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Length based data of *Nemipterus japonicus* to spawning potential ratio (SPR) estimation on small scale fisheries (SSF) management in Sunda Strait

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Abstract. Spawning potential ratio (SPR) is an important parameter to ensure fish stock reproduction, recruitment, and sustainability. This approach more efficient and effective applied to poor and limited information and data to management. Therefore, we used the SPR approach in small scale fisheries, particularly on *Nemipterus japonicus* species in Labuan-Sunda Strait area. This research was conducted in the Labuan fish landing port from 2013 until 2019. The length data were collected each year and then analyzed using the basefoot ecologist toolbox application. The result has shown that SPR of *N japonicus* range from 1 to 6%, and it's relatively low and potentially unsustainable. Fish length spawning at 50 percent (SL50) ranged from 139 mm to 196.29 mm. And then fish length spawning at 95% (SL95) from 160.39 to 243.54 mm. Furthermore, in 2013-2018 monitoring activity SPR relatively low and decrease every year, and first at breeding (50% and 95%) also decrease. It means the gonad maturity and SPR could be used as an indicator of fishing pressure and sustainability.

1. Introduction

The spawning potential ratio (SPR) is a well-establish biological reference point, and an estimate of SPR could be used to inform management decisions for data-poor fisheries[1]. Length and weight measurement of *Nemipterus japonicus* as an exploited stock in the Sunda Strait is generally used by researchers [2]. In practice, at a small scale, and limited data fisheries to management in Sunda Strait, availability data are about stock, age, monitoring production data often restricted by lack of data management in landing port.

As a tropical stock, *N japonicus* known as demersal stock, we sometimes found difficulties defining annual growth from biological information such as otolith, vertebrae, and tagging. Therefore, the length and weight data were commonly used to estimate the biological parameter to understand fish behavior, life history, and dynamic fish stock populations [3].

Commonly used length and weight approaches were developed to evaluate length-weight relationships, population growth, class size structure, recruitment, and length of catch and maturity. These techniques are familiar and popular in Indonesia researcher related to life history and fish population dynamic. Its mean length data analysis of the fish population could be used for fisheries management [4].

As an assume that *N japonicus* was landed in Labuan Fishing port as a unit stock. Therefor will have similar of Bartalanfy growth (g), growth rate (k) mortality of fishing (F), natural mortality (N), with same ratio of natural mortality to the growth rate (M/k), the ratio of fishing mortality to natural mortality (F/M) will be identical [5]. The ratio of F/M can be misleading; however, if not interpreted
with care, the fishery's selectivity is also important [5]. Sometime in the fishing process, 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 $F/M$ can reduce the spawning per recruit of $N$ japonicus drastically if the fishery catches a large proportion of immature individuals [5].

An interesting of length-based methods has been to provide stock parameters that can be compared against predefined biological reference points (brp). The spawning potential ratio (SPR) of $N$ japonicus is defined as the proportion of the unfished reproductive potential left at any level of fishing pressure [5]. It is commonly used to set target and limit reference points for fisheries. These studies aimed to evaluate the maturity, selectivity, size class distribution, spawning potential ratio (SPR), and fishing mortality ratio to natural mortality of $N$ japonicus in the Sunda Strait. The output of this research could be used for the fisheries management process in the surrounding Sunda Strait sea.

2. Material and Methods

2.1. Research Area

The research was conducted in the fish landing port Labuan region in Banten Province (Figure 1). The small-scale fisheries are dominantly (more than 70%) from total fishing activity in Sunda Strait that has characteristics as a one-day fishing program.

![Figure 1. Research area of small scale fisheries in Sunda Strait](image)

2.2. Data Analyses

Length (mm) and weight (gr) data were recorded directly on the port using a data sheet that was previously set as a worksheet. Some biology data collected/measured fecundity and gonad maturity with using gonad- classification [6]. The dynamic population analysis consists as are length size class, length at first maturity ($L_{50}$) [7], selectivity capture, mortality fishing, and natural mortality, and spawning potential ratio (SPR) [8]. Spawning potential ratio (SPR) using a basefoot ecologist toolbox application by CSIRO (2020), and these applications are commonly used and access directly through a public link via http://barefootecologist.com.au/lbspr [8].

3. Result and Discussion

3.1. Length Frequency Distribution

Since 2013-2019 monitoring, the measurement length data of $N$ japonicus on Labuan port is the total length (TL) and total weight. The population recorded from 2013 to 2019 were 559, 961, 609, 207,
263, 203, 422 individuals. The minimum length was 85 mm (in 2017), and the maximum length 350 mm in 2014. The annual average from 2013 to 2019 was 207.9 mm; 201.5 mm; 197.5 mm; 184.0 mm; 155.8 mm; 172.4 mm; 181.2 mm; and total length average of 185.8 ± 18.1 mm. The Distribution frequency of length is shown in figure 2 below.

![Graph showing length distribution frequency of N. japonicus from 2013 to 2019](image)

**Figure 2.** Length distribution frequency of *N. japonicus* from 2013 to 2019

Statistic test (t-test) of average total length in each year to total monitoring (2013-2019) showed different fishes' length size. Generally, length data significantly different from the annual average except in 2016 with *t*<sub>test</sub> is 0.55. It means the three-year monitoring (2013-2015) average length size more than the average length, and in 2017 and 2019 average length size less than the average total length. This data shown the last three years (2017 - 2019), the size structure tent decreased from 2013 to 2015. The minimum length annual average relatively decreases, as indicates the stock population also declines. The generally average *N. japonicus* in Sunda Strait is higher than Andhra-Orissa coast recorded by Mohan 2010 [9].

3.2. Maturity Size
Gonad maturity is - 50% of the adult female population starts to mature condition. Observations during the 2013-2019 length of gonad mature ranged from 145.5 to 306 mm (208.6 mm ± 55.51 mm) (figure 3). The length of 50% gonad maturity greater than the annual average catch ranges from 155.8-207.9 mm (186.5 ± 19.8) mm. These results indicated that most of the length catch was smaller than the average size length at L<sub>m50</sub> maturity. This explained the majority of the total catch was young fishing or in-mature caught by fishermen, but still higher than L<sub>m50</sub> maturity in Bombay coast [10].
Size Selectivity

The dominance of small-size fish populations in total catch indicated the stock's status was the first tent to decline or over-production. The second predominantly availability small size fish population in that area. In general, the Sunda Strait area is an area dominated by young or immature stock. The data analysis from 2013-2019 found the average $L_{50}$ at length was 208.6 mm. Separately, an annual averages were 2013 (207.9 mm); 2014 (201.5 mm); 2015 (197.5mm); 2016 (184 mm); 2017 (155.8 mm); 2018 (172.4 mm) and relatively similar with $L_{50}$ in Veravel water is 183 mm [11] and higher than record in Gulf of Suez [12]. The decrease of length size and young population dominantly caught shown as the low of gear selectivity because the size selectivity of fishing gear is primarily affected to length at first capture[13]. Comparison of $L_{m}$ and annual fish selectivity show in the following figure 4.

3.4. Spawning Potential Ratio (SPR)

Fishing gear that is not selective causes in-mature or young stage dominantly caught by a fisherman in Sunda Strait. Furthermore, it also causes a low proportion of spawning potential ratio (SPR). Based on 2013-2019 research data, the average SPR value ranged from 1 to 6%, and there tends to be decrease and low than SPR in Kagoshima bay [14]. The reduction in the SPR level occurs because spawning
fish decreases in number, both due to decreasing selectivity and adult stock. The environmental factors that influence stock adaptation are food availability, ecosystem health, and climate change. The spawning potential ratio in each year 2013-2019 shows in the figure below.

![Figure 5](image)

**Figure 5.** Percentage of *N japonicus* spawning potential ratio (SPR) from 2013 to 2019

3.5. Relation SPR, F/M Ratio

Concerning the selectivity of fishing gear, the change in the catch's size reflects the instrument's low selectivity. As a result, fishing mortality due to capture will also increase. During 2013-2015 there was a decrease in the ratio between F/M, and then in 2016-2017, the ratio increased. The increase in the F/M ratio during the 2016-2017 period occurred due to low natural mortality (M) or increased fishing mortality. The F/M value from the southern region of the Sudanese Red Seawas is 0.230 and relatively low than Sunda Strait [15].
This means that during 2016-2017 the pressure of catching occurred was very high. Concerning fisheries governance, the change in fisheries governance from Regency or City to Provincial management also affects fishing intensity. During 2015-2019, a vacuum of fishing supervision in the territorial area influenced stock enrichment and decreased fishing mortality [16]. The increasing fishing mortality also affects decreasing SPR and stock tent to over-exploitable [17]. The relationship of F/M, selectivity, and SPR are shown in the following figure.

![Figure 6. Selectivity, F/M and SPR of N japonicus from 2013-2018 in Sunda Strait](image)

4. Conclusion
During 2013-2018, the N japonicus population's average size, which was more than 50% mature (Lm50), was 208.6 mm. The annual gonad maturity pattern from 2013-2018 continues to decline, thus reducing spawning and the ratio of potential spawning to be lower than 7%. This means that N japonicus is very low due to the low selectivity of fishing gear, indicating high mortality due to capture (F). This status can disrupt the long term potential of N japonicus fish stocks.

In the same period, 2013-2018, the total catch was also high, which indicated an abundant supply of fish stocks. The Sunda Strait area is a habitat for young fishes (pre-spawning) or immature fishes. While more adult fishes are in the northern part of the Sunda Strait, around the West Java Sea waters.

Research related to the function as a habitat for young fishes needs to be prepared so that fishery conservation areas can be mapped.

Reference