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Further SCAA runs to Assess US South Atlantic Wreckfish

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Summary

Two SCAA variants are run to explore issues that arise from the alternative DB-SRA wreckfish assessment by MacCall (2012). First, in using SCAA to mimic that assessment which uses only CPUE data in fitting the model, an *M* of 0.038 yr^{-1} is found to provide the optimum fit, in contrast to the posterior median for *M* of 0.023 yr^{-1} estimated by MacCall's analysis. Secondly, developing MacCall's hypothesis of a selectivity dome to explain the paucity of larger fish in the catch, a dome of increasing steepness is introduced to the SCAA assessment with *M* fixed at 0.05. The effect is to increase estimates of biomasses and MSY, and also to improve the overall likelihood of the model fit through an improved fit to the catch-at-length data, but the fit to the CPUE data deteriorates.

Introduction

MacCall (2012) applies a Bayesian production model estimator (DB-SRA) fitted to the CPUE but not the catch-at-length data for the wreckfish fishery to assess the status and productivity of the resource.

The purpose of this paper is first to duplicate the essence of the MacCall (2012) approach within the SCAA framework of Butterworth and Rademeyer (2012). Secondly this paper then uses that same SCAA methodology to investigate MacCall's (2012) hypothesis of dome-shaped selectivity.

Data and Methodology

First, MacCall's (2012) approach is mimicked by fitting the SCAA model for different fixed values of natural mortality (*M*) with steepness (*h*) fixed at 0.75, but omitting consideration of the contribution of the catch-at-length data to the likelihood when choosing the "best" model, i.e. basing this on the fit to the CPUE data only.

For the second analysis, a dome in selectivity is introduced by replacing the flat-topped selectivity-at-length form above a length of 40 in by an exponential decrease:

$$S_l = e^{(-slope(l-40))} \qquad \text{for } l > 40$$

The SCAA assessment for *M* = 0.05 yr^{-1} and *h* = 0.75 is then re-run for a series of positive values of *slope*, reflecting increasingly steeper domes, and with that greater proportions of "cryptic" larger fish not available to the gear used.

Results

Table 1 shows the results of the first analysis. The best fit to the CPUE data only is found for *M* = 0.038 yr^{-1}, with the details of this fit being shown in Fig.1.

Results for the second analysis are shown in Table 2 for a range of *slope* values to a maximum of 0.2. Plots for the original fit (with flat selectivity, *slope* = 0) are compared to those with *slope* = 0.1 and 0.2 in Fig.2 (which shows the selectivity functions themselves) and Fig. 3 which reports the fit diagnostics.

Discussion

For the first analysis, the optimal fit to the CPUE data occurs for *M* = 0.038 (Table 1), somewhat larger than the posterior median of 0.023 found by MacCall (2012). The associated predicted catch-at-length distribution does not match the corresponding observed distribution well (Fig. 1). The associated value of 257 thousand lbs for MSY compares with a corresponding 350 thousand lbs for *M* = 0.05.

When *M* is kept fixed at 0.05 and increasingly steep doming in the selectivity at length is introduced, the estimated biomasses and MSY both increase and the overall fit in log likelihood terms improves as a result of an improved fit to the catch-at-length distribution (Table 2). However the fit to the CPUE deteriorates, to the extent that for *slope* = 0.2, the estimated biomasses become infinite and the model fails to reflect the changes in trend in these CPUE data over time (Fig. 3).

References

Butterworth, D S and Rademeyer, R A. 2012. An application of Statistical Catch at Age Methodology to assess south Atlantic wreckfish. Document presented to the October 2012 meeting of the South Atlantic Fishery Management Council SSC. 15pp.

MacCall, A D. 2012. A data-poor assessment of the US wreckfish fishery. Document presented to the October 2012 meeting of the South Atlantic Fishery Management Council SSC. 10pp.

Table 1: Results for the runs with different *M* values (in yr^{-1}), and steepness *h*=0.75 throughout. Values fixed on **input are bolded**.

M	**0.03**	**0.035**	**0.038**	**0.04**	**0.045**	**0.05**
'-lnL:overall	-38.1	-43.8	-46.2	-47.5	-49.5	-50.3
'-lnL:CPUE	-30.4	-31.4	-31.7	-31.7	-31.0	-29.7
'-lnL:CAL	-7.7	-12.4	-14.5	-15.8	-18.5	-20.7
'-lnL:RecRes	-	-	-	-	-	-
γ	**1**	**1**	**1**	**1**	**1**	**1**
θ	**1**	**1**	**1**	**1**	**1**	**1**
ζ	**0**	**0**	**0**	**0**	**0**	**0**
K^{sp} (tons)	7563	7422	7468	7447	7576	7957
B^{sp}_{2010} (tons)	2589	2702	2890	2976	3354	3976
B^{sp}_{2010}/K^{sp}	0.34	0.36	0.39	0.40	0.44	0.50
$MSYL^{sp}$	0.28	0.28	0.28	0.28	0.28	0.28
B^{sp}_{MSY} (tons)	2114	2090	2110	2108	2152	2258
$B^{sp}_{2010}/B^{sp}_{MSY}$	1.22	1.29	1.37	1.41	1.56	1.76
MSY ('000 lb and tons)	212 (96)	238 (108)	257 (116)	269 (122)	304 (138)	350 (159)
F_{MSY}	0.05	0.06	0.07	0.07	0.09	0.10
F_{2010}	0.05	0.05	0.05	0.05	0.04	0.04
σ_{com}	0.13	0.13	0.12	0.12	0.13	0.14
σ_{len}	0.14	0.13	0.12	0.12	0.12	0.11

Table 2: Results for the runs with different fixed values for the selectivity *slope* (in units of in^{-1}), with *M*=0.05 yr^{-1} and *h*=0.75 throughout. Values fixed on **input are bolded**.

Selectivity slope	**0**	**0.02**	**0.04**	**0.06**	**0.08**	**0.1**	**0.15**	**0.2**
'-lnL:overall	-50.3	-52.6	-54.8	-57.0	-59.1	-61.2	-65.1	-64.8
'-lnL:CPUE	-29.7	-29.1	-28.3	-27.4	-26.4	-25.3	-22.8	-22.1
'-lnL:CAL	-20.7	-23.5	-26.5	-29.5	-32.7	-35.9	-42.3	-42.7
'-lnL:RecRes	-	-	-	-	-	-	-	-
γ	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
θ	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
ζ	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
K^{sp} (tons)	7957	8411	8911	9743	11199	13289	45114	3268960*
B^{sp}_{2010} (tons)	3976	4392	4866	5665	7079	9140	40866	3264630
B^{sp}_{2010}/K^{sp}	0.50	0.52	0.55	0.58	0.63	0.69	0.91	1.00
$MSYL^{sp}$	0.28	0.28	0.28	0.27	0.27	0.26	0.26	0.25
B^{sp}_{MSY} (tons)	2258	2357	2456	2647	3014	3516	11568	810145
$B^{sp}_{2010}/B^{sp}_{MSY}$	1.76	1.86	1.98	2.14	2.35	2.60	3.53	4.03
MSY ('000 lb and tons)	350 (159)	367 (166)	388 (176)	422 (192)	480 (218)	570 (258)	1908 (865)	139027 (63062)
F_{MSY}	0.10	0.10	0.10	0.09	0.09	0.09	0.09	0.09
F_{2010}	0.04	0.03	0.03	0.02	0.02	0.02	0.00	0.00
σ_{com}	0.14	0.14	0.15	0.15	0.16	0.17	0.19	0.20
σ_{len}	0.11	0.11	0.10	0.10	0.09	0.09	0.08	0.08

* The actual estimate is infinity; the value given is simply where the numerical procedure ceases iterating further; this applies also to other biomass-related estimates.

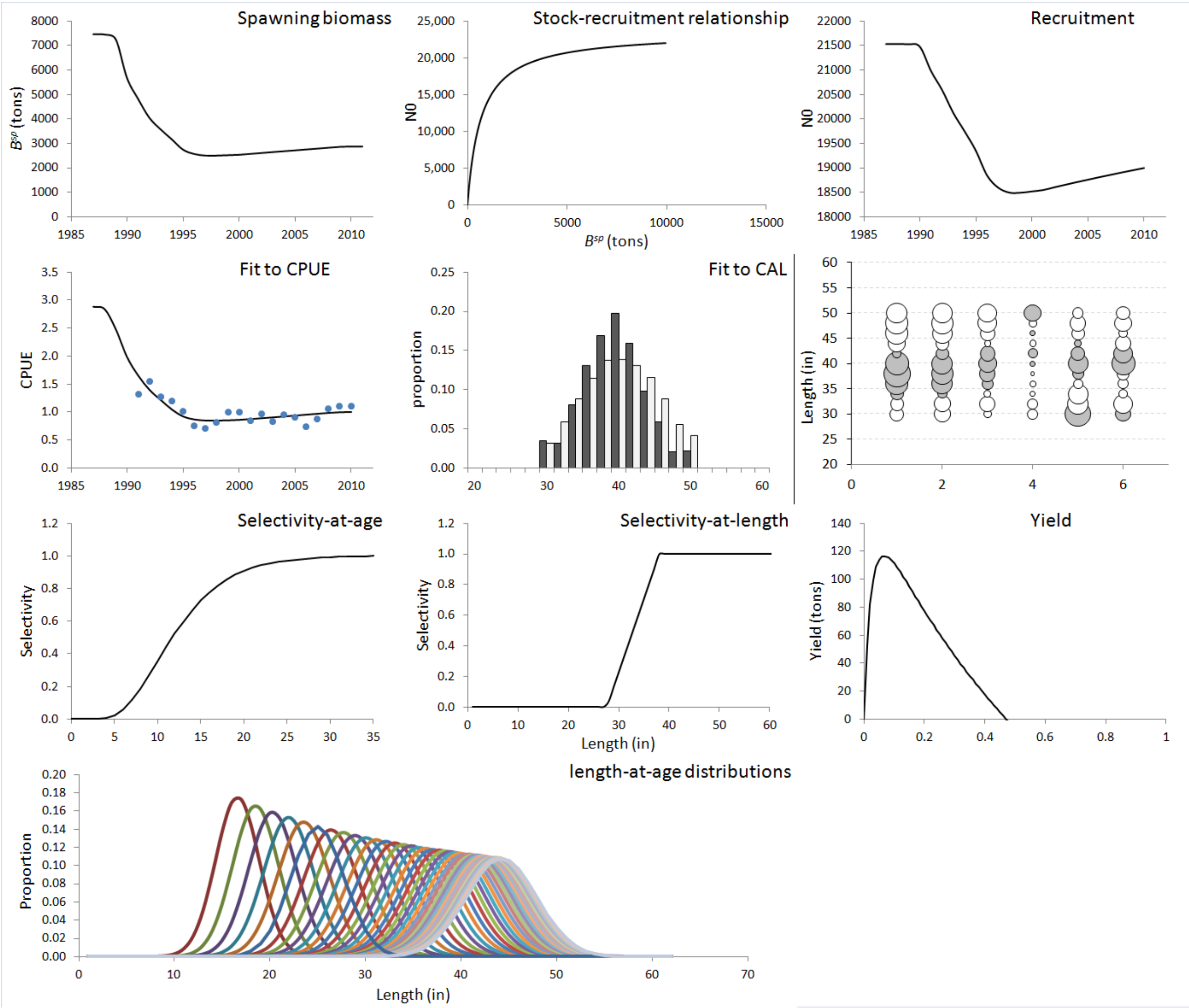

Fig. 1: Results for the run with M=0.038 (h=0.75). The Fit to CAL is averaged over the years for which data are available; for the CAL residuals, the size (area) of the bubble is proportional to the magnitude of the corresponding standardised residual (for positive residuals the bubbles are grey, whereas for negative residuals they are white); for the length-at-age distributions, the distributions, starting from the left, correspond to ages 0, 1, 2, ... , 35.

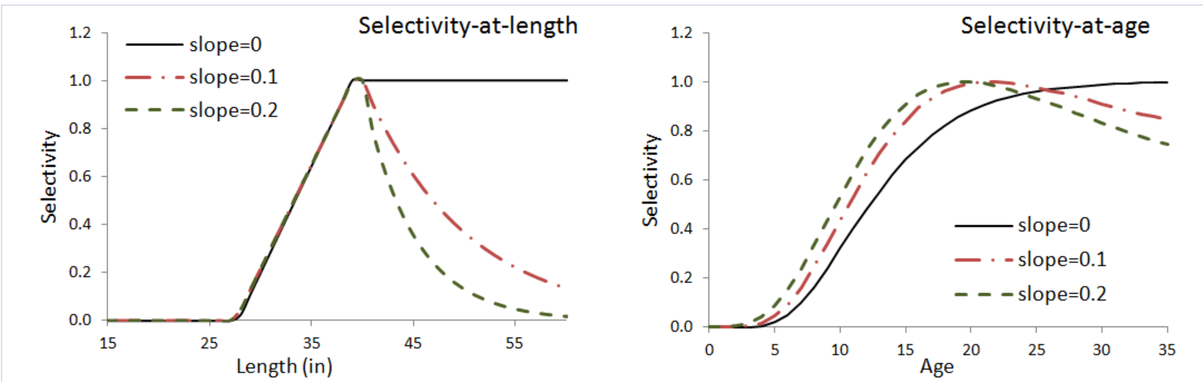

Fig. 2: Selectivity-at-length and resulting selectivity-at-age for three fixed values for the selectivity *slope*.

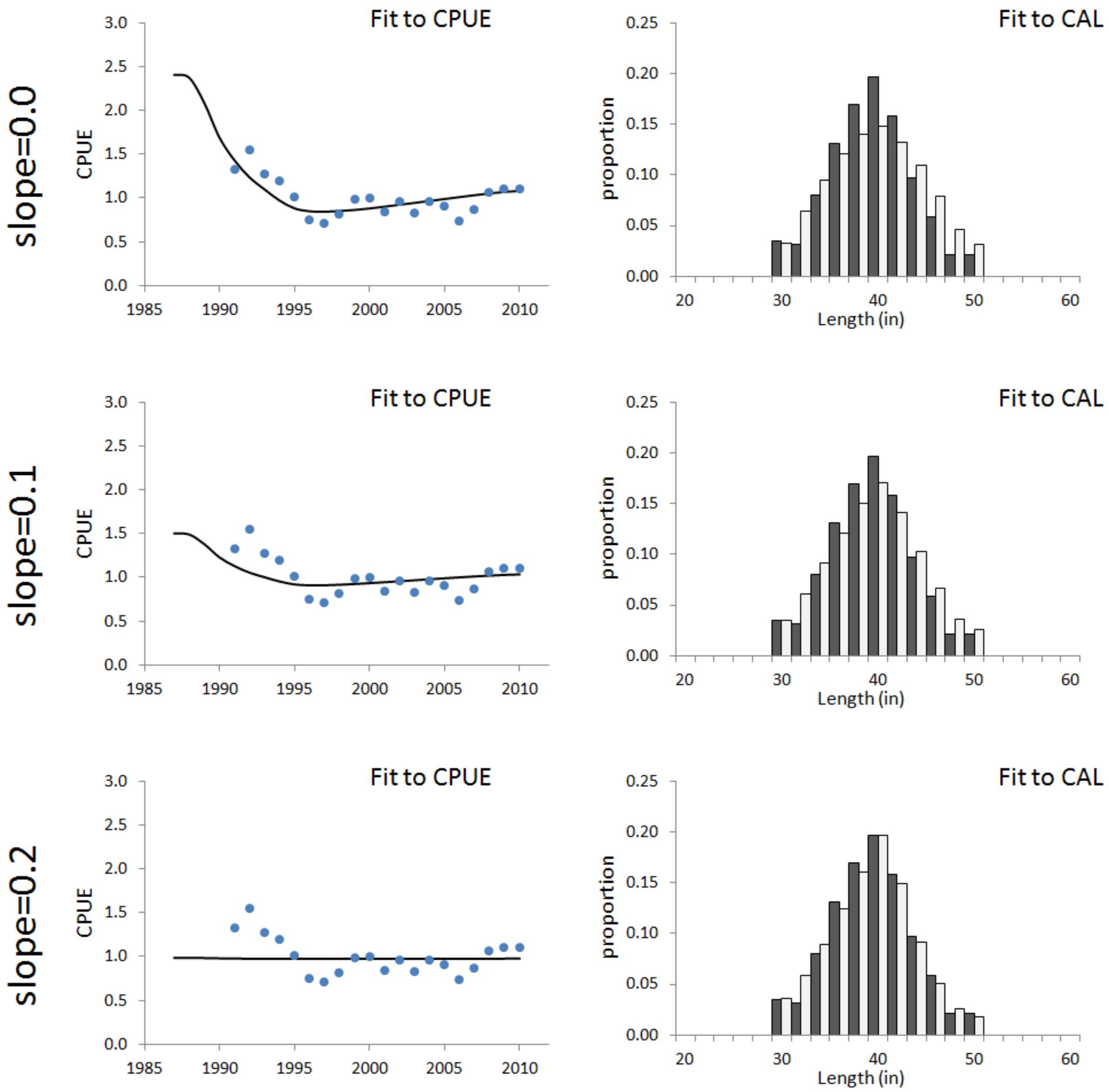

Fig. 3: Fit to the CPUE and CAL data (as averaged over all the years with data available; for the CAL, the filled bars reflect the data) for three runs with fixed slope for the selectivity.