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WKMSEMAC Doc HS2

Note on northeast Atlantic mackerel

SPM parameters for three alternative curve shapes – based on a stock assessment that includes misreported catches 1980-2006

By

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Unreported catches in the past have been very substantial. ICES (2013) looked closely into this and identified four periods of misreporting and ranges of likely misreporting factors were set for each period. ICES (2013) estimates misreporting to be at least 70% and at most 260% in 1972-1989, at least 70% and at most 150% in 1990-2000, and at least 10% and at most 70% in 2001-2005, and almost no misreporting since 2006.

In WKMSEMAC Doc HS1 we argue that the most realistic set of historic catch includes misreporting. We also argue that the assessment based on these from ICES 2013 supplemented with reconstructed stock size estimates for 2012-2018 is the most likely reflection of the past. Using the ratio between sets of TB in 2007-2011 from ICES(2013) and ICES (2019) on TB from ICES (2019) for 2012-2018, these are reconstructed to become consistent with the TBs from the assessment including misreporting by ICES (2013). In that way consistent time series of both catch and TB that includes misreporting are established for 1980-2018. Ideally, a new assessment like the one done by ICES (2019) for 1980-2018 should be run that includes misreported catches, but that is a very time-consuming task. The current reconstruction is considered a good approximation and appropriate for the following analysis of estimating the parameters in SPMs.

Surplus Production Models were estimated based on these catch and TB data. Six models were estimated:

1. the shape parameter Bmsy/K = 0.50, which is the Schaefer model;
2. Bmsy/K = 0.404 equal to the estimate for "all taxa" from Thorson *et al.* (2012);
3. Bmsy/K = 0.353 equal to the estimate for "Perciformes fish" from Thorson *et al.* (2012);
4. fitted to the Fmsy value from the Fmsy-project (www.Fmsyproject.com) and assuming Bmsy/K = 0.5;
5. fitted to the Fmsy value from the Fmsy-project (www.Fmsyproject.com) and assuming Bmsy/K = 0.404;
6. fitted to the Fmsy value from the Fmsy-project (www.Fmsyproject.com) and assuming Bmsy/K = 0.353.

Maximum likelihood parameter estimation was applied assuming a normal distribution of surplus production around the production curve. The results are presented in Figure 1. Residuals for model 4 and 6 are shown in Figure 2 and qqplots in Figure 3. There is not enough information in the observed data to determine which one of the six SPMs is preferable. They have about the same SSQ values. The results in terms of MSY, Bmsy, K

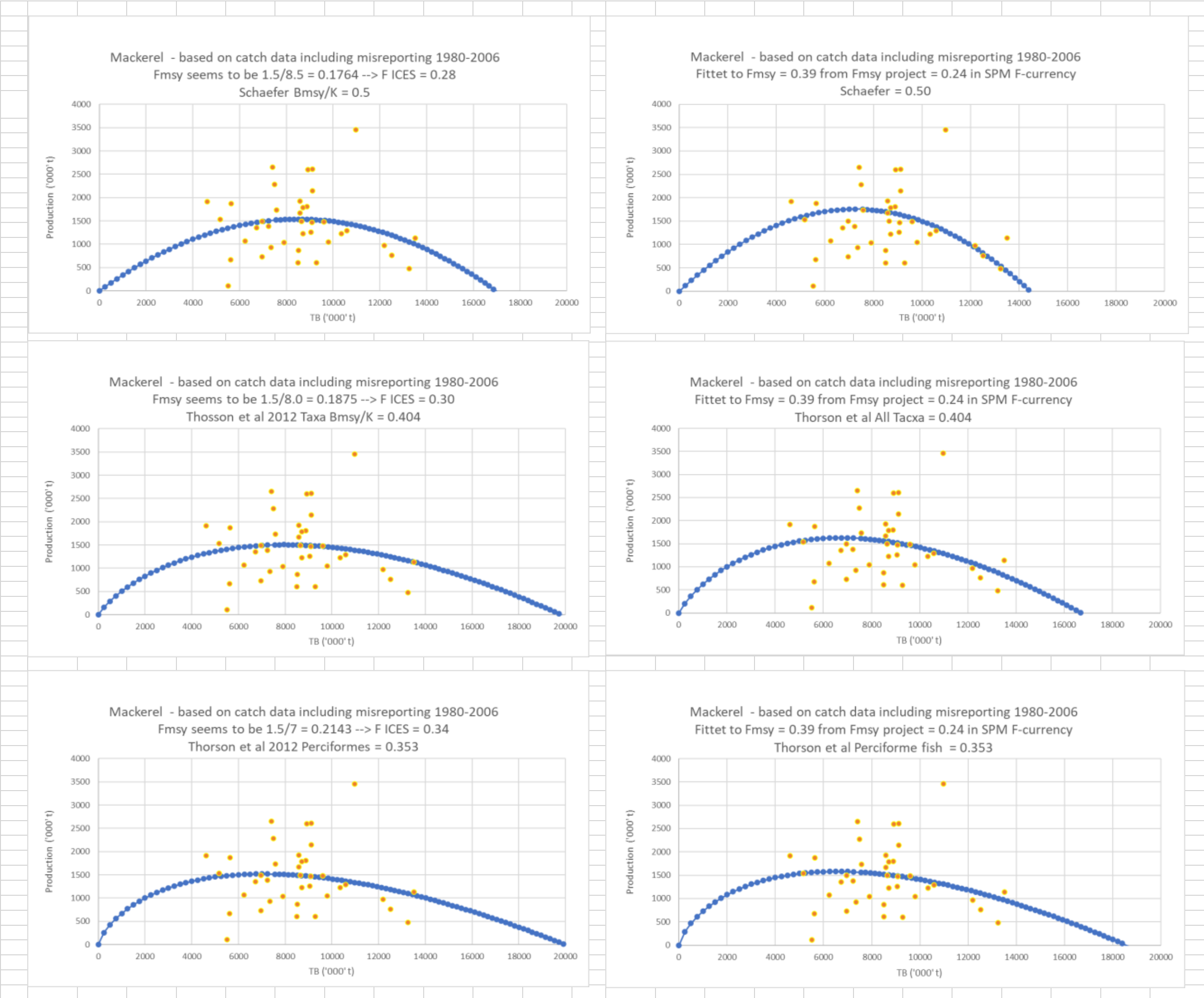

Figure 1. *Mackerel. Estimated production curves based on catch data (including misreporting 1980-2006) and total stock biomass estimates from ICES annual assessment combined from ICES (2013) and ICES (2019) as described in the text.*

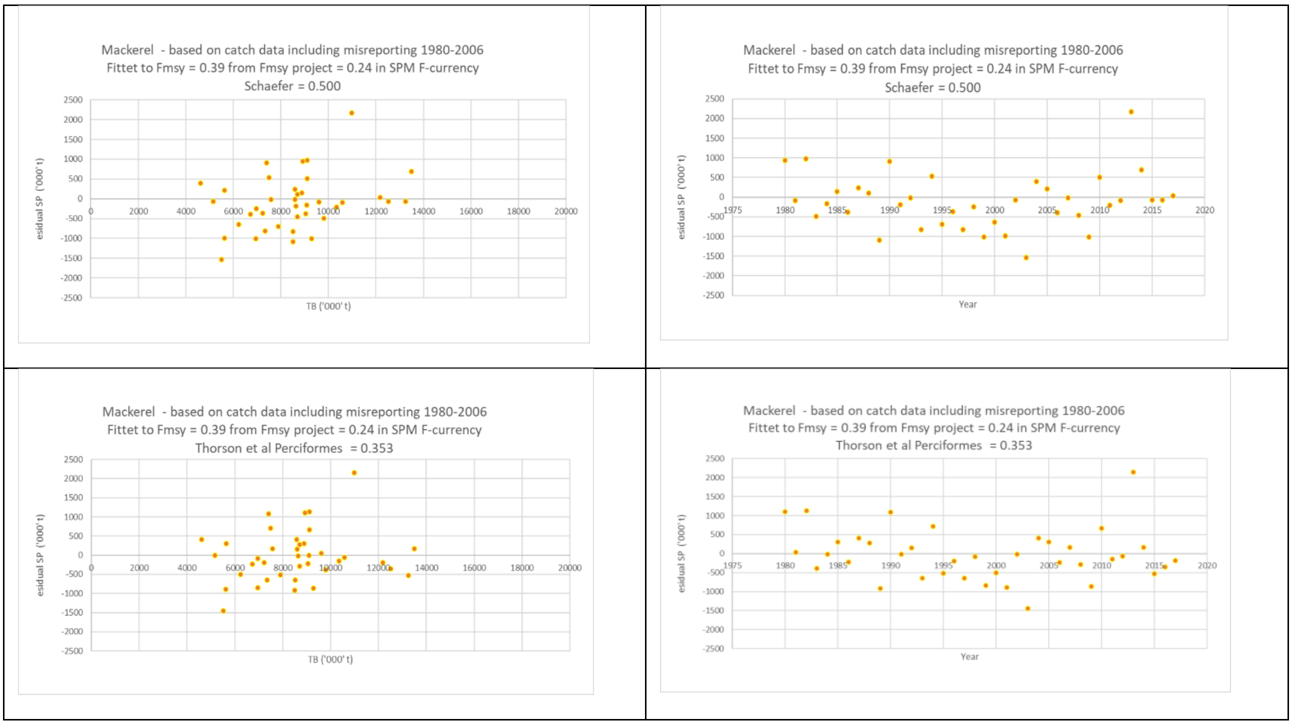

Figure 2. *Mackerel. Residuals for the models #4 (top panels) and #6 (bottom panels) in Table 2, vs TB (total stock biomass) (left panels) and year (right panels).*

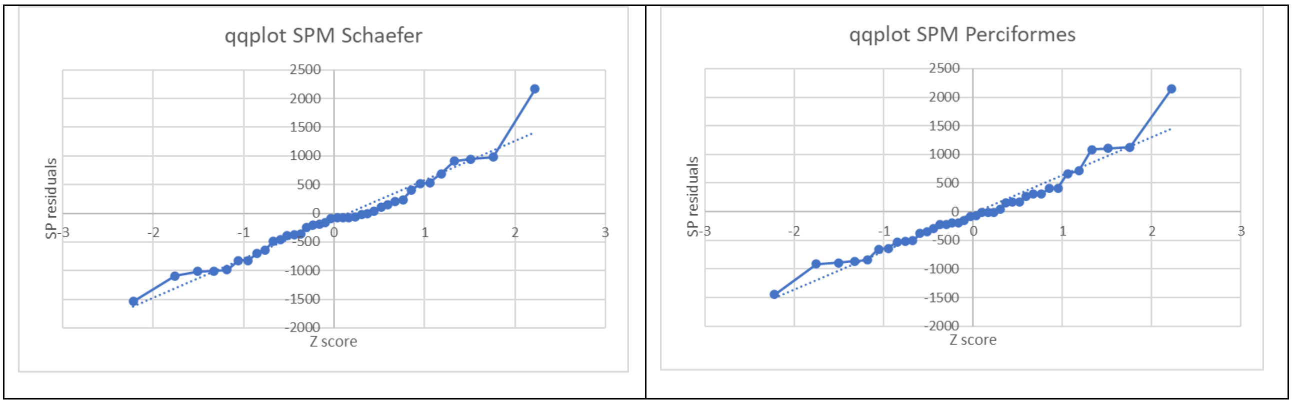

Figure 3. *Mackerel. Residuals qqplot for the models #4 (left panel) and #6 (right panel) in Table 2.*

and Fmsy however vary somewhat (Table 1). Information external to the data from the stock itself, needs to be considered to make further judgements. The Fmsy from the Fmsy project carries such extra information because it is based on several sources of information: results from dynamic pool age based models including density dependent recruitment and growth, variable length of time series of data in a whole suite of SPMs, and multivariate meta-analysis of Fmsy values in relation to life history parameters from 53 data rich stocks in the northeast Atlantic. Other external information used is from Thorson *et al.* (2012) who from meta-analysis determined the shape of the SPMs as mean of 141 fish stocks (shape parameter n (=Bmsy/K) = 0.404 and for Perciformes (mackerel belongs to this group) stocks n = 0.353. For the Schaefer model n=0.5.

Table 1. *Mackerel. Parameter estimates of the three SPMs considered.*

SPM model	Bmsy/K (SPM shape parameter)	SSQs $*10^{-6}$	AIC	AICc	Bmsy million t	MSY in million t	K (Carrying capacity) million t	MSY/Bmsy
#1 Schaefer	0.500	16.47			8.5	1.5	16.9	0.18
#2 Thorson *et al.* (2012) “all taxa”	0.404	16.82			8.0	1.5	19.8	0.19
#3 Thorson *et al.* (2012) “Perciformes”	0.353	17.06	256.7	258.1	7.0	1.5	20.0	0.21
#4 Fitted to Fmsy from Fmsy -project – assuming Schaefer	0.5	18.58	256.0	256.4	7.2	1.7	14.5	0.24
#5 Fitted to Fmsy from Fmsy -project – assuming Thorson *et al.* (2012) “all taxa”	0.404	17.40			6.8	1.6	16.7	0.24
#6 Fitted to Fmsy from Fmsy -project – assuming Thorson *et al.* (2012) “Perciformes”	0.353	17.30	254.9	255.3	6.5	1.6	18.6	0.24

In terms of implications for MSE of mackerel, all six models could be tried as OM and MPs that behave satisfactory in all of the OMs would be preferable. Model #4-6 should probably have most weight due to extra information used from the Fmsy-project and model #6 maybe most due to extra information from Thorson *et al.* (2012). The residuals are also slightly better than for model #4 and the AIC and AICc best of all six models. This model #6 should therefore be the base case OM.

References.

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