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South Pacific Regional Fisheries Management Organisation

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SC11 – DW11_rev1

Progress report on NZs Exploratory fishery for toothfish

(rev1, 6 September 2023)

New Zealand

South Pacific Regional Fisheries Management Organisation

11th Meeting of the Scientific Committee

Interim research report from the New Zealand bottom longline research carried out in the SPRFMO area 2023

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1. Executive summary

Paragraph 7 of CMM 14a-2022 governing Exploratory Fishing for Toothfish by New Zealand-Flagged Vessels in the SPRFMO Convention Area states that the Scientific Committee will review available results from the New Zealand exploratory fishing each year and advise the Commission on progress, including whether any stock indicators show sustainability concerns and what, if any, additional measures might be required to restrict the likely bycatch of deepwater sharks and/or other non-target species. This is the interim report on 2023 activities.

The authorised New Zealand vessel *San Aspiring* carried out a single exploratory fishing trip after our 2022 interim report, with fishing taking place during late March and early April 2023. Unfortunately, due to an issue with microbial fuel contamination the vessel was compelled to return to port prematurely. A total of 13 days were spent within the designated SPRFMO Research Strata, during which five sets were carried out, 15,515 hooks were set following the stipulated cluster design.

A catch of 34.4 tonnes of Antarctic toothfish was taken during the trip. Non-target fish catches constituted less than 0.05% (by weight) of the overall catch, mostly consisting of blue antimora and grenadier. As part of the joint SPRFMO/CCAMLR stock assessment programme 135 Antarctic toothfish were tagged. Two tagged toothfish were recovered (one a within-season capture only briefly at liberty).

Antarctic toothfish of both sexes were found to be generally in a pre-spawning/developing gonad stage with one male found in a ripe gonad state and three male fish in the spent condition. This is consistent with the previously hypothesised winter spawning. The length frequency of fish sampled during 2023 is broadly consistent with previous records from the area fished.

In contrast with previous years when Antarctic toothfish sex ratios have been consistently skewed with males dominating, sex ratios were almost even in 2023.

2. Introduction

In 2015, New Zealand presented a proposal to the SPFRMO Scientific Committee for a two-year Exploratory Fishery for Antarctic toothfish (*Dissostichus mawsoni*) and Patagonian toothfish (*Dissostichus eleginoides*) using bottom longlining, along the southern border of the SPFRMO Convention Area where it borders the CAMLR Convention Area. The proposal was accepted in 2016 under CMM 14-2016.

The Exploratory Fishery had two major objectives (SC6-DW03-rev2):

- to gain a better understanding of the distribution, movement, spawning dynamics, and stock structure of both toothfish species, and,
- to support CCAMLR stock assessment models[3] for Antarctic toothfish.

[3] SPRFMO has agreed and committed to share the data and analyses from this work with CCAMLR. SPRFMO has also adopted the CCAMLR methodology for the research including the fishing stratification for a consistent approach.

In 2016 and 2017 the New Zealand vessel *San Aspiring* successfully completed the first two Exploratory Fishery trips (one in each year), inside two small Research Areas (Research Area A and B; red boxes shown in Figure 1. The 2016 data was summarized in SC-04-DW-02, with a comprehensive report covering both years presented to SPRFMO in 2018 as part of a revised proposal by New Zealand to extend and expand the Exploratory Fishery (SC6-DW03-rev2). The proposal was approved by the SPRFMO Commission under CMM 14a-2019, and another three trips were completed by the San Aspiring in 2019, 2020 and 2021 inside Research Strata L – O (Figure 1.).

At the 2021 meeting (SC9), the SPRFMO Scientific Committee considered a new proposal by New Zealand to further extend and expand the Exploratory Fishery into 2022, 2023, and 2024 (SC9-DW01_rev1). The research results from the 2019 – 21 trips were presented as part of that proposal. The extension of the Exploratory Fishery was approved in 2022 under CMM 14a-2022.

The 2022 approval allowed for up to two authorised New Zealand vessels to take up to 240 tonnes of toothfish annually (both species combined). Fishing is restricted to eight Research Strata (L – S, Figure 1), each having a catch limit of 40 tonnes a year. Up to 50% of the total annual catch (120 tonnes) can be taken outside the post-spawning period (August – October).

The objectives of the Exploratory Fishery are set out in the CMM 14a-2022 as follows:

- To continue mapping the bathymetry of the fishable area (shallower than about 2,500 m) in mid-Pacific to the north of the SPFRMO-CCAMLR boundary.
- Document the spatial distribution, catch rates, and relative abundance of Antarctic and Patagonian toothfish in likely suitable habitat to the north of the CAMLR Convention area by latitude, area, and depth.
- Characterise the biology, life history and spawning dynamics of both species of toothfish in the area.
- Tag enough toothfish to inform stock linkage and life history studies, and for use in the multi-area CCAMLR stock assessment model.
- Collect information on distribution, relative abundance, and life history of bycatch and other associated or dependent species.
- Collect toothfish eggs using plankton net tows, if practical.
- As feasible given the availability of equipment, conduct Continuous Plankton Recorder (CPR) tows for planktonic studies and potentially for eggs; and
- Collect acoustic data using exiting procedures as carried out within the CAMLR Convention Area.
- The first exploratory trip each year may occur any time in 2022, 2023, and 2024 with fishing restricted to a maximum of four trips per year. Some of these trips to be conducted between August and October to characterise post-spawning dynamics (CMM 14a-2022). A further trip is planned for the post-August period 2024 to look at potential post spawning of Antarctic toothfish.

A single exploratory research trip was carried out by *San Aspiring* in March 2022, with the preliminary results summarised in SC10-DW07 and made available to SPRFMO during the 2022 meeting (SC10).

During March - April 2023, *San Aspiring* completed this single exploratory research trip - the second for the three-year project. The Following report briefly summarises activities undertaken to address the requirement for an interim report and provides some brief results recalling that a full analysis of all research and associated data for the 2022-2024 work is to be carried out following the third year of the current project.

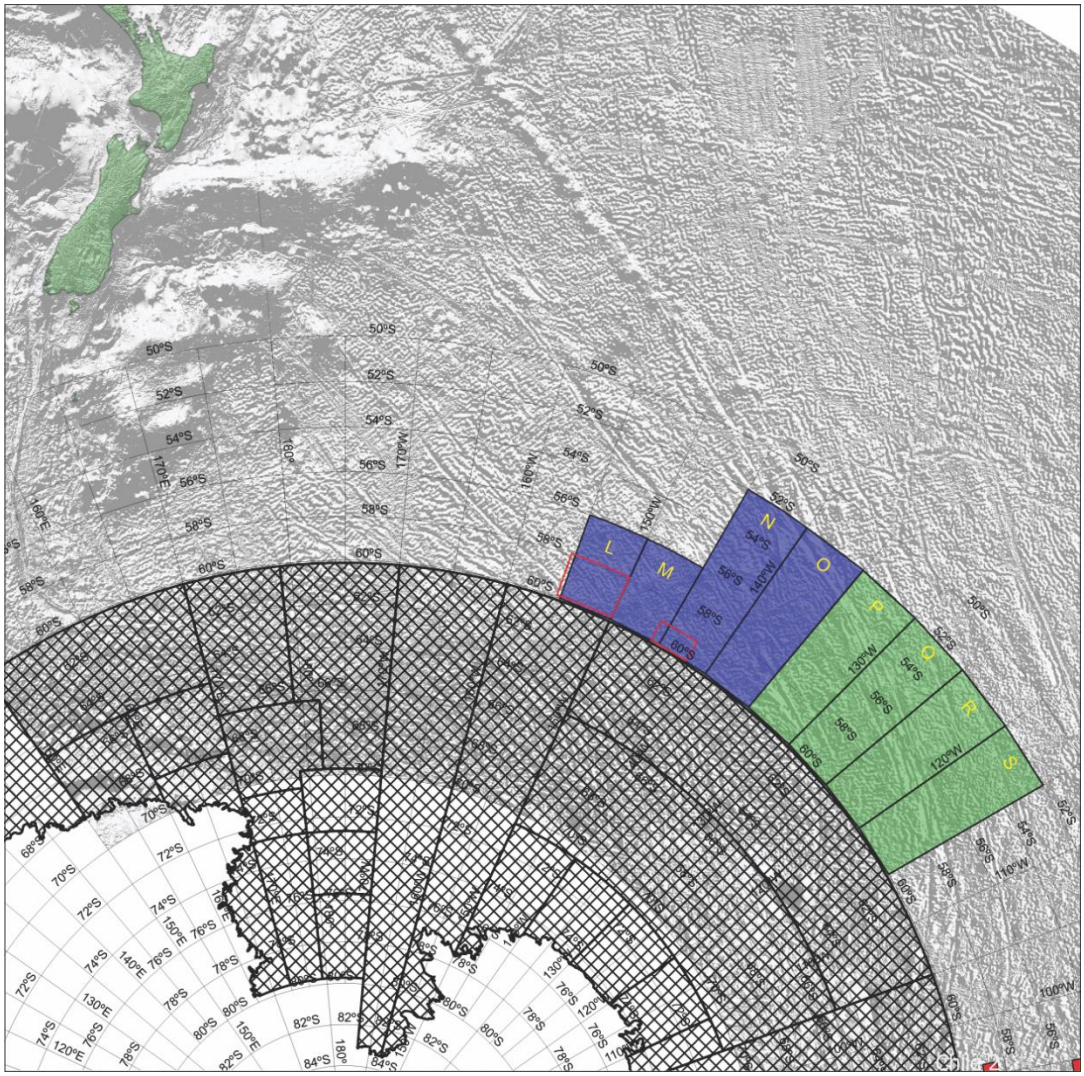


Figure 1. Survey area for 2022-24 research. Research areas P, Q, R, and S are the new areas added, additional to the 2019-21 research areas L, M, N, and O. The open red boxes are the initial research boxes from 2016-2017 which are now included within research areas L-O. The hashed area is the CAMLR Convention Area.

Table 1. Longline set summary for the 2023 SPRFMO research carried out by San Aspiring

Area Name	Number of sets	Total hooks set	Hooks Lost with line sections	Start date	Ed date	Minimum Fishing Depth(m)	Maximum Fishing Depth(m)	Toothfish catch (kg)
L	2	8570	1130	22-Mar-23	23-Mar-23	1347	1528	34 398.8
N	3	6945	2420	25-Mar-23	29-Mar-23	1267	1734	0
TOTALS	**5**	**15515**	**3550**					34 398.8

3. Methods

A full description of the methodology for this project is available in the SPRFMO document SC9-DW01_rev1 Proposal for exploratory bottom longlining for toothfish by New Zealand vessels 2022-2024. Management incorporates both a catch limit and an effort spreading approach designed to minimise the chances of any localised depletion. The managed cluster approach in use in SPRFMO is also used for CCAMLR research fishing and is described fully in SC9-DW01_rev1.

Table 2. A summary of biological data collected during the 2023 research. Lengths are reported to the nearest 1 cm, sex represents number of samples identified by sex, stage is the reproductive state (see appendix 1), gonad weight is to the nearest gram, and otoliths collected sums the number of otolith pairs taken for aging ashore. Numbers otherwise represent the numbers of fish sampled. In addition, in situ records of stomach samples were recorded for all 154 Antarctic toothfish

Common name	Species name	FAO Code	Total Length	Fish weight	Sex	Gonad condition	Gonad Weight (g)	Otolith (pairs) collected
Antarctic Toothfish	*Dissostichus mawsoni*	TOA	154	154	154	154	69	106
Bigeye grenadier	*Macrourus holotrachys*	MCH	3	3	0	0	0	0
Blue Antimora	*Antomora rostrata*	ANT	5	5	2	2	2	2

No more than 50% of the total catch limit can be taken outside the post-spawning period August to October, meaning that there is up to 120 tonnes available for each of the pre-and post-spawning periods. However, there is a maximum limit of 40 tonnes set in each of the eight available Research Areas.

Authorised vessels use an autoline system bottom longline with integrated-weight line to minimise seabird interactions with fishing gear. This is the identical fishing gear configuration

used for fishing operations and research fishing within CCAMLR enabling direct comparability with CCAMLR research. Fenaughty (2008) provides more detail on the fishing method used.

Biological data were collected Antarctic toothfish, when present, which were sampled for length, weight, sex, gonad stage and gonad weight (Table 2). Otoliths were subsampled from each line where toothfish were caught - noting the reduced amount of fishing due to the trip being prematurely curtailed, limited biological data were also collected from two key bycatch species when present including otoliths for ageing studies.

Samples of fish, fish tissue and stomach samples for further examination ashore were collected and returned with the vessel. These were primarily for other research studies (fin clips and muscle samples), other agency requests for specimens, and for identification in circumstances where the further initial identification was uncertain.

4. Results

4.1 Toothfish catch

A total of 1074 Antarctic toothfish were taken during the exploratory fishing in 2023, totalling 34.4 tonnes (Table 3).

All toothfish sampled came from the two sets made in Research Area L. No toothfish were caught on the three sets made in Research N.

4.2 Non-target fish catch

Non-target fish catch amounted to only 0.05% of the total catch by weight and were spread throughout both Research Areas sampled. Blue Antimora *Antomora rostrata* were the main non-target fish catch, totalling just under 0.03% of the overall catch (Table 3). *Macrourus* species comprised the second major bycatch species (0.02% by weight).

Table 3. Non-target fish catch summary for the SPRFMO 2022 research trip. All weights are in kg.

FAO Species code	Common name	Binomial or taxa	Total weight	Numbers caught	Weight Retained	Weight discarded	Numbers Retained	Numbers Discarded	% of catch
TOA	Antarctic Toothfish	*Dissostichus mawsoni*	34 398.8	1209	34 398.8	0	1074	0	99.95%
ANT	Blue Antimora	*Antomora rostrata*	9.1	7	9.1	5.3	3	4	0.03%
GRV	Rattail	*Macrourus spp.*	7.3	6	3.7	3.6	3	3	0.02%
KCX	Crab spp.	*Lithodidae*	0.3	1	0	0.3	0	1	0.00%
		Total	34 415.5		34 411.6	9.2	1080	8	

4.3 Tagging

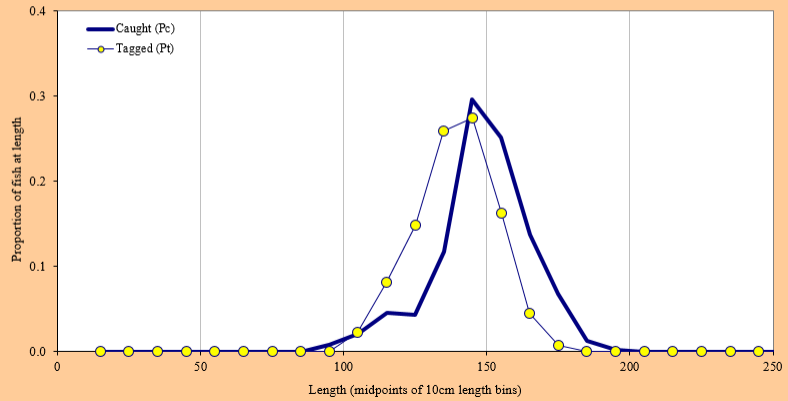
Toothfish are required to be tagged at a rate of 3 fish per tonne of green weight catch retained (approximately 1 in each 10 fish captured). See Figure 2.

CMM 14a-2022 par.16 b requires that: *A minimum tagging rate of three fish of each Dissostichus species per greenweight (live weight) tonne shall be implemented. The rules applied by CCAMLR in the immediately adjacent 88.1 A and B North region, where tagged fish were released starting in early 2015, shall be applied (CM 41-01 Annex C). These rules require a minimum overlap statistic (a comparison between the observed length frequency from vessel biological information and the size composition of fish returned alive with tags, see CCAMLR's calculator) of at least 60% once 30 or more Dissostichus of a species have been successfully released with tags.*

Both the required rate (3.9 per tonne) and overlap statistic (71.4%) were met. Tagging was carried out by crew members trained in both the use of tagging and retrieval equipment and in the recording of data with oversight by the on-board scientific observer. To ensure that tagged fish were randomly selected by size, the hauling room crew were periodically instructed (prior to the fish coming on board) to tag the next suitable[4] fish caught. The fish was then carefully removed from the water using a net, placed on a mat on the haul room floor and assessed for condition. If suitable, the hook was removed, the fish was then measured for total length and two white CCAMLR T-bar tags inserted (one tag either side of the anterior part of the second dorsal fin) following the CCAMLR tagging protocol. Once the tag data had been accurately recorded the fish was released back into the water. Toothfish tagged ranged between 100 – 170 cm TL.

***Dissostichus mawsoni* (TOA)**

Number of hauls reported in C2 data	5
Total green weight caught (tonne)	34.4
Total number of fish caught	1074
Total number of fish tagged	135
Tagging rate (fish/tonne green weight caugl	**3.92** (combined rate for Dissostichus spp. 3.92 see instructions)
Tag overlap statistic (%)	**71.43**



Length (midpoint of 10cm bin)	Proportion of fish at lengt Caught (Pc)	Tagged (Pt)	Difference abs(Pt-Pc)
15	0.000	0.000	0.000
25	0.000	0.000	0.000
35	0.000	0.000	0.000
45	0.000	0.000	0.000
55	0.000	0.000	0.000
65	0.000	0.000	0.000
75	0.000	0.000	0.000
85	0.000	0.000	0.000
95	0.008	0.000	0.008
105	0.020	0.022	0.002
115	0.045	0.081	0.036
125	0.043	0.148	0.105
135	0.117	0.259	0.142
145	0.296	0.274	0.021
155	0.251	0.163	0.088
165	0.137	0.044	0.093
175	0.068	0.007	0.061
185	0.013	0.000	0.013
195	0.002	0.000	0.002
205	0.000	0.000	0.000
215	0.000	0.000	0.000
225	0.000	0.000	0.000
235	0.000	0.000	0.000
245	0.000	0.000	0.000
255	0.000	0.000	0.000
Total	1.000	1.000	0.571
Tag overlap statistic (%)			**71.43**

Figure 2. Tagging size overlap statistic for Antarctic toothfish from the SPRFMO exploratory toothfish fishery in 2022. Weights given are retained weights. The red line is the frequency

[4] Conforming to the suitability requirements specified in the CCAMLR Toothfish and Skate tagging instructions - https://www.ccamlr.org/en/system/files/Toothfish%20and%20Skate%20Tagging%20Instructions.pdf

distribution of the tagged fish for comparison with the biological sample lengths for the caught population.

A total of 135 Antarctic toothfish were tagged and two Antarctic toothfish were recaptured during this trip. One recapture had been tagged and released a short time prior, while the other had been tagged during research on 12 March 2022.

Ongoing tagging and recovery of tagged Antarctic toothfish from SPRFMO exploratory fishing using the CCAMLR tagging protocols enables SPRFMO tagging results to be incorporated in the CCAMLR/SPRFMO integrated stock assessment. This work also increases the geographical area covered by the tagging programme and consequently enhances our ability to investigate the wider geographical movements of toothfish.

4.3 Interactions with seabirds, marine mammals, turtles, or other species of concern

4.3.1 Seabirds

All line setting was carried out after nautical dusk with minimal deck lighting and with a tori line deployed. The vessel uses integrated weighted main line (50 grams of weight per metre of line). A seabird exclusion device (Brickle curtain) is permanently deployed to protect the immediate area of water near the hauling position. Offal, used bait, and bycatch is minced and then discharged on the opposite side to the haul room only when no setting or hauling is taking place. Sump grates are used to prevent the accidental discharge of offal from the factory floor. Few seabirds (generally 5 or less) were seen during the standard bird count during the observer's line observations. Species were mainly non-specified great albatross (Wandering or Royal), Antarctic prions and occasionally petrels (possibly grey petrels). Birds predominantly flew laps around the vessel rather than sitting on the water near the hauler.

Opportunistic observations of birds throughout the trip reflected the standard bird counts. Few birds were seen around the vessel, mainly great albatross – including juveniles. (Figure 3, left), giant petrels, sooty albatrosses, petrels (possibly grey petrels), and Antarctic prions. Birds were predominantly observed flying laps around the vessel rather than sitting on the water. Those sitting on the water were not close to the vessel. On the 27/03/23, four juvenile emperor penguins (identified based on the distinctive pattern on the head; Figure 3, right) were milling around the vessel most of the afternoon and were heard calling most of the night (no fishing or discharge activity were taking place).

No bird fatalities were observed in the SPFRMO area during this trip.

Figure 3. Juvenile great albatross (left); juvenile emperor penguins seen milling around the vessel on 27/03/2023 (middle and right).

4.3.2 Marine mammals, turtles, or other species of concern

Five opportunistic observations of marine mammals took place. One, consisting of several sightings over a few hours (on 27/03/23-28/03/23 UTC) (Table 4). The species were identified as hourglass dolphins *Lagenorhynchus cruciger* based on the distinctive body pattern (Figure 4), fin whales *Balaenoptera physalus* which came in close enough to the ship for good identification (Figure 5), southern bottlenose whale *Hyperoodon planifrons* tentatively identified based on distinctive spots on the body, and pilot whales *Globicephala* identified based on overall shape and size, colour and large pod numbers.

No turtles or other species of concern were observed during the trip.

Table 4. Opportunistic observations of marine mammals during the 2023 SPFRMO Exploratory Fishery. Asterisk denotes observations where photos were taken. All records are in Coordinated Universal Time.

Date/time	Confidence in identification	Position	Species	*n*	Behaviour	Vessel activity
20/03/23 02:15*	Excellent	59°20.8'S 160°54.3'W	Hourglass dolphin (*Lagenorhynchus cruciger*)	3	Following vessel, starboard side	Steaming
25/03/23 22:25*	Good	59°41.3'S 143°46.5'W	Fin whale (*Balaenoptera physalus*)	1	Straight towards vessel, weered off within 50-100m. Rested at surface 300-400 m from vessel, disappeared.	Hauling downline (not yet on hooks)
27/03/23 21:45*	Good	59°44.8'S 143°37.3'W	Fin whale (*B. physalus*)	1	Presumably feeding (repeated diving) in area around vessel.	Laying to (no gear in water)
27/03/23 21:45*	Good	59°44.1'S 143°40.1'W	Fin whales (*B. physalus*)	≥12	Observations over several hours. Presumably feeding (repeated diving) in area around vessel.	Laying to (no gear in water)

28/03/23 00:54*	Tentative	59°44.1'S 143°40.1'W	Southern bottle nose whale (*Hyperoodon planifrons*)	2-5	Dolphin-sized, clear spots; porpoised past vessel (within 50 m)	Laying to (no gear in water)
29/03/23 21:30	Good	58°06.2'S 137°56.0'W	Fin whales (*B. physalus*)	2	Spouts	Steaming
31/03/23 17:00	Good	54°56.6'S 128°11.9'W	Pilot whales (*Globicephala* sp.)	100 estimated	Very large group travelling north	Steaming

Figure 4. Hourglass dolphins close to the vessel on 20/03/2023.

Figure 5. Fin whale identified based on the white chin (left), dorsal fin shape (middle), subtle body pattern, body size, and shape of blow (right).

4.4 Benthic interactions and potential interactions with VMEs

Following the CCAMLR benthic sampling protocol for bottom longline, lines are divided into numbered segments of 1200 m (equivalent to one autoline magazine of 857 hooks). Any benthos found on a segment are placed by the crew into a 10-litre bucket marked with that segment's number. Benthic species are then identified to taxa level by the observer and weighed to the nearest 10 grams.

The total weight of VME indicator taxa recovered on long lines was 1.35 kg. Of the 18 line-segments set, VME indicator taxa were seen on 7, with nothing on the remaining line-segments. Nearly 61% of VME indicator taxa recovered came from Research Area L with the remaining 39% from N.

Siliceous sponges were the most common organisms recovered, amounting to 59.3% of the benthic sample by weight (Table 55). Glass sponges were the next most prevalent class by weight at 26.7% of the overall sample.

Benthic bycatch was much lower than both CCAMLR thresholds for notification and SPRFMO encounter thresholds.

Table 5. Weight (kg) and proportion of total for recorded benthic material from the 2023 exploratory fishing.

Common name	Order	FAO Code	Weight (kg)	% of total weight
Siliceous sponges	*Demospongiae*	DMO	0.80	59.26%
Glass sponge	*Hexactinellida*	HXY	0.36	26.67%
Black corals and thorny corals	*Antipatharia*	AQZ	0.11	8.15%
Gorgonians	*Gorgoniidae*	GGW	0.06	4.44%
Hydroids, hydromedusae	*Anthoathecatae*	AZN	0.01	0.74%
Hard corals, stony corals	*Scleractinia*	CSS	0.01	0.74%
TOTAL			**1.35**	

Results and discussion

The authorised New Zealand vessel *San Aspiring* carried out a single SPRFMO exploratory research trip during March and April 2023. Unfortunately, due to microbial contamination of the diesel fuel (diesel bug) the planned survey was by necessity cut short. During the reduced 23-day survey within the SPRFMO management area the vessel still managed to survey within six Research Areas for fishable grounds, setting a total of 15 515 hooks in two Research Areas (areas L and N) following the required cluster design for a total of 5 longline sets (Table 1). Approximate 5,500 nm of bathymetry track data was obtained and saved during the trip (port to port) including within the NZ EEZ (Figure 6).

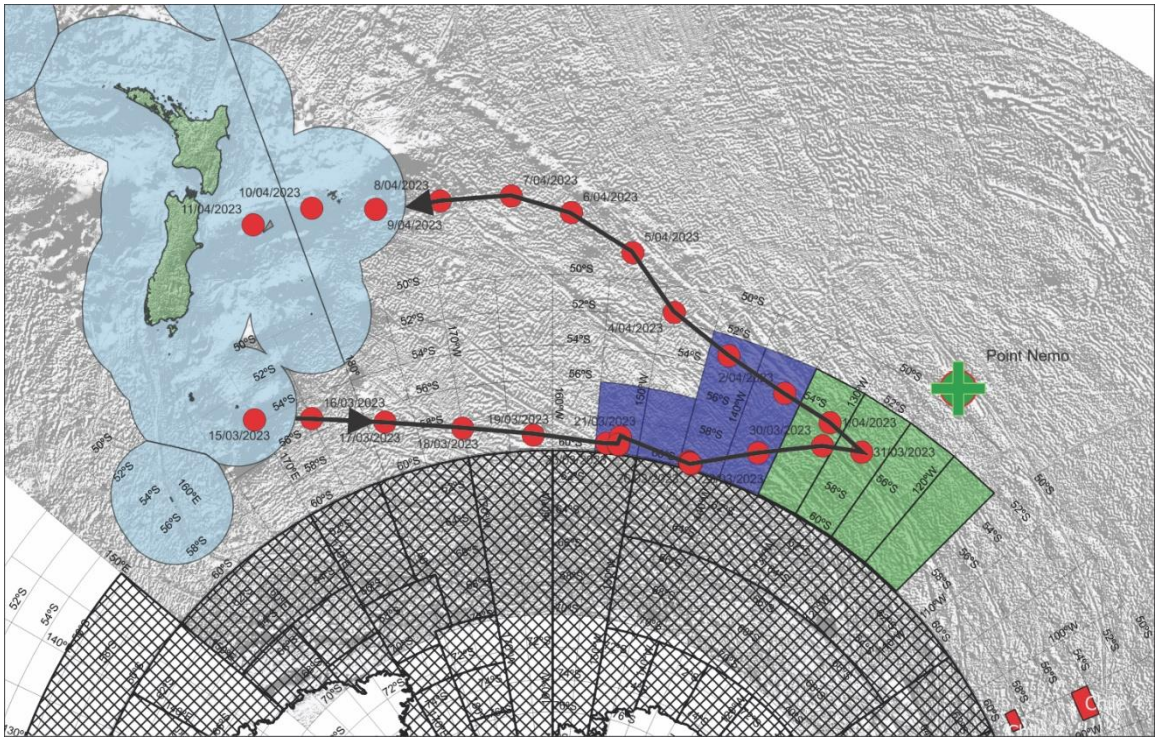


Figure 6. San Aspiring vessel movements as indicated by noon position. While the indicated track length is about 3900 nautical miles from the New Zealand EEZ boundary, the vessel covered considerable additional distance while surveying the bottom for potential fishing grounds. For interest and as a geographical reference the oceanic pole of inaccessibility indicating the point most distant from any land (Point Nemo) is indicated just north of the survey area.

A total toothfish catch of 34.4 tonnes was taken during the trip, all from Research Area L. Non-target fish catch was less than 0.05% of the overall catch weight with blue antimora being the major item (Table 3), spread over both Research Areas Sampled. A total of 135 Antarctic toothfish were tagged as part of the joint SPRFMO/CCAMLR stock assessment programme. Two previously tagged toothfish was recovered (one of which was an in-season tagging).

This is the second interim update on the three-year programme with a full analysis of all research and associated data to be carried out following the third year of the project.

To characterise post-spawning dynamics of Antarctic toothfish (CMM 14a, Paragraph 6) a post-August 2024 trip is planned for next year.

Initial analysis of the 2023 data indicates that results are generally consistent with those obtained during previous research. In summary:

- High catch rates of Antarctic toothfish were again recorded in Research Area L. Catch rates mirror those found in two assumed spawning areas in the northern regions of CCAMLR subareas 88.1 and 88.2 (Fenaughty 2006, Hanchet et al 2008).

- The toothfish catch was entirely composed of Antarctic toothfish.

- In contrast with previous years when Antarctic toothfish sex ratios have been consistently skewed with males dominating, sex ratios were almost even. Males were 59.9% of the total sample in 2022 but just over 50.6% in 2023.

- Antarctic toothfish of both sexes were found to be generally in a pre-spawning/developing gonad stage with one male found in a ripe gonad state and three male fish in the spent condition. This is consistent with the hypothesised winter spawning.

- Following this trip, the number of collected otolith pairs collected for aging from all SPRFMO exploratory toothfish trips totals 679. These will be aged as part of the CCAMLR stock assessment project.

- 806 Antarctic toothfish have been tagged since 2016 and seven previously tagged fish recovered after at least one season. One of these had come from the Ross Sea slope area and had been at liberty for 15 years.

- The Antarctic toothfish sampled are almost entirely adult fish which is consistent with this northern region being a spawning area for Antarctic toothfish. The length frequency sample from 2023 is broadly consistent with previous records (Figure 7).

- There have been no seabird interactions due to fishing operations and only common and widely distributed seabird species have been recorded attending the vessel while fishing. There has been no marine mammal depredation of lines during fishing operations.

- Benthic bycatch was much lower than CCAMLR thresholds for notification and SPRFMO encounter thresholds.

- A post- August 2024 trip is currently planned for next year.

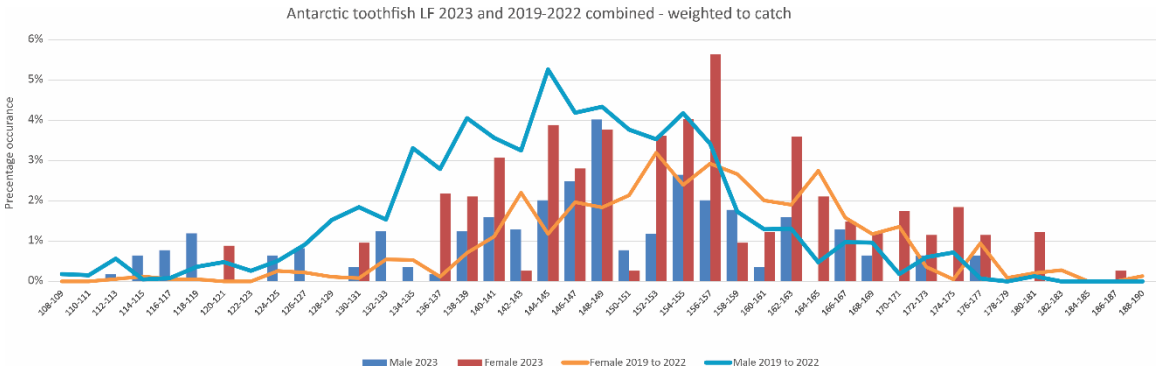


Figure 7. Catch-weighted length frequency for Antarctic toothfish sampled during 2023 and compared with the combined record from 2019-2022.

5. Acknowledgements

We thank Dean Jurasovich, Duncan McDonald, Shane Geange, Andy Biggerstaff and the members of the New Zealand South Pacific working group for constructive review and helpful comment on this report and the 2023 vessel crew and the New Zealand scientific observer for the initial collection of data and samples. Finally, Sanford Limited for enabling this exploratory fishing to be carried out under a consistently challenging operating environment.

6. Recommendations

It is recommended that the Scientific Committee:

- **Accepts** the 2023 interim research report for Exploratory Fishing for Toothfish by New Zealand-Flagged Vessels in the SPRFMO Convention Area, as required under CMM14a-2022

7. References

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8. Appendix 1: CCAMLR staging applied in assessing the fish caught within SPRFMO.

Female maturity stage description

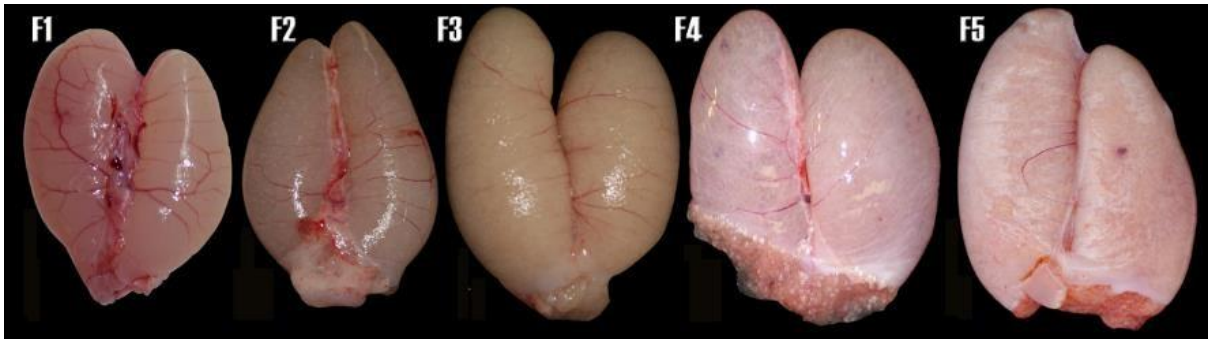
F1. Immature. Ovary small, firm, no eggs visible to the naked eye.

F2. Maturing virgin or resting. Ovary more extended, firm, small oocytes visible, giving ovary a grainy appearance.

F3. Developing. Ovary large, starting to swell the body cavity, colour varies according to species, contains oocytes of two sizes.

F4. Gravid. Ovary large, filling or swelling the body cavity, when opened large ova spill out.

F5. Spent. Ovary shrunken, flaccid, contains a few residual eggs and many small ova.



Males

Maturity stage Description

M1. Immature. Testis small, translucent, whitish, long, thin strips lying close to the vertebral column.

M2. Developing or resting. Testis white, flat, convoluted, easily visible to the naked eye, about 1/4 length of the body cavity.

M3. Developed. Testis large, white and convoluted, no milt produced when pressed or cut.

M4. Ripe. Testis large, opalescent white, drops of milt produced when pressed or cut.

M5. Spent. Testis shrunk, flabby, dirty white in colour.