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**SC14 - DW 07**

**Potential Scientific Requirements to Assist Transition Toothfish Fisheries from  
Exploratory Fisheries to an Established Fishery**

*Chairperson of the DWWG*

## Potential scientific requirements to assist transition toothfish fisheries from exploratory fisheries to an established fishery

### Deepwater Working Group Chair

Conservation and Management Measure (CMM)13-2024 requires that specific CMMs be developed once an exploratory fishery has been fished for 10 years. This paper aims to outline potential scientific and data requirements that are likely to be required during this transition. Broadly this paper has separated these requirements into requirements for data collection and observer programs and a proposed methodology to set catch limits that is consistent with the adjacent CCAMLR fisheries.

There is currently no explicit guidance on what a future CMM may require in terms of advice from SPRFMO SC in the future, however, a number of assumptions can be made. All of the current exploratory fishing CMMs require data collection, carriage of scientific observers, tagging of toothfish and seabird mitigation as well as a catch limit for toothfish. It is assumed that the process to develop a future established fishery regime will require advice on all of these issues.

### Data collection and observer requirements

Data collection, observer coverage, tagging requirements and seabird mitigation are all currently specified in separate CMMs for exploratory toothfish fisheries. Overall, many of the existing requirements appear to already be fit for purpose to collect the necessary information to ensure data is available for the transition to established fisheries. Many of the requirements are also suitable for the monitoring and decision required by an ongoing fishery. There is already substantial consistency amongst the current exploratory fishing CMMs on data collection and observer requirements and the section below highlights key differences and makes recommendations potential ways forward.

#### Data collection

Data collection for catch and effort in bottom fisheries are currently already well specified in CMM 02-2026 and CMM 03-2025. Some CMMs require that data be collected on CCAMLR forms (eg C2s). Collecting data on these forms will ensure that data is collected consistently with CCAMLR fisheries and should minimise issues in any future joint assessments that are undertaken with CCAMLR.

#### *Recommendations;*

*Continue the current data collection requirements as specified in CMM 02 and CMM 03*

*Consider whether catch and effort data collection should be mandated on CCAMLR C2 forms.*

### Scientific observers

Scientific observers collect crucial data for toothfish fisheries and are required in all of the SPRFMO exploratory fisheries, as well as toothfish fisheries in CCAMLR, Australia, France and the UK. Currently three of the SPRFMO exploratory fisheries require one scientific observers and an additional data collection officer, whilst the fourth requires two scientific observers. In practice, all observers that have been deployed during exploratory fishing in SPRFMO have been from CCAMLR accredited observer programs but there is currently no requirement for this.

Many of the boats fishing in the SPRFMO exploratory fisheries also participate in CCAMLR new and exploratory fisheries, some of which have Marine Stewardship Certification. One of these MSC client Groups require these boats to have e-monitoring. Trials are underway within CCAMLR waters to utilise automated processes to identify the landed catch and take length frequencies. It is possible that this technology could collect some of the data that is currently collected by observers and data collection officers. SPRFMO should continue to monitor developments in e-monitoring and artificial intelligence and determine whether it is appropriate for use in SPRFMO.

### *Recommendations;*

*Consider whether SPRFMO should adopt a single standard for the number of scientific observers on each trip.*

*Consider whether SPRFMO should require scientific observers be from CCAMLR accredited programs.*

*Consider whether some data currently collected by observers could be collected through e-monitoring in the future.*

### Tagging

Tagging is a key component of the assessments for toothfish stocks managed in CCAMLR, Australian, French and United Kingdom managed fisheries. All of the current SPRFMO exploratory fisheries include requirements to tag and release toothfish at either 3 or 5 fish per tonne, these are comparable to CCAMLR standards.

CCAMLR has well established tagging protocols and in practice these are implemented by all SPRFMO exploratory fisheries but currently only required to be implemented by CMM 14e (EU). Ensuring that fish are tagged in a way that maximises their chance of survival is critical to the utility of tagging data.

All SPRFMO exploratory fisheries currently require that the tagging overlap statistic be met, but these obligations are currently expressed in different ways in the CMMs.

Consideration could be given standardising tagging overlap statistic requirements, but ensuring post-tagging survival is maximised should be an important consideration.

*Recommendations;*

*Consider whether SPRFMO should adopt the CCAMLR toothfish tagging protocols and implement them in CMMs for either exploratory or established toothfish fisheries.*

*Consider whether to adopt a standardised tagging rate for exploratory fisheries and either the same or separate tagging rate for future established fisheries.*

*Continue to require the tagging overlap statistic to be met and adopt a best practice formulation of this requirement*

### Sea bird mitigation

All of the SPRFMO exploratory fisheries currently fish in accordance with CMM-09 and are generally consistent with CCAMLR CM 25-02. There does not seem to be any reason that seabird measures should be above and beyond what is already specified in CMM-09. This could be reviewed by the SPRFMO SC if seabird mortalities occur.

*Recommendations;*

*Consider whether specific seabird mitigation measures are required in toothfish fishery CMMs.*

## Catch limit setting process

CCAMLR manages Antarctic toothfish fisheries in areas 88.1 and 88.2 adjacent to SPRFMO areas NZ\_A to NZ\_S (see Figure 1 below). It is likely there will be some connectivity between populations of Antarctic toothfish around the CCAMLR / SPRFMO boundary in this area.

CCAMLR uses a trend analysis in data-limited exploratory toothfish fisheries, which estimates biomass from the CPUE-by-seabed analogy and the Chapman mark-recapture estimation ([WG-SAM-16](#), paragraph 2.28), and informs the setting of catch limits ([WG-FSA-17](#), paragraph 4.28 to 4.38). Trend analysis decision rules determine the catch limit for an exploratory toothfish area ([WG-FSA-17](#)). These rules have been adapted over time within CCAMLR. Trend analyses and decision rules have also been adapted for SIOFA exploratory toothfish fisheries ([SIOFA SC9](#), paragraph 202 to 218).

### CPUE-by-seabed analogy

In CCAMLR, biomass is estimated using the CPUE-by-seabed analogy ([Agnew et al., 2009](#)) as follows:

$$Biomass_x = \frac{CPUE_x \times Seabed\ area_x \times Biomass_r}{CPUE_r \times Seabed\ area_r}$$

where,  $x$  represents the exploratory toothfish area,  $r$  represents the reference area, CPUE refers to the median of the haul by haul catch per unit effort (kg per km of fishing line), seabed area refers to the area (km<sup>2</sup>) in the depth range of 600-1800 m, and biomass refers to the current biomass (t) ([CCAMLR Secretariat, 2024](#)). Reference areas are data-rich fisheries assessed using an integrated stock assessment ([CCAMLR Secretariat, 2024](#)). CCAMLR reference areas are Heard Island and McDonald Islands (HIMI) research block with a Patagonian toothfish integrated assessment, and Ross Sea Region Open (RSR Open) research block with an Antarctic toothfish integrated assessment ([CCAMLR Secretariat, 2024](#)).

In SIOFA, the formula above is used, however CPUE is in kg per km of fishing line or kg per hook, and the seabed area is calculated for the depth range of 600-2000 m or 500-2000 m (SIOFA [SC-11-17-Rev1](#), [SC-11-55](#), [SC-11-57](#)). SIOFA uses the HIMI reference area and recently explored using a Crozet Island (CI) reference area which has a Patagonian toothfish integrated assessment (SIOFA [SC-11-17-Rev1](#), [SC-11-55](#), [SC-11-57](#)).

#### Chapman mark-recapture estimation

In CCAMLR and SIOFA, biomass is estimated using the Chapman mark-recapture ([CCAMLR Secretariat, 2024](#)) as follows:

$$B_{season} = \frac{Catch_{season} \times (number\ of\ tagged\ fish\ available_{season-1} + 1)}{number\ of\ tagged\ fish\ recaptured_{season} + 1}$$

where *season* refers to fishing season, and *number of tagged fish recaptured<sub>season</sub>* excludes within-season recaptures. Tagged fish are only included if they were recaptured within the same area (after adding a 5km buffer, [WG-SAM-16](#), paragraph 2.47), and at liberty for 1 to 3 years ([CCAMLR Secretariat, 2024](#)). Where there is extensive migration, time-at-liberty may be further limited (e.g. to 1 year in CCAMLR research blocks 486\_2, 486\_3 and 882H) to avoid biomass overestimation ([WG-FSA-17](#), paragraph 4.37, 4.78, 4.80). Chapman biomass estimate trends are only considered if there are adequate recaptures: 3 or more per year in 2 or more of the last 3 years ([WG-FSA-17](#), paragraph 4.34).

Note *number of tagged fish available<sub>season-1</sub>* in the equation above is calculated by:

$$n_{season} = \begin{cases} r_{season} \times (1 - t) \times e^{-(f+M)} - m_{season}; & \text{if } season = 1 \\ n_{season-1} & ; \text{if } season > 1 \end{cases}$$

where  $r_{season}$  is the total number of fish released in the fishing season,  $m_{season}$  is the total number of tagged fish recaptured in fishing season and  $n_{season-1}$  is the number of tagged fish available for recapture at the end of the season prior to seasons,  $t$  is the post-tagging mortality rate,  $f$  is the annual tag loss rate, and  $M$  is natural mortality (Table 1).

**Table 1.** Parameters used in Chapman biomass estimation by toothfish species.

| Parameter | Patagonian toothfish | Antarctic toothfish |
|-----------|----------------------|---------------------|
| $t$       | 0.1                  | 0.1                 |
| $f$       | 0.0084               | 0.0084              |
| $M$       | 0.155                | 0.13                |

### Trend analysis decision rules

In CCAMLR, if data are not available in the most recent fishing season for an area, the previous catch limit should be used ([WG-SAM-21](#), paragraph 3.32). This is limited to five years, when the catch limit should be re-evaluated.

In CCAMLR and SIOFA, a time-series of biomass estimates and their uncertainty are used to evaluate the overall biomass trend. An inverse variance weighted least-squares regression which incorporates confidence in each biomass estimate determines a trend, and a standardized regression (*beta*) coefficient of the slope is estimated.

A *beta* threshold of 0.1 is used to determine if the overall trend is:

- Decreasing (D) if one of two trends is less than the negative threshold, and both trends are less than 0.
- Increasing (I) if one of two trends is greater than the positive threshold, and both trends are greater than 0.
- Stable (S) if both trends are less than the positive threshold and greater than the negative threshold.
- Unclear (U) if one trend is greater than the positive threshold and the other is negative, or, if one trend is less than the negative threshold and the other positive. In cases where there is insufficient data to for a trend in Chapman estimates, the overall trend is Unclear ([CCAMLR Secretariat, 2024](#)).

The overall trend, whether there are adequate recaptures, and whether the CPUE trend is declining are used in decision rules ([CCAMLR Secretariat, 2024](#)).

## Exploratory fishing results related to trend analyses

### CPUE-by-seabed analogy

Seabed area in SPRFMO exploratory toothfish fishing areas was examined using GEBCO 2026 bathymetric data, based on depth ranges of 600-1800, 600-2000 and 600-2500 m (Table 2, Figure 1). Based on this bathymetric data, there was no seabed at depths of 600-2500 m in 8 areas. In some areas with seabed at depths of 600-2500 m, there was minimal seabed at depths of 600-1800 m and 600-2000 m. In many areas of SPRFMO the data feeding GEBCO models is sparse and there can be considerable differences in the outcomes depending on the version used.

Haul by haul CPUE data were not available from SPRFMO Scientific Committee reports, and CPUE-by-seabed analogy analyses were not performed for SPRFMO exploratory toothfish fishing areas.

Reference areas for SPRFMO exploratory toothfish fishing areas were considered. Ross Sea Region (RSR) Open was the most proximate CCAMLR reference area to SPRFMO areas, which has an Antarctic toothfish integrated assessment. Macquarie Island (MI) could also be considered as a reference area due to its proximity to SPRFMO areas and having a Patagonian toothfish integrated assessment.

*Recommendations:*

*That SPRFMO should consider adopting a formal decision-making process for setting toothfish catch limits. This system should allow precautionary catch limits where information is low and increase catch limits as more information is available.*

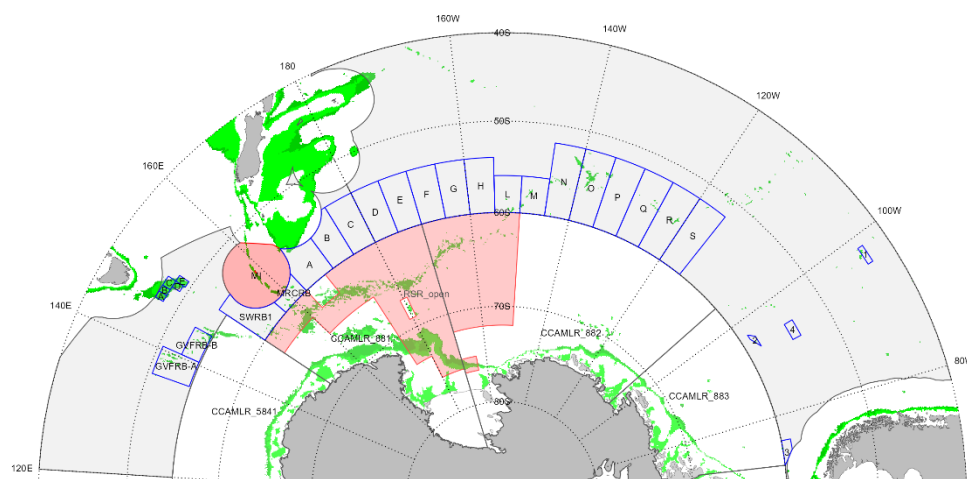
*If SPRFMO adopts a framework similar to that employed by CCAMLR, decisions will need to be made on the following.*

- a) Choose seabed area depth range/s (600-1800, 600-2000 and 600-2500 m)*
- b) Confirm use of the latest GEBCO grid data for calculating seabed areas*
- c) Choose CPUE metric/s (kg per km of fishing line and kg per hook)*
- d) Choose reference area/s (RSR Open and MI)*

**Table 2.** Seabed area in SPRFMO exploratory toothfish fishing areas.

| Area        | Seabed area (km <sup>2</sup> ) in 600-1800 m depth range | Seabed area (km <sup>2</sup> ) in 600-2000 m depth range | Seabed area (km <sup>2</sup> ) in 600-2500 m depth range |
|-------------|----------------------------------------------------------|----------------------------------------------------------|----------------------------------------------------------|
| AU_MRCRB    | 753.27                                                   | 1111.44                                                  | 2548.82                                                  |
| CL_1        | 589.00                                                   | 711.31                                                   | 1049.9                                                   |
| CL_2        | 165.43                                                   | 222.92                                                   | 421.35                                                   |
| CL_3        | 98.58                                                    | 129.36                                                   | 221.28                                                   |
| CL_4        | 0                                                        | 0                                                        | 0                                                        |
| EU_A        | 3360.84                                                  | 4465.05                                                  | 7924.38                                                  |
| EU_B        | 7058.43                                                  | 7740.33                                                  | 8414.98                                                  |
| EU_C        | 8028.84                                                  | 9856.13                                                  | 10934.77                                                 |
| EU_D        | 3422.87                                                  | 5126.58                                                  | 6642.97                                                  |
| EU_E        | 5538.57                                                  | 6408.28                                                  | 8288.62                                                  |
| EU_GVFZRB-A | 606.55                                                   | 1212.92                                                  | 7055.44                                                  |
| EU_GVFZRB-B | 540.29                                                   | 1014.69                                                  | 5866.64                                                  |
| NZ_A        | 926.42                                                   | 1498.64                                                  | 2860.49                                                  |
| NZ_B        | 0                                                        | 0                                                        | 0                                                        |
| NZ_C        | 0                                                        | 0                                                        | 0                                                        |
| NZ_D        | 0                                                        | 0                                                        | 0                                                        |
| NZ_E        | 0                                                        | 0                                                        | 0                                                        |
| NZ_F        | 0                                                        | 0                                                        | 0                                                        |
| NZ_G        | 0                                                        | 0                                                        | 0                                                        |
| NZ_H        | 0                                                        | 0                                                        | 0                                                        |
| NZ_L        | 110.26                                                   | 207.97                                                   | 2297.06                                                  |
| NZ_M        | 3.09                                                     | 15.05                                                    | 2974.22                                                  |
| NZ_N        | 2321.65                                                  | 3106.09                                                  | 7073.58                                                  |
| NZ_O        | 1082.21                                                  | 1798.92                                                  | 15133.87                                                 |
| NZ_P        | 189.45                                                   | 369.93                                                   | 3100.97                                                  |
| NZ_Q        | 1480.12                                                  | 1955.77                                                  | 3566.40                                                  |
| NZ_R        | 365.69                                                   | 578.29                                                   | 3735.69                                                  |
| NZ_S        | 11.29                                                    | 84.5                                                     | 2151.30                                                  |
| NZ_SWRB1    | 25.95                                                    | 133.41                                                   | 2800.40                                                  |

Notes: Uses the GEBCO Compilation Group 2026 grid (doi:10.5285/37c52e96-24ea-67ce-e063-7086abc05f29).

**Figure 1.** SPRFMO exploratory toothfish areas, fishable depths and reference areas.

**Notes:** SPRFMO convention area between 40-60S is shaded light grey. Approved SPRFMO exploratory toothfish fishing areas are blue boxes. Fishable areas between 600-1800 m depth are shaded light green and fishable areas between 1800-2500 m depth are shaded dark green, using the GEBCO Compilation Group 2026 grid (doi:10.5285/37c52e96-24ea-67ce-e063-7086abc05f29) at 10 km resolution. Ross Sea Region (RSR) Open and Macquarie Island reference areas are shaded red. Areas A to E (or EU\_A to EU\_E in Table 1) at South Tasman Rise below Tasmania are defined in CMM-14c-2019 and areas A to E (or NZ\_A to NZ\_E in Table 1) below New Zealand are defined in CMM14i-2025. Adjacent CCAMLR subareas are shown.

### Chapman biomass estimation

Annual tag release and recapture data were available from SPRFMO Scientific Committee reports, but not always for individual areas. Based on the available tag data, there was only the potential for adequate recaptures (3 or more recaptures in 2 or all of the last 3 years) in the EU\_GVFZRB-A area. Tag information was not used in Chapman biomass estimation analyses for SPRFMO toothfish fishing areas.

Chapman biomass estimates of 5,950, 6,297, and 31,810 t in 2022, 2023 and 2024, respectively, have been reported for the EU\_GVFZRB-A area ([SPRFMO SC13-DW06](#)). Parameters for Patagonian toothfish were used in these calculations, as no Antarctic toothfish have been caught in this area. Time-at-liberty was limited 1 to 3 years, and it was unclear whether a 5 km buffer was applied to the area when determining the number of tagged fish recaptured.

#### *Recommendations:*

- a) Choose parameters (Patagonian toothfish or Antarctic toothfish)*
- b) Choose limit for time-at-liberty (1 year or 1 to 3 years)*
- c) Confirm whether to apply a 5 km buffer to the area*

### Trend analysis decision rules

Catch, effort and tag data was compiled from SPRFMO Scientific Committee reports. This information was not used in trend analyses but was used to gauge possible outcomes for each area based on trend analysis decision rules.

No fishing in the last 5 years (2020-2024) was recorded for 21 areas. For the 8 areas with fishing in the last 5 years, 2 areas had no fishing in the latest year (2024), and 2 areas had fishing only in the latest year.

For the 8 areas with fishing in the last 5 years, 7 areas were expected to have inadequate recaptures, in which case the overall biomass estimate trend would be *Unclear* and further work would be required to determine the CPUE trend. There was 1 area that may have had adequate recaptures, for which further work would be required to determine the overall biomass estimate trend and the CPUE trend.

#### *Recommendations:*

*Choose whether to apply the CCAMLR or SIOFA trend analysis decision rules*

## Questions for discussion / recommendations

SPRFMO already has many of the data, observer and management requirements in place for long-term toothfish management. Many of the current management arrangements are specified in four different conservation measures and there are a

number of considerations that could standardise data collection, observers and tagging to ensure consistency in any future transition of toothfish fishing to an established fishery.

In order to facilitate the transition to an established fishery the following questions and considerations need to be addressed.

1. *Continue the current data collection requirements as specified in CMM 02 and CMM 03*
2. *Consider whether catch and effort data collection should be mandated on CCAMLR C2 forms.*
3. *Consider whether SPRFMO should adopt a single standard for the number of scientific observers on each trip.*
4. *Consider whether SPRFMO should require scientific observers be from CCAMLR accredited programs.*
5. *Consider whether some data currently collected by observers could be collected through e-monitoring in the future.*
6. *Consider whether SPRFMO should adopt the CCAMLR toothfish tagging protocols and implement them in CMMs for either exploratory or established toothfish fisheries.*
7. *Consider whether to adopt a standardised tagging rate for exploratory fisheries and either the same or separate tagging rate for future established fisheries.*
8. *Continue to require the tagging overlap statistic to be met and adopt a best practice formulation of this requirement*
9. *Consider whether specific seabird mitigation measures are required in toothfish fishery CMMs.*
10. *That SPRFMO should consider adopting a formal decision-making process for setting toothfish catch limits. This system should allow precautionary catch limits where information is low and increase catch limits as more information is available.*
11. *If SPRFMO adopts a framework similar to that employed by CCAMLR, decisions will need to be made on the following.*
  - a. *Choose seabed area depth range/s (600-1800, 600-2000 and 600-2500 m)*
  - b. *Confirm use of the latest GEBCO grid data for calculating seabed areas*
  - c. *Choose CPUE metric/s (kg per km of fishing line and kg per hook)*
  - d. *Choose reference area/s (RSR Open and MI)*
  - e. *Choose parameters (Patagonian toothfish or Antarctic toothfish)*
  - f. *Choose limit for time-at-liberty (1 year or 1 to 3 years)*
  - g. *Confirm whether to apply a 5 km buffer to the area*
  - h. *Choose whether to apply the CCAMLR or SIOFA trend analysis decision rules*

