

THE MANGROVE ECOSYSTEM POTENTIAL FOR EDUCATIONAL TOUR DEVELOPMENT AROUND POND EDUCATION OF HASANUDDIN UNIVERSITY (UNHAS) IN MALLUSETASI DISTRICT, BARRU REGENCY.

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ABSTRACT

This research was conducted in October 2017. The research location was the Hasanuddin University Education Pond, Bojo Village, Mallusetasi District, Barru Regency. The objectives of this study were: (a) To identify the various types of mangroves that make up the educational field in the Hasanuddin University Education Pond; (b) To Identify and to recognize the organisms associated with various types of mangroves that compose educational sites on the coast of the UNHAS Education Pond, and (c) To analyze data and information related to mangrove ecosystems and their associated organisms for the suitability of Education. Mangrove data collection using transect (Line transect) with 10 x 10 meters plot area, while collecting macrozoobenthos data using a scope and sieve net, while observing other parameters at the five stations with three replications carried out based on instructions (Englis, et al., 1994; Noor, et al., 1999; Saru, 2013; and Bahar, et al., 2015). The results showed that 3 mangrove families were identified, namely Avicenniaceae, Rhizophoraceae, and Sonneratiaceae consisting of 7 species of mangrove, namely: *Avicennia marina*, *Bruguiera gymnorhiza*, *Ceriops decandra*, *Rhizophora apiculata*, *R. mucronata*, *R. stylosa*, and *Sonneratia alba*. While the associated organisms, namely: 3 species for Carustacea, 4 species for Fish, 7 species for Mollusca, 3 species for Bird and 1 species for Reptile. Based on the results of land suitability analysis showed that the ecosystem of mangrove in Hasanuddin University Education Pond included in the conditional category for the development of Mangrove Education tour.

Keywords: Mangrove Ecosystem, Education Tour Development, UNHAS Education Pond.

INTRODUCTION

Barru Regency has a coastline length around 18,055 meters or 18 km, most of which are covered with mangroves with an area of about 113.02 ha, including in Mallusetasi District, there are around 3.16% of the total mangrove area growing on the coast of Barru Regency, while the width area in Bojo Village is around 3.25 ha or around the location of the Unhas Education Pond (Saru, 2013 and Iham, 2018). Mangrove ecosystems can contribute positively to controlling the pace of global climate change and ecological dynamics of an ecosystem, in addition mangrove ecosystems also has functions as ecological stability or balance of ecosystems, nutrient sources, as nursery areas, feeding ground areas, and spawning ground. The important role of the mangrove ecosystem indicates that the mangrove ecosystem needs special attention, so as to avoid damage both naturally and anthropogenic-ally, including visitors of educational tour activities.

Based on the initial survey results in the UNHAS Education Pond area, especially in the mangrove area or we call educational tour activities with the name "Crab Park Indonesia -Hasanuddin University Education Park". This educational tour activity is a partnership between Faculty of Marine Science and Fisheries (FIKP) of Hasanuddin University and the private sector, this is done to optimize the UNHAS assets. One of the educational tour activities that is very related to the mangrove ecosystem, namely

installation of Titian or Tracking in the mangrove area, this activity aimed to pamper visitors to learn directly to nature through direct monitoring of the Mangrove Ecosystem and its associated Organisms.

The existence of the educational tour activity is thought to trigger two possible changes in the mangrove ecosystem, namely: (1) good environmental monitoring and management, especially the mangrove ecosystem by the educational manager, so that the mangrove can develop properly, the density, composition of species and the size of the area increases, including associated organisms; (2) inadequate supervision and management of the environment that causes damage to mangrove ecosystems. If this happens then the Mangrove Ecosystem is degraded, the density, species composition and the width area will be reduced, including the decrease in associated organisms. Therefore it is necessary to do research on How the Potential of Mangrove Ecosystems for Educational Development around the Unhas Educational Pond in Mallusetasi District, Barru Regency. The purpose of this research were: (a) Identifying various types of mangroves that grow or arrange educational activities in the coastal areas of UNHAS Education Pond; (b) Identifying and recognizing organisms or macrozoobenthos associated with various types of mangroves that compose educational tour sites on the coast of the UNHAS Education Pond, and (c) Analyzing data and information related to mangroves

with macrozoobenthos using ecological analysis methods.

MATERIALS AND METHODS

This research was carried out in August - October 2017. The research was conducted at the Hasanuddin University Education Pond, Bojo Village, Mallusetasi District, Barru Regency (Figure 1). Mangrove samples analysis, organisms and environmental parameters were carried out at the Marine Ecology Laboratory and the Physics and Geomorphology Oceanography Laboratory, Department of Marine Sciences, Faculty of Marine Sciences and Fisheries, Hasanuddin University.

The equipments used in this research were GPS, stationary, digital cameras, compasses, roll meters, raffia ropes, pH meters, Handrefractometers, thermometers, scale poles, scopes, paralon pipes, cool boxes, sieve nets, markers, and boats, fishing gear 2 inch mesh size gill nets, label paper, markers and tissue. While the materials used in this research including identification sheets and a guide to the mangroves introduction in Indonesia (Noor et al., 2006), fish identification books, macrozoobenthos identification books (Darma, 1988; Darma, 1992; Colin and Arneson, 1995).

Determination of Research Station

Determination of the station is based on the presence of mangrove species that grow around the research site. The principle of determining this station is based on the representation of the existence of mangroves, where there are 5 stations consisting of 3 replications, each repetition has a number of plots that are adjusted to the thickness of the mangrove.

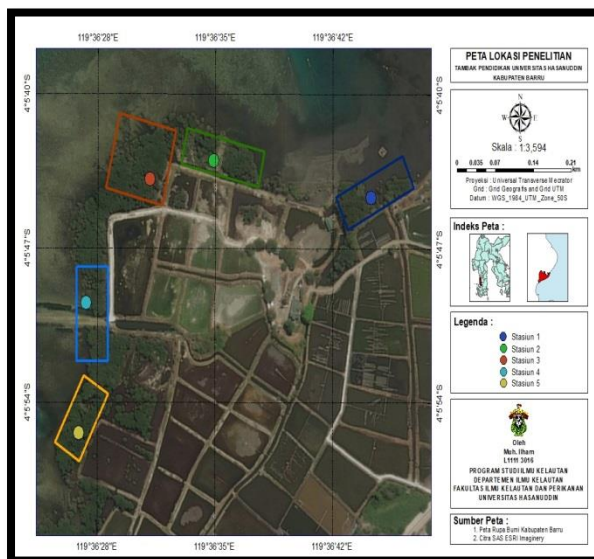


Figure 1. Research location Map, Pannikiang Island in Barru Regency

Measurement of Research Parameters

The mangrove data measurement was carried out using the transect method (line transect), which is to draw lines drawn perpendicularly from the coastline to the station that is adjusted to the extent of the mangrove species growing. Each transect that has been formed at each observation station, in which a 10x10 (m) plot is made for the tree level, mangrove thickness is measured manually using a roll meter that is drawn perpendicular to the coastline starting from the mangrove forest at the sea boundary to the landline (English et al., 1994). Identify the names of mangrove species that were not yet known or by taking parts or pieces from branches, complete with flowers and leaves and were identified based on the mangrove identification book (Noor, 1999). Next, count the mangrove species number and measure the mangrove tree diameter where for the category of trees are woody plants with ≥ 4 cm diameter (Bahar et al., 2015).

Mollusca, Crustacean and water quality samples were taken at each station that was determined, simultaneously based on the procedure: (1) Mollusca and Crustaceans, sampled using a trowel, samples containing macrozoobenthos mixed with sediment were separated by using sieve net, macrozoobentos samples inserted into the in a labeled sample bag, preserved with alcohol and subsequently identified in the laboratory. Sampling was performed 3 times for each observation station. Measuring the supporting variables such as: Temperature, salinity, pH, and basic sediments are carried out simultaneously with the taking of the main variables at each observation station; (2) Identification of Macrozoobenthos Samples, based on manuals: Colin and Arneson (1995), Dharma (1988), Dharma (1992), Gem (1984), Mapstone (1990), Sabelli (1982).

Data analysis

Mangrove data obtained from the field were then analyzed to determine the density of type i (D_i) and closure of type i (C_i) (Bengen, 2002 and Kusmana, 1997). The mangroves condition is based on the standard of mangrove density and closure based on the Minister of the Environment Number 201 of 2004. Whereas macrozoobnetos were analyzed using the Shannon Wiener Formula in (Odum, 1971), to find out: the abundant species (K), diversity (H'), uniformity (E) and dominance (D). Furthermore, to determine the condition of the mangrove ecosystem at the research site, the Ecological Index was used (Odum, 1971; Whtter, 1987 and Naughton, 1990).

RESULTS AND DISCUSSION

Overview of Research Locations

UNHAS Education Pond Area consists of fishpond areas and there are 2 parts of the fish hatchery area.

The distance of fish hatchery is about 500 m from the pond. Both fish and shrimp hatcheries are located on the coast and the Makassar – Pare-Pare axis road. The distance between the two hatcheries is around 80 m, the UNHAS education pond has an area of 212,550 m², located in Bojo Village, Mallusetasi District, Barru Regency. The boundaries are as follows: North is bordered by the Sea, East is bordered by the Makassar-Pare-Pare Road, South is bordered by Pond, West is bordered by the Makassar Strait, as shown on the location map (Figure 2). UNHAS Education Pond with a height of about 2 meters above sea level and an area of 20.63 ha/m², has a wide enough rice fields, with a distance to the district capital ± 1.00 km, and distance to the regency capital ± 35.00 km and distance to the provincial capital ± 115 km. The total population of Bojo Village is 3,564 people.

Mangrove Conditions

Based on the results of research and measurements of the thickness of mangrove ecosystems of each station from the coastline to the land carried out in the UNHAS Education Pond Area obtained results at each station, namely: Station I had an average thickness of mangrove 47.67 m, Station II, the average mangrove thickness was 31.67 m, Station III had an average thickness of mangrove 46.33 m, an average thickness of mangrove in Station IV was 41.33 m and Station V had an average thickness of mangrove 53.00 m. This explains that the highest thickness was found in station V compared to Station I, II, III and IV. Based on mangrove thickness parameters (Ministry of Environment Decree no. 21 of 2014 and Yulianda, 2007), the categories for stations I, II, III, IV were bad for mangrove tourism because they were less than 50 m. Mangrove ecosystems in the UNHAS Educational Pond Area are not yet well known by tourists, both local and long distance. Although a wooden bridge facility (trail) has been built for visitors can enjoy the mangrove forest in UNHAS Educational Pond area. This bridge is not yet a good enough reason for visitors to enjoy the condition of mangrove forests that are quite thick.

Mangrove Type Composition

Based on the identification results carried out in the field, 3 mangrove Families were found, namely Avicenniaceae, Rhizophoraceae, and Sonneratiaceae. Species identified include: *Avicennia marina*, *Bruguiera gymnorhiza*, *Ceriops decandra*, *Rhizophora apiculata*, *R. mucronata*, *R. stylosa*, *Sonneratia alba*. Data on the types of mangroves found in the UNHAS Education Ponds area are presented in Table 1.

Table 1. Composition of mangrove species found in the UNHAS Education Pond Area

Station	Mangrove Typpes	Average (m2)	Tree
I	<i>Avicennia marina</i>	1,00	
	<i>Rhizophora stylosa</i>	1,50	
	<i>Sonneratia alba</i>	2,00	
	<i>Rhizophora apiculata</i>	3,20	
II	<i>Rhizophora apiculata</i>	3,00	
	<i>Bruguiera gymnorhiza</i>	4,00	
	<i>Ceriops decandra</i>	4,00	
	<i>Rhizophora stylosa</i>	6,67	
	<i>Sonneratia alba</i>	11,00	
III	<i>Sonneratia alba</i>	1,00	
	<i>Bruguiera gymnorhiza</i>	2,50	
	<i>Rhizophora apiculata</i>	7,50	
	<i>Rhizophora mucronata</i>	8,00	
	<i>Rhizophora stylosa</i>	9,00	
IV	<i>Sonneratia alba</i>	1,50	
	<i>Rhizophora apiculata</i>	2,50	
	<i>Rhizophora stylosa</i>	7,67	
V	<i>Rhizophora stylosa</i>	8,42	

Table 1 shows that at station i there were 4 species namely *Avicennia Marina*, *Rhizophora Apiculata*, *Rhizophora Stylosa* and *Sonneratia Alba*. Station II there were 5 species namely *Bruguiera Gymnorhiza*, *Ceriops Decandra*, *Rhizophora Apiculata*, *Rhizophora Stylosa* and *Sonneratia Alba*. Station III had 5 species namely *Bruguiera Gymnorhiza*, *Rhizophora Apiculata*, *Rhizophora Mucronata*, *Rhizophora Stylosa*, *Sonneratia Alba*. Station IV had 3 species namely *Rhizophora Apiculata*, *Rhizophora Stylosa* and *Sonneratia Alba*. Station V had 1 species, namely *Rhizophora Stylosa*. Based on the parameters of mangrove types (yulianda, 2007), the categories for stations I, II, III and IV were quite good because the number of species was between 3-5, while station V was not good because the number of species was only one. The numbers of mangrove species in this area were the result of mangrove rehabilitation done by students who were conducting the field practices and managers of UNHAS Education Ponds in collaboration with surrounding communities and become a potential for mangrove education tour in attracting the attention of tourists and researchers.

Mangrove Species Density

Species density is the number of stands of a species in one unit area (Bengen, 2004). The density value of mangrove vegetation in the UNHAS Education Pond Area is presented in Table 2.

Table 2. Density values of mangrove species found in the Hasanuddin Education Pond Area

Station	Mangrove Species	Number of Tree (Ni)	Density (Ind/m ²)
I	Avicennia marina	1	0,01
	Rhizophora	16	0,16
	Rhizophora stylosa	3	0,03
	Sonneratia alba	2	0,02
	Total	22	0,22
	Average		0,03
II	Bruguiera	4	0,04
	Ceriops decandra	4	0,04
	Rhizophora	3	0,03
	Rhizophora stylosa	20	0,20
	Sonneratia alba	11	0,11
	Total	42	0,42
	Average		0,10
III	Bruguiera	4	0,04
	Rhizophora	30	0,30
	Rhizophora stylosa	18	0,18
	Rhizophora	8	0,08
	Sonneratia alba	3	0,03
	Total	63	0,63
	Average		0,09
IV	Rhizophora	5	0,05
	Rhizophora stylosa	46	0,46
	Sonneratia alba	3	0,03
	Total	54	0,54
	Average		0,09
V	Rhizophora stylosa	59	0,59
	Total	59	0,59
	Average		0,08

From the calculated results of the density value of mangrove species based on tree categories at all stations shows that *Rhizophora stylosa* has the highest density value when compared to other types. Based on the average density value at each Station, Station I had a density value of 0.03 ind/m², Station II had a density value of 0.10 ind/m², Stations III and IV had the same density value of 0.09 ind/m², Station V had a density value of 0.08 ind/m². The density parameter (Yulianda, 2007), the category for all stations is bad enough for mangrove tourism because the value was between 5-10 ind/m².

Environmental Parameters

Tidal measurements at the research location were at coordinates 4°05'.701" South and 119°36'.684" East. The measurement results show the type of daily tidal (semi diurnal tide) which is a tide that the rise and the low of tides occur twice that are almost the same height in one day (Wyrski, 1961). Data on tides was

the primary data obtained from measurements at the research location for 39 hours. From tidal data analysis shows that the water level at the research site at the time the highest tide reached 93.00 cm on the tidal signs while the water level at the lowest ebb was 20.00 cm, indicating that the tidal range obtained was 57.50 cm, the tidal range is in the good category (Yulianda, 2007) for the selection of mangrove tourism sites by considering safety and affecting the vertical distribution of mangroves.

The salinity value obtained at the research location from the results of measurements in the field of each station namely Station I had an average salinity value of 31.99 ppt, Station II 31.50 ppt, Station III 34.62 ppt, Station IV 34.33 ppt and Station V 34.11 ppt. High salinity is found at Station III while low salinity is found at Station II. UNHAS Education Pond Area has tidal conditions that greatly affect salinity in mangrove habitats. Salinity conditions measured in the field were suitable for mangrove growth. This is supported by the opinion (Sultan, 2001) which states that mangrove ecosystems can grow in the range of salinity to 42 ppt.

Table 3. Biota found in mangrove forests in the UNHAS Education Pond Area

Biota Objects	Latin Names	Indonesian Names	English Language
Fish	Mugil sp.	Ikan	Mullet
	Epinephelus Bleekeri	Ikan Kerapu Lumpur	Mud Grouper Fish
	Periophthalmus sp.	Ikan Gelodok	Shod Fish
	Sphaeramia orbicularis	Ikan Capungan	Cardinal Fish
	Birds	Ciconia sp.	Burung
Egretta garzetta		Burung Kuntul Kecil	Small egrets birds
Halcyon sancta		Cekakak suci	Sacred Petals
Reptile	Dasia sp.	Kadal	Lizard
Crustaceans	Episesarma	Kepiting	Mangrove
	Scylla serrata	Kepiting Bakau	Mangrove Crab
	Clibanarius sp.	Kelomang Mangrove	Mangrove Hermit Crabs
Molluscs	Littorina sp.	Siput Laut	Sea Snail
	Faunus ater	Siput	Black Devil Snail
	Terebralia sp.	Siput	Sea Snail
	Pila sp.	Keong	Conch
	Nerita sp.	Siput	Snail
	Gafrarium sp.	Kerang	Scallops
	Telescopium	Keong	Mangrove
	Telescopium	Bakau	Conch

Biota object

Biota found in mangrove forests in the Unhas Education Pond Area is presented in Table 3. The fish found in the mangrove forest were generally fish caught in a gillnet that had been set at each station. The discovery of mullet fish (*Mugil* sp.), *Sphaeramia orbicularis* and mud grouper fish (*Epinephelus Bleekeri*) were thought to be due to the influence of ponds in the area, while the shod fish (*Periophthalmus* sp.) were discovered because they are true settlers of the habitat, and its life cycle is in mangrove forests.

Other biota found were birds. Storks (*Ciconia* sp.) are often seen around mangrove forests because of the large number of small fish and other biota that are their food. Types of small egrets birds (*Egretta garzetta*), sacred petals (*Halcyon sancta*) found in mangrove trees as nesting sites, interacting and going out looking for food in the area of the pond around the research site during the morning and evening. In addition to birds, also found one type of reptile, the lizard (*Dasia* sp.). The reptiles were found while crawling on mangrove trees, above the ground, and swimming.

Other biota that was commonly found in mangrove forests was crustaceans and mollusks. Crustaceans found in the mangrove area of the UNHAS Education

Pond were mangrove crabs (*Episesarma* sp.), Mangrove crabs (*Scylla serrata*), and mangrove hermit crabs (*Clibanarius* sp.). Mollusks found in the mangrove areas of UNHAS Education Pond were (*Littorina* sp.), (*Faunus ater*), (*Terebralia* sp.), (*Pila* sp.), (*Nerita* sp.), (*Gafrarium* sp.) And (*Telescopium Telescopium*). Crustaceans and mollusks were found attached to mangroves and they were in the substrate. Whereas other biota found, such as fish, birds, reptiles, crustaceans and mollusks, the category of biota object parameters in the UNHAS Education Pond Area was good.

Land Conformity Analysis and Concept of Mangrove Education Infrastructure Facilities

The research is expected to be able to find various levels of land suitability categories for each parameter at each station, then the calculation and assessment of land suitability for mangrove tourism can be obtained so that the results and categories of the concept of suitability of mangrove tourism facilities and infrastructure basically consist of three parts, namely the buffer area, the reception area and activity areas as presented in Table 4 and Table 5.

Table 4. Results of land suitability assessment for the parameters of mangrove ecosystems in the Hasanuddin University Education Pond.

Parameter	Weight	Station									
		I		II		III		IV		V	
		Score	Value	Score	Value	Score	Value	Score	Value	Score	Value
Mangrove Thickness (m)	0.285	0	0	0	0	0	0	0	0	1	0.285
Mangrove Density (ind/100m ²)	0.238	0	0	1	0.238	1	0.238	1	0.238	1	0.238
Mangrove Types	0.192	2	0.384	2	0.384	2	0.384	2	0.384	1	0.192
Biota Objects	0.143	3	0.429	3	0.429	3	0.429	3	0.429	3	0.429
Tidal (m)	0.095	3	0.285	3	0.285	3	0.285	3	0.285	3	0.285
Salinity (ppt)	0.047	3	0.141	3	0.141	3	0.141	3	0.141	3	0.141
Total			1.239		1.477		1.477		1.477		1.570
Score			41.30%		49.23%		49.23%		49.23%		52.33%
Suitability Category			Conditionally appropriate		Conditionally appropriate		Conditionally appropriate		Conditionally appropriate		appropriate

The suitability of the mangrove ecosystems tourism field shows the highest parameter values are the object of biota, tides and salinity, this means the

UNHAS Education Pond Area has the potential to be developed. Suitability value for Station I was 41.30% with conditional appropriate category supported by

the value of mangrove species, tides, salinity and good biota objects but the thickness value of mangrove and mangrove density was bad for mangrove tourism, the suitability value of Station II, III and IV was 49.23% with conditional appropriate category supported by the value of mangrove species, tides, salinity and good biota objects but the value of mangrove density and thickness of mangrove was bad for tourism, the suitability value of Station V was 52.33% with the appropriate category supported by the value of mangrove thickness, tides, salinity and good biota objects, but the value of mangrove species and mangrove density was bad for mangrove tourism.

Based on the calculation of the land suitability category obtained from the value of each parameter, it can be concluded that the mangrove forest area in the UNHAS Education Pond is a conditionally appropriate category as a mangrove tourism showing that the area needs a development strategy in order to become an appropriate category. The educational tour parameters which were indicators of appropriateness, namely the support of facilities and infrastructure as one of the reference concepts proposed as mangrove tourism areas can be seen in Table 5.

Table 5. Concepts of the suitability of facilities and infrastructure for mangrove tourism in UNHAS Education Pond Area (Pranatha, 2015)

Facility					
Room	Activities	Facilities	Infrastructure	Availability	
1	2	3	4	Yes	No
Buffer Area	Park the vehicles	Parking area	Information Board Signs	Yes	
Reception Area	Visitors reception	Reception Room	Information Board Souvenir Room Ticket Counter Toilet	Yes	
	Fish, Shrimp, Crab Cultivation	Fish, Shrimp, Crab Pond Area	Information Board Boots	Yes	
	<i>Bird watching</i>	Watching Tower	Information Board Binocular	Yes	
Activities Area	<i>Mangrove Seed Planting</i>	Planting Area Deck	Information Board <i>Mangrove Seed</i> Boots	Yes	
	<i>Outbound Activity</i>	<i>Area outbound</i>	Information Board Security Tools	Yes	
	Canoeing	Floating Deck	Information Board Boat Life jacket	Yes	
	Restaurant	Restaurant	Dining Room Toilet	Yes	
	Praying Facilities	Mosque	Praying Room Toilet Boots	Yes	

The availability of facilities and infrastructure for mangrove tourism in UNHAS Educational Pond area is a good category because it has potential tourism objects to be developed. Based on the concept of the suitability level of the facilities and infrastructure obtained, it can be concluded that the educational tourism area can provide a learning to visitors, especially students at the elementary school level, junior high school, senior high school and college, knowing mangroves and interacting directly with the mangrove environment as an effort creating a sustainable region.

CONCLUSION

Based on the results of the research conducted, several conclusions can be concluded: (1). The content of organic material of dominant mangrove sediments on

Pannikiang Island had insignificant organic matter content of $p > 0.05$ between stations that were overgrown with mangroves, while stations that were overgrown with those with no mangroves were significantly different $p < 0.05$. The highest value of organic matter content at station 1 was *Rhizophora apiculata* (32.83) and the lowest organic matter content was at station 4 with no mangroves (2.58%) (2). Regression test results stated that there was a significant relationship ($p > 0.05$) to the content of sediment organic matter with the density of mangrove species and the correlation coefficient value (r) obtained by 0.594 meaning this value was categorized as having a relationship between the content of organic sediment material with the density of mangrove species. It is recommended that further research be carried out on the relationship of organic matter to the density and closure of the dominant

mangrove species by taking sediment samples at high tide and ebb on Pannikiang Island, Balusu District, Barru Regency.

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