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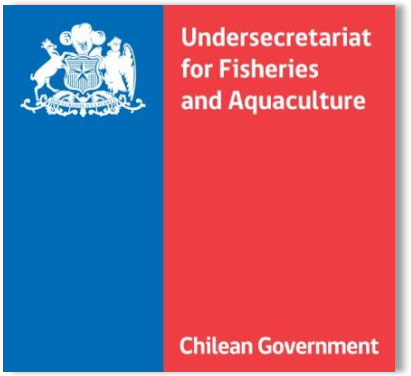
Chile's Annual Report to the 2017 SPRFMO Scientific Committee
Part I: The Jack Mackerel Fishery



CHILE ANNUAL REPORT
JACK MACKEREL FISHERIES

SPRFMO-SCIENTIFIC COMMITTEE

August, 2017.

1. DESCRIPTION OF THE FISHERY

1.1 Composition of the Fleet.

The industrial purse seine fleet operating on jack mackerel fishery in both the SPFRMO area and Chilean EEZ between January and July 2017 consisted of 82 fishing vessels. This number is lower than previous years as a result of the availability of the resource, which is nearer to the coast as in the last three years. The fleet structure was represented by 66% of vessels with a hold capacity not exceeding 600 m^3, which operate mainly in the north area (Table I).

Between 2013 and 2017, the number of vessels operating within the SPRFMO area showed a reduction, with the exception of 2015, where almost 30% of the industrial fleet operated in this area. As a result of changes in the resource´s distribution, the jack mackerel fleet operated mainly within the Chilean EEZ during 2016 and 2017. In terms of structure, the fleet operating in 2017 within the SPRFMO area was mainly represented by vessels with hold capacities greater than 1,500 m^3 (Table II).

Table I. Number of industrial purse seiners catching jack mackerel in the Chilean EEZ and SPRFMO area (combined) between 2013 and June 2017. Data were assembled by year and hold capacity. (2017* are preliminary data).

Hold capacity (m^3)	2013	2014	2015	2016	2017 (*)
0-300	1	0	1	3	1
300-600	60	60	59	57	53
600-900	8	6	6	7	6
900-1200	6	5	3	1	2
1200-1500	8	5	7	6	7
1500-1800	9	8	9	9	9
1800-2100	4	4	4	4	4
TOTAL	**96**	**88**	**89**	**87**	**82**

Table II. Number of industrial purse seiners catching jack mackerel in the SPRFMO area between 2013 and June 2017. Data were assembled by year and hold capacity. (2017* are preliminary data).

Hold capacity (m^3)	2013	2014	2015	2016	2017 (*)
0-300	0	0	0	0	0
300-600	0	0	0	0	0
600-900	2	0	3	1	0
900-1200	1	3	3	0	1
1200-1500	3	3	9	0	0
1500-1800	3	4	7	2	2
1800-2100	1	1	4	2	0
TOTAL	**10**	**11**	**26**	**5**	**3**

1.2 Catches, Seasonality of Catches, Fishing Grounds and By-catch

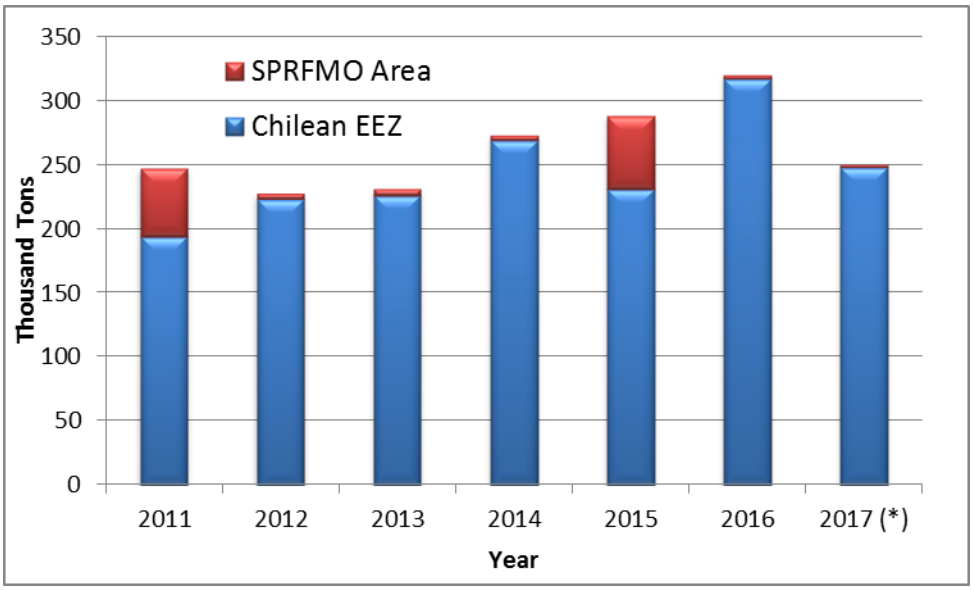
Catches

During 2011-2017 period, the total catch of jack mackerel by the Chilean fleet has been increasing due to compliance with the catch quotas set by SPRFMO.

In this same period, there is a decreasing trend in the catches of jack mackerel within the SPRFMO area, with the exception of 2011 and 2015 where such catches corresponded to 22% and 20% of the total captured in those years respectively (Figure 1 and Table III).

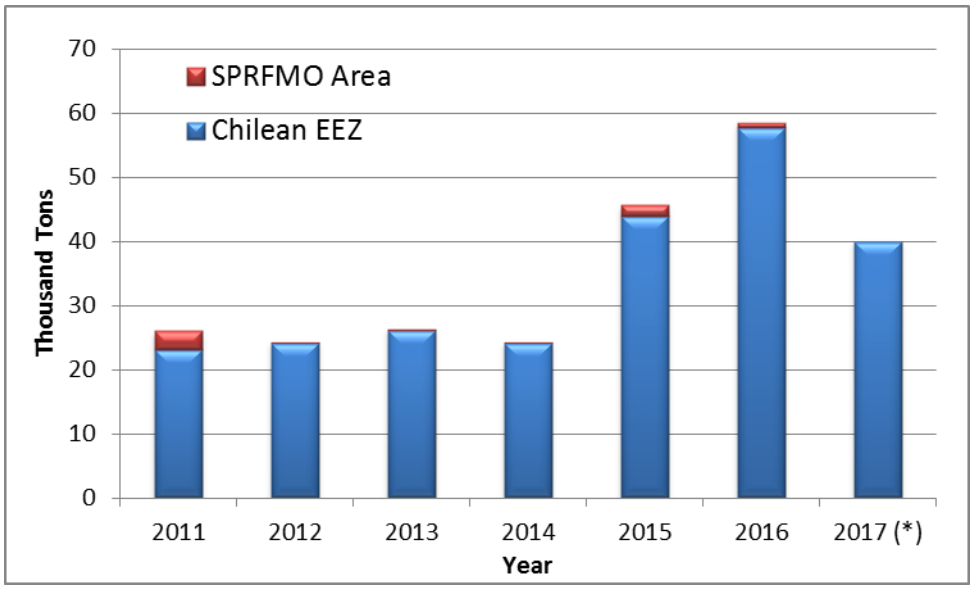
During the first semester of 2017, jack mackerel catches within the SPRFMO area totaled 2,200 tons. This value is similar to the 2016 catches.

Besides jack mackerel, the national fleet also registered chub mackerel catches which totaled 39,928 tons until June 2017. This value was lower to the values registered in 2015 and 2016, but not higher to the 2011-2014 period average. However, catches of chub mackerel in the SPRFMO area will not surpass 1% of this resource's total catch (Figure 2 and Table IV).



Year	Chilean Jack Mackerel (t)		
	Chilean EEZ	SPRFMO Area	Total
2011	193,722	53,573	247,295
2012	223,322	4,138	227,460
2013	225,443	5,917	231,360
2014	268,531	3,983	272,514
2015	231,288	56,806	288,094
2016	317,241	3,159	320,400
2017 (*)	248,100	2,200	250,300

Figure 1 and **Table III**. Total annual jack mackerel catches in the Chilean EEZ and the SPRFMO area with purse seine nets for the period 2011 – June 2017 (preliminary).



Years	Chub Mackerel (t)		
	Chilean EEZ	SPRFMO Area	Total
2011	23,077	2,979	26,056
2012	24,120	199	24,319
2013	26,086	243	26,325
2014	24,135	31	24,166
2015	43,863	1,820	45,683
2016	57,770	790	58,560
2017 (*)	39,928	0	39,928

Figure 2 and **Table IV**. Total annual chub mackerel catches in the Chilean EEZ and SPRFMO area with purse seine nets for the period 2011 - June 2017 (preliminary).

Seasonality of Catches

Unlikely 2015 and 2016, January and February of 2017 showed evidence of very low catches (27,000 tones for both months), mainly because of the high presence of juvenile specimens in the coastal area (Figure 3). Subsequently, during March and May 2017 catches increase again with average values around 65,000 tones, mainly due to the change in the fishing grounds, concentrated in the center-south area of the country. A significant increase was reported in May with catches around 84,000 tones. Therefore, it became the month with the highest catches within the 2013-2017 period.

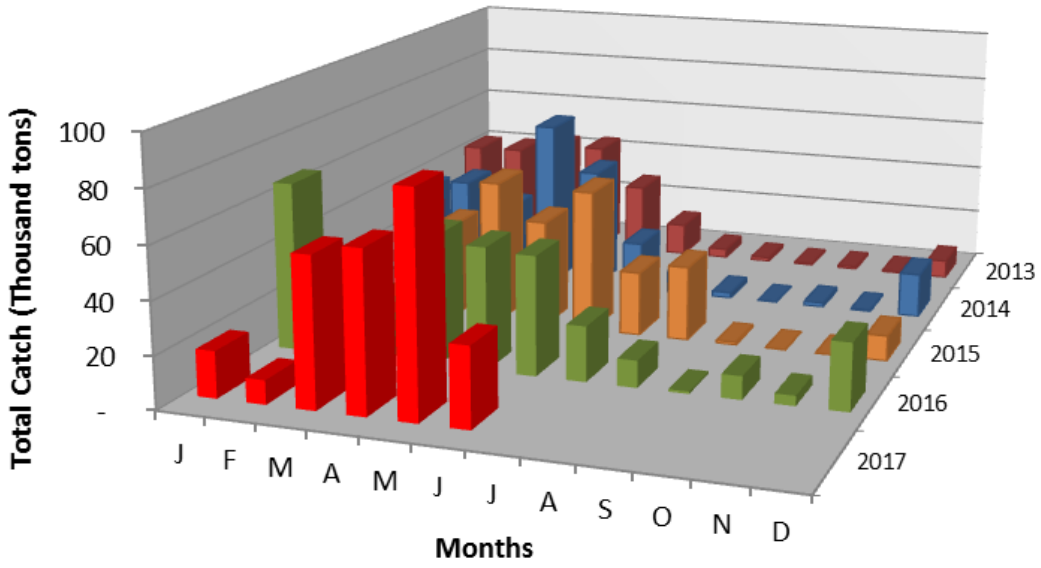


Figure 3: Seasonality of jack mackerel catches by the purse-seine fleet for the period 2013- June 2017. Source: SERNAPESCA.

Spatial Distribution of Catches

During 2015, the fleet operating within the center-south area has shown a wide catch pattern with operation within the EEZ between January and May, and catches within the SPRFMO area between June and August. This shows the typical shift towards ocean waters during the second and third quarter as observed in previous years (Figure 4).

During 2016 and the first half of 2017, the spatial distribution of jack mackerel catches in the center-south area was concentrated in the coastal areas (first 150 nm). The northern area of the country concentrated catches in areas near to the coast (first 50 nm) associated to the catch of anchovy as the target species.

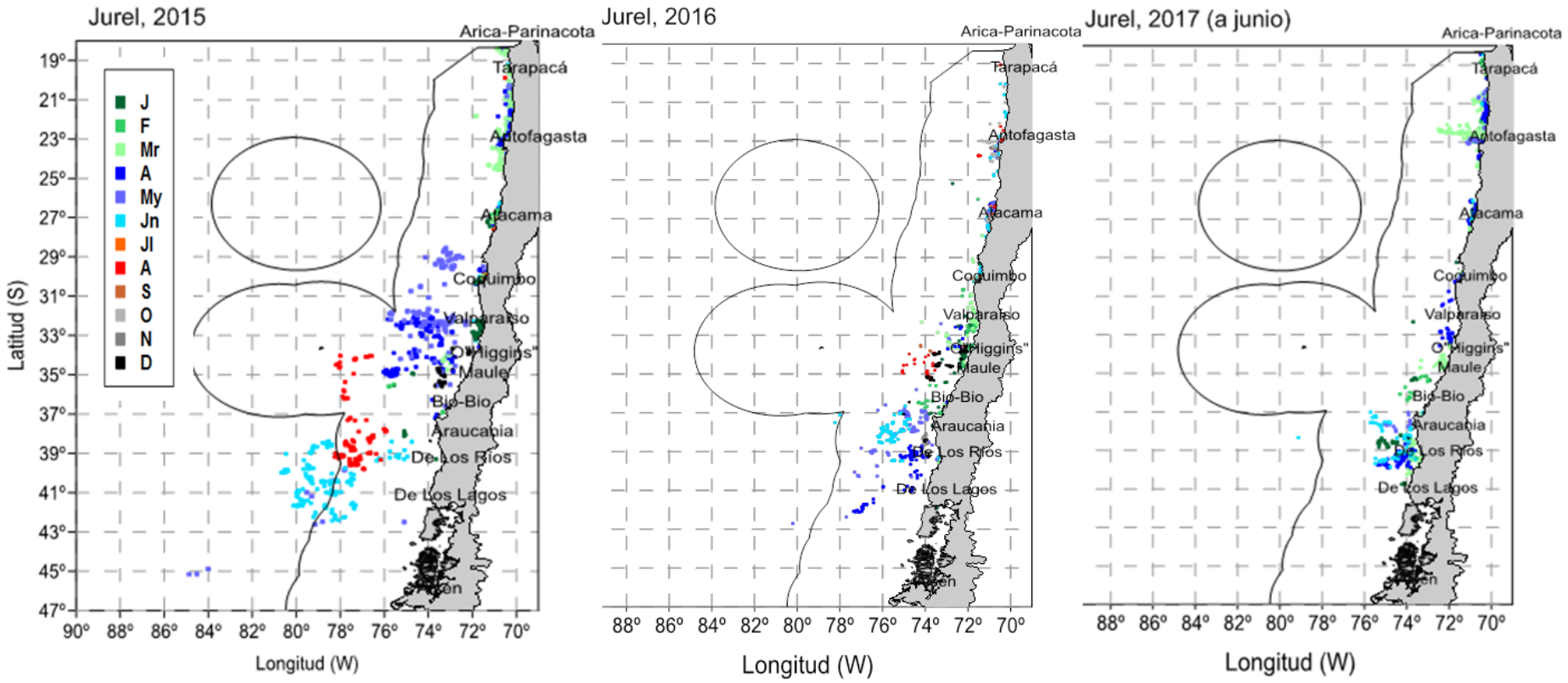


Figure 4: Spatial-temporal distribution of industrial jack mackerel purse seine fleet 2015, 2016, and Jun 2017. Source: IFOP.

Bycatch

During 2016, catches within the SPRFMO Area and the EEZ were represented by the target species jack mackerel (Trachurus murphyi), in 100% and 99 %, respectively. Catch associated within the EEZ was composed mainly by chub mackerel (*Scomber japonicus*) that represented 10.5%.

At the northern area of the country, jack mackerel was captured principally as catch associated to the anchovy fishery.

2. EFFORT AND CPUE FOR JACK MACKEREL FISHERY

This information refers to the center-south fleet operating on jack mackerel as the target species. Catches, effort and CPUE were calculated for each trip in which jack mackerel represented more than 50% of the total catch.

Until 2010, an increasing trend in the duration of the fishing trips was observed (Figure 6), due to the distance of jack mackerel from its fishing grounds. Subsequently, during 2012 and 2013, catches concentrated within the EEZ, significantly reducing the average length of fishing trips (50%). For the last years of the series (2016-2017), catches concentrated again in areas close to the coast, within the first 150 nm, as shown in the reduction of the length of fishing trips around to 4 days.

On the other hand, the standardized CPUE, measured as the utilization rate of the carrying capacity of the fleet (catch / (hold capacity displaced x length of fishing trip)) exhibited a decreasing trend between 2001 and 2011. Subsequently, in 2012, this indicator changed its trend towards an increase in this line which has stabilized between 2013 and 2017. The change in the trend of the indicator from 2012 is explained by a decrease in the average length of the fishing trips as a result of changes in the distribution of the resource (**Figure 5**).

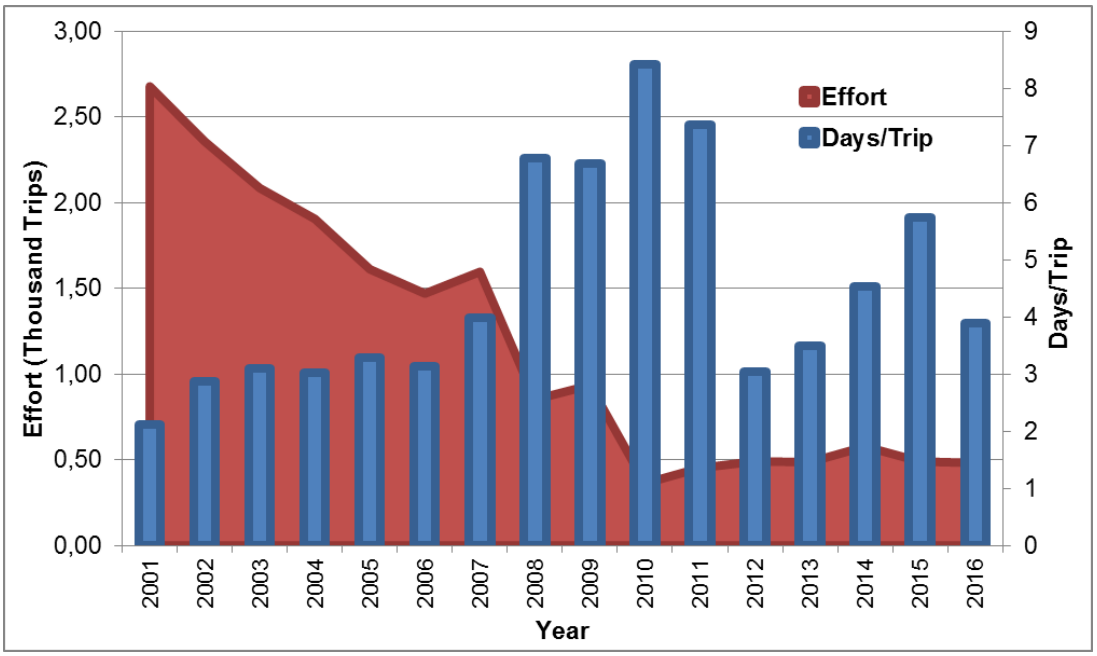


Figure 5: Effort in number of trips with catch (red), and length of fishing trips in days (blue) for the purse seine fleet in the center-southern zone, period 2001-2016 (preliminary). Data SERNAPESCA. Source: IFOP.

3. RESEARCH PROGRAMS

Jack mackerel research programs include standard projects carried out annually by IFOP (Fisheries Research Institute) along with complementary projects. The information obtained is used by the Authority to support the decision-making process.

Basic projects performed by IFOP during 2016-2017:

- Hydroacoustic assessment of jack mackerel biomass between XV and V Regions, 2016

This research cruise was conducted between 9 March and 19 April 2016, and included an exploration area located between the northern boundary of the country and Valparaiso (33° 00´ SL), with perpendicular transects to the coastline reaching up to 100 nm from the coast. As a result, a jack mackerel total biomass of 498,052 tones was estimated in the prospected area.

- Jack mackerel biological condition in the high seas 2016

This research cruise was conducted between 22 November and 6 December 2016, and included a prospection area between 74° W and 94° W and between 33°00´SL

and 38°30¨SL. This project included 6 industrial fishing vessels which carried out 12 transects in total. The results of the index of abundance and biomass estimation are still under development.

- Monitoring of the Jack mackerel fishery

This study enabled the gathering of real time information on the evolution of the main biological and fishing indicators related to the Jack mackerel fishery and incidental catch. The monitoring was conducted throughout the entire maritime space between the Chilean northern boundary and 47° 00' SL, and included information collected from both the artisanal and industrial fleets.

- Assessment of the total allowable catch

Similarly as done by the SPRFMO SWG, this study used the Joint Jack Mackerel (JJM) model. This project was aimed at setting up the status of the resource, and also at assessing biologically sustainable exploitation rates. The results were used by the Fishing Authority to improve the stock assessment, simulate different exploitation scenarios and conduct additional analyses.

• Hydroacoustic assessment of jack mackerel biomass between XV-V Regions, 2017

This research cruise took place from March 9 through April 19^{h} 2017, and included an exploration area located between the northern boundary of the country and Valparaiso (33° 00´ SL), with perpendicular to the coastline transects reaching up to 100 nm from the coast. As a result, in the prospected area, a jack mackerel total biomass of 610,000 tons was estimated.

• Hydroacoustic assessment of jack mackerel in the center-south area, 2017

This research cruise took place from March 23 through July 4, 2017, and included an exploration area located between 32° SL and 44°SL from the 5 nautical miles of the coast up to 84°W in perpendicular transects to the coast. Results are still under assessment.

4. BIOLOGICAL SAMPLING, AND LENGTH AND AGE COMPOSITION OF THE CATCH.

4.1 Biological sampling.

Biological information is obtained on a regular basis from samples collected along the Chilean coast for jack mackerel and its associated species. Sampling is conducted on a daily basis, mainly at landing sites and processing plants, and is also complemented with information gathered by fishing observers onboard fishing vessels. The information collected includes fork length measurements, otolith collection, total weight, gutted weight, gonad weight, and sex and maturity stages.

The amount of length and biological samples obtained for jack mackerel during 2016 added up 37,686 and 14,941 specimens, respectively. For the industrial fleet, samples included at-sea sampling as well as port sampling, covering the whole range of activity reported for this fishery in Chile. The main landing ports sampled were Caldera and Coquimbo in the northern area, and San Antonio in the center-south area of the fishery (**Table V**).

Chub mackerel, as the main bycatch in the jack mackerel fishery, was also sampled during 2016. A total of 1,456 and 2,018 specimens for length and biological samples were collected, respectively.

Table V. Number of Jack mackerel and Chub mackerel specimens collected in 2016 to gather biological and length samples.

Landing Zone	Jack Mackerel		Chub Mackerel	
	Lenght Sampling	Biological Sampling	Lenght Sampling	Biological Sampling
Arica	86	30	71	0
Iquique	2.188	73	200	2
Antofagasta	1.292	320	141	23
Caldera	3.793	1.562	196	173
Coquimbo	5.628	2.251	483	232
San Antonio	10.282	3.960	49	593
Talcahuano	9.828	4.474	246	694
Valdivia	3.480	1.951	19	243
Chiloe	1.109	320	51	58
TOTAL	37.686	14.941	1.456	2.018

4.2 Length and age composition of catches

a.- Jack Mackerel

Size structure of jack mackerel has shown a constant growth from 2015 to 2017 (Figure 6), with a shift of the mode size from 27 cm FL as mode size in 2015, 30 cm FL in 2016, and 34 cm FL during 2017 (first semester). This shift towards larger mode sizes has been also favored with an increase in the number of specimens between 40 and 50 cm FL, particularly during the first semester of 2017.

For this last year, the range of sizes varied between 10 and 68 cm in FL. The main mode was 24-25 cm in FL, which was provided mainly by the northern area of the country; two secondary modes between 30 and 34 cm in FL were provided by the center-southern area.

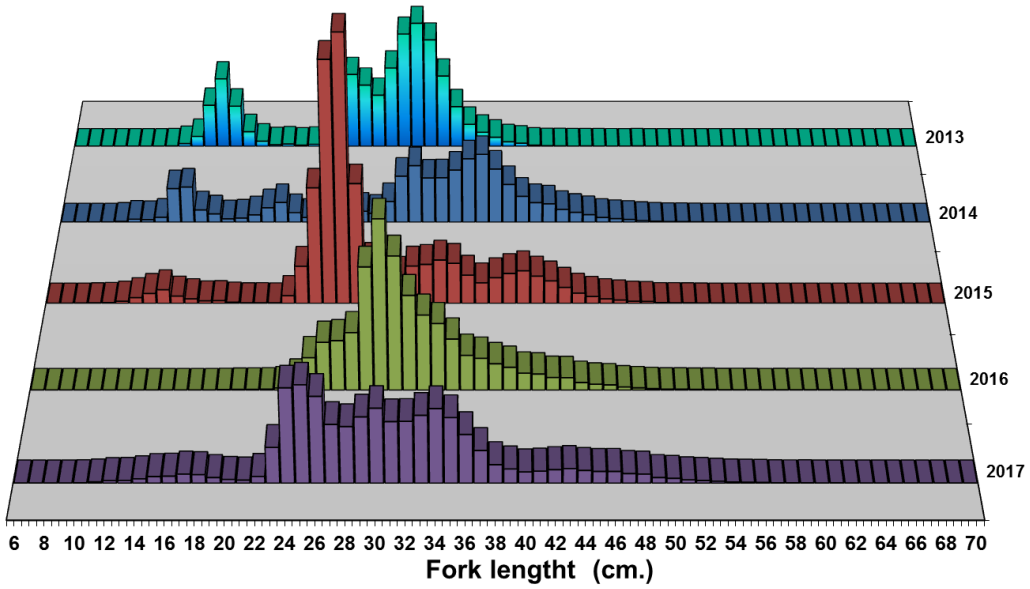


Figure 6. Length structure of jack mackerel, total catch in number 2013 - june 2017. Source: IFOP

Age structure of 2016 was composed of 16 age groups, where ages IV, V, and VI are highlighted as main modes, concentrating 66% of the catches. These age groups were captured both in the northern and center-southern area during 2016 (Figure 7).

For the first trimester of 2017, the size structure of the center-south area of the country presented a structured composed by specimens with a main mode in the age group VI and a strengthening of older ages (mode VII to XI) when compared to the rest of the years, which could be due to a strengthening of the general structure of the stock, as a result of the management measures implemented by SPRFMO.

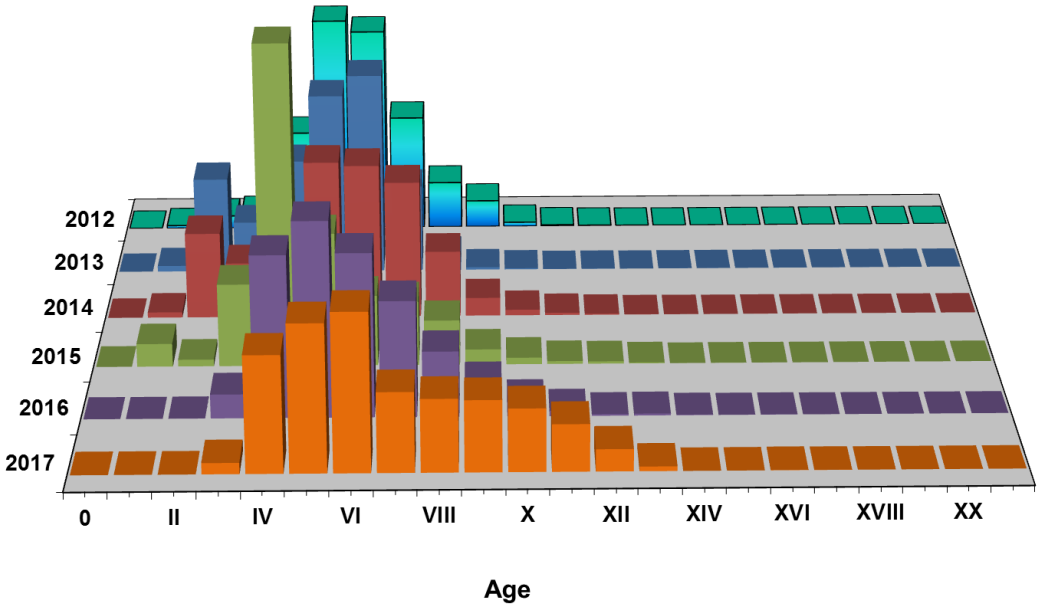


Figure 7. Age structure of jack mackerel, total catch in numbers, 2012 and January–March 2017. Source: IFOP.

b. – Chub Mackerel size composition

Due to the small catches of chub mackerel during the last years (2012-2017), the numbers of samples obtained have not been representative enough as to establish an age structure. However, as a reference point, it is possible to indicate that samples obtained between 19° - 40° S during 2016 exhibited a structure with a main mode at 32 cm FL associated to the catches in the area 24°-30° SL and a secondary mode at 37, associated to the area 34°-39° SL (Figure 8). Chub mackerel catches were obtained as secondary species, associated to the catch of jack mackerel as the target species.

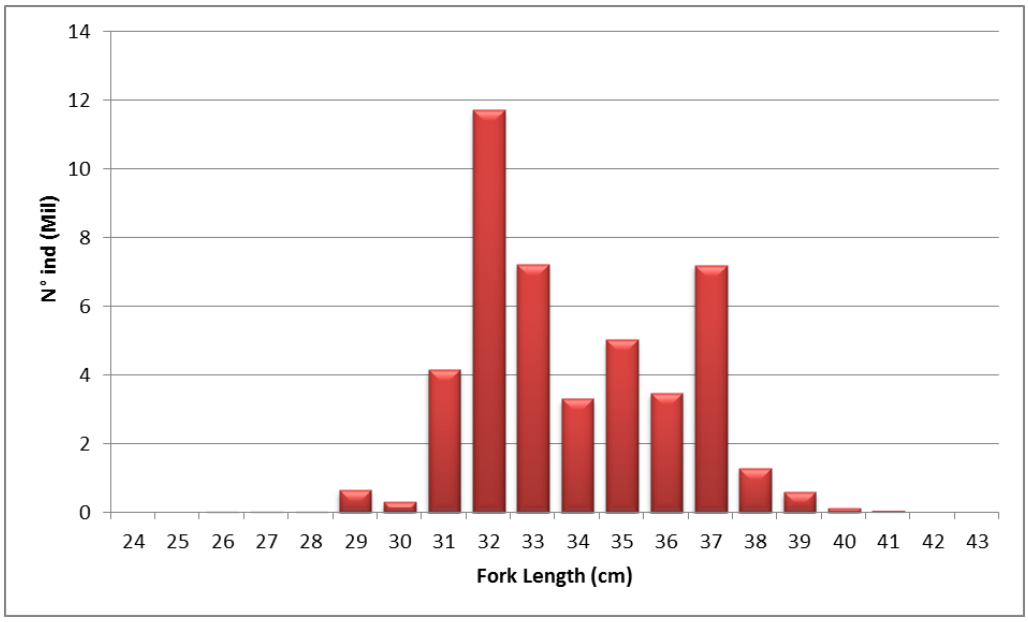


Figure 8. Length structure of horse mackerel, total catch in number 2016. Source: IFOP

5. ECOSYSTEM APPROACH CONSIDERATIONS

There are differences in some countries regarding the definition or interpretation of the bycatch concepts. As an international reference, FAO defines bycatch as “any catches conducted during the fishing process beyond species and sizes of the marine organisms targeted by the fishery, from sponges, corals, commercial or not commercial fish, seabirds, marine mammals and marine reptiles”. The Inter-American Tropical Tuna Commission, IATTC, on the other hand, considers bycatch as the catch composed by fish and other animals different from tuna commercially significant that are discarded dead to the sea. On its part, Chile in the General Law On Fisheries and Aquaculture (Law 20.625, Art. 2) has a narrower definition, characterizing bycatch as the catch composed by species that are not part of the accompanying fauna and that it is composed of marine reptiles, seabirds, and marine mammals. Thus, the precautionary and mitigation approach of the bycatch, in this case, should be aimed at these three groups mainly and should consider fish (cartilaginous and bony) as accompanying fauna of the target species.

The first records associated to bycatch in purse seine fisheries in Chile were conducted occasionally by IFOP’s scientific fishing observers from the Monitoring Pelagic Fisheries of the Center-South Area Project between 2010 and 2013.

During 2014, the Scientific Observer Program, in charge of the Research Program of Discard in Small Pelagic Purse Seine Fisheries, with a team of observers focused on purse seine fleets operating between the V and XIV regions starts the information collection onboard the industrial and artisanal purse seine fleets targeting common sardine and anchovy. In January 2015, record of information is included to the jack mackerel industrial fleet.

In the case of the Jack mackerel purse seine fishery, the interaction between seabirds and fishing operations should be considered as two big scenarios: 1) when the fishing activity is conducted in coastal areas of the EEZ of Chile, and 2) when fishing operations are carried out in ocean areas and international waters. In the first case, the general abundance and presence of coastal species such as sea gulls and pelicans would be higher and therefore these species would be more likely to be captured. In the second scenario, seabirds of the *Procellariiformes* group (mainly albatross and terns), are the ones that would appear relevant in the interaction.

Due the project is still under development, it is not possible to have validated information yet.

The Management Committee of the Jack mackerel fishery (national) will work during the second semester of 2017 on the development of a reduction plan of discard and interaction with other species, which should include its causes and the manner of reducing it.

In the case of the vulnerable marine ecosystems (VME), there are no information recorded regarding interactions with the Jack mackerel purse seine fishery in the EEZ and in the high seas.

6. OBSERVER IMPLEMENTATION REPORTS

6.1 At-sea and port sampling program.

In order to evaluate the sampling coverage within the SPRFMO Area, only fishing trips targeting jack mackerel were considered for this report (i.e. more than 50% of the total catch per fishing trip). This also included fisheries observers onboard and/or at-port sampling coverage.

Since the fishery pattern of jack mackerel nearer to the coast over the last years, it has been difficult to cover the fleet operations within the SPRFMO Area with onboard observers due to low frequent and unpredictable fishing trips in such area. Those fishing trips are not planned in advance either as to ensure the presence of an observer. In spite of the restrictions, out of the 5 fishing trips operating jack mackerel within the SPRFMO Area, 3 trips were covered by scientific observers onboard, corresponding to a 60% of the total, with a total combined sampling coverage of 24.8%. (**Table VI**).

Within the Chilean EEZ, onboard sampling coverage conducted by observers was 10.8%, and at-port sampling coverage was 13.8%, with a total combined sampling coverage of 24.6%.

Table VI. Sampling coverage by observers at port and observers onboard in the Chilean jack mackerel fishery 2016.

	At-Port	On Board	TOTAL
Chilean EEZ	13,8%	10,8%	24,6%
SPRFMO area	0,0%	60,0%	60,0%
TOTAL	13,7%	11,1%	24,8%

6.2 Programe design and coverage

Discard research programs being conducted in the country covered 9 fisheries during 2015 and 2016, with 113 scientific observers (SO, Table VII). It is important to note that SO, related to discard projects, focused their work regarding data collection onboard commercial fishing vessels (embark). For their part, SO related to fisheries monitoring projects, besides embarks, conduct sampling activities at landing points and processing plants.

Table VII. Number of Scientific Observers (OC), per fishery and type of project, 2015 and 2016

Fleet	Fishery	Number of scientific observers (OC)		
		Discard projects	Monitoring projects	TOTAL
Pelagic North Area	Anchovy XV-II, Industrial and artisanal	4	16	20
Pelagic Center-south	Common Sardine -anchovy V-X, Industrial and artisanal	13	18	31
	Jack mackerel V-X and SPRFMO Industrial			
	Southern sardine X, artisanal			
Demersal fish	Common hake industrial and artisanal (Includes hoki center-south)	7	25	32
	industrial trawling (southern demersal fishery, PDA) hoki, southern blue whitining, southern hake and kingclip	5	16	21
	Artisanal PDA (southern demersal fishery) southern hake and kingclip, longline			
	Chilean seabass, southern hake, and kingclip. Longline			
Demersal crustaceans		4	5	9
Highly migratory resources		-	21	21
	Total	**33**	**101**	**134**

Discard research programs and fisheries monitoring projects collect data from 4 dimensions of the ecosystem:

a) Fisheries dimension (variables such as total catch, retained catch, fishing effort, among other operational variables).

b) Biological dimension (variables such as total length, total weight, gutted weight, weight f gonads, otoliths, maturity status, among others).

c) Ecological dimension (variables such as seabird, marine mammals and marine reptile bycatch, sighting of great mammals, among others).

The number of fishing vessels in which OC embarked during 2015 and 2016, is shown in **Table VIII**.

Table VIII. Number of fishing vessels in which SO from IFOP onboard during 2015 and 2016, according to fleet.

	2015		2016	
Fleet	**Artisanal**	**Industrial**	**Artisanal**	**Industrial**
Pelagic North Area	6	38	16	31
Pelagic Center-south	32	27	34	26
Demersal fish	175	22	133	24
Demersal crustaceans		14	1	16
Highly migratory resources	34	1	36	2
Total	**247**	**102**	**220**	**99**

Fuente: Departamento de Tecnologías de la Información – IFOP

6.3 Training

The following specialization courses for OS from IFOP were conducted during 2015 and 2016:

1.- Identification of Marine species
2.- Fishing Biological Sampling Techniques and Methodologies
3.- Fisheries Regulation
4.- Fishing gears
5.- Identification of Seabirds
6.- Identification of Marine Mammals
7.- Safety and Familiarization onboard
8.- Anatomy and Biology of Elasmobranchs

7. ADMINISTRATIVE MEASURES

Total catch quota.

Every year, by December, the Undersecretariat for Fisheries and Aquaculture establishes the catch quotas for each resource in full exploitation regimes to be implemented next year. The jack mackerel quota established by the Undersecretariat for Fisheries and Aquaculture in December 2016 was 320,450 tons.

Subsequently and according to the agreements reached in January 2017 during the 5th SPRFMO Meeting held in Adelaide, the Jack mackerel annual quota (including high seas and EEZ) was reduced to 317,300 tons (Exempt Decree N° 213/2017), which is close to be consumed.

8. ENVIRONMENTAL CONDITION

During the first semester of 2016, Chile was hit by the El Niño event, which declined during the second half of 2016, deriving to neutral values of ONI index. During the first semester of 2017, a progressive increase of the sea surface temperature (SST) was again observed at a monthly level, reaching the ONI level +0.5 in the quarter April-June 2017, with possibilities of maintaining the increase towards the second semester 2017, with a high probability of presenting El Niño again at the end of the year (Figure 9).

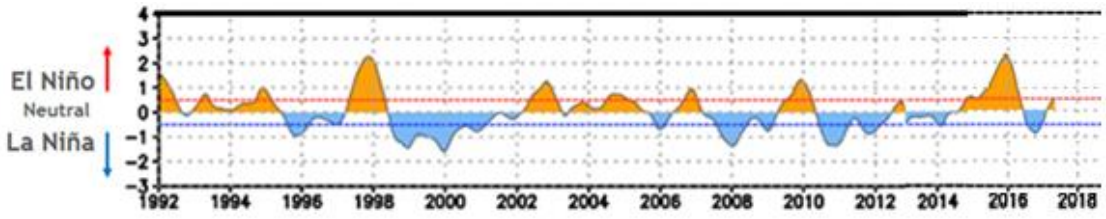


Figure 9. Oceanic Niño Index (ERSST. V4 ONI). Niño 3.4 SST (°C) Anomalies 1992-2017. Source: NOAA.

Similar to the previous year, for the case of the jack mackerel fishery, during the first semester of 2017, a large presence of juvenile in catches associated with a higher availability of the resource in areas near the coast. This same behavior of jack mackerel was also corroborated with the research project of the jack mackerel hydroacoustic assessment North area 2017, conducted in March 2017. It concentrated a high abundance of jack mackerel in the coastal area associated to patches of colder waters.