Community structure of phytoplankton in seagrass beds in the waters of Balikpapan City Bay, East Kalimantan

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ABSTRACT

Seagrasses are flowering plants that live in shallow waters and form an ecological community which is a place for biotic and abiotic interactions. The structure of the phytoplankton community consists of individual arrangements of various types and species that are organized to form a community. Phytoplankton are autotrophic organisms and primary producers in the marine food chain. The purpose of this study was to determine the abundance of phytoplankton, uniformity and dominance values. Measurement of water quality parameters was carried out at the Water Quality Laboratory, Faculty of Fisheries and Marine Sciences, Mulawarman University from November to December. Determination of research locations using the method of consideration (purposive sampling method). Sedgewick-Rafter method was applied for the identification stage. The data were analyzed by calculating the abundance of phytoplankton, diversity index, uniformity index and dominance index, then the data were analyzed using Microsoft Excel. The abundance of phytoplankton ranged from 2772 - 1575 individuals/L. While the diversity index values ranged from 2.79 - 2.57, the uniformity index values ranged from 0.74 - 0.80 and the dominance index values ranged from 0.10 - 0.11.

INTRODUCTION

Seagrass is a flowering plant that lives in shallow waters and forms an ecological community that serves as a place for biotic and abiotic interactions. Ecologically, seagrass has several important functions in coastal areas, one of which is as a primary producer in shallow waters, providing food for various types of organisms. Additionally, seagrass functions as a spawning area for several types of marine organisms and as a filter for nutrients from the sea.

Phytoplankton plays an equally important role in higher-level green plant systems (terrestrial ecosystems) as the primary producer (Hutabarat and Evans, 1986). Phytoplankton are autotrophic organisms and primary producers in the food chain. The structure of the phytoplankton community consists of an arrangement of individuals from various types and species organized to form a community (Prita et al., 2014). The role of phytoplankton is crucial as it is needed by other organisms as a food source. Phytoplankton can be used as an indicator of water fertility and to determine the carrying capacity of a body of water.

The conditions around Balikpapan Bay affect the condition of the seagrass beds in these waters. Damage to seagrass beds will impact the biota living in them, one of which is phytoplankton. The aim of

this research is to determine the abundance, uniformity index value, diversity, and dominance of phytoplankton.

METHODOLOGY

This research was conducted from November 2022 to March 2023. The field research took place in the Kampung Baru Pelindo 4 Port area, Balikpapan Barat District, Balikpapan City. The research was carried out in two stages: the first stage involved sample collection and in-situ field measurements, and the second stage involved phytoplankton identification and water analysis.The research procedure included field observations, station determination, water sample collection, measurement of water quality parameters, data analysis, and preparation of the final report.

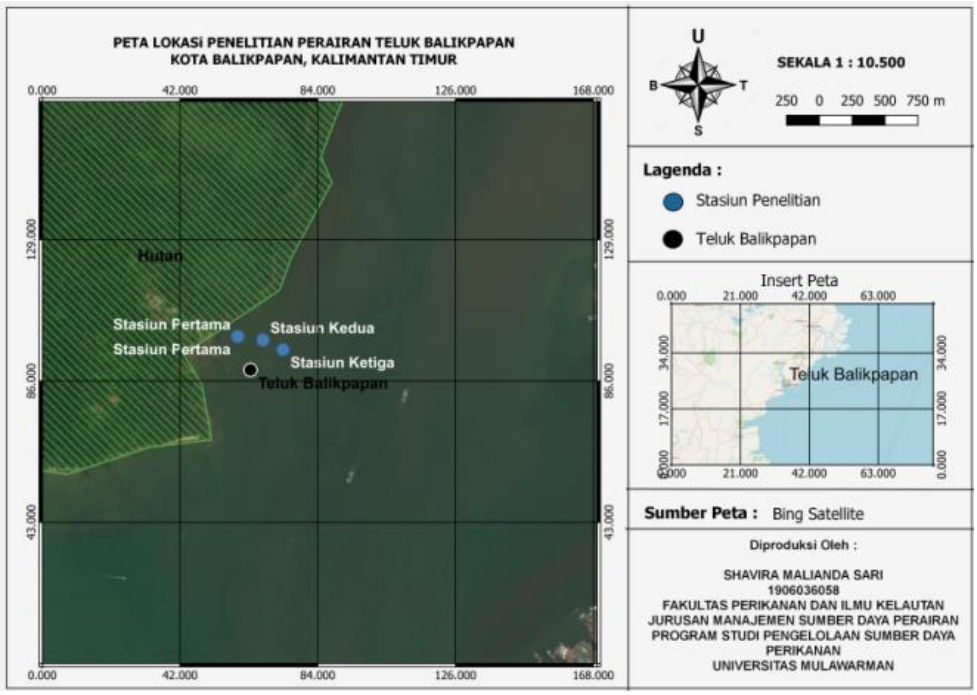

Figure 1. Study location map

The determination of research station locations was carried out through preliminary surveys and the presence of seagrass. The selection of research locations used the purposive sampling method, which involves choosing sample collection locations based on specific objectives and considerations as well as the research targets. Station determination was based on initial observations and was divided into three stations: station 1, station 2, and station 3, each 20 meters apart.

Sample Collection

Phytoplankton samples were collected at each station point, which were 20 meters apart. Phytoplankton sampling was done using a 10-liter bucket, filtered 10 times to collect a total of 100 liters into a plankton net. The filtered samples were then placed in sample bottles labeled with the station points, and the samples were preserved using a Lugol solution.

Measurement of Water Quality Parameters

The water quality parameters measured in this research included temperature, salinity, transparency, current speed, dissolved oxygen (DO), pH, nitrate, and phosphate. The measurements of temperature, transparency, current speed, and DO were performed in situ in the field, while the measurements of salinity,

pH, nitrate, and phosphate were conducted in the Water Quality Laboratory of the Faculty of Fisheries and Marine Sciences, Mulawarman University.

RESULTS AND DISCUSSION

Water Quality Parameters

The water quality parameters measured at the research stations included both physical and chemical parameters. The physical parameters were temperature, transparency, and current speed, while the chemical parameters were dissolved oxygen (DO), pH, phosphate (PO4), salinity, and nitrate (NO3).

Table 1. Water quality parameters

Parameter	Station 1	Station 2	Station 3	Standard*
Temperature	30℃	30℃	29℃	28-30℃
Salinity	25 ‰	24‰	21‰	33-34‰
Water clarity	1 m	1,15 m	1,20 m	>3 m
Water velocity	0,20 m/s	0,23 m/s	0,28 m/s	-
pH	7,55	7,80	7,63	7-8,5
DO	6,8 mg/l	6,25 mg/l	5,91 mg/l	>5 mg/l
Nitrate	0,015 mg/l	0,027 mg/l	0,018 mg/l	>0,015 mg/l
Phosphate	0,021 mg/l	0,029 mg/l	0,032 mg/l	>0,008 mg/l

Standard*: KEPMEN-LH No. 51 Tahun 2004

a. Temperature

According to Kadir et al. (2015), the optimal temperature for phytoplankton life is 25-30ºC. The quality standard according to KEPMEN LH No. 51 of 2004 is 28-30ºC. The measured temperatures in the waters of Balikpapan Bay were 30ºC at station 1, 30ºC at station 2, and 29ºC at station 3. The temperatures in Balikpapan Bay waters are within the optimal range for phytoplankton to thrive.

b. Salinity

Salinity is the concentration of all salt solutions found in seawater, where salinity affects the osmotic pressure of the water; the higher the salinity, the higher the osmotic pressure (Hamuna et al., 2018). According to Nontji (2007), phytoplankton develops well at salinities between 20-32‰. According to KEPMEN LH No. 51 of 2004, the salinity quality standard for marine biota is 33-34‰. The measured salinity in the waters of Balikpapan Bay was 25‰ at station 1, 24‰ at station 2, and 21‰ at station 3. The lower salinity levels in Balikpapan Bay waters are due to high rainfall.

c. pH

High pH values in a body of water can affect the growth rate of phytoplankton. The pH of seawater is considered a major factor limiting the growth rate of phytoplankton, with an optimal range of 7.0-8.5. The measured pH values in Balikpapan Bay waters were 7.55 at station 1, 7.80 at station 2, and 7.63 at station 3, indicating normal pH levels for phytoplankton growth.

d. Transparency

According to KEPMEN LH No. 51 of 2004, the quality standard for marine biota, especially seagrass, is >3. During the transparency measurement in the research location, a 100% transparency was observed due to measurements taken at low tide. Shallow waters allow sunlight to reach the bottom, increasing water temperature. The measured transparency in Balikpapan Bay waters was 1 meter at station 1, 1.15 meters at station 2, and 1.20 meters at station 3.

e. Current Speed

The measured current speeds in Balikpapan Bay waters were 0.20 m/s at station 1, 0.23 m/s at station 2, and 0.28 m/s at station 3, all within the moderate current speed category. These measurements were taken during the lowest tide conditions in the afternoon, aligning with the moderate current speed range of 0.25-0.50 m/s.

f. Dissolved Oxygen (DO)

Dissolved oxygen levels result from photosynthesis by seagrass and phytoplankton (Effendi, 2003). DO is the amount of oxygen gas dissolved in water, measured in mg/L. According to Kep. Men LH No. 51 of 2005, the quality standard for marine biota, especially phytoplankton, is >5 mg/L. The measured DO levels in Balikpapan Bay waters were 6.08 mg/L at station 1, 6.25 mg/L at station 2, and 5.91 mg/L at station 3, indicating optimal environmental conditions for seagrass ecosystems.

g. Nitrate

According to Wardoyo (1982), the optimal nitrate concentration for phytoplankton growth is 0.9-3.5 mg/L. The quality standard for marine biota is 0.008 mg/L according to KEPMEN LH No. 51 of 2004. The measured nitrate levels in Balikpapan Bay waters were 0.015 mg/L at station 1, 0.027 mg/L at station 2, and 0.018 mg/L at station 3, all higher than the quality standard, indicating potential pollution.

h. Phosphate

According to Wardoyo (1982), the optimal phosphate concentration for phytoplankton growth is more than 0.02 mg/L, influencing growth and photosynthesis. The measured phosphate levels in Balikpapan Bay waters were 0.02 mg/L at station 1, 0.020 mg/L at station 2, and 0.032 mg/L at station 3. The quality standard for marine biota is 0.015 mg/L according to KEPMEN LH No. 51 of 2004. The phosphate levels in Balikpapan Bay waters exceed the quality standard, potentially causing pollution and eutrophication.

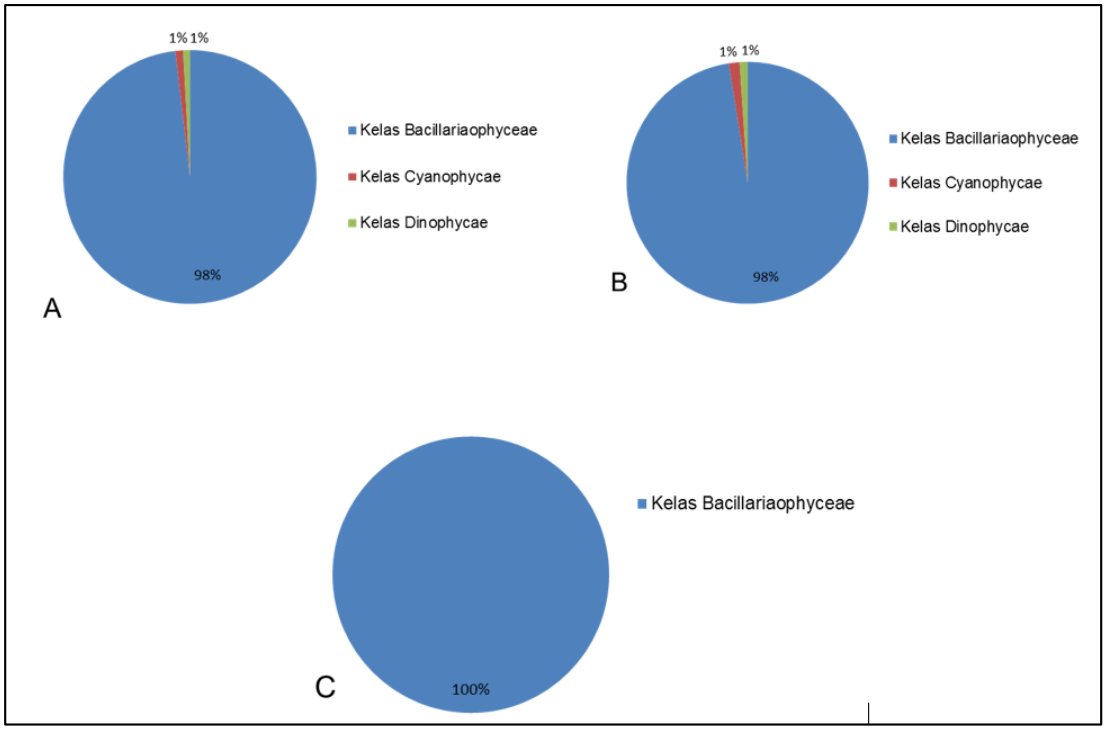

Figure 2. Phytoplankton composition: A) Station 1; B) Station 2; C) Station 3

Species Composition

The phytoplankton species found consisted of 54 species, including the classes Bacillariophyceae (46 species), Cyanophyceae (4 species), and Dinophyceae (4 species). Phytoplankton from the class Bacillariophyceae were the most abundant. At stations 1, 2, and 3, the Bacillariophyceae class had the most species due to their high adaptability and survival in various water conditions. At stations 1 and 2, Bacillariophyceae represented 98% of the phytoplankton, while Cyanophyceae and Dinophyceae each represented 1%. Station 3 had 100% Bacillariophyceae, with no species found from the Cyanophyceae and Dinophyceae classes.

Phytoplankton Abundance

The highest phytoplankton abundance among the stations in the waters of Balikpapan Bay was at station 1, with 2,772 individuals per liter. The comparison of phytoplankton species abundance between stations can be seen in Figure 3.

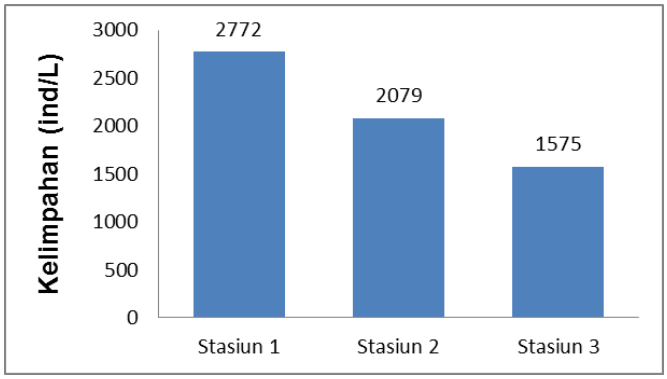

Figure 3. Phytoplankton abundance

The highest plankton abundance was found at station 1, and the lowest at station 3. The phytoplankton species with the highest abundance at stations 1 and 3 was *Nitzschia sigma* from the Bacillariophyceae class, while the lowest abundance at station 2 was *Coscinodiscus sp* from the Bacillariophyceae class. The plankton abundance based on the sampling stations ranged from 2,772 to 1,575 individuals per liter. The differences in phytoplankton abundance at each station were due to varying environmental conditions and nutrient availability at each station.

Analysis of Diversity Index (H'), Evenness Index (E), and Dominance Index (C)

The comparison of the diversity index, evenness index, and dominance index values at each station:

Diversity Index (H')

The diversity index (H') values ranged from 2.79 to 2.57. The highest value was at station 1 with 2.79, followed by station 2 with 2.62, and the lowest at station 3 with 2.57. Station 1 is categorized as having high diversity, indicating a high distribution of individuals and high community stability.

Evenness Index (E)

The evenness index of phytoplankton in the waters of Balikpapan Bay ranged from 0.74 to 0.80. Station 1 had an evenness index of 0.74, station 2 had 0.75, and station 3 had 0.80. The evenness index values range from 0 to 1. If the index approaches 0, it indicates low evenness among species within the community, reflecting significant differences in individual abundances among species. Conversely, if the index

approaches 1, it indicates relatively uniform evenness among species, suggesting that the evenness index in Balikpapan Bay waters is relatively similar across stations with no significant differences.

Dominance Index (C)

The dominance index values in the seagrass beds of Balikpapan Bay waters ranged from 0.10 to 0.11. Stations 2 and 3 had high dominance index values, followed by station 1. If the dominance index values range between 0 and 1, it indicates that no species in the observed community structure extremely dominates over the others. This suggests that the community structure is in a stable condition (Rumengan and Rimper, 2016).

CONCLUSION

1. The identification of phytoplankton in the waters of Balikpapan Bay revealed three classes: Bacillariophyceae, Cyanophyceae, and Dinophyceae. In the Bacillariophyceae class, 46 species were found, with the most abundant species at stations 1 and 3 being *Nitzschia sigma*, and at station 2 being *Coscinodiscus* sp. Both the *Cyanophyceae* and *Dinophyceae* classes had 4 species each.
2. The phytoplankton evenness index across the three stations ranged from 0.74 to 0.80. Station 1 was categorized as having high evenness, indicating a higher distribution of individuals and higher community stability compared to the other two stations. The phytoplankton diversity index across the three stations ranged from 2.79 to 2.57. The species diversity was relatively even, suggesting that the diversity index in the waters of Balikpapan Bay was relatively similar, with no significant differences between the stations. The dominance index at the three stations ranged from 0.10 to 0.11, indicating a stable community structure. This means that no species extremely dominated over the others, contributing to the overall stability of the ecosystem.

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