SPRFMO
South Pacific Regional Fisheries Management Organisation

12th MEETING OF THE SCIENTIFIC COMMITTEE

30 September to 05 October 2024, Lima, Peru

SC 12 – DW 02_rev3

Korea Operational Plan for Toothfish

Republic of Korea

1. SUCCINCT DESCRIPTION

Paragraph 5 of CMM13 requires any Member or CNCP seeking to permit a vessel that flies its flag to fish in an exploratory fishery, or to fish in an exploratory fishery with a gear type that has not been used in that fishery for the previous ten years to submit no less than 120 days prior to the next annual meeting of the Scientific Committee a succinct description of their intended Fisheries Operation Plan for information purposes.

Member/CNCP	Republic of Korea
Area	FAO Fishing Area 81 The proposed research block is within a large area of features forming a box follows: Corner coordinates of the research block: 56°S 155°W; 56°S 145°W; 52°S 145°W; 52°S 115°W; 60°S 115°W; 60°S 155° W"
Target Species	Patagonian Toothfish (*Dissostichus eleginoides*) and Antarctic Toothfish (*D. mawsoni*)
Proposed Methods of fishing	The F.V. *Greenstar*, belonging to TNS Industries Inc., will target Patagonian toothfish (*D. eleginoides*) and Antarctic Toothfish (*D. mawsoni*) employing a Trot-line system, demersal longlining using 5-10 kg of steel weight with an interval of 22-35 metres (the same as used in CCAMLR).
Proposed maximum catch limit	240 tonnes (in green weight)
Expected operation period	2025 to 2027 (for three years)
Submission date	31 May 2024

Description of Exploratory Fishery

In accordance with paragraph 8 of CMM 13-2024 of the South Pacific Regional Fisheries Management Organisation (SPRFMO) requirements for Exploratory Fisheries the Korean Government submits the succinct description of the intended Fisheries Operation Plan for information purpose to the Secretariat to fish in an exploratory fishery during the period of 2025–2027.

According to information that we have received, including indicative bathymetric data, ~~T~~the area that we have selected ~~has~~ contains features rising to depths suitable for the target species, ~~and,~~which, to our knowledge, ha~~s~~ve not been fished before.

From the publicly available bathymetry, much of the area is far too deep for fishing at 2500+ meters. However, as mentioned above, we ~~have~~ can get access to other detailed bathymetric data indicating that there are ~~y available that shows several areas suitable for fishing, with depths that could b~~areas and features that are~~e~~ favourable for fishing, and as such, these are the areas proposed to survey and fish.

TNS Industries Inc. has an interest in fishing this proposed area to look for tag recaptures from the New Zealand proposal, which is to the south of this proposed area and which may contribute to the knowledge of the stock structure of Antarctic Toothfish (*D. mawsoni*) ~~Patagonian Toothfish (*D. eleginoides*)~~ and / or ~~, noting there is a slim possibility of catching~~ Patagonian Toothfish (*D. eleginoides*) ~~Antarctic Toothfish (*D. mawsoni*)~~.

The proposed maximum catch limit is 240 tonnes of green weight, which would be apportioned to the eight~~five~~ different areas within the larger area

2. FISHERIES OPERATION PLAN

Paragraph 5 of CMM13 requires a full Fisheries Operation Plan to be submitted not less than 60 days in advance of the next annual meeting of the Scientific Committee. The Fisheries Operation Plan should include the following information (to the extent it is available):

2.1 Description

A description of the exploratory fishery, including area, target species, proposed methods of fishing, proposed maximum catch limits and any apportionment of that catch limit among areas or species.

Research area

We initially submitted in the succinct FOP on 31 May that the FV Greenstar would undertake exploratory fishing activities within the boundaries of a rectangular research area defined as follows: Starting coordinate 52 00 South, 143 00 West; second coordinate 52 00 South, 121 00 West; third coordinate 56 00 South, 121 00 West; fourth coordinate 56 00 South, 143 00 West; and back to the start coordinate. The research area overlaps with that proposed for research fishing by New Zealand SC9-DW01-rev1, and includes locations within strata N, O, P, Q, R, and S as described in that document.

When initially submitting the succinct FOP, we planned to conduct a survey in some of the areas where New Zealand had previously conducted exploratory fishing. However, we later learned that New Zealand had changed its survey area. The reasons for including NZ's fishing areas in the Full version are as follows:

- There is substantial tagging data in the areas where NZ conducted its fishing.
- Differences in bottom fishing gear methods may lead to different results for VMEs and bycatch species compared to NZ.
- Integrating NZ's survey data with our results allows for long-term data-based analysis.
- It provides an opportunity to compare the 8 years of data collected from surveys in Subarea 88.3 with data from the SPRFMO area.

Additionally, we interpret part (4b) of the CMM13-2024 as indicating that a fishery is considered "exploratory" for a particular gear type or technique if it has not been subject to fishing by that particular gear type or technique in the previous ten years. Although part of the proposed area has been fished as an exploratory fishery by New Zealand in the last ten years, New Zealand uses an autoline system, whereas we use a trotline system. Therefore, the area has not been fished with our specific gear type, aligning with the criteria set in part (4b).

Therefore, we included the areas surveyed by NZ in our survey plan. This change provides an opportunity for New Zealand, Spain, Australia, and Korea to collaborate and conduct a comprehensive assessment of the SPRFMO region.

Given these considerations, we propose to expand the research area to encompass these eight strata for exploratory fisheries: Starting coordinate 56 00 South, 155 00 West; second coordinate 56 00 South, 145 00 West; third coordinate 52 00 South, 145 00 West; fourth coordinate 52 00 South, 115 00 West; fifth coordinate 60 00 South, 115 00 West; sixth coordinate 60 00 South, 155 00 West and back to start coordinate.

Spatial design

During the prospecting phase of the proposed research (years 1-2), we will apply a stepwise process of mapping the bathymetry of the area and identifying likely fishable ground (using vessel acoustics) followed by structured fishing using a clustered design similar to that developed by CCAMLR for feature-based fisheries (e.g. see CCAMLR document WG-FSA-14/61,). Within the research area, 'fishable features' include seamounts

or ridges with sufficient area within fishable depths to support a local population of toothfish. For purposes of this proposal, 'fishable depth' refers to depths from 550 to ~~less than~~ 2200 m.

When suitable fishable ground has been identified, research fishing sets will be deployed in a cluster composed of up to 5 sets, each containing up to 6,900 hooks. Clusters will be no more than 5 sets, with a maximum of 6,900 hooks for any set, and no more than 17,250 hooks per cluster. Following the successful retrieval of all fishing sets in a cluster, the vessel will move on to a new fishable location before beginning a new cluster. Clusters must be separated by at least 10 nautical miles (approximately 18.52 km) to effectively distribute fishing effort. This approach is based on CCAMLR WG-FSA-14/61 and SPRFMO CMM 14a-2022. This minimum spacing requirement applies between all clusters deployed in the same fishing season (even if the season is composed of multiple trips) but does not apply to clusters set in subsequent seasons.

The cluster design and associated effort and spacing requirements serve two purposes during the prospecting phase of exploratory fishing. First, it prevents over-exploitation of any local resource by limiting the amount of effort that can occur in any location in a single season. Second, it ensures that prospecting phase sets are spread widely enough to explore more fishable grounds, while still allowing local concentrations of fishable biomass to be targeted for purposes of deploying tags. By specifying a minimum spacing between clusters, this design serves to limit fishing effort proportional to the fishable ground, even where the bathymetry is not well known; where very little fishable ground exists, fewer sets are allowed. This inherent effort density limitation is not achieved with straightforward effort limits (i.e., maximum number of sets) or catch limits (i.e., maximum tonnes) acting in isolation.

Catch limits

During the prospecting phase, catch limits will be applied at the scale of research strata designated in Figure 1. Catches will be limited to 40 tonnes per stratum (green weight, both species of toothfish combined).

Catches will also be limited at the scale of the larger research area. To be consistent with catch limits already adopted for New Zealand exploratory fishery that includes the same strata, we propose an annual catch limit of 240 tonnes across all strata. The proposed 240-ton limit is directly based on the catch limits previously established for New Zealand's exploratory fishing activities, ensuring continuity and consistency in research efforts across the same fishing grounds.

The proposed study area limit (240 tonnes) is lower than the sum of the individual stratum limits (40 tonnes) across ~~six~~ eight strata. This means that in theory the global 240 ton catch limit could be reached before all strata are explored in a single season, but in practice this is highly unlikely because the spatial cluster design creates inherent limits on effort density, and the amount of fishable ground is likely to be limiting in some strata. Having a higher per-strata catch limit allows for flexibility in the event that some strata have more fishable ground than others, while still imposing the same level of precaution at the scale of the whole proposed research area.

As the research program progresses to the biomass estimation phase, catch limits may instead by assigned to individual research blocks or fishable features, to be identified in the course of the prospecting phase and presented to the SPRFMO Scientific Committee for review and approval. Appropriate catch limits at the scale of individual fishable features or research blocks will be informed initially by CPUE X seabed area estimate, using a precautionary local exploitation rate. This approach has been successfully applied in CCAMLR new and exploratory fisheries. Once sufficient tag return data are available, it is anticipated that the research program will progress to using tag-based estimates of local biomass.

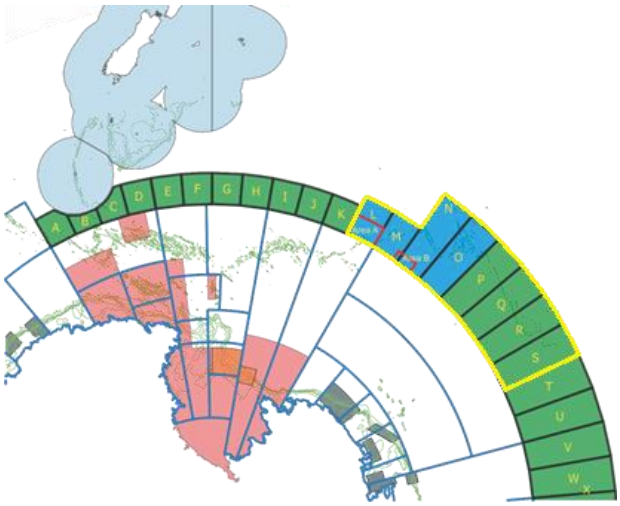

***Figure 1*: Proposed boundaries of research fishing in the southern SPRFMO Area by the Korean vessel, 2025-2027. The initial prospecting phase of research fishing will occur ~~within the area designated in yellow~~in the yellow area. The location of finer-scale research blocks or target features, within which research fishing will subsequently be concentrated during the second 'biomass estimation' phase, will be designated based on the results of the prospecting phase. This figure illustrates relationship to other toothfish research in the adjacent CCAMLR Area.**

Toothfish tagging and data collection requirements

Standard biological data will be collected from all captured fish, including length, weight, sex, gonad weight, and gonad stage, consistent with the data collection plan. Otoliths will be collected, with efforts made to ensure that retained otoliths are collected from a wide range of size classes and including both sexes.

All captured fish will be scanned for tags. Captured toothfish will be tagged with two external T-bar tags inserted into the dorsal musculature, and released at a rate of 3 fish per ton. Preliminary results of New Zealand's exploratory fishery in this area suggest~~s~~ that due to the high average size of toothfish occurring here, this tagging rate equates to roughly one in ten fish being tagged and released.

The vessel will achieve a tag overlap statistic of 80%; this statistic is designed to ensure that the size composition of tagged and released fish is consistent with that of the catch as a whole. Tagging will occur using protocols developed and approved by CCAMLR and described in the following online selection of documents (https://www.ccamlr.org/en/science/ccamlr-tagging-program)

Toothfish selected for tagging will be assessed for injury status, and only fish in good condition for tagging and release (i.e. with only minor injuries and a high probability of survival) will be selected for tagging. Vessel crew responsible for fish tagging will receive training in proper tagging procedures including the assessment of fish injuries and selection of fish most likely to survive release. Fish injury condition diagrams developed by CCAMLR will be displayed in the vessel factory tagging area as an aid to vessel crew.

Biological data collection

Despite the SPRFMO's bottom line gear observer coverage being set at 10% according to CMM 03-2023, a total of two observers will be on board the vessel, ensuring that over 60% of all sets are monitored. We propose the following requirements for routine data collection and biological sampling by the vessel, fisheries observers and/or crew:

Data collection	**Frequency**
Observer catch and effort data	Every set
Length, weight, sex, gonad stage, gonad weight	TOA and TOP: EVERY fish up to maximum of 35 per set
Length, weight, sex, gonad stage	Bycatch: 20 fish sampled per main bycatch species per set
Otoliths	TOT: First 20 fish sampled per set (5 otolith pairs per 10 cm size class, if possible)
Toothfish tagging	Three per ton, double tagged, targeting a high (>80%) overlap statistic. Single hooked fish only in suitable condition
Toothfish recaptures	Scan every fish for tags, photograph and keep tags.
Muscle tissue samples	5 toothfish in each 10 cm length bin by sex and species
Gonad samples	5 fish collected per species and sex from toothfish gonads, with the intent to sample different observed maturity stages
~~Marine environmental data~~	~~An equipment will be deployed to measure temperature and salinity at least twice in each research block.~~

Catch limits as a proportion of likely stock biomass

The proposed catch limit of 240 tonnes is about 6.8% of the precautionary catch limit of 3,499 tonnes in place for *D. mawsoni* in CCAMLR Areas 88.1 and 88.2 A, B for the 2023/24 fishing season. If the toothfish in the SPRFMO Area come from a straddling stock, it will almost certainly be part of the stock that in CCAMLR Areas 88.1 and 88.2 (the Ross Sea and Amundsen Sea). The most recent stock assessment (Mormede, 2019) estimated the equilibrium pre-exploitation spawning stock biomass to be about 77,855 t (95% CIs 71,954–85,115 t) and the current stock status to be 64.3 % B0 (61.3–67.3% B0) in the Ross Sea.

The most recent stock assessment for the Amundsen Sea region (Mormede and Parker 2018) estimated a precautionary equilibrium pre-exploitation stock biomass (B0) to be around 47,310t (~ 95% CI 31,560 – 71,650t) and the current stock status to be 73% B0 (95%CI 62–80% B0 (based on the more precautionary R2 model). This stock assessment was preliminary, but gave biomass estimates consistent with other methods. The biomass and stock status estimates are highly precautionary, and this stock is most likely larger than the values estimated. Thus, the CCAMLR stock is estimated to be in good shape and the proposed exploratory fishing within the SPRFMO Area will only slightly increase the exploitation rate. If the toothfish in the SPRFMO

Area do not come from a straddling stock (which is currently considered very unlikely), then the stock should be largely unfished and close to unfished biomass.

2.2 Fishing gear

Specification and full description of the types of fishing gear to be used, including any modifications made to gear intended to mitigate the effects of the proposed fishing on non-target and associated or dependent species or the marine ecosystem in which the fishery occurs.

The FV *Greenstar* will use the trotline gear configuration and baiting system for all longline sets targeting *Dissostichus* spp. in fulfilment of this research. The system consists of a main line (polypropylene, 20 mm) and a series of several hundred trotlines (p/p 9mm, 15-20 mm length), joined consequently to the main line. The total length of the main line varies from 6,000 to 16,000 m (if possible, the line will be adjusted to 11,000 m). Each trotline has 3 clusters of hooks; each cluster has 4-5 hooks (size 30x75 mm, steel, made in South Korea) and two 5 kg steel weights at the end. The distance between the clusters is 0.5 - 1.2 m.

The deployed trotline will be equipped with a GPS buoy (M3P), colored red and marked by inflatable buoys including the vessel call sign. Each deployed trotline also has an anchor (100 - 120 kg) and three additional weights totaling 70 kg. The "setting" of the trotline is carried out from the stern of the vessel, hauling is from the starboard side. In summary, each trotline deployment consists of the following components (Figure 2):

- Roughly 3,450 – 6,900 hooks are deployed on each set
- The lazy line (from anchor to before mainline) is 200-250 m.
- The main line is connected to the lazy line and branch line.
- The branch line consists of a connect line and snap line.
- The branch lines are successively set on the main line with a setting interval of roughly 22~35 m between branch lines.
- At the bottom end of the line, two 5 kg weights are attached (total 10 kg).
- Each branch line has 3 clusters, each of which consists of 4-5 hooks (i.e. total 12-15 hooks per branch line)
- ~~A small float is attached on the connect line to create lift in the water, in order to prevent fishing hooks and sinkers from contacting the seafloor during fishing.~~

It takes about 30 - 60 minutes per trotline deployment to complete the setting, and roughly 2.5 - 5 hours to complete hauling, for a deployment at a depth of 800 - 1,500 m

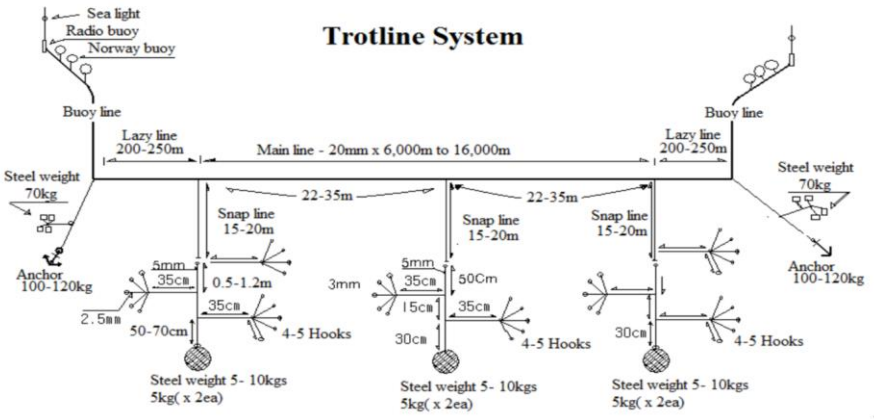

Figure 2. Gear configuration for trot line gear to be deployed by FV Greenstar in delivering this research

Details of the vessels to be used: F.V. Greenstar

This section serves as an application to the Commission to permit Korean vessels to fish in the proposed exploratory fishery for toothfish and includes information that satisfies paragraphs 2 and 3 of Annex 1 of CMM-05-2016 (Record of Vessels). Korea proposes to use the vessel FV Greenstar to conduct this research. This section includes all vessel data required in terms of the SPRFMO Data Standards for vessel data, and confirmation that they appear on the list of approved SPRFMO vessels submitted by flag states to the SPRFMO Secretariat.

(i)	Name of fishing vessel (vessel flag) Previous names (if known) Registration number IMO number (if issued) External markings Port of registry	*Greenstar* (KOR) Katoa No.21 1504001 – 6261101 9125334 White hull and white superstructure. Red below the waterline. In accordance with CM10-01, the vessel's name 'GREENSTAR', is marked in black on the stern and the IRCS "6KCE9" is marked in black on the port and starboard sides and on the deck. Busan
(ii)	the nature of the authorisation to fish granted by the Flag State, specifying the date issued, time periods authorised for fishing (start and end dates), area(s), subareas or divisions of fishing, species targeted and gear used;	Distant Water Fishing License 11-Nov-2022 15-Oct-2020 ~ 14-Oct-2025 Pacific Ocean and Southern Ocean: Designated SPRFMO strata and Subarea 88.3 of CCAMLR Area, targeting *Dissostichus mawsoni/eleginoides* using demersal longline
(iii)	Previous flag (if any)	Japan
(iv)	International Radio Call Sign	6KCE9
(v)	Name of vessel's owner(s) Address of vessel owner(s) Beneficial owner(s) if known	TNS Indistries Inc. 6F, 304 Seocho-daero, Seocho-gu, Seoul Republic of Korea (as above)
(vi)	Name of licence owner Address of licence owner (operator)	(as above)
(vii)	Type of vessel	Demersal long-line
(viii)	Where was vessel built When was vessel built	Japan 1995
(ix)	Vessel length overall LOA (m)	51.01
(x)	12 x 7 cm colour photographs - 1 x starboard side of the vessel - 1 x port side of the vessel - 1 x stern view	See below.
(xi)	Details of the implementation of the Tamper-proof requirements for all ALC's installed on board the vessel.	The vessel is fitted with a type (Argos MAR-GE V3 Transmitter system) approved Automatic Location Communicator (ALC) under the Fisheries (Satellite Vessel Monitoring) Regulation 1993. The satellite monitoring device is located in a sealed unit and protected with a mechanism to indicate if the unit has been accessed or tampered with.
(i)	Name of operator Address of operator	TNS Industries Inc. 6F, 304 Seocho-daero, Seocho-gu, Seoul, Republic of Korea
(ii)	Names and nationality of master	Lee Kiyoung, Republic of Korea
(iii)	Type of fishing method(s)	Demersal trotline
(iv)	Vessel beam (m)	9.0

(v)	Vessel gross registered tonnage	584
(vi)	Vessel communication types and numbers (INMARSAT A, B and C)	INMARSAT B : 8707 7306 2086 IRIDIUM : 8816 7710 6406 Email : greenstar@skyfile.com, (Alternate : sunwoo@swfishery.com)
(vii)	Normal crew complement	42
(viii)	Power of main engine(s) (kW)	1,177 kW
(ix)	Carrying capacity (tonne) Number of fish holds Capacity of all holds (m^3)	380 T 3 460
(x)	Any other information in respect of the vessel considered appropriate (e.g. ice classification).	The vessel for conducting bottom fishing activities under the Conservation Measure 22-06 is authorized by the Ministry of Oceans and Fisheries (MOF), of the Republic of Korea

Starboard side	
Port side	

Stern	

2.3 Time period

The time period the Fisheries Operation Plan covers (up to a maximum period of three years).

It is anticipated that initial research fishing will ~~occur from~~ start from April of 2025 until the end of 2027.

~~Data collected at this time will complement that collected by the previous New Zealand program. As the research progresses efforts will be main where practical to collect data in different seasonal periods, contributing to our collective understanding of seasonal life cycle dynamics in this area.~~

2.4 Biological information

Any biological information on the target species from comprehensive research and/or survey cruises, such as distribution, abundance, demographic data and information on stock identity.

Data collected during Phase 1 (ref. 3.7) will complement the previous New Zealand program's data. As the research progresses the efforts in data collection will be developed to collect seasonal changes to understand the seasonal life cycle dynamics in the study area.

According to SD11-DW11_rev1, ~~H~~high catch rates of Antarctic toothfish were again recorded in Research Area L, mirroring those found in two assumed spawning areas in the northern regions of CCAMLR subareas 88.1 and 88.2. The toothfish catch was entirely composed of Antarctic toothfish. Unlike previous years when Antarctic toothfish sex ratios consistently skewed male, the sex ratios in 2022 and 2023 were nearly even, with males comprising 59.9% of the total sample in 2022 and 50.6% in 2023. Both male and female Antarctic toothfish were generally in a pre-spawning or developing gonad stage, with one male found in a ripe gonad state and three males in a spent condition, consistent with the hypothesized winter spawning. The total number of otolith pairs collected for aging from all SPRFMO exploratory toothfish research reached 679, which will be aged as part of the CCAMLR stock assessment project. Since 2016, 806 Antarctic toothfish have been tagged, with seven previously tagged fish recovered after at least one season. One of these fish originated from the Ross Sea slope area and had been at liberty for 15 years. The sampled Antarctic toothfish were almost entirely adult fish, supporting the hypothesis that this northern region is a spawning area for Antarctic toothfish. The length frequency sample from 2023 is broadly consistent with previous records. 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. Additionally, there has been no marine mammal depredation of lines during fishing operations. Benthic bycatch was much lower than the thresholds set by CCAMLR for notification and SPRFMO encounter thresholds.

2.5 Non-target and associated or dependent species

Details of non-target and associated or dependent species and the marine ecosystem in which the fishery occurs, the extent to which these would be likely to be affected by the proposed fishing activity and any measures that will be taken to mitigate these effects.

Fish bycatch

Early results from New Zealand's exploratory fishing in the southern SPRFMO area suggest~~s~~ that fish bycatch will be very low in these locations. New Zealand reported that in the most recent years of their research program, species other than toothfish constituted less than 0.05% of the total catch (by weight; SC11-DW11-rev1). In earlier years bycatch was higher but still a low proportion of total catch (2-3%). The main bycatch species have been rattail (*Macrourus* spp.), with smaller amounts of *Antimora* spp. ~~And eel cods~~. New Zealand reports that ~~deep~~ deepwater sharks are only rarely caught. (SC9-DW01-rev1). Because the observed bycatch species are widespread and abundant, there are no sustainability concerns with bycatch observed in the current ongoing research.

Based on these results we anticipate that bycatch will continue to be a minor proportion of the total catch observed in research under this proposal. ~~–~~However, recognizing differences in gear configuration between a~~a~~utolines and trotlines, there is a possibility that bycatch species or/and the ratios between target and bycatch species can be different. ~~and in particular the tendency for autoline hooks to sit hard on the ocean bottom, relative to trotlines in which hooks are elevated somewhat above the ocean floor, it is likely that catch ratios between target species and bycatch, or between different bycatch species, will differ.~~ With this research we will monitor and ~~record~~ collect catch rates of all captured fish species, and compare them with the results of New Zealand's research in similar locations~~, to better quantify differences in bycatch species catchability between the different gears.~~

~~Based on previous surveys, the primary species caught is *Macrourus* spp. We have outlined the bycatch limit for this species in the newly added Section 8. If species of higher concern are observed in bycatch under this proposal, these will be reported to SPRFMO, and appropriate measures will be implemented immediately. In anticipation of possible bycatch of species of higher concern, we have also prepared specific mitigation plans to minimize their capture and impact, ensuring compliance with SPRFMO conservation objectives.~~

Seabirds

Longlines have a risk of capturing seabirds in many fisheries worldwide, including at similar latitudes (e.g., Anderson et al. 2011, Baird et al. 2015). However, seabird capture mitigation measures have been successfully developed and implemented by the demersal longline fishers catching toothfish in the CCAMLR Area. To illustrate, in the Ross Sea toothfish fishery, there ha~~s~~ve been only two~~?~~ seabird captures in more than 20 years, with 100% observer coverage. Specific to the research included in this proposal, Korean fishing vessels using similar trotline gear configurations have had no seabird captures in the past 7 years of operation in CCAMLR Subarea 88.3.

Korean vessels operating in CCAMLR fisheries, including the FV *Greenstar* ~~delivering plans to conduct~~proposing to deliver this research, routinely apply the following effective mitigation strategies to minimize the risk of attracting and capturing seabirds:

- strict ~~on~~offal management (to reduce the attractive effect of discarded material).
- Line weighting to ensure rapid sink rates as fishing gear is deployed (see gear configuration diagram, Fig.2)

No seabirds have been captured by the FV Greenstar while conducting research fishing for toothfish in the CCAMLR Area.

Commented [A1]: Is this correct?

~~It is possible that seabird risk is~~Seabird risk may be seasonally variable, noting that research fishing under this proposal may occur at a different time of year than most toothfish fishing in CCAMLR (which necessarily occurs primarily in summer, due to ice conditions). But the timing of seasonal bird migrations, and the effectiveness of night setting as a means of seabird bycatch mitigation, imply that fishing outside of the summer season will further reduce the risk to seabirds. ~~still further.~~

Reports from New Zealand research fishing in the area of this research proposal suggest that the seabird species most likely to be encountered by research vessels are Cape petrels, snow petrels, Antarctic petrels, and giant petrels. New Zealand further reports that no seabirds have been killed or injured to date (SC-9-DW01-rev1).

In 2023~~1~~ New Zealand conducted a global seabird risk assessment of major high seas fisheries interacting with globally distributed seabird species in the southern hemisphere (Edwards et al. 2023). This study used a spatially explicit method to estimate seabird catchability in different fishing methods and gear types. This study confirmed the observations from the SPRFMO and CCAMLR Areas that high seas bottom longlines pose very low risk to seabirds, and that this effect is a function of low catchability (i.e. because captures are rare even when birds are present), not simply low overlap (i.e. seabirds are not present in the same locations as the fishing).

Marine mammals

Interactions with orca and other marine mammals are considered highly unlikely within the study area based on reports from New Zealand's exploratory fishing overlapping the same area and more generally based on the experience of Korean vessels in CCAMLR Subarea 88.3. Observers and/or crew will record all sightings of mammals including details of any interactions with the vessel or gear, and any evidence of depredation. If evidence of depredation by marine mammals (e.g. orcas or sperm whales) is observed or suspected, the vessel will take action to prevent or mitigate further interactions, for example by ceasing to haul the line and moving to other locations until such time as there is no evidence of whales present at hauling.

2.6 Cumulative impact of all fishing activity

The anticipated cumulative impact of all fishing activity in the area of the exploratory fishery if applicable.

The proposed exploratory fishery does not overlap spatially with any other fisheries, except for the areas fished by New Zealand in previous years. As the Korean program is designed to continue from the NZ research plan ~~in~~for consecutive years, the cumulative impacts on taxa and habitats that do not move or migrate will need careful consideration, as they may be influenced by consecutive fishing activities. Seabirds and marine mammals are likely to move in and out of the proposed exploratory fishery area, so cumulative impacts on these species may be higher if interactions were to occur. These impacts are considered further in the risk assessment section, where an evaluation of the cumulative effects of the combined NZ and Korean exploratory fisheries is included to ensure that potential impacts are managed according to SPRFMO's conservation objectives. Antarctic toothfish caught during the proposed exploratory fishery are likely to be a constituent of the stock found in the CCAMLR Convention Area immediately south, so it will be important to consider cumulative effects with the CCAMLR fishery. Information from New Zealand's exploratory fishery in 2016 and 2017 has already been included in the CCAMLR stock assessment and all data from the proposed exploratory fishery will be shared, consistent with the MOU between SPRFMO and CCAMLR. The inclusion of data which would be collected during the proposed exploratory fishery into the working stock assessment model developed by CCAMLR constitutes an explicit mechanism for assessing the cumulative impacts of

fishing on the target species of toothfish. It should be noted that CCAMLR has specified objectives and agreed decision rules to determine precautionary yields for the Ross Sea region toothfish fishery (CCAMLR Convention, Article II) but SPRFMO has not yet developed an analogous long-term fishing strategy for toothfish. The Scientific Committee has agreed to develop a tiered assessment framework (Nicol et al. 2017, paper SC-05-DW-04) and information gathered during the proposed exploratory fishing should help to inform that initiative.

2.7 Similar fisheries

Information from other fisheries in the region or similar fisheries elsewhere that may assist in the evaluation of the relevant exploratory fishery's potential yield, to the extent the Member or CNCP is able to provide this information.

The New Zealand vessel San Aspiring first carried out an exploratory research program for toothfish in the South Pacific Regional Fisheries Management Organization (SPRFMO) Convention Area during August 2016 (Fenaughty et al. 2016) and September 2017. Initial exploration yielded high catch rates of post-spawning Antarctic toothfish, similar to catch rates in the northern Ross Sea region fishery of CCAMLR (Subareas 88.1 and 88.2). This research was continued in 2019 and 2020, with consistent observations across these years. Like in that CCAMLR fishery, the toothfish catch was almost entirely Antarctic toothfish. Sex ratios showed a high proportion of males to females. Fish were in generally poor body condition (i.e. low Fulton's condition factor), consistent with having recently spawned, as has consistently been observed in the northern Ross Sea region in CCAMLR. Because the SPRFMO area is one of the few areas accessible to fishing during the winter period, research fishing in this area can be expected to provide an important source of information to improve our knowledge on Antarctic toothfish spawning.

At the 2021 meeting (SC9) and subsequent Commission, SPRFMO agreed to extend this exploratory fishery into 2022, 2023, and 2024 (SC9-DW01_rev1).

The objectives of the New Zealand exploratory fishery in this location are defined as follows (see CMM 14a-2022):

- 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.
- Characterize 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.

Under this ongoing research plan, up to two authorized New Zealand vessels may take up to 240 tonnes of toothfish annually, limited to up to 40 tonnes within each of strata L – S, (Figure 1), each having a catch limit of 40 tonnes a year.

The research described in this proposal is designed to complement and integrate with the research program already underway using New Zealand vessels. The CCAMLR scientific committee has recognized the importance and additional scientific power of coordinated multi-member research programs. Korean and New Zealand vessels already collaborate effectively to deliver a similar program of research in CCAMLR Subarea 88.3.

2.8 Overlapping fisheries

Information on any overlapping fisheries, current or planned, including information on any fisheries operating in the same area with the same gear in the previous 10 years. This should outline any agreed co-operation with other SPRFMO Members or CNCPs.

2.9 Bottom fishing (if applicable)

If the proposed fishing activity is bottom fishing, as defined in CMM 03 (Bottom Fishing), the assessment of the impact of their flagged vessels' bottom fishing activities, prepared pursuant to paragraph 21(a) of CMM 03 (Bottom Fishing).

Benthic impacts and vulnerable marine ecosystems

It is generally recognized that the impact of bottom longline fishing methods on benthic fauna including VME taxa is low relative to other bottom fishing methods such as bottom trawling. The SPRFMO BFIAS requires that quantitative cumulative impact assessments be provided as part of any bottom fishing application, if possible using approved methods.

A comprehensive framework for cumulative bottom fishing impact assessment has been developed and consistently applied for bottom longline fishing in CCAMLR since 2013 (CCAMLR 2013) based on methods developed initially in CCAMLR (Sharp et al. 2009, Sharp 2010, Sharp 2010b) and subsequently applied also in the SPRFMO area with respect to bottom trawling. This method, ~~labeled~~labelled the 'MSRP' method in SPRFMO is one of four that is endorsed explicitly in the SPFMO Bottom Fisheries Impact Assessment Standard (BFIAS).

Applied for longlines, the Sharp (2010b) method estimates the size of the fishery footprint as a function of the length of the deployed longline multiplied by the width of the area in which the main line may be expected to be in contact with the ocean floor. Impact within the footprint is a function of taxon fragility, expressed as a proportion of the taxa present in the footprint that are expected to be damaged or destroyed due to contact with the fishing gear. In practice impacts are only ever expressed with reference to the most fragile taxon, citing the precautionary principle.

Footprint width is primarily a function of to what extent the longline might move laterally during hauling. It is recognized that lateral movement is highly likely to be negatively correlated with depth, due to trigonometric considerations (Sharp 2010); direct observations using deployed cameras support this notion, whereby two shallow longline deployments (roughly 540 m depth) were observed to move laterally, whereby two deeper deployments (1390-1530 m) were observed to lift vertically from the sea floor with no lateral movement.

Integrating all available data, CCAMLR applies a lateral movement parameterization whereby the average footprint of bottom longlines in contact with the sea floor is assumed to be 5.2 m wide, and within the lateral footprint, 70% of fragile benthic fauna will be damaged or destroyed (CCAMLR 2013). When the line does not move, the footprint is assumed to be .8 m wide, within which 78% of fragile taxa will be damaged or destroyed. Combining these parameters, the 'impact index' of a bottom longline is .00420, representing the impacted area (in km^2) per km of longline deployed. CCAMLR applies this same impact index to Autolines, Spanish longlines, and trotlines. With reference to the present research proposal, this estimate will be precautionary

(i.e. biased high) because the expected fishing depths in the research area are on the deeper end of the range used to parameterize the default CCAMLR index.

The total proportional impact is then estimated by multiplying by the effort density, expressed in km of longline deployed per km^2 of benthic habitat. We estimate a maximum of 250 longlines will be deployed annually by the Korean vessels in the course of this research program. It is not possible to estimate proportional impact at the scale of the research strata because the area of the fishable depths is unknown. Instead, we provide an illustrative analysis of maximum cumulative impacts at scale of individual clusters of research sets, for a range of different cluster sizes (section 8, below), noting that impacts at the scale of research strata will of course be much lower. Once the necessary bathymetric data is collected, we ~~plan to conduct the~~will update this analysis ~~and include it i~~to include an estimate of proportional impact as a proportion of actual fishable depths, in future reports.

Commented [A2]:

Korean observers will record all benthic bycatch and will carry appropriate detailed identification guides to facilitate identification to a useful taxonomic level. The CCAMLR VME Guide will be used to identify pieces of VME taxa retrieved on longline hooks.

~~The impact assessment of fishing effort on fishable depths, including the estimation of effort density and its potential impact on VMEs, is required but cannot be included in this report due to insufficient data. Once the necessary data is collected, we plan to conduct the analysis and include it in future reports.~~

Because the proposed exploratory fishery is a bottom fishery, an assessment of the impact of the proposed fishing activities is included in this proposal, as mandated by paragraph 8(b)(viii) of CMM 13- 2024 (exploratory fisheries) and paragraphs 11, 12, 17, and 18 of CMM 03-2023 (bottom fisheries).

2.10 Adjacent RFMO (or similar) fishery

Where the target species is also managed by an adjacent Regional Fisheries Management Organisation or similar organisation, a description of that neighbouring fishery sufficient to allow the Scientific Committee to formulate its advice in accordance with paragraph 10 of CMM 13.

In CCAMLR area, Patagonian toothfish (*D. eleginoides*) and Antarctic toothfish (*D. mawsoni*) are targeted by licensed fisheries in the Southern Ocean, predominantly using bottom-set longlines at depths of 1,200 to 1,800 meters. These species may also be caught with trawls and pots. There are currently 13 licensed fisheries targeting toothfish in Areas 48, 58, and 88, including seven exploratory fisheries. These fisheries are reviewed annually by CCAMLR's Working Group on Fish Stock Assessment (WG-FSA) and the Scientific Committee. For more information, refer to the annual Fishery Reports. The Commission's established limits for the current fishing season are outlined in the Conservation measures.

3. INPUT INTO SCIENTIFIC COMMITTEE CONSIDERATIONS

Paragraphs 9 and 10 of CMM13 require the Scientific Committee to consider all Fisheries Operations Plans submitted, all information provided in accordance with a Data Collection Plan and any other relevant information, and to provide recommendations and advice to the Commission on each Fisheries Operation Plan on a number of matters. To assist the Scientific Committee in its work, the proponent is requested to indicate what they consider to be an appropriate assessment or recommendation from the Scientific Committee to address each of the Scientific Committee Considerations.

3.1 Management strategies or plans for fishery resources

The SC has previously interpreted this as a clear objective for the fishery.

Fishery objectives identified in section 7 below are fully consistent with the intent and objectives of exploratory toothfish fisheries previously endorsed by the SC.

3.2 Reference points

This should include precautionary reference points as described in Annex II of the 1995 agreement. SC6 suggested (Paragraph 236 of SC6-Report) that the assumptions underlying how biomass estimates are determined should be clearly described in the proposal.

Without data indicative of biomass, CPUE, or fishable depth in the research area, it is not possible to apply biomass-based precautionary reference points. In that context, the adoption of mechanisms to limit effort density to avoid local over-exploitation in the prospecting phase, as described in Section 2.1 above, nested within precautionary catch limits at the scale of research strata, is consistent with best practice in exploratory fisheries previously endorsed by the SC.

3.3 An appropriate precautionary catch limit

SC5 suggested (Paragraph 56 of the SC5 Report) that a literature review of exploitation rates, stock assessment mechanisms and precautionary measures that are used in other similar fisheries would help to contextualise whether a potential catch limit was appropriate as a precautionary fishery.

The proposed precautionary catch limits are the same as previously endorsed by the SC for New Zealand research in these strata, and well within precautionary limits at the scale of the stock under different stock hypotheses, as described in Section 2.1 above.

3.4 The cumulative impacts of all fishing activities in the area of the exploratory fishery

The 2019 SPRFMO Bottom Fishing Impact Assessment Standard (BFIAS) includes "Cumulative impact" as one of the criteria for a risk assessment for benthic habitats, biodiversity and VMEs and notes that the frequency of the impact will influence the risk, with activities occurring repeatedly at a site likely to have a greater risk. This will depend on the amount of fishing effort and should be considered in relation to the recovery of the VMEs/taxa (Section 1.3.5 of the 2019 BFIAS).

Cumulative impacts on vulnerable benthic taxa even at the local scale will be extremely low, as described in Section 2.6 above and Section 8 below. Cumulative impacts at the scale of research strata will be even lower, because to our knowledge the features in this area have not previously been fished.

3.5 The impact of the proposed fishing on the marine ecosystem

SC6 (Paragraph 228 of the SC6 Report) suggested that a risk assessment might be prepared to better allow the likelihood and consequences of bycatch interactions to be evaluated and the adequacy of proposed avoidance and mitigation measures in the proposal to be assessed.

An impact assessment is provided in section 8 below.

3.6 Sufficiency of information available and degree of certainty

This is an assessment of whether there is enough information available to inform the level of precaution required and also an evaluation of the level of uncertainty in the provision of advice.

The information contained in the sections of this proposal meets all of the requirements of CMM13, and are consistent with the contents of research fishing proposals previously endorsed by the SC.

3.7 Consistency with nature as an exploratory fishery

This is the degree to which the approach outlined in the Fisheries Operation Plan is likely to ensure the exploratory fishery is developed consistently with its nature as an exploratory fishery.

SC5 suggested (Paragraph 59-60 of the SC5 Report) a phased approach to the development of an exploratory fishery, for example including:

Phase 1:

- *Wide area surveys to understand distribution, relative abundance and/or density estimates for features*
- *Biological information collection (length information, sex ratio, maturity information etc.)*
- *VME monitoring – potential use of cameras, identification of all benthic organisms, return to land of anything unidentifiable, possible bathymetric data collection*
- *Bycatch data collection - species identification, length data, otolith collection of main species*

Phase 2:

- *Design and implementation of depletion experiment(s) in identified area(s) (e.g. for a sedentary species)*

Phase 3:

- *Work towards stock differentiation and stock assessment (including longer term yield estimates)*

But noted that elements of each phase could occur simultaneously.

The research plan is organised into three phases in accordance with the recommended framework, as described in Section 7 below:

Phase 1: in the **prospecting phase**, research effort will be spread out to map the distribution and abundance of toothfish within fishable depths of the research area, and to collect biological data indicative of stock structure

Phase 2: in the **biomass estimation** phase, research effort will be concentrated into identified target features or research blocks, to collect sufficient data to inform estimates of local abundance, first using CPUE and later using tag returns

Phase 3: in the **stock assessment** phase, data collection including tag returns and biological sampling in target areas will accumulate until there is sufficient data to inform a formal stock assessment.

This design is wholly consistent with the intent of exploratory fisheries as previously endorsed by the SC.

3.8 Consistency with Objective of the Convention

This is the degree to which the approach outlined in the Fisheries Operation Plan is likely to ensure that the exploratory fishery is developed consistently with the objectives of Article 2 of the Convention (the Objective). This should address the following elements from the Objective:

- *through the application of the precautionary approach and*
- *an ecosystem approach to fisheries management,*
- *to ensure the long-term conservation and sustainable use of fishery resources and,*
- *in so doing, to safeguard the marine ecosystems in which these resources occur.*

The objectives and structure of this proposal as described in Sections 2 and 7 are fully consistent with the Objectives of the Convention, and with research fishing proposals previously endorsed by the SC.

3.9 Bottom Fishing advice and recommendations

SC7 noted (Paragraph 342 of the SC7-Report) that it is a requirement of CMM 13 that if the proposed fishing activity is bottom fishing, then an assessment of the possible impact needs to be done. In respect of a Fisheries Operation Plan that proposes any bottom fishing activity, this section should include any advice and recommendations in accordance with paragraph 21 (b) of CMM 03 (Bottom Fishing), i.e. on whether the proposed bottom fishing would contribute to having significant adverse impacts on deep sea fish stocks for which no stock assessment has been completed, bycatch species and/or VMEs and if so whether any proposed or additional mitigation measures would prevent such impacts.

The 2019 SPRFMO Bottom Fishing Impact Assessment Standard (BFIAS) provides a standard for a Bottom Fishing Impact Assessment in SPRFMO.

A bottom fishing impact assessment, including a quantitative benthic impact assessment (using methods endorsed by the BFIAS) applied at the scale of different (hypothetical) set clusters. is provided in Section 8.

4. DATA COLLECTION PLAN

Paragraph 11 of CMM13 also requires the Scientific Committee to develop a Data Collection Plan in respect of the exploratory fishery which should include research requirements, as appropriate. The Data Collection Plan should identify and describe the data needed and any operational research actions necessary to obtain data from the exploratory fishery to enable an assessment of the stock, the feasibility of establishing a fishery and the impact of fishing activity on non-target, associated or dependent species and the marine ecosystem in which the fishery occurs, and under Paragraph 12 require, as appropriate. To assist the Scientific Committee in its work, the proponent is requested to indicate what they consider to be an appropriate assessment or recommendation from the Scientific Committee to address each of the Scientific Committee Considerations with regards to the Data Collection Plan.

4.1 Data required

A description of the catch, effort and related biological, ecological and environmental data required to undertake the evaluations described in paragraph 26 of CMM 13, i.e. to allow the Commission to take a decision to manage the fishery as an established fishery.

The following is the SPRFMO standard for bottom line fishing activity data ~~to~~ that will be submitted by the vessel (as required under Annex 3 of CMM 02-2022):

1. *Data are to be collected on an un-aggregated (set by set) basis.*

2. The following fields of data ~~are to~~ will be collected:

- ***a)*** Vessel flag;
- ***b)*** Vessel name;
- ***c)*** Vessel call sign;
- ***d)*** Registration number of vessel;
- ***e)*** UVI (Unique Vessel Identifier)/IMO number;
- ***f)*** Set start date and time (UTC format);
- ***g)*** Set end date and time (UTC format);
- ***h)*** Set start position (1/100th degree resolution – decimal format), latitude and longitude;
- ***i)*** Set end position (1/100th degree resolution – decimal format), latitude and longitude;
- ***j)*** Intended target species (FAO species code);
- ***k)*** Number of hooks;
- ***l)*** Bottom depth at start of set;
- ***m)*** Incidental captures of species of concern (marine mammals, seabirds, reptiles or other species of concern) or benthic taxa (Yes/No/Unknown);
- ***n)*** FAO species code and estimated live weight of catch retained on board for all species caught by the set including target, bycatch and species of concern;
- ***o)*** FAO species code and estimation of the amount of all living marine resources discarded by species to the extent practicable, including any marine mammals, seabirds, reptiles, species of concern, and benthic taxa.

In addition, Korean observers on board will meet or exceed the requirements of Annex 7 of CMM 02-2022 which specifies a wide variety of information to be collected by observers on board fishing vessels including:

A. Vessel & Observer Data to be Collected for Each Observer Trip
D. Catch & Effort Data to be Collected for Bottom Long Line Fishing Activity
F. Length-Frequency Data to Be Collected
G. Biological Sampling to be Conducted
H. Data to be Collected on Incidental Captures of seabirds, mammals, turtles and other species of concern
I. Detection of Fishing in Association with Vulnerable Marine Ecosystems
J. Data to be Collected for all Tag Recoveries

K of Annex 7 CMM 02-2022 recognizes that observers may not be able to collect all of the data described in the CMM on each trip, and suggests that, where no trip- or program-specific priorities have been specified, the following generalized hierarchy of priorities be applied:

a) Fishing Operation Information
    i. All vessel and tow / set / effort information
b) Reporting of Catches
    i. Record time, weight of catch sampled versus total catch or effort (e.g. number of hooks), and total numbers of each species caught
    ii. Identification and counts of seabirds, mammals, turtles, sensitive benthic species and vulnerable species
    iii. Record numbers or weights of each species retained or discarded
    iv. Record instances of depredation, where appropriate
c) Biological Sampling

i. Check for presence of tags
ii. Length-frequency data for target species
iii. Basic biological data (sex, maturity) for target species
iv. Length-frequency data for main by-catch species
v. Otoliths (and stomach samples, if being collected) for target species
vi. Basic biological data for by-catch species
vii. Biological samples of by-catch species (if being collected)
viii. Take photos

These priorities are broadly appropriate for the proposed exploratory fishing and Korean observers will be briefed accordingly (noting also the more specific guidance in the following sections).

4.2 Due dates

The dates by which this data must be provided to the Commission.

Annual updates will be provided to describe progress each year in the SPRFMO SC, and to highlight any significant new findings and seek guidance as necessary. Data and reports will also be copied to the relevant CCAMLR bodies. Data will be provided to the secretariat and subject to SC agreement, also provided to the CCAMLR Secretariat. The timing of data submission will be conditional on the timing of fishing operations but will be within the calendar year of fishing operations. Final and comprehensive analysis following fishing in 2027 will probably be possible until SC in September 2028.

4.3 A plan for directing fishing effort

A plan for directing fishing effort in the exploratory fishery to allow for the acquisition of relevant data to evaluate the fishery potential and the ecological relationships among harvested, non-target and associated and dependent populations and the likelihood of adverse impact.

The research is as described in section 2, above, and as detailed in section 7, below. This structured, phased approach to exploratory fishing has proven successful at producing actionable data leading to stock assessments in CCAMLR, including in locations where no data were available at the commencement of the research.~~[Add your text here]~~

4.4 Other research data (where appropriate)

Where appropriate, a plan for the acquisition of any other research data obtained by fishing vessels, including activities that may require the cooperative activities of scientific observers and the vessel, as may be required by the Scientific Committee to evaluate the fishery potential and the ecological relationships among harvested, non-target, associated and dependent populations and the likelihood of adverse impacts.

Additional data requirements for consistency with CCAMLR

Additional and/or more precise data will be collected, based on the research data collection plans specified for proximate CCAMLR surveys as described below. Data will be recorded and reported to SPRFMO and shared with CCAMLR using the CCAMLR fine-scale catch and effort data (C2 longline fisheries) forms and CCAMLR observer forms and species codes for maximum consistency. This is critical, as it enables integration between

the vessel catch-effort and observer biological data, ensuring that the data can be prepared, error checked, and combined with CCAMLR data for use in CCAMLR stock assessment and for reporting.

Tagging of toothfish

A minimum tagging rate of three fish of each *Dissostichus* species per green weight ton retained will be implemented for consistency with research fishing requirements in the adjacent CCAMLR areas. The rules applied by CCAMLR in the immediately adjacent SSRUs 88.2 A and 88.2 B north region where tagged fish were released in early 2015 will be used (CM 41-01 Annex C). These rules require a minimum tagging size overlap statistic (that is a comparison between the observed length frequency from vessel biological information and the size composition of fish returned alive with tags) of 60% once 30 or more *Dissostichus* have been successfully released with tags. The masters and crews of the proposed vessels, FV *Greenstar*, have experience working to catch limits and routinely closely monitor catch retained. As the catch limit is approached, the following measures will be used, as appropriate, to constrain the retained catch within the limit: shorter lines will be set; a seawater tank will be maintained on board such that live fish in good condition can be retained in case they need to be tagged and returned alive to stay within the catch limit; and the tagging rate may be progressively increased.

Specific guidance for the collection of biological information

For consistency with previous research underway using New Zealand vessels including in the same area, we propose to replicate guidelines for biological data collection between New Zealand and Korean vessels (SC9-DW01_rev1). The observers and crew of FV *Greenstar* are experienced in collecting and recording this information, having successfully delivered comparable exploratory research fishing in CCAMLR Subarea 88.3, also in coordination with New Zealand vessels. Minimum data collection requirements are summarized as follows:

- All toothfish captured will be observed carefully for the presence of CCAMLR or other tags, and all previously-tagged fish will be retained and sampled for a full suite of biological data and tissue samples.
- All fish and invertebrates will be identified to the finest taxon possible. Photographs and/or specimens of taxa not identified to species level will be retained by the observer. Standard CCAMLR codes will be used by the observer because these include more codes for the species likely to be caught in the exploratory fishing areas. These codes can readily be translated to standard New Zealand (MPI) and SPRFMO codes after the voyages.
- Up to 35 toothfish of each species per line will be measured for total length, weight, sex, and gonad stage and gonad weight. Stomachs will be examined, and stomach contents recorded to the finest visual taxonomic level possible. Sample numbers of each toothfish species will be in proportion to the number of hooks hauled in each line at a rate of 7 fish per 1,000 hooks (https://www.ccamlr.org/en/science/observer-sampling-requirements-dissostichus-spp).
- Additional samples such as muscle tissue, bycatch species, and gonad histology for stable isotope and genetic analysis for stock differentiation, trophic, and movement studies will be collected as specified in each vessel research plan.
- Contingent on the catch, 5 pairs of otoliths per 10 cm length class of toothfish between 100 and 150 cm will be collected for each sex. As it is likely that few toothfish shorter than 100 cm will be caught, otoliths will be collected from all

retained fish shorter than 100 cm, if possible.
- Any macrourids, up to 10 of each species caught on a set, will be identified, if possible and sampled for length, weight, sex, and gonad weight.
- Full biological data (length, weight, sex, gonad stage, gonad weight) will be collected for any captured sharks and skates.
- Catches (including weights to the nearest 0.1 kg) of all benthic invertebrates, including VME[4] indicator taxa, will be recorded using standard SPRFMO protocols and codes.

Marine mammals, seabirds, turtles, and other species of concern

Korean observers are trained to identify seabirds and marine mammals whether these are captured or ~~attending~~ collide with the vessel. The following information will be collected for marine mammals, seabirds, turtles, and other species of concern:

- Opportunistic observations, photography, and identification of marine mammals will be undertaken by observers in collaboration with the crew;
- The observer will have a target of observing hooks hauled for marine mammal, seabird, and turtle captures;
- All marine mammals, seabirds, turtles, and other species of concern captured will be identified, and photographs will be taken of all live birds released and of any birds colliding with the ship that can be recovered;
- Benthic species, VME indicator taxa are covered under benthic and VME section;
- Fish species of concern are covered under the biological measurements section.

4.5 Time scales

An evaluation of the time scales involved in determining the responses of harvested, dependent and related populations to fishing activities.

SC5 (Paragraph 59-60 of the SC5 Report) suggested that this could include a plan for how the information collected will lead to assessment and eventual management of the stocks.

Phase 1, prospecting activities will take place primarily in years 1-2. Depending on the results of year 1, phase 2 biomass estimation activities will commence in year 2 or year 3. Depending on the success of the first phase and the speed with which data accumulates, it may be possible to move begin phase 3 stock assessment as early as year 4 but more likely in year 5 (i.e. requiring approval of an extended or alternate research plan in the same location). ~~[Add your text here]~~

5. SCIENTIFIC COMMITTEE ASSESSMENT CHECKLIST AND RECOMMENDATIONS

This checklist is for the Scientific Committee to complete to ensure that all aspects of the Fisheries Operation Plan and the Data Collection Plan have been assessed. To assist the Scientific Committee with their deliberations, please pre-fill the Rationale column with a brief justification of how your Fisheries Operation Plan and Data Collection Plan address the Scientific Committee consideration. The Scientific Committee will complete the Assessment column.

5.1 Fisheries Operation Plan checklist

Fisheries Operation Plan Considerations	Rationale	Assessment
a) management strategies or plans for fishery resources; [**Note** that SC has previously interpreted this as to mean as having a clear objective for the fishery]	The objectives are outlined in sections 6 and 7 of the proposal.	
b) reference points, including precautionary reference points as described in Annex II of the 1995 Agreement;	No reference points have been defined for toothfish stock in this fishing region. Therefore, we propose to apply a stepwise research design and implementation approach for exploratory toothfish fisheries.	
c) an appropriate precautionary catch limit;	See section 2.1 of the proposal	
d) the cumulative impacts of all fishing activity in the area of the exploratory fishery;	The Scientific Committee has agreed to develop a tiered assessment framework (Nicol et al. 2017, paper SC-05-DW-04) and information gathered during the proposed exploratory fishing should help to inform that initiative.	
e) the impact of the proposed fishing on the marine ecosystem;	See section 2.9 of the proposal	
f) the sufficiency of information available to inform the level of precaution required and the degree of certainty with which the Scientific Committee's advice is provided;	Data Collection Plan and Fisheries Operation Plan explain the processes and information that will be gathered during the exploratory fishing. These plans include biological data of ~~collection~~target and bycatch species, tagging~~, and environmental monitoring,~~ which contribute to the scientific understanding necessary to make precautionary decisions.	

g) the degree to which the approach outlined in the Fisheries Operation Plan is likely to ensure the exploratory fishery is developed consistently with its nature as an exploratory fishery, and consistently with the objectives of Article 2 of the Convention[1]; and	The precautionary limits, spatial separations of lines, and mitigations put in place should ensure this from the onset. The data collection will continue to inform precautionary development throughout the 3 years of the proposal (2025-27) and beyond.	
h) in respect of a Fisheries Operation Plan that proposes any bottom fishing activity, advice and recommendations in accordance with paragraph 20 (b) of CMM 03-2020 (Bottom Fishing)[2].	See section 2.5 of the proposal	

5.2 Data Collection Plan checklist

Data Collection Plan considerations	Rationale	Assessment
a) a description of the catch, effort and related biological, ecological and environmental data required to undertake the evaluations described in paragraph 24;	A full fisheries operation plan is presented in section 2,4 and 7 of the proposal.	
b) the dates by which the data must be provided to the Commission;	See section 4.2 of the proposal	
c) a plan for directing fishing effort in an exploratory fishery to allow for the acquisition of relevant data to evaluate the fishery potential and the ecological relationships among harvested, non-target and associated and dependent populations and the likelihood of adverse impact;	A full fisheries operation plan is presented in section 2,4 and 7 of the proposal.	
d) where appropriate, a plan for the acquisition of any other research data obtained by fishing vessels, including activities that may require the cooperative activities of scientific observers and the vessel, as may be required by the Scientific Committee to evaluate the fishery potential and the ecological relationships among harvested, non-target, associated and dependent populations and the likelihood of adverse impacts; and	A data collection plan isn included in section 4 of the proposal.	

[1] The objective of this Convention is, through the application of the precautionary approach and an ecosystem approach to fisheries management, to ensure the long-term conservation and sustainable use of fishery resources and, in so doing, to safeguard the marine ecosystems in which these resources occur.

[2] The Scientific Committee shall undertake a review of the proposed assessment and provide advice to the Commission on:

i. whether the proposed bottom fishing would contribute to having significant adverse impacts on deep sea fish stocks for which no stock assessment has been completed, bycatch species and/or VMEs and, if so,

ii. whether any proposed or additional mitigation measures would prevent such impacts.

e) an evaluation of the time scales involved in determining the responses of harvested, dependent and related populations to fishing activities *[***Note*** that SC has previously interpreted this as to mean "when will data be analysed and available"*]*	See section 4.2 of the proposal	

5.3 Scientific Committee recommendations (SC to complete)

The SC discussed the [insert Member/CNCP] Fisheries Operational Plan and Data Collection plan and Agreed that the approach outlined in the Fisheries Operation Plan is likely to ensure that the exploratory fishery is developed consistently with its nature as an exploratory fishery, and consistently with the objectives of Article 2 of the Convention, with the following requested modifications (*to be added if necessary*):

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-
-

Or:

The SC discussed the [insert Member/CNCP] Fisheries Operational Plan and Data Collection plan and recommended that a small working group [led by xxx and composed of xxx] meet post SC and to provide additional advice on the proposal, noting that the work is likely to extend intersessionally and would be expected to result in a revised proposal being provided to the next meeting of the Scientific Committee. Aspects of the proposal which are currently deficient include

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-
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Or:

The SC discussed the [insert Member/CNCP] Fisheries Operational Plan and Data Collection plan and agreed that the proposal was lacking critical information in several important areas and was not consistent with the SPRFMO objective. The SC noted that the Fisheries Operational Plan in its current form would require substantive modification to ensure that sufficient information would be available to enable the SC to evaluate the long-term potential and impacts, of the proposed exploratory fishery, and to ensure that the fishery resources would be developed on a precautionary and gradual basis a required by the CMM.

6. Purpose of the exploratory fisheries (supplementary section by Korea)

This paper is the first stage of an application for the Korean fishing vessel to participate in and contribute to the program of exploratory fishing for toothfish in the SPRFMO Convention Area. The exploratory fishing and associated sampling and research activities described in this document will contribute to expanding our collective understanding of the distribution, stock structure, and life history dynamics of both species of toothfish (*D. mawsoni* and *D. eleginoides*) in the SPRFMO Area and in adjoining Southern Ocean areas managed under the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR).

Biological data collection as well as tag releases and recaptures associated with the research fishing activities described here will contribute to the further development and improvement of stock assessment models for Antarctic toothfish currently used by CCAMLR. We also discuss a path toward the development and iterative improvement of local biomass estimates to inform the design of ongoing exploratory fishing in the SPRFMO area, toward the development of full stock assessments for toothfish in the SPRFMO Area, if and when sufficient data have been collected.

This proposal is drafted to conform to Article 22 of the Convention and the requirements of CMM 13-2024 on the management of new and exploratory fisheries, CMM 03-2023 on bottom fisheries, and the Bottom Fishery Impact Assessment Standard (BFIAS). In accordance with CMM-14-2024, this proposal is provided for the consideration of the Scientific Committee meeting such that it can advise the Commission meeting. It is proposed that exploratory fishing pursuant to this proposal occurs in 2025-2027.

7. Proposal (supplementary section by Korea)

Proposed stratification of potential fishing areas for toothfish

Two species of toothfish, *D. eleginoides* and *D. mawsoni*, have broad circumpolar ranges and are known to occur at latitudinal ranges that straddle the boundary between the SPRFMO Area and the CCAMLR Area, and thus are likely to occur on bathymetric features within the study area described in this proposal. Toothfish of both species are known to undertake seasonal spawning migrations in at least some locations, and individual fish have been shown from tag recaptures to sometimes move over very large distances, but stock structure in many areas remains largely unknown. Exploratory fishing like that described in this proposal is a key means of data collection by which we may begin to understand toothfish life cycle and stock structure in the ~~data~~ data-poor areas, especially when tag-recapture data can be matched with large existing datasets of previous tag releases, such as are available from existing programs in the CCAMLR Area.

In 2018 (SC6-DW03-rev2) New Zealand proposed, and the SPRFMO SC subsequently adopted, a spatial stratification for designating toothfish exploratory fishing locations similar to the SSRUs (~~small-~~small-scale research units) used by CCAMLR to manage research designs and assign catch limits for toothfish fishing (Figure 1). Within these strata, the spatial bounds of individual exploratory fishing proposals may be further refined within smaller research blocks

Objectives for Korean exploratory research fishing for toothfish

The Korean program for exploratory toothfish fishing in the SPRFMO Area will build upon the proven success of Korean research fishing in CCAMLR Subarea 88.3, some of which has been delivered by the same vessel (FV *Greenstar*) that will deliver the research described in this SPRFMO proposal. The development and delivery of the ongoing CCAMLR research fishing program delivered by Korean vessels is described in the following CCAMLR documents:

- WG-FSA-15-65 Revised research plan for the exploratory longline fishery for *Dissostichus* spp. in Statistical Subarea 88.3 in 2015/16 (Delegation of the Republic of Korea)
- WG-FSA-18-42 Revised joint research proposal for *Dissostichus* spp. in Subarea 88.3 by Korea and New Zealand (Delegations of the Republic of Korea and New Zealand)
- WG-SAM-19-02 Integrated research proposal for *Dissostichus* spp. in Subarea 88.3 by the Republic of Korea, New Zealand and Ukraine (Delegations of the Republic of Korea, New Zealand and Ukraine)
- WG-FSA-21-34 New research plan for *Dissostichus* spp. under CM 24-01, paragraph 3 in Subarea 88.3 by Korea and Ukraine from 2021/22 to 2023/24 (Delegations of the Republic of Korea and Ukraine)
- WG-FSA-22-26 Continuing research plan for *Dissostichus* spp. under CM 24-01, paragraph 3, in Subarea 88.3 by Korea and Ukraine from 2021/22 to 2023/24 (Delegations of the Republic of Korea and Ukraine)
- WG-FSA-23-20 Continuing research plan for *Dissostichus* spp. under CM 24-01, paragraph 3 in Subarea 88.3 by Korea and Ukraine from 2021/22 to 2023/2424 (Delegations of the Republic of Korea and Ukraine)

The research described in this SPRFMO proposal will complement and build upon the success of the adjacent CCAMLR research fishing program to address key gaps in our knowledge of toothfish distribution, life cycle, and stock structure, with important implications for stock assessment and improved fisheries management in both the CCAMLR and SPRFMO Areas. This research will deliver the following specific objectives:

Objective 1: Distribution and abundance

The main objective of the research is to determine the distribution and abundance of Antarctic and/or Patagonian toothfish in the southern SPRFMO Area. The proposed research will identify and then target bathymetric features within fishable depths of a study area that straddles SPRFMO strata L, M, N, O, P, Q, R, and S (see Figure 1), collecting toothfish catch ~~/~~ /effort and biological data that will ~~inform~~ estimates of local biomass and eventually ~~also~~ conduct more formal stock assessments.

Objective 2: Stock structure

A closely related objective of the research is to better understand the stock structure of toothfish in the southern SPRFMO Area including as it relates to adjacent stocks in CCAMLR Subareas 88.1, 88.2, and 88.3. It is necessary to determine the stock structure of toothfish in the southern SPRFMO Area, and the nature of their relationship to toothfish in the adjacent CCAMLR Subareas, in order to properly interpret tag release and recapture data and to properly account for removals in future stock assessments. Our current understanding of toothfish stock structure in these areas, and hypotheses about connectivity between the CCAMLR and SPRFMO Areas, are described below.

Objective 3: Bycatch and Vulnerable Marine Ecosystems (VMEs)

A third objective is to collect data on the spatial and depth distributions of bycatch species

to complement~~inform~~ bycatch mitigation measures. An improved understanding of bycatch distribution and trophic relationships and ecosystem function will build on~~inform~~ the development of ecosystem-based fisheries management approaches in the future.

Background and approach to achieving objectives of Korean exploratory toothfish fishing

Overview of each phase exploratory fisheries framework

We propose to apply a stepwise research design and implementation approach modified from the process developed in CCAMLR for exploratory toothfish fisheries (see especially Parker et al. 2013). In this approach, the first 1-2 years of a new research fishing program in a new area are referred to as the **'prospecting phase'**. During this phase, the research vessel~~s~~ will find and map the fishable bathymetry and conduct exploratory fishing in a structured manner to identify locations with ~~sufficiently~~ relatively high local abundance. ~~that~~ These locations will justify the designation of ~~a~~ one or more 'research block~~s~~'. In Phase 2, known as the **'Biomass Estimation phase'**, research fishing will be conducted repeatedly within the same research block~~s~~ to estimate local biomass. Initially, this will use a CPUE × seabed area approach, and later a mark-recapture based estimator will be employed once a sufficient number of locally released tags have been recaptured.

Reflecting the relative absence of information about toothfish distribution and stock structure in the SPRFMO Area, we propose that research conducted under this proposal will be in the 'prospecting phase' for the first 1-2 years. At the end of the prospecting phase, specific focal locations (often referred to as 'research blocks' but in this instance probably designated spatially by selecting whole mapped features rather than defining rectangular boundaries) will have been defined. Years 2-3 of this proposal will be Phase 2 research, in which research fishing is conducted repeatedly on those same target features in order to collect CPUE data and maximize tag returns, to inform a tag-based estimate of local biomass.

Contingent on the approval of the Scientific Committee and the SPRFMO Commission, Phase 1 research will commence in 2025. We expect that the initial research fishing will occur in April of 2025. In subsequent years it may be useful to vary the season in which research fishing is conducted on the same targeted features, ~~in order~~ to maximize the collection of biological information indicative of possible life-cycle movements and/or spawning dynamics (i.e. gonad staging, sex ratios, seasonal patterns of tag recaptures).

[[A note on terminology: in the original designation of exploratory toothfish areas within SPRFMO, the areas were simply ~~labeled~~labelled 'research areas' in SC9-DW09 and later referred to as 'strata'. In SC9-DW01-rev1 New Zealand instead referred to these as 'research blocks' for consistency with CCAMLR terminology. However, 'research blocks' in CCAMLR refer to smaller defined areas within which research fishing will be concentrated in Phase 2, the 'biomass estimation' phase; the strata defined in SC8-DW09 are larger than research blocks, and serve to regulate allowable catches in the current Phase 1 'prospecting phase'. We propose to revert to the use of the term 'strata' when referring to the large rectangular research areas labeled L-S~~Z~~ in Figure 1, because the research is still in Phase 1. Once fishable features have been mapped and identified to contain sufficient toothfish biomass to justify repeated research fishing under Phase 2, then these will be referred to as 'research blocks' if they are defined by rectangular coordinates, or 'research target features' if defined by a bathymetric contour designating the fishable depth of an entire seamount or bathymetric feature.]]

Objective 1: Distribution and abundance

Phase1, 'prospecting phase'

In the prospecting phase, we will apply a stepwise process of fishable ground location and feature mapping (using vessel acoustics) followed by structured fishing using a clustered design similar to that developed by CCAMLR for feature-based fisheries (e.g. see CCAMLR document WG-FSA-14/61).

We propose to expand the research area to encompass these eight strata for exploratory fisheries:

Starting coordinate 56 00 South, 155 00 West; second coordinate 56 00 South, 145 00 West; third coordinate 52 00 South, 145 00 West; fourth coordinate 52 00 South, 115 00 West; fifth coordinate 60 00 South, 115 00 West; sixth coordinate 60 00 South, 155 00 West and back to start coordinate.

The proposed research area is therefore the same as the area proposed for research fishing by New Zealand SC9-DW01-rev1. This is important to maximize tag recaptures, which are necessary for biomass estimation and to understand life cycle movements and stock structure.

Phase 1 research will begin by identifying and mapping fishable features using acoustic observation of bathymetry across the more promising parts of the exploratory fishing area. When a promising feature has been identified, exploratory fishing will be conducted using demersal longlines in a structured manner designed to spread fishing effort across on fishable features across different strata within the proposed area. Because the bathymetry is not sufficiently well known in advance to pre-select fishable features or pre-define the locations of individual sets, a stratified random survey approach is unlikely to be suitable. Instead we propose to use a cluster design similar to that adopted by CCAMLR for winter surveys in the northern parts of CCAMLR Areas 88.1 and 88.2. The cluster design allows for multiple sets to be flexibly conducted on discrete fishable features once they are identified, while still spreading fishing effort throughout the larger strata.

We propose an overall catch limit of 240 tonnes per annum (Green weight, both species combined) within the designated larger research area. In Phase 1 this catch will be limited to a maximum of 40 tonnes in any one stratum, to ensure that prospecting occurs across a large area of the designated research area. Once research blocks or target features have been defined at the end of Phase 1, we propose that the catch limit be re-allocated in Phase 2 based on a defined catch limit per research block or target feature rather than per stratum, noting that not all features will be of the same size, and some features may straddle the boundaries of the currently defined strata.

Phase 2, biomass estimation phase

In Phase 2, but until such time as tags have been recaptured, local biomass estimates will arise from CPUE x seabed area methods, in which local biomass is estimated within the 'fishable area', defined as all depths within the boundary of the feature and less than 2200 m. As Phase 2 progresses estimates of toothfish stock abundance will rely more heavily on mark and recapture methods, unless identified features are large enough to permit the design of a systematic or stratified random design in years 2 or 3 of the program. To this end we propose a required tagging rate of 3 fish per ton tagged and released during the prospecting phase, to be revisited in subsequent years when proceeding to the biomass estimation phase. Preliminary results of New Zealand's exploratory fishery in this area suggest~~s~~ that due to the high average size of toothfish occurring here, this tagging rate equates to roughly one in ten fish being tagged and released

Objective 2: Stock structure

The first exploratory research fishing for toothfish in the SPRFMO Area was conducted by New Zealand in the southern part of the SPRFMO area during 2016 and 2017. The results of this initial exploratory fishing showed that Antarctic toothfish, *D. mawsoni*, are dominant in the area, with only low numbers of Patagonian toothfish, *D. eleginoides* observed. On the basis of this initial exploration, it is thought that one or more stocks of Antarctic toothfish straddle the SPRFMO and CCAMLR Area boundaries. SPRFMO and CCAMLR signed an arrangement in 2019 to facilitate co-operation between the two organizations particularly with respect to research involving straddling stocks such as toothfish.

On this basis ~~it is our expectation~~we expect that most of the toothfish encountered in the proposed study area will be Antarctic toothfish *D. mawsoni*. Our current understanding of the stock structure and life cycle movements of *D. mawsoni*, (described in Parker et al. 2020), is illustrated in Figure 3. This diagram illustrates that mature fish from the Ross Sea slope are thought to seasonally migrate to bathymetric features in the northern Ross Sea region (CCAMLR Area 88.1 plus 88.2A and B) for spawning, which occurs in winter. Eggs

and larvae from these prime spawning locations are carried by ocean currents eastward into the Amundson Sea region (the remainder of CCAMLR Area 88.2) where juvenile fish are found in shallower water on the continental slope, often in areas that are largely inaccessible due to persistent multi-year sea ice. From there it is thought that these fish move gradually westward as they mature and eventually settle as adults once again on the continental slope of the Ross Sea, completing the cycle.

Similarly, the eggs and larvae from toothfish that spawn on seamounts in the Amundsen Sea region (CCAMLR Area 88.2) are also thought to be transported eastward across the CCAMLR management boundary into the Bellinghausen Sea region (CCAMLR Area 88.3), and again to settle as juveniles in shallower locations on the continental slope, where they may again move back to the east as they mature, noting that the life cycle of CCAMLR Area 88.2 and 88.3 fish is less well understood than is the case for the Ross Sea stock.

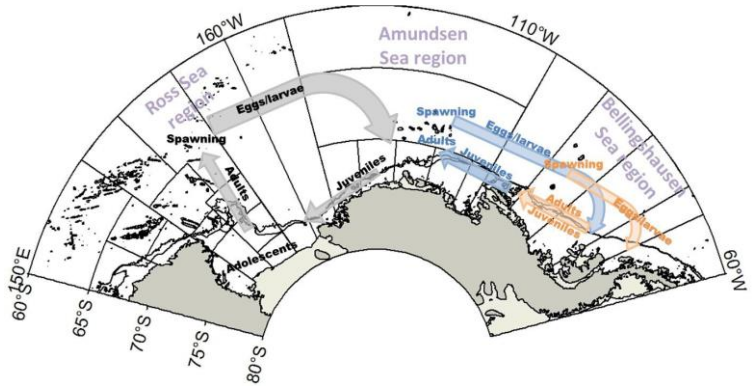

Figure 3. Hypothesized biological structure for Antarctic toothfish stocks in Subareas 88.1, 88.2, and 88.3 of the CCAMLR Area. Colours differentiate presumed biological stocks. Locations and presumed directional movements of eggs /larvae (< 30 cm), juveniles (30–80cm), adolescents (80–120 cm), and mature / spawning fish (> 120 cm) are identified (from Parker et al. 2020).

Korean research fishing in CCAMLR is a key contributor of new information to better inform the life cycle hypothesis for toothfish in the Amundsen Sea region and Bellinghausen Sea region toothfish. As described in a number of submitted CCAMLR documents (Delegations of Korea and Ukraine 2023, Delegations of Korea and Ukraine 2022, Delegations of Korea, New Zealand and Ukraine 2019), Korean vessels have played an instrumental and ongoing role in this research, consistently conducting research fishing within designated research blocks in CCAMLR Subarea 88.3 in coordination with other CCAMLR Member countries. The 'research block' approach to exploratory fishing, in which the same vessels undertake to consistently fish the same locations for a number of years, thereby increasing the number of tagged fishes that will be released and recaptured in the same locations, has proven to be a successful approach to developing estimates of local abundance for toothfish populations. In this document we propose to extend this successful approach also to the SPRFMO area, targeting geographical locations where there remains considerable uncertainty about the abundance, stock identity, and life cycle of toothfish occurring there.

A key gap in our understanding of Antarctic toothfish life cycle dynamics and stock structure, for all three CCAMLR regions depicted in Figure 3, is the role of fish occurring further north of the oceanic gyre dynamics generating the circulation of eggs and larvae depicted in the Figure. Oceanographic dispersal simulations suggest that eggs and larvae from any fish spawn~~ing~~ in the northern extreme of the CCAMLR Area~~.~~ or in the southern extreme of the adjacent SPRFMO Area, will likely be carried eastward and north into the SPRFMO Area rather than eastward and south back to the Antarctic continent. Without analogous shallow and ice-covered habitats in the SPRFMO Area comparable to those on the Antarctic continental slope, where juvenile fish have been observed in high numbers in CCAMLR exploratory fisheries, it is unclear whether there exists a

similar 'closed loop' life cycle for Antarctic toothfish living and spawning in the SPRFMO Area, similar to what exists in the CCAMLR Area. For example, it is possible that juvenile fish from fish spawning in SPRFMO manage to settle and mature on other seamounts in the southern SPRFMO Area. Alternately, it could be that Antarctic toothfish observed on SPRFMO Area seamounts are locally resident but continually replenished by source-sink dynamics from fish spawning further south in CCAMLR. Alternately it could be that Antarctic toothfish in the SPRFMO Area undertake seasonal migrations, either mixing with or remaining largely separate from Antarctic toothfish stocks within CCAMLR. The research described in this proposal will address these key questions, the answers to which are critical for informing ongoing effective fisheries management in both CCAMLR and SPRFMO.

Another key uncertainty is the possible presence and abundance of Patagonian toothfish (*D eleginoides*) in this portion of the southern Pacific Ocean. At comparable latitudes elsewhere around the Southern Ocean, there is a transition from predominantly *D. mawsoni* further south to primarily *D. eleginoides* further north, but whether and where a similar transition occurs in this sector of the SPRFMO Area remains uncertain until the area is better explored. To date, very few Patagonian toothfish have been observed by research fishing activities by New Zealand in these strata. The research described in this proposal will continue to address this key information gap.

Objective 3: Bycatch and Vulnerable Marine Ecosystems (VMEs)

An existing CCAMLR framework for catch and biological data collection regarding bycatch (under CCAMLR CM 33-01, CM 41-05, and CM 41-11) is already being implemented successfully by the FV *Greenstar* in research fishing in CCAMLR Subarea 88.3. We propose to extend this same data collection plan to apply also in the SPRFMO Area for the research described in this proposal. ~~Additionally, we propose to include Vulnerable Marine Ecosystems (VME) research plans within this framework.~~ These data will help to inform estimations of the distribution, relative abundance, and life history of the main bycatch species. Especially when analysed collectively with multi-national data collected also in the CCAMLR Area, data collected under this framework will inform our understanding of the spatial and depth distributions, and comparison of relative abundances between areas, for the main bycatch species. Moreover, integrating VME research will provide critical insights into the locations and conditions of these vulnerable ecosystems, enhancing the overall ecological understanding and conservation efforts. These data, including those from VME research, will be summarized and presented for review by the SPRFMO SC in 2028 ~~at the end of the second and fourth years of this research plan~~.

8. Bottom fishery impact assessment (supplementary section by Korea)

The Bottom Fishery Impact Assessment (BFIA) evaluates the environmental impacts of bottom fishing activities within the SPRFMO Convention Area, focusing on vulnerable marine ecosystems (VMEs), non-target species, and other ecological assets. The assessment aligns with the SPRFMO Bottom Fishery Impact Assessment Standard (BFIAS) and complies with international guidelines such as the FAO's Deep-Sea Fisheries Guidelines.

Identification of objectives, hazards and risks using a hierarchical risk assessment approach & Identification and assessment of impacts

Non-target fish:

Early results from New Zealand's exploratory fishing in the southern SPRFMO area suggests that fish bycatch will be very low in these locations. New Zealand reported that in ~~the most recent year of their research program~~2022,, species other than toothfish constituted less than 0.05% of the total catch (by weight; SC11-DW11-rev1). In earlier years, bycatch was higher but still a low proportion of total catch (2-3%). The main bycatch species have been rattail (*Macrourus* spp.), with smaller amounts of *Antimora* spp. and eel cods.

Commented [A3]: Was there a reason to delete this? I think it's really relevant information.

Korea does not have any experience conducting exploratory fishing in the SPRFMO. Based on information from recent three years of fishing within CCAMLR (Subarea 88.3) close to the southern SPRFMO, *Macrourus* spp, Channichthyidae (ICX), skate and rays and others are the main non-target species. The research fishing in the 88.3 was conducted in accordance with the CCAMLR Conservation Measure 33-03 Limitation of by-catch in new and exploratory fisheries.

Year	TOA	TOP	Macrourus	ICX	Skate	Others	Proportion
2022	113,253	0	3,013	1,292	589	104	4.32%
2023	49,785	109	2,357	993	282	153	7.51%
2024	56,137	0	4,392	594	331	188	9.47%

Based on these results, we anticipate that bycatch will remain a minor proportion of the total catch observed in the research conducted under this proposal. However, considering the differences between the SPRFMO and CCAMLR areas, as well as the gear configurations between autolines and trotlines—particularly the tendency for autoline hooks to rest directly on the ocean bottom, compared to trotlines where hooks are slightly elevated—it is likely that catch ratios between target species and bycatch, or among different bycatch species, will vary.

Through this research, we will monitor and record catch rates of all captured fish species and compare them with results from New Zealand's research in similar locations, to better quantify differences in bycatch species catchability between different gear types.

~~To address these issues, we propose including research blocks L and M in the proposal to compare the effects of different gear types. These blocks are areas where New Zealand previously conducted research and released many tagged fish, increasing the likelihood of recapture.~~

New Zealand reports that deepwater sharks are rarely caught (SC9-DW01-rev1). Given that the observed bycatch species are widespread and abundant, there are no sustainability concerns with the current ongoing research.

The mitigation measures for this proposal include releasing sharks and skates alive when in suitable condition, with tags. The research will also adhere to CCAMLR Conservation Measure 33-03, which limits bycatch in new and exploratory fisheries. Should species of greater concern be observed in bycatch under this proposal, they will be reported to SPRFMO, and appropriate measures will be implemented.

Seabirds

Longlines pose a risk of capturing seabirds in many fisheries worldwide, including those at similar latitudes (e.g., Anderson et al. 2011, Baird et al. 2015). However, effective seabird ~~capture~~ mitigation measures have been developed and successfully implemented by demersal longline fishers targeting toothfish in the CCAMLR Area. For example, in the Ross Sea toothfish fishery, only two seabird captures have been reported over more than 20 years, with 100% observer coverage.

Specifically for this proposal, Korean fishing vessels using similar trotline configurations have reported no seabird captures in the past seven years of operation in CCAMLR Subarea 88.3. Korean vessels operating in CCAMLR fisheries, including the FV Greenstar involved in this research, routinely employ the following effective mitigation strategies to minimize the risk of attracting and capturing seabirds:

- Strict offal management to reduce the attraction of discarded material.
- Line weighting to ensure rapid sink rates of fishing gear during deployment (see Figure 2).

Streamer lines are used during longline setting to deter birds from approaching the hookline.

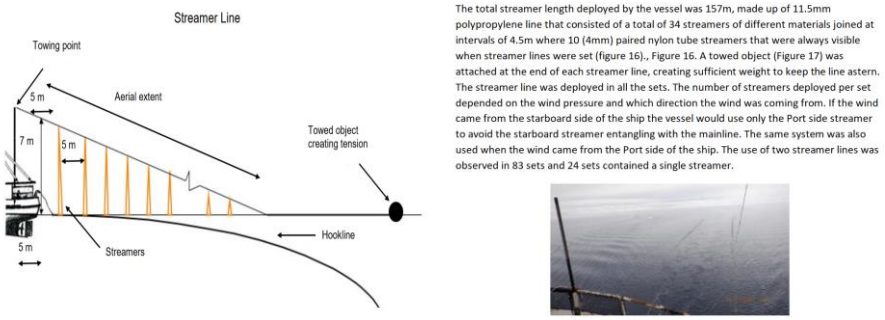

Figure 4. Diagram of a streamer line (Left) and Streamer line reported in a scientific observer report (Right)

It is possible that seabird risk is seasonally variable, particularly since the research fishing under this proposal may occur at a different time of year than most toothfish fishing in the CCAMLR, which primarily occurs in summer due to ice conditions. However, the timing of seasonal bird migrations and the effectiveness of night setting as a seabird bycatch mitigation measure suggest that fishing outside the summer season will further reduce the risk to seabirds.

Reports from New Zealand research fishing in the area of this proposal suggest that the seabird species most likely to be encountered by the research vessel are Cape petrels, snow petrels, Antarctic petrels, and giant petrels. New Zealand further reports that no seabirds have been killed or injured to date (SC-9-DW01rev1).

In 2021, New Zealand conducted a global seabird risk assessment of major high seas fisheries interacting with seabird species distributed across the southern hemisphere. This study used a spatially explicit method to estimate seabird catchability across different fishing methods and gear types. The results confirmed observations from the CCAMLR Area that high seas bottom longlines pose a very low risk to seabirds, primarily due to low catchability (i.e., captures are rare even when birds are present) rather than low spatial overlap (i.e., seabirds not being in the same areas as the fishing activities).

Marine mammals

Interactions with orcas and other marine mammals are considered highly unlikely within the study area, based on reports from New Zealand's exploratory fishing in the same area and the experience of Korean vessels operating in CCAMLR Subarea 88.3. Observers and/or crew will record all sightings of marine mammals, including details of any interactions with the vessel or gear, and any evidence of depredation. If evidence of depredation by marine mammals (e.g., orcas or sperm whales) is observed or suspected, the vessel will take action to prevent or mitigate further interactions, such as ceasing to haul the line and moving to other locations until there is no evidence of whales present during hauling.

VME and Benthic impacts

It is generally recognized that the impact of bottom longline fishing methods on benthic fauna including VME taxa is low relative to other bottom fishing methods such as bottom trawling. The Korean flagged vessel, FV Greenstar, conducted her research activities with trotlines for consecutive three years in the 88.3 and its result regarding the VME was as follows;

Year	No. of hooks	no. of set	Total line set(m)	VME in kg	VME in Litre
2022	610,600	129	1,192,550	0.37	0
2023	621,360	116	1,190,940	0.8	0
2024	722,880	134	1,385,116	0	5.13

A comprehensive framework for cumulative bottom fishing impact assessment has been developed and consistently applied to bottom longline fishing in CCAMLR since 2013 (CCAMLR 2013). This framework is based on methods initially developed within CCAMLR (Sharp et al. 2009, Sharp 2010, Sharp 2010b) and later applied in the SPRFMO area for bottom trawling. This method, known as the 'MSRP' method in SPRFMO, is one of four explicitly endorsed by the SPRFMO Bottom Fisheries Impact Assessment Standard (BFIAS).

Applied to longlines, the Sharp (2010b) method estimates the size of the fishery footprint as a function of the length of the deployed longline multiplied by the width of the area where the main line is expected to contact the ocean floor. The impact within this footprint depends on taxon fragility, expressed as the proportion of taxa within the footprint expected to be damaged or destroyed due to contact with the fishing gear. In practice, impacts are generally expressed with reference to the most fragile taxa, following the precautionary principle.

Footprint width primarily depends on the extent of lateral movement of the longline during hauling. It is recognized that lateral movement is likely negatively correlated with depth, according to trigonometric considerations (Sharp 2010). Direct observations using deployed cameras support this notion, showing that shallow longline deployments (around 540 m depth) tend to move laterally, whereas deeper deployments (1390-1530 m) lift vertically from the seafloor without lateral movement.

CCAMLR integrates all available data to apply a lateral movement parameterization, assuming an average footprint width of 5.2 m for bottom longlines in contact with the seafloor, with 70% of fragile benthic fauna within this footprint expected to be damaged or destroyed (CCAMLR 2013). When no lateral movement occurs, the footprint is assumed to be 0.8 m wide, with 78% of fragile taxa damaged or destroyed. Combining these parameters, the impact index of a bottom longline is calculated as 0.00420, representing the impacted area (in km²) per km of longline deployed. For the present research proposal, this estimate is precautionary (i.e., biased high) because the expected fishing depths are on the deeper end of the range used to parameterize the default CCAMLR index.

Total proportional impact is estimated by multiplying by the effort density, expressed as km of longline deployed per km² of benthic habitat. It is not possible to estimate proportional impact at the scale

of the research strata because the area of the fishable depths is unknown. Instead, we provide an illustrative analysis of maximum cumulative impacts at scale of individual clusters of research sets, for a range of different cluster sizes (below), noting that impacts at the scale of research strata will of course be much lower.

Korean observers will record all benthic bycatch and will carry detailed identification guides to aid in identifying taxa to a useful taxonomic level. The CCAMLR VME Guide will be used to identify pieces of VME taxa retrieved on longline hooks.

The impact assessment of fishing effort on fishable depths, including the estimation of effort density and its potential impact on VMEs, is required but cannot be included in this report due to insufficient data. Once the necessary data is collected, we plan to conduct the analysis and include it in future reports. As the proposed exploratory fishery is a bottom fishery, an assessment of the impact of the proposed fishing activities is included in this proposal, as mandated by paragraph 8(b)(viii) of CMM 13- 2024 (exploratory fisheries) and paragraphs 11, 12, 17, and 18 of CMM 03-2023 (bottom fisheries).

Maximum cumulative impact on VME taxa at the local scale of research set clusters

To illustrate the maximum impact that could be exerted on VME taxa at the scale of a particular feature, we have produced the following simple illustrative analysis.

max. hooks per cluster	max line length per cluster	impact index	impacted area (km2)	radius of cluster (n miles)	radius of cluster (km)	cluster area (km2)	max. proportional impact	years to reach status = 0.8 (no recovery)
17250	33.1	0.0042	0.139	10	18.5	1074.7	0.00013	1545.6
				5	9.25	268.7	0.00052	386.4
				2	3.7	43.0	0.00323	61.8

The maximum hooks per cluster is 17,250, as specified in the proposal.

Using a conversion factor derived from data in the table on p. 35 of the proposal, 17,250 hooks equates to a maximum line length of approximately 33.1 km per cluster.

The impact index of 0.0042 is as derived from the CCAMLR bottom fishing impact assessment. Multiplied by 33.1 km, this yields a maximum impacted area of 0.139 km2 per cluster.

It is not possible to estimate proportional impact without specifying the spatial area of the cluster. Because the bathymetry of the fished features is unknown at this time, we provide three different estimates illustrating the plausible range of how large or small a cluster might be: 10, 5, or 2 nautical miles in diameter.

The largest cluster in our example (10 nm radius) corresponds to the specified minimum distance between clusters; a cluster of this size might be anticipated to occur on large flat features where fishing is unconstrained by topography.

The smallest cluster in our example (2 nm radius) would only occur if every line were laid across each other in a star pattern (e.g. if the cluster was targeting a very small seamount). Due to the length of the lines themselves, it is not possible to constrain the effort into features smaller than this. This is an extreme example that is unlikely to occur under actual fishing conditions.

This illustrative analysis shows that the maximum proportional impact to VME taxa ranges from 0.00013 (for the largest cluster) to 0.0032 (for the smallest cluster).

We note that these impact estimates are much, much lower than what could be considered a 'significant adverse impact' (noting that under the MSC precedent proposed in the updated BFIA, SAI would occur when proportional impact exceeded 0.20 (i.e. status < 0.80). Even assuming non-overlapping lines and no recovery of impacted taxa, we could fish the same locations at the same intensity for 61.8 years (for the smallest cluster) to 1,545 years (for the largest cluster) before VME status was reduced this far. In reality, considering that VME taxa also recover, we could fish at this same intensity in perpetuity.

Other Potential impacts

Gear loss

Based on information from previous exploratory fishing in the CCAMLR Convention Area, the vessels sometimes loss fishing gear partially or completely by the sea-ice after set the gears. Of course, the vessels do not like to set the fishing gear in the condition of heavy sea-ice because of its possible loss. The sea-ice comes to the fishing gear after it is distributed, and cut the line. It is, however, not the case in the area without sea-ice. During the recent three years of exploratory fishing in the 88.3 (January – April), the FV Greenstar lost her gears. She lost twice in the condition of sea-ice and this area is not affected by the sea-ice during January – April. We expect that proposed area in our proposal will not be affected by the sea-ice as it is located in the North of subarea 88.2/88.3.

Year	No. of hooks	no. of set	Total line set (m)	No. hook lost	no. set lost	length of line lost(m)	comment
2022	610,600	129	1,192,550	0	0	0	
2023	621,360	116	1,190,940	0	0	0	
2024	722,880	134	1,385,116	8,040	2	15,410	by sea-ice

Disposal of Plastics and Offal discharge

The Korean-flagged vessel, FV Greenstar, has extensive experience in exploratory fishing in the CCAMLR Convention Area since 2015. The vessel is prohibited from discharging plastic into the sea in accordance with MARPOL Annex V regulations. The same regulations will be applied to the FV Greenstar in the SPRFMO area.

Summary of ~~VME~~ bottom longline fishery impacts from previous work (SPRFMO / CCAMLR)

In accordance with Bottom Fishery Impact Assessment Standard for the South Pacific Regional Fisheries Management Organisation (BFIAS, 2019) para 1.3.5, we introduce a summary of risk assessment for the Korean proposal in the SPRFMO area.

Subject	Spatial Extent	Duration	Intensity	Cumulative	Overall
Over-exploitation of bottom lined fish species	Medium	Medium	Low	Possible	Low/medium
Seabirds	High	Medium	Low	Possible	Medium
Marine mammals	High	Medium	Low	Possible	Medium
VME and Benthic impacts	Site-specific	Long	Low	Possible	Low/medium
Gear loss	None/low	Short	None/low	Unlikely	Low
Disposal of Plastics and Offal discharge	None/low	Long	None	Unlikely	Low

Identification of mitigation, management and monitoring measures relevant to impacts and residual risks

Mitigation of fishing impact on non-target fish

The major by-catches in other toothfish longline fisheries are *Macrourus* spp., Channichthyidae (ICX), skate as we experienced in the CCAMLR area and high sea. The Korean flagged vessel, FV Greenstar, complies with the CCAMLR CM-33-03 to mitigate fishing impacts on non-target fish. This measure applies following provisions;

- Skate and rays: do not exceed 5% of the catch limits of toothfish
- *Macrourus* spp.: do not exceed 16% of the catch limits of toothfish
- All other species: do not exceed 16% of the catch limits of toothfish
- If the by-catch of any one species is equal to, or greater than, 1 tonne in any one haul or set, then the fishing vessel shall move to another location at least 5 n miles distant. The fishing vessel shall not return to any point within 5 n miles of the location where the by-catch exceeded 1 tonne for a period of at least five days

In accordance with the SPRFMO CMM 14e-2024 regarding *Macrourus* spp., we also note that the vessel will move-on to another location at least 5 nm distant if the by-catch of *Macrourus* spp. reaches 150 kg and exceeds 16% of the catch of toothfish in any one haul or set.

No sharks have been caught by the FV Greenstar from the exploratory fishing in the Ross Sea and 88.3 since 2015. New Zealand further reports that deepwater sharks are only rarely caught. (SC9-DW01-rev1). However, skates and rays were caught by the FV Greenstar during the exploratory fishing in the 88.3.

Subject	Spatial overlap	Catchability	Risk	Residual risk after mitigation
Skates	Medium	High	Low	Low
sharks	Medium	Low	Low	Low
Mitigation applied				
Precautionary bycatch limit Skates are able to be release alive Move-on Rule				

One of our objectives is to collect data on the spatial and depth distributions of bycatch species to complement~~inform~~ bycatch mitigation measures. Improved understanding of bycatch distribution, trophic relationships, and ecosystem functions will support the development of ecosystem-based fisheries management approaches in the future.

Mitigation of fishing impact on seabirds

Longlines have a risk of capturing seabirds in many fisheries worldwide, including at similar latitudes (e.g., Anderson et al. 2011, Baird et al. 2015). However, effective seabird ~~capture~~ mitigation measures have been successfully developed and implemented by demersal longline fishers targeting toothfish in the CCAMLR Area. For example, in the Ross Sea toothfish fishery, there have been only two seabird captures in more than 20 years, with 100% observer coverage. Specifically, Korean fishing vessels using similar trotline gear configurations in the CCAMLR Subarea 88.3 have had no seabird captures in the past seven years of operation.

The mitigation measures are specified in CCAMLR Conservation Measure 25-02, and the FV Greenstar has never experienced incidental seabird mortality when conducting longline fishing under this conservation measure. This measure includes the following provisions;

- Vessels using the trotline system shall deploy weights only at the distal end of the droppers in the trotline. Weights shall be traditional weights of at least 6 kg or solid steel weights of at least 5 kg. Vessels alternating between the use of the Spanish system and trotline method shall use:; (ii) for the trotline method: line weighting shall be either 8.5 kg traditional weights or 5 kg steel weights attached on the hook-end of all droppers in the trotline at no more than 80 m intervals
- The dumping of offal and discards is prohibited while longlines are being set.
- A streamer line shall be deployed during longline setting to deter birds from approaching the hookline.
- Every effort should be made to ensure that birds captured alive during longlining are released alive and that, wherever possible, hooks are removed without jeopardizing the life of the bird concerned.

CMM 09-2017 Annex 1 introduces minimizing bycatch of seabirds in the SPRFMO convention area as follows;

1. *To minimise incidental interactions with seabirds in demersal longlines, demersal longline vessels shall:*
   a) Prohibit discharge of any biological material during shooting and hauling, where possible, to avoid attracting seabirds to the vessel, and
   b) Either:
      i. Implement the combined use of the following measures:

a. a line weighting regime, as specified in paragraph 6. Noting the objective of this measure is to maximise hook sink rates close to vessel sterns to reduce the availability of baits to seabirds;

b. bird scaring lines, as specified in paragraph 7. Noting the objective of this measure is to actively deter birds from baited hooks;

c. setting at night, between the times of nautical dark and nautical dawn.

Or:

ii. Where a Member or CNCP has maintained spatially and temporally appropriate observer coverage for the previous 5 consecutive years at levels greater than 10% and recorded a seabird mortality rate less than 0.01 birds/ 1000 hooks, that Member may choose to:

a. require its vessels to apply only one of the three measures specified in paragraph 1; and

b. ensure a minimum of 10% observer coverage that is adequately representative of the spatial and temporal distribution of the fishing fleet.

2. Should a flagged vessel of Member or CNCP applying paragraph 1(b) exceed a seabird mortality rate of 0.01 birds/ 1000 hooks, they will be required to:

a) apply at least one additional measure detailed in paragraph 1 for at least one year from the time of the mortality;

b) report details of the event to the Secretariat within seven days; and

c) report details of the event in their national report.

Reports from New Zealand's research fishing in the area ~~of this research proposal~~ suggest~~s~~ that the seabird species most likely to be encountered by ~~are~~ research vessel are Cape petrels, snow petrels, Antarctic petrels, and giant petrels. New Zealand further reports that no seabirds have been killed or injured to date (SC-9-DW01rev1).

Subject	Spatial overlap	Catchability	Risk	Residual risk after mitigation
Seabirds	High	Low	Low	Low
Mitigation applied				
The FV *Greenstar* delivering this research routinely apply the following effective mitigation strategies to minimize the risk of attracting and capturing seabirds: 1. strict offal management (to reduce the attractive effect of discarded material). 2. Line weighting to ensure rapid sink rates as fishing gear is deployed (see gear configuration diagram) 3. Use of streamer lines				

In 2023~~1~~ New Zealand ~~conducted~~ delivered a global seabird risk assessment of major high seas fisheries interacting with globally distributed seabird species in the southern hemisphere (Edwards et al. 2023). This study used a spatially explicit method to estimate seabird catchability in different fishing methods and gear types. This study confirmed the observations from the CCAMLR Area that high seas bottom longlines pose very low risk to seabirds, and that this effect is a function of low catchability (i.e. because captures are

rare even when birds are present) not simply low overlap (i.e. seabirds are not present in the same locations as the fishing).

Mitigation of fishing impact on marine mammals

Interactions with orca and other marine mammals are considered highly unlikely within the study area based on reports from New Zealand's exploratory fishing overlapping same area and more generally based on the experience of Korean vessels in CCAMLR Subarea 88.3 Observers and/or crew will record all sightings of mammals including details of any interactions with the vessel or gear, and any evidence of depredation. If evidence of depredation by marine mammals (e.g. orcas or sperm whales) is observed or suspected, the vessel will take action to prevent or mitigate further interactions, for example by ceasing to haul the line and moving to other locations until such time as there is no evidence of whales present at hauling.

The proposed exploratory fishery does not overlap spatially with any other fisheries so the cumulative impacts on taxa and habitats that do not move or migrate will be essentially the same as the impact of the exploratory fishery. Seabirds and marine mammals are likely to move in and out of the proposed exploratory fishery area, so cumulative impacts on these may be higher if interactions were to occur.

Mackenzie et al. (2022) delivered a multi-species marine mammal risk assessment for commercial fisheries in New Zealand including bottom longline gear and estimated low risk for bottom longline fisheries on the basis of low catchability. The FV *Greenstar* has not captured marine mammals while fishing with identical fishing gear in other locations.

Subject	Spatial overlap	Catchability	Risk	Residual risk after mitigation
Whales	High	Low	Low	Low
Dolphins	High	Low	Low	Low
Otariids	~~High~~Low	Low	Low	Low
phocids	~~High~~Low	Low	Low	Low
Mitigation applied				
1. When marine mammals are observed, the vessel moves away from the area until the marine mammals have left. 2. No offal and discards will be released while longlines are being set. Offal and discards will be discharged on the non-hauling side of a vessel. 3. All hooks will be removed from offal and discards prior to discharge. 4. Do not use of plastic packing band.				

Korean observers are trained to identify seabirds and marine mammals whether these are captured or ~~attending~~ collide the vessel. The following information will be collected for marine mammals, seabirds, turtles, and other species of concern:

- Opportunistic observations, photography and identification of marine mammals will be undertaken by observers in collaboration with the crew;

- The observer will have a target of observing hooks hauled for marine mammal, seabird, and turtle captures;
- All marine mammals, seabirds, turtles, and other species of concern captured will be identified, and photographs will be taken of all live birds released and of any birds colliding with the ship that can be recovered;

Mitigation of fishing impact on VMEs

Footprint width is primarily a function of to what extent the longline might move laterally during hauling. It is recognized that lateral movement is highly likely to be negatively correlated with depth, due to trigonometric considerations (Sharp 2010); direct observations using deployed cameras support this notion, whereby two shallow longline deployments (roughly 540 m depth) were observed to move laterally, whereby two deeper deployments (1390-1530 m) were observed to lift vertically from the sea floor with no lateral movement.

Integrating all available data, CCAMLR applies a lateral movement parameterization whereby the average footprint of bottom longlines in contact with the sea floor is assumed to be 5.2 m wide, and within the lateral footprint, 70% of fragile benthic fauna will be damaged or destroyed (CCAMLR 2013). When the line does not move, the footprint is assumed to be .8 m wide, within which 78% of fragile taxa will be damaged or destroyed. Combining these parameters, the 'impact index' of a bottom longline is 0.00420, representing the impacted area (in km2) per km of longline deployed. With reference to the present research proposal, this estimate will be precautionary (i.e. biased high) because the expected fishing depths in the research area are on the deeper end of the range used to parameterize the default CCAMLR index.

Total proportional impact is then estimated by multiplying by the effort density, expressed in km of longline deployed per km^2 of benthic habitat.

Korea agrees with the need to implement the precautionary approach for managing bottom fisheries with respect to VMEs due to the difficulty in acquiring data on their location, extent, and risk of significant adverse impact. We also note the need to acquire additional data to contribute to assessments and advice on a long-term precautionary approach to avoiding significant adverse impacts on VMEs.

Subject	Spatial overlap	Catchability	Risk	Residual risk after mitigation
All VMEs Indicator Taxa	Site-specific	High	Medium	Low
Mitigation applied				
1. The FV Greenstar will mark fishing lines into line segments and collect segment specific data on the number of VME indicator units. 2. record all benthic bycatch				

Korean observers will record all benthic bycatch and will carry appropriate detailed identification guides to facilitate identification to a useful taxonomic level. The CCAMLR VME Guide will be used to identify pieces of VME taxa retrieved on longline hooks.

The impact assessment of fishing effort on fishable depths, including the estimation of effort density and its potential impact on VMEs, is required but cannot be included in this report due to insufficient data. Once the

~~necessary data is collected, we plan to conduct the analysis and include it in future reports. Because the proposed exploratory fishery is a bottom fishery, an assessment of the impact of the proposed fishing activities is included in Appendix 1 as mandated by paragraph 5(b)(viii) of CMM 13- 2021 (exploratory fisheries) and paragraphs 10, 11, 16, and 17 of CMM 03-2021 (bottom fisheries).~~

9. References

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