Targets strength of freshwater fish with single beam echosounder

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Abstract. Cyprinus scarpio, Oreochromis niloticus, Pangasius, Anguilla sp, Ospronemus goramy and Serrasalmus sp are the types of fresh fish consumed widely by Indonesian society. Each type of fish has different acoustic backscatter strength influenced by meat, swim bladder and fish behavior at the time of data collection. This acoustic backscatter value has a decibel unit (dB). The purpose of this research is to get the value of single fish acoustic backscatter from those species. Data was recorded using single beam equipment frequency 200 kHz (cruzpro and Simrad EK-15 echosounder equipment). The results show the TS value of the six fish varies between -53 dB to -41dB. The TS relationship with length has a correlation coefficient value (R) greater than 0.5, which means that fish length has contribution more than 50%. Data was observed in a July 2015 trial using the same equipment and software. It was found that fish with the same length, which is 19 cm of different species (C. carpio, Pangasius and O. niloticus) but had different weights, turned out to have the different TS values. It is assumed that the characteristics of each fish body are different.

1. Introduction

Indonesian fishery is divided into two parties, freshwater fisheries and ocean fisheries. However, only a few species which are superior commodities in the market are still dominant. These superior species include Cyprinus carpio, Oreochromis niloticus, Pangasius, Anguilla sp, Ospronemus goramy and Serrasalmus sp. These are six freshwater fish type which are consumed widely by Indonesian people, found in all regions in Indonesia easily, but generally they have different regional names.

The target strength or acoustic size is a measure of the area of a sonar target. This is usually quantified as a number of decibels (db). Both controlled and on-location measurement of TS have been carried out including by [1][2][3][4]. Special freshwater fish research has been conducted by [5][6]. The TS value can be obtained using Cruzproechosounder and Simrad EK-15 hydroacoustic equipment. Both are simple hydroacoustic device, which is operated for the purposes of underwater acoustic research. Cruzpro and Simrad EK-15 echosounder has a single beam and operated at 200 kHz frequency. This device is relatively small, so it is easy to operate and carry out everywhere. Using a processing program, it can be used to provide information about the TS value of that six species of fish. The purpose of this study was to obtain TS value from six types of freshwater fish (Cyprinus carpio, Oreochromis niloticus, Pangasius, Anguilla sp, Ospronemus goramy and Serrasalmus sp.).
2. Materials and methods

2.1. Time and location
Acoustic data recording was carried out at the water tank of the Acoustic and Marine Instrumentation Laboratory, Department of Marine Science and Technology, Faculty of Fisheries and Marine Sciences, IPB University, in July 2015 and February 2017.

2.2. Materials and equipment
The research material is six types of live freshwater fish including 10 fish *Cyprinus carpio*, 10 fish *Oreochromis niloticus*, 10 fish *Pangasius pangasius*, 11 fish *Anguilla Sp*, 10 fish *Ospronemus goramy* and 13 fish *Serrasalmus sp*. These fish are varying in its lengths and weights. Based on its length, the fish are included in the small fish. Research on *Cyprinus carpio*, *Oreochromis niloticus*, and *Pangasius pangasius* were conducted in July 2015 using Cruzpro PcFF80 echosounder equipment with a frequency of 200 KHz. While recording data for *Anguilla sp*, *Ospronemus goramy* and *Serrasalmus sp* were conducted in February 2017 using Simrad EK-15 with a frequency of 200 KHz.

2.3. Data recording
The fish acoustic recording method uses a controlled method that is the tethered method in which the live fish are bound horizontally and placed under the near field area and under the transducer. Data recording for each fish was carried out for 5 minutes. Results of recording is in echograms. Figure 1. is an illustration of data recording. After recording acoustic data, fish length (L) is measured using a ruler and fish weight (w) is measured using a scale.

![Figure 1. Illustration of data recording.](image)

2.4. Data processing
The echogram of the acoustic data is then processed to obtain the TS value of each fish. The data for each fish will be tabulated and further processed to get the regression equation between the TS value and the length of the fish.

3. Results and discussion
The six types of fish examined in this study have different forms. *Cyprinus carpio* has an elongated body and is slightly flattened to the side. *Oreochromis niloticus*, *Serrasalmus sp* and *Ospronemus goramy* tend to be flat. *Pangasius* have a long, thin body and straight back, while the *Anguilla sp* is elongated like a snake. These six types of fish have differences in length, weight, body and meat characteristics. *Cyprinus carpio*, *Oreochromis niloticus*, *Serrasalmus sp* and *Ospronemus goramy* have scales but *Pangasius pangasius* and *Anguilla sp* are not scaly (macro scaly). However, these six fish species have
similarities that are complemented by swim bladder, but in this study swim bladder were not successful for surgery.

The range of fish length, fish weight and target strength (TS) values for each fish can be seen in Table 1. TS values for these six fishes range from -53.00 dB to -41.00 dB. Each type of fish has a TS value differently. This is caused by the characteristics of the fish, but sometimes it is influenced by changes in the position of the fish under the transducer, because fish in a state of life often make movements. Theoretically, the longer fish have greater TS value.

Based on the data obtained, a regression analysis was carried out for the six fish species, namely between the length of the fish (in logarithmic form) and the value of TS. The results showed that the correlation coefficient (R) between fish length and TS for Anguilla sp. had the highest correlation level which was 0.95. Pangasius pangasius ranks second in the correlation between fish length and TS value, which is 0.79. Other fishes have a correlation below 0.75 (Table 1). The relationship between TS and fish length was 0.98 [7].

In addition to the closeness between TS value and fish length we can also see the coefficient of determination (R) of each fish where in eel, fish length affects 91%. This means that the length of the fish affects the TS value of 91%. The TS value of catfish is at second rank at 79%, and other fish have a coefficient of determination (R) below 75%. TS is influenced by fish length by 86% [8]. According to [8] the length of gold fish contributed to the TS value of 83%. In addition, the TS value is thought to be influenced by the characteristics of each fish (meat, swim bladder and bones). TS is influenced by body size, body shape, swim bladder, fish orientation, and fish elements [9, 10]. Dependence of target strength on these factors is called the general trend.

Table 1. The equation of regression of the six-freshwater fish.

| Fish             | # of Samples | Length range | Weight range | TS range (dB) | Regression equation | Value of correlation coef |
|------------------|--------------|--------------|--------------|---------------|---------------------|---------------------------|
| Cyprinus carpio  | 10           | 16.6 - 21.3  | 210 – 600   | -45.35 s/d - 44.47 | TS = -5.266Log(L) - 38.39 | 0.62                      |
| Oreochromis niloticus | 10          | 18 -29      | 118 – 195   | -52.75 s/d - 51.45 | TS= -4.145Log (L) - 46.51   | 0.50                      |
| Pangasius pangasius | 10          | 16 -29      | 90 -280     | -49.45 s/d - 48.07 | TS=3.505Log (L) - 53.772   | 0.79                      |
| Anguilla sp      | 11           | 30 - 45     | 80 – 120    | -51.01 s/d - 41.78 | TS= 51.02 log(L) - 127.4    | 0.95                      |
| Ospronemus goramy | 10           | 12-16       | 23-66       | -53.35 s/d – 42.77 | TS = 36.37 log (L) - 90.24  | 0.57                      |
| Serrasalmus sp   | 13           | 17-27       | 113-331     | -51.10 s/d - 41.12 | TS= 33.34 log(L) - 90.25    | 0.70                      |

In July 2015 (Table 2) using the same equipment and software, it was found that fish of the same length, 19 cm of different species (Cyprinus carpio, Pangasius pangasius and Oreochromis niloticus), but had different weights. These fish turned out to have different TS values. It is suspected that the characteristics of each fish body are different. Based on fish weight known Cyprinus carpio heavier than the weight of Pangasius pangasius and Oreochromis niloticus. Fish weight contributed more than 70% to the value of TS [5][7], however according to the study of [11] fish length more strongly influenced the value of TS compared to fish weight. Several studies have been conducted to see the relationship between fish length and TS value of fish can be seen in Table 3.
Table 2. TS of fish with a length of 19 cm.

| Fish            | Length (cm) | Weight (gr) | TS (dB) |
|-----------------|-------------|-------------|---------|
| *Cyprinus carpio* | 19          | 300         | -44.85  |
| *Oreochromis niloticus* | 19          | 180         | -51.34  |
| *Pangasius pangasius* | 19          | 280         | -49.45  |

Table 3. Regression results from several studies.

| Researcher's Year | Regression Equation | R²     |
|-------------------|---------------------|--------|
| [7] 2002          | TS = 20.53(±0.78)logL - 64.25(±0.80) | 0.98   |
|                   | TS = 6.98(±0.30)logW - 50.07(±0.33) | 0.97   |
|                   | log10W = 6.79(±0.26) + 0.13(±0.005)TS | 0.97   |
| [8] 2006          | TS = 32.1 ln(x) - 64.1 (Frequency 38) | 0.99   |
|                   | TS = 16.2 ln(x) - 66.7 (Frequency 70) | 0.92   |
|                   | TS = 12.6 ln(x) - 68.1 (Frequency 120) | 0.76   |
|                   | TS = 15.5 ln(x) - 67.8 (Frequency 200) | 0.86   |
| Note: x = log (SL) standard length | | |
| [13] 2008         | TS lateral=32Log(L)-70.9 | Note: - = no data | R=0.78 |
|                   | | | R²=0.61 |
| [5] 2005          | TS = 19.14 Log L - 101.08 | R=0.83 |
|                   | | | R²=0.68 |
|                   | TS = 7.28 Log W - 47 | R=0.72 |
|                   | | | R²=0.52 |

Table 4 for three *Anguilla sp* (sample number 3; 8 and 9) which have the same fish length that is 15 cm but have different weights, showing that fish with sample numbers 8 and 9 which have the same weight i.e. 100 gr have TS values not different, that is -48.44 dB and -48.61 dB, but for fish with a smaller weight 80 gr have smaller TS that is -50.64 dB.

This confirms that the fish's weight also influences the TS value. TS is influenced by physiological and natural behavioural effects (intestinal fullness, gonadal development, and tilt angle) [7]. It is suspected that fish with larger weights may have a greater swimming pool volume thus providing a large backscatter. However, this cannot be informed in this paper, which is caused when performing fish surgery, swim bladder is damaged.

Table 4. *Anguilla sp*. with a length of 35 cm.

| Sample number | Length (cm) | Weight (gr) | TS (dB) |
|---------------|-------------|-------------|---------|
| 3             | 35          | 80          | -50.64  |
| 8             | 35          | 100         | -48.61  |
| 9             | 35          | 100         | -48.44  |
4. Conclusion

The TS value of *Cyprinus carpio*, *Oreochromis niloticus*, *Pangasius pangasius*, *Anguilla sp*, *Ospronemus goramy* and *Serrasalmussp* range from -53.00 to -41.00 dB. The relationship of TS with length has a correlation coefficient (R) of more than 0.5, which means that fish length has a contribution of more than 50%.

5. References

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