organizations, *e.g.* the Australian Center for International Agricultural Research (ACIAR) and Mekong River Commission (MRC), had been extended to the country for the sustainable development of its water infrastructures that include maintaining upstream and downstream fish passage, improving understanding of the technologies that facilitate fish migrations onto and from floodplains, and enhancing the country's capability to apply low-head fish passage technologies at various levels and improve biodiversity in the floodplains.

In other Southeast Asian countries, a number of cross-river obstacles have been constructed for several purposes, *e.g.* hydropower generation, irrigation, domestic water supply, flood control, among others. Although most of these obstacles have low-water head (*e.g.* less than 7 m) but the accumulated impacts of such construction particularly to the upstream-downstream migration of fish could also be enormous. During 2015-2017, SEAFDEC with support from ACIAR undertakes a project to design and construct experimental fishway facilities in an easily accessible site to facilitate on-station research where different parameters could be controlled and experimented, focusing on vertical-slot design and targeting at low-head weirs. In addition, public awareness and understanding have been enhanced through on-station demonstrations on the use of fishway to mitigate the impacts of cross-river construction on the inland fishery resources.

To encourage future application of fishways, investigation should be made to evaluate and enhance their effectiveness. Furthermore, methodologies for analyzing the cost-benefit analysis of fishways should also be developed considering the costs of construction, operation, and maintenance of the facilities; expected increased incomes from harvests of the fishery resources; benefits to human health; as well as other ecosystem services that could be rendered from the improved connectivity of habitats through the fishways.

2.2.4 Mitigating the Impacts of Freshwater Aquaculture

The rapidly increasing freshwater aquaculture activities could negatively affect the inland capture fisheries and freshwater environment. Freshwater aquaculture in the Southeast Asian region often uses floating cages in natural water bodies and seedstocks are fed intensively. In some areas, it is possible that introduced species escape from cages or culture ponds into the natural environment expelling the native species, including economically important species and endemic species. Seedstocks that are introduced from different water bodies could also bring with them unknown diseases that are passed into the natural environment. Excessive feeding of cultured fish results in the eutrophication of water bodies and degradation of water quality leading to degraded aquatic resources as a consequence. Competition for the use of waters and areas could also happen between inland fishers and fish farmers (FAO and MSU, 2016). The development of freshwater aquaculture should therefore be promoted in accordance with the carrying capacity of inland water bodies and should take into consideration the possible effects of such aquaculture operations on the water bodies, environment, and existing inland capture fisheries.

3. MARINE SPECIES UNDER INTERNATIONAL CONCERN

3.1 Sharks and Rays

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) promotes the conservation and protection of endangered species of sharks, skates, and rays (elasmobranches) to ensure that their international trade does not threaten the survival of the species in the wild. Meanwhile, FAO promoted the International Plan of Action for Conservation and Management of Sharks (IPOA-Sharks) which was adopted during the Meeting of the FAO Committee on Fisheries (COFI) in 1999. The IPOA-Sharks also intends to provide a framework for the development of national, sub-regional, and regional plans as well as assessments of sharks in the member countries' respective waters and also for transboundary species of sharks.

The Southeast Asian region has rich biodiversity of elasmobranch species. It has been recorded that at least 180 species of sharks, 30 species of skates, and 160 species of rays inhabit the Southeast Asian region from freshwater environments to the deep seas (SEAFDEC, 2016g). The AMSs developed and implemented their respective National Plans of Action for Sharks (NPOA-Sharks) subsequent to that of the IPOA-Sharks published in 1998, by updating the status of the resources, biodiversity, socio-economic aspects as well as information related to trade. Records also show that in the Southeast Asian region, almost all parts of sharks and rays including their meat, skin, liver as well as cartilages, are fully utilized.

In Southeast Asia, sharks and other elasmobranchs are by-catch of hook-and-line, gillnet, trawl net, purse seine net, and other fishing gears. Even though the Southeast Asian waters have one of the richest elasmobranch diversity of the world, the status of production and utilization of sharks and other elasmobranchs is still largely underdetermined due to insufficient data including information on catch and landings at identified species level. Moreover, information on trade as well as on the biological parameters of many shark species are also difficult to establish due to the limited capacity in collecting fishery data of most countries in Southeast Asia. Nevertheless, SEAFDEC reported that the total landing of sharks and rays of the AMSs in

Table 58. Production of sharks of the Southeast Asian countries from 2008 to 2014 by quantity (metric tons)

	2008	2009	2010	2011	2012	2013	2014
Brunei Darussalam	29	15	19	N/A	N/A	6	N/A
Indonesia	125,336	40,960	49,651	59,403	45,651	56,720	57,521
Malaysia	7,346	7,236	6,793	14,735	6,536	7,833	8,004
Philippines	2,380	2,635	2,798	2,556	2,300	2,129	1,955
Singapore	17	20	10	29	24	24	59
Thailand	2,834	2,826	2,936	2,574	2,338	2,064	2,308
Total	**137,942**	**59,392**	**62,207**	**79,297**	**56,849**	**68,776**	**69,847**

Source: *SEAFDEC (2010b; 2011; 2012a; 2013; 2014; 2015a; 2016a)*

Table 59. Production of rays of the Southeast Asian countries from 2008 to 2014 by quantity (metric tons)

	2008	2009	2010	2011	2012	2013	2014
Brunei Darussalam	69	56	63	N/A	N/A	47	N/A
Indonesia	113,012	44,660	44,478	45,084	56,403	56,067	61,953
Malaysia	11,642	15,031	13,770	13,021	15,612	15,774	17,275
Philippines	2,370	2,591	2,713	2,501	2,276	2,163	1,918
Singapore	117	143	105	112	115	93	77
Thailand	6,245	6,219	6,089	5,646	4,296	4,195	4,445
Total	**133,455**	**68,700**	**67,218**	**66,365**	**78,702**	**78,339**	**85,668**

Source: *SEAFDEC (2010b; 2011; 2012a; 2013; 2014; 2015a; 2016a)*

2014 was approximately 69,847 and 85,668 metric tons, respectively (SEAFDEC, 2014), showing a decrease in harvest of sharks and rays in Southeast Asia of about 49.36% and 35.81%, respectively over a seven-year period. Information on the production trends of major species of sharks and rays in the AMSs as reported in the Fishery Statistical Bulletin of Southeast Asia (SEAFDEC, 2010b; 2011; 2012a; 2013; 2014; 2015a; 2016a) are shown in **Table 58** and **Table 59**, respectively.

Information on the trends of marketing and trade as well as competitiveness of sharks and rays at national and regional levels in the Southeast Asian region compared to its trade partners in the world are very important to provide an indication of the extent of commercialization activities of these commodities. Profiling the middlemen, their marketing activities, and practices are therefore crucial to determine the economic roles of each type of middlemen along the supply chain and the value creation on the products. Information on various factors could also provide the indicators of the commodification and marketization of sharks and rays at national and regional level, *i.e.* the major players, value-adding activities, roles of prices on the supply and demand of shark and ray products, and consumer preferences. Moreover, such information could also provide valuable inputs towards designing a sustainable development plan for conservation of sharks and rays from all angles, *i.e.* production, supply, demand, marketing, and resource management.

Meanwhile, during 2013-2016, nine species of sharks and 12 species of rays were listed in Appendix II of CITES, and trading of aquatic species listed under Appendix II of CITES is regulated. Moreover, during the Sixteenth Conference of Parties CITES (CoP16-CITES) in 2013, five species of sharks and all three species of manta rays were also listed in Appendix II. These included the oceanic whitetip shark (*Carcharhinus longimanus*), porbeagle shark (*Lamna nasus*), scalloped hammerhead shark (*Sphyrna lewini*), smooth hammerhead shark (*Sphyrna zygaena*), great hammer-head shark (*Sphyrna mokkaran*), giant manta ray (*Manta birostris*), Alfredi manta ray (*Manta alfredi*), and new species of giant manta (*Manta birostris*). Three years later, during the CoP17-CITES, another four species of sharks and all nine species of mobula rays were listed in Appendix II of CITES, these are the silky sharks (*Carcharhinus falciformis*), thresher sharks (*Alopias pelagicus*, *A. superciliosus*, *A. vulpinus*), and all nine species of devil rays (*Mobula* spp.). In the subsequent CITES-CoP17 in 2016, various issues and concerns on the listing of various aquatic species (including sharks and rays) in the CITES Appendices had been noted and compiled (**Box 5**), which could be reflected in the common position of the AMSs to be raised during the subsequent CITES-CoP.

Based on studies by Ahmad and Lim (2012) and Ahmad *et al*. (2014), silky sharks, all hammerhead sharks, two manta ray species (*Manta birostris*, *M. alfedi*), all three species of thresher sharks and six species of mobula rays (*Mobula japanica*, *M. kuhlii*, *M. thurstoni*, *M. eregoodootenke*,

Box 5. Issues and concerns that could be reflected in the common position of the AMSs during CITES-CoP

a. Most Heads of Delegations of Party are largely from national terrestrial environmental departments, and thus, might have limited knowledge and interest in fisheries issues especially on their impacts to national socio-economies and livelihoods of local fishers
b. Very successful, well-funded NGO media and engagement campaign centering on the message that 'marine species need saving from extinction' as well as other kinds of campaigns, are held continuously and simultaneously during the CITES-CoP, while attractive posters, flyers, books, souvenirs, and the like, are widely distributed for free before the voting
c. Repeated narrative mostly from environmentalists and NGOs seem to indicate that National Fisheries Management and RFMOs are 'not working' and are 'largely ineffective' to conserve and manage sharks and rays resources
d. Most Heads of Delegations of Party believe that CITES is working, despite no clear mechanism or discussion for measuring its effectiveness or efficiency
e. Based on past experiences during CITES-CoP, especially with regards to commercially-exploited aquatic species, the Parties seemed to largely 'favor' and support all proposals to list sharks and rays in any Appendices of the CITES

M. tarapacana and *Mobula* spp.) inhabit the Southeast Asian waters. These species are mostly caught as by-catch either in purse seine and longline as well as in gillnet fisheries targeting the commercially-important bony fish species. Based on the data collected from August 2015 to July 2016, mobula rays and thresher sharks are among the common species caught in Indonesia, while *Sphyrna lewini* is caught in Myanmar and Malaysia (SEAFDEC, 2016g). Meanwhile, from the regional and national studies conducted by SEAFDEC and the AMSs from 2003 to 2016, there are 182 species of sharks, 148 species of batoids (including rays and skates), and 7 species of chimaeras found in the Southeast Asian region (**Table 60**).

Table 60. Number of species of sharks, batoids and chimaeras Southeast Asian countries

Country	Number of species		
	Sharks	Batoids	Chimaeras
Cambodia	11	54	0
Indonesia	117	106	4
Lao PDR	0	3	0
Malaysia	70	91	1
Myanmar	59	87	0
Philippines	94	66	3
Thailand	76	82	2
Viet Nam	52	54	0

3.1.1 Challenges and Future Direction

The AMSs should improve their national statistics by recording the landing of sharks, batoids and other elasmobranches at species level, as this constitute the major issues and challenges on sustainable utilization of elasmobranches in Southeast Asia. Furthermore, AMSs should enhance the understanding of stakeholders on the importance of sharks and rays in the region, establish fisheries management measures for conservation and management of sharks and rays, and compile and regularly update their respective information on harvests and utilization of sharks and rays.

Considering that Parties are largely in 'listing mood' especially for sharks and rays. a trend which is expected to continue in the coming CITES-CoP in 2019, the AMSs should strengthen their effort in compiling relevant information especially scientific data for preparation of the Non-detriment Findings (NDFs) for sharks and rays as required by CITES. Listing of economically important species under CITES Appendix II could affect the livelihoods of local fishers and traders, especially that some countries consider such species as protected under their national laws and regulations without scientific data. Furthermore, no legal trade and import of their products by CITES Parties would be permitted without an NDF. In this regard, data collection at species level must be continued in the Southeast Asian region for the development of NDFs for individual species.

The consequences of the listed species could affect and become a burden to the Scientific Authority and Management Authority of the AMSs due to lack of human resources and expertise in the identification of by-products which are available in many forms in the trade channels. In general, there are no specific catch or trade documentation schemes for sharks and rays in the Southeast Asian region, although general catch documentation systems exist in some countries to monitor the species composition of the shark fin trade. Such systems should be enhanced and sustained as the compiled information would provide insights into the trade. Established mechanisms adopted in the trade channels should be given more focus and that national and regional trade study should be carried out taking into consideration such mechanisms.

Consultations at regional level should be pursued to obtain better understanding on the relevant events that led to the listing of commercially-important species of sharks and rays in the CITES Appendices, and the lessons that could be gained from these events, to ensure that similar concerns would not be repeated in the future and that real gains are achieved. More efforts at national and regional levels are needed, *e.g.* capacity development, species identification, and development of guidelines on NDFs, especially for the Southeast Asian region. In this regard, SEAFDEC would come up with the 'Regional Guidelines' for conducting NDFs based on locally available data and current fisheries issues.