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# PRELIMINARY RESULTS OF SARDINE DAILY EGG PRODUCTION OFF THE NORTHERN COAST OF SPAIN IN APRIL 2008

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## Abstract

This document presents the results of the SAREVA0408 ichthyoplankton survey conducted by IEO (Instituto Español de Oceanografía*)*. This survey was carried out on board R/V *Cornide de Saavedra* for April 2008. The covered area was the North and North-western Iberian Peninsula waters and the inner part of the Bay of Biscay (from 42°N to 45°N).The present paper includes data on sardine (*Sardina pilchardus)* egg distribution and abundance from the SAREVA0408 survey, as well as the estimation of daily egg production (DEPM) for sardine in the north Spanish Atlantic, Cantabrian waters and south of the Bay of Biscay.

## Introduction

In order to provide an estimate of the spawning stock biomass of the Atlantic-Iberian sardine, different DEPM surveys have taken place in 2008 covering the area from the Gulf of Cadiz to the inner part of the Bay of Biscay (Atlantic-Iberian stock). The region from the Gulf of Cadiz to the northern Portugal/Spain border (Miño river) was surveyed by IPIMAR (Instituto de Investigação das Pescas e do Mar, Portugal), while IEO carried out two combined surveys in April 2008 one for ichthyoplankton on board RV *Cornide de Saavedra* (SAREVA 0408) and another for adult surveying on board RV *Thalassa* (PELACUS 0408) covering the north Spanish Atlantic, Cantabrian waters and south of the Bay of Biscay (from 42°N to 4°N).

The DEPM has been regularly applied to northern Spain coast sardine (VIIIc and IXaN ICES Division) by IEO to estimate its biomass . DEPM surveys for sardine have been carried out by IEO in years 1988, 1990, 1997 (Pérez et al., 1989; Garcia et al., 1991; Lago de Lanzós et al., 1998) and since 1999 in a three-year gap between surveys (ICES 2000, ICES 2004, ICES 2006).

Egg production for Atlantic-Iberian sardine presented in this Working Document is estimated in three different ways in relation to development model to the incubation data i) the Traditional

method developed by Lo (1985) ii) the Generalized model or Bayesian method (ICES 2004) iii) the extended Bayesian method or Multinomial model (Bernal et al., 2007). However it was assumed in the WGACEGGS (ICES, 2007) that the best embryonic development model is the Multinomial, since it is statistically the more correct

**Material and methods**

The ichthyoplankton survey (SAREVA 0408) was carried out on board R/V *Cornide de Saavedra* from 2nd to 27th April. A total of 530 samples were taken with a PAIROVET net (double CalVET), on 62 fixed transects perpendicular to the coast and spaced 8 nm. CalVET samples were taken every 3 nm in the inner shelf (up to 200 m depth) and every 3 or 6 nm beyond the inner shelf, depending on the egg abundance indicated on the CUFES (Continuous Underwater Fish Egg Sampler) samples. The CALVET hauls were performed using a 150 µm mesh size and fitted with flowmeters (General Oceanics), operating vertically (1 m/s) net from the sea surface to 100 m depth or 5 m above the bottom in shallow areas.

To set the delimitation of the spawning area of sardine a semiadaptative sampling with CUFES was developed, deciding to enlarging the radial in case the presence of eggs were found at the end of each radial. The outer transect limit was reached when two consecutive CUFES samples were negative beyond the 200 m depth. The CUFES sampling grid coincided with CALVET sampling grid and was carried out simultaneously. A total of 511 samples were taken with CUFES. The CUFES sampler was equipped with a 335 µm mesh size net.

CUFES and CalVET plankton samples were preserved in formaldehyde 4% buffered with borax in fresh water. The CalVET samples from one cod-end were used for sardine egg quantification, while the samples from the other cod-end were used for plankton biomass quantification. Sardine eggs from samples of CalVET and CUFES were sorted on board in order to obtain a preliminary data of sardine egg abundance and distribution. In laboratory, the CalVET samples were sorted again in order to remove any remaining eggs and then all sardine eggs were classified into 11 stages of development (Gamulin and Hure, 1955).

Also, a continuous record of temperature and salinity (at 3 m depth) was obtained from a thermosalinometer during the survey, and a CTD (Sea Bird 25) profile (Temperature and Salinity) was carried out in each CalVET station.

R packages of *geofun*, *eggsplore* and *shachar* (ICES, 2006) were used to analyse the data. Daily egg production ($P_0$) and mortality (z) rates were estimated by fitting an exponential model:

$$E[P] = P_0 \, e^{-Z \, age}$$

The estimate of daily egg production was obtained using an iterative estimation of mortality (generalised linear model with negative binomial distribution) and multinomial egg ages (Bayesian ageing method, Bernal et al., 2008). The Bayesian ageing method requires a probability function of spawning time. Normal distribution has been assumed with peak of spawning activity at 19:00 GMT and 2 h standard deviation.

Relationships between environmental variables (temperature and salinity) and sardine egg density were explored using T-S plot.

**Results**

A total of 294 CUFES stations of a total of 510 sampled stations were positive for sardine eggs. Comparing to last DEPM survey for sardine (SAREVA0405) the distribution area has extended over 200 m depth, upper reaching even the 1000 m depth in the eastern part of the Cantabrian Sea (Figure 1).

A total of 307 CalVET stations were positive over a total of 530 sampled stations. From the total of 62 transects only 2 (located in the Galician Atlantic coast) did not record positive stations (sardine egg presence). Sardine eggs were distributed along the shelf. The larger concentrations of eggs were found between Cape Prior and Cape Ortegal (Figure 2) with a maximum value of 401 eggs/0.05 $m^2$ close to the coast (51 m). As in previous surveys, very few sardine eggs were found off the western coast of Galicia. Most sardine eggs were collected along the Cantabrian Sea and Bay of Biscay. In the French waters a large concentration of sardine was found near 45º N latitude.

A total surveyed area was 59560 $km^2$. The positive area (spawning area) was estimated in 39773 $km^2$ (Figure 3). The surveyed area in Spanish waters was 48672 $km^2$ and the spawning area estimated (Positive area) was 31206 $km^2$. Table 1 shows results obtained for the last DEPM surveys (2005 and 2008) in order to compare both. Positive area from SAREVA0408 has nearly twice SAREVA0405 positive area. Nevertheless the average of eggs by station in positive area was higher in 2005 (26 eggs/station) than in 2008 (16.3 eggs/station). A total of 4893 sardine eggs were sorted out from the CalVET samples in Spanish and French waters.

Estimation of egg production with a Multinomial incubation model has been obtained. The total egg production in the area (Spanish and French waters) by the Multinomial model has been estimated in 4.23 1012 egg/day (CV = 12.1%). Results show an increase in total egg production

for 2008 DEPM survey in Spanish waters in relation to 2005 DEPM survey (30%) (Table 2). Moreover, Lo's and Generalised models have been also applied to get egg production estimation (Table 2) in order to compare results obtained with Multinomial model.

Sea Surface Temperature and Salinity in the area were ranged from 11.9ºC to 16.9ºC and from 32.50 to 37.03 PSU during the SAREVA0408 survey. Warmer and lower salinities waters were found in the innermost sector of Bay of Biscay due to the influence of the Gironde River. But warmer and high salinities waters were found off the western coast due to the influence of the Eastern North Atlantic Central Water (sub-tropical origin). The T-S plot indicates that most stations are located between 27-26 density isolines (pycnocline). T-S plot shows that the preference ranges of temperature and salinity for sardine spawning during the survey were 12 to 15ºC and 34 to 35.5 PSU (Figure 4).

**References**

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| | SAREVA0405 | SAREVA0408 | |
|---|---|---|---|
| | | Spanish waters | French waters |
| Number of sampled stations | 375 | 429 | 101 |
| Positive stations | 123 | 230 | 77 |
| Sampled area ($km^2$) | 41019 | 48672 | 10888 |
| Positive area ($km^2$) | 17917 | 31206 | 8567 |
| Total eggs | 3231 | 3749 | 1144 |
| Eggs/Station in positive area | 26.3 | 16.3 | 15.1 |

Table 1 Results from CalVET sampled in the previous DEPM survey (SAREVA0405) and survey SAREVA0408 by areas.

| | Lo's model | Generalized model | Multinomial model |
|---|---|---|---|
| SAREVA0405 | $2.16\ 10^{12}$ (23.2) | $2.34\ 10^{12}$ (23.6) | $2.10\ 10^{12}$(22.8) |
| SAREVA0408 Spanish waters | $3.61\ 10^{12}$(18.1) | $4.05\ 10^{12}$(18.5) | $3.07\ 10^{12}$(14.7) |
| SAREVA0408 Spanish & French waters | $4.40\ 10^{12}$(15.3) | $4.95\ 10^{12}$(15.7) | $4.23\ 10^{12}$(12.1) |

Table 2. Total Po (egg $day^{-1}$) and CV% in brackets estimated by Traditional (Lo' model), Generalized and Multinomial model.

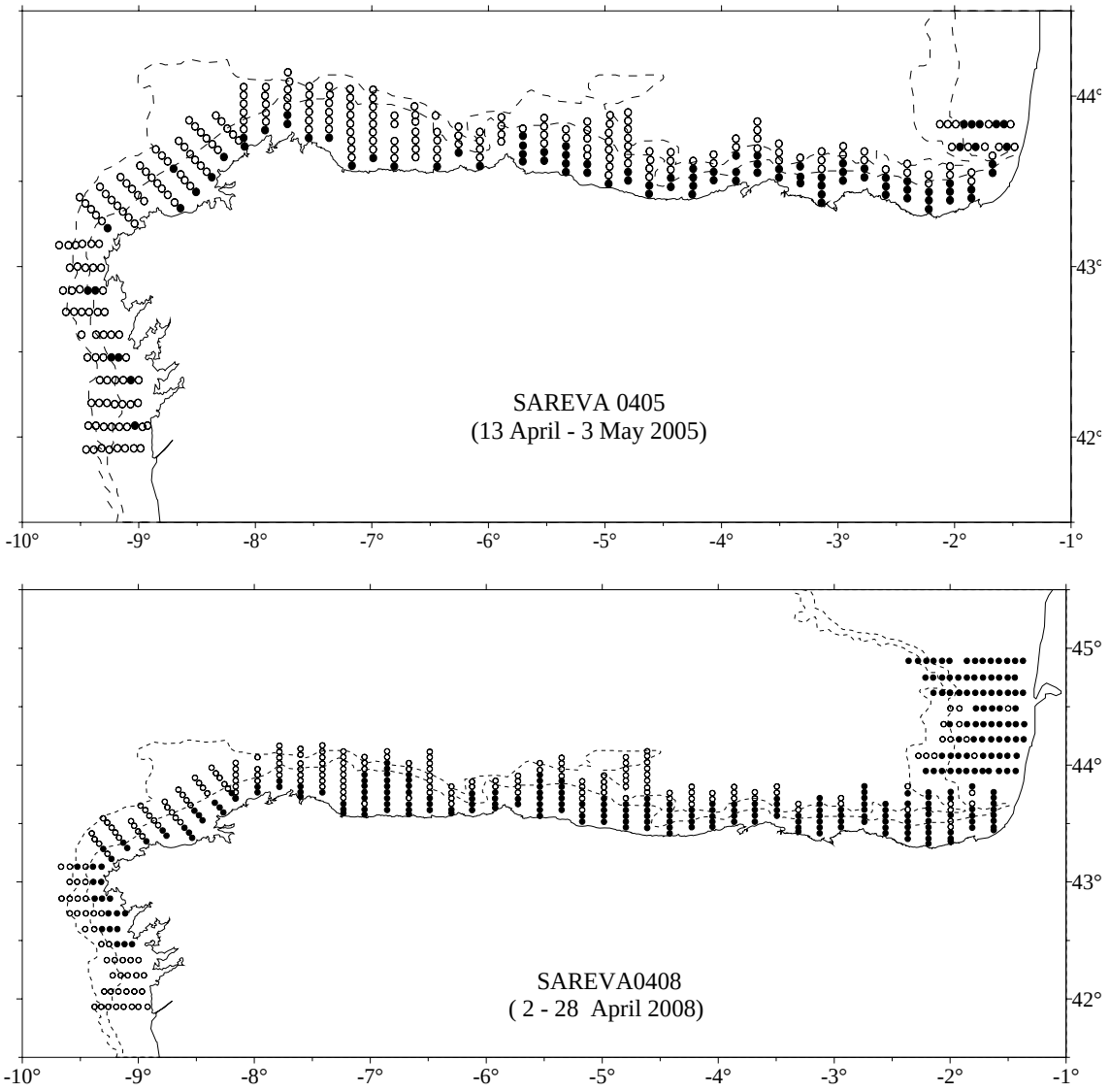


Figure 1. Location of CUFES stations in 2005 and 2008 surveys. Presence (●) and absence (○) of sardine eggs

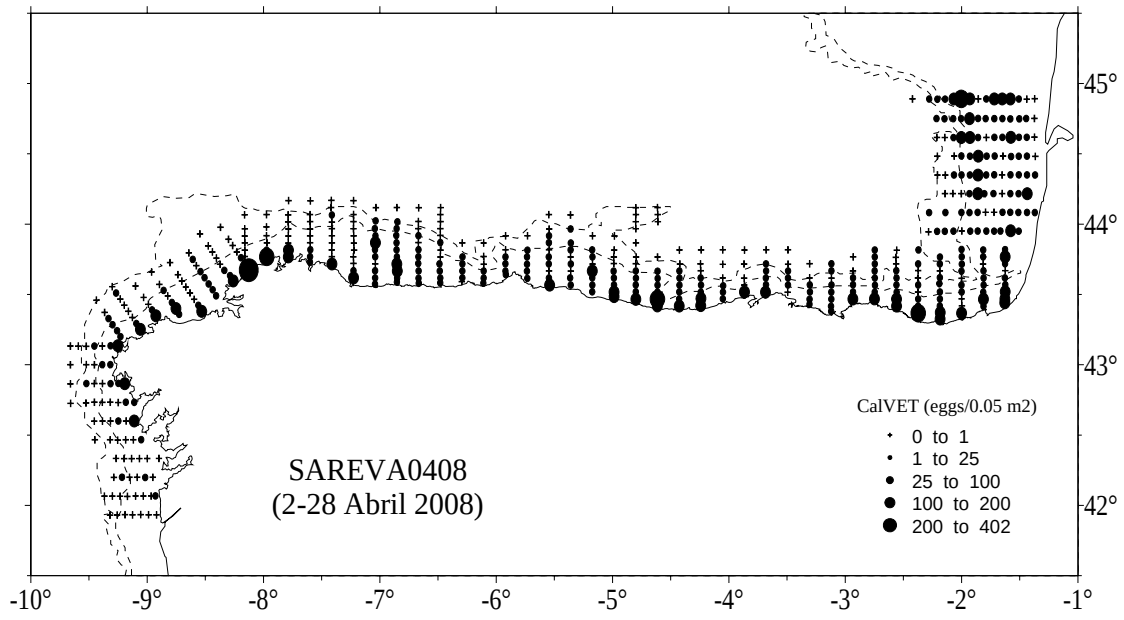


Figure 2. sardine egg distribution and abundance (eggs/0.05 m2, CalVET data). Size of circles is proportional to egg abundance.

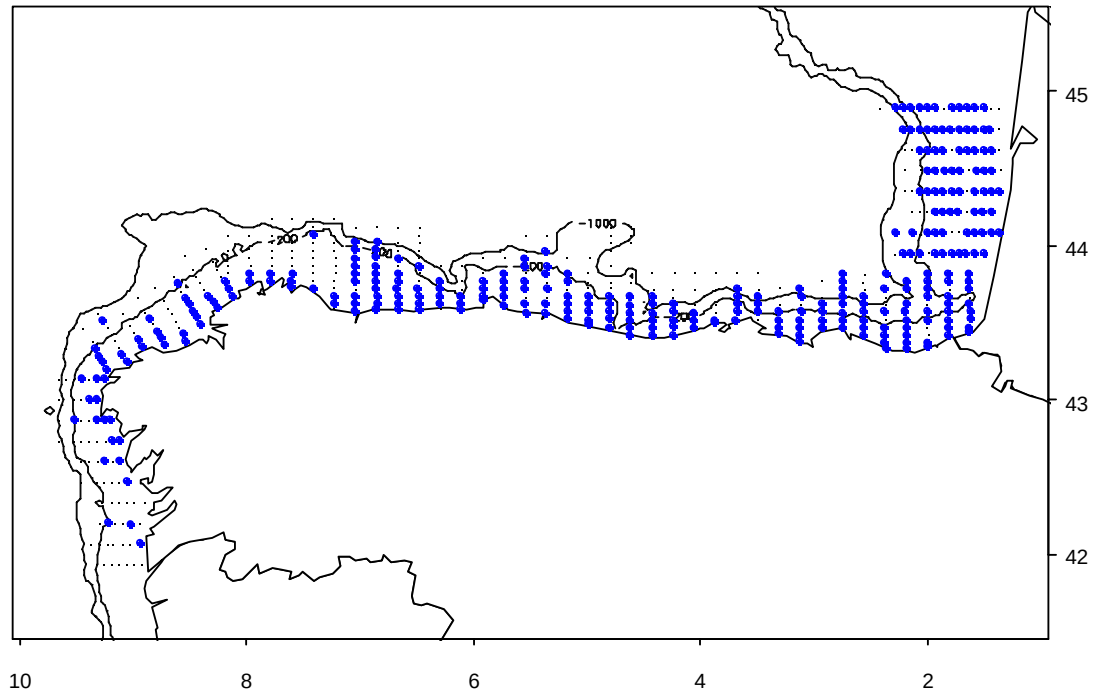


Figure 3. Sardine spawning area delimitation. (blue colour)

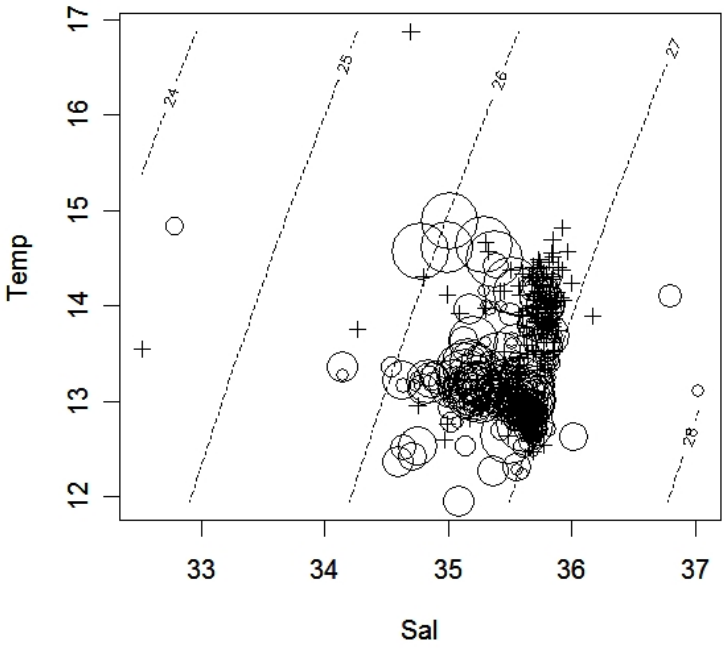


Figure 4. T-S plot. Sardine egg density (nº/m3) considering temperature and salinity. Crosses indicate stations with less than 1 egg while circles represent stations with larger abundances; circle size is proportional to egg density. Dotted lines are isolines of equal water density (pycnocline).