Reproduction of Jack mackerel *Trachurus murphyi* in Peru

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La Paz, Baja California Sur, Mexico. April 24 – 26, 2018

Outline

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2. METHODOLOGY

3. RESULTS

   2.1 MATURITY SCALE
   2.2 REPRODUCTIVE CYCLE
   2.2 MATURITY SIZE

4. FINAL COMENTS

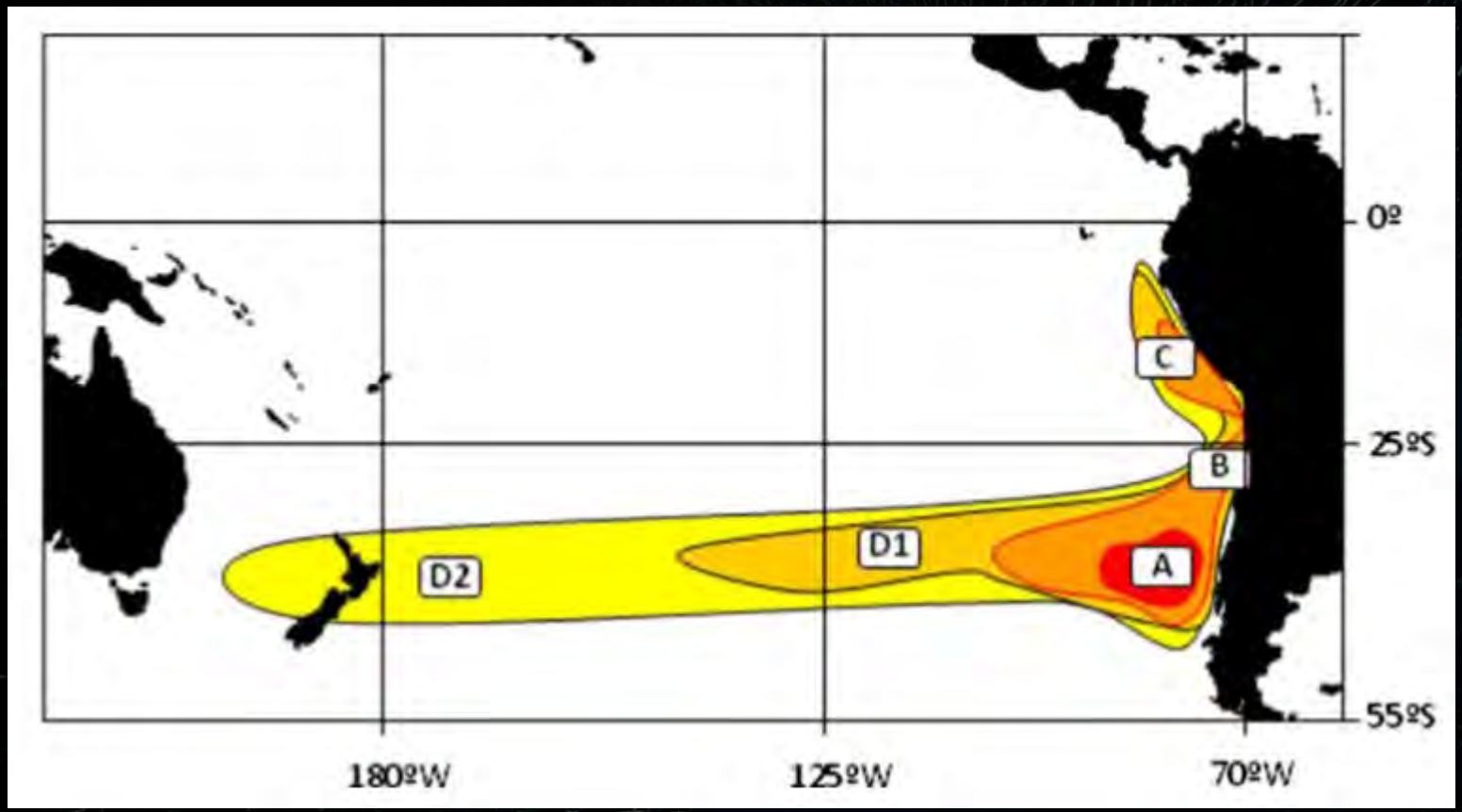
1. BACKGROUND

A: Central Pacific-Centre SouthChilean stock

B: Northern Chilean stock

C: Peruvian stock

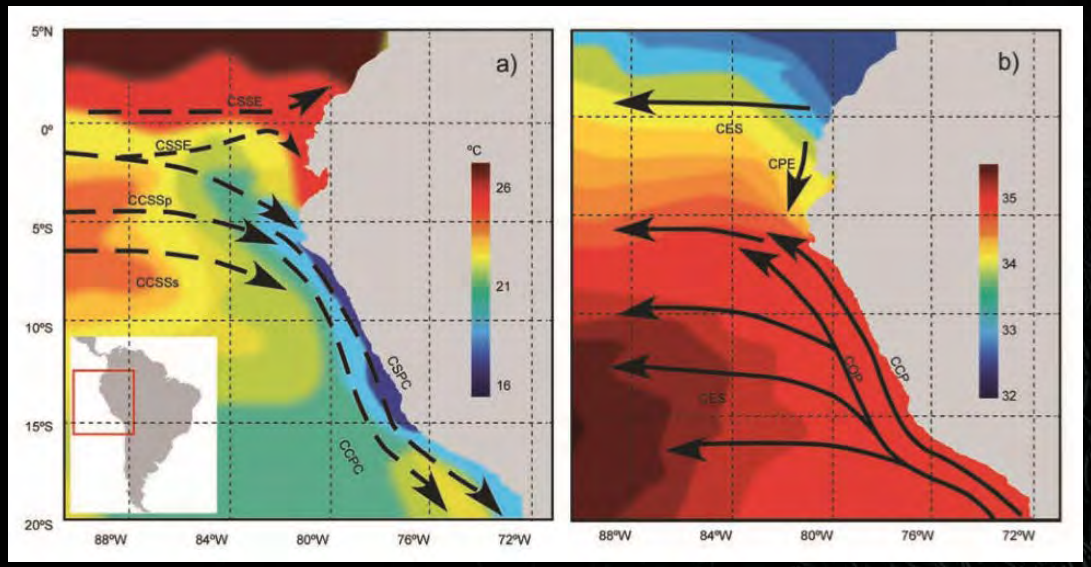
D1 and D2: Central South and Southwest Pacific Ocean stocks



Gerlotto et al (2012)

Between 50 - 100 nm from the coast

Espinoza et al., 2008.

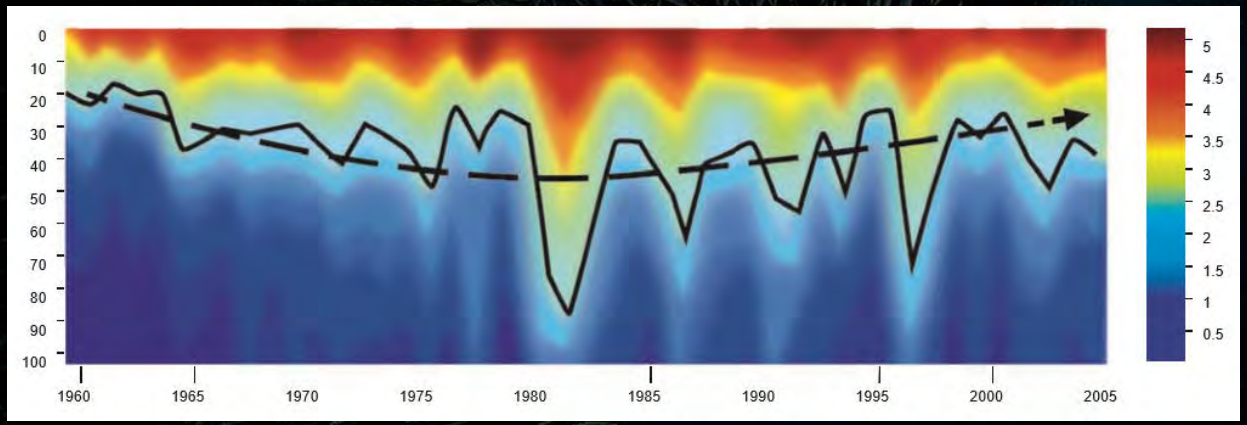


Cold coastal waters and shallow subtropical waters

Dioses (1995) and Grechina et al. (1998)

Bertrand et al. (2004)

Oxycline



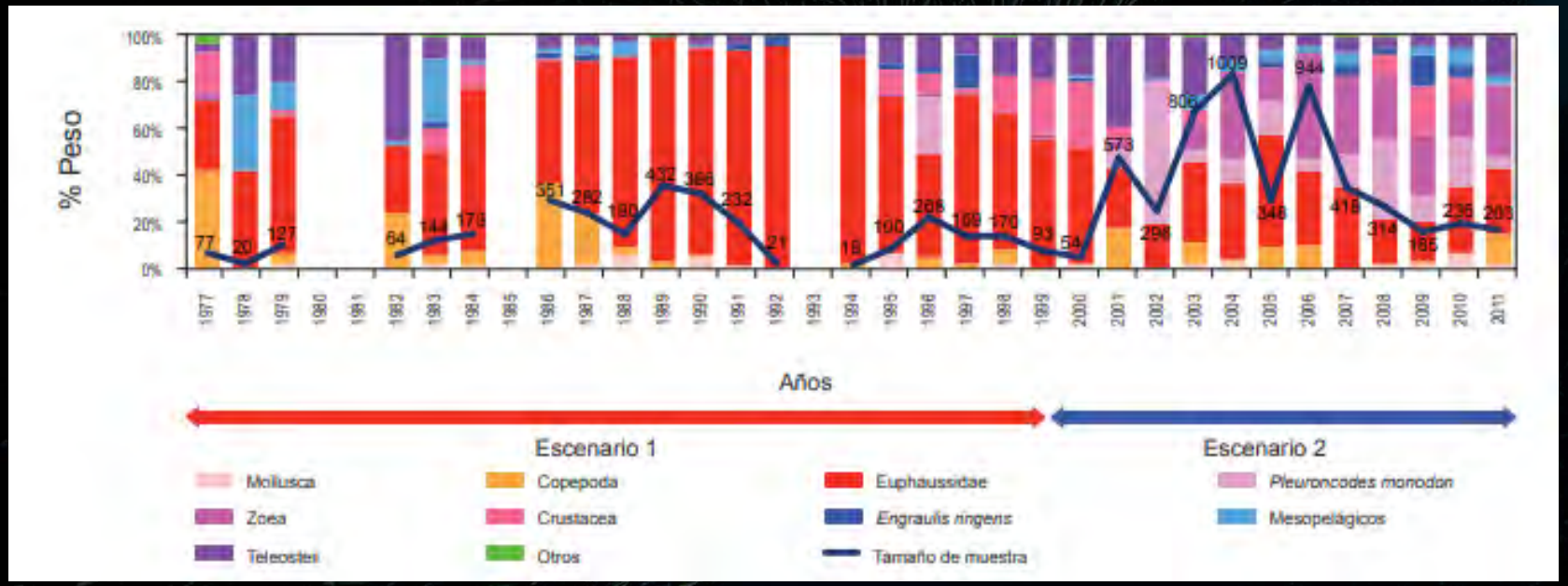
Flores et al (2013)

Dioses et al. (1988)

Around 15 years

30 cm (3 years)

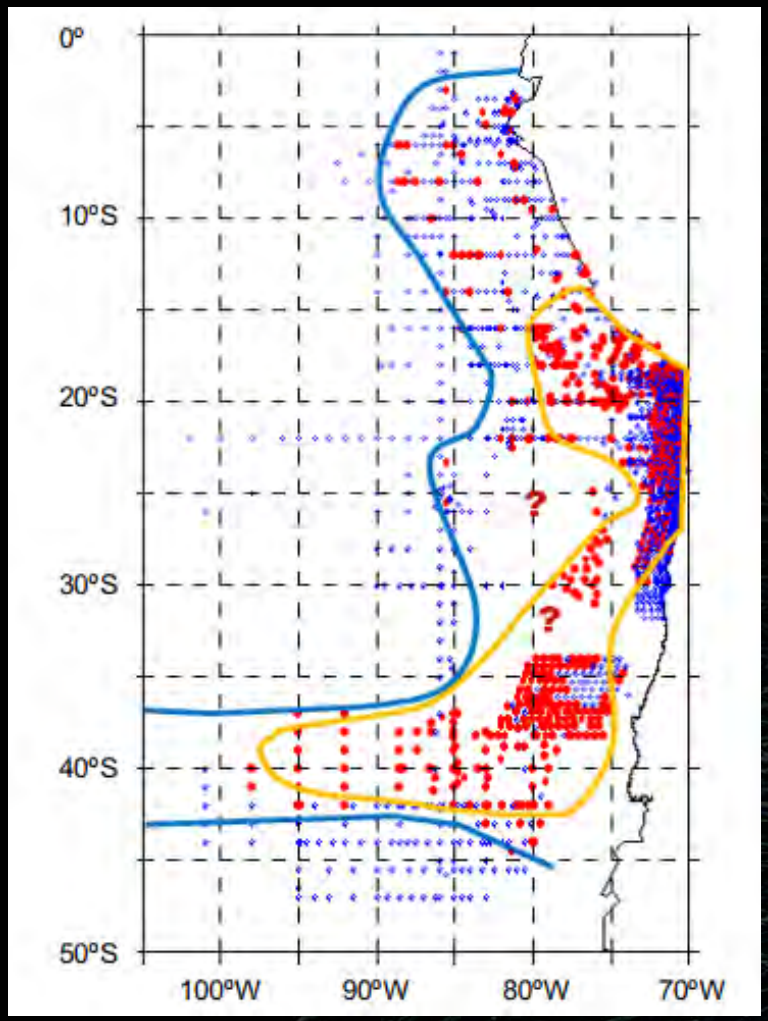
macrozooplankton and micronekton, especially copepods, euphausiids, and mesopelagic fish



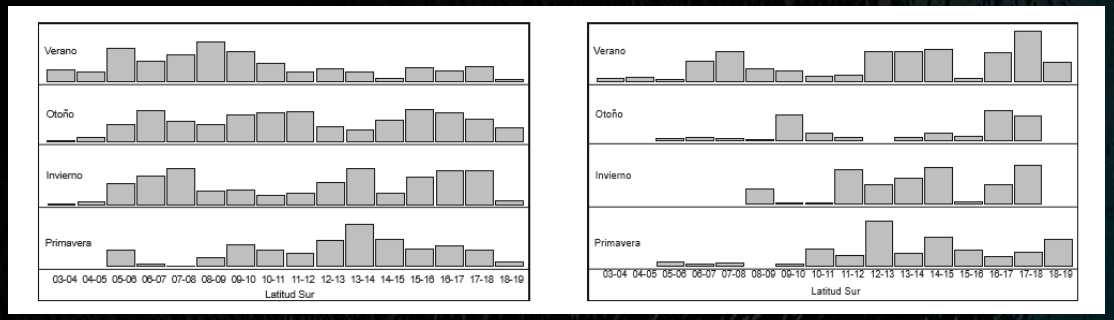
Alegre et al (2013)

14 ° 00'S and 18 ° 30'S

100 and 150 nm



Gerlotto et al (2012)



1972 – 1998

1999 – 2008

Acoustic biomass

Dioses et al (2013)

5 million tonnes in the year of highest production (1995)

0.5 million tonnes in last years

gonochoric

iteroparous

partial spawning pattern

21 cm of total length (LT)

September - December

78 789 oocytes per spawning batch

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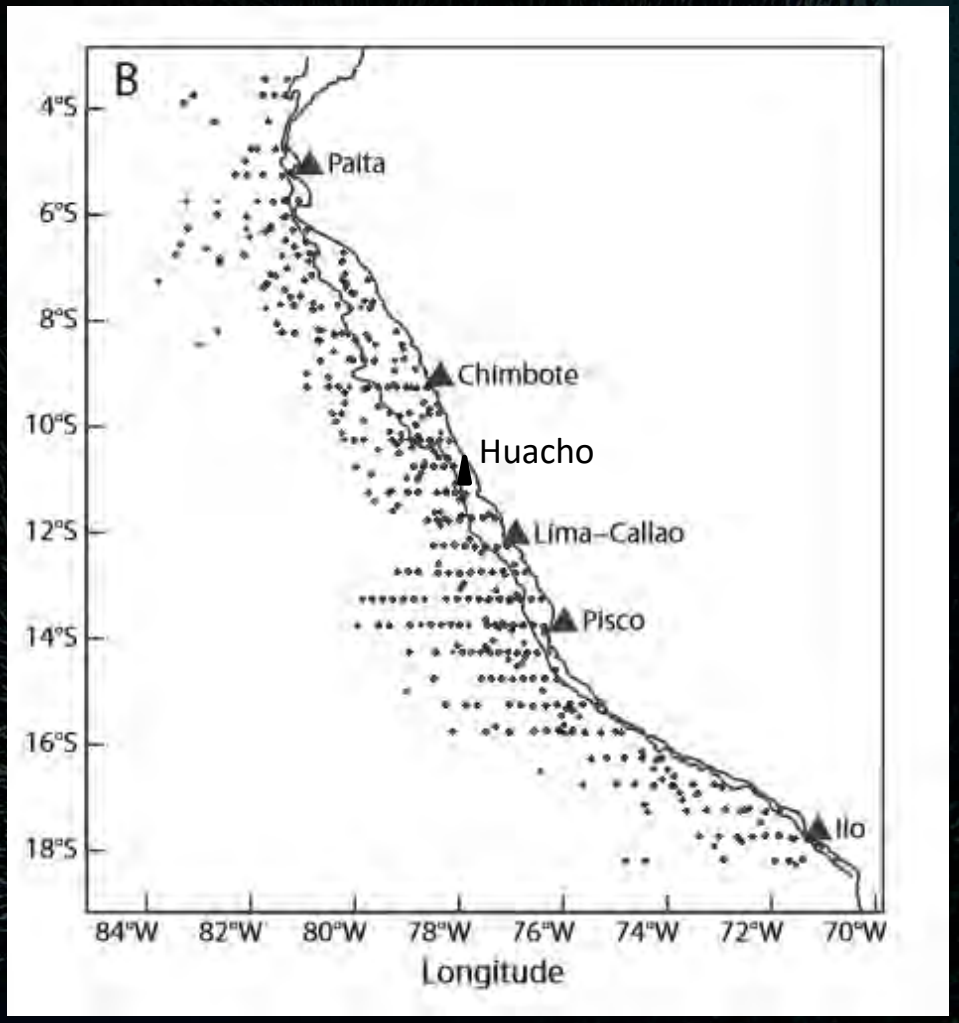
1. METHODOLOGY

145 466 individuals

1967 - 2017

Paita (5 ° S), Chimbote (9 ° S), Huacho (11 ° S), Callao (12 ° S), Pisco (14 ° S) and Ilo (17 ° S)

Total length (LT), Total weight, Gutted weight and Gonad weight



Alegre et al (2013)

Gonadosomatic index (GSI)

$$GSI = \left(\frac{GW}{EBW} \right) * 100$$

Vazzoler (1982)

1. METHODOLOGY

GSI Interannual variations

"critical value"

Average values of GSI per year

September to December (periods of greatest reproductive activity),

The confidence interval was determined, integrating the values of the standard deviation, the sample number and the 95% probability

To compare the reproductive cycle of *T. murphyi* in Peru and Chile, GSI data from Chilean jack mackerel were analyzed from 2001 to 2012

North of Chile : Arica – Antofagasta 23° S - Coquimbo 29° S
South - Central Chile : San Antonio 33° S – Guateca 35° S
Peru : Paita 5° S – Ilo 17° S

Standardized GSI

To compare the reproductive cycles between Chile and Peru, monthly GSI values were standardized, taking as a maximum value 1 and recalculating the monthly values for each series. With the new calculated values, the reproductive cycles for each zone were obtained.

1. METHODOLOGY

Size at maturity

The whole historical series (1967 - 2017) grouping the data every two years to have a representative sample size due to the intermittence of the fishing activity. To construct the maturity ogive, it was ensured that the samples used come from spawning periods and correspond to a wide range of sizes and include virginal individuals. The proportions were adjusted to a logistic curve of the form

$$P_L = [1 + \exp(a - bL]^{-1}$$

Maturity scale

204 gonads (76 testicles and 128 ovaries) Pelagic Fishery Monitoring Program

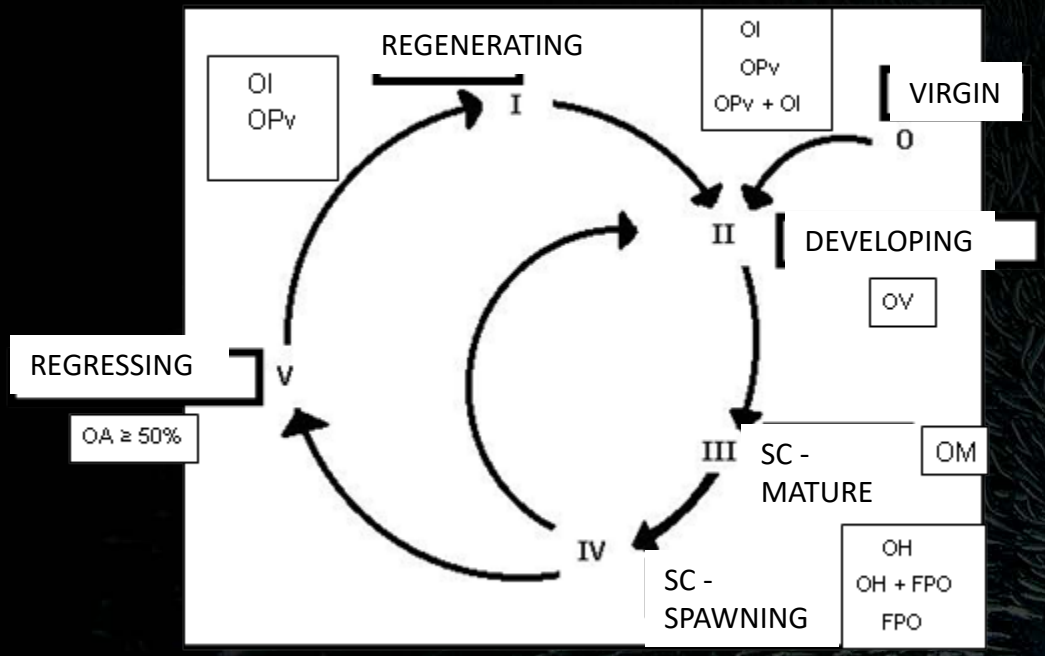
January 2006 - December 2009

147 gonads (81 testicles and 65 ovaries) Hydroacoustic Pelagic cruises

2008 - 2011

2. RESULTS

2.3 Maturity stages



OI = Inmature oocyte
OPV = Previtelogenic oocyte
OV = Vitelogenic oocytes
OM = Mature oocyte
OH = Hydrated oocyte
FPO = Post ovulatory follicle
OA= Atretic oocytes

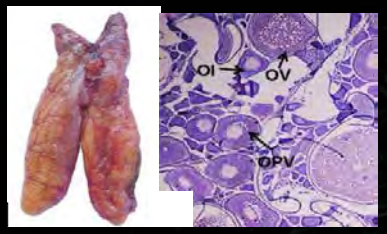
Stages	Female	Male
0	Inmature	Inmature
I	Regenerating	Regenerating
II	Developing	Develloping
III	Spawning Capable (Mature)	Spawning capable (Mature)
IV	Spawning capable (Spawning)	Spawning capable (Spermiation)
V	Regressing	Regressing

Sánchez et al (2013)

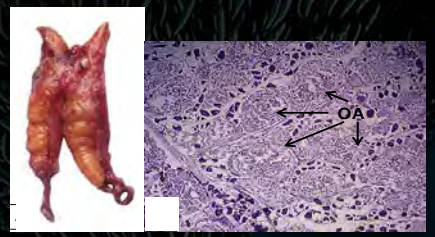
2.3 Maturity stages for females

Inmature

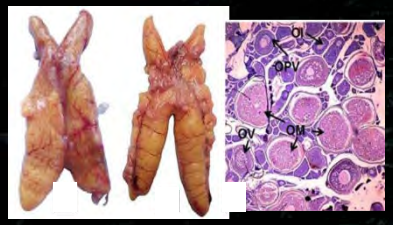
Spawning capable (Spawning)



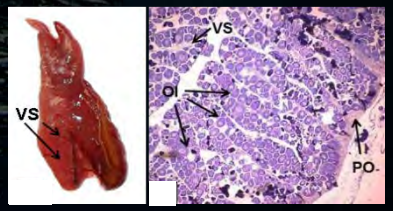
Developing



Regressing



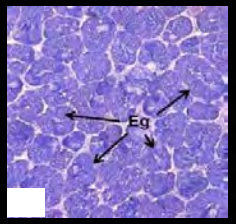
Spawning capable (Mature)



Regenerating

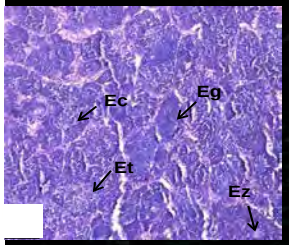
Sánchez et al (2013)

2.3 Maturity stages for males

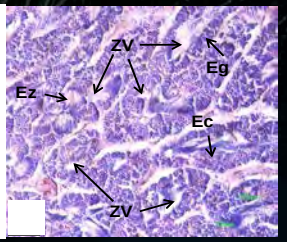


Inmature

Spawning capable (Spermiation)

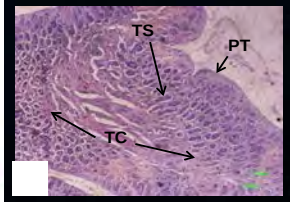


Developing



Regressing

Spawning capable (Mature)

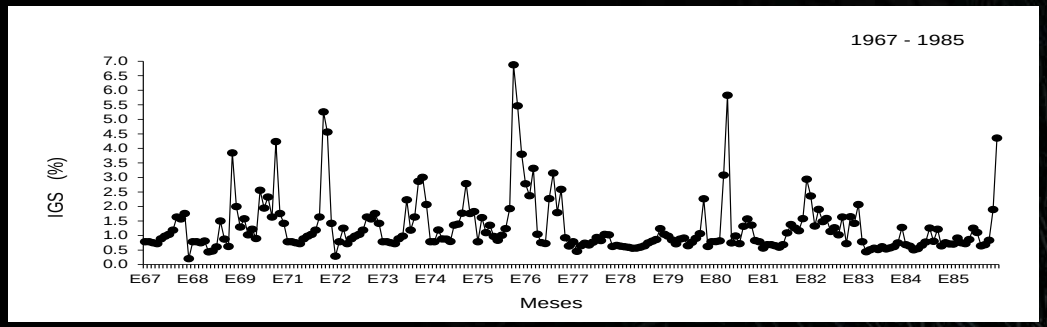


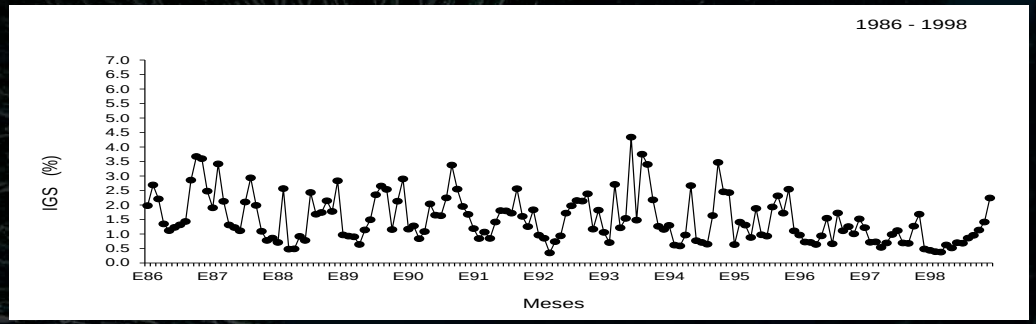
Regenerating

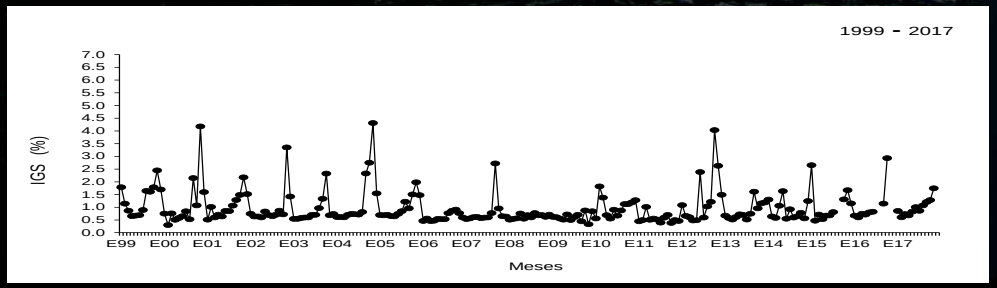
Sánchez et al (2013)

RESULTS

2.1 Reproductive cycle







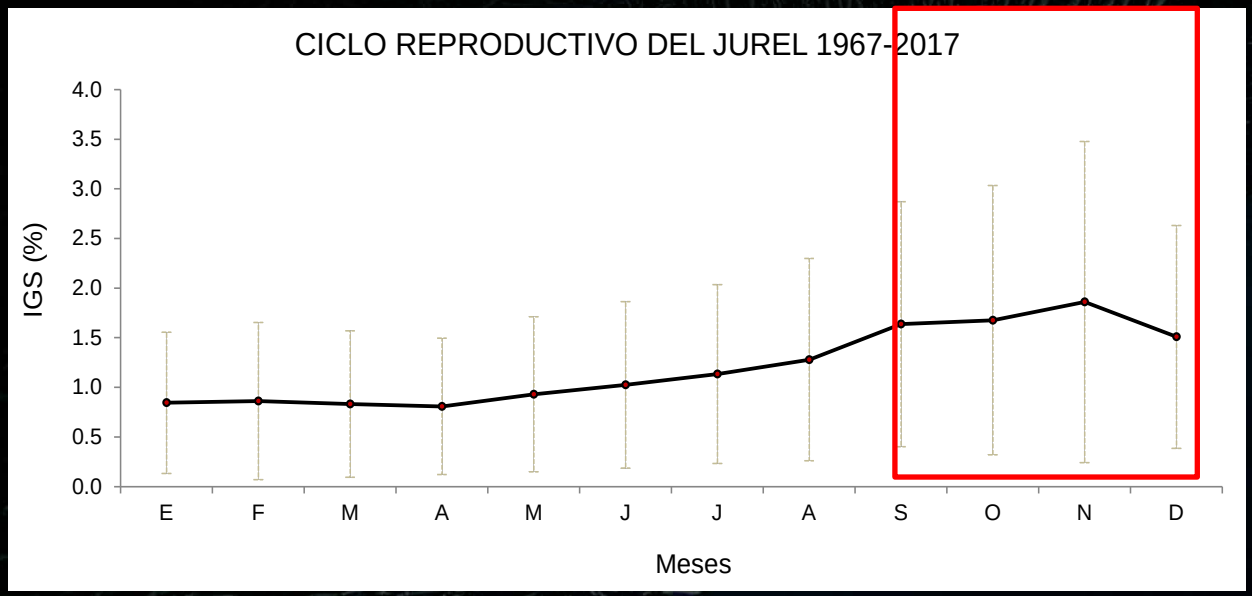
Perea et al (2013)

Critical levels of GSI

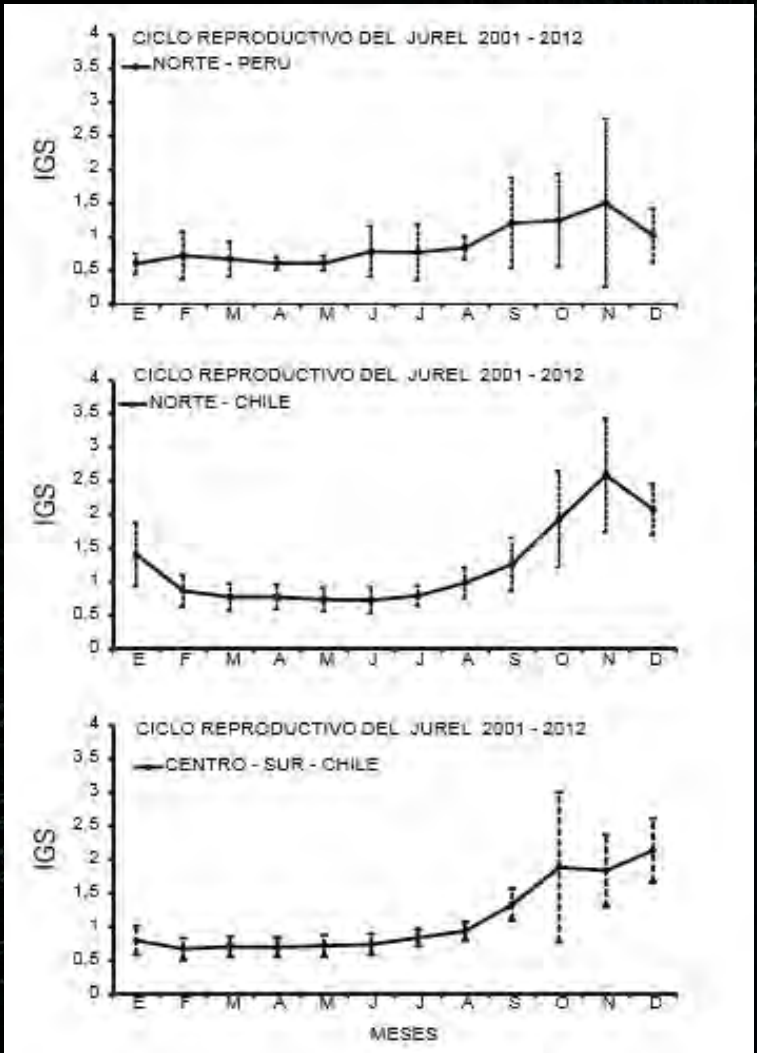
Periods	1967 - 1985	1986 - 1998	1999 - 2017
Critical level	1.09	1.54	0.94
Standard deviation	1.18	1.36	1.06
n	75424	17474	57950
α	0,05	0,05	0,05

2. RESULTS

2.1 Reproductive cycle

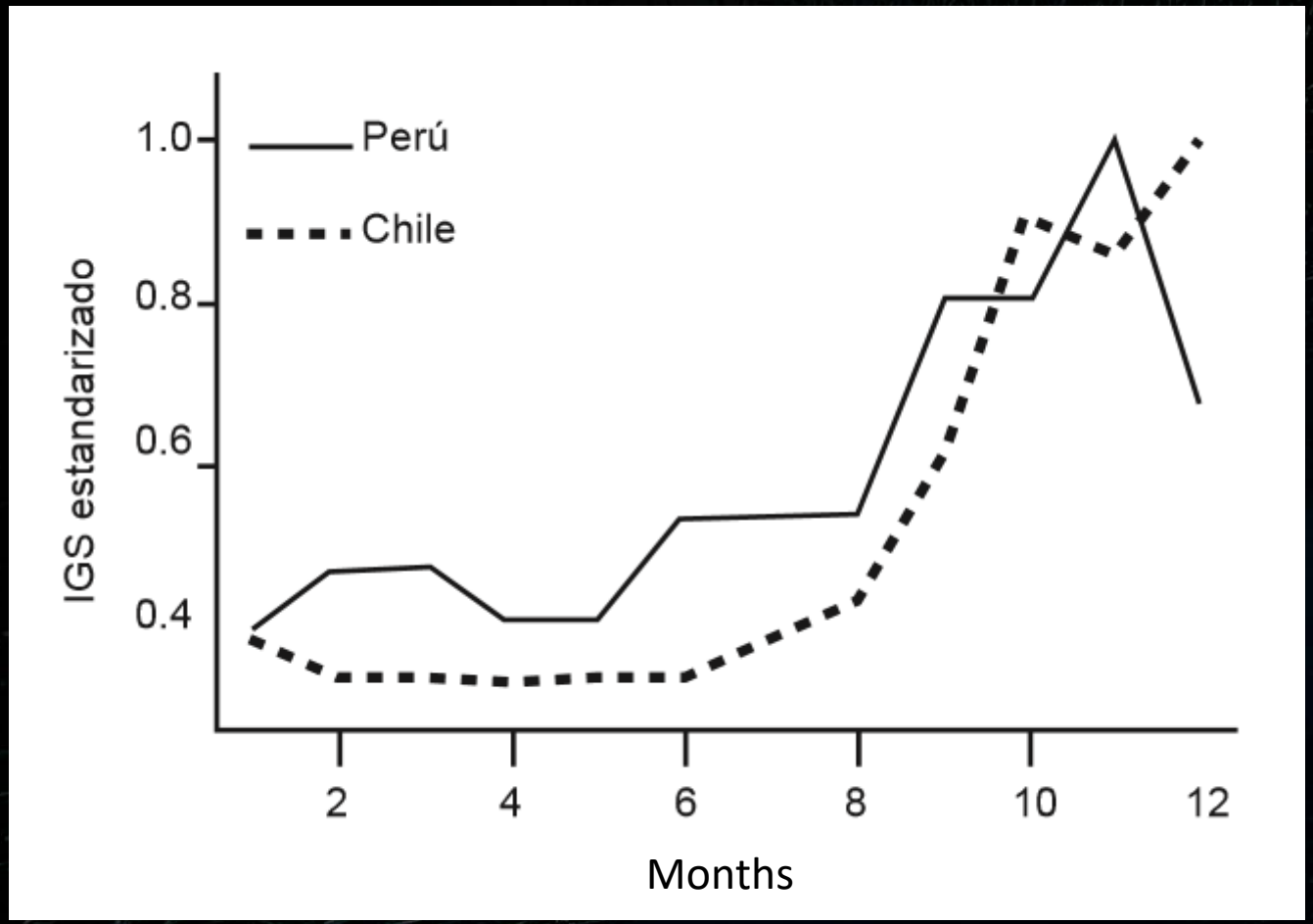


RESULTS



Perea et al (2013)

Standardized GSI



Perea et al (2013)

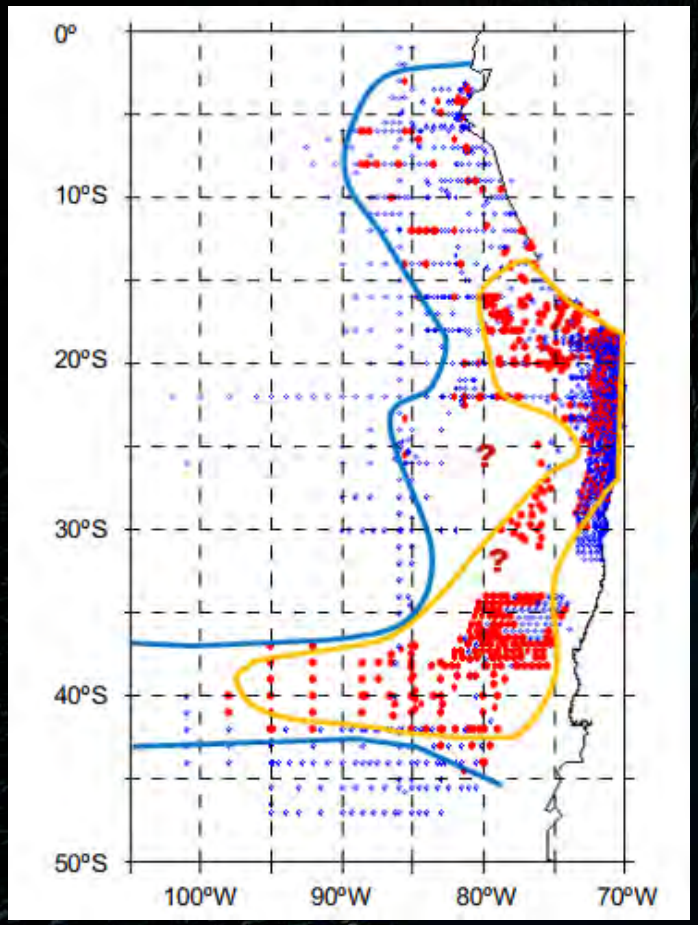
Reproductive activity amplitude of Jack mackerel

	Reproductive cycle of Jack Mackerel		
	Reproductive activity (Number of months)	Maximun spawning activity (month)	Variability of the spawning activity (SD)
Perú	4	November	High (± 1.25)
Chile (north)	3	November	Low (± 0.84)
Chile (center-south)	3	December	Low (±0.54)

Perea et al (2013)

Spawning area of Jack mackerel

EGGS

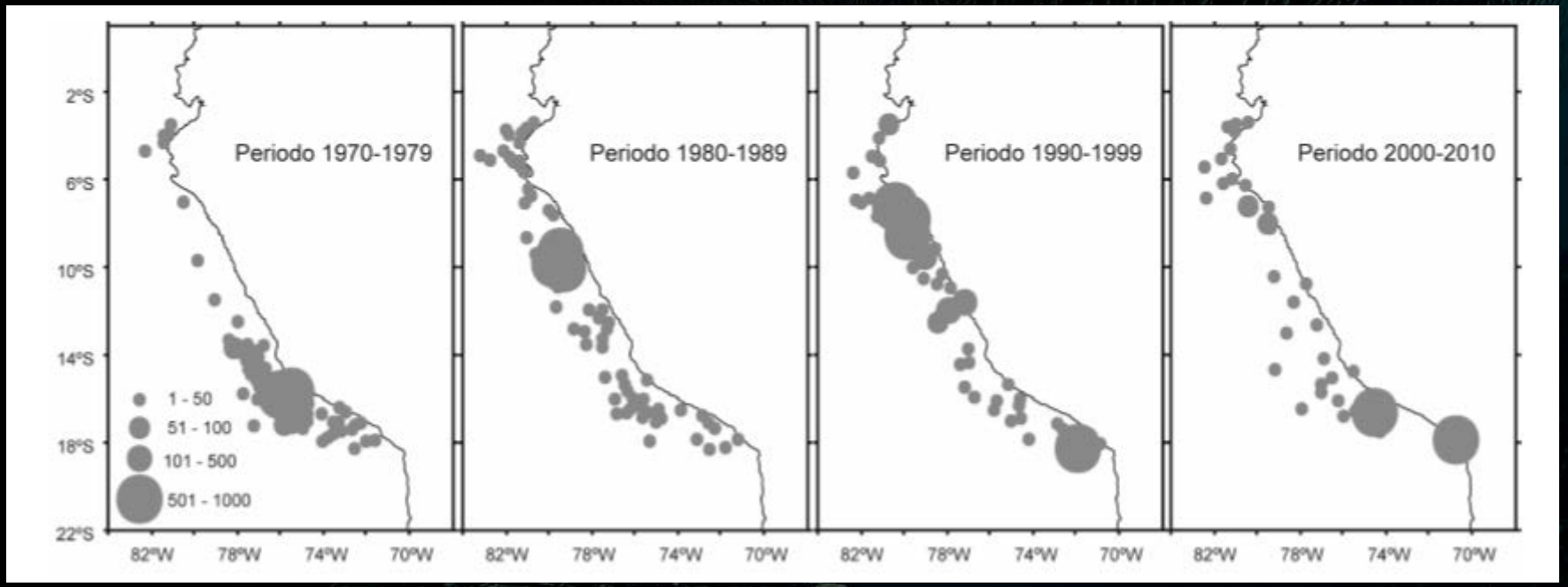


Gerlotto et al (2012)

Larvae area of Jack mackerel

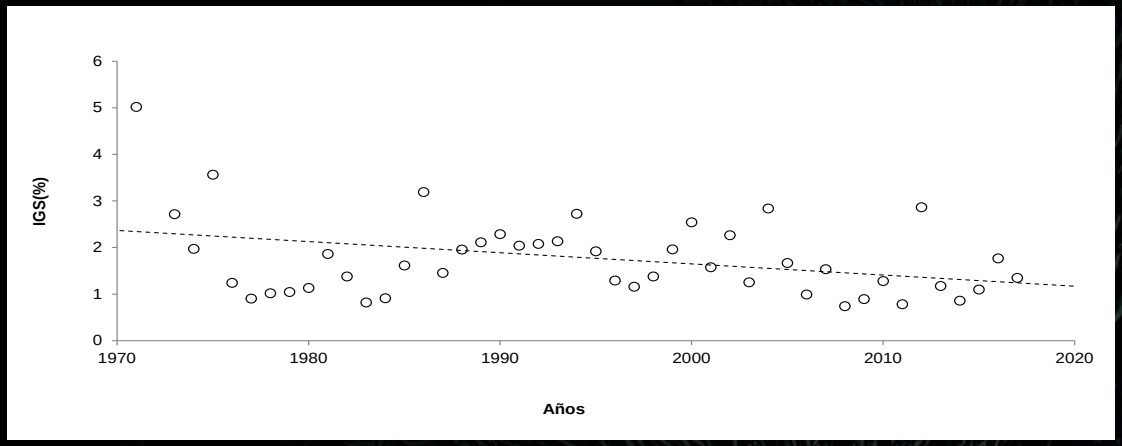
LARVAE

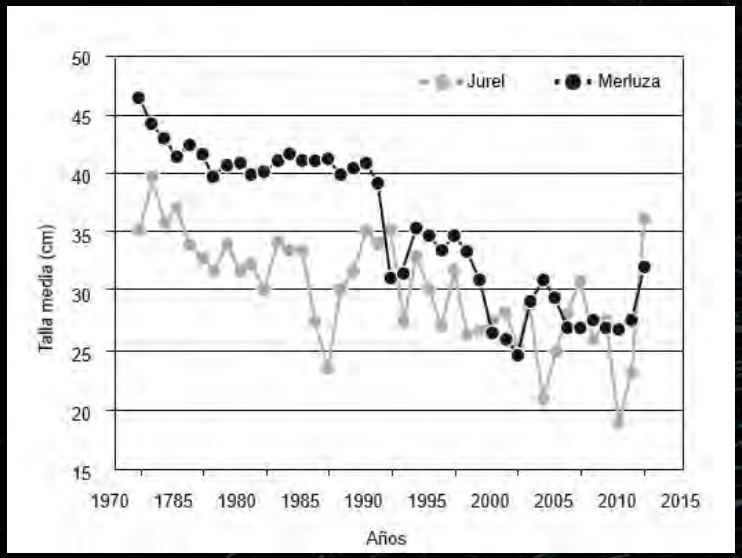
500 larvae / m^2

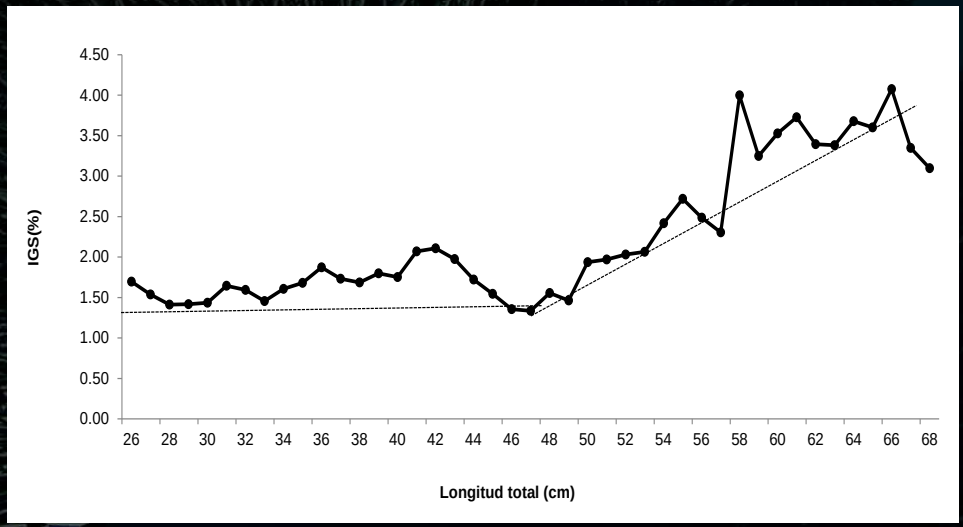


Ayón et al (2013)

Average GSI by periods of year







Dioses et al (2013)

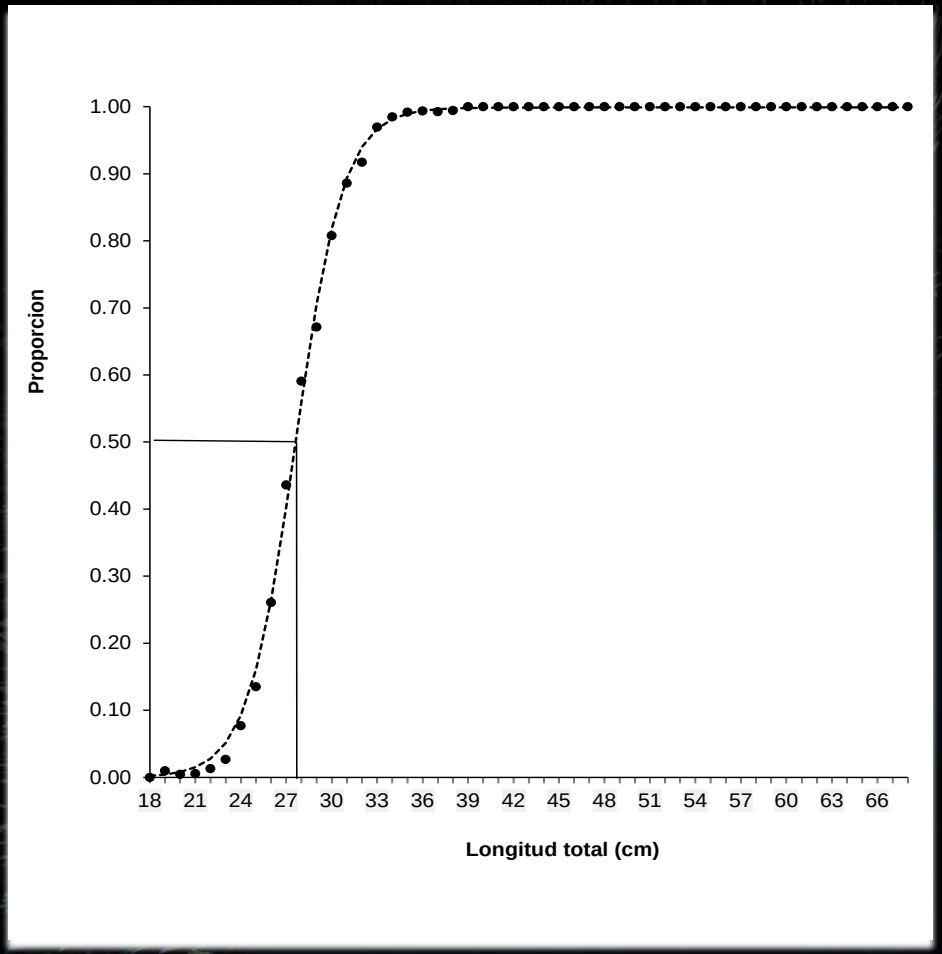
GSI by group of length

2.2 Maturity size

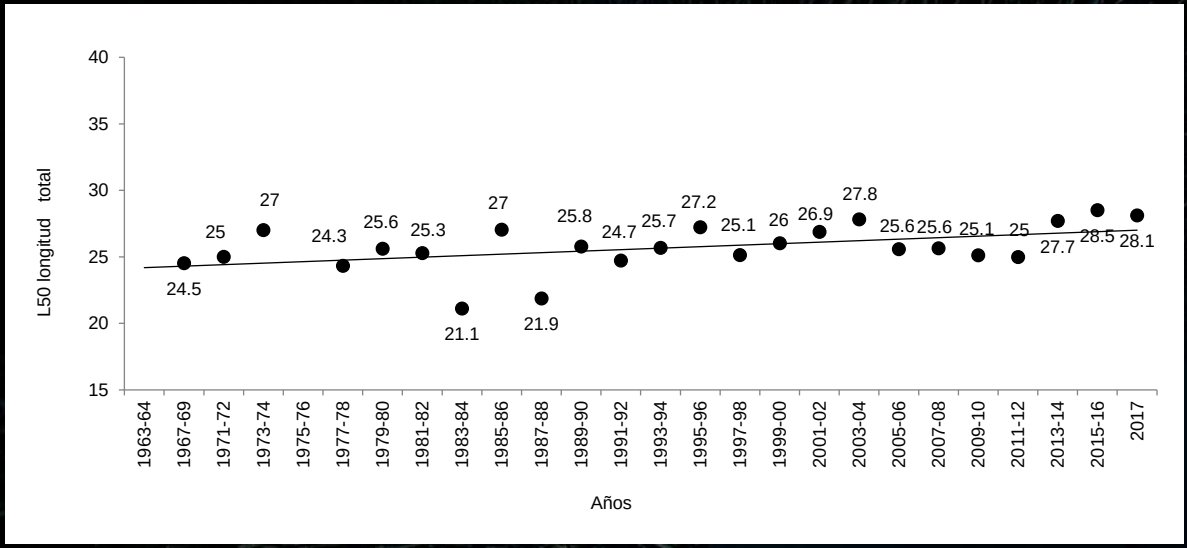
L_{50} =27,7

R^2=0,7

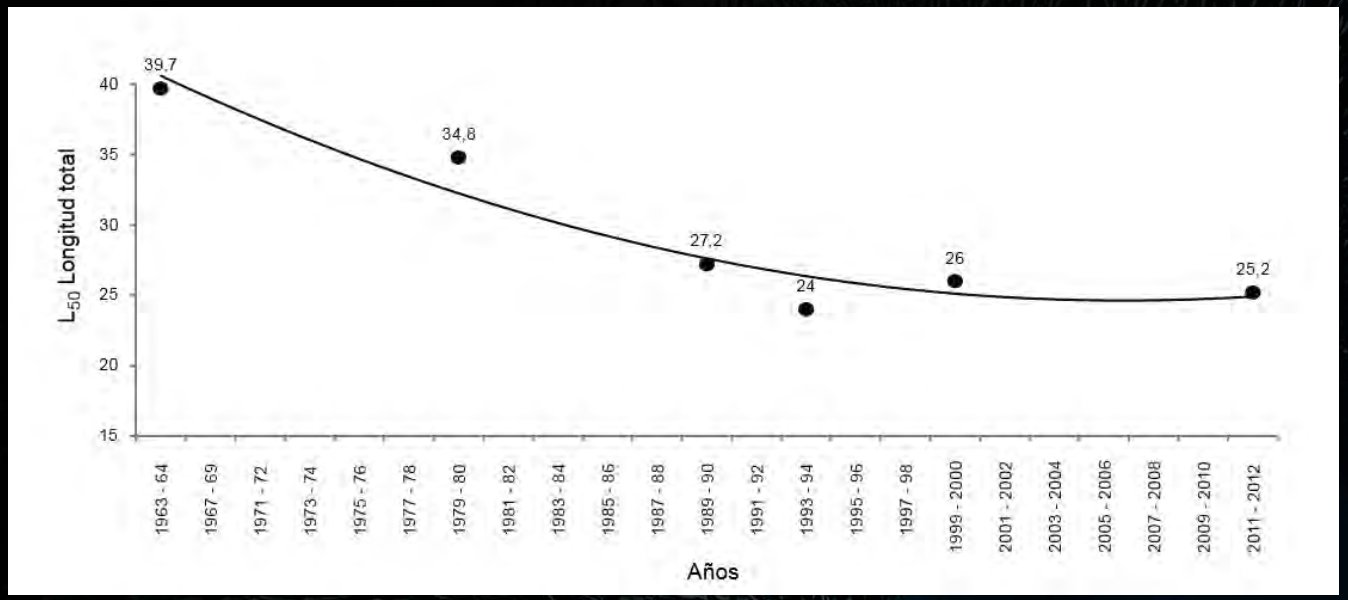
Andrianov (1994) 25 to 27 cm TL



Maturity size along the years in Peru



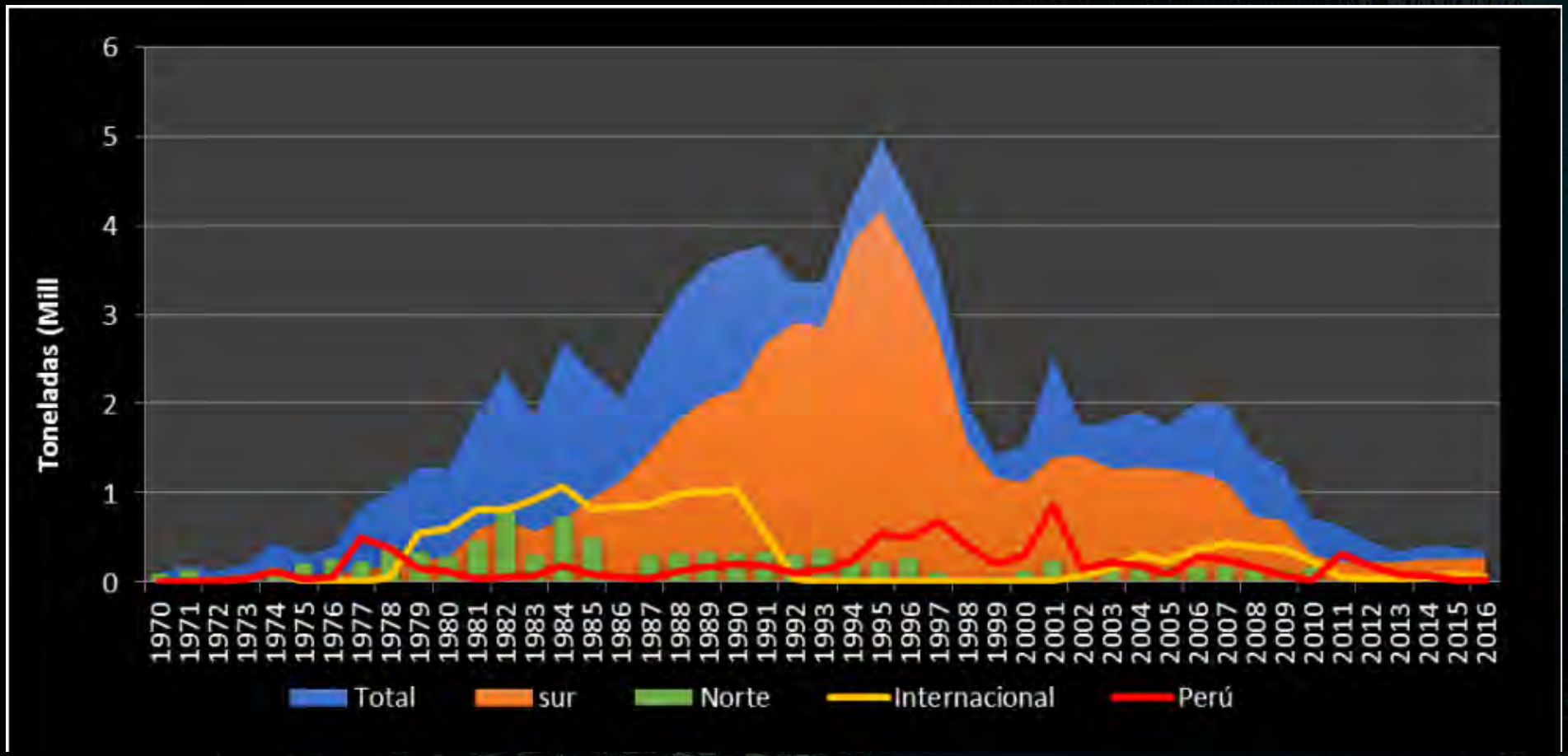
Maturity size along the years in Chile



Maturity size has been decreasing from **39.7** cm LT in the period 1963-1964 (Kaiser 1973) to **26.0** cm LT in the period 1999 - 2000 (Cubillos & Alarcón 2010) and **25.2** cm LT in the period 2011 – 2012.

(Trippel 1995)

Perea et al (2013)



Landings of jack mackerel between 1970 and 2016 Regions XV-II (North Chile), III-X (South Chile), Peru (within its EEZ), foreign fleet (off the coast of Chile outside our EEZ) and global. Source: Sernapesca-SPRFMO, own data.

Subsecretaría de pesca y acuicultura de Chile (2016)

FINAL COMMENTS

- *Trachurus murphy* is a pelagic fish which have a widespread distribution in Southwest Pacific.
- Batch spawner.
- Major intensity spawning between September and December.
- Main spawning area in Peru between 14° SL to 18° SL, on the oceanic front limited by the cold coastal waters of intense upwelling and the superficial subtropical waters.
- There are three interesting differences in the reproductive cycles of Peruvian and Chilean stock:
  1) The maximum spawning period in Peru is 4 months, while in the north and in the center-south of Chile it is 3 months.
  2) Monthly mean values of *T. murphyi* GSI off the Peruvian coast are lower than those of *T. murphyi* off Chilean coast.
  (3) Standard deviation of GSI in the maximum reproductive activity is greater in Peru than in Chile.
- Decrease of maturity size in Chilean Jack mackerel could be a result of the higher fishing pressure compare of lower exploitation in Peru.

ACKNOWLEDGMENTS

PICES

IRD

BIC OLAYA BALANDRA CREW - IMARPE

THANK YOU