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SPRFMO-SCIENTIFIC COMMITTEE

Jumbo squid (*Dosidicus gigas*)

September 2023.

ABSTRACT

The jumbo squid fishery has the participation of both artisanal and industrial vessels. In 2022, the artisanal fleet landed 97,013 tons of this resource, representing 99.31% of the national total (97,687 tons). The artisanal fleet targeting this resource is made up of 1,787 vessels whose length is equal or less than 18 meters. However, the main fishing operation was carried out by vessels of length equal or less than 12 meters, which represented 96,98% of the total number of artisanal vessels, equivalent to 1733. This type of vessel ($\leq 12\text{m}$) altogether landed more 99.00 % of the total landings for the artisanal sector.

On the other hand, during 2022, the participation of the industrial fleet over this resource was developed as bycatch while targeting other resources, and represented landings of 674 tons, representing 0.69% of the total landings for jumbo squid in Chile during 2022 (97,687 tons). The industrial landings of jumbo squid involved 2 factory vessels and 40 vessels of which 19 landed more than 3 tons per fishing trip. Out of those 19 vessels, no factory vessels were involved: 15 operated with purse seines (78.95%), 3 (15.79%) with trawls and 1 with jigging (5.26%). Regarding the total tons landed by the industrial fleets, and its relationship with the fishing gear used, during 2022, 59,00% corresponded to catches performed with trawls, 37.33% with purse seine and only 3.67% with jigging. During 2022, bycatch of marine mammals, seabirds, or sea turtles was not observed for both fleets.

Finally, is important to note that all catches of jumbo squid were performed within the Exclusive Economic Zone of Chile (EEZ).

1 DESCRIPTION OF THE FISHERY

1.1 Composition of the Fleet.

As of 2020 and obeying to legal changes, in Chile, catches of jumbo squid as target species are carried out only by the artisanal fleet. However, the industrial fleet has continued to capture this resource, but only as a bycatch.

A TAC is established annually for jumbo squid, which in 2022 corresponded to 200,000 tons. However, this measure no longer establishes differentiated target allocations for artisanal or industrial sectors, being intended exclusively as an objective for the artisanal sector.

Artisanal Fleet

During 2022, the artisanal fleet landed 97,013 tons, equivalent to 99.31% of the national landings for jumbo squid (97,687 tons). A total of 1,787 artisanal boats of lengths equal to or less than 18 meters participated in this activity (Table 1). The largest volume of the artisanal fishing operation was performed by vessels of lengths equal to or less than 12 meters (1,733 vessels), representing 96.98% of the artisanal fleet altogether in 2022. These vessels ($\leq 12\text{m}$) landed more than 99 % of the total landings for the artisanal sector.

Amongst the artisanal fishing gears, where jumbo squid was caught during 2022, gillnet, longline, and jigging, among others were identified. However, the target fishery over this resource is carried out only with jigging, by a total of 1,779 vessels. The landings of jumbo squid by the artisanal fleet accounted for 99.97% of the landings for this resource in Chile during 2022. On the other hand, landings of jumbo squid with other gears only accounted for 0.03% of the total.

When analyzing the 2010-2022 period, it is identified that from 2011 onward the number of vessels operating on jumbo squid has exceeded 1,000 vessels, with 2012 being the year with the highest number registered. However, the increase in the number of vessels has not been related to a significant increase in landings; in 2022, the number of vessels operating on jumbo squid was 1,787 (Table 1), a higher number than that registered in 2021.

Table 1: Artisanal fleet composed of vessels equal to or less than 18 meters in length, which operated in Chile to capture *Dosidicus gigas* in the 2010-2022 period.

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
N° Boats ($\leq 18\text{m}$)	706	1880	2180	1540	1747	1419	1657	2102	2056	1066	2079	1647	1787
landing (t)	66049	138708	114955	97224	125396	104242	141576	113405	109296	17406	53967	52904	97013

Source: SERNAPECSA

Industrial Fleet

Unlike before 2020, the fishing activity of the industrial fleet during the last three years (2020-2022) over jumbo squid was developed only as bycatch, accounting for a total of 674 tons in 2022, which corresponds to 0.69% of the total landings for jumbo squid in Chile during this year (Table 2).

The industrial landings of jumbo squid involved 2 factory vessels and 40 vessels of which 19 landed more than 3 tons per fishing trip. Out of those 19 vessels, no factory vessels were involved; 15 vessels operated with purse seines (78.95%), 3 with trawls (15.79%), and 1 with jigging (5.26%). Regarding the total tons landed by the industrial fleets, and its relationship with the fishing gear used, during 2022, 59% corresponded to catches performed with trawls, 37.33% with purse seine and only 3.67% with jigging. The latter corresponds to the target catches made by only one industrial vessel that used jigging. Thus, 96.33% of jumbo squid landings were as bycatch in the operation over other fisheries.

During the 2010-2022 period it is observed a decrease in the number of industrial vessels operating in the jumbo squid fishery. 2010 and 2014 stand out as those years in which more tons were landed by the industrial fleet. Due to legal changes, during 2020, 2021 and 2022, landings of the industrial fleet corresponded mostly to catches as bycatch, therefore, the number of vessels in Table 2 reflect this condition. Prior to 2020, the number of vessels included in table 2 reflect the operation of the industrial target fleet over jumbo squid.

Table 2: Industrial vessels with landings greater than 3 tons of *Dosidicus gigas* per fishing trip, which operated in Chile within 2010-2022 period and total landings (t) of the industrial fleet per year.

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
N° Ships	83	86	57	32	35	32	18	19	12	15	19	12	19
Total Landing (t)*	131095	23545	29597	9025	51206	39433	39338	39132	35350	40665	1039	663	674

Source: SERNAPESCA

1.2 Catches, Seasonality of Catches, Fishing Grounds and Bycatch.

1.2.1 Catches

Since 2012, it has been established a catch quota for jumbo squid in Chile, which in 2022 corresponded to 200,000 tons.

When analyzing the 2012-2022 period, it is observed that landings of jumbo squid surpassed 100,000 tons until 2018. However, during 2019, the landings showed a significant decrease mainly explained by the sharp decline in artisanal landings. This responded to a low availability of this resource in the fishing grounds targeted by this fleet. On the other hand, the industrial fleet landed the total of its allocated quota until 2019 (Figure 1).

During the 2020-2021 period, the jumbo squid landings reached total values of around 55,000 tons, with a predominance of the artisanal fleet and a low contribution of the industrial fleet. However, in 2022 the jumbo squid landings increased (97,013 tons), maintaining a predominance of the artisanal fleet and a low contribution from the industrial fleet (674 tons) (Figure 1).

2016 stands out as the year in which the artisanal fleet landed the largest volume of this resource for the 2012-2022 period.

It is important to note that all catches of jumbo squid have been conducted within the Chilean Exclusive Economic Zone (EEZ).

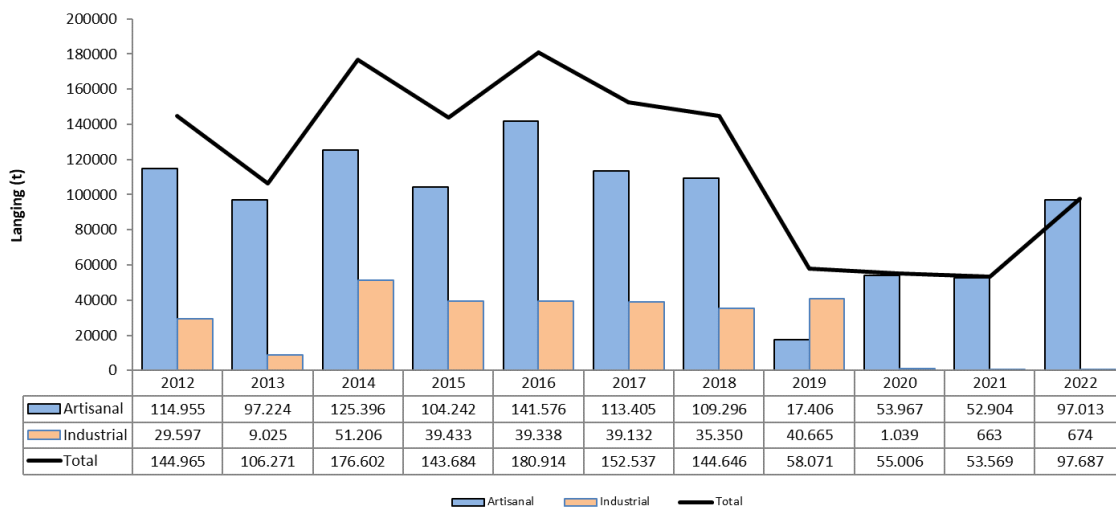


Figure 1. Landings (t) of *D. gigas* in the 2012-2022 period, by the artisanal and industrial fleets (Source: SERNAPESCA).

1.2.2 Temporality of catches during 2014-2022

In general, catches of jumbo squid are concentrated during the first 8 months of each year, decreasing from September-October. In this regard, the monthly seasonal variations recorded are driven by operational and economic aspects of the fishery (Figure 2). During 2022, the fishing activity on jumbo squid was mostly concentrated between March and September, with June showing the highest landing rate, corresponding to 19,403 tons.

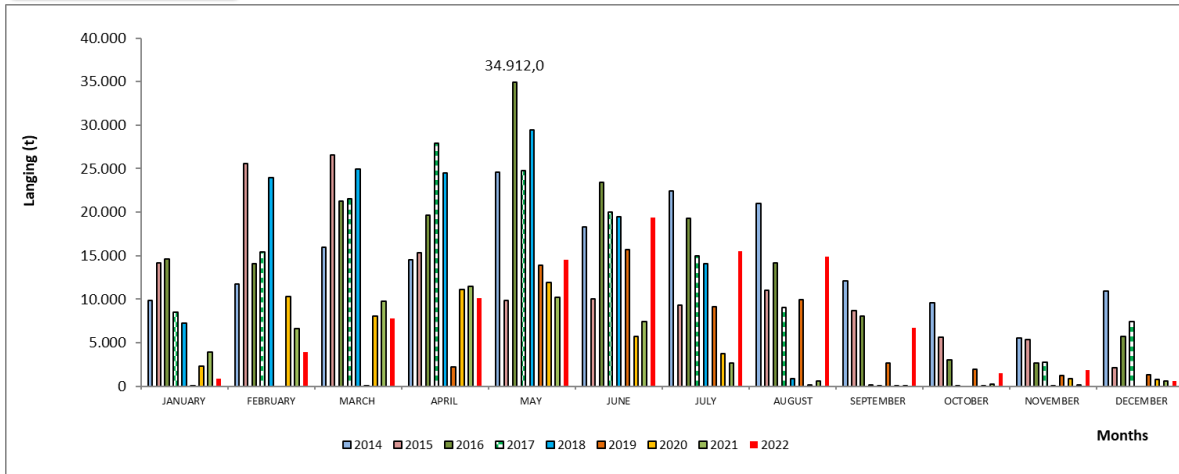


Figure 2. Landed tons of *D. gigas*, distributed monthly for the 2014-2022 period (Source: SERNAPESCA).

1.2.1 Spatial Distribution of Catches

Regarding the geographical distribution of the artisanal operations, and similarly to what was reported in 2021, they were concentrated mainly between 29°21'SL and 38°30'SL (Figure 3). However, the largest operations were registered in the Biobío Region (36° 00'-38°30'SL) and in the Valparaíso Region (33°00'-33°55').

On the other hand, the geographical distribution of the industrial fleet that operated on this resource in 2022 was developed as bycatch. These were distributed mainly between 33°SL and 39°SL, (Figure 4). However, the highest operations were recorded in the Biobío Region, around 36°00'SL and 37°45'SL.

1.2.2 Fishing Grounds and Bycatch

Artisanal fleet

As in 2021, no bycatch of marine mammals, seabirds or sea turtles were observed during 2022 in the jumbo squid artisanal fishery. This condition is not new, and it relates to the high selectivity of the fishing gear used by this fleet.

Industrial Fleet

During 2022, the extractive activity on jumbo squid by this fleet was carried out mainly as bycatch for other target fisheries. These was developed as bycatch while targeting other resources, mainly Hoki and Hake. In this context, the assessment of the interactions and incidental bycatch of marine mammals, seabirds and sea turtles is not applicable in this case. However, these other fisheries are subject to mandatory discard reduction plans, use of incidental bycatch reduction devices, and compliance control through electronic monitoring in 100% of the vessels, therefore the potential discards under control.

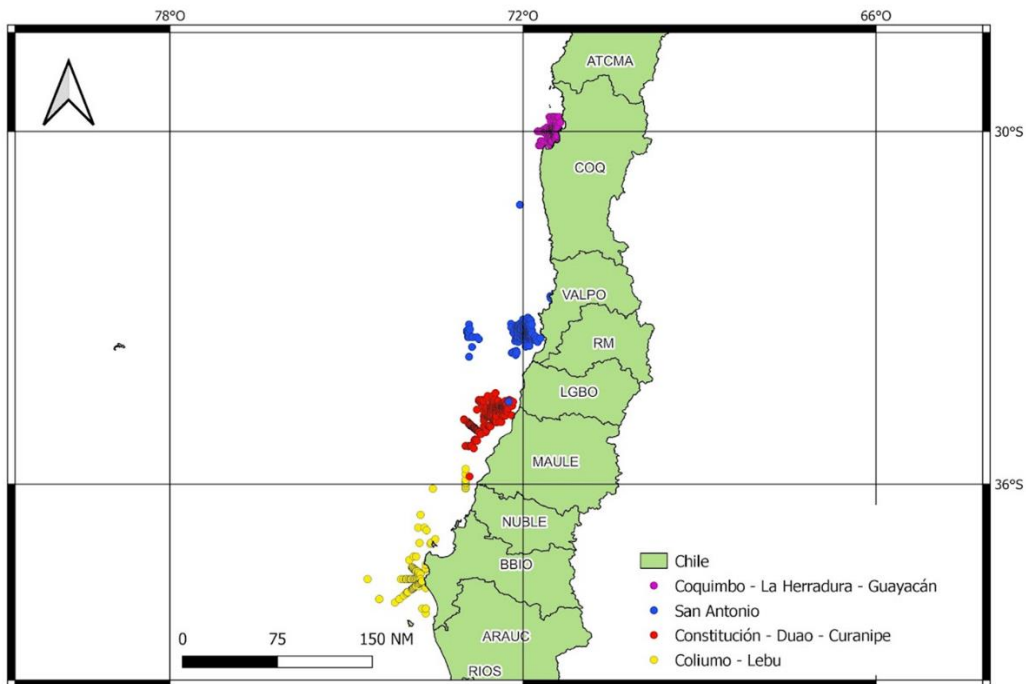


Figure 3.-Spatial distribution of monitored fishing sets with catches of *D. gigas* during 2022 in the artisanal fleet (Source: IFOP).

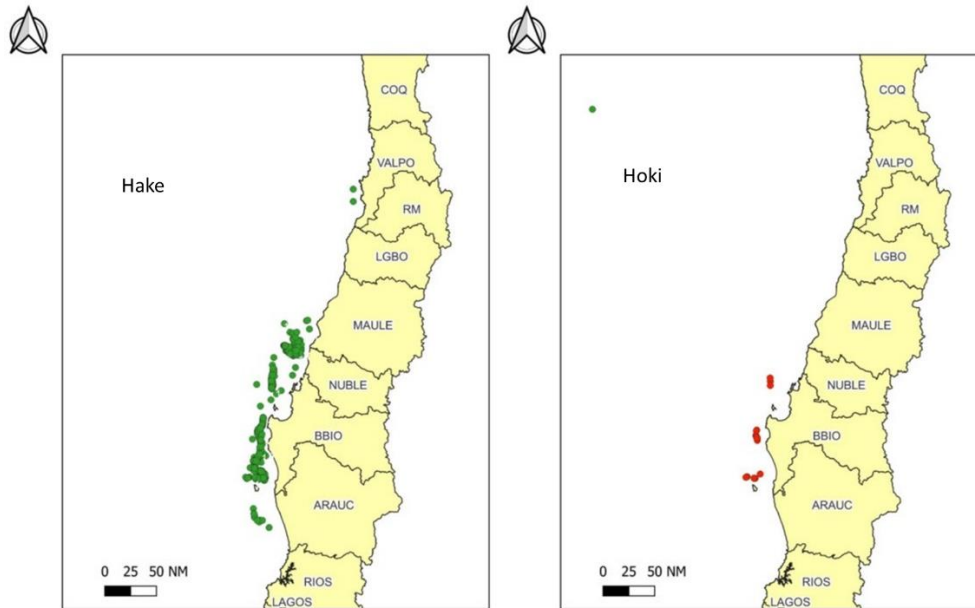


Figure 4.-Spatial distribution of monitored fishing sets deployed by the industrial fleet with catches of *D. gigas* as bycatch in the Hake and Hoki target fisheries during 2022 (Source: IFOP).

2 EFFORT AND CPUE FOR *Dosidicus gigas* FISHERY

Artisanal Effort

As reported in previous years, the effective duration of fishing hours was considered as an indirect indicator of fishing effort for the artisanal fleet. In this context, this indicator has varied between 7 and 8 hours approximately from 2015 to date (Figure 5).

Industrial Effort

As in 2021 and since the catches of jumbo squid for the industrial fleet are performed as bycatch while targeting other fishing resources, during 2022 it was not possible to calculate effort for this sector, discontinuing what had been done until 2019. This situation will be permanent for Chile, in accordance with current legislation.

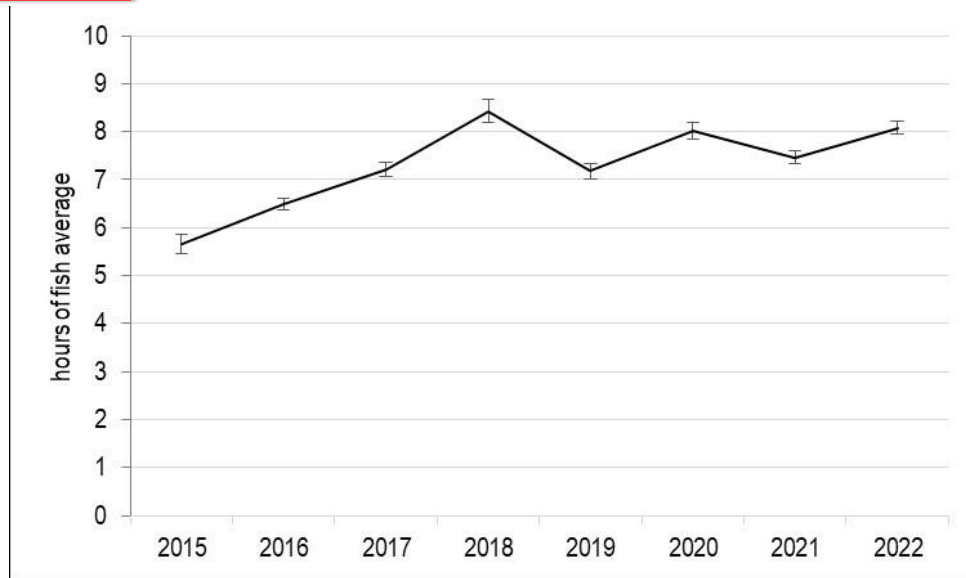


Figure 5.- Average fishing effort per trip, expressed in effective fishing hours, per year. Fleet of vessels smaller than 12 m in length. Coefficient of variation. The 2015-2022 period. Source: IFOP.

Artisanal Yield (CPUE)

The CPUE indicator for the artisanal fleet was obtained from the target fishing operation carried out with jigging fishing gear and expressed in kilograms (hours of fishing jigging). In this regard, the artisanal CPUE has shown a decreasing trend from 2015 to 2019 and a positive trend from 2020 to date. It is noted that the results for CPUE obtained in 2022 show a similarity with the observed in 2021 (Figure 6).

The lowest values for artisanal CPUE in each annual series corresponded to the summer, possibly explained by a lower availability of jumbo squid on the coast of Chile at that time, related with a possible movement of this resource towards oceanic areas.

From the end of 2017 until 2022, the fishing activity on jumbo squid has shown an intermittent behavior, with periods the scant activity between September and January of each year, which may be related to a possible fall in either the fishing availability or the scant intentionality of the fleet on this resource during the spring-summer period.

In general, the CPUE for the artisanal fleet showed a slight positive trend from 2019 to 2022 by the end of this period (2022). However, in the last 2 years (2020-2021) a progressive increase in this indicator has been observed, with higher values in the first half of each year, which by 2021 were close to 100 kg / (hour * jigging) (Figures 6 and 7).

Industrial Yield (CPUE)

As indicated in the previous item "industrial effort", a CPUE indicator for the industrial fleet cannot be obtained to give continuity to the series of data reported until 2019, in accordance with the legislation in force in Chile. However, improvements are being made in order to establish some indicator that allows to report the change in the behavior of the extraction of jumbo squid as bycatch by this fleet.

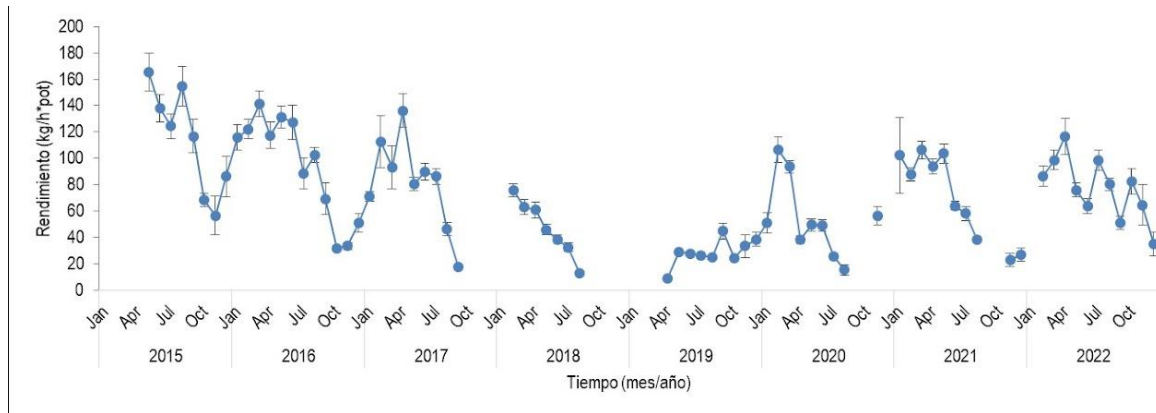


Figure 6.- Historical yield, expressed in kilograms/ (hours of fishing*jiggers) per year and month, of the artisanal fleet targeting jumbo squid, period 2015-2022. Source IFOP.

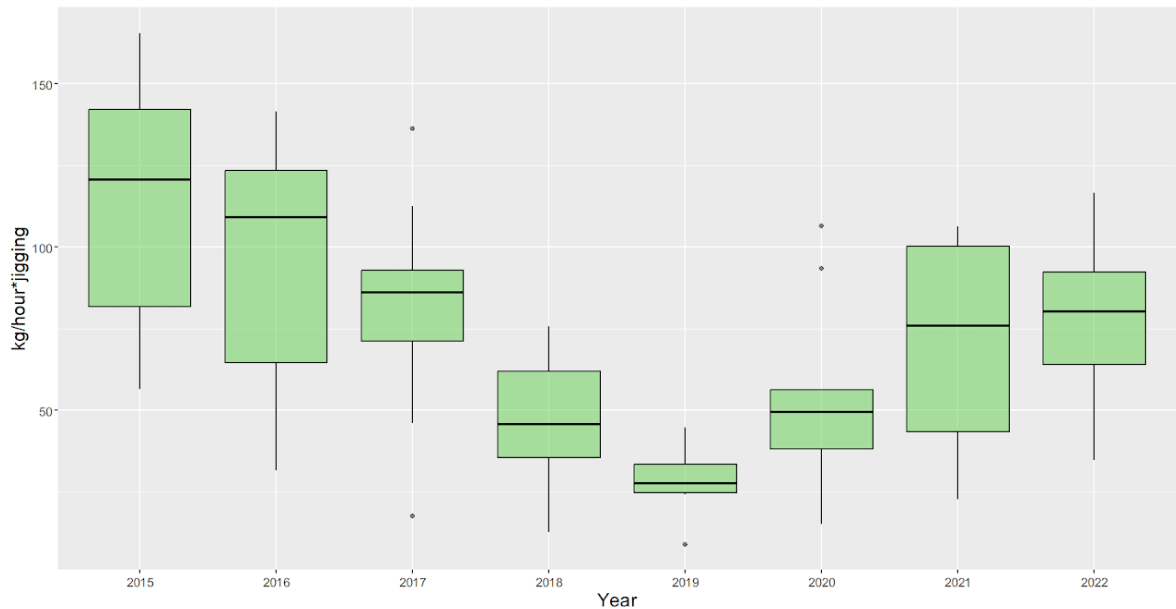


Figure 7.- Boxplot of fishing CPUE (kg / (hour * jigging)) between 2015 and 2022 in Chile. The center line in the boxes represents the median of the data, the bottom horizontal line represents the 1st quartile, while the upper horizontal line represents the 3rd quarter, the vertical lines represent the maximum minimum values and the points outside the "outliers" boxes of the data.

3 RESEARCH PROGRAMS

The research programs for the jumbo squid fishery during 2022 were mainly performed by the Fisheries Development Institute (IFOP) and complemented by other projects required by the fishing authority. The scientific and technical background provided by these projects provided advice to support decision-making process.

The projects developed annually by IFOP are:

- **Fishery monitoring of jumbo squid (*Dosidicus gigas*)**

This study allows the collection of information on the main biological and fishery dependent data and indicators associated with the jumbo squid fishery and its bycatch. Monitoring was concentrated in the regions of the country where the fishery is developed with a higher intensity.

- **Assessment of status and possibility of exploitation**

This project aims to provide the Technical Scientific Committee with the necessary technical advice, data, and information necessary for the analysis of status and exploitation possibilities, determining the levels of Biologically Acceptable Catch for the next annual extractive season in the jumbo squid fishery.

- **Research and monitoring program for discards and incidental bycatch.**

This project was aimed to diagnose and quantify discards as well as incidental bycatch and interactions of the jumbo squid target fishery with seabirds, marine mammals and sea turtles. The information was gathered by observers onboard and the results showed that this fishery has no issues in these matters, which is mainly explained by the selectivity of the fishing gear used. Despite the good results, according to legal requirements, a plan to reduce these practices must be established, which in this case will rather focus on maintaining the conditions that result in null or very low levels of discards and incidental bycatch.

Other projects developed:

- **FIPA PROYECT N° 2020-20: Population genetics of *Dosidicus gigas* present in national territory.**

The results of project of sequencing the mitochondrial genes COI and ND2 indicated that all the studied localities in Ecuador, Peru, and Chile, and as a whole, are characterized by low genetic diversity and an absence of spatial genetic structure. Therefore, it is suggested that there would be one genetic unit of *D. gigas* in the South Pacific Ocean. This low genetic diversity would be associated with a recent population expansion (~40000 - 50000 years ago) according to the analyses performed. The absence of spatial genetic structure is associated with the high vagility of both adults and eggs and paralarvae of jumbo squid.

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

4.1 Biological sampling

The collection of all the biological data from the industrial fleet was carried out through scientific observers onboard, mainly in the Biobío Region, from catches of jumbo squid obtained as bycatch while targeting other resources.

Regarding the collection of data by the artisanal fleet, it was also carried out by scientific observers but mainly at landing sites and to a lesser extent onboard vessels when feasible. Specific biological sampling was carried out in processing plants or at landing sites when possible.

Tables 4 and 5 show the number of specimens sampled (length and biological) for the industrial and artisanal fleet, respectively.

Table 4.- Number of trips, sets and specimens sampled from the catches of jumbo squid as bycatch for the industrial fleet, according to the type of sampling in 2022.

Year	Type of sampling					
	Length			Biological		
	Fishing trips	Fishing sets	Specimens	Fishing trips	Fishing set	Specimens
2022	13	15	566	19	25	544

Fuente IFOP

Table 5.- Number of trips, sets and specimens sampled from the artisanal fleet targeting jumbo squid, according to the type of sampling in 2022.

Region	Type of sampling			
	Length		Biological	
	Fishing trips	Specimens	Fishing trips	Specimens
Coquimbo	50	1487		
Valparaiso	144	5017	23	664
Maule	85	3207	1	30
Biobío	37	1145	36	1078
Total	316	10856	60	1772

Source IFOP

4.2 Length and age composition of catches

Artisanal Fleet

For the period 2015-2022 it is identified that the average size, except for 2019, was above the sexual maturity reference size of 63.8 cm, with lengths fluctuating from 65 to 85 cm. In 2022, the presence of sampled individuals among the 36 cm and 94.5 cm (Figure 8) is highlighted.

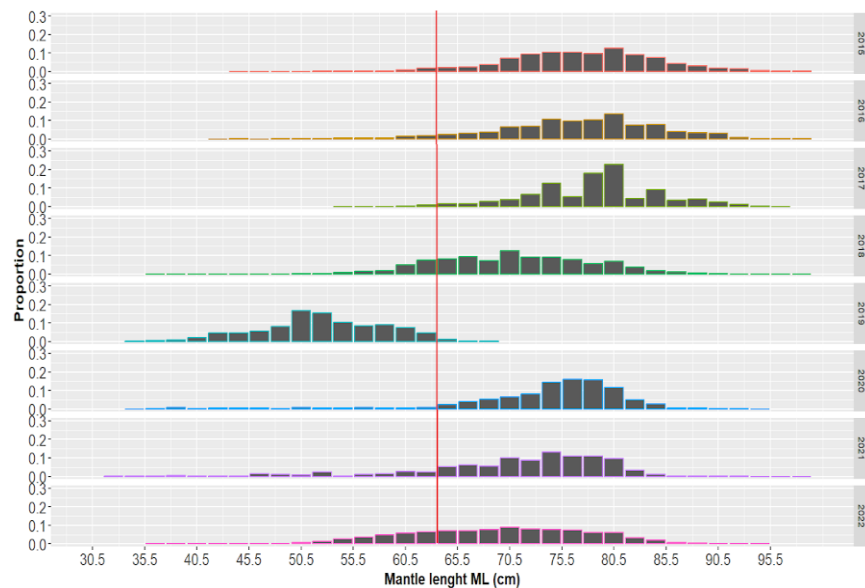


Figure 8.- Composition of mantle length (cm) weighted to artisanal catches of jumbo squid (both sexes combined) Period 2015-2022. Vertical red line corresponds to the sexual maturity reference size of 63.8 cm (Liu *et al.* 2010). Source: IFOP.

Industrial fleet

When analyzing the length structures of the jumbo squid catches obtained by the industrial fleet in the 2014-2022 period, for both sexes combined and weighted to the catch, it is observed that the operation has been generally carried out on specimens of sizes above the sexual maturity reference size of 63.8 cm (Liu *et al.* 2010). However, during 2019, 52% of the specimens monitored were under reference size.

It is important to mention that in 2020, 2021 and 2022 the length structures of jumbo squid in the industrial fleet were obtained from jumbo squid specimens caught as bycatch while targeting other resources.

The size structure of the industrial catch observed during the year 2022 had a distribution between class marks 24.5 cm and 84.5 cm ML. between class marks 24.5 cm and 84.5 cm ML, with a mode at 64.5 cm (Figure 9).

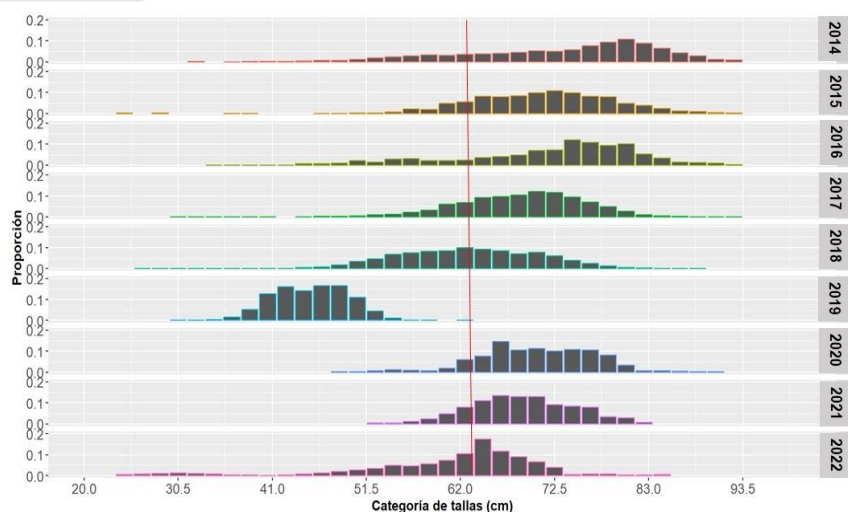


Figure 9.-Composition of mantle length ML (cm) weighted to industrial catches of jumbo squid (both sexes combined). Period 2014-2022. Vertical red line corresponds to the sexual maturity reference size of 63.8 cm (Liu *et al.* 2010). 2020 and 2021 corresponds to catches of jumbo squid obtained as bycatch while targeting other resources. Source: IFOP.

5. AT-SEA AND PORT SAMPLING PROGRAM

Sampling was carried out by Scientific Observers (SO) on board and in port. These monitoring activities covered both the artisanal and industrial fleets.

For the industrial fleet, no trips targeting jumbo squid were monitored during 2022, since the data collected for this fleet was obtained by observers on board while industrial vessels were targeting other resources; specimens sampled there corresponded to bycatch.

For the artisanal fleet, during 2022 there was sampling coverage in all the regions of significant activity for this sector, reaching 5.35% of the total fishing trips, a valor lower that 2021 (Table 6)

Table 6.-Number of fishing trips monitored by region (on land and at sea combined), total trips and monitoring coverage in the artisanal jumbo squid fishery during 2021.

Region	Fishing Trips		
	Monitored	Total	% coverage
Coquimbo	304	2922	10.40
Valparaiso	199	7266	2.74
Maule	333	4631	7.19
Biobío	473	9641	4.91
Total	1309	24460	5.35

6. MANAGEMENT MEASURES

Current Administration Measures

The administrative measures applied to the jumbo squid fishery date from 2012 and were established with the aim of maintaining the sustainability of the jumbo squid fishery. In this sense, the Undersecretary of Fisheries and Aquaculture declared this resource in a state of full exploitation; therefore, restricting the access to new users. On the other hand, in 2012 an annual global catch quota was first established along with the prohibition of using this resource as raw material for the production of fishmeal (Table 7).

Table 7.- Main management measures in course for jumbo squid fishery in Chile.

Management measure	Purpose	Regulations
Regime	Regime of Freedom of Fishing and General Regime of access, both assimilated to a state of full exploitation from the Arica and Parinacota Region to the Magallanes Region (The entire country).	Res. Ex. N° 3.974/2019
Access	Suspension of the registration of the resource in the Artisanal Fishing Registry (RPA), between the regions of Arica and Parinacota to the Magallanes Region for having reached the state of full exploitation. Valid until Dec. 31. 2024.	Res. Ex. N° 3.974/2019
Annual Global Catch Quota (CGAC/ TAC)	The TAC of jumbo squid for the year 2022 was 200,000 tons:	D. Ex. Folio DEXE202100239 MINECON
By catch	Research and monitoring program of bycatch and incidental catch 2018-2020 period.	Res Ex. N°3048/2018
Fishing gear	It establishes that jumbo squid can only be extracted as a target fishery, using jigging or hand line as fishing gear. the capture of jumbo squid with other fishing gear is allowed only as a bycatch	Law No. 21.134/2019
Other measures	Jumbo squid (<i>Dosidicus gigas</i>) is banned as raw material for the production of fishmeal.	D.S N° 98/2012