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DEPM 2014 Preliminary Egg Results for the Atlanto-Iberian Sardine ICES VIII and IXa

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This document provides the preliminary egg parameter results from the 2014 sardine DEPM (IPMA + IEO). This survey will be reported to WGACEGG in November 2014.

1. Summary

The triennial DEPM for estimation of sardine spawning biomass for the Atlanto-Iberian stock areas IXa – VIIIc and VIIIb up to 45 ° N took place in the S and W (IPMA) from 15th March to 26th April and in the N (Galicia , Cantabrian Sea and French coast, IEO) between 29th March and 21st April. The whole area was surveyed however the Portuguese survey occurred much later than usual and suffered several interruptions; part of IPMA´s DEPM survey was conducted simultaneously to the acoustics survey onboard the same vessel. The number of fishing samples was maintained at levels similar to other years but it was evident that sardine schools were less available than during previous surveys in particular in the western and northern shores. Preliminary estimates highlighted a sharp decrease in egg production from 2011 to 2014; this pattern was particularly clear in the northern stratum.

2. Background

The DEPM for estimation of sardine spawning biomass within the Atlanto-Iberian stock area is conducted every three years by IPMA (Instituto Português do Mar e da Atmosfera, Portugal) and IEO (Instituto Español de Oceanografía, Spain) in an internationally coordinated survey. The Portuguese survey covers the Atlantic waters from the entrance of the Strait of Gibraltar to the northern border of Portugal in January/February, while the Spanish survey takes place in March/April in the northern area, from the Portuguese/Galician border to the south of the Armorican shelf, in French waters.

In 2014, the Portuguese survey (PT-DEPM14-PIL) took place exceptionally late in the reproductive season (off peak) due to technical constraints with the research vessel (RV Noruega); moreover it was interrupted in several occasions owing to adverse weather conditions and additional logistical issues. The region north of Lisbon was surveyed during the second half of March (15-21), the survey was then interrupted only to be resumed on the 4th of April; by this

time together with the acoustics survey (PELAGO14) and restarting from south. During the period from 4th April to 13th May both surveys were carried out concurrently; the night period was used for plankton sampling while during light hours the acoustics surveying took place; adult sampling was directed at both surveys. Plankton surveying was repeated in the area north of Lisbon during the acoustics coverage in the region (1-13 May); the egg results available at present do not include the second coverage of the northern area.

The Spanish DEPM survey (SAREVA0414) was undertaken using two vessels; RV Vizconde de Eza , for plankton sampling mainly, from the 28th March to the 21th of April, and RV Miguel Oliver to obtain adult samples which were collected during the acoustics survey (PELACUS0414) from 26 March to 22 April. In 2014 IEO's survey took place on board RV Vizconde de Eza (mostly for plankton surveying) instead of RV Cornide de Saavedra which was used from 1988 to 2011.

3. Analyses methodology

All calculations for area delimitation, egg ageing and model fitting for egg production (P0) estimation were carried out using the R packages (geofun, eggsplore and shachar) available at ichthyoanalysis (<http://sourceforge.net/projects/ichthyoanalysis>). The model of egg development with temperature was derived from the incubation experiment data available within the *sardata*, R library. Egg ageing was achieved by a multinomial Bayesian approach described by Bernal et al (2008); a normal probability distribution was used with peak spawning assumed to be at 21:00h with 3h standard deviation. The exponential model: $E [P] = P_0 e^{-Z \text{ age}}$ was fitted by Generalized Linear Model (GLM), with a negative binomial function.

Strata definition (Figure 1): **Stratum 1- South (IXa South)**: Strait of Gibraltar to Cape S. Vicente, **Stratum 2 - West (IXa West)**- Cape S. Vicente to northern limit between Portugal and Spain; **Stratum 3 -North (IXa North + VIIIc)**- from the Portuguese-Spanish border to the Spanish-French Atlantic limit.

The stratum furthest north, in French waters (sub-area of VIIIb up to 45°N) was analysed separately.

4. Results

The surveys, in areas VIIIc and IXa, covered a total area of 80830 km² of which 22467 km² were considered the spawning area (Figures 1 to 3). In total 793 PairoVET samples were obtained (Table 1). Sardine egg distribution, derived from the PairoVET system, for the whole area is presented in Figure 3. The percentage of stations in the whole area with sardine eggs was 26.0% (S: 41.8%, W: 31.7%, N: 16.7%). In total, 2406 sardine eggs were collected by one of the paired PairoVET nets per survey. The egg numbers obtained in the south and west were comparable to 2011 but were much lower in the north. Measured SST ranged from 12.3 to

19.9°C. Temperature distribution followed the common patterns; the highest temperature values were observed in the southern area and the lowest values registered for the Cantabrian Sea. The higher temperatures recorded in the south were likely due to the period of surveying later than usual, already after the onset of spring. The winter/spring atmospheric conditions in the Atlanto-Iberian region during the first quarter of 2014 were very unstable with episodes of heavy rain and strong wind events, this background led to a highly variable hydrodynamic setting with agitated shelf waters for quite long periods.

The egg production model selected includes independent egg production for the three strata and a common mortality (same model selected for the 2012 series revision, ICES 2012). It was not possible to estimate mortality per strata as the value for the western stratum was non-coherent (Table 2, Figure 4).

summary :

- Portuguese survey conducted much later than usual (and with interruptions); consequently preventing solid comparisons of the 2014 results with the historic series
- spawning area in 2014 for the whole area slightly reduced compared to 2011 and the smallest of the historic series; patchy egg distribution
- spawning area reduction particularly evident in the north (around 40% of the total spawning area in 2011) while in the west it increased to almost the double
- the southern and western regions showed similar daily egg production per m² (eggs/m²/day) which was much larger than in the north; for all strata daily egg production per m² was much lower than in recent surveys
- sum of total egg production for the 3 strata in 2014 much lower than in 2011, in particular in the northern and southern regions, similar in the west (Table 2 and Figure 5)
- mortality value (single mortality for whole area) similar to 2005 and one of the lowest of the series but with high CV
- to note that these are preliminary estimates; the complete set of data will be available before the WGACEGG meeting and the analyses repeated and further discussed

- during the 2014 survey the availability of adult sardine for trawling was limited in the whole area; nevertheless 36 samples were obtained, 11 in the south, 10 in the west and 15 in the north; extra samples (14) from purse-seiners were collect in Portugal
- the number of hydrated females collected was higher than in 2011
- no estimates are available at present for the adults parameters

sub-region VIIIb (french waters)

- 128 PairoVET samples taken in French waters in area VIIIb; 60% with eggs
- high egg densities were observed in the area furthest north; the large majority of the sardine eggs observed during the IEO survey (1449 in a total of 1765; 82%) were collected in the sub-region VIIIb
- spawning area in 2014 reduced to 7914 km² compared to 2011 survey (12400 km²)
- daily egg production per m² in 2014 (212) similar to 2011 survey and much larger than in previous surveys
- total egg production (eggs/day) in 2014 lower than in 2011, 1.67 compared to 2.72 respectively
- daily egg production per m² and total egg production (eggs/day) much higher than in the adjacent stratum, in Cantabrian waters (IXa North + VIIIc)

GLM model adjustment:

Call:

```
glm.nb(formula = cohort ~ offset(log(Efarea)) - 1 + Stratum +  
  age, data = aged.data, weights = Rel.area, init.theta = 0.292046895523314,  
  link = log)
```

Deviance Residuals:

```
  Min      1Q  Median      3Q      Max  
-1.68744 -1.04106 -0.73700  0.02468  3.27516
```

Coefficients:

```
      Estimate Std. Error z value Pr(>|z|)  
Stratum1  4.60780   0.27945  16.489 <2e-16 ***  
Stratum2  4.62316   0.24360  18.978 <2e-16 ***  
Stratum3  3.63291   0.25887  14.034 <2e-16 ***  
age      -0.01250   0.00629  -1.988  0.0468 *
```

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for Negative Binomial(0.292) family taken to be 1)

```
Null deviance: 4367.54 on 521 degrees of freedom  
Residual deviance: 413.08 on 517 degrees of freedom  
AIC: 1758.9
```

Number of Fisher Scoring iterations: 1

```
Theta: 0.2920  
Std. Err.: 0.0272
```

```
2 x log-likelihood: -1748.9290
```

References

Bernal, M., Ibaibarriaga, L., Lago de Lanzós, A., Lonergan, M., Hernández, C., Franco, C., Rasines, I., et al. 2008. Using multinomial models to analyze data from sardine egg incubation experiments; a review of advances in fish egg incubation analysis techniques. *ICES Journal of Marine Science*, 65: 51–59.

ICES. 2012. Report of the Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES Areas VIII and IX (WGACEGG), 26-30 November 2012, Fuengirola, Spain. ICES CM 2012/SSGESST:16. 221 pp.

R Development Core Team (2008). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL <http://www.R-project.org>.

Table 1. General egg and adult sampling sardine DEPM 2014.

* acoustics surveying included, not all hauls directed at sardine echotraces
purse-seiners samples not included

Institute	IPMA	IPMA	IEO	IPMA/IEO	IEO
Survey area	IXa South	IXa West	IXa N + VIIIc	IXa+VIIIc	VIIIb (up to 45° N)
SURVEY EGGS					
R/V	Noruega	Noruega	Vizconde de Eza		Vizconde de Eza
Date	04/04-15/04	15-21/03; 15-26/04	29/03-21/04		09/04-16/04
PairoVET stations	134	265	394	793	128
Positive stations	56	84	66	206	77
Tot. Eggs	1042	1051	316	2406	1449
Max eggs/m2	5900	1620	704	5900	2619
Temp (°C) min-max	14.4-19.9	12.8-14.9	12.3-14.9	12.3-19.9	12.3-14.5
Max age (hour)	57.7	59.2	74.2	56.1	74.3
SURVEY ADULTS					
Numbers of hauls*	13	31	57	101	13
Positive hauls	11	10	15	36	3

Table 2. Egg parameters from 2014 sardine DEPM survey.

Institute	IPMA	IPMA	IEO	IPMA+IEO (total)	IEO
Parameter/Area	IXa South	IXa West	IXa N + VIIIc	IXa+VIIIc	VIIIb (up to 45° N)
Survey area (Km ²)	14558.7	27357.3	38914.4	80830.5	13480.4
Positive area (Km ²)	6077.2	8895.7	7494.5	22467.4	7913.8
Z (hour ⁻¹) (CV%)	-0.012 *(50.3)				-0.021*** (29.2)
P0 (eggs/m2/day) (CV%)	100.3 (27.9)	101.8 (24.4)	37.8 (25.9)		211.5 (27.5)
P0 tot (eggs/day)(x10 ¹²) (CV%)	0.61 (27.9)	0.91 (24.4)	0.28 (25.9)	1.80 (16)	1.67 (27.5)

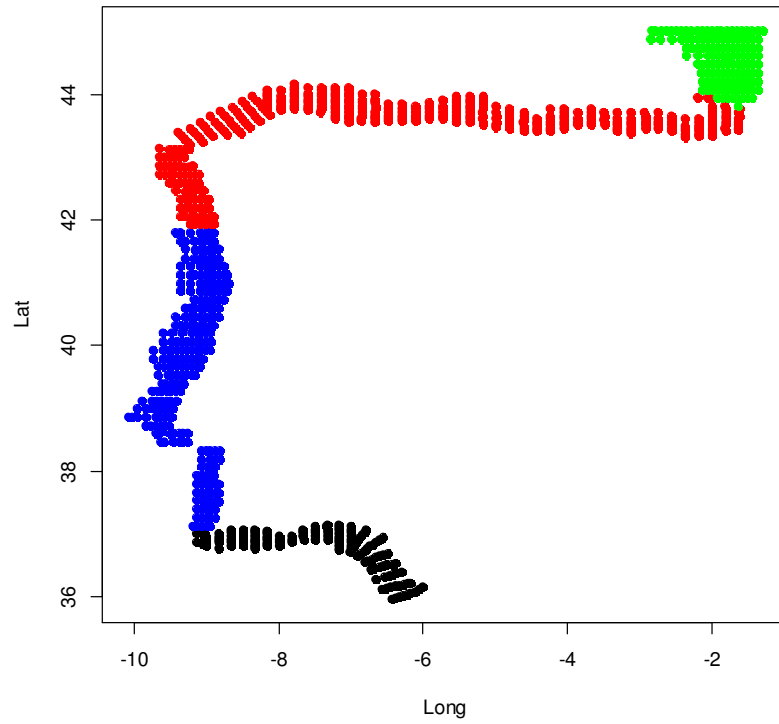


Figure 1. PaioVET hauls undertaken and spatial strata definition (black- IXa South; blue – IXa West; red – Ixa North+ VIIIc; green – sub-area of VIIIb).

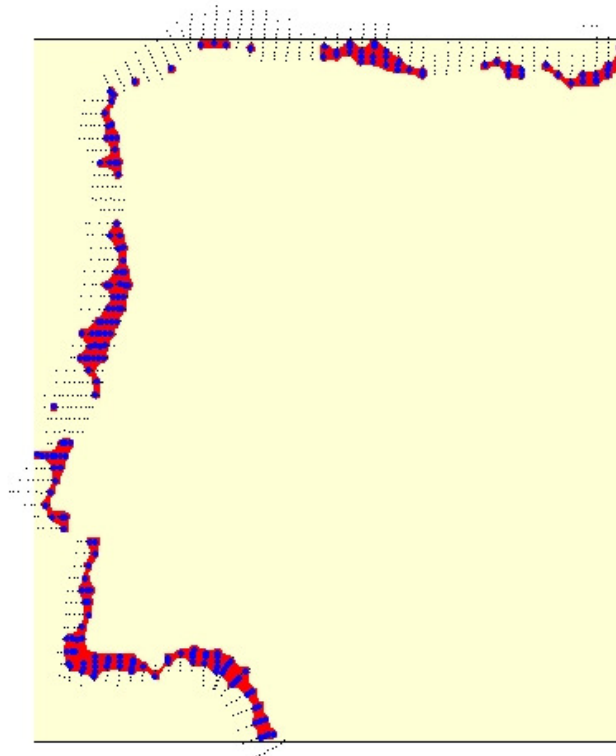


Figure 2. Positive area estimated for area VIIIc and IXa (22467.4 km² from a total Iberian Peninsula surveyed area of 80830.5 km²).

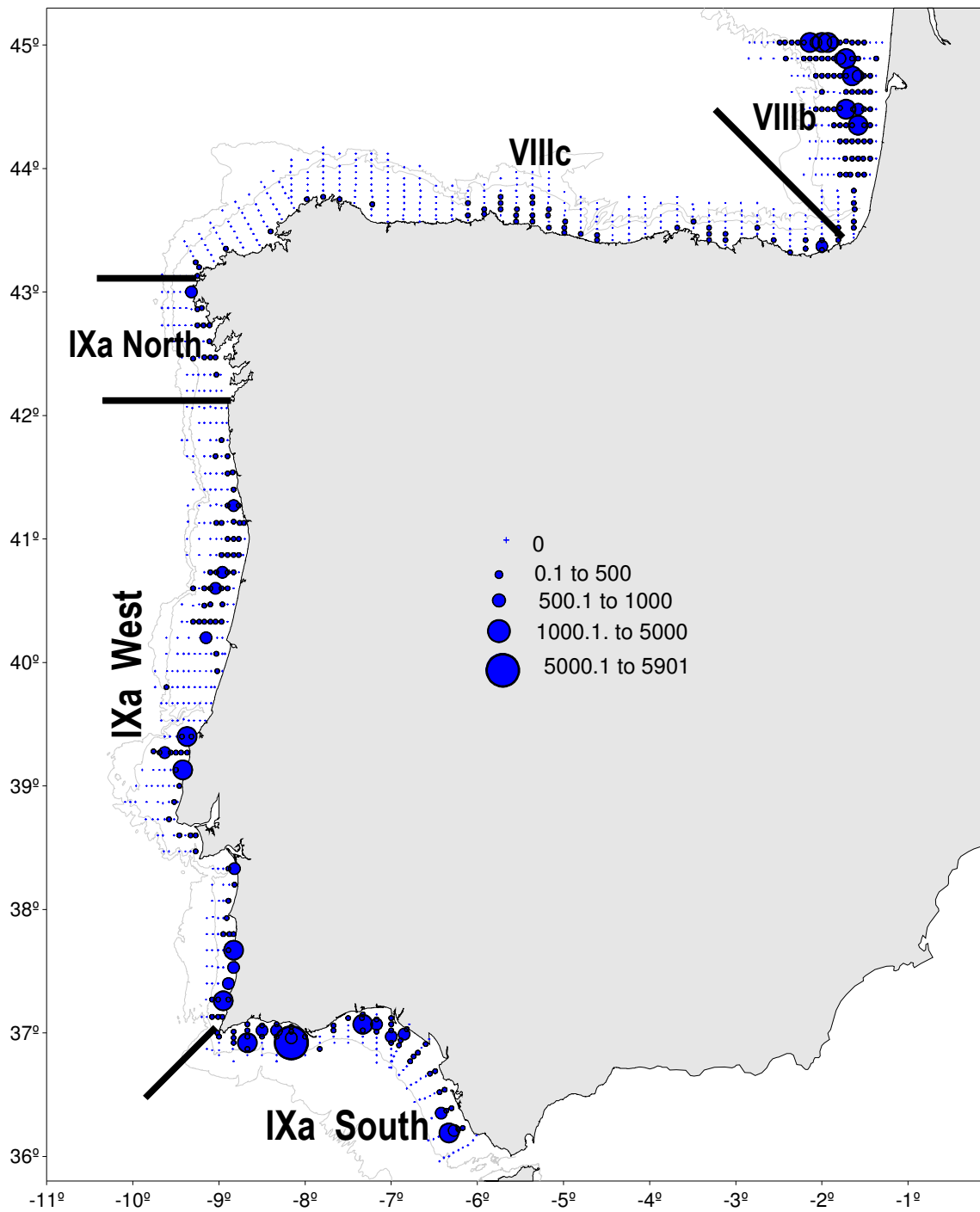


Figure 3. Sardine egg distribution. Egg/m² from PairoVET sampling (+, egg absence). The areas indicated refer to the nomenclature used in the text

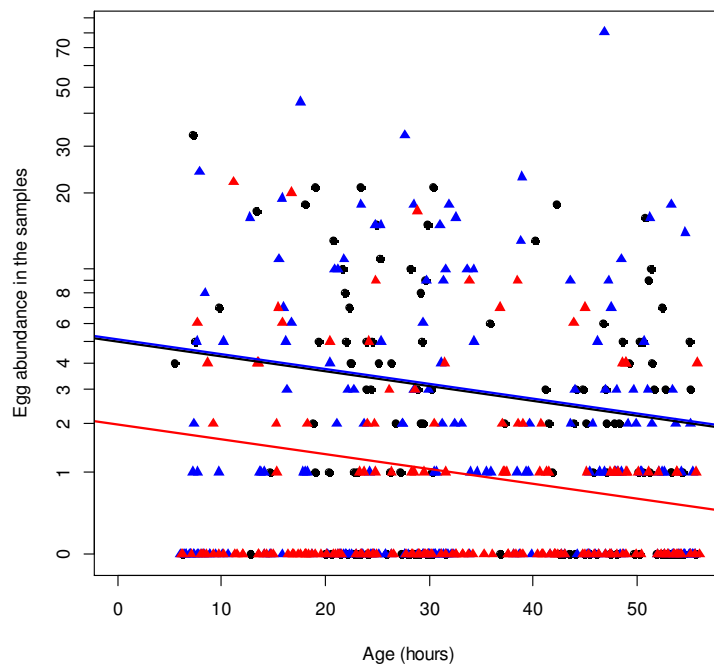


Figure 4. Abundance by age of eggs in the different spatial strata (black – south, blue - west stratum, red - north) and fitted mortality curve (single mortality for all strata).

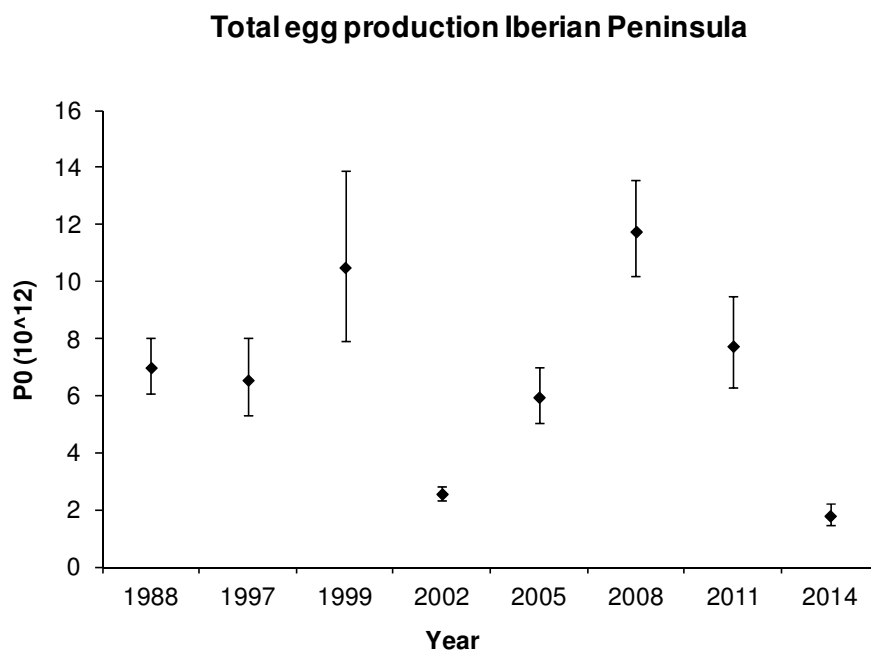
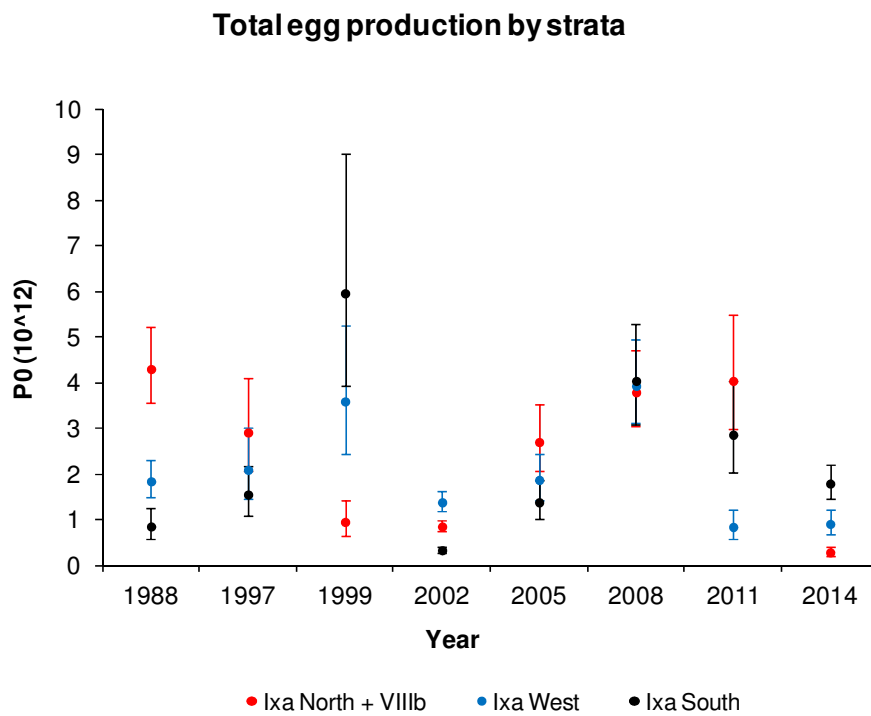


Figure 5. Total egg production (eggs/day*10¹²) by spatial strata (top panel); black – IXa South, blue - IXa West stratum, red – IXa North + VIIIc and for the total stock area off the Iberian Peninsula (bottom panel). Dots and lines indicate the estimates of egg production and their confidence intervals.