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# Impacts of COVID-19 on the value chain of the hake small scale fishery in northern Peru

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ABSTRACT

All aspects of fish supply chains have been severely affected by the COVID-19 pandemic, with jobs, income and food security at risk. In Peru, small scale fisheries are fundamental for food security, contributing to about 2/3 of all fish consumed nationally. One of the most important resources which is more affordable for local and regional consumption is hake (*Merluccius gayi peruanus*). This study is a first attempt to describe the small-scale hake fishery value chain and to quantify the impact of COVID-19 from March to August 2020 in two fishing communities in northern Peru. The levels of fishing and primary buying were the most affected, and we estimate that ~ 23,000 fishing trips were not conducted, ~ 1680 t of hake was not landed (83% decrease), and 620 jobs were negatively impacted during this period. The gross income of vessel owners and primary buyers decreased by ~ $US 913,000. Marked differences were observed in the way each community responded to the pandemic and in their resilience to cope with COVID-19, despite being located less than 10 km away. In El Ñuro, which relied more heavily on the international market for hake trade, the value chain was affected for longer, while in Los Órganos which supplied national markets, the chain was restored after an initial period of adjustment. Our study suggests that government efforts should focus on facilitating a formalisation process in all levels of the chain, develop indicators to monitor the resumption of activities and the inclusion of a value chain approach to small-scale fisheries management.

## 1. Introduction

The small-scale fisheries (SSF) sector is dynamic and diverse. It involves men and women throughout the value chain and provides food and livelihoods to millions of people around the world. There are an estimated 32 million people employed directly as small-scale fishers, an additional 76 million employed in post-capture work, and 81% of the catch is used for local human consumption [57]. SSF account for about half of fish catches worldwide and employs more than 90% of people working in fisheries, half of them women (mainly in marketing and processing) [57]. It is estimated that 97% of these workers live in developing countries, with high levels of poverty [57]. Despite this challenging context, very little effort is being made to manage resources from a broader social and economic development perspective [16].

The COVID-19 pandemic has spread rapidly around the world intensifying pre-existing structural inequalities with significant social and economic effects [12,21]. Fishing communities are considered "hotspots" for disease transmission due to clustering behaviour of fishers at landing sites and poor sanitary conditions [20,46]. The negative implications for SSF have included complete closures of some fisheries, market disruptions, increased health risks to fishers, processors and communities and an increase in illegal, undeclared and unregulated fishing [7,19,20,37]. In other words, all aspects of fish supply chains have been severely affected by the COVID-19 pandemic, with jobs, income and food security at risk [45].

Peru has been severely impacted by the COVID-19 pandemic, not only in terms of mortality [8,56], but also in economic terms [55]. High levels of labour informality drive the need for people to work, undermining disease containment [15]. This is particularly acute in the fishing and seafood supply sector where there are limited economic alternatives. In Peru, SSF are fundamental to food security: about 65% of all seafood consumed nationally comes from SSF [26,42], while it provides direct jobs for about 67 thousand marine fishers [11]. In 2017, 427 thousand tons were commercialised fresh, representing 68% of the total

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marine protein consumed by Peruvians, equivalent to an apparent consumption of 13.4 kg of fish per capita per-annum [41]. About a third of small-scale fishers are based in the Piura region, contributing to about 5% of the regional GDP [26]. One of the most important resources of SSF in this region, in part oriented for local and regional consumption due to its low prices, is hake (*Merluccius gayi peruanus*) [5,14,30]. Hake is captured mainly by the fishing communities of El Ñuro and Los Órganos (EN-LO) using bottom line and gillnets respectively [1,36]. This fishery underpins the economic activity of many families and is important for local, regional and national food security, however its value and supply chain has been greatly affected by COVID-19.

Studies on the effect of COVID-19 on SSF are showing greats impacts on activities of fishers and traders [10], on local consumption patterns [22] and on several aspects of the value chain in general [35,52,54]. The mapping of value and supply chains is the starting point to identify the impacts of COVID-19 on small-scale fisheries and formulate policy strategies to increase the resilience of these fisheries. This study estimates the impacts of COVID-19 on production, income and number of jobs that depend on the hake small-scale fishery throughout its value chain. It also describes the measures implemented by the small-scale fishing communities of EN-LO, in northern Peru, to address the COVID-19 pandemic in the first months after the national lockdown.

## 2. Methods

### 2.1. Small-scale hake fisheries in El Ñuro and Los Órganos

Hake is landed by SSF in around 10 fishing communities in the region of Piura and Tumbes. The fishing communities of EN-LO (Fig. 1) land on average ~ 75% of all hake landed in the Piura region, which constitutes about 63% of the small-scale national landings [31]. Vessels from these two communities are made of wood and use engines and sails to navigate. Skippers target hake most of the year in EN-LO, however two distinct fishing gears are used to capture hake: in EN, fishers use bottom lines with 200 hooks on average while in LO, bottom nets are used [1,36].

### 2.2. Mapping the value chain before COVID-19 (2016–2018)

A hake value chain map was developed for the period 2016–2018 using the ValueLinks manual [53]. Key operators and actors were identified, their interactions and the volume of product flowing from fishers to consumers was quantified. These years were considered representative of this fishery as the volume of landings has been slowly increasing in the last 5 years [4,31] and it covered the most recent data available. The map was designed based on information collected through in-depth semi-structured interviews conducted in February 2020 with 15 key stakeholders in the small-scale fishery (6 fishers, 4 middlemen at landing point and 5 traders in wholesale markets). The semi-structured interviews included the identification of all operators and actors involved in the chain, the distribution and destination of the product, the inputs and services required, the relationship between agents and operators, prices, and the public or private institutions involved in the chain (Appendix 1). For the purposes of this study, operators are those individuals or businesses that become owners of the product at some point in the value chain, while actors are those individuals, businesses or public agencies related to the chain, including service providers [53].

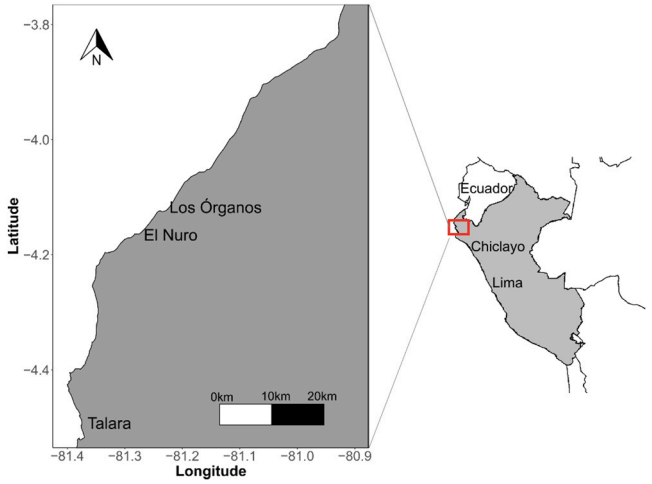


**Fig. 1.** Map showing the location of the two fishing communities of El Ñuro and Los Órganos.

Similar activities were grouped into 6 main levels: fishing, primary buying, wholesaling, processing, retailing and consumption. Secondary information from different sources was used to quantify hake volumes for the period 2016–2018 at each link in the chain. Total volumes of hake landings were obtained from the records of the Peruvian Sea Institute – IMARPE [31]. The volumes of hake going to local retail was estimated using the per capita hake consumption estimates provided by the National Household Surveys and the number of inhabitants in Talara [32–34]. The volume of hake exported to Ecuador was estimated using estimates given by interviewees, who indicated that about 70% of hake landings in EN were transported to Ecuador. The quantities of hake entering the main wholesale markets from EN-LO, and price ranges were obtained from the Ministry of Production's wholesale and retail register – PRODUCE [43]. According to these records the main wholesale markets that sell hake landed in EN-LO are located in Chiclayo and Lima (99% of hake landed). Annual household hake consumption data per capita (grams per year, Appendix 2) were taken from the National Household Surveys [32–34] to calculate the potential annual hake consumption in Chiclayo, Lima (including Callao) and Talara. These values were divided by the total volume of hake entering the corresponding wholesale markets to estimate the percentage of hake destined for each retail market. These percentages were used to distribute the volumes of hake coming specifically from EN-LO from each wholesale market.

Due to the lack of data concerning the number of restaurants offering hake in Lima, the volume of hake in restaurants was estimated as the difference between the volume traded by primary wholesale traders in Lima and the local retail. The semi-structured interviews were used to calculate the number of direct jobs generated in the following levels: fishing, primary buying, and wholesaling. The interviews also allowed the calculation of gross income for each of the following levels: fishing, primary buying, and wholesaling by gathering information of the range in prices of hake at each level.

### 2.3. Mapping the value chain during COVID-19

Two stages were defined for the purpose of this study, a first stage, lasting from March 16th 2020 to June 30th 2020, where a compulsory national lockdown was imposed and enforced by the Peruvian Government. The second stage lasted from July 1st to August 30th (for the purposes of this study), characterized by a relaxation of the self-isolation measures to reactivate the economy. In August 2020, semi-structured interviews were conducted with three vessel owners and three middlemen of EN-LO that had participated in the initial interviews to map the value chain before COVID. The interviews (Appendix 3) aimed to understand the impacts on the value chain (in production, value, and numbers of jobs) that resulted from disruptions in response to the pandemic. The interviews collected detailed information on the effects of the lockdown (for each of the two pandemic stages) on numbers of operating vessels, number of trips conducted, number of jobs, flows of product and changes in interactions between operators in each community. As the volume of landings was not available for 2020, we used

the average monthly landing, the number of vessels and trips during 2016–2018 to estimate the average landing per trip per vessel (kg trip$^{-1}$ vessel$^{-1}$). This estimate was then multiplied by the number of trips conducted during March 16th–August 30th 2020 for each community. Income was calculated using the same range of prices of hake identified at each level for the 2016–2018 chain.

### 2.4. Estimating the impact of COVID-19 on the value chain

The impacts of COVID-19 on production, direct jobs and income was estimated by comparing the COVID-19 value chain to a hypothetical value chain constructed for the same period of time (March 16th–August 30th). For this hypothetical value chain (a no COVID scenario), it was assumed that the landings, flows and proportions of flows between agents would have been similar to the 2016–2018 chain. The impact was quantified as the difference between these hypothetical values and the observed values (see Section 2.3) of the value chain during COVID-19. The number of jobs and income were estimated for the levels of fishing, primary buying, and wholesaling.

## 3. Results and discussion

### 3.1. Pre-COVID-19 value chain (2016–2018)

#### 3.1.1. Fishing

For the period 2016–18, 6301 and 5835 t of hake were landed in LO and EN, respectively (Fig. 2). It was estimated that 150 and 90 vessels operate out of EN-LO respectively, with the same number of shipowners, of which approximately one third do not participate in fishing operations and hire a skipper. An average of two crew members are used in the operation of EN vessels, while in LO there is an average of three crew members per vessel. In total, around 890 direct jobs are created during fishing activities (Table 1). It is important to highlight that indirect jobs such as trade of fuel, food, tools, weatherproof gear, and services such as vessel repair and carpentry, related to this level of the chain have not been quantified for this study but these indirect jobs are mostly locally provided by members of the respective communities. The average gross income of the vessel owners was S./15.2 million Peruvian soles (PEN) (~ US$ 4.3 million) during 2016–2018, considering an average price per kg of S./1.25 (Appendix 4).

#### 3.1.2. Intermediaries

This level includes middlemen, drivers, jetty personnel others involved in activities supporting landing of product (disembarking and cleaning fish, adding ice, and carrying fish to trucks). Middlemen here refers to a group of traders that buy directly from fishers at landing sites and then sell products to wholesale traders. They finance these trips by providing fuel and bait, thus securing priority access to products. This type of coordination is seen in many SSF worldwide [3,13,48]. Middlemen in EN-LO received and transported ~ 10,000 t of hake (83% of the total landings). Of these 10,000 t, ~ 41% were transported by land to Ecuador and sold to processing plants located in the city of Huaquillas. The other 59% is destined for national consumption (Fig. 2). More than 200 people are directly employed either in trade or transport activities (Table 2), and apart from some drivers, all are locals, and almost half of them are women. People involved in activities supporting landing are often given fish as part of their pay, which they use for their own consumption thus contributing to local food security. The average gross income of intermediaries that export to Ecuador was S./7.1 million PEN (~ US$ 2.0 million).

**Table 1**
Numbers of direct jobs during fishing activities.

| Type of job | El Ñuro | Los Órganos | Total |
|---|---|---|---|
| Skippers | 150 | 90 | 240 |
| Vessel owner | 50 | 30 | 80 |
| Crew members | 300 | 270 | 570 |
| Total | 500 | 390 | 890 |

#### 3.1.3. Wholesaling

It was estimated that about 7% (5942 t) of hake sold at Chiclayo wholesale market comes from EN-LO (Fig. 2, Appendix 2). Of these, 92.5% is destined for the wholesale markets in Lima and 7.5% is sold to retailers in Chiclayo for local consumption (446 t). In Lima, 32% (481 t) is distributed to retail markets and the rest (3738 t) to restaurants. The number of wholesale traders in Chiclayo and Lima that are engaged in the marketing of hake was estimated to be 122 (Table 3). During 2016–2018, the average gross income of wholesaling in Chiclayo was S./11.4 million PEN (~ US$ 3.2 million) based on an average price per kg of 1.93, and for the wholesalers of Lima it was 15.0 million PEN (~ US$ 4.3 million) based on an average price per kg of S./2.73 (Appendix 4).

**Table 2**
Number of direct jobs in primary buying.

| Type of job | El Ñuro | Los Órganos | Total |
|---|---|---|---|
| Middlemen | 9 | 9 | 18 |
| Drivers | 8 | 15 | 23 |
| Landing-supporting activities | 63 | 105 | 168 |
| Jetty personnel | 4 | 5 | 9 |
| Total | 90 | 128 | 218 |

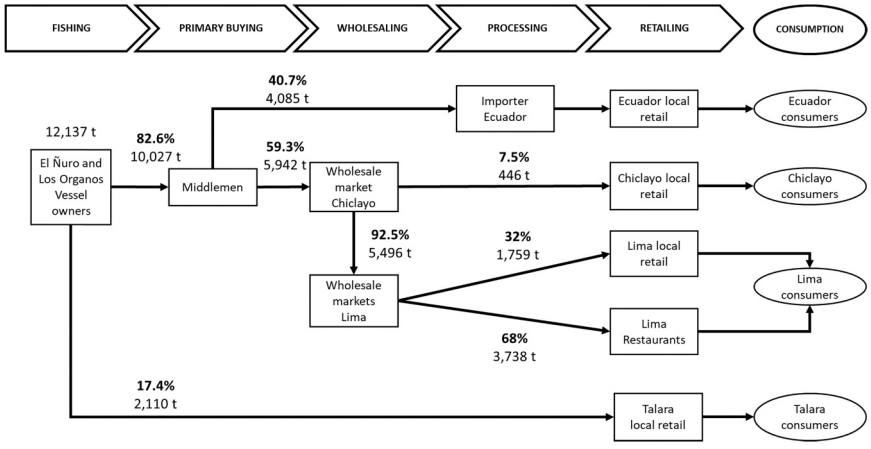


**Fig. 2.** Map of the hake value chain during 2016–2018. Top arrows denote levels, rectangular boxes denote operators, consumers in circles, estimated volumes of hake (t) and percentage flow of product between operators.

**Table 3**
Number of direct jobs related to the wholesale trade of hake from EN-LO.

| Type of job | Chiclayo | Lima | Total |
|---|---|---|---|
| Wholesale traders | 24 | 4 | 28 |
| Drivers | 24 | | 24 |
| Logistical support | 60 | 10 | 70 |
| Total | 108 | 14 | 122 |

#### 3.1.4. Processing

Approximately 4000 t were traded by 4 Peruvian exporters to processing plants in Huaquillas, Ecuador. Six processing plants were identified by respondents. Assuming each exporter required at least two people (a driver and an assistant) to transport the product, we estimate that at least 12 people are involved in exporting activities.

#### 3.1.5. Retailing

We identified five main retail market groups for hake captured in EN-LO. About 17% (2110 t) of hake landings were commercialized in local markets in the Talara province (Fig. 2). The wholesale trader in Chiclayo destined 7.5% of hake to local retailers and the wholesale traders in Lima destined about 32% of hake to local retailers and 68% to restaurants of Lima. For mapping of the chain, we assumed that in Ecuador all hake processed by plants are sold by local retailers.

#### 3.1.6. Consumption

A notable proportion of hake landed in EN-LO is sold to Ecuador, however whether it is sold nationally or exported remains unknown. We estimate that between 2016 and 2018, 8053 t of hake were consumed in Peru.

### 3.2. Changes in fleet dynamics as a response to COVID-19

During the first stage of the pandemic, from March 16th to June 30th, 2020, the initial effect perceived in EN was a decrease in the demand for hake from processing plants in Ecuador. By the end of the first two weeks after national lockdown, middlemen limited their financing of fishing trips for hake fishing vessels. The vessel owners in turn reduced the frequency of weekly trips from 4–5 to 1–2 trips per vessel. At the same time middlemen had difficulties transporting seafood, as many drivers and operators stopped working as a preventive measure against COVID-19. Vessel owners tended not to sell hake to national wholesale markets due to decreased demand and price.

After this first two weeks, and in response to the accelerated increase in COVID-19 cases in Piura, the community of EN, together with the fishermen's association and middlemen, made the decision to suspend fishing trips, as well as prohibit the entry and exit of people and vehicles into the community. During this time when the community was isolated, the boats took turns fishing for subsistence, between 30 and 50 vessels were allowed to fish each day and catch did not exceed 10 kg per vessel. From May 2020, the fisher's association agreed to limit trade only to higher value fishes (not including hake), to wholesale markets in the cities of Piura and Chiclayo through a single middleman authorized by the association.

In LO, during the first stage, the decrease in the price of hake and the reduction in financing from middlemen caused a decrease in hake fishing trips from 4–5 to 2 trips per week per vessel. In addition, for fear of infections, several traders and drivers decided to stop working, complicating fish transport. In the second stage, the number of fishing trips increased to 4 per week per boat, in response to an increase in demand from wholesale markets in Chiclayo and Lima. There was an increase in the average number of crew members per vessel, as vessel owners agreed to board an additional person, usually a relative or friend, who normally undertook other activities but had lost their jobs due to the pandemic. In addition, LO fishers and middlemen influenced the supply by reducing trips and agreeing on catch volumes to avoid a reduction in prices.

EN-LO responded in very different ways to the pandemic and the effect on the hake value chain also varied drastically between the two fishing communities. EN is a smaller fishing community and relatively isolated, with $< 1500$ inhabitants and around 320 households [34] while LO is a bigger town, with $\sim 9000$ people and 3200 households [34] and the Pan American highway crosses right next to their town Plaza. In the past, fishers of EN have shown solid organizational capacities and developed successful autonomous adaptation strategies to reduce fishing effort and diversified economic activities within the community, by encouraging tourism focused projects [39]. The local lockdown implemented in their community was total, with only a few fishers fishing for self-consumption. This, together with the fall of demand and prices from Ecuadorian importers, affected the hake fishery to the point that as of August 2020, the hake fishery was still shut down, and fishers were targeting other higher value species. In contrast, in LO, which relied on national markets for hake, the chain was disrupted in the beginning, but then recovered as national demand reactivated making it more resilient. Additionally, local retailers and fishers sold hake directly to the consumers with wharf/jetty to door delivery services. The subsequent partial opening of restaurants further increased demand.

Similar effects have been observed in the fisheries of other countries, even those with different socioeconomic realities and magnitude of pandemic effects. Fishing sectors showed responses similar to those of EN-LO.with reductions in the sales at the beginning of the pandemic, related to drops in demand and prices were reported in Bangladesh [54], the Northeast United States [52] and Ecuadorian mahi-mahi [51]. Bangladesh experienced difficulties in fish transportation [54], similar to EN-LO. Besides, some commercial fishers of Northeast U.S. had to reduce the frequency of fishing as EN-LO fishers during stage 1, while others decided to stop fishing until circumstances improved. Furthermore, at the beginning of the pandemic, Ecuadorian mahi-mahi fishers intended to redirect their catches to the domestic markets, however, demand was not enough to meet supply [51]. Consequently, prices fell, and fishing trips decreased significantly, as happened in EN. Further examples were seen with the Indonesian blue swimming crab (BSC) and small scale fisheries in Lake Victoria in Kenya – as both exhibited similar strategies to EN fishers with decisions to reduce catches in response to price drops, but allowed catches of other species of higher commercial value. In the Indonesian case, fishers opted to target species in demand within the domestic markets, pausing BSC captures due to international market constraints [51]. In contrast, some Lake Victoria small-scale fishers also reduced their catches but to compensate, they focused only on high valued species and reduced self-consumption [22].

### 3.3. COVID-19 value chain

The average amount of hake landed per trip per vessel during the 2016–2018 period was estimated as 58.9 for EN and 88.4 for LO (Appendix 5). We estimated that in EN, 600 trips were conducted (during the first 2 weeks of lockdown), landing approximately 35 t (Fig. 3a). In LO, 2520 trips were estimated during the first stage, landing about 148.5 t. During the second stage, the number of fishing trips is increased, and 2880 trips are estimated landing approximately 170 t. Thus a total of 354 t of hake landed for EN-LO during the study period (Fig. 3a). The wholesale market in Chiclayo received 241 t of which most was sold on to Lima's wholesale markets. A total of 239 t entering Lima were distributed to retail markets, 76 t (32%), and to restaurants, 162 t (68%), from Lima.

### 3.4. Estimating the impacts due to COVID-19

#### 3.4.1. Production

Using the hypothetical value chain mapped using the same structure identified for the pre-COVID-19 value chain 2016–2018 we estimated

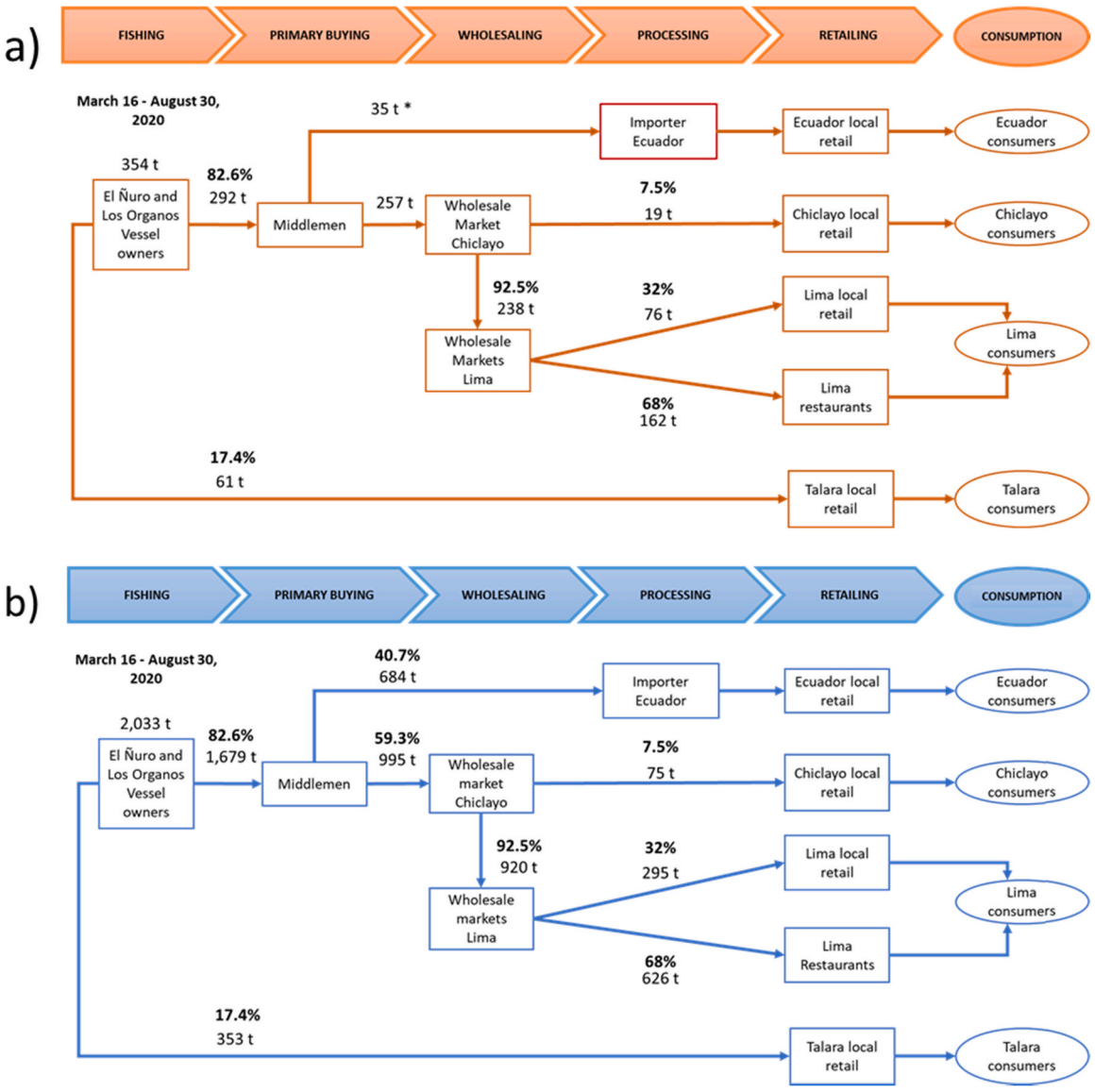


**Fig. 3.** Map of the hake value chain during a) COVID-19 (16th March–30th August 2020); b) an hypothetical scenario without a COVID-19 outbreak (16th March–30th August 2020). Top arrows denote levels, rectangular boxes denote operators, consumers in circles, estimated volumes of hake (t) and percentage flow of product between operators. *Value derived from the total landings in EN in March, before the fleet stopped landing hake.

that 2033 t would have been landed during the 5.5 months of the study period (Fig. 3b). The fleet in EN should have undertaken 18,150 trips and landed circa 1070 t. The fleet in LO should have conducted 10,890 trips and landed 963 t of hake. Comparing this value chain map to the COVID-19 value chain we can estimate that in EN, 17,550 trips were not conducted, resulting in 1034 t less catch, which represents a 97% decrease in number of trips and landings (Table 4). In LO, we estimate that 5490 trips were not conducted, and 644 t hake not landed, representing a 67% decrease in production (Table 5). The volumes of hake traded in wholesaling and domestic markets in this hypothetical scenario were about one fourth of the ones estimated during the pandemic (Fig. 3b), this was primarily due to the decrease in landings. Transport logistics recovered after initial disruptions due to restrictions in domestic transit and hake could have been sold nationally, however, a decrease in hake prices and a change in consumer demand to cheaper products such as chicken [6] affected this part of the chain. In contrast, the export market was heavily affected, only about 5% of the estimated hake volume was exported, highlighting the vulnerability of this part of the chain to the impact of COVID-19.

### 3.4.2. *Number of jobs*

The effect of COVID-19 on the number of jobs was markedly different between EN and LO. In EN, during the first 2 weeks the first jobs affected were those occupied by people not residing in this community, and mostly impacted supporting jobs involved in landing activities at the jetty. After this, the community closed its borders, and only subsistence fishing was allowed. From May 2020 the community allowed middlemen to enter gradually, but about 584 jobs were affected (Table 6). In LO, the fishery did not stop completely, although some middlemen and transporters ceased activities, and the frequencies of trips decreased. Once activities started to normalise a 20% increase in the number of fishers was observed, to support friends or family members. The number of people involved in landing-supporting activities decreased to about half of pre-COVID-19 levels during the first stage.and the numbers of people working gradually increased in the second stage but did not reach pre-COVID-19 numbers by the end of the study period. This is particularly worrisome as approximately half of these jobs are conducted by women, which disproportionately participate in the informal economy and therefore will be more affected by the pandemic [17].

**Table 4**
Estimated impacts on hake production in EN.

| El Ñuro | Hypothetical scenario without COVID-19 | COVID-19 | | Impact | |
|---|---|---|---|---|---|
| | | Stage 1 | Stage 2 | | |
| Duration (months) | 5.5 | 0.5 | 2 | | |
| Monthly fishing trips by vessel (trips month$^{-1}$ vessel$^{-1}$) | 22 | 8 | 0 | | |
| Total fishing trips per vessel during selected time period | 121 | 4 | 0 | | |
| vessels | 150 | 150 | 0 | | |
| Number of fishing trips | 18,150 | 600 | 0 | -17,550 | -97% |
| Estimated total landings (kg) | 1,069,826 | 35,366 | 0 | -1,034,460 | -97% |

**Table 5**
Estimated impacts on hake production in LO.

| Los Órganos | Hypothetical scenario without COVID-19 | COVID-19 | | Impact | |
|---|---|---|---|---|---|
| | | Stage 1 | Stage 2 | | |
| Duration (months) | 5.5 | 3.5 | 2 | – | – |
| Monthly fishing trips by vessel (trips month$^{-1}$ vessel$^{-1}$) | 22 | 8 | 16 | – | – |
| Total fishing trips per vessel during selected time period | 121 | 28 | 32 | – | – |
| Number of active vessels | 90 | 90 | 90 | – | – |
| Number of fishing trips | 10,890 | 2520 | 2880 | -5490 | -50% |
| Estimated total landings (kg) | 962,712 | 148,538 | 169,757 | -644,417 | -67% |

**Table 6**
Estimated impacts on numbers of jobs at the fishing and primary buying.

| Type of job | El Ñuro | | | Los Órganos | | |
|---|---|---|---|---|---|---|
| | Pre-COVID-19 | Stage 1 | Stage 2 | Pre-COVID-19 | Stage 1 | Stage 2 |
| Fishing | 500 | 500 | 0 | 390 | 390 | 480 |
| Middlemen | 9 | 9 | 0 | 9 | 5 | 7 |
| Transport | 8 | 8 | 0 | 15 | 7 | 10 |
| Landing-supporting activities | 67 | 37 | 0 | 110 | 53 | 80 |
| Total | 584 | 554 | 0 | 524 | 455 | 577 |

#### 3.4.3. Income

During COVID-19, the gross income in the fishing level was estimated as 443,000 PEN (~ US$ 126,571). In the hypothetical scenario without COVID-19, the projected gross income EN-LO was estimated as 2,541,000 PEN (~ US$ 726,000), revealing a loss of about 2 million PEN (US$ 599,429) in the economy of fishers and vessel owners (Fig. 4a). Likewise, a loss of 1.1 million PEN (~ US$ 314,285) was estimated for exporting middlemen (Fig. 4b). In wholesaling, the gross loss was approximately 3.3 million PEN (US$ 942,857, Fig. 4c and d).

### 3.5. Challenges and limitations of the study

The impact of COVID-19 on the value chains was estimated via a limited number of telephonic interviews, due to the travel restrictions in place. Responses across interviewees were similar, which gives us confidence in our estimates. Additionally, we assumed that the year 2020 would have resembled catches and market dynamics during 2016–18. As the last five years show an increase in hake landings, we believe this is a reasonable assumption. We could not incorporate seasonality of the catches when estimating the average landing per month during the pandemic, as this information was not available at the appropriate level of resolution. Additionally, we do not know if the catches per trip increased during COVID because of there were fewer fishing vessels participating in the fishery. The effect of COVID-19 on the number of jobs and gross income could only be estimated for a few levels of the chain. Markets are still recognised as one of the main focus points of infection during the pandemic in Peru [28], and were therefore inaccessible, making it difficult to communicate with wholesale and retail traders on site.

For each level of the chain, there were limitations that affected the quality of collected data. Estimations on product flow between operators is based on several assumptions explained in the methods section. In several instances official records appear unsound which, when considered alongside the high levels of informality evidenced throughout the chain, makes assessment challenging. For example, volumes of product entering and leaving wholesale markets do not add up, highlighting issues in data collection in the Ministry of Production's wholesale and retail register [43].

### 3.6. Governmental response to minimise the impact of COVID-19

The government recognised small-scale fishers as an essential food supplier service in the COVID 19 National State of Emergency Law, which meant activity could continue during the general lockdown [47]. However, due to fisher's fear of getting infected, activity was impacted. Furthermore, the mobility restrictions throughout the country, and the drop in demand and prices, caused the majority of fishers to either stop fishing (in EN) or significantly reduce the number of monthly fishing trips (in both EN and LO). This has also been reported in other small-scale fisheries in Peru, such as the jumbo flying squid [2,40] and fisheries in Pisco [28].

The government published general protocols to prevent dissemination of COVID-19 during operations at landing infrastructures [49] and established a small credit program of 2000 soles (~ $555 US dollars) specifically for small-scale fisheries [25]. By June 2020, less than 3700 small-scale fishers (~ 5% of all marine fishers) had received the credit [24]. The informal way in which the fisheries have historically operated resulted in many fishers not meeting the criteria to access this credit scheme (valid fisher ID). Additionally, the cumbersome process to obtain a valid fisher ID probably contributed to the low rate of credit access.

Fishing communities developed autonomous measures to mitigate the spread of the virus and cope with the economic impacts making decisions at community level. These measures were not developed in collaboration with, nor received any assistance from fisheries authorities. Government support for the economic reactivation was focused on assisting large companies' economic recovery [55], even though 70% of Peru's workforce are employed in informal sectors, including small-scale fisheries. These high levels of informality make it challenging to develop a consistent information base for attending the needs of fisher communities during the pandemic, and make it difficult to extend social benefit programs (such as the Universal Family Bonus, a subsidy delivered during the state of emergency for COVID-19) to fishers.

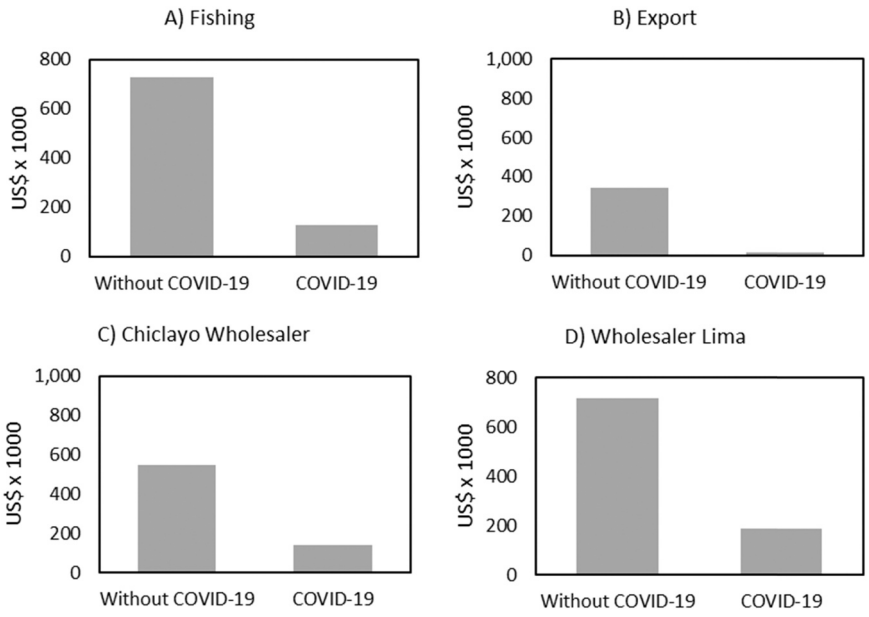


**Fig. 4.** Estimated average gross income in a hypothetical non-COVID-19 scenario and the current scenario under the COVID-19 pandemic effects in sales during a) fishing, b) exports, c) Chiclayo wholesale and d) Lima wholesale.

## 4. Conclusions and recommendations

As of April 2021, the COVID-19 crisis in Peru is still far from over. The numbers of cases are currently increasing, and local and regional lockdowns are in place in an attempt to control the surge in new cases [27,44]. Estimating the final impact that this pandemic will have on small-scale fisher value chains is challenging due to the issues discussed above. This study is an initial attempt to quantify the impact of COVID-19 on the small-scale hake fishery value chain. The largest impact was on fishing and primary buying, with an 80% reduction in the number of fishing trips, an 83% reduction in landings, with more than 600 jobs negatively impacted during the study period. EN-LO showed marked differences in their response to the pandemic, with the high reliance on the international market of Ecuador affecting EN for a longer time period. The national markets increased demand after a period of adjustment, which conferred greater resilience to LO value chain. This analysis provides a first step towards identifying critical elements in the value chain and the responses of the different operators in the chain. This will provide insights in how to mitigate future impacts from shock events, such as El Niño, which are expected to increase in intensity and frequency [9] causing great disruption to fisheries in northern Peru [23,38].

Specific recommendations:

- The Ministry of Production should develop specific and rapidly accessible funds to support the economic reactivation of each of small-scale fisheries, considering the socio-economic differences among fleets, their levels of formalisation and the amounts of credit most suitable to them. Increased effort should be oriented to the formalisation of small-scale fishers [29].
- Recognising the contribution to local and regional food security, it is recommended that the government declare this and other similar fisheries as strategic fisheries of national interest.
- Knowledge and analysis of value chains and their resilience are essential to identify challenges and opportunities faced by fisheries in the face of catastrophic events such as El Niño, climate change and COVID-19 and in this context it is essential that the Ministry of Production, in coordination with IMARPE, Regional Governments, academia, NGOs and other responsible institutions improve the system for the collection, dissemination and exchange of small-scale fisheries data.
- Socio-economic, health and production indicators should be developed and monitored for rapid appraisal of the impact of COVID-19 in coastal fishing communities to support more effective, dynamic and proactive decision making by regional government to mitigate immediate effects of COVID-19 whilst informing policies and actions to reactivate economic activity.
- Strengthening domestic supply chains will support resilience of small-scale fisheries [6], therefore, to increase national consumption of hake and support small-scale fishers, the Ministry of Production, though their National Programme "to Eat Fish" and other public and private institutions could carry out coordinated actions to increase national consumption of hake in Peru, such as increasing the purchase of hake aimed at institutions such as hospitals and communal kitchens and carry out marketing campaigns to increase consumption of hake.The Ministry of Production and the Ministry of Foreign Trade should carry out an analysis to identify potential new markets so that the hake fishery can adapt or be more resilient to fluctuations in consumption or purchase trends associated with COVID-19.

## CRediT authorship contribution statement

**JG:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Methodology, Writing – original draft. **TM:** Conceptualization, Funding acquisition, Methodology, Writing – original draft, Writing – review & editing. **RG:** Conceptualization, Funding acquisition, Methodology, Writing – original draft, Writing – review & editing. **JM:** Conceptualization, Funding acquisition, Methodology, Writing – original draft, Writing – review & editing.

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## Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.marpol.2021.104808.

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