TOKTRAPPORT / SURVEY REPORT

Egg production and spawning stock size of mackerel in the North Sea in 2002

By

S. A. Iversen[1] and A. Eltink[2]

[1]Institute of Marine Research
P.O.Box 1870 Nordnes
5817 Bergen
Norway

[2]RIVO
P.O.Box 68
1970 AB IJmuiden
Netherlands

Material and methods

During the period 3-24 June 2002 Netherlands and Norway carried out egg surveys in the North Sea to estimate the spawning stock biomass (SSB) of mackerel. During this period the spawning area was covered three times. The last time the North Sea was covered several times during the spawning season was in 1999. During the period 1980-1984 the SSB was estimated based on several coverages annually and since then and until 1990 on surveys carried out every second year. In 1990 the Netherlands, Denmark and Norway took part in these investigations (Iversen et.al., 1991). In 1990 the surveys started in March because the investigations also covered the spawning of horse mackerel and some demersal species. Usually the mackerel spawn in the North Sea during the period from mid May towards the end of July. During this period about 95 ship days were spent in 1990 while only 30 ship days were spent in 1996 (Denmark and Norway) and 1999 (the Netherlands and Norway). In 2002 the Netherlands and Norway spent 40 ship days.

The data collecting and the handling of the samples were according to ICES (1997/H:4). R/V "Tridens" carried out the survey with a Gulf III working in double oblique hauls from the surface to 5m above the bottom. "G. O. Sars" towed a 20 cm Bongo for 5 minutes in each of the depths 20m, 15m, 10m, 5m and in the surface. The timing and the results of the surveys are given in Table 1. "G.O. Sars" worked mainly in the area north of 56^o while "Tridens" worked mainly in the area south of this latitude.

The eggs were sorted from each of the sampled stations and their age were estimated according to development stage and to the observed temperature in 5 m. The development stages used in the calculations are eggs without visible embryo (i.e, stage 1A+1B, Lockwood et.al.(1981)). The average number of eggs produced per day per m^2 was calculated for each statistical rectangle of 0.5 ^{o} lattitude * 0.5^o longitude (Figures 1-3). The samples were obtained in the middle of each of the rectangles.The spawning area was covered three times and the egg production was calculated for the total investigated area for each of the three periods (Table 1).

Results and discussion

Egg production.
The distribution of daily egg production per m^2 surface is shown for each of the coverages in Figures 1-3. During all three coverages a very high egg production (197-753 egg/m^2) was observed in one and two of the same rectangles in the western part of the spawning area. About 20, 30 and 40% of the total egg production during the three respective coverages came from these rectangles.

The surveys did not cover the total spawning area and period. Some of the unsampled rectangles are given interpolated values, indicated as shadowed rectangles in Figures 1-3. The part of the interpolated egg production was about 10% of the total production estimates during the two first coverages and about 5% during the third coverage (Table 1). Based on the three production estimates the spawning curve was drawn (Figure 4). These are considered minimum estimates since the sampling were not carried until zero values were obtained in all directions.

The last coverage gave the highest egg production. If the third survey was carried out previous to the peak of spawning in 2002, the egg production might be seriously underestimated. In years with adequate sampling for defining peak spawning, this period occurred within12-24 June (Table 3). Therefore it is unlikely that the egg production obtained during the third coverage in 2002 is a serious underestimate of the peak production. The parameters necessary for drawing the egg production curve and calculating the egg production and SSB are given in Table 2. As in 1999 there are no measurements after the peak of spawning. The curve might be drawn as a straight line from this point to the end of spawning or as a steeper line as indicated in Figure 4.

By integrating the maximum egg production curve in Figure 4 the total egg production was estimated at $147*10^{12}$ eggs. By applying the weight fecundity relationship 1401 eggs/g/female (Adoff and Iversen, 1983) this corresponds to a SSB of 210,000 tons. However by applying the alternative line from peak of spawning (Figure 4) the egg production and the SSB is reduced by 20% (168,000 tons).

There are no new fecundity data from the North Sea since 1982 (Iversen and Adoff, 1983). So far atresia in ovaries from North Sea spawners have not been studied. For mackerel spawning in the western area such data are available from the 1998 investigations (ICES 1999/G:5). If the same weight fecundity relation and atresia as observed in the Western area in 1998 (i.e. 1002 eggs per g female) are applied the estimate of SSB in the North Sea will increase by almost 40%. The very low realised fecundity observed in the western area in 1998 was due to a low relative fecundity and a relatively high level of atresia. It is probably not wise to apply these particularly extreme values observed in the western area in 1998 when calculating the SSB in the North Sea in 2002.

Table 3 gives the estimated egg production in the North Sea for the years with multiple surveys of the spawning area per season (given in different ICES papers by Iversen and Iversen et.al.). The corresponding SSBs based on a standard fecundity of 1401 eggs/g/female (Iversen and Adoff, 1983) are also given in the same table.

During the surveys in 2002 ovaries were collected to study fecundity and atresia. However, at present it is not decided if these ovaries will be analysed.

The age composition of North Sea spawners.
Since research vessels usually does not trawl with commercial equipment it might be questioned how well the mackerel samples obtained by the research vessels are reflecting the real stock. Therefore this year a Norwegian purse seiner, "Endre Dyrøy", was hired to trawl mackerel in areas were spawning were observed to take place. This purse seiner is equipped for trawling bluewhiting. In addition both "G. O.Sars" ans "Tridens" trawled during their surveys. The age distributions obtained by the three vessels are given in Table 4. It is interesting to see that the three age distributions are rather similar with a dominating 1999 year class. If the age distribution of the North Sea mackerel is set as an average of the three distributions, it is possible to calculate the numbers of North Sea spawners by year class (Table 4). The calculations in Table 4 are based on a spawning stock of 210,000 tons.

References:

ICES 1996. Report of the Mackerel/Horse Mackerel Egg Production Working Group. ICES CM 1996/H:2.

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Iversen, S.A. and Adoff, G. R. 1983. Fecundity Observations on Mackerel from the Norwegian Coast. ICES CM 1983/H:45.

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Lockwood, S.J., Nichols, J.H. and Dawson, W.A. 1981. The Estimation of a Mackerel (Scomber scombrus L.) Spawning Stock Size by Plankton Survey. J.Plank.Res., 3:217-233.

Table 1. Mackerel egg surveys in the North Sea in 2002.

Coverage	1	2	3
"Tridens"	3-6 June	10-14 June	17-21 June
"G.O. Sars"	3-9 June	9-14 June	15-24 June
Midpoint of survey Julian day	6 June 157	12 June 163	19 June 170
Total daily egg x 10^{-12}	2.72	2.50	4.26
Interpolated daily egg x 10^{-12}	0.27	0.24	0.20

Table 2. Parameters and formulas used in the egg production and SSB estimates

Parameter	value/formula	Reference
Age of stage 1A+1B eggs	Age = $Temp^{-1.61} * e^{7.76}$	Lockwood et.al. 1981
Fecundity North Sea	Fec. = 560 * $weight(g)^{1.14}$ (i.e. 1401 eggs/g female)	Iversen and Adoff 1983
Fecundity Western area 1998	1206 eggs/g female	ICES 1999
Atresia in Western area 1998	16.9 % (i.e. realised fec. = 1002 eggs/g/female)	ICES 1999
Sex ratio	1 : 1	as in previous years
Spawning period Julian days	17 May - 27 July 137-208	as in previous years, excl.1990
Number of spawning days	72	as in previous years, excl.1990

Table 3. Egg production estimates from egg surveys in the North Sea and corresponding SSB based on a standard fecundity of 1401 eggs/g/female.

Year	Egg prod $*10^{-12}$	SSB$*10^{-3}$ tons	Observed peak of spawning (midpoint of survey)
1980	60	86	(25 June?)[1]
1981	40	57	17 June
1982	126	180	23 June
1983	160	228	13 June
1984	78	111	12 June
1986	30	43	23 June
1988	25	36	20 June
1990	53	76	24 June
1996	77	110	19 June
1999	48	68	-
2002	147 (118)	210 (168)	-

[1]This was the first coverage in 1980.

Table 4. Age compositions obtained by the different vessels, the suggested age distribution and the estimated numbers of North Sea spawners per age group.

	G. O. SARS		ENDRE DYRØY		TRIDENS		TOTAL		Mat.	SPAWNING STOCK	
Age	%	W (g)	%	W (g)	%	W (g)	%	W (g)	ogive	W (g)	N (millions)
0	0		0		0	0	0	0	0		0.00
1	10.60	116.8	0.50	128.3	6.00	122.0	5.78	119.8	0.00	119.8	0.00
2	12.60	234.0	7.80	247.0	12.00	184.0	11.10	209.3	0.37	209.3	29.76
3	51.20	310.4	47.10	248.4	48.00	310.6	48.58	295.5	1.00	295.5	351.98
4	10.20	360.0	13.10	288.0	8.00	373.5	9.83	341.5	1.00	341.5	71.19
5	10.60	396.0	16.40	383.0	12.00	336.3	12.75	363.7	1.00	363.7	92.39
6	2.60	373.0	6.50	341.0	8.00	486.5	6.28	437.1	1.00	437.1	45.47
7	0.30	397.0	1.80	411.0	2.00	462.0	1.53	443.8	1.00	443.8	11.05
8	0.90	410.0	2.00	437.0	0.00	-	0.73	428.6	1.00	428.6	5.25
9	0.80	454.0	1.30	543.0	0.00	-	0.53	509.1	1.00	509.1	3.80
10	0.00	-	1.20	541.0	2.00	626.0	1.30	606.4	1.00	606.4	9.42
11	0.00	-	1.30	643.0	0.00	-	0.33	643.0	1.00	643.0	2.35
12	0.00	-	1.00	643.0	0.00	-	0.25	643.0	1.00	643.0	1.81
13	0.24	899.0	0.00	-	0.00	-	0.06	899.0	1.00	899.0	0.43
14	0.00	-	0.20	665.0	2.00	500.0	1.05	507.9	1.00	507.9	7.61
12+							1.36	550.0	1.00	550.0	9.85
Total		299.7		304.80		319.00		310.80		332.00	632.53

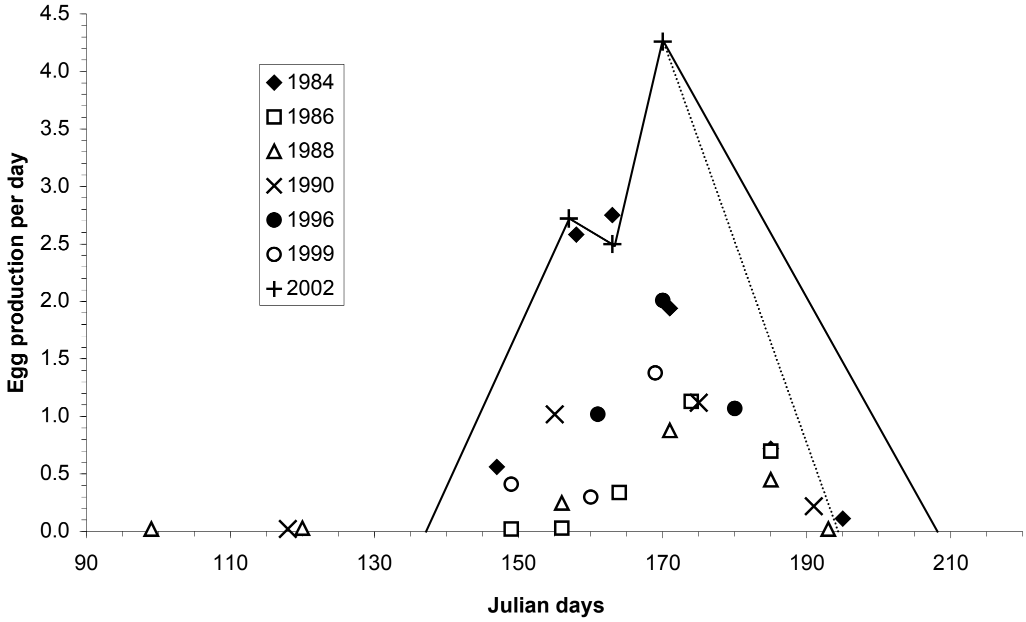

Figure 4. Daily egg production (eggs x 10^{-12}) of North Sea mackerel during the different surveys since 1984. The production curve for 2002 is given as two alternatives.

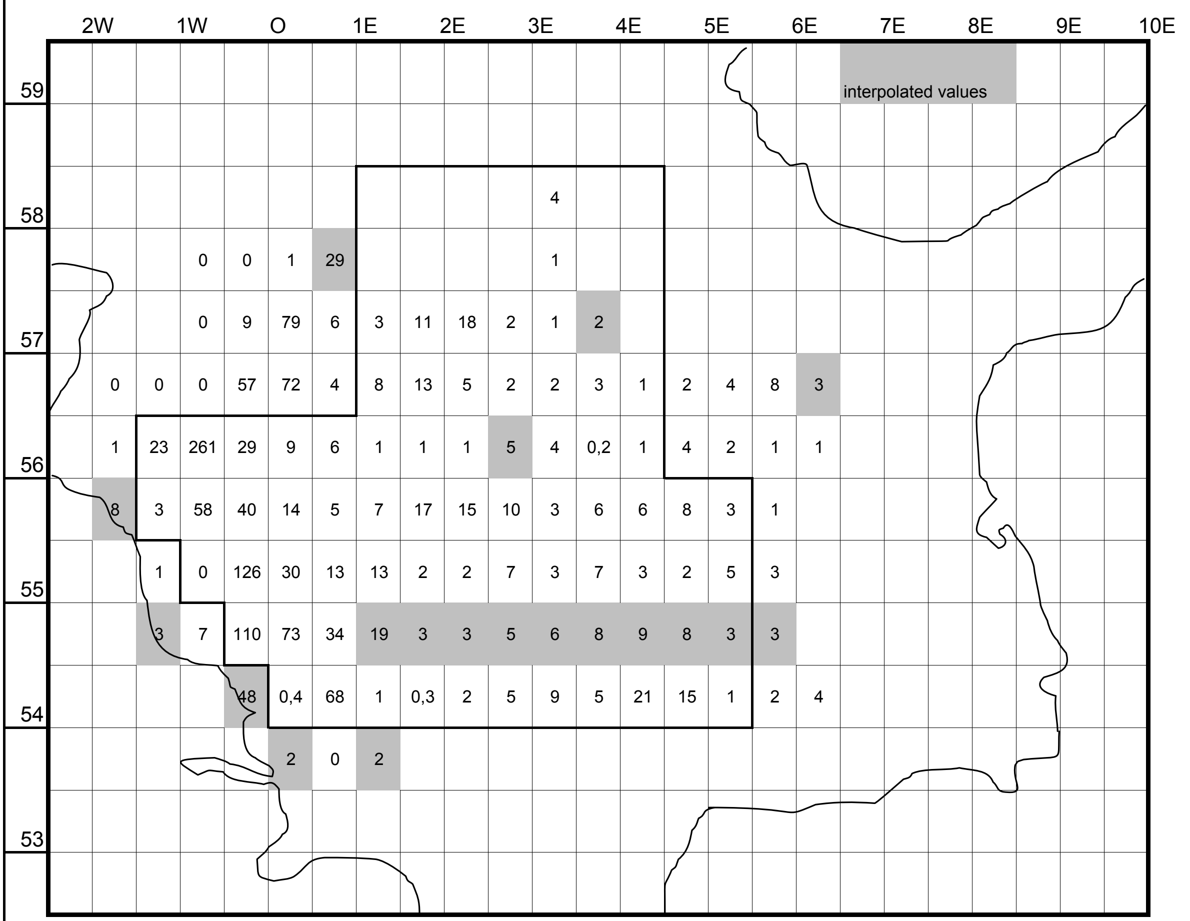

Figure 1. Daily production of mackerel eggs per m2 per rectangle during the first coverage, 3-9 June 2002

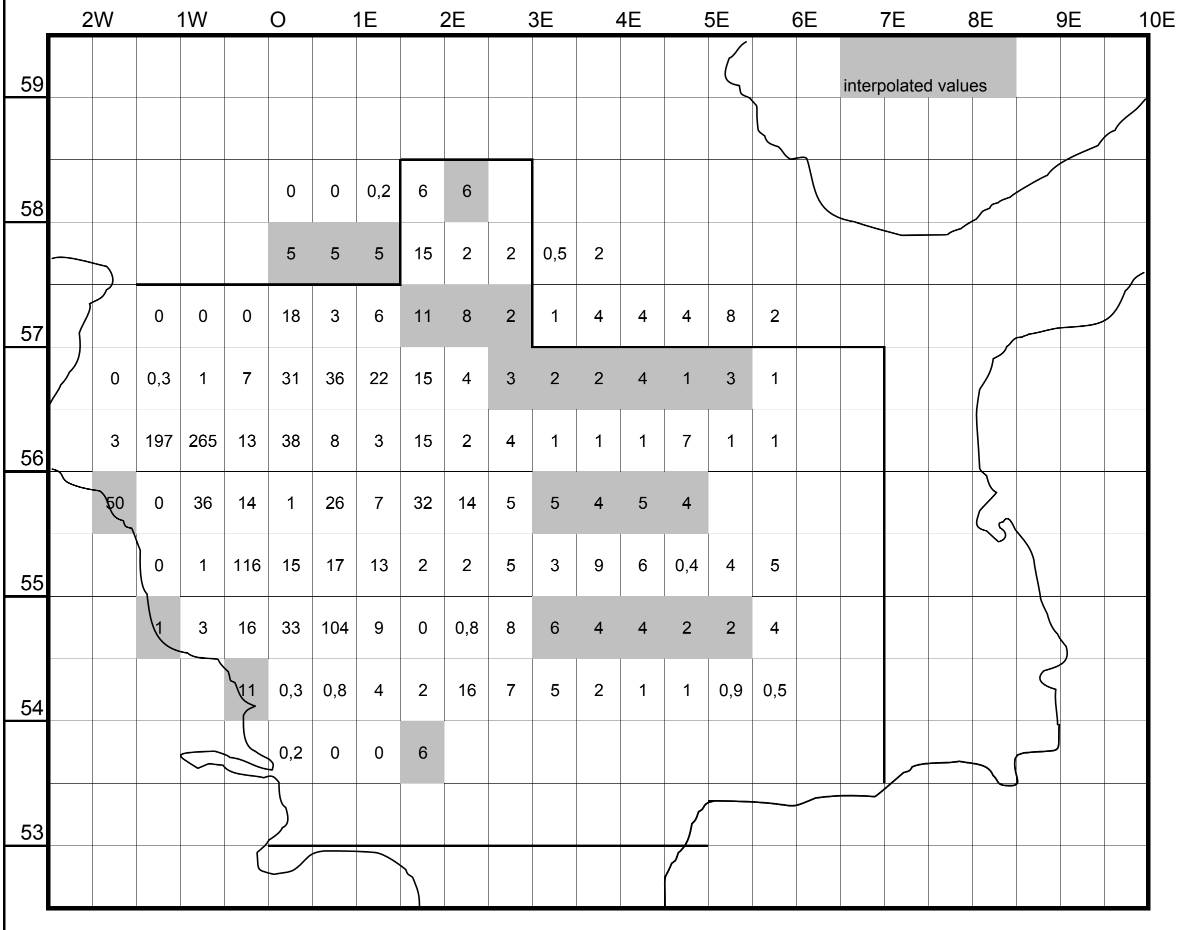

Figure 2. Daily production of mackerel eggs per m2 per rectangle during the second coverage, 9-14 June 2002.

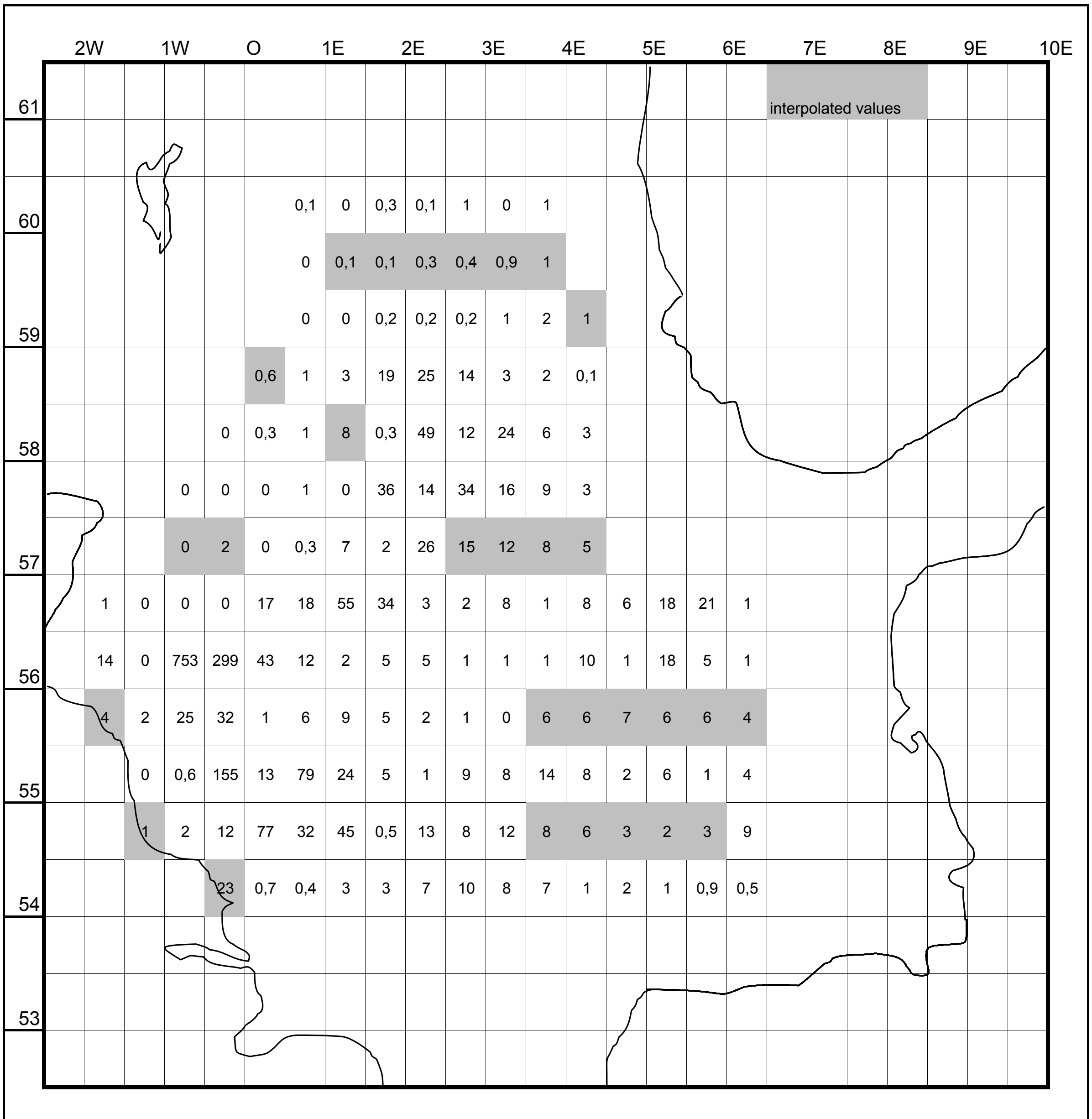

Figure 3. Daily production of mackerel eggs per m2 per rectangle during the third coverage, 15-24 June 2002