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Impact of the COVID-19 crisis: Analysis of the fishing and shellfishing sectors performance in Galicia (Spain)

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1. Introduction

The Spanish economy has been strongly affected by the COVID-19 crisis. The impact of coronavirus disease 2019 has gone beyond the health field to the economic and social sphere, given the measures adopted by the central and regional governments to curb the pandemic (Pak et al., 2020). These measures have resulted in the restriction of people movements and the paralysis of a large part of economic activity. The state of alarm situation lasted for three months, until the termination was decided by each of the Spanish regions to minimize the risk of expansion of the pandemic (Codagnone et al., 2020). The state of alarm situation lasted for three months, until the termination was decided by each of the Spanish regions to minimize the risk of expansion of the pandemic (Codagnone et al., 2020).

The adoption of these measures responds to the application of Article 10 of Royal Decree 463/2020 under the provisions of Organic Law 4/1981, which considers health crises as a justified cause for declaring a state of alarm (Henríquez et al., 2020). Thus, in Spain, since March 14, 2020, economic activity was suspended except for those sectors providing security services and performing functions of “supplying the population and the essential services themselves” (Real Decreto 463/2020, 2020). The state of alarm situation lasted for three months, until the risk of expansion of the pandemic was minimized (Codagnone et al., 2020). Its termination was decided by each of the Spanish regions to which the corresponding competences were transferred. In the case of the region of Galicia, the regional government ordered the termination of the State of Alarm on June 15, 2020 (Orden SND/520/202, 2020).

After a period without restrictions both for the mobility of the population and for the performance of economic activities, the worsening of the health situation due to the COVID-19 led to the declaration of a second state of alarm in Spain. In the case of the Galician region, the activities considered as non-essential suffered a discriminated paralysis from November 7 to December 3, 2020 (Rodríguez-Antón and Alonso-Almeida, 2020).

The Galician fishing and shellfishing sectors were legally considered essential activities by the central government, so they were authorized to maintain their activity without restrictions during the two periods of application of the state of alarm. However, given the reduction in sales, part of the Galician fishing fleet, especially the small-scale segment, decided to limit its activity, while shellfishing activities were practically paralysed in Galicia. It is important to point out that the Galician fishing and shellfishing sectors have great importance in the Galician economy, much more so than in other Spanish coastal regions (Garza-Gil et al., 2017; Piñeiro-Antelo et al., 2019; Surís-Regueiro and Santiago, 2018). In 2016, both industries directly generate 16,559 full-time jobs and €525 million of GVA (Galician Institute of Statistics database (IGE), 2020).

Given the importance of the fishing and shellfishing sectors in...
Galicia, numerous studies have analyzed the problems that have affected this industry. One of the main problems is overfishing, which is a major concern in Galician waters. The Galician fishing fleet consists of 4313 vessels, with a total capacity of 129,099 GT and 255,682 kW (kW). The classification of the Galician fishing fleet distinguishes three major groups of vessels according to their harvesting zone: small-scale fishing fleet (73% of the vessels), medium-scale fishing fleet (24%), and large-scale fishing fleet (3%). The small-scale fishing fleet is the most numerous, with 96% of the vessels. However, it only represents 33% of the total capacity of the Galician fleet in terms of GT. The reason for this is the predominance of small-scale vessels, especially in the minor gears modality (3841 vessels). Other fishing methods used in the small-scale fishing fleet are purse seining (152 vessels), bottom trawling (54 vessels), and gillnetting (24 vessels), with an estimated number of crew members of 8798 (Xunta de Galicia, 2020a). The offshore fishing fleet consists of 71 vessels, representing 15.7% of the total tonnage, and it includes 48 bottom longliners and 23 trawlers. This fleet operates, mostly, in the NEAFC Regulatory Area, specifically in the Grand Sole fishing grounds. The estimated total employment is 861 people. Finally, the large-scale fishing fleet is composed of 99 vessels that accumulate 51.7% of the total GT owing to their large size. This fleet operates in fishing grounds spread around the world, which include the waters of Norway (2 cod trawlers), the NAFO area (15 freezer trawlers), the Southwest Atlantic (Argentina and the Falkland Islands) and Northwest Africa (Morocco, Mauritania, Senegal, Cape Verde and Guinea Bissau) (13 freezer trawlers). There are also 68 surface longliners specialized in catching swordfish and a freezer purse seiner catching tuna, all of them operating both in the Atlantic and in various areas of the Indian and the Pacific Oceans. The large-scale fishing fleet employs an estimated number of crew members of 1058 people (Xunta de Galicia, 2020a).

European hake (Merluccius merluccius, Merluccidae) is by far the main species landed, in terms of value, by the Galician fleet. This fact makes Spain the largest market in the world for this species (Amigo-Dobaino and Garza-Gil, 2011). There exist 65 fish markets located in the different fishing ports of the Galician coast, where first sale of fish and shellfish takes place (Afundación, 2019). Furthermore, the freezing, canning and marketing subsectors complete the fish and seafood production chain in Galicia (Sobrino Heredia and Ganta, 2019).

3. Methodology

3.1. Phases description

The study of the evolution of catches and revenue in the Galician fishing and shellfishing sector during the COVID-19 pandemic has been divided into three phases. The first phase (March 14–June 15, 2020) began with the declaration of the first state of alarm (Real Decreto 463/2020, 2020), in which the population is confined and non-essential economic activities are paralysed. Fishing and shellfishing were two of the activities considered essential and, therefore, authorized by the Spanish Central Government to continue their activity (Real Decreto 463/2020, 2020). However, the HORECA sector had to cease its business, blocking one of the most important distribution channels in the sector (EUMOFA, 2020b). This was a damage to the fishing and shellfishing industry, even more serious in the latter case, since the shellfish sector decided to almost completely paralyse its activity because its main commercial channel was not active (Consellería do mar, 2020a).

The second phase (June 16–November 6, 2020) was characterized by an improvement in the epidemiological situation in Spain, allowing the central government to end the state of alarm. In this way, a scenario of “new normality” was established, and all the productive sectors could restart their activity (Orden SND/520/202, 2020; Resolución del DOG nº 115 de 2020/6/13 Diario Oficial de Galicia, 2020). This measure resulted in the reopening of the HORECA channel, allowing the revitalisation of shellfish farming and the improvement of income in the fisheries sector. However, the start of a second wave of the pandemic resulted in the declaration of a new state of alarm on 25 October, which was extended until May 2021 (Real Decreto 926/2020, 2020; Real Decreto 956/2020, 2020). This measure ended the situation of “new normality” that characterized this second phase.

During the third phase (November 7–December 3, 2020), the Galician regional government, using the powers granted by the central government (Real Decreto 926/2020, 2020), adapted the national declaration of the state of alarm to its territory (Decreto 178/2020, 2020; Decreto 179/2020, 2020). The fishing and shellfishing sectors were able to continue their activity because they were considered as key industries for food supply (Orden del DOG nº 223-Bis, 2020). In contrast, the discriminated closure of the HORECA sector was declared and its activity was ceased in 60 municipalities with a high incidence of COVID-19 (the main cities and 53 other municipalities, representing 60% of the Galician population). The stoppage of activity in this sector lasted approximately one month (November 7–December 3, 2020) (Decreto 202/2020, 2020). This second closure of the HORECA channel caused the demand for fish and shellfish to fall once again.
3.2. Data

The data used in this study were obtained from the fish and shellfish database of the Galician regional government. This database, *Pesca de Galicia*, publishes daily data on the catches, revenue and average price of first sale of a total of 286 species in the 65 fish markets of Galicia. For this analysis, all the species of fish or shellfish from all the Galician fish markets were selected (Xunta de Galicia, 2020c).

Once the three study phases had been established, between 2015 and 2020, the average volume of the main species landed in all the fish markets of Galicia was determined for the six-year period. Then, the top ten species of fish and shellfish caught between 2015 and 2020 were selected for a comparison between production in 2020 and the average production in 2015–2019. For each phase, catches, revenue and average price of first sale were analyzed for the species in 2020 and for the average 2015–2019. In addition, the variation percentages between the two periods were calculated for each of these magnitudes.

On the other hand, another analysis of the fish and shellfish species in the three phases of the pandemic has been carried out. In this case, according to their average price per kg, the species have been classified by quartiles. Both the time range (2020–2015) and the variables (catches, revenue and average price of first sale) are the same as in the previous analysis described.

4. Results

4.1. First phase (March 14th – June 15th)

During the first state of alarm, the fish and shellfish landings decreased its volume by 19.49%, its first sale revenue by 26.63% and its first sale average price by 8.87% compared to the average of the period 2015–2019. In view of this situation, the Galician regional government estimated that the economic losses during this phase were: €25 million at first sale level, about €60 million for the lack of activity, and more than €500 million for the whole maritime industry (EUOMOFA, 2020a).

The economic impact of the pandemic on Galician fishing and shellfishing sectors was not even mitigated by the large drop in the spot price of crude oil, which directly affects the price of marine fuel. Until September 2020, its price was down 30% compared with the same period of 2019 (EUOMOFA, 2020b).

In this phase, the HORECA channel was closed, negatively affecting the commercialisation of fish and shellfish species. It is important to point out that the damage was even more severe in the higher value products, which are preferably marketed by this channel. Therefore, the demand for this type of products decreased during those three months. In contrast, the demand for more affordable products, traditionally with a higher percentage of sales for domestic consumption, suffered a smaller decrease (Revista Mar 600, 2020).

These products are aggregated in quartile two and three, while those in the last quartile are of very low quality and are normally not destined for domestic consumption or the HORECA channel, but for industrial uses.

Another consequence of the closure of HORECA was the temporary reduction of activity in the fisheries and shellfish sectors. In order to alleviate the negative consequences of the temporary business slowdown, the central government enabled wage indemnity for producers with a reduction of 75% or more of their revenue. In this first phase, 3266 applications were submitted in Galicia, distributed as follows: Vilagarcía (1422), Vigo (967) and A Coruña (877). Shellfishing sector was the most affected, with 2454 applications, almost tripling the number of requests for fishing sector (Revista Mar 603, 2020).

4.1.1. Fishing sector

Regarding the impact of COVID-19 on fishing, small-scale and offshore fishing fleets have performed worse than large-scale fishing fleet (EUOMOFA, 2020b). The explanation for this lies in the fact that small-scale and deep-sea vessels land fresh fish; whereas large-scale vessels land frozen fish that does not need to be marketed immediately. This characteristic of the large-scale fishing fleet has benefited it since during the first state of alarm in Spain, the production of frozen fish increased by 24% and its revenue by 28% compared to 2019 (Industria Conservera 140, 2020). In the case of small-scale fishing, the activity has been reduced, trying to adapt to the decrease in demand (European Commission, 2020a). As a result, the drop in prices in the ports with small-scale fishing fleets was pronounced (Revista Mar 600, 2020).

The main ten fish species caught by the Galician fleet at this first stage are shown in Table 1. Eight of them decreased both in catch volume and in revenue. The most pronounced declines are those of the Atlantic chub mackerel (*Scomber colias*, Scombridae) and the bogue (*Boops boops*, Sparidae). This can be largely attributed to the biology of these species, which were less abundant this year (Xunta de Galicia, 2020b). The abundance and catches of Atlantic chub mackerel have increased in recent years, but with oscillations (Villamor et al., 2017).

On the contrary, European pilchard (*Sardinia pilchardus*, Clupeidae) considerably increased the volume of catches, because the Spanish-Portuguese shared quota rised by 76.9% with respect to 2019 (Resolución de 24 de abril de 2020, 2020; Resolución de 30 de junio de 2020, 2020). This increment was possible by a slight recovery in the European pilchard biomass detected by ICES (ICES (International Council for the Exploration), 2020). As far as Spain is concerned, this means that it could increase its European pilchard catches to 6400 tons (Ministerio de Agricultura, 2020b).

Another species that also increases its catch volume, although to a lesser extent, is Atlantic mackerel (*Scomber scombrus*, Scombridae). The reason for this is the 71% increase in the fishing quota compared to 2019, as TACs and swaps were increased (European Commission, 2020b). Although in this phase there was a slight increase in the volume of catches in relation to the previous campaign, the heavy increase in catches of this species was postponed until the third phase of this study since, in view of the fall in market prices, shipowners reduced the daily catch limit until the Christmas season (Revista Mar 601, 2020).

4.1.2. Shellfishing sector

The shellfish catches suffered a much greater reduction than the fish catches during confinement. The explanation for this is that the HORECA channel, which had stopped its activity, is the main sales channel for shellfish products. As a result of the severe drop in demand, the prices of shellfishing products fell by 96% in the first month of the state of alarm (Consellería do mar, 2020b). Faced with this scenario, most shellfish producers chose not to continue with their activity and their various associations proposed to the government to declare the obligatory cessation of their activity in order to benefit from government COVID-19 subsidies (Revista Mar 601, 2020).

The low level of shellfish activity meant that prices in the first two quartiles remained constant because supply adjusted to existing demand, which was reduced by the closure of the HORECA channel. However, in the third quartile of shellfish products, the average price per kg increases. This is because this quartile includes species destined for the canning industry whose demand did not decrease. In fact, until June 2020, the production of canned products in Spain increased by 15% and its turnover by 16% compared to 2019 (Industria Conservera 140, 2020). In the case of quartile four, the weak demand for these lower value products did not allow that drop in production were offset by significant price increases.

At this phase, only one of the ten main shellfish species increased in catch volume and revenue (Table 2). This species is the northern shortfin squid (*Illex illecebrosus*, Ommastrephidae), which is currently experiencing high variability in its abundance. The distribution and abundance of cephalopods in Galician waters have been described as strongly influenced by oceanographic phenomena, in particular the upwelling (Rocha et al., 1999). The remaining nine species suffered strong declines with respect to the 2015–2019 period, due to both the paralysis of the...
shellfishing sector after the HORECA channel closure and other biophysical factors that explain the differences between species.

The meteorological factor is one of those biophysical factors that regularly and unevenly affect shellfish production. In particular, rainfall causes salinity fluctuations that alters the vital parameters and distribution of bivalve mollusks (Pourmozaffar et al., 2019). The heavy rainfall in the winter of 2020 produced a significant drop of the water salinity level that mainly affected bivalves, especially pullet carpet shell (Venerupis pullastra, Veneridae) and common cockle (Cerastoderma edule, Cardiidae). For this reason, the mortality rate in the main common cockle bank of Galicia increased to 67% (La Voz de Galicia, 2020a). The rainfall in the winter of 2020 produced a significant drop of the water temperature (La Voz de Galicia, 2020a).

Table 1

| Catch (Kg) | Revenue (€) | Average price (€/kg) | March 14th - June 15th (2020) | March 14th - June 15th (2015–2019) | Variation in catches, Revenue and average price (2015–2019)/2020 |
|-----------|-------------|----------------------|-------------------------------|-----------------------------------|---------------------------------------------------------------|
| European hake (Merluccius merluccius) | 7,327,046.84 | 21,899,286.54 | 2.99 | 8,221,440.18 | 30,014,516.57 | 3.65 | –10.88% | –27.04% | –18.13% |
| Atlantic mackerel (Scomber scombrus, Scombridae) | 8,004,830.69 | 8,297,773.51 | 1.04 | 7,344,591.32 | 7,408,349.57 | 1.01 | 8.99% | 12.01% | 2.77% |
| Blue whiting (Micromesistius poutassou, Gadidae) | 5,954,970.67 | 3,038,911.18 | 0.51 | 6,023,670.76 | 4,052,181.06 | 0.67 | –1.14% | –25.01% | –24.14% |
| Atlantic horse mackerel (Trachurus trachurus, Carangidae) | 4,233,730.19 | 4,157,465.66 | 0.98 | 5,191,563.14 | 4,796,489.57 | 0.92 | –18.45% | –13.32% | 6.29% |
| Atlantic chub mackerel (Scomber colias, Scombridae) | 615,647.73 | 374,626.05 | 0.61 | 4,283,548.34 | 2,767,285.35 | 0.65 | –85.63% | –86.46% | –5.81% |
| Bogue (Boops boops, Sparidae) | 777,534.20 | 349,836.25 | 0.45 | 2,461,041.98 | 1,061,065.67 | 0.43 | –68.41% | –67.03% | 4.36% |
| Blackbilled angler (Lophius budegassa, Lophidae) | 2,061,474.99 | 7,908,002.53 | 3.84 | 2,128,112.78 | 10,699,588.25 | 5.03 | –3.13% | –26.09% | –23.70% |
| Megrim (Lepidorhombus whiffiagonis, Scophthalmidae) | 1,664,974.67 | 6,458,852.13 | 3.88 | 2,035,911.01 | 7,675,318.63 | 3.77 | –18.22% | –15.85% | 2.90% |
| European pilchard (Sardina pilchardus, Clupeidae) | 1,607,125.99 | 2,164,391.35 | 1.35 | 815,365.40 | 1,068,164.82 | 1.31 | 97.11% | 102.63% | 2.80% |
| Atlantic pomfret (Brama brama, Bramidae) | 579,678.50 | 1,355,297.64 | 2.34 | 619,441.52 | 1,508,534.39 | 2.44 | –6.42% | –10.16% | –4.00% |

Quartiles

| Catch (Kg) | Revenue (€) | Average price (€/kg) | March 14th - June 15th (2020) | March 14th - June 15th (2015–2019) | Variation in catches, Revenue and average price (2015–2019)/2020 |
|-----------|-------------|----------------------|-------------------------------|-----------------------------------|---------------------------------------------------------------|
| Rest of Fish | 3,496,048.41 | 12,340,089.54 | 3.53 | 5,228,085.33 | 17,401,666.33 | 3.33 | –33.13% | –29.09% | 6.05% |
| Total Fish Q1 | 26,323,062.88 | 68,344,532.38 | 3.50 | 44,352,771.25 | 88,453,160.39 | 4.25 | –18.10% | –22.73% | –17.67% |
| Q2 | 854,400.82 | 6,680,099.76 | 8.63 | 1,545,207.27 | 11,474,597.72 | 10.12 | –44.71% | –41.78% | –14.68% |
| Q3 | 12,517,298.14 | 40,539,378.22 | 3.08 | 12,946,425.34 | 49,616,677.57 | 3.83 | –3.31% | –18.29% | –19.56% |
| Q4 | 3,150,670.26 | 4,775,008.76 | 1.55 | 3,352,684.59 | 6,165,862.53 | 2.08 | –6.03% | –22.56% | –25.33% |

During the “new normality” phase, total fish and shellfish landings fell by 16.15% in volume and 13.99% in first sales revenue with respect to the average for 2015–2019. On the other hand, the average first sale price increased by 2.57%.

The opening of the HORECA channel during this period had a positive effect on the fisheries and shellfish sectors in Galicia. The percentages of variation in the catches and revenue of the higher priced species, included in the first quartiles of fish and shellfish, increased. At the same time, there is a decrease in average prices per kg. This contrasts with the reduction in catches and revenue in most other quartiles of fish and shellfish products. Even so, the effect of the reopening of the hospitality industry was less than expected as a result of the partial capacity restrictions on catering establishments and the lower level of attendance.

4.2. Second phase (June 16th - November 6th)

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4.2.1. Fishing sector

As previously mentioned, European pilchard catches grew in 2020 owing to the increase in the joint quota with Portugal. Despite the slight increase in catches in this second period, there is a notable drop in turnover and an even greater decrease in the average price per kg. Compared to the 2015–2019 period (Table 3), the explanation for this is that the COVID-19 forced to cancel all the saint festivities associated with the highest peak in annual European pilchard consumption (EUOMFA, 2020).

The most striking data from this period is that of the European anchovy (Engraulis encrasicolus, Engraulidae), which triples its capture. This is explained by two main factors. The first one is the biological factor, since its biomass increased by 44% with respect to 2019 (ICES (International Council for the Exploration), 2020a). European anchovy has been characterized as a highly variable species in terms of abundance, has recovered after the Bay of Biscay fishery was closed between 2006 and 2010 (Santos et al., 2013). This species has a very irregular catch history in Galicia, and it is only fished in Galician waters in years when its biomass is high. Otherwise, its capture is restricted to Cantabrian waters (Fernández-González et al., 2019). The second one is a market factor. The decline in demand, caused by the closure of the

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Most of the European anchovy production is destined for the canning industry, which only improves for two species: Japanese carpet shell and northern shortfin squid (Table 4). This is because Japanese carpet shell is a species resistant to the salinity variation produced by winter rains and northern shortfin squid is a species with high variability in terms of abundance. Among the species whose records are worsening is the common cockle, whose decrease in production is attributable to three main factors. The first factor is the decrease in quota, which is reduced by 10–7 kg/day for shellfishermen. This decrease is attributable to the low demand for common cockles as a result of the pandemic. Although the largest buyer of this species in 2020 is the canning industry, its purchases are not as plentiful as in previous years, as consumers prefer lower-priced canned foods. The second factor is the closure of the main fish farm for this species because of the high levels of toxin detected. The closure began on September 28, 2020 and continued throughout this second phase (Confraria de Pescadores de Noia, 2020). On the other hand, the effects of the drop in salinity caused by winter rains on common cockle production are prolonged during this phase, as is the case with pullet carpet shell and banded carpet shell, whose production decreases by more than 30%.

The decreasing production of common octopus (Octopus vulgaris, Octopodidae) is in line with the general trend of the year and continues throughout the third phase of this analysis. Its causes are still unknown. Among the hypotheses being considered are the variations observed in

### Table 2

Catches, revenue and average price (euros/kilogram) of first sale of shellfish catches in Galicia. First phase (March 14th – June 15th).

| Quartiles | March 14th - June 15th (2020) | March 14th - June 15th (2015-2019) | Variation in catches. Revenue and average price (2015-2019)/2020 |
|-----------|-------------------------------|-------------------------------------|---------------------------------------------------------------|
|           | Catch (Kg) | Revenue (€) | Average price (€/Kg) | Average catch (Kg) | Average revenue (€) | Average price (€/Kg) | Catch | Revenue (€) | Average price (€/Kg) |
| Most caught species | Japanese carpet Shell (Ruditapes philippinarum, Veneridae) | 371,956.86 | 3,383,475.13 | 9.10 | 589,408.86 | 5,244,666.84 | 8.68 | –36.89% | –35.49% | 4.79% |
| | Common octopus (Octopus vulgaris, Octopodidae) | 277,059.28 | 1,989,236.87 | 7.18 | 397,531.11 | 2,915,240.47 | 7.71 | –30.31% | –31.76% | –6.85% |
| | Common cockle (Ceratodermidae, Cardiidae) | 103,013.79 | 821,907.61 | 7.98 | 254,288.09 | 1,409,532.54 | 5.71 | –59.49% | –41.69% | 39.66% |
| | Northern shortfin squid (Illex illecebrosus, Ommastrephidae) | 240,037.88 | 761,130.44 | 3.17 | 214,884.97 | 485,861.00 | 2.41 | 11.71% | 56.66% | 31.54% |
| | Sea urchin (Parecercatrus livida, Parechinidae) | 146,116.05 | 930,469.49 | 6.37 | 214,221.91 | 1,129,396.13 | 5.37 | –31.79% | –17.61% | 18.71% |
| | Common cuttlefish (Sepia officinalis, Sepiidae) | 170,305.32 | 1,253,166.22 | 7.36 | 189,112.53 | 1,229,026.97 | 6.60 | –9.94% | 1.96% | 11.48% |
| | Lesser Flying Squid (Todaropsis eblanae, Ommastrephidae) | 80,037.65 | 235,981.14 | 2.95 | 192,316.60 | 423,786.56 | 2.39 | –58.38% | –44.32% | 23.43% |
| | Curled octopus (Eledone cirrhosa, Octopodidae) | 82,795.52 | 197,517.75 | 2.39 | 173,962.93 | 283,516.38 | 1.86 | –52.41% | –30.33% | 28.77% |
| | Pullet carpet Shell (Veneropus pullastra, Veneridae) | 53,328.45 | 850,826.44 | 15.95 | 162,183.07 | 2,392,862.17 | 14.74 | –67.12% | –64.44% | 8.18% |
| | Razor Shell (Ensis magnus, Pharridae) | 75,624.05 | 485,619.29 | 6.42 | 135,896.87 | 11,09,149.58 | 8.15 | –44.35% | –56.22% | –21.21% |
| | Rest of Shellfish Total Shellfish | 636,161.67 | 3,564,674.39 | 10.49 | 1,014,558.16 | 7,798,862.14 | 10.82 | –37.30% | –54.29% | –3.08% |
| | Q1 | 146,823.70 | 2,840,478.76 | 28.02 | 343,910.63 | 7,199,093.09 | 28.34 | –57.31% | –60.04% | –1.14% |
| | Q2 | 1,251,199.56 | 9,805,782.69 | 7.63 | 1,802,606.53 | 14,161,024.82 | 7.62 | –30.59% | –30.76% | 0.03% |
| | Q3 | 428,872.23 | 1,368,803.00 | 4.08 | 606,542.91 | 2,157,057.48 | 3.53 | –29.29% | –36.54% | 15.59% |
| | Q4 | 409,541.03 | 458,940.32 | 1.08 | 785,305.02 | 994,725.41 | 1.06 | –47.85% | –53.86% | 2.72% |

HORECA channel, resulted in the Cantabrian fishing sector reducing catches to avoid a large drop in the price of the species. While in June 2019 80% of the quota had already been caught, in the same period of 2020 it was reduced to less than 60% (Revista Mar 603, 2020). Since the European anchovy is a species whose migration takes place from the east to the west of the Cantabrian Sea, this meant that the Galician fleet was able to catch more anchovies. Moreover, the large increase in European anchovy catches in Galicia resulted in a 35% decrease in the average price per kg. at the first sale. Most of the European anchovy production is destined for the canning industry, which requires large specimens. However, the small size of the specimens caught was not valid, in most cases, to supply the national industry, which requires large specimens. The alternative was to export most of the surplus catches to Italy and Morocco. But, because of the COVID-19 pandemic, the borders were closed and this was not possible. The increase in the supply on the domestic market brought down the price of this species (EUMOFA, 2020a; La Voz de Galicia, 2020c).
5.02%. The effect of the new closure of the HORECA channel in the volume and 13.54% in revenue at first sale with respect to the average production has decreased throughout the year.

4.3. Third phase (November 7th - December 3rd)

In this phase, total fish and shellfish landings fell by 17.67% in volume and 13.54% in revenue at first sale compared to the average production. The effect of the new closure of the HORECA channel in the municipalities with a higher incidence of COVID-19 and the limitation of activity.

However, during this phase, the effect of the Christmas season, which usually leads to an increase in production and turnover in the fishing sector, was not noticeable. Only two of the top 10 fish species raised their catches, in both cases resulting from an increase in quotas. This benefited both the offshore fishing fleet and the small-scale fishing fleet (Table 5).

Table 3
Catches, revenue and average price (euros/kilogram) of first sale of fish catches in Galicia. Second phase (June 16th – November 6th).

| Species                      | Catch (Kg) | Revenue (£) | Average price (£/Kg) | June 16th - November 6th (2020) | June 16th - November 6th (2015–2019) | Variation in catches. Revenue and average price (2015–2019)/2020 |
|------------------------------|------------|-------------|----------------------|---------------------------------|--------------------------------------|---------------------------------------------------------------|
| Most caught species          |            |             |                      |                                 |                                      |                                                                |
| Atlantic horse mackerel      | 2,222,3012.79 | 16,653,392.82 | 0.75                | 18,539,810.94 | 12,861,098.25 | 0.71 | 19.87% | 29.49% | 5.63% |
| Atlantic chub mackerel       | 3,339,184.98  | 2,033,513.30  | 0.61                | 20,351,815.04 | 8,613,222.28 | 0.47 | –83.59%| –76.39%| 29.79%|
| European hake               | 9,290,866.69 | 35,777,738.72 | 3.85                | 11,938,106.15 | 50,394,891.60 | 4.22 | –22.15%| –29.01%| –8.77%|
| Blue whiting                | 9,299,725.64 | 5,815,230.38  | 0.63                | 8,249,172.53 | 5,764,834.43 | 0.72 | 12.74% | 8.87%  | –12.50%|
| Blackbilled angler           | 2,749,474.19 | 14,046,306.51 | 5.11                | 2,822,849.78 | 16,168,480.99 | 5.73 | –2.60% | –13.13%| –10.82%|
| Megrim                      | 2,551,287.55 | 9,570,691.75  | 3.75                | 2,748,135.25 | 11,360,593.93 | 4.13 | –7.16% | –15.76%| –9.20% |
| European pilchard           | 2,378,604.69 | 3,651,845.03  | 1.54                | 2,326,131.56 | 4,636,253.89 | 2.03 | 2.26%  | –21.23%| –24.14%|
| European anchovy             | 6,233,031.35 | 6,850,973.08  | 1.10                | 1,494,005.71 | 2,070,057.59 | 1.71 | 317.20%| 196.95%| –35.67%|
| Bogre                       | 1,082,768.50 | 388,469.16   | 0.36                | 2,096,218.75 | 758,174.87 | 0.34 | –48.35%| –48.76%| 5.88%  |
| Albacore                    | 1,662,135.40 | 6,309,446.42 | 3.80                | 1,863,844.76 | 7,521,782.13 | 4.06 | –10.82%| –16.12%| –6.40% |
| Rest of Fish                | 7,548,578.18 | 25,945,174.00 | 4.22                | 8,291,267.96 | 26,272,231.53 | 4.52 | –8.96% | –1.24% | –6.64% |
| Total Fish                  | 68,361,699.96 | 127,042,781.17 | 4.09               | 80,721,358.43 | 146,658,629.50 | 4.37 | –15.31%| –13.38%| –6.41% |
| Q1                          | 4,498,743.93 | 28,815,400.67 | 10.49               | 3,673,060.23 | 26,058,063.05 | 10.85 | 22.48% | 10.58% | –3.31% |
| Q2                          | 15,521,392.83 | 57,251,387.19 | 3.42                | 18,362,196.70 | 76,620,289.80 | 3.80 | –15.47%| –25.28%| –10.05%|
| Q3                          | 4,823,875.38 | 7,965,713.18  | 1.74                | 6,246,847.30 | 12,376,169.54 | 2.07 | –22.78%| –35.64%| –15.66%|
| Q4                          | 43,517,657.82 | 33,010,280.13 | 0.80                | 52,439,254.20 | 31,604,107.10 | 0.88 | –17.01%| 4.45%  | –8.92% |

- Most species refers to the species with the highest catches in volume and revenue. The most caught species were Atlantic horse mackerel (Trachurus trachurus), European hake (Mereuccius merluccius), and Blue whiting (Micromesistius poutassou).
- The effect of the closure of the HORECA channel in volume and revenue was noted, with reductions of 13.54% and 22.78% respectively.
- The most affected species were Atlantic horse mackerel, European hake, and Blue whiting.
- The closure led to a decrease in production and turnover in the fishing sector, with the highest levels of the year encouraged for biological causes, since it is a species with a high variability.

4.3.1. Fishing sector

During this phase, the effect of the Christmas season, which usually leads to an increase in production and turnover in the fishing sector, was not noticeable. Only two of the top 10 fish species raised their catches, in both cases resulting from an increase in quotas. This benefited both the offshore fishing fleet and the small-scale fishing fleet (Table 5).

As far as the offshore fishing fleet is concerned, blackbilled angler (Lophius budegassa, Lophiidae) is the species that increased its quota due to swaps with France, Belgium, and the Netherlands (Council Regulation (EU) 2020/123, 2020; Ministerio de Agricultura, 2020c). However, the new closure of the hospitality industry reduced the demand for this species, leading to a decrease in price and total revenue. As far as the small-scale fishing fleet is concerned, the Atlantic mackerel doubled its landings in this period following a 41% increase in the Spanish quota for this species.

In addition, a quota swap with the Netherlands obtained 1700 tons of Atlantic mackerel for 2020 (Council Regulation (EU) 2020/123, 2020). This benefited both the offshore fishing fleet and the small-scale fishing fleet (Table 5). As far as the offshore fishing fleet is concerned, blackbilled angler (Lophius budegassa, Lophiidae) is the species that increased its quota due to swaps with France, Belgium, and the Netherlands (Council Regulation (EU) 2020/123, 2020; Ministerio de Agricultura, 2020c). However, the new closure of the hospitality industry reduced the demand for this species, leading to a decrease in price and total revenue. As far as the small-scale fishing fleet is concerned, the Atlantic mackerel doubled its landings in this period following a 41% increase in the Spanish quota for this species.

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On the contrary, the great decrease in the captures volume of the Atlantic chub mackerel, with respect to the captures average of the 4 previous years, can be explained by the lower abundance of this species for biological causes, since it is a species with a high variability (Xunta de Galicia, 2020c).
4.3.2. Shellfishing sector

As far as the shellfishing sector is concerned, the increase in several species is remarkable, the most notable being the northern shortfin squid (Illex illecebrosus, Ommastrephidae) also very sensitive to environmental changes (NOAA Fisheries, 2020). This phenomenon is linked to the strong variation in the annual abundance of this species, since it is a species very sensitive to environmental changes (NOAA Fisheries, 2020).

On the other hand, the increase in the production of queen scallop (Aequipecten operculares, Pectinidae) is a consequence of the increase in the permits to exploit this species. This is since the Galician Fisheries Ministry granted temporary permits to king scallop (Pecten maximus, Pectinidae) fishers to collect queen scallop, being common the fishing activity on a lower-priced bivalve such as the scallop (Veneridae), whose possible causes were described in phase two. On the other hand, the species with a more pronounced decrease in their captures were the lesser flying squid, the octopus and the cockle. The first two species followed the trend maintained throughout the year, and their captures were the lesser flying squid, the octopus and the cockle. The king scallop is a high-priced seafood, mainly commercialized by the HORECA channel. Therefore, the closure of the most important cockle extraction banks. This closure was extended until December 30th, 2020 (INTECMAR, 2020). In addition, the heavy autumn rains caused a drop in the level of water salinity that raised the cockle mortality rate (La Voz de Galicia, 2020d). On the other hand, the new closure of the hospitality industry had a negative effect on the demand for this species (EUMOFA, 2020b; FAO, 2020).

5. Conclusions

The impact of the COVID-19 on the Galician fishing and shellfishing sectors has been significant in the three periods analyzed. The interannual comparison carried out has shown appreciable differences in terms of catches, revenue and average price at first sale. Each one of the phases of study (confinement, new normality and closure of the HORECA channel) presents some differentiating characteristics determining a diverse performance for the fishing and shellfishing sectors. Although in the first two stages the shellfishing sector suffers a greater fall in volume and turnover than the fishing sector, in the third period the interruption in production during the first state of alarm, which had an effect similar to a fishery closure.

On the contrary, the species with a more pronounced decrease in their captures were the lesser flying squid, the octopus and the cockle. The first two species followed the trend maintained throughout the year, whose possible causes were described in phase two. On the other hand, the cockle continued to be affected by the presence of toxins in Galician waters which, as specified above, forced the closure of the most important cockle extraction banks. This closure was extended until December 30th, 2020 (INTECMAR, 2020). In addition, the heavy autumn rains caused a drop in the level of water salinity that raised the cockle mortality rate (La Voz de Galicia, 2020d). On the other hand, the new closure of the hospitality industry had a negative effect on the demand for this species (EUMOFA, 2020b; FAO, 2020).

Table 4

| Species                          | Catch (Kg)       | Revenue (£)  | Average price (£/Kg) |
|----------------------------------|------------------|--------------|----------------------|
| Most caught species              |                  |              |                      |
| Common cockle (Cardiidae)        | 717,386.27       | 4,964,182.68 | 6.92                 |
| Japanese carpet shell (Veneridae)| 1,228,108.92     | 11,915,155.91| 9.70                 |
| Common octopus (Otopodidae)     | 185,403.35       | 1,640,931.63 | 8.85                 |
| Pullet carpet shell (Veneridae)  | 256,879.36       | 4,547,399.57 | 17.70                |
| Razor shell (Ensis magnus, Phariidae)| 265,926.15 | 2,447,935.41 | 9.21                 |
| Lesser Flying squid (Ommastrephidae)| 30,414.65 | 89,512.17   | 2.94                 |
| Banded carpet shell (Veneridae)  | 127,275.15       | 1,341,544.22 | 10.54                |
| Northern shortfin squid (Anisostylus illucidus, Ommastrephidae)| 175,375.31 | 580,354.97 | 3.31                 |
| Gooseneck barnacle (Ple Autoridae)| 129,869.21 | 3,913,009.88 | 30.13                |
| Grooved carpet shell (Veneridae) | 110,398.94       | 2,757,366.17 | 24.98                |
| Rest of Shellfish               |                  |              |                      |
| Total Shellfish                 | 932,230.98       | 7,597,504.87 | 9.08                 |
| Q1                               | 742,492.00       | 15,255,185.80| 24.31                |
| Q2                               | 2,787,796.97     | 24,871,438.71| 9.20                 |
| Q3                               | 422,299.87       | 1,475,330.05 | 4.09                 |
| Q4                               | 206,679.45       | 192,942.92   | 1.03                 |

Although in the first two stages the shellfishing sector suffers a greater fall in volume and turnover than the fishing sector, in the third period
normality meant a partial recovery of the fishing and shellfishing the interruption of exports and imports of all types of seafood products. Therefore, its closure had a strong impact on these products in the shellfishing products included in the quartile with the highest average series. These aspects, of a biological, oceanographic and meteorological dependent of the pandemic, are observed throughout the studied time marketing of higher value products, and in the border closures, which meant indirect effects of the pandemic with other factors explain these differences between them can be noticed. The confluence of direct and this trend is reversed due to the Christmas season. When the analysis of the COVID-19 impact is focused on the main target species, great differences between sectors and species. Decision-makers must be aware of this dependence on fishing and shellfishing. At the present time, the this line, circumscribed to a geographical area with a high economic affected by the pandemic.

The COVID-19 pandemic has created an unprecedented situation in all areas of the economy. In the specific case of fishing and shellfishing, which are themselves subject to a high variability because of multiple factors, the pandemic introduces a new distorting element, whose study which mostly lands fresh fish. On the other hand, the large-scale fishing fleet, which captures shellfish (with a higher average price than fish) in much greater proportion than the offshore fishing fleet, which mostly lands fresh fish. On the other hand, the large-scale fishing fleet, which lands exclusively frozen products, has hardly been directly affected by the pandemic.

The COVID-19 pandemic has created an unprecedented situation in all areas of the economy. In the specific case of fishing and shellfishing, which are themselves subject to a high variability because of multiple factors, the pandemic introduces a new distorting element, whose study opens up a wide field of research. This work represents a contribution in this line, circumscribed to a geographical area with a high economic dependence on fishing and shellfishing. At the present time, the pandemic situation persists, and greater economic effects on these ac...
Table 6
Catches, revenue and average price (euros/kilogram) of first sale of shellfish catches in Galicia. Third phase (November 7th – December 3rd).

|                         | June 16th - November 6th (2020) | June 16th - November 6th (2015-2019) | Variation in catches. Revenue and average price (2015–2019)/2020 |
|-------------------------|---------------------------------|--------------------------------------|---------------------------------------------------------------|
| Catch (Kg)              | Revenue (€)                      | Average price (€/Kg)                 | Catch                                                 | Revenue (€)                      | Average price (€/Kg) |
| Common cockle           | 211,327.08                       | 1,239,915.83                         | 5.87                                                 | 581,603.55                       | 2,829,557.92         | 4.72 | –63.66% | –56.18% | 24.47% |
| Veneridae               |                                  |                                      | Japanese carpet shell (Ruditapes philippinarum, Veneridae) | 216,899.86                       | 2,107,647.43         | 9.72 | –14.89% | –1.65%  | 16.27% |
| Common octopus          | 113,063.54                       | 912,358.14                           | 8.07                                                 | 224,324.30                       | 1,611,527.80         | 7.54 | –49.60% | –43.39% | 7.06%  |
| Northern shortfin squid | 335,707.69                       | 673,718.48                           | 2.01                                                 | 117,001.49                       | 263,600.15           | 2.35 | 186.93% | 155.58% | –14.47%|
| Atlantic spiny spider   | 261,369.07                       | 2,018,402.07                         | 7.72                                                 | 157,550.49                       | 1,310,817.26         | 8.76 | 65.90%  | 53.98%  | –11.87%|
| Banded carpet shell     | 16,556.75                        | 33,657.43                            | 2.03                                                 | 132,220.42                       | 253,974.87           | 2.20 | –87.48% | –86.75% | –7.73% |
| Veneridae               |                                  |                                      | Lesser Flying Squid (Todarodes pacificus, Ommastrephidae) | 74,529.94                        | 1,317,597.29         | 17.68 | –25.37% | –13.34% | 14.45% |
| Sea urchin              | 90,679.70                        | 720,456.05                           | 7.95                                                 | 77,119.41                        | 508,175.73           | 7.13 | 17.58%  | 41.77%  | 11.56% |
| Queen scallop           | 93,393.45                        | 271,860.92                           | 2.91                                                 | 58,437.22                        | 188,873.69           | 3.37 | 59.82%  | 43.94%  | –13.65%|
| Banded carpet shell     | 33,884.80                        | 364,621.90                           | 10.76                                                | 56,523.25                        | 499,234.31           | 9.74 | –40.05% | –26.96% | 10.43% |
| Total Shellfish         | 1,739,122.44                     | 12,549,980.89                        | 10.39                                                | 2,064,368.16                     | 14,318,901.81        | 11.51 | –15.76% | –12.35% | –9.70% |
| Rest of Shellfish       | 291,711.56                       | 2,889,745.35                         | 10.99                                                | 304,889.35                       | 3,189,668.36         | 12.53 | –4.32%  | –9.40%  | –12.34%|
| Quartiles               |                                  |                                      |                                                      | 2,064,368.16                     | 14,318,901.81        | 11.51 | –15.76% | –12.35% | –9.70% |
| Q1                      | 183,244.79                       | 3,513,113.70                         | 27.60                                                | 161,655.62                       | 3,249,000.73         | 31.12 | 13.36%  | 8.13%   | –11.30%|
| Q2                      | 780,707.57                       | 6,613,656.98                         | 8.44                                                 | 778,001.52                       | 6,539,355.63         | 8.81 | 1.12%   | 1.14%   | –4.24% |
| Q3                      | 578,024.44                       | 1,661,308.11                         | 4.35                                                 | 800,587.51                       | 3,904,228.92         | 4.54 | –52.78% | –57.45% | –4.34% |
| Q4                      | 391,145.64                       | 761,902.10                           | 1.27                                                 | 324,123.51                       | 626,336.54           | 1.55 | 20.68%  | 21.64%  | –18.09%|

stakeholders in the process of management, decision-making and design of the institutional framework applied to natural resources. The constant need to collect information of various kinds makes it essential to ensure a fluid and uninterrupted collaboration.

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.

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