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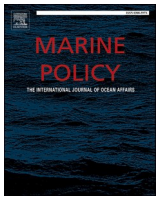

How COVID-19 pandemic affected fisheries (catch volume and price): A case study in Europe

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ABSTRACT

Portugal, with the highest per capita fish consumption and expenditure in the European Union, provides an excellent case study for examining the effects of COVID-19 containment measures on fishing activity. The present study focused exclusively on data obtained from mainland Portugal, covering the years 2015–2021. The analysis included different time periods: namely, pre-lockdown, during lockdown, and post-lockdown. The primary objective was to investigate and gain insights into the potential effects of lockdown measures on the quantity (catch volume) and price ($/Kg) of different fish species groups. During the lockdown, professional fishermen experienced lower quantities, compared to the average of previous years (2015–2019), in some months (March, April and May), of tuna (−44%: from 85 ton to 47 ton), small pelagic fish (−41.8%: from 4510 ton to 2627 ton), crustaceans (−31.9%: from 94 ton to 64 ton), and bivalves (−33.5%: from 412 ton to 274) being landed. Although prices fluctuated, only crustaceans showed a significant decrease in value (−34.8%: from 14.85$/Kg to 9.68 $/Kg). Groundfish, flatfish, cephalopods, and other marine fish groups did not experience any significant impacts on landing quantities. Although there was some recovery in catch volume and market prices in the post-closure period, indicating a certain level of resilience in the sector, the socio-economic context indirectly exacerbated the profitability challenges faced by the fishing industry due to COVID-19. Given the potential for future socio-economic crises, policymakers (e.g., country government) and stakeholders (e.g., Fishers' associations, HORECA) should prepare comprehensive and easily implementable measures to strengthen the sector and minimize potential disruptions.

1. Introduction

In a scenario of population growth, the fisheries and aquaculture sectors play an increasingly significant role in global food supply and socio-economic development in the 21st century. Combined, they accounted for a worldwide production of 178 million tonnes of aquatic animals in 2020, with a total first sale value estimated at USD 406 billion, and employed 58.5 million people in full-time, part-time, occasional, or unspecified positions [16]. For its part, the fisheries sector produced 90 million tonnes of aquatic animals (51% of the global value), of which 78.4 million tonnes came from marine fisheries and 11.2 million tonnes from inland waters, with a first sale value estimated at 141 billion, and approximately 38 million workers [16]. In 2020, according to the National Institute of Statistics, fishing in Portugal represented 0.17% of the GDP.

Of the overall production of aquatic animal food, 89% was used for human consumption, more than five times the quantity consumed nearly 60 years ago, representing an average annual increment rate of 3%. Per capita consumption was primarily influenced by increased supplies, changing consumer preferences, technological advancements, and income growth [16]. In Europe, annual average of fish consumption ranges from 60 kg of fish per capita in Portugal to 6 kg of fish per capita in Czechia, (EU average of 23.97 kg per capita) [14]. Therefore, Portugal has one of the highest levels of seafood consumption in Europe and is the third biggest seafood consumer (per capita) in the world [1,24].

Since early 2020, the rapid and widespread transmission of the COVID-19 pandemic and the associated public health measures adopted by governments to prevent infections or 'flatten the curve' of outbreaks,

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have disrupted various systems and sectors, impacting the lives of billions of people and exacerbating a socio-economic crisis [11,22,36,7]. This sudden and impactful cessation of numerous human activities, lasting for extended periods in many regions worldwide, is exceptionally uncommon. In essence, it provides a historic snapshot of its effects on human wellbeing, the environment and wildlife, including the oceans ([2,6], 2021; [8,25]).

Globally, the COVID-19 pandemic has had an impact on the fisheries sector resulting from changes in consumer demand, market disruptions, and logistical difficulties in implementing strict containment measures. These measures have included the prevention or hindrance of fishing and aquaculture activities through lockdowns, physical distancing requirements during operations and aboard vessels, as well as port restrictions [16]. These impacts have been experienced worldwide, including in Southeast Asia [17], Japan [33], Philippines [23], Africa [28], Spain [35], and South America [34]. Furthermore, the routine data collection and analysis of fishing statistics, fish stock assessment, as well as household surveys and censuses were hindered, or even rendered impossible, thereby impairing the adequate monitoring of fishing activity and potential impacts of COVID-19 [16]. This period was characterized by a struggle for survival, where most individuals and businesses had to focus on finding ways to survive each day. Consequently, the assessment of illegal, unreported, and unregulated activities was challenging, and the socio-economic dimension of the sector and its trends could not be fully evaluated.

In Portugal, to address the pandemic, a complete lockdown period was imposed from March to May 2020. This decision was made based on the most reliable scientific information and in accordance with the established EU policies. The primary objective of this study was to evaluate the potential effects of the COVID-19 lockdown period on the Portuguese fisheries. Specifically, it aimed to address the following questions: (1) How did the lockdown impact the volume of catches and auction prices for different groups of organisms in Portugal? (2) How did these indicators evolve in the post-lockdown period?

2. Material and methods

2.1. Portuguese fisheries profile: pandemic context and data sets

On 31 December 2020, the Portuguese fleet comprised 7 718 vessels, with a total gross tonnage of 86 457 GT and a total propulsion power of 345 249 kW. Of these, 91% were small fishing boats, with an overall length of less than 12 m, and they only accounted for about 14.35% of gross tonnage [10].

Regarding the fishing gear in 2021 (data from EUROSTAT), Portugal had 77% gill nets and entangling nets, which represented 13% traps, 3% surrounding nets, 3% dredges, 2% seines, and 2% trawls.

Mainland Portugal has 22 main locations for fish auctions and another 28 where fish is received and weighted near small ports. All these processes are coordinated by the state-owned company, DOCAPESCA, under the Ministry of Agriculture, Sea, Environment and Physical Planning. DOCAPESCA provides the public service of organising the first sale of fish and supports the fishing and fishing ports sector in mainland Portugal. In Portugal, a total lockdown period occurred from March 20 to May 3, 2020 ([12,13]; Decrees n.º 2-A e 2-B, 2-C and 2-D). Initially, the disease was unknown, causing apprehension among the population. During the first Covid-19 lockdown, most fishing vessels stopped their usual activities due to the difficulty of maintaining social distancing on board. In March 2020, the Portuguese government attempted to address these difficulties by providing financial support to purchase individual protective equipment. After May 3, when the lockdown ended, remote working continued to be strongly encouraged, with many people avoiding in-person shopping and relying extensively on online shopping. A second lockdown period occurred from November 24 to April 30, but only applied intermittently and locally depending on the number of people infected, as mask usage was already mandatory, and the vaccination process had begun.

The data used in the present study were gathered from auction markets, provided by national sources to EUMOFA. In the case of mainland of Portugal, the data were reported by DOCAPESCA. To analyse the pre- and post-COVID 19 periods, a 7-year interval from 2015–2021, was used. The data consisted of total landings (in tonnes), prices (in USD) per kg, and total income, reported monthly.

The main species landed during the assessment period were: mackerel (*Trachurus trachurus)*, horse mackerel (*Scomber colias)*, sardine *(Sardina pilchardus)*, European anchovy (*Engraulis encrasicolus)*, octopus (*Octopus vulgaris*), Blue jack mackerel (*Trachurus picturatus)*, cockle *(Cerastoderma edule*), and scabbard fish *(Aphanopus carbo)*. The commodity groups, as defined by the European Market Observatory for Fisheries and Aquaculture Products, were used (Table 1). EUMOFA is an initiative of the EU Commission's Directorate-General for Maritime Affairs and Fisheries (DG MARE) and consists of a group of experts who define these commodity groups.

The commodity groups and the percentage of each one in terms of quantity landed and value can be seen in Fig. 1.

2.2. Statistical analysis

To assess how the lockdown period affected the catch volume of the different groups of organisms and the market prices (in auctions), we used different univariate and multivariate analysis methods available in PRIMER v7 Statistical package [5] and SPSS *v*21 [20].

To accurately depict the potential effects of the lockdown on fishing activity and the species captured, the data analysis compared corresponding periods, in each year, namely spring, summer, autumn, and winter. Three distinct temporal periods were considered in relation to the occurrence of the lockdown: before the lockdown (until February 2020), during the lockdown (March, April, and May 2020), and after the lockdown (June 2020 to November 2021).

Our expectation is that the volume of catches and the price per kg during the lockdown period (spring: March, April and May 2020) may be different from before (springs 2015–2019) and after (spring 2021) due to the decrease or cessation of fishing activity. To evaluate this, a stepwise approach was considered in the analysis. Initially, we assessed the potential lockdown effects on catch volumes and prices in general, i.e., considering all groups together. Then, the analysis was refined, and we assessed potential effects on each group of organisms individually.

To visually assess potential temporal patterns in the data, we have selected the non-metric multidimensional scaling (nMDS) ordination method. The catches data was log-transformed, and a similarity matrix was computed using the Bray–Curtis coefficient. On the other hand, the prices data was not transformed, and the chosen coefficient was the Euclidean distance. To determine if there were statistically significant

Table 1
Commodity groups and main species fished in Portugal. Catches from 2021.

Commodity groups	Main species fished in Portugal	Scientific name	Catches 2021 (Tonnes)
Groundfish	Pout	*Trisopterus luscus*	1 697.6
	Hake	*Merluccius merluccius*	1121.4
Flatfish	Sole	*Solea solea*	339.2
	Megrim	*Lepidorhombus boscii*	64.0
Small pelagics	Sardine	*Sardina pilchardus*	26 851.0
	Atlantic chub	*Scomber colias*	22 485.8
Tuna and tuna-like species	Swordfish	*Xiphias gladius*	954.3
Other marine fish	Black Scabbardfish	*Aphanopus carbo*	2 245.1
	Skates	*Raja sp.*	1394.4
Crustaceans	Crab	Several species	476.2
Cephalopods	Octopus	*Octopus vulgaris*	5380.3
Bivalves	Cockle	*Cerastoderma edule*	3 920.5
	Clam	*Ruditapes decussatus*	1 402.3

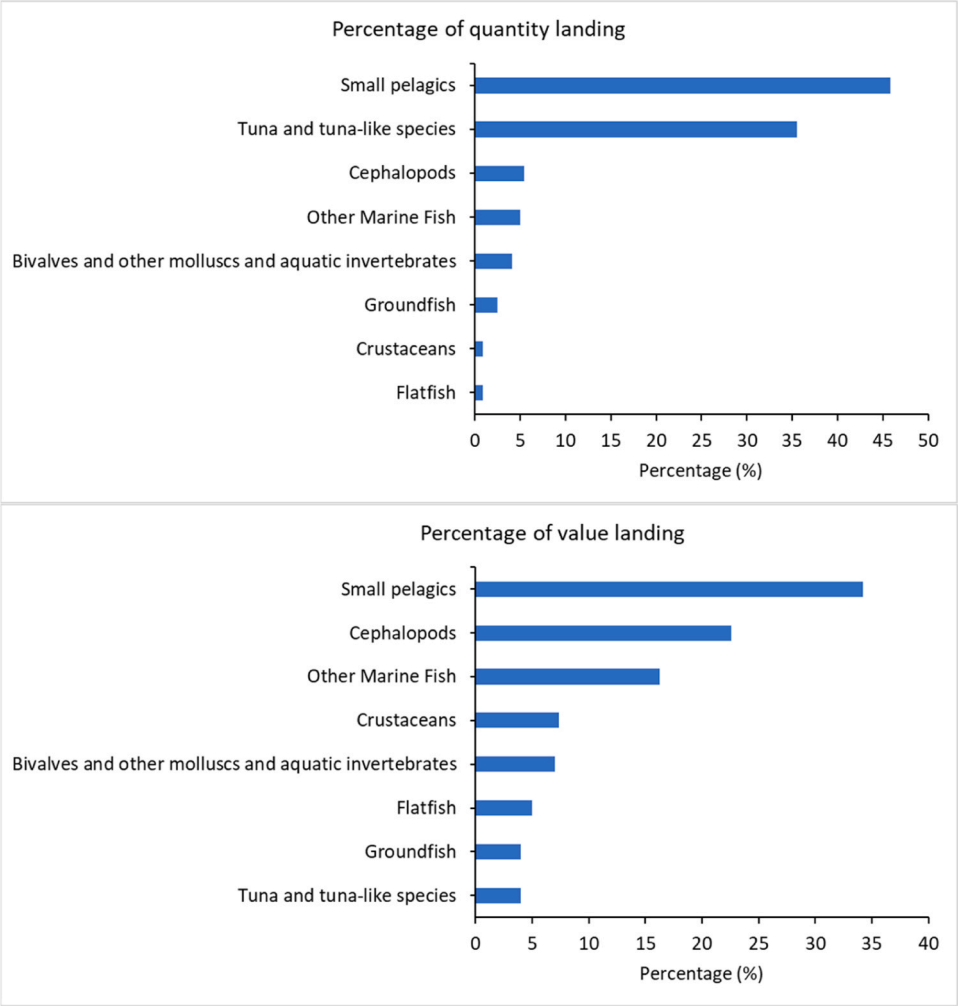

Fig. 1. The proportion of commodity groups in terms of quantity and value of landing (2021 data).

temporal differences in the catches and prices data overall, we performed one-way ANOSIM analyses. The SIMPER test was applied to determine which commodity groups made the greatest contribution to the observed temporal dissimilarity (>70%).

After obtaining an overview of the effects of lockdown on catches and prices, the level of detail was increased, and effects on each group of organisms were analysed using Kruskall-Wallis tests and the Dunn-Bonferroni correction for pairwise comparisons.

For the statistical tests, 9999 random permutations were used and a significance level (p) of 0.05 was considered.

3. Results

The monthly variation in catch volume (in tonnes) by the main species groups can be observed in Fig. 2. The data represents the period before the lockdown (average from 2015 to 2019), during the lockdown (March, April, and May 2020), and after the lockdown (2021). In general, a decrease in catches can be seen for the group's "tuna", "bivalves", "crustacea", "cephalopods", "small pelagic fishes", and "other fish" during the lockdown compared to the average of the previous five years. This decrease is particularly pronounced for "tuna" and "crustaceans" during April 2020. For the "groundfish" and "flatfish" groups, the lockdown does not seem to affect the volume of catches, and the observed pattern is not very distinct from that of previous years (average from 2015–2019).

The monthly variation in the price per kilogram (USD) of the main commodity groups before, during, and after the lockdown can be observed in Fig. 3**.** Overall, the lockdown appeared to have led to a decrease in the price of the "tuna", "crustaceans", and "flatfish" groups, while the price of "bivalves" registered an increase. The variation pattern of the remaining groups was relatively similar during the different periods, with the lockdown not causing significant fluctuations in price as compared to the period before and after (Fig. 3).

When analysing the catch data of all groups collectively, significant temporal differences were detected through the one-way ANOSIM analysis (Global R = 0556; $p < 0.1\%$). These differences are clearly observed in the nMDS ordination plot coded for period and season (Fig. 4 **A.**). The plot reveals a distinct seasonal pattern, with the spring season grouping together across different years. A similar pattern is observed for the remaining seasons (autumn, summer, and winter). Regarding the effects of the lockdown, statistically significant differences have been observed through ANOSIM pairwise comparisons. Specifically, there is a difference between the lockdown period and the corresponding previous period (1-way ANOSIM: R =0463; $p < 0,05$). However, these temporal differences were not as evident in the nMDS ordination plot (Fig. 4 **A.**), which shows minimal separation among samples from different pandemic periods (before, during, and after lockdown). The dissimilarity between these two periods is primarily attributed to the "tuna", "crustacea", "bivalves", and "small pelagic fish" groups, according to SIMPER analysis, which collectively contribute to 75% of the dissimilarity.

In general, there were also observed temporal differences in price/

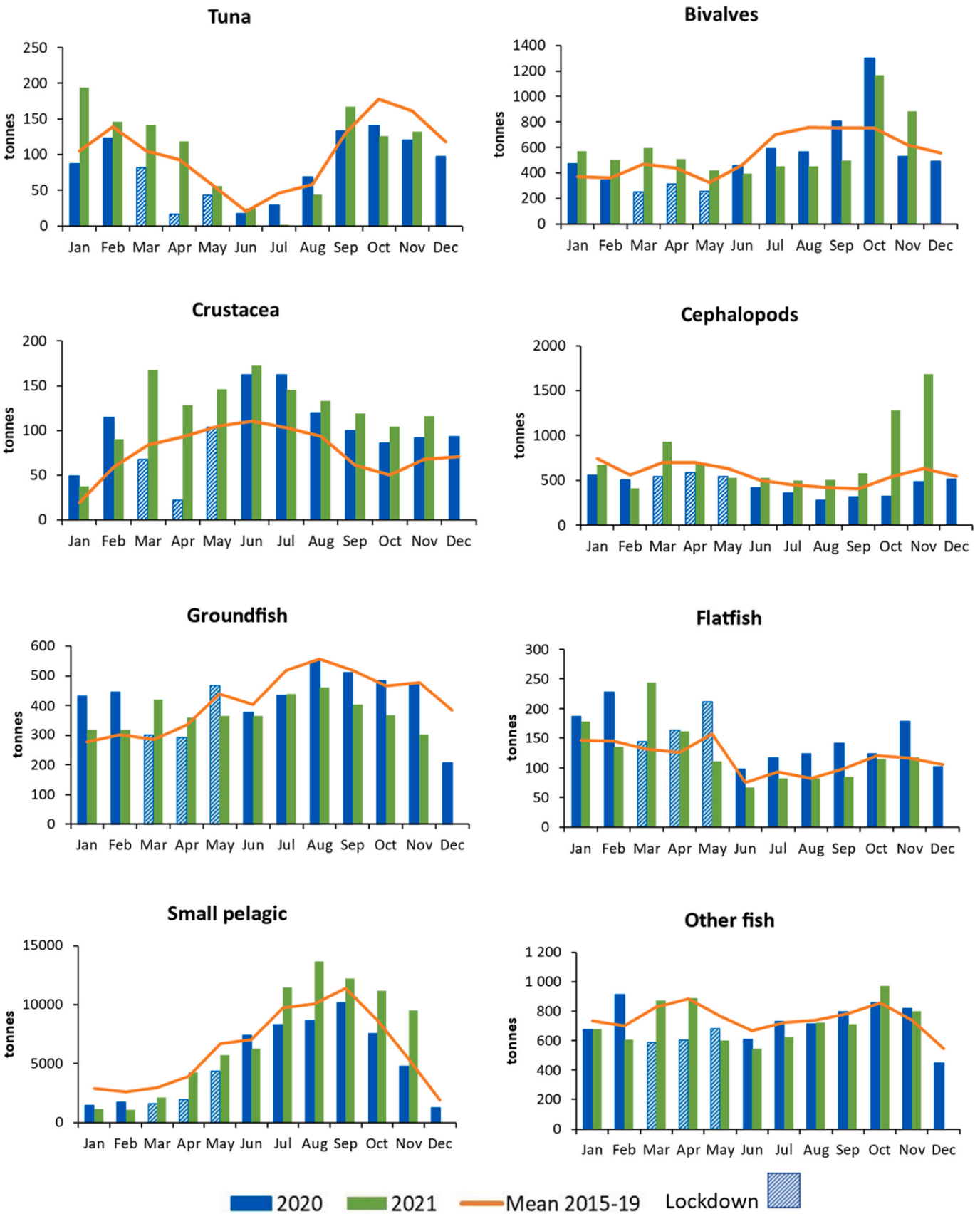

Fig. 2. Monthly variation in the volume of catch for each fishing group throughout the year of the pandemic (2020), the lockdown period (March, April, and May 2020), and the post-lockdown (2021), compared to the average catch of the five previous years.

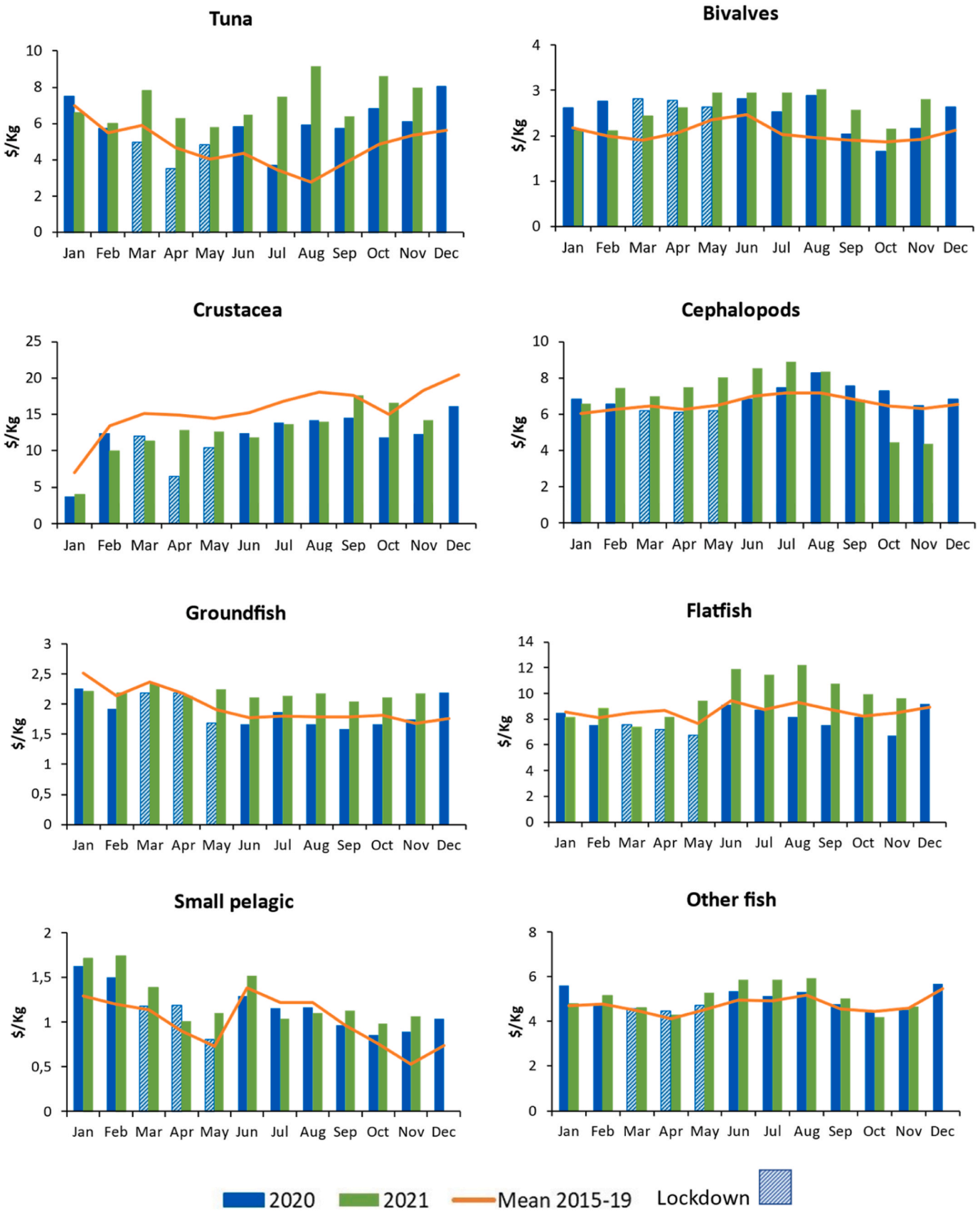

Fig. 3. Monthly price variation (in USD per kilogram) of each fish group during the pandemic (2020), the lockdown period (March, April, and May 2020), and after the lockdown (2021), compared to the average catch of the previous five years.

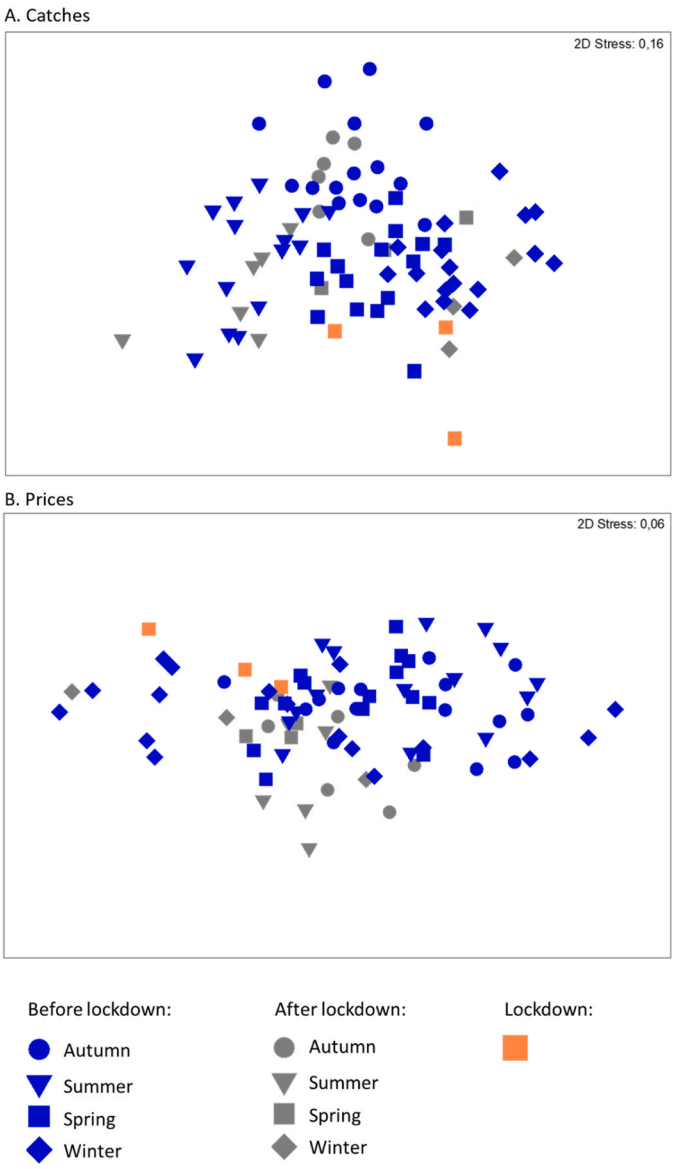

Fig. 4. A. and B. The nMDS ordination plots depict the relationship between catches (A) and prices (B) of fish groups from Continental Portugal's data, illustrating the different pandemic periods (before, during, and after the lockdown – highlighted by different colours) as well as the seasonal variations (winter, autumn, summer, and spring – highlighted by different symbols).

market value ($/kg) data with the ANOSIM analysis (Global R = 0129; $p < 0.1\%$). Unlike the catches, this separation is not as clear in the nMDS plot (Fig. 4 **B**.). However, once again, seasonality dominates over the effect of the lockdown. Similarly, to the catches, the lockdown period differed from the previous homologous period (ANOSIM: R =0354; $p < 0,05$), primarily due to the substantial decrease in prices of "crustacea" during the lockdown (Fig. 5 **B.).** This was confirmed by the SIMPER analysis, where this group contributed 82% to the dissimilarity observed between these periods.

When analysing each group separately, the average catch volume for "tuna", "bivalves", "cephalopods", "crustacea", "small pelagic fish" and "other fish" was lower during the lockdown period compared to before. However, the catch volume started increasing again after fishing activities resumed (Fig. 5 **A.**). Although this trend was observed, the decrease observed was not statistically significant (Kruskall-Wallis H tests tuna $\chi^{2(8)} = 17,3$; bivalves $\chi^{2(8)} = 20.8$; cephalopods $\chi^{2(8)} = 12,1$; crustacea $\chi^{2(8)} = 15,8$; small pelagic fish $\chi^{2(8)} = 14,6$; other fish $\chi^{2(8)} = 39,5$; all

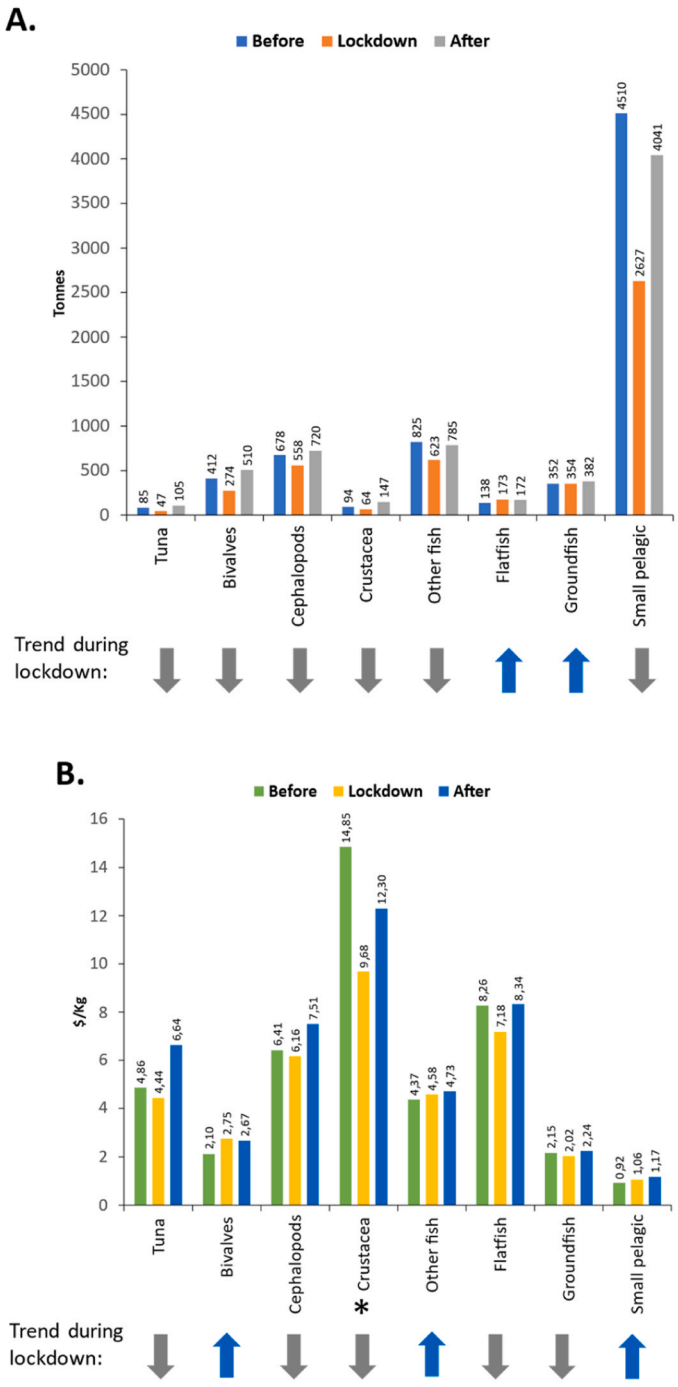

Fig. 5. A. and B. Average comparison of catch volume (in tonnes) and price (in UDS/kg) before (March, April and May 2015–2019), during (March, April and May 2020), and after the lockdown (March, April and May 2021). The trends (increase and decrease) during the lockdown compared to the before period are indicated by arrows, and statistically significant differences with an asterisk ($p < 0,05$).

$p > 0,05$). Most of the differences observed in the pairwise comparisons test were attributed to seasonality. For "flatfish" and "groundfish", no substantial difference was observed in the average catch volume between the different pandemic periods (Fig. 5 **B.;** Kruskall-Wallis H tests: flatfish $\chi^{2(8)} = 15,2$; groundfish $\chi^{2(8)} = 15,3$; both $p > 0,05$)).

For the "tuna", "cephalopods", "flatfish", and "groundfish" groups, small decreases in price were observed during the lockdown, although these decreases were not significant enough to show statistically significant differences (Kruskall-Wallis H tests: tuna $\chi^{2(8)} = 9,8$;

cephalopods $\chi^{2(8)} = 14{,}4$; flatfish $\chi^{2(8)} = 26{,}4$; groundfish $\chi^{2(8)} = 9.6$; all $p > 0{,}05$). Only the "crustacea" group recorded a statistically significant decrease in price during the lockdown ($\chi^{2(8)} = 31{,}3$; $p < 0{,}05$). On the other hand, the "bivalves", "small pelagic" and "other fish" groups experienced a slight increase in price during the lockdown (Fig. 5 **B**). However, these increases were not significant enough to show statistically significant differences (Kruskall-Wallis H tests: bivalves $\chi^{2(8)} = 31{,}3$; small pelagic fish $\chi^{2(8)} = 15{,}2$; other fish $\chi^{2(8)} = 15.2$; all $p > 0{,}05$).

4. Discussion

4.1. Effects of COVID-19 lockdown measures on catch volume and auction prices in Portuguese fisheries

The analysis of the catch volume and auction price of the different groups of organisms fished in Portugal revealed differences between the periods considered: "before the lockdown", "lockdown", and "after the lockdown".

A clear seasonal pattern was observed in catch volume, which is certainly related to the annual biological cycle of the different species, annual variability in fish stocks, fisheries management policies, and inherent constraints in fishing activity, such as climate conditions [29]. Considering the auction price, although a seasonal pattern appears to exist, it is not highly evident. This is likely because the price/market value is influenced not only by the supply originating from the fishing activity but also by the competitive supply from aquaculture. Additionally, the supply chain and the variability in demand play a role in determining the market dynamics.

Overall, the Covid-19 lockdown that was implemented from March to May 2020 seems to have had an impact on fishing activity in Portugal, affecting both catch volume and auction prices, which showed differences between the lockdown period and the previous homologous period.

4.2. Portuguese and global trends

During the "total lockdown" period, extremely strict policies, and containment measures [4] were implemented. These measures included: *i*) severe limitations on travel, transportation, and trading activities; *ii*) suspension of operations in both public and private companies, public agencies, universities, and schools; *iii*) limitations and specific regulations regarding access to essential services, such as hospitals and pharmacies; *iv*) prohibition of public events and social gatherings.

Worldwide, most fishing vessels were compelled to cease their regular activities during this period, due to the imposed restrictions that directly affected work on the vessels, the seafarers (e.g., difficulty of maintaining social distance and adopting preventive measures, preventing crew changes and staff repatriation), and the marine personnel in ports [16]. Moreover, the socio-economic impacts of a total blockade have limited the income potential of the fishing activity, leading to severe yield shortfalls, and even rendering it unprofitable. These impacts have affected the supply chain, such as transportation and cold storage capacity, as well as imposing restrictions on the trading sector. Cessations of tourism and catering activities, along with limitations on social activities, have also resulted in decreased demand for fish and seafood, consequently causing a decline in prices [16,4,9].

In Portugal, the fishing effort have decreased throughout 2020 [31], which has certainly led to the observed catch losses. Worldwide, industrial fishing activities decreased by 6.5% at the end of April 2020 (compared to the same period in 2019) and by 10% from the date the global pandemic was declared, with relevant reductions reported in some regions – China (< 40%), Peru (< 80%), Indonesia (< 70%) [19,7]. In European waters, many large fishing nations (e.g., Spain, Italy) also reported substantial reductions, up to 50% until late May 2020 [19,30,7].

4.3. Socioeconomic impacts on small-scale and government support measures

Most of the Portuguese fishing activity is carried out by small vessels [10], which makes it particularly vulnerable to the COVID-19 pandemic, in line with what was stated by some international studies that consider small-scale fisheries to face the main challenges of the sector as a whole [27,3]. The socioeconomic impact of the implemented lockdown was considered an imperative issue by the Portuguese government, which developed a financial programme to support the fishing activity and the communities involved [31]. This program encompassed the following measures, to professional fishers: *i*) financial support to compensate for the cessation of activities; *ii*) financial assistance for the purchase of personal protective equipment and to carry out COVID tests – mainly targeting processing companies and ship owners; *iii*) support for the development of production and marketing plans.

4.4. Trade disruptions and changing consumption patterns

The export sector was the most affected, as it depends not only on the restrictive measures in each country, but also on increased freight costs, flight cancellations, and border restrictions [16,31]. Nevertheless, domestic supply was also severely impacted by limitations imposed on the retail trade sector, traditional markets, and social activities. Additionally, the closure of food service sectors such as hotels, restaurants, and catering facilities, including schools and work canteens, had a significant impact [15,16,31]. Generally, the entire value chain of fisheries products was affected by the pandemic [18,4], due to the containment measures implemented worldwide.

In Portugal, the food service sector is one of the main distribution channels for fish and seafood products, which was severely hit by the imposed restrictions during the spring of 2020. The sector was forced to rely on take-away services or online sales [26]. As a result, seafood sales experienced a decreased due to the widespread closure of food services. In fact, the eating behaviour of the Portuguese changed during the pandemic, leading to a decrease in fish and seafood consumption [32], which undoubtedly contributed to the lower values recorded in Portugal in 2020, further accentuating the downward trend observed since 2018 [21]. Furthermore, at the retail level, there was an increased demand for frozen/processed seafood, as well as for affordable seafood species. This surge in demand can probably be attributed to the economic instability caused by the pandemic [26]. Lockdowns resulted in decreased demand in several countries, leading to declines in the market prices of fisheries products. As a result, many fishing fleets reduced or halted their activities altogether [16,31,4,9]. There were even instances where fishing quotas remained unfilled due to low demand, market closures, and/or insufficient cold storage capacity [15,16]. During the lockdown period between March and May 2020, there were noticeable decreases in catch volumes across nearly all considered commodity groups, such as "tuna", "bivalves", "cephalopods", "crustacea", "small pelagic fish" and "other fish". These reductions were likely a consequence of the reported reduction in fishing effort [31]. The global difference in catch volume can mainly be attributed to the observed decreases in "tuna", "crustacea", "bivalves" and "small pelagic fish". These groups are widely consumed in restaurants and at festive and social events, especially as a fresh product. Some of them are considered high-value products for special occasions, such as shrimp, lobster, and bivalves, while others hold cultural and traditional significance, like sardines.

Additionally, catering services, such as schools and work canteens, frequently use canned tuna and more affordable fish species like mackerel and horse mackerel. Moreover, small pelagic fish species like sardines, mackerel, and horse mackerel are still preferred to be purchased from traditional markets, despite the increasing dominance of supermarkets. Consequently, the imposed restrictions on these sectors have led to a decrease in demand for these specific groups. Furthermore, limitations imposed on the industrial sector, particularly the processing

and canning industry, as well as international distribution circuits, have certainly restricted the flow of targeted products, such as tuna, sardines, mackerel, or cockles.

On the other hand, there was a slight reduction in market prices for certain commodity groups such as “tuna”, “cephalopods”, “flatfish”, and “groundfish”. However, the overall differences were primarily attributed to "crustacea," whose prices significantly declined during the confinement period and only returned to pre-pandemic levels in September 2021. In fact, “crustacea” was the group most affected by the lockdown period, both in terms of quantity and price. It seems that the demand for this specific group has decreased, which can be explained by the significant decrease in activities related to tourism and social gatherings. In Portugal, crustaceans are typically consumed during parties and celebrations with family and friends, making their demand particularly affected by the imposed restrictions and limitations on the HoReCa channel. Overall, the trade of fresh fish and seafood in Portugal decreased by about 60% between March and May 2020, largely related to the lack of demand [31,9]. Additionally, while out-of-home consumption has significantly decreased due to pandemic containment measures, the decline in tourism and the closure of the HoReCa, in-home consumption has increased by over 30% compared to the same period in 2019 [14,31].

However, this shift in consumption patterns does not seem to have fully compensated for the losses. This can be attributed, in part, to the suspension of social gatherings, cultural, religious, and gastronomic events, where fish and seafood products are traditionally preferred in Portugal. Furthermore, the products consumed in a family in-home context are likely to differ from those consumed in out-of-home or social events, with a focus on cheaper products, aquaculture products, and ready-to-eat meals.

Although a recovery in catch volumes and market prices is observed in the post-closure period, the impact of the strict lockdown between March and May 2020 on the fishing sector continues to persist. Specifically, the overall social and economic instability generated during the pandemic has created uncertainty and shaken consumer confidence. This has led to changes in eating habits and daily behaviour, in addition to the various disruptions experienced by the fisheries supply chain. These factors have exacerbated the constraints on the profitability of the activity.

5. Implications for policy makers

The impact of COVID-19 on the fisheries sector has been considered a key issue by policymakers. Therefore, both the EU and national governments have implemented measures to mitigate the socio-economic impact on the fisheries sector. This includes allocating over 78 million euros in support of 5811 operations through the European Maritime and Fisheries Fund [31]. The adopted measures primarily focused on compensation for unemployment, reduction of activity, income loss, economic losses, and lack of liquidity for small and medium enterprises. This support was provided through direct financial assistance (e.g., direct grants and subsidies) as well as indirect support (e.g., lines of credit and tax advantages). Additionally, support for investment in new production and marketing strategies to adapt to market changes has also been taken into consideration.

First and foremost, the COVID-19 pandemic has demonstrated the vulnerability of the fishing sector to disruptive changes in consumption. Given the possibility of future socio-economic crises resulting from new pandemic events, wars, political conflicts, or the ongoing energy, climate, and migration crises, it is crucial to understand how the fisheries sector can adequately prepare for similar future events. It is thus imperative to be prepared for the future, taking into consideration these possibilities, and working to strengthen the sector’s natural resilience, as well as to be prepared to take effective and comprehensive actions when needed. To improve the policy response, it is essential to have predefined sets of measures that address the sector’s present vulnerabilities and minimize any potential disruptions. In this regard, it would be important to strengthen measures with the same focus as those implemented to support the impacts of COVID-19 [31], including: *i*) providing financial support for workers and companies to cope with unemployment, temporary shutdown of activities, and production breakdowns; *ii*) creating support mechanisms for employers and workers who maintain their activities but are affected by the general fall in prices, such as compensating for additional costs incurred; *iii*) implementing exceptional measures to support cash flow shortages. Additionally, it is necessary to broaden the scope of these measures [31] by focusing not only on the activity itself but also on the sectors associated with consumption (e.g., trade, tourism, processing industry, etc). The suggested actions would comprise: *i*) Establishing the various activities and workers in the supply chain (e.g., fishing, first sale markets, transport and distribution, retail, import/export) as “essential” in a crisis scenario, guaranteeing their operation; *ii*) Ensuring the operability of first sale markets and the overall movement of fish and fish products. *iii*) Considering the application of support mechanisms to the storage and processing sectors. *iv*) Exploring the possibility of accumulating unmet fishing quotas in subsequent periods. v) support promotional campaigns directed to consumers, to different target audiences, to promote product consumption and sales in the various market sectors; *vi*) encourage direct contact with the consumer and engage with the market 4.0; *vii*) ensure the monitoring and assessment of the activity to adequately track its evolution and make timely decisions for optimal outcomes in each situation.

6. Concluding remarks

The COVID-19 pandemic has impacted the fisheries sector due to the implementation of various containment measures during the state of emergency. Overall, fishing activity in Portugal declined, driven by restrictions directly affecting the fisheries sector, lower first-sale prices and, indirectly, by the cross-cutting socio-economic impacts resulting from the implemented lockdown.

The observed trend in catch volume, in the affected groups, was a reduction during the lockdown period, which in some cases (such as “tuna”, “bivalves”, “cephalopods”, and “small pelagic fishes”) lasted throughout 2020. However, there was subsequent recovery in 2021, returning to pre-pandemic levels.

Fish and seafood species preferably consumed in restaurants or festive contexts seem to be most vulnerable to these types of events, particularly “crustacea”, which experienced reductions in catch volume and significant declines in market prices that continued until the third quarter of 2021.

It is mandatory that policy makers and key stakeholders in the fisheries sector prepare for future crises by establishing packages of ready-to-implement measures that strengthen the sector and mitigate potential disruptions.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

Data will be made available on request.

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