The analysis of Krai Tuna (*Auxis thazard*) resource utilization level using pure seine fishing gear in West Coast Waters, Sibolga

A Fadhilah*, D Juniyanti, Y Soemaryono, I E Susetya and A F Dewinta

Department of Aquatic Resources Management, Faculty of Agriculture, Universitas Sumatera Utara, Medan, Sumatera Utara, Indonesia.

E-mail: *amanatul.fadhilah@usu.ac.id

Abstract. Krai Tuna (*Auxis thazard*) is one of the economically important pelagic fish and has a wide distribution to the waters of the Indian Ocean, Sibolga. Utilization of fish resources has provided economic benefits to business people, but to use of resources has external and positive impacts. The exploitation of species has increased throughout the year and is generally caught by pure seine fishing gear. This study aims to determine the status of utilization and allowable catch of Krai Tuna (*Auxis thazard*) in Sibolga City caught using purse seine fishing gear. Secondary data analysis was using the Schaefer model. The level of utilization of Krai Tuna (*Auxis thazard*) resources was over the past 5 years based on purse seine fishing gear with average value of 87.42% and an effort rate of 76.97%. This shows that the condition of the level of resource utilization of Krai Tuna (*Auxis thazard*) is already densely caught. So in this case the results must be optimized by reducing the effort of catching because of that the condition of Krai Tuna (*Auxis thazard*) resources remain sustainable.

1. Introduction

The waters of the west coast of Sibolga have abundant fish resource potential, where the dominant catch is small pelagic fish. Use of fish resources can certainly help the economy of the fishing community in Sibolga. However, every year the waters Sibolga experience of exploitation, especially of the Tuna Krai (*Auxis thazard*).

Sibolga is one of the cities that have a relatively large fishery business compared to other cities on the West coast of Sumatra. In these city fisheries entrepreneurs have played an active role in promoting local, regional and even national fisheries production. The active role shown can be seen from the number and size of the fleet and fishing gear that are operated relatively larger so as to produce greater production as well [1].

Utilization of fish resources has provided economic benefits to business people, but the utilization of fish resources also has positive and negative externalities. Fish resources are renewable resources but do not mean unlimited. So, if do not managed carefully, will have a negative impact on the availability of fish resources and the environment [2].

Sibolga waters are one of the locations representing WPP NRI 572 which covers the Indian Ocean. Krai Tuna (*Auxis thazard*) is one of the important economical fish in Indonesia, especially in the Sibolga area. For this reason, the fishing status of Krai Tuna (*Auxis thazard*) in WPP NRI is very important to know. The level of sustainable were use is needed, especially in areas such as Sibolga.
City, which have shown that the level of exploitation has been over exploited, meaning that the level of utilization of resource stocks has declined due to overexploitation [3].

Krai Tuna (Auxis thazard) is pelagic fish from the Scombridae family. This fish can be found in almost all tropical and subtropical waters. Krai cranium is included in neritic with habitat at sea level to a depth of 50 meters. Migration patterns are local with optimum temperatures between 27 - 27.9 ºC. Catching Krai Tuna (Auxis thazard) increasing every year with a wide variety of fishing gear (gill nets, purse seine and huhate). [4].

Utilization of Tuna Krai (Auxis thazard) resources in the Indian Ocean waters, especially in Sibolga waters, tends to increase from year to year. This is indicated by the increasing number of fishing business permits and the number of fleets operating in the water area. One of the central landings Krai Tuna (Auxis thazard) in the western part of Sumatra is the Nusantara Fishery Port in Sibolga. Fleet used by fishermen in Sibolga to catch Krai Tuna (Auxis thazard) in the waters of the Indian Ocean is dominated by the use of purse seine.

Seeing the potential of pelagic fish resources of considerable potential in the waters of Sibolga and development of the fishing using purse seine fishing gear is necessary to do research on the utilization of Tuna Krai (Auxis thazard) using purse seine fishing gear viewed from the trip catching and fish production Tuna Krai (Auxis thazard). The purpose of this study to determine the status of utilization as well as catches are allowed from Tuna Krai (Auxis thazard) in the waters of the West Coast Sibolga caught using purse seine.

2. Materials and methods
This study will be conducted on May to June 2019 in Sibolga Nusantara Fishery Port (Figure 1). Researchers used descriptive methods by using secondary data which included data from Sibolga Archipelago Fisheries Port from 2014 to 2018 in the form of annual production data per fish species from purse seine fishing gear and the number of purse seine fishing gear.

![Figure 1. Research location](image)

Secondary data analysis uses the Schaefer model which is a regression analysis model of CPUE for the amount of effort, to find out the maximum sustainable potential (MSY) and the optimum effort (opt) for the Tuna Krai (Auxis thazard).
2.1. Model Schaefer
The relationship between C (catch) and f (fishing effort) as follows [5]

\[ C = af + b(f)^2 \]  

Optimum Effort Values \((F_{opt}) [6]\)

\[ F_{opt} = -(a/2b) \]  

Sustainable Maximum Potential Value (MSY)

\[ MSY = -a2/4b \]  

2.2. Estimation the level of utilization and effort
Estimation the level of utilization and effort is carried out to find out how much the level of utilization as well as the utilization of Krai Tuna \((Auxis thazard)\) resources. The equation of utilization level is as follows [7].

\[ TP_C = C_i \times \frac{100\%}{MSY} \]  

The equation of the level of effort is:

\[ TP_f = \frac{f}{f_{opt}} \times 100\% \]  

2.3. The total allowable catch (TAC)
TAC can be determined by analysing the production surplus were using formula [8] :

\[ TAC = 80\% \times MSY \]  

Explanations:
C = Total catch per unit of fishing effort (kg / trip)
a = Intercept
b = Slope
f = Fishing effort (trip) in the period to- i
f opt = Optimum fishing effort (trip)
MSY = Maximum Sustainable Yield (kg/year)
TPc = The utilization rate in the year to -i (%)
TPf = The level of effort for the year to -i (%)
TAC = Total allowable catches (kg / year)

3. Result and discussion

3.1. Production Krai Tuna \((Auxis thazard)\)
Data on the capture fisheries production in Sibolga City shows that the production of Krai Tuna \((Auxis thazard)\) during the last 5 years (2014-2018) based on purse seine fishing gear tends to fluctuate. Data shows fluctuations in fish production of Krai Tuna \((Auxis thazard)\) in the Indian Ocean waters of Sibolga City can be seen in Figure 2.
Figure 2. Production and the number of trips Krai Tuna (*Auxis thazard*) in 2014-2018 by purse seine in Nusantara Fishery Port in Sibolga

The highest fish catch production in 2016 was 1,907,240 tons with a fishing effort of 1,967 trips. The lowest fish catch production in 2014 was 105,376 tons with a catch attempt of 1,830 trips. The relationship between the sizes of the production of fish catches with the fishing effort carried out in the fishing trip unit, has a fluctuating effect on the productivity of the catch (CPUE). Production and productivity of floating fish catches will increase if the fishing effort (trip) can be reduced [9].

If catching is done continuously without regulation and control, the population growth capacity will someday continue to decline so that it will be dangerous to the preservation of the population of Tuna Krai (*Auxis thazard*). The tendency of fluctuations in the level of production of Tuna Krai (*Auxis thazard*) from 2014 to 2018 is one symptom changes Tuna fish population levels Krai Tuna (*Auxis thazard*) caused by a number of fishing effort.

3.2. *Estimation of sustainable potential (MSY) and optimum effort*

Based on the analysis of the potential resources of Krai Tuna (*Auxis thazard*) with a surplus production method using the Schaefer model, linear regression between effort and ln CPUE Krai Tuna (*Auxis thazard*), the obtained a constant (a) of 0.862663734 and a regression coefficient (b) of -0.000131403. The results of the alleged sustainable potential (MSY) of Krai Tuna (*Auxis thazard*) fish resources amounted was found of 1,415.854018 tons / year with an optimum effort of 3,282.51611 trip / year. Based on the regression analysis the coefficient of determination ($R^2$) of 0.1006 can be seen in Figure 3.

The relationship between the catch (C) and the catching effort (f) Krai Tuna (*Auxis thazard*) is shown by using the Schaefer model in equation $C = 1.338391055 - 0.000297733f^2$. The relationship between CPUE and the effort of the Schaefer model linear regression equation is $y = -0.0003x + 1.3384$ with $R^2 = 0.4257$ which means that each increase in 1 trip effort will reduce CPUE by 0.000297733 tons / trip.
Figure 3. Linear Regression Schaefer Model between effort and \( \ln \) CPUE Tuna Krai \((Auxis thazard)\)

The Maximum Sustainable Yield / MSY graph and the optimum effort of Krai Tuna \((Auxis thazard)\) can be seen in Figure 4.

Sustainable potential (Maximum Sustainable Yield/ MSY) for Krai Tuna \((Auxis thazard)\) resources in the Indian Ocean Waters in Sibolga City was found of 1,415.854018 tons / year, while optimum effort \((f_{opt})\) of 3,282.516611 trip / year, which means that if the effort is carried out exceeds the effort optimum will reduce the value of production.

Fluctuations in the sustainable potential and the level of exploitation of Krai Tuna \((Auxis thazard)\) in waters in the Indian Ocean waters of Sibolga from 2014 to 2018 (Figure 3). The number of cath attempts is seen to be non-permanent. In this case was change in fishing effort every year shows a value that is so large, so that if there are additional uncontrolled fishing efforts in the coming years which is certainly very influential on production per business unit (CPUE) so as such additional fishing efforts must be limited according to the maximum amount allowed. The maximum sustainable...
yield analysis (Maximum Sustainable Yield) is one of the biological standards used in the management and conservation of sustainable fisheries resources [10].

3.3. Estimation of utilization and effort level
The value of the utilization rate of Krai Tuna (*Auxis thazard*) in the past five years based on purse seine fishing gear indicates that the level of utilization of Krai Tuna (*Auxis thazard*) has fluctuated (Figure 5). Utilization levels that exceed 100% occurred in 2015 amounted to 118.190%, in 2016 amounted to 134.706% and in 2018 amounted to 122.607%. While in 2014 and 2017 the level of resource utilization Krai Tuna (*Auxis thazard*) remains below 100% or less of the value of its MSY.

The average utilization rate from 2014 to 2018 was found of 87.42% of the MSY value and the effort rate was found of 76.97% and the optimum capture effort (F opt). That means if there is an increase in the utilization rate of 12.58%, the level of effort required is 23.03%, for the sustainable use of floating fish resources.

![Figure 5. Estimation of utilization and effort level of Krai Tuna (*Auxis thazard*)](image)

Fluctuations in the level of utilization of Krai Tuna (*Auxis thazard*) may caused by various factors, the decline in catches also may caused of the decrease in population size due to the high fishing effort in previous years. On the other hand, the increase in catch can be caused by an increase in population size due to the low fishing effort in the previous year, or an increase in the effort itself due to price push.

Allowable catch for Krai Tuna (*Auxis thazard*) amounted 1,132,683,214 tons / year, which means when viewed from MSY then Tuna Krai (*Auxis thazard*) catches already in excess of the allowable catch.

The utilization rate category of Krai Tuna (*Auxis thazard*) in the waters of the west coast of Sibolga reaches densely caught and tends to over-catch, becoming important information in making a policy. Steps to make a policy regarding the regulation of fishing time need to be taken, given the exploitation of the resources of flying fish. In order to use fishery resources in a sustainable and environmentally friendly manner, management efforts need to be made that can balance the level of utilization [11].

4. Conclusion
This study concludes that the level of utilization of Krai Tuna (*Auxis thazard*) resources over the past of 5 years based on purse seine fishing gear has an average value of 87.42% and an effort rate of 76.97%. This shows that the condition of the level of resource utilization of Krai Tuna (*Auxis thazard*) is already densely caught. So in this case the results must be optimized by reducing the effort of catching so that the condition of Krai Tuna (*Auxis thazard*) resources remains sustainable.
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