GOBIERNO DE CHILE
SUBSECRETARÍA DE PESCA

SP-08-SWG-JM-09

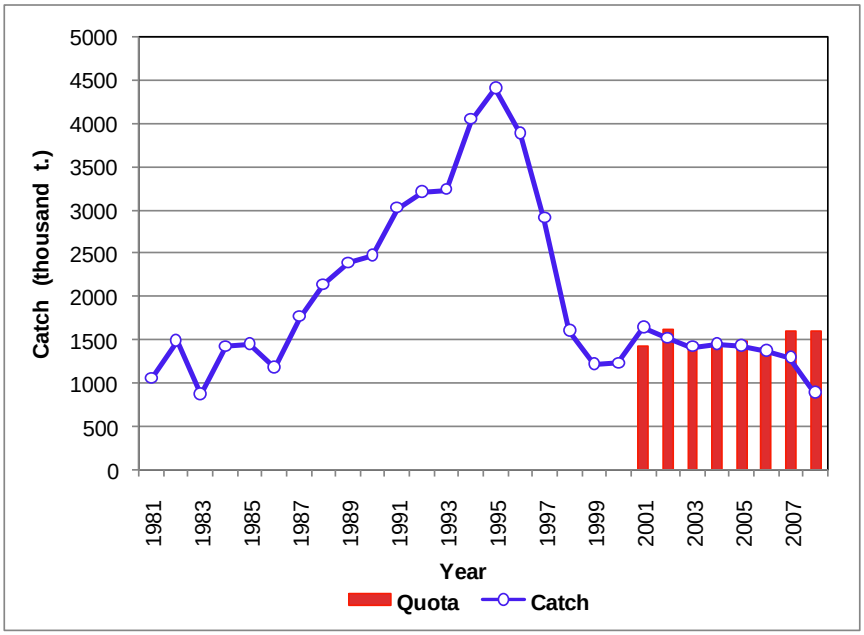
DIAGNOSIS OF THE CHILEAN JACK MACKEREL

This report contains a synthesis of the various papers submitted by Chile to the VIII Meeting of the SPRFMO Science Working Group (Auckland, November 2-6, 2009), related with indicators from the jack mackerel fishery and the stock. It also includes information presented in the Annual National Report (2009) on the Jack Mackerel Fishery and results from stock assessment models.

The indicators of the fishery, stock and exploitation described below gave a strong pattern of further stock decline and increase in the exploitation rate, being the spawning biomass below a precautionary level. Therefore it can be concluded that currently the stock of the Chilean jack mackerel in the South Eastern Pacific is beyond safe or precautionary biological limits. The status of the jack mackerel became evident following the analysis of the biological and fisheries indicators obtained during the monitoring of the fishery, research surveys (e.g. acoustic and eggs surveys) and results from stock assessments.

Fisheries indicators.

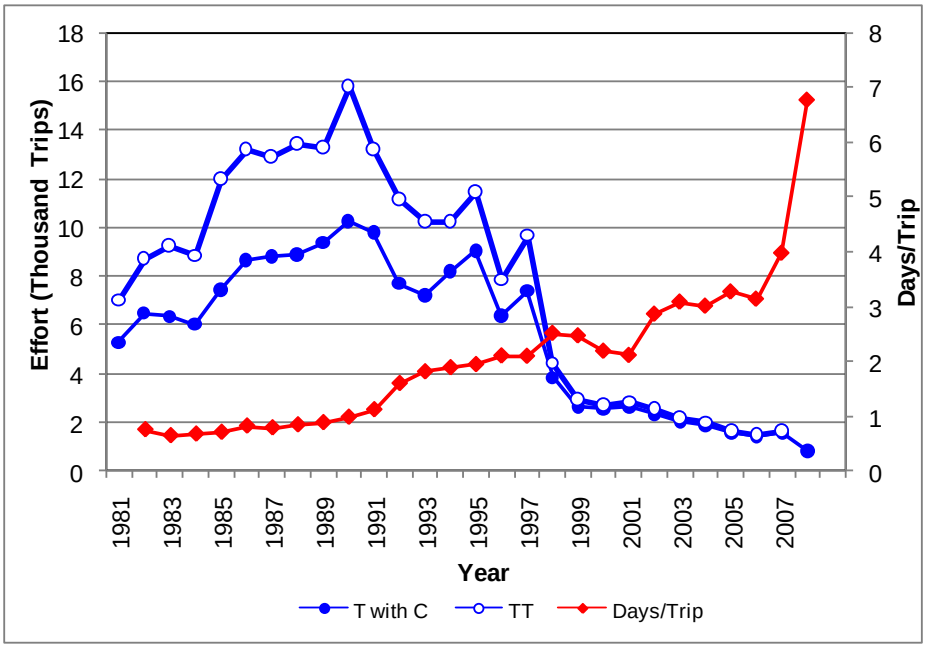
- Catch: A steady decrease of Chilean catches of jack mackerel has been recorded since 2005 and the quota for the Chilean fishery has not been completed in the past 2 years (Figure 1).



Source: Sernapesca

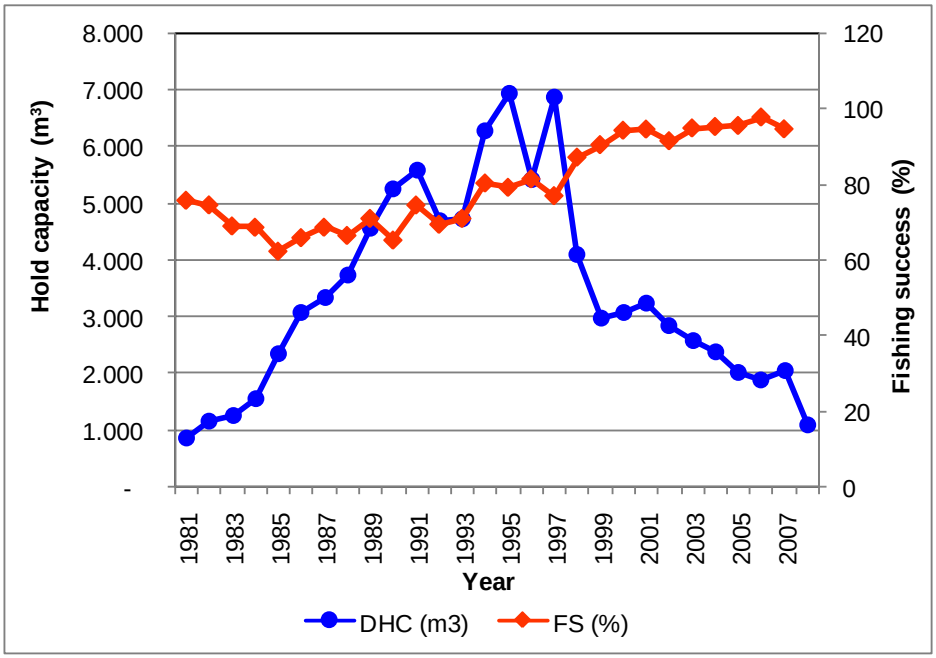
Figure 1: Total catches of jack mackerel with purse seine gear, 1981-2008.

- Operational features: a progressive increase in the duration of the fishing trips has been recorded with a sharp rise in 2008, which is consistent with the growing distance of the fishing grounds from coastal waters (Figure 2). This has led to a decreasing trend in the fishing effort and power measured on the basis on the number of trips and cubic meters of displaced hold capacity (Figure 2 and 3). Despite the latter, the fleet has shown a high level of efficiency in its performance as evidenced by the ratio of the "number of trips with catch" and "number of total trips" (Figure 3).



Source: IFOP

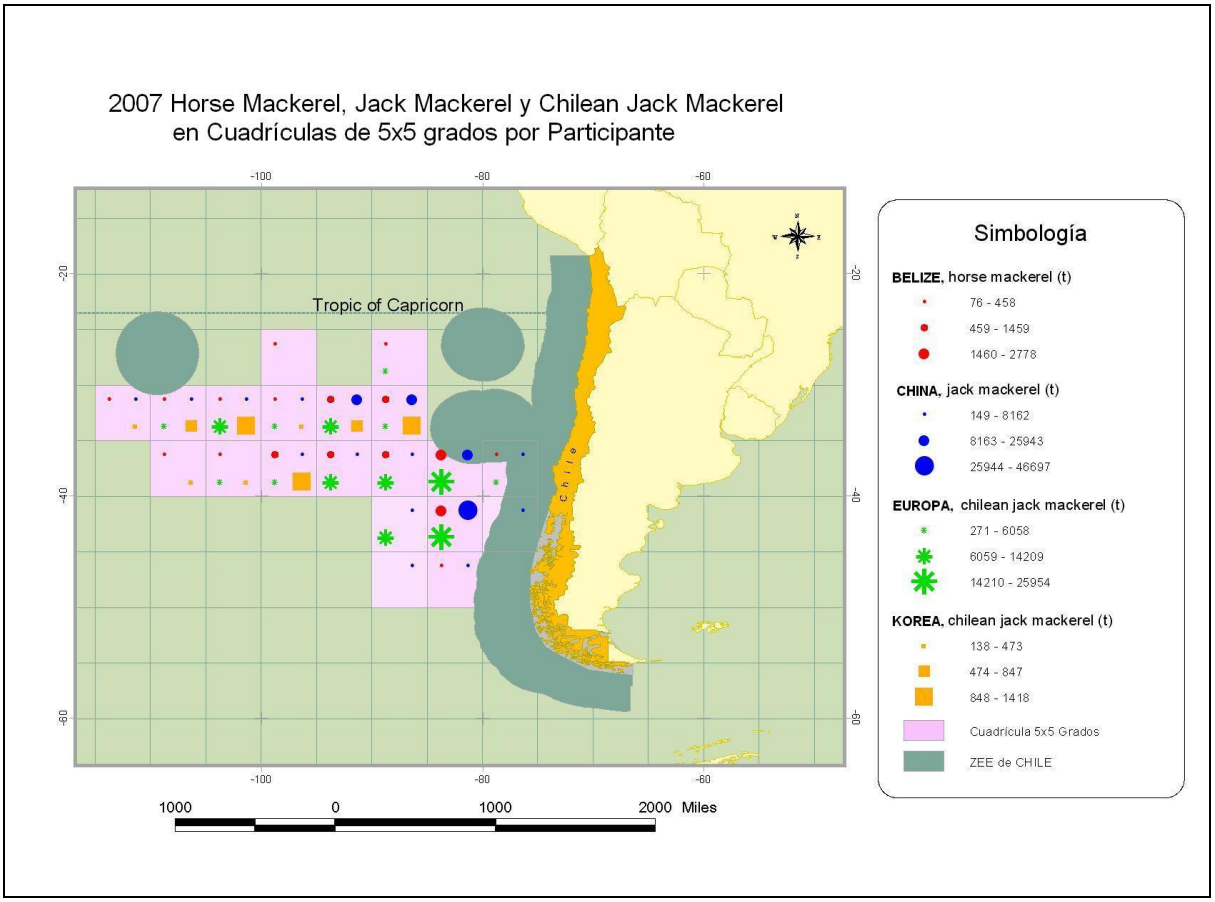
Figure 2: Number of trips with catch (TwC), total trips (TT) and duration of trips in days of the purse seine fleet that fish on jack mackerel off south-central zone, 1981-2008.



Source: IFOP

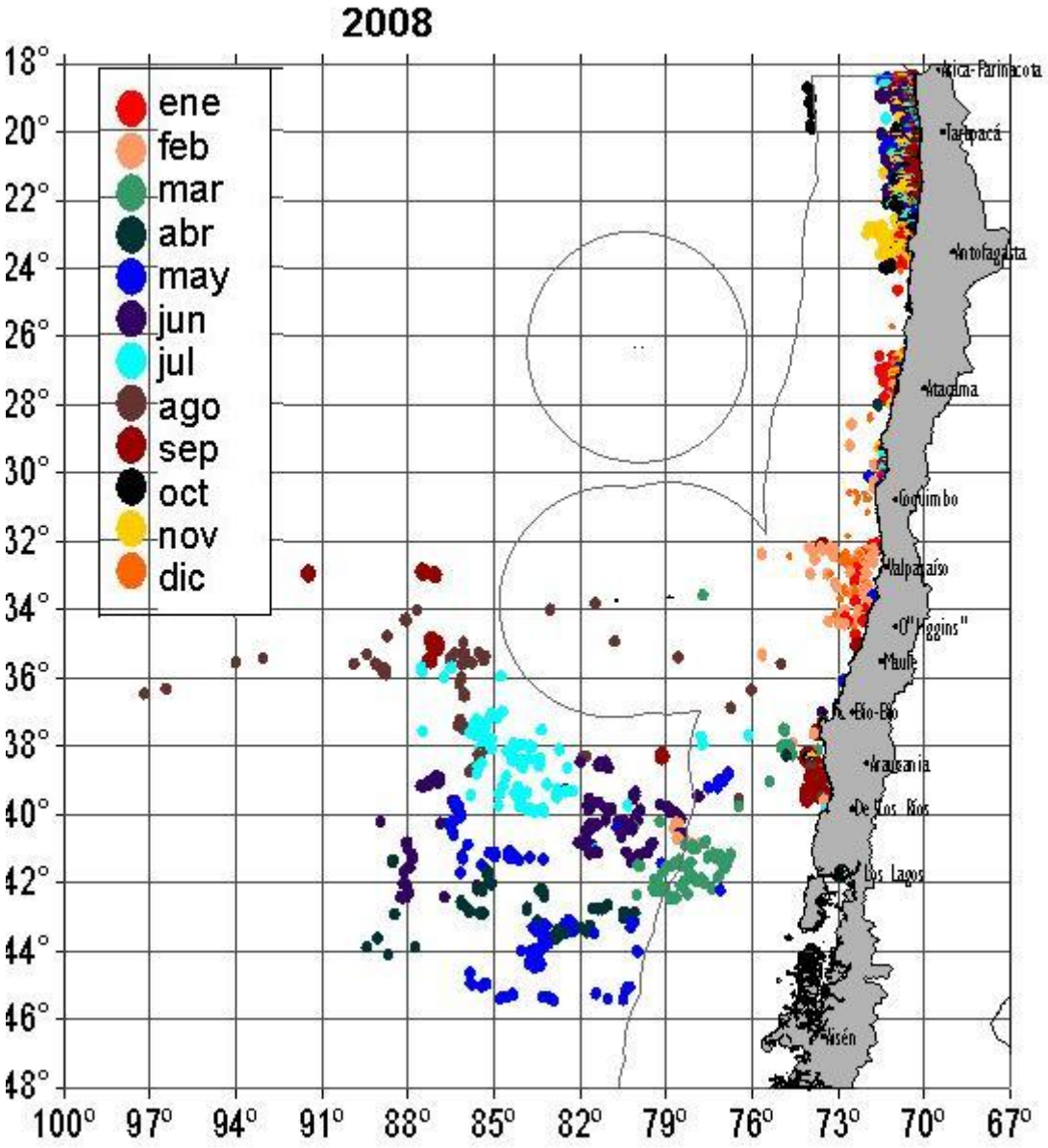
Figure 3: Displaced hold capacity (DHC) and fishing success (FS) (number of trips with catch / number of total trips) in percentages by the purse seine fleet off the south-central zone of Chile, 1981-2008.

- Catch spatial distribution: the spatial distribution of catches indicates that the Chilean fishing fleet and foreign fleets fish for jack mackerel in the same fishing area in the high seas (Figures 4, 5 and 6).

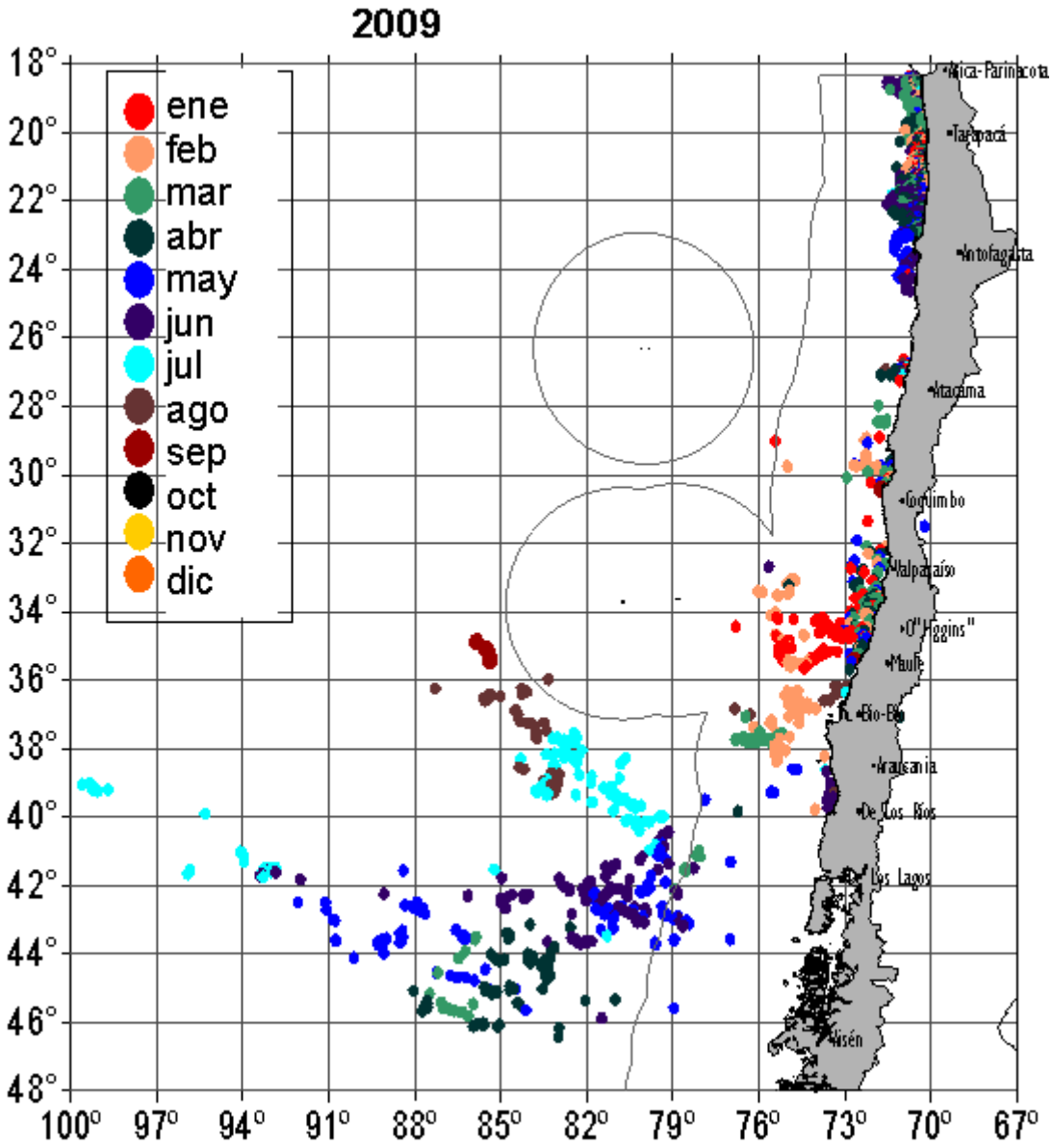


Source: Interim Secretariat , SPRFMO

Figure 4 . Jack Mackerel fishing area of the international fleet in 2007.



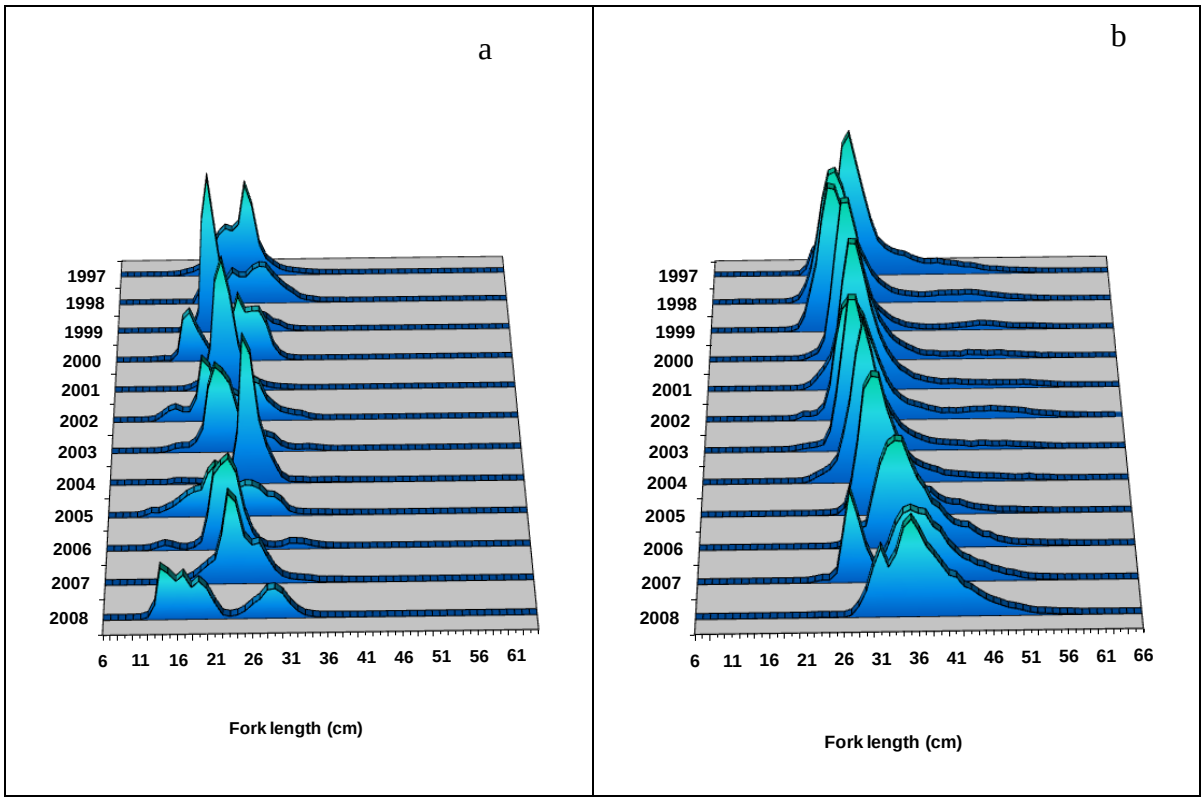
Source: IFOP
Figure 5. Spatial distribution of the jack mackerel catches made by the national fleets, within and outside the EEZ, during 2008.



Source: IFOP
Figure 6. Spatial distribution of the jack mackerel catches made by the national fleets, within and outside the EEZ, during the first semester of 2009.

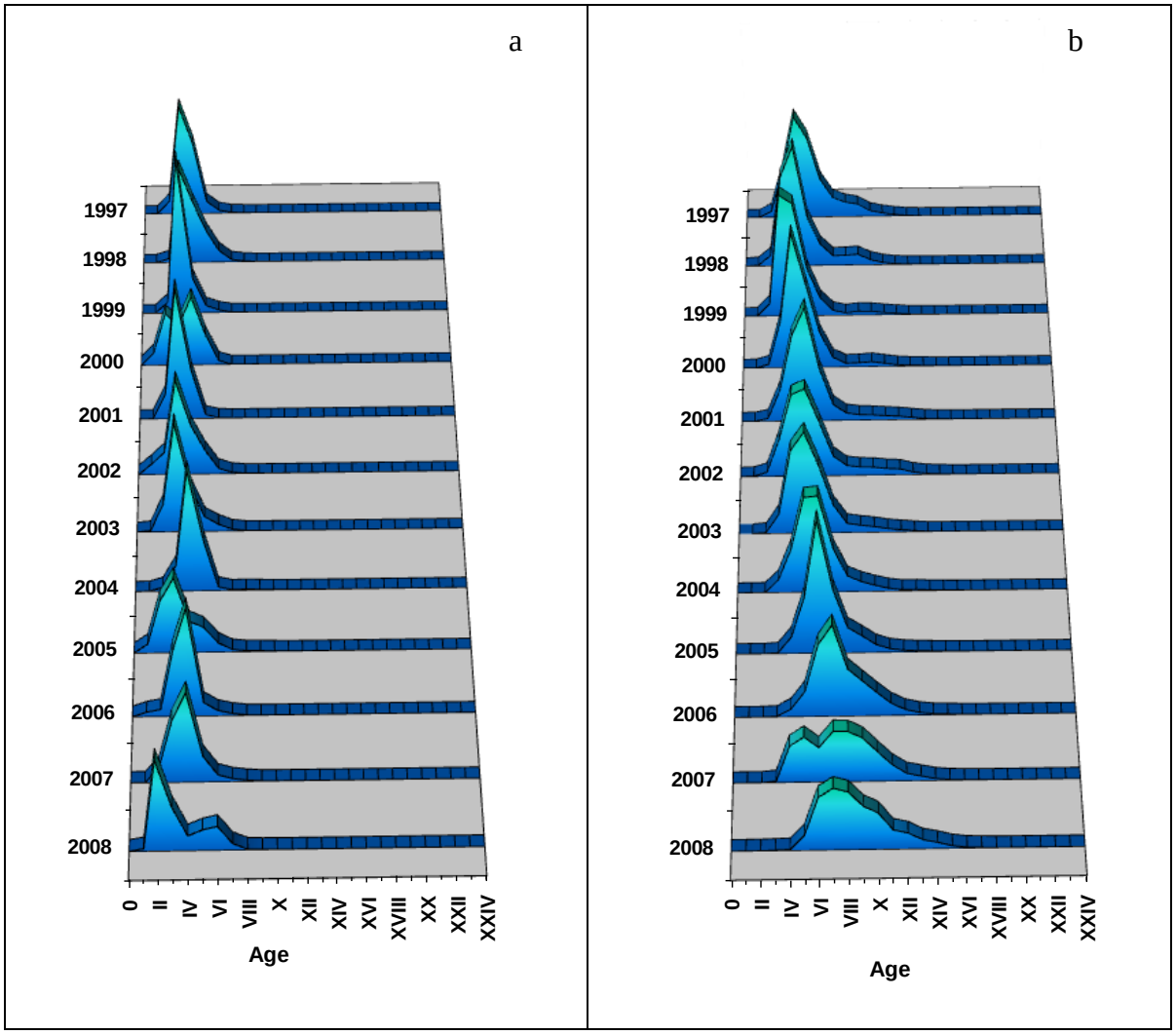
Stock indicators

- Size/age structure: there is a spatial segregation of the size/age structure of jack mackerel; the smallest sizes/ages are mainly found in the northern zone of Chile, while the largest sizes/ages are found off the south-central zone, where the main national fishery is located; the catches in this fishery has shown a progressive "ageing" of the age structure as result of weak recruitments that entered the fishery in the last 8 years (Figures 7 and 8).



Source: IFOP

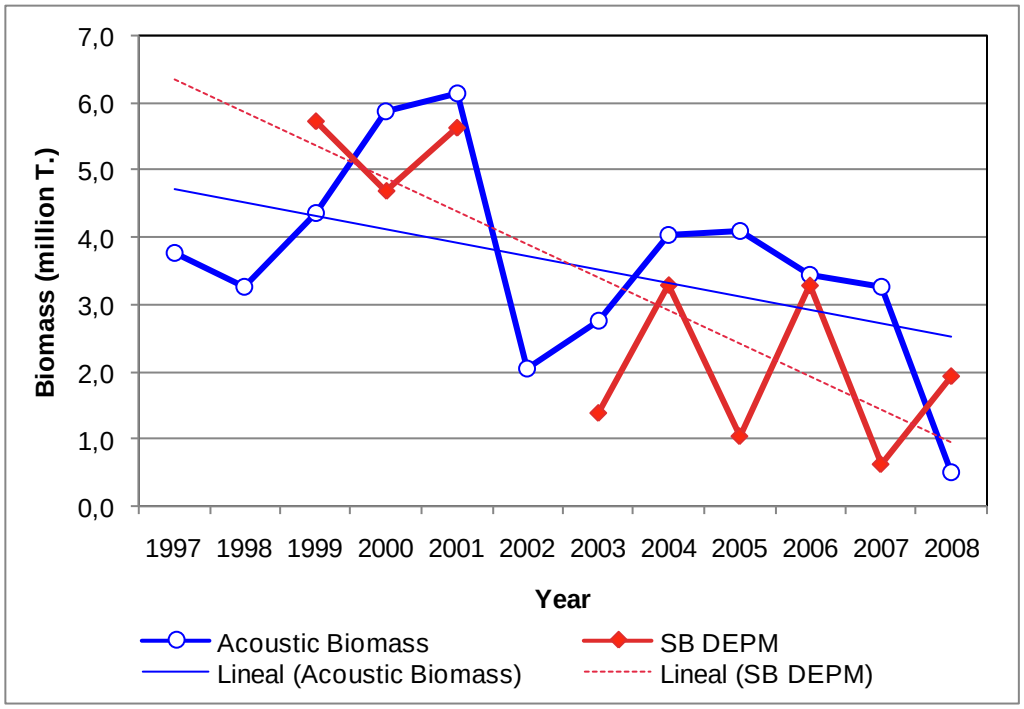
Figure 7: Size structure of jack mackerel catches in percentage; a) Northern fishery; b) South-central fishery, 1997-2008.



Source: IFOP

Figure 8: Age structure of jack mackerel catches in percentages; a) Northern fishery; b) South-central fishery, 1997-2008.

- Independent estimates of biomass: the biomass estimates from acoustic surveys and spawning biomass estimates from eggs surveys point to a declining trend since 2001 (Figure 9).



Source: IFOP-INPESCA.

Figure 9. Biomass estimated by acoustic method and spawning biomass (SB) estimated by the DEPM.

- Acoustic biomass estimate: the biomass estimated with the acoustic method shows a decreasing trend within the first 200 nm., since 2001, attaining very low levels of biomass in 2008. After extending the area of the acoustic survey up to 500 nm. (a process which began in 2003), from 2005 a slight drop in the estimated biomass across the entire area is equally observed, with a strong drop in 2008 (Table I).

- Size composition of the acoustic biomass: in the last few years, the size composition recorded in the acoustic surveys and in the fishery located off the south- central Chile, shows absence of juvenile individuals and a progressive shift in the mode toward larger sizes. There are no differences in the size and age structure of the jack mackerel stock within and outside the EEZ.

Table I. Biomass estimates of the jack mackerel and coefficient of variation (CV) inside-outside the Chilean EEZ and total surveyed area (1997-2008).

Years	5-200 nm		200-400+ nm (1)		Total		
	Biomass (tons)	CV	Biomass (tons)	CV	Biomass (tons)	CV	Area (mn^2)
1997	3,753,516	0.044			3,753,516	0.044	58,000
1998	3,255,838	0,039			3,255,838	0.039	47,540
1999	4,354,999	0.031			4,354,999	0.031	61,317
2000	5,889,227	0.049			5,889,227	0.049	65,196
2001	6,146,418	0.034			6,146,418	0.034	52,636
2002	2,027,384	0.040			2,027,384	0.040	53,496
2003	914,653	0.090	1,831,599	0.067	2,746,252	0.051	53,129
2004	529,790	0.068	3,495,064	0.057	4,024,854	0.051	66,636
2005	583,259	0.106	3,503,062	0.035	4,086,322	0.034	57,226
2006	612,457	0.125	2,827,428	0.075	3,439,885	0.060	52,886
2007	87,753	0.121	3,155,924	0.057	3,243,676	0.055	35,748
2008	1,457	0.100	487,507	0.130	488,965	0.120	8,621

(1)The western limit in year 2006 was 500 nm and 480 nm in 2008.

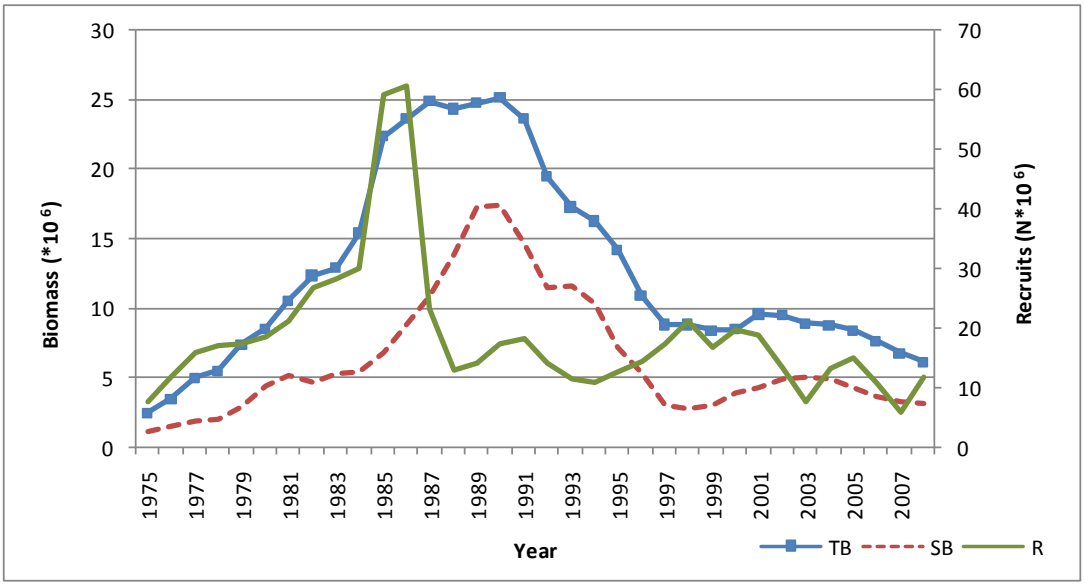
- Spawning biomass: the estimations of spawning biomass obtained from the DEPM (extending up to 94° LW; beyond 1000 nm. from the coast), show a decline from 2003, which points to a shift in the scale of the population level, with biomass levels that have reduced up to 75%, followed by strong fluctuations. A decline is observed both in the spawning area and egg production from 2005 onwards (Table II).

Table II. Summary of the reproductive parameters and the spawning biomass estimation by year of cruise (1999- 2008).

Year	W (g)	P0 (eggs/m^2d-^{1})	Study Area (Km^2)	Spawning Area (Km^2)	Spawning Biomass (t)
1999	191,8	65.28	829.607	663.747	5.723.933
2000	211	49.16	1.011.802	823.077	4.688.208
2001	223,7	46.22	762.883	600.320	5.626.963
2003	394,7	9.20	871.179	647.968	1.387.804
2004	412,1	27.32	1.385.613	1.054.352	3.287.439
2005	364,7	9.94	1.222.143	773.602	1.042.706
2006	532,4	14.79	1.343.682	682.550	3.282.628
2007	532,4b	3.56	1.420.837	544.583	626.465
2008	624,7	11.47	1.464.636	505.542	1.934.723

a: No reproductive data available, value is an average of the years 2000-2001.
b: The reproductive parameters of 2006 were used.

- Biomass: total biomass and spawning biomass estimated through stock assessment shows that following a period of decline of the resource from early nineties, a slight recovery occurred up to 2002, as a result of the management put through by Chile (closures, quotas, Maximum Catch Limits per Shipowner); a declining trend in biomass is again observed since 2003-2004 (Figure 10).



Source: IFOP.

Figure 10: Estimations of total biomass (TB), spawning biomass (SB) and recruitment of jack mackerel on the basis of stock assessments.

  - Spawning biomass: the size of the spawning biomass, that ensures the renovation of the resource, shows a declining trend in the last 5 years (Figure 10).

- Recruitment also shows a declining trend since 2001. (Figure 10).

- Spawning biomass ratio: indicates a decreasing trend since 2004 and reached a level of 27% in 2008 which is below the recommended biological reference level of 40% of the spawning biomass per recruit (Figure 11).

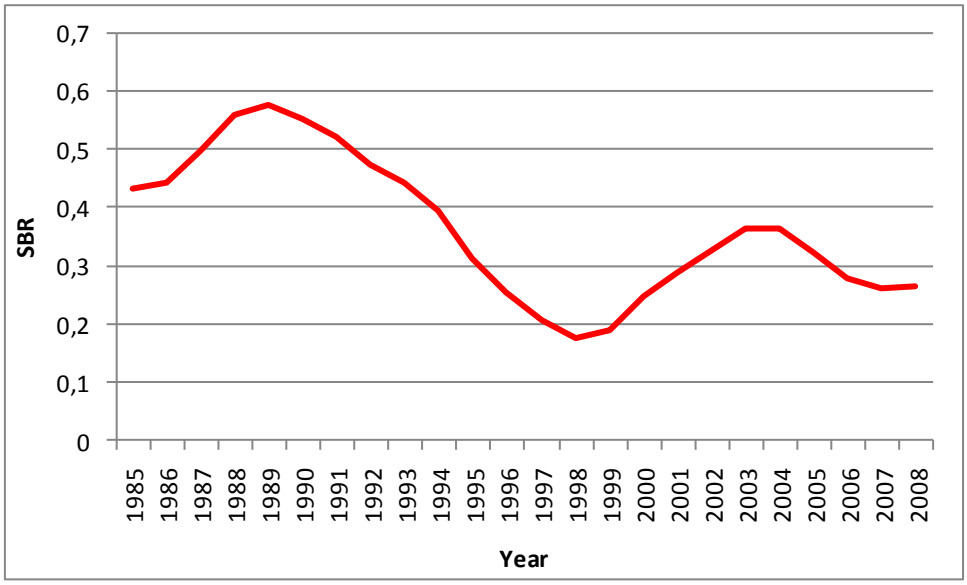
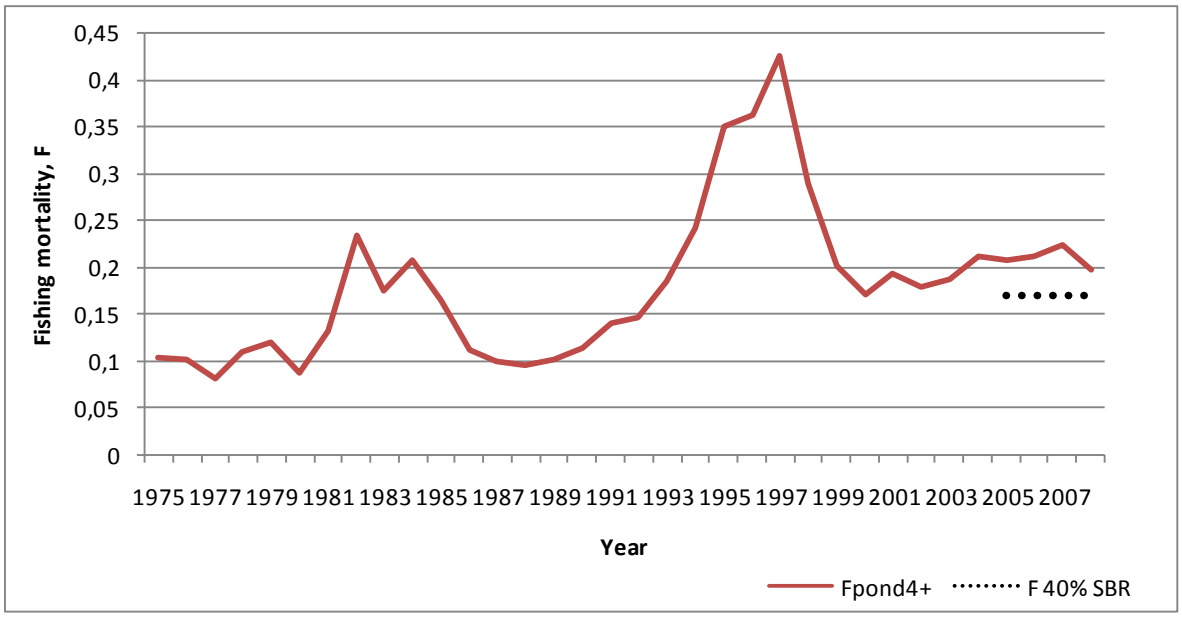


Figure 11. Spawning biomass ratio of the Chilean jack mackerel.

Exploitation Indicators

- Instantaneous fishing mortality rates: fishing mortality displays high levels and exceeds the recommendable target level in accordance with the precautionary biological reference point (F 40% of the spawning biomass per recruit: $F_{40\%SBR}$) (Figure 12).

- Surplus production: catches exceed the surplus production of the stock.



Source: IFOP.

Figure 12: Fishing mortality F4+, and recommended level of reference (F 40% SBR).

Closing remarks

The above described indicators illustrate the rapidly worsening status of the resource in the South-eastern Pacific. If this situation is not reverted the fishery would face a critical situation which may threaten the sustainability of the fishery. Therefore a catch quota is recommended – as an immediate action – in order to avoid a rise of the South-eastern Pacific catch beyond the current levels, as well as restricting the fishing effort.

On the basis of future stock assessments carried out by the Science Working Group of the SPRMFO, a catch quota level in accordance to the status of the resource shall be established.