Life History and Length Based-Spawning Potential Ratio (LB-SPR) of Exploited Demersal Fish Stock (*Upeneus* sp) in Sunda Strait.

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Abstract. Length Based-Spawning potential ratio (LB-SPR) is the most popular technique in worldwide that use for data-poor fisheries management. Based on this situation, LB-SPR tries to apply in demersal fish is Kuniran (*Upeneus* sp) in small scale fisheries search in Sunda Strait to learn about the sustainability potency both of maturity and recruitment potency from spawning potency ratio. Length data was collected by team research from 2014 to 2019 (except 2017, there is no sampling activity), which from Bogor University. Research result show that asymptotic length (*L*∞) is 302.10 mm, natural mortality (M) 0.49, Bartalanffy growth (k) 1.03. The length at 50% maturity size (*L*ₐₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜₜ¢-

1. Introduction

Recently fisheries management try to apply multi-approach to find the best way on management strategy. This approach starts from the data availability, analysis, and strategy formulation. We saw many fisheries spot manage as business as usual without accurate data (poor data). Therefor need a good way to find good management in poor data situation. One management measure that can be applied in poor data fisheries is length based-spawning potential ratio (LP-SPR) approach.

Spawning potential ratio (SPR) based on length data is a well-establish with a biological reference point for data-poor fisheries management [1]. Length measurement is generally done by researchers in landing port or other place fisheries base [2]. As a demersal stock, *Upeneus sp* using of length and weight data essential to know the length-weight relationship, von Bartallanfy growth (k), length frequency distribution, natural mortality (M), and first size maturity (Lm). These techniques easy and most familiar also popular in Indonesia researcher related life history and fish population dynamic study. Its mean length data analysis of the fish population could be used for fisheries management [3].

An interesting of length-based analysis has been to provide parameters of exploited population that can be compared against predefined threshold parameter. The spawning potential ratio approach (SPR) of *Upeneus sp* is defined as the proportion of the *Upeneus sp* unfished reproductive potential left at any given level of fishing process [4]. It is commonly used to set target and limit reference points for exploited fisheries.
In these studies, *Upeneus sp* landed in Labuan fishing port assume as a unit stock. Therefore should behave coefficient growth (g), growth rate (k) mortality of fishing (F), natural mortality (M), with the same ratio of natural mortality (M) to the growth rate (k), the ratio of fishing mortality (F) to natural mortality (M) will be identical [1]. The ratio of fishing mortality to natural mortality (F/M) can be misleading; however, if not interpreted with care, as the selectivity of the fishery [4]. Fishing gear selectivity only targeted to oldest population in total stock. It means the product could be low, and stock potentially sustains for a long time. Conversely, even a relatively low fishing mortality to natural mortality can reduce the spawning per recruit of *Upeneus sp* drastically if the fishery catches a large proportion of immature individuals [4].

The purpose of the study is to evaluate spawning potential ratio (SPR) *Upeneus sp* based on length data, include selectivity size and mortality. The output of this research could be used for fisheries management operational in the surrounding Sunda Strait.

2. Material and methods
2.1. Research Area
This research was conducted in the Labuan landing port, Pandeglang District (see Figure 1). Length data collected by the team directly in port and gonad maturity stage, and others at fisheries biology laboratory, faculty of fisheries and marine science, IPB University

![Figure 1. Research location (sample and length data) collection in Sunda Strait.](image)

2.2. Data Analysis
Length (mm) and weight (gr) data were collected directly on location by data sheet that was previously set as a worksheet. Length data analysis such as is length size class, length at first maturity (Lm), and von Bartallanny growth and mortality. The estimation SPR of an *Upeneus sp* exploited stock conducted directly from the fish size composition of the catch in Labuan Fishing Port. This was done by testing some of the main assumptions such as, the first is length based-spawning potential ratio (LB-SPR) analysis, including recruitment variability and dome-shaped selectivity. The second is examining the sensitivity of the spawning potential ratio model to an error in the input parameters. The third is completing an initial empirical test for the LB-SPR estimation model by applying it to data from a well-studied species. The analysis uses maximum likelihood methods to find the values of relative fishing mortality (F/M) and selectivity-at-length that minimize the difference between the observed and the expected length composition of the catch and calculates the resulting SPR [1]. The spawning
potential ratio (SPR) using basefoot ecologist toolbox application software by CSIRO (2020) that are commonly used and access directly through a public link via http://barefootecologist.com.au/lbspr.

3. Result and discussion

3.1. Length Frequency Distribution

The life history analysis based on length data is asymptotic length $L_\infty$ of 302.1 mm, length at first maturity about ($L_{m50}$ of 134.8 mm), and length of maturity at 95% ($L_{m95}$ is 147) mm. Estimation of the growth rate of Upeneus sp in the Mediterranean was found $L_\infty$=26.20 cm, $K$=0.11, for females, and $L_\infty$=23.86 cm, $K$=0.12 for males [5].

The coefficient growth rate is ($k = 0.3$), which is classified as high; the natural mortality indicator is ($M = 0.31$). The estimate of the $M/k$ ratio is 1.03, which indicates that the natural mortality rate is high. Bertalanffy growth rate of Upeneus sp in the Red Sea recorded by [6] was ($k=0.459/\text{year}$) and natural mortality ($M=1.03$) per year greater than Sunda Strait. Another researcher [7] found von Bertalanffy growth rate was $L_\infty$ = 21.80 cm, $K$ = 0.54 per year, and relatively low than Sunda Strait.

Since the 2014-2019, the data recorded of Upeneus sp in Labuan landing port are total length (TL) and total weight (TW). The total population recorded from 2014 to 2019 (2014=1199 ind; 2015=910 ind; 2016=633 ind; 2018=357 ind; 2019=443 ind) in each year. The length data both of minimum and maximum noted 13.5 mm and of 287 mm recorded in (2015). In easter Mediterranean [8] was found the minimum length of 70 mm and a maximum length of 205 mm. The annual average length data from 2014 to 2019 is ($123.43 \pm 22.68$) mm, where the average of length data in 2014 and 2019 under of annual average and others are above. The distribution frequency of length data shown in figure 2 below.

![Figure 2](image)

Figure 2. The length-frequency distribution data from 2014 to 2019 (excluded 2017).

Statistic difference test (t-test) of fish total length average to annual length average (2014-2019) significant at 2014 and 2015 where t-tets > t-table (2.02 (2014) and 1.78 (2015) > 1.64) It’s mean the average total length at 2014 and 2015 higher or lower than annual average length. Based on figure 2 above, the total catch dominantly under average annual length data that means the dominantly total catch is young stock.
3.2. Gonad Maturity
The parameter gonad maturity \((L_{m50})\) is determined as the proportion of fifty percent, both male and female fish, on sexual maturity. Observations during the 2014-2019 length size of gonad mature ranged from 129.18-147 mm (see figure 3). The first maturity of Upeneus sp species was found in Demak Water is 216.44 mm for male and 219.71 mm for female, and greater than in Sunda Strait. The length of 50% gonad matures greater than the annual average catch (134.8 > 123.48 mm). These results indicate that the majority catch was young fishes or in mature caught by fishermen.

![Figure 3. Length at first at maturity (L50) of Upeneus sp](image)

3.3. Size Selectivity
The dominance of young fish in total catch indicates the status of the stock is the first tent to decline or overfish, the second is availability young fish in Sunda Strait. The size selectivity length \((SL_{50})\) found at 2014=100.37 mm; 2015=99.45 mm; 2016=146.65 mm; 2018=99.32 mm and 2019=90.28 mm. This result lower than first at maturity gonad, that analysis from 2014-2019 data, where found the average \(L_{m50}\) at length 134.8 mm. In the fisheries context, the increase of young stock in population reflects from low size selectivity of fishing gear.

The 50% of selectivity is under \(L_{m50}\) except in 2016. It's mean in 2016, dominant species caught as adult stock and others as young or in-mature stock. Five-year monitoring shown that dominance by young stock or other reason is the Sunda Strait as habitat as nursery ground of Upeneus sp. [10] also found size first capture of Upeneus sp at length 133 mm. The use of Cantrang gear (danish seine) with mesh size 0.5-40 inch (12.7-101.6 mm) will increase the catchability Upeneus sp and the potential to exploited young fish quickly. The selectivity meshes size model and size first at maturity shown as figure below.

![Figure 4: Fish length selectivity of the Upeneus population.](image)
3.4. Spawning Potential Ratio (SPR)

Spawning potential ratio (SPR) is defined as the proportion of natural, or unfished, reproductive production left in a population under fishing pressure [11]. Recently SPR approach most popular used as an instrument to prepare a management strategy in fisheries, particularly for fisheries’ poor data and management. The easy technique on the SPR approach was developed by [1] based-length data from landing based.

The Length Based-Spawning potential ratio (LB-SPR) analysis of Upeneus in the Sunda Strait range from 1-6% (average 2%) for the total population. Furthermore, it also has shown a low proportion of mature stock to be a new stock (recruitment) in population. The decrease in the SPR level occurs while the size of spawning fish is decreasing in number, both due to the effect of a decrease of selectivity and adult stock. The threshold value of SPR is 40% than can be accepted as a proxy for the Maximum Sustainable Yield (MSY) for recruitment overfishing in a less resilient fish population [12]. The environmental factor that has an influence on the adaptation of stock is for food availability, ecosystem health, and climate change effect. Spawning potential ratio in each year 2014-2019 show in the figure below.

3.5. Relation SPR, F/M Ratio

In relation to the selectivity of the fishing gear, the change in the size of the catch reflects the low selectivity of the instrument. As a result, fishing mortality due to capture will also increase. During 2014-2019 there was a decrease in the ratio between F/M, except in 2016 relatively high. The increase in the F/M ratio during 2016 occurred due to low natural mortality (M) or increased fishing mortality. Hordyk [1] explain that SPR declines very quickly with increasing F/M when the fishery selects all
size classes, such as in 2016 (F/M=32%) and 2014 (F/M=8.8%) in Sunda Strait. The other hand explains that in 2016 the fishing pressure occurred was very high or overestimated of F/M.

During the 2014-2019 research, the average size of the *Upeneus* sp population, which was more than 50%, had reached the gonad ripe phase (L\textsubscript{50}) was 134.8 mm. The annual gonad maturity pattern from 2014-2019 continues to decline, thus also reducing the ability of spawning and the ratio of potential spawning to be lower than 6%. This means that the ability of *Upeneus* sp fish is very low due to the low selectivity of fishing gear, which is also an indication of the high mortality due to capture (F). This status can disrupt the long term potential of *Upeneus* sp stocks.

![Figure 6. The trend of Selectivity, F/M and SPR of *Upeneus* sp from 2014-2019](image)

In the same period, 2014-2019, the total catch was also high, which indicates an abundant supply of fish stocks. In conclusion, the Sunda Strait area is a habitat for young fish (pre-spawning) or immature fish. The SPR value between 1-6% is lower than 10% (range 10-20%) show as the critical levels for stock sustainability [13]. In Java, the sea was recorded the SPR value for *Upeneus sulphureus* under seven percent (< 7%) [14]. The trend of SPR value between the Sunda Strait and the Java Sea has shown that the increasing of fishing pressure, impact of mesh size fishing gear, and fishing intensity. The others are research related to the function as a habitat for young fishes, habitat suitability, and also fishing season needed to preserve the stock and conserve young fishes population in Sunda Strait.

4. Conclusion
The conclusion of this research is that SPR range from 1-6% percent and relatively low (under 40%) as a threshold of minimum reproduction to stock for sustainable. The selectivity of the stock is also relatively low than mature size stock maturity (L\textsubscript{50}) as the impact of increasing fishing mortality (F/M). It means that *Upeneus* sp stock in Sunda Strait is potentially high-risk tent to critical and unsustainable.

5. References
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