



RESEARCH ARTICLE

THE PATTERN OF SKIPJACK FISHING SEASON IN BACAN ISLAND WATERS,
SOUTH HALMAHERA REGENCY

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ABSTRACT

Skipjack (*Katsuwonus pelamis*) fishing in the waters of Bacan Island by fishermen based in PPP Panamboang, South Halmahera Regency is generally done using pole and line with auxiliary gear of fish aggregating devices (FADs). Skipjack fishing activity needs effective information so maximum catch can be achieved. Information about the area and season where skipjack can be captured in a large amount can reduce the cost of fishing operation, fishing time, and energy. One solution that offered the best solution is of knowing the pattern of skipjack fishing season. The objective of this research is to analyze the pattern of skipjack fishing season in the waters of Bacan Island, South Halmahera Regency. This research was conducted in the waters of Bacan Island, South Halmahera Regency from October to November 2016. The method was survey-descriptive based on a case study. The results showed that the trend of skipjack catch production in the waters of Bacan Island, South Halmahera Regency during a ten years period (2006-2015) increase, while the trend of fishing trip productivity (ton per trip) has a decrease in 2014. Skipjack season in the waters of Bacan Island, South Halmahera Regency is during Easterly Wind Season (June-August) and peaked in July. This is due to the fertility of the waters tending to increase.

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INTRODUCTION

Skipjack is a pelagic fish that live in schools. According to (Nikolsky, 1963), skipjack individuals in a school tend to have relatively similar in size since they are from one cohort, which individuals resulted from spawning occurring in the same time. Larger fishes are usually in the deeper layer with the number of individuals less than that of in the schooling of smaller fishes in the surface layer. These two fish schoolings are targets of fishermen operating different fishing gear in accordance with the behavior of the fish. Skipjack is regarded as an important pelagic resource and one of non-oil-and-gas commodities. The waters of Bacan Island, South Halmahera Regency is one of the important skipjack fishing areas in Indonesia. In 2015, the catches of skipjack from this area landed to Coastal Fishing Port of Panamboang (PPP Panamboang), South Halmahera Regency was 2,823.68 tonnes (UPTD PPP, 2016). Activities in utilizing the skipjack (*Katsuwonus pelamis*) resource in Bacan Island waters by the fishermen based in PPP Panamboang, South Halmahera Regency are generally done using pole and lines and an FAD as an auxiliary gear. Furthermore (Wild and Hampton, 1994)

indicated that tuna, including skipjack, fishing activities has been being developed in Indonesia waters, especially in eastern Indonesia waters since 1970s. Skipjack captures in Indonesia are done by using pole and line, troll line, purse seine, gill net, and seine net (Burhanuddin et al., 1984). Skipjack fishing activities need effective information in order to achieve an optimum catch. According to (Prasetyo et al., 2014), by knowing the area and time that fish can be caught in a large number the fishing activity becomes more effective. An alternative that gives the best solution is of knowing the pattern of skipjack fishing season. Skipjack season affects considerably fishing production in certain months, therefore by knowing the skipjack fishing season, fishing time can be determine more effective and efficient. Based on their research (Yusuf, 2014), in PPN Tamperan Pacitan East Java, the pattern of skipjack fishing season occurred from May to October with the peak in May-June and the period of the lowest catch was from November to April. Furthermore (Kekenusa et al., 2012), stated that in Manado North Sulawesi waters, skipjack fishing season occurred from April to November, while January, February, March, and December were not considered as a fishing season. According to (Octorina, 2014), skipjack season in Pelabuhan Ratu Bay, Sukabumi Regency occurred in May-October and the fishing peak occurred in May. A problem faced by pole and line fishermen in doing fishing operation in the waters of Bacan

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Island, South Halmahera Regency at the moment is that they do not know yet when the scarcity, average, and peak of skipjack catches occur. To date, the fishermen go fishing for the entire year based on their experience and assume that the skipjack resource is always available. Based on this problem, a piece of research has been done to understand the pattern of skipjack fishing season in the waters of Bacan Island, South Halmahera Regency. The objective of this research is to analyze the pattern of skipjack fishing season in the waters of Bacan Island, South Halmahera Regency. The hypothesis of this research is that the pattern of skipjack fishing season affects skipjack fishing production in the waters of Bacan Island, South Halmahera Regency. Previous research on the assessment of skipjack fishing rate in Prigi East Java waters had been done by (Setiyawan, 2016). Jufri *et al.* (2014) studied characteristics of skipjack fishing ground during westerly wind season in Bone Bay waters, and Angraeni *et al.* (2014), investigated spatial and temporal analysis of skipjack (*Katsuwonus pelamis*) catches and thermal front during transition period of season in Bone Bay waters. Furthermore Husair *et al.* (2014), did a study on analysis of skipjack (*Katsuwonus pelamis*) catches in the fishing ground with and without FADs in the western waters of Banda Sea. However, information on the pattern of skipjack fishing season in the waters of Bacan Island, South Halmahera Regency, are not available yet.

skipjack fishing ground mostly visited by pole and line fleets based in PPP Panamboang, South Halmahera Regency.

Source of data

Method in this research is survey descriptive for case study, which is to give a detail description as a background of specific character and nature. To analyze the pattern of fishing season, the collected data were production data (tonnes) and monthly skipjack fishing trip for 10 years (2006-2015). These data were acquired from fishing statistics of integrated management unit (UPT) coastal fishing port (PPP) Panamboang, South Halmahera Regency.

Data analysis

Data analysis that is used in this research is a descriptive analysis and fishing season pattern analysis. Descriptive analysis in this research is used to describe skipjack fishery including production and productivity of skipjack fishing. The pattern of skipjack fishing season in the waters of Bacan Island, South Halmahera Regency was analyzed using production and monthly fishing effort (trips) data for 120 months (10 years) from 2006 to 2015. This season pattern was determined based on the value of productivity mean and fishing season index (FSI) for each season, where based on the

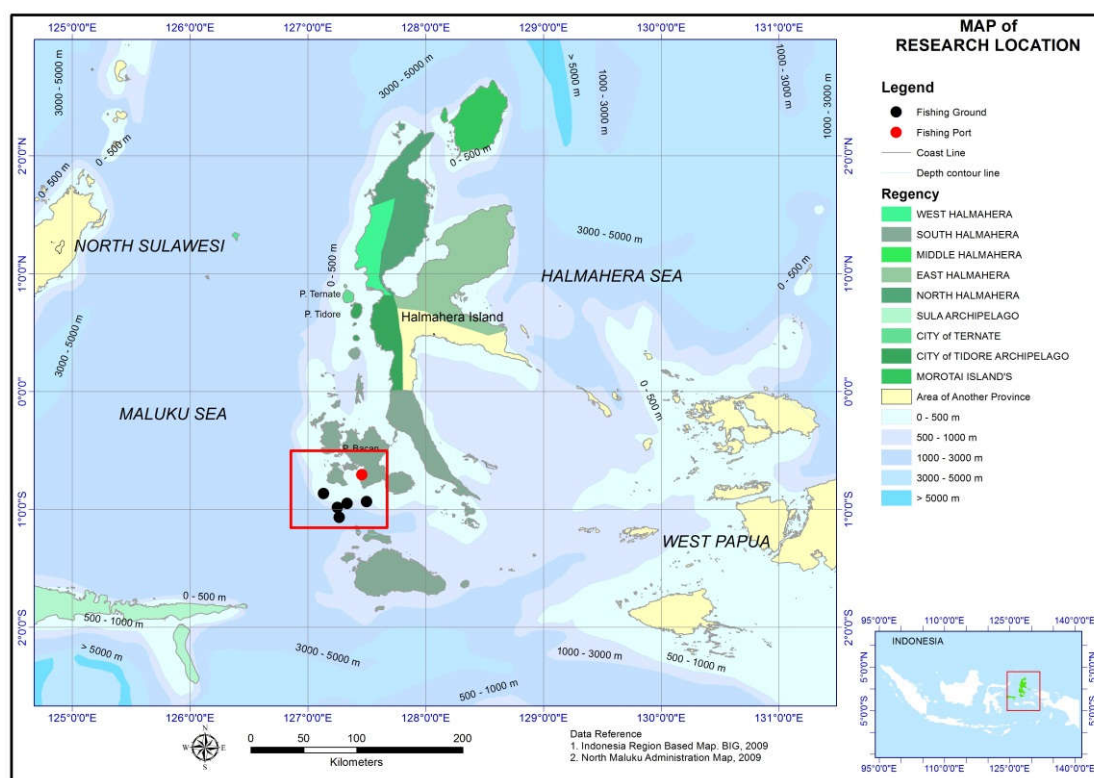


Figure 1. Research location

MATERIALS AND METHODS

Research location and time

This research was conducted in the waters of Bacan Island, South Halmahera Regency from October to November 2016. Data was collected from the field on 26 – 28 November 2016 and the survey area has been limited to coordinates of $0.855687 - 1.096369^{\circ}$ S and $127.09412^{\circ} - 127.543124^{\circ}$ E (Figure 1). This location was selected due to this area is the

interview with pole and line fishermen who fish in the location, there are for season in a year, i.e. Westerly Winds Season (December, January, and February), Transition I Season (March, April, and May), Easterly Winds Season (June, July, and August), and Transition II Season (September, October, November). Fishing season analysis is used to give an effective information regarding skipjack fishing season. According to (Kekenusa *et al.*, 2012), fish season considerably affects fish production on certain months, then by knowing the fish season, fishing time management can be done more

effective and efficient. The pattern of skipjack fishing season was analyzed using the average percentage methods based on time series analysis. The procedures are as follows (Purwasasmita, 1993):

(1) Calculate catch per unit fishing effort (CPUE, U) each month (U_i) and monthly CPUE average in a year (\hat{U}).

$$\hat{U} = \frac{1}{m} \sum_{i=1}^m U_i$$

where:

- \hat{U} = monthly CPUE average in a year (tonnes/trip)
- U_i = monthly CPUE (tonnes/trip)
- m = 12 (number of month in a year)

(2) Calculate U_p , i.e. the ratio of U_i to \hat{U} which indicated in percentage

$$U_p = \frac{U_i}{\hat{U}} \times 100\%$$

(3) Next, calculate the season index (IM).

$$IM_i = \frac{1}{t} \sum_{i=1}^t U_p$$

where:

- IM_i = i -th season index
- t = number of years in the data

(4) If the number of IM_i is not 1200 % (12 months x 100 %),

$$IMS_i = \frac{1200}{\sum_{i=1}^m IM_1} \times IM_i$$

where:

IMS_i = i -th adjusted season index

(5) If there is an extreme value in U_p , then the value of U_p will not be used in season index (IM) calculation, the median (Md) of the IM will be used instead. If the value of Md is not 1200 %, then it will need an adjustment as follows:

$$IMMDS_i = \frac{1200}{\sum_{i=1}^m Md_i} \times Md_i$$

where;

$IMMDS_i$ = i -th season index with adjusted median

(6) The criteria of fish season is if the season index more than 1 (more than 100 %) or above of average; and no fish season if the value of season index less than 1 (less than 100 %). If $IM = 1$ (100 %), this value is similar to the monthly average, in other words it is in normal condition or in balance.

Fishing season can be categorized in three categories based on the value of fishing season index (FSI), namely low catch

season, moderate season, and peak season (Zulkarnain *et al.*, 2012) (Table 1).

Table 1. Fishing season category based on fishing season index (FSI)

No	Value of FSI	Season Category
1	<50%	Low catch
2	50% ≤ IMP < 100%	Moderate
3	≥ 100%	Peak

RESULTS AND DISCUSSION

Catches of skipjack in the waters of Bacan Island unloaded at PPP Panamboang, South Halmahera Regency increased and reached a peak in 2014. The highest catch in 2014 was 3154.35 tonnes, and the lowest was in 2007 of 1127.07 tonnes (Figure 2).

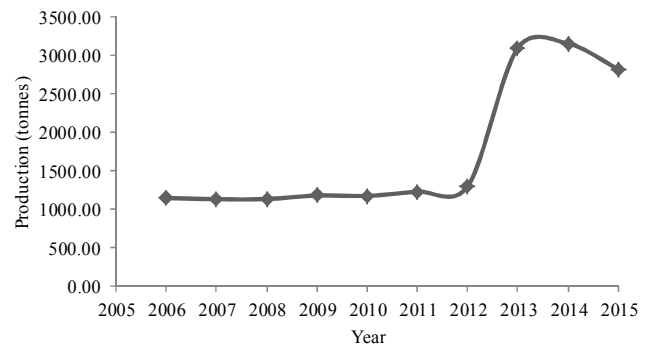


Figure 2. The trend of skipjack catches unloaded at PPP Panamboang, South Halmahera Regency in 2006-2015

The trend of fishing trip productivity (tonnes/trip) of pole and line operating in the waters of Bacan Island and registered at PPP Panamboang, South Halmahera Regency showed a fluctuated productivity from 2006 to 2015. The highest productivity was in 2012 of 1.72 tonnes/trip, and the lowest was in 2008, 2010, and 2011 of 0.90 tonnes/trip (Figure 3).

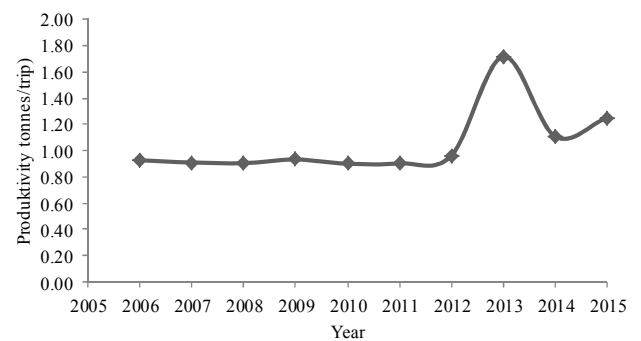


Figure 3. The trend of fishing trip productivity of pole and line based in PPP Panamboang, South Halmahera Regency, 2006-2015

The average of skipjack fishing productivity in the waters of Bacan Island, South Halmahera Regency during Westerly Winds Season was 1.05 tonnes/trip. The highest fishing productivity was 1.15 tonnes/trip in February, the lowest was 0.92 tonnes/trip in December, and the average value of fishing season index (FSI) was 99.17. Transition Season I, the average

fishing productivity was 1.02 tonnes/trip. The highest fishing productivity was in April of 1.19 tonnes/trip and the lowest was in March of 0.91 tonnes/trip. The average value of fishing season index (FSI) was 95.84. During Easterly Winds Season, the average fishing productivity was 1.11 tonnes/trip. The highest fishing productivity was 1.26 tonnes/trip in August, the lowest was 0.95 tonnes/trip in June, and the average value of fishing season index (FSI) was 118.32. During Transition Season II, the average fishing productivity was 0.94 tonnes/trip. The highest fishing productivity was in October of 1.02 tonnes/trip and the lowest was in September of 0.88 tonnes/trip. The average value of fishing season index (FSI) was 87.45 (Table 2).

Table 2. Fishing productivity and FSI of skipjack in the waters of Bacan Island, South Halmahera Regency, 2006-2015

Season	Month	Productivity Average (tonnes/trip)	FSI Average
Westerly Wind	December	0.92	87.59
	January	1.08	103.43
	February	1.15	106.48
	Total	3.14	297.50
Transition I	Average	1.05	99.17
	March	0.91	85.62
	April	1.19	112.02
	May	0.95	89.88
Easterly Wind	Total	3.05	287.53
	Average	1.02	95.84
	June	0.95	108.73
	July	1.12	135.71
Transition II	August	1.26	110.52
	Total	3.32	354.96
	Average	1.11	118.32
	September	0.88	82.79
Transition II	October	1.02	95.38
	November	0.94	84.19
	Total	2.83	262.36
	Average	0.94	87.45

Based on the average values of skipjack fishing productivity, it can be concluded that the highest fishing productivity occurred during Easterly Winds Season followed by during Westerly Winds Season, and then Transition I and II. If related to the value of fishing season index (FSI) as the indicator of skipjack fishing season, then skipjack season in the waters of Bacan Island, South Halmahera Regency occurred during Easterly Winds Season (June, July, and August) and the peak of season was in July (Figure 4).

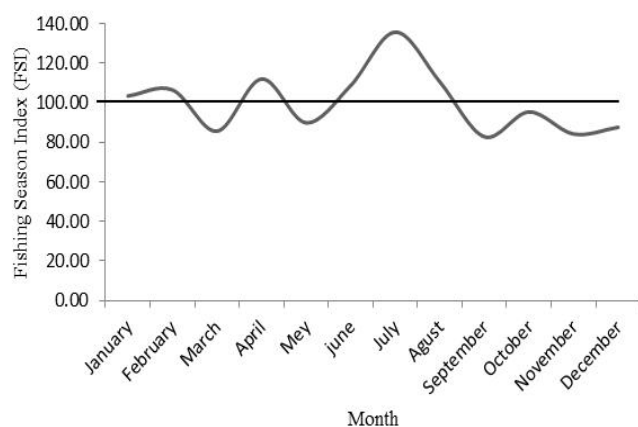


Figure 4. Skipjack fishing season index (IMP) in the waters of Bacan Island, South Halmahera Regency

DISCUSSION

Production value of skipjack caught in the waters of Bacan Island, South Halmahera Regency increased (Figure 2), similarly, the trend of pole and line fishing trip productivity (ton/trip) tended to increase in 2013 and then went down in 2014 (Figure 3). Even though the productivity increased, the fishing trip productivity (ton/trip) tended to decrease. Therefore, increasing the number of unit in a fishing fleet would not affect further in increasing the catch production. The decline of pole and line fishing trip productivity (tonnes/trip) might be due to the fishing location being focused only at FADs in the waters of Bacan Island, South Halmahera Regency, and due to the effect of environmental conditions (sea surface temperature, chlorophyll-a, salinity, weather, and winds) on the resources population and community. Pelagic fish stocks are very sensitive to the environmental change, especially spatial distribution of salinity developed by monsoon winds; furthermore according to Boely *et al.* (1990), oceanographic conditions have a significant effect on the change of CPUE (catch per unit effort), while winds and rain affect directly on fishing activity and catches. This indicates that skipjack fishing rate is already high. This phenomenon is a typical consequence of utilizing open access resources. Therefore, it is necessary to immediately apply a proper management, for example, in a way of do not increase the unit number of pole and line fleets so the utilization of skipjack resource will be sustainable and guaranteed its sustainability. Fishing season is a certain period of time whether there are catches or not during the fishing activity. Fishing season is highly related to fishing activity; therefore the season can affect the total catches. This is similar to the findings of (Yunrong *et al.*, 2013; Li and Sun, 2011), in Beibu Bay, South China Sea that the change of season to fish and the observed distribution and also the biomass were varied considerably and affected the total catches. The fishermen of pole and line based at PPP Panamboang, South Halmahera Regency do skipjack fishing operation throughout the year, however certain phenomenon and condition of the nature lead to high variation of total catches among seasons. During fishing season skipjack abundance is assumed to be high, while during no fishing season the abundance is predicted to be low. Fishing season is related to fish abundance; however not only abundance, oceanographic and weather conditions also affect the total catches. Laevastu and Hela (1970), stated that there were many factors affecting migration and availability of skipjack in a certain place of sea, such as sea surface temperature and biological productivity. Distribution of pelagic fishes like skipjack can be predicted using known optimum temperature and monthly sea surface temperature variations. Based on the value of fishing season index (IMP), skipjack season in the waters of Bacan Island, South Halmahera Regency occurred during Easterly Winds Season (June, July, and August) and peaked in July. This is similar to study by Kekenusa *et al.* (2012), skipjack in the waters of Bitung, North Sulawesi could be caught throughout the year. Season to fish was in January-April, June, July, and September, while season not to fish was in May, August, and October-December. Furthermore Uktolseja (1997), stated that season to catch skipjack in the waters off Bitung can be categorized in four season, i.e. (1) Fishing Season I (April-June) peaked in June; (2) Fishing Season II (September-November) peaked in November; (3) Not Fishing Season I (July-May) reached the lowest in May; and (4) Not Fishing Season II (December to March) with the lowest in January.

According to Rounsefell (1975), the reason of fish monthly/seasonally fluctuation are the availability of fish, number of fishing effort, and success rate of fishing operations. Fish responses on season, to name a few are of moving toward or away from the fishing ground, easy/difficult to catch, disperse, in school, and subjected to composition change. The yield is affected by the number and efficiency of fishing gear, fishing duration, and the availability of target fish besides its abundance. The cause of high skipjack catches occurred on Easterly Winds Season is suspected to be due to upwelling which leads the waters become fertile with plenty of food. With this upwelling, nutrients increase resulted in plankton concentration is also high, so small fishes as the diet of skipjack is abundant and therefore there are plenty of skipjack found in the area. Furthermore Karman (2015), stated that the migration of skipjack into the waters of Bacan Island, South Halmahera Regency from May to July might be related to an increase of chlorophyll-a, which started at 0.135 mg/m³ in May and increased to 0.278 mg/m³ in June and 0.333 mg/m³ in July. According to Polovina *et al.* (2001), chlorophyll-a is a factor that could provide direct indication the availability of fish and also migration area of tuna including skipjack. Furthermore Nontji (1987), pointed out that chlorophyll-a concentration can also be used as a measure of phytoplankton abundance in a waters area and can be used as an indicator of aquatic productivity. High fishing season index of skipjack from June to August is similar to Wyrcki (1961) suggestion, that from August current circulation in Indian Ocean marked by the converging of counter current with equatorial current producing monsoon current and flows toward Indian Ocean. Low fishing index in September (Table 2, Figure 4) is probably due to the occurrence of transition season from easterly winds season to westerly winds season, where the winds did not affect anymore on surface currents which resulting in no flowing water mass into waters around Bacan Island, as a result there was no nutrient enhancement. According to Wyrcki (1961), the main south equatorial current during easterly winds season lies at latitude of 6°S. This condition allowed the occurrence of skipjack schools. One way to manage fishing effort for continuity can be done by regulating fishing period based on time series data of monthly CPUE. Fishing period can be determined by looking at the months with fishing season index of moderate to high, while during very low catch season an appropriate management need to done for the continuity of fishing effort. Nikijuluw (2002), suggested that a management based on fishing season generally has been implemented in developed countries using catch production based on a season that on certain months the catches were abundant or on the contrary, even though fishing were operated in the same location. To achieve the sustainable fisheries, the fishing regime needs to be altered immediately form open access regime to responsible fisheries according to Code of Conduct of Responsible Fisheries. Furthermore Nontji (1987), suggested that closing fishing season can be implemented in a longer period of time if fish population in critical condition due to overfished.

Conclusion

The trend of skipjack catch production in the waters of Bacan Island, South Halmahera Regency for 10 years (2006-2015) increases, while the trend of fishing trip productivity (tonens per trip) decreases in 2014. Skipjack season in the waters of Bacan Island, South Halmahera Regency is during Easterly Winds Season (June, July, August) and the peak of the season

is in July due to the increasing tendency of the waters biological productivity.

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