Addressing the Issues and Concerns on Anguillid Eel Fisheries in Southeast Asia

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The SEAFDEC Inland Fishery Resources Development and Management Department (SEAFDEC/IFRDMD) has been mandated to "*monitor the state of exploitation and utilization of inland fishery resources and to come up with scientific basis for the sustainable development and management of such resources*." After its establishment in 2014, SEAFDEC/IFRDMD was tasked to address one of the concerns that need immediate attention, *i.e.* the conservation and management of the tropical Anguillid eels considering that this resource could be proposed for listing in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and as such, could impact on the fisheries of this economically important species of the Southeast Asian region. It was therefore deemed necessary for SEAFDEC/IFRDMD to initiate a compilation of the available data and information on the biology, population status, use, and trade of these species, which had been carried out through the "Regional Study on Tropical Anguillid eels in Southeast Asia" with the collaboration of concerned ASEAN Member States (AMSs). With funding support from the Japan-ASEAN Integration Fund (JAIF) for three-year period from 2017 to 2018 and the Japanese Trust Fund (JTF) from 2015 to 2018, the regional study is specifically aimed at understanding the status and trends of tropical Anguillid eel fisheries as well as information on trade and management policies in the Southeast Asian region, for the conservation and sustainable utilization of the resource.

Current Status of the Tropical Anguillid Eels

Reports have indicated that a total of 19 freshwater eel species/subspecies (16 species, two subspecies and one new species discovered in 2009) are known to exist worldwide, especially in the Pacific, Atlantic, and Indian Oceans, and of these 19 eel species, eight species/subspecies are known as the Southeast Asian Anguillid eels that inhabit the Southeast Asian waters, especially in the waters of Indonesia (Arai *et al*., 1999). Among the eight tropical Anguillid eels distributed in Southeast Asia, the most economically important species/subspecies are the Indonesian shortfin eel (*Anguilla bicolor bicolor* and *A. bicolor pacifica*) and giant mottled eel (*A. marmorata*). The common names and scientific names of the eel species found worldwide are shown in **Table 1**.

As part of the regional study, data collection was done in the AMSs where tropical Anguillid eel fisheries are practiced, *e.g.* in Cambodia, Indonesia, Myanmar, Philippines, Thailand, and Viet Nam (**Figure 1**), by interviewing the eel consolidators, fishers, farmers and local officers, as well as recording the statistics from country reports. The results had been shared with relevant stakeholders during the International Technical Workshop on Tropical Anguillid Eels in Southeast Asia in June 2018 in Bangkok, Thailand.

Table 1. Eel species known to inhabit the Pacific, Atlantic, and Indian Oceans

Common name	Scientific name	Tropical eel	Southeast Asian eel
European eel	*Anguilla anguilla*		
Southern shortfin eel	*A. australis australis*		
Southern shortfin eel	*A. australis schmidtii*		
Indian mottled eel	*A. bengalensis bengalensis*	*	*
African mottled eel	*A. bengalensis labiata*		
Indonesian shortfin eel	*A. bicolor bicolor*	*	*
Indonesian shortfin eel	*A. bicolor pacifica*	*	*
Indonesian longfin eel	*A. borneensis*	*	*
Celebes longfin eel	*A. celebesensis*	*	*
New Zealand longfin eel	*A. dieffenbachi*		
Highlands longfin eel	*A. interioris*	*	*
Japanese eel	*A. japonica*		
Luzon mottled eel	*A. luzonensis*	*	*
Giant mottled eel	*A. marmorata*	*	*
Pacific longfin eel	*A. megastoma*	*	
African longfin eel	*A. mossambica*	*	
Pacific shortfin eel	*A. obscura*	*	
Speckled longfin eel	*A. reinhardti*	*	
American eel	*A. rostrata*		

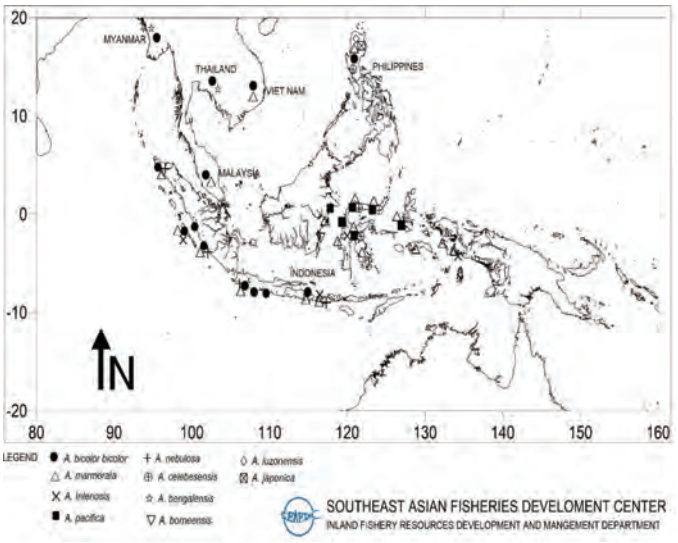


Figure 1. Geographical distribution of *Anguilla* spp. in Southeast Asia

Anguillid Eel Fisheries in Southeast Asia

In establishing a regional cooperation for exchange of information on Anguillid eels in the region, data on eel capture fisheries and eel farming in Southeast Asia were also compiled as these information would lead to the immediate actions that need to be tackled in the future (Honda *et al*., 2016a). However, this led to another concern on the reliance of eel farming on wild-caught eel seeds such as glass eels, elvers and yellow eels that are used for eel aquaculture (Crook and Nakamura, 2013). Since eel seeds are also natural resources, overfishing could occur leading to the decrease and collapse of eel resources (Honda *et al*., 2016b). Information on the catch of glass eels and yellow eels as well as catch effort were therefore compiled and used to analyze the trend of the tropical Anguillid eel resources. Such information was established by collecting production data on catch and aquaculture directly from eel consolidators and eel farmers. Information on the catch and aquaculture of tropical Anguillid eels in Cambodia, Indonesia, Myanmar, Philippines, Thailand, and Viet Nam, is shown in **Figure 2**.

- ***Cambodia***

There is no capture fishery that exploits tropical Anguillid eels in Cambodia, although the culture of elvers of *A. marmorata* (70%) and *A. bicolor pacifica* (30%) had been reported, using seeds imported from the Philippines (1.0 metric tons (mt) in 2017). Nevertheless, the fishers also reported that they can catch Anguillid eels from the wild oftentimes by using crab traps set at night in rivers and hauling the traps the next morning. Moreover, fishers also use hooks to catch eel species in the shallow waters of the rivers. This fishing operation usually takes the whole day during low tide and sometimes, long line is used in the rivers during the whole day, but the main target is not only eel species.

- ***Indonesia***

Capture fishing operations as well as farming of tropical Anguillid eels are more active in Indonesia than in other Southeast Asian countries. There are four main fishing areas for eels in Indonesia, *i.e.* in Palabuhan Ratu Sub-district, Manado District, Poso District, and Cilacap District. Glass eels, elvers, and yellow eels of *A. bicolor* or *A. marmorata* are caught from these areas. In Palabuhan Ratu Sub-district, glass eels are mainly caught between September and December uisng scoop net. While in Cilacap District, elvers and yellow eels are mainly caught by scoop net or PVC trap from October to November. Glass eels, elvers, and yellow eels in Poso District are mainly caught using fyke net or barrier trap from July to August. In Manado District, glass eels are caught by scoop net but the peak fishing season is still unknown. Annual catches in these areas had remained at around 10.0 mt of glass eels for the recent years, and less than 80.0 mt for elvers and yellow eels. The country's production from farming of

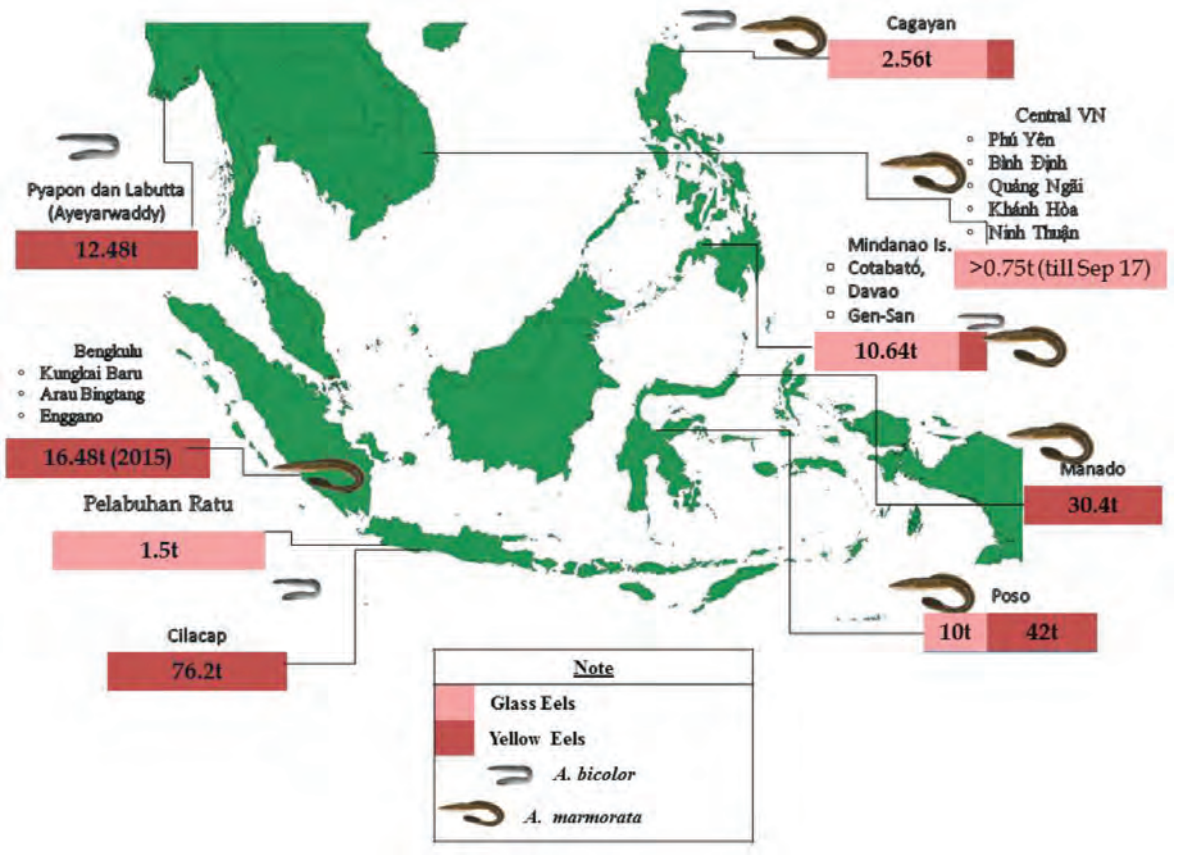


Figure 2. The total production from capture fisheries of glass eels and yellow eels (*Anguilla bicolor* and *A. marmorata*) in Southeast Asia

A. marmorata and *A. bicolor* is usually exported to China, Korea, Japan, Taiwan, and other countries.

- ***Myanmar***

There are no specific fishing operations in Myanmar that target the Anguillid eels. Yellow eels of *A. bicolor* (90%) and *A. bengalensis* (10%) are accidentally caught by stow net, crab trap, or longline hook during the rainy season. *Anguilla bicolor* is the main species farmed in Myanmar, by only one fish farmer, producing about 15.0 mt in 2017, all of which was exported to China.

- ***Philippines***

Anguilla marmorata is the main species of glass eels and elver/yellow eels caught in Luzon and Mindanao Islands of the Philippines. Glass eels are mainly caught by fyke net, stow net, scoop net, or push net between April and August. The country's annual catch of glass eels fluctuated yearly since 2007, where the catch from Luzon in 2007 was about 2.0 mt and 10.0 mt from Mindanao. The fishing gears for elver/yellow eels are seine net, bamboo trap, hook line, and spear gun. The main fishing season for elver/yellow eels is between December and February, and the annual catch from both islands in 2017 was about 0.3 mt. There are 28 fish farmers culturing the Anguillid eels in the Philippines. Production volume of farmed *A. marmorata* and *A. bicolor* in Mindanao is about 100.0 mt based on local official data in 2017, and about 20.0 mt in Luzon. *Anguilla bicolor* is exported to Japan, Korea and Taiwan; while *A. marmorata* is bound for Korea, China and Taiwan.

- ***Thailand***

Elvers and yellow eels of *A. marmorata* and *A. bicolor bengalensis* are caught by trap as by-catch in Ranong Province, Satun Province, and Phangnga Province between May and October. Glass eels imported from China, and elvers and yellow eels from Indonesia are farmed in several provinces of Thailand, the production of which is exported to China.

- ***Viet Nam***

Glass eels of *Anguilla marmorata* (95%) and *A. bicolor pacifica* (5%) are mainly caught in Ky Lo River, Phu Yen Province although there are also few catches in Bin Dinh Province, Auar Ngai Province, Khan Hoa Province, and Nah Tuan Province. The main fishing gears for glass eels are FADs (Fish Aggregating Devices) and scoop net, and the fishing season peaks from November to May in Phu Yen Province. The average annual catch of glass eels was recorded at 0.60-0.75 mt (or 4,000,000-5,000,000 tails). Information on catch of elvers and yellow eels is still being compiled from the survey. Several farmers are culturing eels in Phu Yen Province and Khan Hoa Province. One of the largest eel farms in Khan Hoa Province produces 200,000-300,000 tails of elvers and yellow eels. Meanwhile, information on the import and export of Anguillid eels by the country is still being compiled from the survey.

Types of Fishing Gears Used to Capture Anguillid Eels

In the Southeast Asian region, there are many types of fishing gears used to catch Anguillid eels, depending on the location, as shown in the **Table 2**.

Utilization of Anguillid Eels

Anguillid eels are utilized in many ways in Southeast Asia, however, the high diversity of tropical fishes in the region and the perception that Anguillid eels look like snake, many people in the region prefer to eat other fishes, except in Viet Nam, which uses 50% of its Anguillid eel production for domestic consumption. There are three components and steps in the commodity chain of glass eels in Southeast Asia, *e.g.* fishers, consolidators and shippers. Fishers catch glass eels then send them to consolidators, who after collecting the glass eels from fishers, send these to the shippers. Finally, the shippers send the glass eels to the eel farms, both domestic and overseas, and also to the market. Some consolidators also simultaneously play the role of shippers.

Table 2. Eel fishing gears in the Southeast Asian countries

Country	Fishing gear	Target size	Specification/Information
Indonesia	PVC pipe trap 	Elvers and yellow eels	• Set in rivers, tributaries, irrigation canals, swamp areas, at 5 PM and hauled at 5 AM. • Made of PVC pipe with additional net in the bottom part • Snails put in small bag net are used as bait
	Stow net 	Yellow eels	• Set in irrigation canals and small rivers during rainy season (especially during floods or when water current is strong), hauled every 30 minutes but operation is completed when the catch starts to decline • The frame is made of bamboo with 10 m net attached at the back side

Table 2. Eel fishing gears in the Southeast Asian countries (Cont'd)

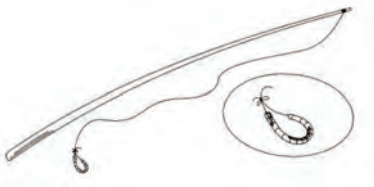
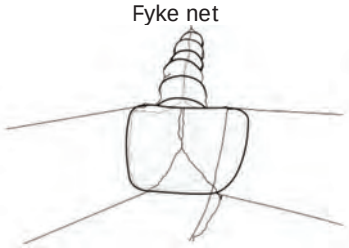
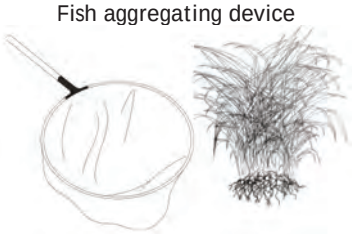
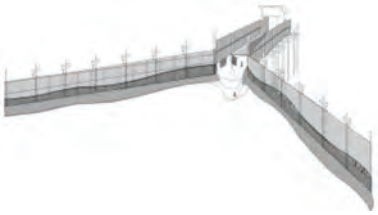
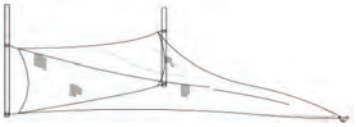
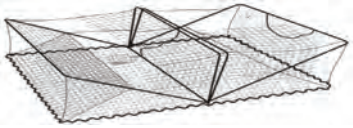
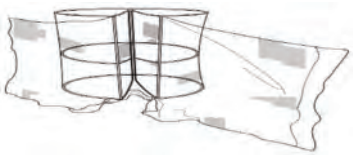
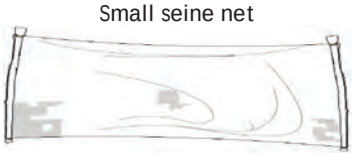
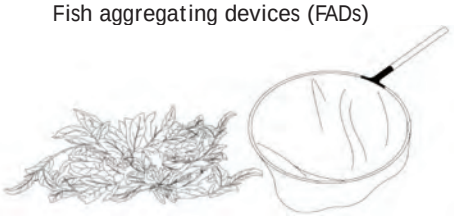
Country	Fishing gear	Target size	Specification/Information
Indonesia	Stick and line 	Yellow eels	• Set in rivers, tributaries and canals, operated at night, especially during new moon from 9 PM until 2 AM • Wooden stick and a line are used to catch yellow eels • Big earthworms are used as the bait
	Triangle scoop net 	Glass eels and elvers	• Set in mouth of rivers and downstream of dams • Glass eel catch activity operates from 9 PM until 2 AM, while the elvers catch operates from 8 PM until abundance declines. • Made of wooden sticks and small mesh-size net.
	Fyke net 	Glass eels and elvers	• Set in mouths of rivers and downstream of dams, at 8 PM and hauled from 2 AM until 5 AM • The frame is made of iron and covered with small mesh-size net; a wing, 2 m in length is attached to each side; diameter of net is 1.5 m and length is 10 m
	Fish aggregating device 	Elvers	• Set in shallow waters of irrigation weirs, and operated from 8 PM until 12 PM during rainy season • Small scoop nets are used to scoop the elvers hiding under grasses
	Barrier trap 	Yellow eels	• A traditional fishing gear set in the middle of rivers, operated only 2 days per month, set at night, and hauled at 6 AM • Made from pieces of bamboo formed into a barrier with additional bag net at the center of the trap
Myanmar	Crab trap 	Yellow eels	• Set in rivers at night and hauled in the next morning • The main target is crab, but eels are also often caught
	Stow net 	Yellow eels	• At sides of rivers, set the whole day and hauled 4 times a day • The main target species is shrimps, but eels are also often caught
Philippines	Fyke net 	Glass eels	• Set in middle sides of rivers at 5 PM and hauled at 3 AM. • The frame is made of circled iron and covered with small mesh-size net • The net is 6 m in diameter and 30 m in length, and a 12 m wing is attached on each side

Table 2. Eel fishing gears in the Southeast Asian countries (Cont'd)

Country	Fishing gear	Target size	Specification/Information
Philippines	Fence net 	Glass eels	• Set at sides of rivers for the whole day and hauled 4 times a day • Made of small mesh-size net and two wings with wooden stick to keep the wings and the mouth standing
	Scoop net 	Glass eels	• Set in mouth of rivers and operated during the night for 3 hours, like that of Indonesia, this gear also has a triangle shape • Made of wooden sticks and covered with a small mesh-size net
Thailand	Crab trap 	Yellow eels	• Set in rivers and mangrove areas at night and hauled the next morning • The main target is crab, but eels are oftentimes caught accidentally
Viet Nam	Fence net 	Glass eels	• Set in rivers and operated from 5 PM until 10 PM • The frame is made of circled iron with a diameter of 50 cm and has a small mouth at the center • The net has a wing of 1.5 m on each side
	Scoop net 	Glass eels	• Set in mouth of rivers and downstream of dams from 6 PM until 2 AM. • Similar in Indonesia and Philippines, the shape of scoop net is triangle • The net is made of wooden sticks and covered with a small mesh-size net
	Small seine net 	Glass eels	• Set in downstream of dams, from 6 PM until 2 AM • Made of two wooden sticks and a small mesh-size net, operated by two fishers
	Fish aggregating devices (FADs) 	Glass eels	• Set in downstream of dams, operated two times per day (from 3 PM until 5PM, and from 5 AM until 8 AM) • Made from branches of trees (Ky Lo River) and grasses (Ba River) • Small scoop net is used to scoop the glass eels hiding under the FADs

Farmers in Indonesia, Philippines, and Myanmar use locally collected seeds for growing eels in their domestic eel farms. While Cambodia imports seeds (> 15 cm and 150 g) from the Philippines and Indonesia, respectively, but the country's Anguillid eel market is not as popular as with the other countries. There is only one eel farm established in Cambodia as of May 2016 which produces 700 kg (since 2017) and supports a local Korean Restaurant. Indonesia, the leading country in Southeast Asia that produces Anguillid eel products such as roasted eel (kabayaki) and crispy roll, exports its products to Japan.

Furthermore, Indonesia also exports live eels to East Asia. In the Philippines, where the dominant cultured species is *A. marmorata*, the country's eel farms send the live eels to other East Asian countries except Japan which prefers *A. japonica* and *A. bicolor.* Frozen eels (*Anguilla* spp.) are traded from the AMSs except Brunei Darussalam.

Trade of Anguillid Eels

In Indonesia, the data on live eels bound for the international export in terms of quantity particularly in 2012-2014 was higher than that of the previous years and the year after due to the high demand of live eels from the East Asian countries. Similar increasing trends were also noted in the Philippine export data and those of Thailand's. On the overall, the export data from Southeast Asia indicated that three countries have been ranked as top exporters of live eels (*Anguilla* spp.), namely: Philippines, Myanmar and Indonesia.

In 2016, the total quantity of eel products, *i.e.* live and frozen eels exported by six AMSs was about 27,220 mt with trade value at US$ 82.94 million. Philippines provided the largest export quantity of live eels at 8,423 mt valued at US$ 30.18 million, followed by Myanmar at 7,242 mt, and Indonesia at 3,593 mt. However, comparing only the export of frozen eel, Indonesia exported the highest quantity at 6,152 mt valued at US$ 15.31 million. Furthermore, trading of eels in Singapore and Malaysia was active during the past three decades, but became inactive during the last decade when the export of live eels (*Anguilla* spp.) was less than 1.0 mt for Malaysia, and no export from Singapore since 2008.

Recommendations and Way Forward

In 2017, the estimated production from capture fisheries of both glass eels and yellow eels (or young eels) for *Anguilla bicolor* (including *A. bicolor bicolor*, *A. bicolor pacifica*) and *A. marmorata*, compiled from the baseline survey, indicated that Indonesia is the largest fishing country of eels in Southeast Asia. Taking into account the project objective which is to understand the actual status of capture fisheries by annual basis, therefore, all harvest data particularly those from Indonesia which is the largest eel producing country should be covered in the next phase of the study.

Furthermore, considering that the geographic distribution of *Anguilla bicolor* in Southeast Asia indicates many locations where the *A. bicolor* is found, such information should be verified and the actual status assessed. However, since the Anguillid eel resources are very dynamic, the status should be evaluated every year to also take into consideration the utilization potentials of the eel resources.

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