Further results for An Application of Statistical Catch-at-Age Assessment Methodology to Assess US South Atlantic Wreckfish

Doug S. Butterworth and Rebecca A. Rademeyer

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

November 2013

Summary

Results of SCAA model runs are presented for an initial set of sensitivities which were specified during a conference call amongst the wreckfish subgroup on 31st October. These include consideration of .the Lytton growth curve, alternative values for natural mortality and stock-recruitment steepness, an open population, domed selectivity, different trends in landings over 2001 to 2008, not assuming the population was at unexploited equilibrium when the catch series commences in 1987, and downweighting the contribution of the catch at length relative to that of the CPUE data in the likelihood.

Introduction

This document reports the results of further runs of the wreckfish SCAA assessment model, where these runs are broadly as chosen for initial attention by members of the wreckfish subgroup in a conference call held on 31st October.

Data and Methodology

The data and methods are as described in Butterworth and Rademeyer (2012), except for the growth curve and length-weight parameters. The new growth curve and length-weight parameters are from Lytton (pers commn):

Von Bertalanffy growth parameters:

L_{inf}	1017	(in mm, fork length)
K	0.132	(in yr^{-1})
t_0	-3.56	(in yr)

Weight-length parameters:

α	1.00E-05	(in gm)
β	3.0778	

Sensitivities are based on the Reference Case (RC) (Lytton's growth curve, *M*=0.4, *h*=0.75):

1) Implications of an open population – this implies recruitment will be unaffected by the size of the spawning biomass so set *h*=1 ("*h*=1")

2) Allow for domed selectivity – exponential trend downwards from *l*=40 cm – for alternative fixed values for that trend ("Dome=0.05", "Dome=0.1" and "Dome=0.15" – see further explanation below)

3) The 2001-2008 catches – the average value for each year is used in the RC – replace by a linear trend up, down or up and down over time ("Cup10", "Cdown10", "Cupdown10" and "Cupdown20")

4) Not assuming that the assessment starts at unexploited equilibrium *K* at the beginning of the data series – instead assume 0.8*K* and 1.2*K* ("θ=0.8" and " θ=1.2")

6) Downweight the CAL data relative to the CPUE; specifically set Wlen = 0.1 rather than the RC assumption that Wlen=1 ("Wlen=0.1").

Results

The basic results of applications of the model across the grid of five values of *M* and three of *h* considered are shown in Table 1. Note that for the runs presented in Rademeyer and Butterworth (2013) selectivity-at-length was mistakenly held fixed. This has been corrected here.

The fit to the CPUE data and CAL data are contrasted in Fig. 1 for the choice of four *M* values.

Results for the Reference Case (RC) (*M*=0.04, *h*=0.75) are given in Fig. 2. The reason for choosing *M*=0.04 for the RC is that unlike *M*=0.05 previously, it offers virtually the best fit to the CPUE data now that Lytton's growth is being used.

Fig. 3 compares the recruitment and spawning biomass trajectories for the RC and the sensitivity for which recruitment is unaffected by the size of the spawning biomass ("*h*=1").

The assumed annual catches for the period 2001-2008 and resulting spawning biomass trajectories for the RC and four variants are compared in Fig. 4.

For the RC, selectivity-at-length is assumed to be flat for large fish. Three sensitivities are presented for which selectivity-at-length is assumed to decrease exponentially from length *l*=40cm ($S_l = S_{l-1}e^{-d}$ for *l*>40cm) with *d* fixed at 0.05, 0.1 and 0.15. The resulting selectivities and spawning biomass trajectories are shown in Fig. 5.

Fig. 6 compares the spawning biomass trajectories for the RC and the sensitivities with different initial conditions.

Results for the RC and the sensitivity in which the CAL data are downweighted are shown in Fig. 7.

Discussion

The patterns of results in relation to input value choices for *h* and *M* are broadly as in Butterworth and Rademeyer (2012). However, given now the use of the Lytton growth curve, results become unrealistic as *M* approaches 0.075, and *M*=0.04 provides almost the best fit to the CPUE data. This last scenario is thus now chosen as the Reference Case (RC).

For an open population (*h*=1) the productivity (MSY) is estimated to be higher than for the RC. On the other hand changing catch trends over the 2001-2008 period hardly affects the results.

An intermediate level of doming (Dome = 0.1) gives the best fit to the data, and suggests a somewhat higher MSY than the RC. Increasing or decreasing the initial (1987) abundance relative to the average pre-exploitation level (*K*) results in decreases or increases respectively to MSY. Downweighting the CAL data in the likelihood by a factor of 10 reduces the MSY estimate by about 10%.

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.

Rademeyer, R.A. and Butterworth, D.S. 2013. Further SCAA runs of US South Atlantic Wreckfish.

Table 1: Results for the 15 basic runs presented of this paper, with different *M* and *h* values. Values fixed on **input are bolded**.

Run	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
h	**0.6**	**0.75**	**0.9**	**0.6**	**0.75**	**0.9**	**0.6**	**0.75**	**0.9**	**0.6**	**0.75**	**0.9**	**0.6**	**0.75**	**0.9**
M	**0.025**	**0.025**	**0.025**	**0.04**	**0.04**	**0.04**	**0.05**	**0.05**	**0.05**	**0.06**	**0.06**	**0.06**	**0.075**	**0.075**	**0.075**
'-lnL:overall	-64.1	-65.0	-65.5	-68.4	-67.8	-67.2	-66.7	-66.0	-65.6	-65.0	-64.8	-64.7	-63.8	-63.8	-63.8
'-lnL:CPUE	-29.7	-30.5	-31.1	-30.8	-30.4	-29.6	-27.9	-26.9	-26.2	-24.5	-24.1	-23.8	-22.1	-22.1	-22.1
'-lnL:CAL	-34.3	-34.5	-34.4	-37.6	-37.5	-37.6	-38.8	-39.2	-39.4	-40.5	-40.7	-40.8	-41.7	-41.7	-41.7
'-lnL:RecRes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
γ	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
θ	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
ζ	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
K^{sp} (tons)	8273	8057	8005	7627	7725	7996	8454	9101	9671	12761	14006	14909	3268870*	3268880*	3268880*
B^{sp}_{2010} (tons)	3026	2956	3014	3251	3550	3969	4601	5459	6173	9400	10838	11866	3266130	3266300	3266410
B^{sp}_{2010}/K^{sp}	0.37	0.37	0.38	0.43	0.46	0.50	0.54	0.60	0.64	0.74	0.77	0.80	1.00	1.00	1.00
$MSYL^{sp}$	0.31	0.26	0.20	0.32	0.26	0.20	0.32	0.26	0.20	0.32	0.26	0.19	0.31	0.26	0.19
B^{sp}_{MSY} (tons)	2603	2102	1600	2406	2020	1589	2669	2379	1904	4028	3646	2886	1027830	841793	611300
$B^{sp}_{2010}/B^{sp}_{MSY}$	1.16	1.41	1.88	1.35	1.76	2.50	1.72	2.29	3.24	2.33	2.97	4.11	3.18	3.88	5.34
MSY ('000 lb and tons)	168 (76)	208 (94)	252 (114)	247 (112)	317 (144)	398 (181)	340 (154)	462 (209)	595 (270)	608 (276)	843 (382)	1'091 (495)	192'790 (87448)	244'031 (110691)	298'795 (135531)
F_{MSY}	0.03	0.04	0.07	0.05	0.08	0.13	0.06	0.10	0.16	0.07	0.12	0.20	0.10	0.15	0.27
F_{2010}	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00
σ_{com}	0.14	0.13	0.13	0.13	0.13	0.14	0.15	0.16	0.16	0.18	0.18	0.18	0.20	0.20	0.20
σ_{len}	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.08	0.08	0.08	0.08	0.08	0.08	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.

Table 2: Results for some sensitivities (see text for descriptions), with M=0.04 and h=0.75 values. Values fixed on **input are bolded**. RC is run 5 of Table 1.

Run	RC	h=1	Cdown10	Cup10	Cupdown10	Cupdown20	Dome=0.05	Dome=0.1	Dome=0.15	θ=0.8	θ=1.2	Wlen=0.1
'-lnL:overall	-67.8	-66.9	-68.4	-67.3	-67.9	-68.0	-70.5	-71.4	-69.8	-63.7	-69.5	-34.8
'-lnL:CPUE	-30.4	-29.1	-31.1	-29.6	-30.5	-30.6	-29.1	-27.9	-25.1	-26.4	-31.0	-31.3
'-lnL:CAL	-37.5	-37.7	-37.3	-37.7	-37.4	-37.4	-41.4	-43.5	-44.7	-37.3	-38.5	-3.5
'-lnL:RecRes	-	-	-	-	-	-	-	-	-	-	-	-
γ	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
θ	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**0.8**	**1.2**	**1**
ζ	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
K^{sp} (tons)	7725	8204	7613	7875	7689	7657	8475	9302	14221	10861	6502	6836*
B^{sp}_{2010} (tons)	3550	4253	3447	3692	3514	3481	4259	5053	9925	5223	3190	2667
B^{sp}_{2010}/K^{sp}	0.46	0.52	0.45	0.47	0.46	0.45	0.50	0.54	0.70	0.48	0.49	0.39
$MSYL^{sp}$	0.26	0.13	0.26	0.26	0.26	0.26	0.26	0.25	0.24	0.26	0.26	0.26
B^{sp}_{MSY} (tons)	2020	1026	1991	2061	2011	2002	2172	2331	3477	2841	1703	1791
$B^{sp}_{2010}/B^{sp}_{MSY}$	1.76	4.15	1.73	1.79	1.75	1.74	1.96	2.17	2.85	1.84	1.87	1.49
MSY ('000 lb and tons)	317 (144)	470 (213)	313 (142)	322 (146)	316 (143)	315 (143)	346 (157)	380 (173)	577 (262)	445 (202)	265 (120)	285 (129)
F_{MSY}	0.08	0.24	0.08	0.08	0.08	0.08	0.07	0.07	0.07	0.08	0.07	0.08
F_{2010}	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.01	0.02	0.04	0.05
σ_{com}	0.13	0.14	0.13	0.14	0.13	0.13	0.14	0.15	0.17	0.16	0.13	0.13
σ_{len}	0.09	0.09	0.09	0.09	0.09	0.09	0.08	0.08	0.08	0.09	0.09	0.09

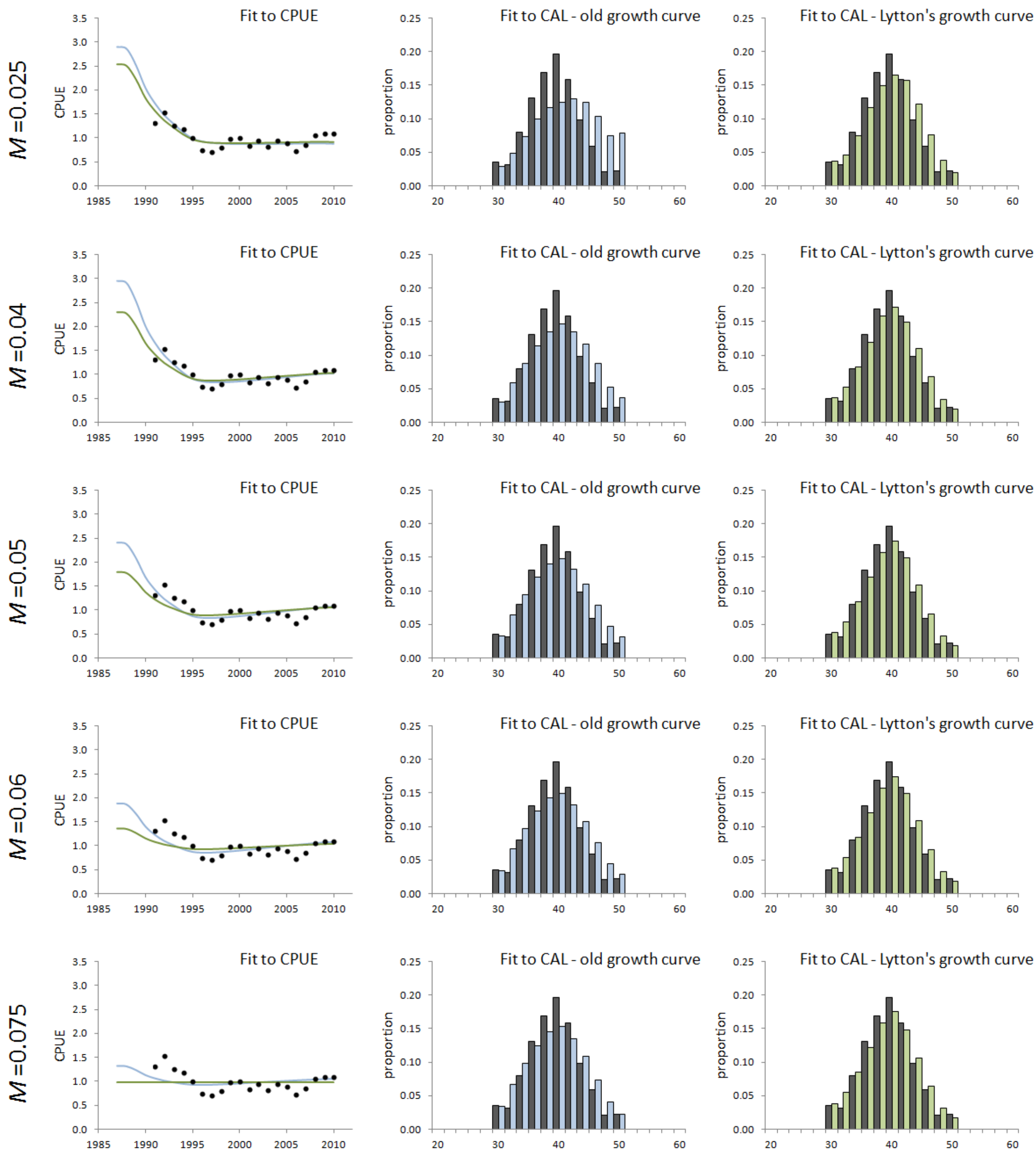

Fig. 1: Fit to the CPUE and CAL data (as averaged over all the years with data available; for the CAL, the filled bars reflect the data) for the five basic runs with *h*=0.75.The blue curve is for the model with the old growth curve while the green curve is for the model with Lytton's growth curve.

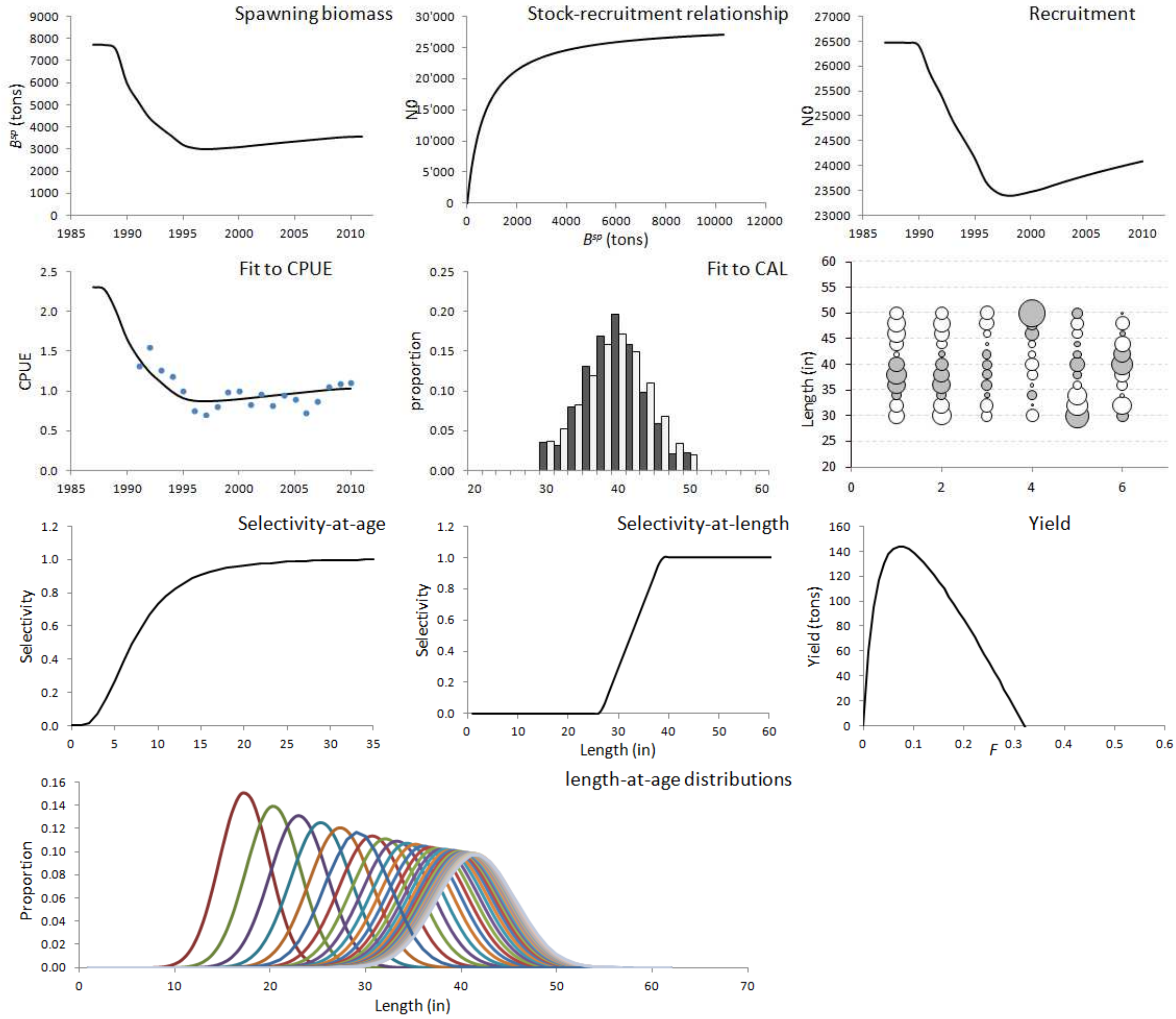

Fig. 2: Results for the RC = run 5 (h=0.75, M=0.04). The fit to CAL is averaged over years for which data are available; for the CAL residuals, the size (area) of the bubble is proportional to the magnitude of the corresponding standardised residual (for positive residuals the bubbles are grey, whereas 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.

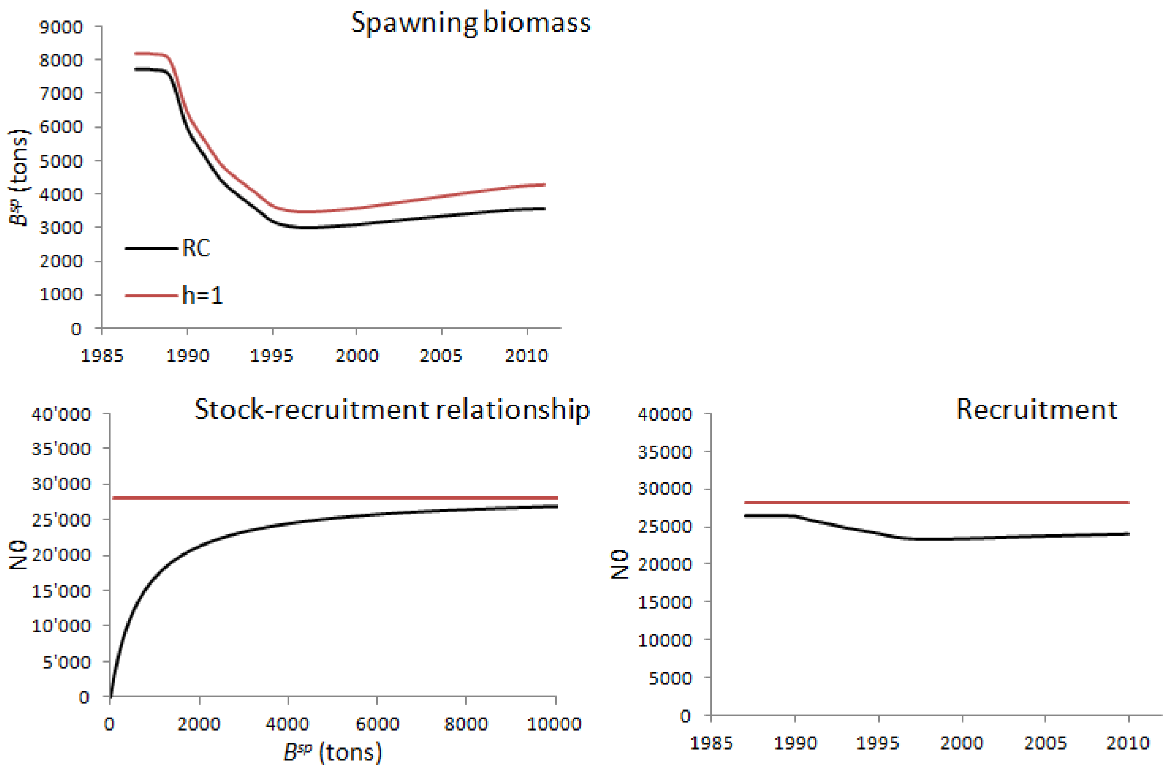

Fig. 3: Spawning biomass trajectories, stock-recruitment relationships and time-series of recruitment for the RC and the sensitivity with *h*=1.

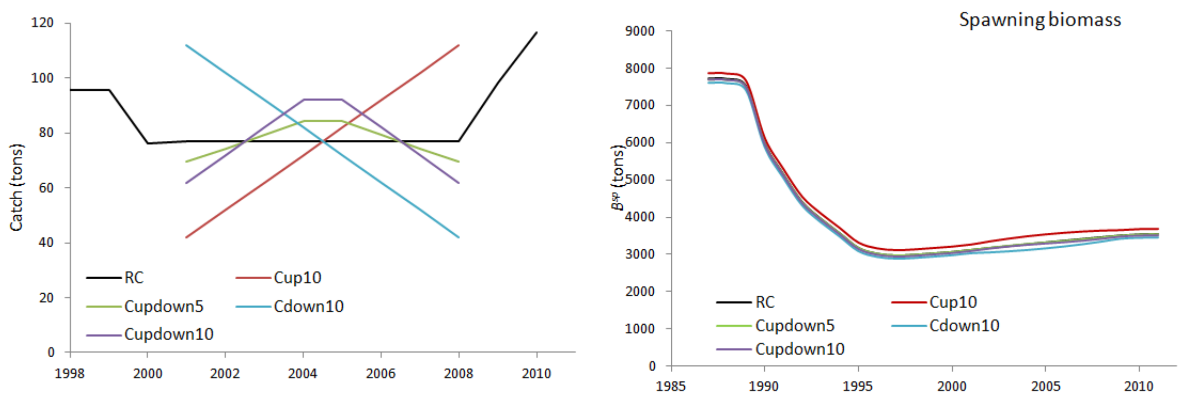

Fig. 4a: Assumed annual catches for the period 2001-2008 and spawning biomass trajectories for the RC and four variants for catch trends over this period.

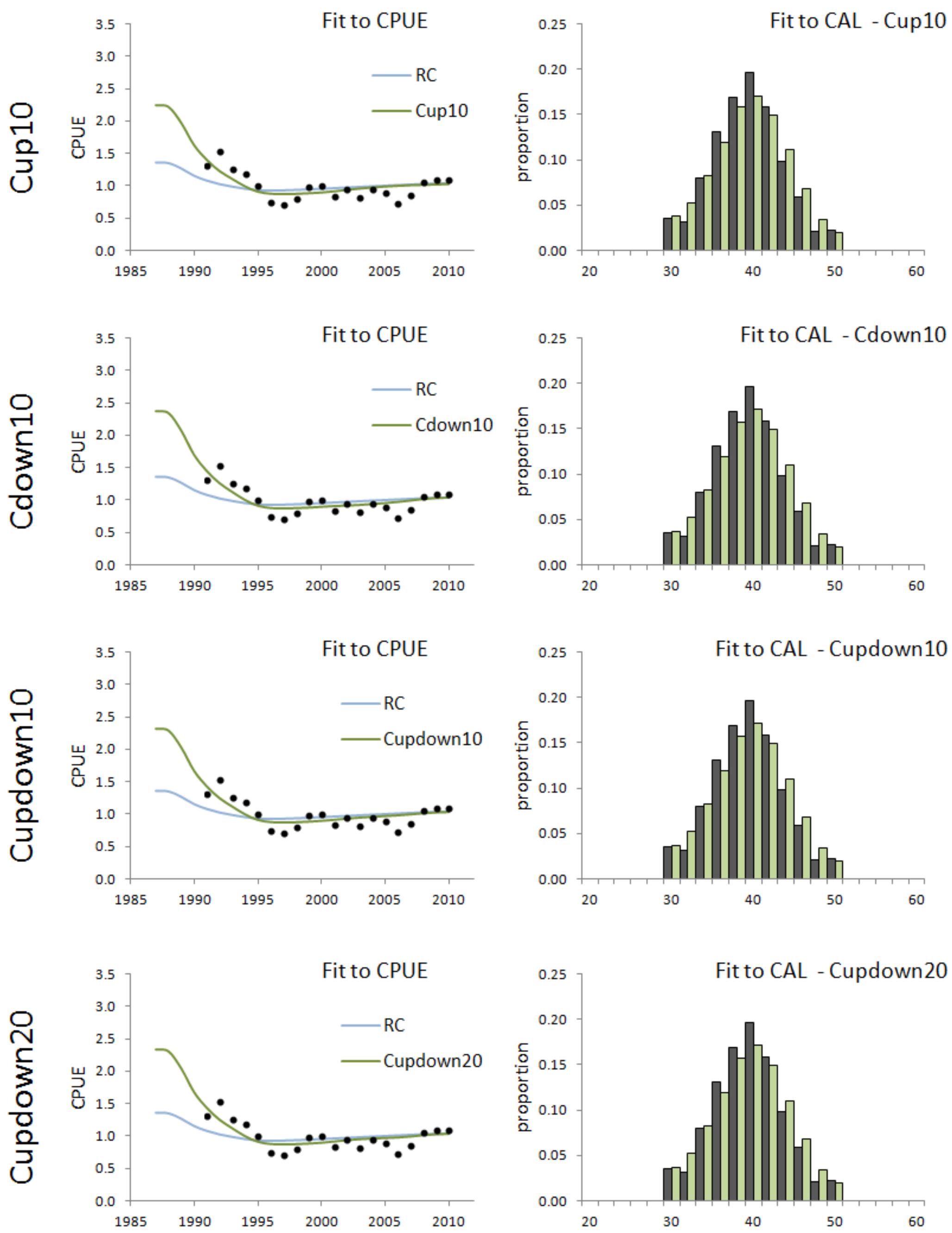

Fig. 4b: Fit to the CPUE and CAL data (as averaged over all the years with data available; for the CAL, the filled bars reflect the data) for the four runs with different trends for 2001-2008 catches.

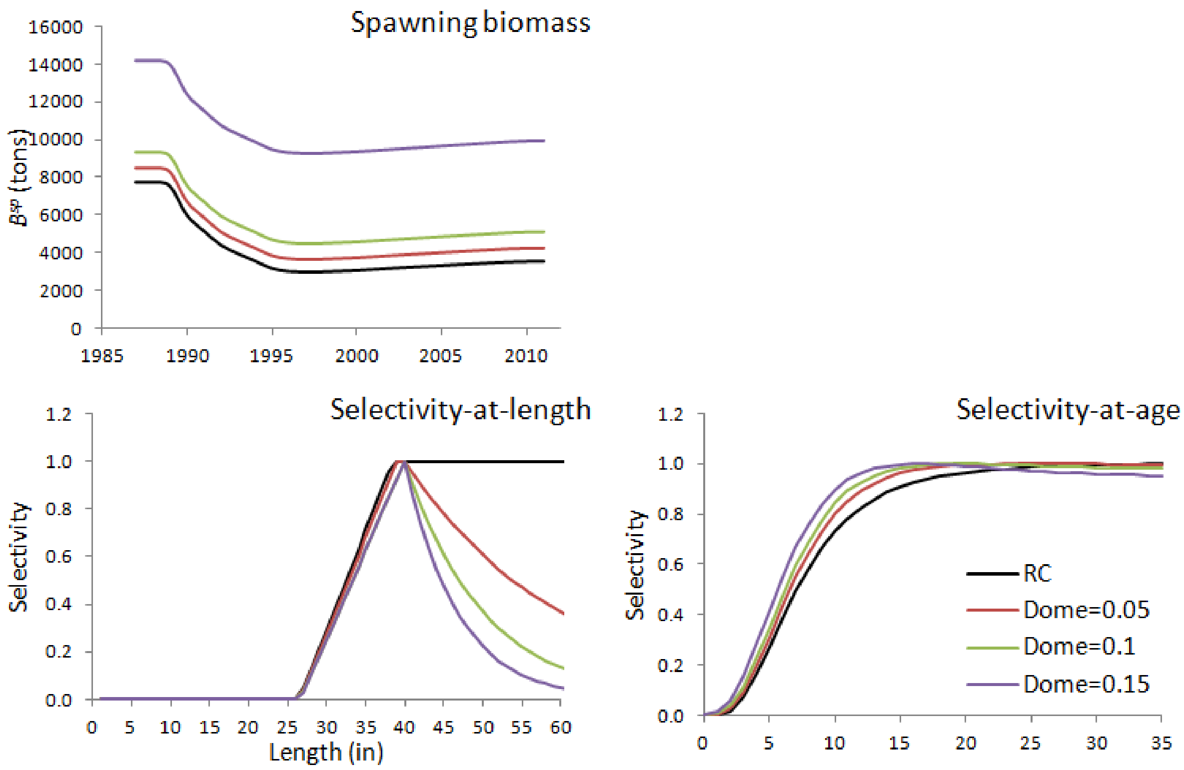

Fig. 5: Spawning biomass trajectories and selectivities-at-length and -at-age for the RC and three variants with decreasing selectivity for larger fish.

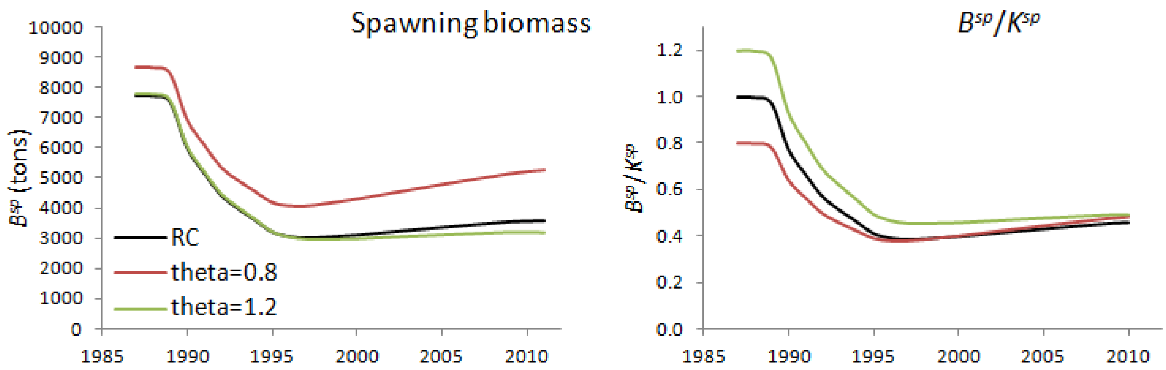

Fig. 6: Spawning biomass (in absolute terms and in term of pre-exploitation level) trajectories for the RC and two variants with different initial conditions.

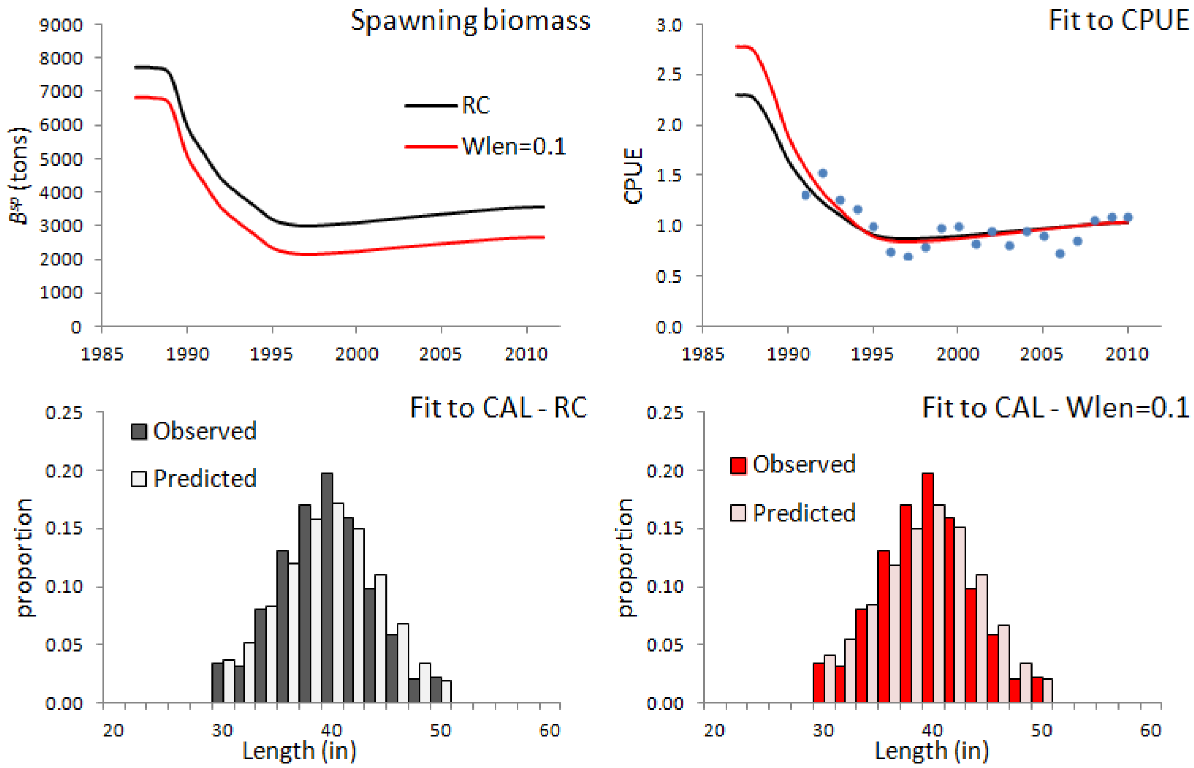

Figure 7: Some results for the RC and the sensitivity which downweights the CAL data (Wlen=0.1). The fit to CAL is averaged over the years for which data are available.