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Paper # 13

Reproductive Parameters and Spawning Biomass of Chilean Jack Mackerel (*Trachurus murphyi*) in 1999-2006, determined by The Daily Egg Production Method.

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BACKGROUND

- The stock assessment of Chilean jack mackerel is carried out by using age/length-structured models that take into account indexes of relative abundance.

- In the past, has been used catch per unit effort (CPUE) and acoustic estimates of biomass in central-southern Chile.

- However, operational changes of the fleet due to the regime of individual quotas and changes in the availability of the resource in the coastal zone cause that **stock assessment models need to look for new independent estimations of biomass**.

BACKGROUND

- In 1997, a first “scouting survey” to evaluate spawning condition, spawners distribution and abundance of eggs and larvae in oceanic waters was required in order to looking for new independent information about the stock.

- Later, it was postulated that the DAILY EGG PRODUCTION METHOD (DEPM: Lasker, 1985), have the potential to be applied in Chilean Jack Mackerel.

- After three years of work, we were able (with the help of international experts) to calculate daily egg production and reproductive parameters required to obtain jack mackerel SSB estimates from the studies FIP 99-14, (Sepúlveda *et al*., 2001), FIP 2000-10 (Cubillos *et al*., 2002), y FIP 2001-12 (Cubillos, 2003).

OBJECTIVE

- To report estimates of spawning biomass of jack mackerel (SSB), obtained from cruises realized during the maximum reproductive activity of Chilean Jack mackerel off Central Chile for the period 1999 - 2007.

MATERIALS AND METHODS

- Surveys and Study Area
- Sampling
- Adult Reproductive Parameters
- Daily Egg Production (P_0)
- Biomass Estimation

Surveys and Study Area

- The daily egg production method (MPDH) considers an intensive sampling of the total egg production in the spawning area, and collect adults for the characterization of reproductive features of the spawning stock (Hunter y Lo 1993, Alheit 1993).

Surveys and Study Area

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www.elsevier.com/locate/fishres

The spatial structure of the oceanic spawning of jack mackerel (*Trachurus murphyi*) off central Chile (1998–2001)

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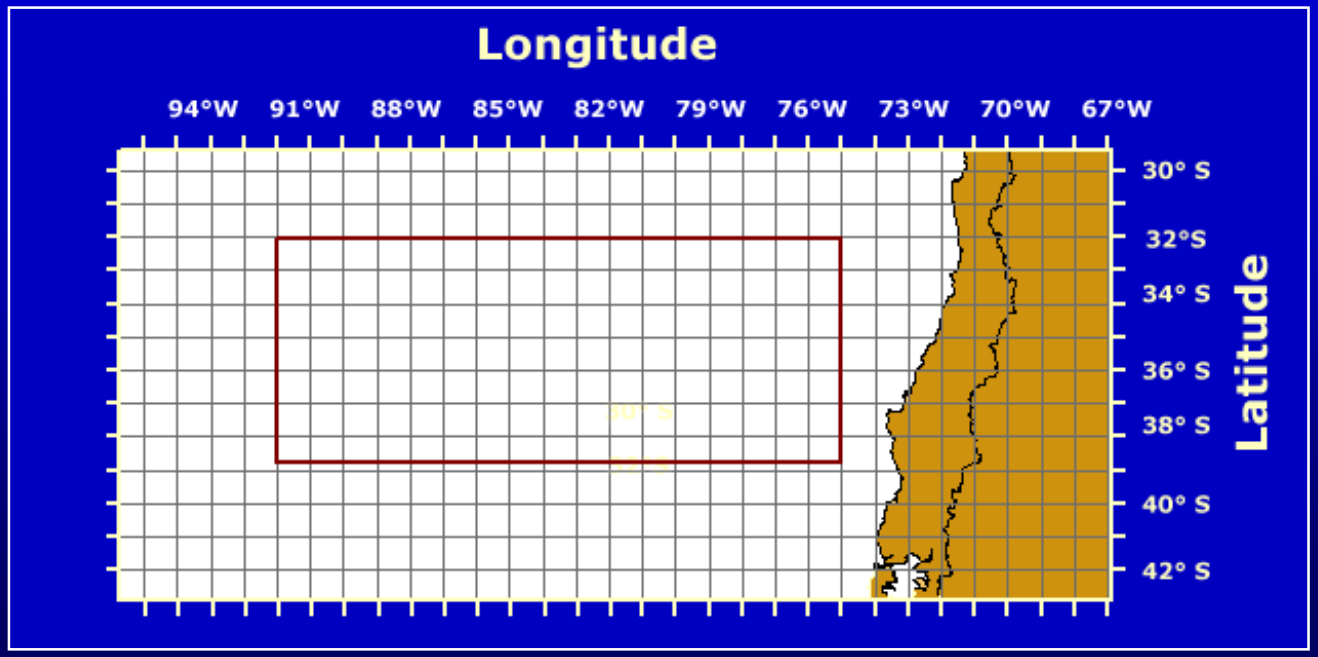
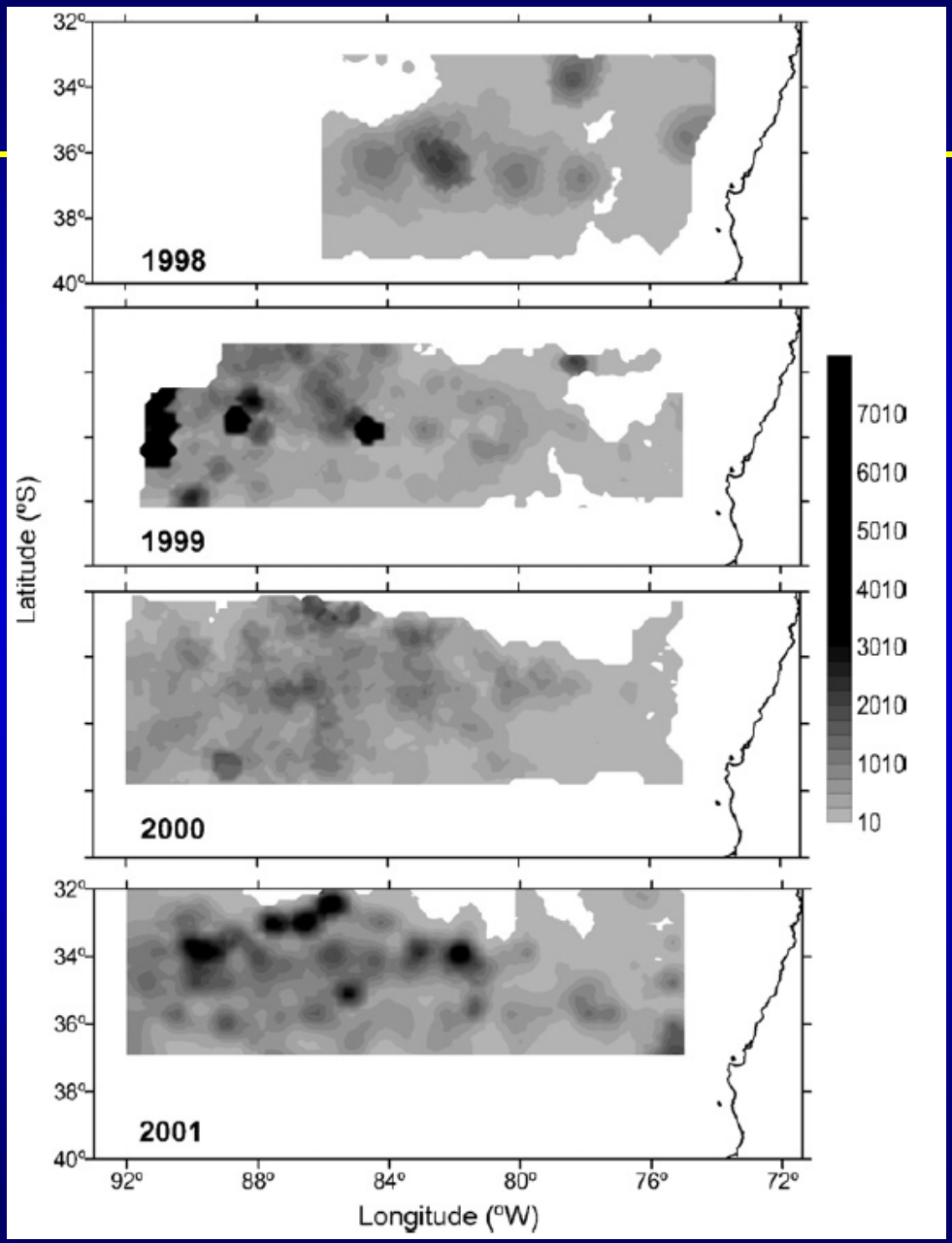
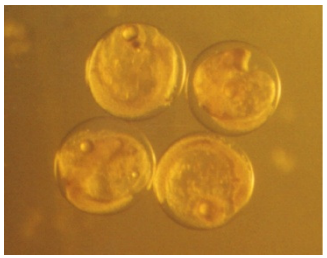
Surveys and Study Area

Year	Date	Latitudinal range	N° Transects	N° Plankton stations	N° Fishing sets
1999	14/11 – 22/11	33°06' – 38°12'	18	751	37
2000	25/11 – 04/12	32°06' – 37°48'	20	880	12
2001	18/11 – 30/11	31°42' – 36°54'	16	694	18
2003	10/11 – 22/11	33°06' – 38°00'	16	694	30
2004	21/11 – 01/12	33°00' – 38°00'	20	910	31
2005	22/11 – 02/12	33°00' – 38°40'	18	784	14
2006	14/11 – 26/11	32°60' – 38°50'	18	805	32



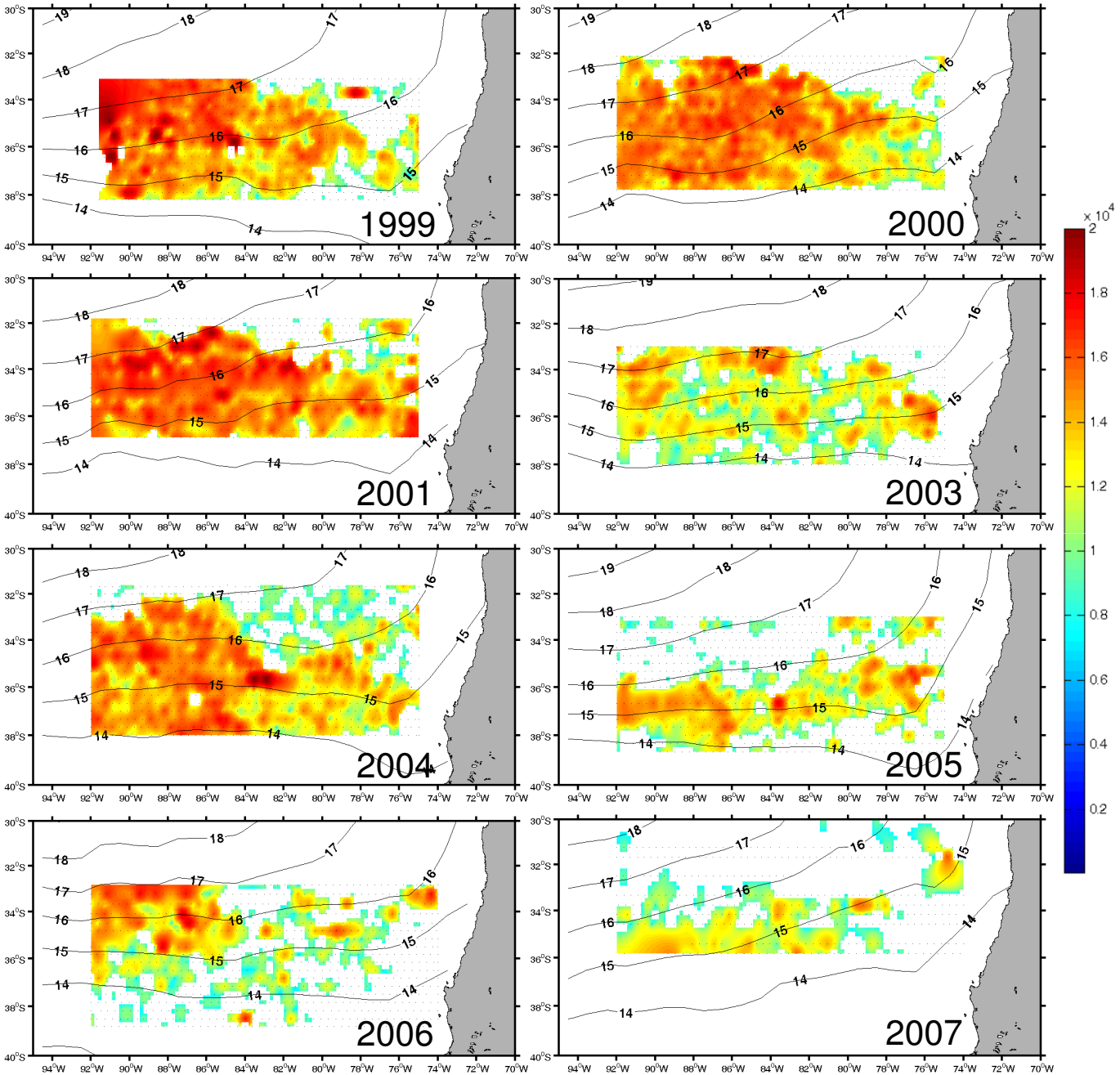

1998
1999
2000
2001
32°
34°
36°
38°
40°
92°
88°
84°
80°
76°
72°
Latitude (°S)
Longitude (°W)
7010
6010
5010
4010
3010
2010
1010
10

SPATIAL DISTRIBUTION OF EGGS. NOVEMBER 1999-2007



High densities were reported between 33-37 º S, and westward to 82-84º W, showing that the bulk of jack mackerel spawning occurs 400-500 nm offshore.

Since 2005, low densities were observed in the study area.



BIOMASS ESTIMATION

- According to Stauffer and Picquelle (1980) the spawning stock biomass is expressed by:

Eggs parameters

$$B = \frac{P_0 A}{\frac{R \times F \times S}{W}}$$

Adults Parameters

Where:

• *B* is the spawning stock biomass (*t*), *P*0 the daily egg production (number of eggs per m2 per day).

• *A* the total survey area (Km2).

• *W* the average weight of mature females (g).

• *R* the fraction of mature females by weight.

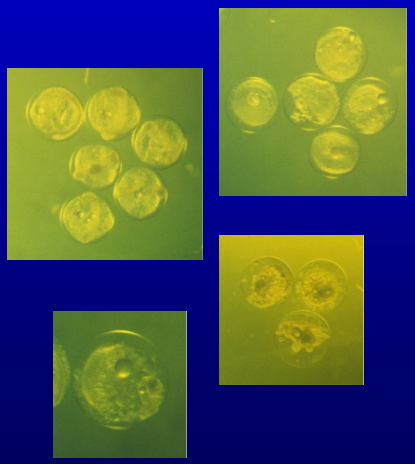
•*S* the fraction of mature females spawning per day.

•*F* is the batch fecundity (mean number of eggs per mature female per spawning).

SAMPLING

Plankton:

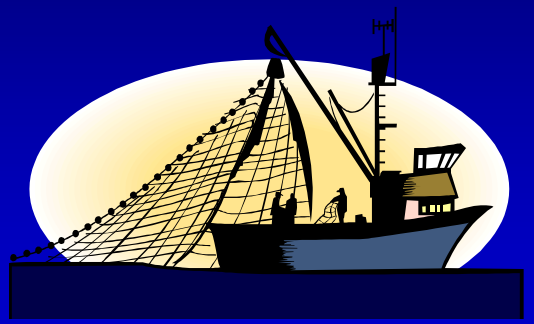
- All cruises: identical WP2 nets were used to collect plankton samples.
- The diameter of the WP2 net frame was 0.6 m and the mesh size of 330 µm, and tow depth of 100m were used.
- Sea surface temperature was recorded at each plankton station.
- All jack mackerel eggs were sorted from the plankton and identified based on characteristics described by Santander and Castillo (1971).
- The density of eggs taken in the WP2 net was expressed as the number of eggs per 10m2 of sea surface water.



SAMPLING

Adults

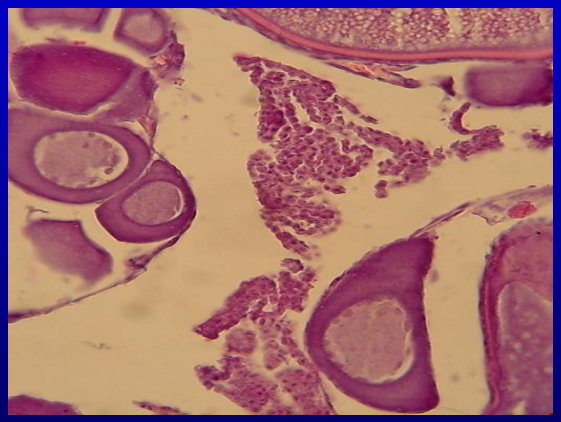
- In each cruise and in each vessel, adults of jack mackerel were randomly sampled.
- First, a random sub-sample of fishes was dissected by mid-ventral incision to determine sex proportion.
- Each adult was analyzed by measuring folk length and total weight (body weight).
- A random sub-sample of mature females was taken from each set and each ovary was preserved in 10% buffered formaldehyde solution, and subjected to histological analysis.
- In addition, any extra females macroscopically detected with hydrated ovaries were preserved in formaldehyde solution for subsequent analysis of batch fecundity.



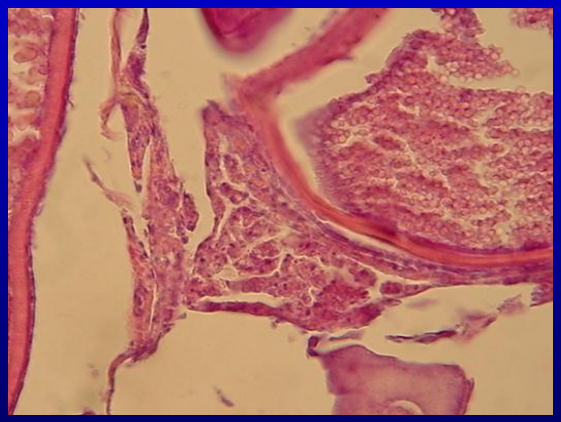
Adult Reproductive Parameters

- The mean weight (*W*) of mature females: The number of mature females in each set was corrected by histology and the mean weight by year was estimated weighted by the number of the mature females in each set.

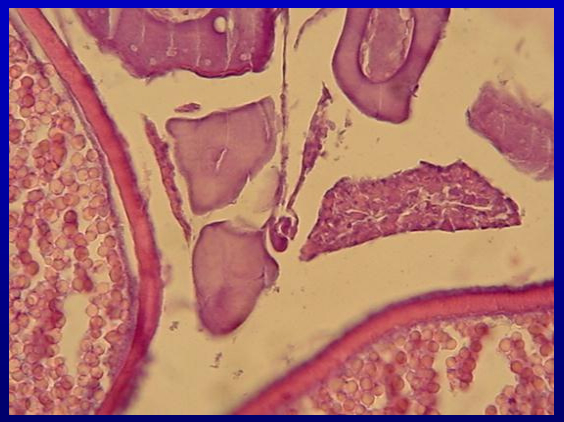
- The spawning fraction (*S*): It was assessed by ageing postovulatory follicles (POFs) according to the criteria developed by Hunter and Goldberg (1980) and Hunter and Macewicz (1985). Spawning fraction was estimated from the proportion of 1-day old POFs for samples captured mainly during daytime (mainly from 6:30 to 18:00 h). We used day-1 because day-2 POFs may appear the same in histology for a longer period than 24 h.



FPO 0 (News)



FPO day 1



FPO day 2

Adult Reproductive Parameters

- The batch fecundity, F (number of eggs to be spawned as a batch): It was estimated using the gravimetric method suggested by Hunter et al. (1985). Batch fecundity was related to ovary-free weight of hydrated females by considering a linear model.

- The sex ratio (R): In the *i*th fishing set was computed from the weight of females divided by the sum of total weight of females and males.

DAILY EGG PRODUCTION (P_0)

Egg numbers were assumed to decline at a constant exponential rate according to the model:

$$Pt = P0 \exp^{(-zt)}$$

Where:

Pt is the egg abundance at age *t* (egg per 10m2 per day) (estimated by a egg development model)

*P*0 the daily egg production per 10m2 per day

Z is the daily total mortality rate.

The fitting procedure to observed data was based on a generalized linear model (GLM).
The daily egg production and variance in the total survey area were computed according to procedures described in Picquelle and Stauffer (1985).

BACK TO BIOMASS ESTIMATION

- According to Stauffer and Picquelle (1980) the spawning stock biomass is expressed by:

Eggs production

$$B = \frac{P_0 A}{R \times F \times S} W$$

Adults Parameters

Where:

• *B* is the spawning stock biomass (*t*), *P*0 the daily egg production (number of eggs per m2 per day).

• *A* the total survey area (Km2).

• *W* the average weight of mature females (g).

• *R* the fraction of mature females by weight.

•*S* the fraction of mature females spawning per day.

•*F* is the batch fecundity (mean number of eggs per mature female per spawning).

RESULTS

- **There is an increase in size of jack mackerel. This situation is reflected in a progressive increase of the main mode and the reduction in the percentage under minimal length (< 26 cm of FL)**

Year	Range	Principal Mode (cm)	% Under Minimal Length (26 cm FL)
1999	21-56	25	56.8
2000	21-54	26	27.0
2001	20-57	26	32.8
2003	18-60	28	15.7
2004	20-65	29	11.4
2005	23-52	31	0.2
2006	26-61	35	0.0

RESULTS

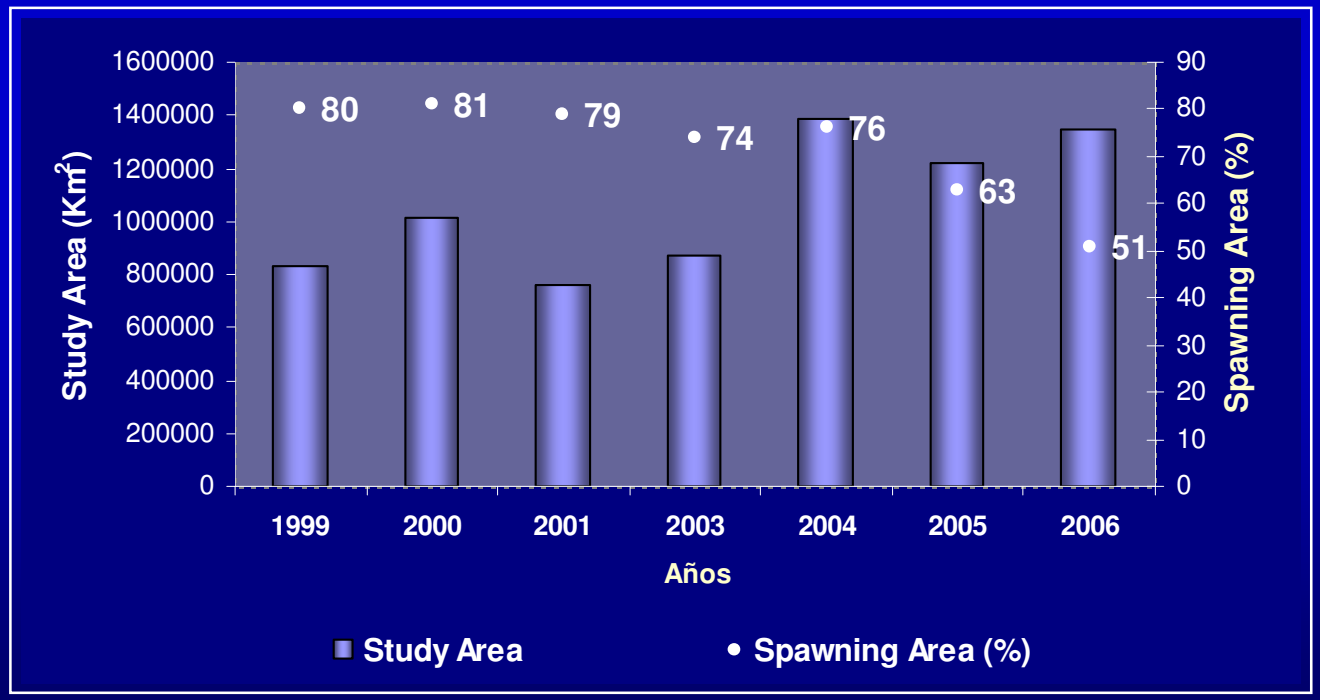
- There is an increase in mean weight of the mature females and its respective fecundity, being considered for the last year of study a mean weight of 532 g and a batch fecundity of 48.213 oocytes.

- The sexual proportion varied between 0.39 and 0.49 per year, with a deviation of only a 0.01 for all the analyzed series.

- The spawning fraction displayed a high variability between years; the lowest fraction was estimated in 2006 just by a 7% and highest in 2004 with a 19% .

RESULTS

- **All the cruises presented a suitable cover of the spawning area, being observed that for every year, the spawning area is superior to a 70% of the total area of study, with the exception of the years 2005 and 2006 that presented only 63 and 51% respectively .**



RESULTS

Resume of the reproductive parameters and the spawning biomass estimation by year of cruise.

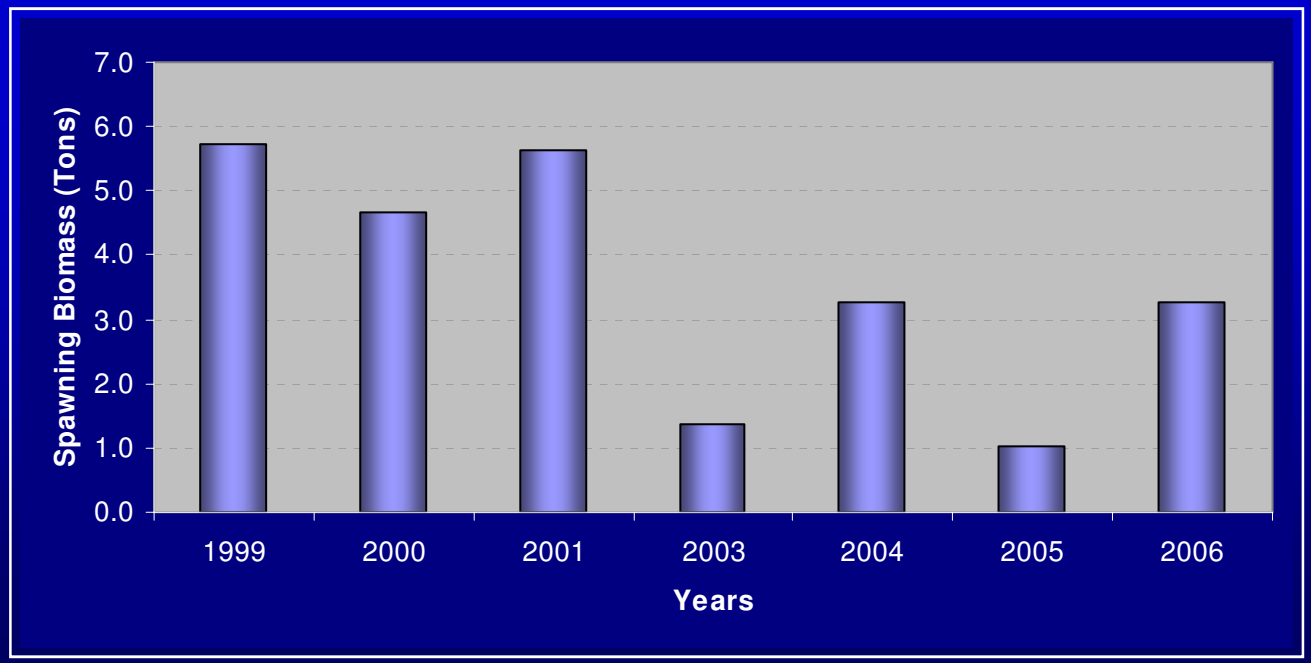
Year	W (g)	F (nº oocytes)	S	R (g)	Po (eggs/m²d-¹)	Study Area (Km²)	Spawning Area (Km ²)	Spawning Area (%)	Spawning Biomass (t)
1999	191,8	26610a	0,126a	0,433a	65,275	829.607	663.747	80	5.723.933
2000	211	26069	0,148	0,472	49,163	1.011.802	823.077	81	4.688.208
2001	223,7	27150	0,104	0,393	46,217	762.883	600.320	79	5.626.963
2003	394,7	39846	0,09	0,480	9,204	871.179	647.968	74	1.387.804
2004	412,1	39957	0,194	0,475	27,318	1.385.613	1.054.352	76	3.287.439
2005	364,7	40463	0,142	0,466	9,94	1.222.143	773.602	63	1.042.706
2006	532,4	48213	0,070	0,490	14,79	1.343.682	682.550	51	3.282.628

a: No reproductive data available, is an average of the years 2000-2001.

RESULTS

- The values of P_0 estimated by year , shown a high variability between years. The rank of the estimations varied between 9,9 to 65,2 eggs per m2 (years 2005 and 1999 respectively).

- Throughout the time a diminution of the spawning biomass is observed, being observed the majors estimations in period 1999-2001. In the last years the biomass varies between 1 to 3 million tons.



FOR DISCUSSION AND CONCLUSIONS

- There is an increase in mean fish size and weight of mature females that are participating in the spawning along the years.
- There are no significant differences between the size composition and weights of the individuals collected from the surveys and the size composition reported by the catches of the industrial fleet during the spring season and the coming fishing season.
- The reproductive parameters used as input in the daily egg production method for estimating spawning stock biomass show that:
- The most stable parameter in the jack mackerel population is the sexual proportion (mean of 0.46 for all the years analyzed)
- The most variable parameter is the spawning fraction.

DISCUSSION

- Po, this parameter show a high variability.
- The bulk of the jack mackerel spawning occur offshore between 78-80◦W and 92◦W, is maximal at 35◦S and associated to SST warmer than 15–16 ◦C

- There is a need to extend the surveys western from the 92ºW (collaborative work and efforts between fishing countries in the RFMO)

ACKNOWLEDGEMENTS

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