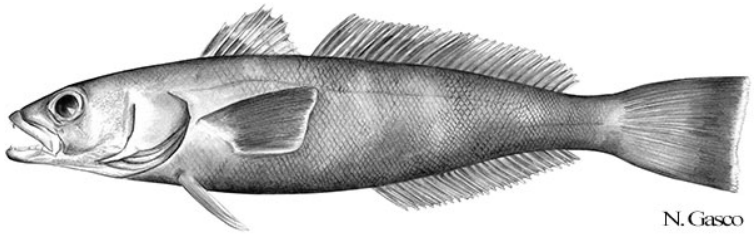
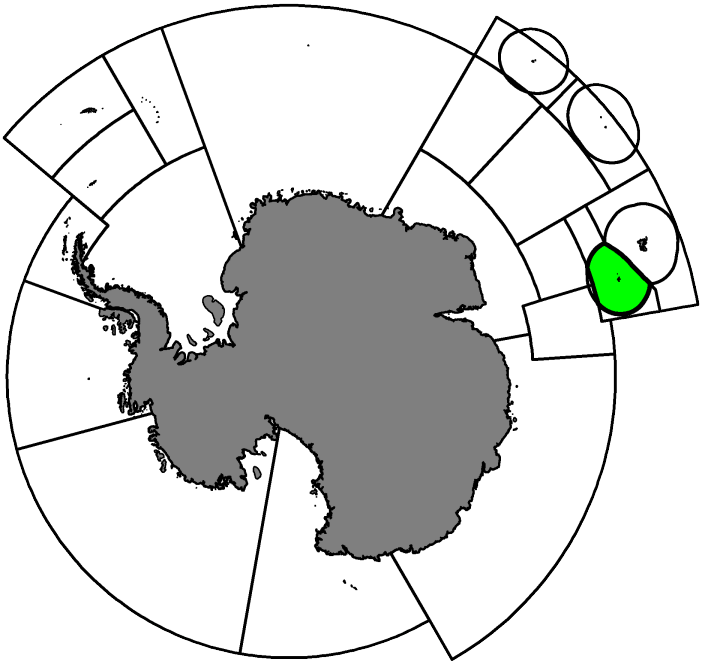
Stock Assessment Report 2021: *Dissostichus eleginoides* at Heard Island (Division 58.5.2)

CCAMLR Secretariat

26 April 2022



Patagonian toothfish *Dissostichus eleginoides* Smitt, 1898.



Map of the management areas within the CAMLR Convention Area. The region discussed in this report is shaded in green.

Stock Assessment Report 2021:
Dissostichus eleginoides Heard Island Australian EEZ (Division 58.5.2)

1. Model configuration

The Heard Island and McDonald Islands fishery for Patagonian toothfish (*Dissostichus eleginoides*) in Division 58.5.2 was assessed in 2021 with an integrated stock assessment using CASAL (WG-FSA-2021/21).

The specification for the assessment model used for management advice are provided in the Stock Annex.

Compared to the 2019 assessment, the 2021 stock assessment took into account (1) updated catch data to 2021 and observations to the end of 2020 including new ageing data from the RSTS and commercial fishery, and (2) updated growth parameters.

2. MPD estimates

The point estimate (maximum posterior density, MPD) for virgin spawing stock biomass B_0 was 69 894 tonnes and the estimated *SSB* status at the end of 2021 was 0.45.

The likelihood profile is shown in Figure 1. While tag-releases in 2013 and to some degree 2015 indicated that B0 should be no more than 60 000 tonnes, tag-releases since then and from 2012 were in disagreement indicating that a much larger B0 was most likely. The survey abundance index indicated that a B0 around 65 000 tonnes was most likely.

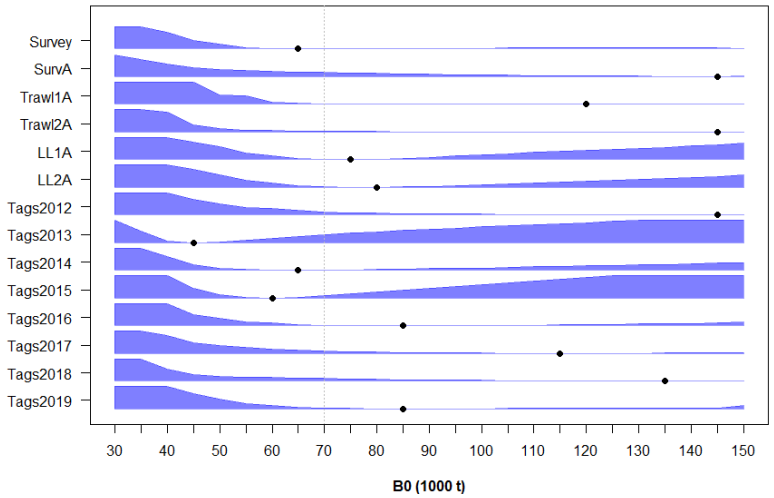


Figure 1: Likelihood profiles (–2 log-likelihood) across a range of B_0 values. To create these profiles, B_0 values were fixed while only the remaining parameters were estimated. The dotted grey line indicates the MPD estimate. 'Survey' is survey biomass index, 'SurvA' is survey catch-at-age, 'Trawl1A' is Trawl1 catch-at-age and so on, tag-release data are denoted by their release year.

MPD fits

The MPD model fits to the survey biomass, tag-recaptures, and median age by sub-fisheries are shown in Figures 2 to 6. The model represented the trend in the biomass and proportions-at-age in the survey reasonably well, with the exception of a growing increase in the estimated survey biomass since 2018 and a corresponding drop in median age when a high proportion of young fish was observed in the survey catch. At this stage, the model does not consider this signal strong enough to represent a recruitment pulse, maybe due to conflicting information from the tagging and the longline catch-at-age data.

Generally good fits were obtained for the proportions-at-age datasets of the longline sub-fisheries, while the fits to the data from the two trawl sub-fisheries were variable, despite the split into two trawl periods (Figure 7).

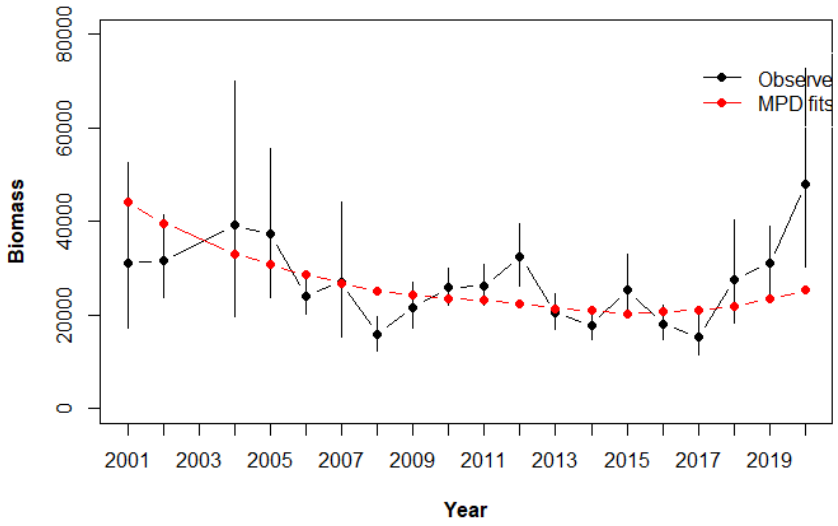


Figure 2: Observed (black line with 95% CI) and predicted (red line) survey biomass.

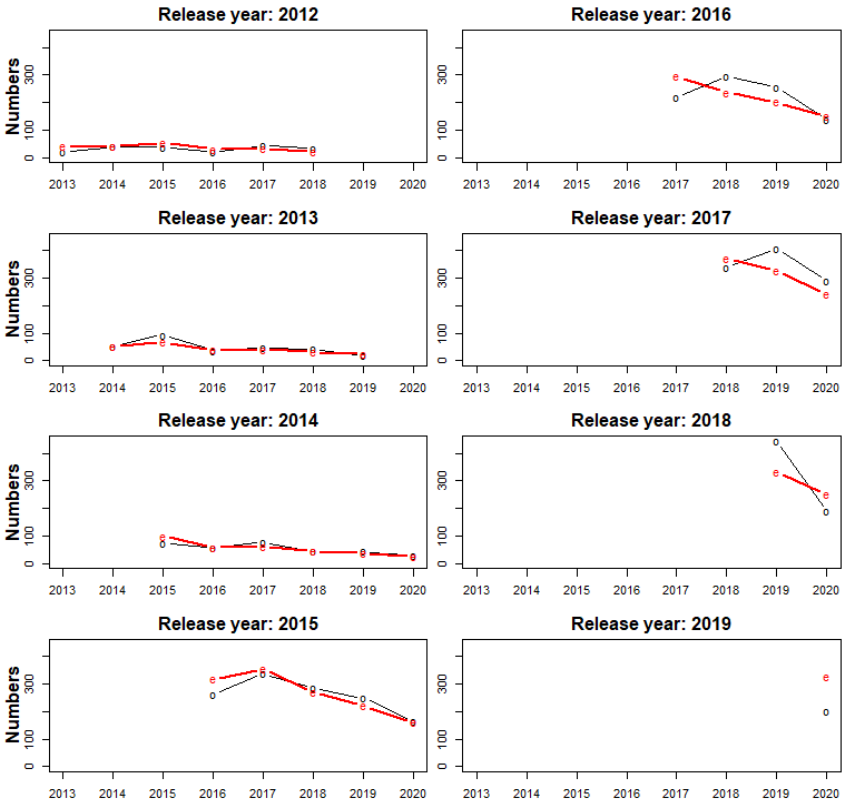


Figure 3: Observed (black lines) and expected (red lines) total tag recaptures by recapture year for tag releases in 2012–2019 and tag recaptures in 2013–2020.

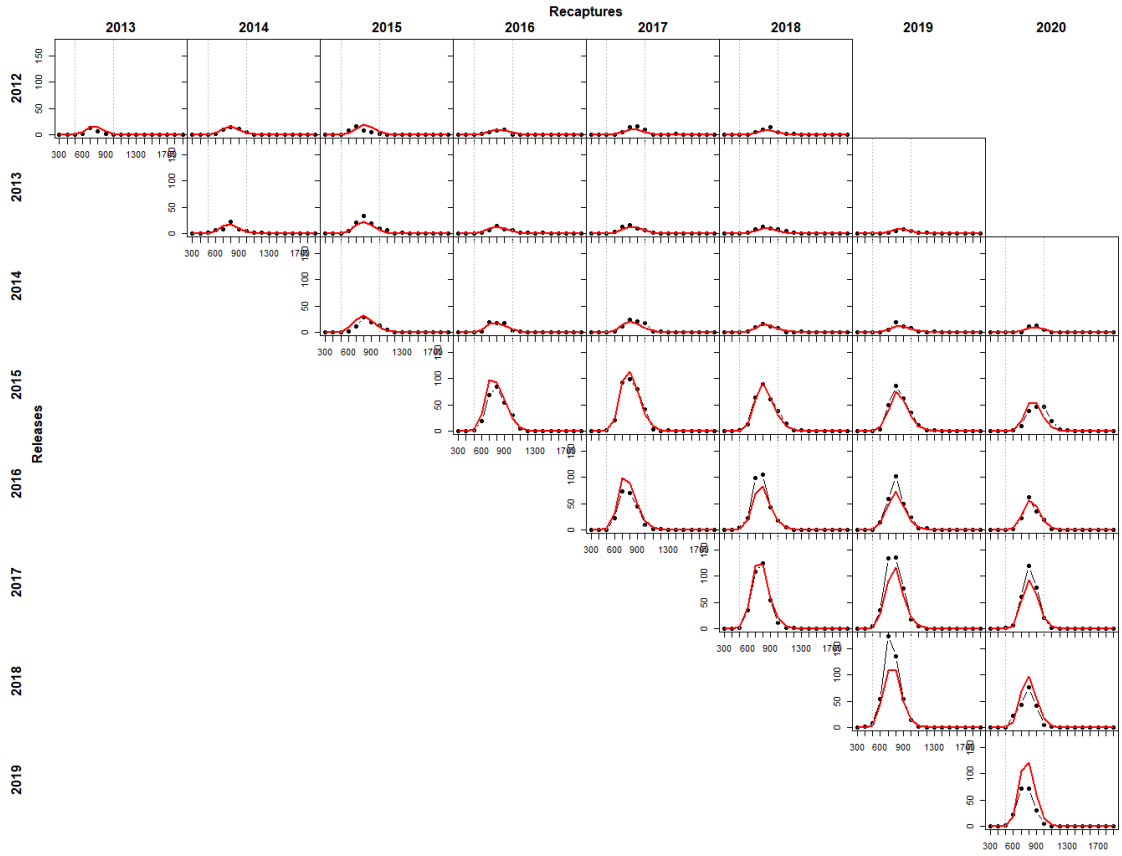


Figure 4: Observed (black lines) and expected (red lines) tag recaptures by 100 mm length for tag releases in 2012–2019 and tag recaptures in 2013–2020.

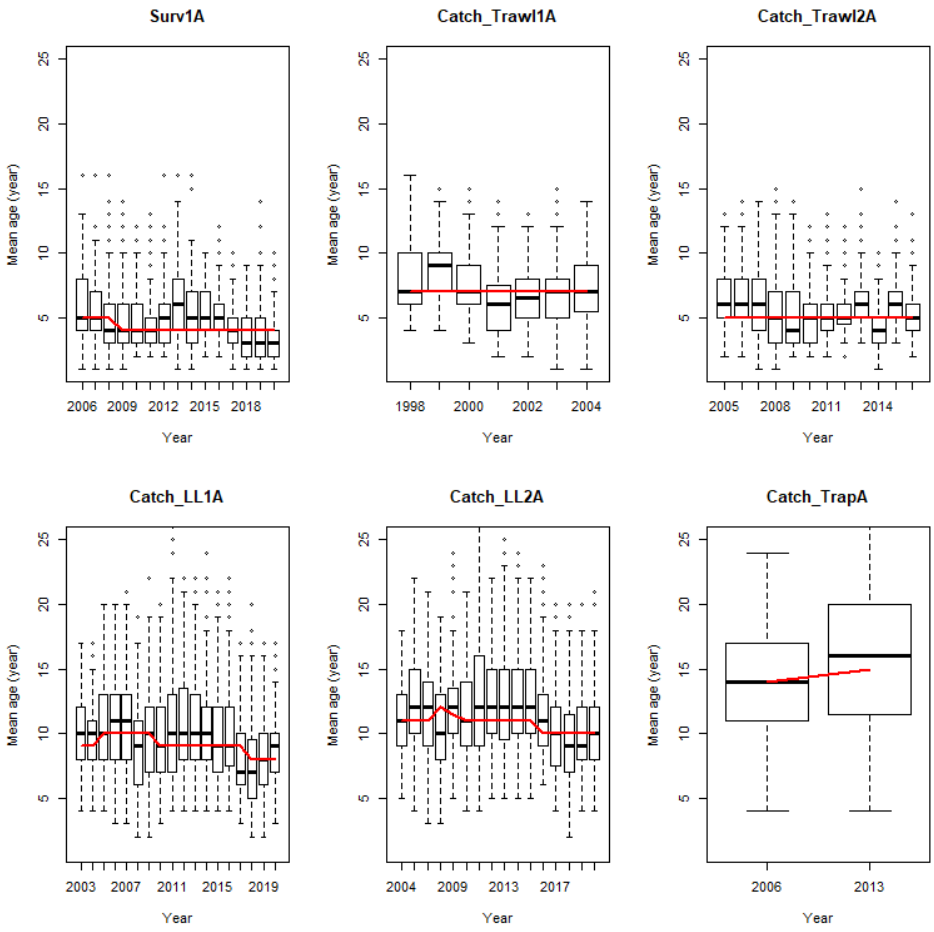


Figure 5: Boxplots of observed age by sub-fishery and expected median age (red line).

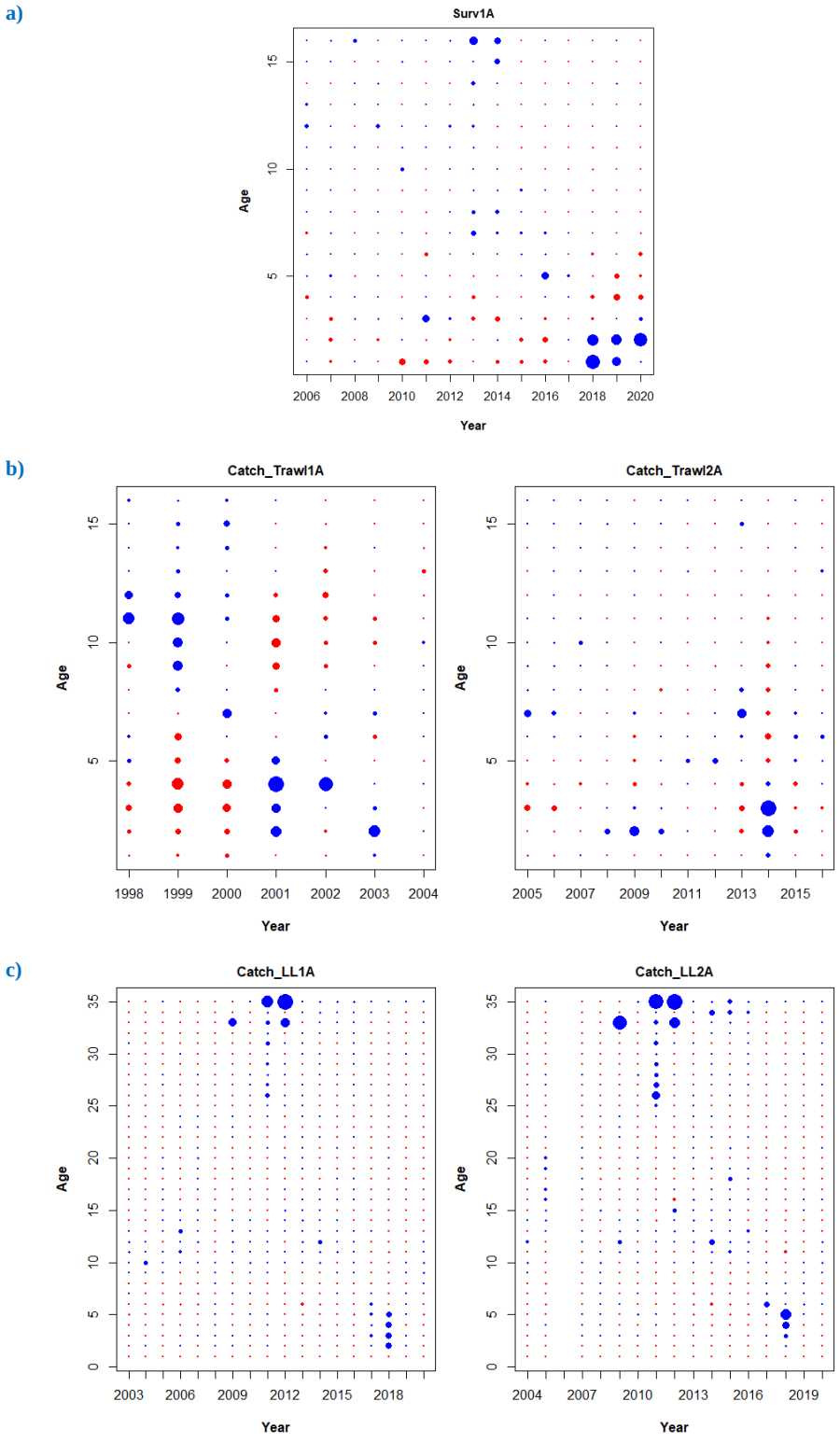


Figure 6: Pearson's residuals of MPD fits by age and year for the (a) survey, (b) commercial trawl and (c) longline sub-fisheries.

3. MCMC estimates

The 2021 assessment model estimated a virgin SSB (B_0) of 69 210 tonnes (95% CI: 64 811-74 758 tonnes) and an estimated SSB status in 2021 of 0.45 (95% CI: 0.44-0.47) (Table 2).

The estimated YCS showed large uncertainty for the earlier years 1986-1995, with an indication of a decline and increasingly higher confidence over time (Figure 7).

The estimated selectivity functions differed distinctly between the survey and the trawl, longline and trap sub-fisheries (Figure 8). The trawl surveys and the commercial trawl sub-fisheries observed predominantly young fish, while the longline and trap sub-fisheries concentrated on older fish, with LL2 in waters deeper than 1500 m catching older fish compared to LL1 in waters shallower than 1500 m. Trap was estimated to catch mainly fish older than 15 years

The trace plots of the MCMCs for B_0, survey q, and all estimated *YCS* showed acceptable mixing behaviour (Figures 9 and 10) and passed the Heidelberger & Welch (1983) stationary and half-width tests. There was some evidence of correlations in selectivity parameters of the survey, possibly due to the model bounds at the minimum age, however the resulting selectivity estimates were tight (Figure 8). While the trace plots for trap selectivity looked poor, this was likely to be without substantial consequences, since data from the trap fishery have little effect on biomass and *YCS* estimates.

.

Table 2: MCMC estimates of median SSB_0 and SSB status in 2021 with 95% confidence intervals.

B_0 (95% CI)	SSB status 2021 (95% CI)
69 210 (64 811 - 74 758)	0.45 (0.44 - 0.47)

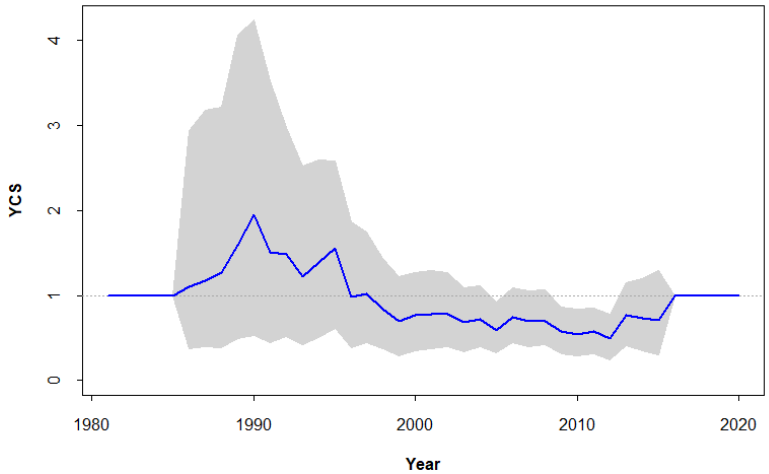


Figure 7: Year-class strength (YCS) estimates with 95% confidence bounds obtained from the MCMC samples.

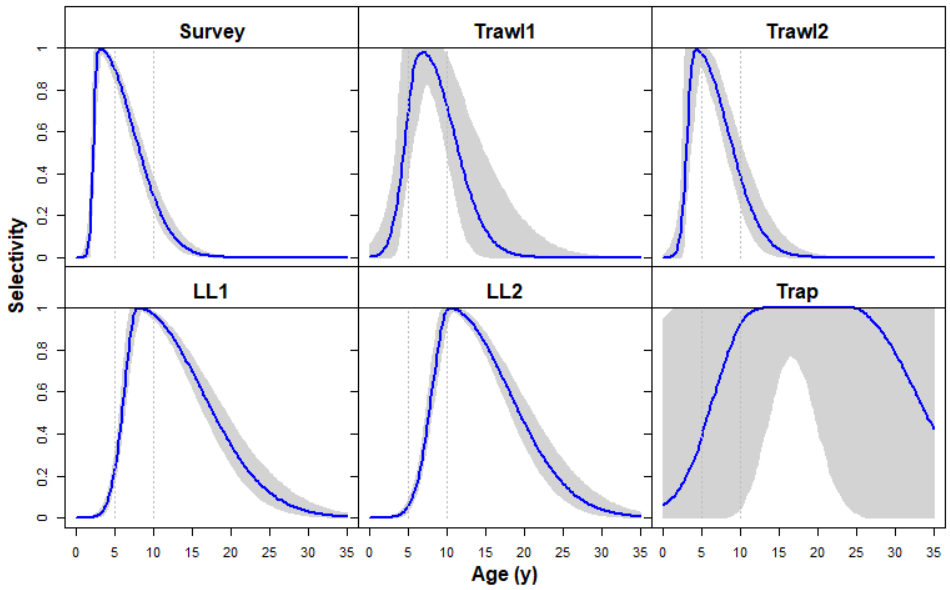


Figure 8: Estimated double-normal-plateau and double-normal fishing selectivity functions for the survey (Surv1) and commercial sub-fisheries, showing 95% confidence bounds obtained from the MCMC samples. Trawl1 is trawl from 1997 to 2004, Trawl2 is trawl from 2005 onwards, LL1 and LL2 are longline in <1 500 m and >1 500 m depth respectively. Vertical reference lines are shown at ages 5 and 10.

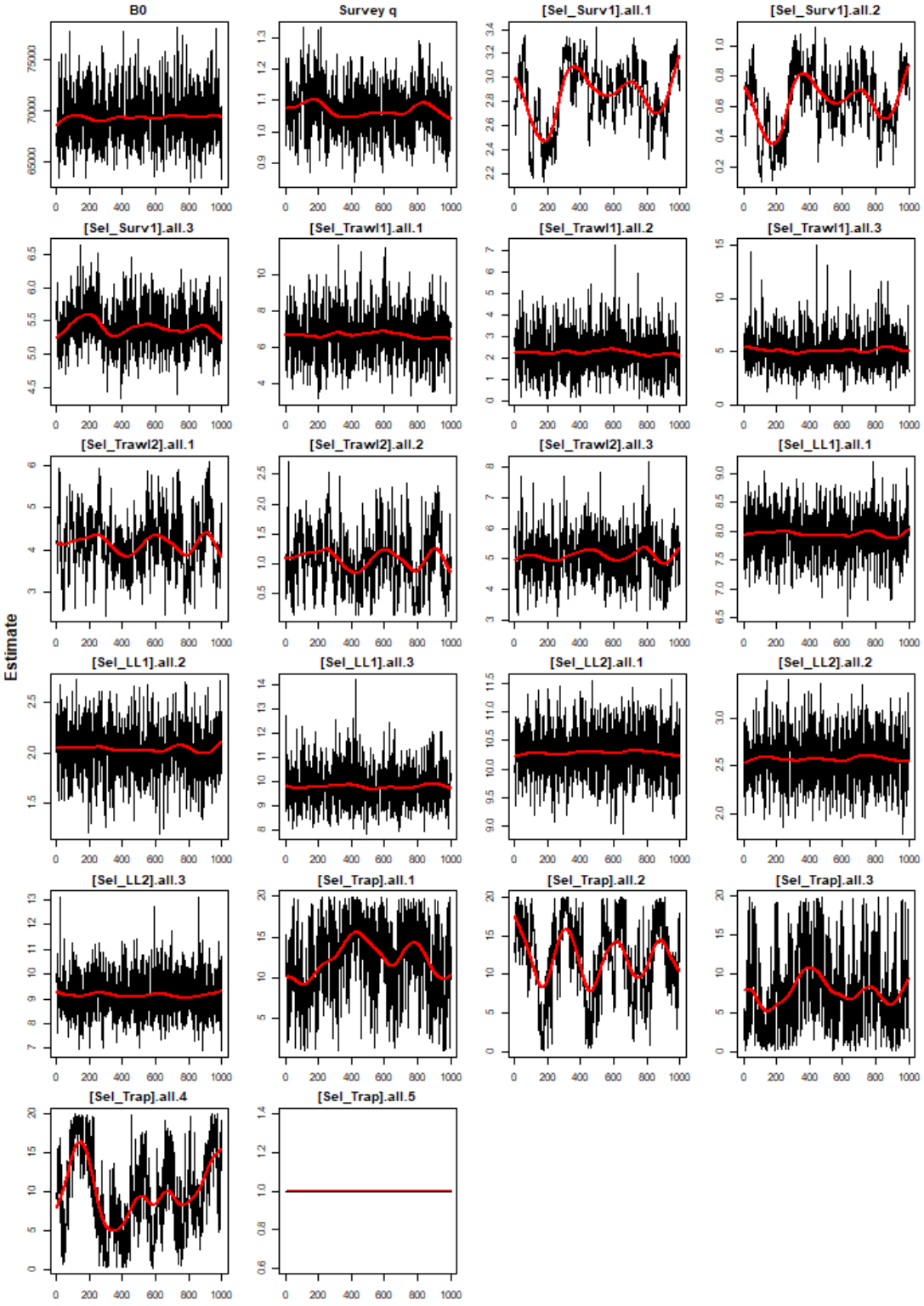


Figure 9: MCMC posterior trace plots for B_0, survey catchability q and all selectivity parameters.

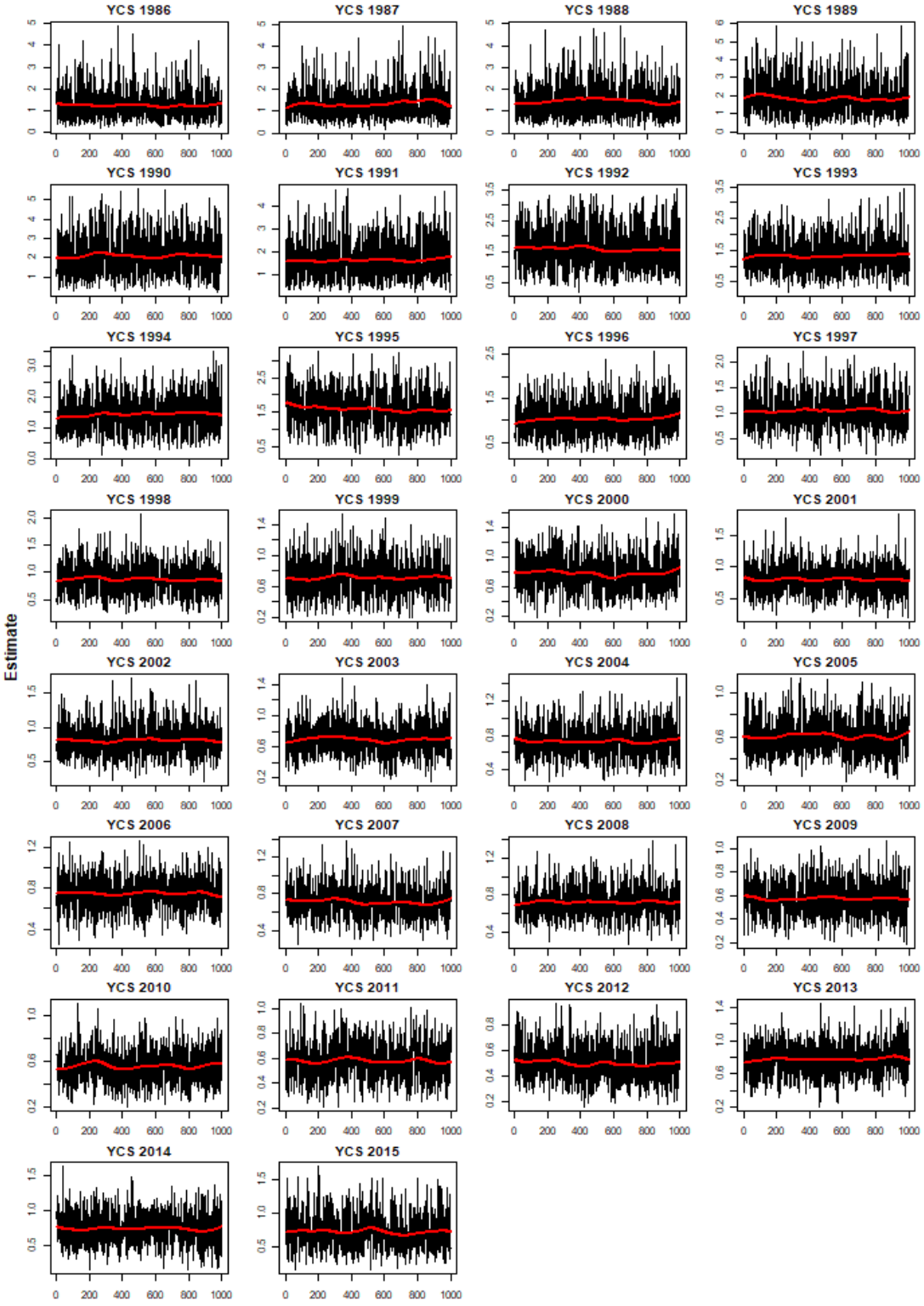


Figure 10: MCMC posterior trace plots for all estimated YCS parameters.

4. Yield estimates

The median CV estimated for the YCS period from 1986 to 2015 was used to generate the random recruitment from 2016 to 2020 and the 35-year projection period from 2021 to 2056 (σ_R = 0.47).

The estimated long-term yield from this projection was 3 010 tonnes with a depletion probability of 0.0 and an escapement probability of 0.501 (Table 3, Figure 11).

Table 3: Estimates of catch limits in tonnes based on MCMC sampling that satisfy the CCAMLR harvest control rules, with (i) a median escapement of the spawning biomass at the end of the 35-year projection period of at least 50% of the median pre-exploitation level ('Target'), and (ii) a less than 10% risk of the spawning biomass dropping below 20% of its median pre-exploitation level at any time over the 35-year projection period ('Depletion').

Model	Catch limit	Target	Depletion
2021 Assessment	3010	0.501	0.00

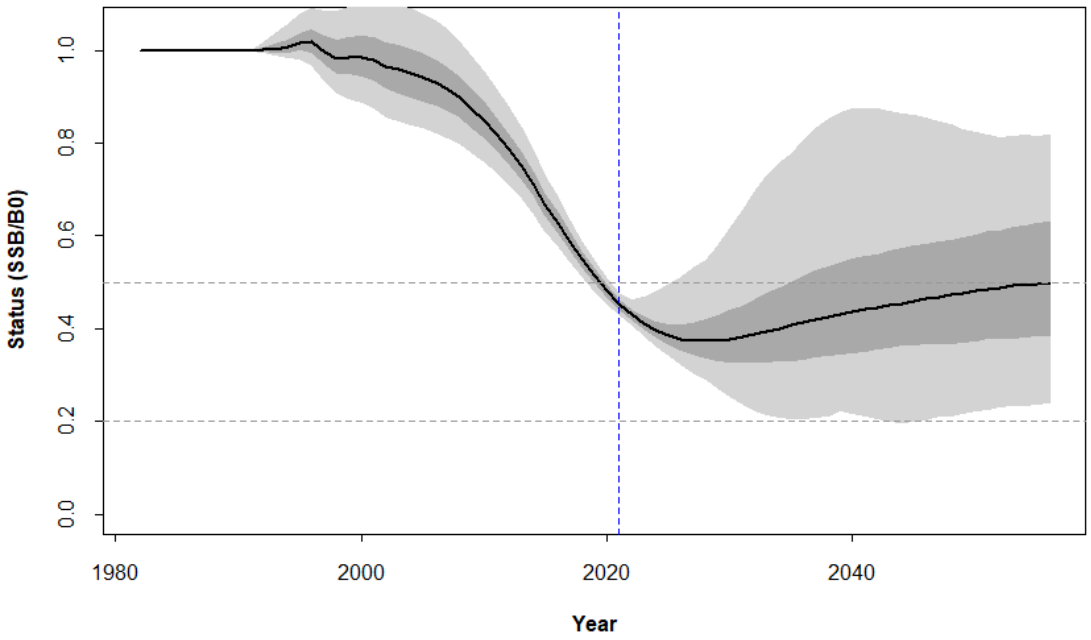


Figure 11: Projected SSB status relative to B0 for the assessment model and a constant future catch of 3010 tonnes using MCMC samples. The YCS period from 1986-2015 was used to generate random lognormal recruitment from 2016-2056. Shown are median (black line), 100% confidence bounds (light grey) and 80% confidence bounds (dark grey). Horizontal dotted lines show the 50% and 20% status levels used in the CCAMLR decision rules, the vertical blue line indicates the current year.

Additional Resources

- Fishery Summary: pdf, html
- Fishery Report: pdf, html
- Species Description: pdf, html
- Stock Annex: pdf
- Fisheries Documents Browser