Identification of Riparian Vegetation Diversity Along the Bedengan Campsite River, Selorejo Village, Dau District, Malang Regency

Aliffian Nisa' Cholida [1*], Ajeng Putri Widowati [2]
[1-2] Master of Biology Education, Postgraduate Program, University of Muhammadiyah Malang, Indonesia

* Corresponding Author: **Aliffian Nisa' Cholida**

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Abstract
The high intensity of tourism activities in the Bedengan Watershed may affect the quality of water and soil in the river area, which can be indicated by the density of riparian vegetation. The purpose of this study was to determine the density and diversity of riparian vegetation along the Bedengan River in Selorejo Village, Dau District, Malang Regency. This study employed a systematic quadrat transect vegetation analysis method with descriptive quantitative data analysis. Vegetation density data were calculated using a density formula and supported by abiotic factor data. The determination of sampling locations and data grouping was based on growth criteria to obtain species abundance data using purposive sampling. The study was conducted in the downstream area of the Bedengan River from May to June. The results showed that the total absolute density value of the riparian population was 6.42, indicating that a higher density value corresponds to a higher level of vegetation density. Five plant families were identified, namely Fabaceae, Asteraceae, Poaceae, Oxalidaceae, and Equisetaceae. The most abundant species was *Ehrharta erecta*, with a total absolute individual density of 2.33. The least abundant species were *Albizia julibrissin*, *Oxalis barrelieri*, *Emilia sonchifolia*, *Sorghum halepense*, and *Bidens bipinnata*, each with a total absolute individual density of 0.04. Abiotic component data included soil temperature of 23°C, soil moisture of 4, soil pH of 5.5, air humidity of 75%, water temperature of 20°C, and wind speed of 34 m/s.

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1. Introduction

A river is a body of flowing water that runs from upstream to downstream and eventually discharges into another river, a lake, or the sea. According to the Menteri Kehutanan Republik Indonesia (2014), a land area that functions as an integrated unit with a river, receiving and collecting rainfall and surrounding soil sediment, and channeling it into the river, is referred to as a watershed. The Bedengan Campsite River is a watershed located in Selorejo Village, Dau District, Malang Regency. This river has fast-flowing water with large rocky substrates originating directly from natural springs. Along both the right and left riverbanks, various types of plants grow abundantly and are commonly referred to as riparian vegetation. Vegetation surrounding rivers, including shrubs, bushes, herbs, and trees, is defined as riparian vegetation (Handayani, 2018).

The presence of riparian vegetation plays an important ecological role in river ecosystems. Riparian vegetation functions to maintain river water quality by controlling water temperature, preventing erosion, and providing habitat for various organisms (Garner *et al;*., 2017; Greenwood & Kuhn, 2014; Orchard *et a;l*., 2018). These important riparian functions need to be preserved to ensure their sustainability and to prevent a decline in biodiversity. Land-use changes within watershed areas include the conversion of forest land into agricultural fields, plantations, and settlements. These land-use changes and utilization are often carried out by communities around the watershed without considering soil and water conservation efforts, resulting in the reduction of forest vegetation and disturbances to the biophysical characteristics of the watershed area.

Based on these considerations, it is necessary to conduct a study examining the diversity of riparian vegetation around watershed areas. Therefore, the objective of this study is to determine and identify the diversity of riparian vegetation in Selorejo Village, Dau District, Malang Regency. The riparian vegetation diversity data obtained are expected to serve as a source of information for the government and local communities, as well as a database to support and facilitate conservation efforts.

2. Literature Review

Wasterhed

A river is an ecosystem that plays an important role for humans and aquatic organisms. Rivers have high functional and ecological value for human life and wildlife. The observation was conducted along the banks of the Bedengan Campsite River in Selorejo Village, Dau District, Malang Regency, which is part of a watershed. A watershed is a land area that forms an integrated unit with its tributaries. The function of a watershed is to collect, store, and naturally channel water originating from rainfall to lakes or the sea. In addition, a watershed also functions as a land boundary that serves as a topographic divider and as a marine boundary extending to waters that are still influenced by terrestrial activities (Putri, 2011). Along riverbanks, various types of plants grow and form vegetation that lines the river margins. Plants located on the right and left sides of a river are referred to as riparian vegetation (Ainy *et a;l*., 2018). Riparian ecosystems along riverbanks are vegetated by diverse plant species that have adapted to survive in these environments. Many riparian plants are able to adapt to flooding, sediment deposition, physical abrasion, and stem breakage caused by flood events (Bando *et a;l*., 2016)**.**

Riparian

Riparian areas are special conservation zones in which native vegetation should be preserved. Riparian vegetation functions to maintain river water quality through the regulation of water temperature, control of erosion and sedimentation, provision of litter as an energy source, and interception of pollutants from terrestrial areas that are transported into rivers through runoff (Siahaan & Ai, 2014). In addition, riparian vegetation is used by animals around rivers as sites for shelter, mating, and spawning. According to Ainy *et a;l* (2018), vegetation has important ecological functions as it supports ecosystem stability by playing a role in the carbon, oxygen, nitrogen, and water cycles. Riparian vegetation also serves as an indicator of environmental quality and functions as a green belt that maintains the integrity of riverbanks.

3. Methodology

Study Area and Research Period

This study was conducted in June 2022 along the Bedengan Campsite River in Selorejo Village, Dau District, Malang Regency, East Java. Purposive sampling was employed to determine the research locations.

Fig 1: Map showing the location of the Bedengan Campsite River in Selorejo Village, Dau District, Malang Regency, East Java.

Materials and Tools

The equipment used in this study included a soil tester, thermometer, thermo-anemometer, hygrometer, camera, scissors, raffia string, stakes, and a measuring tape. The material used in this study was the plant community along the banks of the Bedengan Campsite River in Selorejo Village, Dau District, Malang Regency.

Work Steps

1. Preparing the equipment and materials.
2. Measuring air temperature and wind speed.
3. Measuring water temperature.
4. Measuring air humidity.
5. Measuring soil pH and soil moisture.
6. Measuring soil temperature, soil moisture, and soil pH.
7. Installing 1 m stakes in the predetermined plots.
8. Conducting observations of riparian vegetation in each plot.
9. Photographing the vegetation in each plot

Vegetation Sampling Technique

Sampling of riparian vegetation at the selected locations was conducted using a systematic quadrat transect vegetation analysis method. Quadrat transects were placed on both the left and right sides of the river. The size of each quadrat used in this study was 1 m × 1 m.

Data Analysis

Data analysis involved the calculation of absolute density, relative density, total absolute density, and total relative density. The formulas used for these calculations are as follows:

$$\text{Absolute Density A} = \frac{\text{Number of individuals}}{\text{Plot area}}$$

$$\text{Relative Density} = \frac{\text{Absolute density of a population}}{\text{Absolute density of all populations}} \times 100\%$$

$$\text{Total Absolute Density} = \frac{\sum \text{Species (all sampling zones)}}{\sum \text{Zona} \times \text{plot area}}$$

$$\text{Total Relative Density} = \frac{\text{Total absolute density of a population}}{\text{Total absolute density of all populations}} \times 100\%$$

4. Results

The results of this study identified a total of 15 species, for which density values were calculated. The density parameters included absolute density, relative density, total absolute density, and total relative density, which are presented in detail in the following tables:

Table 1: Absolute density values of various species found during the study

No.	Family	Species name	Densitas Absolut					
			Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
1	Fabaceae	*Calopogonium caeruleum*	0,00	0,00	0,00	0,75	1,00	0,50
2	Asteraceae	*Ageratum conyzoides*	1,75	0,75	1,00	0,50	1,00	0,75
3	Asteraceae	*Bidens pilosa*	0,00	0,00	0,00	0,00	0,00	0,50
4	Fabaceae	*Albizia julibrissin*	0,00	0,00	0,00	0,00	0,00	0,25
5	Poaceae	*Ehrharta erecta*	3,75	2,25	2,00	2,75	1,50	1,75
6	Oxalidaceae	*Oxalis barrelieri*	0,00	0,00	0,00	0,00	0,25	0,00
7	Poaceae	*Pennisetum purpureum*	0,00	0,00	0,00	1,00	0,50	0,75
8	Asteraceae	*Emilia sonchifolia*	0,00	0,25	0,25	0,00	0,00	0,00
9	Poaceae	*Ischaemum rugosum*	2,25	0,00	0,00	0,00	0,00	0,00
10	Fabaceae	*Mimosa pudica*	0,00	0,50	0,50	0,00	0,00	0,00
11	Poaceae	*Sorghum halepense*	0,25	0,00	0,00	0,00	0,00	0,00
12	Poaceae	*Eleusine indica*	1,00	0,75	0,00	0,75	0,50	0,75
13	Asteraceae	*Bidens bipinnata*	0,25	0,00	0,00	0,00	0,00	0,00
14	Equisetaceae	*Equisetum arvense*	1,00	0,00	0,00	0,00	0,00	0,00
15	Equisetaceae	*Equisetum laevigatum*	2,50	0,00	0,00	0,00	1,25	0,00
		Total Absolute Population Density	12,75	4,50	3,75	5,75	6,00	5,25

Table 2: Relative density values of various species found during the study

No.	Family	Species name	Relative density (%)					
			Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
1	Fabaceae	*Calopogonium caeruleum*	0,00	0,00	0,00	13,04	16,67	9,52
2	Asteraceae	*Ageratum conyzoides*	13,73	16,67	26,67	8,70	16,67	14,29
3	Asteraceae	*Bidens pilosa*	0,00	0,00	0,00	0,00	0,00	9,52
4	Fabaceae	*Albizia julibrissin*	0,00	0,00	0,00	0,00	0,00	4,76
5	Poaceae	*Ehrharta erecta*	29,41	50,00	53,33	47,83	25,00	33,33
6	Oxalidaceae	*Oxalis barrelieri*	0,00	0,00	0,00	0,00	4,17	0,00
7	Poaceae	*Pennisetum purpureum*	0,00	0,00	0,00	17,39	8,33	14,29
8	Asteraceae	*Emilia sonchifolia*	0,00	5,56	6,67	0,00	0,00	0,00
9	Poaceae	*Ischaemum rugosum*	17,65	0,00	0,00	0,00	0,00	0,00
10	Fabaceae	*Mimosa pudica*	0,00	11,11	13,33	0,00	0,00	0,00
11	Poaceae	*Sorghum halepense*	1,96	0,00	0,00	0,00	0,00	0,00
12	Poaceae	*Eleusine indica*	7,84	16,67	0,00	13,04	8,33	14,29
13	Asteraceae	*Bidens bipinnata*	1,96	0,00	0,00	0,00	0,00	0,00
14	Equisetaceae	*Equisetum arvense*	7,84	0,00	0,00	0,00	0,00	0,00
15	Equisetaceae	*Equisetum laevigatum*	19,61	0,00	0,00	0,00	20,83	0,00

Table 3: Total absolute density and total relative density values of various species found during the study

No.	Family	Species Name	Total Absolute Density	Total Relative Density (%)
1	Fabaceae	*Calopogonium caeruleum*	0,38	5,92
2	Asteraceae	*Ageratum conyzoides*	0,96	14,95
3	Asteraceae	*Bidens pilosa*	0,08	1,25
4	Fabaceae	*Albizia julibrissin*	0,04	0,62
5	Poaceae	*Ehrharta erecta*	2,33	36,29
6	Oxalidaceae	*Oxalis barrelieri*	0,04	0,62
7	Poaceae	*Pennisetum purpureum*	0,38	5,92
8	Asteraceae	*Emilia sonchifolia*	0,04	0,62
9	Poaceae	*Ischaemum rugosum*	0,58	9,03
10	Fabaceae	*Mimosa pudica*	0,08	1,25
11	Poaceae	*Sorghum halepense*	0,04	0,62
12	Poaceae	*Eleusine indica*	0,63	9,81
13	Asteraceae	*Bidens bipinnata*	0,04	0,62
14	Equisetaceae	*Equisetum arvense*	0,17	2,65
15	Equisetaceae	*Equisetum laevigatum*	0,63	9,81

Based on the results of the study, data on vegetation diversity in the Bedengan Campsite River included herbaceous plants, lianas, shrubs, and subshrubs. Plant species classified as subshrubs included *Calopogonium caeruleum*, *Ageratum conyzoides*, and *Bidens pilosa*. The species classified as trees was *Albizia julibrissin*. Shrub species included *Ehrharta erecta*, *Oxalis barrelieri*, *Sorghum halepense*, *Eleusine indica*, and *Bidens bipinnata*. Herbaceous species included *Pennisetum purpureum*, *Emilia sonchifolia*, *Ischaemum rugosum*, and *Mimosa pudica*. Meanwhile, fern species included *Equisetum arvense* and *Equisetum laevigatum*.

Based on the total relative density values, *Ehrharta erecta*, which is classified as a shrub, showed the highest value and was found in every transect plot. The hight density value indicates a high dominance of *Ehrharta erecta* in the study area. The presence of *Ehrharta erecta* in all plots may be attributed to the fact that the study area was not shaded by trees, allowing optimal light intensity to be available. Differences in density values among growth stages overall are influenced by the presence of several species that grow well at the seedling stage but decline at subsequent stages due to differences in tolerance and intolerance characteristics among species (Lestari *et a;l*., 2018). Sunlight is essential for plant growth and photosynthesis (Putri, 2011). Other factors that may influence the high dominance of *Ehrharta erecta* include suitable soil pH, temperature, and soil moisture.

The presence of riparian vegetation is influenced by several environmental factors, such as temperature, humidity, pH, and light intensity, which affect the diversity, evenness, and dominance of plant species in riparian environments. The soil temperature at the study site was 23°C, soil moisture had a value of 4, soil pH was 5.5, air humidity was 75%, water temperature was 20°C, and wind speed was 34 m/s. Differences in river area characteristics, including climate, soil, topography, and hydrology, contribute to variations in riparian vegetation diversity among rivers.

In addition, Purnawaningsih dan Yusuf (2005) stated that soil has a significant influence on the availability of various nutrients. Plant vegetation in its development requires sufficient and appropriate nutrients to support growth and survival. Soil properties play an important role in determining plant community composition (Lisdayanti *et a;l*.2016). According to Lestari *et a;l* (2018) topographic conditions also influence vegetation composition and fertility through soil fertility and groundwater conditions, elevation-related climatic differences, variations in soil types and properties, and other environmental factors that affect plant distribution, resulting in the formation of different vegetation types.

5. Conclusion

Based on the results of the study entitled *"Identification of Riparian Vegetation Diversity of the Bedengan Campsite River, Selorejo Village, Dau District, Malang Regency"*, the following conclusions can be drawn:

1. The riparian vegetation diversity of the Bedengan Campsite River in Selorejo Village, Dau District, Malang Regency was high, as various plant growth forms were identified, including trees, subshrubs, shrubs, herbaceous plants, and ferns.
2. A wide variety of riparian vegetation species were found along the Bedengan Campsite River. The tree species identified was *Albizia julibrissin*. Shrub species included *Ehrharta erecta*, *Oxalis barrelieri*, *Sorghum halepense*, *Eleusine indica*, and *Bidens bipinnata*. Herbaceous species included *Pennisetum purpureum*, *Emilia sonchifolia*, *Ischaemum rugosum*, and *Mimosa pudica*. Fern species included *Equisetum arvense* and *Equisetum laevigatum*

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