The biological aspect of four shark (*Galeocerdo cuvier*, *Sphyra lewini*, *Atelomycterus marmoratus*, *Carcharhinus melanopterus*) of land in Muncar Coastal Fishing Port Banyuwangi East Jawa

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Abstract: Sharks are often found in all the waters are scattered in various regions of the world. On the other hand, shark fisheries have declined globally due to shark fishing as well as the demand is very high. Thus, vital information regarding the length-weight relationship is essential in the management and protection of shark fishery resources. Data collection was carried out from December 2019 to March 2020 by way of direct observation, interviews by recording almost all shark catches landed by bottom longlines or drift longlines. Results for the study found 28 species, with four species of sharks that have the highest number that is *Galeocerdo Cuvier* 17%, *Sphyra lewini* 16%, 16% *Atelomycterus marmoratus*, and *Carcharhinus melanopterus* 12%. The length-frequency distribution for *Galeocerdo cuvier* distributed between 148-437 cm in *Sphyra lewini* distributed between 109-308 cm, *Atelomycterus marmoratus* is distributed between 39-68 cm, and *Carcharhinus melanopterus* is distributed between 49 - 204 cm. The length-weight relationship between *Galeocerdo cuvier* and *Sphyra lewini* is allometric negative, whereas *Atelomycterus marmoratus*, and *Carcharhinus melanopterus* are isometric.

1. Introduction
Sharks have easily recognizable characteristics, the Chondrichthyes class so that their endoskeletons are composed of cartilage, sharks, rays, and other elasmobranch fish have cartilage features that do not undergo mineralization and are covered with a thin sub-millimetre layer. Most of the elasmobranch species are classified as carnivores because so far there is no record of plankton or other plants in their stomach contents. Sharks do not have swim bladders, so they have to keep swimming to avoid drowning [1,2]

Shark populations have been in rapid decline [3,4,5] many are endangered, [6] many areas that were once abundant but are now decreasing in number [7,8,9], whether caught intentionally or not [5] so that the cause of the decline and loss of shark species due to overexploitation [10,11]. Besides that trigger, more substantial decline include habitat degradation, arrests and climate change [6].

A baseline for the introduction of a shark that is by looking at the position or shape of the dorsal fin, pectoral, pelvic fins and caudal fins. The characteristics of the pelagic sharks with elongated fusiform body shape and usually a little flat. Relatively large body size with very high swimming speeds. Slender cone-shaped head with the surface of a flat stomach. It has large fins with a high heterocercal tail angle. On the reef shark has a tail that is very low and almost straight, with swimming
patterns slow. Generally, reef sharks have a relatively small body size. The first dorsal fin is located at the back, with a big head and a blunt snout. Meanwhile, necessary sharks have a charge that is blunter than surface sharks. It has large fins with a lower heterocercal tail angle than surface sharks [12].

About 400 million years ago, a group of Osteichthyes Chondrichthyes have evolved separately as fish that are classified as Chondrichthyes or cartilaginous fish, sharks, rays, and chimaeras are included in one of the modern fish taxonomy and very diverse. The biogeographical diversity of the Chondrichthyes group in the world includes nine orders, 34 families, 105 genera and 509 species of sharks [13] in comparison, and Southeast Asia is one of the areas with a very high level of shark diversity. Brunei Darussalam, Myanmar, Cambodia, and Vietnam reported as countries with varying levels of shark biodiversity. The first research on shark taxonomy in Indonesia was from 2001 to 2006. The collaboration was carried out in this study between Australia and Indonesia which recorded 137 Chondrichthyes, consisting of 78 shark species, 56 ray species, and three chimaeras. In Indonesia's latest research, there were 213 species from 41 families, consisting of 112 species of sharks, and 98 species of rays that recorded [14].

Characteristics of reproduction in sharks vary greatly among shark species in the same genus. Among the different species of the same can also across the range. Shark reproductive success depends on the growth rate, their spouses, competition for resources, the availability of food, and the displacement of individual sharks. Adult sharks that are 7 to 15 years old will give birth to their cubs once every two to three years. The number of sharks that are born is only one to ten chicks [15].

Banyuwangi Muncar a landing site that precisely captures shark as the main catches. The shark fin trade would Muncar PPP is very high, so the number of sharks are landed every day is also very high. so that information on shark biological parameters (length frequency, relationship length-weight, sex, and sexual maturity) can be used as a basis for sustainable management.

2. Material and methods
The method used in this research is direct observation and interviews in the field. This research was conducted from 23 December 2019 to 31 March 2020 at the Muncar Beach Fishing Port (PPP), Banyuwangi, East Java. Data collection is carried out by identifying the catch, measuring the length (Standard Length, Forked Length, Total Length, and Classers), weight, sex, and class maturity level.

The process of identifying sharks by observing the characteristics of the body shape, colour or pattern, fin shape, mouth shape, head shape. This shark identification refers to the book Sharks and Rays Borneo [16] and the Identification Guide to Sharks, Rays and Skates of The Southeast Asian Region [17].

2.1. Morphological Analysis
Collecting data by recording or photographs of all landed shark species will result in data such as species identification. The existence of recording or photos will minimize errors in determining species because of the similarities.

2.2. Length Frequency Distribution Analysis
There are several stages to analyze shark length-frequency data, namely:
- Determine the Number and interval of classes with formulas:

\[ K = 1 + 3.32 \log N \] ................................. (1)

Information:
K = number of classes
N = Lots of data
- Determine maximum and minimum total length values for sharks
- Determine the middle grade with the formula:
middle value = lower limit - upper limit/ 2 ............... (2)
Then determine the frequency class and enter the frequency into each length class with a predetermined class interval. Furthermore, the predetermined length-frequency distribution for the same class interval was drawn on a graph. It can be seen from the chart that the shift in the distribution of extended classes. The change in the diagram illustrates the number of age groups that exist. If there is a mode shift at the extended frequency, it can be concluded that there is more than one age group.

2.3. Analysis of the Length-Weight Relationship (LWR)

The mathematical equation that explains the length-weight relationship used is \( W = a \times (TL)^b \). Where \( W \) is the total weight, \( TL \) is the total length (cm) and; \( a \) and \( b \) are the regression coefficients [18]. The regression coefficients (\( a \) and \( b \)) and \( r^2 \) (coefficient of determination) were estimated using the least-squares method applied to the logarithmic-change length-weight relationship log expression \( W = \log a + b \log TL \) [19]. To find out \( b \) is allometric or isometric, there needs to be a student test or a t-test.

With the following formula and hypothesis:

\[
T_{hit} = \left| \frac{3 - b}{Sb} \right|
\]

\( H_0: \) Count > T table; value of \( b = 3 \) (isometric).

\( H_1: \) Table > Thitung; value of \( b \neq 3 \) (allometric)

2.4. Comparative Gender Analysis

The ratio between the number of male and female sharks can be calculated using the formula:

\[
NK = \frac{N_{bi}}{N_{ji}}
\] ………………… (5)

Information:

\( NK = \) Gender Ratio

\( N_{bi} = \) The Number of individual females

\( N_{ji} = \) number of male individuals

The sex comparison test has been carried out using the Chi-Square test, with a 95% confidence interval, namely:

\[
X^2 = \sum \frac{(Fo - Fn)^2}{Fn} \] ………………………….. (6)

Information:

\( X^2 = \) Chi Square

\( Fo = \) frequency observed

\( Fn = \) The expected frequency

Test the table within the 95% confidence interval (n-1) with the following hypothesis:

\( H_0 = \) There is no significant difference between the number of male and female shark

\( H_1 = \) There is a significant difference between the number of male and female shark

If \( X^2 \) counts <from \( X^2 \) table, then accept \( H_0 \) reject \( H_1 \). If \( X^2 \) count> \( X^2 \) table then accept \( H_1 \) reject \( H_0 \)

2.5 Analysis of Sexual Maturity Level

The level of sexual maturity in male sharks be primarily determined by the condition Glasper. The liming process makes the clasper longer and harder. The small size of the clasper indicates that the shark is not yet sexually mature. It is essential to know the level of sexual maturity to see the spawning season and spawning time. The length of sexual maturity in the same species varies widely and does not have to be the same.
3. Results and discussion

3.1 Results

3.1.1. Area of Capture
Shark fishing area is divided into two based on the type of fishing gear used. In the waters around the Bali Strait, Blambangan Peninsula, Nusa Dua Bali by using a bottom line. In the waters around Madura Island (Kangean Island and Sekala Island), East Kalimantan, Samarinda and Masalima Island. In these waters using longline gear carried away with other gear that drifts nets (Figure 1).

![Figure 1. Map of Capture Location](image)

3.1.2. Composition of Catch
During the research that took place from December 2019 to March 2020 at PPP Muncar, 395 sharks (90%) were successfully enumerated. Based on the analysis of the composition of catches of shark species consists of 28 species with 17 genera of 5 families. Catches of shark species landed in PPP Muncar dominated by four species of sharks that have the highest number that is *Galeocerdo cuvier* 68 tail, *Sphyrna lewini* 65 tail, *Atelomycterus marmoratus* 62 tail, and *Carcharhinus melanopterus* 48 tail. The composition of the catch sharks in PPP Muncar displayed graphically on the image to determine the species of shark were caught; graphics shark catches can be seen in Figure 2.

![Figure 2. Composition of Catch](image)

3.1.3. Results of Analysis of Biological Studies
Based on the results of statistical data processing, four species of sharks have the highest number, namely *Galeocerdo cuvier*, *Sphyrna lewini*, *Atelomycterus marmoratus*, and *Carcharhinus melanopterus*. The shark species used for the analysis of biological studies because it has data which amounts to over 30, insufficiency of data held on other shark species was feared at the time of data analysis will be biased. Study of biologies such as length frequency distribution, length relationship weight, sex, and level of sexual maturity.

3.1.4 Length Frequency Distribution
The length-frequency distribution of four shark species was obtained by direct measurements in the field. In the species of *Galeocerdo cuvier* as many as 68 individuals, the smallest length is 148 cm, and the largest is 437 cm. The most common size caught in the length range of 228 - 237 cm was nine tails, and an average length of 251 cm.

In the *Sphyrna lewini* species (many as 65 individuals, the smallest length was 109 cm, and the largest length was 318 cm. The most common size caught in the range 139 - 148 cm was 17 tails, and an average length of 154 cm.
In *Atelomycterus marmoratus* as many as 62 species, the smallest length was 39 cm, and the largest was 68 cm. The most common size caught in the length range of 49 - 53 cm were 15 individuals, and an average length of 51 cm.

In the *Carcharhinus melanopterus* species as many as 48 individuals, the smallest length was 49 cm, and the largest was 204 cm. The most common size caught in the length range of 49 - 53 cm was 15, and an average length of 72 cm.

### 3.1.5 Length Weight Relations

*Cuvier Galeocerdo* equation in which \( W = 0.0213 \times L^{1.5577} \), \( b \) value 1.5577, and the value of \( R^2 \) 0.744. The results of t-test scores \( T_{\text{count}} = 12.832 \) and 1.996. It can be concluded that \( T_{\text{count}} \geq T_{\text{table}} \), which means that the growth pattern of weight length is negative allometric.

Obtained the equation for *Sphyra Lewis*, namely \( W = 0.0196 \times L^{1.3015} \), \( b \) value 1.3015, and \( R^2 \) value 0.7014. The results of the t-test get the value of \( T_{\text{count}} = 15.876 \) and \( T_{\text{table}} = 1.99 \). It can be was concluded that \( T_{\text{count}} \geq T_{\text{table}} \), which means that the growth pattern of weight length is negative allometric.

The equation for *Atelomycterus marmoratus* is \( W = 0.000006 \times L^{2.8982} \), \( b \) value 2.8982, and \( R^2 \) value 0.8844. The results of the t-test get the value of count 0.752 and table 2. It can be was concluded that \( T_{\text{count}} \leq T_{\text{table}} \) which means that the growth pattern of length and weight is isometric.

Obtained the equation for *Carcharhinus melanopterus* is \( W = 0.000003 \times L^{3.1478} \), \( b \) value 2.911, and \( R^2 \) value 0.95. The t-test results get the value of \( t_{\text{count}} = 0.794 \) and \( t_{\text{table}} = 2.012 \). It can be was concluded that \( T_{\text{count}} \leq T_{\text{table}} \), which means that the growth pattern of length and weight is isometric.

### 3.1.6 Sex Ratio

Comparative analysis of the sex ratios of four shark species totalling 243 individuals, consisting of 131 females and 112 males. The ratio of male and female sex ratios is 0.9: 1.2. In the species of *Galeocerdo cuvier*, the female sharks were 54% or 37 individuals, while the male sharks were 46% or 31 individuals. In the *Sphyra lewini* species, the female sharks were 54% or 35 individuals, while the...
male sharks were 46% or 30 individuals. In the *Atelomycterus marmoratus* species, the female sharks were 50% or 31 individuals, while the male sharks were 50% or 31 individuals. In *Carcharhinus melanopterus* species, female sharks were 58% or 28 individuals, while male sharks were 42% or 20 individuals. Analysis of the sex ratio was tested using the chi-square, and the calculated chi value was 0.30, and the chi table was 5.99, then the calculated chi value ≤ chi table. It was then concluded that there are no significant differences between the number of male and female fish in four species of shark.

### 3.1.7 Sexual Maturity Level

In *Galeocerdo Cuvier*, the highest percentage was FC category with 81% or 25 heads, NFC category with 19% or six heads. The length of the class is between 7 - 33 cm. In *Sphyrna lewini*, the highest percentage was FC category with 60% or 18 heads, NC category with 30% or nine heads, and NFC category with 10% or three heads. The length of the class is between 3 - 29 cm.

In *Atelomycterus marmoratus*, the highest percentage was the FC category of 52% or 16 heads, the NC category of 35% or 11 heads, and the NFC category of 13% or four heads. The length of the class is between 1 - 10 cm. In *Carcharhinus melanopterus* with the highest percentage, NFC category was 80% or 16 heads, FC category was 15% or three heads, and NC category was 5% or one head. The length of the class is between 2 - 20 cm.

### 3.2 Discussion

#### 3.2.1. Composition of Catch

Seeing these conditions, it can be indicated that the distribution of sharks on every time is not the same, it was suspected because of the behaviour of sharks in each species, the state of these waters, and fishing gear used. Differences in the intensity of fishing activities and the tools used can affect the number of yields and species of sharks caught. In this study, the number of catches is because of the relatively small sharks west season. In the west this season the weather was very bad, very large waves, strong winds so that the fishermen rarely perform fishing activities. Catches will increase in east monsoon, due to the calm waters and the wind is not blowing hard. Deployment sharks are not the same every time caused by the behaviour of sharks, east and west monsoon season, the condition of aquatic and fishing gear used. Different fishing area environments (bottom waters, and depth), fishing gear variables (size of fishing gear and tools used can affect the composition of the catch) [20].

Most of the shark body temperature is very compatible with the surrounding waters, and this is because all the heat generated from the metabolic processes will quickly disappear [21,22]. Besides, that habitat young sharks are born occupies an area nursery located in coastal waters, because the area was deemed safe so that the area can be defined as Area nurseries are defined as an ideal young shark to survive in their early life, the Sharks young occupy nursery areas for 6-8 months in the summer and then will migrate to warmer waters during the winter, although some species in tropical waters remain in the area throughout the year nurseries [23].

Sharks spread throughout the oceans of the world, and there are several species of sharks in coastal, neritic, and demersal areas, winter or long summer will affect the number of shark populations. Besides, the existence of an oceanographic phenomenon such as El Nino and La Nina causes shark populations to move around looking for different areas or places of refuge. Several biotic and abiotic factors influence the distribution of sharks, such as environmental conditions, availability of food in these habitats, shark physiology, and distribution of prey. Temperature can also have a profound effect on the distribution of sharks, limiting many geographic ranges. It is very important to know about the distribution patterns of sharks in the water, so that they can find out about the distribution shift, changes in the seasons for migration, and references for carrying out conservation activities [24,25,26].
3.2.2. Results of Analysis of Biological Studies

3.2.2.1. Length Frequency Distribution
In this study, 63.2% of Galeocerdo cuvier was not fit to be caught. In a previous survey in November 2016 - January 2017, PPP Muncar, Galeocerdo cuvier, was caught in a size of 184 - 330 cm. It can be seen that 9 of them are not yet fit to be caught, and 61 of them are fit to be caught [27]. At Atelomycterus marmoratus, 83.8% of the reef sharks were viable. This research was the same as previous research at Tanjung Pasir Port in February 2017 - January 2018, the length of Atelomycterus marmoratus, which was caught at a size of 170 - 585 cm. It is known that 121 reef sharks are fit to be caught [28]. In Carcharhinus melanocephalus, 88% of the sharks are not yet fit to be caught. In previous studies in Bali in 2015 - 2016, the size of Carcharhinus melanocephalus was caught at 30-90 cm. It is known that all sharks caught are not yet fit for capture [29]. The length of each adult shark species is different so that sharks with the same length may differ in their population status, whether they are still young or have become adult sharks if caught young will likely be detrimental to the survival of the shark. Therefore, the long frequency distribution of sharks for each species must pay attention to the species because the length of each shark species is not the same [30].

3.2.2.2. Length - Weight Relationship
In this study for the same Galeocerdo cuvier previous studies in 2016 in PPP Muncar. Sphyrna lewis is the same as previous research in 2017 at PPP Muncar. Atelomycterus marmoratus is different from research conducted on Seribu Island in 2017 - 2018, which is allometric negative. Carcharhinus melanocephalus differs from research at Tanjung Balai in 2018, which is allometric negative [23,31]. Analysis of the length and weight relationship is very important to do in order to know the stock and the condition of fish biology and facilitate the management of the sustainability of fish biodiversity. This analysis is also an indicator of the state of the ecosystem in these waters. The long relationship of weight adds to information about fisheries resource management [32].

The value of body shape (b) can be used as an indicator of the growth pattern of sharks because the value of body shape, (b) is quite diverse. Differences in the value of body shape, (b) is influenced by two factors: external factors and factor in. Factors in the shark's age, genetic traits, sex, ability to use feed, and resistance to disease. External factors, namely water temperature, availability of food in the waters, and differences in habitat will also affect the body shape, (b) value. Environmental factors will affect the value of growth at the same shark species to a different location. Changing environmental conditions will result in the condition of the shark species have also changed. The usefulness of a long relationship analysis is to determine the difference in weight between the same species with different stocks and estimates the condition factor.

3.2.2.3. Sex Ratio
The catch of four shark species landed was dominated by female sex in almost all shark species. Although dominated by female sharks, the difference in the number of male and female sharks is not very significant in each species. This is due to the behaviour of female sharks that are more easily attracted to fishing gear, although it depends on the conditions of the waters in the fishing area. The catch, which is dominated by female sharks, shows that the population in these waters is not balanced, and it is feared that it could disturb the shark population because their reproductive aspects have also decreased. The unbalanced sex ratio is influenced by differences in behaviour based on sex, capture, and water conditions. Based on the results of the Convict cichlid fish (Arachocentrus nigrofasciatus), showed women were slightly, but not significantly, more than men, but they initiate more social interaction intersexual (i.e. behavioural approaches) than men, much aggression intrasexual, and males chase females more often.[33]

3.2.2.4. Level of Sexual Maturity

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The maturity level of the classers in 4 male shark species was 52% in the FC category, 30% in the NFC category, and 18% in the NC category. The results of this study are different from the results of previous studies in 2014 - 2015 at PPP Muncar. He is noted where the Non Full Calcification (NFC) category has the largest percentage. Capturing a shark in a mature state is influenced by the type of fishing gear, the ability of the boat used, and the size of the fishing gear. This information is taken into consideration to limit the fishing season for sharks by giving sexually mature or mature sharks the opportunity to reproduce [34,35]. Knowing the spawning season and when the sharks start reproducing can help protect the extinction and sustainability of sharks.

4. Conclusion
1. There are four dominant sharks (Galeocerdo cuvier, Sphyra lewini, Atelomycterus marmoratus, Carcharhinus melanopterus) from 28 species of sharks landed
2. Galeocerdo cuvier, Sphyra lewini, and Carcharhinus melanopterus not deserve to be arrested, while Atelomycterus marmoratus it deserves to be arrested
3. The results of the analysis of the length-weight relationship of, Galeocerdo cuvier, Sphyra lewini are allometric negative, while Atelomycterus marmoratus and Carcharhinus melanopterus are isometric.
4. The results of the sex ratio analysis showed that there was no significant difference between the number of male and female sharks.
5. At maturity level clasper, 52% of sharks captured males are sexually mature

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