

## CHARACTERISTICS OF PLANKTON ABUNDANCE AND BIODIVERSITY IN SAPA BATU TAMUN SEAGRASS BEDS, BONTANG CITY

Karakteristik Kelimpahan dan Biodiversitas Plankton di Padang Lamun Sapa Batu  
Tambun Kota Bontang

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### ABSTRACT

The characteristics of abundance and biodiversity of plankton are related to their interactions in the seagrass ecosystem which forms the characteristics of the physical, chemical and biological parameters of the waters. The Sapa Batu Tambun seagrass is a seagrass meadow formed from the dredging activity of shipping channels. This study aims to determine the characteristics of abundance and biodiversity of plankton that interact with the Sapa Batu Tambun seagrass meadow in Bontang City. This study was conducted in May 2025 - January 2026. The research method used was a purposive sampling method at three research stations, namely the plankton community Before Seagrass Meadows (SPL), in Seagrass Meadows (PL), and After Seagrass Meadows (STPL). Data analysis included composition, plankton abundance, and community structure, seagrass composition and density, as well as Principal Component Analysis (PCA) and Correspondence Analysis (CA). The results of the study showed 5 classes of Phytoplankton with 15 species and 2 classes of Zooplankton with 14 species. Plankton abundance reached 91 Individuals/l or in moderate criteria. Seagrass meadows contribute to increasing plankton abundance by 15.39%.

**Keywords:** Characteristics, Plankton, Sapa Batu Tambun, Seagrass beds.

### ABSTRAK

Karakteristik kelimpahan dan biodiversitas plankton berkaitan dengan interaksinya pada ekosistem padang lamun yang membentuk karakteristik parameter fisika, kimia dan biologi perairan. Padang lamun Sapa Batu Tambun merupakan padang lamun yang terbentuk dari aktivitas pengerukan alur pelayaran. Penelitian ini bertujuan untuk mengetahui karakteristik kelimpahan dan biodiversitas plankton yang berinteraksi dengan padang lamun Sapa Batu Tambun Kota Bontang. Penelitian ini dilaksanakan pada bulan Mei 2025 - Januari 2026. Metode penelitian yang digunakan metode *purposive sampling* di tiga stasiun penelitian, yaitu komunitas plankton Sebelum Padang Lamun (SPL), di Padang Lamun (PL), dan Setelah

Padang Lamun (STPL). Analisis data berupa komposisi, kelimpahan plankton, dan struktur komunitas, komposisi dan kerapatan lamun, maupun *Principal Component Analysis (PCA)* dan *Correspondence Analysis (CA)*. Hasil Penelitian terdapat 5 kelas Fitoplankton dengan 15 spesies dan 2 kelas Zooplankton dengan 14 spesies. Kelimpahan plankton mencapai 91 Individu/l atau dalam kriteria sedang. Padang lamun berkontribusi meningkatkan kelimpahan plankton mencapai 15,39%.

**Kata Kunci:** Karakteristik, Padang Lamun, Plankton, Sapa Batu Tambun.

## INTRODUCTION

Plankton play a role as primary producers and the base of the food chain in coastal waters (Utama et al., 2019) and as bioindicators of water fertility (Riyantini et al., 2020; Setyowardani et al., 2021). Plankton are highly sensitive to changes in environmental conditions, thus being used as bioindicators of water quality (Anas et al., 2022). Changes in physical and chemical water parameters such as temperature, clarity, turbidity, nutrients, and dissolved oxygen can affect plankton community structure (Febriyanti et al., 2023). Temperature and phosphate content contribute significantly to plankton abundance, while current velocity is negatively correlated (Rahmah et al., 2022).

Seagrass beds provide habitat for coastal aquatic organisms (Toruan et al., 2024). Seagrass meadows are ecosystems that support coastal water productivity and control plankton blooms (Purvaja et al., 2018) through their important role as biological filters for plankton abundance (Fadilah et al., 2022). Seagrass meadows play a significant role in dampening currents, waves, and sediment distribution (Forrester et al., 2024), and the turbulence of water currents caused by seagrass leaves plays a role in temperature stability (Carr et al., 2012). The morphometrics of *Enhalus acoroides* leaves, which are ribbon-shaped with large leaf widths and lengths (Zahra et al., 2024), characterize its habitat, characterized by a water temperature distribution ranging from 28-31°C (Kusumaningtyas et al., 2023).

The Sapa Batu Tambun seagrass meadow in Bontang City is a seagrass meadow formed from a stretch of bottom substrate resulting from dredging of a shipping channel in 1990. The presence of this seagrass meadow creates ecological interactions between plankton and the impact of anthropogenic activities and the characteristics of the seagrass meadow formed. This study aims to determine the characteristics of the abundance and biodiversity of plankton interacting with the Sapa Batu Tambun seagrass meadow in Bontang City.

## RESEARCH METHODS

### Place and Time

The research was conducted in the Sapa Batu Tambun seagrass meadow, Bontang City, East Kalimantan in May 2025–January 2026.

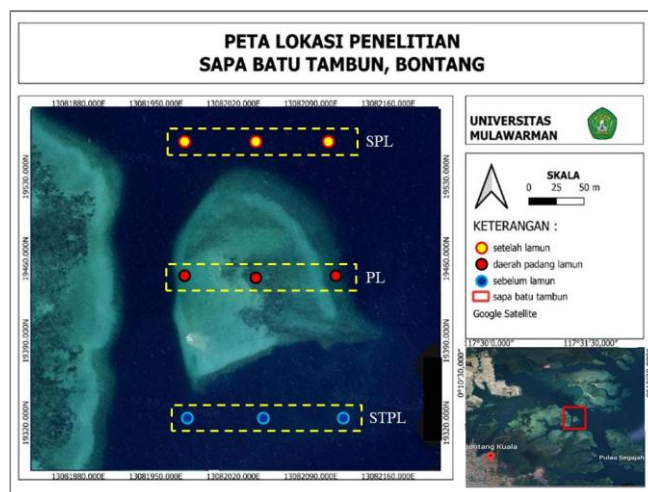


Figure 1. Map of research location

### Tools and Materials

The tools and materials used in this research are:

Table 1. Research tools and materials

No.	Tools	No.	Tools	No.	Tools
1.	Plankton net	5.	Boat	9.	Camera
2.	Microscope	6.	Water checker	10.	GPS
3.	Sample bottle	7.	Coolbox	11.	Stationery
4.	Sacchi disc	8.	Square frame (0.5x0.5m)	12.	Identification book
No.	Materials	No.	Materials	No.	Materials
1.	Plankton samples	2.	Seagrass samples	3.	Lugol

### Sampling techniques

The research location was divided into three stations based on habitat characteristics, namely Before Seagrass Meadows (SPL), in Seagrass Meadows (PL), and After Seagrass Meadows (STPL). The SPL station is located north of the PL station and the STPL is located south of the PL station. The SPL and STPL stations are waters that do not have seagrass meadows. The station determination was carried out using a purposive sampling method by considering the movement of water masses. Plankton sampling was carried out in three replicates at each station. A 100-liter water sample was filtered using a plankton net and preserved with Lugol's solution. Plankton identification and counting were carried out at the Aquatic Biodiversity Laboratory, Faculty of Fisheries and Marine Sciences, Mulawarman University. Seagrass sampling followed line transects, each transect consisting of 3 plots (0.5x0.5m square frames). Water sample measurements were carried out in situ.

### Data Analysis

#### Plankton

#### Composition and Abundance of Plankton Species

Species composition was carried out using a tabulation approach and plankton abundance based on APHA (1989), namely:  $F = \frac{oi}{op} \times \frac{vr}{vo} \times \frac{1}{vs} \times \frac{n}{xp}$

#### Information:

N : Number of individuals per liter

O<sub>i</sub> : Luas gelas penutup preparat (mm<sup>2</sup>)

O<sub>p</sub> : The area of one field of view (mm<sup>2</sup>)

V<sub>r</sub> : Filtered water volume (ml)

V<sub>o</sub> : Observed water volume (ml)

V<sub>s</sub> : Volume of filtered water (L)

n : The number of plankton throughout the field of view

p : Number of observed fields of view

### Diversity Index

This index is used to determine the diversity of aquatic biota species, namely using the Shannon-Wiener equation (Fachrul, 2007), namely:  $H' = -\sum p_i \ln p_i$

Information:

$H'$  : Diversity index  
 $p_i$  : Chances of each species  
 $n_i$  : Number of i-th species  
 $N$  : Total number of individuals

### Uniformity Index

The uniformity index uses the equation, (Odum, 1993), namely:  $E = \frac{H'}{\ln S}$

Information:

$E$  : Uniformity index;  $H'$  : Diversity index;  $\ln S$  : Number of species

### Dominance Index

Simpson's dominance index with the equation (Odum, 1993), namely:  $D = \sum \left(\frac{n_i}{N}\right)^2$

Information:

$D$  : Simpson's dominance index  $n_i$  : Number of i-th species  $N$  : Total number of individuals

### Principal Component Analysis (PCA)

The distribution of the physicochemical characteristics of seagrass meadows, a habitat for plankton, can be analyzed using a multivariate statistic called Principal Component Analysis (PCA), which graphically depicts the relationship between environmental parameters (physicochemical) and habitat (station) (Ludwig and Reynolds 1988).

Data centralization is performed by finding the difference between the initial parameter value and the average parameter value, namely:  $C_{ij} = \bar{X}_{ij} - X_1$

Information  $C_{ij}$  = Centralization  $\bar{X}_{ij}$  = Initial parameter value value;

The reduction is done by dividing the central value by the standard deviation value of the parameter, namely:  $R_{ij} = C_{ij} - S_{dij}$

Keterangan :  $R_{ij}$  = Nilai pemusatan;  $S_{dij}$  = Nilai simpangan baku parameter  
 Jarak Euclidean dinyatakan dengan persamaan:

$$d^2_{(I,I')} = \sum_{j=1}^p \left( \frac{X_{ij}}{X_{i'}} - X_{i'j} \right)^2$$

Information:  $d$  = Euclidean distance;  $i, i'$  = Two stations on the line

$J$  = Physico-chemical parameters in the column vary from 1 to  $p$

### Correspondence Analysis (CA)

The spatial distribution of plankton associated with seagrass at each research station (control station) can be displayed in the form of Correspondence Analysis (CA) (Lugwig and Reynolds 1988). Correspondence Analysis works by comparing the Chi-Quadrant distance between each station. The Chi-Quadrant distance is calculated using the equation:

$$d_2(i, i') = \sum \left( \frac{X_{ij}}{X_i} - \frac{X_{i'j}}{X_{i'}} \right)^2 / X_j$$

Information:  $d_2$  = Chi-Square Distance;  $i, i'$  = Two stations on the line

$X_i$  = Number of rows  $i$  for all columns;  $X_j$  = Jumlah kolom  $j$  untuk baris

$$d_2(ij) = \sum_{j=1}^p \left( \frac{X_{ij}}{X_j} \right)^2$$

Information:  $d_2$  = Chi-Square Distance;  $X_j$  = Number of rows  $i$  for all columns  
 $X_j$  = Jumlah kolom  $j$  untuk baris

## Seagrass

### Density

Species density uses the formula (Odum, 1998), namely:  $D_i = \frac{N_i}{A}$

Information:

$D_i$  : Density of species  $i$  (ind/m<sup>2</sup>);  $n_i$  : Number of  $i$ -th species;  
 $A$  : Sampling area size (m<sup>2</sup>)

## RESULT

### Plankton Composition and Abundance

The plankton found consisted of 7 families divided into 24 genera and 29 species. The highest percentage of family composition was Hexanauplia with a species percentage reaching 35%, then Coscinodiscophyceae 17%, Coscinodiscophyceae, Bacillariophyceae and Dinophyceae each 14%, while Cyanophyceae and Zygnematophyceae each 3% (Figure 2).

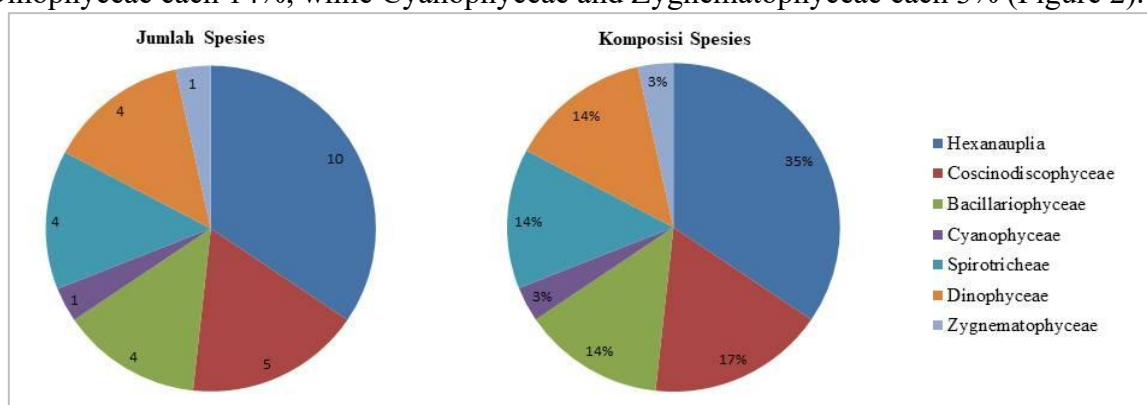


Figure 2. Plankton composition

Plankton abundance ranged from 708 to 992 individuals/l, with an average of 868 individuals/l (Table 2). Based on phytoplankton groups, the SPL Station reached 566 individuals/l, the PL Station reached 683 individuals/l, and the STPL Station reached 855 individuals/l. The highest plankton abundance was found in the Coscinodiscophyceae family with an average abundance of 572 individuals/l, followed by Hexanauplia at 148 individuals/l, Cyanophyceae at 95 individuals/l, Spirotricheae at 19 individuals/l, and Dinophyceae and Zygnematophyceae at 3 individuals/l and 1 individual/l, respectively (Table 2).

Table 2. Plankton abundance by station

Class	Spesies	Station (Individual /l)		
		SPL	PL	STPL
Hexanauplia	<i>Acartia amouri</i>	39	52	78
	<i>Acartia clausi</i>	3	4	2
	<i>Calanus sinicus</i>	1	0	0
	<i>Eurytemora affinis</i>	25	36	0
	<i>Eurytemora carilleae</i>	0	0	11
	<i>Eurytemora pasifica</i>	0	84	12
	<i>Eurytemora caspica</i>	25	0	0
	<i>Macrosetella gracilis</i>	1	3	1

	<i>Macrosetella rosea</i>	1	1	0
	<i>Balanus perforatus</i>	12	26	26
Coscinodiscophyceae	<i>Bacteriastrum</i> sp.	78	38	44
	<i>Chaetoceros</i> sp.	403	481	646
	<i>Leptocylindrus clanicus</i>	9	0	0
	<i>Skeletonema costatum</i>	1	2	1
	<i>Coscinodiscus lacustris</i>	4	9	1
Bacillariophyceae	<i>Eucampia zodiacus</i>	1	0	1
	<i>Nitzschia longissima</i>	4	37	17
	<i>Thalassionema nitszhioides</i>	4	0	0
	<i>Pleurosigma elongatum</i>	9	8	8
Cyanophyceae	<i>Trichodesmium erythraeum</i>	47	105	132
Spirotricheae	<i>Favella ehrenbergii</i>	32	8	5
	<i>Favella campanula</i>	1	5	0
	<i>Tintinopsis tocaninensis</i>	1	1	2
	<i>Rhabdonella poculum</i>	1	0	0
Dinophyceae	<i>Ceratium furca</i>	2	1	3
	<i>Peridinium willei</i>	1	0	0
	<i>Protoperidinium depressum</i>	1	1	0
	<i>Prorocentrum lima</i>	1	0	0
Zygnematophyceae	<i>Staurastrum tohopekaligense</i>	1	1	2
TOTAL		708	903	992

Description: SPL: Before seagrass meadow; PL: Seagrass meadow; STPL: After seagrass meadow.

### Diversity, Uniformity and Dominance Index

The diversity index value ranges from 1.35-1.88 with an average of 1.64, the uniformity index value ranges from 0.47-0.62 with an average of 0.53 and the dominance index value ranges from 0.35-0.89 with an average of 0.58 (Figure 3).

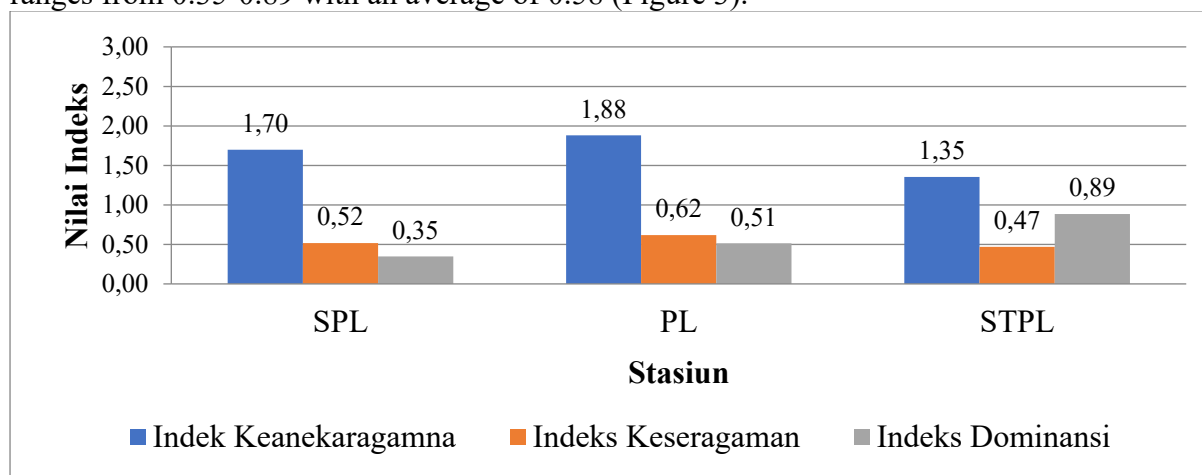


Figure 3. Values of diversity, uniformity and dominance indexes

### Seagrass Composition and Density

The only seagrass species found was *Enhalus acoroides*, with a density ranging from 73 to 117 stands/m<sup>2</sup>, with an average of 91 stands/m<sup>2</sup> (Table 3).

Table 3. Seagrass Density (Stands/m<sup>2</sup>)

Species	West PL	Central PL	East PL
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	Range	Average	Range	Average	Range	Average
<i>Enhalus acoroides</i>	73-79	74	95-117	103	77-107	96

### Physical and Chemical Parameters of Water

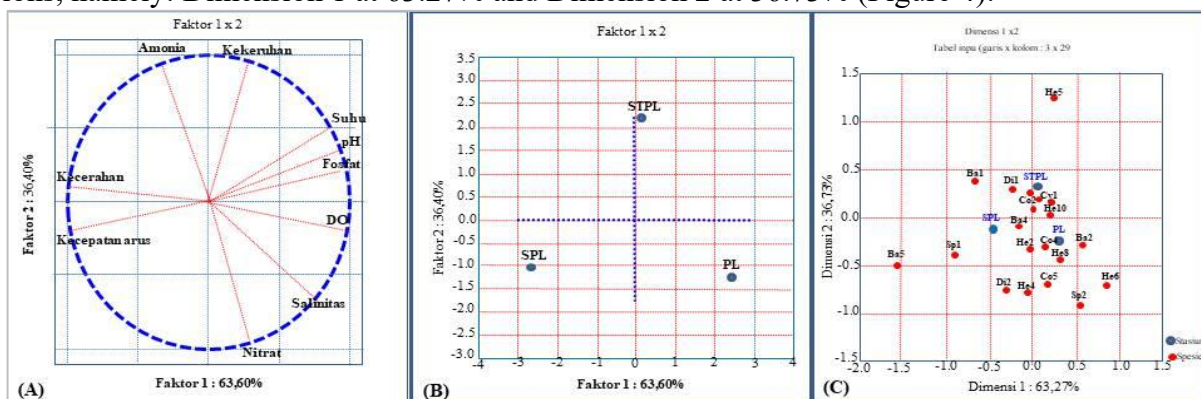
The measured physical parameters of the water were generally within the required quality standards, except for nitrate and phosphate, which exceeded the standards (Table 4).

Table 4. Results of measurements of physical and chemical parameters of the water

Parameter	Unit	Station			Average	Quality standards	
		SPL	PL	STPL			
Physics	Temperature	°C	30.4	32	32.1	31.8	28-30
	Brightness	m	1.67	0.81	1.29	1.14	>3
	Current Speed	m/s	0.11	0.04	0.06	0.06	-
	Turbidity	NTU	0.39	0.49	0.80	0.56	5
Chemistry	Salinity	‰	29.7	30.3	29.6	29.9	33-34
	pH	-	7.68	7.87	7.86	7.84	7-8.5
	DO	mg/L	5.3	6.00	5.56	5.95	>5
	Nitrate	mg/L	2.49	2.79	1.96	2.41	0.008
	Phosphate	mg/L	0.03	0.18	0.14	0.12	0.015
	Ammonia	mg/L	0.18	0.16	0.21	0.18	0.3

### Spatial Distribution of Plankton with Habitat Characteristics

Based on the PCA results, it shows that the information is divided into 2 factors, namely: Factor 1 at 63.60% and Factor 2 at 36.40%. The CA results are divided into 2 dimensions, namely: Dimension 1 at 63.27% and Dimension 2 at 36.73% (Figure 4).



(51.72%) and the zooplankton group is 14 species (48.28%). Based on abundance, the phytoplankton group reaches 80.84% and the zooplankton group reaches 19.16% (Table 2).

Based on the station, it shows that the SPL Station consists of 27 species (93.1%) and 2 species were not found, namely: *Eurytemora affinis* and *E. pacifica*, Station PL consists of 20 species (69%) and species that were not found, namely: *C. sinicus*, *E. carilleae*, *L. clanicus*, *E. zodiacus*, *T. nitszhoides*, *R. poculum*, *P. willei* and *P. lima*. Station STPL consists of 18 species (62.1%) and species that were not found, namely: *C. sinicus*, *E. affinis*, *E. caspica*, *M. rosea*, *L. clanicus*, *T. nitszhoides*, *F. campanula*, *R. poculum*, *P. willei*, *P. depressum*, and *P. lima*. This shows that plankton species originating from Station SPL crossing Station PL resulted in several species not being found, namely: *L. clanicus*, *E. zodiacus*, *T. nitszhoides*, *P. willei*, *P. lima*, *C. sinicus*, and *E. caspica*. Furthermore, plankton species originating from Station PL that crossed Station STPL showed that the following species were not found: *L. clanicus*, *T. nitszhoides*, *P. willei*, *P. lima*, *C. sinicus*, and *E. caspica*. This indicates predation activity at Station PL and indicates that seagrass meadows, as ecosystems, act as biological filters for plankton abundance (Fadilah et al., 2022).

Plankton abundance at Station SPL reached 708 individuals/l, Station PL reached 903 individuals/l, and Station STPL reached 992 individuals/l (Table 2). This indicates that the seagrass meadow at Station PL contributed to an increase in plankton abundance of 27.54%, and plankton abundance at Station STPL increased by 9.86%. The increase in abundance at Station PL compared to SPL was due to an increase in the abundance of *Chaetoceros* sp. by 19.35%, *Skeletonema costatum* (100%), *Coscinodiscus lacustris* (125%), *Nitzschia longissima* (825%), *Trichodesmium erythraeum* (123.4%), *Acartia amouri* (33.3%), *Eurytemora affinis* (44%), *Eurytemora pacifica* (100%), *Balanus perforates* (116.67%), and *Favella campanula* (400%). This condition indicates that the PL Station is a habitat that supports the abundance of these ten species or that the seagrass meadows in Sapa Batu Tambun play an important role in forming the habitat of shallow marine biota (Akhila et al., 2023).

### **Diversity, Uniformity and Dominance**

The diversity index values at the three stations were moderate, the evenness index values tended to be even, and the dominance index values tended to have dominant species (Figure 3). Figure 3 shows that Station PL had the highest diversity value compared to Station SPL and STPL. The evenness index values showed that the highest value was found at Station PL compared to Station SPL and STPL. Similarly, the dominance index values at Station PL tended to be lower than at Station STPL. This condition was caused by increasing temperature, salinity, DO, nitrate and phosphate content, and decreasing current speed (Table 4). This indicates that the seagrass meadows at Station PL support biodiversity with a relatively even distribution of species and are able to prevent the occurrence of plankton species dominance.

### **Seagrass**

Table 3 shows that at Sapa Batu Tambun, or the PL Station, the seagrass succession that forms the seagrass meadow is *Enhalus acoroides*. The formation of these seagrass meadows tends to be natural, with no rehabilitation or restoration approaches. This indicates that the growth and development of seagrass (*E. acoroides*) only require growing space and water conditions that still support its life. This is indicated by the average density of *E. acoroides* reaching 91 individuals/l, which falls within the moderate criteria (scale 3 (moderate): 51-125 stands/m<sup>2</sup>) (Haris and Gosari, 2012).

*Enhalus acoroides*, with its elongated, ribbon-like leaves, is a larger seagrass species than other seagrass species (Zahra et al., 2024), namely *Thalassia hemprichii*, *Cymodocea serulata*, and *C. rotundata*. These morphometrics are able to create shallow water quality that is suitable for aquatic biota habitat, namely: increasing temperature, brightness and salinity,

decreasing current speed, stabilizing turbidity, increasing pH, DO content, nitrate and phosphate and reducing ammonia content compared to SPL Station (Table 4).

### Station characteristics and spatial distribution of plankton abundance

The PCA results indicate that the characteristics of the SPL, PL, and STPL stations (Figures 4A and B) tend to differ. CA analysis indicates a distribution of plankton species that are closely associated with station characteristics (Figure 4C). This close association of plankton species with station characteristics is shown in Table 5.

Table 5. Association of Plankton Species with Station Characteristics

Station	Characteristics of water parameters	Associated plankton
SPL	High brightness and current speed	<i>C. sinicus</i> , <i>E. pasifica</i> , <i>Bacteriastrum</i> sp., <i>E. zodiacus</i> , <i>T. nitszhoides</i> , <i>P. elongatum</i> , <i>F. ehrenbergii</i> , <i>R. poculum</i> , <i>P. willei</i> , <i>P. lima</i> .
PL	high temperature, pH, dissolved oxygen, phosphate content and low brightness and current speed.	<i>A. clausi</i> , <i>E. affinis</i> , <i>E. capsica</i> , <i>M. gracilis</i> , <i>M. rosea</i> , <i>S. costatum</i> , <i>C. lacustris</i> .
STPL	high turbidity and ammonia	<i>A. amouri</i> , <i>E. carilleae</i> , <i>Chaetoceros</i> sp., <i>T. tocantinensis</i> , <i>C. furca</i> , <i>S. tohopekaligense</i> .

Table 5 shows a close association of plankton species with the characteristics of the PL Station, namely: *A. clausi* with an abundance of (4 individuals/l), *E. affinis* (36 individuals/l), *E. capsica* (84 individuals/l), *M. gracilis* (3 individuals/l), *M. rosea* (1 individual/l), *S. costatum* (2 individuals/l), *C. lacustris* (9 individuals/l). Based on the total abundance of these species, they contributed to an increase in plankton abundance at the PL Station reaching 15.39%. This shows that the presence of seagrass meadows in Sapa Batu Tambun forms water characteristics with increased temperature, pH, dissolved oxygen, phosphate content and low brightness and current speed and forms a habitat that supports an increase in plankton abundance.

### CONCLUSION

The conclusions of this research are as follows:

1. The Sapa Batu Tambun seagrass meadow as a habitat supports an increase in plankton abundance of 15.39% with plankton abundance reaching 91 individuals/l or in the moderate criteria.
2. The Sapa Batu Tambun seagrass meadow is a habitat for 27 plankton species with a diversity index in the medium criteria.

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