

12th MEETING OF THE SCIENTIFIC COMMITTEE

30 September to 05 October 2024, Lima, Peru

SC12 - DW 02

Korea Fisheries Operation Plan for Toothfish

Republic of Korea

Template for a SPRFMO Fisheries Operation Plan

(Template version October 2021)

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	<p><u>FAO Fishing Area 81</u></p> <p>The proposed research block is within a large area of features forming a box follows:</p> <p>Corner coordinates of the research block: 52°S 143°W; 52°S 121°W; 56°S 121°W; 56°S 143°W.</p> <p>Within this large area there will be about five discreet smaller boxes that will be the target fishing areas.</p>
Target Species	Patagonian Toothfish (<i>Dissostichus eleginoides</i>) and Antarctic Toothfish (<i>D. mawsoni</i>)
Proposed Methods of fishing	The F.V. <i>Greenstar</i> , belonging to TNS Industries Inc., will target Patagonian toothfish (<i>D. eleginoides</i>) and Antarctic Toothfish (<i>D. mawsoni</i>) 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	200 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.

The area that we have selected has depths suitable for the target species and, to our knowledge, has not been fished before.

From the bathymetry, much of the area is far too deep for fishing at 2500+ meters. However, as mentioned above, we have detailed bathymetry available that shows several areas suitable for fishing, with depths that could be 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 Patagonian Toothfish (*D. eleginoides*), noting there is a slim possibility of catching Antarctic Toothfish (*D. mawsoni*).

The proposed maximum catch limit is 200 tonnes of green weight, which would be apportioned to the 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 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 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. Therefore, we propose to expand the research area to encompass these six strata for exploratory fisheries:

Starting coordinate 52 00 South, 145 00 West; second coordinate 52 00 South, 115 00 West; third coordinate 60 00 South, 115 00 West; fourth coordinate 60 00 South, 145 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 less than 2200 m.

When suitable fishable ground has been identified, research fishing sets will be deployed in a cluster of up to 5 sets. Each set will have a maximum of 11,000m. Following successful retrieval of all fishing sets in a cluster, the vessel will move on to a new fishable location before beginning a new cluster. A minimum spacing of 10 nm will apply between cluster locations, measured as the minimum distance between any portion of any two fishing sets in separate clusters. No minimum distance will apply between sets in the same cluster, in order to allow research fishing to occur on small or irregular features. The 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 serves 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, and 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 either straightforward effort limits (i.e. maximum number of sets) or catch limits (i.e. maximum tons) acting 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 60 tons per stratum (green weight, both species of toothfish combined).

Catches will also be limit 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 tons across all strata.

The proposed study area limit (240 tons) is lower than the sum of the individual stratum limits (60 tons) across six 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-stratum 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.

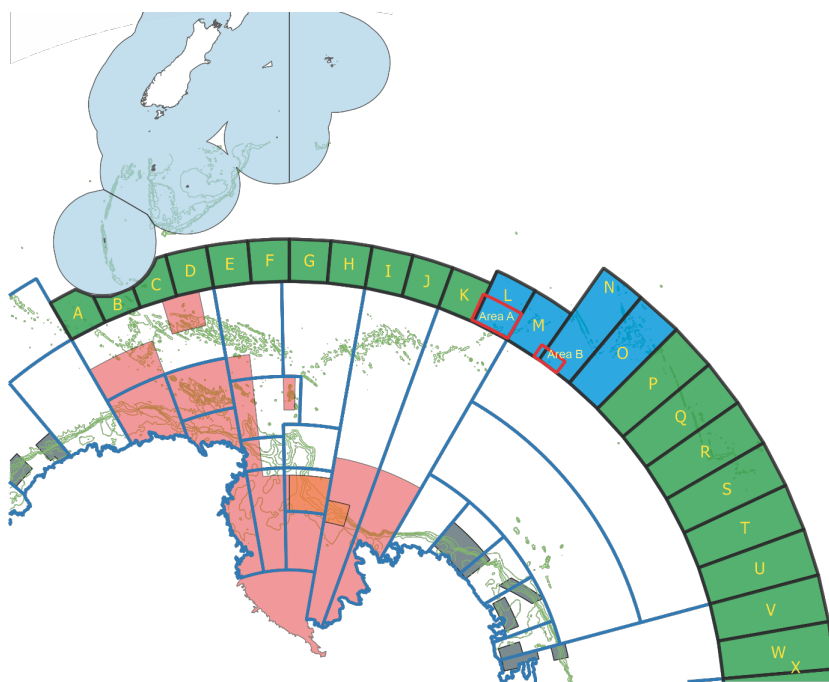


Figure 1: Proposed boundaries of research fishing in the southern SPRFMO Area by Korean vessel, 2025-2027. The initial prospecting phase of research fishing will occur within the area designated in black. The location of finer-scale research blocks or target features, within which research fishing will 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 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 minimum tag overlap statistic of 60% with the aim of achieving 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 3 fish collected per species from toothfish gonads
Gonad samples	5 fish collected per species from toothfish gonads

Marine environmental data	An equipment will be deployed to measure temperature and salinity at least twice in each research block.
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Catch limits as a proportion of likely stock biomass

The proposed catch limit of 240 tons is about 6% of the precautionary catch limit of 3,499 tons 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 3,500 – 9,600 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

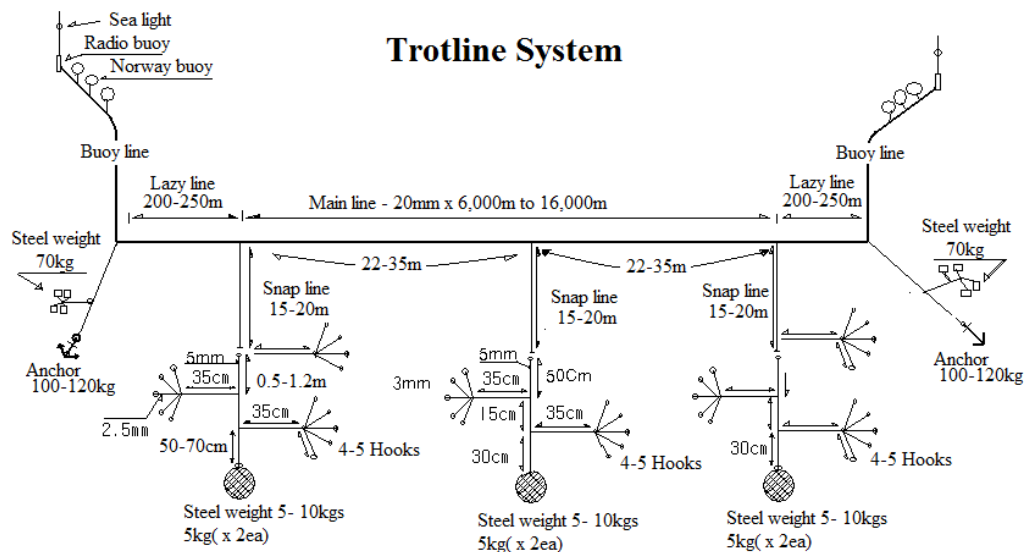


Figure 2. Gear configuration for trot line gear to be deployed by FV Greenstar in delivering this research

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 Previous names (if known) Registration number IMO number (if issued) External markings Port of registry	<i>Greenstar</i> 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 <i>Dissostichus mawsoni/eleginoides</i> 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 Industries 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 Kiyong, 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 Republic of Korea

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 April. 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.

According to SD11-DW11_rev1, 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 that fish bycatch will be very low in these locations. New Zealand reported that in the most recent year 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 water 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 autolines and trotlines, 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 catch rates of all captured fish species and compare with the results of New Zealand research in similar locations, to better quantify differences in bycatch species catchability between the different gears.

If species of higher concern are observed in bycatch under this proposal, these will be reported to SPRFMO and appropriate measures put in place.

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 has been only 2 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 this research, routinely apply the following effective mitigation strategies to minimize the risk of attracting and capturing seabirds:

- strict 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)

It is possible that seabird risk is 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 reduce the risk to seabirds still further.

Reports from New Zealand research fishing in the area of this research proposal suggests 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).

In 2021 New Zealand conducted a global seabird risk assessment of major high seas fisheries interacting with globally distributed seabird species in the southern hemisphere. 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).

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.

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 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. These impacts are considered further in the risk assessment section.

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 SPRFMO-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 tons of toothfish annually, limited to up to 40 tons within each of strata L – S, (Figure 1), each having a catch limit of 40 tons 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.

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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, labelled the 'MSRP' method in SPRFMO is one of four that is endorsed explicitly in the SPRFMO 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 is 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 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 km² of benthic habitat. We estimate a maximum of 250 longlines will be deployed annually by Korean vessels in the course of this research program. The average length of a Korean longline is 1.1 km, for a total deployed length of 275 km of longline deployed annually.

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).

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 the 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.

[Add your text here]

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.

[Add your text here]

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.

[Add your text here]

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).

[Add your text here]

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.

[Add your text here]

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.

[Add your text here]

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.

[Add your text here]

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.*

[Add your text here]

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.

[Add your text here]

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 be submitted by the vessel (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 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 02-2021 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, and to highlight any significant new findings and seek guidance as necessary. Data and reports will be copied to the relevant CCAMLR bodies. Data will be provided to the secretariat and subject to SC agreement, 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 2027.

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.

[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, *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 5 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 VME⁴ 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 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.

[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]		
b) reference points, including precautionary reference points as described in Annex II of the 1995 Agreement;		
c) an appropriate precautionary catch limit;		
d) the cumulative impacts of all fishing activity in the area of the exploratory fishery;		
e) the impact of the proposed fishing on the marine ecosystem;		
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;		
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		
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 .		

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.

5.2 Data Collection Plan checklist

Data Collection Plan considerations	Rationale	Assessment
<i>a) a description of the catch, effort and related biological, ecological and environmental data required to undertake the evaluations described in paragraph 24;</i>		
<i>b) the dates by which the data must be provided to the Commission;</i>		
<i>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;</i>		
<i>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</i>		
<p><i>e) an evaluation of the time scales involved in determining the responses of harvested, dependent and related populations to fishing activities</i></p> <p>[Note that SC has previously interpreted this as to mean “when will data be analysed and available”]</p>		

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*):

-
-
-

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

-
-
-

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 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 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 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 (F/V *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 2023/24 (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 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 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 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 inform bycatch mitigation measures. An improved understanding of bycatch distribution and trophic relationships and ecosystem function will 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. 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, research vessels will map the fishable bathymetry and conduct exploratory fishing in a structured manner to identify locations with sufficiently high local abundance that justify the designation of a 'research block'. In Phase 2, known as the 'Biomass Estimation phase', research fishing will be conducted repeatedly within the same research block 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 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. 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 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 '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-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 six strata for exploratory fisheries:

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

The proposed research area overlaps with that proposed for research fishing by New Zealand SC9-DW01-rev1, and includes portions of strata N, O, P, Q, R, and S as described in that document. 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 tons 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 60 tons 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 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 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 Bellinghousen 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.

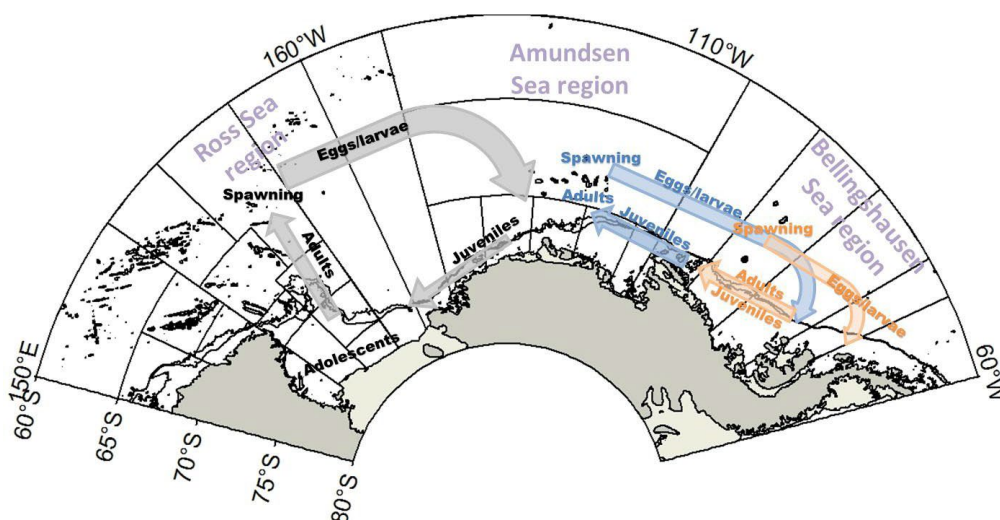


Figure 3. Hypothesized biological structure for Antarctic toothfish stocks in Subareas 88.1, 88.2, and 88.3 of the CCAMLR Area. Colours differentiate presumed biological stocks. Locations and presumed directional movements of eggs /larvae (< 30 cm), juveniles (30–80cm), adolescents (80–120 cm), and mature / 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 Bellinghousen 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 2, 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 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 (see below). 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 at the end of the second and fourth years of this research plan.