

Identification of used components of purse seine in Pekalongan City, Central Java, Indonesia

Evi Sis Maya¹, Arini Mayang Fauni¹, Yakiyatul Sa'diyah¹, Philipus Bektı Sajiwo¹, Trisnani Dwi Hapsari^{1*}, Kukuh Eko Prihantoko¹, Neneng Pebruwanti², and Taryono Kodiran³

¹Departement of Capture Fisheries, Fisheries and Marine Science Faculty, Diponegoro University, 50275 Semarang, Indonesia

²Directorate of Fish Resources Management, Directorate General of Capture Fisheries, Ministry of Marine Affairs and Fisheries, Jakarta, Indonesia

³Department of Aquatic Resource Management, Fisheries and Marine Science Faculty, IPB University, 16680 Bogor, Indonesia

Abstract. Collecting and trading of used components of purse seine in Pekalongan, Central Java, Indonesia, will minimize the impact from pollution caused by dumped fishing gear. The used components of purse seine will be repaired if possible or resold to the plastic ore factories. This study aimed to identify types and quantities of used components of purse seine in the city. Data was collected in Pekalongan City, Central Java. Data analysis was carried out to determine the type of nets materials, the total sinker of each purse seine component. In general, the used materials can be categorized into nets (webbing) consisting of repairable nets and non-repairable nets, ropes, floats, sinkers, and rings. The types of the materials of components were nylon, sponges and PVC for floats, leads for sinkers, polyethylene for ropes, and stainless steel for rings. The monthly average of the major components (i.e., nets) received by the collectors was 32,162 kg and re-sold by the collectors was 47,271 kg. Different quantities between the nets received and re-sold were due to the stock from the previous month being sold in the next month.

1 Introduction

Every year, an estimated eight million tons of waste is dumped into Indonesia's marine areas, making it the world's top source of marine debris after China [1]. The phenomenon of marine debris is still a global problem. Fishing activity, especially capture fishing activity at sea is one of the factors that cause marine debris, especially waste from the use of fishing gear [2]. Abandoned, Lost, and Discarded Fishing Gear (ALDFG), also known as ghost gear, is one contributor to plastic waste in the sea [3, 4, 5]. More than 46% of the marine debris is caused by discarded fishing nets [4, 6]. Marine debris can impact coastal resources in terms of ecological, social, and economic aspects [7, 8].

* Corresponding author: trisanihapsari@live.undip.ac.id

Pekalongan City is one of Central Java cities in the North Coast of Java, also known as Pantura (Pantai Utara Jawa), and has high potential in the fisheries sector. Purse seine is one of the fishing gears that is widely used in the city. Purse seine is a fishing gear consisting of net body, wings, float, ropes, bag, and sinkers. The use of purse seine fishing gear will certainly have an impact on damage to the fishing gear, whether caused by intentional or unintentional factors. The damaged purse seine fishing gear will be repaired by fishers or will be sold to collectors.

The fishers usually sell the used component of purse seine fishing gear to collectors within Pekalongan City. They show an effort to utilize components from used purse seine fishing gear in the form of repairing and reselling the used fishing gear as well as a net collection to be sold to the plastic ore factories. Pekalongan City is the only city in Indonesia where there are collectors of used fishing gear components. The purse seine components that were used by collectors come from various regions in Indonesia, especially Rembang, Pati, Tegal, Jakarta, and East Nusa Tenggara. Subsequently, collectors will sell the used component to buyers who are not only coming from Pekalongan but also from other regions such as Jakarta, Purbalingga, Rembang, Pati, Aceh, Sulawesi, Kalimantan, and East Nusa Tenggara. Ship owners also often purchase used components of surplus seine fishing gear for reuse [9]. Plastic problems caused by using fishing gear remain unsolved because most of the materials used in fishing gear are plastic-based. In fact, almost every component of used purse seine fishing gear has economic value. Therefore, fishing gear waste management can be a circular economy implementation that benefits both fishers and ship owners. To encourage those practices, Pekalongan fishing port is required to build an integrated fishing gear waste handling system. Accordingly, information regarding the potential value of each fishing gear component sold to collectors is needed to support the fishing port program. This study aims to identify material types of used purse seine components and their volume for one month period of collection by collectors in the city.

2 Method

2.1 Time and location

The research was conducted in Pekalongan City, Central Java Province, from 8 January to 8 February 2023. Pekalongan City was selected as the research location because it is the only city in Indonesia where there are collectors of used fishing gear components. Twenty collectors of used fishing gear were respondents in Pekalongan.

2.2 Collecting sample

Primarily, data were collected by interviewing 20 respondents using a questionnaire. The questionnaire contained questions about the types of purse seine fishing gear, materials of its components that have the potential to become waste, and the volume of components from purse seine fishing gear received by collectors every day for one month. Most data in this study were obtained directly from collectors based on their daily data.

2.3 Data analysis

Data were analyzed descriptively and quantitatively to evaluate the existing condition of each component of purse seine including nets, ropes, floats, rings, and sinkers. Those data were tabulated and then depicted in graphs. Subsequently, the results were compared to the theoretical perspective and related studies.

3 Results and Discussion

3.1 Type of used component of purse seine

A purse seine consists of the net body (webbing), head rope, foot rope, wrinkle rope, float rope, ring rope, sinkers rope, float, sinkers, and rings. All those components have economic value. Purse seine components have the potential to become garbage if they are no longer used. Most purse seine components use materials that are difficult to decompose. One way to reduce those components' garbage is to reuse it. Collectors of used purse seine components in Tegal buy used nets to sell and reuse [10]. Several collectors in Pekalongan City also collect the components of used purse seine that will be re-sold. The types of purse seine components used are obtained from incoming and outgoing stocks recorded by collectors. In this study, incoming stock is components of used purse seine bought by collectors, while outgoing stock is the ones that are sold by them. The component images are presented in Figure 1.



Fig. 1. Purse seine components

The types of purse seine gear components used by 20 fishing gear collectors in Pekalongan City consist of webbing, rings, float, sinkers, and ropes. The components of the net body received by collectors are divided into two types of used nets, namely repairable nets and unrepairable nets or commonly referred to as fused nets. The unit of repairable net is in a piece, while the unrepairable net is in kilograms. However, in this study both repairable and unrepairable net are presented in kilograms to facilitate data description. Other used purse seine gear components such as sinkers and ropes are presented in kilograms, while the rings and float are presented in pieces.

3.2 Quantities of used component purse seine

The volume of used components purse seine fishing gear in Pekalongan City has different units. This is intended to facilitate the calculation of the volume of existing components. The unit of calculation for each component is the webbing (kilogram), ring (pcs), sinker (kg), float (pcs), and rope (kg).

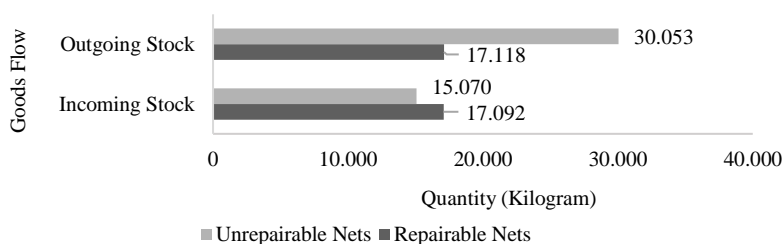


Fig. 2. Net volume by incoming stock and outgoing stock

Originally, the unit of repairable net was presented in a kilogram, while unrepairable net was in a piece. However, in this study both units are presented in kilograms to facilitate data description. The nets that entered the collectors of used fishing gear consisted of repairable nets and unrepairable nets (fused) with a volume of 17,092 kg and 15,070 kg respectively (Figure 3 and 4). Likewise, the stocks that came out (sold) by collectors, namely nets worth repairing and nets not worth repairing (fused), amounted to 17,118 kg and 30,053 kg, respectively. During the span of one month there were 30,053 kg of unrepairable nets sent to the factory to be melted into plastic ore. The number of unrepairable nets sold is higher than the number of repairable nets that enter the collectors. This is because the collectors already have a stock of repaired nets from the previous month so that collectors can fulfil the demand for repairable nets.

Unrepairable nets will have a negative impact if they are not managed and utilized properly. Therefore, used nets that cannot be repaired are called fused nets because the nets will be melted down to make plastic ore. Nets no longer suitable for repair will be sent to the factory according to the factory associated with each collector. This means each collector will deliver the used nets to different factories. The collectors use the term “piece” for 100 meters of the nets, with the depth varying according to the mesh size of the nets. One piece net with a length of 100 meters with mesh sizes 1 inch, 2 inch, and 4 inch consists of 4000, 2000, and 1000 meshes respectively. Meanwhile, for the depth, it can reach 400 meshes, which in a meter unit, is equal to 10 meters for 1 inch mesh size, 20 meters for 2 inch mesh size, and 40 meters for 4 inch mesh size.



Fig. 3. Repairable nets



Fig. 4. Unrepairable nets

Each piece of repairable net contains threads of a uniform size. Conversely, unrepairable nets come in various sizes and comprise heavily damaged pieces, rendering them unusable. Unrepairable nets are measured in kilograms. They are either recycled into plastic or repurposed for tasks such as washing dishes, constructing Fish Aggregating Devices (FADs), building chicken coops, or defining field boundaries.

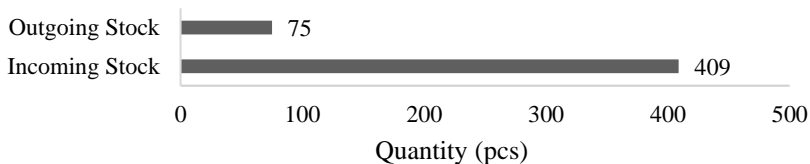


Fig. 5. Ring volume by incoming stock and outgoing stock

The volume of used components of purse seine gear rings that enter the collectors is 220.86 kg or 409 pieces and those that come out (sold) by collectors are 40.5 kg or 75 pieces (Figure 5). The ring has a diameter of 16 cm, and the weight is 0.54 kg. The ring from the purse seine fishing gear is useful as a place for the passage of the furrow rope [11]. Apart from the passage of the furrow rope, the ring is also useful as an additional sinker to increase the sinking force of the net [12, 13, 14]. Normally, the used rings will be bought by the collectors at a ranges of price from IDR 25,000 – IDR 30,000 per one ring, and they will resell it at a price of IDR 35,000 per one ring.

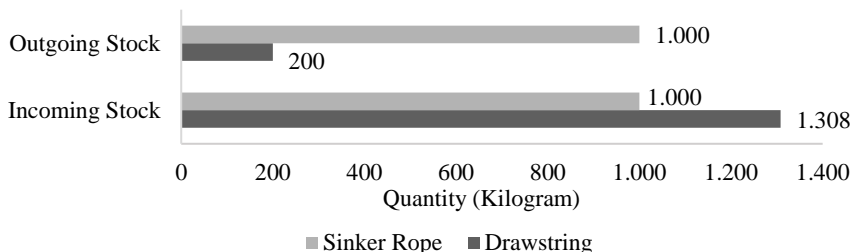


Fig. 6. Rope volume by incoming stock and outgoing stock

Figure 6 shows that 2.308 kg of purse seine fishing ropes entered the collection of used fishing gear in Pekalongan City, consisting of 1,000 kg of sinker ropes and 1,208 kg of drawstring. For one month 1,200 kg of rope was sold by 20 fishing gear collectors, consisting of 200 kg of sinkers rope and 1,000 kg of drawstring. The remaining 1,108 kg of drawstring was not sold that month so it can be resold in the following months. The sinker's rope is 8 mm in diameter, and the drawstring is between 28 mm - 32 mm in diameter. The buying price of rope ranges from IDR 11,000 – IDR 30,000 while the selling price ranges from IDR 25,000 – IDR 35,000 per kg. Rope prices are not differentiated by rope size. However, the rope price is generalized with the unit price per kilogram. Draw string serves to unite the bottom net to form a bag with Polyethylene (PE) material by collecting the rings during hauling so that the bottom of the net is closed so that fish cannot escape from below [14].

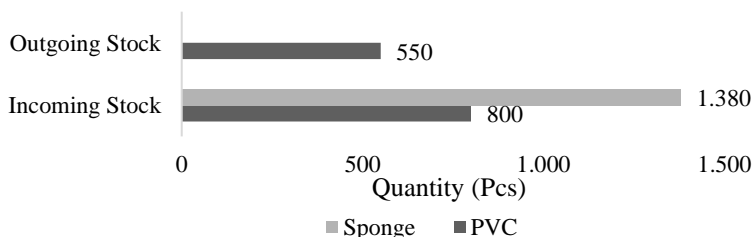


Fig. 7. Float volume by incoming stock and outgoing stock

Floats that enter the collectors as much as 1,047 kg or 2,180 pieces consisting of sponge floats as much as 1,380 pcs, namely the type of float with the YQE brand and 800 PVC floats,

while 83 kg or 550 PVC floats were sold, namely the DS2 float type (Figure 7). The purchase price of used PVC floats ranges from IDR 3,000 per pcs – IDR 10,000 per piece while the selling price of PVC floats per piece ranges from IDR 4,500 – IDR 10,000. The purchase price of YQE brand floats ranges from IDR 9,000 – IDR 80,000 per piece adjusted based on the size of the float, the larger the size of the float, the higher the price of the float. The floats sold were floats that are still good quality and can still be used for fishing gear floats. A total of 927 sponge floats were not sold during the month. However, incoming stocks that are not sold in that month will be used as stock for the next month's sales.

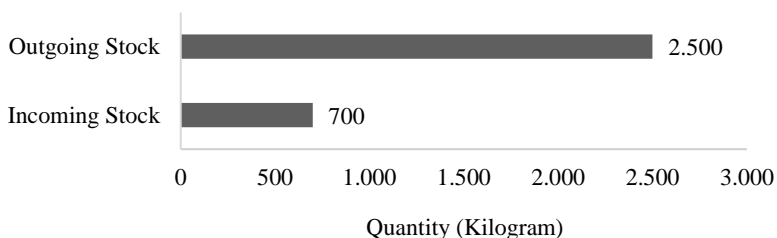


Fig. 8. Sinker volume by incoming stock and outgoing stock

Another component of purse seine fishing gear is sinkers. Based on Figure 8, the volume of sinkers entering the collectors is 700 kg or 3.664 pieces, and the stocks coming out or sold at the collectors are 2.500 kg or 13.089 pieces. The considerable difference between the outgoing and the incoming sinkers is because the collectors have kept sinkers from the previous months so that the collectors can fulfill the demand from customers of 2.500 kg. The weight of one oval-shaped sinker is 135 grams. The sinkers in the used fishing gear collectors are oval-shaped and made of black lead. The sinkers used in purse seine fishing gear are made from lead [15]. Sinkers function to provide sinking force [11], the heavier the sinker, the faster the net will sink [12]. The sinkers components in the collectors of used fishing gear can be melted down and then made into sinkers again or also usually directly resold.

3.3 Materials of used component of purse seine

In general, most purse seine gear construction consists of nets and ropes made from nylon or polyamide multifilament and polyethylene (PE). Nylon or polyamide (PA) multifilament is a synthetic polymer often used in fishing gear construction. Nylon has good strength and resistance criteria against pounding and friction and has better elasticity than other net materials. The breaking force value of wet nylon yarn will decrease by at least 10% from dry and recover when dry [16]. Meanwhile, other components are made from various materials, such as lead for sinkers, PVC and sponge-based for floats, and stainless steel for rings. Due to intense use, fishing gear can be damaged and when no longer used, it potentially becomes garbage. The types of materials of nets components based on incoming stocks and outgoing stocks are presented in Figure 9 and Figure 10.

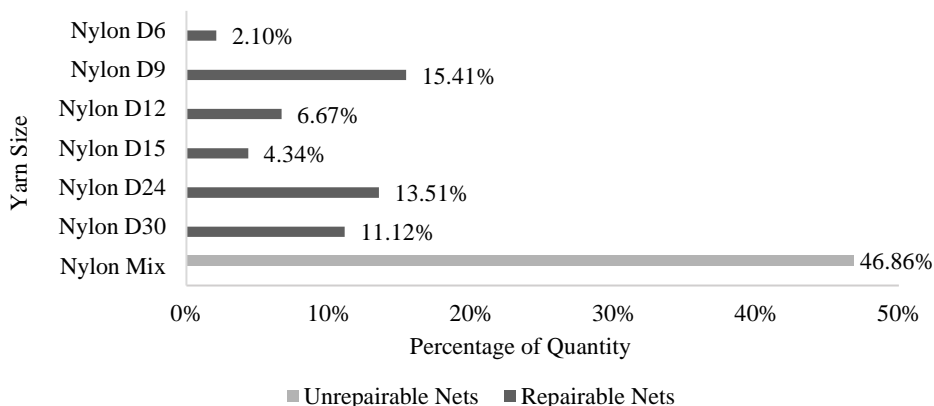


Fig. 9. Materials of net by incoming stock

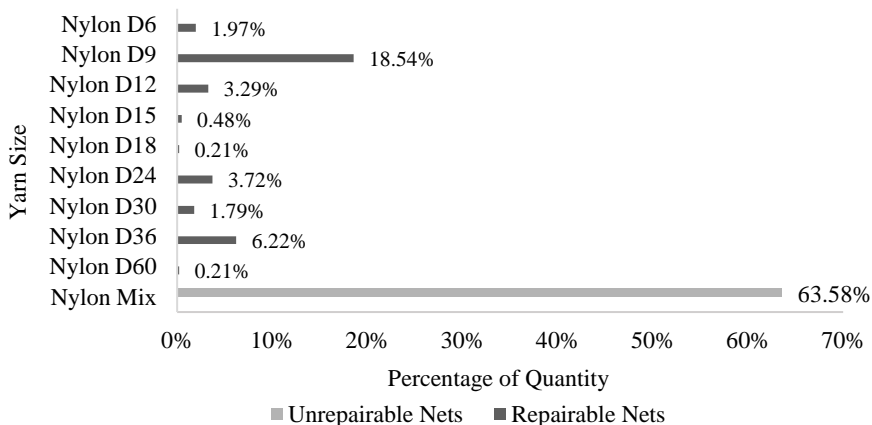


Fig. 10. Materials of net by outgoing stock

The largest percentage is unfit for repair nets (fused nets) for incoming stocks is 46.86% or 15,070 kg and outgoing stocks is amounting 63.58% or 30,053 kg (Figure 9 and Figure 10). The unrepairable or fused net material consisted of nylon material with a mixed yarn diameter and mesh size. Collectors did not sort and differentiate the yarn size because the nets will be converted into plastic ore. The size of the yarn in the used net varies greatly from the smallest to the largest diameter. All net material sent to the factory was nylon material because the factory only requested nylon-based nets. PE-based nets were not used in purse seine fishing gear, but in gill net and mini purse seine. Used nets made from PE are not sent to the factory for further processing but reused for other purposes, such garden fencing.

There are also net materials worthy of repair (Figure 9 and Figure 10). The letter D in the naming of each yarn type refers to the yarn numbering system used in the textile industry. D refers to the base material of the yarn such as polyester or nylon and the number behind it indicates the number of yarns combined to form a stronger thread. Nets that were still worth repairing based on incoming and outgoing stocks at collectors are made from nylon. The largest percentage of net material that was still worth repairing based on incoming stocks and outgoing stocks at collectors was in Nylon D9 with 4,956 kg and 8,764 kg.

The material type of the used purse seine components was dominated by nylon or PA multifilament because most of the used fishing gear found in collectors are nets, both nets that are still suitable for repair and nets that are not suitable for repair (fused nets). This is directly proportional to the previous statement that the largest type of scrap produced by

purse seine fishing gear was nets material. The net material used in purse seine fishing gear was PA multifilament [17]. Net materials with D6 and D9 yarn types were used in the wings, net body, and bag parts [13]. D12 nylon net material for the net body and D9 for the wings [15], D9 for the wings, D15 for the net body, D18 and D24 were used for bags [18]. PA multifilament material was widely used for purse seine fishing gear because nylon yarn has better strength because it is made from plastic which does not absorb much water [19, 20].

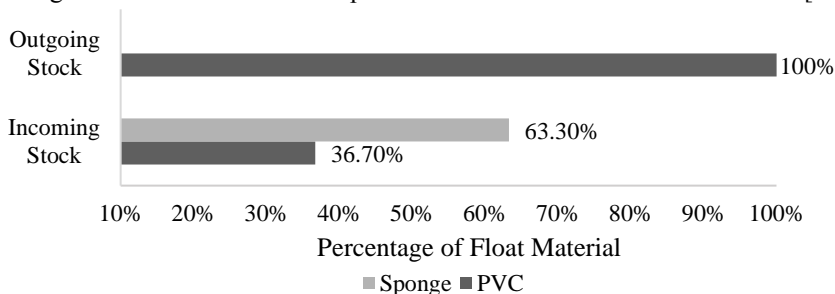


Fig. 11. Percentage of float materials by incoming stock and outgoing stock

One of the components of used purse seine fishing gear was the float. The types of float materials available at collectors of used fishing gear in Pekalongan City were PVC (Polyvinyl chloride) and sponge. PVC floats were durable and have a longer lifespan, and do not absorb water. However, PVC floats tend to be heavier so that they can affect the balance of fishing gear and PVC materials are also among the materials that are difficult to recycle. Meanwhile, sponge floats weigh less than PVC and the material is more easily decomposed than PVC floats. Sponge floats also have a smaller lifespan than PVC, because the material absorbs water. Based on Figure 11, the largest type of float material based on incoming stocks was sponge material with a percentage of 88.54% or equal to 1,380 pcs and PVC with a percentage of 11.46% or 800 pcs. The floats sold at the collector were 100% made from PVC (Polyvinyl chloride), as many as 550 pcs. These two float materials were often used in fishing gear, especially purse seine fishing gear. Floats used in purse seine fishing gear were made from PVC (Polyvinyl chloride) [15, 21]. YQE brand floats with sponge-based materials have higher selling and buying prices than PVC-based floats.

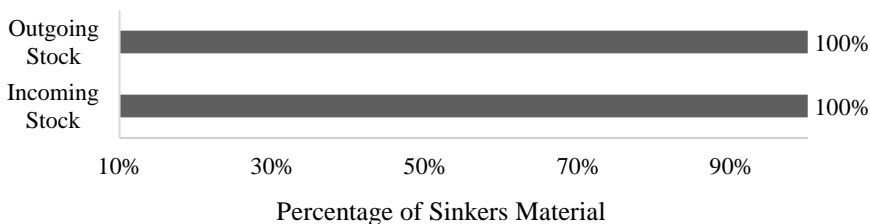


Fig. 12. Percentage for sinkers materials by incoming stock and outgoing stock

All purse seine gear sinkers in the collectors are made from lead and shaped like areca nuts (Figure 12). The percentage illustrates that as much as 700 kg of incoming sinkers, 100% of the sinkers bought, and the sold sinkers are made from lead. The 2,500 kg of sinkers sold to the collectors were all made from lead. The weight of each purse seine sinker was 350 grams [2, 15, 18].

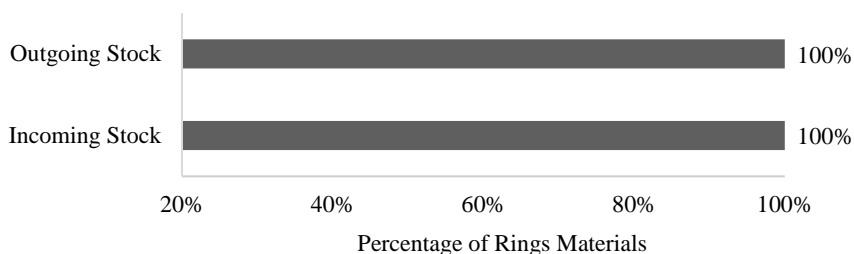


Fig. 13. Percentage of rings materials by incoming stock and outgoing stock

The material used in the ring component was 100% stainless steel (Figure 13). The percentages in the graph illustrate that the rings entered the collectors. As many as 75 rings were entirely stainless steel, and the number of the sold rings was 409 pcs, each made from stainless steel. Commonly, the ring material on purse seine fishing gear is made of stainless steel [16, 22]. However, some of them are also made from brass material [18, 23].

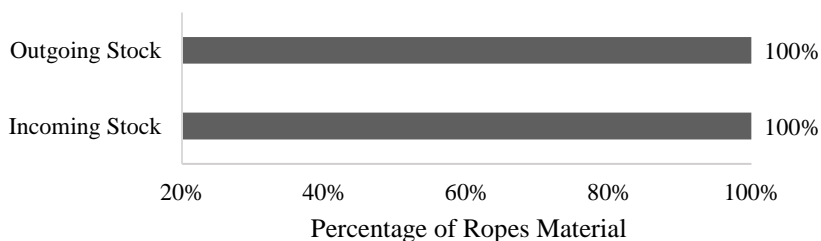


Fig. 14. Percentage of ropes materials by incoming stock and outgoing stock

The rope material used in the purse seine gear component is made entirely of PE (Polyethylene) with the spinning direction to the left (Z) (Figure 14). Figure 14 illustrates that a total of 2,308 kg of rope entering the collectors, both purse line and sinker rope are all made from PE or (Polyethylene) and 1,200 kg of purse line and sinker rope materials sold are all made from PE (Polyethylene). Purse seine fishing gear ropes in the collectors are sinker and purse lines. The sinker rope for purse seine fishing gear is 8 mm and purse line is 34 - 36 mm. The diameter of the sinker rope used is 8 mm [15]. Polyethylene rope material is widely used for ropes on fishing gear because it can last a long time, so it is more economical for fishermen [3]. Polyethylene has the advantages of high elasticity, relatively cheap price, easy to obtain, strong, has a strong breaking power, does not absorb water, and the fibers are not disconnected [3]. Despite the various benefits polyethylene ropes offer fishermen such as durability, affordability, and performance, their extensive use also presents significant environmental challenges. To strike a balance between the advantages and disadvantages of polyethylene ropes, careful consideration of their impact on marine ecosystems, fishing efficiency, and long-term sustainability is essential. Exploring and adopting alternative materials and practices may be necessary to address these challenges and encourage more environmentally responsible fishing practices. The phenomenon of buying and selling back used fishing gear components can provide benefits to fishers because used components that are no longer used can be sold and make money. Meanwhile, this phenomenon can also reduce the disposal of fishing gear waste at sea to minimize plastic waste in the sea. The total economic loss experienced by ghost gear fishers in Tegal is IDR 280,433,674.03 per year for fishers who work every day and IDR 141,883,740,963.19 per year for fishers who work every week. This result illustrates a decrease in income of 11% per year for fishermen who work every day and 1% for fishermen who work every week [10]. Knowing the potential types and amounts of

fishing gear waste managed by fishing gear waste collectors in Pekalongan will provide information for the Pekalongan Nusantara Fishing Port management and related agencies to build an integrated fishing gear waste handling system to realize environmentally based fishing port management.

4 Conclusion

This study concluded that the types of used components of purse seine fishing gear consisted of webbing, ropes, floats, sinkers, and rings. The nets material consisted of Nylon D6, D9, D12, D15, D18, D24, D30, D36, and D60, the float material consisted of sponge and PVC, the sinkers material was ballad, the ring material was stainless steel, and the rope material was polyethylene. The volume of used purse seine fishing gear components is dominated by repairable nets and used nets not worth repairing. The monthly average of the major components (i.e., nets) received by the collectors was 32,162 kg and re-sold by the collectors was 47,271 kg. The number of nets and sinkers sold was more than the bought stock while the number of floats, rings, and ropes that bought by collectors was higher than the number of sold items. The difference between incoming and outgoing stock sold in one month was because the collectors already have stock from the previous month that is sold in the following month. Similarly, unsold stock will be sold the following month.

References

1. J. R. Jambeck, R. Geyer, C. Wilcox, R. T. Siegler, M. Perryman, A. Andrady, R. Narayan, K. L. Law, *Science* **347**, 6223 (2015)
2. A. Wahyudi, E. Lubis, A. B. Pane, *Jurnal Albacore* **1** (2017)
3. B. D. Hardesty, L. Roman, N. C. Duke, J. R. Mackenzie, C. Wilcox, *Marine Pollution* **173** (2021)
4. A. J. Goodman, J. Mcintyre, A. Smith, L. Fulton, T. R. Walker, C. J. Brown, *Marine Pollution Bulletin* **171** (2021)
5. E. Gilman, J. Humberstone, J. R. Wilson, E. Chassot, A. Jackson, P. Suuronen, *Marine Policy Journal* **141**, 1 (2022)
6. N. H. Antonia Unger, *Marine Pollution Bulletin* **107** (2016)
7. J. A. Alves, G. R. A. Rocha, T. F. Souza, P. C. Pinheiro, K. M. F. Freire, *Brazilian Journal of Oceanography* **64** (2016)
8. K. Richardson, B. D. Hardesty, C. Wilcox, *Fish and Fisheries* **20** (2019)
9. W. Y. L. Saunoh, A. C. Paulus, A. L. Kangkan, *Jurnal Bahari Papadak* **3**, 2 (2022)
10. A. Adlina, P. Wijayanti, D. Ratnasai, T. Kodiran, *Jurnal Sosial Ekonomi Kelautan dan Perikanan* **18**, 2 (2023)
11. The National Standardization Agency of Indonesia, *Tentang Ukuran Utama Jaring Lingkar Bertali Kerut (Pukat Cincin) SNI 8186* (2015)
12. Y. Sabe, Y. D. B. R. Minggu, S. Dhengi, *AQUANIPA-Jurnal Ilmu Kelautan dan Perikanan* **3**, 1 (2021)
13. B. B. Jayanto, K. E. Prihantoko, B. S. Sanhajik, *Indonesian Journal of Fisheries Science and Technology* **16**, 1 (2020)
14. N. M. Satyawan, R. F. Larasati, I. N. S. Bhagaskara, *Jurnal Perikanan Unram* **13**, 1 (2023)
15. A. R. Singale, J. Budiman, R. D. C. Pamikiran, *Jurnal Ilmu dan Teknologi Perikanan Tangkap* **5**, 1 (2020)
16. D. Komarudin, M. Baskoro, D. Diniah, B. Murdiyanto, P. Suptijah, *Marine Fisheries: Journal of Marine Fisheries Technology and Management* **10**, 2 (2019)
17. A. Tangdipau, F. Silooy, P. N. I. Kalangi, A. Thamin, *Jurnal Ilmu dan Teknologi Perikanan Tangkap* **7**, 2 (2022)

18. O. S. Kefi, E. M. Katiandagho, I. J. Paransa, *Jurnal Ilmu dan Teknologi Perikanan Tangkap* **1**, 3 (2013)
19. R. L. Bubun, A. Mahmud, R. Alam, *Journal of Marine Fisheries Technology and Management* **12**, 1 (2021)
20. N. Hikmah, M. Kurnia, F. Amir, *Jurnal IPTEKS Pemanfaatan Sumberdaya Perikanan*. **3**, 6 (2016)
21. H. F. Sitorus, A. N. Bambang, B. B. Jayanto, *Journal of Capture Fisheries Indonesia* **1**, 03 (2017)
22. I. Limbong, E. S. Wiyono, R. Yusfiandayani, *ALBACORE Jurnal Penelitian Perikanan Laut* **1**, 1 (2017)
23. T. B. Setyasmoko, A. D. P. Fitri, S. D. Gautama, *Journal of Fisheries Resources Utilization Management and Technology* **5**, 1 (2016)