

# North Sea mackerel daily egg production and spawning stock biomass estimation in 2021

C.J.G. van Damme<sup>1</sup>, E. Blom<sup>1</sup>, B. Huwer<sup>2</sup>, F. Burns<sup>3</sup> & G.Costas<sup>4</sup>

<sup>1</sup> Wageningen Marine Research, IJmuiden, The Netherlands

<sup>2</sup> DTU Aqua, Copenhagen, Denmark

<sup>3</sup> Marine Scotland Science, Aberdeen, Scotland

<sup>4</sup> IEO, Vigo, Spain

## Introduction

The North Sea Mackerel Egg Survey (NSMEGS) is designed to estimate the spawning stock biomass (SSB) of mackerel of the North Sea spawning component of the Northeast-Atlantic stock on a triennial basis. Prior to 2017 this was done utilizing the annual egg production method (AEPM). This method estimates and combines total annual egg production (TAEP), realized fecundity per gram female, and sex (male to female) ratio to calculate SSB.

Spatial and temporal coverage in the North Sea was impaired when Norway withdrew from the survey in 2014 and Netherlands was left as the sole survey participant in 2015 and 2017. In 2021 Denmark was recruited as a new participant for the NSMEGS. However, the planned coverage in 2021 of the mackerel spawning in the North Sea, both temporally and spatially, was far from ideal for the Annual Egg Production Method (AEPM; ICES 2018).

Another issue for the NSMEGS is that since 1982 it has been impossible to collect and sample pre-spawning mackerel, which are necessary in order to estimate the potential fecundity. For SSB estimation using the AEPM, the realized fecundity value used was from the 1982 estimate (Iversen and Adoff, 1983).

Consequently, WGMEGS discussed utilizing the Daily Egg Production Method (DEPM) for the NSMEGS. The DEPM only requires one full sweep, in a short time period, of the entire mackerel spawning area, preferably at peak spawning time, in order to estimate the Daily Egg Production (DEP). A disadvantage of the DEPM is that it requires many more mackerel ovary samples to be collected to estimate batch fecundity and spawning fraction. Considering the pros and cons of the AEPM and DEPM for the NSMEGS, in 2018 WGMEGS decided to switch to the DEPM for the NSMEGS in 2021 (ICES 2018).

Originally the NSMEGS was planned for 2020, however, due to the pandemic and the implementation of Covid-19 measures it was not possible to complete the survey in 2020. After consultation with WGMEGS chairs and the mackerel assessor it was agreed to postpone the survey to 2021.

## Survey

In 2021 Netherlands and Denmark conducted the North Sea mackerel egg survey (NSMEGS). Whilst completing an exploratory egg survey, similar to those in 2017 and 2018, along the Norwegian Sea, Scotland was also able to contribute several additional survey transects within the Northern North Sea that were then incorporated into the 2021 NSMEGS dataset.

During 2021 Covid 19 measures continued to pose significant challenges that impeded the execution of the survey plan. The Dutch vessel was not permitted to enter foreign harbours during survey breaks, instead being required to undertake the long steam back to a Dutch harbour. As a consequence the Netherlands was unable to sample the most northerly transect. However Scotland was able to complete this transect during their exploratory survey.

The samples were collected and analysed according to the WGMEGS manuals (ICES 2019a, 2019b). The Netherlands and Scotland sampled eggs with a Gulf VII plankton sampler while Denmark used a Nackthai sampler. The Netherlands and Denmark utilised a 500 µm plankton net whereas Scotland used a 250 µm plankton net. At each station a double oblique haul was performed from the surface to 5 m above the bottom, a maximum depth of 200 m, or 20 m below the thermocline in case of stratification of the water column. Temperature and salinity were measured during the haul with a CTD mounted on top of the plankton sampler. Electronic flowmeters were mounted on the plankton sampler to monitor flow.

The NSMEGS was carried out from 25<sup>th</sup> May to 12<sup>th</sup> June (Table 1). During this period the spawning area between 53°N and 62°N was surveyed once, receiving a single coverage (Fig. 1). The survey is designed to cover the entire spawning area with samples collected every half ICES statistical rectangle (ICES, 2014). In total 294 plankton stations were sampled. In 26 of the half rectangles more than one plankton sample was collected (Fig. 1a). These rectangles were used to estimate the CV and variance of the DEP. On each transect at least one pelagic trawl haul was performed for the collection of mackerel adult samples (Fig. 1b).

Following the WGMEGS manual temperature at 5m depth was used to estimate egg development (ICES 2019a). For the DEPM only the mackerel eggs in development stage 1A are used to estimate daily egg production.

## Results

### Mackerel daily egg production

During the survey the weather was fine. Denmark and Scotland managed to sample all their planned plankton stations. The Netherlands missed 4 plankton stations due to technical issues and limited sampling time.

The spatial egg distribution is shown in Fig. 2. The standard interpolation rules (ICES, 2019a) were applied where needed (see interpolated stations in Fig. 2). The interpolated egg production accounted for 7.3% of the DEP. The egg distribution is comparable to previous surveys in the same area and period, with the highest numbers of eggs found in the south western area. Previous surveys did not sample above 59°N and no comparison with previous years is available for this area.

The DEP was calculated for the total investigated area (Table 2). For comparison with the previous survey, the DEP was also calculated for the area between 53.5 and 59°N which was the area sampled in 2017 in the same period of the year (extended period 2 of 2017). DEP of 2021 was 11% higher compared to 2017 (Table 3), but the sampled area was also a bit larger in 2021 (11%).

### Adult parameters

Denmark was unable to analyse their ovary samples before the WGWIDE 2021 meeting. The Netherlands screened all samples and analysed part of the ovary samples for batch fecundity and spawning fraction estimation. Denmark had finished the screening of the samples. The Dutch and Danish results will be combined for the final estimations in 2022.

The Netherlands sampled 524 mackerel during the survey and collected ovary samples of 164 females. Of these 164 ovaries 73 can be analysed for batch fecundity estimation, and 108 for POF analyses for spawning fraction estimation. For this working document 40 batch fecundity and 51 POF samples were analysed. Denmark sampled 817 mackerel during the survey and collected ovary samples of 119 females.

The adult parameters are still very preliminary, and are therefore not provided in this document. Without adult parameters the SSB cannot be estimated. When final adult parameter estimates are available and agreed by WGMEGS an estimate of SSB will be provided to WGWIDE.

## References

ICES, 2018. Report of the Working Group on Mackerel and Horse Mackerel Egg Surveys (WGMEGS). ICES CM 2018/EOSG:17, 70 pp.

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Iversen, S.A. and Adoff, G.R. 1983. Fecundity observations on mackerel from the Norwegian coast. ICES C.M.1983, H:45, 6pp.

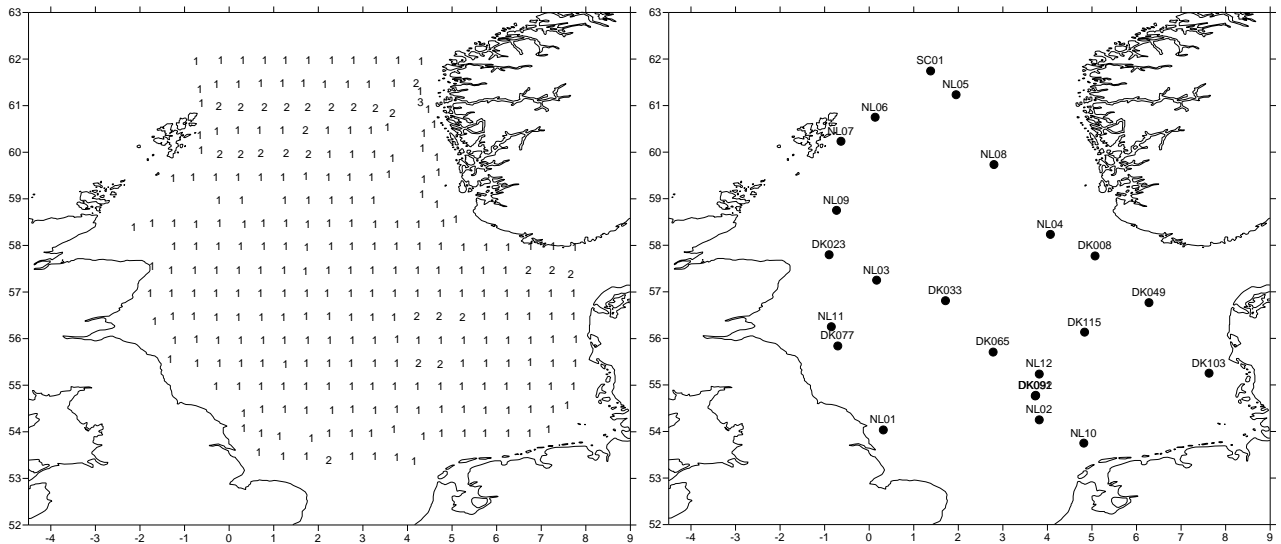


Figure 1. Number of samples for NSMEGS 2021; plankton samples per half ICES rectangle (left) and pelagic trawl hauls for mackerel adult samples (right; all hauls included).

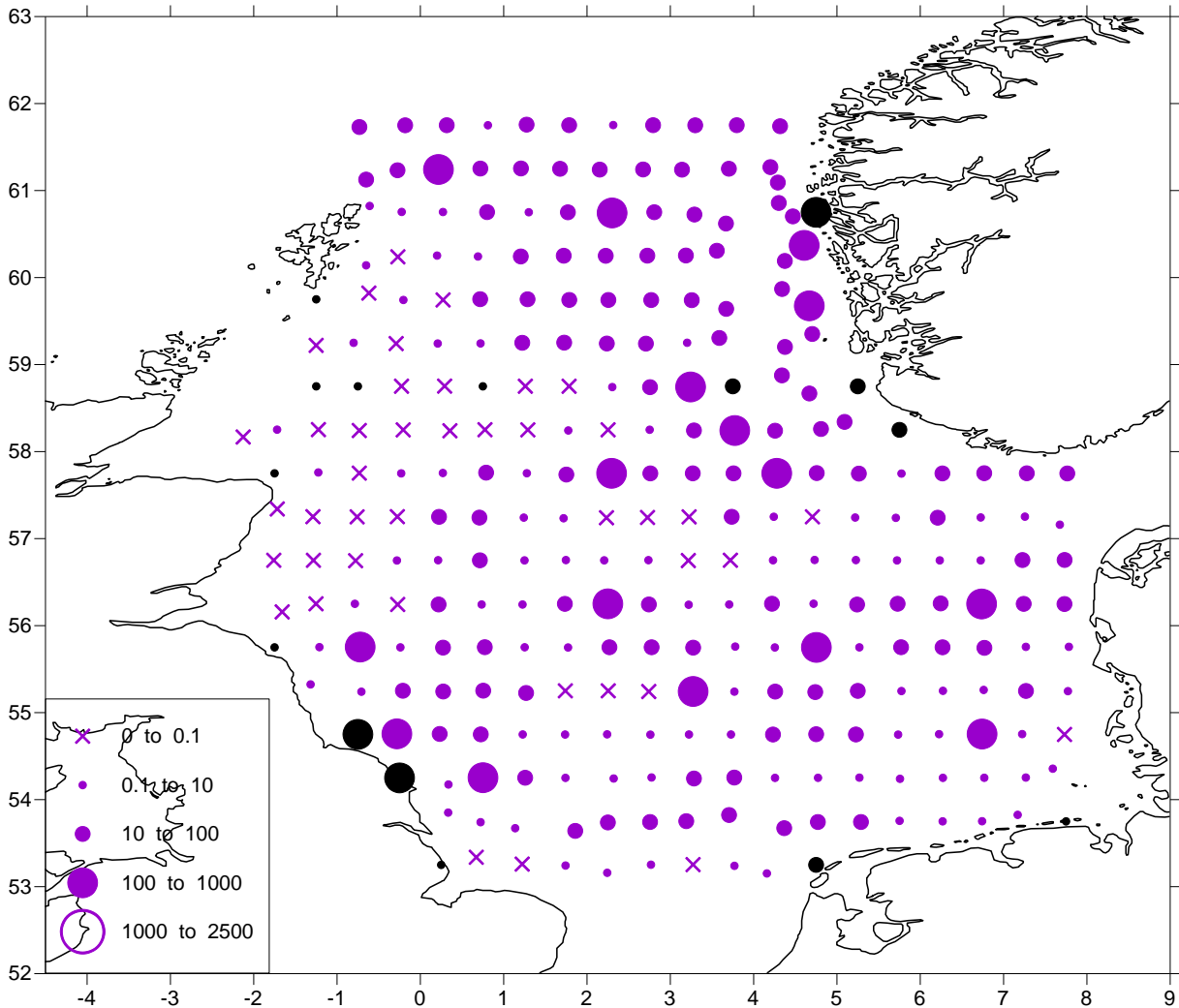


Figure 2. Stage 1A mackerel egg production (eggs/m<sup>2</sup>/day) by half rectangle for NSMEGS 2021. Purple circles represent observed values, black circles represent interpolated values, and crosses represent observed zeros.

Table 1. NSMEGS surveys cruise dates in 2021 (For Scotland only stations used in the NSMEGS DEP calculation are shown.)

<b>Country</b>	<b>NL</b>	<b>DK</b>	<b>SCO</b>
Period	1	1	1
Dates	25.05-12.06	31.05-9.06	8.06-11.06
Plankton stations sampled	174	91	29
Pelagic trawl hauls	12	10	1

Table 2. Daily egg production estimate (stage 1A) in the North Sea.

<b>Year</b>	<b>DEP * 10<sup>13</sup></b>	<b>CV DEP</b>
2021	1.28	16%

Table 3. Comparison of Daily Egg production (stage 1) between 2021 and 2017, in the area between 53.5 and 59°N.

<b>Year</b>	<b>2021</b>	<b>2017 Extended period 2</b>
<b>DEP * 10<sup>12</sup></b>	4.92	4.43
<b>Area sampled (* 10<sup>11</sup> m<sup>2</sup>)</b>	2.24	1.97