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RESEARCH ARTICLE

Fish stock estimation in Sikka Regency Waters, Indonesia using Single Beam Echosounder (CruzPro fish finder PcFF-80) with hydroacoustic survey method

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ABSTRACT

Sikka regency waters including fishery management with a high utilization status so that the necessary stages of an intensive monitoring and research potential of fish resources. This study aimed to obtain the estimated value of stock biomass and density of fish resources with the acoustic method. Quantitative data obtained will be a source of current information on the state of fish resources in the Sikka regency waters, Indonesia. The research was conducted in May 2015. Acoustic data retrieval, using instruments CruzPro fish finder PcFF-80 with sound velocity of 1516 m / s, power 2560 Watt, and method in survey acoustic use hydroacoustic long transect. The horizontal distribution shows a fluctuation striking at research location has the highest salinity levels in the range of 29.3-29.8 psu. Total biomass of fish in this study showed more the number is at a depth of 11-20 m that is 2,008 tons/km and at a depth of 1-10 m have the total fish biomass is 12.33 tons/km, single detection is done using a single target hydroacoustic show more dominance at a depth of 11-20 m in Sikka regency waters, MTB, Indonesia in May 2015. Number of data from results obtained by looking at the relationship between the number of the data with the total biomass in 1-10 m depth has equation Y = 0.0967x + 0.0486 with R2 is 0.0464 (4%) , while at a depth of 11-20 m has a regression equation is Y = 0.0003x + 0041 with the R^2 is 0.0091 (0.9%). Variations in the data or the detection of single targets have variations over the data that is at a depth of 11-20 m with the lowest regression is 0.9%.
Keywords: Hydroacoustic, Salinity, Biomass, Stock estimation, Sikka regency waters.

INTRODUCTION

Quantitative estimation of the size of fish populations is needed in the development and management of fish resources. Utilization of fish resources can be optimally done when stocks and distribution of fish resources were certainly known, as its importance for policy and sustainability. Sikka regency waters have significance for the business activities of fisheries which exploit small pelagic fish resources. Fishing tools that commonly used were gill nets and longlines. Study of oceanography parameters in Sikka regency waters that related to fish distribution is still limited, hence this study becomes important.

The aggregation of pelagic fish into schools or shoals is presumed to confer potential benefits of reduced predation risk, achieved through a variety of different mechanisms (Godin, 1986; Pitcher and Parrish, 1993) and increased foraging success. Despite constant progress in understanding the complex processes involved in the variability of pelagic stock abundance, especially at short and medium time scales, our ability to predict abundance and catches are limited, which in turn limits our capacity to properly manage the fisheries and ensure sustainable exploitation. Substantial progress can be expected from an integrated modeling approach to spatialized models coupling hydrodynamics, biogeochemical, and ecological processes (Watson and Pauly, 2001). However, the foraging value of schooling may shift from benefit to cost if prey densities decline. Under low food conditions, individual foraging success is reduced due to local depletion of food by fellow group members (Folt, 1987). Another potential cost of compact schools includes the energy expended in maintaining position within the echo processing (Lubis *et al.,* 2016a).

Because pelagic fish are highly aggregated, the time was taken to catch them is short in comparison to the time spent searching for them. Modern fishing of pelagic fish is mostly dependent on detection and location of fish shoals by hydroacoustic instruments (Misund, 1997). Larger purse seiners (> 40 m) have a low frequency, low-resolution sonar (18–34 kHz) for detecting fish shoals at long range, and a high-frequency, high-resolution sonar (120–180 kHz) for more detailed mapping of shoal size and fish behavior in relation to the vessel and the net. In addition to this equipment, pelagic trawlers have sophisticated net sonde or trawl sonar that looks both upwards and downwards and facilitates the depth adjustment of the net according to fish behavior (Misund *et al.,* 2002).

In the science of acoustic, there is passive and active acoustic method. In the passive acoustic method usually with namely is bioacoustic, and this method described in researching (Wulandari, 2016; Lubis, 206; Lubis 2014; Lubis *et al.,* 2016b). In the active acoustic with the hydroacoustic method are increasingly being used in all kinds of aquatic ecosystems in order to acquire detailed information about aquatic life, and stock estimation about fish (Simmonds and Maclennan, 2005). This increased understanding of survey biases together with technical advances in equipment manufacture and computing power have led to a gradual movement away from using acoustic biomass estimates merely as relative indices to their use as absolute estimates of abundance (Boyer and Hampton 2001, Løland *et al.* 2007), sometimes with quantitative estimates of uncertainty.

Quantifying sea bottom surface backscattering strength with echosounder and identifying bottom fish by using the hydroacoustic method most recently in the years 2003-2015 is (Manik *et al.,* 2006) and (Manik, 2010), and using Cruzpro Fishfinder according to (Lubis and Pujiyati, 2016), while research about acoustic backscatter quantification of seabed in (Pujiyati, 2008; Pujiyati *et al.,* 2011). The hydroacoustic method also use in estimation of zooplankton (Moniharapon *et al.,* 2014). The aim of this hydroacoustic survey was to estimate the total biomass of fish in Sikka regency waters using long transects sampling patterns and calculation methods of biomass (Lubis and Pujiyati, 2016). The results of this study were described in the map of fish density distribution for each stratum depth.

MATERIALS AND METHODS

Time and Site

The research was conducted in May 2015 in Sikka regency waters, East Nusa Tenggara Province, Indonesia with latitude 8°41'50.77"S , longitude 122° 8'32.67"E. Data collections in this research were using a traditional fishing boat. Sampling points and "long" transect in hydroacoustic survey method (Figure 1). Acoustic data acquisition was done using instruments Cruzpro fish finder PcFF-80 (www.cruzpro.com) with a sound velocity of 1516 m/s and power of 2560 Watt (Figure 2).

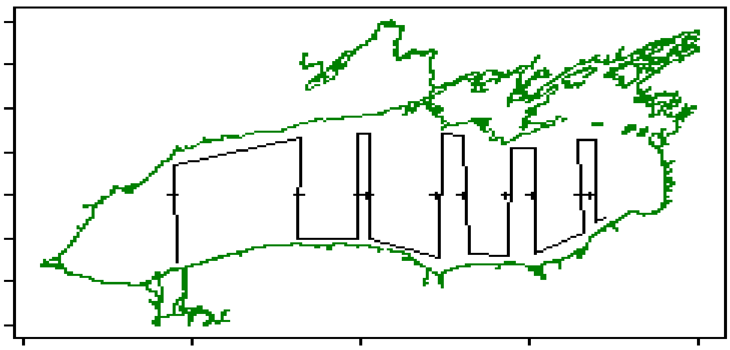

Figure 1. Sampling points and "long" transect in hydroacoustic survey method

Data Collection

The acoustic data were collected using a Cruzpro fish finder PcFF-80 at a frequency 200 and 50 kHz. An equipment calibration was conducted according to Cruzpro fish finder PcFF-80 specifications before the start of each survey. Midwater trawls were used to identify echo-traces and to determine the species size-frequency distribution (MacLennan and Simmonds, 1992).The target strength (TS) was assumed from the equation suggested by Foote (1987).

Acoustic data acquisition was done in the afternoon until the evening for six days period while boat speeds ranging between 6-7 knots. Trails include a data acquisition area of an area that allows the analysis of spatially created with the form of long transect according to (Simmonds and Maclennan, 2005) with the length of each transect approximately 12 km from the boundary islands outwards. Overview of the research sites in Sikka Regency waters and acoustic tracking can be seen in (Figure 3). Acoustic data recording process performed stationary. Acoustic data recording process carried out for 10 to 15 minutes at each sampling station.

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a b c d

Figure 2. Hydroacoustic Instruments CruzPro fish finder PcFF-80 with a)Pc/ Computer , b)Interface , c) Hand GPS, d) Transducer (Single beam echosounder) (personal documentation)

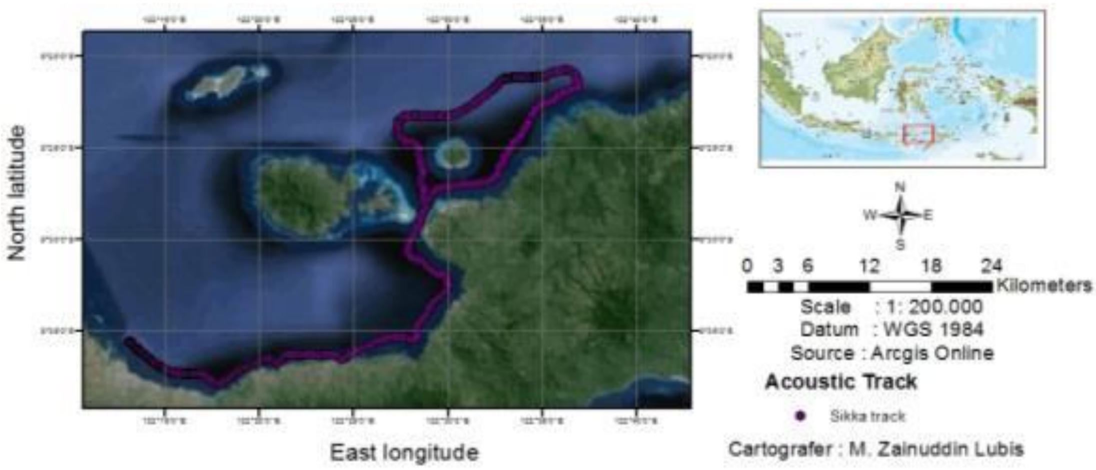

Figure 3. Tracking of cruise acoustic survey (fish stock estimation and research location) in Sikka Regency Waters, Indonesia

Data Processing and Analysis

Acoustic data were processed using Sonar software ver.4 and Matlab R2008b. Analysis of fish estimation was done starting from a depth of 1-10 m, with units of fish biomass yield is (tail/1000m^3). acoustic formula namely Target strength (TS) which described as the ability of the underwater target to return an echo. Based domain is used, the target strength is defined into two, namely in the form of Intensity Target Strength (TSi) and Energy Target Strength (TSE). Target strength can be defined as the quotient between the value of the reflected intensity of the target to the sound intensity hit the target in logarithmic function (Johanesson and Mitson, 1983).

$$TSi = 10 \log \frac{Ir}{Ii} \quad \ldots\ldots\ldots \quad (1)$$

$$TSe = 10 \log \frac{Er}{Ei} \, q \quad \ldots\ldots\ldots \quad (2)$$

Where, Tsi= Intensity of target strength, Ii= Intensity of sound on targets , Ir = intensity of the reflected sound energy targets , Tse= Target Strength , Ei= Energy sound on targets , Er= Energy reflection sound at a distance of 1 meter from the target.

In additio (Natsir *et al.,* 2005) has a long -weighs equation to convert length into weight as follows:

$$Wt=a \{ \sum_1^{i1} ni(Li+ÄL/2).^{b+1} - (Li-ÄL/2).^{b+1}\}/\{(b+1)ÄL\}\} \quad \ldots\ldots\ldots \quad (3)$$

Where, Wt = total weight (g), Al = class interval length (cm), Li = the midpoint of the long-th grade (cm), Ni = number of individuals in the i-th grade, a, b = constants for certain species.

RESULTS AND DISCUSSION

The obtained Values of fish estimation stocks referred to the amount of biomass of the fishery resources in the observed area. The estimation of the stock acquisition value may not reflect the actual condition of fish resources, hence, there are typical of fish in groups (schools) or solitary (Manik, 2010). Single target echogram in depth of 1-10 m, can be seen in (Figure 5a). Analysis of the spatial distribution is useful to know the pattern of aggregation of fish resources in the observed waters so that can know the condition of the existence of fish resources actually closer in nature. Vertical distribution of salinity in Sikka regency waters can be seen in (Figure 4b), and the spatial distribution of resources fish. Acoustic detection results at the time of the survey showed that in (Figure 5a, and 5b).

At a depth of 1-10 have the results of the spatial distribution of fish distribution (Figure 5a) have very little it is expected due to dilution by the relatively higher rainfall in May. In (Figure 5b) shows the vertical distribution of salinity, the horizontal distribution shows fluctuations striking at research location has the highest salinity levels in the range of 29.3-29.8 psu. The 3D spatial distribution of fish at depth of 1-10 meters (Figure 5a) show more fish biomass values were in the range of 0 to 50 (tail / 1000 m^3), whereas the biomass was highest, namely 3101 to 7177 (tail / 1000 m^3). This clearly provides that the information of the distribution of fish at depths of 1-10 m in Sikka waters, Indonesia has very little biomass.

Fish stock estimation of biomass results obtained at a depth of 11-20 meters has a spatial distribution that is more than the depth of 1-10 meters (Figure 5b), these results can be seen in (Figure 5a) in the 3D spatial distribution of fish at the depth of 1-10 meters, with the highest distribution is 0 to 50 (tail / 1000 m^3), the spatial distribution of the most prevalent is 51-100, and distribution of at least the biomass is 201-310 (tail / 1000 m^3). The total biomass of fish in this study showed more the number is at a depth of 11-20 m that is 2,008 tons/Km and at a depth of 1-10 m have the total fish biomass is 12.33 tons/ km with a total different single target detection, the results obtained are the actual results of the tool hydroacoustic a single beam and do not use the fishing gear for example aids gillnet is not the same with other research (Mehner and Schulz, 2002, Patterson *et al.,* 2001). Single detection is done using a single target hydroacoustic show more dominance at a depth of 11-20 m in Sikka Regency waters, Maluku Tenggara Barat, Indonesia in May 2015.

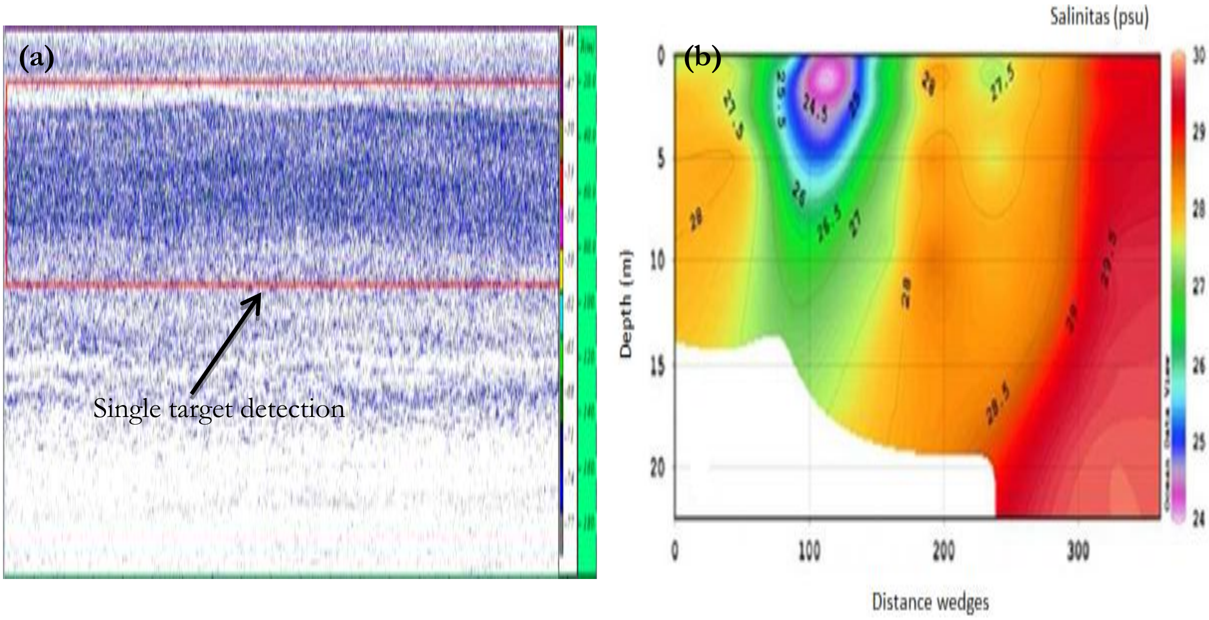

Figure 4. (a) Single target echogram in depth 1-10 m, (b) Vertical distribution of salinity in Sikka regency waters

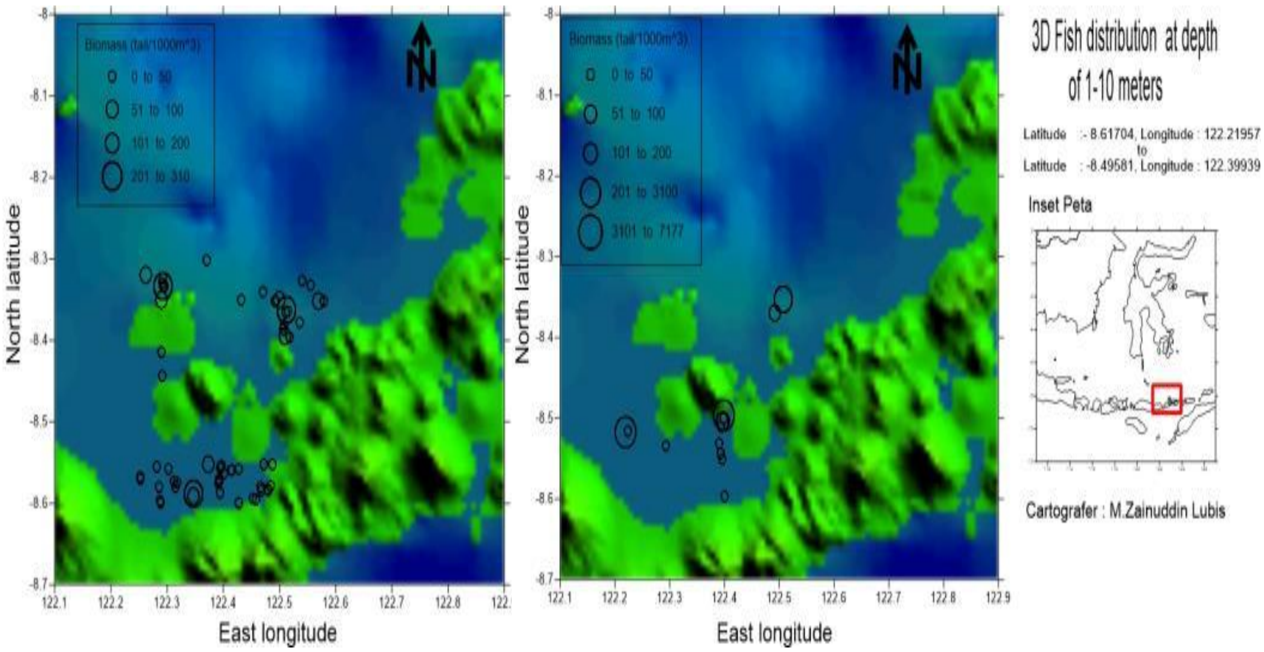

Figure 5. (a) 3D Spatial distribution of fish at depth of 1-10 meters, (b) 3D Spatial distribution of fish at depth of 11-20 m

Table 1. Biomass estimation of fish (ton) in depth 1-10 m

Longitude	Latitude	Biomass (Tons/Km)
122.21957	-8.51704	3.82266
122.22368	-8.51561	0.02488
122.29318	-8.53414	0.02487
122.40081	-8.59689	0.03478
122.39901	-8.5009	0.00146
122.39796	-8.50294	0.10224
122.39796	-8.50295	0.18051
122.3966	-8.50494	0.16814
122.3928	-8.51017	0.04713
122.39069	-8.53182	0.00373
122.39319	-8.54317	0.00501
122.39593	-8.55063	0.00936
122.49183	-8.36976	0.09491
122.50689	-8.35369	0.63692
122.39939	-8.49581	7.17615
Total biomass of fish		**12,33275**

Table 2. Biomass estimation of fish (Ton) in depth 11-20 m

Latitude	Longitude	Biomass (Ton)	Latitude	Longitude	Biomass (Tons/ Km)
-8.68669	122.5065	0.004703047	-8.58455	122.47989	0.008981194
-8.67783	122.5356	0.007950297	-8.58325	122.47823	0.002188497
-8.66572	122.5104	0.003881807	-8.58001	122.2853	0.004874121
-8.66478	122.5154	0.044239808	-8.5785	122.4839	0.068642879
-8.66274	122.5125	0.29413167	-8.56349	122.40122	0.00064447
-8.65238	122.5554	0.007264844	-8.49462	122.50921	0.098055448
-8.651974	122.5687	0.015669971	-8.5544	122.28167	0.001007631
-8.651424	122.5786	0.005101958	-8.57246	122.39305	0.004328867
-8.49566	122.5177	0.028750929	-8.58132	122.50869	0.30854327
-8.63428	122.2926	0.056522535	-8.57009	122.25294	0.027705738
-8.63414	122.2925	0.010249706	-8.58783	122.25292	0.001240871
-8.63414	122.2925	0.01356654	-8.57563	122.3911	0.00372663
-8.63414	122.2932	0.239153825	-8.5745	122.31706	0.008933292
-8.63325	122.2956	0.004363717	-8.57973	122.31514	0.00363591
-8.62993	122.2918	0.002127022	-8.57309	122.3122	0.000760024
-8.62698	122.5402	0.030258324	-8.5708	122.39244	3.49341E-05
-8.62337	122.2909	0.000642236	-8.58775	122.39419	0.001820323
-8.61207	122.2902	0.000568804	-8.55711	122.39471	0.000397759
-8.6089	122.2898	0.006831018	-8.55652	122.3953	0.00125331
-8.60864	122.3468	0.016908005	-8.55598	122.39588	0.00240927
-8.60859	122.3466	0.000236513	-8.55408	122.39655	0.00069515
-8.60442	122.4678	0.082532458	-8.55237	122.37278	0.010107089
-8.60313	122.4662	0.022970984	-8.3018	122.37074	0.027602262
-8.60254	122.4658	0.038551478	-8.320001	122.26257	0.000689822
-8.60086	122.4316	0.006540752	-8.55975	122.41352	0.017430663
-8.60047	122.4711	0.000141708	-8.55967	122.41536	0.07624369
-8.59993	122.4275	0.001094629	-8.55786	122.4279	0.019000405
-8.59987	122.4279	0.027525912	-8.5527	122.47206	0.013723276
-8.59902	122.288	0.003843321	-8.55771	122.30225	0.004436968
-8.59667	122.2878	0.013636692	-8.552286	122.48718	0.049670649
-8.59608	122.4578	0.005058431	-8.551544	122.49152	0.078807879
-8.59378	122.4526	0.099454253	-8.551298	122.49312	0.049432922
-8.550493	122.4998	0.016970998	**Total Biomass of fish : 2,008**		

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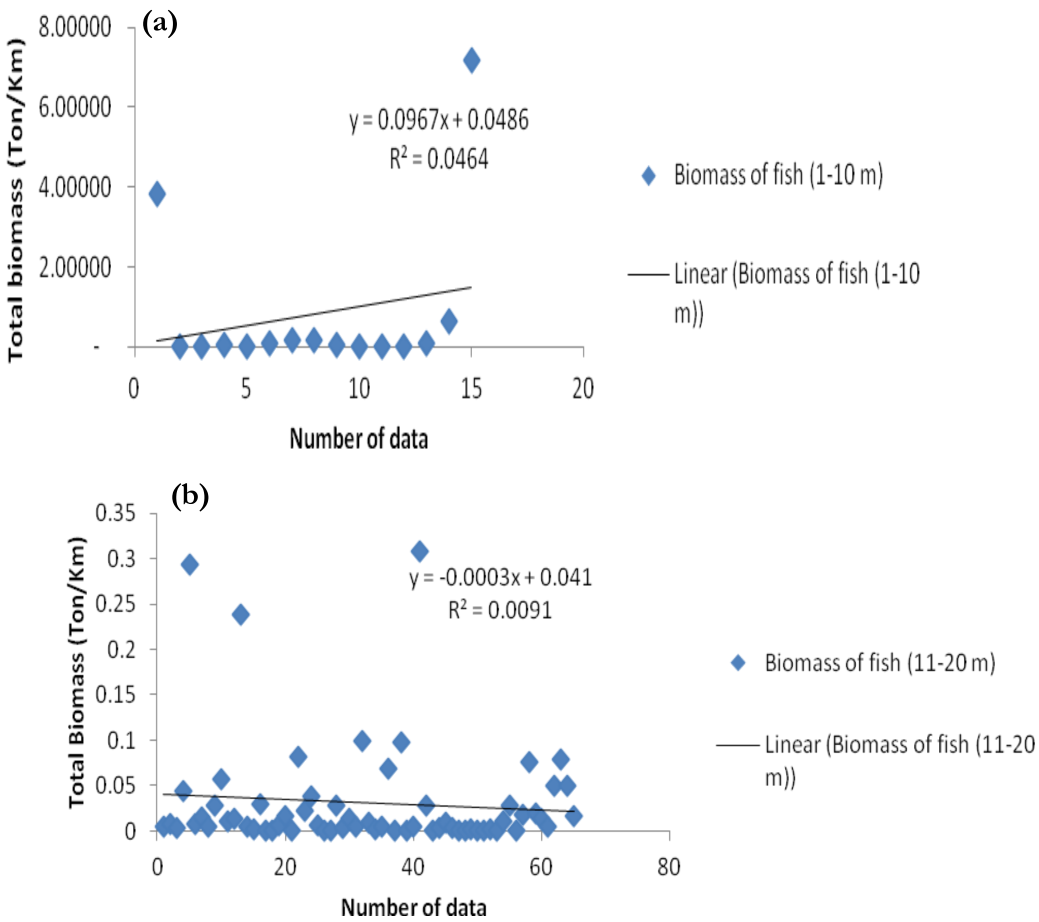

Figure 6. (a).Relationships between number of data with total biomass (Ton) in depth 1-10 m, (b) relationships between number of data with total biomass (Ton) in depth 11-20 m

Total biomass of estimation fish in depth range 1-10 m is 12,33275 tons/km, Biomass estimation of fish (ton) in depth 11-20 m is 2,008 tons/km. The largest biomass in the estimation of fish stock with a depth of 1-10 meters is on longitude 122.39939, latitude -8.49581, with biomass value 7.17615 tons/km. The largest biomass in the estimation of fish stock with a depth of 11-20 meters is on longitude 122.5402, latitude -8.62698, with biomass value 0.030258324 tons/km. On the results of the simple regression performed, at a depth of 11-20 looks variation data is lower than data variation in depth of 1-10 m (Figure 6a, and 6b). Lowest biomass at a depth of 1-10 m range, namely 0.00373 tons/km, while the depth range of 11-20 m has the lowest biomass that is 0.001094629 ton/km. Vertical distribution of salinity in Sikka regency waters have low salinity values is 24 psu while the highest score is 30 psu at a depth of 0-20 meter range. Distance wedges with a range of 250-350 (Figure 4b). Total biomass of fish in this study showed more the number is at a depth of 11-20 m that is 2,008 tons/km and at a depth of 1-10 m have the total fish biomass is 12.33 tons/km, single detection is done using a single target hydroacoustic show more dominance at a depth of 11-20 m in Sikka Regency waters using Cruzpro Fishfinder , Single beam echosounder dual frequency.

Number of data from results obtained by looking at the relationship between the number of the data with the total biomass in depth 1-10 m has to generate Y = 0.0967x + 0.0486 with R^2 is 4% (Figure 6a), while at a depth of 11-20 m has a regression equation is Y = 0.0003x + 0041 with the R^2 is 0.9%). Variations in the data or the detection of single targets have variations over the data that is at a depth of 11-20 m with regression low percentage is 0.9% (Figure 6b).

CONCLUSIONS

Fish stock estimation by using the hydroacoustic method have horizontal distribution shows fluctuations striking at research location has the highest salinity levels in the range of 29.3-29.8 psu. Total biomass of fish in this study showed more the number is at a depth of 11-20 m that is 2,008 tons/km and at a depth of 1-10 m have the total fish biomass is 12.33 tons/km, single detection is done using a single target hydroacoustic show more dominance at a depth of 11-20 m in Sikka Regency waters, MTB, Indonesia in May 2015.

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