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Biological aspects of Longfin Mojarra (*Pentaprion longimanus*, Cantor 1849) in north coast of Central Java, Indonesia

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Abstract. *Oktaviani D, Faizah R, Nugroho D. 2018. Biological aspects of Longfin Mojarra (*Pentaprion longimanus*, Cantor 1849) in north coast of Central Java, Indonesia. Biodiversitas 19: 683-689.* Longfin Mojarra (*Pentaprion longimanus*) locally named as *rengganis*, is a demersal fish species that is commonly caught in Scottish seine fisheries off the north coast of Java. The fisheries are in heavily harvest level since decades. The aim of this study was to observe the biological aspects of this species. Observations were made between August 2014-July 2015 from Tegal fishing port, western part of north coast central Java. General life-history parameters were measured, i.e., monthly length frequency for 1876 fishes, among them 573 specimens were observed for length-weight relationship, including 541 specimens for sex ratio and maturity stages. Fulton index, Gonadosomatic index, sex ratio and estimated length at first mature were analyzed. The result showed fish size ranged between 7.4 to 15.3 cmFL with the average length of 11.2$\pm$1.75 cmFL. We found that length-weight relationship tends to be isometric which statistically the body growth coefficient (b) is equal to 3 ($t_c = 0.53 < t_{ab}$; $p<0.05$) . Monthly Fulton indexes ranged between 1.05-2.87 with an average of 1.90 $\pm$ 0.17. Sex ratio during observation was not significantly different ($p<0.05$) from the expected ratio of 1: 1. Mature females occurred year-round with the highest percentage observed from January to April 2015. The estimated length at first maturity was 13.04 cm FL. These biological parameters will be used to support the population study of the future demersal fish species to improve conservation and management measures.

Keywords: Fulton index, length-weight, Longfin Mojarra, maturity, north coast of Java

INTRODUCTION

The Java Sea is a productive region of shallow waters and contains suitable habitats for a variety of fishes in western Indonesia. Demersal fish species are subjected to an intensive fishery carried out by fleets of trawl like fisheries and landed in major fishing ports along the North coast of Java. Demersal Scottish seine fisheries are one of the major fleets operated in the Java Sea for the past two decades. Based on the national capture fisheries statistics 2005-2015 (DGCF 2016) a large number of fishing fleets (>10000 units) operated in Java Sea under quasi-open access fisheries management.

Longfin Mojarra (*Pentaprion longimanus*), known locally as *rengganis* is a member of the family Gerreidae and are the common species with low proportion on commercial landing. The geographical distribution of *P. longimanus)* is in the Indian Ocean ranging from east India to Japan, the Philippines, Sunda shelf, particularly western part of Indonesia but not to New Guinea or Australia also westward of India. The species inhabits coastal waters down to depths of 30 m, and usually found in large schools at depths between 10 and 30 m. *P. longimanus* feeds mainly on small bottom-living animals (Fisher and Whitehead 1974; Sainsbury et al. 1985).

Previous research found that this species is one of the diverse ichthyofauna associated with bottom shallow waters in the Java Sea. The species is caught in a wide range of fishing activities in the Java Sea in different depth from the shore (Dwiponggo et al. 1986; Martosubroto 1996; Pauly et al. 1996). Nurhakim (2003) showed that Longfin Mojarra is distributed in waters up to 70m and strongly associated with goat fish (*Upeneus suphureus*). Mustafa (2003) stated that this species occurred in depth of fewer than 90 m in Bay of Bengal waters and mixed with threadfin beam (*Nemipterus japonicus*), goat fish (*Upeneus sulphureus*), marine catfish (*Arius* spp). Aglen et al. (1981) informed that *P. longimanus* occurred in the waters of less than 60 m in Peninsular Malaysia. Nugroho et al. (2016) indicate that the species were more abundant in the depth of more than 20 m in western part of the Java Sea.

The fish generally belong to small size demersal fish community, with maximum length of 20 cm. Exploratory fishing in Natuna Sea showed that size distribution of Longfin Mojarra ranged from 4.0 to 20.0 cmFL (Wudianto and Sumiono 2008), while Sadhotomo and Sumiono (1983) indicates this species has fast growth rates. The contribution of annual landing of this species was relatively low (~5%) from the average total catch of demersal Scottish seine fleets in 2015 (Nugroho et al. 2016). Despite available information on its abundance, little is known about the life history parameters of this edible species.

The aim of this study is to provide baseline information on biological parameters such as the proportion of size distribution, length-weight relationship, sex-ratios, monthly variability of Fulton, gonadosomatic indexes, and estimate of length of first maturity. In many cases, existing basic biological knowledge allows the scientific committee to establish a relationship for predicting medium-term variability in population parameters in order to determine mortality, growth and recruitment (Ultang 1996). This data are expected to contribute basic information related to bio-reproduction aspects. These was emphasized to the impact of over-harvesting, its resilience and sustainably this species in Java Sea demersal fish communities.

MATERIALS AND METHODS

Data collecting

Bi-monthly sampling was carried out from August 2014 to July 2015. Samples were randomly collected and measured based on fish caught by commercial demersal Scottish seine fisheries in Tegalsari Fishing Port. The port located on the North coast of Central Java, Indonesia (6°50'58.01" S, 109° 7'43.74" E). A total of 1876 of fish length were measured and consisted of 573 specimens for length and weight parameters including 541 specimens among others for sex determination and gonad observation as a baseline of this study. Data were collected based on the landing of demersal Scottish seine fisheries using cod-end mesh size of 1.25 inch. Fish length was measured using 30 cm ruler as distance from the tip to the nearest centimeter of its caudal fin (fork length, FL), analytical balances with precision of 0.01 g were used to record wet body weight to the nearest gram (whole weight, W).

Data analysis

A general approach to biological aspect was applied in this study. Fork length frequency distribution was calculated within 0.5 cmFL intervals. The frequency grouped following equation of:

$F_i = (n_i / N) * 100$ ………………………………… (1)

Where:
F_i = frequency for a given interval of 0.5 cmFL
n_i = number of specimens within interval
N = total number of measured specimens

Observation on length-weight relationship (LWR) was used to estimate weight (W) that was predicted using measured length (L). LWR were calculated for male, female and unsexed specimens. Parameters of body shape (a) and body proportion (b) by least square regression. The b value was tested using a t-test to verify the if the body shape is isometric. The relationship was determined following general equation (Jobling 2004; Froese 2006):

$W = aL^b$ …………..…………………………..... (2)

Where:
L = length (cmFL),
W = Weight (g),
a = parameter describing body shape and condition;
b = parameter indicating growth in body proportion, with condition of isometric if b = 3 and allometric if $b \neq 3$

A Chi-square test (χ^2) was applied to determine if the population contained equal proportion of male and female, the sex ratio for the entire observation and its significance was tested on how well a model fits the observed data. The null hypothesis was: H_0 = Male: Female is 1: 1, H_1 = Male: Female is ≠1: 1

Fulton's condition factor (K_n) is an indicator of fish health in its habitat. The weight of fish at a given length differs in species differs in species and at different place (Fulton 1904 in Froese 2006). The value was calculated according to Froese (2006) equation as per formula is given below:

$K_n = W/L^3 * 100$ ………………………….……… (3)

Where:
W=weight of fish (g),
L=Length of fish (cm)

Maturation and spawning characteristics were observed by conventional macroscopic methods. Different color levels and percent of abdominal cavity occupied by gonads were used to identify their stage of maturity. Maturity stages were classified into five stages i.e. (I) Immature, (II) Developing/Recovery, (III) Ripe, (IV) Spawning, (V) Spent (King 2007).

Gonadosomatic index (GSI) was determined with the assumption that an ovary proportionally increases in size and development stages compares the mass of gonad (Wg) with total mass of fish (W). Indexes were followed equation (Zeyl et al. 2014) of:

$GSI = 100 * (Wg/W)$ ……………………………… (4)

Distribution of each life stages was illustrated in histogram. Stages of reproductive development were macroscopically indicated by the appearance of ovary and eggs. Estimation of lengths at first maturity was calculated based on the assumption that individual female specimens with stage III and IV were mature groups. The following empirical equation was applied to length and estimated age at maturity (King 2007) :

$P = 1/ (1+\exp [-r (L-L_m)])$ …………………… (5)

Where:
P is proportion of sexual mature individual by length (L),
r is the slope of the curve;
Lm is the mean length at sexual maturity

Table 1. Classification of ovary development stage

Stage	Description	Ovary	Eggs
I	Resting	Undeveloped, small, translucent	None visible to naked eye
II	Developing	Opaque, orange color	Visible and opaque
III	Ripe	Fills body cavity	Translucent, large and round
IV	Spawning	Release eggs when pressed	Large, translucent, some free ovary
V	Spent	Shrinking/slack	Some residual eggs

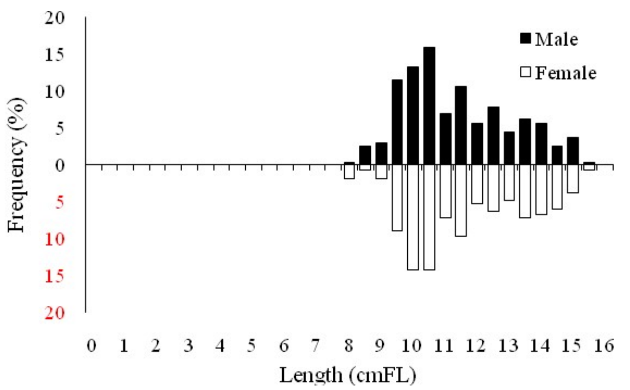

Figure 1. Length frequency distribution by sex of *Pentaprion longimanus* during August 2014 to July 2015

RESULTS AND DISCUSSION

Improving the basic knowledge on nature marine fish diversity including its biological aspects could help baseline information to develop sustainable harvesting strategies (Pauly and Mines 1982; Ultang 1996). Harvesting marine biodiversity is the oldest impact on the ocean environment by humans. Fish biology is basic information for fisheries management and conservation. Scarcity of biological aspects could lead to overharvesting and unsuccessful management. Longfin Mojarra is a common species landed by any demersal bulky fishing gear. The contribution to total catches was relatively low which is generally less than 5% (Beck and Sudradjat 1979; Sadhotomo and Sumiono 1983; Nugroho and Badrudin 1987), 1-2% in Visakhapatnam east India (Rao 1990), 2% in Bay of Bengal (Mustafa 2003); 3% in southern part of South China Sea (Wudianto and Sumiono 2008), one of economic important in Indian waters (Shutharsan and Sivashanthini 2008) but high landings in Sea of Oman (Jawad and Al-Mamry 2011). The depth distribution indicated the species more abundant in the depth of 35 to 45 m (Nurhakim 2003).

Frequency distribution

A total of 1841 specimens were measured during the observation period. Length frequency distribution indicated that fish ranged between 7.5 to 16 cm FL. Most of the catch (78%) were at 10 to 12 cm FL. The monthly average length for unsexed specimens is listed in Table 2. Monthly average length ranged between 9.8 ± 1.14 to 12.6 ± 1.74 cm FL.

Previous research (Sadhotomo and Sumiono 1983) informed that the size distribution ranged from 3.5 to 13.5 cmTL, the same range also occurred in Samar Sea and Carigara Bay Philippines (Ingles and Pauly 1984). Both of those data indicate that the maximum and minimum length (7.0 and 15.3 cm FL) was larger in this study. There is no evidence to support this differences. Shifting fishing areas compared to 1970-1980 probably the most reasonable consideration on this phenomenon. An exploratory survey is needed to confirm this anomaly in size distribution. The length frequency distribution emphasizes that pre-recruit cohorts with length of < 7 cmFL were not in the catch, meaning that most of small size population is untapped by the human intervention.

From the total fish observed, 541 fish were macroscopically observed for sex criteria. Length frequency distribution of male and female specimens was relatively in proportional condition. The range, maximum and minimum size of both sexes were relatively in the same cohorts (Figure 1).

Length-weight relationship

The length-weight relationship (LWR) of fish is a significant component for fisheries assessment and its biological conservation. However the availability of this typical information is still limited, there are not many reports concerning the status of biological information in this area. This relationship is commonly used for two main purposes, i.e., to compare the average associated parameters between fish groups spatially or temporally, and to predict the weight from the length of a fish. From this relationship, weight could be computed from a given length and vice versa through a mathematical equation. The length-weight relationship can be extended for the estimation of fish condition assuming a heavier fish of a given length is in better condition (Freitas et al. 2017). Understanding LWR plays a significant role in fisheries biology and population dynamics and recently to support ecological studies (Kulbicki et al. 2005).

Based on monthly observed specimens, the estimate regression parameters and average condition factors are given in Table 3. The parameter of body growth proportion (b) values of 2.722, 2.723 and 2.723 representing for male, female and unsexed specimens. The value of b is not significantly different of 3 (t_c = 0.98; p<0.05), indicates the fish has isometric growth. This shows that the approach to convert length to weight and calculation of condition factor can be applied using b = 3 and this indicates with increasing growth by weight tend to faster that of its length.

Table 2. Statistical description of monthly length frequency of *Pentaprion longimanus*

2014					
Unit (cmFL)	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Mean±SD	9.8±1.14	12.2±1.82	12.3±1.67	11.2±1.66	11.8±1.77
Range	7.0-14.0	84-15.1	8.6-15.1	8.1-13.9	9.0-15.0
(n)	(171)	(129)	(147)	(141)	(156)

2015							
Unit (cmFL)	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**
Mean±SD	11.6+1.64	12.6+1.74	12.0±2.25	11.0±1.55	10.6±1.01	10.7±1.27	10.7±1.32
Range	9.0-14.2	8.4-15.3	7.4-15.3	8.4-15.2	7.5-12.8	9.0-14.2	7.7-14.2
(n)	(153)	(168)	(148)	(164)	(165)	(148)	(186)

Table1 3. Length-weight relationship of *Pentaprion longimanus* during August 2014-July 2015 observation

Sex	n	Mean K_n	a	b	r	t calc	t 0.05
Male	304	1.88 ± 0.16	0.0365	2.722	0.981	0.0308	1.96
Female	269	1.89 ± 0.16	0.0369	2.723	0.984	0.0300	
Combine sexes	573	1.90 ± 0.17	0.0368	2.723	0.983	0.0357	

This species has a compressed body as an ordinary-shaped fish. The unsexed length-weight relationship is shown in Figure 2. Parameters of LWR indicated that *P. longimanus* were isometric growth and these values are strongly affected by several ecological and individual characteristics (Percin and Akyol 2009). The b value as parameter indicating growth in body proportion is 2.723 and statistically isometric, this could indicate that the environmental conditions are in medium to good condition to support growth of Longfin Mojarra. Previous observations in the Java Sea found the b value was 2.917 with parameter describing body shape (Sadhotomo and Sumiono 1983). In Malaysia, the value is higher at 3.190 (Ahmad et al. 2003), while in Australia (Willing and Pender 1989) showed that the value of b is 2.965. The different could probably due to variability in each local environment and ecosystem and human pressures on marine biodiversity (Nahdi et al. 2016).

Fulton index of condition factors indicated that average monthly value of unsexed specimen ranged between 1.81 to 2.02. The highest value (2.35) occurred in May, June, and July at the same time the lowest was found in June (1.52). The Fulton index was plotted regardless of sexual difference (Figure 3). The average tends to increase from March to July and gradually decreased in September and October then increase up to December and lower in January to March. Variability of index is most likely due to different environmental conditions in the harvesting ground. Length-weight of species could have a different Fulton index within a different period of time and space which is related to the availability of food preference (Froese 2006). Jin et al. (2015) indicate that Fulton index can be used to estimate changes in nutritional condition. More complicated information on physiology and ecology indicates that Fulton index (K factor) acts as a proxy of variability of body component and may serve as an efficient predictor of energy in fish species (Mozsar et al. 2015) while Lloret et al. (2014) suggested that Fulton index uses 1 as one of morphometric indicators that could play a role as bench-mark for the condition of a standard fish. K_n above or below 1 are considered in relatively better or worse condition depending on their distance from the benchmark. The average condition of Longfin Mojarra of 1.88 indicates that the fish were relatively in healthy states even the exploitation status of the demersal fish tend to heavily harvested.

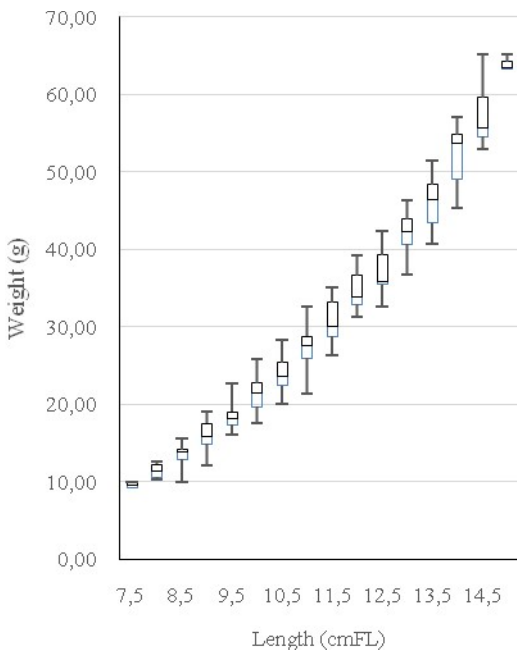

Figure 2. Length-weight distribution of *Pentaprion longimanus*

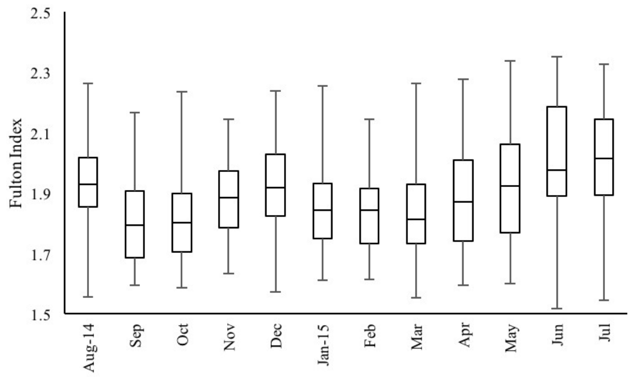

Figure 3. Monthly mean Fulton Index of *Pentaprion longimanus*

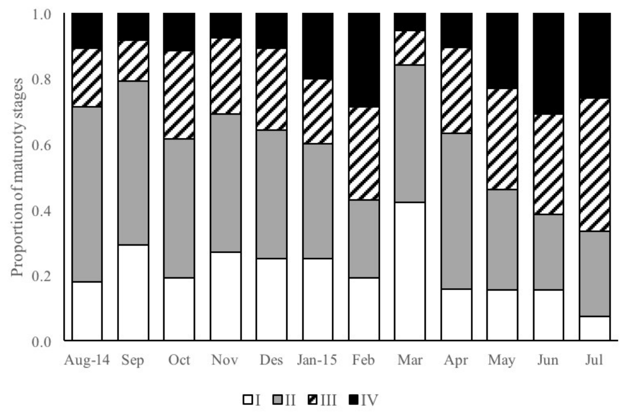

Figure 4. Monthly changes of female maturity stages

Table 4. Chi-square test on sex ratio of *Pentaprion longimanus* in the north coast of Java, Indonesia

Sex	Observed (O)	Expected (E)	O-E	(O-E)2	(O-E)2 / E
Male	272	270	2	4	0.015
Female	268	270	-2	4	0.015
Total					0.030

Sex ratio

A total of 541 specimens were examined. The rest of specimens were not able to be assessed due to a low quality of body cavity. The ratio between male and female for the whole observation period were 1: 1.01. A Chi-square test indicates that the critical values of distribution table at df = 1, $\chi^2_{calc} = 0.030 < \chi^2_{0.05,1} = 3.841$; $p<0.05$, therefore the ratio of male to female of 1.01: 1.0 is not significantly different from expected 1: 1 ratio (Table 4). Looking at seasonal variability in sex ratio, a Chi-square test indicated that there was no significant difference between two sexes ($p<0.05$).

Better understanding of how demographic processes influence mating system plays a significant role to decode ecological influences on sexual selection in nature (Olsson et al. 2010; Aronsen et al. 2013). Beevi and Ramachadran (2005) stated that knowledge of sex ratio of fishes is essential for fisheries management practices. Sex population estimation is defined the abundance of any sex at a particular time or the population in natural condition. It is generally known that in a healthy population, the sex ratio should be 1: 1. There are several other factors such as temperature, water velocity, and vulnerability of females to their predators, migratory phase, and other ecological hazards, which probably affect the sex composition, particularly in streams or rivers. Monitoring on shifting the demographics of a spawning stock in a large geographical scale, such as mean length or age and sex ratio, can also be used as biological indicators of the status of the stock for fisheries management purposes (Farley et al. 2014).

Maturity

The stages V were not found during this study. Based on this examination of female gonads, it was found that ripe and spawning specimens occurred throughout the year with peak during January to May 2015 except on February 2015 (Figure 4). The percentage of immature stages (juvenile) dominated the sample structures and less contribution when the fish grown. This strongly indicated that most of the fish landed were at immature stage. This has been a growing concern in this fisheries for years. The persistence of high landing of juveniles and lower proportion of mature adults in Scottish seine fisheries suggests that large fish abundance was under pressure (Nugroho et al. 2016). As the fish is a typically sedentary species it is predicted that the exploitation rates have a negative impact on current stock status, when the fishing mortality exceed half of the mature fish, the stock status fall below precautionary limits (Vasilakopoulos et al. 2011)

Gonadosomatic index (GSI)

Gonadosomatic index (GSI) analysis indicated that monthly average slightly fluctuated except for May 2015 which give a high index. Since the high index occurred in September, December, May, Jun and July with average range of about 0.8 to 1.8 with exception on high index on May. This index could indicate that spawning occurred several months in a year of observation (Figure 5). However, broad range of GSI appears uncertainty on spawning season of the species and the difficulty on interpreting and predicting the beginning and end of spawning seasons (Flores et al. 2015). The result emphasize there is also no clear evidence on the occurrence of annual reproduction strategy of many species (Chehade et al. 2015). Another reason on this uncertainties, the species spawned across the entire year (Ba et al. 2016) therefore the precautionary approach should be implemented to support resilience key biological parameters.

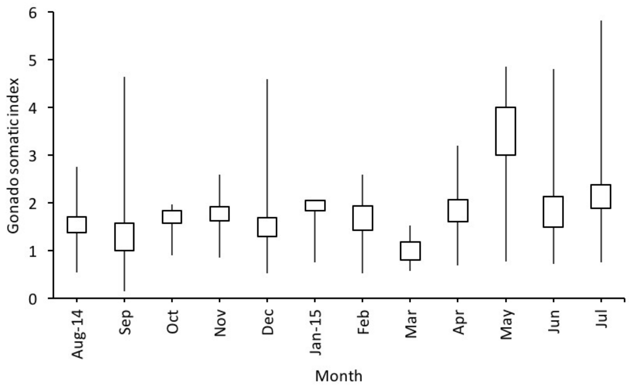

Figure 5. Distribution of gonadosomatic index *Pentaprion longimanus*

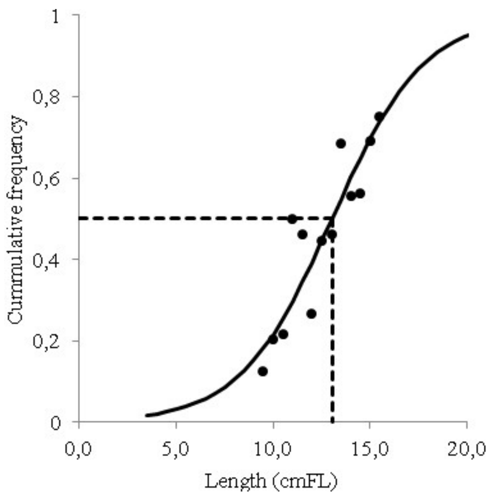

Figure 6. Estimated length of first mature (Lm) of *Pentaprion longimanus*

Estimations of length at first maturity

The mature specimens (stage III and IV) were found at a length range of between 11 to 14 cm FL. The specimens of less than 10.5 cm FL were dominated with immature stages. Based on equation (6) estimated length of first mature (L_m) was found at around 13 cm FL (Figure 6). This estimation showed that most of the fish caught (>70%) by this type of fishing gear were immature specimens. Therefore, reducing number of size on young and immature fish should be considered to let the fish spawn at least once before becoming vulnerable to commercial gears (Voasilakopoulos et al. 2011). This would maintain the abundance of spawning stock as a potential indicator of fishing pressure to the stock healthiness (Froese 2004; Lappalainen et al. 2016)

These findings revealed that *P. longimanus* is one of common demersal fish caught from/in a relatively low abundance of species. The population structures of male and female relatively at equal level with most of the fish landed at immature life stages. A relatively low Fulton index indicates that environmental healthiness was under pressure. Uncertainty on predicting the spawning season for this species should be followed by precautionary approach towards fisheries management. Increasing spawning stock biomass through targeting fish in larger size categories and minimizing catch of under size and immature fish should be part of biological threshold for fisheries. The existing high fishing pressure of semi-industrial demersal fleets lead to disturbance of resilience of marine biodiversity. Commercial over-harvesting of marine biodiversity could gradually diminish the health and resilience of marine ecosystems and fisheries (Myers and Worm 2005). Observations of estimated abundance of Longfin Mojarra in 2015 were at 25% compared with 1975 (Nugroho et al. 2016). This indicates that over-harvesting has led to the disturbance of the resilience of the species.

Improvement harvesting strategy on the demersal fish species should be strongly considered as the majority of the catches were at immature stages. A broad geographical survey is necessary to provide fisheries status as a baseline to develop appropriate conservation and management measures. This result would support knowledge of life history parameters of species which could play a significant role to evaluate the health of the species that have been affected by series of disturbance due to high level of exploitation. Several global initiatives have been introduced to reduce direct pressures to marine biodiversity and promote sustainable use. Aichi target 6 of the Convention on Biological Diversity (CBD 2010) partly initiated that all fish and invertebrate stocks including aquatic plants are managed and harvested sustainably, legally and applying to ecosystem-based approaches. Therefore overfishing is avoided, recovery plans and measures are in place for all depleted species.

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