7.

Contributions of small-scale fisheries to food security and nutrition

David Mills (WorldFish), Fiona Simmance (WorldFish), Kendra Byrd (WorldFish and University of Greenwich)

with contributions to Section 7.3 from James Robinson (Lancaster University), Aaron McNeil (Dalhousie University), Esther Garrido-Gamarro (FAO), Lauren Pincus (WorldFish), Molly Ahern (FAO), Philippa Cohen (WorldFish), Enrica D'Agostino (FAO), Kathryn Fiorella (Cornell University), Christina Hicks (Lancaster University), Marian Kjellevold (Institute of Marine Research), Arne Levsen (Institute of Marine Research), Anne-Katrine Lundebye (Institute of Marine Research), Johannes Pucher (German Federal Institute for Risk Assessment), Matthew Roscher (WorldFish), Monica Sanden (Institute of Marine Research), Ti Kian Seow (FAO), Cecilie Svanevik (Institute of Marine Research), Shakuntala Thilsted (WorldFish), Alex Tilley (WorldFish) and Maria Antonia Tuazon (FAO), to Section 7.4 from Gianluigi Nico (FAO), Edith Gondwe (Michigan State University), Emmanuel Kaunda (Lilongwe University of Agriculture and Natural Resources), Jeppe Kolding (University of Bergen), Bonface Nankwenya (WorldFish) and to Section 7.5 from Lydia O'Meara (WorldFish), Pamela Marinda (University of Zambia), Shwu Jiau Teoh (WorldFish) and Joseph Nagoli (WorldFish)

7.1 Key findings and messages

Contributions of small-scale fisheries to nutrition

- The nutrient potential of fish is measured as the sum of the nutrients contained in the catch at the time of landing. In this study the concentrations of iron, zinc, calcium, vitamin A, selenium and omega-3 fatty acids in each functional group of fish were investigated by analysing publicly accessible databases and novel methods of predictive modelling to estimate the nutrient potential of global inland and marine fisheries catches. Understanding nutrient potential provides an important new method to assess the impacts of fisheries policy on nutrition outcomes.

- While all fish are highly nutritious, the most nutritious species from both inland and marine fisheries are small (< 25 cm body length), pelagic species. For adult women, a 100 g portion of small fish provides on average 26 percent of the recommended nutrient intake (RNI) for calcium and 72 percent of RNI for omega-3 fatty acids, while a 100 g serving of large fish on average provides 12 percent and 51 percent, respectively, for the same nutrients.

- Fish species harvested by large- and small-scale fisheries contain similar quantities of most nutrients, although the average catch from large-scale fisheries contains 25 percent more omega-3 fatty acids than that of small-scale fisheries. This may reflect the relatively high latitude and deep-water focus of large-scale fisheries, where species tend to be richer in omega-3 fatty acids.

- Finfish catches from small-scale fisheries in all regions (but less so in Europe) can play an important role in addressing known nutrient deficiencies. For example, the finfish catch from small-scale fisheries in Africa has the potential to contribute the equivalent of 20 percent of RNI of calcium, selenium, zinc and omega-3 fatty acids to over 50 percent of women (137.0 million) of reproductive age. In Asia, where calcium intakes are estimated to be well below requirements, finfish catch has the potential to contribute the equivalent of 20 percent of RNI of calcium for 25.2 percent of women (271.0 million) of reproductive age.

- Country and territory case studies from Lake Victoria found that a serving of small indigenous *dagaa* (*Rastrineobola argentea*) contains six times the calcium, twice as much iron, three times more zinc, four times more vitamin A and twice the omega-3 fatty acids as an equivalent serving of the introduced Nile perch (*Lates niloticus*).Loss of fish quality and quantity from inadequate handling, processing and storage frequently reduces the contributions of small-scale fisheries to food security and nutrition. The introduction of appropriate food safety standards and education programmes for fishers, fishworkers and households would contribute to improved nutrition and livelihoods.

Small-scale fisheries and physical and economic access to food: new insights in sub-Saharan Africa

- An analysis of World Bank Living Standards Measurement Study data from the African Great Lakes region found that households living close to small-scale fisheries, and engaging in these fisheries, were less likely to be income-poor (down by 9–15 percent); had increased fish consumption (about twice as often per week and up to three times as much); and had higher rates of household food security (up by 12.6 percent).
- Proximity to small-scale fisheries is also associated with lower inequality in fish consumption (i.e. between wealthy and poor households), by an average of 30 percent. Dried fish is more important to the diets of rural households (by a factor of 1.3 to 1.8) compared to urban households) and those living far from fishing grounds.

Small-scale fisheries and fish consumption during the first 1 000 days of life

- The first 1 000 days of life (from conception to 2 years of age) represent a critical window of child development, when children and their mothers require a nutrient-rich diet to ensure proper growth.
- Proximity to small-scale fisheries increases access to fresh fish by a factor of up to 13 and increases dietary diversity in children. Moreover, small-scale fisheries are an important source of nutrient-rich foods for rural children from 6 to 24 months of age, especially in low- and lower-middle-income countries.

Illuminating the magnitude and distribution of nutritional benefits from small-scale fisheries

- Strategies are needed to ensure the nutritional benefits from small-scale fisheries and fish products are shared across value chains to include vulnerable groups.
- Initiatives are required to ensure that the benefits to health from fish consumption by infants, children and lactating mothers are widely known and incorporated into practice in order for the nutrition benefits from small-scale fisheries within households to be optimized.

Figure 7.1 details the pathways through which small-scale fisheries can impact hunger and malnutrition.

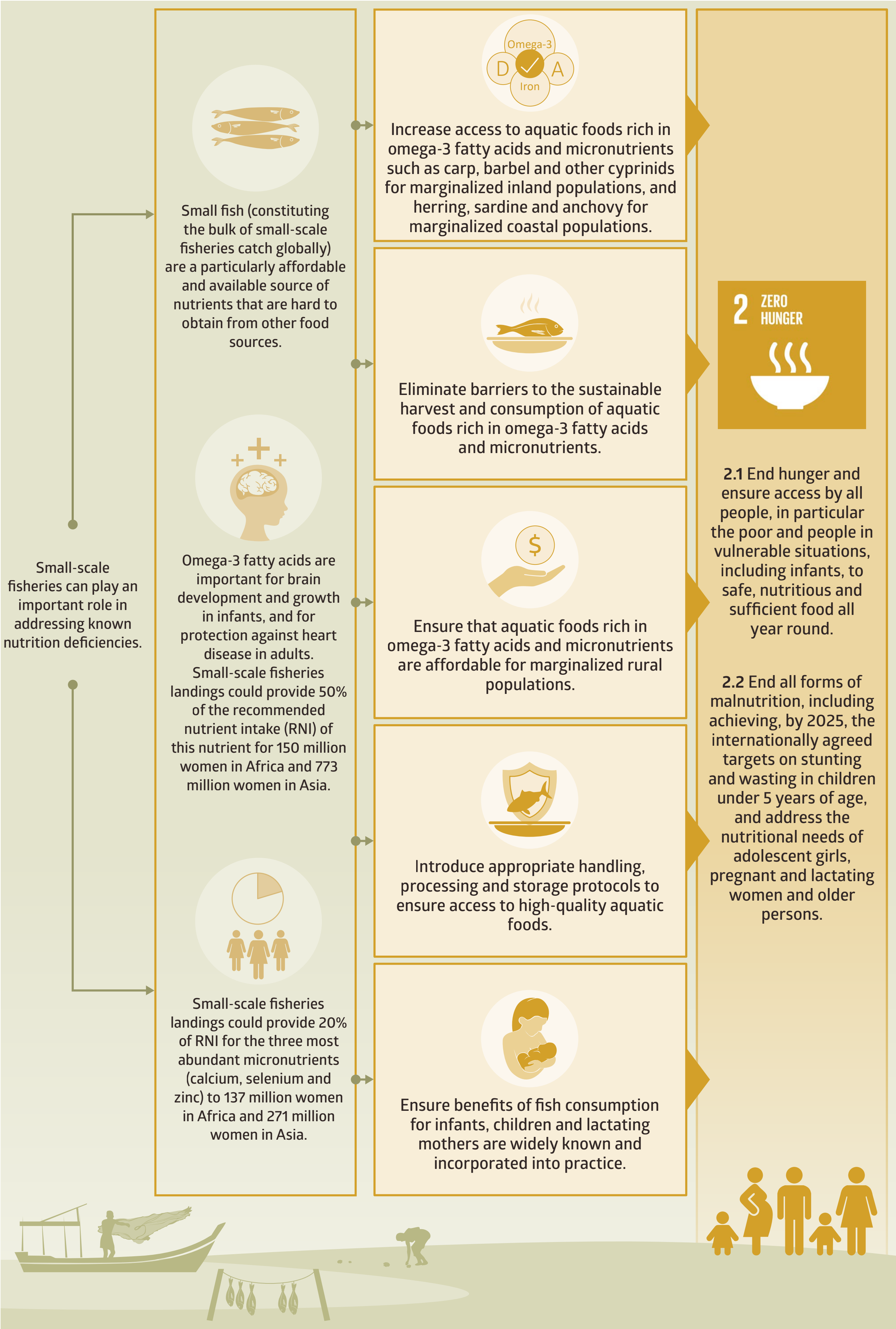
7.2 Introduction

Through a number of global agreements, including the declaration “The future we want” from the 2012 UN Conference on Sustainable Development, the Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication (SSF Guidelines), the 2030 Agenda for Sustainable Development (and associated Sustainable Development Goals) and others, the countries of the world have committed to eradicating hunger and improving nutrition for all. The urgency of achieving these goals is clear: an estimated 720 to 811 million people faced hunger in 2020, an increase of approximately 118 million – but possibly as high as 161 million – compared to the previous year. Considering moderate or severe food insecurity, 2.8 billion people (nearly one in three worldwide) did not have access to adequate food in 2020, representing an increase of nearly 320 million people compared to 2019. This is equal to the combined increase over the previous five years. More than half of the undernourished people in the world live in Asia, and more than one-third in Africa (FAO, 2021e).

The global and regional consequences of this food insecurity and malnutrition are profound. For example, an estimated 22 percent of children under the age of 5 were affected by stunting in 2020 and 6.7 percent by wasting, while 5.7 percent were overweight. Again, Africa and Asia accounted for a large majority of those children. Anaemia is another indicator of malnutrition, with 29.9 percent of women between 15 and 49 years of age suffering from anaemia globally (FAO, IFAD, UNICEF, WFP and WHO, 2021).

Sustainable Development Goal (SDG) 2 includes targets to end hunger, achieve food security and improve nutrition. Achieving these targets will not be possible without sustained, strengthened contributions from the aquatic foods sector, and most notably from small-scale fisheries. Accordingly, SDG Target 2.3 aims to double the productivity and incomes of small-scale food producers, including fishers. The vital role of small-scale fishers is also recognized in the SSF Guidelines, which are intended, among other purposes, “to contribute to global and national efforts towards the eradication of hunger and poverty” (Preface, FAO, 2015). Specifically, Objective 1.1a of the Guidelines aims “to enhance the contribution of small-scale fisheries to global food security and nutrition and to support the progressive realization of the right to adequate food”. The recognition of this core function highlights the key role played by small-scale fisheries organizations in the development of the SSF Guidelines.

Figure 7.1 Key pathways through which small-scale fisheries can impact hunger and malnutrition



These goals and objectives reflect the fact that for millions globally, including vulnerable people and those living beyond the reach of formal markets, aquatic foods from small-scale fisheries represent a crucial and sometimes irreplaceable source of micronutrients and fatty acids needed for growth and good health. The nutritional benefits from small-scale fisheries accrue directly and indirectly. Direct nutritional benefits are realized by providing nutrient-rich food to families, either from fish eaten by members of fishing households, or from fish acquired through gift, trade or purchase. Indirect benefits accrue through economic pathways (see Chapter 5), with small-scale fisheries providing livelihoods for men and women, and thus income for them to purchase food. A better understanding of the values and functioning of these pathways is central to developing policy actions, programmes and investments that enable a sustainable and equitable future for the small-scale fisheries subsector and the livelihoods it supports. In the decade since the original Hidden Harvest report (World Bank, 2012), the global focus on the SDGs has built momentum towards transforming food systems to provide sustainable healthy diets for all. With this, strengthened efforts to highlight the importance of fish in food systems (Simmance *et al.*, 2022a; Hicks *et al.*, 2019) have spurred an increase in the quantity and quality of data on the nutritional profile of fish (Byrd *et al.*, 2021; Golden *et al.*, 2021).

This chapter leverages these new data and innovative predictive models to illuminate the global, regional and national nutritional contributions from small-scale fisheries. Where data do not yet support large-scale synthesis, a focus on certain data "bright spots" provides examples of how analysis of quality data can highlight entry points and policy directions. These illustrate where and how data and research can change to better understand the contributions of small-scale fisheries to food security and nutrition. Modifications to existing demographic, agricultural or fisheries survey systems that account for the idiosyncrasies of small-scale fisheries can substantially improve the quality and relevance of data for improved fisheries management. Specifically, the chapter focuses on the following questions:

- What is the profile of nutrients important to human health that are found in small-scale fisheries catches?
- How do small-scale fisheries provide physical and economic access to nutritious food for urban and rural people?
- How do small-scale fisheries contribute to the diets and healthy growth of rural children during their first 1 000 days of life?
- How can national fisheries information systems be improved to reflect the nutritional contributions of small-scale fisheries?

7.3 The contributions of small-scale fisheries to nutrition

7.3.1 Fish as an important source of nutrition throughout the life cycle

A new understanding has emerged over the past decade, reinforced by global efforts towards achieving the SDGs, that ending malnutrition will require just and sustainable transformations of food systems (Herrero *et al.*, 2020; Sachs *et al.*, 2019). Yet these transformations are already underway, driven by a diversity of economic, environmental and cultural factors. As small-scale fisheries have increasingly become part of a globalized food system, power imbalances have played out in ways that often do not promote or prioritize local food supply and food justice in general (Cohen *et al.*, 2019; Arthur *et al.*, 2021). Navigating the governance challenges that lie at the heart of reshaping food systems, and optimizing the contributions small-scale fisheries can make within these, will benefit from a deeper understanding of the nutrient potential of aquatic foods. Therefore, to achieve SDG targets in many regions – most notably those targets under SDG 2 (Zero hunger) – it is essential to focus research efforts on the role and function of aquatic foods within food systems, as well as tools to integrate new knowledge into policy and management practice.

Eating aquatic foods supports nutrition through all stages of human life, from foetal development during pregnancy through to adult health. Meeting SDG Target 2.2 – eliminating malnutrition in all of its forms (undernutrition, micronutrient deficiencies, overnutrition) – requires radical improvements in global dietary quality, with aquatic foods playing a significant role in sustainable healthy diets worldwide (HLPE, 2014; Willet *et al.*, 2019; Hallstrom *et al.*, 2019; UN Nutrition, 2021). While long recognized as an important source of protein, aquatic food consumption benefits human health by increasing the diversity and availability of micronutrients in diets, providing one of the few dietary sources of essential omega-3 fatty acids, and displacing consumption of less healthy ASFs such as red and processed meats (Golden *et al.*, 2021). Indeed, aquatic foods are a significant source of key micronutrients including vitamin B12, calcium, vitamin D, iodine and selenium, and of essential fatty acids in the omega-3 family (Byrd, Thilsted and Fiorella, 2020; Hicks *et al.*, 2019), as well as vitamin A, iron and zinc when fish are consumed whole (Roos, Islam and Thilsted, 2003; Hasselberg *et al.*, 2020; Aakre *et al.*, 2020; Reksten *et al.*, 2020). Fish, particularly small fish eaten whole, serve as "brain food" for babies during gestation due to the importance of essential fatty acids, iodine and iron to healthy cognitive development (Bath *et al.*, 2013). In developing countries or areas, fish consumption is associated with lower rates of stunting in children aged 6–23 months (Headey, Hirvonen and Hoddinott, 2017; Marinda *et al.*, 2018), likely due to a high concentration of growth-promoting nutrients, such as bioavailable zinc, iron and protein (Thilsted *et al.*, 2016; Byrd *et al.*, 2021). There is also strong evidence that consuming fish as part of a healthy diet is associated with reduced risk for several cardiovascular diseases (VKM, 2014; EFSA, 2014).

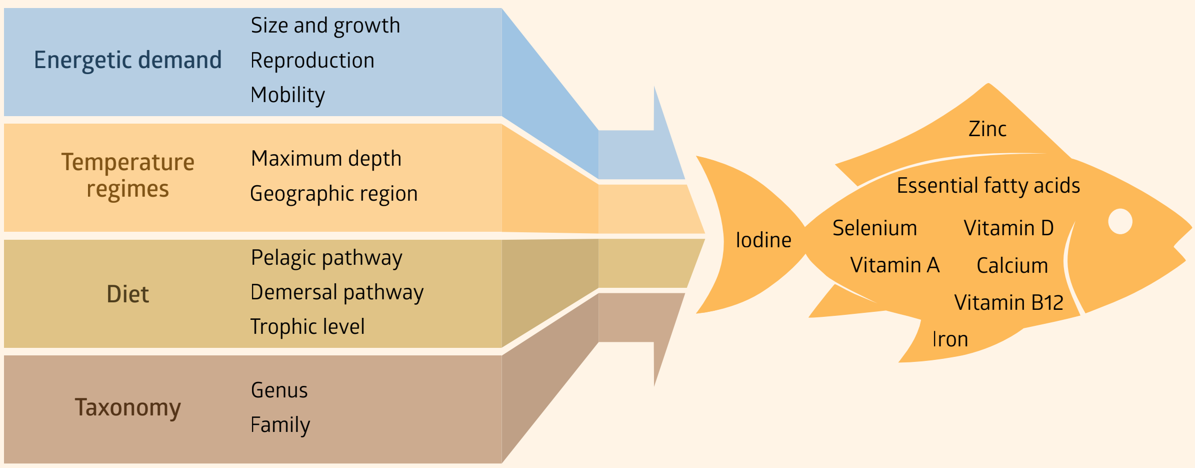
In addition to being nutrient-rich, fish is often the most accessible and affordable form of ASF (Headey and Alderman, 2019). ASFs are particularly beneficial because of the bioavailability (i.e. the potential for absorption by the body) of their nutrients. Thus, compared to plant-based foods, iron and zinc from ASFs such as fish are easier for the body to digest and absorb, making these foods optimal for addressing malnutrition (Sandström *et al.*, 1989; Michaelsen *et al.*, 2009; Sigh *et al.*, 2018). In diets in sub-Saharan Africa and Southern Asia, the most nutritious foods are small fish species, along with foods like chicken liver, beef liver, eggs and meat (Ryckman *et al.*, 2021a, 2021b). However, from this list, fish – particularly dried small fish (Kolding *et al.*, 2019; Kawarazuka, 2010; Bose and Dey, 2007) – is often the easiest to access and the most affordable.

Fish species vary greatly in terms of life strategy, life cycle, diet, habitat and body type, resulting in

Box 7.1

Predicting nutrient values of fish species

All fish are not made nutritionally equal: the composition of nutrients important to human health found in fresh fish varies based on species, season and diet. Directly analysing nutrients in fresh fish samples is prohibitively expensive, which means nutrient composition has only been determined for a small number of important fish species. In 2015, the FishNutrients initiative was begun to complement the established FAO nutrient composition database (the International Network of Food Data Systems, or INFOODS) to collate nutrient data for over five hundred fish species. Using these data, the initiative developed a statistical model[a] that predicts the nutrient composition of a species based on diet, geographic region, size, growth and taxonomy. Launched in 2021 as a function on FishBase (the world's largest online encyclopaedia of fish), the FishNutrients tool provides predictions on the nutritional composition of five thousand different finfish species. The model was first applied to understand the potential of all marine fisheries catches to address nutrient deficiencies of people living in adjacent coastal populations.[b] The integration of the model with FishBase was conducted in parallel with the IHH initiative, thus making it possible to model the nutrient potential of small-scale fisheries catch from both inland and marine waters globally.



Notes: **a** See https://github.com/mamacneil/NutrientFishbase. Based on parameters from Froese, R. & Pauly, D., eds. 2022. FishBase. Updated August 2022. https://www.fishbase.se/search.php **b** Hicks, C.C., Cohen, P.J., Graham, N.A., Nash, K.L., Allison, E.H., D'Lima, C., Mills, D.J. et al. 2019. Harnessing global fisheries to tackle micronutrient deficiencies. *Nature*, 574(7776): 95–98.

strikingly diverse nutrient profiles (Vaitla *et al.*, 2018; Hicks *et al.*, 2019). Understanding the nutrient value of different types of fish, and how each species contributes to the nutrition available from local diets, is an important step towards managing fisheries in a way that optimizes their nutritional benefits.

In this section, a new approach to predicting the nutritional value of fish species (Box 7.1) is used in conjunction with the Illuminating Hidden Harvests (IHH) small-scale fisheries catch data and regional and global extrapolations to shed light on which functional groups of species provide the greatest nutritional benefit, as well as the relative nutritional values of fish from inland, marine, small-scale and large-scale subsectors. Next, a case study of three countries in sub-Saharan Africa allows for a deeper exploration into how increased knowledge of the nutritional contribution of fish can feed into policy development and management practice. Last, key food safety issues that can greatly impact the nutritional benefits accruing from small-scale fisheries catches are outlined, and a suite of mitigation approaches highlighted. These reinforce the central message that improved nutrition outcomes from small-scale fisheries will hinge on action at multiple entry points along value chains (from catch to consumption), and that the idiosyncrasies of these value chains must be accounted for in these actions.

7.3.2 Nutrient value of inland and marine fish

This subsection investigates the concentrations of iron, zinc, calcium, vitamin A, selenium and omega-3 fatty acids in each functional group of species. A list of the nutrient functions in the body and their estimated prevalence of deficiency can be seen in Table 7.1. The most nutrient-rich functional groups (Figure 7.2) for both inland and marine fish catches are those that include small (< 25 cm total length), frequently pelagic species, which are highly productive and often associate in large schools. These species typically feed on plankton (which are low on the food chain), with phytoplankton providing the dietary source of the omega-3 long-chain fatty acids (Gladyshev *et al.*, 2018; Shovonial, 2018) found in particularly high concentrations in these groups. The inland group of carp, barbel and other cyprinids, which includes both large- and small-sized species, had the highest overall nutrient density score, with notably high concentrations of calcium. Among marine fish, the four most nutrient-rich functional groups are also pelagics, both small and large.

Among the IHH country and territory case studies (CCS), the most nutrient-rich marine functional group of species (herring, sardine, anchovy) had a total catch over twice that of the next-largest group (scad and mackerel). Together, these groups represent around one-third of total global catch and clearly have a very high potential to contribute to global dietary nutrient intake. Notably, the habitat of the former group includes the world's largest fishery: Peru's anchoveta (*Engraulis ringens*), most of which is used for reduction to fishmeal and fish oil.

The preference for large fish species as food among consumers with greater purchasing power (Tsikliras and Polymeros, 2014), in addition to limited markets for small, inexpensive fish and the growing price of fishmeal, have all contributed to a trend of using small, relatively inexpensive fish as feed for larger farmed fish (Cashion *et al.*, 2017; Tacon and Metian, 2009). Nonetheless, these functional groups of inland and marine species remain critical to food security and nutrition in many less developed contexts, with small pelagic species often the most sustainable and nutrient-rich (Cashion *et al.*, 2017; Kolding *et al.*, 2019).

This chapter analysis found that nutrient density was higher in the flesh of small fish species from lower levels in the food chain (Figure 7.3), with higher concentrations of omega-3 fatty acids, calcium and zinc than those found in large, high-trophic species. Note, however, that this analysis is for fish flesh only. Many small fish species are eaten whole, which increases the nutrient potential substantially due to the high nutrient loads of their non-flesh components (Kawarazuka and Béné, 2011). As a result, this analysis underestimates the nutritional contributions of small-fish fisheries are underestimated in this analysis. Comparisons between marine and inland fisheries, and small- and large-scale fisheries (Figure 7.3), reveal some differences at a global spatial scale. Omega-3 fatty acids are found in higher concentrations, on average, in fish caught by marine fisheries and large-scale fisheries. Based on the nutrient models, body size is a strong predictor of omega-3 fat content of a species. The higher omega-3 content of fish from large-scale and marine fisheries is likely due to the higher proportion of small pelagic schooling fish found in these fisheries. Hence, the considerable degree of variability among individual species needs to be considered in interpreting these results.

7.3.3 Global estimates of nutritional contributions of finfish from small-scale fisheries

Regional and global estimates of finfish catch in the IHH study were made by extrapolating catches for functional groups of species from CCS to regional and global scales, and where necessary filling gaps from other data sources (see Chapter 4; Annex A).

This study marks the first time this approach has been used to measure the nutrient potential of small-scale fisheries at a global scale, and the resulting data show that this potential is substantial and regionally variable. To provide a measure that makes conceptual sense, rather than presenting nutrient yield values,

Table 7.1 Key nutrients modelled in this chapter analysis, with notes on their function and related deficiencies concerning the human body

Nutrient	Function	Prevalence of inadequate intake or deficiency
Iron	Iron is important for infant neural development and in the development of red blood cells throughout the life cycle.[a]	Anaemia in many cases is caused by iron deficiency and is a common problem plaguing many populations.[b] Globally, more than 600 million women aged 15–49 years are anaemic.[c]
Zinc	Zinc is an important component in the body's use of macro- and micronutrients and plays a central role in the immune system response.[d]	Many diets globally are predicted to be inadequate in zinc;[e] because of the role in fighting infection, zinc deficiency is a major public health concern. In 2012, an estimated 17% of the global population were at risk of inadequate zinc intake.[f]
Calcium	Calcium provides rigidity to bones and teeth and is involved in a number of cell signalling processes.[g]	Many people in low- and middle-income countries do not consume sufficient calcium to maintain homeostasis, especially during the complementary feeding period.[h] An estimated 3.5 billion people are at risk of calcium deficiency.[i]
Selenium	Selenium is important as an antioxidant and for proper thyroid functioning.j Selenium deficiencies have been associated with multiple sclerosis, cancer and reproductive disorders.[k]	Up to a billion people globally suffer from selenium deficiency, which is associated with soil chemistry unfavourable for its uptake in plants.[l] In many diets globally, fish is the main source of selenium.[m]
Vitamin A	Vitamin A plays a key role in vision and the immune system. In addition, it is essential for growth and development.[n]	While current data are scarce, estimates show that up to 22% of women in some countries have an inadequate intake of vitamin A.[o]
Omega-3 fatty acids	DHA is important for brain development during the prenatal and infancy periods,[p] and EPA has potent anti-inflammatory benefits.[q]	Global estimates of omega-3 fatty acid intakes are varied, but notably, intakes in developing countries or areas are below recommendations, especially during the complementary feeding period.[r]

Notes: Essential omega-3 fatty acids include docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA). **a** Karakochuck, C.D., Whitfield, G.T. & Kraemer, K. 2017. *The biology of the first 1000 days*. New York, USA, CRC Press; WHO & FAO. 2004. *Vitamin and mineral requirements in human nutrition*. Second edition. Geneva, Switzerland, WHO. **b** Chaparro, C.M. & Suchdev, P.S. 2019. Anemia epidemiology, pathophysiology, and etiology in low-and middle-income countries. *Annals of the New York Academy of Sciences*, 1450(1): 15–31. **c** Micha, R., Mannar, V., Afshin, A., Allemandi, L., Baker, P., Battersby, J., Bhutta, Z. *et al*. 2020. *2020 global nutrition report: action on equity to end malnutrition*. Bristol, UK, Development Initiatives. **d** WHO & FAO. 2004. *Vitamin and mineral requirements in human nutrition*. Second edition. Geneva, Switzerland, WHO. **e** Beal, T., Massiot, E., Arsenault, J.E., Smith, M.R. & Hijmans, R.J. 2017. Global trends in dietary micronutrient supplies and estimated prevalence of inadequate intakes. *PLoS ONE*, 12(4): e0175554. https://doi.org/10.1371/journal.pone.0175554 **f** Wessells, K.R. & Brown, K.H. 2012. Estimating the global prevalence of zinc deficiency: results based on zinc availability in national food supplies and the prevalence of stunting. *PLoS ONE*, 7(11): e50568. https://doi.org/10.1371/journal.pone.0050568 **g** WHO & FAO. 2004. *Vitamin and mineral requirements in human nutrition*. Second edition. Geneva, Switzerland, WHO. **h** Ferguson, E., Chege, P., Kimiywe, J., Wiesmann, D. & Hotz, C. 2015. Zinc, iron and calcium are major limiting nutrients in the complementary diets of rural Kenyan children. *Maternal & Child Nutrition*, 11(53): 6–20. **i** Kumssa, D.B., Joy, E.J., Ander, E.L., Watts, M.J., Young, S.D., Walker, S. & Broadley, M.R. 2015. Dietary calcium and zinc deficiency risks are decreasing but remain prevalent. *Scientific reports*, 5(1): 1–11. **j** WHO & FAO. 2004. *Vitamin and mineral requirements in human nutrition*. Second edition. Geneva, Switzerland, WHO. **k** El-Ramady, H., Abdalla, N., Alshaal, T., Domokos-Szabolcsy, E., Elhawat, N., Prokisch, J., Sztrik, A., Fari, M., El-Marsafawy, S. & Shams, M.S. 2015. Selenium in soils under climate change, implication for human health. *Environmental Chemistry Letters*, 13(1): 1–19. **l** Fordyce, F.M. 2013. Selenium deficiency and toxicity in the environment. In: O. Selinus, ed. *Essentials of medical geology*, pp. 375–416. Dordrecht, the Netherlands, Springer. **m** WHO & FAO. 2004. *Vitamin and mineral requirements in human nutrition*. Second edition. Geneva, Switzerland, WHO. **n** Karakochuck, C.D., Whitfield, G.T. & Kraemer, K. 2017. *The biology of the first 1000 days*. New York, USA, CRC Press; WHO & FAO. 2004. *Vitamin and mineral requirements in human nutrition*. Second edition. Geneva, Switzerland, WHO. **o** Harika, R., Faber, M., Samuel, F., Kimiywe, J., Mulugeta, A. & Eilander, A. 2017. Micronutrient status and dietary intake of iron, vitamin A, iodine, folate and zinc in women of reproductive age and pregnant women in Ethiopia, Kenya, Nigeria and South Africa: a systematic review of data from 2005 to 2015. *Nutrients*, 9(10): 1096. **p** Hibbeln, C.J.R., Spiller, P., Brenna, J.T., Golding, J., Holub, B.J., Harris, W.S., Kris-Etherton, P. *et al*. 2019. Relationships between seafood consumption during pregnancy and childhood and neurocognitive development: two systematic reviews. *Prostaglandins, Leukotrienes and Essential Fatty Acids*, 151: 14–36. **q** FAO & WHO. 2010. Fats and fatty acids in human nutrition. Proceedings of the Joint FAO/WHO Expert Consultation. November 10–14, 2008. Geneva, Switzerland. *Annals of Nutrition and Metabolism*, 55(1–3): 5–300. **r** Forsyth, S., Gautier, S. & Salem, N. Jr. 2017. Dietary intakes of arachidonic acid and docosahexaenoic acid in early life – with a special focus on complementary feeding in developing countries. *Annals of Nutrition and Metabolism*, 70(3): 217–227.

Box 7.2

Small fish species from small-scale fisheries

Many small fish species that are important for nutrition are caught primarily or exclusively by small-scale fishers. In the African Great Lakes, for example, three species are vital to meeting local nutrition needs: Rastrineobola argentea (commonly called dagaa, omena or mukene) in Lake Victoria; Engraulicypris sardella (also known as usipa) in Lake Malawi; and Limnothrissa miodon (kapenta), which is endemic to Lake Tanganyika. Kapenta has also been successfully introduced without adverse ecological effects in both natural (Lake Kivu) and human-induced (Kariba and Cahora Bassa) lakes, where it has quickly become the most important part of the catch.[a] In Southern Asia, a particularly nutrient-rich fish consumed whole is mola (Amblypharyngodon mola), which is important as an affordable source of micronutrients in Bangladesh.[b]

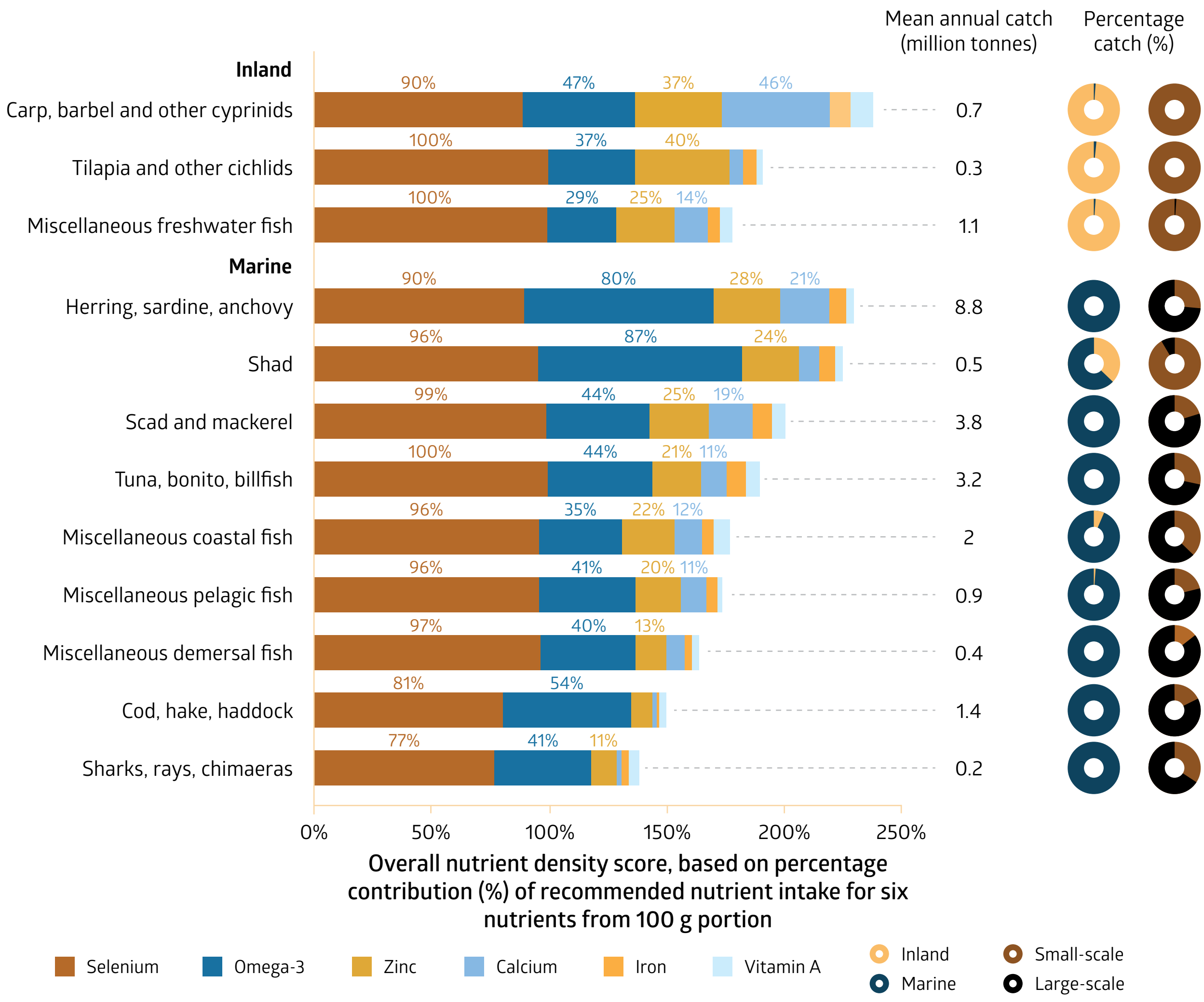
Figure *Kapenta* catch from Lake Malawi

Notes: **a** Kolding, J., van Zwieten, P., Marttin, F., Funge-Smith, S. & Poulain, F. 2019. *Freshwater small pelagic fish and their fisheries in the major African lakes and reservoirs in relation to food security and nutrition.* FAO Fisheries and Aquaculture Technical Paper No. 642. Rome, FAO. https://doi.org/10.4060/ca0843en **b** Bogard, J.R., Farook, S., Marks, G.C., Waid, J., Belton, B., Ali, M., Toufique, K., Mamun, A. & Thilsted, S.H. 2017. Higher fish but lower micronutrient intakes: temporal changes in fish consumption from capture fisheries and aquaculture in Bangladesh. *PLoS ONE,* 12(4): e0175098. https://doi.org/10.1371/journal.pone.0175098 results are presented as a percentage of the female population of reproductive age (UN, 2021a) for whom the small-scale fisheries catch would provide 20 percent of RNI for the six modelled nutrients in this chapter analysis (Table 7.2). This vulnerable group, representing about one-fifth of the global population, is a target for interventions in many development programmes focused on improving nutrition outcomes. The 20 percent level of RNI contribution was selected recognizing that fish should be promoted as part of a diverse diet, and that guidelines suggest a minimum of five food groups should be consumed to meet minimum required dietary diversity.

The results presented in Table 7.2 indicate that marine small-scale fisheries across Africa, Asia and the Americas are a potentially valuable source of the six modelled nutrients, while inland fisheries in Africa and Asia also have potential for substantial population-level contributions.

Selenium is present in high concentrations in marine catches from all regions, and in inland catches from Africa. Up to one billion people globally suffer from selenium deficiency (Fordyce, 2013). Fish can clearly play a role in addressing this deficiency, especially given concerns that selenium uptake through agriculture will decline under current climate change scenarios (Jones *et al.,* 2017).

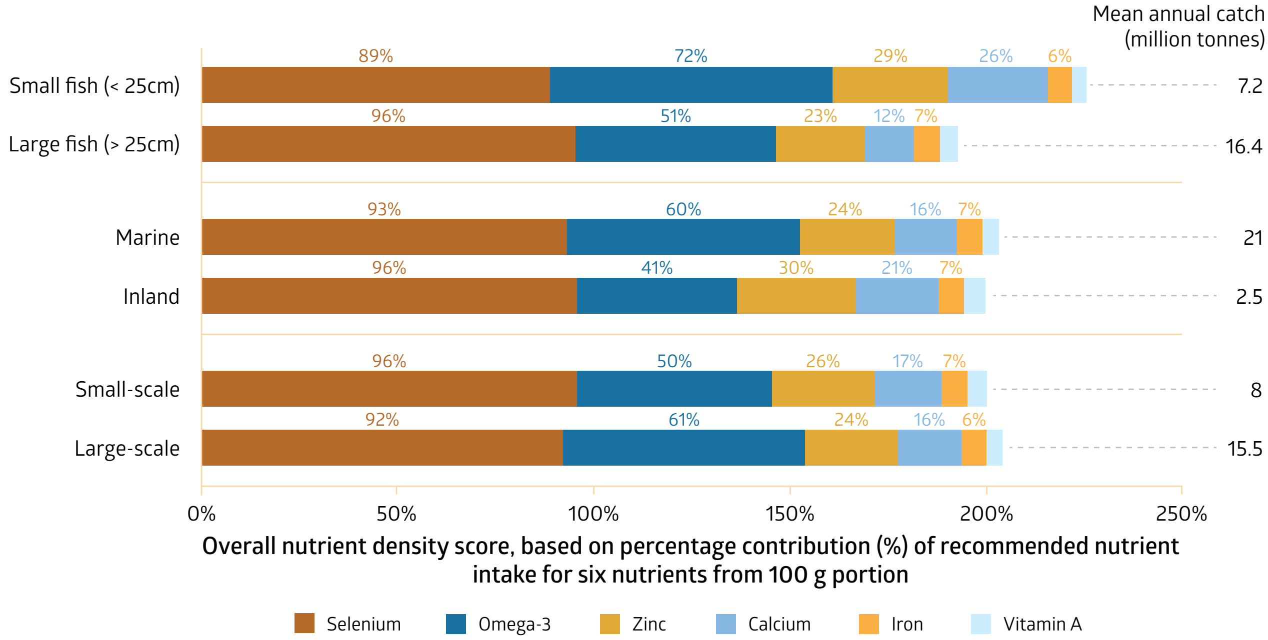
Figure 7.2 Nutritional contribution of various fish species to recommended nutrient intake, based on fisheries data from 44 IHH country and territory case studies (CCS) of least developed and other developing countries or areas



Notes: Bars show the percentage contribution of a 100 g serving of raw muscle tissue from freshwater and marine functional groups of species to recommended nutrient intake (RNI) for six nutrients for adult women. Each bar is the mean RNI contribution across all species that form each functional group, weighted by their contribution to total catch. The nutrient density score (x-axis) is the sum of the percentage contributions for the six nutrients. Where selenium contributions exceeded 100 percent of RNI, values were limited to 100 percent. To the right of each bar is the mean annual catch in millions of tonnes (million t) across all CCS for each group, with donuts indicating the relative catch proportion from marine (blue) and inland (yellow) fisheries and small- and large-scale subsectors (aqua and brown).

Sources: RNI values from WHO & FAO. 2004. *Vitamin and mineral requirements in human nutrition.* Second edition. Geneva, Switzerland, WHO; Lupton, J.R., Brooks, J.A., Butte, N.F., Caballero, B., Flatt, J.P. & Fried, S.K. 2002. *Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein, and amino acids.* Washington, DC, National Academies Press.

Figure 7.3 Comparison of nutrient density scores of catches by species size and fisheries subsector, based on fisheries data from 44 IHH country and territory case studies (CCS) of least developed and other developing countries or areas



Notes: Bars show the percentage contribution of functional groups of fish species to recommended nutrient intake (RNI) for six nutrients for adult women. The nutrient density score (x-axis) is the sum of the percentage contributions for the six nutrients. To the right of each bar is the mean annual catch in millions of tonnes (million t) across all CCS for each group. Note these catch figures do not represent global estimates of catch.

Sources: RNI values from WHO & FAO. 2004. *Vitamin and mineral requirements in human nutrition.* Second edition. Geneva, Switzerland, WHO; Lupton, J.R., Brooks, J.A., Butte, N.F., Caballero, B., Flatt, J.P. & Fried, S.K. 2002. *Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein, and amino acids.* Washington, DC, National Academies Press.

From a policy perspective, past research has shown the value of regional trade in ensuring the benefits of small-scale fisheries are shared (Béné, Lawton and Allison, 2010), but at the risk of obscuring the critical importance of fisheries operating at national and subnational scales that feed directly into local and short value chains. Notably, the low average per capita contributions from small-scale fisheries in Oceania are skewed by the high populations of Australia and New Zealand, yet small-scale fisheries still play a critical role in nutrient provision within Oceania at a subregional and national scale (see high calcium and zinc contributions for Micronesia in Figure 7.4).

Examples of selected subregional analyses for the nutritional contributions from small-scale fisheries (Figure 7.4) highlight the complex interaction between estimations of inadequate nutrient intake and nutritional contribution from small-scale fisheries. Inland fisheries from the African Great Lakes provide notably higher levels of calcium and zinc than iron and vitamin A. At this scale of subregional analysis, these four nutrients may not be found in quantities that would have a substantial impact at the scale of entire populations. Finer spatial scale analyses may tell a different story, with subpopulations heavily reliant on, and benefiting from, these nutrients. In Micronesia, where for most of the population fish is central to their diet, the high availability of zinc in aquatic foods may contribute to the correspondingly low rates of zinc deficiency. However, the analysis also shows that calcium intake is deficient in the subregion, despite the high level of calcium potentially available from aquatic foods. This raises important questions about the calcium supply from aquatic foods as well as food systems in general. The relative lack of understanding of the calcium contributions from aquatic foods may result in calcium intakes being underestimated. Given the importance of calcium for infants and children, research on intrahousehold distributions of calcium intake will also be important.

7.3.4 A "deeper dive" into African Great Lakes fisheries

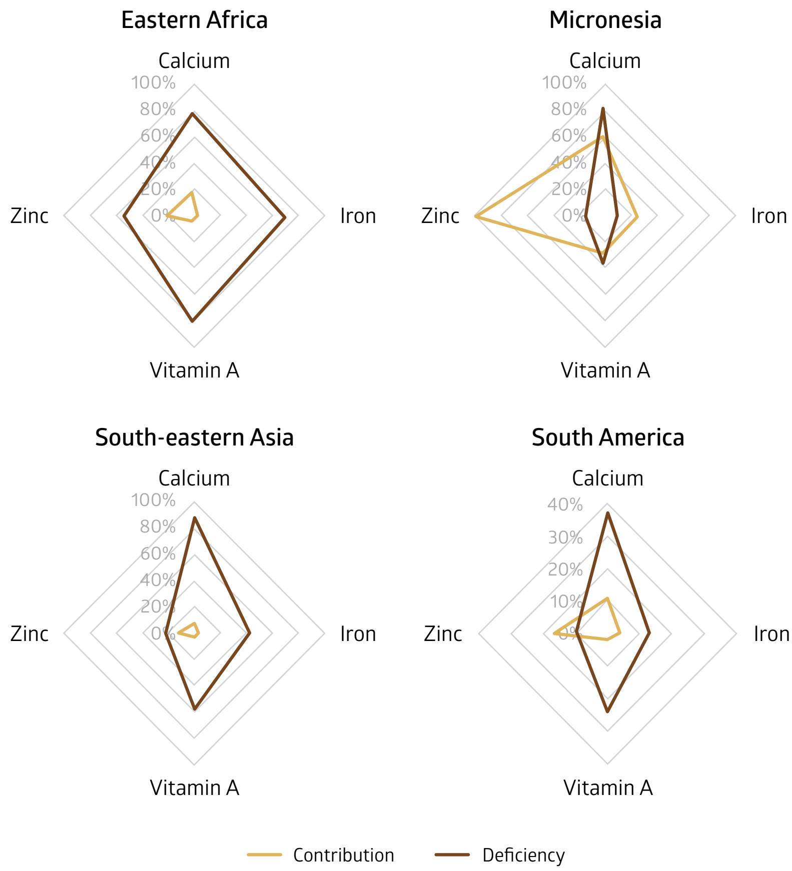
Knowledge of likely or actual changes in nutritional availability as a result of fisheries management shifts or ecological change can be pivotal to aligning fisheries management with nutrition targets. In Eastern Africa, diets are frequently deficient in calcium, iron, zinc and vitamin A (Ferguson *et al.*, 2015; Caswell *et al.*, 2018; Victora *et al.*, 2021), which are all found in fish from small-scale fisheries. In this subregion, inland small-scale fisheries in the African Great Lakes provide the main supply of fish (five times the supply of marine fisheries). In the last few decades, the composition of fish catch has changed progressively to smaller fish; now over 70 percent of inland fisheries catch consists of small pelagic fish species, which are highly abundant but underutilized (Kolding *et al.*, 2019).

Table 7.2 Percentage of the female population of reproductive age (15–49 years) for whom marine and inland small-scale fisheries catches would meet 20 percent of RNI for six nutrients, by region, based on data from IHH country and territory case studies and modelled nutrient values

Region	Ca	Fe	Se	Zn	Vitamin A	Omega-3	Number of women (millions): four nutrients	Number of women (millions): six nutrients
Total								
Africa	50.4%	17.7%	685.4%	75.2%	13.4%	136.5%	137.0	36.4
Americas	25.0%	9.5%	250.3%	40.5%	6.3%	81.8%	60.4	15.2
Asia	25.2%	10.1%	462.5%	44.3%	9.4%	170.4%	271.0	101.0
Europe	3.0%	1.5%	45.8%	7.5%	2.3%	27.3%	5.1	2.6
Oceania	10.5%	9.5%	321.5%	20.0%	6.8%	51.6%	1.0	0.65
Marine								
Africa	15.5%	8.3%	228.8%	26.8%	4.5%	86.8%	42.1	12.2
Americas	22.9%	8.6%	216.1%	35.5%	5.3%	76.2%	55.3	12.8
Asia	18.7%	8.1%	342.6%	32.3%	7.2%	146.5%	201.1	77.4
Europe	2.7%	1.4%	41.9%	7.2%	2.2%	26.1%	4.6	2.4
Oceania	10.1%	9.5%	316.5%	19.5%	6.8%	50.5%	0.9	0.7
Inland								
Africa	34.9%	9.4%	456.7%	48.4%	8.9%	49.8%	94.9	24.2
Americas	2.1%	0.8%	34.2%	5.0%	1.0%	5.6%	5.1	1.9
Asia	6.5%	2.0%	120.0%	12.0%	2.3%	23.8%	69.9	24.7
Europe	0.3%	0.1%	3.9%	0.3%	0.1%	1.2%	0.5	0.2
Oceania	0.4%	0.1%	4.9%	0.4%	0.1%	1.1%	0.0	0.0

Notes: The six nutrients modelled in the analysis are calcium, iron, selenium, zinc, vitamin A and omega-3 fatty acids. The last two columns show the number of women for whom small-scale fisheries would meet 20 percent of recommended nutrient intake (RNI) across four nutrients (calcium, selenium, zinc, omega-3 fatty acids) and all six nutrients.

Figure 7.4 Examples of subregional estimates of inadequate nutrient intake for four nutrients compared with nutritional contribution from selected small-scale fisheries, by subregion



Notes: Estimated inadequate nutrient intakes (orange lines) are displayed as percentage prevalence in the total population. Nutritional contributions (blue lines) are displayed as the percentage of women of reproductive age for whom the subregional catch would provide 25 percent of recommended nutrient intake.

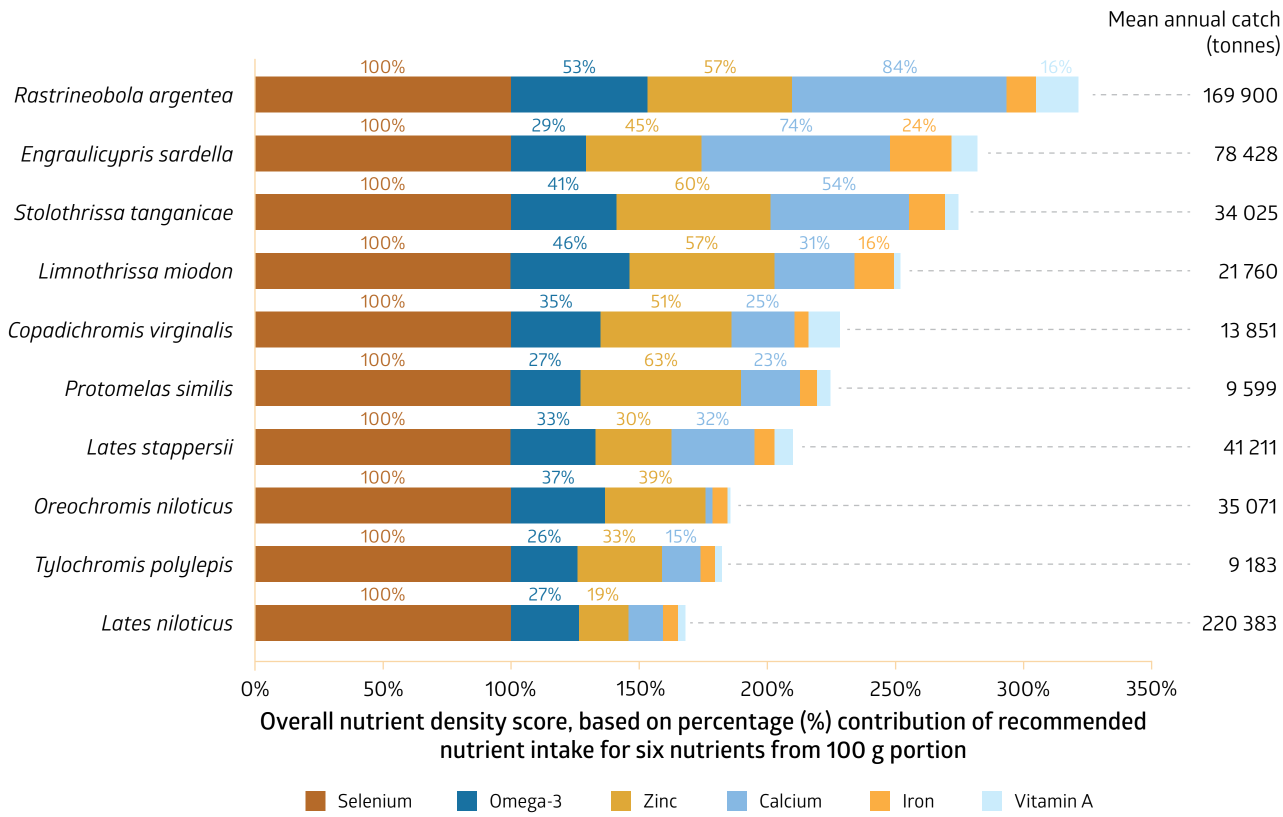
Source: Inadequate nutrition intakes from Beal, T., Massiot, E., Arsenault, J.E., Smith, M.R. & Hijmans, R.J. 2017. Global trends in dietary micronutrient supplies and estimated prevalence of inadequate intakes. *PLoS ONE*, 12(4): e0175554. https://doi.org/10.1371/journal.pone.0175554

Nutrient modelling was undertaken on fish species across four countries in Eastern Africa: Malawi, Uganda, United Republic of Tanzania and Zambia (see Annex A). According to the four CCS, small-scale fisheries catches from the lakes in this region include 38 species, but high-quality, measured nutrient data were available for only four species (*Clarias gariepinus, Engraulicypris sardella,Oreochromis niloticus* and *Lates niloticus*) – hence the utility of the nutrient modelling approach. Among the ten most abundant species reported in the CCS (Figure 7.5), the four with the highest modelled nutrient density scores are all small, schooling pelagic species predominantly from Lake Victoria, Lake Tanganyika and Lake Malawi. The most nutritious of the ten species, *Rastrineobola argentea*, had a nutrient density score twice that of the least nutritious, Nile perch (*L. niloticus*). Concentrations of calcium, zinc and omega-3 fatty acids drive these differences.

Lake Victoria's inland fisheries are among the largest in the world, producing approximately 1 million tonnes per year. Looking deeper into the evolution of Lake Victoria fisheries illustrates how shifts in ecology and management can have a marked impact on nutrient availability, and accordingly where nutrition-sensitive fisheries management can help improve nutrition outcomes. For this analysis, collated regional catch data were used to illuminate the variations in nutrient availability that have occurred as the lake's fisheries have changed.

Until the early 1980s, the fisheries of Lake Victoria were small-scale and locally operated, directly supporting the food supply of the surrounding area. The catch was dominated by both large and small tilapia species and a huge diversity of small fish – mostly from the haplochromine cichlids, a subfamily of tilapia-like species (Aura *et al.*, 2020). However, the introduction of the predatory Nile perch (*L. niloticus*) in the 1960s together with rapidly increasing eutrophication (Kolding *et al.*, 2008) contributed to population declines and extinctions among the haplochromines, along with ecological instability and stark changes in water quality (van Zwieten *et al.*, 2016; Marshall, 2018). Further introductions of other species, including Nile tilapia (*O. niloticus*),

Figure 7.5 Modelled nutrient density scores for the ten most abundant fish species in catches reported in IHH country and territory case studies from Malawi, Uganda, United Republic of Tanzania, and Zambia



Notes: Bars show the percentage contribution of ten fish species to recommended nutrient intake for six nutrients for adult women. The nutrient density score (x-axis) is the sum of the percentage contributions for the six nutrients.

Sources: RNI values from WHO & FAO. 2004. *Vitamin and mineral requirements in human nutrition.* Second edition. Geneva, Switzerland, WHO; Lupton, J.R., Brooks, J.A., Butte, N.F., Caballero, B., Flatt, J.P. & Fried, S.K. 2002. *Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein, and amino acids.* Washington, DC, National Academies Press.

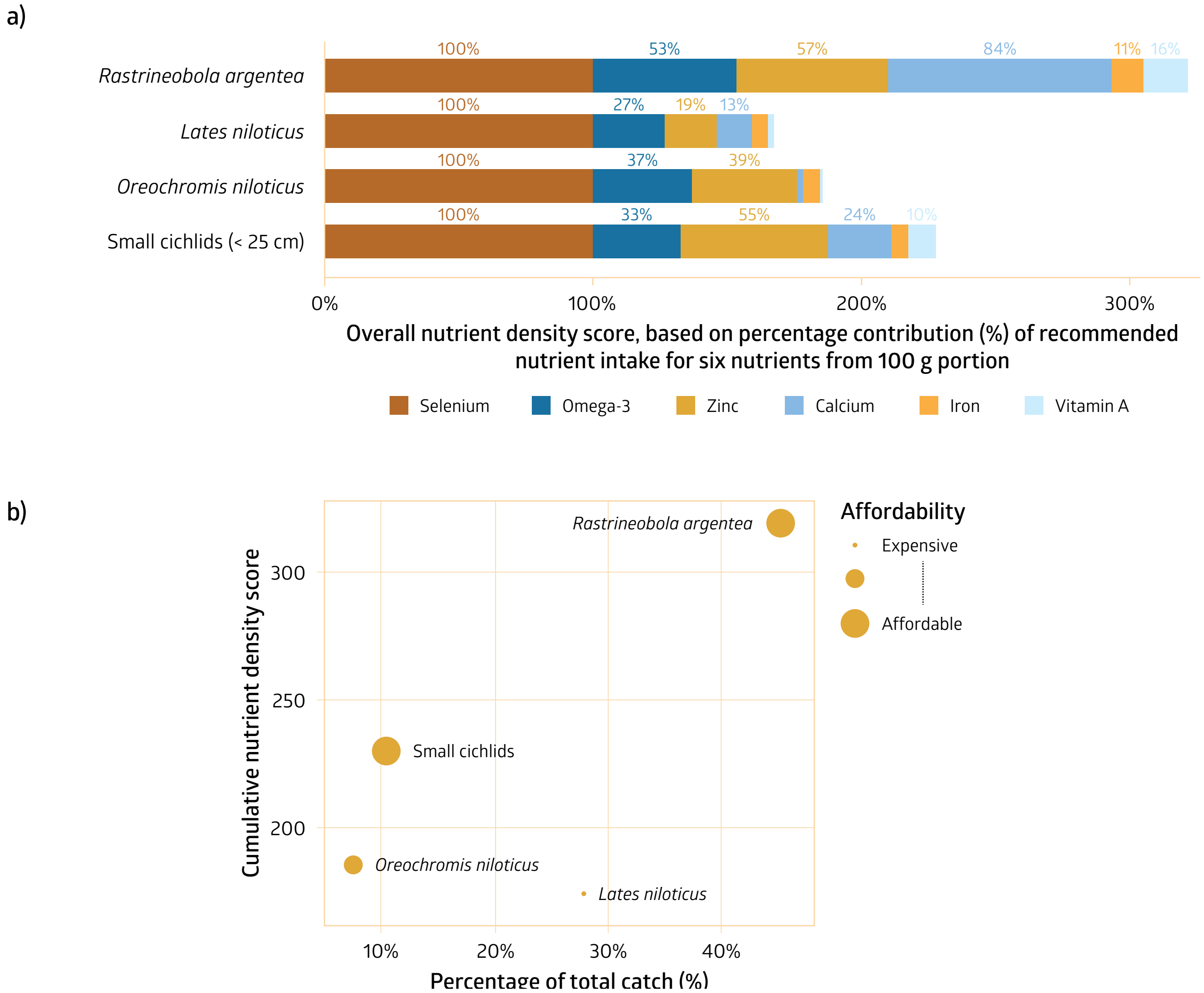
compounded these issues. As the haplochromine population declined, a small pelagic cyprinid (*R. argentea*), locally known as *dagaa* (United Republic of Tanzania), *omena* (Kenya) or *mukene* (Uganda) began to proliferate, after which it became increasingly targeted by local small-scale fishers. By the 1990s, the Nile perch fishery had developed into a multimillion-dollar activity, soon accounting for 90 percent of international fish exports from the countries bordering the lake (Kolding *et al.,* 2014). Later, as demand for fish oil and fishmeal increased, a substantial component of the *dagaa* catch was diverted for reduction to animal feed (Muyodi, Bugenyi and Hecky, 2010). Only 30 percent of *dagaa* production is now used for human consumption, with much of the remaining production going into industrial feed mills for livestock and aquaculture (CAS Regional Working Group, 2015).

Clearly, if household fish consumption had transitioned away from declining indigenous species (mostly consumed whole) towards either Nile perch or Nile tilapia (eaten as fillets), there would have been substantial negative impacts on the nutrient density of a fish-based meal (Figure 7.5; Figure 7.6, panel a). But instead, the focus of much of the local small-scale and subsistence fishers shifted towards *dagaa* (*R. argentea*), which now contributes more than half of the total catch from the lake (CAS Regional Working Group, 2015). *Dagaa* has a modelled nutrient density value that is double that of the average fish in the global database, with a particularly high calcium value that could help address inadequate intake. Considering that *dagaa* is eaten whole, the actual calcium value is likely higher than modelled values for flesh only, although reported values for this species boiled whole (Kabahenda *et al.,* 2011) are very similar to modelled values in this chapter analysis. A recent household survey in a Kenyan fishing community (Fiorella *et al.,* 2016) reported that 39 percent of fish consumed was small Nile perch (*L. niloticus*) and 51 percent was *dagaa*. While the flesh (i.e. fillet) of Nile perch has a relatively low nutrient density (Figure 7.5; Figure 7.6, panel a), it is likely that the increased consumption of highly nutritious *dagaa* in local diets more than compensates for this. The increase in biomass of *dagaa*, and the apparently robust nature of such small pelagic fish stocks, has been borne out in this instance: with only an estimated 10 percent of the annual biological production harvested, the *dagaa* fishery shows no signs of overexploitation (Kolding *et al.,* 2019). The remaining concern is the total volume of fish that is retained for consumption in local communities, with increasing volumes of *dagaa* being diverted instead for fishmeal production.

Visualizing the relationship between fish catch, nutritional value and affordability (Figure 7.6, panel b) is a powerful method for informing policies aiming to improve the nutritional benefits of fisheries. *R. argentea*, being both abundant and highly nutritious, is of particular interest. This species is also highly affordable for local consumers and should thus be a priority for management investment. In contrast, Nile perch has a relatively low nutrient density score and is unaffordable locally (as the fishery is export-oriented, and thus the species has a high landed price). While this species is important for local diets, the locally consumed catch is almost invariably below legal size (Fiorella *et al.*, 2016), so it does not enter formal value chains and is omitted from formal catch data. If included, Nile perch would have a very different pricing structure to the landed price data presented here.

The challenge for management, then, is to balance the economic benefits of the export of Nile perch with the nutritional benefits of this species to local communities. Any attempt to enforce current legal minimum sizes for Nile tilapia and Nile perch would have devastating impacts on their availability for local consumption. Meanwhile, although there are no concerns about the stock status of *dagaa* and of juvenile Nile perch (the latter being the second largest stock in the lake [Natugonza *et al.*, 2016]), policy intervention may be needed to prioritize local consumption over other uses. Analytical approaches as used here are accessible methods for incorporating nutrition outcomes into management goals, and are central in the push to institutionalize nutrition sensitivity as a key pillar of sustainable fisheries management.

Figure 7.6 Nutrient density scores and affordability of small-scale fisheries catch in Lake Victoria, based on IHH country and territory case studies



Notes: Panel a shows nutrient density scores for three dominant locally consumed fish species, plus small cichlids as a group, indicating the percentage contribution of each species to recommended nutrient intake (RNI) for six nutrients for adult women. The nutrient density score (x-axis) is the sum of the percentage contributions for the six nutrients. Panel b compares total nutrient density score (y-axis) with proportion of total catch (x-axis) for the same groups; dot size represents relative affordability.

Sources: RNI values from WHO & FAO. 2004. *Vitamin and mineral requirements in human nutrition*. Second edition. Geneva, Switzerland, WHO; Lupton, J.R., Brooks, J.A., Butte, N.F., Caballero, B., Flatt, J.P. & Fried, S.K. 2002. *Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein, and amino acids*. Washington, DC, National Academies Press.

7.3.5 The impact of food quality and safety on small-scale fisheries contributions to human health and to food security and nutrition

Food quality and safety concerns relate to all types of food, and the potential loss of nutritional value has great implications for human health globally. The nature of the aquatic foods found in aquaculture and capture fisheries give rise to some unique food safety hazards. Small-scale fisheries face challenges linked to land-based contaminants that affect inland and near-shore fish stocks, as well as limited access to quality processing and market chain infrastructure, services and information. As a component of the CCS, national teams were requested to provide information on local food safety concerns in small-scale fisheries. Very few were able to do so but, because of the importance of food safety to improving nutrition outcomes, a brief review is included here to highlight major issues and approaches to their mitigation.

During processing, **spoilage bacteria or protozoans** can be introduced or inadvertently propagated due to inappropriate and unhygienic storage, poor handling, insufficient or dirty ice, and contaminated water. This can result in products with a lower shelf life and nutritional value, and ultimately lower product acceptance among consumers. For example, physical fish losses along small-scale fisheries value chains in Southern Africa are low (4.1 percent) when compared to other regions globally, but losses in quality that increase health risks and reduce nutrition levels can "range between 43 percent and 69 percent depending on the node" (Torell *et al.,* 2020).

Furthermore, some spoilage bacteria convert histidine to histamine (referred to as scombrotoxin), which causes scombroid poisoning. This is a particular concern for scombroid species (mackerel, tuna and bonito), as they have naturally high levels of histidine (Emborg and Dalgaard, 2008; Painter *et al.,* 2013). Scombroid poisoning is especially troublesome because histamine is a heat-stable compound, so once it reaches a high level, there are no mitigation measures (such as cooking) to counteract it. The growth of spoilage bacteria can only be prevented through attention to hygiene, temperature control, careful post-harvest handling, and minimizing transportation time from harvest to consumers (Svanevik *et al.,* 2015).

The contamination of water or surfaces (i.e. in or on fishing gear, handling equipment, storage tanks, landing devices, conveyor belts, filleting machines, dryers, fermenters or smokers) used for processing and handling fish can result in the introduction of pathogenic microorganisms such as *Listeria monocytogenes* (Svanevik *et al.,* 2015; Svanevik and Lunestad, 2011; Huss, 1994); these risks can be exacerbated during extended processes such as sun-drying. Due to the more limited access to higher-quality infrastructure in small-scale fisheries value chains, contamination hazards during handling, processing and storage are disproportionately higher. Fish and other aquatic species harvested through small-scale fisheries may also occasionally accumulate **pathogenic bacteria and viruses** that are naturally present in aquatic environments (Novotny *et al.,* 2004; Mok *et al.,* 2019). Bivalves are the most frequent carriers of these (Painter *et al.,* 2013; Westrell *et al.,* 2010; Iwamoto *et al.,* 2010; Dewey-Mattia *et al.,* 2018), which they accumulate through filter feeding (Cranford, Ward and Shumway, 2011; Mathijs *et al.,* 2012). Bivalve monitoring programmes that assess the presence of contaminants and microorganisms are important mechanisms for consumer protection, but they are also expensive. In low- and middle-income countries, bivalve fisheries are invariably small-scale, and thus these programmes are often not feasible without substantial public funding (FAO and WHO, 2018).

Concentrations of **heavy metals** (e.g. mercury, lead, cadmium, metalloid arsenic) are found in fish and shellfish, depending on the concentrations in the surrounding water and the bioaccumulation tendencies of different species (Castro-Gonzalez and Mendez-Armenta, 2008). These metals originate from both natural and anthropogenic sources, but coastal areas and freshwater systems close to human populations and activities (particularly mining) tend to have higher levels of heavy metal contamination (Baki *et al.,* 2018). Predatory species, such as sharks, swordfish and tuna, often contain the highest levels of mercury (FAO and WHO, 2010). However, fears of mercury toxicity from such fish may have been overemphasized in the past, as research has shown that correspondingly high selenium levels in these fish actually protect against toxicity (Ralston *et al.,* 2007). Similarly, total arsenic levels can be high in marine fish, bivalves and crustaceans, but in a relatively non-toxic form (Bhattacharya *et al.,* 2007). For instance, lead levels are generally low in finfish fillets, but bones and scales can accumulate higher concentrations (Schmitt and Mckee, 2016). Crustaceans and bivalves, on the other hand, can have high levels of undesirable metals, particularly cadmium (Wiech *et al.,* 2020) and inorganic arsenic (Sloth and Julshamn, 2008).

Chemical contaminants can potentially be introduced during pre- and post-harvest activities. Polycyclic aromatic hydrocarbons are well-known carcinogenic and mutagenic compounds that can be found in high concentrations in smoked products, including fish (Ndiaye, Komivi and Ouadi, 2015; Hasselberg *et al.,* 2020). Fish smoking is a common preservation technique in many small-scale fisheries value chains, notably in Africa, where large volumes of the domestic fish catch of mostly fatty species (which are not suitable for drying) are smoked. Different smoking methods, such as the FAO-Thiaroye technique, have been shown to reduce polycyclic aromatic hydrocarbons and improve the safety of smoked products (Bomfeh *et al.,* 2019).

Other important chemical contaminants include persistent organic pollutants, which are primarily lipophilic (i.e. attracted to fats) compounds that tend to be found in higher concentrations in oily fish. The health risks of human exposure to these pollutants vary, but they include reproductive disorders and carcinogenicity. Unfortunately, data on concentrations in fish and other aquatic foods specifically harvested by small-scale fisheries, as well as dietary exposure on the part of consumers through small-scale fisheries product chains, are sparse.

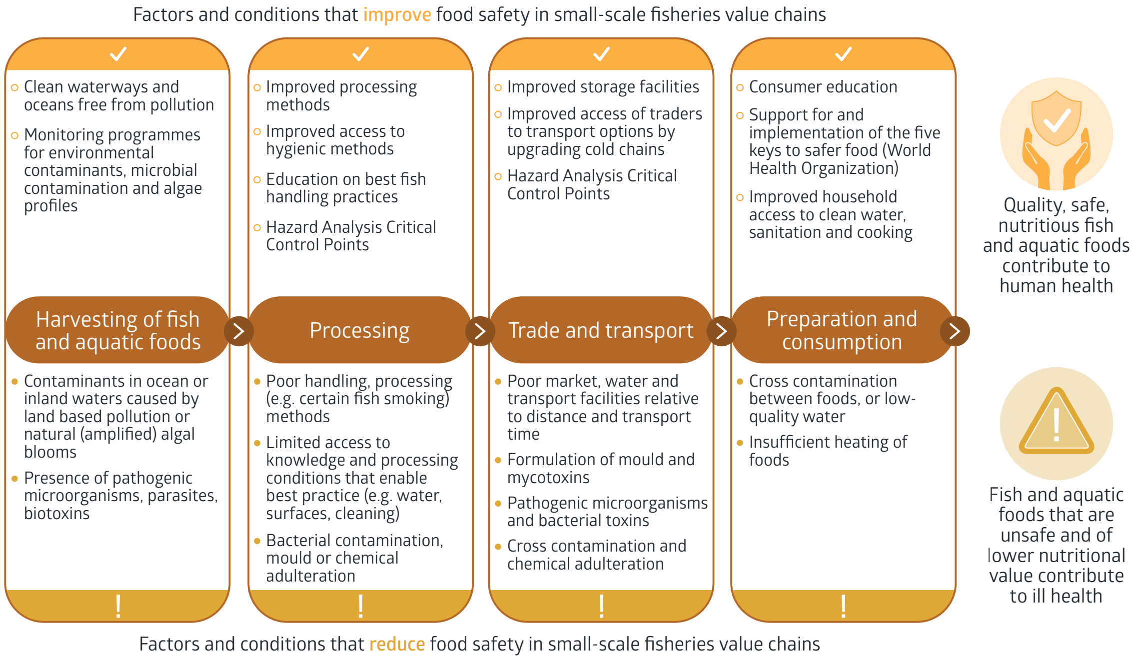
While **algal blooms** are natural phenomena, their intensity and frequency are linked to human-induced impacts on ocean and freshwater chemistry (FAO and WHO, 2020). Certain algal species produce potent biotoxins that can be ingested by shellfish and fish. When consumed by humans they can evoke a variety of physiological, gastrointestinal and neurological illnesses. As with bivalves (above), most low- and middle-income countries do not have the resources to establish monitoring programmes to mitigate the risk of these harmful algal blooms. Fish containing ciguatoxin are responsible for ciguatera poisoning, the most common non-bacterial seafood poisoning globally, which affects digestive, muscular and/or neurological systems. Ciguatoxin originates in a dinoflagellate that becomes seasonally abundant in the tropical Caribbean and Pacific regions, where rates of fish consumption are very high. The incidence of ciguatera has already led to a ban on capturing predatory fish species such as barracuda, red snapper, moray eel and amberjack, as their feeding patterns lead to bioaccumulation of ciguatoxin (FAO and WHO, 2020). Freshwater algal toxins are less commonly reported, but do arise in waterbodies, especially where there are issues with land-based nutrient runoff.

Finally, fish-borne **zoonotic parasites** pose a significant consumer health hazard worldwide (EFSA, 2010). For example, fresh marine fish are a significant vector for human infection by the larvae of *Anisakis* nematodes (Bao *et al.*, 2019; Cipriani *et al.*, 2018; Guardone *et al.*, 2018). Other parasites of concern include the liver flukes *Opisthorchis viverrine* and *Clonorchis sinensis*, which are responsible for several million human infections each year, especially in South-eastern and Eastern Asia (Chai, Murrell and Lymbery, 2005; Sunday and Ada, 2020). Although there is limited understanding of associated morbidity, the potential for an allergic reaction to the *Anisakis* parasite (still possible even when the fish is thoroughly cooked) may pose an additional threat to consumers.

There are opportunities within small-scale fisheries value chains to address food safety concerns and human health costs, including improved landing and processing infrastructure; improved access to clean water; availability of adequate facilities for cooling, drying or smoking; and improved access to and development of storage, transport and trading processes and technologies (Figure 7.7). It may be difficult to meet global best practice standards in all contexts in which small-scale fisheries and their value chains operate, but alternatives can be explored.

For example, potable water is the safest choice for processing, cleaning and ice-making. But if this resource is limited, then measures can be taken to reduce microbial risk. Limiting microbial growth will lead to increased shelf life, improved quality and reduced post-harvest losses (FAO and WHO, 2019) – all of which represent substantial pathways within

Figure 7.7 Summary of factors affecting food safety in small-scale fisheries value chains



Source: Garrido Gamarro, E., Smith Svanevik, C., Lundebye, A.K., Sanden, M., D'Agostino, E., Kjellevold, M., Pincus, L. & Pucher, J. 2023. Challenges in the implementation of Food Safety and Quality Assurance Systems in small-scale fisheries. *Food Quality and Safety*, 7: 1–9.

small-scale fisheries to improve food security and nutrition and human health outcomes.

The food safety concerns that arise from land-based pollution of waterways are likely to be mitigated by the actions of governments and the private sector. Consumers have some agency in addressing food safety issues by demanding safer food from actors higher up the value chain, and also by implementing hygienic food preparation and storage options in wet markets and households. Programming to educate consumers can include information on the five keys to safer food: 1) keep food clean; 2) separate raw and cooked food; 3) cook food thoroughly; 4) keep food at a safe temperature; and 5) use safe water and raw materials (WHO, 2006). The Code of Conduct for Responsible Fisheries (FAO, 1995) includes provisions (11.1.2, 11.1.3) on post-harvest practices and trade that encourage states to protect consumer health; establish and maintain effective national quality and safety assurance systems, with minimum standards that are effectively applied throughout the value chain; and promote the implementation of the international food safety standard Codex Alimentarius (also called the Food Code). Low- and middle-income countries face challenges in engaging in Codex Alimentarius processes, and as much as implementation of the Alimentarius is needed, so too is adjustment of the code to better reflect opportunities to improve food safety in small-scale fisheries food systems. Moreover, the international community needs to assist with building capacity to improve the participation of developing countries or areas in international standard-setting processes within the Codex Alimentarius, so that the views and practices of the small-scale fisheries subsector are included.

7.4 Small-scale fisheries, poverty, and food security and nutrition: quality data provide new insights in sub-Saharan Africa

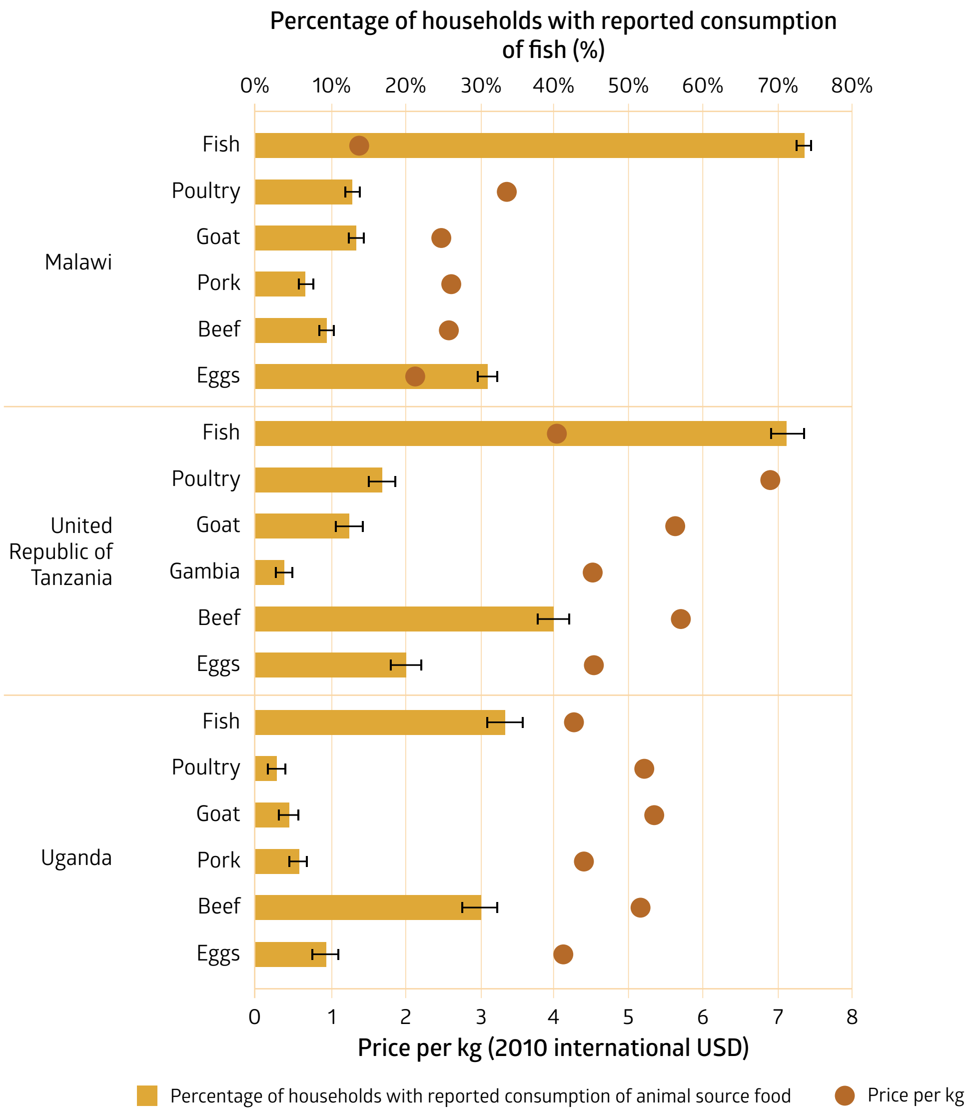
Sub-Saharan Africa has some of the highest rates of poverty, food insecurity and malnutrition in the world, with predictions that this will worsen in the years ahead due to drivers including climate change and increased competition for natural resources (FAO, IFAD, UNICEF, WFP and WHO, 2020). Small-scale fisheries provide the main supply of fish for people in this region and will continue to do so in the coming decades (Chan *et al.,* 2019). The nutrient potential of these fisheries in Africa is the highest of any global region (see Table 7.2).

High-resolution data linking fisheries livelihoods, food security and nutrition and poverty status over large geographic scales are rare, but can provide powerful insights for making impactful policy choices. The World Bank's Living Standards Measurement Study and Integrated Surveys on Agriculture (LSMS-ISA), a nationally representative survey undertaken in sub-Saharan Africa, is unique in that it provides data on poverty and food security and nutrition linked to fish consumption and fisheries livelihoods. A fishery module appended to the survey was designed by fisheries researchers to address key questions for the small-scale fisheries subsector (Béné *et al.,* 2012). Survey data included fish consumption by quantity and form (dried, fresh and smoked) and household engagement in livelihoods related to small-scale fisheries (harvesting, processing and trade activities). Georeferenced data were used to compare rural and urban environments and the impacts of living in proximity to waterbodies where small-scale fisheries operate.

LSMS-ISA data from Malawi, Uganda and the United Republic of Tanzania were used to investigate the flow of benefits from the abundant inland (African Great Lakes) and marine (coastal Western Indian Ocean) small-scale fisheries found in sub-Saharan Africa. Detailed spatial data on livelihoods (small-scale fisheries, agriculture or neither), fish consumption, food consumption profile (as measured by the World Food Programme's food consumption score) and monetary poverty (based on national poverty line) were analysed to understand how distance from waterbodies affects households' physical and economic access to fish (see Annex A) (Simmance *et al.,* 2022b). The food consumption score provides a measure of adequate food consumption, which acts as a proxy for energy sufficiency (Leroy *et al.,* 2015; WFP, 2008). Data availability on fish and fisheries was similar across country surveys, except for Uganda where data on livelihoods were limited to fishing activities only, not extending to the post-harvest segment of small-scale fisheries value chains. These data are used in the following subsections to determine where, and for whom, fish and small-scale fisheries are most important at the subnational level.

In rural and urban contexts across all three countries, more households consume fish than any other ASF (Figure 7.8). In the analysis, the price of fish was almost always lower than other ASFs (except for eggs in Uganda), a likely driver of relatively high fish consumption. More households reported consuming fish (33–73 percent) than other ASFs (< 40 percent for eggs and beef; < 20 percent for poultry, goat or pork); this predominance was most evident in Malawi, but much less so in Uganda. Fish is particularly important in the diets of rural and poor (i.e. living below the national poverty line) households, which consume few

Figure 7.8 Household consumption and purchase price of animal source foods (ASFs) in three sub-Saharan countries



Notes: Percentage of households consuming common ASFs during the seven-day recall period (left axis), and the average price per kg (2010 international USD) of each ASF (right axis).

Sources: World Bank Living Standards Measurement Study – Integrated Surveys on Agriculture (LSMS-ISA) for Malawi (2016–2017), Uganda (2010–2011) and United Republic of Tanzania (2014–2015), available at www.worldbank.org/en/programs/lsms/initiatives/lsms-ISA#40 .

other ASFs. For example, in Malawi, while 63 percent of poor households ate fish in the recall period, only 2 percent ate beef and 3 percent ate pork. In contrast, non-poor households showed a higher diversity of ASF consumption: 82 percent ate fish, 16 percent ate beef and 9 percent ate pork. The national average quantities of fish consumed per year (10 kg/capita in the United Republic of Tanzania, 11 kg/capita in Malawi and 13 kg/capita in Uganda) meet the EAT-Lancet fish consumption recommendations for a healthy diet: 28 g of fish per day, equivalent to 10 kg/year (Willett *et al.*, 2019). However, inequalities exist in access to fish for population subgroups, and malnutrition and food insecurity remain high due to inadequate overall diets and health vulnerabilities. The collection of gender- and age-disaggregated data on ASF (including fish) consumption should be a high priority given the metabolic and health benefits of nutrients available from these foods.

7.4.1 Increased fish consumption due to proximity to waterbodies with small-scale fisheries operations

Households living within 5 km of waterbodies supporting small-scale fisheries eat fish about twice as frequently per week as those living at a distance (by a factor of 1.9 in Malawi and the United Republic of Tanzania, and a factor of 2.1 in Uganda). This applies in both urban and rural settings across countries, but particularly in rural areas. The average quantity of fish consumed is also higher in rural households living close to small-scale fisheries in all three countries (by a factor of 1.1 in Uganda, 2.6 in Malawi and 2.9 in the United Republic of Tanzania), although only fractionally in Uganda (Figure 7.9).

Figure 7.9 Distribution of fish consumption by households living near waterbodies in Malawi, Uganda and the United Republic of Tanzania

Borders of Uganda (top), United Republic of Tanzania (middle) and Malawi (bottom)

Inland waterbodies and coastlines

Households with reported fish consumption

Notes: Brown dots show spatial distribution of fish consumption reported by households living near inland waterbodies and coastlines in Malawi, Uganda and the United Republic of Tanzania. Analysis is of 18 715 households and a sample population of 87 879, framed to be representative of the total population of each country (93.8 million across the three countries).

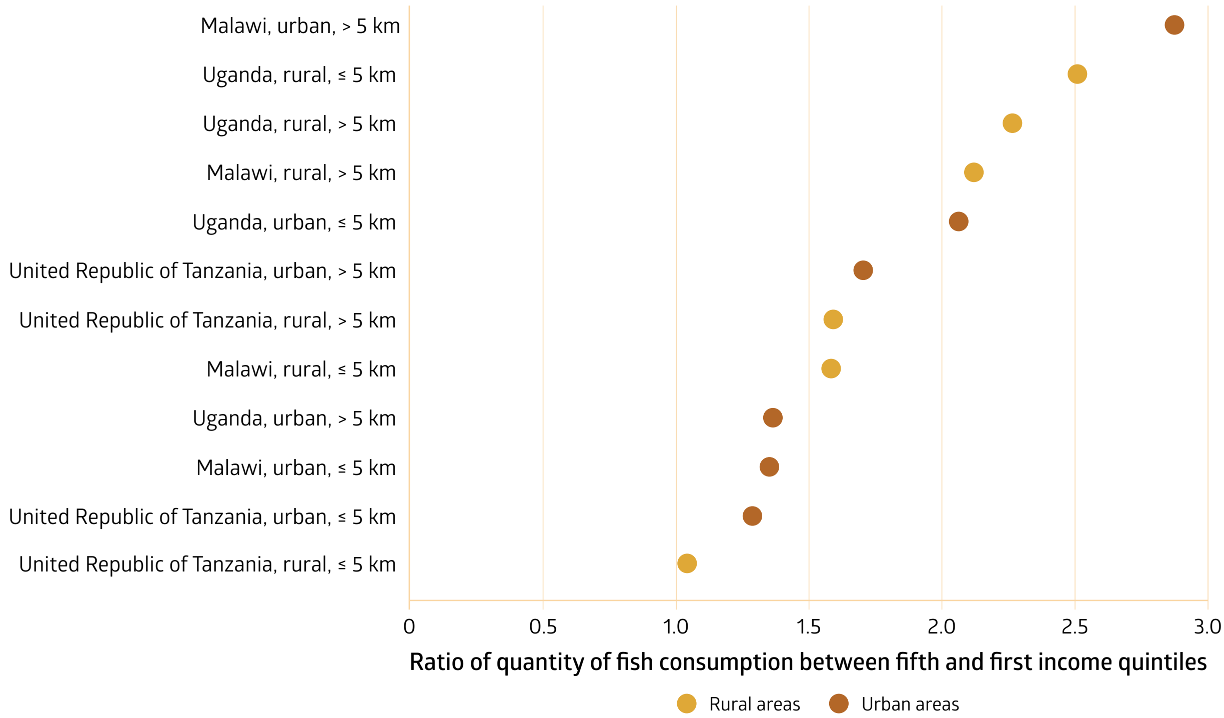
Sources: World Bank Living Standards Measurement Study – Integrated Surveys on Agriculture (LSMS-ISA) for Malawi (2016–2017), Uganda (2010–2011) and United Republic of Tanzania (2014–2015), available at www.worldbank.org/en/programs/lsms/initiatives/lsms-ISA#40; World Wildlife Fund. 2004. Global Lakes and Wetlands Database (GLWD). In: *World Wildlife Fund*. Washington, DC. Cited 15 October 2021. www.worldwildlife.org/pages/global-lakes-and-wetlands-database; European Space Agency & UCLouvain. 2010. GlobCover 2009 (Global Land Cover Map). In: *European Space Agency*. ESA GlobCover 2009 Project. Cited 15 October 2021. http://due.esrin.esa.int/page_globcover.php

In this analysis, the increased access to fish from small-scale fisheries through proximity to fished waterbodies reduced inequalities in fish consumption between wealthy and poor households (measured as the highest and lowest quintiles, respectively, in national income distributions) by an average of 30 percent (Figure 7.10). For example, in Malawi the difference in the quantity of fish consumed between richest and poorest households dropped from 3.0 kg/household/week for households living more than 5 km from fished waterbodies, to 1.5 for households living within 5 km. Unsurprisingly, engagement in small-scale fisheries livelihoods also positively influences fish consumption patterns: fishing households consume greater quantities of fish compared to non-fishing households (by a factor of 2.8 in Malawi, 3.2 in the United Republic of Tanzania, and 1.9 in Uganda). However, agricultural livelihoods dominate in all three countries, and fish is predominantly acquired through purchase (92–96 percent), further highlighting the importance of trade and markets. Small-scale fisheries improve consumption of fish as food by providing a relatively affordable food source compared to other ASFs, but this consumption decreases for those who live farther away from fishing grounds. If the food security and nutrition benefits of small-scale fisheries are to become more widespread, value chain enhancements that reduce fish loss and waste and enable distribution networks to extend to locations that are distant from fished waterbodies will be a key part of the solution.

The form in which fish is consumed (i.e. fresh, dried, other) varies among and within countries, and is again linked strongly with proximity to fished waterbodies. A large share of households reported consuming dried fish: 71 percent in Malawi, 46 percent in the United Republic of Tanzania and 64 percent in Uganda. Consumption of fresh fish is particularly high in the United Republic of Tanzania (71 percent of households), with lower levels in Malawi and Uganda (28 percent and 51 percent, respectively). In all three countries, a higher share of rural households living near small-scale fisheries consume fresh fish than those distant from small-scale fisheries (by a factor of 1.4 in the United Republic of Tanzania, 2.1 in Uganda and 4.6 in Malawi). Conversely, a higher share of rural households living distant from small-scale fisheries consume dried fish (by a factor of 1.3 in the United Republic of Tanzania, 1.5 in Malawi and 1.8 in Uganda) than those living near small-scale fisheries.

Small fish are exclusively processed by sun-drying, and represent 70 percent of total inland fish catch in the region. The predominant species are *usipa* (*Engraulicypris sardella*) in Malawi and *mukene* (*Rastrineobola argentea*) in Uganda (Kolding *et al.*, 2019). The informal trade of dried small fish from small-scale fisheries in the region is vast, which helps explain its dominance as the form of fish consumed (Kolding *et al.*, 2019). Although some nutrients are lost in the drying process, notably vitamin A (HLPE, 2014), in the absence of refrigeration, dried fish remains

Figure 7.10 Difference in fish consumption (kg/household/week) between richest and poorest households, by rural and urban area and proximity to fished waterbodies



Notes: Difference in fish consumption is expressed as the ratio (y-axis) between that of the highest and lowest income quintiles. Dark shading represents less than or equal to 5 km from fished waterbodies; light shading represents greater than 5 km from fished waterbodies.

Source: LSMS-ISA data from Malawi, Uganda and the United Republic of Tanzania.

a highly affordable and nutrient-dense food (Byrd *et al.*, 2021; Simmance, 2017). This highlights the importance of the dried fish trade in improving physical and economic access to nutritious food for remote rural populations living far from small-scale fisheries.

7.4.2 Increased frequency of adequate food consumption via increased access to fish as food

Fish consumption contributes notably to food security in sub-Saharan Africa, as it is the main ASF consumed in the region. Across all three countries analysed, households living adjacent to fished waterbodies had higher rates of adequate food consumption compared to those living distant (by 12.6 percent). Similarly, rural households engaged in fishing livelihoods had higher rates (by 9.8 percent) of adequate food consumption compared to non-fishing rural households. The association between small-scale fisheries livelihoods and food security varies by context: it is strong in rural areas of Malawi and the United Republic of Tanzania, whereas in rural Uganda, fishing households are more likely to be food insecure than agricultural households. This could be a result of inequity in the flow of benefits from the fisheries sector, due to the greater priority given to export-oriented fisheries value chains in Uganda (Fiorella *et al.*, 2014; Fulgencio, 2009).

7.4.3 Fisheries livelihoods and poverty reduction

Food security is underpinned by livelihoods, and the benefits obtained from small-scale fisheries extend beyond increased access to food. Among the three sub-Saharan countries analysed, small-scale fisheries were found to be associated with reduced rates of income poverty. Households living within 5 km of fished waterbodies were 15.2 percent less likely to be income-poor compared to those distant, and fishing households were 9 percent less likely to be poor compared to agricultural households. In the United Republic of Tanzania and Uganda, however, fishing households were on average poorer than households engaged in neither fishing nor agriculture, showing that small-scale fisheries livelihoods remain vulnerable to poverty, and that greater development efforts are needed to support small-scale fishing communities. By contrast, in Malawi, small-scale fisheries households were on average better off than both agricultural and non-agricultural households, showing that the contribution of small-scale fisheries to income poverty is also highly context-specific. The analysis also found, consistent with other empirical studies, that land access and asset wealth vary by small-scale fisheries context (Cinner, McClanahan and Wamukota, 2010; Fisher *et al.*, 2017), and small-scale fishers are often marginalized from economic services such as access to agricultural markets and infrastructure that supports improved food safety outcomes (Béné and Friend, 2011).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7.5 Small-scale fisheries and fish consumption during the first 1 000 days of life

Where malnutrition is pervasive, young children are among the most vulnerable in terms of both immediate and lifelong impacts of poor diets (Leroy *et al.,* 2020). The critical window of growth and development from conception to two years of age is commonly known as the first 1 000 days of life. During this period, infants and young children require a higher ratio of nutrients per kilogram of bodyweight than at any other time in their lives (Adu-Afarwuah, Lartey and Dewey, 2017). Once children start to eat complementary foods they require foods that are nutrient-rich, as their small stomachs dictate a higher concentration of nutrients per gram of food and per calorie (WHO, 2008). Poor nutrition during this time can lead to irreversible negative health impacts that persist into adulthood (Victora *et al.,* 2008; Leroy *et al.,* 2020). Pregnant or breastfeeding women also require a nutrient-rich diet because they are the only source of nutrition for infants *in utero* and during the exclusive breastfeeding period from birth to 6 months of age (Figure 7.11) (Adu-Afarwuah, Lartey and Dewey, 2017).

In low-income countries, diets tend to be monotonous, consisting of a large portion of a starch-rich staple food, a small selection of vegetables, and (in some areas) a small amount of flesh foods, including fish (Popkin, 2004). Fish is often one of the most nutrient-rich components of diets in communities that live near lakes, rivers or the ocean (Alva *et al.,* 2016; van Vliet *et al.,* 2018; O'Meara *et al.,* 2021; Albert *et al.,* 2020); many of these waterbodies are home to small-scale fisheries (FAO, 2020b). Whole, small fish species are often among the most affordable and accessible ASFs in many least developed countries or areas. When dried and crushed into fish powder they are highly nutrient-rich, and can often be purchased in small, affordable portions. This makes them ideal during the first 1 000 days of life (Byrd, Thilsted and Fiorella, 2020) and, due to their preservation as a powder, a secure source of fish throughout the year (Kawarazuka and Béné, 2011).

Various country examples attest to the nutritional advantages of fish in the diets of women and children. In one study in Kenya, adding 3–5 servings per week of small pelagic *omena* (*Rastrineobola argentea*) to the diets of children aged 6–23 months optimized intake of vitamin B12, iron, zinc and calcium (Ferguson *et al.,* 2015). In the small islands of Maldives, where the national per capita fish consumption is among the highest in the world (91 kg/year in 2017, compared to the global average of 20 kg/year [FAO, 2020b]), fish contributes to adequate intakes of riboflavin, vitamin B6, vitamin A and protein in women and children under 3 years of age (Golder *et al.,* 2001).

Similar results are seen in Bangladesh, where women and children who regularly consume small, indigenous pelagic fish are more likely to have adequate nutrition (Bogard *et al.,* 2015a). In Pacific Island countries, high rates of vitamin B12 intake – a vitamin only found in ASFs – have been attributed to the high fish consumption in Samoa, Solomon Islands, Kiribati and the Marshall Islands (EPPSO, FAO and SPC, 2021; SBS and FAO, 2019; FAO and SPC, 2020; KNSO, FAO and

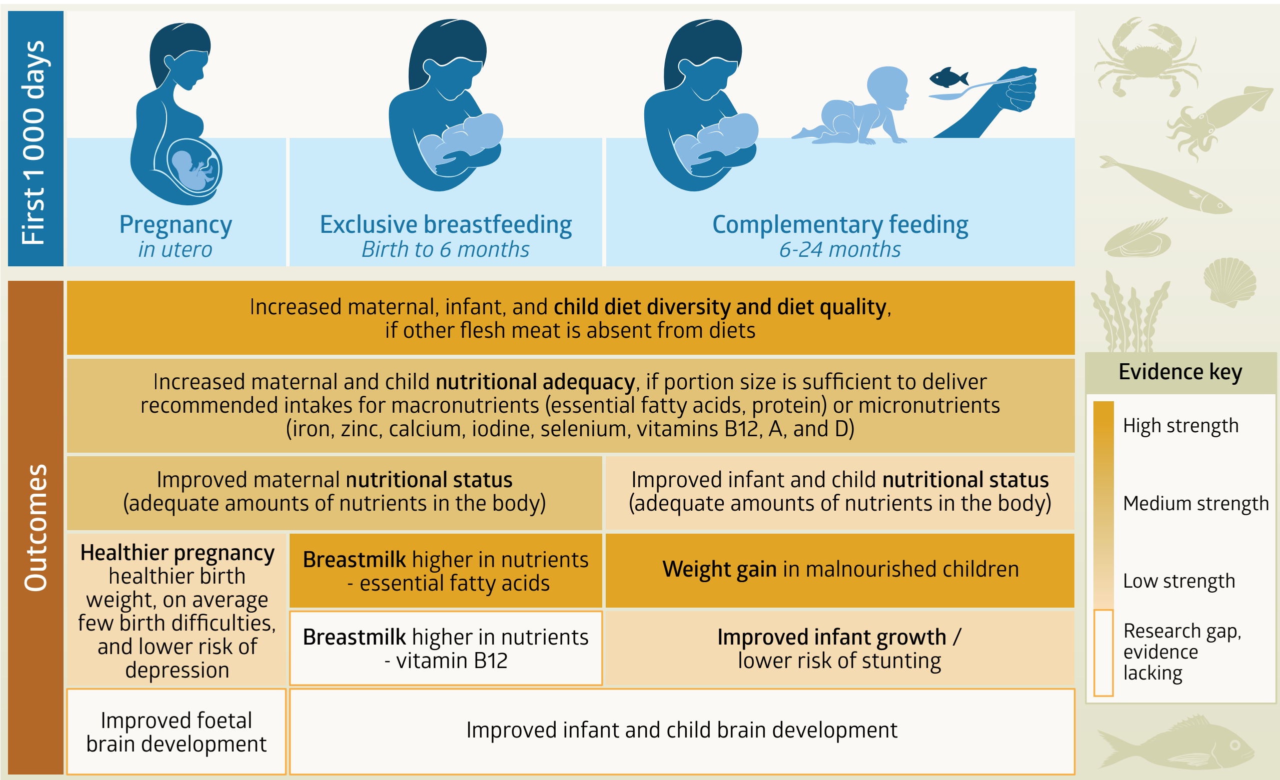
SPC, 2021), all countries where the fish consumed locally comes predominantly from small-scale fisheries.

During pregnancy, fats from fish and seafood (i.e. omega-3 fatty acids, in particular DHA and EPA) are beneficial to both mothers and their children when consumed as part of a healthy diet containing diverse foods (Imhoff-Kunsch *et al.*, 2012). However, while evidence from Inuit mothers in Canada and the Faroe Islands shows that DHA is associated with longer pregnancies and increased gestational age (Grandjean *et al.*, 2001; Lucas *et al.*, 2004), high EPA concentrations in maternal and cord blood are also associated with reduced birthweight (Grandjean *et al.*, 2001). Though the mechanism for the association between EPA and low birthweight is not known, caution around high fish intake (> 3 times per week) or fish oil supplementation during pregnancy is warranted. Nevertheless, fish intake remains important for foetal cognitive development during gestation. A synthesis of results across multiple studies (Hibbeln *et al.*, 2019) showed that fish consumption from as low as 4 oz (112 g) per week on up to 100 oz (2.8 kg) per week was associated with improved measures of neurocognition in children, with no evidence of harm from intakes at that level. Improved cognitive development means that children are more likely to be healthier mentally and physically and, in turn, more likely to do well at school and later in life (Victora *et al.*, 2008; Leroy *et al.*, 2020).

Fish intake also improves the nutrient content of breastmilk, which is the main source of nourishment for infants during the exclusive breastfeeding period from birth to 6 months of age. Specifically, mothers who consume wild fish in various regions around the world are more likely to have high levels of polyunsaturated fatty acids in their breastmilk (Fiorella *et al.*, 2017; Kuipers *et al.*, 2005; Martin *et al.*, 2012; Yakes Jimenez *et al.*, 2015).

In low-income countries, children under 5 years suffer high rates of stunting compared to higher-income countries (UNICEF, 2019). Stunting is a serious manifestation of chronic malnutrition, due in part to poor diets. Thus it can be avoided by eating a diverse diet which includes nutrient-rich foods such as fish, which is high in zinc, calcium and other nutrients. In a global sample of over 112 000 children aged six months to two years, fish consumption in 46 countries was associated with a reduced risk of stunting (Headey, Hirvonen and Hoddinott, 2017). These findings suggest that fish intake in low-income countries could protect against stunting, especially among rural children during the complementary feeding period.

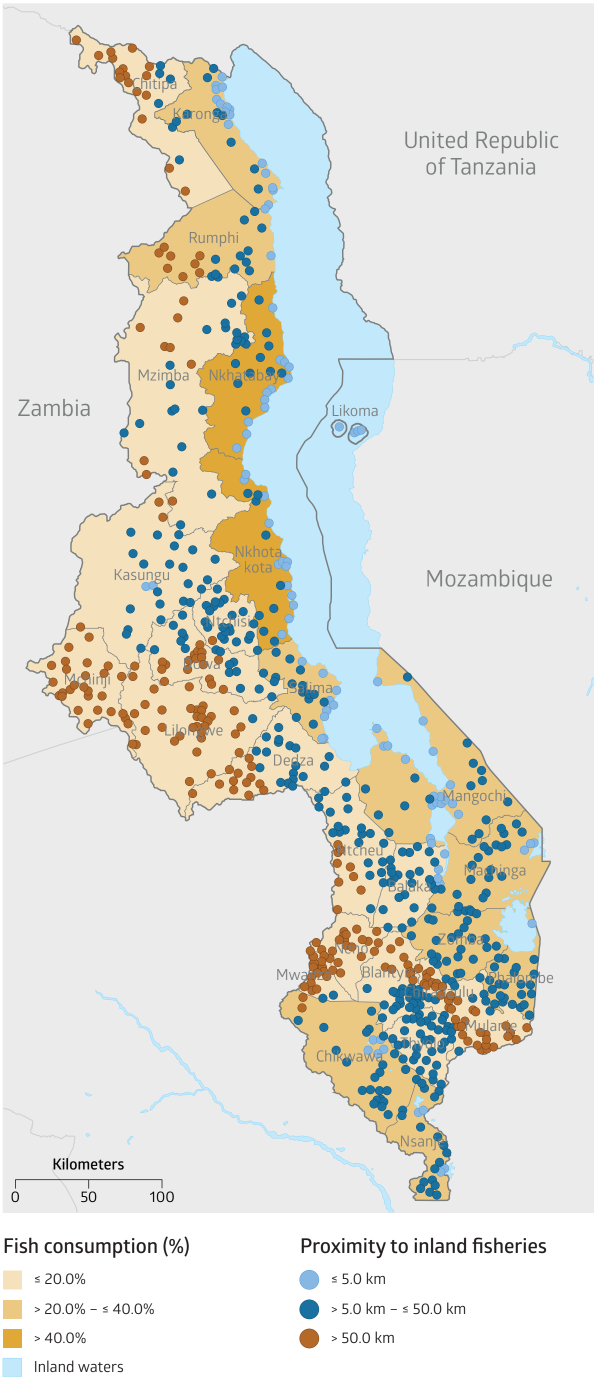
Figure 7.11 The benefits of fish consumption in three stages of the first 1 000 days of life



Notes: The complementary feeding stage (6–24 months) indicates a period when breastfeeding remains important, but solid foods are increasingly added to the diet. The evidence key represents the strength of research evidence from current literature supporting each benefit represented.

Source: Reproduced with permission from Byrd, K.A., Shieh, J., Mork, S., Pincus, L., O'Meara, L., Atkins, M. & Thilsted, S.H. 2022. Fish and fish-based products and nutrition and health in the first 1,000 days: a systematic review of the evidence from low and middle-income countries. *Advances in Nutrition,* 1–30. https://doi.org/10.1093/advances/nmac102

Figure 7.12 Prevalence of fish consumption in Malawi in children aged six months to two years, by district



Notes: Green shading represents percentage of children that consumed fish in the previous 24 hours. Yellow dots represent children living near a waterbody where fisheries are known to operate. Yellow dots may obscure smaller waterbodies due to scale of image.

Sources: National Statistics Office Malawi & ICF. 2017. *Malawi Demographic and Health Survey 2015–16;* World Wildlife Fund. 2019. Global Lakes and Wetlands Database (GLWD). In: *World Wildlife Fund.* Washington, DC. Cited 15 October 2021. www.worldwildlife.org/pages/global-lakes-and-wetlands-database; European Space Agency & UCLouvain. 2010. GlobCover 2009 (Global Land Cover Map). In: *European Space Agency.* ESA GlobCover 2009 Project. Cited 15 October 2021. http://due.esrin.esa.int/page_globcover.php

7.5.1 Contribution of inland small-scale fisheries to diet quality of young children in sub-Saharan Africa and South-eastern Asia

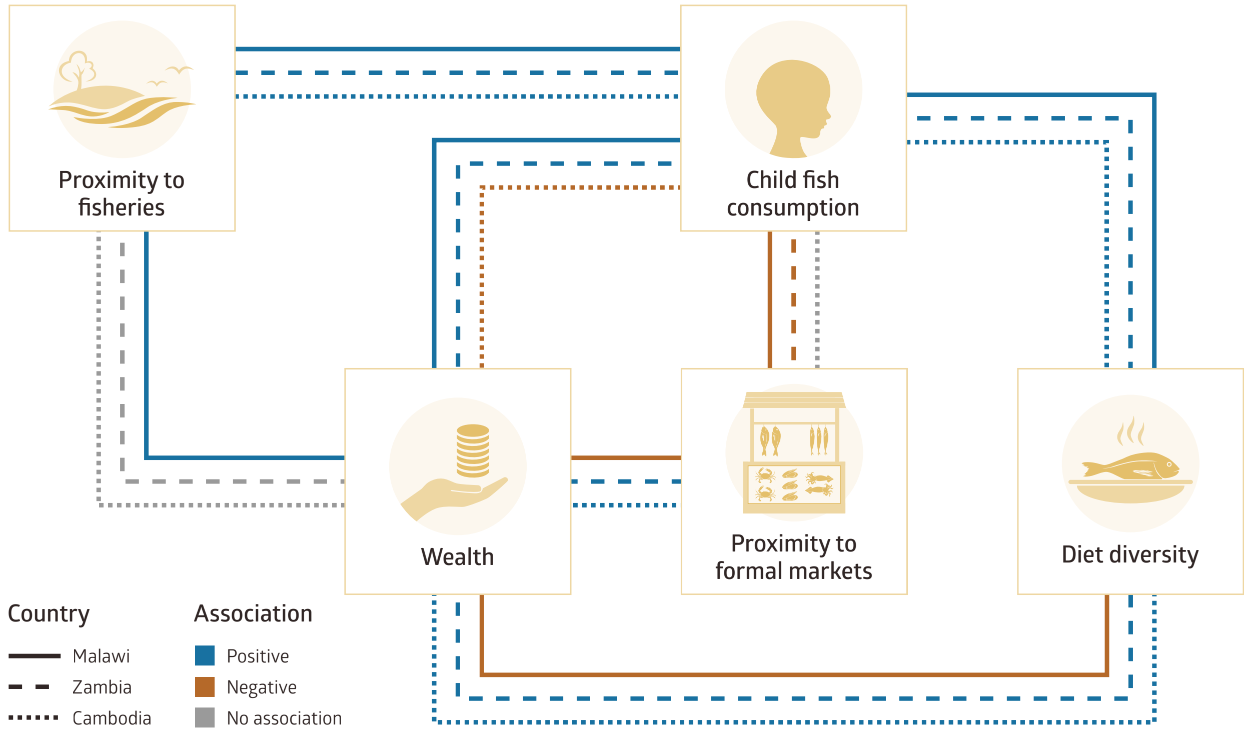
Evidence on the contribution of small-scale fisheries to the diets of children in the first 1 000 days of life at representative scales is limited, particularly in vulnerable regions where food insecurity is high. To address this gap, this subsection presents the first focussed assessment of the contribution of inland small-scale fisheries to fish consumption and diet quality of children during the complementary feeding period in sub-Saharan Africa and South-eastern Asia. As with the earlier analysis of livelihoods and distribution of fisheries benefits (Section 7.3), this assessment utilized secondary data, in this case from demographic and health surveys.[31] These surveys provide information on frequency of fish consumption, dietary diversity, and nutrition and health status of children and women in rural areas. The assessment examined the spatial distribution of fish consumption among rural children in Cambodia, Malawi and Zambia relative to inland waters where small-scale fisheries are known to operate.

Fish intake by children in the previous 24 hours varied considerably by district. However, rural children in all three countries living closer to inland fisheries were significantly more likely to eat fish (Figure 7.13). Similar to the findings in the broader analysis of fisheries benefits in Section 7.3, a higher share of children living closer to inland waters (such as lakes and rivers) reported consuming fish. For example, Lake Malawi skirts the eastern edge of Malawi (Figure 7.12) where indigenous small pelagic fish are common. These consist of sardines (*Engraulicypris sardella*), known locally as *usipa*, and also various small cichlid species: small demersal haplochromines known locally as *kambuzi*, and small pelagic haplochromines known locally as *utaka* (Funge-Smith, 2018; Kolding *et al.,* 2019). In the Ntchisi district, which is far from any fishery, only 6 percent of children consumed fish in the day preceding the survey. By contrast, in Likoma, Nkhotakota and Nkhata Bay districts, over 82 percent, 47 percent and 43 percent of children (respectively) living near the lake ate fish in the day preceding the survey – an increase of 7 to 13 times compared to the Ntchisi district. Clearly, market and distribution networks show a limited capacity to redistribute the nutritional benefits of fisheries to areas distant from their source.

Similarly, in Zambia, the highest percentage of children aged 6–24 months who consumed fish in the past 24 hours was found in Western (38 percent of children) and Luapula (34 percent) provinces, which are rich in fish from the Zambezi River in the west and the wetlands of lakes Mweru and Bangweulu in the north. Mweru fisheries provide small, indigenous pelagic fish called *chisense* (*Poecilothrissa*

[31] See: https://www.dhsprogram.com/

Figure 7.13 Associations between inland small-scale fisheries and childhood nutrition during the first 1 000 days of life for three countries in sub-Saharan Africa and South-eastern Asia



Note: Associations are reported as significant at $p < 0.05$.

Source: National Statistics Office Malawi & ICF. 2017. *Malawi Demographic and Health Survey 2015–16;* Central Statistics Office MoH Zambia & ICF. 2014. *Zambia Demographic and Health Survey 2013–14;* National Institute of Statistics, Directorate General for Health & ICF. 2015. *Cambodia Demographic and Health Survey 2014;* World Wildlife Fund. 2019. Global Lakes and Wetlands Database (GLWD). In: *World Wildlife Fund.* Washington, DC. Cited 15 October 2021. www.worldwildlife.org/pages/global-lakes-and-wetlands-database; European Space Agency & UCLouvain. 2010. GlobCover 2009 (Global Land Cover Map). In: *European Space Agency.* ESA GlobCover 2009 Project. Cited 15 October 2021. http://due.esrin.esa.int/page_globcover.php

mweruensis) that are nutrient-rich (Funge-Smith, 2018; Kolding *et al.,* 2019). In comparison, the lowest share of children consuming fish (6 percent) was found in the eastern district, where there are almost no inland waterbodies supporting fisheries.

In Cambodia, the inland fisheries of Tonlé Sap and the vast Mekong Delta region are the largest in the world, boasting hundreds of fish species (Funge-Smith, 2018). A higher share of children had consumed fish in the past 24 hours in the districts of Kampong Chhnong (85 percent) and Kampong Thom (71 percent) on the southern end of Tonlé Sap, and in the districts of Takeo (73 percent) and Prey Veng (69 percent), covering the large Mekong Delta region. A lower share of children consumed fish in Banteay Mean district (31 percent) which is in north-eastern Cambodia, far from any waterbodies.

7.5.2 Dietary diversity in children and proximity to inland fisheries

Fish consumption was a driver of higher dietary diversity among children in all three countries in the analysis, regardless of other ASF intake (Figure 7.13).

Furthermore, in Malawi, households living closer to inland fisheries were more likely to be wealthier, suggesting the fisheries-related livelihoods that predominate may be an important source of income for rural households in the country. This association was not found in either Zambia or Cambodia. Notably, proximity of rural populations to formal markets[32] did not have an impact on fish consumption in the low-income countries studied. Indeed, in this analysis, children in rural Malawi and Zambia living closer to formal markets were less likely to consume fish than the rural children who lived further from formal markets. This supports previous observations that inland small-scale fisheries play an important role in food security and nutrition in rural environments in low-income countries in sub-Saharan Africa, where markets are informal and communities are more reliant on wild and subsistence food sources (Luckett *et al.,* 2015). As highlighted in Section 7.4, most food purchased is from the region rather than traded from elsewhere; hence wild foods, particularly fish from small-scale fisheries, are an important contributor to formal and informal markets. These findings highlight the importance of local small-scale fisheries in supporting food security and nutrition.

[32] Formal markets have permanent infrastructure and are often composed of businesses and enterprises that are taxed by governments.

However, the analysis also revealed that markets typically fail to distribute fish to areas distant from fished waterbodies, as already highlighted in Section 7.4. At the same time, intrahousehold distribution of fish and social norms around children eating fish can mean limited or delayed introduction of fish to children's diets (Bogard *et al.*, 2015a; Gibson *et al.*, 2020). These results support the ongoing need for interventions and management approaches that target improvements in fish distribution to leverage fisheries to improve food security and nutrition of children during the first 1 000 days of life. But it should be cautioned that local availability does not ensure access; the multiple dimensions that shape access to food – physical, economic and sociocultural – must also be considered.

7.6 Improving data quality to illuminate the magnitude and distribution of nutritional benefits from small-scale fisheries

Increasingly, the importance of small-scale fisheries as a vital source of nutrition in regions where deficiencies are commonplace is being recognized. Understanding both the magnitude and distribution (both spatially and among groups in society) of nutritional benefits from small-scale fisheries is fundamental to improving the management and sustainability of the subsector.

Shifting fisheries management towards incorporating nutrition indicators (or perhaps indicators of healthy diets) presents a challenge, but this goal is important to optimize the contribution of small-scale fisheries to SDG 2. As the most comprehensive global data effort on the diverse benefits of small-scale fisheries, the IHH initiative had ambitions to provide new data on a range of key nutrition indicators, synthesized across broad geographies. While a number of these exercises ultimately provided only limited new data, they offer important lessons for improving nutrition data for small-scale fisheries management.

7.6.1 Understanding national fish consumption

As a component of the CCS, national teams were requested to provide available data on consumption of fish from small-scale fisheries at representative scales (national and subnational), disaggregated by social groups vulnerable to undernutrition (e.g. women and children, the poor) (see Annex A for a more detailed description of case selection criteria and data collected). None of the 58 CCS provided consumption data specific to small-scale fisheries at scales beyond single communities or locations. Only 8 of 58 CCS teams were able to provide nationally representative consumption data for fish, obtained from national or subnational consumption surveys administered through governments or international organizations. Further, none provided data disaggregated by source (small- or large-scale fisheries, aquaculture, imports).

Where national-scale consumption data do not exist, *fish supply* is often used to calculate apparent fish consumption; accordingly, several CCS teams provided this in place of consumption data. Fish supply is calculated from fish production statistics, adjusted for international trade (import and export) and in some cases for non-food use. In this way, it provides what is often the best estimate of the quantity of fish available per capita for consumption. Although fish supply estimates provide a universal standardized metric to assess fish availability, they can be an inaccurate proxy for consumption due to challenges in monitoring and reporting of fish production and trade (e.g. informal and unregulated); losses along value chains prior to consumption that are not accounted for in calculations; and inequities in access, particularly among disadvantaged population groups (Box 7.3). Monitoring issues in particular become acute for small-scale fisheries (Desiere *et al.*, 2018; Fluet-Chouinard, Funge-Smith and McIntyre, 2018), where quality statistics are most needed. This is primarily due to the dispersed catch of these fisheries, as well as a lack of financial incentives to invest in monitoring (de Graaf *et al.*, 2011). As a result, the full contribution of small-scale fisheries to fish supply is not well known, and the subsector is substantially undervalued in global and national assessments of healthy and sustainable diets (Halpern *et al.*, 2019b).

7.6.2 Fish consumption among vulnerable population groups

Consumption data disaggregated by vulnerable group provide a critical input for better managing fisheries and meeting the targets of SDG 2, in particular ensuring that no one is left behind. Again, very few CCS teams were able to provide these data. Where available, disaggregation was by one or more of the following categories: sex, income, pregnant/lactating women, rural/urban women, and age (Box 7.4).

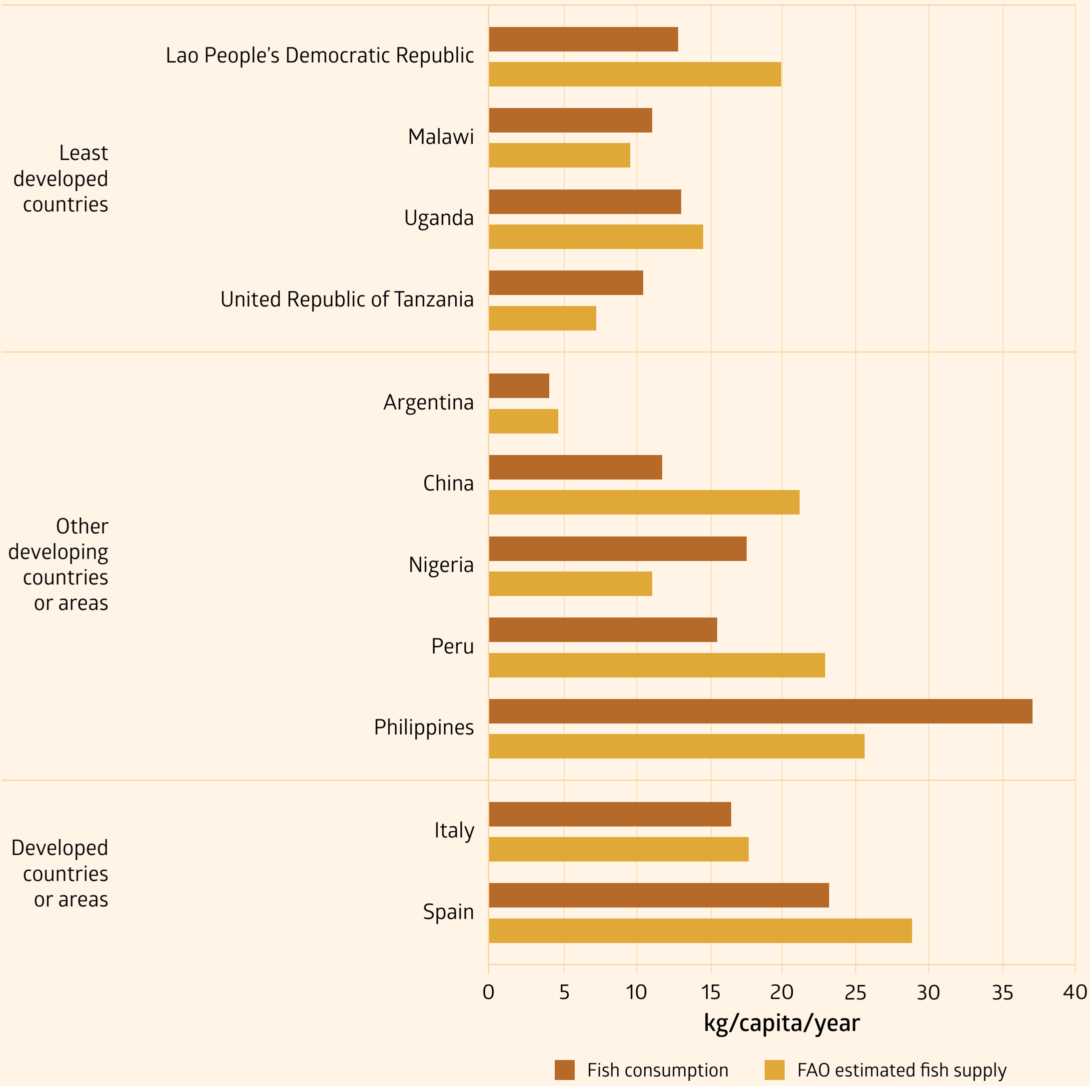
Box 7.3

Limitations of estimating consumption from supply statistics

To better understand the complexities of using supply data to estimate fish consumption, nationally representative finfish consumption data from the IHH country and territory case studies were compared with fish supply estimates from FAOSTAT (see figure below). As supply data used here are unadjusted for the portion of a fish that is edible and for post-harvest losses, it would be expected that per capita consumption figures would be lower than per capita supply.

However, in the 11 countries analysed, measured consumption was higher than supply in 4 countries, and lower in the remaining 7. In the Philippines, measured fish consumption was 40 percent higher than supply estimates, implying there may potentially be 1.1 million tonnes (minimum) of edible fish that are unaccounted for in production and trade figures. These differences are likely due to methodological issues with measuring fish consumption at national scales.

Figure. Comparison of fish supply and consumption (kg/capita/year) in countries for which nationally representative consumption data were available, by development context



Box 7.3 Cont

Notes: Development context for countries or areas is broken down according to United Nations categories (least developed, other developing and developed). Numbers indicate the quantity of fish (kg/capita/year). Supply and consumption figures are for the same year in most instances, and for the closest available year in others. Country consumption data were obtained from IHH country and territory case studies (n = 8) and the FAO/WHO Global Individual Food consumption data Tool (GIFT) (n = 3), where fish consumption was reported from national representative consumption surveys. FAO fish supply data were obtained from FAOSTAT Food Balance Sheets. Fish supply was calculated by summing supply calculations for freshwater fish, demersal fish, pelagic fish and marine fish (other).

Sources: FAO & WHO. 2017. National Food Consumption Survey Lao PDR 2016–2017. In: *Global Individual Food consumption data Tool*. Rome, FAO; FAO & WHO. 2013. Subnational consumption survey in Rosario, Argentina, 2012–13. In: *Global Individual Food consumption data Tool*. Rome, FAO; FAO & WHO. 2006. National food consumption dataset in Italy from 2005–2006. In: *Global Individual Food consumption data Tool*. Rome, FAO; FAO. 2021. Database for fish and animal protein supply quantity. In: *FAOSTAT New Food Balances*. Rome. Cited 15 October 2021. https://www.fao.org/faostat/en/#data/FBS

7.6.3 Opportunities for improving quality of consumption data

The CCS highlighted the difficulties associated with obtaining fish consumption data that provide the required detail to be instrumental in developing policy and shaping management approaches focused on optimizing nutrition outcomes. The international scientific literature contains a diversity of output from research programmes that provide some localized data of the type required. That CCS expert teams were often unable to access these data should be a clarion call to the research and development communities to improve communication of research findings and availability of data. Data and associated analysis published only in international scientific journals are often inaccessible, and therefore of little value, to managers and even scientists in less developed countries. Recognizing data and information formats and analytical presentations that are accessible and usable in management is central to advancing science-based decision-making in management.

The inability in most instances to identify fish consumption data disaggregated by source (small- and large-scale fisheries, aquaculture, imports) limits the ability to enact policies that are relevant to the conditions and needs of small-scale fisheries. As illustrated in the examples here and elsewhere (Bogard *et al.*, 2017; Marinda *et al.*, 2018; Needham and Funge-Smith, 2015), appropriately designed and targeted dietary surveys can shed light on the variation and inequities in fish consumption, and thereby provide important entry points for policy decisions. Additionally, high-quality consumption data disaggregated by source can be used to estimate fish catch, which is particularly important for small-scale fisheries in remote areas where catch monitoring is expensive (Allison and Mills, 2018; Fluet-Chouinard, Funge-Smith and McIntyre, 2018).

There are opportunities to build on existing survey instruments to obtain data highly relevant to improving nutrition-sensitive management, and ultimately the nutrition outcomes from small-scale fisheries (see analysis in Section 7.4; also Chapter 9). A select few national-level household surveys conducted in parts of sub-Saharan Africa (Béné *et al.*, 2012) and Asia (Needham and Funge-Smith, 2015) illustrate approaches that can be adopted to obtain the type of data required. The World Bank's LSMS conducted in sub-Saharan Africa (see Section 7.4) provides an excellent, adaptable fishery module for tackling data gaps (Béné *et al.*, 2012). Uniquely, this module collects consumption data on fish looking at form consumed (e.g. dried or fresh), household livelihood engagement and household location, allowing for in-depth analysis of geographical factors influencing fish consumption (e.g. proximity to fisheries) and subsistence fishing. In Bangladesh, nationally administered household income and expenditure surveys gather information on fish consumption by species. Together with fish production data, this information allows for the disaggregation of fish catch by source – i.e. from capture fisheries or aquaculture. This facilitates the evaluation of the relative contribution that each sector makes to nutrition over time (Bogard *et al.*, 2017), which is important in shaping policy.

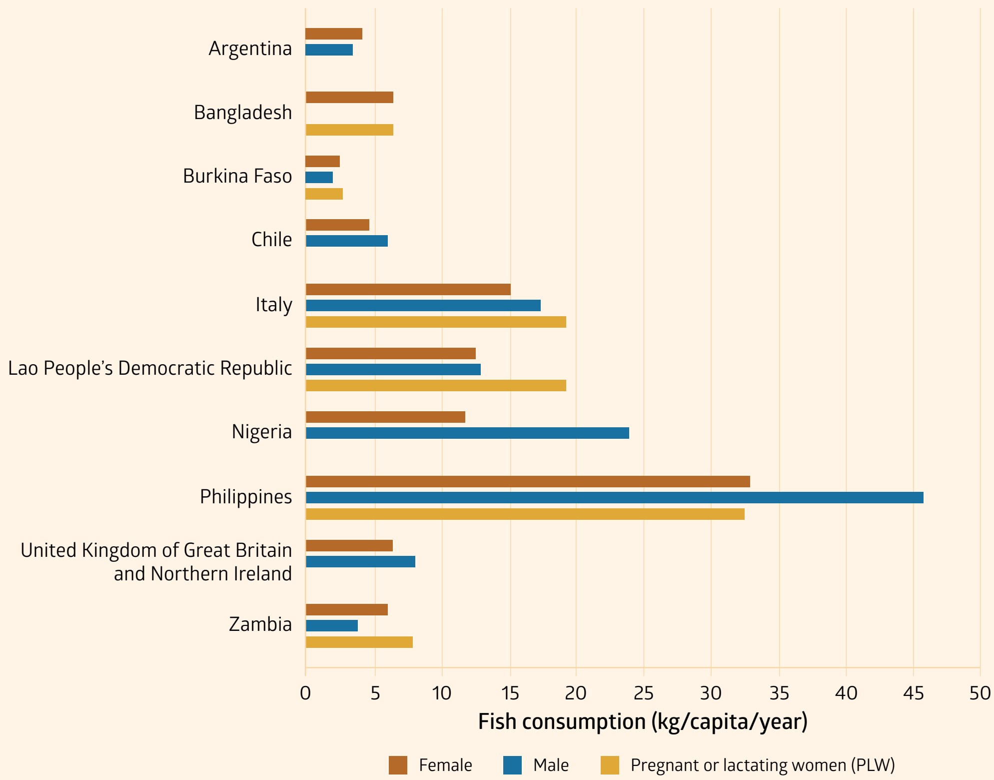
The development of specific fishery modules appended to existing national household or agricultural survey instruments, as well as reporting on disaggregated fish consumption in individuals, presents a plausible pathway to improved data quality. The examples given here are illustrative of approaches to survey design that, if adopted more broadly, would substantially improve the precision of national, regional and global accounts of the role of fish in diets and food systems (Halpern *et al.*, 2019b). Linked to nutrition indicators as part of nutrition-sensitive fisheries management approaches, these data can become a powerful tool in optimizing the nutritional contributions of aquatic foods.

Box 7.4

Sex-disaggregated fish consumption data from IHH country and territory case studies

Women and men have different nutrition needs, and fish can be particularly important to the nutrition needs of pregnant or lactating women.[a] Gender-disaggregated fish consumption data were available for only 9 of the 58 IHH country and territory case studies. In six of these, women consumed lower quantities of fish than men. This disparity was highest in Nigeria and the Philippines, where women consumed 1.5–2 times less fish than men – the greatest difference being by 12 kg/capita/year in Nigeria. Data on fish consumption in pregnant or lactating women were available in six countries. In Italy, Lao People's Democratic Republic and Zambia, fish consumption by pregnant or lactating women was higher than the average for all women, while for Burkina Faso, the Philippines and Bangladesh, the two groups consumed equal amounts.

Figure .[b] Fish consumption (kg/capita/year) for women, pregnant or lactating women (PLW) and men, in countries where data were available



Notes: **a** Grandjean, P., Bjerve, K.S., Weihe, P. & Steuerwald, U. 2001. Birthweight in a fishing community: significance of essential fatty acids and marine food contaminants. *International Journal of Epidemiology*, 30(6): 1272–1278; Imhoff-Kunsch, B., Briggs, V., Goldenberg, T. & Ramakrishnan, U. 2012. Effect of n-3 long-chain polyunsaturated fatty acid intake during pregnancy on maternal, infant, and child health outcomes: a systematic review. *Paediatric and Perinatal Epidemiology*, 26(s1): 91–107; Lucas, M., Dewailly, É., Muckle, G., Ayotte, P., Bruneau, S., Gingras, S., Rhainds, M. & Holub, B. 2004. Gestational age and birth weight in relation to n-3 fatty acids among inuit (Canada). *Lipids*, 39(7): 617–626.
b Country data in this figure were obtained from IHH country and territory case studies (n = 4) and the FAO/WHO Global Individual Food consumption data Tool (GIFT) (n = 6) from national or subnational representative consumption surveys, as follows: FAO & WHO. 2013. Subnational consumption survey in Rosario, Argentina, 2012–13. In: *Global Individual Food consumption data Tool*. Rome, FAO; FAO & WHO. 2010. Food consumption survey in two provinces of rural Burkina Faso. In: *Global Individual Food consumption data Tool*. Rome, FAO; FAO & WHO. 2006. National food consumption dataset in Italy from 2005–2006. In: *Global Individual Food consumption data Tool*. Rome, FAO; FAO & WHO. 2017. National Food Consumption Survey Lao PDR 2016–2017. In: Global Individual Food consumption data Tool. Rome, FAO; Gomna, A. & Rana, K. 2007. Inter-household and intra-household patterns of fish and meat consumption in fishing communities in two states in Nigeria. *British Journal of Nutrition*, 97(1): 145–152; FAO & WHO. 2009. The 2009 Food consumption and Vitamin A status survey in Zambia. In: *Global Individual Food consumption data Tool*. Rome, FAO; FAO & WHO. 2008. HarvestPlus Bangladesh Dietary Survey. In: *Global Individual Food consumption data Tool*. Rome, FAO.

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