CURRENT STATUS AND PROBLEMS OF THE CATCH STATISTICS ON ANGUILLID EEL FISHERY IN INDONESIA

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ABSTRACT

To compensate the decline of the populations of temperate anguillid eels, tropical anguillid eels become getting attention of East Asian eel market in recent years. Many eel farms have been established in Java Island to culture tropical anguillid eels intending to export the products to East Asia. Since eel farming is reliant on wild-caught anguillid eels such as glass eels, elvers and yellow eels, these eel seeds have been captured in various places in Indonesia. However, it is still unknown that how much of tropical anguillid eels are caught as seeds for eel farming. This study showed two different patterns of the commodity chains of eel seeds from both Sukabumi Regency and Bengkulu Province to the eel farms in Java Island. Official catch statistics on anguillid eels found in both Sukabumi Regency and Bengkulu Province were also analyzed on their features and problems underlied. Considering the sustainable use of anguillid eel resources and critical stances on exploitation of eel seeds from all over the world, the Indonesian government should take an immediate action for developing the national catch statistics on anguillid eel fishery as soon as possible.

Keywords: tropical anguillid eel, glass eel, commodity chain, statistics, eel fishery

INTRODUCTION

The international market for cultured eels exceeded 200,000 t in 2000 and reached the peak as 275,014 t in 2009 (FAO, 2015). However, resources of temperate anguillid eels such as Japanese eel (*Anguilla japonica*), European eel (*A. anguilla*) and American eel (*A. rostrata*) decreased rapidly in recent years. Both Japanese and American eels have been classified into "Endangered", European eel has been classified into "Critically Endangered" species on IUCN Red List (Jacoby and Gollock, 2014a; Jacoby *et al.*, 2014a; Jacoby and Gollock, 2014b). European eel has also been listed on CITES Appendix II, and its international trade has been restricted since 2009 (CITES, 2015a).

To compensate the shortage of supply from these temperate anguillid eels, tropical anguillid eels represented by shortfin eel (*A. bicolor*) become getting the attention of East Asian eel

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market in recent years (Jacoby *et al.*, 2014b). The large-scale eel farms, many of them were funded by foreign investors, have been established mainly in Java Island since late 2000's and started culturing tropical anguillid eels (Farmi, 2014).

Eel farming, including the cases of tropical anguillid eels, is reliant on wild-caught anguillid eels such as glass eel, elver and yellow eels as seeds for culture (Crook and Nakamura, 2013). These seeds are collected and captured in various places in Indonesia then transported to the eel farms in Java Island. Since eel seeds are also natural resources, the decrease and collapse of anguillid eel resources caused by overfishing may occur. However, it is quite difficult to know how much eel seeds are fished in Indonesia in the present situation.

In this paper, we investigated two different patterns of the commodity chains of eel seeds for aquaculture, about the location and distance between the fishing ground and eel farms. We also explained some official statistics and the other information of anguillid eel fisheries that we found along with the commodity chains of eel seeds, with some critical issues. Finally, we recommended the need of establishing national statistics on anguillid eel fishery and developing the inventory system of catch statistics on eels in Indonesia.

MATERIALS AND METHODS

Investigations were conducted at two study sites; one was Palabuhan Ratu (also called Pelabuhan Ratu), and the other one was Bengkulu. Palabuhan Ratu is the administrative capital of Sukabumi Regency, West Java Province, located on the southwest coast of West Java facing the Indian Ocean. There is the Cimandiri River, and the fishing ground of glass eel is formed at its river mouth. Bengkulu is the administrative capital of Bengkulu Province, located on the southwest coast of Sumatera Island and also facing the Indian Ocean. There are some rivers with a variety of their width in its scale (Figure 1).

The data on official statistics of anguillid eel catch and shipment were collected from the officers of the local governments of both Sukabumi Regency and Bengkulu province, also at Fatmawati Fish Quarantine Station of Fatmawati Soekarno Airport, Bengkulu. The additional information on anguillid eel fisheries such as opening and closing season of glass eel fishery and the maximum number of glass eel fisherman at the peak season at the mouth of the Cimandiri River, and some other non-quantitative information were obtained by interviewing with the fisherman, eel collectors (middleman/traders specialized in treating the eel seeds) and eel farmers in the region.

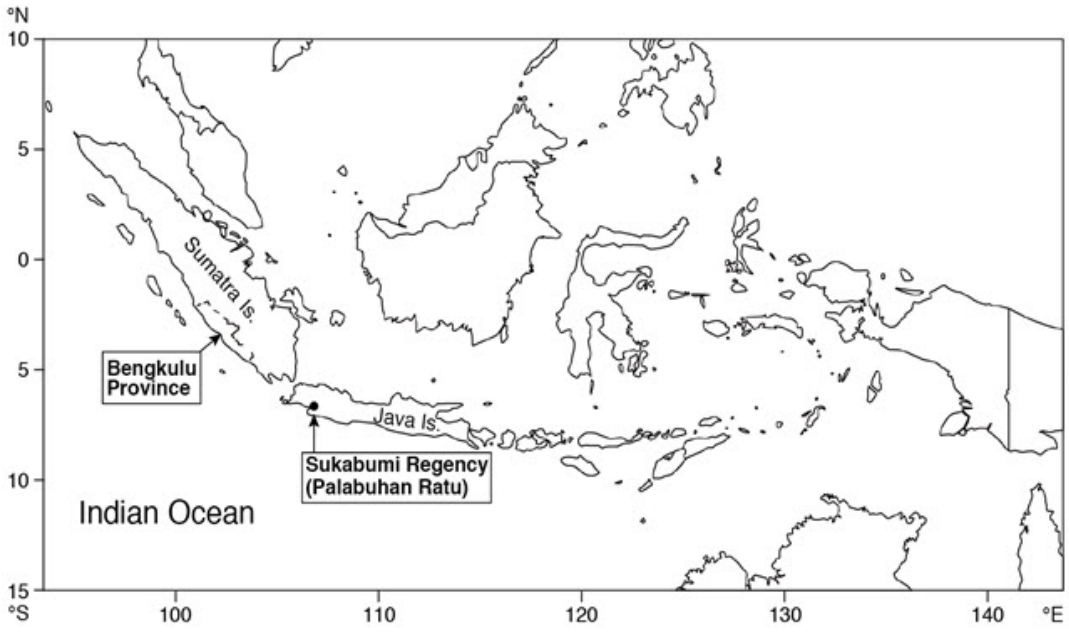

Figure 1. Map of two study sites (Sukabumi Regency and Bengkulu province)

RESULTS

Commodity chains of eel seeds for farming

The distribution routes of eel seeds for farming are clarified with reflecting the features of the distance between the fishing ground and eel farms.

Upper diagram of Figure 2 shows the distribution route of glass eel captured in Sukabumi Regency to the eel farms schematically. At first, fishers catch glass eels at the mouth of the rivers in Sukabumi Regency, represented by the Cimandiri River, using scoop net. Next, eel collectors gather glass eels from fishers, rearing the glass eels for a few days in their temporal rearing tank, then transport them to the eel farms. These glass eels are reared in the eel farms to the marketable size. Finally, eels are processed to baked eel called "Unagi-kabayaki", a Japanese style cuisine. Since almost all the eel farms in Indonesia locate in Java Island, glass eels captured in Sukabumi Regency are transported by land (Soetanto, personal communication).

Lower diagram of Figure 2 shows the distribution route of yellow eels captured in Bengkulu Province to the eel farms in Java Island schematically. At first, fishers catch yellow eels, not glass eels, in the middle basin using traps called "Bubu". Next, eel collectors gather yellow eels and then send them to the eel farms located in Java Island by air. These yellow eels are reared in the eel farms to the marketable size. Finally, eels are processed to "Unagi-kabayaki" too.

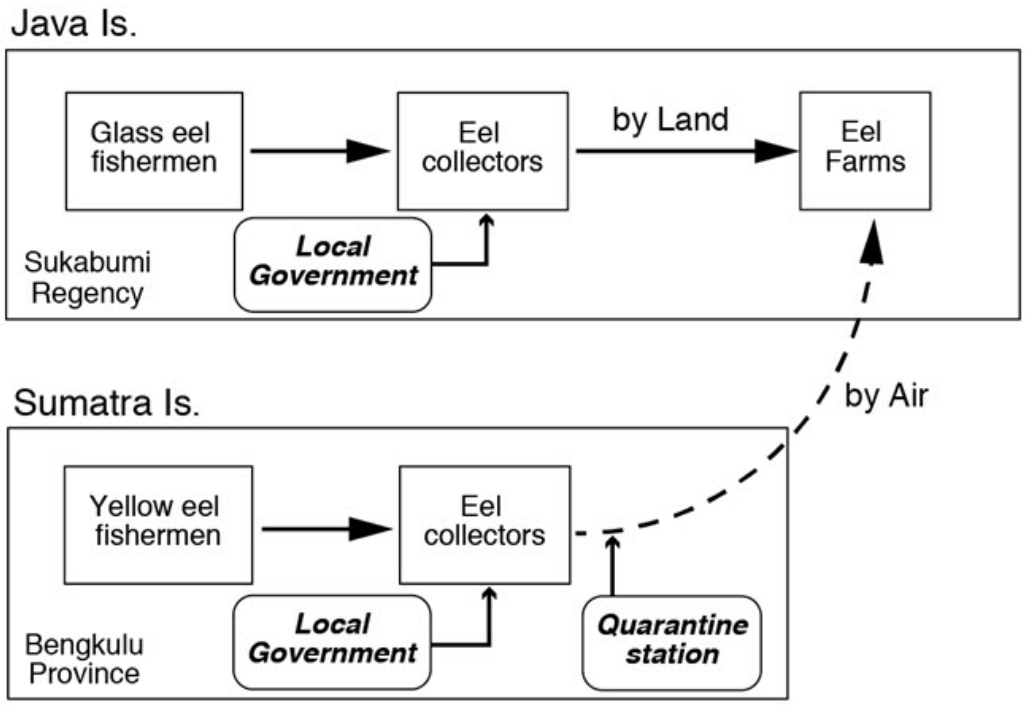

Figure 2. Schematic figure of the distribution routes of eel seeds and the points for collecting statistics by the authorities on its commodity chains in Java and Sumatera Islands, Indonesia

Catch statistics in Sukabumi Regency

Along with these commodity chains of eel seeds, three different kinds of catch and shipping statistics on eel seeds were found, one was in Sukabumi Regency, the other two statistics were in Bengkulu Province.

In 2014, the local government of Sukabumi Regency collected a monthly catch and trade statistics of anguillid eels at each stage in Sukabumi Regency, including Palabuhan Ratu (Table 1, Figures 3 - 4). As shown in the upper diagram of Figure 2, the local government officers collected catch data of anguillid eels at each stage through eel collectors (Leni, an officer of local government of Sukabumi Regency, personal communication). However, it is necessary to exercise caution when interpreting these statistics

at each stage in relation to its classification criteria of juvenile anguillid eels. There were four stages and size categories of anguillid eel catch, “Glass eel stage I” (transparent) and “stage II” (pigmented as black on the whole body), “Elver” (3 - 5cm in length), and “Product size” (larger than 5cm). Since the features of their body color and size ranges of each stage were not described on the original statistics, all these classification criteria described in the brackets were based on the interview with the officer in local government of Sukabumi Regency. However, it seems that these classification criteria are skeptical and may contain misunderstanding on both the features and size ranges at each stage. Despite these possible problematic issues on classification and definition at each stage of juvenile anguillid eels, we use these criteria as is, because it was the only information that we had gotten on the statistics. The problems on classification criteria are discussed later.

Table 1. Monthly catch statistics of anguillid eels with transaction at each stage in Sukabumi Regency, Indonesia in 2014 (Local government of Sukabumi Regency, 2015)

Month (2014)	Glass eel Stage I		Glass eel Stage II		Elver		Product size	
	Catch (kg)	Transaction (IDR in thousands)	Catch (kg)	Transaction (IDR in thousands)	Catch (kg)	Transaction (IDR in thousands)	Catch (kg)	Transaction (IDR in thousands)
Jan.	37.8	94,500	67.5	101,250	1,876.5	750,600	576.8	86,520
Feb.	26.7	66,750	87.6	131,400	1,346.3	538,520	867.4	130,110
Mar.	45.7	114,250	95.6	143,400	1,024.7	409,880	658.4	98,760
Apr.	27.7	69,250	56.8	85,200	1,056.7	422,680	345.2	51,780
May	18.5	46,250	16.7	25,050	756.4	302,560	367.7	55,155
Jun.	21.7	54,250	25.9	38,850	472.5	189,000	257.5	38,625
Jul.	68.7	171,750	67.5	101,250	843.6	337,440	167.3	25,095
Aug.	78.3	195,750	65.8	*98,700	756.4	182,920	214.8	32,220
Sep.	70.6	176,500	73.6	110,400	472.5	120,560	257.5	17,070
Oct.	112.6	171,750	87.6	101,250	573.8	337,440	138.6	25,095
Nov.	214.7	195,750	198.4	*98,700	367.2	182,920	178.5	32,220
Dec.	235.7	176,500	150.8	110,400	254.2	110,560	219.4	17,070
Total	**958.7**	**1,533,250**	**993.8**	**1,145,850**	**9,800.8**	**3,885,080**	**4,249.1**	**609,720**

*Both total sales of “Glass eel Stage II” in Aug. and Nov. were corrected into 1/10 from the original figures by authors considering the unit price (See Fig. 5).

Figure 3 shows the monthly catch at the stage of anguillid eels in Sukabumi Regency in 2014. This graph demonstrates the difference of peak seasons of catch at each stage. The amount of glass eel catch (both “Glass eel stage I” and “Stage II”) peaked at the year-end of 2014. On the other hand, “Elver” and “Product size” were caught much at the beginning of the year 2014 then gradually decreased toward the end of the year.

The monthly trends of the transaction volume and the annual sales of anguillid eels at each stage are shown in Table 1 and Figure 4. These indicate that the total sales of “Elver” in 2014 (Indonesian Rupiah (IDR) 3,885 million) was higher than the total of “Glass eel stage I” and “Stage II” (IDR 2,679 million) and accounted for 54% of the total sales of anguillid eels in Sukabumi Regency in 2014.

The monthly trends of the unit prices of anguillid eels at each stage in 2014 are also calculated from both monthly catch and monthly transaction at each stage (Figure 5). This figure shows two interesting things. One is the younger stages of anguillid eel were more expensive (like “Glass eel stage I” and “Stage II”), older and grown stages of anguillid eel became cheaper (“Elver” and “Product size”). Another one is that the unit prices of anguillid eels kept same prices through first three-quarters then the unit price of glass eel suddenly fell in the last quarter in 2014.

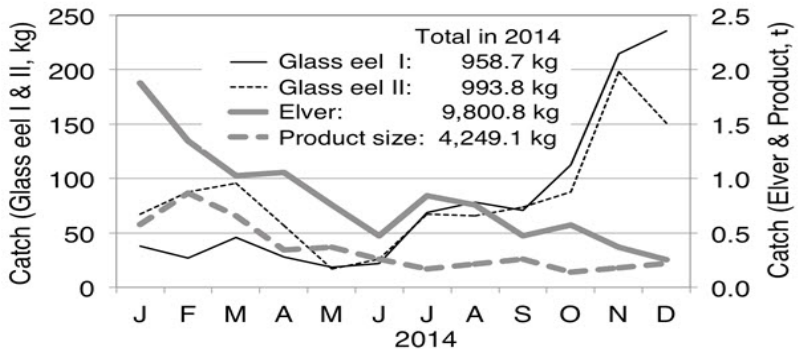

Figure 3. Monthly catch statistics of anguillid eels at each stage in Sukabumi Regency in 2014 (Local government of Sukabumi Regency, 2015)

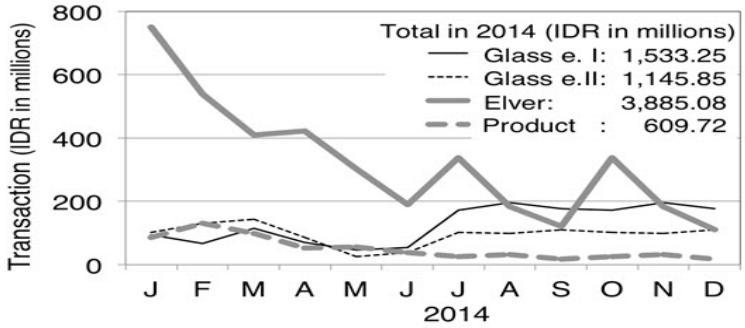

Figure 4. Monthly statistics of transaction of anguillid eels at each stage in Sukabumi Regency in 2014 (Local government of Sukabumi Regency, 2015)

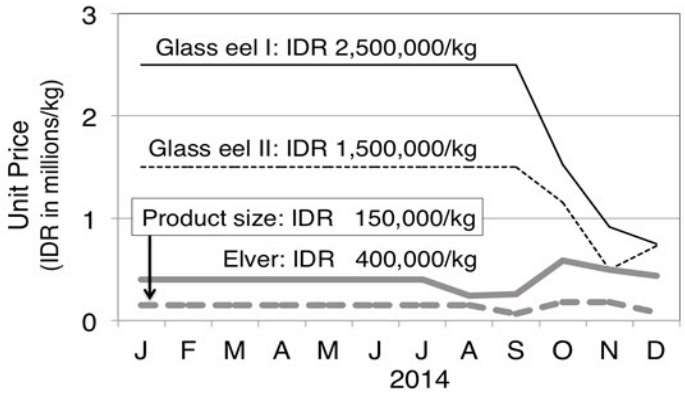

Figure 5. Monthly trends of the unit prices of anguillid eels at each stage in Sukabumi Regency in 2014, derived from the catch statistics and the transaction of eels shown in Table 1, Figs. 3 and 4. Prices in the graph indicate the unit prices of each stage when the prices were stable in first half of the year

The numbers of individuals and the average price of one individual of both "Glass eel" and "Elver" caught in Sukabumi Regency in 2014 were also estimated under the following assumptions. We had adopted the average weight of "Glass eel" as 0.17g from certain eel farmers in West Java as a results of the acceptances of glass eels in 2014, (Anonymous, personal communication). On the other hand, there was no information regarding the average weight of elver with 3–5cm in length that was caught in West Java in 2014. Although there are several kinds of literatures that show the length – weight relationship of glass eels in West Java and other places in Indonesia (Sugeha and Suharti, 2008; Hakim *et al.*, 2015; Sugeha and Genisa, 2015), there are only a few references which denote the weight range of juveniles named "elver".

Therefore, we set four different conditions of the average weight of "Elver" as 0.5, 1.0, 2.0 and 10.0g, heavier a little or quite than that in glass eels (0.17g) with referring from the literature which described the weight range of the elver of *A. bicolor bicolor* caught in India, ranging 0.16 - 2.0g with 55 – 100mm in length (Dorairaj *et al.*, 1980). As a result of the estimation, there were 11,485 thousand individuals of glass eel were caught in Sukabumi Regency in 2014. Regarding "Elver", it varied widely with the assumptions of the average weight of "Elver". Under the assumption that the average weight of "Elver" was 0.5g, annual catch of "Elver" was estimated as 19,602 thousand individuals and it was much greater than that of "Glass eel". Under the different condition of average weights of "Elver" as 1.0, 2.0 and 10.0g, estimated annual catches of "Elver" decreased inversely as follows, 9,801, 4,900 and 980 thousand individuals respectively. In this connection, unit prices of "Glass eel stage I and II", "Elver" under the several assumptions of their average weight are also shown in the right column of Table 2.

The statistics that we have gotten were limited only in 2014 up to the present. Although we had confirmed that there are successive catch statistics on anguillid eels from 2013 to 2015 (Leni, personal communication), we have not received them yet and therefore we could not use these data for analyses in this paper.

Catch/Shipping statistics in Bengkulu

The local government of Bengkulu Province had collected the yearly statistics of yellow eel catch and its transaction at each Regency in Bengkulu Province from 2009 to 2013 (Table 3). It was assumed that the local government officers would collect the catch data on anguillid eels from the eel collectors same as in Sukabumi Regency though, it has not been confirmed in its specific method of data collection (lower diagram in Figure 2).

Another kind of statistics on anguillid eel in Bengkulu Province has been collected at the quarantine station in the airport (lower diagram in Figure 2). When eel collectors sent yellow eel from Bengkulu to eel farms in Java Island by air, Fatmawati Fish quarantine station in Fatmawati Soekarno Airport in Bengkulu recorded the monthly quantity of shipping yellow eels in 2014, except December (Table 4). Although the statistics also, contain the number of individuals, these figures are automatically calculated from the monthly weight under the assumption that one individual of eel weighs 200g on average.

Table 2. Monthly catch statistics of anguillid eels with transaction at each stage in Sukabumi Regency, Indonesia in 2014 (Local government of Sukabumi Regency, 2015)

Stages	Annual transaction (IDR in thousands)	Annual catch weight (kg)	*Unit price at 1 kg (IDR/kg)	**Avg. weight (g)	No. ind. at 1kg (ind./kg)	Annual catch in No. (x 103 ind.)	***Price at ind. (IDR)
Glass eel Stage I	1,533,250	958.7	1,599,301	0.17	5,882	5,639	272
Glass eel Stage II	1,145,850	993.8	1,152,999	do.	do.	5,846	196
Glass eel Stage I+II	2,679,100	1,952.5	1,372,138	do.	do.	11,485	233
Elver (0.5g/ind.)	3,885,080	9,800.8	396,404	0.5	2,000	19,602	198
Elver (1.0g/ind.)	do.	do.	do.	1.0	1,000	9,801	396
Elver (2.0g/ind.)	do.	do.	do.	2.0	500	4,900	793
Elver (10.0g/ind.)	do.	do.	do.	10.0	100	980	3,946

* Unit prices of eel at 1kg at each stage are calculated by a weighted mean of monthly catch, transaction, and also weight ratio between "Glass eel Stage I" and "Glass eel Stage II" (Table 1).

** Avg. weight of "Glass eel" was assumed based on the interviews with certain eel farmers (pers. comm.). Variety of Avg. weight of "Elver" was selected by referring to the literature described the size and weight of *A. bicolor bicolor* elver in India; 55 - 100mm in length and 0.16 - 2.0 g in weight (Dorairaj *et al.*, 1980).

Figure 6 shows the yearly catch/shipping statistics of yellow eel in Bengkulu Province, combined with both catch statistics (2009 - 2013) and shipping statistics (January to November 2014). It seems that the amount of shipment of yellow eel in 2014 rapidly increased, three times higher than the total catch in 2013 and before.

Although we inquired both the local government and the quarantine station to confirm the existence of previous and latest statistics, we have not gotten any replies from them yet.

DISCUSSION

Eel fishery and catch statistics in Sukabumi Regency

According to certain eel farmers whom we interviewed with, the mouth of the Cimandiri River is one of the largest glass eel fishing grounds in Indonesia. More than 1,500 part-time fisherman scooping the glass eels in the peak season (in preparation). Fahmi and Hirnawati (2010) showed that 86% of the glass eel caught in the Cimandiri River was *A. bicolor bicolor*. From these results, it is expected that the total amount of glass eel of *A. bicolor bicolor* and its fluctuation supplied from the Cimandiri River are grasped roughly on the catch statistics of anguillid eels in Sukabumi Regency.

Table 3. Yearly catch statistics of yellow eel with transaction at each Regency in Bengkulu Province from 2009 to 2013 (Local government of Bengkulu Province, 2015)

Regency	Catch weight (kg) / Transaction (IDR in thousands)	2009	2010	2011	2012	2013
South Bengkulu		450	2,000	2,600	1,550	4,000
		11,200	43,500	62,500	53,625	100,000
Rejang Lebong		100	4,000	100	1,060	1,200
		2,000	95,000	2,500	24,780	23,040
North Bengkulu		3,000	4,200	2,300	5,370	1,600
		60,000	105,000	92,000	149,250	40,000
Kaur		2,000	5,000	0	5,200	5,200
		50,000	115,000	0	200,000	260,000
Seluma		5,400	11,000	6,000	7,000	6,000
		110,000	267,500	180,000	177,000	204,000
Mukomuko		1,000	6,800	6,000	2,300	1,600
		20,000	170,000	180,000	51,000	24,000
Lebong		1,000	0	0	2,280	800
		24,500	0	0	55,000	10,000
Kepahiang		840	0	0	0	0
		21,000	0	0	0	0
Bengkulu city		120	3,000	2,500	2,000	4,000
		3,000	70,500	100,000	50,000	100,000
Central Bengkulu		0	1,200	2,000	8,900	2,000
		0	30,000	60,000	288,401	40,000
Total		13,910	37,200	21,500	35,660	26,400
		301,700	896,500	677,000	1,049,056	801,040

***Prices of one individual of eel at each stage and conditions are calculated by a weighted mean of monthly transaction and number of catch at each stage and conditions.

It seems that the time lag of the peaks of catches between "Glass eel" and "Elver" indicates the seasonal migration pattern and subsequent growth of juveniles of anguillid eels in Sukabumi Regency (Figure 3). That is, glass

Table 4. Monthly statistics of yellow eel shipping from Fatmawati Soekarno Airport in Bengkulu in Jan.-Nov., 2014 (Fatmawati Fish Quarantine Station, Bengkulu, 2015)

Month	No. times of shipping	*No. ind.	Weight (t)
Jan.	8	8,700	1.74
Feb.	6	6,825	1.37
Mar.	10	54,240	10.85
Apr.	7	11,757	2.35
May	13	25,200	5.04
Jun.	8	18,550	3.71
Jul.	10	25,800	5.16
Aug.	7	218,700	43.74
Sep.	5	15,600	3.12
Oct.	8	14,118	2.82
Nov.	9	17,033	3.41
Total	**91**	**416,523**	**83.30**

*Number of individuals were calculated from the total weight with the assumption that average weight at individual would be 200 g.

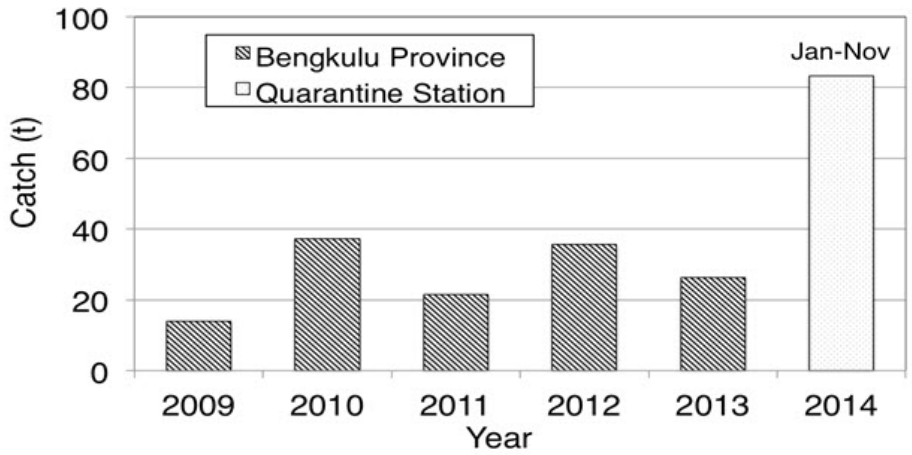

Figure 6. Combined bar graph of both yearly catch statistics of yellow eels in Bengkulu Province from 2009 to 2013 (Local government of Bengkulu Province, 2015) and shipping statistics in Jan.-Nov. 2014 (Fatmawati Fish Quarantine Station, 2015)

eel migrates to the shore of Sukabumi Regency facing the Indian Ocean in the fourth quarter then are captured at the river mouths. At the beginning of the next year, many of the glass eels they had reached last year end grow into elver then captured. According to the information obtained from glass eel fisherman, eel collectors and eel farmers relying on the eel seeds taken from the river mouth of the Cimandiri River, the glass eel fishery opens with the the rainy season and the peak of the catch comes in both beginning (fourth quarter) and ending (second quarter) of the rainy season. This information matched the trend of glass eel catch in Sukabumi Regency in 2014. The first peak of glass eel fishery also matched with the surge of glass eel collection in the fourth quarter in the catch statistics, despite the fact that the second peak had not detected in the statistics though. This hypothesis basis on only one year of catch statistics and therefore the year-end of 2014 was not adjacent to the beginning of 2014. If we can get successive catch statistics on anguillid eel in both 2013 and 2015 successfully in future, this hypothesis can be verified in detail, with comparison of the other studies regarding the migration season of glass eels toward the Indian Ocean side of Java Island (Arai *et al.*, 1999; Sugeha and Genisa, 2015).

Interestingly, the annual transaction of "Elver" in 2014 exceeded that of "Glass eel" (Table 1, Figure 4). Despite the weighted mean of unit price of "Elver" in 2014 (IDR 396,404/kg) was only 25 - 34% of that of "Glass eel" (stage I: IDR 1,599,301/kg, stage II: IDR 1,152,999/kg) (Table 2, Figure 5), total amount of catch of "Elver" in 2014 (9.8t) was five times higher than the total amount of "Glass eel" catch in 2014 (1.9 t). These results indicate that much amount of catch of "Elver" in weight pushed up the total sales of "Elver" higher than that of "Glass eel" in 2014 (Table 1). However, it is rather skeptical from the perspective of the estimated catch numbers (Table 2). It is natural thought that the assumed weight of elver ranging 3-5cm in length weighs 0.5 - 1.0g at most, based on the literature (Dorairaj *et al.*, 1980). Under the assumption of 0.5g of the average weight of "Elver", estimated number of "Elver" catch (19,602 thousand ind.) exceeded the number of "Glass eel" catch (11,485 thousand ind.). Under another option as 1.0g was adopted, estimated number of "Elver" catch (9,801 thousand ind.) reached 85% of the number of "Glass eel" catch. It seems that these estimated number of "Elver" catch are too much comparing to the number of "Glass eel" catch. As described above, Sukabumi Regency including Palabuhan Ratu is a famous place as one of the biggest glass eel fishing grounds in Indonesia. As we mentioned before, there are over 1,500 fisherman collecting glass eel, not containing elvers nor larger ones, at the river mouth of the Cimandiri River in the peak season to meet the demand of the eel farmers as seeds for culture (in preparation). Considering such features and targeted stage of anguillid eel fishery in Sukabumi Regency, estimated number of "Elver" catch under the assumptions that their average weight as both 0.5 and 1.0g are overestimated in comparison with the estimated a number of collected "Glass eel". These results indicate that the average weight of "Elver" in the catch statistics must be heavier than 1.0g, and therefore, the size range of 3-5cm in length for "Elver", noted by the official of the local government, must be too small.

These results suggest the possibilities of contamination of errors in the catch statistics. One conceivable error is the opportunity to over-estimation of annual catch of "Elver". Another possible error is the misunderstanding of the size range of "Elver". Unlike glass eel, classification criterion between elver and yellow eel is rather vague and often varies by person and area. For instance, if the "Elver" contained the bigger individuals who were larger than 5cm in length and their average weight was 10g, estimated the number of "Elver" catch decreased into 980 thousand individuals, less than one-tenth of the estimated number of glass eel catch. This would be acceptable result considering the features of anguillid eel fisheries in Sukabumi Regency. Also, the classification criterion between "Glass eel stage II" and "Elver" has the question too. In general, "glass eel" means juveniles of anguillid eels with clear bodies, while already pigmented juveniles are called "elvers" (Arai *et al.*, 1999; Tesch, 2003; Silfvergrip, 2009; Sugeha and Genisa, 2015). If these classification criteria would apply to the stages on the catch statistics on anguillid eels in Sukabumi Regency, "Glass eel stage II (pigmented as black on the whole body)" must be regarded as "elver" instead of "glass eel". Although the names of juvenile anguillid eels such as "glass eel" and "elver" are commonly used in the anguillid eel fishery and eel farming industry, the definition and biological criteria of them are vague. Crook and Nakamura (2013) pointed out that the terms "glass eels" and "elvers" were often used interchangeably on its size ranges at each area, country and also the species. Bertin (1956) showed the biological stages of both larval and juvenile stages of anguillid eels with characteristics of emerging of the pigmentation and their position of the body. To prevent the misunderstanding and unify the stages of juvenile anguillid eels among the areas, countries and species, introducing these biological criteria to the authorities who collect and establish the catch statistics on juvenile anguillid eels is one of the preferable measures.

Eel fishery and catch statistics in Bengkulu Province

There are two features on anguillid eel fishery in Bengkulu Province. One is its target size and stage of eels. According to certain eel farmers, rearing glass eel into elver needs high-level technique of eel culture. Many middle and small-scale eel farms in Indonesia have not overcome this barrier yet and have to start eel farming from yellow eels (unpublished). This condition creates the demands for yellow eels as seeds. Another feature is the adoption of air transportation to

take eel seed from Bengkulu, Sumatera Island, to eel farms in Java Island, because of its great distance. This condition brought us the chance to find alternative statistics collected by fish quarantine station at the airport.

Combined bar graph of catch statistics (Table 3) and shipping statistics (Table 4) of yellow eels indicates the abrupt increase of catching a yellow eel in 2014 (Figure 6). However, this surge of eel catch and shipping in 2014 should be carefully interpreted, because of the difference in their data sources. Since the catch statistics in 2009 - 2013 and the shipping statistics in 2014 are collected independently by different offices with different criteria, it is not certain whether both statistics could express the same target (= eel catch) and attributes, the same standard on measuring the weight and so on. Because of the absence of overlapping period between both statistics, it is also difficult to evaluate the existence of an "offset" between two statistics. If additional statistics in successive years could be obtained successfully in future, it will promote the verification of anguillid eel catch and shipping then enable us to evaluate catch trend on anguillid eel in Bengkulu Province by cross-checking between two different statistics. Regardless of these problems in the present situation, the existence of the other sources of statistics, such as shipping statistics, is healthy condition for confirming the real situation of anguillid eel fishery. This advantage will help us on treating the long-term catch statistics of anguillid eels in Bengkulu Province.

Searching alternative sources of data on eel fisheries

As described above, comparison and cross-checking among the statistics and information from different sources are the effective measure to evaluate the accuracy and reliability of these statistics. We could find two different kinds of statistical data regarding eel seeds in Bengkulu Province, despite it also required additional data for cross-checking, though. However, in Sukabumi Regency, there was only one catch statistics collected by local government. To support its validity, it would be better if there would be any other kinds of indices that express the trend of anguillid eel fishery. Also, present official statistics lack the indices of fishing effort. In the process of evaluating the fish stock, catch per unit effort (CPUE) is often used for describing the relative trend of fluctuation of fish resources. CPUE requires two kinds of data; one is the amount of catch, and another one is the fishing effort. Although the amount of catch is described on the official catch statistics, fishing effort is not contained in the official catch statistics as of now.

Through this study, we also conducted the interviewing with the eel collectors to explore the possibility of collecting the alternative time-series data of both catch and efforts for anguillid eel fishery.

In Palabuhan Ratu, Sukabumi Regency, we contacted certain eel collectors then obtained daily data of glass eel collection and the approximate number of fishers who worked in the last several years. Since this attempt has just started, we have not completed the detailed analysis of the data yet. Since we could get the approval from the eel collectors to receive the latest data regularly, it will facilitate us to monitor both catch and the effort (number of fishers) then get the continuous trend of CPUE.

In Bengkulu Province, we have also started searching alternative sources of data from the private sector. We requested eel collectors to send us the monthly report regarding the amount of anguillid eel catch (weight and number), the number of fisher and fishing gears. Since last two indices are regarded as fishing effort, we expect that we will get time-series data of CPUE on yellow eel fishery in Bengkulu Province as well.

Since both trials are just getting started from the end of 2015, it will take several years to evaluate the results whether we can observe the annual trend of CPUE properly.

Another missing information on the present official statistics is the species composition at each river and fishing ground. Although it would be rather easier to identify the species on stages of both yellow and silver eels for the fisherman and eel collectors, it is difficult to classify the species on glass eel and elver, especially for the enumerators. To grasp the species composition and its stability at the major fishing grounds, scientific researches on species identification in regular intervals are also needed to complement the official catch statistics.

Need to develop national catch statistics on anguillid eel fishery

It was opportune that we could obtain the official catch statistics on anguillid eels in Sukabumi Regency and Bengkulu Province. We could also get other statistics from the fish quarantine station in the airport in Bengkulu. However, in other places, we have encountered the difficulties of searching catch statistics on anguillid eels very often.

In Indonesia, catch statistics of the inland fishery are collected by each local government, independently from the supervision of the national government. Therefore, latest catch statistics on anguillid eel have not been summarized. Furthermore, Ministry of Marine and Fishery, the competent authorities of the inland fishery in Indonesia, may not know how and where anguillid eels catch data can be collected (Prof. Kartamihardja, personal communication). Since the catch statistics are one of the most basic information to evaluate the present status of fisheries and resources, the present situation is a serious defect as leading country of using anguillid eel resources in Southeast Asia.

Recently, we often read and hear "CITES" relating to the exploitation of tropical anguillid eels. CITES, the Convention on International Trade in Endangered Species of Wild Fauna and Flora, is an international agreement between governments and their aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival (CITES, 2015b). If it is regarded that the usage of tropical anguillid eels will not be appropriate from the perspective of sustainable use of eel resources, tropical anguillid eel species might be listed on CITES Appendix II or higher. If so, the international trade of tropical anguillid eels would also be restricted, same as European eel (*A. anguilla*), then eel farmers in Indonesia and the other Southeastern Asia would lose the chance to export any eel products virtually. If Indonesia and the other Southeastern Asian countries desire to use tropical anguillid eel resources including international trade continuously, they have to express their principle and attitude for sustainable use of tropical anguillid eel resources, such as systems for observing the stock condition of tropical anguillid eel resources and efficient measures for regulating the fishing activities appropriately. Considering these measures, catch statistics are the fundamental and indispensable information.

The Indonesian government should immediately develop the national catch statistical data on anguillid eel fisheries which cover the major fishing grounds of anguillid eels and also establish the inventory system for the statistics on anguillid eels. It is the first step of anguillid eel resources management, and it will become a model for the other countries that has used anguillid eel resources in Southeast Asia.

CONCLUSION

Both the commodity chains and the existence of official catch and shipping statistics of anguillid eels in Sukabumi Regency, Bengkulu Province and Fatmawati Fish Quarantine Station were described. Although these official statistics seemed to be useful for the investigation of anguillid eel catch and seasonal migration of juveniles of anguillid eels, these statistics were often fragmented and had any possibilities of containing errors. Detailed investigation on the contents of these statistics is needed for analyses.

On the other hand, interviewing with the eel fisherman, eel collectors, and eel farmers brought us the alternative data regarding anguillid eel fishery. Statistical information of anguillid eel collection taken by eel collectors will assist the confirmation process of the seasonal trend of anguillid eel fishery by cross-checking with the official catch statistics. Additional information regarding the fishing efforts such as numbers of fisher and fishing gears will enable us to calculate CPUE then evaluate the relative abundance of anguillid eel resources in the near future.

Fisheries statistics are one of the most important basic data for considering the current status and recent trend of fish resources. Since the present situation and its usage of anguillid eel resources in Indonesia attract considerable attention from all over the world, Indonesian government should develop the catch statistical data on anguillid eels and establish the inventory system of the statistics on anguillid eel fishery immediately,

not only for sustainable use of anguillid eel resources but also for future development and conservation of the eel industry in Indonesia.

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