

Short-term projections of the South African anchovy resource using constant catch scenarios

C.L. de Moor*

Correspondence email: carryn.demoor@uct.ac.za

Abstract

This document considers the short- and medium-term impact of a range of future constant catch scenarios on the anchovy resource to assist the SWG-PEL in making a scientifically justified initial anchovy TAC recommendation. Projections are considered under three alternative models and a range of future recruitment scenarios or 'regimes'. Results have been provided for both the 'impact' of the catch scenarios on the resource (by comparing catch to no catch projections) and the depletion of the resource (by comparing catch to Dynamic B_0 projections).

Introduction

In January 2020 the Small Pelagic Scientific Working Group (SWG-PEL) declared Exceptional Circumstances for the South African anchovy resource as a result of (among other things) lower than previously expected recruitment resulting in recent survey estimates being outside the range assumed when OMP-18 (de Moor 2018) was simulation tested. The Total Allowable Catch (TAC) that would have been recommended under OMP-18 was thus set aside. An interim initial anchovy TAC was recommended to allow a start to the anchovy fishery while further analyses were undertaken. This document considers the short- and medium-term impact of a range of constant catch scenarios on the anchovy resource to assist the SWG-PEL in making a scientifically justified initial anchovy TAC recommendation.

Methods

The baseline assessment of the anchovy resource from which short-term projections were undertaken is given in de Moor (2020a). Two sensitivity tests were also considered important for short-term projections: that of assuming natural mortality of all ages increased from 1.2year^{-1} to 2.0year^{-1} from 2017 onwards (A_8 of de Moor (2020b)), and that of assuming a different time-invariant maturity ogive (A_1 of de Moor (2020b)).

The model used for projections, based on the recent updated assessment and key sensitivity tests, is detailed in Appendix A. Although the baseline assessment assumed a Beverton-Holt stock recruitment relationship, future recruitments are drawn from values corresponding to different proportions of the average historical recruitment of the full time series (Table 1). It is possible that anchovy recruitment prior to 1999 was part of a different 'regime' to that from 2000, and recent recruitments may possibly reflect a new 'regime' that is lower than that experienced since the start of the 21st century (see Figure 2 of de Moor (2020c)). Fixing future recruitments at different proportions of the average historical recruitment level allows for easier comparison of assumed recruitment in the short-term future based on different hypotheses of whether or not recruitment is, for example, on a downward trend or in a new 'regime'.

Each assessment provided a single set of model parameters at the joint posterior mode, including numbers-at-length (age) and biomass in November 2019 from which projections were initiated. A likelihood profile of the model predicted November survey

* MARAM (Marine Resource Assessment and Management Group), Department of Mathematics and Applied Mathematics, University of Cape Town, Rondebosch, 7701, South Africa.

biomass in 2019 was calculated from AD Model Builder output (Figure 1). Some variability in the November 2019 starting point for projections was thus incorporated by adjusting the numbers-at-age¹ such that, for simulation i , $1 \leq i \leq 100$, $N_{2019,a}^{A,i} = p_i N_{2019,a}^A$, where $p_i = B_i^{sample} / (k_N^A B_{2019}^A)$, and B_{2019}^A denotes the model predicted total biomass in November 2019 and B_i^{sample} denotes the survey biomass sampled from the likelihood profile.

Four sets of results were considered, to separately indicate the impact of two key uncertainties in the projections – that of variability in future recruitment and that of uncertainty in the initial starting point:

- 1) Deterministic projections (i.e. Appendix A only).
- 2) Including recruitment variability, assuming $N_{y,0}^{A,i} = N_{y,0}^A e^{\varepsilon_y^{A,i}}$, with $\varepsilon_y^{A,i} \sim N(0, 0.67^2)$, where the standard deviation is given by the CV of the recruitment time series and/or the estimated Beverton Holt σ_r^A (de Moor (2020b)).
- 3) Including variability in the November 2019 numbers-at-age using the likelihood profile as detailed in the previous paragraph.
- 4) Including both recruitment variability and variability in the November 2019 numbers-at-age.

As projections are considered under a range of future catch scenarios, including no future catch, the future impact of different levels of catch on the population can be evaluated by comparing projections to the no catch scenario. These projections all begin from the same estimated 2019 population numbers and biomass level.

A historical time series of Dynamic B_0 has also been estimated, suggesting a 70% depletion in 2019 under A_0 (de Moor 2020b). The Dynamic SSB_0 in 2019 was estimated at 1375 000t, and the average Dynamic SSB_0 over the most recent 5 years was 1791 000t. The future depletion of the population can be considered by comparing projections under alternative future catch scenarios to the Dynamic SSB_0 . However, rather than comparing to the Dynamic SSB_0 estimated in recent years, given that the scenarios considered here assume different future recruitment “regimes”, a no future catch scenario is projected from the Dynamic B_0 time series under the identical future recruitment and variability assumptions to allow for comparable estimates of depletion. Each model (A_0 , A_1 and A_8) has a different historical and future Dynamic B_0 time series conditioned with the different model assumptions.

Results

Baseline

The spawner biomass under alternative recruitment and future constant catch scenarios is shown in Figure 2 for the deterministic option and Figure 3 for the option including both recruitment and initial starting point variability. Similar figures for the options including either recruitment or initial variability, but not both are given in Appendix B. Initial variability has a short term (1-2 year) impact only. Figures 4 and 5 show the spawner biomass under alternative recruitment and future constant catch scenarios relative to a no future catch scenario for the deterministic and both recruitment and initial variability options, respectively.

Appendix C shows the model predicted biomass and relative biomass under all scenarios.

¹ The spawning biomass in 2019 was similarly adjusted for the purpose of reporting statistics only.

Table 2 gives the spawner biomass in (a) 2020 and (b) 2029 relative to that in 2019 and this ratio under catch compared to a no catch scenario. Table D.2 gives the spawner biomass in 2021 relative to that in 2019 and this ratio under catch compared to a no catch scenario. The probability of the risk threshold being breached is also given in these Tables. For example, under the 50% future recruitment scenario, the deterministic ratio of spawner biomass projected in 2020 to that in 2019 under a catch to that under a no catch scenario would (obviously) be 1 if future catch were 0, but this decreases to 0.86 if future catch is 300 000t (Table 2a). When considering variability (right side of the table) the 5%ile, 20%ile and median of the ratio of the ratios is 0.77, 0.82 and 0.86 under 300 000t. The risk to the resource in 1 year is 1% and over 10 years is 6% (Table 2a). After 10 years of constant catch of 300 000t, the 5%ile, 20%ile and median of the ratio of the ratios is 0.59, 0.71 and 0.78 with a 7% risk in 2029 (Table 2b).

While Tables 2a and 2b consider the percentiles of the ratios, Table 2c considers the ratios of the percentiles for these and other statistics to consider the shift in the distributions of spawner biomass over time under the various catch and future recruitment scenarios considered.

Table 2d gives the projected depletion of the resource, i.e. the short and medium term projected spawner biomass compared to the spawner biomass projected by the Dynamic B_0 model. For example, under the 50% future recruitment scenario, the deterministic ratio of spawner biomass projected in 2020 to the Dynamic SSB_0 in 2019 is 0.72 under a no catch scenario and 0.62 under 300 000t (1st set of columns), while the 'comparative depletion' in 2020 is 0.84 (no catch) and 0.72 (300 000t) (2nd set of columns). After 10 years of constant catch (last set of columns), the deterministic depletion is 1 for the no catch scenario as there have been sufficient no catch years for the population to return to Dynamic B_0 . Under 300 000t the deterministic depletion is 0.75 in 2029, with the 5%ile, 20%ile and 50%ile being 0.33, 0.58 and 0.91, respectively.

Table 2e considers the shift in the depletion of the distributions over time under the various catch and future recruitment scenarios considered.

While the %iles of the ratios calculated for each simulation (i.e. Tables 2a,b,d) are the statistics one would typically consider, Tables 2c,e which give the ratios of the %iles of the distributions, provide a useful comparison with the Figures.

As should be expected, the (spawner) biomass is projected to decrease as both future recruitment scenarios lower and as future catch scenarios increase. Accordingly, the depletion level is projected to increase both under decreasing future recruitment scenarios and under increasing future catch scenarios.

Sensitivity tests

The summary statistics from the alternative models A_1 and A_8 are given in Tables 3 and 4, respectively. The relative impact of the alternative catch scenarios compared to no catch scenario is greater under A_1 and A_8 compared to A_0 and the risk to the resource is higher (substantially so under A_8). However, under A_8 – which implicitly estimates recruitment in recent years to have been higher with the higher natural mortality accounting for the decrease in the population between the recruitment in May and the biomass in November - it is realistic to consider a higher future recruitment scenario to that under A_0 (Table 1).

Discussion

This document has provided short- and medium-term projections for the South African anchovy resource under three alternative models and a range of future constant catch scenarios. Results have been provided for both the 'impact' of the catch scenarios on the resource (by comparing catch to no catch projections) and the depletion of the resource (by comparing catch to Dynamic B_0 projections).

The methods used and results considered have been drawn both on that used to set the 2019 sardine TAC and TABs (de Moor 2019) and from recommendations by the International Review Panel (Die *et al.* 2019). By considering the impact and depletion statistics under different future recruitment scenarios one is able to more fairly determine the impact of the catch on the population status separately from the impact of future (highly variable) recruitment on the population biomass. However, the risk to the resource does increase as future recruitment scenarios decrease, and increase over time. As recommended, a lower proportion of the available biomass should be allocated to the fishery when the spawner biomass is low (Die *et al.* 2019). It is therefore recommended that these results only be used to recommend an anchovy TAC for 2020 and not a constant catch TAC for multiple years.

Acknowledgements

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Table 1. Future November recruitment (in billions) at different proportions of the historical (1984-2018) average recruitment, under the alternative models. The 100% and 50% of the average recruitment in the most recent 5 and 2 years is also given.

	A ₀			A ₁			A ₈		
	1984-2018	2014-18	2017-18	1984-2018	2014-18	2017-18	1984-2018	2014-18	2017-18
100%	723.9	515.8	366.1	529.9	385.3	276.4	797.2	1011.3	998.4
75%	542.9			397.5			597.9		
50%	361.9	257.9	183.1	265.0	192.7	138.2	398.6	505.6	499.2
40%	289.5			212.0			318.9		
30%	217.2			159.0			239.1		
20%	144.8			106.0			159.4		

Table 2a. The 5%ile, 20%ile and median of the ratio of spawner biomass in **2020** to that in 2019 and this ratio under the catch scenario as a proportion of that under the no catch scenario for **A₀**. The probability that the spawner biomass in **2020** and over the 10 year projection period is below the risk threshold of the 1996 level is also given. Results here are for the 1) deterministic and 4) including both recruitment and initial variability scenarios. Results for 2) recruitment variability only and 3) initial variability only are given in Table D.1. Results are given for different proportions (100%, 75%, 50%, 40%, 30%, 20%) of historical average recruitment and different future constant catch scenarios.

Rec	Catch	Deterministic								Recruitment and Initial variability							
		R=SSB ₂₀₂₀ :SSB ₂₀₁₉			R ^{Catch} :R ^{NoCatch}			R ^{risk} ₂₀	R ^{risk} _{all}	R=SSB ₂₀₂₀ :SSB ₂₀₁₉			R ^{Catch} :R ^{NoCatch}			R ^{risk} ₂₀	R ^{risk} _{all}
		5%	20%	50%	5%	20%	50%			5%	20%	50%	5%	20%	50%		
100%	0	1.61	1.61	1.61	1.00	1.00	1.00	0.00	0.00	0.86	1.12	1.63	1.00	1.00	1.00	0.00	0.00
	50	1.59	1.59	1.59	0.98	0.98	0.98	0.00	0.00	0.84	1.10	1.60	0.97	0.98	0.99	0.00	0.00
	100	1.56	1.56	1.56	0.97	0.97	0.97	0.00	0.00	0.81	1.07	1.58	0.95	0.96	0.97	0.00	0.00
	150	1.53	1.53	1.53	0.95	0.95	0.95	0.00	0.00	0.79	1.05	1.55	0.92	0.94	0.95	0.00	0.00
	200	1.51	1.51	1.51	0.94	0.94	0.94	0.00	0.00	0.77	1.03	1.53	0.89	0.92	0.94	0.00	0.00
	250	1.48	1.48	1.48	0.92	0.92	0.92	0.00	0.00	0.74	1.01	1.50	0.86	0.89	0.92	0.00	0.00
	300	1.46	1.46	1.46	0.91	0.91	0.91	0.00	0.00	0.72	0.98	1.48	0.83	0.87	0.91	0.00	0.00
75%	0	1.32	1.32	1.32	1.00	1.00	1.00	0.00	0.00	0.76	0.96	1.34	1.00	1.00	1.00	0.00	0.00
	50	1.30	1.30	1.30	0.98	0.98	0.98	0.00	0.00	0.74	0.93	1.31	0.97	0.97	0.98	0.00	0.00
	100	1.27	1.27	1.27	0.96	0.96	0.96	0.00	0.00	0.71	0.91	1.29	0.94	0.95	0.96	0.00	0.00
	150	1.25	1.25	1.25	0.94	0.94	0.94	0.00	0.00	0.69	0.89	1.26	0.91	0.93	0.94	0.00	0.00
	200	1.22	1.22	1.22	0.92	0.92	0.92	0.00	0.00	0.67	0.86	1.24	0.88	0.90	0.93	0.00	0.00
	250	1.20	1.20	1.20	0.91	0.91	0.91	0.00	0.00	0.64	0.84	1.21	0.84	0.88	0.91	0.00	0.00
	300	1.17	1.17	1.17	0.89	0.89	0.89	0.00	0.00	0.61	0.82	1.19	0.80	0.85	0.89	0.00	0.00
50%	0	1.03	1.03	1.03	1.00	1.00	1.00	0.00	0.00	0.66	0.79	1.04	1.00	1.00	1.00	0.00	0.00
	50	1.01	1.01	1.01	0.98	0.98	0.98	0.00	0.00	0.64	0.77	1.02	0.97	0.97	0.98	0.00	0.00
	100	0.98	0.98	0.98	0.95	0.95	0.95	0.00	0.00	0.61	0.75	0.99	0.93	0.94	0.95	0.00	0.01
	150	0.96	0.96	0.96	0.93	0.93	0.93	0.00	0.00	0.59	0.72	0.97	0.89	0.91	0.93	0.00	0.02
	200	0.94	0.94	0.94	0.90	0.90	0.90	0.00	0.00	0.56	0.70	0.94	0.85	0.88	0.91	0.00	0.03
	250	0.91	0.91	0.91	0.88	0.88	0.88	0.00	0.00	0.53	0.67	0.92	0.81	0.85	0.88	0.00	0.04
	300	0.89	0.89	0.89	0.86	0.86	0.86	0.00	0.00	0.51	0.65	0.89	0.77	0.82	0.86	0.01	0.06
40%	0	0.92	0.92	0.92	1.00	1.00	1.00	0.00	0.00	0.62	0.72	0.93	1.00	1.00	1.00	0.00	0.01
	50	0.89	0.89	0.89	0.97	0.97	0.97	0.00	0.00	0.60	0.70	0.90	0.96	0.97	0.97	0.00	0.02
	100	0.87	0.87	0.87	0.95	0.95	0.95	0.00	0.00	0.57	0.68	0.88	0.93	0.94	0.95	0.00	0.04
	150	0.84	0.84	0.84	0.92	0.92	0.92	0.00	0.00	0.54	0.65	0.85	0.88	0.90	0.92	0.00	0.06
	200	0.82	0.82	0.82	0.89	0.89	0.89	0.00	0.00	0.52	0.63	0.83	0.84	0.87	0.89	0.01	0.08
	250	0.80	0.80	0.80	0.87	0.87	0.87	0.00	0.00	0.49	0.60	0.80	0.80	0.83	0.87	0.01	0.11
	300	0.77	0.77	0.77	0.84	0.84	0.84	0.00	0.00	0.47	0.58	0.78	0.76	0.80	0.84	0.02	0.14
30%	0	0.80	0.80	0.80	1.00	1.00	1.00	0.00	0.00	0.58	0.66	0.81	1.00	1.00	1.00	0.00	0.06
	50	0.78	0.78	0.78	0.97	0.97	0.97	0.00	0.00	0.55	0.63	0.78	0.96	0.97	0.97	0.00	0.09
	100	0.75	0.75	0.75	0.94	0.94	0.94	0.00	0.00	0.53	0.61	0.76	0.92	0.93	0.94	0.00	0.13
	150	0.73	0.73	0.73	0.91	0.91	0.91	0.00	0.00	0.50	0.59	0.74	0.87	0.89	0.91	0.01	0.18
	200	0.71	0.71	0.71	0.88	0.88	0.88	0.00	0.00	0.48	0.56	0.71	0.83	0.85	0.88	0.02	0.23
	250	0.68	0.68	0.68	0.85	0.85	0.85	0.00	0.00	0.45	0.54	0.69	0.78	0.82	0.85	0.03	0.28
	300	0.66	0.66	0.66	0.82	0.82	0.82	0.00	0.64	0.43	0.51	0.66	0.75	0.78	0.82	0.04	0.33
20%	0	0.69	0.69	0.69	1.00	1.00	1.00	0.00	0.00	0.54	0.59	0.69	1.00	1.00	1.00	0.00	0.25
	50	0.66	0.66	0.66	0.97	0.97	0.97	0.00	0.64	0.51	0.57	0.67	0.96	0.96	0.97	0.00	0.32
	100	0.64	0.64	0.64	0.93	0.93	0.93	0.00	0.73	0.49	0.54	0.64	0.91	0.92	0.93	0.01	0.40
	150	0.61	0.61	0.61	0.89	0.89	0.89	0.00	0.73	0.46	0.52	0.62	0.86	0.88	0.89	0.02	0.47
	200	0.59	0.59	0.59	0.86	0.86	0.86	0.00	0.82	0.44	0.50	0.59	0.81	0.84	0.86	0.04	0.52
	250	0.57	0.57	0.57	0.82	0.82	0.82	0.00	0.82	0.42	0.47	0.57	0.78	0.80	0.82	0.05	0.57
	300	0.54	0.54	0.54	0.79	0.79	0.79	0.00	0.82	0.41	0.44	0.54	0.77	0.75	0.79	0.08	0.61

Table 2b. The 5%ile, 20%ile and median of the ratio of spawner biomass in **2029** to that in 2019 and this ratio under the catch scenario as a proportion of that under the no catch scenario for **A₀**. The probability that the spawner biomass in **2021** and over the 10 year projection period is below the risk threshold of the 1996 level is also given. Results here are for the 1) deterministic and 4) including both recruitment and initial variability scenarios. Results are given for different proportions (100%, 75%, 50%, 40%, 30%, 20%) of historical average recruitment and different future constant catch scenarios.

Rec	Catch	Deterministic								Recruitment and Initial variability							
		R=SSB ₂₀₂₉ :SSB ₂₀₁₉			R ^{Catch} :R ^{NoCatch}			R ^{risk} ₂₉	R ^{risk} _{all}	R=SSB ₂₀₂₉ :SSB ₂₀₁₉			R ^{Catch} :R ^{NoCatch}			R ^{risk} ₂₉	R ^{risk} _{all}
		5%	20%	50%	5%	20%	50%			5%	20%	50%	5%	20%	50%		
100%	0	2.15	2.15	2.15	1.00	1.00	1.00	0.00	0.00	1.22	1.71	2.54	1.00	1.00	1.00	0.00	0.00
	50	2.11	2.11	2.11	0.98	0.98	0.98	0.00	0.00	1.18	1.67	2.49	0.97	0.98	0.98	0.00	0.00
	100	2.06	2.06	2.06	0.96	0.96	0.96	0.00	0.00	1.15	1.62	2.44	0.94	0.95	0.96	0.00	0.00
	150	2.02	2.02	2.02	0.94	0.94	0.94	0.00	0.00	1.10	1.58	2.39	0.90	0.93	0.94	0.00	0.00
	200	1.98	1.98	1.98	0.92	0.92	0.92	0.00	0.00	1.06	1.54	2.34	0.87	0.90	0.92	0.00	0.00
	250	1.93	1.93	1.93	0.90	0.90	0.90	0.00	0.00	1.02	1.49	2.29	0.83	0.88	0.90	0.00	0.00
	300	1.89	1.89	1.89	0.88	0.88	0.88	0.00	0.00	0.98	1.45	2.25	0.80	0.85	0.89	0.00	0.00
75%	0	1.61	1.61	1.61	1.00	1.00	1.00	0.00	0.00	0.92	1.28	1.90	1.00	1.00	1.00	0.00	0.00
	50	1.57	1.57	1.57	0.97	0.97	0.97	0.00	0.00	0.88	1.24	1.86	0.96	0.97	0.97	0.00	0.00
	100	1.53	1.53	1.53	0.95	0.95	0.95	0.00	0.00	0.84	1.20	1.81	0.92	0.94	0.95	0.00	0.00
	150	1.48	1.48	1.48	0.92	0.92	0.92	0.00	0.00	0.80	1.15	1.76	0.87	0.90	0.92	0.00	0.00
	200	1.44	1.44	1.44	0.89	0.89	0.89	0.00	0.00	0.75	1.11	1.71	0.82	0.87	0.90	0.00	0.00
	250	1.39	1.39	1.39	0.86	0.86	0.86	0.00	0.00	0.71	1.07	1.67	0.78	0.83	0.88	0.00	0.00
	300	1.35	1.35	1.35	0.84	0.84	0.84	0.00	0.00	0.67	1.03	1.62	0.73	0.80	0.85	0.00	0.00
50%	0	1.08	1.08	1.08	1.00	1.00	1.00	0.00	0.00	0.61	0.85	1.27	1.00	1.00	1.00	0.00	0.00
	50	1.03	1.03	1.03	0.96	0.96	0.96	0.00	0.00	0.57	0.81	1.22	0.94	0.95	0.96	0.00	0.00
	100	0.99	0.99	0.99	0.92	0.92	0.92	0.00	0.00	0.53	0.77	1.17	0.87	0.90	0.92	0.01	0.01
	150	0.94	0.94	0.94	0.88	0.88	0.88	0.00	0.00	0.49	0.73	1.13	0.80	0.85	0.89	0.01	0.02
	200	0.90	0.90	0.90	0.84	0.84	0.84	0.00	0.00	0.45	0.68	1.08	0.73	0.80	0.85	0.03	0.03
	250	0.86	0.86	0.86	0.80	0.80	0.80	0.00	0.00	0.40	0.65	1.03	0.66	0.76	0.82	0.05	0.04
	300	0.81	0.81	0.81	0.75	0.75	0.75	0.00	0.00	0.36	0.60	0.99	0.59	0.71	0.78	0.07	0.06
40%	0	0.86	0.86	0.86	1.00	1.00	1.00	0.00	0.00	0.49	0.68	1.02	1.00	1.00	1.00	0.01	0.01
	50	0.82	0.82	0.82	0.95	0.95	0.95	0.00	0.00	0.45	0.64	0.97	0.92	0.94	0.95	0.02	0.02
	100	0.77	0.77	0.77	0.90	0.90	0.90	0.00	0.00	0.41	0.60	0.92	0.83	0.88	0.90	0.04	0.04
	150	0.73	0.73	0.73	0.85	0.85	0.85	0.00	0.00	0.37	0.55	0.87	0.75	0.81	0.86	0.07	0.06
	200	0.68	0.68	0.68	0.80	0.80	0.80	0.00	0.00	0.32	0.52	0.83	0.66	0.76	0.82	0.10	0.08
	250	0.64	0.64	0.64	0.74	0.74	0.74	0.00	0.00	0.28	0.47	0.79	0.57	0.70	0.77	0.13	0.11
	300	0.59	0.59	0.59	0.69	0.69	0.69	0.00	0.00	0.23	0.43	0.74	0.48	0.63	0.72	0.17	0.14
30%	0	0.65	0.65	0.65	1.00	1.00	1.00	0.00	0.00	0.37	0.51	0.76	1.00	1.00	1.00	0.07	0.06
	50	0.60	0.60	0.60	0.93	0.93	0.93	0.00	0.00	0.33	0.47	0.71	0.89	0.92	0.94	0.10	0.09
	100	0.56	0.56	0.56	0.86	0.86	0.86	0.00	0.00	0.28	0.43	0.67	0.78	0.83	0.88	0.15	0.13
	150	0.51	0.51	0.51	0.80	0.80	0.80	0.00	0.00	0.24	0.39	0.62	0.66	0.76	0.82	0.21	0.18
	200	0.47	0.47	0.47	0.73	0.73	0.73	0.00	0.00	0.20	0.34	0.58	0.54	0.67	0.76	0.25	0.23
	250	0.42	0.42	0.42	0.66	0.66	0.66	0.00	0.00	0.16	0.31	0.53	0.43	0.60	0.70	0.32	0.28
	300	0.38	0.38	0.38	0.59	0.59	0.59	1.00	0.64	0.13	0.27	0.48	0.35	0.53	0.63	0.39	0.33
20%	0	0.43	0.43	0.43	1.00	1.00	1.00	0.00	0.00	0.24	0.34	0.51	1.00	1.00	1.00	0.29	0.25
	50	0.39	0.39	0.39	0.90	0.90	0.90	1.00	0.64	0.20	0.30	0.46	0.83	0.88	0.90	0.39	0.32
	100	0.34	0.34	0.34	0.80	0.80	0.80	1.00	0.73	0.16	0.26	0.41	0.66	0.76	0.82	0.48	0.40
	150	0.30	0.30	0.30	0.69	0.69	0.69	1.00	0.73	0.12	0.22	0.37	0.48	0.63	0.72	0.56	0.47
	200	0.25	0.25	0.25	0.59	0.59	0.59	1.00	0.82	0.09	0.18	0.32	0.35	0.53	0.63	0.64	0.52
	250	0.21	0.21	0.21	0.48	0.48	0.48	1.00	0.82	0.07	0.14	0.28	0.27	0.42	0.55	0.71	0.57
	300	0.16	0.16	0.16	0.36	0.36	0.36	1.00	0.82	0.05	0.11	0.25	0.22	0.32	0.48	0.76	0.61

Table 2c. The ratios of (a) the deterministic scenario and (b) the 5%ile, 20%ile and median of the recruitment and initial variability scenario for model A_0 for i) the spawner biomass in 2020 under alternative catch scenarios to that estimated in 2019, ii) the spawner biomass in 2020 under alternative catch scenarios to that in 2029 under a no catch scenario and iii) the spawner biomass in 2029 under alternative catch scenarios to that in 2029 under a no catch scenario. Results are given for different proportions (100%, 75%, 50%, 40%, 30%, 20%) of historical average recruitment and different future constant catch scenarios.

	$SSB^C_{2020}:SSB^C_{2019}$				$SSB^C_{2020}:SSB^{noC}_{2029}$				$SSB^C_{2029}:SSB^{noC}_{2029}$				
	Det	5%	20%	50%	Det	5%	20%	50%	Det	5%	20%	50%	
100%	0	1.61	1.02	1.22	1.62								
	50	1.58	0.99	1.2	1.6	0.74	0.66	0.63	0.64	0.98	0.96	0.98	0.98
	100	1.56	0.96	1.17	1.57	0.73	0.64	0.61	0.63	0.96	0.93	0.95	0.96
	150	1.53	0.93	1.14	1.55	0.71	0.62	0.60	0.62	0.94	0.90	0.93	0.95
	200	1.51	0.90	1.12	1.52	0.70	0.60	0.58	0.61	0.92	0.86	0.90	0.93
	250	1.48	0.87	1.09	1.50	0.69	0.58	0.57	0.60	0.90	0.83	0.88	0.91
	300	1.46	0.84	1.06	1.47	0.68	0.56	0.56	0.59	0.88	0.79	0.85	0.89
75%	0	1.32	0.90	1.05	1.34								
	50	1.30	0.87	1.02	1.31	0.80	0.77	0.71	0.70	0.97	0.95	0.97	0.98
	100	1.27	0.84	0.99	1.29	0.79	0.74	0.69	0.69	0.95	0.91	0.94	0.95
	150	1.25	0.81	0.97	1.26	0.77	0.72	0.67	0.68	0.92	0.86	0.90	0.93
	200	1.22	0.78	0.94	1.24	0.76	0.69	0.65	0.66	0.89	0.82	0.87	0.91
	250	1.20	0.75	0.91	1.21	0.74	0.66	0.64	0.65	0.86	0.77	0.84	0.88
	300	1.17	0.72	0.88	1.19	0.73	0.64	0.62	0.64	0.84	0.72	0.80	0.86
50%	0	1.03	0.76	0.86	1.05								
	50	1.01	0.73	0.84	1.02	0.94	0.97	0.88	0.82	0.96	0.93	0.95	0.96
	100	0.98	0.7	0.81	1.00	0.92	0.94	0.85	0.80	0.92	0.86	0.90	0.93
	150	0.96	0.67	0.78	0.97	0.89	0.90	0.82	0.78	0.88	0.79	0.85	0.89
	200	0.93	0.64	0.76	0.95	0.87	0.86	0.79	0.76	0.84	0.72	0.8	0.86
	250	0.91	0.61	0.73	0.92	0.85	0.82	0.76	0.74	0.80	0.65	0.75	0.82
	300	0.89	0.58	0.71	0.90	0.82	0.78	0.74	0.72	0.75	0.58	0.71	0.79
40%	0	0.92	0.72	0.79	0.93								
	50	0.89	0.69	0.77	0.91	1.04	1.15	1.00	0.92	0.95	0.91	0.94	0.96
	100	0.87	0.66	0.74	0.89	1.01	1.10	0.97	0.89	0.90	0.83	0.88	0.91
	150	0.84	0.63	0.71	0.86	0.98	1.05	0.93	0.87	0.85	0.74	0.82	0.87
	200	0.82	0.60	0.69	0.84	0.95	1.00	0.9	0.84	0.80	0.65	0.75	0.82
	250	0.80	0.57	0.66	0.81	0.92	0.95	0.86	0.82	0.74	0.56	0.69	0.78
	300	0.77	0.54	0.63	0.79	0.90	0.90	0.83	0.79	0.69	0.48	0.63	0.73
30%	0	0.80	0.67	0.72	0.82								
	50	0.78	0.65	0.69	0.79	1.21	1.43	1.21	1.06	0.93	0.88	0.92	0.94
	100	0.75	0.62	0.67	0.77	1.17	1.36	1.16	1.03	0.86	0.77	0.84	0.88
	150	0.73	0.59	0.64	0.74	1.13	1.30	1.11	1.00	0.80	0.65	0.75	0.82
	200	0.70	0.56	0.61	0.72	1.09	1.23	1.07	0.97	0.73	0.53	0.67	0.76
	250	0.68	0.53	0.59	0.70	1.05	1.16	1.02	0.93	0.66	0.44	0.59	0.70
	300	0.66	0.51	0.56	0.67	1.02	1.12	0.97	0.90	0.58	0.35	0.51	0.64
20%	0	0.69	0.62	0.64	0.7								
	50	0.66	0.59	0.62	0.68	1.54	1.96	1.61	1.36	0.90	0.83	0.88	0.91
	100	0.64	0.56	0.59	0.65	1.49	1.86	1.54	1.31	0.80	0.65	0.75	0.82
	150	0.61	0.53	0.56	0.63	1.43	1.76	1.47	1.27	0.69	0.48	0.63	0.73
	200	0.59	0.50	0.54	0.60	1.37	1.67	1.40	1.22	0.58	0.35	0.51	0.64
	250	0.57	0.49	0.51	0.58	1.32	1.62	1.33	1.17	0.48	0.27	0.39	0.55
	300	0.54	0.47	0.49	0.56	1.26	1.56	1.28	1.12	0.36	0.23	0.31	0.48

Table 2d. The (a) deterministic and (b) 5%ile, 20%ile and median of recruitment and initial variability scenario model for A_0 of the ratio of spawner biomass in 2020 under alternative future catch scenarios to that in 2019, 2020 and 2029 under the no catch scenario projected from the Dynamic B_0 model. The final sets of columns gives the statistics for the ratio of spawner biomass in 2029 under alternative future catch scenarios to that in 2029 under the no catch scenario projected from the Dynamic B_0 model. Results are given for different proportions (100%, 75%, 50%, 40%, 30%, 20%) of historical average recruitment and different future constant catch scenarios.

	$SSB^C_{2020}:SSB^{B0}_{2019}$				$SSB^C_{2020}:SSB^{B0}_{2020}$				$SSB^C_{2020}:SSB^{B0}_{2029}$				$SSB^C_{2029}:SSB^{B0}_{2029}$				
	Det	5%	20%	50%	Det	5%	20%	50%	Det	5%	20%	50%	Det	5%	20%	50%	
100%	0	1.13	0.59	0.79	1.14	0.89	0.46	0.63	0.90	0.75	0.39	0.53	0.76	1.00	0.57	0.82	1.16
	50	1.11	0.57	0.77	1.12	0.88	0.45	0.61	0.89	0.74	0.38	0.51	0.74	0.98	0.55	0.80	1.13
	100	1.09	0.55	0.75	1.10	0.87	0.44	0.60	0.87	0.73	0.37	0.50	0.73	0.96	0.53	0.78	1.11
	150	1.07	0.53	0.74	1.08	0.85	0.42	0.59	0.86	0.71	0.36	0.49	0.72	0.94	0.51	0.76	1.09
	200	1.06	0.52	0.72	1.07	0.84	0.41	0.57	0.85	0.70	0.34	0.48	0.71	0.92	0.49	0.74	1.07
	250	1.04	0.50	0.70	1.05	0.82	0.40	0.56	0.83	0.69	0.33	0.47	0.70	0.90	0.47	0.72	1.05
	300	1.02	0.48	0.69	1.03	0.81	0.38	0.54	0.82	0.68	0.32	0.46	0.69	0.88	0.45	0.70	1.03
75%	0	0.92	0.51	0.67	0.94	0.87	0.49	0.64	0.88	0.82	0.46	0.60	0.83	1.00	0.57	0.82	1.16
	50	0.91	0.50	0.66	0.92	0.86	0.47	0.62	0.87	0.80	0.44	0.58	0.81	0.97	0.55	0.79	1.13
	100	0.89	0.48	0.64	0.90	0.84	0.45	0.60	0.85	0.79	0.43	0.57	0.80	0.95	0.52	0.77	1.10
	150	0.87	0.46	0.62	0.88	0.82	0.44	0.59	0.83	0.77	0.41	0.55	0.78	0.92	0.49	0.74	1.07
	200	0.85	0.45	0.60	0.87	0.81	0.42	0.57	0.82	0.76	0.40	0.54	0.77	0.89	0.47	0.71	1.05
	250	0.84	0.43	0.59	0.85	0.79	0.41	0.56	0.80	0.74	0.38	0.52	0.75	0.86	0.44	0.69	1.02
	300	0.82	0.41	0.57	0.83	0.78	0.39	0.54	0.78	0.73	0.36	0.51	0.74	0.84	0.41	0.66	0.99
50%	0	0.72	0.44	0.56	0.73	0.84	0.51	0.65	0.86	0.96	0.58	0.74	0.97	1.00	0.57	0.82	1.16
	50	0.71	0.42	0.54	0.72	0.82	0.49	0.63	0.84	0.94	0.56	0.72	0.95	0.96	0.53	0.78	1.11
	100	0.69	0.40	0.52	0.70	0.80	0.47	0.61	0.82	0.92	0.54	0.70	0.93	0.92	0.49	0.74	1.07
	150	0.67	0.39	0.51	0.68	0.78	0.45	0.59	0.80	0.89	0.51	0.67	0.91	0.88	0.45	0.70	1.03
	200	0.65	0.37	0.49	0.66	0.76	0.43	0.57	0.78	0.87	0.49	0.65	0.88	0.84	0.41	0.66	0.99
	250	0.64	0.35	0.47	0.65	0.74	0.41	0.55	0.76	0.85	0.47	0.63	0.86	0.80	0.37	0.62	0.95
	300	0.62	0.33	0.45	0.63	0.72	0.39	0.53	0.74	0.82	0.45	0.60	0.84	0.75	0.33	0.58	0.91
40%	0	0.64	0.41	0.51	0.65	0.83	0.53	0.66	0.84	1.07	0.69	0.85	1.09	1.00	0.57	0.82	1.16
	50	0.63	0.40	0.49	0.64	0.81	0.51	0.64	0.82	1.04	0.66	0.82	1.06	0.95	0.52	0.77	1.10
	100	0.61	0.38	0.48	0.62	0.78	0.49	0.62	0.80	1.01	0.63	0.79	1.03	0.90	0.47	0.72	1.05
	150	0.59	0.36	0.46	0.60	0.76	0.47	0.59	0.78	0.98	0.60	0.77	1.00	0.85	0.42	0.67	1.00
	200	0.57	0.35	0.44	0.59	0.74	0.45	0.57	0.75	0.95	0.58	0.74	0.97	0.80	0.37	0.62	0.95
	250	0.56	0.33	0.43	0.57	0.72	0.42	0.55	0.73	0.92	0.55	0.71	0.94	0.74	0.32	0.57	0.90
	300	0.54	0.31	0.41	0.55	0.70	0.40	0.53	0.71	0.90	0.52	0.68	0.92	0.69	0.28	0.52	0.85
30%	0	0.56	0.39	0.46	0.57	0.81	0.56	0.67	0.82	1.25	0.86	1.03	1.27	1.00	0.57	0.82	1.16
	50	0.54	0.37	0.45	0.56	0.78	0.53	0.64	0.80	1.21	0.82	0.99	1.23	0.93	0.51	0.75	1.09
	100	0.53	0.35	0.43	0.54	0.76	0.51	0.62	0.77	1.17	0.78	0.95	1.19	0.86	0.44	0.69	1.02
	150	0.51	0.34	0.41	0.52	0.73	0.48	0.59	0.75	1.13	0.74	0.91	1.15	0.80	0.37	0.62	0.95
	200	0.49	0.32	0.40	0.50	0.71	0.46	0.57	0.72	1.09	0.70	0.88	1.12	0.73	0.30	0.55	0.88
	250	0.48	0.30	0.38	0.49	0.69	0.43	0.54	0.70	1.06	0.67	0.84	1.08	0.66	0.25	0.48	0.81
	300	0.46	0.29	0.36	0.47	0.66	0.42	0.52	0.68	1.02	0.64	0.80	1.04	0.59	0.20	0.42	0.74
20%	0	0.48	0.35	0.41	0.49	0.78	0.58	0.68	0.80	1.60	1.18	1.38	1.63	1.00	0.57	0.82	1.16
	50	0.46	0.34	0.40	0.47	0.76	0.55	0.65	0.77	1.54	1.12	1.32	1.58	0.90	0.47	0.72	1.05
	100	0.45	0.32	0.38	0.46	0.73	0.52	0.62	0.74	1.49	1.06	1.26	1.52	0.80	0.37	0.62	0.95
	150	0.43	0.30	0.36	0.44	0.70	0.49	0.59	0.72	1.43	1.01	1.21	1.46	0.69	0.28	0.52	0.85
	200	0.41	0.29	0.35	0.42	0.67	0.47	0.56	0.69	1.37	0.95	1.15	1.41	0.59	0.20	0.42	0.74
	250	0.40	0.28	0.33	0.41	0.64	0.45	0.54	0.66	1.32	0.93	1.09	1.35	0.48	0.16	0.32	0.64
	300	0.38	0.27	0.32	0.39	0.62	0.44	0.51	0.63	1.26	0.90	1.05	1.29	0.36	0.13	0.26	0.56

Table 2e. The ratios of (a) the deterministic scenario and (b) the 5%ile, 20%ile and median of the recruitment and initial variability scenario for model A_0 for i) the spawner biomass in 2020 under alternative catch scenarios to that estimated in 2019 from the Dynamic B_0 model, ii) the spawner biomass in 2020 under alternative catch scenarios to that projected in 2020 under a no catch scenario from the Dynamic B_0 model, iii) the spawner biomass in 2020 under alternative catch scenarios to that projected in 2029 under a no catch scenario from the Dynamic B_0 model and iv) the spawner biomass in 2029 under alternative catch scenarios to that projected in 2029 under a no catch scenario from the Dynamic B_0 model. Results are given for different proportions (100%, 75%, 50%, 40%, 30%, 20%) of historical average recruitment and different future constant catch scenarios.

	$SSB^C_{2020}:SSB^{B0}_{2019}$				$SSB^C_{2020}:SSB^{B0}_{2020}$				$SSB^C_{2020}:SSB^{B0}_{2029}$				$SSB^C_{2029}:SSB^{B0}_{2029}$				
	Det	5%	20%	50%	Det	5%	20%	50%	Det	5%	20%	50%	Det	5%	20%	50%	
100%	0	1.13	0.71	0.86	1.14	0.89	0.82	0.85	0.89	0.75	0.68	0.64	0.65	1.00	1.00	1.00	1.00
	50	1.11	0.69	0.84	1.12	0.88	0.80	0.83	0.88	0.74	0.66	0.63	0.64	0.98	0.96	0.98	0.98
	100	1.09	0.67	0.82	1.10	0.87	0.77	0.82	0.87	0.73	0.64	0.61	0.63	0.96	0.93	0.95	0.96
	150	1.07	0.65	0.80	1.08	0.85	0.75	0.80	0.85	0.71	0.62	0.60	0.62	0.94	0.90	0.93	0.95
	200	1.06	0.63	0.78	1.07	0.84	0.73	0.78	0.84	0.70	0.60	0.58	0.61	0.92	0.86	0.90	0.93
	250	1.04	0.61	0.76	1.05	0.82	0.70	0.76	0.82	0.69	0.58	0.57	0.60	0.90	0.83	0.88	0.91
	300	1.02	0.59	0.74	1.03	0.81	0.68	0.74	0.81	0.68	0.56	0.56	0.59	0.88	0.79	0.85	0.89
75%	0	0.92	0.63	0.73	0.93	0.87	0.82	0.83	0.87	0.82	0.80	0.73	0.72	1.00	1.00	1.00	1.00
	50	0.91	0.61	0.71	0.92	0.86	0.79	0.81	0.86	0.80	0.77	0.71	0.70	0.97	0.95	0.97	0.98
	100	0.89	0.59	0.69	0.90	0.84	0.76	0.79	0.84	0.79	0.74	0.69	0.69	0.95	0.91	0.94	0.95
	150	0.87	0.57	0.67	0.88	0.82	0.74	0.77	0.82	0.77	0.72	0.67	0.68	0.92	0.86	0.90	0.93
	200	0.85	0.54	0.66	0.86	0.81	0.71	0.75	0.81	0.76	0.69	0.65	0.66	0.89	0.82	0.87	0.91
	250	0.84	0.52	0.64	0.85	0.79	0.68	0.73	0.79	0.74	0.66	0.64	0.65	0.86	0.77	0.84	0.88
	300	0.82	0.50	0.62	0.83	0.77	0.65	0.71	0.77	0.73	0.64	0.62	0.64	0.84	0.72	0.80	0.86
50%	0	0.72	0.53	0.6	0.73	0.84	0.77	0.80	0.84	0.96	1.01	0.90	0.84	1.00	1.00	1.00	1.00
	50	0.71	0.51	0.59	0.72	0.82	0.74	0.78	0.82	0.94	0.97	0.88	0.82	0.96	0.93	0.95	0.96
	100	0.69	0.49	0.57	0.70	0.80	0.71	0.75	0.80	0.92	0.94	0.85	0.80	0.92	0.86	0.90	0.93
	150	0.67	0.47	0.55	0.68	0.78	0.68	0.73	0.78	0.89	0.90	0.82	0.78	0.88	0.79	0.85	0.89
	200	0.65	0.45	0.53	0.66	0.76	0.65	0.71	0.76	0.87	0.86	0.79	0.76	0.84	0.72	0.80	0.86
	250	0.64	0.43	0.51	0.65	0.74	0.62	0.68	0.74	0.85	0.82	0.76	0.74	0.80	0.65	0.75	0.82
	300	0.62	0.41	0.49	0.63	0.72	0.59	0.66	0.72	0.82	0.78	0.74	0.72	0.75	0.58	0.71	0.79
40%	0	0.64	0.51	0.56	0.65	0.83	0.76	0.80	0.83	1.07	1.20	1.04	0.94	1.00	1.00	1.00	1.00
	50	0.62	0.49	0.54	0.64	0.81	0.73	0.77	0.81	1.04	1.15	1.00	0.92	0.95	0.91	0.94	0.96
	100	0.61	0.46	0.52	0.62	0.78	0.70	0.74	0.78	1.01	1.10	0.97	0.89	0.90	0.83	0.88	0.91
	150	0.59	0.44	0.50	0.60	0.76	0.67	0.72	0.76	0.98	1.05	0.93	0.87	0.85	0.74	0.82	0.87
	200	0.57	0.42	0.48	0.58	0.74	0.64	0.69	0.74	0.95	1.00	0.90	0.84	0.80	0.65	0.75	0.82
	250	0.56	0.40	0.46	0.57	0.72	0.61	0.66	0.72	0.92	0.95	0.86	0.82	0.74	0.56	0.69	0.78
	300	0.54	0.38	0.44	0.55	0.69	0.58	0.64	0.70	0.90	0.90	0.83	0.79	0.69	0.48	0.63	0.73
30%	0	0.56	0.47	0.50	0.57	0.81	0.76	0.78	0.81	1.24	1.49	1.25	1.10	1.00	1.00	1.00	1.00
	50	0.54	0.45	0.48	0.55	0.78	0.72	0.75	0.78	1.21	1.43	1.21	1.06	0.93	0.88	0.92	0.94
	100	0.53	0.43	0.47	0.54	0.76	0.69	0.72	0.76	1.17	1.36	1.16	1.03	0.86	0.77	0.84	0.88
	150	0.51	0.41	0.45	0.52	0.73	0.66	0.69	0.73	1.13	1.30	1.11	1.00	0.80	0.65	0.75	0.82
	200	0.49	0.39	0.43	0.50	0.71	0.62	0.66	0.71	1.09	1.23	1.07	0.97	0.73	0.53	0.67	0.76
	250	0.48	0.37	0.41	0.49	0.68	0.59	0.63	0.69	1.05	1.16	1.02	0.93	0.66	0.44	0.59	0.70
	300	0.46	0.35	0.39	0.47	0.66	0.57	0.61	0.66	1.02	1.12	0.97	0.90	0.58	0.35	0.51	0.64
20%	0	0.48	0.43	0.45	0.49	0.78	0.74	0.76	0.79	1.60	2.06	1.68	1.41	1.00	1.00	1.00	1.00
	50	0.46	0.41	0.43	0.47	0.76	0.70	0.73	0.76	1.54	1.96	1.61	1.36	0.90	0.83	0.88	0.91
	100	0.45	0.39	0.41	0.46	0.73	0.67	0.70	0.73	1.49	1.86	1.54	1.31	0.80	0.65	0.75	0.82
	150	0.43	0.37	0.39	0.44	0.70	0.63	0.67	0.71	1.43	1.76	1.47	1.27	0.69	0.48	0.63	0.73
	200	0.41	0.35	0.38	0.42	0.67	0.60	0.64	0.68	1.37	1.66	1.40	1.22	0.58	0.35	0.51	0.64
	250	0.40	0.34	0.36	0.41	0.64	0.58	0.61	0.65	1.32	1.62	1.33	1.17	0.48	0.27	0.39	0.55
	300	0.38	0.33	0.34	0.39	0.62	0.56	0.58	0.62	1.26	1.56	1.28	1.12	0.36	0.23	0.31	0.48

Table 3a. The 5%ile, 20%ile and median of the ratio of spawner biomass in **2020** to that in 2019 and this ratio under the catch scenario as a proportion of that under the no catch scenario for **A₁**. The probability that the spawner biomass in **2020** and over the 10 year projection period is below the risk threshold of the 1996 level is also given. Results here are for the 1) deterministic and 4) including both recruitment and initial variability scenarios. Results are given for different proportions (100%, 75%, 50%, 40%, 30%, 20%) of historical average recruitment and different future constant catch scenarios.

Rec	Catch	Deterministic								Recruitment and Initial variability							
		R=SSB ₂₀₂₀ :SSB ₂₀₁₉			R ^{Catch} :R ^{NoCatch}			R ^{risk} ₂₀	R ^{risk} _{all}	R=SSB ₂₀₂₀ :SSB ₂₀₁₉			R ^{Catch} :R ^{NoCatch}			R ^{risk} ₂₀	R ^{risk} _{all}
		5%	20%	50%	5%	20%	50%			5%	20%	50%	5%	20%	50%		
100%	0	1.78	1.78	1.78	1.00	1.00	1.00	0.00	0.00	0.88	1.20	1.80	1.00	1.00	1.00	0.00	0.00
	50	1.74	1.74	1.74	0.98	0.98	0.98	0.00	0.00	0.85	1.16	1.76	0.96	0.97	0.98	0.00	0.00
	100	1.70	1.70	1.70	0.96	0.96	0.96	0.00	0.00	0.81	1.12	1.72	0.92	0.94	0.96	0.00	0.00
	150	1.66	1.66	1.66	0.93	0.93	0.93	0.00	0.00	0.77	1.09	1.68	0.88	0.91	0.93	0.00	0.00
	200	1.62	1.62	1.62	0.91	0.91	0.91	0.00	0.00	0.74	1.05	1.64	0.83	0.88	0.91	0.00	0.00
	250	1.58	1.58	1.58	0.89	0.89	0.89	0.00	0.00	0.69	1.01	1.60	0.78	0.84	0.89	0.00	0.00
	300	1.54	1.54	1.54	0.86	0.86	0.86	0.00	0.00	0.65	0.97	1.56	0.74	0.81	0.87	0.00	0.00
75%	0	1.43	1.43	1.43	1.00	1.00	1.00	0.00	0.00	0.76	1.00	1.45	1.00	1.00	1.00	0.00	0.00
	50	1.39	1.39	1.39	0.97	0.97	0.97	0.00	0.00	0.73	0.96	1.41	0.95	0.96	0.97	0.00	0.00
	100	1.35	1.35	1.35	0.95	0.95	0.95	0.00	0.00	0.69	0.92	1.37	0.90	0.93	0.95	0.00	0.00
	150	1.31	1.31	1.31	0.92	0.92	0.92	0.00	0.00	0.65	0.89	1.33	0.86	0.89	0.92	0.00	0.00
	200	1.27	1.27	1.27	0.89	0.89	0.89	0.00	0.00	0.61	0.85	1.29	0.80	0.85	0.89	0.00	0.00
	250	1.23	1.23	1.23	0.86	0.86	0.86	0.00	0.00	0.57	0.81	1.25	0.75	0.81	0.86	0.00	0.00
	300	1.20	1.20	1.20	0.83	0.83	0.83	0.00	0.00	0.53	0.77	1.21	0.69	0.77	0.84	0.01	0.01
50%	0	1.09	1.09	1.09	1.00	1.00	1.00	0.00	0.00	0.64	0.80	1.10	1.00	1.00	1.00	0.00	0.00
	50	1.05	1.05	1.05	0.96	0.96	0.96	0.00	0.00	0.61	0.76	1.06	0.94	0.95	0.97	0.00	0.00
	100	1.01	1.01	1.01	0.93	0.93	0.93	0.00	0.00	0.57	0.73	1.02	0.89	0.91	0.93	0.00	0.01
	150	0.97	0.97	0.97	0.89	0.89	0.89	0.00	0.00	0.53	0.69	0.98	0.82	0.86	0.89	0.00	0.02
	200	0.93	0.93	0.93	0.86	0.86	0.86	0.00	0.00	0.49	0.65	0.95	0.76	0.82	0.86	0.02	0.04
	250	0.90	0.90	0.90	0.82	0.82	0.82	0.00	0.00	0.45	0.61	0.91	0.70	0.77	0.82	0.03	0.07
	300	0.86	0.86	0.86	0.79	0.79	0.79	0.00	0.00	0.41	0.58	0.87	0.64	0.72	0.79	0.05	0.10
40%	0	0.95	0.95	0.95	1.00	1.00	1.00	0.00	0.00	0.59	0.72	0.96	1.00	1.00	1.00	0.00	0.01
	50	0.91	0.91	0.91	0.96	0.96	0.96	0.00	0.00	0.56	0.68	0.92	0.94	0.95	0.96	0.00	0.02
	100	0.88	0.88	0.88	0.92	0.92	0.92	0.00	0.00	0.52	0.65	0.88	0.88	0.90	0.92	0.00	0.04
	150	0.84	0.84	0.84	0.88	0.88	0.88	0.00	0.00	0.48	0.61	0.85	0.81	0.85	0.88	0.01	0.07
	200	0.80	0.80	0.80	0.84	0.84	0.84	0.00	0.00	0.44	0.57	0.81	0.74	0.80	0.84	0.03	0.11
	250	0.76	0.76	0.76	0.80	0.80	0.80	0.00	0.00	0.41	0.54	0.77	0.68	0.74	0.80	0.05	0.16
	300	0.72	0.72	0.72	0.76	0.76	0.76	0.00	0.00	0.39	0.50	0.73	0.66	0.69	0.76	0.07	0.21
30%	0	0.81	0.81	0.81	1.00	1.00	1.00	0.00	0.00	0.55	0.64	0.82	1.00	1.00	1.00	0.00	0.04
	50	0.78	0.78	0.78	0.95	0.95	0.95	0.00	0.00	0.51	0.61	0.78	0.94	0.95	0.95	0.00	0.08
	100	0.74	0.74	0.74	0.91	0.91	0.91	0.00	0.00	0.47	0.57	0.75	0.86	0.89	0.91	0.01	0.14
	150	0.70	0.70	0.70	0.86	0.86	0.86	0.00	0.00	0.43	0.53	0.71	0.79	0.83	0.86	0.04	0.21
	200	0.66	0.66	0.66	0.81	0.81	0.81	0.00	0.00	0.40	0.49	0.67	0.72	0.77	0.81	0.06	0.28
	250	0.63	0.63	0.63	0.77	0.77	0.77	0.00	0.64	0.38	0.46	0.63	0.70	0.72	0.77	0.09	0.35
	300	0.59	0.59	0.59	0.72	0.72	0.72	0.00	0.73	0.37	0.42	0.59	0.69	0.65	0.72	0.13	0.42
20%	0	0.68	0.68	0.68	1.00	1.00	1.00	0.00	0.00	0.50	0.56	0.68	1.00	1.00	1.00	0.00	0.21
	50	0.64	0.64	0.64	0.95	0.95	0.95	0.00	0.00	0.46	0.53	0.64	0.93	0.94	0.95	0.02	0.31
	100	0.60	0.60	0.60	0.89	0.89	0.89	0.00	0.73	0.42	0.49	0.61	0.85	0.87	0.89	0.05	0.41
	150	0.57	0.57	0.57	0.84	0.84	0.84	0.00	0.82	0.39	0.45	0.57	0.78	0.81	0.83	0.08	0.49
	200	0.53	0.53	0.53	0.78	0.78	0.78	0.00	0.82	0.37	0.42	0.53	0.75	0.74	0.78	0.14	0.57
	250	0.49	0.49	0.49	0.72	0.72	0.72	0.00	0.82	0.37	0.39	0.49	0.73	0.70	0.73	0.20	0.63
	300	0.45	0.45	0.45	0.67	0.67	0.67	0.00	0.82	0.36	0.38	0.46	0.72	0.68	0.67	0.27	0.68

Table 3b. The 5%ile, 20%ile and median of the ratio of spawner biomass in **2029** to that in 2019 and this ratio under the catch scenario as a proportion of that under the no catch scenario for **A₁**. The probability that the spawner biomass in **2029** and over the 10 year projection period is below the risk threshold of the 1996 level is also given. Results here are for the 1) deterministic and 4) including both recruitment and initial variability scenarios. Results are given for different proportions (100%, 75%, 50%, 40%, 30%, 20%) of historical average recruitment and different future constant catch scenarios.

Rec	Catch	Deterministic								Recruitment and Initial variability							
		R=SSB ₂₀₂₉ :SSB ₂₀₁₉			R ^{Catch} :R ^{NoCatch}			R ^{risk} ₂₉	R ^{risk} _{all}	R=SSB ₂₀₂₉ :SSB ₂₀₁₉			R ^{Catch} :R ^{NoCatch}			R ^{risk} ₂₉	R ^{risk} _{all}
		5%	20%	50%	5%	20%	50%			5%	20%	50%	5%	20%	50%		
100%	0	2.31	2.31	2.31	1.00	1.00	1.00	0.00	0.00	1.29	1.81	2.66	1.00	1.00	1.00	0.00	0.00
	50	2.24	2.24	2.24	0.97	0.97	0.97	0.00	0.00	1.23	1.75	2.59	0.95	0.97	0.98	0.00	0.00
	100	2.18	2.18	2.18	0.95	0.95	0.95	0.00	0.00	1.17	1.69	2.53	0.91	0.94	0.95	0.00	0.00
	150	2.12	2.12	2.12	0.92	0.92	0.92	0.00	0.00	1.11	1.63	2.47	0.86	0.90	0.93	0.00	0.00
	200	2.05	2.05	2.05	0.89	0.89	0.89	0.00	0.00	1.05	1.57	2.41	0.81	0.87	0.91	0.00	0.00
	250	1.99	1.99	1.99	0.86	0.86	0.86	0.00	0.00	0.98	1.51	2.35	0.76	0.84	0.89	0.00	0.00
	300	1.93	1.93	1.93	0.84	0.84	0.84	0.00	0.00	0.92	1.45	2.28	0.72	0.80	0.86	0.00	0.00
75%	0	1.73	1.73	1.73	1.00	1.00	1.00	0.00	0.00	0.97	1.36	1.99	1.00	1.00	1.00	0.00	0.00
	50	1.67	1.67	1.67	0.96	0.96	0.96	0.00	0.00	0.90	1.30	1.93	0.94	0.96	0.97	0.00	0.00
	100	1.60	1.60	1.60	0.93	0.93	0.93	0.00	0.00	0.85	1.24	1.87	0.88	0.91	0.94	0.00	0.00
	150	1.54	1.54	1.54	0.89	0.89	0.89	0.00	0.00	0.78	1.18	1.81	0.81	0.87	0.91	0.00	0.00
	200	1.48	1.48	1.48	0.85	0.85	0.85	0.00	0.00	0.72	1.12	1.75	0.75	0.82	0.88	0.00	0.00
	250	1.41	1.41	1.41	0.82	0.82	0.82	0.00	0.00	0.66	1.06	1.68	0.68	0.78	0.84	0.00	0.00
	300	1.35	1.35	1.35	0.78	0.78	0.78	0.00	0.00	0.60	1.00	1.61	0.62	0.74	0.81	0.01	0.01
50%	0	1.15	1.15	1.15	1.00	1.00	1.00	0.00	0.00	0.64	0.91	1.33	1.00	1.00	1.00	0.00	0.00
	50	1.09	1.09	1.09	0.95	0.95	0.95	0.00	0.00	0.58	0.85	1.26	0.91	0.94	0.95	0.00	0.00
	100	1.03	1.03	1.03	0.89	0.89	0.89	0.00	0.00	0.52	0.78	1.20	0.81	0.87	0.91	0.01	0.01
	150	0.96	0.96	0.96	0.84	0.84	0.84	0.00	0.00	0.46	0.73	1.14	0.72	0.80	0.86	0.02	0.02
	200	0.90	0.90	0.90	0.78	0.78	0.78	0.00	0.00	0.40	0.67	1.07	0.62	0.74	0.81	0.05	0.04
	250	0.83	0.83	0.83	0.72	0.72	0.72	0.00	0.00	0.33	0.61	1.02	0.52	0.67	0.77	0.07	0.07
	300	0.77	0.77	0.77	0.67	0.67	0.67	0.00	0.00	0.27	0.55	0.96	0.43	0.60	0.72	0.10	0.10
40%	0	0.92	0.92	0.92	1.00	1.00	1.00	0.00	0.00	0.52	0.72	1.06	1.00	1.00	1.00	0.01	0.01
	50	0.86	0.86	0.86	0.93	0.93	0.93	0.00	0.00	0.46	0.66	1.00	0.88	0.92	0.94	0.02	0.02
	100	0.80	0.80	0.80	0.86	0.86	0.86	0.00	0.00	0.39	0.60	0.94	0.76	0.84	0.89	0.05	0.04
	150	0.73	0.73	0.73	0.79	0.79	0.79	0.00	0.00	0.33	0.55	0.87	0.64	0.75	0.82	0.09	0.07
	200	0.67	0.67	0.67	0.72	0.72	0.72	0.00	0.00	0.27	0.48	0.81	0.52	0.67	0.77	0.13	0.11
	250	0.60	0.60	0.60	0.65	0.65	0.65	0.00	0.00	0.21	0.42	0.75	0.40	0.59	0.71	0.17	0.16
	300	0.53	0.53	0.53	0.58	0.58	0.58	0.00	0.00	0.17	0.37	0.69	0.33	0.51	0.65	0.23	0.21
30%	0	0.69	0.69	0.69	1.00	1.00	1.00	0.00	0.00	0.39	0.54	0.80	1.00	1.00	1.00	0.06	0.04
	50	0.63	0.63	0.63	0.91	0.91	0.91	0.00	0.00	0.33	0.48	0.73	0.84	0.89	0.92	0.10	0.08
	100	0.57	0.57	0.57	0.82	0.82	0.82	0.00	0.00	0.26	0.42	0.67	0.68	0.78	0.84	0.16	0.14
	150	0.50	0.50	0.50	0.72	0.72	0.72	0.00	0.00	0.20	0.36	0.61	0.52	0.67	0.77	0.23	0.21
	200	0.43	0.43	0.43	0.63	0.63	0.63	0.00	0.00	0.14	0.30	0.55	0.37	0.56	0.69	0.31	0.28
	250	0.37	0.37	0.37	0.53	0.53	0.53	1.00	0.64	0.11	0.25	0.48	0.29	0.46	0.60	0.40	0.35
	300	0.30	0.30	0.30	0.43	0.43	0.43	1.00	0.73	0.09	0.20	0.42	0.24	0.36	0.53	0.48	0.42
20%	0	0.46	0.46	0.46	1.00	1.00	1.00	0.00	0.00	0.26	0.36	0.53	1.00	1.00	1.00	0.24	0.21
	50	0.40	0.40	0.40	0.86	0.86	0.86	0.00	0.00	0.20	0.30	0.47	0.76	0.84	0.89	0.36	0.31
	100	0.33	0.33	0.33	0.72	0.72	0.72	1.00	0.73	0.13	0.24	0.41	0.52	0.67	0.77	0.49	0.41
	150	0.27	0.27	0.27	0.58	0.58	0.58	1.00	0.82	0.08	0.19	0.34	0.33	0.51	0.65	0.60	0.49
	200	0.20	0.20	0.20	0.43	0.43	0.43	1.00	0.82	0.06	0.13	0.28	0.24	0.36	0.53	0.69	0.57
	250	0.12	0.12	0.12	0.26	0.26	0.26	1.00	0.82	0.06	0.10	0.22	0.22	0.26	0.42	0.76	0.63
	300	0.10	0.10	0.10	0.22	0.22	0.22	1.00	0.82	0.05	0.08	0.18	0.21	0.23	0.34	0.82	0.68

Table 3c. The ratios of (a) the deterministic scenario and (b) the 5%ile, 20%ile and median of the recruitment and initial variability scenario for model A_1 for i) the spawner biomass in 2020 under alternative catch scenarios to that estimated in 2019, ii) the spawner biomass in 2020 under alternative catch scenarios to that in 2029 under a no catch scenario and iii) the spawner biomass in 2029 under alternative catch scenarios to that in 2029 under a no catch scenario. Results are given for different proportions (100%, 75%, 50%, 40%, 30%, 20%) of historical average recruitment and different future constant catch scenarios.

	$SSB^C_{2020}:SSB^C_{2019}$				$SSB^C_{2020}:SSB^{noC}_{2029}$				$SSB^C_{2029}:SSB^{noC}_{2029}$				
	Det	5%	20%	50%	Det	5%	20%	50%	Det	5%	20%	50%	
100%	0	1.78	1.06	1.30	1.79								
	50	1.74	1.02	1.25	1.75	0.75	0.64	0.63	0.67	0.97	0.95	0.97	0.98
	100	1.70	0.97	1.21	1.71	0.73	0.61	0.61	0.65	0.95	0.90	0.93	0.95
	150	1.65	0.92	1.17	1.67	0.72	0.58	0.59	0.64	0.92	0.86	0.90	0.93
	200	1.61	0.88	1.13	1.63	0.70	0.55	0.56	0.62	0.89	0.81	0.87	0.91
	250	1.57	0.83	1.08	1.59	0.68	0.52	0.54	0.61	0.86	0.76	0.83	0.88
	300	1.53	0.78	1.04	1.55	0.67	0.49	0.52	0.59	0.84	0.71	0.80	0.86
75%	0	1.43	0.91	1.09	1.44								
	50	1.39	0.86	1.05	1.41	0.80	0.72	0.70	0.71	0.96	0.94	0.96	0.97
	100	1.35	0.82	1.01	1.37	0.78	0.68	0.67	0.70	0.93	0.87	0.91	0.94
	150	1.31	0.77	0.96	1.33	0.76	0.65	0.64	0.68	0.89	0.81	0.87	0.91
	200	1.27	0.73	0.92	1.29	0.74	0.61	0.62	0.66	0.85	0.74	0.82	0.88
	250	1.23	0.68	0.88	1.25	0.71	0.57	0.59	0.64	0.82	0.68	0.78	0.84
	300	1.19	0.63	0.84	1.21	0.69	0.53	0.56	0.62	0.78	0.61	0.73	0.81
50%	0	1.09	0.76	0.87	1.1								
	50	1.05	0.71	0.83	1.06	0.91	0.90	0.83	0.81	0.95	0.90	0.93	0.95
	100	1.01	0.67	0.79	1.02	0.88	0.84	0.79	0.78	0.89	0.81	0.87	0.91
	150	0.97	0.62	0.75	0.98	0.84	0.78	0.75	0.75	0.84	0.71	0.80	0.86
	200	0.93	0.57	0.71	0.95	0.81	0.72	0.71	0.72	0.78	0.61	0.73	0.81
	250	0.89	0.53	0.67	0.91	0.78	0.66	0.67	0.69	0.72	0.52	0.66	0.76
	300	0.86	0.49	0.63	0.87	0.74	0.61	0.63	0.66	0.67	0.43	0.59	0.71
40%	0	0.95	0.69	0.79	0.96								
	50	0.91	0.64	0.75	0.92	0.99	1.01	0.94	0.88	0.93	0.88	0.92	0.94
	100	0.87	0.60	0.71	0.89	0.95	0.94	0.88	0.85	0.86	0.76	0.83	0.88
	150	0.84	0.55	0.67	0.85	0.91	0.87	0.83	0.81	0.79	0.64	0.75	0.82
	200	0.80	0.51	0.63	0.81	0.86	0.80	0.78	0.77	0.72	0.52	0.66	0.76
	250	0.76	0.48	0.58	0.77	0.82	0.75	0.73	0.74	0.65	0.42	0.57	0.70
	300	0.72	0.46	0.54	0.73	0.78	0.72	0.68	0.70	0.58	0.33	0.49	0.64
30%	0	0.81	0.64	0.70	0.83								
	50	0.78	0.60	0.66	0.79	1.12	1.25	1.11	1.01	0.91	0.84	0.89	0.92
	100	0.74	0.55	0.62	0.75	1.07	1.16	1.04	0.96	0.82	0.68	0.78	0.84
	150	0.70	0.51	0.58	0.72	1.01	1.06	0.97	0.91	0.72	0.52	0.66	0.76
	200	0.66	0.47	0.54	0.68	0.96	0.98	0.91	0.86	0.63	0.38	0.54	0.68
	250	0.62	0.45	0.50	0.64	0.90	0.94	0.84	0.81	0.53	0.29	0.44	0.61
	300	0.59	0.43	0.47	0.60	0.85	0.90	0.78	0.77	0.43	0.25	0.35	0.53
20%	0	0.68	0.58	0.61	0.69								
	50	0.64	0.54	0.57	0.65	1.39	1.69	1.44	1.24	0.86	0.76	0.83	0.88
	100	0.60	0.50	0.53	0.61	1.31	1.55	1.34	1.17	0.72	0.52	0.66	0.76
	150	0.56	0.46	0.49	0.58	1.22	1.43	1.24	1.10	0.58	0.33	0.49	0.64
	200	0.53	0.43	0.46	0.54	1.14	1.35	1.14	1.03	0.43	0.25	0.35	0.53
	250	0.49	0.42	0.43	0.50	1.06	1.31	1.07	0.96	0.26	0.22	0.26	0.41
	300	0.45	0.40	0.42	0.47	0.98	1.27	1.04	0.89	0.22	0.20	0.23	0.32

Table 3d. The (a) deterministic and (b) 5%ile, 20%ile and median of recruitment and initial variability scenario model for A_1 of the ratio of spawner biomass in 2020 under alternative future catch scenarios to that in 2019, 2020 and 2029 under the no catch scenario projected from the Dynamic B_0 model. The final sets of columns gives the statistics for the ratio of spawner biomass in 2029 under alternative future catch scenarios to that in 2029 under the no catch scenario projected from the Dynamic B_0 model. Results are given for different proportions (100%, 75%, 50%, 40%, 30%, 20%) of historical average recruitment and different future constant catch scenarios.

	$SSB^C_{2020}:SSB^{B0}_{2019}$				$SSB^C_{2020}:SSB^{B0}_{2020}$				$SSB^C_{2020}:SSB^{B0}_{2029}$				$SSB^C_{2029}:SSB^{B0}_{2029}$				
	Det	5%	20%	50%	Det	5%	20%	50%	Det	5%	20%	50%	Det	5%	20%	50%	
100%	0	1.11	0.54	0.75	1.12	0.88	0.43	0.59	0.89	0.77	0.38	0.52	0.78	1.00	0.56	0.80	1.14
	50	1.09	0.52	0.72	1.09	0.86	0.41	0.57	0.87	0.75	0.36	0.50	0.76	0.97	0.54	0.77	1.11
	100	1.06	0.49	0.70	1.07	0.84	0.39	0.55	0.85	0.74	0.34	0.48	0.74	0.95	0.51	0.74	1.08
	150	1.04	0.47	0.67	1.04	0.82	0.37	0.53	0.83	0.72	0.33	0.47	0.72	0.92	0.48	0.72	1.06
	200	1.01	0.45	0.65	1.02	0.80	0.36	0.52	0.81	0.70	0.31	0.45	0.71	0.89	0.46	0.69	1.03
	250	0.99	0.42	0.62	0.99	0.78	0.34	0.50	0.79	0.68	0.29	0.43	0.69	0.86	0.43	0.66	1.00
	300	0.96	0.40	0.60	0.97	0.76	0.32	0.48	0.77	0.67	0.28	0.42	0.67	0.84	0.40	0.64	0.98
75%	0	0.90	0.46	0.63	0.90	0.86	0.44	0.60	0.87	0.83	0.43	0.58	0.84	1.00	0.56	0.80	1.14
	50	0.87	0.44	0.60	0.88	0.84	0.42	0.58	0.84	0.81	0.41	0.56	0.81	0.96	0.53	0.76	1.10
	100	0.85	0.42	0.58	0.86	0.81	0.40	0.56	0.82	0.78	0.39	0.54	0.79	0.93	0.49	0.73	1.07
	150	0.82	0.39	0.56	0.83	0.79	0.38	0.53	0.80	0.76	0.36	0.51	0.77	0.89	0.46	0.69	1.03
	200	0.80	0.37	0.53	0.81	0.76	0.36	0.51	0.77	0.74	0.34	0.49	0.75	0.85	0.42	0.65	1.00
	250	0.77	0.35	0.51	0.78	0.74	0.33	0.49	0.75	0.71	0.32	0.47	0.72	0.82	0.38	0.62	0.96
	300	0.75	0.32	0.48	0.76	0.72	0.31	0.46	0.73	0.69	0.30	0.45	0.70	0.78	0.35	0.58	0.92
50%	0	0.68	0.39	0.50	0.69	0.82	0.47	0.61	0.83	0.94	0.54	0.70	0.96	1.00	0.56	0.80	1.14
	50	0.66	0.36	0.48	0.66	0.79	0.44	0.58	0.80	0.91	0.51	0.66	0.92	0.95	0.51	0.74	1.08
	100	0.63	0.34	0.46	0.64	0.76	0.41	0.55	0.77	0.88	0.47	0.63	0.89	0.89	0.46	0.69	1.03
	150	0.61	0.32	0.43	0.62	0.73	0.38	0.52	0.74	0.84	0.44	0.60	0.85	0.84	0.40	0.64	0.98
	200	0.58	0.29	0.41	0.59	0.71	0.35	0.49	0.71	0.81	0.41	0.57	0.82	0.78	0.35	0.58	0.92
	250	0.56	0.27	0.38	0.57	0.68	0.32	0.46	0.69	0.78	0.37	0.53	0.79	0.72	0.29	0.53	0.87
	300	0.54	0.25	0.36	0.54	0.65	0.30	0.44	0.66	0.74	0.35	0.50	0.75	0.67	0.24	0.47	0.81
40%	0	0.60	0.35	0.45	0.60	0.80	0.47	0.61	0.81	1.03	0.61	0.79	1.04	1.00	0.56	0.80	1.14
	50	0.57	0.33	0.43	0.58	0.77	0.44	0.58	0.78	0.99	0.57	0.75	1.00	0.93	0.50	0.73	1.07
	100	0.55	0.31	0.41	0.55	0.74	0.41	0.55	0.75	0.95	0.53	0.70	0.96	0.86	0.43	0.66	1.00
	150	0.52	0.28	0.38	0.53	0.71	0.38	0.52	0.71	0.91	0.49	0.66	0.92	0.79	0.36	0.60	0.94
	200	0.50	0.26	0.36	0.51	0.67	0.35	0.48	0.68	0.87	0.45	0.62	0.88	0.72	0.29	0.53	0.87
	250	0.48	0.24	0.34	0.48	0.64	0.33	0.45	0.65	0.82	0.42	0.58	0.84	0.65	0.24	0.46	0.80
	300	0.45	0.24	0.31	0.46	0.61	0.32	0.42	0.62	0.78	0.41	0.54	0.79	0.58	0.18	0.39	0.73
30%	0	0.51	0.33	0.41	0.52	0.78	0.50	0.62	0.79	1.18	0.76	0.94	1.20	1.00	0.56	0.80	1.14
	50	0.49	0.30	0.38	0.50	0.74	0.46	0.58	0.75	1.12	0.70	0.88	1.14	0.91	0.47	0.71	1.05
	100	0.46	0.28	0.36	0.47	0.70	0.43	0.55	0.72	1.07	0.65	0.83	1.09	0.82	0.38	0.62	0.96
	150	0.44	0.26	0.34	0.45	0.67	0.40	0.51	0.68	1.01	0.60	0.77	1.04	0.72	0.29	0.53	0.87
	200	0.41	0.24	0.31	0.42	0.63	0.36	0.48	0.65	0.96	0.55	0.72	0.98	0.63	0.21	0.43	0.77
	250	0.39	0.23	0.29	0.40	0.60	0.35	0.44	0.61	0.90	0.53	0.67	0.93	0.53	0.17	0.35	0.69
	300	0.37	0.22	0.27	0.38	0.56	0.33	0.41	0.57	0.85	0.51	0.62	0.87	0.43	0.14	0.28	0.60
20%	0	0.42	0.30	0.35	0.43	0.74	0.52	0.62	0.76	1.47	1.03	1.23	1.50	1.00	0.56	0.80	1.14
	50	0.40	0.28	0.33	0.41	0.70	0.48	0.58	0.72	1.39	0.95	1.15	1.41	0.86	0.43	0.66	1.00
	100	0.38	0.25	0.31	0.38	0.66	0.44	0.54	0.67	1.31	0.88	1.07	1.33	0.72	0.29	0.53	0.87
	150	0.35	0.23	0.28	0.36	0.62	0.41	0.50	0.63	1.22	0.81	0.99	1.25	0.58	0.18	0.39	0.73
	200	0.33	0.22	0.26	0.34	0.58	0.39	0.46	0.59	1.14	0.76	0.91	1.17	0.43	0.14	0.28	0.60
	250	0.31	0.21	0.25	0.32	0.54	0.37	0.43	0.55	1.06	0.74	0.86	1.09	0.26	0.12	0.21	0.47
	300	0.28	0.21	0.24	0.29	0.50	0.36	0.42	0.51	0.98	0.71	0.83	1.01	0.22	0.11	0.19	0.37

Table 3e. The ratios of (a) the deterministic scenario and (b) the 5%ile, 20%ile and median of the recruitment and initial variability scenario for model A_1 for i) the spawner biomass in 2020 under alternative catch scenarios to that estimated in 2019 from the Dynamic B_0 model, ii) the spawner biomass in 2020 under alternative catch scenarios to that projected in 2020 under a no catch scenario from the Dynamic B_0 model, iii) the spawner biomass in 2020 under alternative catch scenarios to that projected in 2029 under a no catch scenario from the Dynamic B_0 model and iv) the spawner biomass in 2029 under alternative catch scenarios to that projected in 2029 under a no catch scenario from the Dynamic B_0 model. Results are given for different proportions (100%, 75%, 50%, 40%, 30%, 20%) of historical average recruitment and different future constant catch scenarios.

	$SSB^C_{2020}:SSB^{B0}_{2019}$				$SSB^C_{2020}:SSB^{B0}_{2020}$				$SSB^C_{2020}:SSB^{B0}_{2029}$				$SSB^C_{2029}:SSB^{B0}_{2029}$				
	Det	5%	20%	50%	Det	5%	20%	50%	Det	5%	20%	50%	Det	5%	20%	50%	
100%	0	1.11	0.66	0.81	1.12	0.88	0.80	0.83	0.88	0.77	0.67	0.65	0.68	1.00	1.00	1.00	1.00
	50	1.09	0.63	0.78	1.09	0.86	0.77	0.80	0.86	0.75	0.64	0.63	0.67	0.97	0.95	0.97	0.98
	100	1.06	0.61	0.76	1.07	0.84	0.73	0.77	0.84	0.73	0.61	0.61	0.65	0.95	0.90	0.93	0.95
	150	1.03	0.58	0.73	1.04	0.82	0.70	0.75	0.82	0.72	0.58	0.59	0.64	0.92	0.86	0.90	0.93
	200	1.01	0.55	0.70	1.02	0.80	0.66	0.72	0.80	0.70	0.55	0.56	0.62	0.89	0.81	0.87	0.91
	250	0.98	0.52	0.68	0.99	0.78	0.63	0.69	0.78	0.68	0.52	0.54	0.61	0.86	0.76	0.83	0.88
	300	0.96	0.49	0.65	0.97	0.76	0.59	0.66	0.76	0.67	0.49	0.52	0.59	0.84	0.71	0.80	0.86
75%	0	0.90	0.57	0.68	0.90	0.86	0.78	0.81	0.86	0.83	0.76	0.73	0.73	1.00	1.00	1.00	1.00
	50	0.87	0.54	0.65	0.88	0.84	0.74	0.78	0.83	0.80	0.72	0.70	0.71	0.96	0.94	0.96	0.97
	100	0.85	0.51	0.63	0.85	0.81	0.70	0.75	0.81	0.78	0.68	0.67	0.70	0.93	0.87	0.91	0.94
	150	0.82	0.48	0.60	0.83	0.79	0.66	0.72	0.79	0.76	0.65	0.64	0.68	0.89	0.81	0.87	0.91
	200	0.80	0.45	0.58	0.81	0.76	0.62	0.68	0.76	0.74	0.61	0.62	0.66	0.85	0.74	0.82	0.88
	250	0.77	0.42	0.55	0.78	0.74	0.58	0.65	0.74	0.71	0.57	0.59	0.64	0.82	0.68	0.78	0.84
	300	0.75	0.40	0.52	0.76	0.72	0.54	0.62	0.72	0.69	0.53	0.56	0.62	0.78	0.61	0.73	0.81
50%	0	0.68	0.48	0.55	0.69	0.82	0.74	0.77	0.82	0.94	0.95	0.87	0.84	1.00	1.00	1.00	1.00
	50	0.66	0.45	0.52	0.66	0.79	0.69	0.73	0.79	0.91	0.90	0.83	0.81	0.95	0.90	0.93	0.95
	100	0.63	0.42	0.49	0.64	0.76	0.65	0.70	0.76	0.88	0.84	0.79	0.78	0.89	0.81	0.87	0.91
	150	0.61	0.39	0.47	0.62	0.73	0.60	0.66	0.73	0.84	0.78	0.75	0.75	0.84	0.71	0.80	0.86
	200	0.58	0.36	0.44	0.59	0.71	0.56	0.62	0.70	0.81	0.72	0.71	0.72	0.78	0.61	0.73	0.81
	250	0.56	0.33	0.42	0.57	0.68	0.51	0.59	0.67	0.78	0.66	0.67	0.69	0.72	0.52	0.66	0.76
	300	0.54	0.31	0.39	0.54	0.65	0.47	0.55	0.65	0.74	0.61	0.63	0.66	0.67	0.43	0.59	0.71
40%	0	0.59	0.43	0.49	0.60	0.80	0.71	0.75	0.80	1.03	1.08	0.99	0.92	1.00	1.00	1.00	1.00
	50	0.57	0.40	0.47	0.58	0.77	0.66	0.71	0.76	0.99	1.01	0.94	0.88	0.93	0.88	0.92	0.94
	100	0.55	0.37	0.44	0.55	0.74	0.62	0.67	0.73	0.95	0.94	0.88	0.85	0.86	0.76	0.83	0.88
	150	0.52	0.35	0.42	0.53	0.70	0.57	0.64	0.70	0.91	0.87	0.83	0.81	0.79	0.64	0.75	0.82
	200	0.50	0.32	0.39	0.51	0.67	0.53	0.60	0.67	0.86	0.80	0.78	0.77	0.72	0.52	0.66	0.76
	250	0.47	0.30	0.37	0.48	0.64	0.49	0.56	0.64	0.82	0.75	0.73	0.74	0.65	0.42	0.57	0.70
	300	0.45	0.29	0.34	0.46	0.61	0.48	0.52	0.61	0.78	0.72	0.68	0.70	0.58	0.33	0.49	0.64
30%	0	0.51	0.40	0.44	0.52	0.78	0.70	0.74	0.77	1.18	1.34	1.17	1.05	1.00	1.00	1.00	1.00
	50	0.49	0.37	0.41	0.49	0.74	0.65	0.69	0.74	1.12	1.25	1.11	1.01	0.91	0.84	0.89	0.92
	100	0.46	0.35	0.39	0.47	0.70	0.60	0.65	0.70	1.07	1.16	1.04	0.96	0.82	0.68	0.78	0.84
	150	0.44	0.32	0.36	0.45	0.67	0.56	0.61	0.67	1.01	1.06	0.97	0.91	0.72	0.52	0.66	0.76
	200	0.41	0.29	0.34	0.42	0.63	0.51	0.57	0.63	0.96	0.98	0.91	0.86	0.63	0.38	0.54	0.68
	250	0.39	0.28	0.31	0.40	0.60	0.49	0.52	0.60	0.90	0.94	0.84	0.81	0.53	0.29	0.44	0.61
	300	0.37	0.27	0.29	0.38	0.56	0.47	0.49	0.56	0.85	0.90	0.78	0.77	0.43	0.25	0.35	0.53
20%	0	0.42	0.36	0.38	0.43	0.74	0.69	0.71	0.74	1.47	1.83	1.54	1.32	1.00	1.00	1.00	1.00
	50	0.40	0.34	0.36	0.41	0.70	0.64	0.66	0.70	1.39	1.69	1.44	1.24	0.86	0.76	0.83	0.88
	100	0.38	0.31	0.33	0.38	0.66	0.59	0.62	0.66	1.31	1.55	1.34	1.17	0.72	0.52	0.66	0.76
	150	0.35	0.28	0.31	0.36	0.62	0.54	0.57	0.62	1.22	1.43	1.24	1.10	0.58	0.33	0.49	0.64
	200	0.33	0.27	0.29	0.34	0.58	0.51	0.53	0.58	1.14	1.35	1.14	1.03	0.43	0.25	0.35	0.53
	250	0.31	0.26	0.27	0.32	0.54	0.50	0.50	0.54	1.06	1.31	1.07	0.96	0.26	0.22	0.26	0.41
	300	0.28	0.25	0.26	0.29	0.50	0.48	0.48	0.50	0.98	1.27	1.04	0.89	0.22	0.20	0.23	0.32

Table 4a. The 5%ile, 20%ile and median of the ratio of spawner biomass in **2020** to that in 2019 and this ratio under the catch scenario as a proportion of that under the no catch scenario for **A₈**. The probability that the spawner biomass in **2020** and over the 10 year projection period is below the risk threshold of the 1996 level is also given. Results here are for the 1) deterministic and 4) including both recruitment and initial variability scenarios. Results are given for different proportions (100%, 75%, 50%, 40%, 30%, 20%) of historical average recruitment and different future constant catch scenarios.

Rec	Catch	Deterministic								Recruitment and Initial variability									
		R=SSB ₂₀₂₀ :SSB ₂₀₁₉			R ^{Catch} :R ^{NoCatch}					R ^{risk} ₂₀	R ^{risk} _{all}	R=SSB ₂₀₂₀ :SSB ₂₀₁₉			R ^{Catch} :R ^{NoCatch}				
		5%	20%	50%	5%	20%	50%	5%	20%			50%	5%	20%	50%	R ^{risk} ₂₀	R ^{risk} _{all}		
100%	0	0.98	0.98	0.98	1.00	1.00	1.00	0.00	0.00	0.49	0.66	0.99	1.00	1.00	1.00	0.09	0.08		
	50	0.95	0.95	0.95	0.98	0.98	0.98	0.00	0.00	0.47	0.64	0.96	0.95	0.96	0.98	0.10	0.10		
	100	0.93	0.93	0.93	0.95	0.95	0.95	0.00	0.00	0.45	0.62	0.94	0.91	0.93	0.95	0.13	0.12		
	150	0.90	0.90	0.90	0.93	0.93	0.93	0.00	0.00	0.42	0.59	0.92	0.86	0.90	0.93	0.15	0.14		
	200	0.88	0.88	0.88	0.90	0.90	0.90	0.00	0.00	0.40	0.57	0.89	0.81	0.86	0.90	0.16	0.16		
	250	0.85	0.85	0.85	0.88	0.88	0.88	0.00	0.00	0.37	0.55	0.87	0.76	0.82	0.88	0.19	0.19		
	300	0.83	0.83	0.83	0.85	0.85	0.85	0.00	0.00	0.35	0.52	0.84	0.70	0.79	0.85	0.21	0.21		
75%	0	0.79	0.79	0.79	1.00	1.00	1.00	0.00	0.00	0.43	0.56	0.80	1.00	1.00	1.00	0.17	0.20		
	50	0.77	0.77	0.77	0.97	0.97	0.97	0.00	0.00	0.40	0.53	0.78	0.94	0.96	0.97	0.20	0.23		
	100	0.74	0.74	0.74	0.94	0.94	0.94	0.00	0.00	0.38	0.51	0.75	0.89	0.92	0.94	0.22	0.26		
	150	0.72	0.72	0.72	0.91	0.91	0.91	0.00	0.00	0.36	0.49	0.73	0.84	0.88	0.91	0.26	0.29		
	200	0.69	0.69	0.69	0.88	0.88	0.88	0.00	0.00	0.33	0.46	0.70	0.78	0.83	0.88	0.28	0.32		
	250	0.67	0.67	0.67	0.85	0.85	0.85	0.00	0.00	0.30	0.44	0.68	0.71	0.79	0.85	0.32	0.36		
	300	0.65	0.65	0.65	0.82	0.82	0.82	0.00	0.00	0.28	0.41	0.66	0.65	0.75	0.82	0.36	0.39		
50%	0	0.60	0.60	0.60	1.00	1.00	1.00	0.00	0.82	0.36	0.45	0.61	1.00	1.00	1.00	0.36	0.45		
	50	0.58	0.58	0.58	0.96	0.96	0.96	0.00	0.82	0.34	0.42	0.59	0.94	0.95	0.96	0.41	0.49		
	100	0.56	0.56	0.56	0.92	0.92	0.92	0.00	0.82	0.32	0.40	0.56	0.87	0.90	0.92	0.44	0.53		
	150	0.53	0.53	0.53	0.88	0.88	0.88	1.00	0.91	0.29	0.38	0.54	0.80	0.85	0.88	0.49	0.56		
	200	0.51	0.51	0.51	0.84	0.84	0.84	1.00	0.91	0.26	0.35	0.52	0.73	0.79	0.85	0.52	0.59		
	250	0.48	0.48	0.48	0.80	0.80	0.80	1.00	0.91	0.24	0.33	0.49	0.67	0.74	0.81	0.56	0.62		
	300	0.46	0.46	0.46	0.76	0.76	0.76	1.00	0.91	0.23	0.31	0.47	0.64	0.69	0.77	0.59	0.64		
40%	0	0.53	0.53	0.53	1.00	1.00	1.00	1.00	0.91	0.34	0.40	0.53	1.00	1.00	1.00	0.50	0.60		
	50	0.51	0.51	0.51	0.96	0.96	0.96	1.00	0.91	0.31	0.38	0.51	0.93	0.94	0.96	0.53	0.63		
	100	0.48	0.48	0.48	0.91	0.91	0.91	1.00	0.91	0.29	0.36	0.49	0.86	0.89	0.91	0.58	0.66		
	150	0.46	0.46	0.46	0.87	0.87	0.87	1.00	0.91	0.26	0.33	0.46	0.78	0.83	0.87	0.62	0.69		
	200	0.43	0.43	0.43	0.82	0.82	0.82	1.00	0.91	0.24	0.31	0.44	0.71	0.77	0.82	0.66	0.72		
	250	0.41	0.41	0.41	0.78	0.78	0.78	1.00	0.91	0.23	0.29	0.42	0.67	0.71	0.78	0.69	0.74		
	300	0.39	0.39	0.39	0.73	0.73	0.73	1.00	0.91	0.22	0.26	0.39	0.66	0.65	0.73	0.72	0.76		
30%	0	0.45	0.45	0.45	1.00	1.00	1.00	1.00	0.91	0.31	0.36	0.46	1.00	1.00	1.00	0.66	0.74		
	50	0.43	0.43	0.43	0.95	0.95	0.95	1.00	0.91	0.29	0.34	0.44	0.93	0.94	0.95	0.70	0.77		
	100	0.41	0.41	0.41	0.90	0.90	0.90	1.00	0.91	0.26	0.32	0.41	0.84	0.87	0.90	0.73	0.79		
	150	0.38	0.38	0.38	0.84	0.84	0.84	1.00	0.91	0.24	0.29	0.39	0.76	0.81	0.85	0.76	0.80		
	200	0.36	0.36	0.36	0.79	0.79	0.79	1.00	0.91	0.22	0.27	0.36	0.71	0.75	0.79	0.78	0.82		
	250	0.34	0.34	0.34	0.74	0.74	0.74	1.00	0.91	0.22	0.24	0.34	0.70	0.68	0.74	0.80	0.83		
	300	0.31	0.31	0.31	0.69	0.69	0.69	1.00	0.91	0.21	0.23	0.32	0.69	0.64	0.69	0.83	0.84		
20%	0	0.38	0.38	0.38	1.00	1.00	1.00	1.00	0.91	0.28	0.32	0.38	1.00	1.00	1.00	0.82	0.86		
	50	0.36	0.36	0.36	0.94	0.94	0.94	1.00	0.91	0.26	0.30	0.36	0.92	0.93	0.94	0.86	0.87		
	100	0.33	0.33	0.33	0.88	0.88	0.88	1.00	0.91	0.23	0.27	0.34	0.83	0.85	0.88	0.89	0.87		
	150	0.31	0.31	0.31	0.81	0.81	0.81	1.00	0.91	0.22	0.25	0.31	0.76	0.78	0.81	0.90	0.88		
	200	0.29	0.29	0.29	0.75	0.75	0.75	1.00	0.91	0.21	0.23	0.29	0.75	0.71	0.75	0.92	0.89		
	250	0.26	0.26	0.26	0.69	0.69	0.69	1.00	0.91	0.21	0.22	0.26	0.73	0.70	0.69	0.92	0.89		
	300	0.24	0.24	0.24	0.64	0.64	0.64	1.00	0.91	0.20	0.22	0.24	0.72	0.68	0.64	0.94	0.89		

Table 4b. The 5%ile, 20%ile and median of the ratio of spawner biomass in **2021** to that in 2019 and this ratio under the catch scenario as a proportion of that under the no catch scenario for **A₈**. The probability that the spawner biomass in **2021** and over the 10 year projection period is below the risk threshold of the 1996 level is also given. Results here are for the 1) deterministic and 4) including both recruitment and initial variability scenarios. Results are given for different proportions (100%, 75%, 50%, 40%, 30%, 20%) of historical average recruitment and different future constant catch scenarios.

Rec	Catch	Deterministic								Recruitment and Initial variability									
		R=SSB ₂₀₂₉ :SSB ₂₀₁₉			R ^{Catch} :R ^{NoCatch}					R ^{risk} ₂₉	R ^{risk} _{all}	R=SSB ₂₀₂₉ :SSB ₂₀₁₉			R ^{Catch} :R ^{NoCatch}				
		5%	20%	50%	5%	20%	50%	5%	20%			50%	5%	20%	50%	R ^{risk} ₂₉	R ^{risk} _{all}		
100%	0	0.98	0.98	0.98	1.00	1.00	1.00	0.00	0.00	0.47	0.69	1.08	1.00	1.00	1.00	0.08	0.08		
	50	0.95	0.95	0.95	0.97	0.97	0.97	0.00	0.00	0.44	0.66	1.05	0.94	0.96	0.97	0.10	0.10		
	100	0.92	0.92	0.92	0.94	0.94	0.94	0.00	0.00	0.41	0.63	1.02	0.88	0.91	0.94	0.13	0.12		
	150	0.88	0.88	0.88	0.90	0.90	0.90	0.00	0.00	0.37	0.60	0.99	0.81	0.87	0.92	0.16	0.14		
	200	0.85	0.85	0.85	0.87	0.87	0.87	0.00	0.00	0.35	0.57	0.96	0.74	0.82	0.89	0.18	0.16		
	250	0.82	0.82	0.82	0.84	0.84	0.84	0.00	0.00	0.32	0.53	0.93	0.68	0.78	0.86	0.20	0.19		
	300	0.79	0.79	0.79	0.81	0.81	0.81	0.00	0.00	0.29	0.50	0.90	0.62	0.73	0.83	0.22	0.21		
75%	0	0.73	0.73	0.73	1.00	1.00	1.00	0.00	0.00	0.35	0.52	0.81	1.00	1.00	1.00	0.22	0.20		
	50	0.70	0.70	0.70	0.96	0.96	0.96	0.00	0.00	0.32	0.49	0.78	0.92	0.94	0.96	0.24	0.23		
	100	0.67	0.67	0.67	0.92	0.92	0.92	0.00	0.00	0.29	0.45	0.75	0.83	0.88	0.93	0.27	0.26		
	150	0.64	0.64	0.64	0.87	0.87	0.87	0.00	0.00	0.26	0.42	0.72	0.74	0.82	0.89	0.30	0.29		
	200	0.61	0.61	0.61	0.83	0.83	0.83	0.00	0.00	0.23	0.39	0.69	0.66	0.76	0.85	0.34	0.32		
	250	0.58	0.58	0.58	0.79	0.79	0.79	0.00	0.00	0.20	0.36	0.66	0.57	0.70	0.81	0.37	0.36		
	300	0.54	0.54	0.54	0.74	0.74	0.74	0.00	0.00	0.18	0.34	0.63	0.50	0.65	0.77	0.40	0.39		
50%	0	0.49	0.49	0.49	1.00	1.00	1.00	1.00	0.82	0.23	0.34	0.54	1.00	1.00	1.00	0.49	0.45		
	50	0.46	0.46	0.46	0.94	0.94	0.94	1.00	0.82	0.20	0.31	0.51	0.88	0.91	0.94	0.54	0.49		
	100	0.43	0.43	0.43	0.87	0.87	0.87	1.00	0.82	0.17	0.28	0.48	0.74	0.82	0.89	0.60	0.53		
	150	0.39	0.39	0.39	0.81	0.81	0.81	1.00	0.91	0.14	0.25	0.45	0.62	0.73	0.83	0.64	0.56		
	200	0.36	0.36	0.36	0.74	0.74	0.74	1.00	0.91	0.12	0.22	0.42	0.50	0.65	0.77	0.67	0.59		
	250	0.33	0.33	0.33	0.68	0.68	0.68	1.00	0.91	0.09	0.20	0.39	0.40	0.57	0.71	0.70	0.62		
	300	0.30	0.30	0.30	0.61	0.61	0.61	1.00	0.91	0.08	0.17	0.35	0.32	0.49	0.65	0.73	0.64		
40%	0	0.39	0.39	0.39	1.00	1.00	1.00	1.00	0.91	0.19	0.28	0.43	1.00	1.00	1.00	0.68	0.60		
	50	0.36	0.36	0.36	0.92	0.92	0.92	1.00	0.91	0.16	0.24	0.40	0.84	0.89	0.93	0.72	0.63		
	100	0.33	0.33	0.33	0.84	0.84	0.84	1.00	0.91	0.13	0.21	0.37	0.68	0.78	0.86	0.75	0.66		
	150	0.30	0.30	0.30	0.76	0.76	0.76	1.00	0.91	0.10	0.18	0.34	0.52	0.66	0.79	0.79	0.69		
	200	0.26	0.26	0.26	0.68	0.68	0.68	1.00	0.91	0.07	0.16	0.31	0.40	0.57	0.71	0.81	0.72		
	250	0.23	0.23	0.23	0.59	0.59	0.59	1.00	0.91	0.06	0.13	0.28	0.31	0.46	0.64	0.82	0.74		
	300	0.20	0.20	0.20	0.51	0.51	0.51	1.00	0.91	0.05	0.10	0.24	0.28	0.37	0.56	0.85	0.76		
30%	0	0.29	0.29	0.29	1.00	1.00	1.00	1.00	0.91	0.14	0.21	0.33	1.00	1.00	1.00	0.84	0.74		
	50	0.26	0.26	0.26	0.89	0.89	0.89	1.00	0.91	0.11	0.18	0.30	0.78	0.85	0.91	0.86	0.77		
	100	0.23	0.23	0.23	0.79	0.79	0.79	1.00	0.91	0.08	0.15	0.26	0.57	0.70	0.81	0.89	0.79		
	150	0.20	0.20	0.20	0.68	0.68	0.68	1.00	0.91	0.06	0.12	0.23	0.40	0.57	0.71	0.90	0.80		
	200	0.17	0.17	0.17	0.57	0.57	0.57	1.00	0.91	0.04	0.09	0.20	0.30	0.42	0.61	0.91	0.82		
	250	0.13	0.13	0.13	0.45	0.45	0.45	1.00	0.91	0.04	0.07	0.17	0.27	0.33	0.52	0.93	0.83		
	300	0.10	0.10	0.10	0.34	0.34	0.34	1.00	0.91	0.04	0.06	0.14	0.25	0.29	0.44	0.94	0.84		
20%	0	0.20	0.20	0.20	1.00	1.00	1.00	1.00	0.91	0.09	0.14	0.22	1.00	1.00	1.00	0.96	0.86		
	50	0.16	0.16	0.16	0.84	0.84	0.84	1.00	0.91	0.06	0.11	0.19	0.68	0.78	0.86	0.97	0.87		
	100	0.13	0.13	0.13	0.68	0.68	0.68	1.00	0.91	0.04	0.08	0.15	0.40	0.57	0.71	0.97	0.87		
	150	0.10	0.10	0.10	0.51	0.51	0.51	1.00	0.91	0.03	0.05	0.12	0.28	0.37	0.56	0.98	0.88		
	200	0.07	0.07	0.07	0.34	0.34	0.34	1.00	0.91	0.02	0.04	0.10	0.25	0.29	0.44	0.98	0.89		
	250	0.05	0.05	0.05	0.26	0.26	0.26	1.00	0.91	0.02	0.04	0.07	0.24	0.26	0.34	0.98	0.89		
	300	0.05	0.05	0.05	0.26	0.26	0.26	1.00	0.91	0.02	0.04	0.06	0.24	0.26	0.29	0.99	0.89		

Table 4c. The ratios of (a) the deterministic scenario and (b) the 5%ile, 20%ile and median of the recruitment and initial variability scenario for model **A₈** for i) the spawner biomass in 2020 under alternative catch scenarios to that estimated in 2019, ii) the spawner biomass in 2020 under alternative catch scenarios to that in 2029 under a no catch scenario and iii) the spawner biomass in 2029 under alternative catch scenarios to that in 2029 under a no catch scenario. Results are given for different proportions (100%, 75%, 50%, 40%, 30%, 20%) of historical average recruitment and different future constant catch scenarios.

	SSB ^C ₂₀₂₀ :SSB ^C ₂₀₁₉				SSB ^C ₂₀₂₀ :SSB ^{noC} ₂₀₂₉				SSB ^C ₂₀₂₉ :SSB ^{noC} ₂₀₂₉				
	Det	5%	20%	50%	Det	5%	20%	50%	Det	5%	20%	50%	
100%	0	0.97	0.59	0.73	0.99								
	50	0.95	0.56	0.70	0.96	0.97	0.97	0.93	0.88	0.97	0.94	0.95	0.97
	100	0.93	0.54	0.68	0.94	0.95	0.92	0.89	0.86	0.94	0.87	0.91	0.94
	150	0.90	0.51	0.65	0.92	0.92	0.87	0.86	0.84	0.90	0.81	0.86	0.91
	200	0.88	0.48	0.62	0.89	0.90	0.82	0.82	0.82	0.87	0.74	0.82	0.89
	250	0.85	0.45	0.60	0.87	0.87	0.77	0.79	0.79	0.84	0.68	0.77	0.86
	300	0.83	0.42	0.57	0.84	0.85	0.72	0.75	0.77	0.81	0.61	0.73	0.83
75%	0	0.79	0.51	0.62	0.8								
	50	0.76	0.48	0.59	0.78	1.04	1.11	1.04	0.95	0.96	0.91	0.94	0.96
	100	0.74	0.45	0.56	0.76	1.01	1.04	0.99	0.92	0.91	0.83	0.88	0.92
	150	0.72	0.42	0.54	0.73	0.98	0.97	0.95	0.89	0.87	0.74	0.82	0.89
	200	0.69	0.39	0.51	0.71	0.95	0.90	0.90	0.86	0.83	0.66	0.76	0.85
	250	0.67	0.37	0.48	0.68	0.91	0.84	0.85	0.83	0.79	0.57	0.70	0.81
	300	0.65	0.34	0.46	0.66	0.88	0.77	0.81	0.81	0.74	0.49	0.64	0.77
50%	0	0.60	0.43	0.50	0.61								
	50	0.58	0.40	0.47	0.59	1.19	1.37	1.24	1.08	0.94	0.87	0.91	0.94
	100	0.56	0.37	0.44	0.57	1.14	1.27	1.17	1.04	0.87	0.74	0.82	0.89
	150	0.53	0.34	0.42	0.54	1.09	1.17	1.10	0.99	0.81	0.61	0.73	0.83
	200	0.51	0.31	0.39	0.52	1.04	1.07	1.03	0.95	0.74	0.49	0.64	0.77
	250	0.48	0.28	0.37	0.49	0.99	0.98	0.96	0.91	0.68	0.38	0.55	0.71
	300	0.46	0.28	0.34	0.47	0.94	0.96	0.90	0.86	0.61	0.31	0.47	0.66
40%	0	0.53	0.39	0.45	0.54								
	50	0.51	0.36	0.42	0.52	1.29	1.56	1.39	1.18	0.92	0.84	0.89	0.93
	100	0.48	0.33	0.40	0.49	1.23	1.44	1.31	1.13	0.84	0.68	0.77	0.86
	150	0.46	0.30	0.37	0.47	1.17	1.31	1.22	1.07	0.76	0.52	0.66	0.79
	200	0.43	0.28	0.34	0.44	1.11	1.20	1.14	1.02	0.68	0.38	0.55	0.71
	250	0.41	0.27	0.32	0.42	1.05	1.15	1.05	0.96	0.59	0.30	0.45	0.64
	300	0.39	0.26	0.29	0.40	0.99	1.12	0.97	0.91	0.51	0.27	0.38	0.57
30%	0	0.45	0.36	0.4	0.47								
	50	0.43	0.33	0.38	0.44	1.47	1.91	1.66	1.35	0.89	0.78	0.85	0.90
	100	0.41	0.30	0.35	0.42	1.39	1.74	1.54	1.28	0.79	0.57	0.70	0.81
	150	0.38	0.27	0.32	0.39	1.31	1.57	1.43	1.20	0.68	0.38	0.55	0.71
	200	0.36	0.26	0.30	0.37	1.23	1.49	1.31	1.13	0.57	0.28	0.41	0.62
	250	0.34	0.25	0.27	0.35	1.15	1.43	1.21	1.06	0.45	0.27	0.34	0.52
	300	0.31	0.24	0.26	0.32	1.07	1.39	1.14	0.99	0.34	0.26	0.29	0.44
20%	0	0.38	0.33	0.35	0.39								
	50	0.36	0.30	0.33	0.37	1.82	2.60	2.15	1.67	0.84	0.68	0.77	0.86
	100	0.33	0.27	0.30	0.34	1.70	2.35	1.98	1.56	0.68	0.38	0.55	0.71
	150	0.31	0.25	0.27	0.32	1.58	2.18	1.81	1.45	0.51	0.27	0.38	0.57
	200	0.29	0.24	0.25	0.29	1.46	2.09	1.67	1.35	0.34	0.26	0.29	0.44
	250	0.26	0.23	0.24	0.27	1.34	2.01	1.61	1.24	0.26	0.25	0.26	0.33
	300	0.24	0.23	0.24	0.25	1.24	1.96	1.56	1.16	0.26	0.23	0.25	0.28

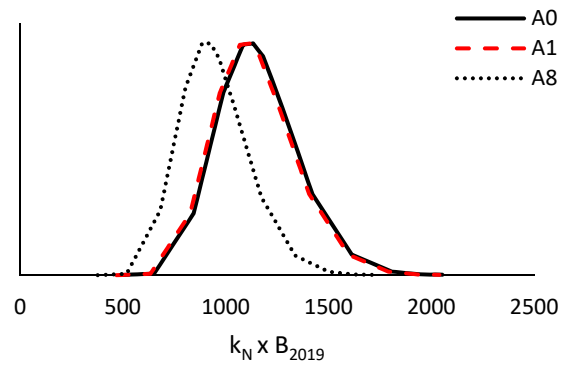


Figure 1. The AD Model Builder estimated likelihood profile over $k_N^A B_{2019}^A$ for the baseline model of de Moor (2020).

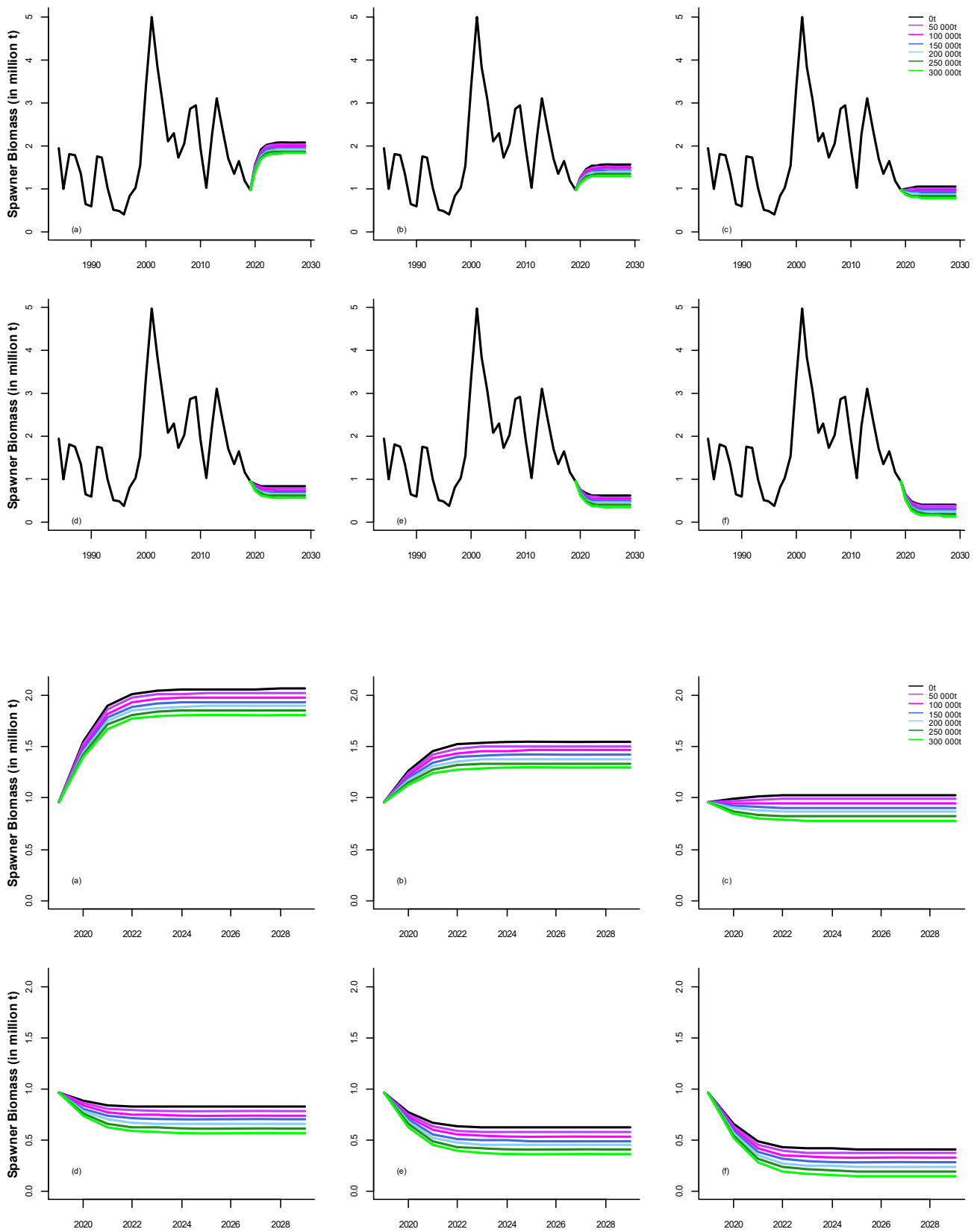


Figure 2. Model estimated deterministic anchovy spawner biomass from 1984 to 2029 under alternative future catch scenarios, with future recruitment being a) 100%, b) 75%, c) 50%, d) 40%, e) 30% and f) 20% of the historical average. The lower panels are a repeat of the top panels, but over a smaller x-axis and y-axis range.

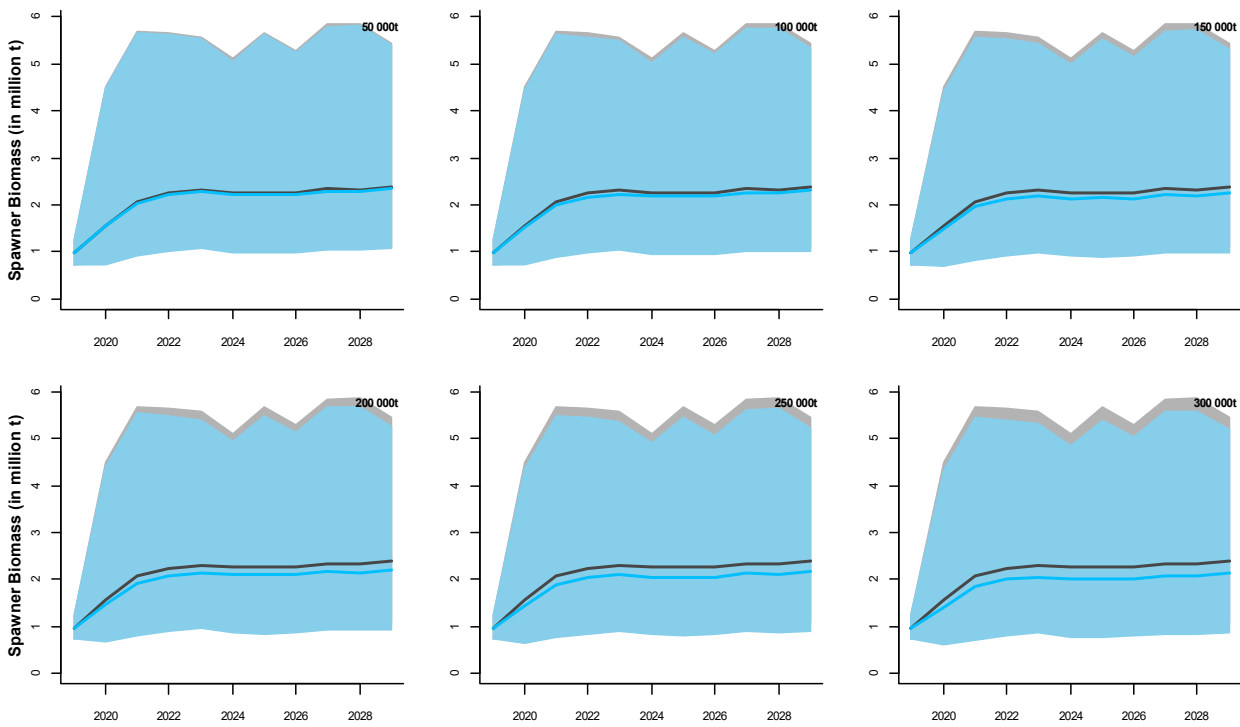


Figure 3a. The median and 95%ile confidence intervals of anchovy spawner biomass from 2019 to 2029 under a no catch (grey) and six alternative catch (blue) scenarios with future recruitment being the historical average, and including both recruitment and starting point variability.

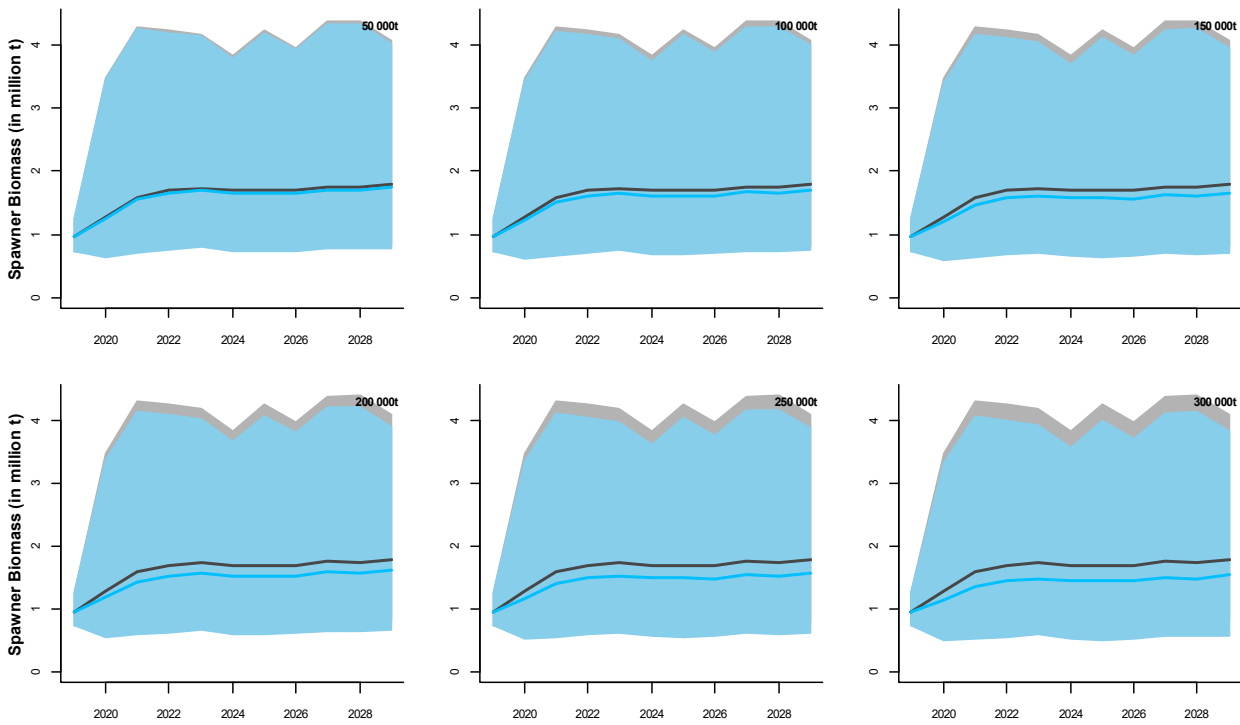


Figure 3b. As per Figure 3a, but with future recruitment being 75% of the historical average.

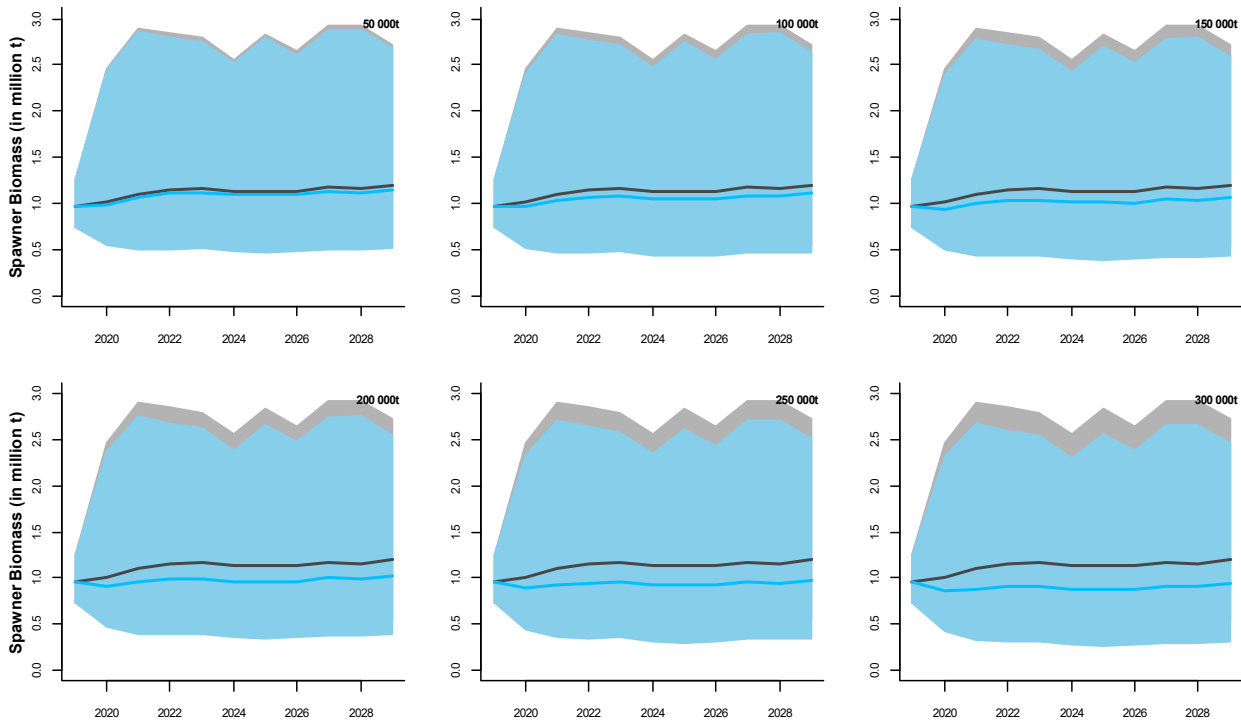


Figure 3c. As per Figure 3a, but with future recruitment being 50% of the historical average.

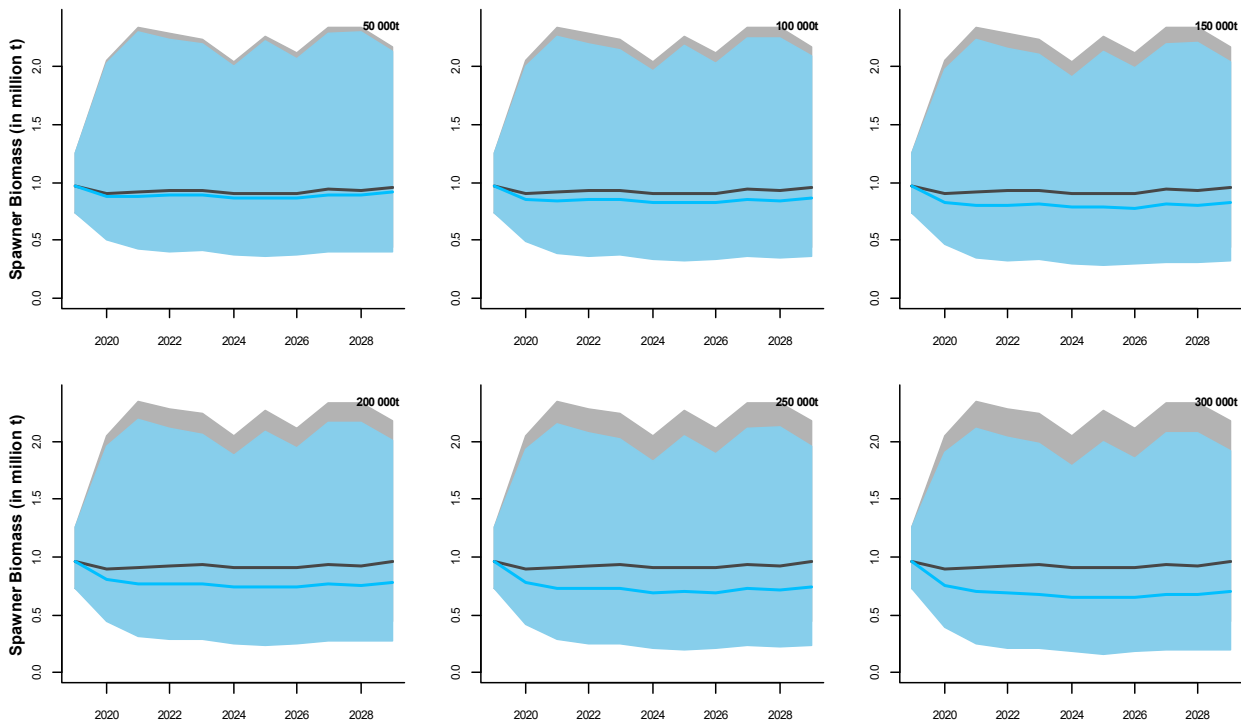


Figure 3d. As per Figure 3a, but with future recruitment being 40% of the historical average.

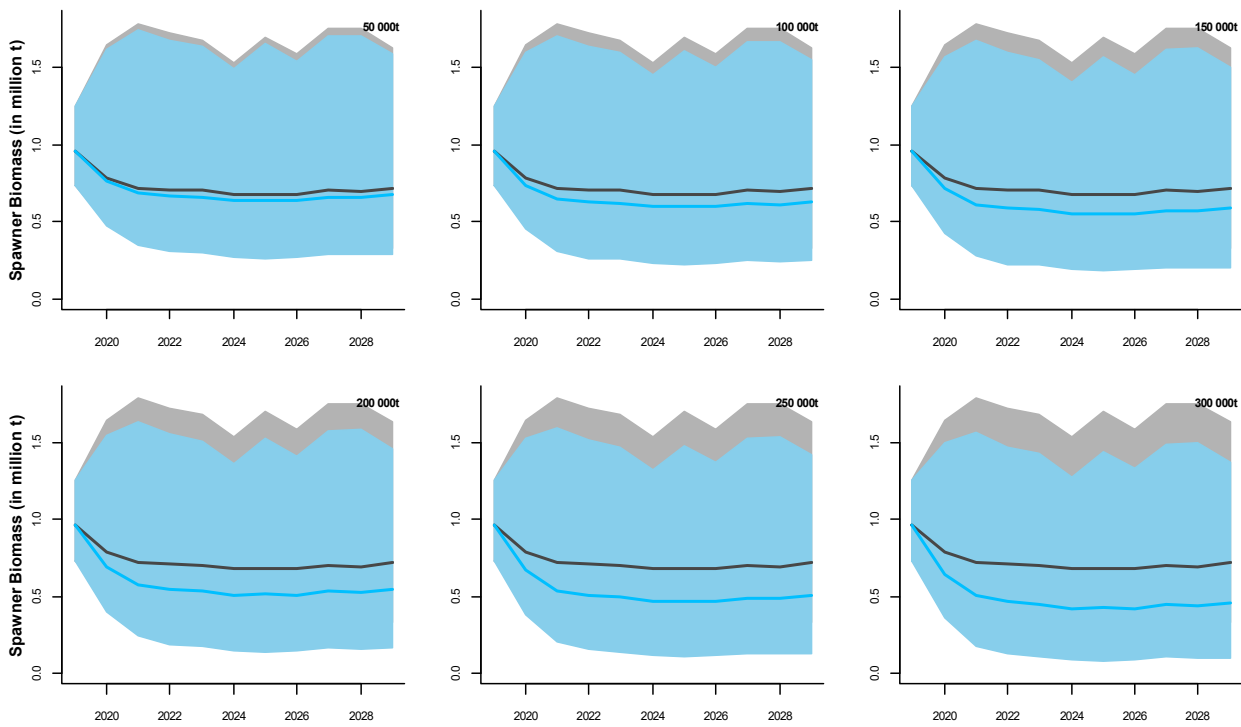


Figure 3e. As per Figure 3a, but with future recruitment being 30% of the historical average.

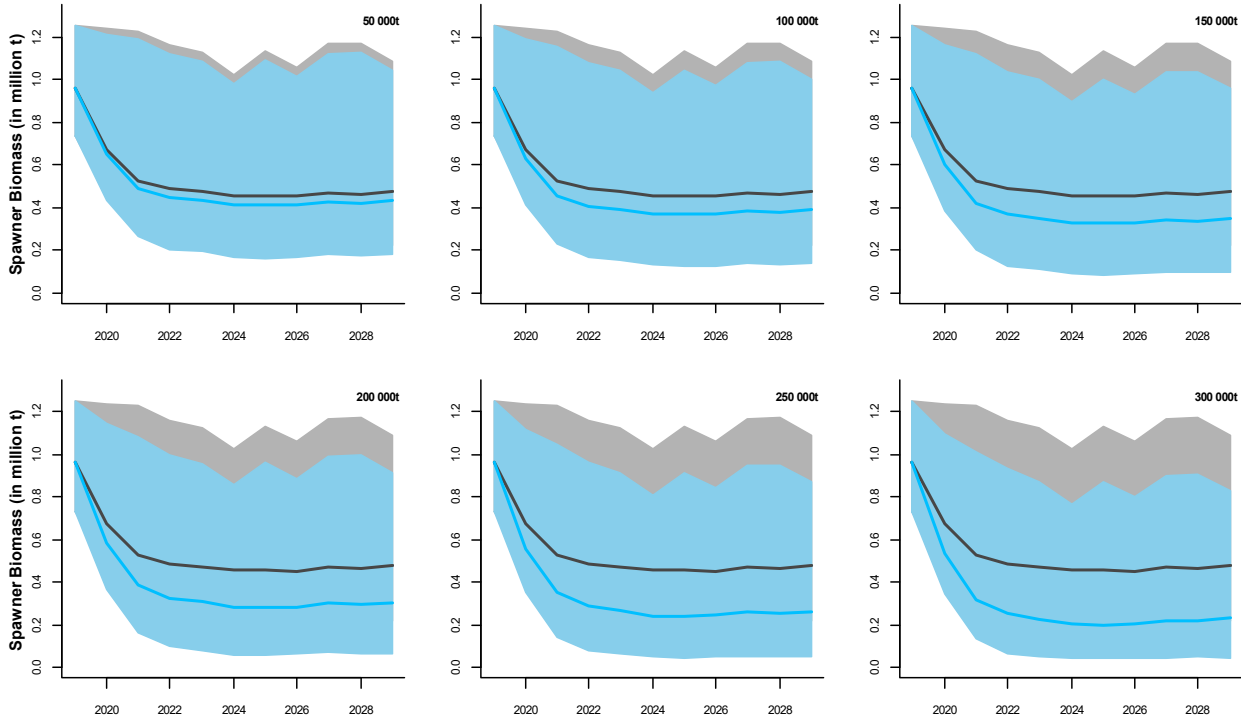


Figure 3f. As per Figure 3a, but with future recruitment being 20% of the historical average.

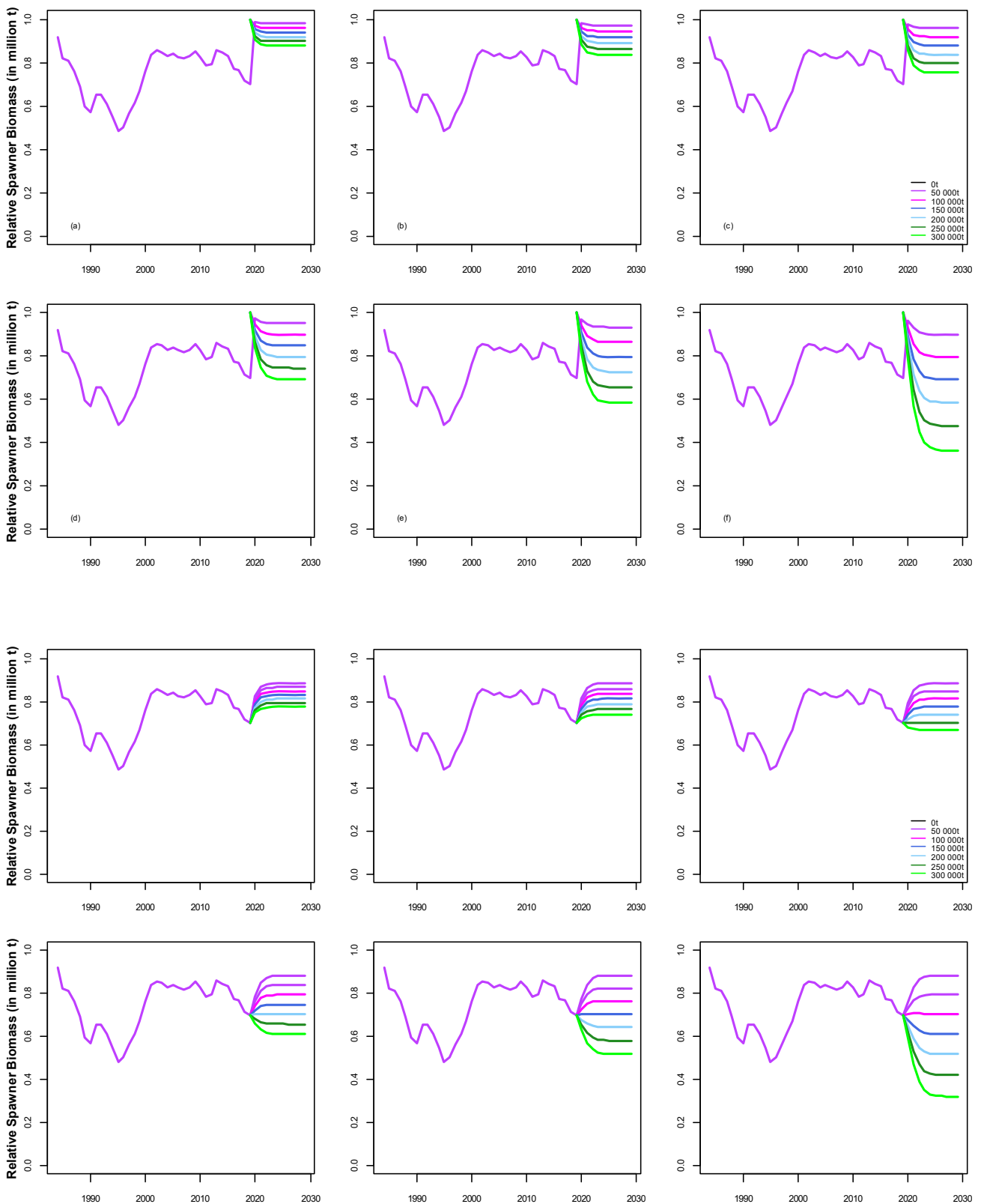


Figure 4. Model estimated deterministic anchovy spawner biomass from 2019 to 2029 under six alternative catch scenarios relative to a no future catch scenario, with future recruitment being a) 100%, b) 75%, c) 50%, d) 40%, e) 30% and f) 20% of the historical average. In the top panel the no future catch scenario begins from the baseline spawner biomass in 2019 estimated using historical catches. In the lower panel the no future catch scenario begins from the Dynamic B₀ estimated 2019 spawner biomass.

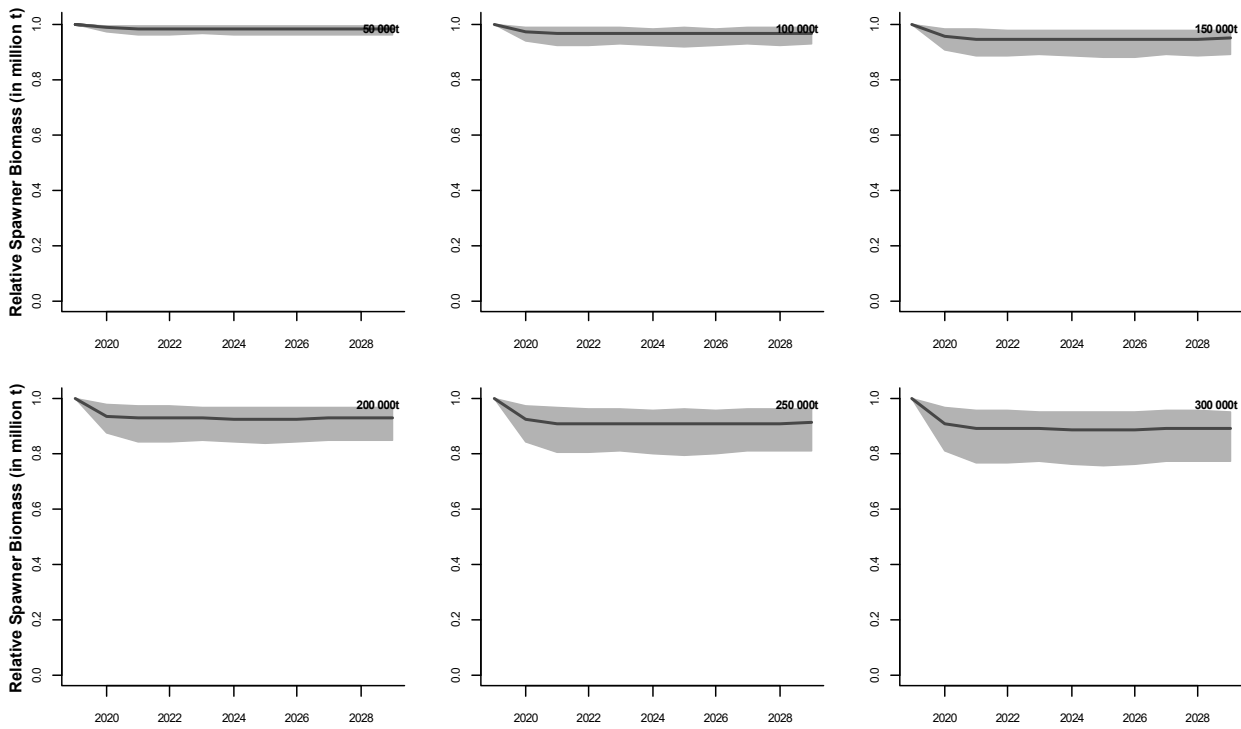


Figure 5a. The median and 95%ile confidence intervals of anchovy spawner biomass from 2019 to 2029 under six alternative catch scenarios relative to a no future catch scenario, with future recruitment being the historical average, and including both recruitment and starting point variability.

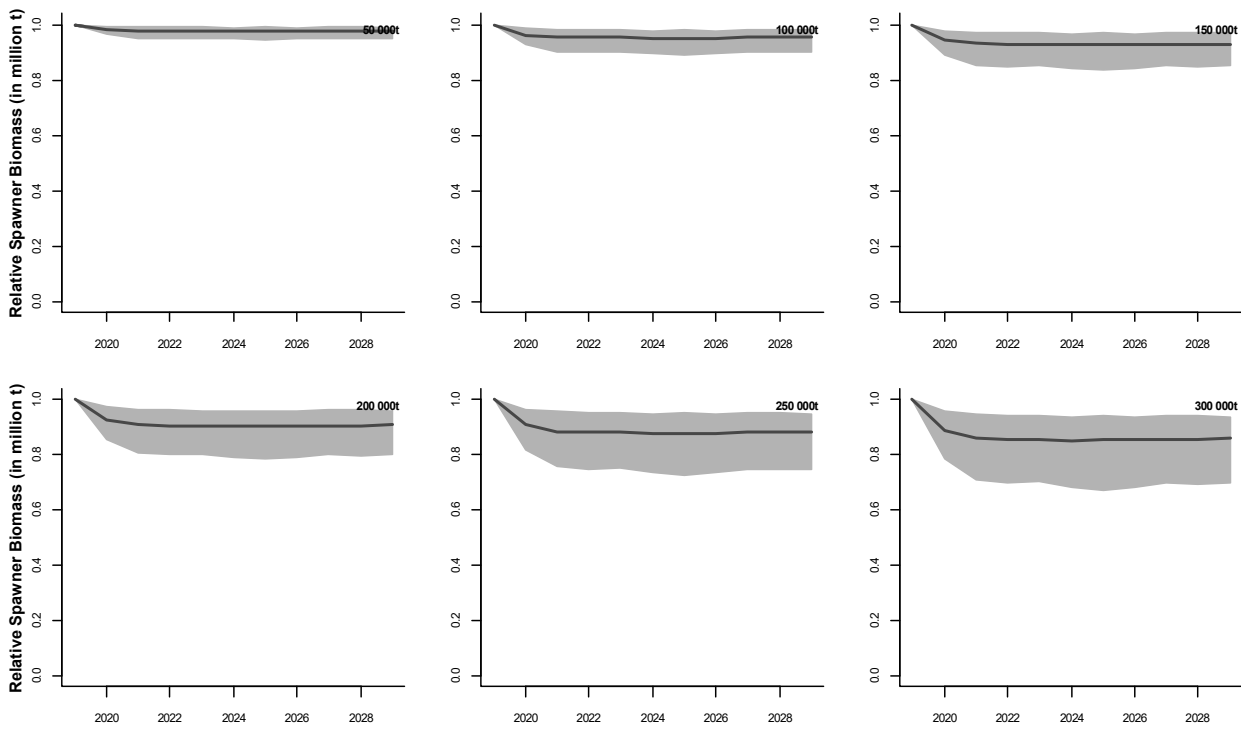


Figure 5b. As per Figure 5a, but with future recruitment being 75% of the historical average.

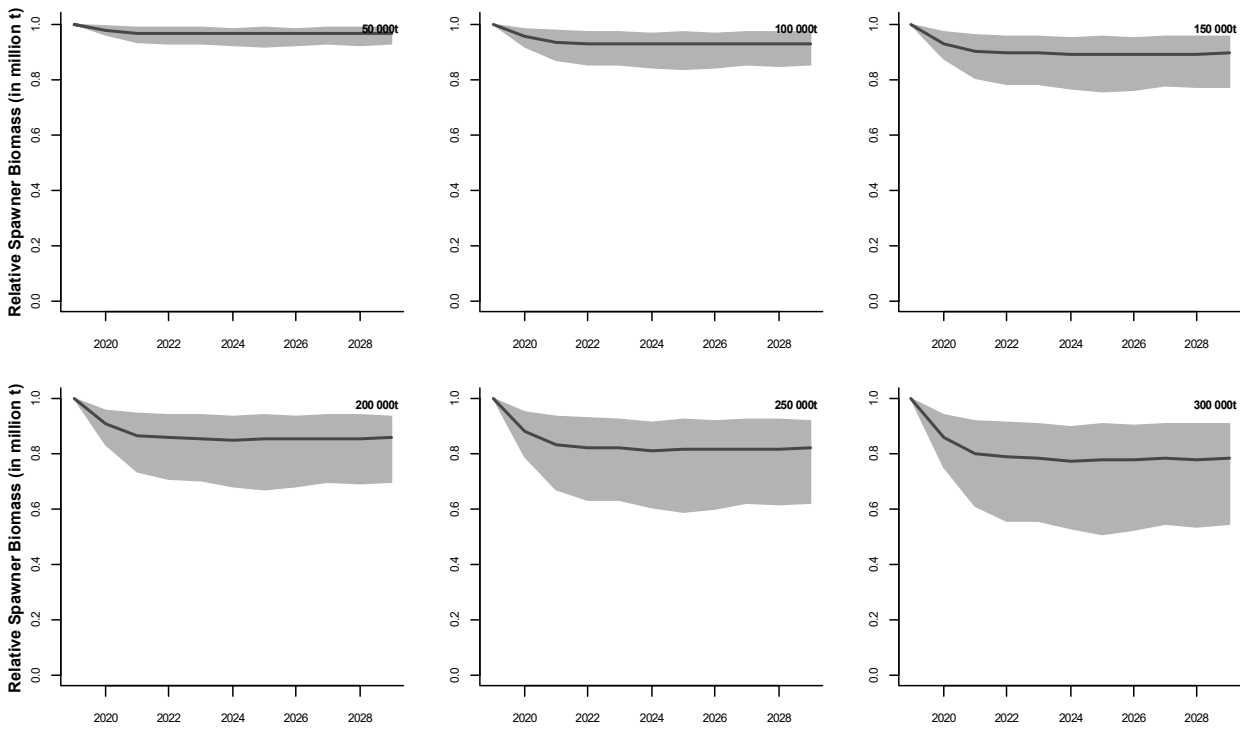


Figure 5c. As per Figure 5a, but with future recruitment being 50% of the historical average.

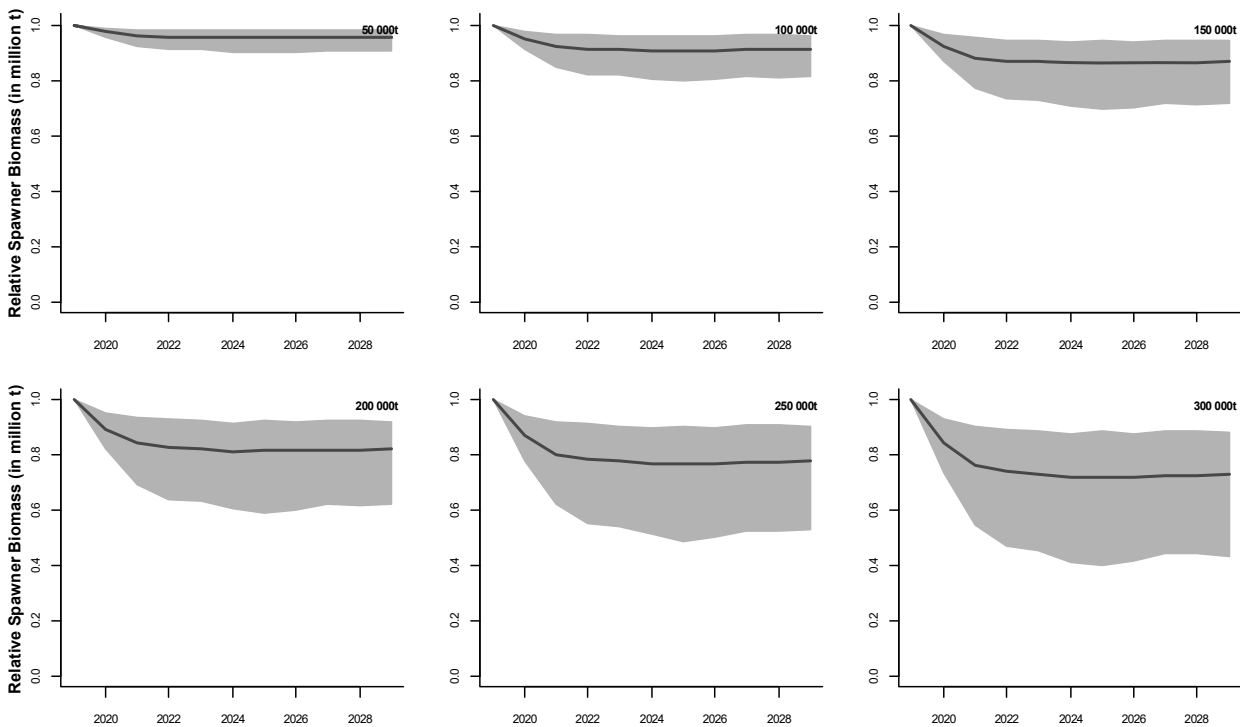


Figure 5d. As per Figure 5a, but with future recruitment being 40% of the historical average.

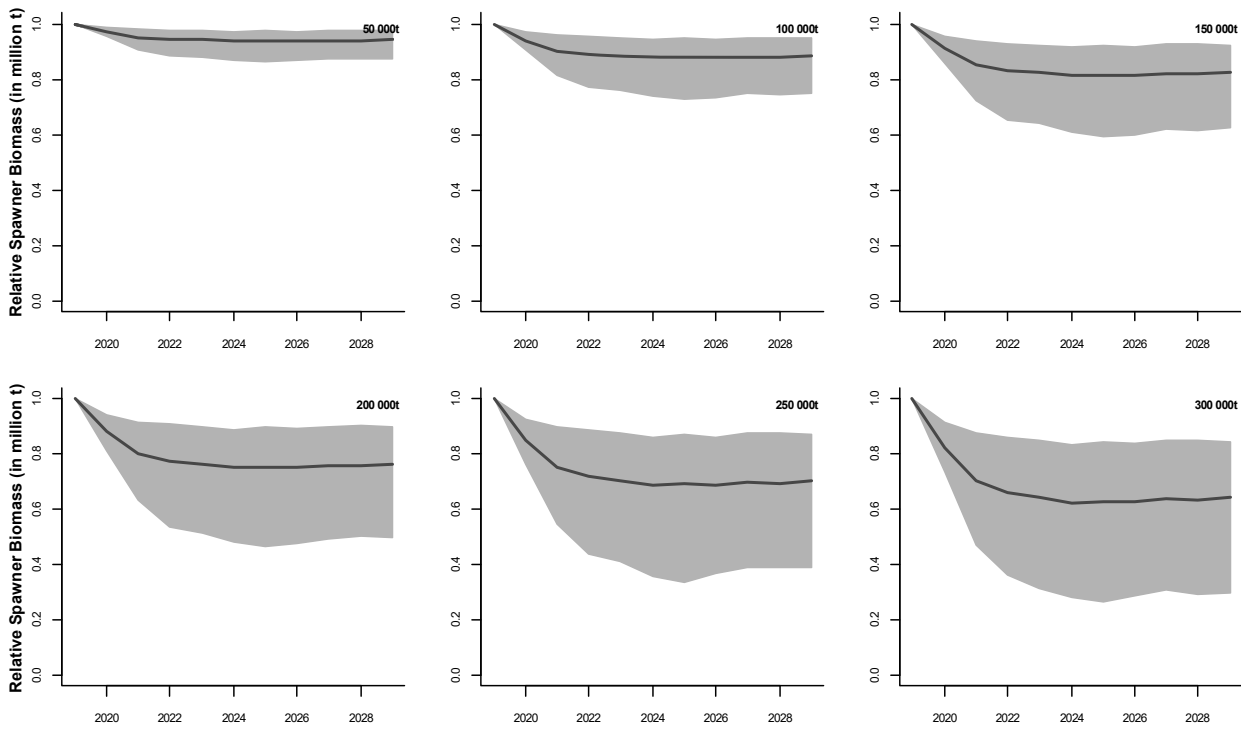


Figure 5e. As per Figure 5a, but with future recruitment being 30% of the historical average.

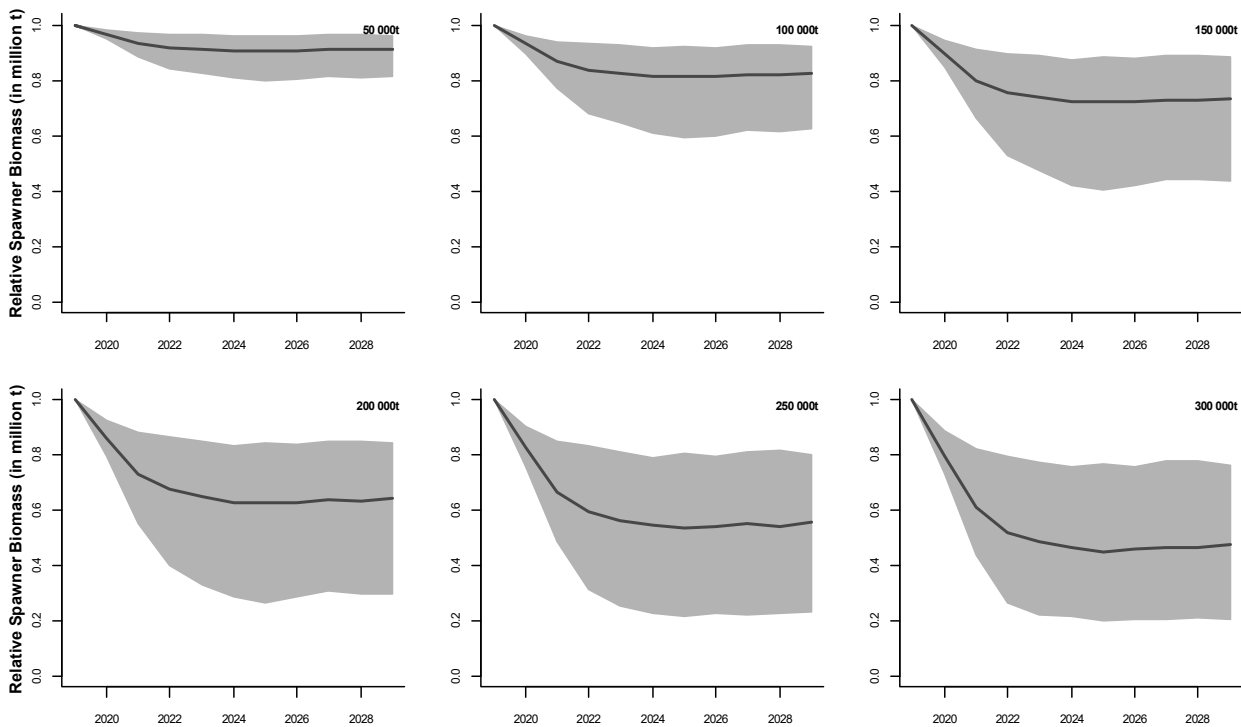


Figure 5f. As per Figure 5a, but with future recruitment being 20% of the historical average.

Appendix A: Projections using constant catch assumptions

The projections are run from November $y_n = 2019$ to November $y_{end} = 2029$. The notation used corresponds to that of Appendix A and Table A1 of de Moor (2020).

- The numbers-at-age are calculated according to equation (A.1) of de Moor (2020)

$$N_{y,a}^A = \left(\left(\left(\left(N_{y-1,a-1}^A e^{-M_{a-1,y}^A/8} - C_{y,1,a-1}^A \right) e^{-M_{a-1,y}^A/4} - C_{y,2,a-1}^A \right) e^{-M_{a-1,y}^A/4} - C_{y,3,a-1}^A \right) e^{-M_{a-1,y}^A/4} - C_{y,4,a-1}^A \right) e^{-M_{a-1,y}^A/8}$$

$$y_n \leq y \leq y_{end}, 1 \leq a \leq 3$$

$$N_{y,4+}^A = \left(\left(\left(\left(N_{y-1,3}^A e^{-M_{3,y}^A/8} - C_{y,1,3}^A \right) e^{-M_{3,y}^A/4} - C_{y,2,3}^A \right) e^{-M_{3,y}^A/4} - C_{y,3,3}^A \right) e^{-M_{3,y}^A/4} - C_{y,4,3}^A \right) e^{-M_{3,y}^A/8}$$

$$+ \left(\left(\left(\left(N_{y-1,4+}^A e^{-M_{4+,y}^A/8} - C_{y,1,4+}^A \right) e^{-M_{4+,y}^A/4} - C_{y,2,4+}^A \right) e^{-M_{4+,y}^A/4} - C_{y,3,4+}^A \right) e^{-M_{4+,y}^A/4} - C_{y,4,4+}^A \right) e^{-M_{4+,y}^A/8}$$

$$y_n \leq y \leq y_{end}$$

- Natural mortality is assumed to be time-invariant at $M_{0,y}^A = M_{1+,y}^A = 1.2 \text{ year}^{-1}$ for all years, as per the initial assessment of de Moor (2020).
- November biomass and spawner biomass are calculated according to equations (A.7) and (A.8) of de Moor (2020), with the numbers-at-length given according to equations (A.2) and (A.3) of de Moor (2020):

$$B_y^A = \sum_{l=1.5^-}^{16^+} N_{y,l}^A w_l^A \quad y_n \leq y \leq y_{end}$$

$$SSB_y^A = \sum_{l=1.5^-}^{16^+} f_l^A N_{y,l}^{A,1+} w_l^A \quad y_n \leq y \leq y_{end}$$

$$N_{y,l}^A = \sum_{a=0}^{4+} A_{a,l}^{sur} N_{y,a}^A \quad y_n \leq y \leq y_{end}, 1.5^- \text{ cm} \leq l \leq 16^+ \text{ cm}$$

$$N_{y,l}^{A,1+} = \sum_{a=1}^{4+} A_{a,l}^{sur} N_{y,a}^A \quad y_n \leq y \leq y_{end}, 1.5^- \text{ cm} \leq l \leq 16^+ \text{ cm}$$

- Quarterly pulse catches are calculated as per equation (A.12) of de Moor (2020):

$$C_{y,1,a}^A = N_{y-1,a}^A e^{-M_{a,y}^A/8} S_{y,1,a} F_{y,1}$$

$$C_{y,2,a}^A = \left(N_{y-1,a}^A e^{-M_{a,y}^A/8} - C_{y,1,a}^A \right) e^{-M_{a,y}^A/4} S_{y,2,a} F_{y,2}$$

$$C_{y,3,a}^A = \left(\left(N_{y-1,a}^A e^{-M_{a,y}^A/8} - C_{y,1,a}^A \right) e^{-M_{a,y}^A/4} - C_{y,2,a}^A \right) e^{-M_{a,y}^A/4} S_{y,3,a} F_{y,3}$$

$$C_{y,4,a}^A = \left(\left(\left(\left(N_{y-1,a}^A e^{-M_{a,y}^A/8} - C_{y,1,a}^A \right) e^{-M_{a,y}^A/4} - C_{y,2,a}^A \right) e^{-M_{a,y}^A/4} - C_{y,3,a}^A \right) e^{-M_{a,y}^A/4} S_{y,4,a} F_{y,4} \quad y_n \leq y \leq y_{end}, 0 \leq a \leq 4^+$$

where

$$F_{y,1} = \frac{p_1^{catch} C_y^{ton}}{\sum_{a=0}^{4+} N_{y-1,a}^A e^{-M_{a,y}^A/8} w_{1,a}^c S_{y,1,a}}$$

$$F_{y,2} = \frac{p_2^{catch} C_y^{ton}}{\sum_{a=0}^{4+} \left(N_{y-1,a}^A e^{-M_{a,y}^A/8} - C_{y,1,a}^A \right) e^{-M_{a,y}^A/4} w_{2,a}^c S_{y,2,a}}$$

$$F_{y,3} = \frac{p_3^{catch} C_y^{ton}}{\sum_{a=0}^{4+} \left(\left(N_{y-1,a}^A e^{-M_{a,y}^A/8} - C_{y,1,a}^A \right) e^{-M_{a,y}^A/4} - C_{y,2,a}^A \right) e^{-M_{a,y}^A/4} w_{3,a}^c S_{y,3,a}}$$

$$F_{y,4} = \frac{p_4^{catch} C_y^{ton}}{\sum_{a=0}^{4+} \left(\left(\left(\left(N_{y-1,a}^A e^{-M_{a,y}^A/8} - C_{y,1,a}^A \right) e^{-M_{a,y}^A/4} - C_{y,2,a}^A \right) e^{-M_{a,y}^A/4} - C_{y,3,a}^A \right) e^{-M_{a,y}^A/4} w_{4,a}^c S_{y,4,a}} \quad y_n \leq y \leq y_{end}$$

and

$$w_{q,a}^{catch} = \begin{cases} \left[1 - \frac{(2q-1)}{8}\right] w_a^A + \frac{(2q-1)}{8} w_{a+1}^A & a < 4^+ \\ w_a^A & a = 4^+ \end{cases} \quad 0 \leq a \leq 4^+, 1 \leq q \leq 4$$

and $w_a^A = \sum_{l=1.5^+}^{16^+} A_{a,l}^{sur} w_l^A$. A penalty is imposed to ensure that $S_{y,l} F_{y,q} < 0.95$ for all l .

- The catch tonnage is split between quarters based on the average over the most recent 5 years: $p_1^{catch} = 0.004$, $p_2^{catch} = 0.304$, $p_3^{catch} = 0.514$ and $p_4^{catch} = 0.178$.
- Six alternatives levels of future recruitment $N_{y,0}^A$ are assumed:
 - i) The historical average 1984-2018 recruitment of 724 billion.
 - ii) 75% of the historical average 1984-2018 recruitment of 543 billion. The average recruitment of the most recent 5 years was 516 billion.
 - iii) 50% of the historical average 1984-2018 recruitment of 362 billion.
 - iv) 40% of the historical average 1984-2018 recruitment of 290 billion.
 - v) 30% of the historical average 1984-2018 recruitment of 217 billion.
 - vi) 20% of the historical average 1984-2018 recruitment of 145 billion.

Appendix B: Further spawner biomass and relative spawner biomass projections under the baseline model A₀

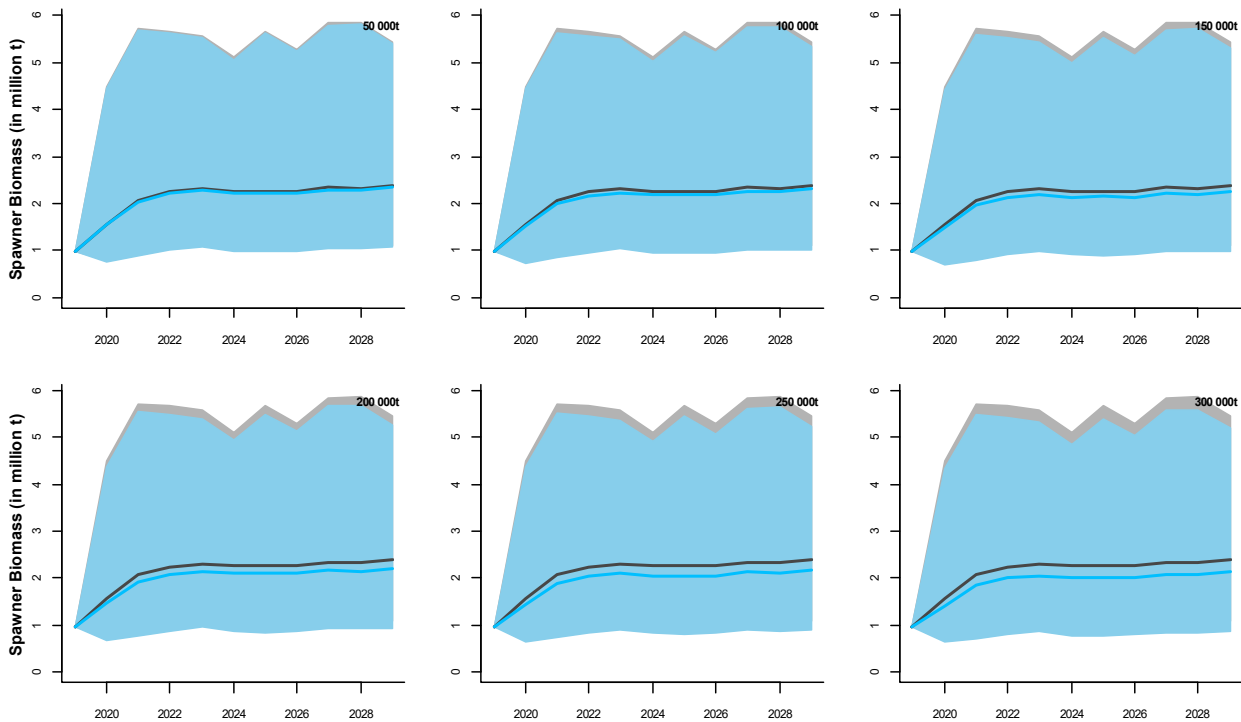


Figure B1a. The median and 95%ile confidence intervals of anchovy spawner biomass from 2019 to 2029 under a no catch (grey) and six alternative catch (blue) scenarios with future recruitment being the historical average, and including recruitment variability only.

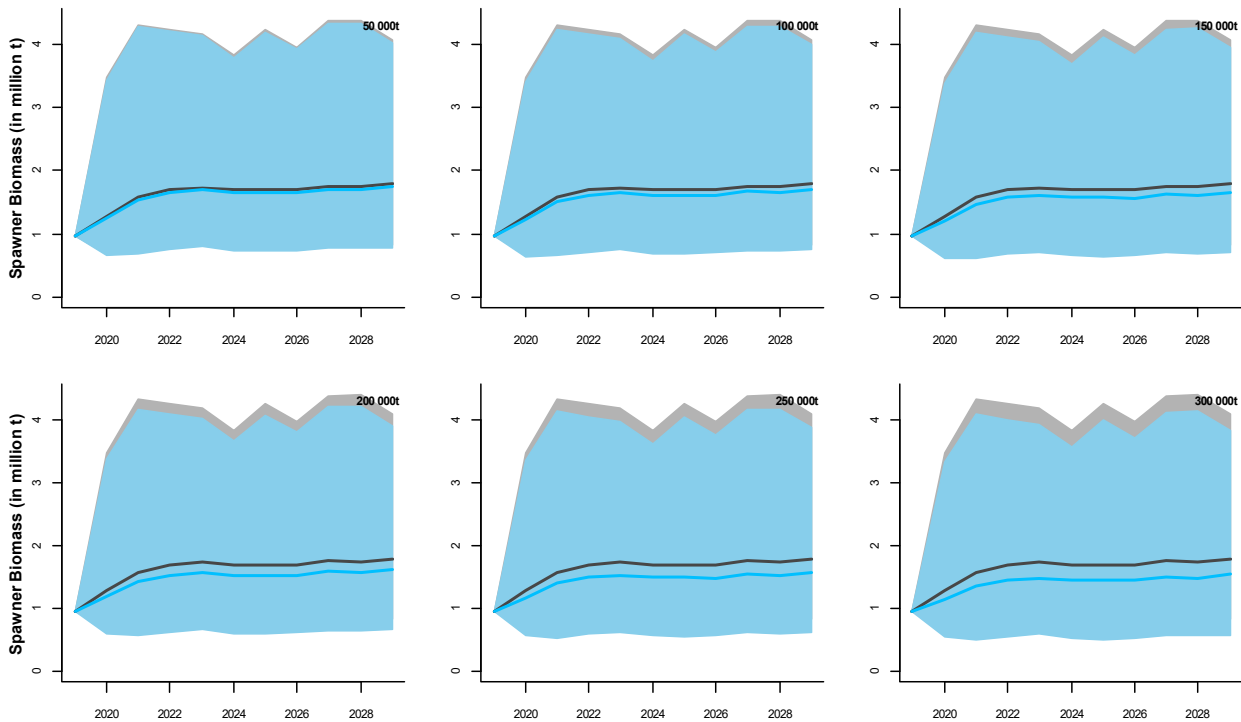


Figure B1b. As per Figure B1a, but with future recruitment being 75% of the historical average.

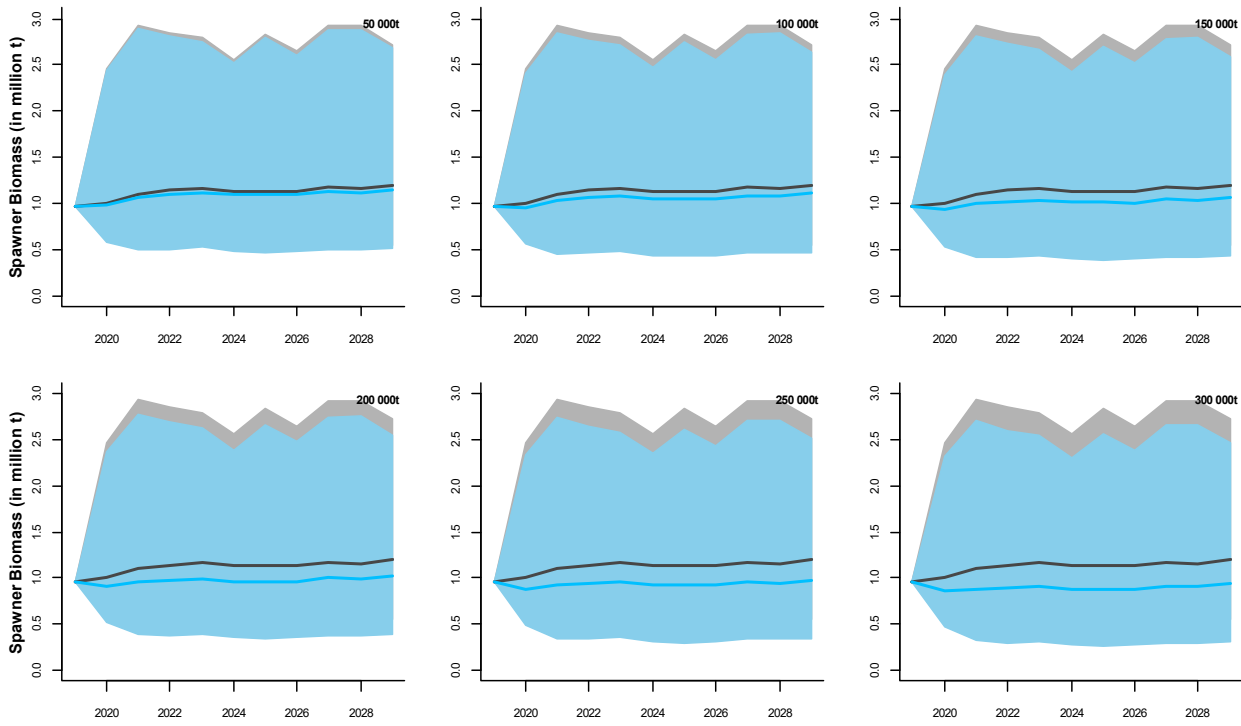


Figure B1c. As per Figure B1a, but with future recruitment being 50% of the historical average.

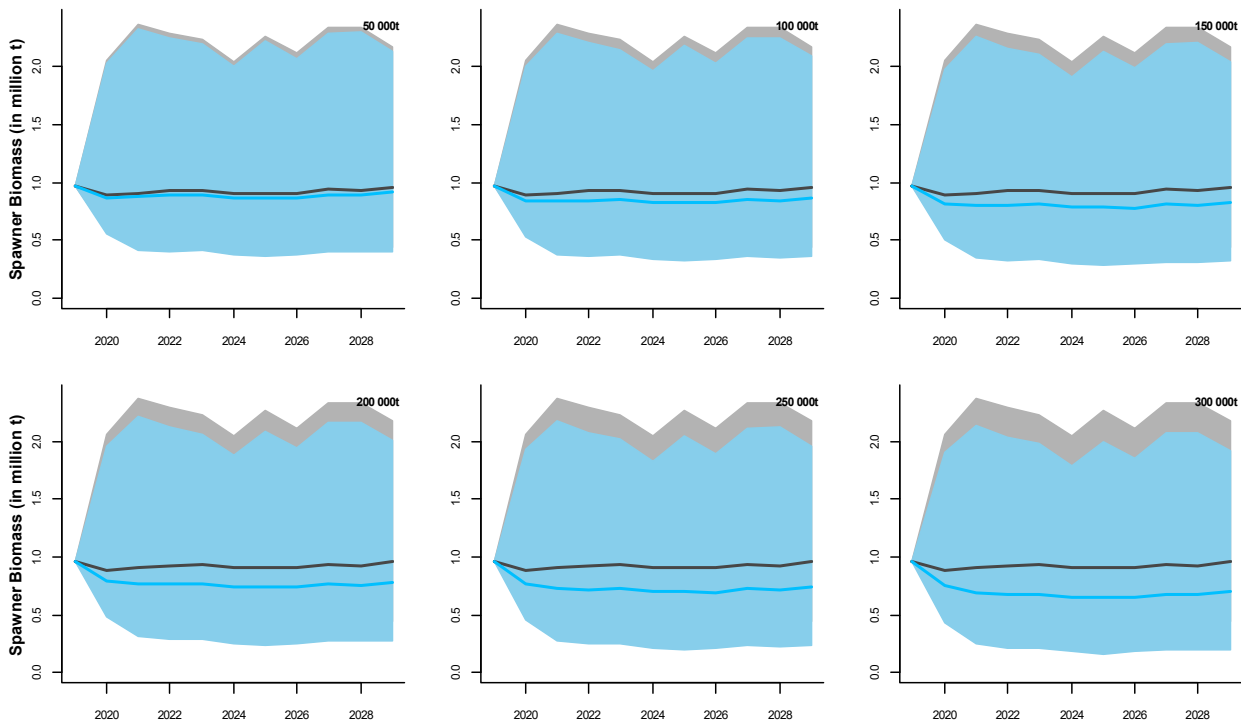


Figure B1d. As per Figure B1a, but with future recruitment being 40% of the historical average.

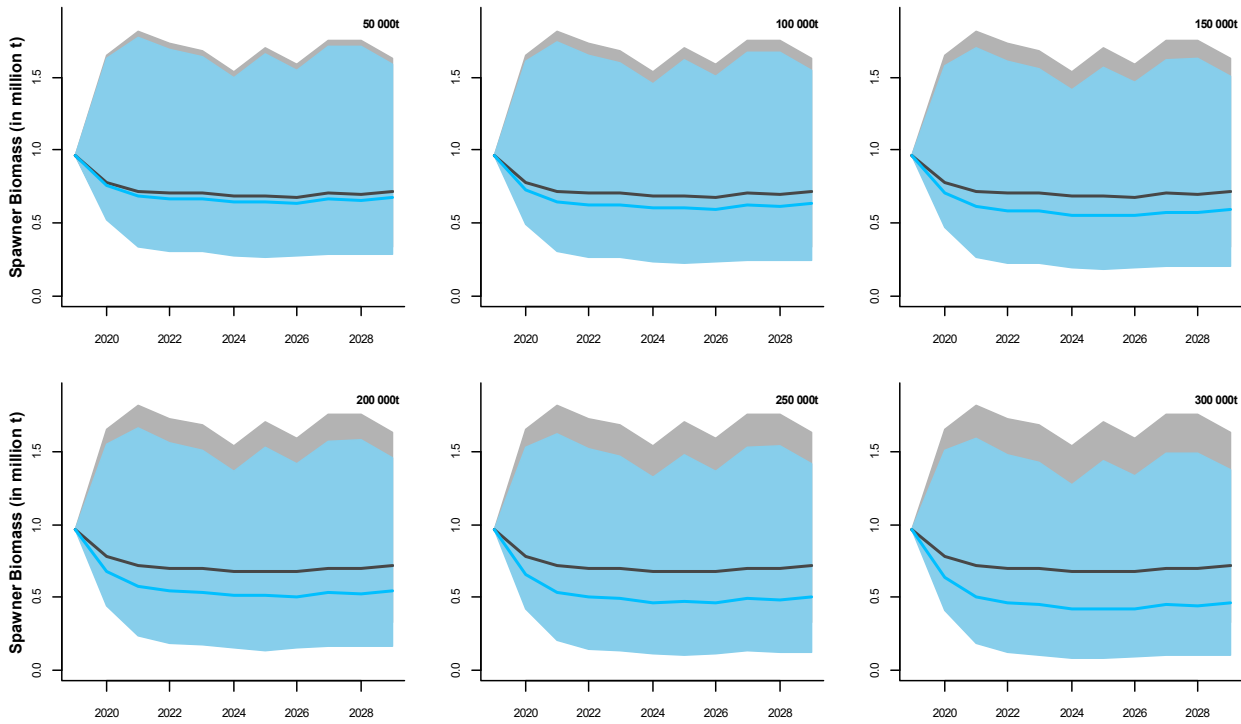


Figure B1e. As per Figure B1a, but with future recruitment being 30% of the historical average.

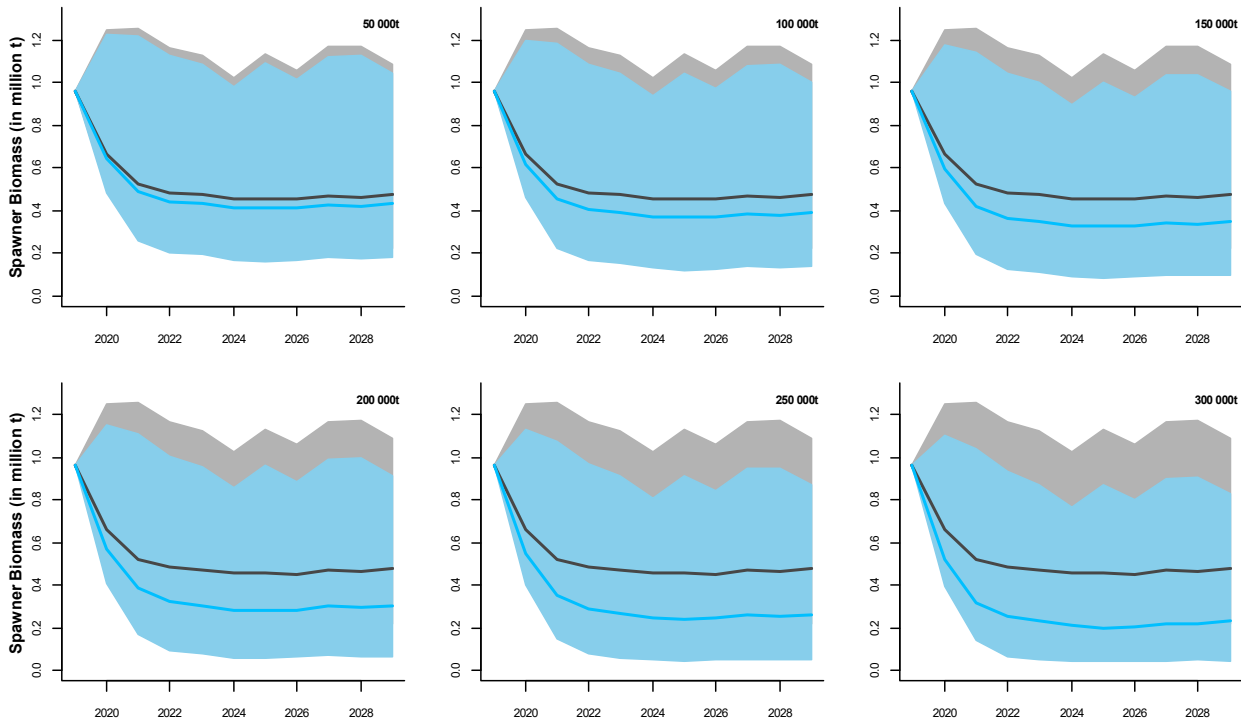


Figure B1f. As per Figure B1a, but with future recruitment being 20% of the historical average.

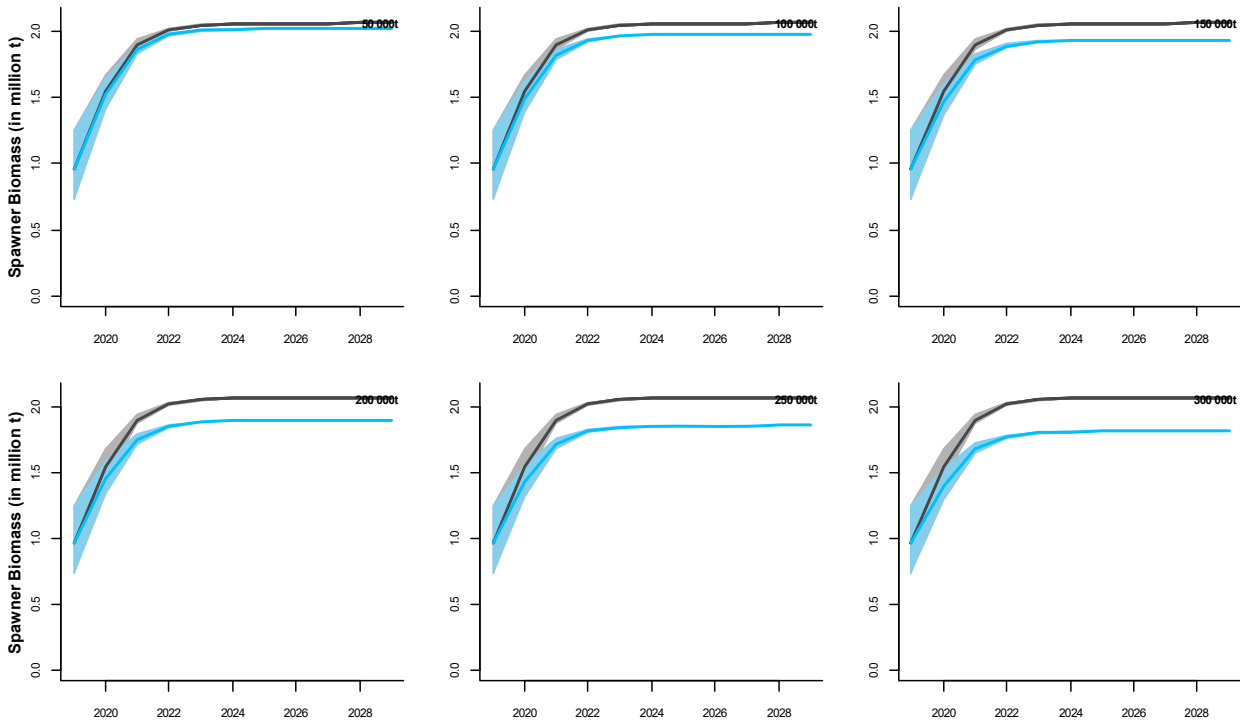


Figure B2a. The median and 95%ile confidence intervals of anchovy spawner biomass from 2019 to 2029 under a no catch (grey) and six alternative catch (blue) scenarios with future recruitment being the historical average, and including starting point variability only.

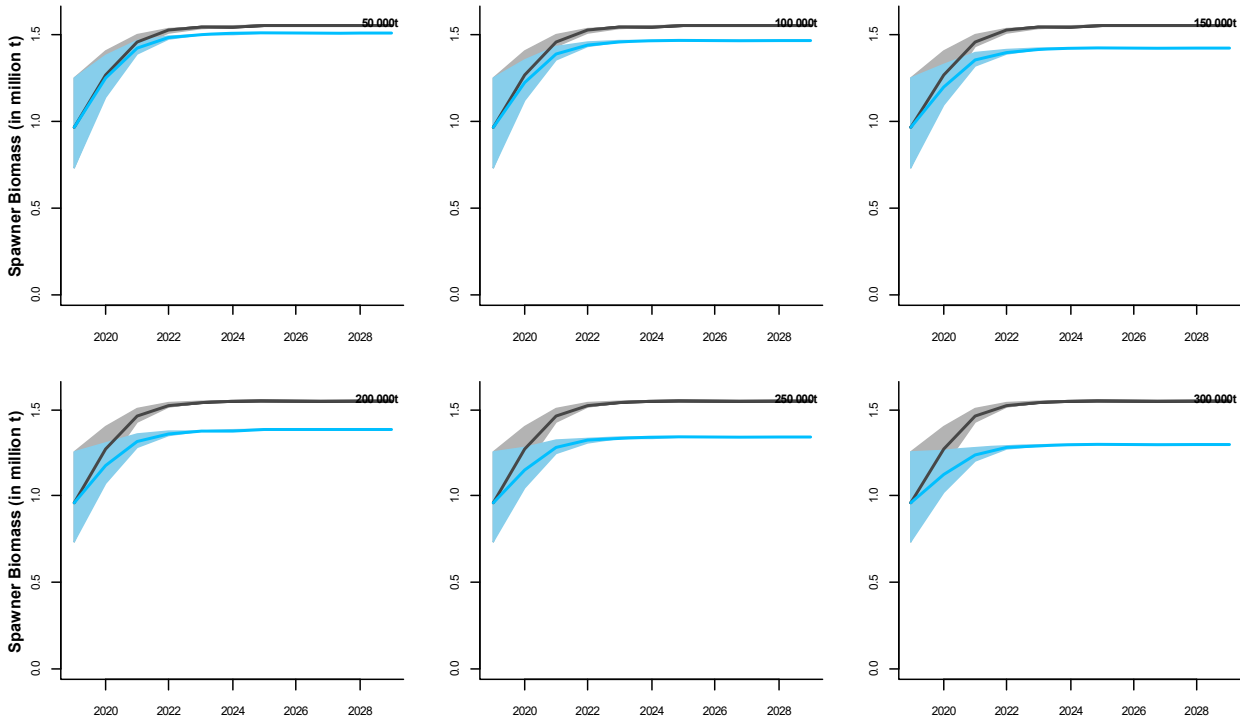


Figure B2b. As per Figure B2a, but with future recruitment being 75% of the historical average.

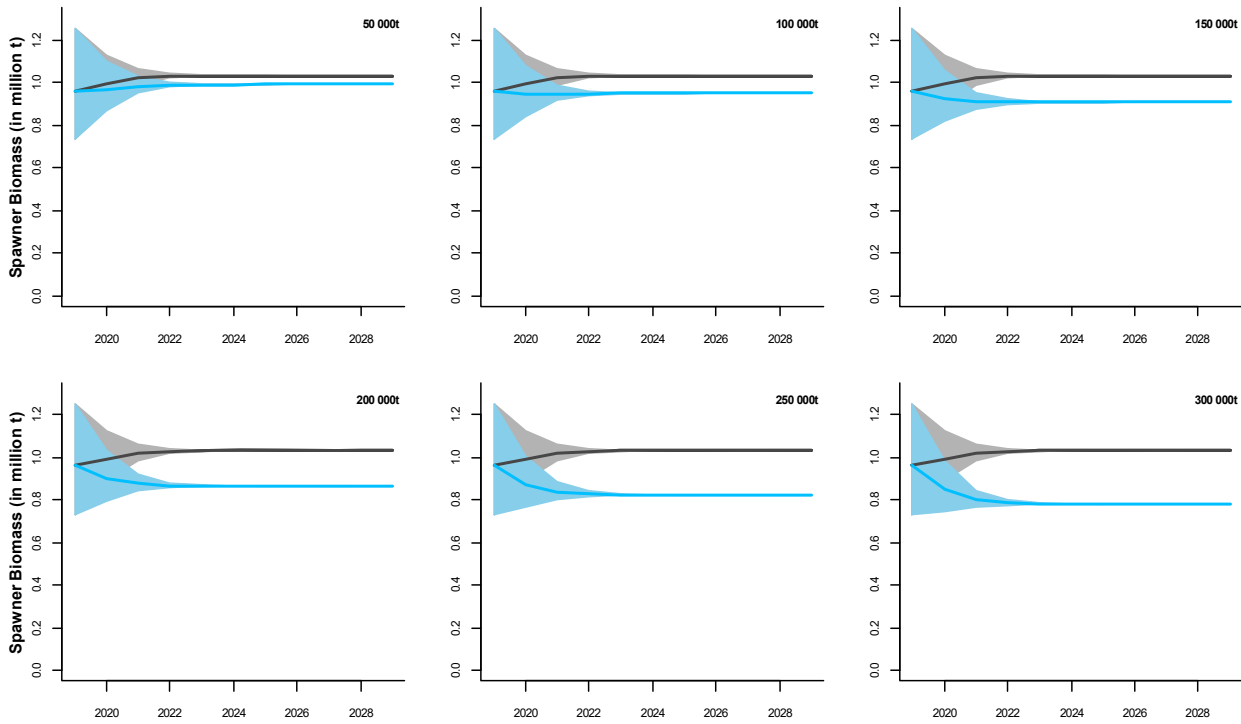


Figure B2c. As per Figure B2a, but with future recruitment being 50% of the historical average.

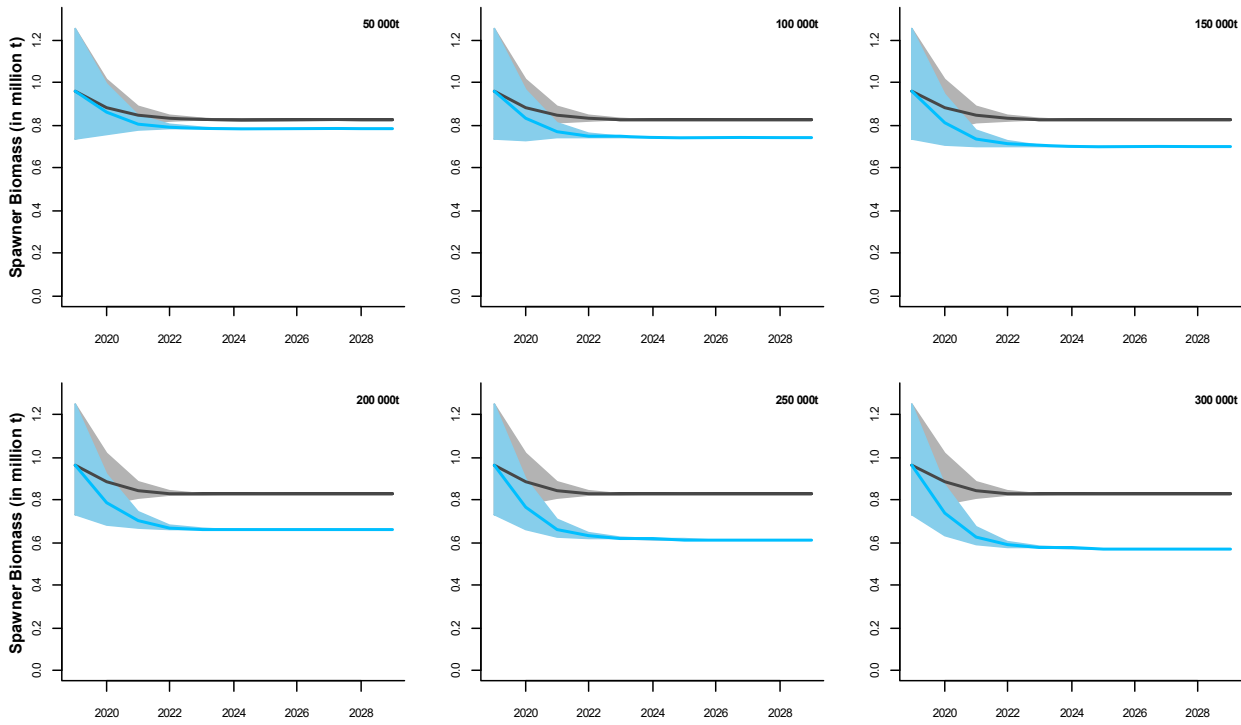


Figure B2d. As per Figure B2a, but with future recruitment being 40% of the historical average.

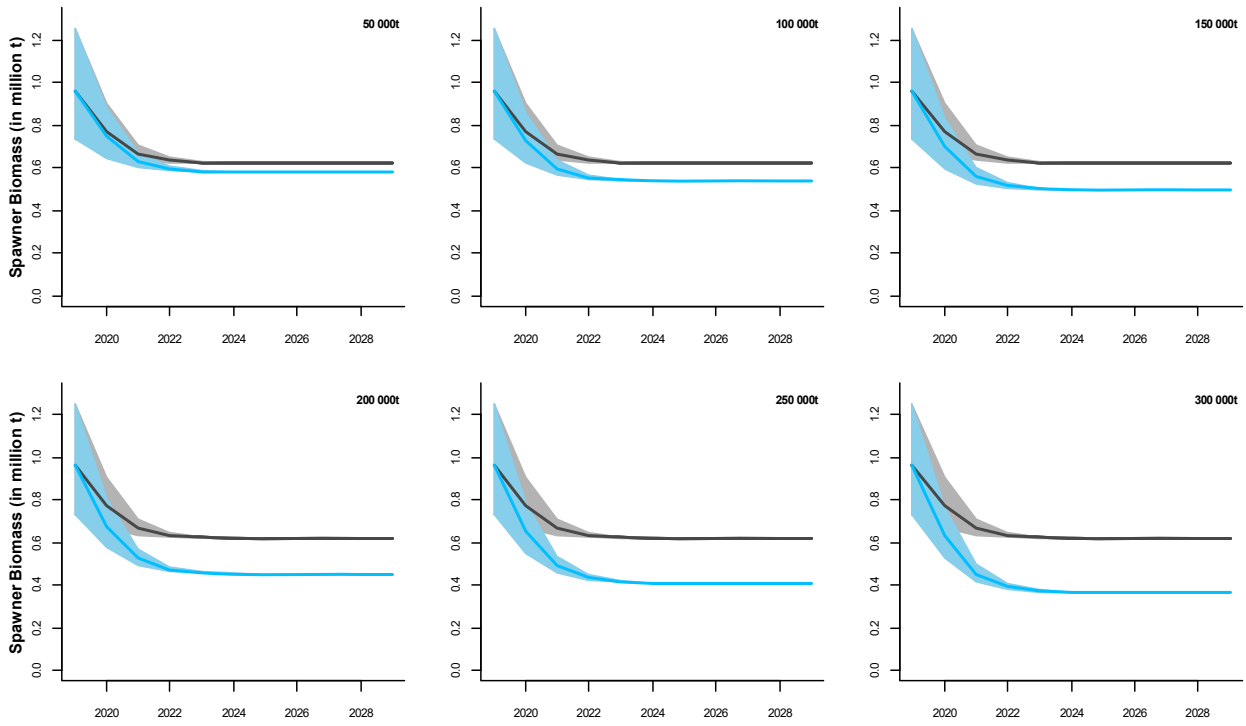


Figure B2e. As per Figure B2a, but with future recruitment being 30% of the historical average.

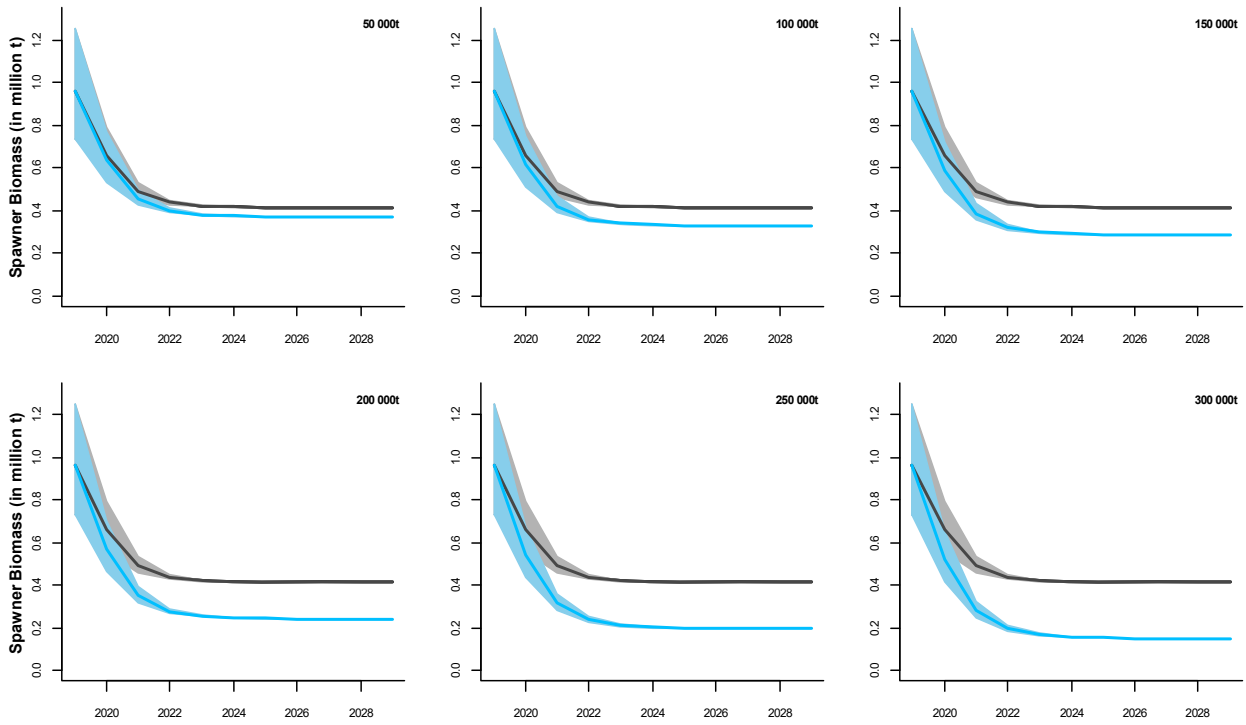


Figure B2f. As per Figure B2a, but with future recruitment being 20% of the historical average.

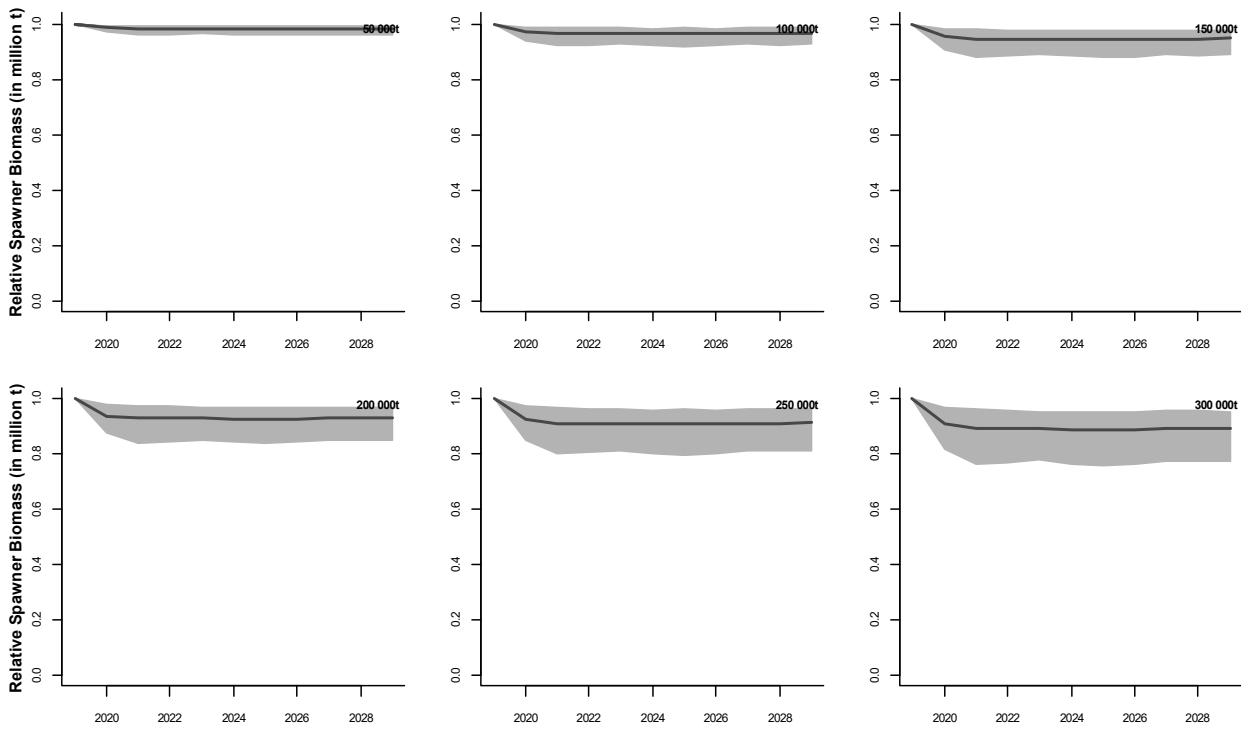


Figure B3a. The median and 95%ile confidence intervals of anchovy spawner biomass from 2019 to 2029 under six alternative catch scenarios relative to a no future catch scenario, with future recruitment being the historical average, and including recruitment variability only.

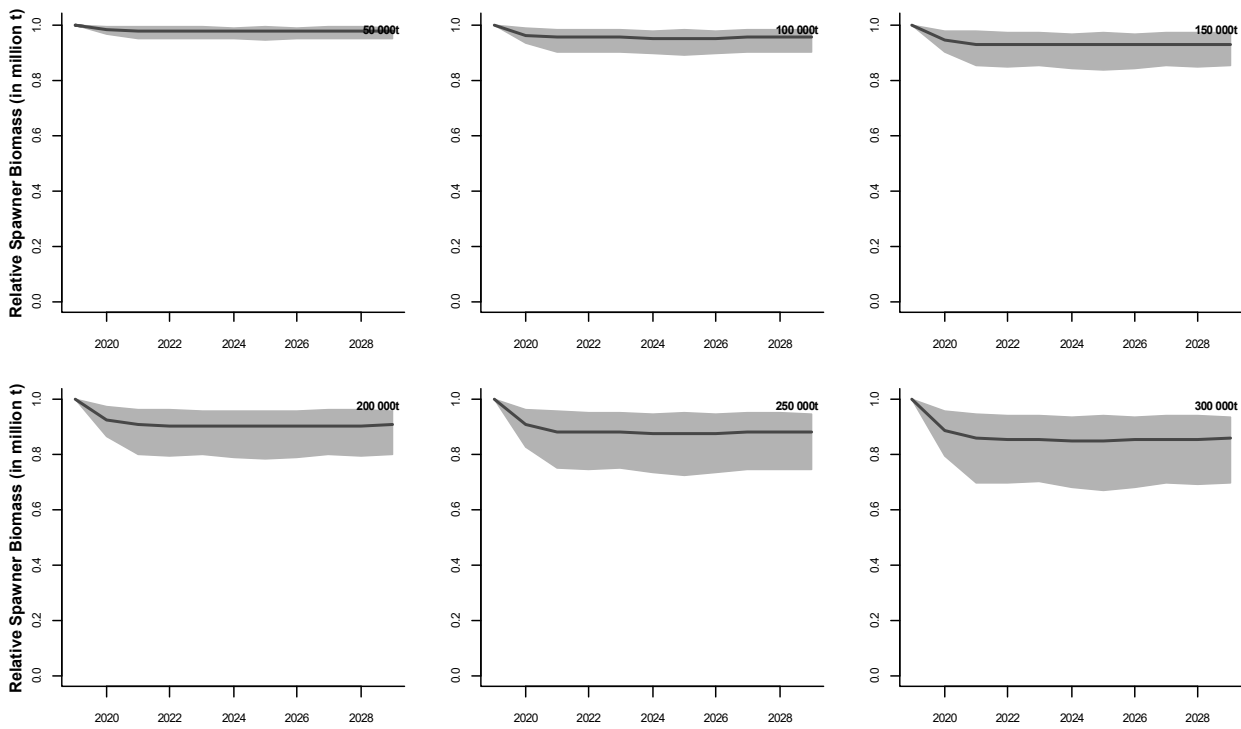


Figure B3b. As per Figure B3a, but with future recruitment being 75% of the historical average.

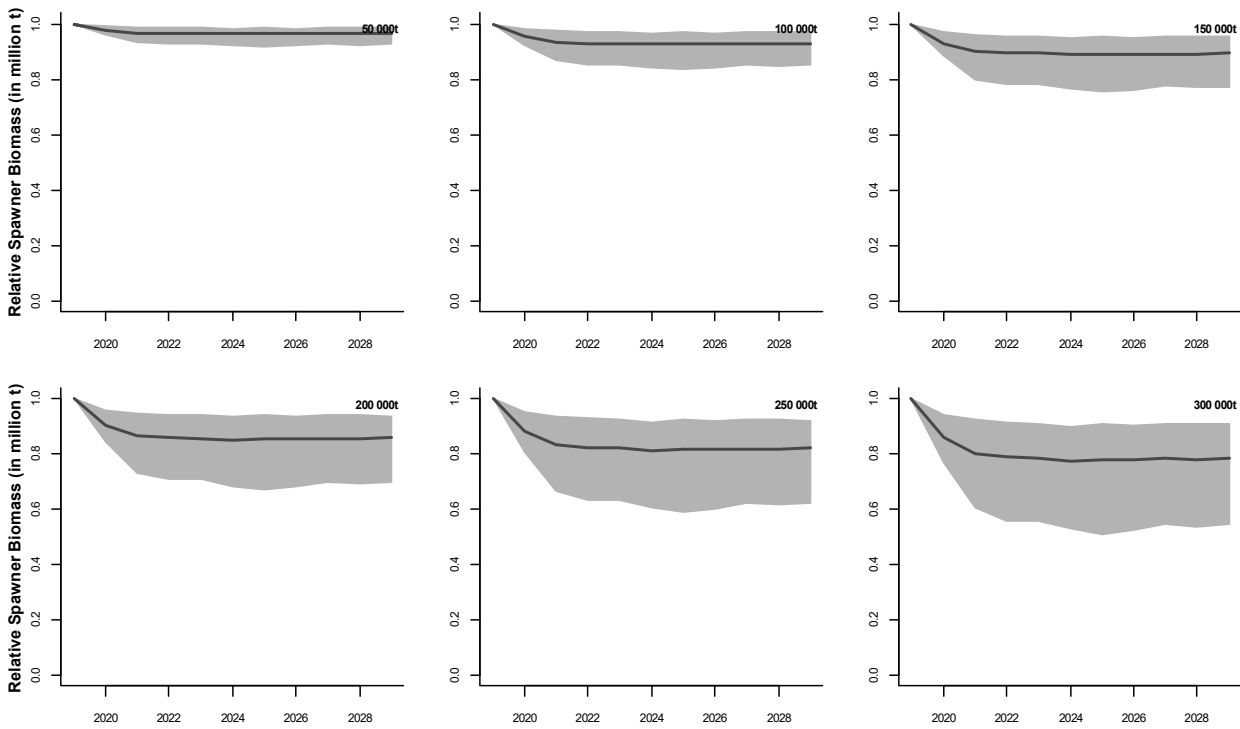


Figure B3c. As per Figure B3a, but with future recruitment being 50% of the historical average.

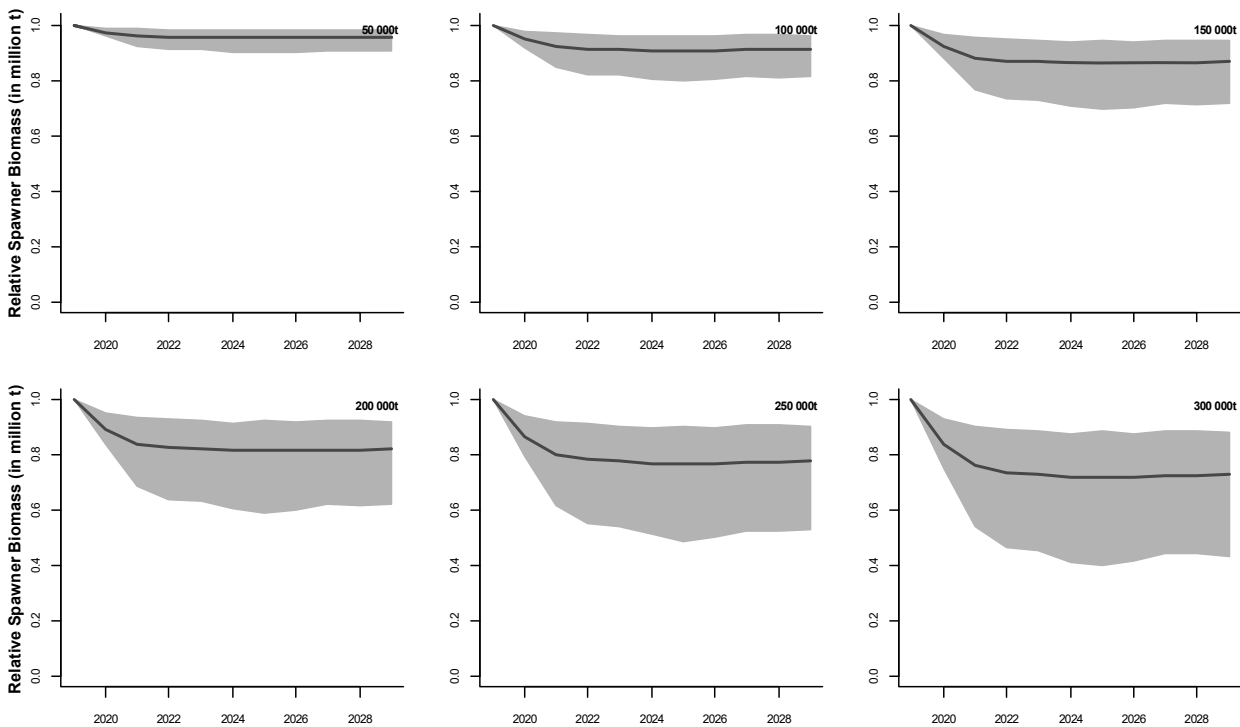


Figure B3d. As per Figure B3a, but with future recruitment being 40% of the historical average.

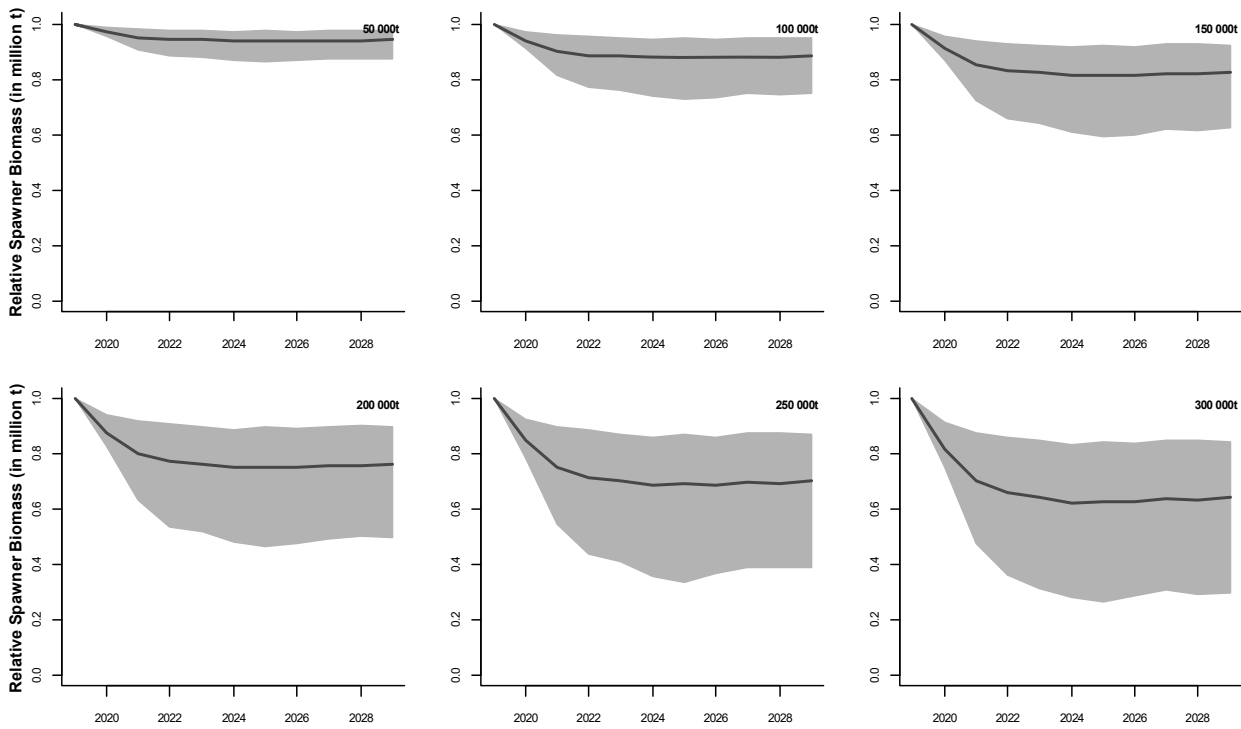


Figure B3e. As per Figure B3a, but with future recruitment being 30% of the historical average.

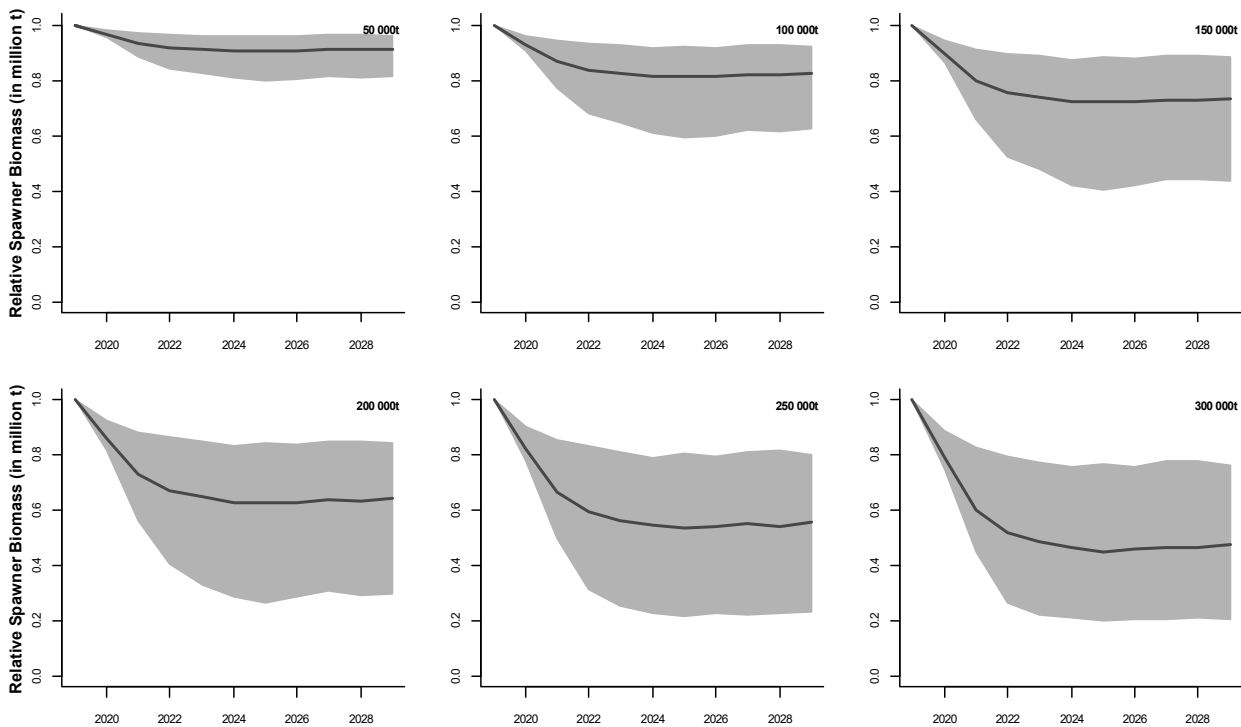


Figure B3f. As per Figure B3a, but with future recruitment being 20% of the historical average.

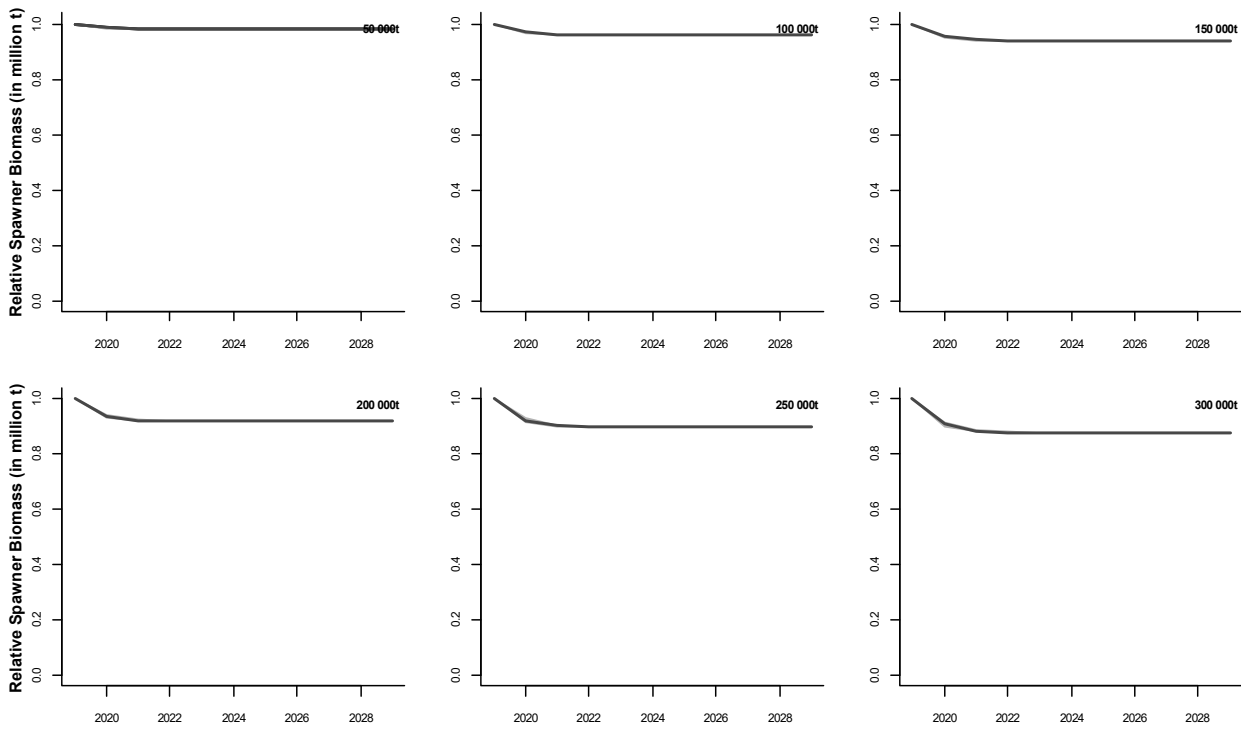


Figure B4a. The median and 95%ile confidence intervals of anchovy spawner biomass from 2019 to 2029 under six alternative catch scenarios relative to a no future catch scenario, with future recruitment being the historical average, and including starting point variability only.

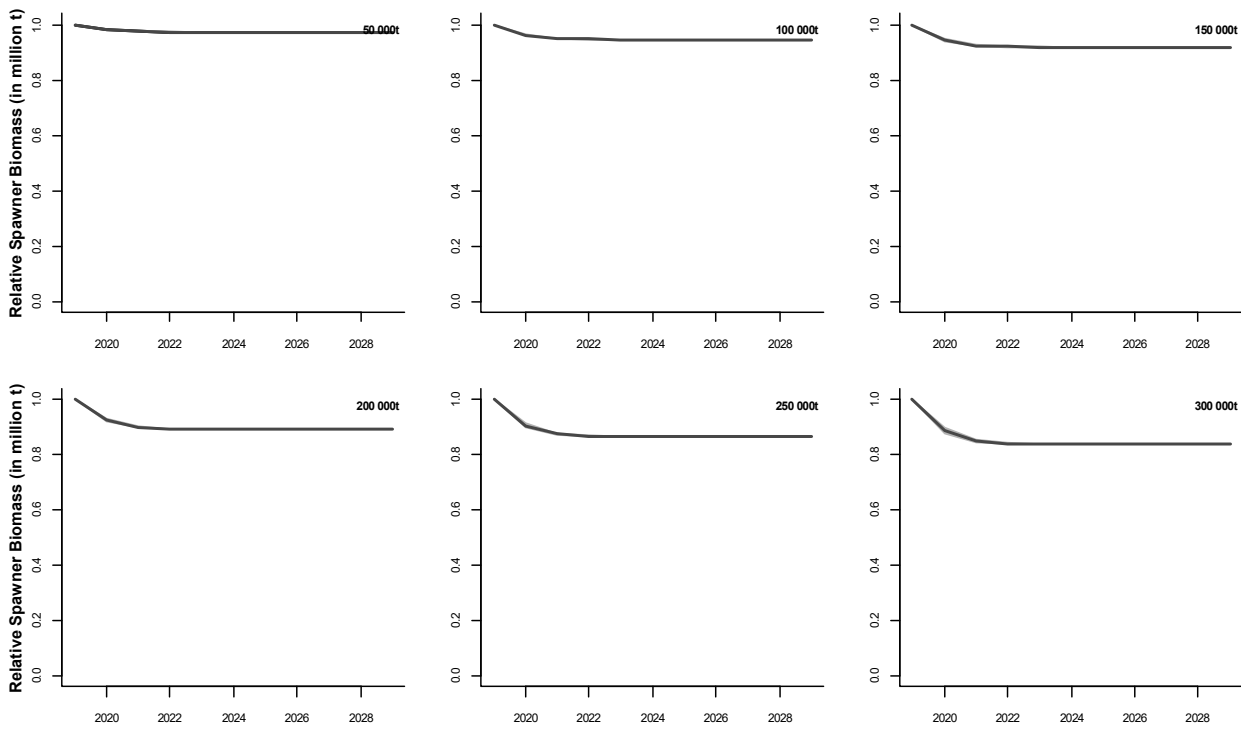


Figure B4b. As per Figure B4a, but with future recruitment being 75% of the historical average.

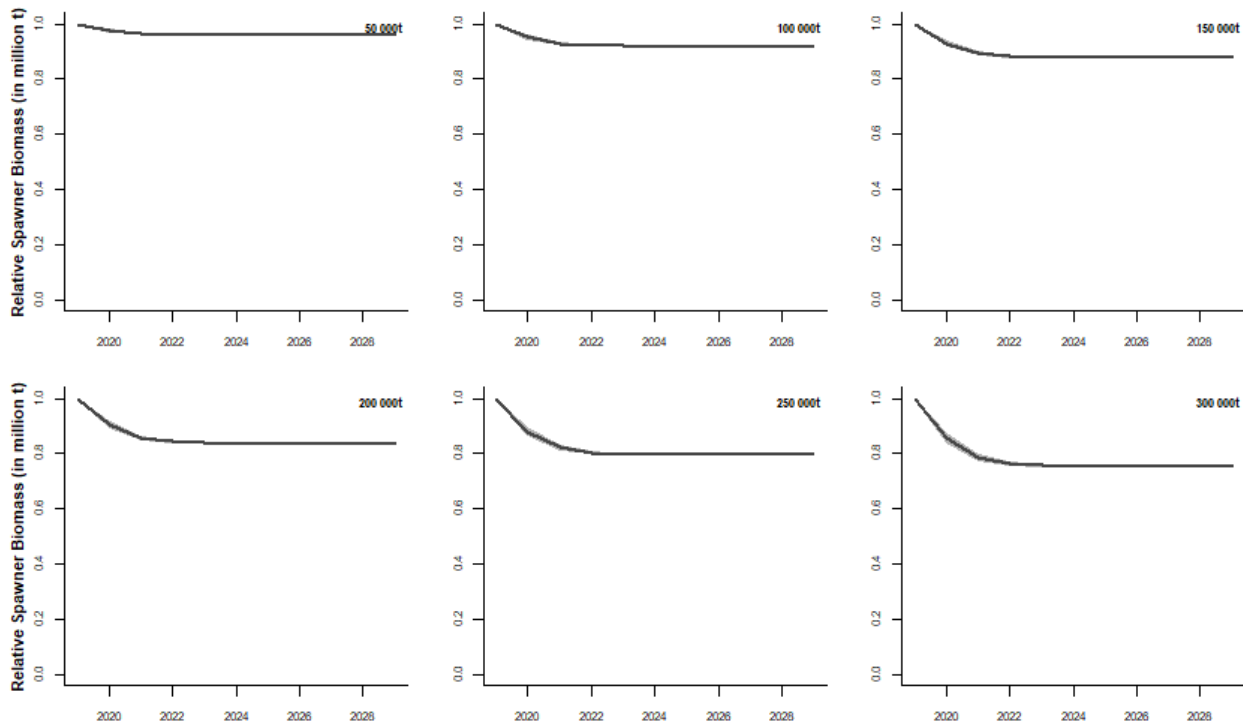


Figure B4c. As per Figure B4a, but with future recruitment being 50% of the historical average.

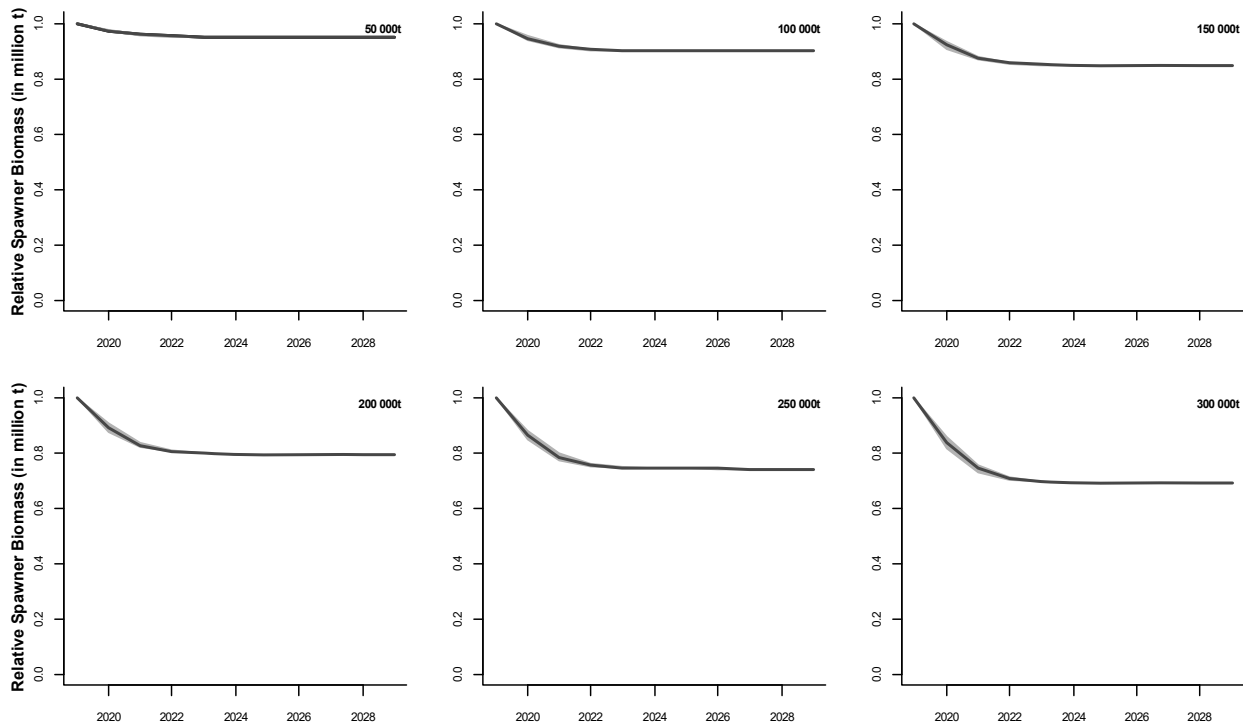


Figure B4d. As per Figure B4a, but with future recruitment being 40% of the historical average.

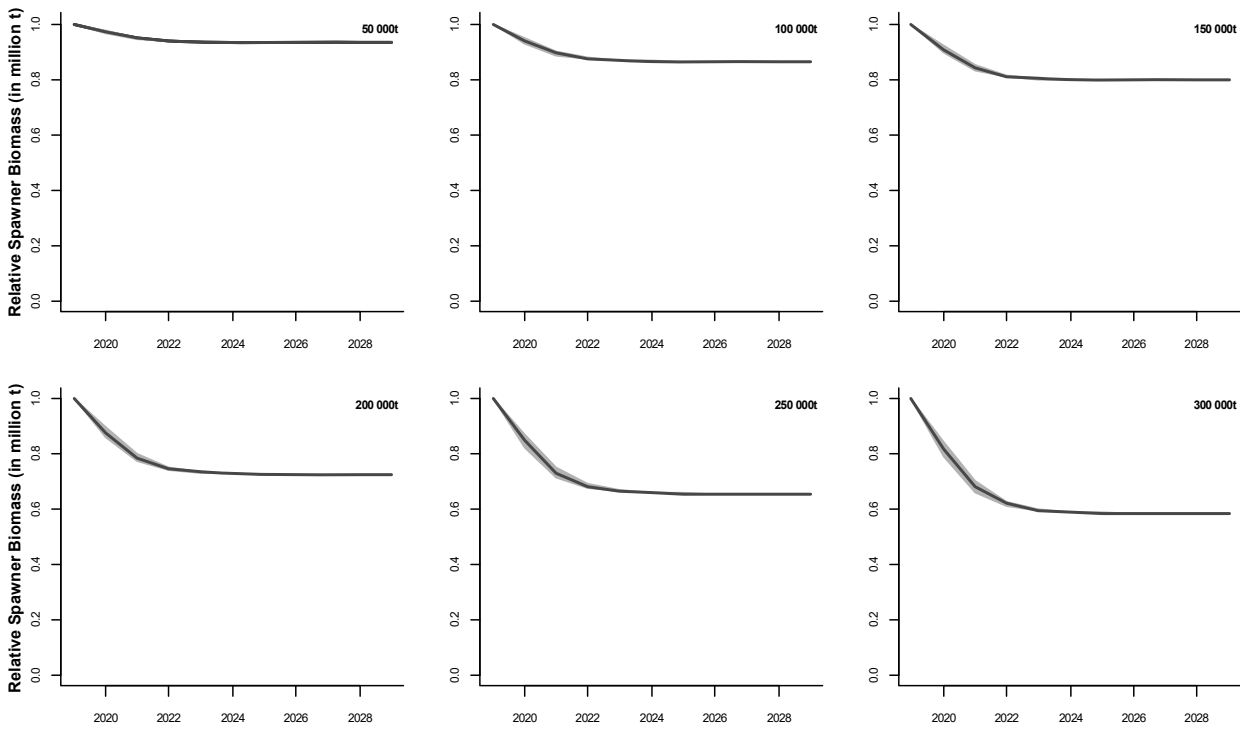


Figure B4e. As per Figure B4a, but with future recruitment being 30% of the historical average.

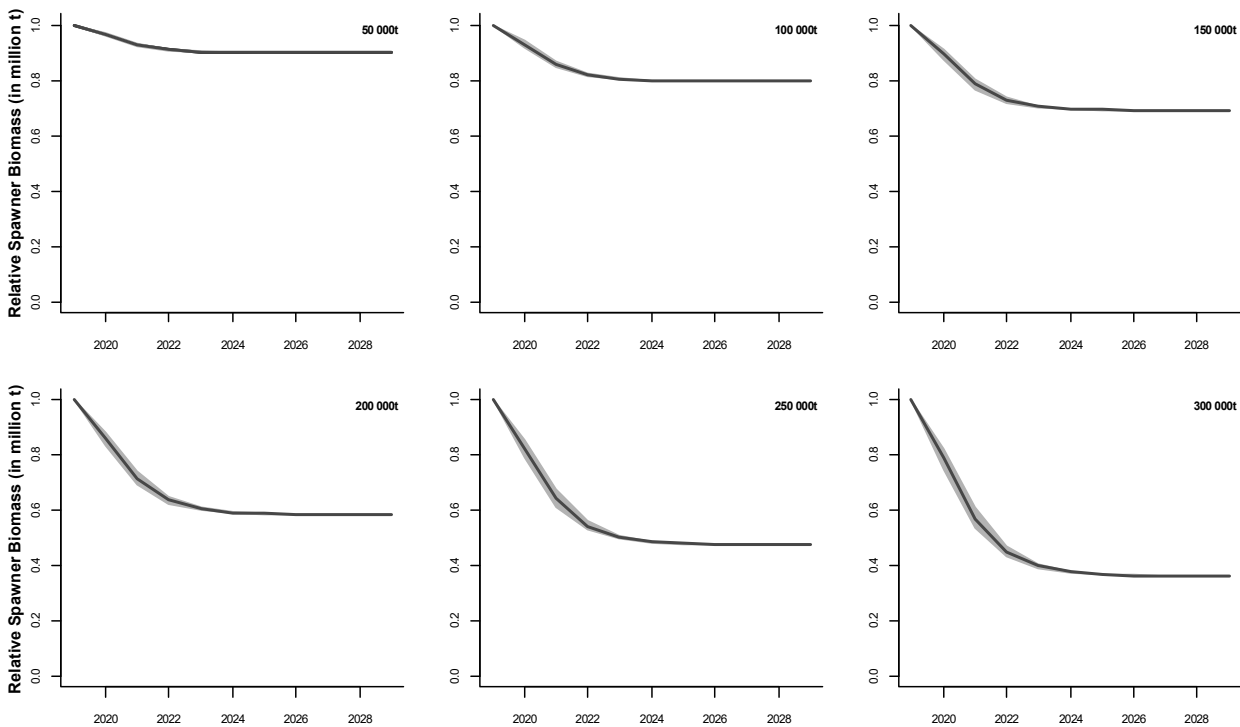


Figure B4f. As per Figure B4a, but with future recruitment being 20% of the historical average.

Appendix C: Biomass and relative biomass projections under the baseline model A₀

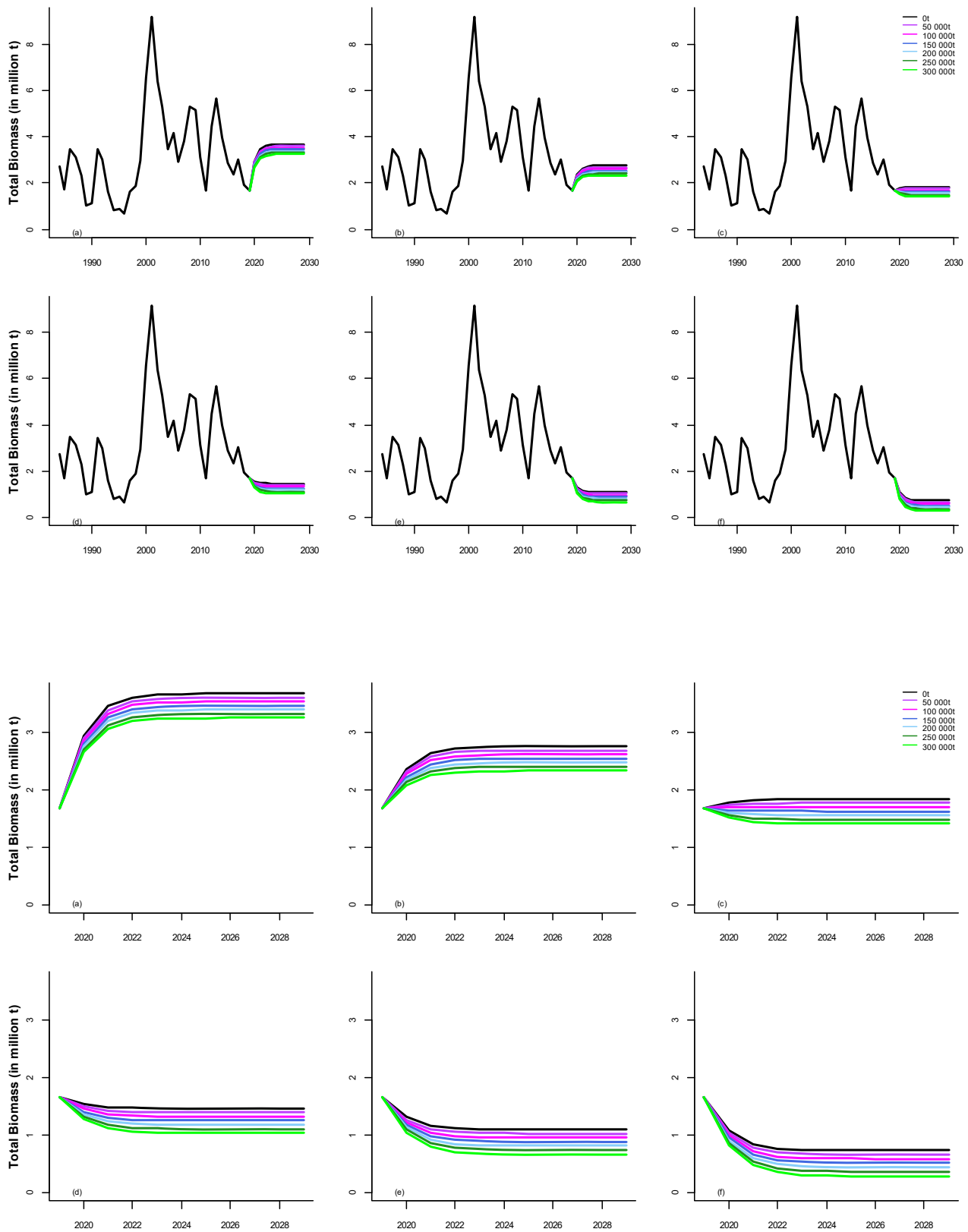


Figure C1. Model estimated deterministic anchovy biomass from 1984 to 2029 under alternative future catch scenarios, with future recruitment being a) 100%, b) 75%, c) 50%, d) 40%, e) 30% and f) 20% of the historical average. The lower panels are a repeat of the top panels, but over a smaller x-axis and y-axis range.

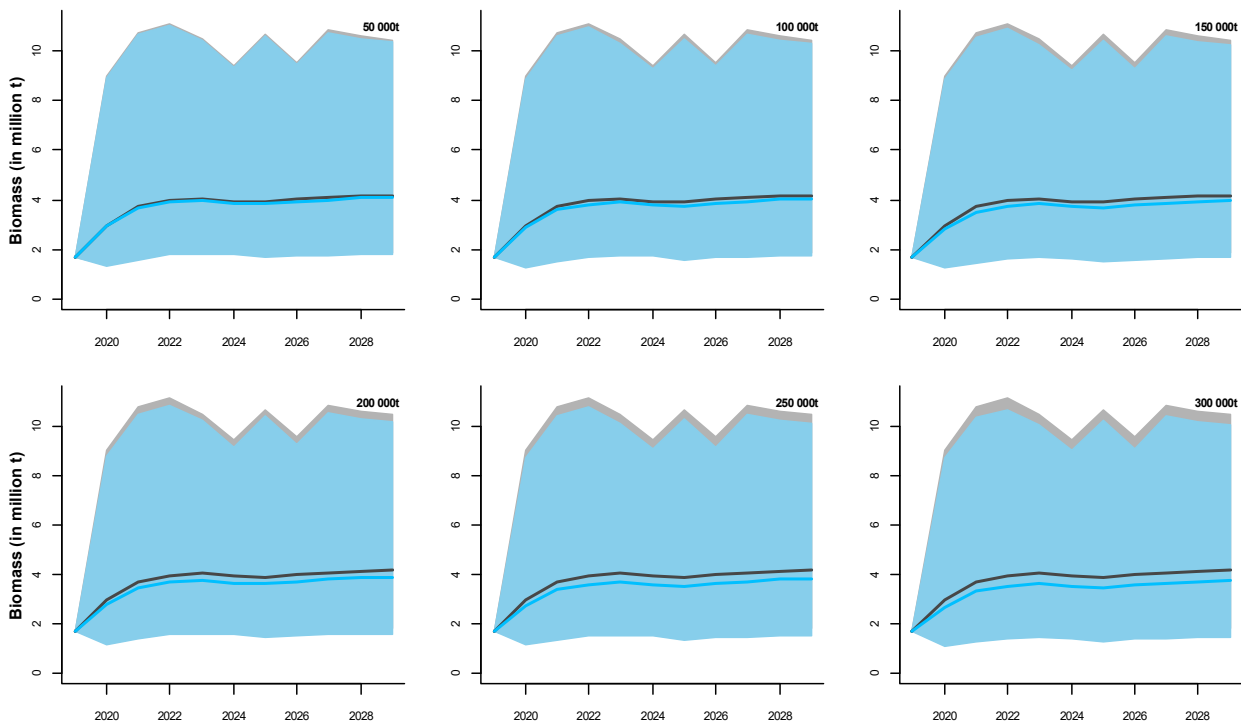


Figure C2a. The median and 95%ile confidence intervals of anchovy biomass from 2019 to 2029 under a no catch (grey) and six alternative catch (blue) scenarios with future recruitment being the historical average, and including recruitment variability only.

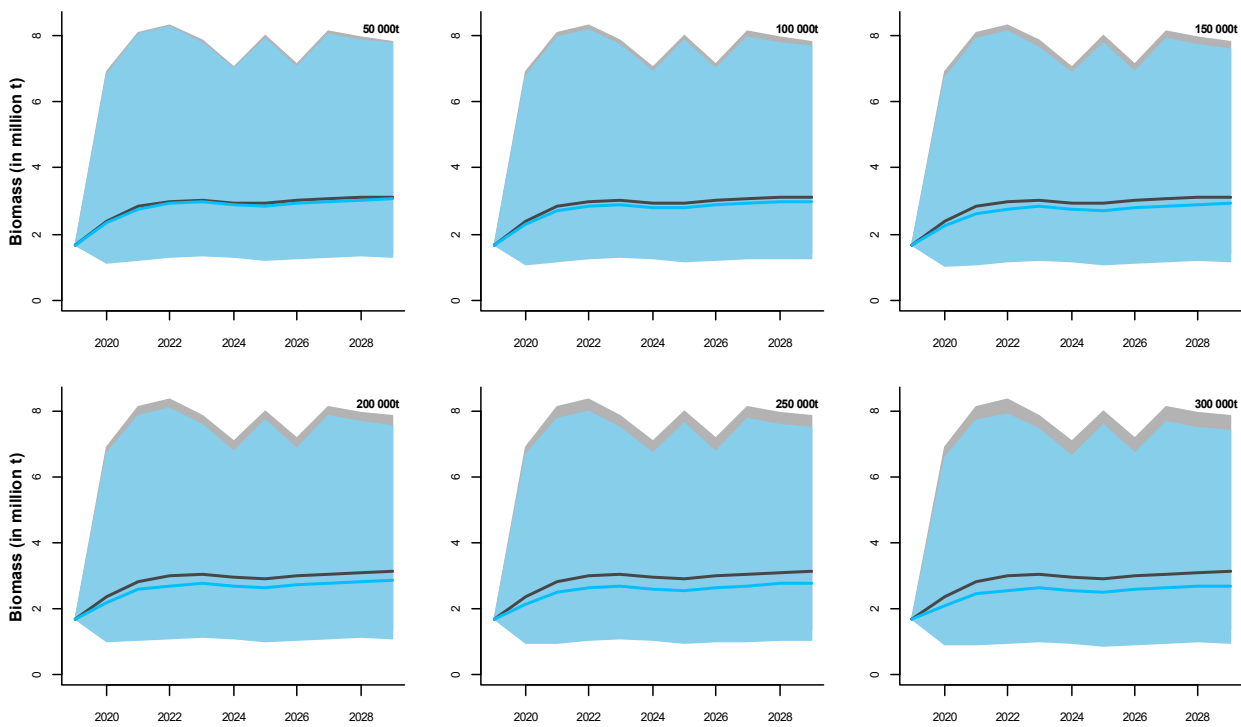


Figure C2b. As per Figure C2a, but with future recruitment being 75% of the historical average.

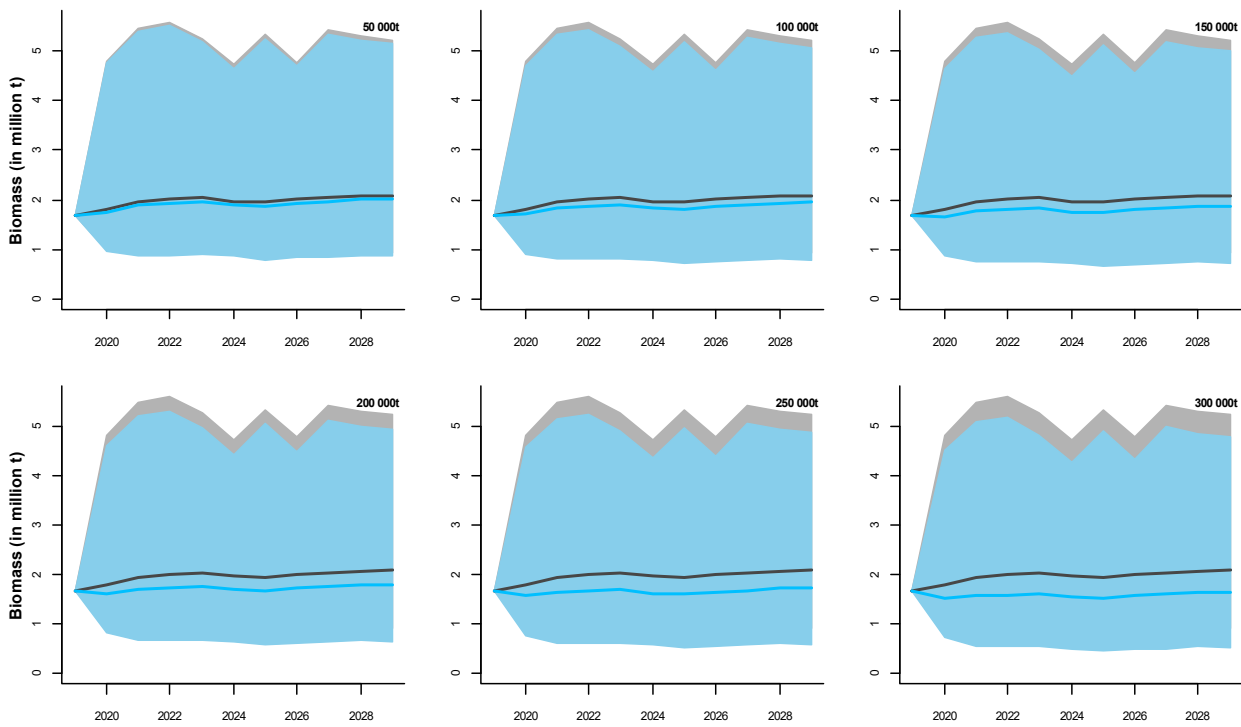


Figure C2c. As per Figure C2a, but with future recruitment being 50% of the historical average.

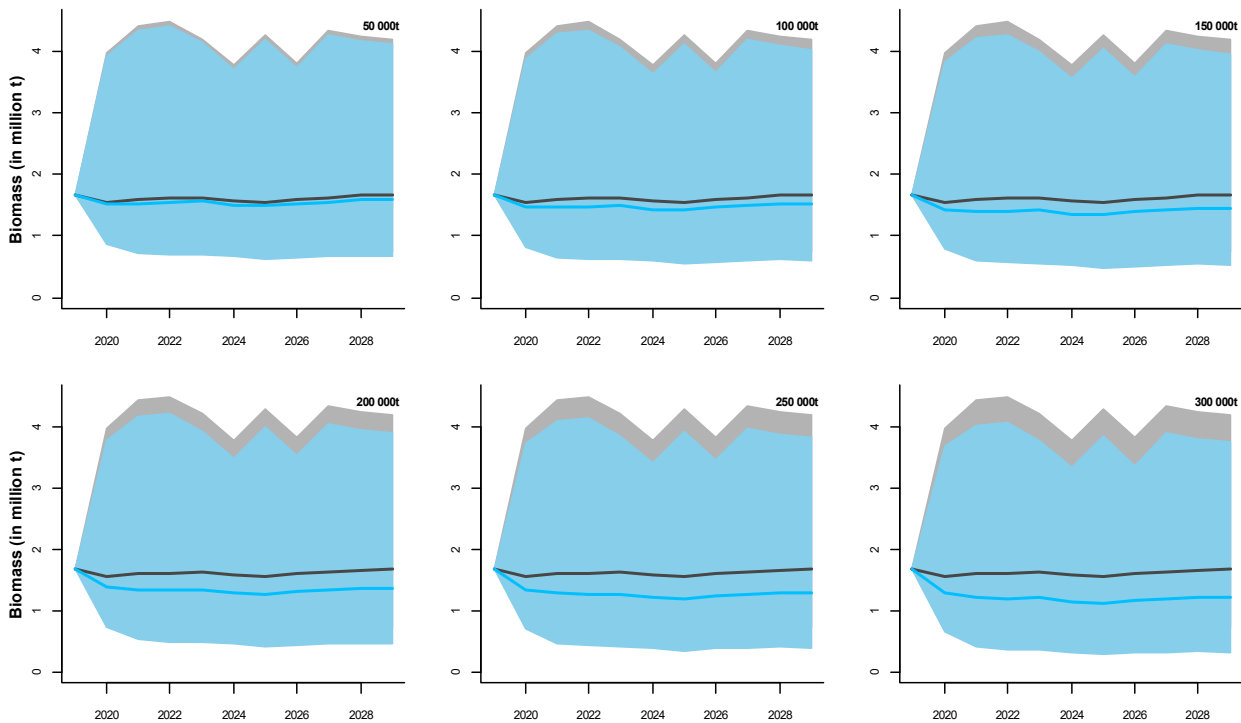


Figure C2d. As per Figure C2a, but with future recruitment being 40% of the historical average.

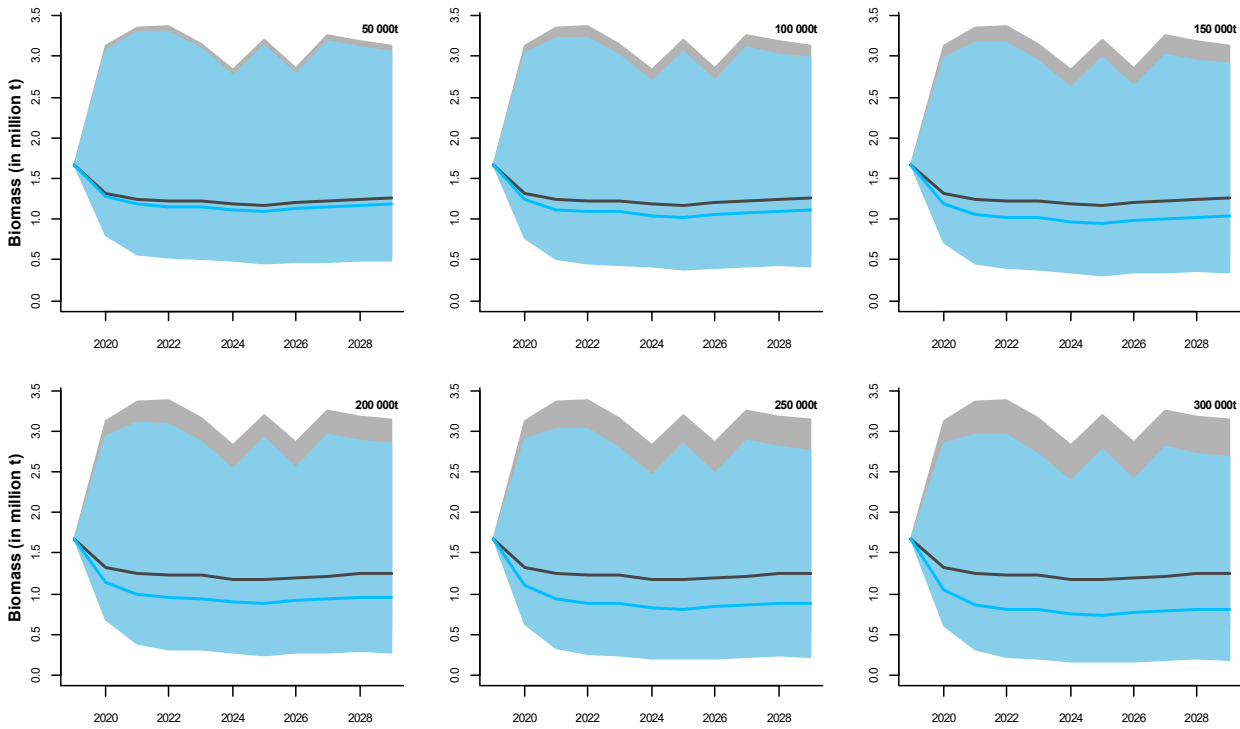


Figure C2e. As per Figure C2a, but with future recruitment being 30% of the historical average.

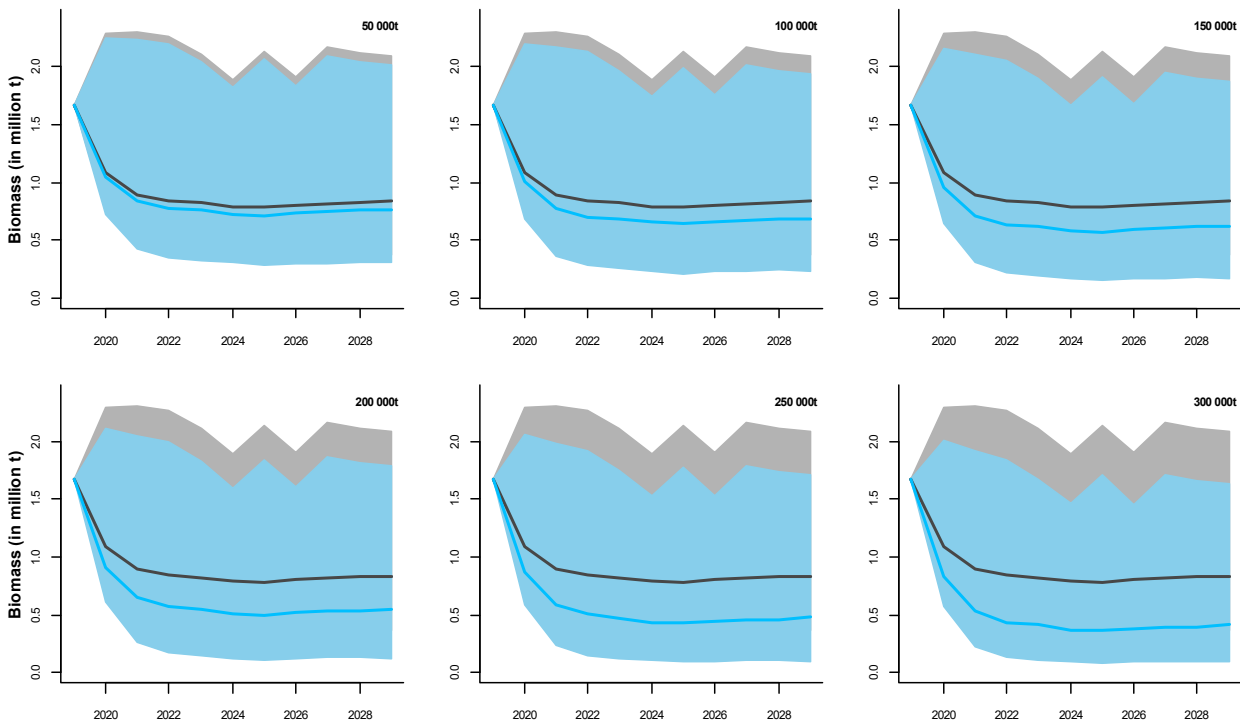


Figure C2f. As per Figure C2a, but with future recruitment being 20% of the historical average.

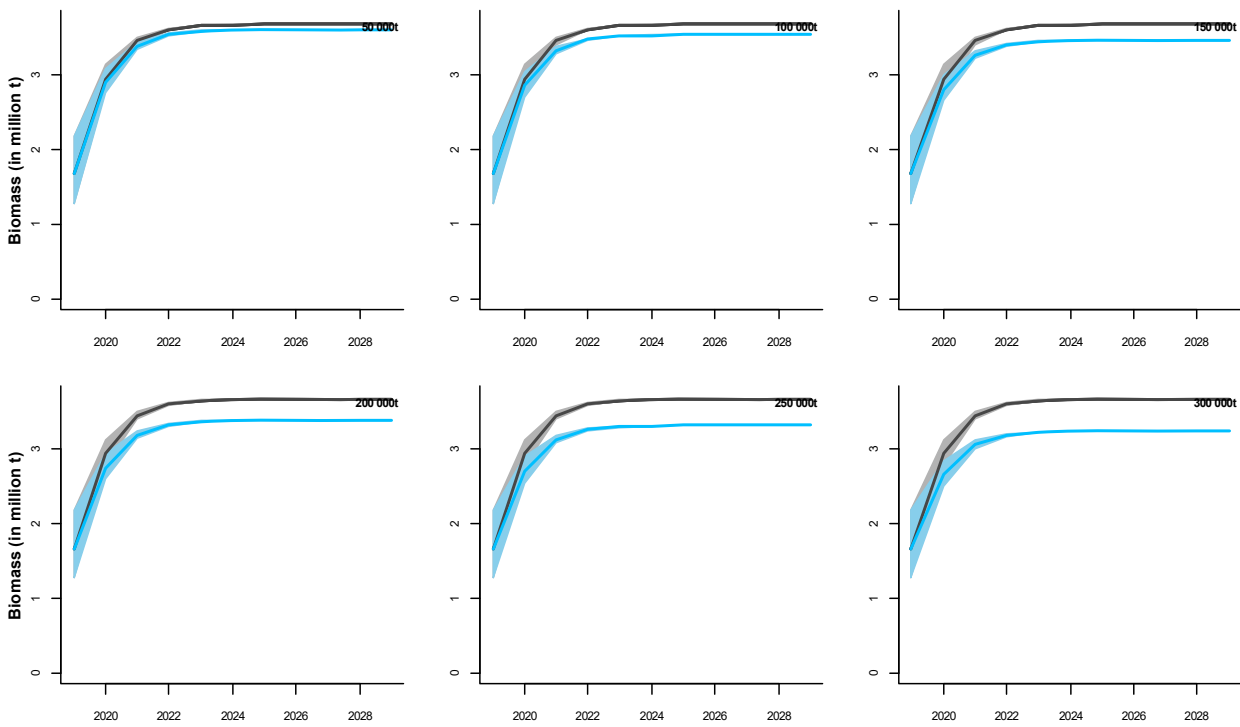


Figure C3a. The median and 95%ile confidence intervals of anchovy biomass from 2019 to 2029 under a no catch (grey) and six alternative catch (blue) scenarios with future recruitment being the historical average, and including starting point variability only.

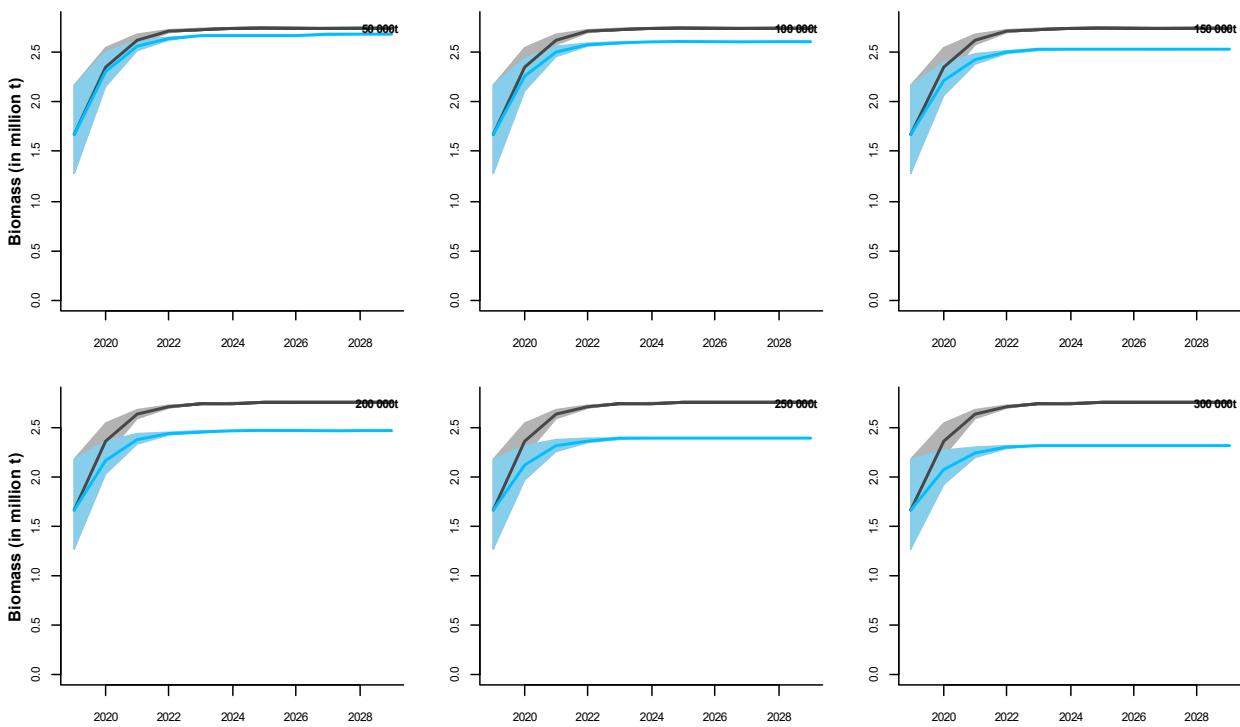


Figure C3b. As per Figure C3a, but with future recruitment being 75% of the historical average.

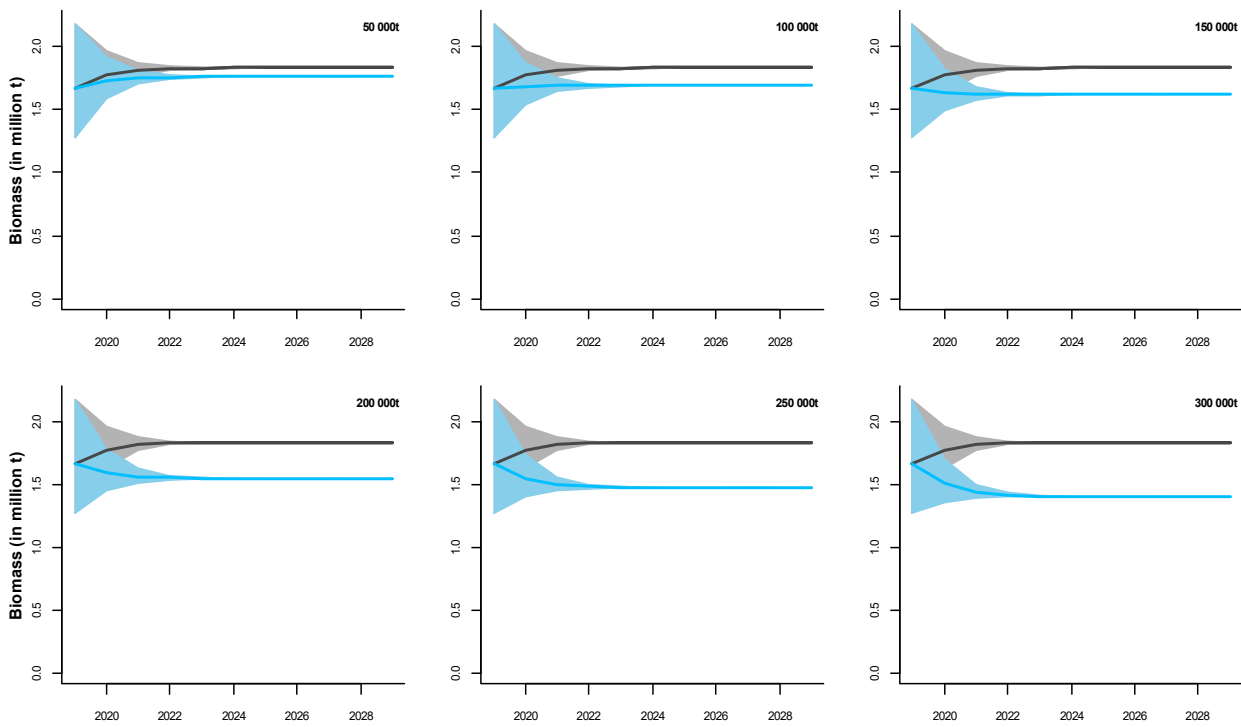


Figure C3c. As per Figure C3a, but with future recruitment being 50% of the historical average.

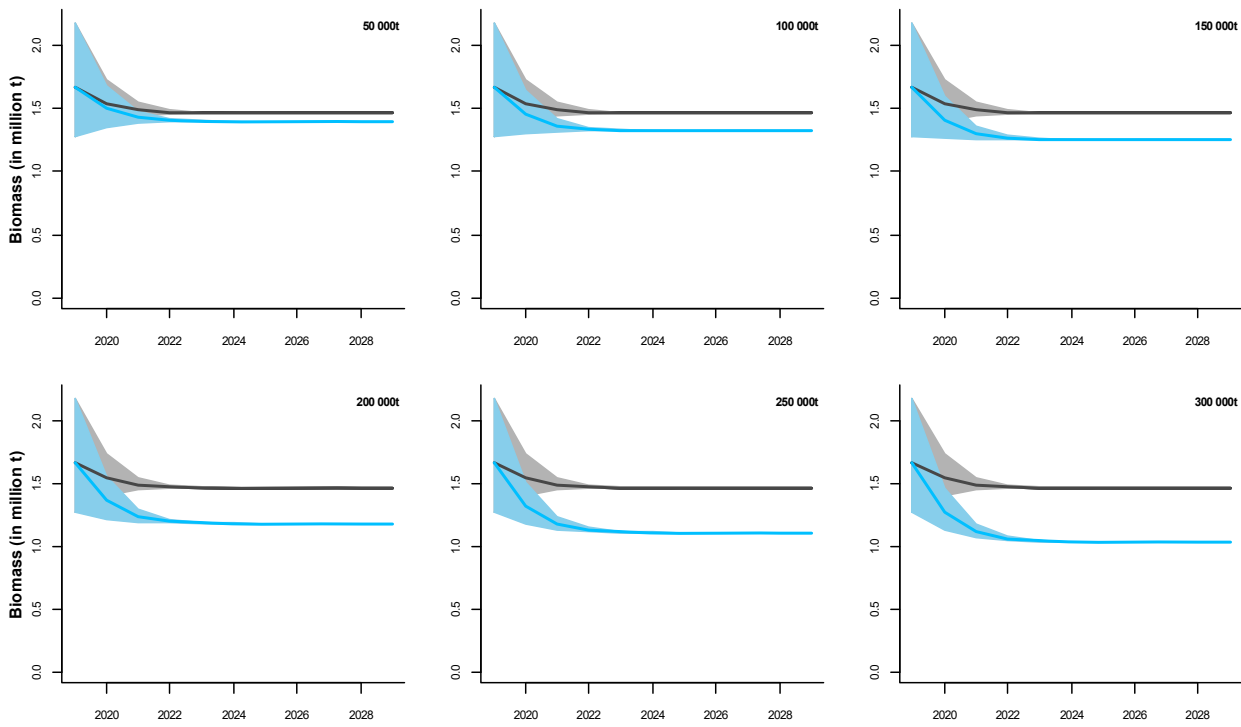


Figure C3d. As per Figure C3a, but with future recruitment being 40% of the historical average.

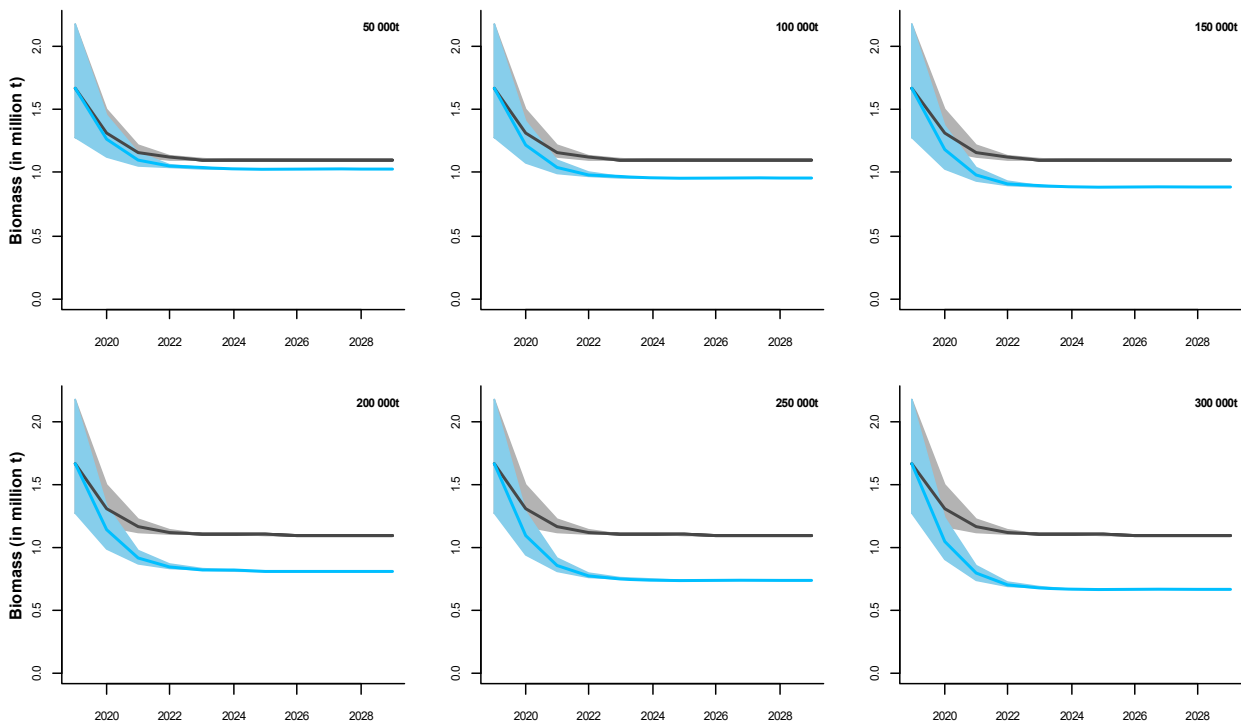


Figure C3e. As per Figure C3a, but with future recruitment being 30% of the historical average.

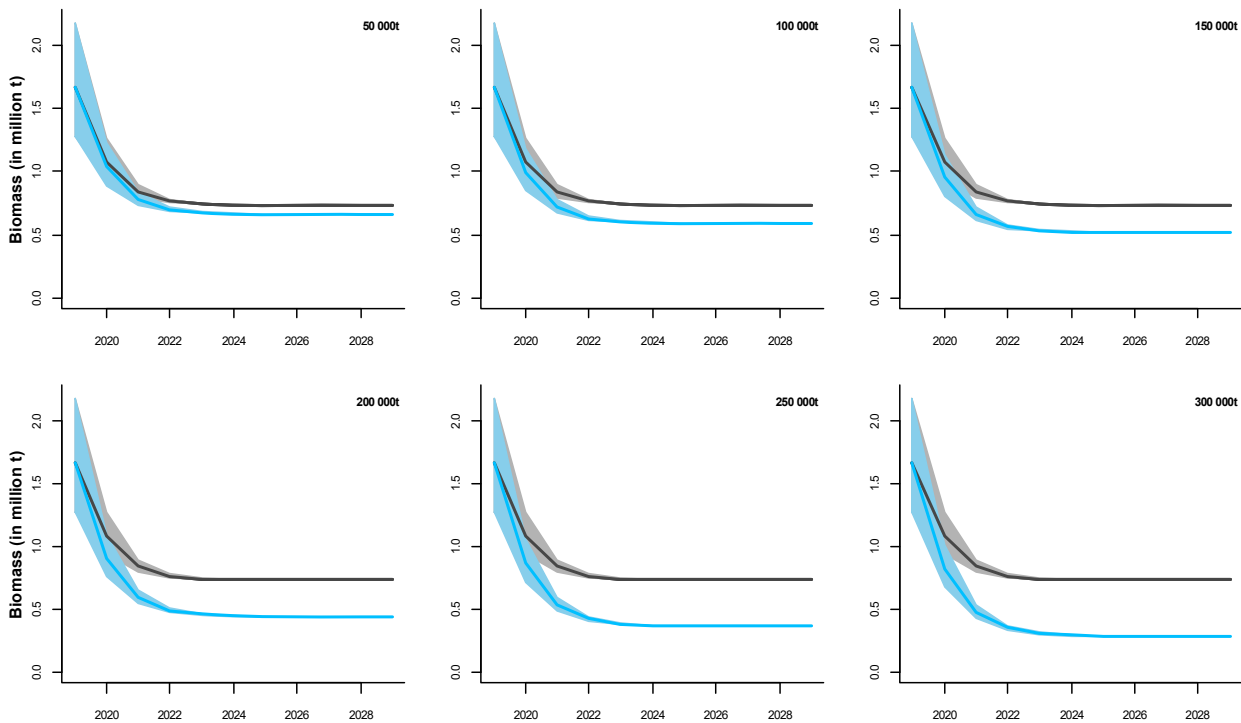


Figure C3f. As per Figure C3a, but with future recruitment being 20% of the historical average.

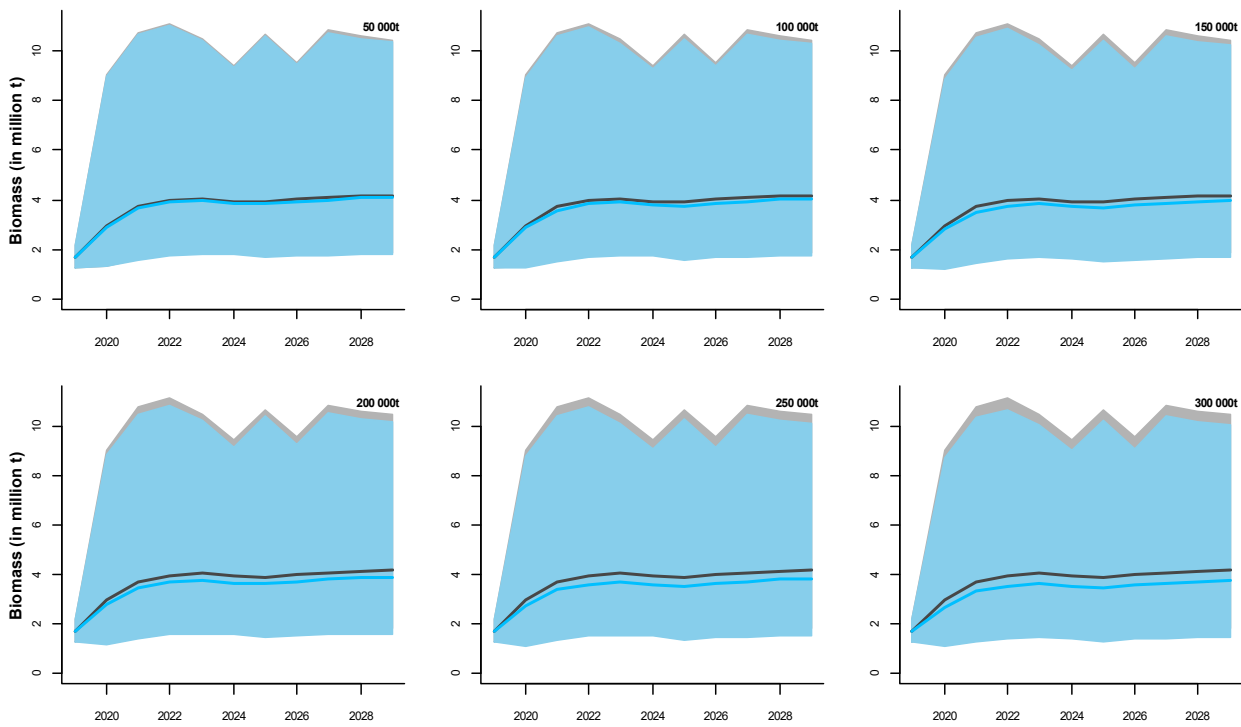


Figure C4a. The median and 95%ile confidence intervals of anchovy biomass from 2019 to 2029 under a no catch (grey) and six alternative catch (blue) scenarios with future recruitment being the historical average, and including both recruitment and starting point variability.

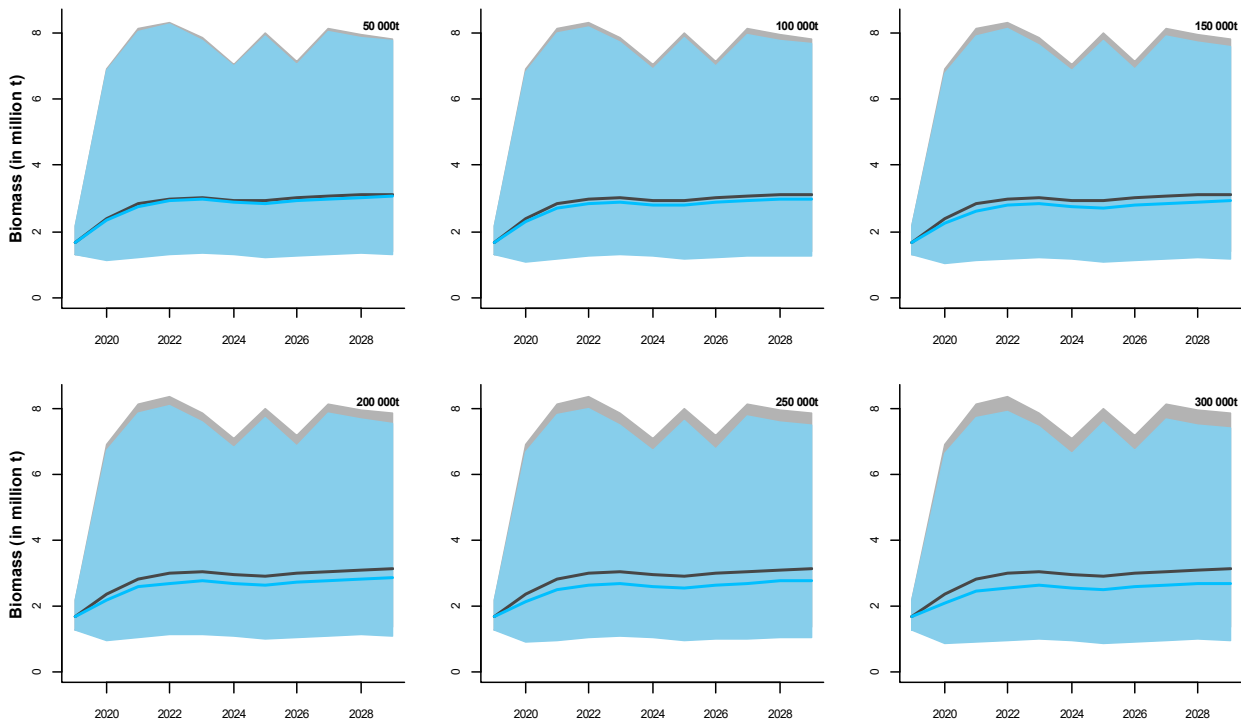


Figure C4b. As per Figure C4a, but with future recruitment being 75% of the historical average.

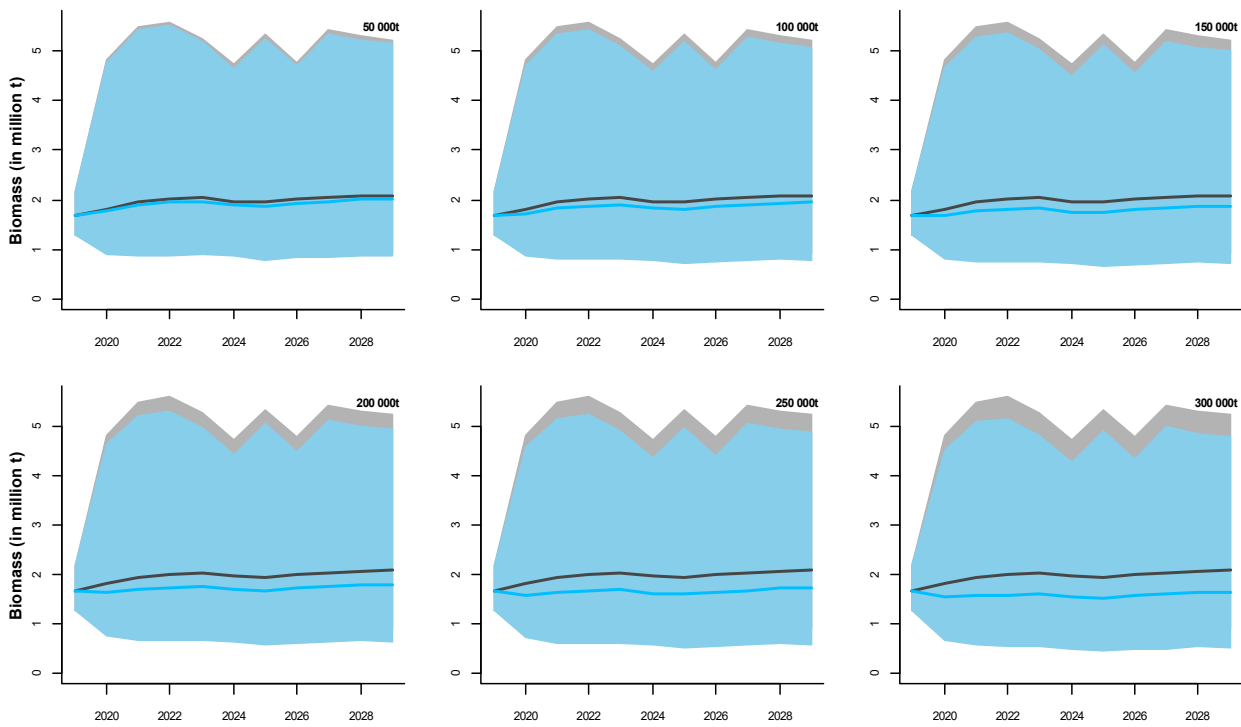


Figure C4c. As per Figure C4a, but with future recruitment being 50% of the historical average.

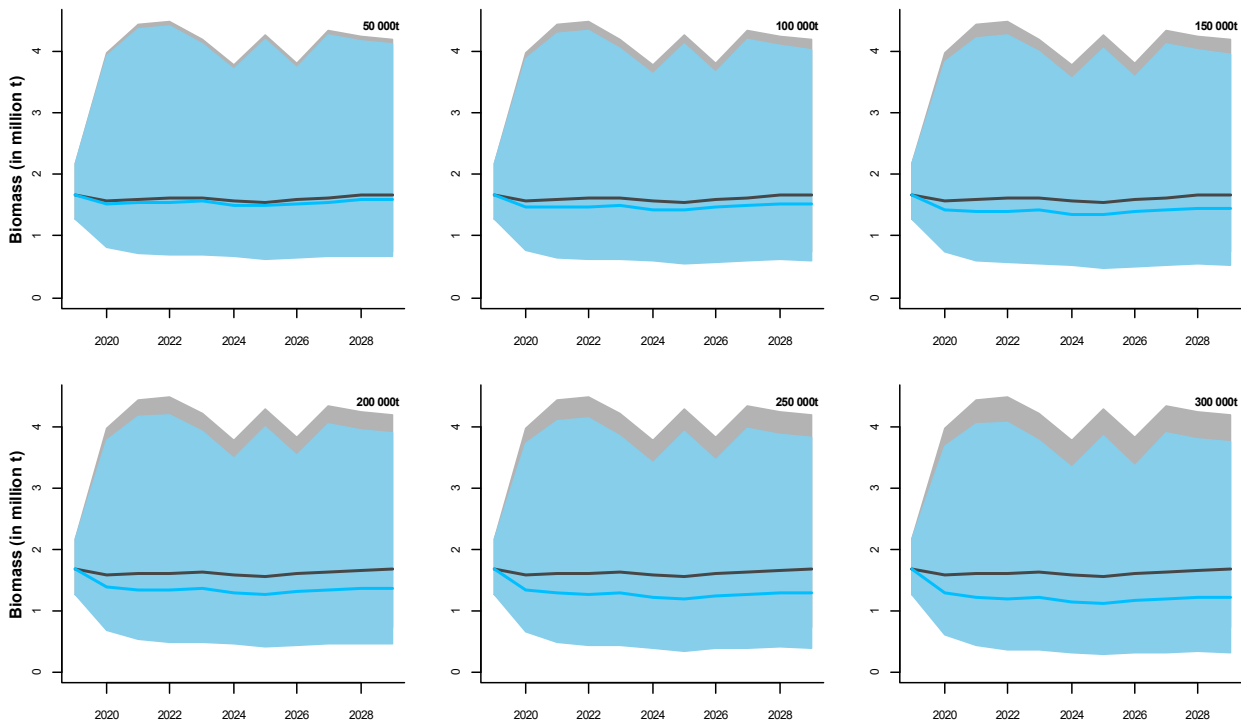


Figure C4d. As per Figure C4a, but with future recruitment being 40% of the historical average.

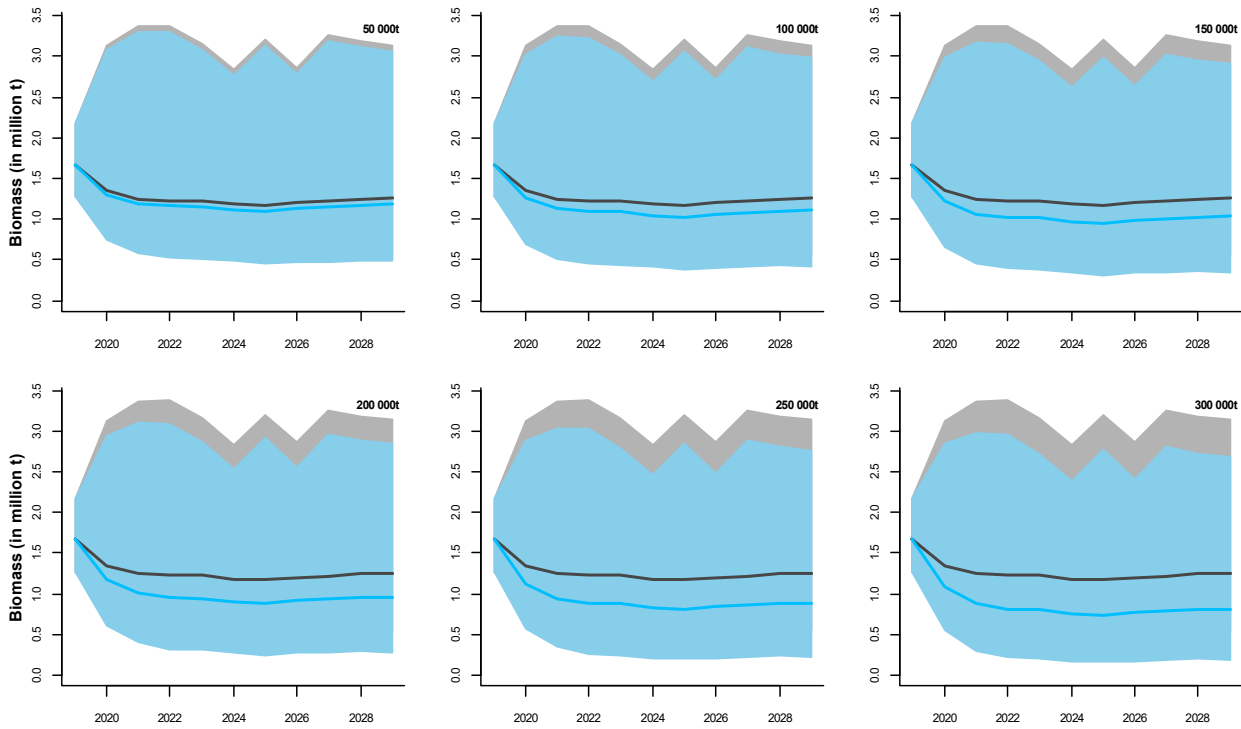


Figure C4e. As per Figure C4a, but with future recruitment being 30% of the historical average.

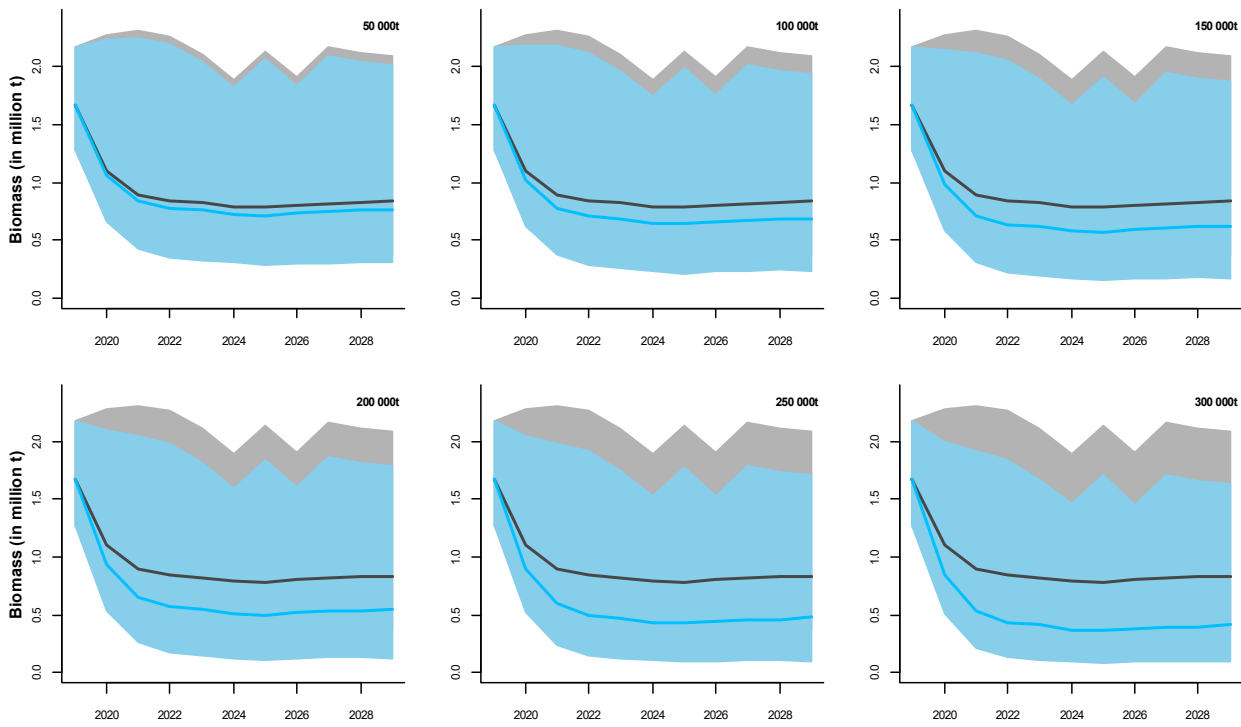


Figure C4f. As per Figure C4a, but with future recruitment being 20% of the historical average.

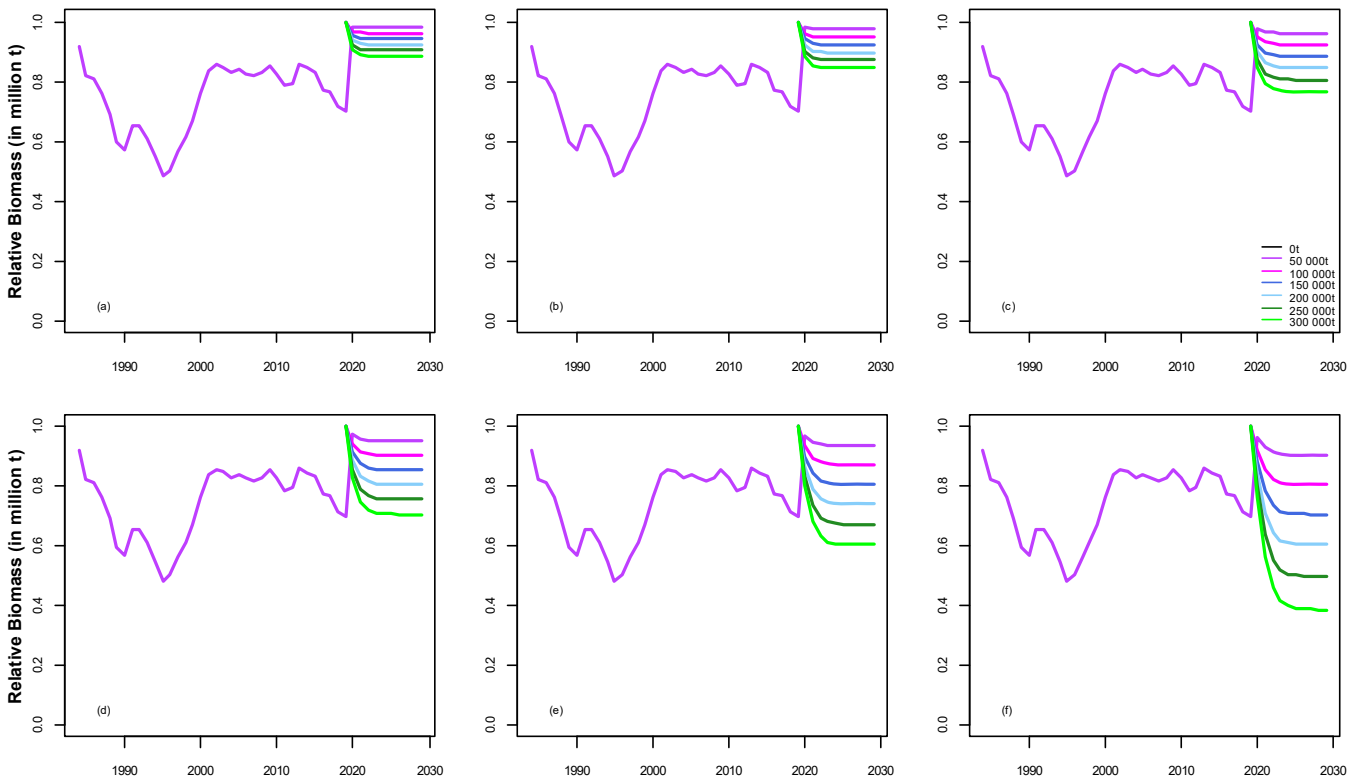


Figure C5. Model estimated deterministic anchovy biomass from 2019 to 2029 under six alternative catch scenarios relative to a no future catch scenario, with future recruitment being a) 100%, b) 75%, c) 50%, d) 40%, e) 30% and f) 20% of the historical average. The no future catch scenario begins from the baseline biomass in 2019 estimated using historical catches.

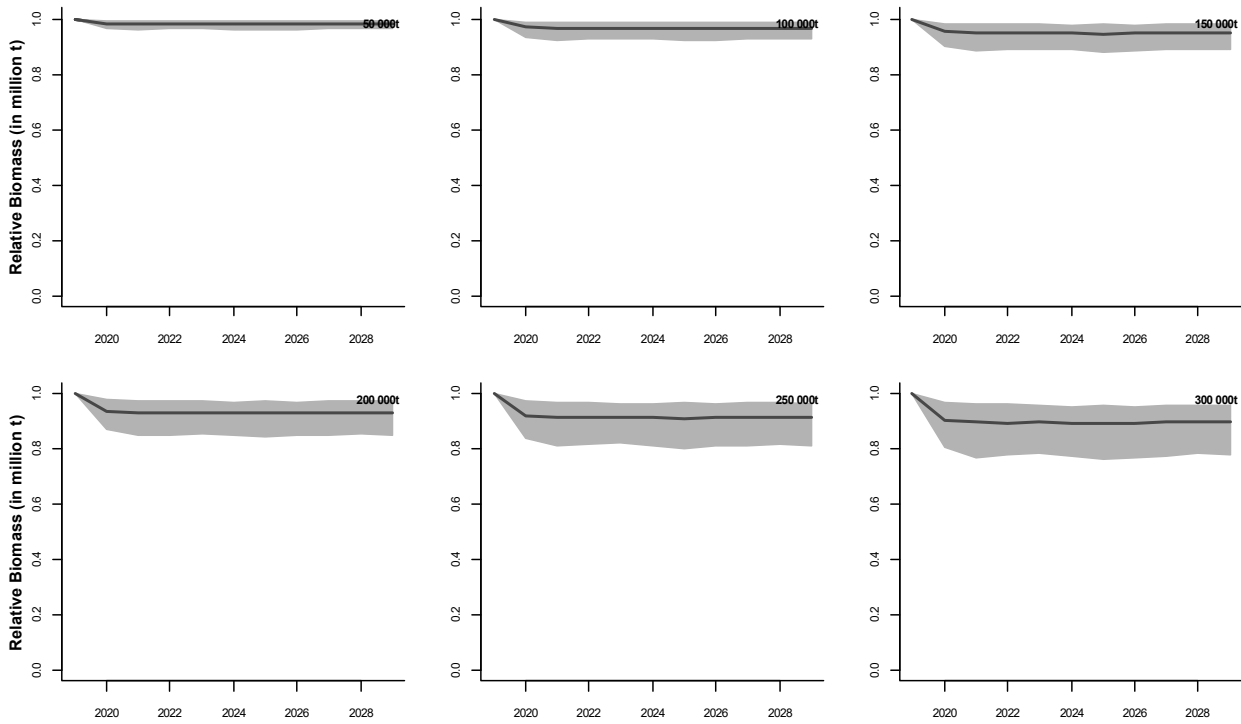


Figure C6a. The median and 95%ile confidence intervals of anchovy biomass from 2019 to 2029 under six alternative catch scenarios relative to a no future catch scenario, with future recruitment being the historical average, and including recruitment variability only.

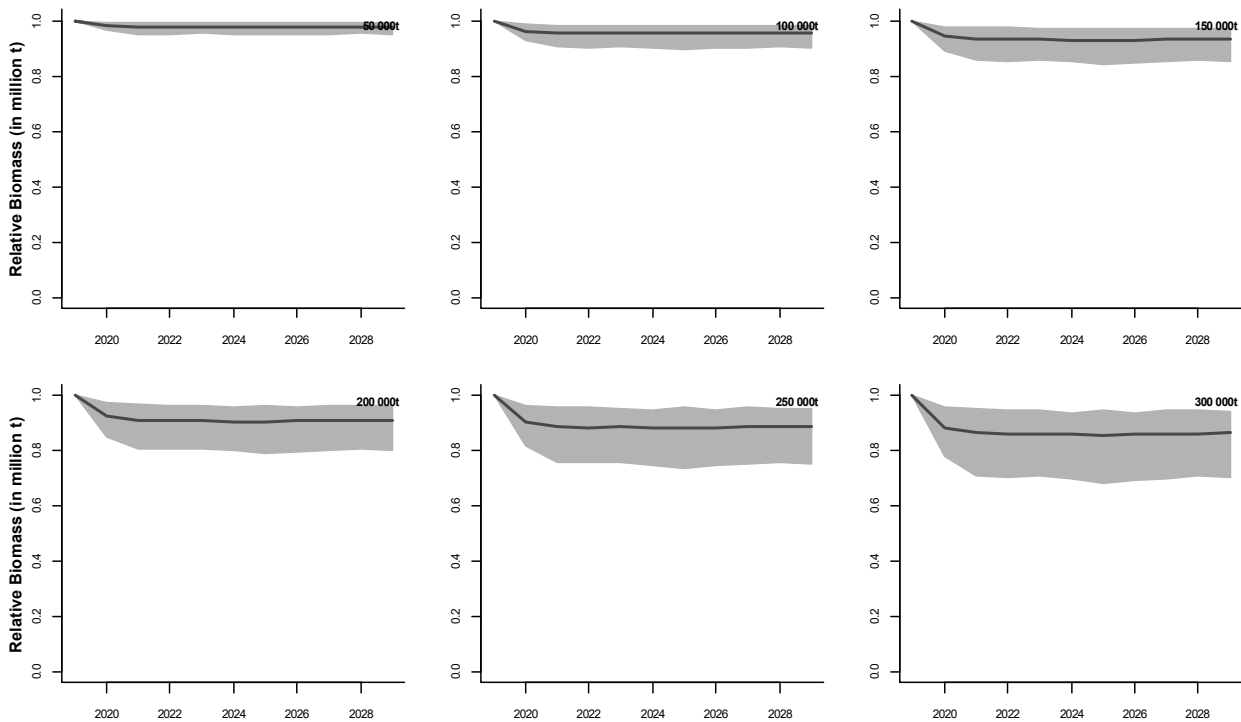


Figure C6b. As per Figure C6a, but with future recruitment being 75% of the historical average.

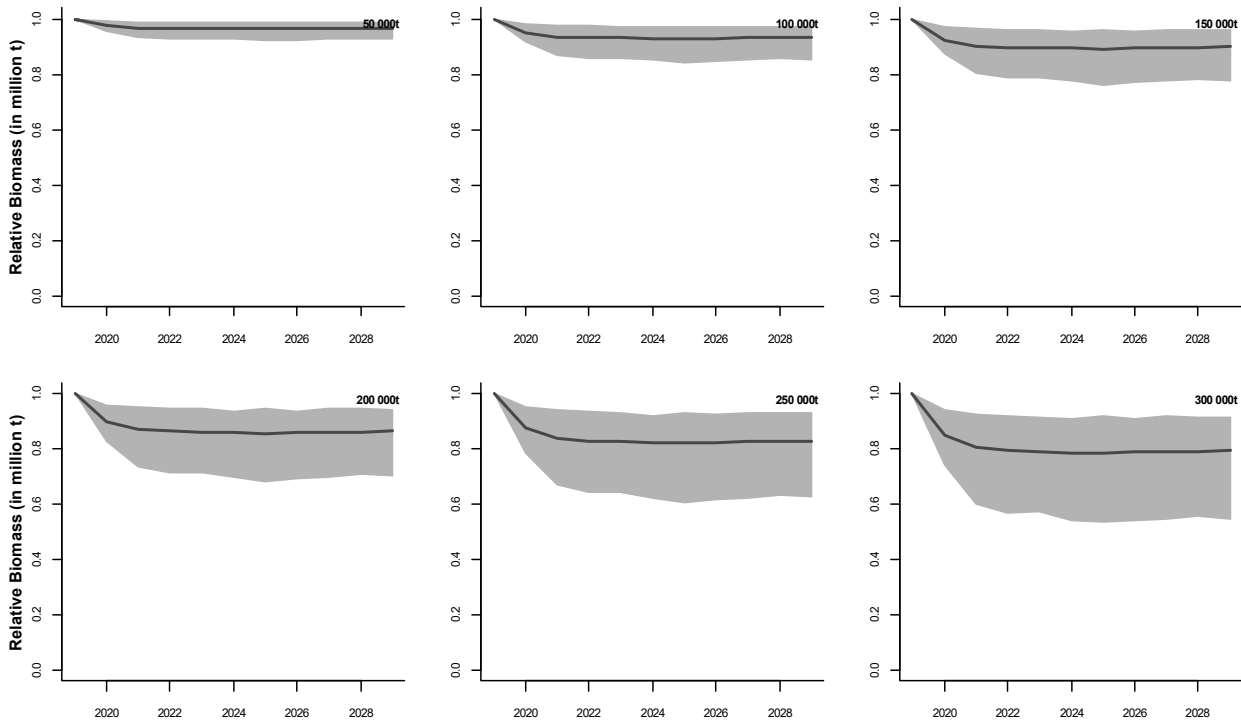


Figure C6c. As per Figure C6a, but with future recruitment being 50% of the historical average.

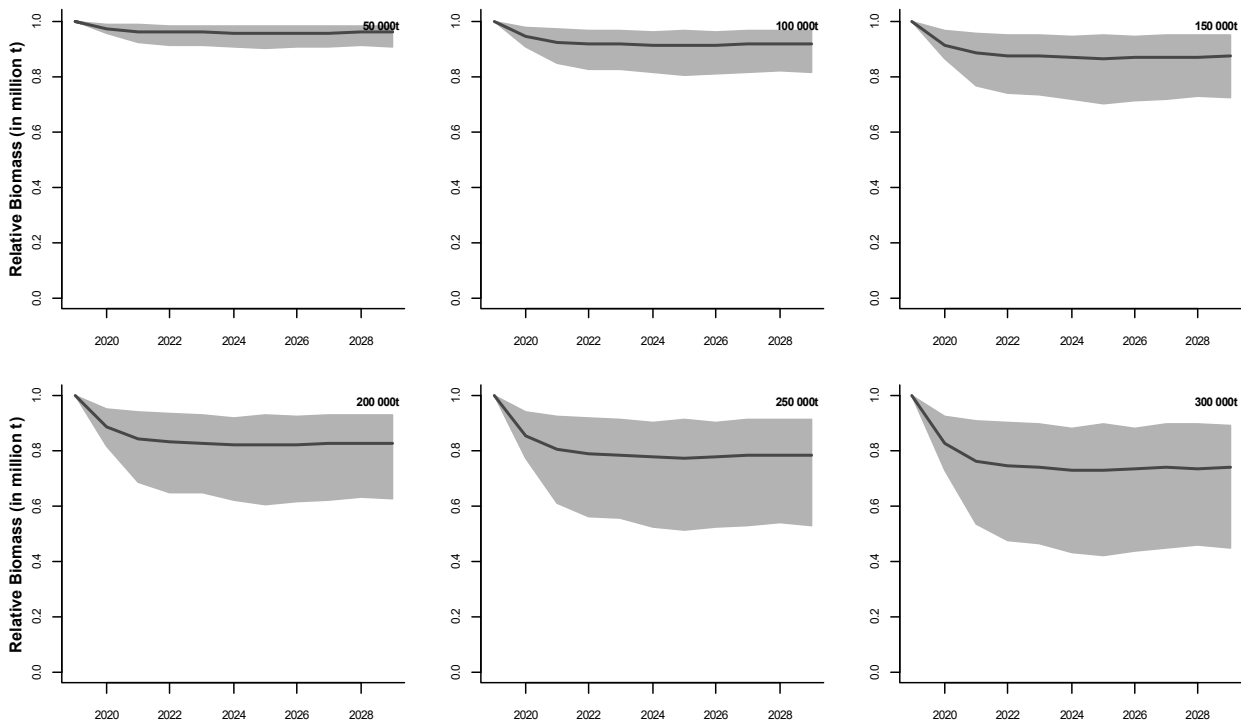


Figure C6d. As per Figure C6a, but with future recruitment being 40% of the historical average.

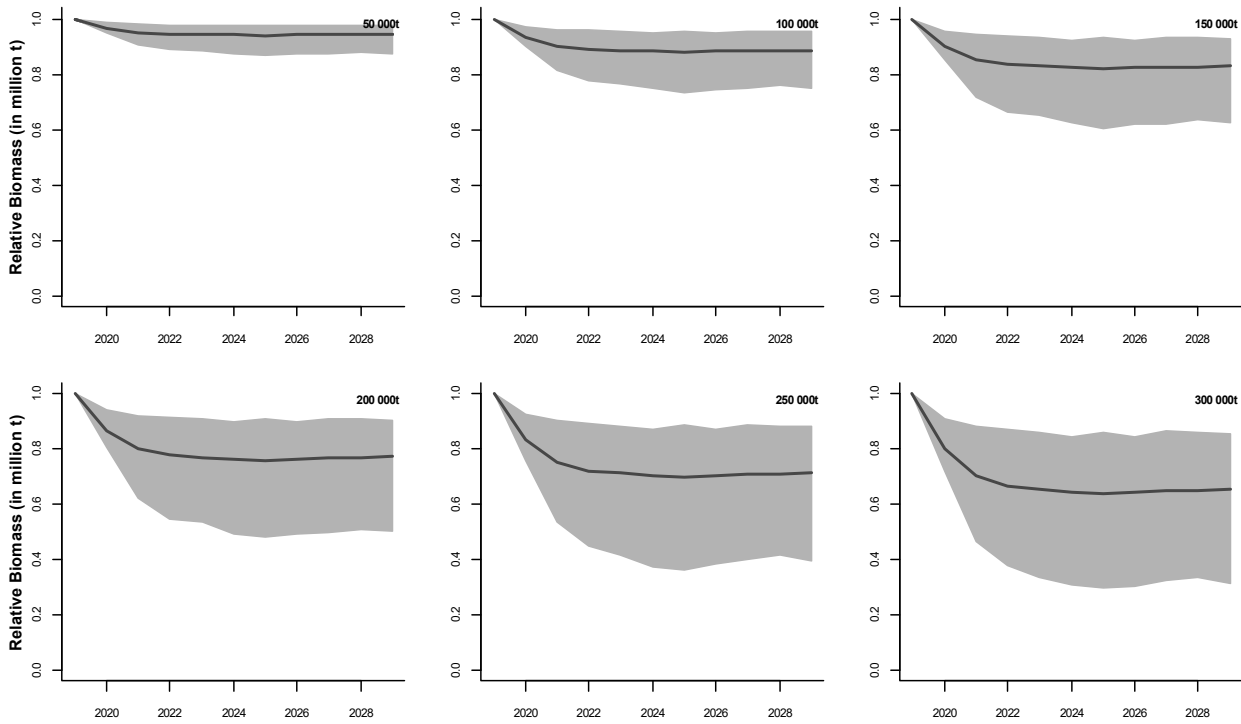


Figure C6e. As per Figure C6a, but with future recruitment being 30% of the historical average.

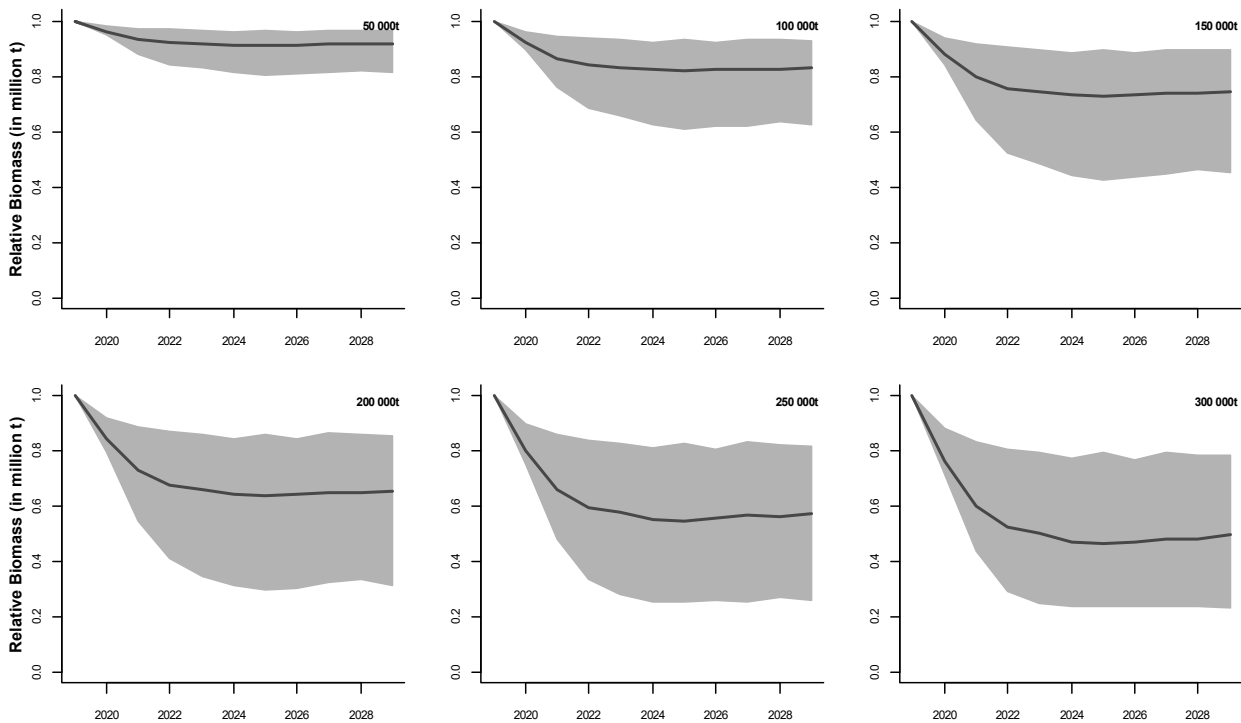


Figure C6f. As per Figure C6a, but with future recruitment being 20% of the historical average.

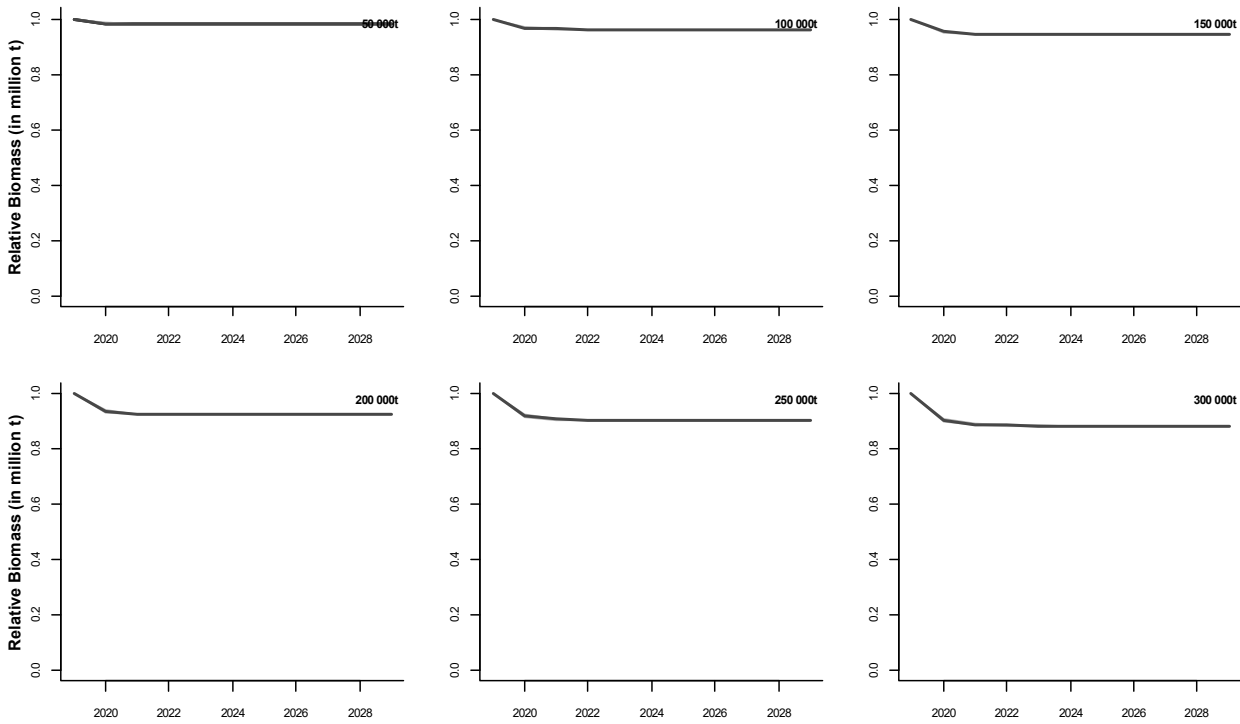


Figure C7a. The median and 95%ile confidence intervals of anchovy biomass from 2019 to 2029 under six alternative catch scenarios relative to a no future catch scenario, with future recruitment being the historical average, and including starting point variability only.

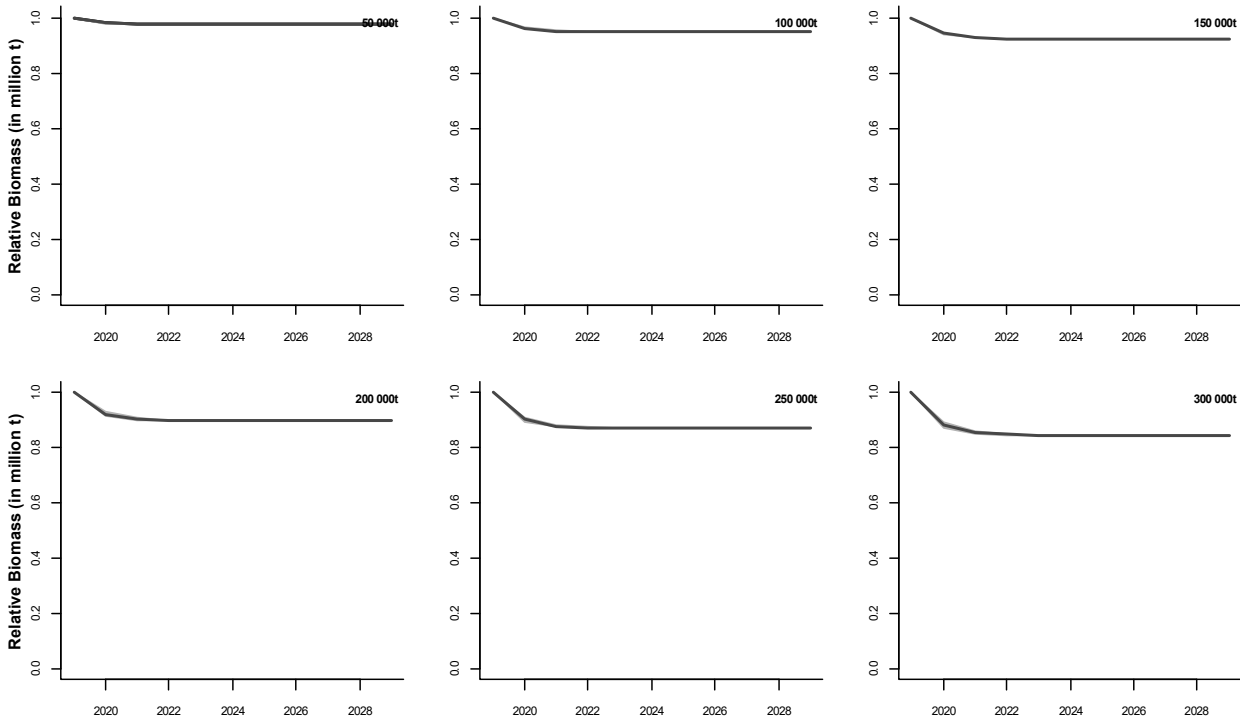


Figure C7b. As per Figure C7a, but with future recruitment being 75% of the historical average.

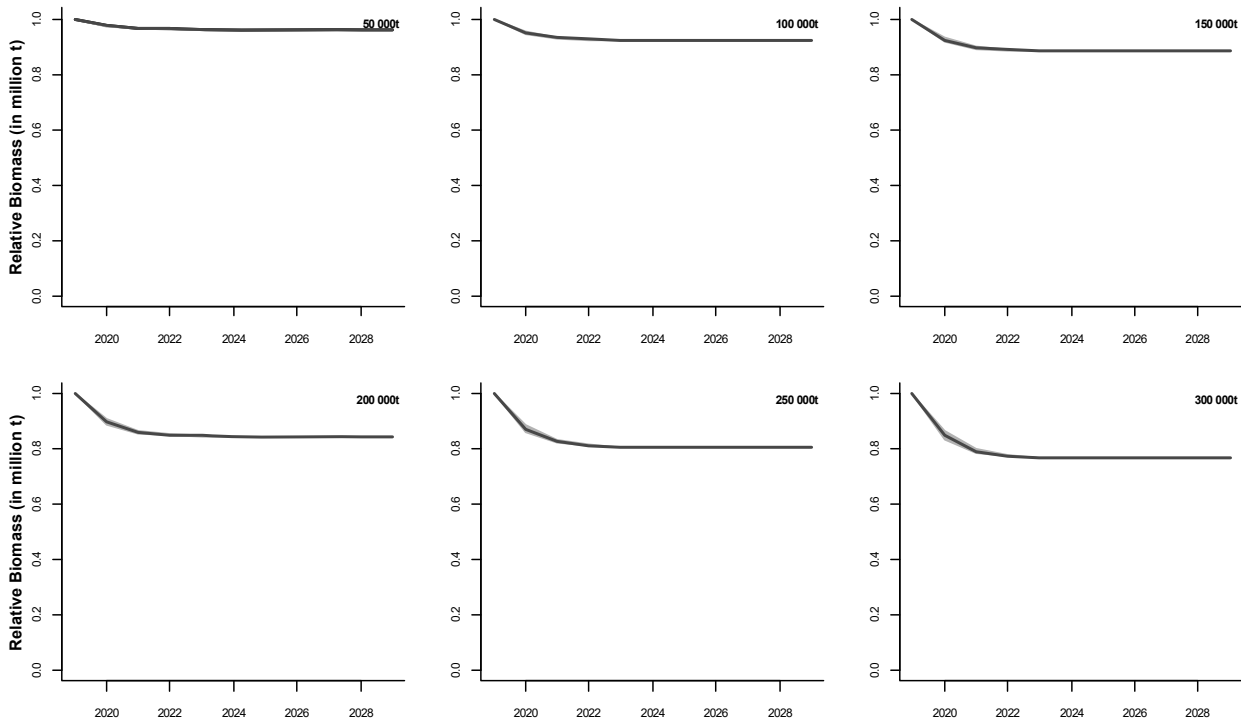


Figure C7c. As per Figure C7a, but with future recruitment being 50% of the historical average.

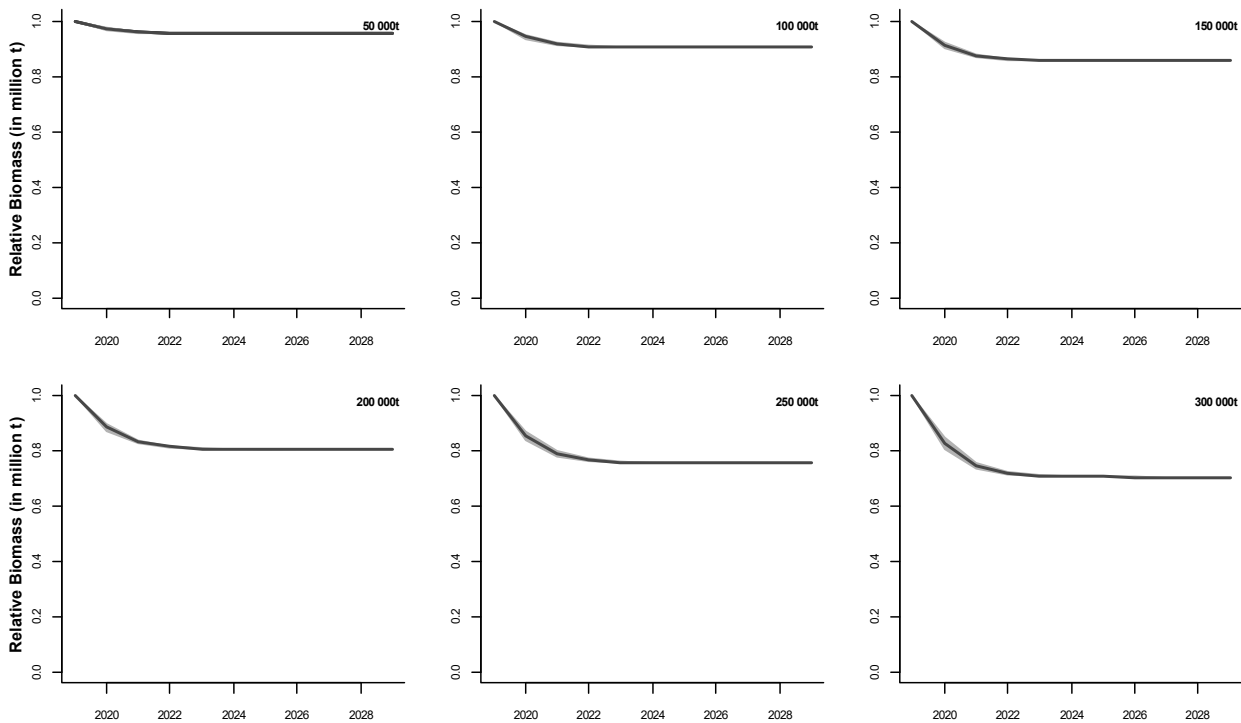


Figure C7d. As per Figure C7a, but with future recruitment being 40% of the historical average.

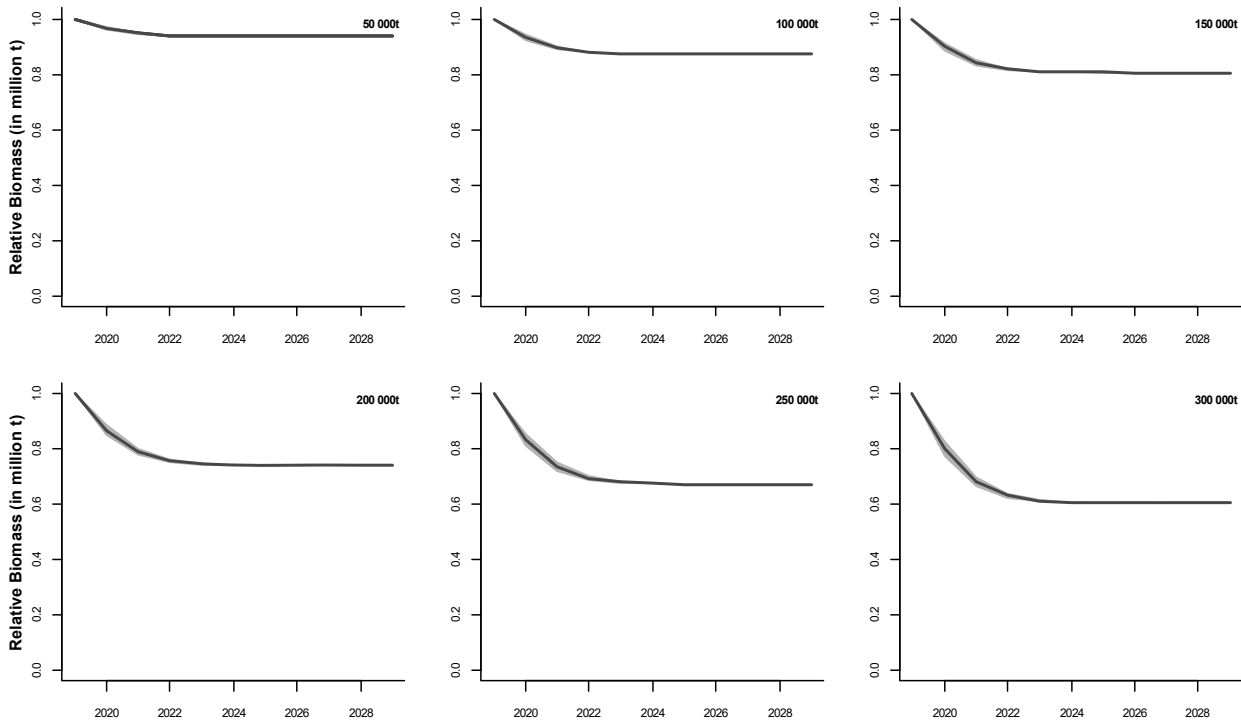


Figure C7e. As per Figure C7a, but with future recruitment being 30% of the historical average.

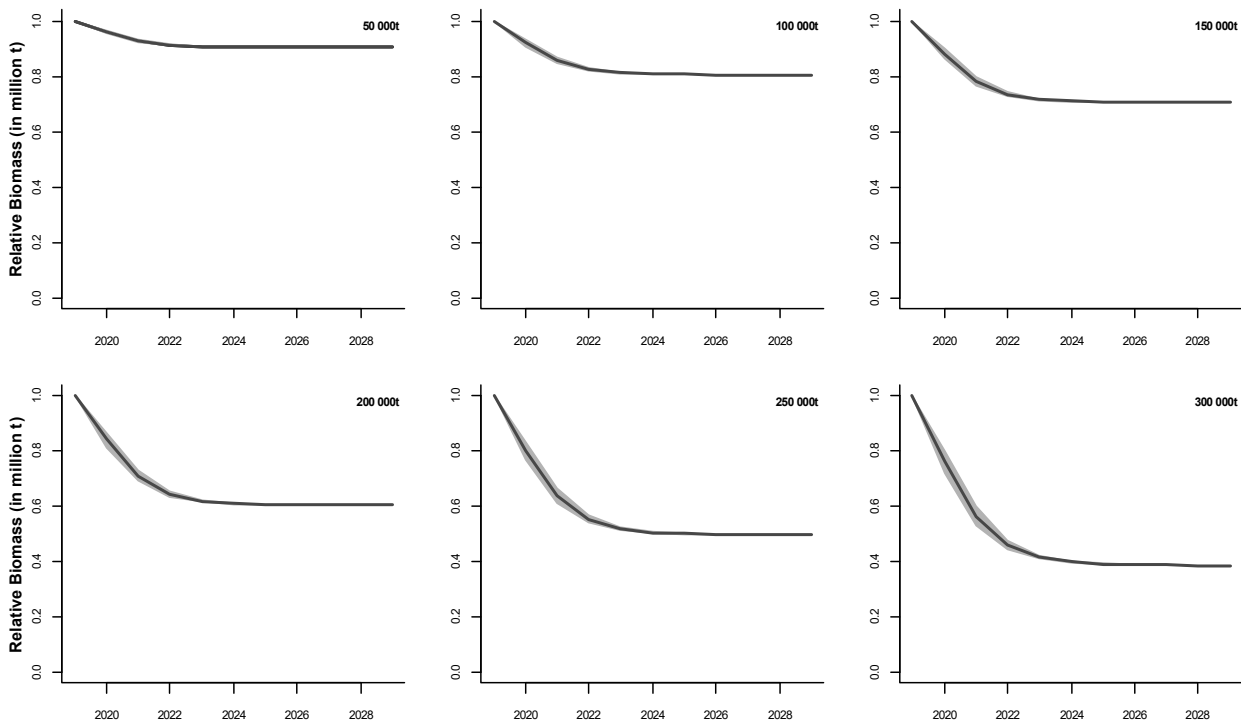


Figure C7f. As per Figure C7a, but with future recruitment being 20% of the historical average.

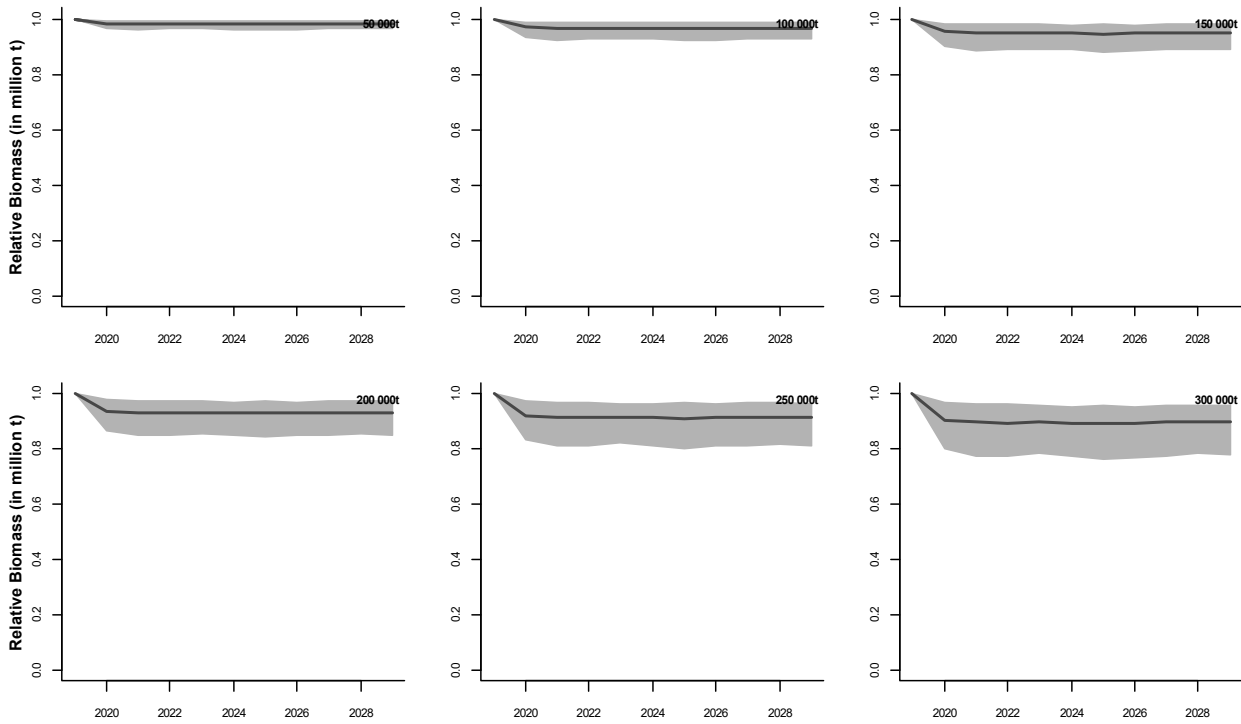


Figure C8a. The median and 95%ile confidence intervals of anchovy biomass from 2019 to 2029 under six alternative catch scenarios relative to a no future catch scenario, with future recruitment being the historical average, and including both recruitment and starting point variability.

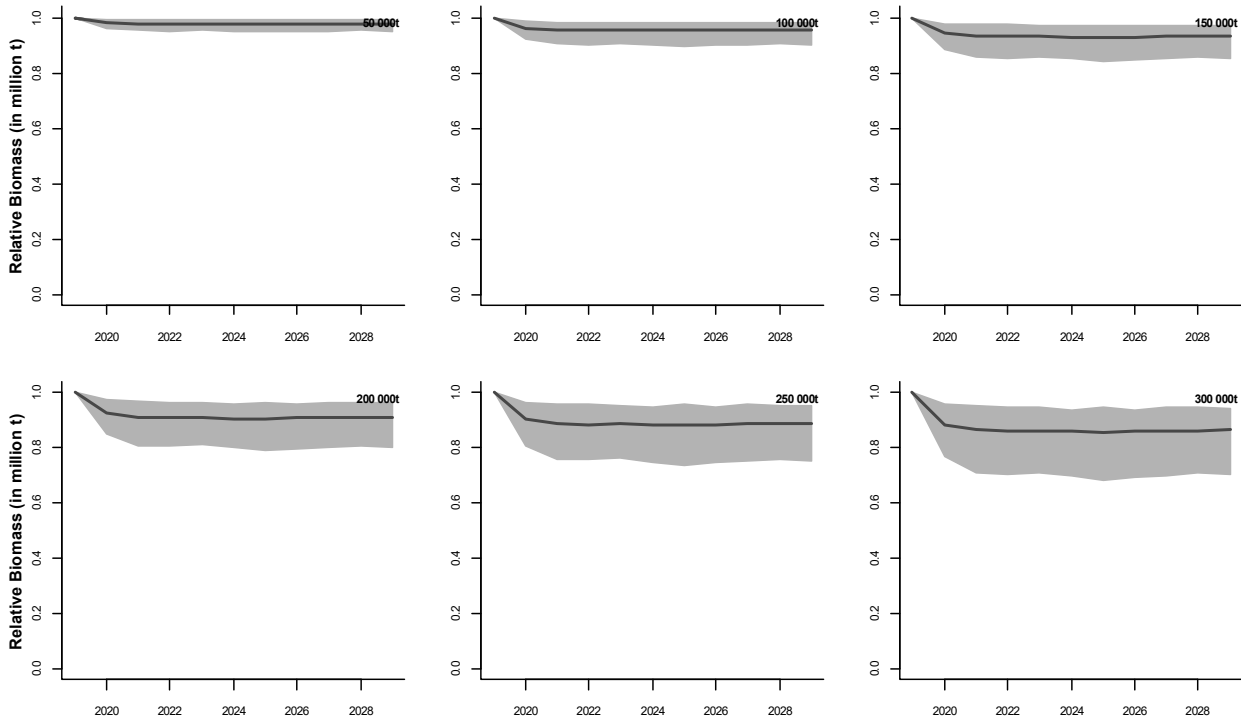


Figure C8b. As per Figure C8a, but with future recruitment being 75% of the historical average.

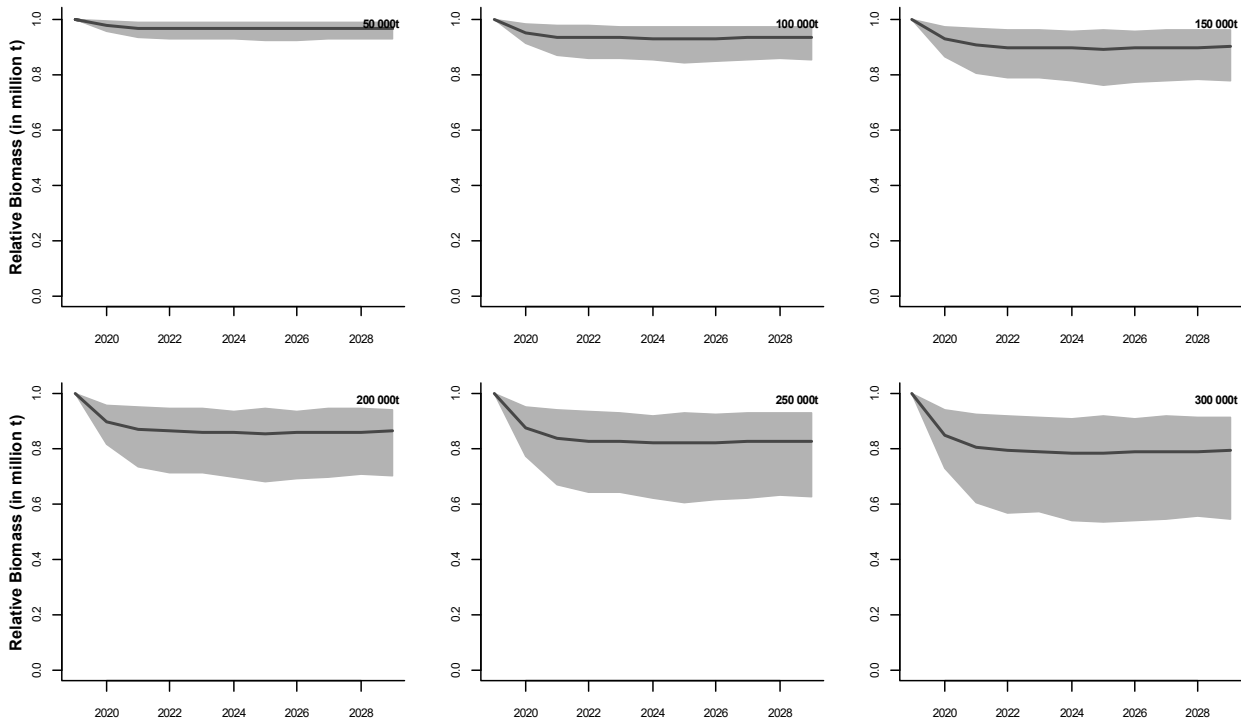


Figure C8c. As per Figure C8a, but with future recruitment being 50% of the historical average.

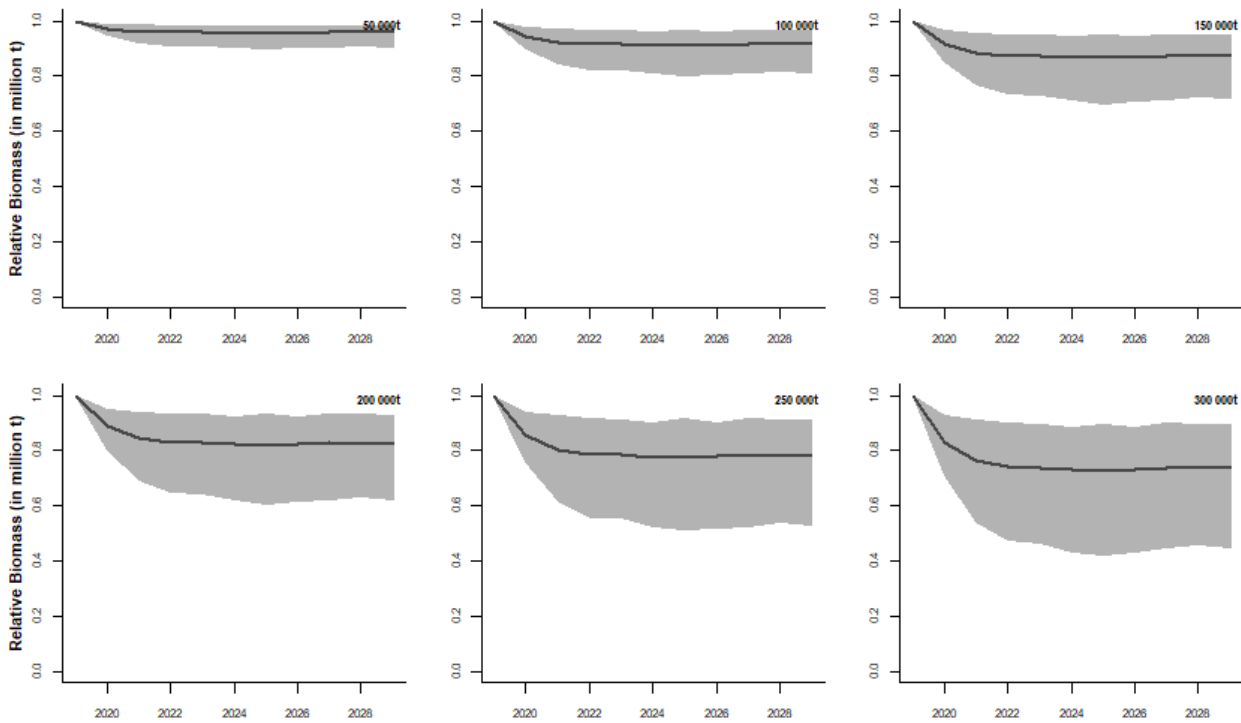


Figure C8d. As per Figure C8a, but with future recruitment being 40% of the historical average.

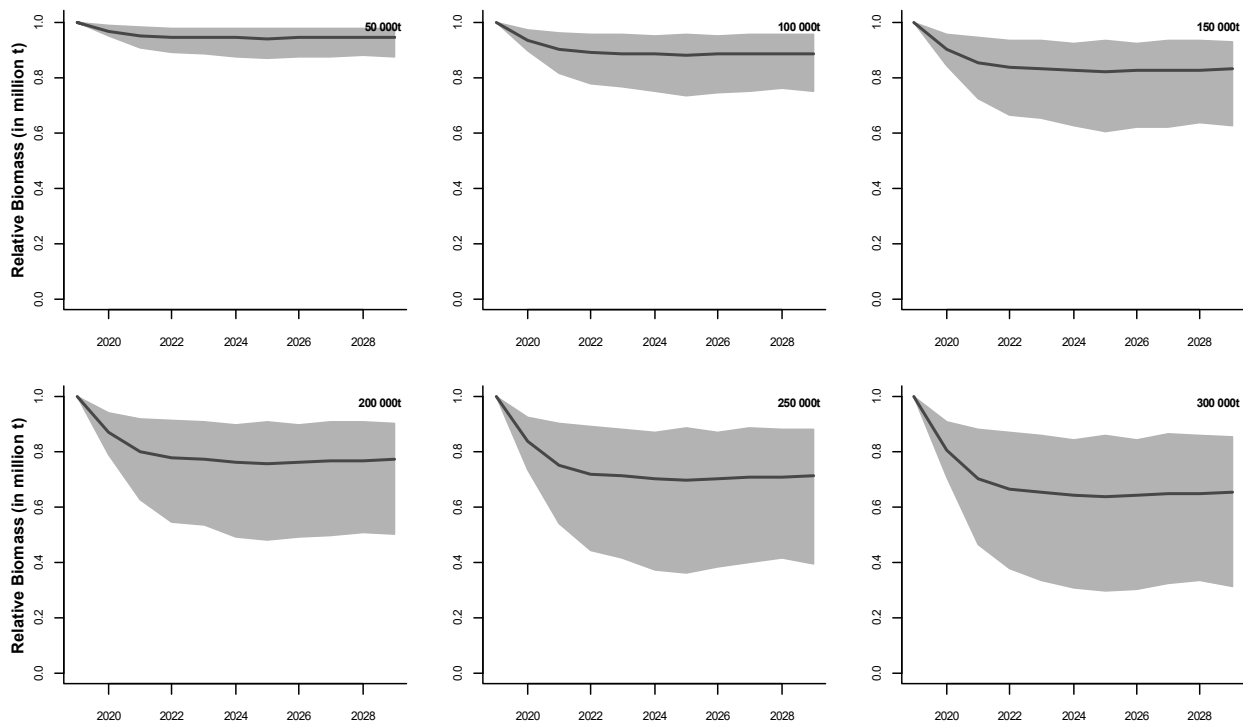


Figure C8e. As per Figure C8a, but with future recruitment being 30% of the historical average.

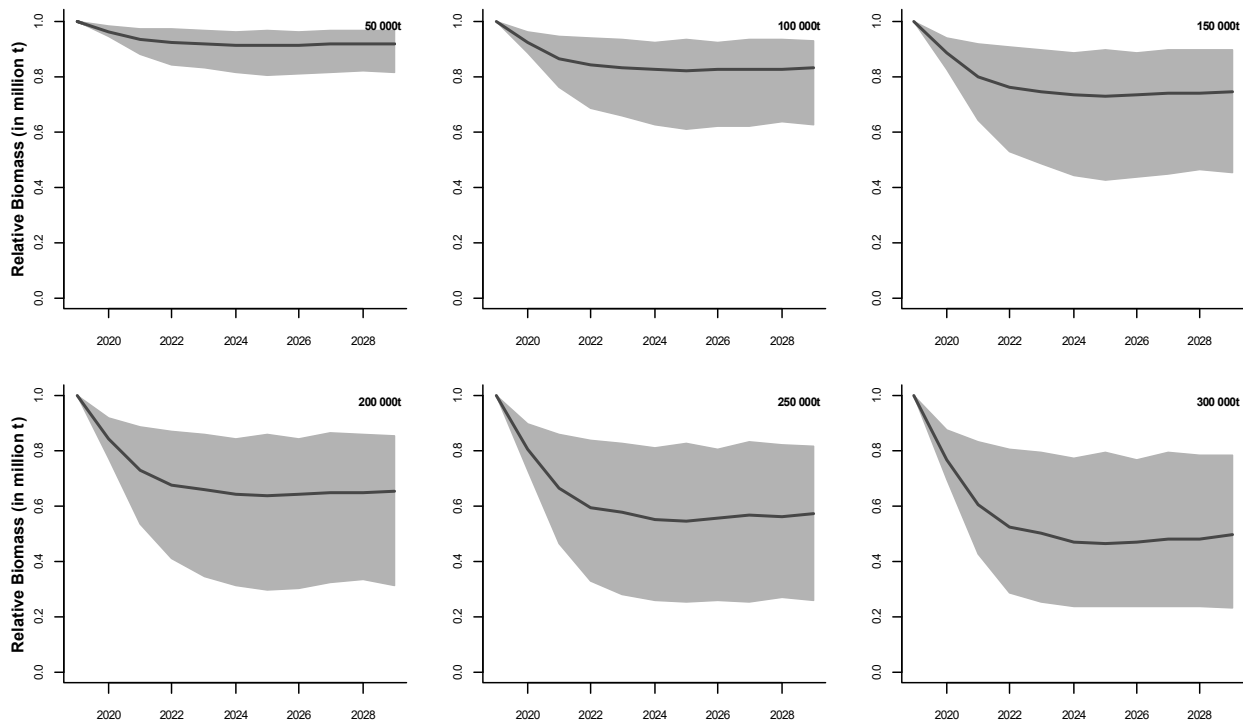


Figure C8f. As per Figure C8a, but with future recruitment being 20% of the historical average.

Appendix D: Tables of additional summary statistics

Table D.1. The 5%ile, 20%ile and median of the ratio of spawner biomass in 2020 to that in 2019 and this ratio under the catch scenario as a proportion of that under the no catch scenario for A_0 . The probability that the spawner biomass in 2020 and over the 10 year projection period is below the risk threshold of the 1996 level is also given. Results here are for 2) recruitment variability only and 3) initial variability only. Deterministic results and results including both recruitment and initial variability are given in Table 2a. Results are given for different proportions (100%, 75%, 50%, 40%, 30%, 20%) of historical average recruitment and different future constant catch scenarios.

Rec	Catch	Recruitment variability								Initial variability							
		R=SSB ₂₀₂₀ :SSB ₂₀₁₉			R ^{Catch} :R ^{NoCatch}			R ^{risk} ₂₀	R ^{risk} _{all}	R=SSB ₂₀₂₀ :SSB ₂₀₁₉			R ^{Catch} :R ^{NoCatch}			R ^{risk} ₂₀	R ^{risk} _{all}
		5%	20%	50%	5%	20%	50%			5%	20%	50%	5%	20%	50%		
100%	0	0.84	1.12	1.63	1.00	1.00	1.00	0.00	0.00	1.39	1.51	1.61	1.00	1.00	1.00	0.00	0.00
	50	0.82	1.10	1.60	0.97	0.98	0.98	0.00	0.00	1.37	1.49	1.59	0.99	0.99	0.98	0.00	0.00
	100	0.80	1.08	1.58	0.94	0.96	0.97	0.00	0.00	1.35	1.47	1.56	0.97	0.97	0.97	0.00	0.00
	150	0.77	1.05	1.55	0.91	0.93	0.95	0.00	0.00	1.33	1.45	1.53	0.96	0.95	0.95	0.00	0.00
	200	0.75	1.03	1.53	0.88	0.91	0.94	0.00	0.00	1.31	1.42	1.51	0.94	0.94	0.94	0.00	0.00
	250	0.72	1.00	1.50	0.86	0.89	0.92	0.00	0.00	1.29	1.40	1.48	0.93	0.92	0.92	0.00	0.00
	300	0.70	0.98	1.48	0.83	0.87	0.91	0.00	0.00	1.27	1.38	1.46	0.91	0.91	0.91	0.00	0.00
75%	0	0.75	0.96	1.33	1.00	1.00	1.00	0.00	0.00	1.16	1.25	1.32	1.00	1.00	1.00	0.00	0.00
	50	0.72	0.93	1.31	0.97	0.97	0.98	0.00	0.00	1.14	1.23	1.30	0.98	0.98	0.98	0.00	0.00
	100	0.70	0.91	1.28	0.94	0.95	0.96	0.00	0.00	1.12	1.20	1.27	0.97	0.96	0.96	0.00	0.00
	150	0.67	0.88	1.26	0.90	0.92	0.94	0.00	0.00	1.10	1.18	1.25	0.95	0.95	0.94	0.00	0.00
	200	0.65	0.86	1.23	0.87	0.90	0.93	0.00	0.00	1.08	1.16	1.22	0.93	0.93	0.92	0.00	0.00
	250	0.63	0.83	1.21	0.84	0.87	0.91	0.00	0.00	1.06	1.14	1.20	0.91	0.91	0.91	0.00	0.00
	300	0.60	0.81	1.18	0.80	0.85	0.89	0.00	0.00	1.04	1.11	1.17	0.90	0.89	0.89	0.00	0.00
50%	0	0.65	0.79	1.04	1.00	1.00	1.00	0.00	0.00	0.92	0.99	1.03	1.00	1.00	1.00	0.00	0.00
	50	0.63	0.77	1.02	0.96	0.97	0.98	0.00	0.00	0.90	0.96	1.01	0.98	0.98	0.98	0.00	0.00
	100	0.60	0.74	0.99	0.93	0.94	0.95	0.00	0.01	0.88	0.94	0.98	0.96	0.95	0.95	0.00	0.00
	150	0.58	0.72	0.97	0.89	0.91	0.93	0.00	0.02	0.86	0.92	0.96	0.94	0.93	0.93	0.00	0.00
	200	0.55	0.69	0.94	0.85	0.88	0.91	0.00	0.03	0.84	0.90	0.94	0.91	0.91	0.90	0.00	0.00
	250	0.53	0.67	0.92	0.81	0.85	0.88	0.00	0.04	0.82	0.87	0.91	0.89	0.89	0.88	0.00	0.00
	300	0.50	0.64	0.89	0.78	0.81	0.86	0.00	0.06	0.80	0.85	0.89	0.87	0.86	0.86	0.00	0.00
40%	0	0.61	0.72	0.93	1.00	1.00	1.00	0.00	0.01	0.83	0.88	0.92	1.00	1.00	1.00	0.00	0.00
	50	0.59	0.70	0.90	0.96	0.97	0.97	0.00	0.02	0.81	0.86	0.89	0.98	0.97	0.97	0.00	0.00
	100	0.56	0.68	0.88	0.92	0.93	0.95	0.00	0.04	0.79	0.84	0.87	0.95	0.95	0.95	0.00	0.00
	150	0.54	0.65	0.85	0.88	0.90	0.92	0.00	0.06	0.77	0.81	0.84	0.93	0.92	0.92	0.00	0.00
	200	0.51	0.63	0.83	0.84	0.87	0.89	0.00	0.08	0.75	0.79	0.82	0.90	0.90	0.89	0.00	0.00
	250	0.49	0.60	0.80	0.80	0.83	0.87	0.00	0.11	0.73	0.77	0.80	0.88	0.87	0.87	0.00	0.00
	300	0.47	0.58	0.78	0.76	0.80	0.84	0.00	0.14	0.71	0.75	0.77	0.86	0.85	0.84	0.00	0.00
30%	0	0.57	0.66	0.81	1.00	1.00	1.00	0.00	0.06	0.74	0.77	0.80	1.00	1.00	1.00	0.00	0.00
	50	0.55	0.63	0.78	0.96	0.96	0.97	0.00	0.09	0.72	0.75	0.78	0.97	0.97	0.97	0.00	0.00
	100	0.52	0.61	0.76	0.92	0.93	0.94	0.00	0.13	0.70	0.73	0.75	0.95	0.94	0.94	0.00	0.00
	150	0.50	0.58	0.73	0.87	0.89	0.91	0.00	0.18	0.68	0.71	0.73	0.92	0.91	0.91	0.00	0.00
	200	0.48	0.56	0.71	0.83	0.85	0.88	0.00	0.23	0.66	0.68	0.71	0.89	0.88	0.88	0.00	0.00
	250	0.45	0.54	0.69	0.79	0.81	0.85	0.00	0.28	0.64	0.66	0.68	0.87	0.86	0.85	0.00	0.00
	300	0.43	0.51	0.66	0.75	0.78	0.82	0.00	0.33	0.62	0.64	0.66	0.84	0.83	0.82	0.00	0.65
20%	0	0.53	0.59	0.69	1.00	1.00	1.00	0.00	0.25	0.64	0.67	0.69	1.00	1.00	1.00	0.00	0.00
	50	0.51	0.57	0.67	0.95	0.96	0.97	0.00	0.33	0.62	0.65	0.66	0.97	0.97	0.97	0.00	0.64
	100	0.49	0.54	0.64	0.91	0.92	0.93	0.00	0.40	0.60	0.62	0.64	0.94	0.93	0.93	0.00	0.73
	150	0.46	0.52	0.62	0.86	0.88	0.89	0.00	0.47	0.58	0.60	0.61	0.91	0.90	0.89	0.00	0.77
	200	0.44	0.49	0.59	0.82	0.84	0.86	0.00	0.52	0.57	0.58	0.59	0.88	0.87	0.86	0.00	0.81
	250	0.42	0.47	0.57	0.79	0.79	0.82	0.00	0.56	0.55	0.56	0.57	0.85	0.83	0.82	0.00	0.82
	300	0.41	0.44	0.54	0.77	0.75	0.79	0.00	0.61	0.53	0.53	0.54	0.82	0.80	0.79	0.00	0.82

Table D.2. The 5%ile, 20%ile and median of the ratio of spawner biomass in **2021** to that in 2019 and this ratio under the catch scenario as a proportion of that under the no catch scenario for **A₀**. The probability that the spawner biomass in **2021** and over the 10 year projection period is below the risk threshold of the 1996 level is also given. Results here are for the 1) deterministic and 4) including both recruitment and initial variability scenarios. Results are given for different proportions (100%, 75%, 50%, 40%, 30%, 20%) of historical average recruitment and different future constant catch scenarios.

Rec	Catch	Deterministic								Recruitment and Initial variability							
		R=SSB ₂₀₂₁ :SSB ₂₀₁₉			R ^{Catch} :R ^{NoCatch}			R ^{risk} ₂₁	R ^{risk} _{all}	R=SSB ₂₀₂₁ :SSB ₂₀₁₉			R ^{Catch} :R ^{NoCatch}			R ^{risk} ₂₁	R ^{risk} _{all}
		5%	20%	50%	5%	20%	50%			5%	20%	50%	5%	20%	50%		
100%	0	1.98	1.98	1.98	1.00	1.00	1.00	0.00	0.00	1.07	1.43	2.16	1.00	1.00	1.00	0.00	0.00
	50	1.94	1.94	1.94	0.98	0.98	0.98	0.00	0.00	1.04	1.39	2.12	0.97	0.97	0.98	0.00	0.00
	100	1.90	1.90	1.90	0.96	0.96	0.96	0.00	0.00	1.00	1.35	2.09	0.93	0.94	0.97	0.00	0.00
	150	1.86	1.86	1.86	0.94	0.94	0.94	0.00	0.00	0.96	1.30	2.05	0.89	0.91	0.95	0.00	0.00
	200	1.82	1.82	1.82	0.92	0.92	0.92	0.00	0.00	0.92	1.27	2.01	0.86	0.89	0.93	0.00	0.00
	250	1.79	1.79	1.79	0.90	0.90	0.90	0.00	0.00	0.88	1.23	1.97	0.82	0.86	0.91	0.00	0.00
	300	1.75	1.75	1.75	0.88	0.88	0.88	0.00	0.00	0.85	1.19	1.93	0.79	0.84	0.89	0.00	0.00
75%	0	1.52	1.52	1.52	1.00	1.00	1.00	0.00	0.00	0.84	1.11	1.66	1.00	1.00	1.00	0.00	0.00
	50	1.48	1.48	1.48	0.98	0.98	0.98	0.00	0.00	0.80	1.07	1.62	0.96	0.96	0.98	0.00	0.00
	100	1.44	1.44	1.44	0.95	0.95	0.95	0.00	0.00	0.76	1.03	1.58	0.91	0.93	0.96	0.00	0.00
	150	1.41	1.41	1.41	0.93	0.93	0.93	0.00	0.00	0.73	0.99	1.54	0.87	0.89	0.93	0.00	0.00
	200	1.37	1.37	1.37	0.90	0.90	0.90	0.00	0.00	0.69	0.95	1.50	0.82	0.86	0.91	0.00	0.00
	250	1.33	1.33	1.33	0.87	0.87	0.87	0.00	0.00	0.65	0.92	1.47	0.78	0.83	0.88	0.00	0.00
	300	1.29	1.29	1.29	0.85	0.85	0.85	0.00	0.00	0.62	0.88	1.42	0.73	0.80	0.86	0.01	0.00
50%	0	1.06	1.06	1.06	1.00	1.00	1.00	0.00	0.00	0.61	0.79	1.15	1.00	1.00	1.00	0.00	0.00
	50	1.02	1.02	1.02	0.96	0.96	0.96	0.00	0.00	0.57	0.75	1.12	0.94	0.95	0.97	0.00	0.00
	100	0.99	0.99	0.99	0.93	0.93	0.93	0.00	0.00	0.53	0.71	1.08	0.88	0.90	0.94	0.01	0.01
	150	0.95	0.95	0.95	0.89	0.89	0.89	0.00	0.00	0.50	0.67	1.04	0.82	0.86	0.90	0.01	0.02
	200	0.91	0.91	0.91	0.86	0.86	0.86	0.00	0.00	0.46	0.64	1.00	0.76	0.81	0.87	0.02	0.03
	250	0.87	0.87	0.87	0.82	0.82	0.82	0.00	0.00	0.43	0.60	0.96	0.70	0.77	0.83	0.04	0.04
	300	0.84	0.84	0.84	0.79	0.79	0.79	0.00	0.00	0.40	0.57	0.92	0.65	0.72	0.80	0.06	0.06
40%	0	0.88	0.88	0.88	1.00	1.00	1.00	0.00	0.00	0.52	0.66	0.95	1.00	1.00	1.00	0.01	0.01
	50	0.84	0.84	0.84	0.96	0.96	0.96	0.00	0.00	0.48	0.62	0.92	0.93	0.94	0.96	0.01	0.02
	100	0.80	0.80	0.80	0.92	0.92	0.92	0.00	0.00	0.44	0.58	0.88	0.86	0.88	0.92	0.03	0.04
	150	0.77	0.77	0.77	0.87	0.87	0.87	0.00	0.00	0.41	0.55	0.84	0.79	0.83	0.88	0.04	0.06
	200	0.73	0.73	0.73	0.83	0.83	0.83	0.00	0.00	0.37	0.51	0.80	0.72	0.78	0.84	0.07	0.08
	250	0.69	0.69	0.69	0.79	0.79	0.79	0.00	0.00	0.34	0.48	0.76	0.66	0.73	0.80	0.11	0.11
	300	0.65	0.65	0.65	0.74	0.74	0.74	0.00	0.00	0.31	0.44	0.72	0.60	0.68	0.76	0.15	0.14
30%	0	0.70	0.70	0.70	1.00	1.00	1.00	0.00	0.00	0.42	0.53	0.75	1.00	1.00	1.00	0.03	0.06
	50	0.66	0.66	0.66	0.95	0.95	0.95	0.00	0.00	0.39	0.49	0.71	0.91	0.93	0.95	0.06	0.09
	100	0.62	0.62	0.62	0.89	0.89	0.89	0.00	0.00	0.35	0.46	0.68	0.83	0.86	0.90	0.11	0.13
	150	0.58	0.58	0.58	0.84	0.84	0.84	0.00	0.00	0.32	0.42	0.64	0.75	0.80	0.85	0.16	0.18
	200	0.55	0.55	0.55	0.79	0.79	0.79	0.00	0.00	0.29	0.39	0.60	0.68	0.73	0.79	0.21	0.23
	250	0.51	0.51	0.51	0.73	0.73	0.73	0.00	0.00	0.25	0.35	0.56	0.59	0.67	0.75	0.26	0.28
	300	0.47	0.47	0.47	0.68	0.68	0.68	0.00	0.64	0.22	0.32	0.53	0.52	0.60	0.70	0.32	0.33
20%	0	0.51	0.51	0.51	1.00	1.00	1.00	0.00	0.00	0.33	0.40	0.55	1.00	1.00	1.00	0.18	0.25
	50	0.48	0.48	0.48	0.93	0.93	0.93	0.00	0.64	0.29	0.36	0.51	0.89	0.91	0.93	0.26	0.32
	100	0.44	0.44	0.44	0.86	0.86	0.86	0.00	0.73	0.26	0.33	0.47	0.79	0.82	0.86	0.34	0.40
	150	0.40	0.40	0.40	0.79	0.79	0.79	0.00	0.73	0.23	0.30	0.44	0.70	0.74	0.79	0.42	0.47
	200	0.37	0.37	0.37	0.71	0.71	0.71	1.00	0.82	0.20	0.26	0.40	0.59	0.66	0.73	0.50	0.52
	250	0.33	0.33	0.33	0.64	0.64	0.64	1.00	0.82	0.18	0.23	0.37	0.53	0.57	0.67	0.55	0.57
	300	0.29	0.29	0.29	0.57	0.57	0.57	1.00	0.82	0.16	0.20	0.33	0.47	0.51	0.60	0.62	0.61

Table D.3. The 5%ile, 20%ile and median of the ratio of spawner biomass in **2021** to that in 2019 and this ratio under the catch scenario as a proportion of that under the no catch scenario for **A₁**. The probability that the spawner biomass in **2021** and over the 10 year projection period is below the risk threshold of the 1996 level is also given. Results here are for the 1) deterministic and 4) including both recruitment and initial variability scenarios. Results are given for different proportions (100%, 75%, 50%, 40%, 30%, 20%) of historical average recruitment and different future constant catch scenarios.

Rec	Catch	Deterministic								Recruitment and Initial variability							
		R=SSB ₂₀₂₁ :SSB ₂₀₁₉			R ^{Catch} :R ^{NoCatch}			R ^{risk} ₂₁	R ^{risk} _{all}	R=SSB ₂₀₂₁ :SSB ₂₀₁₉			R ^{Catch} :R ^{NoCatch}			R ^{risk} ₂₁	R ^{risk} _{all}
		5%	20%	50%	5%	20%	50%			5%	20%	50%	5%	20%	50%		
100%	0	2.14	2.14	2.14	1.00	1.00	1.00	0.00	0.00	1.13	1.54	2.31	1.00	1.00	1.00	0.00	0.00
	50	2.09	2.09	2.09	0.97	0.97	0.97	0.00	0.00	1.08	1.49	2.25	0.95	0.97	0.98	0.00	0.00
	100	2.03	2.03	2.03	0.95	0.95	0.95	0.00	0.00	1.02	1.43	2.19	0.91	0.93	0.95	0.00	0.00
	150	1.97	1.97	1.97	0.92	0.92	0.92	0.00	0.00	0.97	1.37	2.14	0.86	0.89	0.93	0.00	0.00
	200	1.91	1.91	1.91	0.89	0.89	0.89	0.00	0.00	0.91	1.31	2.08	0.81	0.85	0.90	0.00	0.00
	250	1.86	1.86	1.86	0.87	0.87	0.87	0.00	0.00	0.86	1.25	2.02	0.76	0.81	0.88	0.00	0.00
	300	1.80	1.80	1.80	0.84	0.84	0.84	0.00	0.00	0.81	1.19	1.97	0.72	0.77	0.85	0.00	0.00
75%	0	1.64	1.64	1.64	1.00	1.00	1.00	0.00	0.00	0.88	1.19	1.76	1.00	1.00	1.00	0.00	0.00
	50	1.58	1.58	1.58	0.97	0.97	0.97	0.00	0.00	0.83	1.13	1.71	0.94	0.95	0.97	0.00	0.00
	100	1.52	1.52	1.52	0.93	0.93	0.93	0.00	0.00	0.77	1.07	1.65	0.88	0.90	0.94	0.00	0.00
	150	1.47	1.47	1.47	0.90	0.90	0.90	0.00	0.00	0.72	1.02	1.59	0.82	0.86	0.90	0.00	0.00
	200	1.41	1.41	1.41	0.86	0.86	0.86	0.00	0.00	0.66	0.96	1.54	0.76	0.81	0.87	0.00	0.00
	250	1.35	1.35	1.35	0.83	0.83	0.83	0.00	0.00	0.61	0.90	1.48	0.69	0.76	0.84	0.01	0.00
	300	1.30	1.30	1.30	0.79	0.79	0.79	0.00	0.00	0.55	0.84	1.43	0.63	0.71	0.81	0.01	0.01
50%	0	1.13	1.13	1.13	1.00	1.00	1.00	0.00	0.00	0.63	0.83	1.22	1.00	1.00	1.00	0.00	0.00
	50	1.08	1.08	1.08	0.95	0.95	0.95	0.00	0.00	0.58	0.78	1.16	0.92	0.93	0.95	0.00	0.00
	100	1.02	1.02	1.02	0.90	0.90	0.90	0.00	0.00	0.52	0.72	1.10	0.83	0.87	0.91	0.01	0.01
	150	0.97	0.97	0.97	0.85	0.85	0.85	0.00	0.00	0.47	0.66	1.05	0.75	0.80	0.86	0.02	0.02
	200	0.91	0.91	0.91	0.80	0.80	0.80	0.00	0.00	0.41	0.61	1.00	0.66	0.73	0.82	0.04	0.04
	250	0.85	0.85	0.85	0.75	0.75	0.75	0.00	0.00	0.36	0.56	0.94	0.58	0.67	0.77	0.07	0.07
	300	0.80	0.80	0.80	0.70	0.70	0.70	0.00	0.00	0.31	0.50	0.89	0.50	0.60	0.73	0.10	0.10
40%	0	0.93	0.93	0.93	1.00	1.00	1.00	0.00	0.00	0.53	0.69	1.00	1.00	1.00	1.00	0.00	0.01
	50	0.88	0.88	0.88	0.94	0.94	0.94	0.00	0.00	0.48	0.64	0.94	0.90	0.92	0.94	0.01	0.02
	100	0.82	0.82	0.82	0.88	0.88	0.88	0.00	0.00	0.42	0.58	0.89	0.80	0.84	0.89	0.03	0.04
	150	0.77	0.77	0.77	0.82	0.82	0.82	0.00	0.00	0.37	0.52	0.83	0.70	0.76	0.83	0.07	0.07
	200	0.71	0.71	0.71	0.76	0.76	0.76	0.00	0.00	0.32	0.47	0.78	0.60	0.68	0.78	0.11	0.11
	250	0.65	0.65	0.65	0.70	0.70	0.70	0.00	0.00	0.27	0.42	0.73	0.51	0.61	0.73	0.17	0.16
	300	0.60	0.60	0.60	0.64	0.64	0.64	0.00	0.00	0.23	0.37	0.67	0.44	0.54	0.67	0.22	0.21
30%	0	0.73	0.73	0.73	1.00	1.00	1.00	0.00	0.00	0.43	0.55	0.78	1.00	1.00	1.00	0.03	0.04
	50	0.68	0.68	0.68	0.93	0.93	0.93	0.00	0.00	0.38	0.50	0.73	0.88	0.90	0.93	0.07	0.08
	100	0.62	0.62	0.62	0.85	0.85	0.85	0.00	0.00	0.32	0.44	0.67	0.76	0.80	0.86	0.12	0.14
	150	0.57	0.57	0.57	0.78	0.78	0.78	0.00	0.00	0.27	0.39	0.62	0.64	0.70	0.79	0.20	0.21
	200	0.51	0.51	0.51	0.70	0.70	0.70	0.00	0.00	0.22	0.34	0.56	0.52	0.61	0.72	0.27	0.28
	250	0.46	0.46	0.46	0.62	0.62	0.62	0.00	0.64	0.19	0.29	0.51	0.45	0.52	0.65	0.34	0.35
	300	0.40	0.40	0.40	0.55	0.55	0.55	0.00	0.73	0.17	0.25	0.46	0.40	0.45	0.58	0.42	0.42
20%	0	0.53	0.53	0.53	1.00	1.00	1.00	0.00	0.00	0.33	0.41	0.56	1.00	1.00	1.00	0.16	0.21
	50	0.47	0.47	0.47	0.90	0.90	0.90	0.00	0.00	0.28	0.36	0.51	0.84	0.87	0.90	0.26	0.31
	100	0.42	0.42	0.42	0.80	0.80	0.80	0.00	0.73	0.23	0.30	0.46	0.69	0.74	0.81	0.38	0.41
	150	0.37	0.37	0.37	0.69	0.69	0.69	1.00	0.82	0.18	0.25	0.40	0.55	0.62	0.72	0.49	0.49
	200	0.31	0.31	0.31	0.59	0.59	0.59	1.00	0.82	0.15	0.21	0.35	0.47	0.51	0.62	0.57	0.57
	250	0.26	0.26	0.26	0.49	0.49	0.49	1.00	0.82	0.14	0.18	0.30	0.42	0.43	0.53	0.65	0.63
	300	0.20	0.20	0.20	0.38	0.38	0.38	1.00	0.82	0.13	0.16	0.26	0.38	0.39	0.46	0.71	0.68

Table D.4. The 5%ile, 20%ile and median of the ratio of spawner biomass in **2021** to that in 2019 and this ratio under the catch scenario as a proportion of that under the no catch scenario for **A₈**. The probability that the spawner biomass in **2021** and over the 10 year projection period is below the risk threshold of the 1996 level is also given. Results here are for the 1) deterministic and 4) including both recruitment and initial variability scenarios. Results are given for different proportions (100%, 75%, 50%, 40%, 30%, 20%) of historical average recruitment and different future constant catch scenarios.

Rec	Catch	Deterministic								Recruitment and Initial variability							
		R=SSB ₂₀₂₁ :SSB ₂₀₁₉			R ^{Catch} :R ^{NoCatch}			R ^{risk} ₂₁	R ^{risk} _{all}	R=SSB ₂₀₂₁ :SSB ₂₀₁₉			R ^{Catch} :R ^{NoCatch}			R ^{risk} ₂₁	R ^{risk} _{all}
		5%	20%	50%	5%	20%	50%			5%	20%	50%	5%	20%	50%		
100%	0	0.98	0.98	0.98	1.00	1.00	1.00	0.00	0.00	0.48	0.68	1.03	1.00	1.00	1.00	0.09	0.08
	50	0.95	0.95	0.95	0.97	0.97	0.97	0.00	0.00	0.45	0.65	1.00	0.94	0.95	0.97	0.10	0.10
	100	0.92	0.92	0.92	0.94	0.94	0.94	0.00	0.00	0.43	0.62	0.97	0.88	0.91	0.94	0.13	0.12
	150	0.89	0.89	0.89	0.91	0.91	0.91	0.00	0.00	0.40	0.58	0.94	0.82	0.85	0.91	0.15	0.14
	200	0.86	0.86	0.86	0.88	0.88	0.88	0.00	0.00	0.37	0.55	0.91	0.76	0.80	0.88	0.18	0.16
	250	0.83	0.83	0.83	0.85	0.85	0.85	0.00	0.00	0.34	0.52	0.88	0.70	0.76	0.85	0.21	0.19
	300	0.80	0.80	0.80	0.81	0.81	0.81	0.00	0.00	0.31	0.49	0.85	0.64	0.71	0.83	0.23	0.21
75%	0	0.74	0.74	0.74	1.00	1.00	1.00	0.00	0.00	0.37	0.52	0.78	1.00	1.00	1.00	0.22	0.20
	50	0.71	0.71	0.71	0.96	0.96	0.96	0.00	0.00	0.34	0.49	0.75	0.93	0.94	0.96	0.25	0.23
	100	0.68	0.68	0.68	0.92	0.92	0.92	0.00	0.00	0.31	0.45	0.72	0.85	0.88	0.92	0.28	0.26
	150	0.65	0.65	0.65	0.88	0.88	0.88	0.00	0.00	0.28	0.42	0.69	0.77	0.81	0.88	0.31	0.29
	200	0.62	0.62	0.62	0.84	0.84	0.84	0.00	0.00	0.26	0.39	0.66	0.69	0.75	0.85	0.37	0.32
	250	0.59	0.59	0.59	0.80	0.80	0.80	0.00	0.00	0.23	0.36	0.63	0.61	0.70	0.81	0.40	0.36
	300	0.56	0.56	0.56	0.76	0.76	0.76	0.00	0.00	0.20	0.33	0.60	0.53	0.64	0.77	0.44	0.39
50%	0	0.51	0.51	0.51	1.00	1.00	1.00	1.00	0.82	0.26	0.36	0.53	1.00	1.00	1.00	0.50	0.45
	50	0.48	0.48	0.48	0.94	0.94	0.94	1.00	0.82	0.23	0.33	0.50	0.89	0.91	0.94	0.54	0.49
	100	0.45	0.45	0.45	0.88	0.88	0.88	1.00	0.82	0.20	0.29	0.47	0.78	0.82	0.89	0.58	0.53
	150	0.42	0.42	0.42	0.82	0.82	0.82	1.00	0.91	0.17	0.26	0.44	0.67	0.73	0.83	0.62	0.56
	200	0.39	0.39	0.39	0.76	0.76	0.76	1.00	0.91	0.14	0.23	0.41	0.56	0.66	0.78	0.66	0.59
	250	0.36	0.36	0.36	0.70	0.70	0.70	1.00	0.91	0.12	0.21	0.38	0.46	0.58	0.72	0.68	0.62
	300	0.33	0.33	0.33	0.64	0.64	0.64	1.00	0.91	0.10	0.18	0.35	0.39	0.51	0.66	0.70	0.64
40%	0	0.41	0.41	0.41	1.00	1.00	1.00	1.00	0.91	0.21	0.29	0.43	1.00	1.00	1.00	0.66	0.60
	50	0.38	0.38	0.38	0.93	0.93	0.93	1.00	0.91	0.19	0.26	0.40	0.87	0.89	0.93	0.69	0.63
	100	0.35	0.35	0.35	0.86	0.86	0.86	1.00	0.91	0.16	0.23	0.37	0.73	0.78	0.86	0.72	0.66
	150	0.32	0.32	0.32	0.78	0.78	0.78	1.00	0.91	0.13	0.20	0.34	0.60	0.68	0.80	0.74	0.69
	200	0.29	0.29	0.29	0.71	0.71	0.71	1.00	0.91	0.10	0.17	0.31	0.48	0.59	0.72	0.77	0.72
	250	0.26	0.26	0.26	0.64	0.64	0.64	1.00	0.91	0.08	0.15	0.28	0.39	0.51	0.65	0.79	0.74
	300	0.23	0.23	0.23	0.56	0.56	0.56	1.00	0.91	0.08	0.12	0.25	0.35	0.43	0.59	0.82	0.76
30%	0	0.32	0.32	0.32	1.00	1.00	1.00	1.00	0.91	0.17	0.23	0.33	1.00	1.00	1.00	0.80	0.74
	50	0.29	0.29	0.29	0.91	0.91	0.91	1.00	0.91	0.14	0.20	0.30	0.83	0.86	0.91	0.83	0.77
	100	0.26	0.26	0.26	0.81	0.81	0.81	1.00	0.91	0.11	0.17	0.28	0.67	0.73	0.83	0.85	0.79
	150	0.23	0.23	0.23	0.72	0.72	0.72	1.00	0.91	0.09	0.14	0.24	0.51	0.61	0.73	0.87	0.80
	200	0.20	0.20	0.20	0.63	0.63	0.63	1.00	0.91	0.07	0.11	0.21	0.40	0.50	0.64	0.90	0.82
	250	0.17	0.17	0.17	0.53	0.53	0.53	1.00	0.91	0.06	0.09	0.19	0.36	0.41	0.56	0.91	0.83
	300	0.14	0.14	0.14	0.44	0.44	0.44	1.00	0.91	0.06	0.08	0.16	0.33	0.34	0.48	0.92	0.84
20%	0	0.22	0.22	0.22	1.00	1.00	1.00	1.00	0.91	0.12	0.16	0.23	1.00	1.00	1.00	0.94	0.86
	50	0.19	0.19	0.19	0.87	0.87	0.87	1.00	0.91	0.10	0.13	0.20	0.77	0.81	0.88	0.95	0.87
	100	0.16	0.16	0.16	0.74	0.74	0.74	1.00	0.91	0.07	0.10	0.17	0.55	0.64	0.75	0.96	0.87
	150	0.13	0.13	0.13	0.60	0.60	0.60	1.00	0.91	0.05	0.08	0.15	0.43	0.49	0.62	0.96	0.88
	200	0.10	0.10	0.10	0.47	0.47	0.47	1.00	0.91	0.05	0.06	0.12	0.38	0.39	0.51	0.97	0.89
	250	0.08	0.08	0.08	0.36	0.36	0.36	1.00	0.91	0.04	0.06	0.09	0.33	0.34	0.41	0.97	0.89
	300	0.07	0.07	0.07	0.31	0.31	0.31	1.00	0.91	0.04	0.05	0.08	0.33	0.32	0.35	0.97	0.89