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Ocean Action Panels

ADVANCE UNEDITED

Ocean Action Panel 9: Promoting the role of sustainable food from the ocean for poverty eradication and food security

Concept paper prepared by the Secretariat

Summary

The present concept paper was prepared pursuant to paragraph 24 of General Assembly resolution 78/128, in which the Assembly requested the Secretary-General of the 2025 United Nations Conference to Support the Implementation of Sustainable Development Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development to prepare concept papers on each of the themes of the Ocean Action Panels, taking into account the relevant ocean-related processes of the Assembly and other possible contributions. The present paper relates to Ocean Action Panel 9, entitled "Promoting the role of sustainable food from the ocean for poverty eradication and food security". In the paper, the status, trends, challenges and opportunities for the achievement of relevant targets of Sustainable Development Goal 14 are set out, under the overarching theme of the Conference: "Accelerating action and mobilizing all actors to conserve and sustainably use the ocean".

I. Introduction

1. Aquatic foods are fundamental to food security and poverty alleviation [1], especially as climate change and biodiversity loss increasingly threaten global food systems and livelihoods. Ocean-based food sources are rich in essential nutrients, including iodine, selenium, iron, zinc, calcium, and vitamins A, B12, and D. They also provide high-quality proteins and long-chain polyunsaturated fatty acids, playing a critical role in health and vital for cognitive development and heart disease prevention. Moreover, fisheries and aquaculture generate jobs, income and livelihoods for millions of people. When properly managed, many aquatic food systems have a lower environmental footprint and offer climate-resilient alternatives compared to traditional land-based food systems.

2. To maintain current per capita consumption of aquatic animal foods through 2050, a 22 percent increase in its total supply will be necessary. However, this increase must be achieved through responsible practices to safeguard food security[2] and health for present and future generations. The required supply growth will vary by region, achieved through a combination of increased domestic production and, where feasible, strategic imports. It is crucial to thoroughly evaluate the challenges and opportunities to maximize the role of aquatic foods in achieving food security and poverty reduction, while also building resilience to future disruptions. While capture fisheries production has remained relatively stable since the mid-1990s, aquaculture continues to be the fastest-growing food production system, and it is expected that this trend will continue in future decades. However, effective management of the fisheries sector is essential, and the expansion of aquaculture must occur in an environmentally sustainable and socially responsible manner. Furthermore, efficiently using fisheries by-products and minimizing food loss and waste, while maintaining food safety, present key opportunities to enhance access to aquatic foods.

3. Sustainable fisheries management and supporting small-scale fishers, as well as women, vital to the post-harvest sector, are crucial for maximizing the contributions of aquatic foods to food security and poverty eradication. The effects of climate change are already evident, particularly among vulnerable coastal communities, highlighting the urgent need for action to ensure food security, nutrition, and poverty reduction efforts. Aquatic foods are among the most traded food commodities, often viewed primarily through economic objectives, with less emphasis on their critical roles in providing food security, nutrition, sustaining livelihoods and eradicating poverty, especially for vulnerable populations across different countries. While increasing the availability of aquatic foods is important, it is essential to ensure access to these foods. The potential of aquatic food systems to efficiently nourish millions while maintaining a low environmental footprint is well documented. However, to fully realize this potential, these systems must be transformed to align with the current global realities. This aligns with the FAO Blue Transformation roadmap[3], which outlines strategies to enhance the sustainability, resilience, and equity of aquatic food systems and maximize their contribution to the Sustainable Development Goals (SDGs).

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[1] https://doi.org/10.1038/s41586-021-03917-1

[2] A situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. Based on this definition, four food security dimensions can be identified: food availability, economic and physical access to food, food utilization, and stability over time. (FAO)

[3] FAO. 2022. https://doi.org/10.4060/cc0459en

II. Status and trends

Production

4. Total fisheries and aquaculture production has steadily grown since 1950. Yet, since the late 1980s aquaculture has become a key driver of growth in global fisheries and aquaculture production (reaching 60 percent of total production in 2023), playing a critical role in addressing the rising demand for aquatic foods (Figure 1). Despite the increasing role of aquaculture, capture fisheries remain dominant for a number of species and vital for domestic and international food security. Small-scale fisheries (SSF) are responsible for about 40 percent of global capture fisheries production, with two-thirds of SSF catches occurring in marine fishing areas[4].

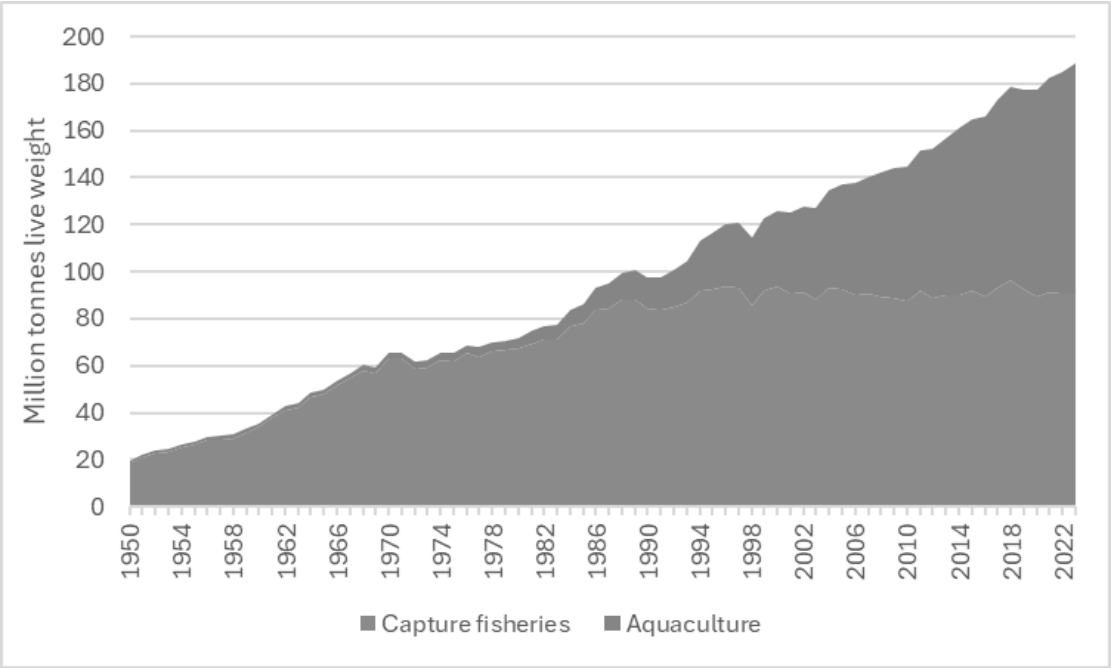
5. Total fisheries and aquaculture production (marine and freshwater) reached a record high of 227.9 million tonnes in 2023, comprising 188.9 million tonnes (live weight equivalent) of aquatic animals and 39.0 million tonnes (wet weight) of algae. It is estimated that 66 percent originated from marine species, whether captured or farmed.

6. Since 2000, fisheries and aquaculture production of marine species increased by 1.5 percent per year on average while total production increased by 2.3 percent over the same period. As a result, the share of production of marine species in total production has been decreasing over time, from 78 percent in 2000 to 66 percent in 2023. The main driver for production of marine species has been aquaculture.

Figure 1. World fisheries and aquaculture production of aquatic animals, 1950-2023[5]

[4] FAO, 2023. https://doi.org/10.4060/cc6062en

[5] FAO. 2025 www.fao.org/fishery/en/statistics/software/fishstatj License: CC-BY-4.0.



International Trade

7. International trade in aquatic products plays a significant role in food security, through imports by enhancing access to aquatic foods and through exports by generating employment and income in the fisheries and aquaculture sector in response to foreign demand. Given regional disparities in production, trade facilitates the global distribution of aquatic foods and their nutrients.

8. In 2023, exports of all aquatic products totalled USD 194 billion, with an estimated 76 percent originating from marine products. Among marine products, it is estimated that approximately 91 percent of the value in 2023 corresponds to marine food products.

9. While international trade in marine products has steadily increased, it has grown at a slower pace than total trade in aquatic products. Since 2000, the annual growth rate of trade in marine products has averaged 4.7 percent, while total trade in aquatic products has grown by 5.3 percent annually. In 2000, marine products represented 87 percent of all traded aquatic products, but this share decreased to 76 percent by 2023.

10. In addition to goods, services related to fisheries and aquaculture are also traded internationally, ge nerating income and supporting economies, though they are difficult to isolate in existing trade-in-services data. To address this, UNCTAD has developed a classification of “trade in fisheries services” based on the Common Product Classification, Revision 2.1[6] as part of its Ocean Economy classification

[6] https://unstats.un.org/unsd/classifications/unsdclassifications/cpcv21.pdf

(2020)[7] that could be used when gathering country level data for this sector to provide a more complete picture of the importance of international trade in services related to this sector.

Consumption

11. The supply of aquatic animal foods available for human consumption has increased over time, due to both higher production levels and a reduction in the share used for non-food purposes. In 2022, 89 percent of aquatic animal production was available for human consumption, up from 67 percent in the 1960s. The remaining 11 percent was used mainly to produce fishmeal and fish oil. Considering marine production only, the share of non-food purposes increases to about 18 percent, as the bulk of the raw material used to produce fishmeal and fish oil consists of marine fish.

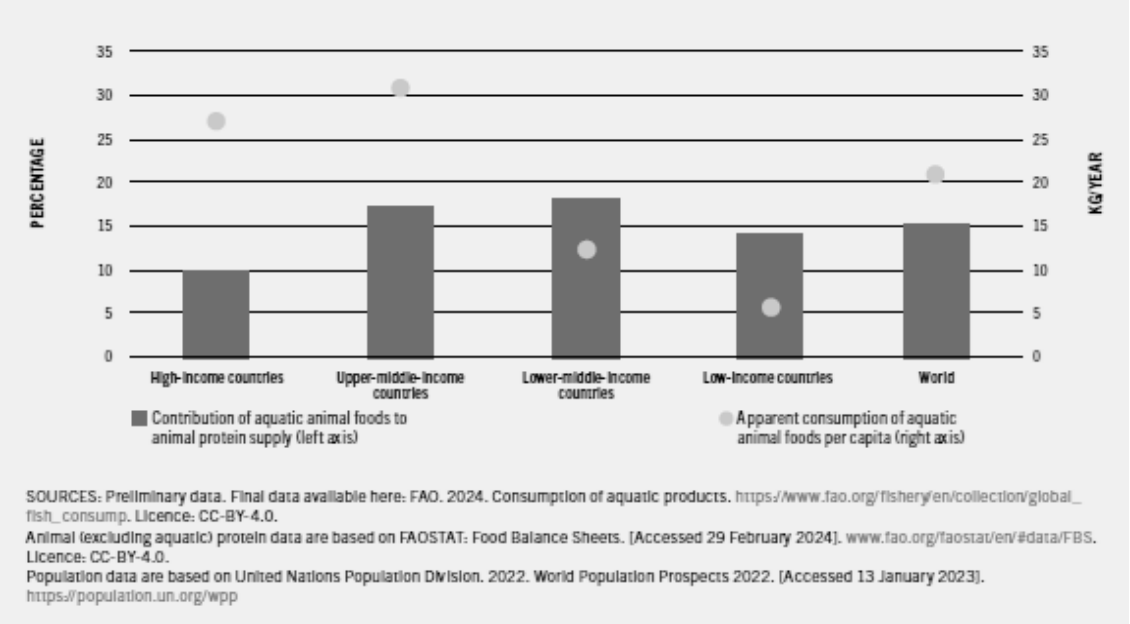
12. By-products that have been traditionally discarded as waste are increasingly being repurposed for both food and non-food uses. For instance, in 2022, by-products accounted for 34 percent and 53 percent of the total production of fishmeal and fish oil, respectively.

13. In 2021, aquatic animal food supply destined for human consumption was estimated at 20.6 kg per capita. Approximately 60 percent came from marine species, while the remainder was sourced from freshwater and diadromous species.

14. Globally, aquatic animal foods provided 15 percent of animal proteins in 2021 but are increasingly recognized for their important contribution to minerals, vitamins and omega-3 fatty acids. Low- and middle-income countries rely more on aquatic animal proteins and other nutrients than high-income countries, although, absolute per capita consumption of aquatic animal foods is significantly lower in low-income countries (Figure 2). For example, in Africa, where consumption averaged just 9.4 kg per capita in 2021, aquatic animal foods still provided 18 percent of animal proteins - above the global average.

Figure 2. Apparent consumption of aquatic animal foods per capita and contribution to supply of animal proteins by economic class, 2021

[7] https://unctad.org/system/files/official-document/ditcted2020d4_en.pdf



SOURCES: Preliminary data. Final data available here: FAO. 2024. Consumption of aquatic products. https://www.fao.org/fishery/en/collection/global_fish_consump. Licence: CC-BY-4.0.
Animal (excluding aquatic) protein data are based on FAOSTAT: Food Balance Sheets. [Accessed 29 February 2024]. www.fao.org/faostat/en/#data/FBS. Licence: CC-BY-4.0.
Population data are based on United Nations Population Division. 2022. World Population Prospects 2022. [Accessed 13 January 2023]. https://population.un.org/wpp

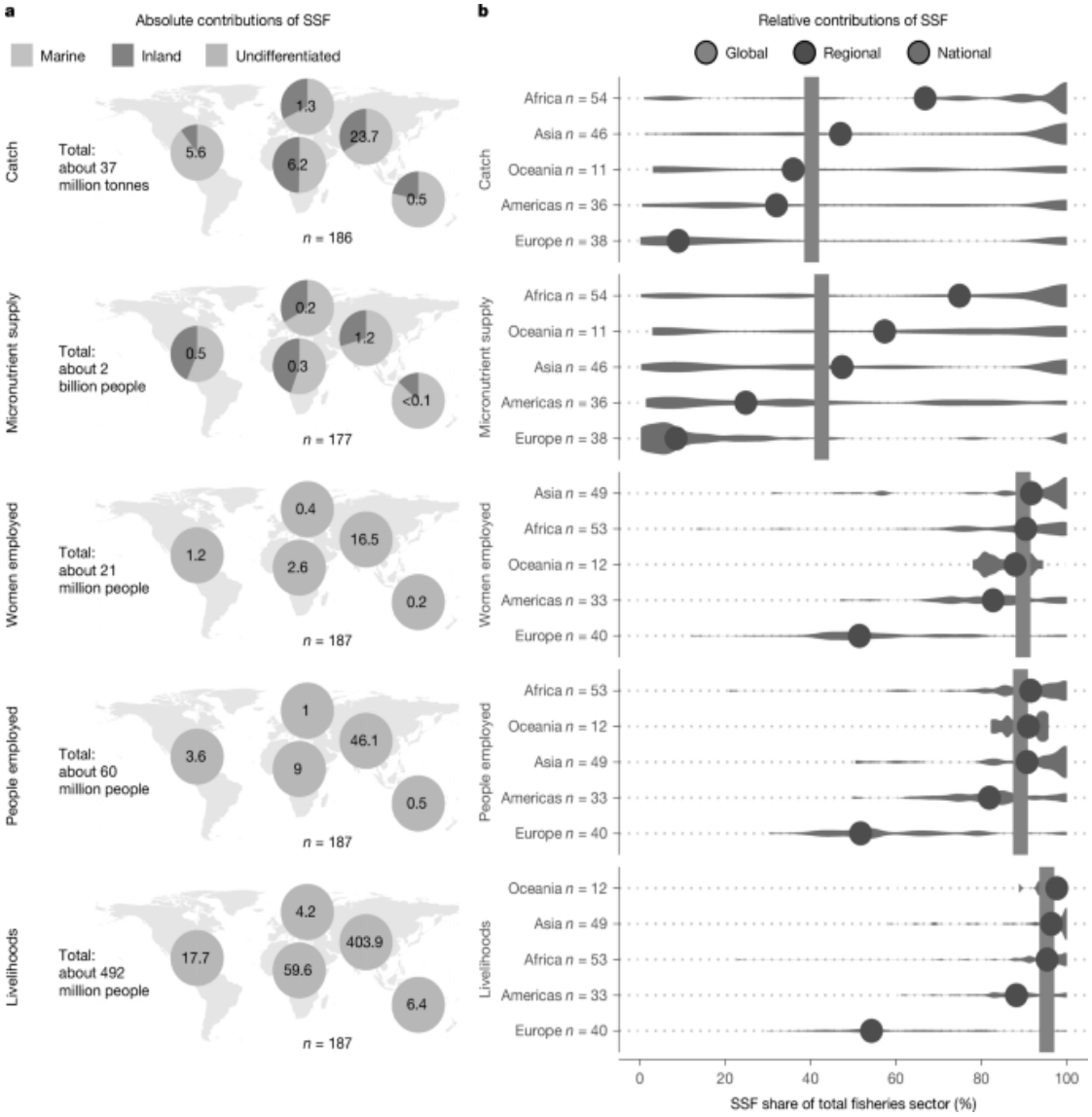
Supporting Livelihoods

15. The fisheries and aquaculture sectors, both marine and inland, support the livelihoods of approximately 600 million people globally, including 62 million directly employed in the fisheries and aquaculture primary sector. For capture fisheries, almost 500 million people depend at least partially on SSF to support their livelihoods[8].

16. The global Illuminating Hidden Harvests Study estimated that 27.5 million people were employed part or full time in the harvesting segment of the value chain, of which 47 percent were from marine small-scale fisheries. Despite their vital role in nutrition, livelihoods, and global fisheries, SSF lack sufficient recognition and both technical and economic support. This is particularly the case for women.

[8] FAO 2023 https://doi.org/10.4060/cc6062en

Figure 3. SSF Multidimensional Contributions to Sustainable Development[9]



17. In SSF, women constitute 40 percent of the workforce (Figure 3), especially in the post-harvest sector[8]. Overall, women play a crucial role in fisheries and aquaculture, not only as a key player in the post-harvest sector but also in leadership and decision-making as well as unpaid labor, subsidizing the fishing economy[10,11]. They also play a critical role in ensuring food security for their family and community. However, women often face disadvantages in accessing resources and

[9] https://doi.org/10.1038/s41586-024-08448-z
[10] https://digitalarchive.worldfishcenter.org/server/api/core/bitstreams/fcbcc3b0-1dcf-4d0b-853c-344a46f47a0d/content
[11] Biswas, N. (2018). "Where have all the women gone?" Yemaya: ICSF's Newsletter on Gender and Fisheries 57:7.

services, including credit, transport, training, information, technologies, and extension systems[12].

Losses and Waste

18. A report by the World Economic Forum from April 2024, reveals that global edible aquatic food loss and waste (FLW) totalled approximately 23.8 million tonnes in 2021, representing 14.8 percent of the total aquatic food produced that year. This figure does not include losses associated with processing at sea, aquaculture production and SSF due to the lack of reliable data[13]. This may be a conservative figure as estimates made by FAO in 2011 suggests that aquatic food value chains globally encounter about 35 percent loss and waste. This share may be higher in low-income, rural areas which lack cold-chain technologies and in those with high climatic variability such as heavy rainfalls leading to high losses[14].

III. Challenges and Opportunities

Stock Status

19. Overfishing remains a critical issue and threatens the long-term viability of aquatic food systems and global food security. Despite notable improvements in some regions, the state of marine fisheries resources remains a concern. The proportion of marine fishery stocks within biologically sustainable levels fell to 62.3 percent in 2021 (Figure 4). However, when weighed by their production levels, an estimated 76.9 percent of the 2021 landings from FAO-monitored stocks came from biologically sustainable stocks. Similarly, 86 percent of major tuna stocks were within biologically sustainable levels. These results highlight that effective fisheries management can lead to stock recovery and increased catches, underscoring the urgent need to expand enforcement efforts to reverse the downward trend.

[12] FAO. 2023. https://www.fao.org/fileadmin/templates/cfs/Docs2223/Gender/Guidelines_Final_Agreed_Version_June_2023_CLEAN/GEWGE_Guidelines_Final_Agreed_Version_June_2023_CLEAN.pdf

[13] https://www3.weforum.org/docs/WEF_Investigating_Global_Aquatic_Food_Loss_and_Waste_2024.pdf

[14] https://www.fao.org/4/mb060e/mb060e00.pdf

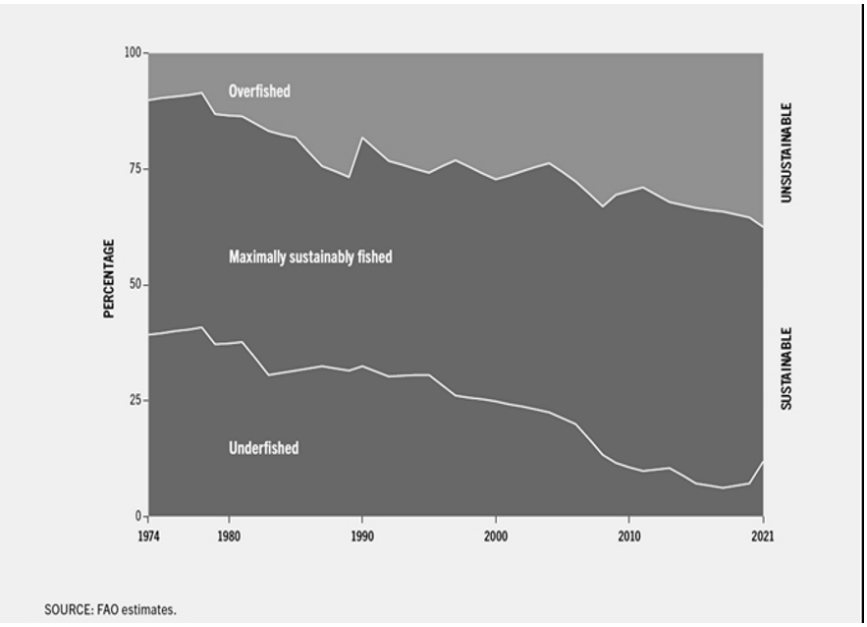


Figure 4. Global trends in the state of the world's marine fishery stocks, 1974-2021[15]

Trade opportunities and barriers

20. International trade of aquatic products bears high potential for enhancing food security and nutrition. Export growth not only improves a country's balance of payment but can also bolster food security by increasing local production capacity and generating income among the most vulnerable countries. Countries such as China, Chile, Viet Nam, and India have developed a strong export sector, while other countries are developing their exports building on their comparative advantage[16]. However, some countries face challenges, including tariff and non-tariff measures such as sanitary and technical barriers, and transport costs, which increase compliance expenses and restrict market access, particularly for small-scale operators.

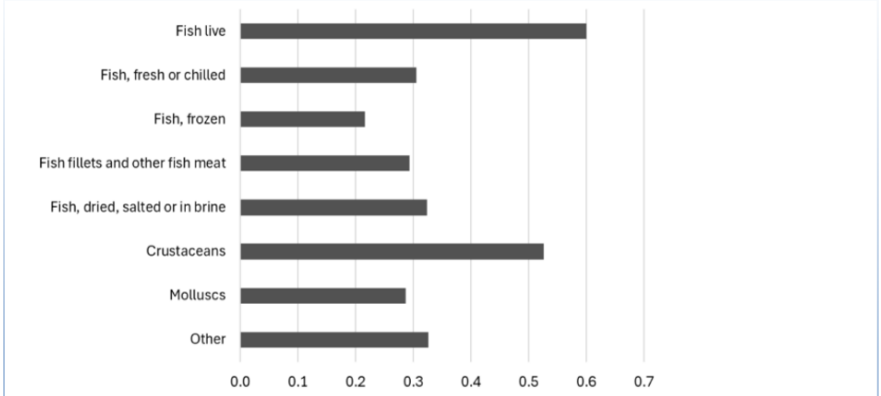
21. A main obstacle for exports of aquatic products consists in their comparatively high transport costs relative to the traded volume. In 2021, the average costs for international transport of one kilogram of fish, crustaceans, molluscs and other aquatic invertebrates amounted to USD 0.30, as compared to USD 0.10 for the international trade of agricultural commodities in total.

22. High transport costs are a challenge especially for poorer economies to sell their fish and other aquatic products on the global market. As Figure 5 shows, transport of live fish (USD0.60 per kg) and crustaceans (USD0.53 per kg) is especially

[15] FAO. 2024. https://doi.org/10.4060/cd0683en
[16] https://unctad.org/publication/south-south-trade-marine-fisheries-and-aquaculture-sectors

costly, whereas transporting fish frozen allows considerable transport costs saving (USD0.22 per kg). In 2021, transport of aquatic commodities by air were on average six times more costly (USD2.44 per kg) than their transport by sea (US0.34 per kg).

Figure 5. Transport costs for international trade of aquatic commodities, 2021 (USD per kilogram



Source: UNCTAD and World Bank (2024), Trade-and-Transport Dataset, UNCTADstat.
Notes: Commodities in Chapter 03 of the Harmonized System classification are considered. Insurance and freight costs are included in transport costs.

Supporting Livelihoods and Eradication of Poverty

23. The sustainability of fisheries, and particular SSF is critical for the communities that rely on them for food security, income and economic stability. Overfishing threatens SSF by depleting marine resources, jeopardizing livelihoods. Many SSFs operate in overexploited waters where fish stocks decline due to poor management and slow adoption and limited enforcement of regulations. Illegal, unreported, and unregulated (IUU) fishing exacerbates this problem, undermining legitimate small-scale fishers, also limiting development aid inflows from the donor community.

24. Climate change significantly impacts SSF and increases the vulnerability of coastal communities. Efforts to address climate resilience and adaptation of SSF are essential to maintain its sustainability and long-term contribution to food security. The UNCTAD Blue BioTrade Principles and Criteria[17] provide guidelines for the conservation, sustainable use and equitable benefit sharing of marine biodiversity-based products. Addressing these socio-economic barriers is crucial for empowering SSF and enabling them to thrive in competitive markets.

25. Barriers such as socio-economic challenges, limited access to markets, financial services, and infrastructure hinder sustainable practices, economic improvement, and participation in value-added activities. Marginalization from policymaking

[17] https://unctad.org/topic/trade-and-environment/biotrade/principles-and-criteria

further entrenches poverty and inequality. Social protection mechanisms play a vital role in fostering resilience among vulnerable fishing communities. Through addressing both immediate needs and long-term stability, these programs not only enhance livelihoods but also promote sustainable fishing practices. Social protection mechanisms are crucial for supporting SSF.

26. By enhancing capacity-building efforts, we can empower communities to not only protect their livelihoods but also contribute to broader environmental and economic objectives. Implementing the SSF Guidelines provides a framework for integrating SSF into national and regional development strategies. Capacity-building initiatives, including training in sustainable fishing practices, financial management, gender-related issues and advocacy, empower fishers to participate more effectively in governance and market systems.

Ensuring Food Security and Nutrition for a Growing Population

27. All food production systems face the challenge of meeting future demand, and aquatic food systems are no exception. With the global population projected to reach 9.7 billion by 2050, the demand for high-quality foods such as aquatic foods, will intensify. At the same time, climate change poses additional challenges and threats, affecting the health of aquatic ecosystems, altering fish migration patterns, and influencing the availability of marine and freshwater resources, further complicating efforts to meet the growing demand.

Exploiting the Full Potential of Aquaculture

28. Aquaculture has emerged as a major contributor to global food supply, now accounting for over 57 percent of aquatic animal supply available for human consumption and this share is expected to grow in the coming decades. This growth has helped to alleviate pressure on overfished stocks while meeting rising demand for animal-sourced foods. However, aquaculture production is geographically concentrated, with 89 percent located in Asia in 2023. This underdevelopment in other areas may limit the regional and global accessibility to aquaculture products and hinder food security as well as economic opportunities.

29. Farmed marine finfish rely on feed which contains certain levels of marine ingredients increasingly used selectively at specific stages of production due to high prices. Future increases in fishmeal and fish oil will mainly need to come from fish by-products and other sources. Research is focusing on alternative sources of marine ingredients, such as fish silage, insect and bacterial meals, in addition to vegetable alternatives as well as algae. Also, marine zooplankton are used, such as krill (*Euphausia superba*) or the copepod (*Calanus finmarchicus*), which are harvested to produce oil-derived products for human consumption as well as feed.

30. In 2023, about a quarter of the aquaculture production of aquatic animals consisted of non-fed species. Farming of bivalves and other low trophic species is an alternative with less impact on the environment that can provide highly nutritious foods as well as increased diversification.

Algae

31. Aquatic foods come from more than just animals. Specifically, seaweeds are low-calorie foods which can be rich sources of essential vitamins (A, B, C, D, E, and K), minerals (iodine, calcium, iron, magnesium), dietary fibers, and bioactive compounds like antioxidants and omega-3 fatty acids[18] with some species even high in proteins.

32. Seaweed can help mitigate deficiencies in iodine, vitamin A and iron, affecting billions of people worldwide, particularly children and pregnant women in low- and middle-income countries. Its ability to provide iodine- a key nutrient often lacking in terrestrial crops – makes it a sustainable alternative for regions vulnerable to nutritional deficiencies[19].

33. Interest in the production and utilization of algae (seaweed, micro-algae and cyanobacteria) has increased greatly in recent years, contributing significantly to food security and providing significant employment opportunities for coastal communities. Production of seaweed and other marine algae has significantly increased during the past decades (from 12 million tonnes (wet weight) in 2000 to 39 million tonnes in 2023, with 97 percent of the 2023 production from aquaculture). The sector has potential to further expand thanks to a rising demand for both food and non-food uses, reflecting its growing role in both food security and economic resilience. Innovations such as seaweed cultivation further enhance the sector's potential. Between 2000 and 2021, the global seaweed market tripled, from USD 5 billion in 2000 to USD 17 billion in 2021. Investment in ten new and emerging markets including bio stimulants, animal and pet foods, bioplastics, methane reducing additives, and fabrics could increase the value of seaweed by USD 11.8 billion by 2030[19]. About 40 percent of all seaweed start-ups globally are led by women[19].

34. Heavy metals and marine biotoxins have been associated with some algae/seaweed[20]. However, there is generally a lack of legislation and guidance

[18] UNCTAD (2024). https://unctad.org/publication/ocean-opportunities-potential-seaweed-advance-food-environmental-and-gender-dimensions

[19] World Bank (2023). Global Seaweed New and Emerging Markets Report.

[20] EFSA Journal. 2023; 21: 1: p. 47. doi.org/10.2903/j.efsa.2023.7798

documents regarding the production and use of seaweed[21]. There are currently no Codex Alimentarius standards establishing any food safety criteria for seaweed or other algae.

Access to Aquatic Foods for Nutritionally Vulnerable Populations

35. One of the biggest challenges in realizing food and nutrition security is that nutritious foods from the ocean often do not reach the most nutritionally vulnerable people. For example,[22] in countries where malnutrition persists, the nutrients available from marine fisheries exceed the dietary requirements for coastal populations. If these countries prioritized even a portion of this catch for domestic consumption, several micronutrient deficiencies could be alleviated. Further efforts are required - particularly across more countries - to support evidence-based policymaking connecting aquatic food system policies with health politics.

36. Although most fishmeal and fish oil produced from whole fish originate from well-managed fisheries, there are concerns about the sustainability of certain fisheries in some countries. In these areas, fishmeal production is increasingly occurring in areas inhabited by impoverished coastal communities that rely on these fish for their sustenance and livelihoods. In West Africa for example, increasing amounts of catch are reduced into fishmeal for export purposes, competing with their traditional use for domestic human consumption. While the sale of fish for fishmeal and fish oil may result in increased income, greater income does not always result in improved food security and nutrition. This not only increases the pressure on fishery resources in the absence of proper resource management, but also negatively impacts food security and livelihoods. It is essential to improve governance and fisheries management, while prioritizing the utilization of aquatic species for human consumption and food security[15].

37. Access to aquatic foods may be limited at the household or community level. For example, aquatic food consumption is limited for vulnerable groups such as infants and young children and schoolchildren[23,24]. Existing distribution networks such as school feeding programs offer an opportunity for delivering aquatic foods to nutritionally vulnerable populations. Home grown school feeding programmes can source fish from SSF-reliant communities. Fish products, which are culturally acceptable, age-appropriate and cost-effective have been developed for infants, young children and adolescents benefiting from school feeding programs, to help address this challenge.

[21] FAO and WHO. 2022.. https://doi.org/10.4060/cc0846en
[22] Hicks et al., 2019. Harnessing global fisheries to tackle micronutrient deficiencies | Nature
[23] https://www.sciencedirect.com/science/article/pii/S030691921630001X
[24] https://doi.org/10.3390/foods10092080

38. Innovative aquatic foods such as fish powder processed using whole fish or fisheries by-products can be added to other foods. Local recipes have been developed under research projects supported by FAO and UNIDO. Fish powders have a long shelf life, allowing transportation and distribution to areas further away from fisheries, and have been evidenced for contributing to improved child growth outcomes, particularly in the first 1000 days of life[25,26]. Dried or powdered fish-based products, for instance, are comparable to commercially produced complementary food supplements, such as small-quantity lipid-based supplements, in their iron, zinc, calcium, and fatty acid content[27]. These innovations may be a solution to reaching nutritionally vulnerable, low income, and non-fish consuming populations, if done in an environmentally, economically and socially sustainable way, to ensure that products meet consumer needs.

39. An analysis of Demographic and Health Survey (DHS) data in five countries found that distance to waterbodies was a good predictor for if children consumed fish, and that a greater percentage of children living within 10km of a marine coastline consumed fish[28]. The percentage of children consuming fish decreased drastically the further away from marine coastlines (unless within 5km of inland water bodies)[27]. This highlights the need to adopt cost-effective technologies for improving fish processing and extending the shelf life to allow for distribution to rural, non-fishing areas. Such technologies enable the distribution of marine foods to inland areas, as well as stabilize consumption during seasonal shifts in fish availability. Studies have found that markets in urban centers in low-income countries are an important distribution point for aquatic foods, particularly in their dried form[29,30].

40. Certification of fish-based products can lead to improvements in safety and quality. However, certification processes are costly, leading to products that are less affordable to low-income groups that are often nutritionally vulnerable. Small-scale producers may be deterred from participating, further limiting the availability of affordable, fish-based products. While certification enhances food safety, it can inadvertently contribute to food insecurity by limiting access to essential nutrients for economically disadvantaged populations. Alternatives such as innovative certification models - voluntary certification schemes that ensure the minimum hygiene standards and do not require significant investments-, and government subsidies may be explored to overcome these challenges.

[25] Chipili, G.; Van Graan, A.; Lombard, C.J.; Van Niekerk, E. https://doi.org/10.3390/nu14112191
[26] https://doi.org/10.1093/advances/nmac102.
[27] https://onlinelibrary.wiley.com/doi/full/10.1111/mcn.13192
[28] Arthur, R., ed. 2024. https://doi.org/10.4060/cd2169en
[29] Simmance et al., 2022. https://onlinelibrary.wiley.com/doi/10.1111/faf.12597
[30] Bennett et al., 2022 https://doi.org/10.1038/s43016-022-00642-4

Reduction of Loss and Waste and By-products Utilization

41. Loss and waste of aquatic foods negatively impact food security by diminishing the availability of nutritious, high-quality food for human consumption. Reduction of food loss and waste is an SDG Target (SDG 12.3) as well as a FAO programme priority area, highlighting its role in sustainable food systems.

42. Fish processing generates a significant volume of by-products and represent more than 50 percent of the fish and often not optimally utilized[31]. The by-products are of high nutritional value but are often used for non-food purposes.

43. Processing fish by-products for human consumption is increasingly being recognized as a contributor to greater fish availability for consumption, and to addressing deficiencies in nutrients such as iron, calcium and several micronutrients. Greater use of processing by-products can provide more food without increased capture or harvest and has potential to reduce negative impacts on our oceans and create additional economic activities for fish processors.

44. Developing efficient, cost-effective technologies to process aquatic by-products into value-added products remains a significant challenge, particularly in regions with limited infrastructure or technical expertise. Furthermore, inconsistent regulations governing the use of by-products can also limit innovation and market expansion. Informed decision-making regarding solutions to FLW and the utilization of by-products is hampered by a lack of robust evidenced based data-particularly on the impact of solutions. Reliable and timely data and information is crucial to design realistic solutions strategies and to further implementation, monitoring and evaluation.

Food Safety

45. Food safety, nutrition and food security are interconnected. Unsafe food can contribute to disease and malnutrition, particularly affecting vulnerable populations. However, the benefits of consuming aquatic foods in most cases outweigh the risks associated with their consumption[32]. Yet, food safety issues remain a barrier to consumption of aquatic foods in many places for the general population due to lack of consumer confidence, or for vulnerable groups such as infants and children through nutrition programs such as school meals. Interventions throughout the aquatic food value chain, such as use of ice onboard fishing vessels and proper handling and hygiene during processing, storage and

[31] Olsen, R.L.; Toppe, J.; Karunasagar, I. Challenges and realistic opportunities in the use of by-products from processing of fish and shellfish. Trends in Food Science & Technology 36(2) DOI: 10.1016/j.tifs.2014.01.007

[32] FAO & WHO. 2024. https://doi.org/10.4060/cd2394en

transportation can make large improvements to food safety, particularly in small-scale aquatic food value chains.

46. Unsafe food containing chemical contaminants, toxins, harmful bacteria, viruses or parasites can cause diseases, ranging from diarrhoea to cancers, but this is not specific to aquatic foods. Certain food safety hazards are linked to mismanaged waste or emissions, while others are intrinsically linked to the aquatic environment. For example, each year, norovirus is estimated to cause 125 million cases of foodborne illness and 35 000 deaths globally. In addition, Hepatitis A virus is estimated to cause 14 million cases of foodborne illness and 28 000 deaths globally annually[33]. It is important to note that the risk of illness of these microorganisms is linked to the consumption of raw, undercooked or cross-contaminated foods. Improved hygienic handling and proper cooking will minimize these risks.

47. Excess intake of essential nutrients can also be harmful. For example, iodine in some seaweed species can reach levels that might be harmful if consumed frequently. An excess of iodine can cause thyroid problems, increasing the risk of developing hyperthyroidism, hypothyroidism and goiter, like symptoms of iodine deficiency. However, between 35 and 45 percent of the global population is estimated to suffer from iodine deficiency, thus excess consumption may pose more concern for high consumers of seaweed[34].

48. Harmful algal blooms (HABs) can also have significant impacts on food safety and security through contamination or mass mortalities of aquatic organisms. If not properly controlled, aquatic products contaminated with HABs biotoxins can be responsible for foodborne diseases such as paralytic shellfish poisoning (PSP), amnesic shellfish poisoning (ASP), ciguatera poisoning (CP)[35] and others. When rapidly growing, HAB consequences include reduced dissolved oxygen in the ocean, dead zones, and mass mortalities of aquatic organisms[36].

49. Other hazards such as heavy metals (methylmercury, cadmium, lead), persistent organic pollutants (dioxins and dioxin-like substances, including polychlorinated biphenyls (PCBs) and per and polyfluoroalkyl substances (PFAS) and possible microplastics are often linked to human activities. Factors such as species, fat

[33] FAO and WHO. 2023https://openknowledge.fao.org/server/api/core/bitstreams/4b51630e-c354-4af1-9ec1-78243bd18c29/content
[34]Hatch-McChesney A, Lieberman HR. Iodine and Iodine Deficiency: A Comprehensive Review of a Re-Emerging Issue. Nutrients. 2022 Aug 24;14(17):3474. doi: 10.3390/nu14173474. PMID: 36079737; PMCID: PMC9459956.
[35] FAO. 2004. https://openknowledge.fao.org/items/61b95c70-6790-48fb-a6b6-e41a29792520
[36] FAO, IOC & IAEA. 2023. https://doi.org/10.4060/cc4794en.

content, geography, size, age and trophic position might influence the concentration in aquatic products and eventually raise food safety concerns.

50. Parasites can also be a public health concern when consuming aquatic products. Human fishery product-borne parasitic diseases can be caused by cestodes, trematodes and nematodes. Freezing or cooking before will eventually kill the parasites but not allergic (hypersensitivity) reactions against parasite antigens.

51. Contemporary climate warming is modifying the marine environment and may result in an extension of time during which parasitic eggs can persist. As a result, there may be an increase in the extent of distribution of the parasites[37]. In general, climate change is accelerating the propagation of pathogens and toxins and contributing to the bioavailability of certain chemicals such as mercury. The understanding of the impact of climate change and anthropogenic activities on food safety for aquatic products is limited due to the lack of monitoring data on contaminants, harmful algal blooms, and toxins, as well as pathogenic bacteria, viruses, and parasites.

52. The establishment of monitoring and early warning systems by governments and businesses could help understand the links between various parameters and the presence and concentration of the hazards. This could prevent food safety outbreaks due to the consumption of aquatic products and support the implementation of initiatives to mitigate these issues. Increased scientific knowledge and research for ocean health can support decision making for the reduction of marine pollution, which is key for food safety for aquatic products and therefore for achieving food security (SDG2).

IV. Solutions to challenges and opportunities

Methods for Ensuring Sustainable Supply

53. Ensuring a stable and sustainable supply of aquatic products is critical for advancing global food security, especially in regions where inadequate infrastructure and environmental pressures hinder aquatic food production. To maintain a consistent supply throughout the year, it is essential to mitigate seasonal variations by processing aquatic products during periods of abundance. This makes them shelf-stable and available when fresh products are scarce. An important initiative is the FAO Blue Transformation roadmap which focuses on sustainable fisheries and aquaculture, promoting innovative solutions to expand aquatic food systems and enhance their contribution to food security and nutrition, conserve

[37] Jerzy Rokicki. 2009. https://doi.org/10.1016/j.polar.2009.06.002.

marine and freshwater ecosystems, foster inclusive economic growth and support livelihoods of coastal and riparian communities.

Improve fisheries management

54. Improving fisheries management is a fundamental requirement to ensure a sustainable supply of aquatic foods from capture fisheries. In the long term, effectively managed fisheries can provide a more stable and resilient aquatic food supply, especially for vulnerable populations reliant on aquatic foods for healthy diets and livelihoods[38].

55. Effective fisheries management relies on robust local, national and global frameworks that reflect the realities of the countries and communities that participate in the sector. This can be achieved through the adoption of Ecosystem Approach to Fisheries and increasing capacity for accurate data and statistics, strengthened fisheries governance at all levels and participatory management, while fostering collaboration among stakeholder to achieve both biodiversity and food security a highly collaborative and transparent process.

56. Accurate data that encompasses the entire value chain are key to both sound policymaking and to assess and track the performance of responsible fisheries. Innovative data systems must support regular assessments of fisheries, tracking the impacts of management interventions across ecological and socioeconomic dimensions.

57. For an in-depth discussion on the benefits, challenges and opportunities for fostering sustainable fisheries management- particularly those related to the small-scale fisheries please refer to the Concept Paper for Ocean Action Panel 5 "**Fostering sustainable fisheries management including supporting small-scale fishers"**.

Sustainable Aquaculture

58. Sustainable aquaculture offers a viable solution to increasing food security, contributing to economic growth and livelihoods. There is a need for policies and practices that balance production growth with ecological sustainability, including the responsible use of land, water, and feed resources. Selecting nutrient dense species of low cost with greater environmental outcomes should be given high priority[39].

59. The FAO Guidelines for Sustainable Aquaculture (GSA) provide a framework for policies and practices that minimize environmental impacts, such as habitat

[38] World Bank. 2017. http://hdl.handle.net/10986/24056 License: CC BY 3.0 IGO.
[39] https://www.aquaculturescience.org/sustainable-aquaculture-development-nutrition-sensitive/

degradation and pollution, while promoting efficiency and resilience in aquaculture systems. They provide valuable direction for strengthening resilience through better water management, species diversification, and improved value chains[40].

60. The widespread adoption of alternative feed ingredients such as microalgae and black soldier fly larvae, may potentially support sustainable aquaculture production while significantly reducing reliance on fishmeal. However, extensive research is required to optimize the large-scale production of these alternative ingredients and to evaluate their impact on food safety and effects on fish health comprehensively. In the absence of wide-scale alternatives, targeting of aquatic foods for non-food uses in regions where they are important for food and nutrition security should be regulated and enforced, to avoid disruptions in aquatic food markets for human consumption[41,42.]

61. Another method of stabilizing aquatic food supply is by integrating aquaculture with land-based agriculture through aquaponics, for example. Integrated systems such as rice-fish systems serve as "storage" for fish, in which farmers harvest periodically for home consumption[43]. This practice is sometimes referred to as a "poor man's fridge" because it ensures a constant supply of fresh fish and aquatic animals without requiring costly storage infrastructure. Likewise, integrating species with complementary ecological roles, such as in integrated multi-trophic aquaculture (IMTA) systems where different aquatic species, including seaweeds, are reared at different trophic levels, promotes year-round productivity, as each species has distinct growth cycles and harvest periods[44].

Enhanced Value Chains

62. Supportive policy measures are vital for stabilizing aquatic food availability, accessibility, and utilization, and balancing trade-offs to ensure food and nutrition security. To support SSF and low- and middle-income countries, it is essential to reduce non-tariff barriers, such as sanitary and technical measures, that elevate compliance costs and restrict market access. In addition, solutions to cut transport costs are critical. Improving data and information on international trade, markets and transport networks can reduce information asymmetries, enabling better access to markets and empowering small-scale operators to navigate complex market requirements.

[40] FAO. 2025. https://doi.org/10.4060/cd3785en
[41] FAO. 2023 https://doi.org/10.4060/cc6229en
[42] FAO. 2011. Aquaculture development. 5. Use of wild fish as feed in aquaculture. FAO Technical Guidelines for Responsible Fisheries. No. 5, Suppl. 5. Rome
[43] Halwart, 2011. Biodiversity, nutrition and livelihoods in aquatic rice-based ecosystems. December 2011. Biodiversity 9(1):36-40. DOI: 10.1080/14888386.2008.9712879
[44] FAO 2024. https://doi.org/10.3389/fsufs.2024.1412919

63. Enhancing value chains is key to boosting the social, economic, and environmental viability of aquatic food systems. By strengthening these value chains, SSF can better meet import requirements of major markets, unlocking opportunities for growth and development. Additionally, it is vital to recognize the essential role of SSF, which employ millions globally, including a significant proportion of women.

64. Finally, traceability systems can be introduced and strengthened to improve control over the whole traceability chain from harvest to export, and to provide necessary credibility to the processed fish products, leading to enhanced transparency and meeting international standards. This will in turn allow for the opening of new markets and may attract new buyers willing to pay higher prices.

Reduce loss and waste and improve by-product utilization

65. Reducing loss and waste as well as increasing the utilization of by-products for food purposes offers potential for increasing access to and availability of aquatic foods, complementing the expansion of aquaculture production to meet the increasing demand. Enhancing the utilization of fish by-products offers a sustainable solution to reduce environmental impacts while creating new economic opportunities. By applying simple, low-cost technologies such as drying, smoking, fermentation, and milling, these by-products can be transformed into affordable and highly nutritious products, often with greater nutritional value than the fillet itself.

66. In many rural areas, the absence of reliable electricity leads to high postharvest loss of aquatic products. One solution involves solar-powered freezers for cold storage to extend the shelf life. Similarly, solar drying tents (with or without solar panels for electricity supply) with improved aeration and protective racks improve shelf-life, can increase productivity and address the drawbacks of traditional open-air drying, such as pest infestation and other food safety risks. Smoking technologies, such as the FAO-Thiaroye Fish Processing Technique (FTT), may offer innovative ways to preserve fish and retain its nutrients[45]. However, for technologies to address food security, they should be designed with the consumer in mind, ensuring that new technologies do not inadvertently increase the price beyond that which low-income users can pay[46].

67. Potential in utilizing fish by-products for food purposes has until recently not been sufficiently considered as a solution to meet nutritional needs to improve food security. However, in terms of volumes, cost and nutritional value, the potential is

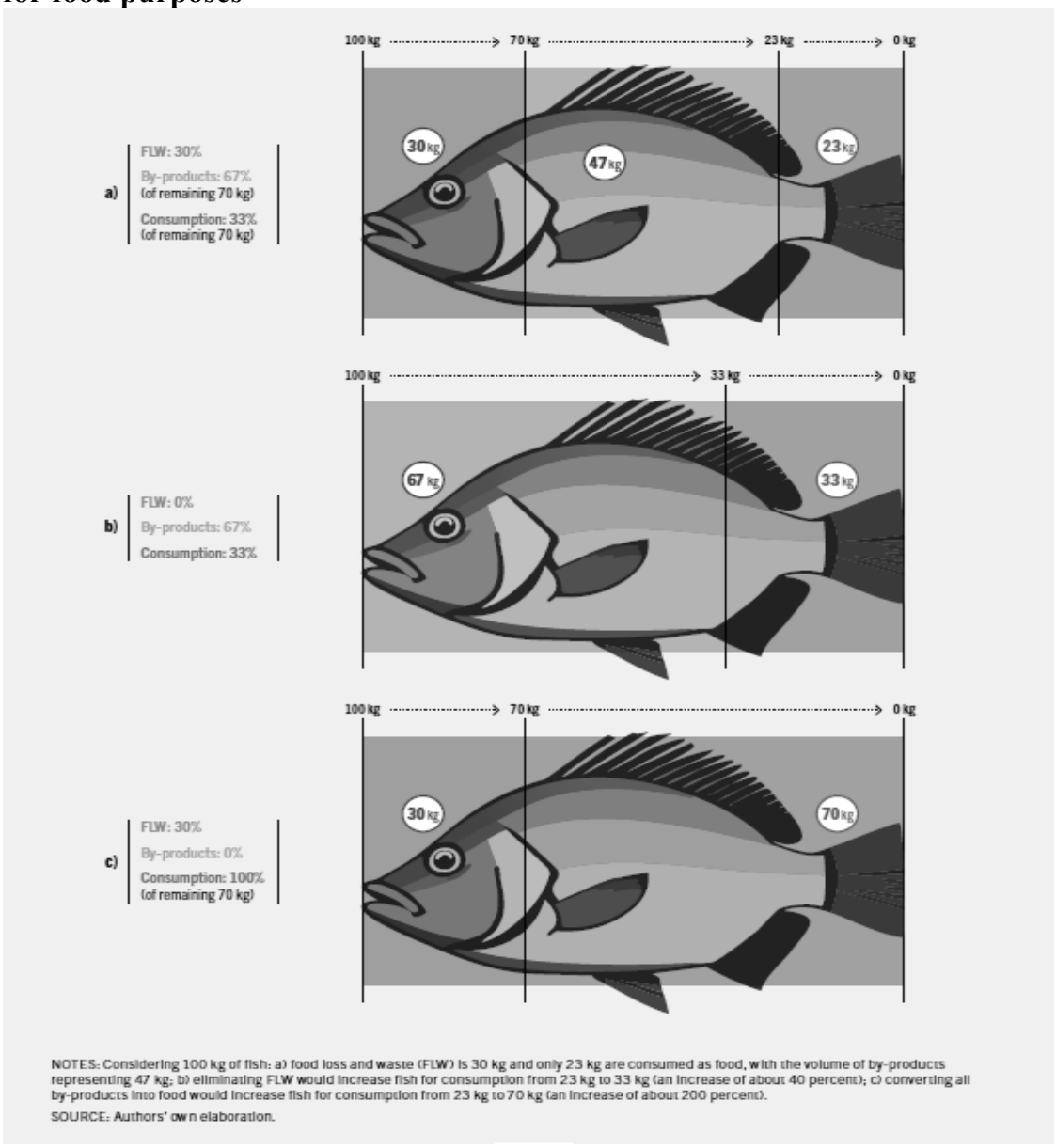
[45] FAO. 2019. https://doi.org/10.4060/CA4667EN
[46] https://doi.org/10.4060/cc6229en

big. In some cases, by-products represent 70 percent of the fish and are considered the least economically valuable parts. In terms of nutrients, in particular micronutrients (minerals and vitamins), these parts are the most valuable ones. The potential in converting by-products into food could in many cases be greater than even eliminating food losses and waste (Figure 6).

68. Effective post-harvest fish loss reduction does not rely on a single factor or variable such as the introduction of a new technology. Rather, it often requires a combination of the right policy, legislation, capacity building, services and infrastructure and effective technology, if solutions are to be long lasting and are to be adopted by beneficiaries. This multidimensional and multi-stakeholder approach is also promoted by the FAO Voluntary Code of Conduct for Food Loss and Waste Reduction which includes provides solutions to food loss and waste reduction that can be adapted into aquatic food value chains.

69. In Colombia, Sri Lanka, and Tanzania, FAO and its partners have promoted sustainable aquatic food systems through multi-dimensional solutions to reduce aquatic food loss and waste. This includes adopting circular economy technologies, improving infrastructure, building skills, and aligning with markets and policies. Addressing FLW can provide economic benefits, have a positive impact on food and nutrition security, improve natural resource use efficiency, and reduce environmental impacts.

Figure 6. Eliminating loss and waste versus utilizing by-products of Tilapia for food purposes[15]



NOTES: Considering 100 kg of fish: a) food loss and waste (FLW) is 30 kg and only 23 kg are consumed as food, with the volume of by-products representing 47 kg; b) eliminating FLW would increase fish for consumption from 23 kg to 33 kg (an increase of about 40 percent); c) converting all by-products into food would increase fish for consumption from 23 kg to 70 kg (an increase of about 200 percent).

SOURCE: Authors' own elaboration.

Technological Improvements in the Value Chain

70. The FAO Blue Transformation Roadmap highlights the need to upgrade aquatic food value chains to fight hunger and malnutrition. This is a challenge in low-income countries where value chins already experience many inefficiencies related to spoilage rates, storage needs, and aquatic food and by-product availability, all of which can also be exacerbated by weather and temperature changes caused by climate change. Upgrades in aquatic food value chains require significant investment in supply chains, storage, transportation, and processing systems to improve the efficiency of distribution, ensuring that more of the aquatic products reach consumers in good condition.

71. Technological improvements in aquatic food value chains must consider the end market's needs. For example, if low-income and nutritionally vulnerable populations demand low-cost fish, technological improvements should keep costs low to ensure sustainability and avoid driving up the cost of production for producers and, consequently, for consumers. Promoting expensive technologies without the end market in mind may inadvertently divert fish from low-income consumers to higher-income consumers, export markets or lead to disuse of these technologies.

72. In the absence of sophisticated equipment and cold rooms, aquatic by-products can be converted into feed, fertilizer or fish silage rich in hydrolyzed proteins and essential amino acids. A growing share of fishmeal and fish oil is being produced using fish by-products from capture and aquaculture processing with a positive impact on waste reduction. These technologies are also used to process low-value fish and bycatch into value-added products, and thus may enhance human nutrition and health, mitigate environmental pollution, and provide livelihoods and economic returns.

73. Technological improvements can decrease waste even for non-food uses, for example, through the development of biodegradable packaging materials from aquatic food waste. This is currently done with chitin found in crustacean shells and squid feathers, combined with lignin waste and offers a solution to address issues of microplastic pollution in foods and packaging needs[47]. The FAO Voluntary Code of Conduct for the Reduction of Food Loss and Waste includes a food material hierarchy, which provides a ranking of recovery alternatives for dealing with food material deemed as surplus, based on their impact or benefits from an environmental, social or economic perspective[48].

Improve Market Access for Small-Scale Fisherfolk and Fish Farmers

74. Improving market access for SSF can enhance income and resilience. Small-scale fishers and fish workers often face barriers to accessing markets such as financial constraints, capacity-building needs, and regulatory hurdles that could hinder further progress. Developing direct marketing channels, such as community-supported fisheries (CSFs) and certification schemes, helps fishers secure better prices and reduce reliance on intermediaries.

[47] K. de la Caba, P. Guerrero, T.S. Trung, M. Cruz-Romero, J.P. Kerry, J. Fluhr, M. Maurer, F. Kruijssen, A. Albalat, S. Bunting, S. Burt, D. Little, R. Newton. From seafood waste to active seafood packaging: an emerging opportunity of the circular economy. J. Clean. Prod., 208 (2019), pp. 86-98

[48] FAO. 2022. https://doi.org/10.4060/cb9433en

75. For example, in Colombia, the FAO SocPro4Fish project worked directly with the *Platoneras*—Afro-Colombian women vendors from Buenaventura who play a crucial role in providing essential nutrition for local families. These women are not only critical to the community's food security but also serve as role models for economic empowerment. Through capacity-building efforts, the project empowered *Platoneras* to formalize their operations, thereby improving their access to public procurement processes and enhancing their economic stability. This initiative highlights the importance of supporting local entrepreneurs in achieving sustainable development.

76. In Senegal, the "Label Rouge" certification for artisanal fisheries has improved market access and prices for local fishers, significantly increasing their incomes[49]. This certification not only enhances the market value of fish products but also promotes sustainable fishing practices.

77. In Cambodia, the Cambodia Quality Seal, a voluntary food safety certification scheme has helped small scale fish processors (majority of which are women owned and/or led) reach new markets, improve working conditions and significantly increase production volumes (around 70 percent). Strengthening value chains through investments in processing, storage, and transportation infrastructure can increase the economic benefits of SSF.

Monitoring Systems to Prevent Food Safety Outbreaks

78. Although cost is always a consideration when establishing monitoring systems, an efficient approach is to use a tiered monitoring strategy. This involves deploying the most frequent, informative, and expensive sampling effort during the most sensitive times, and to gradually reducing monitoring efforts during low-risk periods. Tools/technologies (and their corresponding data) of increasing specificity, resolution, and often expense can be used with increasing frequency sat times where food hazards are expected to occur such as in advance of the fishing/harvesting season or after an incident. Resulting data can help find predictive relationships that could serve for the implementation of early warning systems for a variety of hazards.

Social Safety Nets

79. Social security systems, including health insurance and pensions, offer long-term benefits by providing financial security and access to essential services. These systems ensure that fishers, fish farmers, fish workers and their families can rely on support during times of need, fostering resilience in their communities. Through

[49] Dyhia Belhabib, Vicky W.Y. Lam, William W.L. Cheung. 2016. https://doi.org/10.1016/j.marpol.2016.05.009

investing in social protection, we not only safeguard the livelihoods of those in aquatic food systems but also contribute to the overall stability of coastal economies and aquatic food supply. Integrating social protection into fisheries and aquaculture policies can mitigate socio-economic barriers, promoting sustainable and equitable development. Many roles predominantly held by women in the aquatic value chains are informal and invisible, and therefore not eligible for some social safety net programs.

80. Improved access to unemployment insurance during closed seasons, health insurance, pensions, and other social security measures not only enhances the well-being of fishers and fish workers but also supports sustainable fisheries management. Social assistance programs, such as conditional cash transfers and food aid, provide immediate relief, helping fishers, fish farmers and fish workers cope with income fluctuations and unforeseen shocks.

81. In the Philippines, the Pantawid Pamilyang Pilipino Program (4Ps) includes specific provisions for fishing communities, offering conditional cash transfers that help stabilize incomes during lean fishing periods[50]. In Mexico, the "Seguro del Pescador" program provides unemployment insurance during seasonal fishing bans[51], and in Brazil, "Bolsa Verde" provides financial support to fishers in protected areas. These financial supports are crucial for enhancing food security and improving socioeconomic conditions in coastal communities. Through safeguarding the incomes of fishers, these initiatives in turn play a crucial role in preserving marine ecosystems. Ultimately, such programs can lead to more resilient communities capable of thriving despite environmental challenges.

82. Subsistence fishing has also been evidenced to provide a form of safety net, providing income at times throughout the year to mitigate poverty as well as malnutrition through provision of aquatic foods for consumption [52]. Also, school meal programs and other institutional procurement can offer a nutritional safety net for children and families who struggle with food insecurity. School meal programs have traditionally been a tool of the education sector, to promote enrolment and reduce absenteeism, but are a powerful tool to promote healthy diets from a young age and can support community development when foods are sourced locally. There are few examples of local procurement of aquatic foods for home-grown school feeding programs [53], which may improve the overall nutrient content of school meals for children and provide livelihood benefits to aquatic food producers.

[50] World Bank. 2019. https://www.dof.gov.ph/world-bank-financing-for-4ps-to-accelerate-poverty-reduction/
[51] https://www.oecd.org/content/dam/oecd/es/publications/reports/2010/07/fisheries_g1ghc166/9789264219281-es.pdf
[52] Virdin, J., Basurto, X., Nico, G. *et al.* https://doi.org/10.1038/s43016-023-00844-4
[53] Ahern, M.B.; Thilsted, S.H.; Kjellevold, M.; Overå, R.; Toppe, J.; Doura, M.; Kalaluka, E.; Wismen, B.; Vargas, M.; Franz, N. https://doi.org/10.3390/foods10092080

V. Conclusions and recommendations

83. There are many opportunities to enhance the contribution of marine food systems to food security, nutrition, and poverty eradication. The above sections have outlined these, including opportunities to ensure sustainable supply through improving fisheries sustainability, fully developing sustainable aquaculture practices, and enhancing aquatic food value chains. We must continue to apply monitoring systems to understand both the nutritional contribution of aquatic foods and prevent food safety outbreaks. Social safety nets for those working in aquatic food systems may also increase resilience and ensure food security and nutrition in coastal populations. Investments that support sustainable aquaculture practices and upgrade aquatic food value chains in developing economies can significantly improve local food security and livelihoods**.**

84. **Recommendations**

Enhance Data Collection and Analysis:

Strengthen national and regional capacities to collect, validate, and analyze data on fisheries, aquaculture, food loss and waste (FLW), and aquatic food composition and consumption. Improve monitoring systems for aquatic foods, ensuring data is granular, accurate, and includes key metrics like species, losses throughout the supply chain, and nutritional information.

Support Sustainable Aquaculture and Fisheries:

Promote the development of sustainable aquaculture through improved practices, technologies, and adherence to FAO guidelines. Enhance governance frameworks, including management plans for fisheries, and encourage the implementation of sustainability criteria in trade systems. Support the development of community-based and co-management plans for better resource management.

Ensure Access to Aquatic Foods for Nutrition:

Ensure the affordability and accessibility of nutritious aquatic foods, especially for vulnerable populations, through policies addressing food prices, storage, transportation, distribution and food safety. Promote innovative practices such as seaweed farming and improved aquaculture biosecurity. Invest in programs like school meal initiatives and social protection for small-scale aquatic food producers.

Promote Gender Equality and Inclusivity:

Foster gender-transformative policies in fisheries and aquaculture, ensuring equitable opportunities and benefits for both genders. Encourage the inclusion of women in decision-making and leadership roles and integrate gender-sensitive perspectives into all aquatic food-related interventions.

Improve Market Access and Utilization:

Strengthen market access for small-scale fisheries and aquaculture by investing in infrastructure, low-cost certification schemes, and product innovation. Address food loss and waste by enhancing value chain practices such as processing, preservation, as well as by-product utilization, and implement climate resilience measures to adapt to environmental challenges.

VI. Guiding questions

Promoting aquatic foods for food security and nutrition

1. How are the key actions required to maximize the contribution of aquatic foods to eliminate hunger and malnutrition?
2. How can we ensure that consumers, especially the most vulnerable, have access to quality aquatic foods at affordable prices while securing the livelihoods of fishers, fish farmers and fishworkers?

Sustainable production

3. What best practices can be adopted to minimize environmental impacts from fisheries and aquaculture while ensuring they can produce enough aquatic foods to satisfy increased demand?
4. How can we sustainably expand aquaculture to expand opportunities for increased incomes and support the consumption of aquatic foods?

Research and Monitoring

5. How can data collection and research be used to understand the impact of small-scale actors on local food security, explore actual food consumption patterns and composition of aquatic foods, and determine loss and waste and by-product utilization throughout aquatic food value chains, especially in low- and middle-income countries?

Legal and policy frameworks and management plans

6. How can policy frameworks be strengthened or reinforced to ensure sustainable access to aquatic foods, especially for the most vulnerable?
7. What are the most effective community-based management models for ensuring sustainable resource use for food and nutrition security?

Livelihoods and poverty reduction

8. What role can social protection measures play in supporting small-scale actors and reducing poverty in fishing communities?
9. What strategies can be implemented to ensure a sustainable supply of aquatic foods and secure aquatic food livelihoods in the face of climate change?

Post-Harvest issues, including FLW, access to markets, etc.

10. How can innovation and technology be used to make aquatic food value chains more sustainable in social, economic and environmental terms?
11. How can governments and businesses work together to minimize the risk of aquatic food born illnesses and other hazards for consumers?

12. How can market access be improved for small-scale fishers, particularly in remote or marginalized areas?

Consumer access and nutrition strategies

13. How can food safety and profitability for fisherfolk be enhanced, and environmental impact and fish loss and waste reduced, while ensuring affordability for low-income food and nutritionally insecure consumers?
14. What are the barriers to implementing food safety monitoring and early warning systems, how can they be overcome? how can these systems, build consumer trust and mitigate the impact of climate change and pollution on aquatic food safety?