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Editorial: Ocean/aquatic food systems: Interactions with ecosystems, fisheries, aquaculture, and people

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Editorial on the Research Topic
Ocean/aquatic food systems: Interactions with ecosystems, fisheries, aquaculture, and people

World population is predicted to reach 9.6–12.3 billion this century with most new growth in Africa and Asia. Humanity has moved past planetary boundaries. The ocean is 71% of Earth but provides only 4–8% of human foods. Continued expansion of agriculture is threatening survival of the world's remaining natural areas and biodiversity strongholds. Sustainable intensification of agriculture and large-scale dietary shifts away from terrestrial animal proteins as sole solutions to the agriculture/biodiversity crisis are unreasonable, as they would have to be adopted and implemented nearly universally. To avoid this looming environmental-food calamity, humanity must develop new frameworks and action plans that emphasize the integrated sustainable development of ocean/aquatic food systems (Figure 1).

Marine and freshwater food systems in capture fisheries and aquaculture are managed as if they are independent entities separate from markets. FAO has stated that "Fisheries and aquaculture interact with increasing intensity as fishers shift from fishing to aquaculture and by competing in the same markets with similar products. The need to integrate planning and management of the two sectors seems vital to their future development and sustainability." In this Research Topic, analyses of ocean/aquatic foods were investigated by 82 authors in 10 articles: four original research, two reviews, two perspectives, one policy, and one hypothesis/theory. Articles covered the historical, present status, and policies necessary to increase the production of ocean/aquatic foods in the context of sustainable development goals. Together these studies give insights into the development of this vitally important sector that will be a critical source of food and income into the future.

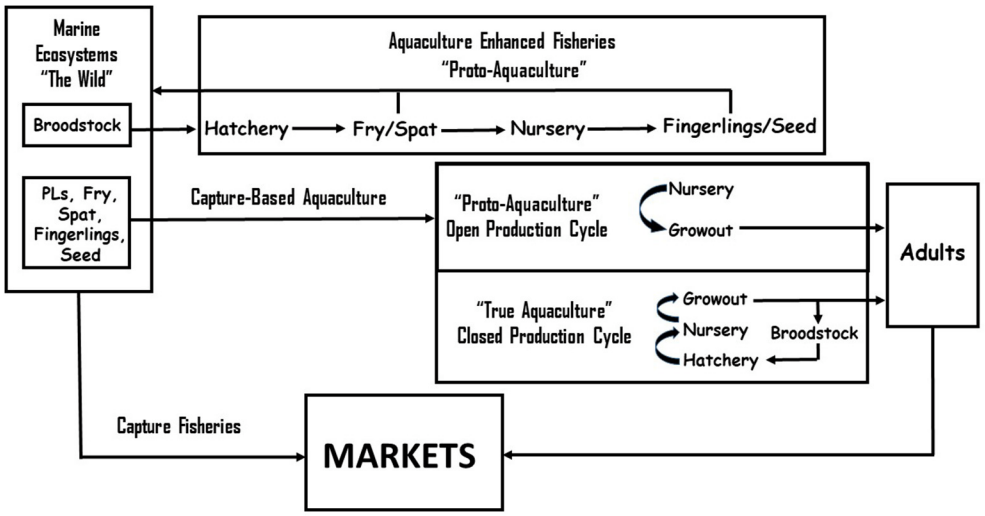

FIGURE 1
System connections between marine ecosystems ("the wild"), capture fisheries, capture-based aquaculture, aquaculture-enhanced fisheries, and aquaculture that together enter a common marketplace. "True" full cycle aquaculture is a closed production network where domestication of an aquatic species is underway. Broodstock are selected from species in captivity and selective breeding occurs via genetic improvement with occassional replenishment of broodstock from the wild, but not at the massive scale or dependancy on the wild as practiced in aquaculture-enhanced fisheries. There are scientific, educational, and governance shortcomings ocean/aquatic ecosystems due to poor, duplicative, or incomplete data that have led to artificial policy,management, and institutional barriers that need to be resolved to accelate food production from the waters of the world.

A recurring theme in this Research Topic was that ocean/aquatic and terrestrial food production systems "remain siloed from each other with few studies addressing their combined contributions." In *Fad, food, or feed: alternative seafood and its contribution to food systems* (Marwaha et al.) key economic, social, and environmental implications associated with production, distribution, and consumption of ocean/aquatic foods, and their interactions with fisheries and aquaculture were explored. Knowledge gaps were identified to inform inclusive, equitable, and sustainable development and governance. Transdisciplinary research in aquaculture has the potential to enhance the resilience of global food systems through diversification and improved efficiencies. Authors of *Seafood in food security: a call for bridging the terrestrial-aquatic divide* (Stetkiewicz et al.) demonstrated that the aquaculture literature is dominated by research in single disciplines, and that ocean/aquatic food systems were under-researched compared to terrestrial animal and plant systems in discussions of food security. Researchers in *Prospects of low trophic marine aquaculture contributing to food security in a net zero-carbon world* (Krause et al.) called for moving aquaculture toward production of low trophic marine (LTM) species to "enable a blue transformation to support a more sustainable blue economy. Transdisciplinary research approaches co-produced with consumers and the wider public will be required for such a blue transformation." In *Making a web-portal with aquaculture sustainability indicators for the general public* (Mikkelsen et al.) progress was made toward assisting society in providing or denying a "social license to operate" for the Norwegian aquaculture industry. Researchers developed a continuously updated web-portal with sustainability indicators covering 22 themes having spatial and temporal resolution from publicly available sources produced by Norwegian authorities or research institutions.

The Chinese market for aquatic products is the largest in the world; however, little has been published on its freshwater fish market. In *Characteristics and dynamics of the freshwater fish market in Chengdu, China* key (Fang and Fabinyi) informants were interviewed at a freshwater fish market. They indicated that price, food safety and quality, freshness and local culinary traditions were the most important influences on freshwater fish consumption. Imported species such as pangasius have increased in popularity, indicative of changes in Chinese markets due to globalization. Markets for wild and farmed Arctic Charr were reviewed in *Wild and farmed Arctic Charr as a tourism product in an era of climate change* (Helgadóttir et al.). Arctic Charr are a traditional food in the Nordic, Arctic, and Subarctic regions. Researchers considered innovative connections between culinary, heritage-based, and nature-based tourism and the Arctic Charr aquatic food system.

"Research and practice will require a closer collaboration between tourism researchers and natural scientists to explore what climate change might mean for Arctic Charr fisheries, aquaculture, and tourism."

In *Farm production diversity in aquaculture has been overlooked as a contributor to sustainability* (Johnson) issues of scale and production diversity were addressed. Promotion of diverse aquaculture scales may allow development of "new ecological and social synergies for smaller farms to achieve economic viability at regional scales. Cost, price and/or regulatory incentives will be needed." Seaweed aquaculture is a good example of this diversity of scales as it is developing rapidly outside of its traditional areas in Asia. In *Commercial seaweed cultivation in Scotland and the social pillar of sustainability: A Q-method approach to characterizing key stakeholder perspectives* (Bjørkan and Billing) responses of stakeholders on how commercial seaweed cultivation in Scotland should develop were summarized. Results indicated that stakeholders thought large-scale and multi-national owned farms were not the ideal model for seaweed aquaculture development. An example of an economically viable alternative for the sustainable development of small scale seaweed aquaculture by fishing families was described in *Engineering a low-cost kelp aquaculture system for community-scale seaweed farming at nearshore exposed sites via user-focused design process* (St-Gelais et al.). Researchers developed and tested an inexpensive, lightweight, and highly mobile gear and completed an economic assessment that showed the "low-cost seaweed farming system could increase incomes when compared to non-farming off season jobs."

Lastly, in *The anthropology of aquaculture* (Costa-Pierce) the cultural/environmental history of aquaculture in seven diverse parts of the world was reviewed. Analysis supported a structural anthropological theory that "whenever the demands of ocean/aquatic food-eating peoples exceeded the abilities of their indigenous fishery ecosystems to provide for them, they developed aquaculture".

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

Author BC-P was employed by the Ecological Aquaculture Foundation LLC.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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