SPRFMO
South Pacific Regional Fisheries Management Organisation

7th MEETING OF THE SCIENTIFIC COMMITTEE

La Havana, Cuba, 7 to 12 October 2019

SC7-JM04

Notes on some biological aspects of Jack mackerel in Peruvian national waters during 2018-2019

Peru

IMARPE

South Pacific Regional Fisheries Management Organisation
2nd Squid Workshop and 7th Meeting of the Scientific Committee
La Havana, Cuba, 5-12 October 2019

NOTES ON SOME BIOLOGICAL ASPECTS OF JACK MACKEREL IN PERUVIAN NATIONAL WATERS DURING 2018-2019

by

Miguel Ñiquen, Ramiro Castillo,
Ana Alegre, Luis La Cruz, Marilu Bouchon and Martin Cornejo
Instituto del Mar del Perú (IMARPE)
Esquina Gamarra y Gerneral Valle s/n, Callao, Perú

2019

SUMMARY

The presence of Jack mackerel in Peruvian national waters during 2018 and 2019 has been highly variable. The highest abundance was observed between Pisco (14°S) and San Juan (15°S) in June 2019. A smaller concentration area was observed more to the south, off Punta Bombon (17°S). The main Jack mackerel fishing areas during April 2018 - March 2019 were located mainly from Callao (12°S) south (18°S) in areas with se surface thermal anomalies under 1°C. Towards the end of January 2019, higher concentration areas of Jack mackerel were found between 15° and 17°S, which led to the capture of 50 thousand tons in February 2019, the largest monthly catch of Jack mackerel in the last five years. Length-frequency distributions of Jack mackerel in August 2018 were bimodal, with a main mode in 29 cm total length (TL) and secondary mode in 35 cm TL, while in October-November 2018 was mostly unimodal, with modal size in 30-31 cm TL; same as in February 2019, but with modal size in 36 cm TL. There is a differentiated spatial distribution of Jack mackerel and jumbo flying squid, both at the latitudinal level and by distance from the coast. Likewise, this separation was also observed at the latitudinal level, there is a mismatch in centers of highest concentration of both species. During the same 2018-2019 period the estimated biomass abundance of both species followed opposite trends, with Jack mackerel increasing and jumbo flying squid decreasing. The schools of Jack mackerel were mainly found at the surface level and at the inner edge of the ocean front of mixed cold coastal waters (CCW) and surface subtropical waters (SSW), while the jumbo flying squid was found deeper and in the outer edge of this CCW-SSW ocean front.

TABLE OF CONTENTS

1. Introduction

Peruvian national waters are exposed to processes of environmental variability that affects the distribution and concentration of Jack mackerel (*Trachurus murphyi*), a transboundary fishery resource that develops its life cycle in areas inside and outside the 200 nautical miles from the coast. The changing environmental dynamics were very noticeable during 2018 and 2019 off Peru.

During the first half of 2018, cold oceanographic conditions, typical of a La Niña event, prevailed in Peruvian national waters; followed by a rapid move towards neutral conditions between July and September 2018, to quickly evolve from October 2018 onwards into warmer conditions, developing into a weak El Niño 2018-2019 that lasted until March 2019, to then evolve into neutral conditions throughout August 2019. These alternating warmer, colder and neutral environmental conditions of varying duration and intensity had caused noticeable changes in the availability of Jack mackerel in Peruvian national waters. Which, after a long period of reduced availability, allowed increased catches to be obtained from the second half of 2018 onwards.

This document analyzes and describes the variations in Jack mackerel biomass estimates, catches and fishing areas during the 2018 and 2019 in Peruvian national waters, including possible interactions with Jumbo flying squid (*Dosidicus gigas*), based on information recorded during acoustic research surveys carried out by the Instituto del Mar del Peru (IMARPE) as well as during IMARPE's regular Pelagic Fisheries Monitoring Program. Fisheries data obtained through this monitoring program and distribution, abundance and other information and data on the spatial and temporal distribution of Jack mackerel recorded during the following five acoustic research surveys carried out by IMARPE during 2018 and 2019 are examined:

(a) Pelagic resources hydroacoustic assessment survey, Cruise 1802-04, from 22 February to 6 April 2018 (IMARPE 2018);
(b) Jack mackerel and chub mackerel hydroacoustic assessment survey, Cruise 1803, from 2 to 31 March 2018 (IMARPE 2018a);
(c) Pelagic resources hydroacoustic assessment survey, Cruise 1809-11, from 27 September to 18 November 2018 (IMARPE 2018b);
(d) Pelagic resources hydroacoustic assessment survey, Cruise 1902-03, from 12 February to 27 March 2019 (IMARPE 2019); and,
(e) Jack mackerel and chub mackerel hydroacoustic assessment survey, Cruise 1905-06, from 20 May to 23 June 2019 (IMARPE 2019a).

The main objective of the pelagic resources hydroacoustic assessment surveys is to assess the biomass of anchoveta (*Engraulis ringens*). Therefore, the surveyed area is covered with a series of parallel transects 10 nm apart, perpendicular to the coastline, from 3-5 nm to at most 100 nm distance from the coast, although some profiles may be extended beyond that distance from the coast in special circumstances. While during the Jack mackerel and chub mackerel research surveys the transects are 20 nm apart and may cover varying distances, from 5 nm to 200 nm, depending on available information on the most likely distribution areas of the species being targeted by the research.

The surveys were carried out with IMARPE's scientific research vessels: R/V José Olaya Balandra, R/V Humboldt and/or R/V Flores Portugal, which are equipped with scientific echosounders Simrad EK80, oceanographic rosettes, fishing nets, and other relevant research equipment. The sampling design was systematic (parallel transects perpendicular to the coast) as described by Simmonds and MacLennan (2005).

2. Horizontal and vertical distribution of Jack mackerel

The presence and distribution of Jack mackerel during 2018 and 2019 has been highly variable. Two general horizontal distribution areas are identified, a larger northern-central area and a smaller

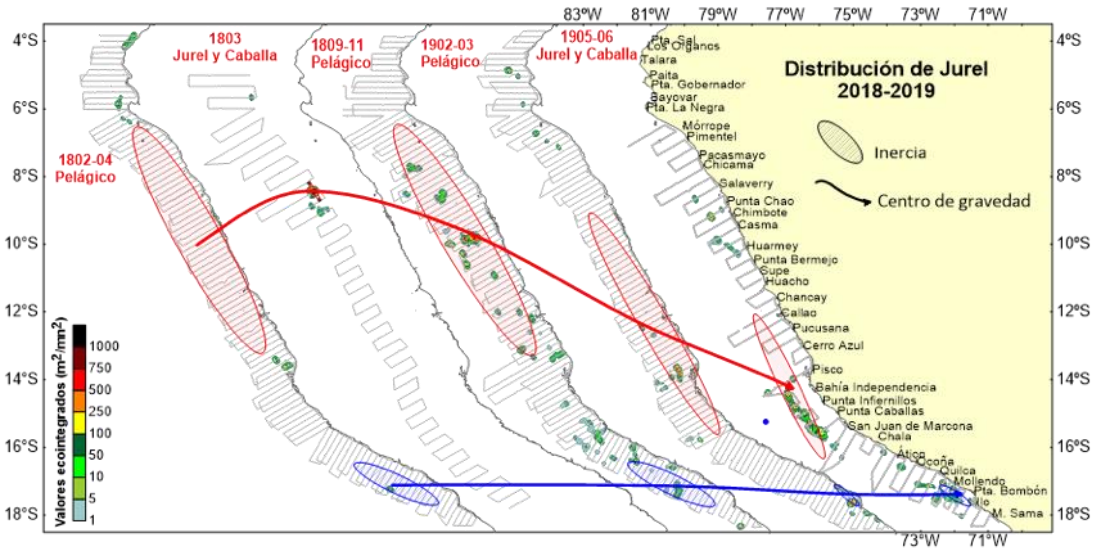

Figure 1.- Observed horizontal distribution of Jack mackerel (*Trachurus murphyi*) during five IMARPE acoustic surveys in 2018 and 2019, with inertia areas and centers of gravity for two general distribution areas. A northern-central area (red shaded area and red arrow) and a southern area (blue shaded area and blue arrow)

southern area (Figure 1). The centers of gravity of the northern-central distribution areas of Jack mackerel moved latitudinally between 8°S and 15°S in 2018-2019, and the best concentrations and highest abundance indices were found in a rather concentrated area off Pisco (14°S) and San Juan (15°S) in June 2019, during Cruise 1905-06. While in the southern area the center of gravity remained stable off Punta Bombon (17°S).

With regards to its vertical distribution, Jack mackerel was distributed within the 70 m surface layer, over a taller water column off Punta Sal (4°S) in February-March 2018 (Cr. 1802-04) and at higher latitudes from September 2018 onwards, with no significant differences between day and night (Figures 2 and 3).

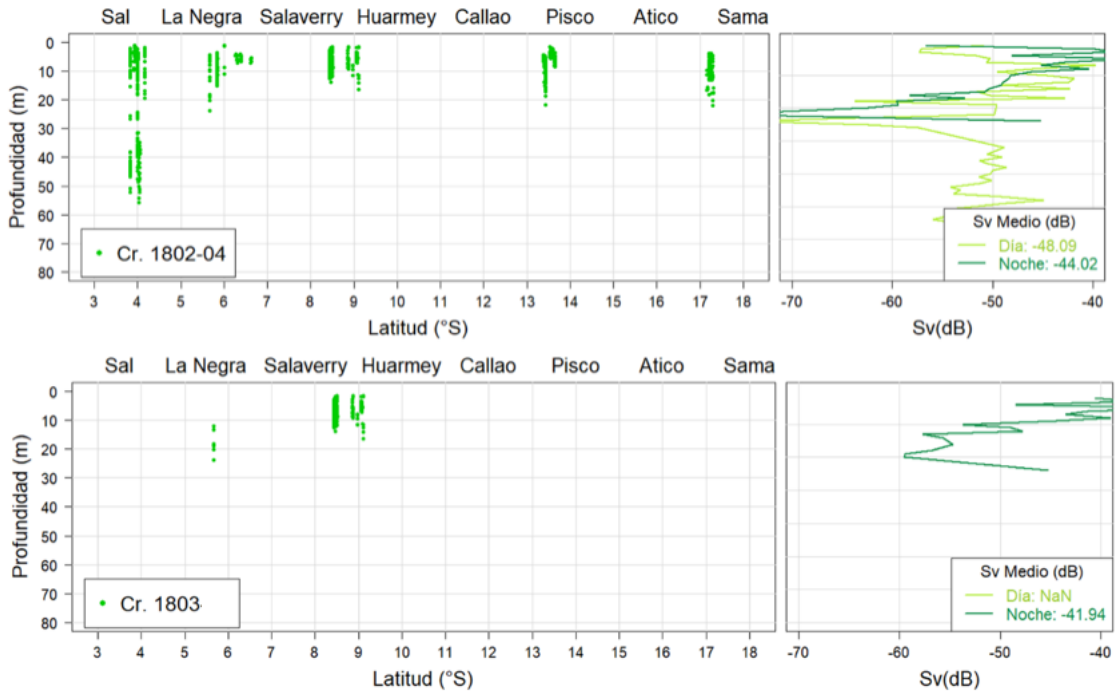

Figure 2.- Vertical distribution of Jack mackerel (*Trachurus murphyi*) concentrations by latitude (left panels, green dots), and mean vertical acoustic volume backscattering strength Sv(dB) (right panels) during day-time (light-green lines) and night-time (dark-green lines), observed during two acoustic surveys conducted by IMARPE between February and April 2018

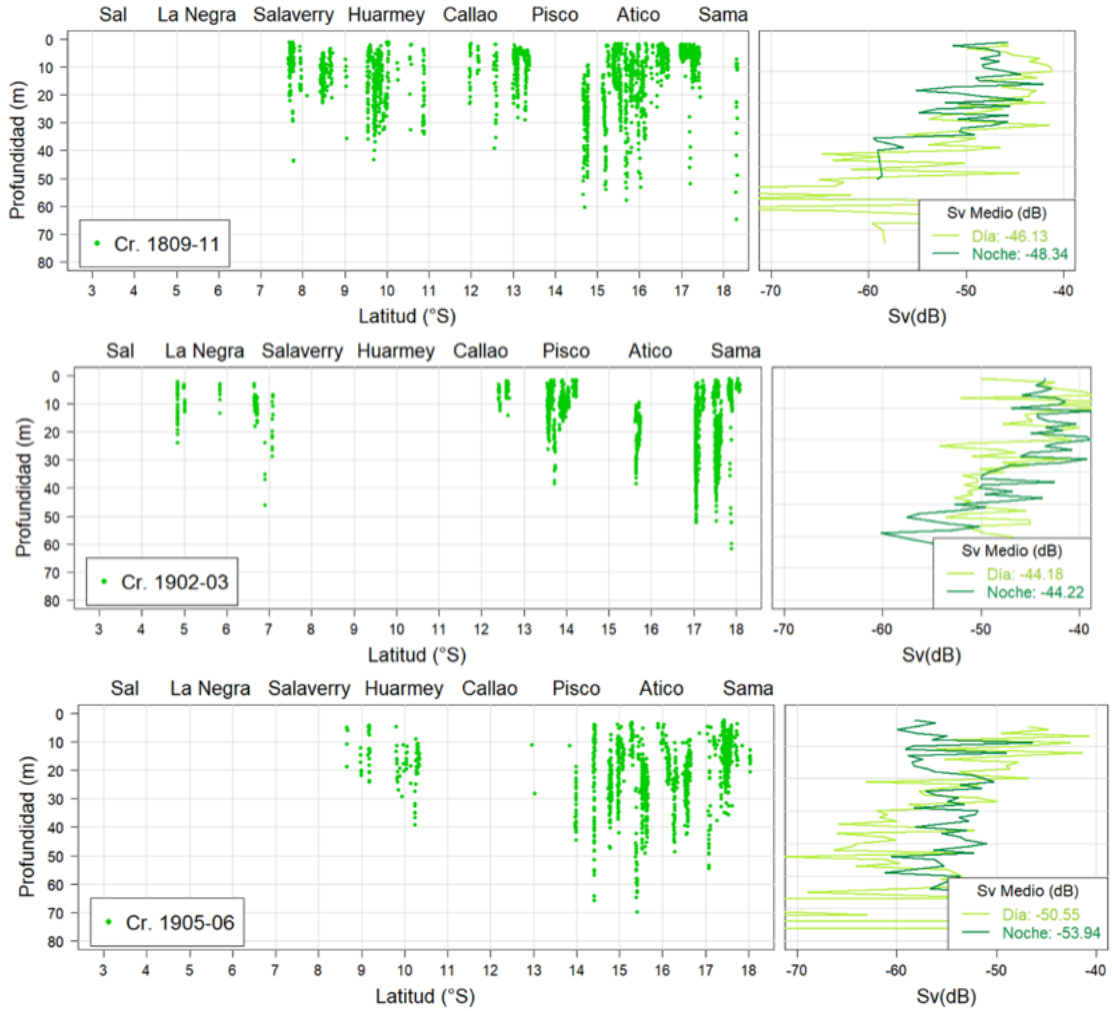

Figure 3.- Vertical distribution of Jack mackerel (*Trachurus murphyi*) concentrations by latitude (left panels, green dots), and mean vertical acoustic volume backscattering strength Sv(dB) (right panels) during day-time (light-green lines) and night-time (dark-green lines), observed during three acoustic surveys conducted by IMARPE between September 2018 and June 2019

3. Environmental conditions and Jack mackerel distribution

The available information on Jack mackerel fishing areas and daily sea surface temperature anomaly (SSTA) along a 60 nm coastal band along the whole Peruvian coast over a one-year period between 1 April 2018 and 31 March 2019 (Figure 4), shows that Jack mackerel was mostly caught to the south from Callao (12° to 18° S) in areas with thermal anomalies under 1°C. In fact, between April and July

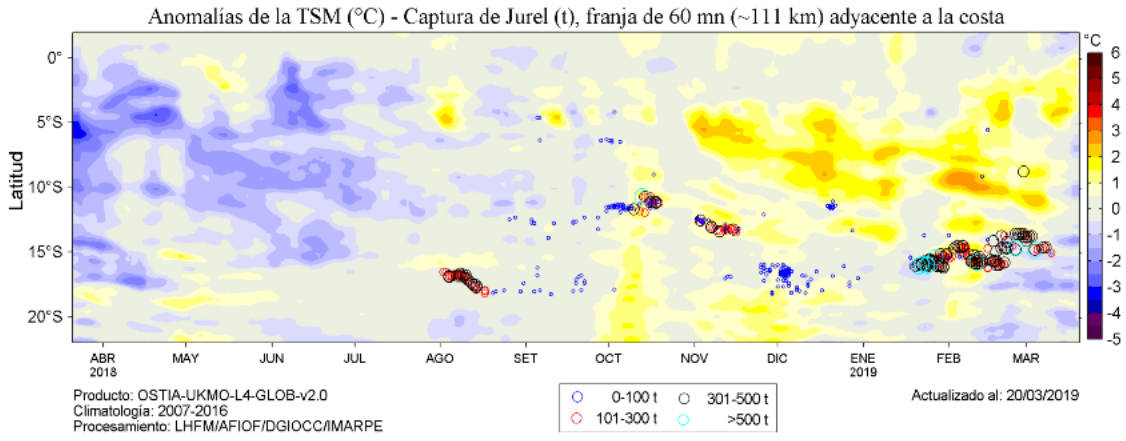

Figure 4.- Jack mackerel fishing areas and sea surface temperature anomalies (SSTA) within the 60 nm distance from the Peruvian coastline, by latitude and by day, between 1 April 2018 and 31 March 2019

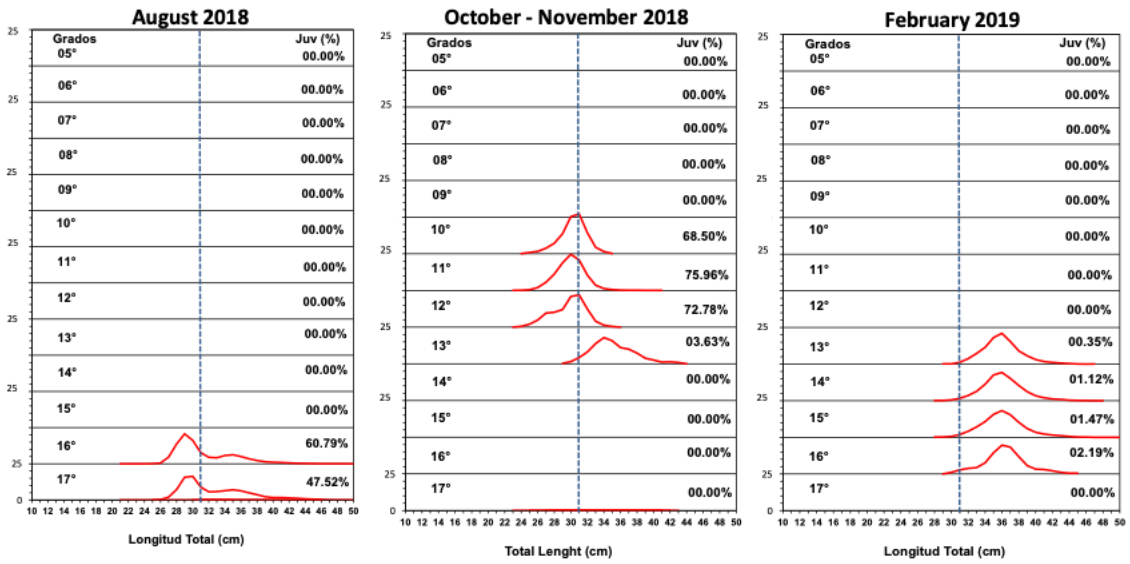

Figure 5.- Length-frequency distribution of Jack mackerel caught in Peruvian national waters, by latitude, in August and October-November 2018 and in February 2019.

2018 there was a generalized low availability of Jack mackerel associated with cold environmental conditions (SSTA lower than -1°C) throughout the whole area. While with the predominance of more neutral environmental conditions in the south in August 2018, some concentration of commercial interest show up between 16° and 18°S, and more concentrations were reported in October-November 2018 between 10° to 14°S. Larger and denser Jack mackerel concentrations were observed from the end of January 2019 onwards between 14° and 17°S, which led to the capture of 50 thousand tons of Jack mackerel in February 2019, the largest monthly catch of Jack mackerel obtained in the last five years.

The Jack mackerel concentrations observed during the commercial fishery at latitudes 16°-17°S in August 2018 had a bimodal length-frequency distribution, with a main modal size of 29 cm total length (TL) and secondary modal size of 35 cm TL (Figure 5). While in October-November 2018 the main concentrations observed at latitudes 10°-13°S presented mainly a unimodal size in 31 cm TL, and in February 2019 the main concentrations in latitudes latitude 13°-16°S were also unimodal, with modal size in 36 cm TL.

Jack mackerel length-frequency distributions observed during December 2018 and January 2019 through IMARPE's scientific research survey Cr. 1812-1901 and its regular fisheries monitoring program (Figure 6), provide evidence of a wide

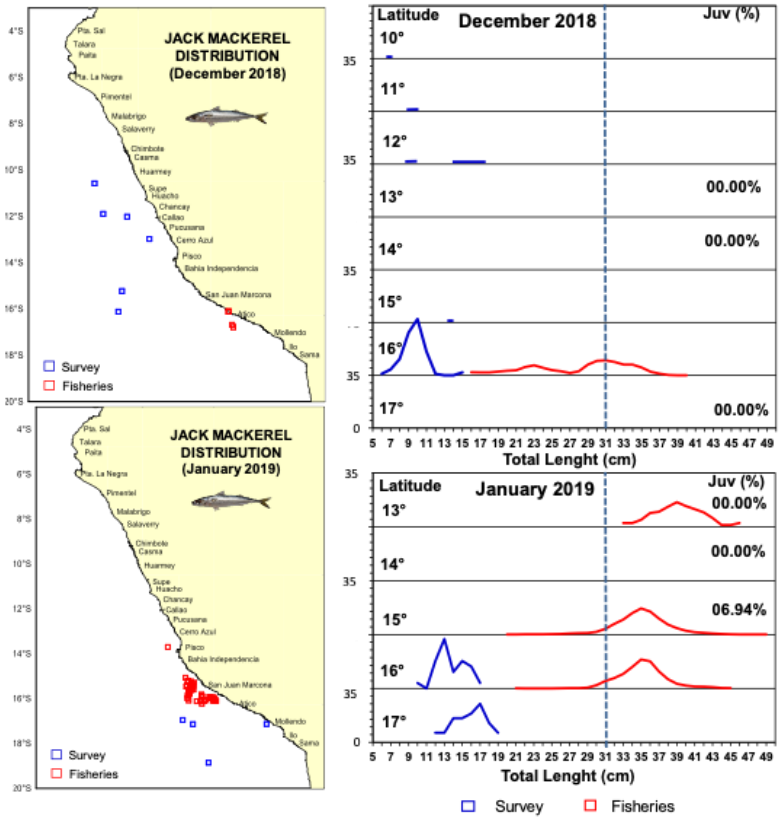

Figure 6.- Jack mackerel horizontal and length-frequency distributions observed during scientific research survey Cr. 1812-1901 (blue dots and lines) and the commercial fishery (red dots and lines) in December 2018 and January 2019

horizontal distribution of Jack mackerel in Peruvian national waters, particularly from latitude 10°S (Huarmey) to 18°S (Sama) and from very close to the coast to as far as 194 nm distance from the coast, off San Juan (15°S).

Several size-groups were observed over this wide distribution area in December 2018 and January 2019, with main modal sizes in 09, 13, 24, 31, 35 and 40 cm TL. It is noteworthy that, within similar latitudes, all these modal groups show a growth-like modal progression from December to January, and that the smaller Jack mackerels were caught in more oceanic farther off-shore areas by the research vessel during Cruise 1812-1901, while the larger Jack mackerels were caught by commercial fishing vessels during their regular fishing operations in more coastal areas.

4. Jack mackerel and jumbo flying squid differences in distribution and abundance

Side by side comparison of the distribution and concentration areas of Jack mackerel and jumbo flying squid observed during scientific research surveys carried out in summer and spring 2018 (Cruises 1802-04 and 1809-11) and summer 2019 (Cruse 1902-03) indicate that there is a differentiated spatial distribution of both resources, both at the latitudinal level and by distance from the coast (Figure 7).

Likewise, it is noted that, at the latitudinal level, there is a mismatch in centers of highest concentration of both species (Figure 8).

Also, during the same period, the estimated biomass abundance of both species followed opposite trends, with Jack mackerel increasing and jumbo flying squid decreasing (Figure 9).

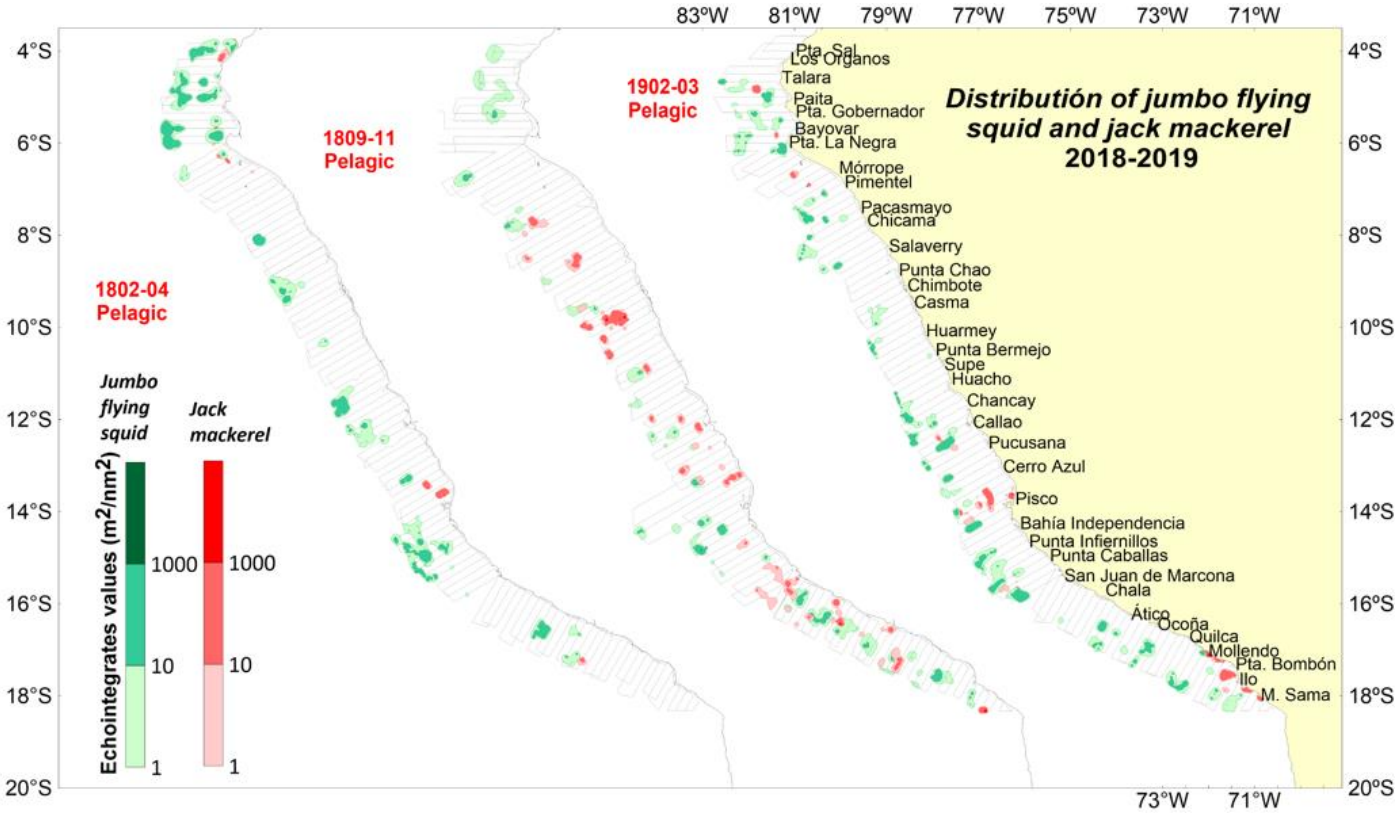

Figure 7.- Distribution and concentration areas of jumbo flying squid (green areas) and Jack mackerel (red areas) off Peru during scientific research surveys carried out in summer and spring 2018 (Cruises 1802-04 and 1809-11) and summer 2019 (Cruse 1902-03)

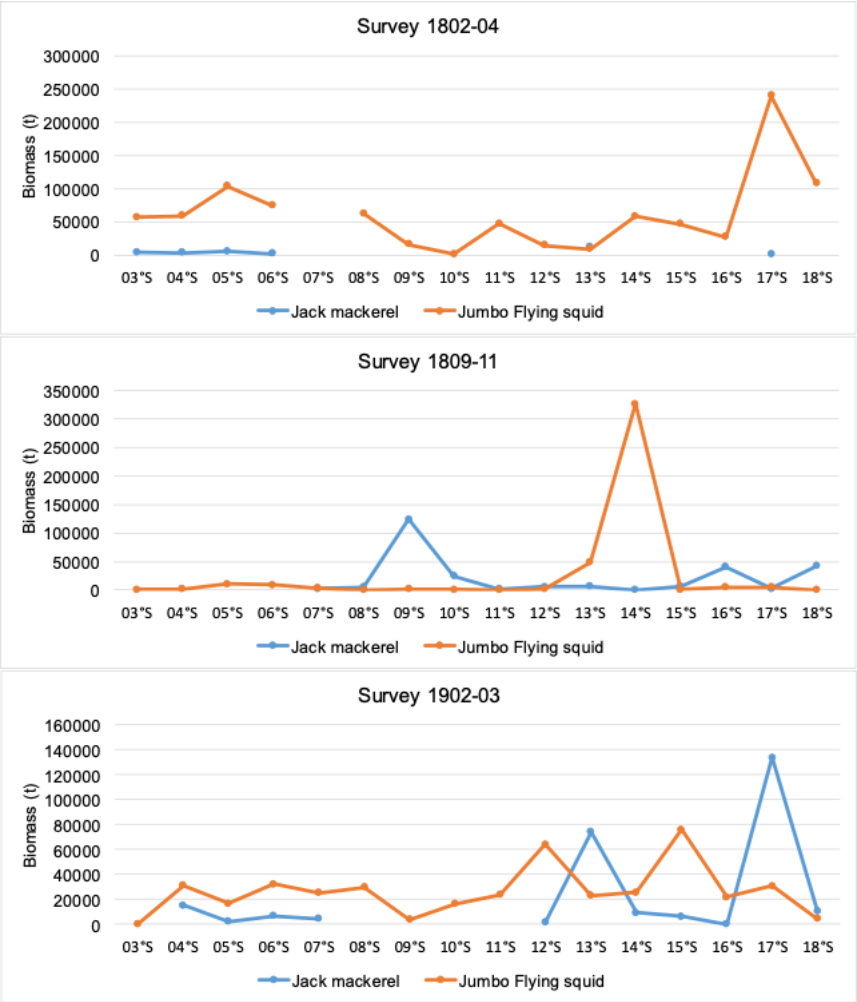

Figure 8.- Biomass of Jack mackerel and jumbo flying squid in Peruvian waters, by latitudinal degree, estimated during scientific research surveys conducted by IMARPE in 2018 and 2019

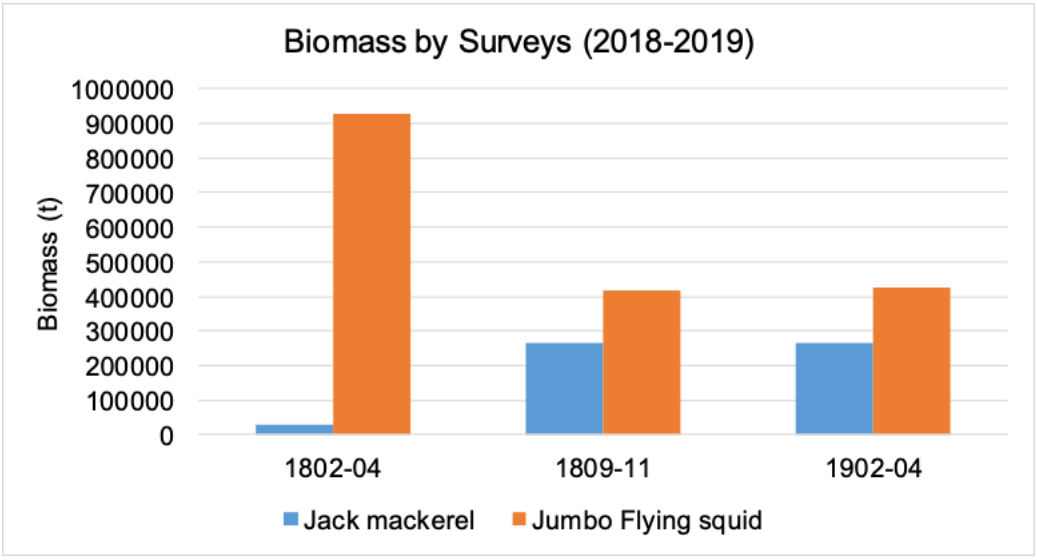

Figure 9.- Acoustic biomass of Jack mackerel and jumbo flying squid in Peruvian waters estimated through scientific research surveys conducted by IMARPE in 2018 and 2019

4.1. *Sea salinity and Jack mackerel and jumbo flying squid horizontal and vertical distribution*

The sea salinity is used as an indicator of the prevailing waters masses during 2018 and 2019, where cold coastal waters (CCW) are identified by lower salinities, typically between 34.8 and 35.0 ups, mixed water fronts by salinities between 35.0 and 35.1 ups, and surface subtropical waters (SSW) by salinities above 35.1 ups.

The observations made in March 2018 (during Cruise 1803) and June 2019 (during Cruise 1905-06) on the horizontal distribution of Jack mackerel and jumbo flying squid in relation to the sea surface salinity indicate a preference of Jack mackerel to be distributed near and on the inner edge of the ocean front formed by the cold coastal waters (CCW) and the surface subtropical waters (SSW). While jumbo flying squid was most frequently found on the outer edge of this front, with preference for the SSW (Figure 10).

Observations made during oceanographic profiles made In March 2018 during Cruise 1802-04 (Figure 11), show that off Chicama (7°S) there was a clear predominance of cold coastal waters (CCW) as far

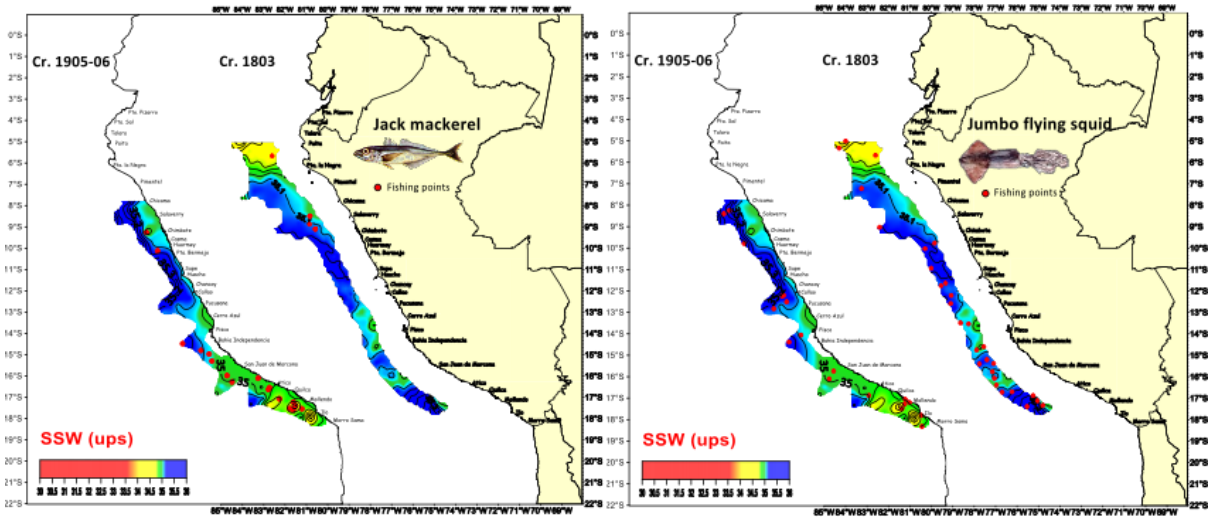

Figure 10.- Horizontal distribution of Jack mackerel and jumbo flying squid in relation to the sea surface salinity (SSS) observed in March 2018 (during Cruise 1803) and June 2019 (during Cruise 1905-06

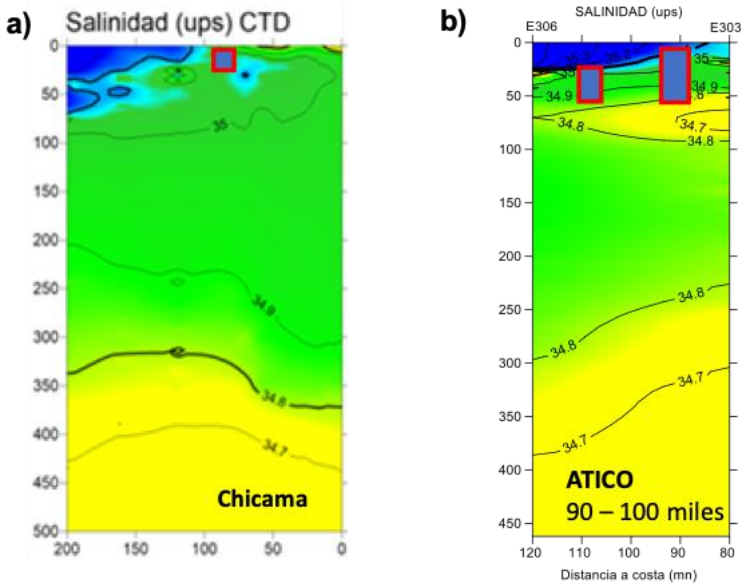

Figure 11.- Vertical distribution of Jack mackerel at 7°S, off Chicama (red square, left panel a) and of jumbo flying squid at 16°S, off Atico (red rectangles, right panel b), in relation to salinity and distance from the coast as observed in March 2018, during Cruise 1802-04

offshore as 80 nm from the coastline, with surface subtropical waters (SSW) at distances greater than 100 miles, in a surface layer 15 to 60 m deep and an ocean front of mixed waters masses, of CCW and SSW, just underneath. Jack mackerel schools were found at the surface level and at the inner edge of this ocean front (Figure 11a). While in the oceanographic profile off Atico (16°S), it is clear the presence SSW with high salinities, of 35.1 to 35.4 ups, dominating the surface layer from 0 to 60 m deep. In this scenario, jumbo flying squid was found at depths of 30 and 50 meters, on the outer edge of the ocean front where SSW mix with the CCW (Figure 11b).

5. References

IMARPE. 2018. Informe Ejecutivo Crucero de Evaluación Hidroacústica de Recursos Pelágicos 1802-04. Callao. Perú.

IMARPE. 2018a. Informe Ejecutivo Crucero de Evaluación Hidroacústica de Jurel y Caballa 1803. Callao. Perú.

IMARPE. 2018b. Informe Ejecutivo Crucero de Evaluación Hidroacústica de Recursos Pelágicos 1809-11. Callao. Perú.

IMARPE. 2019. Informe Ejecutivo Crucero de Evaluación Hidroacústica de Recursos Pelágicos 1902-03. Callao. Perú.

IMARPE. 2019a. Informe Ejecutivo Crucero de Evaluación Hidroacústica de Jurel y Caballa 1905-06. Callao. Perú.

Simmonds J &, MacLennan D. 2005. Fisheries Acoustics. Theory and Practice. Second edition published by Blackwell Science 2005: 436 p.