Received: 15 November 2021 | Revised: 24 May 2022 | Accepted: 27 May 2022
DOI: 10.1111/fme.12576

NOTE

Fisheries Management and Ecology WILEY

Understanding interactions between wild fisheries and aquaculture is essential to sustainable and equitable aquaculture development

Kathryn J. Fiorella

Department of Public and Ecosystem Health, Cornell University, Ithaca, New York, USA

Correspondence
Kathryn J. Fiorella, Public and Ecosystem Health Department, Cornell University, S2-004 Shurman Hall, Ithaca, NY 14853, USA.
Email: kfiorella@cornell.edu

Funding information
Cornell Center for Social Sciences; National Science Foundation, Grant/Award Number: NSF BCS# 2009658

1 | INTRODUCTION

Aquatic food systems are undergoing a rapid transformation: 30 years ago, just 12% of aquatic foods came from aquaculture, while today, over 50% of aquatic foods are farmed (Edwards et al., 2019; FAO, 2020; Naylor et al., 2021a). Demand for fish is projected to double again by 2050, and the aquaculture sector is poised to respond to that growing demand (Naylor et al., 2021b). Increased fish availability is projected to reduce prices and make aquatic foods more affordable for consumers, potentially increasing access to aquatic foods and the critical nutrients they supply (Golden et al., 2021a). Yet the expansion of aquaculture heralds a range of risks, including to aquatic ecosystems, small-scale fishing communities and through diversion of fish that might otherwise be consumed to use as aquaculture feed. Paradoxically, while aquaculture may increase fish availability and herald nutritional gains broadly, within small-scale fishing communities, there may be complex trade-offs for nutritional and livelihood consequences of aquaculture expansion (e.g. Bogard et al., 2017a; Bogard et al., 2017b; Filipski & Belton, 2018; Heilpern et al., 2021b). The interactions between a quickly growing aquaculture sector and the world's small-scale fishers, which in some cases will rely on the same physical spaces and water (e.g. Aura et al., 2019), exemplify the challenges of shifting aquatic food systems. More than 60% of aquaculture production currently comes from freshwater systems (FAO, 2020), and small-scale fishers within fresh waters are particularly reliant on fishing to meet food security and nutritional needs (Brummet, 2022; McIntyre et al., 2016; O'Meara et al., 2021). Understanding interactions between wild fishing and aquaculture sectors is critical to the timely development of aquaculture policy that improves human well-being for small-scale fishers and aquaculture producers, fosters sustainable resource use, and increases global aquatic food access.

The small-scale aquaculture and fisheries sectors collectively harvest half of global fish and supply two-thirds of the aquatic foods destined for direct human consumption (FAO, 2020). This contribution comprises aquatic foods for one billion people and provides livelihoods for 100 million small-scale fishers and producers (Short et al., 2021). While data regarding small-scale actors are often relatively scarce compared with large-scale and industrialised sectors, small-scale harvesters are numerous, diverse and among the sector's most vulnerable actors (Short et al., 2021). While many key questions about aquaculture's trajectory remain to be answered, its ascendency promises to further impact our global fresh water and marine ecosystems, patterns of fish production, and who has access to fish for consumption (Fiorella et al., 2021b). This comment focuses on two recurrent lessons about aquatic foods—first, aquatic foods provide both food and income, and, second, aquatic foods and the food systems that supply them are diverse—and how these lessons might inform monitoring of the food system transitions underway as aquaculture advances.

2 | DIVERSE AQUATIC FOODS SUPPLY FOOD AND INCOME

First, aquatic foods are a source of both food and income, and contribute to nutrition and food security through both roles. Aquatic foods are widely traded, providing high-quality food in regions far from their origins (Gephart & Pace, 2015), and aquatic food consumption has traditionally been especially high near coasts and inland waters (FAO, 2018). When fishers or aquaculturalists subsist on what they catch or produce, the quantity and nutritional quality of household harvests directly impact household nutrition. When fishers and aquaculturalists sell what they produce and use the income to purchase other fish or other high-quality foods (e.g. vegetables and eggs), the aquatic foods available in local markets, prices, and nutritional quality impact household nutrition. Regardless of where aquatic foods are accessed (i.e. through harvest or markets) and the system that produces them (i.e. wild fisheries or aquaculture), the regular inclusion of animal source foods, such as fish, is often a hinge point that determines whether a diet is of high quality or not. Access to animal source foods can reduce rates of stunting, a form of chronic malnutrition in which growth and development are restricted (Headey et al., 2018). Further, the varied and often substantial micronutrients supplied by aquatic foods are increasingly being tabulated and recognised for their potential role in reducing micronutrient malnutrition (Byrd et al., 2020; Golden et al., 2021a; Heilpern et al., 2021a; Heilpern et al., 2021b; Hicks et al., 2019). Inland fisheries may play a particularly important role in diet quality in sub-Saharan Africa, and especially for young children (O'Meara et al., 2021).

The supply of fish is often equated with the provision of food security and nutritious diets. Yet securing access to animal source foods, even within contexts such as inland fisheries where they are ostensibly abundant, is far more complex in reality. Ironically, participating in the harvest of aquatic foods may or may not increase access to them for consumption. Around Lake Victoria, Kenya, fishers do not necessarily enjoy privileged access to fish for consumption, and income is the factor that determines fish access (Fiorella et al., 2014). Within the Senegalese pelagic fishery (dominated by *Sardinella aurita)*, about half the benefits of the fishery are attributable to income opportunities and the other half to consumers having food access (Lancker et al., 2019). Aquatic foods remain most critical to diets where market access is limited and the high-quality food that fisheries provide are not easily substituted by international or domestic imports. As aquaculture expands, monitoring impacts within regions highly reliant on aquatic foods for food and income as well as settings where aquatic foods have been traditionally unavailable will be vitally important to assess shifts in equitable access to employment opportunities, food security and nutritious diets.

Second, substantial strides have been made in disentangling a once homogenous category of "fish" or "seafood" to recognise the biodiversity of aquatic foods. This biodiversity is paralleled by the diversity of ecosystems on which it relies, production methods used to harvest and produce aquatic foods, and people engaged in harvest and production. Such systems range from wild-capture fisheries to high-intensity systems to the continuum of production strategies between these extremes (e.g., stocking in wild fisheries, rice field fishery production systems; Welcomme & Bartley, 1998). In many instances, the resource and physical space demands of aquaculture are likely to have direct trade-offs with wild-capture fisheries. Fundamental to understanding and planning for the ways that expanding aquaculture will interact with broader food systems is recognising their present complexity and interconnections.

While growth in aquaculture will play a key role in meeting increased demand for aquatic foods, it may also lead to substantial shifts within the ecosystems that supply aquatic foods, affect people engaged in aquatic food production, and alter the species of aquatic foods consumed. Growth of aquaculture has already substantially changed the shares of fish consumed and produced from both freshwater and marine systems, with aquaculture driving expansion in freshwater aquatic food consumption (FAO, 2020). Geographically, approximately 90% of all aquaculture production originates in Asia, with China producing the largest share (FAO, 2020). Due to such geographic factors, the people that work in aquaculture and fishery sectors may differ; for example, hundreds of thousands of small-scale fishers in sub-Saharan Africa do not yet have a robust aquaculture industry to turn to as an alternative. Even as aquaculture develops, in many cases, switching between aquaculture and fishing may be unlikely or impossible given the capital, knowledge, and land or water rights required to enter aquaculture. Finally, thousands of wild aquatic species are consumed, yet only 27 species are widely farmed and 4 of those comprise over a third of global aquaculture production (FAO, 2020).

The reduced number of aquatic species produced through aquaculture is important because of differences in nutrient composition of aquatic foods. Recent databases providing detailed information on nutrient composition of diverse aquatic foods (Byrd et al., 2020; Froese & Pauly, 2021; Golden et al., 2021b) have advanced the conversation about aquatic food nutrition beyond their contribution to protein supplies to consider the micronutrients and omega-3 fatty acids aquatic foods provide. Such data expansions have also supported analyses of the relatively wide variation in nutrients supplied by different aquatic foods (Byrd et al., 2020; Golden et al., 2021b; Hicks et al., 2019). Differences in nutrients available are compounded by differences in how aquatic foods are consumed. While some species are eaten as fillets, many small fish are consumed whole and thus provide much higher quantities of micronutrients concentrated in the head, eyes, and bones of fish (Bogard et al., 2015a; Bogard et al., 2015b). Because of this nutrient variation, even when holding the total amount of aquatic foods consumed constant, an increase in the diversity of aquatic species consumed can also increase nutrient intake (Bernhardt & O'Connor, 2021). If aquatic biodiversity declines, however, the impact on nutrients supplied to people will depend on ecological factors, including food web dynamics and functional diversity (Heilpern et al., 2021a).

3 | CHALLENGES FACING FRESHWATER AQUACULTURE EXPANSION

Interconnected aquatic food systems will likely see multiple reverberations as aquaculture expands. These shifts are likely to be highly situational, and examples from major inland fisheries around the world exemplify some of the possible challenges.

Differences in nutrients supplied by wild and aquaculture fish are likely to have complex implications for the nutritional outcomes of aquaculture expansion. Amid broader trends, there is also a key equity question regarding who will be affected by nutritional trade-offs. In the Peruvian Amazon, replacement of wild fish with affordable substitutes such as aquaculture fish or chicken can have mixed impacts on nutrients supplied to consumers; while protein and zinc supplied could increase, iron and omega-3 fatty acids supplied could decline (Heilpern et al., 2021b). Evidence from aquaculture in Bangladesh shows that households consumed more fish as aquaculture expanded, yet the lower nutritional quality of aquaculture species also meant that calcium and iron intake decreased (Bogard et al., 2017a).

Interactions between wild fisheries and fishers with aquaculture production may be particularly contentious where production systems physically overlap. Environmental concerns about aquaculture broadly include nitrogen and phosphorus pollution, disease spread, genetic pollution, invasive non-native species, habitat destruction and freshwater use (Gephart et al., 2021). These issues are acute when aquaculture is situated directly within fresh waters, as is the case for Lake Victoria's cage culture. The production of over 3000 t of tilapia is already happening within cages positioned inside Lake Victoria's waters, which are also home to multi-million dollar small-scale fisheries (Njiru et al., 2019) that produce 8% of the world's inland fish harvest (FAO, 2020). Cages have been located in near-shore areas that overlap with fish breeding grounds and conflict with spaces fishers use, waste feed is a substantial concern in an already eutrophied lake, and isolated fish disease and kills have been observed, which have all fomented concern over cage management and lead to calls for improved policies (Njiru et al., 2019). While direct physical interactions demonstrate these trade-offs, interactions between wild fisheries and aquaculture extend throughout food systems and ecosystems. Water bodies are widely connected, and basin- or catchment-wide environmental interactions are likely. Further afield, increased demand from urban and international markets may also have geographically far-reaching impacts on facets of aquatic food systems ranging from job creation to ecosystem impacts as production increases.

External factors to aquaculture systems, such as climate change and upstream development, may also create challenges for freshwater aquaculture production systems. *Pangasius* catfish cultivation in the Mekong Delta of Vietnam is a centuries-old practice. The rapid expansion of this production has generated a lucrative export industry that supports some 200,000 livelihoods (Halls & Johns, 2013). Given that *Pangasius* cultivation is within the lower Mekong basin, however, the quantity and quality of water that reaches this region is highly dependent on upstream uses (Halls & Johns, 2013). Hydropower, irrigation, and other water diversions are already altering Mekong flows, and large-scale development is driving further shifts (Halls & Johns, 2013). Climate change is predicted to increase wet and especially dry season water availability, with a net increase of water in the Mekong Delta, and predicted sea-level rise may alter salinisation of the Delta too (Halls & Johns, 2013). Especially when interactions between aquatic food systems occur over large geographic scales, as is the case for the more than 4350-km Mekong River, monitoring and addressing these interactions—such as by the Mekong River Commission—will continue to be crucial to supporting aquatic food systems. Fresh waters have considerable advantages for aquaculture expansion compared with marine ecosystems (Belton et al., 2020). Still, the direct and immediate threats facing freshwater ecosystems and the failure to address urgent priorities needed for their recovery (Tickner et al., 2020) also means increased growth of freshwater aquaculture may both exacerbate threats facing freshwater ecosystems and be affected by them.

4 | MONITORING AQUATIC FOOD SYSTEM TRANSITIONS

The preponderance of global fisheries are harvested at or above capacity (FAO, 2020). Climate and environmental changes are likely to reduce fish availability (Cheung et al., 2016; Free et al., 2019), with the potential to also reduce nutrient availability globally (Golden et al., 2016; Heilpern et al., 2021a) and shift fisher behaviour (Fiorella et al., 2021a). In the face of these challenges, aquaculture holds tremendous promise to increase fish availability, create jobs and improve diets. Yet, major questions remain about the interactions between aquaculture and wild fisheries, and where and to whom the nutritional and food security benefits of aquaculture expansion will accrue. Aquaculture promises to impact both the people that join the aquaculture sector and those that remain focussed on the wild fisheries with which aquaculture interacts (e.g., Belton et al., 2014; Belton & Thilsted, 2014; Filipski & Belton, 2018). As aquaculture ushers in transformations of wild fishing grounds into farmed spaces, aquatic food systems around the world stand on the precipice of change.

As this transition progresses, monitoring of aquatic food system shifts will be fundamental to analysing food system performance and supporting accountability (Fanzo et al., 2021). To do this, an integrated effort is needed to understand the aquatic foods produced through aquaculture and wild fisheries, with consideration for their full value chains, the people who access aquatic foods produced through both sectors, jobs across these sectors, and ecological impacts. To understand the global implications of aquatic food system shifts, we must carefully monitor how the complexity of these transitions plays out within local food systems (e.g., Belton et al., 2014; Heilpern et al., 2021b). Such monitoring efforts require reconciliation of data gaps within small-scale sectors to better recognise these sectors contribution to the quantity and diversity of aquatic foods (e.g., McIntyre et al., 2016; Schubert et al., 2022). Newly compiled nutrient composition data (Byrd et al., 2020; Froese & Pauly, 2021; Golden et al., 2021b) offers opportunities to integrate monitoring of nutritional impacts of aquatic food system shifts (Golden et al., 2021a). However, limited overlap in the environmental concerns facing wild fisheries (e.g., overharvest) compared with aquaculture (e.g., disease spread; Gephart et al., 2021) mean environmental sustainability indicators and data must also reconcile monitoring across harvests of both wild and farmed aquatic foods.

Effective monitoring of aquatic food system transitions is requisite to ensuring accountability that food system transitions within the aquatic sector are sustainable and just (Fanzo et al., 2021). Aquaculture producers and fishers at all scales should be closely engaged, with goals of creating incentive structures and policies that promote a "race to the top" of sustainable production. Monitoring efforts should be further integrated into on-going global agenda, such as the Sustainable Development Goals and their 2030 targets (Thilsted et al., 2016), and food systems-specific efforts, such as the Food System Monitoring project (Fanzo et al., 2021). Yet, they must also directly engage the communities where natural resources are managed and aquatic foods are harvested and farmed. Regional bodies already providing for international monitoring and management of key waters, such as the Mekong River Commission or Lake Victoria Fisheries Organization, are ideally positioned to actively engage in generating the most pressing questions about aquatic food system transitions and to work with national policymakers and fishery co-management organisations to respond to findings. Researchers within academia, the Consortium for Global International Agricultural Research (CGIAR), UN-FAO, and others should mobilise to support these research needs with toolkits that facilitate data collection using standardised measures, data interpretation, policy evaluation, and decision-making (e.g., FAO, 2009). Looking to the decades of lessons from land-based agricultural systems may also yield valuable insights that advance important goals in aquaculture development, such as the literature on adoption of sustainable technology by small- and mid-sized operations (e.g., Abegunde et al., 2019). Furthermore, supporting regional and national fishery and food system managers to compare experiences and lessons learned, particularly across continents given more extensive aquaculture capacity in Asia and its quick development within Africa, could further propagate the most effective approaches to sustainable aquatic food system transitions.

The expansion of aquaculture is well underway. The pace at which we understand and respond to societal or environmental trade-offs and develop strategies to mitigate these must match this expansion. A backdrop of climate change and persistent inequality in diet quality requires increased attention to food security, ecosystem resilience, and fish access—which, in turn, demands improved and coordinated aquatic food system governance. The time is now to ensure aquaculture expansion provides not only increased aquatic food production but also increased nutrient access among the most nutritionally vulnerable, equitable employment opportunities, and aquatic ecosystem sustainability.

ACKNOWLEDGEMENTS

Many thanks to Liz Bageant, Sebastian Heilpern and Kira Lancker for their salient feedback on an early draft. In addition, the thoughtful comments from the editors and two anonymous reviewers provided valuable feedback that improved this comment.

CONFLICT OF INTEREST

The author declares no conflict of interest.

ORCID

Kathryn J. Fiorella https://orcid.org/0000-0002-8625-2473

REFERENCES

Abegunde, V.O., Sibanda, M. & Obi, A. (2019) The dynamics of climate change adaptation in sub-Saharan Africa: a review of climate-smart agriculture among small-scale farmers. *Climate*, *7*(11), 132. https://doi.org/10.3390/cli7110132

Aura, C.M., Nyamweya, C.S., Njiru, J.M., Musa, S., Ogari, Z., May, L. et al. (2019) Exploring the demarcation requirements of fish breeding and nursery sites to balance the exploitation, management and conservation needs of Lake Victoria ecosystem. *Fisheries Management and Ecology*, *26*(5), 451–459. https://doi.org/10.1111/fme.12311

Belton, B., Little, D.C., Zhang, W., Edwards, P., Skladany, M. & Thilsted, S.H. (2020) Farming fish in the sea will not nourish the world. *Nature Communications*, *11*(1), 5804. https://doi.org/10.1038/s41467-020-19679-9

Belton, B. & Thilsted, S.H. (2014) Fisheries in transition: food and nutrition security implications for the global south. *Global Food Security*, *3*, 59–66.

Belton, B., van Asseldonk, I.J.M. & Thilsted, S.H. (2014) Faltering fisheries and ascendant aquaculture: implications for food and nutrition security in Bangladesh. *Food Policy*, *44*, 77–87. https://doi.org/10.1016/j.foodpol.2013.11.003

Bernhardt, J.R. & O'Connor, M.I. (2021) Aquatic biodiversity enhances multiple nutritional benefits to humans. *Proceedings of the National Academy of Sciences*, *118*(15), e1917487118. https://doi.org/10.1073/pnas.1917487118

Bogard, J.R., Farook, S., Marks, G.C., Waid, J., Belton, B., Ali, M. et al. (2017a) 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

Bogard, J.R., Hother, A.L., Saha, M., Bose, S., Kabir, H., Marks, G.C. et al. (2015a) Inclusion of small indigenous fish improves nutritional quality during the first 1000 days. *Food and Nutrition Bulletin*, *36*(3), 276–289. https://doi.org/10.1177/0379572115598885

Bogard, J.R., Marks, G.C., Mamun, A. & Thilsted, S.H. (2017b) Non-farmed fish contribute to greater micronutrient intakes than farmed fish: results from an intra-household survey in rural Bangladesh. *Public Health Nutrition*, *20*(4), 702–711.

Bogard, J.R., Thilsted, S.H., Marks, G.C., Wahab, M.A., Hossain, M.A.R., Jakobsen, J. et al. (2015b) Nutrient composition of important fish species in Bangladesh and potential contribution to recommended nutrient intakes. *Journal of Food Composition and Analysis*, *42*, 120–133. https://doi.org/10.1016/j.jfca.2015.03.002

Brummet, R. (2022) Making space for freshwater biodiveristy in low-income fishing economies. *Fisheries Management and Ecology*. https://doi.org/10.1111/fme.12569

Byrd, K.A., Thilsted, S.H. & Fiorella, K.J. (2020) Fish nutrient composition: a review of global data from poorly assessed inland and marine species. *Public Health Nutrition*, *1-11*, 476–486. https://doi.org/10.1017/S1368980020003857

Cheung, W.W.L., Jones, M.C., Reygondeau, G., Stock, C.A., Lam, V.W.Y. & Froelicher, T.L. (2016) Structural uncertainty in projecting global fisheries catches under climate change. *Ecological Modelling*, *325*, 57–66. https://doi.org/10.1016/j.ecolmodel.2015.12.018

Edwards, P., Zhang, W., Belton, B. & Little, D.C. (2019) Misunderstandings, myths and mantras in aquaculture: its contribution to world food supplies has been systematically over reported. *Marine Policy*, *106*, 103547. https://doi.org/10.1016/j.marpol.2019.103547

Fanzo, J., Haddad, L., Schneider, K.R., Béné, C., Covic, N.M., Guarin, A. et al. (2021) Viewpoint: rigorous monitoring is necessary to guide food system transformation in the countdown to the 2030 global

goals. *Food Policy*, *104*, 102163. https://doi.org/10.1016/j.foodpol.2021.102163
FAO. (2009). *Ecosystem approach to fisheries (EAF)*. EAF Toolbox. Available from: https://www.fao.org/fishery/en/topic/166241?lang=en
FAO. (2018). *State of the World's Fisheries and Aquaculture*. Rome, Italy:
FAO. (2020). *State of the World's Fisheries and Aquaculture*. Rome, Italy.
Filipski, M. & Belton, B. (2018) Give a man a fishpond: modeling the impacts of aquaculture in the rural economy. *World Development*, *110*, 205–223. https://doi.org/10.1016/j.worlddev.2018.05.023
Fiorella, K.J., Bageant, E.R., Schwartz, N.B., Thilsted, S.H. & Barrett, C.B. (2021a) Fishers' response to temperature change reveals the importance of integrating human behavior in climate change analysis. *Science Advances*, *7*(18), eabc7425. https://doi.org/10.1126/sciadv.abc7425
Fiorella, K.J., Hickey, M.D., Salmen, C.R., Nagata, J.M., Mattah, B., Magerenge, R. et al. (2014) Fishing for food? Analyzing links between fishing livelihoods and food security around Lake Victoria, Kenya. *Food Security*, *6*, 1–10. https://doi.org/10.1007/s12571-014-0393-x
Fiorella, K.J., Okronipa, H., Baker, K. & Heilpern, S. (2021b) Contemporary aquaculture: implications for human nutrition. *Current Opinion in Biotechnology*, *70*, 83–90. https://doi.org/10.1016/j.copbio.2020.11.014
Free, C.M., Thorson, J.T., Pinsky, M.L., Oken, K.L., Wiedenmann, J. & Jensen, O.P. (2019) Impacts of historical warming on marine fisheries production. *Science*, *363*(6430), 979–983. https://doi.org/10.1126/science.aau1758
Froese, R., & Pauly, D. (2021). FishBase. Version 08/2021. Available from: www.fishbase.org
Gephart, J.A., Henriksson, P.J.G., Parker, R.W.R., Shepon, A., Gorospe, K.D., Bergman, K. et al. (2021) Environmental performance of blue foods. *Nature*, *597*(7876), 360–365. https://doi.org/10.1038/s41586-021-03889-2
Gephart, J.A. & Pace, M.L. (2015) Structure and evolution of the global seafood trade network. *Environmental Research Letters*, *10*(12), 125014. https://doi.org/10.1088/1748-9326/10/12/125014
Golden, C.D., Allison, E.H., Cheung, W.W.L., Dey, M.M., Halpern, B.S., McCauley, D.J. et al. (2016) Fall in fish catch threatens human health. *Nature*, *534*(7607), 317–320.
Golden, C.D., Koehn, J.Z., Shepon, A., Passarelli, S., Free, C.M., Viana, D.F. et al. (2021a) Aquatic foods to nourish nations. *Nature*, *598*, 315–320. https://doi.org/10.1038/s41586-021-03917-1
Golden, C.D., Koehn, J.Z., Vaitla, B., DeSisto, C., Kelahan, H., Manning, K. et al. (2021b) Aquatic food composition database. *Nature*, *534*, 317–320. https://doi.org/10.7910/DVN/KI0NYM
Halls, A. S., & Johns, M. (2013). *Assessment of the vulnerability of the Mekong Delta Pangasius catfish industry to development and climate change in the Lower Mekong Basin*.
Headey, D., Hirvonen, K. & Hoddinott, J. (2018) Animal sourced foods and child stunting. *American Journal of Agricultural Economics*, *100*(5), 1302–1319. https://doi.org/10.1093/ajae/aay053
Heilpern, S.A., DeFries, R., Fiorella, K., Flecker, A., Sethi, S.A., Uriarte, M. et al. (2021a) Declining diversity of wild-caught species puts dietary nutrient supplies at risk. *Science Advances*, *7*(22), eabf9967. https://doi.org/10.1126/sciadv.abf9967
Heilpern, S.A., Fiorella, K., Cañas, C., Flecker, A.S., Moya, L., Naeem, S. et al. (2021b) Substitution of inland fisheries with aquaculture and chicken undermines human nutrition in the Peruvian Amazon. *Nature Food*, *2*(3), 192–197. https://doi.org/10.1038/s43016-021-00242-8
Hicks, C.C., Cohen, P.J., Graham, N.A.J., Nash, K.L., Allison, E.H., D'Lima, C. et al. (2019) Harnessing global fisheries to tackle micronutrient deficiencies. *Nature*, *574*(7776), 95–98. https://doi.org/10.1038/s41586-019-1592-6
Lancker, K., Fricke, L. & Schmidt, J.O. (2019) Assessing the contribution of artisanal fisheries to food security: a bio-economic modeling approach. *Food Policy*, *87*, 101740. https://doi.org/10.1016/j.foodpol.2019.101740
McIntyre, P.B., Reidy Liermann, C.A. & Revenga, C. (2016) Linking freshwater fishery management to global food security and biodiversity conservation. *Proceedings of the National Academy of Sciences of the United States of America*, *113*(45), 12880–12885. https://doi.org/10.1073/pnas.1521540113
Naylor, R.L., Hardy, R.W., Buschmann, A.H., Bush, S.R., Cao, L., Klinger, D.H. et al. (2021a) A 20-year retrospective review of global aquaculture (vol 591, pg 551, 2021). *Nature*, *593*(7858), E12. https://doi.org/10.1038/s41586-021-03508-0
Naylor, R.L., Kishore, A., Sumaila, U.R., Issifu, I., Hunter, B.P., Belton, B. et al. (2021b) Blue food demand across geographic and temporal scales. *Nature Communications*, *12*(1), 5413. https://doi.org/10.1038/s41467-021-25516-4
Njiru, J.M., Aura, C.M. & Okechi, J.K. (2019) Cage fish culture in Lake Victoria: a boon or a disaster in waiting? *Fisheries Management and Ecology*, *26*(5), 426–434. https://doi.org/10.1111/fme.12283
O'Meara, L., Cohen, P.J., Simmance, F., Marinda, P., Nagoli, J., Teoh, S.J. et al. (2021) Inland fisheries critical for the diet quality of young children in sub-Saharan Africa. *Global Food Security*, *28*, 100483. https://doi.org/10.1016/j.gfs.2020.100483
Schubert, A., Nyingi, W., Tuda, P., Aura, C., Obiero, K., Manyala, J. et al. (2022) Reconstructing Kenya's total freshwater fisheries catches: 1950-2017. *Marine & Freshwater Research*, *73*, 57–70.
Short, R.E., Gelcich, S., Little, D.C., Micheli, F., Allison, E.H., Basurto, X. et al. (2021) Harnessing the diversity of small-scale actors is key to the future of aquatic food systems. *Nature Food*, *2*(9), 733–741. https://doi.org/10.1038/s43016-021-00363-0
Thilsted, S.H., Thorne-Lyman, A., Webb, P., Bogard, J.R., Subasinghe, R., Phillips, M.J. et al. (2016) Sustaining healthy diets: the role of capture fisheries and aquaculture for improving nutrition in the post-2015 era. *Food Policy*, *61*, 126–131. https://doi.org/10.1016/j.foodpol.2016.02.005
Tickner, D., Opperman, J.J., Abell, R., Acreman, M., Arthington, A.H., Bunn, S.E. et al. (2020) Bending the curve of global freshwater biodiversity loss: an emergency recovery plan. *Bioscience*, *70*(4), 330–342. https://doi.org/10.1093/biosci/biaa002
Welcomme, R.L. & Bartley, D.M. (1998) Current approaches to the enhancement of fisheries. *Fisheries Management and Ecology*, *5*, 351–382.

How to cite this article: Fiorella, K. J. (2022). Understanding interactions between wild fisheries and aquaculture is essential to sustainable and equitable aquaculture development. *Fisheries Management and Ecology*, *00*, 1–5. https://doi.org/10.1111/fme.12576