

Microplastic Pollution in the Aquatic Ecosystem of Gili Trawangan, Lombok: Abundance, Characteristics, and Implications in Tourism Area

Nadda Khalila Chairunnisa¹, Moh. Awaludin Adam², Dining Aidil Candri^{1*}

¹ Department of Biology Faculty of Mathematics and Natural Sciences, Mataram University, Mataram, Indonesia.

² Research Center for Marine and Land Bioindustry, National Research and Innovation Agency, Tanjung, Indonesia.

Received: April 24, 2025

Revised: June 11, 2025

Accepted: July 25, 2025

Published: July 31, 2025

Corresponding Author:

Dining Aidil Candri

aidilch@unram.ac.id

DOI: [10.29303/jppipa.v11i7.7485](https://doi.org/10.29303/jppipa.v11i7.7485)

© 2025 The Authors. This open access article is distributed under a (CC-BY License)



Abstract: Microplastics (MPs) have become an interesting topic of discussion especially after many studies reported their presence in aquatic ecosystems. Pollution by microplastic particles in aquatic systems is a critical issue the world that has the potential to damage aquatic ecosystems. Therefore, this study aims to identify the abundance and characteristics of MPs in water, sediment and seagrass in tourist areas. Samples were obtained from three location categories, first the port, second the hotel area and third the residential area located in the Gili Trawangan tourist area, Lombok, Indonesia. After optimization of extraction, characterization was carried out using a stereo microscope to identify MPs. The results show that the average abundance of MPs in the three location categories is, 13.25 ± 17.21 ; 19.25 ± 23.30 ; and 16.50 ± 18.52 particles/L at water, 22.00 ± 30.84 ; 20.00 ± 30.80 ; and 6.00 ± 8.49 particles/kg dry weight (dry weight) sediment, and 17.50 ± 15.69 ; 16.25 ± 22.56 ; and 8.25 ± 8.46 particles/individual at seaweed. Then from this abundance, the types of MPs were found in the form of fragments, fibers, films and pellets, where the dominant colors are black, yellow, blue, red and green, with the highest size $< 500 \mu\text{m}$. From this study it is necessary to see the impact of MPs on seaweed and the aquatic environment around Gili Trawangan.

Keywords: Gili Trawangan; Lombok; Microplastics; Pollution

Introduction

Marine debris pollution (Tuahatu & Tuhumury, 2022) is a global issue as marine waste can easily be transported by water currents from one location to another. Marine pollution originate from various sources (Adam et al., 2018, 2019, 2022), including ship crossings in maritime transportation. Disposal of household and plastic waste into the sea, which poses a significant global concern (Suriyanto et al., 2020). Plastic, widely used and integrated into various aspects of daily life, significantly contributes to oceans pollution (Mardalisa et al., 2021). Plastic pollution in the oceans is escalating worldwide, with approximately 300 million

tons of plastic produced annually, and an estimated 150 million tons believed to have contaminated the seas. Moreover, 1-2.5 million tons of plastic are estimated to be dumped into the ocean each year (Tyllianakis & Ferrini, 2021). Despite advanced waste disposal facilities cannot provide an effective solution as the chemicals still permeate the biosphere, impacting the surrounding environment and, particularly, human survival (Istirokhatun & Nugraha, 2019).

Plastic discarded into the sea gradually degrades into small fragments known as microplastics (MPs). Microplastics are synthetic polymer particles originating from industrial production or the degradation of plastic waste into small, non-degradable pieces (Faujiah &

How to Cite:

Chairunnisa, N. K., Adam, M. A., & Candri, D. A. (2025). Microplastic Pollution in the Aquatic Ecosystem of Gili Trawangan, Lombok: Abundance, Characteristics, and Implications in Tourism Area. *Jurnal Penelitian Pendidikan IPA*, 11(7), 907-916. <https://doi.org/10.29303/jppipa.v11i7.7485>

Wahyuni, 2022). MPs disperse rapidly in aquatic habitats due to their buoyancy, small size, and high surface to volume ratio, which allows MPs to move with the wind and accumulate in water bodies (Mathalon & Hill, 2014; Wright et al., 2013). The presence of MPs in aquatic environments, including water, sediment, and biota, has been widely reported by Supit et al. (2022). Microplastics can be easily dispersed through water and air, accumulate in water due to water currents, and end up in the sea (Chamas et al., 2020). MPs in aquatic environments generally originate from anthropogenic activities in terrestrial environments (Boucher & Friot, 2017).

MPs are classified into two categories: primary MPs and secondary MPs. Primary MPs encompass any plastic fragments or particles measuring 5.0 mm or less before entering the environment. This category includes microfibers from clothing, microbeads, and plastic pellets (nurdles) (Liu et al., 2022). Secondary MPs result from the degradation or breakdown of larger plastic products through natural weathering processes after entering the environment. Common sources of secondary MPs include water and soda bottles, fishing nets, plastic bags, tea bags, and used tires. Both types of MPs persist in the environment at high levels, especially in aquatic and marine ecosystems, causing water pollution (Dris et al., 2015).

MPs can negatively impact aquatic organisms through various pathways: physical damage caused by the presence of MPs; potential damage resulting from the presence of additives in MPs; and potential damage resulting from the presence of other pollutants absorbed by MPs. The plankton-like appearance and size of MPs make them easily consumable by aquatic organisms, leading to high biological availability of MPs to these organisms.

The presence of MPs in marine environments can pose a threat to the survival of marine life. MPs are potentially ingested by marine organisms within the ecosystem, and they can also serve as carriers of harmful contaminants, both inorganic and organic (Mardalisa et al., 2021). The presence of MPs in marine environment poses a threat to the survival of marine life, as they potentially ingested by marine organisms and can serve as carriers of harmful contaminants, both inorganic and organic.

The rapidly growing tourism industry often produces poorly managed waste, such as food waste and plastic waste, which will pollute beaches and marine waters (Indirawati, 2017). Ecotourism is a form of sustainable tourism that focuses on managing nature to promote understanding and conservation of the environment and culture (Azizah et al., 2021). In the context of ecotourism, natural resources should be

viewed as significant assets with economic and ecological value (Murdana, 2019). Recently, Gili Trawangan has become a popular destination for tourists from both within and outside the island of Lombok. Gili Trawangan is one of the three Gilis supporting the development of the marine tourism sector in North Lombok Regency, with its vast area of 340 hectares. Gili Trawangan offers beautiful natural scenery with rich marine life, making it suitable for activities such as snorkeling, diving, swimming, and canoeing. It is known for its green sea turtles. The area has also seen the development of hotels, restaurants, dive schools, and other facilities to support tourism. Therefore, it is crucial to assess the impact of MPs on seagrass and the aquatic environment around the Gili Trawangan tourism area (Yulianto, 2007).

The research on microplastics (MPs) in ecotourism activities is currently limited. This lack of research highlights the necessity for conducting studies on microplastics to provide information to readers about the impacts of microplastics pollution in a water environment. Based on this exposition, the current research is undertaken with the aim to identify the abundance and characteristics of microplastics in water, sediment, and seagrass of the *Ulva* sp. type in tourist areas.

Method

Environmental Characteristics and Sample Collection

Figure 1 illustrates the sampling locations in Gili Trawangan, which include the ferry port (site 1), the hotel area (site 2), and the residential area (site 3). These locations were chosen based on their potential environmental impact due to various activities such as ferry transportation, tourist visits, and local community activities.

Sample Collection

Sampling techniques for water, sediment, and biota involved collecting three replicates for each sample. Water samples were taken from the ferry port area used by both local and international tourists. Sediment and biota samples were collected from the residential area.

Sample Extraction

Samples of water, sediment, and biota, once collected, were transported to the laboratory for the extraction of organic materials. The water, sediment, and biota samples were directly transferred to glass beakers. For sediment and biota samples, a drying process was conducted, placing them in an oven for 72 hours at a temperature of 70°C. After removal from the oven, each sample received treatment by adding 10 ml of Fe(II)

solution and 10 ml of 30% H₂O₂ into the glass beaker containing water, sediment, or biota samples. The mixture was allowed to stand at room temperature for 5 minutes, then heated using a hot plate at 75°C for 15 minutes or until the first bubbles appeared. It was then cooled for 5 minutes and heated again for 30 minutes. Subsequently, 20 ml of NaCl was added to the samples and heated until dissolved. After cooling for 24 hours,

the samples were filtered using a plankton net with a mesh size of 0.3 μm containing Whatman size 2 paper and sprayed with distilled water. For sediment and biota samples that had undergone Wet Peroxide Oxidation (WPO) (Zobkov et al., 2020), organic material extraction was performed, and the samples were returned to the process starting from the addition of Fe(II) onwards. Microscopic observations were then carried out.

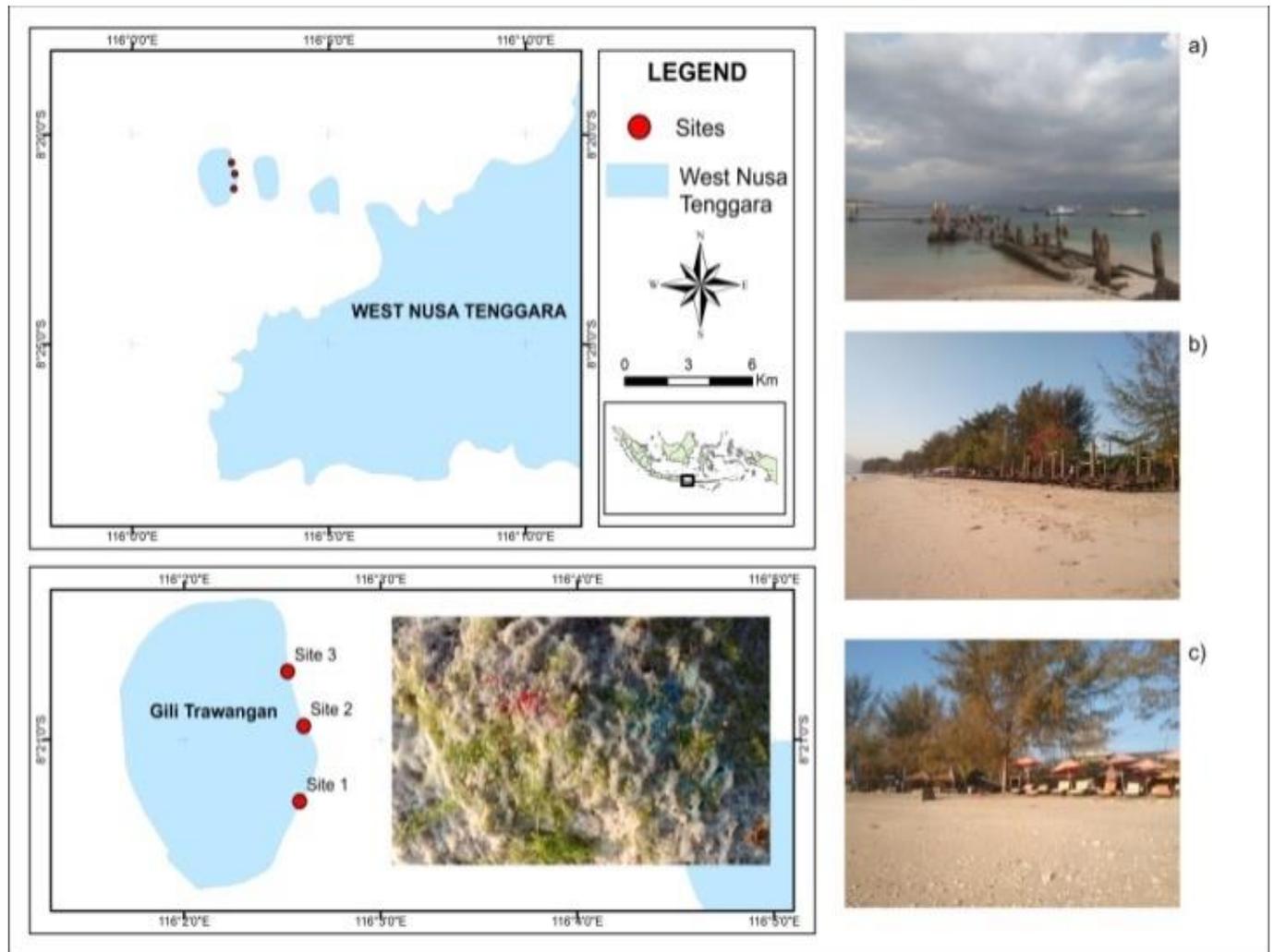


Figure 1. Map of sampling locations in Gili Trawangan, North Lombok: a) Ferry Port Area (site 1); b) Hotels Area (site 2); c) Residential Area (site 3)

Microscopic Observation

Microscopic observations were conducted on the final stage of the extraction and filtration process. The samples, after being extracted and filtered using Whatman size 2 paper, were observed using an inverted microscope to examine the diversity of shapes, quantities, and colors of Microplastics (MPs).

FT-IR Analysis

Fourier Transform Infrared (FT-IR) analysis was modified by Silviyah et al. (2014) and Sulistyani et al. (2018), was performed using a BRUKER Alpha II version

8.2 instrument to identify the functional groups and compounds present in the samples. Three common sample measurement techniques were employed: Transmission FT-IR, Attenuated Total Reflectance (ATR), and Diffuse Reflectance Infrared Fourier Transform (DRIFT). FT-IR was utilized to confirm various types of synthetic polymers originating from the breakdown of plastic waste resembling MPs. The infrared spectrum ranged from 14.000 cm⁻¹ to 10⁻¹, divided into three regions: near-infrared (14000-4000 cm⁻¹) sensitive to vibrational overtones, mid-infrared (4000-400 cm⁻¹) associated with vibrational energy transitions

providing information about functional groups in the molecule, and far-infrared (400-10 cm⁻¹) for analyzing molecules containing heavy atoms such as inorganic compounds, requiring special techniques. The principle of FTIR involves the interaction between energy and matter (Pungut et al., 2021). The gap in the sample controls the amount of energy transmitted to the sample, allowing infrared to enter, with some being absorbed by the sample, and the rest transmitted through the sample surface, allowing infrared light to pass through to the detector. The measured signal is then sent to the computer and recorded as peaks (Sari et al., 2018).

Water Quality Testing

Water samples were collected and tested for ammonia, phosphate, nitrate, nitrite, Total Dissolved Solids (TDS), and Dissolved Oxygen (DO) using the Salifert Freshwater Test Kit.

Data Analysis

The tabulated data were processed using Microsoft Excel 2013.

Result and Discussion

Abundance of MPs Results

The research findings regarding the abundance of microplastics (MPs) are presented in the following Table 1. Based on the research conducted in the waters of Gili Trawangan, the presence of microplastics (MPs) was identified, with the highest average abundance found at Site 3, reaching a value of 19.25 ± 23.30 particles/L. Meanwhile, the abundances at Site 1 and Site 2 were 13.25 ± 17.21 particles/L and 16.5 ± 18.52 particles/L, respectively, indicating the lowest abundance at Site 1. When examining the abundance of microplastics in sediment and biota, Site 1 also showed the highest values, with 22 ± 30.84 particles/kg dry weight for sediment and 17.50 ± 15.69 particles/individual for biota. This may be attributed to the high human activities at Site 1, influenced by ecotourism activities in the area. Site 1 is also a ferry port area serving travel to the Three Gili region and the Bangsal port in North Lombok.

Table 1. Abundance MPs on Water, Sediment and Biota

Sample	Abundance MPs		
	Site 1	Site 2	Site 3
Water (particle/L)			
Mean ± SD	13.25 ± 17.21	16.50 ± 18.52	19.25 ± 23.30
Sediment (particle/kg dw)			
Mean ± SD	22.00 ± 30.84	20.00 ± 30.80	6.00 ± 8.49
Biota (particle/ind)			
Mean ± SD	17.50 ± 15.69	8.25 ± 8.46	16.25 ± 22.56

The results showed that water, sediment and seaweed samples taken in the Gili Trawangan ecotourism area, North Lombok were contaminated with MPs with several types of MPs found, namely fragments, films, fibers and pellets. The type of MPs pellets was found in the highest amount or dominated in all three sites. The high number of pellet MPs particles is known to come from tourism activities, so the number of tourists is a source of pollution at the location (Seprendita et al., 2022). Site 1, which is located in the ferry port, causes input of plastic waste that is thought to be carried by ocean currents or from tourists who throw garbage. In addition, port activities can also affect the accumulation of MPs from land to water (Sulistiyowati et al., 2022). In addition, hotel and residential activities can also trigger the abundance of these pellet-type MPs.

Fragment and film type MPs are one of the types of MPs found with the second highest abundance after pellets. The highest abundance of fragment and film type MPs was at site 2 which is a hotel area. This type of fragment MPs is the result of fragmentation of macro waste (Andrady, 2011) such as beverage bottles, fragments of jars, gallons and paper plastics. Fragment type MPs have a low density so that they can float on the surface of the water (Hidalgo-Ruz et al., 2012). Film-type microplastics come from plastic bags and other food packaging that has degraded (Claessens et al., 2011). The abundance of fiber MPs has the lowest value among other types of MPs. This type of fiber usually comes from synthetic clothing thread, rope, and various forms of fishing gear such as fishing nets (Alam & Rachmawati, 2020).

Microplastics Characteristics

MPs found in the Gili Trawangan ecotourism area show the form of fragments, films, fibers and pellets (Figures 2 and 3). The average number of MPs in the form of fragments, films, fibers and pellets in surface water samples at site 1 showed the results of 11.32 ± 0.57, 9.43 ± 0.95, 7.69 ± 0.50, and 73.58 ± 1.70 particles/L. While at Site 2 it was 9.09 ± 1.00, 16.66 ± 0.95, 7.57 ± 0.95, and 66.66 ± 2.16 particles/L respectively, and at site 3 it was 14.28 ± 1.50, 9.09 ± 1.25, 6.49 ± 0.50, and 70.12 ± 1.91 particles/L. Based on these data, MPs in the form of pellets is the MPs with the highest average.

Sediment samples obtained at site 1 showed that the average number of MPs obtained were 6.81 ± 2.50, 12.50 ± 4.15, 3.40 ± 1.30, and 77.27 ± 24.77 particles/kg dry weight. The average number of 10.00 ± 2.94, 1.25 ± 2.30, 6.25 ± 2.00, and 82.50 ± 22.60 particles/kg dry weight were found at site 2 and 25.00 ± 0.57, 0 ± 0, 0 ± 0 and 75.00 ± 3.31 particles/kg dry weight were found at

site 3. The results of these sediment samples found the highest average in the form of pellets at all sites.

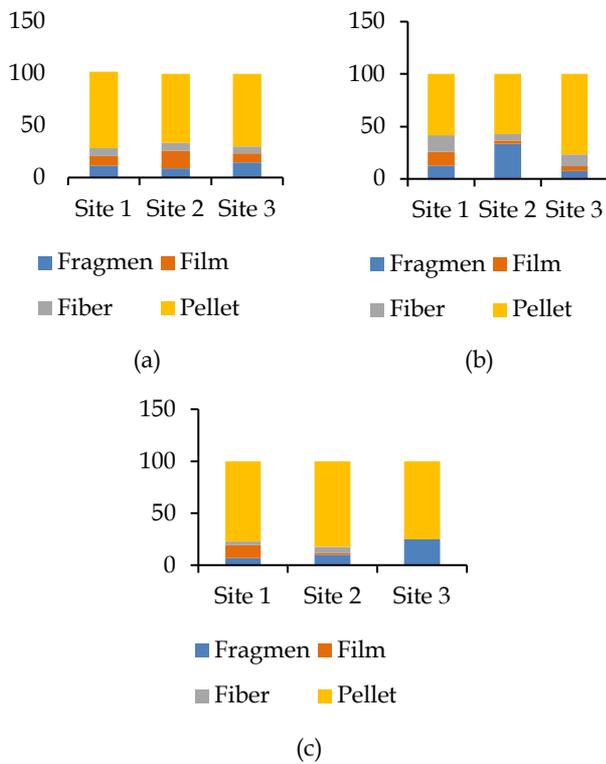


Figure 2. Average of microplastics by location and shape: (a) Water; (b) Sediment; (c) Seaweed

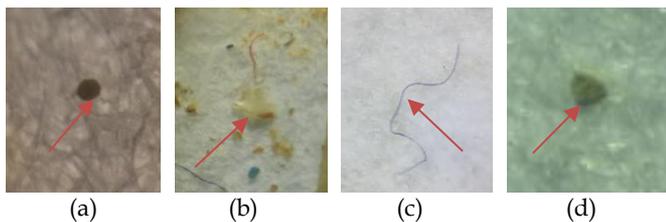


Figure 3. Types of microplastics found. (a) Fragments; (b) Film; (c) Fiber; (d) Pellets

Seaweed samples showed that the average number of MPs in the form of fragments, films, fibers and pellets were 12.85 ± 0.95 , 12.85 ± 1.25 , 15.71 ± 0.95 , and 58.57 ± 2.21 particles/individual at site 1, respectively. At site 2, the average number of MPs found was 33.33 ± 2.50 , 3.03 ± 0.50 , 6.06 ± 0.57 , and 57.57 ± 1.25 particles/individual. The average number of MPs obtained at site 3 was 7.69 ± 1.89 , 4.61 ± 0.95 , 10.76 ± 0.95 , and 76.92 ± 4.50 particles/individual. The results of the seaweed biota sample obtained the highest average is in the form of pellets. With these results, it can be concluded that the highest average number of MPs obtained at all sites is MPs in the form of pellets.

Based on its shape, MPs identified in the Gili Trawangan ecotourism area are in the form of fragments, films, fibers and pellets, all types of MPs found generally have dominant colors of black, yellow,

blue, red and green, with the highest size $< 500 \mu\text{m}$. Seprandita et al. (2022) explained that the black color of MPs is thought to come from plastic bags commonly used to carry consumer goods in daily life. The black color generally indicates that the MPs are still pure and have not undergone discoloration. The color difference in MPs also indicates the length of time the MPs have been photodegraded by UV light (Hiwari et al., 2019).

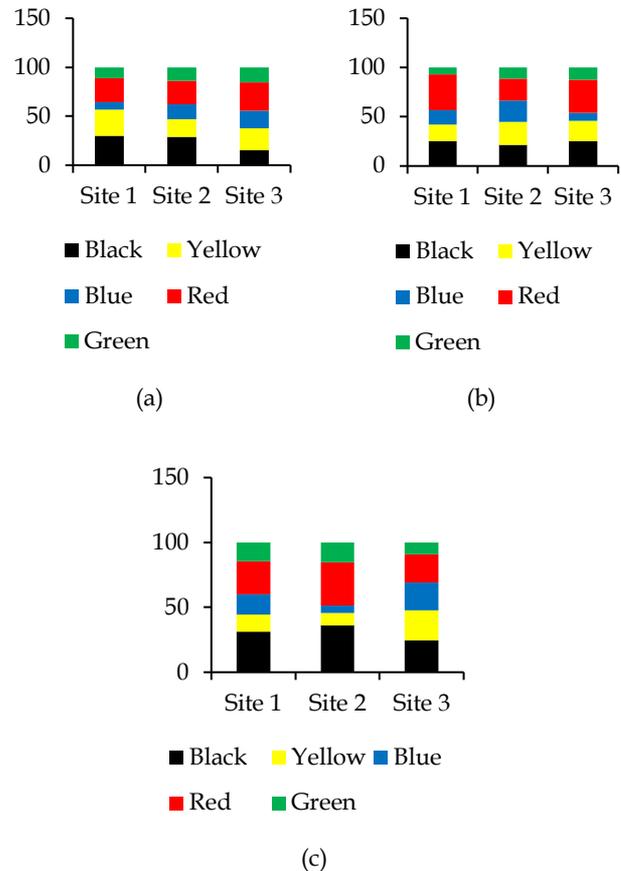


Figure 4. Dominant color of microplastics: (a) Water; (b) Sediment; (c) Seaweed

Types of Polymers

The observed MPs characteristics and calculations were then analyzed using FT-IR to determine the polymer type. MPs polymer types were taken from surface water, sediment and seaweed samples in three parts from three randomly selected locations ($n = 9$). Each polymer type has a different wavelength absorption. Polymers obtained from water samples were Polystyrene (PS) polymers with wavelengths of 3919.37 and 3334.14 cm^{-1} . Polyethylene (PE) polymer with a wavelength of 2229.00 cm^{-1} . Low Density Polyethylene (LDPE) polymer with wavelengths of 2166.81 , 2092.86 , 2092.86 , 1993.06 , and 1969.06 cm^{-1} . The wavelength for Nylon polymer is 1633.86 cm^{-1} as well as Cellulose Acetate (CA) polymer at a wavelength of 583.80 cm^{-1} . Polyterafluoroethylene (PTFE) polymer with a

wavelength of 558.01 cm^{-1} and finally Polystyrene (PS) polymer in the wavelength range of 523.49, 505.63, 474.63, 452.07, 429.78, 419.93, and 405.61 cm^{-1} . The type of polymer found in the sediment sample is Polystyrene (PS) with wavelengths of 3343.39, 1109.47, 665.70, 612.71, 578.99, 541.92, 510.72, 471.88, and 451.06 cm^{-1} . Low Density Polyethylene (LDPE) polymer with wavelengths of 2162.94, 2086.95, 1998.03 and 1634.38 cm^{-1} . The MPs polymer results for biota, especially seaweed, were in the wavelength range of 3327.40, 592.52, 531.06, 514.16, 479.20, 440.10, and 423.95 cm^{-1} for Polystyrene (PS) polymer types. The wavelengths 2206.42, 2156.04, 2085.41, 2015.99, 1999.45, 1948.31, and 1638.30 cm^{-1} are for Low Density Polyethylene (LDPE) polymer type.

FT-IR Analysis

Test samples on FT-IR (Fourier Transform Infra Red) are samples obtained from water, sediment and biota representing the three sites in Gili Trawangan. The three samples were then isolated MPs in each type of sample. The sample results obtained in the form of water that has been filtered for organic matter in each type of sample. From these samples will be obtained data analysis of each water, sediment and biota. FT-IR analysis test results show water, sediment and biota contain several plastic constituent polymers. The following are the results of sample analysis using the FT-IR method.

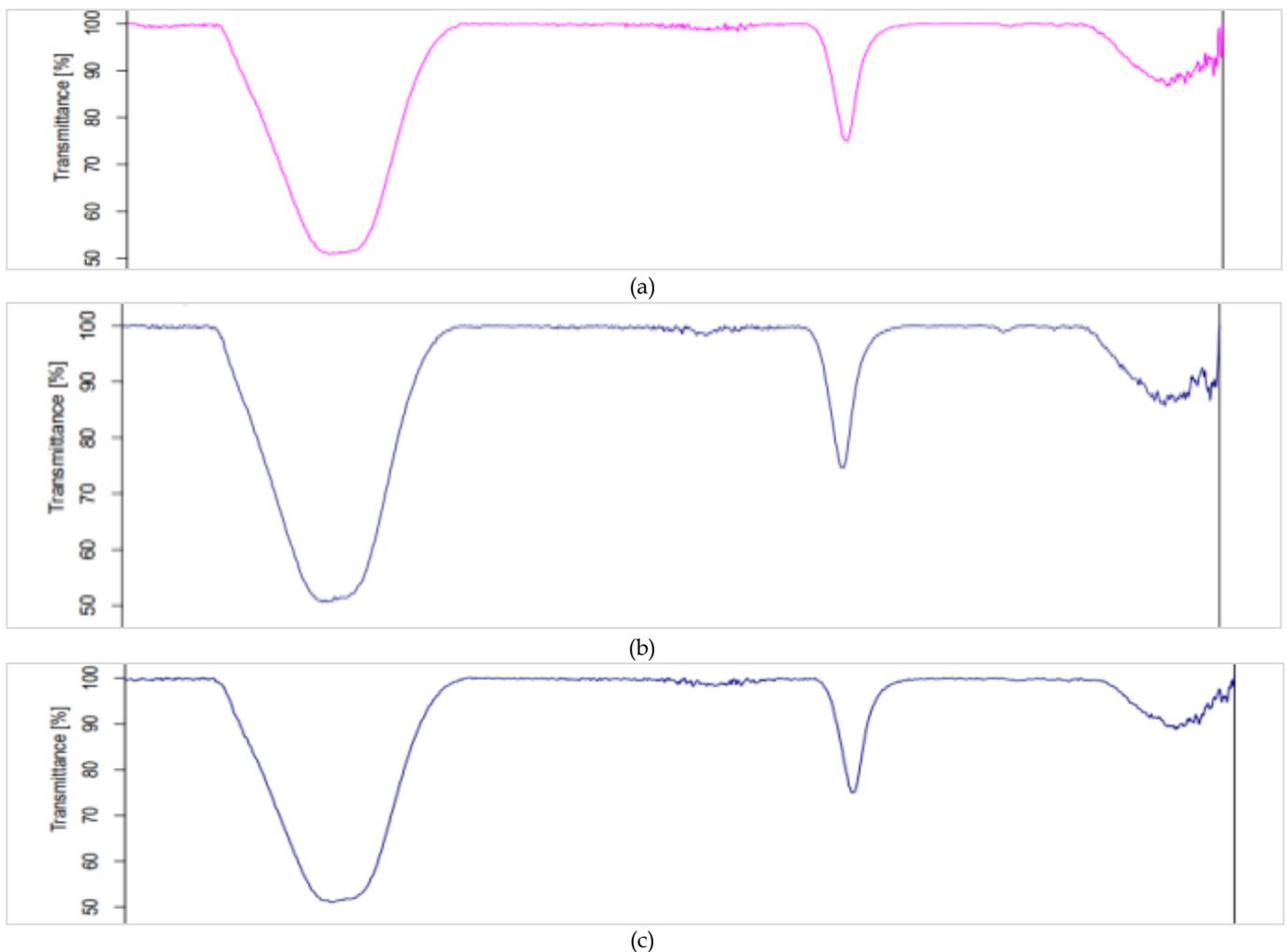


Figure 5. FT-IR spectrum results on Gili Trawangan MPs samples: (a) Spectrum on water; (b) Spectrum on sediment; (c) Spectrum on biota

The results of the FT-IR wave number test obtained in water, sediment and seaweed in the Gili Trawangan ecotourism area showed that the types of plastic found were Polystyrene (PS), Polyethylene (PE), and Low Density Polyethylene (LDPE) except in the water samples tested where polymers were found

Polyterafluoroethylene (PTFE), Nylon and Cellulose Acetate (CA). According to Jung et al. (2018), Sugandi et al. (2021), and Xu et al. (2019) MPs with film form are included in the Polystyrene (PS) polymer type at wave numbers 3919 cm^{-1} with hydroxyl groups (O-H), 3334.14

cm⁻¹ with amine groups (N–H), 523.49 – 405.61 cm⁻¹ with alkane groups (C–H) in water samples.

At wave numbers 3343.39 cm⁻¹ with amine groups (N–H), 1109.47 cm⁻¹ with nitrile functional groups (C–N), bonds C–H (aromatic rings) with wave numbers 665.70–411.59 cm⁻¹ found in sediment samples. And finally at wave number 3327.40 cm⁻¹ with amine groups (N–H) and wave number 592.52–423.95 cm⁻¹ with alkane group (C–H) in seaweed biota samples. In addition to Polystyrene (PS) polymers, Polyterafluoroethylene (PTFE), Nylon and Cellulose Acetate (CA) polymers were also found in the water samples at each wave number of 1633.86 cm⁻¹ and carbonyl groups (C≡C), (C=C), (C=O), or (C–O), 583.80 cm⁻¹ with hydroxyl bonds (O–H), and finally at wave number 558.01 cm⁻¹ which is a CF bond.

Table 2. FT-IR Functional Group Analysis on Gili Trawangan MPs Sample

Site	Wave Number (cm ⁻¹)	Functional Groups	Polymers
Water	3919.37	O–H	PS
	3334.14	N–H	PS
	2229.00	C≡N	PE
	2166.81	C≡C	LDPE
	2092.86 - 1969.06	C=O	LDPE
	1633.86	C=O	Nylon
	583.80	O–H	CA
	558.01	CF	PTFE
	523.49 - 405.61	C–H	PS
	Sediments	3343.39	N–H
2162.94 - 1998.03		C≡C	LDPE
1109.47		C–N	PS
Biota	665.70 - 411.59	C–H	PS
	3327.40	N–H	PS
	2206.42 - 2085.41	C≡C	LDPE
	2015.99	C–O	LDPE
	1999.45 - 1638.30	C≡C	LDPE
	592.52 - 423.95	C–H	PS

Table 3. Water Quality Test Results

	Ammonia (NH ₃)	Phosphate (PO ₄)	Nitrate (NO ₃)	Nitrite (NO ₂)	DO	TDS	Temperature (°C)
S1	0.15	0	0	0	4.00	543	30
S2	< 0.15	0.03	0	0	5	838	29.8
S3	< 0.15	0	0	0	5	840	29.8

Value set by the Ministry of Environment based on Indonesian Government Regulation No. 22 of 2021 concerning the Implementation of Environmental Protection and Management.

The water quality test results of Site 1, Site 2, and Site 3 are shown in Table 3. All water quality meet the set values for marine animals and aquaculture. However, based on the measurement results, it is relevant to note that the TDS value at site 3 is higher than the other sites. Human activities such as pollution from

plastic and industrial and agricultural waste, can also affect TDS in marine waters (Aliyan et al., 2024). Furthermore, the dissolved oxygen value at site 1 is lower than the set value. The high and low content of dissolved oxygen in these waters is caused by the entry of organic matter into the waters so that it requires a lot of dissolved oxygen to decompose it (Patty, 2015). For the measurement of ammonia, nitrate, nitrite, and phosphate levels, all values are still below the specified limits based on government regulations.

Water Quality of Gili Trawangan

Water quality testing conducted at sites 1, 2 and 3 using a TDS meter and water quality testing kit showed that the NH₃, PO₄, NO₃, and NO₂ values obtained were 0.15; 0; 0; and 0, respectively, at site 1, < 0.15; 0.03; 0; 0 at site 2 and < 0.15; 0; 0; 0 at site 3 (Table 3). The results obtained when measuring using the TDS meter at site 1 were high turbidity 543, site 2 838 and at site 3 840. This shows that the water at site 3 may have more mineral content in seawater than the other two sites. This is evidenced by the theory that the higher the number produced on the TDS meter is because it contains many chemical compounds, which also results in high salinity and electrical conductivity values (Rinawati et al., 2016). The increase in the number of tourists visiting will also contribute to an increase in waste generated. Failure to manage this waste properly will lead to pollution of the waters and a decline in water quality, which will have a negative impact on human health and the ecosystem (Harjayanti et al., 2023).

Table 4. Value Set for Marine Animals and Aquaculture

Sampling	
Temperature (°C)	28-32
TDS (ppm)	< 1000
DO (mg/L ⁻¹)	> 5
Ammonia NH ₃ (mg/L ⁻¹)	< 0.3
Phosphate PO ₄ (mg/L ⁻¹)	< 0.015
Nitrate NO ₃ (mg/L ⁻¹)	< 0.06
Nitrite NO ₂ (mg/L ⁻¹)	< 0.06

Conclusion

Based on the research results, microplastics (MPs) were found in the ecotourism area of Gili Trawangan, North Lombok, in surface water, sediment, and seagrass samples. Pellets were the predominant form of MPs, surpassing fragments, films, and fibers, which were found in lesser quantities, demonstrating significant differences among these forms. The identified polymer types in the tested surface water samples include Polystyrene (PS), Low Density Polyethylene (LDPE), as well as Nylon, Cellulose Acetate (CA), and Polytetrafluoroethylene (PTFE) in the tested surface water samples. These findings indicate that further research is needed to explore the broader environmental impact of microplastics on marine ecosystems. This finding indicate the need for further research to explore the broader environmental impact of microplastics on marine ecosystems.

Acknowledgments

The authors would like to thank National Research and Innovation Agency (BRIN) with Elektronik Layanan Sains (ELSA) for funding this work on North Lombok, NTB, Indonesia, and Husna Shofi Talbia, Maya Aprilia, Tuti Mutia, Heni Masrurroh for helping and cheerings the author during research.

Author Contributions

Conceptualization, M.A.A. and D.A.C.; methodology, validation, writing—original draft preparation, writing—review and editing, M.A.A., N.K.C., and D.A.C.; software, N.K.C.; formal analysis, D.A.C.; investigation, resources, visualization, supervision, project administration, funding acquisition, M.A.A.; data curation, M.A.A. and N.K.C.

Funding

This research was funded by National Research and Innovation Agency (BRIN) North Lombok, NTB, Indonesia.

Conflicts of Interest

The authors declare no conflict of interest.

References

Adam, M. A., Maftuch, M., Kilawati, Y., & Tahirah, S. N. (2018). Analysis of Heavy Metal Pollutant in Wangi

River Pasuruan and Its Impact on *Gambusia affinis*. *Jurnal Pembangunan dan Alam Lestari*, 9(2), 120–128.

<https://doi.org/10.21776/ub.jpal.2018.009.02.09>

Adam, M. A., Maftuch, M., Kilawati, Y., Soegianto, A., & Risjani, Y. (2019). The Effects of Acute Exposure to Cadmium Nitrate (CdNO₃) on *Gambusia affinis*. *IOP Conf. Series: Earth and Environmental Science*, 259(012004), 8. <https://doi.org/10.1088/1755-1315/259/1/012004>

Adam, M. A., Widiastuti, I. M., Ernawati, E., Yayan, A. Y., Insivitawati, E., Yuliana, Y., Pakaya, R. F., Soegianto, A., & Khumaidi, A. (2022). Analysis of White Feces Disease (WFD) Caused by *Vibrio* sp. and Dinoflagellata in *Vannamei* Shrimp (*Litopenaeus vannamei*) in Brackishwater Culture Pond. *Jurnal Ilmiah Perikanan dan Kelautan*, 14(1), 160–166.

<https://doi.org/10.20473/jipk.v14i1.26684>

Alam, F. V., & Rachmawati, M. (2020). Perkembangan Penelitian Mikroplastik di Indonesia. *Jurnal Presipitasi*, 17(3), 344–352. Retrieved from <https://ejournal.undip.ac.id/index.php/presipitasi/article/download/33841/pdf>

Aliyan, S. A., Astari, A. J., Jupri, J., Ayesha, P. A., Amelia, N. S., Ibrahim, N., & Kusmana, Z. A. G. (2024). Estimating Concentration of Suspended Solids Load in Estuary System Utilizing Sentinel 2A: A Case Study of Cipatujah Beach, Indonesia. *IOP Conference Series: Earth and Environmental Science*, 1404(1), 012040. <http://dx.doi.org/10.1088/1755-1315/1404/1/012040>

Andrady, A. L. (2011). Microplastics in the Marine Environment. *Marine Pollution Bulletin*, 62(8), 1596–1605.

<https://doi.org/10.1016/j.marpolbul.2011.05.030>

Azizah, M. N. L., Wulandari, D., & Marianti, A. (2021). Tantangan Mewujudkan Ekowisata Sungai Berkelanjutan untuk Meningkatkan Kesejahteraan Manusia dan Melindungi Keanekaragaman Hayati di Indonesia. *Indonesian Journal of Conservation*, 10(2), 72–77.

<https://doi.org/10.15294/ijc.v10i2.31072>

Boucher, J., & Friot, D. (2017). *Primary Microplastics in the Oceans: A Global Evaluation of Sources*. <https://doi.org/10.2305/IUCN.CH.2017.01.en>

Chamas, A., Moon, H., Zheng, J., Qiu, Y., Tabassum, T., Jang, J. H., Abu-omar, M., Scott, S. L., & Suh, S. (2020). Degradation Rates of Plastics in the Environment. *ACS Sustainable Chemistry & Engineering*, 8(9), 3494–3511. <https://doi.org/10.1021/acssuschemeng.9b06635>

Claessens, M., Meester, S. D., Landuyt, L. V., Clerck, K.

- D., & Janssen, C. R. (2011). Occurrence and Distribution of Microplastics in Marine Sediments Along The Belgian Coast. *Marine Pollution Bulletin*, 62(10), 2199–2204. <https://doi.org/10.1016/j.marpolbul.2011.06.030>
- Dris, R., Imhof, H., Sanchez, W., Gasperi, J., Galgani, F., Tassin, B., & Laforsch, C. (2015). Beyond the Ocean: Contamination of Freshwater Ecosystems with (Micro-) Plastic Particles. *Environmental Chemistry*, 12, 539–550. <https://doi.org/10.1071/EN14172>
- Faujiah, I. N., & Wahyuni, I. R. (2022). Kelimpahan dan Karakteristik Mikroplastik pada Air Minum serta Potensi Dampaknya Terhadap Kesehatan Manusia. *Gunung Djati Conference Series*, 7, 89–95. Retrieved from <https://conferences.uinsgd.ac.id/index.php/gdcs/article/view/609>
- Harjayanti, H., Indrasari, W., & Budi, E. (2023). Pemetaan Sebaran Kualitas Tanah dengan Menggunakan Parameter Suhu, Kelembaban, Ph, Salinitas, dan Medan. *Prosiding Seminar Nasional Fisika (E-Journal) SNF 2022*, 11(1), 71–76. <https://doi.org/10.21009/03.1101.FA05>
- Hidalgo-Ruz, V., Gutow, L., Thompson, R. C., & Thiel, M. (2012). Microplastics in the Marine Environment: A Review of the Methods Used for Identification and Quantification. *Environmental Science and Technology*, 46(6), 3060–3075. <https://doi.org/10.1021/es2031505>
- Hiwari, H., Purba, N. P., Ihsan, Y. N., Yuliadi, L. P. S., & Mulyani, P. G. (2019). Condition of Microplastic Garbage in Sea Surface Water at Around Kupang and Rote, East Nusa Tenggara Province. *Seminar Nasional Masyarakat Biodiversitas Indonesia*, 5(2), 165–171. <https://doi.org/10.13057/psnmbi/m050204>
- Indirawati, S. M. (2017). Pencemaran Logam Berat Pb dan Cd dan Keluhan Kesehatan pada Masyarakat di Kawasan Pesisir Belawan. *Jurnal JUMANTIK*, 2(2), 54–60. Retrieved from <https://jurnal.uinsu.ac.id/index.php/kesmas/article/view/1165/914>
- Istirokhatun, T., & Nugraha, W. D. (2019). Pelatihan Pembuatan Ecobricks sebagai Pengelolaan Sampah Plastik di RT 01 RW 05, Kelurahan Kramas, Kecamatan Tembalang, Semarang. *Jurnal Pasopati*, 1(2), 85–90. <https://doi.org/10.14710/pasopati.2019.5549>
- Jung, M. R., Horgen, F. D., Orski, S. V., Rodriguez C., V., Beers, K. L., Balazs, G. H., Jones, T. T., Work, T. M., Brignac, K. C., Royer, S. J., Hyrenbach, K. D., Jensen, B. A., & Lynch, J. M. (2018). Validation of ATR FT-IR to Identify Polymers of Plastic Marine Debris, Including Those Ingested by Marine Organisms. *Marine Pollution Bulletin*, 127(2017), 704–716. <https://doi.org/10.1016/j.marpolbul.2017.12.061>
- Liu, Z., Zhuan, Q., Zhang, L., Meng, L., Fu, X., & Hou, Y. (2022). Polystyrene Microplastics Induced Female Reproductive Toxicity in Mice. *Journal of Hazardous Materials*, 424(PC), 127629. <https://doi.org/10.1016/j.jhazmat.2021.127629>
- Mardalisa, M., Fatwa, E. B., Yoswaty, D., Feliatra, F., Effendi, I., & Amin, B. (2021). Isolasi dan Identifikasi Bakteri Indigenous Pendegradasi Plastik dari Perairan Laut Dumai Provinsi Riau. *Ilmu Perairan (Aquatic Science)*, 9(1), 77–85. <https://doi.org/10.31258/>
- Mathalon, A., & Hill, P. (2014). Microplastic Fibers in the Intertidal Ecosystem Surrounding Halifax Harbor, Nova Scotia. *Marine Pollution Bulletin*, 81(1), 69–79. <https://doi.org/10.1016/j.marpolbul.2014.02.018>
- Murdana, I. M. (2019). Kreatif Ecotourism Kunci Keberlanjutan Pariwisata Pulau: Studi Kasus Kepulauan Gili Matra. *Jurnal Ilmiah Hospitality*, 8(2). Retrieved from <https://stp-mataram.e-journal.id/JIH/article/view/12>
- Patty, S. I. (2015). Karakteristik Fosfat, Nitrat dan Oksigen Terlarut di Perairan Selat Lembeh, Sulawesi Utara. *Jurnal Pesisir dan Laut Tropis*, 3(2), 1–7. <https://doi.org/10.35800/jplt.3.2.2015.9581>
- Pungut, P., Widyastuti, S., & Wiyarno, Y. (2021). Identifikasi Mikroplastik pada Cangkang Kerang Darah (*Anadara granosa* Liin) dengan Menggunakan Fourier Transform Infrared (FTIR) dan Scanning Electron Microscopy (SEM). *Seminar Nasional Hasil Riset dan Pengabdian (SNHRP) Ke-3 Tahun 2021*, 3, 12. Retrieved from <https://snhrp.unipasby.ac.id/prosiding/index.php/snhrp/article/view/177/>
- Rinawati, R., Hidayat, D., Suprianto, R., & Dewi, P. S. (2016). Penentuan Kandungan Zat Padat (Total Dissolve Solid dan Total Suspended Solid) di Perairan Teluk Lampung. *Analit: Analytical and Environmental Chemistry*, 1(1), 36–45. <https://doi.org/10.23960/aec.v1i1.2016.p>
- Sari, N. W., Fajri, M. Y., & Wilapangga, A. (2018). Analisis Fitokimia dan Gugus Fungsi dari Ekstrak Etanol Pisang Goroho Merah (*Musa acuminata* (L)). *IJOB*, 2(1), 31. <https://doi.org/10.47007/ijobb.v2i1.26>
- Seprandita, C. W., Suprijanto, J., & Ridlo, A. (2022). Kelimpahan Mikroplastik di Perairan Zona Pemukiman, Zona Pariwisata dan Zona Perlindungan Kepulauan Karimunjawa, Jepara. *Buletin Oseanografi Marina*, 11(1), 111–122. <https://doi.org/10.14710/buloma.v11i1.30189>
- Silviyah, S., Widodo, C. S., & Masruroh, M. (2014).

- Penggunaan Metode FT-IR (Fourier Transform Infra Red) untuk Mengidentifikasi Gugus Fungsi pada Proses Pembaluran Penderita Mioma. *Pharmaceutical Research*, 4(2), 19–27. Retrieved from <https://www.neliti.com/publications/159773/penggunaan-metode-ft-ir-fourier-transform-infra-red-untuk-mengidentifikasi-gugus>
- Sugandi, D., Agustawan, D., Febriyanti, S. V., Yudi, Y., & Wahyuni, N. (2021). Identifikasi Jenis Mikroplastik dan Logam Berat di Air Sungai Kapuas Kota Pontianak. *Positron*, 11(2), 112. <https://doi.org/10.26418/positron.v11i2.49355>
- Sulistiyani, M., & Huda, N. (2018). Perbandingan Metode Transmisi dan Reflektansi pada Pengukuran Polistirena Menggunakan Instrumentasi Spektroskopi Fourier Transform Infra Red. *Indonesian Journal of Chemical Science*, 7(2), 195–198. <https://doi.org/10.15294/ijcs.v12i2.72451>
- Sulistyowati, L., Nurhasanah, N., Riani, E., & Cordova, M. R. (2022). The Occurrence and Abundance of Microplastics in Surface Water of the Midstream and Downstream of the Cisadane River, Indonesia. *Chemosphere*, 291(P3), 133071. <https://doi.org/10.1016/j.chemosphere.2021.133071>
- Supit, A., Tompodung, L., & Kumaat, S. (2022). Mikroplastik sebagai Kontaminan Anyar dan Efek Toksiknya Terhadap Kesehatan. *Jurnal Kesehatan*, 13(1), 199. <https://doi.org/10.26630/jk.v13i1.2511>
- Suriyanto, S., Amin, B., & Nedi, S. (2020). Distribusi Mikroplastik pada Air Laut di Pesisir Barat Pulau Karimun Provinsi Kepulauan Riau. *Berkala Perikanan Terubuk*, 48(3), 1–8. <https://doi.org/10.31258/TERUBUK.48.3.613-620>
- Tuahatu, J. W., & Tuhumury, N. C. (2022). Sampah Laut yang Terdampar di Pesisir Pantai Hative Besar pada Musim Peralihan 1. *TRITON: Jurnal Manajemen Sumberdaya Perairan*, 18(1), 47–54. <https://doi.org/10.30598/tritonvol18issue1page47-54>
- Tyllianakis, E., & Ferrini, S. (2021). Personal Attitudes and Beliefs and Willingness to Pay to Reduce Marine Plastic Pollution in Indonesia. *Marine Pollution Bulletin*, 173(PB), 113120. <https://doi.org/10.1016/j.marpolbul.2021.113120>
- Wright, S. L., Thompson, R. C., & Galloway, T. S. (2013). The Physical Impacts of Microplastics on Marine Organisms: A Review. *Environmental Pollution*, 178, 483–492. <https://doi.org/10.1016/j.envpol.2013.02.031>
- Xu, J. L., Thomas, K. V., Luo, Z., & Gowen, A. A. (2019). FTIR and Raman Imaging for Microplastics Analysis: State of the Art, Challenges and Prospects. *TrAC - Trends in Analytical Chemistry*, 119, 115629. <https://doi.org/10.1016/j.trac.2019.115629>
- Yulianto, G. (2007). Analisis Permintaan Rekreasi dan Strategi Pengembangan Wisata Bahari di Gili Terawangan Kabupaten Lombok Barat Provinsi Nusa Tenggara Barat. *Buletin Ekonomi Perikanan*, 199, 72–98. Retrieved from <https://www.neliti.com/publications/11040/analisis-permintaan-rekreasi-dan-strategi-pengembangan-wisata-bahari-di-gili-terawangan>
- Zobkov, M., Belkina, N., Kovalevski, V., Zobkova, M., Efremova, T., & Galakhina, N. (2020). Microplastic Abundance and Accumulation Behavior in Lake Onego Sediments: A Journey from the River Mouth to Pelagic Waters of the Large Boreal Lake. *Journal of Environmental Chemical Engineering*, 8(5), 104367. <https://doi.org/10.1016/j.jece.2020.104367>