



# The voice of Mexican small-scale fishers in times of COVID-19: Impacts, responses, and digital divide

Ines Lopez-Ercilla<sup>\*</sup>, Maria Jose Espinosa-Romero, Francisco J. Fernandez Rivera-Melo, Stuart Fulton, Rebeca Fernández, Jorge Torre, Araceli Acevedo-Rosas, Arturo J. Hernández-Velasco, Imelda Amador

Comunidad y Biodiversidad, A.C., Isla del Peruano 215, Guaymas 85448, Sonora, Mexico

## ARTICLE INFO

### Keywords:

Pandemic  
Small-scale fisheries  
Adaptation  
Technology  
Digital connection  
Solutions

## ABSTRACT

The COVID-19 pandemic has dramatically, quickly, and extensively affected fisheries, the effects of which have yet to be quantified globally, although some efforts have already been made locally and regionally. This study provides insights regarding the impacts of the pandemic in Mexican small-scale fisheries, explores community responses and digital divide. A total of 1493 interviews were conducted, and a social media analysis that reviewed 9079 posts from April to December 2020 was performed. The results show large socio-economic and environmental impacts (e.g. 89% of the markets closed in April, and 72% of respondents perceived an increase in the amount of solid waste). Women have faced increased inequalities when accessing fishing resources or healthcare. Responses have been varied and include closing communities, and fishing organizations distributing emergency funds. Fishers relate feeling very or moderately comfortable with technology and have spent more time using digital platforms during the pandemic than before. While the effects are still unfolding, there is an urgent need to breach the digital divide to guarantee equal opportunities for all. Efforts are needed to ensure that the most vulnerable groups (e.g. women, indigenous people, and elderly individuals) are not excluded from opportunities to access, use or manage resources, including technology. This global crisis may also bring opportunities for adaptation and the implementation of local solutions (e.g. reducing the fishing effort for high-value products), to prepare for future shocks. The findings in this study serve to promote development strategies that build resilience in fishing communities for healthier oceans.

## 1. Introduction

The coronavirus SARS-CoV-2 (COVID-19) pandemic has added pressure to a world already in flux, affecting every aspect of daily life. The pandemic has dramatically, rapidly, and extensively affected fisheries worldwide, although its effects have yet to be fully quantified. Small-scale fisheries (SSF) are no exception. Market closures, collapsed prices, lockdown measures, traveling restrictions, and overloaded health services continue to impact the livelihoods of those living in coastal communities.

There are ~ 260,000 small-scale fishers in Mexico [8], most of whom live in remote, coastal communities without access to the same levels of health care, information, facilities, supplies, or basic services that are found in large, urban centers. Members of the SSF sector have had to choose between staying at home or continuing to fish to ensure the

wellbeing of their families. In particular, young fishers with mortgages on their boats or homes and limited savings [34] have been pushed to keep fishing and accept any price for their catch that the market has to offer.

By December 2020, 20% of all COVID-19 cases were reported in the Latin American and Caribbean (LAC) region, which registered the highest reported mortality rate worldwide [20]. The LAC region is not only in second place with regard to the number of reported infections, after the United States [20], it is also the region that has reported the largest inequalities in the world, in addition to general inequity, discrimination, ineffectual institutions, and political instability [30]. In Mexico, the imbalanced access to drinking water, drainage, and formal employment has also deepened social inequalities [1,7].

By late March, when preparation and response measures were first enacted in Mexico [13], fisheries like that of the spiny lobster had

<sup>\*</sup> Corresponding author.

E-mail address: [ilopez@cobi.org.mx](mailto:ilopez@cobi.org.mx) (I. Lopez-Ercilla).

<https://doi.org/10.1016/j.marpol.2021.104606>

Received 15 January 2021; Received in revised form 12 April 2021; Accepted 20 May 2021

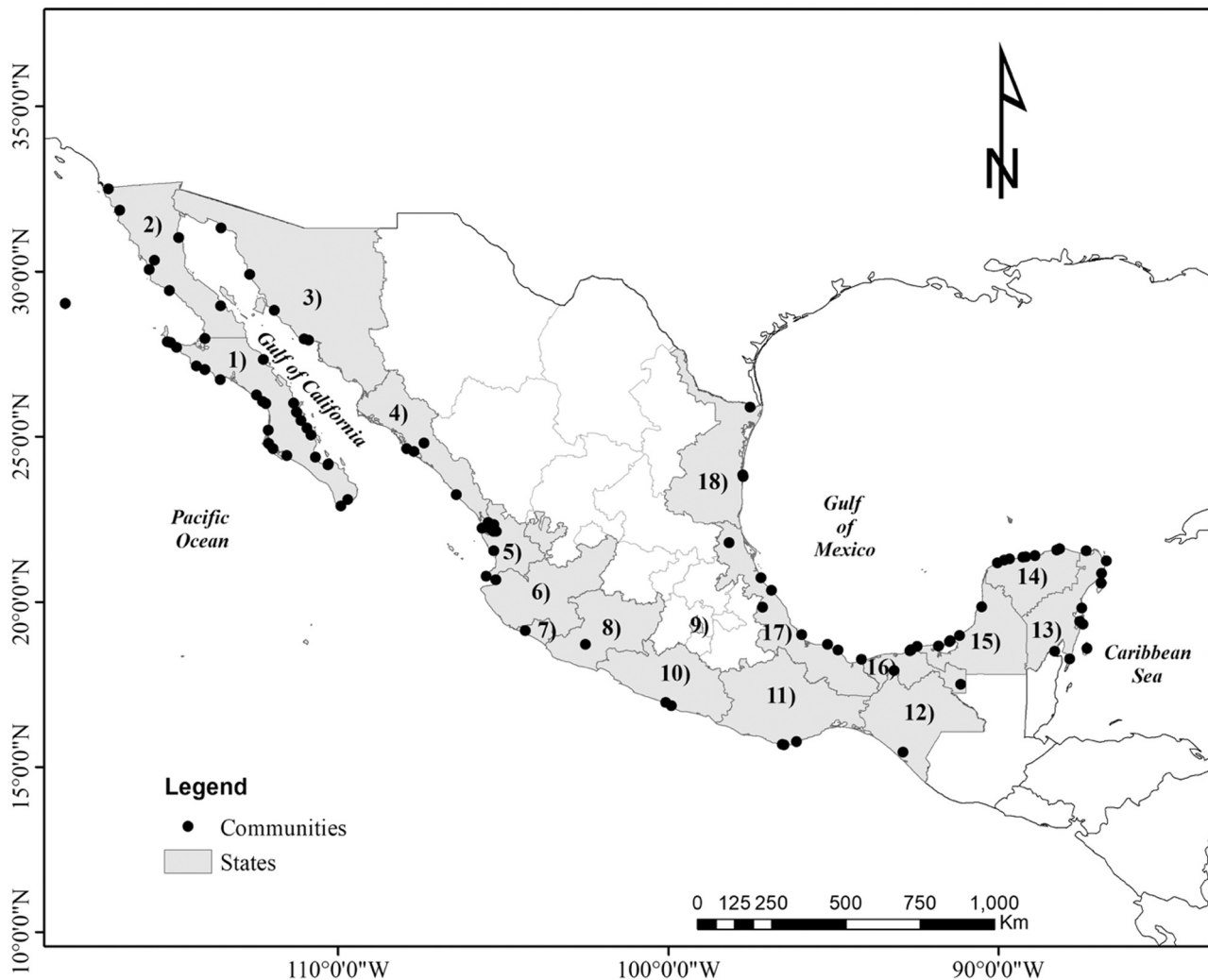
Available online 24 May 2021

0308-597X/© 2021 The Authors.

Published by Elsevier Ltd.

This is an open access article under the CC BY-NC-ND license

(<http://creativecommons.org/licenses/by-nc-nd/4.0/>).



**Fig. 1.** Locations of the 102 communities included in this study. The shaded regions represent the states where the study was conducted (for number references, see Table A.6.), and the dots indicate the exact locations of each community.

already been hit by Asian market closures that had been in place since January [3,24]. At this point, almost all efforts were focused on the sanitary crisis in big cities, which were showing higher numbers of COVID-19 cases than those reported in rural areas and small towns.

The pandemic has not only impacted human health; it also represents a threat to human rights [21], increasing the vulnerability of marginalized groups (e.g., women, children, and indigenous people). In addition, environmental impacts due to pollution and limited monitoring and surveillance have also been reported [3,16,17,35]. The most vulnerable groups in society, namely elderly individuals, women, children, indigenous people, and those living in rural communities, have been among the most affected [2,17]. Therefore, special attention must be given to these groups and the surrounding issues to reduce the unequal consequences of the COVID-19 crisis [21].

The pandemic has also revealed a world that is eager to stay connected but that faces great disparities in terms of access to technology and digital literacy. Although the need to address digital discrimination

and the digital divide was being addressed before the pandemic, inequalities with regard to technological access have been exacerbated by COVID-19 and the subsequent lockdown measures, generating a new source of discrimination, the digital divide [40]. A stable internet connection is crucial for ensuring access to education, training opportunities [41], information, markets and service transactions [3] while simply remaining connected in a socially distanced world. Importantly, connecting rural, remote, and coastal communities must also be achieved while respecting privacy, digital rights, and net neutrality [39].

The COVID-19 crisis has brought about unprecedented uncertainty, hitting everywhere at once, and on a large scale. Nonetheless, some fishers have been able to adapt rapidly, creating local market opportunities and reducing middlemen and the complexity of value chains [3, 25]. However, there is still an urgent need for practical and tailored COVID-19 safety procedures and protocols for fishers [34]. In Peru, a digital platform ([pescalibredecovid19.org](https://pescalibredecovid19.org)) provides valuable, free, outreach materials that indicate how to safely resume fishing activities,

which may be adapted and scaled to the requirements of other countries. In Mexico, no such platform exists and access to important information is yet lacking.

Fishers have a tremendous amount of local and traditional knowledge that informs their decision making, which can be used to foster sustainable fisheries management when combined with scientific knowledge [14,18]. Under non-pandemic conditions, small-scale fishers have proven to be adaptable, quickly shifting from one fishery to another, even under other shocks at scale such as climate change [24]. The pandemic, however, has changed many community dynamics. A resurgence of gender inequalities and abusive buying practices (by driving down prices) has been observed, which has caused fishers to choose between sustainability and economic survival.

This study, which took place from April to December 2020, aimed to elevate the voices of small-scale fishers and coastal community members in Mexico to understand how they are coping with the COVID-19 pandemic. To this end, a national consultation with small-scale fishers in Mexico on three key themes (i.e., the impacts of COVID-19, the responses to the pandemic, and the digital divide) was conducted. The results of this study describe the lessons that have been learned and discuss how fishing may be resumed under what is now the new normal.

## 2. Methods

Interviews were conducted using eight questionnaires, and social media was monitored. The analysis focused on three themes (i.e., socioeconomic and environmental impacts, responses to the pandemic, and the digital divide) which were broken down into seven subthemes (i.e., social, economic, environmental, gender, adaptive capacity, use of digital platforms, and digital connection). Each subtheme included specific content (22 variables in total) that was covered in 60 questions (see Table A. 5) and a social media analysis.

### 2.1. Interviews

A total of 1493 semi structured interviews were conducted over the phone with 397 fishers (24% women) that were either members of fishing organizations (156 organizations were identified in this study) or that were free fishers (people that were not affiliated with a fishing organization). In all, members from 102 communities were interviewed, of which 45 communities only had one interviewee that participated in the study (Fig. 1, see also Fig. A.7 and Table A.6).

Each month, an average of 187 people (from 93 to 241) participated in the interviews, with 83 (21%) people participating once, 58 (15%) people participating twice, and 256 (64%) people participating three or more times. Fishers were 43 years old on average (43 years, men; 39 years, women). The most frequent age range among all interviewees was 30–39 years old for men (23%) and women (9%). The least frequent age ranges among interviewees for men and women were 18–29 (10%) and +51 years old (16%), respectively.

A total of 22 fisheries were included in the study, with 63% of interviewees involved in production, 32% in post-production, 1% in activities complementary to production, and 1% participating in all stages (3% not applicable; see Table A.7). In this study, the term fishers encompass all women and men directly involved in the extraction and/or processing of fishery products. Testimonies were collected from the interviewees. Due to the uncertain nature of the pandemic and lockdown measures, the interviewing process was designed to be remotely implemented via phone calls and, complementary, text and voice messages.

Eighteen trained interviewers applied the questionnaires, which

combined open and closed questions, over the phone. The duration of telephone interviews did not exceed 40 min. Before each interview, the interviewer asked for consent to conduct the interview and gave the interviewee the opportunity to terminate the interview at any point. The questionnaires included from 2 to 13 questions. The collected data was disaggregated by gender, age, stage of the value chain, and fishery and quantitatively analyzed (i.e. ratio and proportion) (see Table A.7).

The classification proposed by Solano et al. [33] for the fishery system and stage of the value chain was used, clustering the fishery system into the four categories of 1) pre-production (bait fishing and supplies), 2) production (harvesting and shipment), 3) post-production (landing, aggregation or storage, processing, transportation, wholesale and retail, and administration) and 4) complementary to production (maintenance of fishing gear/equipment, services, social commission, surveillance, monitoring, beach cleaning, transport, and family support). Fisheries were categorized based on the classification of the target species of the National Fisheries Charter [11,12].

Some questions were posed on several occasions to document changes over time. There was no minimum number of interviews conducted per coastal community, although a maximum limit of 32 interviews per month (see Table A.6) was established to avoid iterative responses. Participants were also encouraged to propose other interviewees. The interviewees were first contacted by someone they already knew (e.g. people working with them in the field prior to the COVID-19 pandemic). After each interview, the participants were asked if they would like to continue to be interviewed.

### 2.2. Social media monitoring

Given the importance of social relationships in fisheries for acquiring information and building knowledge, a social media monitoring approach was applied in the study. The qualitative analysis provided insights to better explore the role of technology in SSF during the COVID-19 pandemic and complemented the analysis of the themes selected for this research, by looking at what information was shared among fishing communities and information targeting SSF (e.g., governmental agencies and civil society organizations.). Social media monitoring also allowed for changes in perceptions of the pandemic to be tracked through a narrative analysis.

A total of 9079 posts were analyzed on social networks (i.e. Facebook and Twitter; see Table A.6) from 137 profiles (39, 35, 22, 11, 11, and 9 profiles from the government, community members, fishing organizations, civil society organizations, international organizations, and collective action platforms, respectively). The social media monitoring process uncovered challenges and local solutions that were shared in reports and discussed in WhatsApp groups, online trainings, meetings, and webinars by participants and other stakeholders. The lessons learned, such as the need to remain organized and connected, and to search for economic alternatives, were used to explore the conditions under which fishing could resume.

Seven trained monitors analyzed two social media platforms: Facebook and Twitter. Facebook is popular among fishers and local fishing organizations, whereas institutions, organizations, academics, and some fishers from confederations (fishing cooperatives are aggregated in federations -regional scale-; and at the same time, federations are aggregated in confederations - national scale) prefer Twitter (observations from the authors). Variables were monitored in relation to the content (key words, original post, or shared post), message format (plain text, photograph/image, video, or link), and category (problem insights, solutions, and collaborative networks...). Data were collected using search tools and filters. In this way, it was possible to determine which

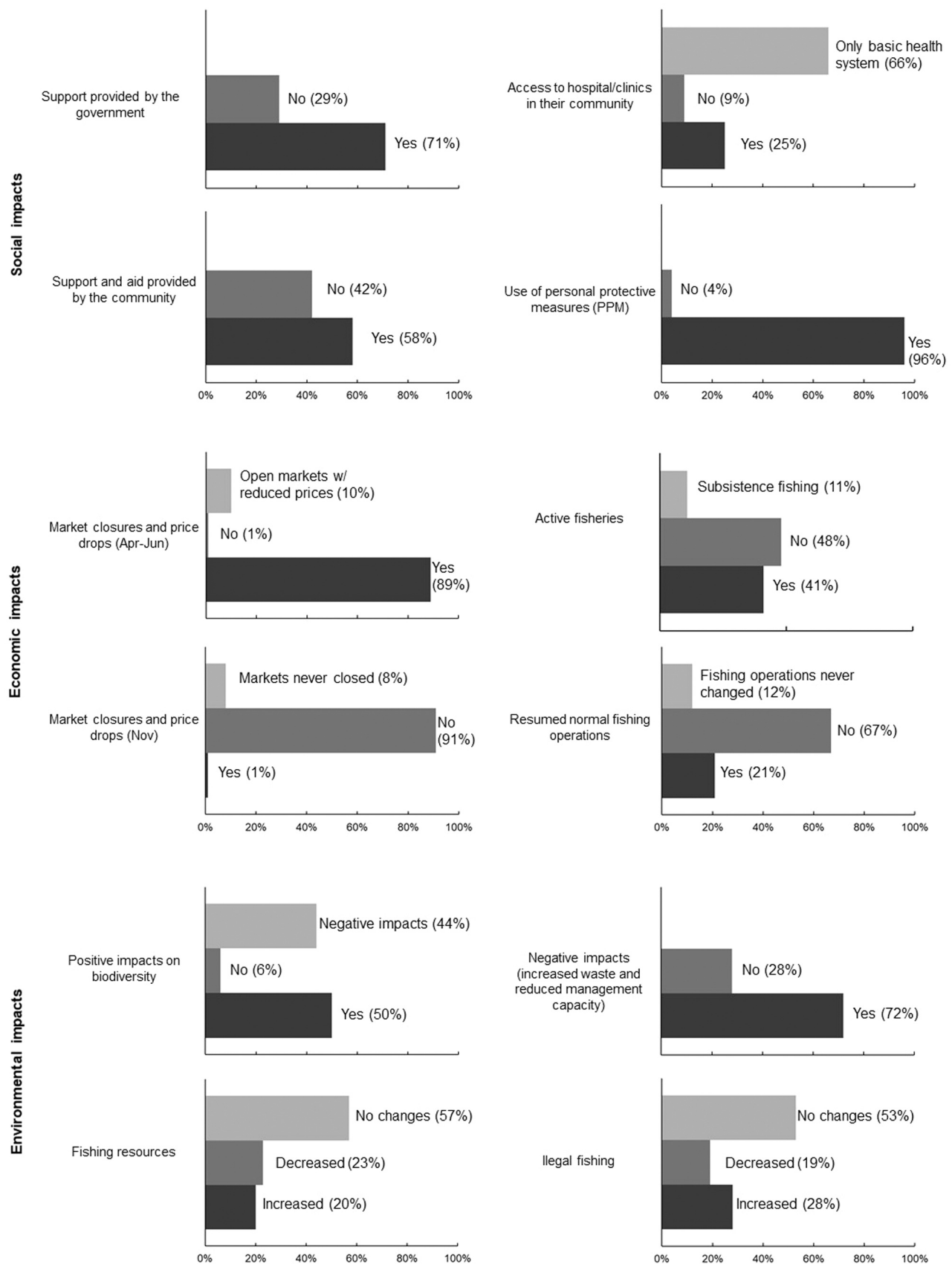



Fig. 2. Perceived social, economic and environmental impacts during the COVID-19 pandemic. The proportion of respondents interviewed is shown (%).

**Table 1**

Price change in seafood products due to COVID-19 lockdown measures and the consequences for national and international markets.

Fishery		Market	Early impacts	Price variation
	California spiny lobster	Asia	January 2020	↓ 40–60%
	Caribbean spiny lobster	Asia and Europe	January 2020	↓ 30–40%
	Panshell	Asia	March 2020	↓ 30–50%
	Finfish	United States and Mexico	March 2020	↓ 50–60%
	Seaweed ( <i>Gelidium</i> sp.)	International	Remained opened	↑ due to the pharmaceutical industry

digital platforms were the most used by fishers. Furthermore, by incorporating social media monitoring in the analysis, it was possible to validate the findings from the interviews.

### 3. Results

The analysis of impacts, responses, and digital divide showed that SSF in Mexico experienced an overwhelming shut down at the early stages of the pandemic. Nine in every 10 interviewees reported market closures and price drops (March–June 2020). Although the markets had reopened by November 2020 (91% of respondents), they opened with limitations (e.g., reduced fishing effort and prices). During the early stages, some of the more isolated coastal communities, protected themselves by closing access to their communities. Five to six months later, most had reopened. The newly reopened communities provided opportunities to reactivate economies, although reopening came hand in hand with an increase in the number of reported COVID-19 cases, despite the preventative measures that were in place. This was evident from the surveys of several questionnaires. Fishers believe that the pandemic has allowed for a certain degree of environmental recovery, although they stress that some complex threats remain ongoing (e.g., pollution and illegal fishing). Moreover, adaptive responses are few and far between or implemented locally. Fishing organizations who had higher levels of organization prior to the pandemic managed to adopt some important measures. Fishers have used technology in their favor to stay informed, engage in e-commerce, and remain connected to others, although less than half (mostly men in their 40's) reported feeling very comfortable in the digital world.

#### 3.1. Socio-economic and environmental impacts

When participants were asked about socio-economic impacts in the early months of the pandemic (March–April 2020), 89% of the

**Table 2**

Proportion of respondents interviewed (%) that use some kind of personal protective measure (PPM). Most participants used more than one PPM.

PPM	Participants
Face masks	96%
Hand sanitizer	91%
Social distancing	91%
Avoiding large groups	84%
Regular hand washing	80%
Sanitization	71%
Gloves	40%

interviewees reported market closures, fishery' shut downs, and price reductions with reduced landings (Fig. 2). A 51-years-old fisher from the Mexican Pacific shared that “*There was no one buying or consuming marine resources. At the beginning of the pandemic, we stopped everything. We closed the processing plant and halted production*”. Price reductions were observed in 70% of national and international sales, except in the seaweed fishery of the Pacific, which was the only fishery to experience an increase in demand and price due to the use of seaweeds in the pharmaceutical industry (Table 1). Four in every 10 respondents reported that they had stopped fishing by April. All interviewees said that they had resumed fishing by November, although with limitations in most cases (67% limited effort and prices; Fig. 2).

Support and aid from the government, which came mainly from local governments, was available during the first months of the pandemic. Food supplies were delivered door-to-door to families during April–May. Cash was also provided through fisheries subsidies and support was given to close access to communities. One fisher commented in May, “*If you are lucky, the municipality gives you one papaya per family, one kilogram of meat, or a little chicken. Could you survive the quarantine with that*

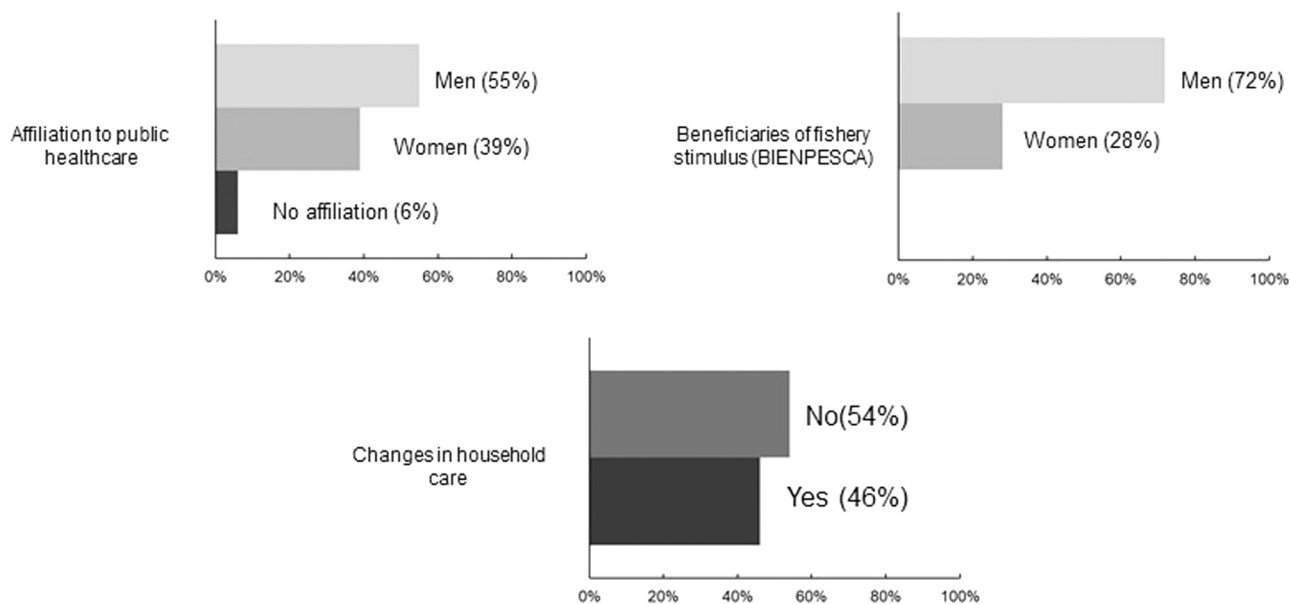


Fig. 3. Impacts on well-being in fishing communities, related to health, household care, and access to subsidies. BIENPESCA is a federal fishing subsidy.

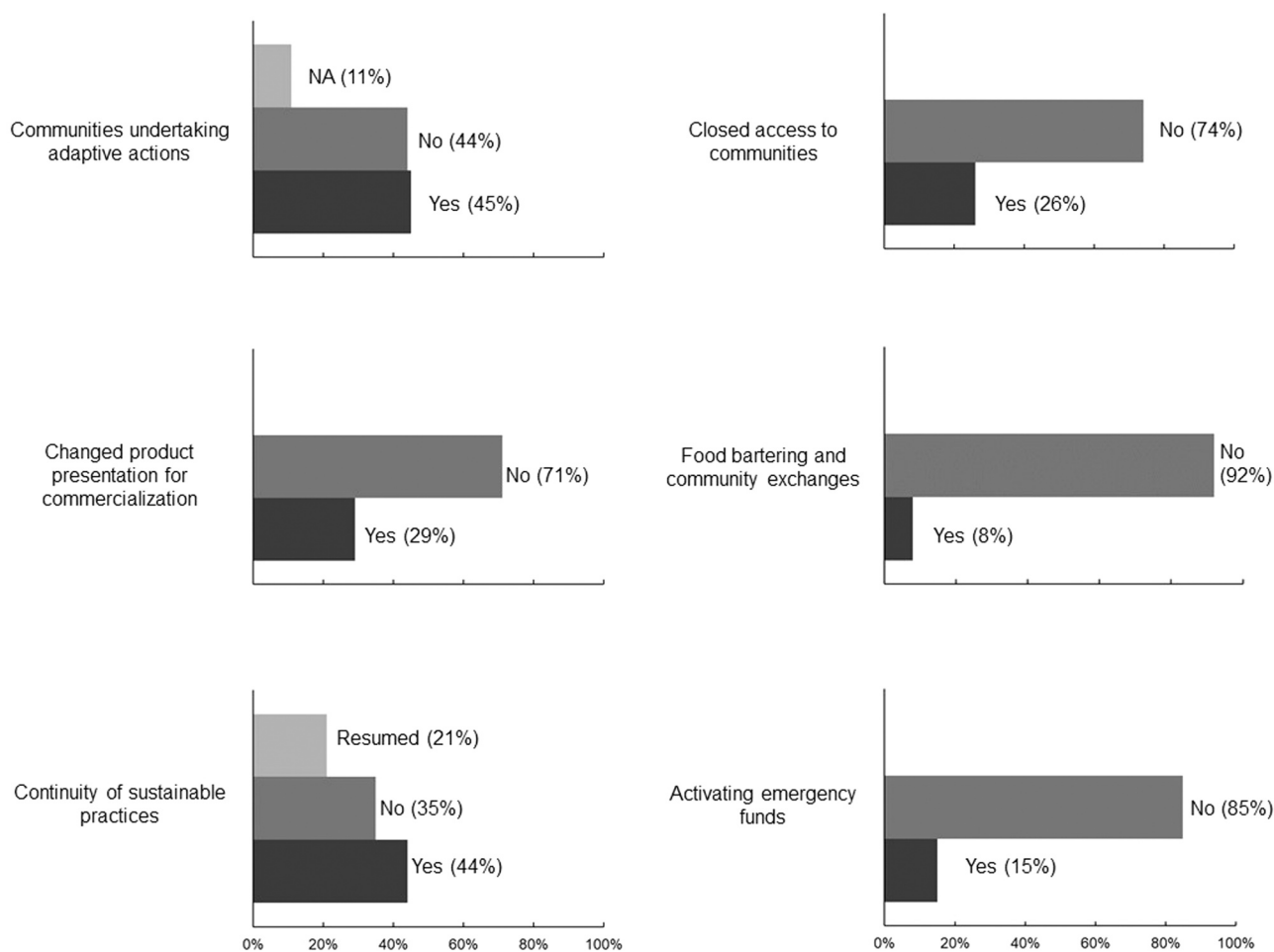


Fig. 4. Adaptive capacity of fishing communities and specific adaptative actions. Participant proportions (%) are shown.

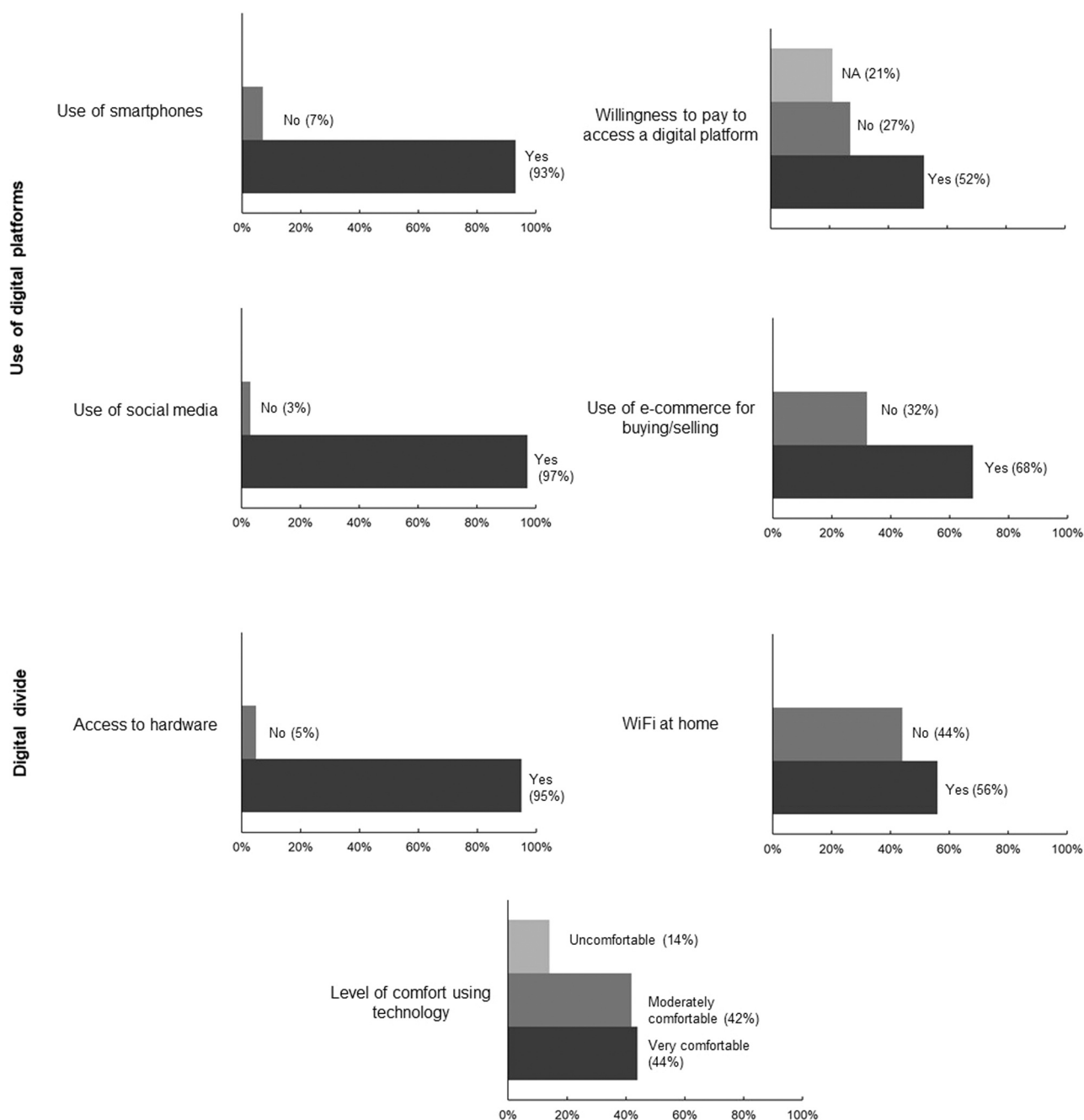
**Table 3**

Participant age ranges in years, and their respective capacities to document solutions.

Age range	With responses	Without responses
18–29	51%	49%
30–40	56%	44%
41–50	58%	42%
+51	66%	34%

*food and a little chicken? Of course not, the pandemic is about social classes, where the poorest always have to sacrifice and at the same time be thankful for what we get, otherwise we do not eat. Subsistence fishing is too expensive, and catches cannot be sold well... from my fishing trips I come back with \$200 pesos (US\$9)".*

Half of the respondents perceived the distribution of aid to be uneven as it did not reach everyone, and the quantities received (MX\$ 2000/US\$ 90) are lower than seventeen *salaries mínimos* (minimum wages; roughly MX\$123/ US\$ 6 per day) in Mexico in 2020. Interviewees were unsure of the criteria used to provide support to different social groups, with only one every three interviewees being able to provide specific answers while 89% stated that they had not received any information from the government about safely resuming fishing (11% received face-to-face information or where informed via Facebook and WhatsApp). Personal protective measures (PPM) were reported to have been used in all communities, except for those that were closed and had not registered any COVID-19 cases (Table 2). Fishers generally lack access to hospitals and clinics in their communities and depend on basic healthcare systems (Fig. 2). Therefore, 94% of the participants reported taking measures to prevent bringing the virus into their homes, and 99% stated that their



**Fig. 5.** Technology use during the pandemic. The proportion of participants is shown (%).



**Table 4**

Proportion (%) of the most-used social media and e-commerce platforms. Most respondents use multiple platforms. NA: Not Applicable.

Social media network	Rate use	E-commerce
WhatsApp	95%	19%
Facebook	90%	31%
Instagram	26%	NA
Twitter	9%	NA
TikTok	5%	NA
MercadoLibre	NA	26%
Amazon	NA	13%
Other (AliExpress, eBay, Shopify, local webs)	NA	11%

communities had implemented preventative measures.

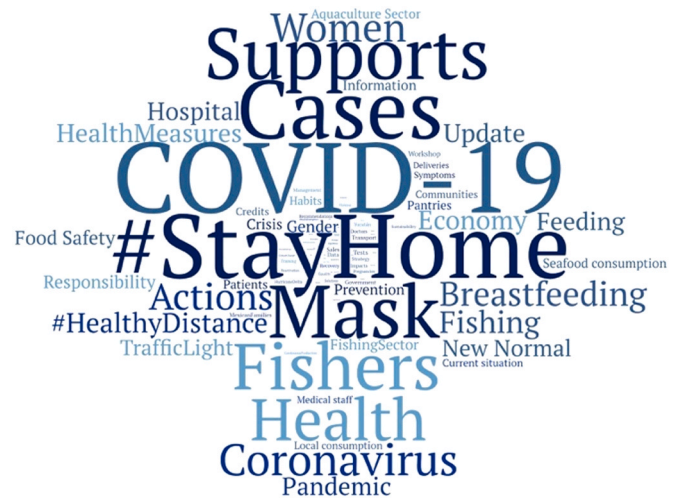
Half of the interviewees perceived positive impacts on biodiversity due to lockdown measures (e.g. cleaner seas and beaches, and clearer water with less oil due to reduced boat traffic and an increased abundance of certain species). A 36-year-old fisher said, “*We have had very beautiful days that we have not seen in a long time.*” However, fishers were also concerned about negative impacts due to the increased volume and deficient management of solid waste (e.g., increased solid waste due to discarded facemasks) as well as being concerned with climate change (e.g. changes in currents, elevated water temperatures, and hurricanes and storms affecting their fishing days). As a 49-year-old fisher said, “*I don’t know if we should attribute this situation to climate change or bad weather, but there are no octopuses; I have talked to my wife and colleagues who are also fishers, and the truth is that fishing has not gone well and we are worried.*”

Half of the respondents had the perception that the quantity of fishing resources had not changed due to the suspension of fishing activities. When asked about illegal fishing, half stated it had not changed and had always been present in their communities (Fig. 2). Respondents included fishers working in areas that included fish refuges or community reserves (83%). As a result of the pandemic, the way in which these areas are managed has not changed since these zones are not fished. The rest of the participants (17%) argued that it had changed due to the suspension of monitoring and enforcement activities. Two communities in the Pacific and one in the Caribbean reported a temporary opening of their community (voluntary) reserves for subsistence fishing and as a measure to reactivate the local economies.

Despite the fisheries lockdowns and having spent many months with limited working days, household care did not notably change for half of the families. When the fisheries value chain was observed, most of the participants were found to have contributed to either production (63% on average) or post-production (32% on average) activities. However, this was not the case when taking into consideration the federal BIEN-PESCA subsidy, a subsidy that fishers receive each year to support their livelihoods, especially during closed fishing seasons. As this is a subsidy oriented for producers, and women typically engage in other stages of the value chain different to production [33], only 28% of the reported beneficiaries were women (Fig. 3). There were no participants involved in only pre-production activities; those who had reported being involved in that stage were also involved in all the other stages (see Table A.7).

### 3.2. Responses

Responses were evaluated by observing variables related to adaptive capacity and community actions undertaken towards adaptive solutions. Fishers have developed local solutions individually (58%). Three of every four fishers who found a solution mentioned that they had



**Fig. 6.** The most common keywords found during the social media monitoring. The size of the word is directly related to the number of times the keyword was used.

implemented it without the participation of external stakeholders. The fishers who reported being unable to adapt (42%) stated that they had taken no action due to a variety of factors, such as lacking market alternatives, concerns about their health, and the need to comply with lockdown measures. A perception that their cooperative or colleagues lacked the ability to effectively organize in order to adapt was also present. When observing the community, less than half of the fishers reported having undertaken adaptive actions (Fig. 4).

Access to some small (<2500 people) coastal communities was restricted. When possible, fishers switched to low-value products (mainly finfish), leaving the high-value products unfished (e.g. lobster and penshell). Some coastal communities (65%) successfully maintained or resumed collaboration practices aimed at sustainability (e.g. collaborative research with universities; beach cleanups; underwater, fishery and oceanographic monitoring; and surveillance; Fig. 4).

With regard to the fishery system, changing the presentation of the product constituted the most common adaptation, although this percentage decreased overtime (29% in April and 15% in June). Participating in alternative street and online (Facebook, WhatsApp) local markets was also a common activity. Only some well-organized fishing organizations that were located primarily in Baja California, Baja California Sur and Quintana Roo were able to access emergency funds to cover salaries and loans. A few communities organized food exchanges and support networks by donating fish. For example, a fisher from Baja California Sur stated that his cooperative had donated five tons of fish to local communities, whereas in Quintana Roo another fisher started a small, online crowdfunding initiative to cover the operation costs of fishing to donate to others. Other communities were selling items cheaply or bartering for foods like beans, corn, or pork. Respondents (45%) acknowledged that women were leading the development of alternative economic activities, such as designing and sewing reusable facemasks, or preparing and selling food.

There was no difference in the capacity to document solutions by gender, although the most successful age group in implementing solutions was that of fishers aged over 51 years of age (Table 3).



### 3.3. Digital divide

To evaluate the use and access to technology, the use of digital platforms and the digital connection were assessed. Fishers feel very to moderately comfortable using technology and have access to smartphones and other hardware like tablets and laptops. There was no significant difference between women and men with regards to the rates of social media use. Participants reported an increased use of social media since the pandemic for all age groups and segments of society (Fig. 5, Table 4) with digital natives (under 35 years old) spending more time online (women spend on average seven hours and men spend on average four hours). A fisher said, *"I am coming out of COVID-19; in these days when I have not been able to see anyone, my ally has been my cell phone and technology."*

In places where the internet is available, 56% of participants accesses the internet via their home Wi-Fi, 37% used mobile data from their cell phones, and 7% used free Wi-Fi hotspots in their communities or workplaces. When asked about their willingness to pay for digital subscriptions, 73% said they would be either willing to pay (52%) or would consider it (21%). Others said they would not pay due to a lack of income and the fact that free platforms would already exist (Fig. 5).

From all of the analysed social media posts (9079), 18% (1661) included selected keywords used to filter and track relevant messages (Fig. 6). When including the keyword "gender", only 3% of the analyzed posts included that keyword, along with "fisheries" and "COVID-19." The most common format chosen for social media posts included pictures and photographs (71%), followed by content shared from other websites (19%), with few videos (6%), and plain text (4%).

The number of times that the word "COVID-19" appeared in posts, decreased over time. A total of 56% of posts reported a problem related to COVID-19 in April, whereas this percentage dropped to 5% in October. Likewise, the normalization of the use of facemasks was documented by their increased use in posts that were accompanied by videos or photos of a meeting or conference.

## 4. Discussion

The COVID-19 pandemic has caused a global health crisis that has brought with it social and economic fragmentation that has cascaded across all sectors of society, including fisheries [7,16]. There is a collective global concern about health, safety, well-being, coupled with the recognition that the poorest and most vulnerable are most affected by the pandemic. However, the impacts of the pandemic have affected primary, secondary, and tertiary activities differently, in addition to affecting cities and rural communities differently [28]. This study elevates the voices of Mexican fishers during the pandemic and provides information about its impacts, responses, and the digital divide. Additionally, the uncertainty about the duration, intensity, and novelty of the pandemic has added extra pressure, triggering social and economic instability that have made it difficult for some fishing communities to adapt [26] or continue with conservation and sustainability efforts. The needs and opportunities identified in this study can be used to develop programs tailored to mitigate the effects of COVID-19 in SSF while promoting adaptation and community resilience (e.g. public and private aid and funding portfolios) and fostering further research.

The impacts of COVID-19 on social, economic and environmental factors are yet to be quantified globally, although some efforts have already been made at the regional level [3,24]. Mexican SSF and the associated communities are not exempt from these impacts [16,24,34]. Fishers worldwide have reported reduced income with declines that vary from 20% in the United States [34] to 100% in Indonesia as a result

of the complete cessation of activities [43]. Other studies have also reported lower incomes in fishing communities that have been specifically related to lack of commercialization channels of fresh seafood ([16,25,35]).

The socio-economic and environmental impacts of COVID-19 on Mexican SSF have been similar to those that have been found worldwide ([16,17,34,25,29]). One of the most important early impacts of the pandemic was the closure of markets and the price drop in seafood resources (Fig. 2), which affected most fisheries. The price decreased between 30% and 60% for various species of both international and domestic interest, with the exception of those used by the pharmaceutical industry (Table 1). Fishers showed a preference for selling low-value products locally [25], as prices stretched around high-value products due to the closures of international markets [3,23] and reduced household incomes. After eight months, the fishing sector had resumed fishing but reported investing less effort coupled with continued price drops. Coastal communities received support from the governments, locally in the form of food and federally in the form of subsidies. Nonetheless, many fishers were not satisfied, as they perceived the aid as having been unequally distributed while being sparse. On the other hand, communities and well-organized fishing organizations have played an important role in developing community networks to support the families in need during extended periods of time. In addition, vaccination programs over the world have brought hope of more normalized conditions, with Mexico starting its vaccination program in February 2021 [9]. On the other hand, potentially reduced sanitary measures due to the fact that people start to be vaccinated, may jeopardize the sector's recovery if the perception of lower risks lead to diminished sanitary measures. Further research will be needed to know if the application of vaccination programs will allow to resume fishing under normal conditions.

During the last two decades, various international instruments have focused on equality and a respect for human rights to reduce economic, social and environmental gaps for humanity [45]. The fishing sector has also echoed on the need of integrating social, economic, and environmental dimensions more forcefully [44]. However, the pandemic has exacerbated challenges related to health, markets, working conditions and the digital divide, which is particularly notable in SSF in rural communities ([3,17]). Most of the fishers (66%) indicated having basic health services (Fig. 2; i.e., medicines, one bed, one doctor, and one nurse). However, those resources did not include the specialized equipment needed to treat a person diagnosed with COVID-19. The fishing sector has followed the federal government restrictions that have been implemented since March 2020 to avoid infections, with 96% of fishers using at least one form of PPM (e.g., face mask or hand sanitizer) and adhering to social distancing (Table 2).

With regard to gender, the results of this study show that women represent less than one third of people that have been benefited from the federal fishery subsidy while having less access to public healthcare than their male counterparts [17]. Women are important drivers of fishers' sustainability and marine conservation in fishing communities [31,37] and adaptive efforts must ensure their voices are heard and considered. When including gender in the social media analysis, the number of messages and posts consistently and substantially dropped, suggesting that the incorporation of a gender perspective in fisheries is lacking in the context of the crisis of the global pandemic.

During the lifetimes of the people alive today, shocks have been either local or regional (e.g., storms, hurricanes, and earthquakes) or have had complex effects that are difficult to track (e.g., climate change). They have, so far, never hit humanity all at the same time. The COVID-19 pandemic is a once in a lifetime event, and it provides an

important opportunity to create an adaptive capacity and the momentum to foster resilience in the face of other global shocks such as climate change, economic recessions, inequality, and the increased discrimination of vulnerable and marginalized groups [2,17,24,25]. The pandemic has demonstrated that the fishing sector has the capacity to adapt and that they can do so quickly by changing product presentations or finding alternative markets. Some of these solutions have begun to be developed at the local scale and include closing or regulating access to communities or adapting to online selling and home delivery. Well organized fishing communities that provisioned emergency funds to their members were better able to cope than those that did not. These lessons can be shared and upscaled within the fishing sector.

Adaptation comes from documenting, learning, and sharing [42]. If we are to adapt to an everchanging world, it is important to document impacts and solutions, in order to discover and co-create new opportunities adaptive opportunities that may be replicated and scaled. By doing so, it is possible to leverage collective action through fair and scalable principles to improve the wellbeing, resilience, and sustainability of all fishers. The pandemic provides an important learning opportunity to face other global shocks, such as climate change or economic recessions. In fisheries, barriers to local, adaptive capacity have been reported to be largely related to institutional and sociocultural factors, especially those related to inequity with regard to access, resource use, and information [27]. Efforts to include diverse, equitable, and equally represented groups of people when conducting research, are paramount to keep advance science, improve ecosystem management, and foster sustainable livelihoods. This study has given a voice to small-scale Mexican fishers during the pandemic, contributing to a documentation of its effects, and providing information of the need and opportunity to design programs (e.g., public and private aid and funding portfolios) and inspire further research.

During three decades of technology development, humanity has pushed for products to perform tasks, facilitate procedures, and quickly and efficiently communicate. Technology has become essential in all aspects of our lives [19]. Every day, an increasing number of people use technology and more activities become available online. This has also led to massive increases in the number of employees working from home [15], the traffic on digital messaging applications, and the use of video platforms for work, education and leisure. Mexico has ~ 81 million Internet users (70% of the population; [22]), a number that grows every year. Most of the people who connect to the Internet do so through their smartphones (95%), and most of the urban population (77%) uses the Internet, while only 48% of rural communities have access [22]. This digital divide increases inequalities [41] between individuals who have access to high-speed Internet and those with limited incomes and coverage or who do not have the skills and tools to use it. This is particularly important in a world under lockdown world in which technology has become a great ally to remain connected; as such, household internet access should be made ubiquitous [2]. The inequalities generated by the lack of stable internet connections or a total lack of access to the Internet and even to phone signals and their impacts have not yet been documented in fishing communities in Mexico.

Social media analysis has been used in the social sciences since the appearance of social networks [36], and has offered valuable insights into fisheries management and governance [4,6], even in the face of shocks [32]. Despite this, cross-analysis studies are scarce, particularly those including quantitative and qualitative information on social networks and collaborative initiatives [5]. Experience shows that the fisher answers will greatly vary depending on the quality of their fishing day (authors knowledge), which could bias the data collected from the interviews. In this study, it was possible to determine which digital platforms were used most by fishers by analyzing social media use, which may foster the co-development of improved communication and engagement strategies [10,38].

With regard to the use of technology use, fishers gave a range of responses. Nonetheless, participants reported that they had spent more

time each day using digital platforms during the pandemic compared to their level of pre-pandemic use (Fig. 5). These platforms have been used to sell seafood, communicate with family members, and receive information about COVID-19 (Fig. 5). In the US, fishers have stated that online meetings are not suitable to effectively communicate their concerns regarding fisheries management [34]. Therefore, digital strategies should also be combined with non-digital means to ensure that the people that are not familiar with, or unable to access, technology are not left behind. In addition, increased efforts (e.g., capacity building and internet connection) are also needed to improve digital connectivity between fishing communities. Overall, the decrease in the use of the keywords “fisheries” and “COVID-19” in the social media analysis indicates that COVID-19 is no longer talked about as much as previously. This may be due to the fact that the pandemic has begun to be “normalized” in Mexico.

## 5. Concluding remarks

Fishers in Mexico experienced a massive shut down during the early stages of the COVID-19 pandemic but have now resumed fishing to some extent. Most of the fishers did not have the organizational resources in place to effectively respond to the pandemic and thus, experienced notable socio-economic impacts. The adaptive capacity of small-scale fishers to foster community-based solutions and responses appears to be more closely related to organization than to innovation. Community-based solutions such as those focused on the implementation of PPM, the development of local markets, and the existence of emergency funds; are needed to foster resilience in fishing communities. Also, new solutions will be needed in the context of the New Normal, as conditions change, and the pandemic evolves.

Overall, as a result of the first pandemic to take place in the age of widespread information technology and globalization, fishers have spent more time in the digital world than fishing. Small-scale fisheries have gone through a digital transition in order to be connected. This has revealed important gaps regarding inclusion and equity in the digital and fisheries world, mainly with regard to vulnerable groups (e.g., women and elderly individuals). To avoid disenfranchising the fishing communities in Mexico and the LAC region, new and existing digital infrastructure for SSF, must provide novel ways to breach the digital divide. This will foster a better and fairer connectivity among fishers while fostering the mobilization of local solutions and opportunities for the sustainable recovery of SSF. Both of these factors are needed to increase increasing community resilience and the sustainability of SSF.

## Credit authorship contribution statement

**Ines Lopez-Ercilla:** Formal analysis, Investigation, Methodology, Visualization, Writing - original draft, Writing - review & editing. **Maria Jose Espinosa-Romero:** Conceptualization, Funding acquisition, Methodology, Writing - original draft, Writing - review & editing. **Francisco J. Fernandez Rivera-Melo:** Investigation, Formal analysis, Visualization, Writing - original draft, Writing - review & editing. **Stuart Fulton:** Investigation, Formal analysis, Visualization, Writing - original draft, Writing - review & editing. **Jorge Torre:** Conceptualization, Funding acquisition, Methodology, Writing - original draft, Writing - review & editing. **Rebeca Fernández:** Data curation, Formal analysis, Investigation, Methodology, Writing - original draft. **Araceli Acevedo-Rosas:** Data curation, Formal analysis, Investigation, Methodology, Writing - original draft. **Arturo J. Hernández-Velasco:** Data curation, Formal analysis, Investigation, Methodology, Visualization, Writing - original draft. **Imelda Amador:** Data curation, Visualization.

## Declarations of Competing Interest

This work was supported by The Walton Family Foundation [grant number 00101951]; the David and Lucile Packard Foundation [grant

number 2019-69961]; the Sandler Supporting Family Foundation [grant number 20200404], the Marisla Foundation [grant number 20200304], and the Summit Foundation [grant number 20200165].

### Data Availability

The datasets generated in this study are available upon request from the corresponding author.

### Acknowledgements

We are especially thankful to the 397 fishers who agreed to be interviewed in who shared their thoughts and their time with us. This study would not have been possible without the support from Alesia Flores, Alfonso Romero, Brenda Luna Cárdenas, Carmen Valdez, Daniel Valdez, Ernesto Gastélum, Fernanda Fitzmaurice, Francisco Chávez, Gabriela Cuevas, Jacobo Caamal, José Estrada, Lorena Rocha, Magdalena Précoma, Mariana Suasnívar, Marco Polo Barajas, Neyra Solano, Raziel Hernández and Sergio Marcos, who interviewed participants and/or conducted social media monitoring. People from other civil society organizations and academic institutions, were trained and collaborated

in the interview process, and we wish to thank Silvia Salas, Mariana Álvarez, Susana Rocha, Alejandro Rodríguez, Carlos Paz, and Paulina Díaz. Finally, we thank Andrea Lievana MacTavish for English language editing.

### Funding sources

This work was supported by The Walton Family Foundation [grant number 00101951], the David and Lucile Packard Foundation [grant number 2019-69961], the Sandler Foundation [grant number 20200404], the Marisla Foundation [grant number 20200304], the Summit Foundation [grant number 20200165], Sac Tun [no grant number], the Paul M. Angell Family Foundation [grant number 20200438], the Waterloo Foundation [grant number 1017-4215], Oceans 5 [no grant number], and GEF's Small Grant Program implemented by UNDP [grant number MEX-SGP-OP6-Y2-STAR-CC-2019-01].

### Appendix A

See Appendix [Tables A.5-A.7](#). [Fig A.7](#).

**Table A.5**

Questions applied in the interviews (60) divided into three themes, eight subthemes, and 22 content variables considered in the study. Some questions were open (qualitative) while others included a range of answers (quantitative). Data were categorized and disaggregated by gender and age. PPM: personal protective measures. BIENPESCA: federal subsidy provided to fishers in Mexico.

Theme	Socio-economic and environmental impacts				
<b>Subtheme</b>	<b>Social impacts</b>				
<b>Content</b>	<b>Questions</b>				
<i>Community impacts</i>	What has been the impact of COVID-19 in your community?	When did you observe the first COVID-19 impacts?	Have yourself or anyone in your family, presented COVID-19 symptoms?		
<i>Support provided by the government</i>	Has your community received any support from the government?	If so, what kind of support?	During the pandemic, have you received any advice or support from a public agency regarding information on how to resume safely the economic activities in your community?		
<i>Support and aid provided by the community</i>	Is someone supporting or providing aid to your fishing organization?				
<i>Access to hospitals/clinics in their community</i>	Are there health care services in your community?	If so, what kind?			
<i>Prevention</i>	Do you implement personal protective measures (PPM)?	Have preventive measures been taken in the streets and businesses of your community to avoid coronavirus infections?	Have you taken preventive measures inside your home to avoid contagion of Coronavirus?	Have you had difficulty obtaining PPE?	Has the price of these items been maintained?
<b>Subtheme</b>	<b>Economic impacts</b>				
<i>Markets and price variations</i>	How are the prices of the products changing?	Have the markets where you sell your products been opened?			
<i>Fishing activity variation</i>	Are you still fishing?	Did your community stop carrying out any of these economic activities at sea due to the pandemic?	Have any of these economic activities been resumed at the sea in the community during the contingency?		
<i>Changes in commercialization</i>	Before COVID-19, did your fishing organization process products to sell?	Has your organization started to process products to sell as a result of COVID-19?			
<b>Subtheme</b>	<b>Environmental impacts</b>				
<i>Biodiversity conservation</i>	Do you harvest inside a protected area? (e.g. fauna and flora protection areas, natural resources protection areas, national parks, or biosphere reserves)	Has the way of managing these zones, changed due to COVID-19?	Before the pandemic, did you carry out any sustainable fishing or marine conservation action?	Have you stopped implementing some of those sustainable fishing or marine conservation actions due to the pandemic?	As a result of the pandemic, have you seen any change in the amount of garbage or waste on the streets or beaches of your community?
<i>Fishing resources</i>	Do you perceive that as a result of the pandemic, the confinement and the	In the wake of the pandemic, have you perceived changes in	During the pandemic, is there any kind of surveillance to prevent any act of illegal		

(continued on next page)

Table A.5 (continued)

Theme	Socio-economic and environmental impacts				
	suspension of some activities, the amount of fishing resources has changed?	illegal fishing in your community?	fishing or that threatens ecosystems?		
Subtheme	Gender				
Support system	Has that support (from the government) been distributed to any specific group? Which group (women, single mothers, the elderly, others)?	Are you the title holder of social services?	Has your fishing organization given support to women and men equally?	In the stages of supply chain, who received BIENPESCA?	Have women in the community had the same opportunities to receive government support? Yes/No
Household care	At home, who is responsible for administering the household finances?	Do you perceive any changes in the distribution of domestic work due to COVID-19? Yes/No	Now that children are staying home for school education due to COVID-19, who is responsible for their care?	Besides your activities (e.g., work, domestic duties, taking care of the family) are you or anyone in your family, taking care of a sick person? (any disease or suffering, besides COVID-19)	
Role of women in local economy	Are women from the community taking part in alternative economic activities to generate income during the pandemic?				
Theme	Responses				
Subtheme	Adaptive capacity				
Communities undertaking adaptive actions	What actions did you take to find solutions to the problem?	Has your fishing organization taken any action to face the COVID-19 crisis?			
Adaptation cases	What mechanisms helped you to take action?	What actions of sustainable fishing have you been able to maintain during the pandemic?	Could you share with us which of the actions that you have taken has been the most successful or the one that has worked the best?	When did you start to implement these actions?	
Theme	Digital divide				
Subtheme	Use of digital platforms				
Use of smartphones	Do you have a smartphone?	How many hours a day do you navigate the internet?			
Use of social media	Have you changed the way you use social media during the pandemic?	How many hours a day do you surf the internet?	Have you changed the way you use social media during the pandemic?		
Use of e-commerce for buying/selling	Have you ever purchased or sold any product online?	If so, which platform do you use?			
Willingness to pay to access a digital platform	Would you be willing to pay for a digital service or platform?				
Subtheme	Digital connection				
Level of comfort using technology	How comfortable do you feel using technology? (apps, digital platforms)				
Access to hardware	How comfortable do you feel using technology? (apps, digital platforms)	Do you or your family have access to a computer or a tablet?			
Wi-Fi at home	How do you connect to the internet?	Do you consider that it is necessary to improve the internet connection in your community?	Do you have phone signal in your community?		

**Table A.6**

Communities and states with participants of this study. The information is disaggregated by gender: women (W) and men (M).

#	State	Community	W	M	SubTotal
1	Baja California Sur	Agua Verde	1	0	1
		Bahía Asunción	1	2	3
		Bahía Magdalena	0	1	1
		Bahía Tortugas	1	3	4
		Cabo Pulmo	0	2	2
		Cabo San Lucas	0	2	2
		El Esterito	0	1	1
		Ensenada Blanca	1	0	1
		Ensenada de Cortés	0	1	1
		Guerrero Negro	0	3	3
		Isla Natividad	5	8	13
		La Bocana	1	3	4
		La Paz	2	6	8
		Las Barrancas	0	3	3
		Ligüi	2	1	3
		Loreto	0	1	1
		Puerto Adolfo López	0	1	1
		Mateos			
		Puerto Chale	0	1	1
		Puerto San Carlos	0	1	1
		Punta Abreojos	0	2	2
		Punta Eugenia	0	1	1
		San Hipólito	0	1	1
		San Juan de la Costa	0	1	1
		San Juanico	0	1	1
		Santa Rosalía	0	3	3
		Tembabichi	0	1	1
SubTotal Baja California Sur			14	50	64
2	Baja California	Bahía de los Ángeles	0	5	5
		El Rosario	3	4	7
		Ensenada	3	8	11
		Isla Guadalupe	2	1	3
		Puerto Canoas	1	3	4
		San Felipe	3	0	3
		San Quintín	0	1	1
		Tijuana	0	1	1
		SubTotal Baja California			12
3	Sonora	Bahía de Kino	9	12	21
		Guaymas	6	5	11
		Puerto Libertad	3	10	13
		Puerto Peñasco	3	1	4
		San Carlos	0	1	1
SubTotal Sonora			21	29	50
4	Sinaloa	Altata	2	0	2
		Culiacán	0	1	1
		El Castillo	1	0	1
		Mazatlán	1	1	2
SubTotal Sinaloa			4	2	6
5	Nayarit	Antonio R. Laureles	1	1	2
		Llano del tigre	1	2	3
		Palmar de Cuautla	0	1	1
		Pescadero	1	2	3
		Punta de Mita	1	1	2
		Rosamorada	0	4	4
		San Blas	0	1	1
		San Miguel	2	1	3
		Tecuala	1	1	2
SubTotal Nayarit			7	14	21
6	Jalisco	Puerto Vallarta	0	1	1
	SubTotal Jalisco			0	1
7	Colima	Manzanillo	1	0	1
	SubTotal Colima			1	0
8	Michoacán	Cojumatlan Petatán	0	1	1

**Table A.6 (continued)**

#	State	Community	W	M	SubTotal
9	SubTotal Michoacán		0	1	1
		CDMX	0	1	1
10	SubTotal CDMX		0	1	1
		Guerrero	1	1	2
11	SubTotal Guerrero	El Mogote	2	1	3
			3	2	5
		Oaxaca	0	1	1
		Bahía de Huatulco	1	8	9
12	SubTotal Oaxaca	Puerto Ángel	1	0	1
		San Agustínillo	2	9	11
		Chiapas	0	1	1
		El Castaño	0	1	1
13	SubTotal Chiapas	Las Garzas	0	1	1
			0	2	2
		Quintana Roo	1	12	13
		Banco Chinchorro	1	1	2
14	SubTotal Quintana Roo	Chetumal	1	1	2
		Cozumel	1	1	2
		Holbox	0	1	1
		Isla Mujeres	0	2	2
		María Elena	1	5	6
		Puerto Morelos	1	1	2
		Punta Allen	5	12	17
		Punta Herrero	3	4	7
		Xcalak	0	1	1
			13	40	53
		Yucatán	10	7	17
		Dzilam de Bravo	0	47	47
		Progreso	0	2	2
		Río Lagartos	0	4	4
San Crisanto	0	14	14		
San Felipe	3	0	3		
Sisal	0	15	15		
Telchac Puerto	0	1	1		
15	SubTotal Yucatán		13	90	103
		Campeche	0	2	2
		Ciudad del Carmen	0	2	2
		Isla Aguada	1	9	10
		Sabancuy	0	1	1
		San Francisco de Campeche	0	1	1
		San Roman	0	1	1
16	SubTotal Campeche		1	16	17
		Tabasco	0	2	2
		Cárdenas	0	3	3
		Frontera	1	0	1
		Frontera, ejido El Palmar	0	1	1
		San Pedro	0	1	1
		Tembladeras	1	7	8
17	SubTotal Tabasco		1	7	8
		Veracruz	1	2	3
		Arroyo de Liza	0	1	1
		La Vigüeta	0	1	1
		Las Barrancas	0	2	2
		Los Arrecifes	0	1	1
		Nuevo Chicayan	0	1	1
18	SubTotal Veracruz	Quintaniagua	0	1	1
		Zapotitlán	0	6	6
			1	14	15
		Tamaulipas	0	1	1
		Frontera	1	0	1
19	SubTotal Tamaulipas	Miguel de la Madrid	0	1	1
		La Pesca Tamaulipas	1	2	3
			1	2	3
Total number of participants			94	303	397
			24%	76%	100%

**Table A.7**

Questionnaire information. The categories for the fisheries value chain are based on those of [33]. Fisheries were categorized based on the National Fishery Charter [11,12]. Date format DD/MM/YYYY. Abbreviations: women (W) and men (M).

Consultation dates	Content of each interview	Number of interviewees	Most and less common age range (years old, %)	Stage of value chain (%)	Number of fishing organizations	Number of communities	Number of questions	Number of monitored publications on social media	List of states (% coastal states represented, n = 17)	List of fisheries
30/03/2020–15/04/2020	Social and economic impacts	93 (34 W, 59 M)	30–40 (40%) 18–29 (15%)	Production 48% Post-production 40% Complementary to production 3% Not applicable 8% All the stages 1%	34 (2 free fishers)	29	6	338	Baja California, Baja California Sur, Campeche, Nayarit, Quintana Roo, Sinaloa, Sonora, Yucatán (47%).	Abalone, clam, conch, finfish, octopus, ornamental fish, oyster, penshell, seaweed, shark, shrimp, spiny lobster (California and Caribbean), squid, and swimming crab.
6/05/2020–14/05/2020	The role of the State	241 (64 W, 177 M)	30–40 (36%) 18–29 (15%)	Production 60% Post-production 35% Complementary to production 1% Not applicable 4% All the stages 1%	90 (22 free fishers)	62	4	1416	Baja California, Baja California Sur, Campeche, Ciudad de México (*), Nayarit, Oaxaca, Quintana Roo, Sinaloa, Sonora, Tabasco, Yucatán (59%).	Abalone, clam, conch, crab, finfish, jellyfish, octopus, ornamental fish, oyster, penshell, sea cucumber, sea urchin, seaweed, shark, shrimp, spiny lobster (California and Caribbean), squid, swimming crab.
1/06/2020 – 12/06/2020	Local Solutions	223 (60 W, 163 M)	30–40 (39%) 18–29 (14%)	Production 62% Post-production 34% Complementary to production 1% Not applicable 4% All the stages 1%	90 (20 free fishers)	67	6	1093	Baja California, Baja California Sur, Campeche, Chiapas, Ciudad de México (*), Nayarit, Oaxaca, Quintana Roo, Sinaloa, Sonora, Tabasco, Yucatán (65%).	Abalone, clam, conch, crab, crown conch, finfish, jellyfish, octopus, ornamental fish, oyster, penshell, sea cucumber, sea urchin, seaweed, shark, shrimp, spiny lobster (California and Caribbean), squid, swimming crab, yellowtail (mariculture).
24/06/2020 – 09/07/2020	Gender	219 (58 W, 161 M)	30–40 (35%) 18–29 (16%)	Production 59% Postproduction 37% Complementary to production 1% Not applicable 2% All the stages 1%	95 (21 free fishers)	102	12	934	Baja California, Baja California Sur, Campeche, Chiapas, Guerrero, Nayarit, Oaxaca, Quintana Roo, Sinaloa, Sonora, Tabasco, Yucatán (71%).	Abalone, clam, conch, crab, crown conch, finfish, jellyfish, octopus, ornamental fish, oyster, penshell, sea cucumber, sea urchin, seaweed, shark, shrimp, spiny lobster (California and Caribbean), squid, yellowtail (mariculture).
29/07/2020 – 10/08/2020	Access to healthcare	207 (47 W, 160 M)	30–40 (32%) 18–29 (16%)	Production 67% Postproduction 30%	86 (37 free fishers)	60	6	1826	Baja California, Baja California Sur, Campeche, Guerrero, Nayarit, Oaxaca,	Abalone, clam, conch, crab, crown conch, finfish, jellyfish, octopus, ornamental fish, oyster,

(continued on next page)



Table A.7 (continued)

Consultation dates	Content of each interview	Number of interviewees	Most and less common age range (years old, %)	Stage of value chain (%)	Number of fishing organizations	Number of communities	Number of questions	Number of monitored publications on social media	List of states (% coastal states represented, n = 17)	List of fisheries
				Complementary to production 1% Not applicable 2% All the stages 1%					Quintana Roo, Sinaloa, Sonora, Tabasco, Yucatán (65%).	penshell, sea cucumber, sea urchin, seaweed, shark, shrimp, spiny lobster (California and Caribbean), squid, swimming crab, yellowtail (mariculture).
28/08/2020 – 09/11/2020	Technology and digital divide	183 (39 W, 144 M)	30–40 (34%) 18–29 (14%)	Production 67% Postproduction 31% Complementary to production 2% Not applicable 2% All the stages 0	81 (28 free fishers)	59	13	1071	Baja California, Baja California Sur, Campeche, Ciudad de México (*), Nayarit, Oaxaca, Quintana Roo, Sinaloa, Sonora, Yucatán (53%).	Abalone, clam, conch, crab, crown conch, finfish, jellyfish, octopus, ornamental fish, oyster, penshell, sea cucumber, sea urchin, seaweed, shark, shrimp, spiny lobster (California and Caribbean), squid, swimming crab, yellowtail (mariculture).
28/09/2020 – 09/10/2020	Environmental impacts	161 (33 W, 128 M)	30–40 (33%) 18–29 (11%)	Production 69% Postproduction 28% Complementary to production % Not applicable 3% All the stages 0	76 (25 free fishers)	62	12	1334	Baja California, Baja California Sur, Campeche, Chiapas, Colima, Nayarit, Oaxaca, Quintana Roo, Sinaloa, Sonora, Tabasco, Tamaulipas, Veracruz, Yucatán (82%).	Abalone, clam, conch, crab, crown conch, finfish, jellyfish, octopus, ornamental fish, oyster, penshell, sea cucumber, sea urchin, seaweed, shark, shrimp, spiny lobster (California and Caribbean), squid, swimming crab, yellowtail (mariculture).
28/10/2020 – 09/11/2020	Principles for the New Normal	166 (35 W, 131 M)	30–40 (37%) 18–29 (15%)	Production 72% Postproduction 24% Complementary to production 2% Not applicable 2% All the stages 1%	86 (27 free fishers)	62	1	1067	Baja California, Baja California Sur, Campeche, Guerrero, Jalisco, Michoacan, Nayarit, Oaxaca, Quintana Roo, Sinaloa, Sonora, Tabasco, Tamaulipas, Veracruz, Yucatán (88%).	Abalone, clam, crab, crown conch, finfish, jellyfish, octopus, ornamental fish, oyster, scallops, sea cucumber, sea urchin, seaweed, shark, spiny lobster (California and Caribbean), swimming crab, yellowtail (mariculture).

\*Ciudad de México (Mexico City) was not considered in the percentages of represented coastal states (n = 17, total coastal states in Mexico)

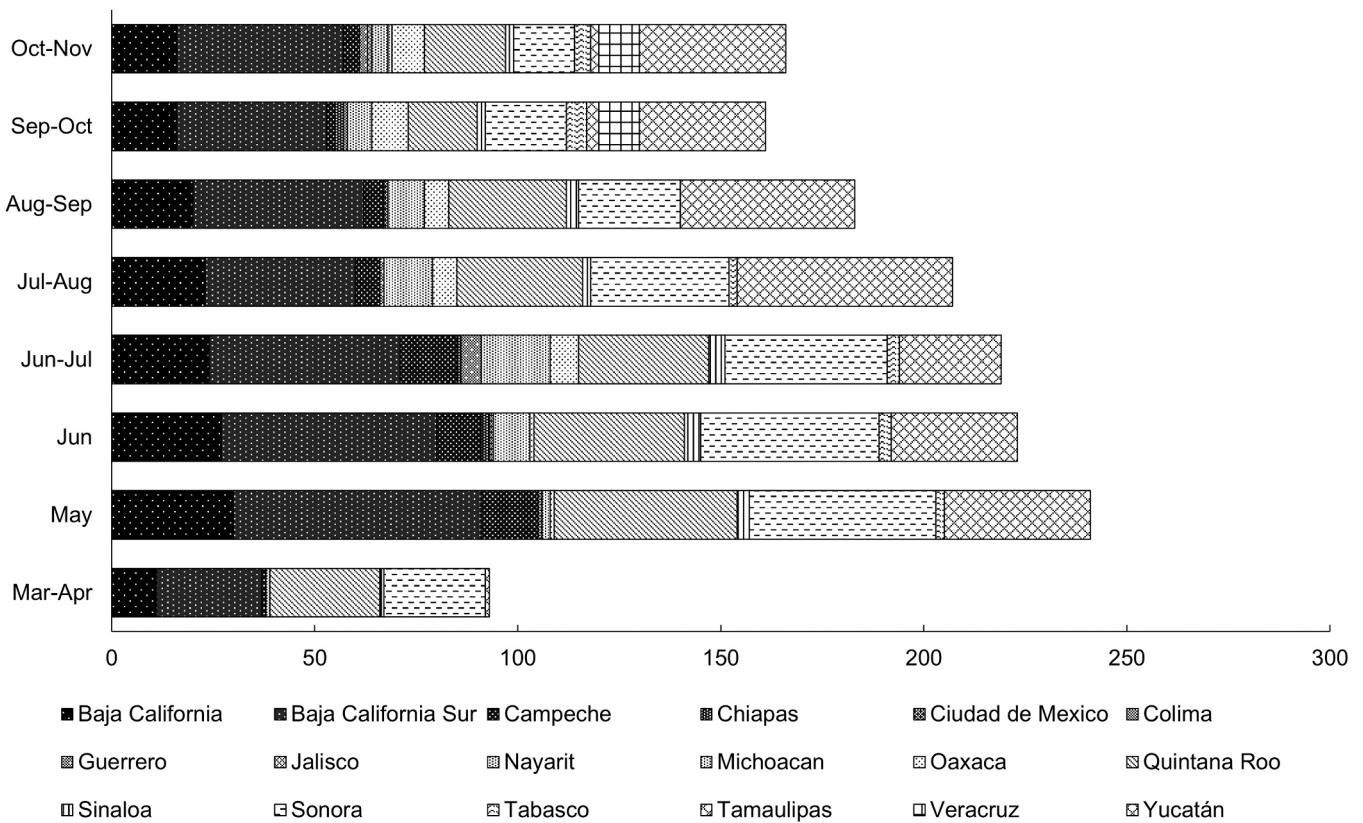


Fig. A.7. Number of interviews applied per period and state throughout this study.

## References

- ACAPS. Assessment Capacities Project Vulnerability to COVID-19 containment measures: Key factors which will shape the impact of the crisis. Retrieved on 21st of April 2020 from: ([https://www.acaps.org/sites/acaps/files/products/files/20200421\\_acaps\\_thematic\\_report\\_vulnerability\\_to\\_covid-19\\_containment\\_measures.pdf](https://www.acaps.org/sites/acaps/files/products/files/20200421_acaps_thematic_report_vulnerability_to_covid-19_containment_measures.pdf)).
- F. Ahmed, N. Ahmed, C. Pissarides, J. Stiglitz, Why inequality could spread COVID-19, *Lancet Public Health* 5 (5) (2020) 240, [https://doi.org/10.1016/S2468-2667\(20\)30085-2](https://doi.org/10.1016/S2468-2667(20)30085-2).
- N.J. Bennett, E.M. Finkbeiner, N.C. Ban, D. Belhabib, S.D. Jupiter, J.N. Kittinger, S. Mangubhai, J. Scholtens, D. Gill, P. Christie, The COVID-19 pandemic, small-scale fisheries and coastal fishing communities, *Coast. Manag.* 48 (4) (2020) 336–347, <https://doi.org/10.1080/08920753.2020.1766937>.
- Ö. Bodin, B.I. Crona, Management of natural resources at the community level: exploring the role of social capital and leadership in a rural fishing community, *World Dev.* 36 (2008) 2763–2779, <https://doi.org/10.1016/j.worlddev.2007.12.002>.
- Ö. Bodin, B.I. Crona, The role of social networks in natural resource governance: what relational patterns make a difference? *Glob. Environ. Change* 19 (3) (2009) 366–374, <https://doi.org/10.1016/j.gloenvcha.2009.05.002>.
- Ö. Bodin, C. Prell, *Social Networks and Natural Resource Management: Uncovering the Social Fabric of Environmental Governance*, Cambridge University Press, Cambridge, UK, 2011, <https://doi.org/10.1017/CBO9780511894985>.
- N. Bottan, B. Hoffmann, D. Vera-Cossio, The unequal impact of the coronavirus pandemic: evidence from seventeen developing countries, *PLoS One* 15 (10) (2020), 0239797, <https://doi.org/10.1371/journal.pone.0239797>.
- CONAPESCA. 2018. Anuario Estadístico de Acuicultura y Pesca 2018. Retrieved from: ([https://www.conapesca.gob.mx/work/sites/cona/dgppe/2018/ANUARIO\\_2018.pdf](https://www.conapesca.gob.mx/work/sites/cona/dgppe/2018/ANUARIO_2018.pdf)).
- Cortés Alcalá, R., López-Gatell Ramírez, H., López Ridaura, R., Gómez Torres, R., Ricaño, X.A., Veras Godoy, M.E., Rodríguez Cabrera, L. and Herrera Castillo, N. (2021). Política Nacional de Vacunación contra el virus SARS-CoV-2, para la prevención de la COVID-19 en México. Documento rector. Gobierno de México.
- B.I. Crona, Ö. Bodin, What you know is who you know? Communication patterns among resource users as a prerequisite for co-management, *Ecol. Soc.* 11 (2) (2006) art7.
- DOF. ACUERDO por el que se da a conocer la Actualización de la Carta Nacional Pesquera. Diario Oficial de la Federación. Mexico: Diario Oficial de la Federación, 2012.
- DOF. ACUERDO por el que se da a conocer la Actualización de la Carta Nacional Pesquera. Diario Oficial de la Federación. Mexico: Diario Oficial de la Federación, 2018.
- DOF. ACUERDO por el que el Consejo de Salubridad General reconoce la epidemia de enfermedad por el virus SARS-CoV2 (COVID-19) en México, como una enfermedad grave de atención prioritaria, así como se establecen las actividades de preparación y respuesta ante dicha epidemia. Diario Oficial de la Federación. 2p, 2020.
- R.G. Ehuán Noh, R. Mariaca, A. y Sáenz-Arroyo, A. Espinoza-Tenorio, Tácticas y saberes: los capitanes de la pesca ante la variabilidad ambiental del mar, *Soc. Y. Ambient* (2020) 23, <https://doi.org/10.31840/sya.vi23.2199>.
- Eurofound and the International Labour Office Working anytime, anywhere: The effects on the world of work. Publications Office of the European Union, Luxembourg, and the International Labour Office, Geneva, 2017.
- FAO. How is COVID-19 affecting the fisheries and aquaculture food systems. Rome, Italy, 2020a. DOI: (<https://doi.org/10.4060/ca8637en>).
- FAO. Gendered impacts of COVID-19 and equitable policy responses in agriculture, food security and nutrition. Rome, Italy, 2020b. DOI: (<https://doi.org/10.4060/ca9198en>).
- Fulton, S., Hernández-Velasco, A., Suárez-Castillo, A., Fernández-Rivera Melo, F., Rojo, M., Sáenz-Arroyo, A., Weaver, A.H., Cudney-Bueno, R., Micheli, F. and Torre, J. From Fishing Fish to Fishing Data: The Role of Artisanal Fishers in Conservation and Resource Management in Mexico. MARE Publication Series, 2019.
- GSMA. The Mobile Economy in Latin America 2019. (<https://www.gsma.com/mobileeconomy/latam/>).
- IDB. Inter-American Development Bank. The IDB group in response to COVID-19 (Coronavirus), 2020. Retrieved from: (<https://www.iadb.org/en/coronavirus/current-situation-pandemic>).
- IDH-América. Pandemia y derechos Humanos en las Américas. OEA, 2020. Available at: (<https://www.scjn.gob.mx/sites/default/files/igualdad-genero/2020-04/Resolucion-1-20-es.pdf>).
- INEGI. Comunicado de prensa número 103/20, 2020. ([https://www.inegi.org.mx/contenidos/saladeprensa/boletines/2020/OtrTemEcon/ENDUTIH\\_2019.pdf](https://www.inegi.org.mx/contenidos/saladeprensa/boletines/2020/OtrTemEcon/ENDUTIH_2019.pdf)).
- P. Kaewnurachadasorn, M. Smithrithee, A. Sato, W. Wanchana, N. Tongdee, V. T. Suliit, Capturing the impacts of COVID-19 on the fisheries value chain of southeast asia, *Fish. People* 18 (2) (2020) 2–8.
- C.J. Knight, T.L.U. Burnham, E.J. Mansfield, L.B. Crowder, F. Micheli, COVID-19 reveals vulnerability of small-scale fisheries to global markets, *Lancet Planet. Health* 4 (6) (2020), e219, [https://doi.org/10.1016/S2542-5196\(20\)30128-5](https://doi.org/10.1016/S2542-5196(20)30128-5).
- D. Love, E.H. Allison, F. Asche, B. Belton, R.S. Cottrell, H.E. Froehlich, J. A. Gephart, C.C. Hicks, D.C. Little, E.M. Nussbaumer, P. Pinto da Silva, F. Poulain, A. Rubio, J.S. Stoll, M.F. Thlusty, A.L. Thorne-Lyman, M. Troell, W. Zhang, Emerging COVID-19 impacts, responses, and lessons for building resilience in the seafood system, *Glob. Food Secur.* 28 (2021), 100494, <https://doi.org/10.1016/j.gfs.2021.100494>.
- A. Marín, Adaptive capacity to coastal disasters: challenges and lessons from small-scale fishing communities in central-Southern Chile, in: S. Salas, M. Barragán-

- Paladines, R. Chuenpagdee (Eds.), *Viability and Sustainability of Small-Scale Fisheries in Latin America and The Caribbean*, vol 19, MARE Publication Series, Springer, Cham, 2019, pp. 51–78, [https://doi.org/10.1007/978-3-319-76078-0\\_3](https://doi.org/10.1007/978-3-319-76078-0_3).
- [27] D.D. Miller, Y. Ota, U.R. Sumaila, A.M. Cisneros-Montemayor, W.W.L. Cheung, Adaptation strategies to climate change in marine systems (<https://doi.org/10.1111/gcb.13829>).
- [28] M. Nicola, Z. Alsafi, C. Sohrabi, A. Kerwan, A. Al-Jabir, C. Iosifidis, M. Agha, R. Agha, The socio-economic implications of the coronavirus pandemic (COVID-19): a review, *Int. J. Surg.* 78 (2020) 185–193, <https://doi.org/10.1016/j.ijsu.2020.04.018>.
- [29] Okeyre, J., Chuku, E.O., Angnuureng, D.B., Boakye-Appiah J.K., Mills, D.J., Babanawo, R., Aheto, D.W. and Crawford, B. Physical distancing and risk of COVID-19 in small-scale fisheries: A remote sensing assessment in coastal Ghana, 2020. DOI: (<https://doi.org/10.21203/rs.3.rs-39872/v1>).
- [30] OEA. Organización de los Estados Americanos, Comisión Interamericana de Derechos Humanos (CIDH) Derechos Humanos de las Personas con COVID-19. Resolución 4/2020 Available at: (<http://www.oas.org/es/cidh/decisiones/pdf/R/esolucion-4-20-es.pdf>).
- [31] D. Revollo-Fernández, A. Aguilar-Ibarra, F. Micheli, A. Sáenz- Arroyo, Exploring the role of gender in common-pool re- source extraction: evidence from laboratory and field experiments in fisheries, *Appl. Econ. Lett.* 23 (2016) 912–920, <https://doi.org/10.1080/13504851.2015.1119786>.
- [32] S. Ramirez-Sanchez, E. Pinkerton, The impact of resource scarcity on bonding and bridging social capital: the case of fishers' information-sharing networks in Loreto, BCS, Mexico, *Ecol. Soc.* 14 (1) (2009) art22.
- [33] Solano, N., López Ercilla, I., Fernández Rivera-Melo, F.J. and Torre, J. Unveiling women's roles and inclusion in Mexican small-scale fisheries (SSF). *Frontiers in Marine Science*, article in press, accepted for publication 14 Dec 2020, 2021.
- [34] J. Sorensen, J. Echard, R. Weil, From bad to worse: the impact of COVID-19 on commercial fisheries workers, *J. Agromed.* (2020), <https://doi.org/10.1080/1059924X.2020.1815617>.
- [35] D.J. Steenberg, P.T. Neihapi, D. Koran, A. Sami, V. Malverus, R. Ephraim, N. Andrew, COVID-19 restrictions amidst cyclones and volcanoes: a rapid assessment of early impacts on livelihoods and food security in coastal communities in Vanuatu, *Mar. Policy* 121 (2020), 104199, <https://doi.org/10.1016/j.marpol.2020.104199>.
- [36] C.L. Streeter, D.F. Gillespie, Social network analysis, *J. Soc. Serv. Res.* 16 (1–2) (1993) 201–222, <https://doi.org/10.1080/1059924X.2020.1815617>.
- [37] J. Torre, A. Hernandez-Velasco, F.J. Fernández-Rivera Melo, J. Lopez, M. J. Espinosa-Romero, Women's empowerment, collective actions, and sustainable fisheries: lessons from Mexico, *Marit. Stud.* 18 (2019) 373–384, <https://doi.org/10.1007/s40152-019-00153-2>.
- [38] R.A. Turner, N.V.C. Polunin, S.M. Stead, Social networks and fishers' behavior: exploring the links between information flow and fishing success in the Northumberland lobster fishery, *Ecol. Soc.* 19 (2) (2014) art38, <https://doi.org/10.5751/ES-06456-190238>.
- [39] UN. United Nations, General Assembly "Report of the Special Rapporteur on the promotion and protection of the right to freedom of opinion and expression: Note by the Secretariat", A/HRC/35/22 (30 March 2017). Retrieved from: (<https://www.undocs.org/A/HRC/35/22>).
- [40] UN. The age of digital interdependence. Report of the UN Secretary-General's High-level Panel on Digital Cooperation. 47 p, 2019.
- [41] UNDP. Human Development Report. New York, USA, 366 Pp, 2019. Retrieved from: (<http://hdr.undp.org/sites/default/files/hdr2019.pdf>).
- [42] C.K. Whitney, N.J. Bennett, N.C. Ban, E.H. Allison, D. Armitage, J.L. Blythe, J. M. Burt, W. Cheung, E.M. Finkbeiner, M. Kaplan-Hallam, I. Perry, N.J. Turner, L. Yumagulova, Adaptive capacity: From assessment to action in coastal social-ecological systems, *Ecol. Soc.* 22 (2) (2017) art22. Retrieved January 02, 2021, from (<http://www.jstor.org/stable/26270135>).
- [43] D. Supriadi Adhuri, Research Centre for Society and Culture, Indonesian Institute of Sciences, The rapid spread of COVID-19 has introduced multiple challenges in the lives of small-scale fishers in Indonesia, *Yemaya* (61) (2020) 12–13.
- [44] FAO. Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication, Food and Agriculture Organization of the United Nations, Rome, 2015.
- [45] UN. Transforming our world: the 2030 Agenda for Sustainable Development., United Nations, 2015.

## Glossary

**BIENPESCA:** A subsidy provided by the federal Mexican government to fishers (formerly called PROPESCA), delivered annually to support fishing groups during closed seasons. Due to the COVID-19, the federal government advanced the delivery of this subsidy in 2020 and 2021. This subsidy is aimed to support fishers under a register of fisheries and aquaculture producers.

**Digital divide:** The gap between the underprivileged members of society, especially the poor, rural, indigenous, women, elderly, and handicapped portion of the population who have ready access to computers or other useful hardware, and the Internet; and those who do not.

**Fishers:** Women and men directly involved in the extraction and/or processing of fishery products.

**Personal protective measures (PPM):** actions and/or equipment that provide protection to minimize the infection risk due to COVID-19 and are implemented by the general population (e.g., hand washing; wearing facemasks; social distancing; avoiding touching the eyes, nose and mouth; and self-isolation).

**Responses:** A community action that is carried out to increase resilience of communities and the health of the oceans, which is in the process of being implemented, but has not been replicated or proven its effectiveness, and that it has the potential to become a solution.

**Small-scale fisheries:** Small-scale fisheries can be broadly characterized as a dynamic and evolving sub-sector of fisheries employing labor-intensive harvesting, processing and distribution technologies to exploit marine and inland water fishery resources. The activities of this sub-sector conducted full-time or part-time, or just seasonally, are often targeted on supplying fish and fishery products to local and domestic markets, and for subsistence consumption. Export-oriented production, however, has increased in many small-scale fisheries during the last one to two decades because of greater market integration and globalization.

**Solutions:** A product, project, or service that has been proven effective for coastal communities to adapt and be more resistant to short-term shocks and global changes. The solutions sought the resilience of the communities, without compromising the health of the oceans.