South Pacific Regional Fisheries Management Organisation

13th MEETING OF THE SCIENTIFIC COMMITTEE

8 to 13 September 2025, Wellington, New Zealand

SC13 - ECO 05

Abundance and biological aspects of jack mackerel and other species of the Peru current in the Humboldt System

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Base report as a contribution to the Scientific Committee of the South Pacific Regional Fisheries Management Organization

July 2025

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ABUNDANCE AND BIOLOGICAL ASPECTS OF JACK MACKEREL AND OTHER SPECIES OF THE PERU CURRENT IN THE HUMBOLDT SYSTEM

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NATIONAL FISHERIES SOCIETY – SCIENTIFIC RESEARCH COMMITTEE

HUMBOLDT INSTITUTE OF MARINE AND AQUACULTURE RESEARCH

SEA RESEARCH INSTITUTE OF PERU

This report contains information on the Jack mackerel fish stock and fishery in Peruvian jurisdictional waters that, we reiterate, the delegation of Peru, in use of its discretionary powers, voluntarily provides for the purpose of information and support to the scientific research work within the Scientific Committee of the SPRFMO. In doing so, while referring to Article 5 of the Convention on the Conservation and Management of High Seas Fishery Resources in the South Pacific Ocean and reiterating that Peru has not given the express consent contemplated in Article 20 (4) (a) (iii) of the Convention, Peru reaffirms that the decisions and conservation and management measures adopted by the SPRFMO Commission are not applicable within Peruvian jurisdictional waters.

Lima, July 2025

SUMMARY

In recent years, there has been a positive trend towards an increase in Jack mackerel biomass, that is, an increase towards medium levels of abundance. Catches in the same period (1983-2025) also show, in general, better fishing yields in years when biomass has been higher. The highest abundance of Jack mackerel, through geostatistical methods since 2024, was estimated during March 2024 with 215 thousand tons.

Also in recent years there has been a positive trend in mackerel biomass, i.e. an increase towards medium levels of abundance. Catches in the same period (1983-2025) show, in general, better yields in the years when the biomass has been higher. The highest abundance of mackerel, through geostatistical methods, since 2024, was estimated during March 2024, with 80 thousand tons.

Considering the last 13 years, during 2011, 2013, 2015, and from 2018 to 2023, the entry into the fishery of modal groups with a high incidence of juveniles was observed for Jack mackerel. However, in 2024 and 2025 the incidence of juveniles was lower compared to previous years. From the distribution by size of mackerel, the decrease in the entry of new modal groups in the last three years (2023 to 2025) stands out.

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1. Introduction

The Scientific Research Committee (CIC) of the National Fisheries Society (SNP), in cooperation with the Humboldt Institute for Marine and Aquaculture Research (IHMA) and the Sea Research Institute of Peru (IMARPE) organized the Thirteenth HNS-IHMA Workshop on the habitat conditions of jack mackerel and other species of the Peru Current in the Humboldt System, which was held virtually from June 30 to July 4, 2025. This activity is a contribution to the national and international effort to investigate and diagnose the current population situation of Jack mackerel, as well as other important fish species of the South Pacific, with special emphasis on aspects related to their abundances, which has been developed since the first workshop in 2011.

Within the framework of the above, the development of the Thirteenth HNS-IHMA Workshop on the habitat conditions of jack mackerel and other species of the Peru Current in the Humboldt System, has generated contributions to the National Report that will be presented in September 2025 during the thirteenth meeting of the SC to be held in Auckland.

2. Specific objectives

1. Collect and consolidate relevant information that has been produced at the national level since the previous year's workshop. This includes the following: set-by-set catch information, as well as biometric, biometric, satellite and acoustic tracking information on Jack mackerel and other species relevant to the years 2024 to 2025.
2. Carry out analyses of the distribution and relative abundance of Jack mackerel, mackerel and others using acoustic and geostatistical techniques.

3. Description of the abundance of Jack mackerel and mackerel using acoustic and geostatistical techniques

3.1. Estimating the abundance of Jack mackerel and mackerel

In the present case, *observed abundance* or *biomass* is understood to be the amount of fish (Jack mackerel and mackerel) measured in mass units (tons) only in the areas of operation of the fishing fleet of the companies affiliated with the National Fisheries Society (SNP). On the other hand, biomass is the total amount of fish in its entire possible distribution area, which is expressed in units of mass (in tons), which cannot be measured only with fishing trips, since the fleet operates in limited areas, it cannot do so within the first 10 miles of coastline and neither in areas with the presence of juveniles.

Apart from the biomass estimates that IMARPE periodically makes of pelagic resources, since the first workshop on Jack mackerel (2011) two methods have been used to estimate the abundance of these species. The first method is acoustic, i.e. a certain number of fishing vessels equipped with digital acoustic detection systems (echo sounders) of 120 kHz frequency, have collected information to be analyzed during the annual workshops.

The second method used is geostatistical, through which all fishing sets carried out between 2021 and 2025, both for Jack mackerel and mackerel, have been regionalized in 8 areas, in order to estimate the centers of gravity and inertia associated with each region. The information was also grouped into weeks from January 2024 to June 2025. The average catch per set and zone/week was used as an indicator (proxy) of fish density (tonnes/mn2). In this way, the multiplication of the average catch by inertia yields an abundance in tonnes, which is assumed to be proportional to the biomass only in the areas of operation where the fleet has operated. The methodological details used for the analysis of the data are described in SNP (2015).

3.1.1. Mackerel biomass estimated by IMARPE using acoustic methods

Information on latitudinal acoustic biomass and annual catches of Jack mackerel along the Peruvian coast has been updated. To this end, information from IMARPE acoustic cruises has been used; the annual landing data have been collected from the website of the Ministry of Production. Figure 3.1.1.1 presents a Hovmoller diagram of changes in latitudinal mackerel biomass between 1983 and June 2025.

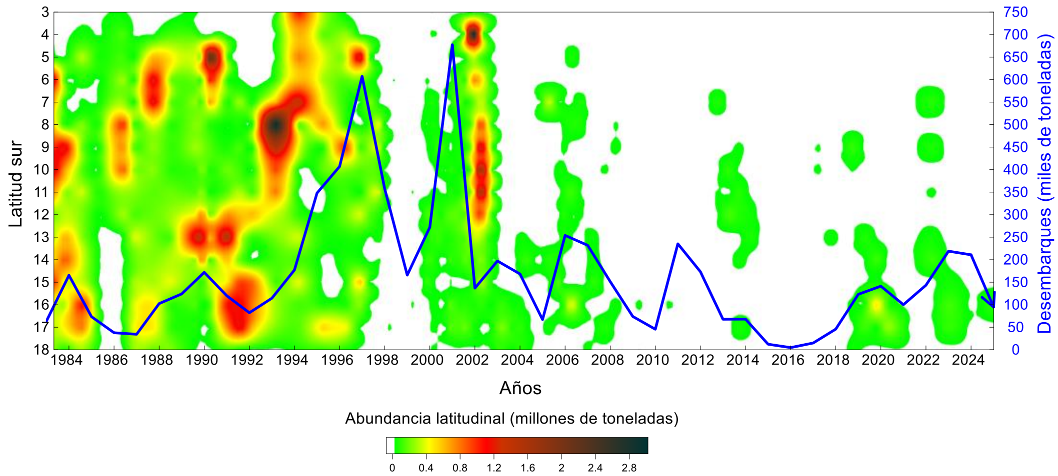


Figure 3.1.1.1. Latitudinal Jack mackerel biomass along the Peruvian coast, represented by the vertical axis on the left between 1983 and 2025 (horizontal axis). The captures are represented by the blue line and the right vertical axis. The colors correspond to biomasses according to the legend of the figure.

In general, two regimes are observed: one between 1983 and 2002, in which biomass fluctuated between medium and high levels; and another regime exists after 2002 with abundances varying between medium and low levels. However, in recent years there has been a positive trend in biomass, that is, an increase towards medium levels of abundance. Catches in the same period (1983-2024) also show, in general, better yields in years when biomass has been higher.

3.1.2. Abundance of Jack mackerel calculated by geostatistical methods

Figure 3.1.2.1. presents the location and distribution of the jack mackerel fishing sets that have been carried out between the months of June 2024 and March 2025. The sets have been classified by geographical areas and by weeks, in order to determine the average catch (tons/mn2), the Center of Gravity (latitude, longitude) and inertia (mn2) in each of them. Jack-mackerel fishing sets have been observed only in the southern zone outside the edge of the shelf, from 10 to more than 200 miles from the coast, and between latitudes 17°00'S (Mollendo) and 19°00'S (Arica). 1,174 hauls have been made, with catches ranging from 1 to 555 tonnes per haul. The average catch was 70.64 tons per set, and 82,939 tons of Jack mackerel have been caught between June 2024 and March 2025.

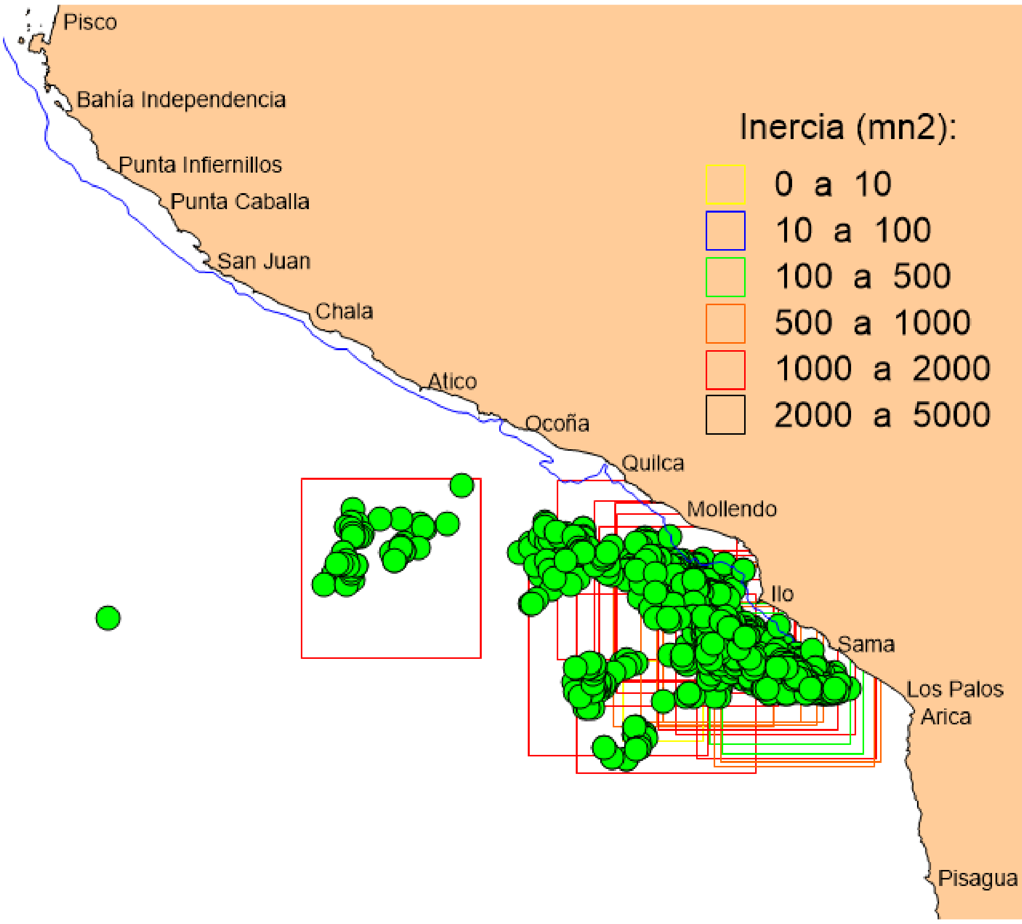


Figure 3.1.2.1. Distribution of Jack mackerel fishing sets and related inertia between 2024 and 2025 indicated by green circles. The centers of gravity and the magnitude of inertia (indicated by squares according to the legend in the figure) in each area and week have been determined in order to estimate the abundance of Jack mackerel using as an indicator the average catch per set per region and per week.

Figure 3.1.2.2. shows the estimated abundances and catches (tonnes) for the distribution of Jack mackerel using geostatistical methods between June 2024 and March 2025. It should be noted that the lack of estimates in months without catch is due to the fact that the fishing vessels were participating in the anchovy fishing seasons, or because the corresponding fishing quota had been reached. The highest abundance of Jack mackerel was estimated during January 2025 (week 12) with 0.22 MT, followed by December 2024 with 0.15 MT.

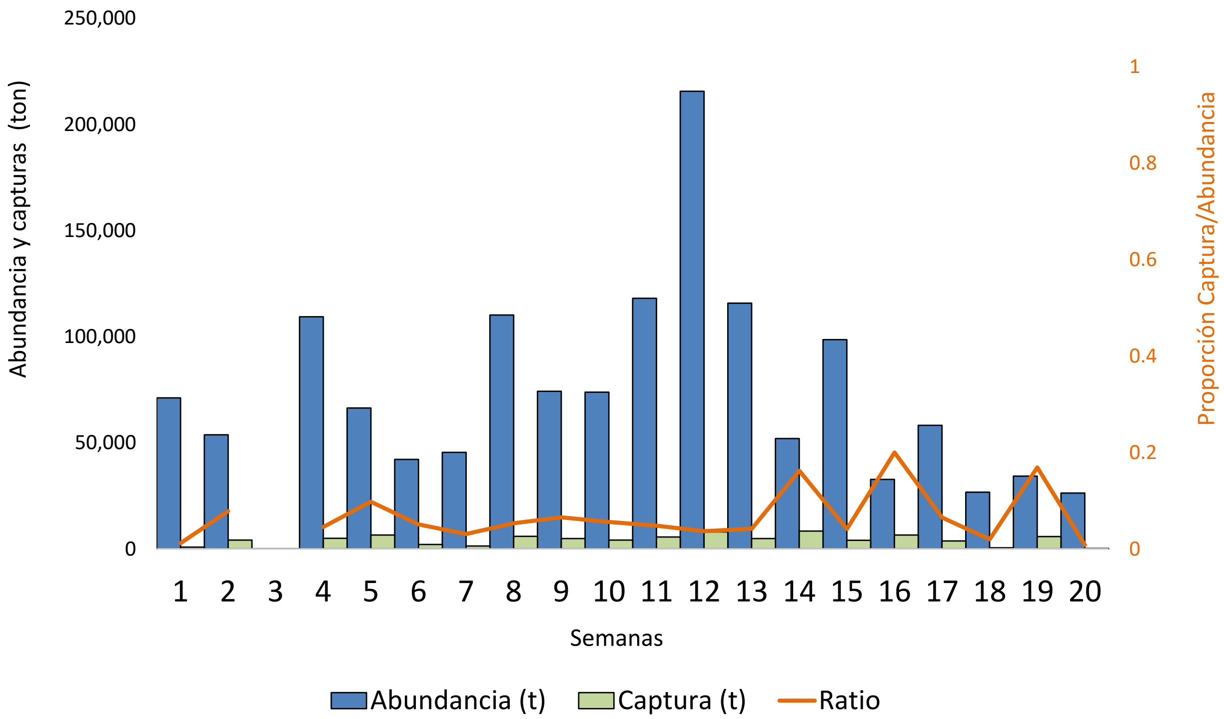


Figure 3.1.2.2. Abundance, catch and relationship between the two for Jack mackerel biomass between June 2024 and March 2025. The estimates shown in blue bars have been made by grouping the catch data by week ("Semanas").

Table 3.1.2.1. Timeline of fishing weeks ("semana") between 2024 and 2025

Semana	Fechas
1	24/06/2024
2	1/07/2024
3	8/07/2024
4	15/07/2024
5	22/07/2024
6	29/07/2024
7	5/08/2024
8	12/08/2024
9	19/08/2024
10	26/08/2024
11	2/09/2024
12	27/01/2025
13	3/02/2025
14	10/02/2025
15	17/02/2025
16	24/02/2025
17	3/03/2025
18	10/03/2025
19	17/03/2025
20	24/03/2025

3.2. Geographical distribution according to acoustic records obtained for Jack mackerel between 2020 and 2025

The geographical distribution of Jack mackerel during the period 2020-2025, based on the assessments carried out during IMARPE surveys and on the fishing activities of the industrial fleet, shows that the highest concentration of this species is south of the 12th degree south latitude, with a more continuous record between 13th and 17th degrees of south latitude. Isolated areas have also been identified in front of Paita, Punta Falsa, Chicama, Chimbote and Huacho. The distribution of Jack mackerel reaches up to 120 nautical miles, but in general, it is within 50 nautical miles. Figure 3.2.1.

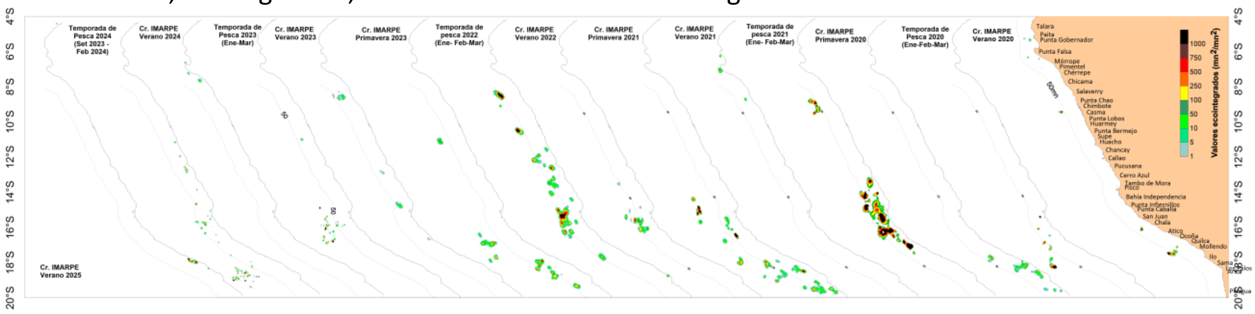


Figure 3.2.1. Geographical distribution of Jack mackerel during IMARPE surveys and SNP Jack mackerel fishing seasons, carried out between the period 2020 and 2025.

3.3 Vertical distribution of Jack mackerel during 2022 to 2025

The vertical distribution of jack mackerel observed from 2022 to 2025 ranged from the surface to 99 meters deep, with an average depth of 15.19 meters. The shallowest schools were recorded in the southern zone, between 15° and 18° south latitude, while the deepest were found in the northern zone of 15° south latitude. On the other hand, the densities were similar up to 30 meters both during the day and at night. Figure 3.3.1.

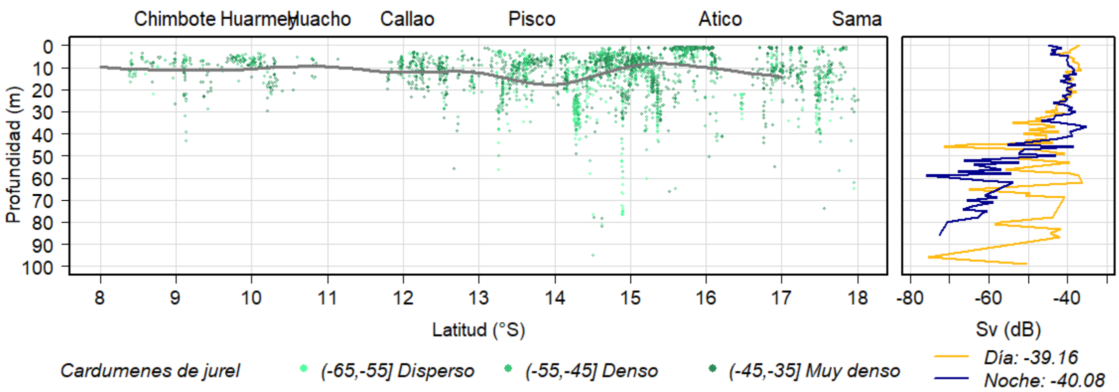


Figure 3.3.1. Latitudinal vertical distribution of Jack mackerel 2018-2025; the right-hand panel shows the backscatter volume (Sv, dB re m2/m3) according to depth.

3.4. Classification of Jack mackerel eco traces 2022 -2025

During the activities of IMARPE surveys of the SNP fleet in the period 2022 - 2025, a total of 5,930 schools of Jack mackerel were detected. A principal component analysis (PCA) was performed, using *Gaussian Mixing Models (GMM, which* is a statistical clustering technique to identify patterns or groups within a dataset without the need to previously know the number or structure of those groups, organizing the variables according to energy criteria (NASC, Minimum Sv, Maximum Sv and average Sv). positional (medium depth) and morphological (length, height, perimeter and area).

The analysis determined three types of clusters 1, 2 and 0; Cluster 1 groups schools with a high acoustic energy and size (possibly dense or large), which would be a priority for industrial fishing operations; followed by cluster 2 (intermediate) and perhaps operable for fishing, but with a greater effort and cluster 0, with little biomass and high variability, therefore, less attractive for fishing (possibly more dispersed). Table 3.4.1.

Table 3.4.1. Parameters of the detections of schools of Jack mackerel during 2022 - 2025

Variable	Min	Max	Promedio	Varianza	Desviación estándar	CV (%)	Cluster
NASC	0.826896	819072.2	77,893.44	1.201E+10	109590.3504	140.69266	Cluster 1
Sv_max	-61.5498	-5.09617	-24.39	74.152367	8.611176888	-35.30114	Cluster 1
Sv_min	-70	-50.9864	-65.89	13.899857	3.728251216	-5.658117	Cluster 1
Sv_promedio	-76.3085	-23.7781	-41.05	57.101502	7.556553611	-18.40698	Cluster 1
Profmedia	0.62819	86.64189	16.25	139.10295	11.79419123	72.562911	Cluster 1
Largo	0.566904	706.179	82.21	6722.7981	81.99267075	99.733741	Cluster 1
Ancho	0.77763	67.728	15.57	83.339213	9.129031353	58.618152	Cluster 1
Perímetro	10.09756	20590.61	1,127.93	1745698.6	1321.248884	117.13911	Cluster 1
Area	1.153363	8862.792	714.90	815044.29	902.7980339	126.28277	Cluster 1
NASC	14.91716	52834.44	9,025.57	113353529	10646.76142	117.96214	Cluster 2
Sv_max	-57.6001	-9.67975	-29.00	52.07983	7.216635655	-24.88308	Cluster 2
Sv_min	-70	-50.6379	-65.42	18.951251	4.353303447	-6.653921	Cluster 2
Sv_promedio	-67.625	-28.7403	-44.10	33.295034	5.770184952	-13.08294	Cluster 2
Profmedia	0.551332	34.84254	8.45	28.665287	5.353997337	63.367613	Cluster 2
Largo	0.121312	131.2233	28.86	525.37239	22.92100322	79.434279	Cluster 2
Ancho	0.504	19.5963	6.04	11.854844	3.443086411	56.965739	Cluster 2
Perímetro	6.853429	1426.232	317.65	73318.396	270.7736988	85.243936	Cluster 2
Area	0.203592	513.3061	96.14	9803.0726	99.01046717	102.98753	Cluster 2
NASC	0.190173	1091.575	152.66	47820.104	218.678084	143.24391	Cluster 0
Sv_max	-63.6887	-21.5619	-48.11	76.557861	8.749734896	-18.18742	Cluster 0
Sv_min	-70	-46.6083	-64.84	13.167981	3.628771252	-5.59661	Cluster 0
Sv_promedio	-80.7925	-40.3234	-56.60	39.783596	6.307423893	-11.14309	Cluster 0
Profmedia	0.487316	48.24186	7.31	33.022996	5.746563845	78.567124	Cluster 0
Largo	0.0189	123.8344	18.53	265.46929	16.29322837	87.93129	Cluster 0
Ancho	0.192327	6.36	1.43	0.9268351	0.962722766	67.120616	Cluster 0
Perímetro	2.812146	557.2548	82.64	4741.4443	68.85814616	83.321999	Cluster 0
Area	0.009694	62.3767	8.58	72.116782	8.492160052	99.005258	Cluster 0

3.5. Mackerel biomass estimated by IMARPE using acoustic methods

Information on latitudinal acoustic biomass and annual catches of mackerel along the Peruvian coast has been updated. To this end, information from IMARPE acoustic surveys has been used; the annual landing data have been collected from the website of the Ministry of Production.

Figure 3.5.1. presents a Hovmoller diagram of changes in mackerel latitudinal biomass between 1983 and March 2025. In general, three regimes can be observed: the first occurred between 1983 and 1992, in which the biomass was uniformly distributed along the entire coast, although with medium abundances; the second period occurred between 1992 and 2002, in which biomass fluctuated between medium and high levels; and a third regime exists after 2002 with abundances varying between medium and low levels.

However, in recent years there has been a positive trend in biomass, that is, an increase towards medium levels of abundance. Catches in the same period (1983-2025) show, in general, better yields in the years when the biomass has been higher.

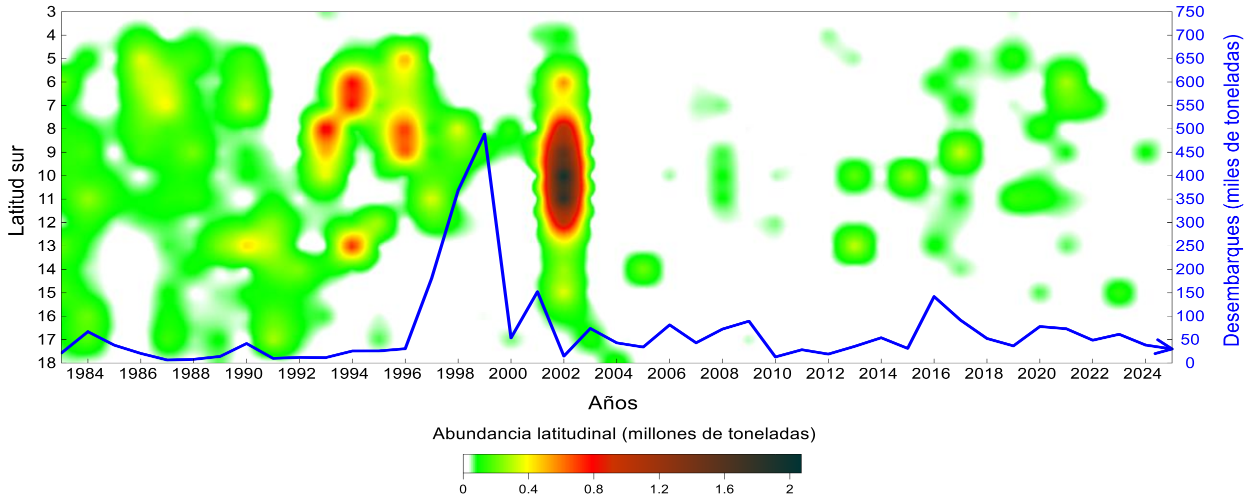


Figure 3.5.1. Latitudinal biomass of mackerel along the Peruvian coast, represented by the vertical axis on the left between 1983 and 2025 (horizontal axis). The captures are represented by the blue line and the right vertical axis. The colors correspond to biomasses according to the legend on the lower side of the figure.

3.5.1. Mackerel abundance calculated by geostatistical methods

Figure 3.5.1.1. presents the location and distribution of mackerel fishing sets that have been carried out between the months of June 2024 and March 2025. The sets have been classified by geographical areas (8) and by weeks, in order to determine the average catch (tons/mn2), the Center of Gravity (latitude, longitude) and inertia (mn2) in each of them. Mackerel fishing sets have been observed in the southern zone from 10 to more than 100 miles from the coast, and between latitudes 16°00'S (Lomas) and 21°00'S (Pisagua). 347 casts have been made, with catches ranging from 1 to 440 tonnes per set. The average catch was 31 tonnes per set, and 10,795 tonnes of mackerel have been caught by the industrial fleet between June 2024 and March 2025.

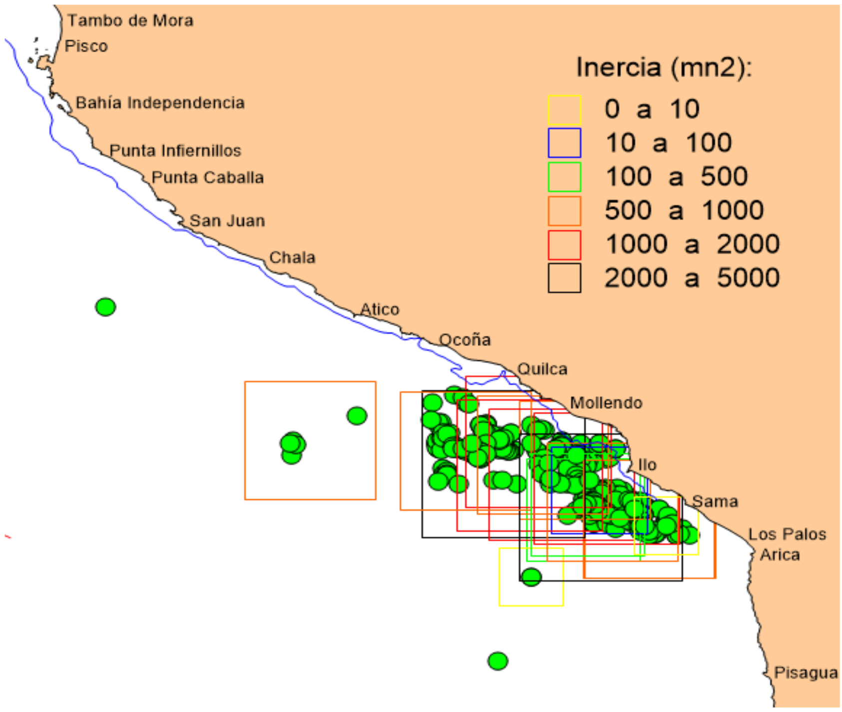


Figure 3.5.1.1. Distribution of mackerel fishing sets and related inertia between June 2024 and March 2025. The green circles correspond to the southern area. The centres of gravity and the magnitude of inertia (indicated by squares according to the legend in the figure) have been determined in each area and week in order to estimate the abundance of mackerel using as an indicator the average catch per set per region and per week.

Figure 3.5.1.2. shows the estimated abundances and catches (tonnes) for the distribution of mackerel calculated using geostatistical methods between June 2024 and March 2025. It should be noted that the lack of estimates in months without catch is due to the fact that fishing vessels were participating in anchovy fishing seasons. The highest abundance of mackerel was estimated during February 2025 (week 13) at 80 thousand tons.

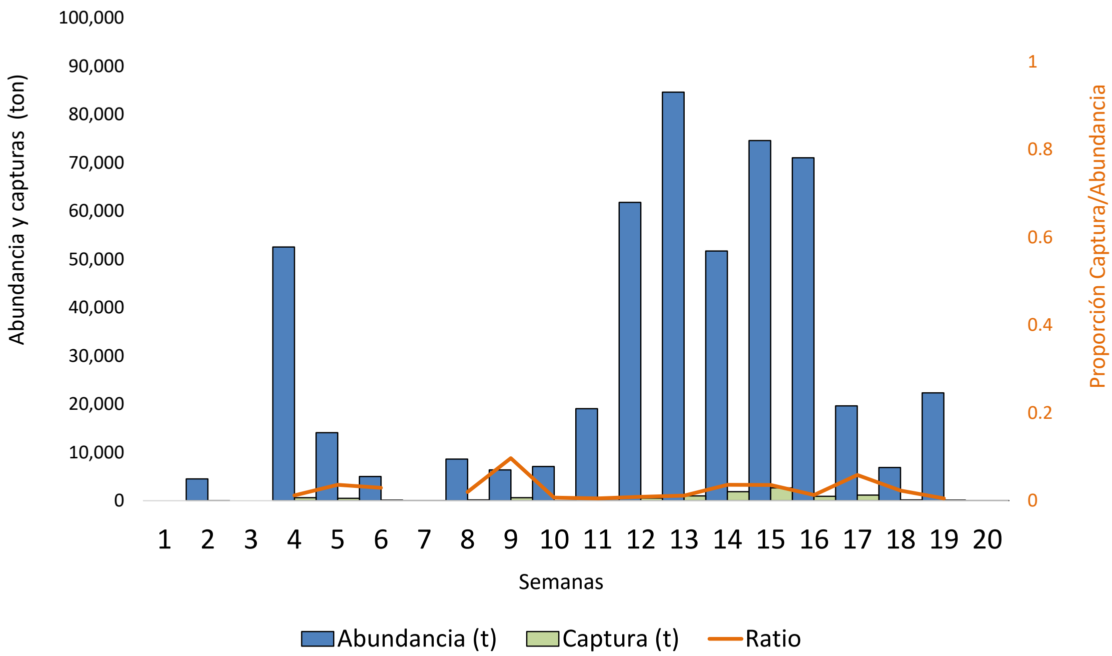


Figure 3.5.1.2. Abundance and catch and relationship between the two for the weeks ("Semanas") between June 2024 and March 2025

3.6. Vertical distribution of mackerel during 2022 to 2025

The vertical distribution of mackerel observed from 2022 to 2025 ranged from the surface to a depth of 154 meters, with an average depth of 37.83 meters. The shallowest schools were recorded in the southern zone, at degrees 14° and 18° south latitude, while the deepest were found between degrees 17° and 18° south latitude. On the other hand, the densities were similar up to 30 meters both during the day and at night. Figure 3.6.1.

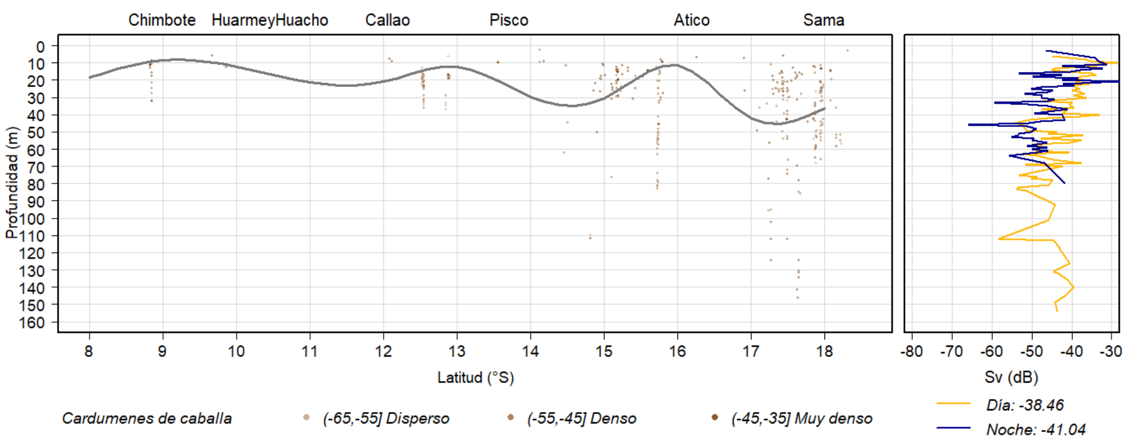


Figure 3.6.1. Latitudinal vertical distribution of mackerel 2018-2025; the right-hand panel shows the backscatter volume (Sv, dB re m2/m3) according to depth.

3.7. Mackerel Eco Trace Classification 2022 -2025

A total of 1 936 schools of mackerel were analyzed, composed of the records on the IMARPE surveys and the SNP fleet. The analysis determined three types of clusters 1, 2 and 0; Cluster 1 groups dense schools, but smaller and more varied; followed by cluster 2 (intermediate) This cluster represents large, elongated, relatively shallow schools of intermediate biomass that may be operable for fishing but with a greater effort and cluster 0; This group represents small and sparse schools, of low direct fishing interest, but important for understanding the behavior of aggregation or disintegration in fishing areas. Table 3.7.1.

Table 3.7.1. Parameters of mackerel school detections during 2022 - 2025

Variable	Min	Max	Promedio	Varianza	Desviación estándar	CV (%)	Cluster
NASC	4399.869	4525.604	4,462.74	7904.624	88.90795446	1.9922294	Cluster 1
Sv_max	-42.2573	-29.3525	-35.80	83.2667	9.125058862	-25.485491	Cluster 1
Sv_min	-67.995	-64.9999	-66.50	4.48536	2.117866834	-3.1848857	Cluster 1
Sv_promedio	-55.5192	-44.7699	-50.14	57.77349	7.600887367	-15.157961	Cluster 1
Profmedia	3.039097	47.63611	25.34	994.4466	31.53484784	124.45869	Cluster 1
Largo	395.0245	3250.48	1,822.75	4076814	2019.112219	110.77271	Cluster 1
Ancho	4.947276	56.256	30.60	1316.293	36.28074667	118.55819	Cluster 1
Perímetro	10276.16	13166.04	11,721.10	4175715	2043.456701	17.434001	Cluster 1
Area	9487.799	14405.53	11,946.66	12092039	3477.36087	29.10738	Cluster 1
NASC	3.638551	918057.5	24,180.84	3.46E+09	58863.89432	243.43199	Cluster 2
Sv_max	-62.6537	-9.89456	-29.26	70.80628	8.414646525	-28.753471	Cluster 2
Sv_min	-67.9999	-51.8444	-64.72	10.7879	3.284493254	-5.0750104	Cluster 2
Sv_promedio	-67.934	-23.5914	-42.09	46.89864	6.848258254	-16.271861	Cluster 2
Profmedia	1.503298	43.90562	9.89	45.74142	6.763240105	68.415926	Cluster 2
Largo	0.023667	647.0275	51.92	5663.191	75.25417903	144.94888	Cluster 2
Ancho	0.40403	44.81357	6.49	29.35503	5.418028197	83.433952	Cluster 2
Perímetro	2.74979	6069.419	396.77	360567.5	600.4727397	151.341	Cluster 2
Area	0.015543	3446.865	191.26	136761.8	369.8132511	193.35214	Cluster 2
NASC	0.209398	931.0588	103.48	27623.9	166.2044052	160.61762	Cluster 0
Sv_max	-63.9645	-27.8324	-51.04	47.77537	6.911972934	-13.543205	Cluster 0
Sv_min	-67.9999	-49.4723	-64.62	20.54059	4.532172303	-7.013899	Cluster 0
Sv_promedio	-79.6465	-40.6668	-57.87	34.69193	5.889985731	-10.177184	Cluster 0
Profmedia	1.02168	24.53697	6.68	10.77389	3.282359816	49.107281	Cluster 0
Largo	0.051984	147.9102	32.42	649.9461	25.49404101	78.634586	Cluster 0
Ancho	0.147462	5.521088	1.26	0.59254	0.769766032	61.182629	Cluster 0
Perímetro	2.484379	636.1999	121.33	10931.83	104.5554071	86.171245	Cluster 0
Area	0.018811	83.23288	14.16	204.9241	14.3151689	101.1106	Cluster 0

3.8. Estimation of the acoustic abundance of Jack mackerel, mackerel and vinchiguerria

In the present case, the acoustic data collected by the ships Chaveli, Maru, Tasa 42, Tasa 51, and Tasa 57 during 20 weeks were analyzed. In all cases, Simrad ES70 model echo sounders operating at the frequency of 120 kHz and Split beam transducers were used. The basic sampling unit (UBM) was 1 nm, having navigated 25,794 nm in total. Two methods have been applied for the estimation of the acoustic abundance of Jack mackerel, which are presented below.

Since the routes made by the ships were random, and not systematic, a system of stratification of statistical squares in two dimensions or spaces of 15 by 15 nm (225 mn2 in area) was adopted, in which all NASC measurements by UBM were averaged including zeros to avoid overestimation of the results.

In this way, the biomass observed in a certain number of strata or statistical quadrants with the presence of Jack mackerel, mackerel and vinciguerria has been calculated, with which two biomass estimates for the prospected area for each week have been found. Figure 3.8.1. Displays ship routes and calculated acoustic biomasses.

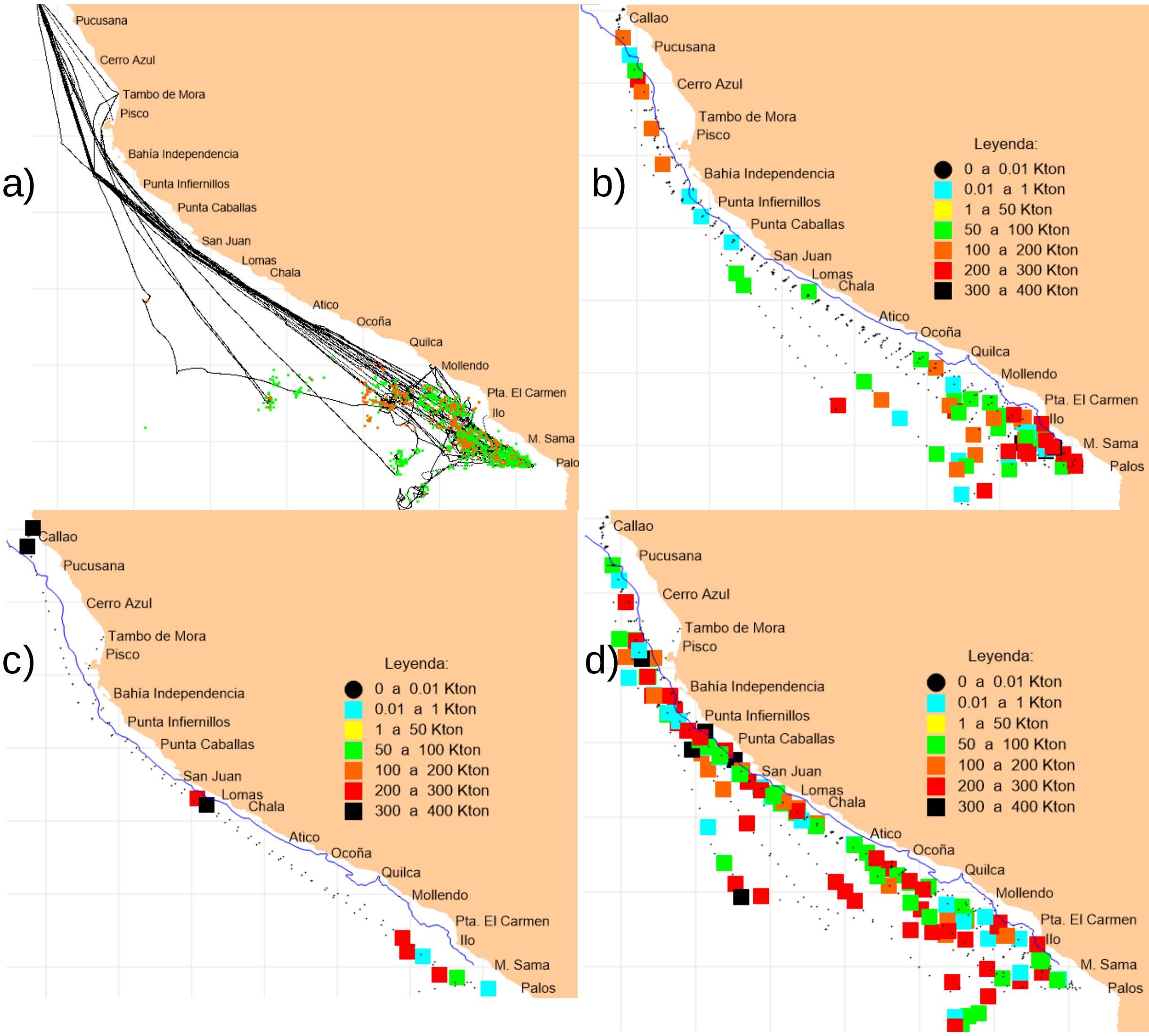


Figure 3.8.1. Routes (a), Acoustic evaluation of the biomass of Jack mackerel (b), mackerel (c), and vinciguerria (d) by statistical squares of 15 x 15 nm in the area evaluated by the fishing vessels during the fishing weeks in the period June 2024 to March 2025

3.9. Synthesis of abundance measurement results for Jack mackerel (*Trachurus murphyi*)

Based on the results shown above, it is presented in Figure 3.9.1 a synthesis of the abundance measurements made for Jack mackerel during 2024 and 2025. Estimates of mackerel abundance have ranged from 22 to 458 thousand tons in the areas prospected by fishing boats. Table 3.9.1 presents the main results, including the area covered each week by Jack mackerel; Figure 3.9.2. shows the size structure of Jack mackerel.

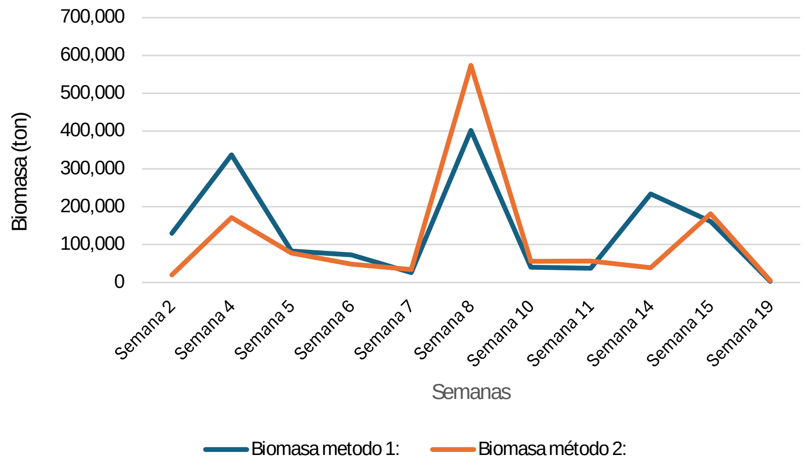


Figure 3.9.1. Synthesis of Jack mackerel biomass estimates through two methods of evaluation of Jack mackerel biomass present only in the areas of operation of vessels that collected acoustic data for four weeks between 2024 and 2025.

Table 3.9.1. Results of the acoustic biomass estimation and estimates of statistical accuracy of the assessment made for Jack mackerel by weeks between 2024 and 2025.

RESULTADOS	Semana 2	Semana 4	Semana 5	Semana 6	Semana 7	Semana 8	Semana 10	Semana 11	Semana 14	Semana 15	Semana 19	Unidades
Número de cuadrados positivos:	7.00	10.00	5.00	8.00	4.00	13.00	12.00	4.00	2.00	2.00	2.00	cuadrados
Area:	1,507.90	2,167.64	856.84	1,718.38	854.38	2,788.94	2,573.10	865.60	427.87	213.93	427.63	n.mi.2
NASC:	1,580.21	1,826.56	430.89	407.98	119.90	2,448.42	243.58	209.56	1,381.17	1,018.53	14.70	m2/n.mi.2
NASC promedio:	225.74	182.66	86.18	51.00	29.98	188.34	20.30	52.39	690.59	509.26	7.35	m2/n.mi.2
Desviación estándar:	226.84	298.53	69.42	399.42	110.01	2,375.01	234.03	200.50	1,363.75	0.00	14.40	m2/n.mi.2
Número de UBMs	361.00	145.00	184.00	864.00	380.00	795.00	596.00	185.00	163.00	81.00	110.00	unidades
NASC promedio ponderado:	17.17	93.81	111.24	33.59	48.10	246.88	26.17	78.49	108.38	1,018.53	13.37	m2/n.mi.2
Varianza ponderada:	192.38	994.40	2,418.67	153,860.74	48,850.69	38,483.73	33,628.46	6,652.98	49,930.61	1,757,921.22	15,844.07	unidades
Factor de conversión:	0.76	0.84	0.81	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	ton/m2
Factor k medio:	5.19	8.76	9.67	11.03	11.03	11.03	11.03	11.03	11.03	11.03	11.03	t/m2/n.mi.2
Densidad media:	13.04	79.14	90.11	27.99	40.08	205.72	21.81	65.41	90.31	848.72	11.14	ton/n.mi.2
Varianza de la densidad:	110.95	707.78	1,587.17	106,835.28	33,920.13	26,721.70	23,350.38	4,619.59	34,669.99	1,220,636.28	11,001.54	unidades
Coeficiente de variación (CV):	80.79	33.62	44.21	1,167.90	459.48	79.46	700.71	103.91	206.18	130.17	941.18	%
Biomasa metodo 1:	129,687.48	337,088.50	83,307.39	72,977.26	25,666.72	401,681.41	40,016.13	37,449.06	234,097.72	161,158.12	2,676.93	ton
Biomasa método 2:	19,661.20	171,553.77	77,210.30	48,091.70	34,246.14	573,737.30	56,113.35	56,617.56	38,640.73	181,565.47	4,765.62	ton
Diferencia:	84.84	49.11	7.32	34.10	-33.43	-42.83	-40.23	-51.19	83.49	-12.66	-78.03	%
Límites de confianza:	0.50	38.52	1.04	18.27	25.14	26.01	38.16	11.55	16.25	2.24	196.27	%
Biomasa adultos	129,533.02	337,088.50	83,307.39	72,977.26	25,666.72	401,681.41	40,016.13	37,449.06	234,097.72	158,463.35	2,676.93	ton
Porcentaje adultos	99.88	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	98.33	100.00	%
Biomasa juveniles	154.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2,694.77	0.00	ton
Porcentaje juveniles	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.67	0.00	%
Área total:	14,709.53	11,268.84	3,479.07	72,977.26	14,905.71	14,076.74	15,806.97	8,905.78	10,392.11	9,724.37	12,762.73	mn2

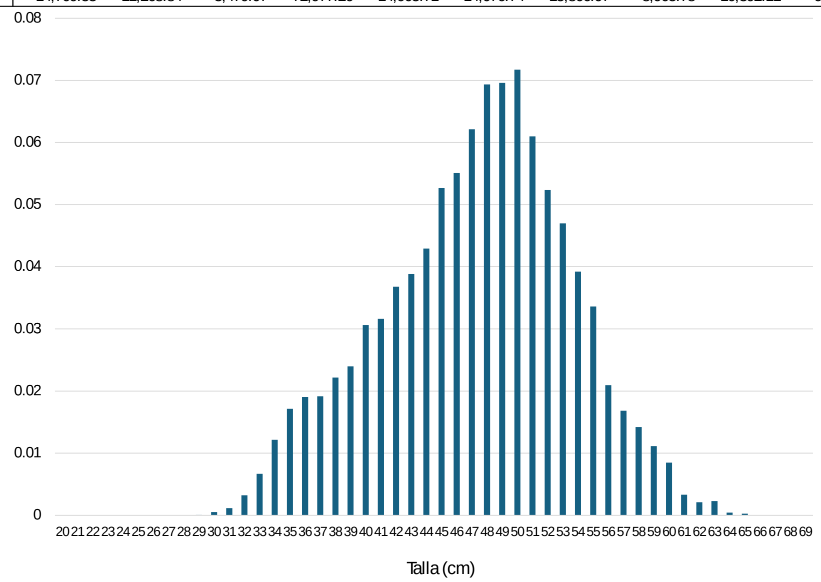


Figure 3.9.2. Weighted structure of percentage of biomass by Jack mackerel sizes in the areas evaluated between June 2024 and March 2025. These estimates apply only to the areas in which the fleet operated. A minimum number of juveniles is observed.

3.10. Synthesis of abundance measurement results for mackerel (*Scomber japonicus*)

Based on the results shown in Figure 4.8.1, Figure 3.10.1 is presented. A synthesis of the abundance measurements made for mackerel during the weeks of the years 2024 and 2025. The estimates of mackerel abundance have only been obtained for the last few weeks (March 2025), and it has been given in a range of 55 to 300 thousand tons in the areas prospected by fishing boats. Table 3.10.1 presents the main results, including the area covered each week by mackerel; Figure 4.10.2. Shows the size structure of mackerel.

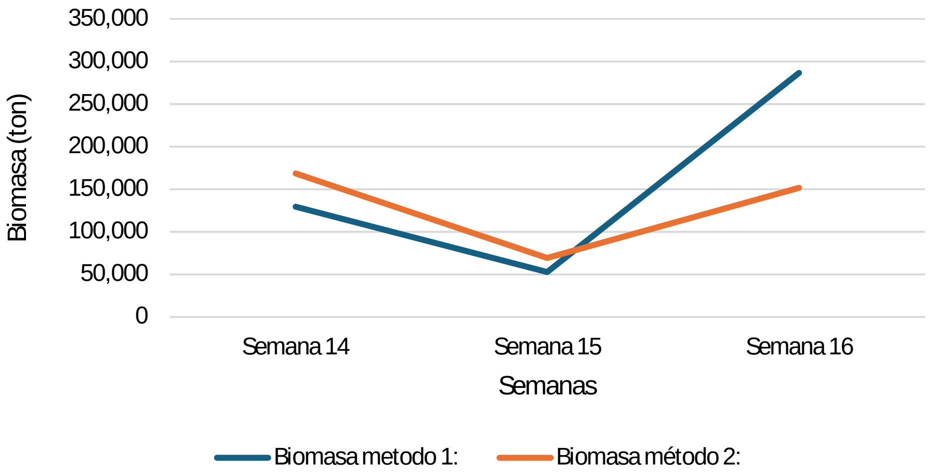


Figure 3.10.1. Synthesis of mackerel abundance estimates through two acoustic methods of biomass assessment. Mackerel was only found in the fourth fortnight of data analysed during 2024

Table 3.10.1. Results of the acoustic biomass estimation and estimates of statistical accuracy of the assessment made for mackerel

Resultados	Semana 14	Semana 15	Semana 16	Unidades
Número de cuadrados positivo	2.00	4.00	7.00	cuadrados
Area:	428.32	857.54	1,502.80	n.mi.2
NASC:	1,013.92	383.31	2,062.94	m2/n.mi.2
NASC promedio:	506.96	95.83	294.71	m2/n.mi.2
Desviación estándar:	719.60	340.53	1,973.36	m2/n.mi.2
Número de UBMs	170.00	424.00	262.00	unidades
NASC promedio ponderado:	472.57	96.77	121.07	m2/n.mi.2
Varianza ponderada:	140,821.71	38,650.02	18,046.63	unidades
Factor de conversión:	0.83	0.83	0.83	ton/m2
Factor k medio:	11.03	11.03	11.03	t/m2/n.mi.2
Densidad media:	393.79	80.64	100.88	ton/n.mi.2
Varianza de la densidad:	97,781.45	26,837.17	12,530.92	unidades
Coeficiente de variación (CV):	79.41	203.16	110.96	%
Biomasa metodo 1:	129,225.97	52,824.45	286,677.03	ton
Biomasa método 2:	168,665.60	69,150.42	151,606.75	ton
Diferencia:	-30.52	-30.91	47.12	%
Límites de confianza:	4.23	3.58	9.10	%
Biomasa adultos	96,930.56	52,824.45	286,677.03	ton
Porcentaje adultos	75.01	100.00	100.00	%
Biomasa juveniles	32,295.41	0.00	0.00	ton
Porcentaje juveniles	24.99	0.00	0.00	%
Area Total:	10,172.02	9,724.37	14,065.31	mn2

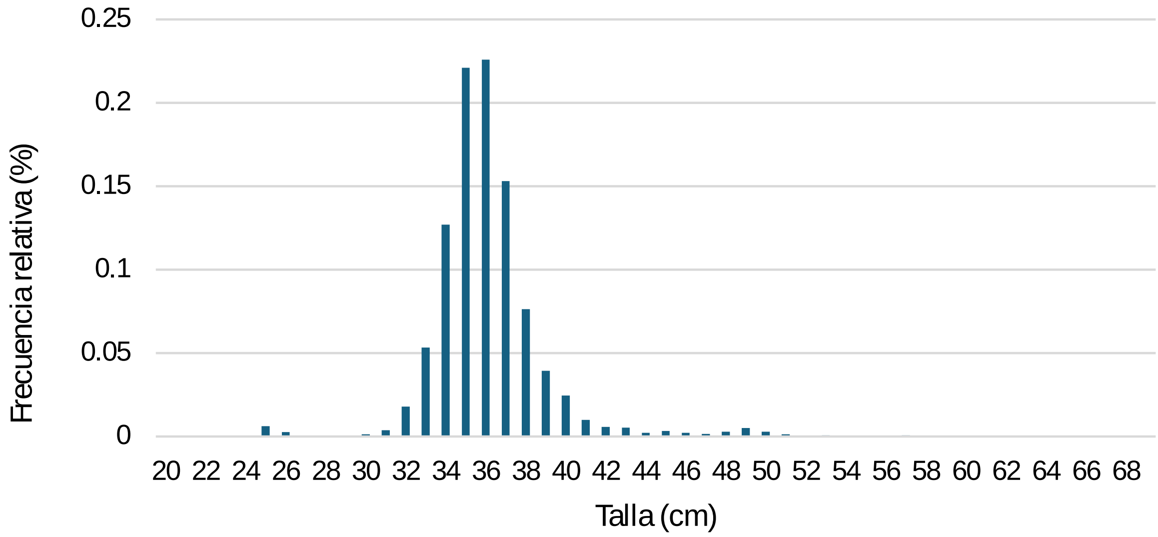


Figure 3.10.2. Weighted structure of biomass by mackerel sizes in the areas evaluated during March 2015

3.11. Synthesis of abundance measurement results for vinciguerria (*Vinciguerria lucetia*)

Based on the results shown in Figure 4.8.1. It is presented in Figure 3.11.1. A synthesis of the abundance measurements made for the Vinciguerria during the months of June 2024 to March 2025. Estimates of abundance of vincchiguerria have ranged from 5 to 550 thousand tons in the areas prospected by fishing boats. Table 3.11.1 presents the main results, including the area covered each week by the vinciguerria. To estimate the biomass of vinciguerria, an average size of 6 cm has been assumed, since there has been no biological sampling on this species.

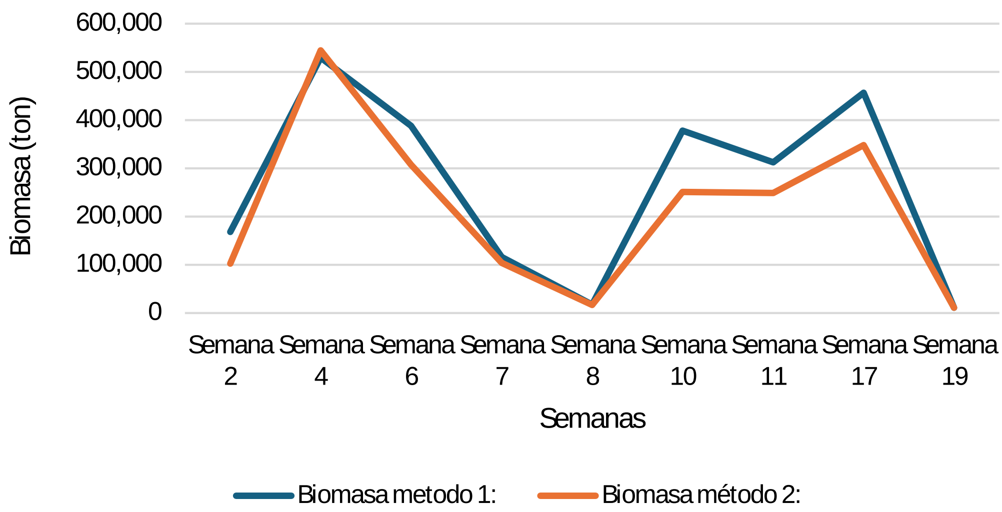


Figure 3.11.1. Synthesis of biomass estimates of mesopelagic fish (mainly vincigueria) by two assessment methods during weeks of 2024 and 2025

Table 3.11.1. Results of the acoustic biomass estimation and statistical accuracy estimates of the assessment made for mesopelagic fishes

RESULTADOS	Semana 2	Semana 4	Semana 6	Semana 7	Semana 8	Semana 10	Semana 11	Semana 17	Semana 19	Unidades
Número de cuadrados:	12.00	23.00	28.00	18.00	7.00	14.00	7.00	19.00	2.00	cuadrados
Area:	2,586.33	4,988.88	6,053.04	3,879.61	1,520.05	3,032.07	1,519.99	4,081.32	434.28	n.mi.2
NASC:	330.24	1,035.48	758.38	227.68	33.60	740.73	610.27	901.82	21.28	m2/n.mi.2
NASC promedio:	27.52	45.02	27.08	12.65	4.80	52.91	87.18	47.46	10.64	m2/n.mi.2
Desviación estándar:	35.58	75.99	745.92	221.72	31.43	718.67	574.47	880.05	15.73	m2/n.mi.2
Número de UBMs	313.00	295.00	1,772.00	1,140.00	356.00	492.00	329.00	1,114.00	67.00	unidades
NASC promedio ponderado:	16.76	46.29	21.56	11.34	4.53	35.08	69.47	36.15	10.88	m2/n.mi.2
Varianza ponderada:	53.11	292.78	197,968.56	103,591.77	22,830.28	19,554.47	14,815.23	100,976.38	3,149.92	unidades
Factor de conversión:	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.36	ton/m2
Densidad media:	39.51	109.13	50.82	26.74	10.68	82.70	163.77	85.23	25.66	ton/n.mi.2
Varianza de la densidad:	295.20	1,627.29	1,100,300.97	575,758.73	126,889.75	108,682.92	82,342.45	561,222.52	17,507.14	unidades
Coeficiente de variación (CV)	43.49	36.97	2,064.03	2,837.29	3,334.33	398.63	175.22	878.99	515.65	%
Biomasa metodo 1:	168,164.45	529,738.88	388,223.28	115,835.45	17,193.18	378,377.88	312,180.81	456,485.18	10,858.44	ton
Biomasa método 2:	102,179.00	544,415.67	307,620.05	103,754.20	16,239.17	250,757.55	248,922.28	347,842.08	11,143.36	ton
Diferencia:	39.24	-2.77	20.76	10.43	5.55	33.73	20.26	23.80	-2.62	%
Límites de confianza:	2.47	4.21	291.98	106.84	22.06	149.02	1.22	19.43	0.49	%
Area total:	14,709.53	11,268.84	15,553.30	14,905.71	14,076.74	15,806.97	8,905.78	20,965.60	12,762.73	mn2

4. Identification of indicators using biological information

4.1. Variations in the size structures of Jack mackerel and mackerel

The analysis of jack mackerel and mackerel size structures was carried out based on biometric information per fishing set recorded in the SNP logbook. These data are obtained from a random sampling, after each fishing set, where ichthyometer measurements are made on the size of the specimens collected of Jack mackerel and mackerel. For data collected during January and March 2025, the size structure of 526 sets for Jack mackerel and 224 sets for mackerel was analyzed. This information corresponded to records collected between January 27 and March 28, 2025. The biometric analysis of the structure by size and species (simple frequency of the total length) was calculated after weighting the frequencies of the catch by fishing set and with a temporal and spatial hierarchy. The weighting factor is the result of the relationship between the weight of the sample and the total caught in the set. Since the biometric data does not contain data on weights by height range, the coefficients of the length-to-weight relationship (a and b) were provided by the Instituto del Mar del Perú (IMARPE):

4.2. Size structure of Jack mackerel

In the 2025 season, between January and March, the industrial fleet associated with the SNP registered a range between 30 and 60 cm of total length (LT), with an incidence of juveniles (< 31 cm) of 0.1% in number. The size composition of jack mackerel caught by the industrial fleet mainly affected adult individuals, with a main mode of 50 cm and secondary modes of 35 cm (Figure 4.2.1.).

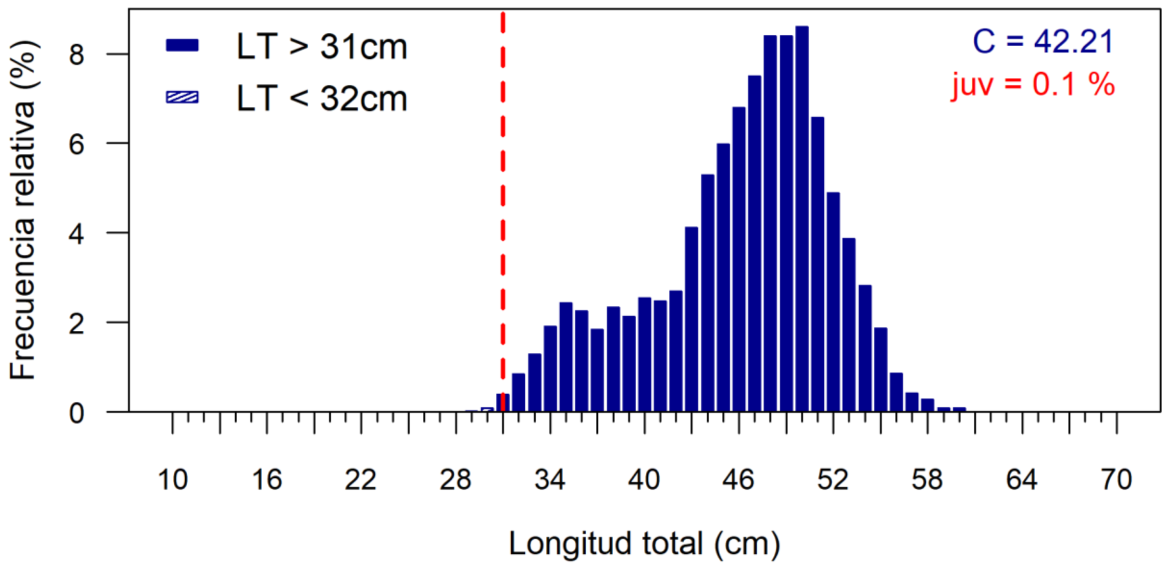


Figure 4.2.1. Size composition of Jack mackerel catches during 2025. The vertical dashed red line corresponds to the minimum catch size (31 cm). Source: SNP biometric log

During the period 2021–2025, the size structure of Jack mackerel presented annual modes that reflect the dominance of certain age groups. In 2021, an adult group with heights close to 42.0 cm predominated. In 2022 the mode was 40.0 cm, which suggests a slight entry of a new juvenile cohort. In 2023 it was particularly notable with a mode of 36.0 and 2024 continued with modes focused on 45.0 to 48.0 cm, evidencing the persistence of the adult group.

A more defined mode was observed in the 48–50 cm range in 2025, possibly reflecting the growth of the same dominant group. Throughout the period, the fishery was mainly concentrated in adult individuals, with very low participation of juveniles, except in 2022 where a more evident entry of new recruits was detected.

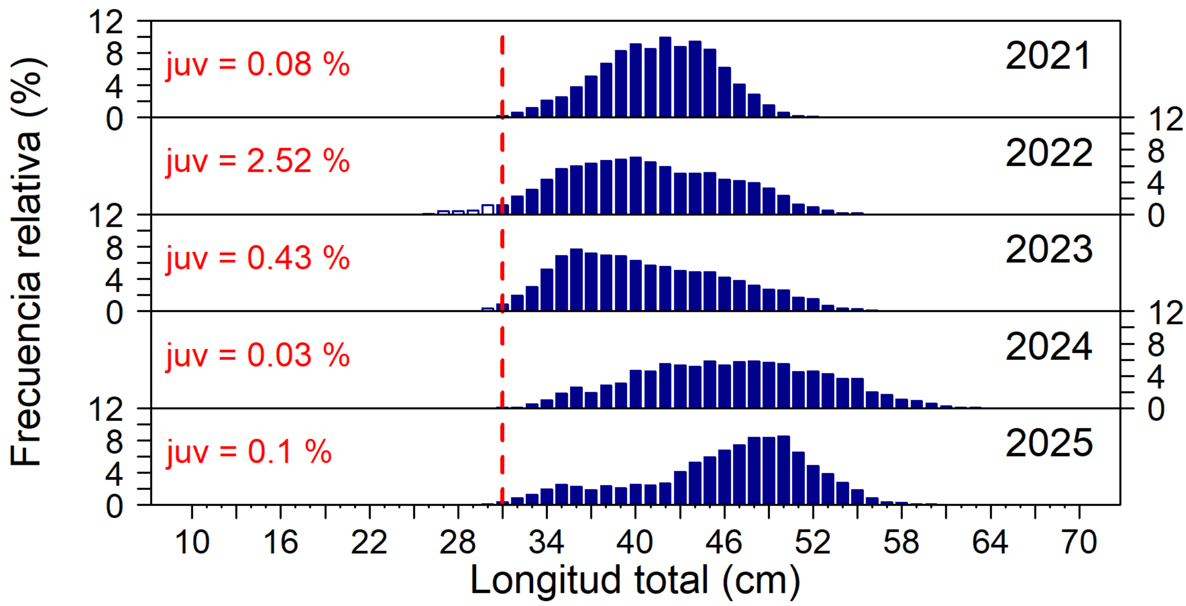


Figure 4.2.2. Size structure of Jack mackerel from 2021 to 2025 according to biometric sampling carried out on board the SNP fleet

The size structure observed weekly, between January and March, presented a low incidence of juveniles (<1%), of which the fourth and fifth weeks have percentages between 0.71% and 0.02% of juvenile jack mackerel. The top fads per week were in a range between 48 and 50cm, with a mode of 36cm in the last week of March (Figure 5.2.2.).

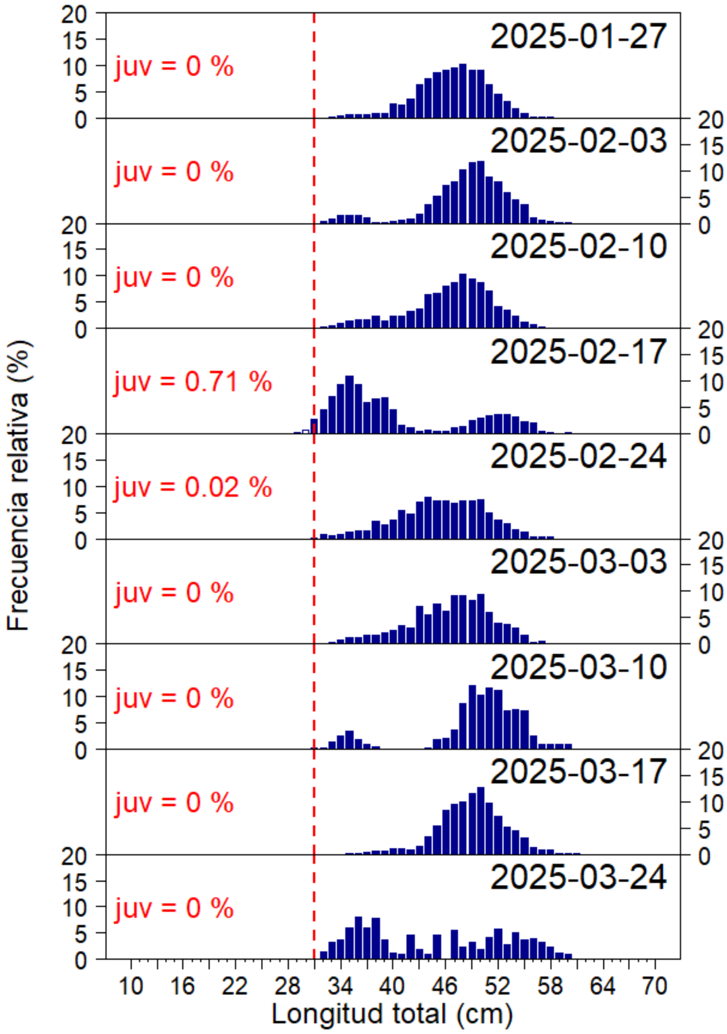


Figure 4.2.3. Size composition of weekly catches of Jack mackerel during 2025. The vertical dashed red line corresponds to the minimum catch size (31 cm). Source: SNP biometric log

The size structure observed by latitudinal degrees obtained between 2024 and 2025 indicates a wider fleet operating area in 2024 (16° - 18°), compared to 2025 (17° - 18°). In addition, a reduced proportion of juveniles is observed in the catches compared to 2024. Latitudinally, during the 2025 season, the composition by size presented greater fashions in degrees 17°LS with values of 50 cm; while minor modes in the 18th degree LS with a value of 48 cm. (Figure 5.2.4.).

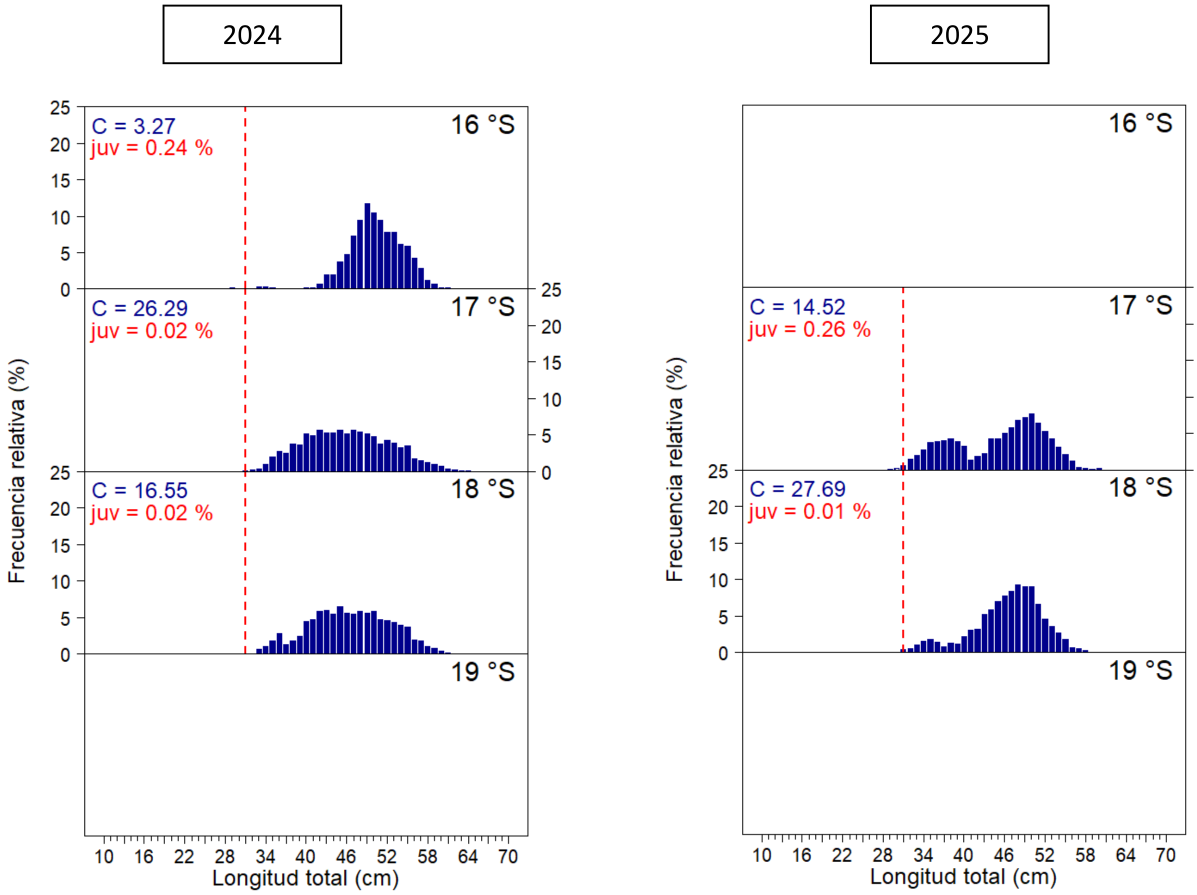


Figure 4.2.4. Size composition of jack mackerel catches by latitude, between 2024 and 2025 (left to right). The vertical dashed red line corresponds to the minimum catch size (31 cm LT). Source: SNP biometric log

The size structure in 2025 according to distance from the coast presented juvenile jack mackerel in number (<31 cm), with slightly high values in the 30 nautical miles with a value of 0.2%. In 2025 it presented the greatest fashions in the 20 miles of the coast with values of 50 cm. However, in 2024 the slightly high values were in the 50 nautical miles with a value of 0.23%. (Figure 4.2.5.).

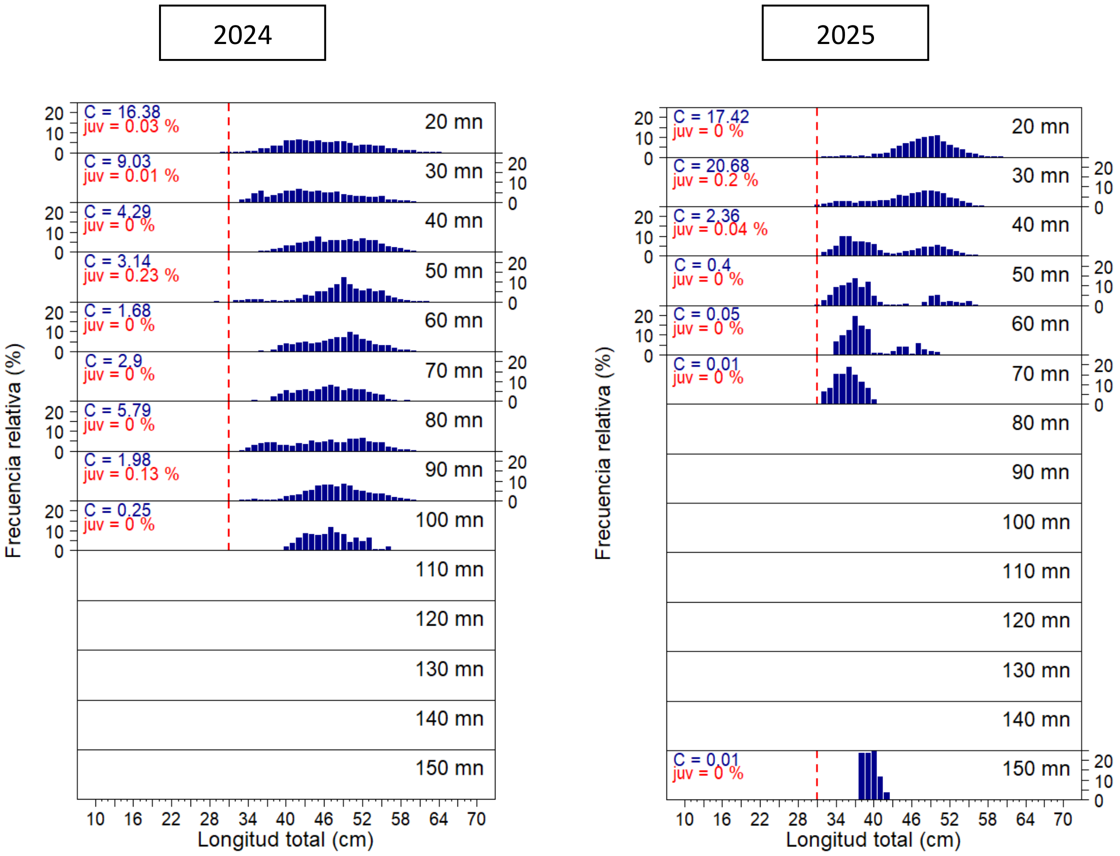


Figure 4.2.5. Size composition of jack mackerel catches by distance to shore (nautical miles) between 2024 and 2025 (left to right). The vertical dashed red line corresponds to the minimum catch size (31 cm LT). Source: SNP biometric log

4.3. Size structure of mackerel

In the 2025 industrial fishing season carried out from January to March, mackerel was caught with a juvenile percentage of 0.01% in number, made up of individuals whose sizes fluctuated between 31 and 42 cm in total length. The size structure shows a main fashion of 35 cm (Figure 4.3.1.).

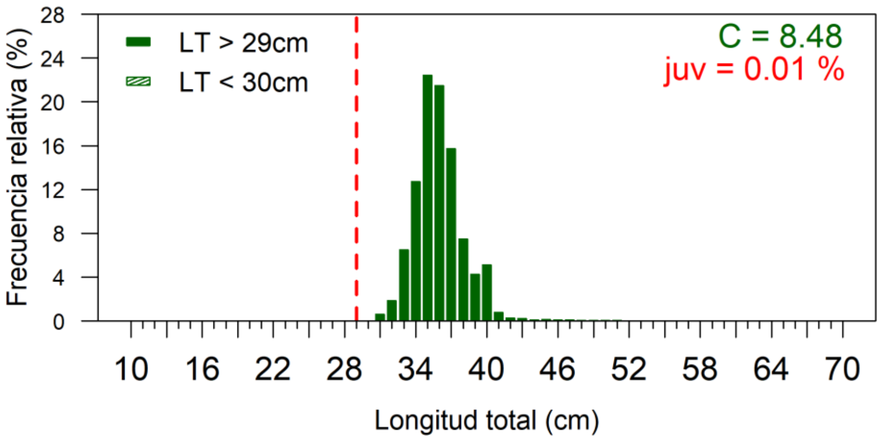


Figure 4.3.1. Size composition of mackerel catches during 2025. The vertical dashed red line corresponds to the minimum catch size (29 cm). Source: SNP biometric log

Regarding the annual distribution of the mackerel size structure during the period 2021 to 2025, it presented annual variations with well-defined modes, which shows the presence of different age groups. In 2021 and 2022, the population was concentrated in a mode of 35.0 cm. In 2023 and 2024, a dominant group in similar sizes of 34.0 cm was observed, which would indicate the entry of a juvenile cohort.

In 2025, the size structure showed a mode of 35.0 cm, possibly corresponding to the same dominant group of years 2021 and 2022 that has continued its growth. Overall, a low proportion of juveniles was observed during most years, with 2021 and 2024 being the seasons with the most visible contribution of young individuals. This suggests a stability in the exploited population, dominated by adults, with occasional recruitments that are not always fully integrated into the fishery.

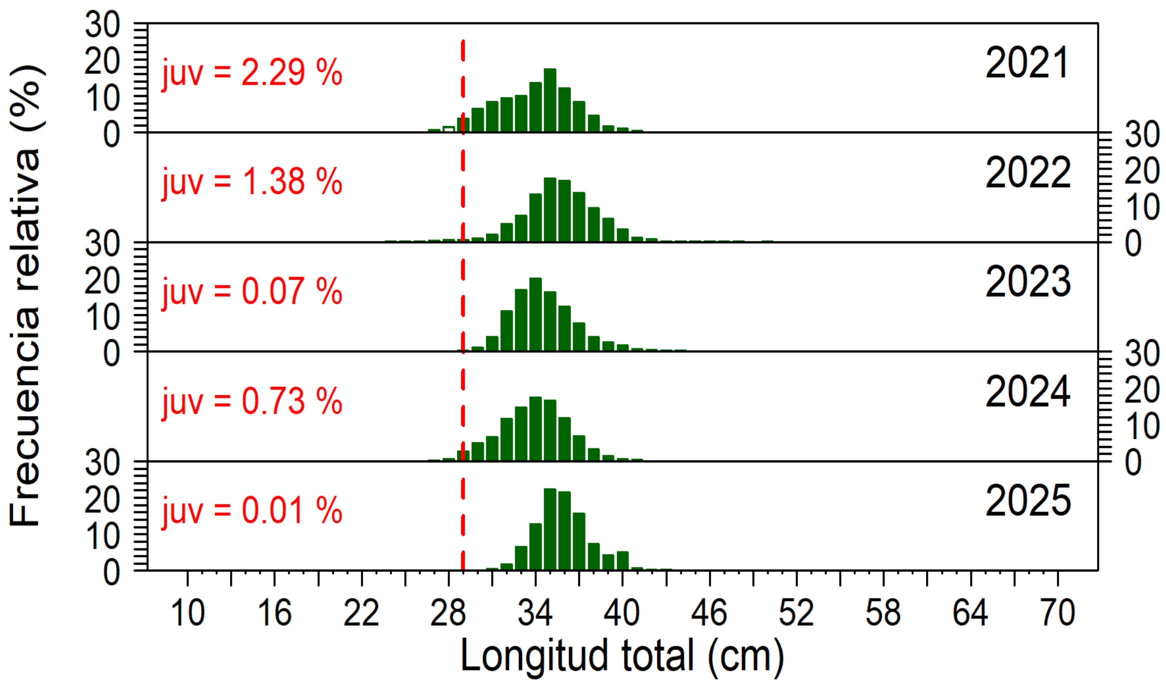


Figure 4.3.2. Mackerel size structure from 2021 to 2025 according to biometric sampling carried out on board the SNP fleet

The structure of mackerel sizes observed weekly, between January and March, presented a low incidence of juveniles (<0.1%), of which the fifth and sixth weeks have percentages of 0.03% juvenile mackerel. The main fashions per week were located in a range between 35 and 37 cm, with the mode between 35 and 36 cm being the most prevalent (Figure 4.3.3.).

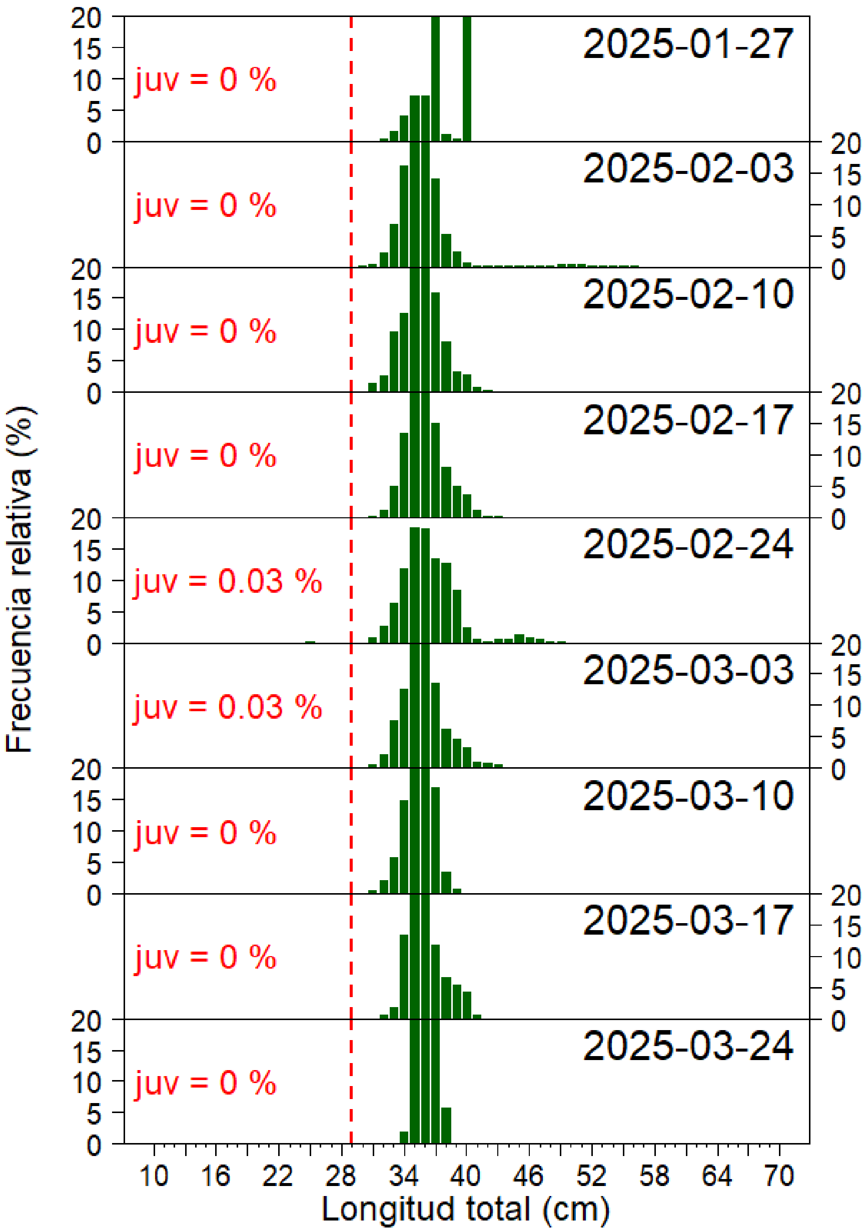


Figure 4.3.3. Size composition of weekly mackerel catches during 2025. The vertical dashed red line corresponds to the minimum catch size (29 cm). Source: SNP biometric log.

The structure of mackerel sizes observed by latitudinal degrees obtained between the years 2024 and 2025 indicates a wider fleet operating area in 2025 (16° - 19°), compared to the year 2024 (16° - 18°). In addition, a reduced proportion of juveniles is observed in catches in the year 2025. Latitudinally, during the 2025 season, the size composition presented a greater fashion in the 16°LS degree, with a range of fashions between 35 and 36 cm. (Figure 4.3.4.).

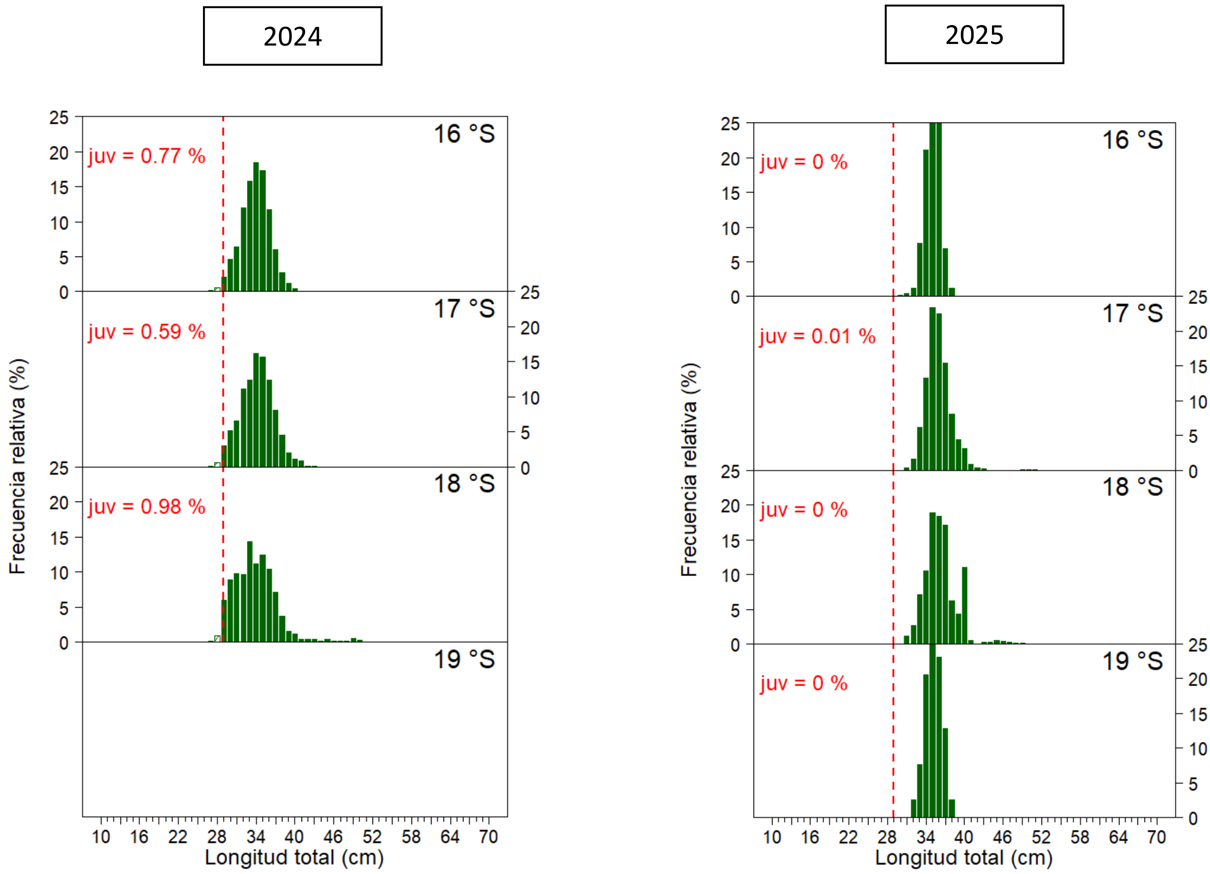


Figure 4.3.4. Size composition of mackerel catches by latitude between 2024 and 2025 (left to right). The vertical dashed red line corresponds to the minimum catch size (29 cm). Source: SNP biometric log

The size structure in 2025 according to distance from the coast presented juvenile mackerel in number (<29 cm), with values of 0.02% between 40 and 50 nautical miles. In 2024 there were high values of juveniles in the 110 nautical miles (5.3%). (Figure 4.3.5).

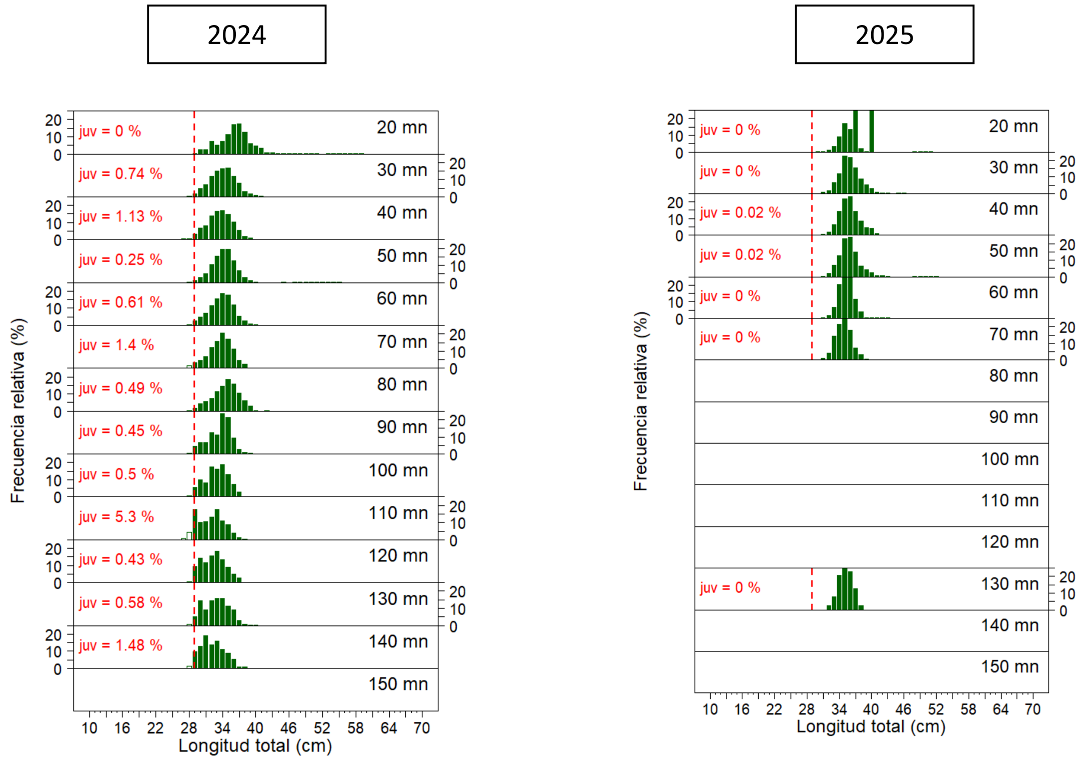


Figure 4.3.5. Size composition of mackerel catches by distance to shore (nautical miles) between 2024 and 2025 (left to right). The vertical dashed red line corresponds to the minimum catch size (29 cm). Source: SNP biometric log.

5. Identification of fishing effort

5.1. SISESAT information and operations area.

Information on the spatial dynamics of the fishing fleet with catches of Jack Mackerel and Mackerel for the years 2023, 2024 and 2025 was analyzed. With the SISESAT (Satellite Tracking System), 462,131 records of 56 vessels from fishing companies (Tasa, Copeinca, Hayduk, Diamante, Exalmar and Austral) were obtained, which were collected during fishing operations for CHD (Direct Human Consumption).

In the first months of 2023, fishing operations were mainly distributed in latitudes 14°LS and 15°LS and with less effort in the northern and central areas of Peru. By the end of that year, fishing moved further south. In 2024 and 2025, fishing operations were distributed in the southern part of Peru (between 16°LS and 18°LS), reaching the border with Chile (Figure 5.1.1.).

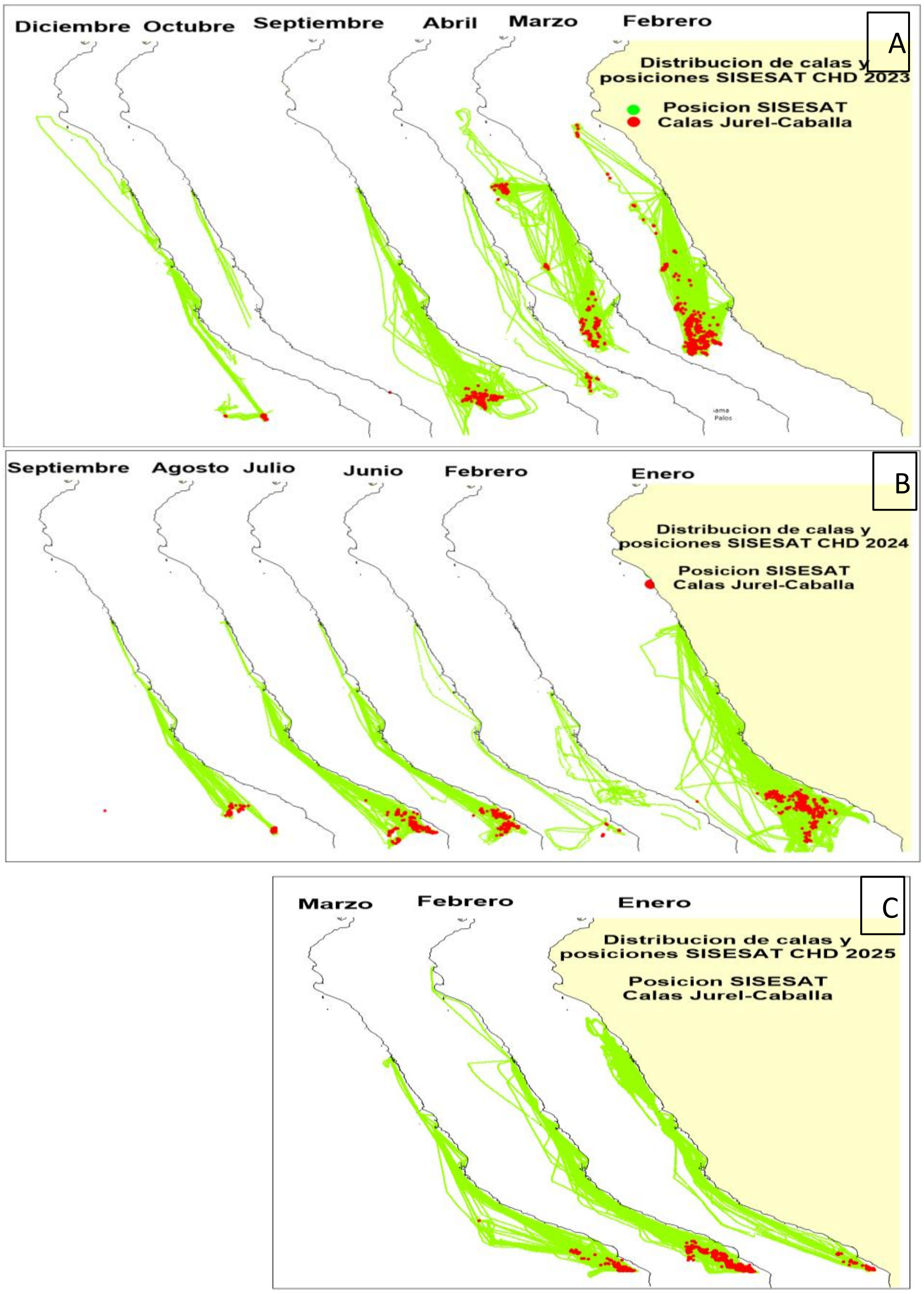
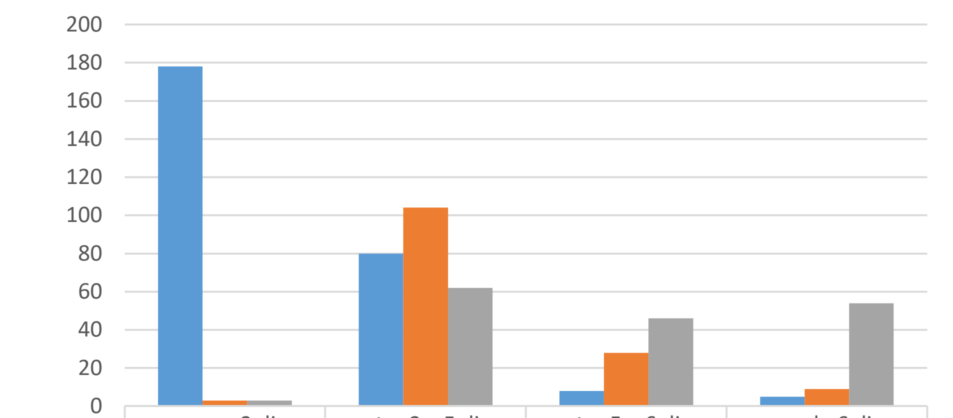


Figure 5.1.1. Monthly tours of fishing vessels during jack mackerel and mackerel fishing. A.- Year 2023, B.-Year 2024 and C.- Year 2025. The red dots represent the fishing hauls made by the boats.

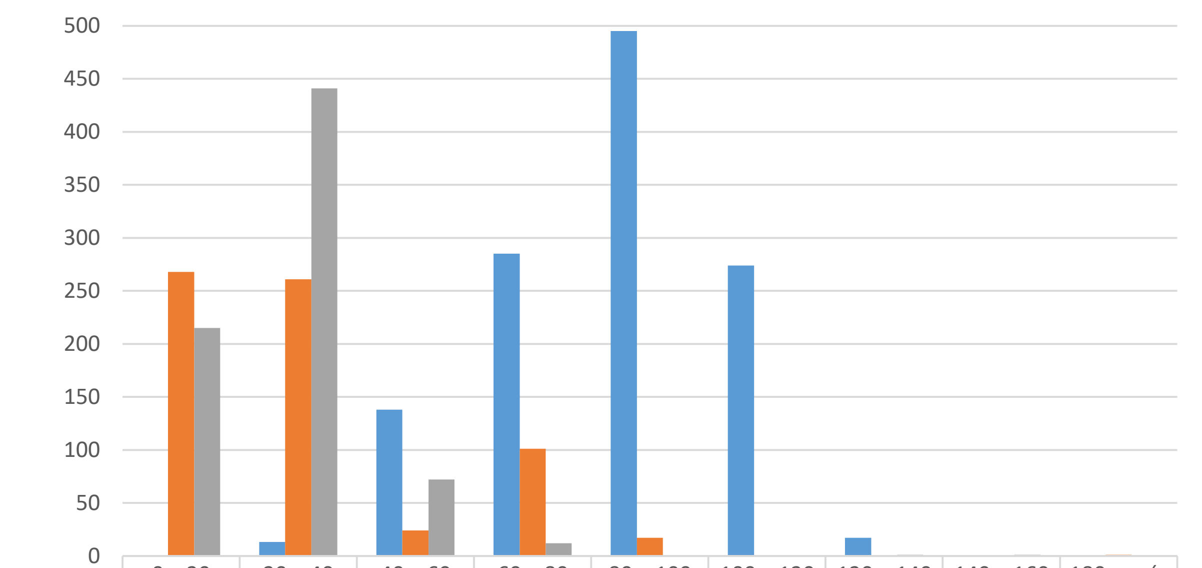
A total of 174 fishing trips corresponding to the month of June, July, August, September 2024 were analyzed and compared with the 165 trips of January, February, March 2025, it is observed that the Jack mackerel fleet in 2023 concentrated its activity in ranges of less than 3 days compared to 2024 and 2025 when its work was seen on average from 3 to 5. Figure 5.1.2 shows the analyses of the 3 years of fishing operations.



	menor a 3 dias	entre 3 a 5 dias	entre 5 a 6 dias	mas de 6 dias
2023	178	80	8	5
2024	3	104	28	9
2025	3	62	46	54

Figure 5.1.2. Duration and number of trips made by the SNP Industrial Fleet during 2020 to 2023.

Regarding the information on Lances (coves) carried out by the fleet, the predominance of the distance to coast within 40 miles from 2024 to 2025 is observed, in the case of this year it is observed that operations were concentrated within 80 mn3 which is interpreted that the resource was available unlike the year 2023 that reached more than 140 nm. Figure 5.1.3 shows the distribution of hauls made with respect to coastal distance.



	0 a 20	20 a 40	40 a 60	60 a 80	80 a 100	100 a 120	120 a 140	140 a 160	180 a más
2023		13	138	285	495	274	17		
2024	268	261	24	101	17				1
2025	215	441	72	12			1	1	

Figure 5.1.3. Number of coves made, categorized by the distance to the coast where they were made. (2020 to 2023).

With respect to the catch of Jack mackerel registered during the year 2025, an increase is observed during February 2025, being a lower catch compared to February 2023, with respect to the Mackerel resource, the catch is observed in the same way it presented a significant increase in catches during February of this year, but, even so, it did not reach the values obtained during 2023. Figure 6.2.1. It shows the distribution of downloads by month from 2023 to 2025.

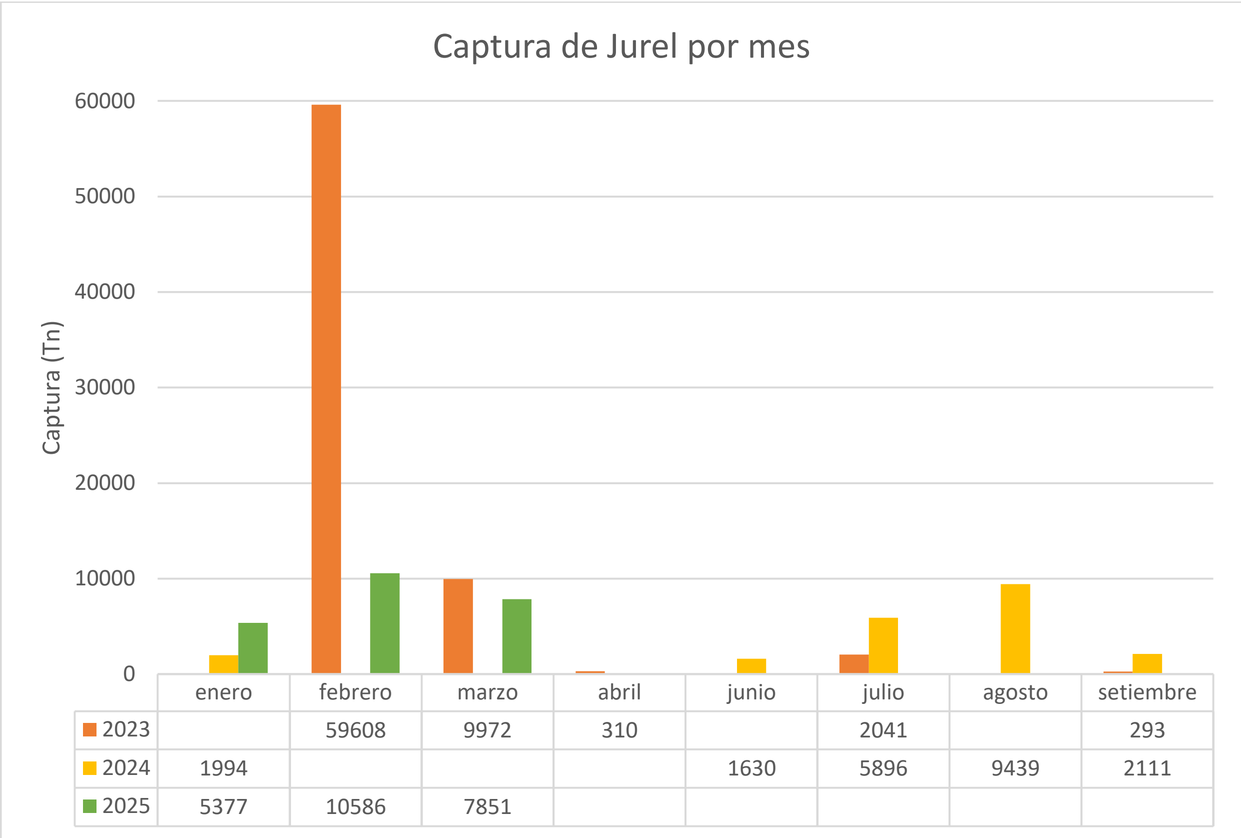


Figure 5.1.4. Monthly catches of jack mackerel during the 2023, 2024, and 2025 fishing seasons.

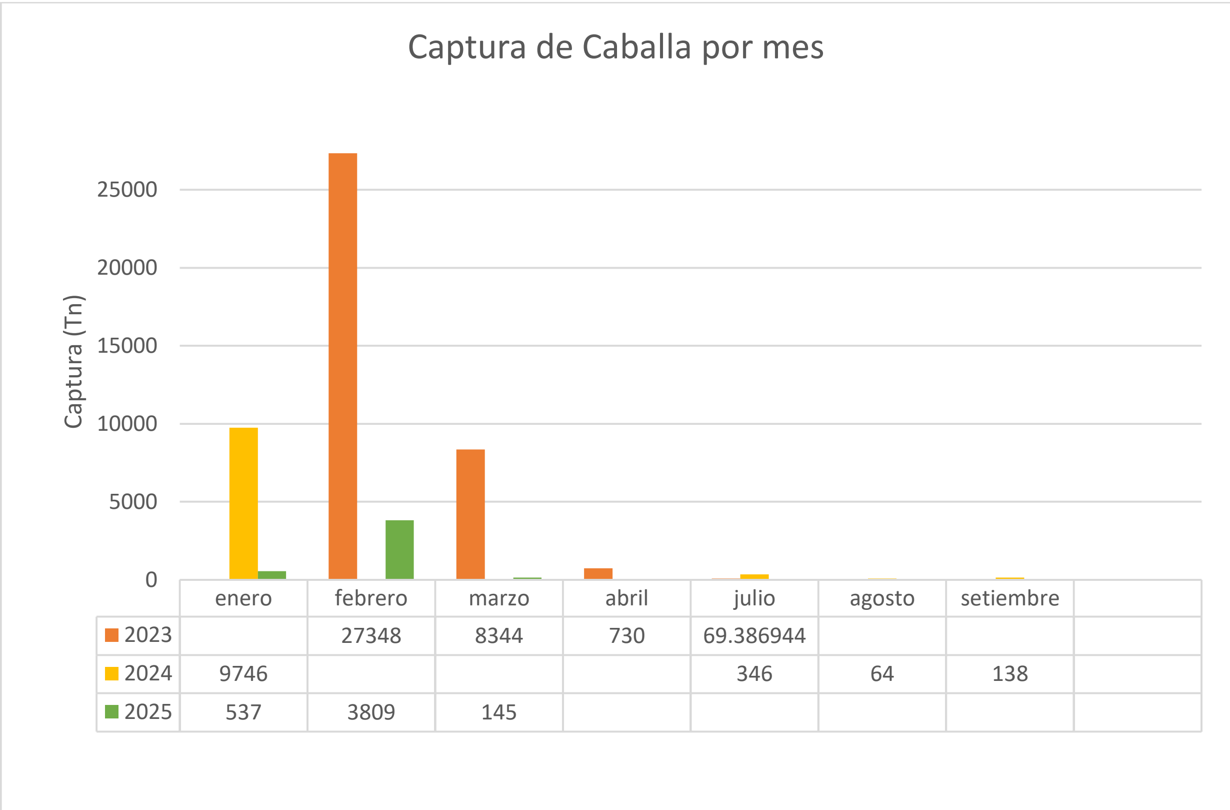


Figure 5.1.5. Monthly catches of mackerel during the 2023, 2024, and 2025 fishing seasons.

5.2. Effort and Capture per Unit of Effort (CPUE)

The fishing effort deployed by the industrial fleet during the first quarter of 2025 was lower than in 2023. The average duration of trips in 2025 was 60 hours, which was increased in the months of March and April.

As for the number of casts, the months of January and March 2025 were similar to 2023. Figure 5.2.1 shows the operational parameters of the flora during 2023 to 2025

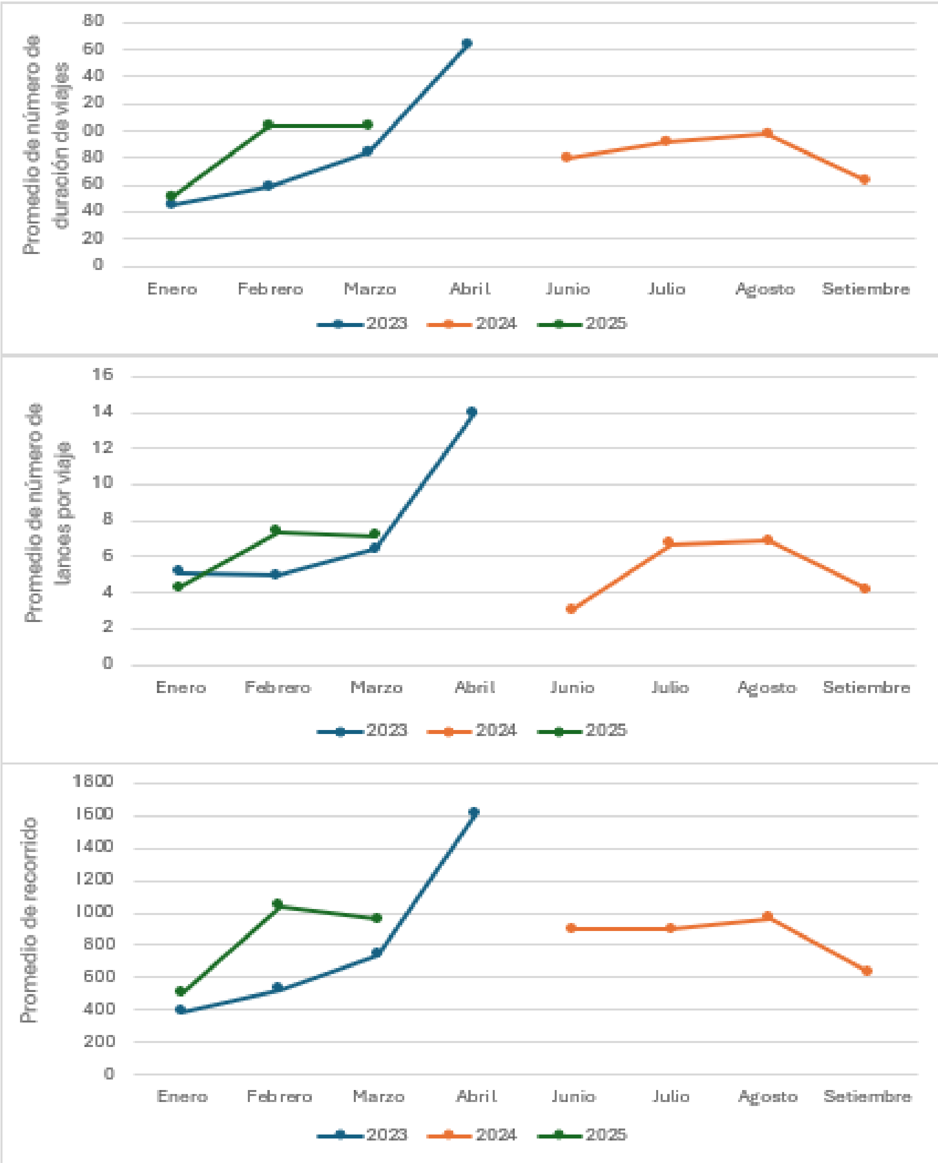


Figure 5.2.1. Comparative average of trip duration (upper panel, hours), number of trips (intermediate panel) and total route (lower panel, in nautical miles) during the months of January to April 2023 and 2025; June and September 2024.

With respect to the monthly values of Catch per Unit of Effort (CPUE) regarding the duration and route of the trip during the year 2024, the graphs show values similar to the first quarter of 2025. As for the hourly effort in both periods, they were in similar conditions and higher catch rates are observed during February 2023. Figure 5.2.2. show the monthly comparison of the CPUE from the years 2023 to 2025.

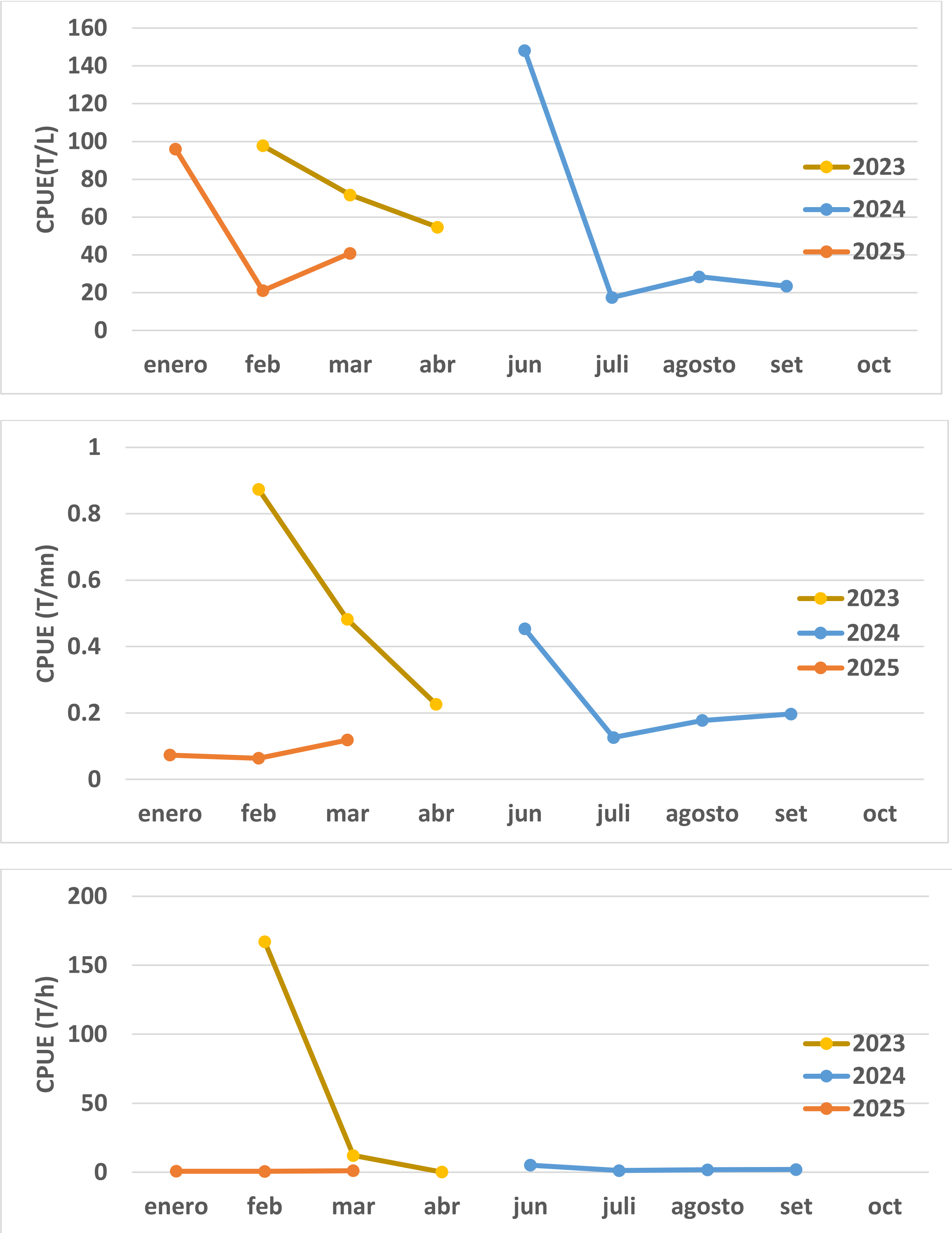


Figure 5.2.2. CPUE compared catch duration (tonnes) per set (upper panel), catch per nautical mile travelled (intermediate panel) and catch per hour made (lower panel) during the months of January to April, and from September to October, in the years 2023, 2024, and 2025.

6. Conclusions

6.1. Regarding the abundance of Jack mackerel and mackerel

- For Jack mackerel biomass, two regimes are observed, between 1983 and March 2024: one between 1983 and 2002, in which biomass fluctuated between medium and high levels; and another regime exists after 2002 with abundances varying between medium and low levels.

- However, in recent years there has been a positive trend in Jack mackerel biomass, i.e. an increase towards medium levels of abundance. Catches in the same period (1983-2024) also show, in general, better yields in years when biomass has been higher.

- For mackerel biomass, three regimes are observed, between 1983 and March 2024: one between 1983 and 1992 in which a uniform distribution was observed along the entire coast, although with medium abundances; the second period occurred between 1992 and 2002, in which the biomass fluctuated between medium and high levels; and a third regime exists after 2002 with abundances varying between medium levels and bass.

- However, in recent years there has been a positive trend in mackerel biomass, i.e. an increase towards medium levels of abundance. Catches in the same period (1983-2023) show, in general, better yields in years when biomass has been higher.

- A total of 5 930 schools of Jack mackerel and 1 936 schools of mackerel were analyzed, which had an average depth of 15.19 and 37.83 meters, respectively; these schools of Jack mackerel and mackerel were grouped into three types of clusters, and clusters 2 and 1 were the ones that presented a higher biomass (NASC) and size. but with a lot of variability.

6.2. Regarding biological aspects

- The size structure of Jack mackerel showed a range between 30 and 60 cm in total length (LT). With an incidence of juveniles (< 31 cm) of 0.1% in number, a slightly higher value compared to 2024. The main fashion was 50 cm and secondary fashions at 30 cm.

- In mackerel, the incidence of juveniles (< 29 cm) was 0.01% in number, with the main mode of 35 cm, with the highest mode in the 16th grade.

- The distribution of Jack mackerel according to latitudinal degrees shows greater amplitude in 2024 (16° - 18°), compared to the year 2025 (17° - 18°).

- From 2021 to 2025, the percentage of juveniles was lower than the 2.52%, which indicates that the industrial fleet has fished in areas characterized by the exclusive presence of adults.

- The percentage of juvenile mackerel registered in 2024 was higher with a value of 0.73% while in 2025 it had a value of 0.01%.

6.3. Identification of fishing effort

• The duration of fishing trips in the period 2024-2025 generally lasted 3 to 5 days.

• The fishing hauls carried out during the study period were, in general, between 20 and 40 nm from the coast, with the 2023 hauls being mostly outside 60 miles.

• In 2023, greater effort was required compared to the first quarter of 2025.

7. Recommendations

- Continue to promote improvement in the data collection process on board the fleet, including Jack mackerel and mackerel biometrics, as well as the collection of information on vessel interactions with major top predator species.

- To reiterate the recommendation to carry out retrospective acoustic analyses of the Centre of Mass Concentration Index and to know the evolution of the density indices of the presence of Jack mackerel and mackerel since the 1980s.

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