothfish 2016 and 2017. WG-FSA-18/39.

Fenaughty, J.M. 2020. *Interim research report from the New Zealand bottom longline research carried out in the SPRFMO area 2019 and 2020*. SPRFMO SC8-DW09.

Fenaughty, J.M. 2021. *Report on the New Zealand exploratory bottom longline fishing for toothfish in the SPRFMO Convention Area 2019 to 2021*. SC9-DW04. 9th Meeting of the SPRFMO Scientific Committee. South Pacific Regional Fisheries Management Organisation.

Fenaughty, J.M. 2022. *Interim research report from the New Zealand bottom longline research carried out in the SPRFMO area 2022*. SC10-DW07. 10th Meeting of the SPRFMO Scientific Committee, Seoul, Korea, 26–30 September 2022. South Pacific Regional Fisheries Management Organisation.

Fenaughty, J.M. 2023. *Temperature data by depth using demersal longlines: the New Zealand experience in the Ross Sea – first steps*. SC-CAMLR-42/BG/29. Background paper for the 42nd meeting of the Scientific Committee, Commission for the Conservation of Antarctic Marine Living Resources, 14 September 2023.

Nyegaard, M.; Fenaughty, J.M. 2023. *Interim research report from the New Zealand bottom longline research carried out in the SPRFMO area 2023*. SPRFMO SC11-DW11_rev1.

Ministry for Primary Industries. 2015. *Proposal for exploratory bottom longline fishing for toothfish in the SPRFMO Area*. SC03-DW-1. 3rd Meeting of the SPRFMO Scientific Committee. South Pacific Regional Fisheries Management Organisation.

Ministry for Primary Industries. 2021. *Proposal for exploratory bottom longlining for toothfish by New Zealand vessels, 2022–2024: Fisheries Operation Plan, suggested Data Collection Plan, and impact assessments*. SC9-DW01_rev1. 9th Meeting of the SPRFMO Scientific Committee. South Pacific Regional Fisheries Management Organisation.

Ministry for Primary Industries. 2024. *Proposal for exploratory bottom longlining for toothfish by New Zealand vessels 2025–2027: Fisheries Operation Plan, Data Collection Plan, Impact Assessments, and Mitigation Summaries for Non-target, Associated or Dependent Species*. SC12-DW01_rev2. 12th Meeting of the SPRFMO Scientific Committee, Lima, Peru, 30 September to 5 October 2024. South Pacific Regional Fisheries Management Organisation.

New Zealand Ministry of Fisheries. 2007. New Zealand national report for SPRFMO preparatory process.

New Zealand Ministry of Fisheries. 2008. *Bottom Fishery Impact Assessment: bottom fishing activities by New Zealand vessels in the SPRFMO Area (2008–09)*.

Parker, S.J.; Mormede, S.; Tracey, D.M.; Carter, M. 2009. Evaluation of VME taxa monitoring by observers in the Ross Sea region Antarctic toothfish longline fishery. CCAMLR TASO-09/8.

Parker, S.J.; Bowden, D.A. 2010. Identifying taxonomic groups vulnerable to bottom longline fishing gear in the Ross Sea region. *CCAMLR Science*, 17: 105–127.

Parker, S.J.; Smith, M.H. 2011. Can toothfish catches be used to predict the presence of vulnerable benthic invertebrate taxa? *CCAMLR Science*, 18: 87–96.

Pham, C.K.; Diogo, H.; Menezes, G.; Porteiro, F.; Braga-Henriques, A.; Vandeperre, F.; Morato, T. 2014. Deep-water longline fishing has reduced impact on vulnerable marine ecosystems. *Scientific Reports*, 4.

Sharp, B.R.; Parker, S.J.; Smith, N. 2008. An impact assessment framework for bottom fishing methods in the CCAMLR area. CCAMLR WSA-08/53.

Sharp, B.R. 2010. Updated impact assessment framework for bottom longline fisheries in the CCAMLR Area. *CCAMLR Science*, 16: 195–210.

South Pacific Regional Fisheries Management Organisation. 2018. *Proposal for exploratory bottom longlining for toothfish in the SPRFMO Area*. SC-06-DW-03-rev2. 6th Meeting of the SPRFMO Scientific Committee.

South Pacific Regional Fisheries Management Organisation. 2019. *Conservation and Management Measure 14a-2019: Conservation and Management Measure for Exploratory Fishing for Toothfish by New Zealand-Flagged Vessels in the SPRFMO Convention Area*.

South Pacific Regional Fisheries Management Organisation and Commission for the Conservation of Antarctic Marine Living Resources. 2019. *Arrangement between SPRFMO and CCAMLR*.

South Pacific Regional Fisheries Management Organisation. 2021. *Conservation and Management Measure 03-2021: Management of Bottom Fishing in the SPRFMO Convention Area*.

South Pacific Regional Fisheries Management Organisation. 2022. *Conservation and Management Measure 02-2022: Standards for the Collection, Reporting, Verification and Exchange of Data*.

South Pacific Regional Fisheries Management Organisation. 2022. *Conservation and Management Measure 19a-2022*.

South Pacific Regional Fisheries Management Organisation. 2023. *Classification Guide for Potentially Vulnerable Invertebrate Taxa in the SPRFMO Area*.

South Pacific Regional Fisheries Management Organisation. 2025. *Conservation and Management Measure 14i-2025: Conservation and Management Measure for Exploratory Fishing for Toothfish by New Zealand-flagged Vessels in the SPRFMO Convention Area*.

Williams, K. 2007. Evaluation of macroscopic staging methods for determining maturity in fish. *Alaska Fishery Research Bulletin*, 12: 252–263.