Yet further 2019 horse mackerel assessments and projections

S.J. Johnston and D.S. Butterworth

Marine Resource Assessment and Management Group
University of Cape Town
Rondebosch, 7700

Summary

This document reports yet further updated 2019 horse mackerel assessments, along with constant midwater catch projections for the base case model, in accordance with requests made by the Demersal Working Group. These include differentiating survey selectivity on the basis of old and new gears, and exploring alternative values for natural mortality at age.

INTRODUCTION

At the previous SWG meeting, where FISHERIES/2019/OCT/SWG-DEM/30 was discussed, the following recommendations were made with regards to the horse mackerel assessment model.

- Change the natural mortality from being a constant (M), to being age-dependant (M_a). This will allow exploration of changes to the constant M assumption.
- Change the time varying survey selectivity so that rather two selectivity functions are estimated that separately reflect the old and new survey gears.

ASSESSMENT MODELS

BC The previous model 3b with a catchability change over 2014 to 2016, but instead of time-varying survey/demersal trawl selectivity (five different periods), the BC model now estimates two survey selectivity functions. The "OLD" selectivity function is used for surveys conducted with the old gear, with the "NEW" selectivity function used for surveys conducted with the new gear. The old gear selectivity function is assumed to apply for the demersal fisheries bycatches taken.

VAR 1 BC model but natural mortality M_{10+} = 2.0 (M_a for other ages remain 0.3), i.e. the size of the plus group is much reduced.

VAR 2 BC model but natural mortality for all ages increased to M_a = 0.5.

VAR 3: BC model but fix last two estimated recruitment residuals (2015 and 2016) equal to zero.

PROJECTIONS

Projections for a series of future constant annual midwater catches of 0, 20, 30 and 40 thousand MT are reported.

RESULTS

Table 1 provides a summary of results for the different assessments. Figure 1a compares the model fits to the *Desert Diamond* (DD) CPUE values. Figure 1b compares the model fits to the Dual Rights vessels' CPUE values. Figures 2a and b compare the model fits to the Autumn and Spring survey biomass estimates respectively. Figures 3a and b plot the spawning biomass estimates and the spawning biomass estimates relative to pristine for different assessment models. Figure 3c and 3d plot the demersal exploitable biomass and midwater exploitable biomass respectively, for different assessment models. Figure 3c plots the Spawning biomass (B^{sp}), exploitable demersal (B^{exp_d}) and exploitable midwater (B^{exp_m}) biomass trajectories for the Base Case Model.

Figure 4a plots the estimated stock-recruit residuals for each assessment, with Figure 4b providing stock-recruit and recruitment over time plots.

Figure 5a reports the estimated (and input) selectivity functions for Model BC, with Figure 5b showing the estimated survey selectivity functions for VAR2. Figure 5c compares OLD survey gear selectivity (top row) and NEW survey gear selectivity (bottom row) for different assessment models.

Figure 6 shows comparisons for the Spring and Autumn survey data of the observed (dots – black=old survey gear and red=new survey gear) and BC model estimated (green squares) average CAL over time. The dashed orange horizontal lines show the length of peak selectivity that is estimated by the model for the old and new survey gear.

Figure 7a shows projection results for the BC Model. Results are shown for various projected levels of constant annual midwater catches. Plots of median and lower 5 %ile B^{sp}/K^{sp}, median CPUE and median midwater catches are shown. Note that the future spawning biomass uncertainty shown takes account of future stock-recruitment variability about the stock-recruitment curve only. Figure 7b shows projection results for the VAR2. Figure 7c compares B^{sp}/K^{sp} median (left) and lower 5^{th} %ile (right) projections for either future midwater constant catch of 20 000 MT (top row) or 30 000 MT (bottom row). Results are shown for four different assessment models.

Figure 8 plots the past pelagic, demersal bycatch, midwater and total catches for the resource.

Note that last year document FISHERIES/2018/OCT/SWG-DEM/53 used the same basis as in the then recent past to make a management recommendation for the **midwater** catch for the 2019 season, which was 25 581 MT. This was in conjunction with a then unchanged effort limitation of 388 Seadays.

DISCUSSION

The following points merit noting.

- The evidence for poor recruitment (Figure 4a) for the last two years for which recruitment is estimated (2015 and 2016) is very weak for the new BC (little deterioration in -lnL when these residuals are set to zero in VAR 3 – see Table 1), and these recruitment estimates impact recent spawning biomasses only very slightly (Figures 3a and b). For *M* increased to 0.5 (VAR 2), the recruitment deviations for these two years are estimated to be virtually zero.

- Changing to survey selectivity based on gear type rather than on year has hardly any impact on the fits to the CPUE series (Figure 1), and only a small impact on the fits to the survey time series (Figure 2).

- Spawning biomass (B^{sp}) trend estimates are hardly altered by the change to the survey selectivity specifications. However, increasing *M* sees the absolute magnitudes of the estimated spawning biomasses drop (Figure 3a). With senescence (a high *M* at large ages), the resource is estimated to have been more heavily depleted historically, though this change in assumptions hardly impacts estimates of depletion (B^{sp}/K^{sp}) at present; however, for *M* higher at 0.5, the depletion estimate at present increases from about 67% to 77% (Figure 3b).

- Over the last decade, the spawning biomass has increased by over 70%, whereas the survey and midwater exploitable components of biomass have been near constant (Figure 3e). This is a consequence of doming in the selectivities for these last two components, which consequently are reflections more of “throughput” than of standing stock.

- The new survey gear selectivity is larger for smaller fish than was the case for the old gear (Figure 5a). If *M* is increased, the extent of doming in these survey selectivities decreases (Figure 5c).

- All the future (non-zero) levels of midwater catch considered lead to a reduction in spawning biomass (and CPUE) in median terms. For annual midwater catches 30 000 MT, this would not be of concern in terms of stock status (which would still remain well above the corresponding MSY level), though CPUE would be expected to drop by about 15% (Figure 7a). These results are not sensitive to variations of the new BC assessment, except insofar as depletions are estimated to be about 5-10% higher if *M* is increased to 0.5 (Figure 7c). However, these projections are rather more pessimistic if the lower 5%-iles rather than the medians of the depletion distributions are considered.

Table 1: Summary of results for different assessment models. All variants fix q_{aut} = 0.75 and h = 0.75. "SR" and "CAL" refer to stock-recruitment and catch-at-length contributions respectively. Biomass units are thousand MT.

	Previous BC	**New BC** M_a = 0.3	**VAR1** M_a = 0.3 except M_{10+} = 2.0	**VAR2** M_a = 0.5	**VAR3** SR residuals = 0 for 2015 and 2016
# estimable parameters	46	42	42	42	40
-ln L :Total	-260.350	-257.571	-257.421	-257.153	-257.469
-ln L :Spr survey	1.162	0.461	0.055	-0.329	0.511
-ln L :Aut survey	-8.048	-7.927	-8.071	-7.432	-7.911
-ln L :CPUE	-10.595	-9.850	-9.822	-9.721	-10.147
-lnL Dual Rights	-6.962	-7.212	-7.240	-6.988	-7.119
-ln L :CAL Spr survey	-48.506	-46.447	-46.188	-45.599	-46.066
-ln L :CAL Aut survey	-87.324	-85.354	-85.163	-84.832	-85.166
-ln L :CAL commercial	-81.810	-82.493	-82.311	-83.257	-82.712
-ln L :SR residuals	-18.267	-18.747	-17.837	-18.995	-18.860
K^{sp} (KT)	789	799	580	441	805
B^{sp}_{2018} (KT)	**512**	**525**	**385**	**340**	**541**
$MSYL^{sp}$ (KT)	193	196	155	107	197
MSY (KT)	58	58	59	65	59
B^{sp}_{2018}/K^{sp}	**0.649**	**0.658**	**0.633**	**0.771**	**0.673**
q: Spr survey	0.790	0.802	0.852	0.721	0.798
q: CPUE (x10^{-6})	1.950	1.891	2.005	1.974	1.888
q_2 (applies to 2014)	0.265*q_{CPUE}	0.272*q_{CPUE}	0.273*q_{CPUE}	0.267*q_{CPUE}	0.273*q_{CPUE}
	M3b.tpl	xHorse.tpl	Xh1.tpl	Xh3.tpl	Xh4.tpl

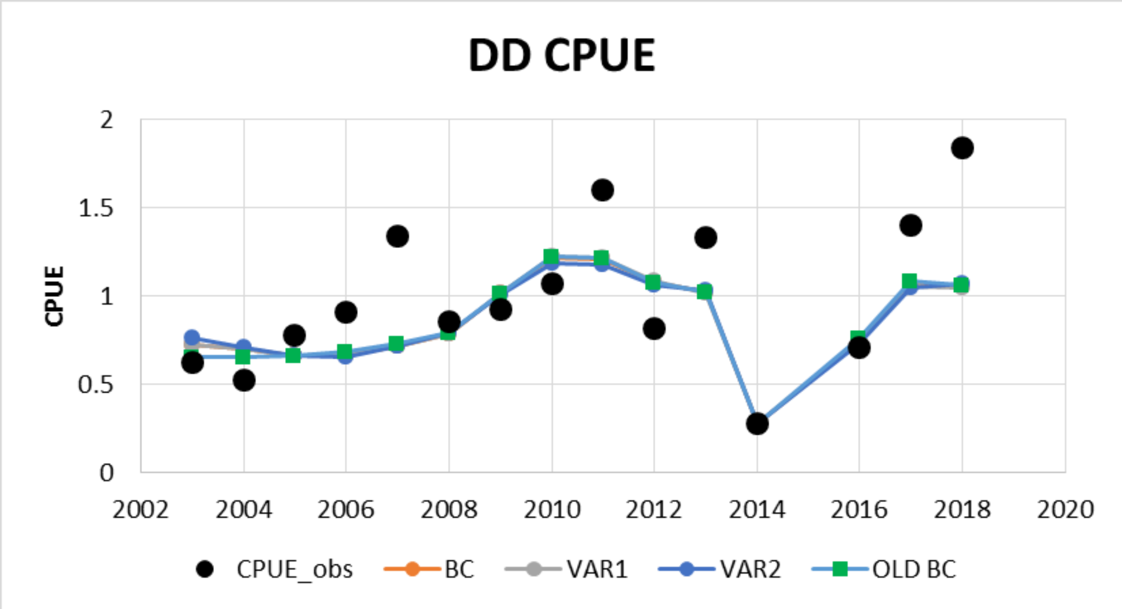


Figure 1a: Comparisons amongst the model fits to the *Desert Diamond* (DD) CPUE values.

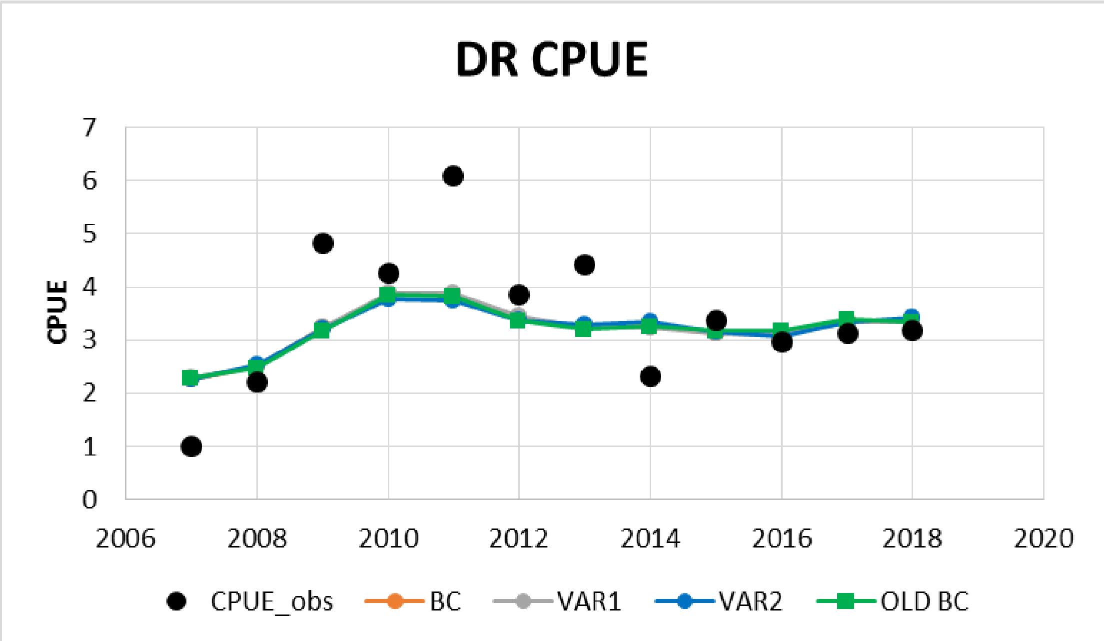


Figure 1b: Comparisons amongst the model fits to the Dual Rights vessels' CPUE values.

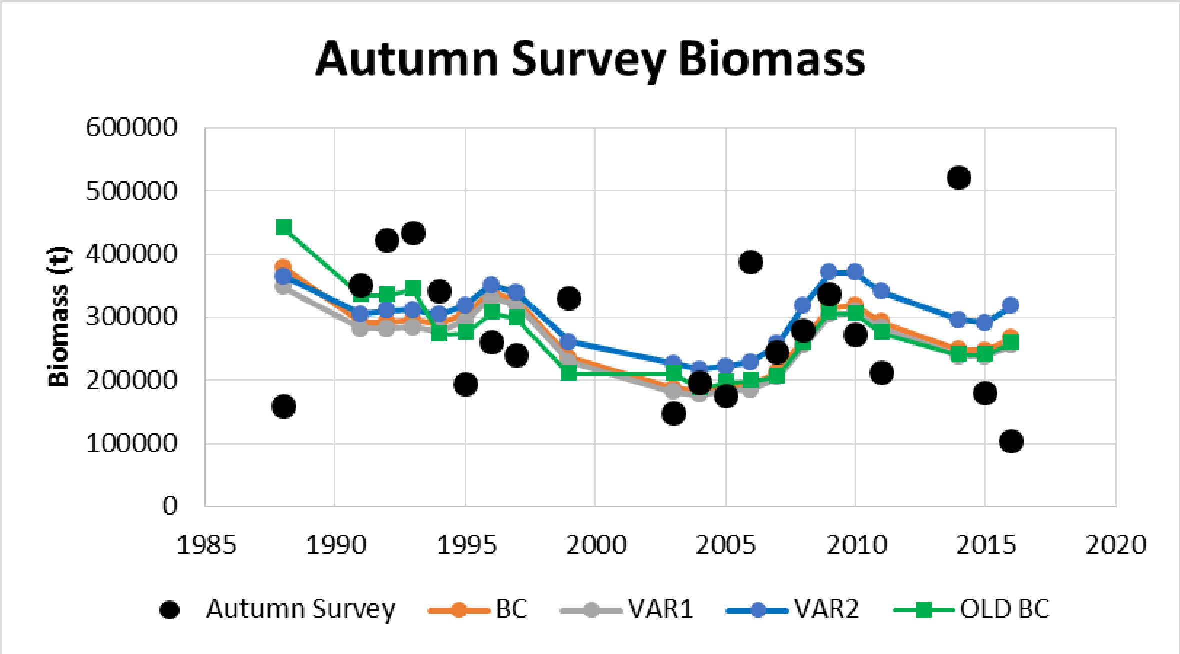


Figure 2a: Model fits to the Autumn survey biomass estimates.

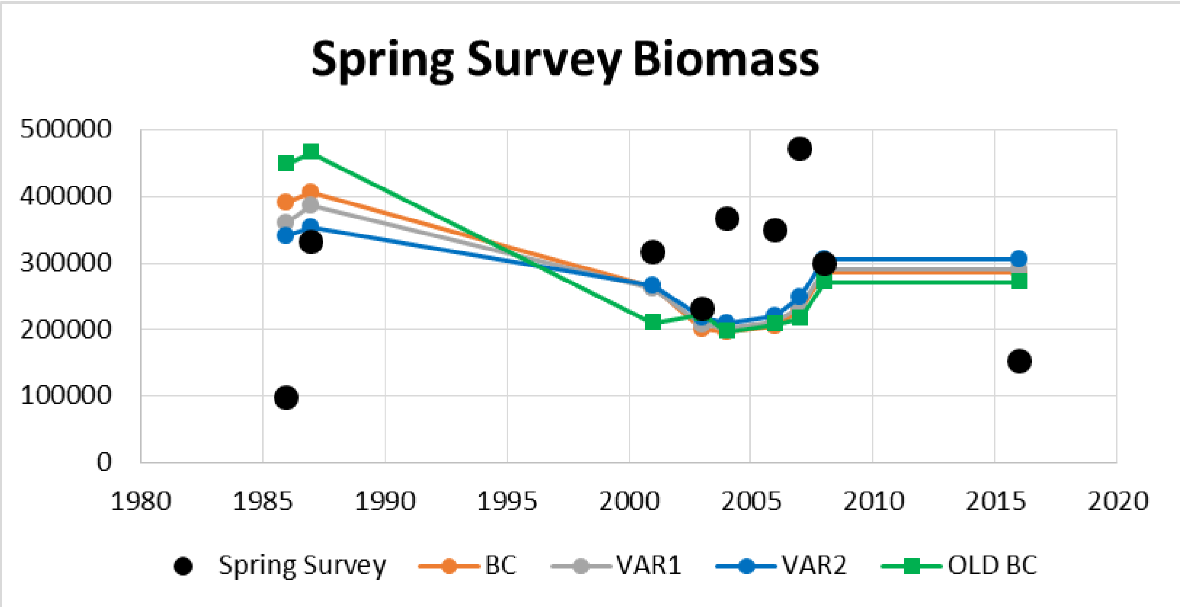


Figure 2b: Model fits to the Spring survey biomass estimates.

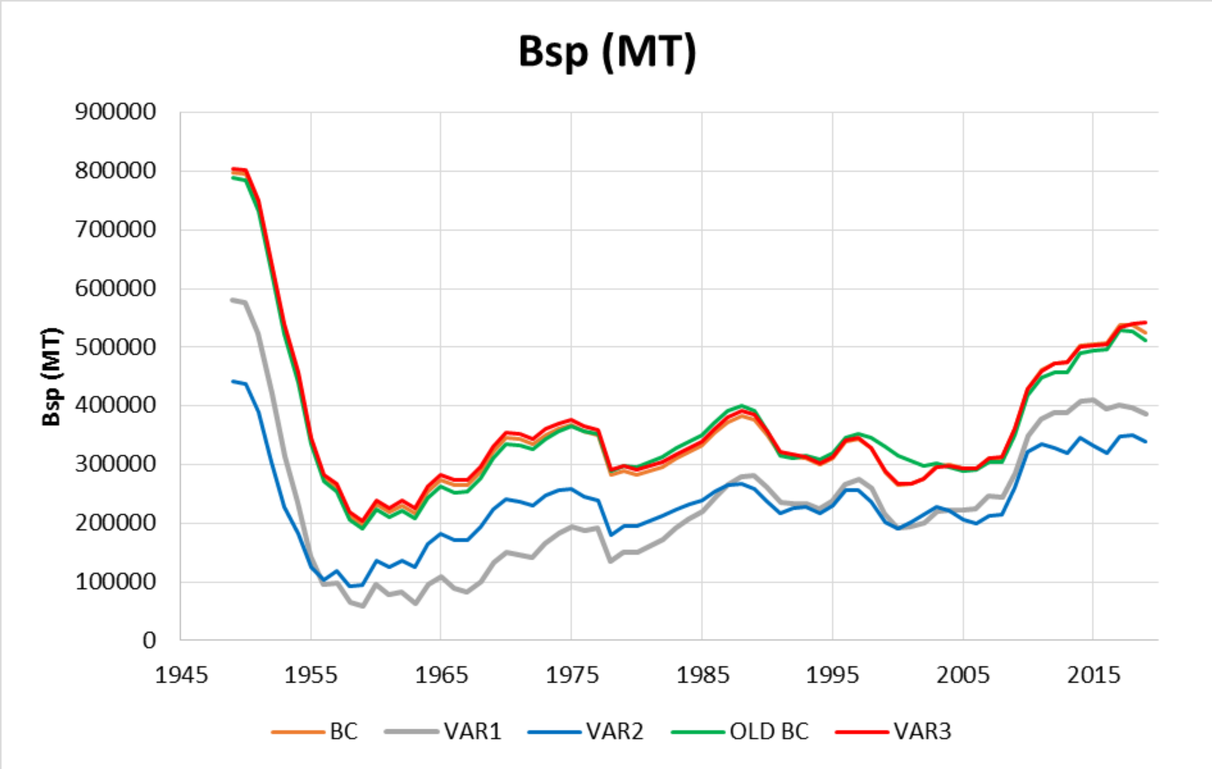


Figure 3a: Spawning biomass estimates for different assessment models.

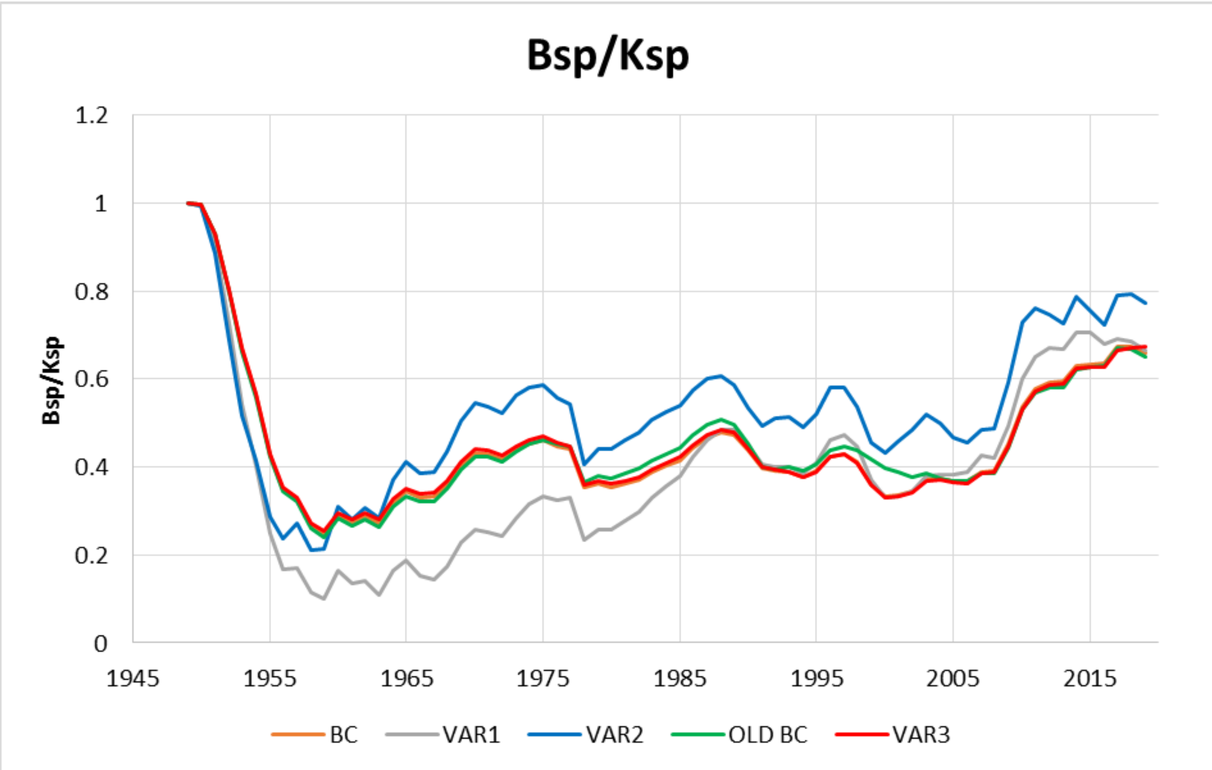


Figure 3b: Spawning biomass relative to K^{sp} estimates for different assessment models.

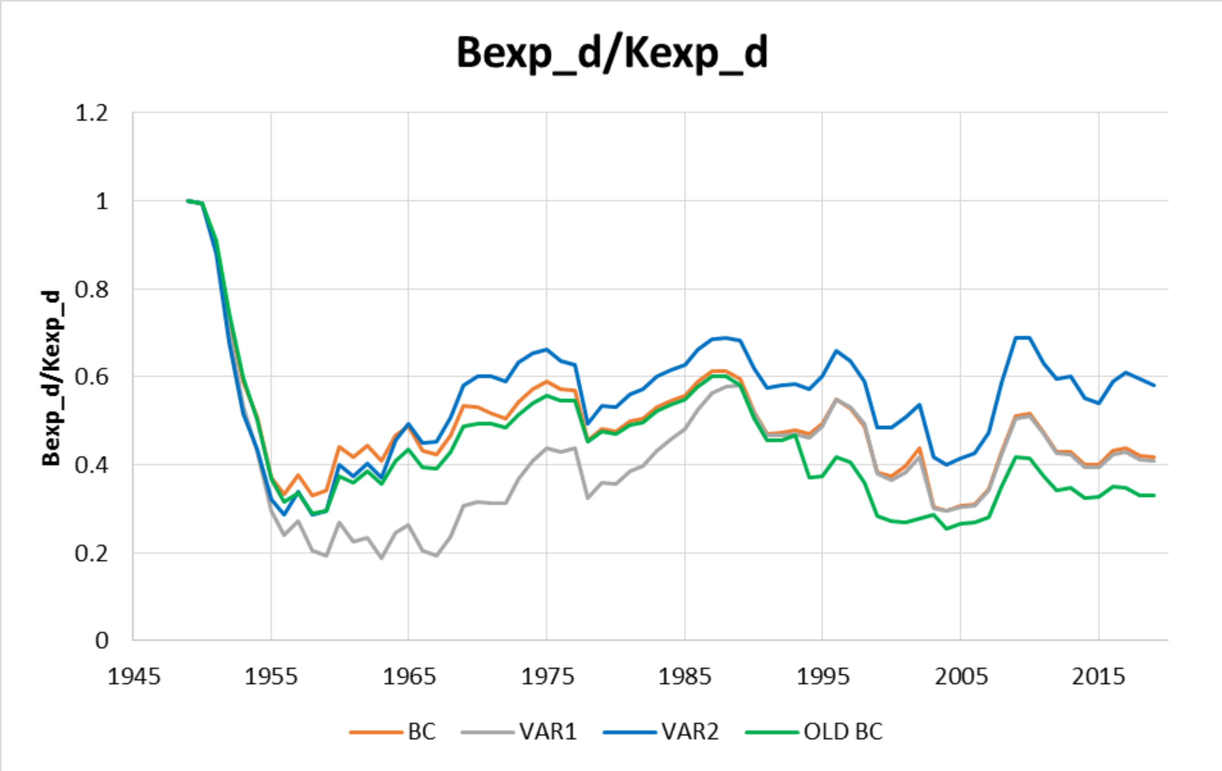


Figure 3c: Demersal exploitable biomass relative to K^{exp_d} estimates for different assessment models.

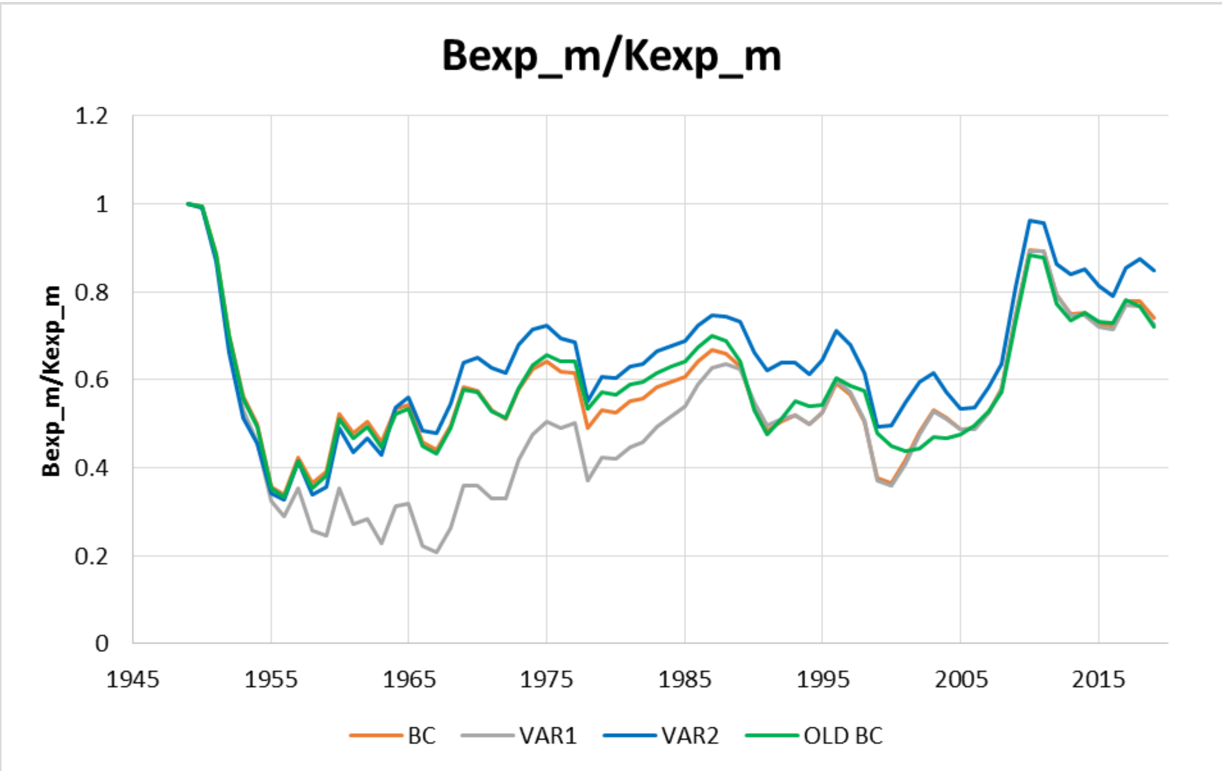
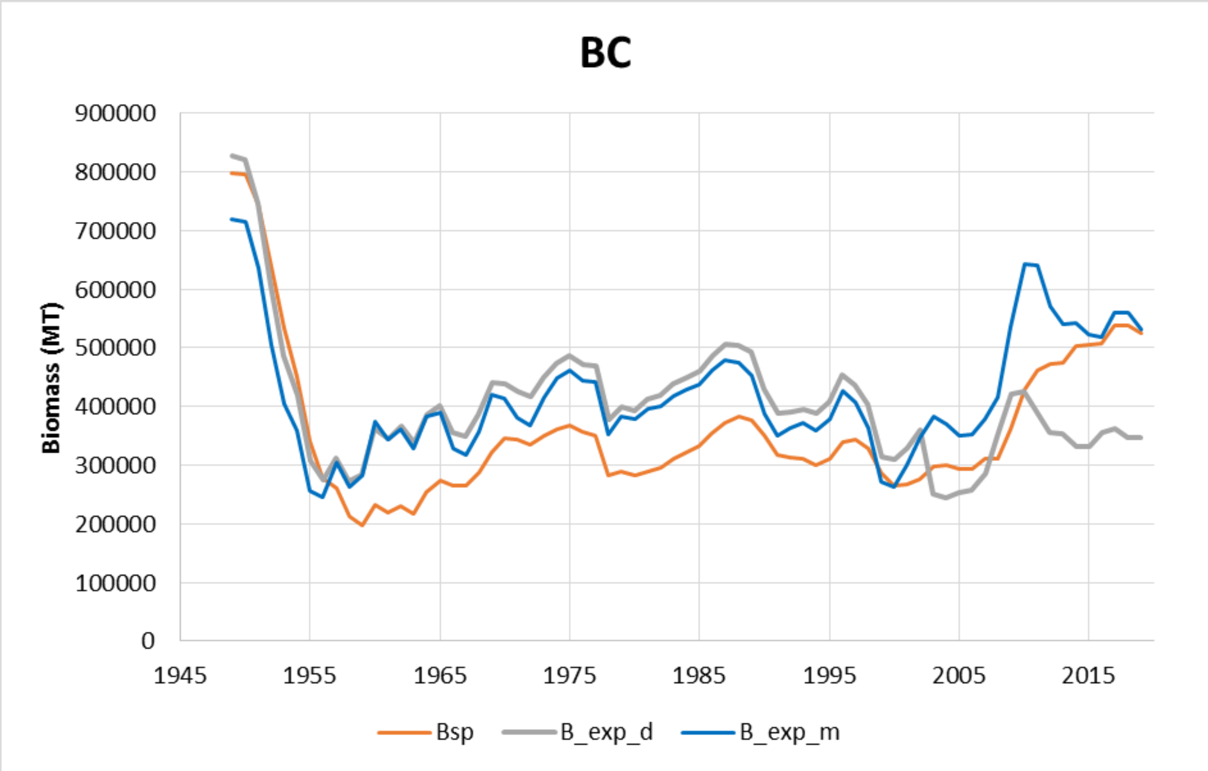


Figure 3d: Midwater exploitable biomass relative to K estimates for different assessment models.



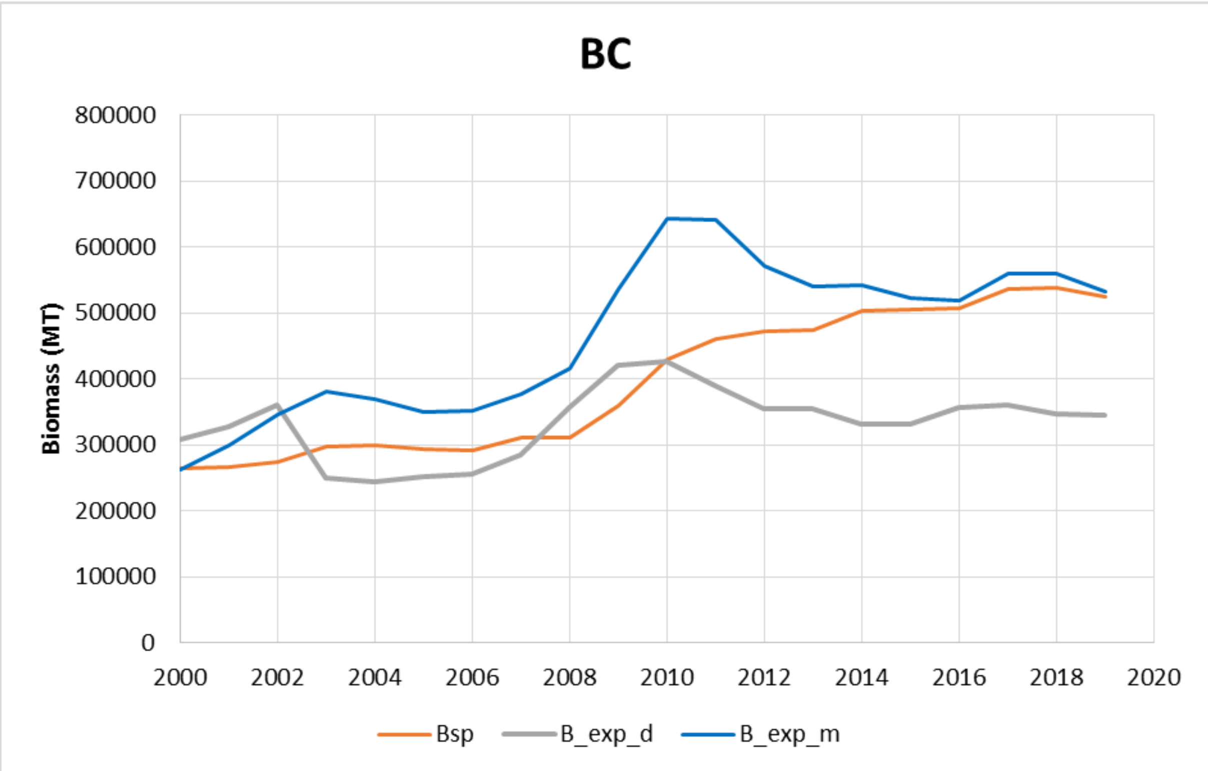


Figure 3e: Spawning biomass (B^{sp}), exploitable demersal (B^{exp_d} – related also to surveys) and exploitable midwater (B^{exp_m} – pertinent to the Desert Diamond) biomass trajectories for the BC Model.

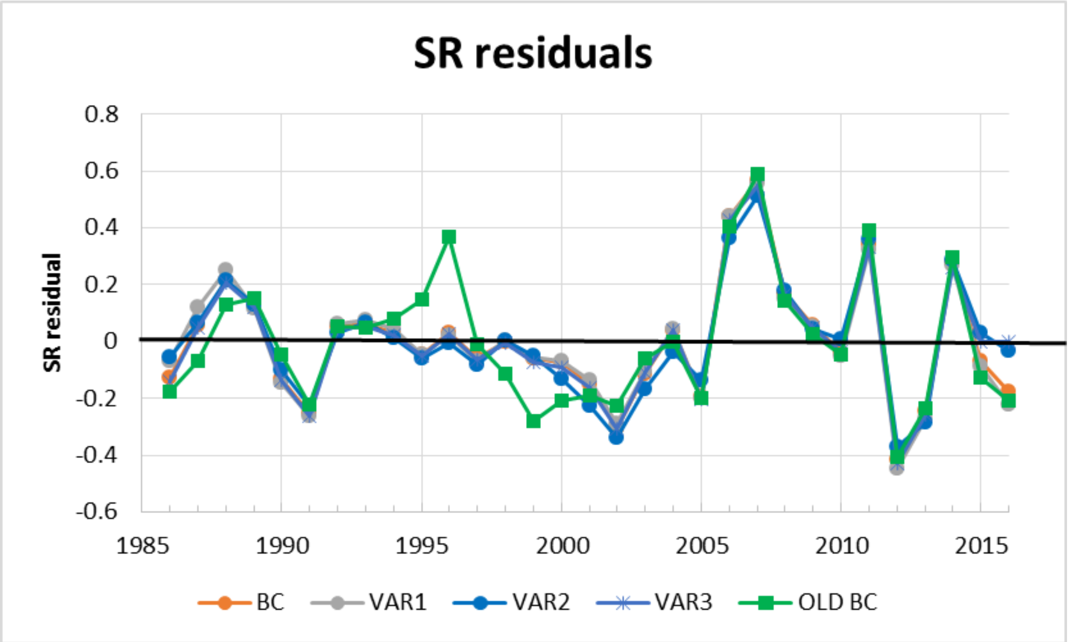


Figure 4a: Estimated stock-recruit residuals.

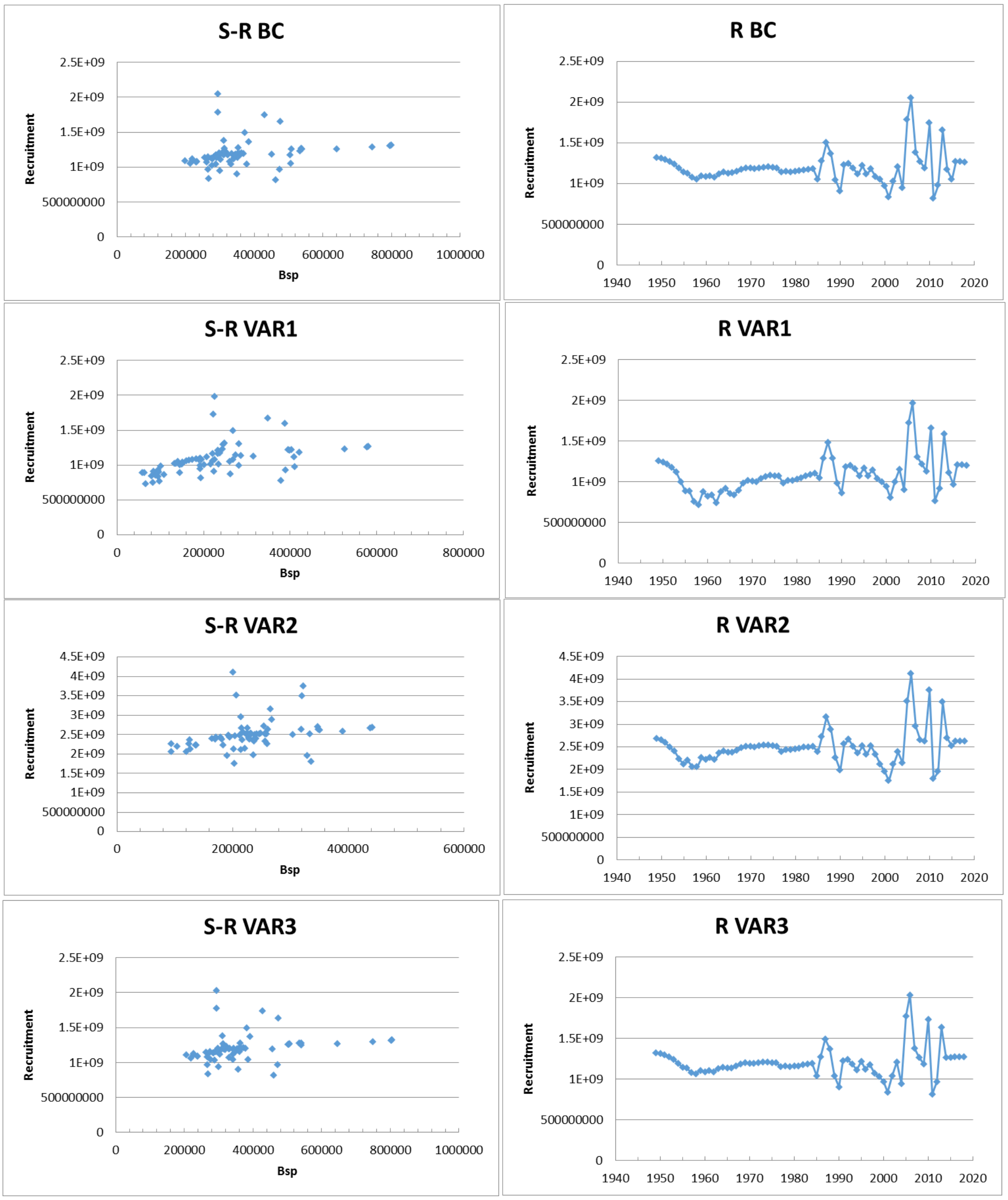


Figure 4b: Stock-recruit (left) and Recruitment over time (right) plots.

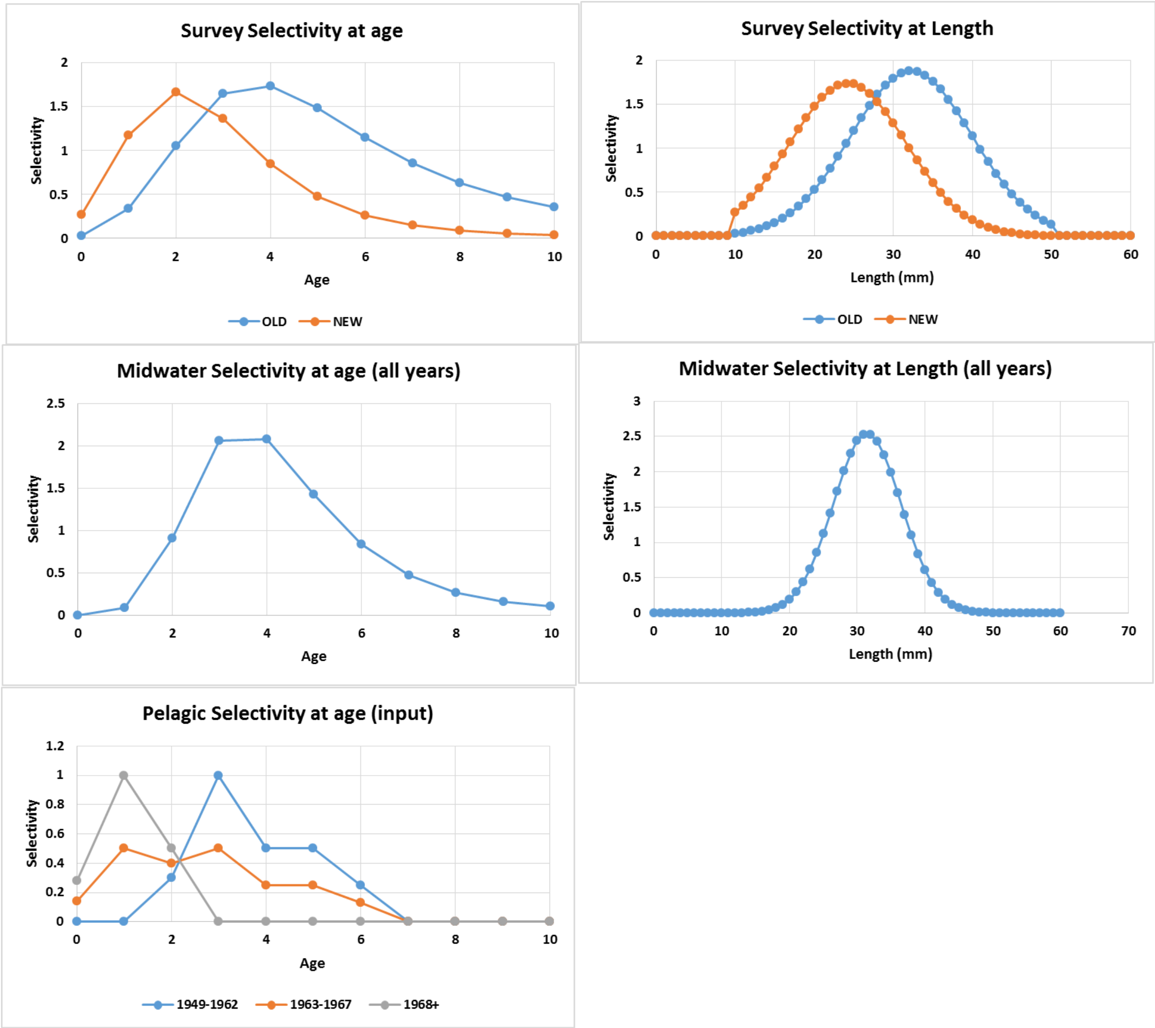


Figure 5a: BC model selectivity functions. The old gear (OLD) survey selectivity plot applies also to the demersal bycatch.

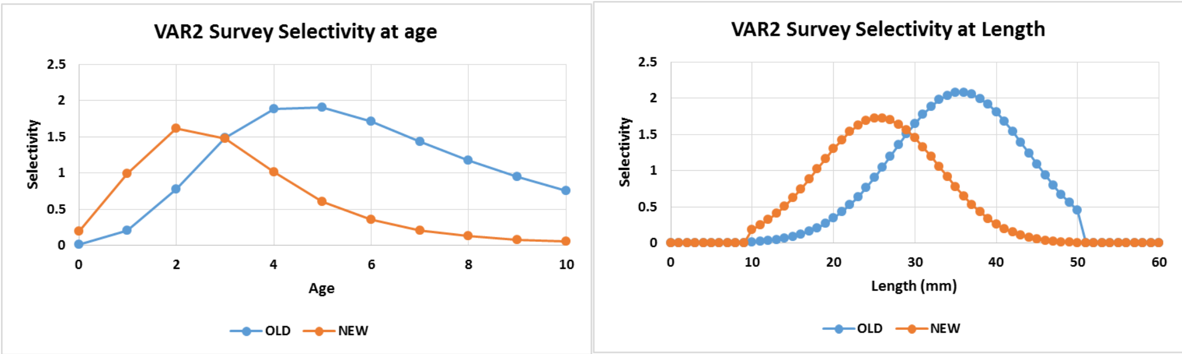


Figure 5b: VAR2 model survey selectivity functions.

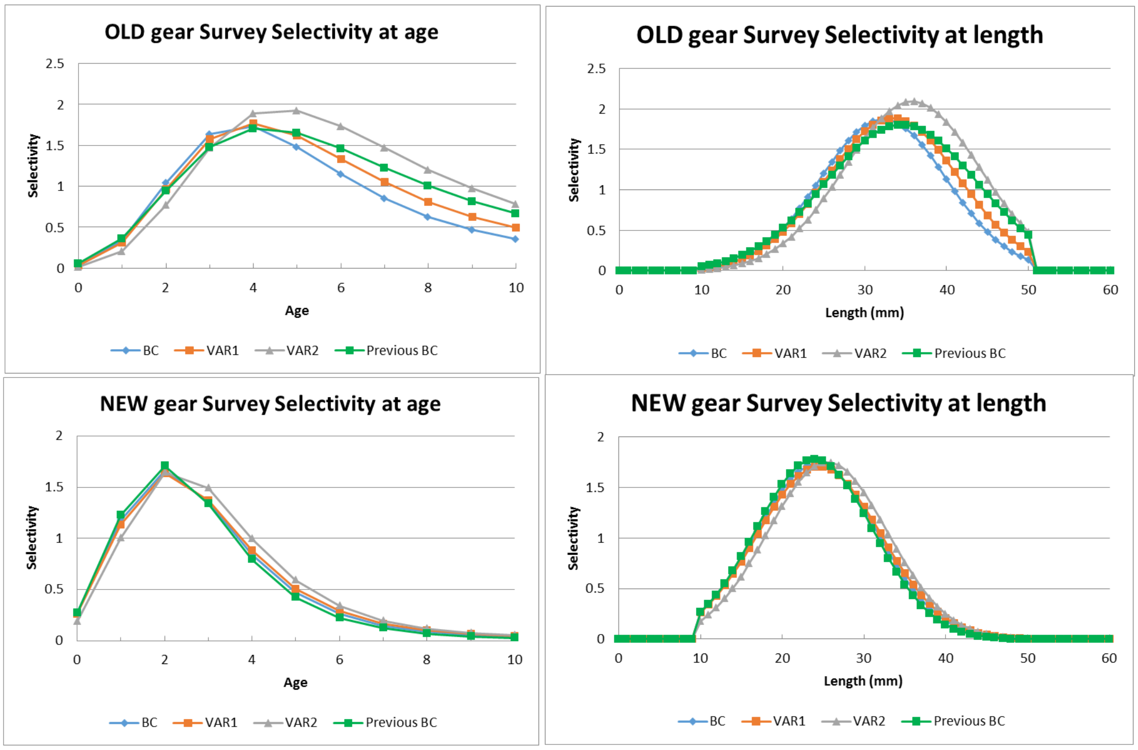
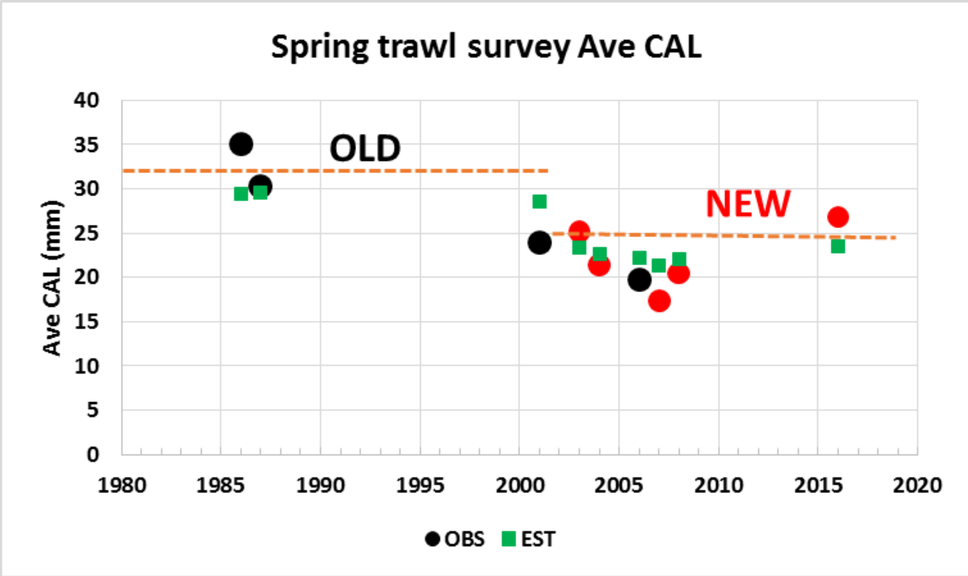


Figure 5c: Comparison of OLD survey gear selectivity (top row) and NEW survey gear selectivity (bottom row). For the Previous BC, the OLD gear plot gives the selectivity estimated for the earliest years, and the NEW gear plot for the latest years.



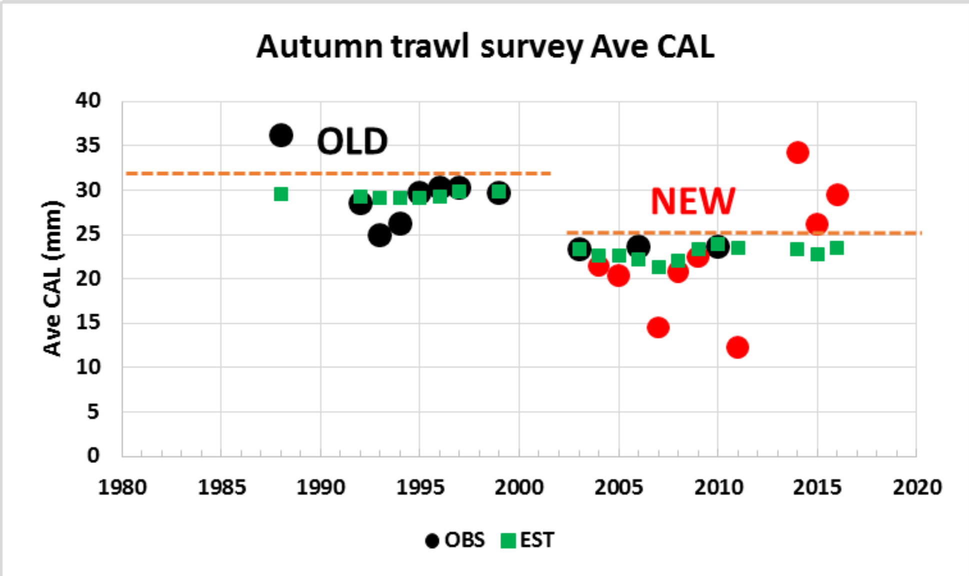


Figure 6: Plots comparing the observed (dots – black=old survey gear and red=new survey gear) and BC model estimated (green squares) average length over time for the CAL data. The dashed orange horizontal lines show the length at peak selectivity that is estimated by the model for the old and new survey gear.

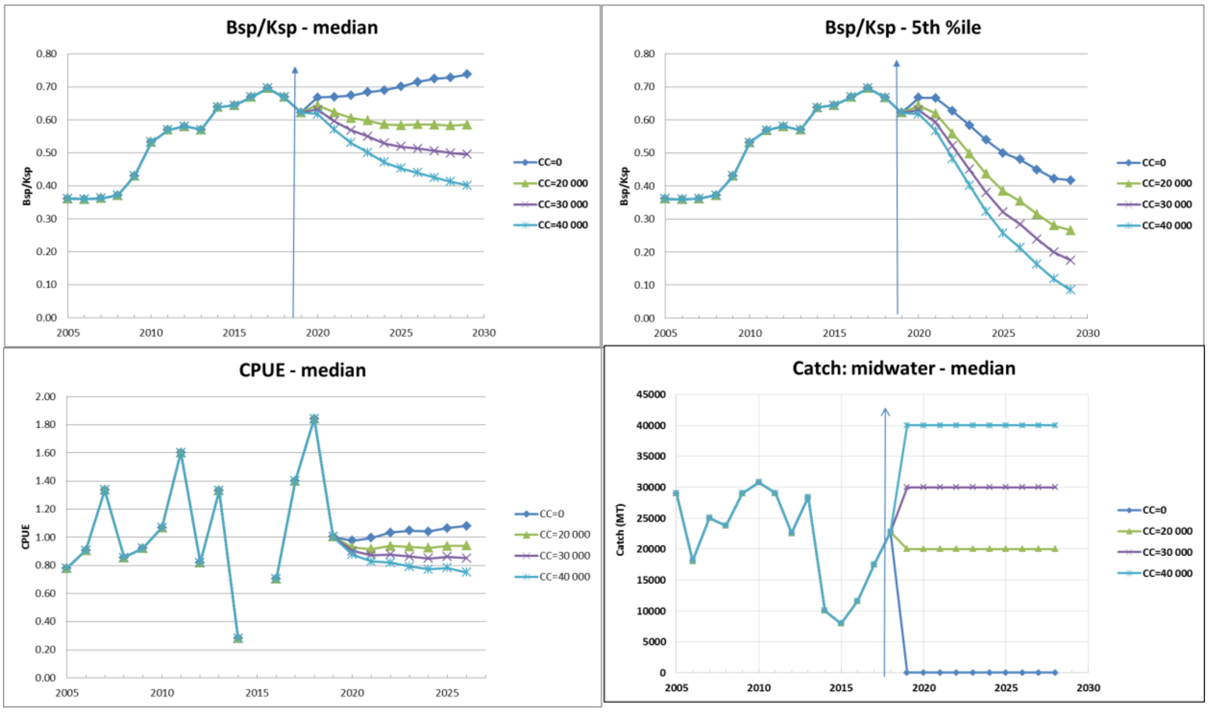


Figure 7a: BC model projections for different constant future levels of annual midwater catch.

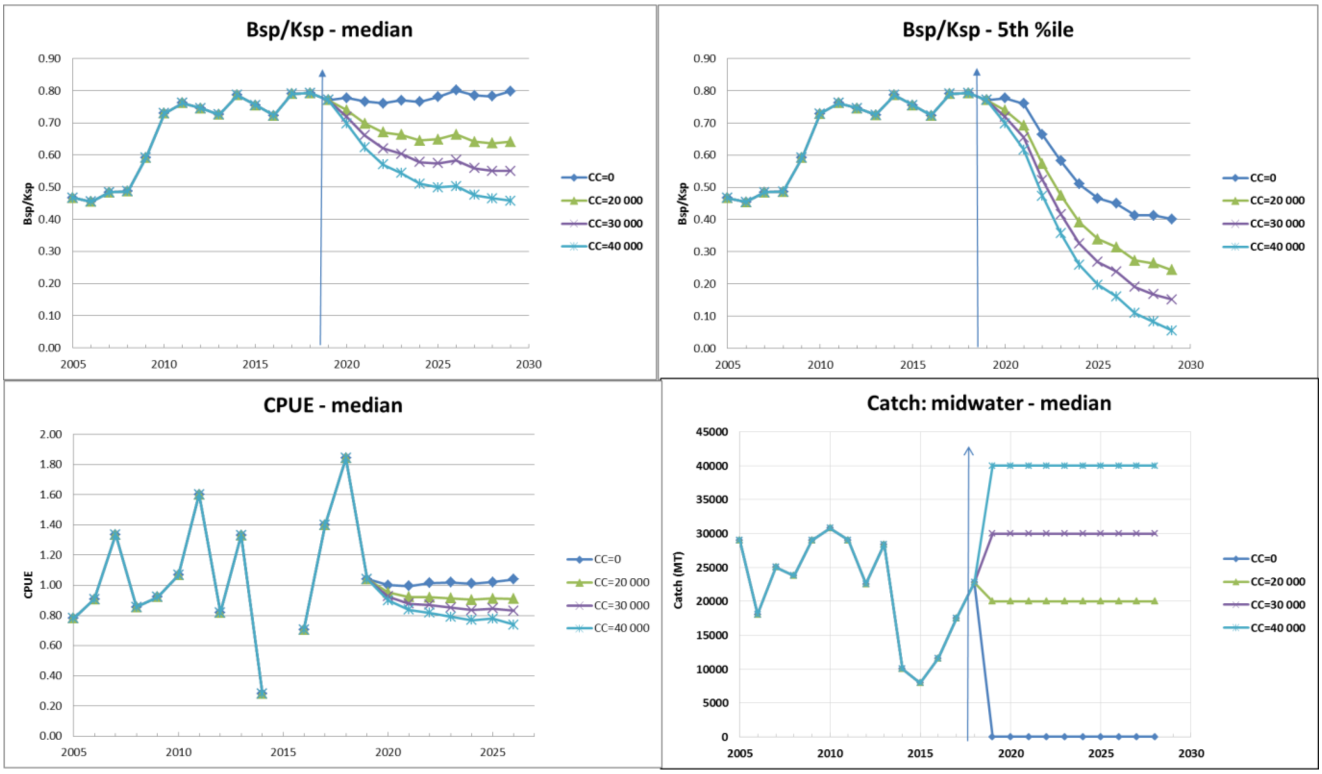


Figure 7b: **VAR2** (*M*=0.5) model projections for different constant future levels of annual midwater catch (in MT).

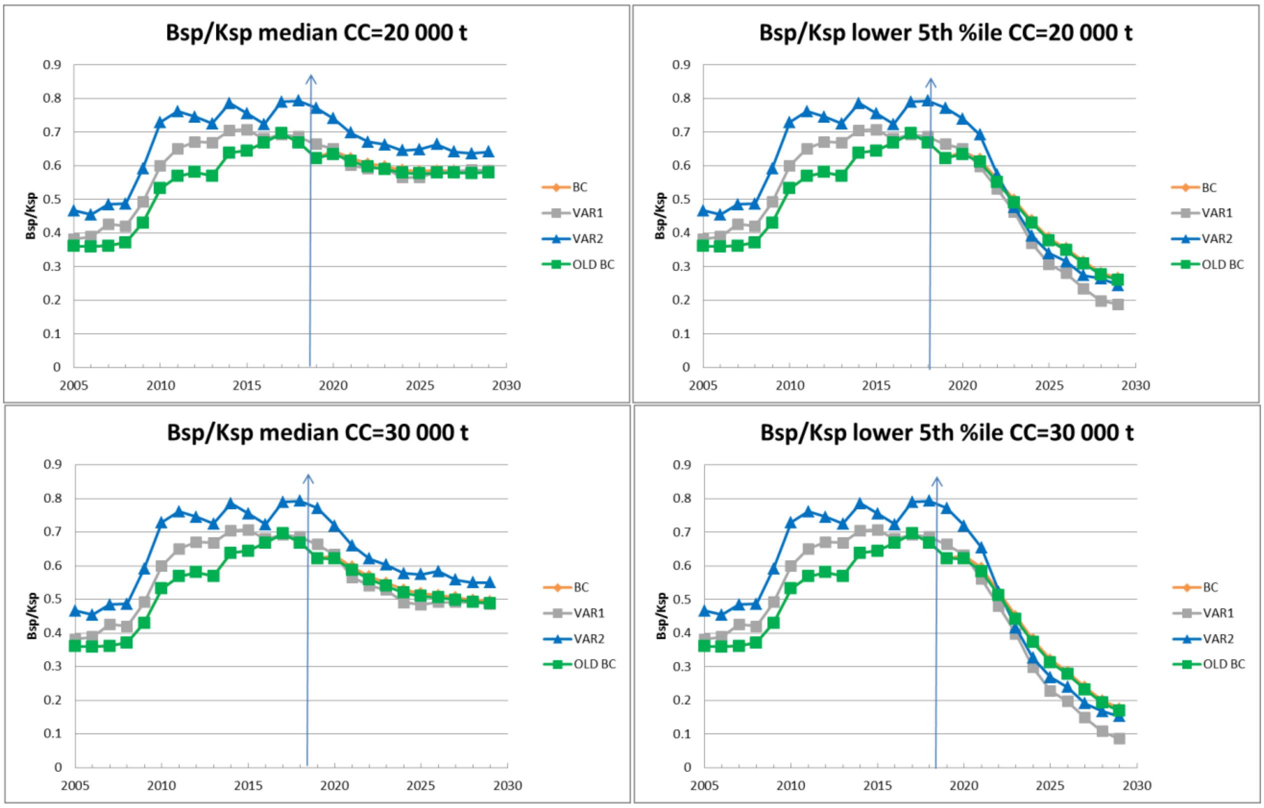


Figure 7c: B^{sp}/K^{sp} median (left) and lower 5th %ile (right) projections for either future midwater constant catch of 20 000 t (top row) or 30 000 t (bottom row). Results are shown for four different assessment models.

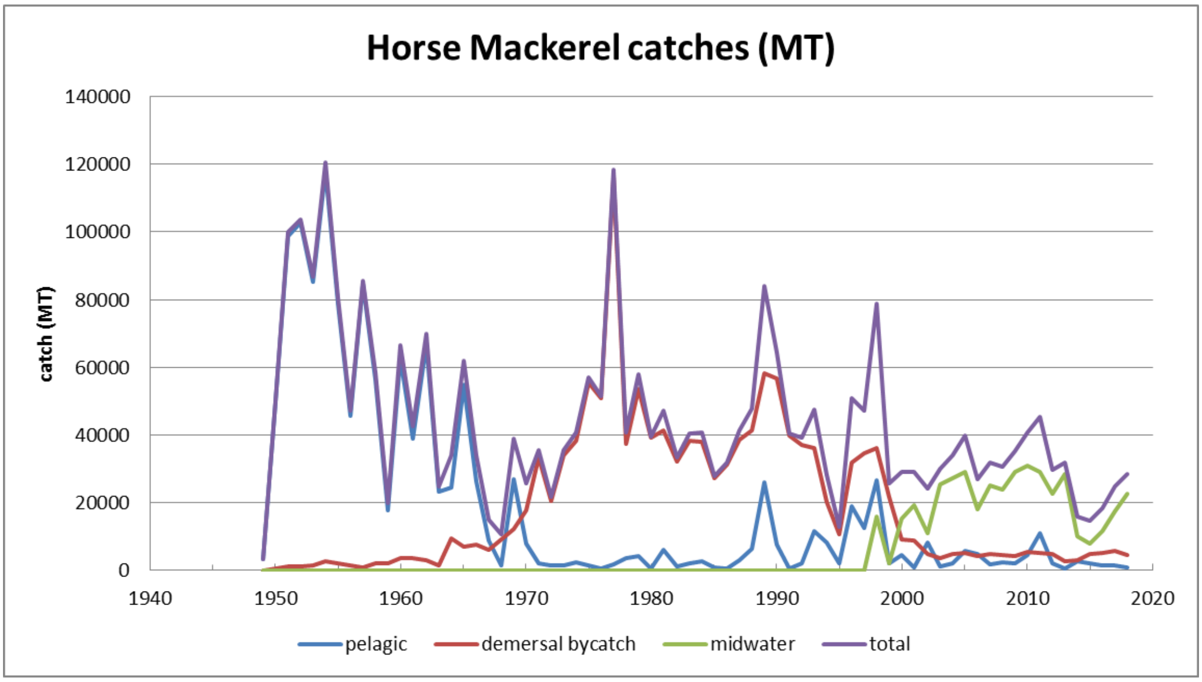


Figure 8: Horse mackerel historical catches (MT).