



(RESEARCH ARTICLE)



## STUDY OF LENGTH-WEIGHT RELATIONSHIP OF BALI SARDINELLA (*Sardinella lemuru* Bleeker, 1853) IN THE BALI STRAIT, INDONESIA

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### ABSTRACT

The development of science and technology, as well as fisheries information, is crucial for understanding the biological aspects of fisheries. Understanding the lifestyles, behaviors, and individual characteristics of aquatic populations and resources is crucial. Indonesia has excellent fisheries potential. Because *Sardinella lemuru* fisheries are the most important and economically valuable fishery resources, this product is widely exploited by fishermen living around the Bali Strait. Production of *Sardinella lemuru* caught in the Bali Strait has currently declined due to overfishing. Lemuru fish resources (*Sardinella lemuru*) catch an important role both ecologically and economically in the waters of the Bali Strait and its surroundings, because it is the dominant catch landed in the region. Research into the condition of the Lemuru fishery in the Bali Strait requires further investigation to determine the condition of the *Sardinella lemuru* and the potential fishing areas. The aim of this study was to observe the species, length, weight, and sex of *Sardinella lemuru*, and length of weight in the Bali Strait. Based on the fishing season index, the *Sardinella lemuru* season occurs twice a year, starting in September, October, and November. Fishing is lowest from May to August. The *Sardinella lemuru* measured had a total length of 15 cm and a body weight of around 45 grams. Based on the t-test results for the b value (slope) *Sardinella lemuru* at a 95% confidence interval ( $\alpha = 0.05$ ) shows that the b value is significantly different from the b value <3. This means that the overall growth pattern of *Sardinella lemuru* is negative allometric (length increase is

faster than weight increase). If the  $L_c$  value  $< L_m$ , then the condition of fish resource management is not good because it can result in unequal fish stock growth with an unbalanced ratio of gonad maturity level (GML) male and female.

**Keywords:** *Sardinella lemuru*, Length Weight, Sex Ratio, Purse Seine, Gonad Maturity Level

## 1 INTRODUCTION

Fishery resources are renewable resources. Proper management efforts are needed to ensure these resources are sustainable and continual. With the advancement of science, technology, and fisheries information, understanding the biological aspects of fisheries is crucial for understanding the life, behavior, and characteristics of a population unit or fishery resource stock. Indonesia has excellent potential for capture fisheries. An example is the *Sardinella lemuru* which is caught in the waters of the Bali Strait. Fishery resources *Sardinella lemuru* is the most dominant and economically valuable fishery resource in the Bali Strait, making it the most exploited commodity by fishermen living around the Bali Strait [1]. Furthermore, *Sardinella lemuru* fisheries catch a significant role in the livelihoods of local communities. Other benefits of lemuru fisheries include providing regional income, supporting local industry, and increasing employment opportunities both at sea and on land [2].

The production of *Sardinella lemuru* catches obtained in the Bali Strait waters has currently decreased as a result of overfishing. The decline in production is indicated by the decreasing size of the fish caught, the decrease in the production of input units and the decreasing number of population structures [3]. Other conditions in *Sardinella lemuru* fisheries include fluctuating production, inefficient utilization of fish resources, and the absence of a sustainable fisheries resource management system strategy [4]. *Sardinella lemuru* is a type of small pelagic fish that is very important in Indonesia, especially as a livelihood for fishermen in the Bali Strait area [5]. Resources *Sardinella lemuru* catch an important role both ecologically and economically in the waters of the Bali Strait and its surroundings, because it is the dominant catch landed in the region [6].

The condition of *Sardinella lemuru* fisheries in the Bali Strait waters requires research efforts to determine the condition of Lemuru fish and the potential fishing areas. This research aims to assess the stock of fishery resources. *Sardinella lemuru* in the waters of the Bali Strait [7].

The aim of this research is to identify the biological aspects of *Sardinella lemuru* in the waters of the Bali Strait including total length, fish weight, gonad weight, gonad maturity level, sex ratio, size when first caught ( $L_c$ ) in the waters of the Bali Strait. And analyzing aspects of capture fisheries in management efforts *Sardinella lemuru* in the waters of the Bali Strait. It is hoped that it will provide information to readers about the biological aspects of *Sardinella lemuru* in the waters of the Bali Strait, can be dedicated as a basis for managing marine resources. *Sardinella lemuru*, as a determining tool in resource management policies *Sardinella lemuru* in the waters of the Bali Strait.

## 2 MATERIAL AND METHODS

This research was conducted for approximately 3 months, starting from March – May 2024, using a mini purse seine vessel located at the Pengambangan Nusantara Fisheries Port, Jembrana, Bali Province, Indonesia.



**Figure 1: Mini purse seine vessel**

### 2.1 Tools and materials

The tools and materials used in this research include scales, cameras, rulers, writing instruments, questionnaires, *Dissecting set*, Gonad Identification, Cutting Board, Magnifying Glass, and Laptop.

## 2.2 Method of collecting data

The data collection method used in this study is survey/direct, field observation of samples *Sardinella lemuru* as the main object of observation. Data collection methods are divided into two, namely primary data collection and secondary data collection. During data collection, data is recorded using writing instruments and digital cameras.

In this research, 2 types of data were used, namely primary data, observations of the relationship between length and weight by measuring the weight of the fish, total length [8], and secondary data, in the form of data obtained from fishing port management officers including production data (catch), number of fishing gear, number of vessels, number of vessel trips, and data related to supporting the capture fisheries sector. Supporting this research was also obtained from journals, articles, literature or previous research related to this research [9].

## 2.3 Data processing methods

Data processing involves entering data into Microsoft Excel, then analyzing, tabulating, and sorting the data according to the themes or topics addressed in the research. Preliminary data collection is used as a preliminary study technique to identify research issues and gain in-depth insights from respondents. Data analysis is presented descriptively using a quantitative approach, describing the information presented in graphs and tables.

## 3 RESULTS AND DISCUSSION

### 3.1 Fishing area

Fishing area of *Sardinella lemuru* located in WPP 573, which lies between Bali and East Java Provinces. The location of the fishing grounds is shown in figure 1:

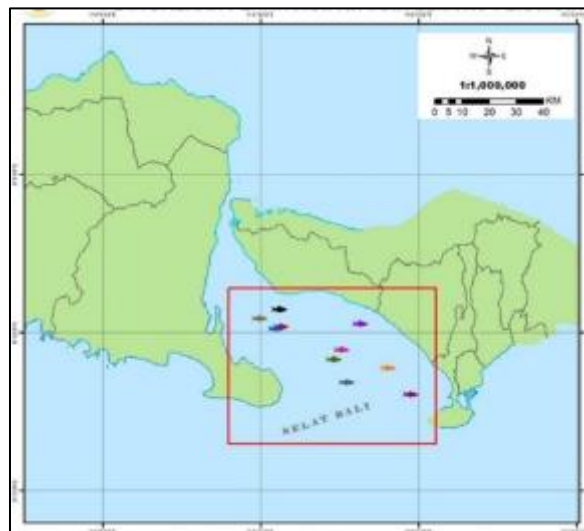


Figure 2: Fishing area

The fishing location map in Figure 2 is a map product containing spatial information on predicted fishing areas in the Bali Strait. This fishing area map is based on direct data from interviews with fishermen using a questionnaire and a map of the Bali Strait.

### 3.2 Fishing season

Spread *Sardinella lemuru* concentrated in the waters of the Bali Strait and its surroundings. Analysis of fishing season patterns using the average percentage methods which is based on times series analysis [10]. From the production data for 2014 – 2024, the fishing season was obtained. *Sardinella lemuru* in the waters of the Bali Strait occurs in the month (September – November) and in September, October, November from the calculation results it was found that the highest peak production was in October as presented in table 1.

**Table 1: Fishing season**

| Month         | Year  |        |        |       |      |       |        |        |            |            | TOTAL      | Average per month |
|---------------|-------|--------|--------|-------|------|-------|--------|--------|------------|------------|------------|-------------------|
|               | 2013  | 2014   | 2015   | 2016  | 2017 | 2018  | 2019   | 2020   | 2021       | 2022       |            |                   |
| January       | 6     | 882    | 774    | 674   | 0    | 0     | 118.0  | 288    | 551,468    | 527,922    | 1,082,132  | 108,213           |
| February      | 0     | 211    | 2,487  | 476   | 0    | 0     | 237    | 20     | 774,003    | 1,206,376  | 1,983,810  | 198,381           |
| March         | 57    | 562    | 3,067  | 1,286 | 0.5  | 3.0   | 1,032  | 719    | 1,153,680  | 1,279,197  | 2,439,604  | 243,960           |
| April         | 90    | 143    | 1,823  | 1,370 | 1    | 3     | 615    | 4,016  | 1,491,985  | 1,610,409  | 3,110,455  | 311,046           |
| May           | 32    | 323    | 92     | 1,588 | 0    | 0     | 1,044  | 1,158  | 992,492    | 1,019,997  | 2,016,726  | 201,673           |
| June          | 15    | 107    | 38     | 1,315 | 0    | 0     | 517    | 1,620  | 527,985    | 989,969    | 1,521,566  | 152,157           |
| July          | 3     | 15     | 288    | 149   | 0    | 0.05  | 659    | 1,087  | 997,349    | 532,293    | 1,531,843  | 153,184           |
| August        | 269   | 574    | 735    | 58    | 0    | 3     | 1,373  | 1,459  | 184,138    | 304,393    | 493,002    | 49,300            |
| September     | 650   | 807    | 912    | 79    | 21   | 21    | 1,109  | 1,749  | 1,225,643  | 1,312,325  | 2,543,316  | 254,332           |
| October       | 2,120 | 4,177  | 2,416  | 105   | 0    | 221   | 3,056  | 1,632  | 3,189,907  | 813,427    | 4,017,061  | 401,706           |
| November      | 1,397 | 3,818  | 2,521  | 38    | 40   | 400   | 2,966  | 1,854  | 1,351,764  | 835,429    | 2,200,227  | 220,023           |
| December      | 1,081 | 2,527  | 885    | 12    | 14   | 503   | 3,277  | 2,499  | 1,307,202  | 578,260    | 1,896,260  | 189,626           |
| Amount (tons) | 5,720 | 14,146 | 16,038 | 7,150 | 77   | 1,154 | 16,003 | 18,101 | 13,747,616 | 11,009,997 | 24,836,002 |                   |

Source: PPN Pengambengan production data.

**Figure 3: Fishing season graph**

### 3.3 Fishing season index

Data presentation and analysis are presented in the form of cross-tabulations and mapped in graphical form. For the analysis of fishing seasons, the method for calculating the fishing season index (IMP) is used moving average. Ideally, the average monthly ratio is equal to 1200 which is obtained from (12 x 100), but due to many factors, the value is not always equal to 1200.

When the amount of IMP is not the same as 1,200% (12 months x 100%) then an adjustment is required using the formula [11].

$$IMS = \frac{1,200}{\sum_{i=1}^m IM_i} \times IM$$

With :

$IMS_i$  = Adjusted Season Index  $i$

$IM_{i_i}$  =  $i$ -the Season Index

**Table 2: Fishing Season Categories**

| IMP Value    | Season Category    |
|--------------|--------------------|
| $\geq 100\%$ | Fish Season        |
| $< 100\%$    | Out of Fish Season |



**Figure 4: Fishing season index**

Based on the fishing season index value, it is known that production has increased *Sardinella lemuru*. This occurs twice a year, namely in March–May and again in September–November. Low fish production occurs in the months of November–February and continues in June–August, as shown in Figure 4.

**Table 3: Fishing Season Index**

| Year | Month |       |       |       |       |      |       |       |       |       |       |       | Amount |
|------|-------|-------|-------|-------|-------|------|-------|-------|-------|-------|-------|-------|--------|
|      | Jan   | Feb   | Mar   | Apr   | May   | Jun  | Jul   | Aug   | Sept  | Oct   | Nov   | Dec   |        |
| 2014 | 6     | 0     | 57    | 90    | 32    | 15   | 3     | 269   | 650   | 2,120 | 1397  | 1,081 | 5720   |
| 2015 | 882   | 211   | 562   | 143   | 323   | 107  | 15    | 574   | 807   | 4,177 | 3,818 | 2,527 | 14,146 |
| 2016 | 774   | 2,487 | 3,067 | 1,823 | 92    | 38   | 288   | 735   | 912   | 2,416 | 2,521 | 885   | 1,638  |
| 2017 | 674   | 476   | 1,286 | 1,370 | 1,588 | 1315 | 149   | 58    | 79    | 105   | 38    | 12    | 7,150  |
| 2018 | 0     | 0     | 1     | 1     | 0     | 0    | 0     | 0     | 21    | 0     | 40    | 14    | 77     |
| 2019 | 0     | 0     | 3     | 3     | 0     | 0    | 0     | 3     | 21    | 221   | 400   | 503   | 1,154  |
| 2020 | 118   | 237   | 1,032 | 615   | 1,044 | 517  | 659   | 1,373 | 1,109 | 3,056 | 2,966 | 3,277 | 16,003 |
| 2021 | 288   | 20    | 719   | 4,016 | 1,158 | 1620 | 1,087 | 1,459 | 1,749 | 1632  | 1,854 | 2,499 | 18,101 |

|                                            |               |               |                 |                   |                   |                   |               |                 |                   |                   |               |                   |                |
|--------------------------------------------|---------------|---------------|-----------------|-------------------|-------------------|-------------------|---------------|-----------------|-------------------|-------------------|---------------|-------------------|----------------|
| 202<br>2                                   | 551,4<br>68   | 774,0<br>03   | 1,153,<br>680   | 1,49<br>1,98<br>5 | 992,<br>492       | 527,<br>985       | 997,34<br>9   | 18<br>4,1<br>38 | 1,22<br>5,64<br>3 | 3,18<br>9,90<br>7 | 1,351,7<br>64 | 1,3<br>07,<br>202 | 13,74<br>7,616 |
| 202<br>3                                   | 527,9<br>22   | 1,206,<br>376 | 1,279,<br>197   | 1,61<br>0,40<br>9 | 1,01<br>9,99<br>7 | 989,<br>969       | 532,29<br>3   | 30<br>4,3<br>93 | 1,31<br>2,32<br>5 | 813,<br>427       | 835,42<br>9   | 578<br>,26<br>0   | 11,00<br>9,997 |
| <b>TOT<br/>AL</b>                          | 1,082<br>,132 | 1,983,<br>810 | 2,439,<br>604   | 3,11<br>0,45<br>5 | 2,01<br>6,72<br>6 | 1,52<br>1,56<br>6 | 1,531,8<br>43 | 49<br>3,0<br>02 | 2,54<br>3,31<br>6 | 4,01<br>7,06<br>1 | 2,200,2<br>27 | 1,8<br>96,<br>260 | 24,83<br>6,002 |
| <b>Ave<br/>rage<br/>per<br/>mon<br/>th</b> | 108,21<br>3   | 198,3<br>81   | 243<br>,96<br>0 | 311,<br>046       | 201,<br>673       | 152,<br>157       | 153,<br>184   | 49,30<br>0      | 254,<br>332       | 401,<br>706       | 220,<br>023   | 189,6<br>26       |                |
| IMP                                        | 52            | 96            | 52              | 150               | 97                | 74                | 74            | 24              | 123               | 194               | 106           | 92                |                |

Source: PPN Pengambengan production data

The peak season for *Sardinella lemuru* falls in the final months of the year, corresponding to the east monsoon (September – December). The *Sardinella lemuru* fishing season typically begins in September or October and ends in March of the following year. Thus, lemuru is a fish that can be caught year-round, although catches vary [12].

### 3.4 Composition of the catch

The catch results from the purse seine fishing gear from three months of research were quite varied, the purse seine catch results were dominated by *Sardinella lemuru* as much as 91% of the total catch is presented in table 7.

**Table 4: Composition of Catch Results**

| Species Name             | Catch Composition |        |       |       |        |        |       |        |        |        | Weight (kg)    | %  |
|--------------------------|-------------------|--------|-------|-------|--------|--------|-------|--------|--------|--------|----------------|----|
|                          | 1                 | 2      | 3     | 4     | 5      | 6      | 7     | 8      | 9      | 10     |                |    |
| <i>Sardinella lemuru</i> | 13,795            | 70,157 | 2,161 | 1,990 | 23,418 | 74,403 | 2,706 | 30,072 | 54,359 | 14,812 | 287,873        | 91 |
| Deles Flyover            | 0                 | 2,754  | 0     | 0     | 0      | 0      | 0     | 1,026  | 0      | 9,100  | 12,880         | 4  |
| Cob                      | 0                 | 2,818  | 0     | 0     | 0      | 0      | 0     | 0      | 0      | 0      | 2,818          | 1  |
| Loud                     | 0                 | 13,038 | 0     | 0     | 0      | 0      | 0     | 0      | 0      | 0      | 13,038         | 4  |
| <b>TOTAL</b>             | <b>316,609</b>    |        |       |       |        |        |       |        |        |        | <b>316,609</b> |    |

Source: PPN Pengambenga production data

#### 3.4.1 Biological aspects of *Sardinella lemuru*

##### 3.4.1.1 Classification & morphometrics of *Sardinella Lemuru*

*Sardinella lemuru* which in FAO species Catalogue called *Sardinella lemuru* [13] is one of the economically important small pelagic fish species in Indonesia [14].

Classification of *Sardinella lemuru* based on FAO is as follows:

- Kingdom: Animalia
- Phylum: Chordata
- Class: Aptinocerrygii
- Order: Clupeiformes
- Family: Clupeidae
- Genus: *Sardinella*

- Species: *Sardinella lemuru*



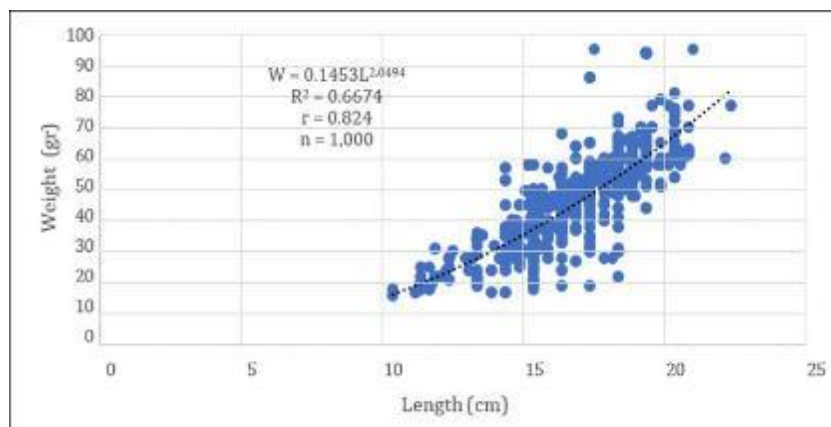
**Figure 5: *Sardinella lemuru***

*Sardinella lemuru* is one of the small pelagic fishery commodities that is spread almost throughout Indonesia. *Sardinella lemuru* It is very popular among the public because of its low price and the nutritional content needed by the human body. *Sardinella lemuru* has a fairly high protein content ranging between 17.8 - 20% and contains essential fatty acids, especially omega-3, which is useful for the human body [15].

*Sardinella lemuru* in the Bali Strait region, they are divided into four size groups, namely *sempenit*, *protolan*, *lemuru*, and *lemuru kucing*. The *sempenit* group is *Sardinella lemuru* with a size of no more than 12.5 cm, the *protolan* group measures between 13-15 cm, then for the *lemuru* group it measures 15-18 cm, and the largest is ranging from 18 to 20 cm [16].

### 3.5 Length weight relationship

The total length (FL) of *Sardinella lemuru* measured in this study was measured. The median size of *Sardinella lemuru* was around 15 cm FL, with a total of 136 individuals. A total of 1,000 fish were observed in this study. The overall *Sardinella lemuru* catch was dominated by fish measuring 15 cm FL. *Sardinella lemuru* which was measured to have a length of 15 cm with a body weight of around 45 grams as shown in Figure 6.

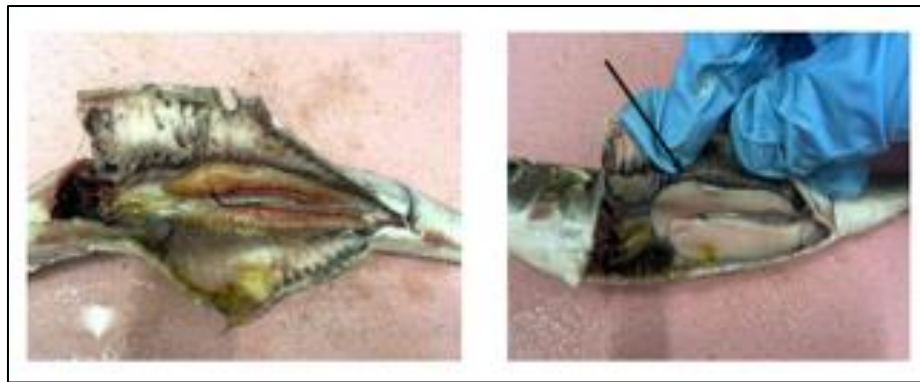


**Figure 6: Graph of the relationship between length and weight.**

The results of the analysis of the relationship between length and weight of fish show that the growth pattern *Sardinella lemuru* not simultaneously. Based on the results of the t-test on the value of b (slope) *Sardinella lemuru* at a 95% confidence interval ( $\alpha = 0.05$ ) shows that the b value is significantly different from the b value  $< 3$ . This means that the overall fish growth pattern is *negative allometric* (length increases faster than weight increases).

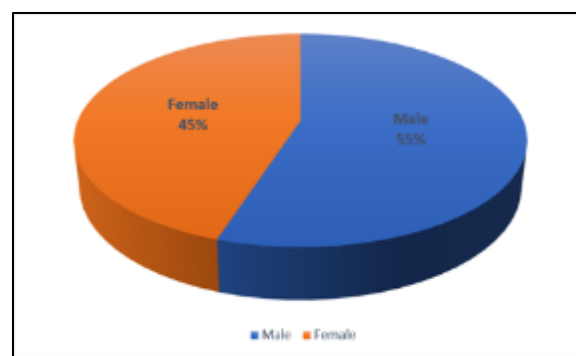
### 3.6 Sex ratio (sex ratio)

Sex ratio is the ratio of males to females in the same population. Knowledge of the sex ratio is important for understanding seasonal differences between the sexes in relative abundance during the breeding season. If the sex ratio of fish in the wild or within the same population is unbalanced, this is an indication that the aquatic environment has been disturbed [17].



**Figure 7: (a) Female gonad and (b) male gonad**

Gender determination *Sardinella lemuru* differentiation between males and females is done by observing differences through secondary characteristics. Sex comparison can predict spawning success.

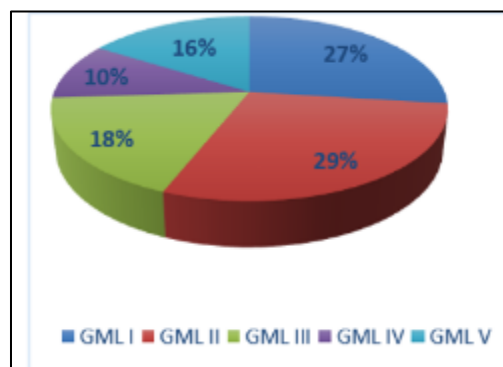


**Figure 8: Presentation sex ratio**

Presentation graphics sex ratio *Sardinella lemuru* presented in Figure 8. Which shows that there are more male GMLs than female GMLs.

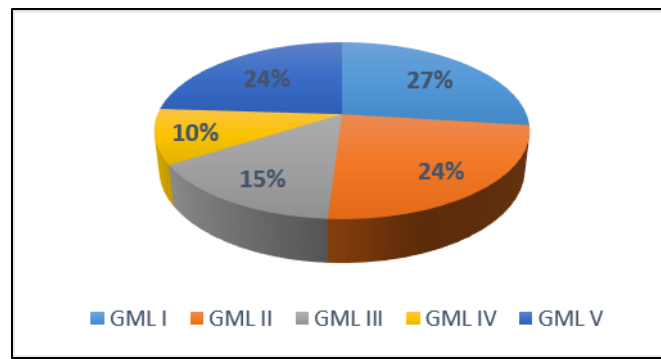
### 3.7 Gonad Maturity Level (GML)

The gonad maturity level in the Bali Strait waters of Muncar and Pengambangan is predominantly immature, although some *Sardinella lemuru* have entered the mature gonad category. Graphs of the gonad development of *Sardinella lemuru* are presented in Figures 9, 10, and 11.



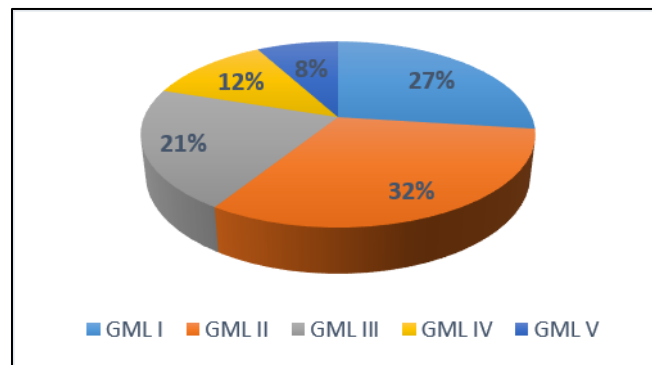
**Figure 9: Total GML percentage**

Presentation graphics sex ratio *Sardinella lemuru* presented in Figure 8. Which shows that GML I is dominant GML I which is not gonad mature when conducting the research.



**Figure 10: Percentage of male GML**

Presentation graphics *sex ratio Sardinella lemuru* presented in Figure 12. Which shows that the dominant male GML with GML I was not gonad mature when conducting the research.

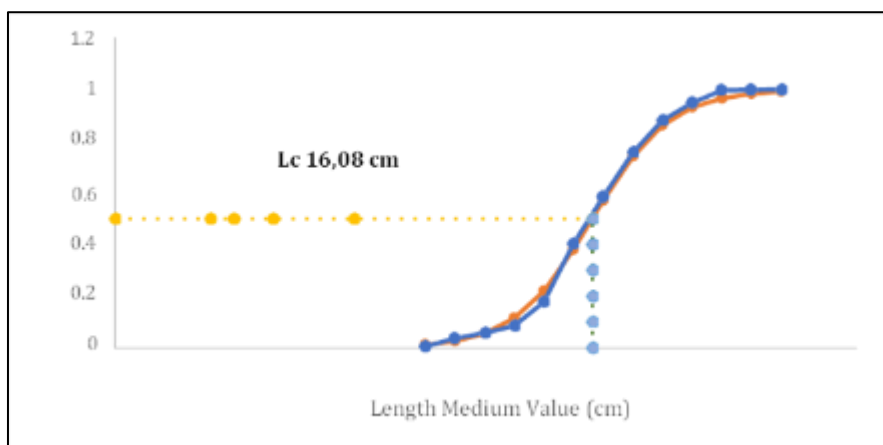


**Figure 11: Percentage of female GML**

Presentation graphics *sex ratio Sardinella lemuru* presented in Figure 11. Which shows that the dominant female GML with GML I was not gonad mature when conducting the research.

### 3.8 Length at first caught (Lc)

The length at first caught (Lc) is an important thing to study if the relationship with the length of first gonad maturity (Lm) can be known about the population status.

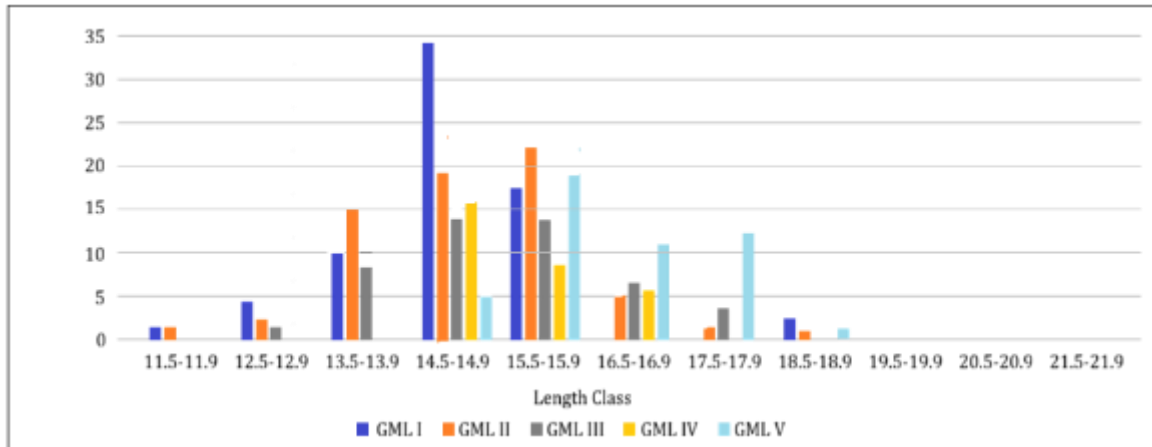


**Figure 12: Graph of length at first caught (Lc)**

The results of the analysis show that the Lc obtained for the *Sardinella lemuru* sample is 16.08 cm. The growth of *Sardinella lemuru* in the Bali Strait waters has quite good oceanographic aspects because the current is slower, thus affecting the presence of plankton as food for *Sardinella lemuru* and affecting the growth aspects of the fish.

### 3.8.1 Size at first gonad maturity

For the results of observations carried out in calculating the level of gonad maturity with the distribution of the total length of fish for 300 fish in the waters of the Bali Strait and located in the Muncar PPP and Pengambangan PPN, the Lm value was 18.6 cm, which can be seen in graph 17.



**Figure 13: Size at first maturity of gonads**

The results of the analysis show that the Lm obtained for the sample *Sardinella lemuru* female is 18.6 cm, the results of the Lm analysis of the male lemuru fish are 18 cm during research at PPP Muncar and PPN Pengambangan.

### 3.8.2 Observation production trend or catch per unit effort (CPUE)

The data used in the analysis is secondary data obtained from PPP Muncar and PPN Pengambangan in the form of production data and lemuru fish catching efforts based on statistical data from 2013 to 2022. The following is time series data on production and *Sardinella lemuru* catching efforts with the fishing gear used. Purse seine presented in table 4.

**Table 5: Production *Sardinella lemuru***

| Production Data of catch at PPN Pengambangan Bali |      |            |        |                |
|---------------------------------------------------|------|------------|--------|----------------|
| No                                                | Year | Catch (kg) | Effort | CPUE (kg/unit) |
| 1                                                 | 2014 | 14,146,000 | 6301   | 2245,04047     |
| 2                                                 | 2015 | 16,038,000 | 2956   | 5425,57510     |
| 3                                                 | 2016 | 7,150,000  | 3142   | 2275,62062     |
| 4                                                 | 2017 | 76,500     | 2241   | 34,13655       |
| 5                                                 | 2018 | 1,154,100  | 6356   | 181,57646      |
| 6                                                 | 2019 | 16,002,900 | 7489   | 2136,85405     |
| 7                                                 | 2020 | 18,101,000 | 7316   | 2474,16621     |
| 8                                                 | 2021 | 13,747,616 | 7202   | 1908,86087     |
| 9                                                 | 2022 | 11,009,997 | 8241   | 1336,00255     |
| 10                                                | 2023 | 8,570,000  | 4211   | 2035,14605     |
| Min                                               |      | 76,500     |        |                |
| Max                                               |      | 18,101,000 |        |                |
| Average                                           |      | 10,825,124 |        |                |

Source: PPN Pengambangan production data

The CPUE table shows that catches fluctuated between 2014 and 2023. The highest catch occurred in 2020, reaching 1,810,100 kg using small pelagic purse seine fishing gear with two vessels and 7,316 trips. The low CPUE value in 2017 was due to the Bali Strait's fishing drought, which began in early 2017.

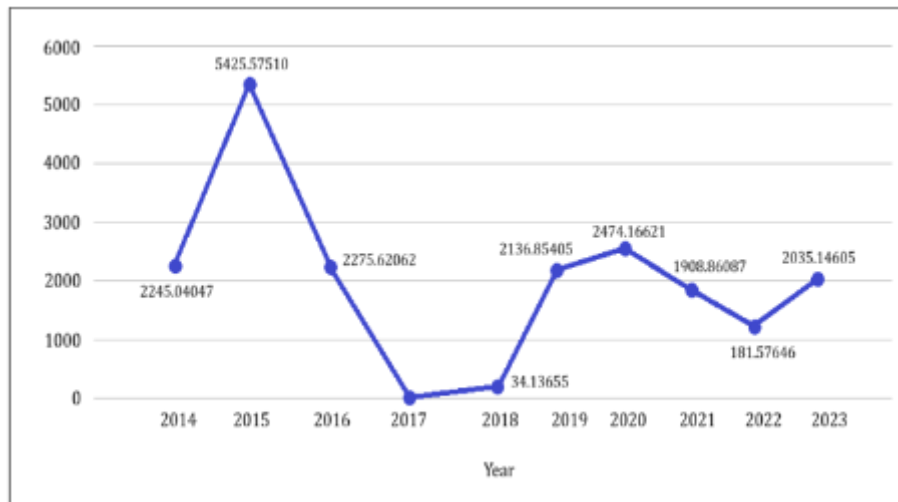


Figure 14: CPUE graph

Table 6: PPP Muncar Production

Production Data of PPP Muncar Banyuwangi Capture

| NO                                 | Year | catch results (KG) | Effort | CPUE (kg/unit) |
|------------------------------------|------|--------------------|--------|----------------|
| 1                                  | 2014 | 8,091,172          | 4505   | 1,796.04       |
| 2                                  | 2015 | 9,540,098          | 4665   | 2,045.04       |
| 3                                  | 2016 | 7,950,983          | 2239   | 3,551.13       |
| 4                                  | 2017 | 4,668,900          | 2417   | 1,931.69       |
| 5                                  | 2018 | 730,715            | 4765   | 153.35         |
| 6                                  | 2019 | 5,041,830          | 8322   | 605.84         |
| 7                                  | 2020 | 10,265,533         | 8676   | 1,183.21       |
| 8                                  | 2021 | 7,634,479          | 4522   | 1,688.30       |
| 9                                  | 2022 | 4,687,968          | 4511   | 1,039.23       |
| 10                                 | 2023 | 6,129,946          | 4311   | 1,421.93       |
| Min                                |      | 730,715            |        |                |
| Max                                |      | 10,265,533         |        |                |
| Average                            |      | 6,474,162          |        |                |
| Source: PPP Muncar production data |      |                    |        |                |

The CPUE table shows that catches fluctuated between 2014 and 2023. The highest catch occurred in 2020 reaching 10,265,533 kg using small pelagic purse seine fishing with two vessels and 8,676 trips.



**Figure 15: CPUE Graph**

Catch per unit effort (CPUE) over the last ten years (2014-2023) has been dominated by purse seine fishing gear. Purse seine has the largest contribution to catch results compared to other fishing gear. This indicates that purse seine fishing gear more productive compared to other fishing gear based on the amount of catch obtained per fishing effort (trip).

#### 4 CONCLUSION

Season *Sardinella lemuru* March to May and September to November. The highest CPUE value was achieved in 2015 due to the abundance of fish stocks in the fishing area. The lowest CPUE value was achieved in 2017.

The size structure of the captured *Sardinella lemuru* has an average length of 15 cmFL with a weight of around 45 grams. An  $L_c$  value  $< L_m$  indicates poor fish resource management conditions because it can result in unequal fish stock growth with an unbalanced ratio of male and female GML. The dominant gonad maturity levels are GML I and II. which occurs due to increased fishing.

Based on the results of the  $t_{\text{-test}}$  on the value of  $b$  (slope) *Sardinella lemuru* at a 95% confidence interval ( $\alpha = 0.05$ ) shows that the  $b$  value is significantly different from the  $b$  value  $< 3$ . This means that the overall growth pattern of lemuru fish is negative allometric (length increase is faster than weight increase). If the  $L_c$  value  $< L_m$ . then the condition of fish resource management is not good because it can result in unequal fish stock growth with an unbalanced ratio of male and female GML.

#### COMPLIANCE WITH ETHICAL STANDARDS

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##### Disclosure of conflict of interest

No conflict of interest to be disclosed.

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