

Positioning of Aquaculture in Blue Growth and Sustainable Development Goals Through New Knowledge, Ecological Perspectives and Analytical Solutions

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Abstract

Saleem Mustafa, Abentin Estim, Sitti Raehanah M. Shaleh, and Rossita Shapawi. 2018. Positioning of Aquaculture in Blue Growth and Sustainable Development Goals Through New Knowledge, Ecological Perspectives and Analytical Solutions. *Aquacultura Indonesiana*, 19 (1): 1-9. Aquaculture is undergoing a rapid phase of expansion as never before. Like any food-producing sector, there are environmental, social and economic implications of aquaculture development as well. It is imperative to identify actions and potential for promoting business ideas behind aquaculture systems that are in harmony with the environment even as this sector increases its contribution to food security and socio-economic welfare. This paper presents an in-depth analysis of the actual and potential role of aquaculture in supporting blue growth and achieving sustainable development goals. It emerges from the synthesis of information so generated that: 1) Aquaculture's key role in sustainable development goals deserves to be adequately documented, backed by facts and figures, 2) Aquaculture's contribution to each of the goals is qualitatively and quantitatively different, 3) Aquaculture is a diverse activity and, therefore, its impacts, especially from an environmental perspective, cannot be generalized across the whole sector, as these will vary with species, farming methods, environmental conditions at the location and the local socio-economic scenario. With its projected role in food security the aquaculture will continue to develop. However, this will be possible through scientific solutions focused on sustainability by informing best practices. As marine aquaculture moves further out to the sea new knowledge will be needed to understand environmental impacts and to support new farming systems. Similarly, data will also be needed to adapt aquaculture methods to changing climate. A systems approach to managing aquaculture is the way forward, a showcase of which is integrated multi-trophic aquaculture. The progress of aquaculture in meeting the sustainable development goals will require a monitoring mechanism that the relevant agencies need to put in place.

Keywords: Aquaculture; Blue growth; Integrated solutions; Sustainable development

Introduction

The 17 Sustainable Development Goals (SDGs) developed by the United Nations are receiving global attention for implementation by individual countries. These aspirational goals comprise all the three dimensions of sustainable development social, environmental and economic with interlinked targets. Although these goals are indivisible in the sense that no one goal is separates from the other two, the priorities in implementation can be adaptable to different country contexts. Using SDGs as the main reference for development policies and programs at national level, each country must determine the feasible course of action based on their priorities, needs, capabilities, resources and governance frameworks to bring about a real change. Having said that, it is necessary to review the policies at national level even if the existing development programs are broadly consistent with the SDGs.

This is to ensure that the national efforts are in tandem with the 15 years (2016-2030) time framework for implementing these goals.

Food security is central to the Agenda 2030 for SDGs. It is the main issue in ending hunger, malnutrition and poverty, improving livelihoods, adapting to changing climate and rationally managing natural ecosystems among other aims. The message is loud and clear that we can no longer look at these issues separately. The approach has to be holistic and well-integrated. Almost 800 million people suffering from hunger despite tremendous progress made in agriculture through the so-called 'green revolutions' is certainly a matter of serious concern that motivated the attention towards 'blue revolution'. The perspectives of SDGs are not only about increasing food production but also developing resilient and sustainable food systems, ensuring access to safe and nutritious food, improving distribution and marketing networks and increasing

incomes with social justice. Several SDGs are relevant to aquatic food resources that support fisheries and aquaculture. One goal that expressly focuses on “Life below water” is the SDG14: *Conserve and sustainably use the oceans, seas and marine resources for sustainable development.*

This paper examines the role of aquaculture in blue growth and its position in SDGs, and elaborates in what ways this sector can expand its contribution to human welfare in multiple ways.

Materials and Methods

Analytical review of the published information and in some cases first-hand assessment of the state of aquaculture were carried out. The review was more of an analytical nature intended to extract and reveal the worthwhile information, paving the way for synthesis of required knowledge. The main sources of primary data were authentic reports and research papers. Institutional-level efforts towards development of aquaculture necessitated visit to the relevant websites and verification of information. On-the-spot assessment, wherever necessary, entailed mining of information pertaining to infrastructure related to aquaculture and efforts being made to support this sector.

All the 17 SDGs were tabulated, with a description about each. Report of the Inter-Agency and Expert Group on Sustainable Development Goal Indicators was reviewed for seeking details of goal targets and their indicators.

In this paper, attention is focussed on Goal 14: ‘Conserve and sustainably use the oceans, seas and marine resources for sustainable development’. Relevance of aquaculture in this goal has been explained. Finally, new areas of research and development that provide a way forward for implementing the goal and achieving expected outcomes have been elaborated.

Results and Discussion

Aquaculture’s contribution to blue growth

Scientific evidences suggest that the decline in wild stocks of fisheries importance is due to overfishing and habitat degradation. In a way, they support a new strategic framework for capture fisheries while lending support to the role of aquaculture in meeting future demand for aquatic food. It emerges that the seafood in particular is the critical component of global food security. Efforts are being made for sustaining seafood supplies from the sea through responsible fisheries management and application of the ecosystem approach to fisheries management (EAFM). These efforts are believed to contribute to preventing further decline or collapse of fisheries stocks under intense pressure. It is a logical conclusion because 31.4% of the assessed fish stocks have been fished at a biologically unsustainable level (i.e., overfished), 58.1% fully fished and only 10.5% underfished (FAO, 2016).

Capture fisheries yielded 93.4 million tonnes of fish in 2014 which is certainly far short of demand (FAO, 2016). Aquaculture remains the only option for increasing the production to bridge the widening gap between supply and demand.

Analysis of production, marketing and employment statistics released by FAO (2016) leaves no doubt about the rapidly growing role of aquaculture in food security and human welfare. The world aquaculture production of fish and plants in 2014 has been reported to be 101.1 million tonnes in live weight, amounting to a total farm gate value of US\$ 165.8 billion. Out of this, fish harvest was 73.8 million tonnes valued at US\$ 160.2 billion whereas that of plants 27.3 million tonnes worth US\$ 5.6 (Figures 1, 2).

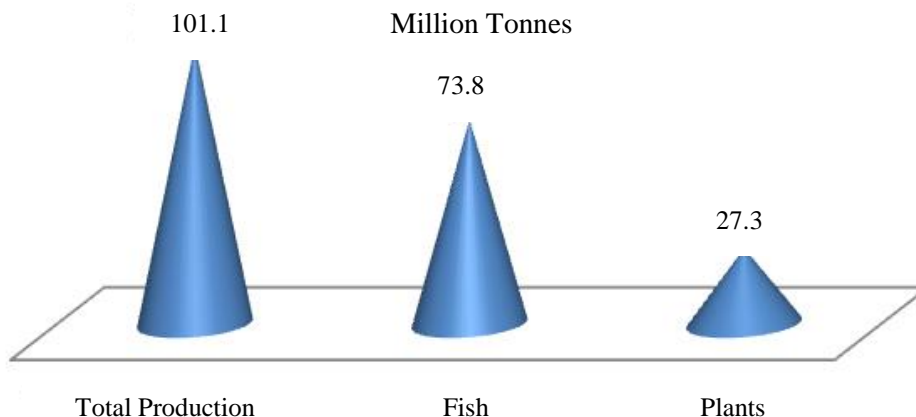


Figure 1. Aquaculture production in 2014
Source: FAO (2016)

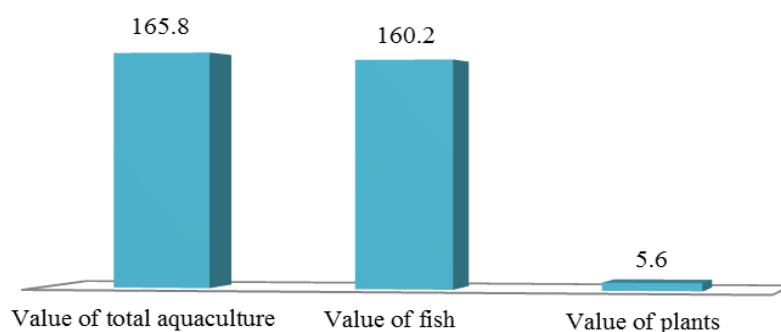


Figure 2. Value of aquaculture production (total, fish and plants) in US\$ billion in 2014.
Source: FAO (2016)

The primary sector of capture fisheries and aquaculture provided employment to 56.6 million people. The proportion of workers engaged in aquaculture increased from 17% in 1990 to 33% in 2014. According to Food and Agriculture Organization statistics, Asia has 84% of the global population engaged in the fisheries and aquaculture. Moreover, of the 18 million people engaged in fish farming, 94% are in Asia. From the point of view of empowerment of women, their 50% representation in the workforce in the combined primary (production) and secondary sectors (postharvest processing and marketing) of the aquatic food is prominent.

Fishery products accounted for 1% of all global merchandise trade in terms of value, representing more than 9% of total agricultural exports (FAO, 2016). Fish remains the most internationally traded food commodity. Its worldwide exports amounted to \$148 billion in 2014, out of which the share of developing countries was \$80 billion, providing higher net trade revenues than meat, tobacco, rice and sugar combined (FAO, 2016).

In the light of such an expanding role of aquaculture and its potential for development, it was deemed important to examine in what ways this sector can contribute to achieving the objectives of SDGs, especially Goal 14. This does not imply that the importance of aquaculture is limited to just this goal. Positioning aquaculture in all the seventeen SDGs is beyond the scope of this paper but it is an important topic that is receiving our attention. The goal targets and indicators are presented in Table 1. Relevance of aquaculture under each target has been elaborated.

In Malaysia, fish farming is a vital sector of economy. The country has a large population of high seafood consumers. This can be imagined from the current annual per capita fish consumption of 56.5 kg. Total aquaculture production was 521,000 tonnes in 2014 (FAO, 2016). Out of this total, aquatic animals (mainly fish, shellfish)

contributed 275,500 tonnes and seaweeds shared 245,300 tonnes. The food fish production sector generated RM 10,598 million for national economy in 2012 (Yusoff, 2015). Seaweeds, ornamental fish and other non-food species were valued at RM 834 million. As many as 29,494 people are employed in the aquaculture sector (Yusoff, 2015).

Malaysia has invested heavily in aquaculture education and research. Aquaculture is a flagship research program of a major centre of excellence 'Borneo Marine Research Institute', which is a postgraduate institute of Universiti Malaysia Sabah (UMS). It is also the niche area of R & D of UMS. These efforts are intended to generate worthwhile knowledge that can help in taking informed decisions vis-à-vis aquaculture development.

Knowledge and innovation to drive aquaculture towards SDG targets

It appears from the foregoing discussion that aquaculture has to step up its contribution to meet the aims of the SDGs. This sector provides many transformational opportunities that researchers, industry players and traditional communities can seize to work together in changing the label on aquaculture as a risky business. Progress in this direction will lead to greater investment, synergistic alliances and focus on innovations to bring about a real change in the aquaculture outlook. This can happen by introducing structural reforms to create an enabling environment for academia-farmer partnership and attracting significant investment. Such a transformation in the aquaculture landscape will be greatly facilitated by making use of information and communications technology. The key elements of information application in aquaculture as suggested by Muir and Bostock (1994) include economically feasible and faster systems for capturing and analysing data and integrating information.

Developments in aquaculture over the last two decades provide a basis for shaping the direction for future course of action. Many research initiatives that have resulted in increased production efficiency should continue to lead to further improvements as they are a sort of work-in-progress besides bringing new topics that deserve priority. These areas are described in Figure 3. New topics deserving more attention are presented in Figure 4.

Monitoring the progress in SGD17 in terms of expected outcomes

Following ratification of the UN SDGs by Malaysia, the issue of formulating the most appropriate policies and plans for implementation of SDG14 among the 17 in the list is a matter of discussion before the relevant government bodies. This will require monetary allocations for research, development projects, and evolving rigorous mechanisms to assess the impact of the initiatives and interventions on the outcomes consistent with the core components of sustainable development. It is high time that the institutions having a strong stake in aquaculture development share ideas to build up momentum for SDG14 and seek decision support from the government. We believe that towards this end a forward movement would be possible by the formation of a national task force mandated by the federal government for developing a blueprint as a national policy document to monitor the implementation of aquaculture-related programs as envisaged under the SDG14. The task force will have to consider the fact that many government agencies currently support aquaculture by way of training, capacity building and infrastructure development but the commercial aquaculture is driven mainly by the private sector (aquaculture industry) in Malaysia. There is a link between public and private sectors but that is visible in the employment opportunities that the industry offers to aquaculture graduates. A suggestion in this regard is to develop a database for aquaculture graduates serving the industry, their key performance indicators, specific achievements that contributed to increase in aquaculture production, salary structure and service conditions.

Among the many other issues needing attention, one is to constitute a single body that coordinates the funding of aquaculture projects from grants earmarked to multiple agencies (the present scenario). That apex body for aquaculture development should be able to prioritize the

various sub-sectors and needs, for example, for targeted research, species selection, farming systems, seed supply provision, extension services, and quality and marketing controls.

There should be a standardized data collection system. Although reliable tools for data analysis are now available but the information that these are capable of generating can be meaningful if the raw data is accurate. Authorities issuing licenses to aquaculture industry can strengthen monitoring mechanisms for compliance with the terms of reference and collection of authentic data on production and marketing. This will establish how far the aquaculture development is progressing along the three pillars (environment, social and economic) of sustainable development. While developing the proposed blueprint an effort will have to be made towards aligning the aquaculture development with the UN SDGs that the government has pledged to implement consistent with the indicators that United Nations Development Program uses to measure the impact on the society. In this context, it is pertinent to align aquaculture with the international development targets and goals because the contribution of aquaculture to the world food supply has exceeded that of the capture fisheries. This trend is likely to prevail at least in the near future. How much the fish matters to food security and poverty reduction themes has been discussed by Bene et al. (2016). While identifying human nutrition, sustainability of seafood supply, demand, access and interests of small-scale operators as important considerations these authors have pointed out that themes as stated above have not been adequately assessed and addressed. Although a wealth of information has been generated as a result of research focused on management aspects driven by considerations of ecological conservation, environmental compatibility and production efficiency but there is a glaring paucity of accurate analysis of strong evidence that supports the contribution of aquaculture and fisheries to food security and poverty alleviation (Bene et al., 2014). Given this scenario, it makes sense to suggest that local specific case studies should be given emphasis at international level and observations should be documented and disseminated on the influence of the use of the information available in the published domain in policy development (Bene et al., 2016), and of course, how that policy decision has influenced the status of aquaculture development. The views expressed earlier by Pollnac (1989) resonate with the current realities

as far as the significance of effective monitoring and evaluation of the impacts of development projects as a means of providing guidance needed for adjusting the ongoing projects and formulating new ones is concerned. This has evolved from the narrative presented by Gerhardsen (1977) who linked lack of realization of expected benefits from fish production to insufficient empirical evaluation of development projects. A survey of literature on food security reveals that the need for improved monitoring and evaluation of projects has been outlined by many researchers in the past (Goldmark and Rosengard, 1985; White, 1986; Norton and Benoliel, 1987; Salmen, 1987) but their views were of general nature, not specifically for aquaculture. Now that the world attention is focused on marine resources for food security, the issues have to be discussed more specifically related to fisheries and aquaculture. These two

sectors collectively supply some 17% of animal protein and provide livelihood to an estimated 12% the global population (FAO, 2016) and this contribution is likely to increase, thus requiring special attention. The realization that the SDG14 would contribute to achieving all the other SDGs as well (Singh *et al.*, 2017) has strengthened this perspective and influenced the emerging ideas on seafood security. Analysis of issues and development programs carried out by Blasiak and Wabnitz (2018) point to the importance of linking international assistance to efforts made by countries to align their fish production with international development goals and targets. These goals also visualize the relevance of building local capacity to conduct long-term monitoring and assessment that will help in improving adaptation strategies in the face of possible future impacts (Kinch *et al.*, 2010), especially those linked to climate change.

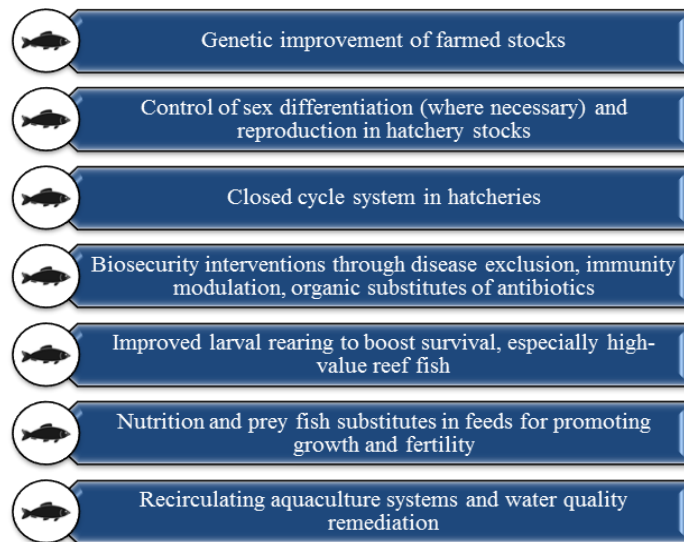


Figure 3. On-going topics of research interest

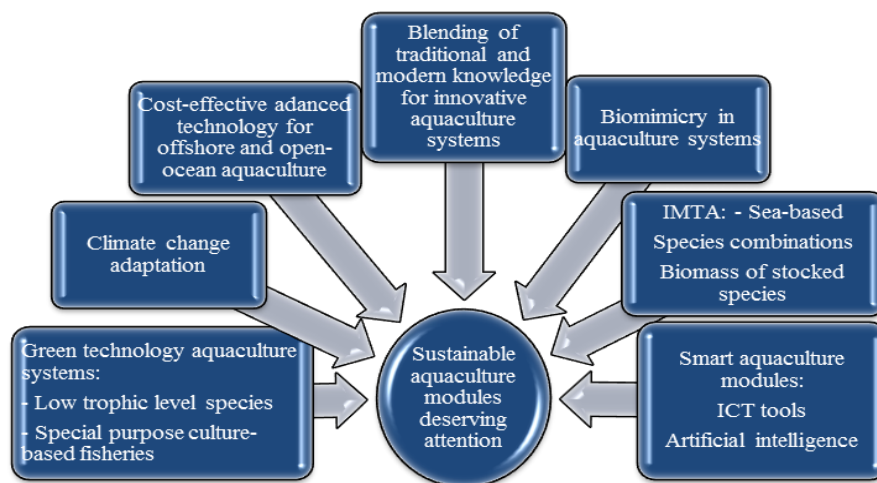


Figure 4. Priority areas of research directed at sustainable aquaculture

Conclusion

Aquaculture has emerged as the main driver of blue growth and a key component of food security which is central to the sustainable development goals. This sector faces challenges that need to be addressed by solution-oriented research, innovative approaches and integrated efforts. Growth trajectory of aquaculture should be shaped by giving due attention to ecological, social and economic pillars of sustainable development. The transformative pathways identified for modern aquaculture hold out optimism in the potential of this sector for meeting the expected outcomes.

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Appendix

Table 1. Relevance of aquaculture in SDG 14.

Targets	Target description	Indicators	Relevance of aquaculture
14.1	By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution.	14.1.1 Index of coastal eutrophication and floating plastic debris density.	Many forms of aquaculture are land-based. When not managed properly, aquaculture has caused nutrient pollution and eutrophication. Also, workers managing land-based fish farms can throw waste, including plastic, after using of consumables. Environment-friendly aquaculture controls such activities.
14.2	By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans.	14.2.1 Proportion of national exclusive economic zones managed using ecosystem based approaches.	Many countries have placed restrictions on conversion of mangroves into shrimp ponds. A mangrove-friendly silvo-fishery model is an example of environment-friendly aquaculture. Seagrass beds are also receiving conservation attention. Use of coastal vegetation as blue carbon stocks for carbon sequestration is gaining importance. Culture of carnivorous fish in sea cages impairs the ecosystem. Prey fish substitutes are being proposed to reduce unsustainable exploitation of marine ecosystem. Aquaculture is adapting to these changes. Forms of aquaculture such as pen culture of sea cucumbers and other species that feed in low trophic levels are eco-friendly stocking systems that are receiving attention.
14.3	Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels.	14.3.1 Average marine acidity (pH) measured at agreed suite of representative sampling stations	Modern aquaculture involves knowledge management and scientific cooperation in the problem posed by ocean acidification. Coastal aquaculture that promotes carbon sequestration can contribute to mitigating the impacts of acidification of sea water. Identification of more resilient species will help in adapting aquaculture to this phenomenon. Aquaculture that can be integrated with coastal vegetation and carbon trading is established, it will help in offsetting the acidification problem to some extent.
14.4	By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics.	14.4.1 Proportion of fish stocks within biologically sustainable levels	Increasing fish supply to the market through aquaculture production of most sought-after species (examples, groupers, wrasses) will lessen the pressure on wild stock to allow them to remain biologically sustainable. Responsible sea ranching that involves releasing hatchery-produced seed into the wild can help in replenishing the depleted stocks.
14.5	By 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on the best available scientific information.	14.5.1 Coverage of protected areas in relation to marine areas.	Authorities dealing with managing marine parks have stepped up efforts to increase the coverage and enforcement mechanisms. Some governments are also offering incentives to fishermen to turn to fish farming and lessen dependence on catch from the wild. In a way, this will lessen community opposition to marine protected areas which have been associated with restriction with the freedom of fishing that the people been doing for livelihood and income. This helps in increasing and better managing the marine parks.

14.6	By 2020, prohibit certain forms of fisheries subsidies which contribute to overcapacity and overfishing, eliminate subsidies that contribute to illegal, unreported and unregulated fishing and refrain from introducing new such subsidies, recognizing that appropriate and effective special and differential treatment for developing and least developed countries should be an integral part of the World Trade Organization fisheries subsidies negotiation.	14.6.1	Progress by countries in the degree of implementation of international instruments aiming to combat illegal, unreported and unregulated fishing.	Farming of fish increases income of fish folk and opens an alternative means of harvesting fish for income generation. Some find farming easier compared to spending time at sea where conditions may turn rough and risky. Catch from the sea is also quite unpredictable. In this way, aquaculture can lead to reduction in fishing pressure and increase in population recruitment.
14.7	By 2030, increase the economic benefits to small island developing States and least developed countries from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture and tourism.	14.7.1	Sustainable fisheries as a proportion of GDP in small island developing States, least developed countries and all countries.	Many governments have special allocations for small island developing States to support infrastructure, logistics and services. Sea farming is an activity that has been going on for a long time. Small island residents carry out fattening of mussels, oysters, abalones and other species until marketable size. They also hold sea cucumbers and even fish in sea pens for the same purpose. These are traditional, or may be considered a primitive form of fish farming, but support livelihood while at the same time keep indigenous communities from recklessly exploiting the fragile marine ecosystem around the small islands.
14a	Increase scientific knowledge, develop research capacity and transfer marine technology, taking into account the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of Marine Technology, in order to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries, in particular small island developing States and least developed countries.	14a(i)	14.a.1 Proportion of total research budget allocated to research in the field of marine technology	Aquaculture is one of the priority areas for research in many countries. In Malaysia, support to aquaculture comes in many forms such as from internal policies of universities and research centers to develop infrastructure, especially hatcheries, and internal grants for research, Ministry of Education, and Ministry of Science, Technology and Innovation providing research grants among other agencies. Industries also sponsor certain projects according to their needs for dealing with aquaculture problems. Government departments fund community-oriented projects that require linking up of industry or community with the research institutions. An outstanding example is that of seaweed estate development in Malaysia. These programs generate new knowledge to strengthen research while benefitting the indigenous communities, especially the impoverished people of the coastal areas of the main land and small islands. There is an active component of knowledge transfer from scientists to farmers for capacity building and empowerment so they can sustain the farming operations once the project funding comes to an end. Because of the involvement of researchers, environmental compatibility of the aquaculture-based development projects receives attention. There are structured projects on the impact of aquaculture on the environment and ways and means of minimizing the impacts to prevent impairment of ocean health. Many countries, including Malaysia, have signed the Convention on Biological Diversity and formulated strategies and action plans to protect marine biodiversity and benefit from its conservation. Reducing fishing pressure by opening up the alternative means of livelihood is among the steps taken in this direction for the reason that reckless fishing is a significant threat to marine biodiversity.

14b	14.b Provide access for small-scale artisanal fishers to marine resources and markets.	14b	Progress by countries in the degree of application of a legal/regulatory/policy/institutional framework which recognizes and protects access rights for small-scale fisheries.	Most countries that signed international conventions have an obligation to protect the rights of artisanal fishers. Moreover, many governments, including Malaysia, have special programs structured for the welfare of traditional fishing communities. Even when marine protected areas are developed around ecologically sensitive areas, especially around small islands, artisanal fishers are among the community representatives consulted. Their apprehensions are addressed by designating multiple use areas within the marine parks. They are also shown the benefits in terms of catch per unit effort in those areas by regulations in surrounding areas.
14c	14.c Enhance the conservation and sustainable use of oceans and their resources by implementing international law as reflected in the United Nations Convention on the Law of the Sea, which provides the legal framework for the conservation and sustainable use of oceans and their resources, as recalled in paragraph 158 of “The future we want”.	14c	Number of countries making progress in ratifying, accepting and implementing through legal, policy and institutional frameworks, ocean-related instruments that implement international law, as reflected in the United Nation Convention on the Law of the Sea, for the conservation and sustainable use of oceans and their resources.	Many countries that have signed these conventions, laws and regulatory frameworks have taken measures under national jurisdictions to implement the various provisions as wisely as possible. Offshore cage culture of high-value fish and sea ranching of low trophic level species are examples where the society can derive benefits on a sustainable basis in their Exclusive Economic Zones.

Source of targets and indicators: IAEG-SDGs (2017)