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Note on northeast Atlantic mackerel

Misreporting in the past and its influence on recent assessments and MSEs

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 (Table 1, from ICES 2013). 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 nothing since 2006.

Table 1. Estimated ranges of misreporting during the four time periods considered.

Period	Year Range	Misreporting Factor	
		Lower bound	*Upper bound*
Klondyking	1972 – 1989	1.7	3.6
Japanese market highgrading	1990 – 2000	1.7	2.5
Uncontrolled IUU	2001 – 2005	1.1	1.7
'Golden age'	2006- 2011	1	1.1

Catches by year including misreporting (assuming it to be around the mid-point of the lower and upper bound from Table 1, are plotted in Figure 1 along with the current set of catch values used by ICES (2019) in the assessment.

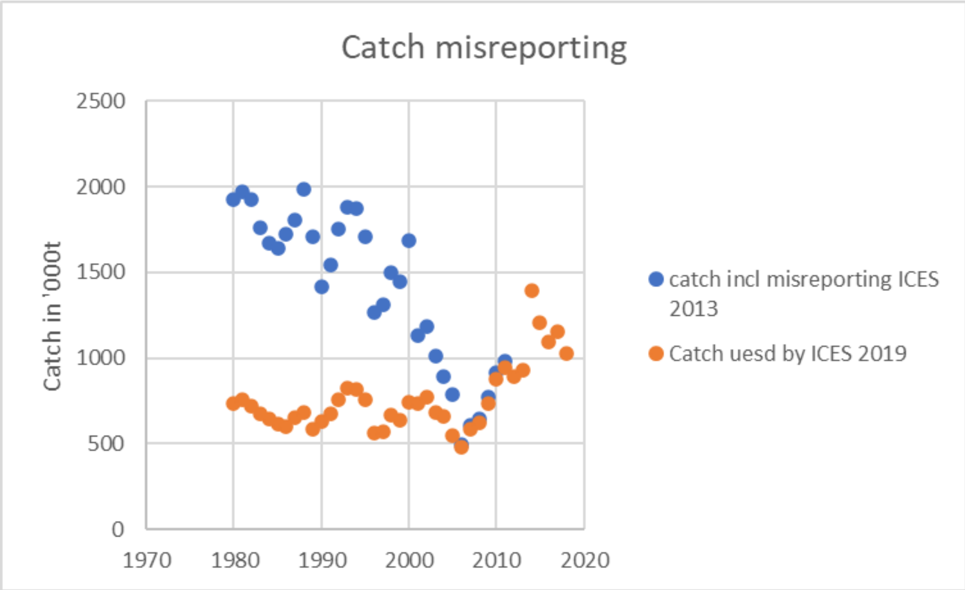

Figure 1. *Mackerel. Catch in weight by year for catches including misreporting (blue dots) and for the current set of values used by ICES (2019) in its assessment.*

ICES (2013) made assessment runs with the catches including misreporting and got the median total biomass (TB) of the stock by year as shown in Figure 2. Also shown are the TBs from the ICES (2019) assessment. The TB from an assessment including misreporting are about twice the TB from the ICES (2019) assessment in all years. It might be surprising that also for the recent years (2006-2011) where the catches are almost equal, that we have a difference of about a factor of 2 in TB estimates for 2006-2011. However, this is likely due to the catchability coefficients estimated for the tuning survey time series. Because currently, ICES (2019) is only estimating historical TBs around half the size of the assessment including misreporting, then catchabilities becomes twice as large and therefore the current TBs (2012-2018) will be a factor of 2 lower than the TBs from ICES (2019). Using the ratio between these two sets of TB in 2007-2011 on TB from ICES (2019), TBs for 2012-2018 that are consistent with the TBs from the assessment including misreporting were reconstructed.

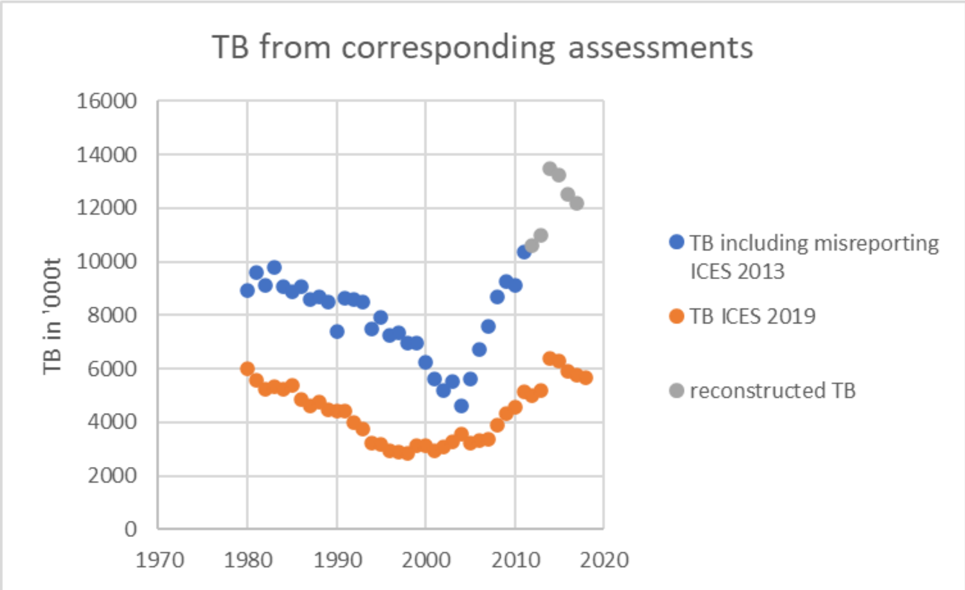

Figure 2. *Mackerel. Total Biomass (TB) of the stock by year from assessment using catch data including misreporting from ICES (2013) (blue dots), using the ICES (2019) catch data (red dots), and using the ratio between these two sets of TB in 2007-2011 on TB from ICES (2019) to reconstruct TBs for 2012-2018 that are consistent with the TBs from the assessment including misreporting.*

If we consider how these catches and assessments fit with Surplus Production Models (SPM), we have fitted the Schaefer model to the “observations” and used the estimate of MSY/BMSY = 0.2412 from the Fmsy-project.

The Schaefer production curve is determined by two parameters, r and K, where r is the slope at the origin and K is the virgin stock biomass. In the Schaefer curve r = 2* MSY/BMSY and r is therefore 0.482. The next step is to find the K for the curve.

Fitting the curve to the observed production by year is done below using the maximum likelihood fitting. The top plot in Figure 3 uses all observations, i.e. from 1980 to 2017. This gives K = 7.622 million t.

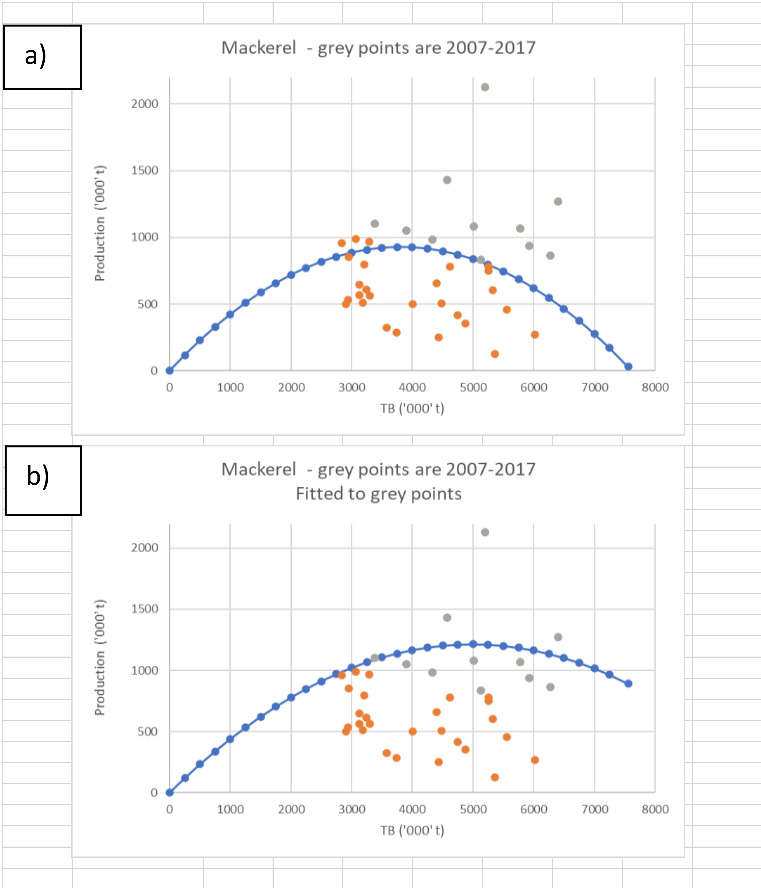

Figure 3. *NE Atlantic Mackerel. Schaefer production curve based on the new Fmsy value from the Fmsy-project and ICES assessment 2019. The r value is 2 times Fmsy and K is obtained by fitting the observed production by year with the maximum likelihood approach. In a) all data points are used in the fitting. In b) only data points from 2007-2017 where misreporting in catches are regarded as minor.*

After 2006 the catch data are regarded as reliable. The grey points in the plots are from the years after 2006 and supposed not to suffer from this misreporting. They are all above the curve in the top plot. Thus, Figure (3b) where the SPM is fitted only to the grey points are more likely a reflection of the realities in the stock dynamics. This has a K = 9.976 million t. Process error is the CV of grey points and is 0.27. This however suffer from the problem that the assessment by ICES (2019) is an underestimate of the stock it seems from comparing with ICES (2013) historically and thus estimated catchabilities to survey tuning indices biased. The real K is therefore likely to be much larger than 9.976 million t.

Another option to get K is to look at the mean F from 1980-2017 compared to Fmsy. If it is around Fmsy it can be expected that the observations of the productivity by year are around the peak of the production curve and K is then found to be values which gives this result. If the mean F is lower than Fmsy it can be expected that the observations are to the right of the peak in the production curve and vice versa if the mean F is above Fmsy.

It turns out the mean F is 0.179 (from the ICES assessment and on the F-currency scale of the SPMs – i.e. catch biomass divided by total biomass) which is lower than Fmsy (0.241). Thus, the observations should generally be to the right of the peak of the production curve. This seems to be the case in the upper plot in Figure 3, but not in the lower plot. However, when an assessment is run with the reported + unreported catch data (ICES 2013), the points for 1980-2006 move to the right in the plot and as well as upwards, because the higher catches will increase the estimated TB in the assessment for the years prior to 2006 and will be added to the production values. F is not likely to change a lot as F is tightly linked to the age composition of the catch data which do not change. Therefore, as expected a plot based on such an assessment (Figure 4) shows that most data points are to the right side of the peak of the curve in the bottom plot and thus consistent with the mean F being lower than Fmsy. However, it is also clear that the data points for 1980-2006 are now indicating that K should be even higher than 9.976 million t.

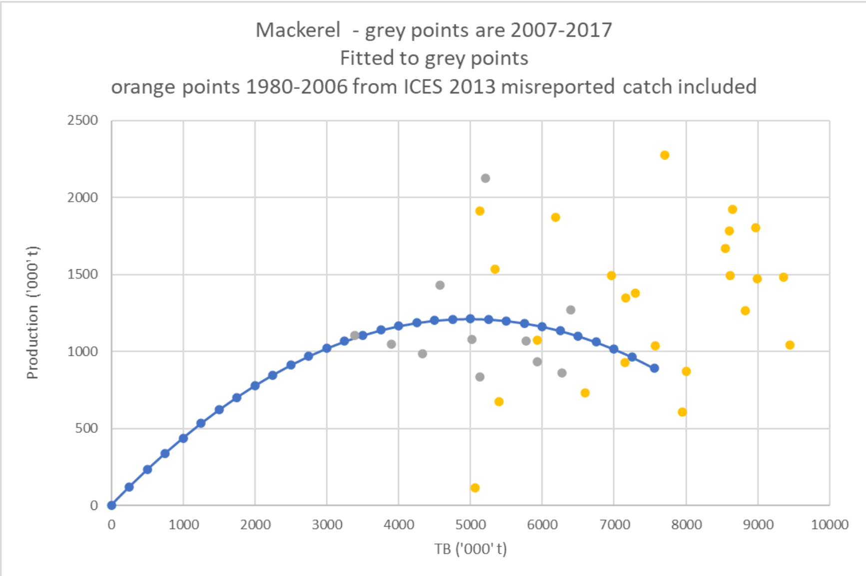

Figure 4. *Same plot as lower plot in Figure 1, except that the points from 1980-2006 now are based on the assessment done by ICES (2013), which included unreported catches.*

There seems to be a broad consensus among scientists and fishers that the ICES (2019) catches are underestimates for 1980-2006. ICES (2013) made an effort to come up with the best possible estimates of unreported catches, drawing upon all types of relevant data available (research vessel surveys, fisheries inspectors, interviews with the fishers and buyers, and others) but by nature these estimates are difficult to document precisely and to compile quantitatively.

If we must choose one only, the ICES (2013) one with the addition of the reconstructed TBs for 2012-2018 seems as the most likely reflection of the reality. The ICES (2019) catch data are according to ICES (2013) an underestimate of at least 70% in 1980-2000, and thus hardly relevant for MSE calculations.

The difference between the two data sets will fade out over the coming years and be smaller in terms of final-year TB estimates because the data from before 2006 will have less influence on the final-year stocks estimates. These stock estimates are the ones to stick into any agreed HCR (Harvest Control Rule – also called Management Plan by some).

An observation model that mimics a fading out of this large bias in estimated/perceived TB might be considered in the MSE, if the misreporting is not fully accounted for in the future annual assessments.

Conclusion: The catch data time series including misreporting fits better with knowledge from the fishery and with normal stock dynamic as exemplified with via Surplus Production Model considerations than the time series without misreporting. This has important implications for the biological OM used in MSEs.

References.

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