THE ASSESSMENT OF PELAGIC FISH STOCK AND ITS DISTRIBUTIONS IN INDIAN OCEAN BY SPLIT BEAM ACOUSTIC SYSTEM

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Abstract

The assessment of pelagic fish stock and its distribution in Indian Ocean, especially southern part of Java-Bali-Lombok, was conducted by SIMRAD EK-500 Split-beam Acoustic System, in October-November 2001. The research was carried out by R/V Baruna Jaya VII of Indonesia Institute of Science (LIPI), under the Fish Stock Assessment Project in Indonesian Waters of fiscal year 2001. As a result, it can be reported that (I) the dominant species of pelagic fish distributed in this area is small pelagic fish with target strength (TS) values between -54.00 dB to - 37.60 dB, absolute density of between 0.07 to 218 fish/1000 m\ and total fish stock of 526.570 ton/year; (2) the large pelagic fish (some species of tuna) also distributed in the area with average TS of -27 dB, absolute density between 0.00 to 0.07 fish/100 m\ and total fish stock of 386,260 ton/year. This result still needs more accurate verification, especially on the species composition and individual size of fish by a more appropriate biological sampling method (mid-water trawl). Consequently, more acoustical surveys combined with oceanographic sampling and exploratory fishing are needed to evaluate the existing condition of marine fish resources in the area, in order to optimize and set up the relevant and accurate fisheries management plan for suitable and responsible utilization offish resources.

Keywords: Split-beam Acoustic System, Fish Stock Assessment, Target Strength, Density, Distribution, Indian Ocean (southern part of Java-Bali-Lombok).

I. Introduction

Indonesia, a maritime country with two third of its area or about 5.8 million km^2 covered by seawater, is located in the cross sea lane between Indian and Pacific Oceans. Each region has its own characteristics, determined by geographical condition, water circulation pattern, temperature and salinity changes, and depth variation of each region.

Located in the tropics, Indonesian seawaters are regarded as one of the highest species diversity region in the world. Some of this species includes small pelagic fish, large pelagic fish, and demersal (bottom) fish. Beside the above living resources, there are also non-living resources, among others are mineral, oil and natural gas deposited in the bottom of the sea.

The above illustration shows that the Indonesian tropical seawaters have high potentials in supporting the country economy. Unfortunately, the utilization and management of these potentials are currently minimal, due to the lack of accurate, comprehensive and up-dated data/information.

This research is one of the numerous studies of fish stock assessment activities in Indonesia, especially by systematic and fundamental application of marine acoustic

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method (scientific echo sounder system) started from the year of 1993 by the implementation of the Java Sea Pelagic Fish Assessment Project sponsored by EEC (European Economic Community). Recently, the activities arc sponsored by die Ministry of Marine Affairs and Fisheries together with other interrelated research institutions and universities under the Fish Stock Assessment Project in Indonesian seawaters.

The objectives of this research are: (1) To measure the *in situ* target strength (TS), size (length) and its distributions of individual targets; (2) To estimate the density and its spatial and temporal distributions; (3) To study the effects of some oceanographic factors to the distributions of pelagic fish population.

II. Methods

This research was conducted in October - November 2001 in the Indian Ocean, especially in the southern part of Java - Bali - Lombok Islands (Figure 1).

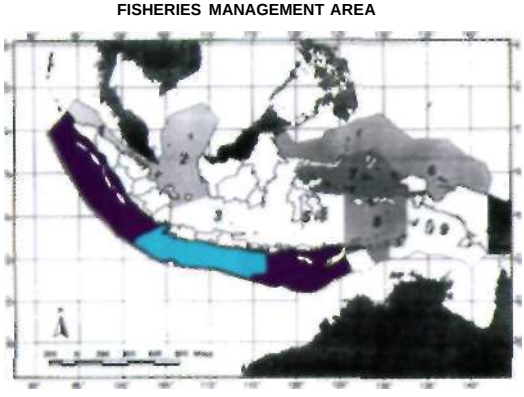


Figure 1. The location of survey/research area

The research was carried out by R.V. Baruna Jaya VII owned by Research Center for Oceanography (RCO) - Indonesia Institute of Science (LIPI). The length (LOA) of this research vessel is 49.90 m, moulded-breadth of 9.60 m, depth (from selther deck) of 4.30 m, maximum draft of 3.25 m, gross weight of 641 ton, and full speed of about 12 knots.

The main marine acoustics instruments is SIMRAD EK-500 Scientific Echo Sounder with split-beam acoustic system and insonifying frequency of 38 kHz. For acoustic data processor, basically by SIMRAD EP-500 echo processor, and data analyzing was supported by Microsoft Excel, Surfer 7.0 and Mathlab 6.0. Furthermore, for oceanographic data acquisition, the instrument used was SEABIRD-SBE 911 Plus CTD (Conductivity Temperature Depth). Both Scientific Echo Sounder and CTD were connected to GPS (Global Positioning System).

Because of very wide area covered in this research, all of the acoustic tracks were designed by systematic parallel track design. Then, the total number of oceanographic stations was 27 stations (along the legs of acoustic track). Block diagram of the acoustic data acquisition and processing system applied in this research is shown in Figure 2. Verification of the surveyed fish species and size compositions of the fish target surveyed was conducted by mid water and bottom trawls. However, it was very regretted that the hard efforts to verify fish species and size were failed because almost all of the biological samplings were not successful.

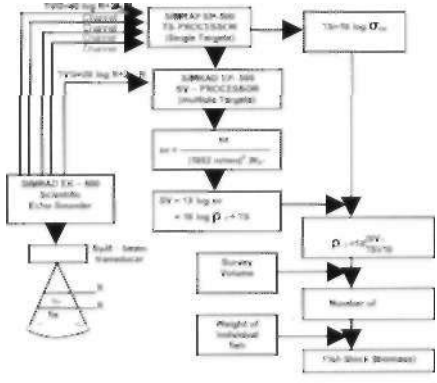


Figure 2. Block diagram of acoustic data acquisition and processing system

III. Results and Discussion

3.1 Fish Target Strength and Its Distributions

The values offish target strength (TS) obtained were in the range of - 60 dB to - 27 dB for the total of about 49,332 individual fish targets. The targets were distributed mainly in the upper layers of the water column, especially for small size of targets of small pelagic fish. Only some large targets or large pelagic fish (possibly species of tuna) with relatively high values of TS were distributed in the lower layers (up to depth of 225 m) (see Figure 3).

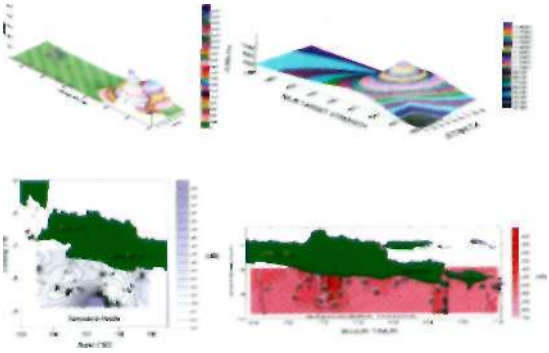


Figure 3. Fish target strength spatial distributions for the Western area (left) and Eastern area (right).

If the target strength data were grouped into the day and night distributions, it was clear that in general the TS values and the number of the TS at night were relatively smaller than at day (Figure 4). This phenomenon may be considered as the diurnal vertical migration of the pelagic fish which affects the orientation (tilt angles) of fish detected by scientific echo sounder. Tilt angel is the dominant factor that significantly affected the TS values.

Conversing TS values to L (fish length) with the application of Footc (1987) equation: TS = 20 Log L + A, where A = - 67.4 dB, and assumed that small pelagic fish with swimbladder was the dominant species, it can be estimated that the length distributions of fish are between 2.3 to 37 cm (Figure 5). This means that in October November, the area were occupied and distributed by small pelagic fish (possibly species of anchovies, sardines, mackerels, scads, squids, etc.) and small size of large pelagic fish (possibly yellow-fin tuna or southern blue-fin tuna). The results are still need field biological sampling for accurate verification of the species and size compositions of fish sampled by scientific echo sounder.

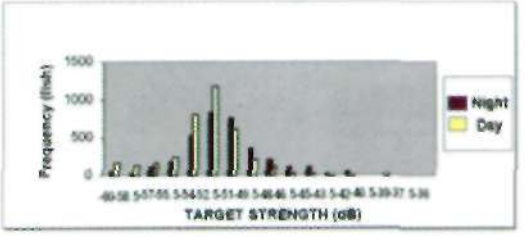


Figure 4. Target Strength distribution by day and night

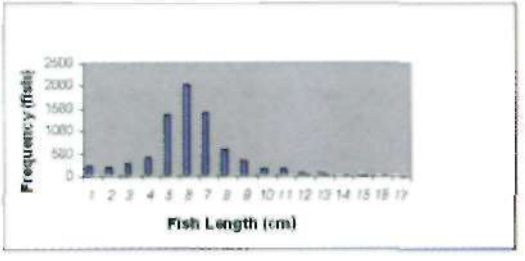


Figure 5. Fish length distribution converted from Target Strength.

3.2 Fish Density and Its Distribution

For multiple or schooled fish targets, the density values are distributed in range between 0.0005 to 704.35 fish/m^3 for small pelagic fish, and between 0.00000 to 0.00007 fish/m^3 for large pelagic fish. The spatial distribution of fish with high density, was concentrated in the upper layers of the water column (up to 100 m depth), only some fish with low density was distributed in the lower layers (below 100 m depth) (Figure 6).

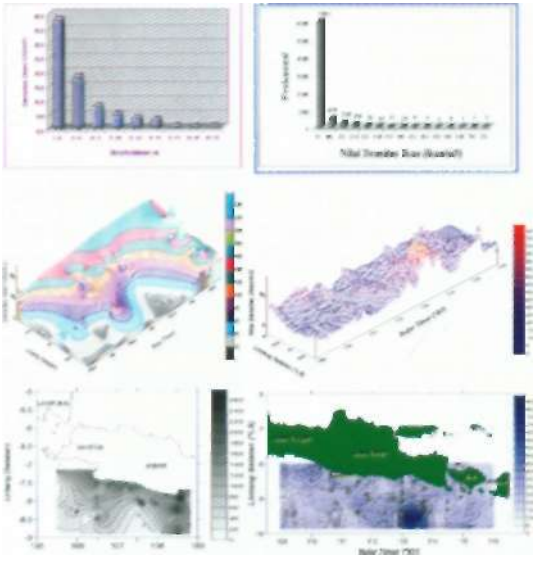
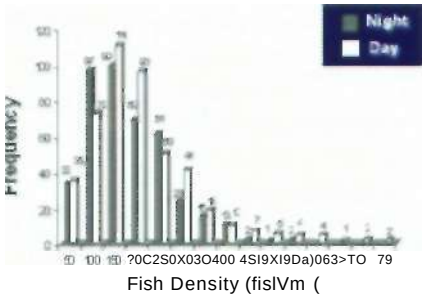


Figure 6. Spatial distribution offish density for the Western area (left) and Eastern area (right)

The distributions of fish density also indicated significant difference between day and night (Figure 7), where fish are more dense at day than at night. It was considered that the pelagic fish (especially small pelagic fish) are dispersed at night in upper layers of the water column, and schooled at day in lower layers, due to the effect of temperature change by sunlight penetration into the water column at day.

3.3 Effects of Oceanographic Factors

The oceanographic factors measured in this research (temperature and salinity) arc considered have a significant effects to the fish distributions in the water column. Basically, each of pelagic fish species have an optimum tolerance to the surrounding environment conditions (temperature and salinity), where small pelagic fish are more comfortable to life and distributed in the warmer water of the upper layers. The vertical and horizontal distributions of the temperature and salinity are described in Figures 8 and 9.



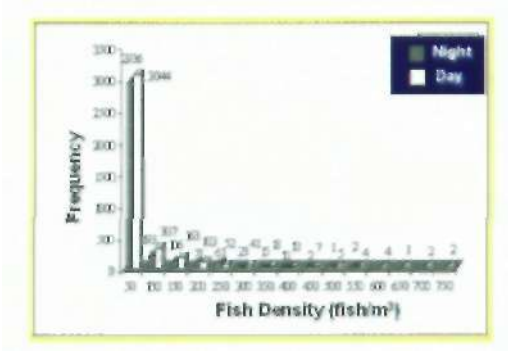


Figure 7. Temporal (day and night) distributions of fish density for the Western area (above) and Eastern area (below)

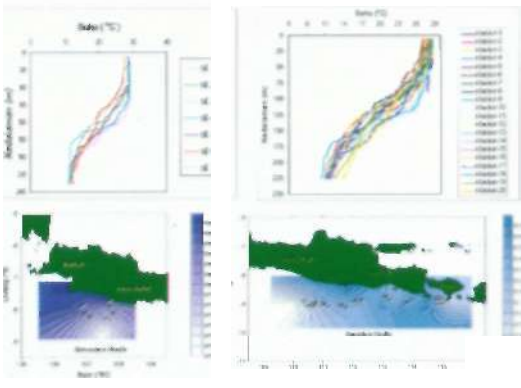


Figure 8. Vertical and horizontal distributions of temperature for Western area (left) and Eastern area (right)

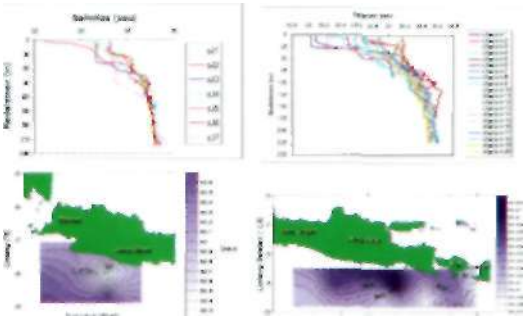


Figure 9. Vertical and horizontal distributions of salinity for Western area (left) and Eastern area (right).

IV. Conclusions

This research gives the conclusions as follow:

1. The dominant species of pelagic fish distributed in the Indian Ocean (southern part of Java - Bali - Lombok Islands) for the depth layer up to 225 m was small pelagic fish (some species of anchovies, sardines, mackerels, scads, squids, etc).
2. The values of small pelagic fish target strength (TS) are distributed in the range between - 54.00 to - 37.60 dB, and for the large pelagic fish (some species of tuna) are in average of - 27 dB.
3. By conversion of the TS values obtained (with an assumption that the bladder fish for small pelagic fish), the estimated values of fish lengths are between 2.3 to 37.0 cm. This means that small pelagic fish and possibly large pelagic fish with small size are very dominant in the water column.
4. The values of fish density in the water column are in the range between 0.00005 to 704.35 fish/m3 for small pelagic fish, and between 0.00000 to 0.00007 llsh/m' for large pelagic fish.
5. The phenomenon that small pelagic fish was the dominant species is considered have close relationship with the oceanographic factors, especially temperature and salinity.
6. The average values of fish density at day arc higher than the average values at night. In other words, the pelagic fish are more disperse at night than at day.

Acknowledgment

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