

adopted in 2010-2011. Furthermore, capacity development on the EAFM has been promoted in many areas of the country.

The Governments of Cambodia, Lao PDR, and Myanmar have also been paying attention on the importance of EAFM by sending their respective fisheries officers to take part in the Regional EAFM Training Course and Training of Trainers on Essential Ecosystem Approach to Fisheries Management (TOT-E-EAFM) organized by SEAFDEC in 2015. SEAFDEC also supported the EAFM and TOT-EAFM on-site training in Lao PDR, Myanmar, and Cambodia starting August 2016. The Department of Fisheries of Viet Nam also started to enhance the capacity of its local fisheries officers by organizing EAFM training courses with the trainers who had been trained by SEAFDEC.

While many countries have already developed their respective fisheries management plans based on the EAFM concept, capacity building on EAFM had been provided to local people in respective countries using the EAFM materials. However, capacity building activities need to be intensified and continued for the effective implementation of EAFM in the Southeast Asian region. Meanwhile, Thailand already translated the EAFM materials into the Thai language for dissemination throughout the country while Myanmar is in the process of translating the materials into the Burmese language. These efforts should be supported and enhanced considering that the EAFM materials would be more useful if these are in the local languages of the countries.

5.6 Habitat Protection and Coastal Fishery Resource Enhancement

The coastal waters of Southeast Asia are blessed with fishery resources with high level of productivity because of rich ecosystems such as dense mangrove forests and sea grass beds sustained by rich effluence of nutrients from land, as well as extensive coral reefs with clean tropical sea environment. These areas are significant to a broad range of aquatic organisms, *e.g.* refuge during their life cycle from breeding, spawning, nursing, and growing; feeding zones of aquatic species that are economically important; and serve as important source of recruitment of a wide diversity of aquatic resources.

It is widely recognized that healthy aquatic environment is a prerequisite for sustainable fisheries production. Therefore, fisheries management in the Southeast Asian region should be directed towards realizing a good balance and relationship between human activities and coastal environment so that aquatic resources could be utilized in

a sustainable manner. Specifically, fisheries management should aim to safeguard the health and reproductive capacity of fish stocks through sustainable protection and conservation of the aquatic resources that provide the foundations for profitable fishing industry and promote equitable sharing of benefits for the resource users. However, most of the important fishery resources in the region are believed to have declined due to many factors that include overfishing, illegal fishing, use of destructive fishing practices, and environmental degradation. Inshore, the massive clearance of mangrove forests for aquaculture, urbanization, industrialization, wood fuel, timber, and the like, has brought about large destruction of the breeding, nursery, and feeding areas of many aquatic species that might have been already destroyed and lost.

Accordingly, the June 2011 ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security Towards 2020 “Fish for the People 2020: Adaptation to a Changing Environment” adopted the ASEAN Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2020 that include provisions encouraging the AMSs to “*Optimize the use of inshore waters through resources enhancement programs such as promoting the installation of artificial reefs and structures, encouraging coordinated and effective planning for coastal fisheries management programs, undertaking environmental impact assessment studies, restocking of commercially-important fish species, as appropriate, and give priority to human resources development for the implementation of such programs*” (Plan of Operation No. 27); and “*Recognizing the different management approaches that are required, sustainably manage major critical coastal habitats, such as mangroves, coral reefs, and sea grasses; and develop and disseminate information and guidance on appropriate tools and interventions*” (Plan of Operation No. 29).

5.6.1 Coastal Fishery Resource Enhancement Programs of the Southeast Asian Countries

Many Southeast Asian countries have been concerned with declining resources, and thus had mainstreamed coastal fishery resource enhancement programs in their respective national plans, policies, and legislations, with the purpose of addressing the degradation of fishery resources. As a result, various tools have been used to alleviate the declining resources, while means of enhancing the habitats and controlling the utilization of resources have been undertaken, *e.g.* deployment of artificial reefs (ARs), promotion of fishery *refugia* and marine protected areas (MPAs), use of fish aggregating devices (FADs), and installation of stationary fishing gears (SFGs). These are summarized in **Box 16**.

Box 16. Coastal fishery resource enhancement tools promoted by the Southeast Asian countries

Country	Habitat Rehabilitation and Artificial Reefs Installation	Management of Fisheries <i>Refugia</i>	Restocking, Stock Restoration, Rehabilitation
Brunei Darussalam	The Government through its Fisheries Department had developed and set up ARs since 1985 as means of promoting fishery resources enhancement using various types, e.g. used tires in 1985; ARs using redundant oil jackets in 1988, 1994, and 2010; and concrete and stainless steel prefabricated pyramidal structures in 2002. Used mainly for enhancing the coastal fishery resources, ARs also play a vital role in protecting the coastal fishing grounds by serving as barrier against illegal fishing gears. Moreover, AR sites are also being developed for eco-tourism activities (FRA-SEAFDEC, 2010).	In 2003, two MPAs were developed in Selirong Island and Pelong Rocks, which had been integrated with the Eighth National Development Plan of Brunei Darussalam (SEAFDEC, 2004; SEAFDEC 2005).	
Cambodia	The Fisheries Administration (FiA) divided the responsibilities of managing the fishing grounds and conservation areas within the Community Fisheries (CF) domain to be managed by community fishers. More than 350 conservation areas had been rehabilitated by the community fishers resulting in enhanced fish stocks and increased fish production through community participation. Mangrove reforestation is a routine activity in the conservation areas where community fishers follow the rules and regulations on mangrove reforestation as prescribed by FiA, while conservation areas had been rehabilitated and community fishers are also engaged in alternative livelihoods, e.g. tourism in the Tonle Sap Great Lake, upon thorough consultations among the members of the CF (Kawamura, <i>et al.</i> , 2016). The Ministry of Environment and the Ministry of Agriculture, Forestry and Fisheries play significant roles in implementing the ARs program in collaboration with donors, e.g. the United Nations Environment Programme (UNEP), Danish International Development Agency (DANIDA), FAO, and the Department for International Development (DFID) of UK. The country's ARs program was initiated in 1991 using 300 units of concrete modules and base and log of trees installed in the Tonle Sap Great Lake at depths of less than 10 m, to provide habitats for aquatic species and improve fish stocks. Furthermore, 700 units were deployed in 1997 and 100 units more in 2002. The concrete ARs also serve as protection of the coastal areas and enhance the biodiversity (FRA-SEAFDEC, 2010). Installation of ARs in the lakes as means of protecting the fishing grounds from encroachment had been successfully carried out (Kawamura, <i>et al.</i> , 2016).	In 1979, FiA established 13 protected areas called "fish sanctuaries" in freshwater zones especially in the Tonle Sap Great Lake. When the Fisheries Law was enforced in 1987, any form of fisheries activities were prohibited in the fish sanctuaries. In 1997, four national parks were established in coastal areas and part of the fifth park covering an area of 366,250 ha was considered as Protected Area (SEAFDEC, 2004; SEAFDEC, 2005). In 2004, Blood Cockerle <i>Refugia</i> was established in Sihanoukville to enhance and protect the habitats of bivalves, blood cockles (<i>Anadara granosa</i>) such as mangroves and sea grass in natural sea beds with the country's Community Fisheries establishing the necessary self-regulatory measures, <i>i.e.</i> fishing rights and entry, fishing seasons and fishing hours, and harvestable size of blood cockles, through consultations with the stakeholders, e.g. local fishers, local officers, government staff, researchers, and relevant organizations and agencies (Kawamura, <i>et al.</i> , 2016). In 2002, MPAs were established by the FiA with funding support from ICRAND project under UNEP, at the Koh Kong side of Sihanoukville where coral reefs are abundant (SEAFDEC, 2004; SEAFDEC, 2005).	
Indonesia	In 1998, the country's 15-year program (1998-2013) known as the Coral Reef Rehabilitation and Management Program (COREMAP) was launched for the protection, rehabilitation, and sustainable use of coral reefs and associated ecosystems through co-management. COREMAP covers 10 provinces, namely: Maluku, Irian Jaya, South Sulawesi, Southeast Sulawesi, North Sulawesi, East Nusa Tenggara, West Nusa Tenggara, Riau, North Sumatra, and West Sumatra. The major initiatives of COREMAP Phase 1 included public awareness campaigns, pilot community-based management, institutional development activities, and information and training network and development of Monitoring, Control and Surveillance (MCS) system (UP-MSI, ABC, ARCBC, DENR, ASEAN, 2002). Rehabilitation and conservation of the country's habitats are carried out through mangrove reforestation, coral transplantation, installation of fish apartments, and the like. Constructed from durable plastic materials that could last for more than 25 years, fish apartments are meant to support the aggregation of fish and serve as fish shelters. Fish apartments installed near fishing communities serve as refuge for fish stocks and prevent encroachment of the fishing areas by illegal fishers (Kawamura, <i>et al.</i> , 2016). Three types of AR models are used in Indonesia, namely: cube shape model, dome model, and pyramid model. Installation of these ARs is meant to promote coral reef biodiversity and economic growth. In 1999, the Marine Habitat Enhancement Program at Minahasa of North Sulawesi implemented a Reef Ball Project in collaboration with the private sector, by deploying approximately 3000 reef balls at three main locations. It was also reported that used tires, out of commission steel structures, and old or confiscated pedicab units have been deployed to serve as ARs in the coastal waters of Indonesia (FRA-SEAFDEC, 2010).		Indonesia's stock enhancement activities include determining the bio-limnological characteristics of release sites, development of fisheries co-management approach, and making use of local wisdom or knowledge for the management of the sites. Fish stock enhancement and culture-based fisheries are options to optimize the utilization of inland waters for producing more fish, ensuring food security, creating additional income, and promoting human welfare. The concerned government agencies also support and take active part in the activities, as well as provide seeds of local fishes for restocking purposes, <i>i.e.</i> Research Institute for Inland Water Fisheries in Palembang; Research Institute for Stock Enhancement in Java; and the SEAFDEC Inland Fishery Resources Development and Management Department in Palembang (Kawamura, <i>et al.</i> , 2016).

Box 16. Coastal fishery resource enhancement tools promoted by the Southeast Asian countries (Cont'd)

Country	Habitat Rehabilitation and Artificial Reefs Installation	Management of Fisheries <i>Refugia</i>	Restocking, Stock Restoration, Rehabilitation
Lao PDR	<p>Being landlocked, the country emphasizes only on inland fisheries. Several government development programs have been oriented towards clarifying boundaries and thereby promoting enclosure of resources within fixed and legible territories. The Department of Livestock and Fisheries is responsible for the management of the country's natural aquatic resources. Between 1993 and 1999, the local government of Lao PDR endorsed the establishment of 68 Fish Conservation Zones as part of a community-based fisheries co-management initiative, all of which are situated in the mainstream Mekong River in Siphadone Wetlands near the border of Cambodia. Besides government's support, communities also received support from international non-governmental organizations, especially for the Lao Community Fisheries and Dolphin Protection Project, and Environment Protection and Community Development (Baird, 2006). In 2010, SEAFDEC started the resource enhancement program at Nam Houm Reservoir, where various activities were conducted during the five-year project period, e.g. compilation of fisheries information and data, promotion of sustainable fisheries and the concepts of community-based and co-management in inland fisheries, strengthening the critical habitats by installing 50 pieces of high effective fish shelters as protective measures of broodstocks from illegal fishers, prohibiting the use of certain fishing gears in conservation areas, transfer of technology on mobile hatcheries to fishers' groups in Nam Houm Reservoir for the breeding the common silver barb using hormones, and promotion of juvenile fish releasing techniques, among others (Kawamura, <i>et al.</i>, 2016).</p>		
Malaysia	<p>The Malaysian Fisheries Act 1985 prohibits any fishing activities within the 0.5 nautical miles radius of artificial reef areas (Kawamura, <i>et al.</i>, 2016). The general objective of Malaysia's ARs program is to create and enhance the fishery resources and stop trawlers from encroaching into the country's coastal areas (SEAFDEC, 2010). Rehabilitation of resources through establishment of ARs and coral replanting programs are among the tools adopted in Malaysia. Thus, FADs and ARs which have been found acceptable for fishery resources enhancement and management tools were installed in the country's waters. As a result, a total of 99 ARs have been deployed since 1975 and an additional of more than 200 ARs have been installed to mitigate the impacts and loss of habitats due to destruction and to enhance the marine resources (SEAFDEC, 2004; SEAFDEC, 2005). From 1987 to 1990, the Department of Fisheries Malaysia deployed 3 000 000 tires as artificial reefs, and from 1990 to 2004, pre-fabricated concrete and PVC reefs were deployed for the special purpose of serving as ARs for lobster and squid, and in 2000 reef ball ARs were deployed in Malaysian waters. The government pursues an extensive ARs program by conducting intensive research and development, and as a result, six innovative large-size ARs weighing 5-19 metric tons had been developed and deployed during 2006-2009, and had been dubbed as cube ARs, cuboids ARs, soft-bottom ARs, lobster ARs, recreation ARs, and tetrapod ARs.</p>	<p>MPAs were first established in Malaysia in 1983 and promoted as no-take zones. At present, a total of 40 marine parks have been gazetted. FAD sites have been developed at the same time with MPAs, and a total of 222 FAD sites were established utilizing a budget of Malaysian Ringgit (RM) 24 million or about US\$560,000 (SEAFDEC, 2004). Meanwhile, special <i>refugia</i> for two economically important commodities such as shrimp and lobster had been established in Sarawak and Johor, respectively, following the concept of <i>refugia</i> similar to that in Sarawak, Malaysia, which is known as the "tagal system" for the seasonal conservation of the freshwater fish Malaysian red mahseer (<i>Tor tombroides</i>). The main objective of the special <i>refugia</i> is to address the country's declining production of penaeid shrimps and lobsters. Thus, activities had been initiated aiming to safeguard spawning aggregations, nursery grounds, and migration routes; protect and revive fish populations from being overfished; and increase and sustain catch and incomes of fishers and relevant stakeholders. In developing the aforementioned new concept of <i>refugia</i>, science-based information had been taken into consideration while agro-tourism aspects were explored so that local communities could generate additional incomes. However, the establishment of such <i>refugia</i> systems is constrained by various factors, e.g. inadequate support from local communities; pollution from terrestrial activities especially the sludge coming from crude palm oil milling factory that flows into the <i>refugia</i> area; local communities not empowered to stop encroachment by illegal fishers in <i>refugia</i> areas; migratory characteristics of target commodities makes it difficult to manage the fisheries; and in the case of eco-tourism activities, the target species become dependent on artificial diets provided by tourists instead of finding food by themselves from the natural environment (Kawamura, <i>et al.</i>, 2016).</p>	<p>During 2010-2014, coral reef restoration activities had been carried out in the waters off Pahang and in Perhentian Island of Terengganu Province through coral replantation. Malaysia is reported to have about 1687 km² of coral reef areas with more than 540 species of hard corals, but only about 9% of the coral reef areas are protected under the country's MPA systems, while some of the coral reefs have been threatened by climate change, pollution, and illegal fishing among others, leading to massive coral bleaching and habitat loss. Based on the country's experience, site selection is crucial as the site should have moderate water current with unobtrusive sunlight, and should not be too near to adjacent natural reefs. Coral fragments used for transplantation must be larger than 10 cm, and the site should be maintained immediately after the corals had been transplanted. Some benefits of coral restoration include increased live coral cover, recovery of targeted coral reefs, increased biodiversity, reestablishment of ecological balance, and stabilizing the surrounding environment (Kawamura, <i>et al.</i>, 2016).</p>

Box 16. Coastal fishery resource enhancement tools promoted by the Southeast Asian countries (Cont'd)			
Country	Habitat Rehabilitation and Artificial Reefs Installation	Management of Fisheries <i>Refugia</i>	Restocking, Stock Restoration, Rehabilitation
Myanmar	<p>The Ministry of Livestock and Fisheries is responsible for the fisheries development of the country, and has established marine parks and marine reserves as well as fisheries protected areas under the country's Fisheries Law. Fishing in these protected areas is prohibited unless specifically licensed to operate. Although ARs deployment and coral planting have not yet been established in the country, the Department of Fisheries (DoF) of Myanmar is more concerned in increasing the number of marine parks and marine reserves or MPAs at places where corals are abundant to restore and enhance the marine aquatic resources (SEAFDEC, 2004; SEAFDEC, 2005). The DoF recognizes that ARs play important role in marine aquatic resources enhancement and intends to establish the country's ARs program but technology on development of ARs and financial support for such development would be required (FRA-SEAFDEC, 2010).</p>		<p>Inland fisheries management in Myanmar is divided into two categories, <i>i.e.</i> leasable fisheries and open fisheries. In leasable fisheries, fishing rights are granted to lease holders under a lease agreement subject to stipulations relating to the area, species, fishing implements, period, and fishing methods used. Those lease holders must take the responsibility of carrying out stock enhancement and conservation of fisheries habitats. It has been reported that there are 3729 leasable fisheries in Myanmar and culture-based system is applied in most of these leasable fisheries. Several activities had been carried out in leasable fisheries to conserve, rehabilitate, and maintain the fisheries habitats and fish stocks, and improve fish production from inland fisheries. Moreover, selective harvesting of stocks is also being promoted while means of protecting the inland fishery resources from illegal fishing activities are also being developed (Kawamura, <i>et al.</i>, 2016).</p>
Philippines	<p>The Philippines started ARs installation in 1981 with 70 small-size ARs along the country's coasts. The Philippine Fisheries Code of 1998 provides specific management measures to conserve and manage the fishery resources of the country. ARs have been deployed by the Bureau of Fisheries and Aquatic Resources (BFAR) and technically supported the Local Government Units (LGUs). BFAR formed the SCUBA divers group to monitor, manage, and safeguard the coral reefs. Initially, the group implemented the Coral Garden and Reef Rehabilitation Project in Tangalan, Aklan in central Philippines (SEAFDEC, 2004).</p>	<p>There are over 500 MPAs around the Philippines that were established through local community initiatives, and are entirely locally-managed marine areas for artisanal (small-scale commercial) fishing activities (UP-MSI, ABC, ARCBC, DENR, ASEAN, 2002). Fisheries <i>refugia</i> have also been established in the Philippines, <i>e.g.</i> in Busuanga, Palawan and in Zamboanga Peninsula. Success of fisheries <i>refugia</i> depends on the actions at the local level with the intensity of support of the community which is dependent on the involvement of local stakeholders while science-based management measures are most crucial. Local knowledge and wisdom are also harnessed as these are critical for site selection and establishment of management measures. In addition, intensified information and communication also help in enhancing communities' acceptance of the fisheries <i>refugia</i> approaches. In the case of the <i>refugia</i> in Busuanga, Palawan, a model of fish egg dispersal and larval settling in Philippine waters was developed where the source and sink of fish eggs and larvae had been used in identifying the spawning and nursery <i>refugia</i>. For the <i>refugia</i> in Zamboanga Peninsula, concerns on the decreasing catch of sardines were addressed leading to the establishment of a management measure, <i>i.e.</i> enforcement of closed fishing season in the Peninsula's fishing ground. Subsequently, the catch of sardines in Zamboanga Peninsula has been increasing (Kawamura, <i>et al.</i>, 2016).</p>	<p>Inland fishery resources in the Philippines comprise swamplands, lakes, rivers, and reservoirs that serve as host of some 340 species of freshwater fishes. The country's National Program on the Fisheries Enhancement of Inland Waters was launched covering 36 minor lakes and 320 small reservoirs in 16 regions in the Philippines for the purpose of increasing the country's fisheries production from inland fisheries. The Program is also intended to rehabilitate and/or restore the physical conditions of the country's minor lakes and reservoirs, enhance fisheries, and repopulate indigenous aquatic species in support of biodiversity conservation, poverty alleviation, and food sufficiency (Kawamura, <i>et al.</i>, 2016).</p>

Box 16. Coastal fishery resource enhancement tools promoted by the Southeast Asian countries (Cont'd)

Country	Habitat Rehabilitation and Artificial Reefs Installation	Management of Fisheries <i>Refugia</i>	Restocking, Stock Restoration, Rehabilitation
Singapore	<p>The Primary Production Department (now the Agri-Food & Veterinary Authority) of Singapore launched a 10-year stocking program in 1986. Over 80 000 sea bass, 8 500 cherry snappers, and 630 000 banana shrimps were released in the country's rivers basically promoting restocking and game fishing. ARs were installed in mid-1989 in the southern islands under the ASEAN-US Coastal Resources Management Project. In 2001, the National University of Singapore and Singapore Tourism Board conducted collaborative research on the use of ARs as part of eco-tourism activities. Nevertheless, MPAs have no place elsewhere in the country so these are not included in the national policies on coral reefs rehabilitation of government agencies responsible for this resource. FADs were however installed to serve as obstacles in waterways but consequently, there was a lack of interest in this aspect (SEAFDEC, 2004).</p>		
Thailand	<p>Since 1978, the Department of Fisheries (DOF) as the main agency responsible in governing the country's fishery resources had been installing ARs for resource rehabilitation, not only in the Gulf of Thailand but also in the Andaman Sea. The objectives of ARs are to rehabilitate coastal fishing grounds, develop and provide job opportunities, increase small-scale fishers' incomes, and promote conservation and management of coastal fisheries. From 1978 to 1986, DOF experimented on the substance, structure, and techniques for deploying ARs. As a result, the DOF established that the most suitable structure of ARs is the square concrete dice block with size 1.5 m×1.5 m×1.5 m as these could provide shelter for aquatic species as well as obstruct trawlers and push netters from entering the AR areas. From 1986 until the present, 280 sites had been installed with small ARs and 30 sites with large ARs during 1988-2006 with a funding of about one billion Baht or about US\$40 million. A project on mass installation of ARs in the Southern of Gulf of Thailand which is under the Royal Initiation of Her Majesty the Queen, deployed artificial reefs in Pattani and Narathiwat Provinces from 2002 to 2015. The materials used for the construction of the ARs included used and out of commission vehicles such as goods train wagons and armored tanks, as well as concrete blocks and concrete pipes. The project has succeeded in elevating the standards of living of fishers and in restoring the natural wealth of the fishery resources. From 1985 to 2009, ARs were also deployed in 329 small sites (1-2 km² from the shoreline) in 18 provinces covering a total area of 493 km² with a budget of 827 million Baht or about US\$25 million. ARs were also deployed in 33 large sites (20-30 km² from the shoreline) in 19 provinces covering an area of 1442 km² with 568 million Baht budget or about US\$17 million (FRA-SEAFDEC, 2010). At present, local fishers can request installation of ARs from local authorities (Supongpan, 2006).</p>	<p>The Master Plan for Marine Fisheries Management of Thailand launched since 2009 served as guide for sustainable management of marine fisheries resources, and included a 10-year plan to "promote sustainable fisheries development based on the sufficient economy that places the people at the center." The DOF has the main responsibility of encouraging related agencies and stakeholders to be involved in the plan. Included in Strategy 4 on ecosystem and fishing ground rehabilitation to safeguard biodiversity and marine environmental quality and to demonstrate the importance of resource enhancement, are several guidelines that include: identification of natural habitats on which important fish stocks depend in certain parts of their lifecycle to ensure sizeable recruitment to fishable stocks; establishment of artificial reefs (ARs) and promotion of the use of living resources surrounding them under the management by community or fishermen organization; and promotion of sea ranching practices that do not jeopardize the marine ecosystem (DOF, 2008). Fisheries <i>refugia</i> has been established in the Gulf of Thailand for Indo-Pacific mackerel (<i>Rastrelliger brachysoma</i>) and other economically important species that face major stock reduction due to various factors, <i>i.e.</i> increasing demand for protein sources together with rapid development and improvement of fishing gear and fishing techniques, and illegal fishing among others. Enforcement of closed seasons and areas in some parts of the Gulf of Thailand for the Indo-Pacific mackerel and other economically important species has been carried out by related agencies. Monitoring changes in the status of target species and evaluating the fishing methods to develop appropriate measures that could be promoted and used for cancellations and revisions of the measures, are conducted from time to time based on the changes in the status of the fishery resources and effective management of the aquatic resources (Kawamura, <i>et al.</i>, 2016).</p>	<p>The natural stock of giant clam (<i>Tridacna squamosa</i>) which has been declining in their natural distribution areas since 1993 necessitated the conduct of hatchery breeding and seed production activities in Thai waters mainly for conservation purposes. Restocking programs had been implemented in the country through the DOF, local administration organizations, provincial agencies, the Electricity Generating Authority of Thailand and other private sector, and government agencies. Results of the trial restoration of giant clam indicated a survival rate of 40% mainly influenced by various factors in the environment. Moreover, the new Management Strategies of Thailand adopted starting 2015 is an important tool that could be used to attain sustainable production from fisheries and maintain fish diversity, as well as means to enforce relevant laws and regulations to combat illegal fishing in the country (Kawamura, <i>et al.</i>, 2016).</p>

Box 16. Coastal fishery resource enhancement tools promoted by the Southeast Asian countries (Cont'd)			
Country	Habitat Rehabilitation and Artificial Reefs Installation	Management of Fisheries <i>Refugia</i>	Restocking, Stock Restoration, Rehabilitation
Viet Nam		Development of the country's MPAs is governed by the Ministry of Science, Technology & Environment (MoSTE), Department of Fisheries Resources Protection, Ministry of Fisheries (MoFi), and Ministry of Forestry. Recently, the Government of Viet Nam authorized MoFi to develop a National Plan for Marine Protected Areas with marine components, particularly coral reefs and sea grass beds, including MPAs in the Spratly's archipelago. Although the plan is still pending government's approval, MoFi will be responsible for the MPAs with the objective of conserving mainly the coral reefs, sea grass beds, island ecosystems, and marine living resources (UP-MSI, ABC, ARCBC, DENR, ASEAN, 2002). As reported, there are 16 MPAs along the coastline of Viet Nam and 16 fisheries <i>refugia</i> were successfully established taking into account available scientific information and traditional knowledge of fishers compiled through consultations with local authorities. The objective of establishing fisheries <i>refugia</i> in Viet Nam is to protect spawning and nursing period of important aquatic species (Kawamura, <i>et al.</i> , 2016). Monitoring of the country's MPAs is done once a year, the results of which are used as basis in formulating policies and regulations on the protection and development of the aquatic resources. Engagement of the stakeholders during the process of establishment the conservation zones helped in pooling the knowledge and experience of local stakeholders, <i>e.g.</i> officers, fishers, scientists, and government authorities. National activities on ARs are still to be implemented as ARs are not yet in place (SEAFDEC, 2004).	During 2012-2015, artificial breeding of abalone (<i>Haliotis diversicolor</i>) was carried out in Bach Long Vi, Viet Nam. This project was carried out to address the concern on degradation of the natural habitat and over-exploitation of this species of abalone (Kawamura, <i>et al.</i> , 2016).

5.6.2 Country Synthesis on Overview of Resources Enhancement

The Workshop on Enhancing Coastal Resources: Artificial Reefs, Stationary Fishing Gear Design and Construction and Marine Protected Areas organized by SEAFDEC/TD in Samutprakan, Thailand in 2003, noted that the respective national legislations, policies, and plans including resource enhancement activities to promote conservation and management of marine resources of the Southeast Asian countries were in place. But this does not include Singapore because the country has no national policies or agencies managing coral reefs and reef resources. Moreover, most of the countries have deployed ARs in their respective waters, promoted the use of stationary fishing gears (SFGs), and established MPAs as approaches towards conservation and management of the coastal resources. Cambodia and Myanmar are currently

promoting only MPAs but with the intention of expanding to other potential measures while Singapore is basically promoting only restocking to increase resident fish stocks and game fishing as well as ARs but not SFGs as these are considered obstacles in navigation pathways. Viet Nam is in the initial stage of deploying ARs.

The resource enhancement activities in most countries are generally focused on the following: mitigating the impacts and loss of habitats due to natural and man-made destructions; enhancing marine productivity and biodiversity of coastal resources; providing physical obstruction against invasion of trawlers into coastal areas; providing productive and alternative near shore fishing areas to small-scale fishers; and promoting sustainable livelihoods such as eco-tourism and small-scale selective fishing in the use of coastal marine resources.

5.6.3 Policy Recommendations and Strategic Plans for Fishery Resource Enhancement in the Southeast Asian Region

Considering that most of the fishery resources in the Southeast Asian waters are already in various levels of decline mainly due to illegal and unregulated fishing activities, and in an effort to address the concerns on resource degradation, SEAFDEC with funding support from the Japanese Trust Fund (JTF), carried out a five-year program “Promotion of Sustainable Aquaculture and Resource Enhancement in Southeast Asia” in 2010. Implemented in the Southeast Asian countries, the program was conceptualized based on two approaches, namely: improvement of critical habitats and nursing grounds of fishery resources; and direct enhancement of fishery resources through artificial propagation techniques. The project “Rehabilitation of Fisheries Resources and Habitats/Fishing Grounds through Resources Enhancement” was implemented by the SEAFDEC/TD to serve as immediate response to the concerns on the deteriorating coastal and inland ecosystems, and preventing further loss of habitats and eventual damage to the aquatic organisms. Simultaneously, the Philippine-based SEAFDEC/AQD carried out the project “Resource Enhancement of Internationally Threatened and Over-exploited Species in Southeast Asia through Stock Release” including the establishment of strategies of stock enhancement through sustainable, responsible, and environment-friendly approaches.

In order to identify the appropriate resource enhancement strategies that could serve as guide for the countries in the region in their efforts towards rehabilitating their respective fishery resources, SEAFDEC with support from the JTF organized the “Symposium on Strategy for Fisheries Resources Enhancement in the Southeast Asian Region” in Thailand on July 2015. Organized with two-pronged themes, namely: Fishery Resources Enhancement through Habitat Improvement and Management; and Fishery Resources Enhancement through Artificial Propagation and Stock Release, the Symposium compiled, consolidated, and exchanged necessary information and technologies based on the countries’ initiatives to enhance the fishery resources that might have already been degraded and destroyed due to illegal and unregulated fishing practices (Kawamura, *et al.*, 2016).

5.6.4 Way Forward

The Policy Recommendations and Strategic Plans for Fisheries Resources Enhancement in the Southeast Asian Region adopted during the July 2015 Symposium on Strategy for Fisheries Resources Enhancement in the Southeast Asian Region (*Appendix I*), were used as

basis for the development of activities under the project “Rehabilitation of Fisheries Resources and Habitat/Fishing Grounds for Resources Enhancement in Southeast Asia” from 2015 to 2019 supported by the JTF. The Project intends to identify the appropriate resource enhancement tools appropriate for the region as well as habitat conservation measures based on analysis and diagnosis of the effectiveness of the measures, and formulate strategies and guidelines for implementation in the Southeast Asian region. Capacity building on fisheries resource enhancement and habitat conservation measures would also be promoted in the AMSs. The Project also aims to strengthen the collaboration and cooperation among the SEAFDEC Member Countries for the promotion of sustainable fisheries resources enhancement in the Southeast Asian region to ensure the sustainability of such measures.

5.7 Challenges and Future Direction

Scientific evidences have demonstrated that several important fish stocks are already fully exploited and even over-exploited, and there are emerging requirements at the global level and from major importing countries for exporting countries including those in the Southeast Asian region to demonstrate that their fish and fishery products are derived from responsible practices. Therefore, measures assuring that fishing practices would not result in negative impacts to the ability of fishery resources to provide long-term contribution to food security need to be established and adopted.

It is well recognized that the availability of scientific information is crucial for sustainable management of fisheries, although the nature of fisheries in Southeast Asia which target multi-species of catch and the large number of small-scale fishers involved in the activities, make it difficult to obtain accurate information on fish catch. Consequently, improvement of data collection at national levels as well as for the regional compilation should be enhanced in order to come up with better picture of the status and trends of fisheries, as such available data and information could be used as basis for sustainable management of the fisheries. Development of appropriate indicators such as Catch Per Unit of Effort (CPUE), and management systems such as Total Allowable Catch (TAC) or Total Allowable Efforts (TAE) and their applicability to fisheries in the Southeast Asian region should also be explored. Promotion of other management approaches that are applicable for the Southeast Asian setting, especially the nature of the region’s fisheries, particularly co-management and ecosystem approach to fisheries management, should be enhanced to boost the understanding and capacity of relevant officers of the AMSs on such management approaches.

While the Code of Conduct for Responsible Fisheries (CCRF) has been promoted as a global policy framework for sustainable and responsible fisheries management with the regionalized version being promoted in the Southeast Asian region through SEAFDEC efforts, international requirements emerged, particularly on the need to combat IUU fishing. Under the framework of the CCRF, the International Plan of Action to Prevent, Deter and Eliminate IUU Fishing was developed, with measures being delineated for coastal States, flag States, and port States to combat IUU fishing practices that undermine all efforts undertaken towards the sustainability of fisheries. Recently, more pressures from international and regional markets exacerbate the adoption of market-related measures by the Southeast Asian countries. These include several schemes for traceability of fish and fishery products including those issued by the private sector and groups of buyers. In 2010, the European Community started to put into force EC Regulation 1005/2008 requiring all fish and fishery products to be accompanied by a catch certificate in order to allow their entry into the Community. The U.S. also issued in 2015 the U.S. Presidential Task Force on Combating IUU Fishing and Seafood Fraud, and subsequently the new U.S. seafood traceability program to ensure that global seafood resources are sustainably managed and not fraudulently marketed.

In order to address such situation and the emerging requirements, the Southeast Asian region developed regional approaches to enhance the sustainable management of fisheries. The ASEAN Guidelines on Preventing the Entry of Fish and Fishery Products from IUU Fishing Activities into the Supply Chain was developed and adopted by the AMSs through the AMAF Meeting in 2015, as a regional framework for combating IUU fishing. The ASEAN Guidelines would be supported by several tools developed at the regional level including the Regional Fishing Vessels Record or RFVR, the ASEAN Catch Documentation Scheme or ACDS, and the RPOA for Management of Fishing Capacity or RPOA-Capacity, among others. Future challenges that lay ahead would be addressed by strengthening the momentum of the aforementioned initiatives and enhancing the capacity of the countries in the implementation of such regional collaborative frameworks.

In 2016, the AMSs adopted the Joint ASEAN-SEAFDEC Declaration on Regional Cooperation for Combating IUU Fishing and Enhancing the Competitiveness of ASEAN Fish and Fishery Products. While it is encouraged that the Joint Declaration be implemented by the AMSs with support from donors and collaborating agencies, it is also necessary that collaboration between and among the AMSs need to be strengthened, *e.g.* through bi-lateral and multi-lateral cooperation. Important issues also arose

during latest regional discussions including the possible development of the ASEAN Common Fisheries Policy. However, at this moment it is still unclear to what extent such common policy would focus and cover. Further discussion on this issue is therefore another important challenge that would pave the way towards the future of fisheries in the Southeast Asian region in the years to come.

6. AQUACULTURE DEVELOPMENT

6.1 Control and Prevention of Present and Emerging Transboundary Aquatic Animal Diseases

Shrimp aquaculture is a lucrative industry responsible for generating billions of US dollars in export income annually. In Southeast Asia, *Penaeus monodon* and *P. vannamei* are the major cultivated species with the latter species currently dominating the Asian and world market. Preceding 2000s, *P. monodon* was the dominant cultivated shrimp species in Asia. However, the scenario fairly changed around that year with the widespread adoption of domesticated and specific pathogen free (SPF) *P. vannamei*, which since then has become the principal choice for shrimp growers chiefly due to its success in avoiding problems concomitant to white spot disease outbreaks.

The intensification of shrimp cultivation in Southeast Asia to increase production has been impeded by pervasive episodes of epidemic diseases, which were inflicted not only by the white spot syndrome virus (WSSV) but also by other pathogenic shrimp viruses such as the yellow head virus (YHV), Taura syndrome virus (TSV), and infectious hypodermal and hematopoietic necrosis virus (IHHNV) among others (Flegel, 2012). Unwarranted occurrences of these viral diseases in cultivated shrimps have led to serious economic losses of about US\$ 15 billion over the past 15 years, with approximately 80% of the losses occurring in Asia (FAO, 2014b). Irresponsible transfer of live shrimps, particularly the farmed stocks, allegedly carrying the pathogens, is the main culprit responsible for the rapid and widespread occurrences of disease outbreaks in hatcheries and grow-out ponds.

Since 2009, the emergence of a new disease, currently termed acute hepatopancreatic necrosis disease (AHPND), has stirred financial havocs among major shrimp producing countries in Southeast Asia, especially in Viet Nam, Malaysia, Thailand, and the Philippines. Aside from AHPND, farmers have been faced with urgent pressures ascribed to the emergence of newly emerging diseases like the hepatopancreatic microsporidiosis (HPM) and the covert mortality disease (CMD), among others (Thimatadee *et al.*, 2016).