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Original Paper

EXPLORATION OF SKIPJACK FISHING GROUND THROUGH SEA SURFACE TEMPERATURE AND CATCHES COMPOSITION ANALYZES IN PALABUHANRATU BAY WATERS

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ABSTRACT

Fishing ground condition is usually affected by oceanographic parameters. One of the oceanographic parameter that had been used in forecasting the availability of pelagic species such as skipjack is sea surface temperature (SST). Skipjack fish is the main target for boat seine net fishery in Palabuhanratu Bay from June to October 2007. Information on skipjack fishing ground availability is very important in order to optimize fishing operation. The purposes of the study are: to determine the SST distribution, to analyze the catch composition of skipjack, to determine the relationship between SST and skipjack catch, and to forecast the skipjack fishing ground in Palabuhanratu Bay from August to October 2007. The research consist of two stages. The first stage was conducted in Palabuhanratu Bay waters in August-October 2007, using survey method, with ten samples of boat seine net (payang). The second stage conducted on December 2007 to collect the SST data, which downloaded from the internet. The range of SST in Palabuhanratu Bay waters ranged from 22^{o}C - 29^{o}C in August 2007, 21^{o}C - 27^{o}C in September 2007 and 20^{o}C - 31^{o}C in October 2007. The SST had no significant effect on catch volume of skipjack in Palabuhanratu Bay during August until October 2007, but gave effect to the size distribution. The big skipjack distributed at the wide range of SST, but the small skipjack distributed at the narrow range of SST. The potential fishing ground of skipjack in Palabuhanratu Bay during September 2007 was found at Teluk Ciletuh, Ujung Karangbentang, Cimaja, Teluk Cikepuh, Ujung Genteng, and Gedogan waters.

Keywords: Sea surface temperature; skipjack; fishing ground; Palabuhanratu Bay

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INTRODUCTION

Palabuhanratu Bay was located in the southern part of West Java, and known as one of potential fishery for skipjack in West Java. Skipjack is one of species that become the main target for fisherman in Palabuhanratu, since skipjack has a high economic value. Skipjack in Palabuhanratu Bay was captured using *boat seine net* (payang), especially in June until October and peak of fishing season in September (Simbolon, 2004). Nevertheless, information about the potential fishing ground of skipjack was still limited in Palabuhanratu Bay. Fisherman had determined the movement of skipjack fishing ground based on their experiences only, with the high uncertaintily level of catches. This means that fisherman will always need a high fishing cost in chasing for the schools of skipjack, and fishing operation become not efficient.

Fishing operation as mentioned above need to be improved through an exploration study to forecast the movement spatial and temporal distribution of skipjack fishing ground. Simbolon and Helmi (2006) stated that fishing ground distribution influenced by oceanography factors, and its distribution pattern would vary depends to temporal and spatial scale. One of those oceanography factors that have an important effect on fishing ground distribution of pelagic species, such as skipjack is sea surface temperature. Laevastu and Hayes (1981) reported that water temperature

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influences the distribution of fish. Simbolon (2008) also had reported that sea surface temperature (SST) have a significant effect on fishing ground distribution of frigate mackerel. Gunarso (1985) stated that optimum SST for skipjack was 28-29^{o}C, and vary according to temporal and spatial scale.

Variability of SST influences the metabolism level and other activities of skipjack at surface layer (Laevastu and Hayes, 1981; Hasyim and Adi, 1999). It means that SST could influence the catch volume as well as the length size composition of skipjack catch. Therefore, it is important to study the SST variability and catch composition in relation to explore the skipjack fishing ground.

Observation of SST variability through in-situ method requires the high cost and long time because it must be done in all sectors by collecting the data manually. This condition pushes many experts, including this research to use satellite remote sensing technology in obtaining the SST data. Besides that, the SST data of Aqua MODIS satellite remote sensing could be obtained continuously due to location and time of fishing operation.

The objectives of the study are: to determine the SST distribution, to analyze the catch composition of skipjack, to determine the relationship between SST and skipjack catch, and to forecast skipjack fishing ground distribution in Palabuhanratu Bay in August to October 2007.

MATERIALS AND METHODS

Material

Research were executed in two stages. First stage was collecting data of the time and position of fishing operation, catch volume and length of skipjack in Palabuhanratu Bay waters, West Java from August to October 2007. Second stage was conducted in December 2007 to obtain the image of sea surface temperature from Aqua MODIS satellite (http://oceancolor.gsfc.nasa.gov).

Method that used in this research was survey through field observation into skipjack fishing activities. The type of fishing unit used was boat seine net, since the main target of this fishing gear was skipjack. The number of fishing unit sample was determined 10 units out of 50 units in intentionally (purposive sampling) with consideration (1) fishing unit samples operated in Palabuhanratu Bay, and (2) boat of fishing unit had a good stability to fishing skipjack. Data collected from each fishing unit sample was consisted of the time and position of fishing operation, number and length size of skipjack catches. The data were collected from the fishing log which had been provided in each fishing unit sample, during August to October 2007. Other data such as the name of fishing ground and weather condition were also obtained through in depth interview with ten crews and ten captains from fishing unit sample.

The SST image data at the same time and position with fishing activities of samples obtained from internet (http://oceancolor.gsfc.nasa.gov). The images show daily distribution of SST at level 1 and level 2 data, and detected by Aqua MODIS at position $06^{0}97'S–07^{0}03'S$ and $106^{0}59'E–106^{0}62'E$.

The number and length size composition of skipjack data were analyzed according to temporary scale (period of fishing operation). The number of skipjack catches were converted into the form of CPUE (kg/unit), and then presented in the graphic form. The distribution of catch volume were divided into three groups: high, middle and a low productivity. This grouping was relied on monthly catches of skipjack during period of 2005-2006, by using boat seine net from Palabuhanratu Bay waters. Length frequency of skipjack catches according to time period (monthly and daily) presented in the graphic form. Distribution of the length size was grouped into two: adult size (>40 cm) and juvenile size ($\leq$40 cm). Determination of adult and juvenile size which refers to Matsumoto (1984), who stated that adult size of skipjack is starting from 40 centimeters of length size.

The SST image which had been detected by Aqua MODIS satellite was then processed by numerical method, and then presented in the form of JPEG format by using software Sea DAS 4.7 in Linux operating system. Steps of SST image processing were as follow:

(1) Data import: to import the satellite data that had been already extracted from bzip2 to HDF format.

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(2) Image cropping: to restrict the image in the research site (Palabuhanratu Bay waters), with geographical boundary at $06^0$97'S – $07^0$03'S and $106^0$59'E–$106^0$62'E.
(3) Image grouping: to group the image which contain clouds and clear image without clouds. From its grouping, the result of SST value was presented on the form of color bar by numerical method.
(4) Layout: conducted in Arcview software, and enhance legend and scale map.

The range, dominant and average values of SST at each fishing ground position calculated and then presented in the form of table. Image SST was also analyzed and interpreted for determining the distribution pattern of SST.

Relationship between catch and SST at the same location and time analyzed by drawing both variables side by side to know the trend line pattern. The potential fishing ground was forecasted by using the catches number, length size, and SST distribution indicators (Simbolon, 2008). Evaluation of three indicators uses scoring technique as follows:

(1) If catch per unit effort (CPUE) at a given fishing location have/yield more than 300 kg/unit, 100 kg/unit up to 300 kg/unit, and less than 100 kg/unit, categorized as a potential fishing ground with score 5, moderate fishing ground with score 3, and less potential fishing ground with score 1 respectively. Classification of CPUE value had been analyzed based on monthly CPUE distribution of skipjack for two years (2005-2006).
(2) Evaluation of length size intended to classify the skipjack catches into high and low quality of sustainable fisheries resource. If length size captured from a certain fishing location more and or equal than 40 cm/individual, categorized as high quality (score 3), but if length size less than 40 cm/individual categorized as low quality (score 1).
(3) Determine the relationship between SST and skipjack catch volume to obtain the optimum SST for fishing. If the optimum SST was dominant at a certain fishing location, given score 3 to indicate a potential fishing ground, whereas a certain fishing location with no found the optimum SST, will have score 1 to indicate the less potential fishing ground.
(4) Total score of each indicator showed the rating of a certain fishing ground for classification as follow: the highest score indicated potential fishing ground, the middle score indicated moderate fishing ground, and the lowest indicated less potential fishing ground.

RESULTS AND DISCUSSION

The lowest catch of skipjack was found in August 2007, whereas the highest catch was found in September 2007. The catch volume in August 2007 was 8,098 kg with CPUE was 5,473 kg/unit. The catch volume in September 2007 was 37,855 kg with CPUE value was 15,555 kg/unit. Furthermore, the catch volume in October 2007 was 15,910 kg with CPUE was 8,817 kg/unit. The daily catch volume of skipjack during August until October 2007 presented in **Fig. 1.**

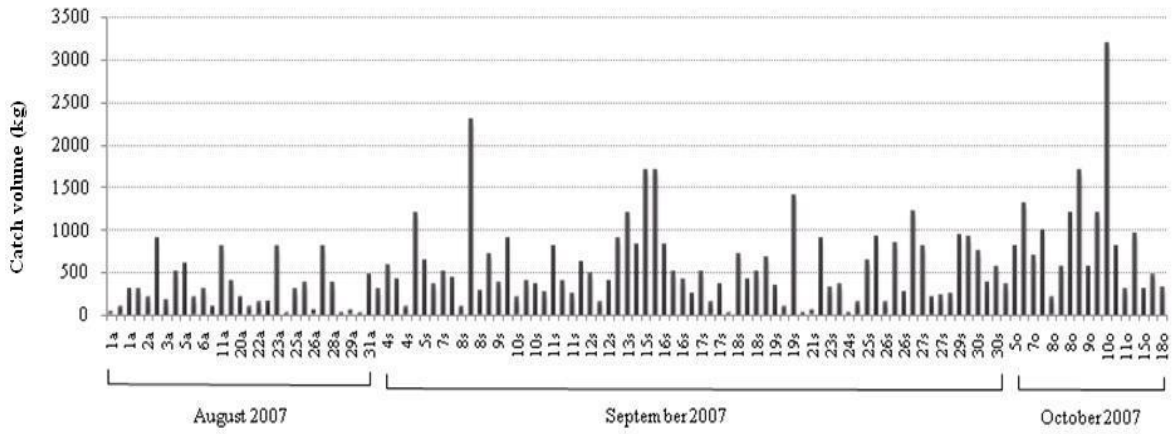

Fig.1. Daily catch volume of skipjack in Palabuhanratu Bay, August-October 2007

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The catch of skipjack in October was found lower than September, because the fisherman reduced their fishing trip in October, since the price of skipjack were very low. The total trip of fishing samples was 18 during October 2007. However, number of trip in August was higher (29 times) compared to October, but the catch volume of skipjack in August was lower compared to October. Wave condition in Palabuhanratu Bay during August 2007 was stronger compared to October 2007. Because of this, they did not go for fishing operation to reach fishing ground during August 2007, as well as the difficulty to detect fish location. Consequently, fisherman decided not doing fishing but looking for other job, such as building labor during poor weather. It was assumed that skipjack fish maybe migrate to other waters region to avoid strong wave that more suitable for their life. This prediction was in accordance with opinion of Laevastu & Hayes (1981), Gafa and Subani (1993), that fish will avoid pressure of strong wave and tend to migrate from inshore to offshore zone.

The length composition of skipjack catches in Palabuhanratu Bay during August-October 2007 was presented as in **Fig. 2.** The study had identified that skipjack catches was dominated by small size, with composition 71% for small size (<40 cm), and 29% for big size (≥40 cm). This condition was not expected because the small size catches could be affecting the reproduction process and contradict to environmental friendly fisheries practices (Suhendrata and Rusmadji, 1991). Base on observation data, mesh size of seine net was found very small and it would influence to selectivity of fishing gear, consequently the catches dominated by small skipjack. Because of this, local government should improve their competence and responsibility in relation to arrangement of regulation about the optimal mesh size of fishing gear.

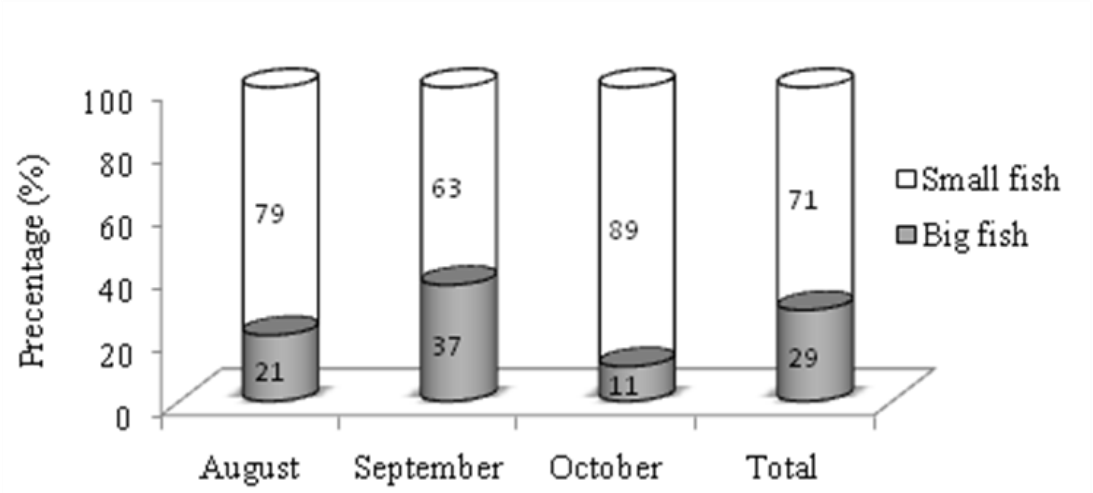

Fig. 2 Length size composition of skipjack catches in Palabuhanratu Bay, August-October 2007.

Distribution of SST from August to October 2007 was found tends to vary with range 20^0C - 31^0C. The range of SST in August 2007 was 22^0C - 29^0C. Distribution of SST in August indicated warm weather nevertheless decrease become cold in September and back to warm weather in October 2007 (**Table 1**).

Table 1. SST profile in Palabuhanratu Bay, August-October 2007

No	Moon	SST (^{o}C)		Category
		Range	Dominant	
1	August	22-29	26-29	warm
2	September	21-27	24-27	cold
3	October	20-31	24-29	Warm

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Numerical method had revealed that warm temperature was concentrated on the coastal area and tend to decrease toward offshore. This condition may be caused by freshwater input from rivers flow where the coastal area got the freshwater input more great number compared to offshore waters (Purba *et al.*, 1994), consequently the seawater around coastal area more warm compared to offshore.

The SST distribution at any time fishing operation presented at **Fig. 3.** The warm seawater were found more frequently occurred compared to the cold seawater in August 2007. This condition related to existence of east season that brought warm water masses in August 2007. Distribution of SST in September 2007 was found more fluctuate along with occurrence of season from east to west season. The warm temperature occurred when light intensity was high and cold temperature occurred when rainfall was high. Cloudiness also could influence the value and image quality of SST, because the cloud was able to absorb the sun light and retain the heat to reach the water surface. The cloud sometime cover whole Palabuhanratu Bay waters and retain the heat for not reach the water surface, and then SST data could not be obtained, (4 September and 9 October 2007). Temporal distribution pattern of SST in inter-monsoon season as elaborated above, have the same pattern with research result of Simbolon and Halim (2006) at coastal zone of West Sumatera waters.

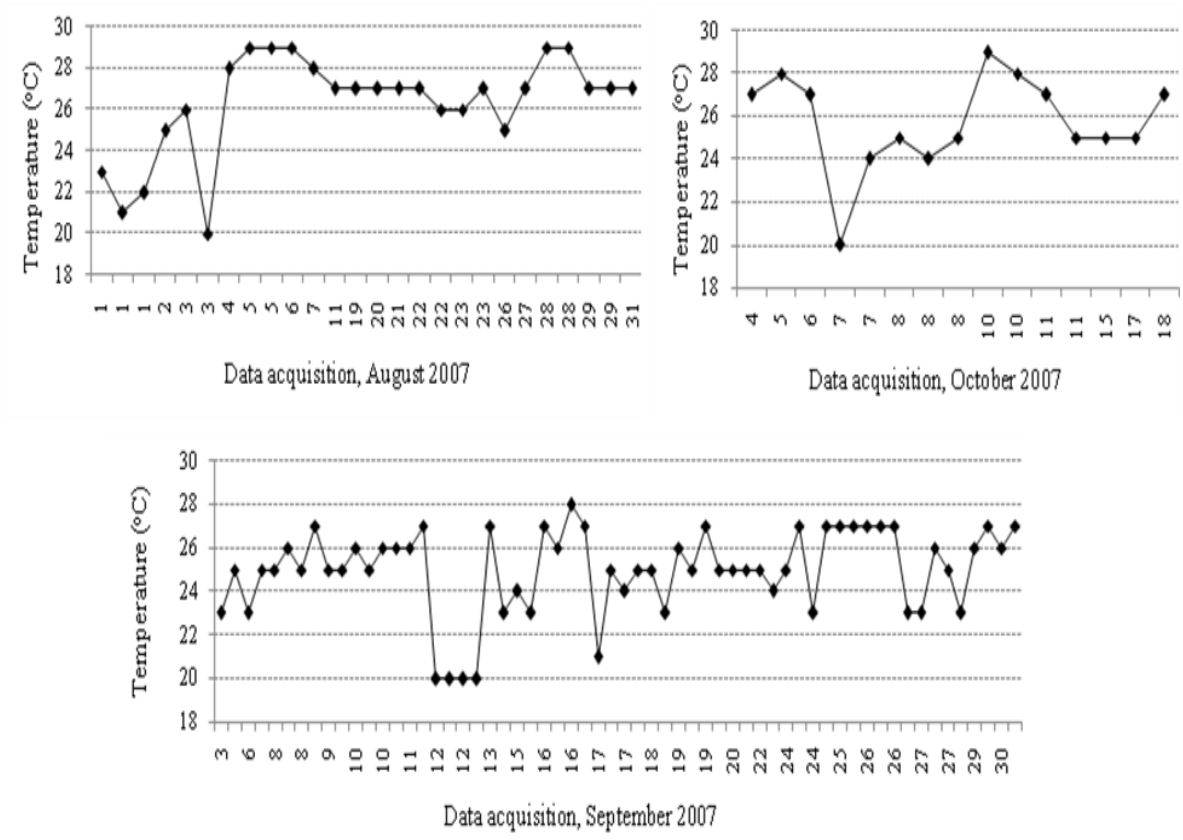

Fig. 3 Distribution of SST at the same location and time of skipjack fishing operation of Palabuhanratu Bay, August - October 2007.

Spatial distribution of SST vary from cold to warm seawater temperature, as found in September and October 2007. Cold seawater temperature in September and October could be influenced by upwelling phenomenon. This prediction based on research's Purba, *et al.*, (1992), who had reported that upwelling often occurred in Palabuhanratu Bay. During the upwelling event, cold water masses from bottom layer would be carried to surface layer. Consequently, there is a part of surface layer that have cooler temperature compared with its surrounding surface (spatial distribution).

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Occurrence frequency of cold temperature was higher compared with warm temperature during September until October 2007, and warm temperature in August 2007 more dominant (**Fig. 3**). This condition relates to season period. The water masses were warm relatively in August, when occurred the east season. After that, the water masses became fluctuate in September and October, and this condition indicates inter-monsoonal season from east season to west season. However, the water mass temperature in inter-monsoonal season dominated by cold temperature. Effect of west season on SST distribution usually more dominant compared with east season in October; therefore, the cold temperature was more frequent than warm temperature (Wahyuningrum, *et al.*, 2011). The research result also shows that cold seawater temperature was found more dominant in September and October compared to August 2007, as presented in **Fig. 3.**

The research result in **Fig. 4** revealed that change of SST was not followed by a certain pattern of catch volume. This indicates that SST distribution have no significant correlation to catch volume of skipjack in Palabuhanratu Bay waters during August to October 2007.

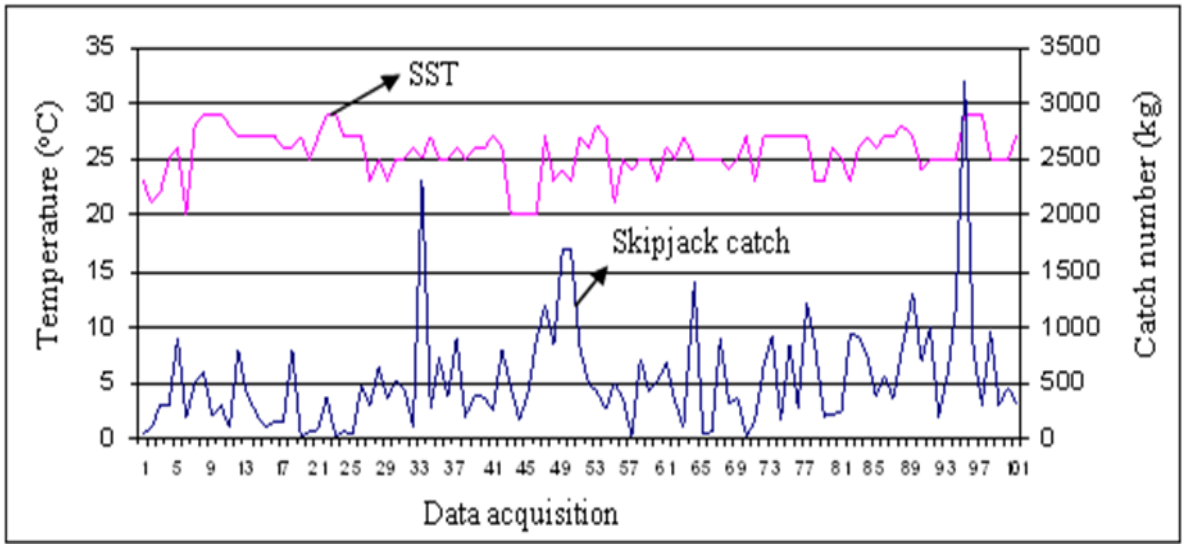

Fig. 4 Fluctuation of SST and skipjack catch every time of data acquisition of Palabuhanratu Bay, August-October 2007.

Optimum SST to catching skipjack in Indonesian waters ranges from 28^0C - 29^0C. This condition indicates the water temperature has an effect on fish distribution and will influence catch volume. Simbolon and Helmi (2006), state that effect of water temperature on fish distribution depends on temperature variability. This research result revealed that SST had not significant effect on catch volume of skipjack because the range of SST still could be tolerated by skipjack. Syahdan, *et al.*, (2007) reported that catch volume was not only influenced by seawater temperature, but also influenced by other oceanographical parameters such as salinity, current, seawater productivity as well as technical factors of fishing operation.

SST analysis such as in **Fig. 5** had showed the regression between SST and length size of skipjack. This shows that bigger size tends to be captured in the waters with seawater temperature of 20^oC – 29^oC. On the other side, the small fish had been captured in the waters with seawater temperature of 20^oC – 27^oC. The distribution patter indicates that bigger size tends to be distributed in warm seawater temperature, whereas small size distributed in cold seawater temperature. The bigger size able to adapt into the wide range of temperature, compared to small skipjack that have ability for adapting into narrow range of temperature. Ibrahim (2006) and Simbolon (2009) reported that big fish have good ability for adapting into various temperature ranges because influenced by good system of metabolism.

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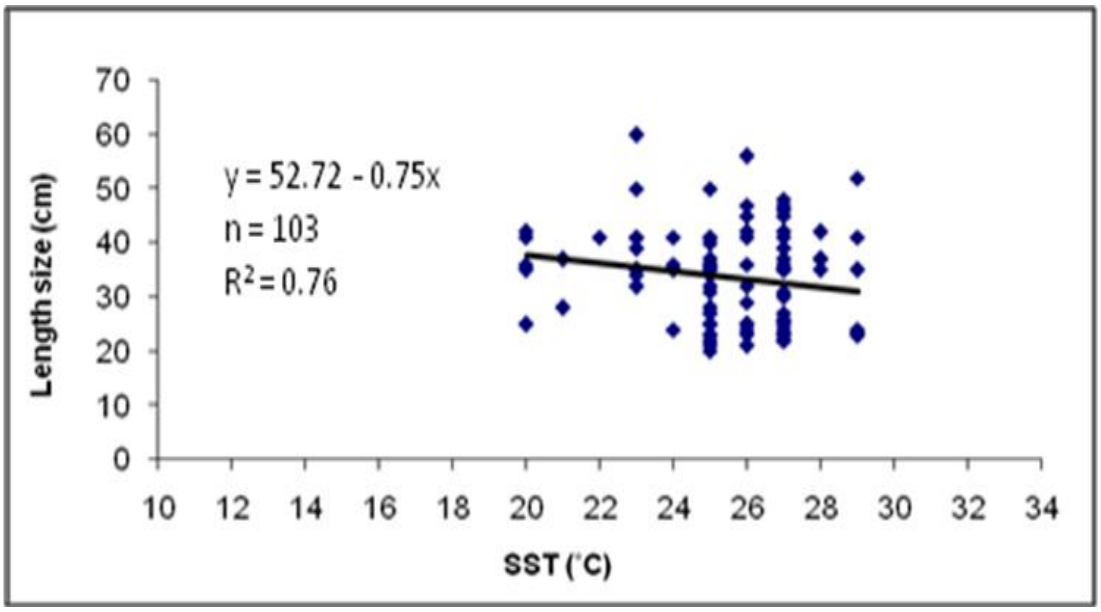

Fig. 5 The Regression of SST and skipjack length every time of data acquisition in Palabuhanratu Bay, August-October 2007.

Evaluation of fishing ground based on three indicators, which are CPUE, length size, and SST. Classification result of three indicators presented as in **Table 2**. Potential fishing ground of skipjack in Palabuhanratu Bay waters during August-October 2007 was presented in **Fig. 6**. The number of potential fishing ground in August, September, and October 2007 were 6 locations, 13 locations, and 4 locations, respectively. The potential fishing ground in September was more great number because the peak of skipjack season in Palabuhanratu predicted in September every year (Monintja *et. al*., 2001). Fisherman rarely found the potential fishing ground in August because skipjack maybe avoid the strong wave in August and then migrate toward offshore direction. The potential fishing ground also rarely found in October because fisherman reduced their fishing trip.

The potential fishing ground of skipjack in Palabuhanratu Bay in August-October 2007 was found at Teluk Ciletuh, Ujung Karangbentang, Cimaja, Teluk Cikepuh, Ujung Genteng and Gedogan waters. The region that categorized as moderate fishing ground in Palabuhanratu was found at Karangpayung, Ujung Penarikan, Cisolok, Teluk Amuran, Guhagede, Ujung Sodongparat, Citepus, Penggeleseram, Cisaar and GOA waters. The region that categorized as less potential fishing ground of skipjack in Palabuhanratu Bay was found at Teluk Bedog.

Table 2. Classification result of CPUE, length size, and SST to determine fishing ground category

Indicator	Range	Score	Percentage (%)
CPUE	>300 kg/unit	5	31
	100-300 kg/unit	3	18
	<100 kg/unit	1	5
Lenght	≥40 cm	3	18
	< 40 cm	1	5
SST	≥27^{o}C	3	18
	<27^{o}C	1	5
TOTAL			100

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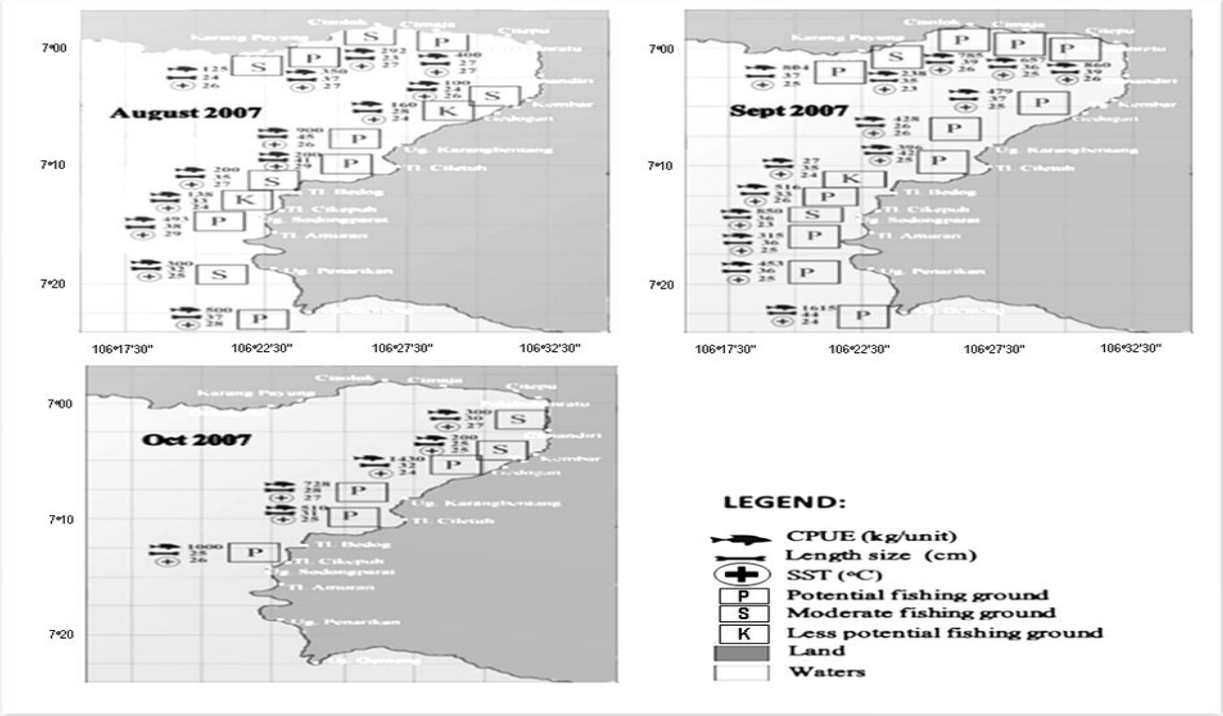

Fig. 6 Map of skipjack fishing ground in Palabuhanratu Bay waters during August - October 2007.

CONCLUSIONS

Conclusions that obtained from this research are:

(1) Distribution of sea surface temperature in Palabuhanratu Bay waters during August-October 2007 range from 20^0C-31^0C. The temperature in August tends homogenous and dominated by warm temperature from 26^0C till 29^0C, whereas in September and October tends to fluctuate from 24^0C–27^0C and 24^0C-29^0C, respectively.

(2) Catch productivity of skipjack in Palabuhanratu Bay waters in September is higher than August and October 2007 with CPUE values are:5,473 kg/unit (August), 15,555 kg/unit (September), and 8,817 kg/unit for October. The skipjack catches dominated by small size, with length size composition is 71% small size and 29% for big size.

(3) Sea surface temperature has no significant effect on catch volume of skipjack in Palabuhanratu Bay waters during August - October 2007, but has a significant effect on length size of skipjack. The small skipjack tends captured at the warm temperature, whereas big skipjack captured at cold and warm temperature.

(4) Potential fishing ground of skipjack in Palabuhanratu Bay is more great number in September compared to August and October 2007, and the potential fishing ground found at Teluk Ciletuh, Ujung Karangbentang, Cimaja, Teluk Cikepuh, Ujung Genteng and Gedogan waters.

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