History of stunting on *Anguilla* spp.: A literature review

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Abstract. Gross Anguilla is one of economic commodity where have demand and price increase every year but not balance with stocking in the nature. Decreasing population was report in Japan, America, Europe including Indonesia which reported in the Central Sulawesi and Central Java water. One the effort to recover the population in the nature is by restocking. Anguilla restocking can be success if the fish used have high survival rate. Good performance of seed which can be obtained by stunting.

1. Introduction

Anguilla considered as high economic fish commodity since it has valuable nutrition, hence the demand and price for this commodity increase [24]. However, the increasing of orice and demand were not balanced with the available stock in the nature which recorded undergo the declining trend [1]. The supply for *Anguilla* mostly 90% is still depending on the rearing aktivity which all the seed were caught from the stock in the wild [2]. The intensive activity in rearing freshwater eel is rising the exploitation of seed especially glass eel in estuary and leading to the declining its population [3]. Another reason for the declining population of Glass eel is because it is easy to be collected by only using simple net as shown in Figure 1.

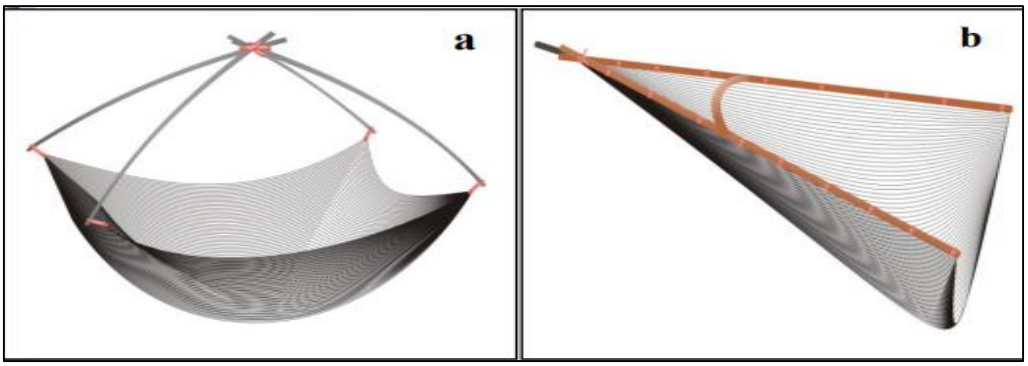

Figure 1. Gears to collecting *Anguilla* spp. [9].

Anguilla known as migratory species since they will be migrate from freshwater to deep ocean for spawning and seed eel migrate to freshwater for growing [16]; [8], their life shown in Figure 2. The seed will be brought by sea current to freshwater while finishing their deplovment to become adult. The migration will be mostly occured in rainy season where the glass eels are attracted by terrestrial odor cues, low salinity, and colder temperature [6].

Figure 2. Lifecyle of the European ell[1].

Recovering of stock in wild can be done by restocking it into the nature [19]. However, there are several circumstances of seed should be fulfilled before it released in to the wild such as size, time and location [14] the size of seed which is appropiate to be restocked is about ±2 g when the seed can be countered the flow. At this size, the seed can avoid the predators by burrowing themshelves in the sand and gravel so the probability to be caught is low. Besides the size, the time to restock seed into wild should also considered. It should have provided supported niche and natural food which also mostly found in winter season. Basin is thought as an ideal location to restock *Anguilla* seeds as it saved water even in drought season. Therefore, the survival of seeds will be increase.

Anguilla seeds (±2 g) can be obtained by rearing glass eel 0,2 g for 3 up to 4 months (Affandi 2015). If the seed that caught in winter season and reared for that period of times, the those seed were not suitable to be restocked into the wild because they will face drought season and lead to lower survival rate. However, if the seed continuous to be reared until the winter season, the expense to maintenance will be costly. Therefore, to obtain the best condition for restocking is by synchronizing the size, time and location by applying stunting.

2. Historical Background

Stunting is a process to produce dwarf individu by natural or artificial process. Klinger *et al*. [20] mentioned that crowding, Blazer [5] and inadequate nutrition are the main factors of stress which produce stunt individu. In the nature, fish stunt usually occurs in lake. Diana [13] reported that lack of appropriate-sized prey and inappropriate thermal regimes could cause stunting and concluded that field work was needed in order to determine which factors limit growth in any particular lake. Heath et al., [17] done to test the genetic differentiation in growth of stunted and non-stunted populations of yellow perch and pumpkinseed. The results show that the growth rate of stunt fish is lower than non-stunt fish

[1] http://www.esf.international

after rearing in normal condition for the same periods. However, there was no differentiation of genetic between stunt and non-stunt fish. It can be said that stunting is only affect the growth performance not changed the genetic of fish.

Stunting can make a good performance in fish because of it can automatically selected fish shorted by their quality [10]. Fish which have lower quality will be death and eliminated. In addition to eliminated lower quality fish, there were some phenomenous called compensatory growth (CG) which mostly found after stunting. Das et al., (2016) stated that the performance of Rohu fish (Hamilton 1822) after post-stunting seed with 2,4,6,8,10,12 months, the results show that the good compensatory growth seen from 2 and 4 post-stunting seed. On the other hand, post-stunting up 6 months show the low compensatory growth. The reason of low compensatory growth is because stunting for 6 months will affect the physiology of seed which can be observed from blood differentiation.

Several research about stunting on *Anguilla*: Wickins [29] reared glass eel for 12 months in optimal condition which showed different growth performance. There are fast and slow growth which caused by *Anguilla* known as voracoius fish and it increase when fish are cultivated in high density which leads to food competition.

Fekri et al. [15] showed that compensatory growth in *Anguilla bicolor bicolor* after rearing using elver postsunted have a better growth than normal rearing. The study from Bhujel et al., [4] in *Nile tilapia* was also revealed that stunt fish has different feeding rate between stunting and non-stunting. Stunting fish showed higher feeding rate more than 3%. However, the feeding rate in non-stunt fish were peacked in 2% and started to decline in 3%. Lingam et al. [21], states that the fillet cutability traits found a higher percentage of meat (64.40%) and lower bone content (14.19%) in poststunted fish. Thus, the stunt fish recorded had the better growth performance. The ability of fish to digest and absorb nutrition are depended on digestive system which can be seen from enzym activity [22]. Taufik et al. [28] reported that small size *Anguilla bicolor bicolor* and *Anguilla japonica* [7] have higher protein capacity compare to larger size since it contains 1,5 to 2 higher protease enzyme.

Fekri et al. [14] has reared seed by stunting process by limitating food. The seed after stunting have range of size diversity. Therefore, Fekri et al. [15] conduct futher research to stunting *Anguilla* by combining food limitation and low temperature. the results show that seed after stunting have a good performance and the seed had a low diversity of variance in size.

3. Issues and Problems

Advance technology to breed *Anguilla* artificially is still desired. There were some reports in Japan towards the succeeds in producing glass eel by artificial breeding [18] although the survival rate of preleptoceplahlus was not survived because of yolk deleption. Another work from Kagawa et al. [18] revealed that by maturation of *Anguilla* sp broodstock by using hormonal manipulation brought succesfull glass eel production after 250 day after hatching (dah).

The technique to induce *Anguilla* breeding by hormon manipulation were still being the problem since the expense for materials will not suitable if applied in high scale industries to support the demand. Besides, the basic reproduction physiology of eel should also be understood since it might be different in another *Anguilla* sp. According to Tanaka et al. [27] even *A. japonica* glass eel can be obtained in laborartory, another eel (*Anguilla anguilla*) artificial maturation is not as sucessfull as *Anguilla japonica.*

Restocking of non-stunt eels into the wild are faced with many factors such as the low survival rate. Shiao et al. [23] stated that the survival of eel from restocking was accounted only 3-20%. Besides the low survival rate, restocking of eels into the wild is also an act that must be comprehensive since the ecology of eel in freshwater is poorly understood. Thus, the monitoring should be continoually.

4. Current Situation

Eel is exploied at all stages which also found in various ecosystem. Dekker [11] stated that the reduce in abudance of glass eel is accounted for 85% . Drastic declining in abundance of glass eel in nature were caused by heavy exploitation of glass eel for aquaculture to supply the demand. *Anguilla* juvenile or glass eel stocks in nature from 1950-2000 (Figure 3) showed that all species experienced serious declining trend and European eel (*Anguilla anguilla*) recorded as the lowest in abundance. Hence, this species of *Anguilla* has been classified in IUCN RED LIST.

According to Neilsen and Prouzet (2008) glass eel are prefer to be purposed for aquaculture and restocking since they have many adventagous reasons as below:

- Glass eel can accept artificial food
- Easy to transport
- Glass eel reported carry fewer pathogerns, parasites, virus and bacteria.

There some measurmenets to overcome the declining stock of eel in nature such as the limited catchment and gears. In addition, such effort to maintain the eel stock in nature is by conducting regulation that nearly 60% of catchment which have size less than 12 cm should be restocked into the wild accoring to Eel Recovery Plan from The European Commission.

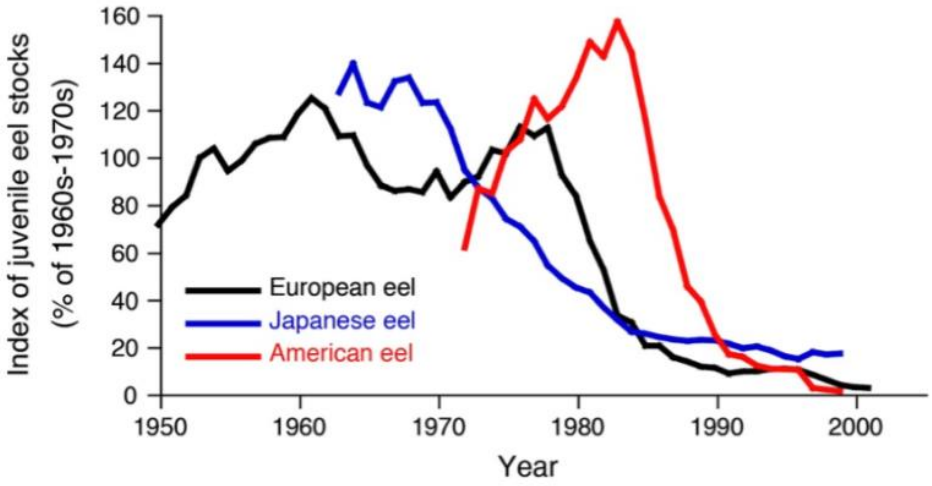

Figure 3. Juveniles abundance of some Anguilla spp. from 1950-2000 [12].

Indonesia has nine species of *Anguilla* so it can be a potential resources to be the leader of producer of *Anguilla*. However, *Anguilla* resources in Indonesia has not been utilized and controlled well. Thus, leads to the decreasing stock of *Anguilla* in Poso and Java as it shown in Figure 4. The effort to recover the stock of *Anguilla* spp in Indonesia has been done in Cimandiri river and Yogyakarta water by using restocking.

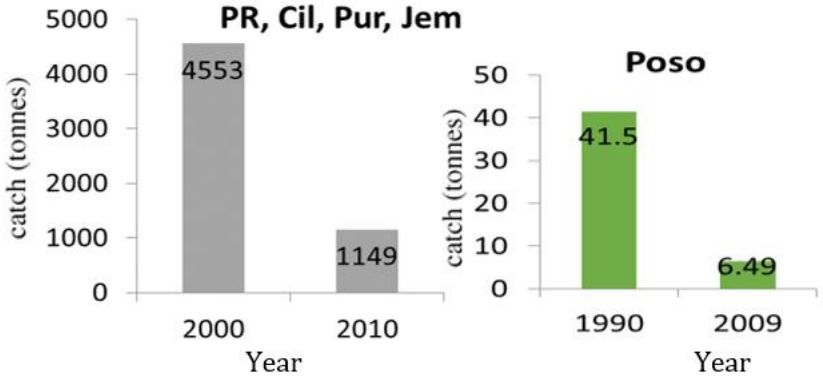

Figure 4. Trends in juvenile stocks in Indonesia.

Releasing glass eel immidately to the water is not the right method. It is also encouraged by statement of European Comission which claimed that the eel should be growing before release. the rearing of fish eel to produce stunt individu is also rarely to be reported since stunting in fish is still considered resulting negative than postitive impact. Ylikarjula et al. [30] also stated that stunt individu will decrease the

economic value. However, by using stunting the cost for maintenance the seed of eel before it reach up the ideal size to be released will be lower.

5. Lessons Learned

Several lessons learned from history stunting:

1. Stunting is a process that produces dwarf individual by natural or artificial process
2. Natural stunting usually occurs in fish which inhabits lake with blooming algae. lake which usually occurs blooming algae, the food will be abundant which support their reproduction. However it cause overpopulation and lead to competition for food and niche.
3. Artificial stunting can be produced by limiting food and changes in environmental condition.
4. Stunting in fish can gives positive or negative impact to the growth as it affects morphology, anatomy and physiology.
5. The effect of stunting can be variety when it applied by some methods to different fishes.
6. Stunting reveals more effect the growth rate of fish which long in somatic. The seed produced from which also found having the best growth performance because the fish that low in quality will be naturally selected.
7. Different stunting period also shows the different compensatory of growth.
8. Fish which sorter in somatic when it stunted and then reared in normal condition with ad libitum food will be developed its gonadic which lead to early spawning period compare to normal condition
9. Some methods to prevent stunting in lake or other natural waters are by manual fish removal, water level manipulation and introduction of predators.

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