The improvement of molluscs population: as a parameter of success of local scale mangrove conservation on the south coast of Lombok

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Abstract. Mangroves are known by local people as mangrove plants that contribute to the sustainability of the diversity of marine biota species, such as molluscs. At the study site, mangrove conservation activities have been carried out by the community and are thought to influence the development of molluscs populations significantly. The study aims to assess the results of local-scale mangrove conservation with the development of molluscs populations. The research method uses observation methods with transect methods for ecological data. Ecological data analysis uses the index of evenness, richness, and diversity. The analysis found 27 species of molluscs consisting of 21 species of gastropods and 6 species of bivalves. The highest evenness and diversity was found at 2.4 in Gerupuk, while the highest wealth index was 16.8 in Poton Bakau. Furthermore, the molluscs species found consists of two classes, namely bivalves and gastropods. The main factor in determining species richness, is more determined by the condition of the substrate. In this case, the presence of mangroves is very important in creating the substrate conditions needed by the diversity of mollusc species. Therefore, mangrove conservation is very important for the protection and preservation and diversity of molluscs species. Information on the ecological potential of mangroves on fauna diversity, especially molluscs, can be a major source of ecosystem-based marine resource management, such as at the study site.

Keywords: Mangrove Conservation, Local Scale, Mollusc Population, Coastal East Lombok

1. Introduction
Mangrove conservation programs at global, regional and local scales have shown significant results, from an ecological aspect [1]. Mangrove ecosystems have essential functions, such as; provision of food for marine biota, fish habitat, habitat for marine biota, source of marine fertility, as water purification, flood control and absorption of heavy metals [2]. Furthermore, the existence of mangroves is required by the diversity of fauna species in their life cycle such as: crustaceans, insects, fish, vertebrates, mammals, primate groups and rivers birds [3,4]. Meanwhile, the success of mangrove management has significantly affected the diversity of molluscs, including the diversity of gastropods and bivalves, and has become a bioindicator [5]. In addition, the ecological function of bivalvia in mangrove ecosystems is to accumulate pollutants [6].
In the ecological system, molluscs have a role in the food web formed in the mangrove ecosystem and can determine the trophic structure of the ecosystem [7, 8]. Bivalves are a group of animals that get their food by filter feeders [9]. In addition, some bivalves, especially shipworms (Teredinidae) play a
very important role in the decomposition and recycling of dead wood [10]. Bivalves in some mangrove areas can be related to sediment texture such as pH and organic matter. However, sediment pH can influence shell erosion [11]. Meanwhile, molluscs diversity can be an indicator for changes in mangrove ecosystem habitat [5]. Furthermore, environmental changes in mangroves will affect the diversity of gastropod and bivalvia species [12].

Mangrove vegetation on the east coast of south Lombok has successfully re-vegetated starting in 1990, especially from the species Rhizophora apiculata and Rhizophora stylosa [13, 14]. In addition, the success of mangrove revegetation is a conservation indicator for the survival of fauna diversity on the south coast of East Lombok [15]. Moreover, indicator of the success of mangrove revegetation is the abundance of fauna with economic value as a source of livelihood for local communities on the southern coast of East Lombok [16]. Another ecological aspect as an indicator of the success of mangrove conservation is the value of its carbon content for environmental sustainability and its conservation on a local scale [17]. The success of mangrove revegetation in the study area is a local scale conservation model involving community participation. However, to assess it comprehensively from an ecological aspect requires other indicators, such as from associated biota, especially bivalves. Studies on the development of the bivalves population as an indicator of mangrove conservation in the study area have not been carried out. Therefore, research from the ecological aspect of mangrove association biota needs to be done. The purpose of this study is to investigate and describe the development of bivalves populations as a parameter of the success of local-scale mangrove conservation.

2. Materials and Methods

2.1. Research sites

The mangrove ecosystem on the south coast of the island of Lombok is spread from the southern East Lombok district and the southern part of Central Lombok district. Research data collection was carried out at 4 locations: Tanjung Luar, Poton Bakau and Teluk Jor (East Lombok) and in the district of Central Lombok is Gerupuk (Figure 1). The study lasted from the month of April - July 2021. Furthermore, the important value of the existence of the mangrove ecosystem in the study location, is to support the diversity of fish species associated with seagrass [18] other biota associated with seagrass, such as Bivalvia [19] and Echinoderms [20].

![Figure 1. Map of research locations.](image)

2.2. Data Collection and Analysis

The source of research data is fauna and ecology data. Fauna and ecological variables include: species name, number of individuals, as well as environmental parameters measured were pH,
substrate type, substrate depth, salinity and temperature. Fauna data retrieval using the quadratic method. Furthermore, environmental data collection: salinity using a refractometer, temperature with a mercury thermometer, pH meter, substrate type and depth were observed directly. Analysis of research data using descriptive statistical analysis. Meanwhile, the analysis of the data on the ecological index uses several analyzes, including the analysis of diversity using the formula of [21], the analysis of wealth and evenness using the formula of [21]. Furthermore, to see the relationship between environmental parameters and ecological indicators (diversity, evenness, and richness) can use the Pearson correlation formula using SPSS 17 software and Microsoft Excel.

3. Results and Discussion

3.1. Molluscs Species Composition at the Study Site
Molluscs are soft animals that have shells. Molluscs are found in many mangrove ecosystems, living on the surface of the substrate as well as in the substrate and attached to mangrove trees. Most molluscs that live in mangrove ecosystems are gastropod and bivalves species. The results of the study species of molluscs and bivalves are in found in four locations research are 27 species (Table 1). The research conducted by the researcher is at 4 locations Tanjung Luar, Gerupuk, Poton Bakau, and Telok Jor. Mollusc species found in the four locations are generally Gastropod species, only a few are Bivalves species. The number of species from the class Gastropods is in line with that written by [22] which states that Gastropods are the class of molluscs that are most successful in living in a variety of varied habitats. The number of gastropods found at each location, due to their high adaptability in both hard (sand) and soft (mud) substrates. In addition, because gastropods have a more active mobile nature than bivalves [23]. Based on the results of the study, mollusc species that were evenly distributed in all locations were Cerithidea cingulata, Cerithidea quadrata, Littoria scabra, and Nerita undata, while others were only found in several locations, species that were only found in one location, namely Chicoreus capunicus, Oliva sp., Assiminea lutea, Cassidula nucleus, Cerithidea quoyii, Cerithidea obtuse, Haminoea tenera, and Platevindex s. most commonly found molluscs that Cerithidea cingulata is because Cerithidea cingulata, have behavioral adaptations are more active when spiring tide (high tide and surutrendah) of the neap tide. During neap tide, these gastropods tend to take shelter from drought and hide in mud or under mangrove roots [24]. Based on research that has been carried out on the abundance of molluscs species obtained from 4 locations, the highest abundance is found on the coast of the Tanjung Luar (Table 3.1). The high value of the abundance of these organisms is influenced by the condition of the substrate in the form of sandy mud and contains many kinds of organic matter. According to [25] sandy silt substrate is a factor that affects the composition and distribution of gastropods. According to [26] such a substrate is a very good environment for the survival of Gastropod organisms.

Based on the distribution table molluscs species and bivalvia located in 4 locations mangrove taken on the island of Lombok, namely: Tanjung Luar, Teluk Jor, Poton Bakau, and G erupuk. 14 species were found on the Tanjung Luar, 4 other species were found on the Teluk Jor, and 8 species were found on the Gerupuk, and 1 species in Poton Bakau (Table 1). If it is related to the conditions of the substrate, hydrography and vegetation in each research location, it can be assumed that the complexity greatly affects the composition and diversity of the existing molluscs species. The existence of mangrove, seagrass and coral reef ecosystems with good conditions plays a major role in the many types of molluscs found. For example, the variety of substrates and ideal seagrass habitats on the coast allows the availability of sufficient food for molluscs as well as shelter for their survival and ultimately affects the diversity of molluscs species that exist [27].
### Table 1. Number of individuals in each research location.

| No | Species                  | Tanjung Luar | Teluk Jor | Gerupuk | Poton Bakau |
|----|--------------------------|--------------|-----------|---------|-------------|
| 1  | Cerithidea cingulate     | 65           | 50        | 9       | 60          |
| 2  | Cerithidea quadrata      | 7            | 9         | 6       | 5           |
| 3  | Chicoreus sp.            | 5            | 4         | 0       | 7           |
| 4  | Littoria scabra          | 6            | 8         | 3       | 4           |
| 5  | Littoraria melanostoma   | 5            | 3         | 0       | 3           |
| 6  | Nerita undata            | 16           | 12        | 7       | 13          |
| 7  | Pomacea canaliculata     | 4            | 5         | 0       | 4           |
| 8  | Strombus sp.2            | 7            | 0         | 3       | 3           |
| 9  | Sulcospira sp.           | 4            | 9         | 0       | 0           |
| 10 | Terebralia sulcata       | 3            | 2         | 9       | 0           |
| 11 | Anadara granosa          | 5            | 5         |         |             |
| 12 | Isognomon ephippium      | 4            | 5         | 0       | 5           |
| 13 | Polymesoda erosa         | 5            | 7         | 0       | 6           |
| 14 | Myristic Volema          | 0            | 3         | 0       | 4           |
| 15 | Ensis directus           | 0            | 7         | 0       | 3           |
| 16 | Saccostrea cuculata      | 0            | 3         | 0       | 7           |
| 17 | Chicoreus capunicus      | 0            | 3         | 0       | 0           |
| 18 | Murex sp.                | 0            | 0         | 3       | 2           |
| 19 | Oliva sp.                | 0            | 0         | 0       | 5           |
| 20 | Assiminea lutea          | 0            | 0         | 35      | 0           |
| 21 | Cassidula aurisfelis     | 8            | 0         | 3       | 0           |
| 22 | Cassidula nucleus        | 0            | 0         | 8       | 0           |
| 23 | Chicoreus capunicus      | 0            | 0         | 13      | 8           |
| 24 | Cerithidea quoyii        | 0            | 0         | 3       | 0           |
| 25 | Cerithidea obtuse        | 0            | 0         | 3       | 0           |
| 26 | Haminoea tenera          | 0            | 0         | 7       | 0           |
| 27 | Platevindex sp           | 0            | 0         | 5       | 0           |
|    | Total Individual         | 144          | 135       | 117     | 143         |

### Table 2. Number of individuals, individual mean, standard deviation (SD) and standard error (SE) of molluscs at each study site.

| No | Location        | Number of individuals | Average number of individuals (X) | Standard Deviation (SD) | Standard Error (SE) |
|----|-----------------|-----------------------|-----------------------------------|-------------------------|---------------------|
| 1  | Tanjung Luar    | 144                   | 5.3                               | 12.51                   | 3.54                |
| 2  | Teluk Jor       | 135                   | 5                                 | 9.66                    | 3.11                |
| 3  | Gerupuk         | 117                   | 4.5                               | 7.23                    | 2.69                |
| 4  | Poton Bakau     | 143                   | 5.3                               | 11.4                    | 3.38                |
|    | Total Individual| 539                   |                                    |                         |                     |
The abundance of molluscs for each research location in the mangrove ecosystems of Tanjung Luar, Teluk Jor, Poton Bakau, and Gerupuk is presented in (Table 2). The highest abundance of molluscs in Tanjung Luar is 5.3 X, SD 12.51 and SE 3.53. Meanwhile abundance molluscs least at Gerupuk that is equal to 4.5 X. At station 1 (Tanjung Luar) abundance molluscs highest are species Cerithidea cingulata, followed by Nerita undata. At station 3 the highest abundance of molluscs was Assiminea lutea species, followed by Chicoreus capunicus species. Habitat characteristics and environmental conditions such as vegetation, sediment type, temperature, and salinity which are almost the same will have similar compositions and abundances of gastropods [28]. The influence of the mangrove vegetation structure lies in the availability of feed for molluscs associated with mangroves, most of which are litter eaters [29, 30, 31] stated that mangrove molluscs tended to prefer Avicennia marina leaves which were not found in the Gerupuk mangrove rehabilitation area. In addition, the high dominance of Rhizophora species in Gerupuk limits the types of molluscs that can associate. Molluscs that feed directly on mangrove leaves have specific properties for certain types of mangroves [31], so that Rhizophora species cannot replace other mangrove species as feed for molluscs that feed directly on mangrove leaves.

3.2. Diameter of Mangrove Fauna at the Study Site

Table 3 shows the diameters of molluscs species, from four locations where molluscs data was collected, namely: Tanjung Luar, Teluk Jor, Poton Bakau, and Gerupuk. Species Cerithidea cingulata had the highest average diameter of 13.56, followed by Nerita undata with an average diameter of 3.44. Next is the species Assiminea lutea with an average diameter of 2.19, the species Cerithidea quadrata has a diameter of 1.63. Then the species that have the smallest diameter, namely Chicoreus capunicus and Cerithidea quoyii have an average diameter of 0.19. This shows that some species have abundant numbers. The variation of molluscs found at the research site is influenced by one factor, for example there is the taking of types of molluscs that have economic value, especially as alternative food sources such as species from the family strobidae, trocidae, and species from the existing bivalves class [32].

3.3. Correlation of Environmental Factors with Bivalves

The results of observations on the condition of the aquatic environment at each location during the research period. The average value of all of the variables is a pH between 7, 3 ppt - 7.6 ppt, temperature 26.7 °C - 29.7 °C, between 24.91 ppt salinity - 33.5 ppt, and a depth of between 57.3 cm – 92 cm (Figure 2). The condition of the aquatic environment at the study site is still within the tolerance range required for the growth and development of molluscs species. For example, salinity tolerance ranges between 19 and 44 pp, temperature 10 °C - 42 °C [33]. Furthermore, salinity are the main factors that affect the distribution patterns and densities [34]. The results also showed that the 4 study sites had almost the same substrate where there were sandy mud, muddy sand, and muddy silt. The majority of mollusc organisms prefer to live in sandy silt substrates. Molluscs tend to choose sandy mud substrates because sand is easy to move/mobilize, while mud substrates tend to have low oxygen levels, therefore organisms that live in them must be able to adapt.
Table 3. Mollusc diameter at the study site.

| No | Species                | Number of individuals/locations | Mean±SD    |
|----|------------------------|---------------------------------|------------|
|    |                        | Tanjung | Luar | Teluk | Jor | Gerupuk | Poton | Bakau |           |
| 1  | Cerithidea cingulate   | 65      |      | 50    | 9   | 60      |       |       | 13.56±2.57 |
| 2  | Cerithidea quadrata    | 7       |      | 9     | 6   | 5       |       |       | 1.63±0.60  |
| 3  | Chicoreus sp.          | 5       |      | 4     | 0   | 7       |       |       | 1.00±0.74  |
| 4  | Littoria scabra        | 6       |      | 8     | 3   | 4       |       |       | 1.56±0.43  |
| 5  | Littoraria melanostoma | 5       |      | 3     | 0   | 3       |       |       | 0.69±0.52  |
| 6  | Nerita undata          | 16      |      | 12    | 7   | 13      |       |       | 3.44±0.43  |
| 7  | Pomacea canaliculata   | 4       |      | 5     | 0   | 4       |       |       | 0.81±0.55  |
| 8  | Strombus sp.           | 7       |      | 0     | 3   | 3       |       |       | 1.00±0.74  |
| 9  | Sulcospira sp.         | 4       |      | 9     | 0   | 0       |       |       | 0.81±1.07  |
| 10 | Terebralia sulcata     | 3       |      | 2     | 9   | 0       |       |       | 0.88±0.97  |
| 11 | Anadara granosa        | 5       |      | 5     | 0   | 4       |       |       | 1.06±0.83  |
| 12 | Isognomon ephippium    | 4       |      | 5     | 0   | 5       |       |       | 0.94±0.63  |
| 13 | Polymesoda erosa       | 5       |      | 7     | 0   | 6       |       |       | 1.06±0.77  |
| 14 | Myristic Volema        | 0       |      | 3     | 0   | 4       |       |       | 0.56±0.66  |
| 15 | Ensis directus         | 0       |      | 7     | 0   | 3       |       |       | 0.63±0.83  |
| 16 | Saccostrea cuculata    | 0       |      | 3     | 0   | 7       |       |       | 0.63±0.83  |
| 17 | Chicoreus capunicus    | 0       |      | 3     | 0   | 0       |       |       | 0.19±0.38  |
| 18 | Murex sp.              | 0       |      | 0     | 3   | 2       |       |       | 0.38±0.48  |
| 19 | Oliva sp.              | 0       |      | 0     | 0   | 5       |       |       | 0.31±0.63  |
| 20 | Assiminea lutea        | 0       |      | 0     | 35  | 0       |       |       | 2.19±0.38  |
| 21 | Cassidula aurisfelis   | 8       |      | 0     | 3   | 0       |       |       | 1.00±1.15  |
| 22 | Cassidula nucleus      | 0       |      | 0     | 8   | 0       |       |       | 0.19±0.38  |
| 23 | Chicoreus capunicus    | 0       |      | 0     | 13  | 8       |       |       | 0.81±0.94  |
| 24 | Cerithidea quoyii      | 0       |      | 0     | 3   | 0       |       |       | 0.19±0.38  |
| 25 | Cerithidea obtuse      | 0       |      | 0     | 3   | 0       |       |       | 0.81±1.63  |
| 26 | Haminoea tenera        | 0       |      | 0     | 7   | 0       |       |       | 0.31±0.63  |
| 27 | Platevindex sp.        | 0       |      | 0     | 5   | 0       |       |       | 0.31±0.63  |
Figure 2. Condition of the aquatic environment at the study site

The correlation index of species diversity, richness and evenness with environmental parameters is presented in (Table 3 and 4). Environmental factors that have the highest correlation with the value of diversity with temperature ($r = 0.906$) and the lowest with salinity ($r = 0.216$). Furthermore, the evenness value has the highest correlation with temperature ($r = 0.798$) and the lowest is pH ($r = 0.090$), while wealth has the highest correlation with environmental factors salinity ($r = 0.842$) and has the lowest correlation with temperature ($r = 0.215$). The correlation value of environmental factors is an important factor to explain the presence of molluscs in the research location. Based on the measurement results of physical parameters, the numbers obtained in each parameter are numbers that are within normal limits. This means that this condition is still in good condition, can support marine life optimally. Good conditions can be maintained if the ecosystem has not had a significant influence from human intervention [35].

Table 4. Correlation of environmental parameters with ecological index.

|          | Temperature | Salinity | pH    | Depth | Diversity | Evenness | Rhicness |
|----------|-------------|----------|-------|-------|-----------|----------|----------|
| Temperature | 1          |          |       |       |           |          |          |
| Salinity  | 0.215       | 1        |       |       |           |          |          |
| pH       | 0.664       | 0.871    | 1     |       |           |          |          |
| Depth    | 0.393       | 0.812    | 0.426 | 1     |           |          |          |
| Diversity| 0.906       | 0.216    | 0.291 | 0.740 | 1         |          |          |
| Evenness | 0.798       | 0.412    | 0.090 | 0.859 | 0.978     | 1        |          |
| Rhicness | 0.215       | 0.842    | 0.513 | 0.905 | 0.597     | 0.743    | 1        |

The results of cluster analysis are grouping observation stations based on the value of the ecological index ($H'$), ($E$), ($R$), and environmental parameters (Table 5). Value resemblance
highest between stations namely Poton Bakau with Gerupuk, and values reached 20.936 %, and which has the lowest similarity value is Tanjung Luat with Gerupuk, and the similarity value is 3,435 %. The grouping of similarities between observation stations can be seen in (Figure 3). The similarity index value between stations can explain the proximity of each station from the ecological index of molluscs species.

| Location      | Tanjung Luat | Teluk Jor | Poton Bakau | Gerupuk |
|---------------|--------------|-----------|-------------|---------|
| Tanjung Luat  | *            | 16,717    | 18,639      | 3,435   |
| Teluk Jor     |              | *         | 16,270      | 8,0001  |
| Poton Bakau   |              |           | *           | 20.936  |
| Gerupuk       |              |           |             | *       |

**Table 5.** Similarity index of mollusc species on the South Coast (Sorrenson Index).

![Dendrogram using Single Linkage](image)

**Figure 3.** Dendrogram based on the similarity of species from each research location.

4. **Conclusion**

Based on research that has been done in Tanjung Luat, Teluk Jor, Poton Bakau, and Gerupuk, it can be concluded that the mollusc species found consisted of two classes, namely bivalves and gastropods. The main factor in determining species richness, is more determined by the condition of the substrate. In this case, the presence of mangroves are very important in creating the conditions subt s rat required by the diversity of molluscs. Therefore, mangrove conservation is very important for the protection and preservation and diversity of mollusc species. Information on the ecological potential of mangroves on faunal diversity, especially molluscs, can be a major source of ecosystem-based marine resource management, such as at the study site.

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Author's Contributions

Agil Al Idrus, Abdul Syukur, Baiq Nunung Hidayati, Wahyu Bintang Ilahi, Erna Ajizah. Conducted all experiments, observation, analysis, and paper manuscript preparation.

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