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Measurement and Analysis of Target Strength of Tiger Grouper Fish (Epinephelus fuscoguttatus) Using Acoustic Methods in Lancang Island Seawater

Agustina Sartika Yos Ekaristi Manik[1], Henry M. Manik[2], Totok Hestirianoto[3]
[1] Graduate Program of Marine Science and Technology, IPB University, Bogor, 16680
[2,3] Department of Marine Science and Technology Faculty of Fisheries and Marine Science IPB University, Bogor, 16680
*Corresponding author e-mail: henrymanik@apps.ipb.ac.id

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Abstract

Coral fish are organisms with the largest amount of biomass and are also large organisms that can be found in coral reef ecosystems. The tendency of coral fish is that they do not move around and are always in a certain area and are very relocated although still many (Nybakken, 1988). The coral fish that are often found on the island of Lancang is the Tiger Grouper fish (Epinepheus fuscoguttatus). Grouper fish have a high economic value if fishermen do good cultivation on this Lancang island. The method used was mobile and controlled hydroacoustics, located in Pulu Lancang Thousand Islands. The instruments used are SIMRAD EK 15. The number of samples measured as many as 3 heads with a total length ranging from 21,70 cm to 42,50 cm and has the total weight of the three fish of 186,9 gr to 640 gr with a recording time of 5 minutes was done at the Dock and Floating Net Cage. The sounding results of tiger grouper were then analyzed using Echoview 4.0 and microsoft excel. The results of the analysis showed the average TS value in 3 tiger groupers whose total length ranged from -34,77 dB to -32,37 dB and the longer the total length of the fish, the greater the TS value.

Keyword: Hydroacoustics, SIMRAD EK 15, Tiger Grouper Reef Fish, target strength, density of grouper fish

1. Introduction

Lancang Island is administratively located in Pari Island sub-district, South Thousand Islands sub-district, Thousand Islands administrative district. Lancang Island area is about 15 hectares with a population of about 1,500 people. This island became the center of the Pari Island sub-district in 2001. The types of fish found on Lancang Island in the Thousand Islands are mackerel, tuna, grouper, baronang fish, mackerel, kuwe fish, selar fish, tembang fish, and fish grouper.

The reef fish that are often found on Lancang Island are Tiger Grouper (Epinephelus fuscoguttatus). Tiger grouper is a type of target fish that has high economic value, so grouper fish are the target for catching by fishermen, both using environmentally friendly fishing gear and fishing gear that can damage the ecosystem. One of the most common uses of the acoustic method is to estimate the density or stock of fish in a waters (Manik, 2013). The basic principle of the acoustic method is the use of sound waves that can propagate deep into the seabed and several layers below it to detect targets (Baik, 2013; Lee *et al.,* 2012; Baik and Lindem, 2014; Lubis *et al.,* 2020). The instruments used in research on analysis of target strength and density estimation of reef fish located in the waters of Lancang Island, mostly use single beam echosounder, while analysis of target strength and estimation of reef fish using single beam echosounder in Lancang Island waters has not been widely used.

Based on the explanation that has been mentioned, it is important to conduct research on measuring the value of target strength and density estimation of reef fish, especially the target fish, namely tiger grouper in the waters of Lancang Island. This research is useful as basic data about the potential condition of reef fish in Lancang Island waters. The waters of Lancang Island, which are included in the Pari Island Village, Kepuluan Seribu Selatan District, with an area of 15.13 hectares, are located to the north of 5°46'15" South Latitude and 106°57'40" east longitude and to the south 5 °59'30" South Latitude and 106°34'22" east longitude west (Fig. 1)

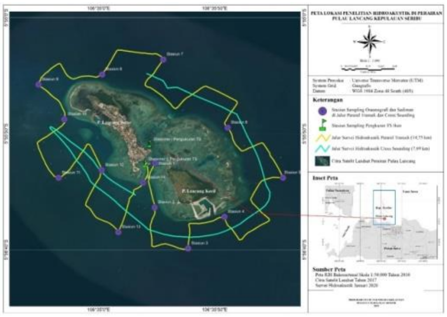

Figure 1. Research Location

2. Methodology

The tools and materials used in this study are presented in Table 1 and the Simrad EK15 specifications are presented in Table 2..

Tabel 1. Tools and materials

Tools and materials	Type	Utility
	Tool	
Single beam echosounder	Simrad EK15	Acoustic data retrieval
furuno FCV-628	Furuno	Data retrieval
Laptop	Asus	Acoustic data processing
Sphere Ball	Tungsten carbide	Calibration Tool
GPS	Garmin	Position Data
Boat	Fishing Boat	Transportation
Net Cage	Net	Fish confinement tool
	Material	
Fish	Kerapu Macan	Lab Test

Table 2. Specifications of Simrad EK15 scientific echosounder system (Simrad 2012)

1	*Operational frequency*	• 200 kHz
2	*Typical range*	• 200 *meters*
3	*Transmission*	• *Simultaneous or sequential* • *Ping rate : Up to* 40 Hz • *Pulse durations* : 80 *to* 1240 µs • *Data rate* : 1.6 Mbps
4	*Transceiver unit*	• *Maximum number in use* : 15 • *Output power* : 45 W • *IP rating* : IP66
5	*Calibration*	• *Built in single beam calibration*
6	*Data output formats*	• *Raw data (EK60 format)* • *Processed data* • *Raw data storage capacity only limited by disk size*
7	*Data subscriptions*	• *Ethernet datagram based system for remote subscription*
8	*Third party post-processing*	• *EchoView dan Sonar5*
9	*Transducer*	• *Type : Single beam* • *Maximum installation depth :* 600 *meters* • *Beamwidth* : 26 *degrees*
10	*Dynamic range*	• *Very high*

As for the specifications of the Simrad EK 15 Scientific echosounder system (Simrad 2012), this Simrad EK 15 has an Operational Frequency of 200 kHz, has a single beam transducer type, and has a beamwidth of 26 degrees. Simrad EK 15 also has a ping rate of up to 40 Hz and has a range of 200 meters. The data obtained can be processed in Echoview and Sonar5.Kalibrasi Instrumen Simrad EK 15.

This calibration aims to avoid errors or deviations in making a measurement (observation), while the function of calibration is to ensure the accuracy of the measuring instrument so that it can produce accurate measurements. The size of the water tank has a height of 3.16 cm and a width of 5.55 cm. The distance of the transducer from the surface of the water is 44 cm and the distance of the transducer to the bottom of the water is 2.72 cm. The Simrad EK15 instrument was calibrated using a sphere with a diameter of 6 cm and a transducer diameter of 5 cm. The distance from the water surface to the transducer is 50 cm, and the distance from the transducer to the sphere is 1 m.

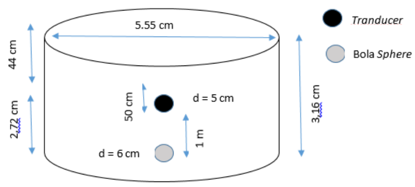

Figure 2. Simrad EK 15 Instrument Calibration Design

Design of Acoustic Data Recording in Floating Net Cages

Making floating net cages can be done on land by first making a framework according to the size of 4 x 6 x 2 m. This framework serves as a place for laying cages that are rectangular in shape and made of bamboo and wood. The distance of the rope from the wooden hanger is 3 m, the distance of the transducer from the surface of the water is 0.8 m, the distance from the transducer to the fish is 1.2 cm and the distance from the fish to the ballast is 1.25 m. The skeletons were placed in floating net cages and near the jetty to measure the density and target strength values of tiger grouper.

This research has a design of floating net cages such as rectangular which has a length of 4 x 6 m2. The floating net cages at the time of recording had 4 net bags with a length of 2 m and a width of 3 m for each net bag. The distance from the water surface to the transducer when recording acoustic data in floating net cages is 0.80 m and the distance from the transducer to the target fish hitting the bottom of the water is 1.2 m. Each fish in 1 bag of floating net cages is 100 fish.

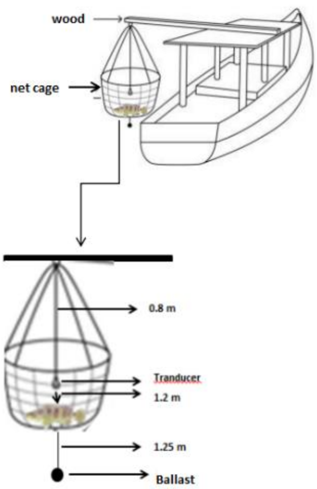

Figure 3. Acoustic recording settings and recording illustrations on the dock

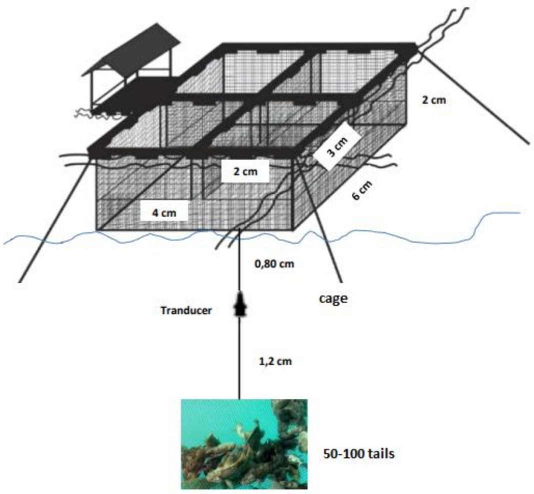

Figure 4. Floating Net Cage Design

Data analysis

Reef Fish Length and Weight Measurement

The relationship between length and weight of fish can be formulated by equation (De Robertie and Williams 2008).

$$W = a L^b$$

Keterangan:

W = Weight (grams)
L = Length (cm)
a dan b = Constants (intercept and slope)

$$\text{Log } W = \text{Log } a + b \text{ Log } L$$

The value of b on the relationship between length and weight in the growth properties of fish expresses the body shape of a fish. The body shape of the fish can be thin/slim, ideal (isometric), or fat/plump. The value of b = 3 means that the growth is isometric, i.e. length growth will always be followed by weight gain (balanced growth). If the value of b > 3 or b < 3 means that the value of b 3 means that the growth is allometric, i.e. length growth is not always followed by weight growth (unbalanced growth). This unbalanced growth trait can have a negative allometric value (b < 3) which means a lean/thin body shape and a positive allometric value (b > 3) which means the fish's body shape is plump/fat (Effendie, 2002).

Relationship of Target Strength (TS) to Fish Length and Weight

According to Manik and Norkomala (2016), TS can be converted into a target length measure. Therefore, Foote (1980) in Manik (2009) states the equation for the relationship between the target strength and fish length and the length of the swim bladder can be seen in the equation.

$$\overline{TS} = m \log L + b$$

Fish length (TL) is acoustically related linearly with scattering cross section (σ). The relationship between TS, total length (TL) and swim bladder length (SBL) can be seen in the following equation (MacLennan 1990):

$$TS = 20 \log L + A$$

The relationship between TS, total length (TL) and swim bladder length (SBL) can be seen in the following equation (MacLennan 1990):

$$TS = 20 \log L + A$$

Where A is the TS value for 1 cm of fish length (normalized target strength). In reality, the value of 20 log L varies depending on the fish species. A from the above equation needs to be found through the following equation:

$$A = \overline{TS} - 20 \log L$$

$$A = \sum \frac{TS - 20 \log L}{n}$$

3. Results and Discussion

Fish Length and Weight Relationship

Analysis of the relationship between length and weight of tiger grouper was used to determine fish growth patterns. The results of the analysis of the relationship between fish length and weight can be seen in Figure 5.

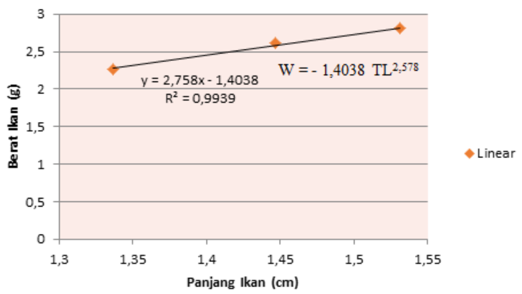

Figure 5. The relationship between the length and weight of the tiger grouper

From the results of the graphic image above, it shows that the length is influenced by the weight of the fish with each increase in fish weight increasing the length of the fish by 0.02758. The variation in the size of the increase in fish length can be explained by the large percentage of fish weight of 0.99% while the rest can be explained by other factors outside the model.

The results of the measurement of the length and weight of the tiger grouper aim to determine how big the relationship or correlation between the length and weight of the tiger grouper is and several factors that influence the length of the weight. In addition, from the relationship between the length and weight of the fish, it can also be seen that the growth of the fish is related to the balance between the length and weight of the tiger grouper. According to Effendie (2002) there are two growth patterns, namely isometric and allometric growth. Isometric growth is defined as a continuous change in proportion to the length or weight of the fish's body, while allometric growth is defined as a disproportionate change between size and weight. Based on the results of the analysis of the relationship between the length and weight of the tiger grouper, the model y = 2.758x – 1.4038 where the b value is 2.758 the results obtained are as shown in (Figure 8) the value of b < 3 which means that the growth pattern is negative allometric, so Tiger grouper growth in length is faster than the increase in body weight of fish (Effendie, 2002).

Echogram Display

The echogram is an image of the results of recording the detected signals (sounding) using a hydroacoustic instrument to obtain information in the form of the distribution of the TS value of an object. The echogram also displays detailed information used to process data on the echoview in the form of the number of pings, depth, navigation, color display and calibration.

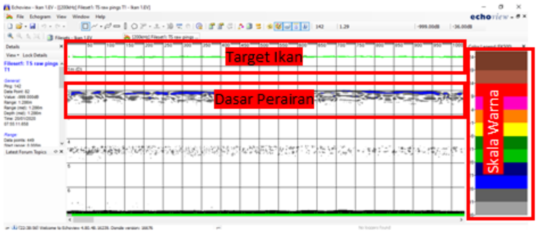

Figure 6. Echoview Tampilan

Near field backscatter is located at a depth of 0 to 0.34 m. Near field is important when recording acoustic data, to identify areas of loss of energy (loss attenuation). Near field is the distance from the surface of the transducer to the distance where there is a high fluctuation of intensity or pressure (Simmonds and MacLennan 2005). Lurton (2002) also states that the near field is a zone of influence from points that are out of phase with one another when the transducer transmits sound. The fish object or target is located at a depth of 0 to 1 m. The color range displayed in gray shows the TS value of the tiger grouper ranging from -34.77 dB to -32.37 dB.

TS Tiger Grouper

The TS values obtained from the three grouper samples were different even though the fish were from the same species. The TS values obtained start from -32.37 dB, -34.40 dB, and -34.77 dB.

Table 3. Length, Weight, and TS Value of Tiger Grouper

Long (cm)	Log L	Weight (gr)	A	TS
21,7	1,34	186,9	-61,1304	-34,40
28	1,45	409	-63,7130	-34,77
42,5	1,63	640	-66,8724	-32,37

The TS obtained from the three individual sunu fish is very important in seeing how the influence of the TS value on the length of the fish and the weight of the fish. The highest TS value was -32.37 dB which came from fish with a total length of 42.5 cm and a fish weight of 640 g while the lowest TS value was -34.77 dB which came from fish with a total length of 21.7 cm and fish weight of 186.9 gr. The standard deviation of the three tiger groupers varies in the range of ± 0.73 to ± 0.97. The lower the standard deviation value, the closer to the average, whereas if the standard deviation value is higher, the further or wider the range of data variations (Ghozali, 2016).

Therefore, it can be said that the standard deviation is the magnitude of the difference from the sample value to the mean. The standard deviation states the diversity of the sample and can be used to obtain data from a population. Karo-karo (2016) states, the standard deviation value is a value that expresses the diversity of the TS values obtained if the standard deviation value is low, the TS value data spread is uniform or close to the average value.

Table 3. Average TS and standard deviation of Tiger Grouper

Sample Number	$\overline{TS}$ (dB)	STDEV	Data summary
1.	-34,4011677	0,932582	2292
2.	-34,77	0,735126	2193
3.	-32,37	0,972888	5416

Relationship between TS Value and Total Length of Tiger Grouper

The total length of the three tiger groupers ranged from 21.70 cm to 42.5 cm with TS values ranging from -34.77 dB to -32.40 dB. The relationship between the target strength value and the total length (TL) can be seen in Figure 7.

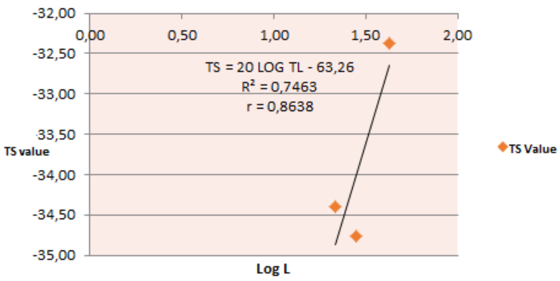

Figure 7. Relationship of Fish Length to TS . Value

Figure 7 shows the variability of TS on the length of each fish with the basic equation model TS = 20 log L+C (Simmonds and MacLennan 2005). In Tiger Grouper, the value of TS variation was detected in the range (-34.77) – (-32.37) dB with a body length of 21.7 – 42.5 cm. The results of linear regression analysis obtained a coefficient of determination (R2) of 0.7463. This means that the formation of the TS value is influenced by the length of 74.63%, while the remaining 25.37% is influenced by other factors that are not included in the scope of this study. The correlation coefficient (r) is 0.863, which means that there is a strong relationship between the body length of the Tiger Grouper and the formation of the TS value. The value -63.26 dB is the TS value for the total length of fish (normalized target strength). Manik (2009) states that TS depends on fish size and can be expressed in the equation in the figure above which shows the relationship between TS value and total length with the equation 20 log TL-63.26〗. Maclennan (1990) in Manik (2009) states that the value of 20 LOG varies depending on the fish species and this value is a constant to see how the relationship between total length and TS is logarithmic.

Research on the effect of fish length on TS values for tiger grouper. In the grouper research conducted by (Ira, 2017) it has the equation TS = 20 log L - 63.26. The difference in this formula occurs because the frequency of the equipment used is different, namely 160 and 200 KHz and different fish species from the same fish genus.berbeda dari genus ikan yang sama.

Distribution of Temperature and Salinity

Temperature Distribution

Based on the results of measurements at 14 stations, the distribution of the average temperature value of the waters of Lancang Island is 29.18 . The highest average temperature is at station 14 which is 29.89 while the lowest average temperature is at station 8 which is 28.99 .

In general, the vertical distribution of temperature values in the research location shows a decrease in temperature with increasing depth, however, there is no significant temperature change on Lancang Island (Putri, 2018).

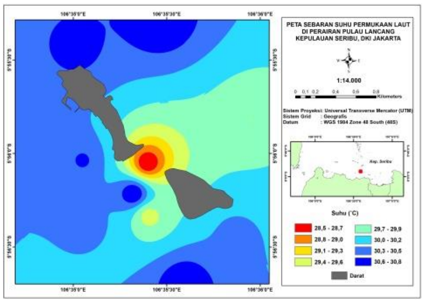

Figure 8. Map of Sea Surface Temperature Distribution in Lancang Island Waters

Salinity Distribution

Based on the results of measurements at 14 stations, the average salinity value of the waters of Lancang Island was 31.34 psu. The highest average salinity is at station 5, which is 31.94 psu, while the lowest is at station 1, which is 28.03 psu.

The vertical distribution of salinity values is in contrast to the distribution of temperature values, where the salinity value will increase with increasing depth. However, vertically, there is almost no significant change in salinity in the Java Sea (Putri, 2018).

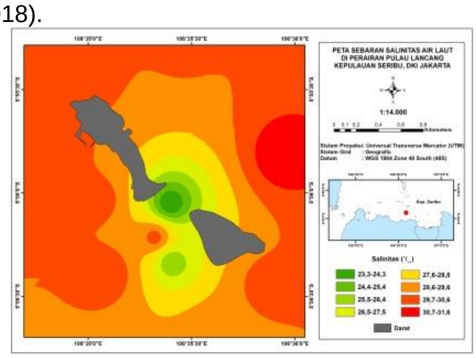

Figure 9. Map of Sea Surface Salinity Distribution in Lancang Island Waters

4. Conclusion

Simrad EK 15 can be used to measure TS values in tiger grouper (Epinephelus fuscoguttatus). The TS values obtained ranged from -34.77 dB to -32.37 dB. The longer the total length of the tiger grouper and the total weight of the tiger grouper, the higher the TS value.

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