Mapping of Potential Fishing Grounds of *Rastrelliger kanagurta* (Cuvier, 1816) in the Archipelagic Waters of Spermonde Indonesia Using Satellite Images

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ABSTRACT

Dynamic oceanographic conditions influence distribution and abundance of fish. Satellite images provide important information on oceanographic conditions which covers wide area. Sea surface temperature (SST) and chlorophyll-a concentration derived from Aqua/Terra MODIS together with fisheries catch data of 2008 and 2009 were used to map potential fishing grounds of *Rastrelliger kanagurta* (Cuvier, 1816) in the archipelagic waters of Spermonde Indonesia. The aim of this study were to determine the preferred range of chlorophyll-a and SST for *R. kanagurta* and to map its potential fishing grounds based on the oceanographic variables. Using the preferred ranges the images were reclassified using relevant scores and combined to generate the potential map using GIS. Results indicated the preferred range with the highest catch of *R. kanagurta* was at chlorophyll-a concentration of 0.31 ± 0.10 mg/m^3 and SST of 29.94 ± 0.23^0C. This study indicates that satellite images and GIS are able to map potential fishing grounds of *R. kanagurta*.

Keywords: potential fishing grounds, satellite images, *R.kanagurta.*

INTRODUCTION

Spermonde archipelagic waters are located at the south of Makassar Strait, at the west coast of Sulawesi island of Indonesia. These waters belong to the fisheries management area of the Republic of Indonesia (WPP-RI) 713 (Ministry of Marine and Fisheries, 2011). Utilization rate of small pelagic fish resources in this area are still under exploited (Ministry of Marine and Fisheries, 2005). This area is an area of considerable fishing potential in Indonesia, with total production of the second largest catching area after the fisheries management of RI 712 (Java Sea). The production is dominated by small pelagic fish that reached an average of 250 thousand tons per year, with production of *R. kanagurta* at 44.1 thousand tons in 2010 (Ministry of Marine and Fisheries, 2011). This species has high commercial value in South Sulawesi (Musbir, 2007).

Fishing grounds are always changing and moving in accordance with the environmental factors. Fish will choose a more suitable habitat for feeding, shelter, reproduction and migration (Palacios et. al., 2006). The habitat is highly influenced by dynamic oceanographic factors. Changes and variations of oceanographic factors indicate that the abundance of fish in

the waters is unlevel (Zainuddin, 2007). Generally, the fishing activities by the fisherman is only based on repeated experiences as well as gathering information from fellow fishermen. They are often in uncertain about location of the potential fishing grounds. This leads to wastage of money and time, and catches are less than optimal which impact on the income of fishermen.

Advancement of remote sensing technology can assist to estimate potential fishing grounds that are more accurate, because it provides important information on oceanographic conditions in wide area, so it can be applied anywhere. This technology can save time in finding fishing grounds, save costs and streamline the fishing operations. Therefore, application of remote sensing is widely used in the fishing industry.

SST and chlorophyll-a are the most important oceanographic parameters and commonly used to predict the potential fishing grounds using remote sensing and GIS (Lanz et al., 2009; Mustapha et al., 2010; Solanki et al., 2005; Zainuddin 2011; Zainuddin & Jamal 2009). Xinjun et al. (2009) used catch data and satellite derived environmental variables to determine habitat suitability indices for *Scomber japonicas*. While the study of the ability of satellite MODIS-Aqua and GIS to map potential fishing grounds of *R. kanagurta* in the exclusive economic zone (EEZ) of the east coast of Peninsular Malaysia (South China Sea) has been carried out by Mustapha et al. (2010).

These studies indicate that satellite based oceanographic data (chlorophyll-a & SST) together with fish catch data can be applied to investigate the relationship between fishing grounds and oceanographic conditions and also to map potential habitats for the pelagic fisheries in the archipelagic waters of Spermonde Indonesia. The objectives of this study were to determine the preferred range of chlorophyll-a and SST for *R. kanagurta* and to map its potential fishing grounds based on the oceanographic variables.

METHODOLOGY

Study Location

This study was conducted in the archipelagic waters of Spermonde (Figure 1). These waters are located in the Makassar Strait at the west coast off Sulawesi Indonesia. This area has the highest potential fisheries resources and is a major fishing ground for fishermen on the west coast of South Sulawesi.

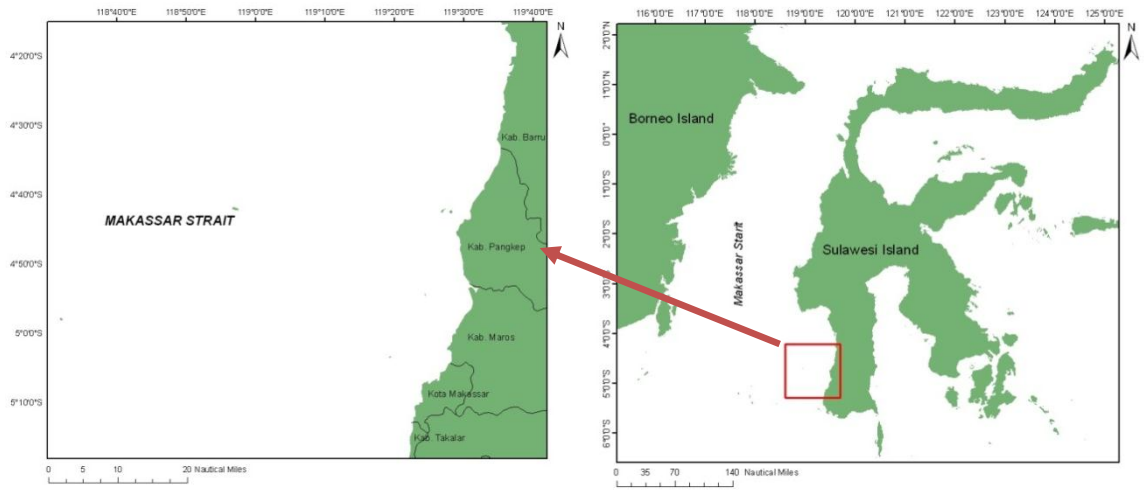

Figure 1. Study area in the archipelagic waters off Spermonde Indonesia.

Fisheries Data

Data analyzed in this study were the fisheries data of 2008 and 2009. Data obtained included the weight (Kg) and fishing position from field survey.

Satellite Data

Level 1 daily data of the Moderate Resolution Imaging Spectroradiometer satellite (MODIS-Aqua/Terra) of chlorophyll-a and SST in year 2008 and 2009 were downloaded from the ocean color website (http://oceancolor.gsfc.nasa.gov/). The data were subset to the study area with geographical extent of 118.50 – 119.70 E and 4.25 – 5.30 S and projected to cylindrical projection using ArcGIS (Environmental Systems Research Institute, Inc.,USA).

Potential Fishing Grounds Map

To detect the potential fishing grounds, frequency of fishing and oceanographic variables (chlorophyll a and SST) were related. Preferred range of the variables was determined from the Suitable Index (SI) by histogram graphs. The intervals represent the favorable environmental factors. Based on the preferred ranges the images were reclassified using relevant scores and combined to generate the potential map using GIS.

RESULTS AND DISCUSSION

Preferred Range of Environmental Variables

Chlorophyll-a concentration in the fishing grounds during the study was around 0.12 - 2.78 mg/m^3. Nontji (2002) reported that the average of a chlorophyll-a concentration in the waters of Indonesia is 0.19 mg/m^3. The distribution of SST in the fishing grounds during the study ranged between 26.25 - 31.97 ^0C.

Based on the histogram (Figure 2a), the highest habitat suitability index (1.00), were at the range of chlorophyll-a concentration of 0.31 ± 0.10 mg/m^3 with the frequency of 69.07% of the total catch and an average weight of 37.33 kg. Zainuddin (2007) found that the potential fishing grounds of *R. kanagurta* is at chlorophyll-a concentration of > 0.3 mg/m^3. The results were similar with the results conducted by Mustapha et al. (2010) who found that the preferred range by R. *kanagurta* is at the chlorophyll concentration of 0.27 ± 0.03 mg/m^3. As for the parameters of SST, the highest habitat suitability index (1.00), was in the range of 29.94 ± 0.23^0C (Figure 2b), with the frequency of 36.08% of the total catch and an average weight of 26.50 kg. The SST value obtained is in accordance with the results of the study by Mustapha et al. (2010) which is 29.91 ± 0.33^0C; Musbir (2007) at 29.2 ^0C, and Zainuddin (2007) at 29 - 29.5^0C.

This indicates that chlorophyll-a and SST influence the distribution and abundance of *R. kanagurta*. The study by Mustapha et al. (2010), indicated relation between biophysical environmental conditions with the catch of *R. kanagurta*, meanwhile Zainuddin (2007) also indicated that temperature gives a significant contribution in explaining the variations in the catch of *R. kanagurta*.

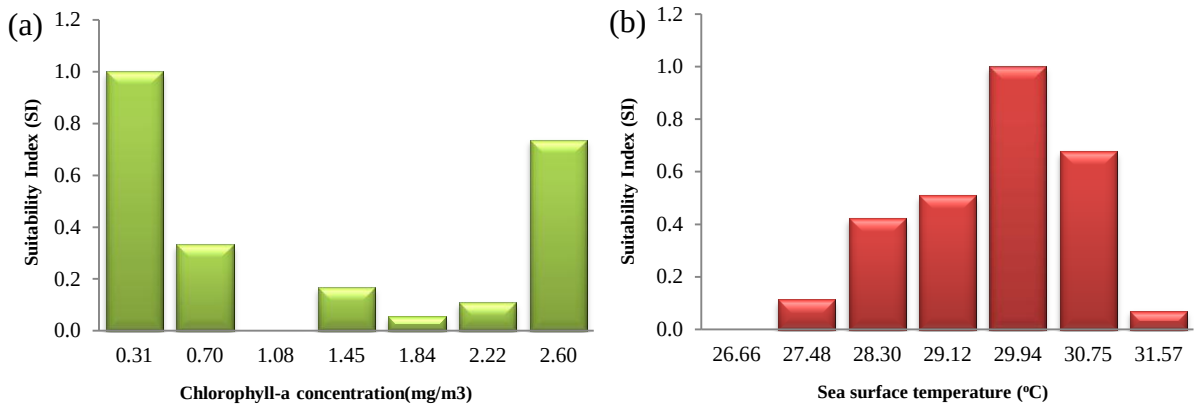

Figure 2. Suitability Index (SI) in relation to environmental variables (a) chlorophyll-a and (b) SST in 2008 and 2009.

Potential Fishing Map

Based on the reclassification of chlorophyll-a and SST, there are six predictions of fishing areas obtained in the archipelagic waters of Spermonde which are: highest, high, moderately high, moderate, moderately low, and low (Figure 3, 4, 5 and 6). The prediction map was then verified to test the accuracy of predictions.

The accuracy of the prediction map depends on the number of catch frequency and satellite image, which is strongly influenced by cloud cover. However remote sensing technology is very helpful in predicting the potential fishing grounds in being able to provide the oceanographic data continuously as well as covering a wide area.

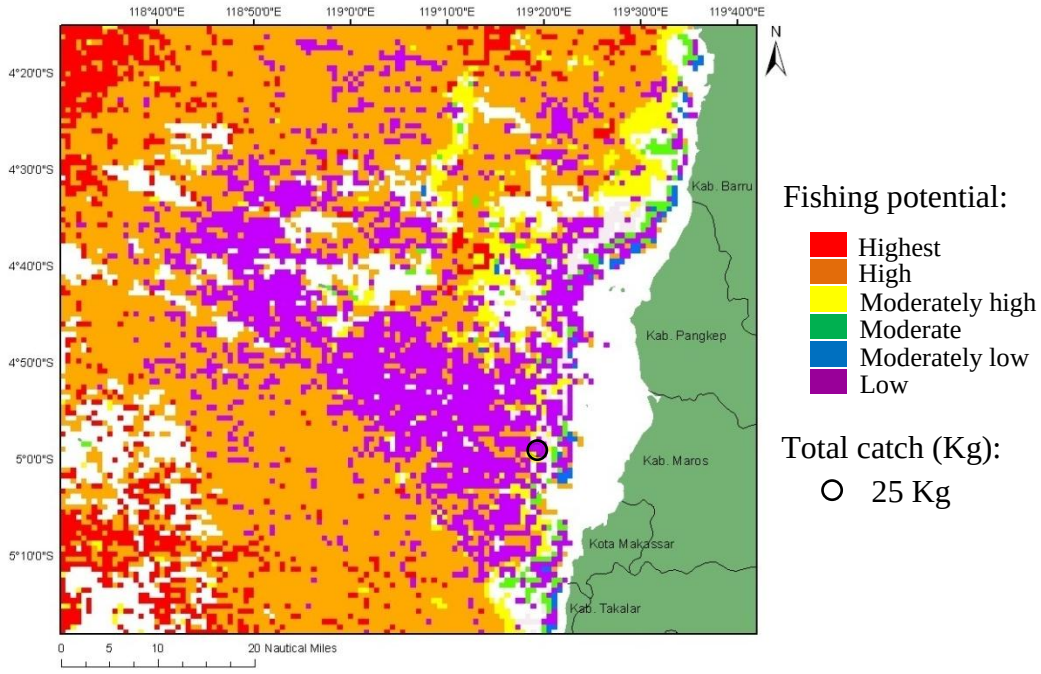

Figure 3. Fishing potential map at 14th April 2008. The map shows that the area were dominated by high and low category of fishing potential area.

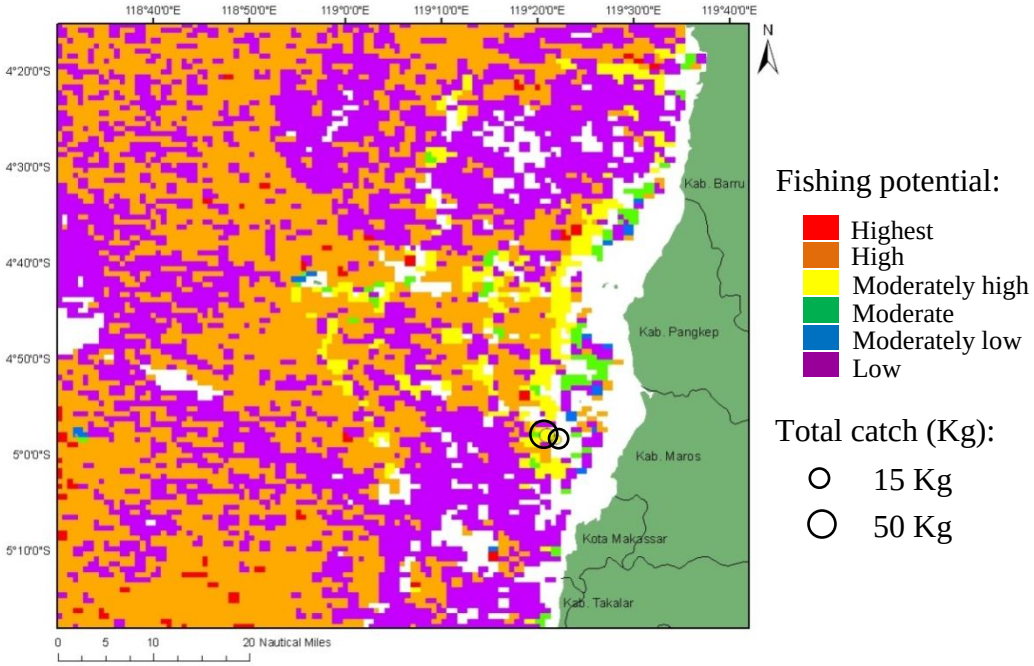

Figure 4. Fishing potential map at 3rd May 2008. The map shows that the area were dominated by high and low category of fishing potential area.

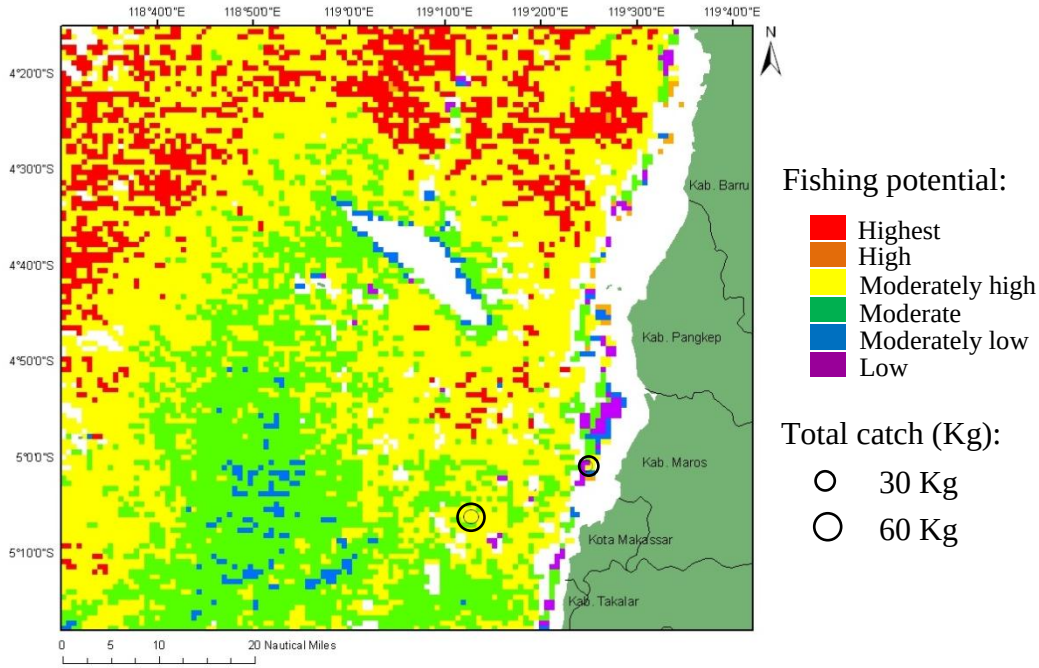

Figure 5. Fishing potential map at 16th June 2009. The map shows that the area were dominated by highest, moderately high and moderate category of fishing potential area.

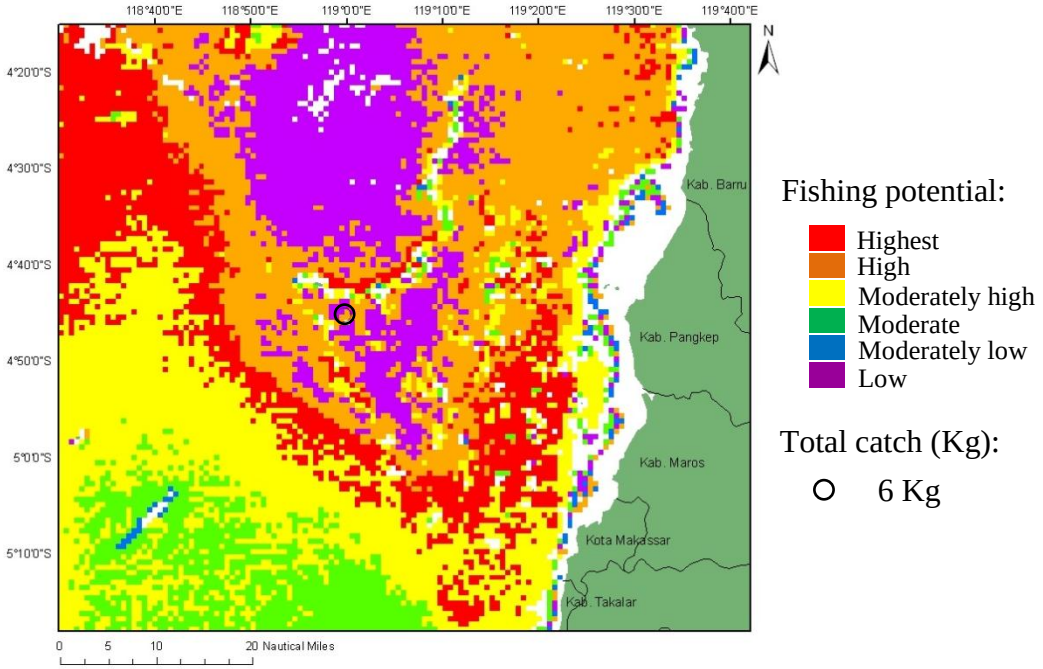

Figure 6. Fishing potential map at 23rd June 2009. The map shows that the area were evenly distributed of all categories of fishing potential area.

Verification indicated that, the prediction is significantly accurate and it indicates the distribution and abundance of *R. kanagurta* around the study area. However, it is always changing and moving, following the dynamics of oceanic environmental factors at the time. Oceanographic conditions affect the dynamics of the sea water horizontally and vertically, which in turn will affect the distribution and abundance of fish (Zainuddin 2007).

The potential fishing grounds of R. kanagurta occurred near the coast of the study area. Zainuddin (2007) found that the potential fishing grounds of *R. kanagurta* located along the eastern coastal waters off Bantaeng South Sulawesi Indonesia. Musbir (2007) also reported that the potential fishing grounds of *R. kanagurta* in Flores Sea South Sulawesi Indonesia scattered along the coastal waters of Bulukumba, Bantaeng, Jeneponto and Takalar. Meanwhile Mustapha et al. (2010) found that the distribution and abundance of *R. kanagurta* in the east coast off Peninsular Malaysia was generally located in the area near the coast. The area surrounding the coast is very productive due high nutrients from the land. Nutrients are available for phytoplankton to grow, which will allure the fish. Chlorophyll-a density range was Considered to be a good indicator for high primary productivity, were the preferred prey organisms are accumulated (Zainuddin, 2011). Knowledge about fish habitat is an essential component for management of fishery resources and sustainable.

CONCLUSIONS

Preferred range with the highest catch of *R. kanagurta* was at chlorophyll-a concentration of 0.31 ± 0.10 mg/m^3 and SST of 29.94 ± 0.23^{0}C. This study also indicates the capability of using satellite images and GIS to map the potential fishing grounds and indicate relation between oceanographic factor and abundance of *R. kanagurta*. This it can be used by fishermen to plan the fishing activities.

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