CCAMLR's approach to data-limited exploratory toothfish fisheries: the trend analysis (2024).

CCAMLR Secretariat

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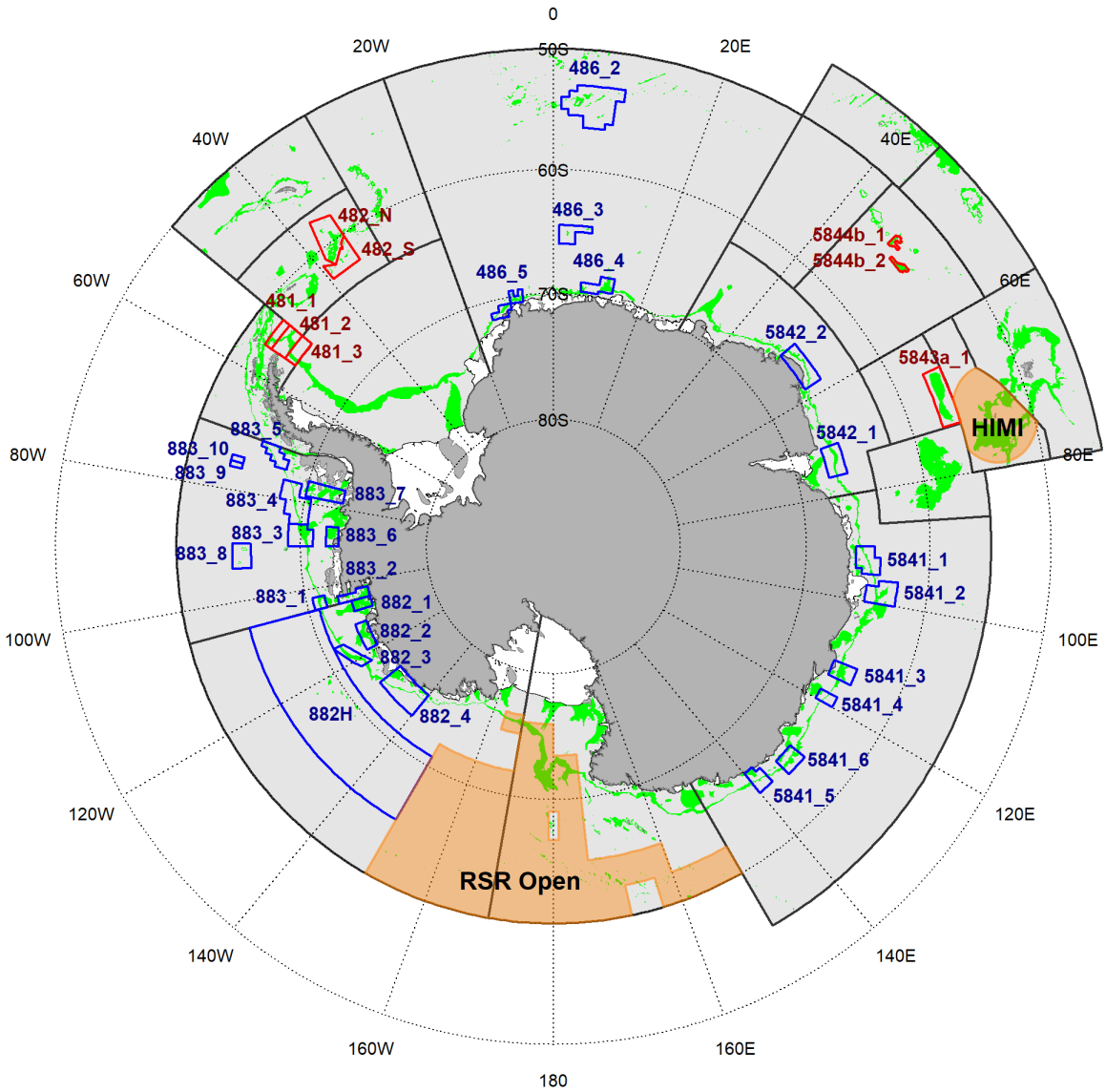

Figure 1: Research Blocks (red: catch advice not required ; blue: catch advice required) and Reference Areas (orange) in the Convention Area. The fishable depth range (600-1800m) is highlighted in green.

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 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 (*e.g.*, Casal2), 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:

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

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).

Applying the Chapman method, only fish that have been tagged and recaptured within a research block (after adding a 5km buffer, WG-SAM-16 para 2.47), and have been at liberty for 1 to 3 years, are included. Time-at-liberty is further constrained to a single year in 486_2, 486_3 and 882H, due to evidence of extensive migration in these areas that results in overestimates of biomass (WG-FSA-17, paras 4.37(iv), 4.78, 4.80). Finally, the trend in Chapman biomass estimates is only considered if a threshold of adequate recaptures is reached (at least 3 recaptures per year in at least 2 of the last 3 years WG-FSA-17, para 4.34).

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.

The time-series of biomass estimates (and their uncertainty; see WG-SAM-17/12 for details on the calculation of uncertainty) 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. 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.

Knowing the overall trend, whether there was an adequate number of recaptures and if the CPUE trend is declining enables a decision to be made based on the trend analysis decision rules. As a result, the recommended catch limit is computed in one of five ways (see Fig. 5):

- As equal to the previous catch limit, if fishing did not occur in the most recent season (see WG-FSA-2021 (para 4.2)),
- As 4% of the last CPUE estimate of biomass, if fishing occurred only in the last of the past five seasons (see WG-FSA-2022 (paras 4.62-4.63)),
- As 80% of the previous catch limit, if the overall trend is declining, or, if it is not declining but there is not an adequate number of recaptures and the CPUE is declining,

- As 4% of the last CPUE estimate of biomass (within bounds), if the overall trend is not declining, there is not an adequate number of recaptures and the CPUE is increasing,
- As 4% of the last Chapman estimate of biomass (within bounds), if the overall trend is not declining and there is an adequate number of recaptures.

The trends in biomass estimates from the CPUE-by-seabed area and Chapman mark-recapture methods are shown in Figures 2-4. The outcomes of the trend analysis decision rules are shown in Figure 5, and the resulting biomass estimates and catch limits for the next fishing season arising from these rules are in Table 1.

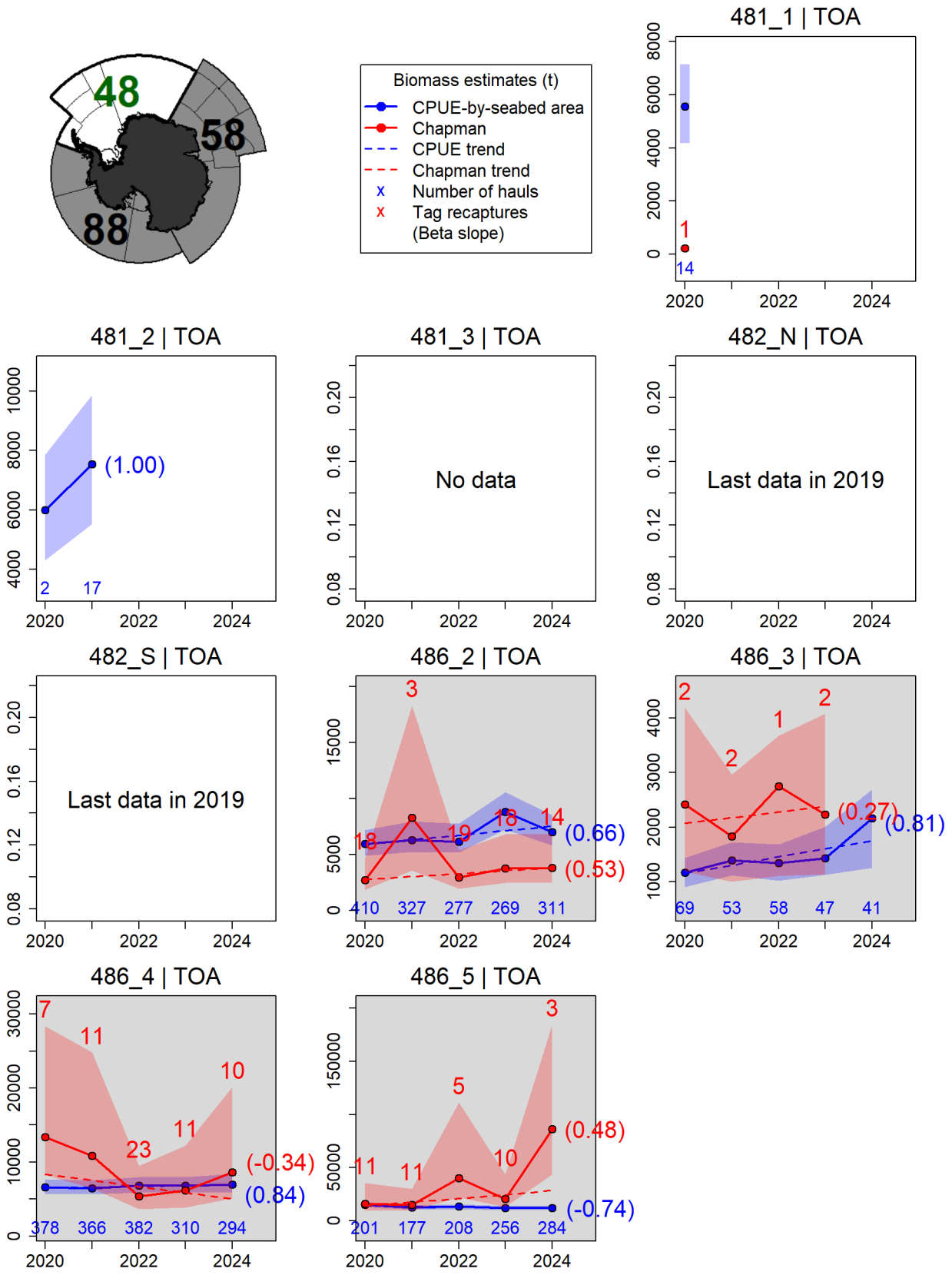

Figure 2: Annual biomass estimates (tonnes, with 95% confidence intervals) and updated trends (dashed lines) for each Research Block in Area 48. Grayed panels indicate those research blocks that require catch advice for the upcoming season. Numbers in parentheses correspond to slope coefficients (|values|>0.1 are deemed significant) of trends while the other numbers indicate sample sizes (red: recaptures, blue: hauls).

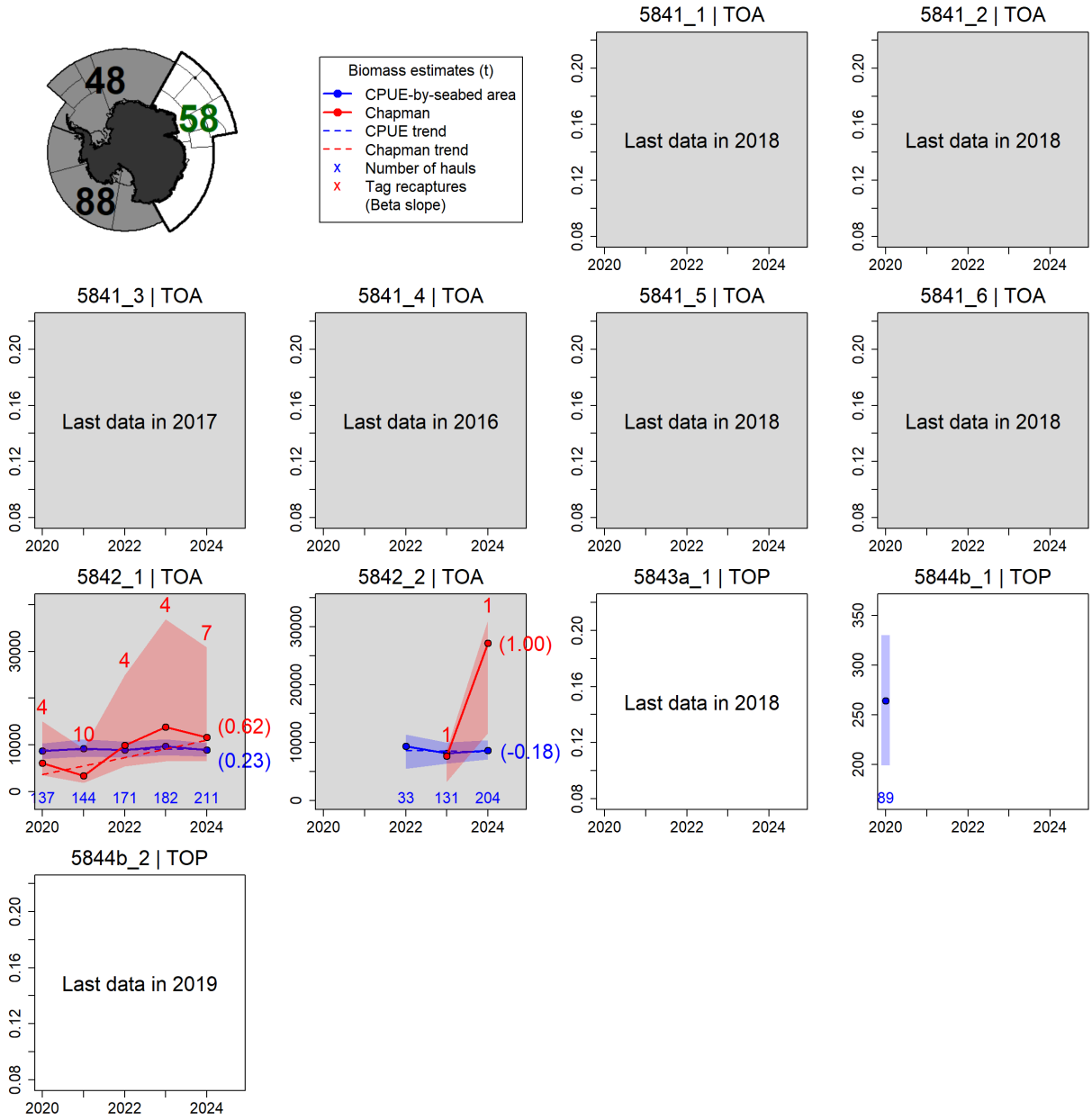

Figure 3: Annual biomass estimates (tonnes, with 95% confidence intervals) and updated trends (dashed lines) for each Research Block in Area 58. Grayed panels indicate those research blocks that require catch advice for the upcoming season. Numbers in parentheses correspond to slope coefficients (|values|>0.1 are deemed significant) of trends while the other numbers indicate sample sizes (red: recaptures, blue: hauls).

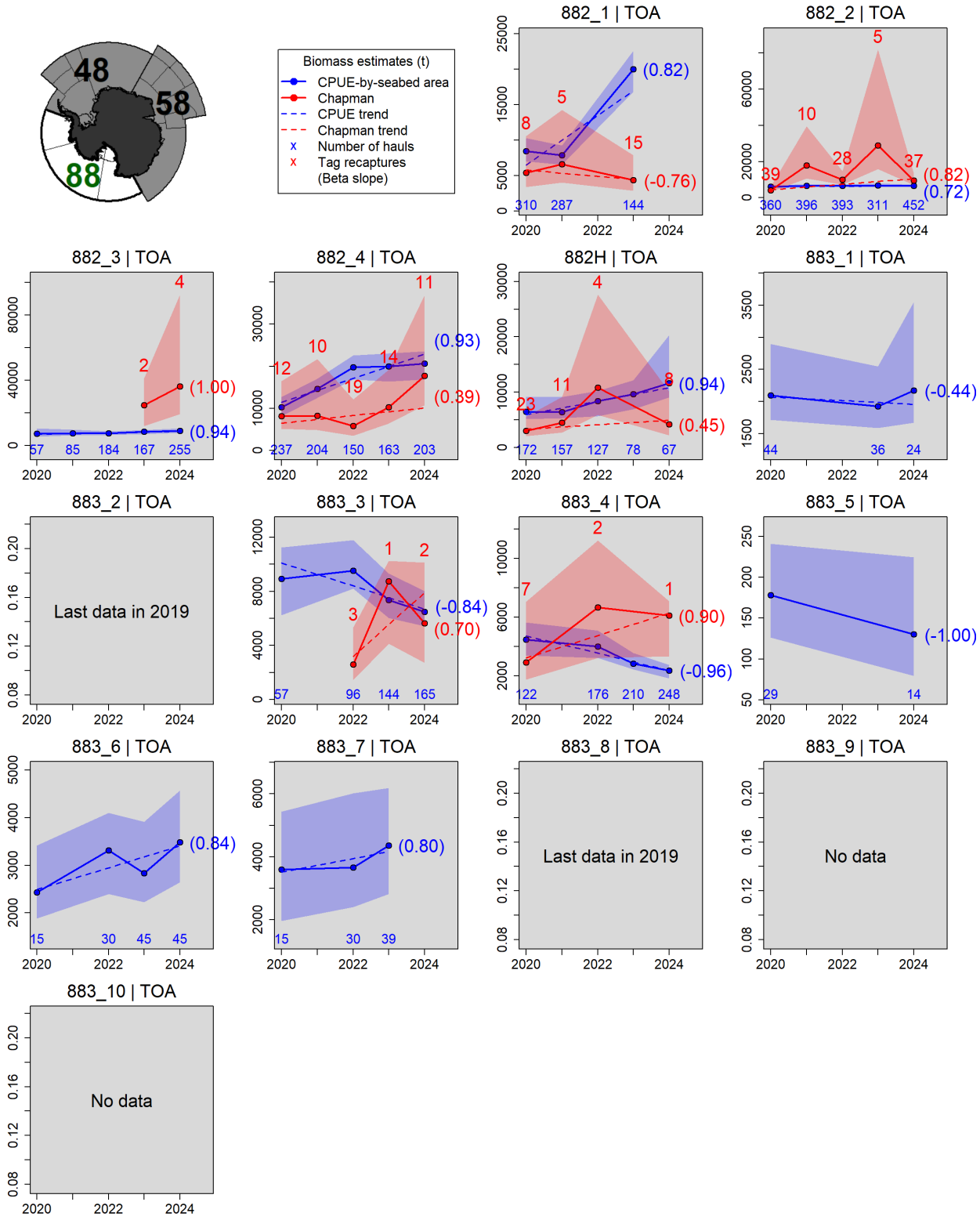

Figure 4: Annual biomass estimates (tonnes, with 95% confidence intervals) and updated trends (dashed lines) for each Research Block in Area 88. Grayed panels indicate those research blocks that require catch advice for the upcoming season. Numbers in parentheses correspond to slope coefficients (|values|>0.1 are deemed significant) of trends while the other numbers indicate sample sizes (red: recaptures, blue: hauls).

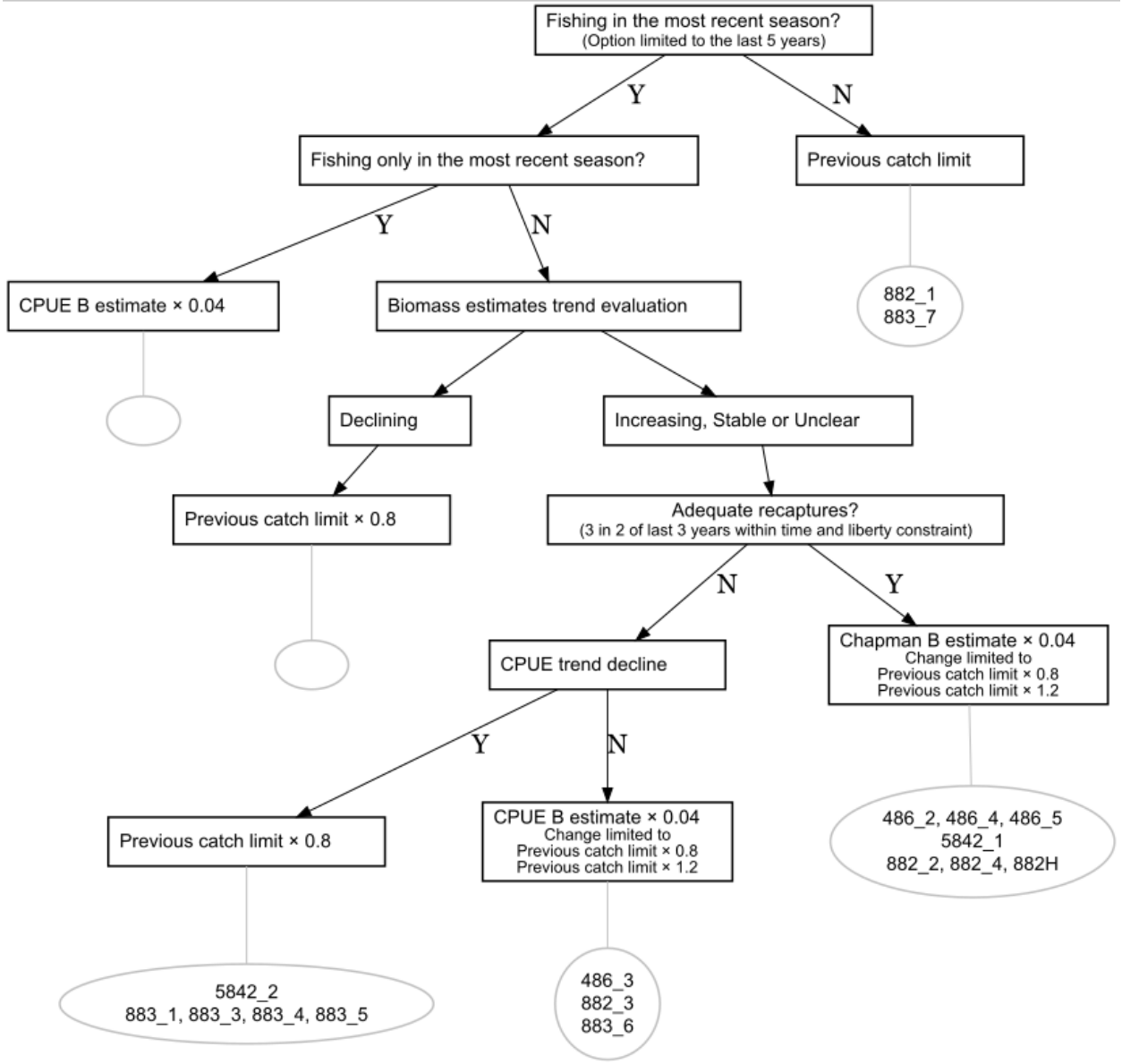

Figure 5: The decision tree of the trend analysis, showing where each Research Block (grey ovals) requiring catch advice belongs this year.

Table 1. Research Blocks biomasses (B, tonnes) and catch limits (CL, tonnes) estimated using the trend analysis. Grayed cells indicate research blocks that require catch advice for the upcoming season. PCL: previous catch limit; ISU: increasing, stable or unclear; D: declining; Y: yes; N: no; -: no fishing in the last Season; x: no fishing in the last 5 Seasons. Recommended catch limits are subject to approval by the Commission.

Area	Subarea or Division	Research Block	Species	PCL	Trend decision	Adequate recaptures	CPUE Trend Decline	B	Bx0.04	PCLx0.8	PCLx1.2	Recommended CL for 2025
48	48.1	481_1	*D. mawsoni*	43	-	-	-	-	-	-	-	43
		481_2	*D. mawsoni*	43	-	-	-	-	-	-	-	43
		481_3	*D. mawsoni*	0	x	x	x	x	x	x	x	x
	48.2	482_N	*D. mawsoni*	75	x	x	x	x	x	x	x	x
		482_S	*D. mawsoni*	75	x	x	x	x	x	x	x	x
	48.6	486_2	*D. mawsoni*	148	ISU	Y	N	3789	152	118	178	152
		486_3	*D. mawsoni*	42	ISU	N	N	2162	86	34	50	50
		486_4	*D. mawsoni*	126	ISU	Y	N	8580	343	101	151	151
		486_5	*D. mawsoni*	202	ISU	Y	Y	86299	3452	162	242	242
58	58.4.1	5841_1	*D. mawsoni*	112	x	x	x	x	x	x	x	x
		5841_2	*D. mawsoni*	80	x	x	x	x	x	x	x	x
		5841_3	*D. mawsoni*	79	x	x	x	x	x	x	x	x
		5841_4	*D. mawsoni*	46	x	x	x	x	x	x	x	x
		5841_5	*D. mawsoni*	116	x	x	x	x	x	x	x	x
		5841_6	*D. mawsoni*	50	x	x	x	x	x	x	x	x
	58.4.2	5842_1	*D. mawsoni*	103	ISU	Y	N	11588	464	82	124	124
		5842_2	*D. mawsoni*	206	ISU	N	Y	8601	344	165	247	165
	58.4.3	5843a_1	*D. eleginoides*	0	x	x	x	x	x	x	x	x
	58.4.4	5844b_1	*D. eleginoides*	18	-	-	-	-	-	-	-	18
		5844b_2	*D. eleginoides*	14	x	x	x	x	x	x	x	x
88	88.2	882_1	*D. mawsoni*	184	-	-	-	-	-	-	-	184
		882_2	*D. mawsoni*	322	ISU	Y	N	9450	378	258	386	378
		882_3	*D. mawsoni*	242	ISU	N	N	8850	354	194	290	290
		882_4	*D. mawsoni*	222	ISU	Y	N	17726	709	178	266	266
		882H	*D. mawsoni*	146	ISU	Y	N	4155	166	117	175	166
	88.3	883_1	*D. mawsoni*	13	ISU	N	Y	2173	87	10	16	10
		883_2	*D. mawsoni*	20	x	x	x	x	x	x	x	x
		883_3	*D. mawsoni*	38	ISU	N	Y	6471	259	30	46	30
		883_4	*D. mawsoni*	38	ISU	N	Y	2378	95	30	46	30
		883_5	*D. mawsoni*	8	ISU	N	Y	130	5	6	10	6
		883_6	*D. mawsoni*	43	ISU	N	N	3485	139	34	52	52
		883_7	*D. mawsoni*	43	-	-	-	-	-	-	-	43
		883_8	*D. mawsoni*	10	x	x	x	x	x	x	x	x
		883_9	*D. mawsoni*	10	x	x	x	x	x	x	x	x
		883_10	*D. mawsoni*	10	x	x	x	x	x	x	x	x

Additional Resources

- Fishery Summary for Subarea 48.1: pdf, html
- Fishery Summary for Subarea 48.2: pdf, html
- 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 58.4.3: pdf, html
- Fishery Summary for Division 58.4.4: pdf, html
- Fishery Summary for Subarea 88.2: pdf, html
- Fishery Summary for Subarea 88.3: pdf, html
- Fisheries Documents Browser