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SHORT COMMUNICATION

# Variability in fish catch rates associated with Sea Surface Temperature Anomaly (Niño 3.4 index) in the West of Java Sea

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**ABSTRACT**

The remotely derived oceanographic variables included sea surface height anomaly (SSHA), sea surface temperature (SST), chlorophyll-*a* (Chl *a*) and fish catches are used as a combined dataset to understand the ocean climate variability and further addresses their relations with the fish catches in the West-Java Sea. Fish catches and remotely sensed data are analyzed for the 5 years datasets from 2010-2014 and emphasized the differences of climate conditions during El Niño Southern Oscillation (ENSO) events. Here, we demonstrate the prominent annual variation of two species small pelagic fish catches (*Euthynus affinis* and *Scomberomorus commerson)* and one demersal species (*Netuma thallasina*) as representative of dominant catch in the region. Small pelagic catches had significant increment during El Niño compared to during La Niña events. Changes in oceanographic conditions during ENSO events resulted in perceivable variations in catches, with an average catches of 839.6 t (*E. affinis*) and 273,7 t (*S. commerson*) during El Niño. During La Niña event catch rates were reduced with an average catches of 602.6 t (*E. affinis*) and 210.3 t (*S. commerson*). During the La Niña event was less favorable for small pelagic catches. In contrast, *N. thallasina* does not seem to be directly affected by the ENSO. The average catches of *N. thallasina* during El Niño (182.17 t) lower than during La Niña (250.14 t). This inferred that different climate events might cause different oceanographic conditions that related to fish biodiversity. Our results would benefit the fish biodiversity-management to reduce risks due to climate regimes.

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***Keywords*:** Catch rates, El Niño, La Niña, oceanographic conditions, Java Sea

## 1. INTRODUCTION

Indonesia is the largest archipelago state in the world with a coastline of 95181 km. Sea area of 5.4 million $km^2$ dominates the total Indonesian territory of 7.1 million $km^2$. This potential puts the country as a sovereign territory with wealthy and rich marine biological resources. The high coastal and marine biodiversity are essential assets in supporting the economic development because they have an important contribution to the environment and the welfare of the people [1, 2].

One of the fishing areas with significant role of fisheries is the northern coast of west Java Sea directly adjacent to the Java Sea. This is proved from the dominant of the fish caches in west Java sea derived from capture fisheries. The dominant catch is tunny (*Euthynnus affinis*). Other catches include narrow-barred Spanish mackerel (*Scomberomorus commerson*) and some demersal fish, such as giant catfish (*Netuma thalassina*) and yellow pike conger (*Congresox talabon*).

Oceanographic parameters such as temperature, sea surface height anomaly, primary productivity affect the distribution and survival of fish resources in the ocean. However, in relation to the wave and current dynamic, the oceanographic condition is rapidly changing related to space and time. Indonesia's unique position is located between Australia and Asia leading to weather and sea conditions that are highly influenced by the monsoons repeated every year. In addition, lying between the Indian Ocean and the Pacific Ocean as the path of Indonesian Troughflow (ITF), the area is affected by regional climate change, the ENSO (El Nino Southern Oscillation) phenomenon, both El Niño and La Niña [3]. This leads to climate variability changing oceanographic conditions that influence the distribution and abundance of diversity of fish resources.

Some studies have confirmed that there is a close relationship between ENSO phenomenon and the abundance and distribution of tuna [4-6]. However, research on the impact ENSO on fish catch rates has not been widely studied. This study, will focus on assessing the influence of ENSO through the SST anomaly in the eastern Pacific Ocean (representative by the Niño Index) on the oceanographic conditions and fish catches in west-Java Sea.

## 2. MATERIALS AND METHODS

### 2. 1. Study area

The study area is in the northern waters of Indramayu, Java Sea on the coordinates of 3-7°S and 108-110°E (Figure 1).

### 2. 2. Data and methods

This study uses satellite remote sensing data consisting of sea surface height anomaly (SSHA) on satellites TOPEX/Poseidon, Jason-1, Jason-2, and ERS-half of Archiving, Validation and Interpretation of Satellite Oceanographic Data (AVISO: http://aviso.oceanobs.gsfc.nasa.gov), Sea Surface temperature (SST) and Chlorophyll-*a* from

satellites Aqua/Modis (http://oceancolor.gsfc.nasa.gov), SST anomaly of Niño 3.4 index from NOAA Climate Prediction Center and fish catches datasets from Karangsong Fish Landing Sites and the Department of Marine and Fisheries Indramayu. Satellite data have a spatial and temporal resolution of 4 km and monthly, respectively.

Data analysis is carried out during January 2010 to December 2014 (5 years) representing regional climate change of El Niño and La Niña. Oceanographic parameters are spatially analyzed by a period of climate change of El Niño and La Niña.

Oceanographic parameters in this study used to detect the El Niño and La Niña which are then determined the relation to the catch rates of fish resources to obtain the outputs in the form of fish resources management recommendations that are sensitive to changes in regional climate.

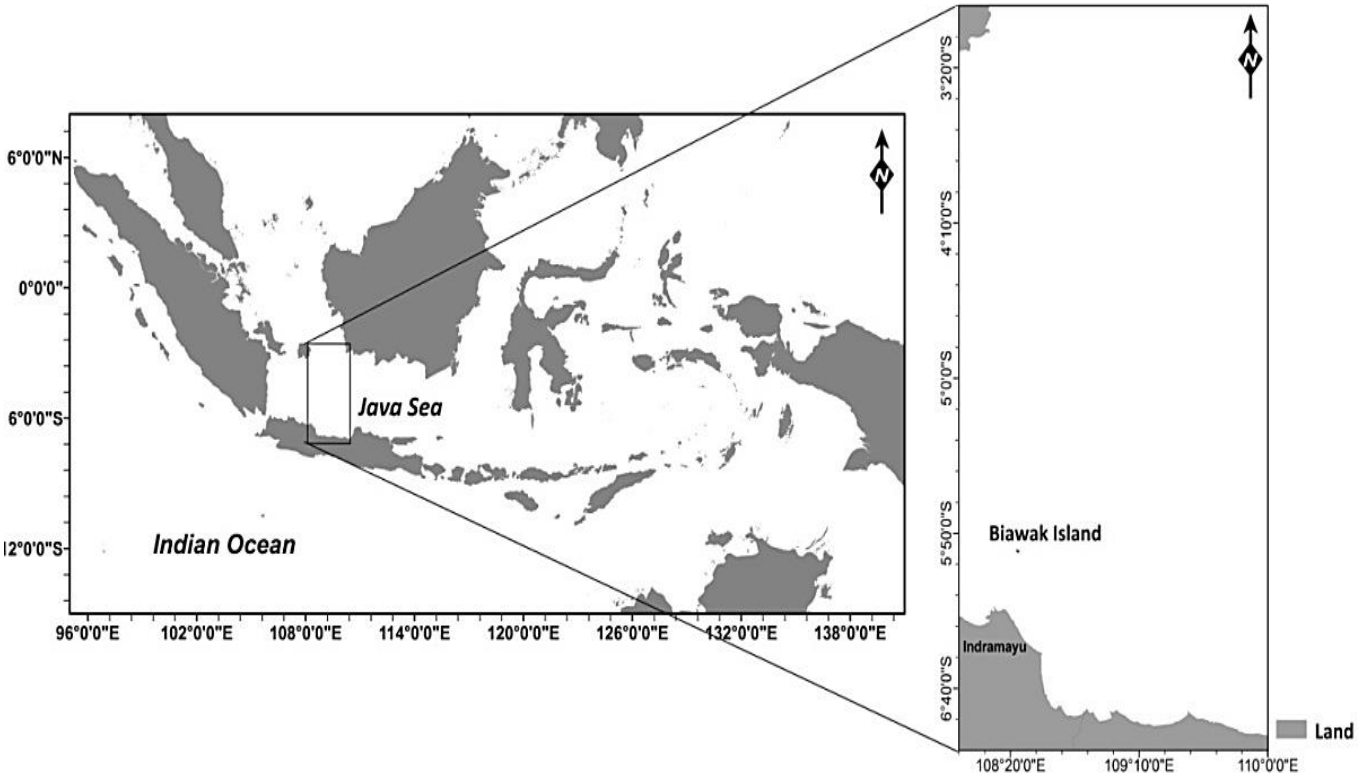


**Figure 1.** Map of the Indonesian Seas with the inset box representing the study area in the west Java Sea

## 3. RESULT AND DISCUSSION

### 3. 1. Variations of fish catches in the north water of Indramayu

Based on data from the Department of Marine and Fisheries Indramayu, Eastern Little Tuna (*Euthynnus affinis*) is the dominant (59%) species caught in the area, followed by Spanish mackerel (*Scomberomerus commerson*) (20%), giant catfish (*Netuma thalassina*) (17%) and yellow-pike conger (*Congresox talabon*) (0.04%). The proportion of the catches can be seen in

Figure 2. Thus it can be concluded that the west of Java Sea is a potential area of small pelagic fishing. For the purposes of this study, analysis will be limited to three species.

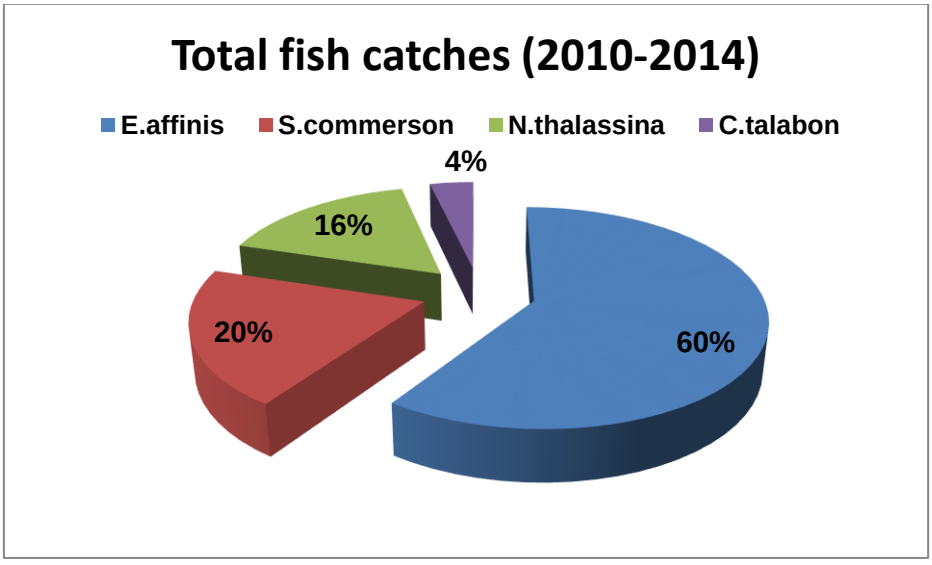


**Figure 2.** The type and proportion of total catches in West of Java Sea

To determine the relationship of ENSO phenomenon and fish catches, it can be seen from the graph of these parameters as shown in Figure 3. The El Niño phenomenon is indicated by Niño index value> 0.5 ºC and La Niña is characterized by Niño index value > -0.5 ºC which occurs for more than five months. Based on the Niño 3.4 index of the SST anomalies, the El Niño event occured in January-April 2010 and October to December 2014, while La Niña happens in July 2010-April 2011 and September 2011-March 2012.

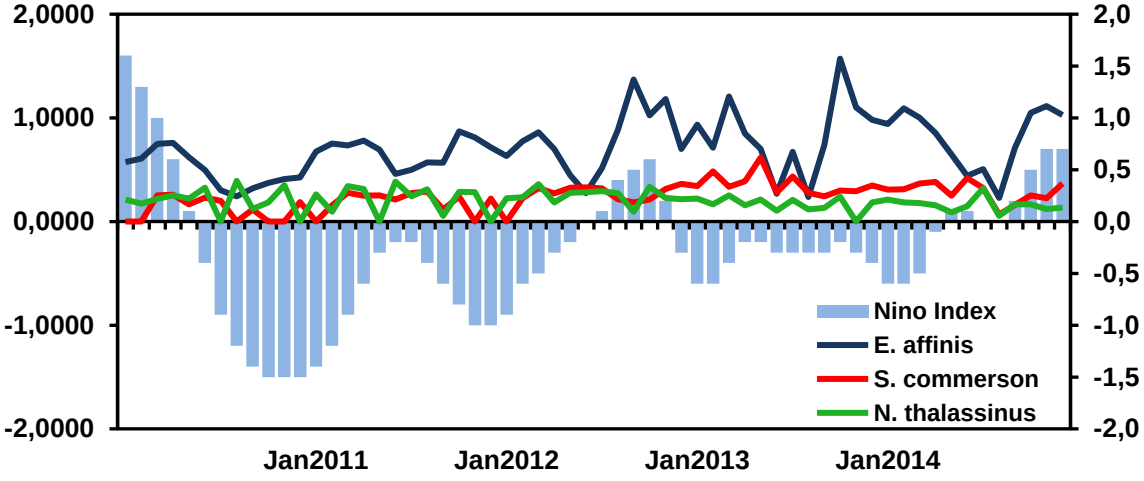


**Figure 3.** Variability in catch rates (solid lines) and SST anomalies from the Niño 3.4 index (blue bar) during 2010-2014

The catches fluctuate during the year of observation (2010-2014). Changes in oceanographic conditions during ENSO contribute to the variation of fish catches landed at Fish Landing Site of Karangsong, Indramayu. By the time of El Niño, the small pelagic fish catches has increased significantly compared to that in La Niña phase. The average catches of Eastern Little Tuna are higher during El Niño (839.6 tonnes) than during La Niña (602.6 tonnes). Likewise with Spanish mackerel catches is slightly higher during El Niño (273.7 tonnes) than during La Niña (210.3 t). This indicates that the oceanographic conditions during La Niña phase is not conducive for the small pelagic fish catches.

The opposite condition occurs to the other species, giant catfish *(N. thallasina)* do not seem to be directly affected by the El Niño effect. The average total catches during El Niño is considerably lower (182.17 tonnes) than that during La Niña (250.14 tonnes). This can be explained that the demersal fish are not affected by the changes in oceanographic conditions on the surface as happened to pelagic fish. In general, based on the variations in catches, the ENSO phenomenon can lead to changes in oceanographic conditions associated also with the diversity of fish catch rates in west of Java Sea.

### 3. 2. Ocean climate variability associated with fish catches and biodiversity

This research has identified differences in oceanographic conditions at the time of climate change both of El Niño and La Niña in the west of Java Sea. Figure 4 displays the results of the monthly average (mean Climatology) for each parameter of oceanography and fish catch rates during 2010-2014.

As we can see on Figure 4, there are differences in the relationship between the number of catches for each species and oceanographic conditions. It shows that oceanographic parameters change according to the seasons change and then affects on fish catches. Eastern Little Tuna are mostly caught in March and October with an average value of the catches 900-1000 tons, along with the SSHA values ranging between 4-8 cm, SST of 29-30 ºC, followed by Chlorophyll-*a* of 0.4-0.5 mg $m^{-3}$.

Spanish mackerel peaks in December with relatively high SSHA conditions 12 cm, SST ranging from 29-30 ºC, and Chlorophyll-*a* concentration starting from 0.4-0.5 mg/$m^3$. On the other hand, this phenomenon does not have considerable effects on the number of giant catfish caught each month. The catch, however, rises in June by high SSHA condition (10-12 cm), SST 30-31 ºC, and Chlorophyll-*a* concentration of 0.5-0.6.

Among the three oceanographic parameters observed, it is perceived that the SST and SSHA change according to climatic conditions that also affect the fish catch. This is consistent with research by [3.4] finding that the SST can be used as an indicator of the distribution of fish. The distribution of the Chlorophyll-*a* concentration is proportionately distinguished along the coastal waters of Indramayu in the phase of El Niño and La Niña due to runoff from the rivers that lead to high fertility rate in the waters.

The Java Sea, despite not being significantly affected by the ITF, has been shaped in the current conditions by the seasonal flow in Indonesia which change according to the monsoon winds. According to Qu,*et. al.* [7] whose findings confirm the mass flow of relatively cold water of the South China Sea through the Karimata Strait experiencing maximum levels during El Niño. This is evident during El Niño; SST is relatively lower during El Niño in which is also supported by the negative SSHA value. This study shows that changes in oceanographic conditions will also influence the distribution of fish species in the search for conducive areas for habitation; consequently, it largely determines the level of biodiversity.

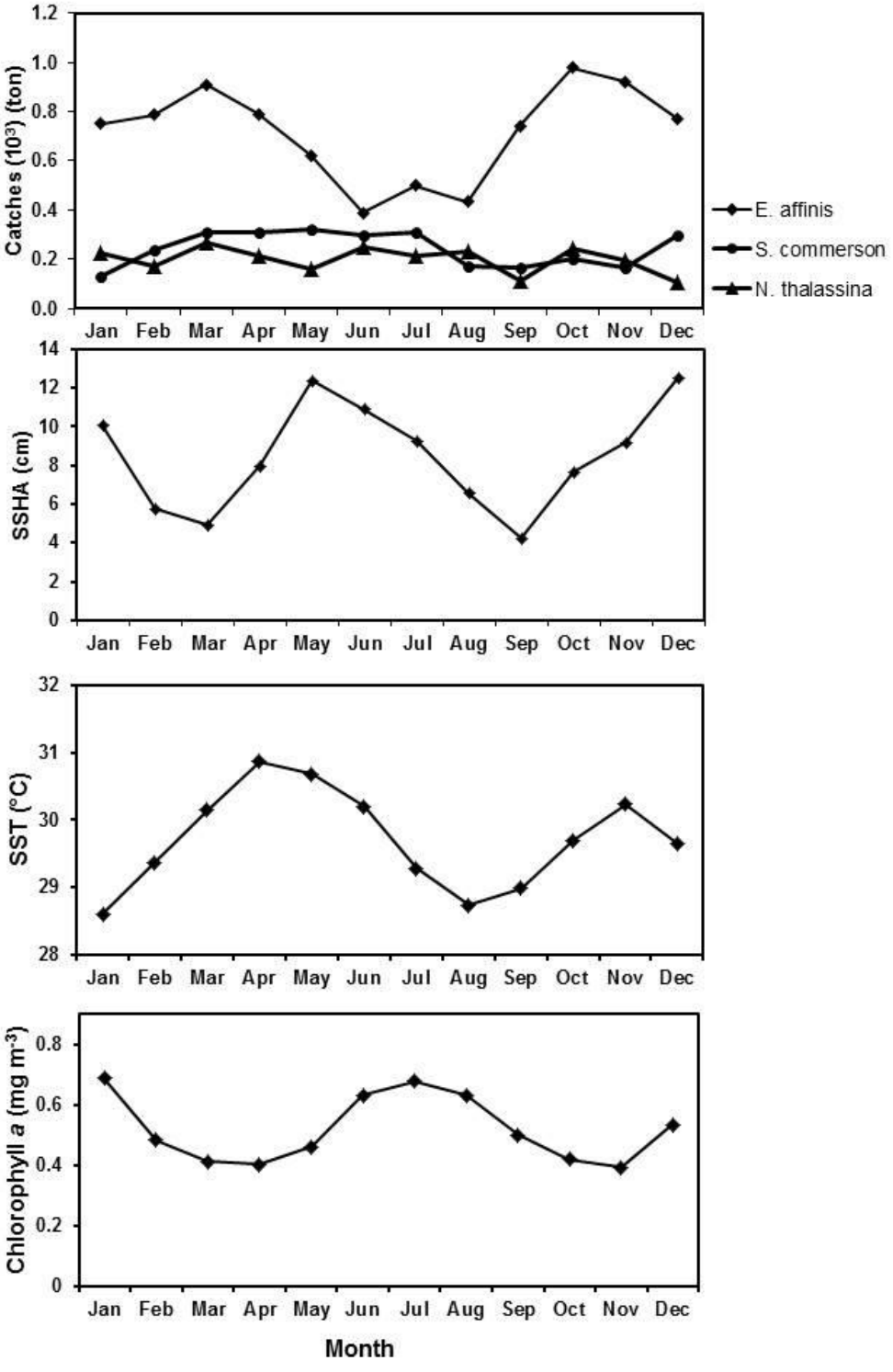


**Figure 4.** Mean monthly of (a) catch rate; (b) SSHA; (c) SST; and (d) Chlorophyll-*a* during 2010-2014

A research conducted by Lehodey, *et. al.* [8] also comes with the similar findings and conclusion on the relationship between the distribution of tuna in the western Pacific during ENSO events.

It is clear that changes in oceanography during ENSO phenomenon determine the abundance and diversity of fish species as they relate to the ecosystem or fish habitat. The effects of El Niño on the changes of surface ocean current affecting the movement of marine organisms and decreasing the number and diversity of fish populations [9]. Research studies prove catches of pelagic fish tend to be higher during El Niño, while La Niña causes less environmental conditions conducive to the fish so that it will decrease the amount of the abundance and diversity of fish in these waters.

## 4. CONCLUSIONS

The results of this study have presented the influence of ENSO climate variability on the oceanographic conditions and fish catches in west of Java Sea. The changes contribute to the fluctuations in the number of the catches, as seen in those of tuna and Spanish mackerels where the activities produce higher number during El Niño than in the time of La Niña. The research also affirms that such phenomenon considerably has a direct effects to pelagic fish observed in this study, while the contradicting effects occur in giant catfish.

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