PRACTICAL GUIDELINE

AQUATIC ECOLOGY

Team:
Dr. Dra. Retno Wimbaningrum, M.Si.
Dra. Hari Sulistiyowati, M.Sc., Ph.D.
Rendy Setiawan, S.Si., M.Si.
Arif Mohammad Siddiq, S.Si., M.Si.

DEPARTMENT OF BIOLOGY, FACULTY OF MATHEMATICS AND NATURAL SCIENCES, UNIVERSITAS JEMBER

PART I. INTRODUCTION OF AQUATIC ECOLOGY PRACTICAL

MEETING 1

EQUIPMENT AND ITS USE IMPLEMENTATION

OBJECTIVE

Able to determine name, function and operation of basic equipment for sampling and analyzing physical data, chemistry and biology of aquatic ecosystems.

PRINCIPLE

With the characteristics of the physical and chemical environment in aquatic ecosystems, as well as the organisms there, conducting research on these ecosystems requires special equipment. The equipment used for sampling aquatic biota includes surber nets, grabs (eg Ekman dredger), plankton nets, water sampling bottles, and fishing nets. Surber net is used for sampling of benthic biota in shallow water and grab is used for sampling of benthic biota in deep water and substrate. Plankton nets and water sample bottles were used for sampling planktonic organisms, then fishing nets for fish sampling. For microalgae attached to the substrate (rocks, aquatic plants, or other materials), then the sampling will be taken by brushing the surface of the substrate. Ecological data of aquatic plants can be collected using the sample plot (1x1 m) method.

Physical and chemical environmental factors of the waters will be taken with an SCT meter (temperature, conductivity, and salinity), refractometer (salinity), Secchi disc (water brightness), DO meter (Dissolved Oxygen and Biological Oxygen Demands), turbidimeter (water turbidity), pH meter (pH of water), flow meter (speed of water flow), scaly wooden stake and scaly rope (depth of water body). Physical and chemical data measurement activities can be carried out at the sampling location or in the laboratory depending on the type of equipment. If the analysis of water samples will be carried out in a laboratory, then water sampling must be carried out properly so as not to change chemical factors. Water sampling should be done with a water sample bottle.

The operating procedure for each type of equipment is specific so it requires proper understanding to operate it. Correctly understanding the function, components, and mechanism of the equipment will support the achievement of accurate data. The equipment that requires calibration before use are pH meters and DO meters. It is also important to manage of the equipment after use. For example, SCT meters and refractometers after use should be washed with distilled water and wiped with a soft cloth.

MATERIALS

The equipment used including Refractometer, DO meter, Turbidimeter, TDS meter, pH meter 2 in 1 (pH and water temperature), Secchi disc, Water sample bottle, Plankton net, Surber net, Fish net, Pincet, Brush, Filter paper "Whatman", and Guide book of biota identification.

PROCEDURE

a. Make observations on the available tools;

b. Observe the name, specifications, and function of the tool;

c. Draw and complete the names of the tool parts;

d. Explain operation procedure through descriptions and reference studies;

REPORT

a) Reports are prepared in the form of scientific articles containing: Title, Author, Abstract, Introduction (containing background and objectives), Materials and Methods, Results and Discussion, Conclusions, Bibliography, and Attachments (Table of raw data that has been acced by the assistant).

b) The report is typed on Times New Roman font, size 10, arranged in two columns, maximum 6 sheets.

c) Reports are submitted at the following MMP Sister

PART II. LOTIC ECOSYSTEM

MEETING 2-5

STUDY OF HYDROLOGY, PHYSICS, CHEMISTRY, AND BIOLOGICAL CHARACTERISTICS OF RIVER ECOSYSTEMS

OBJECTIVE

1. Able to collect data abiotic (physical and chemical) and biotic (benthic macroinvertebrate, nekton, neuston, microalgae, aquatic plant) at the river ecosystem using basic instrument
2. Able to identify of aquatic biota and analyse of water samples
3. Able to analyse data of species composition, species diversity, and species dominance
4. Able to present and to give report of the practical work on the river ecosystem

PRINCIPLE

The river is an ecosystem in the form of a long channel that holds water, nutrient solutions and particles, organic matter, plants, algae, plankton, microbes, and animals whose water continues to flow from upstream to downstream. Generally, the river channel from upstream to downstream increases in size. The characteristics of rivers upstream and downstream can be distinguished. Upstream rivers generally have narrow channels, have a V-shaped structure, and the riverbed consists of boulders, stones, and a small amount of gravel with boulders often predominating. The river channel downstream is wide, tortuous in broad valleys, and the sediments are dominated by clay, clay, and sand. In the rainy season, river water often overflows due to flooding on land followed by a material exchange with the surrounding floodplain (Closs *et al*., 2004).

The flow of water is a characteristic of the river as a lotic ecosystem. River water flow is related to discharge, namely the volume of water flowing at a certain time (m3/second). Water flows also carry sediments and in heavy flows, large particles can also be washed away depending on their shape, arrangement in the riverbed, density, and type of flow. Types of river water flow include laminar, turbulent, and mixed types. Turbulent flow can carry large sediment particles and sometimes agitate them on the riverbed. Fine particles flow in the water column as a suspension.

The concentration of suspended particles controls the turbidity of the river water (turbidity) and the transparency of the river water (brightness). Suspensions and substances dissolved in water also cause variations in color and odor in river water. The suspended matter is material that can contain clay, clay, fine particles of organic or inorganic matter, soluble compounds, plankton, and other microorganisms. Dissolved particles that are also carried by the flow of water can contain

mineral salts that can conduct electricity, called conductivity. The conductivity of freshwater generally ranges from 10 - 1000 Scm-1 or greater than 1000 Scm-1 in polluted waters. The concentration of suspended particles in river water can be determined by measuring the total suspended solids (Total Suspended Solid = TSS), while the concentration of dissolved particles can be determined by measuring the total dissolved solids (Total Dissolved Solid = TDS). Fine suspended particles also act as carriers of chemical compounds.

These chemical compounds bind to suspended particles. The chemical compound contained in river water can determine the quality of river water. These compounds include nutrients (nitrogen compounds, phosphorus compounds), organic compounds (total organic carbon, chemical oxygen demand (Chemical Oxygen Demand = COD), biological or biochemical oxygen demand (Biological Oxygen Demand = BOD), major ions (Ca2+, Mg2+, Na+, K+, Cl-, SO42- and HCO3), compounds other inorganics (sulfite, silica, boron), and metals.

MATERIALS

The equipment used including Refractometer, DO meter, Turbidimeter, TDS meter, pH meter 2 in 1 (pH and water temperature), Secchi disc, Water sample bottle, Plankton net, Surber net, Fish net, Pincet, Brush, Filter paper "Whatman", and Guide book of biota identification.

PROCEDURE

Every group will work on one part of the lotic ecosystem. The parameters measured are physical and chemical data of water, biota, and substrate in the Bedadung river. Measurement of data in the deep zone was carried out by representatives of members of each group. Data sampling are carried out three times for each parameter in each plot of the selected location (Figure 2).

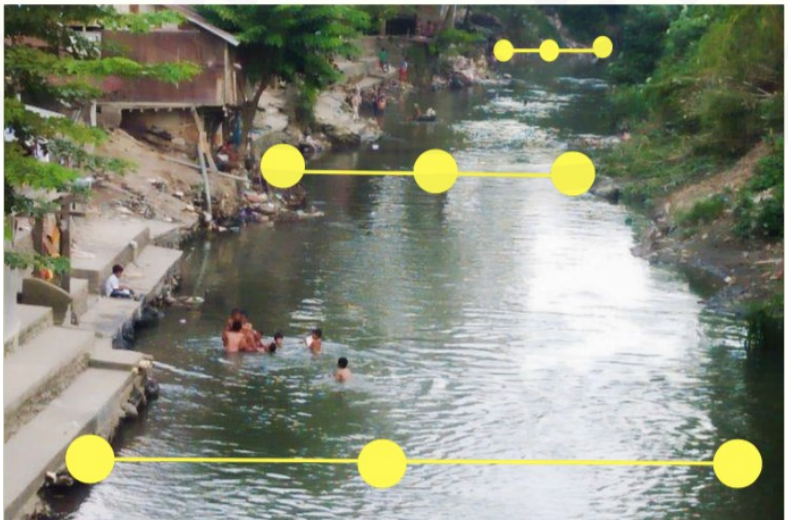

Figure 1. Plotting for data sampling in at the river ecosystem

MEETING 2. Measurement of physical, chemical, and biotic in river ecosystem

1.1.Measurement of physical factors including:

a) Water discharge

Determine the water discharge including the water speed of water flow, depth, and width of the river. The speed of the current is determined by stretching the rope as far as 1 m above the river flow and then releasing the ping pong ball in the direction of the water flow from the starting point of the raffia rope until it reaches 1 m. Record the time it takes for the ball to be released until it reaches a distance of 1 m with a stopwatch. The depth of the water and the width of the river are measured with a ruler.

b) pH Water

Dip the metal part of the pH meter in the water then read the measurement results

c) Water Temperature

Dip the metal part of the pH meter in the water then read the measurement results

d) Water brightness

Dip the Secchi disc into the water perpendicular to the water surface with the white side facing up. When the Secchi keeping does not appear for the first time, the distance is marked and the distance between the water surface and the Secchi keeping does not appear to be the brightness value of the river water.

e) Sediment type

Determine the type of sediment that makes up the riverbed. The sediments that make up the riverbed can be in the form of large stones, small stones, gravel, sand, clay, and clay. After knowing the type of sediment, then determine the proportion of each sediment visually.

f) Colour and smell of water

Visually determine the colour of the river as well as determine the smell that comes from the river water

1.2.Measurement of chemical factors including (before using the digital equipment, firstly calibrate it in the laboratory by following the instructions in the manual):

a) Salinity

Measurement of salinity using a refractometer by dripping 1-3 water samples onto a glass prism. Next, students look at the scale with the position facing the tool to the light source.

b) Dissolved Oxygen

Dip the probe into the water, press the on the button, and let it sit for a while until the DO level reading is stable. If it is stable note the DO value displayed on the screen. Wash the probe with distilled water and dry it with a tissue before using it again.

1.3.Conducting water sample for BOD, TDS, and TSS analysis:

Put the sample bottle into the water, let it sit for a while until the bottle is full of water, shake the bottle and then discard the water in the bottle. Reinsert the water bottle to a depth of 10 cm by allowing the water to enter the bottle after the bottle cap is full while remaining in the water. Put a bottle of water in a cooler filled with ice cubes. The water sample will be analyzed in the laboratory to determine the levels of BOD, TDS and TSS.

1.4.Collection of Aquatic Biota

a) Benthic macroinvertebrates

Collection of benthic macroinvertebrates used a surber net with a mesh size of 0.05 mm and a frame section measuring 25x40 cm. The mesh frame with exposed mesh is placed vertically facing the direction of the flow of water, while the mesh frame without the mesh is placed at the bottom of the channel. The sand and gravel substrate in the surfer mesh frame is stirred by hand, if there are large stones, brush the surface of the stone using a toothbrush so that benthic macroinvertebrates are separated from the substrate and into the mesh cloth. The benthic macroinvertebrate samples collected in the nets were poured into light colored plastic trays such as yellow, white, or pink, after which an inspection was carried out on the surber mesh fabric for the possibility that the sample was stuck in the mesh fabric. If there is a sample of benthic macroinvertebrate stuck on the mesh cloth, it is taken using tweezers. Samples of benthic macroinvertebrates on plastic trays are taken using tweezers, dropper or brush depending on the sample. The benthic macroinvertebrate sample that was obtained was then put into a flacon bottle containing 70% alcohol and labeled based on the sampling location.

b) Necton and Neuston

Data collection of nekton (fish) and neuston using fish net at the practical location. The fish net has a frame size of 20x20 cm, a handle length of 13 cm, and a mesh of 0.1mm.

c) Microalgae

Microalgae specimens were taken by brushing stones, leaves, and plant stems using a brush or toothbrush. The specimen was put into a flacon bottle containing 70% alcohol and labelled based on the sampling location.

d) Plankton

Plankton data retrieval using the horizontal method with plankton nets. Horizontal sampling is done by placing plankton net on the surface of the water and then pulling it horizontally to another point using the withdrawal distance. Furthermore, the sample that has been entered into the bottle which is labelled.

e) Aquatic plant

Aquatic plant data was collected by observing the plants on the plot area. Recording of species name and percent cover of each species.

MEETING 3. Analyse of water samples and identify of aquatic biota

2.1. Analysis of Water Sample:

a) Determination of TDS and TSS Values by Gravimetric Method

The steps in this measurement are as follows: wet Whatman 0.45 m filter paper with distilled water, then dry it in the oven at 105^0 C for one hour, remove it from the oven, put it in a desiccator, and after it cools down weigh the filter paper (A). Wash the porcelain dish, dry it in the oven at 105^0 C for one hour, remove it from the oven, put it in a desiccator, and after it cools down, weigh the porcelain dish (B).

Place the weighed filter paper at the bottom of the buchner funnel, then place the buchner funnel in the buchner flask, and connect the buchner flask line with the vacuum rotary evaporator hose, pour 100 mL of water sample onto the buchner funnel, connect the rotary evaporator to the electric current, press the on button, and the water sample is vacuum filtered. Take the filter paper from the Buchner funnel with tweezers and put it in the oven at 105^0 C for one hour, then remove it from the oven and put it in a desiccator until it cools down, after it cools down weigh the filter paper (C). Pour the water (supernatant) from the Buchner flask into a porcelain cup and put the cup in the oven at oven temperature and put it in a desiccator until it cools down, after it cools down weigh the porcelain cup (D) 180^0C for 1 hour, after all the water evaporated remove the porcelain dish from the oven.

1. Determine the TSS value with the formula 1 below:

   TSS (mg/L) = [(C-A) x 1000] x volume of filtered water sample (mL).....(1)

   With: C = weight of filter paper with suspended suspended solids on top of filter paper; A = empty filter paper weight.

2. Determine the TDS value with the formula 2 below

   TDS (mg/L) = [(B-D) x 1000] x volume of filtered water sample (mL) .....(2)

With: B = weight of porcelain dish with dry dissolved solids; D = empty cup weight

b) Determination of BOD

1. Measure the DO level of the water sample on the day of the water sampling with a DO meter (DO_0), and store the water sample at room temperature in a dark bottle;
2. Re-measure the DO level of the water sample on the day-5 with a DO meter (DO_5).
3. Determine the DO level with the formula 3 below.

Tabulation of Abiotic Parameter Data. Enter the abiotic parameter data from the analysis of water samples into Table 4.

Table 4. Data of TDS, TSS, and BOD

No	Parameter (Unit)	Score
1	TDS	
2	TSS	
3	BOD	

2.2. Identify of Aquatic Biota

Identification of aquatic biota in laboratory:

a. Benthic macroinvertebrates

Benthic macroinvertebrate samples that have been treated with 70% alcohol are placed on plastic trays and grouped according to the visual similarity of morphological characteristics. Insects were observed under a Nikon SMZ745 stereo microscope. Morphological characteristics of each sample were recorded. In insects, the morphological characteristics of the head, chest, and abdomen were recorded. Gastropods and bivalves were observed in the shell. Crustaceans were observed for the head and carapace, while in Turbellaria and Oligochaeta the body parts were observed. Furthermore, each sample is documented using a camera. The photos from the sample documentation were then matched and morphological characteristics were validated using several benthic macroinvertebrate identification books. Insect larvae and nymphs were identified using the book Merritt and Cummins (1996) and the Mekong River Commission (2006), Gastropods using the book Marwoto et al. (2011), and Crustaceans used Ng's book (2004) to obtain data on the composition of benthic macroinvertebrates at the tribal level.

b. Nekton

The nekton specimens were identified by comparing their characteristics with the key referred to Kottelat et al. (1993).

c. Neuston

Observe each specimen of nekton, neuston and aquatic plants, record their morphological characteristics, determine the taxa of each specimen and the number of individuals of each taxa.

d. Identification and counting of plankton and microalgae cells with Sedgwick rafter cells

Drop water containing plankton into the Sedgwick rafter until it is full, cover with a cover glass, observe the plankton using a microscope in 10 fields of view regularly and sequentially, record the taxa (if possible to the species level, and if not possible genus, tribe or order) and count the number of cells or colonies of each taxa.

MEETING 4. Analyse data of species composition, species diversity, and species dominance

a) Species Composition

The composition was determined by listing the types of aquatic biota and the number of individuals. Then the data is tabulated into the following table:

Table 1. Data of biotic

Biota Group	Family	Species	Total of ind
Benthic Macroinvertebrates		1.	
		2.	
		3.	
		n.	
Nekton		1.	
		2.	
Etc		n.	

b) Species Diversity

The diversity of aquatic biota species per group (benthic macroinvertebrate, nekton, neuston, microalgae, aquatic plant) was determined using the calculation of the Shannon Wiener (H') index. Calculation formula below:

$H' = - \Sigma \, pi \ln pi$……...……(3)

pi = ni/N; ni = total individuals of species-I and N = total individuals of all species. The category of high, medium or low species diversity is determined based on the value of H':

High: H'> 3

Medium: 3> H' > 1

Low: H' < 1

c) Species Density

The density of each type of aquatic biota group (benthic macroinvertebrate, nekton, neuston, microalgae, aquatic plant) is calculated by the formula below:

(a) D_{hbi} = ni/ wide mouth surfer net or kick net ……..(4)

(b) D_{mei} = ni/plot area……(5)

(c) D_p = q(s/lp)(p/v)……..(6)

(d) D_{ni} = ni/ filtered water volume……(7)

(e) D_{nsi} = ni/ filtered water volume……(8)

(f) D_{ti} = ni/plot area……(9)

With: D_{hbi} = density of benthic macroinvertebrates species-i; D_{mei} = density of microalga species-i; D_p = density of plankton species-i; D_{ni} = density of nekton species-i; D_{nsi} = density of neuston species-i; D_{ti} = density of aquatic plant species-i.

MEETING 5. Report presentation of the practical work on the river ecosystem

- The results of meeting 1-3 are compiled in final report of lotic ecosystem.
- Reports are prepared in the form of scientific articles containing: Title, Author, Abstract, Introduction (containing background and objectives), Materials and Methods, Results and Discussion, Conclusions, Bibliography, and Attachments (Table of raw data that has been acced by the assistant).
- Abiotic and biotic data parameters that have been analyzed become the main material discussed.
- The report is typed on Times New Roman font, size 10, arranged in two columns, maximum 6 sheets.

- Reports are submitted at the following MMP Sister.
- The report will be presented in a class seminar so that each group must also prepare a PPT.

PART II. LENTIC ECOSYSTEM

MEETING 6-9

STUDY OF HYDROLOGY, PHYSICS, CHEMISTRY AND BIOLOGICAL CHARACTERISTICS OF LAKE ECOSYSTEMS

OBJECTIVE

1. Able to collect data abiotic (hydrology, physics, chemistry) and biotic (macroinvertebrate benthos, epilithic algae, nekton, neuston, and aquatic plant) in the intertidal zone using basic instrument)
2. Able to identify of aquatic biota including macroinvertebrate benthos, nekton, epilithic algae, nekton, neuston, and aquatic plant
3. Able to analyse data of species composition, species diversity, and species dominance
4. Able to present and to give report of the practical work on the lake ecosystem

PRINCIPLE

Lentic ecosystems are aquatic ecosystems that have relatively low current velocities. Examples of lentic ecosystems include ponds, reservoirs, and lakes. Lakes are natural ecosystems that are formed due to natural events that accommodate and store rainwater, springs, seepage, or river water. A lake is a large body of water surrounded by land. Based on the nutrient content, lakes are divided into three, namely 1). Eutrophic lakes (lakes containing abundant nutrient concentrations, producing high concentrations of organic compounds); 2). Mesotrophic lakes (lakes whose water contains moderate amounts of nutrients, between the nutrient content of eutrophic and oligotrophic lakes); and 3). Oligotrophic lakes (lakes with low nutrient content but high oxygen content).

Based on the location and level of depth, the lentic ecosystem is divided into three main zones, namely 1) The littoral zone is a waterfront area that is still in contact with the land and is classified as shallow. Organisms that are usually found include: aquatic plants, molluscs, crustaceans, amphibians, fish, periphyton and others; 2). Limnetic zone which is an area of open water to the depth of effective light penetration, the inhabiting organisms are plankton, nekton, and sometimes found neuston; 3). The deep zone is an area of open water located on the inside that is not exposed to sunlight penetration. This zone is inhabited by few organisms, especially from benthic carnivores and detrifor organisms. Based on the penetration of sunlight, the littoral

and limnetic zones are classified as euphotic zones, while the deep zones are classified as aphotic zones.

Based on the temperature, the lake can be divided into three main zones, namely 1). Epilimnion zone (the surface of the lake, the hottest temperature); 2). The thermocline zone (the layer below the epilimnion zone, the intermediate zone, the temperature rapidly decreases with increasing depth); and 3). Hypolimnion zone (lowest layer below the thermocline zone, the coldest temperature). Each of these zones has different physical, chemical, and biological characteristics.

MATERIALS

The equipment used including Refractometer, DO meter, Turbidimeter, TDS meter, pH meter 2 in 1 (pH and water temperature), Secchi disc, Water sample bottle, Plankton net, Surber net, Fish net, Pincet, Brush, Ekman Dredge, Life vest jacket, Filter paper "Whatman", and Guide book of biota identification.

PROCEDURE

Every group will work on one part of the lake. The parameters measured are physical and chemical data of water, biota, and substrate in the littoral and limnetic zones. Measurement of data in the deep zone was carried out by representatives of members of each group. Data sampling are carried out three times for each parameter in each plot of the selected location (Figure 2).

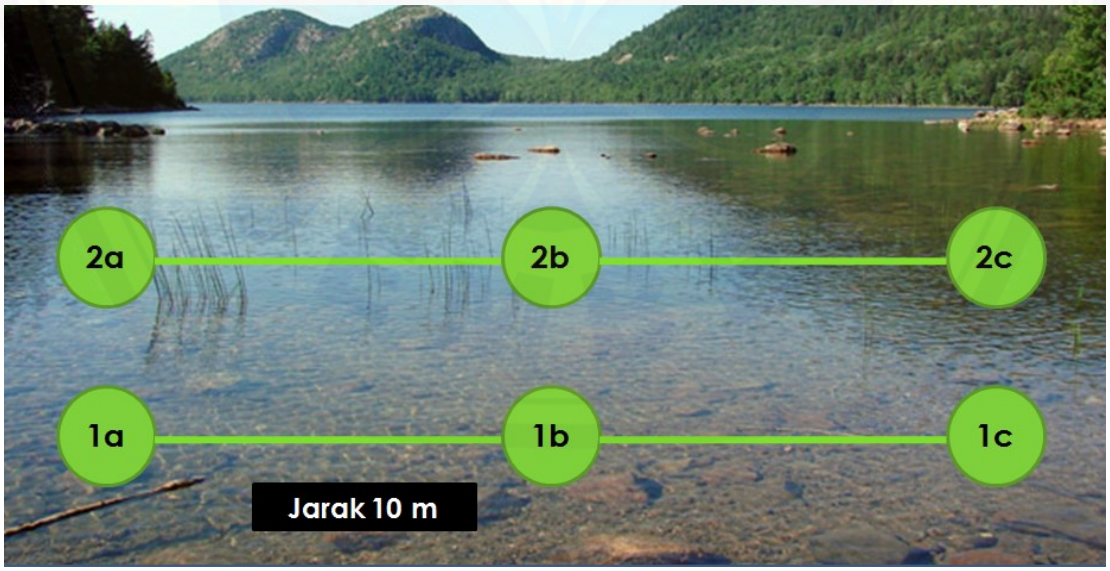

Figure 2. Plotting for data sampling in at the Zona Litoral dan Limnetik of "Ranu Klakah"

MEETING 6. Measurement of physical, chemical, and biotic in intertidal ecosystem

A. Measurement and Data Sampling in the Litoral Zone

A.1. Physical Data Measurement

Physical data measured in the field (in situ) includes the width of the littoral zone, current velocity, depth of water bodies, water color, conductivity, salinity, brightness, and temperature. TDS and TSS measurements are carried out in the laboratory, so it is necessary to take water samples (see Chapter II). The width of the littoral zone is measured from the edge (the lake boundary to the land) up to the light penetration does not reach the bottom of the lake using measuring rope.

A.2. Chemical Data Measurement

The chemical data measured in the field (in situ) are pH and DO, while the BOD measurements are measured in the laboratory so it is necessary to take water samples (see Chapter II).

A.3. Biotic Sampling

1. Aquatic Plants were sampled in a 1 x 1 m plot. The name and characteristics of the species and the cover percentage are recorded. After measurement, five specimens of each species are identified in the laboratory
2. Makroinvertebrate Benthic were sample in a 1 x 1 m plot using surber net. Brushing slowly the invertebrates attached to stones and plants. Collecting and Putting all the invertebrates in the containers/bottles and identify them in the laboratory with the aid of a microscope. All specimens representing each type, put them in a bottle containing a 4% formalin solution or 70% alcohol after the specimens have been cleaned first. Specimens that are not collected are returned to their original habitat
3. Microalgae benthic will collect by brushing on the surface of water hyacinth leaves or aquatic plants covering an area of 25 cm2. In addition, do brushing on the surface of the submerged stone as was done in event II. Storing the brushing results separately in the sample bottles and identify them in the laboratory with the aid of a microscope
4. Nekton and neuston will collect using nets. Determination of species by coding and counting the number of individuals of each type. Taking three or four specimens for each species and placing the specimen in a vial containing 70% alcohol solution. The representative species morphology is recorded for further identification in the laboratory. Large neustons (eg ducks) are simply identified and the number of individuals counted.

5. Plankton are collected using plankton nets. The water sample is put into a bottle. Identification is carried out in the laboratory under a microscope. The amount was measured using a haemacytometer under a microscope.

B. Measurement and Data Sampling in the Limnetic Zone

B.1. Measurement of Physical Data

Physical data measured in the field include width, current velocity, brightness, water color, conductivity, turbidity, salinity, and temperature. TDS and TSS measurements are carried out in the laboratory, so it is necessary to collect water samples (see chapter II).

B.2 Measurement of Chemical Data

The chemical data measured in the field (in situ) are pH and DO, while the BOD and TOM measurements are measured in the laboratory so it is necessary to take water samples (see chapter II). The field measurements of these chemical data are done three times in each plot.

B.3 Biotic Data Sampling

The biota sampled were aquatic plant, nekton, neuston, and plankton. The method used is the same as data collection carried out in the littoral zone.

C. Measurement and Data Sampling in the Profundal Zone

The measurement of physical data including depth from the end of the limnetic zone to the bottom of the lake, temperature, and salinity is done in the zone profundal. The bottom substrate of Profundal zone was also taken with Ekman dredge for collection of benthic animals and substrate texture types.

MEETING 7. Identify of intertidal biota including benthic macroinvertebrate, nekton, neuston, plankton and microalgae cells

Identification of aquatic biota in laboratory:

a. Benthic macroinvertebrates (See chapter II)
b. Nekton (See chapter II)
c. Neuston (See chapter II)
d. plankton and microalgae cells (See chapter II)

MEETING 8. Analyse data of species composition, species diversity, and species dominance

a) Species Composition

The composition was determined by listing the types of aquatic biota and the number of individuals. Then the data is tabulated into the following table:

Table 1. Data of biotic

Biota Group	Family	Species	Total of individuals		
			Litoral	Limnetic	Profundal
Benthic Macroinvertebrates		1.			
		2.			
		n.			
Nekton		1.			
		2.			
		n.			
Neuston		1.			
		2.			
		n.			
Plankton and Microalgae		1.			
		2.			
		n.			

b) Species Diversity (See chapter II)

c) Species Density (See chapter II)

MEETING 9. Report presentation of the practical work on the intertidal ecosystem

- The results of meeting 1-3 are compiled in final report of intertidal ecosystem.
- Reports are prepared in the form of scientific articles containing: Title, Author, Abstract, Introduction (containing background and objectives), Materials and Methods, Results and Discussion, Conclusions, Bibliography, and Attachments (Table of raw data that has been acced by the assistant).
- Abiotic and biotic data parameters that have been analyzed become the main material discussed.
- The report is typed on Times New Roman font, size 10, arranged in two columns, maximum 6 sheets.
- Reports are submitted at the following MMP Sister.
- The report will be presented in a class seminar so that each group must also prepare a PPT.

PART III. INTERTIDAL ECOSYSTEM

MEETING 10-13

STUDY OF HYDROLOGY, PHYSICS, CHEMISTRY, AND BIOLOGICAL CHARACTERISTICS OF INTERTIDAL ZONE

OBJECTIVE

1. Able to collect data abiotic (physical and chemical) and biotic (seagrass, macroalgae, macroinvertebrate benthos, and nekton) in the intertidal zone using basic instrument
2. Able to identify of aquatic biota including seagrass, macroalgae, macroinvertebrate benthos, and nekton
3. Able to analyse data of species composition, species diversity, and species dominance
4. Able to present and to give report of the practical work on the intertidal ecosystem

PRINCIPLE

Intertidal zones are transitional coastal regions. The cycling of the tides influences these regions. These littoral areas are located between the high and low tide marks. They can be found along rocky shores or sandy beaches. The rocky intertidal region can be divided into four vertical zones. These zones are based on height and tidal influence. These four zones include from the highest to the lowest: the splash zone, the high intertidal zone, the mid-intertidal zone, and the low intertidal zone. The splash or spray zone is the highest and driest area. This supralittoral zone is above the highest high tide mark. It is moistened by saltwater spray from waves and freshwater runoff from rain and streams. This relatively dry area is sparsely populated. Few organisms can withstand the extreme fluctuations in moisture, temperature, and salinity found in this zone.

The high intertidal zone is completely covered with water only during high tide. Parts of this region are exposed to the air for long periods as the tides recede. The inhabitants of this area are sturdy individuals. They can remain wet even if they are exposed to the sun and wind. The organisms in this area have also developed attachment devices to help them resist the force of the waves. These devices include muscular feet, suction cups, byssal threads, or holdfasts. The mid-intertidal zone is the area between the average high tide and low tide mark. This region is covered by water during most high tides, but it is exposed to the air during most low tides. This environment contains a more diverse group of organisms, than either the splash zone or high intertidal zone. Organisms that live here must overcome space and competition problems. To overcome some of

these problems, organisms have developed specialized niches within the community. Some organisms grow more quickly than others, so they can find the required space. Others grow in layers on top of each other to take up less room.

The low intertidal zone is the area between the average low tide level and the lowest low tide level. This area stays moist during most low tides making it an ideal home for many kinds of organisms. The low intertidal zone also has lots of food as nutrients are circulated in nearshore waters. Many plankton are found within this habitat, and grazers enjoy the rich abundance of algae available. These four zones can be different from place to place. Some of them may contain highly specific microhabitats such as tidepools. Tidepools are created as the tides recede leaving rocky depressions filled with water. These areas are interesting and fun to explore, because they are home to some unusual creatures. The organisms within the tidepools have had to adapt to extreme changes in salinity. They are able to survive falling salinity levels as rain freshens the water. They can also withstand rising salinity levels as the sun and wind evaporate the water leaving the salt concentrated.

MATERIALS

The equipment used including Refractometer, DO meter, pH meter 2 in 1 (pH and water temperature), Fish net, Pincet, Brush, and Guide book of biota identification.

PROCEDURE

Every group will work on one part of the intertidal zone. The parameters measured are physical and chemical data of water, biota, and substrate in the intertidal zone at Bama Beach Baluran National park. Measurement of data in the deep zone was carried out by representatives of members of each group. Data sampling are carried out three times for each parameter in each plot of the selected location (Figure 2).

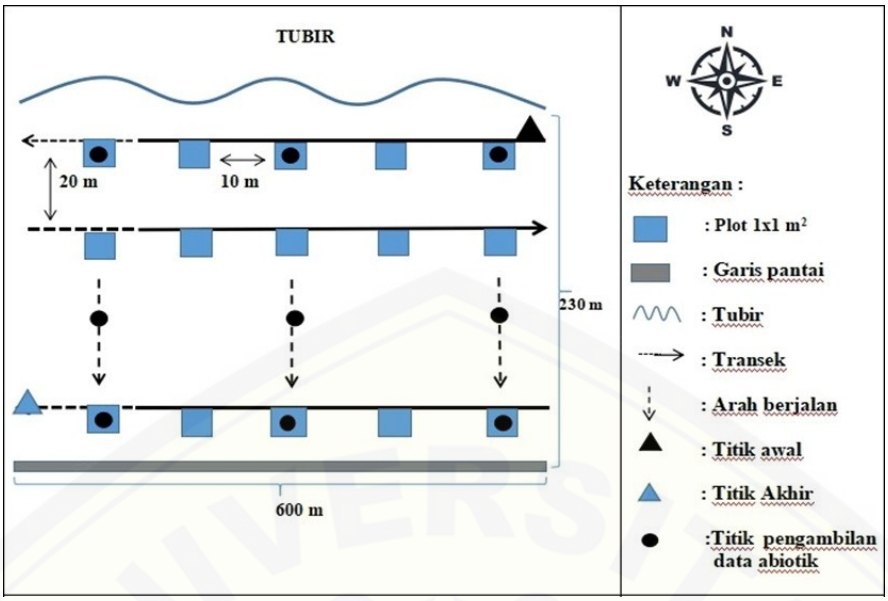

Figure 3. Plotting for data sampling in at the intertidal zone at Bama coastal, Baluran National Park

MEETING 10. Measurement of physical, chemical, and biotic in intertidal ecosystem

1.1. Collection technique of biotic (benthos macroinvertebrates, macroalgae, seagrass, necton)

Collection technique of biotic uses the plot method on systematic transects (Bookhout, 1996). The plot used is a 1x1 m^2 plot. In detail as follows:

a) Data collection of benthos macroinvertebrate

Data collection of benthos macroinvertebrates in each plot was based on their microhabitat, i.e epifauna, tree fauna, and infauna. Data retrieval of benthos epifauna macroinvertebrates was carried out by taking directly specimens that were above the surface of the substrate. Tree fauna collection was carried out by taking benthic macroinvertebrates directly on the roots, stems, and leaves of seagrass or macroalgae. Infauna benthic macroinvertebrates were taken by excavating the substrate with a depth of ± 20 to 30 cm. Sampling was carried out at three points on one observation plot (corner, middle and corner) using a shovel. The benthic macroinvertebrates that have been taken were placed on a plastic tray for data recording. The recorded specimen data includes morphological characteristics, the number of individuals of each species, the total number of individuals of all species. Furthermore, each specimen is documented using a student camera.

b) Data collection of macroalgae and seagrass

This data recording is carried out on each plot. Data recorded in the form of specimen characteristics and percent cover of each species. Furthermore, each specimen is documented using a student camera.

1.2. Measurement of physical and chemical parameter with in-situ

a) Salinity (See Chapter II)
b) Dissolved Oxygen (See Chapter II)
c) pH water (See Chapter II)
d) Water temperature (See Chapter II)
e) Sediment type (See Chapter II)

All the data are tabulated into the following table:

Table 1. The data of abiotic value

No	Abiotic parameters (unit)	Point		
		Point 1	Point 2	Point 3
1	Salinity ($^{o}/_{oo}$)			
2	Dissolved oxygen (m/l)			
3	pH water			
4	Water temperature (^{o}C)			
5	Sediment type			

MEETING 11. Identify of intertidal biota including seagrass, macroalgae, benthic macroinvertebrate, and nekton

2.1.Identify of benthic macroinvertebrate and nekton

Determination of the species composition of benthos macroinvertebrates was carried out by description and identification of specimens found to represent each species found. Each species found was matched for its morphological characteristics with book guides and pictures from identification books :

1. The Larousse Guide to Shells of The World (Oliver (1980);
2. Siput dan Kerang Indonesia 1 (Dharma (1988);
3. Recent & Fossil Indonesia Shells (Dharma (2005);
4. Compendium of Seashells (Abbott & Dance (1982).

2.2.Identify of Seagrass and Macroalgae

Meanwhile, identification of seagrass and macroalgae uses identification books and scientific articles references.

All the data are tabulated into the following table:

Intertidal Biota	Phylum: Species	Total Number
Seagrass	1.	
	2.	
	3.	
	n.	
Benthic macroinvertebrate	1.	
	2.	
Etc	n.	

MEETING 12. Analyse data of species composition, species diversity, and species dominance

a) Species Composition (See Chapter II)
b) Species Diversity (See Chapter II)
c) Species Density (See Chapter II)

MEETING 13. Report presentation of the practical work on the intertidal ecosystem

- The results of meeting 1-3 are compiled in final report of intertidal ecosystem.
- Reports are prepared in the form of scientific articles containing: Title, Author, Abstract, Introduction (containing background and objectives), Materials and Methods, Results and Discussion, Conclusions, Bibliography, and Attachments (Table of raw data that has been acced by the assistant).
- Abiotic and biotic data parameters that have been analyzed become the main material discussed.
- The report is typed on Times New Roman font, size 10, arranged in two columns, maximum 6 sheets.
- Reports are submitted at the following MMP Sister.
- The report will be presented in a class seminar so that each group must also prepare a PPT.