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(RESEARCH ARTICLE)

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Composition of catch results according to moon phase on purse seine vessels in Belawan waters, North Sumatera, Indonesia

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Abstract

Purse seine is one of the dominant fishing gears in the waters of Belawan, North Sumatra, Indonesia. Fishing activities can run well if fishermen know the factors that influence fishing success. The lunar day period can indicate a good time for fishing operations because there are changes in light intensity during each lunar day period and will affect fish that have positive or negative phototactic properties towards light. Differences in intensity will affect the volume of catch when fishermen operate. Research activities will be carried out from November 2022 to March 2023, taking part in fishing operations with purse seiners in Belawan, North Sumatra. This research aims to determine the composition and quantity of catches, determine the factors causing the diversity of catches in the lunar day period, and determine the amount of catch production in the lunar day period. The composition of the catch according to the moon phase is dominated by the new moon at 5,900 kg (40%), the first semi-bright moon phase (quadrant I) 4,215 kg (30%), the second semi-bright moon (quadrant II) 3,250 kg (17%), and at Full Moon Phase 3,465 Kg (13%). In the New Moon Phase period, it is a lunar phase that is very effective for the fishing process, because the catch obtained is the largest catch compared to other lunar phases, whereas in the Bright Moon Phase the catch is not very effective because the catch is less than optimal, which affects selling value. The lunar day period factor will indirectly impact the availability of fish resources, so fishermen need to know changes to the lunar day period system.

Keywords: Moon phase; Purse seine; Lunar day period; Pelagic fish

1. Introduction

Belawan Waters is the largest port in the western part of Indonesia and is also one of the main ports in Indonesia [1]. Belawan PPS is one of the areas producing marine capture fisheries production which plays an important role in capture fisheries activities and marketing in North Sumatra province [2]. The Belawan Ocean Fishing Port is in a quite strategic position, namely located between the waters of the east coast of Sumatra (Malacca Strait). The waters of the Indonesian Exclusive Economic Zone (ZEEI) and the South China Sea [3].

Purse seine is one of the dominant fishing gears in Belawan waters [4]. Fishing activities can run well if fishermen know the factors that influence fishing success. The fishing gear used should be adapted to fishing ground and the type of fish that is the main catch target. Apart from the suitability of fishing gear, fish resources also greatly influence the catch obtained. The lunar day period factor will indirectly impact the availability of fish resources, so fishermen need to know changes to the lunar day period system [5].

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The purse seine is a fishing tool whose main part is a net whose target catch is pelagic fish. Many factors influence the amount of catch and one of them is the Moon Phases. Changes in the moon phases can identify best times for fishing operations [6]. The lunar day period can indicate a good time for fishing operations because there are changes in light intensity during each lunar day period and will affect fish that have positive or negative phototactic properties towards light [7]. Differences in intensity will affect the volume of catch when fishermen operate. Efficient, optimal and sustainable use of marine fisheries resources is an important thing to pay attention to in order to improve the welfare of fishermen, especially the volume of catches and income received [5]. If fishing can be achieved optimally, then the catch obtained will become one of the calculation parameters in the fishermen's income level [8].

2. Material and methods

This research was carried out from November 2022 to March 2023, following catch operations purse seine in Belawan, North Sumatra. The tools and materials used in the research are maps, calendars, stationery, cameras and scales.

Figure 1 Ships used during research

2.1. Method of collecting data

The data collection method used is a survey method by directly following fishing operations. The types of data used in this research are primary data and secondary data. The primary data used are catches taken daily, then grouped based on the period of lunar days during one lunar cycle, namely: new moon phase, 1st quadrant lunar phase (first crescent), phase *full moon*, and the moon phase quadrant 2 (last crescent).

2.2. Data Analysis Methods

In this research, the author uses several discussion methods, namely descriptive which describes the fishing process and the composition of the catch which is connected to fishing operation patterns related to lunar day periods, accompanied by tables and diagrams, then quantitative analysis is also used to determine income and profits. obtained by fishermen from fishing activities.

2.3. Method of Analysis of Composition and Quantity of Catch

The catch *purse its* classified according to type and then weighed. The catches are grouped in a catch table according to the phases of the moon, then presented in diagram form. With simple calculations According to [8] Effendie (2002), to calculate the number and percentage of fish catches during fishing operations *purse its* calculated by the formula:

$$Y = \frac{a}{b} \times 100\%$$

Information:
Y = Percentage composition of fish caught
a = Weight of Catch (tons)
b = Total weight of catch (tons)

3. Results and discussion

3.1. The period of the moon's appearance

According to [10], Changes in the conditions of the lunar day period are divided into four phases. New or dark moon phase (New Moon), quadrant I moon phase (first crescent), full moon phase, and quadrant 2 moon phase (last crescent). The period of change in lunar conditions occurs on average every seven days [11]. This division is based on the time or period of the appearance of the moon. The bright moon condition occurs when the moon appears for more than 8 hours in one day, while the semi-bright moon occurs when the moon appears between 4 hours to 7.5 hours and the dark moon period occurs when the moon appears only between 0 hours to 3.5 hours [12]. During the research, the intensity of moonlight was different every day due to a shift in the appearance of the moon during one month due to the movement of the moon's rotation and revolution regarding the earth [13].

3.2. Composition of Catch

The fish that are the target of catching are fish that are in schools. During the research, the fish caught included: *Rastrelliger brachysoma, Auxis thazard, Decapterus ruselli, Selar crumenophthalmus, Scomberomorus commerson, Selaroides leptolepis, dan Loligo* Sp. As can be seen in figure 2 below.

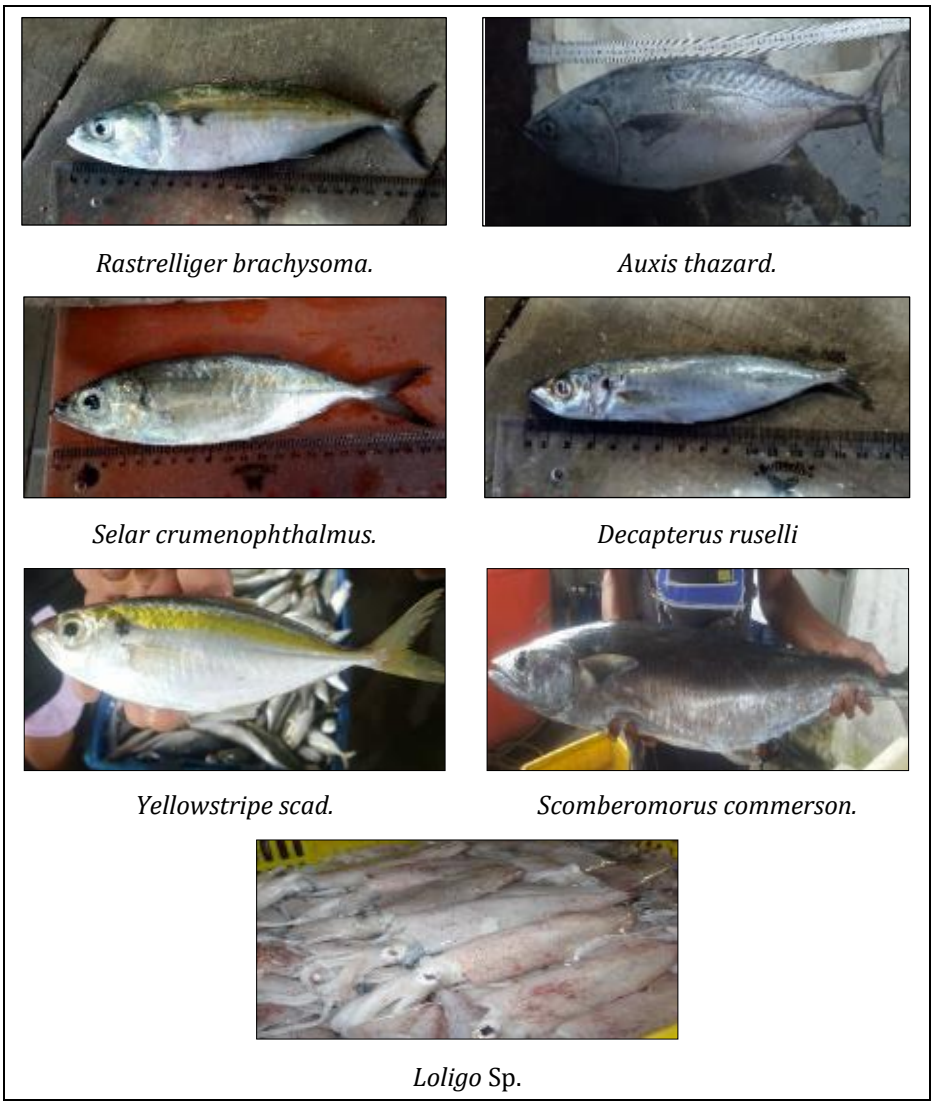

Figure 2 Types of fish caught during research

3.3. Catch Results According to Moon Phases

Changes in the conditions of the lunar day period greatly influence catch results. The intensity of the moon's light is very different every day due to a shift in the appearance of the moon due to the movement of the moon's rotation and revolution towards the earth. Calculation of lunar days is carried out from the dark of the month until the beginning of the dark period of the following month, during this time interval several changes occur from dark to light. Changes in lunar conditions are divided into four phases. These include the New moon phase, quadrant 1 lunar phase (first crescent), Full moon phase, and quadrant II phase (last crescent) [14].

The main catch is from November 2022 to March 2023 with the total catch according to Moon Phase reaching 16,430 Kg. The high percentage of weight of the pelagic catch is influenced by light aids which results in the majority of pelagic type fish having Positive Phototaxis being caught more often. The following is catch data according to Moon Phase:

Table 1 Total main catch according to Moon Phase

Species	New Moon phase (Kg)	moon phase quadrant 1 (first crescent) (Kg)	moon phase quadrant 2 (last crescent) (Kg)	Full Moon phase (Kg)	Total (Kg)
Auxis thazard	1,760	1,200	700	780	4,440
S. crumenophthalmus	800	520	820	475	2,260
R. brachysoma	950	800	400	550	2,700
D. ruselli	870	450	320	360	2,000
S. leptolepis	650	400	500	530	2,080
S.commerson	550	600	300	450	1,900
Loligo Sp.	320	245	210	275	1,050
Total catch	5,900	4,215	3,250	3,465	16,430

Or can be seen in the following picture 3:

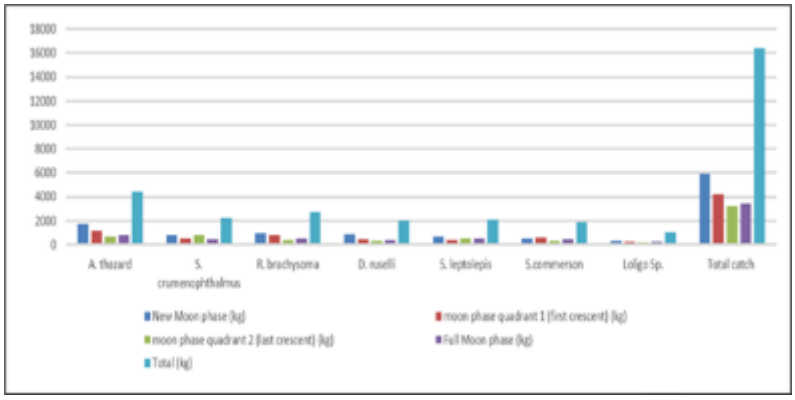

Figure 3 Graph of total catch according to moon phase

Based on figure 3 above, the number of catches obtained during the moon phases, namely *A. thazard*, *S. crumenophthalmus*, *R. brachysoma, D. ruselli, S. leptolepis, S. commerson* and *Loligo* Sp.. The highest catch is *Auxis thazard* reaching 4,440 Kg with the largest catch being in the New Moon Phase, namely 1,760 Kg.

3.4. Comparison of the composition of the diversity of catches according to the moon phase

Based on observations, the largest catch consisted of 6 types of pelagic fish and 1 type of demersal fish. The pelagic fish caught are fish *A. thazard, R. brachysoma, S. crumenophthalmus, S. commerson, D. ruselli*, *S. leptolepis*, while demersal fish *Loligo* Sp.

Based on observations according to lunar phases, the New Moon is the largest catch with an average of 40%. Furthermore, in the semi-bright moon phase 1 the average reaches 30%, in the semi-bright moon phase 2 the average reaches 17% and in the full moon phase only 13% of the catch is obtained. The diversity of types of catch during the New Moon and in the Bright Spring Moon Phase 1 is not much different, only 10% of the catch obtained. Meanwhile, in the semi-bright moon phase 2 and in the full moon phase, it can be seen that there are only a few catches. The following is a graph comparing the composition of catch diversity according to lunar phases.

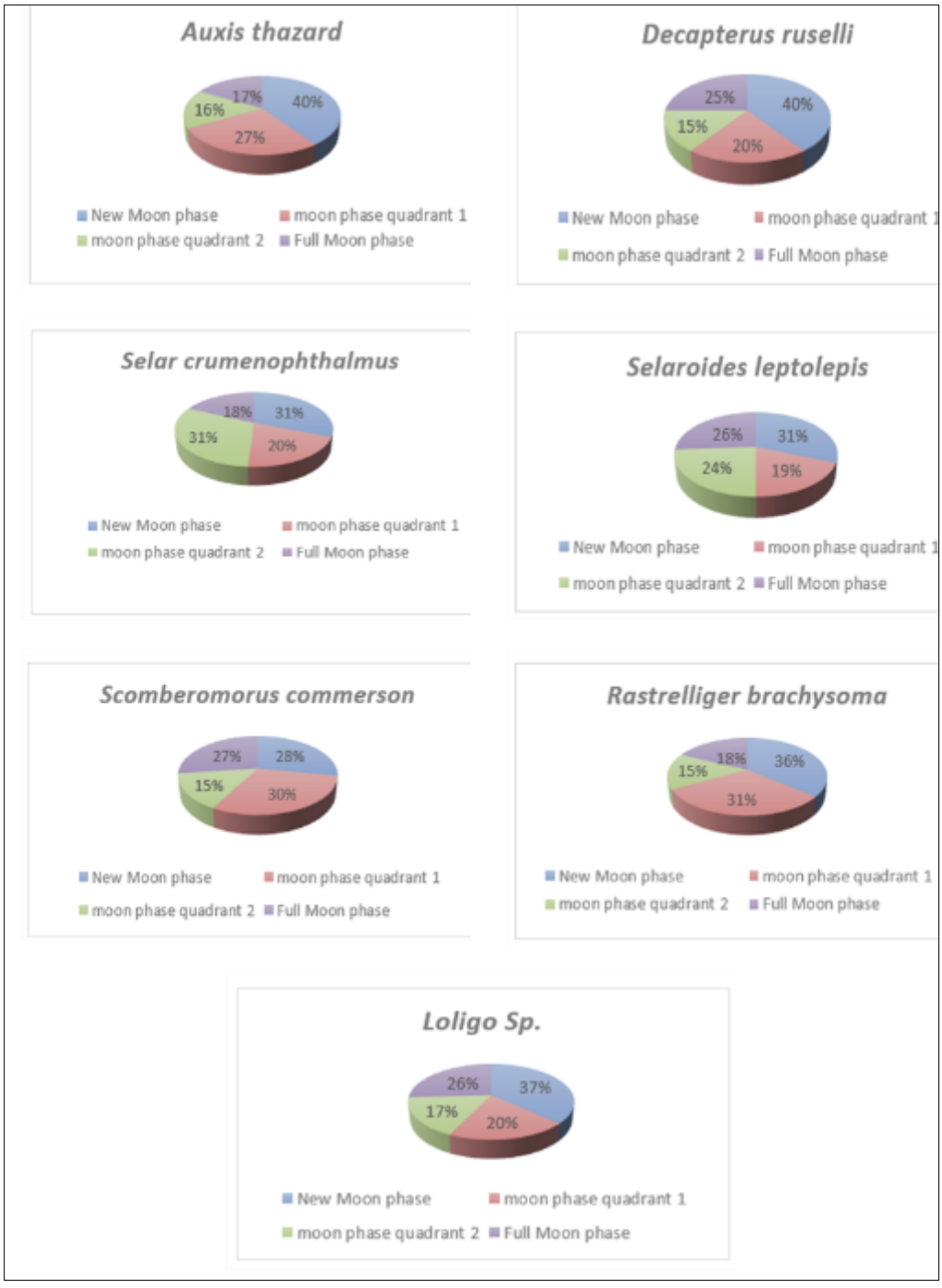

Figure 4 Comparison diagram of the number of catches according to lunar phases

This difference in diversity can be because when the moon is bright there are very high high tides and very low low tides, as a result the moon's gravity pulls sea water more strongly than the earth, so that sea water swells and results in less effective fishing activities due to less than perfect refraction of light. The relative position of the moon to the earth

influences the ebb and flow of sea levels and natural lighting from the sea which results in natural dynamics in the behavior of marine animals so that the diversity of caught species is influenced by the lunar period [15].

3.5. Type of Catch

The influence of catch results is due to the structure of the retina of the fish eye which contains receptors and the sense of sight, which varies greatly for each type of fish and influences the fish's response to light intensity. The influence of the lunar day period is because pelagic fish are classified as marine animals that are positively phototactic and are attracted to light with an intensity of 10-100 lux [16]. Seven of the six main catch fish are pelagic fish which are very influential on light.

3.5.1. Auxis thazard

A. thazard This is the largest catch compared to other fish, namely around 4,440 kg. The highest catch was in the New Moon phase around 1,760 kg, and in the first semi-bright moon phase (quadrant I) with a total of 1,200 kg. while in the second semi-bright Moon Phase (Quadrant II) the catch is not much different from the Full Moon Phase, around 700 kg. Based on the average obtained, during the new moon phase, the catch is very dominant compared to the semi-bright moon phase II (quadrant II) and the Full Moon Phase.

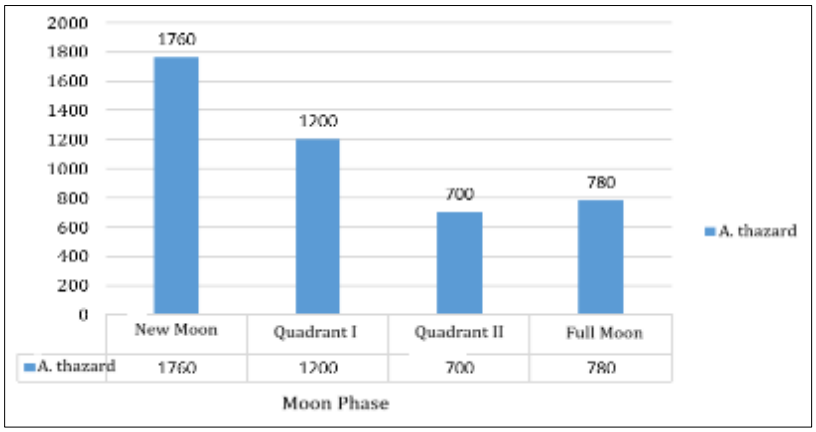

Figure 5 Graph of Catch Results *Auxis thazard*

3.5.2. Selar crumenophthalmus

Based on the catches obtained, *S. crumenophthalmus* is the third largest catch with a total catch of around 2,260 kg. The highest catch was in the second bright semi-moon phase (Quadrant II) with a catch of around 820 kg, while for the new moon phase it was around 800 kg. for Semi Terang II (Quadrant I) it got third place with a total catch of around 520 kg at Full Moon you get the lowest yield of around 475 Kg.

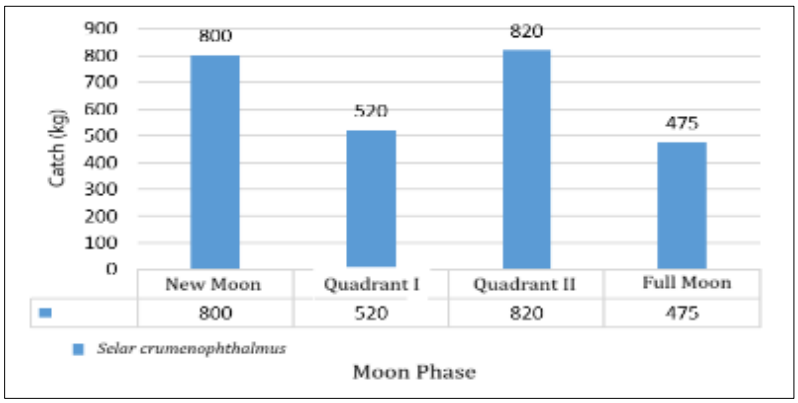

Figure 6 Catch results graph *Selar crumenophthalmus*

3.5.3. Rastrelliger brachysoma

R. brachysoma tend to swim close to the surface of the water at night and during the day descend to deeper layers. This vertical movement is influenced by the daily movement of plankton and changes in temperature, hydrographic factors and salinity [16]. When observing catches, *R. brachysoma* obtained the second highest catch weight after *A. thazard* with a total of 2,700 Kg. According to the moon phase, the new moon is the biggest catch compared to other moon phases, around 950 kg. in the first bright spring moon phase (Quadrant I) the fish catch is around 800 kg. Meanwhile, in the Full Moon phase, the fish caught is around 550 kg. in the semi-bright Moon Phase II (Quadrant II) the catch is the lowest compared to other moon phases, namely around 400 kg.

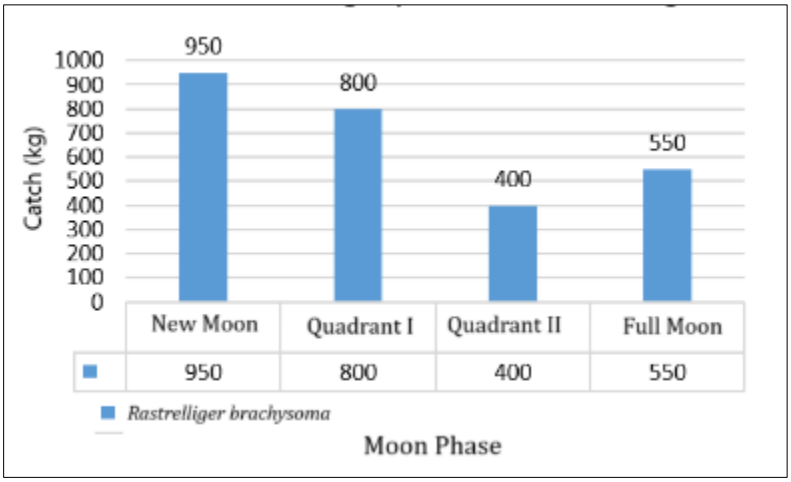

Figure 7 Graph of Catch Results *Rastrelliger brachysoma*

3.5.4. Decapterus ruselli

Based on the graph above the catch results *D. ruselli* Overall the moon phase is around 2,000 Kg. The highest moon phase was in the New Moon Phase with a catch of around 870 kg, while in the first bright moon phase (quadrant I) it was in second place with a catch of around 450 kg. in the semi-bright moon phase II (quadrant II) and in the full moon phase the catch is not much different, around 300 kg.

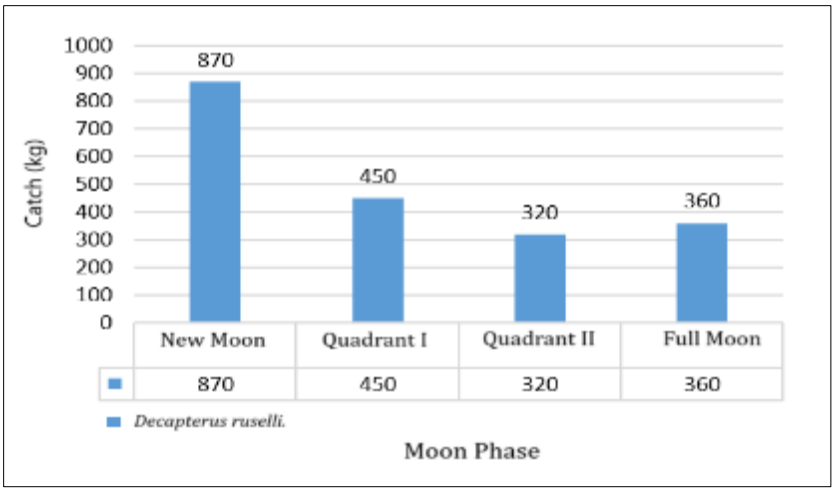

Figure 8 Catch graph *Decapterus ruselli*

3.5.5. Selaroides leptolepis

Selaroides leptolepis Based on the graph above, the catch weight is around 2,080 kg. The highest catch was in the New Moon phase with a catch weight of around 650 kg. At Full Moon the catch is around 530 kg. while in the second semi-bright Moon phase (quadrant II) the catch is around 500 kg. The lowest moon phase is in the first semi-bright moon phase (quadrant I) with a catch weight of around 400 kg.

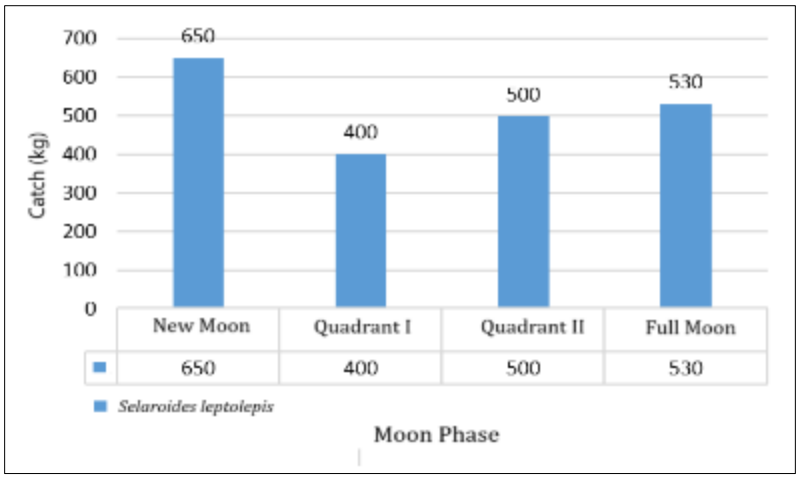

Figure 9 Graph of Catch Results *Selaroides leptolepis*

3.5.6. Scomberomorus commerson

S. commerson Based on the graph above, the total weight of the catch is around 1900 kg. The influence of the highest lunar day period was in the First Bright Semi-Moon Phase (Quadrant I) with a total catch of around 600 kg. in the New Moon Phase the catch is around 550 kg. while in the Full Moon Phase the total catch is around 450 Kg, while the lowest amount of catch in the second Bright Semi Moon Phase (Quadrant II) is around 300 Kg.

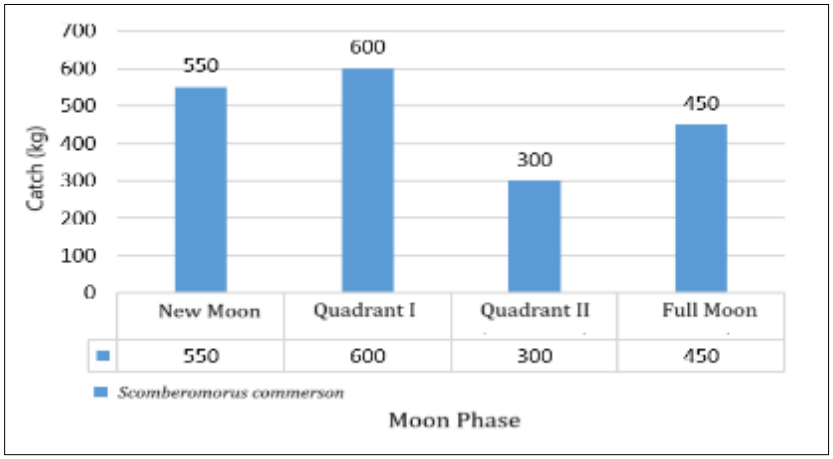

Figure 10 Graph of Catch Results *Scomberomorus commerson*

3.5.7. Loligo Sp.

Loligo Sp. is the lowest catch according to the catch in the moon phase with a total catch of around 1,050 kg. New Moon is the highest catch according to the moon phase with a total catch of around 320 kg. At Full Moon the total catch was around 275 kg. while in the first bright spring moon phase (quadrant I) the total catch is around 245 kg. in the second Bright Spring Moon Phase (Quadrant II) the catch was the lowest with a total catch of around 210 kg.

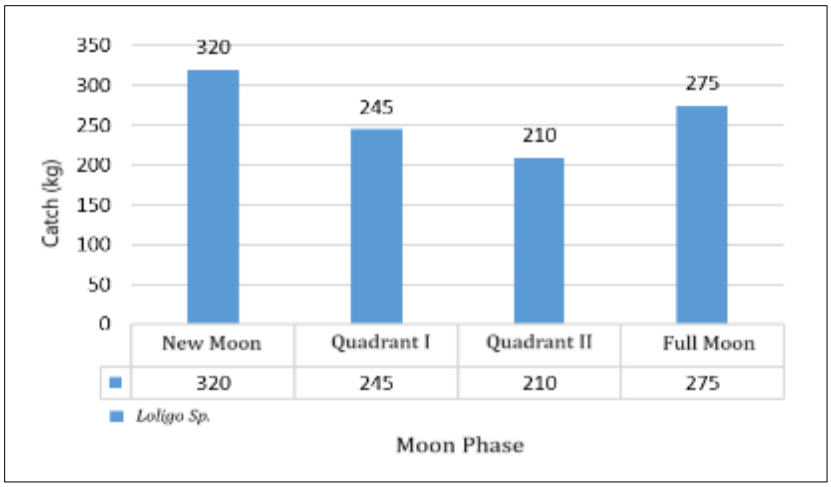

Figure 11 Graph of Catch Results *Loligo* Sp

Based on research, the main catch of the six main caught fish species has a very significant catch on the influence of the lunar day period. In New Moon conditions, the number of main catches is very high compared to several other lunar phases. The number of catches in the New Moon Phase is very different from the Full Moon and Semi-Bright Moon Phases. One of the reasons for the difference in catches in bright conditions is that the moonlight spreads widely over the waters, this is confirmed by data on the appearance of the moon during the brightest months, which reaches 8 to 12 hours per day.

Apart from that, full moon conditions also cause high tides. Tides that occur during a full moon are usually called full moon tides, where during full moon tides, sea water rises to an optimum height compared to the days before and after the full moon. Tidal conditions are also thought to influence catch results [11]. This situation is influenced by water conditions, where the waters after full moon (semi-clear and full moon) are still influenced by high tidal phenomena so that fish are more distributed on the surface. This greatly influences the behavior of fish in searching for food and the behavior of fish in the area.

The influence of lunar periods and the use of light aids on purse seine fishing gear causes fish to adapt to various light intensities. This causes the lunar period to influence pelagic fish catches. Stimulation during the fishing process has a very significant influence, especially the intensity of the surrounding light. The level of adaptation of fish to light such as *R. brachysoma, D. ruselli* will fully adapt to light after midnight, but before midnight it has not fully adapted to light [18].

3.6. Method of Analysis of Composition and Quantity of Catch

The catch *purse its* classified according to type and then weighed. The catches are grouped in a catch table according to the phases of the moon, then presented in diagram form. With simple calculations According to [19], to calculate the number and percentage of fish caught during fishing operations *purse its* calculated by the formula:

$$\mathbf{Y = \frac{a}{b} x\ 100\%}$$

Information:
Y = Percentage composition of fish caught
a = Weight of Catch (tons)
b = Total weight of catch (tons)

3.6.1. New Moon Phase

Based on the catch graph below according to the new Moon phase period, the highest catch percentage is *A. thazard* by 30%, next *R. brachysoma* 16%, *D. ruselli* 15%, *S. crumenophthalmus* 14%, *Selaroides leptolepis* 11%, and *S. commerson* 9%. The lowest catch is *Loligo* Sp. around 5%.

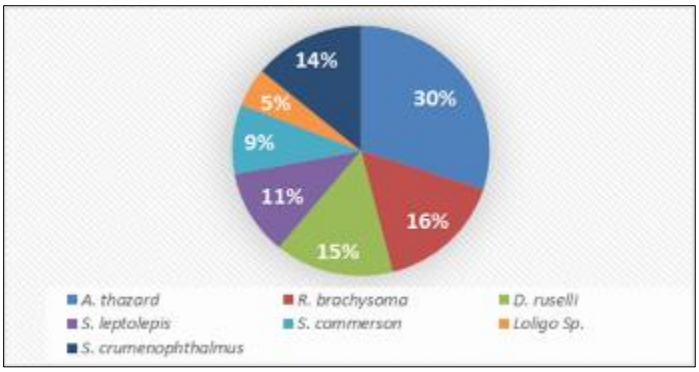

Figure 12 Diagram of Catch Composition According to New Moon Phase

3.6.2. Quadrant I moon phases

The composition of the catch according to the lunar phase Quadrant I, the highest percentage of catch is *A. thazard* namely 28%, next *R. brachysoma* 19%, *S. commerson* 14%, *S. crumenophthalmus* 12%, *D. ruselli* 11%, *S. leptolepis* about 10%, and *Loligo* Sp. around 6%. As seen in the following graph.

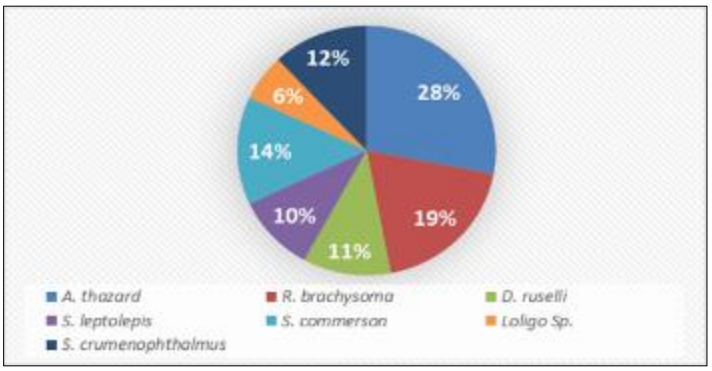

Figure 13 Composition diagram of catch according to moon phase, Quadrant I

3.6.3. Lunar phase quadrant II

Based on the diagram below, the composition of the catch according to the lunar phase in quadrant II, the highest percentage of catch is dominated by *S. crumenophthalmus* by 25%, next *A. thazard* 22%, *S. leptolepis* 15%, *R. brachysoma* 12%, *D. ruselli* 10%, *S. commerson* 9%, and *Loligo* Sp. 7% is the lowest catch.

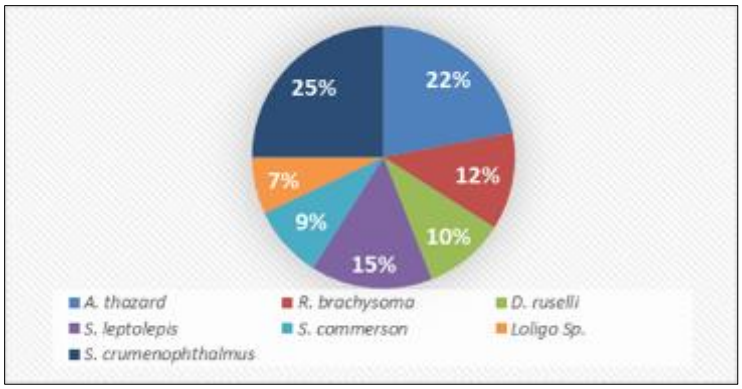

Figure 14 Diagram of Catch Composition According to Moon Phase Quadrant II

3.6.4. Fase full Moon

Based on the catch diagram below according to the full Moon phase, the highest catch percentage is *A. thazard* with 23%, *R. brachysoma* 16%, *S. leptolepis* 15%, *S. crumenophthalmus* 14%, *S. commerson* 13%, *D. ruselli* 11%, and the lowest catch viz *Loligo* Sp. by 8%.

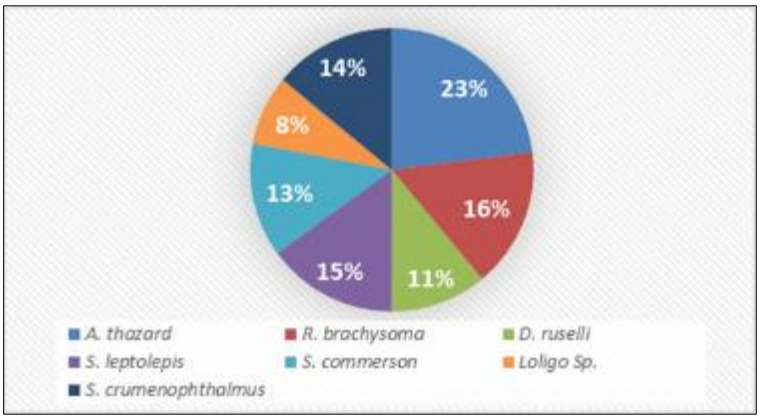

Figure 15 Composition diagram of catches according to full moon phase.

Auxis thazard was the largest catch of around 4,440 kg. During the New Moon the largest catch was around 1,760 kg and during the First Bright Moon Phase the catch was around 1,200 kg.

Selar crumenophthalmus in the Second Bright Spring Moon (Quadrant II) the highest catch is around 820 Kg, while in the New Moon Phase the catch is around 800 Kg.

Rastrelliger brachysoma on the New Moon the highest catch is around 950 Kg, while on the First Bright Moon (Quadrant I) the catch is around 800 Kg.

Decapterus ruselli in the New Moon the highest catch is around 870 Kg, while in the First Bright Spring Moon (Quadrant I) the catch is around 450 Kg.

Scomberomorus commerson in the First Spring (Quadrant I) with the highest catch of around 600 Kg, while in the New Moon Phase the catch is around 550 Kg.

Loligo pealii in the New Moon Phase the highest catch was around 320 Kg, while in the Full Moon Phase the catch was around 275 Kg.

4. Conclusion

Based on research on catches obtained according to Moon Phases, *A. thazard* is the most dominant catch caught around 30%, *D. ruselli* about 15%, *R. brachysoma* about 16%, *S. crumenophthalmus* around 14%, *S. leptolepis* about 11%, *S. commerson* about 9% and *Loligo* Sp. only 5%. According to the lunar phase period, the new moon is the largest catch with an average of 40%. Furthermore, in the first semi-bright moon phase (Quadrant I) the average reached 30%, in the second semi-bright moon phase (quadrant II) the average reached 17% and in the full moon phase only 13% of the catch was obtained. The diversity of catches on the new moon and in the bright half moon phase 1 (Quadrant I) is not much different, only 10% of the catch obtained, whereas in the bright half moon phase 2 and in the full moon phase it can be seen that the catch obtained is only a little.

The results of data analysis using the Pearson correlation test show that there is a relationship between usage time and breaking strength and changes in mesh size with the Sig value. equal to 0.000 < 0.05. The correlation coefficient value between usage time and breaking strength is 0.977 with the relationship level being very strong and negative or unidirectional. The relationship between usage time and mesh size obtained a correlation coefficient of 0.985 with a very strong level of relationship and is positive or in the same direction.

Based on the research results, the suggestion in this research is that the scientific information in this research can be used as a reference in improving maintenance in the form of avoiding net exposure to direct sunlight and should be able to determine repair times and replacement of fishing gear efficiently.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

No conflict of interest to be disclose.

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