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SC11 – DW04
EU FOP for an exploratory Patagonian and Antarctic toothfish fishery in the SPRFMO Area

European Union

European Union proposal for exploratory fishing for Patagonian and Antarctic toothfish within the SPRFMO Convention area, 2024-2026

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1 Purpose

The European Union (EU) wish to apply for a second exploratory fishing program for Patagonian/Antarctic toothfish (*Dissostichus eleginoides* and *D. mawsoni*) in the SPRFMO Convention Area. This application contains the elements established by CMM 13-2021 on the Conservation and Management Measures for the Management of New and Exploratory Fisheries. This proposal includes the Fisheries Operation Plan, including area, target species, proposed fishing methods, fishing gear, period and a preliminary data collection plan for the exploratory fishing activities to be undertaken during 2024-26 in FAO area 57.4 (Figure 1), and which falls under the SPRFMO jurisdiction. The proposal also identifies the relevant elements of CMM 03-2023 on Bottom Fishing in the SPRFMO Convention Area, notably an assessment of bottom fishing activities outside the established footprint, and a risk assessment following the Bottom Fishery Impact Assessment Standard (BFIAS) (2019).

Key information	**Target species**:	*Dissostichus eleginoides* (Patagonian toothfish)
		Dissostichus mawsoni (Antarctic toothfish)
	Vessel:	*FV Tronio*
	Fishing Method:	Seabed Spanish longline
	Time period:	1 May – 15 November, 2024-2026
	Area:	George V Fracture Zone (GVFZ)
	Proposed TAC:	Research Block A – 129t. Research Block B – 33t

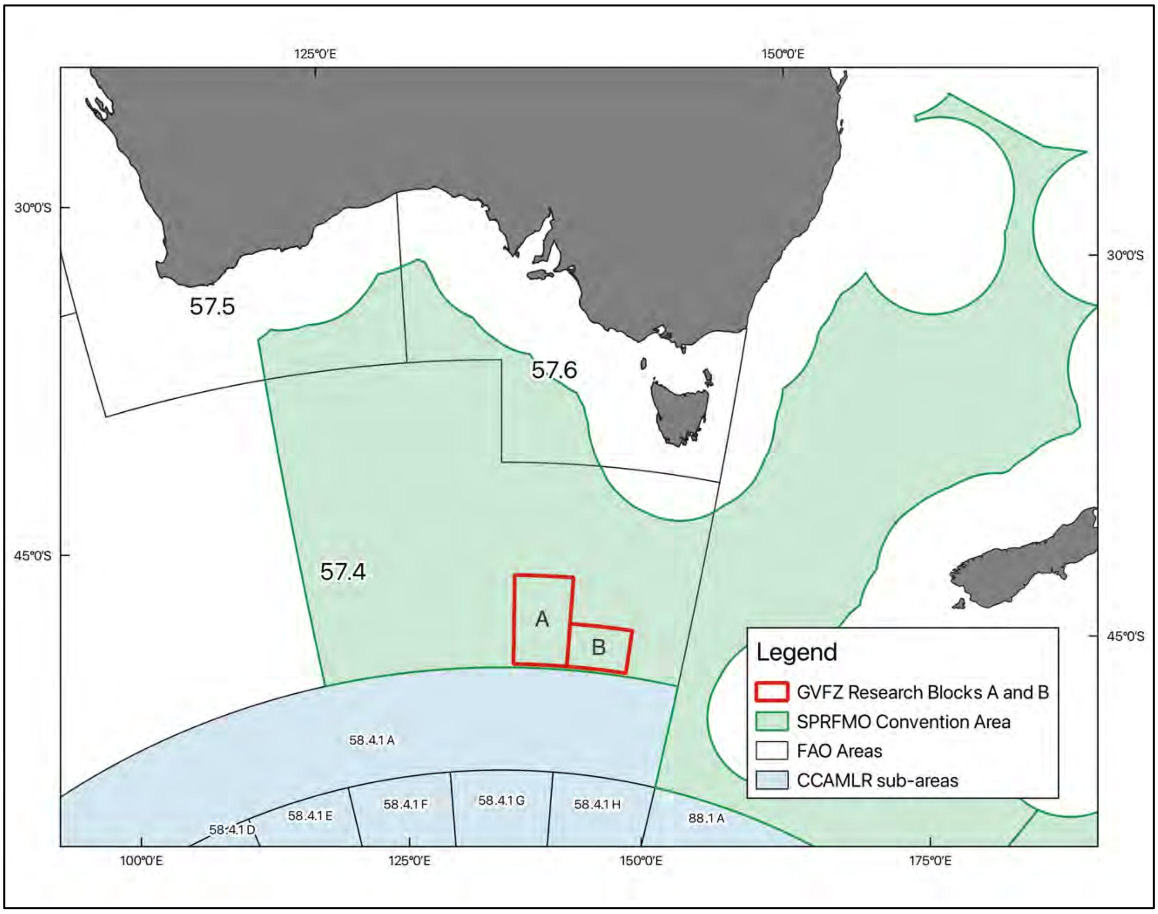


Figure 1: Location of Research Blocks within the GVFZ, SPRFMO Convention Area. Also indicated are FAO area 57.4 and CCAMLR sub-areas.

2 Introduction

This proposal is to conduct a second campaign of exploratory fishing for toothfish (*Dissostichus* spp.) over three consecutive seasons (2024-26) in the area of the George V Fracture Zone (Figure 1). The first campaign (CMM14e-2021) is currently underway, due to be completed in Oct-Nov 2023. The area has now been spatial partitioned into Research Block A and B as fishing in the currently active program is focused on Research Block A. This proposal will expand exploration to Research Block B and continue with fishing in Block A for continued tagging and assessment of stock and other environmental considerations.

The objectives in this proposal are:

a) to further explore the presence and distribution of toothfish in the SPRFMO Convention Area;
b) to collect and provide information and data contributing towards the sustainable management of potential toothfish stocks in specific, data-poor zones of the Convention Area;
c) to assess the potential for a future sustainable toothfish fishery in specific zones of the Convention Area;
d) to provide occurrence information on marine mammals, seabirds, sharks, skates and rays and other species of concern;
e) to better understand patterns of seabirds and marine mammals and their potential for interactions with fishing vessels;
f) to evaluate the potential impacts of longlines on non-target associated or dependent species, and vulnerable marine ecosystems;
g) to undertake tagging activities on toothfish to enable future studies on the migration of toothfish as well as a preliminary stock assessment.

All data will be integrated into current Patagonian/Antarctic toothfish stock hypotheses and connectivity analyses with other regions where appropriate.

Previous to the current campaign, to the best of our knowledge, there has not been any recorded toothfish fishing in the area. Application for a second exploratory fishery campaign is permitted under CMM13-2021 paragraph 4(c).

3 Vessel Specific Details

Exploratory fishing will continue to be conducted form the *FV Tronio*. The *Tronio* Captain and crew have over 20 years of experience fishing for Patagonian and Antarctic toothfish in RFMO regulated fisheries such as SIOFA, SPRFMO, and SEAFO, as well as in CCAMLR regulated fisheries in the Antarctic and in the South Georgia fishery (48.3 & 48.4).

3.1 Vessel details

Tronio has Ice Class 1C. Vessel specific details as required under paragraphs 2 and 3 of Annex 1 of CMM 05-2023 (Record of Vessels) are listed in Table 1.

Table 1: Vessel details.

a) Current vessel flag (using the codes indicated in Annex 2);	EUROPEAN UNION (EU) (SPAIN)
b) Name of vessel;	*FV TRONIO*
c) Registration number;	3GC-1-2-05
d) International radio call sign (if any);	ECJF
e) UVI (Unique Vessel Identifier)/IMO number (if issued)[2];	9361603
f) Previous Names (if known);	N/A
g) Port of registry;	CELEIRO (Spain)
h) Previous flag (if any, and using the codes indicated in Annex 2);	UNITED KINGDOM (GBR)
i) Type of vessel (Use appropriate ISSCFV codes, Annex 10 of CMM 02-2018 (Data Standards));	BOTTOM LONGLINER (LL)
j) Type of fishing method(s) (Use appropriate ISSCFG codes, Annex 9 of CMM 02-2018 (Data Standards));	LLS 09.3.0
k) Length; l) Length type e.g. “LOA”, “LBP”;	55 m LOA
m) Gross Tonnage – GT (to be provided as the preferred unit of tonnage);	1058 GT
n) Gross Register Tonnage – GRT (to be provided if GT not available; may also be provided in addition to GT);	
o) Power of main engine(s) (kW);	1378.70Kw
p) Hold capacity (m3);	632,3 m^3
q) Freezer type (if applicable);	TUNNEL
r) Number of freezers units (if applicable);	3
s) Freezing capacity (if applicable);	30Mt
t) Vessel communication types and numbers (INMARSAT A, B and C numbers);	Inmarsat C :422462320 Inmarsat FBB: +870773184117
u) VMS system details (brand, model, features and identification);	Satlink ELB 2014
v) Name of owner(s);	PESQUERÍAS GEORGIA, S.L.
w) Address of owner(s);	Muelle Sur, Almacén 21- Celeiro – Spain
x) Date of inclusion into the SPRFMO Record;	
y) Vessel authorisation end date;	
z) Flag Authorisation Start Date;	

aa) Good quality high resolution photographs of the vessel of appropriate brightness and contrast, no older than 5 years, which shall consist of:	
• one photograph not smaller than 12 x 7 cm showing the starboard side of the vessel displaying its full overall length and complete structural features;	See below Figure 2
• one photograph not smaller than 12 x 7 cm showing the port side of the vessel displaying its full overall length and complete structural features;	See below Figure 3
• one photograph not smaller than 12 x 7 cm showing the stern taken directly from astern.	See below Figure 4

Figure 2: Tonio starboard side view.

Figure 3: Tronio port side view.

Figure 4: Tronio stern view

3.2 Fishing gear

The fishing gear to be used in the exploratory fishery is the Spanish style seabed longline system (Figure 5); a well-known gear configuration used in many toothfish longline fisheries (as specified in CCAMLR Gear Catalogue, specifically WG-FSA-11/53). The total length of the line can vary by deploying more or less sections (or baskets) per set line ranging from 60-140 baskets (3,640-10,240 hooks). This translates into a variation of length between 5,824 and 16,384 meters. Typically, in exploratory areas, and following acoustic bathymetric surveying of the area of interest, a shorter line of approximately 5,000 hooks is set to first establish fish abundance. Normally, and depending on the fishing success of any initial lines, longer lines may be set to optimize efficiency. However, because of the exploratory nature of this proposal, only lines of approximately 5,000 hooks (estimated length 8,000m) will be set. A 2% variation in number of hooks set may be expected for operational reasons. This detail will be recorded by the bridge and Scientific Observer.

Setting speed is between 7 and 8.5 knots. The average duration of the line setting operation of 5,000 hooks) is ~45 mins, whereas that of line hauling is ~4 hours. Usually there are between 3 and 4 lines in the water simultaneously. Soak time for lines is typically 12-18hrs.

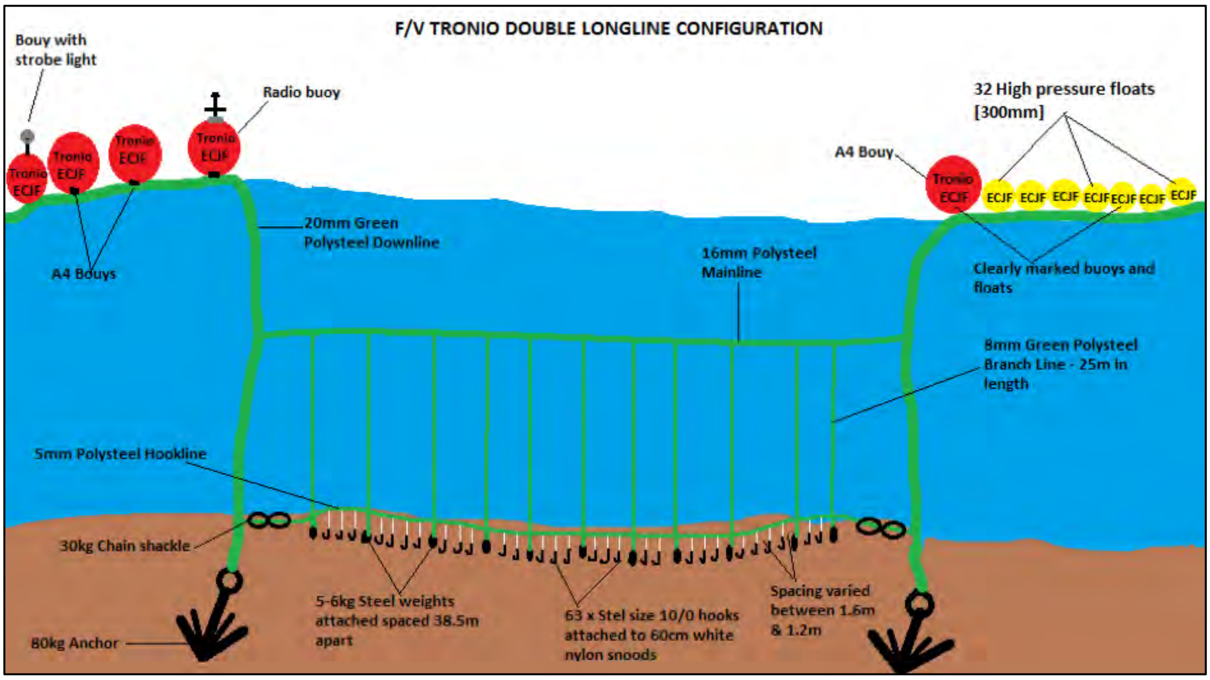


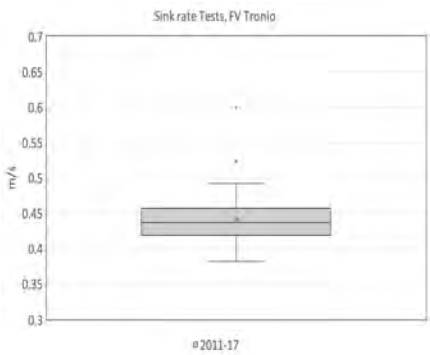
Figure 5: FV Tronio Spanish system. Note that all steel weights are now 6kg (not 5kg).

Hook size used is 'J' type, size 10 (A Poutada) with a 60cm white nylon snood. All hooks are marked to identify the ship. Two types of makings are used; either a rectangle or double line on the shank near the eyelet (Figure 6).

Figure 6: Marked hooks used on FV Tronio during STR exploratory fishing program.

3.2.1 Line sink rate

Between 2011 and 2017, 63 sink rate tests using the bottle test were conducted by Scientific Observers. *FV Tronio*'s mean line sink rate is 0.44m/s (Figure 7), which is faster than the CCAMLR requirements for sink rate (0.3m/s), as detailed in CCAMLR CM 24-02 (2014). Improved sink rate was achieved through increasing hydrodynamic steel sink weights to 6kgs each (Figure 8).



	m/s
mean	0.44
Min	0.38
max	0.60
SD	0.03

Figure 7: Results of line sink rate tests conducted on FV Tronio, 2001 and 2017.

Figure 8: Hydrodynamic shaped steel line weights, 6kg each.

4 Fisheries Operation Plan

4.1 Description of the exploratory fishery

The proposed study area has been named the George V Fracture Zone Research Block (GVFZ). Within this area, Research Blocks A and B have been designated (with coordinates listed in Table 2). Fishing depths will range between 600m and 2500m depth (Figure 9). With these depth constraints, the total fishing area in RB-A area is approximately 11,115 km^2, and in RB-B the fishing area is approximately 6,449 km^2. The fishable depth area is calculated from the bathymetric information provided by GEBCO (2023). However, it is suspected that there may well be inaccuracies, as bathymetric survey activities in this region have been limited. For uniformity and to facilitate analyses, all sets will be lines of ≤ 5,000 hooks (~8,000m in length). The minimum distance between the centre point of each set is 3nm.

Table 2: Proposed study location (corner coordinates) for the Research Blocks A and B.

Research Block	Point	Latitude	Longitude
Block A	NW	50° 30’ S	136° E
	NE	50° 30’ S	140° 30’E
	SE	54° 50’ S	140° 30’E
	SW	54° 50’ S	136° E
Block B	NW	52° 45’ S	140° 30’E
	NE	52° 45’ S	145° 30’E
	SE	54° 50’ S	145° 30’E
	SW	54° 50’ S	140° 30’E

4.2 Catch and effort limits

The target species is Patagonian toothfish (*Dissostichus eleginoides*). There is a possibility of also catching Antarctic toothfish (*Dissostichus mawsoni*), although none has been caught thus far after two seasons of fishing in the area.

A preliminary stock assessment was carried out for GVFZ RB-A based on 2021 and 2022 catch and effort data, and tagging (see Appendix 1 for details). For RB-A, a precautionary 129t TAC is recommended. A TAC of 33t is recommended for RB-B, which is 1/3 of an estimated biomass based on relating the ratio of CPUE to fished seabed area of RB-A to fishable areas in RB-B.

It is proposed to also limit the survey by fishing effort. A maximum of 100 sets in the GVFZ RB A and B combined per annum is permitted in the current program. Given the catch rates achieved in 2021 and 2022, we propose reducing this to 100 lines in RB A and B.

A conversion factor of 1.68 is recommended, based on Scientific Observer data collected in 2021 and 2022 exploratory fishing campaigns in the GVFZ. The conversion factor is a value applied to the total processed (HGT) product weight caught for conversion to whole green weight catch. The conversion factor is established by taking >100 measurements of whole fish and final HGT product each year.

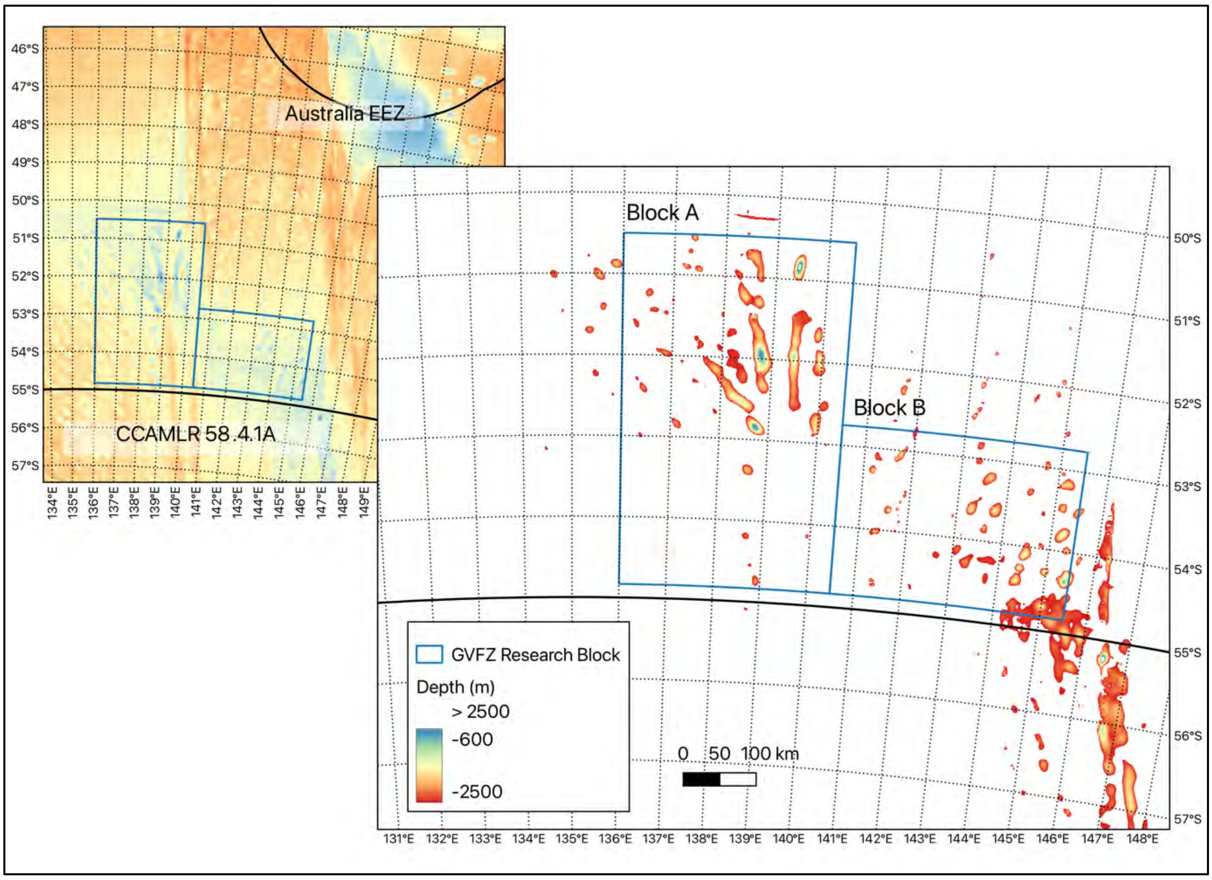


Figure 9: Area of the GVFZ Research Blocks A and B, highlighting the proposed fishing depths ranging between 600 and 2500m depth.

4.3 Time period of the fisheries operation plan

The requested time period for the exploratory survey is 1 May to 15 November, for three consecutive years 2024-26. This would provide good consistency with previous exploratory fishing (CMM 14e 2023). In 2021 and 2022, surveys were completed (reaching TAC of 75t) in 15 days and 17 days respectively. With respect to proposed TACs for RB-A and RB-B, it is predicted that fishing will be completed in approximately 30-40 days.

4.4 IUU detection and reporting

Whilst undertaking the exploratory fishing survey in the GVFZ RBs, the *FV Tronio* will document and report any sighting of fishing vessels suspected of IUU fishing activities to the SPRFMO Secretariat. Furthermore, any abandoned or retrieved fishing gear suspected to be of IUU origin will be photographed, reported with relevant details on position, type of gear, any catches, and retrieved where possible. This is the vessel's normal operating practice under CCAMLR CM 10-02 Annex 10-02/A while fishing in the CCAMLR Convention Area.

5 Biological and Ecological Information

5.1 Biological information on the target species

There is a paucity of information on the toothfish stock and the biological/ecological character of the GVFZ area. Prior to 2021, there were two records of Patagonian toothfish registered with OBIS and apparent records held by the Australian Government (L. Georgeson pers. com.).

The detailed results of exploratory fishing by *Tronio* in 2021 and 2022 are provided in cruise reports following each year (SFL 2022, SFL 2023). Presented in those reports are catch and effort, sex/maturity and length frequency of toothfish and bycaught species, and reporting of VME, seabird, and mammal bycatch and observations, and other science conducted. These reports are briefly summarised here and in proceeding sections examining bycatch risk assessment.

5.1.1 Catch and effort - toothfish

Exploratory fishing in 2021 and 2022 has focused on RB-A (Figure 10). Fishing is restricted to somewhat isolated topographic features such as seamounts and hills. A total of 27 lines were set in 2021 and 32 lines set in 2022. No Antarctic toothfish were caught. CPUE (kg/ km line) of Patagonian toothfish varied between years, and between locations. CPUE between years did not vary significantly. Details are found in Appendix 1 – Preliminary Assessment.

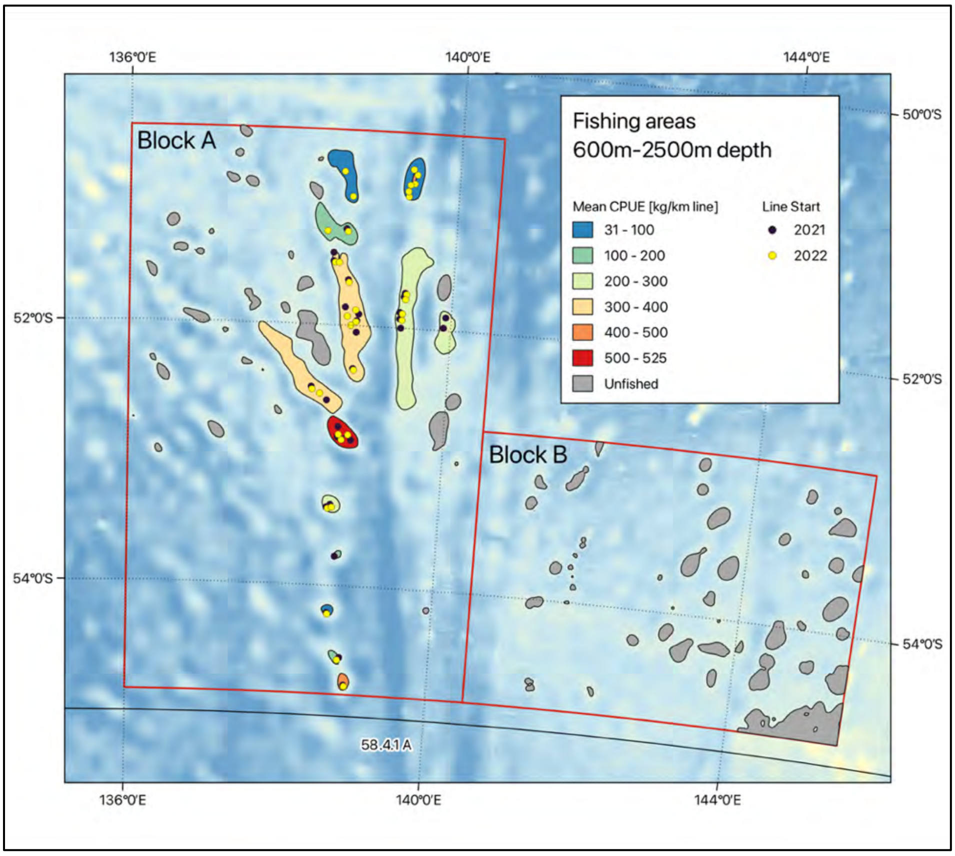


Figure 10: Location of lines set (set_start) in 2021 and 2022. Highlighted are fishable seamounts defined by bathymetry ranging between 600m – 2500m depth. Fished seamounts are coloured according to mean CPUE (kg/km line) for all lines in both years. Unfished seamounts are shown in grey.

5.1.2 Stock structure

The targeted population of Patagonian toothfish consists of fish ranging between approximately 60-170cm total length, with males generally smaller than females (Figure 11). A significant change in size distribution was found between years; early preliminary analysis did not suggest that there was an effect of fishing depth or other spatial factors. Additional exploratory fishing will help elucidate if this change is reflective of natural variability or fishing impact.

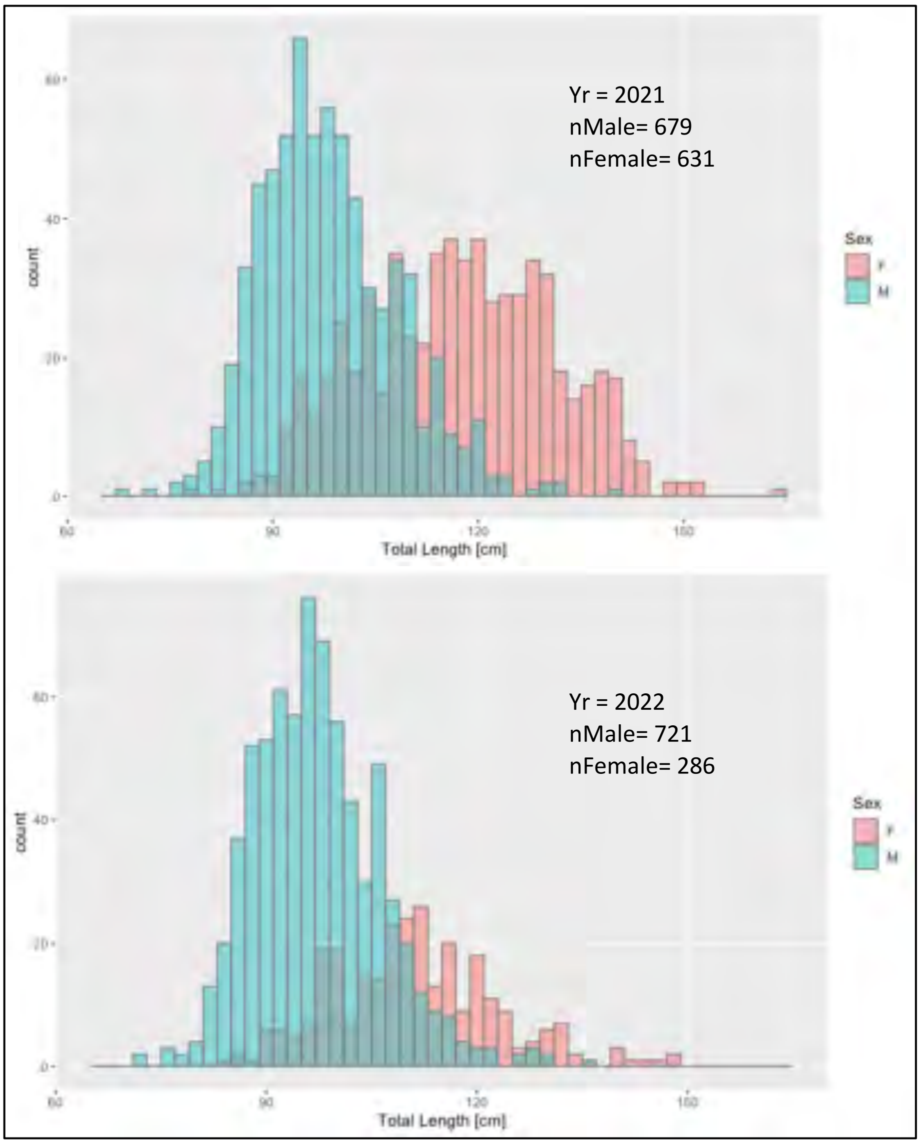


Figure 11: Length-frequency of males and females of TOP in 2021 and 2022.

Captured fish ranged in maturity stages (as described in CCAMLR Scheme of International Scientific Observation Scientific Observer’s Manual Finfish Fisheries Version 2023) with all stages being observed in both males and females in both years (Figure 12). Some variability distribution of maturity stages can be seen between years; further surveys will help understand seasonal and any other spatial patterns in reproduction.

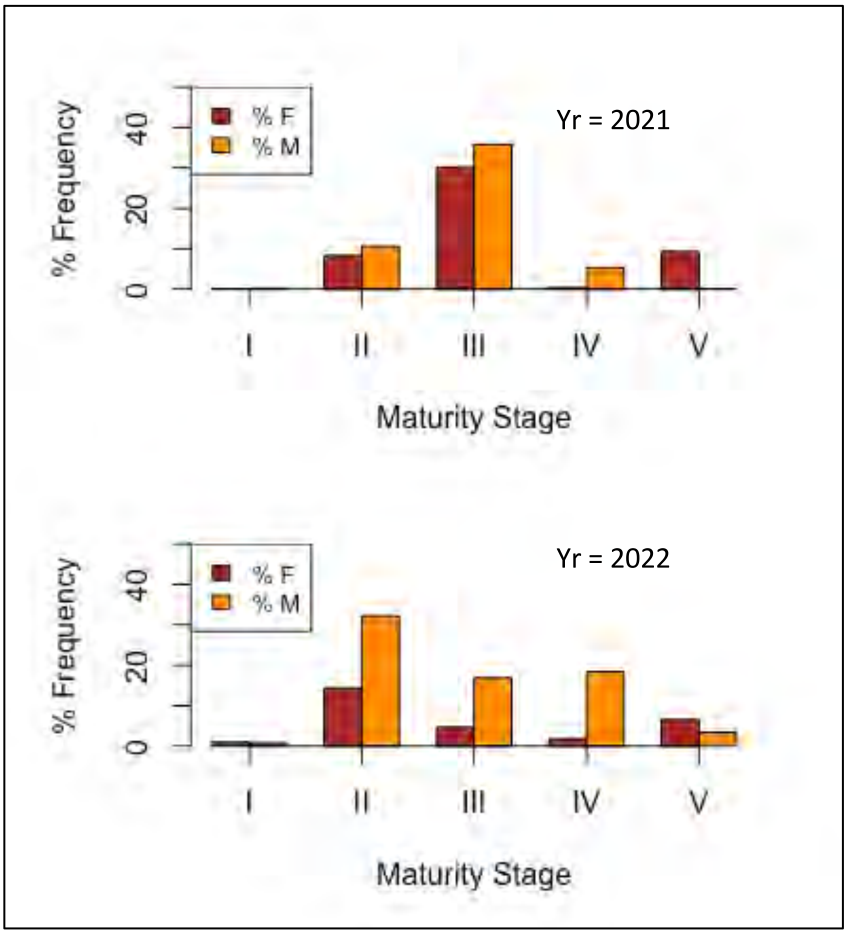


Figure 12: Frequency of maturity of male and female TOP from 2021 and 2022. Maturity stages for Males: I - Immature, II - Developing or resting, III – Developed, IV – Ripe, V – Spent. Maturity stages for Females: I- Immature, II - Maturing virgin or resting, III - Developing, IV – Gravid, V – Spent.

Tag recoveries suggests that there is at least some connectivity of the GVFZ population with other surrounding regions, as six fish were captured that were originally tagged and liberated in the Macquarie Ridge fishery approximately 1,400 kms to the East of the GVFZ (Figure 13). Within the GVFZ, there may be a high degree of fish fidelity on seamounts/hills, as fish tagged in 2021 were recovered in 2022 on the same seamount/hill from which they were released.

5.1.3 Preliminary stock assessment

A preliminary stock assessment was conducted based on 2021 and 2022 catch data. The full report is presented in Appendix 1. CCAMLR methods for data-limited fisheries were used, namely, CPUE-by-seabed area analogy method (Agnew et al., 2009), and Chapman tag-recapture method (CCAMLR SC-XXXV Appendix 5). Results are shown in Table 3.

The TAC of 75t (CMM-14e 2023) was reached in both years. Biomass estimates suggest that this is below the 4% sustainable exploitation rate assumed under the CCAMLR decision tree (WG- FSA-17 para 4.33). However, a great deal of caution must be applied when interpreting this preliminary assessment due to several unknowns regarding spatial and temporal variability of stock characteristics and assumptions not being met under both assessment methods. Further development of the biomass estimates will continue.

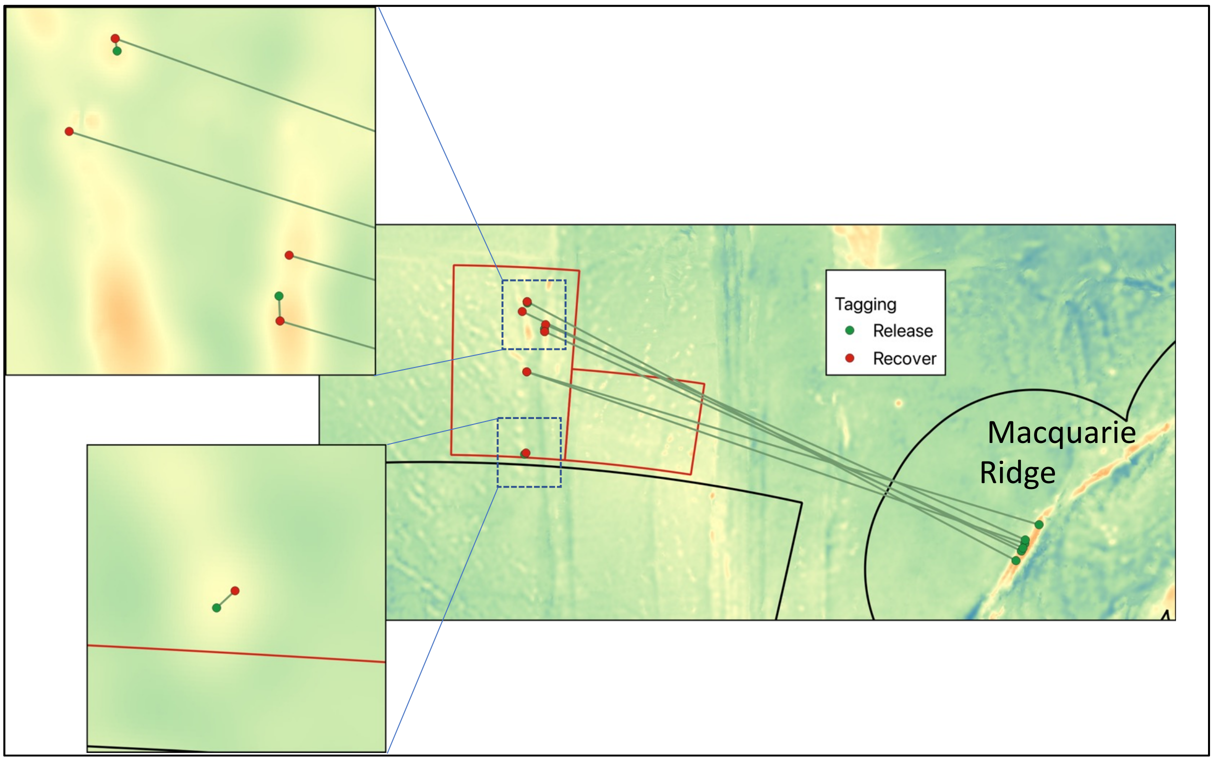


Figure 13: Tagging releases and recoveries on the GVFZ in 2021 and 2022 fishing campaigns.

Table 3: Biomass estimates for GVFZ block A.

Research Block	Species	Season	Biomass Estimate (t)	CI lower (t)	CI upper (t)	N recaptures	N lines	Method
GVFZ A	TOP	2022	5938	2940	13356	3	32	Chapman
GVFZ A	TOP	2022	4316	2803	6266		59	CPUE-by-seabed area

5.1.4 Regional Patagonian toothfish stocks

Patagonian toothfish are characterised by slow growth and late maturity (Collins et al., 2010). It is a bentho-pelagic species, where juveniles are found at shallow (< 200m) and adults in deep (~ 2200m in the GVFZ) depths. Despite being widely distribution in sub-Antarctic waters surrounding islands, seamounts and continental shelves of the southern Pacific, Indian, and Atlantic Oceans, genetic discontinuities in populations have been described. For example, Patagonian toothfish of the Macquarie region are genetically differentiated from other fished areas in the Kerguelen, Crozet, HIMI, South Georgia, South Sandwich Islands (Toomey et al., 2016). Recent genetic work in the southwest Atlantic suggests the designation of a new species of *Dissostichus australis* for Patagonian toothfish populations below the Antarctic Polar Front (APF), as distinct from those north of the APF (Arkhipkin et al., 2022). Tissue samples collected in the current study will help confirm the species identity and genetic connectivity of Patagonian toothfish in the GVFZ.

As far as we have been able to establish, there has never been any Patagonian toothfish fishing in the adjacent CCAMLR area 58.4.1 SSRU A, or at least not since the establishment of the SSRUs. Patagonian toothfish are caught in northwest corner in CCAMLR Subarea 88.1 generally very few small fish (<50 cm). It is likely that they are at their southern range edge here, but their origin is unclear. However, one Patagonian toothfish was caught in SSRU 88.1B in 2007, originally tagged in the Macquarie fishery (per com T. Lamb, Australian Antarctic Division).

5.2 Non-target bycatch species

5.2.1 Bycatch of fish

Fish bycatch from 2021 and 2022 fishing campaigns is shown in Table 4. All bycatch was below the trigger levels (CMM 14e-2023). Eight fish taxa have been reported however it is possible that some species have been misidentified. For example, *Macrourus holotrachys* were found in 2021, but a mix of *M. holotrachys* and *Macrourus carinatus* were found in 2022. Similarly, *Muraenolepis* spp were recorded in 2021, and in 2022 *Muraenolepis microps* were recorded.

Table 4: Fish bycatch in the GFVZ, 2021-2022. Total catch (kg) is reported on the bridge. Number measured, Length range (cm), and Length mean (cm) are measured by Scientific Observers.

	2021					**2022**			
Taxa	Total Catch	Number measured	Length range	Length mean		Total Catch	Number measured	Length range	Length mean
Macrourus holotrachys	783.6	160	50-88	68		338	157	48-86	68
Macrourus carinatus	-	-	-	-		645	54	50-74	57.9
Macrourus caml	0.8	3	58	58		-	-	-	-
Coryphaenoides spp.	3.2	3	65-67	62		-	-	-	-
Antimora rostrata	130.2	49	52-78	65		142	64	44-82	61.4
Muraenolepis spp.	85.9	21	66-95	83		7	2	86-88	87
Muraenolepis microps	-	-	-	-		21	5	79-90	85
Lepidion spp.	-	-	-	-		4.8	2	55-77	67

5.2.2 Bycatch of mammals

No marine mammal bycatch or observations were reported in 2021 or 2022.

A total of 30 marine mammals were identified as overlapping with the GVFZ RB to varying degrees (Section 6.6). The majority of whale species have a high degree of potential overlap with the GVFZ RB region. Otariid seals have been associated with toothfish longline vessels and have been observed to depredate on catch. Fur seal and sea lion toothfish fishing related mortalities appear to be very rare.

Elephant seals (*Mirounga leonina*) have been tracked through the GVFZ area (Section 6.6). They can dive for up to 2h to depths over 1500m and bottom times of up to 15mins at deep-depths. Males tend to dive deeper (down to ~2000m) compared to females (~800m) (Prof. Mike Fedak pers com). Elephant seals are known to travel thousands of kilometres on 10-month long foraging trips (Hindell et al., 2016). The closest colony to the GVFZ RB is on Macquarie Island. IUCN distribution data suggests overlap with the GVFZ RB. Elephant seal tracking data (Fabien et al., 2018) suggest that elephant seals may primarily travel south from Macquarie Island. However, elephant seals have been tracked across GVFZ RB on a number of occasions with some individuals spending some time in the area rather than simply transiting through.

5.2.3 Bycatch of elasmobranchs

No shark or skate bycatch was reported in 2021 or 2022. There are no records in OBIS of skate catch in the GVFZ RB region. Additionally, there are no skate species with predicted distributions in the region (Section 6.4).

A total of 6 shark species were found to have possible distributions over the proposed fished area of the GVFZ RB (Section 6.4). A mix of demersal and pelagic species are identified.

5.2.4 Bycatch of seabirds

Seabird observations were made on both 2021 and 2022 during setting and hauling. In 2021, lines were mostly set at night, and during day setting fewer than 30 birds were noted in any single event, consisting of giant petrels, black- browed albatrosses and cape petrels. In 2022, a more detailed record was made of seabirds observed during setting and hauling, presented in Table 5.

Birds observed have IUCN conservations statuses of either Least Concern (LC) or vulnerable (VU) (Southern Royal and Wandering albatross).

Table 5: Seabirds identified during setting and hauling in 2022.

Species	Common Name	Setting Observations	Hauling Observations	IUCN Status
Daption capense	Cape petrel	157	122	LC
Diomedea epomophora	Southern Royal albatross	0	13	VU
Diomedea exulans	Wandering albatross	76	94	VU
Fulmarus glacialoides	Southern Fulmar	1	2	LC
Macronectes halli	Northern Giant petrel	193	388	LC
Macronectes spp.	Giant petrel	0	25	LC
Pachyptila spp.	Prion	3	14	LC
Thalassarche melanophris	Black-browed albatross	272	114	LC
Total		702	772	

A search of various online data sources (e.g. IUCN, OBIS) indicates that a total of 57 species of seabirds have been identified as overlapping with the GVFZ RB to varying degrees (Section 6.5); birds observed in 2022 are captured in this list.

There is a candidate Important Bird Area (cIBA) in the region the GVFZ research block (Indian Ocean, Antarctic and Southern 52 – Marine, http://datazone.birdlife.org/site/factsheet/indian-ocean-antarctic-and-southern-52--marine-iba-high-seas), proposed on the basis of suggested breeding assemblage between November – April. The depth range within that cIBA ranges from 3354 to 4181m depth.

5.2.5 Benthic habitats and VMEs

The George V Fracture Zone (Sempéré et al., 1996) straddles the Southeast Indian Ridge at approximately 139°E / 53°S. The area is characterised by short chains of seamounts and spreading ridges (Harris et al., 2014) generally rising to approximately 1000m depth (500m depth for the highest seamount), and surround by abyssal hills of approximately 2500m – 3500m depth. Geologically, the area has received a great deal of attention in relation to processes and formations along Southeast Indian Ridge system of active propagating rifts and transform faults, proximity to the Australian-Antarctic Discordance to the west and hydrothermal vent fields along its axis (e.g. Wang et al., 2011). The ridge system extends from the Rodriguez Triple Junction in the West and the Macquarie Triple Junction in the East, which joins further ridge systems to the East and west forming a continuous ridge system between the South Pacific and Atlantic Oceans. This suggests that biologically, the ridge system may be an important feature connecting distinct faunal assemblages of Atlantic and Pacific vent fields (Van Dover et al., 2001; Nakamura et al., 2012).
Herraiz-Borreguero and Rintoul (2011) summarise the circulation and physical properties of the Southern Ocean south of Australia. The region of the GVFZ RB is sandwiched between the Subantarctic Front in the north, and the Polar Front in the south. Eastward flowing Subantarctic Surface Water lies above Antarctic Intermediate Water to a depth of approximately 1500m followed by Antarctic Deep Water to the seabed. The region is characterised by relatively low annual surface productivity, situated between areas of relatively high productivity to the north and south (https://oceancolor.gsfc.nasa.gov).

Very little bycatch of VME indicator taxa was recorded in 2021 and 2022 exploratory fishing periods. VMEs recorded are shown in Table 6 and Table 7. VME move-on rules were not triggered at any time (CMM 03-2023). When physical samples were brought up on the line, observers collected representative living samples and were kept frozen until *Tronio* returned to port. Samples were then photographed and sent to museum specialists for identification and curation.

Table 6: VME indicator taxa bycatch recorded by scientific observers in 2021.

Line	VME Species Code	VME Group name	Weight (kg)	Comments
1	CSS	Scleractinia	0.025	Dead fragment
3	AJZ	Alcyonacea	0.05	
6	AQZ	Antipatharia	0.17	
5	CSS	Scleractinia	0.05	Dead fragment
12	CSS	Scleractinia	0.2	Dead fragment
12	GGW	Gorgoniidae	0.05	
18	GGW	Gorgoniidae	0.05	
18	CSS	Scleractinia	1.3	Dead fragment
21	CSS	Scleractinia	0.05	Dead fragment
23	CSS	Scleractinia	0.05	Broken when coming up to the roller – estimated weight.

Table 7: VME indicator taxa bycatch recorded by scientific observers in 2022. No additional comments were made by observers.

Line	VME Group code	VME Group Name	Weight (kg)
5	CSS	Scleractinia	0.71
7	GGW	Gorgoniidae	0.025
12	CSS	Scleractinia	0.165
15	AQZ	Antipatharia	0.08
28	GGW	Gorgoniidae	0.02
30	AXT	Stylasteridae	2.5
31	AQZ	Antipatharia	0.3
31	CSS	Scleractinia	0.5

Retained samples of VME species were returned to port and photographed and kept frozen (e.g. Figure 14).

Figure 14: VME samples recovered in 2022. Left- Antipatharia. Right – Scleractinia fragment.

Camera video footage of the seabed supports the notion of potentially low VME abundance in the GVFZ RB. Figure 15 shows locations where video footage of the seabed was captured.

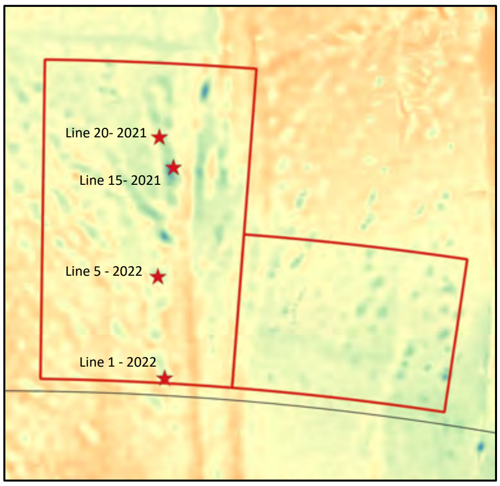


Figure 15: Camera video sites in GVFZ 2021 and 2022 fishing seasons.

Video footage of the seabed indicates the seamount habitat in areas fished is made up of cobble, possibly exposed bedrock, and sand. Few invertebrates were seen on rock surfaces; a small ophiuroid was noted on a rock, and a single small coral, possibly Antipatharia (Figure 16). Larger lithodid crabs were seen at Line 20 in 2021. Chaetognaths and Caridean shrimps were observed swimming through the image field.

Figure 16: Screenshots of video imagry taken at four fished locations in the GVFZ. Depths of lines shown are the average of start and end line setting depths. The bottom image includes a glove accidentally attached to the baited hook during line setting.

Seabed images tend to verify results of VME predictive modelling conducted by others in recent years, where modelling results indicate that the seamounts of the GVFZ RB may have relatively low habitat suitability for VME indicator species. Anderson et al. (2016) found habitat suitability indices of between <0.2-0.4 (range is 0-1) for the GVFZ RB; Tittensor et al. (2009) found decreasing habitat suitability with increasing seamount summit depth (0.6 at 500m depth to near zero probability at 1500m depth); and Davies and Guinotte (2011) predicted zero suitability in a binary model. Most recently, ensemble predictive models based on past modelling and new data were presented to SPRFMO Scientific Committee in 2020 by Australia and New Zealand, which covered the GVFZ RB (SC8-DW07 rev 1). Areas in the GVFZ appear to have relatively low habitat suitability in all VME indicator groups tested. However, the study also notes that environmental data is lacking in the GVFZ area, suggesting lower certainty in the predicted relationship between species occurrence and environmental predictor.

6 Ecological Risk Assessment on Non-target Bycatch

This section is aimed at providing the SPRFMO Scientific Committee (SC) sufficient knowledge to make informed recommendations to the Commission, as required under CMM 13-2021 paragraph 5.

6.1 Methods

The SPRFMO Bottom Fishery Impact Assessment Standard (BFIAS) sets out the hierarchical methodology for identifying Significant Adverse Impacts (SAI) and conducting an ecological risk assessment for effects of fishing (Figure 17). The decision tree is dependent on both the level of information/analysis available as well as the level of unmitigated and mitigated residual risk.

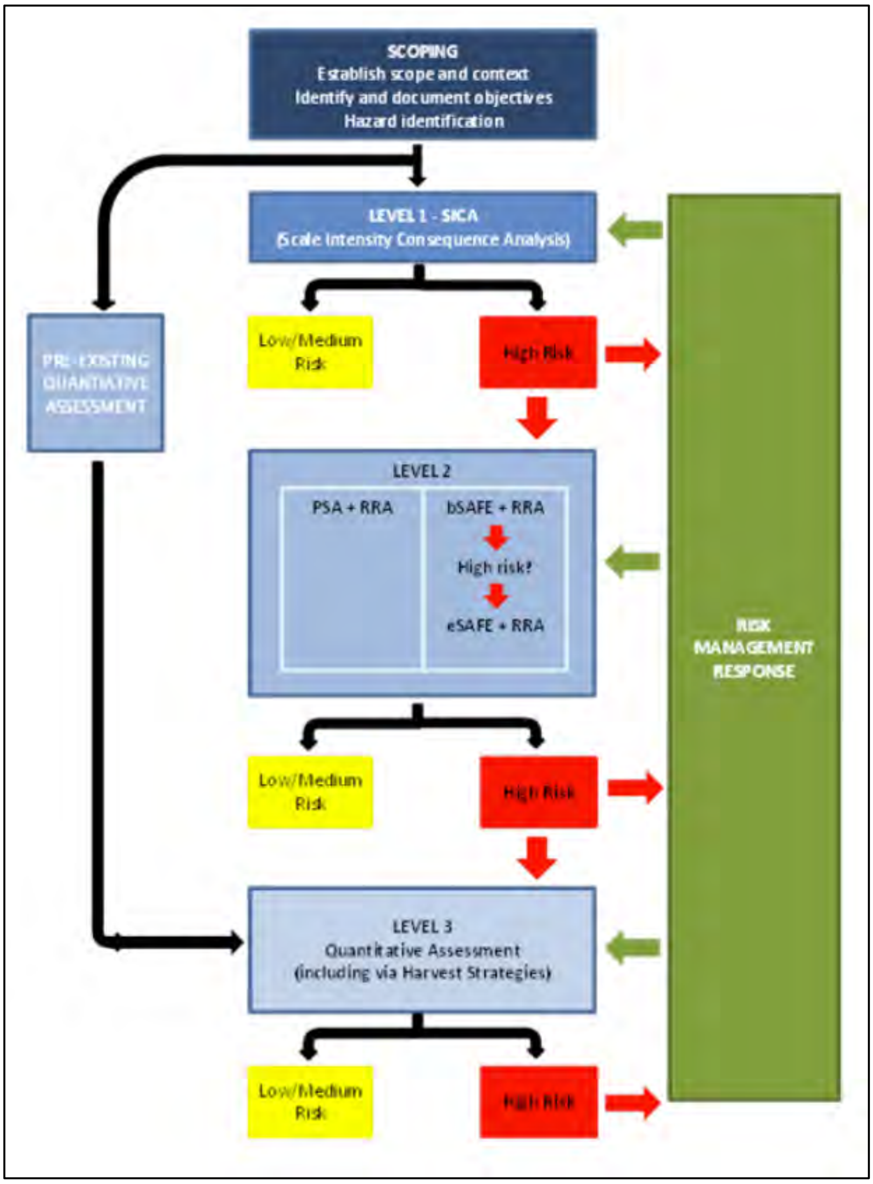


Figure 17: Hierarchical methodology for the Ecological Risk Assessment as set out in the SPRFMO BFIAS.

Scoping. Scope of the current assessment has been described in detail in the previous Sections 3, 4 and 5.

As this is an exploratory fishery in an area not well understood in terms of species presences or abundances, our assessment is limited largely to a Level 1 - SICA (Scale Intensity Consequence Analysis) approach. A qualitative assessment is done incorporating key characteristics of the bycatch species' 'likeliness' and 'consequence' of interactions with demersal longline fishing for toothfish in the GVFZ.

Our SICA process is shown schematically in Figure 18. Data on spatial overlap and catchability is evaluated and given qualitative assignments of 'Low', 'Med', 'High' and combined to form overall risk. Risk Management Response is applied through mitigation, and an RRA (Residual Risk Analysis) was done. Species' IUCN status is used to inform decisions on triggers and actions to be taken for managing risk. Finally, there is a feed-back process for using new knowledge gained to reduce risk through enhanced mitigation.

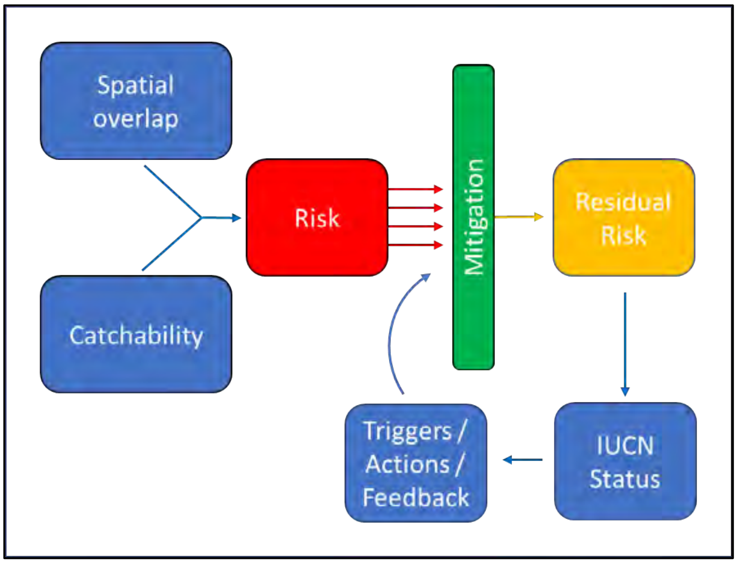


Figure 18: SICA assessment process.

Catchability is considered in the risk assessment. Assuming no mitigation, we assess if the species is susceptible to being caught during demersal longline fishing operations. For seabirds, size, diving behaviour, and other characteristics were considered as gathered from various sources. For non-seabirds, vertical distribution of the species in the water column (either benthic or pelagic) is considered in a relative way; for example, given that the longline is associated with benthic/demersal habitats for long periods (12-16hrs soak time) compared to time spent in the water column during setting and hauling (~6 hrs), higher catchability was applied to benthic/demersal species compared to pelagic species based on longer or shorter exposure times to hooks/gear.

The species' IUCN conservation status is considered in the assessment, acting as a modifier to the above. A more conservative approach to species risk with critical conservation status is taken.

Although seasonality may affect the actual species occurrence at the time of expected fishing in the GVFZ area, an assumption was made that likelihood of impact would be the same in the region despite seasonality, thereby applying the most precautionary assessment.

6.2 Data sources

Data on species observations have been accumulated from the 2021 and 2022 GVFZ fishing campaigns. Additional known and predicted distribution data were gathered from multiple validated online and published sources. Data for taxonomic groups and species were cross validated between multiple sources. Online data sources in include:

- OBIS (Ocean Biogeographic Information Database). OBIS is an open-access web-distributed global atlas of marine biodiversity and biogeographic database, containing georeferenced species occurrence and associated metadata (Grassle, 2000).
- IUCN (www.iucnredlist.org) was used to gather species distribution data using published mapped spatial data (downloaded shape files) and online Threatened Species lists.
- BirdLife International (www.birdlife.org) holds the IUCN distribution shape files and Threatened Species lists for birds.
- Biogeographic Atlas of the Southern Ocean (De Broyer and Koubbi (eds), 2014). A published atlas of Southern Ocean marine species.
- FishBase (www.fishbase.org). A global species database of fish species and mapped predicted distributions via www.aquamaps.org
- Rays of the World (Last et al., 2016)
- Sharks and Rays of Australia (Last and Stevens, 2009)
- Fishes of the Southern Ocean (Gon and Heemstra, 1990)
- Expert opinion from various institutions (SAERI, JNCC, University of St Andrews, Falkland Island Government Fisheries Department)

Species predicted distributions were compared to the fishing area of the GVFZ RB, and a qualitative assessment of likely occurrence overlap was assigned. Qualitative assessment was made on the basis of 1) species observed occurrence in the GVFZ RB region (OBIS data), 2) the assumed distribution (e.g. IUCN) over the GVFZ RB region or if it is at the edge of the assumed range 3) prediction in adjacent areas of similar depth if not observed in the GVFZ RB.

6.3 Non-target fish

Summary Risk

Taxa Group	Spatial overlap	Catchability	Risk
Macrouridae, Moridae,	High	High	High
Other Gadiformes	Medium	Medium	Medium
Other Teleosts	Low or unknown	Low or unknown	Low or unknown
Mitigation			

Precautionary bycatch limit Low number of lines proposed Lines will be set at least 3nm apart from each other, and not set at previous locations.
Residual risk after mitigation
Low

General assessment

In the 2021 and 2022 exploratory fishing campaigns, four species of Macrourids, 1 Morid, and two other Gadoid species were caught in 2021 and 2022 (Section 5.2.1, Table 4). Macrourid catch was highest, but did not exceed trigger levels. Other species were caught in very low amounts.

A large inventory of fish species observed on the GCFZ RB was produced from OBIS data. A total of 37 Families and 115 species/putative species have been recorded in area searched in OBIS. However, the records located within the proposed research block were very few, totalling 7 records including 4 Myctophidae, 1 Gobiidae, and 2 samples of *Dissostichus eleginoides*. Other records for the wide region were predominately small pelagic species.

Sources of risk

Risk to fish bycatch comes from the reduced ability of the population to recover from being captured on hooks. Demersal fish species would be at highest risk. Pelagic species are at risk during line setting and hauling, however this risk is limited due to the line being suspended in the water column for brief periods of time (10s of minutes, less than 1 hour). Fish species also must be large enough to be caught on the hook, which means there is a natural size selection of species that can be caught.

Mitigation

CMM 14e-2023 established a bycatch limit and move-on rule for Macrourus species, stating:

Since Macrourus spp. can be a common by-catch species in other toothfish longline fisheries, as a precaution 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.

This mitigation measure will remain in place. Although catch of other bycatch species caught previously were well below this trigger level, bycatch will be reviewed annually by EU scientists to monitor cumulative impact.

Consequences to populations

After evaluation of spatial overlap, catchability and mitigation, it is considered that the consequences to the non-target fish populations are low with a high likelihood of recovery over short time frames.

After the third year of the current exploratory fishing program, a detailed examination of bycatch will be made. Additional mitigation may be applied if results indicate this requirement.

6.4 Chondrichthyans

SPRFMO SC6-DW08 Risk Assessment for Chondrichthyans

In this assessment for sharks and skates, the risk assessment completed in SC6-DW08 is also considered here in a comparative way. That is to say, the qualitative assessments assigned in this study use some similar concepts as the quantitatively scored, integrated assessment in SC6-DW08 using the PSA and SAFE methods, and therefore any direct use of that assessment here might be confounding.

SC6-DW08 notes that there are both "false positives" and "false negatives" that result in part, from lack of real- world interaction with fishing gears and lack of overall vessel reporting of interactions respectively. In this sense, the assessment for sharks and skates in this study (and indeed all groups assessed here) is made in consideration of possible interactions using a specific gear type (demersal longline) with known bycatch profiles based on other toothfish fisheries, but from a region (GVFZ RB) where there is little available historic longline fishing knowledge.

Summary Risk

Taxa group	Spatial overlap	Catchability	Risk
Skates	Medium	High	Low
Sharks	Medium	High	Medium
Mitigation			
Precautionary bycatch limit Skates are able to be release alive Caveat - Risk assessments are possibly over-precautionary due to limited data.			
Residual risk after mitigation			
Medium			

General assessment

No skates or sharks were caught in the 2021 and 2022 exploratory fishing campaigns. However, considering that skate and shark life histories and ecology makes them particularly susceptible to fishing impacts, these groups will continue to be treated with 'medium' risk after mitigation. Ongoing fishing and data collection is required to determine true risk in this region.

There are no records in OBIS of skate catch in the GVFZ RB region. Additionally, there are no skate species with predicted distributions in the region (Last et al., 2016). A total of 6 shark species were found to have possible distributions over the proposed fished area of the GVFZ RB (Appendix 2). A mix of demersal and pelagic species are identified. Catchability of demersal species were considered to be 'high' whilst pelagic species were considered 'medium' catchability given the shorter time the line is suspended in the water column compared to time on the seabed.

Specific at-risk species

Of the shark species potentially encountered on the GVFZ RB, three are listed as 'VU – Vulnerable', one species as 'NT – Near Threatened', and 2 as 'DD – Data Deficient'. Skate species are not determined.

Included in the compiled list of species potentially encountered in the GVFZ is one CMM 02-2020 (Data standards) Annex 14 species; *Lamna nasus* (Porbeagle shark).

Sources of risk

Risk to skates and sharks comes from the reduced ability of the population to recover from being captured on hooks. Demersal species are at highest risk. Pelagic species are at risk during line setting and hauling, however this risk is limited by the fact that the line is suspended in the water column for brief periods of time (10s of minutes, less than 1 hour).

Mitigation

Skates can often be recovered from the line and released alive, and this will be done in all cases where skates are likely to survive release. In the case of sharks, it is not likely that any will be in such condition to be released alive, particularly the larger species (e.g. some Somniosidae, Lamnidae, Cetorhinidae), however every attempt will be made to release shark species alive where it makes practical sense and there is no risk to crew.

Primary mitigation for reducing risk to chondrichthyans is through precautionary bycatch limits. It is also likely that risk assessments here are over-precautionary, given paucity of available data for most chondrichthyans in SPRFMO and, particularly for demersal longline fishing in the region of the GVFZ RB.

Full biological information will be captured from retained individuals.

Move-on rule

CMM 14e-2023 established a bycatch limit and move-on rule for chondrichthyans species, stating;

If more than 4 individuals of any of the following families Somniosidae, Lamnidae, Cetorhinidae, Alopiidae are caught or if more than 2 individuals of any one of these families of sharks are caught in one haul or set, the vessel shall move on for the duration of the trip, and a next line shall not be set closer than 5 nm from the centre of the preceding line;

If the retained skate by-catch exceeds 5% of the toothfish catch or reaches a maximum of 100 kg in any one haul or set, the vessel will move-on to another location at least 5 nm distant.

Consequences to populations

After evaluation of spatial overlap, catchability and mitigation, it is considered that the consequences to the skate and shark populations are low with a high likelihood of recovery over medium time frames.

6.5 Seabirds

Summary Risk

Taxa Group	Spatial overlap	Catchability	Risk of mortality
Albatrosses	High	High	High
Fulmars	Low	High	High
Petrels	High	Medium	High
Penguins, Prions	Low	Low	Low
Mitigation			
Meets CMM-09-2017 Exceed CMM-09-17; use of 2 x tori lines Meets paragraphs 24 of CMM 14b-2023 (offal discard management) Vessel light management at night Proposed fishing time of year avoids overlap with Short-tailed Shearwater breeding in Candidate IBA			
Residual risk after mitigation			
Low			

General assessment

Due to frequency of night setting and hauling, few detailed seabird observations were made during the 2021 exploratory fishing campaign in the GVFZ. In 2022, seven species of albatross and petrel were observed ranging between 3-81 total individuals per line setting or hauling. Three fulmars were observed (Section 5.2.4, Table 5 for total numbers). Of note is the occurrence of *Diomedea epomophora* (Southern Royal albatross), and *Diomedea exulans* (Wandering albatross) which are listed as Vulnerable (VU) by the IUCN. No mortalities were observed in the 2021 or 2022 exploratory fishing campaigns in the GVFZ.

A total of 57 seabirds were identified as overlapping with the GVFZ to varying degrees in the OBIS record (Appendix 3). There is a candidate Important Bird Area (cIBA) in the region the GVFZ research block (Indian Ocean, Antarctic and Southern 52 – Marine, http://datazone.birdlife.org/site/factsheet/indian-ocean-antarctic-and-southern-52- -marine-iba-high-seas), proposed on the basis of suggested breeding assemblage between November – April. The depth range within the cIBA ranges from 3354 to 4181m depth.

Sources of risk

Seabirds interact with deep-set longline vessels in a number of ways. At the surface, birds are attracted to baited hooks during line setting at the stern of the vessel, where some species may be caught at the surface only (e.g. most albatrosses) or underwater if the species is able to dive and chase baited hooks while descending (e.g. white chinned petrels). During line hauling, birds are attracted to the starboard side of the vessel nearest the hauling bay with the risk again being caught by hooks while attempting to feed on bait. At-risk seabirds are therefore those larger seabirds that are able to feed on squid and herring bait.

Birds striking the vessel itself, so called light-strike, may be a risk particularly at night when vessel lights can attract seabirds from a great distance. This would be a risk primarily to smaller birds or juveniles rather than larger adult albatross species, storm petrels and prions. Although this is not necessarily bycatch, it is related to ship fishing operations.

Mitigation

Taking note of CMM 09-2017, and particularly the specifications in Annex 1, the *FV Tronio* is able to comply fully with all aspects. The bird mitigation devices themselves are detailed below. Officers and crew in collaboration with onboard Compliance officers and Scientific Observers have refined some practical aspects of the devices to best suit the vessel. Figure 19 details the streamer line system deployed during each setting as in place on the vessel since 2017, and which it still uses currently. Figure 20 and Figure 21 show two types of towed devices. The device as shown in Figure 21 shows some of the latest improvements. Note that CCAMLR specifies a single Bird Scaring line, whereas the *Tronio* deploys a Double BSL.

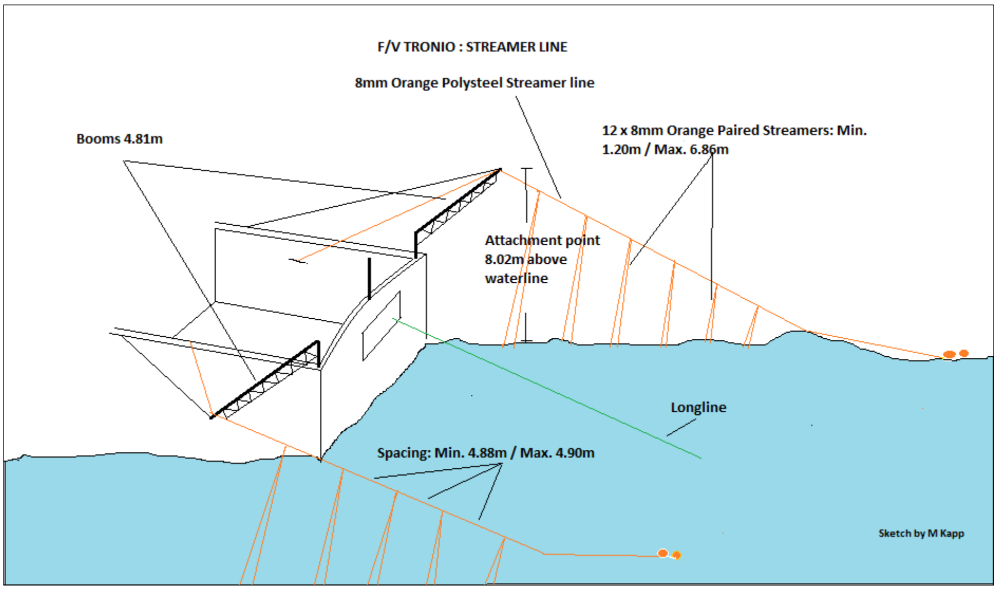


Figure 19: Streamer line alignment during setting.

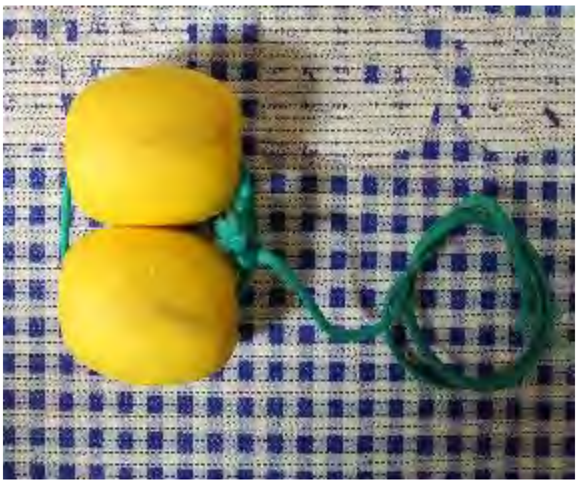


Figure 20: Towed device option 1

Figure 21: Towed device option 2, providing additional drag

Seabird interactions during hauling are mitigated against in a number of ways. Firstly, the vessel always deploys a Bird Exclusion Device (BED) around the hauling bay to deter any seabird interaction with the line as shown in Figure 22.

Discard management will meet paragraph 24 of CMM 14b-2023, specifically:

a) no dumping of offal while lines are being set or hauled,
b) any offal or discards shall be macerated prior to discarding.
c) discarding shall take place only at the end of haul or while steaming; and no biological material shall be discarded for at least 30 minutes before the start of any set or during any set, and
d) discarding will only take place from the opposite side to the hauling position.

The *FV Tronio* has the ability to meet CCAMLR CM 26-01 (2022), which requires offal/discard storage and prohibits dumping of this south of 60°S.

Paragraph 6 of CCAMLR CM 25-02 (2018) requires hook removal from by-catch and discard species and this is standard practice on the vessel.

Figure 22: FV Tronio bird exclusion device (BED) around the hauling bay.

Management of light emission from vessel at night will be done to avoid vessel-strike, reducing the use of light to the minimum required for safety reasons.

SPRFMO CMM 09-2017 sets a trigger level of 0.01 birds/1000 hooks before additional mitigation measures must be made. In the instance of exceeding this limit, an evaluation of mitigation measures will be made, including ensuring correct deployment of mitigation, and strengthening mitigation where possible (e.g. further reducing night hours of setting).

Consequences to populations
After evaluation of spatial overlap, catchability and mitigation, it is considered that the consequences to the seabird populations are very low with a high likelihood of recovery over short time frames.

6.6 Marine mammals

Summary Risk

Taxa Group	Spatial overlap	Catchability	Risk
Whales	High	Low	Low
Dolphins	High	Low	Low
Otariids	High	Low	Low
Phocids	High	Medium	Medium
Mitigation			
Meets paragraphs 24 of CMM 14b-2023 (offal discard management) Avoidance of areas of visible mammal activity Elephant seals may have limited distribution in the GVFZ RB during proposed fishing period. Fishing planned for November - likely low Elephant seal encounters			
Residual risk after mitigation			
Low			

General assessment
No mammals were caught of observed during the 2021 or 2022 exploratory fishing campaigns in the GVFZ.

A total of 30 marine mammals were identified as overlapping with the GVFZ RB to varying degrees (Appendix 4).

The majority of whale species have a high degree of potential overlap with the GVFZ RB region. Whales are likely to be at risk at or near the surface during setting or hauling, where entanglement would likely result in injury or drowning. Catchability of whales is thought to be very low and varies with species (Werner et al., 2015). Orcas and Sperm whales have a very high degree of association with toothfish longline vessels, where interactions are more damaging economically to the vessel in terms of lost or damaged gear and depredation of catch off the line. Damage to individuals may occur, with mortalities low to near-zero. Similarly, dolphin mortalities are thought to be very rare among toothfish longline vessels.

Otariid seals have been associated with toothfish longline vessels and have been observed to depredate on catch. Mortalities of fur seal and sea lions in relation to toothfish fishing appear to be very rare.

Specific at-risk species

Southern Elephant (*Mirounga leonina*) seals may be at risk to incidental mortality, as has been found in other regions. Van Den Hoff, Kilpatrick and Welsford (2017) summarise recent and historic reports of Elephant seal bycatch. These reports include video evidence of interactions with caught toothfish on the seabed as well as reports made by Scientific Observers of Elephant seal mortalities by drowning related to longline fishing.

Elephant seals can dive for up to 2h to depths over 1500m and bottom times of up to 15mins at deep depths. Males tend to dive deeper (down to ~2000m) compared to females (~800m) (Prof. Mike Fedak pers. com). Elephant seals are known to travel thousands of kilometres on 10-month long foraging trips (Hindell et al., 2016). The closest colony to the GVFZ is on Macquarie Island. IUCN distribution data suggest overlap with the GVFZ RB. Elephant seal tracking data (Fabien et al., 2018) suggest that elephant seals may primarily travel south from Macquarie Island However, elephant seals have been tracked across GVFZ RB on a number of occasions with some individuals spending some time in the area rather than simply transiting through (Figure 23).

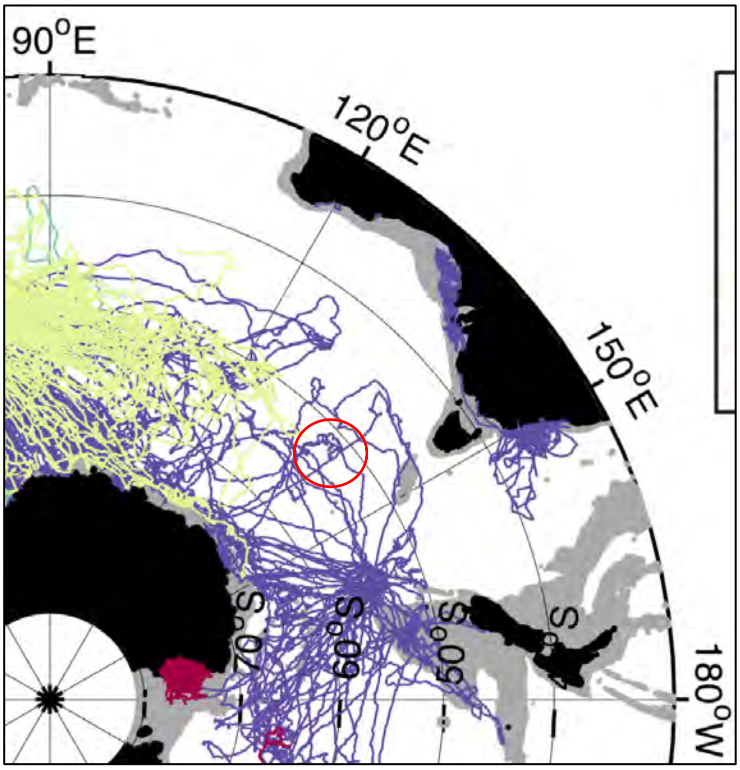


Figure 23: Elephant seal tracking data from Fabien et al. (2018), cropped to focus on the GVFZ RB (red circle). Dataset is MEOP-CTD SH dataset: 387893 profiles, 122 deployments, 891 tags.

IUCN listing for all seals are "LC – Least Concern". Among whale species Fin, Sei, and Blue whales are listed as "EN – Endangered". Sperm whales are listed as "VU – Vulnerable", 5 species listed as "LC – Least Concern" or less, and 12 species listed as "DD – Data Deficient". Dolphins are listed as either "LC- Least Concern" (4), or "DD- Data deficient" (3).

Sources of risk
Risk to mammals comes from entanglement in the longline leading to drowning. If caught, it is highly unlikely that the animal can be recovered and set free. However, entanglement is very rare among all groups.

Mitigation
Few mitigation measures have been recommended to avoid marine mammal by-catch. In the case of Orcas and Sperm whales, the vessel will naturally aim to avoid interactions due to depredation behaviour of toothfish, characteristic of these species. Seasonal avoidance has been recommended for depredation mitigation and may also be effective for reducing by-catch among other species. Pre-setting and hauling assessments of mammal abundance in the vicinity will be done, and judgement will be made on a case-by-case basis as to whether vessel avoidance is necessary.

In the case of Elephant seals, there have been no effective mitigation measures recommended for avoiding elephant seal by-catch due in part, to their deep and long-duration diving capabilities. Seasonal avoidance is suggested, where fishing could be conducted in September-November when adult seals are primarily ashore (Van den Hoff et al., 2017).

Any seal or whale by-catch will trigger a re-evaluation of fishing strategy.

In the very unlikely case of a whale entanglement and possible mortality as a result, prior to all subsequent lines being hauled a one-hour observation period will be conducted to ensure no whales are present.

Consequences to populations
After evaluation of spatial overlap, catchability and mitigation, it is considered that the consequences to the mammal populations are low with a high likelihood of recovery over medium time frames.

6.7 VME

Summary Risk

Taxa Group	Spatial overlap	Catchability	Risk
All VME indicator taxa	Medium	High (damaged on seabed)	Medium
Mitigation			
Limited impact of longline footprint 3nm separation between lines Limited benthic camera observations suggest few VMEs Observations partly validate low model prediction of VME habitat in the area Spatial overlap of line setting in subsequent years will be dependent on the previous year’s review, with the aim of eliminating cumulative effects			
Residual risk after mitigation			
Low			

General assessment

Very small amounts of VME indicator taxa have been brought up on lines during past exploratory fishing in the GVFZ (Section 5.2.5, Table 6, Table 7). A total of four VME taxa groups have been collected from 8 out of 27 lines in 2021 and 8 out of 32 lines in 2022. Weights were very low and did not meet any trigger levels (CMM 03-2023 paragraph 28).

OBIS data were used to compile an inventory of possible VME species that will be encountered in the GVFZ RB. Very few records were found, with a total of 19 benthic invertebrate species (and putative species) recorded. There were only four records of benthic species within the GVFZ RB, and of these, these were found at depths greater than 2500m depth. There have been VME species encountered in the area (L. Georgeson pers. com), and these records have been requested from the Australian authorities.

The small amount of VME recovered from lines as well as seabed images collected during the 2021 and 2022 exploratory fishing campaigns tend to verify results of VME predictive modelling conducted by others in recent years, where modelling results indicate that the seamounts of the GVFZ RB may have relatively low habitat suitability for VME indicator species. Anderson et al. (2016) found habitat suitability indices of between <0.2-0.4 (range is 0-1) for the GVFZ RB; Tittensor et al. (2009) found decreasing habitat suitability with increasing seamount summit depth (0.6 at 500m depth to near zero probability at 1500m depth); and Davies and Guinotte (2011) predicted zero suitability in a binary model. Most recently, ensemble predictive models based on past modelling and new data were presented to SPRFMO Scientific Committee in 2020 by Australia and New Zealand, which covered the GVFZ RB (SC8-DW07 rev 1). Areas in the GVFZ appear to have relatively low habitat suitability in all VME indicator groups tested. However, the study also notes that environmental data is lacking for the GVFZ area, suggesting lower certainty in the predicted relationship between species occurrence and environmental predictor.

Specific at-risk species

Many studies (e.g. Parker et al., 2009) have identified certain invertebrate groups (Orders, Families) that are either sensitive to demersal longline fishing or are indicators of sensitive habitats. Specific species have not been identified as being particularly at-risk, but broadly include those species that form hard structures or frameworks, and with slow recovery potential.

Sources of risk

It should be prudently assumed that VME indicator species will be impacted by demersal longline fishing through mechanical impact from anchors, weights, hooks, and the line but not necessarily by detecting by organisms being brought up on the line. Impact on VMEs from trawl fisheries is mitigated by triggering move-on rules based on catch weights. Challenges in prescribing similar VME management tools for demersal longline fisheries have been identified, primarily related to the lack of comparative longline-derived VME catch and effort data, and the likely low detection rate of VME indicator species when using demersal longline fishing gear.

The footprint of a demersal longline is thought to be relatively low (BFIA SWG-10-DW-01A). This combined with the low number of lines being set across a large spatial extent will ensure low local impact as well as ensure short-term recoverability of impacted habitat. In addition, it is proposed that each line set will be at least 3nm apart (measured from the mid-point of each line). In addition, lines set positions in subsequent years will not overlap previous year line setting positions depending on an annual review of VME indicator species catch and evidence from seabed video monitoring. This will ensure that there are no risks of cumulative impacts on VME, satisfying paragraph 22 of CMM 03-2023.

Mitigation

The potential impact of the longline is considered to be low (BFIAS SWG-10-DW-01A). The Spanish system minimizes contact between the main line and seabed due to its positive buoyancy. Contact may be increased by other factors such as longitudinal movement of the main line over the seabed during hauling, or lateral (sweeping) movements of the main line and hooks during hauling. Movement of the fishing gear may occur in the presence of strong currents.

According to Sharp et al. (2009) and Welsford et al. (2014), longline movement on the seabed occurs mainly during hauling. Studies using video cameras attached to the gear show that there is lateral movement of the line over the seabed during the first phase of hauling where there is an inverse relationship between gear depth and lateral movement of the mainline and the hooks. These studies have been carried out on autoline fishing systems where the entire line lies on the seabed. In the case of Spanish longlines, both hauling and main line have positive buoyancy: only the anchor and weights (between 6 and 9 kg) joined to the hauling line are in direct contact with the seabed (although this may be unlikely at all times). Thus, there may be lateral movement of the gear during hauling, but its impact is expected to be smaller compared to autoline systems. Recent work in the Falkland Islands corroborates the notion of limited seabed impact by seabed longline fishing gear, where initial estimates of seabed contact were in the order of 10s -100s of meters in the immediate vicinity of the longline (Brewin et al., 2020).

The footprint for the Spanish longline system needs a more nuanced evaluation since, the gear having positive buoyancy, most of the gear does not touch the sea bottom. The parts of the gear that will have a direct impact on the bottom are:

1. The weights used as ballast.
2. The anchors and chains used for anchoring both ends of the gear.

The impact of these two parts on the seabed is due to crushing on impact at the time of setting, and also potentially being dragged limited distances along seabed at the time of hauling. Movement of these while on the seabed is considered to be very limited.

3. Hooks and lines should hang above the seabed with mostly only drop weights coming in contact with the seabed. However, in practice hooks and lines also may come in contact with the seabed as evidenced from invertebrates often being caught on lines and/or hooks. This may be due to variable tensioning on the line, uneven topography, or currents causing drag on the fishing gear. As such, although not likely to be the case 100% of the time, a precautionary assumption would be that the entire longline will at some point, come in contact to the seabed during setting, fishing, and hauling periods.

The *FV Tronio* has a broad experience working in the CCAMLR Convention Area where different CMs are in place regarding VME potential encounters (CCAMLR, CMs 22-06 and 22-07).

CMM 03-2023 para 28 requires vessels to cease bottom fishing activities within one nautical miles of any location where evidence of a VME is encountered in the course of fishing activities, and to report the encounter, so that appropriate conservation measures can be adopted in respect of the relevant site. However, no move-on rule is applicable to the current proposed fishing plan because all lines will be set at minimum 3nm apart (measured from the mid-point of the line) as part of the Fisheries Operation Plan.

Consequences to populations

After evaluation of spatial overlap, catchability and mitigation, it is considered that the consequences to the VME populations are low with a high likelihood of recovery over medium time frames, and over small spatial scales.

6.8 Additional impact of longline fishing activity

Gear Loss

Gear loss or parts of it is very infrequent. We estimate that 1% to 2% of the total number of hooks may be lost, but most are loose hooks without any line, hence they may have limited impact on benthic organisms. Line breakage can occur during hauling, but typically does not result in gear loss because the line can be hauled from either end of the longline. In 2021, there were 6 line breakages during hauling out of 27 lines (SFL 2022), and in 2022, there were 2 out of 32 lines broken during hauling (SFL 2023). All gear was recovered.

Mitigation for line breakage can be done in places with a higher risk of line breakage or loss (e.g. ice, strong currents and tides), where the line set is usually shorter and the number of lines set at any one time is also smaller, therefore limiting gear loss. The occasions in which gear is lost are due to loss of the main buoy with radio beacon. Although challenging, in those instances recovery of lost lines has been achieved through a grapnel system to try and recover all or part of the line.

Impact on other relevant fisheries

There are two Australian Patagonian Toothfish fisheries that are prosecuted in their territories such as the Heard Island and McDonald Islands Fishery and the Macquarie Island fishery of which the latter is the nearest: the Heard and McDonald Island EEZ is some 2066+nm to the West of the GVFZ RB, whereas the Macquarie Island EEZ is some 1500nm to the East GVFZ RB. The Macquarie Island Patagonian Toothfish fishery dates back to the mid 1990s and has been a certified MSC fishery since 2012 (https://fisheries.msc.org/en/fisheries/macquarie-island-mi-toothfish/@@view). The annual TAC for this fishery has up until the 2018/19 season been 450t (http://www.afma.gov.au/fisheries/macquarie-island-fishery/), but has since been increased to 555t (https://www.legislation.gov.au/Details/F2020L00286) for the years 2020/21 and 2021/22 22 and 635t for the years 2022/23 and 2023/24. Given the distances involved between the GVFZ RB and the two nearest regulated toothfish fisheries mentioned it is unlikely that there will be impact on the toothfish stocks in either the Heard Island and McDonald Islands Fishery and the Macquarie Island fishery fisheries. Six tagged fish originally tagged in the Macquarie fishery have been recovered in the GVFZ during the current exploratory fishing campaign, suggesting at least some connectivity between the two regions. Although other tagging studies have also shown such occasional long distances migration, the majority of migration in other *D. eleginoides* fisheries suggest this to be an exception to the rule, with migration limited to less than 50km in the Falklands region (Brown et al., 2013), and most fish less than 20km in the South Georgia region (Marlow et al., 2003). The proposed collection of DNA and geochemical samples in the present study may help establish whether any and what regional connectivity between populations exists.

Trophic impact
Toothfish are a higher trophic level predator, and the only likely natural predators are elephant seals and sperm whales (reviewed in Collins et al., 2010; Hanchet et al., 2015). Evidence shows that Elephant seals and Sperm whales will prey on toothfish (Slip, 1995; Collins et al., 2010; Hanchet et al., 2015). However, dependence on toothfish in their diet is likely to be low. Given the low potential extraction of toothfish in this proposed survey, there is low likelihood of any impacts on dependent or related species.

7 Data Collection Plan

For the Fisheries Operation Plan period, the data collection referred to below are proposed for collection in addition to other elements that the Scientific Committee might develop in accordance with paragraph 9 of CMM 13-2021.

The *FV Tronio* will fulfil the data to be collected detailed in CMM 02-2022, and specifically those included in Annex 3 (Standard for Bottom long lining fishing activity data) and a number of sections from Annex 7 (Standard for Observer Data):

Annex 7
Section A: Vessel & Observer Data to be Collected for Each Observer Trip
Section D: Catch & Effort Data to be Collected for Bottom Long Line Fishing Activity
Section E: Length-Frequency Data to Be Collected
Section F: Biological Sampling to be Conducted
Section G: Data to be Collected on Incidental Captures of seabirds, mammals, reptiles (turtles) and other species of concern
Section H: Detection of Fishing in Association with Vulnerable Marine Ecosystems (where relevant for long lining)and
Section I: Data to be collected for all Tag Recoveries.

The *FV Tronio* will comply with SPRFMO data collection requirements regarding standardized seabird, and marine mammal observations and other data recordings and opportunistic observations.

Sufficient data will be collected with the aim of establishing baselines to build future monitoring and mitigation, as required under paragraphs 10 and 24 of CMM 13-2021, and to assist the SC in providing recommendations to the Commission under the primary objective of CMM 03-2023 and CMM-03a-2023, as well as and Annex 7 of CMM 03-2023.

All set and hauled lines (for which detailed start/end position, depths, date/time of start/end setting and start/end hauling, duration, bait type, etc. is recorded) the catch will be assessed for the following (responsible parties in brackets):

1. Identification of the entire catch (target and by-catch species of fish, skates and rays, mammals, sharks, seabirds) by species to the lowest possible taxonomic level. (crew with assistance from CapFish Compliance Officer/Observer).

2. Weight and number of all specimens of all species. (crew as directed by the Compliance Officer/Observer)

3. Representative random biological sampling of each fish species detailing size, weight (sub-samples), sex, maturity. A suggested representative sampling rate of catches could be 50 toothfish and any by-catch species per line (Compliance officer/Observer and National observer).

4. Tagging of toothfish at a rate of 5 fish per 1t per toothfish species. Acknowledging the MoU between SPRFMO and CCAMLR (SC-04-DW-01, "Collaboration between CCAMLR and SPRFMO in respect of Toothfish), CCAMLR tags will be obtained and used during this exploratory period (Compliance officer/Observer and National observer).

5. Collection of representative samples for ageing and other requirements of the target species. (Compliance officer/Observer and National observer)

6. Checking and confirmation of previously established Conversion Factors (to calculate green weight) already employed for Patagonian and Antarctic Toothfish.

7. Identification (to the lowest taxonomic level possible) and quantification of any potential VME species adopting the same protocols as those in place within CCAMLR waters. Unless provided with alternative material by the SPRFMO SC, the company proposes to use CCAMLR VME identification guides. The total benthos recovered will be registered for each line. VME indicator units for each line segment and the midpoint of each line segment on all lines, including zero catches, should be reported in the fine-scale data. (Compliance Officer/Observer and National Observer)

8. Regular (daily) deployment of underwater camera with light system for recording of benthic habitat (Figure 24). This is to record data on:
   a) VME identification and benthic habitat
   b) Impact of the longline on the seabed
   c) Any predator/prey interactions

   (Compliance Officer/Observer and National Observer)

9. Collection of representative samples (frozen or DNA samples or both) of VME species for interested institutes, such as Museum Victoria. (Compliance Officer/Observer and National Observer).

10. Collection of representative samples (frozen or DNA samples or both) of fish, skate and shark species for institutes such as Museum Victoria. (Compliance Officer/Observer and National Observer).

11. Representative collection of tissue samples for DNA (SNP) analysis from Patagonian/Antarctic Toothfish, to allow for comparison with other Patagonian/Antarctic Toothfish stocks. (Compliance Officer/Observer and National Observer).

12. Collection of whole Patagonian toothfish for taxonomic/morphological analysis.

13. Seabird/mammal observer tasks will be carried out. These include recording at each setting and hauling the species, number present, and interaction levels. If pinniped mortalities occur, whisker, teeth and DNA samples will be collected, if possible, the animal will be kept for future necropsy. (Compliance Officer/Observer and National Observer)

14. Monitoring of light strikes. Daily checking of all deck spaces to monitor and log strikes, detailing species and condition. (Crew, Compliance Officer/Observer and National Observer)

15. Following paragraph Section G Annex 7 CMM02-2022, we will identify and photograph all captured shark species

16. If sharks and skates are alive, they will be returned to sea with least possible damage and if possible, hooks removed. Animals with low chance of survival will be retained for sampling, including representative DNA samples for ID.

17. Oceanographic data – Starr-Oddi CTD deployment on at least 50% of the lines.

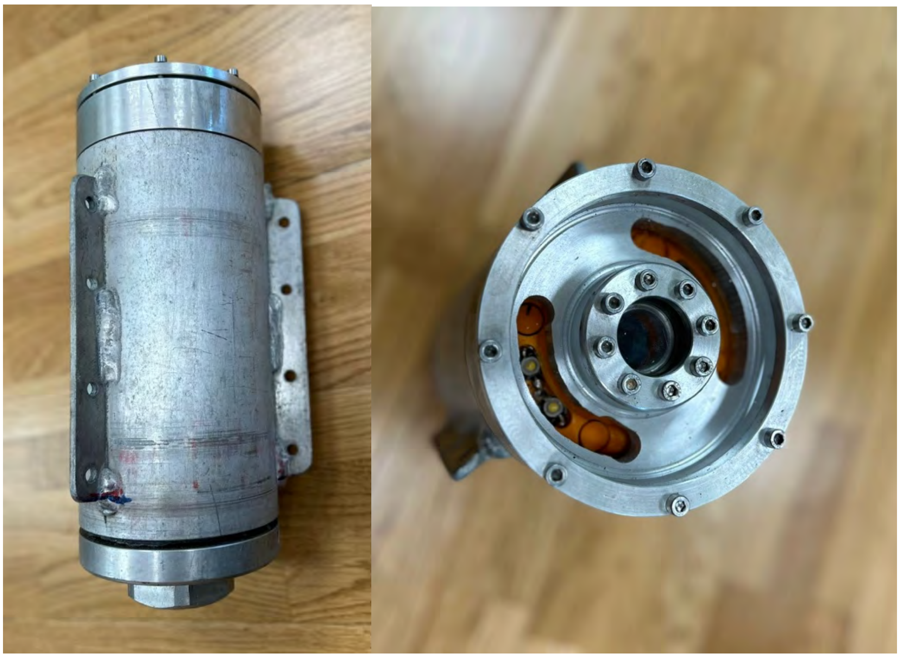


Figure 24: Benthic camera system deploye on longline. Camera system incldudes Akaso Brave 4 Pro (https://www.akasotech.com/product/brave-4-pro) and battery pack 2x Li-Po 11,5V 8A/h powering 4x 3Watt LED lights.

Science Team
The science team will be instructed and guided by the Company's general manager, Joost Pompert, who has over 25 years of experience in at sea commercial fisheries science activities, and also took part in the survey on the South Tasman Rise in Oct-Nov 2019. An experienced toothfish/longline observer will be contracted through Capricorn Fisheries Monitoring CC (www.capfish.co.za). A National Observer will also be on board for the duration of the voyage. Factory and hauling crew will be tasked as appropriate.

8 Post-Survey Science Reporting

The purpose of collecting the data as outlined above is to meet all the SPRFMO data collection requirements, which, inter alia, will advise the SPRFMO Commission on spatial management and sustainable catch levels in the GVFZ RB.

In the case of shark catches, we will aim to fill two main data gaps as identified in SC6-DW08, namely:

a) “Note that the assessment has highlighted that additional work on post capture mortality and gear selectivity of deep-water chondrichthyans would aid future analyses and inform potential future mitigation strategies that would minimise risk associated with susceptibility.”
b) “Recommend to the SPRFMO Commission that identification protocols and biological data collection for deepwater chondrichthyans is strengthened for SPRFMO demersal fisheries.”

In the case of VMEs, data will be collected to fill knowledge gaps as identified in Section 6 of SC6-DW09, specifically “Note that insufficient data from bottom longline fisheries exists to develop a data-informed move-on rule for that method”.

- VME data collection will help to develop VME maps for the SPRFMO area as required under CMM 03-2023.
- Provide data to develop alternative VME threshold methods for demersal longlines such as the incorporation of a biodiversity component, as described in Section 2.6 of SC6-DW09.
- A deep-water video camera will be used to examine species occurrence, density and species / habitat relationships,), as recommended by the BFIAS. In addition, the real-world impact of demersal longline fishing on VME species and habitats will assessed.
- Environmental data will be collected (Conductivity, Temperature, Depth) to be incorporated into regional predictive modelling, as recommended by the BFIAS, and where appropriate.

In addition to the mandatory reporting of data to the SPRFMO Secretariat (CMM 02-2022), analyses of supplementary data and samples collected on the first year’s survey will be treated in the following manner:

Data Analyses	Responsibility	Delivery date
Catch and by-catch data, tagging details	Georgia Seafoods ltd./SAERI (Falklands) Ltd./IEO Spain	60 days before the next SC meeting
VME mapping/spatial analyses	SAERI (Falklands) Ltd.	60 days before the next SC meeting
Deepwater Camera footage	SAERI (Falklands) Ltd.	60 days before the next SC meeting
DNA samples	Prof Stuart Piertney	University of Aberdeen
Taxonomic/Morphometrics	Dr Paul Brickle	SAERI
VME and fish samples	Museums Victoria	TBC

As this proposal covers a period of three years 2024-2026, it is envisaged that 3 annual reports will be submitted to the SPRFMO SC, with a final more comprehensive report following the third survey.

This third report will include detail as above from the entire period 2024-2026. Furthermore, it is envisaged that an approach to assessing stock size can be attempted using these data. This should provide information sufficient for the SC to be alerted to any sustainability concerns and what, if any, additional measures might be required to restrict the potential bycatch of deep-water sharks or other non-target species.

The company, in collaboration with their environmental consultants (SAERI (Falklands) Ltd) (SFL), https://www.south-atlantic-research.org/sfl, based in the Falkland Islands) have been engaged to provide the detail at the next Scientific Committee meeting following the initial survey, providing detail on the presence of the target species, by-catch species, as well as any encounters with VME species. Any fishing impact will be established through the data and imagery collected during this period, and this will be reported on. SFL employs a benthic ecologist (Dr. Paul Brewin) whom will be leading on the analyses. The toothfish DNA samples will be sequenced at University of Aberdeen Otago University under contract with Prof. Stuart Piertney (https://www.researchgate.net/profile/Stuart-Piertney). The results will be published in a peer-reviewed journal. Tootfhish morphological comparisons will be made by Dr Paul Brickle (SAERI) using whole fish.

Museums Victoria (Melanie Mackenzie, Collection Manager, Marine Invertebrates) has agreed to receive all VME samples for curation and identification.

Museums Victoria (Dr. Martin Gomon, Senior Curator, Ichthyology) has agreed to receive any fish specimens to enhance their coverage of the Australasian region.

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Appendix 1 - Preliminary Assessment 2021_22 - Exploratory-Toothfish-EU.pdf

Appendix 2 – Chondrichtyans recorded in online and published sources for the GVFZ.

Group	Species	common name	IUCN status	Habitat	Spatial Overlap	Catchability	Risk	Residual Risk	SC6-DW08 assessment (PSA / SAFE)
Skates	*Rajiformes*	Skates	-	Demersal	Unknown	High	Medium	Low	Low / Low
Sharks									
Alopiidae (Thresher sharks)	*Alopias vulpinus*	Thresher shark	VU	Pelagic	High	Medium	Med-High	Low-Med	Low / Med
Lamnidae (Mackerel sharks)	*Lamna nasus*	Porbeagle	VU	Pelagic	High	Medium	Med-High	Low-Med	Med / Low
Somniosidae (Sleeper sharks)	*Scymnodalatias albicauda*	Whitetail dogfish	DD	Pelagic	Med-High	Med	Med	Low	Med / Low
	Somniosus antarcticus	Southern sleeper shark	DD	Pelagic	Med-High	Med	Med	Low	Med / High
Carcharhinidae (Whaler sharks)	*Prionace glauca*	Blue shark	NT	Pelagic	Low-Med	Med	Medium	Low	Low / Low
Triakidae (Houndsharks)	*Galeorhinus galeus*	School shark	VU	Pelagic	Low	Med	Medium	Low	Med / Low

Appendix 3 – Seabirds recorded in online and published sources for the GVFZ.

Group	Species	common name	IUCN status	Spatial Overlap	Hooked during setting	Hooked during hauling	Light strike	Risk	Residual Risk
Penguins	*Aptenodytes forsteri*	Emperor Penguin	NT	Medium	Low	Low	Low	Low	Low
	Aptenodytes patagonicus	King Penguin	LC	Low	Low	Low	Low	Low	Low
	Eudyptes chrysocome	Southern Rockhopper Penguin	VU	Low	Low	Low	Low	Low	Low
	Eudyptes chrysolophus	Macaroni Penguins	VU	Low	Low	Low	Low	Low	Low
	Eudyptes schlegeli	Royal Penguins	NT	Low	Low	Low	Low	Low	Low
	Eudyptes pachyrhynchus	Fiordland Penguin	VU	Low	Low	Low	Low	Low	Low
	Eudyptes robustus	Snares Penguin	VU	Low	Low	Low	Low	Low	Low
	Eudyptes sclateri	Erect-crested	EN	Low	Low	Low	Low	Low	Low
	Pygoscelis papua	Gentoo Penguin	LC	Medium	Low	Low	Low	Low	Low

Albatross	*Diomedea exulans*	Wandering Albatross	VU	High	Med	High	Med	Med-High	Low
	Diomedea epomophora	Southern Royal	VU	Medium	Med	High	Med	Med-High	Low
	Diomedea sanfordi	Northern Royal Albatross	EN	Medium	Med	High	Med	Med-High	Low
	Thalassarche melanophris	Black-browed Albatross	LC	High	High	High	Med	Med-High	Low
	Thalassarche chrysostoma	Grey-headed Albatross	EN	High	High	High	Med	Med-High	Low
	Thalassarche carteri	Indian Albatross	EN	Low	High	High	Med	Med-High	Low
	Thalassarche chlororhynchos	Atlantic Yellow-nosed Albatross	EN	Low	High	High	Med	Med-High	Low
	Thalassarche salvini	Salvin's Albatross	VU	Low	High	High	Med	Med-High	Low
	Thalassarche cauta	Shy Albatross	NT	Medium	High	High	Med	Med-High	Low
	Thalassarche bulleri	Buller's Albatross	NT	Low	High	High	Med	Med-High	Low
	Thalassarche impavida	Campbell Albatross	VU	Medium	High	High	Med	Med-High	Low
	Phoebetria palpebrata	Light-mantled Albatross	NT	High	Med	Med	Med	Med-High	Low
	Phoebetria fusca	Sooty Albatross	EN	Med-High	Med	Med	Med	Med-High	Low
Fulmar	*Fulmarus glacialoides*	Southern fulmar	LC	High	Med	High	Med	Med-High	Low
Petrel	*Daption capense*	Cape Petrel	LC	High	Med	High	Med	Med-High	Low
	Thalassoica antarctica	Antarctic Petrel	LC	High	Low	Low	High	Medium	Low
	Aphrodroma brevirostris	Kerguelen Petrel	LC	High	Low	Low	High	Medium	Low
	Pterodroma lessonii	White-headed Petrel	LC	High	Low	Low	High	Medium	Low
	Pterodroma macroptera	Great-winged Petrel	LC	Med-High	Low	Low	High	Medium	Low
	Pterodroma mollis	Soft-plumaged Petrel	LC	Med-High	Low	Low	High	Medium	Low
	Pterodroma leucoptera	White-winged Petrel	VU	High	Low	Low	High	Medium	Low
	Pterodroma inexpectata	Mottled Petrel	NT	High	Low	Low	High	Medium	Low
	Pterodroma cookii	Cook's Petrel	VU	Low	Low	Low	High	Medium	Low
	Procellaria aequinoctialis	White-chinned Petrel	VU	High	High	High	Low	High	Low
	Procellaria parkinsoni	Black Petrel	VU	Low	High	High	Low	High	Low
	Procellaria cinerea	Grey Petrel	NT	Med-High	High	High	Low	High	Low
	Procellaria westlandica	Westland Petrel	EN	Low	High	High	Low	High	Low
	Halobaena caerulea	Blue Petrel	LC	High	Low	Low	High	High	Medium

	Oceanites oceanicus	Wilson's Storm Petrel	LC	High	Low	Low	High	Low	Medium
	Fregetta tropica	Black-bellied Storm Petrel	LC	High	Low	Low	High	Low	Medium
	Garrodia nereis	Grey-backed Storm Petrel	LC	Medium	Low	Low	High	Low	Medium
	Pelecanoides georgicus	South Georgia Diving-petrel	LC	Low	Low	Low	High	Low	Medium
	Pelecanoides urinatrix	Common Diving -petrel	LC	Medium	Low	Low	High	Low	Medium
	Macronectes giganteus	Southern Giant Petrel	LC	High	Low	High	Low	Medium	Low
	Macronectes halli	Northern Giant Petrel	LC	High	Low	High	Low	Medium	Low
	Pagodroma nivea	Snow Petrel	LC	Low	Low	Low	Medium	Low	Low
Shearwaters	*Puffinus tenuirostris*	Short-tailed Shearwater	LC	High	High	Med	High	Med-High	Medium
	Puffinus grisea	Sooty Shearwater	NT	High	High	Med	High	Med-High	Medium
	Puffinus gavia	Fluttering Shearwater	LC	Low	High	Med	High	Med-High	Medium
	Puffinus assimilis	Little Shearwater	LC	Low	High	Med	High	Med-High	Medium
Prions	*Pachyptila belcheri*	Slender-billed Prion	LC	Med-High	Low	Low	High	Low	Medium
	Pachyptila desolata	Antarctic Prion	LC	High	Low	Low	High	Low	Medium
	Pachyptila salvini	Salvin's Prion	LC	Med-High	Low	Low	High	Low	Medium
	Pachyptila turtur	Fairy Prion	LC	Med-High	Low	Low	High	Low	Medium
	Pachyptila vittata	Broad-billed Prion	LC	Med-High	Low	Low	High	Low	Medium
Terns	*Sterna paradisaea*	Arctic Tern	LC	Medium	Low	Low	High	Low	Medium
Gulls	*Larus dominicanus*	Kelp Gull	LC	Low	Low	Low	Low	Low	Medium
Skuas	*Stercorarius spp*	Skuas	LC	Med	Low	Med	Low	Low	Medium

Appendix 4 - Mammals recorded in online and published sources for the GVFZ.

Group	Species	Common name	IUCN status	Spatial Overlap	Catchability	Risk	Residual Risk
Seals	*Arctocephalus gazella*	Antarctic Fur Seal	LC	Medium	Low	Low	Low
	Arctocephalus tropicalis	Sub-Antarctic Fur Seal	LC	Medium	Low	Low	Low
	Arctocephalus forsteri	New Zealand Fur seal	LC	Low	Low	Low	Low
	Arctocephalus pusillus	Afro-Australian Fur Seal	LC	Low	Low	Low	Low
	Mirounga leonina	Southern Elephant Seal	LC	High	Medium	Medium	Medium
	Hydrurga leptonyx	Leopard Seal	LC	Low	Low	Low	Low
Whales	*Balaenoptera acutorostrata*	Common Minke Whales	LC	High	Low	Low	Low
	Balaenoptera physalus	Fin Whales	VU	High	Low	Low	Low
	Balaenoptera borealis	Sei Whales	EN	High	Low	Low	Low
	Balaenoptera bonaerensis	Antarctic Minke Whale	NT	High	Low	Low	Low
	Balaenoptera musculus	Blue Whale	EN	High	Low	Low	Low
	Berardius arnuxii	Arnoux's Beaked Whale	DD	High	Low	Low	Low
	Megaptera novaeangliae	Humpback Whales	LC	High	Low	Low	Low
	Eubalaena australis	Southern Right Whales	LC	High	Low	Low	Low
	Physeter macrocephalus	Sperm Whales	VU	HIgh	Low	Low	Low
	Orcinus orca	Killer Whale	DD	High	Low	Low	Low
	Globicephala melas edwardii	Southern Longfinned Pilot Whale	LC	High	Low	Low	Low
	Mesoplodon grayi	Gray’s Beaked Whale	DD	High	Low	Low	Low
	Mesoplodon layardii	Strap-toothed Whale	DD	High	Low	Low	Low
	Mesoplodon bowdoini	Andrew's Beaked Whale	DD	High	Low	Low	Low
	Caperea marginata	Pygmy Right Whale	LC	High	Low	Low	Low
	Hyperoodon planifrons	Southern Bottlenose Whale	LC	High	Low	Low	Low
	Tasmacetus shepherdi	Shepherd's Beaked Whale	DD	Medium	Low	Low	Low
Dolphins	*Tursiops truncatus*	Common Bottlenose Dolphin	LC	Low	Low	Low	Low

Lagenorhynchus obscurus	Dusky dolphins	LC	Low	Low	Low	Low
Lagenorhynchus cruciger	Hourglass dolphins	LC	High	Low	Low	Low
Lissodelphis peronii	Southern Right Whale Dolphin	LC	High	Low	Low	Low
Delphinus delphis	Short-beaked Common Dolphin	LC	Low	Low	Low	Low
Grampus griseus	Risso's Dolphin	LC	Low	Low	Low	Low
Phocoena dioptrica	Spectacled Porpoise	DD	High	Low	Low	Low

Georgia Seafoods Ltd

Exploratory Patagonian toothfish demersal longline fishery: George V Fracture Zone, SPRFMO Convention Area

Preliminary Stock Assessment after year 2 of a 3 year programme

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George V Fracture Zone Exploratory toothfish fishery – Preliminary stock assessment.

Review table

Name	Reviewed by	Date
Version 1	P Brewin, P Brickle	29 May 2023
Version 1.1	J Pompert	30 May 2023
Version 2	P Brewin, J Bleijenberg, J Pompert	04 July 2023

Prepared by: Dr Paul Brewin and Dr Paul Brickle.

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Data Access

All data is stored in the SAERI IMS-GIS Centre (https://www.south-atlantic-research.org/) and can be accessed by request and subject to permission from the data owner.

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1. Introduction

An exploratory fishery for Patagonian toothfish (*Dissostichus* sp) has been underway since 2021 (CMM14e-2021) in an area known as the George V Fracture Zone Research Block (GVFZ) adjacent to the CCAMLR Convention Sub-area 58.4.1 (Figure 1).
The objectives of this exploratory fishery are;

a) to further explore the presence and distribution of toothfish in the SPRFMO Convention Area;
b) to collect and provide information and data contributing towards the sustainable management of potential toothfish stocks in specific, data-poor zones of the Convention Area;
c) to assess the potential for a future sustainable toothfish fishery in specific zones of the Convention Area;
d) to provide occurrence information on marine mammals, seabirds, sharks, skates and rays and other species of concern;
e) to better understand patterns of seabirds and marine mammals and their potential for interactions with fishing vessels;
f) to evaluate the potential impacts of longlines on non-target associated or dependent species, and vulnerable marine ecosystems;
g) to undertake tagging activities on toothfish to enable future studies on the migration of toothfish as well as a preliminary stock assessment.

In this report we conduct a preliminary stock assessment (Objective g) of Patagonian toothfish based on the first two fishing campaigns, summarising biological data, preliminary assessment of biomass, and provide guidance for future fishing campaigns in the area. These data will directly inform integration of this region into current Patagonian toothfish stock hypotheses and connectivity analyses with other regions where appropriate.

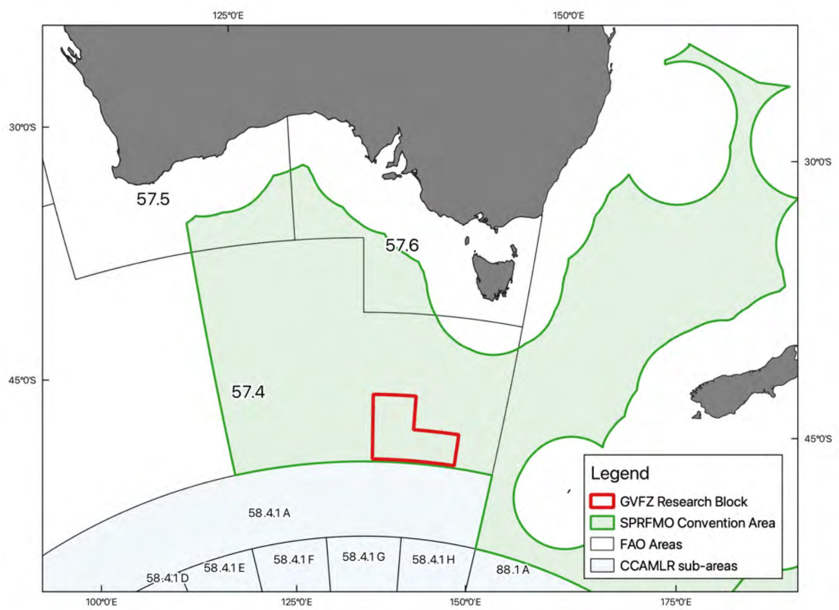

Figure 1 George V Fracture Zone research area within SPRFMO Convention Area. Also shown are FAO Area numbers and CCAMLR Convention Area.

The fishing area straddles the Southeast Indian Ridge at approximately 139°E / 53°S, at a position roughly surrounding the George V Fracture Zone (Sempéré et al. 1996). The area is characterised by short chains of seamounts and spreading ridges (Harris et al., 2014) generally rising to approximately 1000m depth (500m depth for the highest seamount) and surrounded in abyssal hills of approximately 2500m – 3500m depth.

To conduct this preliminary assessment, we use two methods for assessing biomass in data limited fisheries that have proven useful for similar toothfish fisheries in the CCAMLR Convention area; 1) CPUE-by-seabed area analogy method (Agnew et al. 2009) and 2) Chapman mark-recapture estimation (CCAMLR SC-XXXV Annex 5). Only two years of fishery data have been collected so far, meaning that many fundamental characteristics of this stock and ecosystem are not yet well understood, and therefore it is not known if the underlying assumptions of these methods are fully met (see Discussion). Nevertheless, it is useful to examine the application of these two methods in the GVFZ, and document progress in the development of a more robust assessment in parallel with continued exploratory fishing in the area.

2. Methods

2.1 Data collection

All fishing was conducted on the FV Tronio using 'Spanish' seabed longline fishing gear (CCAMLR Gear Catalogue, specifically WG-FSA-11/53). Total length, weight, and sex and maturity for the target species were collected according to the CCAMLR Scheme of International Scientific Observation Scientific Observer's Manual Finfish Fisheries (2020). Data was collected and tagging was conducted by Scientific Observers. Further details are found in the proposed fishing plan (COMM9-Prop16 and SC8-DW05_Rev2).

2.1.1 CPUE-by-seabed area analogy

This method compares the biomass assessed using integrated assessment methods from data-rich fisheries in the Convention Area to exploratory areas spatially constrained to the extent of the fishable seabed where fisheries data is limited. The proportional estimate of biomass in the data-limited research area is then scaled by the ratio of the Catch Per Unit Effort (CPUE; kg of fish caught per km of fishing line) in the data-rich area to that of the data-limited area. Biomass (B) is determined by;

$$B_x = \frac{C_x \times A_x \times B_r}{C_r \times A_r}$$

where the subscripts x denotes the research block and r denotes the reference area. C is the median of the haul-by-haul CPUE, inclusive of tagged fish that were released. A is the seabed area (km^2) in the depth range 600-1800m and Br is the current biomass estimate (kg) from the most recent assessment in the reference area. Further details can be found in Agnew et al. 2009.

The CCAMLR reference areas for Patagonian toothfish is the Heard and MacDonald Islands (HIMI) (Division 58.5.2) fishery (WG-FSA-19). This area was chosen because it is an established fishery in CCAMLR and has an updated integrated assessment carried out every two years. Seabed area is based on GEBCO bathymetry and updated as new versions of GEBCO are produced. The Patagonian toothfish fishery in HIMI operates across a large plateau (Kerguelen Plateau), which is contrast to the predominantly seamount and abyssal hill dominated toothfish habitat in the GVFZ. As such they may differ in oceanography, trophic dynamics, and other ecological factors such that underlying assumptions of comparable habitats are not met. There is very little information on the physical / ecological dynamics of the GVFZ and how that impacts the toothfish stock; our use of the method here assumes the null hypothesis of similar effects physical / ecological dynamics between the two areas as we have no information to assume an alternative at this time. Nevertheless, unknown differences between the HIMI and GVFZ environments present a significant source of caution when interpreting results (see Discussion). It may be that other Patagonian toothfish fisheries are located in more similar habitats, for example along the Macquarie Ridge; this area will be used for comparison to the GVFZ when data is made available.

To adopt this method in the GVFZ exploratory fishery the depth constraint with respect to the GVFZ was expanded to 600-2500m depth to include the main fishing depths over the last two fishing campaigns. CCAMLR constrains seabed area to 600-1800m depths based on the reported fishing depths for the toothfish fishery in Sub-area 48.6 (WG-FSA-12/38). Therefore, it is felt that our expanded depth range remains representative of the main vulnerable biomass of toothfish in the area and does not invalidate area assumptions of the method. Seabed area of vulnerable biomass was calculated in QGIS (v3.30.0), using GEBCO 2023 (www.gebco.net) after reprojection in UTM 53S / EPSG: 32753.

Our adoption of the method converts CPUE in the reference area, which is presented in terms of kg/hooks, to CPUE in terms of kg/km of line. To convert numbers of hooks to line length, numbers of hooks was multiplied by 1.4m, which is the typical distance between hooks on autoline type systems as is currently used by vessels in the HIMI fishery (CCAMLR WG-FSA-08/60). The Spanish line system used on Tronio has a hook spacing of 1.83m per hook based on C2 data.

Reference area CPUE data available at the time of writing this report did not include line-by-line data of catch and effort. As an alternative, we use published data extracted from the CCAMLR Statistical Bulletin Volume 34, where catch and effort are aggregated by month.

A bootstrap procedure is used to calculate estimated biomass and CV for the research block using the above equation and the assessed biomass CV from the reference area.

In summary, Reference area parameters used in CPUE-by-seabed analysis were;

- Reference area HIMI / CCAMLR 58.5.2.
- Reference area biomass 31,111 tonnes (github.com/CCAMLR-Science/)
- Reference area biomass CV 0.0281 (github.com/CCAMLR-Science/)
- Reference area seabed area 113,804 km^2 (github.com/CCAMLR-Science/)
- Reference area CPUE Median monthly aggregated catch/effort 2020-2021

Parameters used for the GVFZ research area;

- Research area seabed area 11,115 km^2
- Research area CPUE Median line-by-line catch/effort 2021-2022

2.1.2 Tag-recapture analysis

Toothfish were tagged at a rate of 5 per tonne. Details of tagging protocols are given in cruise reports 2021 (SFL 2022) and 2022 (SFL 2023).

Analysis of tagging data was done using the Chapman method as detailed in CCAMLR SC-XXXV Annex 5. Biomass is calculated as;

$$B_j = \frac{c\left(n_{j-1} + 1\right)}{mx_j + 1}$$

where n_{j-1} is the number of tagged fish available for recapture at the end of the season prior to season j, c_j is the catch in season j (including those that were tagged and release) and mx_j is the number of tagged fish recaptured in season j (excluding within-season recaptures).

The number of tags available is calculated as;

$$n_j \begin{cases} j = 1, & r_j(1 - t)e^{-(f+M)} - m_j \\ j > 1, & n_{j-1}e^{-(f+M)} + r_j(1 - t)e^{-(f+M)} - m_j \end{cases}$$

Where rj is the total number of fish released in CCAMLR fishing season j, mj is the total number of tagged fish recaptured in CCAMLR fishing season j, and nj–1 is the number of tagged fish available for recapture at the end of the season prior to season j. t is the post-tagging mortality rate of 0.1 (Agnew et al., 2006). f is the annual tag loss rate which is 0.0084 (WG-SAM-11/18). M is natural mortality: 0.155 for Patagonian toothfish (*D. eleginoides*) (Candy et al., 2011)

A length-weight relationship (Figure 2) was calculated for fish captured in 2021-2022 as:

W = 0.3.290e-06 $L^{3.2512}$; $R^2 = 0.934$

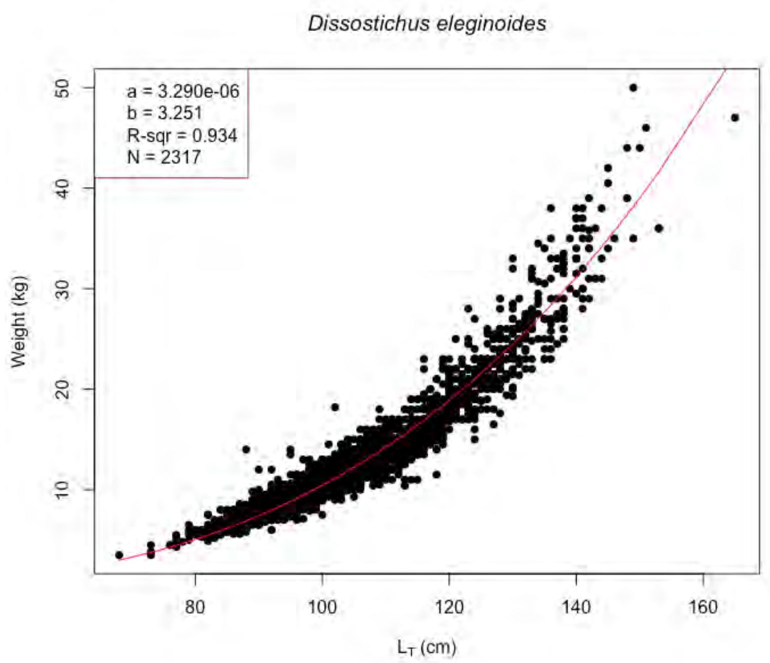

Figure 2. Length-weight relationship for Patagonian toothfish in the GVFZ 2021-22.

Calculations biomass using CPUE-by-area analogy and Chapman tag-recapture methods were implemented in R (4.3.0) using modified scripts provided by CCAMLR (https://github.com/CCAMLR-Science/Trend_Analysis).

3. Results

3.1 Catch and effort

In 2021 mean ± sd CPUE was 316 ± 194 kg/km line, and in 2022 was 257 ± 201 kg/km line, with wide variability in CPUE between lines (Figure 3). Although there may be a slight decline in CPUE between years, the difference is not significant (ANOVA, $f_{1,57}$ =1.301, p = 0.259).

Line setting depth ranged between 1,575m and 2,376m depth. CPUE varied between fishable areas, delineated by depth bands of 600m – 2500m (Figure 4).

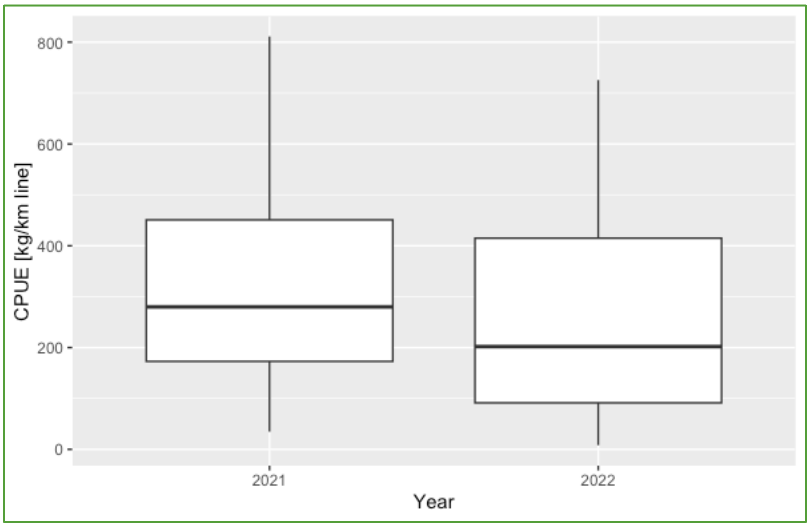

Figure 4. Box and whisker plot of CPUE of all lines in 2021 and 2022, representing medians, upper and lower quartiles and statistical max and min values.

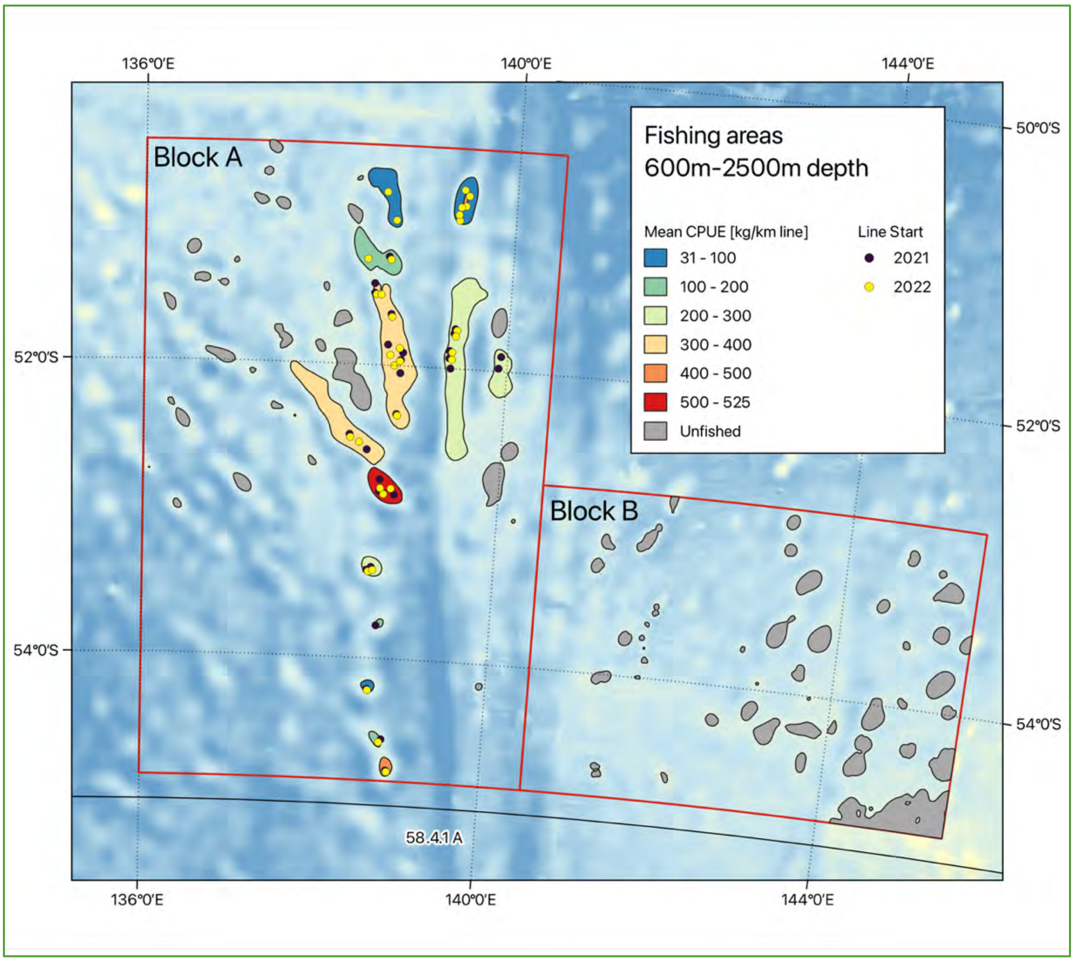

Figure 4. Location of lines set (set_start) in 2021 and 2022. Highlighted are fishable seamounts defined by bathymetry ranging between 600m – 2500m depth. Fished seamounts are coloured according to mean CPUE (kg/km line) for all lines in both years. Unfished seamounts are shown in grey.

3.2 Length – Frequency

The length-frequency of TOP from 2021 and 2022 in shown in Figure 5. Median and mean fish lengths declined between 2021 and 2022, where larger size classes were not present in the catch in 2022. The over-all distributions are significantly different (Kolmogorov-Smirnov Test, $p < 2.2e\text{-}16$).

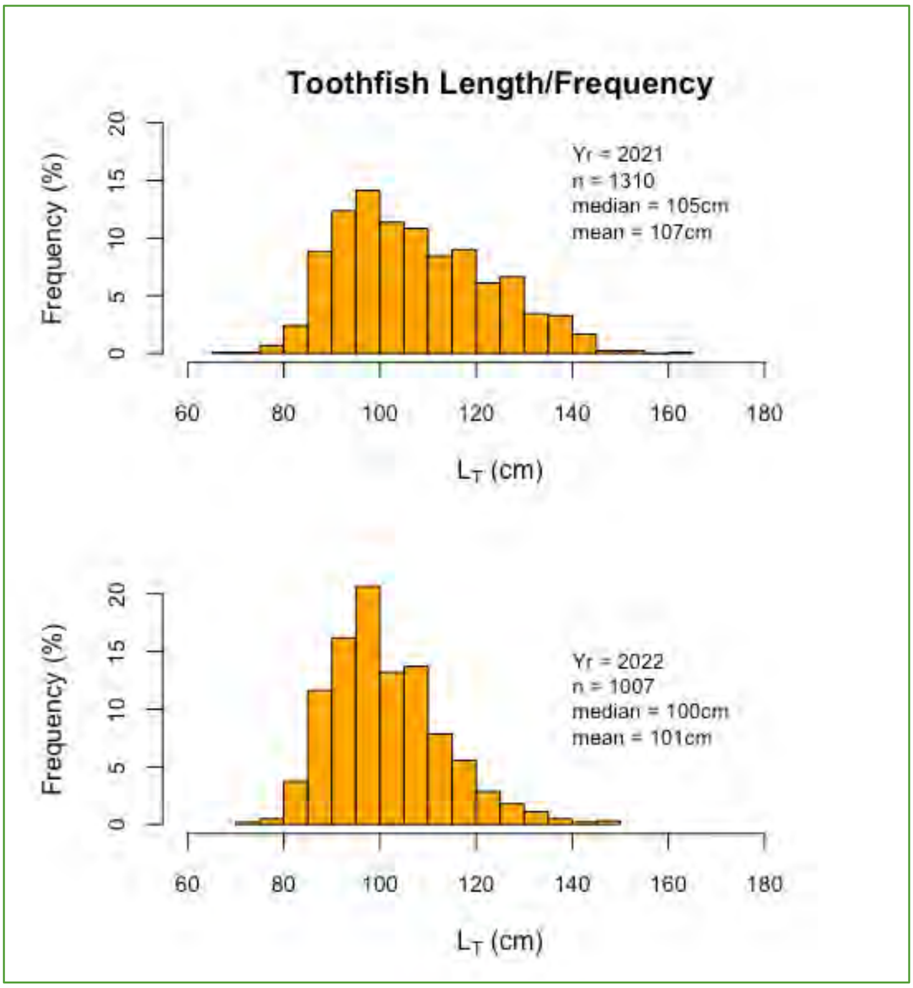

Figure 5. Length-frequency of all TOP in 2021 and 2022.

3.3 Sex and Maturity

Male and female length frequency of TOP is shown in Figure 6. In both years, males were generally smaller than females. The sex ratio of catch changed between years, with more males caught than females in 2022, whilst in 2021 sex ratio was more or less 1:1.

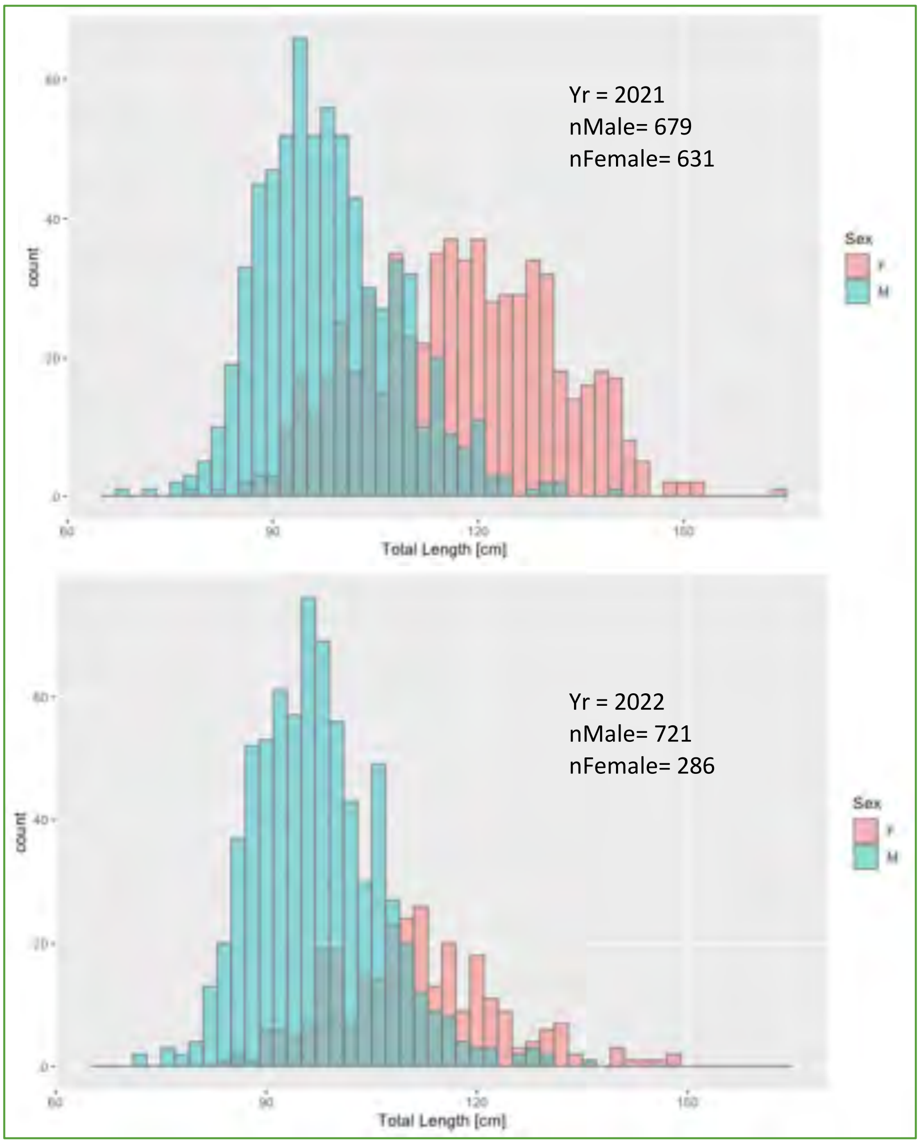

Figure 6. Length-frequency of males and females of TOP in 2021 and 2022.

Maturity stages of males and females caught in 2021 and 2022 are shown in Figure 7. Maturity stage 1-5 were found in both years. In 2021, the majority of fish were in the Stage III (Developed), whilst in 2022 Stage II (Developing) were more common among both males and females.

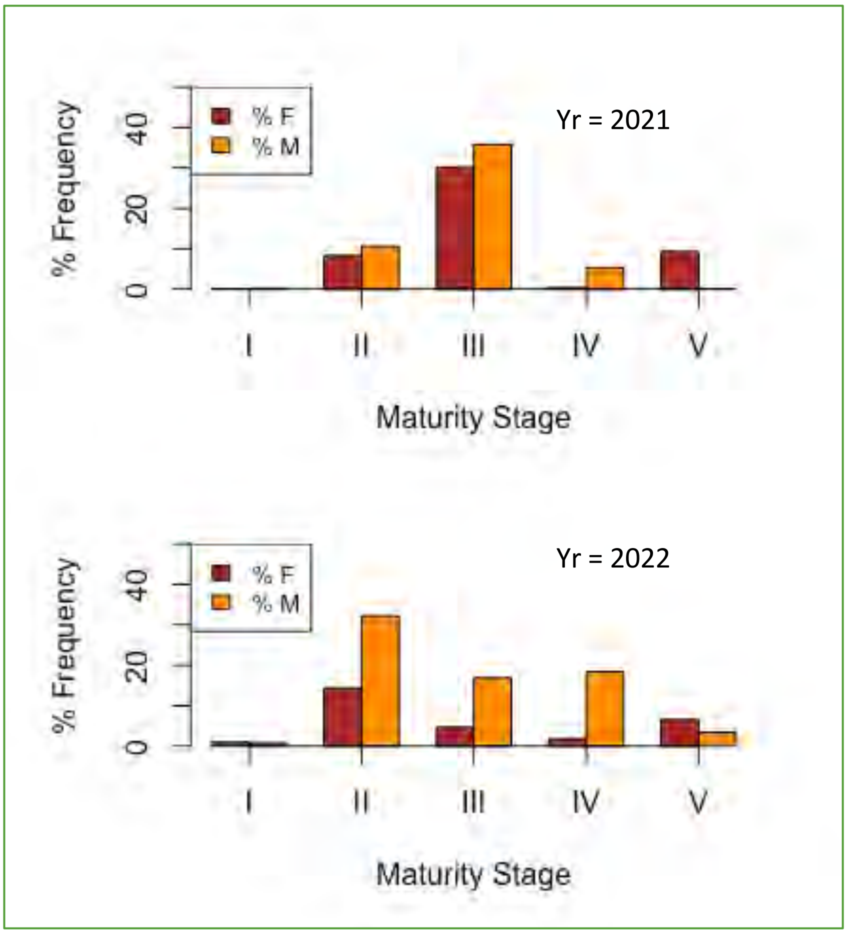

Figure 7. Frequency of maturity of male and female TOP from 2021 and 2022.

3.4 Ageing

Pairs of otoliths were collected from 271 fish in 2021, and 318 fish in 2022. These will be processed as soon as possible for production of an age-length key.

3.5 Tagging

A total of 378 TOP was tagged in 2021 and 380 in 2022. In 2022, three tagged TOP were recovered that were originally tagged in the GVFZ in 2021. All three fish were recovered from the same seamount location in which they were released (Figure 8).

A total of 6 tagged have been recovered in the GVFZ that were originally released in the Macquarie Ridge Fishery (Figure 8). These have not been included in the Chapman tag-release analysis.

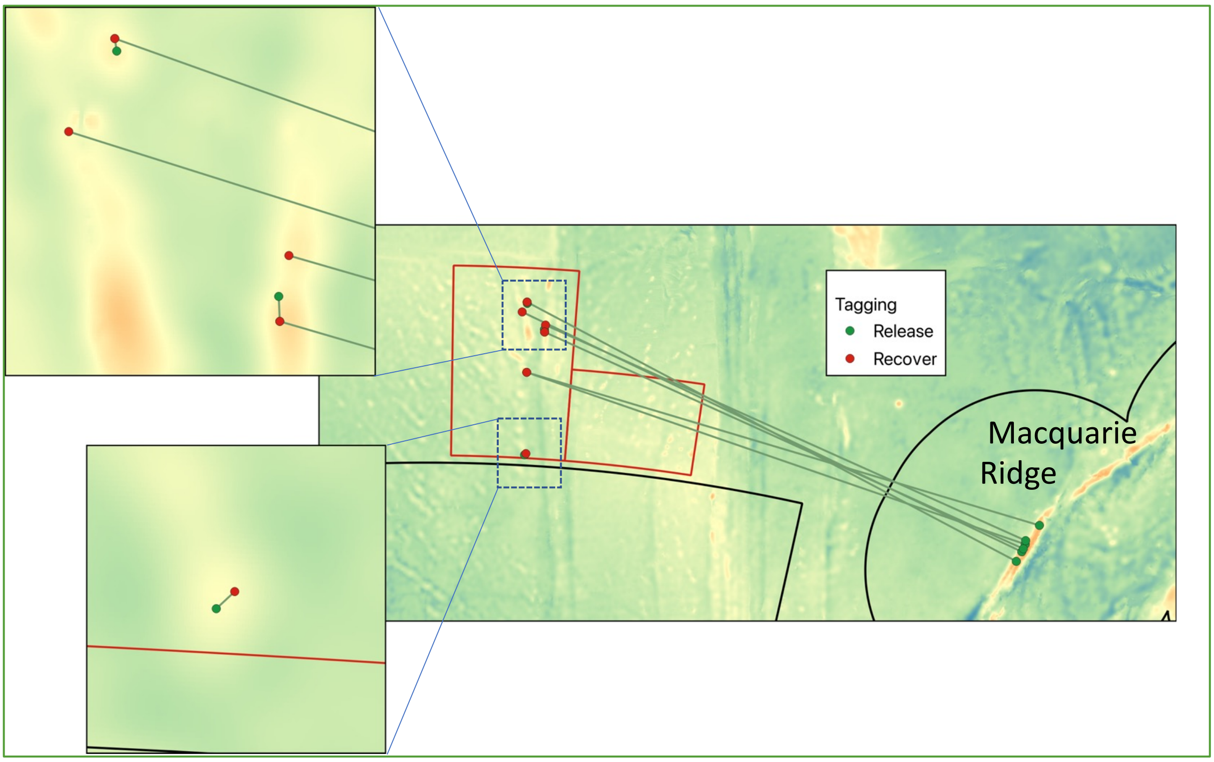

Figure 8. Tagging releases and recoveries on the GVFZ in 2021 and 2022 fishing campaigns.

3.6 Biomass estimates

Table 1 give results of biomass estimates from Chapman tag-recapture and CPUE-by-seabed methods. Biomass estimates ranged between 4,316t (CI_{lower} - 2,802; CI_{upper} - 6,266) from the CPUE-by-seabed area analogy method, and 5,938t (CI_{lower} - 2,940; CI_{upper} - 13,356).

Table 1. Biomass estimates for research block GVFZ A.

Research Block	Species	Season	Biomass Estimate (t)	CI lower (t)	CI upper (t)	N recaptures	N lines	Method
GVFZ A	TOP	2022	5938	2940	13356	3	32	Chapman
GVFZ A	TOP	2022	4316	2803	6266		59	CPUE-by-seabed area

4. Overall assessment

A 75t TAC of *Dissostichus* sp. was set for this research area under CMM14e-2021 and this was reached in both 2021 and 2022 fishing campaign. This is well below the estimate TAC calculated from either method, being approximately ~1-2% of the estimated biomass. However, given that this is the second year of fishing, there are some underlying assumptions that have not been fully evaluated in this short period of fishing to date, suggesting that biomass estimates should be treated with some caution.

GEBCO bathymetry relies on a number of data sources, and therefore the amount of interpolated bathymetry between the two locations may vary, affecting accuracy of calculated seabed area.

The effect of adjustment of fishable seabed area used in our CPUE-by-seabed area method from 600-1800 to 600-2500m in the GVFZ is unknown and requires further examination. For example, the method assumes similar vulnerable fish size selection in the research area and reference area. This can be addressed in part, by taking the modelled biomass-at-size of the population in the reference area and multiplying by the selectivity and size distribution in the research area to get a biomass of the size of fish caught in the research area (S. Parker pers. com). The fine resolution line-by-line data and length-frequency data from the HIMI research area was not available at the time of writing this report; estimated biomass in the GVFZ will be more fully evaluated once these data are available.

In addition, biases in abundance (CPUE) in the GVFZ as calculated by CPUE-by-seabed area method may be introduced due to difference in gear types. Converting reported CPUE from kg/hook to kg/km line may introduce overestimates or underestimates in GVFZ due to varying spaces between hooks in the Spanish system compared to autoline systems. Other differences in characteristics of the fishing methods were not able to be assessed, such as variations in setting speeds and soak times, which may impact CPUE. The two systems may also have different selectivities due to difference in bait, fish interaction with baited hooks on the seabed (autoline) vs suspended off the seabed (Spanish lines), and hook shape and size used.

Regarding the tag-recapture method, the estimated biomass calculation produced very wide confidence intervals, likely due to the program only having been run for two years, with one year of tag returns. Tag recaptures in 2022 indicated the fish's affinity for its local area, where tagged fish were recovered on the same 'seamount' (seabed between 600-2500m depth surrounded by deeper water) from which they were release in the year prior. It is unclear if, in general the population shows similar bathymetric constraint, but these results suggest that further understanding of stock connectivity between the various seamounts within the GVFZ is required to better resolve stock biomass. Furthermore, the six recovered tagged fish that were originally liberated on the Macquarie Ridge fishery may indicated a degree of immigration/emigration beyond the GFVZ. Unresolved knowledge of connectivity in the GVFZ also raises the question of uncertainty in assumptions of catchability (q) when comparing CPUE between seamounts.

Comparison of other stock characteristics between 2021-22 also indicate that some caution should be given to setting the TAC in the future. In particular, size-frequency analysis showed a decline in larger sized fish between the two campaigns. Further examination of sex ratio suggests that it was larger female fish that were not caught in 2022. This may be due to natural variability between years, or indicate some spatial structuring of male and females of the population at this time of year. Further research in the area would be required to elucidate on interannual patterns.

5. Preliminary TAC advice for 2024

With reference to data limited exploratory fisheries, CCAMLR constructed a decision tree indicating rules for setting TAC based on trend analysis of CPUE-by-seabed area analogy and tag-recapture estimates of biomass (WG- FSA-17 para 4.33). Based on those decision rules, an appropriate TAC would be based on the biomass estimate x 0.04 (4%) exploitation rate. However, recognising in the GVFZ that there have been only 2 years of fishing, that assumptions under the different methods are not fully met (seabed area, difference in fishing methods), and that variability in other stock indicators are poorly resolved (e.g. potentially reduced mean length capture, changes in sex ratio, stock connectivity), a 0.03 (3%) exploitation rate of the lowest mean biomass estimate (4,316t CPUE-by-seabed area) would be precautionary. **This suggests a TAC of 129t.** A more precautionary approach would be to assume a 0.04 (4%) exploitation rate of the lower CI (2,803t) of the CPUE-by-seabed area method, **suggesting a TAC of 112t**.

A trend analysis will be conducted at the end of the 2023 fishing campaign, and a TAC will be recommended for further fishing on that basis.

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