Sustainability of the small pelagic fishing industry in Ocean Fishing Port Belawan

R M I Fatoni1*, P C Ayu2, A F Dewinta3, Raju2 and T C Pane1

1Agribusiness Department, Faculty of Agriculture, Universitas Sumatera Utara, Medan, Sumatera Utara, Indonesia.
2Department of Agricultural Engineering, Faculty of Agriculture, Universitas Sumatera Utara, Medan, Sumatera Utara, Indonesia.
3Department of Aquatic Resources Management, Faculty of Agriculture, Universitas Sumatera Utara, Medan, Sumatera Utara, Indonesia.

E-mail: *rbmibrahimfatoni@gmail.com

Abstract. Small pelagic fish have a vital role as the primary source of income for the local community, because of this small pelagic fish creates jobs such as fishing and processing businesses. Excessive fishing by fishers is a form of exploitation of fish populations to dangerous levels. Therefore, it is necessary to research the development of Catch per Unit Effort (CPUE) value, potential utilization (MSY), and the level of utilization to support the small pelagic fishing activities. The data used in this study is primary data and secondary data. Primary data in this study are the results of observations and interviews about fishing efforts (ships, supplies, fishing gear, FAD, fishing systems, fishermen) in the Belawan ocean fishing port. The secondary data is the fisheries Production of small pelagic fish in 2013 - 2018. The result show that small pelagic fish resources at Belawan Ocean Fishing Port still under exploited.

1. Introduction
Small pelagic fish have a vital role as the primary source of income for the local community, because of this small pelagic fish creates jobs such as fishing and processing businesses. Increasing fishing effort is proportional to the increased processing and use of collective fishing gear used. The condition of small pelagic fishing in the Malacca Strait and the Andaman Sea (WPP-RI 571), especially those landed in the Ocean Fishing Port Belawan, has shown smaller size of the catch and the decline in input unit production [1].

Excessive fishing by fishers is a form of exploitation of fish populations to dangerous levels. Fewer fish resources, slow fish growth rates, and low biomass levels are the result of over fishing [2]. The tendency of the decline in catches that occur requires proper management of fishing efforts so that they can utilize fish resources or potential of catches optimally and their utilization levels [2,3]. Therefore, it is necessary to research the development of Catch per Unit Effort (CPUE) value, potential utilization (MSY), and the level of utilization to support the small pelagic fishing activities.
2. Materials and methods

The data used in this study is primary data and secondary data. Primary data in this study are the results of observations and interviews about fishing efforts (ships, supplies, fishing gear, FAD, fishing systems, fishermen) in the Belawan ocean fishing port. The secondary data is the fisheries Production of small pelagic fish in 2013 - 2018. The secondary data were obtained from book of statistical port of the Belawan Ocean Fisheries.

The analytical method used is Catch per Unit Effort (CPUE) and Maximum Sustainable Yield (MSY).

Catch per Unit Effort (CPUE) can be described mathematically as follows:

\[ CPUE_t = \frac{Catch_t}{Effort_t} \]  

(1)

Where : \( CPUE_t \) = Catch per Unit Effort in t-year, \( Catch_t \) = a number of catch in t-year, \( Effort_t \) = a number of fishing effort in t-year [2,3].

Before CPUE calculation for total effort of all fishing gear is done, first the calculation of fishing gear standardization must be calculated. Small Pelagic Fish resources at Belawan Ocean Fishing Port are captured using tree fishing gear, namely purse seine, lift net, and hook and lines. Each fishing gear has a different ability to catch, therefore need to standardize fishing efforts first. Fishing gear standardization process carried out with mathematically form as follows:

\[ FPI = \frac{CPUE_i}{CPUE_s} \]  

(2)

\[ E_j = FPI \times E_i \]  

(3)

Where : \( FPI \) = Fishing Power Index, \( CPUE_i \) = Catch per Unit Effort of i (fishing gear) , \( CPUE_s \) = Catch per Unit Effort of s (fishing gear that becomes the standard (the highest CPUE of all fishing gear)), \( E_j \) = standardized efforts, \( E_i \) = effort of i (fishing gear) [2,3].

Estimation of the potential for small pelagic fish can be estimated by analysing the catch and effort using the Schaefer model surplus production method [2,3]. mathematically can be written as follows:

\[ y = a - bx \]  

(4)

Where: \( y \) = Total CPUE each year, \( x \) = effort each year, a and b = regression parameter. Then parameters a and b can be searched by the formula:

\[ a = \frac{\sum x}{n} - \frac{\sum y}{n} \]  

(5)

\[ b = \frac{n \sum ((x)(y)) - (\sum y)(\sum x)}{n(\sum x^2) - (\sum x)^2} \]  

(6)

After knowing the value of a and b, the next step is calculating the amount Catch of MSY (Maximum Sustainable Yield). Can be known by using the following formula:
the next step is calculating the amount of Effort at the MSY (Maximum Sustainable Yield) level. Can be known by using the following formula:

\[ E_{MSY} = \frac{a}{2b} \]  

(8)

The level of utilization aims to determine the status of the utilization of the resources utilized. Utilization level can be calculated by percentage of the catch to the maximum catch \( C_{MSY} \). The formula for calculating the value of utilization rate and effort level:

\[ Utilization \ Level_t = \frac{catch_t}{C_{MSY}} \times 100\% \]  

(9)

3. Result and discussion

Fishing gear used in extracting the small pelagic resources in Belawan PPI is a lift net, Purse Seine, Gill Nets and hooks and lines. Based on the CPUE results of each fishing gear during 2013 - 2018 the fishing gear with the highest CPUE level is the lift net. This shows that liftnet is the most productive fishing gear among other fishing gear. Therefore, the lift net will be treated as a standard fishing gear in calculating Total CPUE each year.

![Figure 1. CPUE of all fishing gear that used at Belawan Ocean Fishing Port 2013 – 2018](image)

The Total CPUE value fluctuates from 2013-2018 (Figure 2). This happens because during the period of the year there was an increase and decrease in the number of fishing effort. If it is connected between CPUE and effort (trip), the greater the effort, CPUE will decrease, so that production decreases. This means that CPUE is inversely proportional to effort, with each additional effort the lower CPUE result. This is due to increased competition between fishing gears that operate where resource capacity is limited and tends to decrease due to the increasing fishing effort.
Based on the value of CPUE and total production which tends to decrease each year, this indicates that the condition of small pelagic fishing in the Malacca Strait and the Andaman Sea (WPP-RI 571), especially those landed in the Ocean Fishing Port Belawan have experienced more capture (overfishing).

Based on the Relationship between Effort and CPUE at Belawan Ocean Fishing Port 2013 – 2018, the linear equation $y = 0.9321x + 3054$ with $R^2 = 0.3117$. The equation shows that the addition to the fishing effort still increases the catch, only the level of closeness of the relationship is still small at around 30%.
therefore it can be said that the catch at Belawan Ocean Fishing Port is not only influenced by the fishing effort (in this case represented by trip done for one year).

The MSY determination is carried out using the surplus production model from Scheafer, the total catch is expressed as a quadratic function of the total effort capturing the type of fishery, where the curve starts from the origin (0.0). Production surplus model (MSY) formulas only can be apply when parameter b is negative, meaning that an increase in capture effort will cause a decrease in CPUE. Regression results show that parameter b is positive so CMSY and EMSY measurements cannot be performed.

4. Conclusions

Based on the result that small pelagic resources at Belawan Ocean Fishing Port still under exploited, therefore, an increase in fishing effort can result in an increase in catch. Things that affect the yield of production i.e. fishing effort does not originate from the fishing trip alone but can also be influenced by other things such as the use of FAD (Fish Aggregate Demand), number of fishing units, fishing season, physical condition (waves, wind, etc.) the waters.

References

[1] Belawan Ocean Fishing Port 2019 Statistic of Belawan Ocean Fishing Port 2018 (Medan, Indonesia: Belawan Ocean Fishing Port)

[2] Rahmawati M, Fitri ADP and Wijayanto D 2013 Analisis hasil tangkapan per upaya penangkapan dan pola musim penangkapan ikan teri (stolephorus spp.) di Perairan Pemalang [Analysis of catch per unit effort and the Pattern of anchovies (Stolephorus spp.) fishing season in Pemalang waters] Journal of Fisheries Resources Utilization Management and Technology 2(3) p 213-222

[2] Rahman DR, Triarso I and Asriyanto 2013 Analisis bioekonomi ikan pelagis pada usaha perikanan tangkap di Pelabuhan Perikanan Pantai Tawang Kabupaten Kendal [Bio-economic analysis of pelagic fish in capture fisheries at the Tawang Beach Fishery Port Kendal Regency] Journal of Fisheries Resources Utilization Management and Technology 2(1) p 1-10

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