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The COVID-19 impacts and challenges to achieving sustainability in Japan’s fisheries and aquaculture

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ABSTRACT

The Japanese fisheries, aquaculture, and seafood sectors have been undergoing continuous transformation affected by economic downturns due to the new coronavirus (COVID-19) pandemic. Analyses of the COVID-19 impacts on fishery, aquaculture and seafood sectors in six sites in different parts of Japan exhibit that the impacts of the economic recession due to the pandemic differ between sectors, species, and local communities. The impacts of the COVID-19 pandemic were multiplied by other national and international policy changes as well as other factors such as fish stock depletion and the possible relocation of fish stocks due to sea water temperature change. Stagnating demand for fisheries may give incentives to reinforce conservation and introduce new schemes aimed at seafood sustainability. There can be, however, a possible driver for a vicious cycle that induces overfishing and fish price deterioration. Stakeholder ingenuity and policy innovation are required to achieve sustainable fisheries.

1. Introduction

The new corona virus (COVID-19) pandemic caused not only human health damages and casualties but also socio-economic damages across the world. The Japanese fishery sector, though it was contracting over the past decades, was supposed to be revitalized with the adoption of the Fourth Basic Act on Fishery Policy in 2017 and the Revised Fishery Act in 2018. However, since the first case of COVID-19 infection that was reported on 16 January 2020, the COVID-19 pandemic went through three waves in April and July 2020, and January 2021. The 2020 Tokyo Olympic and Paralympic was postponed to 2021, and a state of emergency was declared twice in April 2020 and January 2021 [2]. The Japanese fishery sector suffered from the socio-economical changes by the COVID-19 preventive measures. Its impacts, however, vary by the locality, fishery types and species. Many studies have already been undertaken on the impacts of COVID-19 preventive measures on ecosystem and fishery resource management around the world [4,17]. These impacts are coupled with ongoing policy changes and measures need to be reinforced to enhance the sustainability of fisheries management [5,8].

I assess the COVID-19 impacts on fishery, aquaculture and seafood sectors by examining six sites in different parts of Japan. This article presents the outcome of analysis on the COVID-19 preventive measures and socio-economic impacts on the fishery and aquaculture sector in Japan. The narratives are also supplemented based on the interviews with stakeholders on their views on the impacts of the COVID-19 preventive measures and as well as the effects of concurrent policy changes that are also affecting the Japan’s fishery sector. Building upon the outcome of data and interview analysis, perspectives are presented on the key aspects for promoting sustainable fisheries and aquaculture in Japan that continues to struggle with the recurring COVID-19 pandemic and needs to find a way to revitalize and promote sustainable fisheries and aquaculture.

2. Method

First, the data was collected and analyzed to comprehend the recent trend and impacts caused by the COVID-19 preventive measures on Japan’s fisheries and aquaculture sector and seafood market. Then, in order to understand the local variance, the data was collected and analyzed on the fisheries and aquaculture for the 6 sites in Japan (Fig. 1). Sites were chosen based on the collaboration that was developed for the research work on the promotion of sustainable blue economies. In the sites, fisheries and aquaculture are a vital sector in the local economy and dedicated fishermen and entrepreneurs work toward achieving sustainable fisheries and aquaculture and experiment with innovative measures and promote social partnership while struggling to

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overcome challenges. The data was collected from the information domain of respective sites that are accessible to the public. Interviews were conducted over the phone from April to November 2020 in the light of the inability to travel due to the COVID-19 preventive measures. In analyzing the site specific data, consideration was given to the changes in fisheries and aquaculture particular to the year of 2020 attributable at COVID-19 preventive measures, and other factors that have affected fisheries and aquaculture per site. In developing narratives based on the outcome of interviews with stakeholders, attempts were made to further elucidate the outcome of data analysis, the factors that drove changed or helped stabilizing fisheries and aquaculture, and any other relevant aspects that were deemed as vital to promote sustainable fisheries and aquaculture. Syntheses were also contemplated to draw commonalities and to identify local peculiarities. Building upon these analyses and syntheses, perspectives are presented on key aspects to facilitate the entry of new fishermen and enterprises in the fishery sector while articulating the intent of establishing sustainable fisheries and aquaculture.

3. Results

3.1. Overall trend and impacts on the Japanese fisheries and aquaculture

Seafood is an important source of food supply and constitutes culinary culture in Japan. Domestic fisheries and aquaculture production provide about half of the seafood supply in Japan while the other half is supplied by imports (Table 1). The domestic seafood consumption declined by 23 per cent for the 2007–2017 period while the domestic production fell by 25 per cent. It is promoted by an entrenched shift in the Japanese diet from seafood to meat as the Japanese seafood consumption per capita declined from 28.1 kg per capita and annum in 1965 to 23.9 kg in 2017 and was surpassed by meat consumption in 2007 (Fig. 2). In contrary to the growing seafood consumption at the global level, the Japanese fishery sector faces a spiral of the declining seafood demand and the consequent stagnation of fishermen’s revenue. As a result, there is a concern over the marginalization of fishery communities particularly in rural areas. To reverse such a trend and

| Table 1 | Seafood supply in Japan (2007 and 2017). |
|---------|-------------------|
|          | 2007  | 2017  | Change rate |
| Domestic production (kt) | 5100  | 3830  | -0.25       |
| Import (kt) | 5160  | 4090  | -0.21       |
| Consumption (kt) | 9550  | 7370  | -0.23       |
| Food | 7270  | 5760  | -0.21       |
| Non-food | 2280  | 1620  | -0.29       |
| Export (kt) | 820   | 660   | -0.20       |
| Domestic production/Consumption | 0.53  | 0.52  | 1.09        |

(kt) indicates thousand ton

Developed by the author based on the data contained in the White Paper 2018 by the Ministry of Agriculture, Forestry and Fishery, Japan (in Japanese) https://www.jfa.maff.go.jp/j/kikaku/wpaper/h30/index.html.

revitalize Japanese fisheries, the Government of Japan has adopted the Fourth Basic Plan on Fishery Policy in April 2017 that set out the objectives of enhancing fisheries productivity and the income of fishermen; appropriate management of fisheries resources and habitats, and the promotion of multiple functions of the fisheries sector.

In 2020 the seafood market in Tokyo exhibited the impacts of COVID-19 preventive measures on the seafood sector. The relationship between the fishery commodity trade and COVID-19 preventive measures, reflects the propagation of COVID-19 and the development of preventive measures in Japan. The first COVID-19 case in Japan was detected on 16 January 2020, and infections rose to 708 hitting a peak of the first wave with 81 death toll on 8 April 2020 (13). The emergency declaration was announced on 7 April for the 7 major prefectures that was extended to the entire country on 16 April 2020. Restaurants and hotels were largely closed while the declaration was in effect. The number of infections had then declined thereafter. On 14 May, a month after the declaration was made, it was lifted for 39 prefectures and for the entire country on 25 May 2020. The second surge came in the summer marking a peak with 1574 daily new infections cases on 31 July. The cumulative total death toll reached 916. The state of emergency was not made this time though precautionary measures were encouraged. The number of infectious cases declined to 271 on 5 October 2020 and continued to fluctuate for a while. The number of infection cases resurfaced toward the end of the year and entered a third wave recording 7844 new infection cases on 8 January 2021 with the total death toll of 3931. The Government announced a second state of emergency declaration effective from 8 January 2021 for 4 prefectures and was extended to cover an additional 7 prefectures from 14 January

Fig. 1. The location of studies areas in Japan.

Fig. 2. Ratio of seafood and meat consumption per capita in Japan (1965–2018). Developed by the author from the data provided by the Ministry of Internal Affairs and Communications, https://www.e-stat.go.jp.
2021.

The socio-economic havoc was tremendous already in the first half of 2020 as the postponement of the 2020 Tokyo Olympics and Paralympics caused an enormous reaction from the Japanese economy. The suspension of international flights and inbound tourism caused impacts detrimental to the service sector. Business and school trips, dining gatherings and ceremonial events were canceled or curtailed in 2020. The socio-economic damage by the preventive measures against COVID-19 inevitably affected the fishery sector around the time of announcing the first state of emergency declaration in April 2020 [9]. Reduced seafood trade persisted throughout the year of 2020, though there are variations depending on the types of seafood.

The data of the Tokyo Metropolitan Central Wholesale Market includes the three seafood markets namely, Toyosu, Adachi, and Ohta, exhibit the market response from the COVID-19 preventive measures. The total weight of traded fishery commodity was highest at 37.6 thousand tons in December 2019 with a value of JPY 50.5 billion (US $460.8 million).

After this the weight fluctuated, but it decreased notably in the month of April to May and August 2020 when the declared state of emergency was in effect and the 2nd wave hit the country (Fig. 3). When the traded weight declined, so did the value of fish commodities traded. Nonetheless, the traded value declined more than the traded weight when the data was compared with the same month in 2019 (Fig. 4). The percentage reduction was the greatest in April 2020 in comparison to the data for the same month in 2019 and 2020. The traded weight fell by 15.1 per cent while the traded value fell by 34.6 per cent. The traded value per weight unit (JPY/kg) fell by 22.9 per cent. The value per weight remained in a negative trend throughout the year 2020 and it indicates that the fishery commodity was traded for less value per weight in 2020 compared to 2019.

Further analysis was conducted on the change of fishery commodity trade based by the type of fishery commodity (Table 2). In comparison of the trade weight in 2020 with 2019, live fish fell by 59 per cent with the largest reduction rate among 7 types of fishery commodity followed by clams (49.4 per cent). On the other hand, processed seafood declined by 1.5 per cent with the smallest reduction. In terms of the trade value, like the trade weight, live fish declined with the largest margin of 69.0 per cent followed by clams (55.8 per cent). Seaweed had the smallest reduction (15.5 per cent) followed by processed seafood (19.9 per cent). In terms of the trade value per weight unit (JPY/kg), fresh fish declined most by 25.7 per cent followed by live fish (25.2 per cent). Seaweed actually showed the positive figures with a 7.9 per cent increase. The consistent decline in the traded value per weight indicates that fishery commodities are prone to a sudden decrease in seafood trade partly due to the nature of these fishery commodities that they are perishable and difficult to store for a long time period. Luxury fishery commodities served for banquets and ceremonies are red snapper, lobsters, abalone and clams. It can be also argued that the reduction of fish catch wasn’t implemented swiftly to sustain the reasonable value per weight unit or there could be an entrenched inclination to catch and trade fish commodity irrespective of failing prices due to the need to secure a minimum revenue to cover the fixed cost of fishing operations.

There is, however, a difference in the month of November. The change rate was less for the month of November compared to the month of April. The reduction rates of the traded weight in the month of November were less than those of April for all types of fishery commodity. The change rate of the traded value remained negative for all types of fishery commodity, but with a small margin compared to the month of April. The value per unit weight improved for all types of fishery commodity for the month of November. Seaweed and processed seafood showed the increase in the month of November 2020 compared to the November 2019. It may be due to the improvement in the demand to fishery commodity though there continued to be difficulty in managing the supply of live fish commodity vis-a-vis the market demand.

There may also have been a change in the patterns of fishery commodity imports in Japan in 2020. USA exported fishery commodity to Japan at the highest value of JPY 1.6 billion (US $15.0 million) in 2019 followed by China, Canada, Thailand, and Australia (Table 4). Italy increased its fishery commodity export by 144 per cent for the 2015–2019 period, the largest growth rate of the top 10 fishery commodity exporting countries to Japan followed by the Republic of Korea (24.3 per cent) and Viet Nam (14.1 per cent).

With respect to the tuna import, Taiwan exported most for the period from October 2019 – October 2020 with the cumulative weight of 64.2 thousand tons followed by Indonesia, China, Republic of Korea, and Seychelle (Table 5). To compare the monthly weight of tuna imports to Japan, Taiwan increased its tuna export to Japan at an increase rate (24.3 per cent) followed by China (22.7 per cent), Seychelles (18.9 per cent), Mexico (10.5 per cent) and the Republic of Korea (8.3 per cent). On the other hand, there was a large proportion of reductions in the tuna import from the Philippines (−85.4 per cent), Kiribati (−68.9 per cent), Indonesia (−68.6 per cent), Belize (−64.5 per cent), Vietnam (−52.1 per cent), and Micronesia (−50.0 per cent). It could be due to the combination of disruptions in the maritime transport and the decreased demand in the Japanese markets. Geographic proximity doesn’t offer an explanation to the change in the pattern of tuna import and further

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Fig. 3. Weight of fish and seafood traded at the Tokyo central markets (2019–2020). Developed by the author based on the data provided by the Tokyo Metropolitan Central Wholesale Market, [https://www.shijou.metro.tokyo.lg.jp/torihiki/geppo/](https://www.shijou.metro.tokyo.lg.jp/torihiki/geppo/).

Fig. 4. Change rate of weight, value and value per weight of fishery commodity traded in the Tokyo Central Market (2019–2020). Developed by the author based on the data provided by the Tokyo Metropolitan Central Wholesale Market, [https://www.shijou.metro.tokyo.lg.jp/torihiki/geppo/](https://www.shijou.metro.tokyo.lg.jp/torihiki/geppo/).

1 Data was not available for the month of December 2020. Thus, no comparison was made for the month of December.
With respect to the import of shrimps to Japan, there was an overall reduction in the shrimp import to Japan by 12.9 per cent in October 2020 compared to the import weight in October, 2019 (Table 6). For a large shrimp exporter, Indonesia sustained its shrimp export to Japan with 1.3 per cent increase in October 2020 compared to October, 2019. There was a marginal reduction in the shrimp imports from India (~6.9 per cent) and Viet Nam (~9.5 per cent). On the other hand, shrimp imports from Thailand were reduced by 29.5 per cent. Shrimp imports from the Philippines were also reduced by 69.8 per cent. There can be factors other than geographic proximity that have affected shrimp import such as the socio-economic conditions in exporting countries. The level of COVID-19 infection and preventive measures in exporting countries might have played a role in restraining shrimp exports to Japan. Future developments and the implication of any changes in the monitoring is required to assess the impact of COVID-19 preventive measures on the tuna import to Japan.

Developed by the author from the data provided by the Tokyo Metropolitan Central Wholesale Market, https://www.shijou.metro.tokyo.lg.jp/torihiki/geppo/.

Developed by the author from the data provided by the Ministry of Agriculture, Forestry and Fishery, Japan, 2000. State of import and export in agriculture, forestry and fishery commodity 2019. https://www.e-stat.go.jp.

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tourists have started recovering, up to 47.7 per cent, less than 20 per cent and 5.3 per cent of the same month in 2019 (Fig. 5). The comparison of shrimp imports to Japan in October 2019 and 2020. M. Kobayashi

Table 6
Comparison of shrimp imports to Japan in October 2019 and 2020.

|          | Oct.2019 (kg) | Oct. 2020 (kg) | Change rate Oct.2019 and Oct.2020 (%) |
|----------|--------------|---------------|--------------------------------------|
| World    | 1,73,87,806  | 1,51,52,858   | -12.9 %                              |
| India    | 44,51,312    | 41,43,825     | -6.9 %                               |
| Vietnam  | 33,13,875    | 29,98,381     | -9.5 %                               |
| Argentina| 25,79,925    | 18,43,096     | -28.6 %                              |
| Indonesia| 19,72,394    | 19,98,572     | 1.3 %                                |
| Thailand | 12,44,533    | 8,77,556      | -29.5 %                              |
| China    | 5,76,695     | 5,04,003      | -12.6 %                              |
| Canada   | 5,45,023     | 4,27,352      | -21.6 %                              |
| Russia   | 4,27,983     | 4,29,730      | 0.4 %                                |
| Myanmar  | 3,99,901     | 2,55,689      | -36.1 %                              |
| Philippines| 2,79,728 | 84,585        | -69.8 %                              |
| Australia| 2,64,737     | 2,27,385      | -14.1 %                              |
| Malaysia | 1,90,006     | 1,46,356      | -22.0 %                              |
| Greenland (Denmark) | 1,70,065 | 1,51,122      | -11.1 %                              |
| Pakistan | 1,54,231     | 2,92,143      | 89.4 %                               |
| Ecuador  | 1,14,801     | 1,45,788      | 27.0 %                               |
| Peru     | 90,028       | 1,09,382      | 21.5 %                               |
| Honduras | 88,966       | 37,003        | -58.4 %                              |
| Mexico   | 80,770       | 1,05,000      | 30.0 %                               |
| Sri Lanka| 75,963       | 62,589        | -17.6 %                              |
| Taiwan   | 71,993       | 29,866        | -58.5 %                              |
| Papua New Guinea | 70,350 | 85,948        | 21.8 %                               |

Developed by the author from the data provided by the Ministry of Agriculture, Forestry and Fishery, Japan, 2000. State of import and export in agriculture, forestry and fishery commodity 2019. https://www.e-stat.go.jp.

trade patterns, in the light of the 2019 and 2020 experience, need to be monitored and assessed.

3.2. Naha, Okinawa

Okinawa Prefecture is located in southwest Japan that consists of 160 islands in the semi-tropical climate. The total population of Okinawa Prefecture is 1.46 million of which 73.9 per cent live in Okinawa Island. Its economy is largely based on the tertiary sector (e.g., service sector) that constitutes over 80 per cent of economic production in Okinawa Prefecture. The primary sector produce contributes 1.5 per cent of the Palau EEZ [14]. There was already an anticipation that it would be more difficult than before for the longline fishermen to find targeted fish in enclosed areas.

There is also another requirement for the longline fishermen to follow. Under the conservation measures of the Western and Central Pacific Fisheries Commission (WCPFC) adopted in 2014 and that came into effect in 2015, that set the total catch of bluefin tuna at 8889 tons per annum, the Fishery Agency of Japan enforces bluefin catch quotas directly to the long liners and purse seiners and through prefectoral

Fig. 5. Tourist numbers in Okinawa (2016–2020). Developed by the author based on the data provided by the Okinawa Prefecture Government, https://www.pref.okinawa.jp/site/banka-sports/kankoseisaku/kikaku/statistics/tourists/documents/t2-11geppou.xlsx.

Fig. 6. Change rate of weight, value and value per unit weight of fishery commodities traded in Tomari Fish Market, Naha, Okinawa (2019–2020). Developed by the author based on the information provided by the Okinawa Prefecture’s Fishery Promotion Fund, http://www.okinawa-fish.jp/.
governments to coastal fishermen. OTEC has an allocation of 50 tons for 2020 from the Fishery Agency. The National Tuna Fisheries Association set a voluntary precautionary quota of 45 tons, 10 per cent less than 50 tons official quota. OTEC had to communicate the catch suspension order to the fishing vessels on 10 May 2020, just after when long liners started reporting an increase in bluefin tuna catches. Occasionally, there were additional allocation of quotas after the transmission of catch suspension order. However, after the suspension of the fishing operations, it is difficult to resume fishing due to a great deal of logistic works on board. The stagnant market demand due to the COVID-19 pandemic, the long dormant period prior to fish catch, an increasing need to adjust to new regulations by the partner country, the pressures to comply with the multilateral fishery agreements, and the paradox of fish catches and catch suspension orders all play in laying out challenges to fisheries in Okinawa.

3.3. Oyster farming in Rikuzentakata, Iwate

Rikuzentakata city, Iwate Prefecture is located in Northeast of Japan. It was devastated by the 2011 Great East Japan Disaster including the fisheries sector [10]. While the number of aquaculture fishermen plummeted to about a third of the pre-disaster level, some fishermen facilitated the reconstruction of aquaculture to farm oysters and seaweed. Oyster production and sales had resumed in 2013, and the production level recovered gradually and reached the pre-disaster levels in 2017 in terms of shelled oysters (Fig. 9). For the 2017–2019 period, the production of shelled oysters grew by 16.2 per cent. Maruten, an oyster farming enterprise in Hirota Bay, Rikuzentakata, invested in installing sea water depuration and a sterilization facility in order to boost the sales of shelled oysters for raw consumption in major markets in Tokyo and Kyoto. Maruten increased direct sales to restaurants in major cities while paying fees of its affiliation with the Hiroya Bay Fishery Association. As Maruten explored the sales to the high end restaurants, the closure of restaurants and hotels due to COVID-19 preventive measures reduced the Maruten’s sales to 20 per cent of the previous year. Maruten started making efforts to diversity the buyers of oysters including other restaurants and individuals. The understaff of sales persons and the limited use of information and communication technologies hindered such efforts. Maruten has 14 employees, and the fixed cost of employment and maintaining boats and depuration facilities remain unchanged. The prolonged COVID-19 impacts on the seafood market would further aggravate its operation and management.

On the other hand, a representative of Maruten points out other factors that also raise a concern on the productivity of oysters and seaweed; its major aquaculture commodity. While the production level continued to rise up until the beginning of 2020, the marginal profit of oyster production had been stagnant in recent years. The revenue per unit of shelled oysters was rising until 2015, but then started reducing and becoming stagnant since then. While the total production weight and value remain a priority interest, profitability or the production value per unit is also a useful indicator. Increasing the value of the oyster product is essential and it is vital to sustain a healthy ocean and the marine environment in addition to marketing strategies.

In this respect, there is a concern over the declining production of seaweed in Hirota Bay. This can be an indication to the changes in the marine environment such as the sea water temperature increase. Seaweed production was quickly resumed right after the 2011 disaster and the production weight in 2012 was more than double than the 2010 production weight (Fig. 10). However, production started declining...
since 2012 and it was 526.6 ton in 2018, the lowest for the past years and lower than the 2011 production level. There was a report that indicates the increase of temperature in Hirota Bay in the summer 2020 that was 3.2 degree higher than the past years. So far, no significant adverse impacts of rising sea water temperature on oyster farming are reported. However, a reduction in seaweed growth and production can be a biomarker to show degradation in marine productivity or environment that would hinder seaweed and possibly other local aquaculture. There is a looming concern that the sea water temperature rising sea water temperatures rise may pose a long term adverse impacts may have long-term adverse impacts on local aquaculture.

3.4. Oyster farming in Minamisanriku, Miyagi

Minamisanriku-town, Miyagi prefecture is located in northeast of Japan and 54 km south of Rikuzentakata. Minamisanriku town was devastated by the 2011 Great East Japan disaster. The local oyster farming aquaculture facilities were all swept away. There were 2400 oyster farmers working prior to the disaster, the number failing to 1400 after the disaster [6]. The Tokura Division of the Minamisanriku Fishery Cooperatives strived to restore oyster farming, but not to the pre-disaster level, but to the one third of the pre-disaster level. Prior to the disaster, there was a concern over the deteriorating marine environment due to the excessively dense oyster farming. After the disaster, WWF (World Wide Fund for Nature) Japan and local experts collaborated with local oyster farmers in assessing the marine environment. Then thereafter, local oyster farmers agreed to pursue an alternative path for sustainable aquaculture. Many oyster farmers, particularly elderly ones whose children sought career different from oyster farming abandoned oyster farming after the disaster. The total number of oyster farming entities declined from 78 in 2010–34 in 2012 less than half of the pre-disaster level. Oyster farmers agreed not to aim at restoring the 3000 oyster farming rafts that was level in 2010 prior to the disaster but instead to strive to restore 1000 oyster farming rafts, one third of the pre-disaster level. With the reduction in the density of oyster farming rafts, oysters that used to take 2–3 years to get matured grow fast and ready for harvest in only one year. As a result, despite the production capacity being lowered to one third of the pre-disaster level, the production weight per entity doubled from 1790 kg in 2010–3545 kg in 2017, an increase rate of 98.0 per cent, and the production value increased from JPY 3380 in 2010 to JPY 5009 in 2017 per entity, an increase of 48.2 per cent. Oyster farmers then started a process in 2014 to apply for an Aquaculture Sustainability Council certificate and received it in 2016 [1]. Local stakeholders further collaborated in having Shizuagawa Bay listed in the Ramsar Convention in 2018 on the ground of diverse marine biodiversity particularly kelp and its significance as a habitat for myriad migratory bird species [16].

Director of the Tokura Division, Minamisanriku Fishery Cooperative explained in the interviews in April and May 2020 that it is not possible to claim any price premium in connection with the acquisition of the ASC certificate. However, a large food retailer has become a partner to procure their ASC certified oysters on a long-and-stable basis. Prior to 2016, there used to be price erosion toward the end of the harvesting season. Buyers often tried to procure oysters at lower prices. However, after the acquisition of ASC in 2016 and the establishment of a stable and long-term procurement contract with a large food retailer, such price erosion no longer happens. This is a positive economic return from the acquisition of the ASC certificate.

As their ASC certified oysters were well integrated in the stable and long-term food supply chain, the COVID-19 preventive measures did not cause much reduction in the price or revenue. The end buyers of their products through the retailers are individual household consumers. Thus, the restaurants and hotel closure did not affect the sales of their product. Concerns were more with the health condition of oyster processing facilities. Their oyster products are sold mainly as shucked oysters. There are workers who shuck oysters and the COVID-19 infections, particularly in a cluster could hinder the shucked oyster production. The embeddedness of shucked oysters in the daily retail supply chain functioned as a safeguard against the COVID-19 pandemic economic downturns.

3.5. Abalone farming in Ofunato, Iwate

Abalone is one of the epicurean delicacies in Japan that is popular in high-end restaurants and Japanese hot spring inns. Due to the limited and declining supply of natural catch, abalone aquaculture farming has been attempted in Japan. Kitanihon Suisan, an aquaculture farming enterprise in Ofunato, Iwate Prefecture, promotes abalone farming on coastal land using seawater. By investing in installing seawater sterilization facilities, its product is considered as hygienic and savory. However, the COVID-19 preventive measures reduced demand for its abalone products sharply. The sales volumes had plummeted to 20 per cent in April 2020 compared to the same month in 2019. It exports abalone to Hong Kong, Bangkok and Manila. However, export markets were also disrupted due to the suspension of international freight transport due to the airport and sea port closures as COVID-19 preventive measures at the international level. At the Toyosu Wholesale Market in Tokyo, the traded weight of abalone declined in April 2020 by 66.4 per cent compared to April 2019 (Fig. 11). The value plummeted by 72.8 per cent in April 2020 compared to April 2019. The value per weight also declined by 19.1 per cent in April 2020 compared to April 2019. Although the trade in abalone started recovering, the weight and value of abalone trades at the Toyosu Market was still 15 per cent less in October 2020 compared to October 2019. The trade volume improved in November 2020 getting close to the level of November 2019. Nonetheless, the prolonged or recurring implementation of COVID-19 preventive measures would further exacerbate the operation of abalone aquaculture enterprises. Online sales were launched by the Toyosu Wholesale Market in May 2020 although their impacts are deemed as limited.

3.6. Okinoerabu Island, Kagoshima

Okinoerabu Island, in the Kagoshima Prefecture, is located in southwest Japan; it is a remote island with a land area of 93.7 km² and 13 000 population. There are 255 fishermen engaged in fishery and 30 per cent of their fish catch is consumed in the island, while the rest is sold to Okinawa and other outer markets [7]. The number of tourists to the island is in a range of 80 000–86 000 per annum stopped arriving and its umber went down to zero in mid-February 2020 due to the

Fig. 11. Change in abalone trade in 2020 compared to 2019 at the Toyosu Wholesale Market, Tokyo. Developed by the author based on the data provided by the Tokyo Metropolitan Central Wholesale Market, https://www.shijou.metro.tokyo.jp/torihtki/gesppo/.

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2 Interviews were conducted with Mr. Kiyohiro, Goto, Director of the Tokura Division, Minamisanriku Fishery Cooperative, Miyagi Prefecture.
COVID-19 preventive measures. As a result, the demand to the seafood in the islands plummeted and fishermen suffered a significant loss of revenue. A representative from the Okinoerabu Island Fishery Cooperative explained in the interview in April 2020 that they have explored a number of measures to sustain the sales of their fish catch. However, none of the measures turned to be feasible due to the geographic remoteness to the major market and the lack of fast and low temperature refrigerating facilities. As they handle fresh fish, an expeditious transport system is indispensable. Airflight services were suspended to COVID-19 preventive measures, so air freight options were unavailable. They just have standard refrigerating facilities but do not have fast and low temperature refrigerating facilities that can achieve ~35°C promptly. As the fish price goes down, the revenue for the fishermen also declines. As a result, there are some fishermen who try to fulfill the loss of revenue by trying to capture more fish; that further reduces fish price. There can be a viscous cycle of stagnant fish sales, lowering prices, attempting to catch extra fish to fill the revenue loss, and a subsequential price decline. The representatives underlined that sustainable fish stock management appears to be very important and needs to be reinforced collectively.

The representative also stated that local fishermen were facing a lingering decline in fish catch over the past years. For instance, squid was a major fish commodity in Okinoerabu in the past, but the squid catch was declining in recent years. Its causes have been investigated by the Kagoshima Prefectural Government and experts. However, clear cut findings have not yet been presented. Suspected causes are possible overfishing by the fishermen of neighboring countries and the presumed relocation of squid habitat due to the sea water temperature changes. Squid catch in Kagoshima Prefecture declined from 1294 tons in 2012–447 tons in 2019—a reduction of 65.5 per cent (Fig. 12). The trend of a declining fish catch was already present as a significant challenge to local fishermen when the COVID-19 impacts further aggravated market situations and the local fishermen had little maneuvering capability of coping with COVID-19 impacts.

Developed by the author based on the data provided by the Kyushu Agricultural Policy Bureau, https://www.maff.go.jp/kyusyu/toukei/hensyu/65senpou.html#gyosankou.

3.7. Seagrape aquaculture in Onnason, Okinawa

Onnason village is located in the center-west of Okinawa Island. Onnason village extends to cover 50.8 km² with 11 200 population. It is a popular tourist destination. 2.8 million tourists stay in Okinoerabu village per annum. The Onnason village government promote coral reef conservation by declaring that Onnason village is a village of coral on July 28, 2018 [15]. There is a unique development of social partnership to promote coral reef conservation and restoration among stakeholders including fishermen. Mozuku seaweed is a type of seaweed that grows naturally and farmed in Okinawa. Its aquaculture farming was contemplated in 1973 and now Okinawa Prefecture produces over 90 per cent of the total mozuku seaweed production in Japan. Mozuku seaweed contains fucoxidain, a nutrient that has anti-tumor effects. It is also suggested that mozuku seaweed consumption may have correlation with the longevity of people in Okinawa. Another sea plant framed in Okinawa is sea grape. It had distinctive texture as little bubbles burst in the mouth and has vitamins and mineral nutritional properties.

The social partnership was triggered at the time when there were coral bleaching phenomena in 1998 and 2001 and local fishermen started the experimentation of coral aquaculture by collecting and growing pieces of corals and transplant-grown corals in the sea. The consumer cooperatives and retailers joined such efforts by establishing a Mozuku Seaweed Fund and contribute 0.2 per cent of the sales value to the fund. Funding was provided from the fund to support coral aquaculture and transplantation [18]. Mozuku aquaculture farmers could make their expertise available to support the restoration of corals that were devastated by bleaching in the past and remain susceptible to sea water temperature rise. The efforts mobilized to conserve and replicate corals have attracted more public attention to the need to maintain the healthy ocean environment including the prevention of red soil intrusion and sedimentation that are detrimental to corals, but also mozuku seaweed and seagrape aquaculture. Coral health can also be also be a biomarker to assess the sea water conditions vital for mozuku seaweed and seagrape aquaculture. Tourists visit Onnason village to enjoy viewing corals and they buy mozuku seaweed and seagrape as souvenirs as well. The Mozuku Seaweed Fund helps enhancing the corporate identity of food retailers to support the marine environment. There are mutual benefits in promoting social collaboration among aquaculture farmers, dive shops and food retailers towards conserving and restoring corals.

Seagrape is farmed in Onnason village and marketed by the Onnason Village Fisheries Cooperative directly to local restaurants and souvenir shops in Okinawa and a market in Tokyo without channeling their products through major markets in Okinawa. Aquaculture farming facilities concentrate in Onnason village. Seagrape is perishable and needs to be sold swiftly. Seagrape is not a food that locals eat frequently as it is slightly pricy and rather popular with tourists. Seagrape production in Okinawa as a whole grew by 3 times in the 2006–2014 period (Fig. 13) but has since, stagnated. In 2020, tourists did not come to Okinawa village in the summer and seagrape did not sell well and the Onnason village fisheries cooperative requested aquaculture farmers to reduce their production as surplus seagrape that is perishable had to be disposed as waste. Seagrape needs to be stored not in a refrigerator but in the right temperature in a range of 20–23°C, and not above 27°C and not below 15°C. Thus, selling seagrape to the market outside of

![Fig. 12. Squid catch in Kagoshima Prefecture, Japan (2012–2019).](image-url)

![Fig. 13. Aquaculture production of mozuku seaweed and seagrape in Okinawa Prefecture (2006–2018).](image-url)

Note: Data for seagrape in 2020 is not available.
Okinawa isn’t a feasible option as the temperature management becomes costly, except the spring or autumn time when the air temperature can be suitable for transporting seagrape. However, as airflight services were substantially reduced in 2020, it was not possible to depend on air transport services. As the Onnason Village Fisheries Cooperative instructed aquaculture farmers to reduce their production, the total production of seagrape by the Onnason Village Fisheries Cooperative declined from 28 ton to 16 ton by 42.9 per cent. The sales value of seagrape by the Onna Village Fisheries Cooperative fell from JPY 82.2 million in 2019 to JPY 43.0 million in 2020 with a 47.7 per cent reduction. The sales of seagrape that depend on the consumption by the tourists to visit Okinawa fell sharply in 2020. In light of continuing COVID-19 preventive measures in the first quarter of 2021, a representative of the Onnason Village Cooperative explained that there is no choice but remain with the reduced production and to wait for the reduction in COVID-19 infection cases and the normalization of tourism.

On the other hand, the market conditions for mozuku seaweed did not exhibit adverse impact of COVID-19 preventive measures in 2020. The production of mozuku seaweed increased to 22.9 ton in 2020 with an increase of 39.7 per cent compared to 2019 (Fig. 13). It was a sharp recovery from 2019 when production fell by 25.0 per cent compared to 2018 presumably due to the seawater temperature warming. In 2020, seawater temperature was relatively stable, and red soil intrusion and sedimentation did not adversely affect mozuku seaweed production. In Tokyo, mozuku seaweed trade declined in 2020 from 2019 by 6.2 per cent in weight and 5.3 per cent in value (Fig. 14). This reduction could be considered as modest compared to other fishery commodities that had more significant reductions in 2020 compared to 2019.

A representative of the Okinawa Prefecture Mozuku Seaweed Aquaculture Promotion Council explained that a part of the excessive volume of mozuku seaweed to avoid the fall in the price in 2020. The retailers procured mozuku seaweed in 2020 at the price level of 2019 when there was a shortage in mozuku seaweed supply. The retailers were not able to sell mozuku seaweed stored.

In the refrigerator storage and the retailers indicate their difficulties in offering competitive procurement price in 2021 on the ground of the excessive seaweed stock from 2020. Restaurants and hotel closures have been negatively impacting the demand for mozuku seaweed and the volume of mozuku seaweed in the refrigerating store became rarely changed in 2020. Thus, hardship may hit the mozuku seaweed market in 2021 unless there can be a swift recovery in the demand of mozuku seaweed. Retailers could manage the potential adverse impacts of COVID-19 preventive measures for a short term and there is a time lag between the COVID-19 related market austerity and market trade, and further development needs to be examined in 2021 as an aftershock of the 2020 economic downturns.

4. Discussions

COVID-19 has been inflicting unprecedented hardships on many aspects of the international community, the Japanese fishery sector is not an exception. Fishery commodity and seafood trade suffered significant reductions, but this review has shown that the impacts and responses by the industry differ by the species of fishery commodity and the locality of the market. As COVID-19 may continue to impair economies and fisheries, it may appear to be vital to develop effective responses and resilience to the COVID-19 impacts. It deems that the following aspects deserve further attention in policy, market development and future research.

(i) Embedding commodity and seafood in the daily supply chain

As the demand for the seafood remains to be stable in a wider spatial scale, it appears to be useful to consider integrating fishery commodities and seafood into the daily supply chain of seafood trade. As luxury hotels and restaurants may remain closed at least for the first quarter of 2021, it is essential to reach out to the individual consumers. An attempt can lower the vulnerability of fishery commodity and seafood to the external shocks such as COVID-19 and increase their resilience.

(ii) Diversifying marketing channels

Aquaculture farmers in Rikuzentakata and Ofunato strive to explore online marketing channels as the conventional supply chains have faced the entrenched demand contraction. Diversifying marketing channels provide a risk hedge when a major marketing channel faces external shocks. Regular and repeated customers need to be cultivated and secured in the new and additional marketing channels.

(iii) Multiplying fishery and aquaculture commodities

There are various responses to different commodities in the seafood market. In Okinawa, seagrape was instantly hit by the suspension of tourism while mozuku seaweed remained resilient in 2020 although it may face hardship in 2021. At least, such a time lag can help farmers deal with the market hardship and diversification of fishery and aquaculture commodities.

(iv) Value addition measures

In Minamisanriku, a ASC certificate has given the oyster farmers a long term and stable procurement channels that assure the minimum price and avoids the price erosion that used to happen toward the end of the harvest season. To some extent, partnership developed for coral conservation in Onnason village expands marketing channels and promotes producer-retailer-consumer relationship. Pecuniary and non-pecuniary values need to be explored to market fishery commodities and seafood in a better term for a wide market.

(v) Sustainable fisheries management

Declining fish stock can devastate the fisheries sector particularly at the time of external shocks such as COVID-19. Sustainable fisheries management will ensure a basis for maintaining the income level and an ability to cope with external shocks. The changes in fish stocks can be caused by multiple factors that also require further monitoring, examination and responses.

(vi) Mitigation of climate change and marine environment changes

Seawater temperature changes seems to be one of the emerging threats to aquaculture farming in Rikuzentakata and Okinawa. Red soil intrusion and sedimentation are a threat to mozuku seaweed aquaculture. Monitoring climate and marine environmental conditions need to be continued. Data sharing should also be promoted to link such monitoring data with fisheries and aquaculture with a view to inventing measures to prevent causes and mitigate adverse impacts of sea water temperature increase and marine environment.
(vii) Further research on the impacts of COVID-19 public health measures on the fisheries and aquaculture sector

There are some other aspects that deserve further examination and articulation such as the impacts of COVID-19 preventive measures on the international trade of fishery and aquaculture commodities. The supply chains have been affected by the suspension of international transportation by air and sea. The level of preventive measures implementation might have affected the international trade flows of fishery and aquaculture commodities. Adjustments need to be made swiftly as soon as the COVID-19 preventive measures are reduced or lifted in order to restrain any adverse impacts on the fishermen and aquaculture farmers who depend on international markets.

5. Conclusions

The covid 19 crisis has created immediate issues to sustain revenue in the stagnant markets affected by the pandemic. At the same time, it also revealed compound longer term issues such as fish catch declines. There are a variety of recommendations made to address these issues which vary by region, species and sector nationally. The international community needs to overcome the COVID-19 pandemic and must sustain the livelihood of fishermen and aquaculture farmers who supply an important food source for the people at home and overseas. The COVID-19 pandemic must not deprive them of the important foundations for their livelihoods and the systems to supply food for the people. Fisheries and aquaculture are also closely linked with regional areas and local cultures. All need to be sustained and passed on to future generations in a sustainable manner. The COVID-19 pandemic must not be used as a pretext for leaving fisheries and aquaculture to ail. Instead, all the stakeholders need to amalgamate their efforts to overcome the COVID-19 pandemic and turn fisheries and aquaculture into more sustainable food production, natural resource management and livelihood improvement with the ingenuity and compassion of the people around the world who value sustainable fisheries and aquaculture.

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