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**Spatio-temporal dynamics of Chilean Jack Mackerel fishery off south-central
Chile in 2023**

Republic of Chile

Spatio-temporal dynamics of Chilean JackMackerel fishery off south-central Chile in 2023

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Abstract

In year 2023 (January-June), all the fishing activity for Chilean Jack Mackerel (*Trachurus murphyi*) took place within the coastal strip delimited by the 60 nm offshore, continuing a trend established since 2020. This condition was favoured by the high level of aggregation, commercial abundance, and recurrent sighting zones presented by the schools of *T. murphyi* near the coast. Few incursions were recorded in the oceanic sector, which did not yield positive results in locating fishing zones, similar to what has been observed in the last 4 years.

Monthly size structure showed a higher presence of adults, with a low presence of specimens below the legal minimum size (<26 cm FL), which did not exceed 0.13% (March). Notably, there was a progressively decreasing record of the size fraction of *T. murphyi* in the range of 31-40 cm FL from February to June 2023, concurrently with an increase in the older fraction of 41-50 cm FL.

Biological-fishery background of the *T. murphyi* fishery (2023).

Landings

On a monthly scale, the landings of *T. murphyi* between 2017 and 2023 (up to June) have shown a markedly seasonal pattern, driven by minimal landings in spring associated with a decrease in schools in the fishing area, primarily due to the reproductive migration of this species. By late spring (December), the schools of *T. murphyi* were observed returning to the fishing area, marking the beginning of the fishing activity for this resource once again. Throughout the rest of the summer and fall, average landings remained close to 60,000 tons. However, the presence of maximal values in February is notable (Figure 1). Subsequently, gradually during the winter, the landings decreased until becoming close to zero again in the following spring. From January to June 2023, the observed seasonal trend since 2017 has continued (Figure 2). It is worth highlighting that during this year, the maximum landing values for the analysed series (2017-2023) were reached, with a landing volume up to June totalising 546,548.8 tons. This represents an increase of 18.3% compared to the amount landed during the same period in 2022.

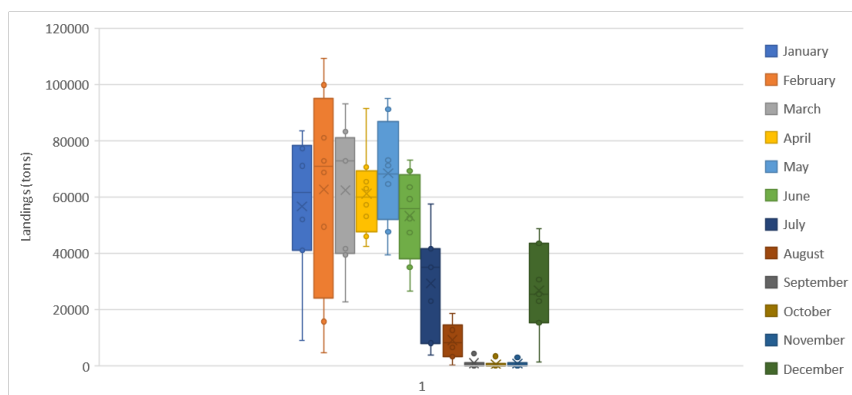


Figure 1. Boxplot of monthly landings of *T. murphyi* from the industrial fleet of central-southern Chile between 2017 and 2023 (up to June), based on the data from Sernapesca.

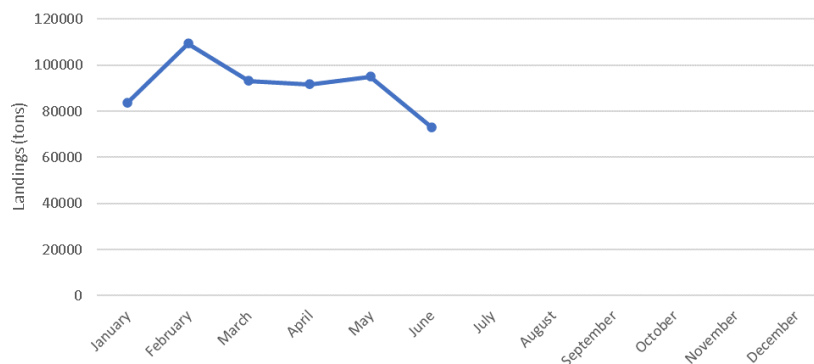


Figure 2. Monthly landings of *T. murphyi* from the industrial fleet of central-southern Chile in 2023 (up to June) based on the data from Sernapesca.

Monthly Size Structure 2023

The Fisheries Research Institute conducts biological monitoring and sampling of the *T. murphyi* at four landing sites of purse seine vessels operating in this resource. There is also maintained a scientific observer program to obtain biological information from the fishing areas. This has allowed them to build a significant biological database for this resource. In this case, monthly size structures of *T. murphyi* expanded to the monthly catch have been registered for the year 2023 (Figure 3).

During these months, there was a notable presence of a size structure primarily composed of adults, with low presence of specimens below the legal minimum size (<26 cm FL). This fraction did not exceed 0.13% (March) in the considered period. Overall, a main mode was recorded, fluctuating between 34 and 37 cm FL during the summer and autumn period. However, towards the end of autumn (May), main modes of 44 and 45 cm FL were observed.

In this context, specimens of *T. murphyi* in the range of 31-40 cm FL represented the predominant group in the landings of the first quarter, reaching 85% of the total in February. However, from March to June, there was a progressive decline in its proportion, dropping to below 30% in June. On the contrary, the size fraction of 41-50 cm FL increased, reaching a value close to 70% in May and June. This determined that the *T. murphyi* catches made in late autumn and winter of 2023, primarily occurs on the older size fraction of this resource.

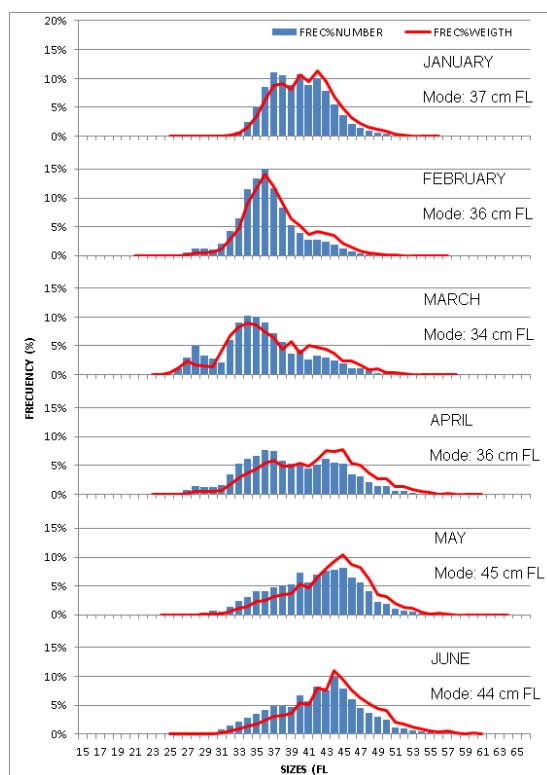


Figure 3. Monthly Length frequencies of *T. murphyi* present in the catches of the Chilean fleet during 2023. (source Inpesca).

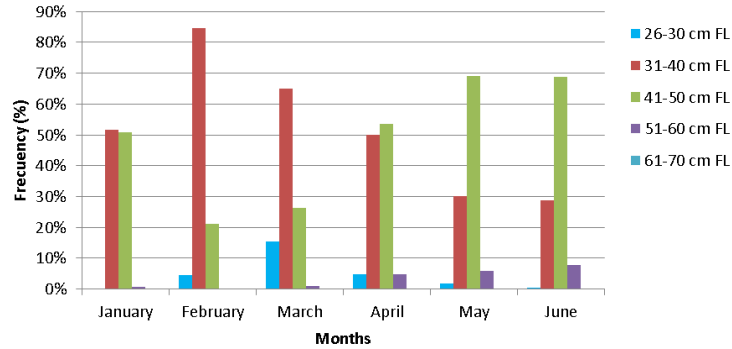


Figure 4. Proportion of size groups present in the landings of *T. murphyi* between January to June 2023 (source: Inpesca).

Spatial distribution of the fishing operation in 2023

During the first 6 months of 2023, the jack mackerel fishing activity exhibited a coastal distribution, confined within the 60 nm offshore zone (Figure 5). In January, the fleet restricted its operations within an area extending 120 nm north of Santa María Island along the longitudinal direction. In February, there was a progressive extension northward of the fishing operations, which surpassed 240 nm in June. Additionally, from April onward, the fishing operations were observed to be oriented towards the south of Santa María Island (Biobío Region), even extending further south of Mocha Island (Araucanía Region). This wider operational area led to an increased search time.

The limited incursions that were made outside of this zone in search of smaller size schools (28-35 cm FL), driven by the need to meet certain industry product requirements, confirmed the absence of commercially significant *T. murphyi* schools west of this zone.

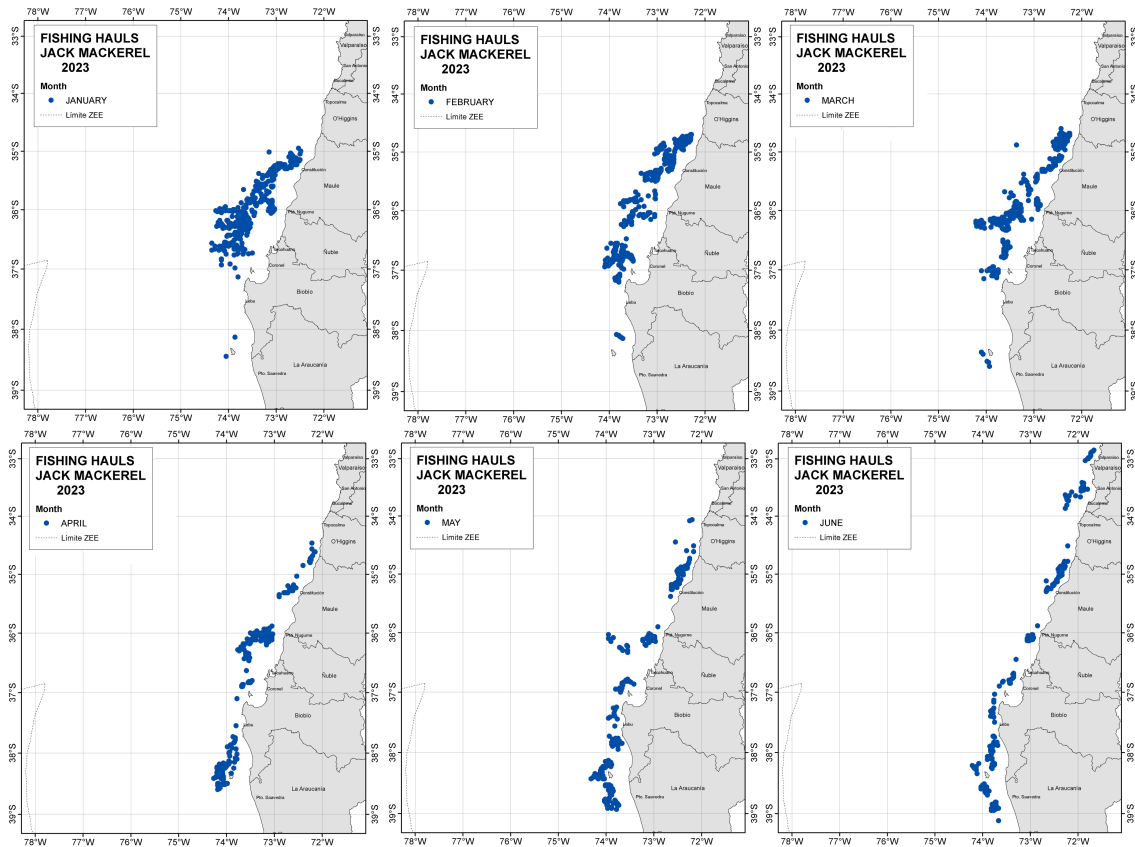


Figure 5. Spatial-temporal distribution of fishing hauls for *T. murphyi* recorded by the Chilean fleet during 2023 (June) (Source: Inpesca)

Analysis of fishing sets density during 2023

In this analysis, the Kernel density tool (Spatial Analyst of ArcMap 10.2) was employed, which enables the calculation of a magnitude per unit area based on the positions of *T. murphyi* fishing hauls. It utilizes a kernel function to adapt a smoothly tapered surface to each point or position of a fishing haul for this resource. In this case, monthly data was converted to a shapefile and subsequently projected into UTM coordinates (WGS84-18S). By subjecting these shapefiles to the Kernel density geoprocessing, they were transformed into raster format, from which the heat map for the fishing sets of each analyzed month of 2023 was derived (Figure 6).

The results of the *T. murphyi* fishing haul density analysis reveal that throughout 2023, the fleet carried out its fishing operations in focal points that have been prevalent during the analysed period of the year. These were situated off the northern part of the Maule region, Ñuble, and the southern part of the Biobío region, exhibiting a greater dispersion compared to what was observed in 2022 (González *et al.*, 2022). In these focal points, the fleet managed to capture a significant portion of its annual quota.

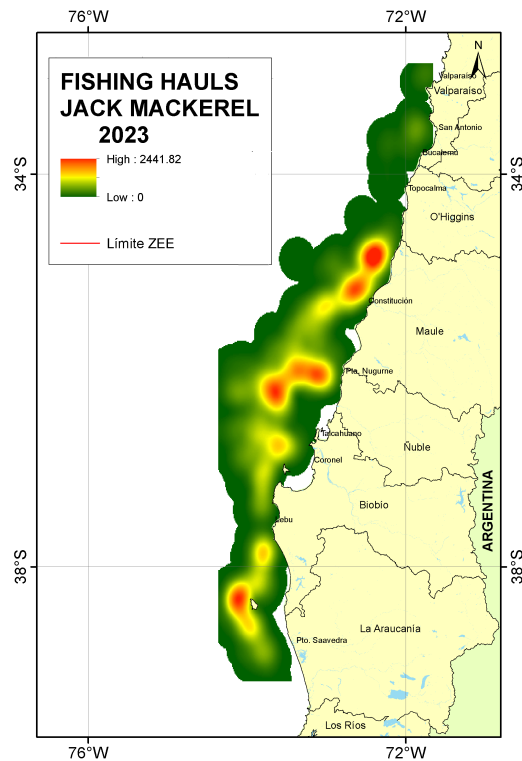


Figura 6. Heat maps relative to the density of *T. murphyi* fishing hauls conducted by the purse seine fleet in the central-southern region, for the year 2023 (June) (Source: Inpesca)

Discussion and Conclusions

The *T. murphyi* fishery during the year 2023 has shown a coastal distribution, confined within the 60 nm offshore zone, similar to what has been recorded since the year 2020 (Gonzalez *et al.*, 2022). This strongly aggregated distribution pattern along the coast was previously recorded in the 1980s (Böhm *et al.*, 1993), a period in which the distribution of this resource also exhibited an oceanic pattern, establishing what was known as the "jurel belt" (Elizarov *et al.*, 1993) in the South Pacific. The latter condition doesn't seem to be the case anymore. In this regard, acoustic surveys conducted by IFOP in 2020, 2021, and 2023 (personal communication) to estimate the biomass of this resource have indicated very low presence beyond the 60 nm offshore zone. At the same time, the search conducted by European community vessels in 2021 and 2023, during the fall season, in the oceanic distribution area of *T. murphyi* associated with the "jurel belt," indicated the nearly non-existent presence of this resource. This led to the need to seek other fishing areas, which ended up being located in the oceanic area (outside the EEZ) off the northern coast of Chile (between Arica and Antofagasta), where they have continued their fishing operations. These findings largely confirm that the resource is not present in the oceanic sector off central-southern Chile and continues to be highly concentrated in the coastal zone during 2023. This is a characteristic for which there are no similar records in past decades.

Regarding the sizes of *T. murphyi*, it is worth noting that the fishery in the central-southern region of Chile has continued to capture mainly adult specimens, consistent with observations in previous years (González *et al.*, 2022). A progressive decrease in the size fraction of *T. murphyi* within the 31-40 cm FL range was highlighted from February to June 2023, along with a simultaneous increase in the older fraction within the 41-50 cm FL range. This decline below 50% for this fraction, recorded in May, influenced the decrease in landings observed in June. This was largely caused by increased search times that allowed significant mobility of the fishing fleet towards other coastal sectors located at the northern and southern extremes of the central-southern area.

References

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