

## Perspective

# Blind spots in visions of a “blue economy” could undermine the ocean’s contribution to eliminating hunger and malnutrition

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## SUMMARY

Increasing the production of food from the ocean is seen as a pathway toward more sustainable and healthier human diets. Yet this potential is being overshadowed by competing uses of ocean resources in an accelerating “blue economy.” The current emphasis on production growth, rather than equitable distribution of benefits, has created three unexamined or flawed assumptions that growth in the blue economy will lead to growth in “blue food” production, increased production will inevitably lead to improved food and nutrition security, and mariculture production will replace marine capture fisheries. In this perspective, we argue that if research and policies are pursued without addressing these “blind spots,” blue food contributions to reducing hunger and malnutrition, and to meeting the Sustainable Development Goals, will be limited. Taking a broader food-system approach beyond production to also considering food access, affordability, and consumption will refocus the blue food agenda on making production and consumption more equitable and sustainable while increasing access for those who need it most.

## INTRODUCTION

The ocean has the potential to contribute to making 21<sup>st</sup> century human diets healthier and more sustainable.<sup>1,2</sup> Whereas seafood was largely excluded from debates on future food and nutrition less than a decade ago,<sup>3,4</sup> there is growing interest in the role of fisheries and aquaculture in providing healthy and sustainable diets.<sup>5,6</sup> The future of ocean food production systems, and their role in global food and nutrition security, is recognized as a challenge at the nexus of the ocean and the economy.<sup>7</sup> Sectors such as fisheries and mariculture are considered to be components of the “blue economy,”<sup>8</sup> a concept in which revenues from the sustainable use of marine resources are optimized while ecosystem degradation is minimized and social benefits are enhanced.<sup>9</sup> We refer to the animals and plants produced for human consumption from oceans and coastal waters as “blue foods,”<sup>10</sup> a definition that elsewhere can include production from inland waters<sup>2</sup> (also known as “aquatic foods”<sup>11</sup>). The aspirations of actors in blue economy and blue food development intersect in a variety of ways, particularly through a shared emphasis on maximizing revenues and increasing seafood productivity. These goals are assumed to be mutually supportive and the most effective route to increasing the oceans’ contribution to nutrition and food security.

However, blue food considerations are becoming overshadowed by competing sectors in blue economy narratives

(Figure 1), and where they are visible, there is limited examination of the systems that lead from production to consumption. Here, we argue that broader food-system considerations, including distribution along value chains and the ability of consumers to access and afford food, are currently underrepresented in the blue economy agenda. This underrepresentation, combined with an emphasis on increasing seafood production for profit over social outcomes, risks undermining the ocean’s contribution to the United Nations (UN) Sustainable Development Goals (SDGs), for example, to address poverty reduction (SDG 1) and hunger and malnutrition (SDG 2) and to transition to a more sustainable human diet (SDG 13 and SDG 14).<sup>12</sup>

The implicit, unexamined, and at times flawed assumptions—or “blind spots”—in current blue economy narratives are as follows:

- (1) Growth in the blue economy will lead to growth in blue food production and consumption, when emerging evidence suggests that industrialization of the ocean economy may compromise its potential to provide more food.<sup>13</sup>
- (2) Increasing food production will directly lead to reduced hunger, when there may already be enough food produced to address hunger,<sup>14</sup> but it is not sufficiently accessible to those who need it.<sup>15,16</sup>



**Figure 1. Blue food: competing for visibility in a growing blue economy**

Illustration of an increasingly busy ocean and coastal space where important blue economy sectors, including mining, energy, ports, transport, tourism, and conservation, are growing and expanding their claims to marine space and resources. The figure depicts this complex and dynamic situation, where the impact of the growing blue economy on food and nutrition is not well understood.

tious food for all<sup>21</sup> if these blind spots are addressed. A blue food future that avoids the consequences of pursuing research and policies limited by these blind spots will contribute to alleviating hunger and malnutrition and achieving the UN SDGs; to do so, it needs to be guided by a broader food-system framing that pays particular attention to questions of equity and justice.<sup>22,23</sup> Systems thinking is crucial to achieving targets such as zero hunger and improving nutrition because it requires consideration of the way in which food is produced, processed, delivered, and consumed, as well as how these elements intersect with human health, the environment, economics, and society.<sup>24–26</sup>

In this perspective, we aim to highlight the three blind spots and their potential to undermine the oceans' contribution to eliminating hunger and malnutrition. We also propose an agenda for future research and policy directions that will address these assumptions and help guide changes to the current dominant global seafood narrative. These directions include developing greater understanding

(3) Mariculture production will replace declining capture fisheries, when the latter still supply half the world's fish catch for direct human consumption and provide many people with a diverse and nutritious food supply. At the same time, capture fisheries support the livelihoods of tens of millions of people.<sup>4</sup>

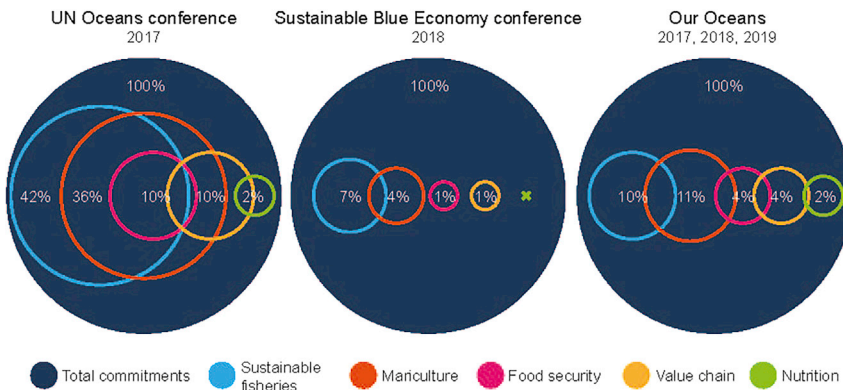
These untested assumptions are made at a time when over 820 million people suffer from hunger and over 2 billion people are unable to regularly access safe, nutritious, and sufficient food.<sup>17</sup> We argue that the growing commodification of ocean resources<sup>18</sup> and the emerging production focus of blue economy narratives may, paradoxically, threaten the food and livelihood security of the "tropical majority":<sup>19</sup> people in developing countries and particularly those in Small Island Developing States who are most dependent on ocean resources for key micronutrients.<sup>20</sup> However, rather than potentially eroding existing food and livelihood security for many, a blue economy could instead contribute to improving the availability and accessibility of nutri-

of the potential impacts of competing blue economy sectors on food availability and access, applying a food-system approach to blue food planning and action, and supporting fisheries for food, culture, and livelihoods.

### BLIND SPOTS IN VISIONS OF A BLUE ECONOMY

#### Blue economy growth will support blue food activities

Producing food from the ocean is cited as an objective in many national and global plans and visions of a blue economy;<sup>8,27</sup> however, food-related activities are rarely prioritized in blue economy narratives or related marine spatial planning exercises. For example, food production from mariculture and fisheries and other food-system considerations, such as distribution, access, affordability, and consumption, were articulated in relatively few of the voluntary commitments relating to the blue economy that were made at recent high-profile international ocean futures platforms (Figure 2). In addition, capture fisheries were completely omitted from the European Commission's strategy



**Figure 2. Blue economy funding priorities revealed**

Voluntary commitments on the blue economy made by stakeholders as part of recent global conferences showed limited focus on improving food security outcomes and on aspects of food distribution, access, and nutrition (see supplemental experimental procedures).

for achieving growth in the blue economy in favor of the energy production, aquaculture, shipping, marine biotechnology, mining, and tourism sectors.<sup>28</sup>

Over 30% of commitments made as part of the UN Oceans conference listed SDG 2 as a relevant goal, yet only 10% included specific reference to improving food security outcomes, and 10% considered aspects of food distribution along value chains. Food distribution considerations were evident in less than 2% of Sustainable Blue Economy conference commitments and less than 5% of Our Oceans commitments. Nutrition was mentioned in less than 2% of voluntary commitments made as part of the UN Oceans and Our Oceans conferences and not at all as part of the Sustainable Blue Economy commitments. Only one blue economy commitment across all conferences mentioned affordability of blue food. Of 179 commitments to improve mariculture across all conferences, 14% also mentioned contributing to food security, 6% mentioned value chain considerations, and 4% mentioned nutrition.

The prioritization of competing blue economy sectors over blue food has resulted in a lack of comprehensive consideration of the ways in which these sectors interact with the availability of, and access to, seafood in blue economy planning. As the blue economy grows, food production must compete with expanding ports, tourism, mining, energy, and conservation sectors for ocean space<sup>8,29</sup> (Figure 3). Development of some of these sectors is important for meeting the UN SDGs, including ensuring access to renewable energy (SDG 7) and sustainable use of the ocean (SDG 14); however, development is also likely to result in impacts on ocean ecosystems, such as physical damage to habitats, waste discharge, oil spills, and noise pollution; see, for example, Chin and Hari<sup>30</sup> and Simpson et al.<sup>31</sup> Further degradation of wild-capture fisheries as a result of these, and related climate change impacts, will potentially reduce the yield of capture fisheries, the result of which will directly contribute to micronutrient deficiencies for 845 million people.<sup>32</sup>

The effects of intersectoral encroachments on fishing and farming areas in the coastal space have compromised access rights for many small-scale fishers.<sup>1</sup> Whereas these effects have largely been overlooked,<sup>22,33,34</sup> they are imperative in understanding the loss of social and economic benefits for this largest group of ocean users. As the blue economy grows, coastal environments may industrialize in a maritime equivalent of the terrestrial conversion of farms to urban and industrial

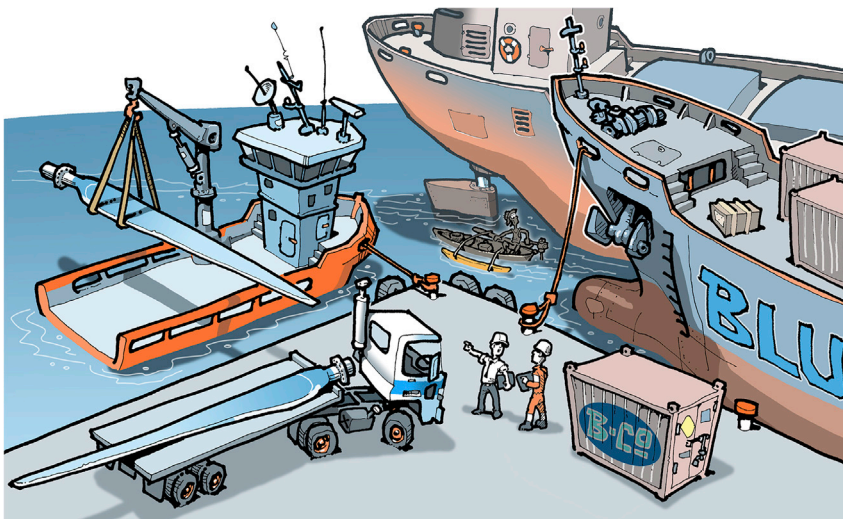
land. Extensive marine spatial planning initiatives have emerged in an attempt to coordinate the growing number of competing intersectoral claims on marine (and especially coastal) space made by governments, nongovernmental organizations, and the private sector. Access rights of small-scale fishers and the local, often traditional, institutions that govern these spaces are either overlooked or insufficiently integrated, effectively marginalizing fishers and having an impact on the rural fish supply for rural and low-income groups.<sup>35,36</sup> Even the implementation of conservation measures such as marine protected areas, in some cases, has been linked to the loss of property rights through “green/blue grabbing”<sup>37</sup> and the dispossession of land and marine access from coastal peoples.<sup>38</sup> These issues are particularly acute where activities such as tourism expand at the expense of artisanal and Indigenous fishing practices and local coastal communities’ social and economic functioning.<sup>39,40</sup>

### Increasing production directly leads to reduced hunger

Where ocean food production systems are visible in blue economy narratives, there is a strong focus on production over other food-system considerations, such as distribution, access, affordability, and utilization. For example, recent optimistic projections suggest the ocean could supply over six times more seafood by volume than it currently produces, representing over two-thirds of the edible animal-source food needed to feed future global populations.<sup>7</sup> Substantially increasing the production of seafood from mariculture, it is assumed, will contribute to food and nutrition security by increasing the overall availability of healthy food.<sup>7,41</sup> Increased production is predicted to fill the gap between increased demand for food<sup>42,43</sup> and anticipated regional declines in agricultural production.<sup>44</sup>

In much the same way as the “green revolution” contributed to increasing agricultural production, reducing food prices and improving food availability,<sup>45</sup> investments in new technologies for a “blue revolution” are anticipated to generate food and economic growth that will increase overall food availability. Economic orthodoxy suggests that increased productivity will improve access to blue food as supply begins to match demand and prices fall. Food prices, it follows, will continue to decline as producers compete in an increasingly saturated market. Efficient globalized markets will, theoretically, ensure that these price benefits are globally distributed.

However, despite ongoing growth in agricultural production and a global food surplus,<sup>14</sup> over 26% of the world population remains food insecure and hunger is on the rise.<sup>46</sup> Increasing the production of food remains the most advocated approach to



**Figure 3. Blue economy growth will not necessarily be compatible with growth of blue food production and consumption**

Illustration of the emerging competition for ocean space among blue economy sectors, including fisheries, ports, and renewable energy. The figure shows that blue food sectors, particularly small-scale or artisanal fisheries and mariculture, are getting hard to “see” in this crowded landscape and are in danger of being overshadowed and squeezed out of the coastal zone as these blue economy sectors become more established.

feeding a growing population and eradicating hunger<sup>15</sup> despite 30% of all food being wasted<sup>46</sup> and 2 billion people lacking regular access to nutritious and sufficient food. This evidence from the green revolution demonstrates that a focus on growth and technology does not *ipso facto* lead to reductions in hunger and malnutrition. Although food will increase in volume when promoted by technological improvements and yield enhancements, history has shown that these improvements are not always accessible to those most in need, particularly women.<sup>45,47</sup> The ongoing coronavirus disease 2019 (COVID-19) pandemic has further exposed inequities and the fragility of globalized food systems,<sup>48,49</sup> including for seafood (Figure 4).<sup>50</sup>

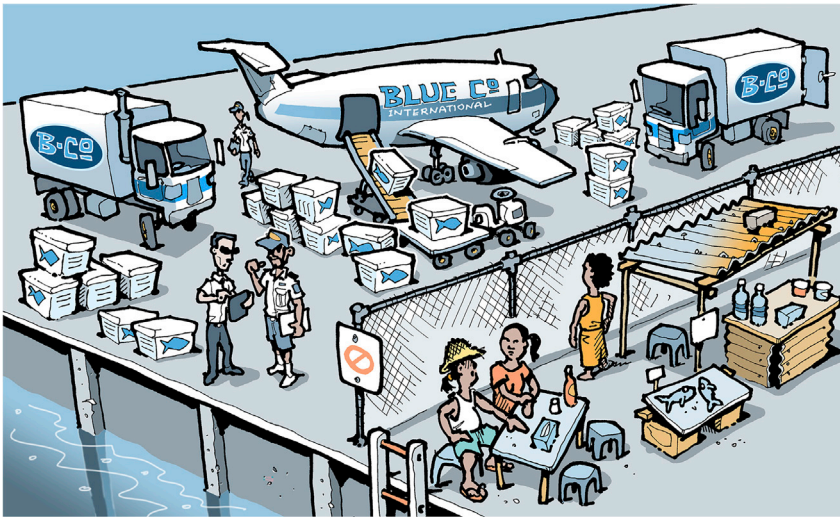
The assumption that increased production will directly lead to reduced hunger is also challenged where production increases are pursued in imperfectly integrated markets and where bigger margins and options for value addition are prioritized. In trade-oriented wild-capture fisheries, for example, seafood is often traded within established market networks<sup>51</sup> by producers who aim to extract the largest value and sell to the highest bidders, commonly in international markets, rather than ensuring seafood is accessible to those who need it. The result is that local people can be denied these sought-after seafood species and the diversity of nutrients they offer.<sup>1,52,53</sup>

The fish trade has also led to developing countries receiving low-cost seafood in exchange for exporting high-value seafood.<sup>54</sup> Although this trade dynamic has not always led to a negative exchange in nutritional terms for developing countries,<sup>55</sup> examples of negative impacts on the nutritional intake of local people from trade exist, for example, in the Pacific region.<sup>56</sup> Furthermore, within developing countries that are well remunerated for their seafood exports, gains from international trade do not necessarily “trickle down” to the local level<sup>57</sup> and, without efforts to improve societal welfare, can result in the poorest people being made worse off as a result of seafood trade.<sup>54</sup> There is no evidence to suggest that the production focus of the current blue food perspective will be able to solve these imbalances, where they exist. It may, in fact, exacerbate the inequitable distribution of benefits and access to fish and its nutrients, particularly for rural or coastal people accessing food outside centralized markets.

the projected 70% growth in output of food and animal feed (from terrestrial and aquatic production) needed to meet demand by 2050 will not guarantee access to adequate food for almost 400 million people.<sup>58</sup> Rather, what is required is greater policy focus on providing access to nutritious food for the poor and reducing loss and waste—including overconsumption by wealthier populations—while improving agricultural production and efficiency. To date, blue food and blue economy narratives have all but ignored critical aspects of food and nutrition security such as accessibility, affordability, and utilization of food, including the varied ways in which food reaches different consumers. As an example, voluntary commitments on the blue economy made by stakeholders as part of recent global conferences rarely articulate support for elements of food systems beyond production, including activities that form part of value chains (Figure 2). In addition, the commitments promoting mariculture development lack clear connections between production and consumption, suggesting an implicit assumption that increased production will inherently contribute to improving food security.

### Mariculture production will replace capture fisheries

The stagnation of catches from wild-capture fisheries and the perception that these are operating beyond sustainable levels, combined with growing “agro-pessimism” around agricultural activities,<sup>59,60</sup> have positioned increasing production from large-scale mariculture as an important food “fix.”<sup>61</sup> It is estimated that there are vast areas suitable for mariculture in nearly every coastal country, and that the development of these areas could produce as much as current wild-capture fisheries while using a small fraction of the global ocean area.<sup>41</sup> Large-scale offshore mariculture developments have recently begun operations, including the cultivation of caged salmon in the Yellow Sea<sup>62</sup> and a fully automated offshore ocean farming facility in Norway.<sup>63</sup> Funding has been provided through government and industry to explore offshore mariculture in other regions, including India, Australia, New Zealand, the United States, and Singapore. Mariculture is also promoted as an alternative livelihood option for small-scale fishers and coastal communities.



**Figure 4. Increased food production does not automatically lead to reduced hunger and malnutrition**

If increased production drives increased fish exports, as depicted here, local low-income consumers may not benefit from it nutritionally. If increased export revenues do not trickle down, increased ocean economic activity may not improve coastal living standards and access to nutritious foods. Greater focus is needed on food-system aspects such as accessibility, affordability, and utilization of food, including the varied ways in which food reaches different consumers.

not take social aspects or production scale into account,<sup>75</sup> nor do they consider spatial requirements of existing or future small-scale fisheries.

Mariculture has the potential to supply sustainable and healthy food, which is also accessible and affordable to poorer people,

In practice, the development of the animal mariculture industry has been inconsistent across the globe.<sup>64</sup> Blue economy narratives promoting mariculture can conflate mariculture and aquaculture, for example, by not differentiating between finfish farming and the culture of seaweed or invertebrates, particularly filter feeders. This conflation has led to incoherence in these narratives,<sup>65</sup> given that animal mariculture has not experienced the rapid growth seen in freshwater animal aquaculture.

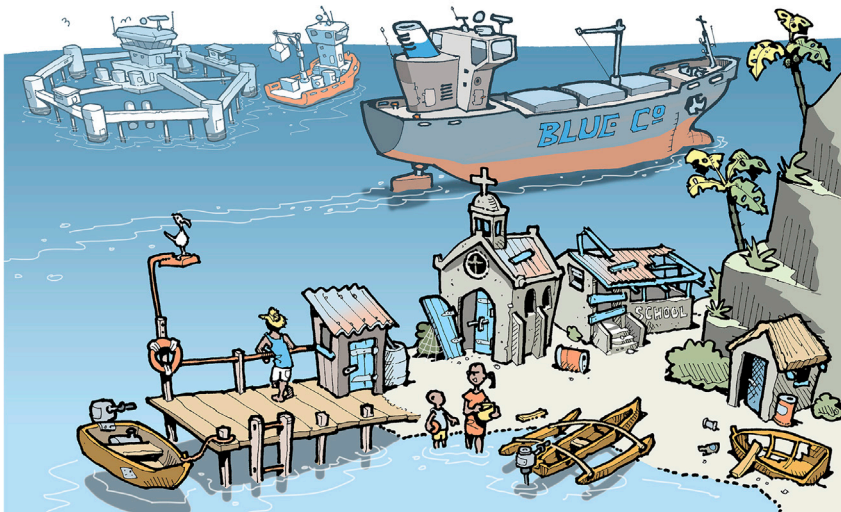
At present, capture fisheries are the main source of food from the ocean, providing 96.4 million metric tons of seafood in 2018,<sup>66</sup> as well as providing livelihoods and cultural connections.<sup>67</sup> Globally, half of all wild-capture seafood comes from small-scale fisheries, and in developing countries, small-scale fisheries produce more fish than large-scale fisheries.<sup>68</sup> The sale, processing, and trade of seafood also contribute to food and nutrition security through livelihoods and income generation.<sup>4</sup> Over 100 million fish workers are engaged through small-scale fisheries in developing countries, accounting for 88% of all fish workers globally.<sup>69</sup> Small-scale fisheries also have unique livelihood functions, often acting as a labor buffer to provide welfare,<sup>70</sup> as well as functioning as a local engine of growth and providing a source of financial independence for millions of women, mostly in the post-harvest sector.<sup>71</sup> They also provide healthy food for people not well integrated into global markets.<sup>22</sup> The positioning of mariculture as a food fix overlooks the significant benefits that the wild-catch sector provides to the tropical majority,<sup>19</sup> who are reliant on wild-capture fisheries for their livelihoods and food and nutrition security. The extent to which future increases in mariculture production will maintain these benefits is unknown<sup>72</sup> (Figure 5).

From a food and nutrition perspective, ensuring effective management and sustainable use of existing capture fisheries should be prioritized over expanding mariculture in many regions, particularly in Small Island Developing States.<sup>73</sup> In addition, blue economy and blue food narratives need to be better aligned with the stable and sustainable provision of sufficient amounts of seafood that is accessible when and where needed, particularly by nutritionally vulnerable populations.<sup>74</sup> Although there are a range of tools and strategies to assess the benefits of mariculture systems, many are not designed for tropical and subtropical regions and do

through the production of a variety of seafood, including shellfish and seaweeds. The contribution of fish will depend on the species choice and how they are farmed (feed composition and systems). Where mariculture is developed, particularly as large-scale systems, appropriate assessment tools and policy mechanisms will be required to ensure that the contribution to food systems is positive overall. Suitable tools will be critical in areas where mariculture is not currently an important food source, for example, most Small Island Developing States. An enormous cultural shift will be required in these areas if mariculture is to replace wild-capture fisheries as the main source of food from the ocean. Technical shifts will also be required, in particular to ensure that the provision of feed from fish resources and agriculture substitutes does not divert food-grade products into feed systems.<sup>76</sup>

## KEY RESEARCH AND POLICY AREAS AND FUTURE DIRECTIONS

The blind spots identified here risk limiting contributions to food and nutrition, both individually and cumulatively. Not only are food production and consumption considerations underrepresented in the blue economy agenda (blind spot 1), where they are visible, the focus is limited to production (blind spot 2), in particular to mariculture production (blind spot 3). Blue food and blue economy narratives currently provide a limited examination of the systems that link production and consumption. Concerns over the inability to achieve or maintain blue economic growth have been linked to failures to anticipate the impacts of adverse extrinsic events and drivers.<sup>23</sup> As the COVID-19 health crisis evolves into a food crisis in many regions, we are reminded of the fragility and ease with which global and domestic supply chains can be disrupted. Whereas supplies of staple foods such as grains have remained robust, people's ability to buy and sell food has been challenged.<sup>77</sup> Identifying and protecting the producer-buyer-seller links in each stage of fisheries and aquaculture supply chains is essential to ensure seafood consumption is maintained.<sup>78</sup> Solutions to overcome issues around food access, affordability, and utilization, to ensure food can get to where it is needed in times of disruption, also present



**Figure 5. Will future seafood be farmed, fished, or both?**

The current blue economy vision of developing large-scale mariculture to replace capture fisheries overlooks the critical social, cultural, and economic role that capture fisheries provide to the tropical majority, particularly in Small Island Developing States, as captured in this Pacific-inspired vision. Offshore mariculture development does not negate the need for continued investment in near-shore capture fisheries and the communities that engage in them.

### APPLYING A FOOD-SYSTEM APPROACH

Global, regional, and local food systems are highly complex and driven by many economic, sociocultural, and environmental factors. The systemic nature of

opportunities to help “transform” the food system toward a more resilient, inclusive, and sustainable post-crisis recovery.<sup>77</sup> Solutions to the current blind spots that will help drive this transformation include changing the research agenda and the narrative that this agenda helps to sustain. Here we summarize an agenda for future research and policy directions (Table 1) to guide what we have argued are the necessary changes to the current dominant global seafood narrative we have described above.

### IMPACTS OF THE BLUE ECONOMY ON BLUE FOOD ACTIVITIES

Greater research focus is needed on the interactions, including competition, trade-offs, and co-benefits, between the blue economy and blue food production and consumption. This focus will need to include the small-scale near-shore fisheries that provide the majority of seafood to lower-income households in the global south, building on existing policy-guiding instruments such as the UN Food and Agriculture Organization’s Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication,<sup>79</sup> as well as the social movements coalescing around “blue justice” and “blue commons.”<sup>80</sup> The importance of small-scale mariculture must also be promoted, given that small-scale operators have limited incentives or ability to move elsewhere, for example, offshore or to a different country, as industrial operations often do. Further research is required on how industrial mariculture can expand without broad disruption of other marine ecosystem services that may have less potential to generate new revenues and growth, but have important social and cultural value. There is opportunity to use marine spatial planning as a tool to help maintain access to small-scale fisheries and small-scale mariculture. Research in this field can build on terrestrial examples, including protected agricultural areas, World Heritage sites, and national parks in which people continue to live and grow or harvest food. Implementing ecosystem-based management for both fisheries and mariculture will also be key to prioritizing sustainable development, increased equity and dialogue between resource actors, and resilience of interlinked social-ecological systems.<sup>81</sup>

these interactions calls for systems approaches and integrated assessment tools to guide change.<sup>82</sup> “Systems thinking” provides a framework and range of methodologies for steering policy and practice beyond one-dimensional solutions<sup>83</sup> and holds the potential for guiding the development of more effective interventions for food security, health, environment, and enterprise over the medium to long term.<sup>84</sup>

Global model-based studies of mariculture production potential, and potential for improved economic output of capture fisheries, drive the blue food agenda.<sup>7,41</sup> Such studies now need to be “ground truthed” with food-system research derived from multiple species and regions to gain a better understanding of what proportion of theorized production potential is realizable and how increased production of food from, for example, offshore mariculture and small-scale coastal systems can improve access, utilization, and sustainability. Some of the value chains most affected by the COVID-19 pandemic were long export chains, which involved more labor and inputs, had weak market diversification, and involved perishable products.<sup>85</sup> These chains are also creating additional opportunities for disease transmission.<sup>49</sup> The pandemic has shown there is a need for investment in local supply chains, including strengthening the diversity of value chain activities and products that can overcome the challenges of social distancing and international trade disruptions.

The blue economy presents an opportunity to reduce the contribution of the food system to global environmental change. Global ocean dialogues will need to heed calls for new modes of inquiry that make more use of knowledge across the disciplines<sup>86</sup> to help ensure that local food environments are studied and understood, as well as the broader food system they operate within. Examples from terrestrial agriculture may help identify where gains in food and nutrition security can be made from focusing on increasing access and use, for example, identifying relevant indicators to monitor the access dimension of food security.<sup>87</sup>

A systems approach can also help facilitate intersectoral collaboration and policy coordination by breaking down traditional operational silos to build the relationships required to jointly address future challenges. It can help to identify trade-

**Table 1. Summary of pathways forward and proposed research and policy agenda to drive change**

Pathway forward	Key research and policy needs	Mechanisms of change
1. Understand and manage the impacts of blue economy sectors on blue food availability and access	<ul style="list-style-type: none"> <li>● identify best ways of adaptive planning to support blue food availability and access</li> <li>● broaden the scope of cross-sectoral research and development activities beyond relative economic and environmental impacts to include social dimensions</li> <li>● increase recognition of small-scale fisheries to be better incorporated as a source of critical nutritious food in blue economy priorities</li> <li>● governance arrangements ensure that intersectoral blue economy growth does not negatively affect food systems and trade-offs are identified</li> </ul>	<ul style="list-style-type: none"> <li>● establish and foster alliances to strengthen connections between blue economy sectors</li> <li>● building on existing policy instruments, such as the UN Food and Agriculture Organization’s voluntary guidelines in support of small-scale fisheries, as well as the social movements coalescing around “blue justice” and “blue commons”</li> <li>● involve private sector and governments to ensure that multinationals, corporations, and regulators are meaningfully engaged</li> </ul>
2. Apply a food-system approach to blue food planning and action	<ul style="list-style-type: none"> <li>● apply a food-system approach to blue food and blue economy research and policy development</li> <li>● encourage governments and private sector to protect the nutritional security of local fish consumers while pursuing economic needs and goals</li> <li>● identify means for the production of blue food to contribute to overcoming existing constraints on food and nutrition security</li> <li>● better align public goods within private-goods market systems</li> <li>● identify new and existing mechanisms that ensure that seafood reaches poorer people</li> <li>● development of more diverse performance indicators for fishery and mariculture management</li> </ul>	<ul style="list-style-type: none"> <li>● support communities (local or international) to help one another, including south-south and triangular cooperation</li> <li>● strengthen existing local informal markets and supply chains</li> <li>● marshal food-system governance and trade law that prioritizes food security</li> <li>● redefine blue economy as a tool to address hunger rather than to increase production</li> <li>● apply a nutrition-sensitive fishery and mariculture approach to identifying diverse production types that enable equitable access for all populations to nutrition-rich seafood</li> </ul>
3. Recognize and support wild-capture fisheries as a source of food, culture, and livelihoods	<ul style="list-style-type: none"> <li>● strengthen the benefits and social importance of wild-capture fisheries in blue food narratives</li> <li>● ensure equitable distribution of benefits of improved fishery management with particular inclusion of marginalized, poor, and resource-dependent groups</li> <li>● ensure that mariculture production complements rather than replaces fish supplied by wild-capture fisheries, especially small-scale fisheries</li> <li>● broader implementation of both community-based fishery management and the provision of the UN Food and Agriculture Organization’s voluntary guidelines in support of small-scale fisheries</li> </ul>	<ul style="list-style-type: none"> <li>● support wild-capture fishers and mariculturists to feed themselves through diverse types of trade, e.g., local or intraregional, to encourage resilience and self-sufficiency at local, regional, and national scales</li> <li>● incorporate economic, social, and ecological objectives in fisheries management design to address diverse objectives and minimize trade-offs</li> <li>● build on examples of south-south and triangular cooperation to provide training for management of small-scale fisheries and development of pro-poor mariculture</li> </ul>

offs between the goals of key blue economy sectors, such as increased production of goods and services, poverty reduction, and environmental protection. A food-system approach can be applied to identify opportunities to simultaneously accomplish multiple objectives, as well as facilitating the coordination

needed to achieve them.<sup>88</sup> Such coordination requires collaboration among academia, governments, and the private sector. It is critical to identify options to incentivize governments and private sector actors to prioritize the nutritional security of local seafood consumers, who may be unable to generate demand for a

public good in a globalizing market, while also satisfying the economic needs and ambitions of both household economies and those of enterprises operating in the seafood sector. Recent positive developments include the creation of the food-system dashboard (<https://foodsystemsdashboard.org/>). This new tool aims to describe global, regional, and national food systems in order to assess the challenges in improving diets, nutrition, and health and to guide its users to set priorities and decide on actions. Although currently focused on diets and nutrition, the tool also includes several environmental and natural resource indicators that are important for the resilience of food systems, and these will be expanded to increase the focus on sustainability.<sup>89</sup> The Blue Foods Assessment (<https://www.bluefood.earth/>) is a coalition of researchers working to significantly expand the existing scientific understanding of the role of blue food and how it can support the shift toward a sustainable and healthy food system. These sorts of initiatives will help integrate future seafood-production studies with food-system research and help to challenge the productivist narrative.

### SUPPORT FISHERIES FOR FOOD, CULTURE, AND LIVELIHOODS

Hall, Hilborn, Andrew, and Allison<sup>90</sup> make the case that seafood should be regarded as more than just another traded commodity and fisheries as more than just another economic activity. This case is particularly relevant to developing nations where capture fisheries are the dominant source of seafood and mariculture makes only marginal contributions to food and nutrition security.<sup>91</sup> Securing a sustainable supply is a necessary precondition for seafood to fulfill and maintain its potential role in the future blue economy, and improved management and governance are fundamental to that ambition.<sup>92</sup> This conclusion notwithstanding, a narrow focus on ecological sustainability and yield maximization does not adequately support policies and practices that ensure these fisheries play the role they need to play in local economies and societies.

Although foundational, the sustainability of production needs to be integrated with issues around distribution, acquisition, and consumption, in short, a wider perspective of seafood within societies and cultures.<sup>90</sup> This broadening of the framing of seafood in the blue economy suggests that a more diverse set of performance indicators for fishery management is required. Further, prescriptions for fishery reform, particularly those proven successful in countries with strong management institutions and based on economic incentives for sustainability, need to be taken with caution in other settings. The challenge of securing the supply of seafood in developing countries is deeper and more complex than issues around the allocation of rights and the economic incentives that flow from them.<sup>93</sup> Although many gaps remain in the policies and practice of fishery management in the developing world,<sup>94</sup> the field is an active frontier for innovation and debate.<sup>95–97</sup> Enabling that innovation is an imperative if small-scale fisheries are to take their place in a just and equitable blue economy.<sup>22</sup>

Generating global and regional datasets, such as through the joint Europe-Africa-funded SmallFishFood project, the interdisciplinary Dried Fish Matters project, and the multi-institutional Illuminating Hidden Harvests initiative,<sup>98</sup> will give small-scale fisheries greater visibility in blue food narratives and support the inclusion

of fish in food and nutrition security policy and planning. Visibility will also be strengthened through advocacy of small-scale fishers, coastal Indigenous peoples, and food sovereignty groups who question the drive toward greater production and global market integration and propose instead support for local and regional value-chain development and an emphasis on nutrition value rather than production quantity and efficiency. This approach has been echoed by the UN Special Rapporteur on the Right to Food, who has advocated for rebuilding local food systems and moving away from a dependence on food imports.<sup>99</sup>

Recognizing and supporting existing capture fishery sectors will help ensure that, where increased mariculture production leads to greater supplies of seafood in domestic markets, it complements, rather than replacing, seafood supplied by capture fisheries.<sup>22</sup> Cooperation in creating opportunities for knowledge exchange on appropriate mariculture technology for domestic markets will promote the development of “fit-for-purpose” solutions. For example, after a request from Cambodian fishery authorities, Indonesia has been helping to accelerate the development of finfish mariculture in Cambodia through training of tertiary students and the private sector.<sup>100</sup>

### CONCLUSION

The ocean has the potential to contribute significantly to reducing global hunger and malnutrition and to reducing the contribution of the food system to global environmental change. This potential can be realized within a blue economy that optimizes revenues alongside the sustainable and equitable use of marine aquatic resources. However, the current focus of the blue economy on production and profit is leading to the domination of blue economy narratives by these interests, to the exclusion of other voices calling for distributional equity. Addressing the current blind spots in the blue economy is essential to ensure that the voices of small-scale fishers and mariculturists are heard alongside all others.

### EXPERIMENTAL PROCEDURES

#### Resource availability

##### Lead contact

Further information and requests for resources should be directed to and will be fulfilled by the corresponding author, Anna Farmery ([afarmery@uow.edu.au](mailto:afarmery@uow.edu.au)).

##### Materials availability

This study did not generate new unique materials.

##### Data and code availability

Original data for Figure 2 are available at <https://doi.org/10.5061/dryad.wm37pvm9>. The sources of these data are UN Oceans Conference commitments (<https://oceanconference.un.org/commitments/>), Blue Economy Conference commitments (<http://www.blueeconomyconference.go.ke/wp-content/uploads/2018/12/FINAL-SBEC-COMMITMENTS-14-December-2018-4pm.pdf>), and Our Oceans commitments (<https://ourocean2019.no/commitments/>).

### SUPPLEMENTAL INFORMATION

Supplemental information can be found online at <https://doi.org/10.1016/j.oneear.2020.12.002>.

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#### AUTHOR CONTRIBUTIONS

The manuscript and data for Figure 2 were prepared by A.F. All co-authors contributed to the original ideas and writing of the manuscript.

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