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Forecasting the Fishing Ground of Small Pelagic Fishes in Makassar Strait Using Moderate Resolution Image Spectroradiometer Satellite Images

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ABSTRACT

The Makassar Strait is the major fishing ground for small pelagic fish, on South Sulawesi, Indonesia using both commercial fishing vessels and boats with traditional fishing gear. Though small pelagic fish is one of dominant commercial food fish in South Sulawesi, the annual Catch per Unit Effort (CPUE) decreased from 6163.3 tons in 2007 to 5148.7 tons in 2011. The purpose of this research was to forecast the fishing ground of small pelagic fishes employing Moderate Resolution Imaging Spectroradiometer (MODIS) satellite images in Makassar Strait territory with the study interest of 3°S to 5°S and 118°E to 120°E. Fishing data collected from the fishermen include fishing locations, catch, sea surface temperature, and chlorophyll concentrations. To determine the relationship between catch and oceanographic parameters, a linear regression analysis was employed. We also examined sea surface temperature (SST) and Chlorophyll-a concentration field data vs. MODIS satellite data. The result showed that SST and Chlorophyll distributions had a close relationship with the distribution of fishing ground of small pelagic fishes. The fishing ground tended to spread on the waters with the SST ranged from 26°C to 30°C and the Chlorophyll concentration ranged from 0.3mg/m^3 to 2.8 mg/m^3. By using MODIS satellite images, the fishermen may be easier to find the potential fishing grounds of small pelagic fishes in Makassar Strait.
Keywords: small pelagic fish, fishing ground, satellite images, Makassar Strait.

INTRODUCTION

The Makassar Strait is the major fishing ground for small pelagic fish in South Sulawesi, Indonesia. Both commercial fishing vessels and boats using traditional fishing gear are operated in this area [1]. Based on statistic data, the total annual Catch per Unit Effort (CPUE) decreased from 6163.3 tons in 2007 to 5148.7 tons in 2011. There are many problems faced by the fishermen to increase their production, such as man power, the price increase of gasoline and limited information of the potential fishing zones. Limited information about the distribution of the potential fishing zone is a major problem in fishery resources utilization. In general, Indonesian fishermen use the conventional methods to fish. They mostly depend on their experiences to find a fishing ground. This method brings them to an uncertain condition and makes their work inefficient [2].

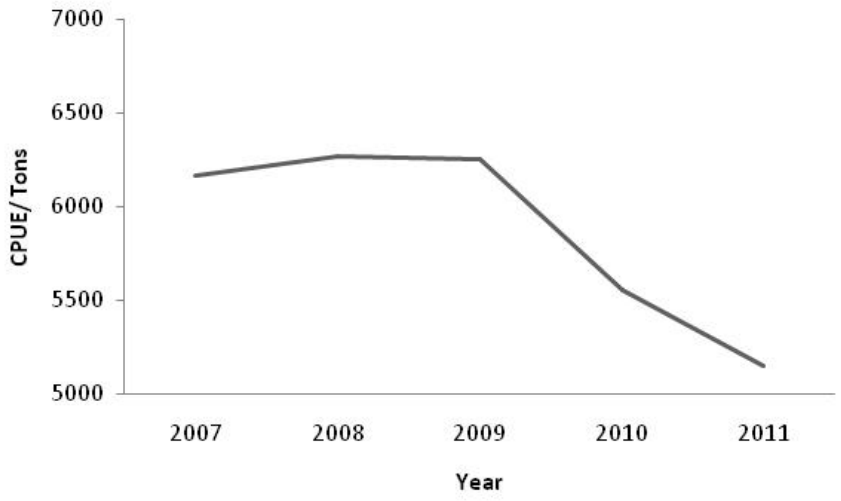

Figure 1 Production of Small Pelagic Fish in South Sulawesi from 2007 to 2011

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Finding fishing grounds do not only depend on the experiences, but also the knowledge of habitat of fish. The habitat of fish is closely related to certain value of oceanographic properties, such as sea surface temperature, salinity, current, and the abundance of phytoplankton. Therefore, to be able to manage optimal sustainable fishery resources, information about the above oceanographic parameters is very important the productivity of waters is linearly related to the being available of phytoplankton [2, 3]. The biomass of phytoplankton can be calculated by measuring concentration of chlorophyll-a and water temperature [3, 4, 5]. One of the methods to estimate the sea surface temperature and Chlorophyll-a concentration is by using the technology of remote sensing satellite. Recently, satellite remote sensing has been utilized as an important tool for obtaining synoptic measurements of the ocean. Satellite data have been applied to study the relationship between oceanographic conditions and the distribution of pelagic fishes [6, 7, 8]. The usage of remote sensing satellite data becomes important to provide the information of potential fishing zone. Many researches have developed a method of using satellite data to investigate the potential fishing zone [9, 10, 11]. However, there has been no research to study the potential fishing zone for short mackerel in Makassar Strait. The purpose of this research is to determine the fishing ground of small pelagic fish using Moderate Resolution Imaging spectro-radiometer (MODIS) satellite images in Makassar Strait.

MATERIALS AND METHODS

This study was conducted in Makassar Strait located between 118oE to 20oE and 3oS to 5oS The Makassar Strait has a complex oceanic characteristic due to the Indonesian Through Flow which has a significant effect on fishing activities. In general, methods of this research were made to the following steps. First of all, we collected the in-situ data. Those data consisted of fishing ground locations, catch, sea surface temperature, chlorophyll-a. The relationship between catch and oceanographic parameters was examined by using the histogram. Next, we observed the MODIS satellite image data which was taken simultaneously with in-situ measurement. The satellite data used to identify distribution of Chlorophyll were channel 3 (459 to 479 nm), channel 9 (438 to 448 nm) and channel 12 (546 to 556 nm). While channel 20 (3.660 to 3.840 µm), 31 (10.780 to 11.280 µm) and 32 (11.770 to 12.270 µm) were used to observe the distribution of sea surface temperature (SST). Then, the observed satellite data to estimate the SST and Chlorophyll concentrations. Next step, we generated contour of selected SST and Chlorophyll Images. Finally, GIS software (ErMapper 7.0 and ArcView GIS 3.3) was used to overlay between SST and Chlorophyll contour images to forecast the potential fishing location of small pelagic fish.

RESULTS AND DISCUSSION

The most abundance species of small pelagic fishes captured was Short Mackerel (8556.3 kg), the remaining species captured in decreasing trend were the Goldstripe Sardinella (4882.4 kg), Indian scad (2399.2 kg), Skipjack (2295.2 kg), and other species (1222.6 kg) (Figure 2). Traditionally, the fishermen relatively do not have much information for the fishing grounds. They often go fishing to the same fishing grounds as the days before. This is one of a good explanation, why the total annual Catch per Unit Effort (CPUE) decreased (Figure 1).

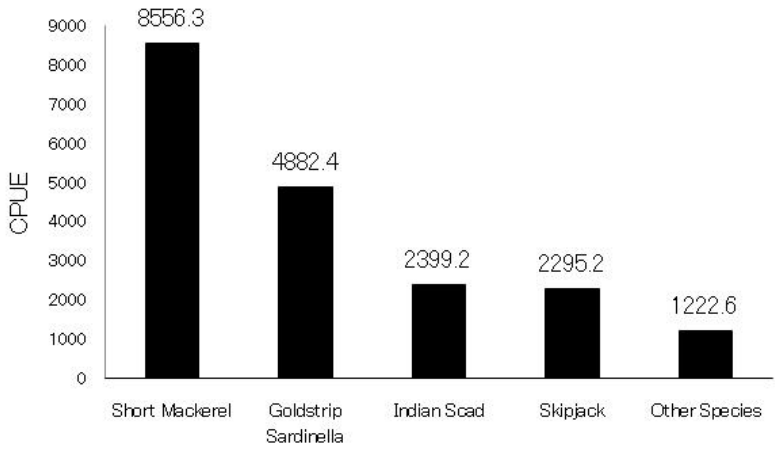

Figure 2 Composition of catch caught by the Purse Seiner during 2007 -2011

The results of this study showed that the small pelagic fish tended to spread in the SST values ranging from 26°C to 30°C. However, the most abundance catch was found in the SST around 28°C (Figure 3). The results were in-line with the previous researches that most of small pelagic fish fishing grounds were found in the SST area about 26°C to 30°C [3, 12].

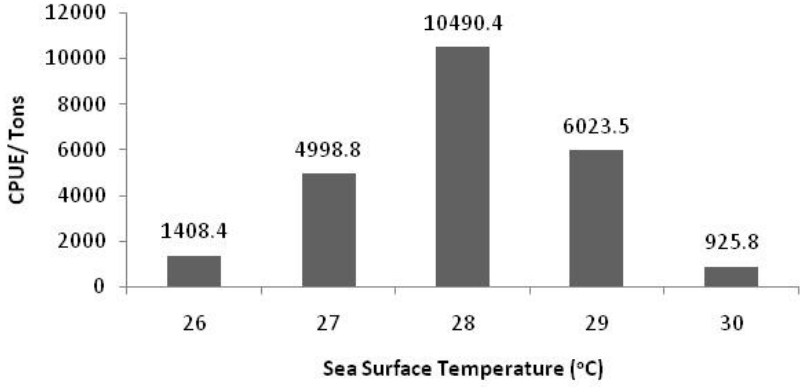

Figure 3 Relationships between the Catch and SST during 2007 -2011

Based on the in-situ measurements, the small pelagic fishes were mostly captured in the waters with the chlorophyll concentration ranged from 0.3 mg/m^3 to 2.8 mg/m^3. The most abundance catch distributed in the areas contain the chlorophyll concentration around The previous research stated that the chlorophyll concentration between 0.3 mg/m^3 to 2.5 mg/m^3 might be indicated as good fishing grounds for short mackerel [3, 12].

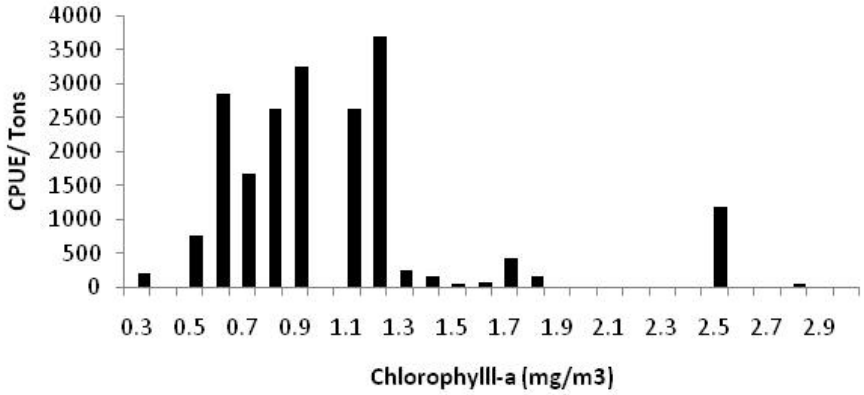

Figure 4 Relationships between the Catch and Chlorophyll-a Concentration during 2007 -2011

The potential fishing grounds of small pelagic fishes were estimated by overlaying the SST contour and the chlorophyll concentration contour of MODIS image [3]. The SST contours ranged between 26 ° C and 30 ° C (Figure 5). The contours of chlorophyll concentration ranged between 0,3mg/m^3 and 2,8mg/m^3 (Figure 6). The ranges were estimated based on the catch data during 2007 – 2011. The meeting points between the contours generated from SST and Chlorophyll distribution are likely good fishing grounds for small pelagic fisheries. We recorded that on October 28, 2011, a purse seiner caught as much as 98.6 Kg of the small pelagic fish at location of 119° 15' 59.2"E and 4° 26' 24.8"S. This location was close to one of the cross sections generated from the contours of SST and chlorophyll on October 28, 2011 (Figure 7).

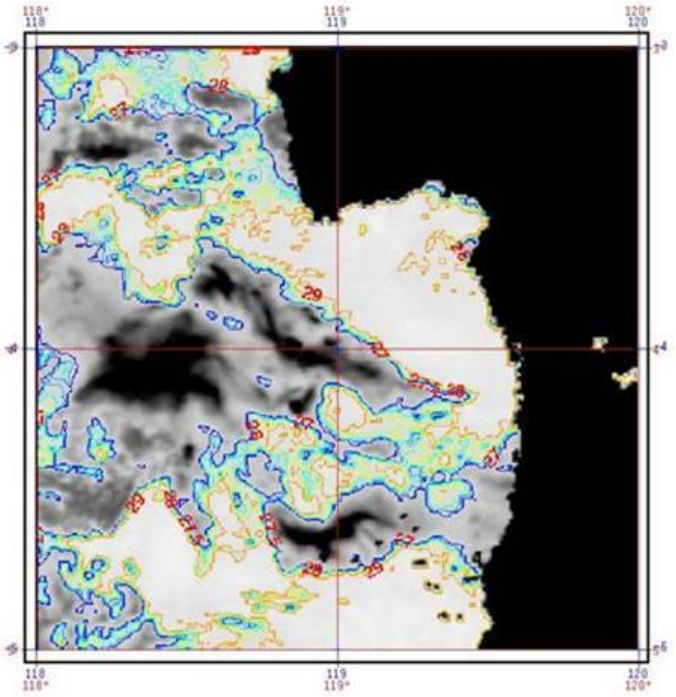

Figure 5 Contours of SST distribution (Thin yellow lines) generated from MODIS image. October 28, 2011

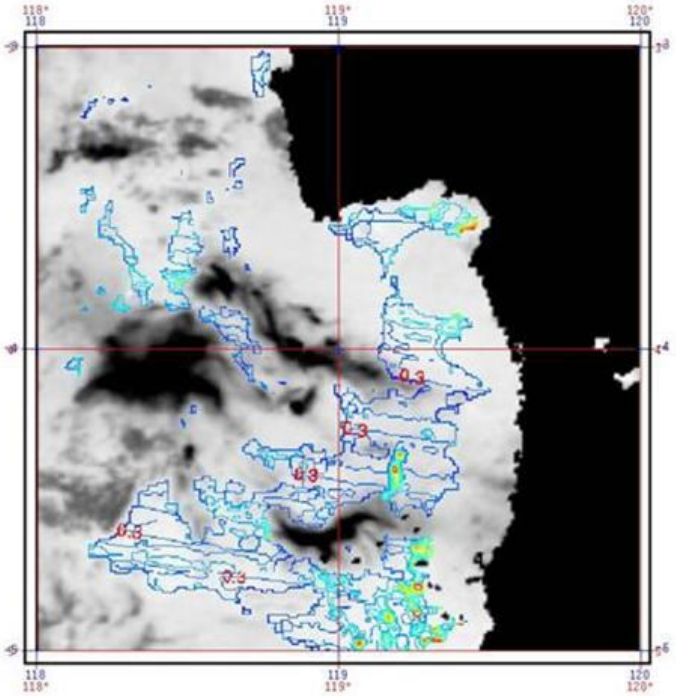

Figure 6 Contours of chlorophyll concentration distribution (Thin blue lines) generated from MODIS image. October 28, 2011

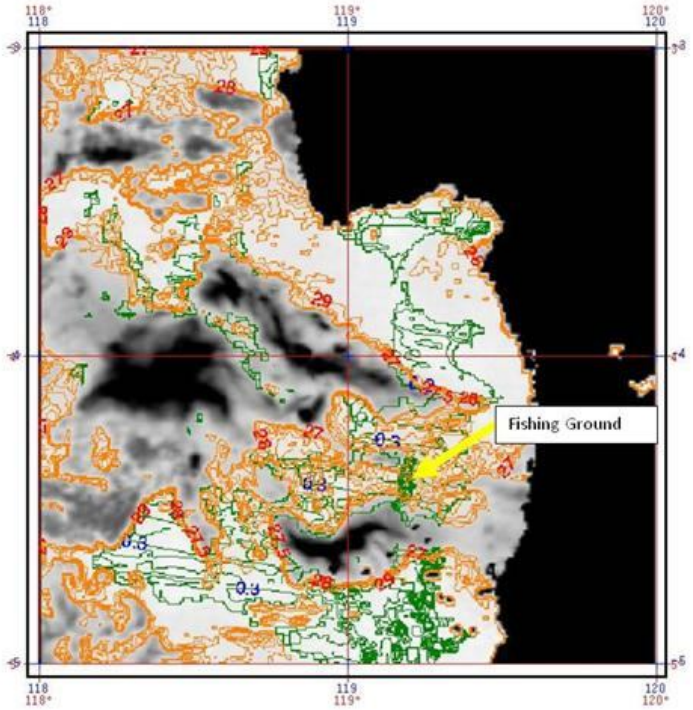

Fig. 7 Contours of SST and chlorophyll distributions generated from MODIS satellite image, October 28, 2011. Intersection points (For example: Arrow) indicated the potential fishing ground of small pelagic fisheries

CONCLUSION

In general, small pelagic fishes, including short mackerel, golden strip sardinella, Indian scads and skipjack, is highly abundance in the areas having SST distribution ranged from 26°C to 30°C and chlorophyll concentration ranged from 0.3mg/m^3 to 2.8mg/m^3. The result of the study reveals that the overlay between the contour maps of SST distribution and those of the chlorophyll concentration distribution pattern generated from MODIS satellite images can be used as a tracer for the fishing grounds of small pelagic fishes. Forecasting fishing ground of small pelagic fish may be detected directly using MODIS satellite images. Furthermore, the map can help the fishermen to find the fishing ground of small pelagic fishes more efficiently.

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