CCAMLR's approach to data-limited exploratory toothfish fisheries: the trend analysis (2021).

CCAMLR Secretariat

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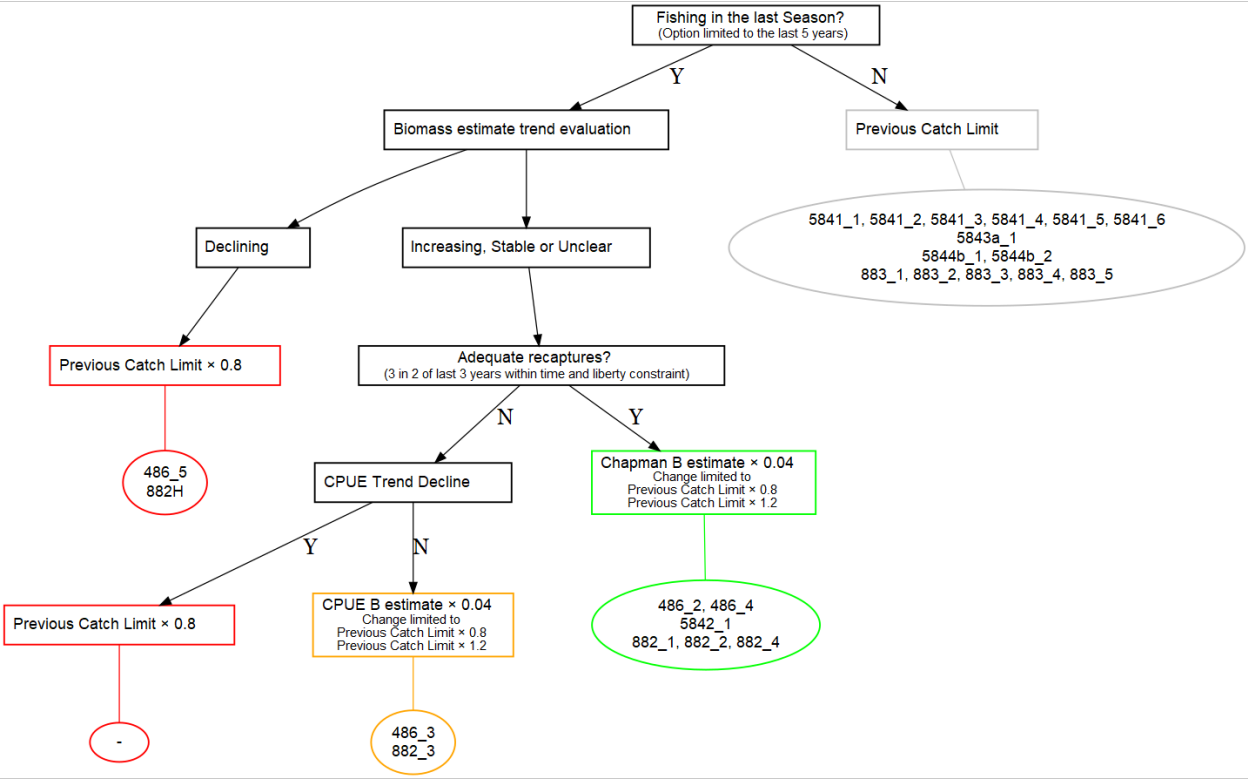

Figure 1: The decision tree of the trend analysis, showing where each Research Block belongs this year.

Background

For data-limited toothfish fisheries in the Southern Ocean there are generally no fishery-independent data on the status of the stock. Therefore, the collection of such data is included in the CCAMLR management process that sets the requirements for vessels to participate in those fisheries.

Determining the appropriate catch limits in data-limited toothfish fisheries that allow sufficient data collection for stock assessments, but that do not place stocks at risk in the interim of having an assessment, is a widespread topic in fisheries generally and one that has been a longstanding issue for CCAMLR (SC-CAMLR-XXIX, paragraphs 3.128-3.129).

In 2016, CCAMLR agreed to an approach for estimating biomass in data-limited areas that uses two methods, the CPUE-by-seabed area analogy and the Chapman mark-recapture estimation (WG-SAM-16 paragraph 2.28).

In theory the two methods for biomass estimation should provide similar results, however, differences in estimates between methods may arise due to limitations in these methods (*e.g.*, these do not account for varying tag survival or fish migrations).

In 2017, CCAMLR (WG-FSA-17 paragraphs to 4.28 to 4.38) agreed that, where time-series of such biomass estimates are available, the trends in these estimates, as well as the most recent estimates of biomass, should be used to provide information on setting and/or changing catch limits.

CPUE-by-seabed area analogy

A central element that underpins any assessment is the estimation of the biomass of the target species in the proposed fishing area. While CCAMLR has a number of data-limited toothfish fisheries it also has data-rich fisheries that are assessed using an integrated assessment software (CASAL), and, information from these assessed fisheries is used to guide the assessment of data-limited fisheries.

For data-limited fisheries, an initial estimate of biomass can be obtained using the biomass estimated in a data-rich area and assuming the same density of fish in the data-limited area. As fishing data becomes available this simple 'seabed area' approach scales biomass 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 in the data-limited area (*i.e.*, the CPUE-by-seabed area analogy method; Agnew et al., 2009) such that the biomass B can be estimated as:

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

Where the subscripts x and r denote parameters from the research block and reference/assessed area respectively. C is the median of the haul by haul CPUE where the total catch (t) on a line, including fish that are tagged and released, is divided by the length of line (km). A is the seabed area (km^2) in the depth range 600-1800m and B_r is the current biomass estimate (t) from the most recent assessment in the reference area.

Chapman mark-recapture estimation

A requirement for participating in all CCAMLR data-limited toothfish fisheries is to tag and release fish at a rate of 3 to 5 fish per tonne caught such that mark-recapture data can be used to estimate biomass (*e.g.*, via the Peterson/Chapman estimation methods).

The Chapman mark-recapture-based biomass estimation relies on the assumption that the ratio of tagged and un-tagged fish in the population is represented by that ratio in the catch. The biomass B in fishing season s can be estimated as:

$$B_s = \frac{C_s(n_{s-1}+1)}{m_s+1}$$

where n_{s-1} is the number of tagged fish available for recapture at the end of the previous fishing season, C_s is the catch in season s (as with CPUE the catch includes fish that are tagged and released) and m_s is the number of tagged fish recaptured in season s (excluding within-season recaptures).

Trend Analysis decision rules

A set of trend analysis decision rules were developed by the Working Group on Fish Stock Assessments (WG-FSA-17) to determine a catch limit for each research block in a data-limited fishery. These decision rules have evolved over time to adapt management to fisheries dynamics.

In recent years, due to the lack of consensus over fishing in some areas (*e.g.*, CCAMLR-40 paragraph 6.43), WG-SAM-21 (paragraph 3.32 (iii)) agreed that in order to establish catch limits in research blocks where fishing had not taken place in recent fishing seasons, if data were not available from the most recent fishing season, the previous catch limit should be carried forward. Such an approach should be limited to five years, after which time the catch limit would need to be re-evaluated outside the current trend analysis framework (see Fig. 1).

Within the Chapman method, due to the potential bias introduced when few fish are recaptured, trends are considered only where there were sufficient recaptures, which is defined as being at least three recaptures per year in at least two of the last three years (WG-FSA-17 paragraph 4.33).

The time-series of biomass estimates from both methods are used to evaluate overall trends in biomass. An inverse variance weighted least-squares regression is used to incorporate the confidence of each biomass estimate in the determination of the trend in the biomass time-series. In order to compare between trends across research blocks the standardized regression (*beta*) coefficient of the slope is estimated.

Each trend is then evaluated using a threshold of *beta*=0.1 so that the overall trend is determined to be:

- Decreasing (**D**) if either of the two trends is less than the negative threshold, and both trends are less than 0.
- Increasing (**I**) if either of the 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 not sufficient data to compute a trend in Chapman estimates, the overall trend would be determined to be Unclear.

Following the trend evaluation, a decision tree (Fig. 1) is used to determine the appropriate biomass estimate and associated catch limit at an exploitation rate of 4% of that biomass estimate. This process further includes a maximum change of +/- 20% in the catch limit between years in order to provide stability in the planning process.

The latest estimates obtained using this method are shown in Table 1 and a map of those research blocks is shown in Figure 2. Recommended catch limits are subject to approval by the Commission.

Table 1. Latest Research Blocks biomasses (B, tonnes) and catch limits (CL, tonnes) estimated using the trend analysis. PCL: previous catch limit; ISU: increasing, stable or unclear; D: declining; Y: Yes; N: No; -: No fishing occurred in the last Season. Recommended catch limits are subject to approval by the Commission.

Subarea or Division	Research Block	Species	PCL	Trend decision	Adequate recaptures	CPUE Trend Decline	B	Bx0.04	PCLx0.8	PCLx1.2	Recommended CL for 2022
48.6	486_2	*D. mawsoni*	112	ISU	Y	N	5617	225	90	134	134
	486_3	*D. mawsoni*	30	ISU	N	N	957	38	24	36	36
	486_4	*D. mawsoni*	163	ISU	Y	Y	10816	433	130	196	196
	486_5	*D. mawsoni*	263	D	Y	Y	15036	601	210	316	210
58.4.1	5841_1	*D. mawsoni*	138	-	-	-	-	-	-	-	138
	5841_2	*D. mawsoni*	139	-	-	-	-	-	-	-	139
	5841_3	*D. mawsoni*	119	-	-	-	-	-	-	-	119
	5841_4	*D. mawsoni*	23	-	-	-	-	-	-	-	23
	5841_5	*D. mawsoni*	60	-	-	-	-	-	-	-	60
	5841_6	*D. mawsoni*	104	-	-	-	-	-	-	-	104
58.4.2	5842_1	*D. mawsoni*	60	ISU	Y	N	3416	137	48	72	72
58.4.3	5843a_1	*D. eleginoides*	19	-	-	-	-	-	-	-	19
58.4.4	5844b_1	*D. eleginoides*	18	-	-	-	-	-	-	-	18
	5844b_2	*D. eleginoides*	14	-	-	-	-	-	-	-	14
88.2	882_1	*D. mawsoni*	192	ISU	Y	N	6588	264	154	230	230
	882_2	*D. mawsoni*	186	ISU	Y	Y	17892	716	149	223	223
	882_3	*D. mawsoni*	170	ISU	N	N	5308	212	136	204	204
	882_4	*D. mawsoni*	128	ISU	Y	Y	8274	331	102	154	154
	882H	*D. mawsoni*	128	D	Y	Y	4500	180	102	154	102
88.3	883_1	*D. mawsoni*	16	-	-	-	-	-	-	-	16
	883_2	*D. mawsoni*	20	-	-	-	-	-	-	-	20
	883_3	*D. mawsoni*	60	-	-	-	-	-	-	-	60
	883_4	*D. mawsoni*	60	-	-	-	-	-	-	-	60
	883_5	*D. mawsoni*	8	-	-	-	-	-	-	-	8

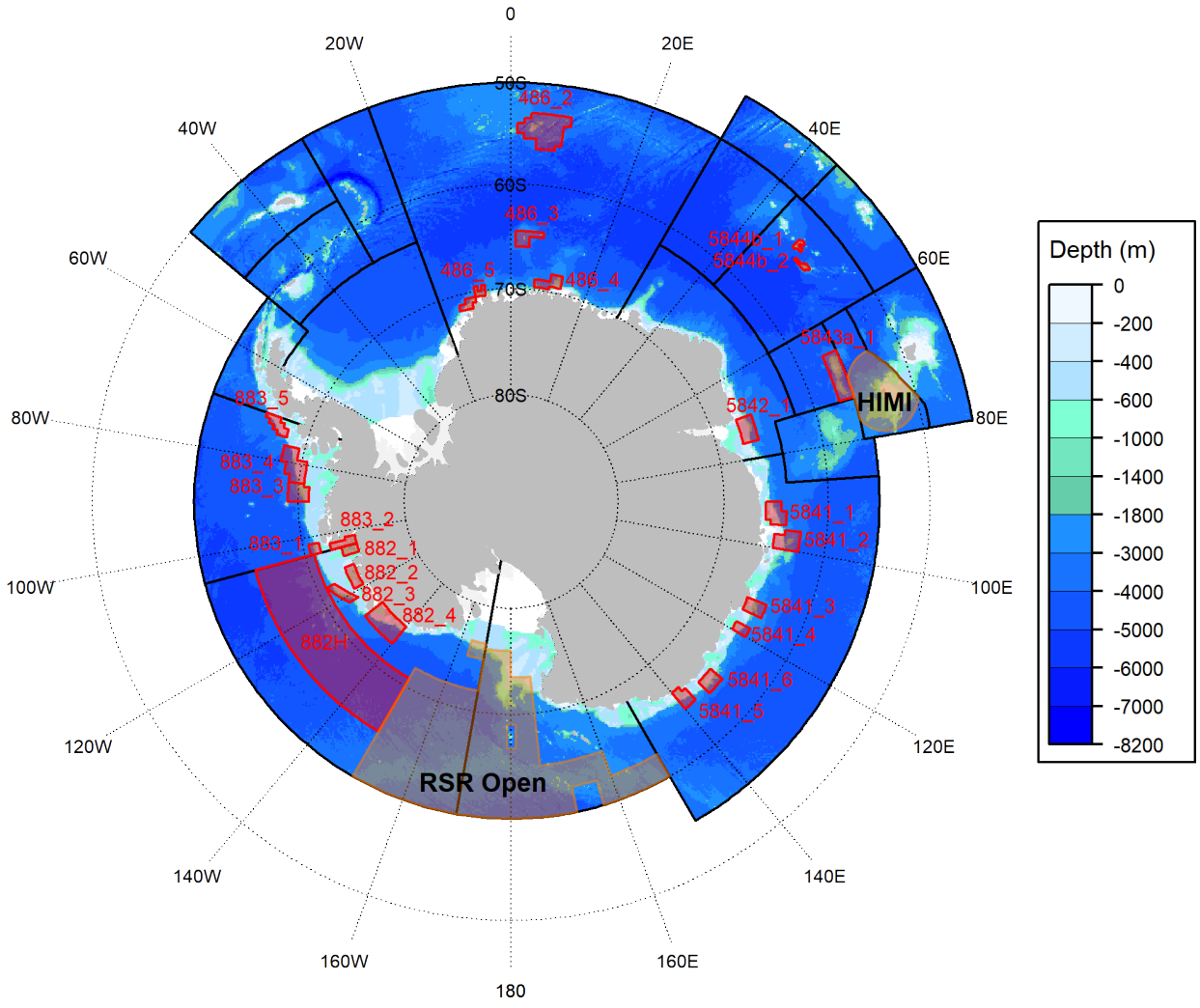

Figure 2: Location of the Reference Areas (orange) and Research Blocks (red) for which the trend analysis was last used. The fishable depth range (600m-1800m) is highlighted in shades of green.

Additional Resources

- Fishery Summary for Subarea 48.6: pdf, html
- Fishery Summary for Division 58.4.1: pdf, html
- Fishery Summary for Division 58.4.2: pdf, html
- Fishery Summary for Division 58.4.3a: pdf, html
- Fishery Summary for Division 58.4.4b: pdf, html
- Fishery Summary for Subarea 88.2: pdf, html
- Fishery Summary for Subarea 88.3: pdf, html
- Fisheries Documents Browser