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Differential effect of fisheries to the COVID-19 pandemic in the region of Andalusia (Spain)

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ABSTRACT

Fishing is one of the most widespread and important human activities in coastal ecosystems and it plays a fundamental role in employment and the economy of coastal communities. However, in the period 2020–2021, the global outbreak of COVID-19 negatively affected fishing economic activity. Against this background, Andalusia (South of Spain) is an important region in which the resilience of different fishing exploitation systems can be studied, but within the same social and economic framework. Therefore, the main study aim was to investigate the resilience of fishing activity to the COVID-19 pandemic in two Andalusian fishing grounds (i.e. Atlantic and Mediterranean). We analysed daily landings and the first-sale prices of fresh fish of the most caught species in both fishing grounds, while taking into account the different seasonal behaviour of the fisheries. Generalised Linear Models were used to compare the data, which were obtained during periods in which the COVID-19 severity levels differed. These levels were implemented according to political measures. The final objective was to understand how the degree of industrialisation in the fleets can hinder or help maintain the economic activity of fisheries during major crises.

1. Introduction

Currently, humanity is experiencing the effects of the COVID-19 pandemic [1] caused by a coronavirus (CoV), SARS-CoV-2. The global outbreak of COVID-19 in the period 2020–2021 led to a slow-down in the economic activity of all production sectors, which is without precedent in recent history [2–4]. The COVID-19 pandemic severely disrupted fisheries in many ways [5–7]. During the most difficult period of the pandemic, fresh seafood prices were in free fall due to the decrease in consumption caused by the mobility restrictions [8]. Border closures and the suspension of air travel prevented fishing companies from sending supplies to the vessels or changing their crews [9]. In addition, it has been observed that the basic reproduction number of the SARS-CoV-2 virus (R0) is unusually high on ships. For example, on the cruise ship Diamond Princess, R0 reached the value of 11, with almost 192 positive tests for COVID-19 per 1000 people, whereas in unconfined environments R0 has typically been between 2.2 and 5.7 [10,11]. This situation was referred to by Báez and González Carballo [8] as the Diamond effect (i.e. the particular high contagion rate on boats, which made fishing on boats a high risk activity).

Since the declaration of the COVID-19 pandemic in 2020 by the World Health Organization, many countries opted for mobility restrictions, bar and restaurant closures, and other social distancing measures. The first cases of COVID-19 were linked to a marine shellfish and fish market in Wuhan (China) [12]. Subsequently, traces of virus were discovered on chopping boards used for imported salmon in Beijing (China) [13]. This led to a reduction in seafood consumption and social alarm, which affected fresh seafood consumption around the

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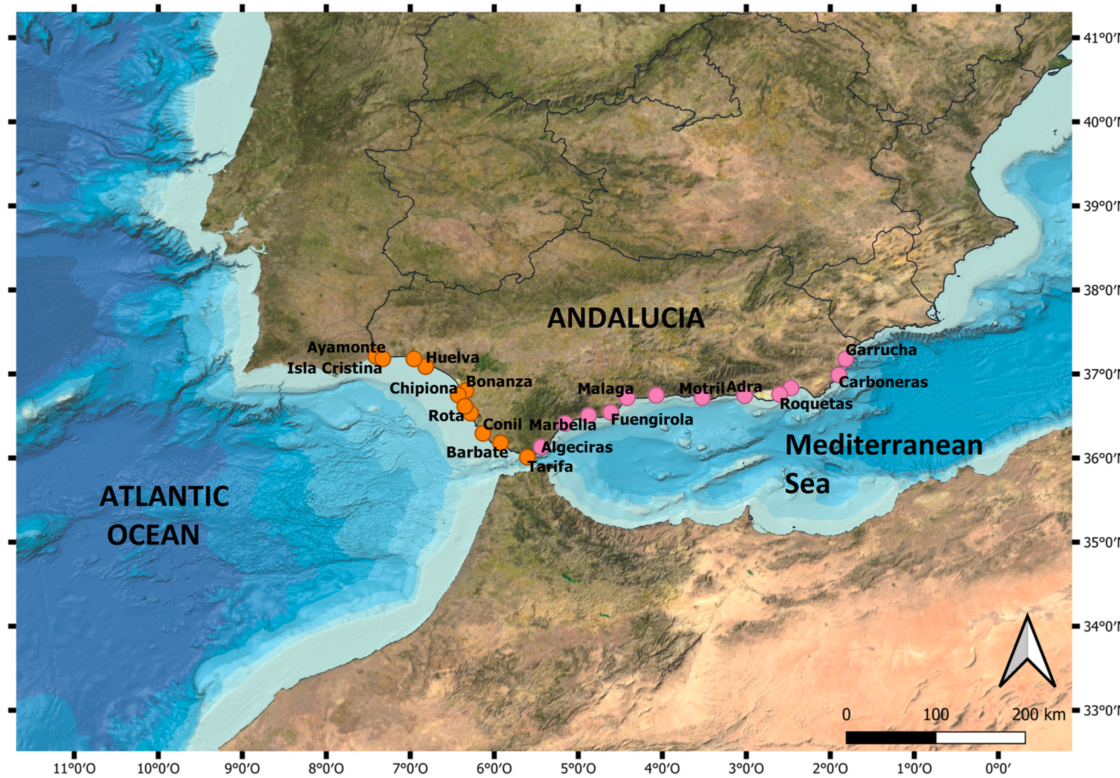

Fig. 1. Andalusian region showing the (a) Atlantic and (b) Mediterranean fishing grounds and the main harbours.

world leading to decreases in the economic activity of fisheries. In fact, the fall in demand was such that some fishermen chose to stay in the harbours [8,14]. For example, in the western Mediterranean, the fishing effort was reduced by 34 % during the most difficult months of the lockdown (March-May 2020), and landings and revenues fell by 34 % and 49 %, respectively, when compared to those from the period 2017–2019 [7].

Fishing is one of the most widespread and important human activities in coastal ecosystems and it plays a fundamental role in employment and the economy of coastal communities [15]. Therefore, any reduction in the economic activity of fisheries could be detrimental to the entire coastal community. After Galicia, the Region of Andalusia (Southern Spain) has the highest number of fishing landings in Spain [16]. Fishing activity in Andalusia has immense economic value and is a key element in its social and cultural image [17,18]. This region is naturally divided by the Strait of Gibraltar into two different fishing grounds, one in Atlantic waters and the other in the Mediterranean Sea. According to Maya-Jariego [17], there is a clear differentiation between fleets in these two areas, one fleet with a considerably higher level of technology (mainly working in the Atlantic), and the other more coastal-based fleet (mainly working in the Mediterranean). Thus, in the Atlantic, the non-artisanal fishing fleet uses high-level technology for the extractive tasks, more stratified labour organization, and links with transformation industries and commercial networks [17]. On the other hand, in the Mediterranean basin, the non-artisanal fishing fleet is more traditional and has a lower level of technology [16–18]. In contrast, the artisanal fleet is very similar in both fishing grounds.

Due to the geographical and oceanographic separation of the fishing grounds of Andalusia, the international management of fishing in the Atlantic fishing ground is under the responsibility of the International Council for the Exploration of the Sea (corresponding to the ICES 9a division), whereas the Mediterranean fishing ground is managed by the General Fisheries Commission for the Mediterranean (GFCM, corresponding the Geographical Sub-Areas [GSAs] GSA1 and GSA2 [19]). In addition, the fisheries targeting tuna and tuna-like species in both fishing grounds are under the management of the International Commission for the Conservation of Atlantic Tunas (ICCAT).

Against this background, we highlight the fact that Andalusia is an important region in which the resilience of different fishing exploitation systems can be studied, but within the same social and economic framework. Therefore, our main study aim was to investigate the resilience of fishing activity to the COVID-19 pandemic in the two Andalusian fishing grounds. We analysed daily landings and first-sale prices of fresh fish (hereafter, first-sale prices) of the most caught species in different periods of the pandemic. Generalised Linear Models were used to assess the fitness of fishing activity and to understand how the degree of industrialisation can hinder or help to maintain the economic activity of fisheries.

2. Material and methods

2.1. The fishing fleet in the Region of Andalusia

The Atlantic fishing ground of the Region of Andalusia mainly covers the Gulf of Cádiz, whereas the Mediterranean ground mainly runs from the port of Estepona to the port of Vera (Fig. 1). From a geographical point of view, the ports of Algeciras and Atunara (La Linea de la Concepción; Cádiz) are in the Mediterranean Sea, but from a fisheries perspective they are included in the Atlantic fishing ground, because fleets from these ports mainly operate in this fishing ground. In the period 2020–2021, the total number of registered vessels in the entire area was 1376 (including both artisanal and non-artisanal fishing boats), of which 761 were located in the Atlantic ground and 615 in the Mediterranean one. In 2020, total fisheries landings in Andalusia were 54,566 tons, with 35,993.5 tons from the Atlantic (66 %) and 18,572.5 tons from the Mediterranean (34 %) [20]. Total first-sale prices were €171,992,213.8, divided into €121,064,817.62 from the Atlantic fishing ground (70.4 %) and €50,927,396.19 from the Mediterranean one (29.6 %). Therefore, there was an economic ratio of €3.4/kg for the Atlantic fishing ground vs €2.7/kg for the Mediterranean one [21].

Table 1
Total landings and total of first-sale prices in both fishing grounds.

	Atlantic Ocean		Mediterranean Sea	
Fishing mode	Kilograms	€	Kilograms	€
Bottom trawler	14.919.585	63.787.535,82 €	325,25	22.259.578,79 €
Artisanal fisheries	3.382.879	20.258.898,98 €	1.628.209	8.458.525,45 €
Tuna	155.136	1.326.980,24 €	101.314	1.022.968,95 €
Purse seine	14.695.472	25.716.090,54 €	11.784.967	13.168.897,51 €
Dredger	2.192.342	7.341.821,06 €		
Longline	223.373	1.054.587,47 €	586.698	3.825.662,20 €
RASTRO	330.156	1.156.130,43 €	1.039.987	1.992.559,02 €
Shellfishing	94.399	517.038,09 €		
Almadraba (Trap Net)	185	5.735,00 €	179.036	199.204,28 €
TOTAL	**35.993.527**	**120.642.045**	**15.141.500**	**50.728.192**

Regarding landings and economic value, in the period 2020–2021, the main fishing gear used in both fishing grounds were bottom trawls and purse seines (Table 1). In terms of economic value, artisanal fisheries represented 9.4 % and 8.77 % of landings, and 16.74 % and 16.61 % from the Atlantic and Mediterranean fishing grounds, respectively. Therefore, the differential effect of the artisanal fleet on the Atlantic fishing ground vs the Mediterranean fishing ground should be considered to be nonsignificant when both fishing grounds are compared.

2.2. Landing data

The Junta de Andalucía (2021) provided the daily landings by species (in tons) and first-sale prices (in euros) datasets for 2020 and 2021 [20,21]. We analysed the most abundant and common species from both fishing grounds. Table 2 shows the selected species according to their fisheries behaviour (i.e., seasonal or otherwise), daily total amount, and first-sale prices. We select species mostly caught by non-artisanal boats.

It should be noted that the same target species could be caught on different types of gear and by different boat strata. In addition, according to fishing ground, each species lives in a different biological setting and comes under a different management approach. Therefore, we tested possible trends by species and within the same fishing ground given that a) the effect of the artisanal fleet is considered to be nonsignificant between the two fishing grounds, and b) the target species could also differ between fishing grounds.

2.3. Statistical analysis

We created a statistical variable based on political measures, because the ones implemented to prevent the spread of the disease are representative of the different COVID-19 severity levels [7]. More specifically, to avoid confounding effects, we created a categorical variable—henceforth the COVID variable—which was defined in a slightly different way for species that have seasonal or nonseasonal fisheries behaviour (Fig. 2). Thus, we considered two sets of species: seasonal or nonseasonal, depending on intra-annual presences observed in previous years, such that when there are no landings whatsoever in a single quarter, the fishery was considered to be seasonal. For nonseasonal fisheries, the COVID covariable could take the value No COVID, State of alarm 1, After State of alarm 1, and State of alarm 2 according to the different levels of severity. Hence, we analysed whether there were significant differences between the response variables (landings and first-sale prices) and the three latter categories in relation to the No COVID reference category. For seasonal fisheries, the No COVID level was divided into three categories, Reference State of alarm 1, Reference after State of alarm 1, and Reference State of alarm 2 (see Fig. 2). In this way, we analysed differences in landings and first-sale prices by comparing the same months of the year before and after the occurrence of COVID-19, thus avoiding any confounding effects due to the seasonal behaviour of the fishery.

To define the COVID covariable, the dates of the states of alarm were obtained from the official Spanish government website [22].

Table 2
Numerical summary of the response variables (landings and first-sale prices) by species and fishing grounds (Atlantic and Mediterranean Sea). Species are also classified by the seasonality of their fishery.

Fishery (seasonality)	Species name	Common name	Atlantic		Mediterranean	
			Mean Landings	Mean price	Mean Landings	Mean price
Non Seasonal	*Trachurus mediterraneus*	Mediterranean horse mackerel	1871	1	3499	1.3
	Trachurus picturatus	Blue jack mackerel	90	2.3	1028	0.7
	Trachurus trachurus	Atlantic horse mackerel	2796	1.2	4012	1.1
	Scomber scombrus	Atlantic mackerel	172	1.5	37	2.7
	Sardina pilchardus	Sardine	15,689	2.5	9675	2.3
	Scomber colias	Atlantic chub mackerel	20,962	1	7187	0.7
	Micromesistius poutassou	Blue whiting	2862	1.8	326	3.9
	Argyrosomus regius	Meagre	842	8	17	5.2
	Pagellus bogaraveo	Blackspot seabream	105	24.4	41	17.2
	Scomber japonicus	Pacific chub mackerel	8		457	0.9
Seasonal	*Octopus vulgaris*	Common octopus	6894	5.7	4124	6.3
	Engraulis encrasicolus	European anchovy	31,209	2.6	7883	3.2
	Sarda sarda	Atlantic bonito	672	3.3	393	5
	Dicologlossa cuneata	Wedge sole	634	9.2	5	7.9
	Parapenaeus longirostris	Deep-water rose shrimp	12,792	9.1	1449	12.9
	Phycis phycis	Forkbeard	84	5.7	31	7.4
	Auxis thazard	Frigate	108	1.8	4602	2.3
	Auxis rochei	Bullet tuna	86	1.8	2897	2
	Euthynnus alletteratus	Little tunny	113	2.6	743	2.6
	Nephrops norvegicus	Norway lobster	786	18.1	134	38
	Scorpaena scrofa	Red scorpion fish	9	19.1	59	12.6
	Xiphias gladius	Swordfish	3994	6.6	3227	7.2
	Caranx rhonchus	False scad	92	3.4	25	4
	Boops boops	Bogue	1168	0.5	1445	0.4
	Aristeus antennatus	Blue and red shrimp	340	36.7	528	37.6
	Sardinella aurita	Round sardinella	3661	2.4	10,583	0.4
	Thunnus thynnus	Atlantic bluefin tuna	14,559	12.9	1869	9.4

Note: Prices are given in Euros and landings in tons.

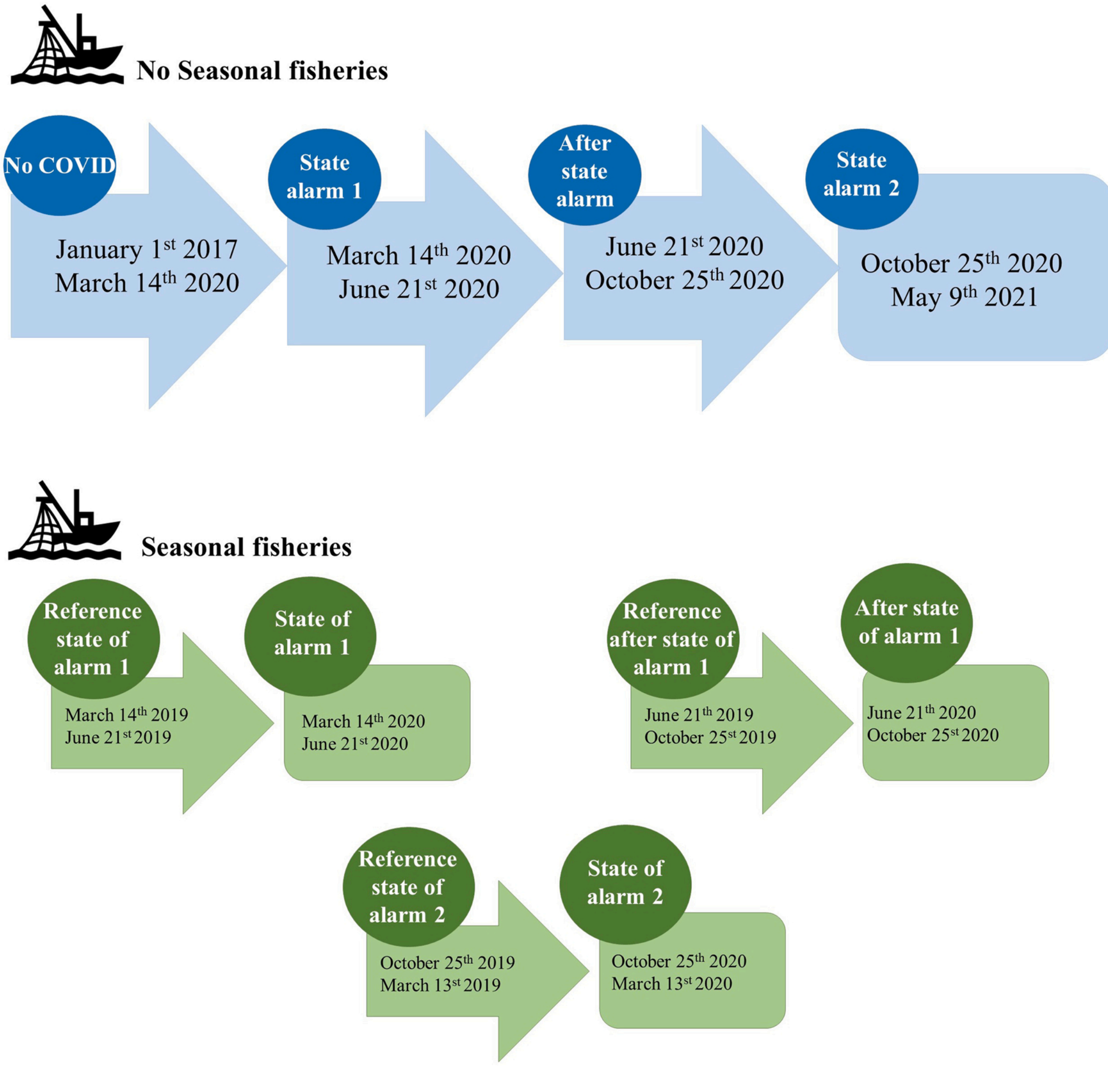

Fig. 2. Framework of the different levels of the COVID variable used in the Generalised Linear Models for species with a seasonal or nonseasonal fishery.

Generalised Linear Models [23] were used to investigate the influence of COVID levels on daily landings and first-sale price of the chosen species. GLMs are an extension of Linear Models (LMs) for which the distribution of the response variable can be other than Gaussian. For this reason, a link function *g* is required between the expected response and conditional response of the variable Y, $\mu(X)=E(Y=X)$, $X = (X_1, \ldots, X_p)$ being the covariables and the linear predictor, formulating the GLM as.

$$g(\mu(X)) = \beta_0 + \beta_1 X_1 + \cdot + \beta_p X_p \quad (1)$$

where β_0, β_1,.,β_p are the unknown model parameters.

A GLM assumes that the response variable follows a distribution belonging to the exponential distribution family. This family includes distributions that are practical for modelling, such as Poisson, Binomial, Normal or Gamma distributions. Depending on the distribution of the response variable, different link functions can be applied that give rise to different models. For example, if the response follows a Gaussian distribution and the link is the identity function, the GLM becomes an LM. However, in our analysis, we assumed that our response variables (i.e. landings and first-sale prices) follow a Gamma distribution with a natural logarithm link due to their being strictly positive continuous variables.

In GLMs, the effects of categorical variables are considered to be fork-1 of the k factor levels, with the remaining one considered to be the base level. Hence, the estimated coefficient of each factor level will indicate the deviation in relation to the value of the base level. In our case, for nonseasonal fisheries, the COVID variable generates a coefficient for each of the levels—State of alarm 1, After State of alarm 1, and State of alarm 2—which indicates the deviation in relation to the value of the No COVID level. To avoid the confounding effects of seasonal patterns, the same approach was taken in relation to seasonal fisheries such that each level was compared to the corresponding year in which there was no COVID disease.

GLMs were performed using R software [24]. All the R code used in this study can be found as an open-access source in the GitHub repository (link).

3. Results

This study investigated the resilience of fishing activity to the COVID-19 pandemic by analysing 27 different species in the Andalusian fishing grounds (Atlantic Ocean and Mediterranean Sea). For each of the species, we conducted two GLMs using the response variable landings and first-sale prices, respectively. Table 3 shows the results of the GLM models in relation to the effects of the COVID levels by price and landings.

Due to the small sample size, we were unable to detect significant effects in either of the two response variables for some species. This was the case of *Scomber japonicus*, for which there were insufficient data on

Table 3
Summary of the GLM results.

Fishing grounds	Species name	Response variable	Atlantic			Mediterranean		
			State of alarm 1	After state of alarm 1	State of alarm 2	State of alarm 1	After state of alarm 1	State of alarm 2
NonSEASONAL	*Trachurus mediterraneus*	Price	ns	ns	-	ns	-	ns
		Landings	-	-	-	ns	+	ns
	Trachurus picturatus	Price	ns	ns	+	ns	-	-
		Landings	ns	-	-	-	-	+
	Trachurus trachurus	Price	-	-	ns	ns	-	+
		Landings	ns	ns	-	-	+	+
	Scomber scombrus	Price	-	-	-	-	-	-
		Landings	ns	+	+	-	-	ns
	Sardina pilchardus	Price	+	-	+	+	-	+
		Landings	-	+	-	-	-	-
	Scomber colias	Price	ns	-	ns	ns	-	+
		Landings	-	+	-	-	ns	-
	Micromesistius poutassou	Price	ns	+	+	+	+	+
		Landings	ns	ns	-	-	-	-
	Argyrosomus regius	Price	-	+	ns	-	ns	ns
		Landings	-	-	-	ns	ns	-
	Pagellus bogaraveo	Price	-	-	-	+	+	ns
		Landings	ns	-	ns	ns	ns	ns
	Scomber japonicus	Price	ned	ned	ned	ned	ned	ned
		Landings	ned	ned	ned	ned	ned	ned
SEASONAL	*Octopus vulgaris*	Price	-	+	+	-	ns	+
		Landings	-	-	ns	ns	ns	ns
	Engraulis encrasicolus	Price	+	-	-	ns	-	ns
		Landings	+	+	ns	ns	-	+
	Sarda sarda	Price	+	+	+	ns	ns	+
		Landings	ns	-	+	ns	ns	ns
	Dicologlossa cuneata	Price	-	+	+	+	ns	+
		Landings	+	ns	-	ns	ns	-
	Parapenaeus longirostris	Price	+	ns	-	-	-	+
		Landings	-	ns	-	+	+	-
	Phycis phycis	Price	ns	-	+	+	+	ns
		Landings	-	+	ns	-	ns	+
	Auxis thazard	Price	ned	+	ns	ned	ns	ns
		Landings	ned	+	ns	ned	-	-
	Auxis rochei	Price	ned	+	ned	ned	ns	+

(continued on next page)

Table 3 (*continued*)

		Landings	ned	-	ned	ned	+	-
	Euthynnus alletteratus	Price	-	+	ns	-	ns	ns
		Landings	ns	-	ns	ns	+	-
	Nephrops norvegicus	Price	ns	+	+	-	ns	+
		Landings	ns	ns	-	-	ns	ns
	Scorpaena scrofa	Price	-	-	ns	-	ns	ns
		Landings	ns	-	+	-	+	+
	Xiphias gladius	Price	ned	ned	ns	-	+	ns
		Landings	ned	ned	-	ns	ns	ns
	Caranx rhonchus	Price	+	+	ns	ns	ns	ns
		Landings	ns	+	ns	ns	ns	ns
	Boops boops	Price	-	-	ns	ns	-	ns
		Landings	+	+	ns	ns	+	+
	Aristeus antennatus	Price	ns	+	+	-	+	ns
		Landings	+	ns	ns	ns	ns	-
	Sardinella aurita	Price	ned	ned	ned	ns	ns	-
		Landings	ned	ned	ned	ns	+	+
	Thunnus thynnus	Price	-	ns	ned	-	-	-
		Landings	ns	+	ned	-	ns	ns

Note: + or - denote a significant increase or decrease in price or landings, respectively, in the levels of State of alarm 1, After State of alarm 1, and State of alarm 2 relative to the reference state. ns indicates that no significant differences were found between the expected values of the response variables during the pre-pandemic and pandemic levels. ned indicates that there were insufficient data to determine significant differences between the COVID levels.

Table 4
The percentage of species for which a significant increase or decrease in price or landings was found during State of alarm 1, After State of alarm, and State of alarm 2 relative to the reference state. Note: The percentages are provided for each response variable (landings and first-sale prices). The percentage was computed for the total of species for which a significant effect was detected. D (%) denotes a decreasing percentage; I (%) denotes an increasing percentage.

	Landings			Price		
	State of alarm 1	After state of alarm 1	State of alarm 2	State of alarm 1	After state or alarm 1	State of alarm 2
D (%)	81	50	67	67	56	32
I (%)	19	50	33	33	44	68

any of the COVID levels in both fishing grounds. In addition, there were not enough data on *Auxis thazard, Auxis rochei, Xiphias gladius, Sardinella aurita*, and *Thunnus thynnus* to conduct some of the comparisons between the different COVID levels (Table 3).

Table 4 shows significant decreases/increases in the price or landings variables for several species for each corresponding COVID level in relation to the reference level. In particular, the percentage of significant increases or decreases is provided for each response variable (landings and first-sale prices), which were computed for the total of species for which a significant effect in the COVID level was detected.

For all species, and relative to the no-COVID-19 period, a significant decrease was found in the price variable of 67 % during State of alarm 1, whereas there were decreases of 56 % and 32 % during the after the State of alarm 1 and the State of alarm 2, respectively.

Also in relation to the no-COVID-19 period, a significant decrease of the 87 % was found in the landings variable during State of alarm 1, and decreases of 50 % during after the State of alarm 1 % and 67 % during State of alarm 2.

The results show that the pandemic had the greatest negative impact on the price variable during State of alarm 1—although this variable was already recovering during the following two pandemic levels—and had the greatest negative impact on the landings variable in States of alarm 1 and 2, although the effect was less during the latter state. Thus, the pandemic had a greater effect on landings than on prices.

For completeness, Table 5 shows significant increases or decreases in prices and landings by percentage of species and by fishing ground (Gulf of Cádiz and Mediterranean Sea). Relative to the no-COVID-19 period, we observed the following significant decreases in the price variable: 67 % and 66 % for all species in the Atlantic and in the Mediterranean Sea during State of alarm 1, respectively; 45 % and 69 % for all species in the Atlantic and Mediterranean Sea during the post-State of alarm 1, respectively; and 36 % and 29 % of all species during State of alarm 2 in the Atlantic and Mediterranean Sea, respectively.

Thus, the results show that the pandemic had a negative effect on prices in State of alarm 1 in both fishing grounds. However, during post-State of alarm 1, this effect was only observed in the Mediterranean,

Table 5
The percentage of models for which a significant increase or decrease in price or landings was found during State of alarm 1, After State of alarm, and State of alarm 2 relative to the reference state. Note: The percentage are provided for each response variable (landings and first-sale prices) by fishing grounds (Atlantic and Mediterranean Sea). The percentage was computed for the total of species for which a significant effect was detected. D (%) denotes a decreasing percentage; I (%) denotes an increasing percentage.

	Landings						Price					
	Atlantic			Mediterranean			Atlantic			Mediterranean		
	State of alarm 1	After state or alarm 1	State of alarm 2	State of alarm 1	After state or alarm 1	State of alarm 2	State of alarm 1	After state or alarm 1	State of alarm 2	State of alarm 1	After state or alarm 1	State of alarm 2
D (%)	64	50	71	100	50	62	67	45	36	66	69	29
I (%)	36	50	29	0	50	38	33	55	64	33	31	71

whereas the Atlantic was slowly recovering.

Relative to the no-COVID-19 period, we observed the following significant decreases in the landings variable: 64 % and 100 % for all species in the Atlantic and Mediterranean Sea during State of alarm 1, respectively; 50 % for all species in both fishing grounds during the post-State of alarm 1; and 71 % and 62 % for all species in the Atlantic and the Mediterranean during State of alarm 2, respectively.

The results show that the pandemic had a negative effect on landings in State of alarm 1 in both fishing grounds, although the effect was greater in the Mediterranean Sea. During post-State of alarm 1, the decrease in landings was lower for all species.

Both fishing grounds showed a common pattern of decreases/increases in first-sale prices for the species *Scombur scombrus, Sardina pilchardus, Micromesistius poutassou, Octopus vulgaris, Sarda sarda, Scorpaena scrofa, Boops boops,* and *Thunnus thynnus*.

4. Discussion

In order to assess the fitness of fishing activity, we compared the impact of different periods of the pandemic on landings and the first-sale prices of fresh fish in two Andalusian fishing grounds by species and by fishing ground.

The results show that during State of alarm 1 there was a sharp fall in first-sale prices and landings in both Andalusian grounds. It is clear that the collateral economic effects of the market disturbances affected the ability of fishermen to make a living because of the reduced demand and consequent price collapse. Export-oriented fisheries faced greatly reduced demands, port closures, loss of access to cold storage, and the cessation of sea and air transport [25].

However, during subsequent periods the decreases were lower, which may have been due to the fact that the losses related to the first period were cushioned by reduced operating costs and the deployment of a wide network of public aid to the sector [6]. Indeed, after the first lockdown period, there was a major reduction in oil consumption worldwide, which led to decreased oil prices, thus benefiting fisheries [7].

The results show that the economic recovery from the COVID-19 lockdowns was temporary because it was reversed by successive restrictions related to mobility as well as fluctuations in demand for seafood during State of alarm 2. Uncertainty in food supplies and disruptions in traditional value chains meant that the resumption of fishing depended on the reopening of markets, restaurants, and other large-scale activities associated with the consumption of seafood, such as tourism [5,26]. In fact, the interruptions caused by the COVID-19 restrictions completely changed market and eating habits [27]. Grocery stores saw an increased demand for typically inexpensive frozen or canned seafood, such as canned tuna [28]. Meanwhile, vessels oriented to the fresh fish market were not working due to the lack of demand [29]. Therefore, fisheries may remain vulnerable to any resurgence in COVID-19 infection rates and demands for fresh fish, especially higher value products.

The results showed that the Atlantic fishing ground was more resilient to the COVID-19 disruptions in terms of prices, whereas the Mediterranean one was resilient in terms of landings. This could be due to the fact that in operational terms, the Mediterranean fleet is mainly composed of small vessels with small crews, which facilitated their rapid return to work once the main health issues were resolved [7]. In contrast, the Atlantic fleet requires more crew members per vessel, which could hinder the return to work for operational and economic reasons in the face of any future severe crisis.

However, from an operational point of view, although the Mediterranean fisheries recovered quickly, they were more affected than the Atlantic fisheries by the decrease in the demand for local fresh fish. It should be noted that, in order to combat unemployment, several public support schemes were approved that partially compensated the sector for the decrease in fishing activity and enabled many fishermen to cease fishing until the health measures were implemented and minimum market conditions were ensured [30,31].

Our results are in line with those of recent studies that have found that landings and prices have been disrupted by abrupt changes in demand and supply and limitations on the movement of people and goods [7,32,33]. In conclusion, our study suggests that the COVID-19 pandemic has been and continues to be a major challenge for the fisheries sector in Spanish waters and global ones. Although there have been some political initiatives to offset the negative consequences of the pandemic, the immediate impacts of the crisis were profound in relation to catches and market prices. Short-term responses need to be rapid and should target the most vulnerable sectors. As mentioned by Bennett et al. [14], a coordinated response needs to be developed to transform existing institutions, supply chains, and food systems in ways that improve the conditions and resilience of the fisheries sector to prepare for future unforeseen global crises.

Data Availability

Data will be made available on request.

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