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Study of Eco-Friendly Fishing Gear for Sustainable Fisheries in Pangandaran District, Indonesia

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Abstract:- **Sustainable fisheries is an issue that has become the main objective of fisheries management in Indonesia. One of the strategy is the using of eco-friendly fishing gear.This study aims to determine the level of eco-friendly and productivity of fishing gear based on catches in Pangandaran district. Data collection was carried out from 1st September to 8th October of 2017 using gill net, trammel net, mini bottom trawl net, beach trawl and long line fishing gear. Data analysis includes composition of species of catch, size of catch, size of main catch, and utilization of catches. The productivity value of the fishing gear is calculated using the CPUE (Catch per Unit Effort) value. The results showed that the most widely used fishing gear by Pangandaran fishermen was gill nets. Three-layer net fishing equipment (trammel net) has the highest level of eco-friendly in category of "Eco-friendly", followed by gillnet and long line fishing gear. Trammel net has the highest level of eco-friendly in category of "Eco-friendly", followed by gillnet and long line fishing gear. Mini bottom trawl and beach seine is categorized as a fishing gear that is "not eco- friendly". The highest productivity (CPUE) is indicated by a mini bottom trawl fishing gear with a productivity value of 62 kg/trip and the lowest productivity is found on trammel net with 16 kg/trip of productivity.**

Keywords:- *Eco-Friendly Fishing; Fishing Gear; Pangandaran; Sustainable Fisheries.*

I. INTRODUCTION

The development of fishing technology is emphasized on environmentally friendly fishing technology in hopes of utilizing fisheries resources in a sustainable manner and to preserve the sustainability of fish resources in Pangandaran District. Fisheries sustainability is recognized to have four pillars: ecological, economic, social and institutional [1][2]. Increased of fishing activities can reduce fisheries production and reduce stability of ecosystem. When resources are limited, a common approach for supporting management is risk assessment, which seeks to describe the magnitude of fisheries impacts and requirements for measures to meet management objectives [3].

In 2013, the potential utilization of demersal fish in Pangandaran experienced a significant increase in accordance with Nurhayati's [4] statement on the potential of demersal fish on the basis of the precautionary principle that the total allowable catch (TAC) of fish was 80% of sustainable potential (MSY), which was equal to 1,265.74 tons, whereas when viewed from the level of utilization of fisheries resources in Pangandaran in 2013 the average total of catches was 1,972,937 tons, which was a fairly high catch per year so it can be said to experienced Overfishing in the Pangandaran Region of West Java Province.

In addition to fisheries in Pangandaran district which has tended to overfishing, there is one more potential in Pangandaran district which has a negative impact on the ecosystem that is there, namely the tourism sector. Pangandaran has a lot of potential tourist attractions, especially natural tourist attractions such as coastal and nature reserves. Actually the existence of these two potential sectors is a comparative advantage for Pangandaran District to increase the economic passion of the region. In fact the development of these two sectors has not been optimally integrated, if it is not managed properly, tourism can cause negative externalities for the fisheries sector, especially for fishermen [6]. This study aims to establish the most environmentally friendly fishing gear used in Pangandaran District, thus it can be a guideline and information for fishermen in Pangadaran, especially Pangandaran TPI about environmentally friendly fishing gear.

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II. METHOD

This research was carried out at Pangandaran Fish Landing Base (PPI) by analyzing the catch composition per unit of fishing equipment used by fishermen in Pangandaran District, West Java. This research was conducted on June to October 2017. The method used in this study was purposive sampling method. Primary data collected directly during the study was the amount of production (weight), composition and proportion of fish species caught, proportion of catch utilization, and length of Lm (length at first maturity).

2.1. Data Analysis

Environmental friendliness analysis was assessed based on species composition, size and utilization of catches. Based on the catching target of fishermen, the catch was differentiated into the main target catch (HTU) and by-catch (HTS). Utilization was calculated by identifying the catches sold and consumed (utilized) and the catches that were discarded (not utilized).

2.2. Proportion Analysis and Composition of Catch Type

The proportion of primary and secondary target catches, each data on the number and weight of the main target catches (HTU) and or by catch (HTS). Rare species that were protected by law were also included in the by catch category of fishing operations calculated in percentage form [6].

2.3. Analysis of Catch Size Composition

The proportion of fish worth catching biologically was known based on the size of the length of the fish at first maturity. Fork length data of the main catched fish for each fishing gear were processed by calculating the frequency distribution. Next, compare the data on the size of the main length of the fish caught during the study with the length of the fish at first maturity or Lm (length at first maturity). Furthermore, the proportion of the main catch of fish was worthy of catching biologically

2.4. Analysis of Composition of Catching Product Utilization

Based on utilization, the main catch was divided into two groups, the main catches were utilized and those that were not utilized. By-products were also divided into two groups, namely by-products that were utilized and which were not utilized. All catch data (Ht) that was utilized was compared to the catch that was not used (discarded) in the form of proportions.

2.5. Friendliness Level of Fishing Gear

According to Mallawa [7] friendliness factors that can be used as an assessment to see the environmental friendliness of a fishing unit [8], among others, from the results of the calculation and scoring on the criteria of fishing equipment which was broken down into four (4) sub criteria that refer to the opinion of Monitja [9] which was useful to facilitate assessment of fishing gear. The assessment was carried out in the following method (Table 1).

Table 1. Assessment of the level of eco-friendly fishing

Eco-friendly factor	Indicator (%)	Criteria	Score
Main catch	81-100	Very eco-friendly	4
	61-80	eco-friendly	3
	41-60	less eco-friendly	2
	1-40	not eco-friendly	1
Catch size (*length at first maturity*)	81-100	Very eco-friendly	4
	61-80	eco-friendly	3
	41-60	less eco-friendly	2
	1-40	not eco-friendly	1
Catch Utilization	81-100	Very eco-friendly	4
	61-80	eco-friendly	3
	41-60	less eco-friendly	2
	1-40	not eco-friendly	1

Source: Mallawa [7]

Furthermore, the total results of the score were accumulated to determine the level of friendliness of fishing gear (Table 2).

Table 2. Overall Assessment of the Level of eco-friendly fishing

No	Total Score	Criteria
1	3-5	Very eco-friendly
2	6-8	eco-friendly
3	9-11	less eco-friendly
4	12	not eco-friendly

Source: Mallawa [7]

In addition analysis is also done using the following assessment criteria:

1. High Selecitivity
2. Not damaged habitats and other biota living places
3. No harm to fisherman
4. Produced good quality of fish
5. Products do not endanger consumers
6. Minimun of bycatch
7. Minimum impact to decreased biodiversity
8. Do not catch endangered species
9. Socially acceptable

III. RESULT AND DISCUSSION

3.1. Type of Fishing Gear and Fishing Gear Friendliness

The type of fishing equipment operated by Pangandaran fishermen varies according to the type of fish caught. Pangandaran District fishermen, one fisherman family, has an average of more than one type of fishing gear [10]. Most fishermen operate their fishing gear using a fleet of motorized vessels <5 GT in size and in accordance with the type of fishing gear used. Types of fishing gear found in Pangandaran district include: gill nets, three layers of mini bottom trawl nets, beach trawls, and longline fishing rods (Table 3). The type of gill net fishing gear is the dominant fishing gear owned by fishermen in Pangandaran District.

Table 3. Types of fishing gear operating in Pangandaran District

No	Type of Fishing Gear	Total (unit)
1	Gill net	2.069
2	Trammel net	305
3	Mini bottom trawl	21
4	Beach seine	23
5	Longline	50

Source: DKPKP [10]

3.2. Composition of Catch Type

Fishing technology can be said to be environmentally friendly if the fishing gear has high selectivity, meaning that the fishing gear is attempted to only catch fish / organisms that are the target of the assessment [9]. The results of identification in terms of catches (Table 3) showed that seine trawl and jogol nets have the lowest proportion of catches compared to gill nets, three-layer nets and longline fishing. This can be seen from the results of mini bottom trawl and trawl nets that captures all basic organisms from fish, crustacean classes such as shrimp and crab, soft animals from the cephalopoda class and so on so that the fishing gear is declared to have low selectivity because of the many catches by catch compared to catching primary fish catch.

Table 3. Proportion of Main Catch of Each Fishing Gear

Spesies	Wightof Main Catch (kg)	Subtotal (kg)	Prop. (%)
Gill Net			
Pampus argenteus	10.84	32.86	47.4
Trichiurus lepturus	22.02		
Tramel Net			
Penaeus merguiensis	24.16	54.08	58.4
Metapenaeus ansis	29.92		
Mini Bottom Trawl			
Parapenaeopsis sculptilis	15.24	56.44	38.3
Mysis relicta	41.2		
Metapenaeus tenuipes	4		
Cynoglossus lingua	26.84		
Beach Seine			
Parapenaeopsis sculptilis	1.32	16.4	32.5
Trichiurus lepturus	4.82		
Stolephorus devisi	10.26		
Longline			
Latjanus bitaeniatus	21.92	48.9	55.1
Epinephelus pachycentrum	19.98		
Nethuma thalassina	6.52		
Thunnus tonggol	12.85		

3.3. Size Composition of Main Catch Results

Individual size is one indicator to know the age of an individual or an indicator of his reproductive biology. Fish biology data is one of the four main types of data needed in order to implement fisheries management measures [11]. Catching the size of fish first matured by gonads can provide an opportunity to catch fish to reproduce and spawn before being caught, thus the recruitment process of the small fish phase into the adult fish phase can escape [11].

Table 5. Size Composition of Main Catch Results More Than Lm

No	Kind of Fishing Gear	Proportion of Main Catch	
		> *Lm*	< *Lm*
1.	Gill net	80 %	20 %
2.	Trammel net	87 %	13 %
3.	Mini bottom trawl	18 %	82 %
4.	Beach seine	19 %	81 %
5.	Longline	80 %	20 %

The results of the percentage measurements on the composition of the main catch size is in Table 5, showing the gill nets, three-layer nets, mini bottom trawl nets, seine trawls and longline fishing had different valuation propositions. The composition of the main catch size with the best value was shown in three-tier net (trammel net) gill nets (gill net) and longline fishing with results in terms of the size of the catch on these three fishing gear was relatively uniform with an 80% percentage with this it was stated that the fishing gear is selective because it catches fish more than Lm. According to Monintja [9] the selectivity of fishing gear determines the diversity of catches, the more uniform the catch means the more selective the fishing gear is. The results of the proportion of the main catch size in mini bottom trawl nets and seine trawls had a percentage of less than 20% with this it can be said that the fishing gear was less selective because more fish catches did not reached the size of Lm.

This less selective mini bottom trawl fishing gear was because the fishing gear in the bag section used polyethilene material which had very small mesh sizes thus the fish caught in various types and sizes differ greatly causing the operation of this fishing gear to catch catches that were not yet worth catching, causing selectivity to the mini bottom trawl nets and beach trawls was very low, in line with the statement of Sarmintohadi [12] environmentally friendly fishing gear has a level of selectivity both to species and size. Solution to increase selectivity by replacing mesh size in mini bottom trawl nets and beach trawls with larger mesh sizes.

3.4. Composition of Utilization of Catches Results

Eco-friendly fishing gear that is selective fishing gear and does not damage the aquatic environment (fish resource ecosystem / habitat) and the lack of wasted catches [13]. Fisheries potential that is high enough should be able to be used properly and use the principle of good utilization as well as the assessment of the five fishing gears that are sampled in the study, generally having an optimal level of catch utilization. The results of the utilization of the catch seen from comparing the catches that were used and not utilized by each fishing gear all fishing gear showed very good value,

which was above 90% (Tabel 6), so almost all catches in each fishing gear were commodities with high economic value thus they can be sold and suitable for consumption as well as catches that were not utilized and the catch was relatively small, according to the statement of Monintja (. Damaging the environment is environmentally friendly fishing in terms of the minimum wasted catch.

Table 6. Utilization Catch of Each Fishing Gear

Fishing Gear	Used	Not Used
	%	
Gill Net	98	2
Tramel Net	98	2
Mini Bottom Trwal	91	9
Beach Seine	98	2
Panicing Rawai	90	3

3.5. Assessment of the Results of Environmental Friendly Levels for Each Results Fishing Gear

Based on an assessment of the level of environmental friendliness of the five fishing gears identified showed that environmentally friendly fishing gears were gill nets, three-layer nets and longline fishing rods. Mini bottom trawl nets and beach trawlers was classified as inhospitable fishing gear with less environmentally friendly criteria. The results of the study showed that the cause of the low number of scores triggered by the high proportion of the size of the catch that had not reached mature gonads, this referred to the basis of operation in the mini bottom trawl net and seine trawl fishing gear which is very small causing all organisms and even trash to enter this tool. We recommend that the use of the fishing gear be stopped and then look for alternatives to other fishing equipment classified as environmentally friendly fishing gear. The following are the results of the comparison of the level of environmental friendliness of each fishing gear presented in Table 15.

Table *7*. Comparison of the Level of Friendly Fishing Gear in Pangandaran District

Fishing Gear	Indicator (%)			Score	Criteria
	Main Catch	Main catch > LM	Utilization		
Gill net	47,4%	80	98	9	Eco-friendly
Trammel net	58,4	87	98	10	Eco-friendly
Mini bottom trawl	38,3	18	91	6	Less Eco-friendly
Beach seine	32,5	19	91	6	Less Eco-friendly
Longline	47	80	98	9	Eco-friendly

Table *8*. Comparison of the Level of Friendly Fishing Gear in Pangandaran District

No	Criteria	Gill Net	Trammel net	Beach Seine	Dogol	Longline
1	High Selecitivity	3	3	1	1	1
2	not damaged habitats and other biota living places	4	4	1	1	3
3	No harm to fisherman	2	2	2	2	3
4	Produced good quality of fish	4	4	2	2	4
5	Products do not endanger consumers	3	3	2	2	3
6	Minimun of bycatch	2	4	2	2	3
7	Minimum impact to decreased biodiversity	4	4	2	2	3
8	Do not catch endangered species	3	3	2	2	2
9	Socially Acceptable	3	2	1	2	2
	Criteria	Eco-friendly	Eco-friendly	Non Eco-friendly	Non Eco-friendly	Eco-friendly

IV. CONCLUSIONS

Trammel net has the highest level of eco-friendly in category of “Eco-friendly”, followed by gillnet and long line fishing gear. Mini bottom trawl and beach seine is categorized as a fishing gear that is “not eco- friendly”. The highest productivity (CPUE) is indicated by a mini bottom trawl fishing gear with a productivity value of 62 kg/trip and the lowest productivity is found on trammel net with16 kg/trip of productivity.

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