

The logo for the Chilean Jack Mackerel Workshop is a dark blue rounded rectangle with a textured, wavy pattern. The text "Chilean Jack Mackerel Workshop" is centered in white, with "Chilean Jack Mackerel" on the top line and "Workshop" on the bottom line.

Catch size compositions for jack mackerel (*Trachurus murphyi*) off Chile (1975-2006)

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Abstract

The sampling effort made from 1975 to 2006 for generating Chilean jack mackerel (*Trachurus murphyi*) size structures is presented herein, along with the size compositions per studied zone. Off northern Chile, only juvenile size structures were recorded. The average sizes showed a downward trend until 1999, when it reached about 22 cm FL and stabilized through 2006. The size structures recorded off southern Chile, however, revealed important cohort development in 1980, 1986-1987, and 1997-1998, explaining both the development of the fishery and the changes in jack mackerel abundance.

The information gathered has allowed us, on the one hand, to follow the jack mackerel stock dynamic spatially-seasonally through stock evaluations and, on the other hand, to strengthen hypotheses regarding the structure of Chile's jack mackerel stock.

1. Introduction

The IFOP has monitored extractive activities all along Chile from the early 1970s. This has allowed us to gather valuable information as to the attributes of the jack mackerel population. Size composition is an important element that grants early understanding of structural population variations and establishes life history processes such as recruitment. Moreover, it permits the elaboration of catch age compositions by integrating them into age-size keys in order to understand the strength and contribution of the development of cohorts over time. Here we summarize the methodology used to elaborate size compositions by zone, month, and year from 1975 to 2006.

2. Materials and Methods

2.1 Sampling area

Fishery activity was monitored and samples collected at the main ports and fishing areas from the very north of Chile to 43°30'S. The main ports in the north are: Arica, Iquique, Tocopilla, Mejillones, Caldera, and Coquimbo. In the central-south zone, the principal ports are: San Antonio, Talcahuano, San Vicente, Coronel, Tomé, and Corral (Figure 1.)

2.2. Sampling procedure

a) Data sources and types of variables

Jack mackerel specimens were sampled both on land and on board. This was done by selecting a vessel for sampling and then recording all its operational and catch information. From this sample, individuals were selected at random for a length sample; fork length was measured and the maturity stage recorded. A “biological sample” was taken on land. This size-stratified sample was measured for fork length, total weight, eviscerated weight, and gonad weight; sex was also recorded. Along with these variables, otoliths and stomachs were collected (the latter only on board and in the northern zone). It should be noted that the sampling effort was aimed at achieving an adequate representation of the monthly jack mackerel size structure per zone considering the sampling sizes established by Young et al. (2001). Fish length (fork length) was recorded with an ichthyometer (precision 1 cm), rounding to the nearest whole number. For example, if the range observed was 10.5 – 11.5 cm, the recorded length was 11 cm.

b) Designs and sampling sites

The team of scientific observers (samplers) was proportional in number to the importance of the landing and the established sample size. On land, samples were taken daily at the landing sites of the main ports; on a monthly basis. These follow a two-stage statistical design in which the first stage is the fishing trip and the second stage the specimens. On board, a three-stage sampling design

was used in which the first stage was the fishing trip, the second stage the hauls, and the third stage the sampling of individuals.

Samples for length were taken by randomly selecting 20 monthly trips per fishing zone. On land, the samples for length included 80 to 100 specimens, whereas on board samples were made up of 100 to 130 specimens per haul. The biological samples considered 80 to 100 individuals on land. Otoliths were collected per port (12 pairs per month per size range). The basic unit of sample collection was a 25-kg bin that was filled at random according to the size of the specimens at the landing area. The compliance with the sample size is subject to the landing levels of the fleet, which, in certain periods of the year, are quite low due to the seasonality of the fishery, resource availability, weather conditions, or migration of the resource for reproductive purposes.

d) Estimated size composition

The size composition was aggregated monthly and constructed based on the fishing trip samples using the following estimator:

$$\hat{p}_{hk} = \sum_{i=1}^{n_h} \frac{y_{hi}}{y_h} \cdot \hat{p}_{hik}$$

$$\hat{p}_{hik} = \frac{n_{hik}^*}{\sum_k n_{hik}^*}$$

where i is the fishing trip, y is the catch from the trip, h is the range (zone, month), k is the size range, n^* is the number of specimens in the sample, and p_k is the proportion of individuals in size range k . Later, the monthly structures in numbers are aggregated by zones and macrozones and the annual composition obtained.

3. Results

Between 2002 and 2006, the number of specimens measured at the national level based on the length samples exceeded 150,000 specimens annually; in the case of the biological samples, 26,000 specimens were measured annually. One exception was the sampling done between 1997 and 2001, which was intensified in order to monitor the critical condition of the resource. The greatest number of specimens was measured at the ports of Iquique, San Vicente, and Coronel;

these, in turn, had the most important landings (Table 1, 2).

Table 1

Number of specimens measured in the jack mackerel length sample (1997 - 2006).

Year	1	2	3	4	5	6	7	8	9	10	11	12	Total
1997	3.452	9.728	3.177	3.327	13.004	27.229	55.545	53.601	421.813	258.831	9.211		858.918
1998	2.815	9.811	597	8.245	2.002	8.364	23.763	57.348	305.661	242.248	13.314		674.168
1999	6.163	19.478	1.032	3.384	13.150	8.825	15.657	79.105	348.360	210.333	8.643		714.130
2000	3.309	21.630	3.052	2.613	41.300	20.864	13.146	37.675	257.197	133.874	27.314		561.974
2001	26.014	304.221	45.108	72.474	25.809	21.543	12.856	34.408	119.012	60.068	1.541	3.166	726.220
2002	6.009	32.693	7.439	20.508	9.397	31.444	60.505	18.930	65.223	16.461	623	3.419	272.651
2003	16.766	54.807	20.979	16.284	7.909	12.022	587	14.874	45.030	10.189		2.824	202.271
2004	1.417	16.911	5.438	11.972	9.983	5.760		5.398	27.457	4.870	89		93.113
2005	4.634	32.857	4.141	5.705	10.589	1.188		9.340	25.527	2.687		1.835	98.550
2006	7.735	34.078	3.417	2.605	10.342	1.737		5.258	26.709	6.781		2.445	101.107

1: Arica, 2: Iquique, 3: Tocopilla, 4: Mejillones, 5: Caldera, 6:Coquimbo, 7:San Antonio, 8:Talcahuano, 9: San Vicente, 10: Coronel, 11: Tome, 12: Corral

(Source: IFOP)

Table 2

Number of specimens measured in the jack mackerel biological sample (1997 and 2006).

Year	1	2	3	4	5	6	7	8	9	10	11	12	Total
1997	1.070	1.311	286	692	3.289	10.195	5.020	2.601	6.930	2.746	527		34.667
1998	866	3.416	78	1.525	1.240	4.188	1.113	3.386	10.270	6.700	568		33.350
1999	1.214	1.190	24	980	2.435	3.683	1.146	3.811	10.901	5.830	470		31.684
2000	238	1.819	90	339	4.109	7.403	763	2.366	20.673	5.386	248	36	43.470
2001	84	4.050	1.212	1.040	2.149	8.450	1.267	4.959	26.028	9.012	339	1.430	60.020
2002	547	2.462	1.097	1.248	1.167	10.993	2.944	2.209	16.529	4.321	85	1.338	44.940
2003	2.827	4.403	1.012	1.231	1.845	4.718	79	2.689	13.240	3.398		1.682	37.124
2004	169	2.499	646	633	3.305	2.878		1.484	11.611	970		1.809	26.004
2005	50	2.049	123	545	1.118	728		820	6.147	601		889	13.070
2006	233	1.534	153	538	2.069	860		647	3.586	2.316		763	12.699

1: Arica, 2: Iquique, 3: Tocopilla, 4: Mejillones, 5: Caldera, 6:Coquimbo, 7:San Antonio, 8:Talcahuano, 9: San Vicente, 10: Coronel, 11: Tome, 12: Corral

(Source: IFOP)

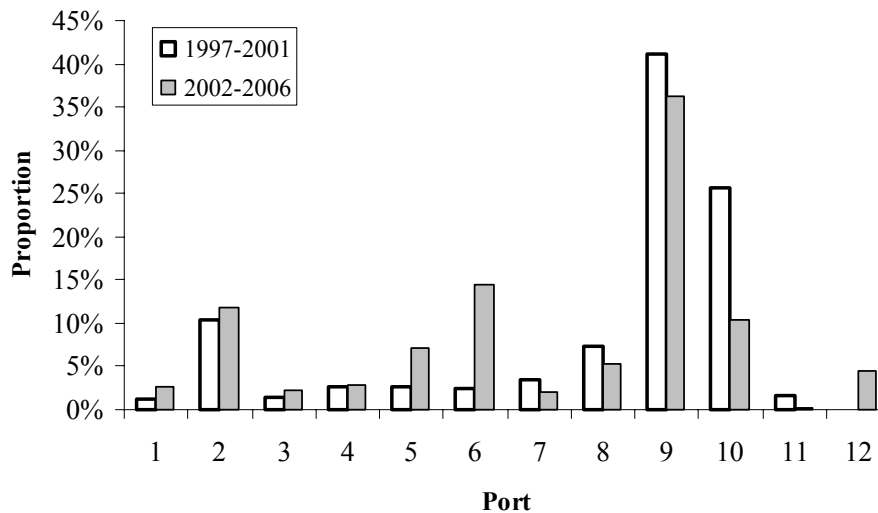


Figure 2. Proportion of length samples per port

Catch size compositions indirectly reveal the main processes of population dynamics: recruitment, growth, and mortality. For jack mackerel in particular, the annual structures clearly show the development of the main cohorts that have sustained the fishery, as well as the spatial stratification of the resource. In the northern zone, the presence of the juveniles of the stock results in lower modal sizes than are found in the central-southern zone. In the north, the modal and mean sizes have tended to decrease progressively, ranging between 20 and 26 cm (Figure 3). The area to the north of 30° LS is considered to be a rearing zone or habitat for jack mackerel juveniles (Arcos et al., 2004). The central-southern zone presents larger size structures and the development of strong cohorts of the stock is clear for 1980, 1986-1987, and 1997-1998, years that coincide with the most important recruitments recorded for the fishery. Of these, the last two were recorded in both zones (Figure 3, 4).

The series of average sizes in the catch per zone show, on the one hand, a sustained reduction in the northern zone and, on the other, an increase in the southern zone after 1986-1987, when the average sizes dropped in the northern zone. The increased average size in the central-southern zone after 1999 obeys the combined effect of an orientation of the fleet to seek out larger sizes and the last recruitment, which occurred in 1998-1999. Previous records show that, during unusually warm years, typically associated with “EL Niño” events (1982-1983, 1987, 1991), changes have occurred in the spatial distribution of several jack mackerel size groups (Elizarov et al., 1993).

On a monthly level, the northern zone registers a clear modal progression, with the development of the annual classes throughout the year. It should be noted that the development of size classes over 28 cm was not observed; upon reaching this size, the fish migrate to the south in order to join the adult stock. We noted that the classes have been incorporated into the fishery at ever earlier sizes, for example, at 20 cm FL in 2002-2003 and at 16 cm FL in 2004-2006 (Figure 6a).

In the central-southern zone, the monthly structures record a greater breadth, with modal sizes from 26 to 28 cm FL and maximum records reaching 60 cm FL. In the case of the central-southern zone, on a monthly level, no such clear modal growth was registered, possibly because of the lower growth rate and greater superimposition of classes. In 1998-1999, the lowest modal size (24 cm FL) was recorded and, since then, the parameter has increased to 33 cm FL.

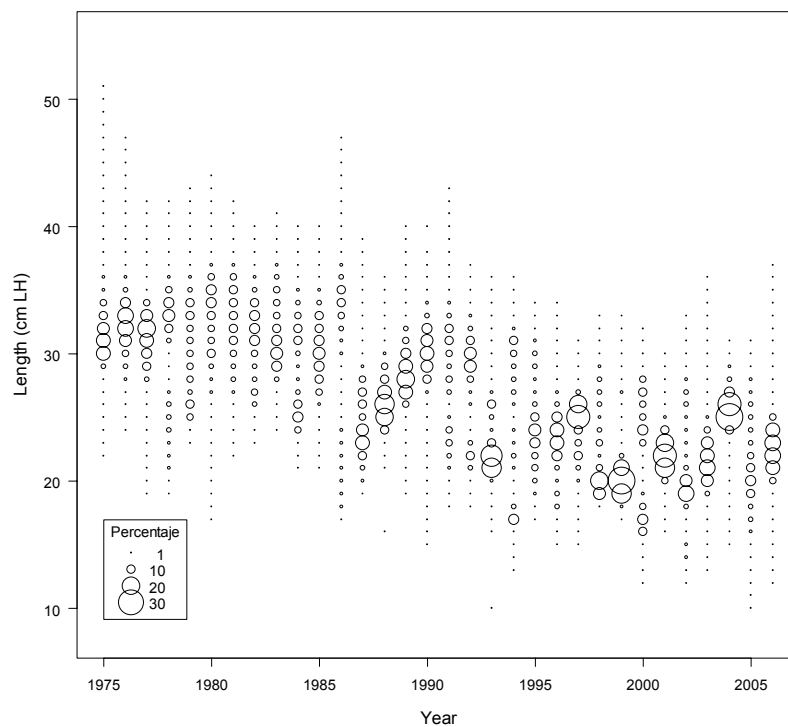


Figure 3. Jack mackerel length compositions in the northern zone of Chile 1975-2006

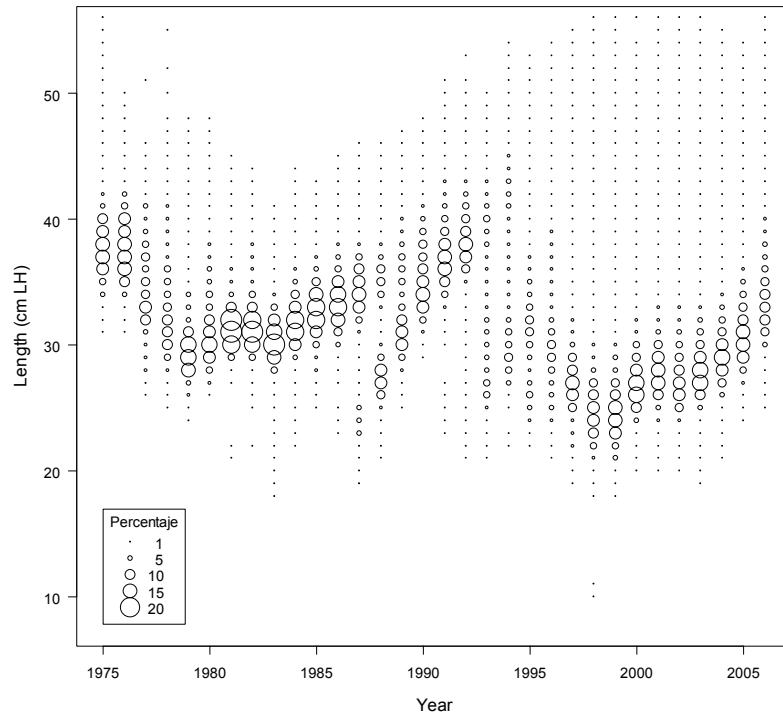


Figure 4. Jack mackerel length compositions in the central-south zone of Chile 1975-2006

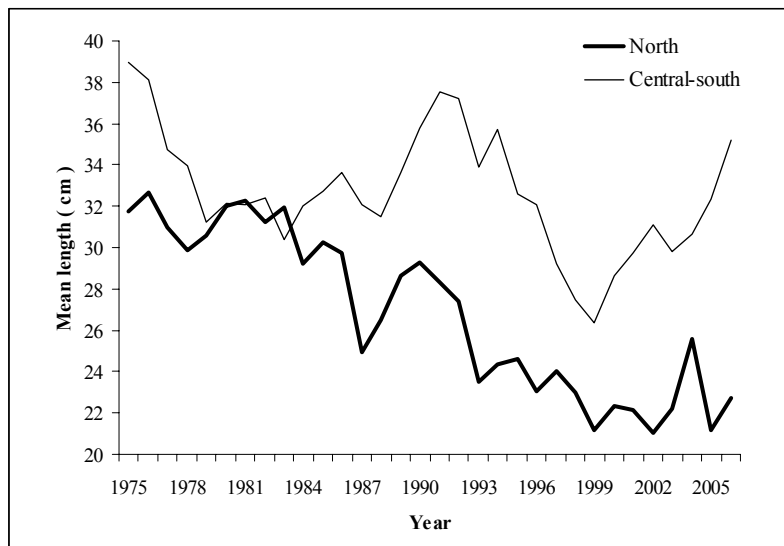


Figure 5. Mean length recorded in the catches sampling of the jack mackerel 1975-2006

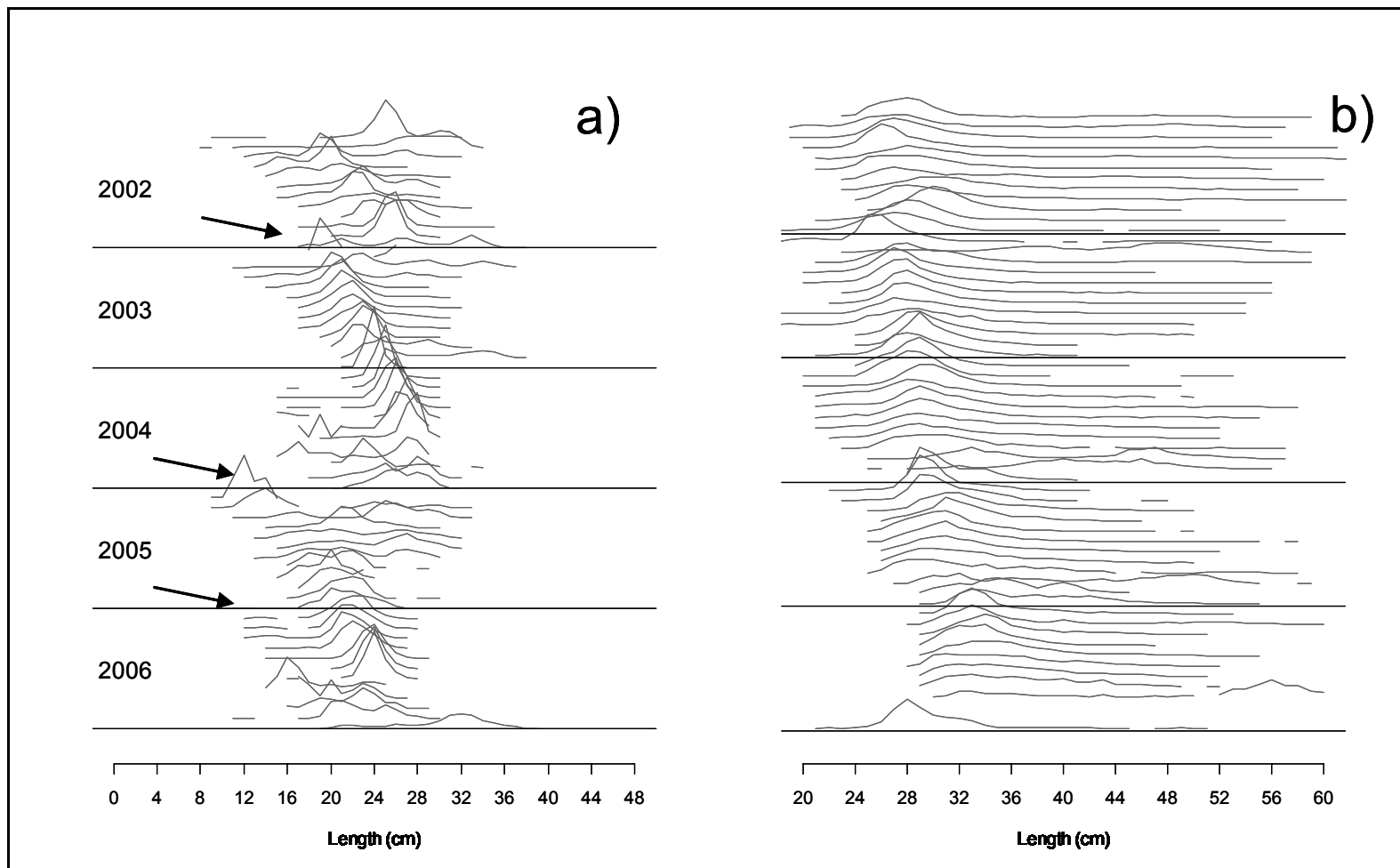


Figura 6. Jack mackerel monthly length compositions, a) North zone (Arica -Antofagasta), y b) Central-south zone (San Antonio- Corral), 2002-2006.

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