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The Effect of Moon Phases on Gill Net Fishing Results in Penampi and Kelebuk Villages of Bengkalis Regency

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ABSTRACT

This study aims to examine the differences in gill net catch results with the lunar phase in Penampi Village and Kelebuk Village, Bengkalis Regency. Data were collected from January 5 to April 5, 2024, involving 15 fishermen (eight from Penampi Village and seven from Kelebuk Village). Global Positioning System (GPS) technology was used to record the route of the boats, the number of catches (tails), and the total weight (kg) during fishing activities. Statistical analysis using an independent t-test was conducted to evaluate the effect of the lunar phase on catch results. The study found that the lunar phase did not significantly affect the number of catches (fish). However, catch weight was significantly influenced by the dark lunar phase (173.9 kg) and the semi-dark phase (30.5 kg). This study provides important insights into gill net fishing practices in the region. Fishermen are advised to focus on fishing during the dark moon phase, as this period yields the highest catch weight. During the semi-dark phase, fishermen are advised to consider alternative strategies, such as adjusting fishing locations and times to improve catch outcomes. Additionally, weather and sea conditions should be monitored to support the success of fishing activities.

Keywords: Catchweight variation, Gill net catch, Independent t-test, Moon phases

1. INTRODUCTION

Fishing activities in the waters of the Bengkalis Strait, particularly in Penampi and Kelebuk villages, are the local community's primary livelihood source. With 80 active fishermen contributing 25% of the catch in the area, this sector plays a significant role in supporting the local economy. However, the fishermen's dependence on catch as their sole source of income makes them vulnerable to fluctuations in catch due to seasonal factors, environmental conditions, and increasing living costs. Limited skills outside the fishing sector narrow their opportunities to seek alternative sources of income (Seygita, 2022). Furthermore, the lack of optimization of fish landing sites (FLS) as the primary distribution channel causes most of the catch to be sold directly to collectors, affecting the quality and selling price (Susilawati, 2019). This contributes to the instability of fishermen's income, which averages between Rp 3–4 million per month, posing a significant challenge to improving their well-being (Nugroho et al., 2020).

Gill nets are the primary fishing gear used by fishermen in Penampi and Kelebuk villages, with a mesh size of 2–4 inches and a length of 25.2–57.6 m. Gill nets are generally rectangular with uniform mesh sizes throughout. The mesh size is adjusted according to the type and size of the target fish (Alwi et al., 2020). This gear is known to be effective and selective, capturing only fish of the appropriate size (Surbakti & Basri, 2024). Various factors influence the effectiveness of gill net use, including net dimensions, wave strength, currents, wind speed, net deployment duration, and the material used (Kurniawan et al., 2014). Additionally, a study by Tamimi et al. (2023) indicates that environmental conditions, such as lunar phase and tides, also significantly influence catch outcomes. Selecting the appropriate size and operating the nets correctly are key to successful fishing in both villages.

The lunar phase plays a significant role in fishing activities. As Earth's satellite, the moon has three movements: rotation, revolution, and orbit around the sun. The lunar phase, consisting of half-light, full, half-dark, and dark phases, occurs due to changes in the relative positions of the moon, sun, and Earth (Kahono et al., 2021). These phases influence the intensity of light at night, which in turn affects the behaviour of target fish. Amahoru et al. (2024), marine organisms, including fish, exhibit positive and negative phototaxis, where they respond to light in their environment. Additionally, lunar phases influence tidal conditions, determining the optimal timing for fishing activities (Pangauan et al., 2020).

Although some studies have examined the relationship between lunar phases and catch yields, no comprehensive research has focused on the Bengkalis Strait, particularly in Penampi and Kelebuk villages. Previous research by Taufik et al. (2020) in the Bengkalis Strait showed variations in fish larvae abundance based on dark and light moon phases; however, the focus of the study differed, making the results not directly applicable to the Bengkalis Strait. A better understanding of the influence of the lunar phase on gill net catch results in both villages is crucial for optimizing fishermen's income.

2. RESEARCH METHOD

Time and Place

This study was conducted from January 5 to April 5, 2024, in Penampi Village and Kelebuk Village, Bengkalis District, Bengkalis Regency, Riau Province, Indonesia (Figure 1). Both villages are directly adjacent to the Bengkalis Strait, making fishing the community's main livelihood. Based on village profile data from 2023, there are 66 active fishermen in Penampi Village and 24 in Kelebuk Village. The study area is within the Fisheries Management Area (FMA) 571. The Bengkalis Strait is an estuarine water body influenced by freshwater inflow and possesses diverse fishery resources, particularly demersal fish. Data was collected through direct observation of 96 fishing trips using gill nets, covering four lunar phases: dark, semi-dark, light, and semi-light. This study used three types of Global Positioning System (GPS) receivers to record spatial data on fishing activities: GARMIN GPSmap 62s, Garmin GPSmap 64s, and Garmin eTrex 10. GPS was used to record the position and route of fishing during the study period, which was then analyzed to determine the movement patterns of fishermen in each lunar phase.

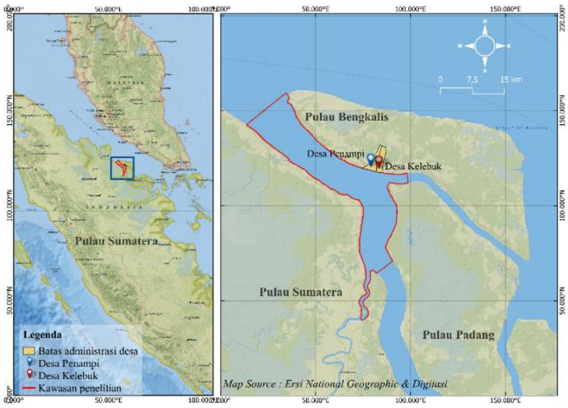

Figure 1. Research location

Method

This study used a survey method involving 15 fishermen, consisting of eight fishermen from Penampi Village and seven fishermen from Kelebuk Village. Fishermen were selected using purposive sampling with the following criteria: (1) active fishermen who operate gill nets, (2) at least five years of experience, and (3) willing to participate during the study period. Primary data collection was conducted through three methods. First, structured interviews with fishermen were undertaken to obtain information about fishing techniques and factors affecting catch results. Second, recording fishing routes using GPS to identify boat movement patterns. Third, recording catch results, including the number of individuals (fish) and weight (kg) for each species of fish caught. The fishing fleet consisted of wooden vessels with a gross tonnage (GT) of 1-5. The main fishing gear was gill nets with the following technical specifications: total length of 126-2,860 meters, net depth of 2-9 m, and mesh size adjusted to the target fish. The variation in gear size considers the vessels' capacity and the characteristics of the fishing grounds in the Bengkalis Strait.

Procedures

Fishing activities were recorded using a GPS operated by fishermen from the beginning to the end of the fishing trip. GPS data recorded five stages of fishing activities according to categorization: journey to the fishing ground, net setting, net soaking, net hauling, and journey back to the fishing base. Catch data collection included species identification, counting the number of individuals (fish), and measuring each fish species' weight (kg). Species identification was done by referring to the FishBase database (www.fishbase.org) to ensure taxonomic identification accuracy. All catch data are tabulated in Microsoft Excel format, including information on the fishing trip, fish species, and catch quantities. The lunar phase is determined by analyzing the fishing activity times recorded on the GPS. Position and lunar phase data are obtained through the MoonCalc platform (www.mooncalc.org), which provides accurate spatial and temporal information on the lunar phase. The moon phase data were then integrated with the catch data for further analysis of the relationship between moon phase and catch productivity.

Data Analysis

Statistical analysis was conducted to test differences in catchment between moon phases using an independent t-test with a significance level (α) of 0.05. This test was chosen because it can compare two independent data groups from different moon phases (Krisanti, 2019). Before the t-test is conducted, the data will undergo Shapiro-Wilk normality and Levene homogeneity tests to ensure that the basic assumptions of parametric statistics are met (Usmadi, 2020). The hypotheses tested in this study are: H_0: $\mu_1 = \mu_2$ (there is no significant difference in catch results between moon phases), H_1: $\mu_1 \neq \mu_2$ (there is a significant difference in catch results between lunar phases), where μ_1 and μ_2 are the average catch results in the compared lunar phases. The decision is based on the p-value compared to the α value (0.05). If the p-value $< \alpha$, then H_0 is rejected, indicating a significant difference in catch results between lunar phases. Conversely, if the p-value $\geq \alpha$, then H_0 is accepted, indicating no significant difference (Nilasari et al., 2016)

3. RESULT AND DISCUSSION

Water Quality

During the study period (January 5 to April 5, 2024), 12 species were caught, consisting of 11 fish species and one crustacean species (Table 1). The dominant pelagic fish group caught by gill nets is *Pampus argenteus*, *Scomberomorus commerson* and *Chirocentrus nudus*. The demersal fish group caught included *Harpadon nehereus* and *Pangasius nasutus*. The Clupeidae family was the most abundant group, consisting of *Ilsha elongata* and *Tenualosa macrura*. Other species seen include *Chonerhinos naritus*, *Hemigaleus microstoma*, and *Farfantepenaeus* sp.

Table 1. Composition of fish caught and landed in Penampi Village and Kelebuk Village, from January 5 to April 5, 2024

No	Scientific Name	Family	Local Name	Number (ind)	Weight (kg)
1	*Pampus argenteus*	*Pleuronectidae*	Bawal	17	0,340
2	*Ilsha elongata*	*Clupeidae*	Biang	10.084	21,530
3	*Chonerhinos naritus*	*Tetraodontidae*	Buntal	79	3,160
4	*Hemigaleus microstoma*	*Carcharhinidae*	Jejo	9	0,523
5	*Harpadon nehereus*	*Dasyatidae*	Lomek	26.664	34,880
6	*Gempylus serpens*	*Gempylidae*	Malong	27	22,317
7	*Chirocentrus nudus*	*Chirocentridae*	Memparang	2	0,651
8	*Pangasius nasutus*	*Pangasiidae*	Patin	1	0,432
9	*Tenualosa macrura*	*Clupeidae*	Pias	18	1,167
10	*I. melastoma*	*Clupeidae*	Puput	20	3,852
11	*Scomberomorus commerson*	*Scombridae*	Tenggiri	506	36,954
12	*Tenualosa macrura*	*Clupeidae*	Terubuk	221	92,928
13	*Farfantepenaeus*	*Penaeidae*	Udang Gogo	8.01	120,644

The results of gill net catches in Penampi and Kelebuk villages during the study period (January 5 to April 5, 2024) showed significant variations in abundance between species (Figure 2). Based on the number of individuals and weight, four dominant species contributed more than 80% of the total catch. *Farfante penaeus* sp. was the most dominant species with 8,010 individuals (45.3% of the total catch) and 120,644 kg (38.7% of the total weight). The dominance of gogo shrimp indicates that this species is the main fishing target in both villages. The second position is occupied by *T. macrura*, which, despite only 221 individuals (1.2%), contributes significantly in terms of weight at 92,928 kg (29.8%). The following dominant species was the *H. nehereus* with 26,664 individuals (15.1%) and a weight of 34,880 kg (11.2%), followed by the *I. elongata* with 10,084 individuals (5.7%) and a weight of 21,530 kg (6.9%). The *S. commerson* showed an interesting pattern with relatively few individuals (506, 2.9%) but significantly contributed to total weight (36,954 kg, 11.8%). The species with the lowest abundance was the *P. argenteus*, with only 17 individuals (0.1%) and a total weight of 0.340 kg (0.1%). Variations in catch results between species in the two villages also provide insights into the fish population dynamics in the waters of the Bengkalis Strait at the two fishing bases. The dominance of *Farfantepenaeus sp*. reflects the availability of suitable habitats, such as shallow muddy waters. Conversely, the decline in the abundance of *P. argenteus* compared to the previous year may indicate overfishing pressure, reducing the natural stock of this species. The selectivity of gill nets as fishing gear also plays an important role, facilitating the capture of species with small to medium body sizes, such as *H. nehereus*. Interestingly, the low number of individual *S. commersoni*, but their significant weight contribution, indicates pelagic characteristics with large bodies and more dispersed distribution.

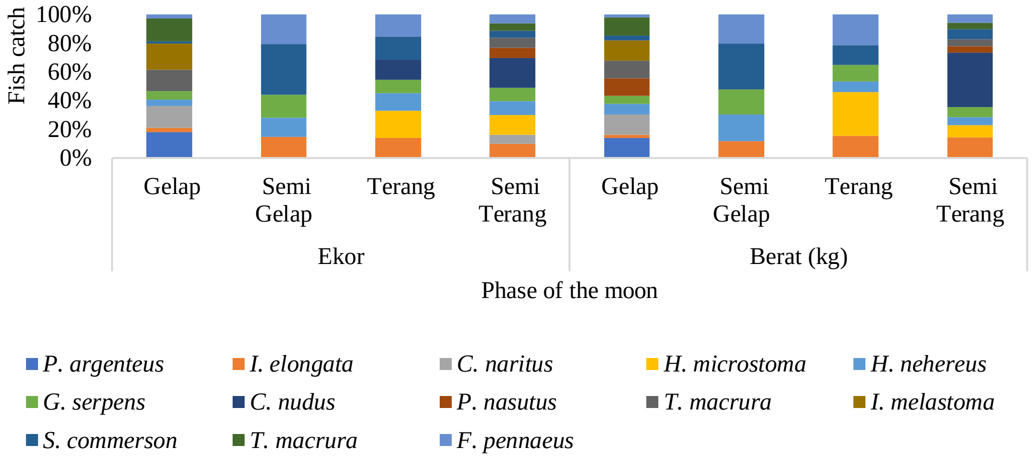

Figure 2. Composition of fish species caught in units of number and weight (kg)

The data show how fish and shrimp species are caught based on the lunar phase. The fish species *P. argenteus* is only seen during the dark phase of the moon, with 100% of the catch occurring during this phase. This indicates that P. argenteus tends to be more active or easier to catch during the dark phase of the moon, which may be related to their feeding or migration behaviour influenced by the dimmer moonlight conditions.

The fish species *I. elongata* shows a more even distribution of catches across different lunar phases. During the bright phase, 49% of the catch occurs, while during the semi-dark and semi-bright phases, 24% and 10%, respectively. This indicates that *I. elongata* has fairly consistent activity across different lunar phases, which may suggest that this fish species is not significantly influenced by changes in moonlight in terms of feeding or movement. Some fish species, such as *C. naritus* and *I. melastoma*, were only caught during certain lunar phases, with *C. naritus* being more dominant during the dark phase (85%) and less during the semi-light phase (15%). Meanwhile, I. melastoma was only caught during the dark moon phase (100%). This may indicate that these two fish species have more specific behavioural patterns toward certain moon phases, such as feeding patterns influenced by lunar conditions. In contrast, fish species like *S. commersoni* and *F. pennaeus* showed more dispersed catch results across various moon phases, with significant catch proportions during the bright and semi-bright phases.

Fishing activities in the Bengkalis Strait were conducted using a one-day fishing pattern during four lunar phases. Each lunar phase (dark, semi-dark, bright, and semi-bright) lasted for ±7.4 days with an appearance duration of 0-12.5 hours. Although fishermen generally operate during one lunar phase, fishing activities sometimes occur between two phases, with the dominant phase used as a reference for data grouping. Based on an analysis of 96 fishing trips recorded using GPS, there were 33 trips during the dark phase, 11 during the semi-dark phase, 36 during the bright phase, and 16 during the semi-bright phase. Spatial data in latitude and longitude coordinates show the distribution pattern of fishing activities (Figure 3). Fishing activities are concentrated in three main areas: Bengkalis Island, Sumatra Island, and Padang Island. This distribution pattern reveals potential zones frequently utilized by fishermen, particularly in the central part of the Strait and around river mouths. The selection of these locations is influenced by several factors, such as water depth, current strength, accessibility, and considerations regarding maritime transport routes to avoid spatial conflicts with passing vessels.

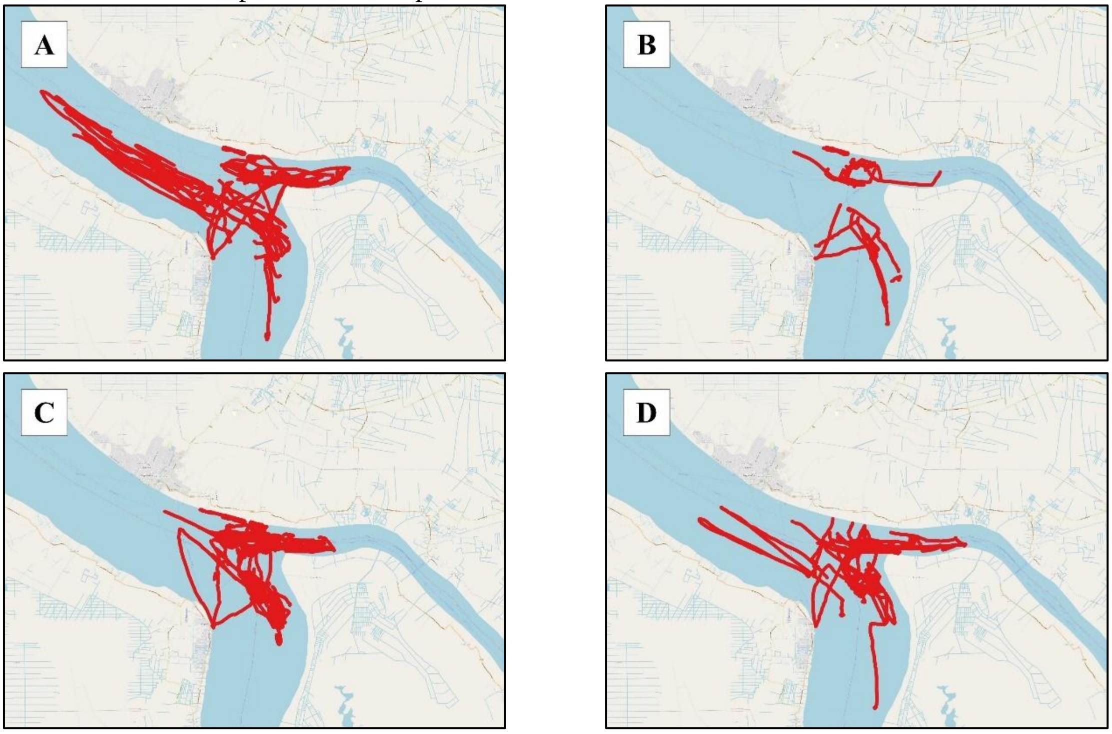

Figure 3. Map of the fishing area (A. Dark moon phase, B. Semi-dark moon phase, C. Full moon phase, D. Semi-bright moon phase)

The results of the t-independent test to compare catch results between lunar phases showed different patterns between calculations based on the number of individuals (fish) and weight (kg) (Table 2). The lunar phase test was conducted six times based on four lunar phases, and data on fish and weight (kg) were collected. The results of the lunar phase test and catch results in tails are as follows: dark and semi-dark phase with Tcalculated -0.32 and Ttable 1.68, dark and light phase with Tcalculated -2.23 and Ttable 1.68, dark and semi-light phase with Tcalculated -3.56 and Ttable 1.68, semi-dark and light phase with Tcalculated 0.04 and Ttable 1.68, semi-dark and semi-light phase with values of Thitung -2.47 and Ttabel 1.71, followed by the light and semi-light phase with values of Thitung -0.20 and Ttabel 1.68. Meanwhile, the results of the moon phase testing and the catch results in weight units (kg) are as follows: dark and semi-dark phase with a Thitung value of 2.24 and a Ttabel value of 1.68, dark and bright phase with a Thitung value of 0.80 and a Ttabel value of 1.68, dark and semi-bright phase with a Thitung value of -1.40 and a Ttabel value of 1.68, semi-dark and bright phase with a Thitung value of -1.35 and a Ttabel value of 1.69, semi-dark and semi-light phase with values of Thitung -0.86 and Ttabel 1.71, followed by the light and semi-light phase with values of Thitung -1.12 and Ttabel 1.68.

The catch results based on the number of individuals showed that all comparisons between lunar phases had Tcount values < Ttable, indicating acceptance of H_0. This shows no significant difference in the number of individuals caught between lunar phases during the study period. However, analysis based on catch weight showed different results, particularly between the dark and semi-dark phases, where Tcount values > Ttable were obtained. This finding indicates a significant difference in catch weight between the two phases, with the dark phase showing higher results. Five other tests for weight comparisons between lunar phases showed Thitung < Ttabel, indicating no significant difference.

Table 2. Moon phase testing based on the number of fish catches and weight (kg)

Moon phase testing	Tail			Weight (kg)		
	$T_{calculated}$	T_{table}	Decision	$T_{calculated}$	T_{table}	Decision
Dark and semi-dark	-0,32	1,68	H_0 accepted	2,24	1,68	H_0 rejected
Dark and light	-2,23	1,68	H_0 accepted	0,80	1,68	H_0 rejected
Dark and semi-light	-3,56	1,68	H_0 accepted	1,40	1,68	H_0 rejected
Semi-dark and light	0,04	1,68	H_0 accepted	-1,35	1,69	H_0 rejected
Semi-dark and semi-light	-2,47	1,71	H_0 accepted	-0,86	1,71	H_0 rejected
Light and semi-light	-0,20	1,68	H_0 accepted	1,12	1,68	H_0 rejected

These differences in catch results can be explained by the behaviour of fish influenced by the lunar phase. Maturbongs et al. (2019) explain that fish tend to be active at the water surface during the dark moon phase, increasing the chances of being caught by gill nets. Conversely, Lestari et al. (2024) found that during the bright moon phase, fish tend to disperse and move away from the surface, reducing the effectiveness of fishing. This phenomenon is complicated by the tidal characteristics of the Bengkalis Strait, which exhibit a double daily tidal pattern, including the spring tide phenomenon, which is the highest annual tide. Spring tides typically occur in November and December, coinciding with the full moon phase, causing water levels to rise into coastal areas (Aulia, 2022).

4. CONCLUSION

The study shows that the lunar phase does not significantly affect the number of fish caught, but the dark and semi-dark phases significantly affect the catch weight. The bright lunar phase resulted in the highest catch with 21,617 fish and 202.3 kg, while the semi-dark phase recorded the lowest catch with 3,580 fish and 30.5 kg. The results of testing the total catch weight (kg) based on the dark and semi-dark moon phases showed significant differences. It is recommended that fishermen conduct fishing during the dark moon phase and adjust their fishing strategies and locations during the semi-dark moon phase. Environmental factors, weather conditions, and sea conditions are also important considerations in improving catch yields.

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