The relationship between concentration of chlorophyll-a with skipjack (*Katsuwonus pelamis, Linnaeus 1758*) production at West Sumatera waters, Indonesia

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Abstract. The regression and correlation technic was uses to evaluated the contribution of chlorophyll-a concentration on variation of longline skipjack tuna production. An analysis was performed by placing Chlorophyll-a as predictor and Skipjack (*Katsuwonus pelamis, Linnaeus 1758*) production as dependent variable, using Chlorophyll-a derived from NPP VIIRS, and CPUE derived from longline fisherman log books for the year of 2013. Chlorophyll-a distribution which derived from NPP VIIRS between 0.13 -0.26 mg/m3 whereas maximum CPUE as much as 0.1875 kg/trip in April. The regression equation obtained was $CPUE = -1.12 + 11.5 \text{ Chl-a}$. Correlation between chlorophyll-a and CPUE have moderate relationship ($r=0.51$). From regression equation for those variables showed that the variation of chlorophyll-a had affected about 26% on variation of CPUE, only.

1. Introduction

Skipjack tuna (*Katsuwonus pelamis, Linnaeus 1758*) is one of the economically important marine fish resources resulting from marine waters of Indonesia, both as an export commodity as well as domestic consumption to meet national nutritional needs. Based on statistical data, the production of tuna fishery at West Sumatera since 2008 showed a very significant improvement. In 2008 the province recorded a production of 300 tons, which increased by more than double in 2009 which became 735 tons [1].

In 2006 the annual catch of skipjack in the Indian Ocean peaked at 620,000 tons and since then, catches have not exceeded 450,000 tons as reported by Indian Ocean Tuna Commission, 2010 in Dueri, Faugeras, and Maury, [2]. Commodity featured fish and potential for export are yellow fin tuna, bigeye tuna, skipjack, tuna and mackerel are mostly caught by fishermen using troll line, trolling and longline.

Fishing activities would be more efficient and effective when fishing areas can be predicted in advance, before the fishing fleet set out from the base. One step to determine potential fishing areas through the study of fishing grounds and its relation to oceanographic phenomenon in a sustainable manner [3].

Laevastu and Hela [4] stated that one of the properties tuna is highly migratory and hunting areas are plentiful source of food. As it is known that the chlorophyll-a can be used to determine the abundance of phytoplankton and can be used as indicators of marine productivities. Thus, indirectly,
there is a relationship between phytoplankton to the presence of fish. The distribution of chlorophyll-a concentration can be detected by remote sensing, using satellite imagery MODIS aqua. On the other hand, some oceanographic parameters are not obtained directly from these sensors, but instead, they are estimated by the radiance reflected and/or emitted by the ocean surface. The conversion of this radiance into values of oceanographic parameters (e.g. sea surface temperature and chlorophyll-a concentration) estimate by using the specific algorithms. This allows the monitoring of surface oceanic parameters that influence the distribution of pelagic species, i.e. those living in surface waters.

Skipjack tuna, is a pelagic species adapted to perform large migrations that inhabit the three largest oceans of the world [5]. Skipjack tuna is the most important species targeting by local fishermen in the Indian Ocean, specially long line and purse seine fisherman from West Sumatera. The distribution and migration of this species are strongly influenced by oceanographic factors such as distributions of SST and chlorophyll-a (hereafter Chl-a). SST and Chl-a derived from satellite data are determinant factors in predicting tuna forage and their habitat in Western North Pacific Ocean [3]. The objectives of this study are to explore the short term relationship between oceanographic factors and skipjack tuna abundance, and to predict potential fishing grounds using GIS techniques.

2. Material and methods

2.1. Study area
The study area covered skipjack tuna fishing ground at Indian Ocean, West Sumatera, Indonesia and located at 0°25'48" – 5°34'48" N and 95°25'23" - 100°57' E (Figure 1). Determining the location of the research is based on the logbook tuna fishing ground carried out by fishermen whose landing their catch in PPS Bungus

![Figure 1. Study area](image)

2.2. Fisheries data
Skipjack tuna daily catch data obtained from fishing logbook of long line fishery, for the period January to December 2013. These data comprised daily geo-referenced fishing positions (latitude and longitude), catch in kilogram and effort, and catch per unit effort (CPUE) was determined.

2.3. Remote sensed environmental data
By using the biological environmental data to describe the oceanographic conditions at the fishing ground were Chl-a, derived from SATELLITE IMAGE NPP VIIRS level 3 for the year of 2013.

2.4. Data analysis
In this study, firstly the fishing data were plotted on Chl-a image maps. Then the oceanographic data around the fishing positions were extracted to understand the spatial and temporal distribution pattern of skipjack fishing grounds relative to the oceanographic conditions. To describe the relationship
between oceanographic conditions of chl-a, and skipjack production (CPUE), we were using regression and corellation analysis.

3. Result and Discussion

The potential areas of tuna fishing ground of West Sumatera waters in the position 0° 25'48"N - 5° 34'48"S and 95° 25'23"-100°57'E. Fishing gears were standardized to purse seine since we found this gears commonly used by the fishermen. Total catching station on the east and west season are 21 and 24 stations, while the highest point in the monsoon II as many as 50 stations and in the monsoon II is 30 stations.

Determination of catching station based on the experience of the fishermen in the previous year. Natural conditions such as the rainy season and dry season which also affects the catch. The distribution of chlorophyll-a were analyzed by using satellite imagery NPP VIIRS level 3 in each fishing ground in 2013 had the highest level of chlorophyll-a at 1.22 mg m\(^{-3}\) and the lowest at 0.075 mg m\(^{-3}\). Septiawan [6] stated that the highest level of chlorophyll-a in April included in the high category between 0.501 to 1.0 mg m\(^{-3}\) whereas chlorophyll-a has a value of 0.075 mg m\(^{-3}\) was the lowest. Based on the fertility level in the waters. Gunarso [7] explained that catching station which has a value of chlorophyll-a 1.22 mg m\(^{-3}\) included in the category of fertile i.e 0.4 to 2 mg m\(^{-3}\) while the chlorophyll-a-value of 0.075 mg m\(^{-3}\) fertility rate is very low at <0.2 mg m\(^{-3}\) (Figure 2).

![Figure 2. Monthly of Chl-a concentration distribution](image-url)
Analysis of chlorophyll-a satellite image of NPP VIIRS show in 2013 recorded an average value of chlorophyll-a is 0.22 mg m\(^{-3}\). Viewed from the fishing season the average value of chlorophyll-a increased. When the west season the average value of chlorophyll-a is 0.19 mg m\(^{-3}\), at monsoon 1 when the average value of chlorophyll-a is 0.20 mg / m\(^3\), at the east season 0.24 mg m\(^{-3}\) and 0.26 mg m\(^{-3}\) while monsoon II.

Based on the level of eutrophication of waters according to Bricker et al. in [8] average of chlorophyll-a in 2013 in the category low as 0-5 mg m\(^{-3}\). Nixon in [8] defined eutrophication as a process of increasing the rate of supply of organic material to the water body, whether originating from within the water itself (autochthonous) or from outside the waters (allochthonous). Enrichment of this water causes an increase in phytoplankton growth and turbidity. This condition causes a negative impact on aquatic ecosystems, such as reduced oxygen in the water column and in extreme conditions can cause death in fish and benthic organisms.

The regression equation obtained was CPUE = -1.12 + 11.5Chl-a. The result showed that increasing the chlorophyll-a had positive impact on the CPUE of skipjack (Katsuwonus pelamis). The highest CPUE occurred in November is 4.310 kg/settings as well as the concentration of chlorophyll-a in November is 0.287 mg m\(^{-3}\) (Table 1). This condition could be caused by the location of tuna fishing ground, environmental factors such as weather, wind, salinity and fishing season.

| Month      | Chl-a | CPUE  |
|------------|-------|-------|
| January    | 0.128 | 0.631 |
| February   | 0.169 | 1.000 |
| March      | 0.174 | 1.000 |
| April      | 0.207 | 1.494 |
| May        | 0.206 | 1.579 |
| June       | 0.239 | 0.554 |
| July       | 0.241 | 0.608 |
| August     | 0.254 | 1.000 |
| October    | 0.229 | 1.774 |
| November   | 0.287 | 4.310 |
| December   | 0.260 | 1.180 |

The coefficient correlation between the concentration of chlorophyll-a and CPUE of skipjack (Katsuwonus pelamis) is 0.51. This means that the relationship between the concentration of chlorophyll-a and CPUE in tuna was moderate. In addition, the coefficient of determination between the two variables was only 26%, there was about 74% caused by others factors.

4. Conclusion
The regression equation obtained was CPUE = -1.12 + 11.5Chl-a and the increasing the chlorophyll-a had positive impact on the CPUE of skipjack. The coefficient of determination between the two variables was only 26%, there was about 74% caused by others factors.

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