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COMPARISON OF ZOOPLANKTON DENSITY ESTIMATION USING BONGO PLANKTON NET AND UNDERWATER ACOUSTICS METHOD

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Abstract. Zooplankton is one of the factors that can affect water conditions. The existence and abundance of zooplankton can indicate the level of water fertility. Zooplankton abundance can be observed by using two methods. These are the bongo plankton net and underwater acoustics method. This study aims to determine the abundance of zooplankton using bongo plankton net 250 µm mesh size and underwater acoustics method using Simrad EK15 200 kHz frequency. This study was conducted in July 2019 in the Banyuasin estuary. The results showed the abundance of zooplankton using bongo plankton net ranged from 7-116 ind/$m^{3,}$ and the zooplankton density in underwater acoustics ranges from 0-2700 ind/m^3. It means the ratio between both of the methods is around 1:20. The comparison could illustrate the difference in zooplankton density. It is necessary to adjust the specifications instrument and sampling technique of zooplankton sampling equipment and underwater acoustics instruments to obtain more accurate results.

Keywords: Abundance, Banyuasin estuary, hydroacoustics, zooplankton,

1. Introduction

An estuary is a partially enclosed coastal body of brackish water with one or more rivers or streams flowing into it and a free connection to the open sea [1]. Estuaries are coastal areas where the ocean's saline waters meet with fresh water from streams and rivers. Estuarine habitats are usually very productive because of the accumulation of nutrients from freshwater runoff. Estuaries offer reasonable fishing grounds for the fisherman as the water column is shallow. These zones are breeding habitats for a variety of Shrimp and Prawn species, oysters, and fish. They also provide sheltered harbors for ocean-going ships. Estuarine waters are used for the cooling of water in power generations [2].

Banyuasin estuary is a meeting point of Lalan river, Banyuasin river, and Bungin river. This area is also a place where people do their activities. The activities that do not pay attention to the environment can threaten the Banyuasin estuary ecosystem. Excessive human activity such as waste disposal, fish ponds, fishing, and transportation (ship routes) in rivers can directly or indirectly affect the ecosystem Banyuasin estuary.

One factor that can affect water conditions is plankton. Plankton is an organism, both animals and plants floating on water with minimal mobility, so the flow always carries the organism. Overall the plankton cannot move against the current [3]. Plankton can be classified based on their function into phytoplankton, zooplankton, bacterioplankton, and virioplankton [4]. Zooplankton usually acts as primary consumers and constitute an essential link between primary producers (phytoplankton) and higher consumers like carnivore fish in the aquatic food chain. The zooplankton mainly consumes primary producers and form the major food source for tertiary consumers. Certain species of zooplanktons are used as bioindicators of water quality. The estimation of plankton analysis helps explain the cause of color, turbidity, odor, taste, and visible particles in water [5].

The most common method for zooplankton sampling is to use a net that has a tiny mesh size. The technique is to pull the net vertically or horizontally, then collected the zooplankton that the net has retained. Nevertheless, this method is less effective if used on a broad or deep area, so another method to provide the information is underwater acoustics. The underwater acoustics method can provide information directly and entirely at the water layer to be analyzed. In general, research on zooplankton underwater acoustics is also supported by net sampling, and this is used for data validation.

This study aims to compare the density of zooplankton using the bongo net method and underwater acoustics method.

2. Materials and Methods

2.1 Study area

This research was carried out in July 2019 at Banyuasin estuary. This estuary has an average depth of 8.5 m. Bongo net samples and acoustics data were collected from 10 different stations. Figure 1 shows the sampling station for data acquisition.

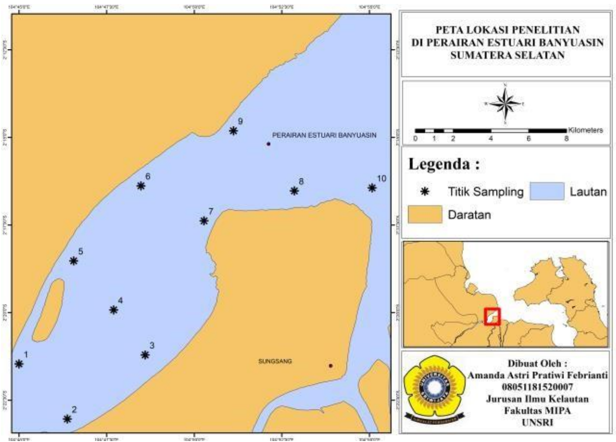

Figure 1. Sampling location

2.2 Tools and Materials

2.2.1 Biological sampling

Zooplankton was collected using bongo nets with a diameter of 72 cm and a mesh size of 250 µm. Bongo net was pulled horizontally along with acoustics data recording for 5 minutes with a boat speed of 1-2 knots at a depth of 1.5-2 m (Figure 2). Zooplankton samples were preserved with formalin solution to reach a concentration of 4% and stored in a cool box for species identification. The process of identifying and calculating zooplankton abundance is carried out by the census sub-sample method. The zooplankton species was determined using a reference book of plankton identification Davis (1955), Wickstead (1965), Yamaji (1966), Newell and Newell (1977).

2.2.3 Acoustics data acquisition

The acoustic data was obtained with the hydroacoustic system Simrad EK15 200 kHz frequency equipped with GPS. The echosounder aboard in a small boat (approximately 10 m). The transducer was placed 0.5 m from the surface downward-looking vertically. Acoustic data were processed using Echoview 4.8, which is equipped with a dongle with an echo integration method.

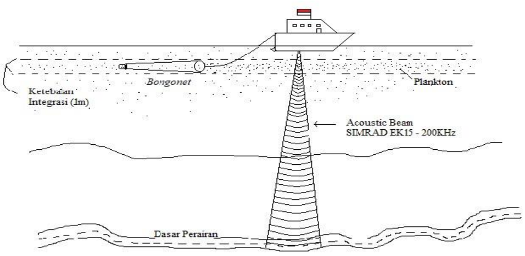

Figure 2. Zooplankton and acoustics acquisition technique

2.3 Data Analysis

Data processing and analysis were conducted in the Laboratory of Marine Exploration Resource and Acoustics, Faculty of Mathematics dan Natural Science, Sriwijaya University.

2.1.1. Zooplankton abundance.

Plankton abundance is expressed in individual/m^3 for zooplankton. The formula in calculating zooplankton abundance is calculated using this equation [6]:

$$D = \frac{q}{f \; x \; t}$$

Where:

D = total zooplankton content (Ind/m^3)

q = number of zooplankton in the subsample (Ind)

f = fraction taken (subsample volume per sample volume)

V = volume of filtered water (m^3)

2.1.2 Acoustics data analysis for zooplankton

Raw data taken by the 200 kHz Simrad EK15 echo sounder were post-processed and scrutinized using Echoview 4.8 equipped with Garmin 76csx GPS. The abundance of zooplankton was estimated from the volume backscattering strength (Sv) and recorded on transects covering the sampling area. During the collecting process, data for a selected distance were thresholded (filtered) in amplitude, Sv, ranging from -83,9 dB to -62,5 dB for enhancing echoes from zooplankton and removing echoes from the unwanted target. The technique was used in order to extract and separate zooplankton and unwanted target. Fish shows much stronger backscattering than zooplankton on the recorded echogram. Data stored from 1 m thickness layer. The conversion factor between SV and the area backscattering coefficient (SA) are given by the expression acoustic zooplankton density values are calculated by formula [7]:

$$\rho_{Vs} = \frac{p_S}{\sigma_{bs}} Sv$$

Where:

ρ_{Vs} =Volumetric fish density in the region (unit/m^3)

Ps $= \sum_{S=0}^{N_s-1} P_s = 1$

σ_{bs} =Weighted mean backscattering cross-section of all species 0 to N_S-1 (m^2)

Sv =The linear mean Sv value for the region (m^2/m^3)

3. Results and Discussion

3.1 Zooplankton composition

The observed area's average salinity was 26.4 ppt, pH average 6.2, temperature average 28.2 ^{o}C during the day and night time, and the deep average of 8.2 m. The observations were carried out in the rainy season. Salinity, pH, temperature, and depth are the parameters used to calculate sound speed. Based on these data using the formula [8] the average speed of sound in the observation field is 1532.67 m/s.

Observational results analysis of zooplankton found 21 species consist of phylum Chaetognatha, Chordata, Coelenterata, Crustaceans, Chtenopora, Echinoderms, and a group of fish larvae. The highest zooplankton composition was found in the Crustacea phylum that was 63%, Coelenterata phylum 16%, Ctenophora phylum 7%, Chaetognatha phylum 6%, Echinodermata phylum 4%, group of fish larvae 3%, and the lowest zooplankton composition were in the phylum Chordata which was 1% (Figure 3). The most dominant zooplankton in the Crustacean phylum is *Zoea shrimp* taxa, which they found throughout the station. Taxa Gonionema, Obelia, and Ctenophora are also found throughout the station but in smaller amounts than the Zoea shrimp taxa.

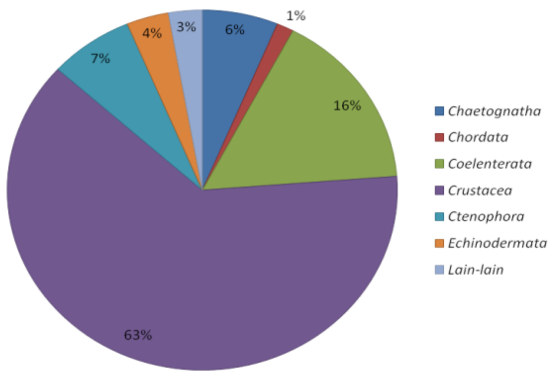

Figure 3. Zooplankton composition

The most commonly found zooplankton in the Banyuasin estuary was from crustacean phylum as 63%, with the total identified are 12 species. The dominance of crustaceans in the waters can be related to the omnivorous character, so they quickly get food and have a high tolerance to the environment to adapt quickly. [3] Overall, zooplankton in waters is generally dominated by Crustacean species, both in the number of individuals and the number of species. Coelenterata phylum was found 16% with four species. The Ctenophora phylum was found at 7%, the Chaetognatha phylum 6%, the

Echinodermata phylum 4%, and a group of fish larvae was 3%. The Chordata phylum in the Appendicularia class is a small planktonic animal, sometimes in large numbers. This planktonic animal has a mucous head to catch prey in the form of phytoplankton [9]. This Appendicularia class is classified as holoplankton because during its lifetime only as plankton. In Banyuasin estuary, the Appendicularia class found the Oikopleura was only 1% identified.

3.2 Zooplankton acoustics data analysis

Visual echograms are slightly easier to separate between zooplankton and fish, but calculating the Sv backscattering coefficient is more difficult because the backscattering of fish is stronger than the backscattering of zooplankton. When compared to the backscatter of one million zooplankton, it is still weaker than a few fish. It needs to be considered in detail about the characteristics of zooplankton as the object of study to separate the backscattering of zooplankton without mixing with the backscatter from fish or other objects.

3.3 Abundance estimation

Estimates of abundance from echoes on echogram are assumed to come from a crustacean as the most dominant zooplankton are crustaceans. There are three categories of zooplankton based on the acoustics backscattering, fluid-like (e.g., Euphausiid shrimp), rigid or elastic shell (e.g., Gastropods), and Gas Bearings (e.g., Siphonophores) [7]. Results identification of zooplankton bongo net obtained two category zooplankton were detected from the fluid-like and gas-bearing category. Zooplankton from the fluid-like category was found to be more numerous than the gas-bearing category. Fluid Like category is mostly from crustaceans.

Table 1. Zooplankton abundance estimation based on bongo net and underwater acoustics method

Station	Zooplankton abundance estimation using bongo net (Ind/m^3)	Zooplankton abundance estimation using bongo net (Ind/m^3)
1	54	920
2	17	470
3	39	689
4	45	1428
5	23	**290**
6	16	364
7	**7**	341
8	**116**	**2041**
9	43	773
10	69	1509
Average	42,9	882,5
Ratio	1	20

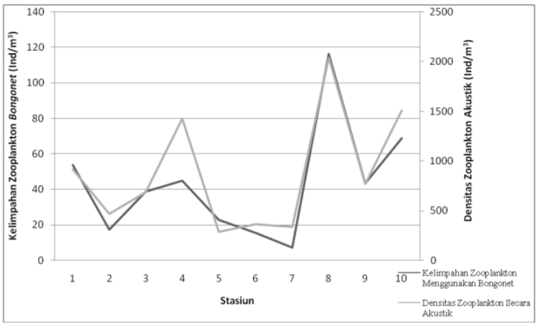

Figure 4. Trends of zooplankton abundance

Table 1 shows station eight zooplankton density has the highest abundance, both bongo net (116 ind/m^3) and acoustics method (2,041 ind/m^3). The lowest abundance of zooplankton using bongo net is at station 7, which is only seven ind/m^3, while the lowest zooplankton density in acoustics method at station 5, which is 290 ind/m^3. Based on Table 1, it can be seen that the value of acoustic zooplankton density with zooplankton abundance shows a striking difference. The large mesh size of the bongo net can be caused by the large mesh size, causing many zooplankton to escape or not be trapped in the bongo net, while the acoustic data integration uses a relatively low threshold. The comparison ratio between zooplankton trapped in bongo nets and zooplankton detected by the acoustic method is 1:20. It means that one ind/m^3 zooplankton identified using bongo nets is the same as 20 ind/m^3 zooplankton detected by the acoustic method. Another thing that causes differences in the zooplankton abundance is that the acoustic data integration thickness is more expansive, which is 1 m compared to the bongo net opening diameter, which is 72 cm. The plankton threshold also does not have an integrated value or still diverse, so it is a bit difficult to be adopted in a suit with the conditions of the study location.

4. Conclusion

Even though there are significant differences, acoustic methods can estimate zooplankton abundance, where the operation is performed by taking biological samples as validation. The use of acoustic and bongo net methods to estimate zooplankton abundance needs to pay attention to the device specifications, the data collection techniques, and the study site's characteristics. The right combination of these three things with the net and acoustic methods is expected to produce more reliable data.

5. Appreciation

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