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CHARACTERISTICS OF FISH COMMUNTIES ASSOCIATIONS IN THE WATER OF MALAHING VILLAGE, BONTANG CITY, EAST KALIMANTAN

Karakteristik Asosiasi Komunitas Ikan pada Padang Lamun di Perairan Kampung Malahing, Kota Bontang, Kalimantan Timur

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ABSTRACT

The important role of seagrass beds as habitat for fish communities, both as nursery ground, feeding ground and shelter. The aim of the research was to determine the association of fish communities in seagrass beds in relation to the characteristics of the seagrass species that make up the seagrass beds. The research was carried out in seagrass beds in the waters of Malahing Village, Bontang City, East Kalimantan from October 2024–February 2025, using a purposive sampling method. Sampling consisted of 2 stations with three repetitions. Fish samples were taken using a trap net and seagrass density using a 50x50cm square frame. The seagrass species found at both stations consisted of E. acoroides and T. hemprichii. The fish species caught consisted of 10 families, 11 genera and 15 species. Fish community association was positively correlated with T. hemprichii density.

Keywords: Association, Fish, Malahing, Seagrass

ABSTRAK

Peran penting padang lamun sebagai habitat komunitas ikan, sebagai daerah asuhan, tempat mencari makan dan berlindung. Tujuan penelitian untuk mengetahui asosiasi komunitas ikan di padang lamun berkaitan dengan karakteristik spesies lamun menyusun padang lamun. Penelitian dilaksanakan di padang lamun perairan Kampung Malahing Kota Bontang, Kalimantan Timur dari bulan Oktober 2024 – Februari 2025, dengan menggunakan metode *purposive sampling*. Pengambilan sampel terdiri dari 2 Stasiun dengan tiga kali pengulangan. Pengambilan sampel ikan menggunakan alat tangkap belat (*trap net*) dan kerapatan lamun menggunakan bingkai kuadrat 50x50cm. Spesies lamun yang ditemukan di kedua stasiun terdiri dari *Enhalus acoroides* dan *Thalassia hemprichii*. Spesies ikan yang tertangkap terdiri dari 10 famili, 11 genus dan 15 spesies. Asosasi komunitas ikan berkorelasi positif terhadap kerapatan *T. hemprichii.*

Kata Kunci: Asosiasi, Ikan, Lamun, Malahing

INTRODUCTION

Fish communities in coastal waters are generally associated with coral reef ecosystems, mangrove forests and seagrass beds (Belinda et al., 2022; Irawan et al., 2024). Seagrass beds are expanses or colonies consisting of multispecies or monospecific (Irawan & Nganro, 2016) and seagrass is a flowering plant (angiospermae) that lives in the intertidal to subtidal zones which is characterized by the presence of a root system, rhizomes, leaves, flowers and fruit (Tulung et al., 2024).

The presence of fish communities in seagrass beds is related to the role of seagrass beds as high primary producers (Jalaludin et al., 2020), habitat for various biota (Billah et al., 2016) and distribution of individual sizes based on the characteristics of the species that make up the seagrass beds (Irawan et al., 2021). The important role of seagrass beds as nursery grounds, feeding grounds, and shelter from predators (Miftahudin et al., 2020), and seagrass beds as habitats for various fish species from other coastal ecosystems (coral reefs, mangroves, and estuaries) in the juvenile phase and in the adult phase returning to the coastal ecosystem (Irawan et al., 2018).

Seagrass beds in the waters of Kampung Malahing are composed of *Enhalus acoroides* and *Thalassia hemprichii* (Irawan et al., 2024). Irawan et al. (2024) reported that *Siganus canaliculatus* in the adult phase tends to associate with *E. acoroides* stands. Based on this, this study aims to determine the association of fish communities in seagrass beds related to the characteristics of seagrass species that make up the seagrass beds.

METHODS

Place and Time of Research

The research was conducted in the seagrass meadows of Kampung Melahing Waters, Bontang City, East Kalimantan (Figure 1) from October 2024 – February 2025.

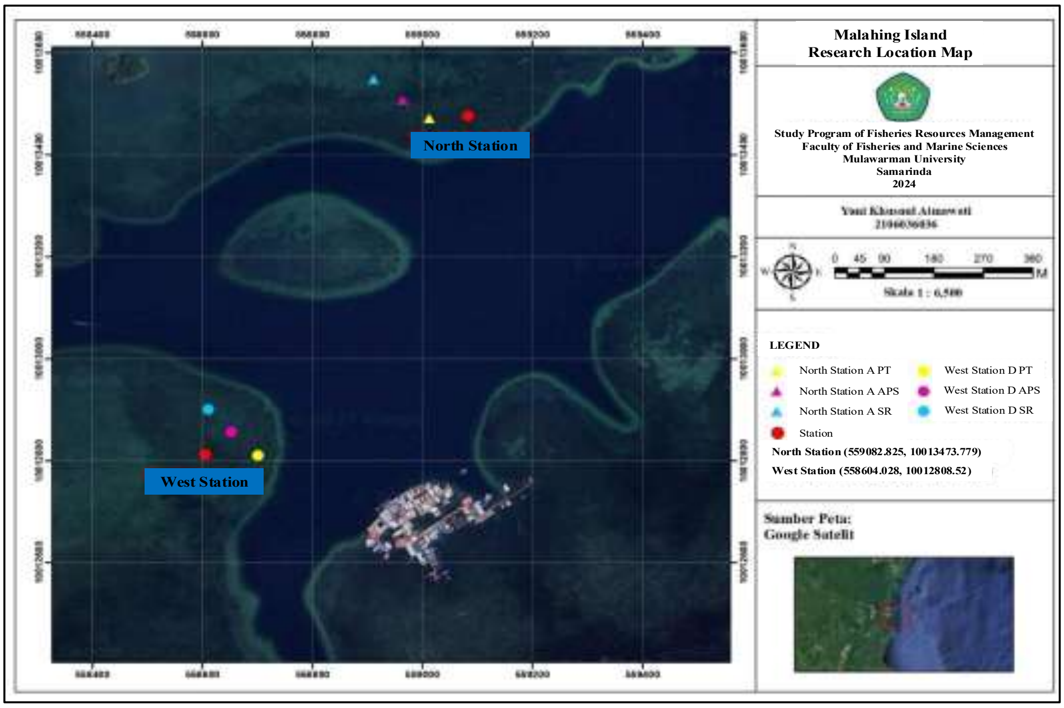

Figure 1. Research Location

Tools and Materials

The tools and materials used in the research are as follows:

Table 1. Tools and Materials

No.	Tools			
1.	Boat	6. String of raffia	11. Jerigen	16. Shovel
2.	Splint	7. Camera	12. DO Meter	17. Stationery
3.	GPS	8. Scales	13. *Secchi disk*	18. Tissue
4.	*Water checker*	9. Ruler	14. *Cool box*	
5.	Quadrant 50x50 cm	10. Sample Plastic	15. Paralon Pipe	
No.	**Materials**			
1.	Fish Sample	2. Seagrass sample	3. Basic substrate sample	4. Aquades

Sampling Technique

The research stations consisted of the North Station and the West Station. Sampling of fish, seagrass, water quality and bottom substrate was done using the purposive sampling method and repeated 3 times with an interval of 15 days (at the highest tide and lowest ebb) (Setiawan et al., 2024). Fish sampling using a splint fishing gear, the fish caught were identified based on species, the number of individuals was counted and their length and weight were measured. Identification of fish species based on Allen (1999); Bergbauer & Kirschner (2020). Observation and counting of seagrass samples were carried out using a 50 x 50 cm square frame (English et al., 1994). Seagrass individuals in the frame were identified by species and the number of stands was counted. Identification of seagrass species based on Fortes (1993); Tomascik et al. (1997); Water sample measurements were carried out in situ and ex situ.

Data Analysis

Water Quality and Basic Substrate

Analysis of water quality and basic substrate data is presented in graphical form and compared with the water quality standard criteria based on Government Regulation of the Republic of Indonesia Number 22 of 2021 concerning the Implementation of Environmental Protection and Management.

Seagrass

Species density is calculated using the formula (Widyawati et al., 2022):

$$Di = Ni/A$$

Where:
Di = Density of the i-th species (ind./m^2)
Ni = Total number of stands of the i-th species
A = Area of observation point (m^2)

Relative density is the ratio between the number of individuals of a species and the total number of individuals of all species. The relative density of seagrass can be calculated using the equation (Tuwo, 2011):

$$KR = ni/N \times 100\%$$

Where:
KR = Relative abundance
ni = Number of individuals of each i-th species
N = Number of individuals of all species.

Fish

Species composition, number of individuals and length and weight of fish caught are presented in tabular and graphical form. The Biological Rank or Importance Value is calculated based on the number of individuals of the 10 species with the highest abundance. The species with the highest abundance is first given a value of 10, then the second highest abundance is given a value of 9 until the 10th highest abundance is given a value of 1. Based on the Biological Index value obtained by each species, the rank or importance value of the species in the community can be determined. Only species with a Biological Index value of five or more are considered significant in the community (Widyawati et al., 2022).

Relationship between Fish Abundance and Seagrass Density

Pearson Product Moment correlation analysis (Riduwan, 2003) was used to determine the relationship between fish abundance and seagrass density, with the formula:

$$r_{xy} = \frac{n\sum XY - \sum X \sum Y}{\sqrt{n\sum X^2 - (\sum X)^2}\sqrt{n\sum Y^2 - (\sum Y)^2}}$$

Where:
r = Relationship between variable x and variable y
n = Number of data
X = Value of variable x
Y = Value of variable y

The correlation coefficient (r) ranges from -1 to 1, the r value can be expressed as follows (Abdullah and Susanto, 2015): r = -1, the relationship between X and Y is perfect and negative; r = 0, the relationship between X and Y is very weak or there is no relationship; and r = 1, the relationship between X and Y is perfect and positive.

The Diversity Index (H') uses the formula (Widyawati et al., 2022):

$$H' = - \sum pi \ ln \ pi$$

Where:
H' = Diversity index
pi = proportion of the number of individuals (ni/N)

The range of Shannon diversity index values is determined based on the following criteria: If the value of H <1 then the diversity index value is low; if the value of 1 < H <3 then the diversity index value is moderate; and if the value of H > 3 then the diversity index value is high.

Uniformity Index (E) uses the formula (Widyawati et al., 2022):

$$E = H' / ln \ S$$

Where:
E = Uniformity index
H' = Diversity index
S = Number of species

Criteria for uniformity value (E) (Ohorella and Dobo, 2019), namely: if the value is 0.00 ≤E ≤0.50 then the community uniformity index value is depressed; if the value is 0.50 ≤E ≤0.75 then the community uniformity index value is unstable; and if the value is 0.75 ≤E ≤1.00 then the community uniformity index value is stable.

Dominance Index uses the formula (Widyawati et al., 2022):

$$C = \sum(ni / N)2$$

Where:
C = Simpson's dominance index
N = Number of individuals of all species
ni = Number of individuals of the i-th fish species

Dominance value criteria (C) (Ohorella and Dobo, 2019): If the value is 0.00 ≤ C ≤0.50 then the dominance index value is low; if the value is 0.50 ≤ C ≤0.75 then the dominance index value is moderate; and if the value is 0.75 ≤ C ≤1.00 then the dominance index value is high.

RESULTS

Physical, Chemical Parameters of Water and Basic Substrate

The average water temperature reaches 31.85ºC, average brightness 0.65 m, average turbidity 1.68 NTU, average current velocity 13.83 cm/s, average salinity 30.35%0, average pH 8.43, average DO 8.15 mg/l, average nitrate 0.03 mg/l and average phosphate 0.003 mg/l. The sand fraction ranges from 89.52-90.2%, dust ranges from 7.84-8.16% and clay ranges from 2.0-2.32% (Figure 2).

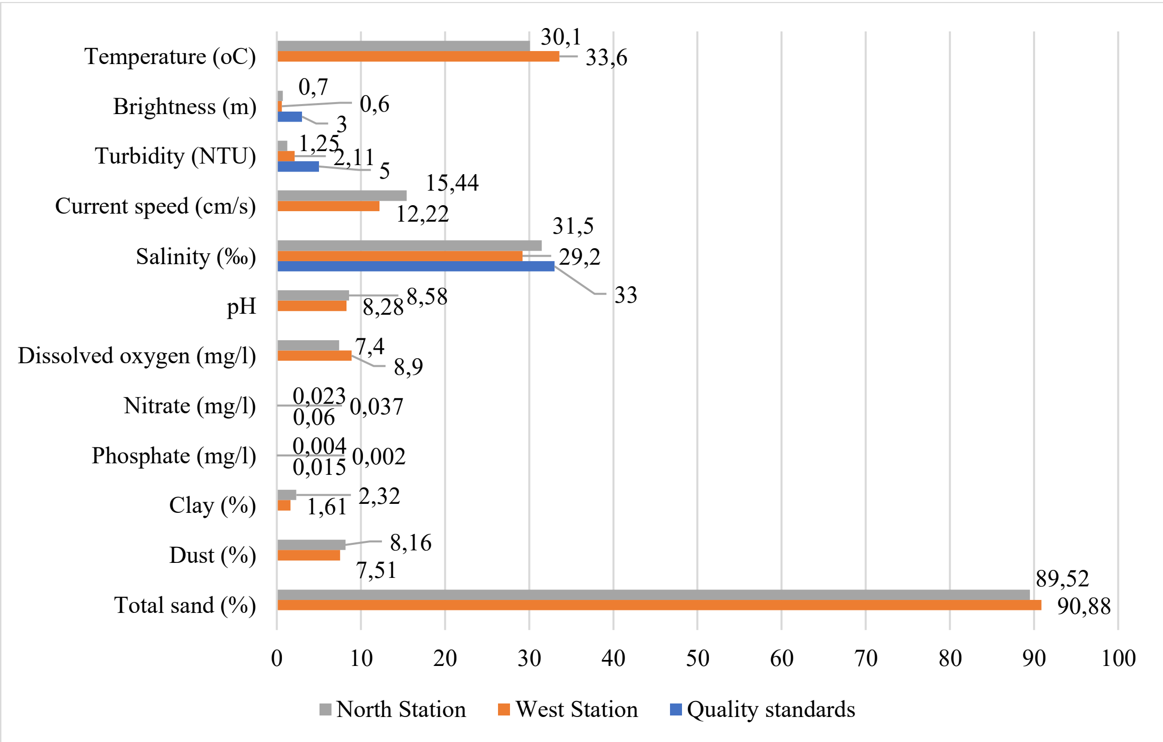

Figure 2. Water Quality Parameters

Seagrass

Species Density and Composition

Seagrass species that make up seagrass beds consist of two species, namely *E. acoroides* and *T. hemprichii*. The total density of seagrass ranged from 263–268 stands/m^2 with the composition of *E. acoroides* stands ranging from 69.40–80.99% and *T. hemprichii* ranging from 19.01–30.60% (Table 2).

Table 2. Density and Composition of Seagrass Species

	North Station		West Station	
	Density (Stand/m^2)	Relative Density (%)	Density (Stand/m^2)	Relative Density (%)
Total Seagrass	263±4.04		268±16.26	
Enhalus acoroides	213±12.12	80.99	186±12.12	69.40
Thalassia hemprichii	50±5.69	19.01	82±4.16	30.60

Fish Community

Abundance, Composition and Biological Rank of Species

The fish community consists of 13 families, 14 genera and 15 species with an average abundance of individuals ranging from 128-156 individuals/trip/day, with an average total length ranging from 15.0 - 16.0 cm and an average weight ranging from 42.0-45.9 gr (Table 3). The species composition ranges from 0.6 - 24.4% and the highest biological rank is *S. canaliculatus* (Figures 3 and 4).

Table 3. Abundance, Total Length and Weight at North and West Stations

Family	Species	North Station			West Station		
		Abundance (indv./trip/ day)	**Total length (cm)**	**Weight (g)**	**Abundance (indv./trip/ day)**	**Total length (cm)**	**Weight (g)**
Apogonidae	*Apogon* sp.	2±0.6	10.1±1.5	14.0±0.7	1±0.6	8.2±0	12.0±0.0
Caesionidae	*Caesio cuning*	8±1.2	13.4±1.7	29.4±2.7	1±0.6	13.2±0	28.0±0.0
Carangidae	*Caranx ignobilis*	10±0.6	12.8±2.0	40.3±13.2	17±0.6	14.6±2.2	37.8±11
Centriscidae	*Centriscus scutatus*	3±1.0	12.9±0.4	2.3±0.6	2±0.6	12.9±0.1	2.5±0.7
Holocentridae	*Myripstristis* s|	10±1.5	15.1±1.5	48.3±15.1	3±0.0	15.3±1.3	59.7±5.5
	Sargocentrun cornutum	9±1.0	15.8±1.8	34.6±7.7	4±0.6	15.2±2.8	37.0±6.3
Labridae	*Choerodon schoenleinii*	4±0.6	19.5±1.3	43.5±8.1	10±0.6	13.2±2.7	1.1±1.2
Lutjanidae	*Lutjanus ehrenbergii*	11±1.2	17.0±0.8	60.5±7.9	4±0.6	15.2±0.4	58.8±3.0
Monacanthidae	*Monachantus chinensis*	3±0.0	16.2±2.1	15.0±2.0	14±0.6	10.1±2.5	11.1±3.2
Nemipteridae	*Scolopsis lineata*	2±0.6	10.2±2.8	35.5±10.6	11±0.6	13.7±2.7	37.2±12
Platycephalidae	*Platycephalus indicus*	1±0.6	23.0±0.0	72±0.0	9±1.0	20.0±1.8	84.1±6.1
Serranidae	*Epinephelinae fuscoguttatus*	11±0.6	17.4±0.7	51.7±13.8	1±0.6	15.3±0.0	38.0±0.0
Siganidae	*Siganus canaliculatus*	25±0.6	13.3±2.8	58.4±19.2	38±2.5	14.9±2.6	51.9±20
	Siganus guttatus	10±1.2	13.6±0.2	39.5±8.9	32±2.1	14.9±1.9	50.0±15
Sphyraenidae	*Sphyraena barracuda*	19±0.6	29.9±3.8	142.8±30	9±0.0	28.0±3.6	121.3±38

Family	Species	North Station			West Station		
		Abundance (indv./trip/ day)	**Total length (cm)**	**Weight (g)**	**Abundance (indv./trip/ day)**	**Total length (cm)**	**Weight (g)**
Average			16.0±1.6	45.9±9.4		15.0±1.6	42±8
Total		128			156		

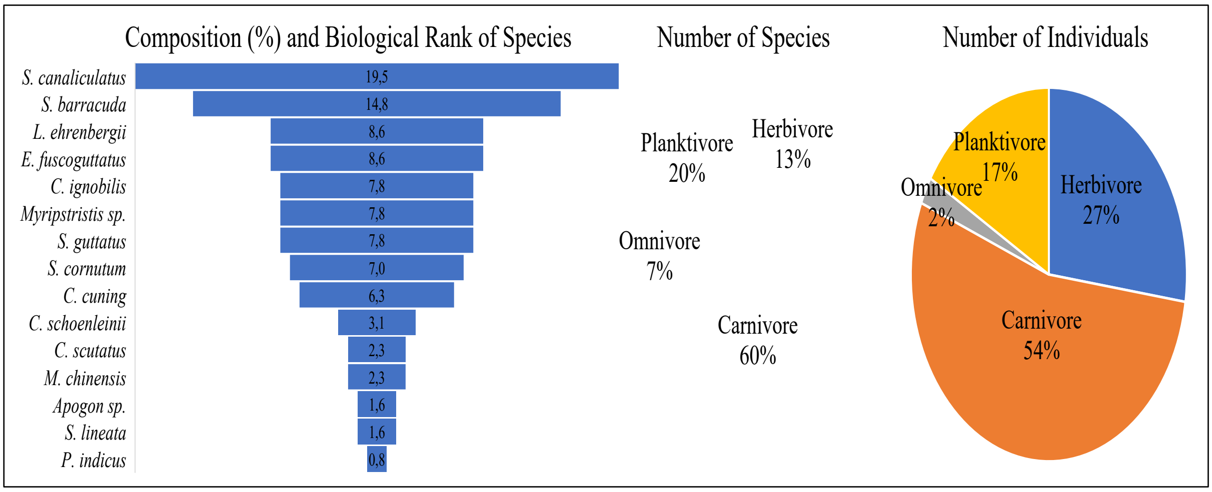

Figure 3. Composition and Biological Ranking of Fish Species at North Station

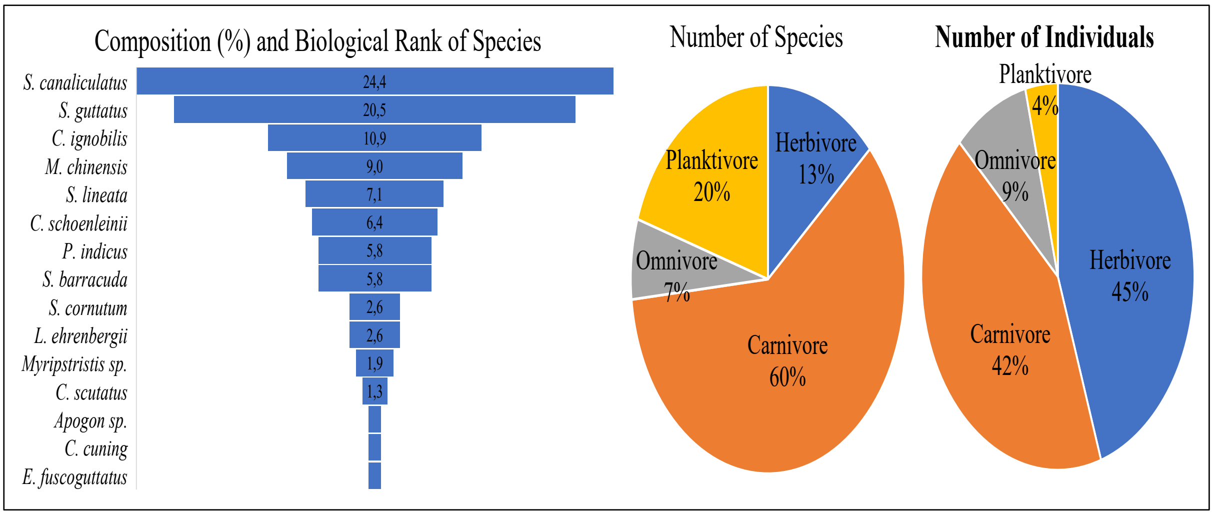

Figure 4. Composition and Biological Ranking of Fish Species at West Station

Relationship between Fish Abundance and Seagrass Meadows

The relationship between fish abundance and seagrass meadows in the Malahing Waters of Bontang City can be seen in Table 4.

Table 4. Correlation between Fish and Seagrass Meadows

Abundance (Individual/m^2)	Density (Stand/m^2)		
	Total Seagrass	*E. acoroides*	*T. hemprichii*
Fish	r = (+) 0.107	r = (-) 0.684	r = (+) 0.709

Diversity, Uniformity and Dominance Index

The value of the fish species diversity index at the North Station and West Station ranged from 2.16 to 2.45, the uniformity index value ranged from 0.80 to 0.91 and the dominance value ranged from 0.10 to 0.15 (Table 5).

Table 5. Value of Diversity Index, Uniformity Index and Dominance Index

Index	North Station		West Station	
	Range	Average (±SD)	Range	Average (±SD)
Diversity (H')	2.25 – 2.45	2.38±0.14	2.16 - 2.26	2.20±0.02
Uniformity (E)	0.83 – 0.91	0.88±0.05	0.80 – 0.84	0.81±0.01
Dominance (C)	0.10 – 0.11	0.11±0.02	0.12 – 0.15	0.14±0.00

DISCUSSION

Physical, Chemical and Basic Substrate Characteristics of Waters

The physical parameters of water quality, namely temperature, brightness, and turbidity are still within the water quality standards (PP No. 22/2021). Chemical parameters, namely pH, salinity and dissolved oxygen are still within the standard range, while nitrate and phosphate content tend to be lower than the standard range (PP No. 22/2021) (Figure 2). The basic substrate fraction is dominated by the total sand fraction ranging from 89.52-90.88%, the dust fraction ranging from 7.51-8.16% and the clay fraction ranging from 1.61-2.32% (Figure 2).

Characteristics of Seagrass Meadows

The seagrass species found consisted of *E. acoroides* (Table 2). The composition of *E. acoroides* ranges from 69.40-80.99% with an average of 75.20% and *T. hemprichii* ranges from 19.01-30.60% with an average of 24.80% (Table 2). This shows that *E. acoroides* tends to have a higher density than *T. hemprichii* (Table 2).

Based on Table 2, it shows that the total density of seagrass stands ranges from 263±4.04 - 268±16.26 stands/m^2 with an average of 266±10.15 stands/m^2. The range and average density are in the very dense criteria or density> 175 stands/m^2 (Braun-Blanquet in Gosari 2012). Based on the standard deviation value of the average density based on the station, it shows that the distribution of seagrass density at the North Station tends to have smaller density distribution fluctuations than the density at the West Station.

Based on the density of each species, it shows that the density of *E. acoroides* ranges from 186±12.12 - 213±12.12 stands/m^2 with an average of 200±12.12 stands/m^2. This shows that the density of *E. acoroides* in the criteria is very dense (Braun-Blanquet in Gosari 2012) and based on the standard deviation value, the density at both stations is relatively the same. The density of *T. hemprichii* which ranges from 50±5.69 - 82±4.16 stands/m^2 with an average of 66±4.93 stands/m^2, this shows that its density in the criteria is rare (25-75 stands/m^2) to quite dense (density 75-125 stands/m^2) (Braun-Blanquet in Gosari & Haris, 2012). The tendency for higher density of *E. acoroides* than *T. hemprichii* based on station shows that increasing percentage of dust and clay (Figure 2) drives increasing density of *E. acoroides* stands (Table 2) and increasing percentage of total sand fraction (Figure 2) drives increasing density of *T. hemprichii* stands (Table 2).

Characteristics of Fish Community

The abundance of individual fish in the seagrass beds of Malahing Village ranges from 128-156 individuals/trip/day with an average of 142 individuals/trip/day consisting of 15 species (Table 2). The abundance and number of species are relatively lower than the abundance and number of species found in the seagrass beds of Kedindingan Island, namely an average abundance of 258 individuals/trip/day divided into 28 species (Widyawati et al., 2022). Likewise, the comparison of the composition and biological ranking of species in the seagrass beds of Malahing Village found were: *S. canaliculatus* ranging from 19.5 to 24.4% (rank 1), *C. ignobilis* ranging from 7.8 to 10.9% (rank 2), *S. guttatus* ranging from 7.8 to 20.5% (rank 3), *S. barracuda* ranging from 5.8 to 14.8% (rank 4), and *L. Ehrenbergii* ranging from 2.6 to 8.6% (rank 5), while the composition and biological ranking in the seagrass beds of Kedindingan Island were: *Pentapodus bifasciatus* reaching 37.68% (rank 1), *Lethrinus letjan* reaching 22.06% (rank 2), *Pentapodus trivittatus* reaching 8.26% (rank 3), *Lutjanus quinquelineatus* reaching 6.06% (rank 4) and *Scolopsis ciliates* reached 4.9% (rank 5) (Widyawati et al., 2022), this shows differences in the composition and biological ranking and feeding habit groups of fish species in the two seagrass beds. The feeding habit groups for the 5 highest ranks in the Kampung Malahing Seagrass Bed (Figures 3 and 4), namely herbivores 40%, carnivores 40% and omnivores 10%, while in the Kedindingan Island seagrass bed is dominated by the carnivore group which reaches 100% (Widyawati et al., 2022). The differences in individual abundance, number of species and highest species composition in the Malahing seagrass beds and Kedindingan Island are closely related to the diversity of seagrass species that make up the two seagrass beds, namely the Malahing Village seagrass bed is composed of *E. acoroides* and *T. hemprichii* (Table 2) while on Kedindingan Island it is composed of *T. hemprichii, Halopila ovalis, Halopila minor, E. acoroides, Syringodium isoetifolium, Cymodocea rotundata* (Widyawati et al., 2022).

Based on the station, the abundance of fish at the North Station with an average of 128 individuals/trip/day tends to be lower than the abundance of fish at the West Station, which is an average of 156 individuals/trip/day with the same number of species, namely 15 species (Table 2) with groups of eating habits based on the number of species at each station, namely herbivores reaching 13% (Lotuconsina et al., 2021; Parawansa et al., 2020), carnivores reaching 60% (Moreno-Sanchez et al., 2019; McMahon & Berumen, 2011; Pears et al., 2006; Loupatty et al., 2021), omnivores reaching 7% and plankton eaters reaching 20% (Figures 3 and 4). The feeding habit group based on the percentage of the number of individuals shows that at the North Station for the herbivore group it reaches 27%, carnivores reach 54%, omnivores reach 2% and plankton eaters reach 17%, while at the West Station for the herbivore group it reaches 45%, carnivores 42%, omnivores reach 9%, and plankton eaters reach 4% (Figures 3 and 4).

The difference in the composition of fish feeding habits at the two stations is related to the total length and weight of fish species that adapt to the characteristics of the abundance of seagrass species at each station. Based on the average total length of the herbivore group at the North Station it reaches 13.45 cm which tends to be shorter than the average total length at the West Station reaching 14.90 cm, likewise the average weight of the herbivore group at the North Station reaches 48.95 g which tends to be smaller than the average weight at the West Station which reaches 50.95 g (Table 2). Likewise, the total length and weight of the plankton-eating fish group at North Station reached 13.80 cm with a weight of 26.67 g, tending to be smaller than the total length (13.80 cm) and weight (30.07 g) of the fish group at West Station (Table 2). This shows that the herbivorous group at North Station is smaller than the herbivorous group at West Station and also shows that the seagrass beds at North Station tend to be nursery and shelter areas for herbivorous and plankton-eating fish groups. The herbivorous fish groups tend to make the seagrass beds at North Station related to the total length of *S. canaliculatus* in the pre-mature phase (Irawan et al., 2024).

The tendency can be seen from the composition of seagrass species that make up the seagrass beds, namely the North Station for the percentage of relative density of *E. acoroides* reaching 80.99% and *T. hemprichii* reaching 19.01%. The high relative density of *E. acoroides* provides a protected space for herbivorous and plankton-eating fish species, this is because the morphometrics of *E. acoroides* are larger than other seagrass species. However, there is a tendency for herbivorous and plankton-eating fish groups to be smaller in size at the North Station, which encourages the presence of carnivorous fish groups to forage in the seagrass beds, this is also related to the total length and average weight of the carnivorous group caught, which is 17.30 cm with a weight of 54.99 g and the omnivorous fish group with a total length of 16.20 cm with a weight of 15.00 g (Table 2) or the carnivorous and omnivorous fish groups are larger than the herbivorous and plankton-eating fish groups.

At the West Station, herbivorous, plankton-eating, carnivorous and omnivorous fish groups tend to have a greater average total length and weight than the feeding habit groups at the North Station. This condition indicates that fish species that have larger sizes tend to associate with seagrass species that have smaller morphometrics, this can be seen from the increase in the relative density of *T. hemprichii* which reached 30.60% and the relative density of *E. acoroides* reached 69.40%. The change in the composition of seagrass species that make up the seagrass bed contributed to the distribution of species abundance, total length and weight of fish feeding habit groups, and the characteristics of seagrass beds at the West Station tended to be feeding areas. This relationship can be seen from the high correlation between fish abundance and *T. hemprichii* stand density which is positive (r = (+) 0.709) with a coefficient of determination reaching 50.27% (Table 3) or an increase in abundance, total length and weight of fish in line with the increasing density of *T. hemprichii*. The existence of 4 groups of eating habits shows that seagrass beds are not only a habitat and buffer for fish biodiversity in coastal waters (Irawan et al., 2018) and the presence of seagrass as food for herbivorous fish as well as a place to find food for carnivorous, omnivorous and plankton-eating fish.

Based on the value of the fish species diversity index, the index value ranges from 2.20 ± 0.02 (West Station) - 2.38 ± 0.14 (North Station) (Table 4), this range indicates that the index value is in the moderate criteria. The uniformity index value ranges from 0.81 ± 0.01 (West Station) - 0.88 ± 0.05 (North Station) in the stable community criteria. The dominance index value ranges from 0.11 ± 0.02 (North Station) - 0.14 ± 0.00 (West Station) in the low species dominance criteria. Based on the standard deviation values of the three index values which have very small values or the fluctuations in index values at the two stations are very small, it means that the population dynamics of fish species in the seagrass beds of Malahing Village are relatively stable.

CONCLUSION

The conclusions of this study are:

1. The fish community consists of 13 families, 14 genera and 15 species with an average abundance of individuals ranging from 128-156 individuals/trip/day, with an average total length ranging from 15.0 - 16.0 cm and an average weight ranging from 42.0-45.9 g and a species composition ranging from 0.6 - 24.4% with *S. canaliculatus* having the highest biological ranking.
2. Seagrass beds provide habitat niches for herbivorous, carnivorous, omnivorous and plankton-eating fish groups.
3. The association of the fish community is positively correlated with the density of *T. hemprichii*.

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