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### Community structure of bivalve on seagrass ecosystems in the West Bali National Park area

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#### ABSTRACT

The waters of Taman Nasional Bali Barat are one of the waters that have abundant diversity of marine ecosystems. Seagrass is an ecosystem that has many benefits for organisms that live in it, one of which is bivalves. Bivalves can be used as jewelry, food sources, and are often used as bioindicators of pollution. Seagrass and bivalves have the same characteristics related to the type of substrate that serve as habitat and need each other in both growth and reproduction processes. This study aims to determine the condition of seagrass cover, the abundance and diversity of bivalves, and the relationship between seagrass cover and bivalves density. This research was conducted at 3 stations, namely Karang Sewu, Terima Bay, and Labuhan Lalang in August 2020. This research was conducted using survey method and sampling technique using a purposive sampling method. To determine the relationship between seagrass cover and bivalves density using a linear regression test. The results showed that the seagrass cover at the three stations was 31.04%, 50.46%, and 50.68%. Bivalves density in Karang Sewu Bay was 29.8% *Aomalodiscus squamosus*, Terima Bay with 50% *Pinna bicolor*, and Labuhan Lalang with 30.4% *Trachycardium flavum* and *Pinna bicolor*. Based on the linear regression test, it showed a significant value  $<0.5$  which means that there is the relationship between seagrass cover and the density of bivalves found in the waters of Taman Nasional Bali Barat.

#### Introduction

The waters of the West Bali National Park are one of the waters that have an abundant diversity of marine ecosystems, one of which is the seagrass ecosystem (McKenzie *et al.*, 2009; Zarkasyi *et al.*, 2016). Seagrass ecosystems function as primary producers, nutrient recyclers, and water bottom stabilizers with their root systems that can capture sediment, as habitats, spawning grounds, nurturing and food sources as well as shelters for marine biota (Carpenter & Angelis, 2016; Taurusman *et al.*, 2009). Many seagrass ecosystems are inhabited by various types of marine biota, one of which is bivalves (Wahyuni *et al.*, 2022).

Bivalvia has high economic value because they can be used as jewelry, food sources, and are often used as bio-indicators of pollution (Carpenter & Niem, 2001; Febrina *et al.*, 2018). The existence of bivalves in the seagrass ecosystem can indicate an interaction

between seagrasses and bivalves where the two have a relationship that requires each other both in the process of growth and reproduction (Allifah & Rosmawati, 2018; Febrina *et al.*, 2018; Junaidi *et al.*, 2017). This study aims to determine the condition of seagrass cover, the abundance and diversity of bivalves, and the relationship between seagrass cover and bivalves density in the waters of the West Bali National Park.

#### Materials and Methods

##### Location and time of research

This research will be carried out in August 2020. This research was conducted in Karang Sewu, Terima Bay, and Labuhan Lalang, West Bali National Park (TNBB), Bali Province, Indonesia (Figure 1).

##### Research Tools and Materials

The materials and tools used in this study included GPS, field meters, iron stakes, skin diving equipment,

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cameras, transect quadrants, shovels, plastic zip-lock bags, DO meters, thermometers, pH paper, current gauges.



**Figure 1.** Research location map

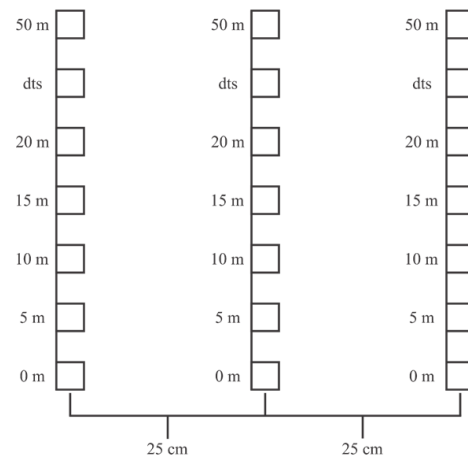
### Research Methods

The method used in this research is a descriptive survey method and the sampling technique uses purposive sampling method. The main variables in this study were seagrass cover and bivalves density. Data collection was carried out at 3 stations, namely Karang Sewu Bay (Station 1), Terima Bay (Station 2), and Labuhan Lalang Beach (Station 3) (Figure 2). Installation of transect lines that are drawn through the seagrass ecosystem area by pulling a 50-meter roll meter towards the edge (intertidal area). The transect plot used was 1 m x 1 m in size which was divided into 25 sub-plots measuring 20 x 20 cm with 5 m intervals. The types of bivalves found on each transect line were observed and recorded with reference to the book (FAO Species Identification Guide for Fishery Purpose) (Carpenter & Angelis, 2016; Carpenter & Niem, 2001).

### Research Implementation

The stages of the research carried out included determining the location of the transect, observing seagrass cover, taking bivalve samples, classifying sediment substrates, and measuring water quality parameters. At the stage of determining the location of the transect, a direct survey was carried out to determine the condition or presence of seagrass beds at the study site. The observation phase of seagrass closure and sampling of bivalves was carried out by setting up a transect line that was drawn through the seagrass ecosystem area by pulling a 50-meter roll meter towards the edge (intertidal area). The transect plot used was 1 m x 1 m in size which was divided into 25 sub-plots measuring 20 x 20 cm with 5 m intervals. In each predetermined plot, determine each type of seagrass that is present and count the number of individuals of each type. A sampling of bivalves on each seagrass transect plot was carried out at low tide

using a shovel which was then filtered using a sieve with a mesh size of 0.5 mm, and the bivalves found were put into a zip-lock plastic bag, then given formalin to be preserved and identified. in the laboratory. This bivalve identification process can include observing the color and shape of the shell. Identification of bivalve samples using a book (FAO Species Identification Guide for Fishery Purpose (Carpenter & Angelis, 2016; Carpenter & Niem, 2001). Sediment samples analysed at three station, on substrate classification,  $\pm$  100 grams of dried sediment samples were weighed, then sieved using a multilevel sieve net for 15 minutes to obtain separation of sediment particles based on each sieve size (2 mm, 1 mm, 0.5 mm, 0.063 mm and <0.063 mm) is then classified based on percent particle size. The environmental parameters measured in this study were temperature, water depth, salinity, pH, velocity, and DO.



**Figure 2.** Transect and Plot Position on three station

### Data Analysis

The data obtained from the results of this study included primary data (seagrass and bivalves) and secondary data (measurement of environmental parameters, seagrass monitoring guidelines, identification of bivalves, and other literature sources).

The primary data obtained from the survey results were then processed and analyzed descriptively by comparing them in the form of tables and diagrams referring to guidebooks and literature. The secondary data is used as material to support the primary data and can also be used as a reference in making reports. Data processing in this study can include the calculation of seagrass cover, bivalves density. To determine the relationship between seagrass cover and bivalves density, a linear regression test was used.

a. Seagrass cover

To observe the percentage of seagrass cover, can be determined using a 1 x 1 m transect. The formula for calculating the cover of certain types of seagrass in each plot is carried out using the formula (Fachrul, 2007):

$$C = \frac{\sum (Mi \times fi)}{\sum f}$$

C = Percentage of seagrass cover

Mi = Percentage midpoint of seagrass presence class *i*

F = Number of sub-plots of seagrass presence *i*

b. Bivalve density

The density of an organism in a body of water can be expressed as the number of individuals per unit area or volume (Brower *et al.*, 1990). The density of identified bivalves is calculated using the formula:

$$Ki = \frac{ni}{A}$$

Ki : Density of bivalves (individual/m<sup>2</sup>)

ni : The number of individuals of the *i*-th species (individuals)

A : Observation area (m<sup>2</sup>)

c. Bivalve diversity index

The diversity index describes the condition of bivalves mathematically in order to make it easier to observe population diversity in a community. In this calculation, the ShanonWiener diversity index:

$$H' = -\sum Pi \ln Pi = -\sum \frac{ni}{N} \ln \frac{ni}{N}$$

H' : Shannon-Wiener diversity index

Pi : ni/N

ni : Number of individuals in each species

N : Total Number of Individuals

d. Bivalve dominance index

To see whether there is dominance by certain species in bivalves, the Simpson dominance index (Fachrul, 2007):

$$C = \sum [ni/N]^2$$

C : Simpson dominance index

ni : The number of individuals of each species

N : Total number of individuals

e. Sedimentary substrate classification

This method is used to classify sand and silt substrates by weighing  $\pm 100$  grams of dried sediment samples, then sieved using a multilevel sieve net for 15 minutes to obtain separation of sediment particles based on each sieve size. sieve until clean and then weighed. To calculate the % weight of sediment in the dry sieve method, the following formula (Agustina, 2016):

$$\%weight = \frac{sieve\ weight}{total\ weight\ of\ the\ sieve} \times 100\%$$

Sediment classification based on particle size can be seen in Table 1 below:

**Table 1.** Sediment classification based on particle size

| No | Grain Name       | Diameter (mm) |
|----|------------------|---------------|
| 1  | Very coarse sand | 1,00 – 2,00   |
| 2  | Coarse sand      | $\geq 0,50$   |
| 3  | Medium Sand      | $\geq 0,25$   |
| 4  | Fine Sand        | $\geq 0,10$   |
| 5  | Very fine sand   | $\geq 0,05$   |
| 6  | Dust             | $\geq 0,002$  |
| 7  | Silt/clay        | $\leq 0,002$  |

f. Relationship between seagrass cover and bivalves density

To see the relationship between seagrass density and bivalves density, it is analyzed using Simple Linear Regression using SPSS software, the formula used is:

$$Y = a + bX + ei$$

Y = Abundance of Bivalve

X = Seagrass Density

a = intercepts

b = Slopes

ei = Error

To calculate the close relationship between seagrass density and bivalves density, a simple correlation analysis was used. The formula used to calculate the simple correlation coefficient is:

$$r = \frac{n \sum xy - (\sum x)(\sum y)}{\sqrt{n \sum x^2 - (\sum x)^2} \sqrt{n \sum y^2 - (\sum y)^2}}$$

r = correlation coefficient value

x = seagrass vegetation density per transect

y = Bivavian density per transect

## Results

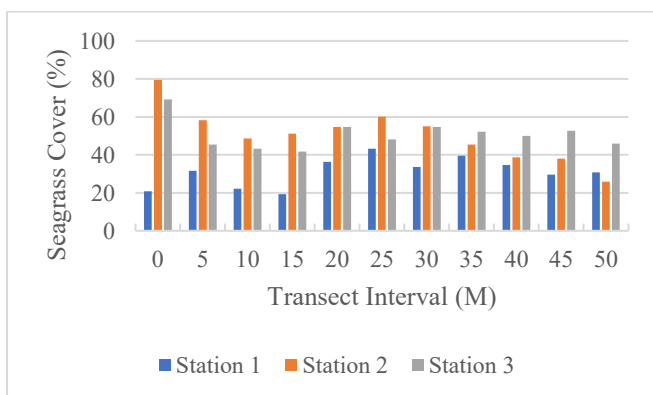
### Seagrass Cover Percentage

The results of calculating the percentage of seagrass cover at each station in the West Bali National Park area show varied values. The percentage of seagrass cover can be seen in Table 2 as follows:

**Table 2.** Seagrass cover percentage

| Transect Distance (m) | Station 1 (%) | Station 2 (%) | Station 3 (%) |
|-----------------------|---------------|---------------|---------------|
| 0                     | 20.81         | 79.42         | 69.12         |
| 5                     | 31.56         | 58.15         | 45.41         |
| 10                    | 22.15         | 48.61         | 43.23         |
| 15                    | 19.22         | 51.13         | 41.63         |
| 20                    | 36.24         | 54.70         | 54.65         |
| 25                    | 43.28         | 60.13         | 48.13         |
| 30                    | 33.67         | 55.09         | 54.63         |
| 35                    | 39.59         | 45.45         | 52.14         |
| 40                    | 34.67         | 38.64         | 49.94         |
| 45                    | 29.58         | 37.93         | 52.59         |
| 50                    | 30.72         | 25.79         | 45.98         |
| Average               | 31.04         | 50.46         | 50.68         |

Seagrass cover values at station 1 ranged from 20.81% - 43.28%. Seagrass cover values at station 2 ranged from 25.79% - 79.42%. The percentage of seagrass cover at station 3 ranges from 41.63% - 69.12%. The average values are 31.04%, 50.46% and 50.68% respectively (Figure 3). Following the Decree of the Minister of Environment No. 200 of 2004 that stations 1, 2, and 3 show moderate status or in less rich water conditions (30-59.9%). The percentage of seagrass cover describes the area of seagrass covering a body of water, where the height of the cover is not always linear with the high density of species. This is influenced by the observed closure of the leaf blades, while the density observed is the number of seagrass stands. The wider the length and width of the seagrass leaves, the greater they cover the bottom substrate of the waters.



**Figure 3.** Graph of seagrass cover at each station

## Bivalve Density

The results of the identification of bivalves found in the West Bali National Park area contained seven species including *Macraa grandis*, *Modiolus*, *Trachycardium flavum*, *Atrina pectinata*, *Aomalodiscus squamosus*, *Pinna bicolor*, *Mytilus viridis*. The highest relative density of bivalves found at station 1 was *Aomalodiscus squamosus* with 29.8% and the lowest was *Mytilus viridis* with 3.6%. At station 2 the highest density was *Pinna bicolor* with 50% and the lowest was *Macraa grandis* and *Atrina pectinata* with 9.1%. The highest relative density of bivalves at station 3 was *Trachycardium flavum* and *Mytilus viridis* at 30.4%, while the lowest were *Macraa grandis* and *Modiolus species* at 8.7%. More detailed data can be seen in Table 3.

**Table 3.** Relative density of bivalves

| No    | Species                       | Relative Density (%) |           |           |
|-------|-------------------------------|----------------------|-----------|-----------|
|       |                               | Station 1            | Station 2 | Station 3 |
| 1     | <i>Macraa grandis</i>         | 21.4                 | 9.1       | 8.7       |
| 2     | <i>Modiolus</i>               | 16.7                 | 13.6      | 8.7       |
| 3     | <i>Trachycardium flavum</i>   | 28.6                 | 18.2      | 30.4      |
| 4     | <i>Atrina pectinata</i>       | -                    | 9.1       | -         |
| 5     | <i>Aomalodiscus squamosus</i> | 29.8                 | -         | 21.7      |
| 6     | <i>Pinna Bicolor</i>          | -                    | 50.0      | 30.4      |
| 7     | <i>Mytilus viridis</i>        | 3.6                  | -         | -         |
| Total |                               | 100.0                | 100.0     | 100.0     |

The relative density of bivalves in Karang Sewu Bay with the highest percentage was *Aomalodiscus squamosus* at 29.8%, in Accept Bay were *Pinna bicolor* at 50%, and in Labuhan Lalang were *Trachycardium flavum* and *Pinna bicolor* at 30.4%. The high value of the relative density of bivalves can be attributed to various physical and chemical factors, such as the type of sediment which is dominated by fine sand (Table 5).

Not all stations found the same species, for example, *Atrina pectinata* and *Pinna bicolor* were not found at station 1. Furthermore, *Aomalodiscus squamosus* and *Mytilus viridis* were not found at station 2. *Atrina pectinata* and *Mytilus viridis species* were not found at station 3.

## Bivalve Diversity Index

The results of the calculation of the diversity index of bivalves found in the West Bali National

Park area at each station were 1.47, 1.36, and 1.48 respectively (Figure 4). Based on the category the Shannon-Wienern index value shows  $1 < H' < 3$  for all stations having a moderate category diversity.

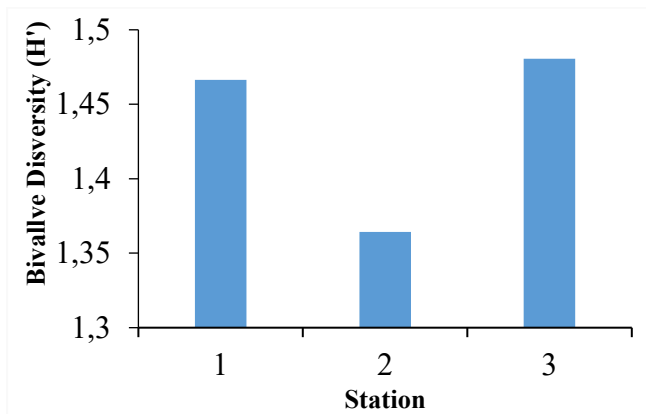


Figure 4. Graph of bivalve diversity

### Bivalve Dominance Index

The results of the calculation of the dominance index of bivalves in the West Bali National Park area at each station were 0.25, 0.32, and 0.25 respectively. Based on the category, the Shannon-Wienern index value shows a value of C close to 0 ( $C < 0.5$ ) for all stations, indicating that there is no species dominance in the area.

### Environmental and Sediment Parameters

The results of water quality measurements in the waters of the West Bali National Park area have normal values. The results of measurements of temperature, water pH, salinity, DO, current speed, and water depth can be seen in Table 4.

Table 4. Environmental Parameters in TNBB

| Environmental Parameters | Station 1 | Station 2 | Station 3 |
|--------------------------|-----------|-----------|-----------|
| Temperature °C           | 28.0      | 28.4      | 29.1      |
| pH                       | 7         | 7         | 7         |
| Salinity (‰)             | 32.7      | 32.7      | 32.7      |
| DO (mg/L)                | 5.9       | 6.3       | 6.4       |
| Velocity (m/s)           | 0.05      | 0.23      | 0.04      |
| Depth (M)                | 0.3       | 0.2       | 0.3       |

The results of the classification of sediments in the West Bali National Park area using five types of mesh. The mesh sizes used include mesh numbers 2.0, 1.16, 0.6, 0.25, and 0.075 (Table 5). Based on the sediment classification, the type of sediment that dominates in the West Bali National Park area from stations 1 to 3 is very fine sand.

Table 5. Results of sediment classification

| No Mesh | Station 1        |          | Station 2        |          | Station 3        |          | Grain Name       |
|---------|------------------|----------|------------------|----------|------------------|----------|------------------|
|         | Sieve Weight (g) | % Weight | Sieve Weight (g) | % Weight | Sieve Weight (g) | % Weight |                  |
| 2.0     | 8.3              | 9.1      | 5.5              | 5.4      | 4.5              | 4.4      | Very coarse sand |
| 1.16    | 9.5              | 10.4     | 8.2              | 8.2      | 5.0              | 4.9      | Coarse sand      |
| 0.6     | 10.4             | 11.4     | 13.1             | 13.1     | 5.9              | 5.7      | Medium sand      |
| 0.25    | 23.9             | 26.2     | 24.2             | 24.1     | 12.9             | 12.6     | Very fine sand   |
| 0.075   | 39.2             | 42.9     | 33.5             | 33.3     | 54.2             | 52.8     |                  |

At a mesh size of 2.0, the highest percentage was found at station 1 with 9.1%. Furthermore, in mesh 1.16 the highest percentage is at station 1 with 10.4%. In the mesh size of 0.6, the highest percentage is at station 2 with 13.1%. Then the mesh size of 0.25 has the highest percentage at station 1 with 26.2%. As well as for a mesh size of 0.075, the highest percentage was found at station 3 with 52.8% (Figure 5).

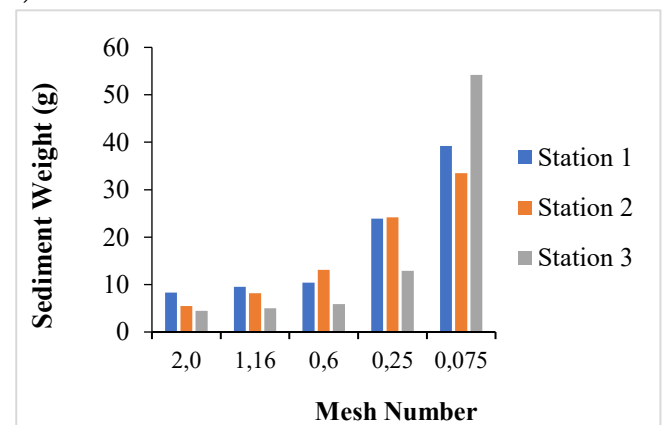


Figure 5. Graph of sediment classification

### Relationship of Seagrass Cover with Bivalve Abundance

The results of the linear regression test were carried out to see whether or not there was an effect of seagrass cover on bivalves density. The ANOVA test results show a significant value of 0.00 or  $< 0.05$  (Table 6). These results indicate the influence of seagrass cover on the density of bivalves in the West Bali National Park area.

Table 6. ANOVA test results

| Model      | ANOVA <sup>a</sup> |    |             |           |                   |
|------------|--------------------|----|-------------|-----------|-------------------|
|            | Sum of Squares     | df | Mean Square | F         | Si g.             |
| Regression | 62.598             | 1  | 62.598      | 19596.141 | .000 <sup>b</sup> |
| Residual   | .022               | 7  | .003        |           |                   |
| Total      | 62.620             | 8  |             |           |                   |

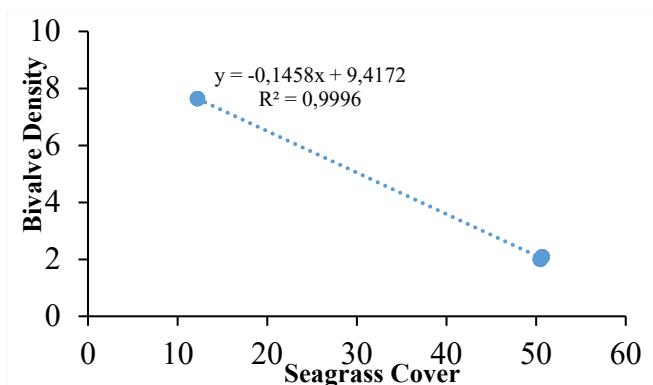
a. Dependent Variable: Bivalves Density

b. Predictors: (Constant), Seagrass cover

The results of the correlation determination ( $R^2$ ) were carried out to see how much influence the seagrass cover had on the density of bivalves. The results of the determination correlation test ( $R^2$ ) show a value of  $0.9996 > 0.90$ . Based on the guidelines according to [Latuconsina \(2013\)](#) these results indicate a very strong or perfect relationship.

**Table 7.** Result of Determination correlation test

| Model Summary                             |                    |          |                   |                            |
|-------------------------------------------|--------------------|----------|-------------------|----------------------------|
| Model                                     | R                  | R Square | Adjusted R Square | Std. Error of the Estimate |
| 1                                         | .9996 <sup>a</sup> | .9996    | .9996             | .05652                     |
| a. Predictors: (Constant), Seagrass cover |                    |          |                   |                            |
| Source: processed using SPSS              |                    |          |                   |                            |



**Figure 6.** Graph of the correlation scatter diagram

## Discussion

The results of environmental parameter measurements ([Table 4](#)) at all stations show relatively the same value. So this is following the opinion of [Dahuri et al., \(2001\)](#) stating that the distribution of seagrass depends on several factors, namely brightness (with a depth of  $<10$  m), temperature ( $28-30^{\circ}\text{C}$ ), salinity (10-40), substrate (40% coarse and fine silt deposits) and water current velocity (about 0.5 m/s). Seagrass can grow in shallow areas at low tide reaching a depth of less than 1 meter at the lowest tide and prefers waters exposed to sunlight.

These results indicate that the higher the seagrass cover, the higher the abundance of bivalves in the area. Physical, chemical, and biological environmental factors have an influence on the existence of a type of macrozoobenthos in the seagrass area. Macrozoobenthos of the bivalve type are generally found on the bottom substrate while other organisms only live temporarily as a place to find food and protection from predators. It is

suspected that the seagrass ecosystem has many food sources for macrozoobenthos originating from the organic decomposition of dead seagrasses. The abundance of macrobenthos is determined by various factors including the physics and chemistry of the waters ([Devi et al., 2019](#); [Ilahi et al., 2014](#)). Bivalves that live in seagrasses have larger body sizes compared to those that live in areas without seagrasses ([Peterson & Heck Jr, 2001](#); [Syukur et al., 2021](#)).

At each station, there is a relationship between seagrass cover and bivalves density. Based on the sediment characteristics of each station, very fine sand is very suitable for a bivalve ecosystem. Bivalve group likes fine sandy substrate for the breeding process ([Ariska, 2012](#); [Chin et al., 2021](#)). Meanwhile, seagrass plants also easily reproduce on fine sand substrates to make it easier for seagrass roots to form colonies ([Agustina, 2016](#); [Vian et al., 2022](#)). The density of bivalves is also influenced by the quality of the water that supports it. Based on the research results, the water quality in the West Bali National Park area is still very optimum.

## Conclusion

Based on the description of the results and discussion above, it can be concluded that there is a relationship between seagrass cover and the density of bivalves found in the waters of the West Bali National Park as indicated by the results of the linear regression test showing a significant value  $<0.5$ . These results indicate that the higher the seagrass cover, the higher the abundance of bivalves in the TNBB area. Meanwhile, the condition of seagrass cover at Karang Sewu Bay (31.04%), Terima Bay (50.46%), and Labuhan Lalang (50.68%) is in the less rich category. The relative density of bivalves in Karang Sewu Bay with the highest percentage was *Aomalodiscus squamosus* at 29.8%, in the Terima Bay were *Pinna bocolor* at 50%, and in Labuhan Lalang were *Trachycardium flavum* and *Pinna bicolor* with 30.4%. For the diversity of bivalves from the three stations, the indexes were 1.47, 1.36, and 1.48 in the moderate category. This means that there is no competition between bivalve species in the West Bali National Park area. Diversity is classified as moderate indicating that the conditions of the aquatic environment are sufficiently supportive for macrozoobenthos life.

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