INSTITUTO ESPAÑOL DE OCEANOGRAFÍA **SECRETARIA GENERAL DE PESCA**

Cruise Report RV "Vizconde de Eza"

Survey MEGS22 – CAREVA

13/03/2022-03/04/2022

IEO Spanish Participation in the International Mackerel and Horse Mackerel Egg Survey 2O22 (PERIOD 3)

Isabel Riveiro, Gersom Costas, Dolores Garabana, Luisa Iglesias, María Dolores García, Antonio Solla, Andrés Villaverde

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Acknowledgements

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We thank the crew of the R/V “Vizconde de Eza” and R/V “Miguel Oliver” and scientific staff onboard for their professional assistance, ensuring the success of the survey.

1. INTRODUCTION

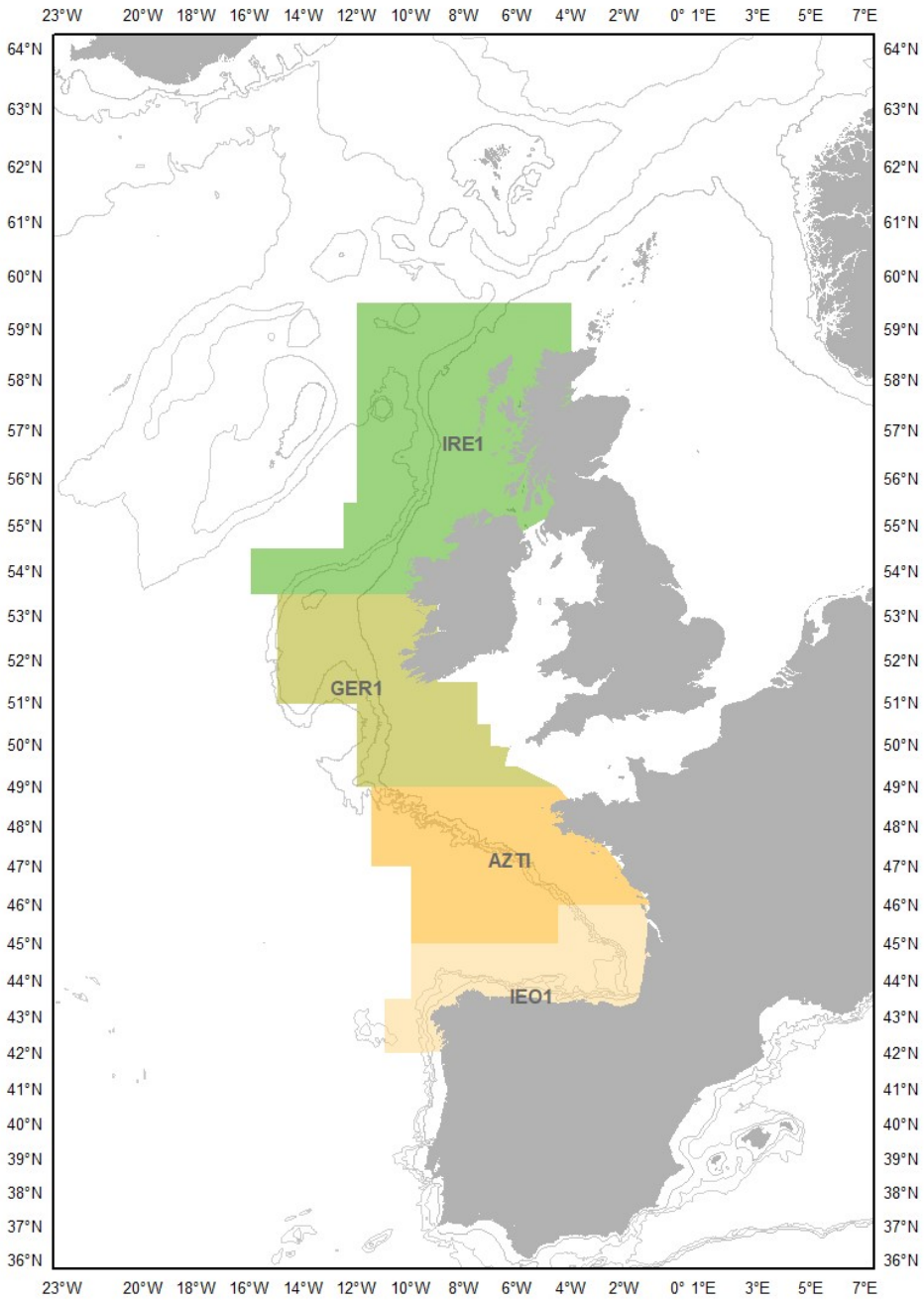
CAREVA survey (IEO1) is part of the Spanish "Data Collection Framework" program and is coordinated within the framework of the ICES Working Group on Mackerel and Horse Mackerel Egg Surveys (ICES WGMEGS).

The survey calendar for 2022 is shown in the following table (in yellow the commitment of the IEO):

Week	Starts	Area 9a	Cantabrian Sea	Biscay	Celtic sea	West of Ireland	West of Scotland	Northern area	Period
3	09-Jan-22								1
4	16-Jan-22	PO1							2
5	23-Jan-22	PO1							2
6	30-Jan-22	PO1							2
7	06-Feb-22	PO1							2
8	13-Feb-22	PO1							2
9	20-Feb -22	PO1				SCO (IBTS)	SCO (IBTS)		2
10	27-Feb-22					SCO (IBTS)	SCO (IBTS)		2
11	06-Mar-22				IRL 1	IRL 1	IRL 1		3
12	13-Mar-22		IEO1	IEO1	IRL 1	IRL 1	IRL 1		3
13	20-Mar-22		IEO1	IEO1/ AZTI1	GER1	IRL 1	IRL 1		3
14	27-Mar -22		IEO1	AZTI1	GER1	GER1			3
15	03-Apr-22		IEO1	AZTI1	GER1	GER1			3
16	10-Apr-22		IEO2	IEO2	GER2	GER 2 /SCO1	SCO1		4
17	17-Apr-22		IEO2	IEO2	GER2	GER 2 /SCO1	SCO1		4
18	24-Apr -22		IEO2	IEO2	GER2	GER 2 /SCO1	SCO1		4
19	1-May-22		AZTI2 (DEPM)						4
20	8-May-22		AZTI2 (DEPM)	AZTI2 (DEPM)/ NED1	NED1	NED1 / SCO2	SCO2	NOR	5
21	15-May-22			AZTI2 (DEPM)/ NED1	NED1	NED1 / SCO2	SCO2	NOR	5
22	22-May -22			AZTI2 (DEPM)/ NED1	NED1	NED1 / SCO2	SCO2	NOR	5
23	29-May-22							FAR	6

24	5-Jun-22			NED2	NED2	IRL2	IRL2	FAR	6
25	12-Jun-22			NED2	NED2	IRL2	IRL2	FAR	6
26	19-Jun -22			NED2	NED2	IRL2	IRL2		6
27	26-Jun -22								6
28	3-Jul-22				SCO3	SCO3	SCO3		7
29	10 –Jul-22				SCO3	SCO3	SCO3		7
30	17-Jul-22				SCO3	SCO3	SCO3		7
31	24-Jul-22				SCO3	SCO3	SCO3		6

The sampling scheme for the THIRD period, in which CAREVA (IEO1) has been carried out, is shown in the following map:



2. PARTICIPANTS AND AFFILIATION

ISABEL RIVEIRO ALARCÓN (1)
GERSOM COSTAS BASTIDA (1)
GABRIEL POMAR VERT (2)
JOSE LUIS VILLAVERDE ROSALES (1)
VENICIO PITA FREIRE (3)
ISABEL MANEIRO ESTRAVIZ (1)
LORENA RODRÍGUEZ FERNANDEZ (1)
SUSANA JUNQUERA LÓPEZ (1)
LUISA IGLESIAS GARCÍA (1)
CARMEN HERNÁNDEZ PARRAS (4)
IRIA MANEIRO MOREIRA (4)
ARANCHA CARROCEDA CARBALLO (5)
ROQUE TABOADA (6)
NOELIA IBAÑEZ (6)
HUGO RIOBÓ (7)

1: CO Vigo, IEO-CSIC, 2: CO Baleares, IEO-CSIC, 3: CO Gijón, IEO-CSIC, 4: CO Santander, IEO-CSIC, 5: CO A Coruña, IEO-CSIC, 6: IPD, 7:TRAGSATEC

3. ITINERARY

Date (UTC)	
13/03/2022-18/03/2022	Vigo Harbour. Administrative issues and repairs.
18/03/2022 8:00	Start of sampling in Galicia waters
18/03/2019-23/03/2022	Plankton stations in Galicia – Cantabrian waters (st 1-st 31)
20/03/2022	Fishing hauls for fecundity samples (1-2)
23/03/2022	Fishing hauls for fecundity samples (3-4)
24/03/2022	Break in Santander Harbour
25/03/2022 7:00	Start of sampling in Cantabrian waters
18/03/2022-02/04/2022	Plankton stations in French – Cantabrian-Galicia waters (st 32-st 89)
30/03/2022	Fishing hauls for fecundity samples (5-6)
03/04/2022 10:00	End of CAREVA survey in Vigo Harbour

CAREVA survey was originally scheduled to start on 13th March on board *R/V Vizconde de Eza (Secretaría General de Pesca*). However, due to a power failure on the *R/V Miguel Oliver (Secretaría General de Pesca)*, which was carrying out the Portuguese PELAGO acoustic survey, there was an exchange of vessels between the two surveys. Finally, CAREVA survey started on board the Miguel Oliver with a few days delay (first station was carried out on 18th March). These facts caused a reduction of survey days and resulted in a restructuring of the survey design in order to cover the designated survey area in the available time (Figure 1).

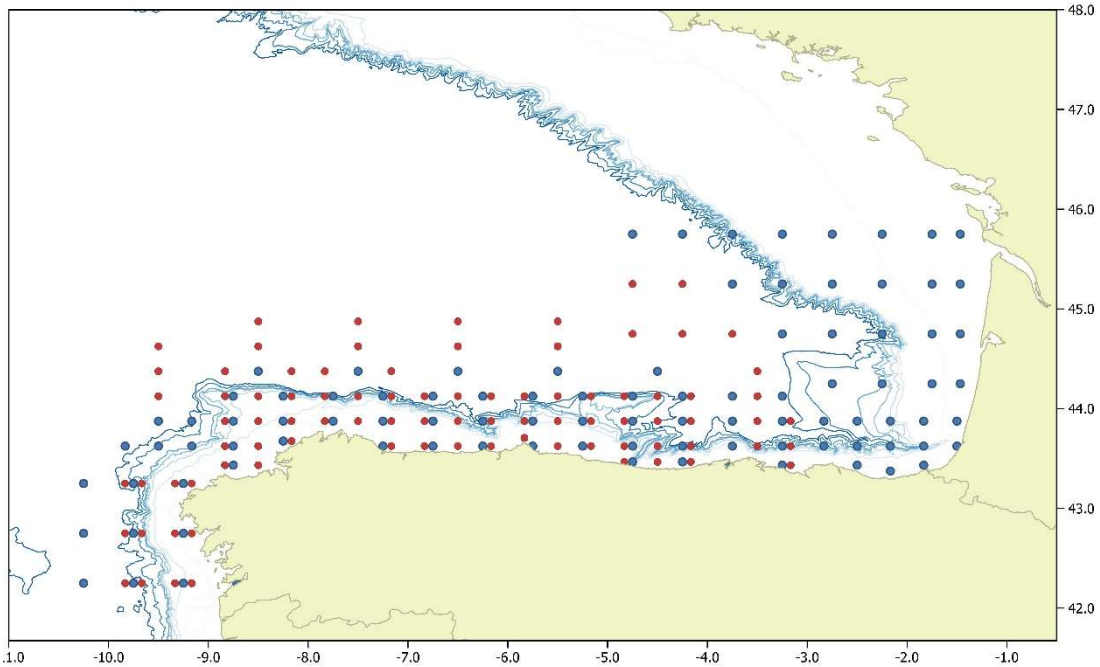


Figure 1. Red: Initial sampling design for CAREVA. Blue: alternative design to accommodate the reduction of survey days.

The first survey, CAREVA, began in the port of Vigo on March 13th. Plankton stations were performed in alternative transects from south to north (beginning in 42º 15'N 9º 15'W) in Galicia and Cantabrian waters. The first leg of the survey was characterised by good weather conditions and ended with a scheduled personnel exchange on 24th March in Santander Port.

During the second leg, the R/V "Miguel Oliver" moved to the northernmost sampling area on the French shelf (45º 45'N) and from there, the plankton stations continued southward to the Spanish coast in the Cantabrian Sea (transects east-west).

In those areas where high mackerel egg concentration was detected, fishing hauls were carried out in order to collect adult female samples for fecundity.

Extra adult samples (in order to complete areas and periods) were provided by PELACUS0322 Spanish acoustic survey operating in spring in the same area.

Figure 2 shows fishing hauls and plankton stations performed during CAREVA survey (period 3).

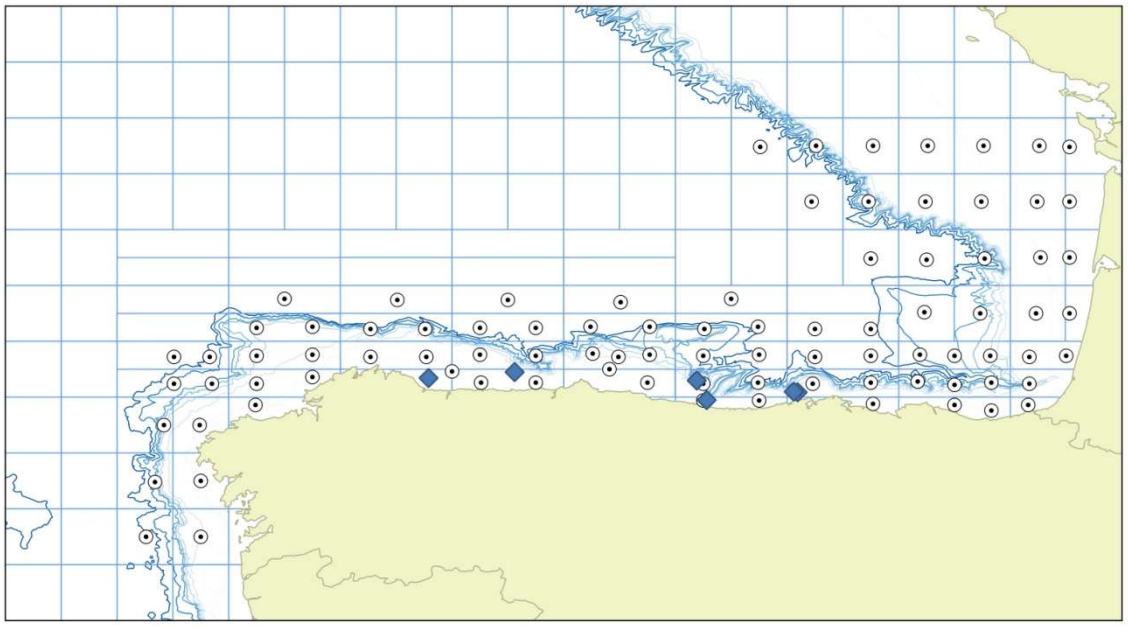


Figure 2. Sampling intensity. Fishing hauls (blue diamonds) and plankton stations (circles) during period 3.

4. METHODS

4.1. Plankton sampling

Sampling consisted of ichthyoplankton sampling on fixed (BONGO) stations. BONGO net consists in a double net structure of 40 cm mouth. The bongo hauls were performed using a net with 250 µm mesh size and plastic cod-ends, operating obliquely from 200 m depth to the surface. In shallower areas, the net was towed from 5 m above the bottom to the surface. *General Oceanics* and *Hydro-bios* flowmeters were used to record the towing length and estimate the sampled water volume (assuming a filtration efficiency of 100%), while a trawl sounder (*Marport*) coupled to the net was used to record maximum sampling depth.

Fish eggs from one of the nets were separated from the remaining plankton organisms onboard, by performing the spray method recommended by the WGMEGS. Fish eggs were identified using morphological criteria (egg diameter, oil globule diameter, segmentation of yolk sac and pigmentation) and counted immediately after collection.

All samples were fixed in 4% buffered formaldehyde solution for subsequent verification of egg counts and staging in the laboratory. At least sub-samples of up to 100 individuals per target species (mackerel, horse mackerel) were staged.

With the objective of performing biochemical analysis (genetics,...), the plankton of the remaining net was preserved in absolute ethanol just after the sampling, and 72 hours after fixation the ethanol was renewed. These samples will be sorted and analysed in the lab.

4.2. Hydrographic sampling

A CTD *Seabird25* was deployed in every station for the hydrographical description of the water column (until 200m depth or 5m above the bottom in shallower stations).

4.3. Fecundity

AEPM and DEPM egg production methods require fecundity samples match in time and space with plankton (egg) sampling. In previous triennials IEO obtained mackerel adult data for fecundity and sex ratio from PELACUS acoustic survey, which overlaps in space and time with CAREVA and JUREVA IEO ichthyoplankton surveys. Collecting adult samples from the fishing hauls carried out during PELACUS, reduces the number of technicians on board and allows more time to cover ichthyoplankton sampling in CAREVA. Fresh commercial samples from Santander and A Coruna fish market have been usually taken to fulfil the required number of samples.

This year, fecundity samples requested for period 3 could not be collected during PELACUS because the survey was interrupted by a COVID event. In addition, it was impossible to take commercial samples due to administrative internal problems. Thus,

for period 3, all fecundity samples were obtained from the fishing hauls performed during CAREVA. A demersal otter bottom 4-panel trawl (OTB_MPD) net was used, towed at about 4 knots of speed.

Fecundity sampling for both, AEPM and DEPM estimates was performed trying to follow the desired temporal and spatial distribution of the samples per survey period and institute in WKAEPM report, (ICES, 2022), but only was possible in four hauls that were taken when a high density of eggs was found (Figure 2). Following the WKAEPM guidelines, fecundity samples for the AEPM were taken from females in maturity stages 3 to 6 (Walsh scale), while for the DEPM sampled females were in maturity stages 2 to 6 (Walsh scale). The manuals SISP-5 (ICES, 2019a) and SISP-6 (ICES 2019b) were followed for sampling and data collection methodology.

RESULTS

4.4. Egg abundance and distribution

In total, 89 plankton stations were carried out during CAREVA survey (PERIOD 3).

No eggs were found in 13 of the 89 stations (15%).

A total of 32 918 fish eggs were sampled, with an average abundance of 370 eggs/station (average density of 300 eggs m^{-2}). These mean densities represent only 38% of the mean densities recorded during the same period in 2019.

- Mackerel egg abundance and distribution.

Figure 3 shows mackerel egg distribution during CAREVA survey.

Mackerel was the most abundant species in the area, with a total number of eggs in the samples of 25 970. Nevertheless, the abundance of mackerel during CAREVA was much lower than in 2019 CAREVA survey (74 610 eggs in 2019).

This species was collected in the 58% of the Bongo stations (63% in 2019), with a higher abundance in the most coastal stations in the Cantabrian Sea. The average density in 2022 CAREVA survey was 240 egg/m^2 (2019= 702 egg/m^2).

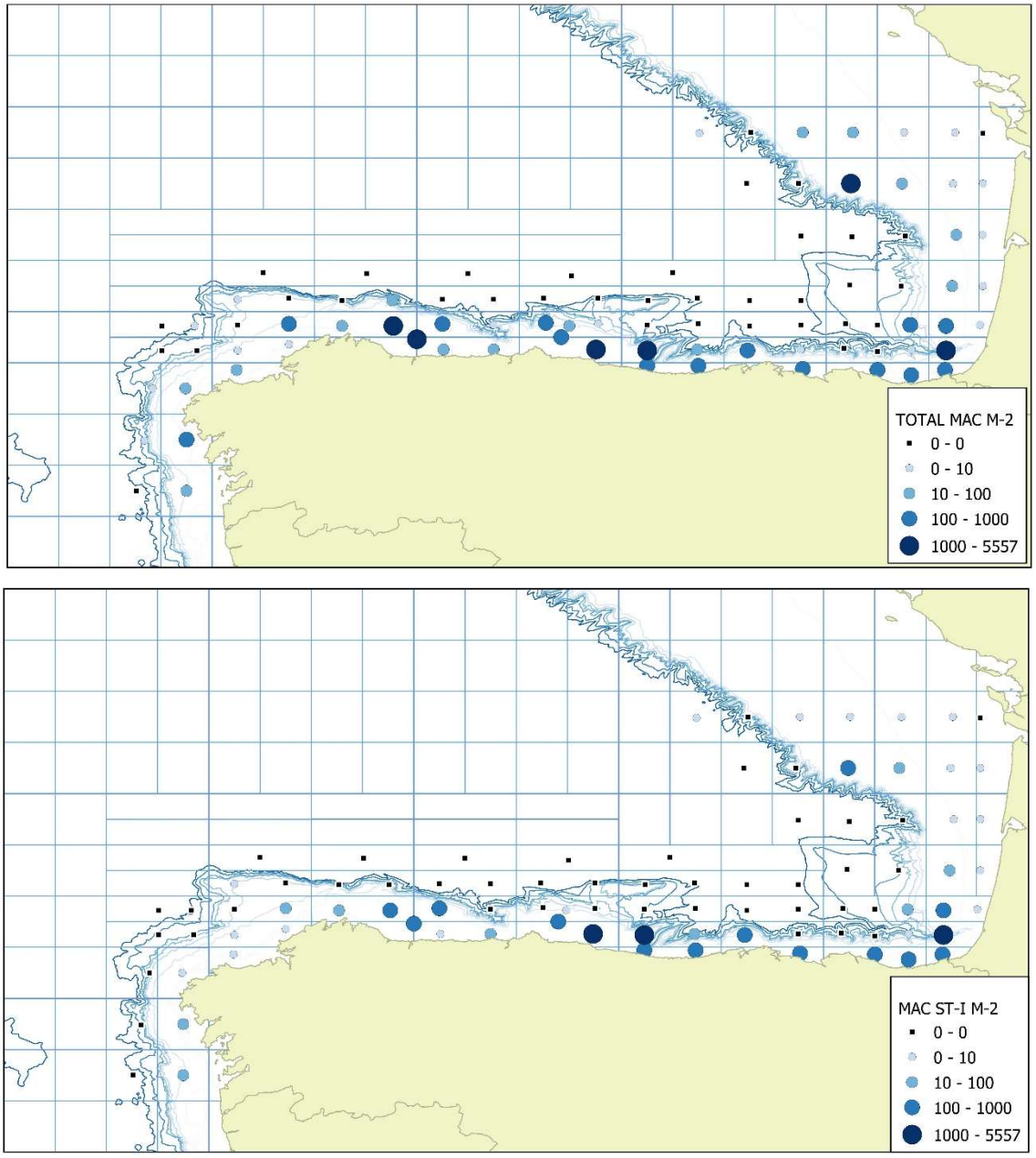


Figure 3. Mackerel abundance and distribution during CAREVA survey. 3a) Total egg distribution (eggs m^{-2}) and figure 3b) Eggs (eggs m^{-2}) in stage IA and IB.

- Horse mackerel egg abundance and distribution.

Figure 4 shows horse mackerel egg distribution during CAREVA survey.

Horse mackerel eggs were found in 50% of the stations (40% in 2019) but the density this year was scarce (11 eggs m^{-2}) and lower than in the previous 2019 CAREVA survey (16 eggs m^{-2}).

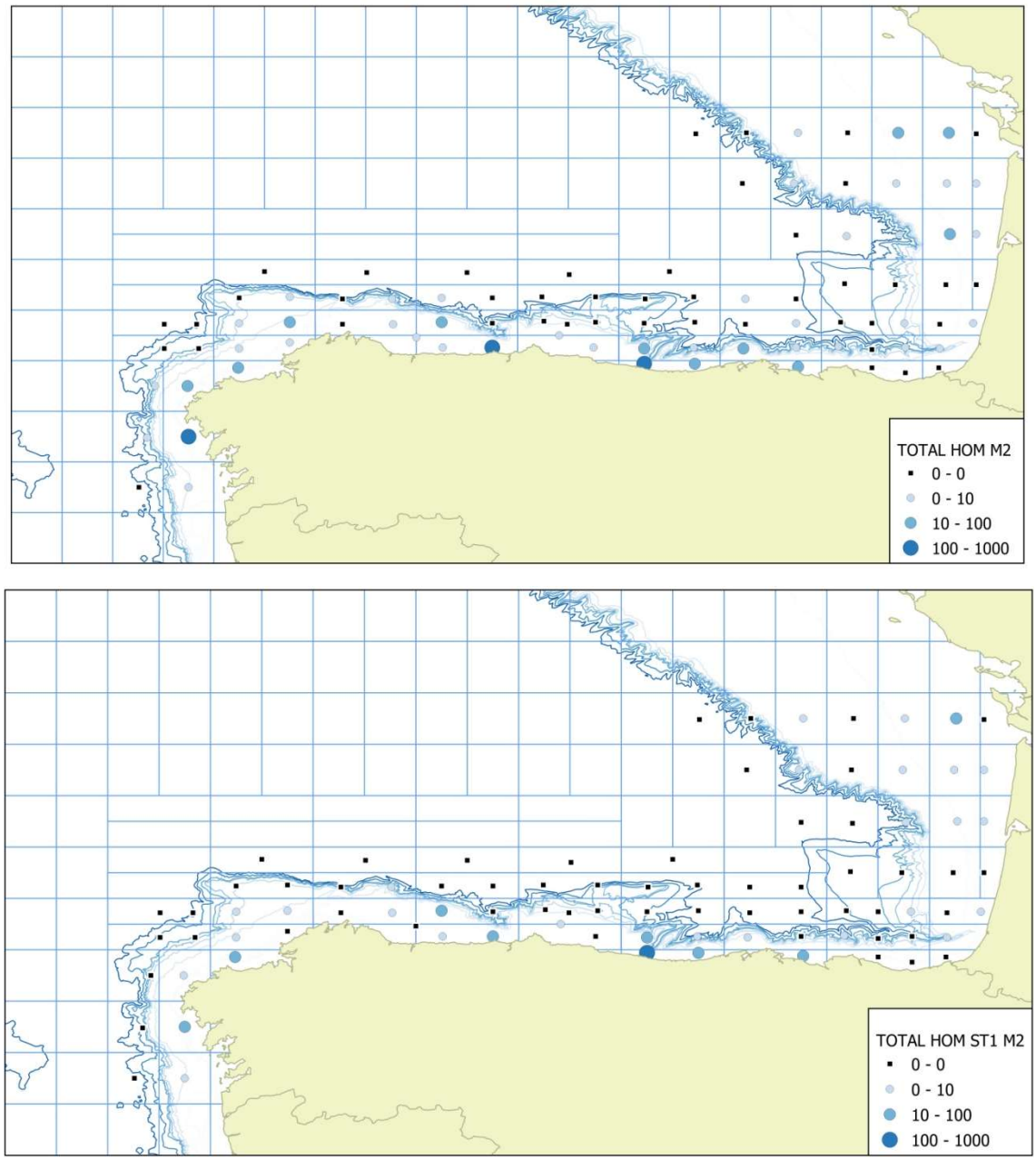


Figure 4. Horse mackerel abundance and distribution during CAREVA survey. 4a) Total egg distribution (eggs m^{-2}) and figure 4b) Eggs (eggs m^{-2}) in stage IA and IB.

- Sardine egg abundance and distribution.

Figure 5 shows sardine egg distribution during CAREVA survey.

Sardine eggs were located in the 24% of the stations, with a total of 484 eggs (3749 eggs in 2019 survey), corresponding to an average density of 4.25 eggs m^{-2} (42.09 eggs m^{-2} in 2019 survey).

Higher sardine egg abundances were detected in shallower waters of French platform and in central area of Cantabrian Sea.

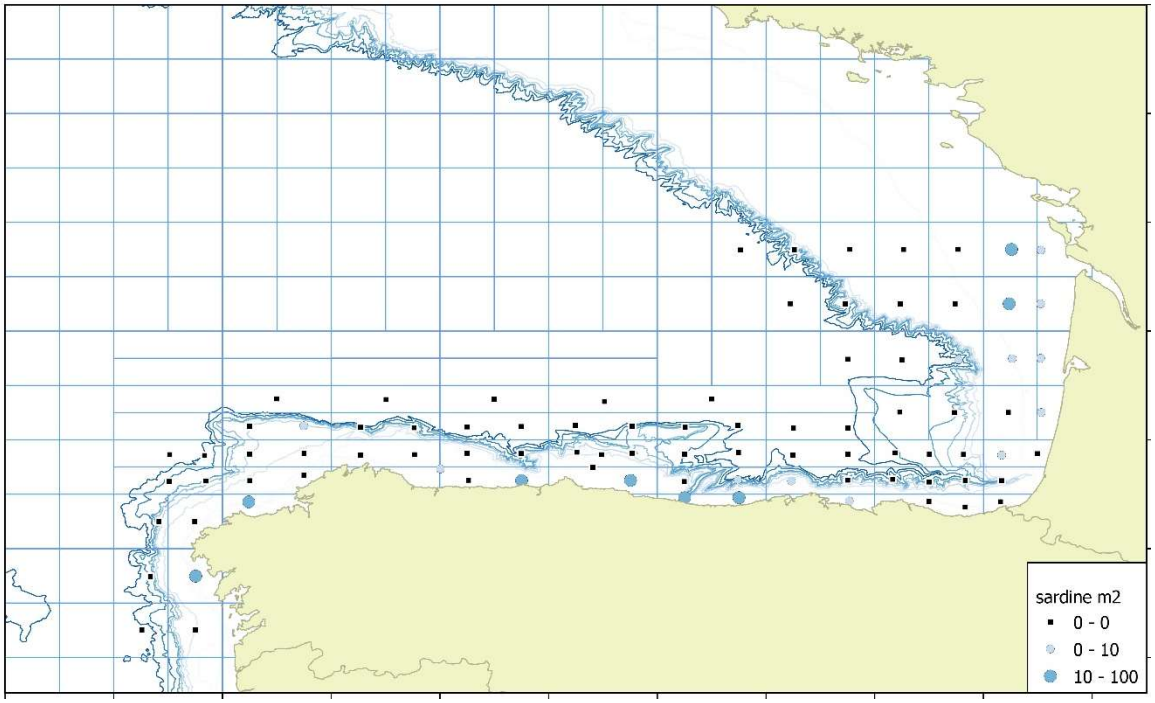


Figure 5. Sardine egg abundance and distribution during CAREVA survey.

- Anchovy egg abundance and distribution.

Figure 6 shows anchovy egg distribution during CAREVA survey.

Anchovy eggs were scarce during CAREVA, because spawning time for anchovy in this area begins later in the year.

In total, a total of 36 anchovy eggs were found in 7 stations, mainly in the inner part of the Bay of Biscay.

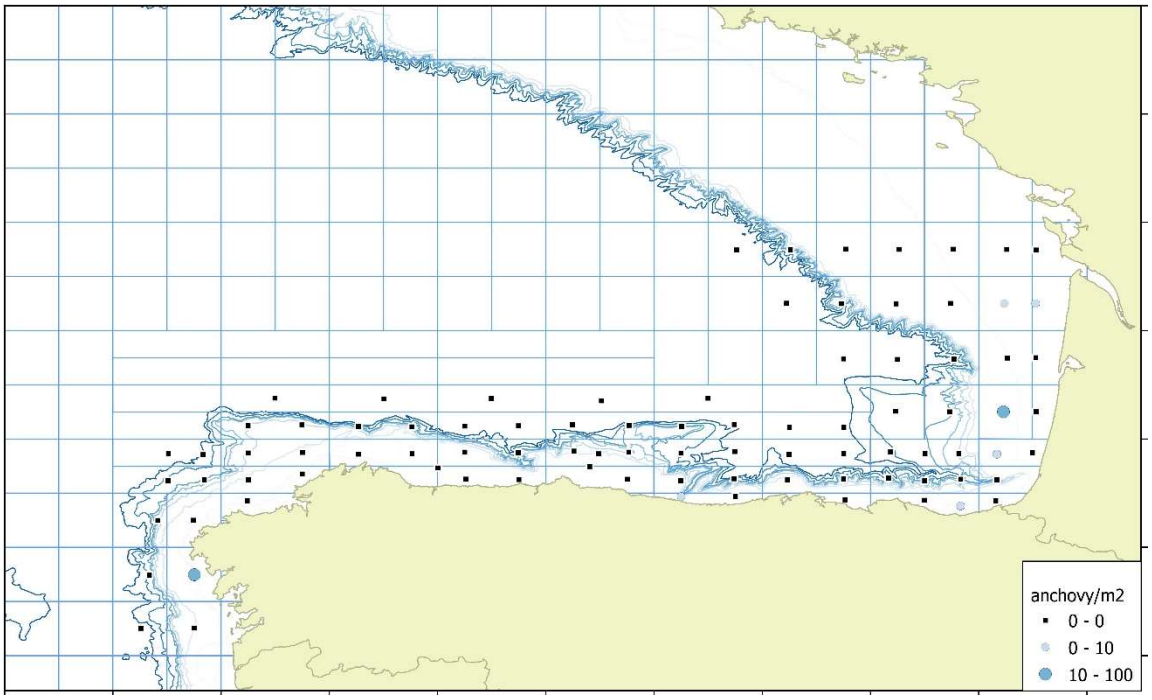


Figure 6. Anchovy egg abundance and distribution during CAREVA survey.

- Other species abundance and distribution.

Figure 7 shows egg distribution of other species during CAREVA.

5032 fish eggs of many more species (in addition to those mentioned in the previous sections) were found, mainly of the mesopelagic species: *Maurolicus muelleri* (especially in the deeper stations) and of some other species with multiple oil drops and without oil drop in shallower waters.

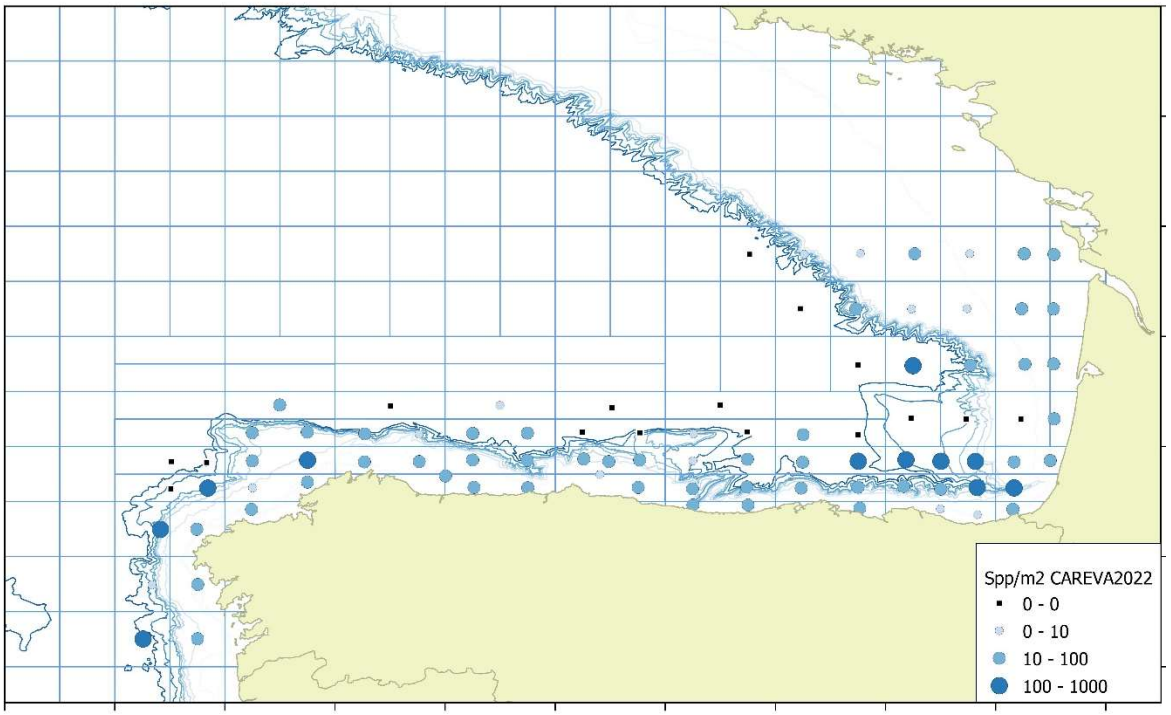


Figure 7. Egg abundance and distribution of other fish species during CAREVA survey.

4.5. Hydrography

Data from 89 CTD performed during the survey have been sent in the Excel spreadsheet to the group WGMEGS, and will be analysed in depth before the next meeting.

Figure 8 shows surface temperature (a) and temperature at 20 m depth (b), and figure 9 shows surface salinity (8a) and salinity at 20m depth, during CAREVA survey.

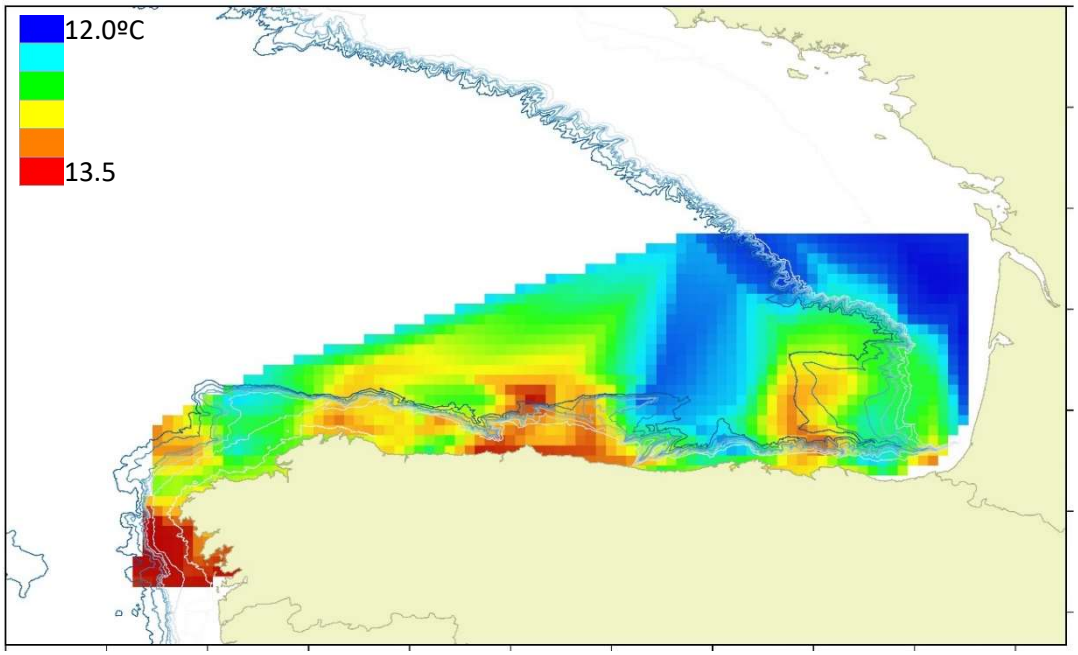


Figure 8a. Sea surface temperature during CAREVA survey.

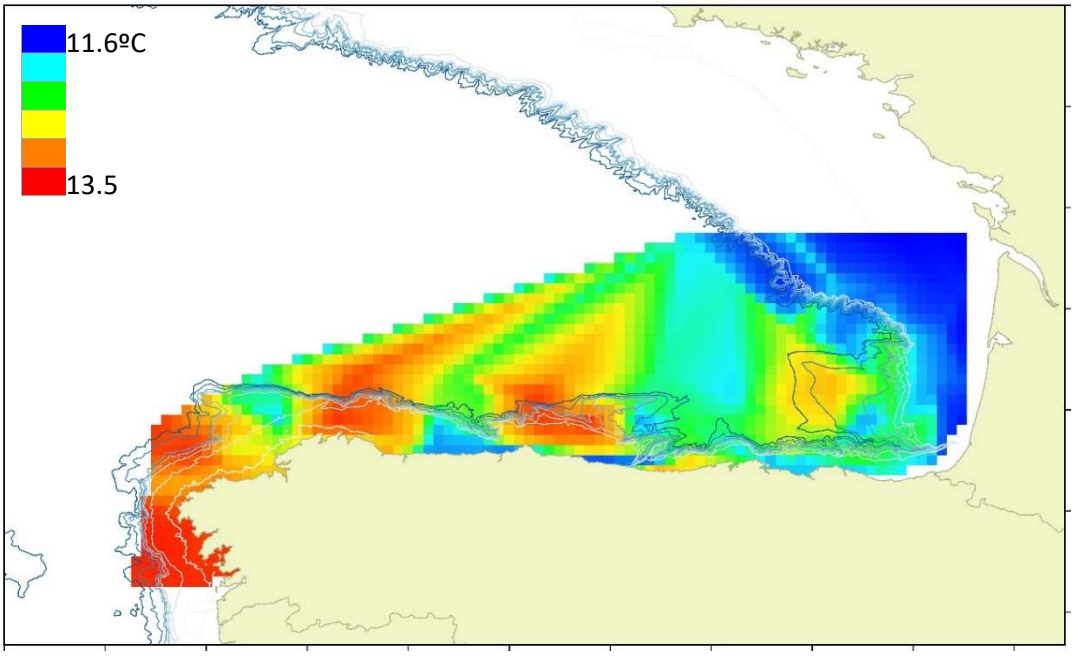


Figure 8b. Temperature at 20m depth during CAREVA survey.

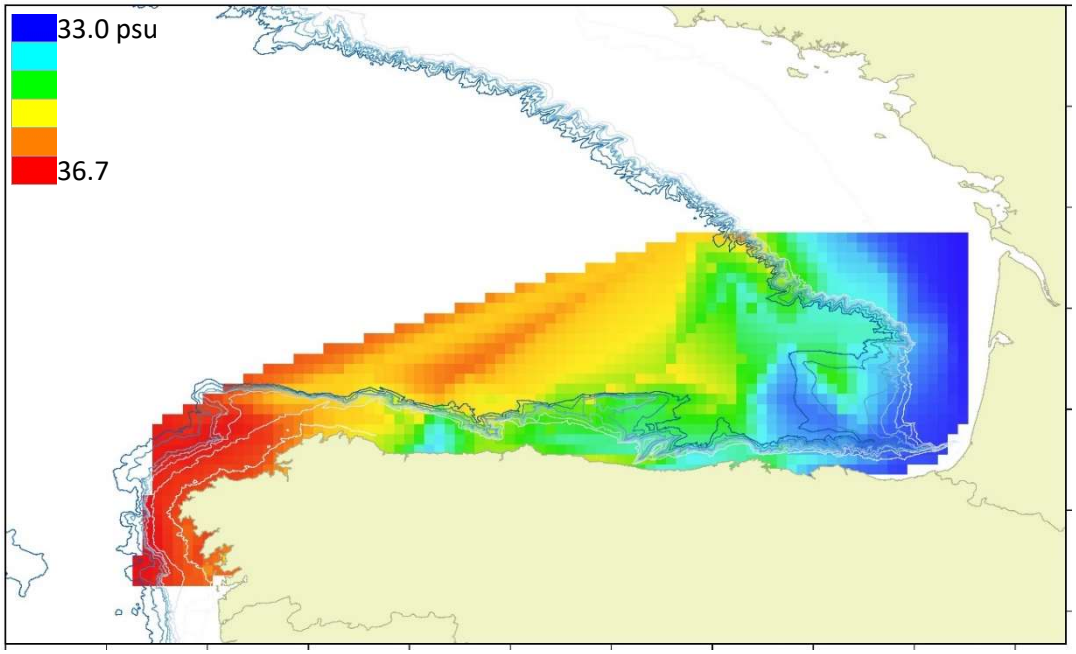


Figure 9a. Sea surface salinity during CAREVA survey.

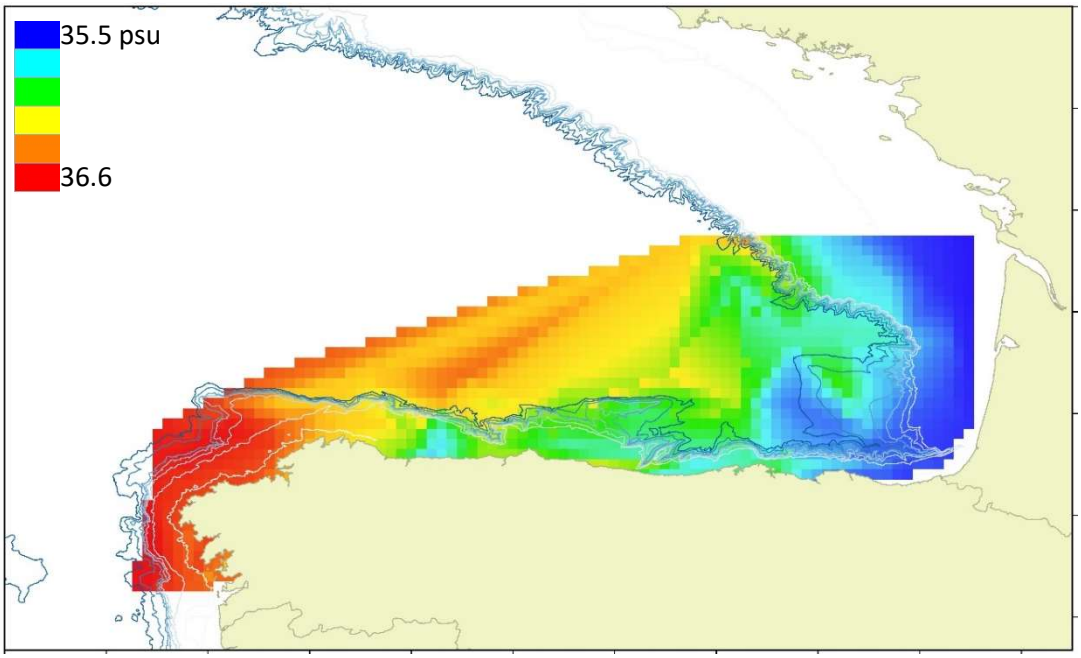


Figure 9b. Salinity at 20m depth during CAREVA survey.

4.6. Fecundity

At the time of writing this report, the fecundity samples have not yet been processed in the laboratory, so only data derived from biological sampling on board are available.

A total of 381 fish were taken for AEPM and DEPM estimations (Table 1), of which 169 were females. Fish (male and female) were collected during four fishing hauls conducted between 20th and 30th March. Biological data (length, weight, sex and macroscopic maturity) were taken on board from all the individuals and from 139 selected females, ovary samples were taken.

Table 1. Number of total fish (nFish) and fecundity samples (nFec) for AEPM and DEPM estimations by date in the four fishing hauls during CAREVA survey.

Hauls	Date	n Fish	n Fec
Careva0322-0002	20 /03	103	39
Careva0322-0004	23/03	105	37
Careva0322-0005	30/03	73	28
Careva0322-0006	30/03	100	35
Total		**381**	**139**

Examining fish maturity stages with the naked eye, females showed ovaries at maturity stages 2 to 6 and no males were found in the early stages of maturation, but all were either in spawning or post-spawning (Table 2).

In the most abundant size range, 35-41 cm, the proportions of males and females are similar (54.6 % males). At larger sizes, 80 % of the individuals are females and, on the contrary, at smaller sizes, males are more abundant, representing 64.7 % (Table 2).

Table 2. Size distribution of total fish catch, by maturity stage in males and females. (Maturity by Walsh scale).

	FEMALE maturity						MALE maturity			
Size	**2**	**3**	**4**	**5**	**6**	Total	**4**	**5**	**6**	Total
27-29							1	2		3
29-31	4	1	1	3	3	12		8	11	19
31-33	2	1		2	1	6	3	7	7	17
33-35	1			6		7	3	4		7
35-37		7	10	7	1	25	32	8		40
37-39		26	19	18	1	64	75	10		85
39-41		21	18	7	1	47	35	4		39
41-43		3	3	1		7	2			2
43-45		1				1				
Total	**7**	**60**	**51**	**44**	**7**	**169**	**151**	**43**	**18**	**212**

Ovarian sampling for fecundity was performed in 139 selected females of the 169 collected (table 3).

Table 3. Female sampled for Fecundity

	Female Maturity Walsh Scale					
Size	**2**	**3**	**4**	**5**	**6**	**Total**
27-29						
29-31	3	1	1	3	3	11
31-33	2	1		2	1	6
33-35	1			5		6
35-37		4	10	5	1	20
37-39		14	19	15	1	49
39-41		16	18	7		41
41-43		1	3	1		5
43-45		1				1
Total general	**6**	**38**	**51**	**38**	**6**	**139**

At stage 3 (pre-spawning advanced maturity) 38 females were collected (Table 3). At this maturity stage, the female has not started to laid eggs, and thus are valid for total fecundity calculations in the annual method. In practice, the number of females suitable for this calculation is reduced after the histological analysis of the gonad, as microscopically is possible to identify structures that indicate that the female has already started to spawn, the post ovulatory follicles (POFs), and thus the gonad cannot be included in the total fecundity analysis.

38 females were collected showing oocytes at a maturity stage of Hydration (stage 5) (Table 3). Hydrated females are selected for batch fecundity calculations as hydratation leads to a growth in size that result in the separation in size of the group of oocytes that form the batch. Only when the batch is completely separated from the rest of the oocytes and no fresh POFs are found in the ovary, we can use these samples to calculate batch fecundity. These requirements can only be checked after sample analysis, but usually result in the number of valid samples being considerably lower than the number of samples collected.

Bibliography:

ICES. 2019 a). Manual for the AEPM and DEPM estimation of fecundity in mackerel and horse mackerel. Series of ICES Survey Protocols SISP 5. 89 pp. ttp://doi.org/10.17895/ices.pub.5139.

ICES. 2019 b). Manual for mackerel and horse mackerel egg surveys, sampling at sea. Series of ICES Survey Protocols SISP 6. 82 pp. http://doi.org/10.17895/ices.pub.5140

ICES. 2022. Workshop on Adult Egg Production Methods Parameters estimation in Mackerel and Horse Mackerel (WKAEPM). ICES Scientific Reports. 4:28. 43 pp. http://doi.org/10.17895/ices.pub.19430855