**A REVIEW OF ARTISANAL EXTRACTION STRATEGIES IN LAKES FOR THE OPTIMIZATION OF SUSTAINABLE FISH PRODUCTION AND MARKETING**

**Reyes-Bedriñana1, Magno Rosendo2, Delgado-Bardales José Manuel3, Contreras-Julián Rosa Mabel4**

**Abstract**

Artisanal extractive capacity in lakes represents a key factor to improve the sustainable production and commercialization of fish, which corresponds to a vital resource for rural communities and aquatic ecosystems. This study conducted a systematic review following the PRISMA protocol, where 24 articles obtained from three high impact databases (Scopus, Web of Science and ScienceDirect) were analyzed to synthesize the environmental, sanitary and socioeconomic management strategies applied in artisanal lake extraction systems. The results show as findings that Integrated Multitrophic Aquaculture (IMTA) significantly improves water quality and fish production by co-culture of fish with extractive species such as bivalves and macroalgae, and that regulated fisheries management and adequate pond management techniques contribute to substantial increases in fish production and quality (size, taste, reproducibility). However, poor sanitation practices and inadequate hygienic conditions pose risks to food safety and public health. Economic and social factors that condition the profitability and sustainability of artisanal fisheries were also identified. The integration of robust ecological, sanitary and socioeconomic practices is essential to optimize artisanal extractive capacity in lakes, ensuring environmental sustainability and economic viability. Future studies are recommended to deepen longitudinal and multidisciplinary assessments to strengthen the sustainable management of these ecosystems.

**Keywords:** Artisanal fisheries; lake ecosystems; integrated multi-trophic aquaculture; fishery management; food security

**1 Introduction**

The exploration of the data shows that artisanal fishing in lakes is a fundamental source of food, income and livelihoods for many rural communities around the world (Selvaraj et al., 2022). However, the exploitation of these resources faces multiple challenges related to extractive capacity, environmental sustainability and the quality of the products traded (Grati et al., 2025). Artisanal extractive capacity in lakes can significantly improve fish production and commercialization, if strategies are implemented that promote ecosystem health, water quality, and efficient management practices (Liu et al., 2023).

The literature indicates that one of the most promising strategies is Integrated Multitrophic Aquaculture (IMTA), which combines the simultaneous culture of fish with extractive species, such as bivalves and macroalgae, contributing to the reduction of pollutants and the improvement of aquaculture production (Castilla-Gavilán et al., 2024; Loayza-Aguilar et al., 2023). In recent years, various studies have shown that the integration of GIFT fish with freshwater mussels and aquatic macrophytes not only improves fish growth and performance but also reduces water pollution through the biological activity of extractive species (Bakshi et al., 2023; Ingle et al., 2022; Valenti et al., 2021). Similarly, the incorporation of oysters into IMTA systems has shown benefits in water quality and biomass production (Cunha et al., 2019; Rusco et al., 2024; Shinde et al., 2024).

On the other hand, the regulated management of artisanal fisheries, which includes intensive practices in small and medium-sized lakes, has shown a significant increase in fish production and quality, especially when techniques such as the controlled use of herbicides and fertilizers are applied, which can increase production by up to 300% (Aubakirova et al., 2019; Nyamweya et al., 2023). In parallel, improving environmental and sanitation practices is crucial to ensure food security and prevent fish contamination, as evidenced in lakes such as Malawi and in regions such as the Cross River in Nigeria, where poor hygienic practices have resulted in significant bacterial contamination (Effiong & Ogbonna, 2017; Samikwa et al., 2019).

Under the socio-economic approach, well-managed artisanal fisheries can generate substantial economic benefits for rural communities, ensuring stable and viable production, as observed in Lake Femund, Norway (Tidd et al., 2023). However, the sustainability of this activity also depends on overcoming challenges related to the recruitment of fishermen and the proper development of local and international markets (Sandlund et al., 2004).

Delving into the research, among the main challenges to maximize artisanal extractive capacity are the environmental impact derived from overexploitation and inadequate management, which can degrade lake ecosystems and reduce fish populations, as well as the need to implement sustainable practices and effective regulations (Cooke et al., 2024); It is also necessary to ensure food safety by controlling contamination and promoting hygienic practices throughout the supply chain is essential to maintain product quality (Rosa et al., 2020; Samikwa et al., 2019). Likewise, economic viability demands the development of market strategies, the modernization of fishing gear, and the continuous training of fishermen to improve their incomes and ensure long-term profitability (Muyot et al., 2021).

Given this reality, this systematic review aims to synthesize the findings of various studies on artisanal extractive capacities in lakes and their impact on fish marketing, with special attention to environmental, health and socioeconomic management strategies; Similarly, the study seeks to provide a comprehensive vision that allows the identification of good practices and recommendations to strengthen sustainable and profitable artisanal fishing in lake ecosystems, mainly in developing countries and in those where the environmental impact is imminent.

At the specific level, it was considered to have specific objectives such as: identifying and analyzing the Integrated Multitrophic Aquaculture (IMTA) strategies applied in artisanal extraction systems in lakes and their impact on fish production and water quality; as well as to evaluate the practices and effects of the regulated management of artisanal fishing in lakes, focusing on management techniques and their contribution to the improvement of fish production and quality. On the other hand, it is necessary to examine the environmental and sanitation practices implemented in artisanal fisheries to guarantee food security and the health of the lake ecosystem, as well as to analyze the economic and social factors that influence the commercialization and economic viability of artisanal fishing in lakes. Finally, it seeks to identify the main environmental, health and economic challenges that affect artisanal extractive capacity and propose recommendations for its sustainability and profitability.

**3 Methodology**

**Research Type and Design**

This study corresponds to a systematic review (SR) of literature with a descriptive and analytical approach (Colquhoun et al., 2014), because its objective is to synthesize and evaluate the scientific evidence related to artisanal extractive capacities in lakes to improve the commercialization of fish. The SR was developed following the guidelines established by the PRISMA 2020 protocol (Page et al., 2021), which made it possible to guarantee transparency, rigor and reproducibility in the process of searching, selecting and analyzing the included studies.

**Data collection and search process**

The information search process was carried out in three high-impact electronic databases, internationally recognized for their quality and coverage in environmental and social sciences: Scopus, Web of Science (WOS) and Science Direct (AlRyalat et al., 2019). Search strategies were designed combining key terms and Boolean operators related to artisanal aquaculture, fisheries management, water quality and fish marketing in lake ecosystems. The search strings included descriptors such as "artisanal fishing capacity", "lake aquaculture", "fisheries management", "water quality", "fish marketing", and their variants in English, applied in the title, abstract and keyword fields.

Es así como se presentaron las siguientes ecuaciones de búsqueda: Para Scopus TITLE-ABS-KEY("artisanal fisheries" OR "small-scale fisheries" OR "lake fisheries" OR "inland fisheries" AND aquaculture OR "integrated multi-trophic aquaculture" OR IMTA OR "fish farming" AND "environmental management" OR "water quality" OR "ecosystem health" AND "fish marketing" OR "fish commercialization" OR "supply chain" OR "market access" AND sustainable OR "economic viability" OR "social factors" OR "community development"). De igual manera, para WOS TS=("artisanal fisheries" OR "small-scale fisheries" OR "lake fisheries" OR "inland fisheries") AND TS=(aquaculture OR "integrated multi-trophic aquaculture" OR IMTA OR "fish farming") AND TS=("environmental management" OR "water quality" OR "ecosystem health") AND TS=("fish marketing" OR "fish commercialization" OR "supply chain" OR "market access") AND TS=(sustainable OR "economic viability" OR "social factors" OR "community development"); y para SienceDirect se considero: TITLE("artisanal fisheries" OR "small-scale fisheries" OR "lake fisheries" OR "inland fisheries" AND aquaculture OR "integrated multi-trophic aquaculture" OR IMTA OR "fish farming" AND "environmental management" OR "water quality" OR "ecosystem health"). De igual manera, el periodo de búsqueda comprendió hasta enero de 2025, sin restricciones idiomáticas, para maximizar la exhaustividad de la revisión. Tras la eliminación de duplicados y la aplicación de filtros iniciales, se seleccionaron 24 artículos que cumplían con los criterios de inclusión definidos para la revisión.

**Eligibility criteria for articles**

To develop the study, it was necessary to consider the minimum criteria to be able to enter as appropriate for a better analysis: a) empirical studies that addressed artisanal extractive capacities or fisheries management techniques in lakes or freshwater bodies, b) works that evaluated aspects related to fish production, water quality, sanitary practices or commercialization of fish; c) articles published in journals indexed in recognized databases, and c) publications in English, Spanish or Portuguese up to the date of the search cut-off date were also considered.

Similarly, the following were excluded: a) theoretical studies without empirical evidence, b) previous bibliographic reviews, meta-analyses or systematic studies, as they were not an umbrella study, c) works focused exclusively on marine fishing or intensive aquaculture without an artisanal component, d) those documents not available in full text, and e) grey literature.

**Data Analysis Method**

The extraction process and the respective management was carried out through a structured format in Microsoft Excel ®, where key elements have been presented, such as author, year, objectives, methodology and main results that were linked to the previously set objectives. To assess the methodological quality and potential biases in the included studies, the authors reviewed the full text for better understanding. On the other hand, it is important to clarify that the analysis was aimed at carrying out a narrative and comparative synthesis, identifying common patterns, methodological differences, reported impacts and knowledge gaps. In this way, 24 articles were reviewed, under a critical analysis of extractive practices and strategies in relation to their effectiveness to improve fish production and marketing, as well as their environmental and socioeconomic implications that are evidenced in the sector.

**3 Research**

For the study, the results have been considered from the perspective of the objectives set by the researchers, where the following components are obtained:

Impact of Integrated Multitrophic Aquaculture (IMTA) Strategies

IMTAs have proven to be an effective strategy to improve artisanal extractive capacity in lakes, favoring both fish production and the environmental health of the aquatic ecosystem (Spillias et al., 2024; Yang et al., 2025). Several key studies show that the co-cultivation of GIFT fish together with extractive species such as freshwater mussels and aquatic macrophytes contributes significantly to the reduction of pollutants, such as excess nutrients and turbidity, improving water quality and enzymatic activity. This translates into accelerated fish growth and an increase in biomass yield (Cunha et al., 2019; Effiong & Ogbonna, 2017). Similarly, the introduction of oysters into IMTA systems has been reported as a natural mechanism to control phytoplankton, reducing eutrophication and favoring sustainable fish production (Nyamweya et al., 2023). However, methodological variability between studies has been evidenced, which suggests the need to standardize environmental and productive indicators to facilitate comparisons and scalability.

Regulated fisheries management: techniques and production

The transition from traditional extractive practices to regulated fisheries management models has shown a positive impact on fish production and quality in small and medium-scale lakes. Properly managed intensive lake farms were able to increase fish production significantly, with reports of increases of more than 300% when implementing specific techniques such as the controlled use of herbicides and fertilizers (Sandlund et al., 2004). However, some studies revealed that environmental monitoring and accurate description of management protocols are insufficient, limiting the full assessment of the sustainability of these practices. This underscores the importance of integrating long-term environmental assessments to avoid negative impacts from intensification.

Environmental practices, sanitation and food security in lake ecosystems

According to the review, it is evident that improving water, sanitation and hygiene practices throughout the production chain is essential to guarantee the quality and safety of fish (Milijasevic et al., 2024; Oliveros et al., 2019; Pinto Jimenez et al., 2023). In Lake Malawi, high levels of E. coli contamination associated with unhygienic practices were detected during fish harvesting and marketing, posing a significant risk to public health (Kalumbi et al., 2020). Similarly, other studies in the Cross River Basin, Nigeria, have highlighted that pollution and deterioration of the ecosystem negatively affect artisanal fisheries productivity, making evident the need for interventions to improve health infrastructure and promote better environmental practices (Elegbede et al., 2025; Moghimi Dehkordi et al., 2024). Although a limited amount of research with detailed microbiological and health analyses has been appreciated, it shows an important gap in current research, so they should be used or developed focused on the substantial improvement of these.

Socio-economic factors influencing the commercialization of artisanal fisheries

In terms of the data obtained, the studies indicated that the commercial exploitation of inland fishery resources can generate considerable economic benefits for rural communities, provided that adequate management and marketing systems are put in place (Elliott et al., 2022; Tabe-Ojong et al., 2025). A clear example is evidenced in studies where commercial whitefish fishing was shown to be stable and profitable thanks to the proper management of the resource(Ashrafi et al., 2021). However, in contexts such as Cross River State in Nigeria, challenges associated with lack of training, difficulties in recruiting fishermen and limitations in the development of efficient markets are evident (Effiong & Ogbonna, 2017). In view of these results, it is stated that the economic viability of artisanal fishing depends not only on the extractive capacity but also on social and market factors that require comprehensive attention by the State and organizations.

Environmental, economic and health challenges in artisanal fisheries

The main challenges identified in the studies include overexploitation of the resource, environmental degradation due to unregulated practices, contamination of the ecosystem and deficiencies in sanitary practices, which together compromise artisanal extractive capacity and fish quality (Cámara & Santero-Sánchez, 2019; Henriksson et al., 2021; Vázquez Pinillos & Barragán Muñoz, 2024). On the other hand, the vast majority of authors agree on the need to implement strict regulations, environmental monitoring protocols, and training programs that integrate technical, environmental, health, and socioeconomic aspects to strengthen the sustainability and profitability of the sector (Torralba-Burrial & Dopico, 2023; Troell et al., 2023; Wani et al., 2024). These data are conducive to highlighting that the absence of these actions can lead to the depletion of fishing resources and the loss of income for dependent communities, or those that are developing.

**4 Discussion**

The SR study has synthesized recent and robust evidence on artisanal extractive capacities in lakes, highlighting strategies that contribute to the improvement of fish production and marketing, with special emphasis on environmental, health and socioeconomic management. Faced with this reality, the findings reinforce the importance of integrated and regulated systems, such as Integrated Multitrophic Aquaculture (IMTA), which not only increase fish production, but also contribute to the conservation and improvement of water quality, fundamental aspects for the long-term sustainability of ecosystems (Verdegem et al., 2023). However, the variability in methodologies and the absence of standardization in environmental and production measurements limit the comparability and generalizability of results, suggesting the urgency of homogeneous protocols that can be replicated in future research.

In terms of regulated fisheries management, there is significant potential to increase extractive capacity through techniques that optimize production, such as the controlled use of herbicides and fertilizers. However, the scarce documentation on environmental impacts and the lack of long-term environmental monitoring indicate that the intensification of production must be accompanied by strict environmental regulatory policies to avoid habitat degradation and guarantee the viability of the resource (Kumar et al., 2021; Pozza & Field, 2020). In this way, the implementation of these policies requires the participation of local communities and regulatory bodies, strengthening the sector's fisheries governance. Regarding environmental and sanitation practices, the results show that the current hygienic and sanitary conditions in many artisanal systems are insufficient to guarantee food safety, generating risks to public health (Nhabe & Malebo, 2025; Tohonon et al., 2025). In this way, it results in the imperative need to promote interventions focused on improving health infrastructures and the training of actors in the production chain, thus guaranteeing a safe and quality final product for the sector.

Similarly, the analysis of economic and social factors shows that artisanal fisheries, when well managed, can represent a stable source of income and socio-economic development for rural communities (Cook et al., 2024). However, the absence of technical training, limited access to markets and precariousness in marketing are relevant obstacles that must be overcome through public policies aimed at strengthening capacities and access to formal markets (López-Ercilla et al., 2024). Under this scenario, the combination of technical improvements with sustainable market strategies is key to maximizing the positive economic impact and guaranteeing the development of the environment and populations that are in vulnerability, with the presence of better mechanisms.

Analyzing the aspects of the environmental, sanitary and economic challenges detected, it is evident that the sustainability of artisanal extractive capacity depends on a multidimensional approach that integrates environmental regulations, adequate sanitary protocols and effective socioeconomic support for fishing communities (Gómez & Maynou, 2021). In this sense, the absence of integrated policies can lead to resource depletion and loss of livelihoods. Therefore, it is recommended to implement robust regulatory frameworks, participatory environmental monitoring systems, and comprehensive training programs, which together promote sustainable, profitable, and socially just artisanal fisheries.

The study in question has also presented inherent limitations to the methodological heterogeneity of the systematized articles, including differences in experimental designs, measurement scales and environmental variables considered, which makes direct comparison difficult. Similarly, most studies focused on specific lakes and particular regions, which restricts the overall generalizability of the results; In order to limit these, rigorous evaluation elements were established. Likewise, another important limitation corresponds to the scarce one is the scant attention to the long-term assessment of ecological and socioeconomic impacts, as well as the lack of in-depth analyses on potential biases in data collection and reporting, fundamental aspects to validate the robustness of the conclusions. Under this reality, among the strengths of the study is the exhaustiveness of the SR that covered various databases, as well as the inclusion of recent and relevant studies that address both productive and environmental, health and social aspects. The application of the PRISMA protocol to evaluate the methodological quality of studies. Similarly, the review integrates interdisciplinary perspectives, which provides a holistic view of artisanal extractive capacity in lakes, with practical implications for public policies and sustainable management in emerging countries.

Regarding the exploration of the implications and possible recommendations, where the need to promote the adoption and standardization of IMTA systems in artisanal lakes is highlighted, accompanied by regulated management policies that protect ecosystems and optimize fish production. It recommends the implementation of robust sanitary protocols to ensure fish safety and protect public health, as well as the strengthening of technical training and access to markets for artisanal fishers. Thus, for future studies, it is suggested to promote longitudinal research that evaluates the environmental, health, and socioeconomic impact of extractive practices in the medium and long term. In addition, it is necessary to expand geographical coverage to include lakes in various regions and socioeconomic contexts, and to incorporate mixed methodologies that allow understanding both the quantitative and qualitative aspects of artisanal fisheries. Finally, it is crucial to include detailed analyses of possible biases in data selection and reporting to strengthen evidence and better guide sustainability and profitability policies.

**5 Conclusions**

In summary, SR shows that artisanal extractive capacities in lakes, when managed through innovative practices, regulated fisheries management and the implementation of adequate sanitary protocols, have a significant positive impact on fish production, which favors the sustainable and profitable commercialization of fish. However, significant challenges remain related to environmental degradation, insufficient health infrastructure, and socioeconomic constraints that condition the viability of these activities. In addition, to achieve long-term sustainability, it is essential to promote comprehensive policies that articulate strict environmental regulations, improvements in technical training, access to markets, and participatory environmental monitoring systems. Finally, the results highlight the need for future multidisciplinary and longitudinal research that allows for a more accurate assessment of the effects of these practices and the implementation of adaptive strategies in various lake contexts in emerging or developing countries.

**Acknowledgment**: to the researchers who have made the development of this work possible

References

AlRyalat, S. A. S., Malkawi, L. W., & Momani, S. M. (2019). Comparing Bibliometric Analysis Using Pubmed Scopus And Web Of Science Databases. *Journal of Visualized Experiments*, *152*, e58494. https://doi.org/10.3791/58494

Ashrafi, T. A., Syed, S., & Eide, A. (2021). Individual quotas and revenue risk of fishing portfolio in the trawl fishery. *Fisheries Research*, *241*, 105990. https://doi.org/10.1016/j.fishres.2021.105990

Aubakirova, G., Adilbekov, Z., Inirbayev, A., & Dzhamanbayev, T. (2019). Fish fauna and assessment of fish safety in the reservoirs of Akmola region of norther Kazakhstan. *Pakistan Journal of Zoology*, *51*(5), 1919-1925. Scopus. https://doi.org/10.17582/journal.pjz/2019.51.5.1919.1925

Bakshi, B., Bouchard, R. W., Dietz, R., Hornbach, D., Monson, P., Sietman, B., & Wasley, D. (2023). Freshwater Mussels, Ecosystem Services, and Clean Water Regulation in Minnesota: Formulating an Effective Conservation Strategy. *Water*, *15*(14), Article 14. https://doi.org/10.3390/w15142560

Cámara, A., & Santero-Sánchez, R. (2019). Economic, Social, and Environmental Impact of a Sustainable Fisheries Model in Spain. *Sustainability*, *11*(22), Article 22. https://doi.org/10.3390/su11226311

Castilla-Gavilán, M., Guerra-García, J. M., Hachero-Cruzado, I., & Herrera, M. (2024). Understanding Carbon Footprint in Sustainable Land-Based Marine Aquaculture: Exploring Production Techniques. *Journal of Marine Science and Engineering*, *12*(7), Article 7. https://doi.org/10.3390/jmse12071192

Colquhoun, H. L., Levac, D., O’Brien, K. K., Straus, S., Tricco, A. C., Perrier, L., Kastner, M., & Moher, D. (2014). Scoping reviews: Time for clarity in definition, methods, and reporting. *Journal of Clinical Epidemiology*, *67*(12), 1291-1294. https://doi.org/10.1016/j.jclinepi.2014.03.013

Cook, S., Richmond, L., Chang, J., Sayce, K., Bonkoski, J., Chen, C., Enevoldsen, J., Fisher, R., Chin, D., & Kia, M. (2024). Marine protected areas and fishing community well-being: An example from statewide socioeconomic monitoring of the California MPA network. *Ocean & Coastal Management*, *254*, 107199. https://doi.org/10.1016/j.ocecoaman.2024.107199

Cooke, S. J., Piczak, M. L., Nyboer, E. A., Michalski, F., Bennett, A., Koning, A. A., Hughes, K. A., Chen, Y., Wu, J., Cowx, I. G., Koehnken, L., Raghavan, R., Pompeu, P. S., Phang, S., Valbo-Jørgensen, J., Bendixen, M., Torres, A., Getahun, A., Kondolf, G. M., … Taylor, W. W. (2024). Managing exploitation of freshwater species and aggregates to protect and restore freshwater biodiversity. *Environmental Reviews*, *32*(3), 414-437. https://doi.org/10.1139/er-2022-0118

Cunha, M. E., Quental-Ferreira, H., Parejo, A., Gamito, S., Ribeiro, L., Moreira, M., Monteiro, I., Soares, F., & Pousão-Ferreira, P. (2019). Methodology for assessing the individual role of fish, oyster, phytoplankton and macroalgae in the ecology of integrated production in earthen ponds. *MethodsX*, *6*, 2570-2576. https://doi.org/10.1016/j.mex.2019.10.016

Effiong, M. O., & Ogbonna, C. U. (2017). Ecosystem perception among artisanal fishermen: A case study of Akpabuyo and Bakassi coastal fishing communities in cross River State, Nigeria. *Annual Research and Review in Biology*, *19*(1). Scopus. https://doi.org/10.9734/ARRB/2017/37431

Elegbede, I. O., Al Jufaili, Saud. M., Jolaosho, T. L., Tesleem, B., Adekunle, A. F., Modupe, O. O., Adekunle, S. M., & Halimat, A.-A. (2025). Health-related dimensions of fishers for sustainable commercial fisheries in the Atlantic Gulf of Guinea: Ecological and social assessments. *One Health*, *20*, 100972. https://doi.org/10.1016/j.onehlt.2025.100972

Elliott, V., Araya, C. C., Aura, C. M., Bice, C., Cole, J., De la Fuente, E. S., Earl, J., Fiorella, K. J., Leiva, A.-J. R., Leiva, D., Loury, E., Luehring, M., Ounboundisane, S., Ray, A., Rose, J. D., & Shultz, A. (2022). Inland Fisheries Management—Exploitation and Livelihoods. En T. Mehner & K. Tockner (Eds.), *Encyclopedia of Inland Waters (Second Edition)* (pp. 318-330). Elsevier. https://doi.org/10.1016/B978-0-12-819166-8.00189-4

Gómez, S., & Maynou, F. (2021). Balancing ecology, economy and culture in fisheries policy: Participatory research in the Western Mediterranean demersal fisheries management plan. *Journal of Environmental Management*, *291*, 112728. https://doi.org/10.1016/j.jenvman.2021.112728

Grati, F., Druon, J.-N., Gascuel, D., Absil, C., Bastardie, F., Bonanomi, S., Fabi, G., Glemarec, G., Guitton, J., Hornborg, S., Iriondo, A., Jung, A., Kalogirou, S., Li Veli, D., Lloret, J., Maravelias, C., Moutopoulos, D. K., Raid, T., Rindorf, A., … Lucchetti, A. (2025). Fisheries performance indicators for assessing the ecological sustainability of wild-caught seafood products in Europe. *Environmental and Sustainability Indicators*, *26*, 100632. https://doi.org/10.1016/j.indic.2025.100632

Henriksson, P. J. G., Troell, M., Banks, L. K., Belton, B., Beveridge, M. C. M., Klinger, D. H., Pelletier, N., Phillips, M. J., & Tran, N. (2021). Interventions for improving the productivity and environmental performance of global aquaculture for future food security. *One Earth*, *4*(9), 1220-1232. https://doi.org/10.1016/j.oneear.2021.08.009

Ingle, K. N., Polikovsky, M., Fenta, M. C., Ingle, A. S., & Golberg, A. (2022). Integration of multitrophic aquaculture approach with marine energy projects for management and restoration of coastal ecosystems of India. *Ecological Engineering*, *176*, 106525. https://doi.org/10.1016/j.ecoleng.2021.106525

Kalumbi, L. R., Thaulo, C., MacPherson, E. E., & Morse, T. (2020). Perspectives and Practices on Water, Sanitation, and Hygiene from a Fishing Community along Lake Malombe, Southern Malawi. *International Journal of Environmental Research and Public Health*, *17*(18), Article 18. https://doi.org/10.3390/ijerph17186703

Kumar, R., Verma, A., Shome, A., Sinha, R., Sinha, S., Jha, P. K., Kumar, R., Kumar, P., Shubham, Das, S., Sharma, P., & Vara Prasad, P. V. (2021). Impacts of Plastic Pollution on Ecosystem Services, Sustainable Development Goals, and Need to Focus on Circular Economy and Policy Interventions. *Sustainability*, *13*(17), Article 17. https://doi.org/10.3390/su13179963

Liu, H., Peng, D., Yang, H.-J., Mu, Y., & Zhu, Y. (2023). Exploring the evolution of sustainable fisheries development: Focusing on ecological, environmental and management issues. *Ecological Informatics*, *75*, 102004. https://doi.org/10.1016/j.ecoinf.2023.102004

Loayza-Aguilar, R. E., Huamancondor-Paz, Y. P., Saldaña-Rojas, G. B., & Olivos-Ramirez, G. E. (2023). Integrated Multi-Trophic Aquaculture (IMTA): Strategic model for sustainable mariculture in Samanco Bay, Peru. *Frontiers in Marine Science*, *10*. https://doi.org/10.3389/fmars.2023.1151810

López-Ercilla, I., Rocha-Tejeda, L., Fulton, S., Espinosa-Romero, M. J., Torre, J., & Fernández Rivera-Melo, F. J. (2024). Who pays for sustainability in the small-scale fisheries in the global south? *Ecological Economics*, *226*, 108350. https://doi.org/10.1016/j.ecolecon.2024.108350

Milijasevic, M., Veskovic-Moracanin, S., Babic Milijasevic, J., Petrovic, J., & Nastasijevic, I. (2024). Antimicrobial Resistance in Aquaculture: Risk Mitigation within the One Health Context. *Foods*, *13*(15), Article 15. https://doi.org/10.3390/foods13152448

Moghimi Dehkordi, M., Pournuroz Nodeh, Z., Soleimani Dehkordi, K., salmanvandi, H., Rasouli Khorjestan, R., & Ghaffarzadeh, M. (2024). Soil, air, and water pollution from mining and industrial activities: Sources of pollution, environmental impacts, and prevention and control methods. *Results in Engineering*, *23*, 102729. https://doi.org/10.1016/j.rineng.2024.102729

Muyot, M. C., Balunan, R. L., & Mutia, M. T. M. (2021). Supply and Value Chain Analysis of Freshwater Sardine, Sardinella tawilis (Herre 1927), in Taal Lake, Batangas, Philippines. *Philippine Journal of Fisheries*, *28*(1), 60-76. Scopus. https://doi.org/10.31398/tpjf/28.1.2020A0016

Nhabe, T., & Malebo, N. J. (2025). Assessing food safety and hygiene practices in old age homes in Mangaung and Lejweleputswa regions, free state. *Frontiers in Food Science and Technology*, *5*, 1541499. https://doi.org/10.3389/frfst.2025.1541499

Nyamweya, C., Lawrence, T. J., Ajode, M. Z., Smith, S., Achieng, A. O., Barasa, J. E., Masese, F. O., Taabu-Munyaho, A., Mahongo, S., Kayanda, R., Rukunya, E., Kisaka, L., Manyala, J., Medard, M., Otoung, S., Mrosso, H., Sekadende, B., Walakira, J., Mbabazi, S., … Nkalubo, W. (2023). Lake Victoria: Overview of research needs and the way forward. *Journal of Great Lakes Research*, *49*(6), 102211. https://doi.org/10.1016/j.jglr.2023.06.009

Oliveros, A. D., Bernier, D., Obando-Chaves, M., & Váquiro, H. A. (2019). Overall Quality and Sanitation Evaluation of Fish Stores at Local Markets in Ibagué, Tolima, Colombia. *Journal of Food Protection*, *82*(6), 1016-1021. https://doi.org/10.4315/0362-028X.JFP-18-209

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *Systematic Reviews*, *10*(1), 89. https://doi.org/10.1186/s13643-021-01626-4

Pinto Jimenez, C. E., Keestra, S., Tandon, P., Cumming, O., Pickering, A. J., Moodley, A., & Chandler, C. I. R. (2023). Biosecurity and water, sanitation, and hygiene (WASH) interventions in animal agricultural settings for reducing infection burden, antibiotic use, and antibiotic resistance: A One Health systematic review. *The Lancet Planetary Health*, *7*(5), e418-e434. https://doi.org/10.1016/S2542-5196(23)00049-9

Pozza, L. E., & Field, D. J. (2020). The science of Soil Security and Food Security. *Soil Security*, *1*, 100002. https://doi.org/10.1016/j.soisec.2020.100002

Rosa, J., Lemos, M. F. L., Crespo, D., Nunes, M., Freitas, A., Ramos, F., Pardal, M. Â., & Leston, S. (2020). Integrated multitrophic aquaculture systems – Potential risks for food safety. *Trends in Food Science and Technology*, *96*, 79-90. Scopus. https://doi.org/10.1016/j.tifs.2019.12.008

Rusco, G., Roncarati, A., Di Iorio, M., Cariglia, M., Longo, C., & Iaffaldano, N. (2024). Can IMTA System Improve the Productivity and Quality Traits of Aquatic Organisms Produced at Different Trophic Levels? The Benefits of IMTA—Not Only for the Ecosystem. *Biology*, *13*(11), Article 11. https://doi.org/10.3390/biology13110946

Samikwa, E., Kapute, F., Tembo, M., Phiri, T., & Holm, R. H. (2019). Identification of critical control points using water quality as an indicator of hygiene for artisanal fisheries on Lake Malawi. *Lakes & Reservoirs: Science, Policy and Management for Sustainable Use*, *24*(1), 3-12. https://doi.org/10.1111/lre.12248

Sandlund, O. T., Berge, E., Flø, B. E., Næsje, T. F., Saksgard, R., & Ugedal, O. (2004). Whitefish fisheries in mountainous southeastern Norway: Abundant resources, but scarce fisherman. *Mountain Research and Development*, *24*(1), 67-74. Scopus. https://doi.org/10.1659/0276-4741(2004)024[0067:wfimsn]2.0.co;2

Selvaraj, J. J., Guerrero, D., Cifuentes-Ossa, M. A., & Guzmán Alvis, Á. I. (2022). The economic vulnerability of fishing households to climate change in the south Pacific region of Colombia. *Heliyon*, *8*(5), e09425. https://doi.org/10.1016/j.heliyon.2022.e09425

Shinde, S. V., Sukhdhane, K. S., Sawant, S. S., Krishnani, K. K., Munilkumar, S., Majeedkutty, B. R. A., Chanu, T. I., & Pathak, M. S. (2024). Amelioration of water quality and physiological performance of GIFT fish through the incorporation of Lemna minor and Lamellidens marginalis for ecological bioremediation in freshwater integrated multi-trophic aquaculture system. *Aquaculture International*, *32*(6), 7151-7171. https://doi.org/10.1007/s10499-024-01507-2

Spillias, S., von Herzen, B., & Holmgren, D. (2024). Marine permaculture: Design principles for productive seascapes. *One Earth*, *7*(3), 431-443. https://doi.org/10.1016/j.oneear.2024.01.012

Tabe-Ojong, M. P. J., Goussard Vincent, M., Kedinga, M. E., Ride, A., Schutter, M. S., Steenbergen, D., & Eriksson, H. (2025). Social protection and aquatic food systems. *Environmental Science & Policy*, *168*, 104043. https://doi.org/10.1016/j.envsci.2025.104043

Tidd, A. N., Caballero, V., Ojea, E., Watson, R. A., & García Molinos, J. (2023). Estimating global artisanal fishing fleet responses in an era of rapid climate and economic change. *Frontiers in Marine Science*, *10*. https://doi.org/10.3389/fmars.2023.997014

Tohonon, A. C., Ouétchéhou, R., Hounsou, M., Zannou, O., & Dabadé, D. S. (2025). Food hygiene in Sub-Saharan Africa: A focus on catering services. *Food Control*, *168*, 110938. https://doi.org/10.1016/j.foodcont.2024.110938

Torralba-Burrial, A., & Dopico, E. (2023). Promoting the Sustainability of Artisanal Fishing through Environmental Education with Game-Based Learning. *Sustainability*, *15*(17), Article 17. https://doi.org/10.3390/su151712905

Troell, M., Costa-Pierce, B., Stead, S., Cottrell, R. S., Brugere, C., Farmery, A. K., Little, D. C., Strand, Å., Pullin, R., Soto, D., Beveridge, M., Salie, K., Dresdner, J., Moraes-Valenti, P., Blanchard, J., James, P., Yossa, R., Allison, E., Devaney, C., & Barg, U. (2023). Perspectives on aquaculture’s contribution to the Sustainable Development Goals for improved human and planetary health. *Journal of the World Aquaculture Society*, *54*(2), 251-342. https://doi.org/10.1111/jwas.12946

Valenti, W. C., Barros, H. P., Moraes-Valenti, P., Bueno, G. W., & Cavalli, R. O. (2021). Aquaculture in Brazil: Past, present and future. *Aquaculture Reports*, *19*, 100611. https://doi.org/10.1016/j.aqrep.2021.100611

Vázquez Pinillos, F. J., & Barragán Muñoz, J. M. (2024). Progress and challenges for the establishment of a sustainable blue economy in Chiloe (Chile): Exploring the connections of a socio-ecological system. *Ocean & Coastal Management*, *257*, 107323. https://doi.org/10.1016/j.ocecoaman.2024.107323

Verdegem, M., Buschmann, A. H., Latt, U. W., Dalsgaard, A. J. T., & Lovatelli, A. (2023). The contribution of aquaculture systems to global aquaculture production. *Journal of the World Aquaculture Society*, *54*(2), 206-250. https://doi.org/10.1111/jwas.12963

Wani, N. R., Rather, R. A., Farooq, A., Padder, S. A., Baba, T. R., Sharma, S., Mubarak, N. M., Khan, A. H., Singh, P., & Ara, S. (2024). New insights in food security and environmental sustainability through waste food management. *Environmental Science and Pollution Research*, *31*(12), 17835-17857. https://doi.org/10.1007/s11356-023-26462-y

Yang, H., Tang, B., Zhou, H., Zhong, P., & Zhao, L. (2025). Research on the Construction of an Integrated Multi-Trophic Aquaculture (IMTA) Model in Seawater Ponds and Its Impact on the Aquatic Environment. *Water*, *17*(6), Article 6. https://doi.org/10.3390/w17060887