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UPDATE OF THE MACKEREL SSB ESTIMATED FROM THE TRIENNIAL ANNUAL EGG PRODUCTION METHOD SURVEYS.

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Introduction

Following the recommendation of the 2014 WKPELA benchmark workshop (ICES, 2014a), WGMEGS carried out a revision of the mackerel egg survey historical database and a recalculation of the whole time series of the TAEP (Total Annual Egg Production) and SSB (Spawning Stock Biomass) in 2014. The historical time series was recalculated by applying the Mendiola mackerel egg development equation (Mendiola et al., 2006) instead of the Lockwood equation (Lockwood et al. 1977). The decision to use the Mendiola mackerel egg development equation instead of Lockwood's (traditional methodology) was adopted by WGMEGS in 2012 (ICES, 2012).

Material and Methods

The review TAEP estimates of the whole time series were calculated using a new updated code in R that has been developed in recent years. Until 2007 a FORTRAN code was used to estimate TAEP for mackerel. From 2010 onwards a new code in R was used to estimate mackerel and horse mackerel TAEP. This has been updated and developed further in 2015 to include checking routines which consequently detected some bugs in the existing script and which have now been corrected. . The most important bug detected was in the interpolation algorithm. This bug resulted in the algorithm not correctly integrating the unsampled neighboring rectangle area to the sampled rectangle. This resulted in an overall underestimation of the egg production for interpolated rectangles. Consequently, the revised time-series estimates provided within this working document in Figures 1 - 3 and Tables 1 - 3 do not correspond and in fact supercede those TAEP and SSB estimates presented to WGWIDE in 2014 (ICES, 2014c).

The estimate of TAEP variance was also calculated over the same period and is presented using the Mendiola equation (tables 1 - 3). These variances were calculated using 2 methods. The variance of the TAEP estimate is based on assuming that the raw production data are distributed with a constant Coefficient of Variation (CV). The CV of the data can be estimated by assuming a lognormal distribution for the positive egg production observations. The CV by traditional methodology is calculated by an ANOVA of log daily production on replicate rectangles that have at least two hauls of non-zero observations in each period. An alternative methodology is estimate CV by a GAM using interaction latitude, longitude and period to model the log egg production. This alternative methodology permits the use of more data points as opposed to the traditional methodology and is therefore more suited to the MEGS dataset.

Results

The main results using Mendiola mackerel egg development equation in the temporal series and the update code in R for mackerel components are presented in Tables 1 – 3 and Figure 4 & 6.

As result a revised time-series of TAEP and SSB estimates that show an increase of around 25% for the TAEP and SSB compared to previously reported estimates. (Figures 1-4)

Differences in the TAEP and SSB in the time-series between reported values and the new update of the egg development equation over the revised egg production database from 1992 to 2013 are shown in Figures 1 – 3. In the updated time-series the 1992 and 1995 estimations were revised substantially.

- The reported 1992 estimate had not included the egg production from the southern area of the survey so it was corrected to include those data. In addition, the 1992 survey did not cover the entire distribution of the mackerel eggs because the survey design just covered a denoted "standard area" that was defined in previous reports (ICES, 1993).

- In the original calculation of the 1995 reported estimate only the data from the "standard area" corresponding to that used in 1992 (ICES, 1996) were used. The revised estimate in 2014 includes all the data collected from the entire surveyed area, thus providing more complete coverage of the spawning distribution in the western area. The reported TAEP estimation for the 2013 survey was calculated using the mendiola development equation whereas the previous reported estimates utilized the Lockwood development equation.

These results were also presented in the WGMEGS in 2015 (ICES, 2015).

References

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Lockwood, S. J., Nichols, J. H., and Coombs, S. H. 1977. The development rates of mackerel (Scomber scombrus L.) eggs over a range of temperature. ICES CM 1977/J:13, 8pp.

Mendiola, D., P. Alvarez, U. Cotano, E. Etxebeste, A. Martínez de Murguia, 2006. Effects of temperature on development and mortality of Atlantic mackerel fish eggs. Fisheries Research 80 (2006) 158–168.

Component	Year	TAEP (n.stag.1 egg)	CV TAEP (var. Trad.)	CV TAEP (var. GAM)	SSB (000 t)	CV SSB
southern	1992	4.45*e14	3%	3%	672.4	NA
southern	1995	3.02*e14	81%	20%	601.3	81%
southern	1998	6.43*e14	244%	99%	1185.7	244%
southern	2001	3.66*e14	52%	32%	479.4	52%
southern	2004	1.65*e14	41%	18%	370.0	41%
southern	2007	4.42*e14	60%	32%	945.3	NA
southern	2010	5.72*e14	67%	36%	1154.9	NA
southern	2013	7.79*e14	113%	45%	1391.0	NA

Table 1. Results of TAEP and SSB estimates and coefficient of variation for mackerel southern component using Mendiola mackerel egg development equation across the whole temporal-series of the International Mackerel Egg Surveys (1992-2013).

Component	Year	TAEP (n.stag.1 egg)	CV TAEP (var. Trad.)	CV TAEP (var. GAM)	SSB (000 t)	CV SSB
western	1992	2.82*e15	7%	6%	4263.6	NA
western	1995	2.35*e15	26%	27%	3904.6	26%
western	1998	1.65*e15	16%	14%	3558.6	16%
western	2001	1.48*e15	23%	17%	3105.0	23%
western	2004	1.51*e15	21%	12%	3109.5	27%
western	2007	1.63*e15	17%	11%	3483.2	NA
western	2010	2.12*e15	16%	13%	4285.8	NA
western	2013	2.37*e15	77%	23%	4241.9	NA

Table 2. Results of TAEP and SSB estimates and coefficient of variation for mackerel western component using Mendiola mackerel egg development equation across the whole temporal-series of the International Mackerel Egg Surveys (1992-2013).

Component	Year	TAEP (n.stag.1 egg)	CV TAEP (var. Trad.)	CV TAEP (var. GAM)	SSB (000 t)	CV SSB
NE Atlantic Mackerel	1992	3.27*e15	6%	5%	4936.0	
NE Atlantic Mackerel	1995	2.66*e15	25%	24%	4506.0	25%
NE Atlantic Mackerel	1998	2.29*e15	69%	10%	4744.4	
NE Atlantic Mackerel	2001	1.85*e15	21%	15%	3584.5	21%
NE Atlantic Mackerel	2004	1.68*e15	19%	11%	3479.4	24%
NE Atlantic Mackerel	2007	2.07*e15	19%	11%	4428.5	
NE Atlantic Mackerel	2010	2.70*e15	19%	13%	5440.7	
NE Atlantic Mackerel	2013	3.15*e15	64%	21%	5632.9	

Table 3. Results of TAEP and SSB estimates and coefficient of variation for NEA mackerel combined components using Mendiola mackerel egg development equation across the whole temporal-series of the International Mackerel Egg Surveys (1992-2013).

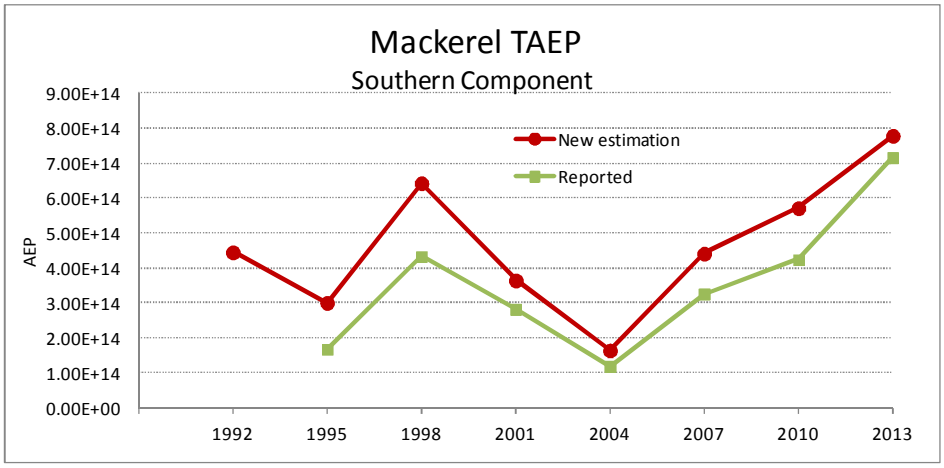

Figure 1. Mackerel AEP estimates (n. of stage 1 mackerel eggs) for the southern survey area. The green line represents the reported estimates for the southern component mackerel. The red line represents the new estimates.

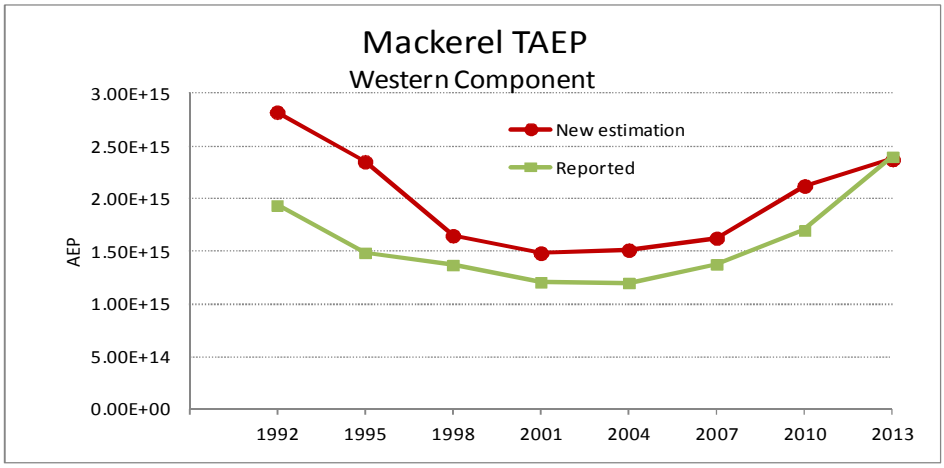

Figure 2. Mackerel AEP estimates (n. of stage 1 mackerel eggs) for the western survey area. The green line represents the reported estimates for the Western component mackerel. The red line represents the new estimates.

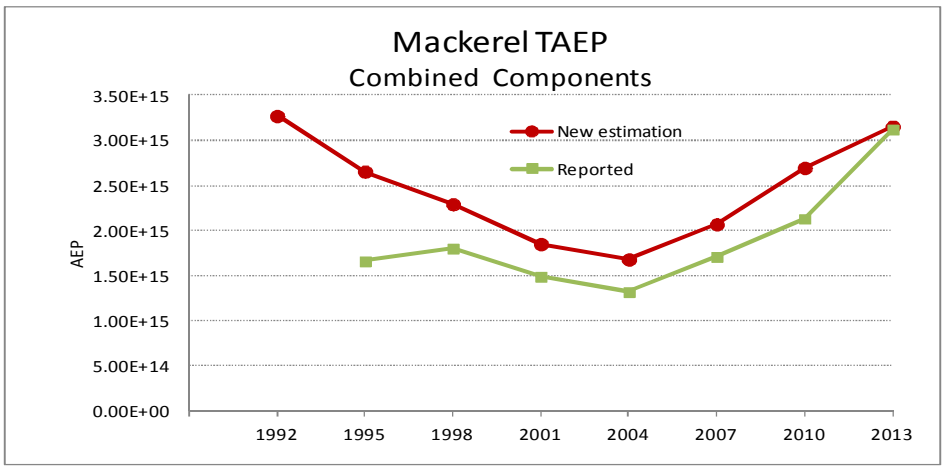

Figure 3. NE Atlantic Mackerel Annual egg Production (AEP) estimates for the combined survey area. The green line represents the input data for the mackerel assessment until 2012. The red line represents the update recalculated egg production using Mendiola equation. It should be noted that reported egg production in 2013 was estimated using Mendiola equation.

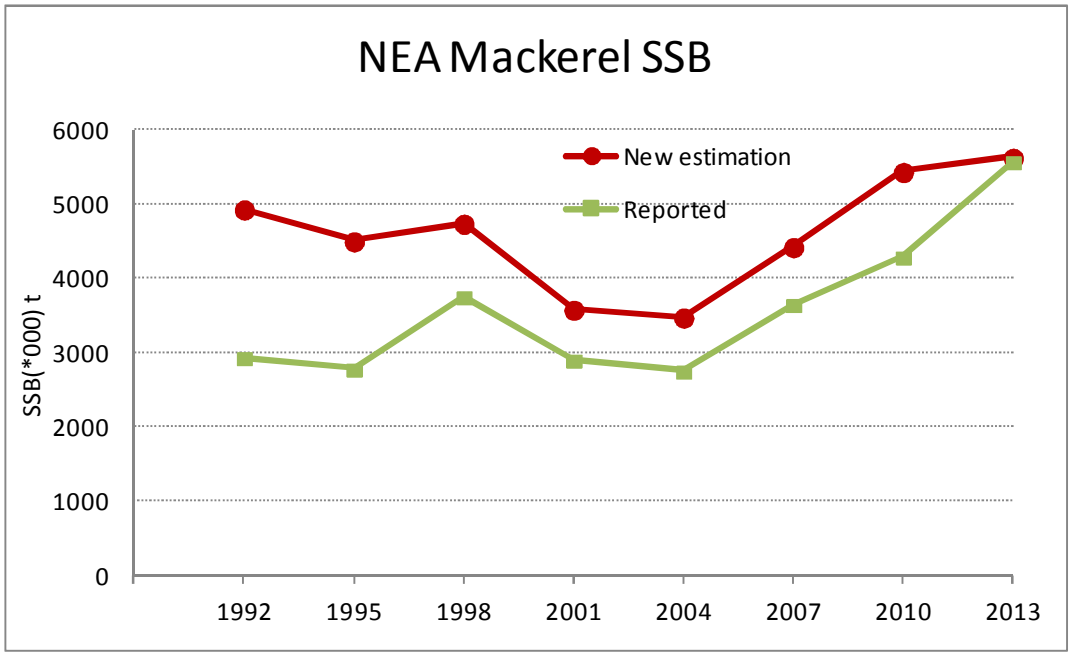

Figure 4. NE Atlantic mackerel SSB estimates derived from the mackerel egg surveys for the combined survey are. The green line represents the reported estimates for the mackerel. The red line represents the agreed new estimates input data by WGWIDE 2014 using Mendiola egg development equation.

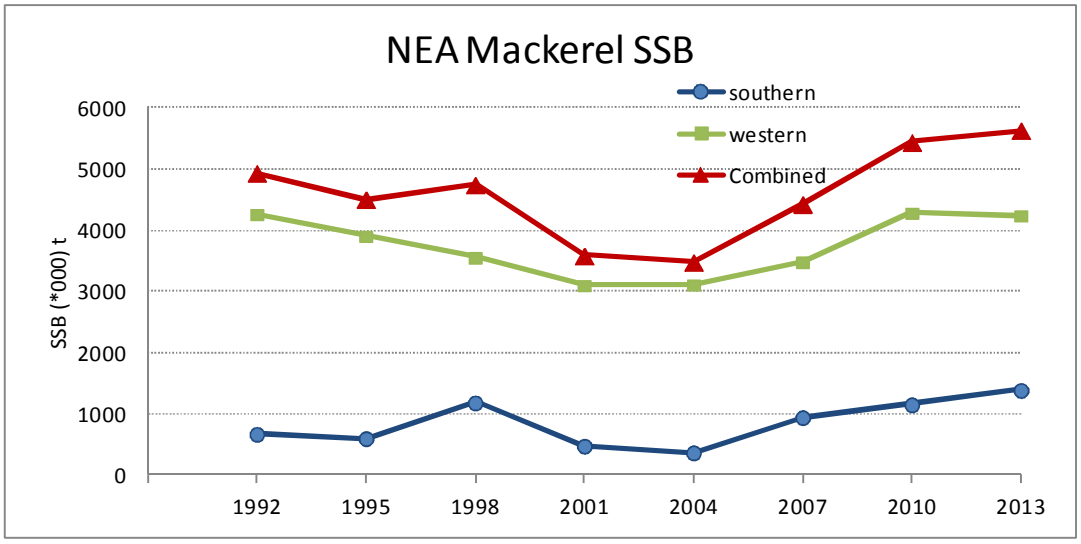

Figure 5. Atlantic mackerel SSB estimates derived from the mackerel egg surveys for the southern (blue), western (green) and combined (red) survey areas using Mendiola egg development equation.

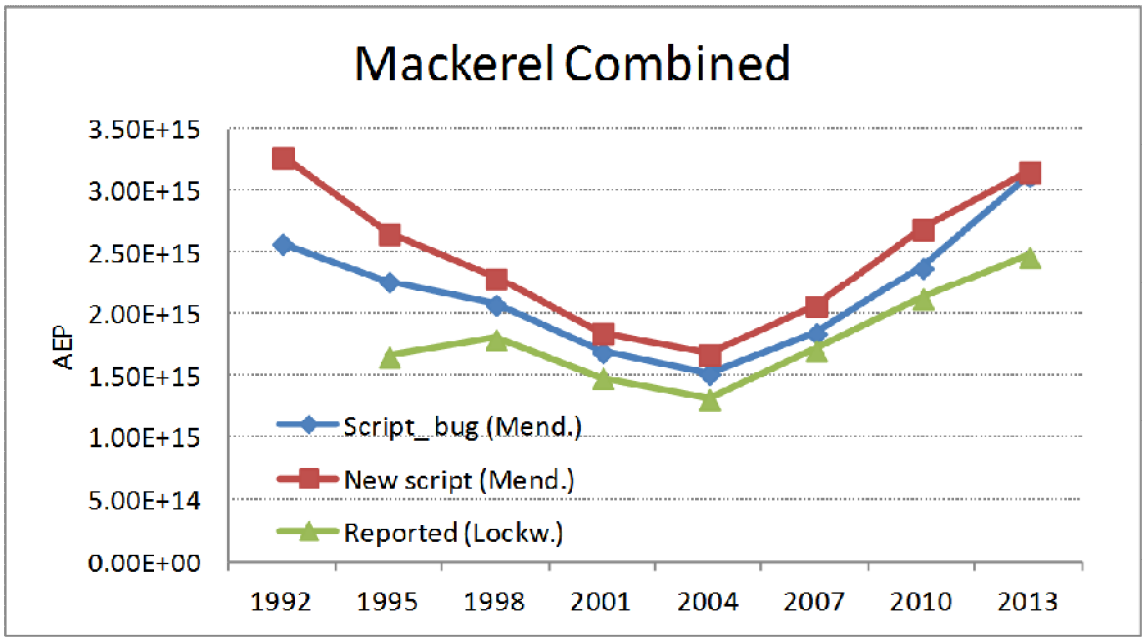

Figure 6. Comparison of the originally reported (using Lockwood eq.), recalculation presented in 2014 using Mendiola eq. (Script with interpolation bug) and update revised mackerel egg production (using Mendiola eq.) for the NEA mackerel combined components.