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Peru’s Annual report Part II: the Peruvian fishery in National Jurisdictional Waters

Ministrio de la Producción

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Peru National Report Nº 2

PERU

NATIONAL REPORT ON THE SITUATION OF THE PERUVIAN STOCK OF JACK MACKEREL (FAR-NORTH STOCK) AND THE PERUVIAN FISHERY IN NATIONAL JURISDICTIONAL WATERS

2015

SUMMARY

This report updates information on the biology and fishery of the Jack mackerel (*Trachurus murphyi*) in Peru presented in previous Scientific Committee meetings. A weak El Niño developed during 2014 and a moderate to strong one developed during the first part of 2015. During 2014 and particularly during 2015 Jack mackerel concentrations were only found in coastal areas, within 20 and some times within 10 nm from the coast. This change in the spatial distribution is related to the closeness to the coast of the Subtropical Surface Waters and the almost disappearance of the mixed layer with Cold Coastal Waters. In 2014 the Jack mackerel landings in Peru by all fleets was 74,528 t. No catches of Jack mackerel have been reported by the industrial purse seine fleet during the first semester of 2015 and the only catches of this species in Peruvian waters during the first semester of 2015 are the almost 13,000 t caught by the artisanal and small scale fleets. Several modal groups of Jack mackerel were observed in the fishery between January and May 2014, with a predominance of adults with modal lengths between 31 and 34 cm total length. Jack mackerel ranging from 15 to 37 cm TL were observed from September 2014 to May 2015, with a predominate of fish with modal sizes between 25 and 31 cm TL and a higher incidence of juveniles (smaller than 31 cm TL). The estimated TAC for 2015 using the JJM model assuming a risk of 16% that the projected biomass to January 1st 2016 be lower than that estimated for 2015 was 96,000 t and this was the TAC included in the recommendations to the Government, which also included a proposal for an intensified monitoring of the fishery and of the environmental conditions to ensure early detection of possible stock and environmental changes. This IMARPE recommendation was accepted by the Government and was included in the R.M. N° 003-2015-PRODUCE of 6 January 2015, which sets the total allowable catch (TAC) to be taken between January and December 2015.

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1 INTRODUCTION

This report updates information already provided by the Peruvian delegation on the occasion of the 11th Meeting of the SPRFMO Science Working Group held in 2012 and the 1st and 2nd meetings of the SPRFMO Scientific Committee held in 2013 and 2014 (IMARPE-PRODUCE 2012, 2012a, 2013, 2014) and in IMARPE's publication on the biology and fishery of the Jack mackerel (*Trachurus murphyi*) in Peru (Csirke et al, 2013).

Warmer than normal environmental conditions compatible with weak to moderate El Niño have prevailed off Peru during part of 2014 and most of first semester of 2015, and during this period the abundance indexes and catches of Jack mackerel in Peruvian jurisdictional waters continued to be low. Nevertheless, the few recent observations confirm or fit well within the known characteristics of large year-to-year variability and other features of the marine environment and the fish abundance and biology in the Peruvian Humboldt Current System described by various authors (Jordan, 1983; Zuta *et al*., 1983; Serra, 1983, 1991; Csirke, 1995; Bertrand *et al*., 2008; Chavez *et al*., 2008; Checkley *et al*., 2009; Espino, 2013; Flores *et al*., 2013), as well as with the prevailing hypothesis that "*Jack mackerel caught off the coasts of Peru and Chile each constitute separate stocks which straddle the high seas*" (SPRFMO 2008). As noted in earlier reports, the existence of two or more stocks or subpopulations of Jack mackerel *T. murphyi* in the Southeast Pacific (Serra 1991; Arcos and Grechina 1994; SPRFMO 2008; Gerlotto *et al*. 2010, 2012; IMARPE-PRODUCE, 2012a, 2013; Csirke *et al*., 2013) is to a great extent supported by the continued presence of resident stocks comprising all life history stages of Jack mackerel off Chile and off Peru, as well as by the differences in some important features and characteristics between the Peruvian (far-north) stock and the more southern Chilean stock, including differences in growth rate, reproduction patterns and seasonality, size and age at first maturity, spawning areas, environmental preferences, etc., which may suggest that Jack mackerel off Peru may have developed some adaptations to the more variable environmental conditions prevailing in the Northern Humboldt Current System.

2 THE MARINE ENVIRONMENT

A weak El Niño developed during 2014 and a moderate to strong one developed during the first part of 2015. During the first half of 2015 the sea surface temperatures showed a substantial increase with respect to the last period of 2014. Warm waters from the West and from the North (Gulf of Guayaquil) and the arrival of at least two Kelvin waves created warmer than normal conditions along almost the entire Peruvian coast. Towards the end of the first semester of 2015 the conditions were completely warm along the northern coast with surface temperature anomalies exceeding +2.0°C and some spots exceeding +4°C off Talara (04°34'S) (Figure 1).

At the beginning of 2015 the mixed waters of the oceanic front between Cold Coastal Waters and Equatorial Surface Waters was within the 30 nm from Punta Aguja (05°54'S) and the mixed front between Cold Coastal Waters and Sub-tropical Surface Waters was within the 10 nm between Paita (05°00'S) and Chimbote (09°00'S). The salinity and temperature water distribution confirmed the intrusion of Equatorial Waters at 50 nm off Paita (05°00'S), while

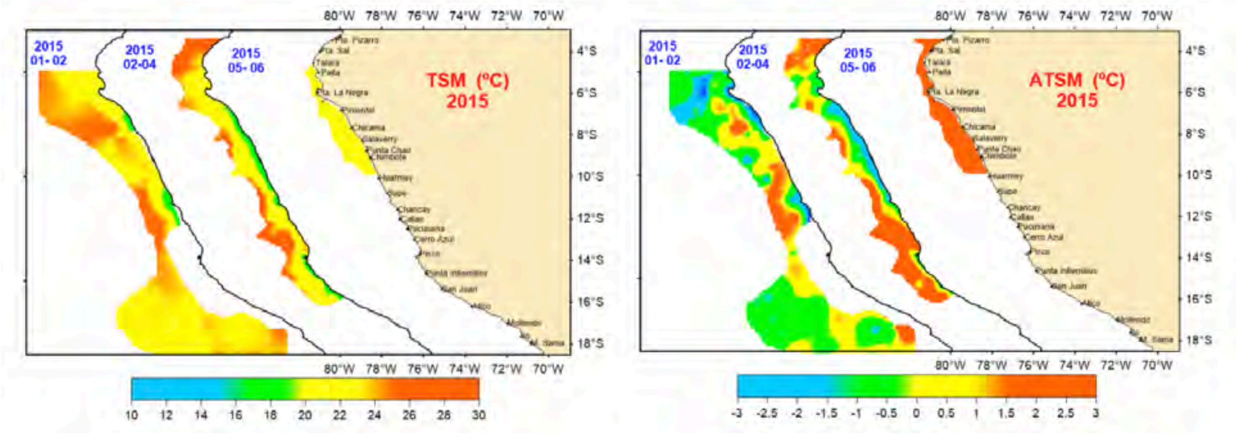

Figure 1.- Surface water temperature (TSM) and anomaly of the surface water temperature (ATSM) in °C, off Peru during the first semester of 2015

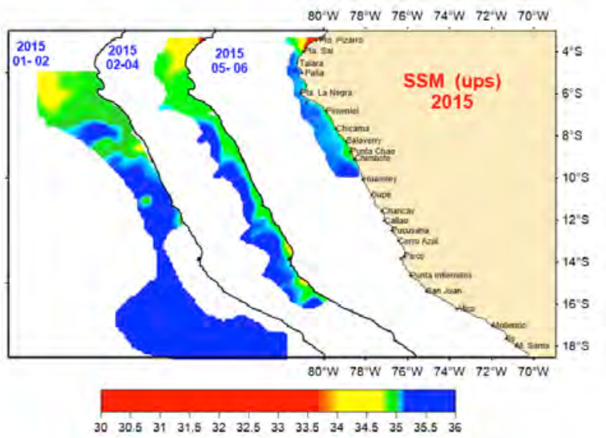

Figure 2.- Surface salinity (SSM) in ups off Peru during the first semester of 2015

Subtropical Surface Waters were found at 20 nm from the coast off Chicama (07°50'S) and on the coastline south of Punta Chao (08°45'S). Halfway through the first semester of 2015 the Subtropical Surface Waters were within 20 nm from the coast and approaching the 10 nm from the coast in some areas between Pimentel (06°50′S) and Huarmey (10°04'S), while the Equatorial Waters approached the coastline between Paita (05°00'S) and Puerto Pizarro (03°30'S) where there was also some presence of Surface Tropical Waters (Figure 2). By the end of the first semester of 2015 the presence of masses was more uniform, with salinity values higher than 35.05 ups associated with Subtropical Surface Waters beyond the 5 nm from the coast, with Surface Tropical Waters and Equatorial Waters to the North of Talara (4°34'S).

The El Niño Coastal Index (ICEN) (Figure 3) categorizes short-term environmental conditions such as El Niño (EN) and La Niña (LN) and is calculated as the three-month moving average of the anomalies of sea surface temperature in the El Niño 1+2 region (between 00-10°S and 90°-80°W) in the Equatorial Pacific taking as reference the monthly mean sea surface temperature pattern of 1981-2010. This index clearly shows the development of El Niño and La Niña in the Southeastern Eastern Pacific. A similar index based on SST records from IMARPE's coastal stations in Figure 4 shows the more coastal development of El Niño and La Niña conditions along the Peruvian

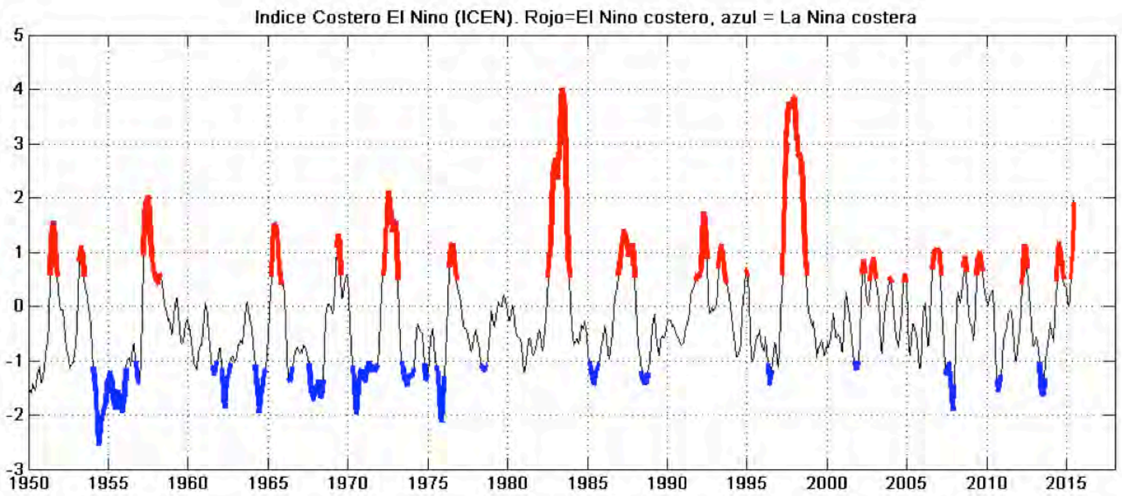

Figure 3.- Monthly thermic anomalies (°C) based on the Coastal Index of El Niño (ICEN) in the El Niño 1+2 region off Peru, years 1950-2015. El Niño (EN) conditions highlighted in red and La Niña (LN) conditions highlighted in blue. The anomalies are referred to a 30-year (1981-2010) monthly mean pattern

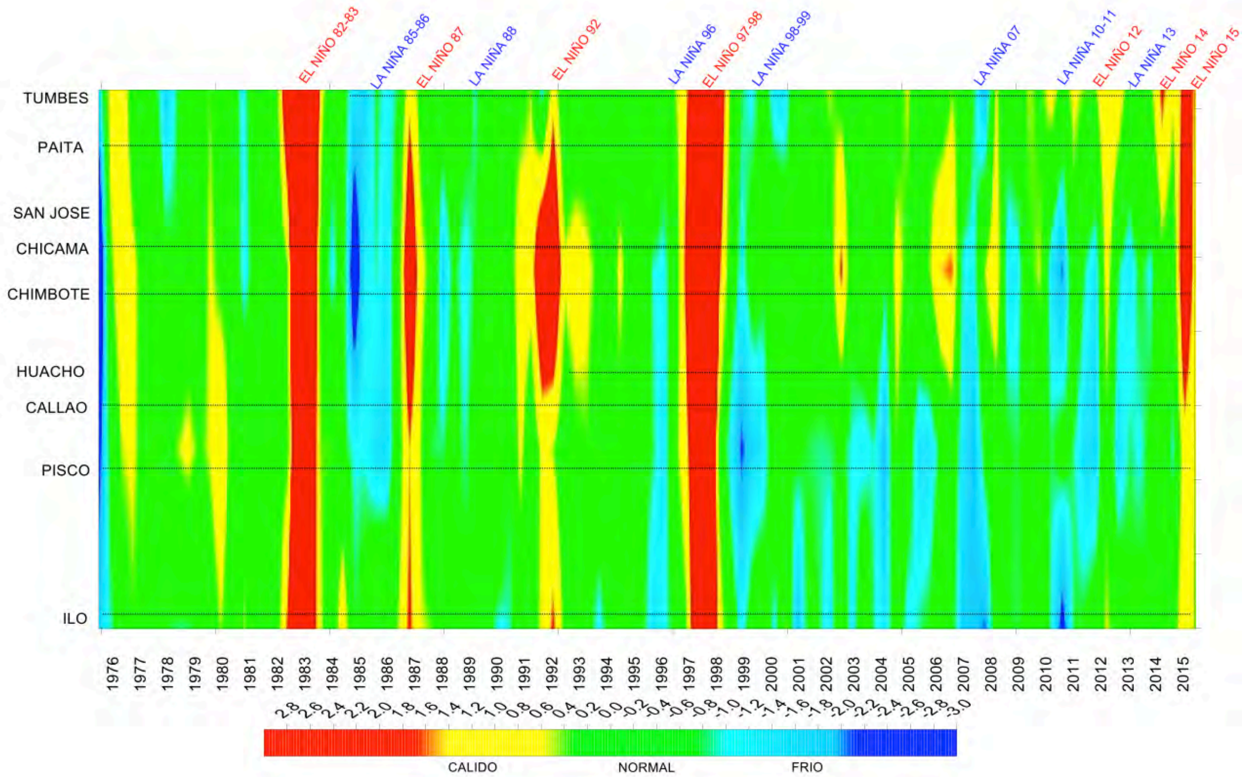

Figure 4.- Sea Surface Temperature Anomalies (°C) from IMARPE´s Coastal Stations, by latitude along the entire Peruvian coast, years 1976–2015

coast in recent years, including the evolution of the weak El Niño 2014 as well as the strong El Niño 2015.

3 CHARACTERIZATION OF THE STOCK

As noted in earlier reports, there are evidences of life cycle adaptations of the Peruvian stock of Jack mackerel (*Trachurus murphyi*) to the multi-scale natural environmental fluctuations typical of the Peruvian Humboldt Current System. Also, it is worth noting that the identification of the main biological and behavioral responses to these changing driving environmental forces may help explaining the observed dynamics of Jack mackerel in Peruvian jurisdictional waters and the adjacent high seas. Therefore, after the brief description of the most recent environmental conditions in the previous section, this section will focus on reporting on the main biological and behavioral observations since last years report.

3.1 Spatial distribution

As noted by Santander and Flores (1983) and Dioses (1995, 2013b), the preferred habitat of the Jack mackerel off Peru is represented by the mixed waters of the oceanic front formed by the encounter of Subtropical Surface Waters and Colder Coastal Waters, and most of the changes in the abundance and in the inshore-offshore and vertical distribution of the main Jack mackerel concentrations seem to be well explained by the observed changes in this oceanic front.

Furthermore, off Peru the Jack mackerel seems to be adapted to waters masses slightly warmer (above 15°C) than further south since off Peru the depth of isotherm of 15°C is usually associated to the oxygen isocline of 1 mL/L, and this minimum content of oxygen is one of the key factors limiting the vertical distribution of the Jack mackerel shoals. Off Peru, the water columns with these characteristics usually reach depths of 20-30 m close to the coast and depths of 80-100m at 90nm from the coast, and are within these water masses and distance from the coast where the best fishing grounds for the Peruvian purse seiners fishing for Jack mackerel usually occur.

However, the warmer El Niño conditions in 2014 and mainly in 2015 caused a displacement of the Jack mackerel concentrations. Particularly during 2015, Jack mackerel concentrations were only found in coastal areas, within 20 and some times within 10 nm from the coast, within reach of the artisanal and small scale fleet (Figure 10) but outside the traditional fishing grounds of the industrial purse seine fleet. This change in the spatial distribution of Jack mackerel in 2014 and particularly 2015 is closely related to the closeness to the coast of the Subtropical Surface Waters and the almost disappearance of the mixed layer with Cold Coastal Waters.

3.2 Age and growth

The few age readings and length frequency distributions observed during 2014 and 2015 fall within the range of observations and growth estimates described by Dioses (1995, 2013a), Goicochea *et al*. (2013) and Diaz (2013), and the parameters of the von Bertalanffy growth function, where: L_∞ = 80.77 cm total length, k= 0.1553 y^{-1} and t_o = -0.3562.

3.3 Reproductive aspects

The long-term analysis of the Gonadosomatic Index of the Peruvian Jack mackerel (Perea *et al* 2013) shows that the intensity of the reproduction process has been relatively low in recent years (Figure 5), with pulses well below the 2002-2012 mean values (taken as standard) during the spawning seasons of 2008-2009, 2009-2010 and 2011-2012; values slightly below the standard mean values during the spawning seasons of 2010-2011 and 2013-2014; pulses noticeably above but out of phase of the standard mean values in September 2007, February-March 2010, May 2011, February and June 2012, April-May

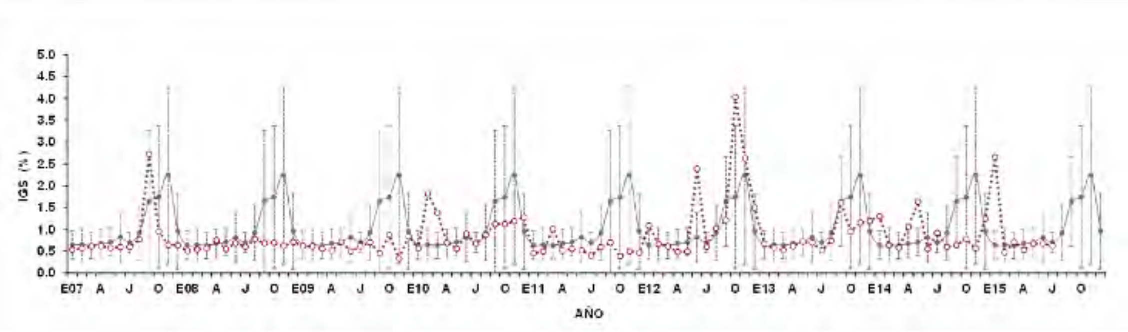

Figure 5.- Monthly variability of the Gonadosomatic Index of Jack mackerel in Peruvian jurisdictional waters, 2007-2015. The grey dots and vertical lines are the monthly means and their respective standard deviations of 2002-2012, taken as the standard. The red circles are the actual observed monthly values from January 2007 to July 2015

2014 and January 2015; and, a strong pulse well above the mean standard during the August 2012-January 2013 spawning season.

3.4 Trophic relationships

The updated information on food content based on the work by Alegre *et al*. (2013, 2015) confirms the great diversity of preys in the diet of Jack mackerel, with a clear predominance of euphausids (Figure 6). It is worth noting the stronger dominance of euphausids in the diet of Jack mackerel during the warmer period of 1977-2000 and the more diversified diet during the slightly colder period starting in 2001. Euphausids are still an important component of the Jack mackerel diet in recent slightly colder years but there is an increased presence of other species, specially zoeas and squat lobster (*Pleuroncodes monodon*).

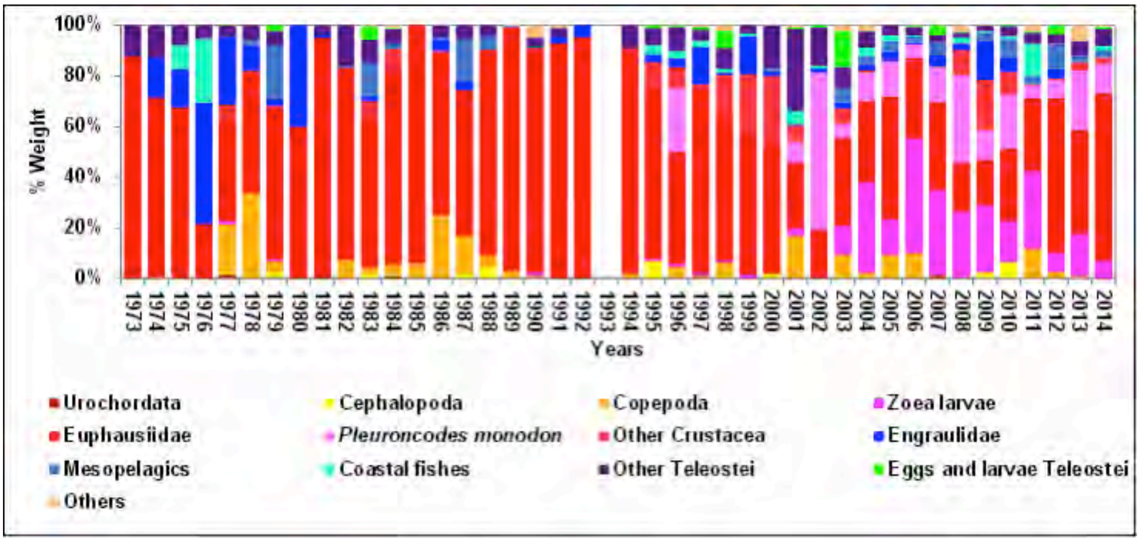

Figure 6.- Proportion of prey in stomachs of Jack mackerel *Trachurus murphyi* off Peru from 1973 to 2014 (updated from Alegre *et al.* 2013, 2015)

4 DESCRIPTION OF THE FISHERY

Over the past ten years Jack mackerel ranked third in importance by volume, after anchoveta and jumbo squid (Ñiquen et al., 2013), and in 2014 it has maintained this position at national level. There are basically three national fleets that fish for Jack mackerel in Peruvian jurisdictional waters. An industrial purse seine fleet that also targets mackerel and participates in the anchoveta fishery, and an artisanal and a small scale fishery that is more opportunistic and targets a large variety of species depending on their availability and market demand.

The Peruvian industrial purse seiner fleet targeting on Jack mackerel in Peruvian jurisdictional waters mostly operates within the 100 nm from the coast. In 2014 this fleet was of 104 industrial purse seiners with a total hold capacity of 33,359m^3; of which 62 were steel (30,177m^3 total hold capacity) and 42 were wood (3,082m^3 total hold capacity). Although their catches are highly variable, there is also an important participation of the artisanal and small scale fleets in the Jack mackerel fishery. The artisanal fleet is composed of around 500 boats with an average hold capacity of 8 m^3 and the small scale fleet is composed of around 100 small vessels with and average hold capacity of 12 m^3.

4.1 Catch trends

During the last ten years, Peruvian landings of Jack mackerel have not exceeded 300 thousand tons per year, with pulses of low landings in 2010 and 2014 and higher landings in 2006 and 2011 (Figure 7) and in 2014 the Jack mackerel landings by all fleets was 74,528 t, a value slightly lower than in 2013.

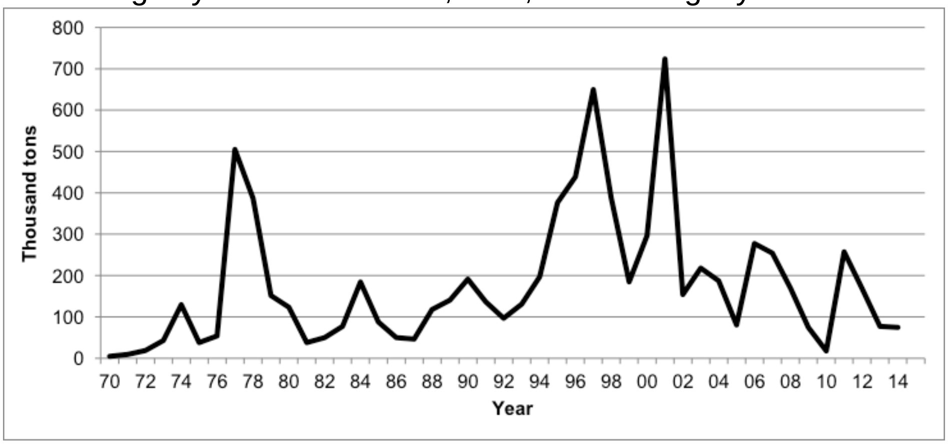

Figure 7.- Annual landings of Jack mackerel *T. murphyi* in Peru, years 1970-2014.

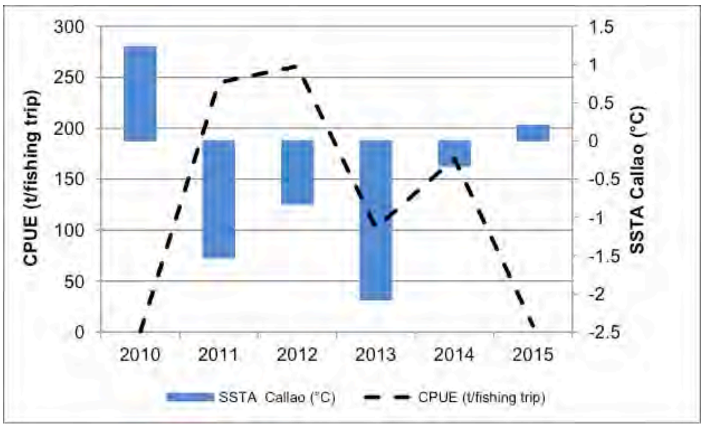

Figure 8.- CPUE index (t/trip) of Jack mackerel (*T. murphyi*) by the industrial purse seine fleet (dashed line) and Sea Surface Temperature Anomaly in Callao (solid bars) during January-April, years 2010 to 2015

The catch per unit effort (CPUE) index for the period 2010-2015 based on the Jack mackerel catches of the industrial purse seine fleet by their number of trips during January-April of each year shows an irregular behavior with a minimums in 2010 and 2015 and maximum in 2012 (Figure 8). The comparison of this CPUE index with the anomalies of the sea surface temperature in Callao (12°S) suggest a mild tendency for the CPUE to increases when the sea surface temperature anomaly varies between 0 and -1.5, while at positive anomalies or more extreme negative anomalies the CPUE index decreases.

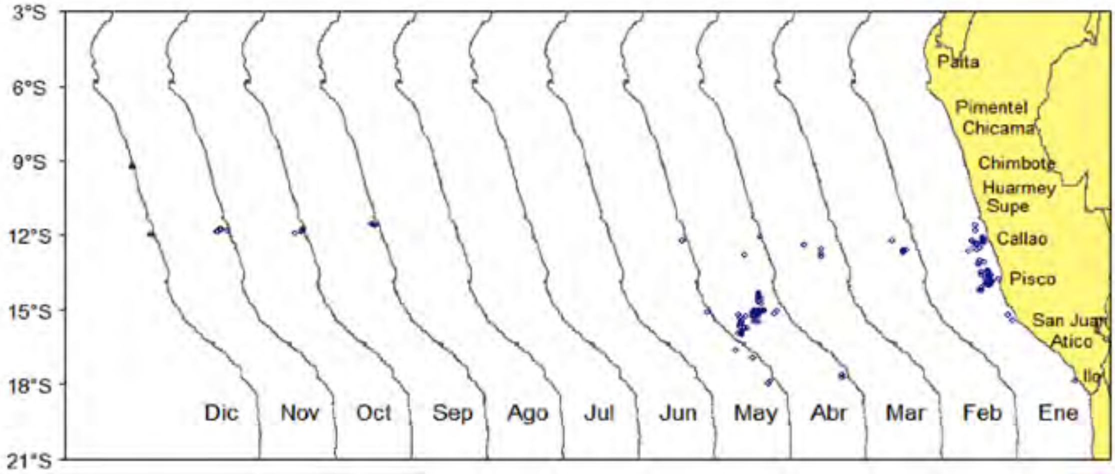

Figure 9.- Distribution of Jack mackerel fishing areas in Peru during January-December 2014

The distribution of Jack mackerel catches by the industrial purse seine fleet during January-December 2014 (Figure 9) was restricted to a coastal area within the first 30 nm from the coast between Huarmey (10°00'S) and Bahia Independencia (15°00'S); except for January 2014 when catches were made within 40 nm from the coast and April 2014 when there were catches as far as 120 nm from the coast off Atico (16°00'S). The few catches made in spring (September-December 2014) were located close to the coast off Callao (12°00'S).

No catches of Jack mackerel have been reported by the industrial purse seine fleet during the first semester of 2015. In January 2015 the industrial purse seine fleet actively searched for suitable concentrations of Jack mackerel between Pimentel (06°30'S) and Camana (16°30'S), but without success. No major attempts to catch jack mackerel were made by this fleet later in the semester. The only catches of Jack mackerel reported in Peruvian waters during the first semester of 2015 are those of the artisanal and small scale fleets. These two fleets caught almost 13,000 t during the first semester of 2015

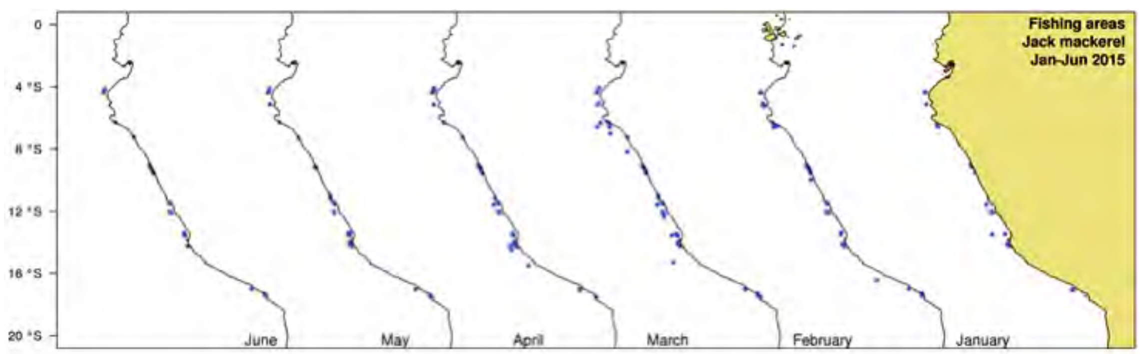

Figure 10.- Distribution of Jack mackerel fishing areas in Peru during January-June 2015

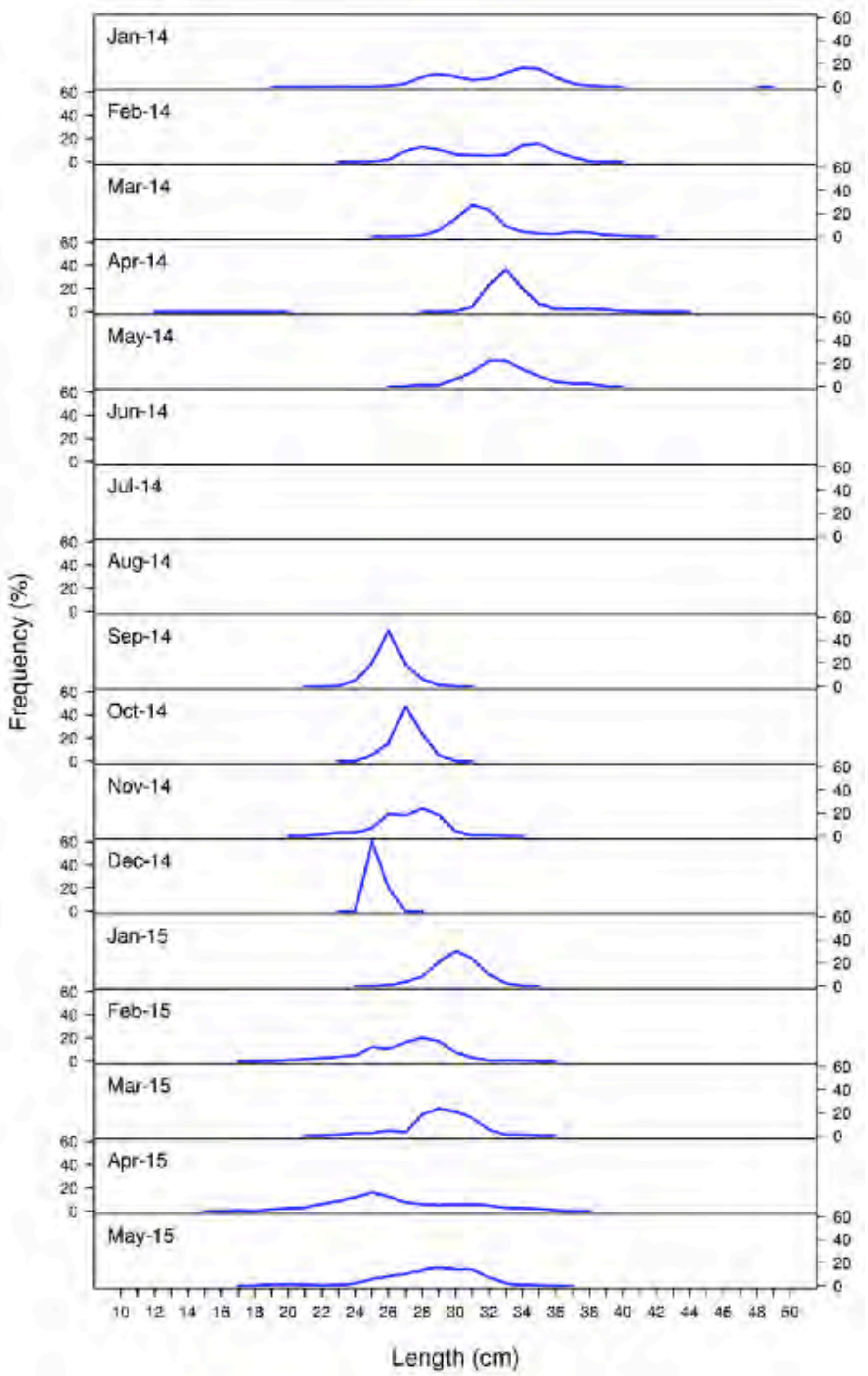

Figure 11.- Size frequency distribution of Jack mackerel (*T. murphyi*) caught in Peruvian jurisdictional waters by all fleets by month between January 2014 and May 2015

and their main fishing areas were very near to the coast, mainly between Talara (04°00'S) and Morro Sama (17°30'S) (Figure 10).

4.2 Size structure

Several modal groups of Jack mackerel were observed in the fishery between January and May 2014 with a predominance of adults with modal lengths between 31 and 34 cm total length and a secondary modal group of juveniles with 16 cm in April 2014 (Figure 11). This group of juveniles was also observed as part of the incidental catches of the anchoveta fishery during April-

June 2014 within 30 nm from the coast between in Chicama (07°30'S) and Cerro Azul (13°00'S).

Smaller Jack mackerel ranging from 15 to 37 cm TL are observed from September 2014 to May 2015 with a predominate of fish with modal sizes between 25 and 31 cm TL and a higher incidence of juveniles (smaller than 31 cm TL).

5 STOCK ASSESSMENT

A brief summary of the 2014 assessment of the Peruvian Jack mackerel stock (far-north stock) is presented here, together with the main results of the preliminary 2015 assessments done by IMARPE.

5.1 2014 assessment and TAC

In January 2015 IMARPE updated the 2014 Jack mackerel assessment in order to advice to the Vice-Ministry of Fisheries on the most current stock situation and the estimated Total Allowable Catch (TAC) for 2015. This assessment was based on the last version of JJM developed during the 2nd Meeting of the Scientific Committee held in Honolulu, Hawaii, U.S.A., in October 2014 (SPRFMO, 2014).

The stock size estimated at January 1st 2015 was further projected under several exploitation scenarios, each one related to a TAC and to a relative reduction of the fishing effort. For each case the fishing effort to be applied was estimated taking into account the risk that the biomass estimated at January 1st 2016 was lower than that estimated for 2015. Assuming a risk of 16% the estimated TAC was 96,000 t. This was the TAC included in the recommendations to the Government, which also included a proposal for an intensified monitoring of the fishery and of the environmental conditions to ensure early detection of possible stock and environmental changes.

5.2 2015 assessment

The main purpose of the 2015 assessment was a comparison between different configurations for the JJM model using different stock-recruitment regimes for the Peruvian Jack mackerel stock (far-north stock). Some modifications were made to the JJM model allow the flexibility to incorporate several regimes and one or more stocks. It is important to note that the modified JJM model runs flawlessly and reproduces the same results as the previous model.

5.2.1 Updated information used for 2015 assessment

Information about catch, catch at length and catch at age was updated to 2015. However CPUE from the Peruvian purse seine fleet targeting Jack mackerel and assumptions on selectivity, fishery independent data (acoustic biomass, standardized acoustic biomass and the echo-abundance), and biological data and parameters (sexual maturity, age and growth, weight at age and M) remained the same as in the 2014 model.

Catch and length compositions are routinely collected by the IMARPE´s Fisheries Monitoring System. Year length compositions were converted to ages using the age and growth parameters estimated by Dioses (2013). The CPUE (catch per trip) was estimated using GAM models where time (year, month), space (latitude, offshore distance) and size of vessels (represented by the hold capacity) were used as explanatory variables.

Three acoustic indices were used during the assessment. The first one is the *acoustic biomass*, which is directly estimated by summer surveys covering the coastal part of the Peruvian jurisdictional waters from the coastline to 100 nm from the coast. The second one is the *standardized acoustic index*, which aims at correcting the observed biomass by using the potential habitat of Jack mackerel. This index was estimated by modelling the presence and absence of Jack mackerel in the South-eastern Pacific from a series of environmental variables like Sea Surface Temperature (SST), Sea Surface Salinity (SSS), water masses (WM), oxycline depth (OD) and chlorophyll (CHL). The third index is the *echo-abundance*, estimated as the mean value of all the Nautical Area Backscattering Coefficients (S_A) recorded during the acoustic surveys. Since biomass estimation requires additional information like length frequencies, which sometimes have not been collected properly during these surveys, in this case it was assumed that the S_A was a better proxy of the actual abundance.

Regarding to biological data, sexual maturity at age was estimated from a length based ogive using the information described in Perea *et al.* (2013) and Dioses (2013). Weight at age matrix was estimated from the mid length at age, age and growth parameters and the length-weight relationship parameters estimated by year. More details are given in Table 1.

Table 1.- Data used in the 2015 assessment

Model	Description
Data update	
0.0	As 2014 configuration and data Indices: *echo-abundance* (cv=0.2) and CPUE (cv=0.2) Stock-recruitment relationship: recruits from 1970 to 2012 to scale (steepness=0.8, sigma R=0.6). One regime.
0.1	As in model 0.0 but with updated catch and length composition to 2015
Sensitivity to biomass indices	
1.0	As in model 0.1
1.1	As in model 1.0 but using the *standardized acoustic biomass index* (cv=0.2) instead of *echo-abundance*
1.2	As in model 1.0 but using the *acoustic biomass* (cv=0.2) instead of *echo-abundance*
Model configuration	
2.0	As in model 1.0
2.1	As in model 2.0 but two regimes: 1970 – 1996, 2001 – 2012. Break 2001
2.2	As in model 2.1 but estimate sigma R
2.3	As in model 2.1 but estimate steepness
2.4	As in model 2.1 but estimating sigma R and steepness

5.2.2 Joint Jack mackerel Model (JJM)

Several configurations were implemented in JJM during the 2015 assessment with the purpose of achieving the best representation of the population dynamics of the Peruvian Jack mackerel stock (far-north stock). These models started from a case base (configuration 2014, using *echo-abundance index* and CPUE from the industrial purse seine fishery) and were progressively implemented to consider: adding updated information (group 0 models), the individual use of indicators (group 1 models) and different assumptions on the recruitment and productivity of the stock, mainly attempting two stock-recruitment regimes (group 2 models). All these configurations are presented in Table 2.

Table 2.- Model configurations implemented during the 2015 assessment

Model	Description
Data update	
0.0	As 2014 configuration and data Indices: *echo-abundance* (cv=0.2) and CPUE (cv=0.2) Stock-recruitment relationship: recruits from 1970 to 2012 to scale (steepness=0.8, sigma R=0.6). One regime.
0.1	As in model 0.0 but with updated catch and length composition to 2015
Sensitivity to biomass indices	
1.0	As in model 0.1
1.1	As in model 1.0 but using the *standardized acoustic biomass index* (cv=0.2) instead of *echo-abundance*
1.2	As in model 1.0 but using the *acoustic biomass* (cv=0.2) instead of *echo-abundance*
Model configuration	
2.0	As in model 1.0
2.1	As in model 2.0 but two regimes: 1970 – 1996, 2001 – 2012. Break 2001
2.2	As in model 2.1 but estimate sigma R
2.3	As in model 2.1 but estimate steepness
2.4	As in model 2.1 but estimating sigma R and steepness

The addition of updated information, either age compositions and catches (group 0 models), did not result in a substantial change in the overall trend of the total biomass, being almost the same. Two periods with marked contrast of productivity were still observed. The first one with very high biomass observed during the 1980s and 1990s, and the second one with low biomass observed since 2000 (Figure 12a). Similarly, the mean value of fishing mortality estimated for years between 1970 and 2015 was very similar for the two configurations, as well as their distributions (Figure 12b).

Greater differences were observed for the second group of models (group 1 models) aimed to analyse the impact of the abundance indices available for the Peruvian stock (far-north stock). It was observed that the use of *acoustic biomass* instead of the *ecoabundance index* resulted in different levels of biomass in almost the whole series (Figure 12c). Mean values of fishing mortality as well as their distribution estimated over the entire series were not similar, showing greater fishing mortality for the *acoustic biomass* (Figure 12d). The use of *standardized acoustic biomass index* instead of the *echo-abundance* resulted in very different values for total biomass, although the series trend for the period 1990-2015 seems to be the same, as well as for the *acoustic biomass*. The resulting values of fishing mortality are almost the same of the *acoustic biomass*.

When different assumptions on recruitment, productivity of the stock and the number of stock-recruitment regimes were considered (group 2 models), some differences are observed at the beginning of the series but no substantially differences in trends or magnitudes of the total biomass (Figure 12e) or fishing mortality (Figure 12f) are observed for the recent years except for an only a slight difference in 2015.

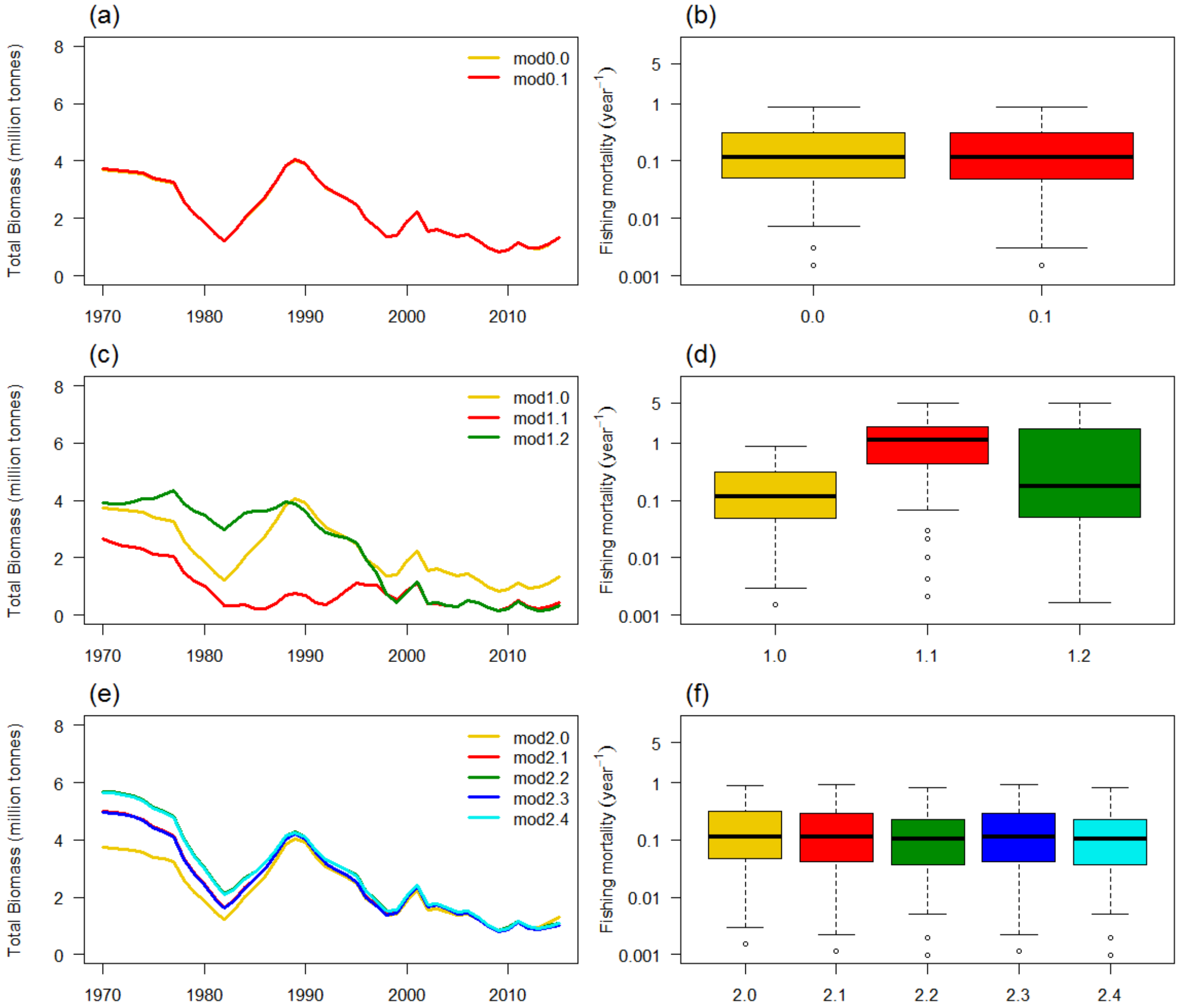

Figure 12.- Total biomass series (left panels) and yearly fishing mortality distribution (right panels) of the 2015 assessment estimated for: group 0 models (top panels, testing the sensitivity to updated data); group 1 models (middle panels, testing the sensitivity to indices); and, group 2 models (bottom panels, testing the sensitivity to assumptions on recruitment, productivity and stock-recruitment regimes)

Outputs of the final configuration showing the history and current situation of the Peruvian stock (far-north stock) are presented in Figure 13. According to this configuration the stock has passed through two regimes or stages of productivity, with high levels of total biomass during the 1990s and low levels at present. These levels have been represented by two stock-recruitment regimes (bottom panel in Figure 13), one regime from 1970 to 1996 and other from 2001 to 2012. The period 1997-2000 was not taken in account since high variability was observed for those years, mainly induced by El Niño 1997/1998. Current fishing mortality is not high enough to explain an unfished biomass similar to that for the 1990s.

6 FISHERIES MANAGEMENT REGULATIONS

The Peruvian General Fisheries Law (Legislative Decree N° 25977 of 21 December 1992) provides the legal framework for the development of all Peruvian fisheries and for the case of the Jack mackerel fishery in Peruvian jurisdictional waters the fisheries regulations and management measures are further specified by the “Bylaw for the management of Jack mackerel and

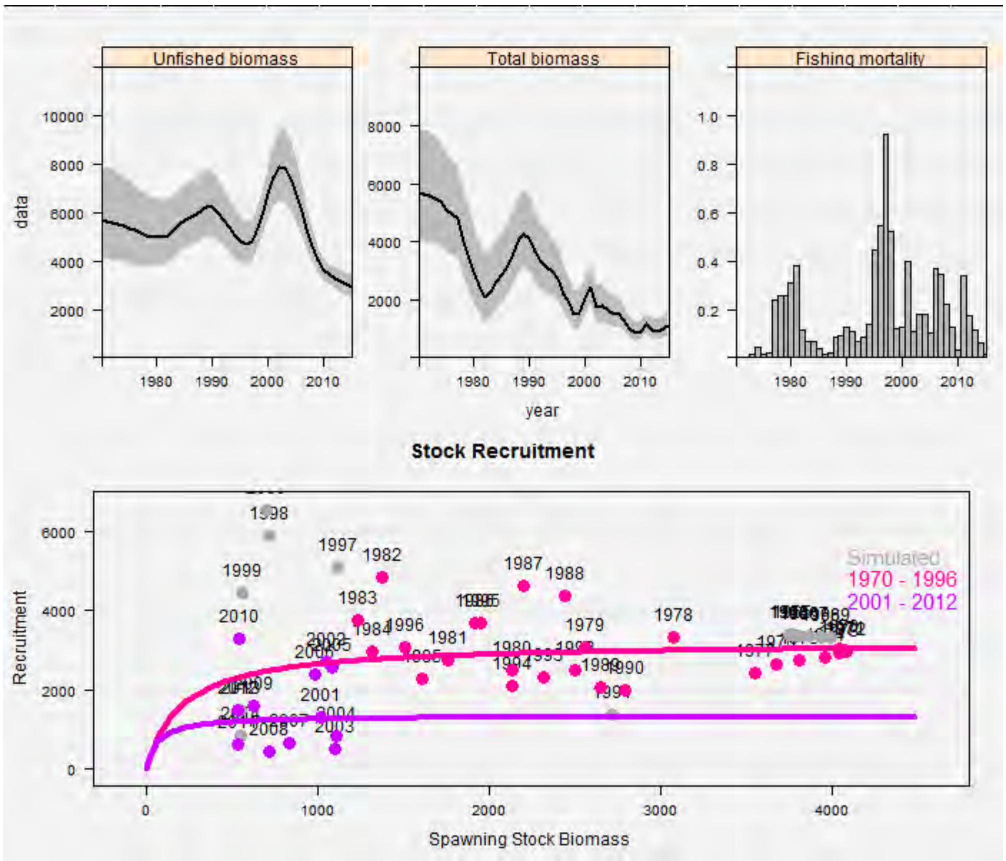

Figure 13.- Outputs of the final configuration of the 2015 assessment showing the history and current situation of the Peruvian Jack mackerel stock (far-north stock). Top panels: unfished biomass, total biomass and fishing mortality. Bottom panel: stock-recruitment showing two regimes, fro 1970-1996 and 2001-2012

mackerel" approved by the Supreme Decree 011-2007-PRODUCE of 12 April 2007. Among other measures, this bylaw establishes that catches of Jack mackerel and mackerel should only be used for direct human consumption, a minimum size in the catches of 31 cm in total length and other management measures that are described by Zuzunaga (2013) and IMARPE-PRODUCE (2012, 2013, 2014).

6.1 Fisheries management measures for Jack mackerel in 2014 and 2015

The main fisheries management measures and regulations of the Peruvian Jack mackerel fisheries adopted or that entered into force during 2014 and 2015 include:

R.M. N° 363-2013-PRODUCE, December 23, 2013. Sets the total allowable catch (TAC) for 2014, to be taken between January 16 and December 31, 2014, of 104,000 t for Jack mackerel (*Trachurus murphyi*) and 48,000 t for mackerel (*Scomber japonicus peruanus*).

R.M. N° 003-2015-PRODUCE, January 06, 2015. Sets the total allowable catch (TAC) for 2015, to be taken between January and December, 2015, of 96,000 t for Jack mackerel (*Trachurus murphyi*) and 44,000 t for mackerel (*Scomber japonicus peruanus*).

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