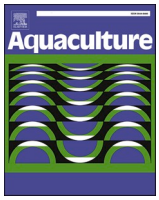
Aquaculture 553 (2022) 738127

Contents lists available at ScienceDirect

Aquaculture

journal homepage: www.elsevier.com/locate/aquaculture



The stakeholder's perception of socio-economic impacts generated by COVID-19 pandemic within the Italian aquaculture systems

S. Mirto [a], V. Montalto [a,*], M.C.M. Mangano [b], F. Ape [a], M. Berlino [c], C. La Marca [a], M. Lucchese [c], G. Maricchiolo [d], M. Martinez [a], A. Rinaldi [a], S.M.C. Terzo [c], I. Celic [e], P. Galli [f], G. Sarà [c]

[a] Institute of Anthropic Impacts and Sustainability in marine environment, National Research Council (IAS-CNR), Lungomare Cristoforo Colombo 4521 (ex complesso Roosevelt), 90149 Palermo, Italy
[b] Stazione Zoologica Anton Dohrn, Dipartimento Ecologia Marina Integrata, Sede Interdipartimentale della Sicilia, Lungomare Cristoforo Colombo (ex complesso Roosevelt), 90149 Palermo, Italy
[c] Dipartimento di Scienze della Terra e del Mare, Università di Palermo, Viale delle Scienze Ed. 16, 90128 Palermo, Italy
[d] Institute for Biological Resources and Marine Biotechnology, National Research Council (IRBIM-CNR), Via S. Raineri 86, 98122, Messina, Italy
[e] Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, Borgo Grotta Gigante 42/C, 34010 Sgonico, TS, Italy
[f] Dipartimento di Scienze dell'Ambiente e della Terra, Università degli Studi di Milano Bicocca, Piazza della Scienza 1, 20126 Milano, Italy

ARTICLE INFO

Keywords:
Pandemic restrictions
Food supply chain
Italy
Aquaculture

ABSTRACT

From the beginning of March 2020 and for the following two and half months, many European countries comprising Italy have been forced into an unprecedented lockdown, allowing only the opening of essential economic activities needed to address the problems created by the pandemic (e.g. sanitary, food provision). Like many sectors of the Italian economy, aquaculture has also slowed down due to the ongoing emergency and the consequent closure of business. In our study we provided a 'snapshot' of the socio-economic effects of the lockdown on the aquaculture sector in Italy, immediately following the adoption of the COVID-19 restrictions as they were perceived by the workers. Although it was surveyed for a short-time period, differences in perception have been detected both in relation to the type of aquaculture as well as to the geographic locations where farms were placed, partially reflecting the economic gaps already existing within the northern and the southern part of the country before the lockdown.

1. Introduction

The year 2020 will be remembered as a turnaround point in human history, destabilizing our daily lives so much that this period has deserved the appellative of anthropause (Rutz et al., 2022). Indeed, with over 100 countries having gone into lockdown, the COVID-19 pandemic triggered the third and greatest economic, financial and social shock of the 21st century after 2011 and the global crisis of 2008 (OECD, 2020). Italy was the first country in Europe to be hit by the pandemic (later revealed also one of the countries most affected in Europe with almost 30,000 deaths following the lockdown period; data from https://covid19.who.int/ updated to 4th May 2020) and as such is one of the first to have implemented restrictive measures. Thus, as a main consequence the lockdown produced a significant and transitory modulation or decrease of the anthropogenic impact on the environment, including the marine coastal systems, where this was most relevant before the lockdown. For Italy alone, positive effects have been reported for the Venice lagoon and the numerous channels crossing the city where waters have cleared for the first time in years (Braga et al., 2020; Khan et al., 2020); an improvement in air quality have been described for the northern part of the country probably as a result of the reduction of air pollution and (Donzelli et al., 2020; https://atmosphere.copernicus.eu/; https://www.esa.int). the reappearance of species has been reportedin spaces vacated by people both in terrestrial and aquatic environments (Manenti et al., 2020; Silva-Rodríguez et al., 2021; https://www.forbes.com/; www.thesun.co.uk).

If on the one hand scientists have found scientific evidence of nature benefited globally from the lockdown, from an anthropocentric point of view the pandemic has led to an unprecedented health and socio-economic emergency. In fact, not only the measures of social restrictions such as distancing and limiting mobility, but above all the closure of most business has caused an economic crisis which in Italy

* Corresponding author.
E-mail address: valeria.montalto@cnr.it (V. Montalto).

https://doi.org/10.1016/j.aquaculture.2022.738127
Received 24 September 2021; Received in revised form 25 January 2022; Accepted 5 March 2022
Available online 9 March 2022

will account for a GDP loss of 8.9% (https://www.istat.it/it/archivio/pil; data updated to December 2020). Such a crisis concerned mainly industries, commercial and transportation activities with workers employed in manufacturing (about 60% would be affected; OECD Trento Centre for Local Development, 2020), construction, tourism (there was a decrease in internal flights of about 75% and of more 90% in restaurant reservations; https://lab24.ilsole24ore.com/economia-italiana-post-covid/) and retail suffered the most (Barbieri et al., 2020; Sanfelici, 2020).

Among the productive activities, aquaculture - like all sectors crucial to ensure the sustainability of supply chain worldwide - is sensitive to limitations imposed by the pandemic. In Italy, aquaculture has a long history dating back to the Roman and Etruscan period, and it grew as a widely diversified activity thanks to the high heterogeneity of Italian coasts (Cataudella and Spagnolo, 2011). To date, the total Italian aquatic production amounted to 143,300 t in 2018 (FAO, 2018), corresponding to 14% of the total European production and ranking the country in the 3rd position in Europe, after Spain (21%) and France (15%; Scientific, Technical and Economic Committee for Fisheries (STECF), 2018). However, the expected economic consequences of pandemic on aquaculture sector will be highly variable in relation to geographic zones being directly linked to other cultural and societal aspects (FAO, 2018). In this context the opportunity to survey and analyse how the COVID-19 pandemic is likely to affect key stakeholder perceptions among aquaculture systems become an important opportunity to provide a snapshot of the response of the aquaculture sector to socio-economic pressures increase.

The purpose of this work, which originates from a larger project that has involved stakeholders worldwide (Sarà et al., 2021), is to investigate the impacts generated by the crisis due to COVID-19 pandemic as they have been perceived by stakeholders involved in production at the farm site or within the company, also evaluating whether these differences are also linked to a distribution of activities on a national scale where known socio-economic differences exist (e.g. D'Agostino and Scarlato, 2013; Dunford, 2008).

2. Materials and methods

To investigate the perceptions of COVID-19 effects on stakeholders operating in the aquaculture sector (both land- and sea-based), a semi-structured questionnaire was designed (Sarà et al., 2021; study approved by the Ethical Committee at the University of Palermo, UNIPA-183-Prot. 767–05/05/2020 n. 1/2020 29/04/2020) and circulated by means of a web survey (by using Qualtrics platform https://www.qualtrics.com) that has been sent to aquaculture companies at different geographical locations and of different sizes across the country. Together with the questionnaire, contacted companies received information about the purpose of the survey and were encouraged to share it with any other company that was directly concerned. Questions have been designed to rapidly assess the perceptions of aquaculture stakeholders of the direct or indirect economic loss associated to COVID-19 and of which reasons could have mainly perceived as responsible of that loss. The reported economic impact due to COVID-19 was divided into four categories: no loss, low (2–4); moderate (5–7) and high (8–10) while the possible causes included: loss of usual customers and retailers, loss of buyers, loss of markets due to the absence of consumers, loss of international markets, decrease in prices, difficulties of suppliers collecting seafood, logistical restrictions on transportation, difficult to trade juvenile and fry supply, reduction of raw material, increase in prices of transportation, insolvency/abandonment by insurance companies, missing infrastructures, loss of jobs, difficulty finding farmers. Respondents were also asked to report and specify any other encountered reason of economic loss. To be sure that we reflected the immediate perceptions of the emerging COVID-19 crisis, the survey distribution started at the beginning of the so-called Phase-2 of coronavirus disease in Italy, with the reopening of manufacturing activities, and it had a duration of three weeks (5th - 29th May 2020).

Replies have been grouped as a function of the typology of aquaculture (land intensive (L-INT), sea-based intensive (S-INT), sea-based extensive (S-EXT)) and in order to investigate potential relations with the geographic area where farms were located, we adopted the partition of Italian Peninsula into two geographical divisions (Northern-Central Italy and Southern Italy including the two main islands, Sicily and Sardinia), which is widely used in official statistics (www.demo.istat.it) and follow the same subdivisions of the Italian First level NUTS of the European Union to reflects the long-established disparities still observed in the country (e.g. Musolino, 2018).

2.1. Statistical analysis

To test differences of the perceptions of aquaculture stakeholders of the direct or indirect economic losses associated to COVID-19 and related control measures (i.e. lockdown and social distancing), a Permutational Multivariate analysis of variance (PERMANOVA, Anderson, 2001) was used to test significant differences between our multivariate response data, represented by the possible causes are believed as main responsible and two different explanatory variables: "Type of aquaculture" and "Location". PERMANOVAs were based on Bray–Curtis similarity matrices after presence/absence transformation of the data using 9999 permutations under unrestricted permutations of the raw data with a Type III (partial) sum of squares (Anderson, 2001). Because of the restricted number of unique permutations, p values were obtained from Monte Carlo samplings (Anderson and Robinson, 2003). "Type of aquaculture" (TAQ, 3 levels, L-INT, S-INT, S-EXT) and "Location (LOC, 2 levels, CENTRE-NORTH, SOUTH AND ISLANDS) were treated as fixed factors, separately, in the experimental design. PERMANOVAs were carried out by using the PRIMER software (version 6.0).

3. Results and discussions

While long-term trends in the aquaculture industry have been estimated as increasing in the next future, the looming, global economic downturn due to the pandemic has created a pervasive sense of uncertainty that may well persist in the short to medium term (OECD, 2020). Our study, although performed at a national scale level, allowed to provide a timely and indicative overview of the impacts of COVID-19 aquaculture and to catch such a feeling among Italian aquaculture farmers, by also identifying other reasons that may have driven the socio-economic impact suffered due to the pandemic.

Over a total of almost 100 questionnaires supplied, only 25% (n = 24) have been fully filled and then considered for the analysis. About the 60% of respondents worked in sea-based intensive and extensive systems, and the rest practiced land-based intensive aquaculture.

As expected almost all stakeholders reported an economic loss due to the COVID-19 pandemic (Fig. 1), the 87.5% (n = 21) of respondents having estimated an average percentage of loss from 50 to 100% (corresponding to moderate and high levels Fig. 2).

On national scale, our analysis suggested that land-based

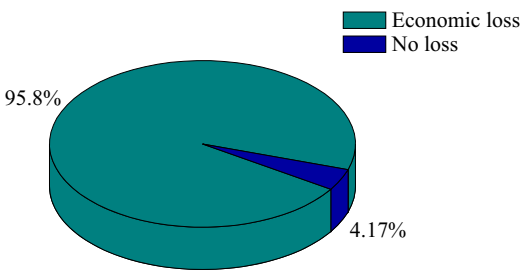


Fig. 1. Percentage of aquaculture stakeholders reporting an economic loss due to the COVID-19 pandemic.

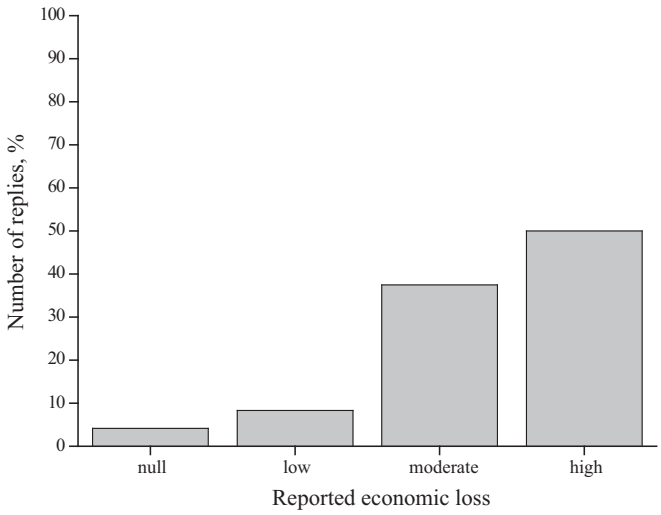


Fig. 2. Percentage of reported economic impact due to COVID-19 pandemic grouped into four categories: null, low, moderate, high.

aquaculture farmers reported higher impact than colleagues working in marine open waters, both in intensive and extensive farming systems ($p < 0.05$; Table 1). Indeed, as reported in Fig. 2, different pressures among those we have included in the questionnaire have been recognized by workers as damaging and specifically, farmers on land were badly affected by economic and logistic concerns as those related to the loss of usual customers and retailers such as schools and restaurants (with 37.5% of replies) and to the reduction of raw material or of transportation (each representing more than 30% of replies). The same problems have been reported by farmers of extensive marine farms (S-EXT, Fig. 3) together with loss of market due to the absence of consumers (16.67% of replies) and to the loss of jobs (20.83%). Concerning intensive systems one third of interviewees reported difficulties related to the impossibility of selling at auction and a quarter of them difficulties among suppliers to collect seafood.

Such a trend is in line with the estimates resulted by the FAO's Initial assessment (FAO, 2020a) reporting the magnitude of impacts of COVID-19 on aquaculture from the perspective of the 12 secretariats of important organizations worldwide and with the most recent literature showing that significant issues raise at different levels across the supply chain worldwide (Belton et al., 2021; Jamwal and Phulia, 2021; Love et al., 2021; Trottet et al., 2021; White et al., 2021; Yusoff et al., 2021). Wide-ranging impacts have been reported along the four segments of the chain, i.e. demand-side (Azra et al., 2021; Godoy et al., 2021; Lebel et al., 2021; Wright, 2020), supply-side (Ragasa et al., 2022; Kiruba-Sankar et al., 2022; Kumaran et al., 2021. Mandal et al., 2021, van Senten et al., 2021), management/operation (Kiruba-Sankar et al., 2022; Murray et al., 2021; Ragasa et al., 2022) and logistics/infrastructure (Azra et al., 2021; Lebel et al., 2021; Murray et al., 2021), which differ between countries and the nature of farming (Borsellino et al., 2020; White et al., 2021).

Among them, land-based aquaculture farming seems to suffer sever impacts due to COVID-19 pandemic; indeed similarly to what observed by Mangano et al. (2022) on a global scale, as a main result of restrictions on transportation and marketing infrastructure, they have been make inoperable due to lockdowns and fears of virus transmission. Such a fact have triggered a cascade of effects, resulting in increase of economic costs due to market delay and to the need for continued feeding at least at maintenance (i.e. not growth rate) to keep fish alive (FAO, 2021). Moreover the risk for aquaculture production dying increased because fish farmers were not able to harvest on time and also could not start a new production cycle, having for example the latest harvest gone waste or being fingerlings low available at the time of seeding (FAO, 2020b;; Krishnan and Babu, 2022; Manlosa et al., 2021; Mohanty, 2020; Moriarty et al., 2020).

When analyzed in relation to the geographic area where they were located, as expected, our results well reproduced the existing economic gaps between the northern and the southern regions of Italian Peninsula which is characterized by a sharp North-South gradient on many economic and labor market variables (Accetturo et al., 2019). Indeed, as showed in Table 1 significant differences among perceptions of farmers working within the Centre and the North of Italy and those coming from the south and from insular regions ($p < 0.05$; Table 1) have been detected. In particular, in the central-northern regions the main causes are to be found in the consequences due to the lockdown restrictions such as the closure of many activities affecting the supply chain and logistical difficulties related to both the supply of raw materials and limitations in incoming and outgoing transport. Southern regions causes have been attributed mainly to the loss of the worker's figure, both in terms of seasonal recruitment failure as well as difficulty of finding farmers (Fig. 4).

Apparently, several differences between locations emerged also when we asked to the companies to list the other causes believed to be responsible for the economic crisis due to COVID-19; once again in fact while northern regions manifested problems mainly concerning the market reduction as a result of restaurant and local market closure; the southern counterparts claimed for a lack of coordination among the aquaculture sector and local/national positing focus particularly on aspect such us the protection policies of Made in Italy and the supply chain and the lack coordination of access to credit and management of the 'unsold' before and at the beginning of PHASE 2.

Lastly, while the COVID-19 crisis has increased the existing inequalities, other environmental emergencies such as the occurrence of extreme climatic events loom large and were perceived as much damaging for the aquaculture Italian sector. Indeed, although not strictly related to the main aims of this study, an important role played by other important stressors emerged as one of important reasons has worsening the socio-economic crisis (Sanchez-Jerez et al., 2022; Sarà et al., 2021), in some cases more than Covid pandemic (i.e. 67% of replies). We observed that extreme weather events and in particular storms, heatwaves, diseases of farmed species, such as parasitosis, zoonoses, virosis and flooding and erosive phenomena, have been reported

Table 1
PERMANOVA results.

Source	df	SS	MS	Pseudo-F	P(perm)	perms	P(MC)
Locality	1	4888.6	4888.6	27.637	0.0255	9711	0.0335 *
Residuals	22	38,916	1768.9				
Total	23	43,804					
Type of aquaculture	2	8906.2	4453.1	26.797	0.0051	9934	0.0172*
Residuals	21	34,898	1661.8				
Total	23	43,804					

SS = sum of squares; MS = mean squares; P = probability; perms = number of permutations; P(MC) = Monte Carlo probability) (ns = no significant difference; * = difference at $p < 0.05$; ** = difference at $p < 0.01$; *** = difference at $p < 0.001$.

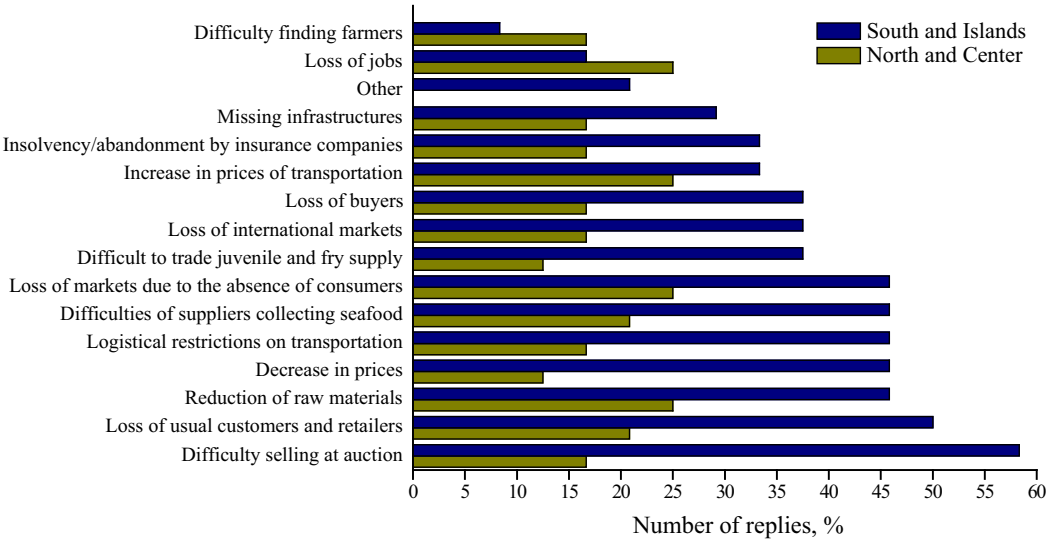


Fig. 3. Replies reporting the different "pressures" perceived as more damaging by farmers working in different regions of the country (grouped in South and Islands, North and Center).

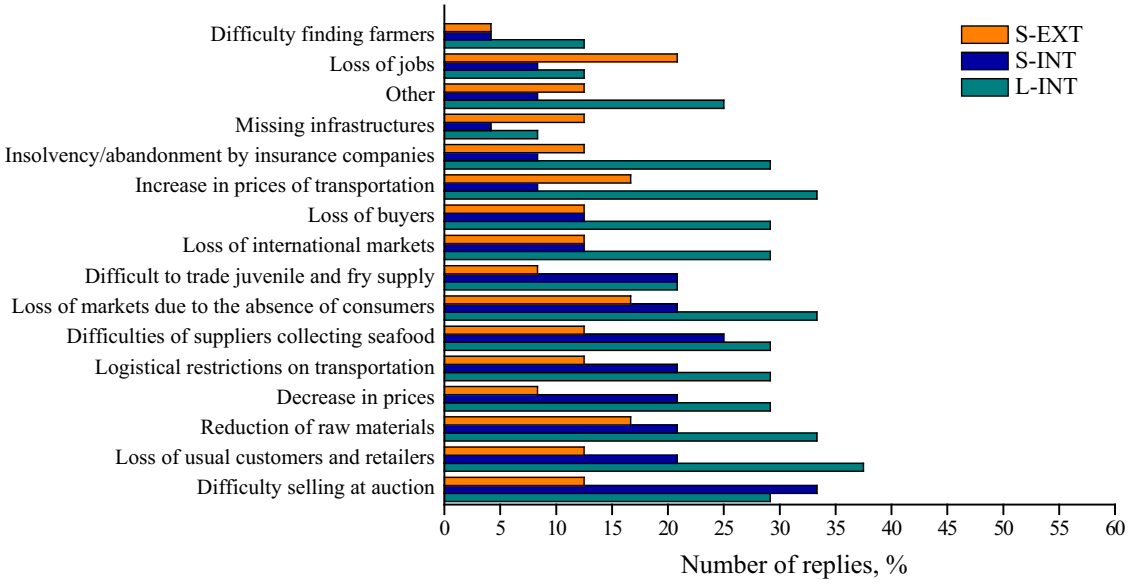


Fig. 4. Replies reporting the different "pressures" perceived as more damaging by farmers working on sea-based (intensive and extensive) and land-based aquaculture.

as factors more affecting activities located in the center and in the north of Italy. The economy of sector in the southern regions, seemed to mainly influenced by difficulties concerning hypoxia/anoxia events and related increased costs to guarantee suitable conditions of oxygen to farmed species and consequently of the entire seafood chain. After all, these events are well known to impact both directly and indirectly the stability of ecosystems and of related aquatic resources. As recently evidenced by Sarà et al. (2021), not only the majority of respondents perceived more damaging impacts from climatic stressors than pandemic, but above all that COVID-19 and anthropogenic stressors influenced unequally the different parts of the supply chain emphasizing as the opportunity of exploring the perceived impacts while they are still ongoing. This could give important information on the effectiveness of resilience strategies to put in act when multiple stressors of both climatic and non-climatic origin occur (Sharifi and Khavarian-Garmsir, 2020) and could be useful to build adaptive policies to promote "new narrative" for the economy (Love and Stockdale-Otárola, 2017).

Author statement

Details of each author with their contribution in this paper:

Name of the author and e-mail ID	Types of contribution
Mirto S; simone.mirto@cnr.it	Writing - original draft; Formal analysis; Visualization; Supervision
Montalto V; valeria.montalto@cnr.it	Writing - original draft; Formal analysis; Visualization
Mangano MC; mariacristina.mangano@szn.it	Writing - review & editing; Supervision
Ape F; francesca.ape@ias.cnr.it	Formal analysis; Visualization
Berlino M; mberlino22@gmail.com	Data curation; Writing - review & editing
	Data curation; Writing - review & editing

(*continued on next page*)

(*continued*)

Name of the author and e-mail ID	Types of contribution
La Marca C; Claudia.lamarca@ias.cnr.it	
Lucchese M; martalook94@gmail.com	Data curation; Writing - review & editing
Maricchiolo G; giulia.maricchiolo@cnr.it	Data curation; Writing - review & editing
Martinez M; marco.martinez@ias.cnr.it	Data curation; Writing - review & editing
Rinaldi A; alessandro.rinaldi@ias.cnr.it	Data curation; Writing - review & editing
Terzo SMC; stella.terzo@gmail.com	Data curation; Writing - review & editing
Celic I; icelic@inogs.it	Data curation; Writing - review & editing
Galli P; paolo.galli@unimib.it	Data curation; Writing - review & editing
Sarà G; gianluca.sara@unipa.it	Conceptualization; Writing - review & editing; Supervision

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgment

This paper was supported by the SNAPSHOT (Synoptic Assessment of Human Pressures on key Mediterranean Hot Spots) project, funded by the Department of Earth System Science and Environmental Technologies, CNR (Italy) and by the PATINER (Promouvoir et développer une aquaculture multi-trophique durable et intégrée) project, funded by the Programme de Coopération Transfrontière (CT) Italie-Tunisie 2014-2020.

References

Accetturo, A., Lamorgese, A., Mocetti, S., et al., 2019. Local development, urban economies and aggregate growth. Ital. Econ. J. 5, 191–204. https://doi.org/10.1007/s40797-019-00095-y.

Anderson, M.J., 2001. A new method for non-parametric multivariate analysis of variance. Austral. Ecol. 26, 32–46.

Anderson, M.J., Robinson, J., 2003. Generalised discriminant analysis based on distances. Aust. NZJ Stat. 45 (3), 301–318.

Azra, M.N., Kasan, N.A., Othman, R., Noor, G.A.G.R., Mazelan, S., Jamari, Z.B., Ikhwanuddin, M., 2021. Impact of COVID-19 on aquaculture sector in Malaysia: findings from the first national survey. Aquac. Rep. 19, 100568 https://doi.org/10.1016/j.aqrep.2020.100568.

Barbieri, T., Basso, G., Scicchitano, S., 2020. Italian Workers at Risk during the COVID-19 Epidemic. Available at SSRN. https://ssrn.com/abstract=3572065.

Belton, B., Rosen, L., Middleton, L., Ghazali, S., Mamun, A.-A., Shieh, J., Thilsted, S.H., 2021. COVID-19 impacts and adaptations in Asia and Africa's aquatic food value chains. Mar. Policy 129, 104523.

Borsellino, V., Kaliji, S.A., Schimmenti, E., 2020. COVID-19 drives consumer behaviour and agro-food markets towards healthier and more sustainable patterns. Sustainability 12, 8366. https://doi.org/10.3390/su12208366.

Braga, F., Scarpa, G.M., Brando, V.E., Manfè, G., Zaggi, L., 2020. COVID-19 lockdown measures reveal human impact on water transparency in the Venice lagoon. Sci. Total Environ. 736, 139612.

Cataudella, S., Spagnolo, M. (Eds.), 2011. The State of Italian Marine Fisheries and Aquaculture. Ministero delle Politiche Agricole, Alimentari e Forestali (MiPAAF), Rome (Italy), p. 620.

D'Agostino, G., Scarlato, M., 2013. Innovation, socio-institutional conditions and economic growth in Italian regions. Reg. Stud. https://doi.org/10.1080/00343404.2013.838000.

Donzelli, G., Cioni, L., Cancellieri, M., Llopis Morales, A., Morales Suárez-Varela, M.M., 2020. The effect of the COVID-19 lockdown on air qualiy in three Italian medium-sized cities. Atmosphere 11, 1118.

Dunford, M., 2008. After the three Italies the (internally differentiated) north–south divide: analysing regional and industrial trajectories. Annales de Géographie 6 (664), 85–114.

FAO, 2018. The State of World Fisheries and Aquaculture 2018 - Meeting the Sustainable Development Goals. Rome.

FAO, 2020a. The Impact of COVID-19 on Fisheries and Aquaculture A global Assessment from the Perspective of Regional Fishery Bodies: Initial Assessment, May 2020. No. 1. Rome.

FAO, 2020b. The State of World Fisheries and Aquaculture 2020. Sustainability in Action. Rome. https://doi.org/10.4060/ca9229en.

FAO, 2021. The Impact of COVID-19 on Fisheries and Aquaculture Food Systems, Possible Responses: Information Paper, November 2020. Rome. https://doi.org/10.4060/cb2537en.

Godoy, M.G., Kibenge, M.J.T., Kibenge, F.S.B., 2021. SARS-CoV-2 transmission via aquatic food animal species or their products: a review. Aquaculture 536, 736460. https://doi.org/10.1016/j.aquaculture.2021.736460.

Jamwal, A., Phulia, V., 2021. Multisectoral one health approach to make aquaculture and fisheries resilient to a future pandemic-like situation. Fish Fish. 22, 449–463. https://doi.org/10.1111/faf.12531.

Khan, I., Shah, D., Shah, S.S., 2020. COVID-19 pandemic and its positive impacts on environment: an updated review. Int. J. Environ. Sci. Technol. https://doi.org/10.1007/s13762-020-03021-3.

Kiruba-Sankar, R., Saravanan, K., Haridas, H., Praveenraj, J., Biswas, U., Sarkar, R., 2022. Policy framework and development strategy for freshwater aquaculture sector in the light of COVID-19 impact in Andaman and Nicobar archipelago, India. Aquaculture 548, 737596.

Krishnan, M., Babu, S.C., 2022. COVID-19 opens up domestic market for Indian shrimp. Aquaculture 550, 737818.

Kumaran, M., Geetha, R., Antony, J., Kumaraguru Vasagam, K.P., Anard, P.R., Ravisankar, T., Vijayan, K.K., 2021. Prospective impact of Corona virus disease (COVID-19) related lockdown on shrimp aquaculture sector in India – a sectoral assessment. Aquaculture 531, 735922.

Lebel, L., Maung Soe, K., Thanh Phuong, N., Navy, H., Phousavanh, P., Jutagate, T., Lebel, B., 2021. Impacts of the COVID-19 pandemic response on aquaculture farmers in five countries in the Mekong Region. Aquac. Econ. Manag. 25 (3), 298–319. https://doi.org/10.1080/13657305.2021.1946205.

Love, Patrick, Stockdale-Otárola, Julia (Eds.), 2017. "Towards a New Narrative", in Debate the Issues: Complexity and Policy Making. OECD Publishing, Paris.

Love, D.C., Allison, E.H., Asche, F., Belton, B., Cottrell, R.S., Froehlich, H.E., Zhang, W., 2021. Emerging COVID-19 impacts, responses, and lessons for building resilience in the seafood system. Glob. Food Secur. 28, 100494.

Mandal, S.C., Boidya, P., Haque, M.I.M., Hossain, A., Shams, Z., Mamun, A.A., 2021. The impact of the COVID-19 pandemic on fish consumption and household food security in Dhaka city, Bangladesh. Glob. Food Sec. 29, 100526.

Manenti, R., Mori, E., Di Canio, V., Mercurio, S., Picone, M., Caffi, M., Rubolini, D., 2020. The good, the bad and the ugly of COVID-19 lockdown effects on wildlife conservation: insights from the first European locked down country. Biol. Conserv. 249, 108728.

Mangano, M.C., Berlino, M., Corbari, L., Milisenda, G., Lucchese, M., Terzo, S., Sarà, G., 2022. The aquaculture supply chain in the time of COVID-19 pandemic: vulnerability, resilience, solutions and priorities at the global scale. Environ. Sci. Pol. 127, 98–110.

Manlosa, A.O., Hornidge, A.K., Schlüter, A., 2021. Aquaculture-capture fisheries nexus under COVID-19: impacts, diversity, and social-ecological resilience. Marit. Stud. 20, 75–85.

Mohanty, B.K., 2020. Prawn Farming Feels Pinch, Lakhs Affected. Telegraph. May 23. https://www.telegraphindia.com/india/coronavirus-outbreak-prawn-farming-feels-pinch-lakhs-affected/cid/1760934.

Moriarty, M., Murray, A.G., Berx, B., Christie, A.J., Munro, L.A., Wallace, I.S., 2020. Modelling temperature and fish biomass data to predict annual Scottish farmed salmon, *Salmo salar* L., losses: development of an early warning tool. Prev. Veterin. Med. 178, 104985.

Murray, A.G., Ives, S.C., Smith, R.J., Moriarty, M., 2021. A preliminary assessment of indirect impacts on aquaculture species health and welfare in Scotland during COVID-19 lockdown. Vet. Anim. Sci. 11, 100167.

Musolino, D., 2018. The north-south divide in Italy: reality or perception? Europ. Spat. Res. Pol. 25 (1), 29–53. https://doi.org/10.18778/1231-1952.25.1.03.

OECD, 2020. Sustainable Ocean for All: Harnessing the Benefits of Sustainable Ocean Economies for Developing Countries. The Development Dimension, OECD Publishing, Paris. https://doi.org/10.1787/bede6513-en.

OECD Trento Centre for Local Development, 2020. Italian Regional SME Policy Responses. https://www.oecd.org/cfe/leed/COVID-19-Italian-regions-SME-policyresponses.pdf.

Ragasa, C., Agyakwah, S.K., Asmah, R., Mensah, E.T.D., Amewu, S., Oyih, M., 2022. Accelerating pond aquaculture development and resilience beyond COVID: ensuring food and jobs in Ghana. Aquaculture 547, 737476.

Rutz, C., Loretto, M.C., Bates, A.E., Davidson, S.C., Duarte, C.M., Jetz, W., Cagnacci, F., 2022. COVID-19 lockdown allows researchers to quantify the effects of human activity on wildlife. Nat. Ecol. Evol. 4, 1156–1159.

Sanchez-Jerez, P., Babarro, J.M.F., Padin, X.A., Longa Portabales, A., Martinez-Llorens, S., Ballester-Berman, J.D., et al., 2022. Cumulative climatic stressors strangles marine aquaculture: ancillary effects of COVID-19 on Spanish mariculture. Aquaculture 549, 737749.

Sanfelici, M., 2020. The Italian response to the COVID-19 crisis: lessons learned and future direction in social development. Int. J. Comm. Soc. Dev. 2 (2), 191–210.

Sarà, G., Mangano, M.C., Berlino, M., Corbari, L., Lucchese, M., Milisenda, G., Helmuth, B., 2021. The synergistic impacts of anthropogenic stressors and COVID-19 on aquaculture: a current global perspective. Rev. Fish. Sci. Aquac. 1–13.

Scientific, Technical and Economic Committee for Fisheries (STECF), 2018. Economic Report of the EU Aquaculture Sector (STECF-18-19). Publications Office of the European Union, Luxembourg. https://doi.org/10.2760/45076. ISBN 978–92–79-79402-5. JRC114801.

Sharifi, A., Khavarian-Garmsir, A.R., 2020. The COVID-19 pandemic: impacts on cities and major lessons for urban planning, design, and management. Sci. Total Environ. 749, 142391.

Silva-Rodríguez, E.A., Gálvez, N., Swan, G.J.F., Cusack, J.J., Moreira, D., 2021. Urban wildlife in times of COVID-19: what can we infer from novel carnivore records in urban areas? Sci. Total Environ. 765, 142713 https://doi.org/10.1016/j.scitotenv.2020.142713.

Trottet, A., George, C., Drillet, G., Lauro, F.M., 2021. Aquaculture in coastal urbanized areas: a comparative review of the challenges posed by harmful algal blooms. Crit. Rev. Environ. Sci. Technol. https://doi.org/10.1080/10643389.2021.1897372.

van Senten, J., Engle, C.R., Smith, M.A., 2021. Effects of COVID-19 on U.S. aquaculture farms. Appl econ Perspect. Policy. 43, 355–367. https://doi.org/10.1002/aepp.13140.

White, E.R., Froehlich, H.E., Gephart, J.A., et al., 2021. Early effects of COVID-19 on US fisheries and seafood consumption. Fish Fish. 22, 232–239. https://doi.org/10.1111/faf.12525.

Wright, J., 2020. The coronavirus pandemic's influence on aquaculture priorities. Glob. Aquacult. Adv. Retrieved from https://www.aquaculturealliance.org/advocate/the-coronavirus-pandemics-influence-on-aquaculture-priorities/.

Yusoff, F.M., Abdullah, A.F., Aris, A.Z., Umi, W.A.D., 2021. Impacts of COVID-19 on the aquatic environment and implications on aquatic food production. Sustainability 13, 11281. https://doi.org/10.3390/su132011.