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Analysis of the Abundance and Diversity of Microplastic Contamination in Ekas Bay Cultivation Areas

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ABSTRACT

Ekas Bay is a semi-enclosed bay and estuary in the southern part of Lombok Island. Ekas Bay has an area of 5,312.68 hectares, although it is not very wide, this bay has its own uniqueness and is relatively protected from waves because it is located inland. In Ekas Bay itself, two river estuaries are found, namely the Awang River Estuary and the Kelongkong River Estuary. The existence of these two river estuaries has a negative impact on the condition of the waters of Ekas Bay because residue from household activities is carried away by the river current, one of which is plastic waste. The presence of microplastics on ocean coasts has a negative impact on sea water quality and the life of marine biota, microplastics cannot evaporate or degrade by themselves, microplastics will accumulate in sea water and the body parts of marine biota. This research aims to identify the type and abundance of microplastics in the Ekas Bay floating net cage area and the results obtained in water samples were that the abundance of microplastics at point A was 49.44 par/L, point B was 55.76 par/L and point C was 40.40 par /L. The abundance of microplastics in sediment samples at point A was 12.25 par/L, point B was 10.8 par/L and point C was 11.01 par/L.

INTRODUCTION

Indonesia is considered the second largest producer of plastic waste into marine waters after China. Around 3.2 million tonnes of plastic waste per year is generated from activities around the coast, 0.48-1.29 million tonnes per year will accumulate in sea waters. Various natural processes such as exposure to the sun and reactions with the aquatic environment can cause degradation and transformation of macroplastics into microplastics with effects that can harm the environment, aquatic biota and humans themselves (Dwiyitno *et al.*, 2018). Microplastics in waters vary greatly in terms of composition and characteristics (size, shape, color, density and other properties).

The presence of microplastics on ocean coasts has a negative impact on sea water quality and the life of marine biota. Micro plastics cannot evaporate or degrade by themselves, microplastics will accumulate in sea water and the body parts of marine biota. Microplastics can be found in the surrounding environment, especially in marine coastal sediments throughout the world. Microplastics have various sizes, specific gravities and shapes (Duis & Coors, 2016). Plastic can be fragmented by chemical and physical factors such as sunlight, currents and waves into microplastics in various forms such as film fragments, granules, pellets, fiber and foam (Hidalgo-Ruz *et al*., 2012).

Microplastics are generally found on the surface of sea water, this is because microplastics have a smaller density than sea water. The presence of microplastics in sediment is caused by microplastics floating in sea water carried by currents, waves and tides, until they eventually accumulate and become buried in coastal sediments. Microplastics can also settle on bottom substrates and sediments by the activity of microorganisms, biofouling and the presence of other particles attached to microplastics. Microplastics in sediment will continue to settle, so that the microplastic content at a certain depth can be used to estimate the age of the microplastics (Lusher *et al*., 2017).

As an archipelagic province, West Nusa Tenggara has quite large potential for marine and fisheries resources, namely with a sea area of 29,159.04 km^2 (59.13%) which is wider than its land area of 20,153.15 km^2 (40.87%). West Nusa Tenggara Province has a fairly complete aquatic ecosystem, such as pelagic sea waters, demersal seas, coastal ecosystems and small islands which are rich in coral reefs, seagrass beds, mangroves and public waters such as reservoirs, lakes, rivers and reservoirs which are abundant in fisheries and marine resources. (KKP, 2022).

According to data from the Dinas Perikanan Provinsi NTB (2022), the potential of marine aquaculture resources is utilized to develop commodities that have economic value, including seaweed, pearls, grouper, snapper and pomfret. Important economic commodities developed in brackish water cultivation (ponds) include: shrimp, milkfish and seaweed *Gracillaria* sp. The high potential of fisheries owned by West Nusa Tenggara Province, especially on Lombok Island and the increasingly high level of pollution in the sea, means there is a need for research on the status of microplastic contamination in fish cultivation areas. The aim of this research is to determine the status of pollution and identify the type and abundance of microplastics present. is in the Ekas Bay floating net cage area.

METHODS

a. Time and Place

This research was carried out from May to October 2023. The research location was carried out in the aquaculture water area located in Ekas Bay, East Lombok Regency. This location was chosen because it is a fish cultivation area that has important economic value such as lobster, grouper and pomfret.

b. Material

As for material which used that is distilled water for sterilize toollaboratory, 70% ethanol to kill bacteria, NaCl to separate microplastics with other particles, FeSO4 to reduce the sample solution water and H_2O_2 for remove material organic on sample, sample water, and sediment (Ayuningtyas, 2019).

c. Tool

The research tools used are plankton nets for taking water samples (Nugroho *et al*., 2018), Zip locks for containers for sediment samples that have been taken, sample bottles, cool boxes for storing samples, molds for taking sediment samples, cameras, measuring cups. 250 ml, Erlenmeyer 500 ml, beaker glass 500 ml, dropper pipette, analytical scale for weighing samples, oven for drying samples, portable microscope for identifying microplastics, GPS for determining coordinates, petri dish, 30 cm ruler, sieve (mash), paper filter.

d. Research Methodology

The type of this study was description quantitative. Objective This research is to see, review and describe with figures about object Which researched in accordance with circumstances field and interesting conclusion about phenomenon which looks on moment study. Taking data use method exploration with method taking sample in a way direct on 3 Stationin 1 location in Ekas Bay namely, the floating net cage area, 200 m before the floating net cage and at the mouth of the river.

e. Research Procedure

Sampling was carried out directly in the field (in situ). Sediment samples were taken using a modified Ekman grab, namely a pipe measuring 5 cm in diameter and 10 cm high. Sample testing in this study aims to provide treatment to the samples that have been obtained for data analysis. Sample analysis aims to determine the number, shape and type of microplastic polymers present in water and sediment. The following are the stages of sample testing and research data analysis. The sediment samples that have been taken are then sieved to separate large sand substrates, then the samples are dissolved in water and filtered using a plankton net (Prata *et al*., 2019). The filtered samples are stored in a container for further observation and analysis in the laboratory (ex situ). The microplastic particles were then observed using a microscope. The checking of microplastic objects refers to the methods of De-Witte *et al*. (2014); Shim *et al*. (2017); Campbel *et al*. (2017). Identification of microplastic samples refers to Hidalgo-Ruz *et al*. (2012); De Witte *et al*. (2014); Masura *et al*. (2015); and Virsek *et al*. (2016).

RESULTS

Description of Ekas Bay

Ekas Bay is a semi-enclosed bay and is an estuary in the southern part of the island Lombok. Ekas Bay have wide 5,312.68 hectares, although not so wide but bay This own uniqueness separately And relatively protected towave because location indented toin. In Ekas Bay itself Two river estuaries were found, namely estuary River Awang and estuary River Kelongkong. The waters of Ekas Bay are part of a vulnerable and complex coastal area, especially because the characteristics of coastal areas are greatly influenced by the interaction of ocean and land. The influence of these two regions results in the dynamics of various environmental parameters.

The sampling locations are divided into three points, namely, (a): water and sediment in estuary, (b): water and sediment in 200 m around floating net cage, (c): water and sediment in floating net cage.

Results of Identification of Microplastic Abundance

1. Total Abundance of Microplastics in Water

The results of identifying the abundance of microplastics at each station can be seen in Figure 1 below.

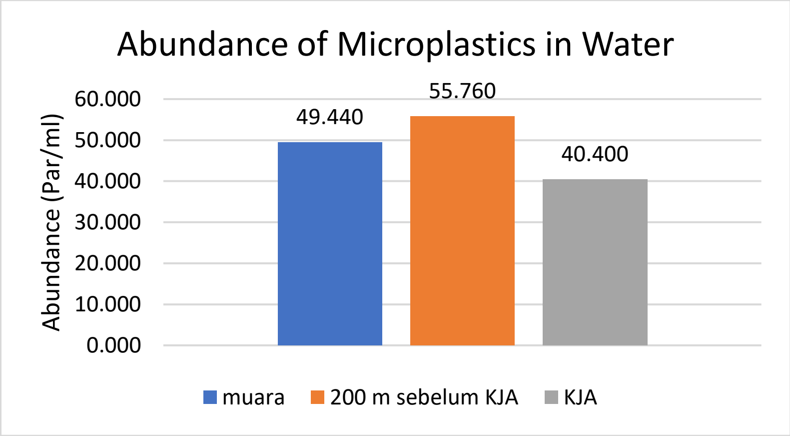


Figure 1. Abundance of Microplastics in Water

Based on the results of observations on water samples carried out in this study, the highest abundance of microplastics was found at the location 200m before the floating net cage, namely 55.70 par/l. at the estuary sampling point, it was found to be 49.44 par/l and the lowest abundance of microplastics was found at the location next to the floating net cage at 40.4 par/l.

2. Total Abundance of Microplastics in Sediments

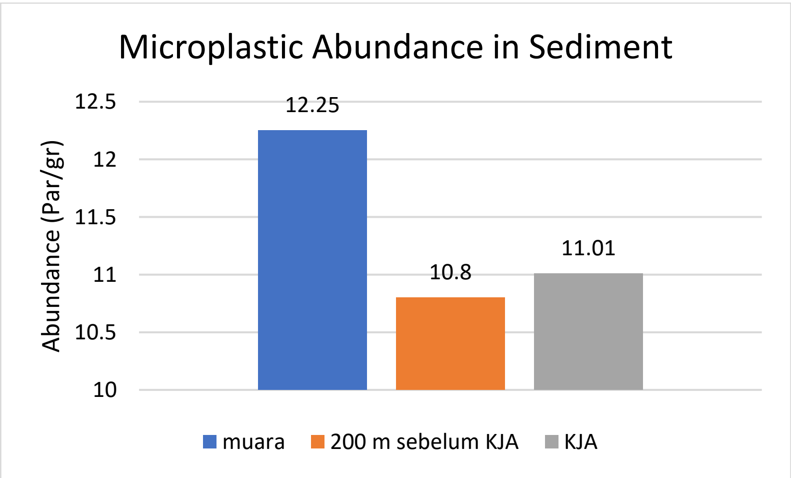


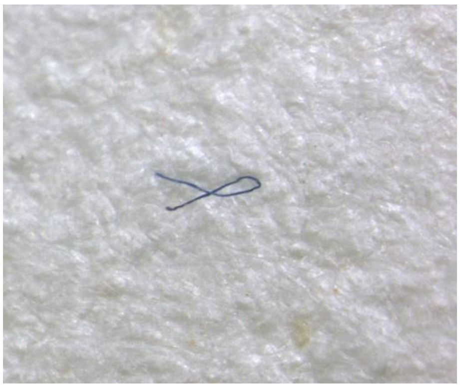
Figure 2. Microplastic Abundance in Sediment

Sediment samples used in this study were taken from three different points, namely at the estuary point, 200m before the floating net cage and at the floating net cage. sediment samples were taken, then the total abundance of microplastics from the three different points was calculated. the results of the total abundance of microplastics in this study can be seen in figure 2. the highest total abundance was in sediment samples, namely there were sediment samples at the estuary point of 12.25 par/g, the total abundance in floating net cage was 11.01 par/g and the lowest abundance was in 200m before floating net cage of 10.8 par/g.

Results of Identification of Microplastic Types

1. Types of Microplastics

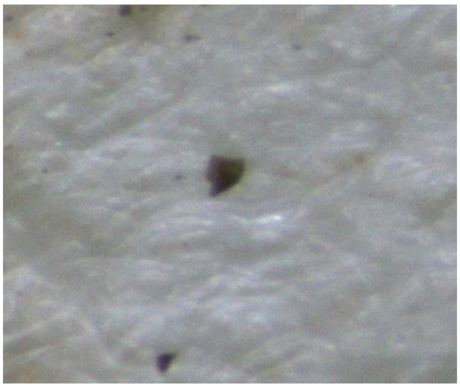
Based on the research results, the types of microplastics found in this study in water and sediment were microplastic fragments, fibers, pellets and films. The shapes and types of microplastics found can be seen in Figure 3 below.



(a) Fiber Type Microplastics

(b) Fiber Type Microplastics

(c) Fragment Type Microplastics



(d) Fragment Type Microplastics

(e) Pellet Type Microplastics

(f) Film type microplastics

Figure 3. Types of Microplastics

Percentage of Abundance of Microplastic Types in Water

After calculating the total abundance of microplastics in the water after the research samples were calculated, the types and abundance were then identified. This aims to get an idea of the origin of the microplastic contamination in the water and at each sampling location. The percentage of abundance of microplastic types in the water in Ekas Bay can be seen in Figure 4 below.

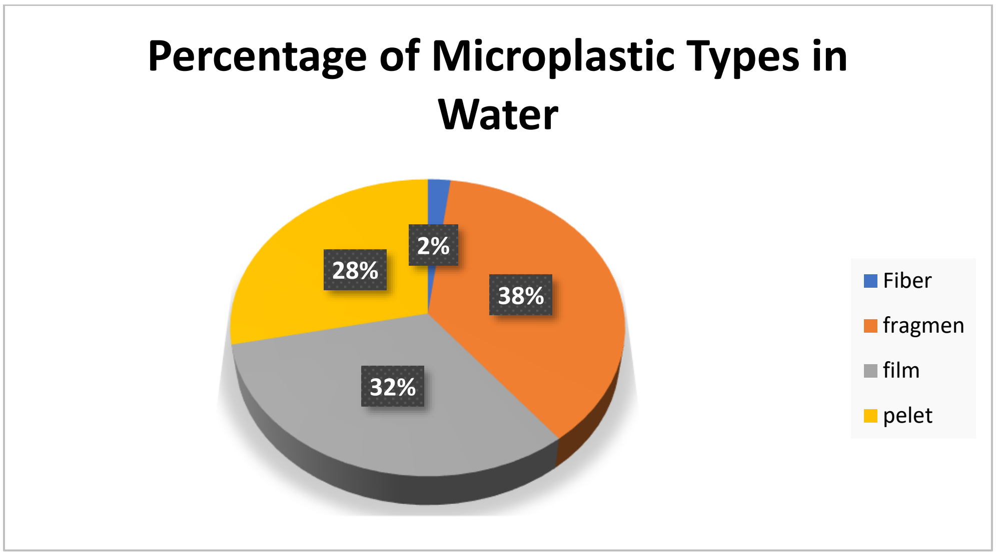


Figure 4. Percentage Diagram of Abundance of Microplastic Types in Water

Based on the results obtained at each station, the types of microplastics identified in this study were in the form of fibers, fragments, films and pellets. The percentage of fiber is the type of microplastic that is least found at all stations, which is 2% of the average at each station. The pellet type was obtained by 28% and the film type was obtained by 32%. In the calculation results, the largest type of microplastic obtained was the fragment type, which amounted to 38% of the total number of microplastics found.

Percentage Abundance of Microplastic Types in Sediment

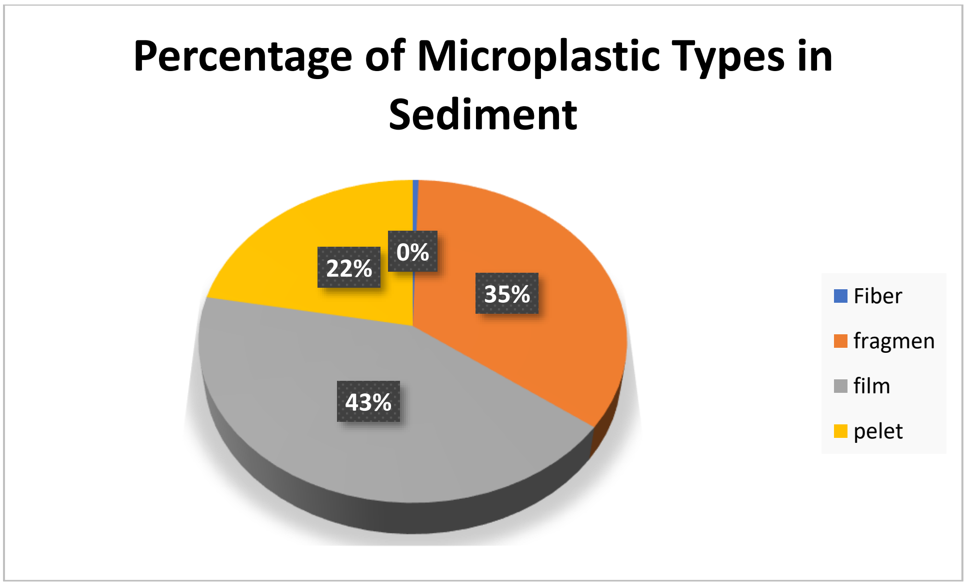


Figure 5. Percentage of Microplastic Types in Sediment

Based on observations of the percentage of microplastic types in the sediment, it was found that the least fiber type was found, namely only 0.05% of the total identified samples. The pellet type was found at 22% and the fragment type at 35%. In the sediment samples, the most common type found was film, namely 43%.

DISCUSSION

Microplastic abundance is the number of microplastics present in a body of water. Plastic waste that has been degraded in the form of microplastics enters the waters and pollutes the ecosystem in Ekas Bay. Based on the results of research on water samples, it was found that the highest abundance of microplastics was 200 meters before the floating net cage with an average value of 55.76 par/ml. This result is because this area is close to the coast and will be greatly affected by anthropogenic activities carried out by local residents. The waters in the estuary were the sampling location with the second abundance of microplastic contamination, as much as 49.44 par/ml was found at this point. The estuary area is the final point of the flow of a river which carries various kinds of remains of human activities from the land area to the sea. This also influences microplastic pollution in the estuary area because it is the starting point between sea water and fresh water which usually tends to carry higher levels of pollutants due to human activities. The water sample at the floating net cage location was the lowest because at this point the influence of the current was strong enough, making the distribution of microplastics wider so that they were not easily caught when sampling was carried out. The presence of all types of microplastics in this study is influenced by the tides and currents that carry plastic food packaging waste scattered around the beach. This is in line with the statement by Nainggolan *et al*. (2022) which states that tides and currents influence the majority of microplastic sources obtained from community activities.

The results of analysis of microplastic contamination in sediment at three sampling locations were different from the results obtained in waters. If the water sample area 200 m before the floating net cage is the location with the highest microplastic contamination, then for point sediment in the estuary it is the location with the highest microplastic contamination at 12.25 par/ml. The estuary area is the highest point of pollution because this location is where fresh water flows from rivers meet. The flow of river water generally carries waste towards the sea and will accumulate in the estuary area. This is what causes the pollution rate in the estuary area to be higher than in others. Apart from that, the muddy substrate in estuaries is also one of the causes because microplastic particles are trapped in the substrate. At the floating net cage location, microplastic contamination was found to be 11.01 par/ml, higher than at 200 m floating net cage, which was 10.8 par/ml. The sediment under the floating net cage contains microplastic contamination because it comes from nets or floats made from styrofoam from the floating net cage which have begun to rot and degrade into microplastics, causing contamination at this point. The abundance of microplastics in sediment is caused by plastic waste which is then degraded into microplastics so that they can spread on the surface of the water and then sink and settle in the sediment. This is in line with the statement of Mauludy *et al*. (2019) stating that this occurs due to mass transport, which makes the movement of microplastics tend to be slower compared to microplastics in the water column. Sediment has a low density, allowing microplastics to enter and become trapped in it. This statement is also in line with Ridlo *et al*. (2020) who stated that microplastics generally float because their density is smaller than sea water, they are carried by currents, waves and tides, eventually accumulating and buried in coastal sediments. Microplastics can sink and settle on bottom substrates and sediments by the activity of microorganisms, biofuling and the presence of other attached particles.

The highest percentage of microplastic types in water samples was fragment type microplastics which were found at 38% of the total abundance of water samples obtained. The type of microplastic fragments found in this research are like pieces of plastic, have an irregular shape, the surface looks thicker than the others. According to Hiwari *et al.* (2019) stated that most microplastics in the form of fragments have a low density so they float on the surface of the water. The high abundance of this type of microplastic fragment is thought to be caused by the use of drums in floating net cages whose outer layer degrades into microplastics, as well as floating net cage activities that use disposable drink bottles that are thrown into the water. This is in line with the statement of Ulfa *et al*. (2022) which states that microplastic fragments can come from pieces of plastic products with strong synthetic polymers that have a denser density, such as from pipes, bottle caps, buckets, bottle waste, mica jars and etc. Likewise, research by Nugroho *et al*. (2018) stated that the type of microplastic that was most often found at each station was fragment type microplastic. This is proven because the fragments are the result of cutting plastic products with very strong synthetic polymers.

The abundance of microplastic types found in sediment samples was obtained from the abundance of microplastic types which was different from the abundance of microplastic types in water. The most common type of microplastic found in sediment samples was the film type at 43%. Film type microplastics are shaped like very thin plastic sheets. Film-type microplastics are thought to come from plastic waste scattered around the beach and carried by water currents and degraded into microplastics. This is in accordance with research by Ningrum *et al.* (2022) film type microplastics come from plastic bags and other food packaging which tends to be transparent and has undergone degradation. Film-type microplastics come from the fragmentation of plastic bags or plastic packaging, which is the main plastic waste that is thrown into waters in coastal areas.

CONCLUSION

Based on the results of observations at each sampling point, it was found that the total abundance of microplastics in the water 200m before the floating net cage was 55.70 par/L, the estuary was 49.44 par/L and the floating net cage was 40.4 par/L. The highest total abundance in the sediment samples was in sediment samples at the estuary point 12.25 par/g, the total abundance in the floating net cage was 11.01 par/g and the lowest abundance was 200m before the floating net cage at 10.8 par/g. The types of microplastics obtained in this research were fibers, fragments, films and pellets. This type of fiber was found in the lowest percentage in water and sediment samples, namely 2% and 0.05%. The fragment type was 38% in water and 35% in sediment, the film type was 32% in water and 43% in sediment and the pellet type was found to be 28% in water and 22% in sediment.

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REFERENCES

Ayuningtyas, W. C., Yona, D., Julinda, S. H., & Iranawati, F. (2019). Kelimpahan mikroplastik pada perairan di Banyuurip, Gresik, Jawa Timur. *JFMR - Journal of Fisheries and Marine Research, 3*(1), 41-45.

Bajt, O., Szewc, K., Horvat, P., Pengal, P., & Grego, M. (2015). Microplastics in sediments and fish of the Gulf of Trieste. In *Micro 2015: Book of Abstracts*.

Barasarathi, J., Agamuthu, P., Emenike, C. U., & Fauziah, S. H. (2014). Microplastic abundance in selected mangrove forest in Malaysia. In *Proceeding of The ASEAN Conference on Science and Technology* (pp. 1-5).

Barnes, D. K. A., Walters, A., & Gonçalves, L. (2010). Macroplastics at sea around Antarctica. *Marine Environmental Research, 70*(3), 250-252.

Claessens, M., Van Cauwenberghe, L., Vandegehuchte, M. B., & Janssen, C. R. (2013). New techniques for the detection of microplastics in sediments and field collected organisms. *Marine Pollution Bulletin, 70*(1-2), 227-233. https://doi.org/10.1016/j.marpolbul.2013.03.009

Dinas Perikanan Provinsi NTB. (2022). Profil Kelautan dan Perikanan.

Duis, K., & Coors, A. (2016). Microplastics in the aquatic and terrestrial environment: Sources (with a specific focus on personal care products), fate and effects. *Science of the Total Environment, 541*, 2-25. https://doi.org/10.1016/j.scitotenv.2015.11.030

Dwiyiatono, D., Wibowo, S., Januar, H. I., & Barokah, G. R. (2018). Ancaman cemaran marine debris dan mikroplastik pada lingkungan perairan dan produk perikanan. *ResearchGate*. Retrieved from https://www.researchgate.net/publication/331033141

Eriksen, M., Mason, S., Wilson, S., Box, C., Zellers, A., Edwards, W., Farley, H., & Amato, S. (2013). Microplastic pollution in the surface waters of the Laurentian Great Lakes. *Marine Pollution Bulletin, 77*(1-2), 177-182. https://doi.org/10.1016/j.marpolbul.2013.10.007

Galgani, F. (2015). The Mediterranean Sea: From litter to microplastics. In *Micro 2015: Book of Abstracts*.

Hidalgo-Ruz, V., & Thiel, M. (2012). Microplastics in the marine environment: A review of the methods used for identification and quantification. *Environmental Science & 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). Kondisi sampah mikroplastik di permukaan air laut sekitar Kupang dan Rote, Provinsi Nusa Tenggara Timur. *Prosiding Seminar Nasional Masyarakat Biodiversitas Indonesia, 5*(2), 165-171. https://doi.org/10.13057/psnmbi/m050204

Jambeck, J. R., Geyer, R., Wilcox, C., Siegler, T. R., Perryman, M., Andrady, A., Narayan, R., & Law, K. L. (2015). Plastic waste inputs from land into the ocean. *Science, 347*(6223), 768-771. https://doi.org/10.1126/science.1260352

Juao, F., Nash, R., Pagter, E., & O’Connor, I. (2018). Standardised protocol for monitoring microplastics in sediments. *JPI-Oceans BASEMAN Project*.

Kementerian Kelautan dan Perikanan. (2018). Potensi usaha dan peluang investasi kelautan dan perikanan Nusa Tenggara Barat.

Kim, I. S., Chae, D. H., Kim, S. K., Choi, S. B., & Woo, S. B. (2015). Factors influencing the spatial variation of microplastics on high-tidal coastal beaches in Korea. *Archives of Environmental Contamination and Toxicology, 69*(3), 299-309. https://doi.org/10.1007/s00244-015-0155-6

Lusher, A. L., Hollman, P., & Mendoza-Hill, J. (2017). Microplastics in fisheries and aquaculture: Status of knowledge on their occurrence and implications for aquatic organisms and food safety. Rome: *Food and Agriculture Organization of the United Nations*.

Mauludy, M. S., Yunanto, A., & Yona, D. (2019). Microplastic abundances in the sediment of coastal beaches in Badung, Bali. *Jurnal Perikanan Universitas Gadjah Mada, 21*(2), 73-82. https://doi.org/10.22146/jfs.45871

Nainggolan, D. H., Indarjo, A., & Suryono, C. A. (2022). Mikroplastik yang ditemukan di perairan Karangjahe, Rembang, Jawa Tengah. *Journal of Marine Research, 11*(3), 374-382. https://doi.org/10.14710/jmr.v11i3.35021

Ningrum, I. P., Sa'adah, N., & Mahmiah, M. (2022). Jenis dan kelimpahan mikroplastik pada sedimen di Gili Ketapang, Probolinggo. *Journal of Marine Research, 11*(4), 785-793. https://doi.org/10.14710/jmr.v11i4.35467

Nugroho, D. H., Restu, I. W., & Ernawati, N. M. (2018). Kajian kelimpahan mikroplastik di perairan Teluk Benoa Provinsi Bali. *Current Trends in Aquatic Science, 1*(1), 80-90.

Rachmat, S. L. J., Purba, N. P., Agung, M. K., & Yuliadi, L. P. S. (2018). Karakteristik sampah mikroplastik di Muara Sungai DKI Jakarta. *Depik Jurnal Ilmu-Ilmu Perairan, Pesisir dan Perikanan, 8*(1), 9-17.

Reunura, T., & Prommi, T. O. (2022). Detection of microplastics in *Litopenaeus vannamei* (Penaeidae) and *Macrobrachium rosenbergii* (Palaemonidae) in cultured pond. *PeerJ, 10*, e12916. http://doi.org/10.7717/peerj.12916

Ridlo, A., Ario, R., Al Ayyub, A. M., Supriyantini, E., & Sedjati, S. (2020). Mikroplastik pada kedalaman sedimen yang berbeda di Pantai Ayah Kebumen Jawa Tengah. *Jurnal Kelautan Tropis, 23*(3), 325-332. https://doi.org/10.14710/jkt.v23i3.7424

Tanković, M. S., Perusco, V. S., Godrijan, J., & Pfannkuchen, M. (2015). Marine plastic debris in the northeastern Adriatic. In *Micro 2015: Book of Abstracts*.