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Enhancing survey coverage with no net increase in survey effort

Matthias Kloppmann[1], Finlay Burns[2], Cindy van Damme[3], Jens Ulleweit[1]

[1] Thünen Institute of Sea Fisheries, Palmaille 9, 22767 Hamburg, Germany
[2] Marine Scotland, Science, Marine Laboratory, 375 Victoria Road, Aberdeen AB11 9DB, UK
[3] IMARES, Haringkade 1, 1970 AB IJmuiden, The Netherlands.

Extended Abstract:

The mackerel egg survey (MEGS) delivers the only fishery independent data for the assessment of Northeast Atlantic mackerel. Changes in the temporal and geographical distribution of mackerel spawning coupled with renewed discussion surrounding the spawning biology in mackerel necessitated an examination of the traditional MEGS design. During the 2007 MEGS a large expansion of the mackerel spawning area to the Northwest was observed for the first time. This raised concerns whether it would be possible to cover the entire spawning area during future surveys with the limited available ship time. As an alternative survey strategy sampling on every other standard transect was proposed in order to gain ship time to survey a much larger area in the Northwest. However, reliability of the survey results shouldn't be affected by such modification of the survey strategy.

Exceptionally good weather during the 2007 survey allowed for an excellent coverage of the survey enabling a recalculation of the total egg production from interpolating every other transect for almost all sampling periods. Also, replicate sampling during the 2007 MEGS provided information on intra period egg production variability as well as the potential impact to the total annual egg production (TAEP) of only surveying alternate transects.

TAEP recalculation

In order to test possible effects of sampling every other transect, the 2007 annual egg production was recalculated based on evenly or oddly numbered transects only. Therefore, results from either even resp. odd transects were deleted and subsequently interpolated from neighboring stations as described in the MEGS manual. The recalculation was done for the western component of the stock and for periods 2 – 5 only, since period 6 was already done on alternating transects.

Recalculation of the 2007 survey results showed that using alternating transect approach would have resulted in either 16.7 % under- or 14.7 % overestimation of the total annual stage I egg production depending on whether interpolation was done on evenly or oddly numbered transects. Total annual egg production was either $1.11 * 10^{15}$ when interpolated on even transects or $1.53 * 10^{15}$ when interpolated on odd transects while the originally calculated egg production was $1.34 * 10^{15}$ (Table 1, Figs. 1 & 2).

Table 1: Western estimate of mackerel total stage I egg production by period after integration of area under the egg production histogram for 2007. Grey: values not recalculated			
period	**days**	**Total (even interpolated) production x 10^{15}**	**Total (odd interpolated) production x 10^{15}**
pre 2	41	0.07	0.17
2	30.5	0.19	0.46
3	28	0.14	0.16
4	24.5	0.34	0.37
5	21	0.16	0.17
6	21	0.15	0.15
post 6	15	0.05	0.05
total		**1.11**	**1.53**

While in periods 3 – 5 differences between odd and even transect interpolation was only marginal, major differences occurred for period 2 and, hence, pre 2 (Table 1, Figs 1 & 2). Consequently, the earliest sampling period contributed the most to the difference between both interpolations.

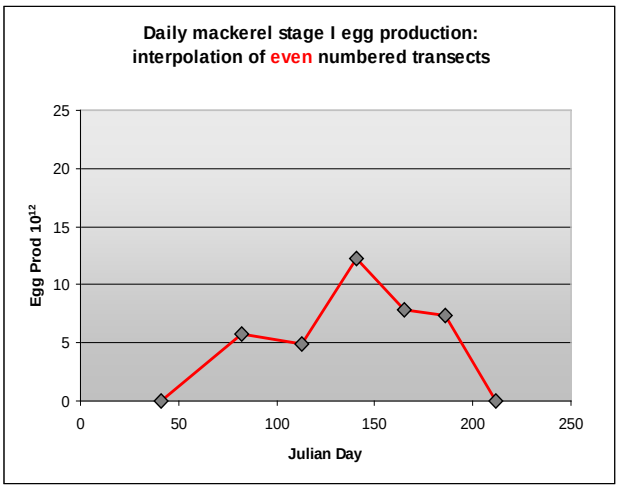

Figure 1: Daily mackerel stage I egg production in 2007 calculated after interpolating the even numbered transects.

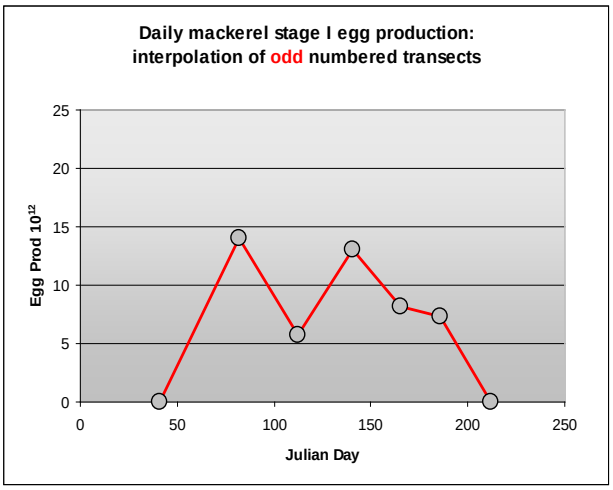

Figure 2: Daily mackerel stage I egg production in 2007 calculated after interpolating the odd numbered transects.

Variability on replicate transects

Altogether, for 5 transects sampled during periods 2 and 3 at least one replicate was available to test for temporal and spatial variability in stage 1 mackerel egg production, 2 transects in sampling period 2 and 3 transects of sampling period 3. Particularly in period 2 when there was large time lag of 10 – 11 days between samplings, the egg production by transect differed conspicuously by an order of magnitude (Table 2). At shorter time lags between replicates differences in total egg production was

much lower even though station by station variability was high. During the 3rd sampling period, differences in total egg production by replicate were lower, even at longer time lags (Table 2).

Table 1: Daily egg production per each replicate. The factor is calculated by dividing the larger result by the smaller one. *) Factor between 1st and 2nd sampling on transect 2 was 1.38, between 2nd and 3rd 1.75 and between 1st and 3rd was 2.42

Transect no.	Egg production 1 eggs transect^{-1} day^{-1}	Egg production 2 eggs transect^{-1} day^{-1}	Egg production 3 eggs transect^{-1} day^{-1}	Factor
1	$8.83 \cdot 10^{10}$	$7.59 \cdot 10^{11}$		8.60
2	$7.20 \cdot 10^{11}$	$5.21 \cdot 10^{11}$	$2.98 \cdot 10^{11}$	*)
3	$1.57 \cdot 10^{11}$	$1.42 \cdot 10^{11}$		1.11
4	$2.53 \cdot 10^{11}$	$1.42 \cdot 10^{10}$		5.86
5	$1.62 \cdot 10^{11}$	$3.60 \cdot 10^{11}$		2.22

Conclusion

High variability in egg production early in the spawning season (period 2 and pre 2) was mainly responsible for the differences between the 2 recalculations of the 2007 TAEP with the highest variability in both abundance and stage composition existing between replicates with the longest time interval between samplings. Short time intervals revealed a large variability when mean abundance was high as well. This station by station variability was to a large degree negated however when calculating the daily egg production by transect. The results show that the alternate transect design is optimised for the AEPM design. Given the current expansion of the mackerel spawning area with every subsequent MEGS survey the alternate transect option provides enhanced survey coverage capability where there is no net increase in survey effort. However, it may be advisable that early in the spawning season when major spawning starts, at least the core of the spawning area is sampled intensively.

Contact author: Matthias Kloppmann, Thünen Institute of Sea Fisheries, Palmaille 9, 22767 Hamburg, Germany, email: matthias.kloppmann@vti.bund.de

Reference number: 2755.