CONVENTION ON INTERNATIONAL TRADE IN ENDANGERED SPECIES
OF WILD FAUNA AND FLORA

Thirtieth meeting of the Animals Committee
Geneva (Switzerland), 16-21 July 2018

Species specific matters

STATUS AND RESOURCES MANAGEMENT OF TROPICAL ANGUILLID EELS IN SOUTHEAST ASIA

1. This document has been submitted by the Secretariat on behalf of the Southeast Asian Fisheries Development Center (SEAFDEC) in relation to item 18 of the agenda.*

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Information Document

Status and Resources Management of Tropical Anguillid Eels in Southeast Asia

Southeast Asian Fisheries Development Center
June 2018

Preface

The ASEAN Member States (AMSs) have their own national fishery management programs for the management and conservation of aquatic resources. With this in mind, The 7 countries namely Cambodia, Indonesia, Malaysia, Myanmar, Philippines, Thailand and Viet Nam are range states for tropical anguillid eels agreed to work together under the vision of developing the effective management practices for sustainable use and conservation of anguillid eel resources. Since 2015, AMSs have established initiatives for the management and conservation of anguillid eels in the region, recognizing the importance of these transboundary-species. The initiatives include research, policy development, and identification of practices to strengthen management and conservation of anguillid eel resources across the areas of biology, genetics, fisheries and aquaculture, trade and utilization, and habitat conservation. The following document (Status and Resources Management of Tropical Anguillid Eels in Southeast Asia**)** provides information on describing current progress of the regional initiative for tropical anguillid eels in Southeast Asia.

Southeast Asian Fisheries Development Center

Contents

Status and Resources Management of Tropical Anguillid Eels in Southeast Asia

June 2018
Southeast Asian Fisheries Development Center

A. PROPOSAL

Other relevant information on conservation of and trade in Tropical Anguilla species

The 17th Conference of the Parties came to a decision (No.17.186-17.189 Eels *Anguilla* spp.)) directed to the CITES Secretariat that included: (a) facilitate the conduct of "a study compiling information on challenges and lessons learnt with regards to implementation of the Appendix II listing of European Eel (*Anguilla anguilla*) and its effectiveness"; (b) facilitate the conduct of study on non-CITES listed Anguilla species to: (i) document "trade levels and possible changes in trade patterns following the entry into force of the listing of the European Eel in CITES Appendix II in 2009; and (ii) compile "available data and information on the biology, population status, use and trade in each species," and identify "gaps in such data and information, based on the latest available data.."; (d) "organize, where appropriate, international technical workshops, inviting cooperation with and participation by relevant range States, trading countries, …. Such workshops should in particular cover the topics identified by the reports described in subparagraphs a) and b) of this Decision and could focus on challenges species to the various eel species, …"

Under this circumstance, the Southeast Asian Fisheries Development Center (SEAFDEC) as an inter-governmental organization "mandated to promote and facilitate concerted actions among its Member Countries to ensure the sustainability of fisheries and aquaculture in Southeast Asia," is implementing the regional study on the tropical anguillid eels in Southeast Asia in collaboration with the ASEAN Member States (AMSs).

Through the baseline and subsequent regular surveys, as well as the series of technical consultations and meetings organized as part of the activities of the regional study, information have been compiled on the exploitation through fisheries of anguillid eel resources either in the form of glass eels, or elvers, or yellow eels from the wild for aquaculture as well as eel processing for export or domestic uses. The results of this regional study will be shared with relevant stakeholders during the International Technical Workshop on Tropical Anguillid Eels in Southeast Asia in June 2018 in Bangkok, Thailand when concerned international organizations, NGOs, and officials from the SEAFDEC Member Countries have been invited.

It is expected that this document that provides the initial findings of the regional study on tropical anguillid eel in Southeast Asia could be reviewed by the 30th Animals Committee and used for further discussion that would draw recommendations for the promotion of sustainable anguillid eel fisheries and trade, for consideration at the next CITES CoP18.

B. PROPONENT

Southeast Asian Fisheries Development Center (SEAFDEC)

C. SUPPORTING PROJECT ACTIVITY

The project plan and activities:

1. Project Objective and Activities

❖ Project Objective

To support foundational capacity building, portfolio learning and targeted research on resources management scheme for sustainable fisheries and aquaculture of the tropical anguillid eel resources in the AMSs.

❖ Activities

- Statistical data surveys
- Survival rate surveys
- Formulation of resources management plans

2. Statistical Data Surveys

2.1 Baseline Survey

Output	Compilation of statistical data and information on eel fisheries, status on usage of eel resources, production from farming of tropical anguillid eels from the AMSs where anguillid eel fisheries are practiced
Survey period	August 2017- December 2018
Survey area	In AMSs where anguillid eel fisheries are practiced: Cambodia, Indonesia, Myanmar, Philippines, Thailand and Viet Nam.
Method	Interview of eel consolidators, fishers, and farmers

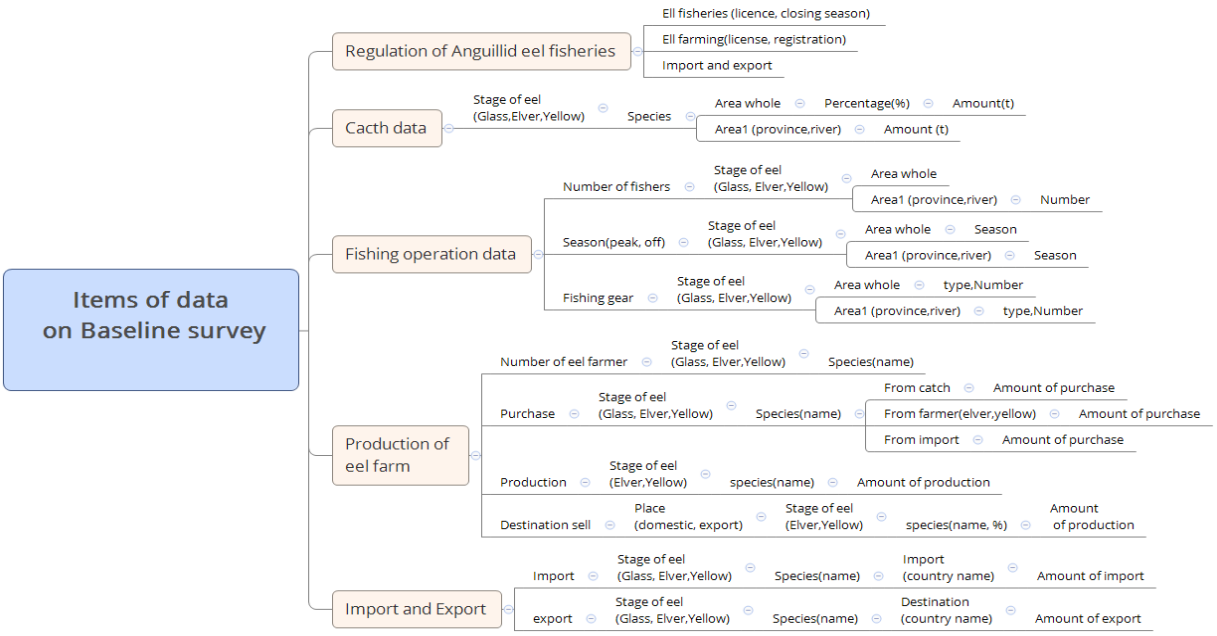

Figure 2.1A: Data collection process during baseline survey

2.2 Regular Survey

Output	Compilation of information on catch of glass eels and yellow eels as well as catch effort to analyze the trend of the tropical anguillid eel resources
Survey period	August 2017- July 2019
Survey area	Indonesia, Myanmar, Philippines and Vietnam.
Method	Collect production data on catch and aquaculture directly from eel consolidators and eel farmers
Data items	Catch quantity by eel species, stage of growth, area (river), aquaculture production by quantity, and amount of input to ponds by species, stages of growth

2.3 DNA Analysis

Output	Clarification of the population structure and genetic diversity among *Anguilla bicolor* populations in Southeast Asia
Survey period	April 2018- July 2019
Survey species and area	*A. bicolor bicolor*, *A. bicolor pacifica:* Indonesia, Myanmar, Philippines and Vietnam (the species of tropical anguillid eels were selected from the dominant and main target species in the Southeast Asia region)
Method	Describe and assess the level of the population genetic diversity based on samples of the tropical eels collected in study area, using standard molecular genetics techniques (mitochondrial DNA analysis)

2.4 Survival Rate Survey

Output	Improvement of aquaculture techniques for increased survival of eel juveniles under captive rearing conditions in eel farms
Survey period	August 2017- July 2019
Survey species and area	*A. bicolor bicolor*, *A. bicolor pacifica*, *A. marmorata* (species were selected considering that these are the most caught tropical eels that inhabit the Southeast Asian waters)
Method	Identify the factors that could reduce mortality in the culture process from glass eels to elvers through culture experiments; and collect information by interview survey of eel farmers on survival rates and the factors affecting survival
Dissemination of techniques	Develop a manual on aquaculture techniques and disseminate these technique to eel farmers in the Southeast Asian region

2.5 Resources Management

In general, the relevant AMSs will formulate their respective management plans for conservation and sustainable utilization of anguillid eel resources. At the regional level, SEAFDEC will work with the AMSs to formulate Regional Policy Recommendations and Measures covering both capture fisheries and aquaculture of the anguillid eels. The draft Regional Policy Recommendations and Measures will be submitted for consideration and adoption by the high-level authorities of the ASEAN Member States.

The project would also establish the system of collecting statistical data on the tropical anguillid eels for long-term implementation. In addition, to avoid and prevent illegal trade of

anguillid eels, the existing ASEAN Catch Documentation Scheme could be adapted for enhancing the traceability of anguillid eel fisheries in Southeast Asia.

3. Overview

Among the eight (8) species/subspecies of anguillid eels found in Southeast Asia, the most economically important species/subspecies are the Indonesian shortfin eel (*A. bicolor bicolor* and *A. bicolor pacifica*) and giant mottled eel (*A. marmorata*). Only a few studies are available for the population differentiation within the subspecies of *A. bicolor;* however, no population structure had been detected from previous morphological and genetic studies (Sugeha *et al*., 2009; Fahmi *et al*., 2015). For *A. marmorata*, notwithstanding its wide geographic distribution, no genetic difference was detected from previous morphological and genetic studies (Cheng *et al.*, 2012). Glass eels were recruited throughout the year (Arai *et al.*, 2001). Regarding the recruitment and catch per unit effort (CPUE) that are generally considered as an abundance index of the stock status, interannual fluctuation of the recruitment of tropical juvenile eels in Indonesia was reported (Arai *et al*., 1999). The CPUE of glass eel utilization in Sukabumi also fluctuated during 2014-2017, therefore, the anguillid eels fishery in this area is potentially for development but the utilization potential of eel resources should be based on the principle of "precautionary approach." Valdez and Castillo (2016) also reported that the CPUE calculated from the catch weight per hour in Pangi River, Philippines ranged from 0.075 g to 500 g. Although information on stock status of tropical eels is still scarce, the status of fisheries (capture and aquaculture) of the tropical anguillid eels in the AMSs could become clearer because of the SEAFDEC supporting program. While the management policy for conservation and promotion of sustainable utilization of anguillid eels endorsed by high level authorities of the ASEAN had been adopted since 2015, such regional policy and management measures might need to be revised taking into consideration the scientific findings from the regional study.

4. Current Status of the Tropical Anguillid Eels

4.1 Habitat and Biology

❖ Taxonomy of the Tropical Anguillid Eels

Southeast Asia is home to several tropical anguillid eel species (Arai *et al*., 1999). Among the total of 19 freshwater eel species/subspecies (16 species and 3 subspecies) that are known to exist worldwide (Pacific, Atlantic, and Indian Oceans; see Appendix 1 for the distribution maps), 13 species/subspecies are distributed in the Indo-Pacific region. Among these 13 tropical eels, eight species/subspecies inhabit Southeast Asia, especially in the Indonesian waters. The common names and scientific names of these eel species are shown below.

Kingdom	Phylum	Class	Order	Family
Animalia	Chordata	Actinopterygii	Anguilliformes	Anguillidae
Common name	Scientific name	Tropical eel	Southeast Asian eel	
European eel	*A. anguilla*			
Southern shortfin eel	*A. australis australis*			
Southern shortfin eel	*A. australis schmidtii*			
Indian mottled eel	*A. bengalensis bengalens*	*	*	

Kingdom	Phylum	Class	Order	Family
Animalia	Chordata	Actinopterygii	Anguilliformes	Anguillidae
Common name	Scientific name	Tropical eel	Southeast Asian eel	
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*			

Among the eight tropical anguillid eels distributed in Southeast Asia, the most economically important species/subspecies are the Indonesian shortfin eel (*A. bicolor bicolor* and *A. bicolor pacifica*) and giant mottled eel (*A. marmorata*). This information document therefore focuses on these three economically important species/subspecies.

❖ Definition of Each Stage (glass eel, elver, yellow eel and silver eel)

Figure 4.1A. shows that tropical anguillid eels follow a catadromous life cycle, meaning that they live in freshwater or brackish water most of their lives but matured adults mate and spawn in the open ocean. The leptocephalus (leaf-shaped larva of eel) is hatched from eggs and drift towards the continental shelf area with the oceanic currents where they metamorphose into streamlined glass eels. The glass eels grow and mature to silver eels via elvers followed by yellow eels in the rivers for several years until downstream spawning migration in the open ocean starts. The tropical eels are believed to be semelparous which means that they die after spawning (Arai and Abdul Kadir, 2017).

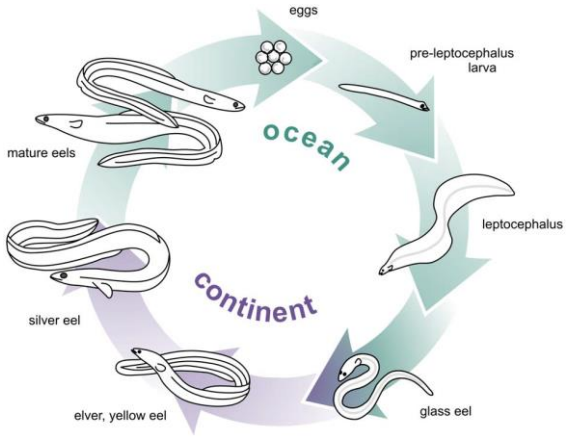

Figure 4.1A: Catadromous life cycle of the tropical eel (Henkel et al. 2012).

❖ Distribution by Species in Southeast Asia

A. bicolor: The Indonesian shortfin eel is divided into two subspecies, one is distributed in the Indian Ocean side known as *A. bicolor bicolor* and the other in the western Pacific side known as *A. bicolor pacifica*. The Indian Ocean subspecies, *A. bicolor bicolor*, is not only widely existing in the tropical Indian Ocean with some extension to northwestern Australia, but is also distributed from around India to the east coast of Africa. The Pacific subspecies, *A. bicolor pacifica* inhabits the western Pacific Ocean from the coasts of Philippines to China and the islands of Borneo to New Guinea and the Marianas. Although these two subspecies are morphologically quite similar (Sugeha *et al*., 2008), they are genetically clearly distinct (Watanabe and Miller, 2012; Fahmi *et al.*, 2015).

A. marmorata: The giant mottled eel has extensive geographic distribution over the western-central Pacific and Indian Oceans (Ishikawa *et al*., 2004; Minegishi *et al*., 2008; Watanabe and Miller, 2012). Its west-east distribution ranges from the east coast of Africa, the Indian Ocean, the Indo-Pacific Ocean, to central South Pacific; while its north-south distribution ranges from southwestern Japan, Taiwan and southeastern China to the Southern Cape in South Africa (Watanabe and Miller, 2012).

❖ Migration by Species in Southeast Asia

Sexual maturation to silver eels initiates spawning migration of the eels to the ocean (Sugeha *et al*., 2001; Sugeha *et al.*, 2006). Such downstream migration takes place mostly from January to mid-August (rainy season to the middle of dry season); while a few eels are known to be migrating from mid-August to December (dry season to the middle of rainy season). Therefore, the tropical eel species likely undergo downstream migration throughout the year, although such movement is strongly affected by the water level.

One of the major differences of the tropical eels from the temperate eels is that the tropical eels conduct relatively short distant spawning migration (50-1000 kilometers) to local spawning areas adjacent to their freshwater habitats (Arai, 2014a).

❖ Biodiversity

A. bicolor: Only a few studies are available that looked into the population differentiation within the subspecies. The previous morphological and genetic studies detected no population structure within each of the subspecies in the Indonesian waters (Sugeha *et al*., 2009; Fahmi *et al*., 2015).

A. marmorata: Previous morphological and genetic studies indicated that, despite the wide geographic distribution, this species appeared consistent with only four or five different populations in the North Pacific Ocean, Indian Ocean and South Pacific (Ishikawa *et al*, 2004; Minegishi *et al*., 2008; Gagnaire *et al*., 2011). Within each of the major oceans, the population is likely panmictic. For instance, no genetic difference was detected among the individuals collected from the Philippines, Taiwan, and Japan (Cheng *et al.*, 2012).

❖ Reproduction (recruitment)

Glass eels are recruited throughout the year. Back-calculation of hatching dates of the glass eels from examining the otolith microstructure strongly supported the possibility of year-round

spawning of the tropical eels around the Indonesian waters that corresponded to the observed year round recruitment of the tropical glass eels in river mouths (Arai *et al*., 2001).

A. bicolor: The Indian Ocean subspecies, *A. bicolor bicolor*, is believed to spawn in deep tropical and subtropical oceans off the southwest coast of Sumatra and Java probably throughout the year (Figure 4.1B.). The spawning area is thus close to where they recruit in their growth habitats (Kuroki *et al.*, 2007). In contrary, no small leptocephali of the Pacific Ocean subspecies, *A. bicolor pacifica*, have been detected in any sites, so the spawning area of this subspecies is still unknown. Considering its North Pacific distribution, however, the spawning area might be somewhere offshore in western North Pacific (Aoyama, 2009).

A. marmorata: One of the spawning areas of this species is known, especially for the North Pacific population which is in the same oceanic area of the North Equatorial Current as the temperate Japanese eel, *A. japonica* (Miller *et al.*, 2002). However, those of the other populations have not yet been identified.

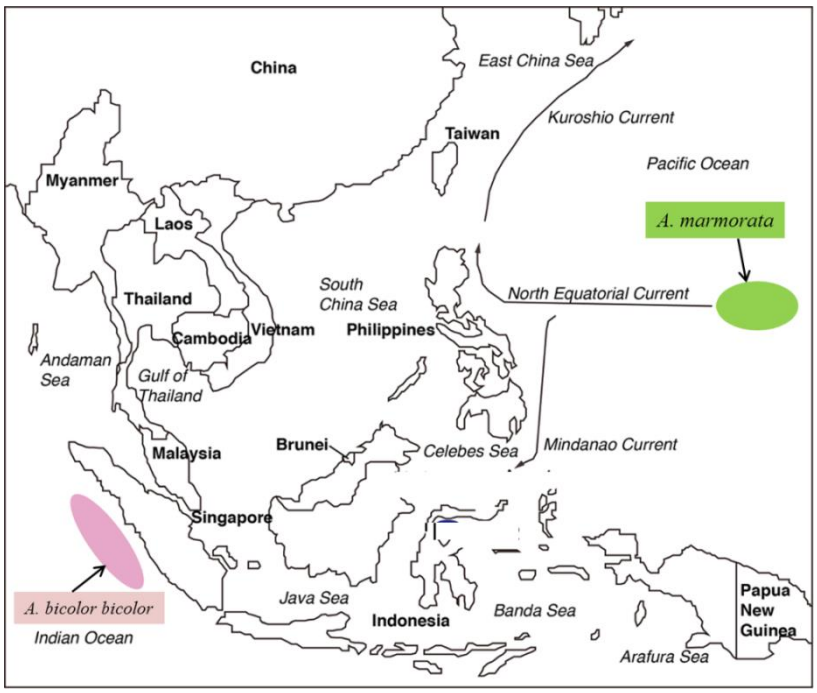

Figure 4.1B: Possible spawning areas of A. marmorata, and A. bicolor bicolor (Slightly modified from Arai (2014b)).

❖ Other Biological Information

A. bicolor: Analysis of the otolith Strontium (Sr) and Calcium (Ca) concentrations from the samples of *A. bicolor bicolor* in the Indonesian waters showed two different patterns of migration and habitat use (Chino and Arai, 2010). One group appeared to live in either brackish or sea waters with no freshwater life, whereas the other group migrates from freshwater to brackish or sea waters, suggesting that the use of freshwater habitat may not be obligatory.

4.2 Possible Threat(s)

Few studies have been conducted to examine the types of threats that prevent long-term

persistence of these species. However, it is not difficult to raise some possible threats that might have significant harmful effects to these species. Threats like dam construction, hydropower turbines, waste disposal (pollution), water quality, habitat reduction/degradation, deforestation, inappropriate river bank management, agriculture, human over-population, and over-exploitation of resources, and so on, could severely impact the existence of these species. In addition, recent changes in the global climate (warming, ocean acidification, torrential rains, and drought, among others) could also have long-term negative effects on the species.

4.3 Status of Fisheries and Utilization

Catch and Aquaculture

The status of fisheries (catch and aquaculture) for the tropical anguillid eels in Southeast Asia has become clearer from the baseline surveys conducted by SEAFDEC project. Summary information on catch and aquaculture of tropical anguillid eels in Cambodia, Indonesia, Myanmar, Philippines, Thailand, and Viet Nam are described in this section.

❖ Cambodia

Catch: There is no fishery that exploits tropical anguillid eels in Cambodia.

Aquaculture: Elvers of *A. marmorata* and *A. bicolor pacifica* imported from Philippines (100 kg in 2017), are farmed in Cambodia, the production of which is utilized by domestic restaurants, as described in Table 4.3A.

Table 4.3A: Summary of fisheries, aquaculture, and trade of tropical anguillid eels in Cambodia

Cambodia					
Catch Data	Glass eel	No fishery			
	Elver/Yellow eel	No fishery			
Fishing Operation Data	Number of fishers	None			
	Season (peak, off)	-			
	Fishing gear	-			
Production of Eel Farm	Number of eel	1			
	Purchase	Elver eel	*A. marmorata* 30% *A. bicolor pacifica* 70%	100 kg from Philippines (2017)	
	Production	Yellow eel	*A. marmorata* 30% *A. bicolor pacifica* 70%	0.5 t (2017)	
	Destination	Domestic cosumption, then local Korean restaurants			
Import and Export	Import	Philippines	Elver eel	*A. marmorata* *A. bicolor pacifica*	100 kg (2017)
	Export	None			

❖ Indonesia

Catch: Fisheries activities, including 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: Palabuhanratu Sub-district, Manado Municipality, Poso District, and Cilacap District. Glass eels, elvers, and yellow eels of *A. bicolor* or *A. marmorata* are caught in these areas. In Palabuhanratu Sub-district, glass eels are mainly caught between September and December by scoop net (see Appendix 2). In Cilacap District, elvers and yellow eels are mainly caught by scoop net or PVC trap from October to November. In Poso District, glass eels, elvers, and yellow eels are

mainly caught by fyke net or barrier trap from July to August. In Manado Municipality, glass eels are caught by scoop net but the peak fishing season in still unknown. Annual catches in these areas has remained at around 10.0 ton in recent years for glass eels and less than 80.0 ton for elvers and yellow eels.

Aquaculture: The production from farming of *A. marmorata* and *A. bicolor* in 2016 is 511.0 ton, consisting of brackish pond culture of 111.0 ton and from freshwater pond culture of 400.0 ton. Production of eel culture in brackish ponds culture mainly came from West Java province. The production of eel culture in the freshwater pond culture came from Lampung province, West Java, Central Java, East Java, West Kalimantan, North Sulawesi, and Central Sulawesi. The production exported to China, Korea, Japan, Taiwan, and other countries, as described in Table 4.3B.

Table 4.3B: Summary of fisheries, aquaculture, and trade of tropical anguillid eels in Indonesia

Catch Data	Glass eel	*A. bicolor* or *A. marmorata* (depends on areas)	Palabuhanratu Sub-district	Annual catch 1.5 t (~2017 Sep)	
			Manado Municipality	30.75 t (2014), 11.85 t (2015), 12.22 t (2016), 7.85 t (2017)	
			Poso District & Palu Municipality	10.0 t (2017)	
	Elver/Yellow eel	*A. bicolor* or *A. marmorata* (depends on areas)	Cilacap District	Annual catch 76.2 t (2015)	National catch of eels in 2015 is 748.0 t and in 2016 is 687.0 t (revised data, based on the confirmation from district in West Kalimantan Province that some data are monopteros)
			Poso District & Palu Municipality	42.0 t (2017)	
			Manado Municipality	30.4 t (2016)	
Fishing Operation Data	Number of fishers	Glass eel	Palabuhanratu Sub-district	>1,000 fishers	
		Elver/Yellow eel	Cilacap District	800-1,000 fishers	
		Glass eel, Elver/Yellow eel	Poso District	>200 fishers	
		Glass eel	Manado Municipality	>50 fishers	
	Peak Season	Glass eel	Palabuhanratu Sub-district	Sep-Dec	
		Elver/Yellow eel	Cilacap District	Oct-Nov	
		Glass eel, Elver/Yellow eel	Poso District	Jul-Aug	
		Glass eel	Manado Municipality	Under survey	
	Fishing gear	Glass eel	Palabuhanratu Sub-district	Scoop net	
		Elver/Yellow eel	Cilacap District	Scoop net, PVC trap	
		Glass eel, Elver/Yellow	Poso District	Fyke net, Barrier trap	
		Glass eel	Manado Municipality	Scoop net	
Production of Eel Farm	Number of eel farmers	12 companies (2016)	West Java 11		
			East Java 1		
	Purchase	Glass eel (Java)	*A. bicolor*	Palabuhanratu Sub-district	
				Cilacap District	
		Elver/Yellow eel (Kalimantan)			
	Production	Yellow eel	*A. bicolor* 90%	Official national statistics data 354.0 t (2015) and 511.0 t (2016)	
			A. marmorata 10%		
	Destination sell	China,Vietnam,Hongkong, Taiwan, Japan, Thailand, other countries and domestic			
Import and Export	Import	China,Japan, Australia	China: 96.56% (2016)	National import of eels in 2015 : 27.0 t, and in 2016 : 21.0 t (data source : Central Bureau of Statistics of Indonesia)	
			Japan: 3.40% (2016)		
			Australia: 0.04% (2016)		
	Export	China,Vietnam,Hongkong, Taiwan, Japan, Thailand, others	China: 51.28% (2016)	National export of eels in 2015: 8,202.58 t, and in 2016: 9,830.43 t (data source : Central Bureau of Statistics of Indonesia)	
			Viet Nam: 33.77% (2016)		
			Hong Kong: 7.85% (2016)		
			Taiwan: 2.66% (2016)		
			Japan: 2.34% (2016)		
			Thailand: 1.40% (2016)		
			others: 34.48% (2016)		

❖ Myanmar

Catch: No specific fishers catch anguillid eels in Myanmar. Yellow eels of *A. bicolor bicolor* and *A. bengalensis* or *A. marmorata* are accidentally caught by stow net, crab trap, or longline hook in the rainy season.

Aquaculture: *A. bicolor bicolor* is the main species farmed in Myanmar. Farming production from the only one farmer was 15.0 ton in 2017, all of which was exported to China, as described in Table 4.3C.

Table 4.3C: Summary of fisheries, aquaculture, and trade of tropical anguillid eels in Myanmar

Myammar

Catch Data	Glass eel	No fishery		
	Yellow eel (no fishery in elver stage)	*A. bicolor bicolor* 90%	Ayeyarwady region	10.44 t
			Tanintharyi region	1.28 t
			Yangon region	0.5 t
		A. bengalensis or *A. marmorata* 10%	Approximately total 12.22 t (2017)	
Fishing Operation Data	Number of fishers	No specific fishers catch for anguillid eels, which are bycatch from other fisheries.		
	Peak Season	Rainy season since May-Oct hightest in Jul-Aug		
	Fishing gear	Stow net, crab trap, longline hook		
Production of Eel Farm	Number of eel farmers	1 in Mandalay region		
	Purchase	Yellow eel (20-30 cm length or smaller than 1.0 kg)	*A. bicolor bicolor* 100%	Annual 2.0 t
	Production	Yellow eel (bigger than 1.0 kg)	*A. bicolor bicolor* 100%	Annual 15.0 t (2017)
	Destination sell	China 100%		
Import and Export	Import	None		
	Export	mostly to China, some time send to Japan, Korea and other countries depend on demand.	*A. bicolor bicolor* 90% *A. bengalensis* 10%	Approximately 21.8 t to China (2017)

❖ Philippines

Catch: *A. marmorata* is the main species of glass eels and elver/yellow eels caught in Luzon and Mindanao islands. Glass eels are mainly caught by fyke net, stow net, scoop net, or push net between April and August. Annual catch of glass eels fluctuated yearly since 2007. In 2017, the catch was about 2.26 ton from Luzon Island and 10.30 ton from Mindanao Island. The fishing gears for yellow eels are seine net, bamboo trap, hook line, and spear gun. Main fishing season for yellow eels is between December and February, and the annual catch from both islands in 2017 was about 0.64 ton.

It is important to note that in 2012, the country reinstated the ban on the export of elvers with sizes of 15 cm or less by virtue of Fisheries Administrative Order (FAO) 242, Series of 2012, which significantly reduced the catch and export of anguillid eels in succeeding years.

Aquaculture: There are 28 farmers who farm eels in the Philippines. Production volume of farmed *A. marmorata* and *A. bicolor* in Mindanao Island is about 93.88 ton based on local official data in 2016, and more than 20.23 ton in Luzon Island. *A. bicolor* is exported to Japan, Korea and Taiwan; while *A. marmorata* is for Korea, China and Taiwan. Both species are also consumed locally as described in Table 4.3D.

Table 4.3D: Summary of fisheries, aquaculture, and trade of tropical anguillid eels in Philippines

Philippines

Catch Data	Glass eel	*A. marmorata* 85-90%, *A.bicolor pacifica* 10-15%	Luzon Is. (Cagayan province)	(2007-2015 official data) 2007: 2,493 kg 2012: 3,826 kg 2008: 828 kg 2013: 2,693 kg 2009: 372 kg 2014: 165 kg 2010: 1,300 kg 2015: 115 kg 2011: 1,471 kg 2017: 2,260 kg (survey data)
			Mindanao Is. (Cotabato, Davao City, General Santos)	Depend on demands, in 2017 is Approximately 10.3 t
	Elver/Yellow eel	*A. marmorata* 95% *A.bicolor pacifica* 5%	Luzon Is. (Cagayan province)	2017: 300 kg
			Mindanao Is. (Cotabato, Davao City, General Santos)	2010: 400 kg 2015: 2,000 kg (<1.0 kg size is not target) 2017: >340 kg

Fishing Operation Data	Number of fishers	Glass eel	Luzon Is.	>1,000 fishers
			Mindanao Is.	>2,000 fishers
		Elver/Yellow eel	Luzon Is. (Cagayan river)	>100 fishers (not only eels)
			Mindanao Is. (Agusan river,Agusan Marsh, Rio Grande de Mindanao river, Simuay river and Lake Mainit)	>300 fishers
	Peak season	Glass eel	Luzon Is.	Apr-Jul
			Mindanao Is.	Jun-Aug
		Elver/Yellow eel	Luzon Is.	Jan-Feb
			Mindanao Is.	Dec-Feb
	Fishing gear	Glass eel	Luzon Is.	Fyke net, stow net
			Mindanao Is.	Fyke net, scoop net, push net
		Elver/Yellow eel	Luzon Is.	Seine net,
			Mindanao Is.	Bamboo trap, hook line, speargun

Production of Eel Farm	Number of eel farmers	28 farms	Luzon Is.: 17 farms Mindanao Is.: 10 farms Cebu Is.: 1 farms	Visited: Luzon Is.: 7 farms Mindanao Is.: 3 farms	farm owner: filipino: 40% Japanese co-owner: 32% Taiwanese co-owner: 16% Korean co-owner: 12% (ref: Dr.Frank Seth Fabia Santos)
	Purchase:	Glass eel	Mix with all *Anguilla* spp. the ratio depend on season and ability of supplier to find the source of glass eel that have higher percentage of *A.bicolor pacifica* (target species.)	Luzon Is. and Mindanao Is.	Mr. Pantas from General Santos City is the only consolidator who classify the glass eel with naked eyes before selling
	Production:	Elver/Yellow eel	*A. marmorata* 20%, *A. bicolor pacifica* 80%	Mindanao Is.	2016: 93.88 t official data from Local transport Permit in ARMM region
				Luzon Is.	2017: 20.23 t (Estimate data from 7 farms)
	Destination sell	Export and local consumption			

Import and Export	Import	None		
	Export	*A. bicolor pacifica* : Japan, Korea, Taiwan	from ECC (EXPORT COMMODITY CLEARANCE)	
		A. marmorata : Korea, China, Taiwan	2012: 106,133 kg 2013: 73,419 kg 2014: 74,339.5 kg	2015: 33,598.5 kg,(*A.bicolor pacifica* 26,578.5 kg = 79.11%) 2016: 48,287 kg,(*A.bicolor pacifica* 48,227 kg = 99.87%) 2017: 21,199 kg, (*A.bicolor pacifica* 12,150 kg = 57.31%)

❖ Thailand

Catch: Elver/yellow eels of *A. marmorata, A. bengalensis and A. bicolor bicolor* are accidentally caught by trap in Ranong Province, Satun Province, and Phangnga Province between May and October.

Aquaculture: Glass eels from China and yellow eels from Indonesia are farmed in several provinces and exported to China as described in Table 4.3E.

Table 4.3E: Summary of fisheries, aquaculture, and trade of tropical anguillid eels in Thailand

Thailand

Catch Data	Glass eel	No glass eel fishery		
	Elver/Yellow eel	*A. marmorata* or *A. Bengalensis*	Ranong Province	Kraburi River (upper) in 4 canal (Krapuur canal, Naka canal, Kampuan canal and Kraburi canal)
		A. bicolor bicolor	Satun Province	
			Phangnga Province	

Fishing Operation Data	Number of fishers	No specific fishers catch for anguillid eels, which are bycatch from other fisheries.	Ranong Province
	Peak season	May - October	Ranong Province and Satun Province
	Fishing gear	Freshwater fish trap, long trap (by catch)	

Production of Eel Farm	Number of eel farmer	3 farmers	One farmer each in Ranong, Chachoengsao and Samutprakan Provinces	
	Purchase	Glass eel	Ranong Province	Eel seed is from China
			Chachoengsao	
		Elver/Yellow eel	Samutprakan Province	Yellow eel is from Indonesia, and every 20 days, order is made at 20-30 kg/time (2015)
	Production	Ranong Province	*A. bicolor* is 700-800 g/pcs, and *A. marmorata* is 1.5 kg/pcs and sold to China	
		Samutprakan Province	>1 kg/pcs and total amount could reach 2.0 ton and sold to China	

Import and Export	Import	Live Eel	2013: 127,820 kg 2016: 2,251 kg	2014: 38,622 kg 2017: 10,392 kg	2015: 17,465 kg
			France, Spain, Myanmar, and Taiwan (2016)		
	Export	Live Eel	2013: 35,238 kg 2016: 50,337 kg	2014: 268 kg 2017: 180 kg	2015: 10,965 kg
			China, Hongkong and Vietnam (2016)		

❖ Viet Nam

Catch: Glass eels of *A. marmorata* (95%) and *A. bicolor pacifica* (5%) are mainly caught in Phu Yen province although there are also few catches in Binh Dinh, Quang Ngai, Khanh Hoa and Ninh Thuan provinces. The main fishing gears for glass eels are towing net and scoop net and the fishing season peaks are from November to May in Phu Yen province. The total annual catch of glass eels was 0.60-0.75 ton (4,000,000-5,000,000 pieces). Information on catch of elver/yellow eels is still being compiled from the survey.

Aquaculture: Several farmers are culturing eels in Phu Yen and Khanh Hoa provinces. One largest eel farmer in Khanh Hoa province produces 200,000-300,000 pieces of elver/yellow eels as described in Table 4.3F. Information on eel import and export is still being compiled from the survey.

Table 4.3F: Summary of fisheries, aquaculture, and trade of tropical anguillid eels in Viet Nam

Viet Nam

Catch Data	Glass eel	*A. marmorata* 95% *A. bicolor pacifica* 5%	Total catch amount is 0.600-0.750 t/year (information from the largest eel farm in Khanh Hoa Province)		
			Phu Yen Province >0.480-0.600 t (>80%)	Ba River 70% Ky lo River 30%	(Information from Fisheries officer of Phu Yen Province)
			Binh Dinh Province 0.060-0.113 t (10-15%)		
			Quang Ngai Province 0.012-0.038 t (2-5%)		
			Khanh Hoa Province 0.006-0.008 t (1%)		
			Ninh Thuan province 0.006-0.008 t (1%)		
	Elver/Yellow eel	under survey			
Fishing Operation	Number of fishers	Glass eel	under survey		
			under survey		
			Number of fishers in Phu Yen Province is 250-300 fishers in peak season, and 150-170 fishers in lean		
		Elver/Yellow eel	under survey		
	Peak season	Glass eel	Phu Yen Province	November - May	
		Elver/Yellow eel	under survey		
	Fishing gear	Glass eel	Phu Yen Province	90% used towing net and 10% used fence net in Ba river	
				90% used scoop net (with FAD) and towing net in Ky lo river	
		Elver/Yellow eel	under survey		
Production of Eel Farm	Number of eel farmer	Mekong Delta area	> 1,000 eel farmers	Information from the largest eel farm in Khanh Hoa Province	
		Phu Yen Province	14 farmers (family scale) and 5 farmers (grow from glass eel to elver)		
		Khanh Hoa Province	One largest eel farm and other farm in family scale (under survey)		
	Purchase	Glass eel	under survey as whole		
			Phu Yen Province	2016: 10,000 pieces	2017: 15,000 pieces
			Khanh Hoa Province	2015: 1,000,000 pieces 2017: 300,000 pieces	2016: 500,000 pieces
	Production	under survey as whole			
		Phu Yen Province	2 types farmers (glass eel to elver, elver or small yellow to big yellow)		
		Khanh Hoa Province	200,000-300,000 pieces/year	50% of eels product are sent to 100 farmers in Ca Mau Province (Mekong delta area). then sold to domestic consumption	
Import and Export	Import	under survey			
	Export	under survey			

Utilization of Anguillid Eel Resources

In Southeast Asia, anguillid eels are utilized in many ways as summarized in Table 4.3G. Due to high diversity of tropical fishes in Southeast Asia and the perception that anguillid eels look like snake, many people prefer to eat other fish, except in Viet Nam, which used 50% of its aguillid eels 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. Farmers from Indonesia, Philippines and Myanmar use their own seeds for growing eels in their domestic eel farms. While Cambodia imports seeds (> 15 cm or 150 g) from the Philippines the country's anguillid eels market is not popular yet compared to the other countries. There is only one eel farm

established in Cambodia as of May 2016 which with production 500 kg (since 2017) supports a local Korean Restaurant. While Thailand import glass eels from China and yellow eels from Indonesia then export to China after rearing up to 1 kg per individual. Some of *A. marmorata* from the wild were caught to sell in domestic market as ornamental fish. Indonesia, which is the leading country in Southeast Asia that produces anguillid eel products such as roasted eel (kabayaki) and crispy roll, its products are exported to Japan. Furthermore, Indonesia also exports live eels to East Asia. In the Philippines, where the dominant species is *A. marmorata*, but the main target species is *A. bicolor pacifica*. *A. marmorata* were sorted and mostly released to the wild. The country's eel farms send the live eels to Japan, Korea and other East Asian countries. There is also have a restocking program in Cagayan Valley under collaboration between BFAR RO2 and ZSL.

Table 4.3G: Summary of utilization of tropical anguillid eels in Southeast Asia

Country	Domestic consumption	Export for direct consumption	For grow-out in domestic farms	Export for grow-out in farms
Cambodia	✓	-	✓	-
Indonesia	✓	✓	✓	✓
Myanmar	✓	✓	✓	-
Philippines	✓	✓	✓	✓
Viet Nam	✓	✓	✓	-
Thailand	✓	✓	✓	-

4.4 Stock Status of Tropical Anguillid Eels

Information on the stock status of tropical anguillid eels is still scarce. As mentioned earlier, there had been inter-annual fluctuation of the recruitment of tropical juvenile eels in Indonesia while the CPUE calculated from the catch weight per fisher per hour in Pangi River, Philippines ranged from 0.075 g to 500 g. Considering that these findings may not be able to describe the population status of the tropical anguillid eels, there is still a need to collect long-term data necessary for stock assessment and further research to analyze the population status of the tropical anguillid eels in Southeast Asia. Therefore, in the SEAFDEC project, data collection was initiated to obtain understanding of the population trend of tropical anguillid eels. The preliminary results were obtained from the regular surveys.

Regular surveys were conducted in countries with anguillid eel fisheries, namely: Indonesia, Myanmar, and Philippines, while Viet Nam is still in the process of establishing the data collection methodology. The initial observations are shown in Table 4.4A. In Indonesia, four survey sites were identified. The first site is Palabuhan Ratu in Sukabumi Regency, West Java Province. The second is Cilacap, one of the regencies in Central Java Province. Located in the southwest coast of Java Island, Palabuhan Ratu and Cilacap also face the Indian Ocean. Cimandiri River in Palabuhan Ratu is a famous fishing ground for glass eels that are usually gathered from the river mouth every year. Cilacap Regency is a fishing ground for yellow eels through its rivers and swamps with varying widths. The other two location sites are Poso in Central Sulawesi, and Manado in North Sulawesi. These survey sites face the Pacific Ocean and are famous grounds for glass eel fishing. In the Philippines, the Aparri River in Cagayan Province of Northern Luzon Island, and Cotabato City and General Santos City in Mindanao Island were chosen as survey sites because these areas are known not only as home of various eel species abut also as important eel habitats. In Myanmar, Yangon, Ayeyarwady, Tanintharyi and Mandalay Provinces were chosen. Yangon is the largest city in Myanmar, and eel fishers from Ayeyarwady and Tanintharyi Provinces send their harvest of anguillid eels to collectors in Yangon. In Viet Nam, Phu Yen and Khanh Hoa

Provinces are chosen as survey sites not only because of their locations that face the South China Sea, but also because in these Provinces, many areas are known to be glass eel fishing areas.

Table 4.4A: Initial observations from the regular surveys

Country	Sampling areas Province/ District	River	Period of observation	No of Observations	Fishing gear	Species	Stage
Indonesia	Bengkulu	Kungkai Baru	Feb 2016 – Apr 2017	438	Hand line and Trap	*A. bicolor*	YE
		Arau Bintang	Apr 17	106			
		Enggano	Apr 17	12			
	Sukabumi	Cimandiri	Nov 2013 – Nov 2017	672	Scoop net	*A. bicolor*	GE
	Cilacap	Serayu	Jan 2017-Feb 2018	538	trap	*A. bicolor*	YE
	Poso	Poso Lake	Jan 2004- Jan 2018	248	trap	*A. marmorata*	YE
	Poso	Poso River	Dec 2017-April 2017	12	fyke net	*A. marmorata*	GE
	Manado	Poigar	Apr 17	2	fyke net	*A. marmorata*	GE
Myanmar	Pyapon	Ayeyarwady	Dec 2017	29	Crab trap	*A. bicolor*	YE
	Labutta		Dec 2017-Jan 2018	23			
	Myeik	Taninthrayi	Dec 2017	3			
	Yangon	Yangon	Nov-Dec 2017	14			
Philippines	Cagayan Mindanao Island	Cagayan	Nov 2017 – Jan 2018 Dec 2017	176	Fyke net	*A. marmorata*	GE GE

Note: GE=Glass eel, YE=Yellow eel

However, only the data from Palabuhan Ratu in Indonesia have been used in the analysis for the CPUE due to the availability of data series since November 2013 (Figure 4.4A.). For the current analysis, the data from January 2014 to December 2017 (4 years) from the series had been extracted. Specifically, the data from the enumerators in Cimandiri River in Sukabumi Regency of West Java were analyzed. While the findings of Fahmi and Hirnawati (2010) indicated that the dominant species of the glass eels caught in the Cimandiri River was *A. bicolor bicolor*, it is expected that such findings would be confirmed through the results of the regular surveys which will roughly show the total amount of *A. bicolor bicolor* glass eels and its fluctuation in the Cimandiri River.

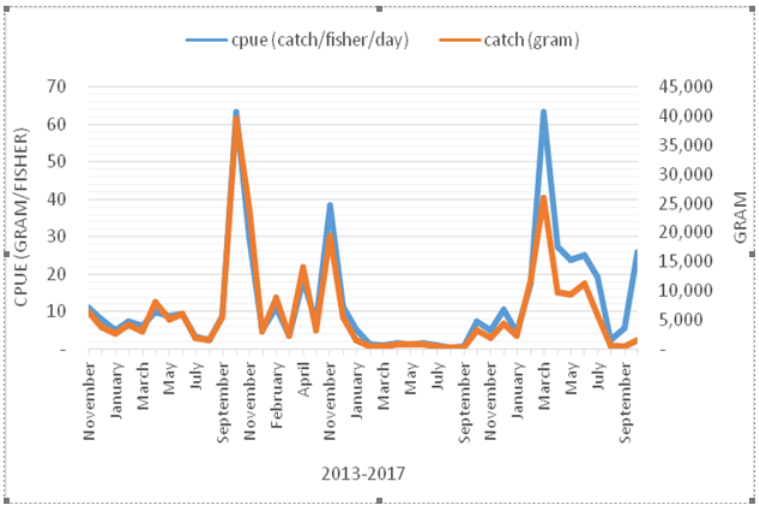

Figure 4.4A: Trend of the CPUE and production of Anguillid eel fisheries in Palabuhan Ratu, Indonesia (2013-2017)

As shown in Figure 4.4A, there are three periods of the peak season of the anguillid eel fisheries in Palabuhan Ratu, Indonesia during 2013-2017. The first occurred in October 2014 - September 2015, the second from October 2015 to September 2016 and the third in January-April 2017. The declining catch from the first period to the second period could be because of the non-acceptance of glass eels by major eel farms in the very beginning of the second period and the eel farms stopped accepting glass eel since January 2015. As the demand from eel farms decreased since January 2015, the number of fishers and catch also decreased drastically. Therefore, it is not appropriate to assess the migration of the tropical anguillid eel species based on the annual catch only. While the level of CPUE during the third peak season was similar to those of the first peak season, the level of the catch of anguillid eels has noticeably decreased.

According to certain eel farmers who were interviewed, the mouth of the Cimandiri River is one of the largest glass eel fishing grounds in Indonesia. There are more than 1,500 part-time fishers scooping the glass eels during the peak season using the scoop net as the fishing gear. Since there is only one fishing gear used, therefore gears standardization was not necessary.

4.5 Trade in Tropical Anguillid Eels

Taking into account the fact that the supply of catadromous eels (*Anguilla* spp.) for the world market is dependent on the natural resources and as techniques for full-life cycle aquaculture are yet to be developed for commercial use, the sustainable utilization in terms of conservation and fisheries management of the eel resources is therefore very crucial. To support the SEAFDEC project which aims to understand the status of tropical anguillid eel stocks and come-up with effective management strategy for the Southeast Asian region, this paper also reviews the trade of tropical anguillid eels focusing on the *Anguilla* spp., making use of the available data from UN ComTrade.

4.5.1 Source of Data

This paper made use of the available trade data from the UN ComTrade (https://comtrade.un.org/data/), which includes the export and import data of live anguillid eels (*Anguilla* spp.*)* under commodity code 030192(HS2007) and frozen eels (*Anguilla* spp.) under commodity code 030326. The frozen eels (*Anguilla* spp.) used in this paper exclude fillets, fish meat under code 0304, and edible fish offal of subheadings 0303.91 to 0303.99. The available trade data include those from the AMSs except Brunei Darussalam. The period covered depends on the availability of data as reported by the countries to the UN data system.

A comparison of the data from the UN ComTrade was made with the data compiled from the project's baseline survey particularly on the species composition for exported live eels (*Anguilla* spp.) from each ASEAN Member State. Results of the comparison would enhance the understanding of the real condition of the export of anguillid eels and improve future data reporting to the UN ComTrade.

4.5.2 Results of Trade Data Analysis

a) Export of Live and Frozen Eels (*Anguilla* spp.)

The export data of live and frozen eels (*Anguilla* spp.) that was reported by the ASEAN Member States to the UN ComTrade system during the past years until 2017 indicated the export trends of live eels of Indonesia, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Viet Nam respectively as shown in Figure 4.5A-G.

*Figure 4.5A: Export in quantity and value of live eels (*Anguilla *spp.) of Indonesia*

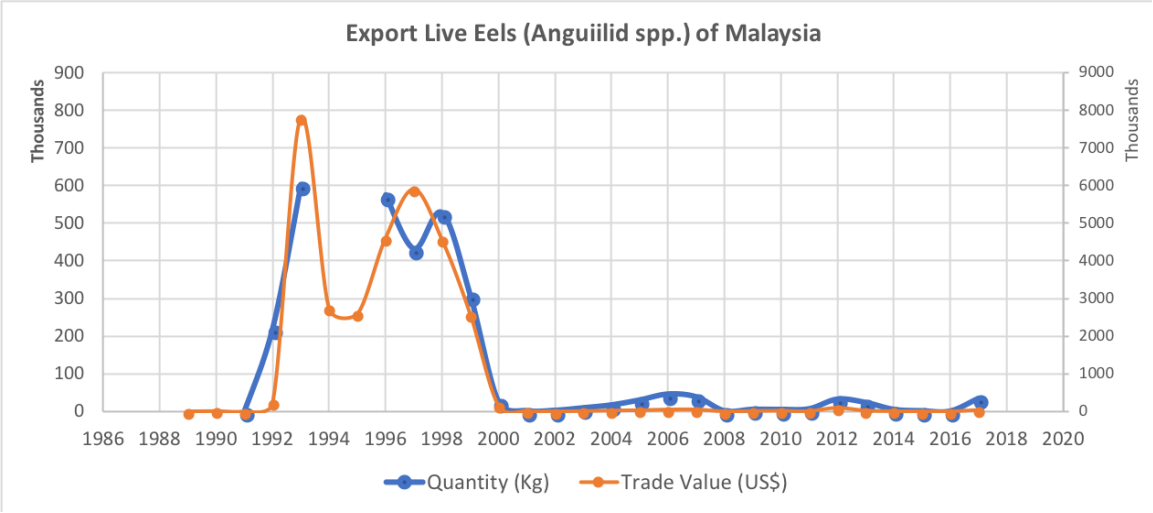

*Figure 4.5B: Export in quantity and value of live eels (*Anguilla *spp.) of Malaysia*

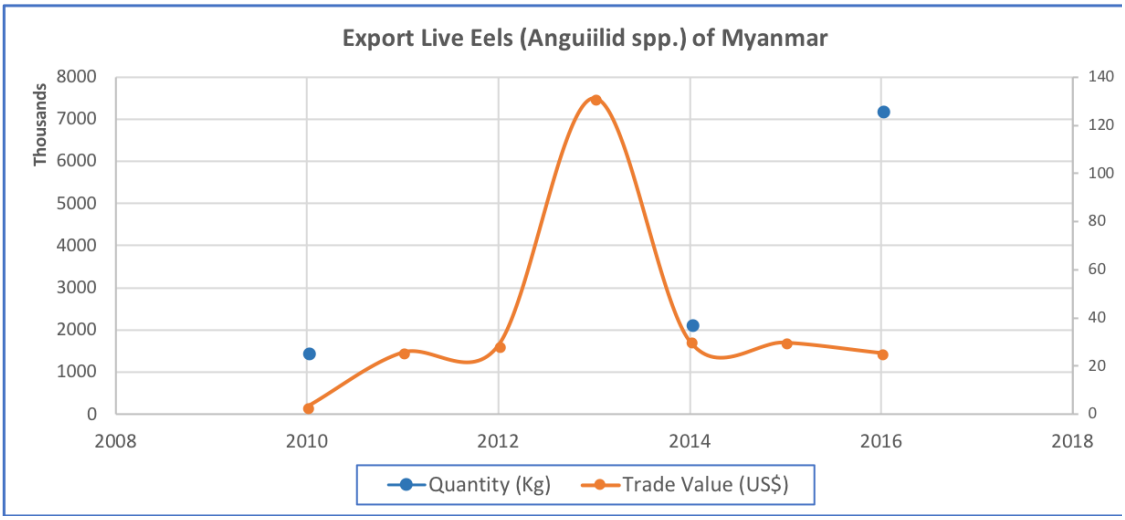

*Figure 4.5C: Export in quantity and value of live eels (*Anguilla *spp.) of Myanmar*

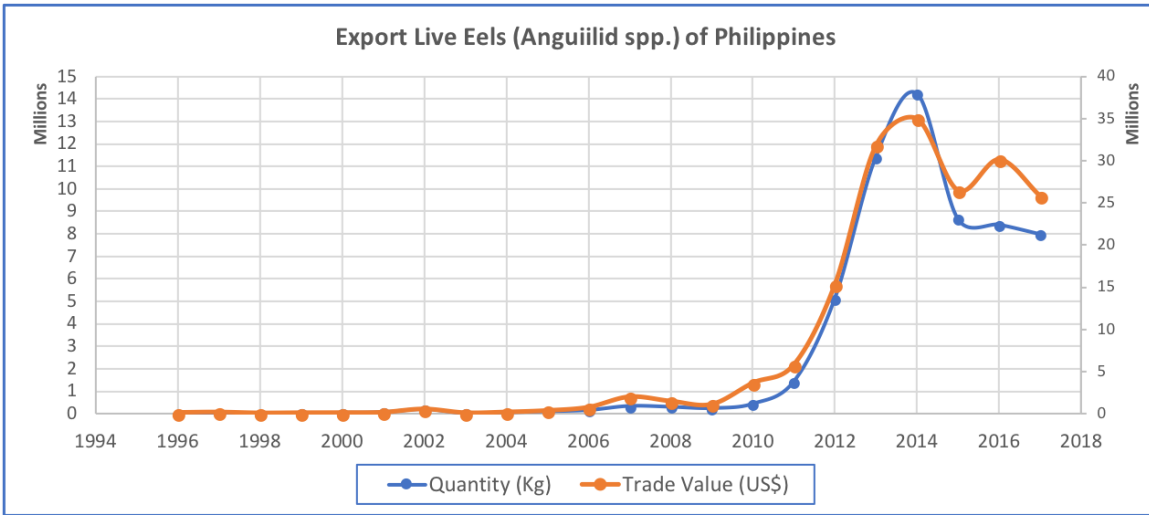

*Figure 4.5D: Export in quantity and value of live eels (*Anguilla *spp.) of the Philippines*

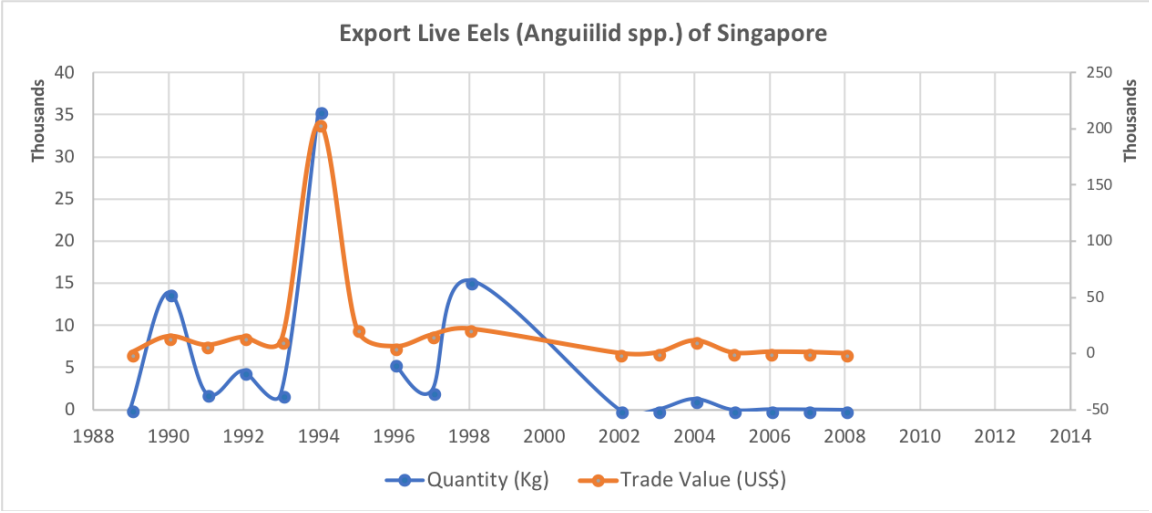

*Figure 4.5E: Export in quantity and value of live eels (*Anguilla *spp.) of Singapore*

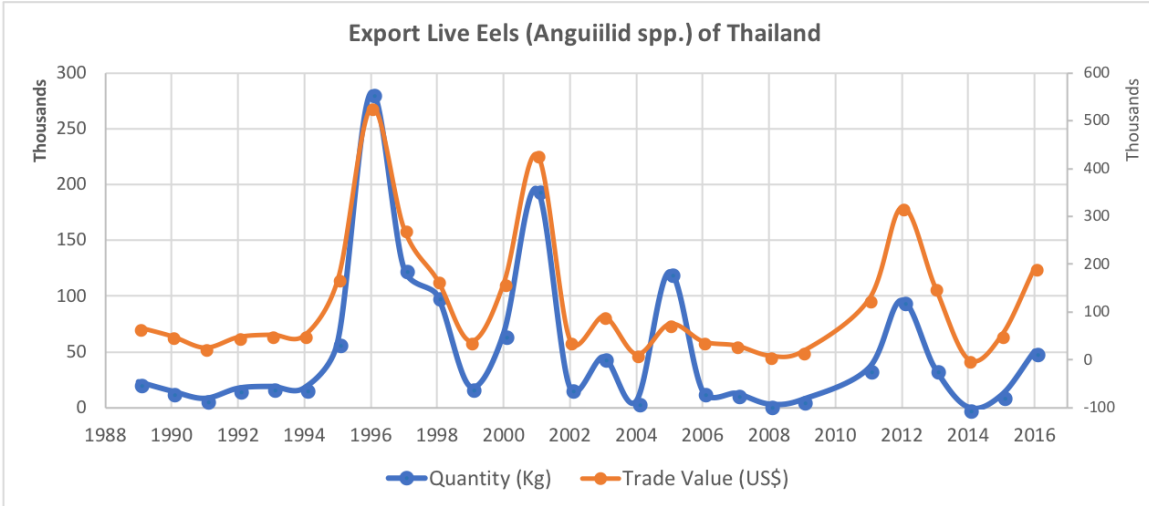

*Figure 4.5F: Export in quantity and value of live eels (*Anguilla *spp.) of Thailand*

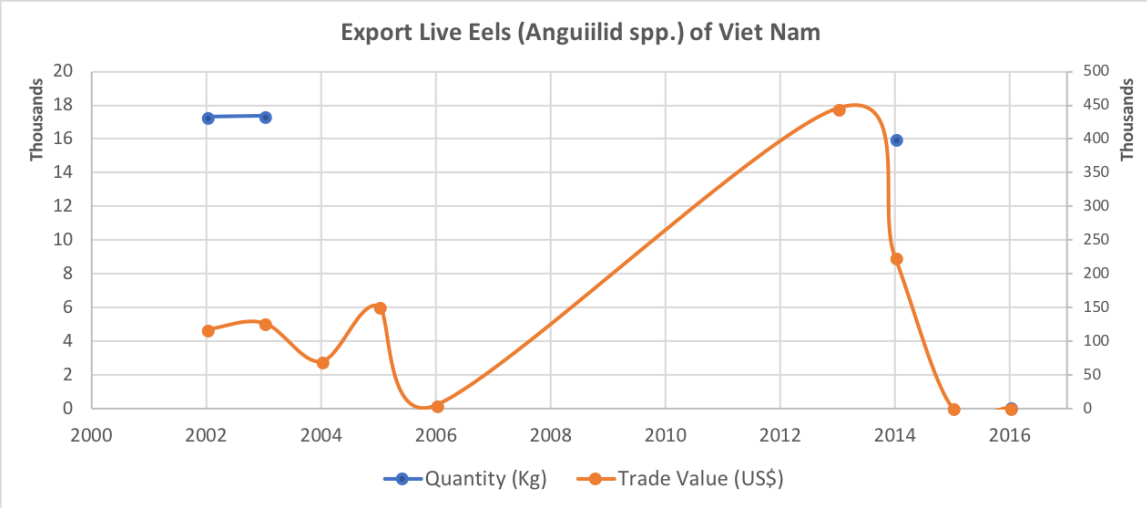

*Figure 4.5G: Export in quantity and value of live eels (*Anguilla *spp.) of Viet Nam*

In Indonesia, the data of live eels for international export in quantity particularly in 2012-2014 was higher than that of the previous year 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 (see Figure 4.5D) and Thailand (see Figure 4.5F). On the overall, export data from Southeast Asia indicated that there are three (3) top rank countries that export 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 (6) AMSs was about 27.22 ton with trade value of about USD 82.94 million as shown in Table 4.5A. Philippines provided the largest export quantity of live eels at 8,423 ton valued at about USD 30.18 million, followed by Myanmar at 7,242 ton and Indonesia at 3,593 ton. However, comparing only the frozen eel export, Indonesia exported the highest quantity at 6,152 ton valued at USD 15.31 million. Furthermore, trading of eels in Singapore and Malaysia was active during the past three (3) decades, but became inactive during the last decade when the export of live eels (*Anguilla* spp.) was less than 1.0 ton for Malaysia, and no export from Singapore since 2008.

Table 4.5A: Quantity and value of live eels (HS code 30192) and frozen eels (HS code 30326) exported by six ASEAN Member States in 2016

Export in quantity and value of live and frozen eels from Southeast Asia

Exporting Country	Commodity HS-Code and name		Quantity (ton)	Trade Value (US$)
Indonesia	30192	live, eels (*Anguilla* spp.)	3,592.92	7,796,698
	30326	frozen, eels (*Anguilla* spp.)	6,152.03	15,305,787
Malaysia	30192	live, eels (*Anguilla* spp.)	0.86	2,661
	30326	frozen, eels (*Anguilla* spp.)	1,756.65	3,944,845
Myanmar	30192	live, eels (*Anguilla* spp.)	7,242.32	25,519,178
	30326	frozen, eels (*Anguilla* spp.)	1.30	945
Philippines	30192	live, eels (*Anguilla* spp.)	8,423.08	30,174,983
	30326	frozen, eels (*Anguilla* spp.)	-	-
Thailand	30192	live, eels (*Anguilla* spp.)	50.34	192,981
	30326	frozen, eels (*Anguilla* spp.)	1.09	587
Viet Nam	30192	live, eels (*Anguilla* spp.)	0.08	875
	30326	frozen, eels (*Anguilla* spp.)	0.06	591
		TOTAL	**27,221**	**82,940,131**

b) Export Routes of Live Eels from Southeast Asia

Figure 4.5H-L shows the respective export routes of live eels from Indonesia, Malaysia, Myanmar, Philippines, and Thailand in 2016. Considering the export data from the six ASEAN Member States (Table 4.5A), it could be noted that 87% of total live eels in the Southeast Asia are exported to China and Hong Kong SAR. The remaining 13% is exported to Japan, Rep. of Korea, Spain, the Netherlands, Switzerland, France, United Arab Emirates, and other Asian countries.

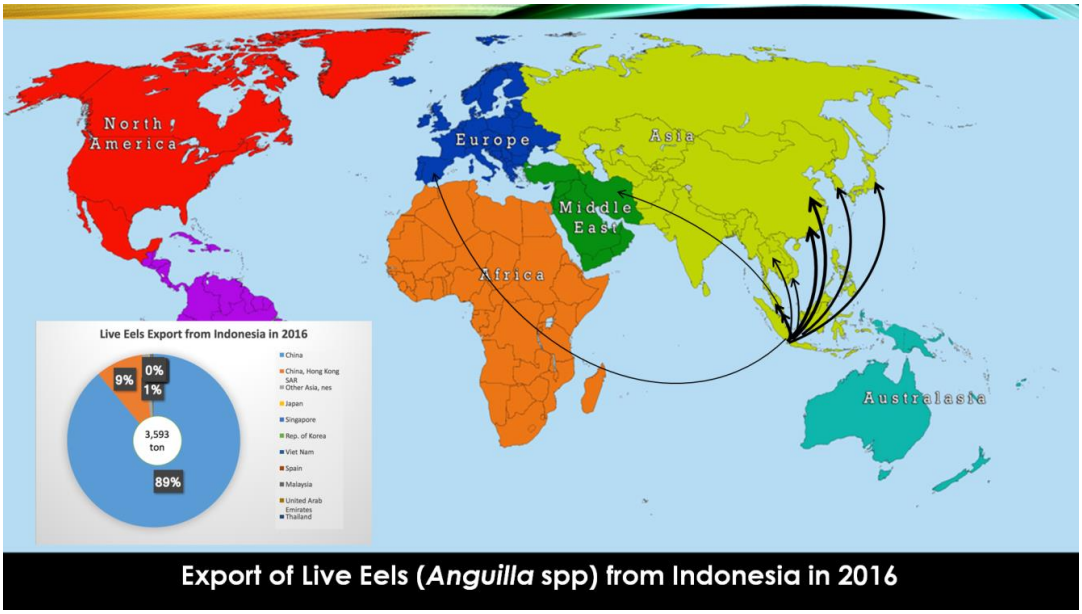

*Figure 4.5H: Export of live eels (*Anguilla *spp.) from Indonesia in 2016*

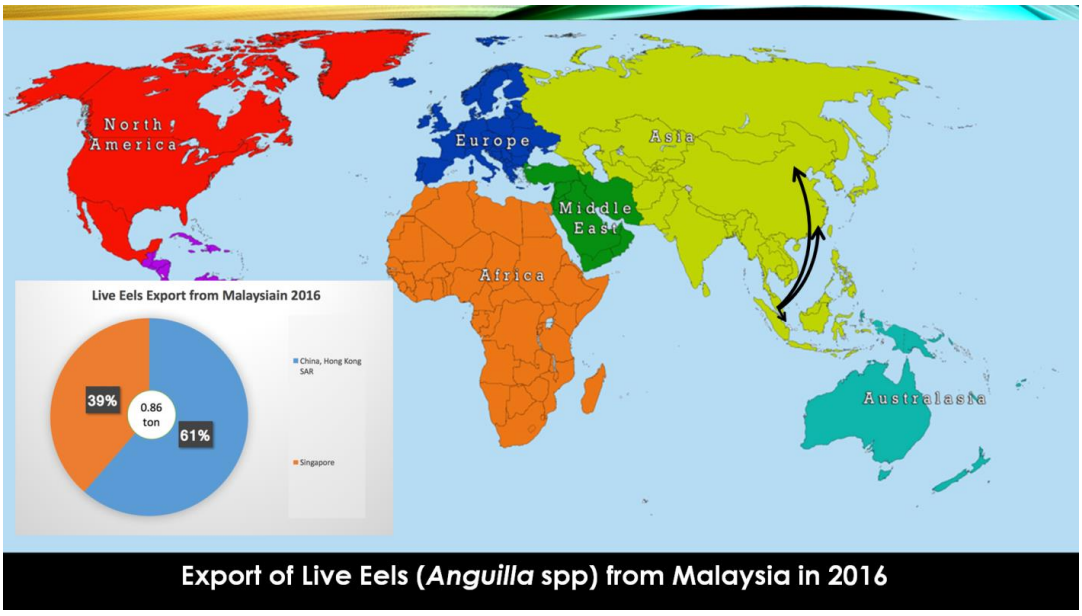

*Figure 4.5I: Export of live eels (*Anguilla *spp.) from Malaysia in 2016*

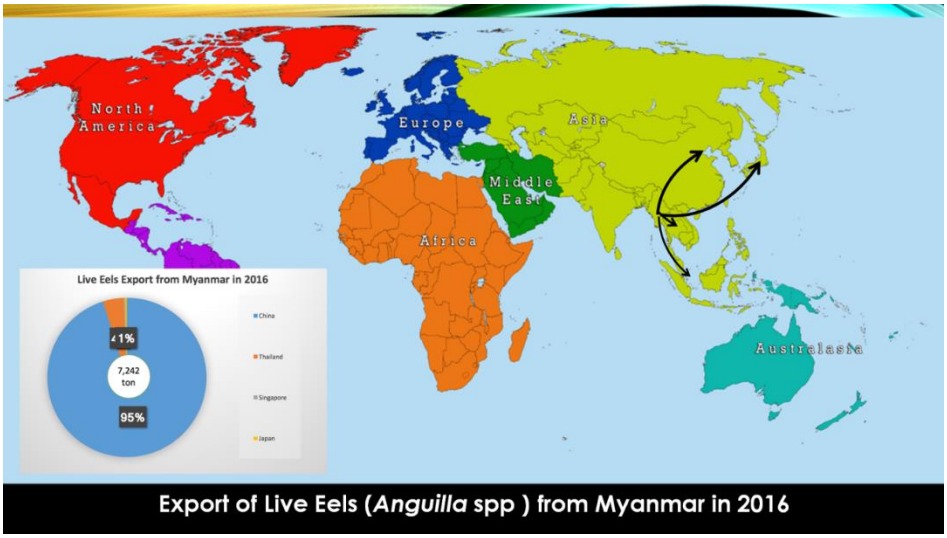

Figure 4.5J: Export of live eels (including Anguilla *spp and swam eels) from Myanmar in 2016*

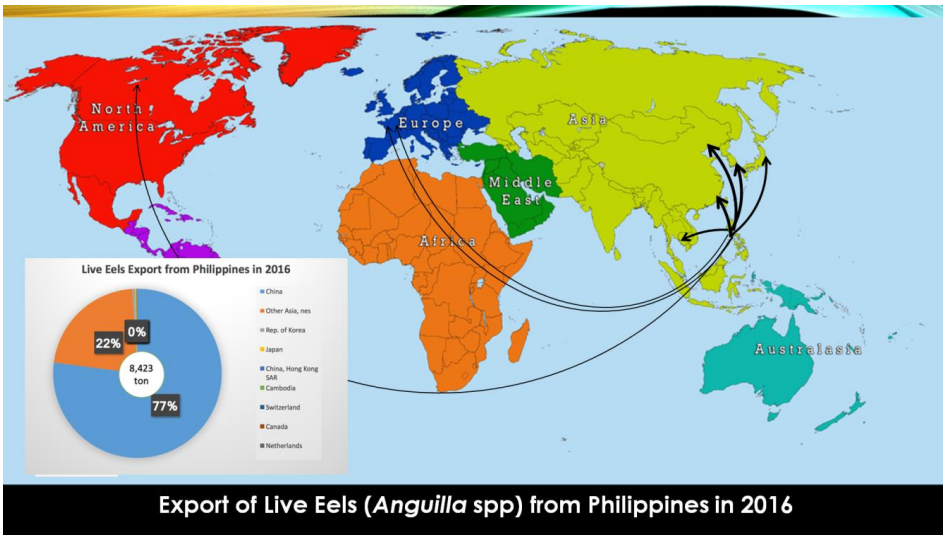

*Figure 4.5K: Export of live eels (*Anguilla *spp.) from the Philippines in 2016*

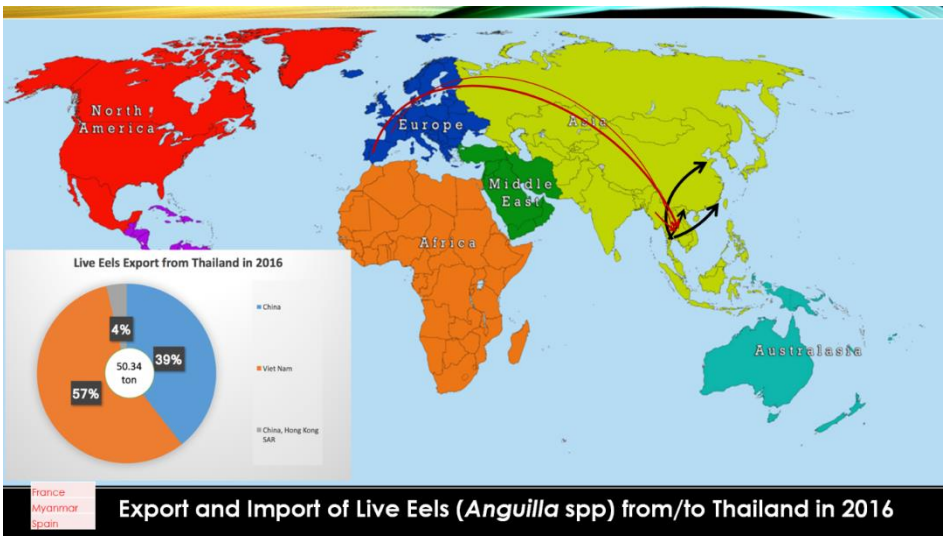

*Figure 4.5L: Export of live eels (*Anguilla *spp.) from Thailand in 2016*

c) Import Value and Quantity of Live Eels to Southeast Asia

The imported data of live eels in quantity (ton) and value (USD) by the Southeast Asian countries during 2015-2016 are shown in Table 4.5B. However, the data from Viet Nam in 2015 were not available (based on the UN Trade data system). The data in 2016 showed that four (4) Southeast Asian countries imported live eels into their countries, namely: Cambodia, Malaysia, Thailand, and Viet Nam although the data from Viet Nam is not complete.

Table 4.5B: Value and quantity of live eels imported by four Southeast n countries in 2016

Year	Reporter	Import Value (USD)	Import Quantity (kg)	Average Price USD/kg
2016	Cambodia	$15,551	1,320	11.78
2016	Malaysia	$5,214	327	15.94
2016	Thailand	$4,758	2,251	2.11
2015	Viet Nam	$203,864	N/D	

The import of frozen eel products under the HS code 30326 in the UN-ComTrade system into the Southeast Asia since 2012-2017 indicates that only three countries recently imported frozen eel products: Malaysia, Thailand and Viet Nam.

Figure 4.5M shows the share of the live eels import (in value) by four importing countries, namely: Cambodia, Malaysia, Thailand, and Viet Nam. A big bulk (89%) of the total live eels imported by the Southeast Asian region was made by Viet Nam, while (7%) was made by Cambodia which mainly came from the Philippines. Thailand reported that its imported live eels come from France and Spain.

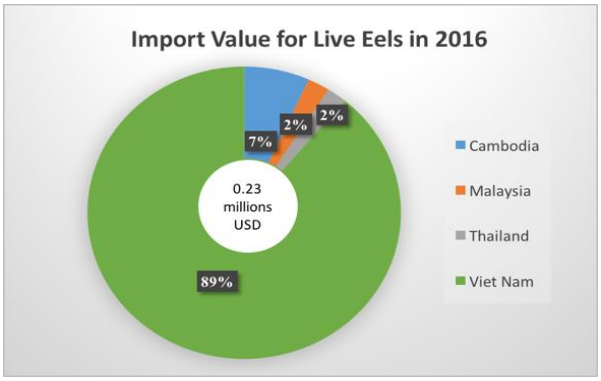

Figure 4.5M: Shares of live eels import value by four Southeast Asian countries in 2016

4.5.3 Comparison between UN ComTrade DATA and SEAFDEC Baseline Survey Data

Referring to the SEAFDEC baseline and regular surveys conducted during August 2017-May 2018 in six ASEAN Member States, namely: Cambodia, Indonesia, Myanmar, Philippines, Thailand, and Viet Nam, the results particularly on the export of live eels are shown in Table 4.5C. Specifically, comparing with the results of the baseline survey in Myanmar, Philippines, and Indonesia, the species composition recorded under the UN ComTrade Code 30192 for live eels *could have included not only the* Anguilla *spp. but also swam and snake eels.* The official data from the Philippines shows very clearly that live eels exported in 2016 (48.29 ton) identified as *Anguilla* spp. were *Anguilla bicolor pacifica*. However, there was a very big difference in quantity with that of the UN ComTrade Data which recorded the export quantity at 8,423 ton. Another

example is in the case of Myanmar, the key informants indicated that Myanmar submitted to the UN ComTrade data on live eels not only *Anguilla* spp., but also those of the swam and snake eels. So far only less than 10 percent of the total export quantity had been identified as *Anguilla* spp. Similar faulty recording was also found in the case of Indonesia.

*Table 4.5C. Comparing live eels (*Anguilla *spp.) export data from Southeast Asia: UN ComTrade Statistics* vs. *SEAFDEC Baseline Survey*

Country	UN ComTrade Export Data	Baseline survey Data	Notes
Cambodia	0	0	- There is only one eel farm in Cambodia which makes use of 100 kg of elvers from the Philippines, the production of which are utilized for domestic consumption and local Korean restaurants
Indonesia	3,593 t (2016) 1,155 t (2017)	24 t (2016)	- the Government's official statistics also indicated 98 ton of swamp eels
Myanmar	7,242 t (2016) 8,900 t (2017)	 *21.8 t (2017)	- *Anguilla* spp. and swamp eels are not separated in official statistics data of Myanmar (based on future plans) - local officers and consolidators mentioned that only about 10% of total live eel exported by the country is identified as *Anguilla* spp. - *estimated data from interviews
Philippines	8,423 t (2016) 8,002 t (2017)	48.29 t (2016) 21.2 t (2017)	- *Anguilla spp.* and swamp eel are not separated in official statistics data of the Philippine Statistics Authority - export data provided by governmental official data from the ECC (Export Commodity Clearance): 2012: 106.13 ton 2013: 73.42 ton 2014: 74.34 ton 2015: 33.60 ton (*A. bicolor pacifica* 26.58 ton = 79.11%) 2016: 48.29 ton (*A. bicolor pacifica* 48.23 ton = 99.87%) 2017: 21.20 ton (*A. bicolor pacifica* 12.15 ton = 57.31%)
Thailand	50 t (2016) NA (2017)	50 t (2016) 0.18 t (2017)	- there is only one live eel exporter in Thailand, which imports glass eel from China to culture in his farm and then export to China
Vietnam	16 t (2014)	Under Survey	

4.6 Status of Anguillid Eels in Aquaculture

Survival Rate Survey

One of the major activities of the aquaculture component of the project is to conduct a survey of aquaculture farms in AMSs focused in rearing glass eels to elvers to obtain information on species, source of seeds, feeds and feeding management, and factors which affect survival. So far, only farms in the Philippines have been surveyed with plans to conduct a similar survey in anguillid nursery farms in Vietnam. There have been eight (8) eel farms that have been surveyed from north to south of the Philippines in the provinces of Cagayan, Zambales, Laguna, Pampanga, Agusan del Norte and in the City of Davao. The following is the summary of the survey results:

- Farm Owner – three farms are owned solely by Filipinos; 3 farms each in partnership with Filipino and Japanese, Korean and Taiwanese nationals and 1 farm each owned by a Taiwanese and Japanese.
- Type of Farm – Most farms are indoor, with one farm having a combination of outdoor and indoor facilities. The farms focused on grow-out have indoor nursery facilities and outdoor grow-out ponds. The nursery operations of five farms rely on static-renewal system of

water change ranging from daily water change of 10 to 75% of the total water volume daily. One farm has a recirculating system and two farms have flow-through system.

- Scale of operation and farm capacity- Glass eels stocking capacity of farms range from 10 to 300 kg of glass eels per year. Size of nursery culture tanks vary from $4m^3$ to $500m^3$.
- Source of water- mainly deep-well or ground water
- Years in operation- Farms range from one to six years in operation
- Source of glass eels- mainly Aparri in Cagayan Province and the following areas in Mindanao: General Santos, Sarangani, and Davao.
- Post-transport survival of glass eel- generally high at 95% to almost 100%
- Price of glass eels on procurement- recent price (2017-2018) range from PHP 3,500 to PHP 5,000 per kilogram but pre-sorted glass eels with at least 90% *A. bicolor pacifica* are sold at PHP 20,000 to PHP 35,000 per kilogram (PHP 53 = USD 1)
- Quarantine & Conditioning Practice upon arrival of glass eels- Four farms observe quarantine practices while other rely on treatment of newly arrived glass eels to salt bath. One farm admitted to the use of some antibiotic upon arrival of the glass eels in the farm
- Stocking density- Initial stocking density of glass eels range from 1 to 12 pcs per liter.
- Feeds, Feed ration and feeding rate- Some farm use tuna eggs, *Artenia nauplii* or *Tubifex* spp. as initial feed for newly stocked glass eels, at least for a week to 10 days. The rest use commercially formulated diet while one farm formulates its own feed. In subsequent stages of the nursery rearing although there is a local feed company producing commercial diets formulated for tropical anguillid eels, most of the farms surveyed prefer to use feeds imported from China, Japan or Korea. The imported feeds give better results in terms of growth and survival according to the farm respondents. Feeding is normally done twice a day with the feed in dough form. One farm practice *ad libitum* feeding but the rest calculate feeding rate based on the standing biomass.
- Survival of glass eel to elver (at least 15 cm) – survival rates for 2017 ranged from 30 to 98%. Some farms had total mortalities at the initial stage of operation.
- Nursery rearing protocol – Size grading or sorting during the nursery rearing is done by all the farms from as early as one month after stocking. One farm claim to sort the eels monthly while others at a lesser frequency of every 2 months.
- Culture duration from glass eel to elver (at least 15 cm)- the shortest culture duration for fast-growing individuals is 3 months with the longest as 18 months. Most farms average 6 months to produce the elvers of the desired size. *A. bicolor pacifica* reach the target size at a generally shorter culture period compared to *A. marmorata*
- Suspected cause of mortalities – Farmers interviewed suspect bacterial and fungal infection as contributing to mortalities in the nursery. Poor water quality in the culture tanks also lead to mortalities. Poor quality of glass eels delivered to the farm by the suppliers also result in initially high mortalities of the glass eel stocks.
- Price of elvers (at least 15 cm)- Elvers of *A. bicolor pacifica* range from PHP 25 to PHP 48 per piece while that of *A. marmorata* is cheaper at PHP 10 to PHP 20 per piece. (PHP 53 = USD 1)

- Species identification – Except for one farm, all the farms surveyed are unable to identify visually the species of glass eels upon arrival at the farm. However, two consolidators in Mindanao claim to have skilled people who are able to visually sort glass eels enabling them to sell pre-sorted glass eels at a premium price.

Based on the survey of anguillid eel aquculture farms, the following issues have been identified and is hoped to be addressed:

- Species identification of glass eels
- Market promotion and value-adding for *A. marmorata*
- Lower the production cost
- Ensure reliable source of bloodworm and other live food
- Reduce rearing period from glass eel to 15 cm elvers from 6 months to 3 months
- Address disease problems e.g. gas bubble disease, fungal and bacterial infection
- Address illegal trade of anguillid eels, particularly glass eels need to be addressed
- Control unreliable suppliers/consolidators who promise to deliver goods
- Water quality problems
- Cost efficient feeds
- stable power supply and at lower cost to facilitate establishment of recirculating system

Nursery Rearing Experiments Conducted by SEAFDEC/AQD

Glass eels sourced from Aparri in Cagayan Province and General Santos City in South Cotabato were transported to the Binangonan Freshwater Station of SEAFDEC/AQD. Small scale nursery rearing experiments using different stocking densities as well as feeding trials using different types of experimental diets for glass eel nursery are being conducted. Experimental trials started only in October 2017 and are still on-going.

Each batch of glass eel samples (n=100 pcs/stock) was checked for species identity through preliminary morphometric examination of some diagnostic characters, such as tail pigmentation patterns (Figure 4.6A), total length and ano-dorsal length (Figure 4.6B) (Leander *et al.*, 2012). From the initial morphological assessment using the caudal patterns, it was noted that some species especially the long-finned eels like *A. luzonensis* and *A. marmorata*, were difficult to visually distinguish from each other. The protocol proceeded to having the samples, now with presumptive identities, genetically analyzed at the Onagawa Field Center, Tohoku University. DNA extraction and PCR amplification were done on all the samples for subsequent mtDNA marker analysis(Figure 4.6C). MtDNA sequence variation at cytochrome b and COI or cytochrome oxidase I marker genes were obtained. The mtDNA sequence information data (primarily good quality cyt b sequences as Figure 4.6D) were matched/compared with reliable databases using BLAST search for species identification and analysis of phylogenetic relationships. Results from the genetic analysis of the Aparri samples enabled the accurate identification of 77 pcs *A. luzonensis* among the stock, aside from 19 *A. marmorata*. Samples from General Santos City in Mindanao Island were validated as being composed of 95 *A. marmorata* and one *A. bicolor pacifica* based on cyt B sequence alignments. Table 4.6A shows the genetic diversity of the species examined in the study.

Figure 4.6A: Actual pigmentation patterns at the caudal fin of the following: (a) A. luzonensis, *(b)* A. marmorata, *(c)* A. bicolor pacifica *(viewed at 0.8X magnification) which were initially accurately identified through genetic marker analysis.*

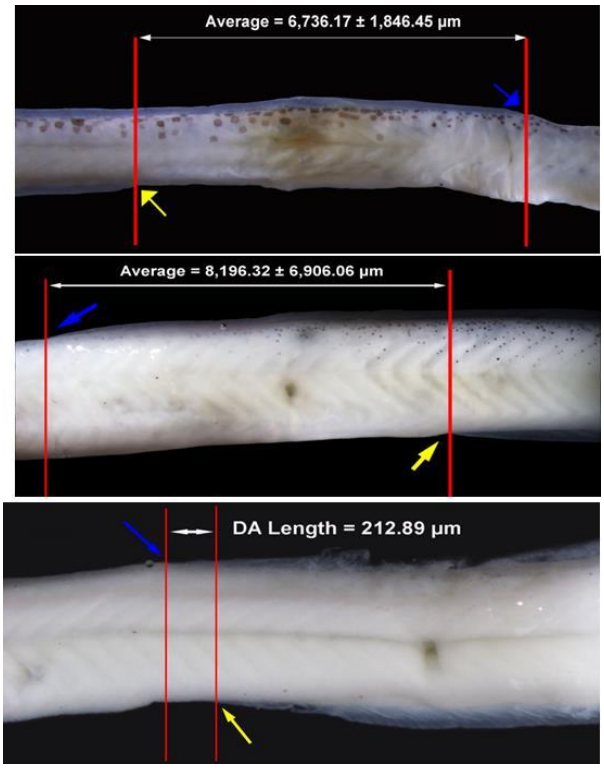

Figure 4.6B: Ano-dorsal length (DA) length of A. luzonensis, A. marmorata, *and* A. bicolor pacifica *as viewed in 0.8X magnification (Blue arrow: start point of dorsal fin, Black arrow: anus or start point of anal fin)*

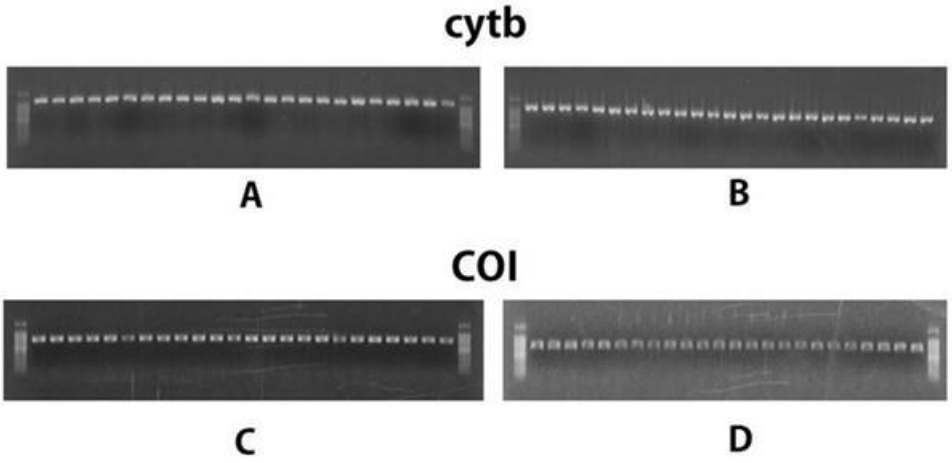

Figure 4.6C: Representative gels showing PCR products for mitochondrial cyt b (A: Aparri eel samples; B: Mindanao eel samples) and COI (C: Aparri eel samples; D: Mindanao eel samples) genes.

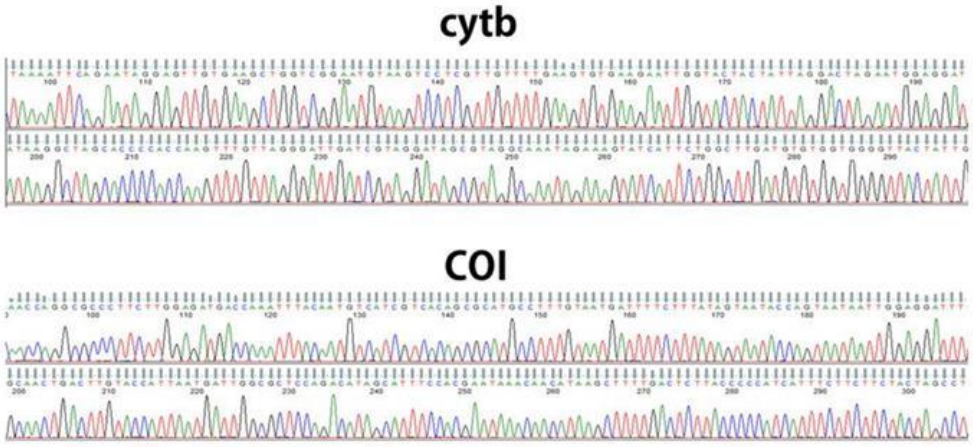

Figure 4.6D: Representative trace files showing good quality sequences of mitochondrial cyt b and COI genes of Aparri eel samples.

Table 4.6A: Genetic diversity of A. luzonensis *and* A. marmorata *from Aparri and Mindanao based on sequence polymorphism of mitochondrial cyt b gene (Note: n = no. of samples; Nhp = no. of haplotypes; h = haplotype diversity; π = nucleotide diversity)*

Sample source	Species	n	Nhp	h	π
Aparri	*A. luzonensis*	77	39	0.9477 ± 0.0145	0.0052 ± 0.0028
	A. marmorata	19	16	0.9825 ± 0.0223	0.0039 ± 0.0023
Mindanao	*A. marmorata*	94	39	0.9385 ± 0.0130	0.0032 ± 0.0019
Total		190	94	2.8687 ± 0.0498	0.0123 ± 0.0070

5. Tropical Anguillid Eels Resources: Regulations and Management Measures in the AMSs

5.1 Regulations and Management Measures in Each Country

Country	Organization (Arrangement of the Staff in charge)		Data Collection Scheme		Regulation to manage the eel fisheries	
	Current situation Name (title)	Future schedule	Current situation	Future schedule	Current situation	Future schedule
Brunei Darussalam	—	—	—	—	—	—
Cambodia	1) Mr. Buoy Roitana, Deputy Director General of Fisheries Administration (FiA); 2) Dr. Chea Tharith, Deputy Director, Marine Fisheries Research and Development Institute (MAFReDI), FiA.	The officers in charge of eels have been assigned for both in Central (Phnom Penh) and provincial (Kampong Cham) levels. The FiA needs capacity building for officers and data collectors	Only one Anguillid eel culture farm in Cambodia. The farm sends data and information to Kampong Cham Fisheries Administration Cantonment and SEAFDEC through MAFReDI	Data and information on Anguillid eel culture are sent to MAFReDI and Kampong Cham FiA Cantonment every 3months	MAFF's Proclamation on aquaculture of aquatic animals (6 July 2016): culture of eel from 600-1000 heads need permission from fishery office at provincial level and for more than 1000 heads, permission is obtained from the FiA.	If the culture of aquatic animals for export grows fast, exportation regulations will be needed.
Indonesia	1) Dr. Toni Ruchimat, Director of Centre for Fisheries Research, Board of Marine and Fisheries Research, Ministry of Marine Affairs and Fisheries 2) Mr. Coco Kokarkin Soetrisno Director for Fish Seeds Development, Directorate General of Aquaculture,-Ministry of Marine Affairs and Fisheries 3) Ms. Sri Dyah Retnowati SP, Head of Sub-Directorate of Inland Water Fish Resources, Directorate General of Capture Fisheries, Ministry of Marine Affairs and Fisheries. 4) Mr. Muhammad Anas, Head of Subdivision of Data, Directorate General of Capture Fisheries, Ministry of Marine Affairs and Fisheries	The staff in charge of eel have been assigned. The government will strengthen the capacity of local government officers working on eel fisheries and aquaculture.	Data on eel fisheries production (adult eels) and eel culture production are collected through the national data collection system, but not by species Data collection of glass eels has not yet been carried out	The government considers that the system of collecting eel catch data by species will be established in a few years. The eel import and export quantities will soon be collected by species.	Indonesia issued Ministerial Decree No. 19/ 2012 which prohibits the export of eel 150 gram/ind and below 150 gram/ind Indonesia has drafted its Fisheries Management Plan (FMP) on eels Indonesia has a National Plan of Action (NPOA) for eel conservation	Under the current general fishing law, detailed rules such as closed fishing season for glass eels and closed area for adult eel fishing are being studied
Lao PDR	—	—	—	—	—	—
Malaysia	—	—	—	—	—	—

Country	Organization (Arrangement of the Staff in charge)		Data Collection Scheme		Regulation to manage the eel fisheries	
	Current situation Name (title)	Future schedule	Current situation	Future schedule	Current situation	Future schedule
Myanmar	1) Mr.Myint Zin Htoo, SEAFDEC Alternate Council Director for Myanmar. 2) Mr.Tun Win Myint, SEAFDEC National Coordinator for Myanmar. 3)Mr.Myint Than Soe, Contact person for Department of Fisheries.	The Staff in charge of eel have been assigned .The Department of Fisheries will strengthen collaboration and cooperation with SEAFDEC to implement sustainable development of Anguillid eel resources and also to improve eel fishery and aquaculture.	According to current situation in Myanmar, there are weaknesses in the statistic data collection system for Anguillid eel.	Thus, the Department of Fisheries will make sure that collection system is improved and strengthened with support from SEAFDEC	DoF.Myanmar ,issued the directories on prohibits the collecting of *A.bicolor* and *A.bengalensis* during the spawning season from 1st June to 31st August every year [Ngala/Aqua.0 11/2006 (1538)]	Thus, the Department of Fisheries will try ensure that the needs and weaknesses of the management regulations are addressed with advise from SEAFDEC
Philippines	1) Dir. Eduardo Gongona, Director of the Bureau of Fisheries and Aquatic Resources (BFAR) 2) Ms. Drusila Esther Bayate Asst Director for Technical Services 3) Dr. Evelyn Ame Agri. Center Chief and Phil Eel Focal Person 4) Dr. Mudjekeewis Santos NFRDI in charge of DNA analyisis 5) Dr. Macmod Mamalangkap in charge of Eel survey in Mindanao Island.	The staffs in charge of eel have been assigned. The government will strengthen the capacity of local government units that have eel fisheries aquaculture under their jurisdictions; plan has been made to develop and conserve the eel fisheries in the country. Survey in Mindanao island will be conducted.	There is a list of eel farmers in the country However, reporting of data by the Philippine Statistics Office does not segregate data on Anguillid eels from that of swamp eels. Collect additional data from the National Stock Assessment Program (NSAP)	The amount of import and export of eels will be collected by species by BFAR. Traceability system will be imposed especially on the issuance of Local Transport Permits before any eel could be exported. Trade data will be used to segregate information on swamp and Anguillid eels.	1) Fisheries Administrative Order (FAO) 242 - banning the export of elvers less than 15 cm 2) FAO 233 - Aquatic wildlife conservation which include eels; 3) FAO 319 – includes the requirements for exporting live food fish and crustaceans 4) Philippine General Memorandum Circular Oder No 2 S 2009 includes the requirements for the export of live aquatic animals	Imposition of traceability system to include the Local Transport Permit, eel farm registration and collectors permit; and implementation of pertinent laws on transport of live aquatic products. Establishment of reference point of harvest control rules are now under public consultation
Singapore	—	—	—	—	—	—

Country	Organization (Arrangement of the Staff in charge)		Data Collection Scheme		Regulation to manage the eel fisheries	
	Current situation Name (title)	**Future schedule**	**Current situation**	**Future schedule**	**Current situation**	**Future schedule**
Thailand	1) Mrs. Umaporn Pimolbutr, Deputy Director General of Department of Fisheries (DOF) 2) Dr. Kanchanaree Pongchawee, Aquaculture system technology expert, contact person for DOF	DOF will cooperate with ASEAN countries to enhance the management of eel resources.	No glass eel fisheries in Thailand. Most of angullid eel are accidently caugh by crab traps. There are 3 Anguillid eel culture farms in Thailand. Yellow eel (*A. bicolor* and *A.marmorata*) were imported from Indonesia. Four species of anguillid eel have been found inThailand : *Anguilla bicolor, A. bengalensis, A. marmorata* and *A. australis*, but few quantities.	The data on Anguillid eel resources, aquaculture, import and export will be collected.	The regulation related to Anguillid eel: Import and export Europian eel (*Anguilla anguilla)* must obtain license issued by D.G. of DOF or a person assigned by D.G. Imported Europian eel must have a certificate from the competent authority of the exporting country.	DOF will fulfill Thailand's international obligations with regard to the conservation and management of aquatic resources
Viet Nam	Directorate of Fisheries (DFISH), Ministry of Agriculture and Rural Development	The capacity on the management of eel fisheries and aquaculture of local governments will be strengthened;	No offical statistical data. Provincial Sub-Department of Fisheries gathered data on eel catch and aquaculture from District Divisions of Agriculture and Rural Development. Summary reports are prepared regularly or upon request.	Statistical data on eel species' catch, aquaculture, import and export will be collected and integrated into national fisheries management database system.	1) Fisheries Law 2003 (amended in 2017, (entry into force in Jan 2019) 2) Red Book Viet Nam: *A. japonica* 3) Ministry decision: No.57/2008/QĐ-BNN. Eel aquaculture 4) Ministry decision: No.82/2008/QĐ-BNN regulating list of rare and endangered aquatic species: EW: *A. japonica*; VU: *A. bicolor, A. borneoensis, A. marmorata* 5) Circular No 04/2015: regulating conditional export of *Anguilla* spp. including *A. marmorata, A. bicolor,* and *A. japonica* (only for aquaculture)	Fisheries Law 2017 that enters into force on 1st. Jan 2019 provides provisions on eel fisheries and aquaculture, import and export. Government decrees and ministerial circulars are being drafted to provide detailed rules and regulations for the implementation of the Fisheries Law 2017.

5.2 Existing Regional Management Policy Recommendations in the ASEAN Region

Taking into account the urgent requirements for conservation and management of anguillid eels in Southeast Asia, the 36th Meeting of the SEAFDEC Program Committee in November 2013 requested SEAFDEC to spearhead the conduct of a study on eel resources with the collaboration of the Member Countries - covering the following issues: a) basic information on eel species in Southeast Asia; b) research on eel biology; c) eel fishery management measures; and d) sustainable aquaculture of eels. In this connection, SEAFDEC organized the 1st Regional Technical Meeting on Information Gathering of Eel Resources and Aquaculture Production in Southeast Asia on 27 January 2014 in Bangkok, Thailand, with the objectives of compiling information related to eel resources from the wild and status of aquaculture in the Southeast Asian Countries, and developing the way forward and establishing the network of eel experts from the Southeast Asian region. In addition, SEAFDEC also organized the 2nd Regional Consultation on Development of Regional Policy Recommendation on Sustainable Management of Eel Resources and Aquaculture Production in Southeast Asia in Palembang, Indonesia from 31 August to 1 September 2014, the results of which included the Regional Policy Recommendations and Strategic Actions for the Conservation and Management of Anguillid Eel Resources (*Anguilla* spp.) and Sustainable Development of Anguillid Eel Aquaculture in Southeast Asia. However, the ASEAN-SEAFDEC Member Countries consider that the proposed Policy Recommendations and Strategic Actions would require regional cooperation that would be aligned with the promotion of the ASEAN Economic Community in 2015. Such policy recommendations was therefore, raised for consideration and adoption by the 47th Meeting of the SEAFDEC Council in April 2015, and later was endorsed by the ASEAN Sectoral Working Group on Fisheries and supported by SOM-AMAFF in the same year (Appendix 4 and Appendix 5).

Results from the SEAFDEC study carried out starting 2017, which is based on the scientific evidence and information, could therefore be used to improve and/or adapt the existing regional management policy to ensure that the management policy recommendations cover the effective management measures not only at national but also at regional level, by including the regional commitments to support the sustainable utilization of the tropical anguillid eels in the Southeast Asia.

6. **Conclusion and Suggestions**

In 2017, an estimated production of capture fishery for both glass eel stage and yellow eel (or young eel) for *Anguilla bicolor (*including *A. bicolor bicolor*, *A. bicolor pacifica)* and *Anguilla marmorata* from the baseline survey indicates Indonesia is the largest fishing country in Southeast Asia having about 165.5 ton for yellow eels and about 11.5 ton of glass eel, respectively (see Figure 6A). In Myanmar, main commodity is yellow eels stage of *A. bicolor bicolor*, while less than 10% of *A. bengalensis* and *A. marmorata,* for a total production 12.84 ton in 2017. In Philippines, survey data before September 2017 shows that a total amount of 13.52 ton are mainly glass eels stages as *A. marmorata* found in the north of Luzon Island and Mindanao Island, while the main target species is *A. bicolor pacifica*. There is less than 1 ton of yellow eels are harvested. Taking into accounts, the project objective is to understand the actual status of capture fisheries by annual basis. Therefore it is suggested to cover all data harvested particularly in Indonesia which is largest countries. Furthermore, the geographic distribution of *Anguilla bicolor* in Southeast Asia (Parinthon, 2018 after Sugeha *et al*.,2008) as shown in Figure 6B indicates many locations where the *Anguilla bicolor* found and needs to be assessed. In addition, the UN-ComTrade indicates that Malaysia exports live anguillid eels to international market therefore it is better to clarify on this

matter for better understanding the overall situation in Southeast Asia.

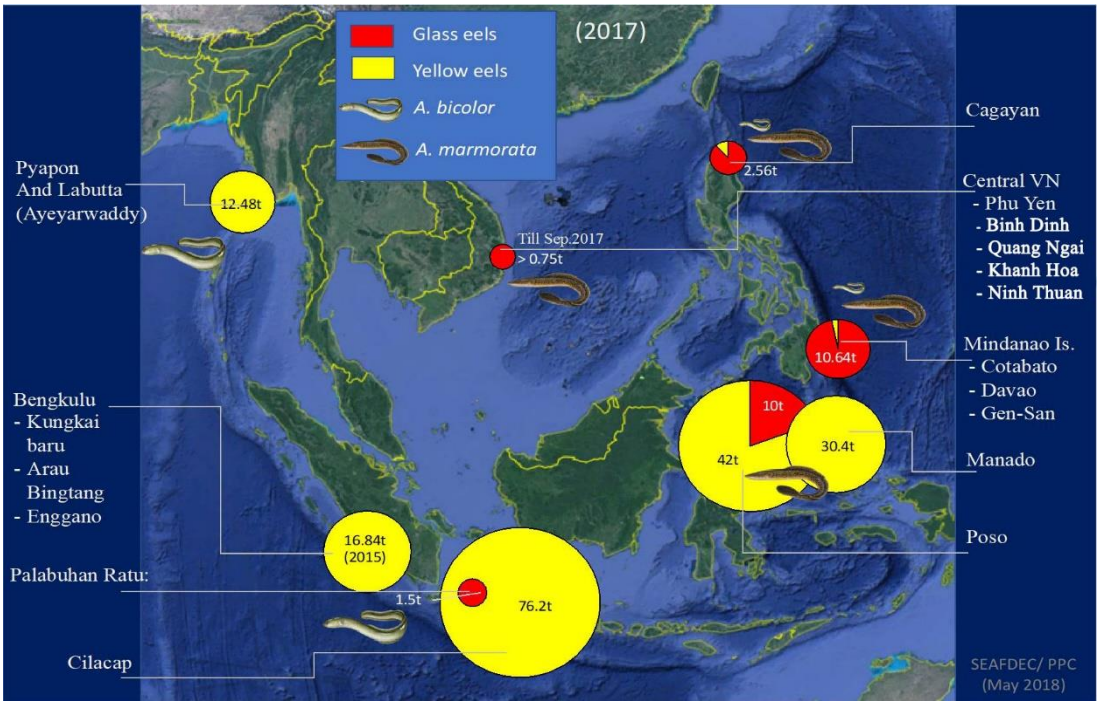

Figure 6A: The total productions of capture fishery for glass eel and yellow eel of Anguilla bicolor *and* Anguilla marmorata *in Southeast Asia.*

Figure 6B: Geographical Distribution of Anguilla bicolor *in Southeast Asia (Parinthon,2018)*

In connection to the above assessment of *Anguilla spp*. harvested by each AMS, and the reviews of international trade in tropical anguillid eels using the available data from UN ComTrade which is focused on the commodity HS-code 030192(HS2007) for live *Anguilla* spp. and the commodity code 030326 for frozen eels (*Anguilla* spp.), it is quite clear that the UN-ComTrade reported by some AMSs may not be accurate because the results from baseline survey in Indonesia, Myanmar, and Philippines indicated that the export data of live *Anguilla* spp. to international market throughout custom system including large quantity of swam eels (*Monopterus* spp.) and snake eels (*Pisodonophis* spp.). The study also find out that in the process of exportation of live eels by country, the exporter weight live eels by species before exportation under the Harmonized

Standard Code of 30192 (for *Anguilla* spp.). However, because there is **no specific HS-code for swam eels and snake eels**, therefore all live eels are recorded into the same HS-Code for Live eels (*Anguilla* spp.) The study suggested that it is better to consult with Custom to create another live eels code for swam eel and snake eels separately. In addition, some AMSs, Fisheries Department is not authorized for import-export permit which cause difficulty for inspection and monitoring import and export of live eels for *Anguilla* spp. To solve this problem, the project also suggests applying the Catch Documentation Scheme (CDS) such as ASEAN Catch Documentation Scheme to control in and monitor of overall trade flow of any anguillid eels fishery products from point of catching to exportation are needed. In addition, the ACDS for tropical anguillid eels will support understanding the status and trends of anguillid eels and provide the effective sustainable fisheries management in long term.

Genetic diversity and population structure studies are widely accepted in the role of stock assessment and fisheries management. These studies are required to support the project outputs since genetic diversity determines the survival and adaptability of a species when the environment of population's habitat changes (NBII, 2011). The more genetically diverse the population, the more fit these are to adapt and survive. On the other hand, population structure describes how these variants are distributed. The study of tropical anguillid eel is mainly proposed to identify fish stocks accurately as this has important implications in fishery resource conservation and management. Several population genetic structure researches of widely distributed *Anguilla* spp. were done to understand their population. But there is still lack of information about genetic relationship of *Anguilla* spp. in Southeast Asia. Therefore, the project may need to focus more on genetic diversity for *Anguilla* spp. throughout the major part of the Indo-Pacific region.

ACKNOWLEDGEMENT:

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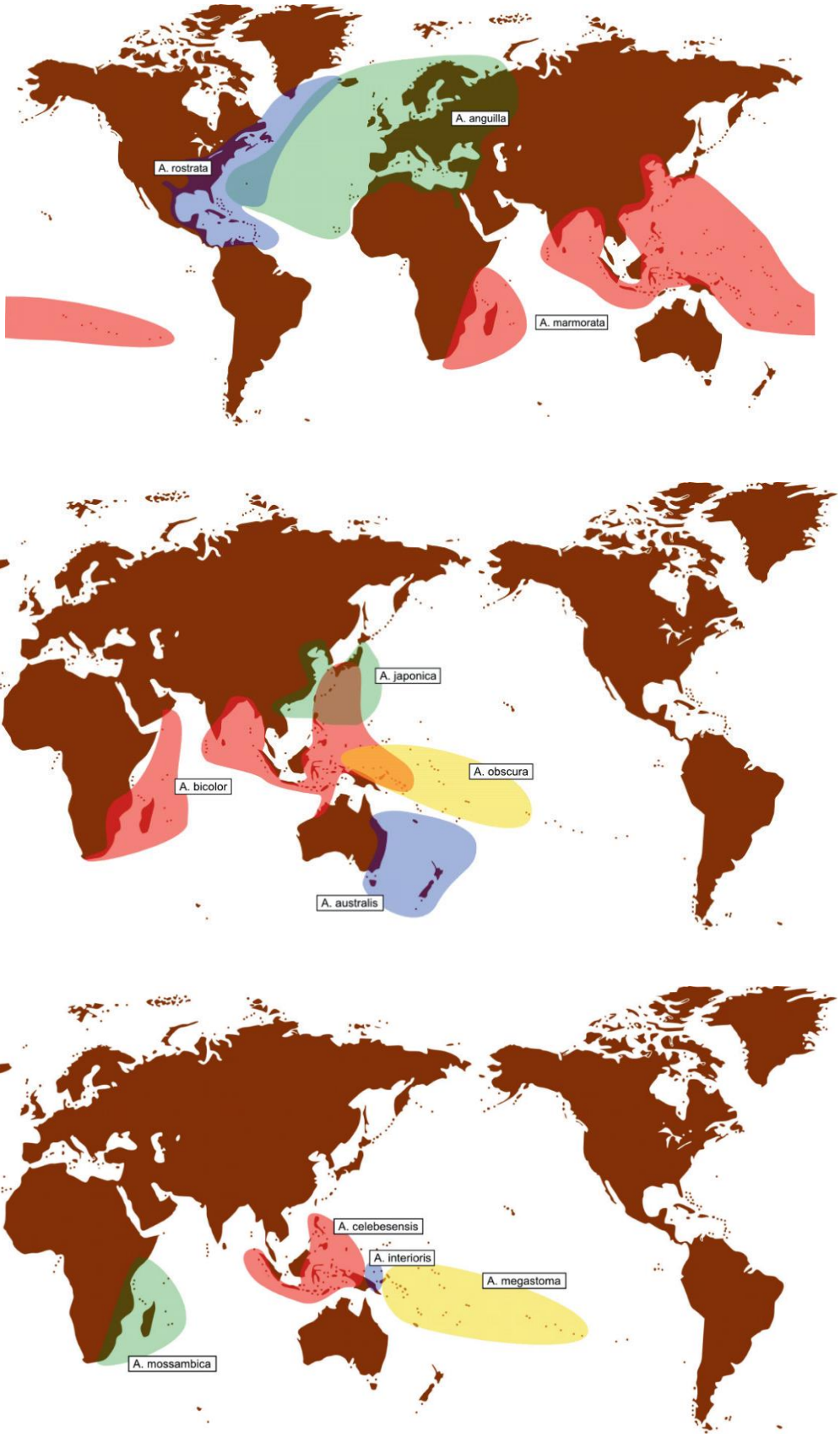
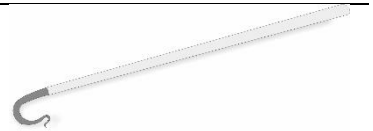
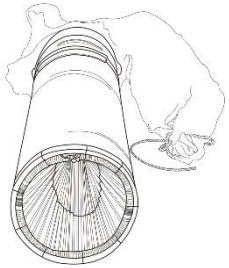
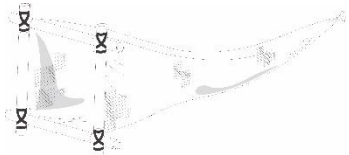
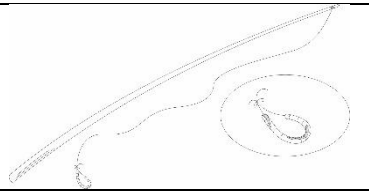
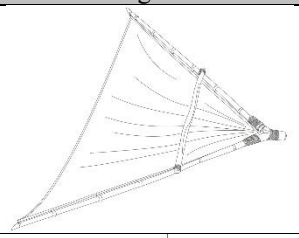
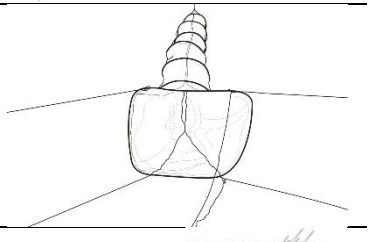
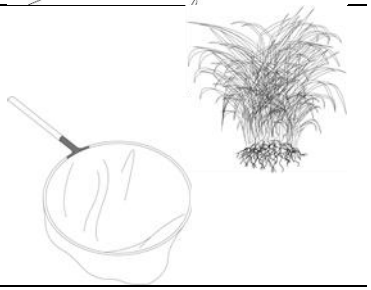
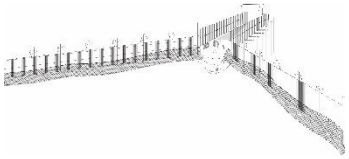
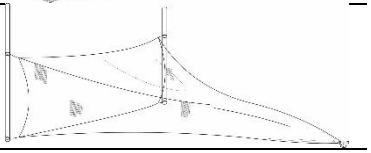
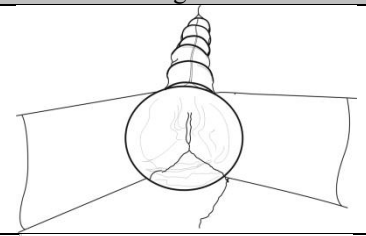
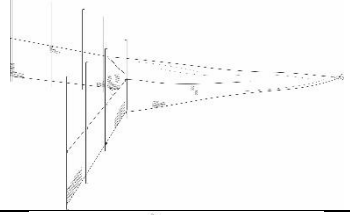
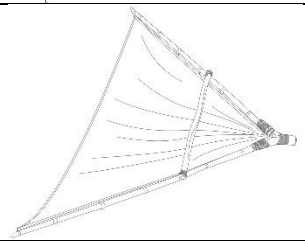
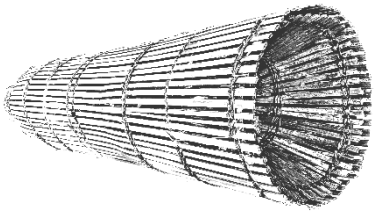
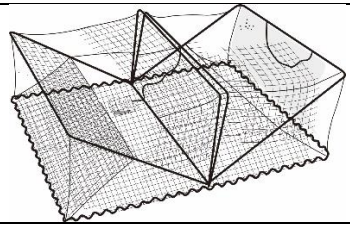
Appendix 1: Geographical Distribution of Freshwater Eels Worldwide (Anguillidae) (from Silfvergrip (2009)).

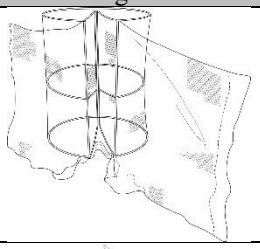
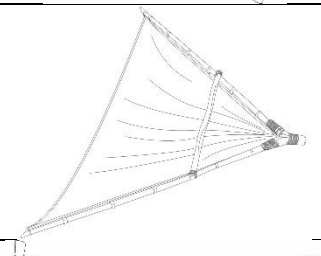
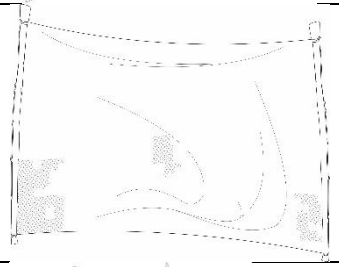
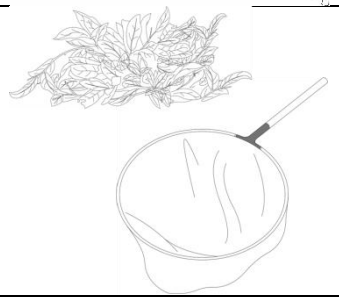


Appendix 2: Eel Fishing Gears in Southeast Asian Countries

Country	Fishing gear	Target size	Fishing location	Operation time	Specification/Information	Figure
Cambodia	Centipede - shaped fishing net	Snake eels	In rivers	Set in rivers at night and hauling the next morning	The main target is crab, but oftentimes Angullid eels are also caught	
	Hook	Snake eels	In shallow waters of rivers	Whole day, low tide	The main target is not only eel species but also other fishes	
	Long line	Snake eels	In rivers	Whole day	The main target is not only eel species but also other fishes	
Indonesia	PVC pipe trap	Elvers and yellow eels	In rivers, tributaries, irrigation canals, swamp areas	Starting from 5 PM and hauling at 5 AM	• Made of PVC pipe with additional net in the bottom side • Snails put in the small bag net are used as the bait	
	Stow net	Yellow eels (snakehead eels)	In irrigation canals and small rivers	Set during rainy season (especially during floods or when water current is strong), hauling every 30 minutes but completes when catch starts to decline	• The frame is made of bamboo with 10 m net attached to the back side • Used only in rainy season	
	Stick and line	Yellow eels	In rivers, tributaries and canals	Operated at night, especially during new moon from 9 PM until 2 AM	• Wooden stick and a line used to catch yellow eels • Big earthworms used as the bait	

Country	Fishing gear	Target size	Fishing location	Operation time	Specification/Information	Figure
Indonesia (Cont.)	Triangle scoop net	Glass eels and elvers	In mouth of rivers and downstream side of dams	• Glass eels: Operated from 9 PM until 2 AM • Elvers: Operated from 8 PM until abundance declines	Made of wooden sticks and small mesh-size net	
	Fyke net	Glass eels and elvers	In mouth of rivers and downstream side of dams	Gear is set 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	Elver	In shallow waters of irrigation weirs	Operated from 8 PM until 12 PM in rainy season	• Small scoop nets are used to scoop elvers hiding under grasses • Operated only in rainy season	
	Barrier trap	Yellow eels	In the middle of rivers	Operated only 2 days per month, set at night, and hauled at 6 AM	• A traditional fishing gear • Made from pieces of bamboo formed into a barrier with additional bag net at the center of the trap	
Myanmar	Crab trap	Yellow eels	In rivers	Set in rivers at night and hauled 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	

Country	Fishing gear	Target size	Fishing location	Operation time	Specification/Information	Figure
Philippines	Fyke net	Glass eels	In middle sides of rivers	Set from 5 PM and hauled at 3 AM	• The frame is made of circle 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	
	Fence net	Glass eels	At sides of rivers	Set 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	
	Push net	Glass eels	In mouth of rivers	Operated during the night for 3 hours	• Similar in Indonesia, this gear has a triangle shape • Made of wooden sticks and covered with a small mesh-size net	
	Bamboo trab	Yellow eels	In rivers	Set in rivers whole day and hauled 4 times a day	Made from bamboo, the diameter of gear specific to the expectation size of eels.	
Thailand	Crab trap	Yellow eels	In rivers and mangrove areas	Set at night and hauled the next morning	The main target is crab, but eels are oftentimes caught accidentally	

Country	Fishing gear	Target size	Fishing location	Operation time	Specification/Information	Figure
Viet Nam	Fence net	Glass eels	In rivers	Operated from 5 PM until 10 PM	• The frame is made of circle 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	In mouth of rivers and downstream of dams	Operated 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	In downstream of dams	Operated from 6 PM until 2 AM	Made of two wooden sticks and a small mesh-size net, being operated by two fishers	
	Fish aggregating device	Glass eels	In downstream of dams	Operated two times per day •From 3 PM until 5PM •Ffrom 5 AM until 8 AM	• Made from branches of trees (Ky Lo River) and grasses (Ba River) • Small scoop net is used to scoop glass eels hiding under the gear	

Appendix 3: Survey of Anguillid Eel Farms in the Philippines

Parameter	OAP	FWFVR	AFF	CARC	MEAFC	AAC	CAV
Owner	Filipino-Korean partnership	Filipino	Taiwanese	Filipino-Japanese partnership	Japanese	Filipino	Filipino
Location	Cabangan, Zambales	Magalang, Pampanga	Magalang, Pampanga	Cabadbaran, Agusan del Norte	Davao City	Binan, Laguna	Victoria Laguna
Type of Farm	Static-renewal; twice daily water replacement of 50-75%;	flow-through system	flow-through; with some vegetation to absorb excess nutrients	static renewal	Static-renewal; 50% water replacement after feeding	recirculating system provided with aerators, UV filters, biofilters, mechanical filters, foam fractionator, and oxygen generators; 10% of total water volume replaced daily; indoor	Static-renewal both indoor and outdoor facilities
Final product	elvers	elvers and grow-out (for *A. marmorata* due to lack of market for elvers)	elvers and grow-out (50% elver and the rest is grow-out average 1 kg/pc)	grow-out	elvers	elvers	elvers
Scale of operation	8 tanks of 200m2 each	9 units of concrete tanks 3x12m	60-70 small tanks of various sizes	4.5 ha area for eel (out of total farm area of 95 ha)	15 units 2x2m tanks; 5 units 5x5m tanks	10 units of 60 m3 circular tanks which they plan to expand to 20 units	16 units of 500 ton capacity concrete tanks and smaller rectangular indoor tanks
Source of water	deep well	ground water	ground water	deep well	deep well	Deep weel	Deep well
Farm capacity	250-300kg glass eel/year ; 1 million elvers/year	200,000 pcs glass eels or about 40 kg glass eels	33 kg glass eel per year	140 kg glass eels/year; 2017 annual production is 60 ton; in 2018, average of 7 ton per month	10-12 kg glass eels/year (60,000 to 70,000 pcs); plan to expand to 300,000 pcs/year	42,000 pcs kuroko or 250 kg	3 million kuroko/cycle, with each cycle lasting 6 months
Years in operation	3	6	5	5	1.5	2	4
Source of glass eels	Aparri, Davao and Gen San	Gen San, Cotabato, Davao and Cagayan (high mortalities)	Cotabato (40%) and Aparri (60%) due to availability	Gen San and Aparri	Ladol River, Alabel, Sarangani Province	Aparri and Davao	Aparri and South Cotabato
Post-transport survival of glass eel	almost 100%	almost 100%	almost 100%	99.90%		95%	95%
Price of glass eels on procurement	PhP 3500 - 4000	PhP 15,000/kg highest price paid 6 years ago; PhP3500/kg from Cagayan and Mindanao	PhP 50,000/kg highest price paid; PhP 3500-4000/kg	PhP20000 to 30000/kg of pre-sorted glass eels with 99% *A. bicolor pacifica*	PhP 30,000 to 35,000 per kg of pre-sorted glass eels (95%) *A. bicolor pacifica*	PhP 3500 to 17500/kg	PhP 3000/kg

Parameter	OAP	FWFVR	AFF	CARC	MEAFC	AAC	CAV
Price of glass eels on procurement	PhP 3500 - 4000	PhP 15,000/kg highest price paid 6 years ago; PhP3500/kg from Cagayan and Mindanao	PhP 50,000/kg highest price paid; PhP 3500-4000/kg	PhP20000 to 30000/kg of pre-sorted glass eels with 99% *A. bicolor pacifica*	PhP 30,000 to 35,000 per kg of pre-sorted glass eels (95%) *A. bicolor pacifica*	PhP 3500 to 17500/kg	PhP 3000/kg
Quarantine & Conditioning Practice upon arrival of glass eels	no quarantine; treatment with salt bath only; some usage of antibiotics like OTC and neomycin	no quarantine; only acclimation of glass eel upon arrival in farm	practiced as needed	2 days quarantine	2 days quarantine to observe for diseases	35ppt salt bath for a minute; antibiotic oxytetracycline (OTC) is also used	40ppt salt bath where the glass eels are immersed for 30 seconds to 1 minute.
Feeds and Feeding practices	Feed sourced from China with 1% higher CP than feeds from Korea but is cheaper (e.g. US$70 per 20kg bag from Korea (plus shipping cost) while China feed cost only US$52 per 20 kg bag including shipping; do not use local feeds due to bad experience	formulate own feed using 65% fish meal ground and mixed with tilapia fry mash to dough form	use tilapia fry mash, no other ingredients added	initial feed is tuna eggs and or Japan-made feeds with 60% CP (PhP12,000/kg) for first 20 days; 52% CP for next 2 months; CP52% for next 2 months; CP48% to grow-out	Used feeds purchased from Cabadbaran farm; no uses only Tateh eel Feeds; looking for alternative feeds from China	blood worm (*Tubifex* sp) for the first week at a daily ration of 10 to 12% wet weight basis; Weaning from live feed to formulated diet is done once the eels reach one gram; powdered inert diet with 52% crude protein sourced from China is made into dough consistency;	initial feed used is tuna eggs and blood worm; Commercial feeds imported from Taiwan, Korea and Japan at 54% crude protein; gradual weaning from fresh feed to commercial diet;
Feed ration/Feeding rate	Feed efficiency is 70-80% for big eels and 40-50% for smaller eels	demand feeding		start at 10% BME; based on sliding scale; 2x a day feeding	sliding scale feeding rate	twice daily at a ration equivalent to 5% biomass on dry weight basis Feeding is twice a day, ad libitum.	Ad libitum feeding twice daily
Survival glass eel to elver	claim of farm manager 98%; but computation from actual data is only 57-80%	80% for *A. bicolor pacifica*; 40% for *A. marmorata* for glass eels to elver	20% first year; 50% 2nd year; 60% current survival	98%	95% (based on interview) 81-95% based on reported production	3%- 70%	70-80%
Survival from elver to grow-out		90%	no data provided	64% survival (inferred from interview data)			

Parameter	OAP	FWFVR	AFF	CARC	MEAFC	AAC	CAV
Nursery rearing protocol	size grading/sorting after 2.5 to 3 months; 10% of slowest growers are discarded at the first and second size grading	size sorting at 2 months	size sorting monthly	size grade every 2 months	partial replenishment as stocks are sold	Sorting/size grading after 1 month; Stocking density is 1 kg/m^3 for glass eel.	50 to 100 pcs/m^3
Culture duration from glass eel to elver	6-8 months before elver size for export	glass eel to elvers grow in 4 to 5 months	16 months for *A. bicolor pacifica* and 18 months for *A. marmorata*	3 to 5 months	6-7 months (40%); 12 months to sell all in the batch	5-6 month	5-6 month
Culture duration from glass eel to grow-out	not applicable	2 years to grow *A. marmorata* to 1 kg; 12-14 months to grow to 300g	36 to 38 months to grow to 250g	8 to 18 months to grow-out to marketable size (200g)		not applicable	not applicable
Suspected cause of mortalities	none given	fungal infection and ick	bacterial and fungal infection of glass eels			problems with "gas bubble" disease	fungal infection
Price of elvers	PhP2500/kg	PhP 25/pc for *A. bicolor pacifica*; PhP25/pc for 200pcs/kg; PhP30/pc for 100pcs/kg	PhP 40/pc of *A marmorata* and PhP48/pc *A. bicolor pacifica* (Taiwan price)	no saleof elvers	PhP 30 to 40/pc depending on volume and supply (140-150 pcs/kg elvers)	PhP10.00/pc for *A. marmorata*; PhP30.00/pc for *A. bicolor pacifica*	PhP10.00/pc for *A. marmorata*; PhP30.00/pc for *A. bicolor pacifica*
Species identification	only once eels reach bigger sizes	no skill; only when eels have grown can they be identified		Technician able to identify species at glass eel stage	pre-sorted glass eels are procured	Only at 1 g size with 70% success rate	Only for bigger sizes; difficulty in identification at glass eel stage
Stocking density	2 glass eels per liter	1 per liter	6.25 per liter	1.1 per liter for glass eel; reduced to 0.4/liter after elver; reduce to 0.13 per lieter oginal growout	0.8 per liter of glass eel		
Other Observations/Comments	bulk of produce exported to Korea; with a few to Taiwan	elvers sold locally but buyers export to Taiwan and Japan; *A. marmorata* grown to 300g to 1 kg size sold at PhP650/kg; Davao eel showed best survival	no water quality management; owner has grow-out operations in Taiwan; 30% cheaper to grow out elvers in Taiwan than in the Philippines; bigger elvers (70pcs/kg) are sent to Taiwan	has eel processing plant in the farm; based on Japanese technology; export live eels to Japan; awaiting HACCP certification to export processed eels	exported to Taiwan (Mr. Otah lives in Taiwan) and the rest exported to japan via middlemen; farm production is currently short of more than 100,000 pcs based on demand	Grow-out of *A marmorata* to marketable size unintentional due to lack of buyers of the species	Mainly Korean and Japanese buyers

Appendix 4: Policy Recommendations for the Conservation and Management of Catadromous eel Resources in Southeast Asia[2]

I. SUSTAINABILITY OF THE RESOURCES

ISSUES AND CONCERNS	STRATEGIC ACTIONS	POLICY RECOMMENDATIONS
1) Unclear status and trends of eel resources/fisheries 2) Decline in landing of glass eels 3) Inadequate information on ecology, biology, habitat, distribution, and migration of different species 4) Lack of appropriate and practical methodology for species identification 5) The difficulty in handling the fish way for eel stepping using CCTV camera	*Improve data collection for stock assessment* • Review the existing data/information (including collection historical data) from relevant agencies in the ASEAN Member States (AMSs) • Improve time series data collection on resources and rate of utilization of eels (adults, elvers, biomass of glass eels, etc.) • Develop appropriate technology/methodology for identification of eel species available in the region (*e.g.*, for glass eels apply molecular techniques) to assess the heavily exploited species • Improve collection of national statistics at species level (or at least at the genus level) • Analyze data and information to understand the status and trend of eel resources • Develop and implement R&D Programs on ecology, biology, habitat, distribution, and migration and recruitment of different eel species • Assess the causes in the decline of landing of glass eels • Engage regional fisheries bodies to support the AMSs in data collection • Install CCTV in the surface of the water where the eel pass	▪ Establishment of regional cooperation on data sharing of information on landings, and species composition of glass eels collected from various sources, in order to provide baseline information for stock assessment and management of eel resources ▪ Effective control and surveillance toward compliance upon laws and regulations ▪ Strengthen coordination with the water power plant or another related sector dealing with eels life cycle habitat.

[2] The results from the 2nd Regional Consultation on Development of Regional Policy Recommendation on Sustainable Management of Eel Resources and Aquaculture Productions in the Southeast Asia, 31 August – 1 September 2014, Palembang, Indonesia.

II. HABITAT MANAGEMENT

ISSUES AND CONCERNS	STRATEGIC ACTIONS	POLICY RECOMMENDATIONS
1) Degradation of habitats 2) Cross-river obstacles that inhibit migration 3) Lack of monitoring of the effectiveness of habitat management	• Identify critical habitats including migratory routes • Ban collection of glass eels in critical habitats • Rehabilitate critical habitats (*e.g.*, promote the incorporation of fish pass in weir construction) • Develop measures to allow the escape of silver eels to their spawning habitats • Monitor the effectiveness of habitat management activities implemented in the AMSs	▪ Identification and conservation/ rehabilitation of critical habitats including migratory routes

III. REGULATIONS AND MANAGEMENT MEASURES

ISSUES AND CONCERNS	STRATEGIC ACTIONS	POLICY RECOMMENDATIONS
1) Inadequate regulations and management measures specifically for eels, such as: Input Control System, *e.g.* licensing for harvesting, effort, gear restriction; zoning; closed season; etc. 2) Illegal trade/export of glass eels and elvers 3) Inadequate monitoring of the effectiveness of management measures	• Improve enforcement of existing laws and regulations to ensure maximum compliance • Establish laws and regulations for management of eels as applicable to respective AMSs • Legalize trading of glass eels within the AMSs in accordance with national laws and regulations as well as Sanitary and Phyto-sanitary (SPS) requirements • Implement effective management of fisheries through an ecosystem approach to fisheries (EAFM) that integrates habitat and fishery resource management aimed at increasing the social and economic benefits to all stakeholders • Encourage the compliance of management measures based on international instruments, *e.g.*, UNCLOS Convention Article 67	▪ Consider the application of the precautionary approach for sustainable utilization of eel resources in spite of insufficient data and information (could include limitation of harvest and trading of certain stages of eels) ▪ Establishment of traceability/certification system for trading of glass eels and elvers ▪ Strengthening of the enforcement of laws and regulations, including through capacity building and intelligent investigation ▪ Every AMSs develop a notification and send to importing countries to not trade eel with size <150 g

IV. STRENGTHENING OF INFORMATION AND EDUCATION CAMPAIGN (IEC)

ISSUES AND CONCERNS	STRATEGIC ACTIONS	POLICY RECOMMENDATIONS
1) Lack of awareness of stakeholders on impacts of glass eel fishing activities, degradation of habitats, and resource status	• Conduct massive awareness building and educational campaign on the impacts of fishing activities, degradation of habitats, and resource status to all stakeholders (*e.g.* fishers, consumers, local traders, exporters, public, etc.)	▪ Promotion of massive awareness building activities and educational campaigns on the impacts of fishing activities, degradation of habitats, and resource status to all stakeholders (*e.g.* fishers, consumers, local traders, exporters, public, etc.) through considering the EAFM approach

V. REGIONAL COOPERATION FOR MANAGEMENT FRAMEWORK

ISSUES AND CONCERNS	STRATEGIC ACTIONS	POLICY RECOMMENDATIONS
1) Unauthorized/Illegal trading of glass eels as inputs for eel aquaculture in the region 2) Lack of regional collaborative management on monitoring of eel fisheries management	• Harmonize intra-regional trade of glass eels for aquaculture proposes within the AMSs • Develop the system of monitoring the exact catch and fishing effort, and complying with control measures • Establish protocols for cross-border movement of eels species in accordance with the FAO Guidelines on Responsible Movement of Live Aquatic Animals	▪ Establishment of regional policy and guidelines on the collection, handling, transporting, cross-border movement, and trading of glass eels among AMSs as inputs for eel aquaculture in the region

VI. CROSS-CUTTING ISSUES

ISSUES AND CONCERNS	STRATEGIC ACTIONS	POLICY RECOMMENDATIONS
1) Unclear marketing system 2) Unstable price of glass eels 3) Oceanographic changes/climate change 4) Lack of post-harvest technology and product development	• Undertake study on marketing and pricing system of eels • Monitor-the impacts from El Niño and La Niña to harvesting of glass eels for future analysis • Develop post-harvest technology and product development-for eels	▪ Improvement of marketing system, with due consolidation of existing markets and development of new markets ▪ Conducting studies / R&D of eel processing into refined products which favored by the public / consumers of local / regional and international. ▪ Capacity building on eel processing technology

Appendix 5: Policy Recommendation for Sustainable Development of Catadromous eel Aquaculture in Southeast Asia[3]

I. DEVELOPMENT OF SUSTAINABLE AQUACULTURE TECHNOLOGY AND PRACTICES

ISSUES AND CONCERNS	STRATEGIC ACTIONS	POLICY RECOMMENDATIONS
1) Lack of technologies on breeding and larval rearing of eels 2) Inadequate methodology for species identification of glass eels used for aquaculture 3) Low survival rate of glass eels gathered from the wild.	• Develop guidelines on best practices for collection, transportation and handling of wild-caught glass eels for aquaculture to ensure maximum survival • Learn from experience of Japan and other East Asian countries and areas to adapt technology for aquaculture of eel species developed in these countries and areas as model to accelerate development of eel aquaculture in the region, and on identification of glass eel species for aquaculture • Promote the business segmentation to eel grow up business • Develop eel/ fish way mapping • Develop technology on the eel feed formulation	▪ Sharing of experience among ASEAN Member States on practices for collection, transportation and handling of wild-caught glass eels for aquaculture ▪ Establishment of cooperation and conduct of regular interaction among experts, the academe and institutions, as well as with relevant aquaculture business entrepreneurs working on eel aquaculture within and outside the region to fast-track aquaculture development of eel species into the AMSs and other advanced countries ▪ Development of technology for tropical eel aquaculture ▪ Establishment of good aquaculture practices for sustainable development ▪ Strengthening of the enforcement of laws and regulations on eel aquaculture

II. MANAGEMENT OF EEL AQUACULTURE

ISSUES AND CONCERNS	STRATEGIC ACTIONS	POLICY RECOMMENDATIONS
1) Inadequate regulations on eel aquaculture 2) Inadequate data number of companies/farms engaged in aquaculture, quantity of glass eels used, production from aquaculture	• Establish regulations on eel aquaculture, *e.g.*, registration and licensing of eel aquaculture farms, effective monitoring by government authorities, and requirements for reporting the source of	▪ Application of ecosystem approach for the management of eel aquaculture ▪ Habitat reparation/ rehabilitation of the damaged fish way of eels

[3] The results from the 2nd Regional Consultation on Development of Regional Policy Recommendation on Sustainable Management of Eel Resources and Aquaculture Productions in the Southeast Asia, 31 August – 1 September 2014, Palembang, Indonesia

ISSUES AND CONCERNS	STRATEGIC ACTIONS	POLICY RECOMMENDATIONS
3) Lack of traceability system on the source of stocks for eel aquaculture	glass eels for aquaculture and production output • Countries with existing eel aquaculture should monitor inputs used and production • Develop traceability system/certification of origin for cultured eels	▪ Application of precautionary approach on management of eel aquaculture ▪ Development of measures that would ensure that promotion of eel aquaculture would not impact on the natural eel populations

III. REGIONAL COOPERATION ON SUSTAINABLE DEVELOPMENT OF EEL AQUACULTURE[4]

ISSUES AND CONCERNS	STRATEGIC ACTIONS	POLICY RECOMMENDATIONS
1) Fragmented development of technologies on eel aquaculture by individual countries 2) Lack of regional situation on harvest of glass eels and eel aquaculture production	• Consolidate information and knowledge on eel aquaculture technologies among the AMSs • Share information on eel aquaculture industries among the AMSs	▪ Sharing of information on eel aquaculture technologies among countries in the region. ▪ Strengthen the market information on eel aquaculture ▪ Development of regional guidelines on best practices for eel aquaculture

IV. CROSS-CUTTING ISSUES

ISSUES AND CONCERNS	STRATEGIC ACTIONS	POLICY RECOMMENDATIONS
1) Poor handling/transporting of glass eels 2) Inadequate information on the impacts of aquaculture to the environments	• Improve fish handling and transportation processes to reduce high mortality of glass eels for aquaculture • Promote responsible movement of eels in the AMSs • Develop a regulation to enclose the document of origin for eel seed distribution.	▪ Designated port of entry and port of exit for carrier vessels transporting eels product

[4] The meeting take note the recommendation from Indonesia to "establish the ASEAN Eel Association", while the issue will be raised again at the forth coming 23rd ASWGFi by Indonesia.