Working Document 5

Applying a Bayesian model incorporating discards in the assessment of four-spot megrim (*Lepidorhombus boscii*) Southern stock

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Since 2003 when the DCF started at European level by countries, discards data are available for many stocks. Four-spot megrim is traditionally assessed with XSA (extended survivor analysis) which does not include discards. For this species, discards in number are very important, being around the 60% of total catch. A Bayesian model incorporating discards was realized for the hake stock in ICES Divisions VIIIc and IXa by Fernández *et al*. (2010). This model was also designed to produce a complete time-series of discard estimates. Final run of the model is compared with results from XSA performed in the working group of 2010, showing that mayor differences are in the fishing mortality for younger ages, being higher incorporating discards data.

MATERIAL AND METHODS

Data are the same used in the working group for the assessment of the Southern stock of *L. boscii*.

Landings data are provided by National Government and research institutions of Spain and Portugal with data since 1986. Age compositions of landings are based on annual Spanish ALKs. Since there is no landing for age 0, landed numbers-at-age are presented from age 1 to 7+.

Discards estimates are available for Spanish since 2003 and before this year, there are data only for 1994, 1997, 1999 and 2000. Discard numbers-at-age are presented from age 0 to 5. Portuguese discards are assumed to be zero at this moment, but they will be able to be incorporated if they are available.

To tune the model two indices are available, one commercial fleet and one survey index. A Coruña trawl fleet (SP-CORUTR8c) contributing with data of effort and LPUE till 1999 due to changes in the fishing gears and the Spanish groundfish survey (SP-GFS), available since 1983, are the two indices. Numbers-at-age are from 3 to 6 in the trawl fleet and from 0 to 6 in the research survey.

Assessment model

Model is described in Fernández *et al.* (2010). It is a Bayesian model computed in the free software WinBUGS for simulating the posterior distribution via Markov chain Monte Carlo (MCMC). The population dynamics is based on the usual equations for closed population and the rate of fishing mortality is disjointed in two terms, one related to landings and other related to discards.

$$F(y,a)=f(y).(s_L(y,a)+s_D(y,a))$$

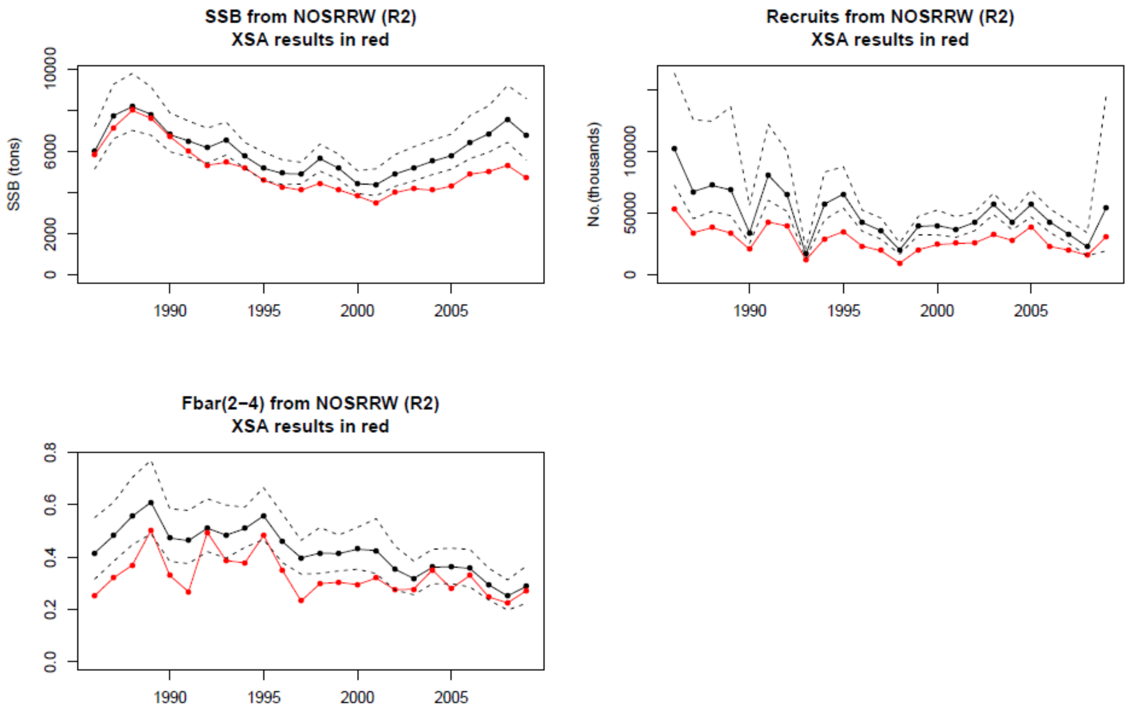
Fishing mortality is the result of the product of fishing effort and the exploitation pattern, being the last one age dependant. To obtain landed numbers-at-age, the model applies the Baranov catch equation. The two series correspond to the commercial fleet and the research survey, are used to obtain relative indices of abundance-at-age. All formulations are showed in the paper mentioned above.

The unknown parameters of the model are assigned prior distributions. These distributions are set with two values, the median and the precision. As better is our previous parameter knowledge, setting values have lesser variability.

The number of iterations used to fit the model was the same as in the hake model. The fitting was made using MCMC to simulate the posterior distribution with 112000 iterations. The first 32000 were not achieved and 5000 iterations from the rest were kept.

RESULTS AND DISCUSSION

Figure 1 shows results of SSB, Recruits and Fbar from the model comparing with those obtained with XSA in the last assessment. Trends are very similar. In SSB, first years are more coincident than last years', where Bayesian model estimates greater values of SSB. Including discards, looks to have an effect on the recruitments estimation, resulting in higher values almost all the time-series. Discards contribute with important amounts of earlier ages. Fishing mortalities also present the same trend, but last years are more similar than the beginning of the series.



In figure 2, the evolution of fishery age selectivity is presented comparing with the same results from XSA. As it is expected, there are more differences in the two first ages when discards are introduced in the model. First of all we have fishing mortalities for age 0, which did not appear in the XSA results because there are not commercial landings for this age. For age 1, values are now higher than in the XSA model and a little higher in age 2. In the rest of ages, values are more or less coincident.

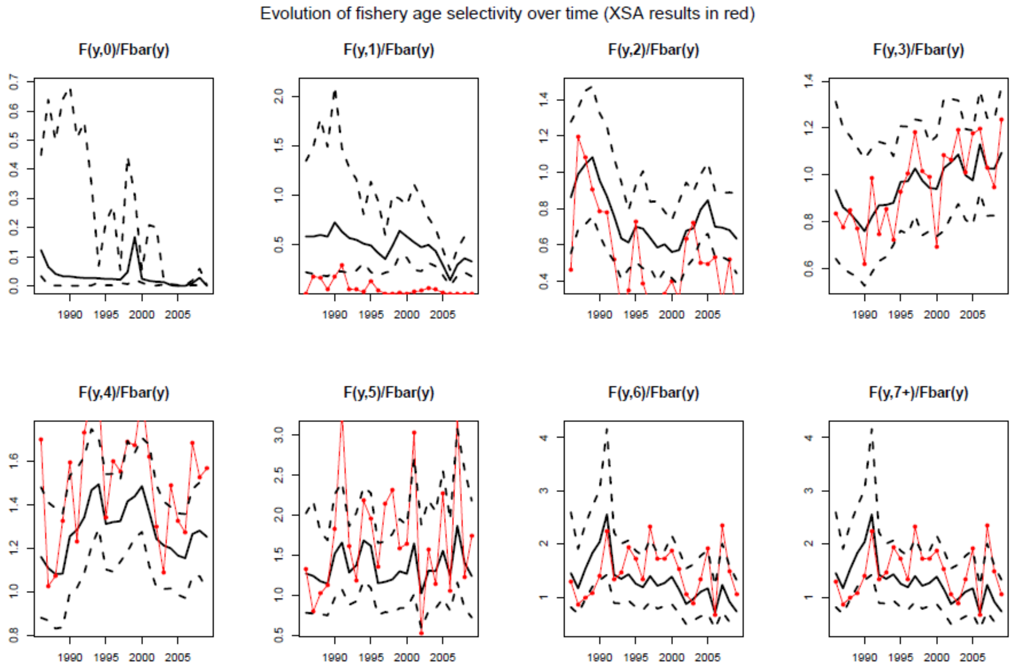


Figure 3 shows the same as figure 2 but with all ages together. Red line is corresponding to the last assessment year (2009), where the exploitation pattern indicates the biggest fishing pressures on ages 3 to 5.

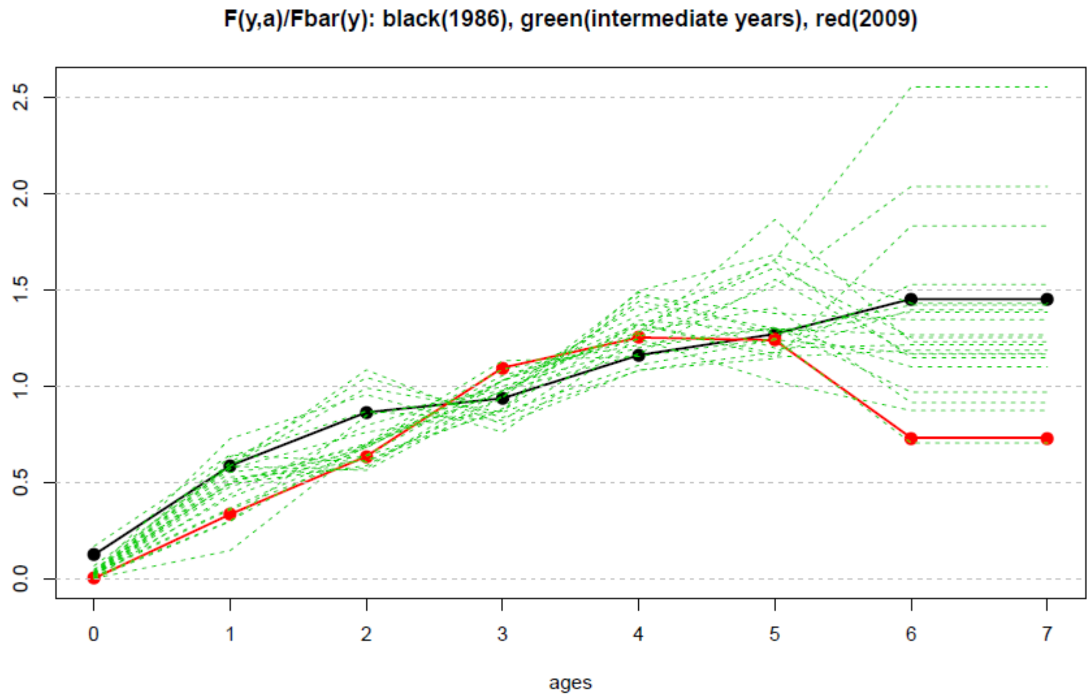
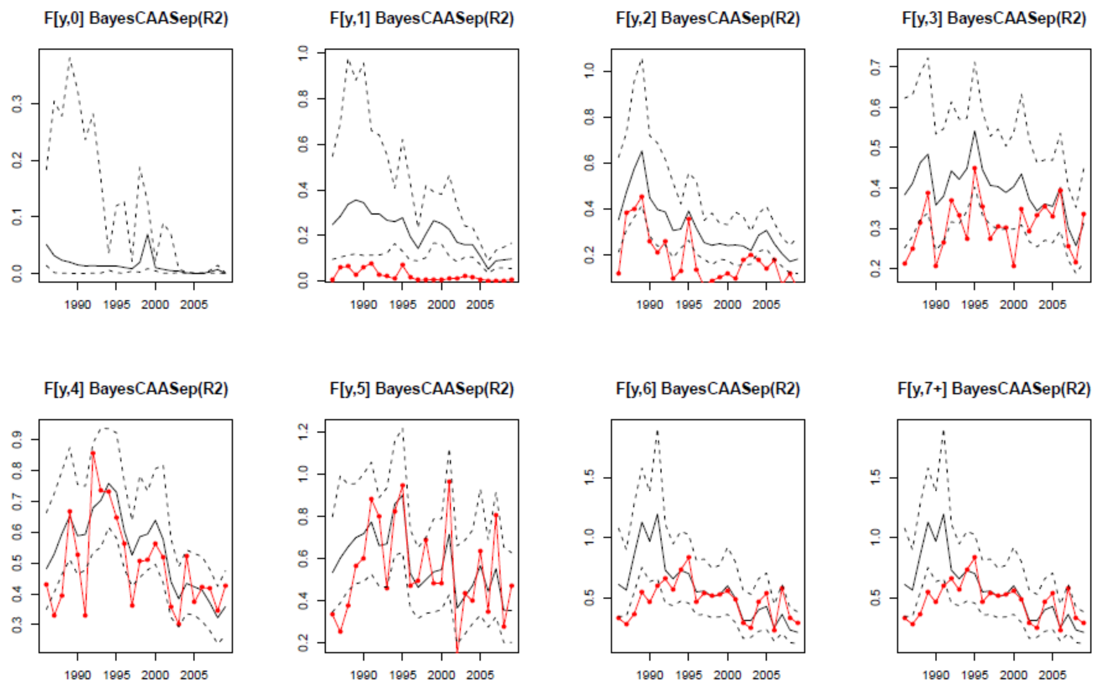


Figure 4 shows the values of fishing mortalities for all years and ages. As in the case of de fishery age selectivity, the biggest changes are for age 0 and 1, being a bit higher of XSA results for ages2 and 3 and more similar for the rest of the ages.



In figure 5 the probability that the fish being caught are discarded for the different years and ages is presented. There is no evidence of the effect of the progressive enforcement of the MLS for this stock since 2000. Apparently, there is a decrease of the probability after this year for ages 2–4, but a high increase is detected following it for ages 2 and 3.

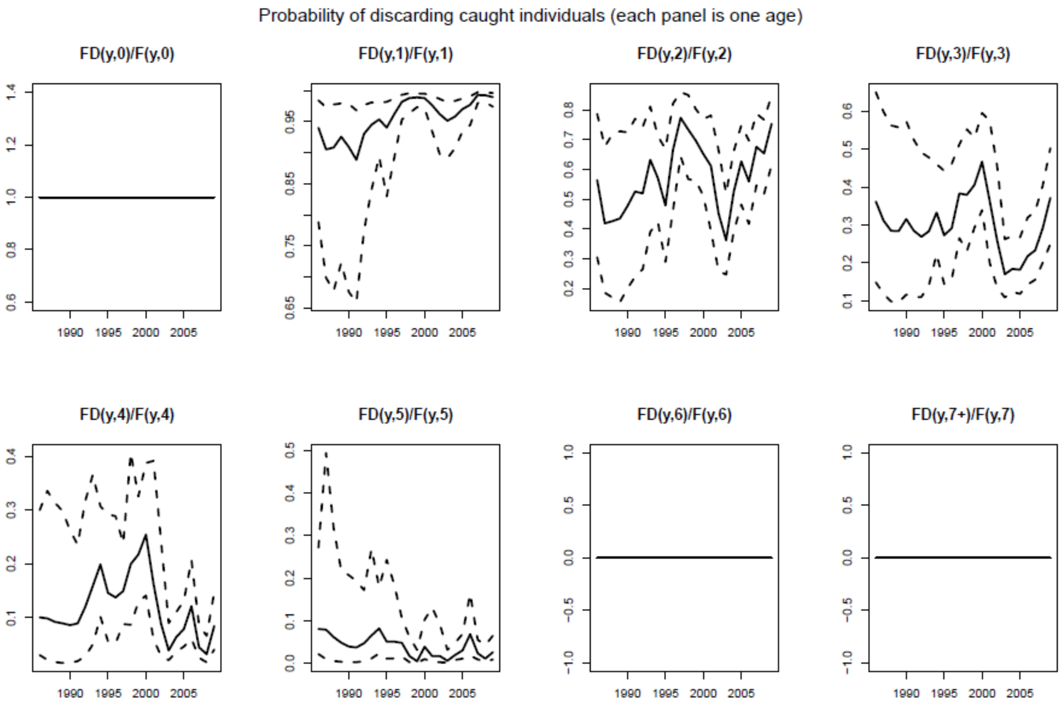
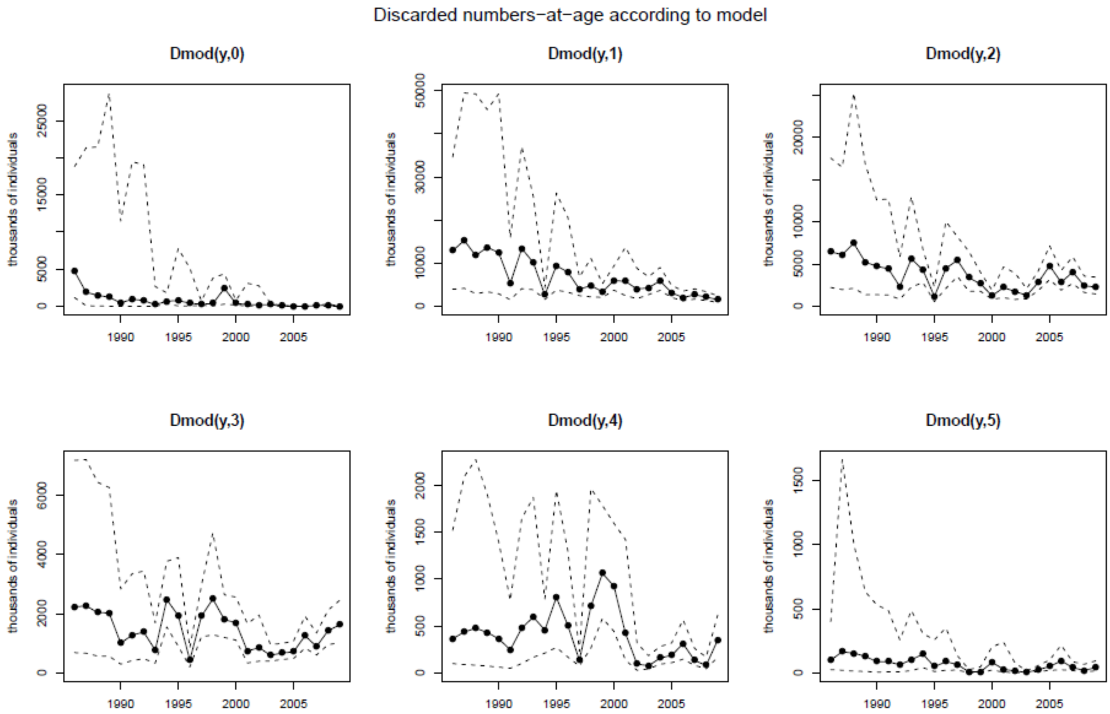


Figure 6 presents discarded number-at-age as result of the model. Very high variability can be observed in the first years of the time-series, when only a few years have observed data. Since 2003 model fits better because all years have been sampled.



From Figures 7 to 11, standardized residuals are presented. There is nothing relevant to discuss about this values, and its evolution during the time-series can be observed in next figures.

Figure 7:

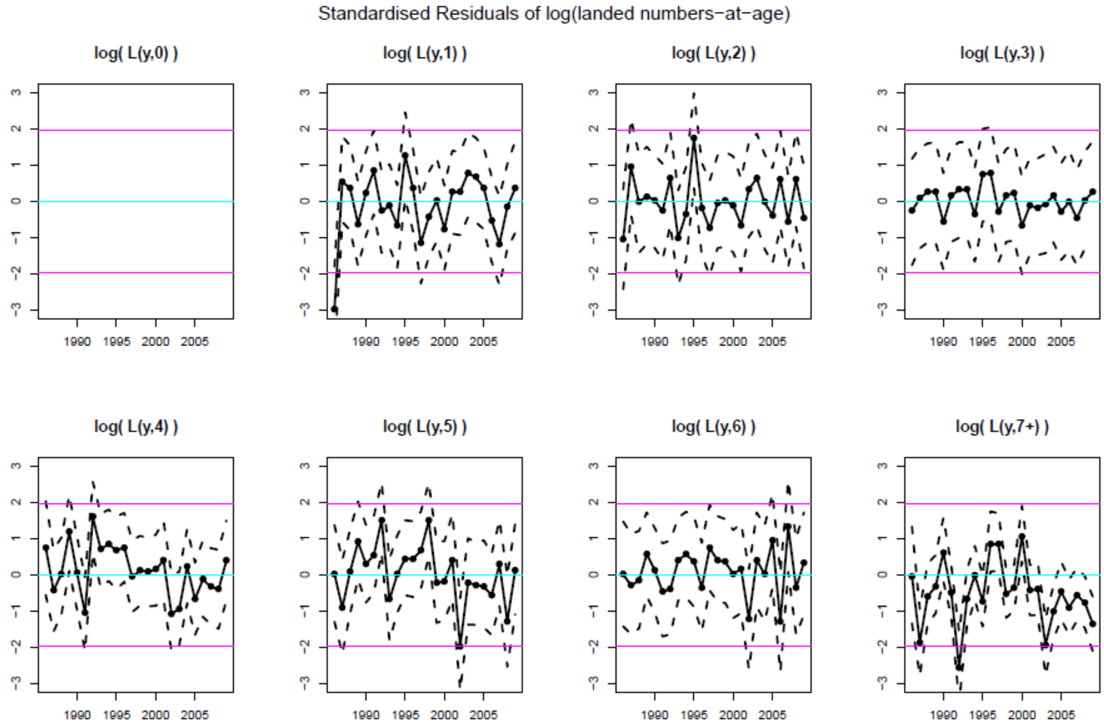


Figure 8:

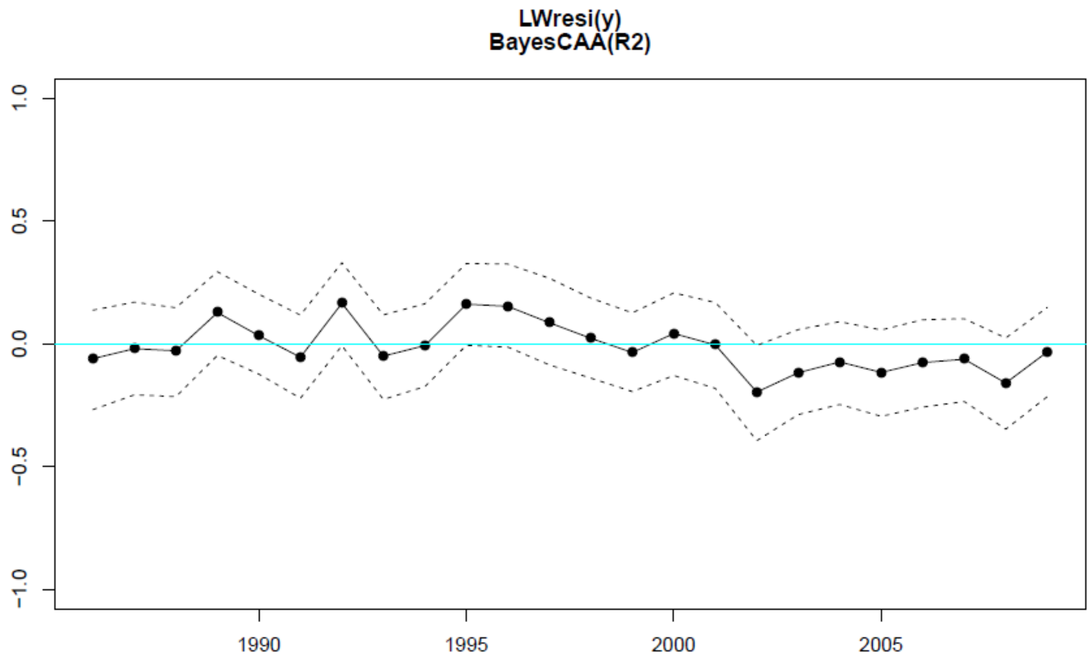


Figure 9:

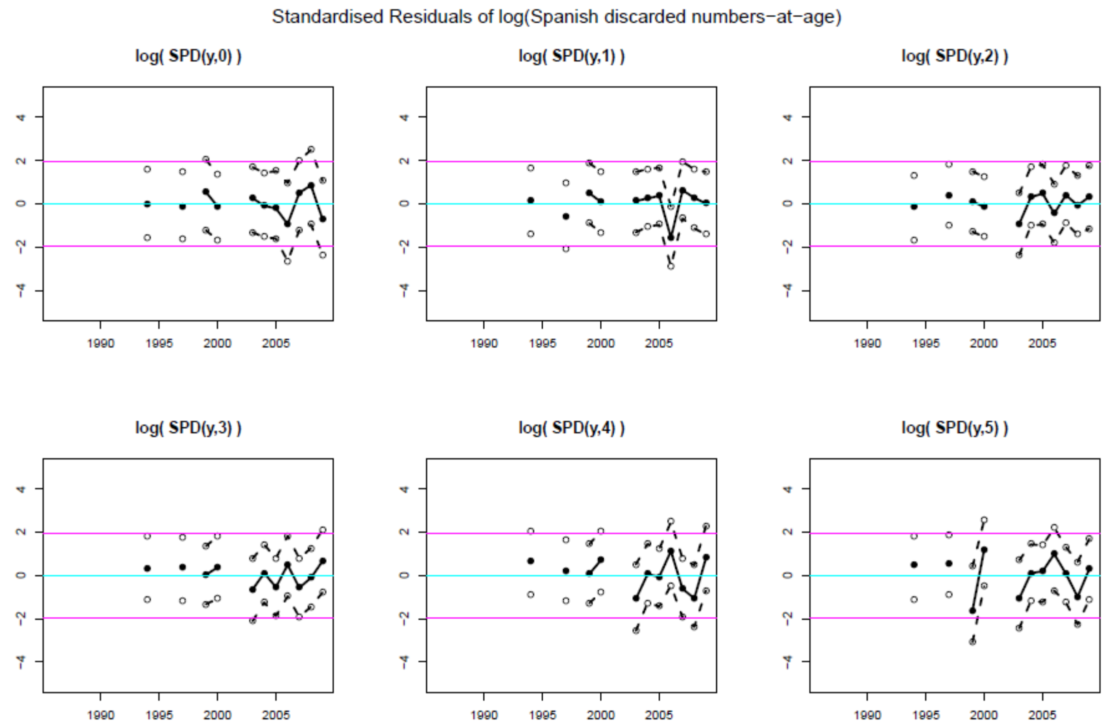


Figure 10

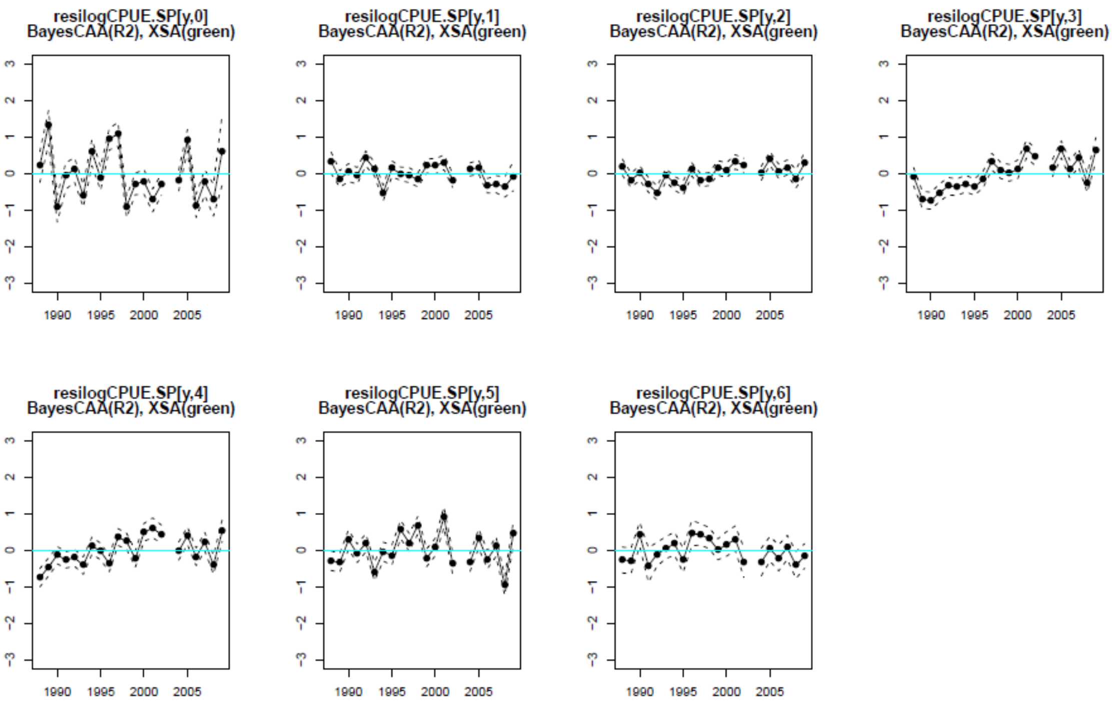


Figure 11

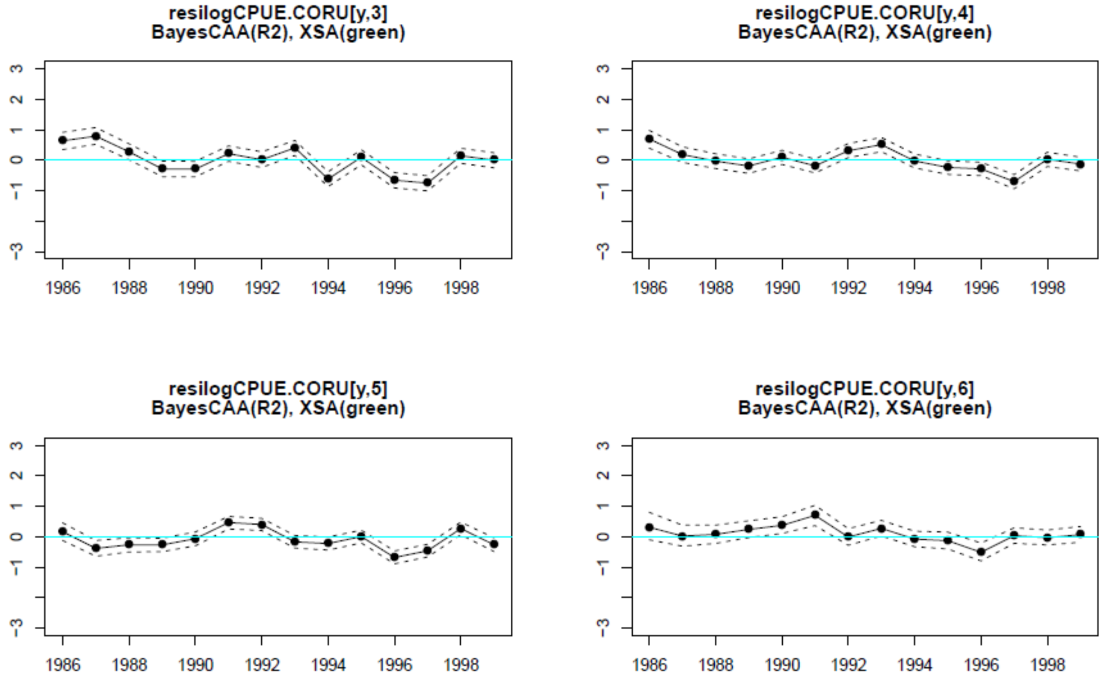
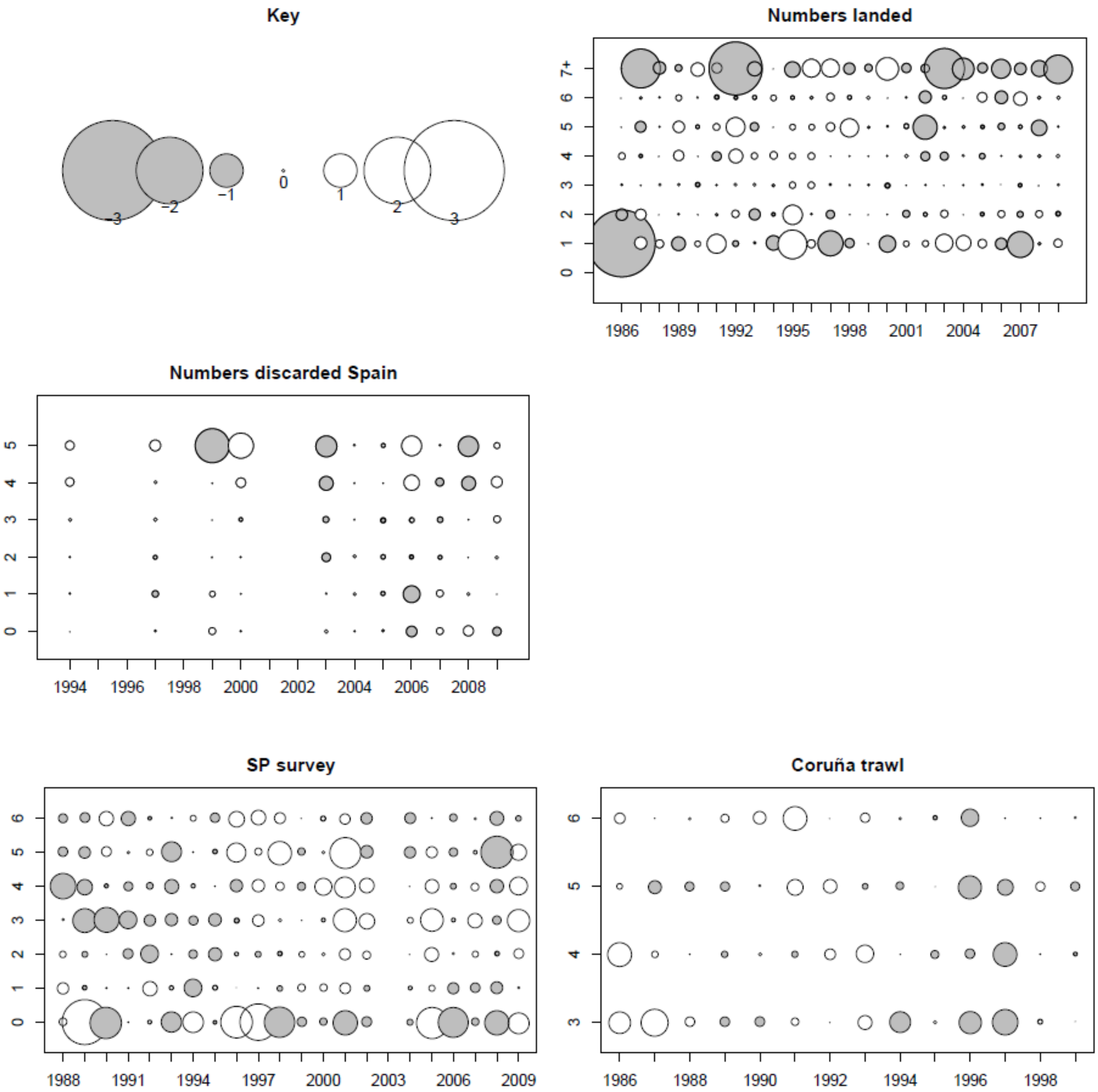
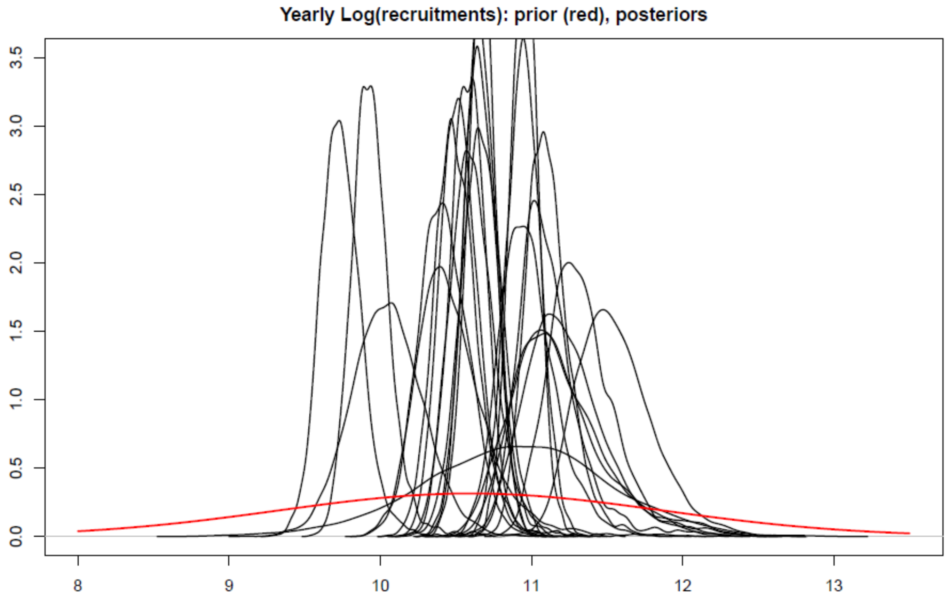

resilogCPUE.CORU[y,3]
BayesCAA(R2), XSA(green)
resilogCPUE.CORU[y,4]
BayesCAA(R2), XSA(green)
resilogCPUE.CORU[y,5]
BayesCAA(R2), XSA(green)
resilogCPUE.CORU[y,6]
BayesCAA(R2), XSA(green)
3
2
1
0
−1
−3
1986
1988
1990
1992
1994
1996
1998

Figure 12 shows bubble plots for the residuals of numbers-at-age of landings, discards and the two tuning fleets. Tracking cohorts is not very clear. It looks there is no year effect. In landings higher residuals are for ages 0 and 7+ and in Coruña trawl since 1994 almost all values are negative, in opposite with medium years where values are positive.



As in the model for southern hake, when discards are incorporated, recruitment and fishing mortality for young ages increase. We need to evaluate the influence on biological reference points and make projections to detect short and long-term effects on the assessment.



References:

Fernández, C., Cerviño, S., Pérez, N., and Jardim, E. 2010. Stock assessment and projections incorporating discard estimates in some years: an application to the hake stock in ICES Divisions VIIIc and IXa. ICES Journal of Marine Science, 67: 1185–1197.