Original Research Article

The Selectivity of Purse Seine Againt Tuna Kawakawa (*Euthynnus affinis*) Catch in PPN Muara Angke Jakarta

ABSTRACT

Purse seine is one of the fishing gear that had been used by PPN Muara Angke fisher to catch pelagis fish. The selectivity and the eco-friendly of *purse seine* was still being researched until now. This research was conducted with the aim of knowing the selectivity of *purse seine* with selectivity length of the tuna kawakawa (*Euthynnus affinis*) was worth and selectivity of catch also knowing the score total every ship in the assessment of the eco-friendly based on CCRF *purse seine* fishing gear which was landed at PPN Muara Angke. The research had been conducted from June 2020 until November 2020 at PPN Muara Angke, DKI Jakarta. This research came with the survey method and the data was obtained from primary and secondary resources. The primary resources included catch yield and weight, length of first capture (Lc) tuna kawakawa, fish quality, fishing gear identification, safety suit and tools, supplies, navigation device, the ship work accident history, while the secondary resource was from UPPP Muara Angke. The research results pusre seine fishing gear which was landed at PPN Muara Angke was not selective due to the percentage length of the tuna kawakawa was worth, proportion of amount and weight less than 60% also the score total Makmur Jaya 78 and Selat Jaya 06 ship got a score of 23 when the Sumber Mulya 02, Bintang Makmur and Sumber Makmur ship got a score of 22 which indicated the purse seine fishing gear on the five ships had a fairly eco-frienldy fishing gear category.

Keyworlds: purse seine, tuna kawakawa fish, selectivity, eco-friendly.

1. INTRODUCTION

One of the attempts that can be carried out to continue the sustainability of fish resources is the use of selective fishing gear [1]. Selective fishing gear is a fishing gear that catches decent fish caught, both in age and size, and this fishing gear can escape fish that are not decent fish caught, protected fish, and unwanted fish without injuring or killing them [13]. A purse seine is a multi-species fishing gear, where it catches more than one type of fish because of catching fish by confining fish. In many cases, it is often found that the mesh size of purse sine fishing gear is very small. This can affect the catch obtained. In the study [7], the catch of purse seine in Muara Angke is very diverse, with the number of main catch is 1:4 with by-catches. High catch diversity is worried to threaten the reduced sustainability of marine biota species.

Tuna kawakawa is high productivity for the category of pelagic fish. According to the data obtained from the report of One Marine and Fishery Production Data 2017 [11] , the productivity of tuna kawakawa in Jakarta was 13,583 tons, and the economical price of tuna kawakawa was IDR 271,670,094, so that tuna kawakawa is highly sought after by fishermen due to its high selling price. The increasing tuna kawakawa consumers make the fishermen have to meet the consumer demand by maximizing the tuna kawakawa catches without looking at the sustainability of tuna kawakawa. The tuna stocks in Indonesian waters have decreased due to poor recruitment, illegal fishing, and inadequate closed fishing season scheme [10]. The catch rate of tuna kawakawa in the Java Sea has been fully exploited that can cause stock depletion of tuna kawakawa [3]. Therefore, there must be control over the catches of tuna kawakawa to create long-term sustainability, and tuna kawakawa remains sustainable.

Catch operation can run well if a fishery business has several criteria for environmentally friendly fishing technology. Good fishing gear is a fishing gear that meets the environmentally friendly criteria made by FAO. Assessment criteria of environmentally friendly fishing gear made by FAO are the Code of Conduct for Responsible Fisheries (CCRF). The criteria of environmentally friendly fishing gear used by the Ministry of Marine Affairs and Fisheries based on CCRF consist of 9 criteria:

1. Having a high selectivity;
2. Doe not destroy habitat;
3. Resulting in a high-quality fish;
4. Does not harm the fishermen;
5. Production does not harm consumers;
6. Low by-catch;
7. Low impact on biodiversity;
8. Does not harm protected fish;
9. Socially acceptable criteria for environmentally-friendly fishing gear in Indonesia.

These criteria are the reference in the assessment of environmentally friendly fishing gear. The development goal of capture fisheries both at the national level or international level is to improve the quality of life without affecting or disturbing the quality of the environment. Responsible fishing guidelines are expected to use as guidance to carry out environmentally friendly fishery activities.

Identification in this research is how selective the purse seine to the catches of tuna kawakawa landed in PPN (Archipelagic Fishing Ports) Muara Angke and what score was obtained for the CCRF-based environmental friendliness of purse seine fishing gear landed in PPN Muara Angke.

The aim of this research is to determine the selectivity of purse seine fishing gear with the selectivity of the length of tuna kawakawa and selectivity of catches, as well as to determine the total score obtained by each vessel in the assessment of CCRF-based environmental friendliness on purse seine fishing gear landed in PPN Muara Angke.

The use of this research is to provide information regarding the selectivity of purse seine fishing gear to the commodity of tuna kawakawa, and the environmental friendliness of purse seine fishing gear landed in PPN Muara Angke.

1. RESEARCH METHODS

The data collection of this research was conducted from June 2020 to November 2020. The research site was in the PPN Muara Angke, Kecamatan Penjaringan, Jakarta Utara City, DKI Jakarta.

The method used in this research was the survey method with quantitative descriptive analysis. The data collected during the research were primary data and secondary data. Primary data included the number and weight of catches, fork length of tuna kawakawa, the freshness of tuna kawakawa, and interview data including identification of fishing gear, work equipment, safety tools, supplies, navigation tools, and history of shipwreck. Secondary data included production data of purse seine catches from 2015-2019 dan vessel data obtained from Central Port Management Unit Jakarta and PPN Muara Angke. Data analysis methods in this research were selectivity of length size of decent tuna kawakawa caught, selectivity of the type of catch, and CCRF-based environmentally friendly fishing gear.

2.1 Selectivity of Length Size of Decent Tuna Kawakawa Caught

The analysis of the selectivity of length size of decent tuna kawakawa caught used Sturges formula [12] as follows:

1. The determination of the number of classes in tuna kawakawa length

$$K=1+3{,}3\log n$$

Notes:

K= Number of class in tuna kawakawa length (class)

n= Number of data in tuna kawakawa length (fish)

2. The determination of the wide for each class in tuna kawakawa length

$$C=\frac{Longest\ Data-Shortest\ Data}{K}$$

Notes:

C= Interval width for each class in tuna kawakawa length (cm)

K= Number of classes in tuna kawakawa length (class)

3. Determining the lower limit of the first class.
4. Writing the number of frequencies for each class in tuna kawakawa length.
5. Classifying the tuna kawakawa with decent size caught and decent size caught in the form of a percentage.

One of the indicators that fishing gear is selective to the catches is if Length of first capture (Lc) > Length of first matured (Lm) and the number of length proportion of decent tuna kawakawa caught ≥ 60% from the number of length proportion of the whole tuna kawakawa [20]. This research used the results [14], where the first value of gonad maturity from tuna kawakawa of 43.2 cm was used as a reference for the fork length of decent tuna kawakawa caught.

2.2 Selectivity for the Type of Catches

In the analysis of selectivity for the type of catches, it was seen from the proportion of the number and weight of catches. Stated that in order to find out the proportion of weight and number of catches, each fishing unit uses to catch fish using the formula [19] as follows:

1. The proportion of the weight of main catch and by-catch from purse seine fishing gear
   a. The proportion of the weight of the main catch from purse seine fishing gear ($P_{Main\ catch}$)

$$P_{Main\ catch} = \frac{a_1}{a_1 + b_1} \times 100\%$$

   b. The proportion of the weight of by-catch from purse seine fishing gear ($P_{By\text{-}catch}$)

$$P_{By-catch} = \frac{a_1}{a_1 + b} \times 100\%$$

notes:

a_1: The weight of main catch from purse seine fishing gear (Kg)

b_1: The weight of by-catch from purse seine fishing gear (Kg)

2. The proportion of the number of main catch and by-catch from purse seine fishing gear
   a. The proportion of the number of main catch from purse seine fishing gear ($P_{Main\ catch}$)

$$Q_{Main\ catch} = \frac{a_2}{a_2 + a_2} \times 100\%$$

   b. The proportion of the number of by-catch from purse seine fishing gear ($P_{By\text{-}catch}$)

$$Q_{By-catch} = \frac{a_2}{a_2 + b_2} \times 100\%$$

Notes:

a_2: The number of main catch from purse seine fishing gear (Fish)

b_2: The number of by-catch from purse seine fishing gear (Fish)

The proportion of weight and number is made in the form of a percentage. If the proportion of the main catch obtained ≥ 60% of the total catches, then the fishing gear can be stated as selective [20].

2.3 Code of Conduct for Responsible Fisheries-Based Environmentally Friendly Fishing Gear

In the analysis of CCRF-based environmentally-friendly fishing gear, the assessment of fishing gear was obtained from the score modification on the criteria according to CCRF. There

are six criteria in the assessment of CCRF-based fishing gear, and there are five scores in each criterion, which have different score weights (Appendix 1). The total score obtained determined the category of environmentally friendly or not environmentally friendly fishing gear (Table 1):

Table 1. Eco-friendly fishing equitment category score

No	Category	Score
1	Not very eco-friendly	6-11
2	Not eco-friendly	12-17
3	Sufficient eco-friendly	18-23
4	Eco-friendly	24-29
5	Very eco-friendly	30

3. RESULTS AND DISCUSSION

3.1 The Production of Tuna Kawakawa in PPN Muara Angke

The catches of tuna kawakawa landed in PPN Muara Angke were mostly obtained from the purse seine vessel.

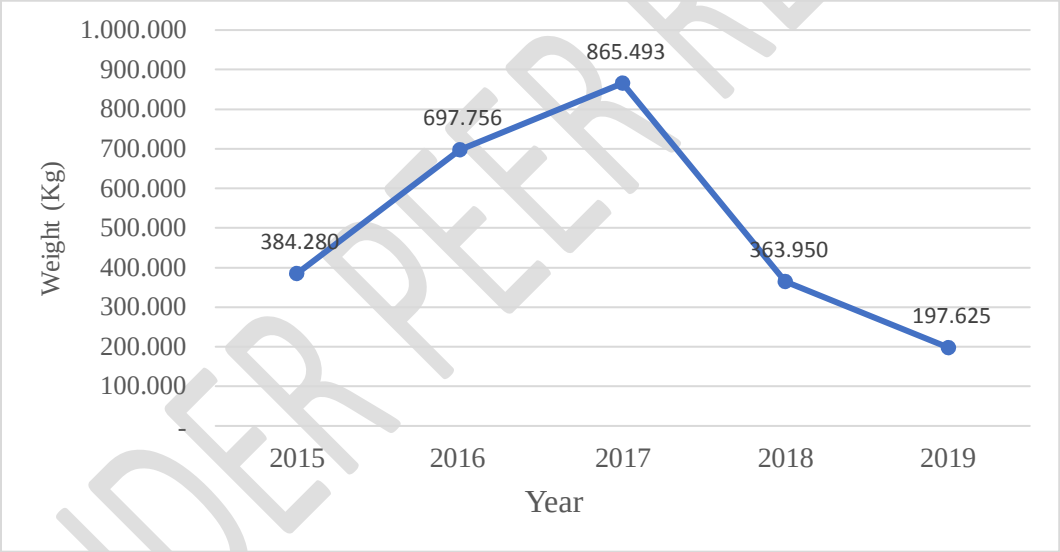

Fig 1. Graph Production of Tuna Kawakawa Catches with Purse Seine Fishing Gear in 2015-2019

Based on the figure above, the highest total production of tuna kawakawa in 2017 was 865,493 kg, while the lowest total production of tuna kawakawa in 2019 was 200,547 kg. The production of tuna kawakawa has increased from 2015 with 384,280 kg to 2017 with 865,493 kg. When entering 2018 to 2019, the production of tuna kawakawa has decreased up to 200,547 kg in 2019. Based on the results of the interview with the harbormaster officer and vessel owner, in 2018, the vessels that previously used purse seine fishing gear switched to stick-held dip-net fishing gear. This is because the company's board targeted squid catches for the raw material needs of the company.

3.2 Purse Seine Fishing Gear Unit

3.1.1 Purse Seine Fishing Gear

Purse seine gear consists of main nets, wing nets, bad nets, selvage, upper rigging, rope lifeline, top rigging rope, bottom rigging rope, corrugated rope, ballasts, and rings [16]. The number of fishing gear used in this research was five purse seine fishing gears, each of which has a different size and number (Table 2).

Table 2. Purse Seine Fishing Gear Data

	Vessel				
	Sumber Mulya 02	Makmur Jaya 78	Selat Jaya 06	Bintang Makmur	Sumber Makmur
Fishing Gear Length (Meter)	400	400	400	400	400
Fishing Gear Wide (Meter)	100	100	130	120	120
Mesh Size (Inch) Ballast	1	1	1	1	1
(Unit) Ring	900	900	850	880	880
(Unit)	400	400	400	400	400
Lifebuoy (Unit)	1750	1750	2500	2200	2200

The net material used in purse seine fishing gear is nylon. Ballast and ring materials used in purse seine fishing gear are tin coated with brass. The ballast used in purse seine has 1,000 grams weight, and the ring is 500 grams weight. According to the purse seine vessel captain, each meter of net contains two to three ballast, one ring, and four to five lifebuoys. This is made so that when conducting a setting, the net will widen to the bottom perfectly.

3.1.2 Fishing Vessel

As a critical success factor in the catching operation, the Purse Seine coat should have size and propulsion according to the type of fishing gear used [21]. Purse seine vessels used in this study were Sumber Mulya 02, Makmur Jaya 78, Selat Jaya 06, Bintang Makmur, and Sumber Makmur (Table 3).

Table 3. Purse Seine Vessel Size and Engine Data

No.	*Vessel*	*Gross Ton*	*Length (Meter)*	*Wide (Meter)*	*Deep (Meter)*	*Machine*	*Paarden Kracht (PK)*
1	Sumber Mulya 02	89	21.37	6.83	2.66	Mitsubshi	215
2	Makmur Jaya 78	84	23.90	6.60	2.00	Mitsubishi	280
3	Selat Jaya 06	87	20.30	6.70	2.63	Mitsubishi	200
4	Bintang Makmur	81	22.00	6.20	2.50	Nissan	300
5	Sumber Makmur	87	21.50	6.50	2.40	Nissan	280

The material of the purse seine vessel uses wood. Furthermore, the purse seine vessel uses two to three drive engines, one line hauler, and a cold storage machine in the vessel hatch. Purse seine vessel operates for three to six months in one trip. Purse seine vessel landed in PPN Muara Angke has 21-28 crews. This is because when pulling the net onto the vessel still uses human power. The vessel that has the largest GT is Sumber Mulya 02, with 89 GT. The larger the vessel GT, the larger the catches [21]. Bintang Makmur vessel has a large PK among others and has a small GT so that the vessel can be faster and more effective in operating purse seine fishing gear. How much speed when setting towards the catches is greater the speed when setting, then the catches will be maximum [21].

3.1.3 Catches

In this research, fish that became the main catch research were tuna kawakawa, while HTS consisted of 23 species. The diversity of species caught can be caused by the location of catches is the habitat for the target and non-target fish. Total catches from five purse seine vessels were 101,123 kg. The most type of weight of catches was Decapterus of 13,651 kg, and the least weight of catches was Marlin of 259 kg. The type of the highest number of catches was Indian mackerel of 121,253 kg, and the smallest number of catches was Marlin of 6 fish (Table 4).

Table 4. Total Catch Compotition 22 June – 20 Noverber 2020.

Catch	Species	Weight (kg)	Amount (fish)
Main Catch	*Euthynnus affinis*	11,967	18,834
By-catch	*Sphyraena argentea*	983	1,027
	Parastromateus niger	264	900
	Selar crumenophthalmus	7,634	49,252
	Rachycentron canadumz	553	760
	Sardinella fimbriata	10,158	75,540
	Muraenesox talabon	1,017	1,294
	Eubleekeria splendens	2,808	80,229
	Abalistes stellaris	1,352	3,108
	Rastrelliger kanagurta	9,094	121,253
	Caranx ignobilis	866	979
	Decapterus kurroides	13,651	86,715
	Trichiurus lepturus	781	4,056
	Coryphaena hippurus	679	886
	Dussumieria acuta	601	1,123
	Sardinella lemuru	7,905	64,844
	Arius thalassinus	2,557	2,570
	Mene maculate	1,818	24,568
	Scomberomorus commerson	1,497	1,137
	Megalaspis cordyla	12,011	102,525
	Auxis Thazard	2,571	7,346
	Loligo Pealei	9,410	91,156
	Tetrapturus angustirostris	259	6
	Scomberoides tol	687	5.367
	Total Catch	101,123	745,473

3.2 Selectivity of Purse Seine Fishing Gear

3.2.1 Selectivity of Fork Length Size of Tuna Kawakawa

The length of the initial level of gonad maturity used in this research was the result of the study by Masuswo et al. [14], which obtained the first value of tuna kawakawa gonad maturity was 43.2 cm. According to Maulidin [12], the catches with decent size caught can provide the opportunity for catch target fish to be able to spawn before being caught so that the recruitment process can run properly and the resource stock is still maintained. Knowing the length of caught tuna kawakawa can be used to find out the level of selectivity of fishing gear based on the feasibility of catch size. The data for the fork length size of tuna kawakawa used in this research were 1250 fish per five vessels, and in one vessel, 250 tuna kawakawa were randomly taken. Data for the length of tuna kawakawa obtained from the five vessels were grouped into several classes with frequency distribution to see the domain and average size of tuna kawakawa caught (Figure 2).

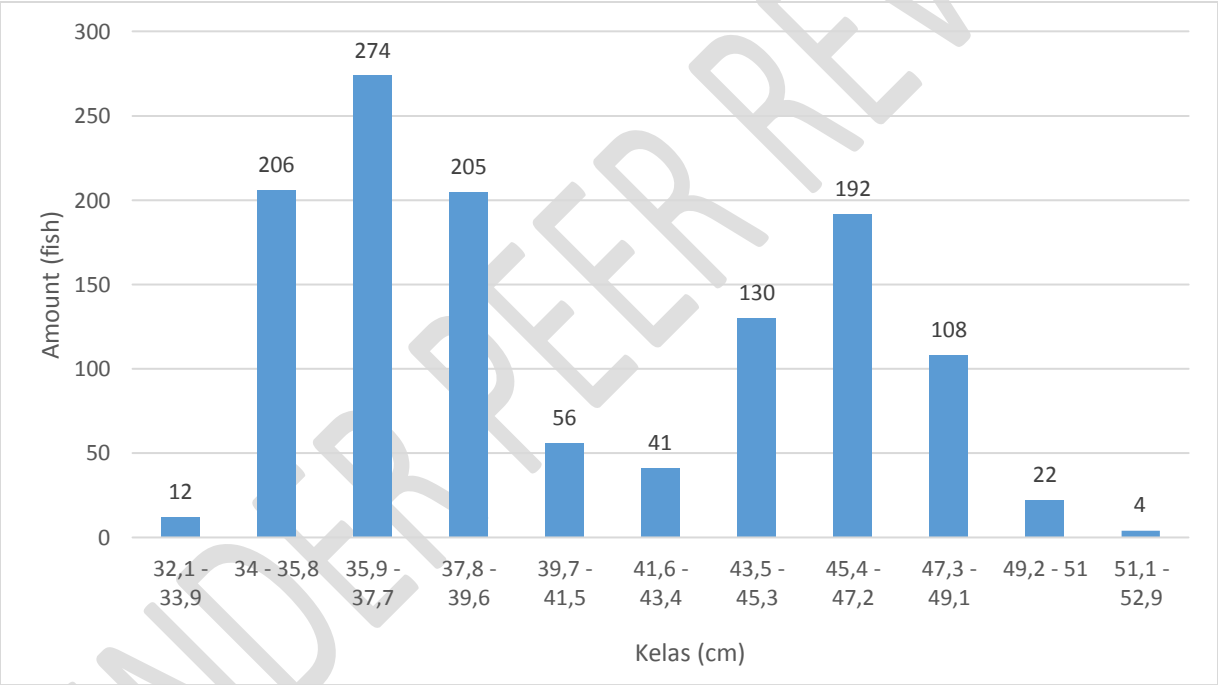

Fig 2. Graph of Total Fork Class of Tuna Kawakawa In 22 June – 20 November 2020

Data for the fork length of tuna kawakawa in the whole coat has a size of 32.1-52.3 cm with the most catches of tuna kawakawa were in the class size of 35.9-37.6 cm by 274 fish, and the least catches of tuna kawakawa were in the class size of 51.1-52.9 cm by 4 fish. The average data for the fork length of tuna kawakawa was 40.7 cm. The percentage of decent tuna kawakawa caught that obtained was 36.90%, with 461 fish, while the percentage of not decent tuna kawakawa caught was 63.10%, with 789 fish. Purse seine fishing gear is not selective in the selectivity of decent tuna kawakawa caught because the decent catches caught are less than 60%. The fishing gear is stated selective if the percentage for the number of the length of decent fish caught

is ≥ 60% [20]. The number of tuna kawakawa catches with decent size caught is caused by mesh used by purse seine fishing gear is small so that decent tuna kawakawa caught cannot escape.

The ability of fishing gear in catching decent fish caught, both age or size, can escape not decent fish caught, protected fish, and unwanted fish without injuring or killing them [6]. Purse sine fishing gear used in each purse seine is not selective to catch tuna kawakawa because it is more dominant the not decent size caught than decent caught. Purse seine fishing gear is unselective due to the small mesh size and the cluster of tuna kawakawa with various types of size so that the size of decent tuna kawakawa caught and no decent tuna kawakawa caught cannot be selected.

3.2.2 Selectivity for the Type of Catches

The selectivity for the type of catches is the comparison between the main catch and by-catch. This analysis used the composition of tuna kawakawa as the main catch, and the rest is the by-catch.

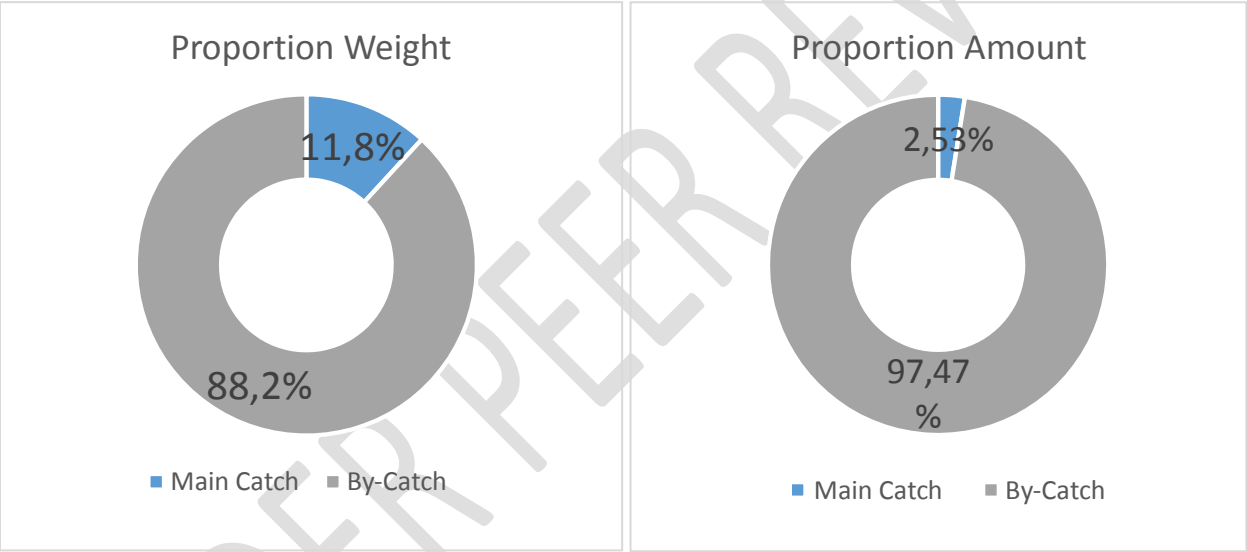

Fig 3. Weight and Amount Proportion Percentage of Main Catch and By-Catch in 22 June until 20 November 2020

The percentage of the total weight of the main catch was 11.80%, while the percentage of the total weight of by-catch was 88.20%. The percentage of the total number of the main catch was 2.53%, while the total number of by-catch was 97.47%. Purse seine fishing gear used by the fishermen in PPN Muara Angke is not selective in the selectivity of catches because the percentage value obtained was less than 60%. If the proportion of the main catch obtained ≥ 60% of the total catches, then the fishing gear can be stated as selective [20].

The percentage of total by-catch was greater than the percentage of the main catch. It is caused by several factors: purse seine fishing gear is multi-species and has a small mesh size, as well as the habitat of tuna kawakawa along with other fish. The larger the proportion of fish with decent size caught and main target catch resulted, it can be stated that the fishing gear is selective

to catch target fish [1]. Factors causing many of these non-target resources are caused by seasonal and habitat conditions and geographic area that has potential impact in the composition of species and community structure [24]. The difference in the selectivity assessment can occur because Indonesia has high biodiversity; Indonesia is a tropical country, and it is difficult to cat target fish without the by-catch so that causing the determination of selectivity can be seen from various things [19].

3.3 Code of Conduct for Responsible Fisheries-Based Fishing Gear

The assessment in this research focused on purse seine vessel in PPN Muara Angke. The number of purse seine vessel researched were five vessels, including Sumber Mulya 02, Makmur Jaya 78, Selat Jaya 06, Bintang Makmur, and Sumber Makmur. The following are the results for the assessment of CCRF-based environmentally friendly fishing gear:

Table 5. CCRF Based of Environmentally Friendly Purse Seine Fishing Gear Assessment.

Vessel	CCRF-based environmentally friendly fishing gear assessment criteria						Score Total
	A	B	C	D	E	F	
Sumber Mulya 02	2	3	3	4	5	5	22
Makmur Jaya 78	2	3	4	4	5	5	23
Selat Jaya 06	2	3	4	4	5	5	23
Bintang Makmur	2	3	3	4	5	5	22
Sumber Makmur	2	3	3	4	5	5	22

Information :

A: High selectivy,
B: Has a minimum impact to the decline in biodiversity,
C: Not harm to fishermen,
D: Produce good quality fish,
E: Low by-catch,
F: Do not catch protected fish

3.3.1 High Selectivity

In the assessment of high selectivity, the five s obtained a score of 2 vessel with the point of purse seine fishing gear caught 18 to 24 species with the dominant main catch was a not decent fish caught. The number of the type of catches in Sumber Mulya 02 and Makmur Jaya 78 vessel were 23 species, while Selat Jaya 06, Bintang Makmur, and Sumber Makmur were 24 species. The number of fish caught is caused because the purse seine is multi-species. The catches of purse seine in Muara Angke are very diverse, with the number of the main catch is 1:4 with by-catches [7]. The calculation of the selectivity of catches is divided into two, weight proportion and number proportion.

Table 6. Weight and Amount Proportion Percentage of Main Catch and By-Catch Vessel in 22 June until 20 November 2020

Vessel	Percentage Catch			
	Weight		Amount	
	Main Catch	By-Catch	Main Catch	By-Catch
Sumber Mulya 02	12,14%	87,86%	1,87%	98,13%
Makmur Jaya 78	11,90%	88,10%	1,89%	98,11%
Selat Jaya 06	12,21%	87,79%	1,96%	98,04%
Bintang Makmur	11,33%	88,67%	1,80%	98,20%
Sumber Makmur	11,59%	88,41%	1,83%	98,36%

Based on the data above (Table 6), the five vessels with purse seine fishing gear are not selective to the catches because the weight proportion and the type of catches are less than 60%. The fishing gear is stated selective if the percentage for the number of the length of decent fish caught is ≥ 60% [20]. The selectivity data for the fork length size of decent mackerel tuna caught was obtained from the sample collection of 250 fish randomly from purse seine vessels. The data of fork length size of decent mackerel tuna caught were analyzed in the form of a percentage.

Table 7. Feasible proportion of tuna kawakawa (*Euthynnus affinis*) catches

Vessel	**Fork Lenght**	
	> Lm (%)	**< Lm (%)**
Sumber Mulya 02	37,6	62,4
Makmur Jaya 78	35,6	64,4
Selat Jaya 06	34,4	65,6
Bintang Makmur	38,0	62,0
Sumber Makmur	40,0	60,0

Based on the data above (Table 7), purse seine fishing gear for each vessel was not selective because each vessel obtained a percentage less than 60%. Based on [20], one of the indicators that fishing gear is selective to the catches is if Length of first capture (Lc) > Length of first matured (Lm) and the number of length proportion of decent mackerel tuna caught ≥ 60%.

3.1.1 Having Minimum Impact on the Decline of Biodiversity

In table 6, the five vessels obtained a score of 3 with the point of fishing gear, and its operation caused the death of demersal fish and pelagic fish caught but not destroying the habitat. The catch of pelagic fish and demersal fish is caused by the use of lights at night during the operation to attract fish. The behavior of fish in responding to light sources that are often used by fishermen is the tendency of fish to gather around the light sources [23]. The operation of purse seine fishing gear does not destroy the habitat because the catching area is in the middle of the sea so that this fishing gear does not affect the seabed and does not disturb the livings on the seabed. The catches obtained experienced death. This is caused by the long hauling process and vessel

facilities that do not allow the fish to live until in the PPN Muara Angke. The catches of purse seine fishing gear with the use of light for catching demersal fish are black pomfret [18].

3.1.2 Criteria for Not Harming Fishermen

In the table 5, Sumber Mulya 02, Bintang Makmur, and Sumber Makmur vessels obtained a score of 3, while Makmur Jaya 78 and Selat Jaya 06 vessels obtained a score of 4.

Tabel 8. Hasil Kuisioner Kriteria Tidak Membahayakan Nelayan

Keterangan		Vessel				
		Sumber Jaya 02	**Makmur Jaya 78**	**Selat Jaya 06**	**Bitang Makmur**	**Sumber Makmur**
Navigation	GPS	Yes	Yes	Yes	Yes	Yes
	Compas	Yes	Yes	Yes	Yes	Yes
	Cadio (VMS, HF *Transceiver*, VHF *Tranceiver*, HP, HT)	Yes	Yes	Yes	Yes	Yes
	Fish Finder / Echoshounder	Yes	Yes	Yes	Yes	Yes
Safety Tools	Sekoci / Inflateble Boat	No	No	No	No	No
	Life Jaket/ Life Boy	Yes	Yes	Yes	Yes	Yes
	First Aid	Yes	Yes	Yes	Yes	Yes
	Conductor	Yes	Yes	Yes	Yes	Yes
	Inner Tube	Yes	Yes	Yes	Yes	Yes
Work Attribute	*Oilskins*	Yes	Yes	Yes	Yes	Yes
	Helmet	Yes	Yes	Yes	Yes	Yes
	Boots	Yes	Yes	Yes	Yes	Yes
	Gloves	Yes	Yes	Yes	Yes	Yes
	Ear Protector	No	No	No	No	No
	Workshop Tools	Yes	Yes	Yes	Yes	Yes
	Safety Glasses	Yes	Yes	Yes	No	No
Accident While Sailing	Minor Injured	Yes	Yes	Yes	Yes	Yes
	Bruised	Yes	Yes	Yes	Yes	Yes
	Seriously Injured	No	No	No	No	No
	Dead	No	No	No	No	No

The negligence that occurred on the vessel is when repairing line hauler without using a mask can cause cough and shortness of breath (Table 8). Pain that usually occurs due to the operation of purse seine is a muscle injury, aches, and fever. Muscle injury and aches occur due to the pulling out of the purse seine fishing gear on the vessel. Hauling operation of *soma pajeko* (mini purse seine) that has the greatest potentials for the risk of work accidents occurs due to the high work intensity so that this activity stage is a critical point (highest activity level) of the overall stage of *soma pajeko* operation, which affects the work safety of *soma pajeko* fishermen [5].

The navigation tools used were GPS (Global Positioning System), echo sounder, and radio HF SBB (High-Frequency Single Sideband) (Table 8). GPS is useful to know the vessel position and the FADs installed. An echo sounder is used to know the number of fish around the vessel. Moreover, radio HF SSB is used to communicate with vessels or seek assistance when an emergency occurs. Vessel safety equipment used in purse seine vessel in TPI (fish auction) Tegal City Harbor consist of navigation tools such as compass, GPS, and radio [8].

Medical devices on the five vessels only carried First Aid (Table 8). Medicines used are usually headache medicines, fever medicines, iodines, patches, alcohol, balms, and bandages. When in the vessel and someone gets dehydrated due to diarrhea or vomiting, then he/she is only given ORS.

The safety equipment on the five vessels were life jackets, lifebuoys, car tires, and jerry cans. The safety equipment was only used in an emergency conditions, including helping the drowning people and shrinking vessels/ships. Car tires were used by the crews assigned to plunge into the sea in operating the purse seine fishing gear.

Work equipment on Bintang Makmur and Sumber Makmur vessels were oilskin, boots, gloves, and workshop tools. Meanwhile, on Sumber Mulya 02, Makmur Jaya 78, and Selat Jaya 06 vessels, the work equipment were oilskin, boots, gloves, workshop tools, and ear protector (Table 8). Work equipment that is usually used by the crew vessel in operating fishing gear is only gloves and boots, while oilskin and head protector is rarely used because of the minimum for the availability of work equipment. Workshop tools are used when the engine is damaged, which must be fixed in the middle of the sea. This is contrary to Act No. 1 of 1970 regarding Work Safety (1970), which contains the obligation to use personal protective equipment and meet and comply with all work safety and health requirements.

3.1.3 Resulting Good Quality Fish

In table 5, the five vessels obtained a score of 4 with the points of the conditions of mackerel fish were: the eyeball was flat, the gill color was less bright red, the mucus was slightly cloudy or less transparent, the texture was slightly dense, no broken fins/tails, and no wounds or bruises. The organoleptic test was divided into five, including eyes, smell, gills, mucus, the wholeness of fish, and fish damage. Each category of the organoleptic test had five different scores (Table 9).

Tabld 9. Test Organoleptic Score and Category

Category	Score	Spesifikation
Eyes	1	Very sunken eyeballs
	2	sunken eyeballs
	3	Sunken eyeballs
	4	Flat eyeballs
	5	Convex eyeballs
Smell	1	Strong stench
	2	Strong sour smell
	3	Slightly sour smell
	4	Fresh, less specific types
	5	Very fresh, strong type specific
Gill	1	Gray gill color
	2	Gill color grayish brown
	3	Pink gill color with cloudy mucus
	4	The color of the gills is pink with a little cloudy mucus
	5	The color of the gills is dark red with transparent mucus
Mucus	1	Thick mucus layer clots
	2	The thick layer of mucus is a little lumpy
	3	Thick mucus layer
	4	The mucus layer is starting to get a little cloudy
	5	Transparent mucus layer
Texture	1	Very soft
	2	Soft finger marks visible
	3	Slightly soft, less elastic
	4	Slightly soft, slightly elastic
	5	Dense, compact, highly elastic

In the eye freshness test, Makmur Jaya 78 vessel obtained the highest score of 5 with the 149 fish, while the Sumber Makmur vessel obtained the highest score of 4 with 121 fish. In the odor freshness test, Makmur Jaya 78 vessel obtained the highest score of 5 with the 69 fish, while the Sumber Makmur vessel obtained the highest score of 4 with 215 fish. In the gill freshness test, the five vessels obtained a score of 4 with 250 fish. In the mucus freshness and texture test, the five vessels obtained a score of 5 with 250 fish. In the test of the wholeness of mackerel tuna, Sumber Makmur vessel obtained 202 fish without broken fins, and Makmur Jaya 78 obtained 74 fish with broken fins. Meanwhile, Selat Jaya 06 vessel obtained 243 fish without bruises or wounds, and the Bintang Makmur vessel obtained 20 fish with bruises or wounds (Table 10).

Tabel 10. Test Organoleptik Tuna Kawakawa Fish Result in 22 June until 20 November 2020

Category	Score	Vessel				
		Sumber Mulya 02	Makmur Jaya 78	Selat Jaya 06	Bintang Makmur	Sumber Makmur
Eyes	1	0	0	0	0	0
	2	0	0	0	0	0
	3	0	0	0	0	0
	4	113	118	101	112	121
	5	137	132	149	138	129
Smell	1	0	0	0	0	0
	2	0	0	0	0	0
	3	0	0	0	0	0
	4	215	181	204	196	192
	5	35	69	46	54	58
Gill	1	0	0	0	0	0
	2	0	0	0	0	0
	3	0	0	0	0	0
	4	250	250	250	250	250
	5	0	0	0	0	0
Mucus	1	0	0	0	0	0
	2	0	0	0	0	0
	3	0	0	0	0	0
	4	0	0	0	0	0
	5	250	250	250	250	250
Texture	1	0	0	0	0	0
	2	0	0	0	0	0
	3	0	0	0	0	0
	4	0	0	0	0	0
	5	250	250	250	250	250
Broken Fin		66	74	57	60	48
Not Broken Fin		184	176	193	190	202
Bruises/Wound		12	13	7	20	15
No Bruises/Wound		238	232	243	230	235

In the organoleptic test of tuna kawakawa conducted, the average vessels obtained a score of 4 and 5, indicating that the fish were still fresh. The mackerel tuna with broken fins and bruises occur due to several factors: during the catching and storage, the fish were stacked, and during the process of unloading fish from the vessel to the auction place were not good. Several types of fishing gear in one catching operation can catch various kinds of fish in large quantities, which allows the fish to pile up or overlap each other, causing bruises, wounds, and even physical damage (Metusalach *et al*., 2014).

Handling mackerel tuna on the vessel has five stages: fish shorting, fish cleaning, fish freezing, the fish organization in the fish hatch, and catch packaging. Sorting is the process of selecting and separating fish according to their type, size, and quality [9]. Sorting was conducted to differentiate the type, size, and quality of fish so that it could be known the price and quality

when the fish are marketed. After sorting, mackerel tuna were cleaned with seawater. Cleaning the fish is to clean the scale and blood before being frozen, which this is to inhibits the rate of fish spoilage [22]. After cleaning, the mackerel tuna were put into the fish hatch until frozen. After fish were frozen, fish were put into the LDPE (Low-Density Polyethylene) plastic package.

3.1.4 The Utilization of By-Catch

In table 5, the five vessels obtained a score of 5 with the point of by-catch caught had high economic value. All by-catches caught by purse sine vessel were sold to companies or fish auction. Before the catches were brought to the auction place, the type and size were separated first because the price of each size, type, and quality of fish was different.

3.1.5 Not Catching Protected Fish

In table 5, the five vessels obtained a score of 5 with the point of not catching fish that are protected by the law. In the operating process of fishing gear, whale sharks entered the purse seine trap but then released back into the sea. When the catches were lifted onto the vessel, the sharks and turtle were caught by purse seine but then released back into the sea. Purse seine fishermen of PPN Muara Angke have been understood the type of biota that should not be caught.

Total score obtained by Makmur Jaya 78 and Selat Jaya 06 were 23 points, while Sumber Mulya 02, Bintang Makmur, nand Sumber Makmur were 22 points. The five purse seine vessels landed in PPN Muara Angke had a quite good category of fishing gear in the assessment of environmentally friendly fishing gear. Purse seine fishing gear in the Tawang is environmentally friendly in terms of economic assessment, does not contradict local culture, and products resulted have good quality [4]. Purse seine fishing gear used by Southeast Sulawesi fishermen is categorized as environmentally friendly fishing gear [2].

4. CONCLUSION

Based on the results of the research conducted, it can be concluded that purse seine fishing gear landed in PPN Muara Angke are unselective to the catches of mackerel tuna because the percentage of the length size of decent mackerel tuna caught, the proportion of main catches, weight, and the number is less than 60% from the total length of mackerel tuna and catches. Furthermore, the total score of Makmur Jaya 78 and Selat Jaya 06 vessels obtain a score of 23, while Sumber Mulya 02, Bintang Makmur, and Sumber Makmur obtain a score of 22, indicating that purse seine fishing gear on the five vessels include in the category of quite environmentally friendly because the score obtained range from 18 until 23.

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